Luminant

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

October 25, 2021

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

Re: Duck Creek Power Plant Ash Pond No. 1 and No. 2; IEPA ID # W0578010001-01, 02

Dear Mr. LeCrone:

In accordance with 35 I.A.C. § 845.200, Illinois Power Resource Generating, LLC (IPRG) is submitting an operating permit application for the Duck Creek Power Plant Ash Pond No. 1 and No. 2 (IEPA ID # W0578010001-01, 02). One hardcopy and one digital copy are provided with this submittal.

The permit application was prepared in accordance with 35 I.A.C. § 845.230(d)(2) (Existing, Inactive and Inactive Closed CCR Surface Impoundment that have completed an Agency approved closure before July 30, 2021). This submittal includes the completed permit forms as required by § 845.210.

Sincerely,

Cynthia E Vodopivec

Cynthia Vodopivec
SVP-Environmental Health and Safety

Enclosures

Prepared for

Illinois Power Resources Generating, LLC
1500 Eastport Plaza Drive, Collinsville, Illinois 62234

INITIAL OPERATING PERMIT

DUCK CREEK ASH PONDS 1 & 2

Prepared by

BURNS McDONNELL

425 South Woods Mill Road, Suite 300
St. Louis, MO 63017

October 25, 2021

ATTACHMENTS

1. INTRODUCTION

Illinois Power Resources Generating, LLC (Dynegy) is operator of the coal-fired Duck Creek Power Plant (Plant) located near Canton, Illinois. The IEPA assigned identification numbers assigned to the Duck Creek Ash Ponds 1 & 2 are: W0578010001-01 and W0578010001-02. The National Inventory of Dams (NID) numbers assigned for the Duck Creek Ash Ponds 1 & 2 are IL50715 and IL50014.

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

This initial operating permit application is for the Duck Creek Ash Ponds 1 & 2.

1.1. Facility Information

> Section 845.210(b)(1): *All permit applications must contain the name, address, email address and telephone number of the operator, or duly authorized agent, and the property owner to whom all inquiries and correspondence shall be addressed.*

Facility:	Duck Creek Ash Ponds 1 & 2 Duck Creek Power Plant 17751 North Cilco Road Canton, IL 61520
Owner/Operator:	Dynegy Midwest Generation, LLC 1500 Eastport Plaza Drive, Collinsville, Illinois 62234

1.2. Owner Signatures

> <u>Section 845.210(b)(2):</u> *All permit applications must be signed by the owner, operator or a duly authorized agent of the operator.*

The owner of the Duck Creek Power Plant is a corporation.

> <u>Section 845.210(b)(3):</u> *An application submitted by a corporation must be signed by a principal executive officer of at least the level of vice president, or his or her duly authorized representative, if that representative is responsible for the overall operation of the facility described in the application form..*

The signature of Cynthia Vodopivec on behalf of Illinois Power Resources Generating, LLC can be found in the cover letter as well as the permit applications located in Section 3.

1.3. Legal Description

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

A legal description has been developed in compliance with Section 845.210(c) and is included in Attachment A.

1.4. Previous Assessments

> <u>Section 845.210(d):</u> *Previous Assessments, Investigations Plans, and Programs*

Previous assessments were performed in accordance with 40 CFR § 257 and may be referenced within the permit application and included in the appropriate Attachments.

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

A previous hydrogeologic site investigation or characterization, groundwater monitoring well or system, or groundwater monitoring plan have been completed with a seal from an Illinois Licensed Professional Geologist or Licensed Professional Engineer. However, field investigations have been completed that supplement that work that will be utilized in the following sections of this report.

<u>Section 845.210(d)(2):</u> For existing CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a previously completed location restriction demonstration required by Section 845.300 (Placement Above the Uppermost Aquifer), Section 845.310 (Wetlands), Section 845.320 (Fault Areas), Section 845.330 (Seismic Impact Zones), and Section 845.340 (Unstable Areas) provided that the previously completed assessments meet the applicable requirements of those Sections.

No previous assessments are included in the Duck Creek Ash Ponds 1&2 permit application.

<u>Section 845.210(d)(3):</u> For existing CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a previously completed assessment to serve as the initial assessment required by Section 845.440 (Hazard Potential Classification Assessment), Section 845.450 (Structural Stability Assessment) and Section 845.460 (Safety Factor Assessment) provided that the previously completed assessment: A) Was not completed more than five years ago; and B) Meets the applicable requirements of those Sections.

No previous assessments are included in the Duck Creek Ash Ponds 1&2 permit application.

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

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

2. OPERATING PERMIT

2.1. Initial Operating Permit

<u>Section 845.230(d):</u> *Initial Operating Permit for Existing, Inactive and Inactive Closed CCR Surface Impoundments*

The Duck Creek Ash Ponds 1&2, as defined by IEPA, are closed inactive CCR surface impoundments that have not completed post-closure care. Per Part 845, DMG is submitting an initial operating permit application to IEPA by October 31, 2021. The permit applications (CCR-1 and CCR-2OE) are provided in Section 3.

The following sections contain information or references to documents required for the Operating Permit application (Section 845.230).

2.2. History of Construction

<u>Section 845.230(d)(2)(A):</u> *The history of construction specified in Section 845.220(a)(1);*

The history of construction prepared in 2016 pursuant to 40 CFR § 257.73(c) is provided in Attachment B.

2.3. Permanent Markers

<u>Section 845.230(d)(2)(E):</u> *Evidence of permanent markers required by Section 845.130 have been installed;*

Evidence of permanent markers at the Duck Creek Ash Ponds 1&2 as required by Section 845.130 is provided in Attachment E.

2.4. Slope Maintenance

<u>Section 845.230(d)(2)(F):</u> *Documentation that the CCR surface impoundment, if not incised, will be operated and maintained with one of the forms of slope protection specified in Section 845.430;*

Duck Creek Ash Ponds 1&2 are not incised. Documentation of slope protection as required by Section 845.430 is provided in Attachment J.

2.5. Groundwater Monitoring

<u>Section 845.230(d)(2)(I):</u> *Groundwater monitoring information:*

The groundwater monitoring information for the Duck Creek Ash Ponds 1&2 are described in the following sections.

> *<u>Section 845.230(d)(2)(I)(i):</u> Hydrogeologic site characterization (see Section 845.620);*

Hydrogeologic site characterization for the Duck Creek Ash Ponds 1&2 are provided in Attachment H.

> *<u>Section 845.230(d)(2)(I)(ii):</u> Design and construction plans of a groundwater monitoring system (see Section 845.630);*

Design and construction plans of a groundwater monitoring system are provided in Attachment I.

> *<u>Section 845.230(d)(2)(I)(iii):</u> A groundwater sampling and analysis program that includes selection of the statistical procedures to be used for evaluating groundwater monitoring data (see Section 845.640); and*

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

> *<u>Section 845.230(d)(2)(I)(iv):</u> Proposed groundwater monitoring program that includes a minimum of eight independent samples for each background and downgradient well (see Section 845.650(b));*

A proposed groundwater monitoring program that meets the requirements of Section 845.650(b) is provided in Attachment I.

2.6. Initial Post-Closure Care Plan

> *<u>Section 845.230(d)(2)(K):</u> Initial written post-closure care plan, if applicable (see Section 845.780(d));*

The Duck Creek Ash Ponds 1&2 were closed by capping the CCR in place. The initial Post closure Care Plan was developed in accordance with Section 845.780 and is provided in Attachment K.

2.7. History of Groundwater Exceedances

> *<u>Section 845.230(d)(2)(M):</u> History of known exceedances of the groundwater protection standards in Section 845.600, and any corrective action taken to remediate the groundwater;*

A history of known exceedances and any corrective action taken is provided in Attachment M.

2.8. Financial Assurance Requirements

> <u>Section 845.230(d)(2)(N):</u> *A certification that the owner or operator meets the financial assurance requirements of Subpart I;*

A certification meeting the requirements of Section 845.230(d)(2)(N) stating that the Owner meets the financial assurance requirements of *Subpart I* is provided in Attachment N.

3. PERMIT APPLICATION

All permit applications must be made on the forms prescribed by the Agency and must be mailed or delivered to the address designated by the Agency on the forms. The permit applications (CCR-1 and CCR-2OE) are provided below.

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

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

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

Facility, Operator, and Owner Information

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

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

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

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

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

Internet Site				
3.1	Web Address(es) to publicly accessible internet site(s) (CCR website)			
	www.luminant.com/illinois-ccr/			
3.2	Is/are the website(s) titled “Illinois CCR Rule Compliance Data and Information”			
	☑	Yes	☐	No

SECTION 4: IMPOUNDMENT IDENTIFICATION

Impoundment Identification			
4.1	List all the impoundment identification numbers for your facility and check the corresponding box to indicate that you have attached a written description for each impoundment.		
	W0578010001-01 (see Attachment A)	☑	Attached written description
	W0578010001-02 (see Attachment A)	☑	Attached written description
		☐	Attached written description
		☐	Attached written description
		☐	Attached written description
		☐	Attached written description

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

SECTION 5: CHECKLIST AND CERTIFICATION STATEMENT

Checklist and Certification Statement

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

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

5.2 **Certification Statement**

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

Name (print or type first and last name) of Owner/Operator	Official Title
Cynthia Vodopivec	SVP - Environmental
Signature: Cynthia E. Vodopivec	Date Signed: 10/25/2021

Form CCR 2OE

Illinois Environmental Protection Agency

CCR Surface Impoundment Permit Application

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

Bureau of Water ID Number:
W0578010001

CCR Permit Number:
Initial Permit
Initial Permit

Facility Name:
Duck Creek Power Plant
Initial Permit

For IEPA Use Only

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

Construction History

1.1	CCR surface impoundment name.	
	Ash Pond No. 1 & 2	
1.2	Identification number of the CCR surface impoundment (if one has been assigned by the Agency).	
	W0578010001-01 and W0578010001-02	
1.3	Describe the boundaries of the CCR surface impoundment (35 Ill. Adm. Code 845.210 (c)).	
	See Attachment A	
1.4	State the purpose for which the CCR surface impoundment is being used.	
	See Attachment B	
1.5	How long has the CCR surface impoundment been in operation?	
	See Attachment B	
1.6	List the types of CCR that have been placed in the CCR surface impoundment.	
	See Attachment B	
1.7	List the name of the watershed within which the CCR surface impoundment is located.	
	See Attachment B	
1.8	What is the size in acres of the watershed within which the CCR surface impoundment is located?	
	See Attachment B	
1.9	Check the corresponding boxes to indicate that you have attached the following:	
	✔	A description of the physical and engineering properties of the foundation and abutment materials on which the CCR surface impoundment is constructed.

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

SECTION 2: ATTACHMENTS			
Attachments	2.1	Check the corresponding boxes to indicate that you have attached the following:	
		☑	Evidence that the permanent markers required by 35 Ill. Adm. Code 845.130 have been installed.
		☑	Documentation demonstrating that the CCR surface impoundment, if not incised, will be operated and maintained with one of the forms of slope protection specified in 35 Ill. Adm. Code 845.430.
		☐	Emergency Action Plan and accompanying certification required by 35 Ill. Adm. Code 845.520(e).
		☑	Written post-closure care plan, if applicable (see 35 Ill. Adm. Code 845.780(d)).
		☑	History of known exceedances of the groundwater protection standards in 35 Ill. Adm. Code 845.600, and any corrective action taken to remediate the groundwater.

SECTION 3: GROUNDWATER MONITORING			
	3.1	Check the corresponding boxes to indicate whether you have attached the following groundwater monitoring information:	
		☑	A hydrogeologic site characterization meeting the requirements of 35 Ill. Adm. Code 845.620.

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

ATTACHMENT A

CONTROL MONUMENTATION				
POINT NO.	NORTHING	EASTING	ELEVATION	DESCRIPTION
6007	1384994.93	2345108.56	595.10	FOUND BOLT
6008	1382338.27	2345072.63	592.05	FOUND 1/2" IRON REBAR
6010	1387695.44	2345144.88	586.28	FENCE CORNER BEND
6012	1385599.94	2345087.76	591.91	FENCE CORNER BEND
6013	1396951.85	2345269.87	593.69	FOUND 3/4" IRON BAR
6014	1404763.11	2345377.54	623.78	FOUND 5/8" REBAR

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ILLINOIS POWER RESOURCES GENERATING L.L.C.
DUCK CREEK POWER PLANT

0' 800' 1600'

LEGEND

SECTION LINE

RESTRICTED USE BOUNDARY

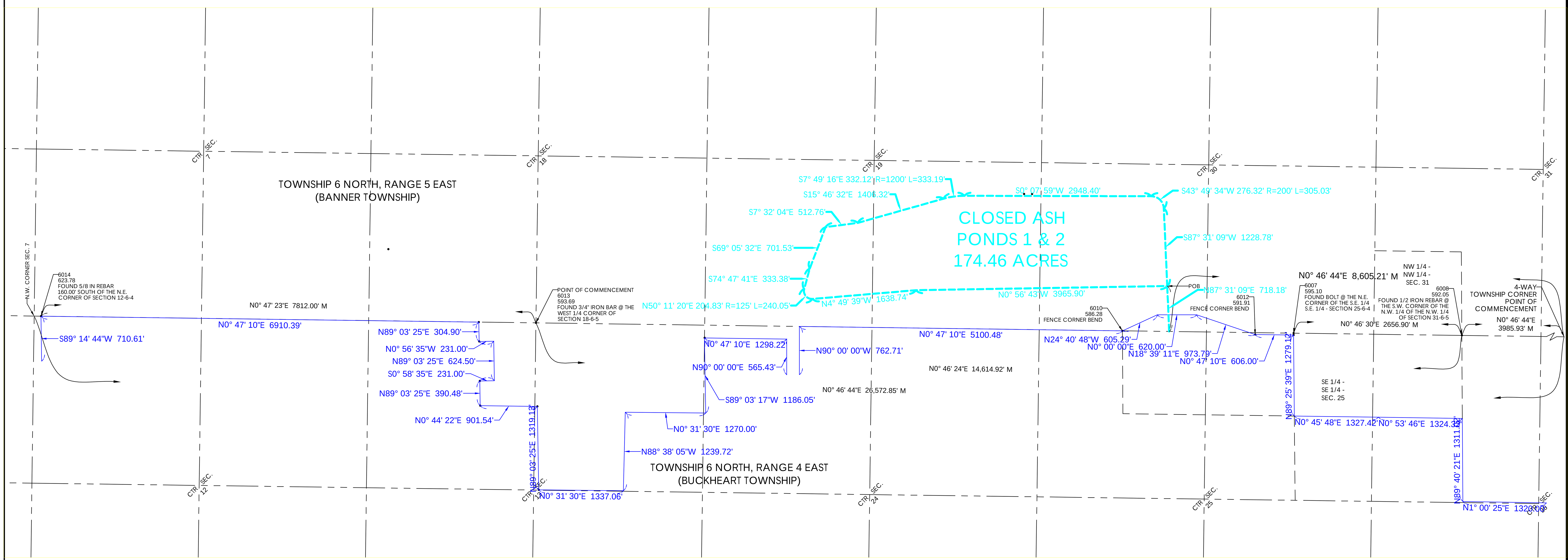
APPROXIMATE DUCK CREEK POWER STATION PROPERTY BOUNDARY LINE

N0° 47' 10"E 3100.48' RECORD BOUNDARY DIMENSIONS

● FOUND SURVEY MARKER AS NOTED

○ SET 5/8" IRON REBAR (UNLESS OTHERWISE NOTED)

SURVEY NOTE:
THIS DRAWING AND THE INFORMATION SHOWN HERE ON WAS OBTAINED FROM DATA COLLECTED FROM A FIELD SURVEY MADE BY INGENAE, LLC BETWEEN MARCH 16 THROUGH JUNE 29, 2021. SURVEY COORDINATES, BEARINGS & DISTANCES ARE REFERENCED TO ILLINOIS WEST 1202 STATE PLANE COORDINATE SYSTEM NAD 1983. ELEVATIONS SHOWN HEREON ARE BASED ON NAVD 1988.



Land Description of the Duck Creek Power Plant
Closed Ash Pond 1 and 2 Restricted Use Area
174.46 Acres

Part of the Northwest Quarter of Section 19, Part of the Southwest Quarter of Section 19 And Part of the Northwest Quarter of Section 30, all in Township 6 North, Range 5 East of the Fourth Principal Meridian, Fulton County, Illinois and being more particularly described as follows:

Commencing at the Four Way Township Corner Being the same as the Southeast corner of Section 36 T. 6 N., R. 4 E., also being the same as the Southwest corner of Section 31 T. 6 N., R. 5 E. of the Fourth Principal Meridian; thence North 0 degrees 46 minutes 44 seconds East along the Township line dividing T. 6 N., R 4 E. and T. 6 N., R. 5 E. a distance of 8605.21 feet; thence North 87 degrees 31 minutes 09 seconds East a distance of 718.18 feet to the Point of Beginning of the Tract described herein; thence North 0 degrees 56 minutes 43 seconds West a distance of 3965.90 feet; thence North 4 degrees 49 minutes 39 seconds West a distance of 1638.74 feet; thence along a curve to the right having a radius of 125.00 feet, a curve length of 240.05 feet, a chord bearing North 50 degrees 11 minutes 20 seconds East, a chord distance of 204.83 feet; thence South 74 degrees 47 minutes 41 seconds East a distance of 333.38 feet; thence South 69 degrees 05 minutes 32 seconds East a distance of 701.53 feet; thence South 7 degrees 32 minutes 04 seconds East a distance of 512.76 feet; thence South 15 degrees 46 minutes 32 seconds East a distance of 1406.32 feet; thence along a curve to the right having a radius of 1200.00 feet a curve length of 333.19 feet, a chord bearing South 7 degrees 49 minutes 16 seconds East, a chord distance of 332.12 feet; thence South 0 degrees 07 minutes 59 seconds West a distance of 2948.40 feet; thence along a curve to the right having a radius of 200.00 feet, a curve length of 305.03 feet, a chord bearing South 43 degrees 49 minutes 34 seconds West, a chord distance of 276.32 feet; thence South 87 degrees 31 minutes 09 seconds West a distance of 1228.78 feet to the Point of Beginning and containing 174.46 Acres.

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

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

MICHAEL J. GRAMINSKI 035-002901 STATE OF ILLINOIS

Sept 22 2021

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

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

Submissions / Revisions:		Date:
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Luminant

Project Name & Location:

DUCK CREEK
POWER PLANT
17751 N. CILCO RD.
CANTON, IL 61520

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

Drawing Name:
CLOSED ASH PONDS 1 & 2
RESTRICTED USE
BOUNDARY EXHIBIT

Date: 9/22/2021	Project No.
Type: SITE	Drawing No. 1
Drawn By: CB	
Approved By: MG	
Scale: AS NOTED	

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ILLINOIS POWER RESOURCES GENERATING L.L.C.
DUCK CREEK POWER PLANT

CONTROL MONUMENTATION				
POINT NO.	NORTHING	EASTING	ELEVATION	DESCRIPTION
6007	1384994.93	2345108.56	595.10	FOUND BOLT
6008	1382338.27	2345072.63	592.05	FOUND 1/2" IRON REBAR
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6012	1385599.94	2345087.76	591.91	FENCE CORNER BEND
6013	1396951.85	2345269.87	593.69	FOUND 3/4" IRON BAR
6014	1404763.11	2345377.54	623.78	FOUND 5/8" REBAR

0' 800' 1600'

LEGEND

- SECTION LINE
- RESTRICTED USE BOUNDARY
- APPROXIMATE DUCK CREEK POWER STATION PROPERTY BOUNDARY LINE
- N0° 47' 10"E 3100.48' REVISED BOUNDARY DIMENSIONS
- ● FOUND SURVEY MARKER AS NOTED
- ○ SET 5/8" IRON REBAR (UNLESS OTHERWISE NOTED)

SURVEY NOTE:
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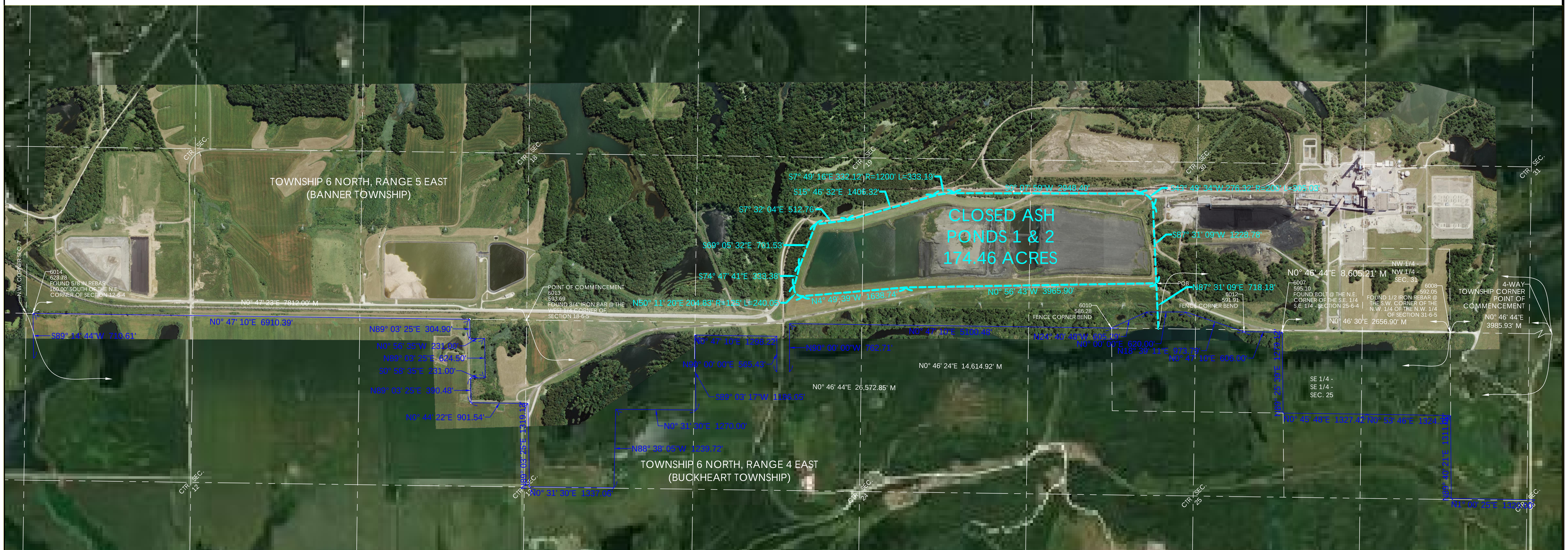

IngenAE
502 Earth City Plaza, Suite 120
Earth City, MO 63045
www.ingenae.com

Submissions / Revisions:	Date:
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Luminant

Project Name & Location:

DUCK CREEK
POWER PLANT
17751 N. CILCO RD.
CANTON, IL 61520

DO NOT SCALE PLANS
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Drawing Name:
CLOSED ASH PONDS 1 & 2
RESTRICTED USE
BOUNDARY EXHIBIT

Date: 9/22/2021	Project No.
Type: SITE	Drawing No. 2
Drawn By: CB	
Approved By: MG	
Scale: AS NOTED	

RESTRICTED USE ARE BOUNDARY CORNERS SET				
Point #	Northing	Easting	Elevation	DESCRIPTION
1000	1387041.40	2347080.57	0.00	RESTRICT BOUNDARY
1001	1386988.21	2345852.94	0.00	RESTRICT BOUNDARY
1002	1390953.57	2345787.51	0.00	RESTRICT BOUNDARY
1003	1392586.49	2345649.60	0.00	RESTRICT BOUNDARY
1004	1392717.64	2345806.94	0.00	RESTRICT BOUNDARY
1005	1392630.20	2346128.66	0.00	RESTRICT BOUNDARY
1006	1392379.85	2346784.00	0.00	RESTRICT BOUNDARY
1007	1391871.51	2346851.23	0.00	RESTRICT BOUNDARY
1008	1390518.16	2347233.57	0.00	RESTRICT BOUNDARY
1009	1390189.13	2347278.76	0.00	RESTRICT BOUNDARY
1010	1387240.74	2347271.91	0.00	RESTRICT BOUNDARY
1011	1386957.12	2345135.43	0.00	RESTRICT BOUNDARY

CORNERS SET ON ______, 2021

Luminant

ILLINOIS POWER RESOURCES GENERATING L.L.C.
DUCK CREEK POWER PLANT

0' 200' 600'

LEGEND

SECTION LINE

RESTRICTED USE BOUNDARY

APPROXIMATE DUCK CREEK POWER STATION PROPERTY BOUNDARY LINE

FOUND SURVEY MARKER AS NOTED

SET 5/8" IRON REBAR (UNLESS OTHERWISE NOTED)

SURVEY NOTE:
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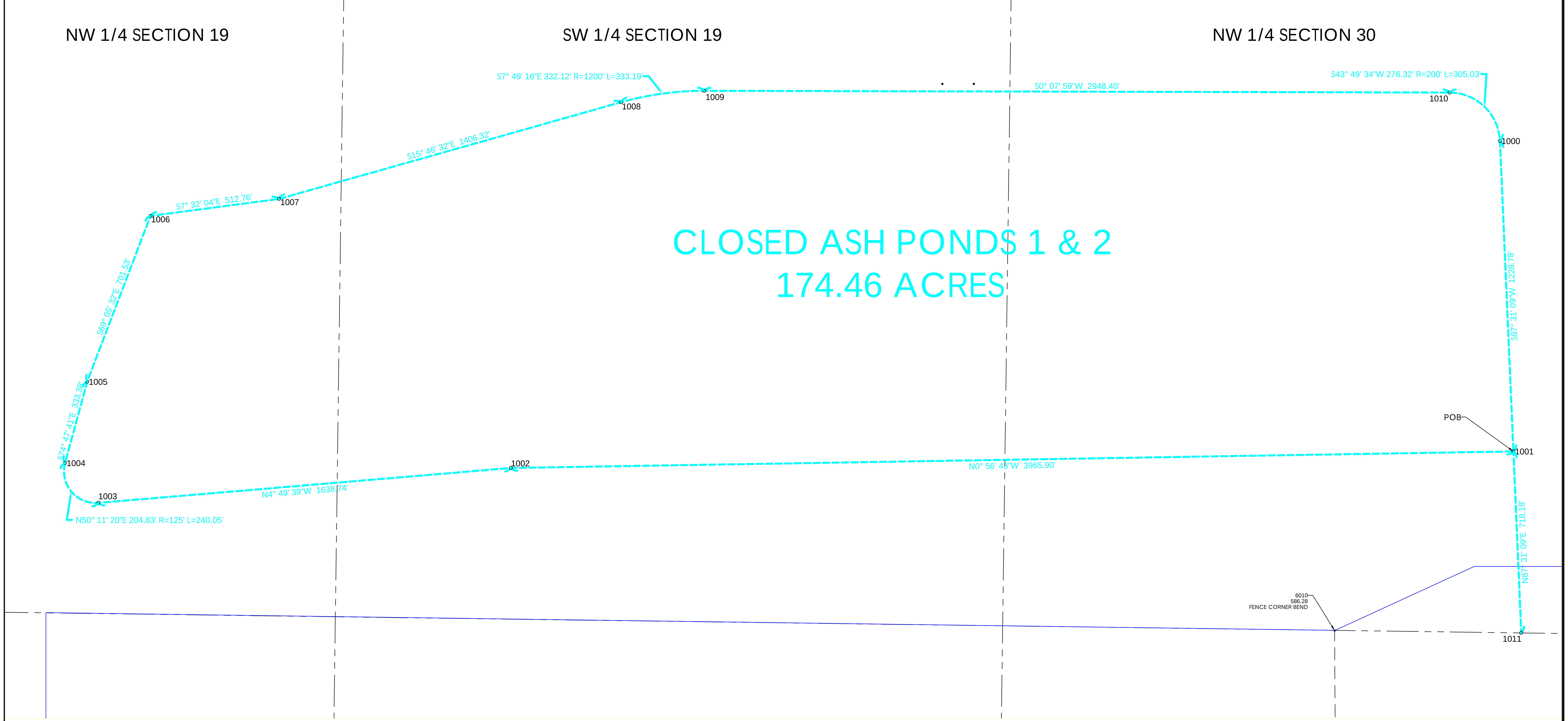

IngenAE
502 Earth City Plaza, Suite 120
Earth City, MO 63045
www.ingenae.com

Submissions / Revisions:	Date:
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Luminant

Project Name & Location:

DUCK CREEK
POWER PLANT
17751 N. CILCO RD.
CANTON, IL 61520

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

Drawing Name:
CLOSED ASH PONDS 1 & 2
RESTRICTED USE
BOUNDARY EXHIBIT

Date: 9/22/2021	Project No.
Type: SITE	Drawing No. 3
Drawn By: CB	
Approved By: MG	
Scale: AS NOTED	

RESTRICTED USE ARE BOUNDARY CORNERS SET				
Point #	Northing	Easting	Elevation	DESCRIPTION
1000	1387041.40	2347080.57	0.00	RESTRICT BOUNDARY
1001	1386988.21	2345852.94	0.00	RESTRICT BOUNDARY
1002	1390953.57	2345787.51	0.00	RESTRICT BOUNDARY
1003	1392586.49	2345649.60	0.00	RESTRICT BOUNDARY
1004	1392717.64	2345806.94	0.00	RESTRICT BOUNDARY
1005	1392630.20	2346128.66	0.00	RESTRICT BOUNDARY
1006	1392379.85	2346784.00	0.00	RESTRICT BOUNDARY
1007	1391871.51	2346851.23	0.00	RESTRICT BOUNDARY
1008	1390518.16	2347233.57	0.00	RESTRICT BOUNDARY
1009	1390189.13	2347278.76	0.00	RESTRICT BOUNDARY
1010	1387240.74	2347271.91	0.00	RESTRICT BOUNDARY
1011	1386957.12	2345135.43	0.00	RESTRICT BOUNDARY

CORNERS SET ON , 2021

Luminant

ILLINOIS POWER RESOURCES GENERATING L.L.C.
DUCK CREEK POWER PLANT

0' 200' 600'

LEGEND

- SECTION LINE
- RESTRICTED USE BOUNDARY
- APPROXIMATE DUCK CREEK POWER STATION PROPERTY BOUNDARY LINE
- FOUND SURVEY MARKER AS NOTED
- SET 5/8" IRON REBAR (UNLESS OTHERWISE NOTED)

SURVEY NOTE:
THIS DRAWING AND THE INFORMATION SHOWN HERE ON WAS OBTAINED FROM DATA COLLECTED FROM A FIELD SURVEY MADE BY INGENAE, LLC BETWEEN MARCH 16 THROUGH JUNE 29, 2021. SURVEY COORDINATES, BEARINGS & DISTANCES ARE REFERENCED TO ILLINOIS WEST 1202 STATE PLANE COORDINATE SYSTEM NAD 1983. ELEVATIONS SHOWN HEREON ARE BASED ON NAVD 1988.

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

Submissions / Revisions:	Date:
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Luminant

Project Name & Location:

DUCK CREEK
POWER PLANT
17751 N. CILCO RD.
CANTON, IL 61520

Drawing Name:
CLOSED ASH PONDS 1 & 2
RESTRICTED USE
BOUNDARY EXHIBIT

Date: 9/22/2021	Project No.
Type: SITE	Drawing No. 4
Drawn By: CB	
Approved By: MG	
Scale: AS NOTED	

ATTACHMENT B

AECOM

October 2016

Illinois Power Resources Generating, LLC
17751 North Cilco Road
Canton, IL 61520

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

On behalf of Illinois Power Resources Generating, LLC, AECOM has prepared the following history of construction for the Ash Pond No. 1, Ash Pond No. 2, and GMF Pond at the Duck Creek Power Station in accordance with 40 CFR § 257.73(c). The Bottom Ash Basin is an incised pond with a storage volume of less than 20 acre-feet. A history of construction is not required for the Bottom Ash Basin as specified in § 257.73(b).

BACKGROUND

40 CFR § 257.73(c)(1) requires the owner or operator of an existing coal combustion residual (CCR) surface impoundment that either (1) has a height of five feet or more and a storage volume of 20 acre-feet or more, or (2) has a height of 20 feet or more to compile a history of construction by October 17, 2016 that contains, to the extent feasible, the information specified in 40 CFR § 257.73(c)(1)(i)–(xii).

The history of construction presented herein was compiled based on existing documentation, as reasonably and readily available (see 80 Fed. Reg. 21302, 21380 [April 17, 2015]), AECOM's site experience, and discussion with plant engineers. AECOM's document review included construction drawings, geotechnical investigations, observation reports, etc. for the Ash Pond No. 1, Ash Pond No. 2, and GMF Pond at the Duck Creek Power Station.

HISTORY OF CONSTRUCTION

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

Owner:	Illinois Power Resources Generating, LLC
Address:	1500 Eastport Plaza Drive Collinsville, IL 62234
CCR Units:	Ash Pond No. 1 Ash Pond No. 2, IDNR Dam ID No. IL50014 GMF Pond, IDNR Dam ID No. IL50573

Ash Pond No. 1 does not have a state assigned identification number.

§ 257.73(c)(1)(ii): The location of the CCR unit identified on the most recent USGS $7^{1}/_{2}$ or 15 minute topographic quadrangle map or a topographic map of equivalent scale if a USGS map is not available.

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

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

The following captures the purpose of each CCR unit:

- The Ash Pond No. 1 (inactive) was used to store and dispose of fly ash and bottom ash.
- The Ash Pond No. 2 (inactive) was used to store and dispose of fly ash and bottom ash and to clarify CCR contact stormwater prior to discharge in accordance with the station's Water Pollution Control Permit (#2015-EO-59369).
- The GMF Pond is being used to store and dispose of gypsum and to clarify recycled process water for plant operations.

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

[1] This history of construction report was prepared on a facility-wide basis for CCR surface impoundments at the Duck Creek Power Station. The inclusion of Ash Pond No. 1 and Ash Pond No. 2 in this history of construction report does not concede and should not be construed to concede that Ash Pond No. 1 and Ash Pond No. 2 are subject to the Design Criteria or all Operating Criteria in the CCR Rule.

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

Ash Pond No. 1, Ash Pond No. 2, and the GMF Pond are located at the western edge of the Rice Lake-Illinois River Watershed with a 12-digit Hydrologic Unit Code (HUC) of 071300030603 and a drainage area of 21,203 acres (USGS, 2016).

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

Physical properties of the foundation materials for Ash Pond No. 1 and Ash Pond No. 2 are primarily strip-mine spoils with variable thickness overlying shale bedrock. The mine spoils consist of a mixtures of native loess and glacial till and, to a lesser extent, the underlying (primarily shale) bedrock. The loess is classified as silty low plastic clay, with a zone of high plastic clay identified in the upper few feet of the stratum. The glacial till is classified as medium stiff to stiff, silty low plastic clay with trace sand and gravel.

Physical properties of the foundation materials for the GMF Pond are (from top to bottom) native loess, glacial till, and bedrock (primarily shale). The loess is classified as silty low plastic clay, with a zone of high plastic clay identified in the upper few feet of the stratum. The glacial till is classified as medium stiff to stiff, silty low plastic clay with trace sand and gravel.

An available summary of foundation material engineering properties for Ash Pond No.1, Ash Pond No. 2, and the GMF Pond is presented in **Table 1** below. The foundation material engineering properties are based on previous geotechnical explorations and laboratory testing.

Table 1. Summary of Foundation Material Engineering Properties

Material	Unit Weight (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters	
		c' (psf)	Φ' (°)	c (psf)	Φ (°)
Loess	116	100	32	1,250	0
Glacial Till	125	200	30	1,900	0
Mine Spoils	120	100	30	250	15
Shale Bedrock	130	300	26	600	13

Ash Pond No.1, Ash Pond No. 2, and the GMF Pond are enclosed impoundments with embankments and do not have abutments.

§ 257.73(c)(1)(vi): A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR unit; the method of site preparation and construction of each zone of the CCR unit; and the approximate dates of construction of each successive stage of construction of the CCR unit.

The embankments of the Ash Pond No. 1 and Ash Pond No. 2 were constructed with mine spoils excavated from within the center of the existing pond footprints. The mine spoils consist of a mixtures of native loess and glacial till and, to a lesser extent, the underlying (primarily shale) bedrock. The loess is classified as silty low plastic clay, with a zone of high plastic clay identified in the upper few feet of the stratum. The glacial till is classified as medium stiff to stiff, silty low plastic clay with trace sand and gravel.

The embankments of the GMF Pond generally consists of silty, low plastic clay and generally had a stiff to very stiff consistency and appeared to be well-compacted material. The liner system within the GMF Pond consists of (from top to bottom) a 60-mil textured high density polyethylene (HDPE) geomembrane, 1-foot-thick layer of “cushion dirt”, 4-ounce geotechnical filter fabric, 1-foot-thick drainage layer, 10-ounce geotextile cushion, 60-mil textured HDPE geomembrane, a Bentomat SDN reinforced geosynthetic clay liner (GCL), and 3-foot-thick layer of compacted clay. A typical cross section profile of the liner system is shown on drawing C180-C102-8 presented in **Appendix B**.

An available summary of construction material engineering properties is presented in **Table 2** below. The construction material engineering properties are based on previous geotechnical investigations and laboratory testing.

Table 2. Summary of Construction Material Engineering Properties

Material	Unit Weight (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters	
		c’ (psf)	Φ’ (°)	c (psf)	Φ (°)
Liner-Cushion Material	116	0	38	660	0
Liner-Granular Drainage Layer	120	0	33	0	33
Liner-Geotextile /Geomembrane	75	100	25	100	25
Embankment Fill	116	150	32	2,150	0

The methods used for preparation and construction of Ash Pond No. 1 and Ash Pond No. 2 are not reasonably and readily available.

The site preparation work for the GMF Pond included stripping and stockpiling the topsoil. The subsoil was then excavated to approximately 5.4 feet above the proposed foundation grade and stockpiled. Temporary and permanent erosion control measures were also installed. The site was later excavated to the proposed subgrade and proof rolled to inspect for unsuitable soils. Any unsuitable soils were either removed or reworked. A sheepsfoot roller was used to compact suitable backfill material placed in 8-inch lifts. Compaction testing was performed using a nuclear density gauge at a minimum rate of one test per 10,000 cubic yards (minimum one test per lift). Backfill was compacted to at least 95% of standard proctor maximum dry density and with a moisture content of -2% to +2% of optimum. Embankment construction was performed using similar compacting and testing techniques as for the subgrade preparation.

Prior to constructing the clay liner for the GMF Pond, two test pad liners were constructed using separate borrow material. Testing of both liners indicated that the construction practice and material used were acceptable. The full scale clay liner was constructed with fill placed in 8-inch lifts and compacted with a sheepsfoot roller. Placed fill was compacted to at least 95% of standard proctor maximum dry density and with a moisture content of optimum to +5%. Compaction testing was performed using a nuclear density gauge at a minimum rate of one test per 1,000 cubic yards (minimum one test per lift). After the minimum clay liner thickness was achieved, the surface was smooth rolled in preparation of the GCL. The GCL and lower geomembrane were then placed sequentially followed by the 10-ounce geotextile cushion. A leak detection/leachate collection and recovery system (LD/LCRS) was then installed which includes a 1-foot-thick sand drainage layer and collection pipes. The sand was graded to minimum thickness using a dozer. The LD/LCRS was completed by placing a 4-ounce geotechnical filter fabric on top of the sand. A 1-foot-thick “cushion dirt” layer was then placed using a dozer to spread general fill. The liner was completed by placing the upper geomembrane on top.

The approximate dates of each successive event stage of construction of Ash Pond No. 1, Ash Pond No. 2, and the GMF Pond are provided in **Table 3** below.

Table 3. Approximate dates of construction of each successive stage of construction.

Date	Event
1976	Ash Pond No. 1 was commissioned
1986	Ash Pond No. 2 was commissioned
2007	Surface preparation for GMF Pond began
2008-2009	Construction of GMF Pond

§ 257.73(c)(1)(vii): At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR unit, detailed dimensional drawings of the CCR unit, including a plan view and cross sections of the length and width of the CCR unit, showing all zones, foundation improvements, drainage provisions, spillways, diversion ditches, outlets, instrument locations, and slope protection, in addition to the normal operating pool surface elevation and the maximum pool surface elevation following peak discharge from the inflow design flood, the expected maximum depth of CCR within the CCR surface impoundment, and any identifiable natural or manmade features that could adversely affect operation of the CCR unit due to malfunction or mis-operation.

Drawings that contain items pertaining to the requested information for Ash Pond No. 1, Ash Pond No. 2, and the GMF Pond are listed in **Table 4** below. Items marked as "Not Available" are items not found during review of reasonably and readily available record documentation

Table 4. List of drawings containing items pertaining to the information requested in § 257.73(c)(1)(vii).

	Ash Pond No. 1	Ash Pond No. 2	GMF Pond
Dimensional plan view (all zones)	C180-G1916-3	C180-G1916-4, C180-G1916-6	C180-C102-8 thru -11
Dimensional cross sections	C180-G1916-3	C180-G1916-7	C180-C102-12 thru -14
Foundation Improvements	C180-G1916-3	C180-G1916-7	Not Applicable
Drainage Provisions	Not Applicable	C180-G1916-9 thru -11, M-1001	C180-C102-12 thru -14 C180-C102-30 thru -31
Spillways and Outlets	C180-G1916-3	C180-G1916-8	C180-C102-15, C180-C102-29
Diversion Ditches	Not Applicable	Not Applicable	Not Applicable
Instrument Locations	Figure in Appendix C, Plate 2	Figure in Appendix C, Plate 2	Not Applicable
Slope Protection	C180-G1916-3	Not Available	C180-C102-12
Normal Operating Pool Elevation	Not Available	Not Available	Not Available
Maximum Pool Elevation	C180-G1916	C180-G1916-7	Not Available
Approximate Maximum Depth of CCR in 2016	68 feet	59 feet	25 feet

All drawings referenced in the table above can be found in **Appendix B** and **Appendix C**.

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

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

Existing instrumentation at Ash Pond No. 1 and Ash Pond No. 2 consists of open-standpipe piezometers. The purpose of the piezometers is to measure the pore water pressures within and around the CCR units. Two (2) piezometers (B-2 and B-5) were installed in 2010 and the locations are presented on Plate 2 in **Appendix C**. Five (5) additional piezometers were installed in 2010 and the locations are presented in **Appendix C**.

The GMF Pond does not contain existing instrumentation used for monitoring the operation of the CCR unit.

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

Area-capacity curves for the Ash Pond No. 1 and Ash Pond No. 2 are not reasonably and readily available. The area-capacity curve for the GMF Pond is presented in **Figure 1** below. “Area-capacity curves”, as defined by 40 CFR § 257.53, “means graphic curves which readily show the reservoir water surface area, in acres, at different elevations from the bottom of the reservoir to the maximum water surface, and the capacity or volume, in acre-feet, of the water contained in the reservoir at various elevations.”

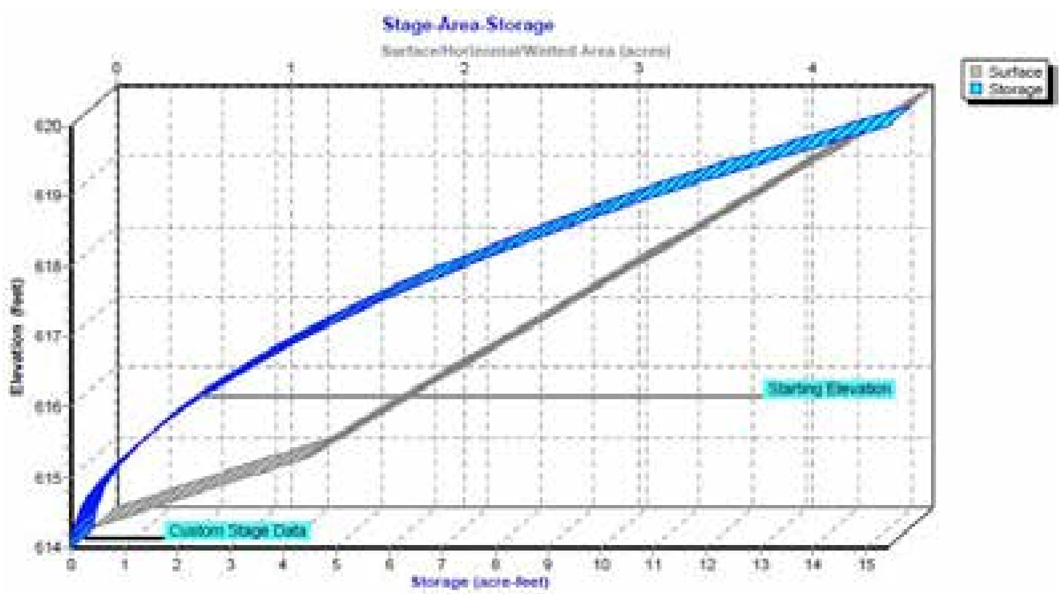


Figure 1. Area-capacity curve for GMF Pond prepared in 2016

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

Ash Pond No. 1 does not contain an active spillway or diversion feature. Stormwater collected in Ash Pond No. 1 is manually pumped to Ash Pond No. 2 at the judgement of plant personnel. Current discharge capacity and calculation information for Ash Pond No. 1 is not reasonably and readily available.

Stormwater collected in Ash Pond No. 2 is drained via a 36-inch diameter (dia.) steel morning glory spillway, formed by 2-foot tall stacked sections, located in the northeast corner of the pond. The spillway transitions to a 36-inch dia. reinforced concrete pipe (RCP) and drains towards the return water pumphouse and discharges in accordance with the station’s Water Pollution Control Permit. Current discharge capacity and calculation information for Ash Pond No. 2 is not reasonably and readily available.

The GMF Pond contains a transfer channel that discharges clear water into the GMF Recycle Pond. The transfer channel is trapezoidal in shape with 3H:1V side slopes. The channel transitions from a 16-foot bottom width at an invert elevation of 616 feet at the upstream end to a 35-foot bottom width at an invert elevation of 609 feet at the downstream end. In 2016 the discharge capacity of the GMF Pond was evaluated using HydroCAD 8.50 software modeling a 1,000-year, 24-hour rainfall event. The results of the HydroCAD 8.50 analysis are presented below in **Table 5**.

Table 5. Results of HydroCAD 8.50 analyses

	GMF Pond
Approximate Minimum Berm Elevation[1] (ft)	620.0
Approximate Emergency Spillway Elevation[1] (ft)	616.0
Starting Pool Elevation[1] (ft)	616.0
Peak Elevation[1] (ft)	618.3
Time to Peak (hr)	12.0
Surface Area (ac)	3.5
Storage[2] (ac-ft)	8.3

Notes: 1. Elevations are based on NAVD88 datum.
2. Storage given is from Starting Pool Elevation to Peak Elevation

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

The construction specification for Ash Pond No. 1 is located in Technical Specification Section 21, however the construction specification is not reasonably and readily available. The construction specification for the Ash Pond No. 2 is not reasonably and readily available. The construction specification for the GMF Pond is located in *Project Manual; Specification No's.: C180-C102* (presented in **Appendix D**).

The provisions for surveillance, general maintenance, and repair of the GMF Pond are presented in **Appendix E**.

The operations and maintenance plans for Ash Pond No. 1, Ash Pond No. 2, and GMF Pond are currently either being generated or being revised by Illinois Power Resources Generating, LLC. This section will be updated when the new operations and maintenance plans are available.

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

There is no record or knowledge of structural instability of Ash Pond No. 1, Ash Pond No. 2, and the GMF Pond at Duck Creek Power Station.

LIMITATIONS

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

Sincerely,

Claudia Prado
Project Manager

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

REFERENCES

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

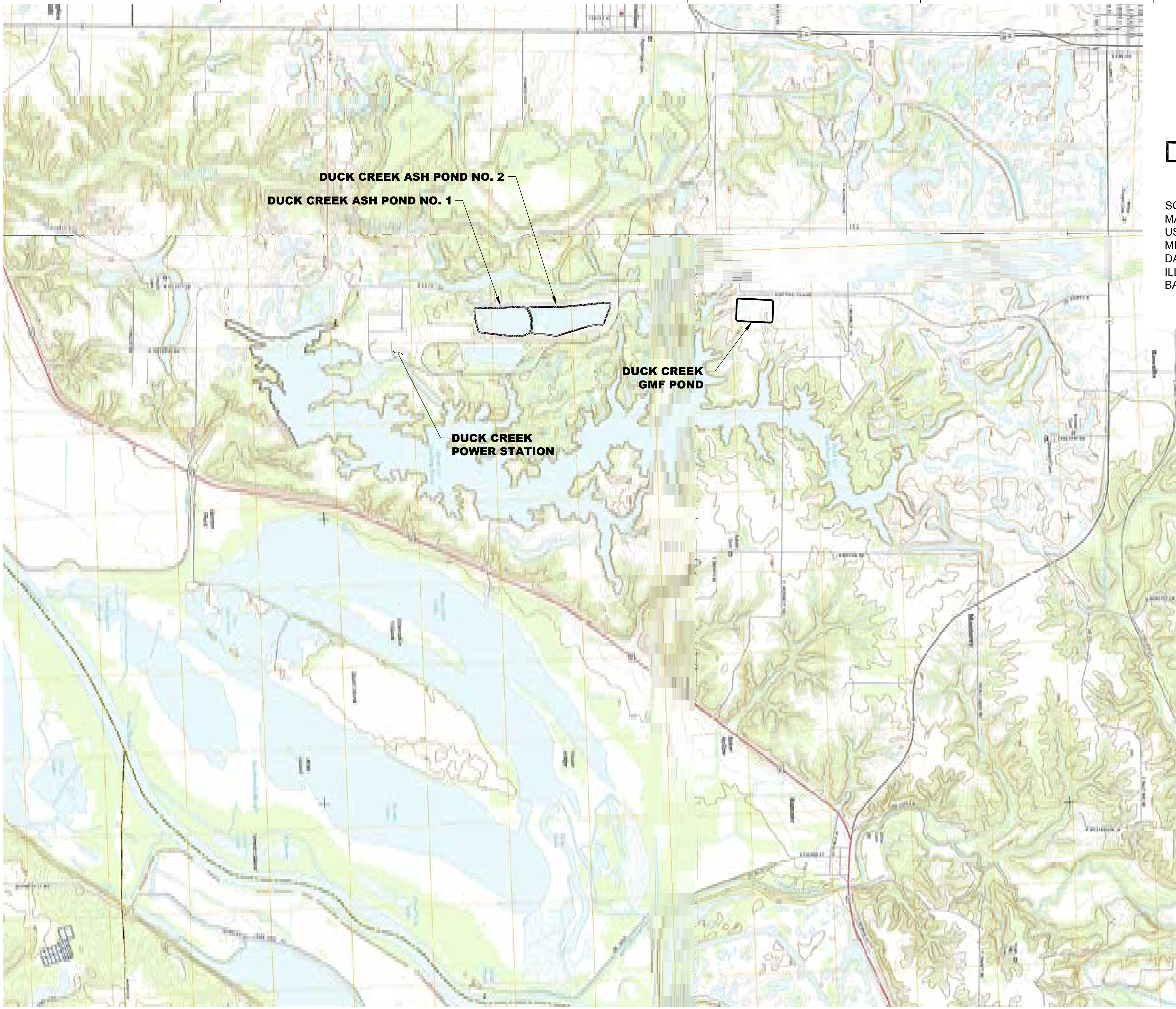
United States Geological Survey (USGS). (2016). The National Map Viewer. http://viewer.nationalmap.gov/viewer/. USGS data first accessed in March of 2016.

APPENDICES

Appendix A: History of Construction Vicinity Map
Appendix B: Duck Creek Power Station Drawings
Appendix C: Duck Creek Power Station Boring and Piezometer Locations
Appendix D: Project Manual; Specification No's.: C180-C102 (excerpt)
Appendix E: Operation and Maintenance Manual, Duck Creek Energy Center, Gypsum Management Facility

AECOM

Appendix A: History of Construction Vicinity Map



LEGEND

CCR UNITS

SOURCE:
MAP PROVIDED FROM ELECTRONIC USGS DIGITAL RASTER GRAPHIC 7.5 MINUTE TOPOGRAPHIC MAP OF SAINT DAVID ILLINOIS, DUCK CREEK ISLAND ILLINOIS, CANTON ILLINOIS AND BANNOR ILLINOIS, REVISED 2015.

QUADRANGLE LOCATION

N

0 2000 4000 6000

SCALE IN FEET

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

ILLINOIS POWER RESOURCES GENERATING, LLC
17751 North CILCO Rd.,
Canton, IL 61520

HISTORY OF CONSTRUCTION

DUCK CREEK POWER STATION
CANTON, ILLINOIS

ISSUED FOR BIDDING DATE BY

ISSUED FOR CONSTRUCTION DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

AECOM PROJECT NO:	60489731
DRAWN BY:	DJD
DESIGNED BY:	DJD
CHECKED BY:	MN
DATE CREATED:	2016-04-13
PLOT DATE:	
SCALE:	1" = 2000'
ACAD VER:	2014

SHEET TITLE

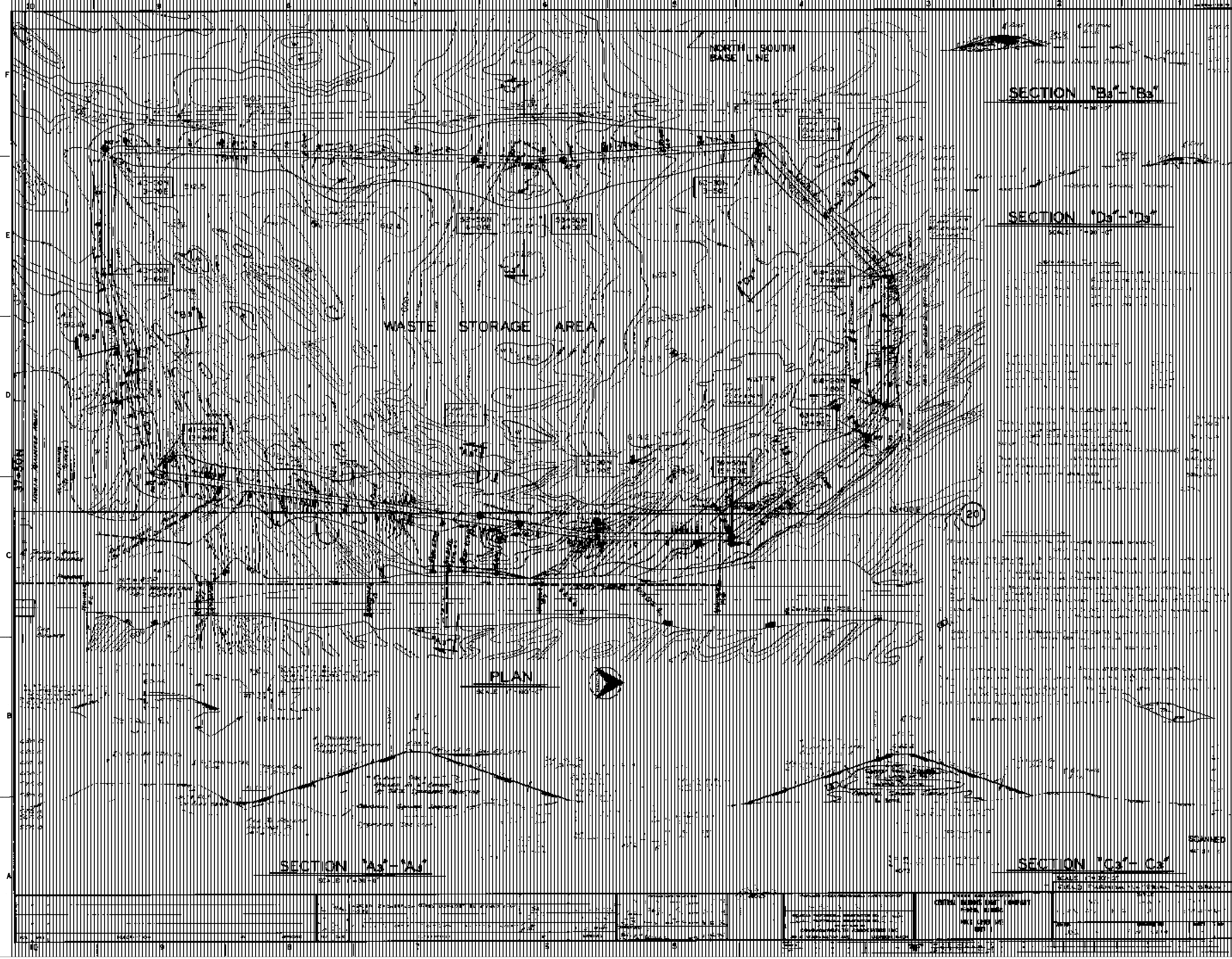
HISTORY OF CONSTRUCTION VICINITY MAP

01

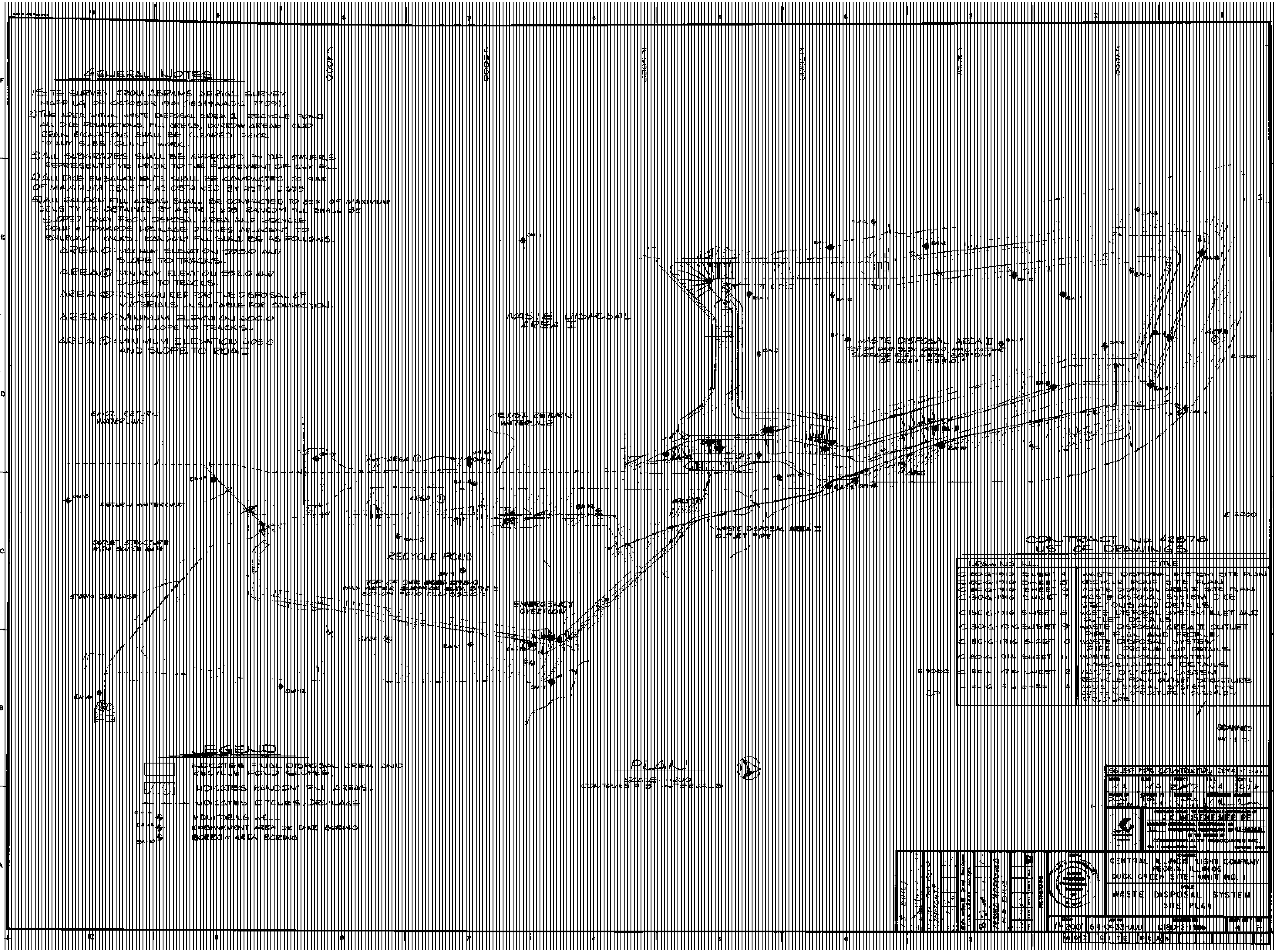
AECOM DRAWING PATH: P:\Projects\Geotech\60428794_DynegyCCR\13_Construction History\04 Technical Production\2_Duck Creek\Reference Documents\Vicinity Location Map References\Figures\C-01 History of Construction Vicinity Map (Duck Creek) --MJN.dwg NANAK, MATT, 8/23/2016 4:02 PM

Appendix B: Duck Creek Power Station Drawings

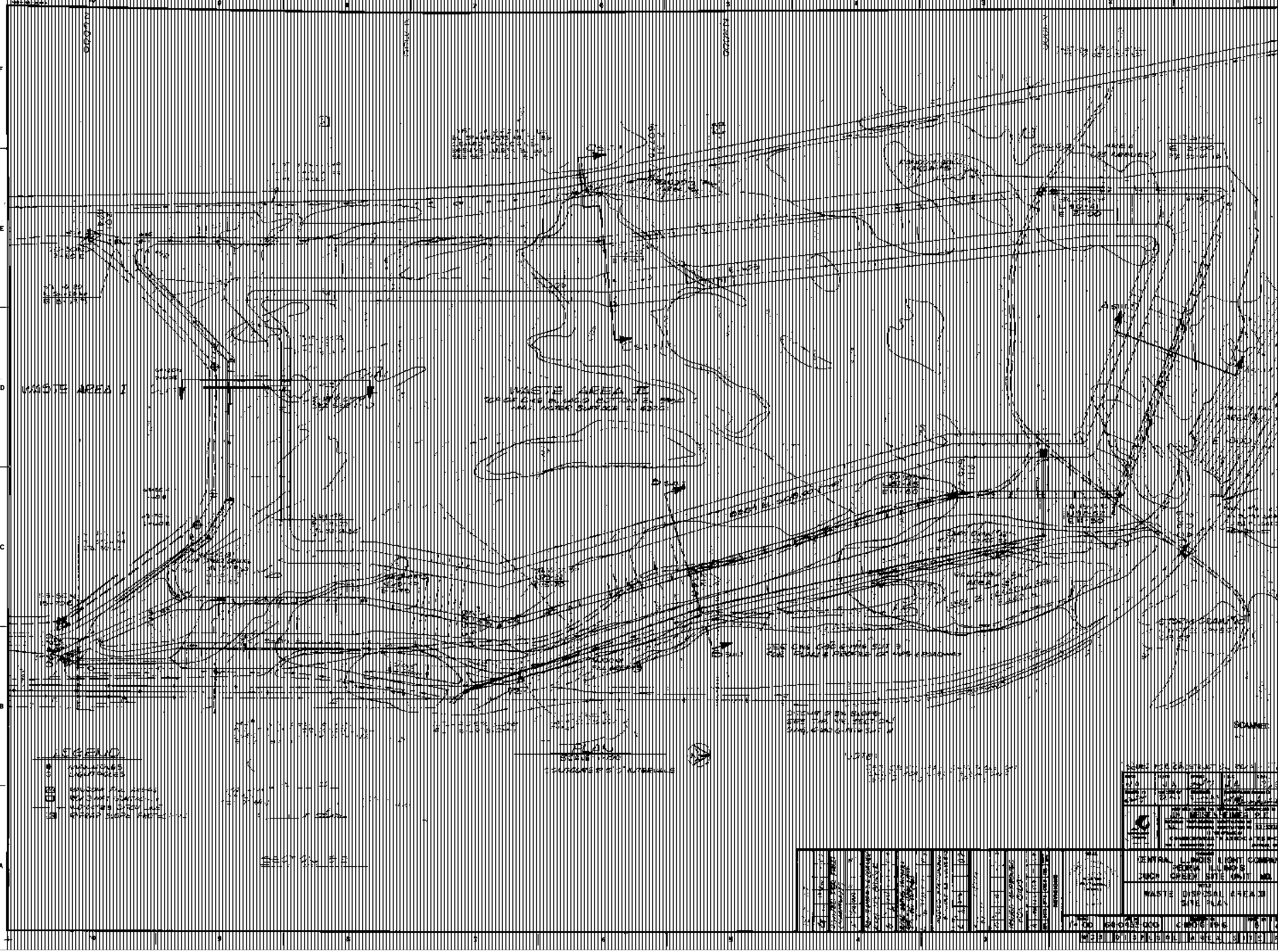
1. "Waste Storage System, Plan and Details of Dike Embankment", Drawing No. C180-G1916-3, Revision D, 13 February, 1975, Commonwealth Associates Inc.
2. "Waste Disposal System, Site Plan", Drawing No. C180-G1916-4, Revision C, 16 October, 1984, Commonwealth Associates Inc.
3. "Waste Disposal Area II, Site Plan", Drawing No. C180-G1916-6, Revision G, 16 October, 1984, Commonwealth Associates Inc.
4. "Waste Disposal System, Dike Sections and Details", Drawing No. C180-G1916-7, Revision D, 16 October, 1984, Commonwealth Associates Inc.
5. "Waste Disposal System, Inlet and Outlet Details", Drawing No. C180-G1916-8, Revision E, 16 October, 1984, Commonwealth Associates Inc.
6. "Waste Disposal Area II, Outlet Pipe Plan & Profile", Drawing No. C180-G1916-9, Revision E, 11 October, 1984, Commonwealth Associates Inc.
7. "Waste Disposal System, Pipe Profile and Details", Drawing No. C180-G1916-10, Revision E, 10 October, 1984, Commonwealth Associates Inc.
8. "Waste Disposal System, Miscellaneous Details", Drawing No. C180-G1916-11, Revision E, 10 October, 1984, Commonwealth Associates Inc.
9. "Pipe Plan & Profile, Recycle Pond Bypass", Drawing No. M-1001, Revision 0, 30 July, 2004, Sargent & Lundy LLC.
10. "Gypsum Stack – Foundation Grade", Drawing No. C180-C102-8, Revision 6, 5 March, 2009, Hanson Professional Services, Inc.
11. "Gypsum Stack – Clay Layer Grade", Drawing No. C180-C102-9, Revision 4, 5 March, 2009, Hanson Professional Services, Inc.
12. "Gypsum Stack – LD/LCRS Drainage Layer Grade", Drawing No. C180-C102-10, Revision 6, 5 March, 2009, Hanson Professional Services, Inc.
13. "PWRS-Ring Drain System Cushion Dirt Layer Grade", Drawing No. C180-C102-11, Revision 6, 5 March, 2009, Hanson Professional Services, Inc.
14. "PWRS-Ring Drain Details", Drawing No. C180-C102-12, Revision 5, 5 March, 2009, Hanson Professional Services, Inc.
15. "PWRS-Ring Drain Details", Drawing No. C180-C102-13, Revision 2, 5 March, 2009, Hanson Professional Services, Inc.
16. "LD/LCRS Sections & Details", Drawing No. C180-C102-14, Revision 3, 5 March, 2009, Hanson Professional Services, Inc.
17. "Recycle Pond Plan", Drawing No. C180-C102-15, Revision 5, 5 March, 2009, Hanson Professional Services, Inc.
18. "Miscellaneous Details", Drawing No. C180-C102-29, Revision 2, 5 March, 2009, Hanson Professional Services, Inc.
19. "LD/LCRS Underdrain Dewatering System-Seep 1", Drawing No. C180-C102-30, Revision 2, 5 March, 2009, Hanson Professional Services, Inc.
20. "LD/LCRS Underdrain Dewatering System-Seep 2", Drawing No. C180-C102-31, Revision 2, 5 March, 2009, Hanson Professional Services, Inc.



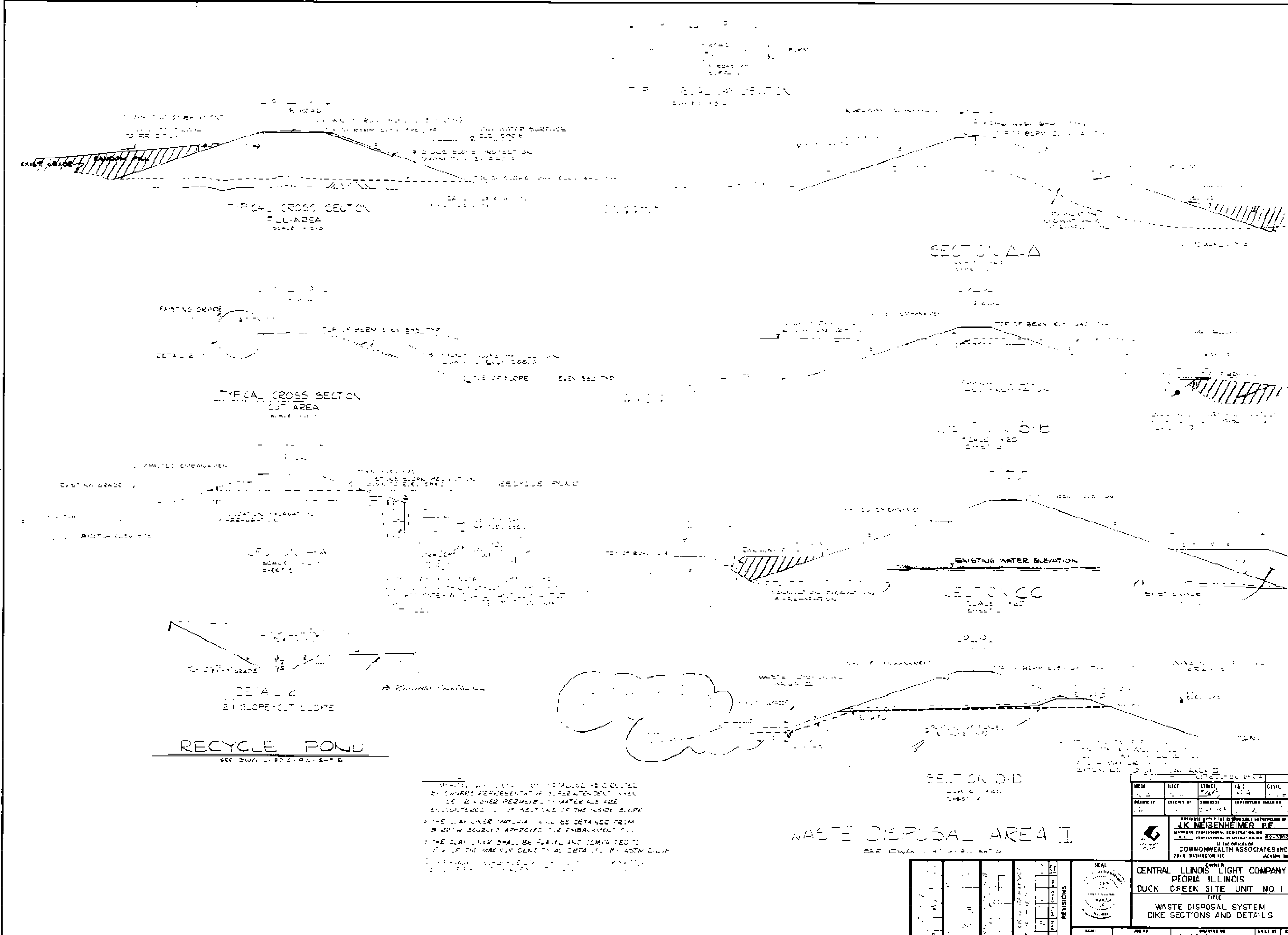
NORTH - SOUTH
BASE LINE
SECTION "B3"-"B3"
SECTION "D3"-"D3"
WASTE STORAGE AREA
PLAN
SECTION "A3"-"A3"
SECTION "C3"-"C3"
SCANNED



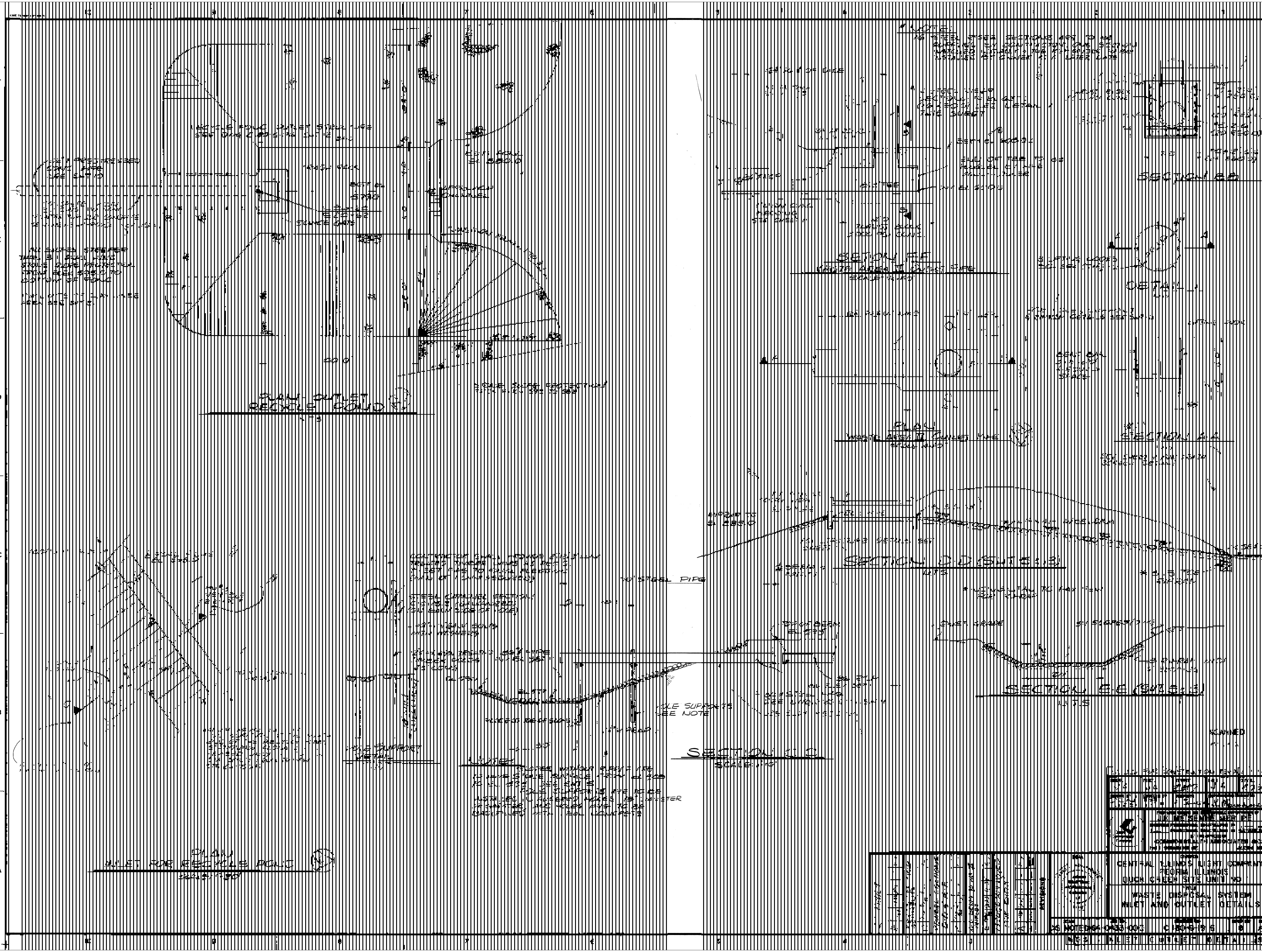
GENERAL NOTES
WASTE DISPOSAL AREA II
RECYCLE ROAD
CONTRACT No. 42878
LIST OF DRAWINGS
TITLE
LEGEND
PLAN
CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK SITE - UNIT NO. 1
WASTE DISPOSAL SYSTEM
SITE PLAN
60-C-1916



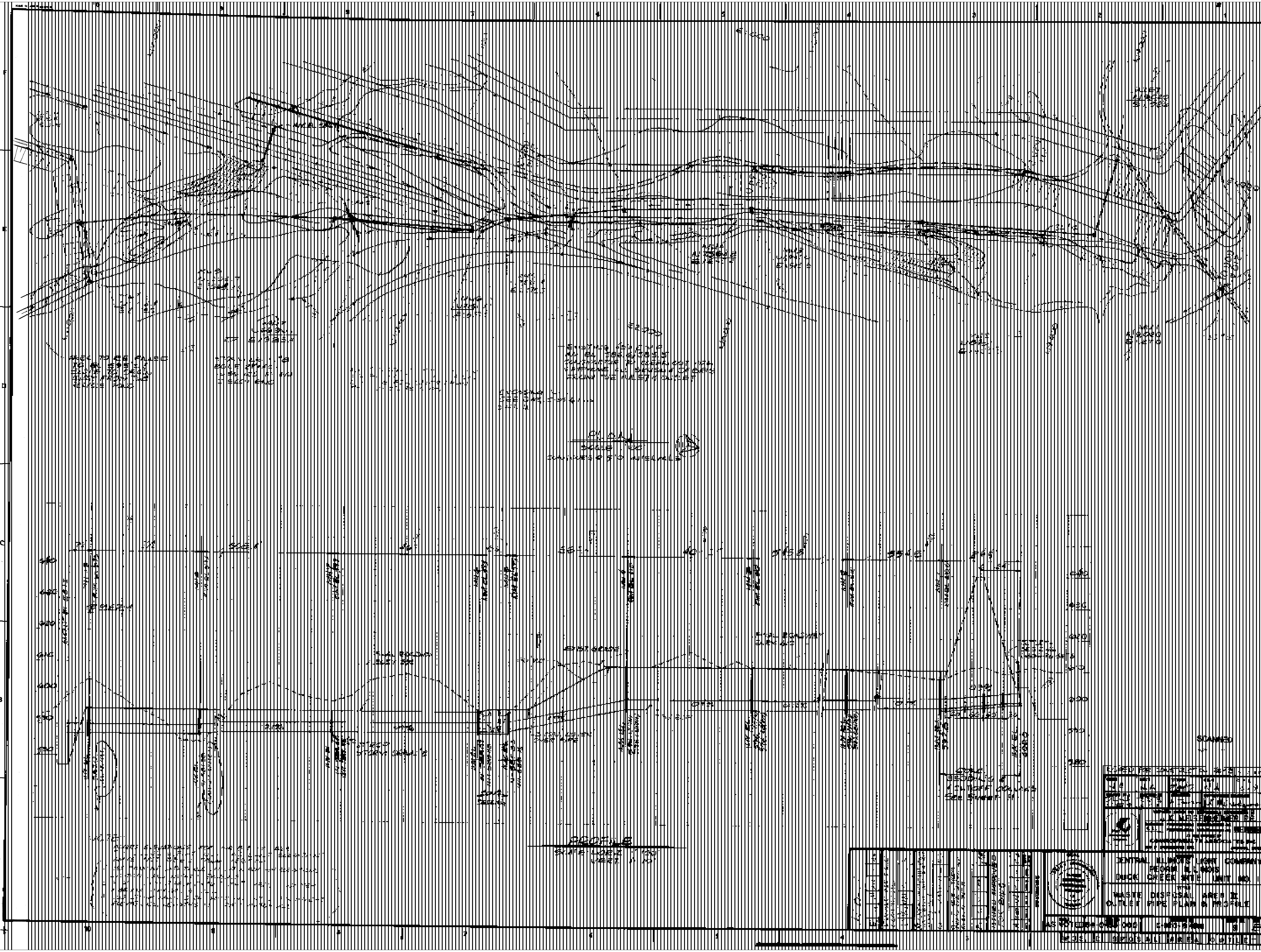
WASTE AREA I
WASTE AREA II
LEGEND
SCANNED
CENTRAL ILLINOIS LIGHT COMPANY
PEORIA ILLINOIS
DUCK CREEK SITE UNIT NO. 1
WASTE DISPOSAL AREA II
SITE PLAN



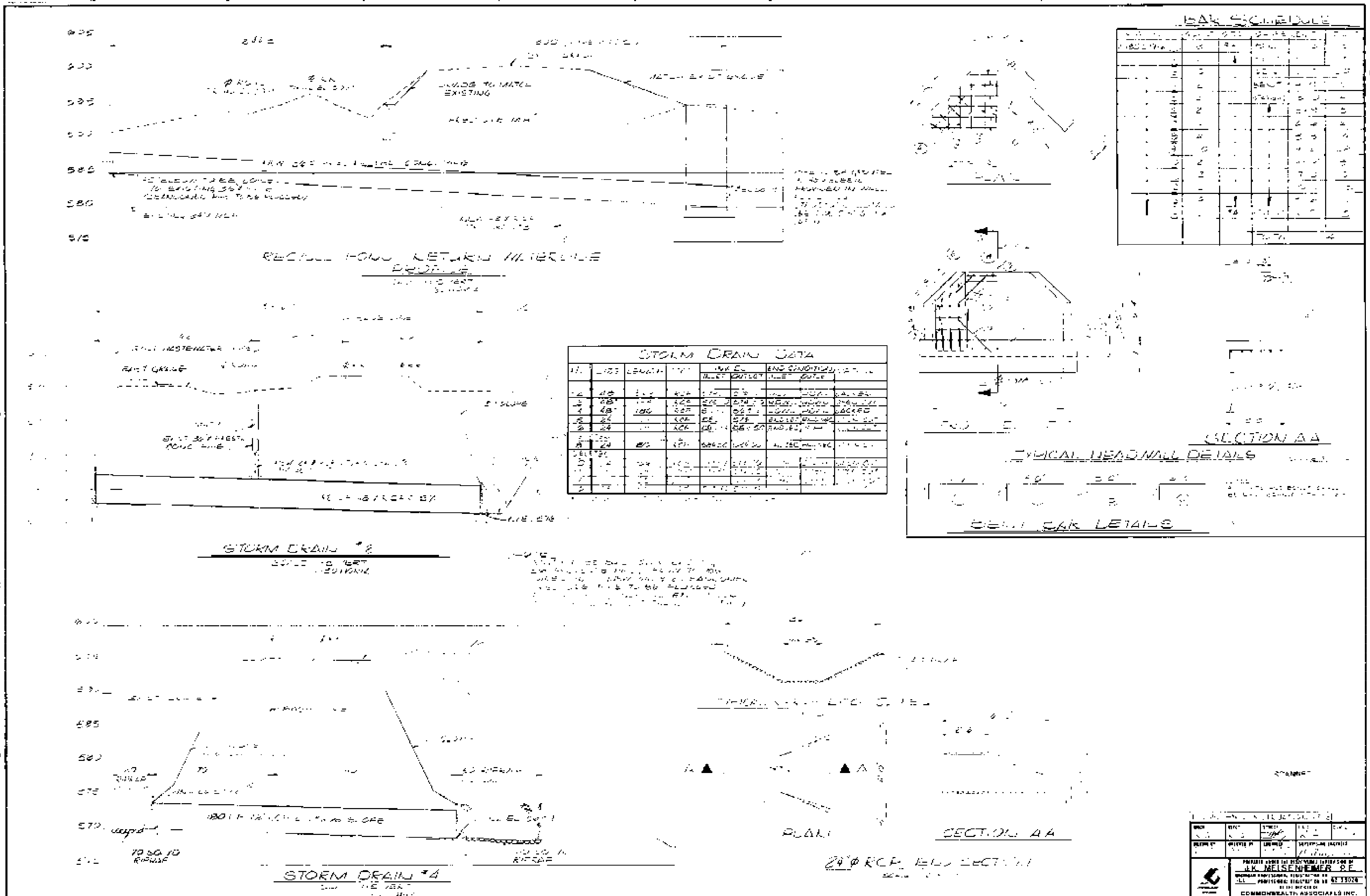
TYPICAL CROSS SECTION
FILL AREA
EXIST. GRADE
RANDOM FILL
SECTION A-A
TYPICAL CROSS SECTION
CUT AREA
EXISTING GRADE
DETAIL 2
EXISTING WATER ELEVATION
DETAIL 4
RECYCLE POND
WASTE DISPOSAL AREA I
SECTION D-D
J.K. MEIZENHEIMER P.E.
COMMONWEALTH ASSOCIATES INC.
CENTRAL ILLINOIS LIGHT COMPANY
PEORIA ILLINOIS
DUCK CREEK SITE UNIT NO. 1
WASTE DISPOSAL SYSTEM
DIKE SECTIONS AND DETAILS
AS NOTED
84 0433 000
C 180 G 1916
7



STEEL PIPE
PILE SUPPORTS
SEE NOTE
SECTION C-C
SCALE
SECTION E-E
SECTION A-A
PLAN
CENTRAL ILLINOIS LIGHT COMPANY
PEORIA ILLINOIS
WASTE DISPOSAL SYSTEM
INLET AND OUTLET DETAILS



PROFILE
CENTRAL ILLINOIS LIGHT COMPANY
PEORIA, ILLINOIS
DUCK CREEK STATION UNIT NO. 1
WASTE DISPOSAL AREA II
OUTLET PIPE PLAN & PROFILE
SCANNED



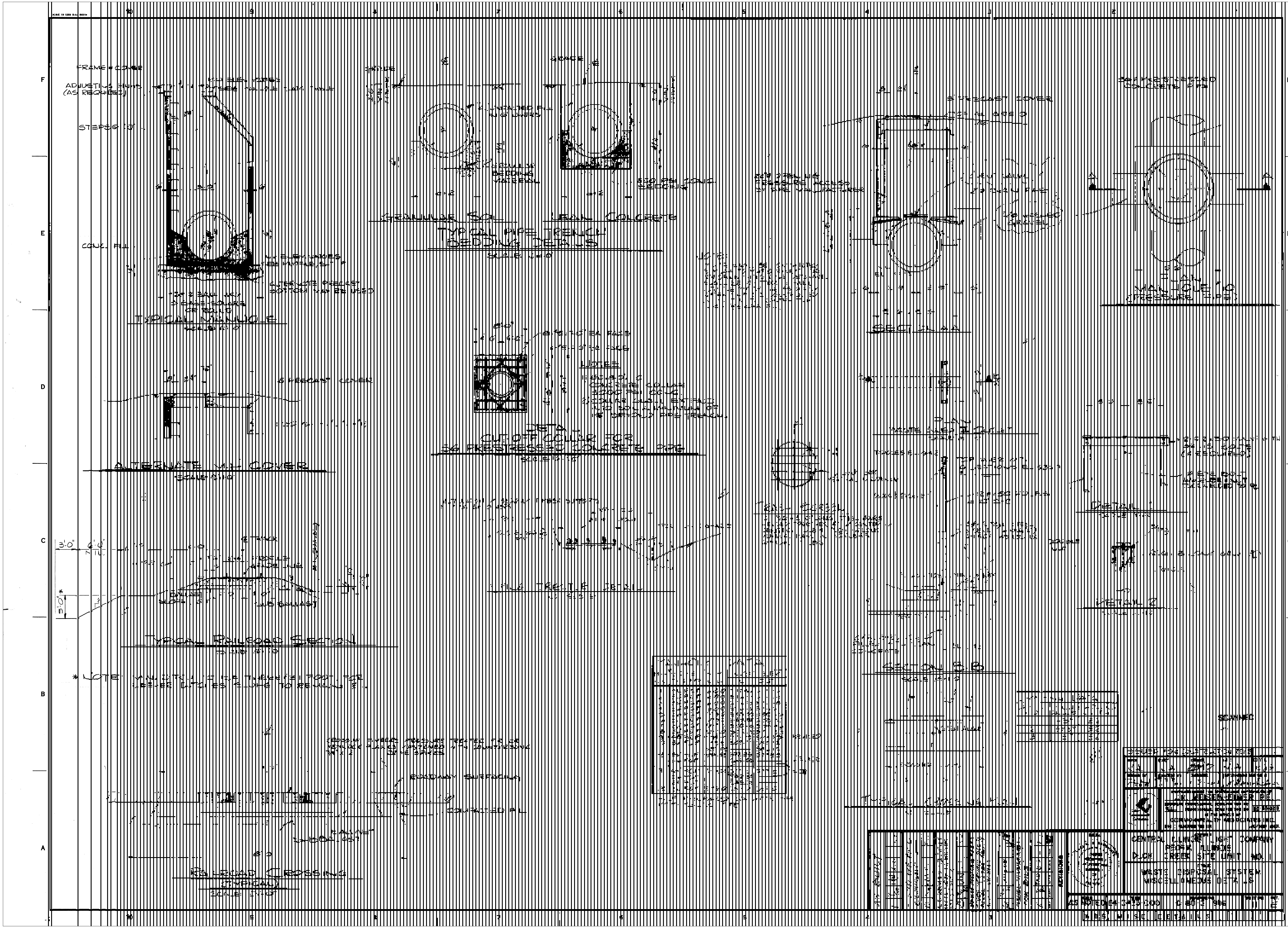
J.K. MEISENHEIMER P.E.
COMMONWEALTH ASSOCIATES INC.

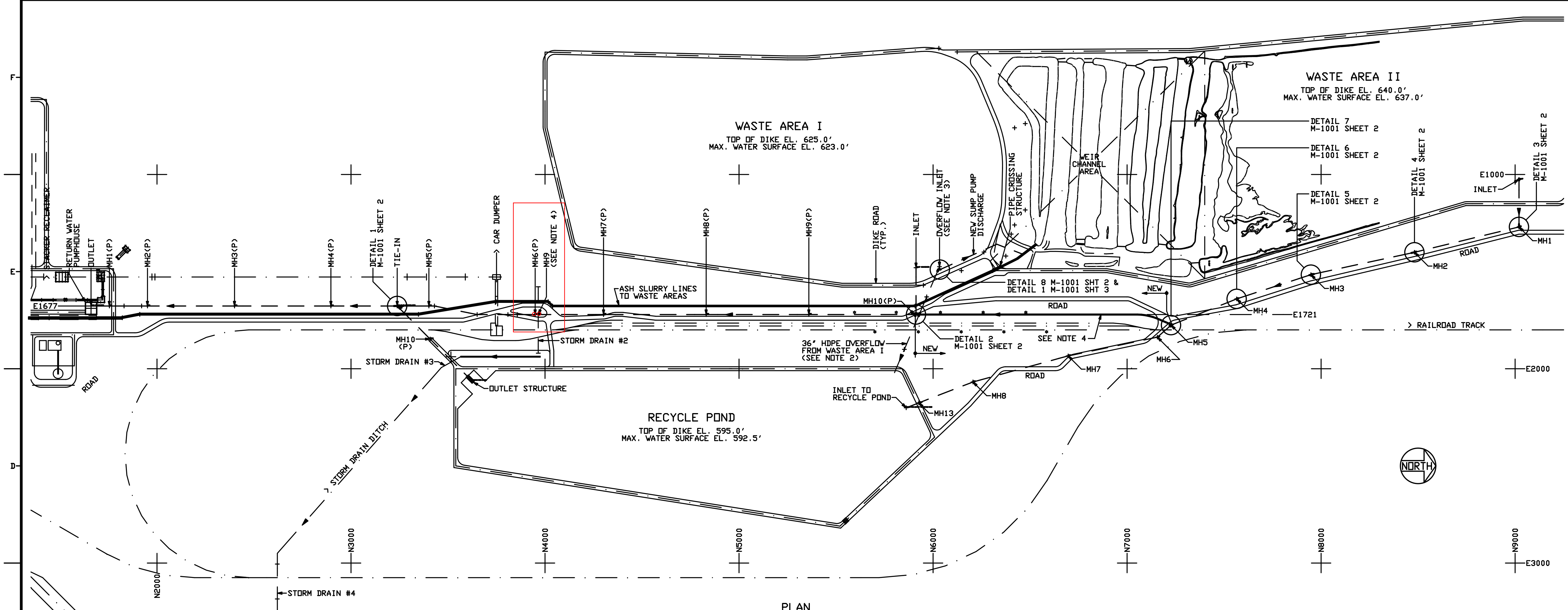
CENTRAL ILLINOIS LIGHT COMPANY
PEORIA ILLINOIS
DUCK CREEK SITE UNIT NO. 1

WASTE DISPOSAL SYSTEM
PIPE PROFILE AND DETAILS

SCALE	JOB NO.	DRAWING NO.	SHEET NO.	REV.
AS NOTED	64 0433-000	C 160 G 1916	10	E

WDS PIPE PROFILES & DET


FRAME & COVER
ADJUSTING RINGS (AS REQUIRED)
STEPS @ 1'0"
CONC. FILL
TYPICAL MANHOLE
GRANULAR SOIL
LEAN CONCRETE
TYPICAL PIPE TRENCH BEDDING DETAILS
MANHOLE 10
SECTION A-A
NOTES
CUT OFF COLLAR FOR 36" PRESTRESSED CONCRETE PIPE
ALTERNATE M.H. COVER
DETAIL 1
DETAIL 2
TYPICAL RAILROAD SECTION
* NOTE
SECTION B-B
ROADWAY SURFACING
COMPACTED FILL
RAILROAD CROSSING (TYPICAL)
SCANNED
CENTRAL ILLINOIS LIGHT COMPANY
PEORIA, ILLINOIS
DUCK CREEK SITE UNIT NO. 1
WASTE DISPOSAL SYSTEM
MISCELLANEOUS DETAILS
AS NOTED
C-80-1-916
WDS MISC DETAILS



PLAN

REFERENCE DRAWINGS:

1. EXISTING PIPE ROUTE FROM WASTE AREA I INLET TO RETURN WATER PUMPHOUSE PER DRAWING C180-G1929 SHEET 1 AND 'INTERPACE' PIPE LAYING SCHEDULE SB-74-26.

2. EXISTING PIPE ROUTE FROM RECYCLE POND OUTLET STRUCTURE TO TIE-IN POINT TO ORIGINAL RETURN LINE AND FROM WASTE AREA II INLET TO RECYCLE POND PER DRAWING C180-G-1916 SHEETS 5 AND 9 RESPECTIVELY.

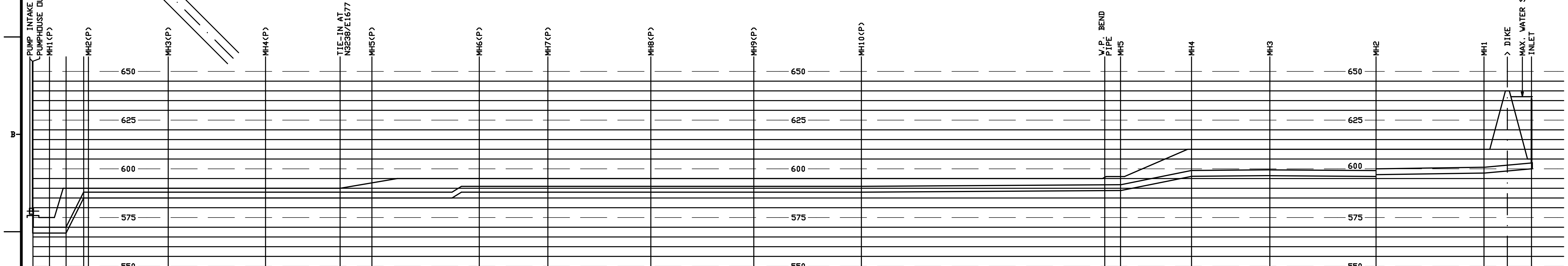
NOTES:

1. MANHOLES (MH) WITH PRESSURE ACCESS HATCHES INDICATED WITH A (P).

2. EXISTING OVERFLOW PIPE TO BE ABANDONED AS PART OF THE RETIREMENT OF WASTE AREA I. PIPE SECTION TO BE CUT OUT TO ALLOW FOR THE INSTALLATION OF THE WASTE WATER RETURN LINE FROM WASTE AREA II; BOTH ENDS IN THE EXCAVATION TO BE CAPPED.

3. OVERFLOW OUTLET REUSED BY CUTTING INTO THE OVERFLOW PIPE INSIDE OF THE DIKE ROAD AND INSTALLING A NEW HDPE SUMP. DISCHARGE FROM SUMP PUMP ROUTED TO PIPE CROSSING STRUCTURE AT WASTE AREA II.

4. HDPE PIPE ALTERNATE MAY TRANSITION FROM UNDERGROUND CONNECTION AND MAY BE ROUTED ON GRADE; ROAD CROSSINGS SHALL BE BELOW GRADE.



PROFILE
SCALES: HORIZONTAL 1"= 200' / VERTICAL 1"= 20'

ANY MODIFICATION OR ADDITION TO THIS DRAWING BY AN ORGANIZATION OTHER THAN SARGENT & LUNDY IS NOT THE RESPONSIBILITY OF SARGENT & LUNDY

FILE I.D.: M1001 01.DGN

DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
0	07/30/04	J.ALCANTARA	M.MAZZAFERRO	————	FOR RECORD/SENT TO CLIENT	

SCALE 1"=200'
PROJECT NUMBER 11478-006

PIPE PLAN & PROFILE
RECYCLE POND BYPASS

DUCK CREEK SITE
UNIT 1
CANTON, ILLINOIS
AMEREN CILCO

Sargent & Lundy LLC

DRAWING NO. M-1001 REV. 0
SHEET 1 OF

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF FOUNDATION ELEVATION DESIGN	TOP OF FOUNDATION ELEVATION RECORD
F0101	16094.44	600.00	591.92	591.92
F0102	16129.48	600.00	601.93	601.72
F0103	16171.72	600.00	614.00	613.76
F0104	16181.80	600.00	614.00	613.93
F0105	16181.80	600.00	618.50	618.41
F0106	16207.05	600.00	618.50	618.41
F0107	16212.92	599.97	616.81	617.46
F0201	16093.44	700.00	591.63	591.43
F0202	16128.99	700.00	601.78	601.57
F0203	16171.75	700.00	614.00	613.66
F0204	16181.83	700.00	614.00	613.83
F0205	16181.83	700.00	618.50	618.45
F0206	16207.08	700.00	618.50	618.39
F0207	16214.65	699.99	616.33	616.08
F0301	16095.59	800.00	592.23	592.10
F0302	16130.09	800.00	602.09	601.78
F0303	16171.78	800.00	614.00	613.92
F0304	16181.86	800.00	614.00	613.80
F0305	16181.86	800.00	618.50	618.40
F0306	16207.11	800.00	618.50	618.36
F0307	16231.93	800.00	611.41	613.77
F0401	16097.41	884.70	592.75	592.62
F0402	16131.01	884.69	602.34	601.96
F0403	16171.81	884.68	614.00	613.88
F0404	16181.89	884.67	614.00	613.95
F0405	16181.89	884.67	618.50	618.46
F0406	16207.14	884.67	618.50	618.49
F0407	16233.79	884.62	610.88	611.16
F0501	16084.47	897.40	592.72	592.61
F0502	16084.09	931.08	602.34	601.98
F0503	16083.63	971.90	614.00	613.82
F0504	16083.52	981.98	614.00	613.99
F0505	16083.52	981.98	618.50	618.42
F0506	16083.24	1007.23	618.50	618.27
F0507	16082.98	1032.66	611.24	612.16
F0601	16000.00	894.01	592.01	591.89
F0602	16000.00	928.91	601.99	601.71
F0603	16000.00	970.96	614.00	613.85
F0604	16000.00	981.05	614.00	613.91
F0605	16000.00	981.05	618.50	618.35
F0606	16000.00	1006.30	618.50	618.19
F0607	15999.99	1027.93	612.32	614.31
F0701	15900.00	889.98	591.18	591.13
F0702	15900.00	926.34	601.57	601.53
F0703	15900.00	969.85	614.00	613.72
F0704	15900.00	979.93	614.00	613.97
F0705	15900.00	979.93	618.50	618.32
F0706	15900.00	1005.18	618.50	618.28
F0707	15900.00	1090.84	594.03	610.36
F0801	15800.00	885.96	590.35	590.35
F0802	15800.00	923.77	601.15	601.09
F0803	15800.00	968.73	614.00	613.77
F0804	15800.00	978.81	614.00	613.82
F0805	15800.00	978.81	618.50	618.32
F0806	15800.00	1004.06	618.50	618.35
F0807	15799.99	1029.78	611.15	611.95
F0901	15700.00	881.93	589.52	589.33
F0902	15700.00	921.20	600.74	600.58
F0903	15700.00	967.62	614.00	613.65
F0904	15700.00	977.70	614.00	613.93
F0905	15700.00	977.70	618.50	618.36
F0906	15700.00	1002.95	618.50	618.42
F0907	15700.00	1023.57	612.61	613.54
F1001	15600.00	874.33	587.67	587.28
F1002	15600.00	918.63	600.32	600.30
F1003	15600.00	966.50	614.00	613.79
F1004	15600.00	976.58	614.00	613.81
F1005	15600.00	976.58	618.50	618.43
F1006	15600.00	1001.83	618.50	618.42
F1007	15600.00	1020.54	613.15	613.94
F1101	15500.00	866.73	585.81	585.69
F1102	15500.00	916.06	599.91	599.75
F1103	15500.00	965.38	614.00	613.70
F1104	15500.00	975.46	614.00	613.81
F1105	15500.00	975.46	618.50	618.40
F1106	15500.00	1000.72	618.50	618.37
F1107	15500.02	1020.41	612.87	613.37
F1201	15400.00	862.70	584.98	584.93
F1202	15400.00	913.48	599.49	599.29
F1203	15400.00	964.27	614.00	613.73
F1204	15400.00	974.35	614.00	613.78
F1205	15400.00	974.35	618.50	618.32
F1206	15400.00	999.60	618.50	618.32
F1207	15399.98	1028.62	610.20	611.46
F1301	15300.00	858.67	584.15	583.89
F1302	15300.00	910.91	599.08	598.88
F1303	15300.00	963.15	614.00	613.76
F1304	15300.00	973.23	614.00	613.83
F1305	15300.00	973.23	618.50	618.38
F1306	15300.00	998.48	618.50	618.12
F1307	15300.00	1032.07	608.91	610.62
F1401	15200.00	854.65	583.32	583.20
F1402	15200.00	908.34	598.66	598.57
F1403	15200.00	962.03	614.00	613.76
F1404	15200.00	972.12	614.00	613.80
F1405	15200.00	972.12	618.50	618.27
F1406	15200.00	997.37	618.50	618.45
F1407	15199.99	1026.69	610.12	611.00
F1501	15100.00	850.62	582.49	582.35
F1502	15100.00	905.77	598.24	598.08
F1503	15100.00	960.92	614.00	613.65
F1504	15100.00	971.00	614.00	613.79
F1505	15100.00	971.00	618.50	618.43
F1506	15100.00	996.25	618.50	618.33
F1507	15099.99	1029.67	608.96	611.29
F1601	15000.00	846.59	581.66	581.56
F1602	15000.00	903.20	597.83	597.75
F1603	15000.00	959.80	614.00	613.69
F1604	15000.00	969.88	614.00	613.88
F1605	15000.00	969.88	618.50	618.37
F1606	15000.00	995.13	618.50	618.28
F1607	15000.03	1043.53	604.67	611.24
F1701	14900.00	842.57	580.83	580.78
F1702	14900.00	900.63	597.41	597.33
F1703	14900.00	958.69	614.00	613.84
F1704	14900.00	968.77	614.00	613.82
F1705	14900.00	968.77	618.50	618.39

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF FOUNDATION ELEVATION DESIGN	TOP OF FOUNDATION ELEVATION RECORD
F1706	14900.00	994.02	618.50	618.33
F1707	14900.00	1028.15	608.75	611.74
F1801	14813.44	839.08	580.21	579.97
F1802	14782.32	869.87	589.00	588.95
F1803	14781.16	957.36	614.00	613.89
F1804	14781.02	967.44	614.00	613.98
F1805	14781.02	967.44	618.50	618.33
F1806	14780.69	992.69	618.50	618.30
F1807	14780.28	1021.66	610.22	612.15
F1901	14813.44	839.08	580.21	579.95
F1902	14782.32	869.87	589.00	588.94
F1903	14694.82	870.06	614.00	613.79
F1904	14684.74	870.09	614.00	613.82
F1905	14684.74	870.09	618.50	618.35
F1906	14659.49	870.14	618.50	618.28
F1907	14631.04	870.23	610.37	618.75
F2001	14814.22	800.00	579.88	579.87
F2002	14754.51	800.00	596.94	596.83
F2003	14694.80	800.00	614.00	613.87
F2004	14684.72	800.00	614.00	613.81
F2005	14684.72	800.00	618.50	618.21
F2006	14659.47	800.00	618.50	618.43
F2007	14625.16	799.98	608.69	617.10
F2101	14816.20	700.00	579.31	579.28
F2102	14755.49	700.00	596.65	596.51
F2103	14694.78	700.00	614.00	613.87
F2104	14684.70	700.00	614.00	613.87
F2105	14684.70	700.00	618.50	618.46
F2106	14659.45	700.00	618.50	618.31
F2107	14604.09	699.98	602.68	617.45
F2201	14815.21	600.00	579.59	579.48
F2202	14754.98	600.00	596.79	596.47
F2203	14694.76	600.00	614.00	613.77
F2204	14684.68	600.00	614.00	613.90
F2205	14684.68	600.00	618.50	618.48
F2206	14659.43	600.00	618.50	618.47
F2207	14616.86	600.00	606.34	617.52
F2301	14813.75	500.00	580.00	579.84
F2302	14754.25	500.00	597.00	596.67
F2303	14694.74	500.00	614.00	613.66
F2304	14684.66	500.00	614.00	613.68
F2305	14684.66	500.00	618.50	618.35
F2306	14659.41	500.00	618.50	618.47
F2307	14628.55	499.97	609.69	617.85
F2401	14815.70	400.00	579.43	579.29
F2402	14755.21	400.00	596.72	596.41
F2403	14694.72	400.00	614.00	613.71
F2404	14684.64	400.00	614.00	613.74
F2405	14684.64	400.00	618.50	618.37
F2406	14659.39	400.00	618.50	618.39
F2407	14575.59	399.99	594.55	611.78
F2501	14815.59	300.00	579.46	579.37
F2502	14755.14	300.00	596.73	596.50
F2503	14694.70	300.00	614.00	613.66
F2504	14684.62	300.00	614.00	613.78
F2505	14684.62	300.00	618.50	618.43
F2506	14659.37	300.00	618.50	618.19
F2507	14620.64	299.98	607.44	616.64
F2601	14813.56	200.00	580.03	579.89
F2602	14754.12	200.00	597.02	596.76
F2603	14694.68	200.00	614.00	613.71
F2604	14684.60	200.00	614.00	613.92
F2605	14684.60	200.00	618.50	618.35
F2606	14659.35	200.00	618.50	618.27
F2607	14631.96	199.98	610.68	617.40
F2701	14812.67	156.13	580.28	580.17
F2702	14782.16	125.21	589.00	588.97
F2703	14694.66	125.04	614.00	613.87
F2704	14684.58	125.02	614.00	613.79
F2705	14684.58	125.02	618.50	618.43
F2706	14659.33	124.97	618.50	618.20
F2707	14635.10	124.92	611.57	614.44
F2801	14812.67	156.13	580.28	580.21
F2802	14782.16	125.21	589.00	588.96
F2803	14783.14	37.72	614.00	613.81
F2804	14783.25	27.64	614.00	613.79
F2805	14783.25	27.64	618.50	618.42
F2806	14783.53	2.39	618.50	618.22
F2807	14783.96	-34.35	608.00	610.18
F2901	14900.00	154.79	581.00	581.00
F2902	14900.00	97.03	597.50	597.36
F2903	14900.00	39.27	614.00	613.93
F2904	14900.00	29.19	614.00	613.98
F2905	14900.00	29.19	618.50	618.11
F2906	14900.00	3.94	618.50	618.45
F2907	14900.00	-23.80	610.57	613.06
F3001	15000.00	153.27	581.81	581.73
F3002	15000.00	96.94	597.91	597.64
F3003	15000.00	40.61	614.00	613.86
F3004	15000.00	30.53	614.00	613.95
F3005	15000.00	30.53	618.50	618.43
F3006	15000.00	5.28	618.50	618.36
F3007	14999.97	-14.01	613.00	614.78
F3101	15100.00	151.74	582.63	582.56
F3102	15100.00	96.84	598.32	598.32
F3103	15100.00	41.94	614.00	613.93
F3104	15100.00	31.86	614.00	613.87
F3105	15100.00	31.86	618.50	618.29
F3106	15100.00	6.61	618.50	618.15
F3107	15100.02	-8.95	614.06	614.92
F3201	15200.00	150.22	583.45	583.22
F3202	15200.00	96.75	598.72	598.64
F3203	15200.00	43.28	614.00	613.96
F3204	15200.00	33.19	614.00	613.93
F3205	15200.00	33.19	618.50	618.39
F3206	15200.00	7.94	618.50	618.30
F3207	15199.98	-7.68	614.03	615.32
F3301	15300.00	148.69	584.26	584.18
F3302	15300.00	96.65	599.13	599.11
F3303	15300.00	44.61	614.00	613.96
F3304	15300.00	34.53	614.00	613.96
F3305	15300.00	34.53	618.50	618.32
F3306	15300.00	9.28	618.50	618.15
F3307	15300.02	-5.09	614.39	615.54
F3401	15400.00	147.17	585.08	584.94
F3402	15400.00	96.55	599.54	599.46
F3403	15400.00	45.94	614.00	613.92

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF FOUNDATION ELEVATION DESIGN	TOP OF FOUNDATION ELEVATION RECORD
F3404	15400.00	35.86	614.00	613.89
F3405	15400.00	35.86	618.50	618.35
F3406	15400.00	10.61	618.50	618.30
F3407	15299.99	-4.81	614.10	615.48
F3501	15500.00	145.64	585.90	585.79
F3502	15500.00	96.46	599.95	599.88
F3503	15500.00	47.28	614.00	613.88
F3504	15500.00	37.19	614.00	613.95
F3505	15500.00	37.19	618.50	618.35
F3506	15500.00	11.94	618.50	618.28
F3507	15399.98	-3.03	614.22	616.45
F3601	15600.00	140.54	587.74	587.67
F3602	15600.00	96.36	600.36	600.28
F3603	15600.00	48.61	614.00	613.87
F3604	15600.00	38.53	614.00	613.95
F3605	15600.00	38.53	618.50	618.43
F3606	15600.00	13.28	618.50	618.13
F3607	15600.01	0.68	614.90	617.26
F3701	15700.00	135.44	589.57	589.38
F3702	15700.00	96.27	600.77	600.75
F3703	15700.00	49.94	614.00	613.94
F3704	15700.00	39.86	614.00	613.84
F3705	15700.00	39.86	618.50	618.31
F3706	15700.00	14.61	618.50	618.16
F3707	15699.99	6.05	616.06	618.25
F3801	15800.00	133.92	590.39	590.28
F3802	15800.00	96.17	601.17	600.92
F3803	15800.00	51.28	614.00	613.73
F3804	15800.00	41.20	614.00	613.78
F3805	15800.00	41.20	618.50	618.39
F3806	15800.00	15.94	618.50	618.48
F3807	15799.99	13.41	617.77	619.70
F3901	15900.00	132.39	591.21	591.17
F3902	15900.00	96.07	601.58	601.40
F3903	15900.00	52.61	614.00	613.83
F3904	15900.00	42.53	614.00	613.99
F3905	15900.00	42.53	618.50	618.41
F3906	15900.00	17.28	618.50	618.27
F3907	15899.97	14.63	619.26	620.26
F4001	16000.00	130.87	592.02	591.82
F4002	16000.00	95.98	601.99	601.75
F4003	16000.00	53.94	614.00	613.93
F4004	16000.00	43.86	614.00	613.91
F4005	16000.00	43.86	618.50	618.37
F4006	16000.00	18.61	618.50	618.28
F4007	15999.98	13.17	620.06	620.37
F4101	16084.55	129.59	592.71	592.70
F4102	16085.00	95.91	602.34	602.23
F4103	16085.54	55.08	614.00	613.89
F4104	16085.68	45.00	614.00	613.91
F4105	16085.68	45.00	618.50	618.34
F4106	16086.02	19.76	618.50	618.11
F4107	16086.08	13.77	620.21	620.54
F4201	16097.17	142.27	592.74	592.52
F4202	16130.77	142.26	602.34	602.02
F4203	16171.58	142.25	614.00	613.64
F4204	16181.66	142.25	614.00	613.89
F4205	16181.66	142.25	618.50	618.49
F4206	16206.91	142.24	618.50	618.30
F4207	16214.67	142.24	616.28	619.55
F4301	16095.97	200.00	592.39	592.38
F4302	16130.18	200.00	602.17	601.94
F4303	16171.60	200.00	614.00	613.94
F4304	16181.68	200.00	614.00	613.93
F4305	16181.68	200.00	618.50	618.31
F4306	16206.93	200.00	618.50	618.44
F4307	16223.64	199.97	613.72	618.76
F4401	16093.88	300.00	591.79	591.57
F4402	16129.15	300.00	601.86	601.47
F4403	16171.63	300.00	614.00	613.88
F4404	16181.71	300.00	614.00	613.82
F4405	16181.71	300.00	618.50	618.42
F4406	16206.96	300.00	618.50	618.45
F4407	16223.86	300.00	613.66	618.51
F4501	16093.81	400.00	591.76	591.75
F4502	16129.13	400.00	601.85	601.64
F4503	16171.66	400.00	614.00	613.61
F4504	16181.74	400.00	614.00	613.62
F4505	16181.74	400.00	618.50	618.41
F4506	16206.99	400.00	618.50	618.48
F4507	16219.15	400.02	615.01	618.75
F4601	16095.96	500.00	592.36	592.32
F4602	16130.22	500.00	602.15	601.93
F4603	16171.69	500.00	614.00	613.80
F4604	16181.77	500.00	614.00	613.86
F4605	16181.77	500.00	618.50	618.39
F4606	16207.02	500.00	618.50	618.42
F4607	16214.87	500.01	616.27	617.97
FB01	14900.00	352.42	579.83	579.50
FB02	15000.00	352.42	580.64	580.45
FB03	15100.00	352.42	581.45	581.24
FB04	15200.00	352.42	582.26	582.22
FB05	15300.00	352.42	583.06	582.98
FB06	15400.00	352.42	583.87	583.69
FB07	15500.00	352.42	584.68	584.44
FB08	15600.00	352.42	586.49	586.24
FB09	15700.00	352.42	588.30	588.08
FB10	15800.00	352.42	589.10	588.95
FB11	15900.00	352.42	589.91	589.89
FB12	16000.00	352.42	590.72	590.64
FB13	14900.00	513.35	580.78	580.38
FB14	15000.00	513.35	581.59	581.25
FB15	15100.00	513.35	582.40	582.32
FB16	15200.00	513.35	583.21	583.08
FB17	15300.00	513.35	584.01	584.00
FB18	15400.00	513.35	584.82	584.74
FB19	15500.00	513.35	585.63	585.53
FB20	15600.00	513.35	587.44	587.26
FB21	15700.00	513.35	589.24	589.05
FB22	15800.00	513.35	590.05	589.78
FB23	15900.00	513.35	590.86	590.62
FB24	16000.00	513.35	591.67	591.39
FB25	14900.00	674.29	579.83	579.69
FB26	15000.00	674.29	580.64	580.47
FB27	15100.00	674.29	581.45	581.42
FB28	15200.00	674.29	582.26	582.06
FB29	15300.00	674.29	583.07	582.93

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF FOUNDATION ELEVATION DESIGN	TOP OF FOUNDATION ELEVATION RECORD
FB30	15400.00	674.29	583.87	583.66
FB31	15500.00	674.29	584.68	584.50
FB32	15600.00	674.29	586.49	586.28
FB33	15700.00	674.29	588.30	588.21
FB34	15800.00	674.29	589.10	588.95
FB35	15900.00	674.29	589.91	589.81
FB36	16000.00	674.29	590.72	590.51
FG01	14900.00	200.00	580.73	580.50
FG02	15000.00	200.00	581.54	581.17
FG03	15100.00	200.00	582.35	582.15
FG04	15200.00	200.00	583.15	583.01
FG05	15300.00	200.00	583.96	583.91
FG06	15400.00	200.00	584.77	584.43
FG07	15500.00	200.00	585.58	585.40
FG08	15600.00	200.00	587.39	587.18
FG09	15700.00	200.00	589.19	589.14
FG10	15800.00	200.00	590.00	589.85
FG11	15900.00	200.00	590.81	590.59
FG12	16000.00	200.00	591.62	591.40
FG13	14900.00	300.00	580.14	580.01
FG14	15000.00	300.00	580.95	580.68
FG15	15100.00	300.00	581.76	581.61
FG16	15200.00	300.00	582.57	582.52
FG17	15300.00	300.00	583.37	583.29
FG18	15400.00	300.00	584.18	584.10
FG19	15500.00	300.00	584.99	584.80
FG20	15600.00	300.00	586.80	586.62
FG21	15700.00	300.00	588.60	588.48
FG22	15800.00	300.00	589.41	589.33
FG23	15900.00	300.00	590.22	590.13
FG24	16000.00	300.00	591.03	591.03
FG25	14900.00	400.00	580.11	580.11
FG26	15000.00	400.00	580.92	580.78
FG27	15100.00	400.00	581.73	581.55
FG28	15200.00	400.00	582.54	582.42
FG29	15300.00	400.00	583.34	583.21
FG30	15400.00	400.00	584.15	584.05
FG31	15500.00	400.00	584.96	584.74
FG32	15600.00	400.00	586.77	586.65
FG33	15700.00	400.00	588.58	588.49
FG34	15800.00	400.00	589.38	589.32
FG35	15900.00	400.00	590.19	590.14
FG36	16000.00	400.00	591.00	590.87
FG37	14900.00	500.00	580.70	580.46
FG38	15000.00	500.00	581.51	581.30
FG39	15100.00	500.00	582.32	582.10
FG40	15200.00	500.00	583.13	583.07
FG41	15300.00	500.00	583.93	583.81
FG42	15400.00	500.00	584.74	584.39
FG43	15500.00	500.00	585.55	585.47
FG44	15600.00	500.00	587.36	587.35
FG45	15700.00	500.00	589.17	588.77
FG46	15800.00	500.00	589.97	589.84
FG47	15900.00	500.00	590.78	590.72
FG48	16000.00	500.00	591.59	591.28
FG49	14900.00	600.00	580.27	580.18
FG50	15000.00	600.00	581.08	580.89
FG51	15100.00	600.00	581.89	581.71
FG52	15200.00	600.00	582.70	582.56
FG53	15300.00	600.00	583.50	583.45
FG54	15400.00	600.00	584.31	584.25
FG55	15500.00	600.00	585.12	584.75
FG56	15600.00	600.00	586.93	586.75
FG57	15700.00	600.00	588.73	588.52
FG58	15800.00	600.00	589.54	589.41
FG59	15900.00	600.00	590.35	590.21
FG60	16000.00	600.00	591.16	590.91
FG61	14900.00	700.00	579.99	579.83
FG62	15000.00	700.00	580.79	580.44
FG63	15100.00	700.00	581.60	581.34
FG64	15200.00	700.00	582.41	582.31
FG65	15300.00	700.00	583.22	583.05
FG66	15400.00	700.00	584.02	583.64
FG67	15500.00	700.00	584.83	584.58
FG68	15600.00	700.00	586.64	586.37
FG69	15700.00	700.00	588.45	588.13
FG70	15800.00	700.00	589.26	588.99
FG71	15900.00	700.00	590.06	589.98
FG72	16000.00	700.00	590.87	590.75
FG73	14900.00	800.00	580.57	580.46
FG74	15000.00	800.00	581.38	581.22
FG75	15100.00	800.00	582.19	582.05
FG76	15200.00	800.00	583.00	582.86
FG77	15300.00	800.00	583.81	583.66
FG78	15400.00	800.00	584.61	584.46
FG79	15500.00	800.00	585.42	585.34
FG80	15600.00	800.00	587.23	587.14
FG81	15700.00	800.00	589.04	588.70
FG82	15800.00	800.00	589.84	589.50
FG83	15900.00	800.00	590.65	590.50
FG84	16000.00	800.00	591.46	591.42

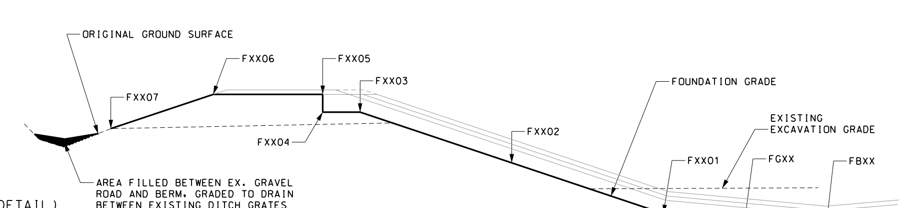
NOTE: RECORD ELEVATIONS AND LAYER THICKNESSES BASED ON A COMPILATION OF RECORD SURVEY DATA PROVIDED BY MAURER-STUTZ, INC. THIS RECORD SURVEY PROVIDED BY MAURER-STUTZ, INC., IS CONTAINED ELSEWHERE IN THIS ACCEPTANCE REPORT.

TYPICAL POINT NUMBER LOCATION

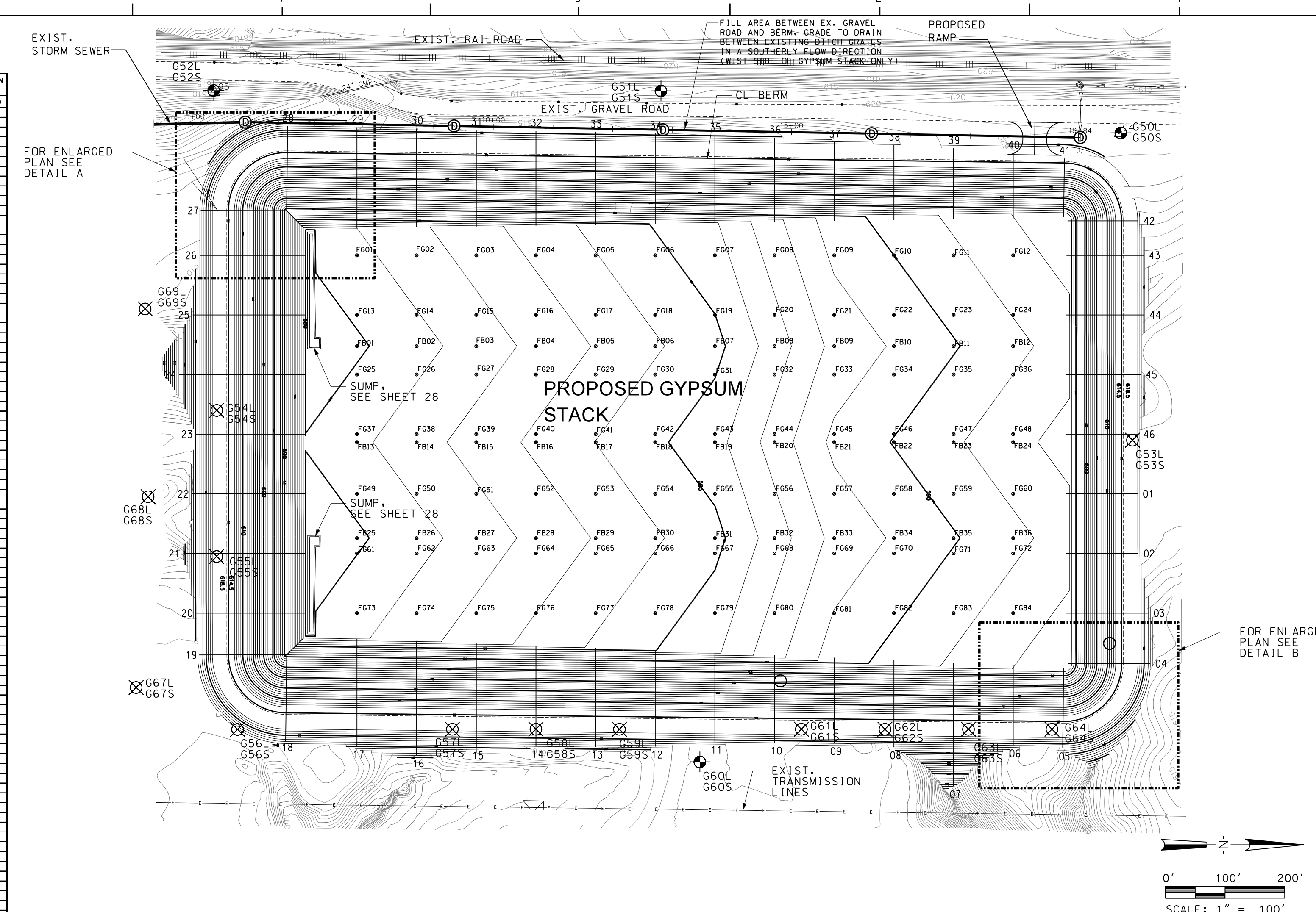
FB 00
GRID POINT NUMBER
FOUNDATION GRADE (BREAK POINT)

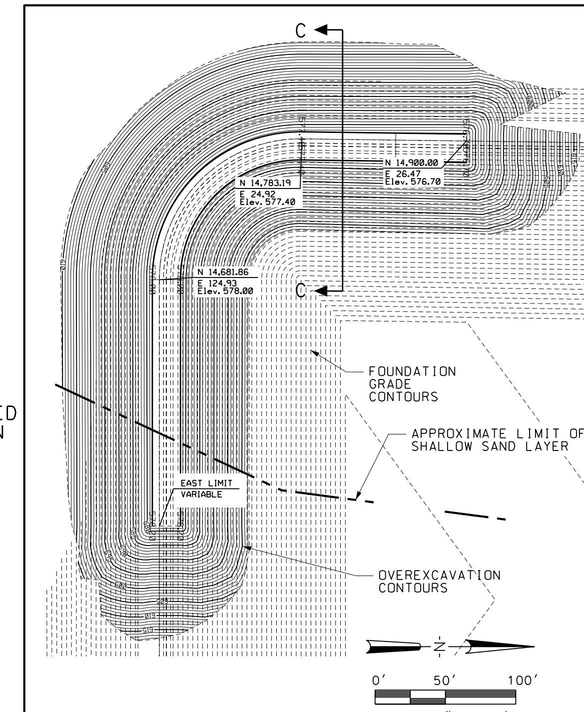
FG 00
GRID POINT NUMBER
FOUNDATION GRADE

F 00 00
POINT NUMBER (SEE POINT NUMBERING DETAIL)
CONTROL LINE NUMBER
FOUNDATION GRADE

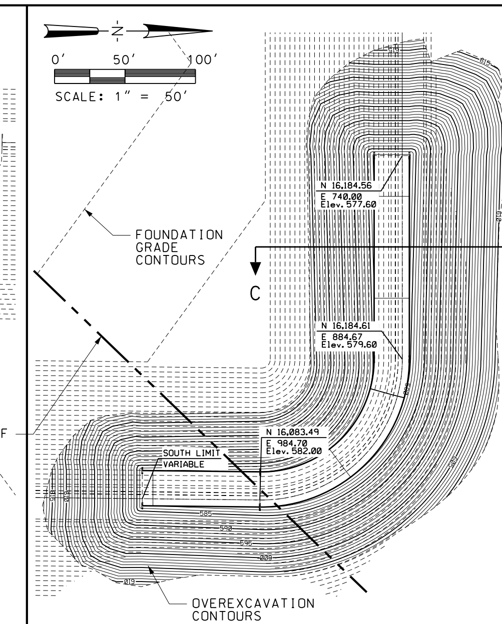


POINT NUMBERING DETAIL

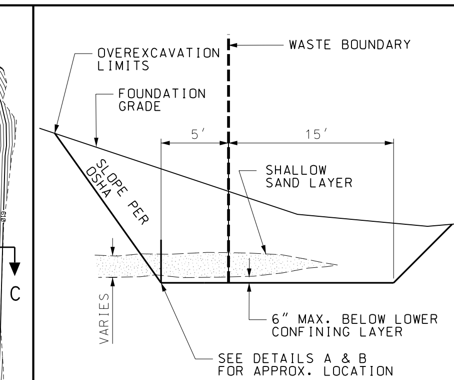




DETAIL A



DETAIL B



DETAIL C

NOTES:

1. GRADES ARE APPROXIMATE BASED ON AVAILABLE GEOTECHNICAL DATA. ACTUAL GRADE TO FULLY EXCAVATE THE SHALLOW SAND LAYER SHALL BE APPROX. 6" BELOW THE LAYER AS SHOWN ABOVE.
2. CONTRACTOR SHALL EXCAVATE TO THE LATERAL LIMITS OF THE SHALLOW SAND LAYER. GRADE LOCATIONS MAY CHANGE BASED UPON THE ACTUAL EXCAVATION REQUIRED TO CUT OFF THE LAYER AS SHOWN ON THE DETAIL ABOVE.

RECORD DRAWING

FILE NO. -C180-C102-08.dgn

AEG CAD GENERATED
DO NOT REVISE MANUALLY

REFER TO OTHER PLAN SHEETS FOR STANDARD LEGEND

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-22-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	03-05-08	SKB	SMB	SMB	CORRECTIONS TO TABLE - ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
2	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
3	04-18-08	SKB	SMB	SMB	REVISED OVER EXCAVATION LIMITS
4	07-17-08	SKB	SMB	SMB	REVISED ELEVATION FOR POINT F0304 TO BE 614.0
5	07-25-08	DBH	SMB	SMB	RAISED FOUNDATION FLOOR ELEV. TWO FEET AT ALL POINTS NORTH OF N15500 INCLUDE REVISED CONTOURS AND POINT TABLE
6	03-05-09	SKB	ADC	SMB	ISSUED FOR RECORD DRAWING

LAYOUT SMB 05/08/07
DRAWN SKB 02-21-08
REVIEWED

Brand0939
09-Apr-2009

HANSON
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, Illinois 62703-2886
Phone: (217) 788-2450 Fax: (217) 788-2503
Illinois Licensed Professional Service Corporation #184-001084
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SCALE

DRAFTER

DATE 03-26-09

DRAWING TITLE

GYPSUM STACK-FOUNDATION GRADE

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy Resources Generating

DRAWING NUMBER C180-C102 REV. 6

SHEET NO. 08 OF 33

30x42

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF CLAY LAYER DESIGN	TOP OF CLAY LAYER RECORD	CLAY LAYER THICKNESS	CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF CLAY LAYER DESIGN	TOP OF CLAY LAYER RECORD	CLAY LAYER THICKNESS	CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF CLAY LAYER DESIGN	TOP OF CLAY LAYER RECORD	CLAY LAYER THICKNESS
S0101	16094.01	600.00	594.92	595.29	3.4	S4001	16000.00	131.30	595.02	595.38	3.6	SG61	14900.00	700.00	582.99	582.99	3.2
S0102	16131.93	600.00	605.75	605.94	3.4	S4002	16000.00	93.78	605.74	605.83	3.3	SG62	15000.00	700.00	583.79	583.88	3.4
S0103	16176.55	600.00	618.50	618.66	4.8	S4003	16000.00	49.11	618.50	618.58	4.7	SG63	15100.00	700.00	584.60	584.62	3.3
S0201	16093.01	700.00	594.62	595.01	3.6	S4101	16084.55	130.01	595.71	596.11	3.4	SG64	15200.00	700.00	585.41	585.45	3.1
S0202	16131.96	700.00	605.75	605.83	3.3	S4102	16085.04	92.92	606.31	606.49	3.3	SG65	15300.00	700.00	586.22	586.24	3.2
S0203	16176.58	700.00	618.50	618.59	4.8	S4103	16085.61	50.25	618.50	618.66	4.8	SG66	15400.00	700.00	587.02	587.09	3.5
S0301	16095.16	800.00	595.23	595.72	3.6	S4201	16096.74	142.27	595.74	596.24	3.7	SG67	15500.00	700.00	587.83	587.92	3.3
S0302	16132.64	800.00	605.94	606.02	3.4	S4202	16133.75	142.26	606.31	606.47	3.5	SG68	15600.00	700.00	589.64	589.73	3.4
S0303	16176.61	800.00	618.50	618.68	4.8	S4203	16176.41	142.25	618.50	618.70	4.9	SG69	15700.00	700.00	591.45	591.50	3.4
S0401	16096.98	884.70	595.74	596.05	3.4	S4301	16095.54	200.00	595.39	595.74	3.4	SG70	15800.00	700.00	592.26	592.34	3.4
S0402	16133.97	884.69	606.31	606.33	3.4	S4302	16132.87	200.00	606.05	606.20	3.4	SG71	15900.00	700.00	593.06	593.07	3.1
S0403	16176.64	884.68	618.50	618.70	4.8	S4303	16176.43	200.00	618.50	618.61	4.7	SG72	16000.00	700.00	593.87	594.03	3.3
S0501	16084.47	896.97	595.71	596.24	3.6	S4401	16093.45	300.00	594.78	595.08	3.5	SG73	14900.00	800.00	583.57	583.57	3.1
S0502	16084.06	934.06	606.31	606.41	3.5	S4402	16131.83	300.00	605.75	605.94	3.5	SG74	15000.00	800.00	584.38	584.45	3.2
S0503	16083.58	976.73	618.50	618.65	4.7	S4403	16176.46	300.00	618.50	618.64	4.8	SG75	15100.00	800.00	585.19	585.20	3.2
S0601	16000.00	893.58	595.01	595.08	3.2	S4501	16093.38	400.00	594.75	595.01	3.3	SG76	15200.00	800.00	586.00	586.00	3.1
S0602	16000.00	931.11	605.73	605.74	3.3	S4502	16131.87	400.00	605.75	605.91	3.4	SG77	15300.00	800.00	586.81	586.82	3.2
S0603	16000.00	975.79	618.50	618.51	4.6	S4503	16176.49	400.00	618.50	618.68	5.1	SG78	15400.00	800.00	587.61	587.70	3.2
S0701	15900.00	889.55	594.18	594.28	3.2	S4601	16095.53	500.00	595.36	595.55	3.2	SG79	15500.00	800.00	588.42	588.52	3.2
S0702	15900.00	928.54	605.32	605.41	3.1	S4602	16131.90	500.00	605.75	605.92	3.4	SG80	15600.00	800.00	590.23	590.29	3.1
S0703	15900.00	974.68	618.50	618.50	4.7	S4603	16176.52	500.00	618.50	618.59	4.8	SG81	15700.00	800.00	592.04	592.13	3.4
S0801	15800.00	885.53	593.35	593.44	3.1	SB01	14900.00	352.42	582.83	582.85	3.4	SG82	15800.00	800.00	592.84	592.90	3.4
S0802	15800.00	925.97	604.90	604.98	3.2	SB02	15000.00	352.42	583.64	583.71	3.3	SG83	15900.00	800.00	593.65	593.69	3.2
S0803	15800.00	973.56	618.50	618.55	4.8	SB03	15100.00	352.42	584.45	584.49	3.3	SG84	16000.00	800.00	594.46	594.76	3.3
S0901	15700.00	881.50	592.52	592.61	3.3	SB04	15200.00	352.42	585.26	585.32	3.1						
S0902	15700.00	923.40	604.49	604.57	3.2	SB05	15300.00	352.42	586.06	586.06	3.1						
S0903	15700.00	972.45	618.50	618.57	4.8	SB06	15400.00	352.42	586.87	586.97	3.3						
S1001	15600.00	873.90	590.66	590.75	3.5	SB07	15500.00	352.42	587.68	587.76	3.3						
S1002	15600.00	920.83	604.07	604.16	3.2	SB08	15600.00	352.42	589.49	589.54	3.3						
S1003	15600.00	971.33	618.50	618.51	4.7	SB09	15700.00	352.42	591.30	591.31	3.2						
S1101	15500.00	866.30	588.81	588.90	3.2	SB10	15800.00	352.42	592.10	592.20	3.3						
S1102	15500.00	918.26	603.66	603.72	3.2	SB11	15900.00	352.42	592.91	593.03	3.1						
S1103	15500.00	970.21	618.50	618.50	4.7	SB12	16000.00	352.42	593.72	593.88	3.2						
S1201	15400.00	862.27	587.98	588.08	3.2	SB13	14900.00	513.35	583.78	583.86	3.5						
S1202	15400.00	915.68	603.24	603.30	3.3	SB14	15000.00	513.35	584.59	584.66	3.4						
S1203	15400.00	969.10	618.50	618.51	4.8	SB15	15100.00	513.35	585.40	585.41	3.1						
S1301	15300.00	858.25	587.15	587.19	3.3	SB16	15200.00	513.35	586.21	586.26	3.2						
S1302	15300.00	913.11	602.82	602.89	3.3	SB17	15300.00	513.35	587.01	587.04	3.0						
S1303	15300.00	967.98	618.50	618.51	4.7	SB18	15400.00	513.35	587.82	587.86	3.1						
S1401	15200.00	854.22	586.32	586.41	3.2	SB19	15500.00	513.35	588.63	588.65	3.1						
S1402	15200.00	910.54	602.41	602.41	3.1	SB20	15600.00	513.35	590.44	590.55	3.3						
S1403	15200.00	966.87	618.50	618.51	4.7	SB21	15700.00	513.35	592.24	592.26	3.2						
S1501	15100.00	850.19	585.49	585.59	3.2	SB22	15800.00	513.35	593.05	593.14	3.4						
S1502	15100.00	907.97	601.99	602.01	3.2	SB23	15900.00	513.35	593.86	593.91	3.3						
S1503	15100.00	965.75	618.50	618.52	4.8	SB24	16000.00	513.35	594.67	594.85	3.5						
S1601	15000.00	846.17	584.65	584.73	3.2	SB25	14900.00	674.29	582.83	582.91	3.2						
S1602	15000.00	905.40	601.58	601.65	3.2	SB26	15000.00	674.29	583.64	583.72	3.3						
S1603	15000.00	964.63	618.50	618.57	4.8	SB27	15100.00	674.29	584.45	584.47	3.1						
S1701	14900.00	842.14	583.82	584.08	3.3	SB28	15200.00	674.29	585.26	585.35	3.3						
S1702	14900.00	903.35	601.31	601.39	3.2	SB29	15300.00	674.29	586.07	586.09	3.2						
S1703	14900.00	963.52	618.50	618.50	4.7	SB30	15400.00	674.29	586.87	586.95	3.3						
S1801	14813.86	838.67	583.11	583.51	3.5	SB31	15500.00	674.29	587.68	587.75	3.3						
S1802	14782.32	869.87	592.12	592.18	3.1	SB32	15600.00	674.29	589.49	589.59	3.3						
S1803	14781.09	962.19	618.50	618.54	4.6	SB33	15700.00	674.29	591.30	591.34	3.1						
S1901	14813.86	838.67	583.11	583.51	3.5	SB34	15800.00	674.29	592.10	592.19	3.2						
S1902	14782.32	869.87	592.12	592.16	3.1	SB35	15900.00	674.29	592.91	592.92	3.1						
S1903	14689.99	870.07	618.50	618.52	4.7	SB36	16000.00	674.29	593.72	593.94	3.4						
S2001	14814.62	800.00	582.89	582.98	3.1	SG01	14900.00	200.00	583.73	583.84	3.3						
S2002	14752.10	800.00	600.75	600.82	3.2	SG02	15000.00	200.00	584.54	584.56	3.4						
S2003	14689.97	800.00	618.50	618.58	4.7	SG03	15100.00	200.00	585.35	585.42	3.3						
S2101	14816.61	700.00	582.31	582.51	3.2	SG04	15200.00	200.00	586.15	586.21	3.2						
S2102	14752.08	700.00	600.75	600.80	3.2	SG05	15300.00	200.00	586.96	587.04	3.1						
S2103	14689.95	700.00	618.50	618.50	4.6	SG06	15400.00	200.00	587.77	587.81	3.4						
S2201	14815.61	600.00	582.59	582.75	3.3	SG07	15500.00	200.00	588.58	588.66	3.3						
S2202	14752.06	600.00	600.75	600.76	3.3	SG08	15600.00	200.00	590.39	590.43	3.3						
S2203	14689.93	600.00	618.50	618.50	4.7	SG09	15700.00	200.00	592.19	592.26	3.1						
S2301	14814.16	500.00	583.00	583.15	3.3	SG10	15800.00	200.00	593.00	593.07	3.2						
S2302	14752.03	500.00	600.75	600.78	3.4	SG11	15900.00	200.00	593.81	594.03	3.4						
S2303	14689.91	500.00	618.50	618.52	4.9	SG12	16000.00	200.00	594.62	594.69	3.3						
S2401	14816.11	400.00	582.44	582.87	3.6	SG13	14900.00	300.00	583.14	583.21	3.2						
S2402	14752.01	400.00	600.75	600.77	3.3	SG14	15000.00	300.00	583.95	584.05	3.4						
S2403	14689.89	400.00	618.50	618.51	4.8	SG15	15100.00	300.00	584.76	584.77	3.2						
S2501	14815.99	300.00	582.46	582.58	3.2	SG16	15200.00	300.00	585.57	585.67	3.1						
S2502	14751.99	300.00	600.75	600.78	3.3	SG17	15300.00	300.00	586.37	586.41	3.1						
S2503	14689.87	300.00	618.50	618.52	4.8	SG18	15400.00	300.00	587.18	587.22	3.1						
S2601	14813.97	200.00	583.04	583.13	3.2	SG19	15500.00	300.00	587.99	588.09	3.3						
S2602	14751.57	200.00	600.86	600.86	3.2	SG20	15600.00	300.00	589.80	589.81	3.2						
S2603	14689.85	200.00	618.50	618.53	4.7	SG21	15700.00	300.00	591.60	591.65	3.2						
S2701	14813.09	156.55	583.29	583.56	3.4	SG22	15800.00	300.00	592.41	592.45	3.1						
S2702	14782.16	125.21	592.12	592.22	3.1	SG23	15900.00	300.00	593.22	593.41	3.3						
S2703	14689.83	125.03	618.50	618.52	4.7	SG24	16000.00	300.00	594.03	594.10	3.1						
S2801	14813.09	156.55	583.29	583.54	3.4	SG25	14900.00	400.00	583.11	583.23	3.1						
S2802	14782.16	125.21	592.12	592.20	3.1	SG26	15000.00	400.00	583.92	584.00	3.2						
S2803	14783.19	32.89	618.50	618.51	4.7	SG27	15100.00	400.00	584.73	584.75	3.2						
S2901	14900.00	155.22	583.99	584.23	3.2	SG28	15200.00	400.00	585.54	585.61	3.2						
S2902	14900.00	94.62	601.31	601.36	3.2	SG29	15300.00	400.00	586.34	586.35	3.1						
S2903	14900.00	34.44	618.50	618.51	4.6	SG30	15400.00	400.00	587.15	587.23	3.2						
S3001	15000.00	153.70	584.81	584.85	3.1	SG31	15500.00	400.00	587.96	588.05	3.3						
S3002	15000.00	94.74	601.66	601.72	3.3	SG32	15600.00	400.00	589.77	589.80	3.1						
S3003	15000.00	35.78	618.50	618.55	4.6	SG33	15700.00	400.00	591.58	591.64	3.1						
S3101	15100.00	152.17	585.63	585.72	3.2	SG34	15800.00	400.00	592.38	592.45	3.1						
S3102	15100.00	94.64	602.06	602.09	3.0	SG35	15900.00	400.00	593.19	593.26	3.1						
S3103	15100.00	37.11	618.50	618.51	4.6	SG36	16000.00	400.00	594.00	594.07	3.2						
S3201	15200.00	150.65	586.45	586.54	3.3	SG37	14900.00	500.00	583.70	583.77	3.3						
S3202	15200.00	94.55	602.47	602.47	3.1	SG38	15000.00	500.00	584.51	584.58	3.3						
S3203	15200.00	38.44	618.50	618.57	4.6	SG39	15100.00	500.00	585.32	585.36	3.3						
S3301	15300.00	149.12	587.26	587.46	3.3	SG40	15200.00	500.00	586.13	586.19	3.1						
S3302	15300.00	94.45	602.88	602.93	3.0	SG41	15300.00	500.00	586.93	586.95	3.1						
S3303	15300.00	39.78	618.50	618.51	4.5	SG42	15400.00	500.00	587.74	587.82	3.4						
S3401	15400.00	147.60	588.08	588.26	3.3	SG43	15500.00	500.00	588.55	588.60	3.1						
S3402	15400.00	94.35	603.29	603.37	3.1	SG44	15600.00	500.00	590.36	590.43	3.1						
S3403	15400.00	41.11	618.50	618.51	4.6	SG45	15700.00	500.00	592.17	592.23	3.5						
S3501	15500.00	146.07	588.90	588.93	3.1	SG46	15800.00	500.00	592.97	593.05	3.2						
S3502	15500.00	94.26	603.70	603.69	3.1	SG47	15900.00	500.00	593.78	593.79	3.1						
S3503	15500.00	42.45	618.50	618.49	4.6	SG48	16000.00	500.00	594.59	594.83	3.6						
S3601	15600.00	140.97	590.73	590.85	3.2	SG49	14900.00	600.00	583.27	583.37	3.2						
S3602	15600.00	94.16	604.11	604.16	3.1	SG50	15000.00	600.00	584.08	584.17	3.3						
S3603	15600.00	43.78	618.50	618.50	4.6	SG51	15100.00	600.00	584.89	584.95	3.2						
S3701	15700.00	135.87	592.57	592.65	3.3	SG52	15200.00	600.00	585.70	585.70	3.1						
S3702	15700.00	94.07	604.51	604.53	3.0	SG53	15300.00	600.00	586.50	586.50	3.0						
S3703	15700.00	45.11	618.50	618.49	4.6	SG54	15400.00	600.00	587.31	587.39	3.1						
S3801	15800.00	134.35	593.39	593.44	3.2	SG55	15500.00	600.00	588.12	588.18	3.4						
S3802	15800.00	93.97	604.92	604.99	3.4	SG56	15600.00	600.00	589.93	590.03	3.3						
S3803	15800.00	46.45	618.50	618.50	4.7	SG57	15700.00	600.00	591.73	591.81	3.3						
S3901	15900.00	132.82	594.20	594.71	3.5	SG58	15800.00	600.00	592.54	592.57	3.2						
S3902	15900.00	93.87	605.33	605.43	3.3	SG59	15900.00	600.00	593.35	593.44	3.2						
S3903	15900.00	47.78	618.50	618.54	4.6	SG60	16000.00	600.00	594.16	594.43	3.5						

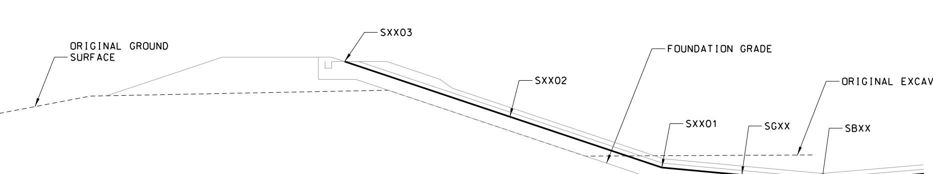
NOTE: RECORD ELEVATIONS AND LAYER THICKNESSES BASED ON A COMPILATION OF RECORD SURVEY DATA PROVIDED BY MAURER-STUTZ, INC. THIS RECORD SURVEY PROVIDED BY MAURER-STUTZ, INC., IS CONTAINED ELSEWHERE IN THIS ACCEPTANCE REPORT.

TYPICAL POINT NUMBER LOCATION

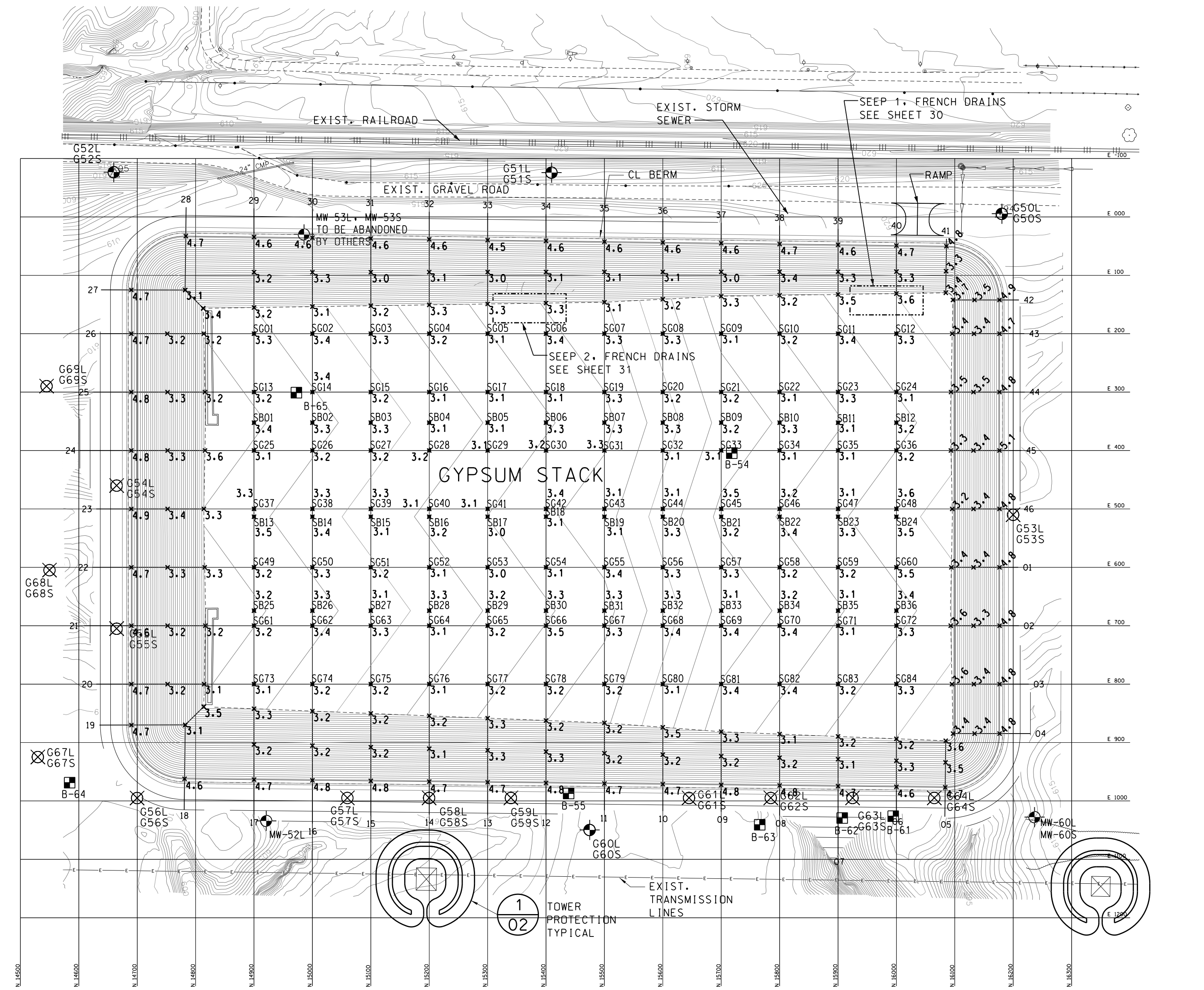
SB 00 — GRID POINT NUMBER — CLAY LAYER GRADE (BREAK POINT)

SG 00 — GRID POINT NUMBER — CLAY LAYER GRADE

S 00 00 — POINT NUMBER (SEE POINT NUMBERING DETAIL) — CONTROL LINE NUMBER — CLAY LAYER GRADE



POINT NUMBERING DETAIL



STANDARD LEGEND
(ALL SYMBOLS MAY NOT BE USED ON EACH PLAN)

ORIGINAL CONTOURS	NEW CONTOURS
FENCELINE	LD/LCRS COLLECTION PIPE
TRANSMISSION TOWER	GEONET
OVERHEAD ELECTRIC	MW-53L MONITORING WELL
LIMITS OF VEGETATION	B-55 BORING
GRAVEL ROAD	G69L FUTURE GROUNDWATER MONITORING WELL
RAILROAD	
STORM SEWER	4" DIA. PERFORATED DRAINAGE PIPING
CONTROL POINT	6" DIA. OUTFALL PIPING
	3.1 CLAY LAYER THICKNESS (IN FEET)

0' 100' 200'
SCALE: 1" = 100'

AEG CAD GENERATED
DO NOT REVISE MANUALLY

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-21-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	03-05-08	SKB	SMB	SMB	REVISED POINT NO. DETAIL - ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
2	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
3	08-29-08	DBH	SMB	SMB	RAISE BOTTOM ELEV. OF NORTH 400' OF CELL-UPDATE CONTOURS & POINT TABLE
4	03-05-09	SKB	ADC	SMB	ISSUED FOR RECORD DRAWING

LAYOUT SMB 05/08/07 — DRAWN SKB 03-05-08 — REVIEWED

RECORD DRAWING

FILE NO. -C180-C102-09.dgn

HANSON
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, Illinois 62703-2886
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DRAWING TITLE
GYPSUM STACK - CLAY LAYER GRADE

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy Resources Generating

SCALE — DRAFTER — DATE 03-26-09

DRAWING NUMBER C180-C102 REV. 4

SHEET NO. 09 OF 33

Brand0939
09-Apr-2009

30x42

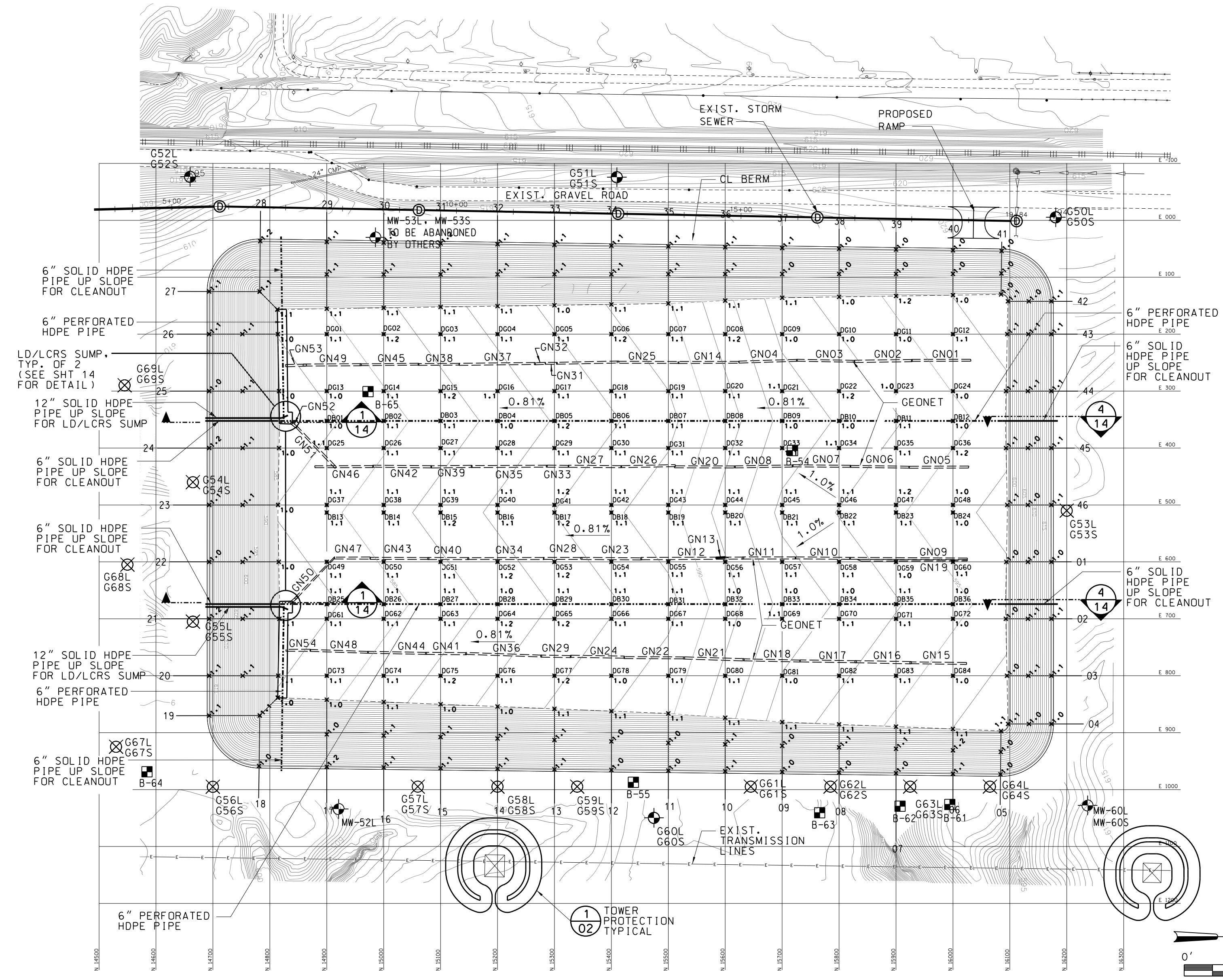
C180-C102
PAGE NO. - 10

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF DRAINAGE DESIGN	TOP OF DRAINAGE RECORD	DRAINAGE LAYER THICKNESS
D0101	16093.86	600.00	595.92	596.32	1.0
D0102	16131.65	600.00	606.71	606.92	0.9
D0103	16172.91	600.00	618.50	618.67	1.0
D0201	16092.87	700.00	595.62	596.04	1.0
D0202	16131.68	700.00	606.71	606.88	1.1
D0203	16172.94	700.00	618.50	618.70	1.1
D0301	16095.02	800.00	596.23	596.74	1.0
D0302	16132.36	800.00	606.90	607.10	1.1
D0303	16172.97	800.00	618.50	618.71	1.1
D0401	16096.83	884.70	596.74	597.14	1.1
D0402	16133.70	884.69	607.27	607.31	1.0
D0403	16173.00	884.68	618.50	618.72	1.0
D0501	16084.47	896.82	596.71	597.34	1.1
D0502	16084.06	933.79	607.27	607.40	1.0
D0503	16083.62	973.09	618.50	618.69	1.0
D0601	16000.00	893.44	596.01	596.18	1.1
D0602	16000.00	930.84	606.70	606.89	1.2
D0603	16000.00	972.15	618.50	618.58	1.1
D0701	15900.00	889.41	595.18	595.38	1.1
D0702	15900.00	928.27	606.28	606.46	1.1
D0703	15900.00	971.04	618.50	618.56	1.0
D0801	15800.00	885.38	594.35	594.55	1.1
D0802	15800.00	925.70	605.86	606.04	1.1
D0803	15800.00	969.92	618.50	618.56	1.0
D0901	15700.00	881.36	593.52	593.70	1.1
D0902	15700.00	923.12	605.45	605.55	1.0
D0903	15700.00	968.81	618.50	618.61	1.0
D1001	15600.00	873.76	591.66	591.85	1.1
D1002	15600.00	920.55	605.03	605.16	1.1
D1003	15600.00	967.69	618.50	618.67	1.1
D1101	15500.00	866.16	589.81	589.95	1.1
D1102	15500.00	917.98	604.62	604.70	1.0
D1103	15500.00	966.57	618.50	618.50	1.0
D1201	15400.00	862.13	588.98	589.17	1.1
D1202	15400.00	915.41	604.20	604.28	1.0
D1203	15400.00	965.46	618.50	618.53	1.0
D1301	15300.00	858.10	588.15	588.33	1.1
D1302	15300.00	912.84	603.79	603.94	1.1
D1303	15300.00	964.34	618.50	618.62	1.1
D1401	15200.00	854.08	587.32	587.44	1.0
D1402	15200.00	910.27	603.37	603.53	1.1
D1403	15200.00	963.22	618.50	618.61	1.1
D1501	15100.00	850.05	586.49	586.59	1.0
D1502	15100.00	907.70	602.95	603.09	1.1
D1503	15100.00	962.11	618.50	618.58	1.1
D1601	15000.00	846.02	585.65	585.79	1.1
D1602	15000.00	905.12	602.54	602.69	1.1
D1603	15000.00	960.99	618.50	618.61	1.1
D1701	14900.00	842.00	584.82	585.04	1.0
D1702	14900.00	903.07	602.27	602.39	1.0
D1703	14900.00	959.88	618.50	618.70	1.2
D1801	14814.00	838.53	584.11	584.50	1.0
D1802	14782.32	869.87	593.16	593.36	1.1
D1803	14781.03	958.55	618.50	618.58	1.0
D1901	14814.00	838.53	584.11	584.54	1.0
D1902	14782.32	869.87	593.16	593.36	1.1
D1903	14693.63	870.07	618.50	618.62	1.1
D2001	14814.76	800.00	583.89	584.06	1.1
D2002	14752.37	800.00	601.71	601.84	1.1
D2003	14693.61	800.00	618.50	618.65	1.1
D2101	14816.75	700.00	583.31	583.61	1.1
D2102	14752.35	700.00	601.71	601.84	1.1
D2103	14693.59	700.00	618.50	618.65	1.2
D2201	14815.75	600.00	583.59	583.79	1.0
D2202	14752.33	600.00	601.71	601.85	1.1
D2203	14693.57	600.00	618.50	618.52	1.0
D2301	14814.30	500.00	584.00	584.18	1.0
D2302	14752.31	500.00	601.71	601.82	1.1
D2303	14693.55	500.00	618.50	618.68	1.1
D2401	14816.25	400.00	583.44	583.86	1.0
D2402	14752.29	400.00	601.71	601.85	1.1
D2403	14693.53	400.00	618.50	618.68	1.2
D2501	14816.13	300.00	583.46	583.64	1.0
D2502	14752.27	300.00	601.71	601.90	1.1
D2503	14693.51	300.00	618.50	618.67	1.0
D2601	14814.10	200.00	584.04	584.16	1.0
D2602	14751.84	200.00	601.83	601.97	1.1
D2603	14693.49	200.00	618.50	618.67	1.1
D2701	14813.23	156.69	584.29	584.61	1.1
D2702	14782.16	125.21	593.16	593.32	1.1
D2703	14693.47	125.04	618.50	618.68	1.1
D2801	14813.23	156.69	584.29	584.61	1.1
D2802	14782.16	125.21	593.16	593.32	1.1
D2803	14783.15	36.53	618.50	618.67	1.2
D2901	14900.00	155.37	584.99	585.36	1.1
D2902	14900.00	94.89	602.27	602.46	1.1
D2903	14900.00	38.08	618.50	618.63	1.1
D3001	15000.00	153.84	585.81	585.95	1.1
D3002	15000.00	95.01	602.62	602.78	1.1
D3003	15000.00	39.42	618.50	618.61	1.0
D3101	15100.00	152.32	586.63	586.81	1.1
D3102	15100.00	94.92	603.03	603.16	1.1
D3103	15100.00	40.75	618.50	618.68	1.2
D3201	15200.00	150.79	587.44	587.64	1.1
D3202	15200.00	94.82	603.43	603.55	1.1
D3203	15200.00	42.09	618.50	618.70	1.1
D3301	15300.00	149.26	588.26	588.52	1.0
D3302	15300.00	94.72	603.84	603.97	1.1
D3303	15300.00	43.42	618.50	618.63	1.1
D3401	15400.00	147.74	589.08	589.38	1.1
D3402	15400.00	94.63	604.25	604.38	1.1
D3403	15400.00	44.75	618.50	618.66	1.1
D3501	15500.00	146.21	589.89	590.06	1.1
D3502	15500.00	94.53	604.66	604.75	1.1
D3503	15500.00	46.09	618.50	618.61	1.1
D3601	15600.00	141.11	591.73	591.95	1.1
D3602	15600.00	94.44	605.07	605.18	1.1
D3603	15600.00	47.42	618.50	618.64	1.1
D3701	15700.00	136.02	593.57	593.77	1.1
D3702	15700.00	94.34	605.48	605.53	1.0
D3703	15700.00	48.75	618.50	618.60	1.1
D3801	15800.00	134.49	594.39	594.47	1.0
D3802	15800.00	94.24	605.88	605.98	1.0
D3803	15800.00	50.09	618.50	618.58	1.0
D3901	15900.00	132.96	595.20	595.94	1.2
D3902	15900.00	94.15	606.29	606.39	1.0
D3903	15900.00	51.42	618.50	618.54	1.0

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF DRAINAGE DESIGN	TOP OF DRAINAGE RECORD	DRAINAGE LAYER THICKNESS
D4001	16000.00	131.44	596.02	596.39	1.0
D4002	16000.00	94.05	606.70	606.83	1.0
D4003	16000.00	52.75	618.50	618.59	1.0
D4101	16084.54	130.16	596.71	597.11	1.0
D4102	16085.04	93.19	607.27	607.46	1.0
D4103	16085.56	53.89	618.50	618.69	1.0
D4201	16096.59	142.27	596.74	597.31	1.1
D4202	16133.47	142.26	607.27	607.50	1.0
D4203	16172.77	142.25	618.50	618.78	1.1
D4301	16095.39	200.00	596.39	596.84	1.1
D4302	16132.59	200.00	607.02	607.27	1.1
D4303	16172.79	200.00	618.50	618.67	1.1
D4401	16093.30	300.00	595.78	596.21	1.1
D4402	16131.56	300.00	606.71	606.93	1.1
D4403	16172.82	300.00	618.50	618.73	1.1
D4501	16093.23	400.00	595.75	596.06	1.1
D4502	16131.59	400.00	606.71	606.88	1.0
D4503	16172.85	400.00	618.50	618.72	1.1
D4601	16095.39	500.00	596.36	596.65	1.1
D4602	16131.62	500.00	606.71	606.93	1.0
D4603	16172.88	500.00	618.50	618.65	1.1
DB01	14900.00	352.42	583.83	583.91	1.1
DB02	15000.00	352.42	584.64	584.81	1.1
DB03	15100.00	352.42	585.45	585.60	1.1
DB04	15200.00	352.42	586.26	586.37	1.0
DB05	15300.00	352.42	587.06	587.23	1.2
DB06	15400.00	352.42	587.87	588.05	1.1
DB07	15500.00	352.42	588.68	588.84	1.1
DB08	15600.00	352.42	590.49	590.65	1.1
DB09	15700.00	352.42	592.30	592.32	1.0
DB10	15800.00	352.42	593.10	593.22	1.0
DB11	15900.00	352.42	593.91	594.11	1.1
DB12	16000.00	352.42	594.72	594.92	1.0
DB13	14900.00	513.35	584.78	584.95	1.1
DB14	15000.00	513.35	585.59	585.76	1.1
DB15	15100.00	513.35	586.40	586.60	1.2
DB16	15200.00	513.35	587.21	587.41	1.1
DB17	15300.00	513.35	588.01	588.20	1.2
DB18	15400.00	513.35	588.82	588.97	1.1
DB19	15500.00	513.35	589.63	589.79	1.1
DB20	15600.00	513.35	591.44	591.61	1.1
DB21	15700.00	513.35	593.24	593.40	1.1
DB22	15800.00	513.35	594.05	594.21	1.1
DB23	15900.00	513.35	594.86	594.99	1.1
DB24	16000.00	513.35	595.67	595.85	1.0
DB25	14900.00	674.29	583.83	584.03	1.1
DB26	15000.00	674.29	584.64	584.80	1.1
DB27	15100.00	674.29	585.45	585.58	1.1
DB28	15200.00	674.29	586.26	586.38	1.0
DB29	15300.00	674.29	587.07	587.24	1.1
DB30	15400.00	674.29	587.87	588.04	1.1
DB31	15500.00	674.29	588.68	588.85	1.1
DB32	15600.00	674.29	590.49	590.62	1.0
DB33	15700.00	674.29	592.30	592.36	1.0
DB34	15800.00	674.29	593.10	593.24	1.0
DB35	15900.00	674.29	593.91	594.00	1.1
DB36	16000.00	674.29	594.72	594.96	1.0
DG01	14900.00	200.00	584.73	584.87	1.0
DG02	15000.00	200.00	585.54	585.71	1.2
DG03	15100.00	200.00	586.35	586.53	1.1
DG04	15200.00	200.00	587.15	587.33	1.1
DG05	15300.00	200.00	587.96	588.14	1.1
DG06	15400.00	200.00	588.77	588.97	1.2
DG07	15500.00	200.00	589.58	589.78	1.1
DG08	15600.00	200.00	591.39	591.58	1.2
DG09	15700.00	200.00	593.19	593.28	1.0
DG10	15800.00	200.00	594.00	594.10	1.0
DG11	15900.00	200.00	594.81	595.05	1.0
DG12	16000.00	200.00	595.62	595.76	1.1
DG13	14900.00	300.00	584.14	584.23	1.0
DG14	15000.00	300.00	584.95	585.15	1.1
DG15	15100.00	300.00	585.76	585.94	1.2
DG16	15200.00	300.00	586.57	586.77	1.1
DG17	15300.00	300.00	587.37	587.56	1.1
DG18	15400.00	300.00	588.18	588.35	1.1
DG19	15500.00	300.00	588.99	589.17	1.1
DG20	15600.00	300.00	590.80	590.90	1.1
DG21	15700.00	300.00	592.60	592.80	1.1
DG22	15800.00	300.00	593.41	593.62	1.2
DG23	15900.00	300.00	594.22	594.44	1.0
DG24	16000.00	300.00	595.03	595.14	1.0
DG25	14900.00	400.00	584.11	584.27	1.0
DG26	15000.00	400.00	584.92	585.08	1.1
DG27	15100.00	400.00	585.73	585.87	1.1
DG28	15200.00	400.00	586.54	586.69	1.1
DG29	15300.00	400.00	587.34	587.46	1.1
DG30	15400.00	400.00	588.15	588.32	1.1
DG31	15500.00	400.00	588.96	589.12	1.1
DG32	15600.00	400.00	590.77	590.89	1.1
DG33	15700.00	400.00	592.58	592.71	1.1
DG34	15800.00	400.00	593.38	593.57	1.1
DG35	15900.00	400.00	594.19	594.38	1.1
DG36	16000.00	400.00	595.00	595.25	1.2
DG37	14900.00	500.00	584.70	584.87	1.1
DG38	15000.00	500.00	585.51	585.65	1.1
DG39	15100.00	500.00	586.32	586.43	1.1
DG40	15200.00	500.00	587.13	587.31	1.1
DG41	15300.00	500.00	587.93	588.11	1.2
DG42	15400.00	500.00	588.74	588.89	1.1
DG43	15500.00	500.00	589.55	589.73	1.1
DG44	15600.00	500.00	591.36	591.49	1.1
DG45	15700.00	500.00	593.17	593.34	1.1
DG46	15800.00	500.00	593.97	594.11	1.1
DG47	15900.00	500.00	594.78	594.94	1.2
DG48	16000.00	500.00	595.59	595.85	1.0
DG49	14900.00	600.00	584.27	584.45	1.1
DG50	15000.00	600.00	585.08	585.24	1.1
DG51	15100.00	600.00	585.89	586.06	1.1
DG52	15200.00	600.00	586.70	586.86	1.2
DG53	15300.00	600.00	587.50	587.67	1.2
DG54	15400.00	600.00	588.31	588.47	1.1
DG55	15500.00	600.00	589.12	589.30	1.1
DG56	15600.00	600.00	590.93	591.09	1.1
DG57	15700.00	600.00	592.73	592.90	1.1
DG58	15800.00	600.00	593.54	593.66	1.1
DG59	15900.00	600.00	594.35	594.45	1.0
DG60	16000.00	600.00	595.16	595.52	1.1

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF DRAINAGE DESIGN	TOP OF DRAINAGE RECORD	DRAINAGE LAYER THICKNESS
DG61	14900.00	700.00	583.99	584.10	1.1
DG62	15000.00	700.00	584.79	584.95	1.1
DG63	15100.00	700.00	585.60	585.77	1.1
DG64	15200.00	700.00	586.41	586.61	1.2
DG65	15300.00	700.00	587.22	587.41	1.2
DG66	15400.00	700.00	588.02	588.19	1.1
DG67	15500.00	700.00	588.83	589.00	1.1
DG68	15600.00	700.00	590.64	590.73	1.0
DG69	15700.00	700.00	592.45	592.57	1.1
DG70	15800.00	700.00	593.26	593.42	1.1
DG71	15900.00	700.00	594.06	594.22	1.1
DG72	16000.00	700.00	594.87	595.07	1.0
DG73	14900.00	800.00	584.57	584.70	1.1
DG74	15000.00	800.00	585.38	585.57	1.1
DG75	15100.00	800.00	586.19	586.39	1.2
DG76	15200.00	800.00	587.00	587.08	1.1
DG77	15300.00	800.00	587.81	587.98	1.2
DG78	15400.00	800.00	588.61	588.73	1.0
DG79	15500.00	800.00	589.42	589.59	1.1
DG80	15600.00	800.00	591.23	591.41	1.1
DG81	15700.00	800.00	593.04	593.17	1.0
DG82	15800.00	800.00	593.84	594.02	1.1
DG83	15900.00	800.00	594.65	594.84	1.1
DG84	16000.00	800.00	595.46	595.81	1.0

NOTE: RECORD ELEVATIONS AND LAYER THICKNESSES BASED ON A COMPILATION OF RECORD SURVEY DATA PROVIDED BY MAURER-STUTZ, INC. THIS RECORD SURVEY PROVIDED BY MAURER-STUTZ, INC., IS CONTAINED ELSEWHERE IN THIS ACCEPTANCE REPORT.

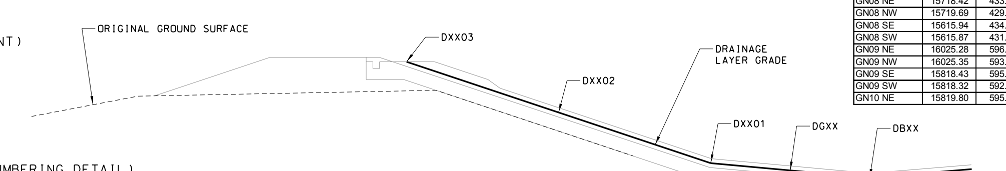


TYPICAL POINT NUMBER LOCATION

DB 00
GRID POINT NUMBER
DRAINAGE LAYER GRADE (BREAK POINT)

DG 00
GRID POINT NUMBER
DRAINAGE LAYER GRADE

D 00 00
POINT NUMBER (SEE POINT NUMBERING DETAIL)
CONTROL LINE NUMBER
DRAINAGE LAYER GRADE



POINT NUMBERING DETAIL

GEONET COORDINATES (AS SURVEYED BY MAURER-STUTZ, INC. OCT. 16, 2008 THRU NOV. 09, 2008))

MSI Point #	Northing	Easting	Elevation
GN01 NE	16031.54	247.52	594.68
GN01 NW	16031.29	244.17	594.67
GN01 SE	15926.87	247.82	593.88
GN01 SW	15927.72	244.24	593.84
GN02 NE	15928.44	248.25	593.86
GN02 NW	15928.47	244.45	593.89
GN02 SE	15826.47	249.75	593.09
GN02 SW	15826.90	245.83	593.03
GN03 NE	15827.58	249.31	593.11
GN03 NW	15827.56	245.97	593.11
GN03 SE	15724.79	247.49	592.19
GN03 SW	15725.54	244.14	592.19
GN04 NE	15726.76	247.64	592.22
GN04 NW	15726.53	244.25	592.23
GN04 SE	15624.04	250.74	590.71
GN04 SW	15623.67	247.37	590.64
GN05 NE	16027.25	435.11	594.51
GN05 NW	16028.07	431.72	594.59
GN05 SE	15922.82	435.53	593.71
GN05 SW	15922.46	432.03	593.76
GN06 NE	15923.21	435.36	593.79
GN06 NW	15923.77	432.01	593.83
GN06 SE	15819.28	433.87	592.79
GN06 SW	15819.45	430.55	592.82
GN07 NE	15820.73	433.82	592.78
GN07 NW	15820.49	430.32	592.79
GN07 SE	15717.44	433.09	591.93
GN07 SW	15717.99	429.43	591.88
GN08 NE	15718.42	433.40	591.89
GN08 NW	15719.69	429.72	591.92
GN08 SE	15615.94	434.80	590.33
GN08 SW	15615.87	431.37	590.35
GN09 NE	16025.28	596.65	594.63
GN09 NW	16025.35	593.25	594.70
GN09 SE	15818.43	595.37	592.90
GN09 SW	15818.32	592.16	592.92
GN10 NE	15819.80	595.64	592.86
GN10 NW	15820.24	592.11	592.92
GN10 SE	15722.77	594.71	592.16
GN10 SW	15722.89	591.21	592.17
GN11 NE	15724.17	594.85	592.15
GN11 NW	15724.23	591.29	592.13
GN11 SE	15629.65	595.03	590.66
GN11 SW	15629.87	591.23	590.77
GN12 NE	15632.28	595.03	590.67
GN12 NW	15632.86	591.56	590.85
GN12 SE	15451.68	596.23	587.71
GN12 SW	15451.35	592.15	587.70
GN13 NE	15605.74	593.03	590.43
GN13 NW	15599.46	590.51	590.32
GN13 SE	15583.49	594.48	589.98
GN13 SW	15583.20	591.39	590.09
GN14 NE	15624.25	250.96	590.79
GN14 NW	15624.41	247.74	590.72
GN14 SE	15517.29	251.54	588.81
GN14 SW	15517.13	248.02	588.93
GN15 NE	16023.98	780.10	594.76
GN15 NW	16023.87	776.59	594.74
GN15 SE	15924.36	778.84	593.99
GN15 SW	15924.38	775.56	594.00
GN16 NE	15927.03	779.12	594.02
GN16 NW	15927.24	775.19	594.00
GN16 SE	15827.80	777.22	592.97
GN16 SW	15827.73	773.53	593.04
GN17 NE	15830.61	777.06	593.00
GN17 NW	15830.44	773.72	593.10
GN17 SE	15730.92	775.62	592.32
GN17 SW	15731.18	772.17	592.22
GN18 NE	15731.53	775.87	592.31
GN18 NW	15731.95	772.39	592.28
GN18 SE	15631.43	773.88	590.69
GN18 SW	15631.16	770.26	590.80
GN19 NE	16025.38	598.28	594.62
GN19 NW	16024.98	595.88	594.71
GN19 SE	15838.81	598.82	592.95
GN19 SW	15831.46	595.63	592.99
GN20 NE	15617.61	434.97	590.48
GN20 NW	15617.55	431.59	590.41
GN20 SE	15510.69	434.63	588.58
GN20 SW	15511.01	431.12	588.61
GN21 NE	15633.12	773.95	590.75
GN21 NW	15633.24	770.09	590.87
GN21 SE	15526.36	770.62	588.81
GN21 SW	15526.55	766.84	588.94
GN22 NE	15528.76	770.34	588.89
GN22 NW	15528.77	767.03	589.01
GN22 SE	15422.07	769.78	587.75
GN22 SW	15421.99	766.33	587.66
GN23 NW	15453.29	592.84	587.86
GN23 NE	15453.28	596.50	587.92
GN24 NW	15422.97	765.40	587.78
GN24 NE	15423.07	769.15	587.83
GN24 SE	15327.62	767.72	587.11
GN24 SW	15327.97	764.02	586.94
GN23 SE	15346.02	595.83	587.31
GN23 SW	15345.82	592.13	587.31
GN25 NW	15518.48	247.99	588.99
GN25 NE	15518.60	251.22	588.81
GN25 SW	15410.27	247.61	587.78
GN25 SE	15409.83	251.05	587.63
GN26 NW	15512.37	429.11	588.64
GN26 NE	15512.63	432.65	588.59
GN26 SE	15416.67	434.44	587.53
GN26 SW	15416.87	431.04	587.52
GN27 NE	15417.98	434.48	587.68
GN27 NW	15417.81	431.10	587.66
GN27 SE	15324.00	433.85	586.82
GN27 SW	15324.22	430.17	586.74
GN28 NE	15348.32	595.83	587.17
GN28 NW	15348.50	592.19	587.14
GN28 SE	15280.49	595.53	586.49
GN28 SW	15280.81	592.02	586.50
GN29 NE	15329.00	768.16	586.87
GN29 NW	15329.37	764.66	586.88
GN29 SE	15275.78	767.33	586.47
GN29 SW	15275.65	763.68	586.43
GN30 NE	15413.16	250.66	587.69
GN30 NW	15413.20	247.14	587.73
GN30 SE	15303.26	252.85	586.68
GN30 SW	15303.99	249.39	586.72
GN31 NE	15304.78	252.93	586.65
GN31 NW	15305.07	249.40	586.69
GN31 SE	15283.42	252.82	586.67
GN31 SW	15283.58	249.45	586.64
GN32 NE	15284.07	252.89	586.68
GN32 NW	15284.26	249.47	586.72
GN32 SE	15264.76	253.73	586.42
GN32 SW	15264.61	250.34	586.47
GN33 NE	15325.03	433.92	586.83
GN33 NW	15325.35	430.48	586.84
GN33 SE	15285.46	433.71	586.42
GN33 SW	15285.75	430.05	586.39
GN34 NE	15281.57	595.92	586.47
GN34 NW	15281.56	592.20	586.49
GN34 SE	15147.45	595.83	585.37
GN34 SW	15147.56	592.50	585.43
GN35 NE	15286.92	433.49	586.51
GN35 NW	15287.52	430.21	586.48
GN35 SE	15153.79	434.44	585.52
GN35 SW	15153.69	430.90	585.54
GN36 NE	15277.72	766.98	586.58
GN36 NW	15277.69	763.85	586.54
GN36 SE	15143.59	762.46	585.40
GN36 SW	15144.03	759.10	585.42
GN37 NE	15266.60	253.18	586.50
GN37 NW	15266.46	249.73	586.57
GN37 SE	15132.02	254.75	585.29
GN37 SW	15132.27	251.11	585.32
GN38 NE	15133.08	254.33	585.31
GN38 NW	15132.85	251.37	585.37
GN38 SE	15060.30	254.72	584.76
GN38 SW	15060.61	251.69	584.86
GN39 NE	15155.35	434.02	585.54
GN39 NW	15155.43	430.31	585.54
GN39 SE	15083.15	434.97	584.96
GN39 SW	15082.88	431.25	584.93
GN40 NE	15149.50	595.99	585.39
GN40 NW	15149.77	592.33	585.44
GN40 SE	15077.26	595.93	584.91
GN40 SW	15077.23	592.28	584.92
GN41 NE	15145.81	763.07	585.41
GN41 NW	15145.86	759.40	585.44
GN41 SE	15073.33	762.40	584.84
GN41 SW	15073.46	758.79	584.83
GN42 NE	15084.07	434.86	585.04
GN42 NW	15084.09	431.10	584.95
GN42 SE	14980.63	433.68	583.98
GN42 SW	14980.73	430.12	583.92
GN43 NE	15079.59	595.77	585.00
GN43 NW	15079.33	592.38	584.97
GN43 SE	14975.70	595.52	584.02
GN43 SW	14976.07	591.83	584.02
GN44 NE	15075.20	762.40	584.95
GN44 NW	15075.46	758.98	584.88
GN44 SE	14972.05	760.53	584.06
GN44 SW	14971.75	757.08	583.97
GN45 NE	15062.01	254.22	584.77
GN45 NW	15061.72	251.14	584.87
GN45 SE	14958.41	255.32	584.01
GN45 SW	14958.62	252.09	584.07
GN46 NE	14981.65	434.40	584.02
GN46 NW	14981.93	430.81	583.98
GN46 SE	14879.21	434.56	583.30
GN46 SW	14878.92	431.17	583.25
GN47 NE	14976.68	595.20	584.09
GN47 NW	14976.62	591.43	584.05
GN47 SE	14874.46	595.48	583.24
GN47 SW	14913.11	591.69	583.51
GN48 NE	14973.19	760.40	584.08
GN48 NW	14972.78	757.35	583.97
GN48 SE	14870.34	757.20	583.11
GN48 SW	14870.84	753.85	583.10
GN49 NE	14960.65	255.51	584.07
GN49 NW	14960.75	251.85	584.15
GN49 SE	14858.52	256.02	583.11
GN49 SW	14858.47	252.52	583.12
GN50 NE	14913.55	594.10	583.52
GN50 NW	14913.90	590.98	583.55
GN50 SE	14845.55	666.01	582.57
GN50 SW	14843.33	663.46	582.50
GN51 NE	14914.55	435.80	583.49
GN51 NW	14916.84	433.09	583.51
GN51 SE	14845.94	364.15	582.68
GN51 SW	14848.57	362.28	582.60
GN52 NE	14846.05	365.22	582.69
GN52 NW	14848.49	362.29	582.62
GN52 SE	14835.80	356.67	582.13
GN52 SW	14838.16	353.78	581.88
GN53 NE	14864.21	256.21	583.19
GN53 NW	14864.37	252.71	583.22
GN53 SE	14827.98	257.35	581.68
GN53 SW	14827.72	253.34	581.66
GN54 NE	14871.73	757.18	583.27
GN54 NW	14871.46	753.51	583.22
GN54 SE	14828.12	756.99	581.83
GN54 SW	14828.60	753.59	582.03
GN55 NE	14849.01	663.25	582.55
GN55 NW	14846.64	660.64	582.64
GN55 SE	14837.45	673.29	581.61
GN55 SW	14835.22	670.81	581.88

LEGEND

$\times_{1.1}$ DRAINAGE LAYER THICKNESS (IN FEET)

GN54 GEONET

RECORD DRAWING

FILE NO. -C180-C102-10.dgn

AEG CAD GENERATED
DO NOT REVISE MANUALLY

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-22-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	03-05-08	SKB	SMB	SMB	REVISED POINT NO. DETAIL - ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
2	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
3	10-10-08	TCJ	DBH	SMB	ADDITION OF GEOGRID AND SUMP MODIFICATIONS, REVISE GRADES DUE TO 2 FT. FOUNDATION RAISE
4	03-05-09	SKB	ADC	SMB	ISSUED FOR RECORD DRAWING

LAYOUT	DBH	05-10-07
DRAWN	SKB	03-05-08
REVIEWED	SMB	10-10-08

30x42

HANSON
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, Illinois 62703-2886
Phone: (217)788-2450 Fax: (217) 788-2503
Illinois Licensed Professional Service Corporation #184-001084

SCALE -
DRAFTER -
DATE 03-26-09

DRAWING TITLE

GYPSUM STACK - LD/LCRS DRAINAGE LAYER GRADE

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy
Resources Generating

DRAWING NUMBER C180-C102 REV. 4

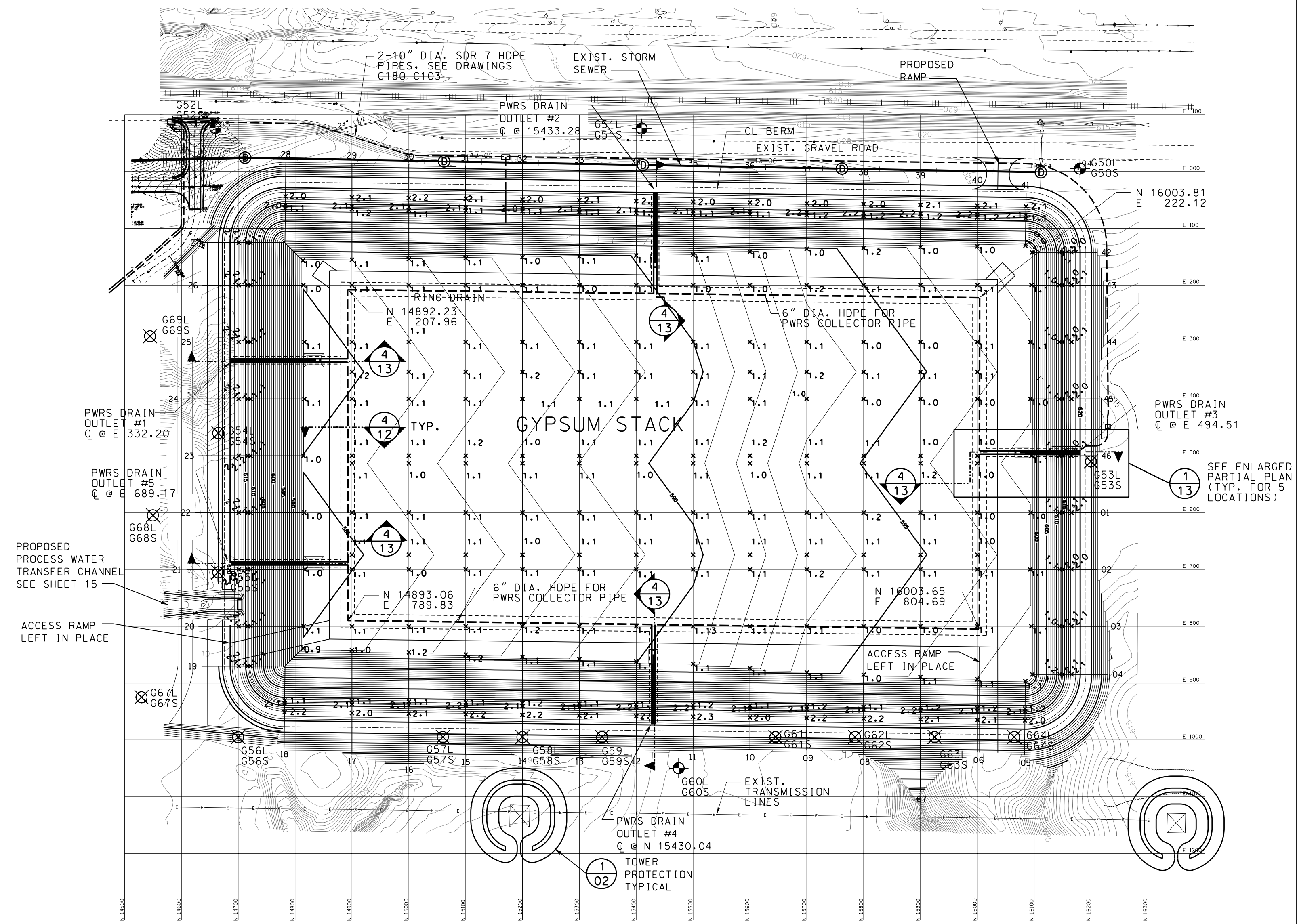
SHEET NO. 10 OF 33

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF CUSHION DIRT DESIGN	TOP OF CUSHION DIRT RECORD	CUSHION DIRT
C0101	16093.72	600.00	596.91	597.36	1.0
C0102	16144.88	600.00	611.53	611.82	1.1
C0103	16149.88	600.00	614.00	614.30	2.1
C0104	16165.63	600.00	618.50	618.74	2.1
C0201	16092.72	700.00	596.62	597.10	1.1
C0202	16144.91	700.00	611.53	611.82	1.1
C0203	16149.91	700.00	614.00	614.24	2.0
C0204	16165.66	700.00	618.50	618.74	2.0
C0301	16094.87	800.00	597.23	597.82	1.1
C0302	16144.94	800.00	611.53	611.75	1.0
C0303	16149.94	800.00	614.00	614.29	2.1
C0304	16165.69	800.00	618.50	618.78	2.1
C0401	16096.68	884.70	597.74	598.24	1.1
C0402	16144.96	884.71	611.53	611.79	1.2
C0403	16149.96	884.70	614.00	614.23	2.1
C0404	16165.72	884.69	618.50	618.74	2.1
C0501	16084.47	896.68	597.71	598.41	1.1
C0502	16083.93	945.11	611.56	611.85	1.2
C0503	16083.88	950.06	614.00	614.25	2.1
C0504	16083.70	965.81	618.50	618.69	2.0
C0601	16000.00	893.29	597.01	597.27	1.1
C0602	16000.00	944.12	611.53	611.82	1.2
C0603	16000.00	949.12	614.00	614.24	2.1
C0604	16000.00	964.87	618.50	618.72	2.1
C0701	15900.00	889.27	596.18	596.47	1.1
C0702	15900.00	943.00	611.53	611.82	1.2
C0703	15900.00	948.01	614.00	614.29	2.2
C0704	15900.00	963.76	618.50	618.70	2.1
C0801	15800.00	885.24	595.35	595.60	1.0
C0802	15800.00	941.89	611.53	611.80	1.1
C0803	15800.00	946.89	614.00	614.26	2.1
C0804	15800.00	962.64	618.50	618.78	2.2
C0901	15700.00	881.21	594.52	594.81	1.1
C0902	15700.00	940.77	611.53	611.82	1.2
C0903	15700.00	945.77	614.00	614.26	2.1
C0904	15700.00	961.53	618.50	618.80	2.2
C1001	15600.00	873.61	592.66	592.94	1.1
C1002	15600.00	939.66	611.53	611.76	1.1
C1003	15600.00	944.66	614.00	614.25	2.1
C1004	15600.00	960.41	618.50	618.73	2.0
C1101	15500.00	866.01	590.81	591.07	1.1
C1102	15500.00	938.54	611.53	611.82	1.2
C1103	15500.00	943.54	614.00	614.26	2.2
C1104	15500.00	959.29	618.50	618.78	2.3
C1201	15400.00	861.99	589.98	590.25	1.1
C1202	15400.00	937.42	611.53	611.82	1.2
C1203	15400.00	942.42	614.00	614.29	2.2
C1204	15400.00	958.18	618.50	618.73	2.2
C1301	15300.00	857.96	589.15	589.38	1.1
C1302	15300.00	936.31	611.53	611.79	1.1
C1303	15300.00	941.31	614.00	614.23	2.1
C1304	15300.00	957.06	618.50	618.75	2.1
C1401	15200.00	853.93	588.32	588.57	1.1
C1402	15200.00	935.19	611.53	611.82	1.2
C1403	15200.00	940.19	614.00	614.25	2.1
C1404	15200.00	955.94	618.50	618.76	2.2
C1501	15100.00	849.91	587.48	587.77	1.2
C1502	15100.00	934.07	611.53	611.81	1.1
C1503	15100.00	939.07	614.00	614.27	2.2
C1504	15100.00	954.83	618.50	618.78	2.2
C1601	15000.00	845.88	586.65	586.96	1.2
C1602	15000.00	932.96	611.53	611.81	1.1
C1603	15000.00	937.96	614.00	614.26	2.1
C1604	15000.00	953.71	618.50	618.72	2.1
C1701	14900.00	841.85	585.82	586.02	1.0
C1702	14900.00	931.84	611.53	611.82	1.1
C1703	14900.00	936.84	614.00	614.29	2.1
C1704	14900.00	952.60	618.50	618.71	2.0
C1801	14814.14	838.40	585.11	585.38	0.9
C1802	14781.51	930.52	611.53	611.79	1.1
C1803	14781.45	935.52	614.00	614.20	2.1
C1804	14781.24	951.27	618.50	618.77	2.2
C1901	14814.14	838.40	585.11	585.40	0.9
C1902	14721.66	870.00	611.53	611.75	1.1
C1903	14716.66	870.01	614.00	614.25	2.1
C1904	14700.91	870.05	618.50	618.76	2.1
C2001	14814.90	800.00	584.89	585.18	1.1
C2002	14721.64	800.00	611.53	611.82	1.1
C2003	14716.64	800.00	614.00	614.25	2.1
C2004	14700.89	800.00	618.50	618.71	2.1
C2101	14816.88	700.00	584.31	584.59	1.0
C2102	14721.62	700.00	611.53	611.80	1.1
C2103	14716.62	700.00	614.00	614.21	2.1
C2104	14700.87	700.00	618.50	618.72	2.0
C2201	14815.89	600.00	584.59	584.83	1.0
C2202	14721.60	600.00	611.53	611.81	1.2
C2203	14716.60	600.00	614.00	614.20	2.1
C2204	14700.85	600.00	618.50	618.70	2.2
C2301	14814.43	500.00	585.00	585.22	1.0
C2302	14721.58	500.00	611.53	611.81	1.1
C2303	14716.58	500.00	614.00	614.29	2.2
C2304	14700.83	500.00	618.50	618.76	2.1
C2401	14816.38	400.00	584.44	584.96	1.1
C2402	14721.56	400.00	611.53	611.77	1.1
C2403	14716.56	400.00	614.00	614.23	2.1
C2404	14700.81	400.00	618.50	618.71	2.1
C2501	14816.27	300.00	584.47	584.76	1.1
C2502	14721.54	300.00	611.53	611.78	1.2
C2503	14716.54	300.00	614.00	614.23	2.1
C2504	14700.79	300.00	618.50	618.74	2.2
C2601	14814.24	200.00	585.04	585.25	1.0
C2602	14721.52	200.00	611.53	611.78	1.1
C2603	14716.52	200.00	614.00	614.25	2.1
C2604	14700.77	200.00	618.50	618.72	2.1
C2701	14813.37	156.83	585.29	585.66	1.0
C2702	14721.50	125.09	611.53	611.75	1.1
C2703	14716.50	125.09	614.00	614.24	2.1
C2704	14700.75	125.05	618.50	618.70	2.1
C2801	14813.37	156.83	585.29	585.68	1.0
C2802	14782.84	64.56	611.53	611.79	1.1
C2803	14782.89	59.56	614.00	614.21	2.0
C2804	14783.07	43.81	618.50	618.68	2.0
C2901	14900.00	155.51	585.99	586.42	1.1
C2902	14900.00	66.12	611.53	611.82	1.2
C2903	14900.00	61.12	614.00	614.23	2.1
C2904	14900.00	45.37	618.50	618.74	2.1
C3001	15000.00	153.98	586.81	587.08	1.1

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF CUSHION DIRT DESIGN	TOP OF CUSHION DIRT RECORD	CUSHION DIRT
C3002	15000.00	67.45	611.53	611.75	1.1
C3003	15000.00	62.45	614.00	614.23	2.1
C3004	15000.00	46.70	618.50	618.78	2.2
C3101	15100.00	152.46	587.63	587.91	1.1
C3102	15100.00	68.79	611.53	611.81	1.1
C3103	15100.00	63.79	614.00	614.25	2.1
C3104	15100.00	48.03	618.50	618.77	2.1
C3201	15200.00	150.93	588.44	588.66	1.0
C3202	15200.00	70.12	611.53	611.81	1.1
C3203	15200.00	65.12	614.00	614.23	2.0
C3204	15200.00	49.37	618.50	618.71	2.0
C3301	15300.00	149.41	589.26	589.61	1.1
C3302	15300.00	71.45	611.53	611.77	1.1
C3303	15300.00	66.45	614.00	614.25	2.1
C3304	15300.00	50.70	618.50	618.74	2.1
C3401	15400.00	147.88	590.08	590.46	1.1
C3402	15400.00	72.79	611.53	611.79	1.1
C3403	15400.00	67.79	614.00	614.22	2.1
C3404	15400.00	52.03	618.50	618.66	2.0
C3501	15500.00	146.36	590.89	591.14	1.1
C3502	15500.00	74.12	611.53	611.77	1.1
C3503	15500.00	69.12	614.00	614.24	2.1
C3504	15500.00	53.37	618.50	618.62	2.0
C3601	15600.00	141.26	592.73	592.98	1.0
C3602	15600.00	75.45	611.53	611.78	1.1
C3603	15600.00	70.45	614.00	614.25	2.1
C3604	15600.00	54.70	618.50	618.68	2.0
C3701	15700.00	136.16	594.57	594.81	1.0
C3702	15700.00	76.79	611.53	611.77	1.2
C3703	15700.00	71.79	614.00	614.27	2.2
C3704	15700.00	56.03	618.50	618.61	2.0
C3801	15800.00	134.63	595.39	595.65	1.2
C3802	15800.00	78.12	611.53	611.80	1.2
C3803	15800.00	73.12	614.00	614.26	2.2
C3804	15800.00	57.37	618.50	618.61	2.0
C3901	15900.00	133.11	596.20	596.94	1.0
C3902	15900.00	79.45	611.53	611.81	1.2
C3903	15900.00	74.45	614.00	614.25	2.2
C3904	15900.00	58.70	618.50	618.67	2.1
C4001	16000.00	131.58	597.02	597.43	1.0
C4002	16000.00	80.79	611.53	611.83	1.2
C4003	16000.00	75.79	614.00	614.30	2.2
C4004	16000.00	60.03	618.50	618.71	2.1
C4101	16084.54	130.31	597.71	598.14	1.0
C4102	16085.19	81.93	611.53	611.80	1.1
C4103	16085.25	76.93	614.00	614.24	2.1
C4104	16085.46	61.17	618.50	618.76	2.1
C4201	16096.44	142.27	597.74	598.33	1.0
C4202	16144.74	142.26	611.53	611.83	1.1
C4203	16149.74	142.26	614.00	614.26	2.0
C4204	16165.49	142.25	618.50	618.81	2.0
C4301	16095.25	200.00	597.39	597.91	1.1
C4302	16144.76	200.00	611.53	611.78	1.0
C4303	16149.76	200.00	614.00	614.26	2.0
C4304	16165.51	200.00	618.50	618.77	2.1
C4401	16093.16	300.00	596.78	597.28	1.1
C4402	16144.79	300.00	611.53	611.80	1.0
C4403	16149.79	300.00	614.00	614.21	2.0
C4404	16165.54	300.00	618.50	618.79	2.1
C4501	16093.09	400.00	596.75	597.07	1.0
C4502	16144.82	400.00	611.53	611.79	1.1
C4503	16149.82	400.00	614.00	614.25	2.0
C4504	16165.57	400.00	618.50	618.78	2.0
C4601	16095.24	500.00	597.36	597.71	1.1
C4602	16144.85	500.00	611.53	611.80	1.1
C4603	16149.85	500.00	614.00	614.22	2.0
C4604	16165.60	500.00	618.50	618.76	2.1
CB01	14900.00	352.42	584.83	585.07	1.2
CB02	15000.00	352.42	585.64	585.91	1.1
CB03	15100.00	352.42	586.45	586.72	1.1
CB04	15200.00	352.42	587.26	587.53	1.2
CB05	15300.00	352.42	588.06	588.29	1.1
CB06	15400.00	352.42	588.87	589.10	1.1
CB07	15500.00	352.42	589.68	589.97	1.1
CB08	15600.00	352.42	591.49	591.72	1.1
CB09	15700.00	352.42	593.30	593.51	1.2
CB10	15800.00	352.42	594.10	594.35	1.1
CB11	15900.00	352.42	594.91	595.17	1.1
CB12	16000.00	352.42	595.72	596.00	1.1
CB13	14900.00	513.35	585.78	586.01	1.1
CB14	15000.00	513.35	586.59	586.80	1.0
CB15	15100.00	513.35	587.40	587.68	1.1
CB16	15200.00	513.35	588.21	588.46	1.1
CB17	15300.00	513.35	589.01	589.30	1.1
CB18	15400.00	513.35	589.82	589.99	1.0
CB19	15500.00	513.35	590.63	590.92	1.1
CB20	15600.00	513.35	592.44	592.65	1.0
CB21	15700.00	513.35	594.24	594.54	1.1
CB22	15800.00	513.35	595.05	595.28	1.1
CB23	15900.00	513.35	595.86	596.16	1.2
CB24	16000.00	513.35	596.67	596.84	1.0
CB25	14900.00	674.29	584.83	585.12	1.1
CB26	15000.00	674.29	585.64	585.88	1.1
CB27	15100.00	674.29	586.45	586.73	1.1
CB28	15200.00	674.29	587.26	587.43	1.0
CB29	15300.00	674.29	588.07	588.35	1.1
CB30	15400.00	674.29	588.87	589.18	1.1
CB31	15500.00	674.29	589.68	589.93	1.1
CB32	15600.00	674.29	591.49	591.74	1.1
CB33	15700.00	674.29	593.30	593.51	1.1
CB34	15800.00	674.29	594.10	594.32	1.1
CB35	15900.00	674.29	594.91	595.15	1.1
CB36	16000.00	674.29	595.72	596.01	1.0
CG01	14900.00	200.00	585.73	585.97	1.1
CG02	15000.00	200.00	586.54	586.80	1.1
CG03	15100.00	200.00	587.35	587.59	1.1
CG04	15200.00	200.00	588.15	588.45	1.1
CG05	15300.00	200.00	588.96	589.15	1.0
CG06	15400.00	200.00	589.77	590.03	1.1
CG07	15500.00	200.00	590.58	590.79	1.0
CG08	15600.00	200.00	592.39	592.62	1.0
CG09	15700.00	200.00	594.19	594.49	1.2
CG10	15800.00	200.00	595.00	595.25	1.1
CG11	15900.00	200.00	595.81	596.13	1.1
CG12	16000.00	200.00	596.62	596.82	1.1
CG13	14900.00	300.00	585.14	585.35	1.1
CG14	15000.00	300.00	585.95	586.21	1.1

CONTROL POINT NUMBER	GRID COORDINATES NORTHING	GRID COORDINATES EASTING	TOP OF CUSHION DIRT DESIGN	TOP OF CUSHION DIRT RECORD	CUSHION DIRT
CG15	15100.00	300.00	586.76	587.03	1.1
CG16	15200.00	300.00	587.57	587.86	1.1
CG17	15300.00	300.00	588.37	588.67	1.1
CG18	15400.00	300.00	589.18	589.41	1.1
CG19	15500.00	300.00	589.99	590.25	1.1
CG20	15600.00	300.00	591.80	592.04	1.1
CG21	15700.00	300.00	593.60	593.86	1.1
CG22	15800.00	300.00	594.41	594.67	1.0
CG23	15900.00	300.00	595.22	595.45	1.0
CG24	16000.00	300.00	596.03	596.27	1.1
CG25	14900.00	400.00	585.11	585.36	1.1
CG26	15000.00	400.00	585.92	586.15	1.1
CG27	15100.00	400.00	586.73	587.01	1.1
CG28	15200.00	400.00	587.54	587.78	1.1
CG29	15300.00	400.00	588.34	588.58	1.1
CG30	15400.00	400.00	589.15	589.40	1.1
CG31	15500.00	400.00	589.96	590.20	1.1
CG32	15600.00	400.00	591.77	592.03	1.1
CG33	15700.00	400.00	593.58	593.74	1.0
CG34	15800.00	400.00	594.38	594.62	1.0
CG35	15900.00	400.00	595.19	595.41	1.0
CG36	16000.00	400.00	596.00	596.27	1.0
CG37	14900.00	500.00	585.70	586.00	1.1
CG38	15000.00	500.00	586.51	586.75	1.1
CG39	15100.00	500.00	587.32	587.59	1.2
CG40	15200.00	500.00	588.13	588.34	1.0
CG41	15300.00	500.00	588.93	589.21	1.1
CG42	15400.00	500.00	589.74	590.01	1.1
CG43	15500.00	500.00	590.55	590.81	1.1
CG44	15600.00	500.00	592.36	592.65	1.2.
CG45	15700.00	500.00	594.17	594.43	1.1
CG46	15800.00	500.00	594.97	595.22	1.1
CG47	15900.00	500.00	595.78	595.97	1.0
CG48	16000.00	500.00	596.59	596.89	1.0
CG49	14900.00	600.00	585.27	585.53	1.1
CG50	15000.00	600.00	586.08	586.34	1.1
CG51	15100.00	600.00	586.89	587.16	1.1
CG52	15200.00	600.00	587.70	587.97	1.1
CG53	15300.00	600.00	588.50	588.78	1.1
CG54	15400.00	600.00	589.31	589.59	1.1
CG55	15500.00	600.00	590.12	590.35	1.0
CG56	15600.00	600.00	591.93	592.23	1.0
CG57	15700.00	600.00	593.73	593.98	1.1
CG58	15800.00	600.00	594.54	594.82	1.2
CG59	15900.00	600.00	595.35	595.59	1.1
CG60	16000.00	600.00	596.16	596.52	1.0
CG61	14900.00	700.00	584.99	585.21	1.1
CG62	15000.00	700.00	585.79	585.98	1.0
CG63	15100.00	700.00	586.60	586.86	1.1
CG64	15200.00	700.00	587.41	587.68	1.1
CG65	15300.00	700.00	588.22	588.48	1.1
CG66	15400.00	700.00	589.02	589.30	1.1
CG67	15500.00	700.00	589.83	590.12	1.1
CG68	15600.00	700.00	591.64	591.85	1.1
CG69	15700.00	700.00	593.45	593.72	1.1
CG70	15800.00	700.00	594.26	594.52	1.1
CG71	15900.00	700.00	595.06	595.32	1.1
CG72	16000.00	700.00	595.87	596.17	1.1
CG73	14900.00	800.00	585.57	585.81	1.1
CG74	15000.00	800.00	586.38	586.66	1.1
CG75	15100.00	800.00	587.19	587.44	1.1
CG76	15200.00	800.00	588.00	588.27	1.2
CG77	15300.00	800.00	588.81	589.10	1.1
CG78	15400.00	800.00	589.61	589.80	1.1
CG79	15500.00	800.00	590.42	590.72	1.1
CG80	15600.00	800.00	592.23	592.52	1.1
CG81	15700.00	800.00	594.04	594.31	1.1
CG82	15800.00	800.00	594.84	595.06	1.0
CG83	15900.00	800.00	595.65	595.88	1.0
CG84	16000.00	800.00	596.46	596.87	1.1

NOTE: RECORD ELEVATIONS AND LAYER THICKNESSES BASED ON A COMPILATION OF RECORD SURVEY DATA PROVIDED BY MAURER-STUTZ, INC. THIS RECORD SURVEY PROVIDED BY MAURER-STUTZ, INC., IS CONTAINED ELSEWHERE IN THIS ACCEPTANCE REPORT.



STANDARD LEGEND

(ALL SYMBOLS MAY NOT BE USED ON EACH PLAN)

- ORIGINAL CONTOURS
- FENCELINE
- TRANSMISSION TOWER
- OVERHEAD ELECTRIC
- LIMITS OF VEGETATION
- GRAVEL ROAD
- RAILROAD
- STORM SEWER
- CONTROL POINT
- 650 NEW CONTOURS
- LD/LCRS COLLECTION PIPE
- GEONET
- MW-53L MONITORING WELL
- B-55 BORING
- G69L FUTURE GROUNDWATER MONITORING WELL
- 4" DIA. PERFORATED DRAINAGE PIPING
- 6" DIA. OUTFALL PIPING
- 1.1 CUSHION DIRT LAYER THICKNESS (IN FEET)
- RING DRAIN SAND LIMITS
- CONSTRUCTION ROAD LIMITS

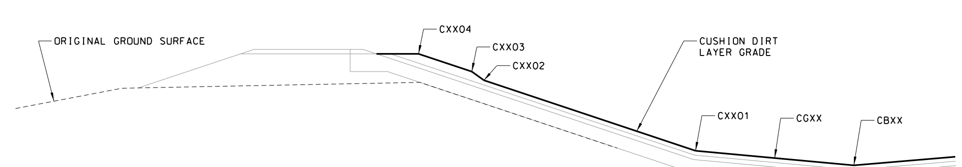
0' 100' 200'
SCALE: 1" = 100'

TYPICAL POINT NUMBER LOCATION

CB 00
- GRID POINT NUMBER
- CUSHION LAYER GRADE (BREAK POINT)

CG 00
- GRID POINT NUMBER
- CUSHION LAYER GRADE

C 00 00
- POINT NUMBER (SEE POINT NUMBERING DETAIL)
- CONTROL LINE NUMBER
- CUSHION LAYER GRADE



POINT NUMBERING DETAIL

RECORD DRAWING

FILE NO. -C180-C102-II.dgn

HANSON
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, Illinois 62703-2886
Phone: (217) 788-2450 Fax: (217) 788-2503
Illinois Licensed Professional Service Corporation #184-001084

DRAWING TITLE

PWRS-RING DRAIN SYSTEM CUSHION DIRT LAYER GRADE

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy Resources Generating

DRAWING NUMBER: C180-C102 REV.: 6
SHEET NO. 11 OF 33

SCALE: -
DRAFTER: -
DATE: 03-26-09

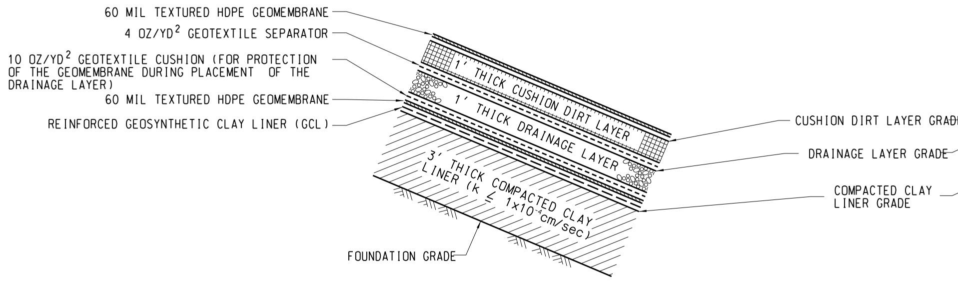
AEG CAD GENERATED
DO NOT REVISE MANUALLY

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-22-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	03-05-08	SKB	SMB	SMB	REVISED CONTOURS / TABLE - ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
2	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
3	10-14-08	TJL	DBH	SMB	REVISED GRADING TABLE AND CONTOURS FOR 2 FT. FOUNDATION GRADE RAISE FOR THE NORTH 400' OF THE GYPSUM STACK FLOOR
4	11-17-08	DBH	DBH	SMB	ADDED CENTERLINE COORDINATES FOR PWRS DRAIN LOCATIONS
5	02-09-09	DBH	SKB	SMB	RELOCATE SOUTH RING DRAIN ALIGNMENT 30' NORTH
6	03-05-09	SKB	ADC	SMB	ISSUED FOR RECORD DRAWING

LAYOUT / DRAWN / REVIEWED: KNK 05/10/07, SKB 03-05-08

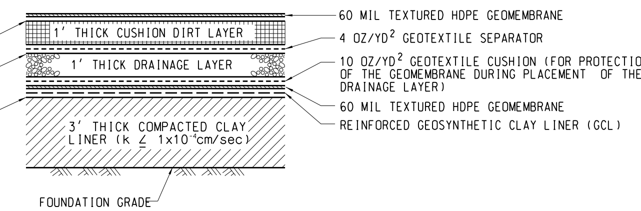
Brand0939
09-Apr-2009
I:\03jobs\03s5010\Gypsum Stack\CADD\Sheets\C180-C102-II.dgn

30x42



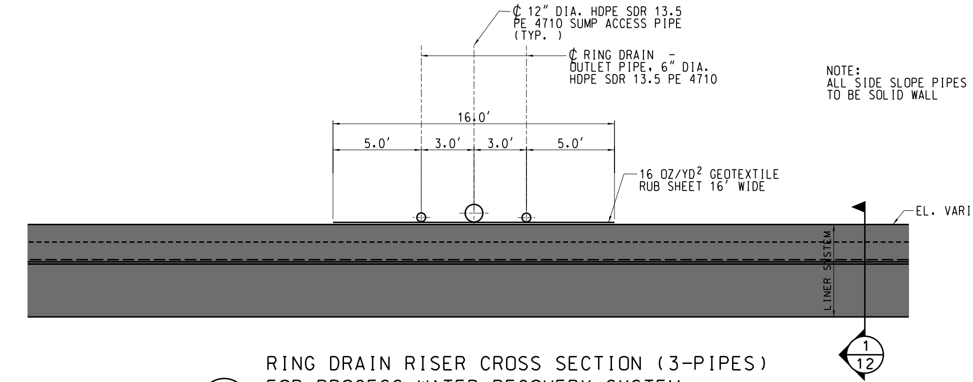
1/12 SIDE SLOPE LINER SYSTEM
NTS

NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN

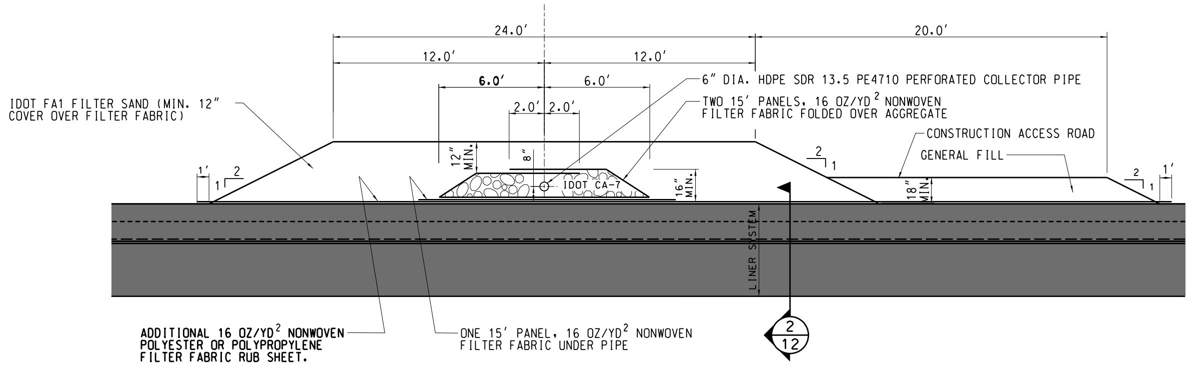


2/12 BOTTOM LINER SYSTEM
NTS

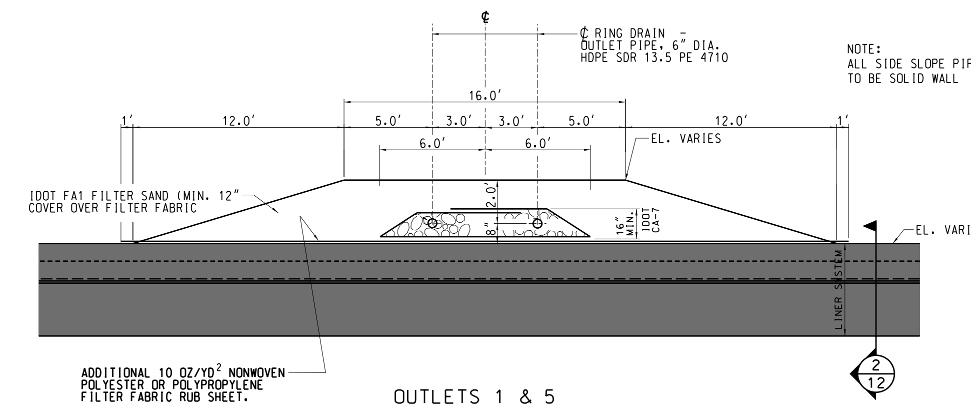
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN



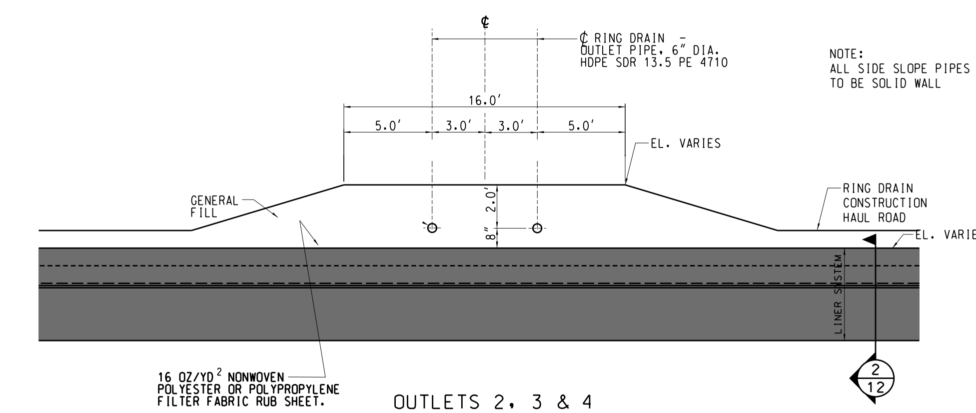
3/12 RING DRAIN RISER CROSS SECTION (3-PIPES) FOR PROCESS WATER RECOVERY SYSTEM
SCALE: 1" = 4'
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN



4/12 RING DRAIN COLLECTOR CROSS SECTION FOR PROCESS WATER RECOVERY SYSTEM
SCALE: 1" = 4'
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN

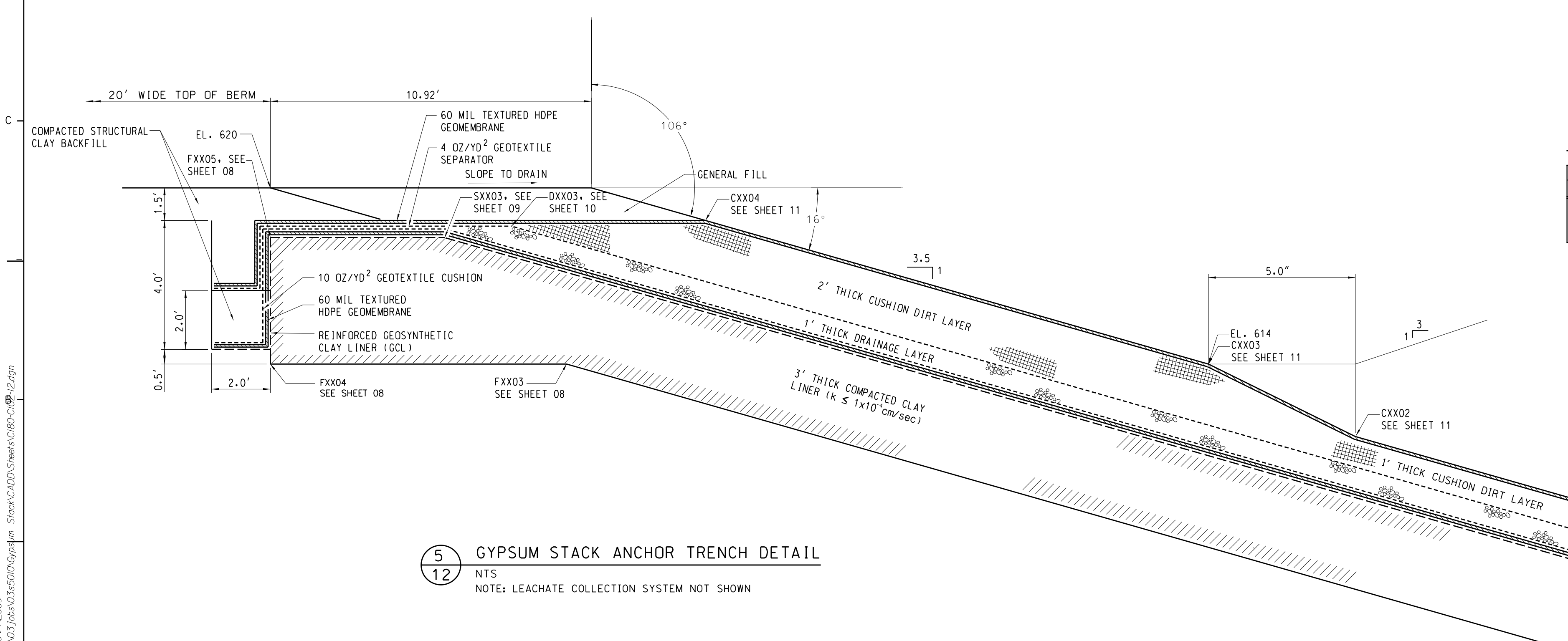


OUTLETS 1 & 5



OUTLETS 2, 3 & 4

6/12 PIPES BETWEEN RING DRAIN AND RISERS FOR PROCESS WATER RECOVERY SYSTEM
SCALE: 1" = 4'
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN



5/12 GYPSUM STACK ANCHOR TRENCH DETAIL
NTS
NOTE: LEACHATE COLLECTION SYSTEM NOT SHOWN

RECORD DRAWING

FILE NO. -C180-C102-12.dgn

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09-Apr-2009
ln03job\03s5010\Gypsum Stack\CADD\Sheets\C180-C102-12.dgn

AEG CAD GENERATED
DO NOT REVISE MANUALLY

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-22-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	03-05-08	SKB	SMB	SMB	REVISED DETAIL 5 - ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
2	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
3	9-19-08	TCJ	RWH	RWH	ADDED LEACHATE COLLECTION NOTE TO ALL DETAILS
4	02-12-09	SKB	SMB	SMB	REVISED DETAIL 6
5	03-05-09	SKB	JMM	-	ISSUED FOR RECORD DRAWING BY HANSON

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
-	-	-	-	-	

LAYOUT KNK 05/15/07
DRAWN SKB 03-05-08
REVIEWED

HANSON
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, Illinois 62703-2886
Phone: (217)788-2450 Fax: (217) 788-2503
Illinois Licensed Professional Service Corporation #184-001084

SCALE -

DRAFTER -

DATE 03-26-09

DRAWING TITLE

PWRS - RING DRAIN DETAILS

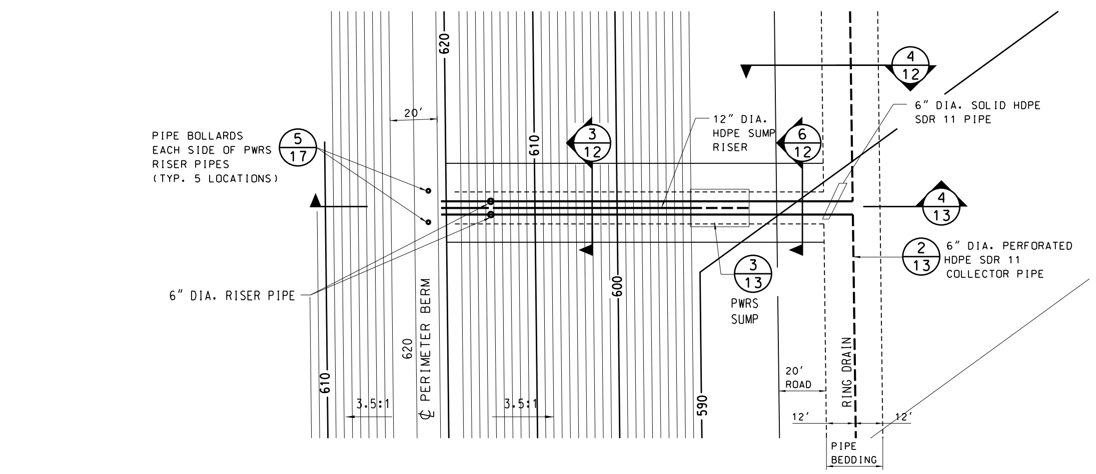
GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy Resources Generating

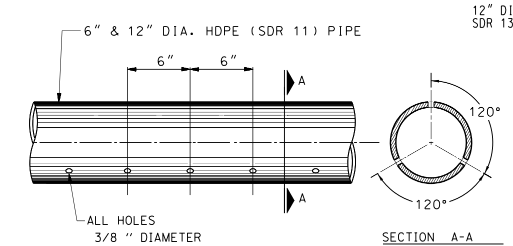
DRAWING NUMBER C180-C102 REV. 5

30x42

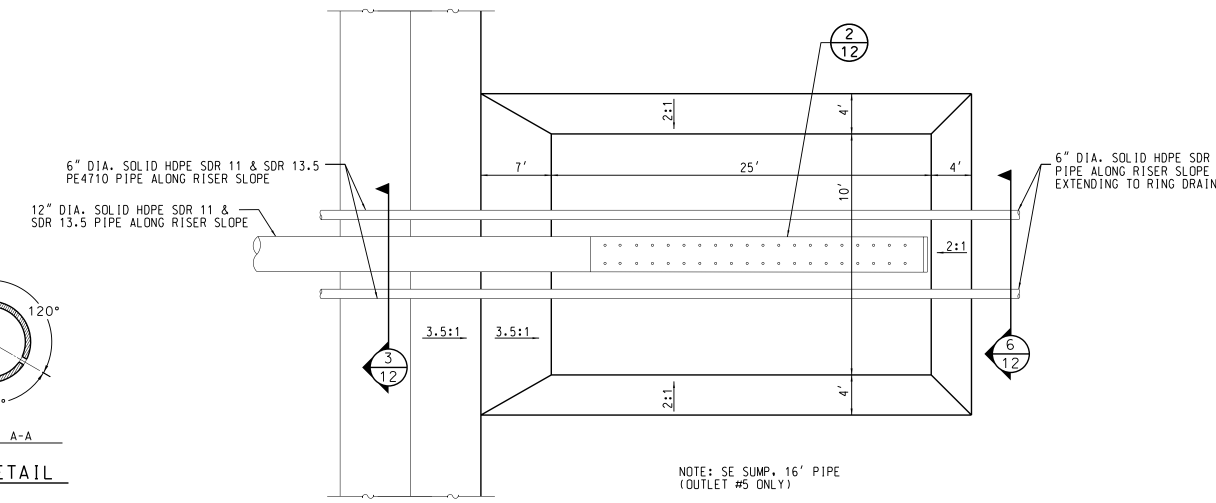
PERFORATED PIPE
SOLID PIPE



1/13 PROCESS WATER RECOVERY SYSTEM - PARTIAL PLAN (TYP. 5 LOCATIONS)
SCALE: 1"=30'

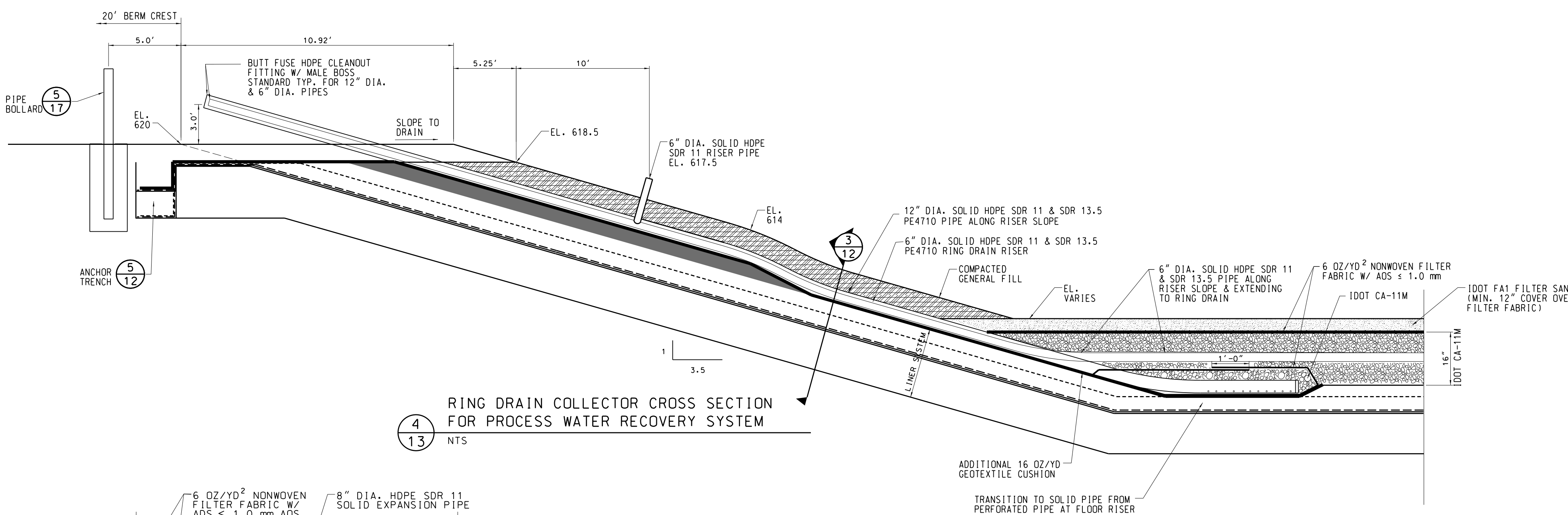


2/13 RING DRAIN COLLECTOR PIPE DETAIL
NTS

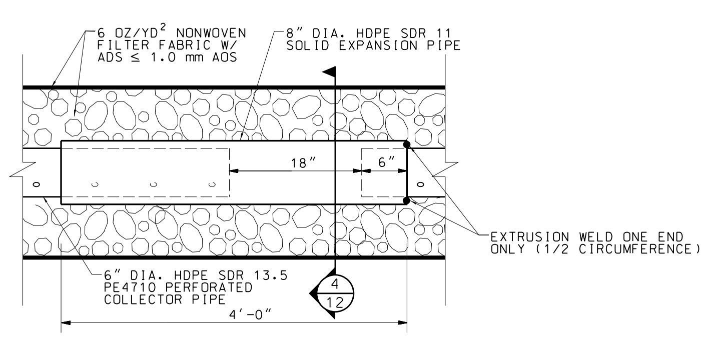


NOTE: SE SUMP, 16' PIPE (OUTLET #5 ONLY)

3/13 PWRS SUMP PLAN
NTS



4/13 RING DRAIN COLLECTOR CROSS SECTION FOR PROCESS WATER RECOVERY SYSTEM
NTS



5/13 RING DRAIN COLLECTOR PIPE EXPANSION UNION
NTS

NOTE:
INSTALL EXPANSION UNION EVERY 100 FT OF 6" DIA. PERFORATED COLLECTOR PIPE

NOTE:
RING DRAIN COLLECTOR PIPES ARE PERFORATED.
RING DRAIN RISER PIPES ARE NOT PERFORATED.

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DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-22-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
2	-	SKB	JDM	-	ISSUED FOR RECORD DRAWING

LAYOUT	DRAWN	REVIEWED
KNK 05-15-07	SKB 04-15-09	

RECORD DRAWING

FILE NO. C180-C102-13.dgn

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Hanson Professional Services Inc.
1525 South Sixth Street
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Phone: (217)788-2450 Fax: (217) 788-2503
Illinois Licensed Professional Service Corporation #184-001084

DRAWING TITLE
PWRS - RING DRAIN DETAILS

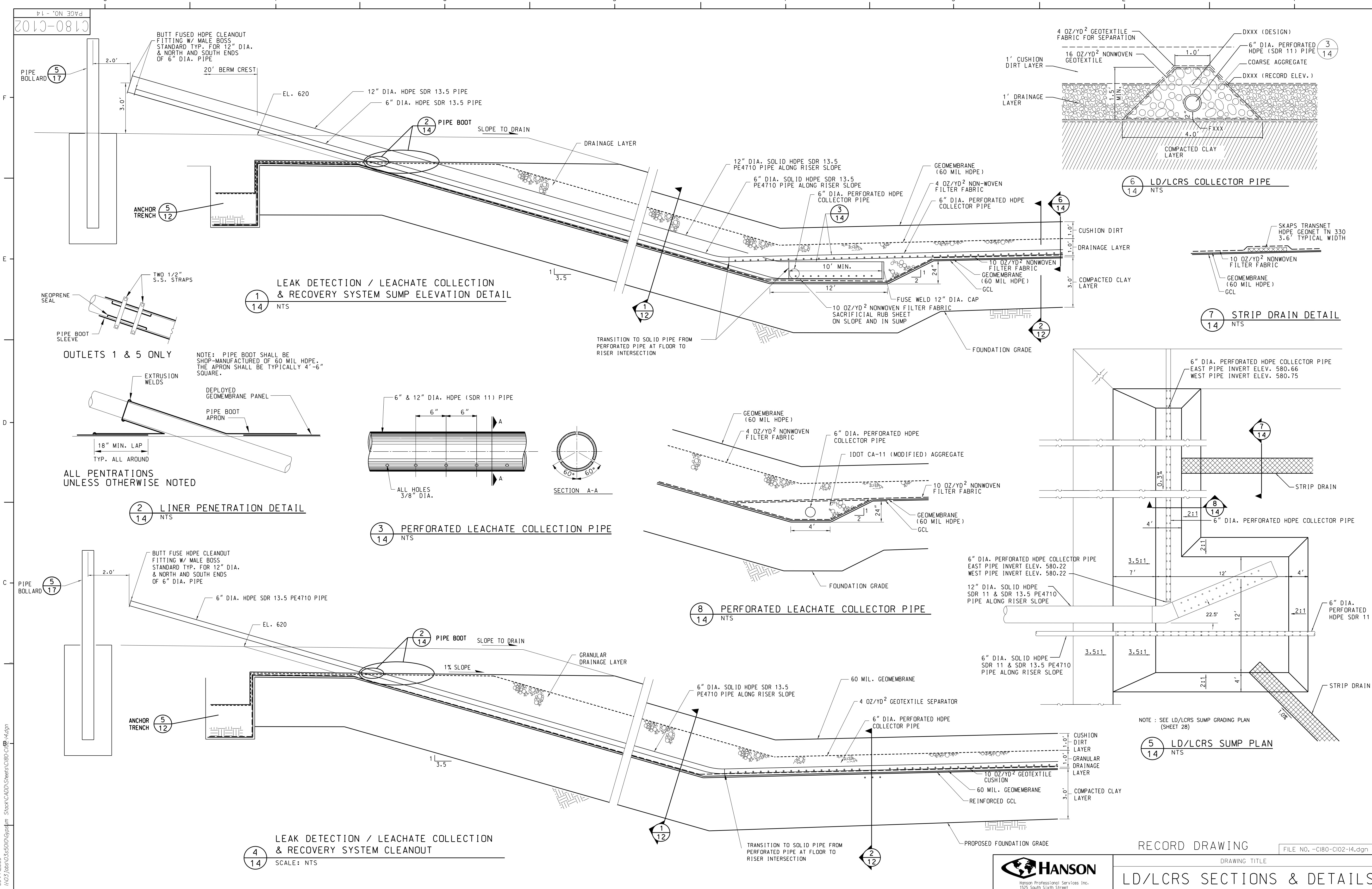
GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

SCALE -
DRAFTER -
DATE 03-26-09

Ameren Energy Resources Generating

DRAWING NUMBER C180-C102
REV. 2

30x42



RECORD DRAWING

FILE NO. -C180-C102-14.dgn

DRAWING TITLE

LD/LCRS SECTIONS & DETAILS

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

HANSON
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, Illinois 62703-2886
Phone: (217) 788-2450 Fax: (217) 788-2503
Illinois Licensed Professional Service Corporation #184-001084
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SCALE -
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DATE 03-26-09

DRAWING NUMBER: C180-C102
REV. 3
SHEET NO. 14 OF 33

AEG CAD GENERATED
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DRAWING RECORD

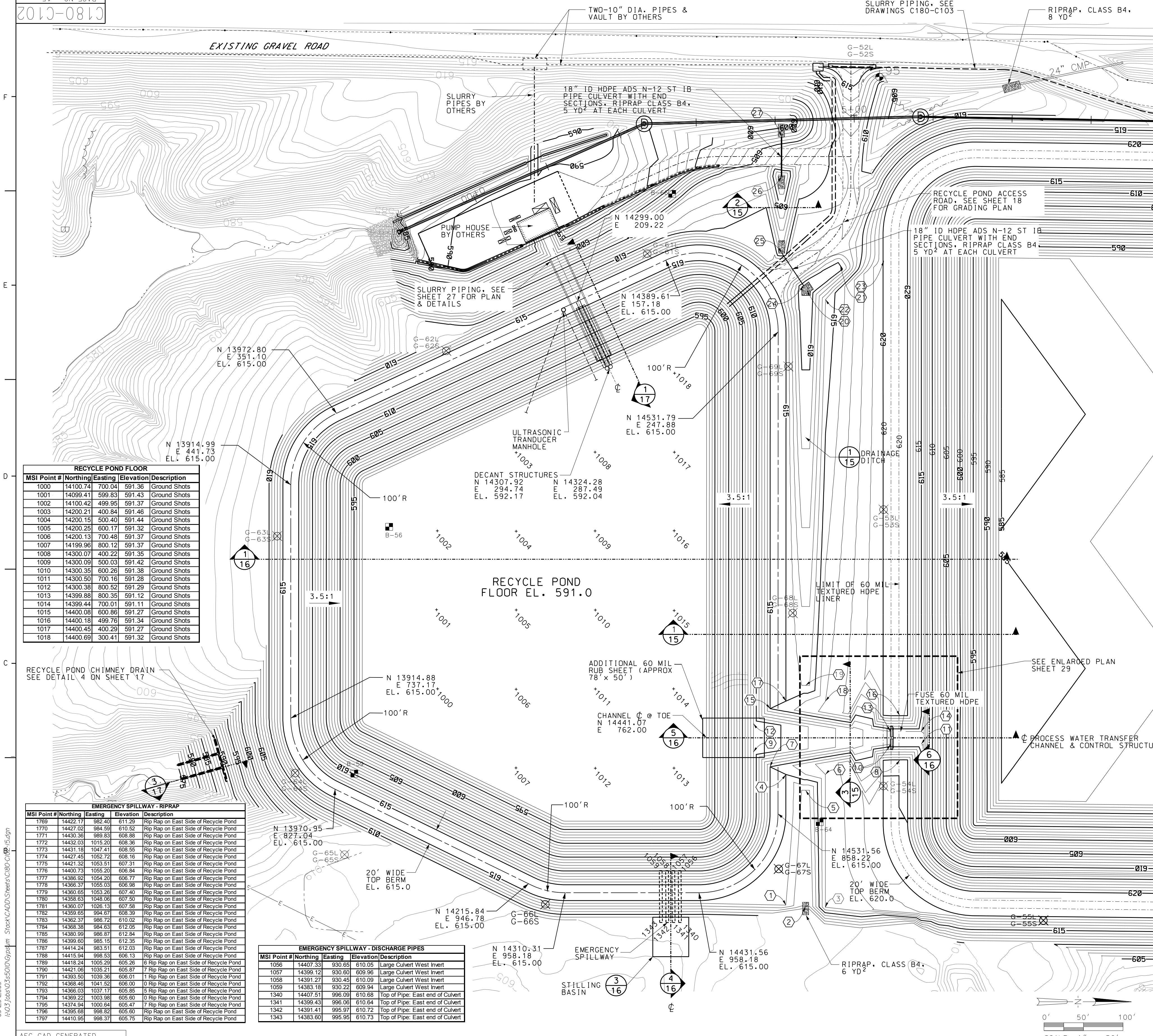
REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-22-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	04-11-08	SMB	SMB	SMB	ISSUED FOR CONSTRUCTION
2	10-10-08	TCJ	DBH	SMB	MODIFIED LD/LCRS SUMP PLAN
3	03-05-09	SKB	JMM	-	ISSUED FOR RECORD DRAWING BY HANSON

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
-	-	-	-	-	-

LAYOUT	KNK	05-15-07
DRAWN	SKB	04-16-09
REVIEWED	-	-

30x42

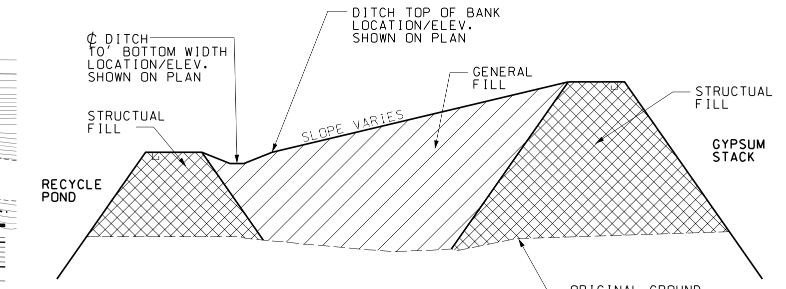
Brand0939
09-Apr-2009
\\03jobs\03s5010\Gypsum Stack\CADD\Sheets\C180-C102-14.dgn



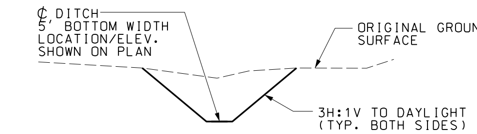
RECYCLE POND FLOOR				
MSI Point #	Northing	Easting	Elevation	Description
1000	14100.74	700.04	591.36	Ground Shots
1001	14099.41	599.83	591.43	Ground Shots
1002	14100.42	499.95	591.37	Ground Shots
1003	14200.21	400.84	591.46	Ground Shots
1004	14200.15	500.40	591.44	Ground Shots
1005	14200.25	600.17	591.32	Ground Shots
1006	14200.13	700.48	591.37	Ground Shots
1007	14199.96	800.12	591.37	Ground Shots
1008	14300.07	400.22	591.35	Ground Shots
1009	14300.09	500.03	591.42	Ground Shots
1010	14300.35	600.26	591.38	Ground Shots
1011	14300.50	700.16	591.28	Ground Shots
1012	14300.38	800.52	591.29	Ground Shots
1013	14399.88	800.35	591.12	Ground Shots
1014	14399.44	700.01	591.11	Ground Shots
1015	14400.08	600.86	591.27	Ground Shots
1016	14400.18	499.76	591.34	Ground Shots
1017	14400.45	400.29	591.27	Ground Shots
1018	14400.69	300.41	591.32	Ground Shots

EMERGENCY SPILLWAY - RIPRAP				
MSI Point #	Northing	Easting	Elevation	Description
1769	14422.17	982.40	611.29	Rip Rap on East Side of Recycle Pond
1770	14427.02	984.59	610.52	Rip Rap on East Side of Recycle Pond
1771	14430.36	989.83	608.88	Rip Rap on East Side of Recycle Pond
1772	14432.03	1015.20	608.36	Rip Rap on East Side of Recycle Pond
1773	14431.18	1047.41	608.55	Rip Rap on East Side of Recycle Pond
1774	14427.45	1052.72	608.16	Rip Rap on East Side of Recycle Pond
1775	14421.32	1053.51	607.31	Rip Rap on East Side of Recycle Pond
1776	14400.73	1055.20	606.84	Rip Rap on East Side of Recycle Pond
1777	14386.92	1054.20	606.77	Rip Rap on East Side of Recycle Pond
1778	14366.37	1055.03	606.98	Rip Rap on East Side of Recycle Pond
1779	14360.65	1053.26	607.40	Rip Rap on East Side of Recycle Pond
1780	14358.63	1048.06	607.50	Rip Rap on East Side of Recycle Pond
1781	14360.07	1026.13	607.58	Rip Rap on East Side of Recycle Pond
1782	14359.65	994.67	608.39	Rip Rap on East Side of Recycle Pond
1783	14362.37	986.72	610.02	Rip Rap on East Side of Recycle Pond
1784	14368.38	984.63	612.05	Rip Rap on East Side of Recycle Pond
1785	14380.99	986.87	612.84	Rip Rap on East Side of Recycle Pond
1786	14399.60	985.15	612.35	Rip Rap on East Side of Recycle Pond
1787	14414.24	983.51	612.03	Rip Rap on East Side of Recycle Pond
1788	14415.94	998.53	606.13	Rip Rap on East Side of Recycle Pond
1789	14418.24	1005.29	605.26	6 Rip Rap on East Side of Recycle Pond
1790	14421.06	1035.21	605.87	7 Rip Rap on East Side of Recycle Pond
1791	14393.50	1039.36	606.01	1 Rip Rap on East Side of Recycle Pond
1792	14368.46	1041.52	606.00	0 Rip Rap on East Side of Recycle Pond
1793	14366.03	1037.17	605.85	5 Rip Rap on East Side of Recycle Pond
1794	14369.22	1003.98	605.60	0 Rip Rap on East Side of Recycle Pond
1795	14374.94	1000.64	605.47	7 Rip Rap on East Side of Recycle Pond
1796	14395.68	998.82	605.60	Rip Rap on East Side of Recycle Pond
1797	14410.95	998.37	605.75	Rip Rap on East Side of Recycle Pond

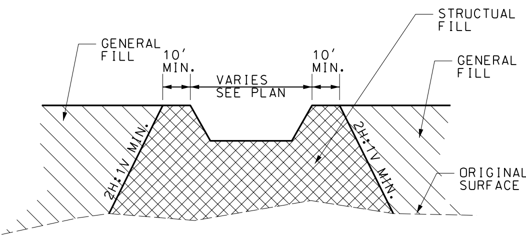
EMERGENCY SPILLWAY - DISCHARGE PIPES				
MSI Point #	Northing	Easting	Elevation	Description
1056	14407.33	930.65	610.05	Large Culvert West Invert
1057	14399.12	930.60	609.96	Large Culvert West Invert
1058	14391.27	930.45	610.09	Large Culvert West Invert
1059	14383.18	930.22	609.94	Large Culvert West Invert
1340	14407.51	996.09	610.68	Top of Pipe: East end of Culvert
1341	14399.43	996.06	610.64	Top of Pipe: East end of Culvert
1342	14391.41	995.97	610.72	Top of Pipe: East end of Culvert
1343	14383.60	995.95	610.73	Top of Pipe: East end of Culvert



1/15 SECTION THROUGH FILL AREA
NTS



2/15 SECTION THROUGH DITCH
NTS



3/15 SECTION THROUGH FILL AREA
NTS

STANDARD LEGEND
(ALL SYMBOLS MAY NOT BE USED ON EACH PLAN)

- ORIGINAL CONTOURS
- FENCELINE
- TRANSMISSION TOWER
- OVERHEAD ELECTRIC
- LIMITS OF VEGETATION
- GRAVEL ROAD
- RAILROAD
- STORM SEWER
- CONTROL POINT
- 650 NEW CONTOURS
- LD/LCRS COLLECTION PIPE
- GEONET
- MW-53L MONITORING WELL
- B-55 BORING
- G69L FUTURE GROUNDWATER MONITORING WELL
- 4" DIA. PERFORATED DRAINAGE PIPING
- 6" DIA. OUTFALL PIPING
- 1001 POINT SURVEYED BY MAUERER-STUTZ, INC.

GRADING TABLE

POINT NUMBER	DESCRIPTION	NORTHING	EASTING	ELEVATION OR INVERT
1	DITCH TOP OF BANK	14,541.49	973.94	614.00
2	CENTERLINE OF DITCH	14,566.49	975.25	612.00
3	DITCH TOP OF BANK	14,591.49	976.56	617.00
4	DITCH TOP OF BANK	14,541.55	808.45	615.00
5	CENTERLINE OF DITCH	14,566.54	828.46	613.00
6	DITCH TOP OF BANK	14,591.55	808.47	617.00
7	PWTC TOP OF BANK	14,521.55	798.85	615.00
8	PWTC TOP OF BANK	14,685.65	790.09	620.00
9	PWTC BOTTOM	14,500.57	780.02	609.00
10	PWTC BOTTOM	14,673.64	770.09	614.00
11	PWTC BOTTOM	14,712.97	770.10	614.00
12	PWTC BOTTOM	14,500.57	744.02	609.00
13	PWTC BOTTOM	14,673.64	754.09	614.00
14	PWTC BOTTOM	14,712.96	754.10	614.00
15	PWTC TOP OF BANK	14,521.58	725.21	615.00
16	PWTC TOP OF BANK	14,685.63	734.09	620.00
17	DITCH TOP OF BANK	14,541.59	715.67	615.00
18	DITCH TOP OF BANK	14,591.59	715.69	617.00
19	CENTERLINE OF DITCH	14,566.59	695.68	614.00
20	CENTERLINE OF DITCH	14,566.78	193.68	609.00
21	CENTERLINE OF DITCH	14,610.57	164.41	610.00
22	DITCH TOP OF BANK	14,591.78	207.04	614.00
23	DITCH TOP OF BANK	14,665.51	157.75	620.00
24	CENTERLINE OF CULVERT	14,564.00	189.52	609.00
25	CENTERLINE OF DITCH/CULVERT	14,536.22	147.95	608.90
26	CENTERLINE OF DITCH/CULVERT	14,536.22	51.05	602.50
27	CENTERLINE OF CULVERT	14,536.22	1.05	602.30

NOTE: PWTC = PROCESS WATER TRANSFER CHANNEL

NOTES:

1. CONTOURS SHOWN IN RECYCLE POND REPRESENT TOP OF LINER.
2. THE PROPERTY IS LOCATED IN SECTION 18, TOWNSHIP 6 NORTH, RANGE 5 EAST, 4TH P.M., FULTON COUNTY, ILLINOIS.

RECORD DRAWING
FILE NO. -C180-C102-15.dgn

0' 50' 100'
SCALE: 1" = 50'

AEG CAD GENERATED
DO NOT REVISE MANUALLY

Brans00939
09\29\2009
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DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	02-22-08	SKB	SMB	SMB	ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
1	03-05-08	SKB	SMB	SMB	ADDED SLURRY PIPING - ISSUED FOR BIDDING - NOT FOR CONSTRUCTION
2	04-11-08	SKB	SMB	SMB	ISSUED FOR CONSTRUCTION
3	09-29-08	DBH	SMB	SMB	REVISED COORDINATES FOR PROCESS WATER CONTROL STRUCTURE
4	12-19-08	TCJ			REVISED CHIMNEY DRAIN
5	03-05-09	SKB	JMM	–	ISSUED FOR RECORD DRAWING BY HANSON

LAYOUT SMB 05/08/07
DRAWN SKB 04-16-09
REVIEWED

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Illinois Licensed Professional Service Corporation #184-001084

SCALE –
DRAFTER
DATE 03-26-09

DRAWING TITLE
RECYCLE POND PLAN
GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. –

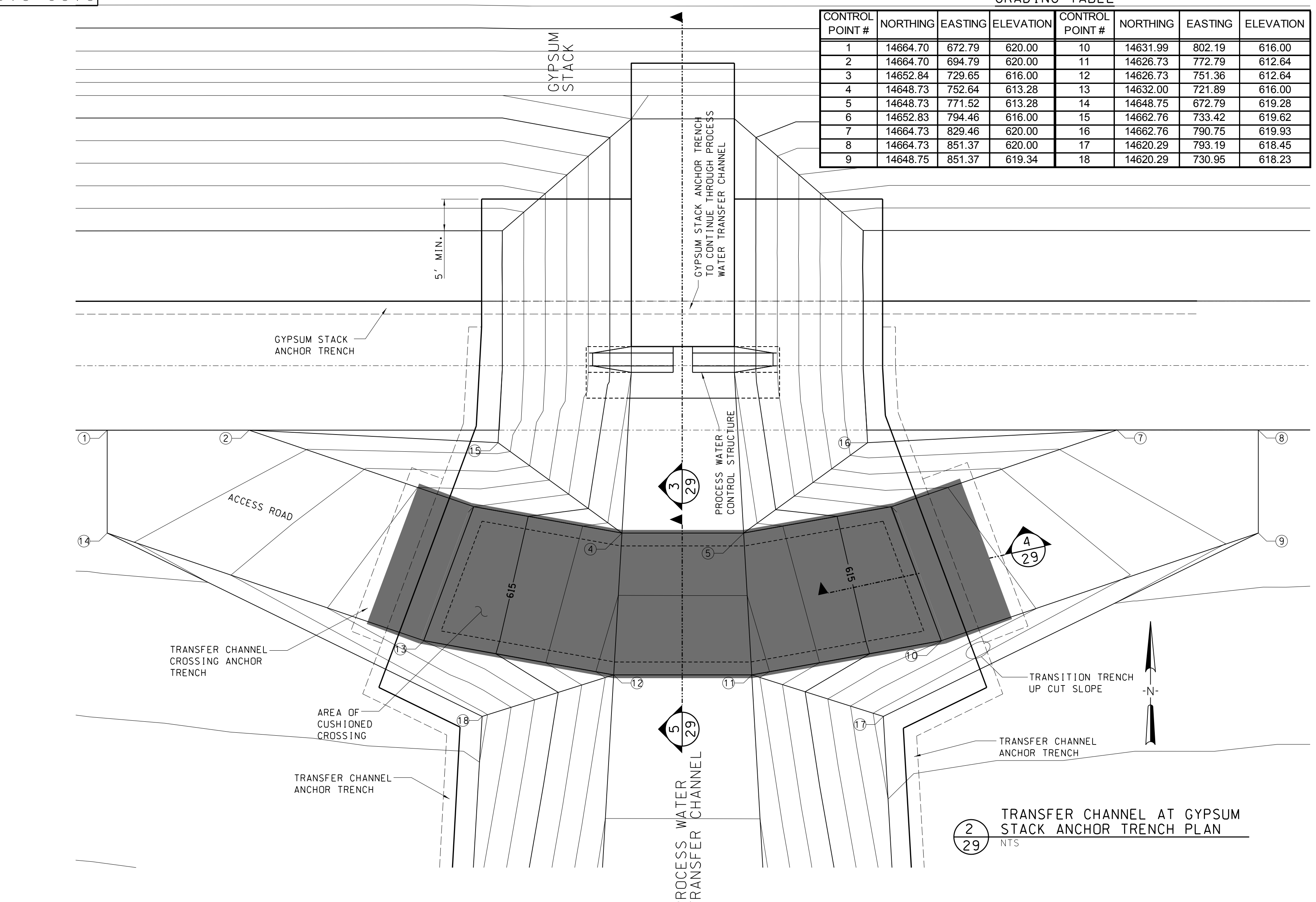
Ameren Energy Resources Generating

DRAWING NUMBER C180-C102
REV. 5
SHEET NO. 15 OF 33

30x42

GRADING TABLE

CONTROL POINT #	NORTHING	EASTING	ELEVATION	CONTROL POINT #	NORTHING	EASTING	ELEVATION
1	14664.70	672.79	620.00	10	14631.99	802.19	616.00
2	14664.70	694.79	620.00	11	14626.73	772.79	612.64
3	14652.84	729.65	616.00	12	14626.73	751.36	612.64
4	14648.73	752.64	613.28	13	14632.00	721.89	616.00
5	14648.73	771.52	613.28	14	14648.75	672.79	619.28
6	14652.83	794.46	616.00	15	14662.76	733.42	619.62
7	14664.73	829.46	620.00	16	14662.76	790.75	619.93
8	14664.73	851.37	620.00	17	14620.29	793.19	618.45
9	14648.75	851.37	619.34	18	14620.29	730.95	618.23

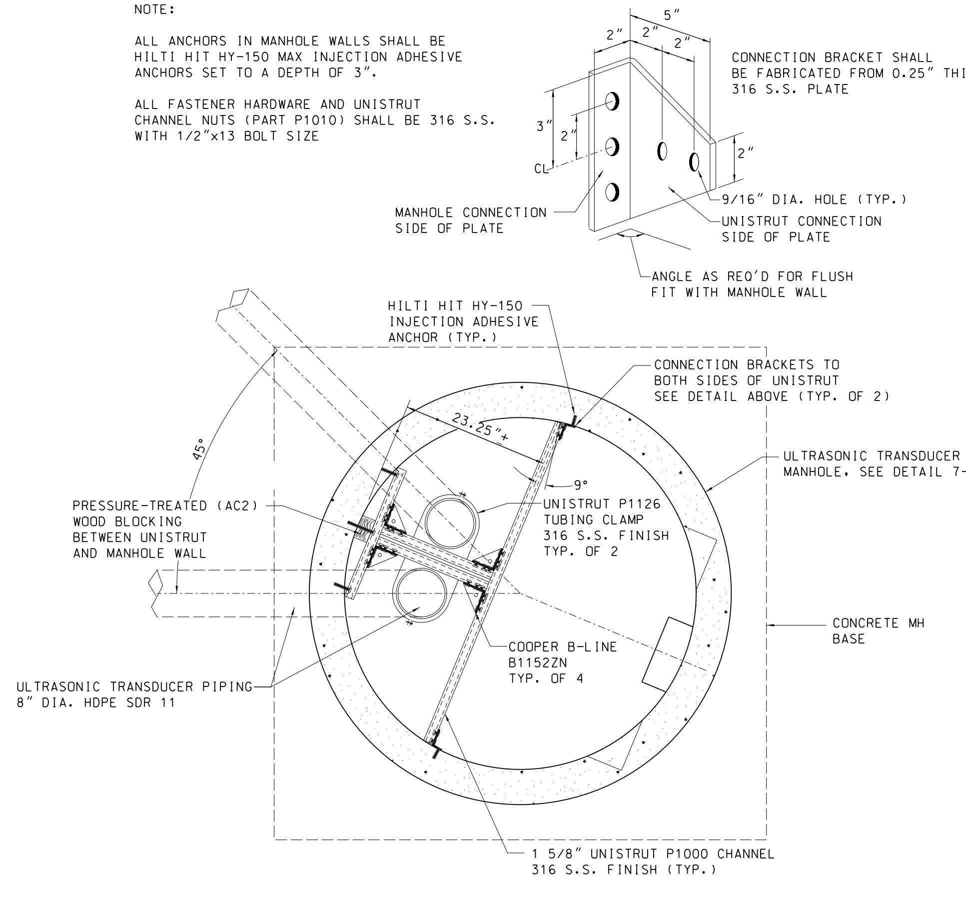


2/29 TRANSFER CHANNEL AT GYPSUM STACK ANCHOR TRENCH PLAN
NTS

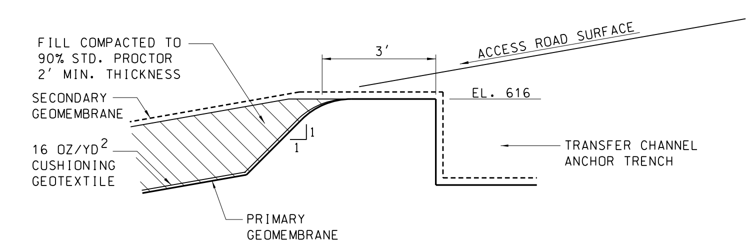
NOTE:

ALL ANCHORS IN MANHOLE WALLS SHALL BE HILTI HIT HY-150 MAX INJECTION ADHESIVE ANCHORS SET TO A DEPTH OF 3".

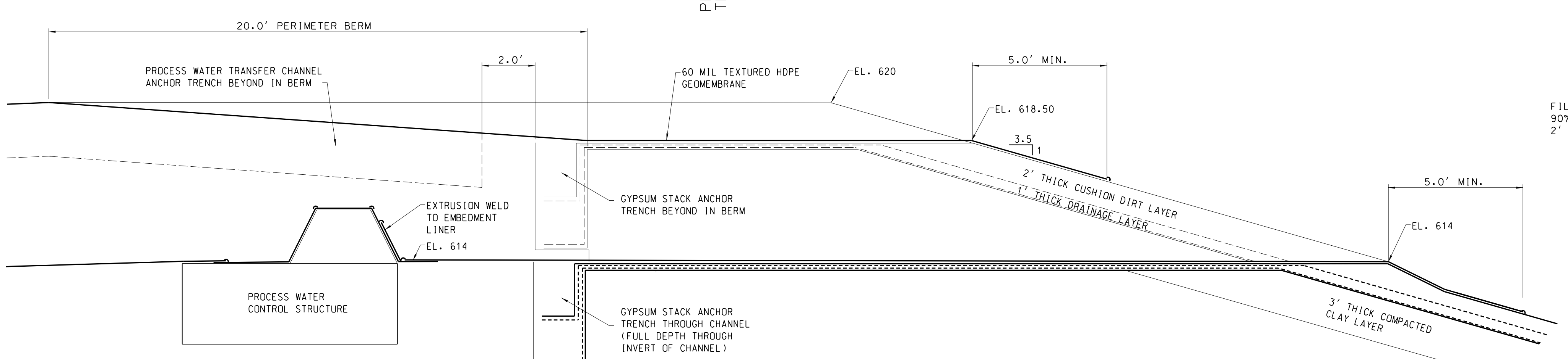
ALL FASTENER HARDWARE AND UNISTRUT CHANNEL NUTS (PART P1010) SHALL BE 316 S.S. WITH 1/2"x13 BOLT SIZE



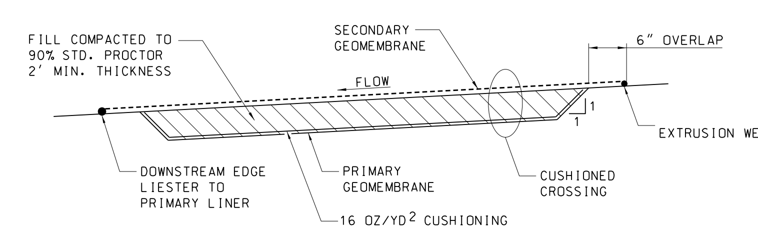
1/29 ULTRASONIC TRANSDUCER PIPE SUPPORT DETAIL
1"=1'



4/29 ACCESS ROAD AT TRANSFER CHANNEL TRENCH
NTS



3/29 TRANSFER CHANNEL AT GYPSUM STACK ANCHOR TRENCH SECTION
NTS



5/29 ACCESS ROAD THRU PROCESS WATER TRANSFER CHANNEL TRENCH
NTS

AWING

FILE NO. -C180-C102-29.dgn

Brand0939
09/25/2009
\\O3Jobs\03s5010\Gypsum Stack\CADD\Sheets\C180-C102-29.dgn

AEG CAD GENERATED
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REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
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1	01-08-09	TCJ	DBH	DBH	ADDED ACCESS ROAD CROSSING AND DETAILS
2	03-05-09	SKB	JMM	-	ISSUED FOR RECORD DRAWING

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION

LAYOUT TCJ 10-21-08
DRAWN SKB 04-28-09
REVIEWED - -

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SCALE
-

DRAFTER
-

DATE
03-26-09

DRAWING TITLE

MISCELLANEOUS DETAILS

GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS

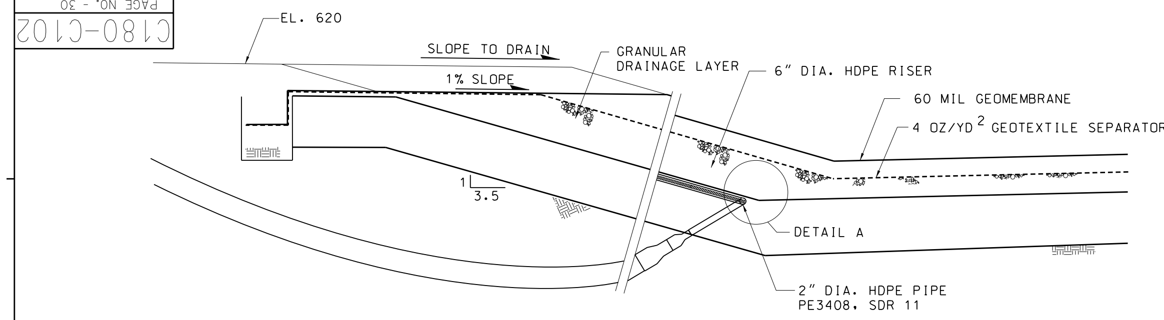
DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy Resources Generating

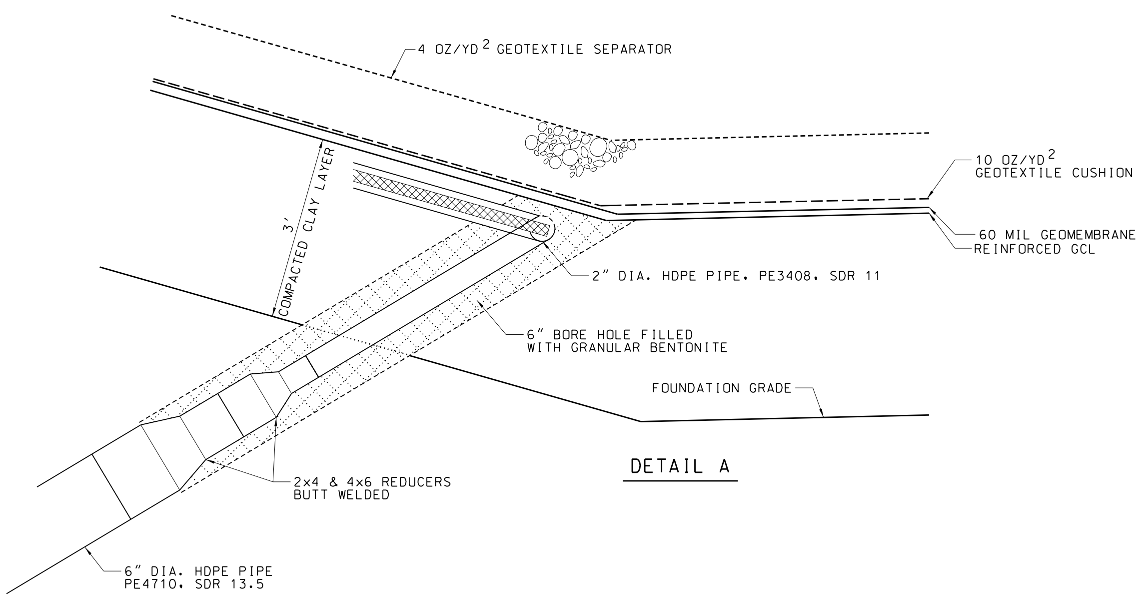
DRAWING NUMBER: C180-C102
REV.: 2

SHEET NO. 29 OF 33

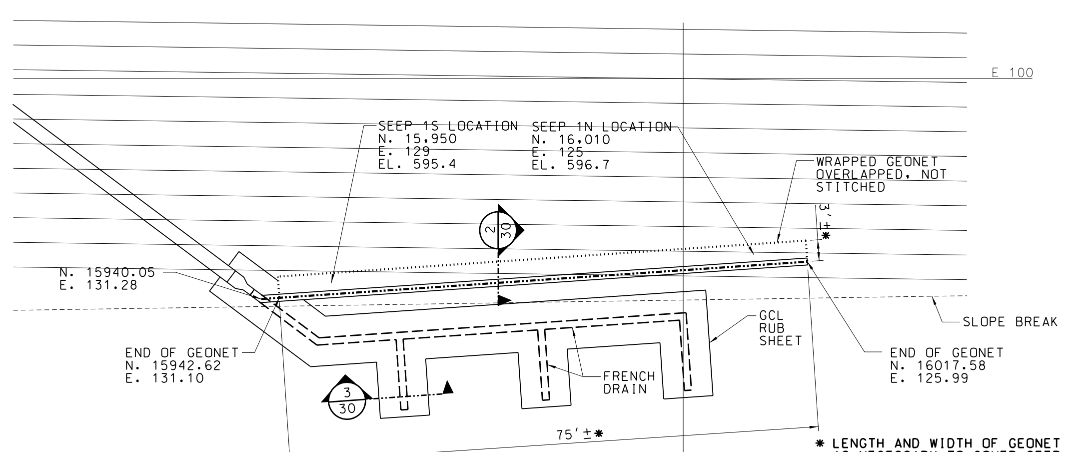
30x42



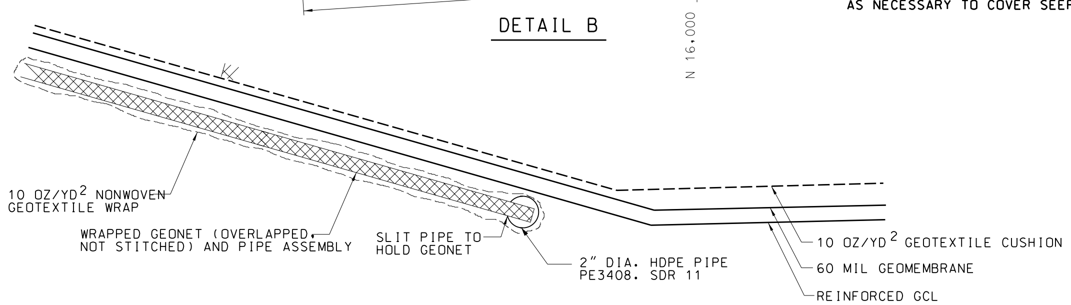
1/30 RISER DETAIL
SCALE: NTS



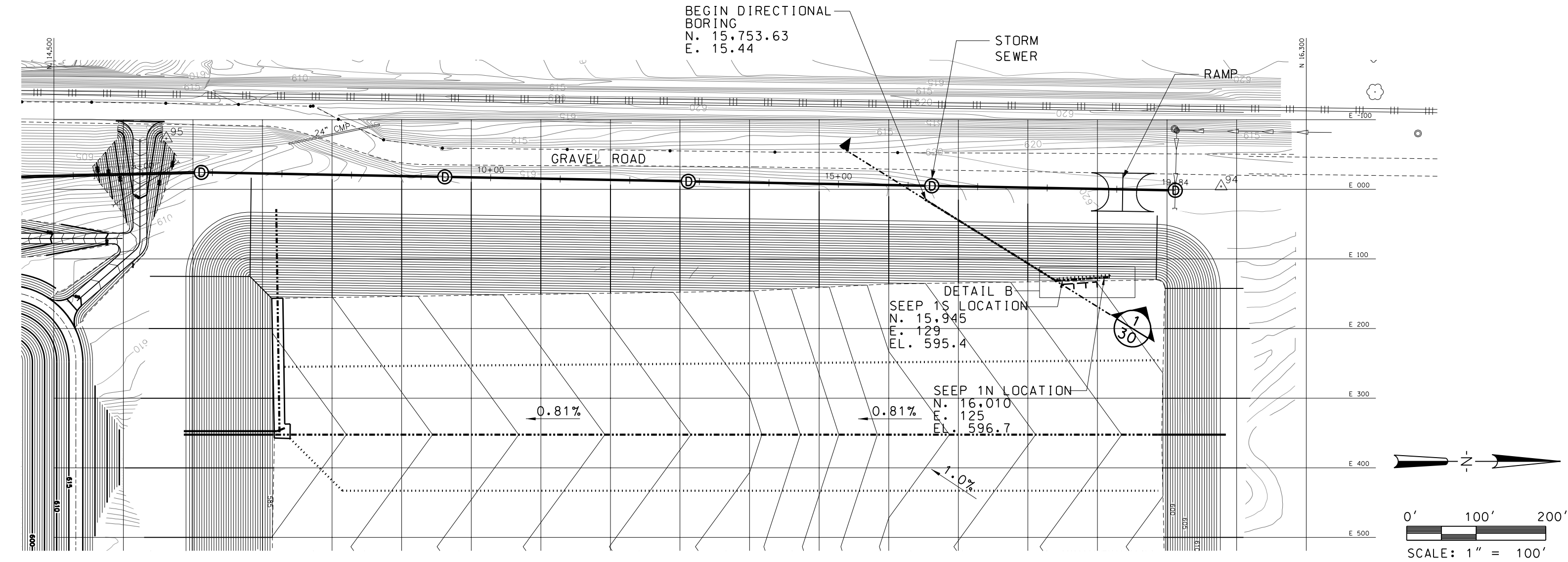
DETAIL A

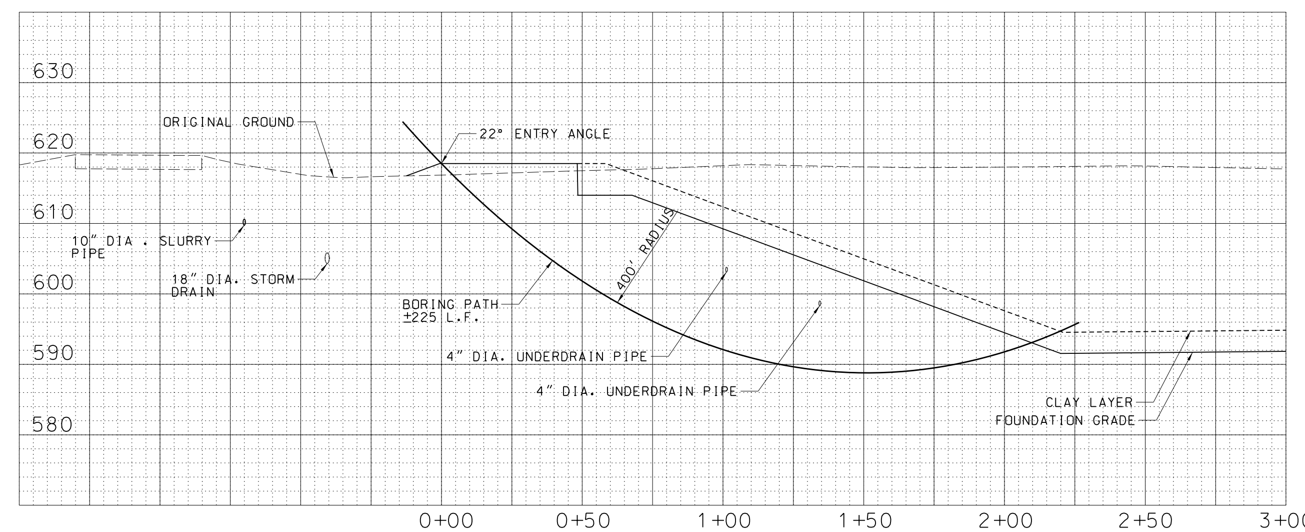


DETAIL B



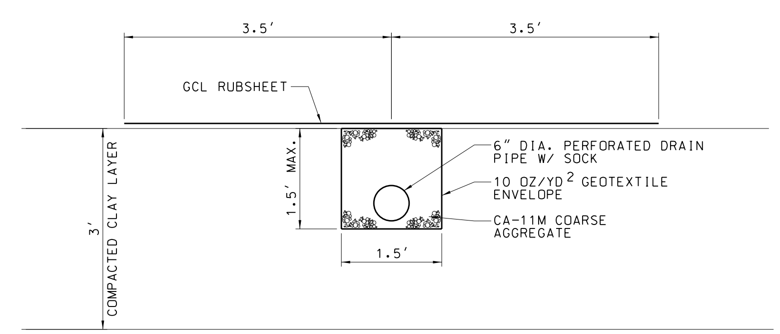
2/30 GEONET DETAIL
SCALE: NTS





BORING PROFILE

STATION	CLAY LAYER ELEVATION	BORING PATH ELEVATION
0+00	618.50	618.50
0+10	618.50	614.57
0+20	618.50	610.94
0+30	618.50	607.62
0+40	618.50	604.58
0+50	618.50	601.82
0+60	618.26	599.34
0+70	616.79	597.14
0+80	615.31	595.19
0+90	613.84	593.51
1+00	612.36	592.09
1+10	610.89	590.93
1+20	609.41	590.02
1+30	607.94	589.36
1+40	606.46	588.95
1+50	604.98	588.80
1+60	603.51	588.89
1+70	602.03	589.23
1+80	600.56	589.83
1+90	599.08	590.67
2+00	597.61	591.77
2+10	596.13	593.13
2+20	594.66	594.74



3/30 FRENCH DRAIN DETAIL
SCALE: NTS

NOTE:
SEE OTHER PLAN SHEETS FOR STANDARD LEGEND.

RECORD DRAWING

FILE NO. -C180-C102-30_SEEP1.dgn

Brans00939
09\5\2009
I:\03 jobs\03s50\0\Gypsum Stack\CADD\Sheets\C180-C102-30_SEEP1.dgn

AEG CAD GENERATED
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LAYOUT	TCJ	11-03-08
DRAWN	SKB	04-28-09
REVIEWED	DBH	11-05-08

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION	REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	11-07-08	TCJ	RWH	DBH	ISSUED FOR CONSTRUCTION	-	-	-	-	-	
1	11-14-08	TCJ			REVISED BORING PATH AND ENTRY POINT - ISSUED FOR CONSTRUCTION						
2	03-05-09	SKB	JMM		ISSUED FOR RECORD DRAWING BY HANSON						

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SCALE
DRAFTER
DATE 03-26-09

DRAWING TITLE

LD/LCRS UNDERDRAIN DEWATERING SYSTEM-SEEP 1

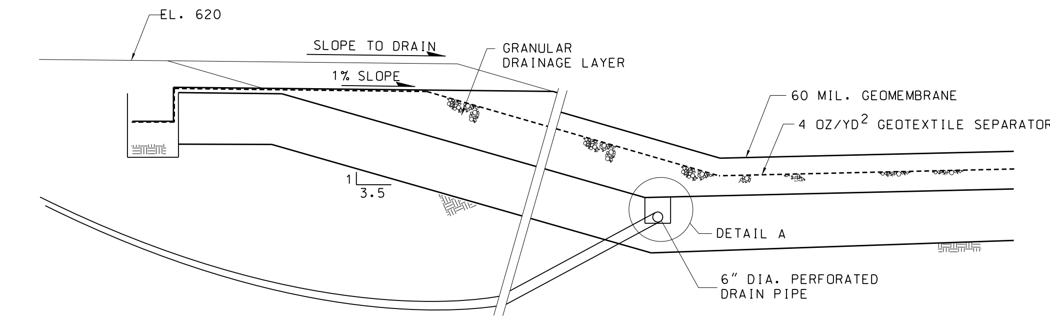
GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy Resources Generating

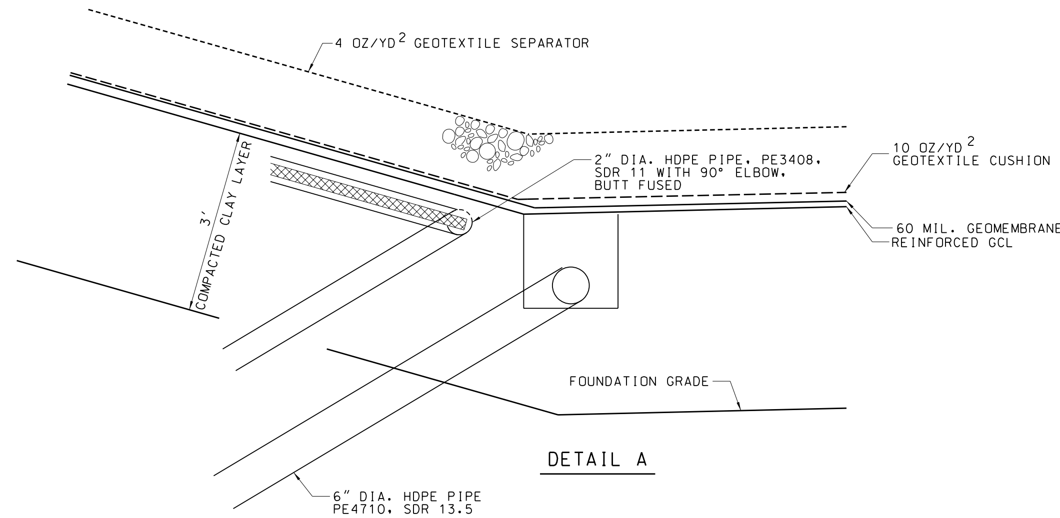
DRAWING NUMBER C180-C102 REV. 2
SHEET NO. 30 OF 33

30x42

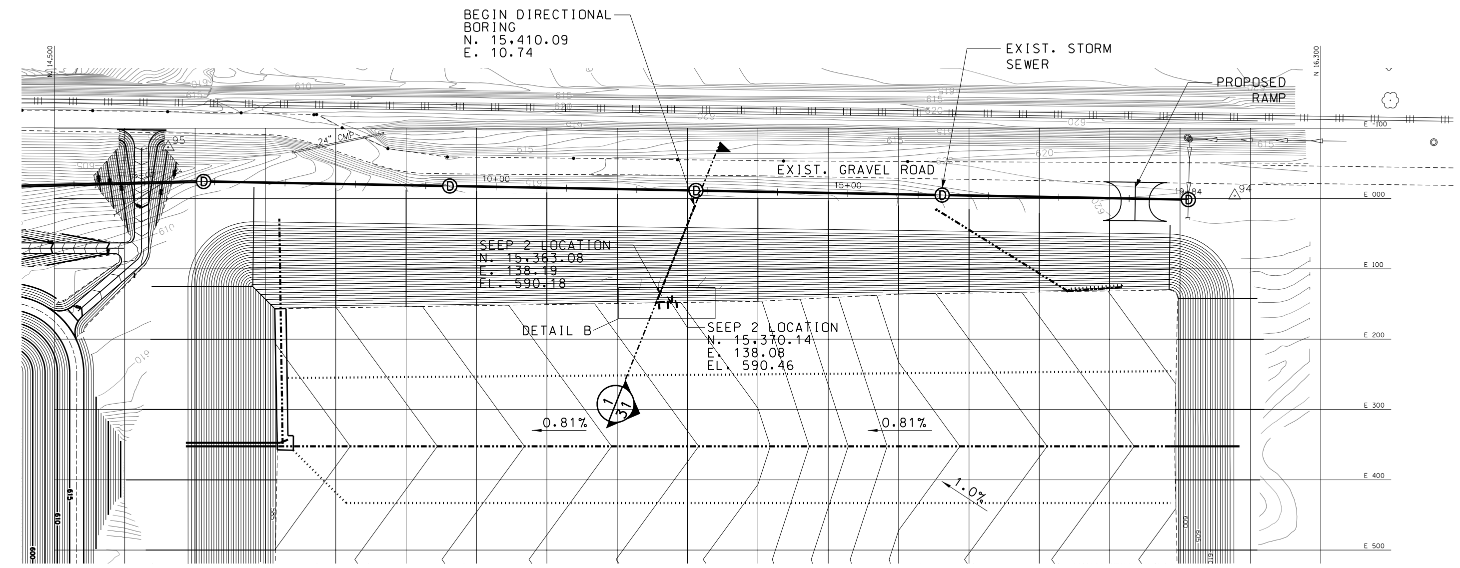
C180-C102
PAGE NO. - 31

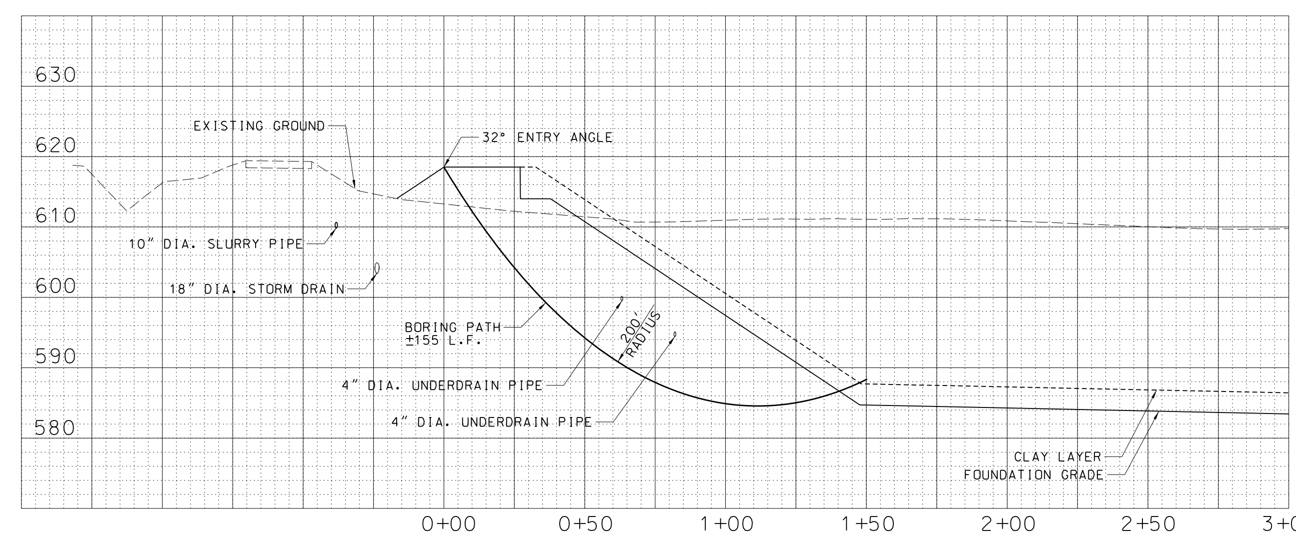


1/31 RISER DETAIL
SCALE: NTS



DETAIL A

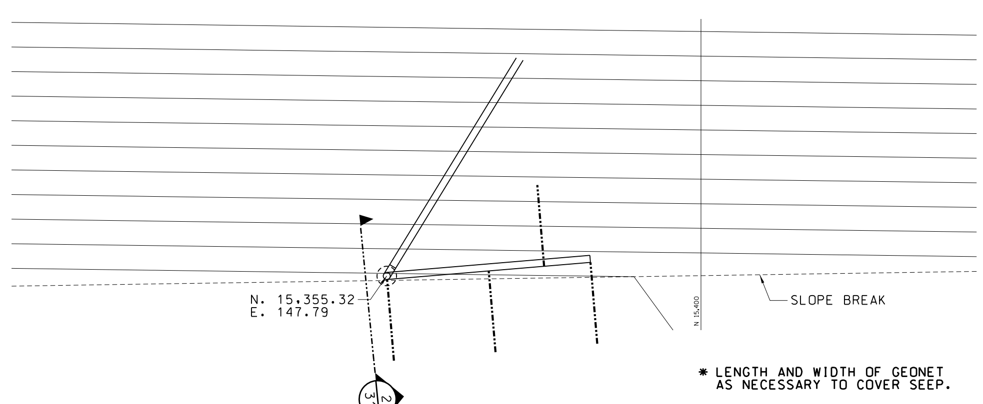




BORING PROFILE

①

STATION	CLAY LAYER ELEVATION	BORING PATH ELEVATION
0+00	618.50	618.50
0+10	618.50	612.21
0+20	618.50	606.70
0+30	618.50	601.90
0+40	616.55	597.77
0+50	613.88	594.24
0+60	611.21	591.30
0+70	608.55	588.91
0+80	605.88	587.05
0+90	603.21	585.72
1+00	600.54	584.89
1+10	597.88	584.57
1+20	595.21	584.75
1+30	592.54	585.43
1+40	589.88	586.61



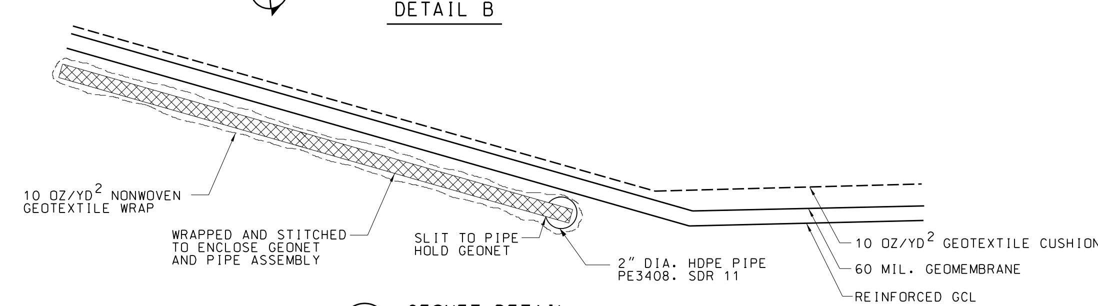
* LENGTH AND WIDTH OF GEONET AS NECESSARY TO COVER SEEP.

DETAIL B

STANDARD LEGEND
(ALL SYMBOLS MAY NOT BE USED ON EACH PLAN)

ORIGINAL CONTOURS	NEW CONTOURS
FENCELINE	LD/LCRS COLLECTION PIPE
TRANSMISSION TOWER	GEONET
OVERHEAD ELECTRIC	MW-53L MONITORING WELL
LIMITS OF VEGETATION	B-55 BORING
GRAVEL ROAD	G69L FUTURE GROUNDWATER MONITORING WELL
RAILROAD	4" DIA. PERFORATED DRAINAGE PIPING
STORM SEWER	6" DIA. OUTFALL PIPING
CONTROL POINT	

0' 100' 200'
SCALE: 1" = 100'



2/31 GEONET DETAIL
SCALE: NTS

RECORD DRAWING
FILE NO. -C180-C102-31_SEEP2.dgn

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DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0	11-19-08	TCJ	---	---	ISSUED FOR CONSTRUCTION
1	11-24-08	TCJ	RWH	DBH	ISSUED FOR CONSTRUCTION REVISED PENETRATION LOCATION
2	03-05-09	TCJ	JMM	-	ISSUED FOR RECORD DRAWING BY HANSON

LAYOUT TCJ 11-03-08
DRAWN TCJ 11-19-08
REVIEWED DBH

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SCALE -
DRAFTER -
DATE 03-26-09

DRAWING TITLE
LD/LCRS UNDERDRAIN DEWATERING SYSTEM-SEEP 2
GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS
DUCK CREEK POWER STATION UNIT NO. -

Ameren Energy Resources Generating

DRAWING NUMBER C180-C102
REV. 2
SHEET NO. 31 OF 33

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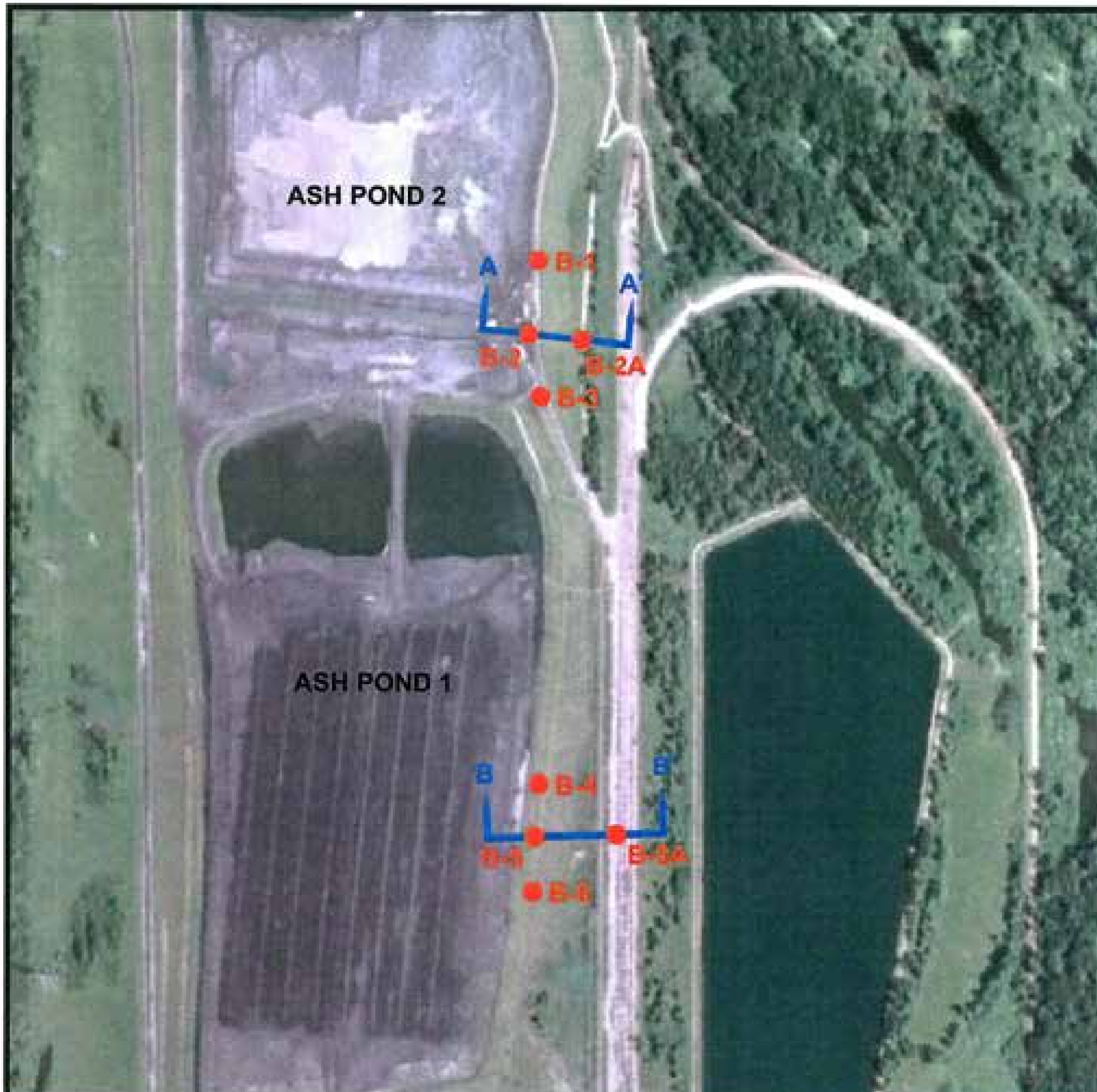
03/05/2009
I:\03Jobs\03s5010\Gypsum Stack\CADD\Sheets\C180-C102-31_SEEP2.dgn

30x42

AECOM

Appendix C: Duck Creek Power Station Boring and Piezometer Locations



NOTES

1. Plan adapted from an aerial photograph courtesy of Google Earth.

LEGEND

● Boring Location

▬ Slope Stablity Cross Section

0 500 1000

APPROXIMATE SCALE IN FEET

N

Drawn By: SLC	Ck'd By: SLC	App'vd By: DJV
Date: 11-03-10	Date: 12/14/10	Date: 1/4/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Duck Creek Power Station
Canton, Illinois

AERIAL PHOTOGRAPH OF SITE AND BORING LOCATIONS

Project Number J017150.01	PLATE 2

Figure C.1. Piezometer locations for Ash Pond No. 1 and Ash Pond No. 2.

AECOM

Appendix D: Project Manual; Specification No's.: C180-C102 (excerpt)

PROJECT MANUAL
GYPSUM STACK AND RECYCLE POND AND CCB LANDFILL CONSTRUCTION
GYPSUM MANAGEMENT FACILITY AND CCB LANDFILL
DUCK CREEK POWER STATION
FULTON COUNTY, ILLINOIS

SPECIFICATION NO'S.: C180-C102

Prepared For:

AMEREN ENERGY RESOURCES GENERATING COMPANY

Prepared By:

HANSON PROFESSIONAL SERVICES INC.
1525 South Sixth Street
Springfield, Illinois 62703

Specifications for Construction

April 11, 2008

BIDDING CLARIFICATIONS FOR AMEREN CONTRACT DOCUMENTS
AMEREN ENERGY RESOURCES GENERATING COMPANY
GYPSUM MANAGEMENT FACILITY AND CCB LANDFILL
PROJECT SPECIFICATIONS NO. C180-C102
ADDENDUM #2

Prepared March 24, 2008
By Hanson Professional Services, Inc.
Preparer: DBH

Hanson Professional Services is please to provide the following clarifications to outstanding questions regarding the contract documents:

1) *Please clarify again Bid Form page BF-A-5 the 146,740 cy is the amount excavated and stockpiled. In addition in that price we include 146,740 cy going back in place?*

   Answer: The Estimated Quantity of 146,740 C.Y. shown on Bid Forms A and B is our estimated TOTAL excavation needed for the Over-excavation of Soil and Sand from NE & SW Corners of Gypsum Stack Area. The excavation shall be backfilled with suitable structural backfill after the unsuitable sand lens material has been removed and stockpiled. Our estimate for unsuitable sand material is the 17,600 C.Y. shown in the same section of the Bid Forms.

2) *What is the status of design on slurry piping plan and details? Currently sheet C102-27 does not provide sufficient information.*

   Answer: An updated sheet will be issued with Addendum #2.

3) *Per sheet C102-05, "All under drain pipes installed under the excavation contract C180-C101 shall remain in place. Subsurface drainage piping shall be sealed with bentonite slurry in accordance with project specifications upon completion of the liner system". Please provide specifications.*

   Answer: Sealing of the subsurface drainage system is specified in Section 02141 - Surface Water Management, paragraph 3.06.

4) *Is dwg. format available with Landfill, Gypsum and Recycle Pond area merged to one drawing. We specifically need existing and proposed contours for both projects consolidated as one design and existing layer. The tins provided are for the Gypsum Pond only, would appreciate fill for Landfill if drawings can not be merged. Will Hanson be able to provide design contours for cushion dirt layer? Currently available drawings provide points only from sheet C102-11.*

   Answer: We will be issuing updated tin & dwg files for the Gypsum Stack Recycle Pond that reflects the work completed under Contract C180-C101 with Addendum #2. Tin & DWG files for the CCB Landfill will be issued later in the week, as it is currently being surveyed and verified.

5) *The granular materials for the drainage layer and seperation berm shall provide a minimum hydraulic conductivity (ASTM D2434) of 1 X 10-3. Is there a specific material anticipated for the completion of this work?*

   Answer: The granular materials required for the drainage layer and separation berm are adequately specified in the Project Specifications. The Contractor shall be responsible for determining availability and sourcing for these materials.

6) *Is a construction joint allowed in the Process Water Control Structure.*

Answer: A Bonded Construction Joint will be allowed for this structure, provided that it is constructed in accordance with article 503.09 of the Illinois Department of Transportation "Standard Specifications for Road and Bridge Construction" Adopted January 1, 2007.

7) *What if anything is required on the low water crossing on sheet 16 of the CCB Landfill?*

Answer: No special materials are required in this area, the invert of the existing spillway channel shall be maintained and crossed by the proposed haul road.

8) *Is the Coarse Aggregate for the Leachate collection pipe also the IDOT CA-7 Per Article 1004.1 of IDOT Specs.*

Answer: The Coarse Aggregate for the Leachate Collection Pipe shall be a gradation as required to provide a minimum hydraulic conductivity (ASTM D2434) of 1×10^{-3} cm/sec. We will issue a correction to the specifications with Addendum #2.

9) *Detail 7/17 for the Ultrasonic Transducer from your web site is different than your handout at the pre-bid meeting is the web site detail the one we are to provide?*

Answer: The latest detail on the web site is the latest one, however a revision to that detail will be issued with Addendum #2.

10) *Bid Form page A-3 Riprap Class B4, the unit of measure is LF, should that be TONS or S.Y.?*

Answer: The correct unit should be S.Y.

11) *In an effort to utilize local aggregate sources, can we use "Special Provision Rock" as specified by IDOT for Contracts 68206 & 68205 for the aggregate base and surface course?*

Answer: All aggregates shall be supplied as specified in Section 02315 Granular Materials.

12) *Can we substitute a butt fusion reducer in lieu of the 50% welded extrusion joints" as shown in detail 5/13?*

Answer: A butt fusion reducer would be acceptable in that location (Detail 5/13 - Plans C180-C102)

13) *Page 27, slurry piping- Is this the sluice piping from section 2640? There is no size listed on the plans. The plan shows dashed and solid lines, what do they represent. Section 2640 calls for valves in the sluice piping, are these the valves shown on sheet 27?*

Answer: A revised sheet C180-102-27 and a new sheet C180-102-28 are included in Addendum #2.

14) *The specs say all underdrain within lined areas of cell is to be grouted. Is the recycle pond lined?*

Answer: The subdrainage outfall piping beneath the recycle pond is to be grouted.

15) *We are trying to figure out what gradation of rock is required for detail 6/14 on the gypsum stack and also for detail 1/12 and 2/12 on the CCB Landfill. Section 2315 Part 2 does not have the gradation language we are used to looking at for the CCB Landfill Course Aggregate.*

Answer: The Coarse Aggregate material called out in these details is the same as is specified in Section 02315 - Part 2.01-B-2 for CCB Landfill Coarse Aggregate. A revised specification will be included in this Addendum.

<u>BIDDING CLARIFICATIONS FOR AMEREN CONTRACT DOCUMENTS</u>
AMEREN ENERGY RESOURCES GENERATING COMPANY
GYPSUM MANAGEMENT FACILITY AND CCB LANDFILL
PROJECT SPECIFICATIONS NO. C180-C102

<u>ADDENDUM #3</u>

Prepared March 27, 2008
By Hanson Professional Services, Inc.
Preparer: DBH

Hanson Professional Services is pleased to provide the following clarifications to outstanding questions regarding the contract documents:

Question: One GCL manufacturer produces a double nonwoven, needlepunch reinforced geosynthetic clay liner that will meet or exceed the project requirements and the GRI-GCL-3 specification, with only two clarifications:

Footnote #2 in Table 1 of the GRI-GCL-3 specification states that for nonwoven reinforced GCLs, one of the Geotextiles must contain a scrim component of mass > 2.9 oz/yd2 for dimensional stability. An exception to the scrim reinforcement requirement has been requested.

Table 1 of the GRI-GCL-3 specification states that nonwoven reinforced GCLs should be manufactured with minimum 5.9 and 5.8 oz/yd2 Geotextiles. Our product is manufactured with minimum 6.0 and 2.7 oz/yd2 nonwoven Geotextiles and it will still meet the peel and tensile strength requirements in the specifications. Accordingly, an exception to the minimum geotextile weights has been requested.

Answer: *We will allow these exceptions, provided that all of the other requirements of the specifications are met by the GCL being submitted for bid.*

Question: Aggregate suppliers cannot perform the testing required to qualify that their materials will meet the project specifications in the time allotted for bidding. What can the aggregate suppliers do to provide a reasonable quote for the aggregate materials within the Gypsum Stack and CCB Landfill footprints.

Answer: Adequate bidding time was allotted for relatively quick permeability and gradation testing, and these test results should be available. However, based on the time allotted for bidding and the turn-around time needed to complete the longer tests necessary to certify project specification compliance, we will allow aggregate suppliers to certify a unit price for these materials based on the contingency that they will meet the following required specifications:

ASTM D3042-03 Standard Test Method for Insoluble Residue in Carbonate Aggregates (15% loss Max.)

Na_2SO_4 Soundness 5 Cycle, Illinois Modified AASHTO T 104 (15% Loss Max.)
ASTM C 1260 Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method) (Less than 0.10% internal expansions at 16 days after casting)

Additional question related to the overexcavation and replacement of materials in the NE and SW corners of the gypsum stack area:
Please clarify "The excavation shall be backfilled with suitable structural backfill". How and where will that backfill be paid for?

Answer: Please note that the bid form section for additional items to be paid on a unit cost or time and material basis provides estimated quantities only. The bid form allows for separate pricing for unsuitable sand soils that will need to be excavated from the NE and SW corners of the gypsum stack areas and transported to stockpiles (estimated at 17,600 cy) and for excavation and recompaction of soil material suitable for reuse (estimated at 146,740 cy). Based on these ESTIMATED volumes, the total ESTIMATED volume to be over-excavated from the NE and SW corners of the gypsum stack excavation is 164,340 cy (17,600 cy of which is estimated to be unsuitable sand that needs to be transported out of the excavation and stockpiled). Note again that we will be removing an unknown amount of sand from the excavation. Shrinkage as a result of the compaction process may also be a factor. Any shortage of suitable backfill shall be obtained from the subsoil stockpiles. Backfilling the excavation with Structural Fill to be obtained from stockpiles will be paid for at Time and Material or by the unit cost included on the bid form for "Backfill w/Structural Fill from Stockpile."

Question: Can the test pad for the clay liner be constructed outside the footprint of the cell?

Answer: The test soil liner must be constructed within the footprint of the cell.

What end treatment is to be applied to the upstream ends of the 6" and 12" perforated laterals shown on Sheet C180-C110-09 and detailed on sheet C180-C110-12 for the CCB Landfill?

Answer: Cleanouts with threaded caps shall be installed at the termination points for the 6" and 12" perforated laterals. Revised drawing #C180-C110-09 is attached indicating this detail.

Question: The new details for vaults on the slurry lines show 8" RFP being bolted into 8" Valves, then a 10" HDPE pipes. The bolt patterns on the 10" pipe and 8" valve are not compatible. Please clarify.

Answer: An FRP spindle needs to be provided to go from the 8" valve to the 10" HDPE pipe. Revised drawing #C180-C102-28 is attached to show this configuration.

FINAL NOTE: THE BIDS ARE DUE MONDAY, 3/31/08. NO MORE QUESTIONS WILL BE ACCEPTED PRIOR TO BIDDING. PLEASE INCLUDE ANY ADDITIONAL ASSUMPTIONS AND CLARIFICATIONS WITH YOUR BIDS.

GYPSUM STACK AND RECYCLE POND AND CCB LANDFILL CONSTRUCTION
GYPSUM MANAGEMENT FACILITY AND CCB LANDFILL
DUCK CREEK POWER STATION
FULTON COUNTY, ILLINOIS

TABLE OF CONTENTS

PART 1. GENERAL

1.0 INTRODUCTION

A. Gypsum Management Facility

The intent of this contract is to provide the services of a General Contractor to construct Gypsum Management Facility, consisting of a lined Gypsum Stack and Recycle Pond for the disposal of gypsum at Ameren Energy Resources Generating Company (AERG) Duck Creek Power Station's Gypsum Management Facility located near Canton, Illinois.

Excavation to approximately 5.4 ft. above foundation grade, partial construction of Recycle Pond perimeter berm, installation of a temporary stormwater outlet ditch, a temporary subsurface drainage system and the Recycle Pond pump station pad with access road were completed under a prior contract as outlined in the plans. Excavated material was stockpiled north and east of the excavation for use in this contract.

B. CCB Landfill

The intent of this contract is to provide the services of a General Contractor to construct a CCB Landfill, consisting a base 3 ft. thick Compacted Clay Liner, Geosynthetic Clay Liner (GCL), High Density Polyethylene (HDPE) Geomembrane, Geotextile Cushion Fabric and Leachate Collection System for the permanent disposal of coal combustion by-products (CCB) at the Ameren Energy Resources Generating Company (AERG) Duck Creek Power Station CCB Landfill located near Canton, Illinois.

Excavation to approximately 6 in. above foundation grade, construction of perimeter berm, installation of a permanent berm ditch outlet structure and a temporary subsurface drainage system were completed under prior contract. Excavated material was visually segregated during excavation and stockpiled east of the excavation for use in this contract.

2.0 DESCRIPTION OF WORK

2.01 Gypsum Management Facility

The scope of work shall consist of furnishing all materials, equipment, tools, labor, and incidentals necessary to perform the work as described below:

A. Gypsum Stack - Foundation Preparation

1. Excavate areas indicated on the plans to remove areas of underground sand seams and backfill with structural soil backfill.
2. Locally excavate to the foundation grade as indicated on the plans and finish grade the portion of the cell to be covered by Compacted Clay Liner.
3. Proof roll to identify unsuitable foundation soil materials.
4. As directed by the Owner's Representative, Excavate and replace unsuitable foundation materials consisting of unknown pockets of peat, sand, muck or other unsuitable materials with suitable structural backfill. Installation of geotextile fabric for ground stabilization, as deemed necessary by the owner's Representative, will be installed on a time and materials basis.

B. Gypsum Stack - Compacted Clay Liner

1. Construct Test Soil Liner, as outlined Section 5.0 of the project Construction Quality Assurance (CQA) Plan, included in Appendix 2, to demonstrate construction procedures and equipment that will produce the specified permeability.
2. Obtain Foundation Grade Verification by Amerens Field Surveyor prior to constructing areas requiring Compacted Clay Liner, as outlined in Section 6.2.1a of the project Construction Quality Assurance Plan.
3. Install Compacted Clay Liner in accordance with the project specifications using the compactive means demonstrated by the Test Soil Liner.

C. Gypsum Stack - Excavation and Backfill of Anchor Trench

1. Excavate anchor trench.
2. Place initial trench backfill after installation of Geosynthetic Clay Liner (GCL) and High Density Polyethylene (HDPE) Geomembrane by geosynthetic liner Contractor.
3. Complete trench backfill after installation of separation geotextile.

D. Gypsum Stack - Geosynthetic Clay Liner (GCL)

1. The Geosynthetics Installer's Representative shall jointly inspect the surface of the Compacted Clay Liner with the Owner's Representative

before commencing daily work. The Geosynthetics Installer's Representative shall continuously observe the condition of the Compacted Clay Liner during GCL placement and submit a Certificate of Acceptance in the daily report that no GCL was placed over visibly defective Compacted Clay Liner.

2. Furnish and install GCL on accepted Compacted Clay Liner. Provide re-inforced GCL on the sideslopes and bottom of Gypsum Stack. Protect GCL per the Manufacturer's recommendations until it is covered by HDPE Geomembrane

E. Gypsum Stack High Density Polyethylene (HDPE) Geomembrane (Lower Layer)

1. The Geosynthetics Installer's Representative shall jointly inspect the GCL with the Owner's Representative; continuously observe the condition of the GCL during HDPE Geomembrane placement; and submit a Certificate of Acceptance in the daily report that no HDPE Geomembrane was placed over visibly defective GCL.
2. Furnish and install HDPE geomemebrane on accepted GCL. Provide textured HDPE liner on the side slopes and bottom of the Gypsum Stack. Protect HDPE liner until it is covered by geotextile cushion fabric.
3. The Geosynthetics Installer shall perform non-destructive seam testing at frequencies specified in Section 6.3.2 of the Construction Quality Assurance Plan. Provide samples for destructive seam testing by the Owner's testing consultant, and repair sampled locations.

F. Gypsum Stack - Geotextile Cushion Fabric

1. The Geosynthetics Installer's Representative shall jointly inspect the HDPE Geomembrane with the Owner's Representative; continuously observe the condition of the HDPE Geomembrane during placement of the geotextile cushion fabric; and submit a Certificate of Acceptance in the daily report that no geotextile fabric was placed over visibly defective HDPE Geomembrane.
2. Furnish and install geotextile cushion on accepted Geomembrane.
3. Furnish and install drainage layer material for ballast.

G. Gypsum Stack - HDPE Leachate Collection Piping

1. Furnish and install geotextile fabric for coarse aggregate envelope.
2. Furnish and install initial lift of coarse agregate.
3. Furnish and install leachate collection piping as shown on the plans.
4. Furnish and install coarse aggregate along the pipe to provide lateral stability.
5. The piping installer shall obtain concurrance with the Owner's Representative that the piping installation meets the intended design

requirements before placing remainder of coarse aggregate and geotextile envelope.

H. Gypsum Stack - Drainage Layer

1. Furnish and install granular material for drainage layer in accordance with the project plans and specifications.
2. Obtain verification by the Owner's Field Surveyor that the minimum required Drainage Layer thickness has been achieved.

I. Gypsum Stack - Separation Fabric

1. The Geosynthetics Installer's Representative shall jointly inspect the Drainage Layer with the Owner's Representative; continuously observing the condition of the surface of the Drainage Layer during placement of the Geotextile Separation Fabric; and submit a Certificate of Acceptance in the daily report that no geotextile fabric was placed over visibly defective Drainage Layer surface.
2. Furnish and install geotextile fabric on accepted Drainage Layer and anchor geotextile fabric in anchor trench.

J. Gypsum Stack - Cushion Dirt

1. Place Cushion Dirt to facilitate installation of the second HDPE Geomembrane. The Contractor shall protect the underlaying Separation Fabric per the project specifications.
2. Obtain verification by the Owner's Field Surveyor that the minimum required Cushion Dirt thickness has been achieved.

K. Gypsum Stack High Density Polyethylene (HDPE) Geomembrane (Upper Layer)

1. The Geosynthetics Installer's Representative shall jointly inspect the surface of the Cushion Dirt with the Owner's Representative before commencing daily work. The Geosynthetics Installer's Representative shall continuously observe the condition of the Cushion Dirt during HDPE Geomembrane placement and submit a Certificate of Acceptance in the daily report that no HDPE Geomembrane was placed over visibly defective Cushion Dirt.
2. Furnish and install HDPE Geomembrane on approved Cushion Dirt. Provide textured HDPE Geomembrane on cell side slopes and bottom of cell. Protect HDPE Geomembrane until it is initially covered by gypsum waste material.
3. The Geosynthetics Installer shall perform non-destructive seam testing at frequencies specified in Section 6.3.2 of the Construction Quality Assurance Plan. Provide samples for destructive seam testing by the Owner's testing consultant, and repair sampled locations.

L. Gypsum Stack - HDPE Process Water Recovery System

1. Furnish and install HDPE Process Water Collection System, as shown on the plans.
2. The piping installer shall obtain concurrance with the Owner's Representative that the piping installation meets the intended design requirements before covering the piping with aggregate and filter fabric as shown on the plan.

M. Gypsum Stack - Miscellaneous Earthwork

1. Provide access ramp to perimeter berm of cell.

N. Gypsum Sluice Piping

1. Connect to existing piping and install new Gypsum Sluice Piping, fittings and valves for the Gypsum Stack.

O. Gypsum Stack - Subdrainage System

1. Abandon existing subdrainage system, and remove vent pipes, vertical drains and inlet structures as specified in Section 02140 – Surface Water Management.

P. Gypsum Stack - Erosion Control

2. Maintain previously installed temporary erosion control systems during the life of the contract.
3. Seed and mulch all exposed soil surfaces.

Q. Recycle Pond - Earthwork

1. Strip topsoil from areas of the proposed excavation and proposed compacted berms.
2. Excavate the recycle pond to the lines and grades shown on the plans.
3. Proof roll stripped/excavated areas to expose unsuitable materials.
4. Remove and replace unsuitable foundation material and/or install geotextile fabric for ground stabilization as directed by the Owner's Representative. Work required to correct unsuitable foundation material will be paid by the Owner on a Time and Materials Basis.
5. Construct Recycle Pond Embankments, Process Water Transfer Channel and Emergency Spillway to the line and grades shown on the plans.

R. Recycle Pond – Toe Drain

1. Furnish and install aggregate materials and filter fabric at the outside toe of the recycle pond dam as shown on the plans.

S. Recycle Pond - Excavation and Backfill of Anchor Trench

1. Excavate anchor trench.
2. Backfill trench after installation of High Density Polyethylene (HDPE) Geomembrane by Geosynthetics Installer.

T. Recycle Pond - HDPE Geomembrane

1. The Geosynthetics Installer's Representative shall jointly inspect the surface of the recycle pond foundation soils with the Owner's Representative before commencing daily work. The Geosynthetics Installer's Representative shall continuously observe the condition of the foundation soils during HDPE Geomembrance placement and submit a Certificate of Acceptance in the daily report that no HDPE Geomembrane was placed over visibly defective foundation soil.
2. Furnish and install HDPE Geomembrane on approved foundation soil. Provide textured HDPE Geomembrane on recycle pond side slopes and bottom. Anchor in the excavated anchor trench and backfill in accordance with the project specifications.
3. The Geosynthetics Installer shall perform non-destructive seam testing at frequencies specified in Section 6.3.2 of the Construction Quality Assurance Plan. Provide samples for destructive seam testing by the Owner's testing consultant, and repair sampled locations.

U. Recycle Pond - Water Transfer Structures

1. Furnish, fabricate, and install all materials and aggregate necessary to construct the Process Water Control Structure, Process Water Transfer Channel, Recycle Pond Emergency Spillway/Riprap Stilling Basin, and Side Slope Decant Pipe/Riprap Basin as shown on the plans.

~~V. Construction Field Office~~

~~The Contractor shall furnish and install a Construction Field Office for the Owner's use in accordance with the Specifications of Appendix 4 of these Specifications.~~

2.02 CCB Landfill

A. Foundation Preparation:

1. Remove top 6" of soil from the existing excavation and stockpile in an area designated on the Plans.
2. Finish grade the portion of the cell to be covered by Compacted Clay Liner.
3. Proof roll to expose any unsuitable foundation materials..
4. Remove and replace unsuitable foundation material and/or install geotextile fabric for ground stabilization as directed by the Owner's Representative.

B. Compacted Clay Liner

1. Construct Test Soil Liner, as outlined Section 5.0 of the project Construction Quality Assurance (CQA) Plan, included in Appendix 2, to demonstrate construction procedures and equipment that will produce the specified permeability.
2. Obtain Foundation Grade Verification by Amerens Field Surveyor prior to constructing areas requiring Compacted Clay Liner, as outlined in Section 6.2.1a of the project Construction Quality Assurance Plan.
3. Install Compacted Clay Liner in accordance with the project specifications using the compactive means demonstrated by the Test Soil Liner.

C. Excavation and Backfill of Anchor Trench:

1. Excavate anchor trench.
2. Place initial trench backfill after installation of GCL and HDPE geomembrane by geosynthetic liner contractor.
3. Complete trench backfill after installation of separation geotextile.

D. Geosynthetic Clay Liner (GCL)

1. The Geosynthetics Installer's Representative shall jointly inspect the surface of the Compacted Clay Liner with the Owner's Representative before commencing daily work. The Geosynthetics Installer's Representative shall continuously observe the condition of the Compacted Clay Liner during GCL placement and submit a Certificate of Acceptance in the daily report that no GCL was placed over visibly defective Compacted Clay Liner.
2. Furnish and install GCL on accepted Compacted Clay Liner. Provide re-inforced GCL on the sideslopes and bottom of the cell. Protect GCL per the Manufacturer's recommendations until it is covered by HDPE Geomembrane

E. High Density Polyethylene (HDPE) Geomembrane (Lower Layer)

1. The Geosynthetics Installer's Representative shall jointly inspect the GCL with the Owner's Representative; continuously observe the condition of the GCL during HDPE Geomembrane placement; and submit a Certificate of Acceptance in the daily report that no HDPE Geomembrane was placed over visibly defective GCL.
2. Furnish and install HDPE Geomemebrane on accepted GCL. Provide textured HDPE Geomembrane on cell side slopes and smooth HDPE Geomembrane on bottom of the cell. Protect HDPE liner until it is covered by geotextile cushion fabric.
3. The Geosynthetics Installer shall perform non-destructive seam testing at frequencies specified in Section 6.3.2 of the Construction Quality Assurance Plan. Provide samples for destructive seam testing by the Owner's testing consultant, and repair sampled locations.

F. Geotextile Cushion Fabric:

1. The Geosynthetics Installer's Representative shall jointly inspect the HDPE Geomembrane with the Owner's Representative; continuously observe the condition of the HDPE Geomembrane during placement of the geotextile cushion fabric; and submit a Certificate of Acceptance in the daily report that no geotextile fabric was placed over visibly defective HDPE Geomembrane.
2. Install geotextile cushion on accepted Geomembrane.
3. Install drainage layer material for ballast.

G. HDPE Leachate Collection Piping:

1. Place geotextile fabric for coarse aggregate envelope.
2. Place initial lift of Coarse Aggregate Bedding.
3. Furnish and install HDPE Leachate Collection Piping on Coarse Aggregate bedding.
4. Place coarse aggregate along the pipe to provide lateral stability.
5. The piping installer shall obtain concurrance with the Owner's Representative that the piping installation meets the intended design requirements before covering the piping with remainder of coarse aggregate and geotextile envelope as shown on the plans.

H. Drainage Layer and Separation Berm:

1. Place granular material for separation berm and drainage layer.

I. Separation Fabric:

1. Install geotextile fabric on accepted drainage layer and anchor geotextile fabric in anchor trench.

J. Haul Road

s

1. Funish materials and construct Haul Road to the top of the CCB Landfill.

K. Miscellaneous Earthwork:

1. Provide construction access ramp to bottom of cell.
2. Place general fill to form in-board side of berm ditch.

L. Construct and maintain temporary erosion control systems during the life of the contract. Remove and dispose of temporary erosion control items when no longer required. Seed and mulch all remaining disturbed soil surfaces.

3.0 OWNER AND MANUFACTURER'S DRAWINGS

3.1 Provided By Ameren Energy Resources Generating

A. Hard-Copy Drawings

The following drawings are intended to indicate the scope of the work to be done and details necessary for the installation of items set forth in this specification, and are part of this specification. These drawings in general are to scale, but dimensions shall always be followed and drawings are not to be scaled. In case of errors or discrepancies, the Owner's Representative shall be consulted for the adjustment of all complications arising therefrom. The Owner's Representative's decisions shall be final.

AERG DRAWING NO.	SHEET TITLE
C180-C102-01	Title & Index
C180-C102-02	General Notes
C180-C102-03	Site Plan
C180-C102-04	Existing Site Conditions
C180-C102-04A	Existing Subsurface Drainage Profiles
C180-C102-05	Existing Subsurface & Vertical Drain Details
C180-C102-06	Existing Subsurface Drainage Details
C180-C102-07	Existing Grading Plan
C180-C102-08	Gypsum Stack-Foundation Grade
C180-C102-09	Gypsum Stack-Top of Clay Layer
C180-C102-10	Gypsum Stack- Leak Detection/Leachate Collection

AERG DRAWING NO.	SHEET TITLE
	Recovery System (LD/LCRS) Drainage Layer Grade
C180-C102-11	Process Water Recovery System (PWRS) - Ring Drain System Cushion Dirt Layer Grade
C180-C102-12	PWRS-Ring Drain Details
C180-C102-13	PWRS-Ring Drain Details
C180-C102-14	LD/LCRS Sections & Details
C180-C102-15	Recycle Pond Plan
C180-C102-16	Recycle Pond Details
C180-C102-17	Recycle Pond Details
C180-C102-18	Access Road and Pump Station Site Plan
C180-C102-19	Access Road Vertical Alignments
C180-C102-20	Erosion Control Plan
C180-C102-21	Erosion Control Details
C180-C102-22	Groundwater Monitoring & Boring Plan
C180-C102-23	Geological Cross Sections
C180-C102-24	Geological Cross Sections
C180-C102-25	Geological Cross Sections
C180-C102-26	Geological Cross Sections

AERG DRAWING NO.	SHEET TITLE
C180-C110-01	Title and Index
C180-C110-02	General Notes
C180-C110-03	Site Plan
C180-C110-04	Foundation Grade Plan
C180-C110-05	Foundation Grade Control Data
C180-C110-06	Base Grade Plan
C180-C110-07	Base Grade Control Data
C180-C110-08	Geomembrane Panel Layout
C180-C110-09	Drainage Layer Grade Plan & Leachate Collection Piping
C180-C110-10	Drainage Grade Control Data
C180-C110-11	Typical Sections and Details
C180-C110-12	Leachate Collection Details
C180-C110-13	Typical Cross Sections
C180-C110-14	Separation Berm Details
C180-C110-15	Exist. Sub-Drain Plan & Details
C180-C110-16	~~Haul Road / Construction Water Access Road Plan~~ ***Landfill Haul Road***
~~C180-C110-17~~	~~Construction Water Access Road~~
C180-C110-17	Boring Well and Section Locations

AERG DRAWING NO.	SHEET TITLE
C180-C110-18	Geologic Cross Sections A and B
C180-C110-19	Geologic Cross Sections C, D, and E
C180-C110-20	Geologic Cross Sections F to K

B. Electronic Files

The following electronic files are provided solely for the convenience of the bidder and/or Contractor and are subject to the terms and conditions stipulated in the Disclaimer text included with the electronic files.

1. Drawings listed above in PDF format.
2. TIN files of the existing and proposed ground surfaces.
3. Bid Forms.
4. Disclaimer text.

In the event of a conflict between the hard-copy documents and the electronic files, the hard-copy documents shall govern.

3.2 Provided by the Contractor

The Contractor shall submit to the Owner's Representative, with such promptness as to cause no delay in the performance of the work, four copies of shop drawings, product data sheets, etc., as required by these specifications. No purchasing, fabrication, erection, processing, or shipping of the aforementioned materials may begin until the required documentation has been reviewed by the Owner.

Three copies of data required to be submitted to the Owner's Representative shall be forwarded to each of the following:

Ameren Energy Resources Generating
Dave Boyce
Duck Creek Power Station
17751 North CILCO Road
Canton, Illinois 61520

Hanson Professional Services Inc.
Steven Bishoff
1525 South Sixth Street
Springfield, Illinois 62703-2886

Data sheets and shop drawings shall be reviewed and returned to the Contractor within ten (10) working days after receipt. Approval is for general design features only and will not relieve the Contractor of responsibility for proper quantities, adequacy of details, and coordination with other trades. Deviation from Contract Documents are not approved unless specifically requested in writing by the Contractor and approved in writing by the Owner.

Should field changes be required, such changes shall be promptly documented by the Contractor and submitted to the Owner in the form of as-built drawings. The field change order process is included in Appendix I.

4.0 MATERIALS AND EQUIPMENT SUPPLIED BY THE OWNER

The materials and equipment that are to be furnished by the Owner are listed in the schedule below:

ITEM	SHIPPING DATE	LOCATION
~~Drainage Layer Material (Gypsum Stack & CCB Landfill)~~	~~Prior to Start of Construction~~	~~Stockpile~~
~~Coarse Aggregate Encasement for Ring Drain Piping (IDOT CA-7) (Gypsum Stack)~~	~~Prior to Start of Construction~~	~~Stockpile~~
~~Filter Sand for Protection of Ring Drain Piping (IDOT FA-1) (Gypsum Stack)~~	~~Prior to Start of Construction~~	~~Stockpile~~
~~Coarse Aggregate Coarse Encasement For Leachate Collection Piping (CCB Landfill)~~	~~Prior to Start of Construction~~	~~Stockpile~~

Note: Per Addendum #1, none of the above listed aggregates will be supplied by the owner

5.0 MATERIALS AND EQUIPMENT FURNISHED BY THE CONTRACTOR

All materials, equipment, tools, and any incidental items necessary to complete each portion of the work described herein and/or shown on the drawings shall be furnished by the Contractor.

6.0 UTILITIES, FACILITIES, AND MISCELLANEOUS

The following utilities, facilities, etc., shall be provided as indicated.

	Item	Provided By
A.	Telephone Service for Use of Construction Forces	Contractor
B.	Sanitary Facilities	Contractor
C.	Drinking Water	Contractor
D.	Construction Water	Contractor
E.	Electric Service for Contractor's Use	Contractor
F.	Construction Office and Storage Facilities for Contractor's Use	Contractor
G.	Construction of Gravel Haul Roads and Parking Area for Construction Forces	Contractor

Submit with the bid documents a general layout of temporary facilities required for the Contractor's operations, such as haul roads, parking areas, temporary drainage facilities, Contractor's construction field office and storage facilities, electric service, telephone service, staging and laydown areas, etc.

7.0 SCHEDULE

The Contractor shall be required to furnish the Owner's Representative with a complete schedule of the Work to be performed under this contract broken down by major activity.

The schedule shall include the Contractor's estimate of man-days required for each activity, and shall show precedent relationships between activities. The schedule shall be included as part of the bid package presented by the Contractor. The schedule shall comply with the dates and guidelines listed below:

A. The required start date of this contract is upon receipt of Purchase Order. The Purchase Order is expected to be issued within two (2) weeks of the bid due date.

B. The required finish date of this for the Gypsum Management Facility Contract is September 30, 2008. The required finish date for the CCB Landfill Contract is December 31, 2008 for the Scope of Work incuded in Bid Forms A & C.

C. The level of detail in each schedule shall be sufficient to permit the Owner to monitor the Contractor's performance relative to the specified guidelines. The required level of detail will be discussed at the pre-bid meeting.

D. The Contractor shall submit a daily construction report and shall furnish schedule status reports at weekly progress meetings until the work is completed. The schedule status reports shall indicate by activity the scheduled percent of completion as shown on the original schedule, the actual percent completion as of the date of the report, and the number of man-days expended on the project to date.

If at any time during this Contract, when the Contractor's actual progress, in the opinion of the Owner, is such that the completion dates of the work will not be met, the Contractor shall participate in a re-evaluation of the remaining work.

If, as a result of this re-evaluation of the remaining work, it is determined by the Owner that the completion date will not be met, the Owner retains the right to direct the Contractor to accelerate the construction program. It shall be the responsibility of the Contractor to initiate and comply with such corrective action as required or directed.

At the time of the award of this contract, scheduling requirements will be discussed in detail by all interested parties.

8.0 CONSTRUCTION QUALITY CONTROL ASSURANCE

A. Construction Quality Assurance Plan

A Construction Quality Assurance (CQA) Plan has been developed for this project to ensure compliance with the all applicable permit requirements. A copy of this plan is included in Appendix 2. The testing requirements and frequency of this plan will govern in instances which there may be discrepancies between the CQA Plan and these specifications.

B. Testing and Inspections:

1. The Contractor is responsible for construction quality control testing, sampling, and inspections to ensure that the materials and workmanship comply with the plans and specifications. The Contractor shall submit results of construction quality control testing. The Contractor shall visually inspect underlying surfaces on a continuous basis immediately ahead of placement of geosynthetics and geotextile and shall certify in the daily report that no material was placed over visibly defective substrate.
2. The Contractor is responsible for non-destructive testing of all Geomembrane seams and for providing samples for prequalification material testing and destructive seam testing as directed by the Owner's

Representative. The minimum sampling frequencies are specified in Appendix 2.

3. Except as specified above, Construction Quality Assurance (CQA) testing, sampling, and inspections to verify compliance with the plans and specifications are the responsibility of the Owner. The CQA sampling and testing requirements are summarized in Appendix 2. The Contractor shall coordinate and cooperate with the Owner's materials testing consultant to provide samples and accommodate testing activities at no additional cost to the Owner.

C. Construction Surveying

Construction surveying for layout and grading control shall be the responsibility of the Contractor. Finished grades will be surveyed by the Owner's surveyor to verify that the finished grade is within 0.1 ft. of plan grade.

D. CQA Surveys to certify material thickness, leachate piping and ditch grades are the responsibility of the Owner. CQA Surveying requirements are summarized in Appendix 2.

9.0 COORDINATION WITH OTHERS

This Contractor will work in close harmony with other Contractors or AERG personnel who may be employed at this site. In the event of differences of opinion regarding scheduling of work, the decision of the Owner will be final and binding.

The following construction activities are anticipated within the landfill facility boundary during this contract:

A. Loading and Hauling of coal combustion by-product to the site by AERG personnel or Contractor.

B. Loading and Hauling of water for dust contol operations on AERG property.

C. Loading and hauling stockpiled excavated material from the stockpile south of East McKinley Road by Fulton County Highway Department Contractor and by Ameren personnel or contractor.

D. Monitoring, removing, and disposing of leachate by Ameren's CCB disposal facility operator.

10.0 SAFETY AND SITE SECURITY

The Contractor will comply with safety and security requirements stipulated in the General Conditions and Supplemental General Conditions.

A. Although the Ameren Energy Resources Generating property is generally fenced and patrolled by Ameren Energy Resources Generating security, the site should not be considered secure.

   1. A Security Check-In Station will be provided by AERG for the duration of the construction project at the entrance on McKinley Road.

B. Contractor personnel will be required to attend a 2-hour site-specific safety orientation conducted by the Owner.

C. Contractor personnel will be required to submit to a ten (10) panel drug test to be performed and provided by AERG.

D. A copy of the Contractor's Field Construction Safety Program shall be submitted with the Contractor's bid package.

E. The Contractor shall have a designated Safety Supervisor on site whenever construction work is being performed.

11.0 DUST CONTROL

The Contractor shall be responsible for controlling dust and air-borne dirt generated by construction activities. Dust shall be controlled by applying water to exposed surfaces, particularly surfaces on which construction vehicles travel. Water from the Duck Creek Reservoir is unsuitable. A pond north and east of the proposed CCB Landfill is designated at the only water source available for use by the Contractor.

No chemical dust suppressants shall be permitted unless approved in writing by the Owner's Representative. Dust control measures shall be readily available for implementation whenever the Contractor or the Owner's Representative deems that that dust control is needed. The cost of dust control shall be included in the contract lump sum price.

PART 2. PRODUCTS

No products used.

PART 3. EXECUTION

1.0 The Contractor shall be responsible for inspecting the site to note any and all conditions that may affect the work under the contract. The Contractor shall satisfy himself as to the nature, extent and location of the work; the configuration of the ground; the equipment and facilities needed for construction; the general and local conditions of the area; and all other factors and conditions which can, in any way, affect the work under the contract. Any failure by the Contractor to do so will not relieve him from responsibility for successfully performing the work without additional expense to the Owner.

2.0 The Contractor is specifically advised of the presence of overhead power lines that traverse the project work area.

END OF SECTION 01010

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PART 1. GENERAL

1.01 DESCRIPTION

A. This section pertains to the construction and maintenance of existing and proposed temporary erosion control systems to control erosion and sediment damage to adjacent properties and water resources.

1.02 RELATED SECTIONS

The following sections contain items which are related to the work in this section:

02936 - Topsoil, Seeding, and Mulching.

1.03 REFERENCES

The following reference, or cited portions thereof, governs the work:

Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007.

1.04 SUBMITTALS

A. Submittals shall follow the provisions of Section 01010.

B. Preconstruction Submittals: A storm water best management practices (BMP) plan shall be submitted that includes the following items:

1. Inspection and record-keeping procedures; and
2. Maintenance procedures for erosion controls.

PART 2. PRODUCTS

2.01 EROSION CONTROL SYSTEMS

Materials for erosion control systems shall be in accordance with Article 280.02 of the IDOT Standard Specifications.

PART 3. EXECUTION

3.01 EXAMINATION

The site shall be examined to determine the condition existing temporary erosion controls systems installed under a prior contract and the extent of new work required.

3.02 PRECONSTRUCTION JOBSITE INSPECTION

A. The person who shall be at the jobsite during construction and who shall be responsible for insuring that erosion control work is completed in a timely manner shall be identified at the preconstruction meeting.

B. A jobsite inspection shall be conducted with the Owner's Representative to review and designate the locations and types of erosion protection to be placed. The inspection shall be scheduled at the preconstruction conference and carried out on the job site before beginning any work that will disturb existing drainage or potentially create erodible conditions.

3.03 CONSTRUCTION

A. Temporary erosion control systems shall be constructed in accordance with IDOT Standard 280001 and Article 280.04 of the Standard Specifications and as directed by the Owner's Representative. Erosion control devices shall be in place and approved by the Owner's Representative prior to beginning other work.

B. Incorporate permanent erosion control features into the project at the earliest practicable time to minimize the need for temporary erosion controls.

3.04 MAINTENANCE

A. Temporary erosion control systems shall be maintained in accordance with Article 280.05 of the Standard Specifications, except that measurement and payment provisions shall not apply.

B. Temporary erosion control systems for unprotected disturbed areas shall be cleaned of trapped sediment and repaired immediately prior to project close out.

C. Temporary seeding shall be applied to all disturbed areas except the gypsum stack excavation and the future fill and topsoil stockpiles.

3.05 REMOVAL AND DISPOSAL

All temporary erosion control system shall be left in place by the Contractor for future construction operations at both facilities.

END OF SECTION 01356

PART 1. GENERAL

1.01 DESCRIPTION

Logs of borings and laboratory soil test data.

PART 2. PRODUCTS

No products used.

PART 3. EXECUTION

3.01 TEST BORINGS

A. Test borings were taken at the locations shown on the drawings. Copies of boring logs, along with soil test data on soil samples recovered from the borings are included in Appendix 3.

B. Data on indicated subsurface conditions are not intended as representations or warrants of continuity of such conditions between soil borings. It is expressly understood that the Owner will not be responsible for interpretations or conclusions drawn therefrom by the Contractor. Data are made available for the convenience of the Contractor.

C. Additional test borings and other exploratory operations may be made by the Contractor at no additional cost to the Owner, provided such operations are approved by the Owner's Representative.

3.02 SITE OBSERVATIONS

B. Gypsum Management Facility (Gypsum Stack & Recycle Pond)

1. The Gypsum Stack has been excavated to foundation grade on the sideslopes, and to within approximately 5.4 of foundation grade at the bottom of the cell. The remaining 5.4 feet of material will be utilized to construct the 3 foot thick clay layer. A drainage channel was cut from the southwest floor of the excavation to allow adequate surface water drainage. During the pre-bid meeting, Contractors will be given opportunity to view the excavation and resulting stockpiles, and to observe the in-situ conditions at the time of the meeting.

2. The earthwork for the recycle pond pump station pad and access road, as well as sections of the recycle pond perimeter berm have been constructed to finish grade. During the pre-bid meeting, Contractors will be given the opportunity to view the in-situ conditions at the time of the meeting.

A. CCB Landfill

1. The CCB Landfill has been excavated to within 6 in. of foundation grade. During the pre-bid meeting, Contractors will be given opportunity to view the excavation and observe the in-situ conditions near foundation grade at the time of the meeting.

END OF SECTION 02010

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PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to stripping of topsoil and vegetation from areas of the site that are to be excavated.

1.02 RELATED SECTIONS

No related sections.

PART 2. PRODUCTS

No products used.

PART 3. EXECUTION

3.01 EXAMINATION

The Contractor shall examine the site to determine the extent of work required, as well as the extent of previously stripped topsoil completed under a previous contract.

3.02 SITE PREPARATION - STRIPPING

A. The Gypsum Stack and portions of the Recycle Pond grading limits have been previously stripped under a separate contract as shown on the plans. Any remaining vegetation and topsoil encountered within the Gypsum Stack and Recycle Pond grading limits required to complete the work in this contract shall be stripped. ~~Topsoil shall be kept clean and free of all foreign material, and stored in separate stockpiles from vegetation and common excavations. Stockpiles shall be located as indicated on the drawings or as directed by the Owner's Representative.~~ ***Topsoil removed by stripping shall not be stockpiled, and shall be deposited completely as described in section 3.02-C of this specification.***

B. The top 6" of the existing excavation area of the CCB Landfill-Cell 1 within the CCB Landfill shall be removed and stockpiled per Specification Section 02200 Earthwork.

C. Stripped Topsoil shall be used to fill depressions east of the Gypsum Management Facility as shown in the Plans.

3.03 DISPOSAL

A. All materials resulting from site preparation operations shall be stockpiled in the designated spoil area. Contractor shall obey all laws and regulations when disposing of the materials.

END OF SECTION 02100

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PART 1. GENERAL

1.01 DESCRIPTION OF WORK

Control of surface water caused by precipitation and abandonment of existing subsurface drainage facilities within the construction limits of the Gypsum Management CCB Landfill shall be considered as part of the work under this specification.

A. The work to be completed by the Contractor includes, but is not necessarily limited to, the following:

1. Maintenance of existing Erosion and Sedimentation Control Measures according to Section 01356; and
2. Dewatering excavations from water caused by precipitation.
3. Abandonment of the existing subdrainage systems.

B. The Contractor shall be responsible for providing all materials, equipment, labor, and services necessary for care of water and erosion control and abandonment of the existing subsurface dewatering systems at the end of the Contract.

1.02 EXISTING FACILITIES

A. Gypsum Management Facility

1. An existing ditch at the south end of the existing excavation provides gravity outlet for the excavation to 5.4 feet above the foundation grade.

2. An existing subdrainage system provides limited control of groundwater migration into the excavation. The subdrainage system outlets by gravity flow to an existing ditch approximately 0.3 mile south of the existing excavation.

B. CCB Landfill Facility

1. An existing ditch at the southeast corner of the existing excavation provides gravity outlet for the excavation to foundation grade.

2. An existing subdrainage system provides limited control of groundwater migration into the excavation. The subdrainage system outlets by gravity flow to an existing channel approximately 0.2 mile east of the existing excavation.

1.03 REQUIREMENTS

B. The General Contractor shall employ standard surface water management practices to prevent the ponding of stormwater runoff and/or erosion of existing and proposed earth surfaces, as required to complete the work.

1.04 RELATED SECTIONS

The following sections contain items which are related to the work in this section:

1. 01356 – Storm Water Pollution Prevention Measures
2. 02010 - Subsurface Investigation
3. 02200 - Earthwork

PART 2. PRODUCTS

2.01 MATERIALS

A. Materials and equipment for surface water management shall be reviewed by the Owner's Representative for compatibility with future construction and operation of the facility.

PART 3. EXECUTION

3.01 SURFACE WATER MANAGEMENT

A. The Contractor shall be responsible for providing all facilities required to divert, collect, control, and remove water caused by precipitation from all construction work areas and excavations.

B. Drainage features shall have sufficient capacity to avoid flooding of work areas.

C. Drainage features shall be so arranged and altered, as required to avoid degradation of the final excavated surface(s).

D. The Contractor shall utilize all necessary erosion and sediment control measures according to Section 01356 to avoid construction-related sedimentation of existing and proposed facilities.

3.02 WATER DISPOSAL

A. Dispose of water removed from the excavations in such a manner as:

1. Will not endanger portions of work under construction or completed.
2. Will cause no inconvenience to Owner or to others working near site.
3. Will comply with the stipulations of Section 01356.

4. Will control runoff. The Contractor shall be responsible for control of runoff in all work areas, including, but not limited to: excavations, access roads, parking areas, stockpile, laydown, and staging areas. The Contractor shall provide, operate, and maintain all ditches, basins, sumps, culverts, site grading, and pumping facilities to divert, collect, and remove all water from the work areas. All water shall be removed from the immediate work areas and shall be disposed of in accordance with Section 01356.

B. Existing site drainage features or proposed subdrainage system may be used for water disposal.

3.03 DAMAGES

A. Immediately repair damages to adjacent facilities caused by the surface water management facilities, as constructed by the Contractor.

3.04 REMOVAL OF STORMWATER MANAGEMENT SYSTEMS INSTALLED BY CONTRACTOR

A. Remove and backfill temporary sumps, ditches, trenches, etc. according to Section 02300, as required by the Owner.

3.05 CORRECTIVE ACTION

Work shall be performed as necessary for reinstatement of foundation soil and damaged structure resulting from such inadequacy or failure by Contractor to control surface water, at no additional cost to Owner.

3.06 ABANDONMENT OF EXISTING SUBDRAINAGE SYSTEMS

Concurrence shall be obtained from Owner before discontinuing operation of subdrainage system.

The General Contractor shall maintain the existing subdrainage systems during construction of the Gypsum Management and CCB Landfill Facilities.

Prior to construction of the Compacted Clay Liner at the Gypsum Management Facility, all vertical drains consisting of a geotextile fabric encased pea gravel envelope shall be removed. The pea gravel shall be stockpiled and the geotextile fabric shall be removed and disposed of in a legal manner. Subdrainage piping damaged during removal of the vertical drains shall be repaired with equal material incidental to the work. An existing drainage structure consisting of 24" diameter reinforced concrete pipes with a ditch grate shall be removed. The concrete pipes shall be disposed of in a legal manner and the ditch grate shall be salvaged per the direction of Owner's Representative

Upon completion of the construction of either facility, that facility's existing subdrainage system within the lined portion of the cell shall be abandoned as follows:

1. At each subdrainage vent pipe riser location, a mixture of high solids bentonite grout shall be pumped into the subdrainage piping to completely seal the system. The high solids bentonite grout shall be CETCO Volclay Grout or an approved equal that is NSF/ANSI Standard 60 certified. The grout shall be mixed according to the manufacturer's specifications for this application to provide a low permeability seal less than 1×10^{-7} cm/sec.
2. Cut the vent pipe risers 36 inches below with the ground surface. Fill the remaining vent piping with concrete as shown on the plans.
3. Remove completely the existing concrete inlet at the southeast quadrant of the gypsum stack excavation and dispose of in a legal manner. The grate will be salvaged and stored at the direction of the owner.
4. Remove completely the vent pipe protective bollards and dispose of in a legal manner.

END OF SECTION 02140

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PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to excavation, fill, and backfill required for foundation preparation, construction of Compacted Clay Liners, anchor trench construction, miscellaneous site grading, berm construction.

1.02 RELATED SECTIONS

A. The following sections contain items which are related to the work in this section:

1. 01356 – Storm Water Pollution Prevention Measures
2. 02100 - Site Preparation
3. 02140 – Surface Water Management
4. 02373 – Geotextiles
3. 02936 - Topsoil, Seeding, and Mulching

1.03 REFERENCES

The following references, or cited portions thereof, govern the work:

1. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007
2. Department of Sustainable Natural Resources, Soil Survey Standard Test Method, Unified Soil Classification System: Field Method (USCS).

1.04 MEASUREMENT AND PAYMENT

A. The Contractor shall be responsible for estimating the extent of excavation and fill required to complete the work, including, but not limited to, excavation to required elevations; loading, transporting, placing, and compacting the Compacted Clay Liners; excavation and backfill of anchor trench; and miscellaneous site grading, including berm construction. The Contractor shall include the dollar amount associated with all earthwork in his Lump Sum Bid amount.

B. Removal and replacement of unsuitable foundation material (including underground sand channel materials) and subgrade stabilization measures directed by the Owner's Representative will be paid for on a time and material basis. Payment quantities will be based volume of excavation, determined from field surveys by the Owner's Field Surveyor.

1.05 EARTHWORK COMPLETED UNDER PRIOR CONTRACT

A. Gypsum Management Facility

1. The gypsum stack has been excavated to approximately 5.4 ft. above foundation grade across the bottom of the cell.

2. Excavated subsoil material was stockpiled north and east into short term and long term subsoil stockpiles as shown on the plans. Stripped Topsoil was stockpiled separately.

3. The ~~75,000 yard~~ subsoil stockpile east of the Gypsum Stack shall be completely depleted under this contract. Schedule and timing shall be determined by the Contractor.

B. CCB Landfill

1. The cell has been excavated to approximately 6 in. above foundation grade and the perimeter berm has been completed, except for an existing construction access ramp on the east side of the cell near Sta. 205+00.

2. Excavated material was stockpiled in locations east of the excavation. The intended use and location for each stockpile is shown on the plans

1.06 COORDINATION

Existing utilities or other plant facilities shall not be interrupted, except when permitted in writing by the Owner's Representative and then only after acceptable temporary services have been provided. A minimum 48-hour notice shall be provided prior to proceeding with an approved temporary interruption.

1.07 SURFACE WATER MANAGEMENT

Control of surface water caused by precipitation necessary for completion of the work under this contract according to Section 02140 is the responsibility of the Contractor and shall be included in the contract lump sum price.

1.08 SUBMITTALS

A. Materials Handling Plan.

A materials handling plan shall be submitted for construction and protection of the Compacted Clay Liner. The plan shall describe the following:

1. Processing and placement of the Compacted Clay Liner: type, model number, weight, and critical dimensions of equipment to be used for soil processing, compaction, scarification, and smooth rolling;

2. Method of protecting the Compacted Clay Liner from changes in moisture content and freezing after placement.

PART 2. PRODUCTS

2.01 MATERIALS

A. Earth Fill Material

Earth Fill Material shall consist of a mixture of clay, silt, sand, and gravel-sized particles obtained from previously constructed subsoil stockpiles. These materials can be used separately or mixed as required for best results. These materials shall be free of ice, snow, organic matter, rubbish, and debris. Coarse-grained particles shall be well dispersed to prevent the development of segregated pockets or zones with insufficient fine material to fill the interstices.

B. Compacted Clay Liners

1. Gypsum Management Facility

The Compacted Clay Liner for the Gypsum Management Facility shall be soil materials obtained from the approximately 5.4 ft. of material remaining above the foundation grade that was left in-place under the previous excavation contract. The material shall be free of ice, snow, organic matter, rubbish, and debris, and shall have a maximum clod size no greater than the length of the compactor foot for the compaction equipment proposed by the Contractor. When compacted, the material shall have a vertical hydraulic conductivity of less than 1×10^{-4} cm/sec.

2. CCB Landfill

The Compacted Clay Liner for the CCB Landfill shall be soil materials obtained from on-site excavations and materials stockpiled east of the cell. The material shall be free of ice, snow, organic matter, rubbish, and debris, and shall have a maximum clod size no greater than the length of the compactor foot for the compaction equipment proposed by the Contractor. When compacted, the material shall have a vertical hydraulic conductivity of less than 1×10^{-6} cm/sec.

C. Soil Stabilizers and Moisture Conditioning Agents

Additives to accelerate drying or to improve stability and workability of soil shall not be permitted unless approved in writing by the Owner's Representative.

2.02 EQUIPMENT

A. Compaction Equipment

1. Tamping foot rollers

Compaction equipment shall consist of tamping foot rollers which have a minimum weight of 40,000 pounds. At least one tamping foot shall be provided for each 110 square in. of drum surface. The length of each tamping foot, measured from the outside surface of the drum, shall be at least 1 in. longer than the loose lift thickness.

2. Steel-Wheeled Rollers

Equipment used to produce a smooth compacted surface shall be a smooth, non-vibratory steel wheeled roller weighing not less than 1,000 lb. per lineal ft.

B. Scarification Equipment

Discs, rotor tillers, or other equipment used to scarify the surface shall be capable of uniformly disturbing at least the upper 6 in. of surface to provide good bonding between lifts.

C. Mixing and Spreading Equipment

Discs, harrows, and motor graders or other similar equipment shall be available at the site for use in spreading, mixing, and drying Compacted Subsoil Stockpile Material.

PART 3. EXECUTION

3.01 PREPARATION

A. Control of Work

Benchmarks, monuments, and other reference points shall be maintained throughout the work area.

B. Utility Location

Before starting excavation, the location and extent of underground utilities in the work area shall be established.

3.02 EXCAVATION

A. General

Excavation consists of removal and redistribution of material encountered when establishing required grade and subgrade elevations. The Contractor shall be responsible for dewatering, protection, shoring, and disposal of excavated materials as necessary to complete the excavation.

B. Procedures

Excavation may be accomplished by any method and by use of any equipment that is suitable to the work, except that blasting will not be permitted. Based on previous construction experience at the site, it is recommended that excavation to the foundation grade be completed as far in advance of the Compacted Clay Liner placement as possible to allow the foundation surface to dry and form a "crust" capable of sustaining compactive effort.

C. Overexcavation

Overexcavation shall be performed to the lines and grades indicated on the plans. Additional overexcavation required to remove unsuitable materials as requested by the Owner's Representative shall be paid for by the Owner for at the Unit Price for Excavation. Any overexcavation or excess excavation not requested by the Owner's Representative shall be at the expense of the Contractor.

D. Disposal of Excavated Materials

Contractor shall stockpile excess excavated subsoil or topsoil materials in their corresponding stockpile for future use.

3.03 SUBGRADE PREPARATION

A. Areas to receive fill shall be proof rolled under the observation of the Owner's Representative. Soft, loose, weak, or wet materials shall be removed and replaced with compacted fill or stabilized with geotechnical fabric or geogrid as directed by the Owner's Representative and paid on a time and materials basis. Joints, fractures, and moisture seeps shall be repaired, and local sand deposits, if present at foundation grade, shall be removed and backfilled with compacted fill material as directed by the Owner's Representative.

B. The Owner's Representative may recommend additional drying time for soft, wet subgrade that has not been exposed long enough to permit "crust" formation. If approved by the Owner's Representative, the Contractor may install, at his own expense, geotechnical fabric to stabilize the wet subgrade and expedite construction.

C. Following the excavation for the Compacted Clay Liner, the CQA Officer shall direct the Owner's Field Surveyor to verify that actual depths and grades of the foundation are in accordance with the plans and specifications. Elevations shall be surveyed on a 100 ft. grid pattern for the bottom of the cell. The points surveyed for side slopes will be at the top, midpoint, and toe. In addition, all breaks in grade will be surveyed. Foundation excavation grading shall meet a control tolerance requirement of 0 ft to -0.4 ft. The measured depths and grades shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor agency. The CQA Officer shall review the survey data for conformance to requirements and, if found in agreement with requirements, provide certification for the work in accordance with CQA Plan Procedures.

C. The Contractor shall not place fill until the subgrade has been examined jointly with the Owner's Representative and a certificate of approval for the subgrade has been submitted to the Owner's Representative.

3.04 STRUCTURAL FILL

A. Placement

1. Unless otherwise indicated on the plans, all Fill shall be composed of Earth Fill Material.
2. Fill materials used in embankment construction shall normally be placed in lanes parallel to the embankment axis and shall be placed in conformance with the lines, grades, and slopes as indicated on the plans. Placement of fill materials in lanes which are not parallel to the embankment will be allowed only where working room is too restricted for normal placement as determined by the Owner's Representative.
3. Fill shall be spread in approximately flat layers in such a manner as to obtain lifts of relatively uniform thickness without spaces between successively deposited loads. Segregation shall be prevented during placing and spreading. Hauling equipment shall be routed across the fill in such a way as to promote uniform compaction and to prevent the formation of ruts.
4. The maximum compacted thickness of each lift shall not exceed 8 in. where heavy compaction equipment will be used. The maximum compacted thickness shall not exceed 3 in. where power tampers or similar smaller equipment will be used. It may be necessary to reduce the thickness of lifts in order to obtain the required minimum density.
5. Where compacted Fill is to be placed against existing slopes, each lift shall be keyed into existing slope by removing existing slope material in steps as each new lift is placed.
6. The surface of the fill shall be kept reasonably smooth. The fill surface shall be sloped transverse to the axis of the embankments to allow drainage. If the compacted surface is, in the opinion of the Owner's Representative, too smooth or too dry to bond properly with the succeeding lift, it shall be roughened by scarifying, light discing, or other acceptable means, and it shall be sprinkled with water before the

succeeding lift is placed thereon. If the surface becomes rutted or uneven subsequent to compaction, it shall be flattened and leveled before placing the next lift. This extra work shall be at the Contractor's expense.

7. Fill operations shall be suspended during periods of extended wet weather. Upon resuming operations, all fill materials that are excessively wet or soft shall be reprocessed in place or removed and stockpiled for reprocessing. The removal of soft material shall be carried to such depth as is necessary to expose firm materials. Fill shall not be placed on frozen surfaces.
8. When filling operations at any section will be suspended for any period in excess of 12 hours or in wet weather, the surface of the fill shall be rolled smooth to seal it against excessive absorption of moisture and to facilitate runoff. Prior to resuming fill placement and compaction, the fill surface shall be scarified and/or disced and moisture conditioned as required.
9. The Contractor will receive no additional compensation for any removal, reprocessing, stockpiling, recompaction, wasting, or similar operation related to suspensions or conditions due to weather or other causes unless caused by the Owner.
10. Earth fill access ramps shall not be constructed within the limits of the compacted embankments without the approval of the Owner's Representative. When such ramps are approved, they shall be constructed of Compacted Clay Liner material (in-board of the perimeter berm) or compacted Fill (out-board of the perimeter berm).

B. Compaction -

1. Fill materials shall be compacted to a dry density equal to or greater than the following:

   a. The Gypsum Management Facility: 95 percent of the maximum dry density obtained from the Standard Proctor Test, ASTM D698.
   b. The CCB Landfill: 90 percent of the maximum dry density obtained from the Standard Proctor Test, ASTM D698.

   In order to insure uniform coverage and to facilitate construction inspection and control, the compaction of each layer shall proceed in a systematic, orderly, and continuous manner. Rolling shall be parallel to the embankment axis, except where there is insufficient working room for such operations.

2. The moisture content of all earth fill materials shall be as uniform as practicable throughout each lift. Fill shall be compacted at a moisture content that is no more than 2 percent below and no more than 2 percent above optimum moisture content.
3. Moisture conditioning of fill materials shall be performed by discing, harrowing, plowing, blading, or other suitable means prior to excavation. Moisture conditioning where the fill is placed shall be limited to minor adjustments prior to compaction. Addition of moisture shall be by using a

pressure spray bar mounted in front of or to one side of a water tanker so that water will not collect in the tracks of the truck.

4. Any materials that are placed but not compacted prior to drying out or becoming too wet shall be removed and replaced or reprocessed at the Contractor's expense.
5. No admixtures as drying agents or to improve the workability of the soil will be allowed.

3.05 GENERAL FILL

General Fill materials shall be placed to the specifications for Structural Fill, except it shall be compacted to a dry density equal to or greater than 92 percent of the maximum dry density obtained from the Standard Proctor Test, ASTM D698

3.06 COMPACTED CLAY LINERS

A. Sources

The Compacted Clay Liners for both the Gypsum Management Facility and the CCB Landfill shall be constructed from Compacted Clay Liner material as described in paragraph 2.01(B) above.

B. Test Soil Liner

A Test Soil Liner of the actual full scale liner shall be constructed in accordance with the following requirements:

1. Test liner will be constructed from the same soil material sources, to the same design specifications, and with similar equipment and procedures as are proposed for the full scale liner.
2. Test liner will be at least four times the width of the widest piece of equipment to be used.
3. Test liner will be no less than 100 ft long to allow equipment to reach normal operating speed before reaching a central 40-ft test area.
4. Test liner will be constructed with maximum 8-in. compacted lifts for a total liner thickness of 3 ft.
5. Test liner will be tested by the Owner's Testing Firm in accordance with the project Construction Quality Assurance (CQA) Plan, included in Appendix 2, summarized below for each of the following physical properties:

   a. Multiple two-stage Boutwell permeameter tests will be used on the test liner to determine the hydraulic conductivity. The two-stage field hydraulic conductivity test is a falling head infiltration test conducted in a cased borehole, typically 4 in. in diameter. The test is cited in the U.S. EPA Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities, September 1993 (EPA/600/R-93/182).

b. Undisturbed samples (Shelby tubes) will be tested in the laboratory for hydraulic conductivity to determine if there is a statistical correlation to the field testing results.

c. Other engineering parameters including, but not limited to, particle size analysis, liquid limits, plasticity, water content, and in-place density that are needed to evaluate the full scale liner will be determined.

6. Additional test fills will be constructed for each new soil type or for each change in equipment or procedures.

C. Full Scale Liner Construction:

1. Full scale liner construction shall not be commenced until the results of the in-place compaction testing and Boutwell permeameter tests on the test liner confirm that the construction procedures and specified compaction requirements produce in-situ hydraulic conductivities as specified in Section 2.01(B) above.

2. The liner shall be constructed according to the placement and compaction requirements for general fill, except the material shall be compacted to a density of no less than 95 percent of maximum dry density as determined by the Standard Proctor Test (ASTM D 698) at the following moisture contents:

a. Gypsum Stack Compacted Clay Liner shall be compacted at a moisture content between 100 percent and 105 percent of optimum.

b. CCB Landfill Compacted Clay Liner shall be compacted at a moisture content determined by the "acceptable zone" criteria as outlined in the project CQA Plan.

The same compaction procedures, such as number of passes, speed, and compaction equipment used on construction of the test liner shall be used. Grade stakes shall not be driven into the clay liner.

3. Moisture/density, hydraulic conductivity, and strength testing of the Compacted Clay Liner shall be conducted by the soil testing agency under the requirements and frequencies specified in the project CQA Plan to verify that ongoing liner placement meets the criteria developed by the Test Soil Liner.

4. The completed liner shall be smooth rolled to limit moisture loss and promote run-off of surface water. Moisture content shall be maintained within the specified range and erosion or other damage that occurs in the soil liner shall be repaired as directed by the Owner's Representative until the geosynthetic liner is placed.

5. Voids created in the Compacted Clay Liner during construction (including, but not limited to, penetrations for test samples, and other penetrations necessary for construction) shall be repaired by removing material that does not meet the requirements for Compacted Clay Liner material, backfill with Compacted Clay Liner material, granular or pelletized bentonite, or a mixture of bentonite and Compacted Clay Liner material in lifts no thicker than 2 in. and tamping each lift with a steel rod. Each lift shall be tamped a minimum of 25 times altering the location of the rod within the void for each blow. Other ruts and depressions in the surface of the lifts shall be scarified, filled, and then compacted to grade.

3.07 CUSHION DIRT (Gypsum Management Facility Only)

Cushion Dirt to be placed beneath the upper High Density Polyethylene (HDPE) Geomembrane is to be placed to the specifications for General Fill in Section 3.04 above, except fill materials for Cushion Dirt shall be compacted to a dry density equal to or greater than 90 percent of the maximum dry density obtained from the Standard Proctor Test, ASTM D698.

3.08 ANCHOR TRENCH CONSTRUCTION

A. Gypsum Management Facility – Gypsum Stack

1. The anchor trench shall be excavated to the depth and width shown on the anchor trench details. The front edge of the trench shall be rounded to eliminate any sharp corners that could cause excessive stress to the geosynthetic liners. Loose soil shall be removed or compacted into the floor of the trench.

2. Subsequent to Geosynthetic Clay Liner (GCL), Bottom HDPE Geomembrane and Geotextile Cushion installation, the liners shall be placed in the trench to fully cover the entire trench floor, but do not extend up the back of the trench wall. After the liner installation, the trench shall be backfilled with 1 ft. of Compacted Clay Liner material. The backfill shall be deposited and compacted according to the requirements for general fill in such a manner as to prevent damage to the GCL and liner materials.

3. Subsequent to installation of separation geotextile on top of drainage layer, it shall be verified that the fabric extends across the top of the initial 1 ft layer of trench backfill, but does not extend up the back of the trench wall. After the separation geotextile has been installed in, the trench shall be backfilled with 2 ft of Compacted Clay Liner material. The backfill shall be deposited and compacted according to the requirements for general fill in such a manner as to prevent damage to the separation geotextile.

4. Subsequent to installation of the upper HDPE Geomembrane, the liner shall be installed into the trench and extend across the top of the initial 1 ft layer of trench backfill, but not extend up the back of the trench wall. After the liner installation in the trench has been inspected jointly with the Owner's Representative, and the Geosynthetics Installer's Representative has submitted a certificate of approval that the HDPE Geomembrane was installed in the anchor trench in accordance with the plans and specifications, the Contractor may backfill the remainder of the trench to the top of the Compacted Clay Liner. Deposit and compact the backfill according to the requirements for general fill in such a manner as to prevent damage to the HDPE Geomembrane.

B. Gypsum Management Facility – Recycle Pond

1. The anchor trench shall be excavated to the depth and width shown on the anchor trench details. The front edge of the trench shall be rounded to eliminate any sharp corners that could cause excessive stress to the geosynthetic liners. Loose soil shall be removed or compacted into the floor of the trench.

2. Subsequent to HDPE Geomembrane installation, it shall be verified that the liner covers the entire trench floor, but does not extend up the back of the trench wall. After the liner installation in the trench has been inspected jointly with the Owner's Representative, and the Geosynthetics Installer's Representative has submitted a certificate of approval that the HDPE Geomembrane was installed in the anchor trench in accordance with the plans and specifications, the Contractor may backfill the remainder of the trench to the top of the Recycle Pond berm. The backfill shall be deposited and compacted according to the requirements for general fill in such a manner as to prevent damage to the liner material.

C. CCB Landfill

1. Excavate a ledge at bottom of anchor trench elevation and place and compact Compacted Clay Liner material on the ledge as shown on the anchor trench details in the plans.

2. Excavate the anchor trench to the depth and width shown on the anchor trench details. Round the front edge of the trench to eliminate any sharp corners that could cause excessive stress to the geosynthetic liners. Remove loose soil or compact it into the floor of the trench.

3. Subsequent to GCL and HDPE geomembrane installation by the geosynthetic liner contractor, verify that the liners cover the entire trench floor, but do not extend up the back of the trench wall. After the liner installation in the trench has been inspected jointly with the Owner's Representative, and the Geosynthetics Installer's Representative has submitted a certificate of approval that the HDPE Geomembrane was

installed in the anchor trench in accordance with the plans and specifications, the Contractor may backfill the remainder of the trench to the top of the Compacted Clay Liner. Deposit and compact the backfill according to the requirements for general fill in such a manner as to prevent damage to the GCL and HDPE geomembrane.

4. Subsequent to installation of separation geotextile on top of drainage layer, verify that the fabric extends across the top of the initial 1 ft layer of trench backfill, but does not extend up the back of the trench wall. After the fabric installation in the trench has been inspected and approved by the Owner's Representative, backfill the remainder of the trench to the top of the Compacted Clay Liner. Deposit and compact the backfill according to the requirements for general fill in such a manner as to prevent damage to the geotextile fabric.

3.09 TESTING

A. Construction Quality Assurance (CQA) compaction and permeability tests will be made by the Owner's Testing Consultant during the progress of the work as indicated in the Construction Quality Assurance Plan, included in Appendix 2. The Contractor shall cooperate with the Testing Consultant and allow such tests to be performed.

B. If tests indicate that an area of fill or Compacted Clay Liner does not meet the specified requirements, additional tests shall be performed to determine the extent of non-compliance. The Contractor shall moisture condition and recompact that area until a passing test result is obtained.

C. Moisture/density testing by nuclear methods will be conducted by the Owner's Testing Firm at a minimum frequency as outlined in the Construction Quality Assurance (CQA) Plan. The range of moisture content will be determined in accordance with the "acceptable zone" method which is also outlined in the Project CQA Manual. A moisture test will be considered failed if the result indicates that the moisture content does not lie within the "acceptable zone." Material that fails will be dried or wetted until satisfactory moisture content is achieved. A density test will be considered failed if the result indicates a dry density outside the "acceptable zone." The material will be compacted until a passing test is achieved.

To ensure accuracy and reproducibility of testing of the soil liner for compaction and moisture content, all density gauges shall be certified by annual calibration.

3.10 FINISH GRADING

All excavated and filled areas shall be fine graded and leveled to provide a smooth finish free of debris, foreign matter, objectionable stones, clods, lumps, pockets, or high spots, properly drained and true to indicated elevations. Finish grading shall be only near completion of work or when requested. Any portions of the berm damaged by construction shall be restored. The berm ditch shall be finished to design grade, and the ditch side slopes shaped and trimmed to provide a uniform ditch cross section.

3.11 CONSTRUCTION TOLERANCES

A. Elevations will be surveyed at breaks in slopes and on a 100 ft. grid pattern on the base before and after liner construction to verify liner thickness and to verify that proper drainage slopes to leachate collection piping are maintained. To verify material thickness, all horizontal survey coordinates will be the same for the bottom and the top of the material that is placed. Side slope thicknesses will be verified using crest (top), midpoint, and toe documentation points. A test will be considered failed if it does not meet the minimum design requirements. To obtain the specified design thickness, additional soil material will be placed and compacted in failing areas where the as-built thickness is less than the design thickness. Surveying required for verification of final construction tolerances will be performed by the Owner's Land Surveyor.

B. The minimum specified design thickness of all Compacted Clay Liners shall be 3.00 ft.

END OF SECTION 02200

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PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to the placement of riprap for erosion control.

1.02 RELATED SECTIONS

The following section contains items which are related to the work in this section:

02200 - Earthwork

1.03 REFERENCES

Specified references or cited portions thereof, current at date of bidding documents unless otherwise specified, govern the work.

A. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007.

1.04 SUBMITTALS

Product Data: Provide quarry name and material type prior to delivery.

PART 2. PRODUCTS

2.01 MATERIALS

A. Stone Riprap and Bedding materials according to Article 1005.01 of the Illinois Standard Specifications for Road and Bridge Construction.

B. Filter Fabric material, where required by IDOT specifications for Stone Riprap, shall furnished according to Article 1080.03, with an AOS (Apparent Opening Size) as indicated on the plans.

C. Riprap Source shall be listed on the current IDOT Approved Aggregate Source List.

D. Gradation as indicated in the drawings. Quality shall be Class A.

PART 3. EXECUTION

3.01 CONSTRUCTION REQUIREMENTS

A. Stone Riprap and Bedding shall be installed in accordance with Section 281 of the Illinois Standard Specifications for Road and Bridge Construction for the placement of Stone Riprap. Measurement and payment provisions of Section 281 shall not apply.

B. Filter Fabric for Stone Riprap shall be installed in accordance with Section 282 of the Illinois Standard Specifications for Road and Bridge Construction.

C. The Owner's Representative shall be allowed to visually inspect Riprap for compliance with specifications prior to placement.

END OF SECTION 02275

PART 1. GENERAL

1.01 DESCRIPTION

A. Gypsum Management Facility

This section pertains to the following:

1. Furnishing and placing granular drainage materials for the drainage layer and Leachate Collection System piping.
2. Furnishing and placing coarse aggregate for encasement of the Process Water Recovery System piping.
3. Furnishing and installing Filter Sand for the protection of the Process Water Recovery System piping.
4. Furnishing and installing materials for roadbed construction related to the Gypsum Management Facility access roads.
5. Recycle Pond Drain.
6. Furnishing and installing materials for roadbed construction related to maintaining McKinley Road on AERG property.
7. ***Furnishing and installing materials for roadbed construction related to the Landfill Haul Road.***

B. CCB Landfill

This section pertains to the following:

1. Placing granular material for Drainage Layer.
2. Placing granular material for Separation Berm.
3. Placing Coarse Aggregate for encasement of leachate collection piping.
4. Furnishing and installing materials for roadbed construction related to the landfill access road.

1.02 RELATED SECTIONS

The following sections contain items which are related to the work in this section:

1. 02300 - Earthwork
2. 02373 – Geotextiles
3. 02640 - Leachate Collection Piping

1.03 REFERENCES

The following references, or cited portions thereof, govern the work:

1. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007.
2. American Society for Testing and Materials (ASTM):

    a. ASTM D 75 (2003) Practice for Sampling Aggregates.
    b. ASTM D 422 (1963; R 2002) Test Method for Particle-Size Analysis of Soils.
    c. ASTM D 2434 (1968, R 2000) Test Method for Permeability of Granular Soils (Constant Head).
    d. ASTM D 3042 (2003) Test Method for Insoluble Residue in Carbonate Aggregates.
    e. ASTM C 1260 (2005) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).

3. American Geological Institute (AGI). Geoscience Handbook AGI Data Sheets, 4th Edition.

1.04 MEASUREMENT AND PAYMENT

The Contractor shall be responsible for estimating the extent of granular materials required to complete the work including, but not limited to, construction of drainage layer, encasement of leachate collection piping, and road-bed construction. The Contractor shall include the dollar amount associated with furnishing and placing all granular materials in his Lump Sum Bid amount.

1.05 COORDINATION

A. The geosynthetic liner shall be covered with granular materials as soon as practicable after a section of liner has been approved by the Owner's Representative.

1.06 SUBMITTALS

A. Product Data:

1. Aggregate source list: Submit a list of proposed aggregate sources.

2. Shipping Tickets: Submit shipping tickets for the granular materials delivered to the site. Shipping tickets shall be according to paragraph 1004.01f of the IDOT Standard Specifications.

B. Test Reports.

1. Submit results of grain size analysis (ASTM D422) and hydraulic conductivity testing (ASTM D2434) for gradations established by the Contractor that provide the specified hydraulic conductivity. Test results are required for each proposed source and gradation. Submit test results for each source demonstrating compliance with reactivity, soundness, and abrasion requirements specified herein.

C. Samples:

1. Submit one sample per source for each gradation proposed for use on the project. Samples shall be at least one pound and shall be obtained and shipped according to ASTM D75. Submit samples at least 15 days prior to starting construction of the drainage layer and coarse aggregate encasement for leachate piping.

1.07 STORAGE AND HANDLING

A. Storage and handling of granular materials shall be according to paragraph 1004.01e of the IDOT Standard Specifications.

PART 2. PRODUCTS

2.01 MATERIALS

A. General

1. Coarse Granular materials shall be meet the Description of Gravel, as described in Section 1004.01(a)(1) of the IDOT Standard Specifications, and shall be spherical to sub-discoidal, sub-rounded to well rounded particles as defined by AGI Data Sheet, 4^{th} Edition, Sheet 8.4 – Comparison Charts for Estimating Roundness and Sphericity.
2. Granular materials shall experience no more than 15 percent carbonate loss per ASTM D3042.
3. Granular materials shall be free of deleterious material. and shall meet the Na_2SO_4 soundness and Los Angeles Abrasion Specifications for Class B quality aggregate per paragraph 1004.01 of the IDOT Standard Specifications.
4. All material shall pass the 2 in. sieve, and no greater than 5 percent shall be retained on the No. 200 sieve.
5. Granular materials shall be innocuous to alkali-silica reactivity, and shall exhibit internal expansions of less than 0.10 percent at 16 days after casting as determined by ASTM C 1260.

B. Gypsum Management Facility Granular Materials

1. Granular Materials for Drainage Layer

Gradation for granular material for Drainage Layer shall be as required to provide a minimum hydraulic conductivity (ASTM D2434) of 1×10^{-3} cm/sec.

2. Coarse Aggregate around Ring Drain Collection Piping

Coarse Aggregate used to encase the ring drain collection piping shall be IDOT Gradation CA 7 material as outlined in Article 1004.01 of the IDOT Standard Specifications for Road and Bridge Construction.

3. Filter Sand

Filter Sand used for protective cover over the ring drain collection system shall be IDOT Gradation FA 1, Class B or better according to Article 1003 of the IDOT Standard Specifications for Road and Bridge Construction.

4. Aggregate Base Course, Type B

Aggregate Base Course, Type B used for base material for all new access roads and ***the Landfill Haul Road*** shall be IDOT Gradation CA 2, in accordance with Section 1004.04 of the IDOT Standard Specifications for Road and Bridge Construction. The requirements from Section 2.01A of this specification shall not apply.

5. Aggregate Surface Course, Type B

Aggregate Surface Course, Type B used for surface material for all new access roads and the ***Landfill Haul Road*** ~~McKinley Road relocation~~ shall be IDOT Gradation CA 6, in accordance with Section 1004.04 of the IDOT Standard Specifications for Road and Bridge Construction. The material shall originate from an IDOT approved source. The requirements from Section 2.01A of this specification shall not apply.

6. Coarse Aggregate for Leachate Collection/Leachate Detection Piping

Gradation for coarse aggregate encasement around Leachate Collection/Leachate Detection Laterals shall be as required to provide a minimum hydraulic conductivity (ASTM D2434) of 1×10^{-1} cm/sec.

B. CCB Landfill Granular Materials

1. Granular Materials for Drainage Layer and Separation Berm.

   Gradation for granular material for drainage layer and separation berm shall be as required to provide a minimum hydraulic conductivity (ASTM D2434) of 1×10^{-3} cm/sec.

2. Coarse Aggregate.

   Gradation for coarse aggregate shall be as required to provide a minimum hydraulic conductivity (ASTM D2434) of 1×10^{-1} cm/sec.

2.02 EQUIPMENT

Equipment for spreading and compacting granular materials shall be low ground pressure equipment to prevent damage to the underlying geosynthetic liners.

PART 3. EXECUTION

3.01 PROTECTION OF GEOSYNTHETICS

A. Protection of the geosynthetic liners is critically important. Approved geosynthetic liner shall be covered by granular material as soon as practicable. Granular material shall be placed to a minimum thickness of 1 ft before any heavy equipment or loaded trucks are allowed on the lined area.

B. No vehicular traffic shall travel directly on the geosynthetic liner other than an approved low ground pressure All Terrain Vehicle or equivalent.

C. Any damage to the geosynthetic liner system shall be repaired, as directed by the Owner's Representative, at the expense of the Contractor.

3.02 DRAINAGE LAYER (GYPSUM STACK)

A. Placement on Cell Floor

1. The granular material shall be back-dumped on the geotextile cushion fabric in a sequence of operations beginning at the perimeter of the liner on the cell floor.
2. Placement of material on the fabric shall be accomplished by spreading dumped material off of previously placed material with a bulldozer blade or endloader. in such a manner as to prevent tearing or shoving of the cloth. Dumping of material directly on the fabric will only be permitted to establish an initial working platform. No vehicles or construction

equipment shall be allowed on the fabric prior to placement of the granular blanket to a minimum thickness of 1 ft.

B. Placement on Cell Side Slopes

1. Placement of granular material on cell side slopes shall be accomplished using methods and equipment similar to that specified for placement of material on cell floor.
2. The Contractor may place earth fill material underlain with separation geotextile fabric to buttress the granular material on the slope:

   a. The Construction Quality Assurance (CQA) survey to certify thickness of drainage material shall be completed within the footprint of the gypsum stack before it is covered with separation geotextile fabric.
   b. Separation geotextile fabric shall extend beyond the toe of gypsum buttress a sufficient distance to prevent contamination of the granular drainage layer. See Sections 02373 and 02320 for construction of separation geotextile fabric.

3.03 DRAINAGE LAYER (CCB LANDFILL)

A. Placement on Cell Floor.

1. The granular material shall be back-dumped on the geotextile cushion fabric in a sequence of operations beginning at the perimeter of the liner on the cell floor.
2. Placement of material on the fabric shall be accomplished by spreading dumped material off of previously placed material with a bulldozer blade or endloader, in such a manner as to prevent tearing or shoving of the cloth. Dumping of material directly on the fabric will only be permitted to establish an initial working platform. No vehicles or construction equipment shall be allowed on the fabric prior to placement of the granular blanket to a minimum thickness of 1 ft.

B. Placement on Cell Side Slopes.

1. Placement of granular material on cell side slopes shall be accomplished using methods and equipment similar to that specified for placement of material on cell floor.
2. The Contractor may place CCB underlain with separation geotextile fabric to buttress the granular material on the slope:

   a. The Construction Quality Assurance (CQA) survey to certify thickness if drainage material shall be completed within the footprint of the CCB before CCB placement.

b. Separation geotextile fabric shall extend beyond the toe of CCB buttress a sufficient distance to prevent contamination of the granular drainage layer. See Sections 02373 and 02320 for construction of separation geotextile fabric and CCB, respectively.

C. Placement in Separation Berm.

1. Granular material for the separation berm shall be placed and spread in uniform lifts not to exceed 1 ft. The initial lift shall be placed according to paragraph A. The separation berm shall be constructed across the floor of the cell to at least the level of the top of drainage layer before any CCB is placed within the cell, and the top of berm shall be maintained at or above the level of adjacent CCB as CCB placement progresses.

3.04 COARSE AGGREGATE FOR ENCASEMENT OF RING DRAIN COLLECTION PIPING (GYPSUM MANAGEMENT FACILITY)

A. The geotextile filter fabric for encasement of leachate collection piping shall be placed on the approved cushion geotextile fabric according to Section 02373 – Geotextiles.

B. The coarse aggregate shall be placed and consolidated with a vibratory plate compactor on the encasement fabric to the width shown on the plans to the level of the bottom of the ring drain collection piping.

C. Course aggregate shall be placed and consolidated with a vibratory plate compactor along the pipe during pipe installation. The coarse aggregate shall be placed longitudinally along the pipe in lifts not to exceed 8 in. thick to a height of at least the center of the pipe. The aggregate shall be maintained at equal elevation on each side of the pipe, and the first lift of material shall be mechanically tamped to ensure that the space under the pipe is completely filled. The top of pipe shall not be covered until the CQA survey certifies leachate piping grade has been completed.

D. After the CQA survey has been completed, coarse aggregate material shall continue to be placed in lifts not to exceed 8 in. thick, as specified in the previous paragraph until the minimum cover height shown in the plans is attained.

E. The running of trucks or heavy equipment over leachate piping shall be avoided until there is at least a 12 in. cover of Filter Sand over the completed geotextile envelope.

3.05 COARSE AGGREGATE FOR ENCASEMENT OF LEACHATE COLLECTION PIPING (CCB LANDFILL)

A. Place geotextile fabric for encasement of leachate collection piping on the approved cushion geotextile fabric according to Section 02373 – Geotextiles.

B. Place and consolidate coarse aggregate with a vibratory plate compactor on the encasement fabric to the width shown on the plans to the level of the bottom of the leachate piping.

C. Place and consolidate course aggregate along the pipe during pipe installation. Place coarse aggregate longitudinally along the pipe in lifts not to exceed 8 in. thick to a height of at least the center of the pipe. Maintain the aggregate at equal elevation on each side of the pipe, and mechanically tamp the first lift of material to ensure that the space under the pipe is completely filled. Do not cover the top of pipe until the CQA survey to certify leachate piping grade has been completed.

C. After the CQA survey has been completed, continue placing coarse aggregate material in lifts not to exceed 8 in. thick, as specified in the previous paragraph until the minimum cover height shown in the plans is attained.

D. Avoid running trucks or heavy equipment over leachate piping until there is at least 12 in. cover over the completed geotextile envelope. Provide temporary ramps no steeper than 10H:1V transverse to the piping for temporary equipment crossings until the first lift of CCB is placed.

3.06 ROADWAY CONSTRUCTION

A. Prepare the roadway subgrade as shown on the plans, in accordance with Section 02200 – Earthwork.

B. Furnish Geotechnical Fabric for Ground Stabilization in accordance with Section 02373 – Geotextiles.

C. Furnish Aggregate Base Course, Type B in accordance with Article 351 of the IDOT Standard Specifications for Road and Bridge Construction.

D. Furnish Aggregate Surface Course, Type B in accordance with Article 402 of the IDOT Standard Specifications for Road and Bridge Construction.

3.07 TESTING

A. Independent gradation and permeability tests will be made by the Owner's Testing Lab during the progress of the work at frequencies as required in the project Construction Quality Assurance (CQA) Plan, included in Appendix 2.

The Contractor shall cooperate with the Testing Lab and allow such tests to be performed.

B. If tests indicate that an area of granular material or coarse aggregate does not meet the specified requirements of the project CQA Plan, then the Contractor shall remove the material and replace it with suitable material.

3.05 FINISH GRADING

The granular drainage layer shall be fine graded, but not compacted, to provide a smooth finish before a CQA survey of the completed portion of the drainage layer is requested. The CQA Officer shall direct the survey agency to determine elevations at the top of the final constructed surface of the Drainage Layer using a 100 ft. grid pattern (and the break points in slope) to verify attainment of the plan grades and elevations. To verify thickness, all horizontal survey coordinates shall be the same for the top of the cushion, and final constructed surface. Side slope thicknesses will be verified using crest (top), midpoint, and toe documentation points. In co instance shall the field determined thickness be less than 1.0 ft. The measured depths and grades shall be documented on "as built" drawings furnished to the CQA Officer by the survey agency. Ruts or erosion damage shall be repaired before placement of the separation geotextile fabric.

END OF SECTION 02315

PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to furnishing and installing geotextile fabrics on prepared surfaces.

1.02 RELATED SECTIONS

The following sections contain items which are related to the work in this section:

1. 02300 - Earthwork
2. 02315 - Granular Materials
3. 02800 – HDPE Geomembrane

1.03 REFERENCES

The following references, or cited portions thereof, govern the work:

1. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007.
2. American Society for Testing and Materials (ASTM):

    a. ASTM 3776 (1996; R 2002) Standard Test Method for Mass per Unit Area (Weight) of Fabric;
    b. ASTM D 3786 (2001) Test Method for Hydraulic Bursting Strength of Textile Fabrics -- Diaphragm Bursting Strength Tester Method;
    c. ASTM D 4533 (2004) Test Method for Trapezoid Tearing Strength of Geotextiles;
    d. ASTM D 4632 (1991; R 2003) Test Method for Grab Breaking Load and Elongation of Geotextiles;
    e. ASTM D 4751 (2004) Test Method for Determining Apparent Opening Size of Geotextile;
    f. ASTM D 4833 (2000) Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products;
    g. ASTM D 4873 (2002) Guide for Identification, Storage, and Handling of Geosynthetic Rolls;
    h. ASTM D 4884 (1996; R 2003) Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles;
    i. ASTM D5261-92(2003) Standard Test Method for Measuring Mass per Unit Area of Geotextiles

j. ASTM D6241-04 Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

1.04 MEASUREMENT AND PAYMENT

A. The Contractor shall be responsible for estimating the extent of geotextile fabric required to complete the work including fabric for laps, anchorage, repairs, and samples for Construction Quality Assurance (CQA) testing. The Contractor shall include the dollar amount associated with all geotextile construction in his Lump Sum Bid amount, except as specified in paragraph B.

B. Geotextile Fabric for Ground Stabilization, when directed by the Owner's Representative for stabilization of foundation soils, will be paid for on a time and materials basis.

C. No additional payment will be made for geotextile fabric for ground stabilization installed at the Contractor's discretion.

1.05 SUBMITTALS

A. Product Data

1. The manufacturer's list of guaranteed properties for each geotextile fabric proposed for use on the project shall be submitted.
2. The manufacturer's installation guidelines shall be submitted.

B. Samples

Samples of geotextile fabrics shall be submitted for CQA prequalification testing. Sample size and sampling frequency are specified in Appendix 2.

C. Inventory

A copy of the roll inventory that identifies, as a minimum, manufacturer or supplier, product or style number, roll number, width, and length of roll as identified on the roll label shall be submitted.

1.06 STORAGE AND HANDLING

Geotextiles shall be stored and handled according to ASTM D4873.

PART 2. PRODUCTS

2.01 MATERIALS

A. Geotextile Fabric for Liner System

Geotextile fabrics for use in the cell liner system shall consist of non-woven filaments of polypropylene, polyester, or polyethylene. Stabilizers and/or inhibitors shall be added to the base polymer if necessary to make the filaments resistant to deterioration caused by ultraviolet light and heat exposure. Reclaimed or recycled fibers or polymer shall not be added to the formulation. Non-woven fabric may be needle-punched, heat-bonded, or a combination thereof. The filaments shall be dimensionally stable (i.e., filaments shall maintain their relative position with respect to each other) and resistant to delamination. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile. The filaments shall be free from any chemical treatment or coating that might significantly reduce porosity and permeability.

Fabric shall have the following physical properties:

Physical Properties[1]	4 oz. (Separation)	6 oz. (PWRS)	16 oz. (CA Envelope & Rub Sheet)
Mass/Unit Area (oz./yd^2) ASTM D5261	4.0	6.0	16.0
Grab Tensile Strength (lb.) ASTM D4632	115	160	380
Grab Elongation (%) ASTM D4632	50	50	50
Puncture Strength (lb.) ASTM D4833	65	85	240
Puncture (CBR) Strength (lb.) ASTM D6241	310	410	1025
Mullen Burst Strength (psi) ASTM D3786	210	280	750
Trapezoidal Tear Strength (lb.) ASTM D4533	50	60	150
Width (ft.)	15	15	15
Apparent Opening Size (AOS) Max. US Std. Sieve No. ASTM D4751	70	70	100
UV Resistance[2] (%) ASTM D4355	70	70	70
Roll Width (ft.)	15	15	15

Notes

(1) All Values listed are Minimum Average Roll Values (MARV) unless otherwise noted, calculated as the typical minus two standard deviations.

(2) UV Resistance is a minimum value and not a MARV. Evaluation to be on 2.0 inch strip tensile specimens after 500 hours exposure.

B. Geotextile Cushion

Fabric for Geotextile Cushion shall consist of non-woven filaments of polypropylene, polyester, or polyethylene. Stabilizers and/or inhibitors shall be added to the base polymer if necessary to make the filaments resistant to deterioration caused by ultraviolet light and heat exposure. Reclaimed or recycled fibers or polymer shall not be added to the formulation. Non-woven fabric may be needle-punched, heat-bonded, or a combination thereof. The filaments shall be dimensionally stable (i.e., filaments shall maintain their relative position with respect to each other) and resistant to delamination. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile. The filaments shall be free from any chemical treatment or coating that might significantly reduce porosity and permeability.

Fabric shall have the following physical properties:

Physical Properties[(1)]	**10 oz. (Geotextile Cushion)**
Mass per unit area (oz/yd^2) ASTM D5261	10
Grab Tensile Strength (lb.) ASTM D4632	230
Grab Tensile Elongation (%) ASTM D4632	50
Trapezoidal Tear Strength (lb.) ASTM D4533	95
Puncture (CBR) Strength (lb.) ASTM D6241	700
Puncture (CBR) Elongation (in.) ASTM D6241	1.5
UV Resistance[(2)] (%) ASTM D4355	70
Apparent Opening Size (Max.) (AOS) Sieve No. - ASTM D4751	---
Roll Width (ft.)	15

Notes

(1) All Values listed are Minimum Average Roll Values (MARV) unless otherwise noted, calculated as the typical minus two standard deviations.

(2) UV Resistance is a minimum value and not a MARV. Evaluation to be on 2.0 inch strip tensile specimens after 500 hours exposure.

C. Geotechnical Fabric for Ground Stabilization

Geotechnical fabric for ground stabilization shall conform to Article 1080.02 of the IDOT Standard Specifications for Road and Bridge Construction.

D. Thread for Seams

High strength thread should be used such that seam test should conform to ASTM D4884. The thread shall meet the chemical, ultraviolet, and physical requirements of the geotextile, and the color shall be different from that of the geotextile.

E. Securing Devices

Pins, staples, and other devices that project through the geotextile fabric are not permitted for fabrics installed above the geomembrane. Sandbags, stone, or other appropriate means approved by the Owner's Representative shall be used to prevent movement of the geotextile.

2.02 EQUIPMENT

A. Equipment for spreading and compacting granular materials shall be low ground pressure equipment to prevent damage to the underlying geosynthetic liners.

PART 3. EXECUTION

3.01 SAMPLES FOR CQA TESTING

A. Geotextile fabric samples shall be obtained, identified and packaged from rolls designated by the Owner's Representative according to ASTM D4873.

B. Samples shall be 3 ft. wide by the full roll width.

3.02 BASE PREPARATION

A. Surface on which the geotextile will be placed shall be prepared to a relatively smooth surface condition, and shall be free from obstruction, debris, depressions, erosion features, or any irregularities that would prevent continuous, intimate contact of the geotextile with the entire surface. Rills, gullies, and ruts must be graded out of the surface before geotextile placement. Areas on which geotextile are to be placed shall be graded and/or dressed in accordance with Section 02200 – Earthwork and Section 02315 – Granular Materials. Prior to daily placement, the Installer shall provide the CQA Officer daily "certificates of acceptance" which document the Installer's inspection and acceptance of the underlying surface as being suitable for the geotextile installation.

B. Geotextile cushion fabric will be installed directly on the geosynthetic liner. Jointly inspect the liner with the Owner's Representative before commencing fabric installation each day. Notify the Owner's Representative promptly of any damage or defects observed in the liner as fabric installation progresses. Do not place fabric in the damaged or defective area until the liner has been repaired and approved by the Owner's Representative. Submit a daily inspection report identifying the area of fabric placement and certifying that there were no visible defects in the area of fabric placement.

C. Do not run heavy vehicle traffic directly on the geosynthetic liner or cushion geotextile. Use vehicles and equipment as specified in paragraph 2.02 to transport and deploy fabric on the liner. Operate the equipment with care, and place protective cover over the geomembrane, if necessary, to avoid damaging the liner. Route traffic and personnel over installed cushion fabric and use the installed fabric as a working platform to the greatest extent possible.

3.03 INSTALLATION

A. General Requirements:

1. Geotextile fabric shall be unrolled and laid out following these requirements to the greatest extent practical:

   a. Orient panels with the longest dimension parallel to the slope.
   b. Minimize the number of seams in corners and odd-shaped areas.
   c. Extend panels on slopes a minimum of 5 ft onto a horizontal surface.

   Geotextile panels shall be unrolled using methods that will not damage the fabric and will protect underlying surface from damage. While unrolling, the geotextile fabric shall be visually inspected for imperfections and faulty or suspect areas marked. Ballast shall be placed on fabric to prevent wind uplift. Expansion and contraction should be allowed for by leaving slack.

   Heavy vehicle traffic shall not be run directly on geotextile fabric. Fabric in areas of heavy traffic shall be protected with protective cover over the fabric.

2. Laps

   Individual panels of geotextile fabric shall be lapped according to manufacturer's instructions and as specified herein. Provide a minimum overlap of 3 in. unless otherwise specified herein or in the plans. Shingle overlaps so that water or other material cannot run down the slope between the two layers of fabric.

3. Field Seams

Continuously sew all laps on slopes steeper than 10H:1V. This requirement does not apply to the heavy geotextile fabric for envelopment of coarse aggregate around leachate piping.

4. Defects and Repairs

Examine the installed geotextile fabric for defects, holes discontinuous seams, puckered or separated laps, etc. Repair defective laps and seams. Patch holes and defects according to manufacturer's recommendations and as directed by the Owner's Representative. Do not cover suspect or patched areas until they have been inspected and approved by the Owner's Representative.

B. Geotextile Fabric for Separation

1. Use low ground pressure equipment to avoid rutting the granular material.
2. Horizontal seams (parallel to top of slope) will be permitted on cell side slopes to facilitate staged construction of the drainage layer on the side slope.
3. Extend separation geotextile fabric into and across the bottom of the anchor trench and complete backfill of the trench according to Section 02200.

C. Geotextile Fabric for Coarse Aggregate Envelope

1. Geotextile for coarse aggregate envelope will be installed directly on the cushion fabric. Remove any foreign materials from the cushion fabric within the footprint of the coarse aggregate leachate piping encasement before installing the geotextile envelope. Place sufficient width to completely envelop the coarse aggregate and provide a longitudinal lap of at least 6 in.
2. After the coarse aggregate encasement has been completed, according to Section 02315, wrap the geotextile around the mounded aggregate, and cover the lap with at least 6 in. of material before permitting vehicle or equipment on the fabric.
3. Any ballast material other than coarse aggregate, according to Section 02315, that is placed within the envelope will require removal during coarse aggregate construction.

D. Geotechnical Fabric for Ground Stabilization

1. Install Geotechnical Fabric for Ground Stabilization in accordance with Section 210 of the IDOT Standard Specifications for Road and Bridge Construction.

2. If approved by the Owner's Representative, the Contractor may, at his own expense, install geotextile or geogrid for ground stabilization outside the limits designated by the Owner's Representative.
3. Submit as-built drawings that clearly delineate limits and type of ground stabilization.

3.04 PROTECTION

A. Protect installed fabric until it is covered by at least 1 ft. of overlying material.

B. Any damage to the geotextile during its installation or during placement of overlying materials shall be replaced by the Contractor at no cost to the Owner. Unless otherwise noted, the work shall be scheduled so that the covering of the geotextile with a layer of the specified material is accomplished within 14 calendar days after placement of the geotextile. Failure to comply shall require replacement of geotextile. The geotextile shall be protected from damage prior to and during the placement of overlying materials. Before placement of overlying materials, the Contractor shall demonstrate that the placement technique will not cause damage to the geotextile.

3.05 TESTING AND INSPECTION

A. Prequalification Testing

Geotextiles are subject to CQA testing by the Owner's Testing Consultant to verify conformance with the manufacturer's list of guaranteed properties according to the project Construction Quality Assurance Plan, included in Appendix 2. The Contractor shall provide samples as specified herein. Any fabric that does not conform to the list of guaranteed properties shall be removed from the site.

B. Installed fabric shall be inspected by the Owner's Representative. No material shall be placed on the fabric, other than ballast, until the installation has been approved by the Owner's Representative. Ballast shall not obscure seams or significant length of unseamed laps. The Owner's Representative may require removal of ballast to inspect suspect areas.

C. If the Owner's Representative suspects that completed work has been damaged by construction methods that do not conform to the specifications, he may require removal of completed work to verify the integrity of the underlying materials. The Contractor shall bear the cost of removal and subsequent repair as directed by the Owner's Representative, if the integrity of the underlying materials was damaged. If no damage was found, the Owner will pay the Contractor for the investigation work on a time and materials basis.

END OF SECTION 02373

PART 1. GENERAL

1.01 DESCRIPTION

A. This section covers furnishing and installation of a reinforced needlepunched Geosynthetic Clay Liner (GCL) at the Gypsum Management Facility and the CCB Landfill.

B. The work includes furnishing all equipment and materials, providing all labor, supervision, administration and management necessary to perform the work as specified herein and as shown on the plans.

1.02 RELATED SECTIONS

None.

1.03 REFERENCES

The following references, or cited portions thereof, govern the work

1. Geosynthetic Institute

    a. GRI-GCL3, Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs).

2. American Society for Testing and Materials (ASTM):

    a. ASTM D 4632 (1991; R 2003), Standard Test Method for Grab Breaking Load and Elongation of Geotextiles;
    b. ASTM D 4643 (2000), Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method;
    c. ASTM D 5084 (2003), Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter;
    d. ASTM D 5261 (1992; R 2003), Test Method for Measuring Mass Per Unit Area of Geotextiles;
    e. ASTM D 5321 (2002), Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method;

f. ASTM D 5887 (2004). Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter;
g. ASTM D 5888 (1995; R 2002), Practice for Storage and Handling of Geosynthetic Clay Liners;
h. ASTM D 5889 (1997; R 2003), Practice for Quality Control of Geosynthetic Clay Liners;
i. ASTM D 5890 (2002), Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners;
j. ASTM D 5891 (2002), Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.

1.04 SUBMITTALS

A. With the bid, the Contractor shall furnish the following information:

1. Conceptual description of the proposed plan for placement of the GCL panels over the areas of installation.
2. GCL Manufacturer's Quality Control (MQC) Plan for documenting compliance with Sections 2.01 and 2.02 of these specifications.
3. GCL manufacturer's historical data for reinforced GCL of a) 10,000-hour creep shear testing per Section 2.01 D. and b) seam flow data at 2 psi confining pressure per Section 2.01 E.
4. A copy of GCL manufacturer's International Standards Organization (ISO) Quality Certificate of Registration.
5. Statement of experience from the proposed GCL supplier.
6. Statement of experience from the proposed GCL installer.

B. At the Owner Representative's or Owner's request, the Contractor shall furnish:

1. A representative sample of the GCLs.
2. A project reference list for the GCL(s) consisting of the principal details of at least ten projects totaling at least 10 million sq. ft (100,000 sq. meters) in size.

C. Upon shipment, the Contractor shall furnish:

1. The GCL manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the project are in accordance with the requirements of this specification.
2. Inventory of materials received.

D. As installation proceeds, the Geosynthetics Installer's Representative shall submit certificates of subgrade acceptance, signed by the Contractor and Construction Quality Assurance (CQA) Inspector (see Sections 1.06 and 3.03) for each area that is covered by the GCL.

E. Warranty

After construction, the contractor shall submit material and installation warranty certificates.

1.05 QUALIFICATIONS

A. GCL Manufacturer must have produced at least 10 million sq. ft. (1 million sq. meters) of GCL, with at least 8 million sq. ft. (800,000 sq. meters) installed.

B. The GCL Installer must either have installed at least 1 million sq. ft. (100,000 sq. meters) of GCL, or must provide to the Engineer satisfactory evidence, through similar experience in the installation of other types of geosynthetics, that the GCL will be installed in a competent, professional manner.

1.06 CONSTRUCTION QUALITY ASSURANCE (CQA)

A. Construction Quality Assurance of the GCL installation shall be performed as outlined in the project Construction Quality Assurance Plan, included in Appendix 2 of these Specifications.

B. The GCL Installer shall provide his own CQA inspector. The Owner shall provide a third-party inspector for CQA monitoring of the GCL installation. The inspector shall be an individual or company who is independent from the manufacturer and installer and who shall be responsible for monitoring and documenting activities, related to the CQA of the GCL throughout installation.

C. Testing of the GCL as necessary to support the CQA effort shall be performed by a third party laboratory retained by the Owner and independent from the GCL manufacturer and installer.

WARRANTY

The geomembrane material shall be warranted, on a pro-rata basis against manufacturer's defects for a period of five (5) years from the date of liner installation. The installation shall be warranted against defects in workmanship for a period of (1) year from the date of liner completion.

PART 2. PRODUCTS

2.01 MATERIALS

A. The GCL shall be manufactured as a hydraulic barrier consisting of clay bonded between two layers of nonwoven geotextile by needle punching.

B. The GCL shall be manufactured to conform with the test methods, required properties, and testing frequencies of the GRI-GCL3 specification for Reinforced, Geotextile Related GCL.

C. In addition to the minimum properties given in Table 1(a) of GRI-GCL3, the GCL shall conform to the following specifications.

Test Method	Minimum Value
Bentonite Mass/Area (ASTM D 5993)	0.75 lb./ft^2
GCL Grab Tensile Strength (ASTM D 4632)	90 lb.
GCL Peel Strength (ASTM D 4632)	15 lb.

D. The reinforced GCL shall have seam test data from an independent laboratory showing that the seam flow with a grooved cut in one of the nonwoven geotextiles is less than 1 x 10^{-8} m^3/m^2/s at 2 psi hydraulic pressure.

E. The minimum acceptable dimensions of full-size GCL panels shall be 150 ft. (45.7 m) in length. Short rolls [(those manufactured to a length greater than 70 ft. (21 meters) but less than a full-length roll)] may be supplied at a rate no greater than three (3) per truckload or three (3) rolls every 36,000 sq. ft. (3,500 sq. meters) of GCL, whichever is less.

2.02 PRODUCT QUALITY DOCUMENTATION

The GCL manufacturer shall provide the Contractor or other designated party with manufacturing QA/QC certifications for each shipment of GCL. The certifications shall be signed by a responsible party employed by the GCL manufacturer and shall include:

A. The Manufacturer's Certification that the material was manufactured and tested in accordance with GRI-GCL3 specifications, together with a report of the test results, shall be furnished at the time of shipment.

B. The manufacturers recommended seaming method with seam test data from an independent laboratory showing that the seam flow is less than 1 x 10^{-8} m^3/m^2/s at 2 psi hydraulic pressure.

C. GCL lot and roll numbers supplied for the project (with corresponding shipping information).

2.03 PRODUCT LABELING

A. Prior to shipment, the GCL manufacturer shall label each roll, identifying:

1. Product identification information (Manufacturer's name and address, brand product code).

2. Lot number and roll number.
3. Roll length, width and weight.

2.04 PACKAGING

A. The GCL shall be wound around a rigid core whose diameter is sufficient to facilitate handling. The core is not necessarily intended to support the roll for lifting but should be sufficiently strong to prevent collapse during transit.

B. All rolls shall be labeled and bagged in packaging that is resistant to photodegradation by ultraviolet (UV) light.

2.05 ACCESSORY BENTONITE

A. The granular bentonite sealing clay used for overlap seaming, penetration sealing and repairs shall be made from the same natural sodium bentonite as used in the GCL and shall be as recommended by the GCL manufacturer. Seaming of GCLs shall be conducted in accordance with the manufacturer's guidelines for each particular GCL.

PART 3. EXECUTION

3.01 SHIPPING AND HANDLING

A. The rolls of GCL shall be packaged and shipped by appropriate means to prevent damage to the material and to facilitate off-loading.

B. The Installation Supervisor shall be present during delivery and unloading of the GCL. A visual inspection of each roll should be made during unloading to identify if any packaging has been damaged. Rolls with damaged packaging should be marked and set aside for further inspection. The packaging should be repaired prior to being placed in storage. The Installation Supervisor shall prepare and submit an inventory that includes lot and roll number for materials received.

C. The Installer is responsible for unloading the GCL. The Installer should contact the Manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment.

3.02 STORAGE

A. Storage of the GCL rolls and accessory bentonite shall be the responsibility of the Installer.

B. Rolls should be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks. Rolls should be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four).

C. All stored GCL materials and the accessory bentonite must be covered with a plastic sheet or tarpaulin until their installation.

D. The integrity and legibility of the labels shall be preserved during storage.

3.03 EARTHWORK

A. The compacted clay liner upon which the GCL is installed shall be prepared and compacted prior to installation. The surface shall be smooth, firm, and unyielding, and free of:

1. Vegetation.
2. Construction debris.
3. Sticks.
4. Sharp rocks.
5. Void spaces.
6. Ice.
7. Abrupt elevation changes.
8. Standing water.
9. Cracks larger than 0.25 in. (6 mm) in width.
10. Any other foreign matter that could contact the GCL.

B. Immediately prior to GCL deployment, the compacted clay liner shall be final-graded by the contractor to fill in all voids or cracks and then smooth-rolled to provide the best practicable surface for the GCL. At completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade. Furthermore, all protrusions extending more than 0.5 in. (12 mm) from the surface shall either be removed, crushed or pushed into the surface with a smooth-drum compactor.

C. Prior to daily GCL placement, the installer shall provide to the CQA Officer daily "certificates of acceptance" which document the Installer's inspection and acceptance of the underlying surface as being suitable for GCL installation.

D. It shall be the Installer's responsibility thereafter to indicate to the Owner's Representative any change in the condition of the compacted clay liner that could cause the subgrade to be out of compliance with any of the requirements listed in this Section. The Installation Supervisor shall certify in the daily report that no GCL was placed over visibly defective low permeability soil surface.

E. At the top of sloped areas of the job site, an anchor trench for the GCL shall be excavated by the contractor in accordance with the project plans. The trench shall be excavated and approved by the CQA Inspector prior to GCL placement. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist anywhere within the trench.

3.04 GCL PLACEMENT

A. GCL rolls shall be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging shall be carefully removed without damaging the GCL. The orientation of the GCL (i.e., which side faces up) shall be in accordance with the Owner Representative's recommendations.

B. Equipment which could damage the GCL, shall not be allowed to travel directly on it. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues.

C. Care must be taken to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic subgrade covering commonly known as a slip sheet or rub sheet may be used to reduce friction damage during placement.

D. The GCL panels shall be placed parallel to the direction of the slope.

E. All GCL panels shall lie flat on the underlying surface, with no wrinkles or folds, especially at the exposed edges of the panels.

F. Only as much GCL shall be deployed as can be covered at the end of the working day with soil, a geomembrane, or a temporary waterproof tarpaulin. The GCL shall not be left uncovered overnight. If the GCL is hydrated when no confining stress is present, the Installer shall remove and replace the hydrated material as directed by the Owner Representative.

3.05 ANCHORAGE

A. As directed by the project drawings and specifications, the end of the GCL roll shall be placed in an anchor trench at the top of the slope. The front edge of the trench shall be rounded so as to eliminate any sharp corners. Loose soil shall be removed from the floor of the trench. The GCL shall cover the entire trench floor, but shall not extend up the rear trench wall.

3.06 SEAMING

A. The GCL seams shall be constructed by overlapping their adjacent edges according to the manufacturer's recommendations. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris.

B. End-of-roll overlapped seams shall be constructed with a minimum overlap of 24 in. (600 mm). Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone. End-of-roll overlapped seams for all reinforced GCL seams require bentonite-enhanced seams as described below.

C. Bentonite-enhanced seams shall be constructed between the overlapping adjacent panels as follows. The underlying edge of the longitudinal overlap is exposed and then a continuous bead of granular sodium bentonite is applied along a zone defined by the edge of the underlying panel and the 6-inch (150 mm) line. The granular bentonite shall be applied at a minimum application rate of one quarter pound per lineal ft. (0.4 kg/m). A similar bead of granular sodium bentonite is applied at the end-of-roll overlap.

3.07 DETAIL WORK

A. There shall be no penetrations through the GCL.

B. Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are recommended to avoid damage to the geotextile components of the GCL during the cutting process.

3.08 DAMAGE REPAIR

A. If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it may be possible, if approved by the Owner's Representative, to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll and shall be cut to size such that a minimum overlap of 12 in. (300 mm) is achieved around all of the damaged area. Granular bentonite or bentonite mastic shall be applied around the damaged area prior to placement of the patch. It may be desirable to use an adhesive to affix the patch in place so that it is not displaced during cover placement. Patching shall be certified by the Installer's CQA Inspector and observed by the Owner's Representative.

PART 4. GRI-GCL3 SPECIFICATIONS

Geosynthetics Research Institute (GRI) GRI-GCL3, "Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs).", Dated -- May 16, 2005.

END OF SECTION 02376

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Original - May 16, 2005

GRI-GCL3*

Standard Specification for

"Test Methods, Required Properties, and Testing Frequencies of
Geosynthetic Clay Liners (GCLs)"

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

1.1 This specification covers the manufacturing quality control (MQC) of geosynthetic clay liners (GCLs), describing types of tests, the proper test methods, minimum and sometimes maximum values, and the minimum testing frequencies.

> Note 1: Geosynthetic Clay Liners (GCLs) are also called Clay Geosynthetics Barriers (GBR-Cs).

1.2 There are two general categories of GCLs covered in this specification: reinforced and nonreinforced. Within each category there are geotextile, polymer coated geotextiles, and geomembrane/geofilm related types.

1.3 This specification is intended to aid manufacturers, suppliers, purchasers and users of GCLs in establishing an acceptable level of effort for manufacturing quality control.

*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version.

1.4 This specification does not address manufacturing quality assurance (MQA), product acceptance testing, or conformance testing. These are independent activities taken by organizations other than the GCL manufacturer.

1.5 The values stated in SI (metric) units are to be regarded as the standard. The U.S. (English) units are calculated values using a "soft" conversion accuracy.

1.6 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards

- D 638 Test Method for Tensile Properties of Plastics
- D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D 882 Test Method for Tensile Properties of Thin Plastic Sheeting
- D 1141 Practice for Preparation of Substitute Ocean Water
- D 1505 Test Method for Density of Plastics by the Density-Gradient Method
- D 4354 Practice for Sampling of Geosynthetics for Testing
- D 4439 Terminology for Geosynthetics
- D 4632 Test Method for Grab Breaking Load and Elongation of Geotextiles
- D 4759 Practice for Determining the Specification Conformance of Geosynthetics
- D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
- D 5261 Test Method for Measuring Mass per Unit Area of Geotextiles
- D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
- D 5887 Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using Flexible Wall Permeameter
- D 5888 Practice for Storage and Handling of Geosynthetic Clay Liners
- D 5889 Practice for Quality Control of Geosynthetic Clay Liners
- D 5890 Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
- D 5891 Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
- D 5993 Test Method for Measuring the Mass Per Unit Area of Geosynthetic Clay Liners
- D 5994 Test Method for Measuring the Core Thickness of Textured Geomembrane
- D 6102 Guide for Installation of Geosynthetic Clay Liners
- D 6141 Guide for Screening the Clay Portion of a GCL for Chemical Compatibility to Liquids

D 6243 Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method
D 6495 Guide for Acceptance Testing Requirements for Geosynthetic Clay Liners
D 6496 Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
D 6766 Test Method for Evaluation of Hydraulic Properties of Geosynthetic Clay Liners Permeated with Potentially Incompatible Liquids
D 6768 Test Method for Tensile Strength of Geosynthetic Clay Liners

2.2 GRI Standards

GM13 Test Properties. Testing Frequency and Recommended Warrant for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
GM17 Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
GM18 Test Properties, Testing Frequency and Recommended Warrant for Flexible Polypropylene (fPP and fPP-R) Nonreinforced and Reinforced Geomembranes (Presently suspended as of May 3, 2004)

2.3 Government Document:

U.S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182. September 1993. 305 pgs.

3. Terminology

3.1 Definition

3.1.1 Geosynthetic Definitions:

3.1.1.1 geotextile. n a permeability geosynthetic comprised solely of textiles. (ASTM D 4439)
3.1.1.2 geomembrane, n—an essentially impermeable geosynthetic barrier composed of one or more synthetic sheets. (ASTM D 4439)
3.1.1.3 geofilm, n—a thin polymeric film which is essentially impermeable having a thickness no greater than 0.25 mm (10 mils).
3.1.1.4 geotextile-polymer, n -a geotextile which has been coated with, or impregnated by, a polymer such as polypropylene

3.1.1.5 geosynthetic clay liner, n—a manufactured hydraulic barrier consisting of clay bonded to a layer or layers of geosynthetic materials. (ASTM D 4439)

Note 1: Geotextile Related GCL is one in which two geotextiles are used respectively as cap and carrier to the bentonite. Cap and carrier designations in this standard refer to respective orientations during manufacturing. This may or may not be the as-placed orientation in the field. It can be internally reinforced by needle punching or stitching, or be nonreinforced.
Geotextile Polymer Coated GCL is one in which two geotextiles are used respectively as cap and carrier to the encased bentonite, however, one of the geotextiles has been polymer coated in a manner that the permeability and flux are decreased. Cap and carrier designations refer to the as manufactured product and not necessarily to the as-placed orientation. It can be internally reinforced by needle punching or stitching, or be nonreinforced.
Geomembrane/Geofilm Related GCL is one in which a geomembrane or geofilm is included in the cross section either above or below the cap geotextile. It can be internally reinforced needle punching or be nonreinforced. Also in the nonreinforced category is bentonite adhesively bonded to a geomembrane.

3.1.2 Material Definitions

3.1.2.1 bentonite—a distinct type of fine-grained clay soil typically containing not less than 80% montmorillionite clay, usually characterized by high swelling upon wetting.

3.1.2.2 Formulation, n - The mixture of a unique combination of ingredients identified by type, properties and quantity. For geosynthetic materials, a formulation refers to the exact percentages of resin, additives, carbon black and/or other additives. It does not necessarily refer to individual suppliers of each ingredient. The individual suppliers must meet the manufacturer's internal quality control specification.

3.1.3 Organizational Definitions:

3.1.3.1 installer, n—the party who installs, or facilitates installation of, any materials purchased from manufacturers or suppliers.

3.1.3.2 manufacturer, n—the group, corporation, partnership, or individual that manufactures a product.

3.1.3.3 purchaser, n—the person, company, or organization that purchases any materials or work to be performed.

3.1.3.4 supplier, n- the party who supplies material or services.

3.1.4 Quality Definitions:

3.1.4.1 Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications. ref. EPA/600/R-93/182

3.1.4.2 Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project. ref. EPA/600/R-93/182

3.1.4.3 Construction Quality Control (CQC) - A planned system of inspections that are used to directly monitor and control the quality of a construction project. Construction quality control is normally performed by the geosynthetics manufacturer or installer, or for natural soil materials by the earthwork contractor, and is necessary to achieve quality in the constructed or installed system. Construction quality control (CQC) refers to measures taken by the installer or contractor to determine compliance with the requirements for materials and workmanship as stated in the plans and specifications for the project. ref. EPA/600/R-93/182

3.1.4.4 Construction Quality Assurance (CQA) - A planned system of activities that provide assurance that the facility was constructed as specified in the design. Construction quality assurance includes inspections, verification, audits, and evaluations of materials and workmanship necessary to determine and document the quality of the constructed facility. Construction quality assurance (CQA) refers to measures taken by the CQA organization to assess if the installer or contractor is in compliance with the plans and specifications for a project. ref. EPA.600/R-93/182

4. Significance and Use

4.1 GCLs must be properly manufactured in a manner consistent with a minimum level of quality control as determined by in-house testing of the final product. This specification presents the types of tests, standard methods of the testing, required (usually minimum) test values, and minimum testing frequencies which should be embodied in the manufacturer's quality control documents. The quoted tests, test methods and test values in Table 1 must appear in the MQC plan and the MQC report.

4.2 It should be clearly recognized that manufacturers may perform additional tests or at greater frequency than required in this specification, or both. In this case, the manufacturer's quality control plan will then take precedence over this specification.

4.3 It should also be recognized that purchasers and installers of GCLs may require additional tests or at a great frequency than called for in this specification, or both. The organization(s) producing such project specific specification or quality assurance plan should recognize that such requirements are beyond the current state-of-the-practice. If such a request is made by purchasers or installers, they should clearly communicate the requirements to the manufacturer or supplier during the contract decisions in order that disputes do not arise at a subsequent time.

5. Procedure

5.1 The procedures embodied in this specification are contained in the respective test methods given in Table 1.

5.1.1 The minimum recommended quality control tests for the manufacture of GCLs are given in Table 1. Specific tests are performed on the bentonite, the geosynthetic component materials, and the finished GCL. Table 1(a) is in S.I. (Metric) units and Table 1(b) is in U.S. (English) units.

Note 2: The conversion from S.I. units into U.S. units is soft.

5.1.2 The individual properties in Table 1 are minimum values; except fluid loss, moisture content, and permeability (or flux). They are maximum values. The manner of taking specimens is described in the appropriate test method. When an average value is indicated, it is listed in the table as "min. ave.", or "max. ave.".

5.2 Bentonite (as received)
Two tests are required; swell index and fluid loss. The latter is a maximum value. These tests should be performed on the bentonite prior to fabrication into a GCL.

or on bentonite taken from the manufactured product if the bentonite is modified in any way during manufacturing, e.g., if an adhesive is added.

5.3 Geotextile (as received)

Mass per unit area is required on the as-manufactured cap and carrier fabrics, with different values depending on the fabric being nonwoven or woven.

> Note 3: These tests are to be performed on the geotextiles before manufacturing into the final GCL. Removal of the geotextiles from the manufactured product and subsequent testing will give erroneous values and is not an acceptable practice. The exception is polymer coated GCLs where the geotextile must be removed to determine its mass per unit area.

5.4 Geomembrane/Geofilm (as received)

The following tests are required; thickness, density, and tensile strength at break. All are minimum required values. Tensile strength at break is the lowest of machine direction and cross machine direction.

> Note 4: These tests are to be performed on the geomembrane or geofilm before manufacturing into the final GCL. Removal of the geomembrane or geofilm from the manufactured product and subsequent testing will give erroneous values and is not an accepted practice.

5.5 GCL (as manufactured)

Six tests are required on the as-manufactured GCL with one having an alternative, i.e., hydraulic conductivity or flux. All are minimum values, with the exception of moisture content and hydraulic conductivity or flux.

5.6 GCL (long-term)

The purpose of these long-term or endurance tests is to provide confidence in the continuing acceptable performance of the bentonite and geosynthetic components of the installed GCL.

5.6.1 The durability of the bentonite is evaluated using a permeant consisting of 0.1 M calcium chloride solution. See ASTM D 6141 which is a guide for this particular aspect of the specification. The GCL is to be hydrated with distilled dionized water prior to conducting the tests with the calcium chloride solution. In this regard, ASTM D6766 Scenario I and Method C is the procedure to be used. Furthermore, this test is conducted twice at two different normal pressures, i.e., 35 and 500 kPa. The maximum allowable values are listed in Table 1.

5.6.2 The geotextiles in their as-received condition are evaluated by incubation in a forced air oven per ASTM D5721 set at 60°C for 50 days. The minimum percent in tensile strength retained at break, as measured by ASTM D6768, is 65%. If individual yarns are used in reinforcing GCLs, they must also meet this same endurance criterion.

5.6.3 The geomembrane in its as-received condition is evaluated for durability via the appropriate GRI Specification. For high density polyethylene (HDPE), the specification is GRI GM13. For linear low density polyethylene (LLDPE), the specification is GRI GM17. For flexible polypropylene (fPP), the specification is GRI GM18.

5.6.4 The geofilm in its as-received condition is evaluated by incubation in a forced air oven per ASTM D5721 set at 60°C for 50 days. The minimum percent tensile strength retained at break for either MD or XMD, as measured by ASTM D882, is reported accordingly and must meet or exceed the specification value.

Note 5: It should be recognized that the above durability criterion for geofilms is not as stringent as the criteria for geomembranes stated in Section 5.6.3.

6. Workmanship and Appearance

6.1 Waterproof ink overlap lines should be printed on both edges of one of the surfaces (geotextile or geomembrane) of the manufactured GCL.

Note 6: The overlap lines are minimally 150 mm (6.0 in.) from the edges of the GCL. Other design-related situations may require greater overlap distances to be printed on the GCLs, e.g., when not backfilled in a timely manner.

6.2 Needle punched and stitch bonded GCLs shall be essentially free of broken needles and fragments of needles that would negatively effect the performance of the final product. There must be continuous needle detection and removal devices, e.g., metal detectors and magnets, used during manufacture of GCL products.

6.3 The manufactured GCL shall have good appearance qualities. It shall be free from such defects that would affect the specified properties and integrity of the product.

6.4 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents. ASTM D5888 and D5889 should be followed in this regard.

7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Table 1. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width, see ASTM D 4354.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Table 1.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave.". When the property is a maximum value, the designation is "max. ave.".

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marking

9.1 The GCL shall be rolled, clearly labeled, and onto a substantial core, encased in a waterproof wrapper. Packaging must be adequate for safe transportation to the point of delivery.

9.2 The label should include manufacturer, style, lot and/or roll number, weight, length and width.

10. Conformance and Certification

10.1 Conformance of the manufactured GCL to this specification, or agreed-upon variation thereof, shall be performed by the MQA organization or designated by the purchaser/owner. ASTM D 4759 can be used as a general guide, but individual test methods must be clearly stipulated and communicated to the parties involved.

10.2 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

Table 1(a) – Specification for Geosynthetic Clay Liners (GCLs)

Property	ASTM Test Method	Reinforced GCL			Non-Reinforced GCL			Testing Frequency
		GT-Related	GT Polymer Coated	GM-GF Related	GT-Related	GT Polymer Coated	GM-GF Related	
Clay (as received)								
swell index (ml/2g)	D5890	24	24	24	24	24	24	50 tonnes
fluid loss (ml)[1]	D5891	18	18	18	18	18	18	50 tonnes
Geotextiles (as received)								
cap fabric (nonwoven) - mass/unit area (g/m^2)[2]	D5261	200	200	200	70	100	n/a/70	20,000 m^2
cap fabric -(woven) - mass/unit area (g/m^2)	D5261	100	100	100	-	-	-	20,000 m^2
carrier fabric (nonwoven composite) - mass(g/m^2)[2]	D5261	240	240	240	90	100	n/a/90	20,000 m^2
carrier fabric (woven) - mass/unit area (g/m^2)	D5261	100	100	100	-	-	-	20,000 m^2
coating - mass/unit area (g/m^2)[3]	D5261	n/a	100	n/a	n/a	100	n/a	4,000 m^2
Geomembrane/Geofilm (as received)								
thickness[5] (mm)	D5199/D5994	n/a	n/a	0.40/0.50/0.10	n/a	n/a	0.40/0.75/0.10	20,000 m^2
density (g/cc)	D1505/D792	n/a	n/a	0.92	n/a	n/a	0.92	20,000 m^2
break tensile strength, MD&XMD (kN/m)	D6693	n/a	n/a	n/a	n/a	n/a	6.0	20,000 m^2
break tensile strength, MD (kN/m)	D882	n/a	n/a	2.5	n/a	n/a	2.5	20,000 m^2
GCL (as manufactured)								
mass of GCL (g/m^2)[6]	D5993	4000	4050	4100	4000	4050	4100	4,000 m^2
mass of bentonite (g/m^2)[6]	D5993	3700	3700	3700	3700	3700	3700	4,000 m^2
moisture content[1] (%)	D5993	(4)	(4)	(4)	(4)	(4)	(4)	4,000 m^2
tensile str., MD (kN/m)	D6768	4.0	4.0	4.0	4.0	4.0	4.0	20,000 m^2
peel strength (N/m)	D6496	360	360	360	n/a	n/a	n/a	4,000 m^2
permeability[1] (m/sec), "or"	D5887	5×10^{-11}	5×10^{-12}	5×10^{-12}	5×10^{-11}	5×10^{-12}	5×10^{-12}	25,000 m^2
flux[1] ($m^3/sec\text{-}m^2$),	D5887	1×10^{-8}	1×10^{-9}	1×10^{-9}	1×10^{-8}	1×10^{-9}	1×10^{-9}	25,000 m^2
GCL permeability[1][7] (m/sec) (max. at 35 kPa)	D6766	1×10^{-8}	1×10^{-9}	1×10^{-9}	1×10^{-8}	1×10^{-9}	1×10^{-9}	yearly
GCL permeability[1][7] (m/sec) (max. at 500 kPa)	D6766 mod.	5×10^{-10}	5×10^{-11}	5×10^{-11}	5×10^{-10}	5×10^{-11}	5×10^{-11}	yearly
Component Durability								
geotextile and reinforcing yarns[8] (% strength retained)	See § 5.6.2	65	65	n/a	65	65	n/a	yearly
geomembrane	See § 5.6.3	n/a	n/a	GM Spec[9]	n/a	n/a	GM Spec[9]	yearly
geofilm/polymer treated[8] (% strength retained)	See § 5.6.4	n/a	85	80	n/a	85	80	yearly

n/a = not applicable with respect to this property

(1) These values are maximum (all others are minimum)
(2) For both cap and carrier fabrics for nonwoven reinforced GCLs, one, or the other, must contain a scrim component of mass ≥ 100 g/m^2 for dimensional stability
(3) Calculated value obtained from difference of coated fabric to as-received fabric
(4) Value is both site-specific and product-specific and is currently being evaluated
(5) First value is for smooth geomembrane; second for textured geomembrane; third for geofilm
(6) Mass of the GCL and bentonite is measured after oven drying per the stated test method
(7) Value represents GCL permeability after permeation with a 0.1 M calcium chloride solution (11.1 g $CaCl_2$ in 1-liter water)
(8) Value represents the minimum percent strength retained from the as-manufactured value after oven aging at 60°C for 50 days
(9) Durability criteria should follow the appropriate specification for the geomembrane type used, i.e., GRI GM-13 for HDPE, GRI GM-17 for LLDPE or GRI GM-18 for fPP

Table 1(b) – Specification for Geosynthetic Clay Liners (GCLs)

Property	ASTM Test Method	Reinforced GCL			Non-Reinforced GCL			Testing Frequency
		GT-Related	GT Polymer Coated	GM-GF Related	GT-Related	GT Polymer Coated	GM-GF Related	
Clay (as received)								
swell index (ml/2g)	D5890	24	24	24	24	24	24	50 tonnes
fluid loss (ml)[1]	D5891	18	18	18	18	18	18	50 tonnes
Geotextiles (as received)								
cap fabric (nonwoven) - mass/unit area (oz/yd^2)[2]	D5261	5.8	5.8	5.8	2.1	2.9	n/a/2.1	25,000 yd^2
cap fabric (woven) - mass/unit area (oz/yd^2)	D5261	3.0	3.0	3.0	-	-	-	25,000 yd^2
carrier fabric (nonwoven composite) - mass/(oz/yd^2)[2]	D5261	5.9	5.9	5.9	2.7	2.9	n/a/2.7	25,000 yd^2
carrier fabric (woven) - mass/unit area (oz/yd^2)	D5261	3.0	3.0	3.0	-	-	-	25,000 yd^2
coating - mass/unit area (oz/yd^2)[3]	D5261	n/a	2.9	n/a	n/a	2.9	n/a	5,000 yd^2
Geomembrane/Geofilm (as received)								
thickness[5] (mils)	D5199/D5994	n/a	n/a	15/20/4	n/a	n/a	15/30/4	25,000 yd^2
density (g/cc)	D1505/D792	n/a	n/a	0.92	n/a	n/a	0.92	25,000 yd^2
break tensile strength, MD&XMD (lb/in.)	D6693	n/a	n/a	n/a	n/a	n/a	34	25,000 yd^2
break tensile strength, MD & XMD (lb/in.)	D882	n/a	n/a	14	n/a	n/a	14	25,000 yd^2
GCL (as manufactured)								
mass of GCL (lb/ft^2)[6]	D5993	0.82	0.83	0.84	0.82	0.83	0.84	5,000 yd^2
mass of bentonite (lb/ft^2)[6]	D5993	0.75	0.75	0.75	0.75	0.75	0.75	5,000 yd^2
moisture content[1] (%)	D5993	(4)	(4)	(4)	(4)	(4)	(4)	5,000 yd^2
tensile str., MD (lb/in.)	D6768	23	23	23	23	23	23	25,000 yd^2
peel strength (lb/in.)	D6496	2.1	2.1	2.1	n/a	n/a	n/a	5,000 yd^2
permeability[1] (cm/sec), "or"	D5887	5×10^{-9}	5×10^{-10}	n/a	5×10^{-9}	5×10^{-10}	n/a	30,000 yd^2
flux[1] (cm^3/sec-cm^2)	D5887	1×10^{-6}	1×10^{-7}	n/a	1×10^{-6}	1×10^{-7}	n/a	30,000 yd^2
GCL permeability[1][7] (cm/sec) (max. at 5 lb/in.^{2})	D6766	1×10^{-6}	1×10^{-7}	1×10^{-7}	1×10^{-6}	1×10^{-7}	1×10^{-7}	yearly
GCL permeability[1][7] (cm/sec) (max. at 70 lb/in.^{2})	D6766 mod.	5×10^{-8}	5×10^{-9}	5×10^{-9}	5×10^{-8}	5×10^{-9}	5×10^{-9}	yearly
Component Durability								
geotextile and reinforcing yarns[8] (% strength retained)	See § 5.6.2	65	65	n/a	65	65	n/a	yearly
geomembrane	See § 5.6.3	n/a	n/a	GM Spec[9]	n/a	n/a	GM Spec[9]	yearly
geofilm/polymer treated[8] (% strength retained)	See § 5.6.4	n/a	85	80	n/a	85	80	yearly

n/a = not applicable with respect to this property

(1) These values are maximum (all others are minimum)
(2) For both cap and carrier fabrics for nonwoven reinforced GCLs: one, or the other, must contain a scrim component of mass ≥ 2.9 oz/yd^2 for dimensional stability
(3) Calculated value obtained from difference of coated fabric to as-received fabric
(4) Value is both site-specific and product-specific and is currently being evaluated
(5) First value is for smooth geomembrane; second for textured geomembrane; third for geofilm
(6) Mass of the GCL and bentonite is measured after oven drying per the stated test method
(7) Value represents GCL permeability after permeation with a 0.1 M calcium chloride solution (11.1 g CaCl2 in 1-liter water)
(8) Value represents the minimum percent strength retained from the as-manufactured value after oven aging at 60°C for 50 days
(9) Durability criteria should follow the appropriate specification for the geomembrane used; i.e., GRI GM-13 for HDPE, GRI GM-17 for LLDPE or GRI GM-18 for fPP

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PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to construction of the HDPE (High Density Polyethylene) Piping for the Leachate Collection System, Process Water Recovery System, ~~***the Slurry Piping and Valves,***~~ and Recycle Pond Decant System at the Gypsum Management Facility and the Leachate Collection System for the CCB Landfill.

1.02 RELATED SECTIONS

None.

1.03 REFERENCES

The following references, or cited portions thereof, govern the work

A. American Society of Testing and Materials:

1. ASTM D 2683 (2004); Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
2. ASTM D 3261 (2003); Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
3. ASTM D 3350 (2005); Specification for Polyethylene Plastics Pipe and Fittings Materials.
4. ASTM F 412 (2001a); Terminology Relating to Plastic Piping System.
5. ASTM F 1055 (1998); Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.
6. ASTM F 1056 (2004); Specification for Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings.
7. ***ASTM F714-06a Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.***
8. ***ASTM F2164-02 Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure***

1.04 SUBMITTALS

A. Qualifications

Submit qualifications of the Welding Supervisor who will be responsible for construction quality control of the pipe joining process.

B. Material Certifications

Submit manufacturer certifications that the pipe provided complies with the requirements herein.

C. Product Data

1. Submit product data and operating instructions for pipe joining equipment.
2. Submit pipe manufacturer's recommended procedures for storing, handling, and installing pipe and fittings.

1.05 QUALIFICATIONS

A. The Contractor or Subcontractor performing the work under this section shall have in his employ a Welding Supervisor who has completed a minimum of 10,000 ft of pipe joining work using the type of equipment proposed for use in this work. The Welding Supervisor shall be on site at all times during pipe line installation, and shall provide direct supervision over other employees.

1.06 WARRANTY

A. The pipe and fittings shall be warranted, on a pro-rata basis, against manufacturer's defects for a period of five (5) years from the date of pipe installation. The installation shall be warranted against defects in workmanship for a period of one (1) year from the date of completion.

PART 2. PRODUCTS

2.01 MATERIALS

A. Leachate and Process Water Collection Piping

1. Pipe material shall be High Density Polyethylene (HDPE) PE 3408, according to ASTM F412, with minimum cell classification values of 345464C, according to ASTM D3350. Iron pipe size (IPS) and standard dimension ratio (SDR) shall be as indicated in the plans.

2. Size and spacing of holes in perforated pipe shall be as indicated in the plans.

~~B. *Slurry* Sluice Piping~~

~~Pipe for HDPE Sluice Lines shall be manufactured from a PE 3408 resin. The resin material shall meet the specifications of ASTM D3350-02 with a minimum cell~~

~~classification of PE345464C. Pipe O.D. sizes 4" to 54" shall be available in steel pipe sizes (IPS). Pipe shall have a manufacturing standard of ASTM D3035 and be manufactured by an ISO 9001 certified manufacturer. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. The pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, voids, or other injurious defects.~~

~~Pipe shall be manufactured from a pipe resin which meets ASTM D 3350-05 with a minimum cell classification of 445474C. Pipe shall be manufactured to the dimensions of ASTM F-714. The service factor to determine the pressure rating shall be 0.63. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.~~

C. Fittings ***(Leachate and Process Water Collection Piping)***

1. Fittings shall be made of the same material and size as the HDPE piping, and shall have a pressure rating no less than 160 psi.

2. Butt Fusion Fittings

   Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-99. Butt Fusion Fittings shall have a manufacturing standard of ASTM D3261. Molded & fabricated fittings shall have the same pressure rating as the pipe unless otherwise specified on the plans. Fabricated fittings are to be manufactured using a Data Logger. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the quality control records.

3. Electrofusion Fittings - Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-99. Electrofusion Fittings shall have a manufacturing standard of ASTM F-1055. Fittings shall have the same pressure rating as the pipe unless otherwise specified on the plans.

4. Flanged and Mechanical Joint Adapters - Flanged and Mechanical Joint Adapters shall be PE 3408 HDPE, Cell Classification of 345464C as determined by ASTM D-3350. Flanged and Mechanical Joint Adapters shall have a manufacturing standard of ASTM D-3261. Fittings shall have the same pressure rating as the pipe unless otherwise specified on the plans. Flanged and Mechanical Joint Adapters are to be used for Sluice Piping only.

~~D. Valves~~ ***~~and Valve Piping~~*** ~~for Sluice~~ ***~~Slurry~~*** ~~Piping~~

~~Valves used for Sluice Piping shall be ITT Fabri Valve XS150-ULV Urethane~~

~~Lined Knife Gate Valves. Valve Material: Yet to Be Determined~~

~~*Valves used for the Slurry Piping System shall be Clarkson KGF Knife Gate Valve with ductile iron housing high tear strength gum rubber sleeves, C276 gate rated at 300 psig, with manual handwheel actuation.*~~

~~*Fittings and piping at valve stations shall be SILVER STREAK model fiberglass reinforced plastic (FRP) as manufactured by Fiber Glass Systems. Flanges shall have ANSI B16.5 Class 150 bolt hole patterns. Flanged connections to valves shall have ANSI B16.5 Class 300 bolt hole patterns. ASTM A307, Grade B, hex head bolts shall be supplied. Washers shall be supplied on all nuts and bolts. Gaskets shall be 1/8" thick, 60-70 durometer full-face type suitable for the service shown on the drawings and as recommended in the manufacturer's standard installation procedures. Pipe shall be installed as specified and indicated on the drawings.*~~

~~*E. Fittings for HDPE Slurry Piping*~~

~~*1. Butt Fusion Fittings - Fittings Pipe shall be manufactured from a pipe resin which meets ASTM D 3350-05 with a minimum cell classification of 445474C. Pipe shall be manufactured to the dimensions of ASTM F-714. The service factor to determine the pressure rating shall be 0.63. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material*~~

~~*2. Molded Butt Fusion Fittings shall have a manufacturing standard of ASTM D-3261. Molded & fabricated fittings shall have the same pressure rating as the pipe unless otherwise specified on the plans. Fabricated fittings must have the same pressure rating as the pipe; a DR less than the pipe shall be used. Fabricated fittings are to be manufactured using a Data Logger to record temperature, fusion pressure, and a graphic representation of the fusion cycle shall be part of the Quality Control records.*~~

~~*3. Electrofusion Fittings - Fittings shall be made from resin or pipe meeting ASTM D 3350-05 with a minimum cell classification of 445474C.; Electrofusion Fittings shall meet the manufacturing standard of ASTM F-1055. Fittings shall have the same pressure rating as the pipe or higher unless otherwise specified on the plans.*~~

~~*4. Flanged and Mechanical Joint Adapters - Flanged and Mechanical Joint Adapters shall be made from materials containing resin that meets ASTM D 3350-05 with a minimum cell classification of 445474C.*~~

2.02 EQUIPMENT

A. Sections of polyethylene pipe should be joined into continuous lengths on the jobsite above ground. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements of 400 degrees Fahrenheit, alignment, and an interfacial fusion pressure of 75 PSI. The butt fusion joining will produce a joint weld strength equal to or greater than the tensile strength of the pipe itself. All field welds shall be made with fusion equipment equipped with a Data Logger. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the Quality Control records.

B. Sidewall fusions for connections to outlet piping shall be performed in accordance with HDPE pipe and fitting manufacturer's specifications. The heating irons used for sidewall fusion shall have an inside diameter equal to the outside diameter of the HDPE pipe being fused. The size of the heating iron shall be ¼ inch larger than the size of the outlet branch being fused.

C. Mechanical joining will be used where the butt fusion method can not be used. Mechanical joining will be accomplished by either using a HDPE flange adapter with a Ductile Iron back-up ring or HDPE Mechanical Joint adapter with a Ductile Iron back-up ring.

D. Socket fusion, hot gas fusion, threading, solvents, and epoxies will not be used to join HDPE pipe.

PART 3. EXECUTION

3.01 MATERIAL DELIVERY, STORAGE, AND HANDLING

A. HDPE pipe and fittings shall be packaged and shipped by appropriate means to prevent damage to the material and to facilitate off-loading. The Owner will provide an on-site storage site. Storage site requirements (size and preferred location) shall be submitted with the bid documents.

B. Storage and handling shall be according to manufacturer's recommendations.

3.02 BASE PREPARATION

HDPE Piping for leachate and process water collection shall be installed on a layer of coarse aggregate placed by the Contractor in accordance with the plans. The grade of the coarse aggregate base shall be verified before installing the piping.

3.03 TRENCH INSTALLATION

Excavation, Foundation, Bedding and Haunching for the underground installation of HDPE Sluice Piping shall be in accordance with Section 20-2.20 of the "Standard Specifications for Water and Sewer Main Construction in Illinois". The trench shall be backfilled with excavated material to the top of trench surface. Excavations in areas of Structural Fill shall be backfill with and compacted to the specifications of Section 02200-Earthwork for Structural Fill. All other areas shall be backfilled to 92% of the dry density, as determined by the Standard Proctor Test ASTM D698.

3.03 INSTALLATION

All pipe and fittings shall be installed according to the manufacturer's recommendations. Removal of weld beads is not required. Contractor shall place coarse aggregate along the pipe to provide lateral stability. Welds shall not be obscured until they have been approved by the Owner's Representative, the top of pipe shall not be covered until the Construction Quality Assurance (CQA) survey has been completed to verify conformance with specified tolerances.

3.04 INSPECTIONS

A. The Owner's Representative shall shall visually inspect pipe materials to verify that each pipe material is properly stamped (by the manufacturer) for ASTM acceptance before installation. Defective or damaged materials shall be removed from the site.

B. Each weld and connection shall be visually inspected by the Owner's Representative. Defective welds shall be repaired as directed by the Owner's Representative and according to manufacturer's recommendations. Welds and connections shall not be covered until they have been approved by the Owner's Representative.

3.05 TOLERANCES

A. HDPE piping shall be located within 0.5 ft. of plan location, and elevation shall be within 0.1 ft. of plan elevation with no adverse slopes.

~~***3.06 TESTING***~~

~~***A. All Slurry Piping shall be Hydrostatic Tested in accordance with ASTM F 2164, using a Design Pressure of 270 PSIG.***~~

END OF SECTION 02936

PART 1. GENERAL

1.01 DESCRIPTION

A. This section includes installing pipe culverts and end sections for pipe culverts.

B. Storm Drainage installation shall include incidental related work such as topsoil removal, trench excavation, backfill, compaction, tie-in of existing system, etc.,

1.02 RELATED SECTIONS

A. The following sections contain items which are related to the work in this section:

1. 02200 - Earthwork

1.03 REFERENCES

A. The following reference, or cited portions thereof, governs the work:

1. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007. Payment provisions shall not apply.

PART 2. PRODUCTS

2.01 PIPE CULVERTS

A. ***HDPE*** Pipe Culverts shall be installed in accordance with Article 542 of the Standard Specifications. All piping shall be Corrugated PE (Polyethylene) with a Smooth Interior, in accordance with AASHTO M 294, Type S.

2.02 METAL END SECTIONS

A. Metal End Sections shall be either aluminum or steel in accordance with Article 542.07(c) of the Standard Specifications.

2.03 REINFORCED CONCRETE CULVERT PIPE

A. Reinforced Concrete Culvert Pipe shall be furnished in accordance with Article 1042.06(a) of the Standard Specifications.

2.03 PRECAST REINFORCED CONCRETE FLARED END SECTIONS

A. Precast Reinforced Concrete Flared End Sections shall be furnished in accordance with Article 1042.07(a) of the Standard Specifications.

PART 3. EXECUTION

3.01 STORM DRAINAGE PIPING INSTALLATION

A. Construct pipe culverts in accordance with the Article 542 of the Standard Specifications. Bedding and Haunching shall be IDOT CA-6 Gradation. Trench excavations are to be backfilled with on-site clayey materials instead of sand. Compact backfill to 95 percent of the maximum dry density as determined by the Standard Proctor test – ASTM D-698.

3.02 ~~METAL~~ END SECTION INSTALLATION

A. End Treatments shall be installed according to Article 542.07 of the Standard Specifications.

END OF SECTION 02700

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PART 1. GENERAL

1.01 DESCRIPTION

A. This section includes manufacturing, furnishing, and installing High Density Polyethylene (HDPE) Geomembranes for the Gypsum Management Facility and the CCB Landfill.

B. The work includes furnishing all equipment and materials and providing all labor, supervision, administration and management necessary to perform the work as shown on the plans.

1.02 RELATED SECTIONS

A. The following sections contain items which are related to the work in this section:

1. 02373 – Geotextiles
2. 02376 – Geosynthetic Clay Liner

1.03 REFERENCES

A. The following references, or cited portions thereof, govern the work:

1. American Society for Testing and Materials (ASTM):

   a. D 638, Standard Test Method for Tensile Properties of Plastics.
   b. D 751, Standard Test Methods for Coated Fabrics.
   c. D 792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   d. D 1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
   e. D 1204, Standard Test Method for Linear Dimensional Changes of Non Rigid Thermoplastic Sheeting or Film at Elevated Temperature.
   f. D 1238, Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
   g. D 1505, Standard Test Method for Density of Plastics by Density-Gradient Technique.
   h. D 1603, Standard Test Method for Carbon Black in Olefin Plastics.
   i. D 3895, Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis.

j. D 4218, Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
k. D 4437, Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
l. D 4833, Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products.
m. D 5199, Standard Test Method for Measuring Nominal Thickness of Smooth Geomembranes.
n. D 5397, Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefins using Notched Constant Tensile Load Test.
o. D 5596, Standard Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
p. D 5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
q. D 5721, Practice for Air-Oven Aging of Polyolefin Geomembranes.
r. D 5820, Test Method for Air Testing.
s. D 5885, Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry.
t. D 5994, Standard Test Method for Measuring Nominal Thickness of Textured Geomembranes
u. D 6365, Standard Practice for the Nondestructive Testing of Geomembrane Seams using The Spark Test

2. Geosynthetic Research Institute (GRI):

a. GRI GM 6, Pressurized Air Channel Test for Dual Seamed Geomembranes
b. GRI GM 9, Cold Weather Seaming of Geomembranes
c. GRI GM 10, Specification for Stress Crack Resistance of HDPE Geomembrane Sheet
d. GRI GM 13, Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
e. GRI GM 14, Test Frequencies for Destructive SeamTesting

1.04 SUBMITTALS

A. Submit the following to the Engineer or Owner, for review and approval, within a reasonable time so as to expedite shipment or installation of the Geomembrane:

1. Documentation of manufacturer's qualifications as specified in subsection 1.05A of this Section.

2. Manufacturer's Quality Control program manual or descriptive documentation.

3. A material properties sheet, including at a minimum all properties specified in GRI GM 13, including test methods used.

4. Sample of the material.

5. Documentation of Installer's qualifications, as specified below and in subsection 1.05B of this Section.
   a. Submit a list of at least ten completed facilities. For each name and type of facility; its location; the date of installation; phone number of contact at the facility; type and thickness of geomembrane and; surface area of the installed geomembrane.
   b. Submit resumes or qualifications of the Installation Supervisor, Master Seamer and Technicians to be assigned to this project.
   c. Quality Control Program.

6. Example Material Warranty and Liner Installation Warranty complying with subsections 1.07 and 1.08 of this Section.

7. Resin Supplier's name, resin production plant identification, resin brand name and number, production date of the resin, resin Manufacturer's quality control certificates, and certification that the properties of the resin meet the requirements of these specifications.

B. Shop Drawings

1. Submit copies of shop drawings for engineer's approval within a reasonable time so as not to delay the start of geomembrane installation. Shop drawings shall show the proposed panel layout identifying seams and details. Seams should generally follow direction of the slope. Butt seams or roll-end seams should not occur on a slope unless approved by the Owner's Representative. Butt seams on a slope, if allowed, should be staggered.

2. Placement of geomembrane will not be allowed to proceed until Owner's Representative has received and approved the shop drawings.

C. Additional Submittals (In-Progress and at Completion)

1. Manufacturer's warranty (refer to subsection 1.08).
2. Geomembrane installation warranty (refer to subsection 1.09).
3. Daily written acceptance of subgrade surface (refer to subsection 3.01.C).
4. Low-temperature seaming procedures if applicable (refer to subsection 3.03.A)
5. Prequalification test seam samples (refer to subsection 3.05.A.6).
6. Field seam non-destructive test results (refer to subsection 3.05.B.1).
7. Field seam destructive test results (refer to subsection 3.05.C.6).
8. Daily field installation reports (refer to subsection 3.05.G).

9. Installation record drawing, as discussed in subsection 3.05.G).

1.05 QUALITY CONTOL

A. Manufacturer's Qualifications:

The manufacturer of geomembrane of the type specified or similar product shall have at least five years experience in the manufacture of such geomembrane. In addition, the geomembrane manufacturer shall have manufactured at least 10,000,000 sq. ft. of the specified type of geomembrane or similar product during the last five years.

B. Installer's Qualifications:

1 The Geomembrane Installer shall be the Manufacturer, approved Manufacturer's Installer or a contractor approved by the Owner's Representative to install the geomembrane.

2 The Geomembrane Installer shall have at least three years experience in the installation of the specified geomembrane or similar. The Geomembrane Installer shall have installed at least 10 projects involving a total of 5,000,000 sq. ft. of the specified type of geomembrane or similar during the last three years.

3 Installation shall be performed under the direction of a field Installation Supervisor who shall be responsible throughout the geomembrane installation, for geomembrane panel layout, seaming, patching, testing, repairs, and all other activities of the Geomembrane Installer. The Field Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 10 projects involving a total of 5,000,000 sq. ft. of geomembrane of the type specified or similar product.

4 Seaming shall be performed under the direction of a Master Seamer (who may also be the Field Installation Supervisor or Crew Foreman) who has seamed a minimum of 3,000,000 sq. ft. of geomembrane of the type specified or similar product, using the same type of seaming apparatus to be used in the current project. The Field Installation Supervisor and/or Master Seamer shall be present whenever seaming, patching, other welding operations, and testing is performed.

5 All seaming, patching, other welding operations, and testing shall be performed by qualified technicians employed by the Geomembrane Installer.

1.06 DELIVERY, STORAGE AND HANDLING

A. Each roll of geomembrane delivered to the site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, material thickness, roll number, roll dimensions and roll weight.

B. Geomembrane shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

C. Rolls shall be stored away from high traffic areas. Continuously and uniformly support rolls on a smooth, level prepared surface.

D. Rolls shall not be stacked more than three high.

1.07 PROJECT CONDITIONS

Geomembrane shall not be installed in the presence of standing water, while precipitation is occurring, during excessive winds, or when material temperatures are outside the limits specified in Section 3.03.

1.08 MATERIAL WARRANTY

As required by specification, or as required in GRI GM 13 (attachment A)

1.09 GEOMEMBRANE INSTALLATION WARRANTY

The Geomembrane Installer shall guarantee the geomembrane installation against defects in the installation and workmanship for 1 year commencing with the date of final acceptance.

1.10 GEOMEMBRANE PRE-CONSTRUCTION MEETING

A. Geomembrane Pre-Construction Meeting shall be held at the site prior to installation of the geomembrane. At a minimum, the meeting shall be attended by the Geomembrane Installer, Owner, Owner's representative (Engineer and/or CQA Firm), and the General Contractor.

B. Topics for this meeting shall include:

1. Responsibilities of each party.
2. Lines of authority and communication. Resolution of any project document ambiguity.
3. Methods for documenting, reporting and distributing documents and reports.
4. Procedures for packaging and storing archive samples.
5. Review of time schedule for all installation and testing.
6. Review of panel layout and numbering systems for panels and seams including details for marking on geomembrane.
7. Procedures and responsibilities for preparation and submission of as-built panel and seam drawings.
8. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade, geomembrane, or ambient moisture and temperature conditions for working during liner installation.
9. Subgrade conditions, dewatering responsibilities and subgrade maintenance plan.
10. Deployment techniques including allowable subgrade for the geomembrane.
11. Plan for controlling expansion/contraction and wrinkling of the

geomembrane.

12. Covering of the geomembrane and cover soil placement.
13. Measurement and payment schedules.
14. Health and safety.

C. The meeting shall be documented by the Owner's Representative and minutes shall be transmitted to all parties.

PART 2. PRODUCTS

2.01 SOURCE QUALITY CONTROL

Manufacturing Quality Control

A. The test methods and frequencies used by the manufacturer for quality control/quality assurance of the above geomembrane prior to delivery, shall be in accordance with GRI GM13, or modified as required for project specific conditions.

B. The manufacturer's geomembrane quality control certifications, including results of quality control testing of the products, as specified in subsection 2.01.C of this Section, must be supplied to the Owner's Representative. The certification shall be signed by a responsible party employed by the manufacturer, such as the QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers and corresponding shipping information.

C. The Manufacturer will provide Certification that the geomembrane and welding rod supplied for the project have the same base resin and material properties.

2.02 GEOMEMBRANE

A. The geomembrane shall consist of new, first quality products designed and manufactured specifically for the purpose of this work which shall have been satisfactorily demonstrated by prior testing to be suitable and durable for such purposes. The geomembrane rolls shall be seamless, high density polyethylene (HDPE- Density >0.94g/cm) containing no plasticizers, fillers or extenders and shall be free of holes, blisters or contaminants, and leak free verified by 100% in line spark or equivalent testing. The geomembrane shall be supplied as a continuous sheet with no factory seams in rolls. Smooth Geomembrane shall meet the property requirements shown in Table 1(a) of the GRI GM13 Specifications included at the end of this Section. Textured Geomembrane shall meet the property requirements shown in Table 2(a) of the GRI GM13 Specifications included at the end of this Section.

B. Material shall be reviewed for conformance to the project specifications by the Owner's Representative.

PART 3. EXECUTION

3.01 SUBGRADE PREPARATION

A. Geomembrane installed over geosynthetic clay liner (GCL) (Gypsum Stack and CCB Landfill).

The area of GCL to be covered with geomembrane shall be jointly inspected by the Geosynthetics Installer's CQA Representative daily with the Owner's Representative before commencing geomembrane installation for the day, and the condition of the GCL shall be continuously observed as geomembrane installation progresses. Rocks, stones, sticks, sharp objects and debris of any kind shall be removed from the surface of the GCL. The Owner's Representative shall be notified of any discontinuities, premature hydration, or otherwise defective GCL. Geomembrane shall not be placed over suspect areas until they have been repaired to the satisfaction of the Owner's Representative. The Geosynthetics Installer's CQA Representative shall submit a certificate of acceptance to the Owner's Representative daily, stating that the GCL surface was acceptable at the time of geomembrane installation.

B. Geomembrane installed over cushion dirt.(Gypsum Stack only) ***or Earth Fill Material (Recycle Pond only)***

The area of cushion dirt to be covered with geomembrane shall be prepared in accordance with the Section 02200 – Earthwork. The surface shall be smooth and free of ruts and holes, rocks, stones, sticks, sharp objects and debris of any kind.

C. The Geomembrane installer shall provide daily, a certificate of acceptance for the surface to be covered by the geomembrane in that day's operations. The surface shall be maintained in a manner, during geomembrane installation, to ensure subgrade suitability.

D. All subgrade damaged by construction equipment and deemed unsuitable by the Owner's Representative for geomembrane deployment shall be repaired prior to placement of the geomembrane. All repairs shall be reviewed by the Owner's Representative and approved by the Geomembrane Installer. This damage, repair, and the responsibilities of the contractor and Geomembrane Installer shall be defined in the preconstruction meeting.

3.02 GEOMEMBRANE PLACEMENT

A. No geomembrane shall be deployed until the applicable certifications and quality control certificates listed in subsection 1.04 of this Section are submitted to and approved by the Owner's Representative. Should geomembrane material be deployed prior to approval by the Owner's Representative it will be at the sole risk of the Geomembrane Installer and/or Contractor. If the material does not meet project specifications it shall be removed from the work area at no cost to the owner.

B. The geomembrane shall be installed to the limits shown on the project drawings and essentially as shown on approved panel layout drawings.

C. No geomembrane material shall be unrolled and deployed if the material temperatures are lower than 0 degrees C (32 degrees F). Temperature limitations should be defined in the preconstruction meeting. Typically, only the quantity of geomembrane that will be anchored and seamed together in one day should be deployed.

D. No vehicular traffic shall travel on the geomembrane other than an approved low ground pressure All Terrain Vehicle or equivalent.

E. Sand bags or equivalent ballast shall be used as necessary to temporarily hold the geomembrane material in position under the foreseeable and reasonably - expected wind conditions. Sand bag material shall be sufficiently close- knit to prevent soil fines from working through the bags and discharging on the geomembrane.

F. Geomembrane placement shall not be done if moisture prevents proper subgrade preparation, panel placement, or panel seaming. Moisture limitations will be defined in the preconstruction meeting.

G. Damaged panels or portions of the damaged panels which have been rejected shall be marked and their removal from the work area recorded.

H. The geomembrane shall not be allowed to "bridge over" voids or low areas in the subgrade. In these areas, the subgrade shall be prepared to allow the geomembrane to rest in intimate contact with the subgrade.

I. Wrinkles caused by panel placement or thermal expansion should be minimized in accordance with section 1.10 B11.

J. Considerations on Site Geometry: In general, seams shall be oriented parallel to the line of the maximum slope. In corners and odd shaped geometric locations, the total length of field seams shall be minimized. Seams shall not be located at low points in the subgrade.

K. Overlapping: The panels shall be overlapped prior to seaming to whatever extent is necessary to effect a good weld and allow for proper testing. In no case shall this overlap be less than 75mm (3 in.).

3.03 SEAMING PROCEDURES

A. No geomembrane material shall be seamed when liner temperatures are less than 0 degrees C (32 degrees F).

B. No geomembrane material shall be seamed when the sheet temperature is above 75 degrees C (170 degrees F) as measured by an infrared thermometer or surface thermocouple.

C. Seaming shall primarily be performed using automatic fusion welding equipment and techniques. Extrusion welding shall be used where fusion welding is not possible such as at pipe penetrations, patches, repairs and short (less than a roll width) runs of seams.

D. Fishmouths or excessive wrinkles at the seam overlaps, shall be minimized and when necessary cut along the ridge of the wrinkles back into the panel so as to effect a flat overlap. The cut shall be terminated with a keyhole cut (nominal 10 mm (1/2 in) diameter hole) so as to minimize crack/tear propagation. The overlay shall subsequently be seamed. The key hole cut shall be patched with an oval or round patch of the same base geomembrane material extending a minimum of 150 mm (6 in.) beyond the cut in all directions.

3.04 PIPE AND STRUCTURE PENETRATION SEALING SYSTEM

A. Provide penetration sealing system as shown in the Project Drawings.

B. Penetrations shall be constructed from the base geomembrane material, flat stock, prefabricated boots and accessories as shown on the Project Drawings. The pre-fabricated or field fabricated assembly shall be field welded to the geomembrane as shown on the Project Drawings so as to prevent leakage. This assembly shall be tested as outlined in section 3.05.B. Alternatively, where field non destructive testing can not be performed, attachments will be field spark tested by standard holiday leak detectors in accordance with ASTM 6365. Spark testing should be done in areas where both air pressure testing and vacuum testing are not possible.

1. Equipment for Spark testing shall be comprised of but not limited to: A hand held holiday spark tester and conductive wand that generates a high voltage.
2. The testing activities shall be performed by the Geomembrane Installer by placing an electrically conductive tape or wire beneath the seam prior to welding. A trial seam containing a non welded segment shall be subject to a calibration test to ensure that such a defect (non welded segment) will be identified under the planned machine settings and procedures. Upon completion of the weld, enable the spark tester and hold approximately 25mm (1 in) above the weld moving slowly over the entire length of the weld in accordance with ASTM 6365. If there is no spark the weld is considered to be leak free.
3. A spark indicates a hole in the seam. The faulty area shall be located, repaired and retested by the Geomembrane Installer.
4. Care should be taken if flammable gases are present in the area to be tested.

3.05 FIELD QUALITY CONTROL

The Owner's Representative shall be notified prior to all pre qualification and production welding and testing, or as agreed upon in the pre construction meeting.

A. Prequalification Test Seams

1. Test seams shall be prepared and tested by the Geomembrane Installer to verify that seaming parameters (speed, temperature and pressure of welding equipment) are adequate.
2. Test seams shall be made by each welding technician and tested in accordance with ASTM D 4437 at the beginning of each seaming period. Test seaming shall be performed under the same conditions and with the same equipment and operator combination as production seaming. The

test seam shall be approximately 3.3 meters (10 feet) long for fusion welding and 1 meter (3 feet) long for extrusion welding with the seam centered lengthwise. At a minimum, tests seams should be made by each technician 1 time every 4–6 hours; additional tests may be required with changes in environmental conditions.

3. Two 25 mm (1 in) wide specimens shall be die-cut by the Geomembrane Installer from each end of the test seam. These specimens shall be tested by the Geomembrane Installer using a field tensiometer testing both tracks for peel strength and also for shear strength. Each specimen shall fail in the parent material and not in the weld, "Film Tear Bond"(F.T.D. failure). Seam separation equal to or greater than 10% of the track width shall be considered a failing test.
4. The minimum acceptable seam strength values to be obtained for all specimens tested are listed in Subsection 3.05.C.4 of this Section. All four specimens shall pass for the test seam to be a passing seam.
5. If a test seam fails, an additional test seam shall be immediately conducted. If the additional test seam fails, the seaming apparatus shall be rejected and not used for production seaming until the deficiencies are corrected and a successful test seam can be produced.
6. A sample from each test seam shall be labeled. The label shall indicate the date, geomembrane temperature, number of the seaming unit, technician performing the test seam and pass or fail description. The sample shall then be given to the Owner's Representative for archiving.

B. Field Seam Non-destructive Testing

1. All field seams shall be non-destructively tested by the Geomembrane Installer over the full seam length before the seams are covered. Each seam shall be numbered or otherwise designated. The location, date, test unit, name of tester and outcome of all non-destructive testing shall be recorded and submitted to the Owner's Representative.
2. Testing should be done as the seaming work progresses, not at the completion of all field seaming. All defects found during testing shall be numbered and marked immediately after detection. All defects found should be repaired, retested and remarked to indicate acceptable completion of the repair.
3. Non-destructive testing shall be performed using vacuum box, air pressure or spark testing equipment.
4. Non-destructive tests shall be performed by experienced technicians familiar with the specified test methods. The Geomembrane Installer shall demonstrate to the Owner's Representative all test methods to verify the test procedures are valid.
5. Extrusion seams shall be vacuum box tested by the Geomembrane Installer in accordance with ASTM D 4437 and ASTM D 5641 with the following equipment and procedures:
   a. Equipment for testing extrusion seams shall be comprised of but not limited to: a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket

attached to the base, port hole or valve assembly and a vacuum gauge; a vacuum pump assembly equipped with a pressure controller and pipe connections; a rubber pressure/vacuum hose with fittings and connections; a plastic bucket; wide paint brush or mop; and a soapy solution.

b. The vacuum pump shall be charged and the tank pressure adjusted to approximately 35 kPa (5 psig).

c. The Geomembrane Installer shall create a leak tight seal between the gasket and geomembrane interface by wetting a strip of geomembrane approximately 0.3m (12 in) by 1.2m (48 in) (length and width of box) with a soapy solution, placing the box over the wetted area, and then compressing the box against the geomembrane. The Geomembrane Installer shall then close the bleed valve, open the vacuum valve, maintain initial pressure of approximately 35 kPa (5 psig) for approximately 5 seconds. The geomembrane should be continuously examined through the viewing window for the presence of soap bubbles, indicating a leak. If no bubbles appear after 5 seconds, the area shall be considered leak free. The box shall be depressurized and moved over the next adjoining area with an appropriate overlap and the process repeated.

d. All areas where soap bubbles appear shall be marked, repaired and then retested.

e. At locations where seams cannot be non destructively tested, such as pipe penetrations, alternate nondestructive spark testing (as outlined in section 3.04.B) or equivalent should be substituted.

f. All seams that are vacuum tested shall be marked with the date tested, the name of the technician performing the test and the results of the test.

6. Double Fusion seams with an enclosed channel shall be air pressure tested by the Geomembrane Installer in accordance with ASTM D 5820 and ASTM D 4437 and the following equipment and procedures:

a. Equipment for testing double fusion seams shall be comprised of but not limited to: an air pump equipped with a pressure gauge capable of generating and sustaining a pressure of 210 kPa (30 psig), mounted on a cushion to protect the geomembrane; and a manometer equipped with a sharp hollow needle or other approved pressure feed device.

b. The Testing activities shall be performed by the Geomembrane Installer. Both ends of the seam to be tested shall be sealed and a needle or other approved pressure feed device inserted into the tunnel created by the double wedge fusion weld. The air pump shall be adjusted to a pressure of 210 kPa (30 psig), and the valve closed,. Allow 2 minutes for the injected air to come to equilibrium in the channel, and sustain pressure for 5 minutes. If pressure loss does not exceed 28 kPa (4 psig) after this five minute period the seam shall be considered leak tight. Release pressure from the opposite end verifying pressure drop on needle to ensure testing of the entire seam. The needle or other approved pressure feed device shall be removed and the feed hole sealed.

c. If loss of pressure exceeds 28 kPa (4 psig) during the testing period or pressure does not stabilize, the faulty area shall be located, repaired and retested by the Geomembrane Installer.

d. Results of the pressure testing shall be recorded on the liner at the seam tested and on a pressure testing record.

C. Destructive Field Seam Testing

1. One destructive test sample per 150 linear m (500 linear ft) seam length or another predetermined length in accordance with GRI GM 14 shall be taken by the Geomembrane Installer from a location specified by the Owner's Representative. The Geomembrane Installer shall not be informed in advance of the sample location. In order to obtain test results prior to completion of geomembrane installation, samples shall be cut by the Geomembrane Installer as directed by the Owner's Representative as seaming progresses.
2. All field samples shall be marked with their sample number and seam number. The sample number, date, time, location, and seam number shall be recorded. The Geomembrane Installer shall repair all holes in the geomembrane resulting from obtaining the seam samples. All patches shall be vacuum box tested or spark tested. If a patch cannot be permanently installed over the test location the same day of sample collection, a temporary patch shall be tack welded or hot air welded over the opening until a permanent patch can be affixed.
3. The destructive sample size shall be 300 mm (12 in) wide by 1 m (36 in) long with the seam centered lengthwise. The sample shall be cut into three equal sections and distributed as follows: one section given to the Owner's Representative as an archive sample; one section given to the Owner's Representative for laboratory testing as specified in paragraph 5 below; and one section retained by the Geomembrane Installer for field testing as specified in paragraph 4 below.
4. For field testing, the Geomembrane Installer shall cut 10 identical 25 mm (1 in) wide replicate specimens from his sample. The Geomembrane Installer shall test five specimens for seam shear strength and five for peel strength. Peel tests will be performed on both inside and outside weld tracks. To be acceptable, 4 of 5 test specimens must pass the stated criteria in section 2.02 with less than 10% separation. If 4 of 5 specimens pass, the sample qualifies for testing by the testing laboratory if required.
5. If independent seam testing is required by the specifications it shall be conducted in accordance with ASTM 5820 or ASTM D4437 or GRI GM 6.
6. Reports of the results of examinations and testing shall be prepared and submitted to the Owner's Representative.
7. For field seams, if a laboratory test fails, that shall be considered as an indicator of the possible inadequacy of the entire seamed length corresponding to the test sample. Additional destructive test portions shall

then be taken by the Geomembrane Installer at locations indicated by the Engineer, typically 3 m (10 ft) on either side of the failed sample and laboratory seem tests shall be performed. Passing tests shall be an indicator of adequate seams. Failing tests shall be an indicator of non-adequate seams and all seams represented by the destructive test location shall be repaired with a cap-strip extrusion welded to all sides of the capped area. All cap-strip seams shall be non-destructively vacuum box tested until adequacy of the seams is achieved. Cap strip seams exceeding 50 M in length (150 FT) shall be destructively tested.

D. Identification of Defects

1. Panels and seams shall be inspected by the Installer and Owner's Representative during and after panel deployment to identify all defects, including holes, blisters, undispersed raw materials and signs of contamination by foreign matter.

E. Evaluation of Defects: Each suspect location on the liner (both in geomembrane seam and non-seam areas) shall be non-destructively tested using one of the methods described in Section 3.05.B. Each location which fails non-destructive testing shall be marked, numbered, measured and posted on the daily "installation" drawings and subsequently repaired.

1. If a destructive sample fails the field or laboratory test, the Geomembrane Installer shall repair the seam between the two nearest passed locations on both sides of the failed destructive sample location.
2. Defective seams, tears or holes shall be repaired by reseaming or applying a extrusion welded cap strip.
3. Reseaming may consist of either:
    a. Removing the defective weld area and rewelding the parent material using the original welding equipment; or
    b. Reseaming by extrusion welding along the overlap at the outside seam edge left by the fusion welding process.
4. Blisters, larger holes, and contamination by foreign matter shall be repaired by patches and/or extrusion weld beads as required. Each patch shall extend a minimum of 150 mm (6 in) beyond all edges of the defects.
5. All repairs shall be measured, located and recorded.

F. Verification of Repairs on Seams: Each repair shall be non-destructively tested using either vacuum box or spark testing methods. Tests which pass the non-destructive test shall be taken as an indication of a successful repair. Failed tests shall be reseamed and retested until a passing test results. The number, date, location, technician and test outcome of each patch shall be recorded.

G. Daily Field Installation Reports: At the beginning of each day's work, the Installer shall provide the Engineer with daily reports for all work accomplished on the previous work day. Reports shall include the following:

1. Total amount and location of geomembrane placed;

2. Total length and location of seams completed, name of technicians doing seaming and welding unit numbers;
3. Drawings of the previous day's installed geomembrane showing panel numbers, seam numbers and locations of non-destructive and destructive testing;
4. Results of pre-qualification test seams;
5. Results of non-destructive testing; and
6. Results of vacuum testing of repairs.

H. Destructive test results shall be reported prior to covering of liner or within 48 hours.

3.06 LINER ACCEPTANCE

A. Geomembrane liner will be accepted by the Owner's Representative when:

1. The entire installation is finished or an agreed upon subsection of the installation is finished;
2. All Installer's QC documentation is completed and submitted to the owner
3. Verification of the adequacy of all field seams and repairs and associated geomembrane testing is complete.

3.07 ANCHOR TRENCH

A. Construct as specified on the project drawings.

3.08 DISPOSAL OF SCRAP MATERIALS

A. On completion of installation, the Geomembrane Installer shall dispose of all trash and scrap material in a location designated by the Owner's Representative, remove equipment used in connection with the work herein, and shall leave the premises in a neat acceptable manner. Scrap sections larger than 5 feet on each edge shall be segregated from smaller scraps and retained by the Owner. No scrap material shall be allowed to remain on the geomembrane surface.

PART 4. GRI GM13 SPECIFICATIONS

Geosynthetics Research Institute (GRI) Test Method GM13 – "Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes", Revision 8, Dated July 10, 2006.

ATTACHMENT A:

Minimum Average Weld Properties for Smooth and Textured HDPE Geomembranes (English units)								
Property	**Test Method**	**30 mil**	**40 mil**	**50 mil**	**60 mil**	**80 mil**	**100 mil**	**120 mil**
Peel strength (fusion & extrusion) lb/in.	ASTM 4437	39	52	65	78	104	130	156
Shear strength (fusion & extrusion) lb/in.	ASTM 4437	60	80	100	120	160	200	239

END OF SECTION 02800

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Revision 8: July 10, 2006
Revision schedule on pg. 11

GRI Test Method GM13*

Standard Specification for

"Test Methods, Test Properties and Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

1. Scope

1.1 This specification covers high density polyethylene (HDPE) geomembranes with a formulated sheet density of 0.940 g/ml, or higher, in the thickness range of 0.75 mm (30 mils) to 3.0 mm (120 mils). Both smooth and textured geomembrane surfaces are included.

1.2 This specification sets forth a set of minimum, physical, mechanical and chemical properties that must be met, or exceeded by the geomembrane being manufactured. In a few cases a range is specified.

1.3 In the context of quality systems and management, this specification represents manufacturing quality control (MQC).

Note 1: Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in this specification.

1.4 This standard specification is intended to ensure good quality and performance of HDPE geomembranes in general applications, but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive

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*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version.

values for test indicated, may be necessary under conditions of a particular application.

Note 2: For information on installation techniques, users of this standard are referred to the geosynthetics literature, which is abundant on the subject.

2. Referenced Documents

2.1 ASTM Standards

- D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement
- D 1004 Test Method for Initial Tear Resistance of Plastics Film and Sheeting
- D 1238 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 Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis
- D 4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
- D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
- D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
- D 5397 Procedure to Perform a Single Point Notched Constant Tensile Load – (SP-NCTL) Test: Appendix
- D 5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
- D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
- D 5885 Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
- D 5994 Test Method for Measuring the Core Thickness of Textured Geomembranes
- D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

2.2 GRI Standards

- GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet
- GM 11 Accelerated Weathering of Geomembranes using a Fluorescent UVA-Condensation Exposure Device
- GM 12 Measurement of the Asperity Height of Textured Geomembranes Using a Depth Gage

2.3 U. S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities." EPA/600/R-93/182, September 1993, 305 pgs.

3. Definitions

Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications.
ref. EPA/600/R-93/182

Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project.
ref. EPA/600/R-93/182

Formulation, n - The mixture of a unique combination of ingredients identified by type, properties and quantity. For HDPE polyethylene geomembranes, a formulation is defined as the exact percentages and types of resin(s), additives and carbon black.

4. Material Classification and Formulation

4.1 This specification covers high density polyethylene geomembranes with a formulated sheet density of 0.940 g/ml, or higher. Density can be measured by ASTM D1505 or ASTM D792. If the latter, Method B is recommended.

4.2 The polyethylene resin from which the geomembrane is made will generally be in the density range of 0.932 g/ml or higher, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min.

4.3 The resin shall be virgin material with no more than 10% rework. If rework is used, it must be a similar HDPE as the parent material.

4.4 No post consumer resin (PCR) of any type shall be added to the formulation.

5. Physical, Mechanical and Chemical Property Requirements

5.1 The geomembrane shall conform to the test property requirements prescribed in Tables 1 and 2. Table 1 is for smooth HDPE geomembranes and Table 2 is for single and double sided textured HDPE geomembranes. Each of the tables are given in English and SI (metric) units. The conversion from English to SI (metric) is soft.

Note 3: The tensile strength properties in this specification were originally based on ASTM D 638 which uses a laboratory testing temperature of 23°C ± 2°C. Since ASTM Committee D35 on Geosynthetics adopted ASTM D 6693 (in place of D 638), this GRI Specification followed accordingly. The difference is that D 6693 uses a testing temperature of 21°C ± 2°C. The numeric values of strength and elongation were not changed in this specification. If a dispute arises in this regard, the original temperature of 23°C ± 2°C should be utilized for testing purposes.

Note 4: There are several tests often included in other HDPE specifications which are omitted from this standard because they are outdated, irrelevant or generate information that is not necessary to evaluate on a routine MQC basis. The following tests have been purposely omitted:

- Volatile Loss
- Dimensional Stability
- Coeff. of Linear Expansion
- Resistance to Soil Burial
- Low Temperature Impact
- ESCR Test (D 1693)
- Wide Width Tensile
- Water Vapor Transmission
- Water Absorption
- Ozone Resistance
- Modulus of Elasticity
- Hydrostatic Resistance
- Tensile Impact
- Field Seam Strength
- Multi-Axial Burst
- Various Toxicity Tests

Note 5: There are several tests which are included in this standard (that are not customarily required in other HDPE specifications) because they are relevant and important in the context of current manufacturing processes. The following tests have been purposely added:

- Oxidative Induction Time
- Oven Aging
- Ultraviolet Resistance
- Asperity Height of Textured Sheet (see Note 6)

Note 6: The minimum average value of asperity height does not represent an expected value of interface shear strength. Shear strength associated with geomembranes is both site-specific and product-specific and should be determined by direct shear testing using ASTM D5321/ASTM D6243 as prescribed. This testing should be included in the particular site's CQA conformance testing protocol for the geosynthetic materials involved, or formally waived by the Design Engineer, with concurrence from the Owner prior to the deployment of the geosynthetic materials.

Note 7: There are other tests in this standard, focused on a particular property, which are updated to current standards. The following are in this category:

- Thickness of Textured Sheet
- Puncture Resistance
- Stress Crack Resistance
- Carbon Black Dispersion (In the viewing and subsequent quantitative interpretation of ASTM D 5596 only near spherical agglomerates shall be included in the assessment).

Note 8: There are several GRI tests currently included in this standard. Since these topics are not covered in ASTM standards, this is necessary. They are the following:

- UV Fluorescent Light Exposure
- Asperity Height Measurement

5.2 The values listed in the tables of this specification are to be interpreted according to the designated test method. In this respect they are neither minimum average roll values (MARV) nor maximum average roll values (MaxARV).

5.3 The properties of the HDPE geomembrane shall be tested at the minimum frequencies shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent and is certified accordingly, it must be followed in like manner.

Note 9: This specification is focused on manufacturing quality control (MQC). Conformance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality assurance engineer, respectively.

6. Workmanship and Appearance

6.1 Smooth geomembrane shall have good appearance qualities. It shall be free from such defects that would affect the specified properties of the geomembrane.

6.2 Textured geomembrane shall generally have uniform texturing appearance. It shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.

6.3 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Tables 1 and 2. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Tables 1 and 2.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave."

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marketing

9.1 The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

10. Certification

10.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

ENGLISH UNITS

Table 1(a) – High Density Polyethylene (HDPE) Geomembrane -Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. ave.)	D5199	nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Per roll
• lowest individual of 10 values		-10%	-10%	-10%	-10%	-10%	-10%	-10%	
Density mg/l (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties *(1)* (min. ave.) • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	63 lb/in. 114 lb/in. 12% 700%	84 lb/in. 152 lb/in. 12% 700%	105 lb/in. 190 lb/in. 12% 700%	126 lb/in. 228 lb/in. 12% 700%	168 lb/in. 304 lb/in. 12% 700%	210 lb/in. 380 lb/in 12% 700%	252 lb/in. 456 lb/in. 12% 700%	20,000 lb
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	54 lb	72 lb	90 lb	108 lb	144 lb	180 lb	216 lb	45,000 lb
Stress Crack Resistance *(2)*	D5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI-GM10
Carbon Black Content (range)	D 1603 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	20,000 lb
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(5)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	200,000 lb
Oven Aging at 85°C *(5), (6)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(7)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	GM 11 D 3895 D 5885	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	per each formulation

(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 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC) UNITS

Table 1(b) – High Density Polyethylene (HPDE) Geomembrane - Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness - mils (min. ave.) • lowest individual of 10 values	D5199	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	per roll
Density (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties *(1)* (min. ave.) • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	11 kN/m 20kN/m 12% 700%	15 kN/m 27 kN/m 12% 700%	18 kN/m 33 kN/m 12% 700%	22 kN/m 40 kN/m 12% 700%	29 kN/m 53 kN/m 12% 700%	37 kN/m 67 kN/m 12% 700%	44 kN/m 80 kN/m 12% 700%	9,000 kg
Tear Resistance (min. ave.)	D 1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	240 N	320 N	400 N	480 N	640 N	800 N	960 N	20,000 kg
Stress Crack Resistance *(2)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM-10
Carbon Black Content - %	D 1603 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	9,000 kg
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(5)* (a) Standard OIT — or — (b) High Pressure OIT	D 3895 D 5885	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	90,000 kg
Oven Aging at 85°C *(5)*, *(6)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	per each formulation
UV Resistance *(7)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 3895 D 5885	N. R. *(8)* 50%	N.R. *(8)* 50%	N.R. *(8)* 50%	N.R. *(8)* 50%	N.R. *(8)* 50%	N.R. *(8)* 50%	N.R. *(8)* 50%	per each formulation

(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 33 mm
Break elongation is calculated using a gage length of 50 mm
(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
(3) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.
(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3
(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

ENGLISH UNITS

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	GM 12	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	every 2nd roll *(2)*
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties (min. ave.) *(3)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	63 lb/in 45 lb/in 12% 100%	84 lb/in 60 lb/in 12% 100%	105 lb/in 75 lb/in 12% 100%	126 lb/in 90 lb/in 12% 100%	168 lb/in 120 lb/in 12% 100%	210 lb/in 150 lb/in 12% 100%	252 lb/in 180 lb/in 12% 100%	20,000 lb
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	45 lb	60 lb	75 lb	90 lb	120 lb	150 lb	180 lb	45,000 lb
Stress Crack Resistance *(4)*	D 5397 (App.)	300 hr	300 hr	300 hr	300 hr	300 hr	300 hr	300 hr	per GRI GM10
Carbon Black Content (range)	D 1603 *(5)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	20,000 lb
Carbon Black Dispersion	D 5596	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(7)* (a) Standard OIT or (b) High Pressure OIT	D 3895 D 5885	100 min. 400 min.	100 min 400 min	100 min 400 min	100 min 400 min	100 min 400 min	100 min 400 min	100 min 400 min	200,000 lb
Oven Aging at 85°C *(7)*, *(8)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	per each formulation
UV Resistance *(9)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(11)*	GM11 D 3895 D 5885	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	per each formulation

(1) Of 10 readings, 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils; also see Note 6.

(2) Alternate the measurement side for double sided textured sheet

(3) 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

(4) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.

The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing

(5) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established

(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:

9 in Categories 1 or 2 and 1 in Category 3

(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane

(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response

(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C

(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples

(11) UV resistance is based on percent retained value regardless of the original HP-OIT value

Table 2(b) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	GM 12	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	every 2nd roll *(2)*
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties (min. ave.) *(3)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	11 kN/m 8 kN/m 12% 100%	15 kN/m 10 kN/m 12% 100%	18 kN/m 13 kN/m 12% 100%	22 kN/m 16 kN/m 12% 100%	29 kN/m 21 kN/m 12% 100%	37 kN/m 26 kN/m 12% 100%	44 kN/m 32 kN/m 12% 100%	9,000 kg
Tear Resistance (min. ave.)	D 1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	200N	267 N	333 N	400 N	534 N	667 N	800 N	20,000 kg
Stress Crack Resistance *(4)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM10
Carbon Black Content (range)	D 1603 *(5)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	9,000 kg
Carbon Black Dispersion	D 5596	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(7)* (a) Standard OIT — or — (b) High Pressure OIT	D 3895 D 5885	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	90,000 kg
Oven Aging at 85°C *(7), (8)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	per each formulation
UV Resistance *(9)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(11)*	GM11 D 3895 D 5885	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	per each formulation

(1) Of 10 readings, 8 out of 10 must be ≥ 0.18 mm, and lowest individual reading must be ≥ 0.13 mm; also see Note 6.
(2) Alternate the measurement side for double sided textured sheet
(3) 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 33 mm
Break elongation is calculated using a gage length of 50 mm
(4) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
(5) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.
(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3
(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
(11) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Adoption and Revision Schedule

for

HDPE Specification per GRI-GM13

"Test Methods, Test Properties, Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

Adopted:	June 17, 1997
Revision 1:	November 20, 1998; changed CB dispersion from allowing 2 views to be in Category 3 to requiring all 10 views to be in Category 1 or 2. Also reduced UV percent retained from 60% to 50%.
Revision 2:	April 29, 1999: added to Note 5 after the listing of Carbon Black Dispersion the following: "(In the viewing and subsequent quantitative interpretation of ASTM D5596 only near spherical agglomerates shall be included in the assessment)" and to Note (4) in the property tables.
Revision 3:	June 28, 2000: added a new Section 5.2 that the numeric table values are neither MARV or MaxARV. They are to be interpreted per the the designated test method.
Revision 4:	December 13, 2000: added one Category 3 is allowed for carbon black dispersion. Also, unified terminology to "strength" and "elongation".
Revision 5:	May 15, 2003: Increased minimum acceptable stress crack resistance time from 200 hrs to 300 hrs.
Revision 6:	June 23, 2003: Adopted ASTM D 6693, in place of ASTM D 638, for tensile strength testing. Also, added Note 2.
Revision 7:	February 20, 2006: Added Note 6 on Asperity Height clarification with respect to shear strength.
Revision 8:	Removed recommended warranty from specification.

PART 1. GENERAL

1.01 DESCRIPTION

This section pertains to seeding and placing mulch or erosion control blanket over seeded areas.

1.02 RELATED SECTIONS

A. Specified elsewhere:

1. 02200 - Earthwork

1.03 REFERENCES

The following reference or cited portions thereof, current at date of bidding documents unless otherwise specified, governs the work.

A. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, adopted January 1, 2007.

1.04 SPECIFICATIONS

A. Work shall conform to the applicable requirements of Sections 250 and 251 of Standard Specifications for Road and Bridge Construction and to the requirements hereinafter specified.

B. Exceptions: All references in the IDOT specifications to methods of measurement and payment shall not apply.

1.05 WARRANTY

A. Warranty for one (1) year plus one growing season from date of substantial completion shall be provided.

PART 2. PRODUCTS

2.01 MATERIALS

A. Seed: Seed shall conform to Article 1081.04 of the IDOT Standard Specifications where IDOT seed mixtures are specified. In areas where Ameren Energy

Generating hay seeding mix is specified, it shall be composed as follows:

Seed Type	Pounds/Acre
Vernal Alfalfa	12
Wrangler Alfalfa	8
Medium Red Clover	6
Timothy	4

B. Mulch Material and Erosion Control Blanket: Mulch material shall conform to Article 1081.06 and the excelsior blanket/knitted straw mat shall conform to Article 1081.10 of the IDOT Standard Specifications.

C. Fertilizer and agricultural ground limestone will not be permitted.

PART 3. EXECUTION

3.01 CONSTRUCTION

A. Seed bed preparation and seeding methods shall conform to Section 250 of the IDOT Specifications. Seeding of areas disturbed by construction activities after September 30, 2008 may be deferred until Spring 2009 at no additional cost to the Owner.

B. Seed shall be applied to the perimeter berm ditch, to disturbed portions of the perimeter berm, and to all disturbed earth surfaces outside of the existing perimeter berm. IDOT seeding mixture 7 shall be used on stockpiles. IDOT seeding mixture 1A shall be used on the gypsum stack perimeter earthen berm, the recycle pond dam embankment and on slopes that are 4H:1V or steeper. The Ameren hay seed mix shall be used on slopes flatter than 4H:1V.

C. Application rates for IDOT seed mixtures shall be as specified in Section 250 of the IDOT Specifications. The application rate for the Ameren Energy Resources Generating's seed mix shall be as specified in the Ameren Energy Resources Generating's hay seeding mix.

D. Seeded areas shall be mulched in accordance with Article 251.03. The Contractor may use either Method 2 or Method 3.

3.02 MAINTENANCE OF COMPLETED WORK

A. All areas seeded by the Contractor shall be maintained by the Contractor during the period between completion of such work and final completion and acceptance of the Contractor's work by the Owner. This maintenance shall be such that the completed work, at time of acceptance, complies in all respects with the requirements herein specified.

B. The areas seeded will be required to germinate. If the seed does not germinate, the Contractor will be required to regrade and reseed at no additional cost to the Owner.

END OF SECTION 02936

PART 1. GENERAL

1.01 WORK INCLUDES

A. The complete installation of the formwork for cast-in-place concrete, with shoring, bracing and anchorage, openings for other work, form accessories, form stripping.

1.02 RELATED SECTIONS

A. Section 03200 - Concrete Reinforcement.

B. Section 03300 - Cast-In-Place Concrete.

C. Section 03400 – Concrete Embedment Liner.

1.03 REFERENCES

A. ACI 347 - Recommended Practice For Concrete Formwork.

B. ACI 301 - Specifications For Structural Concrete For Buildings.

1.04 DESIGN REQUIREMENTS

A. Design, engineer and construct formwork, shoring and bracing to conform to design and code requirements; resultant concrete to conform to required shape, line and dimension.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 347 and 301.

1.06 REGULATORY REQUIREMENTS

A. Conform to applicable code for design, fabrication, erection and removal of formwork.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store off ground in ventilated and protected manner to prevent deterioration from moisture.

1.08 COORDINATION

A. Coordinate this Section with other Sections of work which require attachment of components of formwork.

B. If formwork is placed which results in insufficient concrete cover over reinforcement, request instructions from Owner's Representative before proceeding.

PART 2. PRODUCTS

2.01 WOOD FORM MATERIALS

A. Softwood Plywood: 3/4 in. PS 1-83 "B-B" (concrete form) plywood, Class I, exterior grade or better, mill-oiled and edge sealed with each piece bearing legible inspection trademark.

B. Architectural Plywood: 3/4 in. PS 1-83 "B-B" plyform, Class I, with High Density smooth overlay, 1 surface, edge sealed with each piece bearing legible inspection trademark.

2.02 MANUFACTURERS - PREFABRICATED FORMS

A. Weyerhauser Concrete Form.

B. Georgia Pacific, G-P Exterior Soft Wood Plywood Product.

C. Plywood and Door Corporation's Finn-Form.

2.03 PREFABRICATED FORMS

A. Preformed Steel Forms: Minimum 16 gage matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

B. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.

2.04 FORMWORK ACCESSORIES

A. Form Ties: Snap-off type, galvanized metal, adjustable length, 1 in. back break dimension, free of defects that could leave holes larger than 1 in. in concrete surface; Dayton-Sure Grip snap-in-form ties, as manufactured by Dayton Superior

Corp., Symons Ties as manufactured by Symons Corporation, Snap-Tys as manufactured by Richmond Corporation. Ties shall be removed after forms are removed, and holes filled with mortar that matches the adjacent surfaces.

B. Form Release Agent: Colorless mineral oil which will not stain concrete, or absorb moisture; by Magic Kote manufactured by Symons Manufacturing Co., Form Coat manufactured by Concrete Services Co., Formcel manufactured by Lambert Corp.

C. Corners: Chamfered, wood strip type; 3/4 x 3/4 in. size on all exterior corners, 3 x 3 in. size where shown on the drawings; maximum possible lengths.

D. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

E. Concrete Embedment Liner, where required, shall be installed in accordance with Section 03400 – Concrete Embedment Liner.

PART 3. EXECUTION

3.01 EXAMINATION

A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.02 EARTH FORMS

A. Earth forms are not permitted, except for footings.

3.03 ERECTION - FORMWORK

A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301. Metal forms shall be installed in strict accordance with manufacturer's directions and specifications.

B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

D. Align joints and make watertight. Keep form joints to a minimum.

E. Obtain approval before framing openings in structural members which are not indicated on drawings.

3.04 APPLICATION - FORM RELEASE AGENT

A. Apply form release agent on formwork in accordance with manufacturer's recommendations.

B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

C. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings which are affected by agent.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings where required for items to be embedded in or passing through concrete work.

B. Locate and set in place items which will be cast directly into concrete.

C. Coordinate work of other Sections in forming and placing openings, slots, reglets, recesses, chases, sleeves, bolts, anchors, and other inserts.

D. Install accessories in accordance with manufacturer's instructions, straight, level, and plumb. Ensure items are not disturbed during concrete placement.

E. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

F. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.06 FORM CLEANING

A. Clean and remove foreign matter within forms as erection proceeds.

B. Clean formed cavities of debris prior to placing concrete.

C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

D. During cold weather, remove ice and snow from within forms. Do not use de-icing salts or water to clean out forms. Use compressed air or other means to remove foreign matter.

3.07 FORMWORK TOLERANCES

A. Construct formwork to maintain tolerances required by ACI 301.

3.08 FIELD QUALITY CONTROL

A. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.

B. Do not reuse wood formwork more than three times for concrete surfaces to be exposed to view. Do no patch formwork.

3.09 FORM REMOVAL

A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.

B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finished concrete surfaces scheduled for exposure to view.

C. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

END OF SECTION 03100

PART 1. GENERAL

1.01 WORK INCLUDES

A. The complete installation of the reinforcing steel bars and accessories for cast-in-place concrete.

1.02 RELATED SECTIONS

A. Section 03100 - Concrete Formwork.

B. Section 03300 - Cast-in-Place Concrete.

1.03 REFERENCES

A. ACI 301 - Structural Concrete for Buildings.

B. ACI 318 - Building Code Requirements For Reinforced Concrete.

C. ACI SP-66 - American Concrete Institute - Detailing Manual.

D. ASTM A615 - Deformed and Plain Billet Steel Bars for Concrete Reinforcement.

E. CRSI - Concrete Reinforcing Steel Institute Manual of Practice.

1.04 SUBMITTALS

A. Submit under provisions of Section 01010.

B. Shop Drawings: Indicate bar sizes, spacings, locations, and quantities of reinforcing steel, and bending and cutting schedules. Contract drawings shall not be reproduced as the basis for shop drawings.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with CRSI Manual of Standard Practice.

B. Submit certified copies of mill test report of reinforcement materials analysis.

1.06 COORDINATION

A. Coordinate with placement of formwork, formed openings and other work.

PART 2. PRODUCTS

2.01 REINFORCEMENT

A. Reinforcing Steel: ASTM A615, 60 ksi yield grade; deformed billet steel bars.

2.02 ACCESSORY MATERIALS

A. Tie Wire: Minimum 16 gage, annealed steel wire, epoxy coated when used with epoxy-coated reinforcement.

B. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions.

C. Special Chairs, Bolsters, Bar Supports, Spacers Adjacent to Weather Exposed Concrete Surfaces: Plastic coated steel type; size and shape as required.

2.03 FABRICATION

A. Fabricate concrete reinforcing in accordance with CRSI Manual of Standard Practice and ACI SP-66.

B. Splice reinforcement on at locations indicated on drawings. Indicate location of splices on shop drawings.

PART 3. EXECUTION

3.01 PLACEMENT

A. Place, support and secure reinforcement against displacement. Do not deviate from required position. Clean reinforcement of foreign particles or coatings.

B. Accommodate placement of formed openings.

C. Conform to ACI 318 code for concrete cover over reinforcement.

3.02 FIELD QUALITY CONTROL

A. Contractor shall notify the Owner's Representative at least 24 hrs. in advance of concrete placement. Placement of reinforcing shall occur in such sequence that the Owner's Representative has sufficient time to inspect the correctness of the reinforcing within the placement area. The Owner's Representative retains the right to require necessary revisions be made before concrete is placed.

END OF SECTION 03200

PART 1. GENERAL

1.01 WORK INCLUDES

A. The complete installation of cast-in-place concrete structures, including joint sealants.

1.02 RELATED SECTIONS

A. Section 03100 - Concrete Formwork: Formwork and accessories.

B Section 03200 - Concrete Reinforcement.

C. Section 03400 – Concrete Embedment Liner

1.03 REFERENCES

A. ACI 301 – Structural Concrete for Buildings.

B. ACI 302 - Guide for Concrete Floor and Slab Construction.

C. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

D. ACI 305R - Hot Weather Concreting.

E. ACI 306R - Cold Weather Concreting.

F. ACI 308 - Standard Practice for Curing Concrete.

G. ACI 318 - Building Code Requirements for Reinforced Concrete.

H. ASTM C31 - Concrete Test Specimens.

I. ASTM C33 - Concrete Aggregates.

J. ASTM C94 - Ready-Mixed Concrete.

K. ASTM C150 - Portland Cement.

L. ASTM C260 - Air Entraining Admixtures for Concrete.

M. ASTM C494 - Chemical Admixtures for Concrete.

1.04 SUBMITTALS

A. Product Data: Provide data on joint devices, attachment accessories, admixtures.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301.

B. Acquire cement and aggregate from same source for all work.

C. Conform to ACI 305R when concreting during hot weather.

D. Conform to ACI 306R when concreting during cold weather.

1.06 COORDINATION

A. Coordinate this Section with other Sections which require embedment of components in cast-in-place concrete.

1.07 PRODUCT DATA

A. Submit proposed mix design to Owner's Representative for review prior to commencement of work. Identify source and provide material certificates for cement, fine and coarse aggregates. Provide recent laboratory gradation for fine and coarse aggregates and mix design information in accordance with ACI 301.

B. Submit Construction joint plan.

PART 2. PRODUCTS

2.01 CONCRETE MATERIALS

A. Cement: ASTM C150, Type I - Normal Portland Type, Gray Color.

B. Fine and Coarse Aggregates: ASTM C33.

C. Water: Potable.

2.02 ADMIXTURES

A. Air Entrainment: ASTM C260.

B. Chemical: ASTM C494. Maximum 0.05% Chloride Ion Contents.

C. The use of calcium chloride in any concrete is not permitted.

2.03 ACCESSORIES

A. Non-Shrink Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.

B. Curing Compound: Dress and Seal No. 18 by L&M Construction Chemicals, MB-429 by Master Builders, or Sikagard Cure/Hard by the Sika Corporation.

C. Epoxy Grouted Adhesive Anchors: Hilti, Red Head, Simpson, or Rawl.

2.04 CONCRETE MIX

A. Mix concrete in accordance with ACI 304. Deliver concrete in accordance with ASTM C94.

B. Select proportions for normal weight concrete in accordance with ACI 301.

C. Provide normal weight concrete of the following characteristics:

1. Compressive strength at 28 days: 4,000 psi.

2. Slump: 4 in. - A tolerance of up to 1 in. above the maximum shall be allowed for one batch in any five consecutive batches tested.

3. Water/cement ratios: 0.4 (max).

D. Use accelerating admixtures in cold weather only when approved by Owner's Representative. Use of admixtures will not relax cold weather placement requirements.

E. Use set-retarding admixtures during hot weather only when approved by Owner's Representative.

F. Water-reducing admixtures may be used in all concrete except footings and in strict compliance with the manufacturer's directions.

G. Add air-entraining agent to concrete mix for air content of 6% (± 1%).

PART 3. EXECUTION

3.01 EXAMINATION

A. Verify requirements for concrete cover over reinforcement.

B. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.

3.02 PLACING CONCRETE

A. Place concrete in accordance with ACI 301.

B. Notify Owner's Representative minimum of 24 hours prior to commencement of operations.

C. Ensure reinforcement, inserts, and embedded parts are not disturbed during concrete placement.

D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

E. Place concrete continuously between predetermined expansion, control, and construction joints.

F. When air temperature is between 80°F and 90°F, reduce the mixing and delivery time specified in ASTM C94 from 1-1/2 hours to 75 minutes. When the air temperature is above 90°F, reduce the mixing and delivery time to 60 minutes.

G. Cold weather concreting. Comply with ACI 306 except as follows:

1. In freezing weather, provide suitable means for maintaining concrete temperature at a minimum of 70°F for three days, or 50°F for five days after placing.

2. Cooling of concrete to outside temperature: Not faster than 1° per hour for first day and 2° per hour thereafter until outside temperature is reached.

3. Maximum temperature of concrete produced with heated aggregated, heated water, or both, at any time during its production or transportation: 90°F.

4. Do not mix chemicals or other foreign materials in concrete to prevent freezing or to accelerate hardening of concrete, unless approved in writing by Owner's Representative.

H. Hot weather concreting. Comply with ACI 305R.

1. ACI recommendations shall be observed when any combination of high air

temperature, low relative humidity and wind velocity tend to impair the quality of fresh or hardened concrete.

2. Retarding and water reducing admixtures shall be approved in writing for each concrete mix design prior to placement.

3.03 CONCRETE FINISHING

A. Provide exterior concrete formed surfaces to be left exposed with smooth rubbed finish in accord with ACI 301. All other formed surfaces shall have fins, projections and offsets removed.

B. Provide Class A tolerances to exterior concrete slabs according to ACI 301.

1. Broom finish all exterior slabs. Broom out all tool marks.

C. Pitch slabs to drain.

3.04 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for a period necessary for hydration of cement and hardening of concrete in accordance with ACI 308.

C. Cure and protect finished concrete slabs in accordance with ACI 308.

3.05 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed in accordance with ACI 301 and under provisions of Section 01010, paragraph 8.0.

B. Testing firm will take cylinders, perform slump and air entrainment tests in accordance with ACI 301.

C. Provide free access to Work and cooperate with appointed firm.

D. Submit proposed concrete mix design to Owner's Representative firm for review 14 days prior to commencement of Work.

E. Testing frequency shall be as specified in Section 01010, paragraph 8, except that one additional test cylinder will be taken during cold weather concreting, cured on job site under same conditions as concrete it represents.

3.06 PATCHING

A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

B. Repair or replacement of defective concrete will be determined by Owner's Representative and performed by the Contractor at no additional cost to the project.

C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Owner's Representative for each individual area.

END OF SECTION 03300

PART 1. GENERAL

1.01 WORK INCLUDES

A. Specifications and guidelines for manufacturing and installing high-density polyethylene embedment liners.

1.02 RELATED SECTIONS

A. Section 03100 - Concrete Formwork.

B. Section 03300 - Cast-in-Place Concrete.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
2. D 1603 Test Method for Carbon Black in Olefin Plastics
3. D 5199 Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
4. D 5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
5. D 6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
6. D 1204 Standard Test Method for Linear Dimensional Changes of Nongrid Thermoplastic Sheeting or Film at Elevated Temperature
7. D 696 Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C With a Vitreous Silica Dilatometer
8. D 746 Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
9. D 570 Standard Test Method for Water Absorption of Plastics
10. E 96 Standard Test Method for Water Vapor Transmission of Material

1.04 SUBMITTALS

A. All work for and in connection with the installation of the lining, field seaming and welding joints shall be completed in strict conformity with all applicable instructions and recommendations of the liner manufacturer.

B. Included with the shipment of liner, submit certified test reports that the liner and material are manufactured in accordance with standards specified herein.

1.05 QUALIFICATIONS

A. The HDPE liner specified in this section shall be furnished by a manufacturer who is fully experienced, reputable and qualified in the manufacturing of the materials. The manufacturer must at least 10 years of manufacturing experience.

B. Locking devices must be extruded to the sheet as a one step process.

C. Liner shall be GSE StudLiner as manufactured by GSE Lining Technology, Inc.

D. Liner shall be 8 feet in width.

E. Liner shall demonstrate a minimum pull-out strength of 14,000 psf.

1.06 COORDINATION

A. Coordinate with placement of formwork, formed openings and other work.

PART 2. PRODUCTS

2.01 ROLL DIMENSIONS

A. Embedment sheets shall be produced in rolls that are 8.0 ft (2.4 m) in width and a thickness range of 80 mils (2.0 mm) to 200 mils (5.0 mm) in thickness. Roll lengths vary according to thickness.

B. Locking studs of the same material as that of the liner shall be integrally extruded with the sheet. Stud spacing shall be on approximate 1.25 in (30 mm) centers, such that there are approximately 110 studs per square foot (1200 per square meter).

2.02 MATERIAL PROPERTIES

A. The material used in the embedment liner and in all welding strips shall be made from 97-98% virgin high density polyethylene and 1.5-3% carbon black or pigmentation for the purpose of an otherwise specified color.

B. Plasticizer shall not be added to the resin formulation.

C. Embedment sheet and welding strips shall be free of holes, pinholes, bubbles, blisters, excessive contamination by foreign matter, and nicks and cuts on roll edges.

D. The HDPE cap strips shall be made from HDPE, have good impact resistance and have an elongation sufficient to bridge up to 1/4 inch settling cracks.

E. Cap strips shall be approximately 4 inches wide or greater and shall be equivalent to that of the liner.

F. Material shall maintain a repairable state through it's lifecycle by methods approved and recommended by the manufacturer.

G. Embedment sheets shall have the following physical properties when tested in accordance with Table 1.

H. Raw resin shall have the following properties when tested in accordance with Table 2.

Table 1: Material Properties

Property	Test Method	Nominal Value				Testing Frequency
Thickness, mm (mil)	ASTM D 5199	2.00 (80)	3.00 (120)	4.00 (160)	5.00 (200)	Every 5[th] roll
Density, g/cm^3	ASTM D 1505	0.94	0.94	0.94	0.94	1/100,000 ft^2
Tensile Properties Strength@Yield, lb/in^2 (MPa) Elongation @ Break, %	ASTM D 6693 Type IV, Dumbell G.L. = 2.0in.	2,200 (14.5) 500	2,200 (14.5) 500	2,200 (14.5) 500	2,200 (14.5) 500	1/100,000 ft^2
Stud Pull-Out Strength[1], lb/ft^2 (kN/m^2)		>14,000 (669.89)	>14,000 (669.89)	>14,000 (669.89)	>14,000 (669.89)	1/ product
Carbon Black Content/ Pigment Content, % Black Liner Gray Liner	ASTM D 1603, mod. ASTM D 5630, mod.	2-3 1.5 – 2.5	2-3 1.5 – 2.5	2-3 1.5 – 2.5	2-3 1.5 - 2.5	1/100,000 ft^2
Carbon Black Dispersion[2]	ASTM D 5596	Note 2	Note 2	Note 2	Note 2	1/100,000 ft^2
Notched Constant Tensile Load, hours	ASTM D 5397	400	400	400	400	1/ formulation
Coefficient of Linear Thermal Expansion, per °C	ASTM D 696	1.20E-04	1.20E-04	1.20E-04	1.20E-04	1/ product
Low Temperature Brittleness, °C	ASTM D 746	-77	-77	-77	-77	1/ product
Dimensional Stability, % (each direction)	ASTM D 1204	± 1.0	± 1.0	± 1.0	± 1.0	1/ product
Water Absorption, %	ASTM D 570	0.1	0.1	0.1	0.1	1/ product
Water Vapor Transmission, (g/m^2/day)	ASTM E 96	<0.01	<0.01	<0.01	<0.01	1/ product

[1]Note: Concrete must have a compressive strength of at least 5,000 lb/in^2 (34,500 kPa)
[2]Note: Disperson only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view for category 3

Table 2: Raw Material Properties

Property	Test Method	Value	Testing Frequency
Density, g/cm3	ASTM D 1505	0.932	1/ resin lot
Melt Flow, g/10 min	ASTM D 1238 (190/2.16)	$\leq$ 1.0	1/ resin lot
OIT, minutes	ASTM D 3895 (1atm/200°C)	100	1/ formulation

2.03 MATERIAL SUPPLY

A. Embedment sheets shall be supplied in roll form, sheets, pre-fabricated tubes or panels.

B. Cap strips shall be supplied in 4 inch widths or greater.

PART 3. EXECUTION

3.01 PLACEMENT

A. Place, support and secure reinforcement against displacement. Do not deviate from required position. Clean reinforcement of foreign particles or coatings.

B. Accommodate placement of formed openings.

C. Conform to ACI 318 code for concrete cover over reinforcement.

3.02 FIELD QUALITY CONTROL

A. Contractor shall notify the Owner's Representative at least 24 hrs. in advance of concrete placement. Placement of the Concrete Embedment Liner shall occur in such sequence that the Owner's Representative has sufficient time to inspect the correctness of the placement within the concrete formwork area. The Owner's Representative retains the right to require necessary revisions be made before concrete is placed.

END OF SECTION 03200

APPENDIX 2

CONSTRUCTION QUALITY ASSURANCE PLAN

TABLE OF CONTENTS

FIGURES

APPENDICES

1.0 INTRODUCTION

This Plan describes the Construction Quality Assurance (CQA) program for the proposed Gypsum Management and CCB Landfill Facilites at the Ameren Duck Creek Power Plant in Fulton County, Illinois. The plan has been developed in accordance with the requirements of 35 IAC Part 811. Subpart E entitled *Construction Quality Assurance* Programs.

The Plan requires a scheduled program of CQA monitoring, inspection, sampling and testing to verify compliance with project plans and specifications. The Plan also addresses the testing requirements for test soil liners that will be constructed to verify materials and construction methods for the full-scale liners. The goal of this program is to achieve a reasonable degree of certainty that the construction of the facilites meets the specified designs.

Appendix A lists the testing methods, acceptance requirements and testing frequencies that shall guide the implementation of this plan. Also listed is the party responsible for conducting the testing for each of the constucted components of the landfill. The plan requires oversight by the CQA Officer for all testing carried out by the geosynthetic installers.

The CQA Plan also requires preparation by the CQA Officer of a final report at the end of construction that provides all inspection and testing documentation and certifies that the facilites have been constructed in accordance with the engineering design.

This Plan is intended to supplement, the project plans and specifications. Where a conflict exists, the approved CQA Plan will govern.

2.0 RESPONSIBILITY AND AUTHORITY OF PROJECT PERSONNEL

The project participants involved in the construction and quality assurance oversight of the construction are shown in Figure 2.1 *Project Organization Chart*. The Owner is the Ameren Energy Resources Generating Company (AERG or Ameren) who will retain a General Contractor to construct the facilities and a CQA Officer to provide the quality assurance oversight services. The following list the responsibilities and authority of each of the participants shown in Figure 2.1.

2.1 Owner

Ameren Energy Resources Generating Company (Ameren) is responsible for obtaining all necessary permits for construction and operation of the facilities. Ameren retains under contract all parties for the construction including the General Contractor, the Design Engineer (Hanson Professional Services Inc.), the CQA Officer, and the CQA testing and monitoring firms.

The Ameren Construction Manager will be in charge of coordinating overall construction activities and will act as Ameren's primary interface with the General Contractor. The Construction Manager coordinates all matters involving contract issues with the Ameren Project Manager including approving field changes to the project plans and specifications.

2.2 Design Engineer

The Design Engineer (Hanson Professional Services Inc.) is responsible for development of plans and specifications that fulfill the needs of the Owner and meet the requirements of the regulatory agencies. The Design Engineer is also responsible for responding to Contractor requests for information (RFIs) during the construction process as may be required to clarify the plans and specifications or to address identified conflicts in the documents. The Design Engineer is further responsible for developing any modifications to the plans and specifications as may be required to address changed field conditions, field cost savings, design improvements or other necessary or desired modifications as approved by the Owner.

2.3 CQA Personnel

2.3.1 Key Personnel (Owner's Representative)

Ameren will retain a CQA Officer for the project who will report directly to Ameren's Construction Manager (see Figure 2.1 *Organization Chart*). The CQA Officer shall be a professional engineer registered in the State of Illinois, who is a person other than the operator or an employee of the operator, and who will supervise and be responsible for all inspection, testing, and other activities required to be implemented as part of the CQA program. The CQA Officer will also be responsible for, and will provide direct supervision to, the testing and monitoring firms shown in Figure 2.1 who will perform the monitoring, testing, sampling, and inspections required by the CQA program as described more specifically in Section 6.0. The CQA Officer will be present at the outset of major undertakings and at critical times during the construction. The time that the CQA Officer must be at the project site will be dependent upon the type of construction being conducted. The CQA Officer will exercise his/her own professional judgment to be present at the project site as required to assume full responsibility for the inspection and testing performed by those persons under his/her direct supervision. The CQA Officer shall have sufficient on-site full-time staff to adequately carry out the quality assurance activities specified herein.

If the CQA Officer is unable to be present to perform duties as outlined, then the CQA Officer will provide, in writing, reasons for his/her absence including designation of the person who will exercise professional judgment in carrying out the duties of a CQA Officer as the designated CQA Officer-in-absentia. A signed statement shall be provided and recorded that the CQA Officer assumes full responsibility for all inspections performed and reports prepared by the designated CQA Officer-in-absentia during any absence of the CQA Officer.

It is required that the CQA Officer (or his designated representative), with on-site support personnel as required, provide oversight of the monitoring, inspection, testing and/or sampling of the following construction activities for the facilities:

- Test Liner,
- Excavation, grading, and preparation of the subgrade and foundation,
- Placement of the compacted soil liner,
- Placement of geosynthetic components,

- Installation of the leachate drainage and collection systems.
- Construction of surface water ditches, channels, berms, and drainage structures, and
- Placement of concrete structures.

The CQA Officer (or his designated representative) must certify that the sampling, inspection and test results for the major elements of the construction are in compliance with established design requirements before subsequent sequential items of the construction can be initiated. The major elements of Work requiring compliance certification include:

- Subgrade prior to placement of soil test liner (CCB landfill facility only),
- Soil test liner prior to placement of the low permeability soil liner,
- Subgrade prior to placement of the low permeability soil liner (CCB landfill facility only),
- Low permeability soil liner prior to placement of the geosynthetic clay liner (GCL),
- GLC liner prior to placement of the geomembrane,
- Geomembrane prior to placement of the geotextile cushion,
- Geotextile cushion prior to placement of the drainage layer,
- Piping installation prior to completed placement of the drainage layer,
- Drainage layer prior to placement of geotextile fabric,
- Cushion Dirt prior to placement of the geomembrane (gypsum facility only), and
- Geosynthetic installations in anchor trenches prior to backfilling.

Certification will require a through review of all inspection, sampling and testing completed for the work item to ensure that all design requirements have been met, a visual inspection of the work item, and the completion and signing of form CQAP 2.1 *CQA Certification* by the CQA Officer. The Contractor or Installer for the immediately following item of work shall not be allowed to initiate work until completion of the signed form by the CQA Officer.

The completed and signed forms CQAP-2.1 shall be filed as a project records in accordance with the provisions of Section 11.0

2.3.2 *Document Controller*

The staff of the CQA Officer shall include a Document Controller who will be responsible for: (1) control of the CQA Plan to ensure that only current documents are being employed by the CQA staff and (2) filing of all CQA records related to the monitoring, sampling, inspecting and testing specified in the CQA Plan.

Requirements for control of the CQA Plan and for filing of project records are presented in Section 11.0.

2.4 Testing and Monitoring Firms

The testing and monitoring firms, under the direction of the CQA Officer (see Figure 2.1), shall be responsible for conducting the quality assuranace sampling, inspection and testing required by Section 6.0 of the CQA Plan <u>except that</u> only monitoring and limited (independent) sampling and testing shall be required for the geosynthetics (i.e., geomembranes, geothensytic clay liners and geotextiles). The suppliers and installers shall be responsible for all the sampling and testing required by Section 6.0 for the geosynthetics (see Section 2.6).

2.4.1 Soil/Concrete Testing (Lab and Field)

One or more soil/concrete testing firms that has been qualified by the Illinois Department of Transporation (IDOT) will be retained to perform the field and laboratory sampling and testing required by the CQA Plan. Materials sampled and tested will include fine-grained soils, coarse grained soils, aggregates, rip rap and concrete.

Each firm shall be required to provide "certificates of calibration" (or other proof of calibration) to the CQA Officer for each of the measuring and/or test equipment used in the laboratory or field; except that such certificates are not required for commercial grade equipment such as rulers, tape measures or other devices that provide adequate accuracy for their intended purpose.

All field and laboratory forms proposed for collection of data shall be subject to review by Ameren prior to use. Forms deemed to be incomplete or otherwise shall be modified to meet the intent of the CQA Plan.

2.4.2 Surveyor

One or more surveyors will be retained to verify attainment of specified elevations, slopes and grades within the tolerances required by the CQA Plan. The firm(s) selected shall have the capacity to complete all work by or under the supervision of an Illinois Professional Land Surveyor.

Each surveyor will be required to provide "certificates of calibration" (or other proof of calibration) to the CQA Officer for each surveying device used; except that such certificates are not required for commercial grade equipment such as rulers, tape measures or other devices that provide adequate accuracy for their intended purpose.

All field forms proposed for collection of data shall be subject to review by Ameren prior to use. Forms deemed to be incomplete or otherwise unacceptable shall be modified to meet the intent of the CQA Plan.

2.4.3 Geosynthetics Monitor and Geosynthetics Testing Laboratory

A geosynthenties monitoring firm will be retained to conduct oversignt of the quality assurance inspections, testing and sampling carried out in the field by the suppliers and installers for the geosynthetics (see Section 2.5) to ensure that the requirements of the CQA Plan are met including directing additional inspection, sampling and testing as may be deemed necessary by the monitoring firm. The monitoring firm will also collect its own representative samples of the geosynthetics for independent testing by a geosynthetics testing laboratory. The monitoring firm shall have previous experience in installation oversight of at least 10,000,000 sq. ft. of similar geosynthetic materials.

The laboratory will be independent of both the manufacturer and the installer of the geosynthetics and will be required to have its own QA plan for the project work. The QA Plan shall be subject to review by Ameren prior to start of services.

All field and laboratory forms proposed for collection of data shall be subject to review by Ameren prior to use. Forms deemed to be incomplete or otherwise unacceptable shall be modified to meet the intent of the CQA Plan.

2.5 Contractors, Suppliers and Installers

The contractor, subcontractors, suppliers and installers are responsible for completing their portions of the work within specified schedules and in accordance with the requirements of the plans and specifications. They additionally shall accommodate the monitoring, sampling, inspections and testing that are the responsibility of the CQA Officer under the QCA Plan.

The geosynthetic Suppliers and Installers shall provide the quality assurance inspection, sampling and testing as required by Section 6.0 of the CQA Plan. Additionally, the geosynthetic suppliers shall be required to submit "certificates of acceptance" for certain items of work that precede their construction activities. The "certificates" are more specifically discussed in Section 4.0.

3.0 PROJECT MEETINGS

Periodic meetings will be held during the life of the project to enhance coordination among the various parties involved. Meetings will include preconstruction meetings, routine progress meetings and, as needed, problem or work deficiency meetings.

3.1 Preconstruction Meetings

Preconstruction meetings shall be held at the site for the major earthwork items and geosynthetic installations. At a minimum, the Ameren Construction Manager, the CQA Officer, representatives of the testing firms, and the earthwork contractor or geosynthetic installer should attend. In addition to the topics for discussion as listed in the project specifications, the following CQA items will be covered:

- Discuss the established protocol for inspections, tests and sampling including use of form CQAP 8.1 *Daily Inspection Report* (see Section 8.0).
- Discuss items of work requiring CQA Officer certification or Installer acceptance before subsequent work items can be initiated (see Section 4.0), and
- Discuss the established protocol for handling construction deficiencies, corrective measures, and retesting (see Section 7.0).

The meeting shall be conducted by the Ameren Construction Manager or CQA Officer and will be documented by CQA personnel with distribution to all attendees. Meeting minutes will be filed as project records in accordance with Section 11.0.

3.2 Progress Meetings

At the discretion of the Ameren Construction Manager or the CQA Officer, brief progress meetings will be scheduled to discuss on-going and up-coming construction activities. The meeting will be attended by the Ameren Construction manager, the CQA Officer, and the appropriate site foreman (i.e. when earthwork is being performed, the earthwork foreman will be present; when geosynthetics are being installed, the installer foreman will be present, etc.). In addition to the CQA Officer topics of discussion regarding progress, the following CQA items should be reviewed:

- Discuss the established protocol for inspections, tests and sampling including use of form CQAP 8.1 *Daily Inspection Report* (see Section 8.0),
- Discuss items of work requiring CQA Officer certification or Installer acceptance before new work items can be initiated (see Section 4.0), and
- Discuss the established protocol for handling construction deficiencies, corrective measures, and retesting (see Section 7.0).

These meetings will be documented by the CQA Officer with distribution to all attendees including the Ameren Project Manager. Meeting minutes will be filed as project records in accordance with Section 11.0.

3.3 Problem or Work Deficiency Meetings

Special meetings will be approved by the CQA Officer when a problem or work deficiency is present (or is likely to occur) that is (or could be) of a serious nature. At a minimum, the meeting should be attended by theAmeren Construction Manager, earthwork or installer foremen as appropriate, and the CQA Officer. The Ameren Project Manager should attend those meetings that include discussions of severe and/or recurring problems or deficiencies. The purpose of these meetings is to define and resolve the problem or work deficiency in the following manner:

- Define the problem or deficiency and its probable causes,
- Discuss alternative actions to address the problem or deficiency ,
- Implement the selected action to resolve the problem or deficiency, and
- Verify that the implemented action has been effective.

The meeting will be documented by the CQA Officer with distribution to all attendees including the Ameren Project Manager. Meeting minutes will be filed as project records in accordance with Section 11.0.

4.0 IN-PROGRESS ACCEPTANCE OF WORK

4.1 Introduction

It is very important during placement of the geosynthetics not to entrap fugitive clay, stones, sand, etc. that could damage the geosynthetic, cause clogging of drains or filters, or hamper seaming of the geosynthetic. The geosynthetic installers shall accept responsibility for inspecting the substrate (on a daily basis) to ensure such entrapments are not present within the substrate area to be covered each day. When found acceptable, the installer shall complete and sign form CQAP-4.1 *Installer Certificate of Acceptance* that documents (on a daily basis) acceptance of the substrate for geosynthetic placement. The Installer shall provide the original signed document to the CQA Officer for his signature of receipt.

Completed and signed forms CQAP-4.1 shall be filed as project records in accordance with the provisions of Section 11.0.

4.2 Elements of Work Requiring Prior Acceptance

The following table cites the elements of work that shall require daily "certificates of acceptance" for the substrate including the installer responsible for providing the certification. Any other areas of geosynthetic installation not included in the table shall still be subject to the requirements of this section.

Table 4.1 Installer Certifications for Acceptance of Work

Substrate to Be Accepted by Installer	Installer
1. Surface of Low Permeability Soil Liner	Geosynthetic Clay Liner (GLC) Installer
2. Surface of Geosynthethic Clay Liner (GCL)	Geomembrane Installer
3. Surface of Geomembrane	Geotextile Cushion Installer
4. Surface of Drainage Layer	Geotextile Filter Installer
5. Surface of Cushion Dirt	Geomembrane Installer

5.0 TEST SOIL LINER

5.1 Introduction

A compacted low permeability soil test liner shall be constructed within the footprint of the proposed soil liner prior to any work being initiated on the full scale construction. The purpose of the test liner is to verify that the materials and methods of construction proposed for the full scale liner will provide the quality of construction required by the CQA Plan. Additional soil test liners shall be constructed for each time the material properties from a new borrow source are found to be significantly different or there is a significant change in the methods of construction and/or equipment.

The test liner will be constructed on a competent foundation from the same prequalified soil material sources, to the same design specifications, and with similar equipment and procedures as are proposed by the contractor for the full scale liner. The foundation (subgrade) for the soil test liner shall be subject to the requirements of Section 6.2.1 and sampling/testing for material prequalification and placement shall be that provided in Section 6.2.2 except that:

1. The survey grid for foundation grade verification and for liner thickness verification shall be as established by the CQA Officer.

2. The frequencies for placement testing shall be as established by the CQA Officer.

3. The testing for hydraulic conductivity shall be as provided in Section 5.2.

5.2 Sampling and Testing Program

The soil test liner shall be sampled and tested under the direction of the CQA officer as described below for each of the physical properties listed.

1. At least five (5) two-stage field tests (ASTM designation D 6391-06) shall be used on the test liner to determine the hydraulic conductivity. Both the vertical hydraulic conductivity (k1) and the horizontal hydraulic conductivity (k2) shall be calculated.

2. Undisturbed samples (Shelby tubes) will be tested in the laboratory for vertical hydraulic conductivity to determine if there is a statistical correlation to the field testing results. At least two (2) samples should be tested.

3. The determination of other engineering parameters including, but not limited to, particle size analysis, liquid limits, plastic limits, water contents, and unconfined compressive strengths that are needed to evaluate the full scale liner shall be as directed by the CQA Officer.

5.3 Requirements for CQA Certification of Test Soil Liner for Landfill Construction

1. At least four of the five field hydraulic conductivity tests shall result in a measured vertical hydraulic conductivity of 5.0×10^{-7} cm/sec or less. No test shall have a hydraulic conductivity greater than 1.0×10^{-6} cm/sec.

2. The laboratory hydraulic conductivity tests shall indicate a measured vertical hydraulic conductivity of 1.0×10^{-6} or less.

5.4 Requirements for CQA Certification of Test Soil Liner for Gypsum Stack

1. At least four of the five field hydraulic conductivity tests shall result in a measured vertical hydraulic conductivity of 5.0×10^{-5} cm/sec or less. No test shall have a hydraulic conductivity greater than 1.0×10^{-4} cm/sec.

3. The laboratory hydraulic conductivity tests shall indicate a measured vertical hydraulic conductivity of 1.0×10^{-4} or less.

5.5 Report of Results and Certification

The CQA Officer shall prepare reports describing the test programs carried out and the results obtained. The reports shall be filed as project records in accordance with Section 11.0.

The CQA Officer shall review the sampling and test results for the test soil liners and, if found in agreement with requirements, provide certification for the work using form CQAP 2.1.

6.0 SAMPLING AND TESTING REQUIREMENTS

6.1 Introduction

Prequalification and placement sampling/testing requirements for the various materials and construction activities are as summarized in Table A.1. Frequencies for material placement testing listed in Table A.1 are based on the volume of material used in construction and are to be considered minimums. The CQA Officer shall select the specific locations for testing on a random basis exercising professional judgment to ensure that testing and sampling fairly represent the construction.
The testing firms under the direction of the CQA Officer shall be responsible for the sampling and testing listed in Table A.1 for: (1) the Soils Prequalification and Placement Testing, (2) the Drainage Media Prequalification and Placement Testing, and (3) the Other Material Placement Testing. The geosynthetic installers shall be responsible for the sampling and testing listed in Table A.1 for the Geosynthetics Prequalification and Placement Testing with daily overview (and some independent laboratory testing) by the geosynthetic firms and the CQA Officer.

The results of the sampling and testing shall be documented on <u>a daily basis</u> by each agency or installer providing the quality assurance activities and the <u>originals</u> of the sampling and testing results provided to the CQA Officer. The CQA officer shall complete form CQAP 8.1 *Daily Inspection Report* (see Section 8.0) for <u>each</u> of the testing firms or installer proving results and attach the results to the form. The completed form CQAP 8.1 and attached results shall be incorporated into the *Daily Summary Report* (see Section 8.0).

6.2 Soils

6.2.1 Foundation (Subgrade) – Low Permeability Soil Liner

6.2.1a. Foundation Grade Verification

Following excavation for the low permeability soil liner, the CQA Officer shall direct the surveyor to verify that actual depths and grades of the foundation (subgrade) are in accordance with the plans and specifications. Elevations shall be surveyed on a 100 ft grid pattern for the bottom of the cell. The points surveyed for side slopes will be at the top, midpoint, and toe. In addition, all breaks in grade will be surveyed. Foundation excavation grading shall meet a control tolerance requirement of 0 ft to -0.4 ft. The measured depths and grades shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor.

The CQA Officer shall review the survey data for conformance to requirements and, if found in agreement with requirements, provide certification for the work using form CQAP 2.1.

6.2.1b. Foundation Fill

Foundation (subgrade) materials not meeting the requirements of the plans and specifications are required to be excavated and replaced with suitable foundation fill to develop a stable foundation for the landfill. The CQA Officer shall make a foundation inspection with the soil testing firm and direct any sampling and testing necessary to identify areas requiring removal and replacement. The CQA Officer shall inform the earthwork contractor of unsuitable areas requiring removal and replacement.

Foundation fill used by the contractor for replacement shall be sampled and tested by the soil testing firm to check compliance with the prequalification and placement requirements listed in Table A-1. The CQA Officer shall direct the surveying firm to determine the locations and extent of all removal and replacement activity and to document all such information on "as built" drawings to be furnished to the CQA Officer.

The CQA Officer shall review the sampling and test results for the foundation fill and, if found in agreement with the prequalification and placement requirements, provide certification for the work using form CQAP 2.1. The certification for foundation fill may be provided on the same form providing the certification for foundation grade.

6.2.2 Low Permeability Soil Liner

6.2.2a. Prequalification Testing

Table 1.1 requires that prequalification testing for each soil type being used for liner construction at the landfill include the development of an "acceptable zone" of moisture-density for the compacted soil that will result in a liner with a minimum hydraulic conductivity of 1.0×10^{-6} cm/sec. The resulting "acceptable zone" then serves as the major control for material placement during construction.

The CQA officer shall direct the soil testing agency to determine the "acceptable zone" for each soil type to be used for landfill liner construction and provide the results in a written report to be available for comparisons with the material placement testing results. The determination of the "acceptable zone" shall be in accordance with Appendix B or other published methodology used in the profession. The report will be filed as a project record in accordance with Section 11.0.

There is no prequalification testing required for the soil materials to be used for the gypsum stack liner construction except that the materials selected shall have sufficient fines to achieve the in-place hydraulic conductivity specified in Section 5.4.

6.2.2b. Material Thickness Testing

The CQA Officer shall direct the survey agency to determine elevations at the foundation of the soil liner and at the final constructed surface using a 100 ft grid pattern (and the break points in slope) to verify attainment of the plan grades and elevations. To verify liner thickness, all horizontal survey coordinates shall be the same for the foundation and final constructed surface. Side slope thicknesses will be verified using crest (top), midpoint, and toe documentation points.

The measured depths and grades shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor agency.

6.2.2c. Moisture/Density Testing

Moisture/density testing of the compacted soil liner shall be conducted by the soil testing agency under the requirements and at the frequencies specified in TableA.1. During construction of the soil liner the CQA Officer shall confirm the following:

- Use of the same construction equipment as used in the test soil liner.
- Use of same procedures, such as number of passes and speed,
- Uniformity of coverage by compaction equipment,
- Consistent achievement of density, water content and permeability of each successive lift,
- Use of methods to bond successive lifts together,
- Achievement of liner strengths on sidewalls,
- Contemporaneous placement of protective covering to prevent drying and desiccation, where necessary,
- Prevention of placement of frozen material or the placement of material on frozen ground,
- Prevention of damage to completed liner sections, and
- That construction proceeds only during favorable climatic conditions.

6.2.2d. Hydraulic Conductivity Testing

Samples of the in-place liner shall be obtained and tested for hydraulic conductivity under the requirements and at the minimum frequency as specified in Table A.1. Multiple samples may be collected at a given test location for the purpose of retesting in the event of unacceptable hydraulic conductivity results from the initial sample.

Boreholes, excavations or other disturbances to the soil liner resulting from the obtainment of samples shall be backfilled as directed by the CQA Officer.

6.2.2e. Certification of Work

The CQA Officer shall review the sampling and test results for the low permeability soil liner and, if found in agreement with the prequalification and placement requirements, provide certification for the work using form CQAP 2.1.

6.2.3 Berms

6.2.3a. Landfill Containment Berms

The CQA Officer shall direct verification of excavated foundation (subgrade) depths and grades as specified in Section 6.2.1a except that the foundation grid shall be as directed by the CQA Officer. Foundation fills shall be as specified in Section 6.2.1b.

Prequalification testing for material sources shall meet the requirements in Table A.1.

The CQA Officer shall direct the soil agency to conduct the following inspection activities during berm construction:

- Observation of fill material characteristics,
- Observation of loose lift thickness,
- Observation of clod size reduction and material homogenization, and
- Placement testing as specified in Table A.1.

Documentation of construction on "as-built" plans shall be as specified in Section 6.5.2.

The CQA Officer shall review the sampling and test results for the landfill containment berms and, if found in agreement with the prequalification and placement requirements, provide certification for the work using form CQAP 2.1.

6.2.3b Temporary Cell Separation Berms

The CQA Officer shall direct verification of excavated foundation (subgrade) depths and grades as specified in Section 6.2.1a except that the foundation grid shall be as directed by the CQA Officer. Foundation fills shall be as specified in Section 6.2.1b.

Prequalification testing for material sources shall meet the requirements in Table A.1.

The CQA Officer shall direct the soil agency to conduct the following inspection activities during berm construction:

- Observation of fill material characteristics,
- Observation of loose lift thickness,
- Observation of clod size reduction and material homogenization,
- Placement testing as specified in Table A.1, and
- Measurements of berm slopes.

6.3 Geosynthetics

6.3.1 Geosynthetic Clay Liner (GCL)

6.3.1a. Prequalification Testing

The geosynthetic clay liner (GCL) installer shall provide to the CQA Officer the test results from a qualified laboratory for the type and frequency of prequalification testing listed in Table A.1. The submittal shall include certification from the laboratory that the test results verify the manufacturer's guaranteed properties.

The CQA Officer shall direct the geosynthetics QA monitor firm to select a representative number of additional samples of the GCL for submittal to the monitor's geosynthetic laboratory for independent verification of the manufacturer's guaranteed properties.

The results of laboratory testing shall meet the GCL manufacturer's specifications as shown in the following table.

GCL Laboratory Testing Methods/Minimum Values Required	
Test Method	**Minimum Value**
Bentonite Mass/Area (ASTM D5993)	0.75 lb./ft^2
GCL Grab Tensile Strength (ASTM D4632)	90 lb.
GCL Peel Strength (ASTM D4632)	15 lb.

The installer shall direct the test laboratory to submit the results of all laboratory test results and certification to the Document Controller for filing as project records in accordance with Section 11.0.

6.3.1b. Installer Certification of Placement Surface

Prior to daily clay liner placement, the installer shall provide to the CQA Officer daily "certificates of acceptance" (form CQAP-4.1) which document the installer's inspection and acceptance of the underlying surface as being suitable for the GCL installation (see Section 4.0).

All daily "certificates of acceptance" (form CQAP-4.1) shall be filed as project records in accordance with Section 11.0.

6.3.1c Deployment

The CQA Officer shall direct the geosynthetic QA monitor firm to oversee activities of the installer during placement and field testing of the GCL.

Incoming rolls of GCL shall be inventoried and inspected by the installer. Manufacturer's certifications will be inspected for conformance with the requirements of this plan. Holes or other visible defects shall be recorded in the CQA Officer's daily report and clearly marked on the GCL roll for identification of necessary repairs or rejection of the roll.

GCL shall be placed such that all seams run parallel to the slope. GCL should be dry when installed. Wet or hydrated GCL shall not be used. GCL panels shall be laid with a minimum 6 in. overlap on longitudinal seams and a minimum 12 in. overlap on panel end seams. Seam overlaps shall be placed such that the direction of flow is from the top panel to the underlying panel to form a shingle effect. Direct contact with GCL shall be minimized.

6.3.1d. Seaming

The GCL shall be sealed in accordance with the recommendations of the GCL manufacturer. Dry bentonite having the same chemical and material properties as the GCL shall be evenly dispersed from the panel edge to the lap line continuously along the seam or overlap areas. All dirt, gravel, or other debris shall be removed from the seam or overlap areas.

Prior to covering the GCL, the installer shall verify all exposed seams or overlaps and examine the GCL for any defects. At the judgment of the installer, a panel or section that becomes seriously damaged or hydrated shall be replaced. All repairs shall be made by placement of a patch of the same material over the damaged area at least 1 ft beyond the repair area. The GCL will be immediately covered and protected from precipitation by the overlaying geomembrane.

6.3.1e. Shear Strength Conformance Testing

Shear strength conformance tests shall be performed on the GCL to verify the interface shear strengths of the GCL with the appropriate material (HDPE geomembrane or compacted clay). The results of the shear strength conformance tests will be used to confirm that the actual interface shear strengths are equal to or greater than the interface shear strengths used in the stability analyses. Shear strength conformance tests on subsequent phases and/or cell development need not be performed if the same manufacturer and materials are used in the construction of the subsequent phase and/or cell. Conformance testing shall be in accordance with ASTM D 5321 or other suitable method.

6.3.2 Geomembrane

6.3.2a. Prequalification Testing

The geomembrane installer shall provide to the CQA Officer the test results from a qualified laboratory for the type and frequency of prequalification testing listed in Table A.1. The submittal shall include certification from the laboratory that the test results verify the manufacturer's guaranteed properties.

The CQA Officer shall direct the geosynthetics QA monitor firm to select a representative number of additional samples of the geomembrane for submittal to the monitor's geosynthetic laboratory for independent verification of the manufacturer's guaranteed properties.

The installer shall direct the test laboratory to submit the results of all laboratory results and certification to the Document Controller for filing as project records in accordance with Section 11.0.

6.3.2b. Installer Certification of Placement Surface

Prior to daily geomembrane placement, the installer shall provide to the CQA Officer daily "certificates of acceptance" (form CQAP-4.1) which document the installer's inspection and acceptance of the underlying surface as being suitable for the geomembrane installation (see Section 4.0).

All daily "certificates of acceptance" (form CQAP-4.1) shall be filed as project records in accordance with Section 11.0.

6.3.2c. Placement Testing for Seam Overlap

The contractor and installer shall arrange geomembrane sections such that the use of field seams is minimized and that horizontal seams are not used on side slopes. Seam overlaps shall be field measured by the installer to verify the requirement in Table A.1 is met for all seams within the geomembrane footprint. The CQA Officer shall direct the geosynthetics QA monitor firm to make independent measurements of a representative number of seam overlaps for additional verification of the requirement in Table A.1.

At completion of geomembrane placement, the installer shall provide the CQA Officer with "as-built" drawings of the geomembrane installation showing all seam locations and seam measurement locations.

6.3.2d. Placement Non-Destructive Testing

The installer shall conduct non-destructive testing of seams at the frequency specified in Table A.1. All seams shall be nondestructively tested over their full-length using a vacuum test unit, air pressure test or other method approved by the CQA Officer. Continuity testing will be completed as the seaming progresses.

The CQA Officer shall direct the geosynthetics QA monitor firm to monitor all non-destructive testing carried out by the installer.

The installer shall submit all non-destructive field testing results to the CQA Officer for filing as project records in accordance with Section 11.0.

Vacuum testing and air pressure testing procedures shall be as given in the following sections.

Vacuum Testing (Extruded Welds)

The following procedures are applicable to those processes which produce an extruded weld.

Equipment

The following equipment shall be used when conducting vacuum tests:

- A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a port hole or valve assembly, and a vacuum gauge,
- A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections,
- A rubber pressure/vacuum hose with fittings and connections,
- A bucket, and
- A soapy solution.

Procedures

The following procedures will be followed:

1. Energize the vacuum pump and reduce the tank pressure to approximately minus 5 psi (10 in. of Hg) gauge.
2. Wet a strip of geomembrane approximately 12 in. wide by 48 in. long (an area larger than the coverage size of the vacuum box) with the soapy solution.
3. Place the box over the wetted area.
4. Close the bleed valve and open the vacuum valve.
5. Verify that a leak tight seal is created.

6. For a period of not less than 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
7. If no bubble appears after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area, repeat the process.
8. All areas where soap bubbles appear will be marked and repaired and then retested until passing test results are obtained.

Air Pressure Testing (For Double Fusion Seam Only)

The following procedures are applicable to those processes which produce a double seam with an enclosed space.

Equipment

The equipment will be comprised of the following:

- An air pump (manual or motor driven) equipped with pressure gauge capable of generating and sustaining a pressure between 25 psi to 30 psi and mounted on a cushion to protect the geomembrane,
- A rubber hose with fittings and connections, and
- A sharp hollow needle, or other approved pressure feed device.

Procedures

The following procedures will be observed:

1. Both ends of the seam to be tested will be sealed.
2. A needle or other approved pressure feed device will be inserted into the tunnel created by the fusion weld.
3. A protective cushion will be inserted between the air pump and the geomembrane.
4. The air pump will be energized to a pressure between 25 psi and 30 psi. The valve will be closed, and the pressure will be sustained for approximately 5 minutes.
5. If loss of pressure exceeds 3 psi or does not stabilize, the faulty area will be located, then repaired and retested until passing test results are obtained.
6. At the conclusion of a passing air pressure test, the opposite end of the seam will be slit and subsequent drop in pressure will be monitored. This will ensure that the entire seam was completely tested.
7. Remove needle or other approved pressure feed device and seal.

6.3.2e. Placement Destructive Testing

General

Destructive seam tests shall be performed at randomly selected geomembrane locations. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

The CQA Officer shall direct the geosynthetics QA monitor firm to monitor all destructive testing carried out by the installer.

The installer shall submit the results of all destructive testing to the CQA Officer for filing as project records in accordance with Section 11.0.

Location and Frequency

The installer shall select locations where seam samples will be cut out for testing. Those locations shall be established as follows:

1. Selection will be at a minimum frequency of one test location per 500 ft of seam length. This minimum frequency is to be determined as an average taken throughout the entire area of placement.

2. Test locations will be determined during seaming at the installer's discretion. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of imperfect welding.

The CQA Officer shall direct the geosynthetics QA monitor firm to select and cut out a representative number of additional samples for independent laboratory testing.

Sampling Procedure

Samples will be cut as the seaming progresses in order to have laboratory test results before the geomembrane is covered by another material. The installer shall:

- Assign a number to each sample, and mark it accordingly,
- Record sample location on layout ("as-built") drawing, and
- Record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired. The continuity of the new seams in the repaired area shall be vacuum tested.

Field Testing

The installer shall test in the field, by tensiometer, two 1 in. wide sample strips from the samples identified for destructive testing; one for peel and one for shear. This testing shall include the independent samples obtained by the geosynthetics QA monitor firm. Field testing will prequalify samples for laboratory testing. The requirements and frequency for field testing shall be as provided in the table at the end of this section.

The installer shall conduct all field tests and mark all samples and portions with their number. The installer shall also log the date, time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description, and attach a copy to each sample portion.

Geosynthetic Quality Assurance Laboratory Testing

Prequalifying field tests shall identify samples for laboratory testing. The installer's quality assurance laboratory shall be as selected by the installer with concurrence of the CQA Officer.

Testing shall include shear strength and peel adhesion. At least five specimens shall be tested by the installer's laboratory for each method. Specimens shall be selected alternately by test from the samples (i.e., peel, shear). All laboratory testing shall be accordance with ASTM D 4437.

The CQA Officer shall direct the geosynthetic QA monitor firm to have additional samples tested for peel and strength by the monitor's independent geosynthetics laboratory as deemed necessary.

Procedures for Destructive Test Failure

The following procedures will apply whenever a sample fails a destructive test, whether the test was conducted in the laboratory or by field tensiometer. The installer has two options:

1. The installer may reconstruct the seam between any two passed test locations.

2. The installer may trace the welding path to an intermediate location at least 10 ft from the point of the failed test in each direction, and take a small sample for an additional field test at each location. If these additional samples pass the tests, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is reconstructed between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed.

All acceptable seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 150 ft of reconstructed seam, a sample taken from the zone in which the seam has been reconstructed must pass destructive testing.

The installer will document all actions taken in conjunction with destructive test failures.

Geomembrane Destructive Seam Tests and Frequency

Property	Test Method	60-mil HDPE	40-mil HDPE	40-mil LLDPE	Frequency
Seam Shear Strength	ASTM D 4437	120 ppi	80 ppi	44 ppi	See Note 1
Seam Peel Strength (hot wedge fusion)	ASTM D 4437	78 ppi	52 ppi	40 ppi	See Note 1
Seam Peel Strength (fillet extrusion)	ASTM D 4437	72 ppi	45 ppi	40 ppi	See Note 1

Notes:
1. Destructive testing of seams shall occur at a minimum frequency of once per 500 ft of seam length.
2. Values apply for both smooth and textured geomembranes.

6.3.3 Geotextile

6.3.3a. Prequalification Testing

The geotextile installer shall provide to the CQA Officer the test results from a qualified laboratory for the type and frequency of prequalification testing listed in Table A.1. The submittal shall include certification from the laboratory that the test results verify the manufacturer's guaranteed properties.

The CQA Officer shall direct the geosynthetics QA monitor firm to select a representative number of additional samples of the geomembrane for submittal to the monitor's geosynthetic laboratory for independent verification of the manufacturer's guaranteed properties.

The installer shall submit the results of all laboratory results and certification to the CQA Officer for filing as project records in accordance with Section 11.0.

6.3.3b. Installer Certification of Placement Surface

Prior to daily geotextile placement, the installer shall provide to the CQA Officer daily "certificates of acceptance" (form CQAP-4.1) which document the installer's inspection and acceptance of the underlying surface as being suitable for the geotextile installation (see Section 4.0).

All daily "certificates of acceptance" (form CQAP-4.1) shall be filed as project records in accordance with Section 11.0.

6.3.3c. Deployment

Incoming rolls of geotextile shall be inventoried and inspected by the installer. Manufacturer's certifications will be inspected for conformance with the requirements of this plan. Holes, tears, or other visible defects will be recorded in the CQA Officer's daily report and clearly marked on the synthetic for identification of necessary repairs.

The installer shall check that the geosynthetic installation conforms to the construction requirements and manufacturer's recommendations. The CQA Officer shall direct the geosynthetics QA monitor firm to oversee the inspections by the installer.

On slopes steeper than 10H:1V, all geotextiles shall be continuously sewn. Geotextiles shall be overlapped a minimum of 3 in. prior to seaming. This requirement does not apply to the leachate system filter fabric. All sewing shall be done using thread with physical, chemical, and ultraviolet high resistance properties equal to or exceeding those of the geotextile. The CQA Officer shall direct the geosynthetics QA monitor firm to make independent measurements of a representative number of seam overlaps for additional verification of the requirement in Table A.1.

The 10-oz. cushion geotextile (immediately above the geomembrane liner and beneath the drainage layer) shall be placed with vertical seams running up the slopes and into the anchor trench. Horizontal seams (perpendicular to the slope) shall be allowed on side slopes for the 4-oz. filter geotextile overlaying the drainage layer to facilitate staged construction of the drainage layer going up the slope. All overlaps shall be "shingled" so that water or other material can not run down the slope between the geotextile seams.

6.4 Drainage Media

6.4.1 Granular Drainage Layer

6.4.1a. Prequalification Testing

Each source of material for the drainage layer shall be tested for hydraulic conductivity and grain size analyses in accordance with Table A.1 to determine suitability of the source.

6.4.1b. Material Thickness Testing During Placement

The CQA Officer shall direct the survey firm to determine elevations at the top of the geotextile cushion and at the final constructed surface of the granular drainage layer using a 100 ft grid pattern (and the break points in slope) to verify attainment of the plan grades and elevations. To verify liner thickness, all horizontal survey coordinates shall be the same for the top of the cushion and final constructed surface. Side slope thicknesses will be verified using crest (top), midpoint, and toe documentation points.

The CQA officer may approve the use of thickness plates as an alternative method to surveying.

In no instance shall the field determined thickness be less than 1.0 ft. The measured depths and grades shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor.

6.4.1c. Gradation and Hydraulic Conductivity Testing During Placement

The CQA officer shall direct the soil test firm to take an initial sample of the granular drainage layer within the first 100 cu. yds. of material placement and test for hydraulic conductivity and grain size to confirm suitability of the source. Continuing sampling and testing shall be completed at the frequencies specified in Table A.1.

Compaction of the drainage layer shall not be allowed during placement to avoid breakdown of materials

Gradation tests may be considered passing provided the hydraulic conductivity requirements are met and the specified percentage of fines is not exceeded.

6.4.d. Certification of Work

The CQA Officer shall review the sampling and test results for the granular drainage layer and, if found in agreement with the prequalification and placement requirements, provide certification for the work using form CQAP 2.1.

6.4.2 Coarse Aggregate

6.4.2a. Prequalification Testing

Each source of material for the coarse aggregate shall be tested for hydraulic conductivity and grain size analyses in accordance with Table A.1 to determine suitability of the source.

6.4.2b. Material Placement

The CQA Officer shall direct that inspection of piping as provided in Section 6.5.1 be completed prior to placement of coarse aggregate around the piping. Compaction of the coarse aggregate shall not be allowed during placement to avoid breakdown of materials.

The CQA officer shall direct the soil test firm to take an initial sample of the coarse aggregate within the first 100 cu. yds. of material placement and test for hydraulic conductivity and grain size to confirm suitability of the source. Continuing sampling and testing shall be completed at the frequencies specified in Table A.1.

Gradation tests may be considered passing provided the hydraulic conductivity requirements are met and the specified percentage of fines is not exceeded.

6.4.2c. Certification of Work

The CQA Officer shall review the sampling and test results for the coarse aggregate and, if found in agreement with the prequalification and placement requirements, provide certification for the work using form CQAP 2.1.

6.5 Other Material Placement Testing

6.5.1 Placement testing of Leachate Piping System

The CQA Officer shall direct the surveyor to check the invert elevations and plan coordinates for the constructed piping system at the locations and frequencies specified in Table A.1.

The CQA Officer or other CQA staff shall inspect pile size, materials and connections including all components of the leachate collection and management systems to verify compliance with plan and specification requirements.

The measured grades and coordinates shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor.

The CQA Officer shall review the survey results for the leachate piping system and management systems and, if found in agreement with the placement requirements, provide certification for the work using form CQAP 2.1.

6.5.2 Placement Testing of Surface Water Management System

The CQA Officer shall direct the survey agency to determine the elevations and grades of the constructed berms and channels in accordance with the requirements and frequency specified in Table A.1.

The measured elevations and grades shall be documented on "as built" drawings furnished to the CQA Officer by the surveyor.

6.5.3 Placement Testing of Concrete

The CQA Officer shall direct the soil test firm to carry out placement testing for concrete in accordance with the requirements and frequency specified in Table A.1.

The contractor shall submit proposed concrete mix designs to the CQA Officer for review prior to ordering of concrete.

The CQA Officer shall review the concrete testing results and, if found in agreement with the placement requirements, provide certification for the work using form CQAP 2.1.

7.0 CORRECTIVE MEASURES

The CQA Officer shall reject and require replacement of all materials for which sampling, testing or inspection results show that prequalification requirements are not met. The CQA Officer shall also reject workmanship (and require corrective rework) for which sampling, testing or inspection results show that material placement requirements are not met. The lateral and/or vertical extent of corrective measures for rework shall be based on the frequency of testing and judgment of the CQA Officer.

The CQA Officer may neglect the occasional occurrence of failed moisture/density tests or laboratory hydraulic conductivity tests carried out for the low permeability soil liner provided the failed tests can be shown to be outliers and are not concentrated in one area or lift. The CQA officer shall provide written justification in the Daily Summary Report for assignment of failed tests as outliers.

8.0 DOCUMENTATION OF SAMPLING AND TESTING

8.1 Daily Summary Reports

A daily summary report shall be prepared by the CQA Officer, or under the direct supervision of the CQA Officer, during each day of activity. Form CQAP 8.1 *Daily Summary Report* shall serve as the base document to which the daily inspection reports (see Section 8.2) are to be attached.

Each report shall be signed and dated by the CQA Officer and CQA Officer-in-absentia. The original report (and attachments) shall be submitted to the Document Controller and filed as a project record in accordance with Section 11.0.

8.2 Daily Inspection Reports

A daily inspection report shall be prepared by the CQA Officer, or under the direct supervision of the CQA Officer. for each day that materials, or placement of materials, are being inspected, sampled or tested. Form CQAP 8.2 *Daily Inspection Report* shall serve as the base document to which the test data, photographic records, test results, etc. are to be attached.

Each report shall be signed and dated by the CQA Officer or CQA Officer-in-absentia. The original report (and attachments) shall be submitted to the CQA Officer who shall incorporate the report into the daily summary report.

8.3 Photographs

Photographs may be incorporated into the daily inspection report or daily summary report to provide a visual record of work progress, inspection/testing activity, construction work, or other items considered important to the report. The photographs, at a minimum, shall be furnished with the following information:

- The location, date and time of the photograph,
- A description of the item photographed including direction of view (N,S,E or W),
- Personnel, testing agencies, installers or contractors present, and
- Name of photographer.

9.0 FINAL CERTIFICATION REPORT

Upon completion of the construction contract (but before the landfill or gypsum stack is placed into service), the CQA Officer shall submit an acceptance report to the Illinois Environmental Protection Agency. The acceptance report shall contain the following:

- A certification by the CQA officer that the construction has been prepared and constructed in accordance with the engineering design.
- As-built drawings as specified herein, and
- All daily summary reports.

10.0 CONSTRUCTION MANAGEMENT ACTIVITIES

10.1 Requests for Information (RFIs)

The general contractor or installer may, after exercising due diligence to locate required information, request from the CQA Officer clarification or interpretation of the contract documents. The general contractor or installer shall make specific reference to the contract drawing(s) or specification(s) in question and include estimates of any cost or schedule impacts that could possibly be associated with the requested clarification or interpretation.

The general contractor or installer shall initiate the RFI in a timely manner using form CQAP-10.1 *Request for Information*. The CQA Officer shall, with reasonable promptness, respond to the RFI on the same form CQAP-10.1 and return a copy of the completed form to the party making the request as final disposition of the matter.

Additional copies of the completed form shall be distributed as directed by the CQA Officer. All RFI's shall be filed as project records in accordance with Section 11.0.

10.2 Review of Contractor Submittals

The Contractor shall submit shop drawings, product data and samples to the CQA Officer in accordance with the requirements of the project specifications and with such promptness as to cause no delay of the work. The Contractor shall not authorize purchase, fabrication, erection, processing or shipping of any items associated with the submittal until review of the shop drawings, product data or samples has been completed by the CQA Officer and no resubmittals are required by the CQA Officer.

All submittals from subcontractors shall be reviewed first by the Contractor to satisfy the contractor's responsibilities for lengths, dimensions, quantities, means and methods, and other such items.

The CQA Officer and/or Design Engineer shall review the submittals for conformance with design concepts and conformance with the information shown in the contract documents. Upon completion of review, the CQA Officer shall return the submittal to the Contractor with one of the following notations for each item in the submittal:

- No exceptions taken.
- Furnish as corrected,
- Revise and resubmit,
- Submit specified item, or
- Rejected.

The Contractor shall resubmit corrected shop drawings, product data or samples for those items noted as requiring revision or submission or noted as rejected.

The CQA Officer shall maintain copies of all submittals and a log documenting submittal descriptions, dates of receipt, dates of return, review personnel, and actions taken on the submittals. Copies of submittals and the log shall be filed as project records in accordance with Section 11.0.

10.3 Field Change Order Process

The Contractor shall be responsible for preparing requests for field change order (FCO) in accordance with AREG procedures and submitting the FCO requests on the appropriate AREG FCO form to the CQA Officer.

The CQA Officer shall be responsible for reviewing the FCO with the Design Engineer, determining agreement or non-agreement with the requested change, and submitting the documented decision to the Contractor on the appropriate AREG CFO form with copies to the Ameren Project Manager. Agreement to the FCO shall require signature approval of the Ameren Project Manager.

The CQA Officer shall maintain an on-going log of authorized FCOs and running balance of project costs. Copies of the FCOs and log of authorized FCOs shall be retained as project records in accordance with Section 11.0.

11.0 DOCUMENT CONTROL AND PROJECT RECORDS

11.1 CQA Plan

The CQA officer shall control the preparation, issue and revisions of the CQA Plan so that correct documents are being employed by the project participants. The CQA Plan, including all changes thereto, shall be reviewed for adequacy and approved for release by the CQA Officer and Ameren Project Manager.

The Document Controller shall issue controlled copies of the CQA Plan and maintain all records associated with its preparation, issue and revisions.

11.2 Project Records

The maintenance of project records during construction of the landfill shall be the responsibility of the Document Controller and shall be protected against damage, deterioration, and loss. Records shall be maintained in a manner as to be readily identifiable and retrievable.

Control of CQA documents and samples during the construction process shall be as shown in Figure 11.1. All original CQA documents from both the field and laboratories shall be ultimately furnished to the Document Controller for filing and maintenance. Samples may be discarded after testing and documentation of results is complete.

Project records shall be made available to the Ameren Project Manager as requested during construction and, when requested, shall be turned over to AERG at completion of the construction contract.

Records shall include, but not be limited to, the following:

- CQA Plan (all revision levels),
- CQA Plan documentation (reviews, issuance and revisions),
- Meeting minutes,
- Daily inspection reports (form CQAP 8.1),
- Daily summary reports (form CQAP 8.2),
- Certificates of acceptance by geosynthetic installers,
- CQA certifications (form CQAP 2.1),
- Certificates of calibration for inspection, measuring and test equipment,
- Report for test soil liner,
- Report for compacted soil liner "acceptable zone",
- "As-built" drawings,
- Laboratory test results for soils, drainage media, and concrete,
- Laboratory test results for geosynthetics,
- Laboratory certifications of manufacturer's guaranteed properties for geosynthetics,
- Contractor Requests for Field Change Order (AERG FCO form),

- Log of Authorized Field Change Orders,
- Shop drawing submittals,
- Log of shop drawing submittals,
- Requests for information from contractor/installers,
- Responses to requests for information, and
- Final certification report.

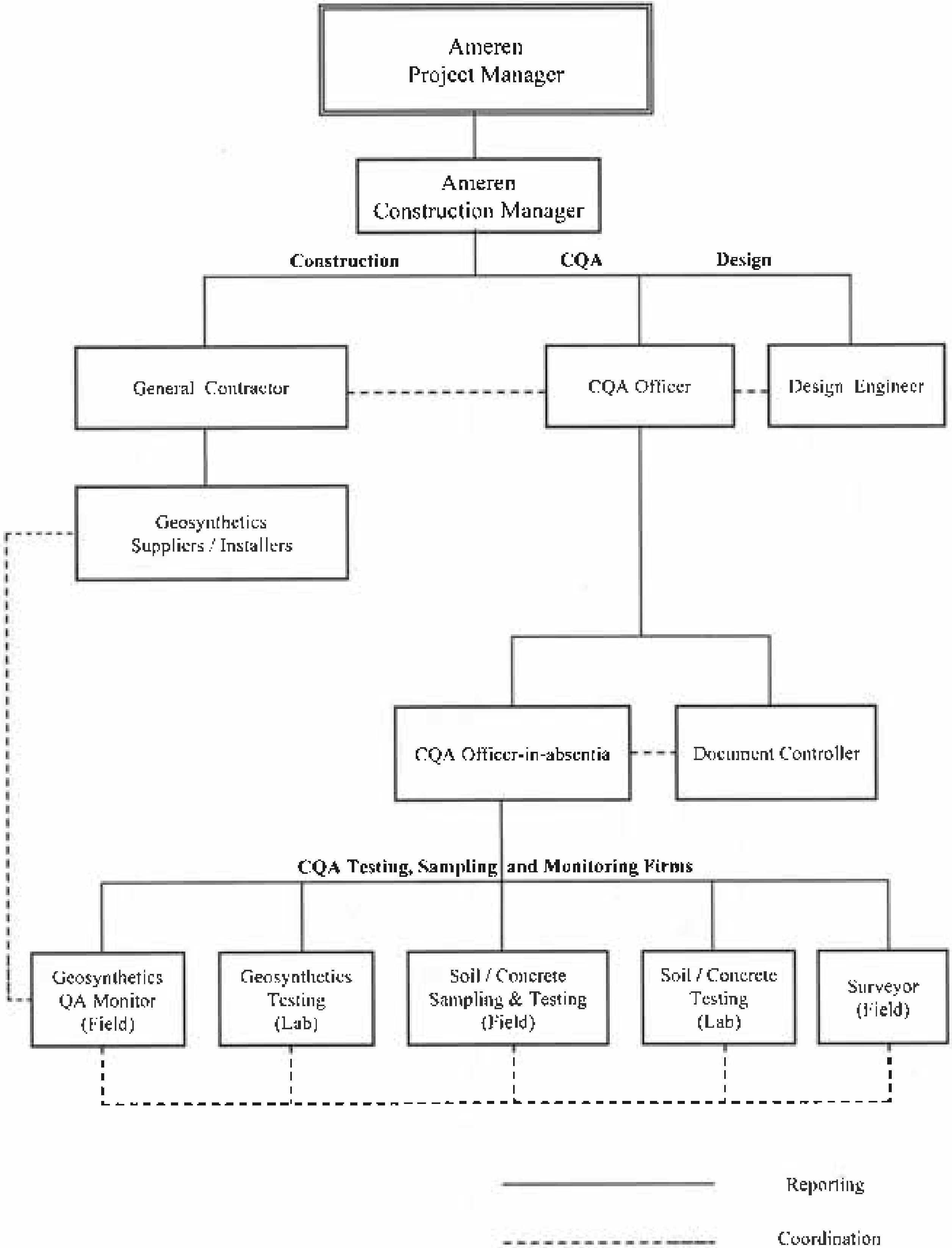

Figure 2.1 Project Organization Chart

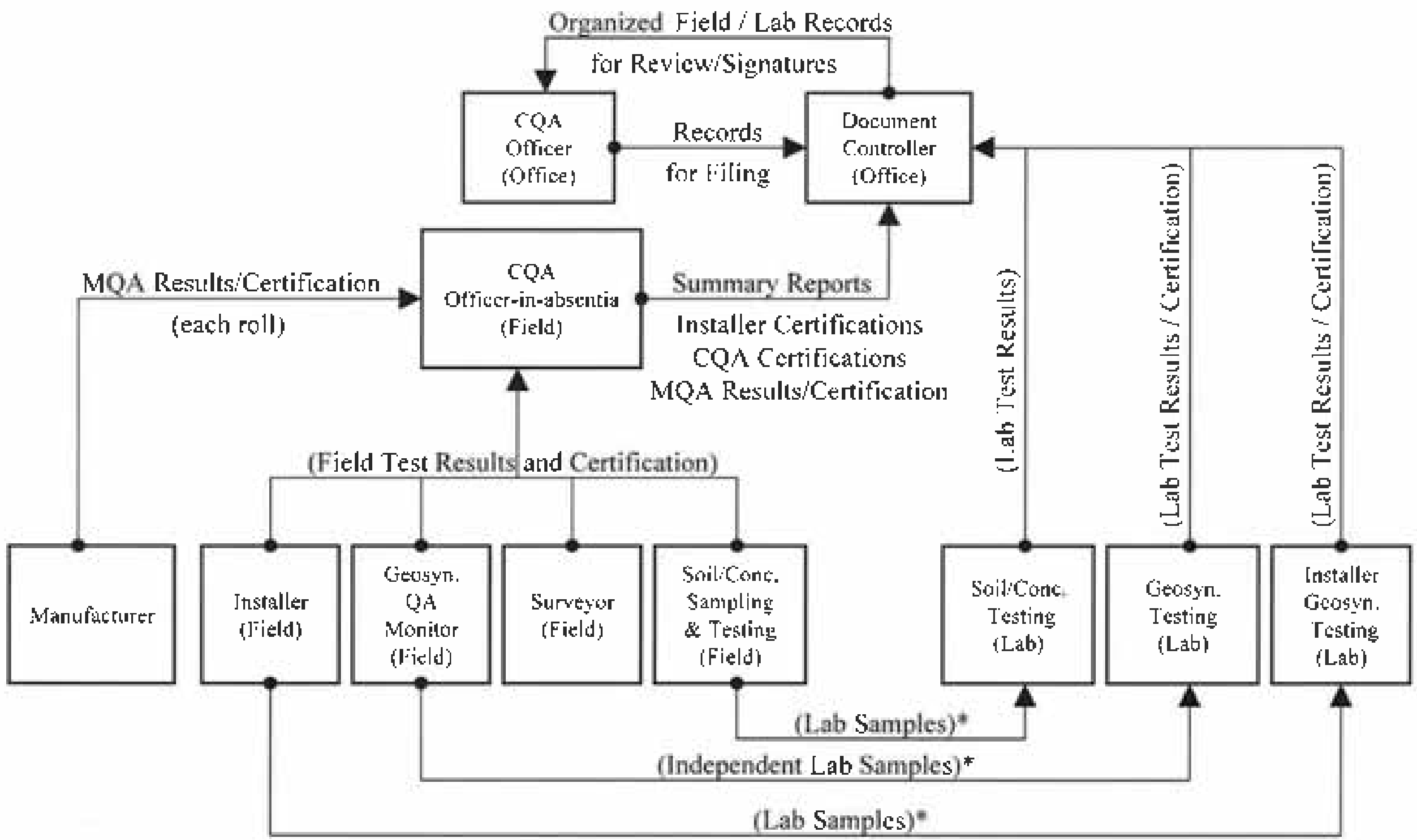

Figure 11.1 Control of CQA Documents and Samples

* Transmittal letters shall direct the original lab test results/certifications to be sent to Document Controller with copies to submitting installer or testing/monitoring agency.

Appendix A

Material Testing and Frequency

TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
SOILS - PREQUALIFICATION TESTING			
FOUNDATION FILL & BERMS			CQA Officer
Standard Proctor Curve - ASTM D698		Per soil type (See Note 2)	
Atterberg Limits - ASTM D4318	PI < 5, LL < 20%	Per soil type	
Grain Size Analysis - ASTM D422	200 Sieve > 50%	Per soil type	
Hydraulic Conductivity - ASTM D5084	See Note 1	Per soil type	
		Per soil type	
SOIL LINER			CQA Officer
Standard Proctor Curve - ASTM D698	"Acceptable Zone" see Appendix B	Per soil type	
Atterberg Limits - ASTM D4318	USCS Classification	Per soil type	
Grain Size Analysis - ASTM D422	USCS Classification	Per soil type	
Hydraulic Conductivity - ASTM D5084	1.0 x 10[illegible] cm/sec	Per soil type	
Develop "Acceptable Zone"	"Acceptable Zone" see Appendix B	Per soil type	
3' PROTECTIVE FINAL SOIL COVER			Not Applicable to this Contract
Standard Proctor Curve - ASTM D698*	"Acceptable Zone" see Appendix B	Per soil type*	
Atterberg Limits - ASTM D4318*	USCS Classification	Per soil type*	
Grain Size Analysis - ASTM D422*	USCS Classification	Per soil type*	
Hydraulic Conductivity - ASTM D5084	See Note 1	Per soil type*	
Develop "Acceptable Zone"*	"Acceptable Zone" see Appendix B	Per soil type*	
Suitable for Vegetation	Visual Acceptance	Per soil type	

* On the first two feet of the protective layer only. (The third foot is topsoil.)

Note 1: There is no specific requirement for hydraulic conductivity for the foundation, berms and final cover soils as they are not part of the liner system. However, insitu materials on the site generally exhibit hydraulic conductivities in the range of 1 x 10[illegible] cm/sec to 1 x 10[illegible] cm/sec. The construction contractor will attempt to utilize the most impermeable materials available (as identified visually) when constructing foundation fill and berms. For purposes of a complete construction record, hydraulic conductivity of placed foundation fill and side berms will be field tested at a rate of 1 test per each 10,000 cubic yards of material placed, although no specific threshold values are required.

Note 2: "Soil Type" refers to differences in soil color and/or textural consistency that would be indicative of differences in soil characteristics.

Note for Geosynthetics: See Section 6.0 of the CQA Plan for additional GCL and geomembrane testing requirements.

TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
SOILS - MATERIAL PLACEMENT TESTING			
FOUNDATION			CQA Officer
Survey	0 to -0.5 feet Design Grade	100-foot grid	
FOUNDATION FILL & BERMS			CQA Officer
Density/Moisture - ASTM D2922 & D3017	90% Standard Proctor Density and -1% to Optimum Moisture Content	1 per 10,000 cubic yards (minimum 1 per compacted lift)	
Strength	0.5 tsf (hand-held penetrometer)	1 per 10,000 cubic yards (minimum 1 per compacted lift)	
Hydraulic Conductivity - ASTM D5084	See Note 1	1 per 10,000 cubic yards	
Sieve and Hydrometer Analysis of Soils - ASTM D422	200 Sieve > 50%	Per Soil Type	
Liquid Limit, Plastic Limit and Plasticity Index (Atterberg Limits) - ASTM D4318	PI > 5, LL > 20	Per Soil Type	
SOIL LINER			CQA Officer
Thickness	3 feet minimum thickness (base), 1 foot minimum thickness (cover), and maintain design grade	100-foot grid	
Density/Moisture - ASTM D2922 & D3017	95% Standard Proctor Density and Optimum to +5% Moisture Content in accordance with "Acceptable Zone" (see Note 3)	1 per acre per lift or 1 per 1,000 cubic yards	
Strength	0.5 tsf (hand-held penetrometer)	1 per acre per lift or 1 per 1,000 cubic yards	
Hydraulic Conductivity - ASTM D5084	See Note 4	1 per 10,000 cubic yards	
3' PROTECTIVE FINAL SOIL COVER			Not Applicable to this Contract
Thickness	3 feet minimum total thickness including 1 foot of topsoil - maintain design grade	100-foot grid	
Density/Moisture* - ASTM D2922 & D3017	90% Standard Proctor Density and -3% to Optimum Moisture Content	1 per 10,000 cubic yards (minimum 1 per compacted lift)	
Strength*	0.5 tsf (hand-held penetrometer)	1 per 10,000 cubic yards (minimum 1 per compacted lift)	

* On the first two feet of the protective layer only. (The third foot is topsoil.)

Note 1 There is no specific requirement for hydraulic conductivity for the foundation, berms and final cover soils as they are not part of the liner system. However, insitu materials on the site generally exhibit hydraulic conductivities in the range of 1 x 10[illegible] cm/sec to 1 x 10[illegible] cm/sec. The construction contractor will attempt to utilize the most impermeable materials available (as identified visually) when constructing foundation fill and berms. For purposes of a complete construction record, hydraulic conductivity of placed foundation fill and side berms will be field tested at a rate of 1 test per each 10,000 cubic yards of material placed, although no specific threshhold values are required.

Note 3 Acceptable Zone" restriction applies only to the soil liner for the landfill. The gypsum stack soil liner shall only be required to meet the compaction and moisture content specification.

Note 4 The hydraulic conductivity for the landfill soil liner is 1.0 x 10[illegible] cm/sec(maximum) and for the gypsum stack soil liner is 1.0 x 10[illegible] cm/sec (maximum).

TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
GEOSYNTHETICS - PREQUALIFICATION TESTING			
GEOMEMBRANES (60 mil smooth, 60 mil textured, 40 mil textured)			Installer
Raw Materials	Manufacturer's List of Guaranteed Properties	All rolls	
Geomembrane Properties	Manufacturer's List of Guaranteed Properties	All rolls	
Puncture Resistance - ASTM D4833	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
Tear Resistance - ASTM D1004	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
Thickness - ASTM D5199/D5994	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
Tensile Strength and Elongation - ASTM D638 (Modified) or D6693	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
GEOTEXTILES (Non-Woven, 4 ounce, 10 ounce, 16 ounce)			Installer
Geotextile Properties	Manufacturer's List of Guaranteed Properties	All rolls	
Mass per Unit Area - ASTM D5261	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	
Grab Tensile Strength - ASTM D4632	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	
Trapezoidal Tear Strength - ASTM D4533	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	
Apparent Opening Size - ASTM D4751	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	
Puncture Resistance - ASTM D3787	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	
Permittivity - ASTM D4491	Manufacturer's List of Guaranteed Properties	1 per lot or one per 100,000 square feet, whichever is greater. Sample 3 feet wide by the full roll width	

TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
GEOSYNTHETICS - PREQUALIFICATION TESTING			
GEOSYNTHETIC CLAY LINER (GCL)			Installer
GCL Properties	Manufacturer's List of Guaranteed Properties	All rolls	
Bentonite Mass/Area - ASTM D5993	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
Grab Tensile Strength - ASTM D4632	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
Peel Strength - ASTM D4632	Manufacturer's List of Guaranteed Properties	1 per 100,000 square feet or per raw material batch, whichever is greater. Sample 3 feet wide by the full roll width	
GEOSYNTHETICS - MATERIAL PLACEMENT TESTING			
GEOMEMBRANES (60 mil smooth, 60 mil textured, 40 mil textured)			Installer
Seam Overlap	3" to 4"	All Seams	
Non-Destructive Testing	As per Section 6.3.2d of CQA Plan	All Seams	
Destructive Testing	As per Section 6.3.2e of CQA Plan	Minimum One Every 500 Feet	
GEOTEXTILES (Non-Woven, 4 ounce, 10 ounce, 16 ounce)			Installer
Seam Overlap	3" to 4"	All Seams	
Installation	Physical Installation per Section 6.3.3c of CQA Plan	None	
GEOSYNTHETIC CLAY LINER (GCL)			Installer
Seam Overlap	As per Section 6.3.1d of CQA Plan	All Seams	
Installation	Physical Installation per Section 6.3.1e of CQA Plan	None	

TABLE A.1: MATERIAL TESTING & FREQUENCY

Property/Test Method	Requirement/Specification	Frequency	Responsibility
DRAINAGE MEDIA - PREQUALIFICATION TESTING			
GRANULAR DRAINAGE LAYER			
Hydraulic Conductivity - ASTM D2434	1.0×10^{-3} cm/sec (Minimum)	One Test per Source	CQA Officer
Grain Size Analysis - ASTM D422	Field Established Based on Hydraulic Conductivity (Fines Passing #200<5%)	One Test per Source	
COARSE AGGREGATE			
Hydraulic Conductivity - ASTM D2434	1.0×10^{-1} cm/sec (Minimum)	One Test per Source	CQA Officer
Grain Size Analysis - ASTM D422	Field Established Based on Hydraulic Conductivity (Fines Passing #200<5%)	One Test per Source	
DRAINAGE MEDIA - MATERIAL PLACEMENT TESTING			
GRANULAR DRAINAGE LAYER			
Thickness	One Foot Minimum Thickness	100 Foot Grid	CQA Officer
Gradation - ASTM D422	Field Established Based on Hydraulic Conductivity (Fines Passing #200 < 5%)	1 per 3,000 cubic yards	
Hydraulic Conductivity - ASTM D2434	1.0×10^{-3} cm/sec (Minimum)	1 per 10,000 cubic yards	
COARSE AGGREGATE			
Gradation - ASTM D422	Field Established Based on Hydraulic Conductivity (Fines Passing #200 < 5%)	1 per 3,000 cubic yards	CQA Officer
Hydraulic Conductivity - ASTM D2434	1.0×10^{-1} cm/sec (Minimum)	1 per 10,000 cubic yards	

TABLE A.1: MATERIAL TESTING & FREQUENCY

OTHER MATERIAL PLACEMENT TESTING REQUIREMENTS

Property/Test Method	Requirement/Specification	Frequency	Responsibility
LEACHATE PIPING SYSTEM ELEVATIONS & LOCATIONS			CQA Officer
Survey	Elevation +/- 0.1 feet with no adverse slopes. Plan location +/- 0.5 feet.	Every 100 feet and connections	
Welds and Connections	Visual Inspection	Each connection	
SURFACE WATER MANAGEMENT SYSTEM			CQA Officer
Survey	Field established for positive drainage (+/- 0.4 feet)	Inlet and Outlet and every 100 lineal feet along ditch channel	
CONCRETE			CQA Officer
Slump - ASTM C143	2" to 4" at time of placement	1 per 25 cubic yards or minimum 1 per day	
Air Entrainment - ASTM C231	5% to 7% at time of placement	1 per 100 cubic yards or minimum 1 per day	
Compressive Strength - ASTM C31 and C39	3,500 psi at 28 days	2 cylinders per 50 cubic yards or minimum 2 cylinders per day	
Delivery Time - ASTM C94	Total Mixing and Delivery Time Less than 1.5 Hours	Each Delivery	

Appendix B

Acceptable Zone Procedure

PROCEDURE FOR DETERMINATION OF SOIL LINER ACCEPTABLE ZONE OF COMPACTION AND MOISTURE CONTENT

INTRODUCTION

One of the most significant factors affecting the performance of compacted soil liners is the adequate control of water content and dry unit weight during construction. A carefully written compaction specification will result in a compacted soil liner achieving the required hydraulic conductivity while also satisfying other factors affecting performance such as strength, compressibility, and resistance to desiccation. Because a soil liner is meant to be a hydraulic barrier, hydraulic conductivity requirements are the primary factor affecting the criteria of a compaction specification. The specification should be then tightened as necessary to meet other performance standards.

For this project, the specification will require that the soil be compacted to at least 95 percent maximum dry density as obtained from the Standard Proctor test per ASTM D 698, with a moisture range of optimum to 5 percentage points wet of optimum. Testing of the proposed liner soils will be performed to determine its acceptable density and moisture content zone for a maximum hydraulic conductivity of 1.0×10^{-6} cm/sec for the final cover and base liner. Research work performed by Benson and Daniel (1990) shows that the acceptable zone can be expected to parallel a "line of optimums." This procedure should be run when a new source of soil is selected for liner construction or when the Proctor density changes by 10 pcf or more.

PROCEDURE

The following steps will be performed during prequalification of a soil source for liner construction. The source investigation will identify consistency of the soil and have completed soil index tests including grain size distribution and Atterberg Limit determinations. Once the initial index testing is complete, a proper value for Proctor density can be selected, and then the following steps can be followed.

- Compact three samples at a controlled moisture of ±1 percent of optimum moisture at approximately 97 percent to 93 percent of standard Proctor maximum dry density. These samples should be tested for hydraulic conductivity using ASTM D 5084. If all samples pass, it can be assumed as confirmation that the specified 95 percent of maximum dry density is an appropriate lower density range.

- If all three initial hydraulic conductivity test results are $\leq 1.0 \times 10^{-6}$ cm/sec for the base liner and the final cover, then three more samples shall be prepared to confirm the moisture content range. Using approximately 93 percent to 95 percent dry density, prepare one sample at -1 points (dry of optimum), one at +3 points and one at +8 points of optimum moisture content. Test these new samples for hydraulic conductivity using ASTM D 5084. If all samples pass, it can be assumed as confirmation that the optimum to +5 percentage points is an appropriate moisture content range.

- If the first two steps do not confirm the permeability window, the CQA Officer will determine if the soil will be used for construction. If it will be used, then further testing can be performed to define a smaller acceptable zone.

- In some cases, the borrow sources may be so variable that composting of the soil will be required for testing. In these cases, three or four Proctor tests should be performed to determine the range of maximum dry density. If the range of maximum dry densities is less than 10 pcf, a composite can be tested as outlined above. If the range of maximum dry densities is greater, the highest and lowest soil values should be tested to determine an acceptable range.

Selection of density value shall be based on inspector's identification of soil percentages. Prequalification testing will assure the conformance of permeability.

USE OF THE ACCEPTABLE RANGE

During construction, the acceptable window will be verified by the specified interval of construction sample testing. Each sample will be tested for density, moisture, grain size, and Atterberg Limits when submitted for hydraulic conductivity testing. The results can then be compared to prequalification testing to verify soil consistency and passing hydraulic conductivity. These tests can also be plotted on the Proctor curve as documentation of acceptable zone or as a demonstration that the zone can be enlarged.

AECOM

Appendix E: Operation and Maintenance Manual, Duck Creek Energy Center, Gypsum Management Facility

Operation and Maintenance Manual
Illinois Power Resources Generating, LLC
Duck Creek Energy Center
Gypsum Management Facility
Fulton County, Illinois

Prepared For:

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Revised August 2014

OPERATION AND MAINTENANCE MANUAL
DUCK CREEK ENERGY CENTER
GYPSUM MANAGEMENT FACILITY
FULTON COUNTY, ILLINOIS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

SECTION 1.0
GENERAL

This operation and maintenance (O&M) manual outlines objectives, proposed policies, responsibilities, and procedures for Illinois Power Resources Generating, LLC (IPRG) and Contractor personnel who are responsible for the management of the Duck Creek Energy Center Gypsum Management Facility (GMF). The GMF incorporates two reservoirs, the Gypsum Stack and the Recycle Pond, for processing and storing gypsum.

1.1 REASONS FOR DEVELOPMENT OF THE O&M MANUAL

In addition to providing guidance to the IPRG and Contractor personnel who are responsible for the operations and maintenance of Duck Creek GMF, this manual has been prepared in accordance with state regulations. The State of Illinois Rivers, Lakes and Streams Act, (615 ILCS 5) Paragraph 23a includes the statement "The Department is authorized to carry out inspections of any dam within the State, and to establish standards and issue permits for the safe construction of new dams and the reconstruction, repair, operation and maintenance of all existing dams." (emphasis added).

Part 3702 of the 17 Illinois Administrative Code, Chapter I entitled the "Construction and Maintenance of Dams" details the requirements to obtain a permit for the construction, operation, and maintenance of a dam. Section 3702.40 b) includes the following statement:

> "5) As a condition of each permit, the dam owner shall submit a maintenance plan detailing the procedures and schedules to be followed to maintain the dam and its appurtenances in a reasonable state of repair."

Thus it is a requirement of all dam owners who have dams which fall under the jurisdiction of the Illinois Department of Natural Resources to operate and maintain them safely.

As a dam owner, IPRG is responsible for the safety of the public and for maintaining the structures at the facility for both safety and economy. The overall public interest is served by providing a document to serve as a basis for the safe and economical operation and maintenance of the dam during both emergency and day-to-day conditions.

1.2 GENERAL RESPONSIBILITIES CONCERNING DAMS

IPRG is responsible for the operation and maintenance of the Gypsum Stack Dam and the Recycle Pond Dam. These responsibilities include general maintenance (mowing, removing debris from decants, placing riprap where needed, etc.), operation, inspection and emergency action decisions. IPRG plans to enter into an agreement with an independent contractor to perform certain aspects of the operation and maintenance of the GMF.

SECTION 2.0
DEFINITIONS

Abutment - That part of the valley side or concrete walls against which the dam is constructed. Right and left abutments are those on respective sides of an observer when viewed looking downstream.

Appurtenant Works - The structures or machinery auxiliary to dams which are built to operate and maintain dams; such as outlet works, spillways, gates, valves, channels, etc.

Boil - A stream of water discharging from the ground surface downstream of the dam carrying with it a volume of soil which is distributed around the hole formed by the discharging water.

Berm - A horizontal step or bench in the sloping profile of an embankment dam.

Breach - A break, gap, or opening (failure) in a dam which releases impoundment water.

Dam - A barrier built for impounding or diverting the flow of water.

Dike (Levee) - An embankment, usually applied to embankments or structures built to protect land from flooding.

Drain, Layer or Blanket - A layer of pervious material in a dam to facilitate the drainage of the embankment including such items as a toe drain, a weephole, and a chimney drain.

Drawdown - The resultant lowering of the water surface level due to the release of water from the impoundment.

Duck Creek Plant Datum - the Duck Creek Station horizontal and vertical coordinate system ("Plant System") on which the design and construction survey information, and elevations used in this document is based. Reference the control points shown on the construction drawings (Drawing C180-C102-04, Rev 3, or later) for horizontal and vertical control information.

Embankment - Fill material, usually rock or earth, placed with sloping sides.

Earthen Dam - Any dam constructed of excavated natural materials.

Failure - An incident resulting in the uncontrolled release of water from the dam.

Freeboard - The vertical distance between a stated water level and the top of the dam.

Gate or Valve - In general, a device in which a leaf or member is moved across the waterway to control or stop the flow.

Groin - The junction of the upstream or downstream face of the dam with the valley wall.

Maintenance - The upkeep, involving labor and materials, necessary for efficient operation of dams and their appurtenant works.

Operation - The administration, management, and performance needed to operate the dam and appurtenant works.

Operation and Maintenance Inspection - Inspections conducted by the dam Operator. These inspections are frequent visual "Walk-around" inspections of the dam surface and appurtenant works.

Outlet - An opening through which water can freely discharge for a particular purpose from an impoundment.

Phreatic Surface - The upper surface of saturation in an embankment.

Piping - The progressive development of internal erosion by seepage, appearing downstream as a hole or seam, discharging water that contains soil particles.

Riprap - A layer of large stones, broken rock or precast blocks placed in a random fashion usually on the upstream slope of an embankment dam, on a reservoir shore, or on the sides of a channel as a protection against wave and ice action.

Silt/Sediment - Soil particles and debris in an impoundment.

Slump/Slide Area - A portion of earth embankment which moves downslope, sometimes suddenly, often with cracks developing.

Spillway System - A structure or structures over or through which flows are discharged. If the flow is controlled by gates, it is considered a controlled spillway. If the elevation of the spillway crest is the only control of the flows, it is considered an uncontrolled spillway.

Emergency Spillway - A spillway designed to operate very infrequently, only during exceptionally large floods, usually constructed of materials expected to erode slowly.

Principal Spillway - The main spillway which controls both normal and flood flows and is usually constructed of non-erodable materials.

Auxiliary Spillway - A spillway which works in conjunction with the principal spillway to control flood flows and is usually constructed of non-erodable materials.

Stilling Basin - A basin constructed to dissipate the energy of fast flowing water, such as from a spillway, and to protect the streambed from erosion.

Toe of Embankment - The junction of the face of the dam with the ground surface in the floodplain upstream or downstream of the dam.

SECTION 3.0
INFORMATION ABOUT THE DAMS

3.1 LOCATION

The Gypsum Stack and Recycle Pond Dams are located in the NW 1/4 of Section 18, Township 6 North, Range 5 East of the Forth Principal Meridian in Fulton County, Illinois. More specifically, the dams are located east of Bethel Cemetery Road approximately 2 miles southeast of Canton, Illinois. A map showing the location of the dams is included in Appendix A.

3.2 DESCRIPTION OF DAM AND APPURTENANCES

The gypsum stack dam has a maximum earthen embankment height of 32 ft and a maximum impounding capacity of 773 acre-ft, measured at the top of the earthen dam elevation of 620 ft per Duck Creek Plant Datum (EL 620). However, due to the "stacking" of gypsum above the top of the earthen dam, the total volume within the completed gypsum stack will be approximately 2256 acre-ft. The recycle pond dam has a maximum embankment height of 41 ft and a maximum impounding capacity of 150 acre-ft (measured at the top of dam elevation of 615 ft).

The gypsum stack dam has a single high density polyethylene (HDPE) lined spillway (transfer channel) which discharges to the recycle pond. The transfer channel is a trapezoidal channel with 3H:1V side slopes. The transfer channel transitions from a 16-ft bottom width at an invert elevation of 614.0 ft at the upstream end, to a 35-ft bottom width at an invert elevation of 609.0 ft at the downstream end. A 2-ft tall HDPE covered concrete weir, located near the upstream end of the transfer channel, is fitted with stop logs capable of raising the discharge control elevation to 616.0 ft. To protect the HDPE liner from abrasion during flows, the transfer channel and a portion of the recycle pond dam incorporate an additional sacrificial layer of HDPE at the location where the transfer channel discharges to the recycle pond.

The emergency spillway for the recycle pond consists of four 42-inch diameter HDPE pipes which discharge into a riprap lined plunge pool. The upstream inverts of the pipes are at EL 610.0 and the downstream inverts are at EL 607.0. The emergency spillway has been provided in the event of an accidental overfilling of the recycle pond or catastrophic rainfall only. It is not expected to be activated during the life of the facility.

Pertinent data about the dams, appurtenant works, and reservoirs are presented in Appendix B.

3.3 SIZE CLASSIFICATION

The gypsum stack earthen dam has a maximum embankment height of 32 ft and a maximum impounding capacity of 773 acre-ft (measured at the top of dam elevation of 620 ft). Based on IDNR criteria, the gypsum stack earthen dam is classified as a small-size dam. However, since the gypsum stack is planned to ultimately meet or exceed 100 ft in height, the gypsum stack will eventually be classified as a large-size dam.

The recycle pond dam has a maximum embankment height of 41 ft and a maximum impounding capacity of 150 acre-ft (measured at the top of dam elevation 615 ft). Since the recycle pond dam embankment exceeds 40 ft in height, it is classified as an intermediate-size dam.

3.4 HAZARD CLASSIFICATION

The breach wave resulting from a failure of either dam is expected to be contained within the Duck Creek Reservoir located immediately downstream. Considering the low probability for causing loss of life or economic loss to adjacent landowners, both dams are classified as CLASS III, LOW HAZARD POTENTIAL dams.

SECTION 4.0
OPERATIONS ACTIVITIES

The operations plan describes the proposed operation of the Duck Creek Gypsum Management Facility (GMF) which includes the gypsum stack and the recycle pond.

4.1 SITE OPERATIONS

The GMF will receive flue gas desulfurization sludge (gypsum) from the Duck Creek Energy Center (the Plant). Gypsum will be transported to the GMF in slurry form (approximately 20 percent solids) and allowed to settle. Clarified process water will then be siphoned or decanted to the recycle pond and returned to the Plant for reuse via pipeline.

The GMF will potentially receive gypsum slurry 24 hours per day, seven days per week. Routine operation and maintenance activities are expected to be conducted during day shift hours. The filling times and staging chronology included in this document are calculated from gypsum production rates estimated at 23,500 tons per month, which is based on the plant burning high sulfur coal (6.8 lbs of SO_2 per million BTU) at a 90% capacity factor. The sluice and process water return rates referenced in this document are per the Hitachi Power Systems America, Ltd. MATERIAL BALANCE Case Study: 4,131 mmBtu/hr Drawing No. 0013-361-110-0381 Rev. B dated 3-19-07. Variations in these parameters would result in variations in the estimated chronology and flow rates.

The Plant is a restricted access location. A series of fences and gates exist to prevent unauthorized access to the property. The proposed GMF is located within the restricted plant confines, and is, therefore, not accessible to the general public.

4.2 PERSONNEL

The proposed GMF will be owned and operated by IPRG. Corporate offices are located in Houston, Texas. IPRG plans to enter into an agreement with an independent Contractor to perform certain aspects of the operation and maintenance of the GMF. The contractual operator (Operator) of the gypsum stack will be responsible for daily operation and maintenance of the gypsum stack, recycle pond and peripheral areas.

4.3 OPERATION OF VAULTS AND VALVES

IPRG personnel will be responsible for the operation of the valves which control the flow of slurry and water between the Plant, recycle pond and gypsum stack to the first valve vault located at the recycle pond entrance road. Beyond that point, the Operator will be responsible for distribution of gypsum slurry to various areas of the gypsum stack (this includes the valve vaults on the mid-western side of the gypsum stack and the north side of the gypsum stack). Two redundant pipes will carry the gypsum slurry from the plant. Although only one pipe will be in use at any time, conditions at the plant may result in a discharge pipe switch at any time. BOTH PIPES MUST BE AVAILABLE TO DISCHARGE GYPSUM AT ALL TIMES WHEN

THE PLANT IS OPERATING. Valves to both pipes must be open, and the ends of both pipes must be positioned so that there would be no restrictions to gypsum discharge at any time.

4.4 GYPSUM MANAGEMENT FACILITY STARTUP

The major components of the GMF consist of:

- The gypsum stack;
- The recycle pond;
- The HDPE-lined earthen transfer channel that connects the two structures, and through which clarified process water will be decanted from the gypsum stack into the recycle pond; and
- The recycle pond decant system and pump-house, through which process water will be returned to the Plant for reuse.

Upon completion of the recycle pond construction, the recycle pond will be partially filled with water pumped from the Plant or from Duck Creek Reservoir. The recycle pond pumps will be commissioned and then shut off pending the introduction of slurry into the gypsum stack. Procedures for these operations are discussed in the following sections.

4.4.1 Siphon Installation and Operation

The bottom of the gypsum stack is approximately 29 ft below the transfer channel invert elevation of 614 ft. During the period when the gypsum sluicing and stacking operations are conducted below the transfer channel elevation, clarified water must be siphoned from the gypsum stack to the recycle pond. Based on a slurry discharge rate of 653 gal/minute (gpm), and an average reclaim water return rate of 626 gpm, a minimum of two redundant (2) 10-inch diameter HDPE siphons should be primed and operable at all times. Installation of the siphon pipes and valves is included in the original GMF construction.

Each of the siphon pipes will pass through the transfer channel and the outlet end of the siphon pipes shall be laid on the bottom of the recycle pond at elevation 590 ft. Ballast will be required at the outlet of the pipe to prevent the pipes from potentially floating to the surface and breaking the siphon. Ballast or other means of restraint may also be required in the transfer channel to hold the pipes in place. For a 300 ft long, 10-inch diameter HDPE siphon, the water level in the gypsum stack will need to be approximately 4.5 ft higher than the water level in the recycle pond in order to pass the equilibrium process water return rates discussed above.

4.4.2 Initial Filling of Recycle Pond With Water

The recycle pond will initially be partially filled with water pumped from Duck Creek Reservoir or the plant. The recycle pond will be filled to a water surface elevation of 598 ft in order to accommodate proper pump functioning during commissioning and startup of the slurry discharge to the gypsum stack. Duck Creek plant personnel will monitor and regulate the water level in the recycle pond.

4.4.3 Commissioning the Pumps and Siphons

Once the recycle pond and gypsum stack have operational levels of water, the siphons, the recirculation pump system (recycle pond to gypsum stack), and the recycle pump system (recycle pond to plant) will be primed and tested. IPRG will be responsible for operation and maintenance of the recycle / recirculation pumps.

4.5 GYPSUM MANAGEMENT FACILITY OPERATION

The gypsum slurry (approximately 20 percent solids) will be pumped from the Plant to the gypsum stack via piping. Piping will be HDPE with a pressure rating for the design hydraulic and static head. The HDPE pipe will discharge the slurry into the gypsum stack, and the gypsum will settle by gravity.

The water level in the recycle pond should be maintained at a minimum elevation of 598 ft in order to insure uninterrupted pumping of water back to the plant. However, at times, there will be intermittent outages at the plant. During an outage, bottom drains in the gypsum stack will continue to discharge water to the recycle pond and the recycle pumps will continue to recirculate water from the recycle pond to the gypsum stack. <u>The recirculation of water is required during outages</u> in order to utilize the water storage capacity of the gypsum to help maintain sufficient storage capacity in the recycle pond to accommodate all precipitation runoff from the entire gypsum stack/recycle pond area during an expected maximum 12-week maintenance outage at the Plant.

At a placement rate of 23,500 tons per month, it will take approximately 3 years to fill the gypsum stack with gypsum to the invert of the HDPE-lined transfer channel at EL 614. Until that time, clarified return water will be siphoned into the recycle pond using one of two redundant 10-inch diameter siphon pipelines. Water that flows from the gypsum stack to the recycle pond will be pumped back to the Plant for reuse, or recirculated to the top of the gypsum stack during periods when the plant is shutdown.

In order to stack the gypsum material with the required factors of safety for slope stability, a system of strategically placed perimeter ditches and dikes must be constructed. Interior dikes will also need to be constructed to accommodate the installation of ring drains and the development of cells located within the gypsum stack. Key components of the gypsum stacking process are described in the following sections to highlight the effort required to successfully stack gypsum with the required factors of safety against slope failure.

4.5.1 Initial Filling With Gypsum Slurry

There are two redundant gypsum slurry pipelines which will be capable of discharging midway along the north side or west side of the of the gypsum stack at a maximum rate of 1.5 cfs (675 gal/min). The initial construction of the GMF includes a ring drain system on the HDPE liner on the bottom of the gypsum stack. When gypsum slurry is initially discharged into the gypsum stack, **extreme care must be taken to prevent any erosion of the sand layer over the ring drain**. **Any displacement of sand may impair the function of the ring drain.** If necessary, the sand layer may be protected with a layer of larger aggregate or temporarily covered with an approved geotextile wherever necessary to prevent erosion of the sand layer. It may be preferable to use a flange-connected pipe extension to extend the slurry discharge line to the interior side of the ring drain so that the bottom troughs will collect the water and prevent erosion of the sand layer. The pipe extension can be removed when the ring drains are covered and protected by settled gypsum. <u>If any ring drain sand is displaced, the Operator shall immediately notify Ameren so that an appropriate response and repair method can be determined.</u> Please see Figure A for details and a general depiction of the ring drain assembly.

Settled gypsum will gradually create a plane of material (gypsum beach) sloping gently towards the south end of the gypsum stack. Please see Figure B for a depiction of the gypsum beach. Clarified water will collect in the south end of the gypsum stack and will be siphoned into the recycle pond when it reaches EL 602.5, the level necessary to provide the head to siphon the process water at the system equilibrium rates. The GMF Operator will be responsible for operation and maintenance of the siphons. At the design flow rates, it will take approximately 95 days of operation in order for the water in the gypsum stack to reach this level.

4.5.2 Gypsum Dike and Cell Construction

The bottom slope of the gypsum stack liner, and the siphoning of water from the gypsum stack to the recycle pond, will partially drain the gypsum to allow for "early stacking" of material below the crest of the earthen dam. This is advantageous for several reasons. One reason is that the construction of compacted dikes at a lower elevation may improve foundation conditions for the remainder of the stack. Employing stacking procedures at a lower elevation also affords the opportunity for the Operator to become familiar with the material and develop confidence in a construction routine which will maximize stability when stacking the material above the top of the earthen embankment. Early stacking also allows Ameren the opportunity to complete preliminary testing on proposed piezometer locations for development of a piezometer installation and monitoring plan, as discussed in Section 4.5.8, which will be refined prior to stacking above the top of the earthen embankment.

The procedures for controlling the deposition of gypsum will begin once the gypsum beach at the north end of the gypsum stack reaches an elevation of approximately 605 ft, NGVD, which is 10 ft above the HDPE liner (7.5 ft above the top of the ring drain assemblies). Based on an assumed deposited gypsum slope of 0.3%, and a water level of 602.5 ft, the gypsum beach which will be visible above water is predicted to span half the length of the gypsum stack (reference Figure B). At full production (16.7 acre-ft deposited per month), the time required for the gypsum beach to reach this configuration is estimated at five to six months. .

The first procedural steps in controlling the deposition of (stacking) gypsum are the construction of a perimeter ditch, a perimeter dike, a rim ditch, and a rim dike. The perimeter ditch is the ditch which will be formed between the earthen embankment and the gypsum. The perimeter dike is the gypsum dike on the interior side of the perimeter ditch. The rim ditch is a ditch which will be formed on the interior side of the perimeter dike. The rim dike is a gypsum dike which will be formed on the interior side of the rim ditch. These basic components of the gypsum stack are illustrated in Figure C. Specific details pertaining to the ditches are provided in Sections 4.5.3 and 4.5.4.

During the initial stages of stacking, the perimeter ditch, perimeter dike, rim ditch and rim dike will be constructed simultaneously. They will be constructed by building two elevated dikes on the gypsum beach beginning at the middle of the north side and proceeding both clockwise and counterclockwise around the perimeter of the gypsum beach (see Figure D). Access to the beach will be provided by carefully pushing an approved fill material onto the beach from the crest of the earthen embankment to create an access pad. The thickness of the fill layer will need to be at least 24-inches over the geomembrane liner to avoid damage to the liner, and will need to be at least 36-inches over the gypsum beach. Once the fill material has been placed far enough out onto the beach to allow excavation of the gypsum without damaging the liner, the access pad can be completed using gypsum excavated from the beach (see Figure E).

Gypsum excavated from the beach is expected to be soft and saturated and must be windrowed and allowed to dewater before it can be spread and compacted to form the roadway. The gypsum is expected to dewater sufficiently in 24 hours to allow spreading and compacting. Adequate compaction is expected to be achieved by tracking with a D-6 dozer or similar equipment.

After construction of the dikes and ditches has begun, the slurry discharge lines should be relocated to discharge to the rim ditch. This will allow the rim ditch to be refilled each day to provide gypsum for raising the roadway as the excavator retreats from the most recently placed windrow. The rim ditch will also serve as the primary means of diverting slurry around the stack to the location where deposition is desired.

When the initial perimeter dike is completed, the top of the perimeter dike should be at least 30 ft wide, at least 10 ft above the beach and the side slopes graded to be 3.0H:1.0V (see Detail A on Figure B). The top of the initial rim dike should be at least 3.5 ft above the beach. Additional interior dikes may also be constructed as needed to create cells which facilitate the settling process. The exterior side slope of the rim dike shall be 3.0H:1.0V. The interior side slope of the rim dike and the side slopes on any interior dikes may be allowed to form at the angle of repose for the gypsum material. **A minimum freeboard of 3.5 ft must be maintained between the slurry level in the rim ditch and the crest of the perimeter dike. Subsequently, the perimeter dike must always be maintained at an elevation at least 3.5 ft higher than the rim dike or any other interior dike.**

The rim and perimeter dikes should be raised in lift increments of approximately 1 foot and may be moved laterally each lift as needed to maintain the required design slopes of 3.0H:1.0V on the perimeter dike. The slopes can be graded with a smooth-edged excavator bucket, e.g., a finish or cleanup bucket. **Under no circumstances should the slopes of the gypsum stack be graded using a toothed excavator bucket**.

Clarified water will be transferred from the rim ditch to the perimeter ditch where it will be carried to the transfer channel for discharge to the recycle pond. The GMF construction included installation of a stop log system for the transfer channel. The stop logs may be used for **temporary** reductions in flow to the Recycle Pond and increases in water levels in the gypsum stack for water balance purposes during operation. During the initial stacking process, when a siphon must be used to transfer water to the recycle pond, the transfer of water from the rim ditch to the perimeter ditch may be achieved with an open cut through the perimeter dike. However, once the perimeter dike rises above elevation 614 ft (the invert of the transfer channel), decants, stilling wells and splash pads (see Sections 4.5.5 and 4.5.7) are required for the purpose of transferring clarified water from the rim ditch to the perimeter ditch.

4.5.3 Perimeter Ditch

Throughout the stacking operations, a perimeter ditch must be constructed and maintained around the toe of the gypsum stack. The perimeter ditch will be located between the perimeter dike (outer gypsum slope) and the HDPE lined earthen embankment. This ditch will collect water from the ring drains, decants and rainfall runoff, and convey it to the transfer channel where it will be discharged to the recycle pond. The perimeter ditch shall be constructed by covering the HDPE liner with a 2 ft thick protective layer of gypsum and shaping the channel to the required dimensions. The perimeter ditch is required to have a maximum invert elevation of 614 ft (6 ft below the top of the earthen perimeter dam) and a bottom width of at least 5 ft. A larger ditch bottom width may be utilized to reduce the frequency of any dredging necessary to maintain the minimum required dimensions.

4.5.4 Rim Ditch

The rim ditch will be the primary means of diverting slurry from the slurry discharge pipes to the desired deposition area. The rim ditch will also transport clarified water to the decant structures so the water can be discharged to the perimeter ditch. Consequently, the width of the rim ditch will vary according to the needs at any particular location on the gypsum stack. There may also be cases were blocking the rim ditch is desirable to divert water into a particular cell. There are only two primary constraints on the construction of the rim ditch: (1) the outer slope shall not be steeper than 3.0H:1.0V (this is the inner slope of the perimeter dike); and (2) the normal operating water level shall be at least 3.5 ft below the top of the perimeter dike.

4.5.5 Installation and Operation of Decants and Stilling Wells

The progressive stacking of gypsum will require the installation of at least four (4) decant structures (2 redundant sets of 2) in the rim ditch to convey water to the lower perimeter ditch without eroding the gypsum stack slopes. A minimum of two (2) decant structures are required in order to maintain the water level in the rim ditch and provide adequate discharge capacity for design precipitation events. An additional redundant set of two (2) decant structures will also be required to be installed. The decant structures will consist of 16-inch diameter solid wall HDPE IPS DR 11 pipe sections with 12-inch diameter screw-capped tees installed at 6 ft intervals along the length of the pipe. (When installed on a 3H:1V slope, the tees at 6 ft intervals will translate to 2 ft elevation intervals.) The decant structures will each discharge to a stilling well located in the perimeter ditch at the toe of the outer gypsum stack slope.

During construction of the first gypsum dike above elevation 614 ft (the invert elevation of the perimeter ditch and transfer channel), a 16-inch diameter solid wall HDPE IPS DR11 pipe will be installed as shown in Figure F**Error! Reference source not found.**. The horizontal portion of the pipe will be approximately 80 ft long with an invert at EL 614. The inlet end of the horizontal pipe will be attached to the first decant pipe section with an 18.4 degree angle fitting. Prior to backfilling over the horizontal portion of the pipe, a 20 ft wide geogrid must be installed over the entire horizontal portion of the pipe, to prevent the pipe from potentially floating out of the saturated gypsum layer during the initial stages of the stacking operation.

The outlet end of the decant pipe will be welded to, and discharge into, a 48-inch diameter HDPE stand pipe with a 1-inch thick HDPE plate welded to the bottom. The stand pipe will have a top elevation of 618 ft and a bottom elevation of 611 ft. The stand pipe will be filled with concrete ballast to EL 614 (see Detail A on Figure F). Additionally, a 4-inch diameter low flow drain will be installed in the stand pipe at elevation 614 ft in order to allow for the cleanout of any gypsum which might accumulate in the stand pipe. In order to allow for proper function of the stilling well, the low flow drain pipe should <u>not</u> be installed in line with the 16-inch decant pipe, but rather offset to one side.

Each time the perimeter gypsum dike is raised, a new decant pipe section will be butt welded to the decant structure. The decant pipe section will be supported by the interior 3H:1V slope of the rim ditch. The water level in the rim ditch will be progressively raised through the stacking operation by capping the appropriate tees in the decant pipe sections. As previously stated, the normal water level shall be at least 3.5 ft below the crest of the perimeter gypsum dike.

4.5.6 Installation of Upper Ring Drains

Upon completion of the first gypsum dike above elevation 614 ft, and prior to construction of the next progressively stacked dike, two interior ring drains must be installed concurrent with development and operation of the interior gypsum cells. Additional ring drains will be required as the height of the gypsum stack increases. Final details and specifications for the upper ring drains will be provided by the design engineer at the time of installation. The upper ring drains are required to control the phreatic surface which will develop within the stack. A preliminary design for the upper ring drains is as follows, as shown on Figure C: A 3 ft tall gypsum dike will be constructed along the centerline of the proposed ring drain using the same techniques as for gypsum dike construction. After construction of the dike, a 4 ft deep channel with a 4 ft bottom width will be excavated along the center of the dike. Side slopes on the cut should be no steeper than 1:1. The bottom and sides of the cut should be filled with IDOT FA1 gradation sand to form a layer which is 1 ft thick. After the sand is placed, the channel will then be lined with non-woven geotextile to be specified by the design engineer. The geotextile will be covered with coarse granular material (to be specified) 2 ft wide by 2 ft deep, with a perforated HDPE pipe imbedded in the center. The fabric will then be wrapped over the top of the coarse granular material and covered with an additional 1 ft thick layer of FA1 gradation sand. The gypsum must not be in direct contact with the non-woven geotextile. The upper ring drains will discharge to the perimeter ditch via solid-wall HDPE pipe.

4.5.7 Splash Pads at Ring Drain & Decant Discharge Locations

At each location where a ring drain and/or a decant structure discharges to the perimeter ditch, the ditch shall be lined with a material capable of resisting the erosive velocities. Materials such as concrete, cable stayed concrete blocks or a geogrid backfilled with washed aggregate may be acceptable. Operator-proposed methods shall be submitted to Ameren for approval prior to placement. The splash pads shall be installed concurrently with or immediately after construction of the perimeter ditch, ring drain outlets and decant stilling wells.

4.5.8 Piezometer Installation and Monitoring

The side slopes of the gypsum stack will be constructed with 3.0H:1.0V side slopes. (After consolidation of the settled gypsum over time, the final slopes are expected to approach 3.75H:1.0V.) The stability of the gypsum stack slopes is critically dependent on the location of the phreatic surface which will develop within the gypsum stack. Proper installation and functioning of the ring drains will ensure that the phreatic surface is located an adequate distance from the surface of the slope as necessary to maintain a stable slope. In order to monitor the phreatic surface within the gypsum stack, piezometers will be installed on each side of the gypsum stack. A preliminary piezometer detail is included on Figure C. The location and depth of each piezometer will be determined by the design engineer prior to installation, and an installation and monitoring plan will be developed based on information obtained during the initial gypsum stacking operations below the level of the earthen berm. “Critical elevations” corresponding to the anticipated readings at various stages during the progressive raising of the gypsum stack will be established for each piezometer. The water level in each piezometer will be read and recorded in accordance with a specified schedule. If at any time a reading is recorded higher than the “critical elevation” for that stage of operation, Ameren and the design engineer must be contacted immediately for evaluation of the reading. It is imperative that the piezometers are installed and monitored in accordance with the plan and the design engineer’s specifications. Depending on the piezometer readings, it may also be necessary to install additional seepage collection drains to maintain the phreatic surface at or below the critical level within the gypsum stack.

Figure A – Bottom Ring Drain Assembly

Figure B - Initial Gypsum Dike Construction

Figure C - Components of Gypsum Stack

Figure D - Progression of Ditch and Dike Construction

Figure E - Access Pad Extension onto Gypsum Beach

Figure F - Decant Pipe and Stilling Well Details

SECTION 5.0 DAM INSPECTIONS

The inspection program includes two types of dam inspections which are required to be performed in accordance with IDNR/OWR's Rules for Construction and Maintenance of Dams. The first type of inspection is regularly conducted by the dam Operator and is referred to as an Operation and Maintenance Inspection. The second type of inspection, referred to as the Engineering Inspection, is conducted by a qualified engineer approved by Ameren.

Inspections shall be conducted throughout the operating life of the structures. The "operating life of the structure" will be considered to cease upon receipt of written affirmation from IDNR/OWR indicating that the structure is no longer considered a dam. Copies of all inspection reports shall be maintained at the Plant for the operating life of the structures.

5.1 OPERATION AND MAINTENANCE INSPECTION

"Walk-around" inspections of the dams and appurtenant works are to be made by the dam Operator. During these inspections, a checklist of items to be maintained and items to be observed should be recorded. The checklist provided in Appendix B shall be utilized for these inspections. **If any of the following items are found to be unusual or are cause for concern, the Ameren Shift Supervisor should be immediately notified.**

Frequency: Weekly. Also, during and after unusual events such as heavy rainfall or after an earthquake.

Inspection Items: During each inspection the following items should be noted in particular.

1. Water Level - Maximum levels as a result of heavy rainfall should be recorded.

2. Earth Embankment - Walk the crest, side slopes and downstream toe of the dam concentrating on surface erosion, seepage, cracks, settlement, slumps, slides, and animal burrows. These are described as follows:

    - Surface Erosion - Removal of vegetative cover by water action or pedestrian or vehicle usage forming deep ruts or gullies.

    - Seepage - The passage of water through and/or underneath the earth embankment abutment and natural groundline or at the contact between the embankment and outlet works. It can be indicated by cattails or other wet environmental vegetation, erosion, channelization, or slumping on the embankment face.

    - Cracks - Deep cracks usually indicate the movement of the dam and/or the foundation and can be in either the longitudinal (along the length of the dam) or transverse (across the dam) directions. Cracking can be an indicator of the beginning of slumps. Shallow cracks may develop during the summer when the surface soils of the embankment become severely dried and are usually of no concern in regard to the safety of the dam.

- Settlement - Settlement is indicated by depressions or low spots and can be signs of consolidation of the dam or foundation or the loss of material beneath the settlement area.

- Slumps/Slides - A slow or sudden movement of the earth embankment slope on either face toward the toe of the dam.

- If seepage indicates the presence of soil particles, or if deep cracks, settlement, slumps, or slides are noticed, a qualified engineer should be contacted immediately for consultation.

- Animal Burrows - Animal burrows result in a loss of earth embankment material and can provide seepage paths for water through the embankment.

3. Gypsum Embankment - Walk the crest, side slopes and downstream toe of the dam concentrating on surface erosion, seepage, cracks, settlement, slumps, slides and animal burrows. The descriptions for these are the same as for earth embankment.

4. Vegetation - Grass should be a thick vigorous growth to stabilize the earth embankment soils and prevent erosion from occurring. Note the height of the grass; if greater than 1 foot a mowing of the area should be scheduled before the next inspection. There should be NO trees on the earth embankment and NONE within a minimum of 20 ft of the embankment toes or other structures. The gypsum embankment will not be seeded and is not expected to have any vegetation.

5. Gypsum Stack piezometers should be inspected for any damage or loss of function. Damaged piezometers must be promptly repaired or replaced since their function is critical to ensuring stability of the gypsum stack.

6. The water level in each Gypsum Stack piezometer must be measured and recorded. If the water level in any piezometer is above the "critical elevation" as discussed in Section 4.5.8, Ameren should be notified and the **design engineer should be immediately consulted for guidance on an appropriate course of action**.

7. Gypsum Stack LD/LCRS Drains - The change in location or amount of flows discharging from the Leak Detection/Leachate Collection Recovery System (LD/LCRS) should be recorded. If a significant change has occurred, a qualified engineer should be contacted for consultation.

8. Gypsum Stack Ring Drains - The change in location or amount of flows discharging from the Ring Drains should be recorded. If a significant change has occurred, a qualified engineer should be contacted for consultation.

9. Gypsum Stack Fixed Decant – Check the alignment and supports for the pipe. Record the amount of flows discharging from the pipe and any erosion or scour around the discharge point.

10. Gypsum Stack Perimeter Ditch – The perimeter ditch should have a consistent prismatic shape for the entire length. Inspect the perimeter ditch for evidence of erosion, sediment deposition and irregularity in channel geometry, especially in the vicinity of siphon, decant or ring drain outfall structures. If irregularities are noted, repairs should be scheduled and completed.

11. Stop Logs - Check to make sure that the stop logs in the transfer ditch are undamaged, and, if installed, are operating well and allowing for the free flow of water over them.

12. Transfer Channel - Check for any debris or other obstructions which may block or restrict the free flow of water. Check for any pools or undulation of the floor of the channel.

13. Recycle Pond Decant - Check for any debris or other obstructions around the Recycle Pond decant which may block or restrict the free flow of water. The emergency dewatering valve should be lubricated. If there is no return water in the pipe, the emergency dewatering valve should be exercised. Record the physical and operating conditions of the system.

14. Recycle Pond Drop Inlet Spillways - Check for any debris or other obstructions around the inlet crest and at the bottom of the drop inlet which may block or restrict the free flow of water. Check for the development of any rusty areas on the concrete, and seepage, cracking, breaking, or spalling of the concrete. Check for settlement or cracking of the crest. Check for any debris in the pipes which may restrict the flow of water. Check for any tears or leaks in the HDPE liner covering the concrete.

15. Recycle Pond Rip Rap Basin - Check for any debris or other obstructions in the riprap basin which may block or restrict the free flow of water. Check to make sure that the rip rap is remaining in a uniform position. Freeze/thaw action or flow over the rip rap may tend to lift or fracture, thus requiring replacement or leveling to maintain the necessary level of protection. NO trees or woody vegetation should be growing through the rip rap.

16. Fences - Check for damage, accumulated debris, operation of gates and locks, and adequacy of locations (this may change with time as people access the area or development occurs in the area).

17. Perimeter - Check the perimeter of the dams for a distance of at least 100 ft beyond the toe for signs of seepage or boils.

18. HDPE Liner – Wherever exposed, the HDPE Liner should be inspected for tears, gouges, protrusions under the liner and abrasion.

Records: Log books of activities occurring at the dam is to be kept current by the dam Operator. The log books shall be made available for review by the inspecting engineer during the Engineering Inspection. The log books should contain at the least the following documentation:

1. Completed operation and maintenance inspection checklists
2. Readings from all piezometers on the Gypsum Stack
3. Additional visual observations
4. A list of maintenance performed
5. A list of any unusual occurrences at the dam
6. A copy of the engineering inspection reports

5.2 ENGINEERING INSPECTION

The engineering inspection is to be conducted by a qualified engineer approved by IPRG. The inspection will provide a thorough evaluation of the dam and appurtenant structures. The forms provided in Appendix C shall be utilized for these inspections.

Frequency: The Gypsum Stack Dam and Recycle Pond Dam are classified as CLASS III, LOW HAZARD POTENTIAL dams. Class III dams are to be inspected at least once every five years.

Inspection Items: The engineer will thoroughly inspect all of the items noted under Operation and Maintenance Inspection.

Records: The Dam Inspection Report form, Appendix C, will be completed by the inspecting engineer and will be signed and sealed by an Illinois Registered Professional Engineer. This report will document any deficiencies; recommend remedial actions; and establish time requirements for addressing the deficiencies. The original report will be retained in Ameren's file and a copy of the report will be submitted to the Illinois Department of Natural Resources, Office of Water Resources.

SECTION 6.0
MAINTENANCE ACTIVITIES

Timely repairs are a must after problem areas have been identified. The dam Operator is to perform the work required to correct items noted in the operation and maintenance and engineering inspections. Such items include mowing, seeding, tree and brush removal, replacing rip rap, repairing fences and locks, clearing debris, etc. The maintenance activities specified in the following sections are minimum requirements. NOTE: NO alterations or repairs to structural elements should be made without the assistance of a qualified engineer and the concurrence of the Illinois Department of Natural Resources, Office of Water Resources.

6.1 ROUTINE MAINTENANCE

Debris: Remove all trash, logs and other debris which may obstruct flow into the principal spillway pipes and drop inlets, or block passage from their discharge channels.

Rip Rap: Replace rip rap as needed to provide adequate protection against erosion.

Vegetation Control:

1. Maintain a good grass cover on the embankment by seeding, fertilizing and mulching areas which are refilled, barren, or thinly vegetated. Seeding mixtures used for maintenance reseeding shall result in a cover compatible with adjacent cover. The seeding mixture specified at the time of the dam's construction was IDOT Standard Specifications Class 1A (Salt Tolerant Lawn Mixture) as follows:

   IDOT Class 1A Salt Tolerant Lawn Mixture
   Bluegrass ....60 lb/acre
   Perennial Ryegrass..........20 lb/acre
   Dawsons Red Fescue.......20 lb/acre
   Scaldis Hard Fescue ....20 lb/acre
   Fults Salt Grass ....60 lb/acre

2. Grassed areas such as the embankment and the areas beyond the embankment toes for a distance of at least 20 ft should be mowed at least twice annually or at any time the height of the grass exceeds 1 foot.

3. All erosion areas will be filled and compacted, reseeded, fertilized and mulched to establish a thick erosion resistant cover.

4. Remove all trees and brush growing on the dam embankment to prevent development of a root system which could provide seepage paths. Herbicides utilized for tree and brush control are discussed in Appendix D.

5. Keep the riprap basin clear of weeds, brush, and trees.

6. Remove all trees and brush growing on the dam embankment to prevent development of a root system which could provide seepage paths. Herbicides utilized for tree and brush control are discussed in Appendix D.

7. Clear all brush and trees to a distance of approximately 20 ft beyond both toes of the dam.

Animal Damage: Fill rodent holes and other animal burrows with compacted clayey dirt and reseed. If rodents become a nuisance, an effective rodent control program as approved by the Illinois Department of Natural Resources District Wildlife Biologist should be implemented.

Signs: All warning sings shall be maintained (repaired, painted, or replaced) as needed.

6.2 EROSION AND DUST CONTROL

As stacking operations commence, the dewatered gypsum is expected to form a thin layer of "crust" which will resist erosion and prevent the migration of fugitive dust from the gypsum stack. (This expectation is based on a case study of flue-gas desulfurization by-product (gypsum) stacking by the Electric Power Research Institute entitled Evaluation of Chiyoda Thoroughbred 121 FGD Process and Gypsum Stacking, Volume 3 Addendum, dated March 1981.) Should a protective layer of crust fail to form or fail to provide adequate erosion and dust control, appropriate measures for addressing these concerns will be implemented.

APPENDIX A
LOCATION MAP

APPENDIX B
PERTINENT DATA ABOUT THE DAMS

Gypsum Stack Dam

DAM		
Top of Dam Elevation	620	ft
Invert of Reservoir Elevation	585	ft
Reservoir Area at Invert	0.7	acres
Reservoir Area at Top of Dam	31.6	acres
Total Reservoir Volume	773.2	acre-ft
Total Watershed Area	31.6	acres

PERIMETER DITCH		
Bottom Width	5.00	ft
Top Width	44.00	ft
Depth	6.00	ft
Outer Side Slope	3.5:1	H:V
Inner Side Slope	3:1	H:V
Upstream Invert	615.16	ft
Downstream Invert	614.00	ft
Ditch slope	0.00050	ft/ft
Bank Full Cross-sectional Area	147.00	sf
Length of Each Ditch (Centerline)	2322.00	ft
Bank Full Volume of Each Ditch	7.84	acre-ft
Total Ditch length (Centerline)	4644.00	ft
Total Ditch Bank Full Volume	15.67	acre-ft

TRANSFER CHANNEL		
Bottom Width	16.00	ft
Top Width	16.00	ft
Depth	6.00	ft
Upstream Invert	614.00	ft
Downstream Invert	609.00	ft
Weir Elevation	616.00	ft
Weir Length	16.00	ft

0.5 PMF STORM EVENT		
Critical Storm Duration	24	hours
Peak Inflow	374.7	cfs
Peak Outflow	190	cfs
Total Inflow	54.88	acre-ft
Total Outflow	54.91	acre-ft
Peak Storage	9.46	acre-ft
Peak WSEL (HEC-HMS)	618.5	ft
Peak WSEL (HEC-RAS)	618.31	ft
Freeboard over Max WSEL	1.5	ft
Wave Runup/Wind Setup	1.48	ft

100-YR STORM EVENT		
Critical Storm Duration	0.5	hours
Peak Inflow	274.7	cfs
Peak Outflow	91.4	cfs
Total Inflow	21.08	acre-ft
Total Outflow	21.12	acre-ft
Peak Storage	6.31	acre-ft
Computed WSEL (HEC-HMS)	617.54	ft
Computed WSEL (HEC-RAS)	617.66	ft
Freeboard over Max WSEL	2.34	ft
Wave Runup/Wind Setup	1.48	ft

Recycle Pond Dam

DAM		
Top of Dam Elevation	615	ft
Invert of Reservoir Elevation	592	ft
Reservoir Area at Invert	4.87	acres
Reservoir Area at Top of Dam	8.21	acres
Total Reservoir Volume	150.4	acre-ft
Total Watershed Area	39.81	acres

SPILLWAY		
Pipe Length	60	ft
Pipe Diameter (Inside)	42	inch
Number of Pipes	4	
Pipe Slope	0.03333	Ft/ft
Upstream Invert	610	ft
Downstream Invert	607	ft
Entrance Loss Coefficient	0.9	

0.5 PMF Storm Event - Starting WSEL @ 610		
Critical Storm Duration	24	hours
Peak Inflow	252.4	cfs
Peak Outflow	123.6	cfs
Total Inflow	65.96	acre-ft
Total Outflow	62.88	acre-ft
Peak Storage	135.79	acre-ft
Peak WSEL (HEC-HMS)	612.99	ft
Peak WSEL (HEC-RAS)	613.00	ft
Freeboard over Peak WSEL	2.01	ft
Wave Runup/Wind Setup	1.77	ft
Peak Spillway Outlet Velocity	12.73	fps

100-yr Storm Event - Starting WSEL @ 610		
Critical Storm Duration	2	hours
Peak Inflow	107.1	cfs
Peak Outflow	29.5	cfs
Total Inflow	27.22	acre-ft
Total Outflow	24.15	acre-ft
Peak Storage	125.25	acre-ft
Peak WSEL (HEC-HMS)	611.37	ft
Computed WSEL (HEC-RAS)	611.37	ft
Freeboard over Peak WSEL	3.63	ft
Wave Runup/Wind Setup	1.77	ft
Peak Spillway Outlet Velocity	9.92	fps

0.5 PMF Storm Event - Starting WSEL @ 599.5		
Critical Storm Duration	24	hours
Peak Inflow	252.1	cfs
Peak Outflow	0	cfs
Total Inflow	65.96	acre-ft
Total Outflow	0	acre-ft
Peak Storage	114.47	acre-ft
Peak WSEL (HEC-HMS)	609.70	ft
Freeboard over Peak WSEL	5.3	ft
Wave Runup/Wind Setup	1.77	ft

100-yr Storm Event - Starting WSEL @ 604		
Critical Storm Duration	24	hours
Peak Inflow	32.3	cfs
Peak Outflow	0	cfs
Total Inflow	36.46	acre-ft
Total Outflow	0	acre-ft
Peak Storage	114.07	acre-ft
Peak WSEL (HEC-HMS)	609.64	ft
Freeboard over Peak WSEL	5.36	ft
Wave Runup/Wind Setup	1.77	ft

APPENDIX C
OPERATION AND MAINTENANCE INSPECTION CHECKLIST

OPERATION AND MAINTENANCE INSPECTION CHECKLIST

Dam Name (circle one): Gypsum Stack Dam Recycle Pond Dam

Date: ____________________________ Time: ___________________________

Name of Inspector: ____

Reservoir Elevation: _________________ ft

ITEM	NO	YES	IF YES
Record Piezometer Readings for Gypsum Stack. Are any readings above the critical level? (see section 4.8.2 of O&M)			Contact Engineering Manager and notify Hanson Professional Services
Note the condition of the Piezometers on the Gypsum Stack. Any damage?			Contact Engineering Manager
Deep Surface Cracks			Contact Engineering Manager
Slump or Slide on the upstream or downstream face			Contact Engineering Manager
Erosion from runoff, wave action or traffic			Repair and stabilize
Wet areas on the gypsum or earthen embankment indicating seepage			Contact Engineering Manager
Flows of cloudy water from seepage areas on the gypsum or earthen embankment			Contact Engineering Manager
Uneven settlement			Contact Engineering Manager
Trees, brush or burrow holes on the embankment or in the riprap basin			Remove trees and brush, fill holes
Transfer channel or Spillway pipes blocked			Clear immediately
Damage to stop logs			Repair or replace
Tear in Liner			Repair and schedule engineer inspection
Settlement or displacement of Gypsum Stack siphon decant pipes or outlets			Schedule engineer inspection
Settlement or displacement of Gypsum Stack fixed decant pipes or outlets			Schedule engineer inspection
Discharge from Gypsum Stack LD/LCRS Drains?			Record discharge rate for each outlet (time to fill bucket)
Discharge from Gypsum Stack Ring Drains?			Record discharge rate for each outlet (time to fill bucket)
Gypsum Stack Perimeter Ditch erosion			Schedule repair
Problems with Recycle Pond decant			Contact Engineering Manager
Height of grass (inches	inches		If more than 1 foot, schedule mowing

APPENDIX D
ENGINEERING INSPECTION FORM

Dam Inspection Report

Name of Dam IPRG Duck Creek Gypsum Stack & Recycle Pond Dams Dam ID No. IL50573 & IL50574

Permit Number DS2007125 Class of Dam III

Location NW 1/4 Section 18 Township 6N Range 5E 4th P.M.

Owner ______________________ ______________________
Name Telephone Number (Day)

______________________ ______________________
Street Telephone Number (Night)

______________________ County Fulton
City Zip Code

Type of Dam Homogeneous earthen embankment (gypsum stack is homogeneous gypsum embankment)

Type of Spillway ______________________

Date(s) Inspected ______________________

Weather When Inspected ______________________

Temperature When Inspected ______________________

Pool Elevation When Inspected ______________________

Tailwater Elevation When Inspected ______________________

Inspection Personnel:

____
Name Title

____
Name Title

____
Name Title

____
Name Title

Professional Engineer's Seal

The Department of Natural Resources is requesting information that is necessary to accomplish the statutory purpose as outlined under the River, Lakes and Streams Act, 615 ILCS 5 (1994 State Bar Edition). Submittal of this information is REQUIRED. Failure to provide the required information could result in the initiation of non-compliance procedures as outlined in Section 702.160 of the "Rules for Construction and Maintenance of Dams". This form has been approved by the State Forms Management Center.

CONDITION CODES

EC	-	Emergency Condition. A serious dam safety condition exists that needs immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; such as, pool draw down, work stoppage, plant stoppage.
NE	-	No evidence of a problem
GC	-	Good condition
MM	-	Item needing minor maintenance and/or repairs within the year, the safety or integrity of the item is not yet imperiled
IM	-	Item needing immediate maintenance to restore or ensure its safety or integrity. Remediation should be completed within 1 month.
EC	-	Emergency condition which if not immediately repaired or other appropriate measures taken could lead to failure of the dam
OB	-	Condition requires regular observation to ensure that the condition does not become worse
NA	-	Not applicable to this dam
NI	-	Not inspected - list the reason for non-inspection under deficiencies
EC	-	Emergency Condition. A serious dam safety condition exists that needs immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; such as, pool draw down, work stoppage, plant stoppage.

GYPSUM STACK - EARTH EMBANKMENT

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Surface Cracks			
Vertical and Horizontal Alignment of Crest			
Unusual movement or Cracking at or Beyond Toe			
Sloughing or Erosion of Outer Embankment Slopes			
Upstream Face Slope Protection (HDPE Liner)			
Seepage			
Animal Damage			

GYPSUM STACK - EARTH EMBANKMENT
(Continued)

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Vegetative Cover			

<u>GYPSUM STACK - GYPSUM EMBANKMENT</u>

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Surface Cracks			
Vertical and Horizontal Alignment of Crest			
Unusual movement or Cracking at or Beyond Toe			
Sloughing or Erosion of **Outside** Embankment Slopes			
Sloughing or Erosion of **Inside** Embankment Slopes			
Seepage			
Animal Damage			

GYPSUM STACK - GYPSUM EMBANKMENT

(Continued)

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Condition of Piezometers on Gypsum Stack			
Piezometer Readings on Gypsum Stack Above Critical Level?			

GYPSUM STACK – PERIMETER DITCH

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Ditch Geometry (15 ft bottom width, 3:1 slopes, 8-9 ft depth)			
Concrete Apron at ring drain outlets			
Ring Drain Discharge Pipes			
Stilling Wells for Fixed Decants			

TRANSFER CHANNEL - (between gypsum stack and recycle pond)

☐ Drop Inlet Structure ☒ Overflow Spillway Structure ☐ Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Debris			
Side Slope Stability			
HPDE Liner			
HDPE Liner Welds			
Stop Logs			
Differential Settlement			

RECYCLE POND - EMBANKMENT

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Surface Cracks			
Vertical and Horizontal Alignment of Crest			
Unusual movement or Cracking at or Beyond Toe			
Sloughing or Erosion of Outer Embankment Slopes			
Upstream Face Slope Protection (HDPE Liner)			
Seepage			
Animal Damage			

RECYCLE POND - EMBANKMENT

(Continued)

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Vegetative Cover			

RECYCLE POND - PRINCIPAL SPILLWAY (Left, Looking Downstream)

[X] Drop Inlet Structure   [ ] Overflow Spillway Structure   [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Alignment of Structure Walls			
Construction Joints			
Differential Settlement			
Erosion, Spalling, Cavitation			
Joint Separation			
Seepage Around or into Conduit			
Surface Cracks			

RECYCLE POND - PRINCIPAL SPILLWAY (Left, Looking Downstream)

(Continued)

[X] Drop Inlet Structure [ ] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Structural Cracks			

RECYCLE POND - PRINCIPAL SPILLWAY (Center)

[X] Drop Inlet Structure [ ] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Alignment of Structure Walls			
Construction Joints			
Differential Settlement			
Erosion, Spalling, Cavitation			
Joint Separation			
Seepage Around or into Conduit			
Surface Cracks			

<u>RECYCLE POND - PRINCIPAL SPILLWAY (Center)</u>

(Continued)

X Drop Inlet Structure ☐ Overflow Spillway Structure ☐ Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Structural Cracks			

RECYCLE POND - PRINCIPAL SPILLWAY (Right, Looking Downstream)

[X] Drop Inlet Structure [ ] Overflow Spillway Structure [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Alignment of Structure Walls			
Construction Joints			
Differential Settlement			
Erosion, Spalling, Cavitation			
Joint Separation			
Seepage Around or into Conduit			
Surface Cracks			

RECYCLE POND - PRINCIPAL SPILLWAY (Right, Looking Downstream)

(Continued)

[X] Drop Inlet Structure   [ ] Overflow Spillway Structure   [ ] Gated

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Structural Cracks			

RECYCLE POND - ENERGY DISSIPATOR

[X] Principal Spillway [ ] Outlet Works Type: Riprap Basin

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Riprap			
Outlet Channel			
Debris			

RECYCLE POND - DECANT STRUCTURE

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Alignment			
Connection to Bollard			
Debris in Inlets			
Condition of Pipe			
Condition of Liner Beneath Pipe			
Connection to Ballast			
Connection of Pipe Boot to Liner			

RECYCLE POND - DECANT STRUCTURE

(continued)

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE
Seepage Around or into Conduit			

RECYCLE POND – WATER LEVEL GAGE STRUCTURE

ITEM	CONDITION	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES & SCHEDULE

APPENDIX E
HERBICIDES

HERBICIDES

Site personnel should check with the Illinois Department of Natural Resources, Regional Fisheries Biologist and the Regional Wildlife Biologist before using any herbicide. Read the product label prior to use and follow the use directions and precautions accordingly.

On March 1, 1979 the U.S. Environmental Protection Agency (U.S.E.P.A.) halted the use of the herbicide 2, 4, 5-T in parks and recreation areas. The use of silvex (2, 4, 5-TP) around water has also been banned.

The Agronomy Department at the University of Illinois and the Aquatic Biology Section of the Department of Natural Resources, Office of Scientific Research and Analysis indicate that the herbicides containing the 2, 4-D or 2, 4-DP are legal for use in parks and recreation areas and effective for controlling brush and woody growth. Some examples of approved herbicides are:

1. Tordon RTU by DOW Chemical. (Can be obtained with blue dye.)
2. WEEDONE 170 by Union Carbide
3. WEEDONE, 2, 4-DP by Union Carbide
4. A 1% to 2% solution of ROUNDUP
5. Garlon by DOW Chemical
6. Banvel by Sandoz

Your distributor may carry brand name herbicides other than those listed above. Be certain that the product does not contain the ingredients 2, 4, 5-T or 2, 4, 5-TP. An example of an unacceptable product is ESTERON 2, 4, 5 by DOW Chemical.

ATTACHMENT E


DUCK CREEK
ASH POND NO. 1
ID #: W0578010001-01
ILLINOIS POWER RESOURCES
GENERATING, LLC

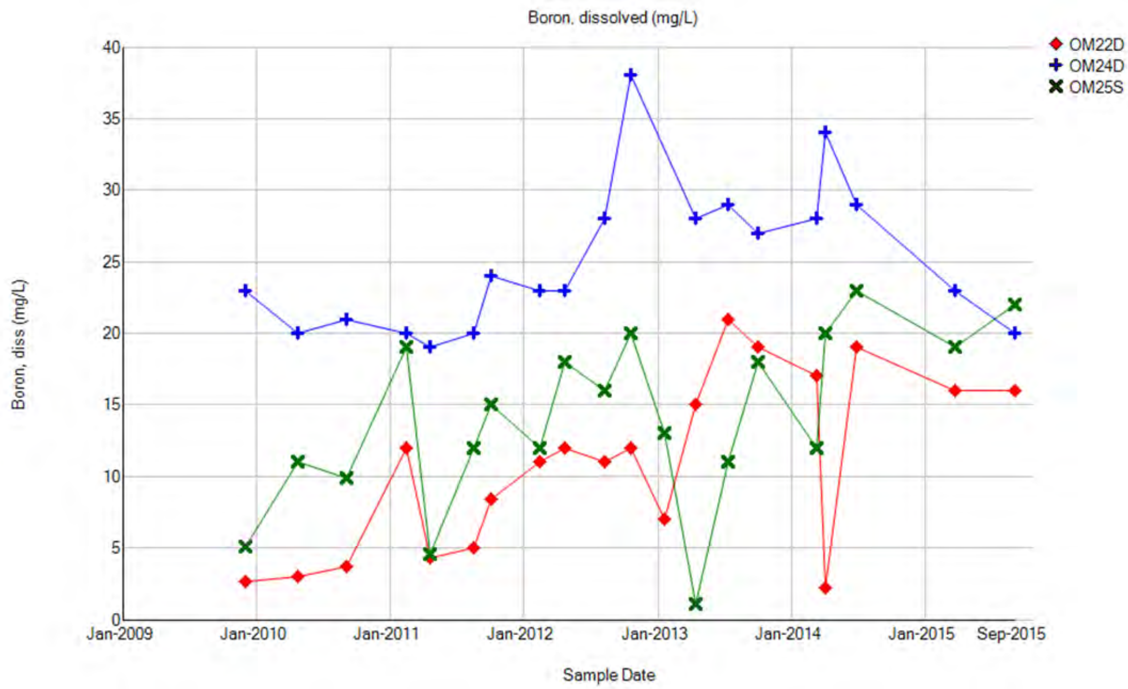

DUCK CREEK
ASH POND NO. 2
ID #: W0578010001-02
ILLINOIS POWER RESOURCES
GENERATING, LLC

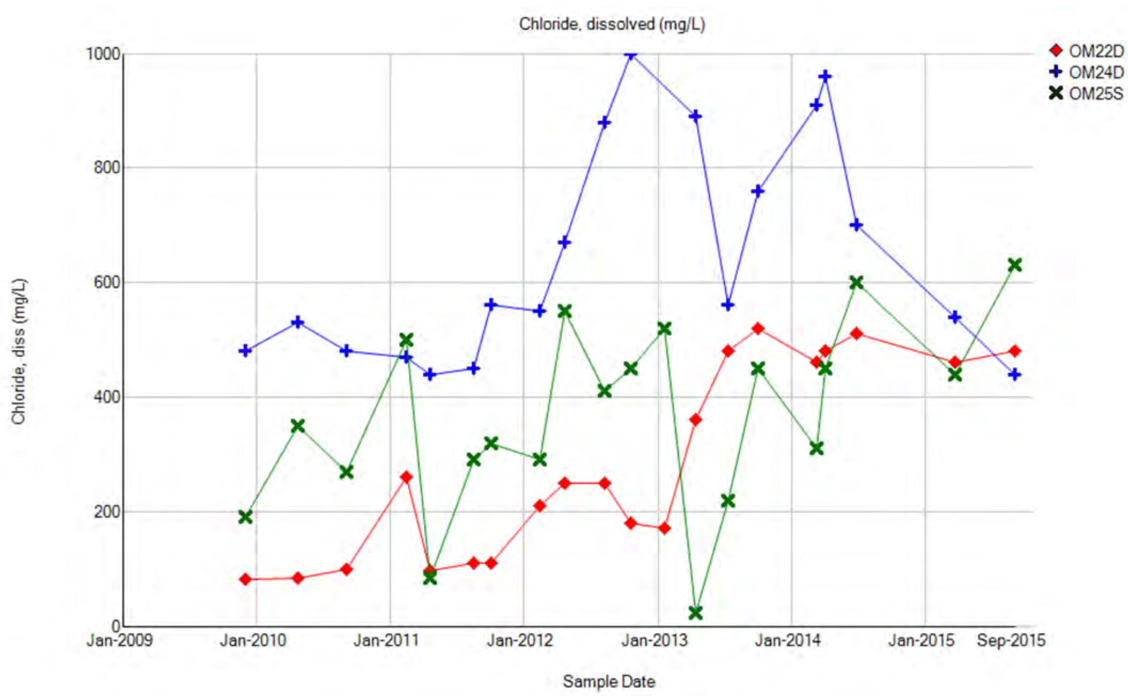
ATTACHMENT H

SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATON AND GROUNDWATER MONITORING PLAN
Duck Creek Ash Ponds 1 and 2
Duck Creek Energy Center
Canton, Illinois
Project No: 2333
March 31, 2016

Revised Pages:

- 3-5
- 5-1 and 5-2
- 6-1 and 6-2
- Table 3-1





As previously noted in Section 3.3, background boron concentrations in the coal mine spoils can be as high as 2 mg/L.

5 APPLICABLE GROUNDWATER QUALITY STANDARDS

5.1 Groundwater Classification

The Duck Creek Ash Ponds 1 and 2 are located within a previously mined area and monitoring has demonstrated that the groundwater is not capable of consistently meeting the standards for Class I: Potable Resource Groundwater (35 IAC 620.410) or Class II: General Resource Groundwater (35 IAC 620.420). Therefore, the applicable classification of groundwater at the site is Class IV: Other Groundwater (35 IAC 620.240(g)).

5.2 Applicable Groundwater Quality Standards

For groundwater within a previously mined area, the applicable groundwater quality standards for the site are the standards for Class IV: Other Groundwater. The groundwater quality standards for Class IV: Other Groundwater cannot be exceeded (35 IAC 620.440(c)) except as provided below:

- The groundwater quality standards for TDS, chloride, iron, manganese, sulfate, and pH, are the existing concentrations (35 IAC 620.440(c)).
- Except as provided above, Class IV: Other Groundwater standards are equal to the existing concentrations of constituents in groundwater (35 IAC 620.440(c)).

The list of applicable groundwater quality standards for the site is shown on Table 3-1. Off-site groundwater also occurs within mine spoils, and is therefore Class IV: Other Groundwater. Applicable off-site groundwater quality standards will be the same as described above.

5.3 Proposed Exceptions to the Groundwater Quality Standards

Based on the results of groundwater monitoring performed at the site to date, the following exceptions to the above applicable Class II: General Resource Groundwater standards are proposed:

- Leachate (Appendices C-1, C-2) and groundwater (Appendix C-3) samples collected at the site do not indicate exceedances of the groundwater quality standards for Class II General Resource Groundwater inorganic constituents listed in 35 IAC 620.420(a)(1). The analyzed constituents include antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, cyanide, fluoride, lead, mercury, nitrate, and thallium.[2] These constituents will not be monitored because they currently meet the standards for Class II General Resource

[2] Perchlorate and vanadium are parameters listed in 35 IAC 620.420(a)(1) but have not been analyzed.

Groundwater and are not associated with the chemical characteristics of the Duck Creek ash ponds.[3]

- Leachate (Appendices C-1, C-2) and groundwater (Appendix C-3) samples collected at the site do not indicate exceedances of the groundwater quality standards for Class II General Resource Groundwater for inorganic constituents copper, nickel, selenium, silver, and zinc listed in 35 IAC 620.420(a)(2). These constituents will not be monitored at wells OM23D and OM25D because they currently meet the standards for Class II General Resource Groundwater and are not associated with the chemical characteristics of the Duck Creek ash ponds.

The proposed groundwater monitoring parameters for the Duck Creek ash ponds are discussed in Section 6.1.

[3] An anomalous arsenic concentration of 0.31 ug/L was observed on October 21, 2013 at OR13S; all other results (thirteen sampling events) at this location exhibited As concentrations below 0.015 ug/L, which are well below the Class II groundwater quality standard of 0.2 ug/L.

6 GROUNDWATER MONITORING PLAN

The groundwater monitoring plan will monitor and evaluate groundwater quality to demonstrate compliance with the groundwater quality standards for Class IV: Other Groundwater[4]. The post-closure groundwater sampling network is proposed to consist of three background monitoring wells and 19 compliance monitoring wells. Table 4-1 provides a list of the wells and their intended use for the monitoring program.

6.1 Monitoring Parameters

Groundwater samples will be collected and laboratory-analyzed for the following parameters that are indicator constituents for coal ash leachate from the ash ponds:

- Boron (dissolved)
- Chloride (dissolved)

The following field parameters will be also measured for each groundwater sample:

- pH
- Specific conductance
- Temperature

The depth to groundwater and total well depth will also be recorded during each sampling event.

As discussed in Section 5, other parameters regulated under 35 IAC 620 will be not be monitored because either:

- Their Class II: General Resource Groundwater standard is the existing concentration of the constituent in groundwater (TDS, iron, manganese, sulfate), and they are not indicator constituents for leachate migration from the ash ponds; therefore, there is no basis to which compare the data
- Groundwater monitoring results to date indicates that the inorganic constituents antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, cyanide, fluoride, lead, mercury, nickel, nitrate, selenium, silver, thallium and zinc currently meet the Class II: General Resource Groundwater standards and are not associated with the chemical characteristics of the Duck Creek ash ponds.

[4] Based on the conclusions of the Hanson (2016a) report in Appendix B1, there is no Uppermost Aquifer as defined by the US EPA (2015) [40 CFR 257.53].

Upon Illinois EPA's request, pH and additional inorganic chemicals listed in 35 IAC 620.410 will be added to the list of reported groundwater monitoring parameters for one or more scheduled sampling events.

6.2 Sampling Schedule

Groundwater sampling will initially be performed quarterly according to the schedule provided in Table 4-2. Five years after approval of the Closure Plan, a request may be made to modify the post-closure care plan to reduce the frequency of groundwater monitoring to semi-annual sampling by demonstrating all of the following:

- Monitoring effectiveness will not be compromised by the reduced frequency of monitoring
- Sufficient data has been collected to characterize groundwater
- Concentrations of constituents monitored at the downgradient boundaries show no statistically significant increasing trends that can be attributed to the former ash ponds

If concentrations of parameters of concern at the downgradient boundaries of the site show no statistically significant increasing trends that can be attributed to the ash ponds for the five years after reducing the monitoring frequency to semi-annual, a request may be made to modify the post-closure care plan to reduce monitoring frequency to annual sampling by demonstrating the same items above as for the reduction to semi-annual monitoring.

Groundwater monitoring may be discontinued upon IEPA's approval of a certified post-closure care report. Specifically, when no statistically significant increase is detected in the concentration of any constituent above that measured and recorded during the immediately preceding scheduled sampling for four consecutive years after changing to an annual monitoring frequency.

6.3 Groundwater Sample Collection

Groundwater samples will be collected according to the protocol included in Appendix F. The procedure is summarized below.

All groundwater elevations will be measured on a single day, in conjunction with sampling of the wells. Monitoring wells will be sampled using either a peristaltic pump or bladder pump. Each well will be purged utilizing low flow techniques, and until the measured pH, temperature, and specific conductance have stabilized within ±10 percent. If low-flow stabilization is not possible, either a submersible pump or bailer will be used to remove four well volumes and/or bail the well dry. Field parameters will be collected following purging of the well. Field parameters will be recorded in the logbook.

Boron samples will be field-filtered (using a 0.45 micron disposable filter); and the sample will be collected in laboratory-provided high-density polyethylene (HDPE) bottles with the appropriate preservatives. All

Table 3-1
Monitored Parameters and Groundwater Quality Standards
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Parameter	Time Interval Monitored	Applicable Groundwater Quality Standard
Antimony	2011 to 2014	Class II
Arsenic	2011 to 2014	Class II
Barium	2011 to 2014	Class II
Beryllium	2011 to 2014	Class II
Boron	1980 to Present	Class II
Cadmium	2011 to 2014	Class II
Chloride	1980 to Present	(1)
Chromium	2011 to 2014	Class II
Cobalt	2011 to 2014	Class II
Copper	2011 to 2014	Class II
Cyanide	2011 to 2014	Class II
Fluoride	2011 to 2014	Class II
Hardness	1980 to Present	(2)
Iron	1980 to Present	(1)
Lead	2011 to 2014	Class II
Manganese	1980 to Present	(1)
Mercury	2011 to 2014	Class II
Nickel	2011 to 2014	Class II
Nitrate nitrogen	2011 to 2014	Class II
pH	1980 to Present	(1)
Selenium	2011 to 2014	Class II
Silver	2011 to 2014	(2)
Specific Conductance	1980 to Present	(2)
Sulfate	1980 to Present	(1)
Temperature	1980 to Present	(2)
Thallium	2011 to 2014	Class II
Total Dissolved Solids	1980 to Present	(1)
Zinc	2011 to 2014	Class II

Notes

Except as noted below, Class II standards are applicable for Class IV groundwater in previously mined areas

(1) Per 35 IAC 620.440(c) the standard for this constituent is the existing concentration.

(2) There is no Class II or Class IV standard for this constituent. Per 35 IAC 620.440(c)

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GROUNDWATER MANAGEMENT ZONE APPLICATION

Duck Creek Ash Ponds 1 and 2
Duck Creek Energy Center
Canton, Illinois

Project No: 2333

September 9, 2016

Natural Resource Technology

Environmental Consultants

NATURAL
RESOURCE
TECHNOLOGY

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GROUNDWATER MANAGEMENT ZONE APPLICATION

DUCK CREEK ASH PONDS 1 AND 2
DUCK CREEK ENERGY CENTER
CANTON, ILLINOIS

Project No. 2333

Prepared For:

Illinois Power Resources Generating, LLC
1500 Eastport Plaza Drive
Collinsville, IL 62234

Prepared By:

Natural Resource Technology
2422 E. Washington Street, Suite 104
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September 9, 2016

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Principal Hydrogeologist

Robert J. Karnauskas, PG, PH
Senior Hydrogeologist

TABLE OF CONTENTS

FIGURES

APPENDICES

1 INTRODUCTION

1.1 Overview

This Groundwater Management Zone Application was prepared by Natural Resource Technology, Inc. (NRT) in support of the Closure Plan for Ash Ponds 1 and 2 located at the Duck Creek Energy Center which is owned by Illinois Power Resources Generating, LLC (IPRG). This application is submitted pursuant to Illinois Administrative Code Title 35, Part 620: Groundwater Quality (35 IAC Part 620).

DMG requests establishment of a Groundwater Management Zone (GMZ) pursuant to 35 IAC 620.250(a)(2) as a three-dimensional region containing groundwater being managed to mitigate a potential release of Coal Combustion Residuals (CCR) constituents from Ash Pond 1, Ash Pond 2 and the previously closed Recycle Pond. The boundary of the GMZ is approximated in map view on Figure 1. The GMZ boundary generally extends around the perimeter of Ash Ponds 1 and 2 as well as the Closed Recycle Pond. A legal description and map of the proposed GMZ is provided in Appendix A. The GMZ will extend vertically through all water-bearing strata to the top of bedrock (Carbondale Formation shale).

1.2 Technical Support Documents

Technical documents in support of the Closure Plan for the Duck Creek Ash Ponds 1 and 2, include, but are not limited to, the following:

- **NRT, August 15, 2016. Revisions to Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan; Duck Creek Energy Center Ash Ponds 1 and 2.** Provides revised pages 3-5, 5-1, 5-2, 6-1, 6-2, and Table 3-1 in accordance with IPRG's August 12, 2016 response letter to Illinois EPA comments dated August 9, 2016.

- **NRT, March 31, 2016. Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan; Duck Creek Energy Center Ash Ponds 1 and 2.** Provides results of additional hydrogeologic investigation of the unlithified and bedrock materials and presents a groundwater monitoring plan.

- **AECOM, December 23, 2015. 30% Design Data Package for Dynegy Duck Creek Station; Ash Pond No. 1 and Ash Pond No. 2 CCR Units.** A geotechnical program consisting of installation of auger borings, CPT soundings and piezometers to obtain information for compliance with requirements of the federal CCR rule.

- **Hanson, March 2010. Hydrogeologic Report Ameren Duck Creek Power Generating Station - Solid Waste Disposal System (Ash Pond 1, Ash Pond 2, and Recycle Pond).** Provided documentation of background information, a description of subsurface geology, and discussions of groundwater analytical trends and hydrogeologic conditions while Ash Pond 1, Ash Pond 2 and the Recycle Pond were in service.

- **Hanson, February 29, 2016a. Ash Pond 1 and Ash Pond 2, Aquifer Evaluation in the Surface (Strip) Mining Area, Duck Creek Power Station, Illinois Power Resources Generating, LLC, Fulton County, IL.** Conducted hydraulic conductivity testing of unlithified mine spoil material and bedrock to assess aquifer characteristics

- **Hanson, February 29, 2016b. Closure Design Evaluation of Ash Pond 1 and Ash Pond 2. Illinois Power Resources Generating, LLC, Canton, Fulton County, IL.** Hydrologic Evaluation of Landfill Performance (HELP) model report providing analysis of the post-closure hydrostatic equilibrium groundwater elevations beneath the ash ponds.

1.3 Site Location and Background

The Duck Creek Energy Center is located in Sections 19 and 30 of Township 6 North, Range 5 East, southeast of Canton, in Fulton County, Illinois. Figure 1 depicts the approximate GMZ location, topography, and surrounding land use near the Duck Creek Energy Center as well as the locations of Ash Pond 1, Ash Pond 2, the previously clean-closed Recycle Pond, coal storage yard, generating facility and nearby surface water bodies. Surface waters include the Duck Creek Cooling Pond, which is used as a source of cooling water for the Duck Creek Energy Center, and Long Lake, a remnant of the area’s surface mining history. Figure 2 is an aerial photograph of the ash ponds showing the boundary of the GMZ.

Prior to construction of the power plant and associated facilities, strip mining of coal took place within the boundaries of the Duck Creek Energy Center, specifically in the area now occupied by the ash ponds, and on land immediately surrounding the ash ponds. Mining occurred at the Buckheart Mine No. 17, from 1937 to 1984, originally operated by United Electric Coal Company (1937 to 1975), and then later by Freeman United Coal Mining Company (1975 to 1984). As a result of these mining activities, subsurface investigations have encountered a mixture of mining spoils with native materials–mostly silt, clay, and broken shale bedrock–as evidence of past mining activities (Hanson, 2010).

Ash Pond 1 was constructed and permitted in 1976, concurrent with the commissioning of the Duck Creek Energy Center. The structure is as an above ground impoundment with raised berms covering approximately 60 acres. At an average depth of 21 feet, Ash Pond 1 has a design capacity of 1,230 acre feet (acre-ft). Ash Pond 2 was constructed in 1984, also as an above ground impoundment covering approximately 80 acres with an average depth of 40 feet. Ash Pond 2 has a design capacity of 3,200 acre-ft. The Recycle Pond was constructed below grade at an average depth of 3½ feet over approximately 40 acres resulting in a capacity of 140 acre-ft.

Fly ash was sluiced to Ash Pond 1 between 1976 and 1986, while Ash Pond 2 accepted fly ash beginning in 1984. Clean closure activities at the Recycle Pond were completed in 2010, when Ash Pond 1 and Ash Pond 2 were removed from service. Ash from the Recycle Pond was excavated and placed in Ash Ponds 1 and 2. IPRG no longer sluices fly ash at the Duck Creek Energy Center, and has and constructed landfill facilities to manage fly ash and FGD residue as well as a new lined basin to treat bottom ash transport water and miscellaneous low volume wastewater.

Ash Ponds 1 and 2 will be closed by leaving CCR in place and using a conventional earth soil cover system. The final cover system soils will be compacted to a permeability less than the subsoils underlying the CCR. This design will control the potential for water infiltration into the closed CCR unit and will allow drainage of surface water off of the cover system (AECOM, 2016).

1.4 Geologic and Hydrogeologic Summaries

1.4.1 Geology

The undisturbed unconsolidated materials near the Duck Creek Energy Center consist of loess, diamictons, and lacustrine/alluvial deposits (Willman, 1975). These materials are present in the strip mine spoil material, but have been excavated and mixed due to the surface mining activities. The Duck Creek Energy Center and surrounding area are part of several, large, surface coal mines that have since stopped mining operations

Previous site investigations indicate that bedrock in the area is overlain by mine spoil ranging in thickness from approximately 10 ft to 85 feet. The mine spoil consists of excavated bedrock (weathered shale, shale fragments, and some coal fines) mixed with the sand, silts and silty clays of the unconsolidated glacial and aeolian deposits. AECOM (2015) completed a geotechnical investigation that included an additional 31 borings that were reported in the 30% design data package for the Ash Ponds 1 and 2. Soils encountered were typically described as mottled grey to reddish brown lean clay.

The uppermost bedrock consists of a Carbondale Formation shale unit that lies stratigraphically beneath the Springfield (No. 5) Coal Member that was mined. The near surface bedrock at the Site generally consists of shale, siltstone, sandstone, and coal. In general, the depth to bedrock increases to the south and east. However, there appears to be a bedrock ridge that lies approximately midway (north-south axis) beneath Ash Pond 2 (Hanson, 2010). Bedrock under the ash ponds generally occurs between elevations 564 and 521 MSL.

1.4.2 Hydrogeology

Surface water drainage over much of the Site flows into the Duck Creek Cooling Pond, the cooling water impoundment for the Station. The western-most portion of the Site (west of the ash ponds) slopes toward the west. Surface water runoff from this area of the Site drains to a surface mining remnant known as Long Lake. The lake is an end-cut or last-cut lake formed when a mine operator leaves the last mining excavation or cut open, instead of backfilling with earth or other mined spoils. Long Lake lies on property currently owned by Freeman United Coal Company.

Shallow groundwater at the site occurs within coal mine spoils. Following closure of the Recycle Pond and removal of Ash Ponds 1 and 2 from service, porewater elevations measured in wells within the ash ponds have generally decreased by about 2 to 5 ft between November 2010 and May 2012 due to the site regrading and the reduction of surface water in the ash ponds. Large decreases in average groundwater elevation were also recorded at wells adjacent to the ash ponds, particularly in wells located between the Recycle Pond and Ash Ponds 1 and 2. Large decreases in groundwater elevations (3 to 7 ft) were also noted at wells located immediately east of the Recycle Pond. Comparison of the April 2007 and September 2015 water table elevation contour maps indicates that while the pond closure activities have lowered porewater heads within the ash, groundwater mounding within the ash ponds maintains a general radial flow pattern. Groundwater elevations are expected to continue to dissipate after the cap is constructed.

Hydraulic conductivity testing (slug testing) performed within mine spoil material at 12 monitoring wells immediately surrounding Ash Pond 1 and Ash Pond 2 yielded a geometric mean of 2.0×10^{-4} cm/sec, with values ranging from 1.5×10^{-3} cm/sec to 5.2×10^{-6} cm/sec. The geometric mean hydraulic conductivity for 4 laboratory tests performed within mine spoil material was 1.3×10^{-7}, several orders of magnitude lower than the field slug test results. The falling head permeability tests on undisturbed soil samples measure hydraulic conductivity in a vertical orientation whereas the field tests measure a much larger section of saturated soil in a horizontal orientation. Slug tests in the field at this site will encounter discontinuous lenses of sand and silt within the disturbed mine spoil that will exhibit localized higher hydraulic conductivity.

During September 2015, Hanson (2016a) completed a boring 255 feet below the top of bedrock (encountered at 85 feet bgs). Packer testing indicated that the uppermost 100 ft. of bedrock tested had almost no water uptake and the bedrock is acting as an aquitard to vertical migration of groundwater.

1.5 Groundwater Monitoring Activities

Groundwater monitoring has been performed at the site since 1980. Samples are currently collected semi-annually from 20 of the site's 31 monitoring wells in accordance with Site Operating Permit 2010-EO-0296 for analysis of boron, chloride, hardness, iron, manganese, sulfate and total dissolved solids (TDS) as well as field parameters pH, specific conductance and temperature. Samples of porewater and surface water from the ash ponds were also historically collected and analyzed.

1.5.1 Leachate Concentrations

The leachate is characterized by boron concentrations greater than 100 mg/L, chloride, sulfate and hardness concentrations greater than 1,000 mg/L, and low concentrations for most trace metals. Boron and chloride are indicator parameters of the presence of ash pond leachate constituents in groundwater for this site. As discussed further below, these constituents have high concentrations in leachate relative to background.

1.5.2 Background Groundwater Quality

Boron and chloride concentrations monitored in wells distant (more than 2,000 feet) from the ash ponds (OM10, OM16, OM17) are low with median concentrations less than 0.2 mg/L boron and 10 mg/L chloride (Table 3-4), indicating that these wells represent background groundwater quality within the mine spoils. Hardness, sulfate and TDS concentrations in these wells are high and occur within the concentration ranges of these constituents in leachate. Median iron and manganese concentrations are higher than leachate concentrations. Groundwater monitoring results indicate that hardness, sulfate, TDS, iron and manganese are not useful indicator constituents for determining the extent of leachate migration from the ash ponds.

Additional background samples were collected from the well nests OM50 and OM51 in 2009-2010, which were located 1.5 miles northwest and south, respectively, of the ash ponds in areas where no power plant activities occur. These wells were screened in mine spoils consisting largely of shale, which has been documented elsewhere as a source for boron concentrations greater than 1 mg/L in groundwater (Rowe, 1999). Data from OM50D and OM51D indicate that shale within the mine spoils at this site are capable of leaching boron at concentrations up to 2 mg/L. Therefore, boron concentrations higher than 2 mg/L may indicate the presence of ash pond constituents in groundwater.

2 GROUNDWATER IMPAIRMENTS AND CONTROL OPTIONS

2.1 Extent of Groundwater Impairments Associated with Ash Impoundments

The Duck Creek Ash Ponds 1 and 2 are located within a previously mined area and monitoring has demonstrated that the applicable classification of groundwater at the site is Class IV: Other Groundwater (35 IAC 620.240(g)).

The applicable groundwater quality standards for the currently monitored parameters hardness, iron, manganese, pH, sulfate and total dissolved solids, are the existing concentrations, 35 IAC 620.440(c). The background concentrations for these parameters occur within or above the concentration ranges of these constituents in the ash pond leachate. These constituents are not useful indicator parameters for determining the extent of leachate migration from the ash ponds.

The Illinois Environmental Protection Agency (Illinois EPA) approved monitoring the parameters boron and chloride in the groundwater monitoring plan (Illinois EPA, August 9, 2016). As discussed in section 1.5.2 above, boron concentrations higher than 2 mg/L may indicate the presence of ash pond constituents in groundwater. Elevated chloride concentrations are typically associated with occurrences of elevated boron concentrations.

Figure 3 shows the boron concentrations detected in samples collected during the September 2015 groundwater monitoring event. To the north, south, and east of the ash ponds, the extent of boron concentrations greater than 2 mg/L is limited to an area within the property boundary and within approximately 1,000 feet of the boundaries of ash ponds. Along the west property boundary, concentrations higher than 2 mg/L are observed in at least one monitoring well at each monitoring well nest (OM22 through OM25), suggesting that concentrations may exceed 2 mg/L off-site towards Long Lake.

2.2 Impairments to Groundwater Usage

There are currently no impairments to groundwater usage on the Duck Creek Energy Center property or surrounding properties caused by Ash Pond 1, Ash Pond 2 and the Recycle Pond. No impairments to groundwater usage resulting from establishment of the proposed GMZ are anticipated.

Hanson (2010) identified one domestic water supply well approximately one mile north-northwest of Ash Pond 2. This well is sufficiently distant that it cannot be considered downgradient of the ash ponds. The boring log for the potable well indicates that it was completed to a total depth of 50 feet bgs. Water is obtained from clay at a depth of 48 feet with a reported pumping capacity of 10 gallons per minute. The well is located within an area where the unconsolidated deposits have not been disturbed by mining.

The results of the Illinois State Geological Survey water well survey, combined with the information contained within the groundwater monitoring reports, indicate that there are no water wells, potable or non-potable, that are likely to be impacted by groundwater from the Duck Creek Energy Center Ash Ponds.

2.3 Closure of Ash Ponds 1 and 2

The Closure Plan for Ash Ponds 1 and 2 has been submitted under separate cover (AECOM, 2016). In November 2015, in accordance with 40 CFR Part 257, Subpart D, IPRG submitted to the Illinois EPA a notice of intent to close the inactive Ash Ponds 1 and 2. Because the ponds are inactive, the CCR Rule deadline for completing closure of these two ponds is November 2020.

Ash Ponds 1 and 2 are inactive unlined surface impoundments separated by a dike. The Closure Plan includes the following corrective action elements, with the capped area shown on Figure 4:

- Closure construction activities will include, but are not limited to, pumping to remove surface water, dewatering of the CCR, relocating and/or reshaping the existing CCR to achieve acceptable grades for closure
- Ash Ponds 1 and 2 will have a final soil cover system comprised of a 6-inch vegetative support layer (topsoil) overlying an 18-inch compacted barrier soil that has a permeability less than the subsoils and complies with the CCR Rule
- The design of the final soil cover system will control the potential for water infiltration into the closed CCR unit and will allow drainage of water off of and water out of the closed CCR unit.
- A non-contact stormwater management system will be constructed to convey non-contact stormwater runoff from the cover system to interior collection channels located along the perimeters of each Pond. Let-down structures will be constructed to convey non-contact stormwater to the previously clean-closed Recycle Pond and to an existing pond located to the north of the Ponds. Both of these ponds drain to the Duck Creek Cooling Pond.

The proposed corrective action elements will provide hydraulic control of surface water on the cover system, will lower leachate levels and establish hydrostatic equilibrium within the ponds, and will decrease transport off-site both spatially and temporally.

3 APPLICATION FOR GROUNDWATER MANAGEMENT ZONE

3.1 Environmental Impact of Proposed Groundwater Management Zone

Establishment of this GMZ will have a positive environmental impact. The corrective action, consisting of capping, control of surface water on the cover system, lowering of leachate levels within the ponds, and establishment of hydrostatic equilibrium within the ponds, will decrease transport of leachate-impacted groundwater from the ash ponds. Boron and chloride impacts from Ash Ponds 1 and 2, in addition to other constituents found in ash pond leachate and impacting groundwater above background concentrations, will be decreased both spatially and temporally. The current horizontal extent of the principal parameter of concern related to CCR leachate (boron) that exceeds the Class II groundwater standard is along the western property boundary at Long Lake (Figure 3). The corrective action being instituted at Ash Ponds 1 and 2 will decrease movement and concentrations of impacted groundwater both within the Site boundaries and mitigate potential off-site impacts.

3.2 Proposed Groundwater Management Zone

The proposed GMZ incorporates the area currently exhibiting constituents in groundwater that are attributable to the Ash Ponds 1and 2 as measured in the groundwater monitoring well network, and also includes the area within the Duck Creek Energy Center property boundary that has boron concentrations above the Class II groundwater standard. A legal description and map depicting the proposed groundwater management zone is provided in Appendix A. The boundary of the proposed GMZ is depicted in Figure 2. The GMZ will extend vertically through the unlithified deposits to the Carbondale Formation shale bedrock unit within the boundaries of Ash Pond 1, Ash Pond 2 and the Recycle Pond, which ranges from approximately 10 to 85 feet bgs.

3.3 Compliance with Applicable On-Site Groundwater Quality Standards

In accordance with IAC 620 Section 620.240, the compliance boundary is a lateral distance of 25 feet outward from the outermost edge of the Ash Ponds 1 and 2 berms. Following completion of the corrective action, the groundwater standard at the compliance boundary will be in accordance with IAC 620 Section 450(a)(4) for groundwater quality restoration such that the standard for each released chemical constituent will be the higher of either the Class II groundwater standard or the concentration determined by groundwater monitoring at the compliance boundary.

Compliance with on-site groundwater quality standards, as measured at the proposed monitoring well network, will be achieved when there are no statistically significant increasing trends that are attributed to Ash Ponds 1 and 2 for parameters detected at the compliance boundary after a minimum 30 years of post-closure groundwater monitoring has been completed.

4 PROPOSED GROUNDWATER MONITORING PLAN

Groundwater monitoring will be performed according to the groundwater monitoring plan, incorporated by reference, in the accompanying report:

- Natural Resource Technology, Inc. March 31, 2016. Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan; Duck Creek Energy Center Ash Ponds 1 and 2. (with revisions dated August 15, 2016)

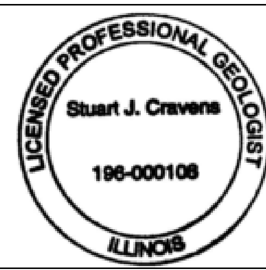
The groundwater monitoring well network utilizes 31 previously installed groundwater monitoring wells as shown on Figure 3. Nineteen of these monitoring wells will be used for compliance sampling and analytical testing. Groundwater elevation will also be measured in twelve additional wells (31 wells total). Groundwater samples will be collected, analyzed, and reported for dissolved boron and chloride, both of which are indicator constituents for coal ash leachate from the ash ponds. In addition, upon any future request by the Illinois EPA, pH and additional inorganic parameters listed in 35 IAC 620.410 will be added to the list of reported groundwater monitoring parameters for one or more sampling events.

The elements of the groundwater monitoring plan include:

- Groundwater monitoring system with designation of background and compliance monitoring wells along with monitoring well depths and construction.
- Groundwater monitoring parameters.
- Groundwater monitoring frequency and sampling schedule, along with statistical basis for reduction of monitoring frequency.
- Groundwater sample collection protocol with standard operating procedures.
- Laboratory analysis by a state-certified laboratory and listing of methods and reporting limits.
- Quality Assurance Program for field collection of samples and laboratory analysis of samples.
- Groundwater monitoring system maintenance, including schedule of inspections and methods for inspection of monitoring wells.
- Data reporting schedule and content of reports.
- Demonstration of compliance. Statistical methods for evaluating groundwater quality data.
- A notification schedule with actions to be taken in cases of non-compliance.

5 LICENSED PROFESSIONAL ACKNOWLEDGEMENT

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

Stuart J. Cravens, PG Principal Hydrogeologist Natural Resource Technology, Inc. 2422 E. Washington Street, Suite 104 Bloomington, Illinois 61704 (217) 390-1503 Registration No. 196000108	Seal:  Expires: 03/31/2017
Signature	September 9, 2016 Date

6 REFERENCES

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Natural Resource Technology, Inc. August 15, 2016. Revisions to Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan; Duck Creek Energy Center Ash Ponds 1 and 2.

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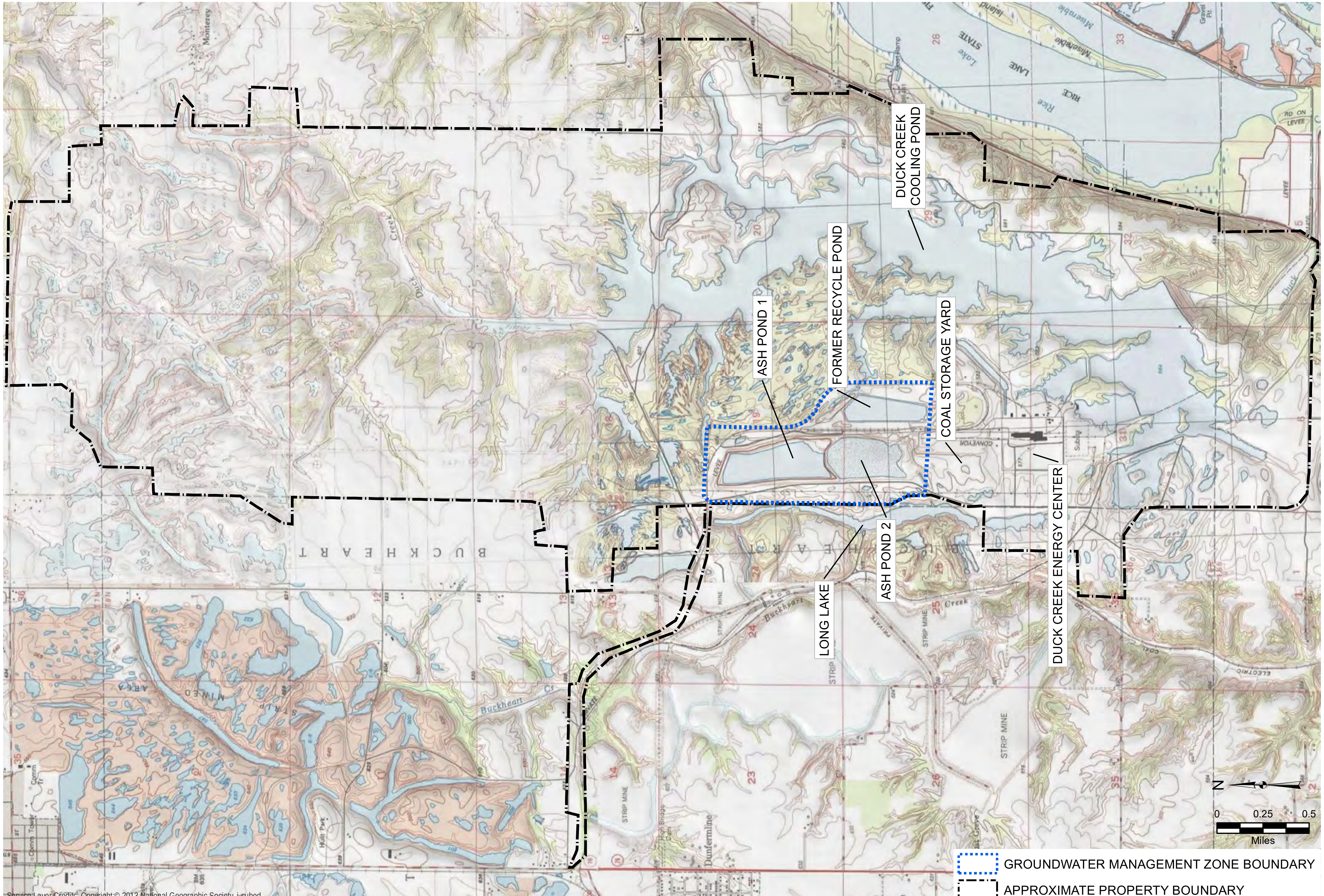
Willman, H. B., E. Atherton, T.C. Buschbach, C. Collinson, J.C. Frye, M.E. Hopkins, J.A. Lineback, and J. A. Simon, 1975. “Handbook of Illinois Stratigraphy”, Bulletin 95, Illinois State Geological Survey, Urbana, IL, 261 pp.

FIGURES



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REVIEWED BY/DATE: RJK 9/7/16
APPROVED BY/DATE: SJC 9/8/16

SITE LOCATION MAP

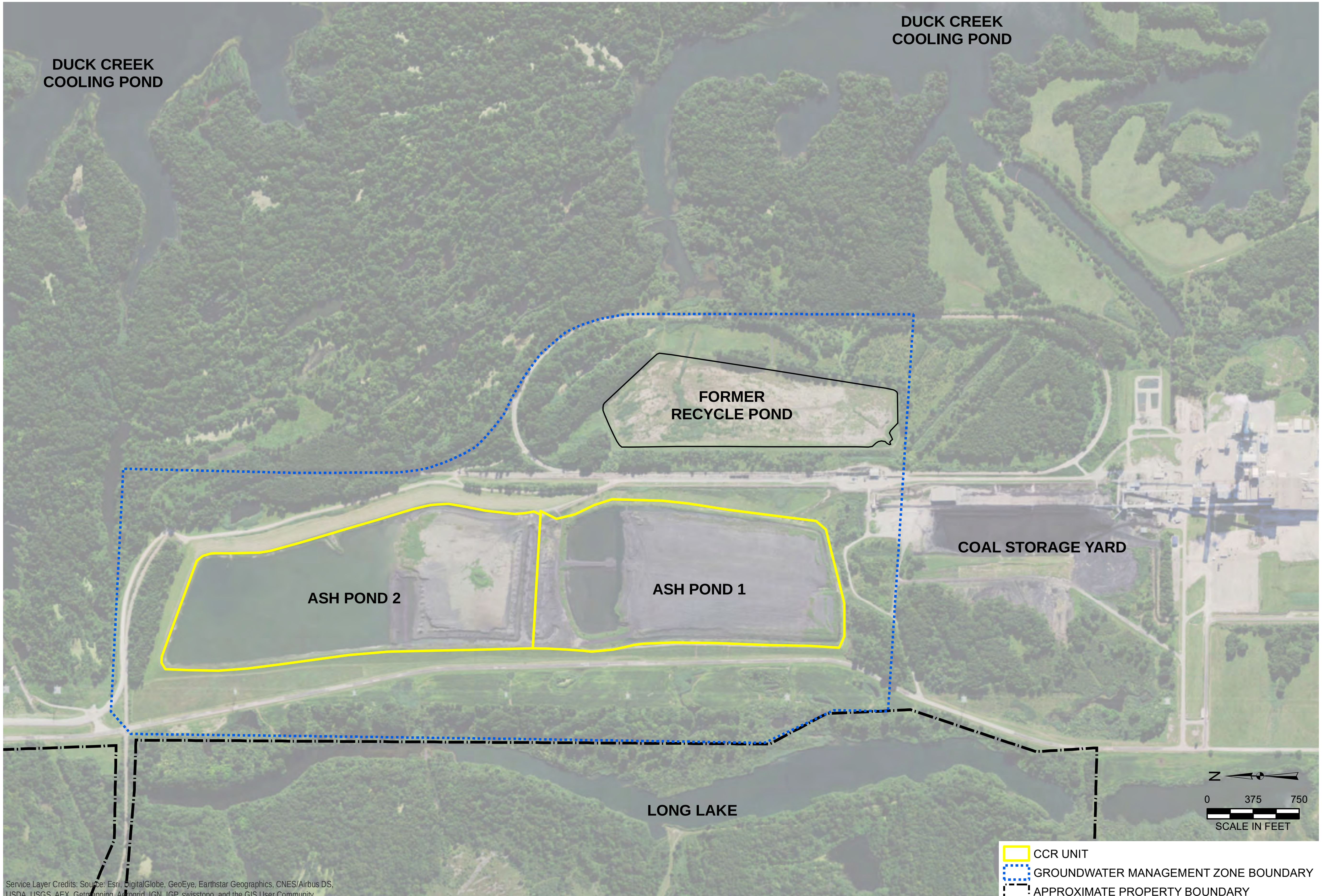
GROUNDWATER MANAGEMENT ZONE APPLICATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 1

NATURAL RESOURCE TECHNOLOGY

Y:\Mapping\Projects\23\2333\MXD\Groundwater Management Zone Application\Figure 1_Site Location Map.mxd Author: sstolz; Date/Time: 9/8/2016, 3:59:44 PM



DRAWN BY/DATE: SDS 9/7/16
REVIEWED BY/DATE: RJK 9/7/16
APPROVED BY/DATE: SJC 9/8/16

DETAILED SITE MAP WITH GMZ BOUNDARY

GROUNDWATER MANAGEMENT ZONE APPLICATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 2

NATURAL RESOURCE TECHNOLOGY

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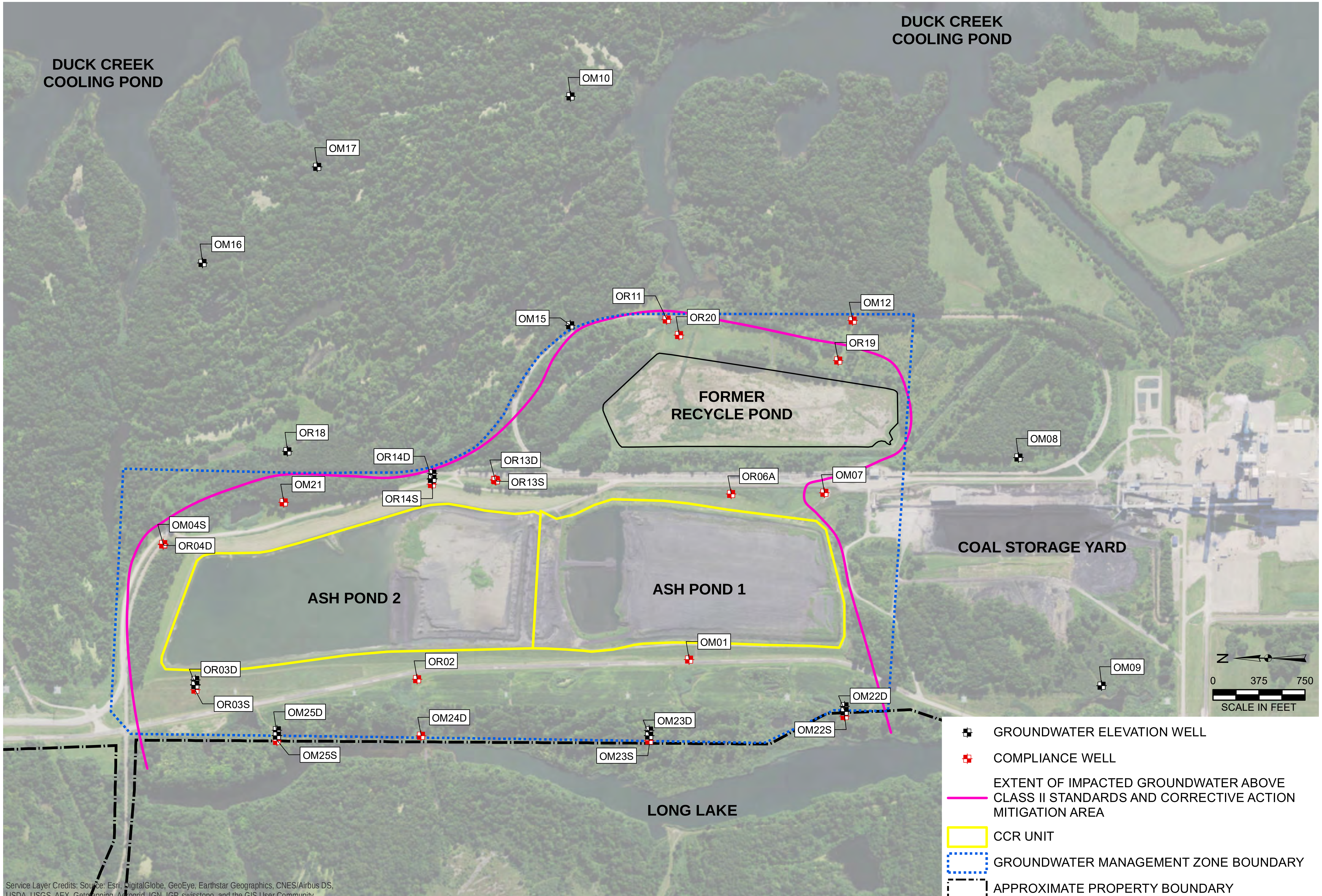

Y:\Mapping\Projects\23\2333\MXD\Groundwater Management Zone Application\Figure 3_Monitor Well Location.mxd Author: sstolz; Date/Time: 9/8/2016, 3:55:52 PM

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REVIEWED BY/DATE: RJK 9/7/16
APPROVED BY/DATE: SJC 9/8/16

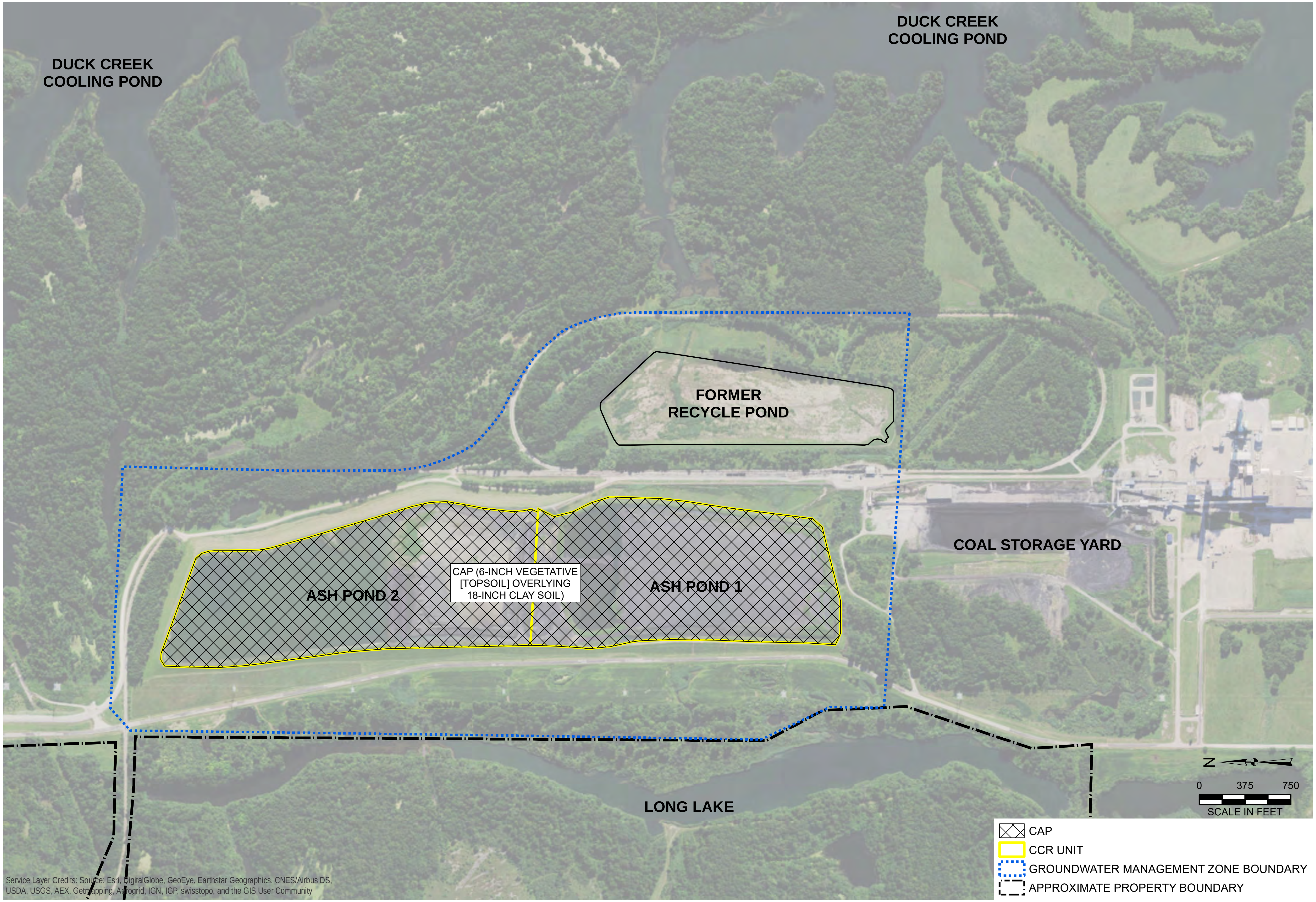
MONITORING WELL LOCATION MAP

GROUNDWATER MANAGEMENT ZONE APPLICATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 3

NATURAL RESOURCE TECHNOLOGY



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APPROVED BY/DATE: SJC 9/8/16

SITE CLOSURE PLAN

GROUNDWATER MANAGEMENT ZONE APPLICATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 4

NATURAL RESOURCE TECHNOLOGY

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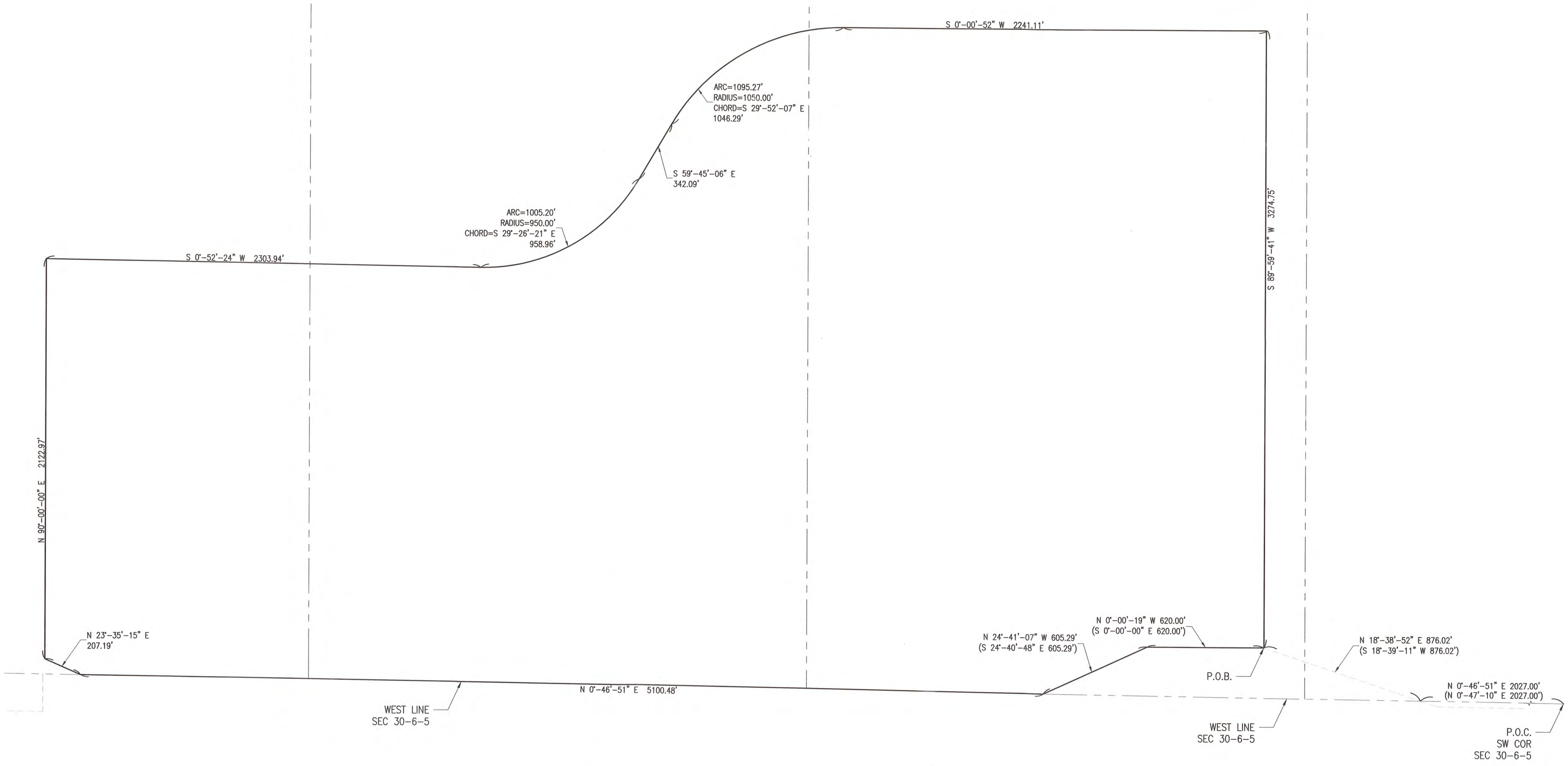
APPENDIX A

GROUNDWATER MANAGEMENT ZONE LEGAL DESCRIPTION



LEGEND

P.O.C. - POINT OF COMMENCEMENT
P.O.B. - POINT OF BEGINNING
- PARCEL LINE
- EXISTING PROPERTY LINE
- SECTION LINE
- NOT TO SCALE

N

300 0 300 600

LEGAL DESCRIPTION

Part of Section 19 and Section 30, both in Township 6 North, Range 5 East of the Fourth Principal Meridian, Fulton County Illinois;

Commencing at the Southwest Corner of said Section 30; thence North 0°-46'-51" East along the west line of said Section 30 a distance of 2,027.00 feet; thence North 18°-38'-52" East 876.02 feet to the Point of Beginning

From the Point of Beginning, thence North 0°-00'-19" West 620.00 feet; thence North 24°-41'-07" West 605.29 feet to a point on the west line of said Section 30; thence North 0°-46'-51" East along the west line of said Section 30 and the west lien of said Section 19 a distance of 5,100.48 feet; thence North 23°-35'-15" East 207.19 feet; thence North 90°-00'-00" East 2,122.97 feet; thence South 0°-52'-24" West 2,303.94 feet; thence southeasterly along a curve to the left an arc distance 1,005.20 feet, said curve having a radius of 950.00 feet and a chord bearing South 29°-26'-21" East 958.96 feet; thence South 59°-45'-06" East 342.09 feet; thence southeasterly along a curve to the right an arc distance 1,095.27 feet, said curve having a radius of 1,050.00 feet and a chord bearing South 29°-52'-07" East 1,046.29 feet; thence South 0°-00'-52" West 2,241.11 feet; thence South 89°-59'-41" West 3,274.75 feet to the Point of Beginning.

Containing 418.352 acres, more or less.

State of Illinois)
SS
County of Peoria)

We, Hanson Professional Services Inc., Professional Design Firm No. 184-001084, do hereby certify that this is a true and correct representation of a survey made for Natural Resource Technology, Inc. as shown on sheet 1 of 1.

Dated at Peoria, Illinois, this 2nd day of SEPTEMBER, 2016.

By: Andrew D. Canopy
Andrew D. Canopy
Illinois Professional Land Surveyor No. 3391
License Expires 11-30-2016

PROFESSIONAL LAND SURVEYOR ANDREW D. CANOPY NO 3391 PEORIA, IL STATE OF ILLINOIS

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Date 09/02/2016

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DRAWN	SIP	09/02/2016
REVIEWED	ADC	09/02/2016

Phone: (217) 788-2450
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HANSON
Hanson Professional Services Inc.
7625 N University St., Suite 200
Peoria, IL 61614
Illinois Licensed Professional Design Firm #184-001084

GROUNDWATER MANAGEMENT ZONE (GMZ) BOUNDARY

ASH POND 1 AND ASH POND 2
DUCK CREEK POWER STATION
CANTON, FULTON COUNTY, ILLINOIS

C1

1 of 1 sheets

Part of Section 19 and Section 30, both in Township 6 North, Range 5 East of the Fourth Principal Meridian, Fulton County Illinois;

Commencing at the Southwest Corner of said Section 30; thence North 0°-46'-51" East along the west line of said Section 30 a distance of 2,027.00 feet; thence North 18°-38'-52" East 876.02 feet to the Point of Beginning

From the Point of Beginning, thence North 0°-00'-19" West 620.00 feet; thence North 24°-41'-07" West 605.29 feet to a point on the west line of said Section 30; thence North 0°-46'-51" East along the west line of said Section 30 and the west lien of said Section 19 a distance of 5,100.48 feet; thence North 23°-35'-15" East 207.19 feet; thence North 90°-00'-00" East 2,122.97 feet; thence South 0°-52'-24" West 2,303.94 feet; thence southeasterly along a curve to the left an arc distance 1,005.20 feet, said curve having a radius of 950.00 feet and a chord bearing South 29°-26'-21" East 958.96 feet; thence South 59°-45'-06" East 342.09 feet; thence southeasterly along a curve to the right an arc distance 1,095.27 feet, said curve having a radius of 1,050.00 feet and a chord bearing South 29°-52'-07" East 1,046.29 feet; thence South 0°-00'-52" West 2,241.11 feet; thence South 89°-59'-41" West 3,274.75 feet to the Point of Beginning.

Containing 418.352 acres, more or less.

SMARTER SOLUTIONS

EXCEPTIONAL SERVICE

VALUE

SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION AND GROUNDWATER MONITORING PLAN

Duck Creek Ash Ponds 1 and 2
Duck Creek Energy Center
Canton, Illinois

Project No: 2333

March 31, 2016

NATURAL
RESOURCE
TECHNOLOGY

ENVIRONMENTAL CONSULTANTS

NATURAL RESOURCE TECHNOLOGY
ENVIRONMENTAL CONSULTANTS

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SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION AND GROUNDWATER MONITORING PLAN

DUCK CREEK ASH PONDS 1 AND 2
DUCK CREEK ENERGY CENTER
CANTON, ILLINOIS

Project No. 2333

Prepared For:

Illinois Power Resources Generating, LLC
1500 Eastport Plaza Drive
Collinsville, IL 62234

Prepared By:

Natural Resource Technology
2422 E. Washington Street, Suite 104
Bloomington, Illinois 61704

March 31, 2016

Stuart J. Cravens, PG
Principal Hydrogeologist

LICENSED PROFESSIONAL GEOLOGIST
Stuart J. Cravens
196-000108
ILLINOIS

Robert J. Karnauskas, PG, PH
Senior Hydrogeologist

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

1 INTRODUCTION

1.1 Overview

This Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan was prepared for Illinois Power Resources Generating, LLC (IPRG) to develop hydrogeologic information in support of a Closure Plan for the Duck Creek Energy Center Ash Ponds 1 and 2.

Numerous site-specific subsurface investigations were performed at the Duck Creek Energy Center over the past 30 years, in compliance with various State and Federal environmental monitoring requirements. Hanson Professional Services, Inc., (Hanson) prepared a Hydrogeologic Report in March 2010, which Ameren[1] subsequently submitted to IEPA on March 25, 2010. The Hanson (2010) report provided documentation of background information, a description of subsurface geology, and discussions of groundwater analytical trends and hydrogeologic conditions while Ash Pond 1, Ash Pond 2, and Recycle Pond were in service.

The Hanson (2010) report is supplemented herein with additional information on the site geology and hydrogeology as well as groundwater analytical trends. The results of hydrostatic equilibrium modeling of the closure of Ash Ponds 1 and 2 will be submitted independent of this report.

1.2 Site Location and History

The Duck Creek Energy Center is located in Sections 19 and 30 of Township 6 North, Range 5 East, southeast of Canton, in Fulton County, Illinois. Figure 1-1 depicts the location, topography, and surrounding land use near the power plant. Figure 1-2 is an aerial photograph that identifies the locations of Ash Pond 1, Ash Pond 2, the previously clean-closed Recycle Pond (collectively referred to herein as the “ash ponds”), coal storage yard, generating facility, and nearby surface water bodies, including Duck Creek Cooling Pond, which is used as a source of cooling water for the Duck Creek power generation units, and Long Lake, a remnant of the area’s surface mining history.

Prior to construction of the power plant and associated facilities, strip mining of coal took place within the boundaries of the Duck Creek Energy Center, specifically in the area now occupied by the ash ponds, and on land immediately surrounding the ash ponds. Mining occurred at the Buckheart Mine No. 17, from

[1] IPRG has owned and operated the Duck Creek Energy Center since December 2, 2013. As relevant herein, Ameren Energy Resources Generating Company (Ameren) owned and operated the Duck Creek Energy Center up to December 2, 2013.

1937 to 1984, originally operated by United Electric Coal Company (1937 to 1975), and then later by Freeman United Coal Mining Company (1975 to 1984). As a result of these mining activities, subsurface investigations have encountered a mixture of mining spoils with native materials–mostly silt, clay, and broken shale bedrock–as evidence of past mining activities (Hanson, 2010).

Ash Pond 1 was constructed and permitted in 1976, concurrent with the commissioning of the Duck Creek Energy Center. The structure is as an above ground impoundment with raised berms covering approximately 60 acres. At an average depth of 21 feet, Ash Pond 1 has a design capacity of 1,230 acre feet (acre-ft). Ash Pond 2 was constructed in 1984, also as an above ground impoundment covering approximately 80 acres with an average depth of 40 feet. Ash Pond 2 has a design capacity of 3,200 acre-ft. The Recycle Pond was constructed below grade at an average depth of 3½ feet over approximately 40 acres resulting in a capacity of 140 acre-ft.

Fly ash was sluiced to Ash Pond 1 between 1976 and 1986, while Ash Pond 2 accepted fly ash beginning in 1984. Clean closure activities at the Recycle Pond were completed in 2010, when Ash Pond 1 and Ash Pond 2 were removed from service. Ash from the Recycle Pond was excavated and placed in Ash Ponds 1 and 2. AECOM Figures 2A and 2B (Appendix A) show the current topography of the ash ponds.

IPRG no longer sluices fly ash at the Duck Creek Energy Center, and has obtained permits and constructed landfill facilities to manage fly ash and FGD residue, and a new lined basin to treat bottom ash transport water and miscellaneous low volume wastewater.

2 SUMMARY OF SITE GEOLOGY AND HYDROGEOLOGY

2.1 Site Geology

The site-specific geology was described by Hanson (2010). Regionally, the upper unconsolidated materials consist of Wisconsinan Stage materials overlying Illinoian Stage deposits. The undisturbed unconsolidated materials near the Site consist of loess, diamictons, and lacustrine/alluvial deposits (Willman, 1975). These materials are present in the strip mine spoil material, but have been excavated and mixed due to the surface mining activities. The Site and surrounding area are part of several, large, surface coal mines that have since stopped mining operations (Berg and Kempton, 1988). AECOM Figure 1 (Appendix A) shows the approximate limits of mining activities within and surrounding the Site.

Previous site investigations completed and reports prepared for the Site indicate that bedrock in the area is overlain by mine spoil ranging in thickness from approximately 10 ft (at monitoring well OM24D) to 75 feet (at OM15). The mine spoil consists of excavated bedrock (weathered shale, shale fragments, and some coal fines) mixed with the sand, silts and silty clays of the unconsolidated glacial and aeolian deposits. In general, the depth to bedrock increases to the south and east. However, there appears to be a bedrock ridge that lies approximately midway (north-south axis) beneath Ash Pond 2 (Hanson, 2010).

AECOM (2015) completed a geotechnical investigation that included an additional 31 borings that were reported in the 30% design data package for theAsh Ponds 1 and 2. Soils encountered were typically described as mottled grey to reddish brown lean clay. Representative samples from the borings were submitted to Alpha-Omega Geotech, Inc. (Alpha-Omega) for laboratory determination of soil geotechnical properties, including, but not limited to, Atterberg Limits, natural moisture (%), unconfined compression strength, void ratio, hydraulic conductivity and triaxial compression tests. The geotechnical information is being submitted as a separate report for the ash pond closure plan.

The uppermost bedrock consists of a Carbondale Formation shale unit that lies stratigraphically beneath the Springfield (No. 5) Coal Member that was mined. The near surface bedrock at the Site generally consists of shale, siltstone, sandstone, and coal. Geologic cross-sections are shown on Hanson Figures 4 and 5 (Appendix A).

2.2 Site Hydrology

The Site topography and drainage is shown on Figure 1-1. Surface water drainage over much of the Site flows into the Duck Creek Cooling Pond, the cooling water impoundment for the Station. The western-most portion of the Site (west of the ash ponds) slopes toward the west. Surface water runoff from this area of the Site drains to a surface mining remnant known as Long Lake. The lake is an end-cut or last-cut lake formed when a mine operator leaves the last mining excavation or cut open, instead of backfilling with earth or other mined spoils. Long Lake lies on property currently owned by Freeman United Coal Company.

2.3 Site Hydrogeology

2.3.1 Groundwater Flow within Coal Mine Spoils

As described in the Hanson (2010) report, shallow groundwater at the site occurs within coal mine spoils. During the period of operation of Ash Pond 1 and Ash Pond 2, the ponded surface water created mounding of the water table and generated a radial pattern of flow beneath the ponds. Groundwater flowed to the east toward the Duck Creek Cooling Pond, to lowland areas to the north and in a westerly direction toward Long Lake. A water table contour map for April 2007, prior to removal of service of the ash ponds, is shown on Figure 2-1.

Following closure of the Recycle Pond and removal of Ash Ponds 1 and 2 from service, changes in groundwater elevation were observed within the ash ponds (Table 2-1) and at multiple monitoring wells (Table 2-2). Porewater elevations measured in wells within the ash ponds decreased by 1.8 to 4.9 ft between November 2010 and May 2012. Large decreases in average groundwater elevation were recorded at wells adjacent to the ash ponds, with the largest average decreases (greater than 5 ft) occurring at wells located between the Recycle Pond and Ash Ponds 1 and 2 (OR05D, OM05S, OR06A, OM07, OR13D). Large decreases in groundwater elevations (3 to 7 ft) were also noted at wells OR11, OR19 and OM20/OR20 located immediately east of the Recycle Pond.

Increases in average groundwater elevation ranging from 0.5 to 5.0 ft were typically noted in wells located in lowland areas east of the ash ponds (Table 2-2, OM10, OM12, OR14D, OM15, OM16, OM17 and OR18). These increases are not related to closure of the Recycle Pond or removal of Ash Ponds 1 and 2 from service.

Representative hydrographs of wells between the closed Recycle Pond and Ash Pond 2 (OR6A), wells located immediately east of the Recycle Pond (OR20), and wells located in lowland areas east of the ash ponds (OM16) are shown below.

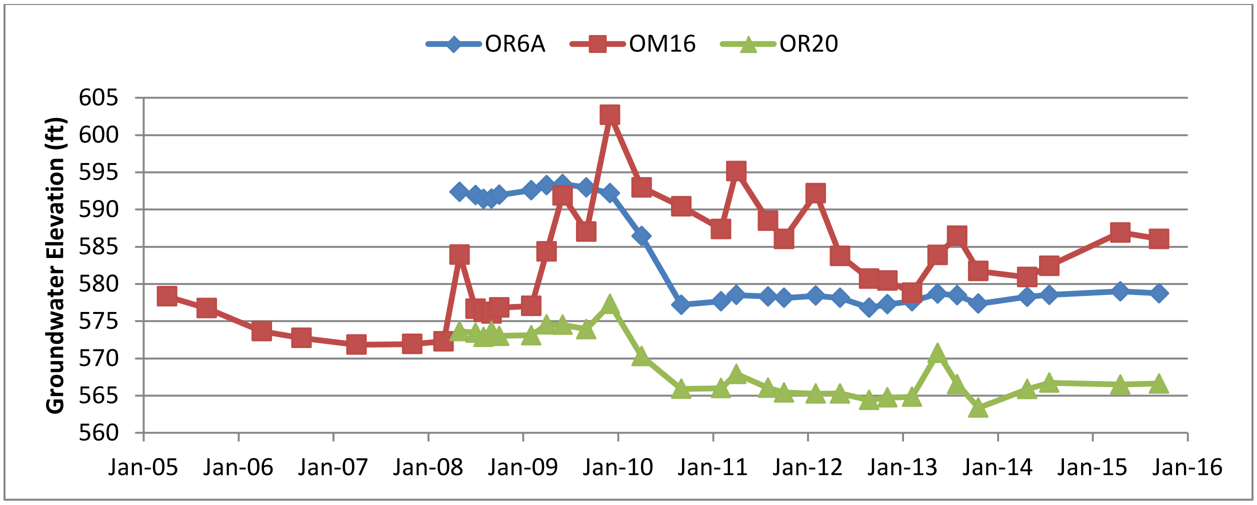


Figure 2-2 shows water table elevation contours and flow directions in September 2015, approximately five years following closure of the Recycle Pond and removal of Ash Ponds 1 and 2 from service in 2010. Comparison of the April 2007 and September 2015 water table elevation contour maps indicates that while the pond closure activities have lowered porewater heads within the ash, groundwater mounding within the ash ponds maintains a general radial flow pattern. However, the groundwater quality data (discussed in Section 3) suggests there may be an increased component of flow in a westerly direction toward Long Lake, based on increasing boron and/or chloride concentrations in selected wells.

2.3.2 Hydraulic Conductivity within Coal Mine Spoils

Hanson (2016a) completed hydraulic conductivity testing (slug testing) of the monitoring wells immediately surrounding Ash Pond 1 and Ash Pond 2. Analyses of the falling head and rising head tests performed at each well were performed using the Bower-Rice method [B-R] (Bouwer & Rice, 1976; Bouwer, 1989) and the Kansas Geological Survey method [KGS] (Butler, 1998) unconfined solutions. The geometric mean hydraulic conductivity for the 23 tests performed within mine spoil material was 2.0 x 10^{-4} cm/sec, with values ranging from 1.5 x 10^{-3} cm/sec at OR03D to 5.2 x 10^{-6} cm/sec at OM04S. Test methods and details are provided in Appendix B1 and the results are summarized below.

Field Hydraulic Conductivity Test Results (cm/sec)

Well Number	Falling Head	Rising Head	Geometric Mean	Analysis Method
OM01	0.00045	0.00065	0.00054	B-R
OR02	0.00037	0.00047	0.00042	B-R
OR03D	0.0015	0.00077	0.0011	B-R
OR03S	0.00039	0.00030	0.00034	B-R
OR04D	0.00015	0.00031	0.00021	B-R
OM04S	0.0000052	0.000055	0.000017	B-R
OR05D	0.000034	0.000034	0.000034	KGS
OM05S	0.000095		0.000095	B-R
OR06A	0.00018	0.00054	0.00031	B-R
OM07	0.00011	0.00024	0.00016	B-R
OM09	0.00031	0.00026	0.00028	KGS
OM21	0.00035	0.00036	0.00035	B-R
Geometric Mean =	1.7×10^{-4}	2.7×10^{-4}	2.0×10^{-4}	

Four falling head permeability tests (ASTM D5084 Method C) were also performed in the Alpha-Omega laboratory on undisturbed soil samples collected from the AECOM (2015) geotechnical borings B008, B015, B019 and B026. Sample locations are shown on AECOM Figures 2A and 2B Ash Pond Borehole Location maps in Appendix A. Test methods and details are provided in Appendix B2 and the results are summarized below.

Laboratory Hydraulic Conductivity Test Results (cm/sec)

Boring Number	Sample Depth (feet)	Hydraulic Conductivity
B008	16 – 17.5	6.8×10^{-8}
B015	56 – 57.5	8.1×10^{-8}
B019	43.5 - 45	3.7×10^{-7}
B026	33.5 – 35	1.5×10^{-7}
Geometric Mean =		1.3×10^{-7}

The geometric mean hydraulic conductivity of 1.3×10^{-7} for the 4 laboratory tests performed within mine spoil material was several orders of magnitude lower than the field test results. The falling head permeability tests on undisturbed soil samples measure hydraulic conductivity in a vertical orientation whereas the field tests measure a much larger section of saturated soil in a horizontal orientation. Slug tests in the field at this site will encounter discontinuous lenses of sand and silt within the disturbed mine spoil that will exhibit localized higher hydraulic conductivity. Given this anisotropy of the mine spoil material, a range of horizontal hydraulic conductivities measured in the field that is several orders of magnitude higher than the range of vertical hydraulic conductivity measured in the laboratory is not unexpected. These results suggest groundwater will preferentially flow laterally through the mine spoils rather than vertically and that the rate of lateral groundwater flow will be highly variable.

2.3.3 Potential for Saturated Ash

As previously discussed, groundwater mounding within the ash ponds persists since the ponds have been removed from service in 2010. Porewater levels measured in piezometers screened within the coal ash (Table 2-1) indicate head fluctuations of about 3 ft. Boring logs for OM26, OM27, and OM28, which were drilled in the center of Ash Ponds 1 and 2, indicated an ash thickness of 60 to 63 ft below ash surface elevations of 650 to 660 feet. This places the base of ash at an elevation of approximately 590 feet. Given porewater elevations of 627 to 638 ft measured in December 2015, the current thickness of saturated ash is roughly 40 to 50 ft.

These porewater elevations are roughly 30 to 40 ft higher than in monitoring wells located in the surrounding berms. As previously noted, it appears groundwater levels in selected wells have been decreasing, due to the site regrading and the reduction of surface water in the ash ponds (Table 2-2). Groundwater elevations are expected to continue to dissipate after the cap is constructed. It is possible that ash will not be saturated once the cap is applied and the mound dissipates.

A more detailed analysis of the post-closure hydrostatic equilibrium groundwater elevations beneath the ash ponds is provided in the modeling report prepared by Hanson (2016b).

2.3.4 Groundwater in Bedrock

During September 2015, Hanson (2016a) completed boring OM26B to a depth of 355 ft below ground surface (bgs). Bedrock was encountered at a depth of 85 ft. At the completion of the coring operations, the lower 255 ft. of bedrock in the boring was pressure (packer) tested. The interval between the two packers was approximately 8.5 ft. Flow to the bedrock test interval (i.e. hydraulic conductivity) was measured at several increasing and decreasing pressures. As shown below, the mean hydraulic conductivity values decreased as pressure testing continued up the borehole. The greatest water uptake during the testing was noted in the bottom 20 ft. of the borehole with mean hydraulic conductivity values ranging from 2 to 9 x 10^{-6} cm /sec. The uppermost 100 ft. of bedrock tested had almost no water uptake during the pressure testing.

Field Packer Test Hydraulic Conductivity Results (cm/sec)

Test No.	Depth (ft.)	Arithmetic Mean of Hydraulic Conductivity	Median of Hydraulic Conductivity
A	351.57	1.7×10^{-6}	1.3×10^{-6}
B	331.64	8.5×10^{-6}	5.8×10^{-6}
C	321.54	5.7×10^{-8}	3.9×10^{-8}
D	300.77	5.0×10^{-7}	2.7×10^{-8}
E	279.77	0.0	0.0
F	269.17	7.1×10^{-9}	0.0
G	258.72	5.9×10^{-7}	4.6×10^{-8}
H	248.62	3.0×10^{-9}	0.0
I	227.61	0.0 *(no take)*	0.0 *(no take)*
J	217.05	3.6×10^{-8}	0.0 *(no take)*
K	206.51	1.5×10^{-9}	0.0
L	196.37	0.0 *(no take)*	0.0 *(no take)*
M	185.77	1.5×10^{-9}	0.0
N	175.55	0.0 *(no take)*	0.0 *(no take)*
O	165.39	4.1×10^{-9}	0.0
P	155.25	0.0 *(no take)*	0.0 *(no take)*
Q	144.75	1.5×10^{-9}	0.0
R	134.15	1.3×10^{-9}	0.0
S	124.04	0.0 *(no take)*	0.0 *(no take)*
T	113.86	0.0 *(no take)*	0.0 *(no take)*
U	103.41	0.0 *(no take)*	0.0 *(no take)*

Based on these results, the bedrock is acting as an aquitard to vertical migration of groundwater. Details of the packer testing and boring log are provided in the Hanson (2016a) report in Appendix B1.

2.3.5 Proximity of Potable Wells

Hanson (2010) identified one domestic water supply well approximately one mile north-northwest of Ash Pond 2 as shown on Hanson Figure 1 (Appendix A). This well is sufficiently distant that it cannot be considered downgradient of the site. The boring log for the potable well indicates that it was completed to a total depth of 50 feet bgs. Water is obtained from clay at a depth of 48 feet, and a reported pumping capacity of 10 gallons per minute. The well is located within an area where the unconsolidated deposits have not been disturbed by mining.

3 GROUNDWATER QUALITY

3.1 Summary of Groundwater Monitoring Activities

Groundwater monitoring has been performed at the site since 1980. Sampling was initially performed semi-annually for the parameters specified in the facility's IEPA, Subpart B permit. Samples are currently collected semi-annually from 20 of the site's 31 monitoring wells in accordance with Site Operating Permit 2010-EO-0296 for analysis of boron, chloride, hardness, iron, manganese, sulfate and total dissolved solids (TDS) as well as field parameters pH, specific conductance and temperature. Samples of porewater and surface water from the ash ponds were also historically collected and analyzed. Table 3-1 lists monitored parameters and the time interval over which the parameters have been sampled and analyzed. Table 3-2 is a list of existing monitoring wells at the facility and the period each well has been monitored for groundwater elevation and/or chemistry. Figure 3-1 shows the monitoring well locations and elevations of the bottom of the well screens.

3.2 Leachate Concentrations

Appendix C-1 lists leachate sample results for surface water from Ash Ponds 1 and 2 and former Recycle Pond, and Appendix C-2 provides porewater leachate sample analytical laboratory reports from two piezometers screened in the ash ponds. Table 3-3 lists the low, high and median concentrations for the constituents analyzed in Ash Ponds 1 and 2 and the Recycle Pond as well as the porewater leachate samples.

The leachate is characterized by boron concentrations greater than 100 mg/L, chloride, sulfate and hardness concentrations greater than 1,000 mg/L, and low concentrations for most trace metals. Boron and chloride are the most likely indicators of the presence of ash pond leachate constituents in groundwater for this site. As discussed further below, these constituents have high concentrations in leachate relative to background.

3.3 Background Groundwater Quality

Appendix C-3 lists groundwater analytical results for samples collected from all monitoring wells since 2000. Boron and chloride concentrations monitored in wells distant (more than 2,000 feet) from the ash ponds (OM10, OM16, OM17) are low with median concentrations less than 0.2 mg/L boron and 10 mg/L chloride (Table 3-4), indicating that these wells represent background groundwater quality within the mine spoils. Hardness, sulfate and TDS concentrations in these wells are high and occur within the concentration ranges of these constituents in leachate. Median iron and manganese concentrations are higher than leachate concentrations. These results indicate that hardness, sulfate, TDS, iron and manganese are not useful indicator constituents for determining the extent of leachate migration from the ash ponds.

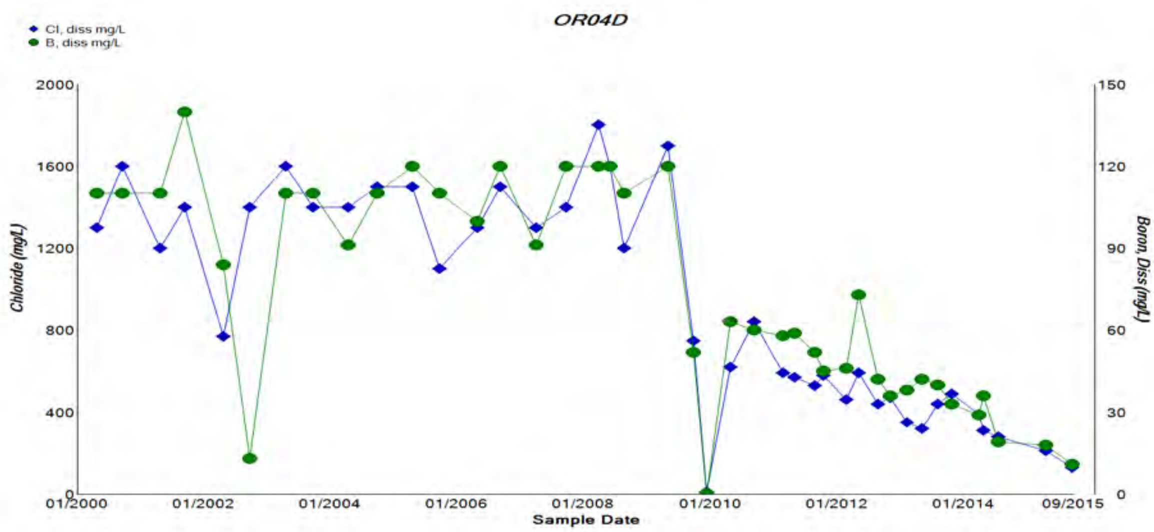
Additional background samples were collected from the well nests OM50 and OM51 in 2009-2010, which were located 1.5 miles northwest and south, respectively, of the ash ponds in areas where no power plant activities occur. With the exception of boron in the deep wells, concentrations from these wells had ranges similar to the ranges observed in OM10, OM16, and OM17. Median boron concentrations in OM50D and OM51D (2.0 and 1.2 mg/L, respectively) were not within the range of values observed at OM10, OM16, and OM17 (Table 3-4). Inspection of geologic logs for these wells (Appendix D) showed that OM50D and OM51D were screened in mine spoils consisting largely of shale, which has been documented elsewhere as a source for boron concentrations greater than 1 mg/L in groundwater (Rowe, 1999). Data from OM50D and OM51D indicate that shale within the mine spoils at this site are capable of leaching boron at concentrations up to 2 mg/L. The OM50 and OM51 well nests have been abandoned.

3.4 Changes in Groundwater Quality Since 2010

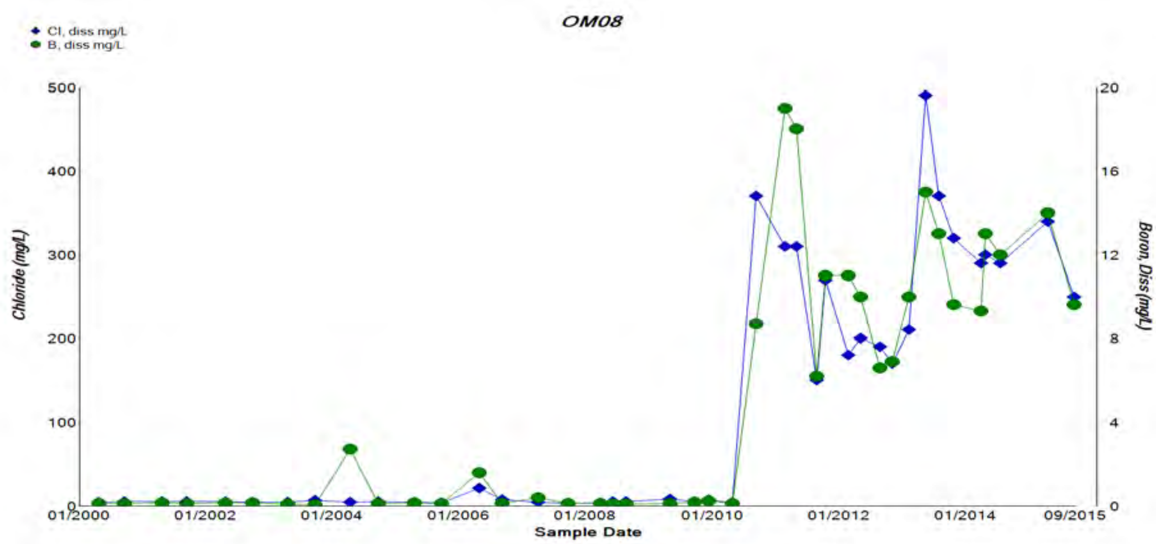
Table 3-5 compares average boron and chloride concentrations immediately before closure of the Recycling Pond and removal of Ash Ponds 1 and 2 from service (2008-2009) to the period March 2014 through September 2015 for wells sampled during both monitoring periods. Time-series plots of boron and chloride concentrations for all currently monitored wells are provided in Appendix C-4. The concentration averages during the two time periods and the time-series plots of boron and chloride concentrations indicate the following:

- Changes and trends in boron and chloride concentrations are closely aligned. The similarities in the trends of these constituents at all well locations (Appendix C-4) reinforce their usefulness as indicator parameters of ash leachate presence and migration in groundwater.
- Average concentration decreases of 28 to 98 percent were observed in seven monitoring wells (OR04D, OM07, OR13S, OR13D, OR14D, OR19, OR20) after closure of the Recycle Pond and removing Ash Ponds 1 and 2 from service. All of these wells are located east of the ash ponds and concentration trends suggest decreases will continue beyond 2015 (see plot for OR04D below).

Natural Resource Technology

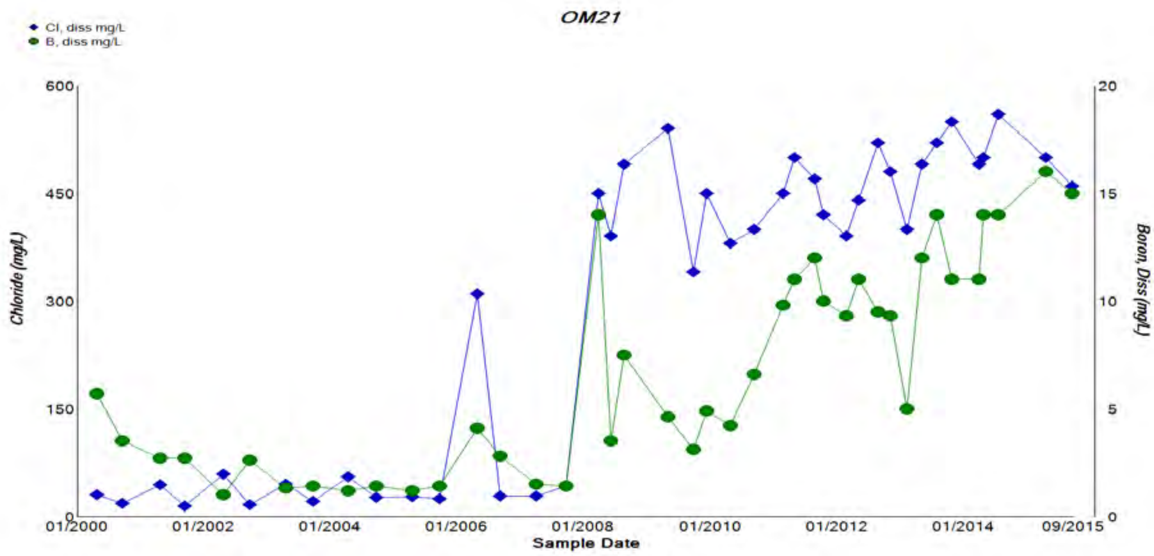


- Concentrations increased at OM08 and OR11 following removal of the recycle pond. OM08 was side-gradient of the ash ponds prior to 2010 and is now upgradient of the ash ponds. There are no apparent groundwater flow mechanisms to explain the relatively large concentration increase observed at this monitoring point (see plot for OM08 below). In the case of OR11, the increase was relatively small in absolute value and temporary. Decreasing concentration trends were observed at OR11 beginning in 2013 and may represent a shift in groundwater flow direction caused by removal of the Recycle Pond.



NATURAL RESOURCE TECHNOLOGY

- Average concentration increases greater than 40% percent for boron and/or chloride were observed in monitoring wells OM21, OM22D, OM24D and OM25S. The plot for OM21 located east of the ash ponds, shown below, exhibits increasing concentration trends in 2008, prior to removing Ash Ponds 1 and 2 from service. Concentration trends suggest boron and chloride may stabilize or decrease beyond 2015. Similar observations cannot be confirmed at OM22D, OM24D and OM25S because sampling of these wells did not commence until December 2009. Additional discussion of these wells west of the ash ponds is provided below.



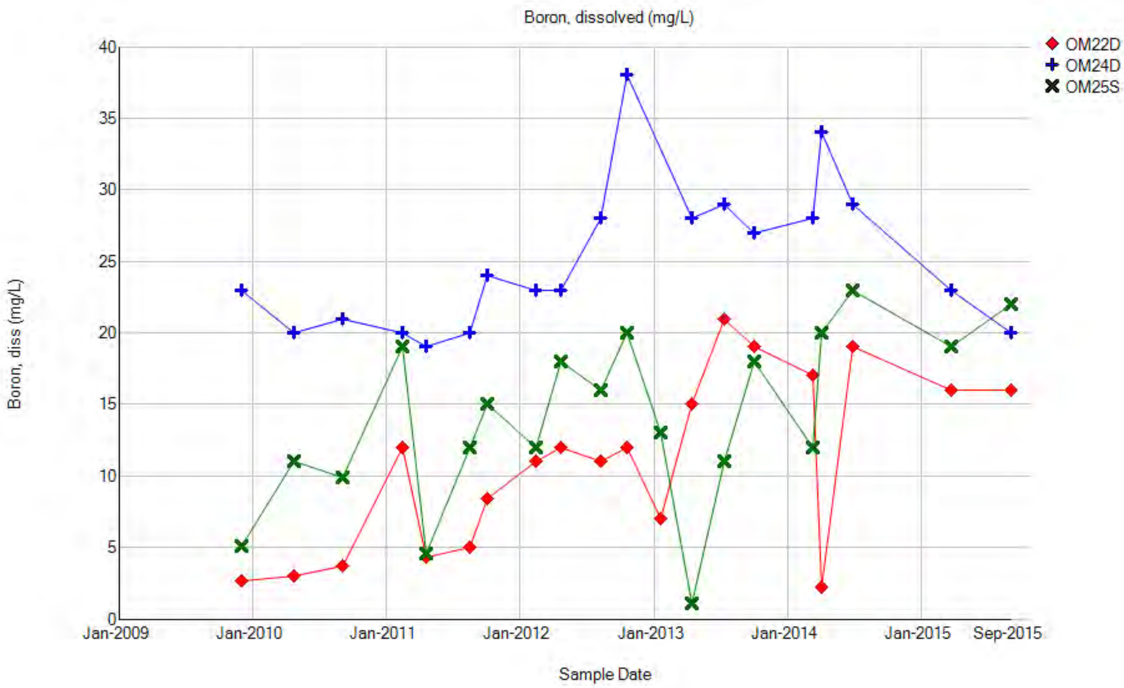
3.5 Potential for Off-Site Migration

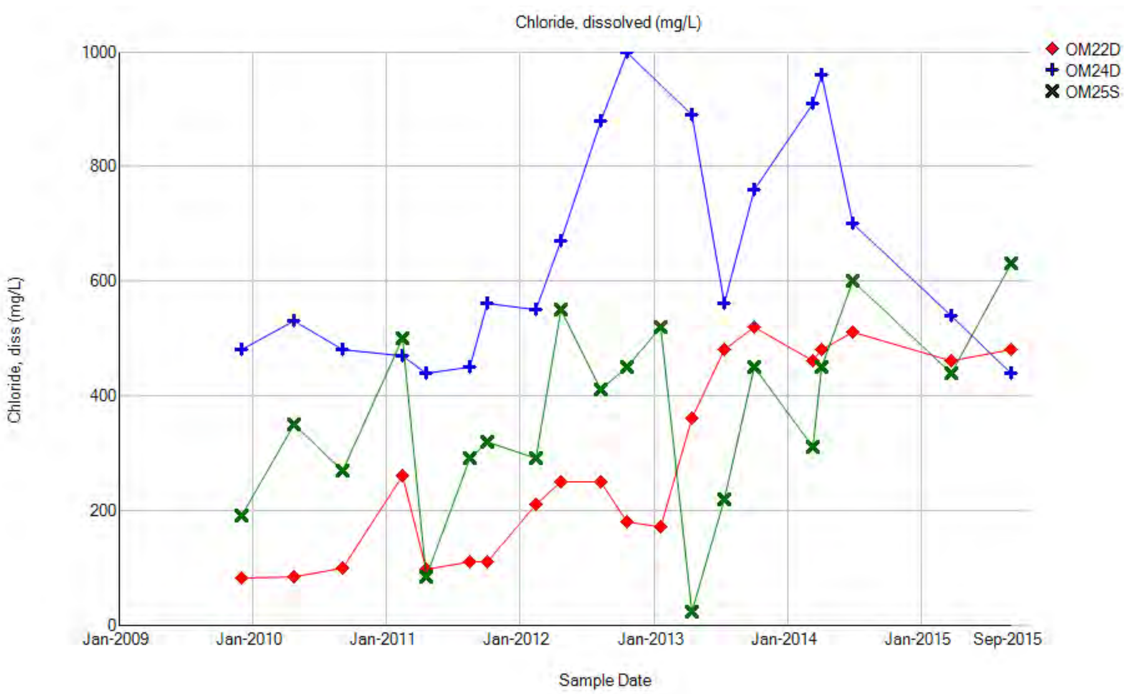
Monitoring wells OM22D, OM22S, OM23D, OM23S, OM24D, OM25D, and OM25S are located west of the ash ponds along the west property boundary. Boron concentrations in these monitoring wells range from less than 2 to 38 mg/L and chloride concentrations range from less than 20 to 1,000 mg/L.

- Wells OM22S and OM23S are screened in mine spoils predominantly consisting of silt and clay. When last sampled in 2010, boron concentrations in these wells were lower than 2 mg/L and chloride concentrations were 21 mg/L or less, indicating that these wells are not measurably affected by leachate from the ash ponds.

- Wells OM23D and OM25D are screened beneath mine spoils containing shale. Boron concentrations in these wells are typically about 2 mg/L and chloride concentrations are typically about 35 mg/L at OM23D and 100 mg/L at OM25D. The boron concentrations are at levels similar to the background concentrations observed at OM50D and OM51D. Chloride concentrations are higher than background (10 mg/L), suggesting the possible presence of ash pond leachate.

- As previously noted, concentration increases of boron and/or chloride were observed in monitoring wells OM22D, OM24D, and OM25S. These wells have boron concentrations greater than 10 mg/L and chloride concentrations greater than 100 mg/L, suggesting that these wells are monitoring groundwater mixed with leachate from the ash ponds. Since hydraulic gradients previously mapped in this area are toward the west, boron concentrations may be higher than 2 mg/L west of these monitoring wells and the west property boundary (see plots below).





While the Class II groundwater quality standard for boron is 2 mg/L, this standard is not applicable for the site monitoring wells that sample groundwater within disturbed coal spoil fill. As previously noted in Section 3.3, background boron concentrations in the coal mine spoils can be as high as 2 mg/L.

Therefore, boron concentrations higher than 2 mg/L may indicate the presence of ash pond constituents in groundwater. Figure 3-2 shows the boron concentrations detected in samples collected during the September 2015 groundwater monitoring event. To the north, south, and east of the ash ponds, the extent of boron concentrations greater than 2 mg/L is limited to an area within the property boundary and within 1,000 feet of the boundaries of ash ponds. Along the west property boundary, concentrations higher than 2 mg/L are observed in at least one monitoring well at each monitoring well nest (OM22 through OM25), suggesting that concentrations may exceed 2 mg/L off-site towards Long Lake.

3.6 Conceptual Site Model

A groundwater model can be useful for estimating the time over which water quality will improve after closure and for evaluating the extent of ash pond constituents in areas that are otherwise inaccessible for groundwater monitoring.

The coal mine spoils at the Site are heterogeneous over a small scale, and any single boring log may encounter highly variable sequences of silt, clay, and shale fragments randomly placed over the former mine surface. This geologic heterogeneity results in a groundwater flow pathway that is complex and tortuous as well as an inconsistent distribution of boron and chloride concentrations. Even with the large number of boring logs available at this Site, calibrating a numerical flow and transport model to match the complex groundwater flow and concentration distribution at this Site will require estimation of hydraulic conductivity and effective porosity zones that will not be supported by field data, resulting in a low confidence level in the model results.

Since this Site cannot be numerically modeled with confidence, a conceptual model of groundwater flow was developed to evaluate the potential off-site extent of ash pond constituents. There are numerous small ponds surrounding the Site within the coal spoils that fill closed depressions. These ponds are typically surface expressions of the water table, and the elevations of these ponds, as depicted on topographic maps, are the elevations of the water table at the time that the map was generated. The most-recent USGS topographic map for this area was generated in 2012. Figure 2-3 shows the elevation of surface waters—as interpreted from the 2012 USGS topographic map—to the north, west, and south of the ash ponds. These elevations provide an approximate (±10 feet) elevation of the water table that can be used to interpret high points and low points in the water table, enabling interpretation of the flow paths that groundwater may follow through these deposits on a larger scale. Based on the surface and groundwater elevation data and information provided in this supplemental hydrogeologic site characterization, the conceptual model for groundwater flow at the Site is as follows:

- Groundwater flowing to the east from the ash ponds discharges to various small surface waters and ultimately to the Duck Creek Cooling Pond.

- Long Lake lies between the ash ponds to the east and a watershed divide to the west. Groundwater flowing to the west from the ash ponds discharges to Long Lake. As noted previously, the lake is an end-cut or last-cut lake formed when a mine operator leaves the last mining excavation or cut open, instead of backfilling with earth or other mined spoils.

- Surface waters to the north have elevations higher than Long Lake and the Duck Creek Cooling Pond. The groundwater mound and radial flow from the former ash ponds will cause groundwater from the north to flow either west or south toward Long Lake or east toward the Duck Creek Cooling Pond.

- Surface water flow out of Long Lake will likely migrate via groundwater southward, consistent with the regional drainage.

- Hydraulic conductivity testing indicates groundwater flow through the disturbed mine spoils will be preferentially horizontal. The shale bedrock unit underlying the Springfield Coal Member that was mined has been demonstrated by packer testing to be an aquitard that will minimize vertical migration of ash pond constituents.

4 GROUNDWATER MONITORING SYSTEM

A groundwater monitoring system is proposed for the site to monitor groundwater, evaluate post-closure groundwater quality and trends, and to demonstrate compliance with the applicable groundwater quality standards identifed in Section 5.

The proposed groundwater monitoring well network consists of a sufficient number of wells, installed at appropriate locations and depths to monitor post-closure compliance with groundwater quality standards for Class IV: Other Groundwater. The groundwater monitoring well network on-site utilizes 31 previously installed groundwater monitoring wells. Nineteen of these monitoring wells will be used for compliance sampling and analytical testing. Groundwater elevation will also be measured in twelve additional wells (31 wells total).

The proposed groundwater monitoring system has been modified from the system proposed by Hanson (2010) and the monitoring program currently being employed. The proposed groundwater monitoring system is summarized on Table 3-2 and is being modified as follows:

- Wells OR05D and OM05S are not currently used for monitoring groundwater quality and are in close proximity to the OR13 well nest. Wells OR05D and OM05S will be abandoned following IEPA approval of the proposed monitoring plan.
- Monitoring well OM08 is upgradient of the ash ponds (see Figure 2-2) and shows elevated groundwater concentrations that cannot be due to groundwater migration from the ash ponds. Therefore, groundwater sampling at this well will be discontinued and it will be used for measurement of elevation only, pending IEPA approval of the proposed monitoring plan.
- Wells OM26, OM27, OM28, OM30 and OM31 are located within or immediately adjacent to the ash ponds and have not been monitored since 2011. These wells will be abandoned following IEPA approval of the proposed monitoring plan.

Boring logs and monitoring well construction reports for the groundwater monitoring system are provided in Appendix D. Monitoring well locations are shown on Figure 4-1. Well screen intervals, total well depths and September 2015 groundwater elevations at the proposed monitoring well network locations are summarized in Table 4-1. The depth that the bottom of the monitoring well is screened below the water table is also shown. Monitoring wells that are screened within the upper 20 ft of groundwater will be utilized to construct water table contour maps. Deeper nested monitoring wells (designated by the suffix ‘D’) and wells screened at depths greater than about 20 ft below the water table are piezometers that will be utilized to monitor potential deeper migration pathways of ash pond constituents and vertical hydraulic gradients. Historical groundwater elevations for the period of 2014 and 2015 at the proposed monitoring well locations are provided in Appendix E.

The monitoring wells are designed and constructed in accordance with applicable standards, including the following:

- All monitoring wells are cased in a manner that maintains the integrity of the boreholes.
- Wells are screened to allow sampling only at the specified interval.
- All wells are covered with vented caps, unless located in flood-prone areas, and equipped with devices to protect against tampering and damage.

The monitoring well network fulfills the following goals:

- Enables the collection of groundwater samples that represent the quality of groundwater that has not been affected by the ash ponds
- Enables the collection of groundwater samples that represent the quality of downgradient groundwater
- Includes wells that are located within the stratigraphic unit(s) that may serve as potential chemical migration pathways

5 APPLICABLE GROUNDWATER QUALITY STANDARDS

5.1 Groundwater Classification

The Duck Creek Ash Ponds 1 and 2 are located within a previously mined area and monitoring has demonstrated that the groundwater is not capable of consistently meeting the standards for Class I: Potable Resource Groundwater (35 IAC 620.410) or Class II: General Resource Groundwater (35 IAC 620.420). Therefore, the applicable classification of groundwater at the site is Class IV: Other Groundwater (35 IAC 620.240(g)).

5.2 Applicable Groundwater Quality Standards

For groundwater within a previously mined area, the applicable groundwater quality standards for the site are the standards for Class IV: Other Groundwater. The groundwater quality standards for Class IV: Other Groundwater cannot be exceeded (35 IAC 620.440(c)) except as provided below:

- The groundwater quality standards for TDS, chloride, iron, manganese, sulfate, and pH, are the existing concentrations (35 IAC 620.440(c)).
- Groundwater quality standards for Class II General Resource Groundwater do not apply for pH, barium, boron, chloride, copper, iron, manganese, nickel, selenium, TDS, sulfate, and zinc when groundwater is either within fill or in parent material within 10 feet of fill, if the fill was placed prior to November 25, 1991 (35 IAC 620.420(a)(3)(A)). The coal spoils were placed prior to 1991 and all monitoring wells except for OM23D and OM25D are either screened within coal spoil or in native material within 10 vertical feet of coal spoil. Therefore, these analytical parameters are only applicable to monitoring wells OM23D and OM25D.
- Except as provided above, Class IV: Other Groundwater standards are equal to the existing concentrations of constituents in groundwater (35 IAC 620.440(c)).

The list of applicable groundwater quality standards for the site is shown on Table 3-1. Off-site groundwater also occurs within mine spoils, and is therefore Class IV: Other Groundwater. Applicable off-site groundwater quality standards will be the same as described above.

5.3 Proposed Exceptions to the Groundwater Quality Standards

Based on the results of groundwater monitoring performed at the site to date, the following exceptions to the above applicable Class II: General Resource Groundwater standards are proposed:

- Leachate (Appendices C-1, C-2) and groundwater (Appendix C-3) samples collected at the site do not indicate exceedances of the groundwater quality standards for Class II General

Resource Groundwater inorganic constituents listed in 35 IAC 620.420(a)(1). The analyzed constituents include antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, cyanide, fluoride, lead, mercury, nitrate, and thallium.[2] These constituents will not be monitored because they currently meet the standards for Class II General Resource Groundwater and are not associated with the chemical characteristics of the Duck Creek ash ponds.[3]

- Leachate (Appendices C-1, C-2) and groundwater (Appendix C-3) samples collected at the site do not indicate exceedances of the groundwater quality standards for Class II General Resource Groundwater for inorganic constituents copper, nickel, selenium, silver, and zinc listed in 35 IAC 620.420(a)(2). These constituents will not be monitored at wells OM23D and OM25D because they currently meet the standards for Class II General Resource Groundwater and are not associated with the chemical characteristics of the Duck Creek ash ponds.

The proposed groundwater monitoring parameters for the Duck Creek ash ponds are discussed in Section 6.1.

[2] Perchlorate and vanadium are parameters listed in 35 IAC 620.420(a)(1) but have not been analyzed.

[3] An anomalous arsenic concentration of 0.31 ug/L was observed on October 21, 2013 at OR13S; all other results (thirteen sampling events) at this location exhibited As concentrations below 0.015 ug/L, which are well below the Class II groundwater quality standard of 0.2 ug/L.

6 GROUNDWATER MONITORING PLAN

The groundwater monitoring plan will monitor and evaluate groundwater quality to demonstrate compliance with the groundwater quality standards for Class IV: Other Groundwater[4]. The post-closure groundwater sampling network is proposed to consist of three background monitoring wells and 19 compliance monitoring wells. Table 4-1 provides a list of the wells and their intended use for the monitoring program.

6.1 Monitoring Parameters

Groundwater samples will be collected and laboratory-analyzed for the following parameters that are indicator constituents for coal ash leachate from the ash ponds:

- Boron (dissolved)
- Chloride (dissolved)

The following field parameters will be also measured for each groundwater sample:

- pH
- Specific conductance
- Temperature

The depth to groundwater and total well depth will also be recorded during each sampling event.

As discussed in Section 5, other parameters regulated under 35 IAC 620 will be not be monitored because either:

- Their Class II: General Resource Groundwater standard is the existing concentration of the constituent in groundwater (TDS, iron, manganese, sulfate), and they are not indicator constituents for leachate migration from the ash ponds; therefore, there is no basis to which compare the data
- There is no applicable standard for the constituent in groundwater monitored in fill placed prior to November 1991
- Groundwater monitoring results to date indicates that the inorganic constituents antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, cyanide, fluoride, lead, mercury, nickel, nitrate, selenium, silver, thallium and zinc currently meet the Class II:

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[4] Based on the conclusions of the Hanson (2016a) report in Appendix B1, there is no Uppermost Aquifer as defined by the US EPA (2015) [40 CFR 257.53].

General Resource Groundwater standards and are not associated with the chemical characteristics of the Duck Creek ash ponds.

6.2 Sampling Schedule

Groundwater sampling will initially be performed quarterly according to the schedule provided in Table 4-2. Five years after approval of the Closure Plan, a request may be made to modify the post-closure care plan to reduce the frequency of groundwater monitoring to semi-annual sampling by demonstrating all of the following:

- Monitoring effectiveness will not be compromised by the reduced frequency of monitoring
- Sufficient data has been collected to characterize groundwater
- Concentrations of constituents monitored at the downgradient boundaries show no statistically significant increasing trends that can be attributed to the former ash ponds

If concentrations of parameters of concern at the downgradient boundaries of the site show no statistically significant increasing trends that can be attributed to the ash ponds for the five years after reducing the monitoring frequency to semi-annual, a request may be made to modify the post-closure care plan to reduce monitoring frequency to annual sampling by demonstrating the same items above as for the reduction to semi-annual monitoring.

Groundwater monitoring may be discontinued upon IEPA's approval of a certified post-closure care report. Specifically, when no statistically significant increase is detected in the concentration of any constituent above that measured and recorded during the immediately preceding scheduled sampling for four consecutive years after changing to an annual monitoring frequency.

6.3 Groundwater Sample Collection

Groundwater samples will be collected according to the protocol included in Appendix F. The procedure is summarized below.

All groundwater elevations will be measured on a single day, in conjunction with sampling of the wells. Monitoring wells will be sampled using either a peristaltic pump or bladder pump. Each well will be purged utilizing low flow techniques, and until the measured pH, temperature, and specific conductance have stabilized within ±10 percent. If low-flow stabilization is not possible, either a submersible pump or bailer will be used to remove four well volumes and/or bail the well dry. Field parameters will be collected following purging of the well. Field parameters will be recorded in the logbook.

Boron samples will be field-filtered (using a 0.45 micron disposable filter); and the sample will be collected in laboratory-provided high-density polyethylene (HDPE) bottles with the appropriate preservatives. All

samples will be placed in a cooler with ice to maintain a temperature of less than 4º Celsius during transport to the analytical laboratory.

In addition to groundwater well samples, quality assurance samples will be collected as described in Section 5.5.

6.4 Laboratory Analysis

Laboratory analysis will be performed by a state-certified laboratory using methods approved by IEPA. The constituents to be monitored, analytical methods and the Practical Quantitation Limits (PQL) are as follows:

Parameter	USEPA Analytical Method	PQL (mg/L)
Boron	SW 6020	0.010
Chloride	EPA 300.0	1.0

Concentrations lower than the practical quantitation limit (PQL) will be reported as less than the PQL. The PQL for all parameters analyzed will be lower than the applicable groundwater quality standard. The Class IV Groundwater Quality Standards for the site are discussed in detail in Section 5.

6.5 Quality Assurance Program

Additional quality assurance samples to be collected will include the following:

- Two blind duplicate groundwater samples from randomly selected monitoring wells
- One equipment blank sample will be collected and analyzed for each day of sampling. If dedicated sampling equipment is used, than equipment blank samples will not be collected.

The duplicate and equipment blank quality assurance samples will be supplemented by the laboratory QA/QC program, which typically includes:

- Regular generation of instrument calibration curves to assure instrument reliability
- Laboratory control samples and/or quality control check standards that have been spiked, and analyses to monitor the performance of the analytical method
- Matrix spike/matrix spike duplicate analyses to determine percent recoveries and relative percent differences for each of the parameters detected
- Analysis of replicate samples to check the precision of the instrumentation and/or methodology employed for all analytical methods
- Analysis of method blanks to assure that the system is free of contamination

6.6 Groundwater Monitoring System Maintenance Plan

Monitoring wells will be inspected during each groundwater sampling event. Maintenance will be performed as needed to assure that the monitoring wells provide representative groundwater samples. Monitoring well inspections will consist of the following:

- Visual inspection, clearing of vegetation, replacement of markers, and painting of protective casings as needed to assure that monitoring wells are clearly marked and accessible
- Visual inspection and repair or replacement of well aprons as needed to assure that they are intact, drain water away from the well, and have not heaved
- Visual inspection and repair or replacement of protective casings as needed to assure that they are undamaged, and that locks are present and functional
- Checks to assure that well caps are intact and vented, unless in flood-prone areas in which case caps will not be vented
- Annual measurement of monitoring well depths to determine the degree of siltation within the wells. Wells will be redeveloped as needed to remove siltation from the screened interval if it impedes flow of water into the well
- Checks that wells are clear of internal obstructions, and flow freely

If maintenance of a monitoring well cannot address an identified deficiency, a replacement well will be installed.

6.7 Annual Statistical Analysis

Trend analysis will be performed annually for each of the parameters of concern. Sen's Estimate of Slope will be applied to a minimum of four consecutive quarterly monitoring results. If there are increasing trends during closure and post-closure care periods, they will be further investigated as described below.

- If the results of sampling and analysis show an increasing trend at any compliance monitoring well, a Mann-Kendall analysis will be performed at 95 percent confidence to determine whether or not the increasing trend is statistically significant.
- If a statistically significant increasing trend occurs during post-closure care, further investigation of monitored concentrations will be performed as well as more frequent inspections of the surface of the cover system.
- If the investigation attributes a statistically significant increasing trend to a source other than the Duck Creek Energy Center ash ponds, then the IEPA will be notified in writing, stating the cause of the increasing trend and providing the rationale used in such a determination.
- If there is not an alternative source causing the statistically significant increasing concentration and the sampling frequency had been reduced to semi-annual or annual sampling, a quarterly sampling schedule will be reestablished. The frequency of sampling will return to either semi-annual or annual, once four consecutive quarterly samples show no statistically significant increasing trend.

Notifications concerning statistically significant increasing trends and revisions of the sampling frequency will be reported to IEPA in writing within 30 days after making the determinations.

6.8 Data Reporting

Sampling and analysis data from quarterly, semi-annual and/or annual groundwater monitoring will be reported to IEPA within 60 days after completion of sampling.

Statistical analysis of the laboratory analytical data will be reported to IEPA with the annual report for the facility.

6.9 Compliance with Applicable On-Site Groundwater Quality Standards

Compliance with on-site groundwater quality standards will be achieved when there are no statistically significant increasing trends that are attributed to the Duck Creek Energy Center ash ponds for parameters detected at the downgradient boundaries.

6.10 Corrective Action

If a statistically significant increasing trend is observed to continue over a period of two or more years following completion of the final cover, and a subsequent hydrogeologic site investigation demonstrates that such exceedances are due to a release from the Duck Creek Energy Center ash ponds and corrective actions are appropriate to mitigate such releases, a corrective action plan will be proposed as a modification to the post-closure care plan. A corrective action plan will be submitted to IEPA within 180 days after completion of the investigation activities. The plan will propose corrective actions to be undertaken to mitigate the impacts associated with the constituents of concern which exceed applicable groundwater standards.

7 REFERENCES

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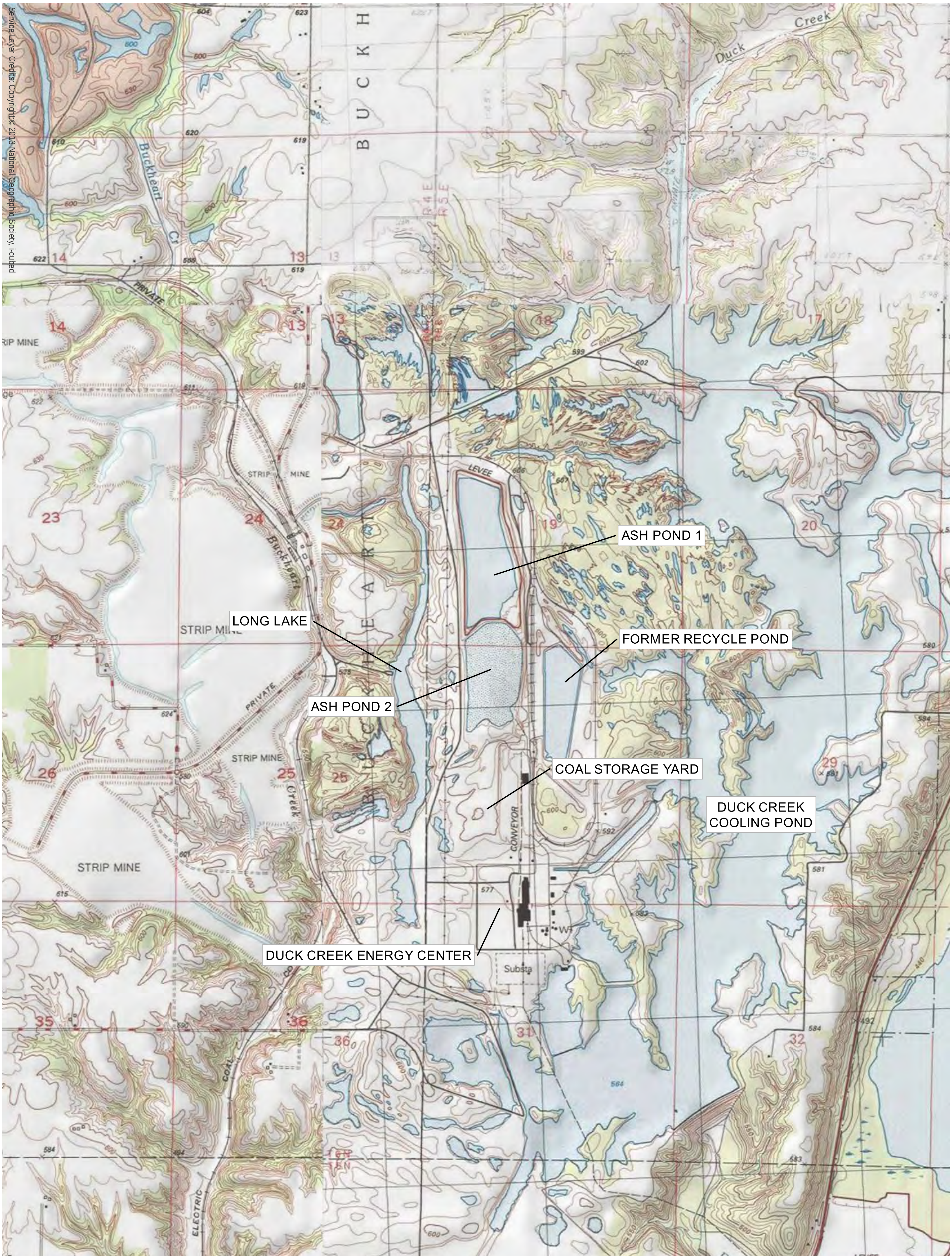
FIGURES

Y:\Mapping\Projects\23\2333\MXD\Supplemental Hydrogeo Site Char\Figure 1-1_Site Location Map.mxd Author: sstolz; Date/Time: 3/31/2016, 9:47:53 AM



SITE LOCATION MAP

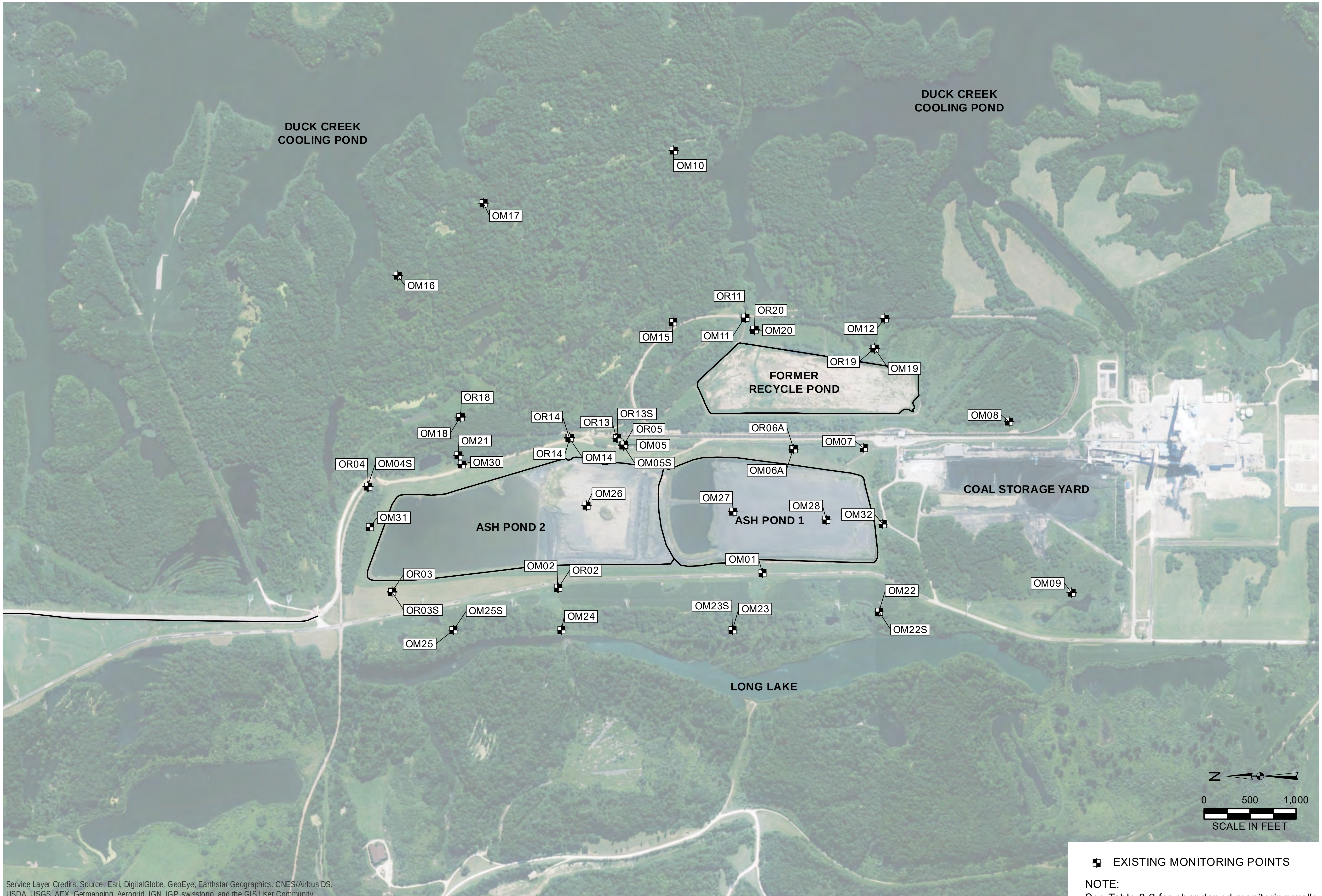
SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

DRAWN BY/DATE: DMD 1/5/2016
REVIEWED BY/DATE: RJK 1/6/2016
APPROVED BY/DATE: SJC 3/24/16

PROJECT NO: 2333

FIGURE NO: 1-1

NATURAL RESOURCE TECHNOLOGY



DRAWN BY/DATE: DMD 1/5/2016
REVIEWED BY/DATE: RJK 1/6/2016
APPROVED BY/DATE: SJC 3/24/16

SITE MAP

SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 1-2

NATURAL RESOURCE TECHNOLOGY

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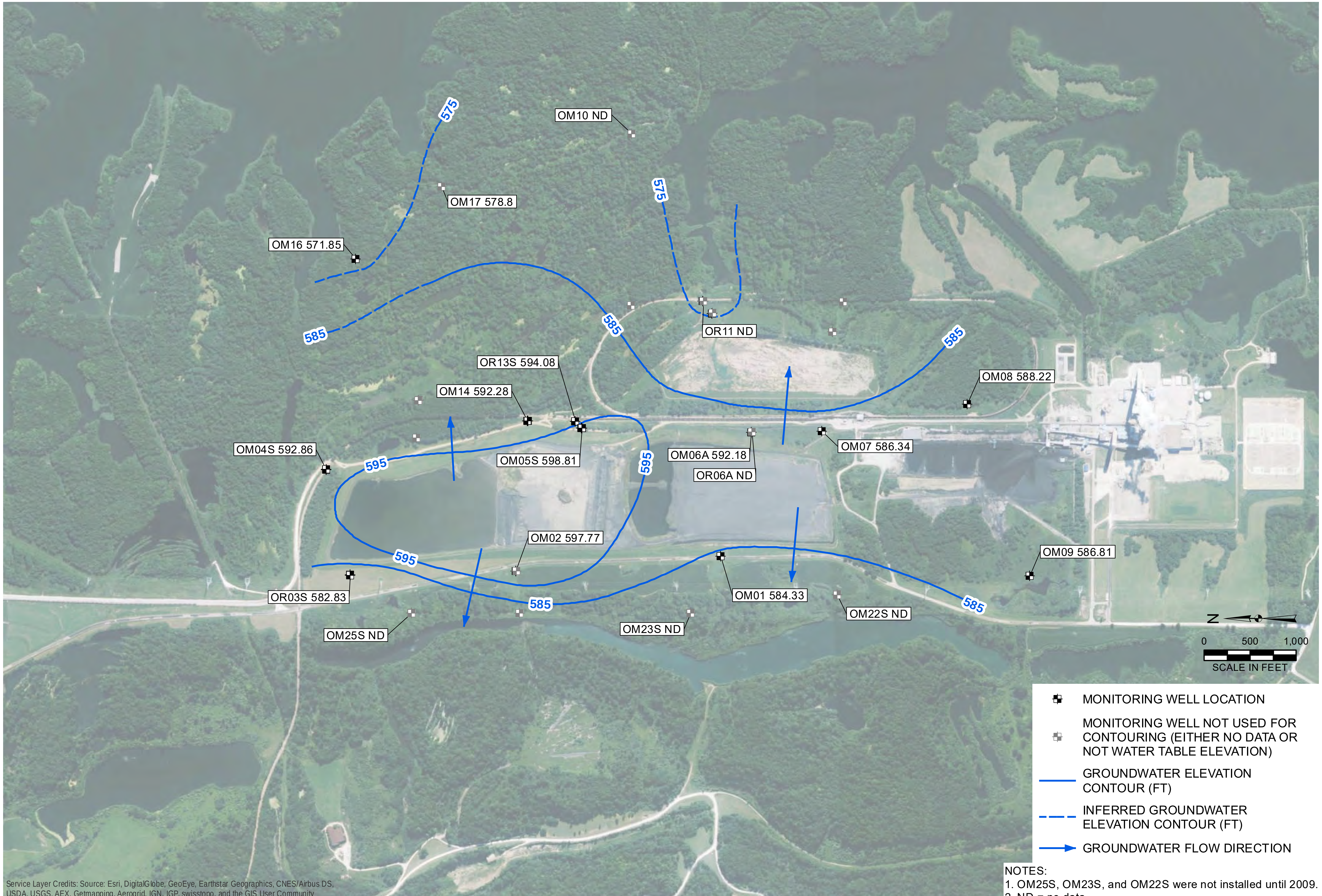


NOTES:
1. OM25S, OM23S, and OM22S were not installed until 2009.
2. ND = no data

DRAWN BY/DATE: DMD 1/5/2016
REVIEWED BY/DATE: RJK 1/6/2016
APPROVED BY/DATE: SJC 3/24/16

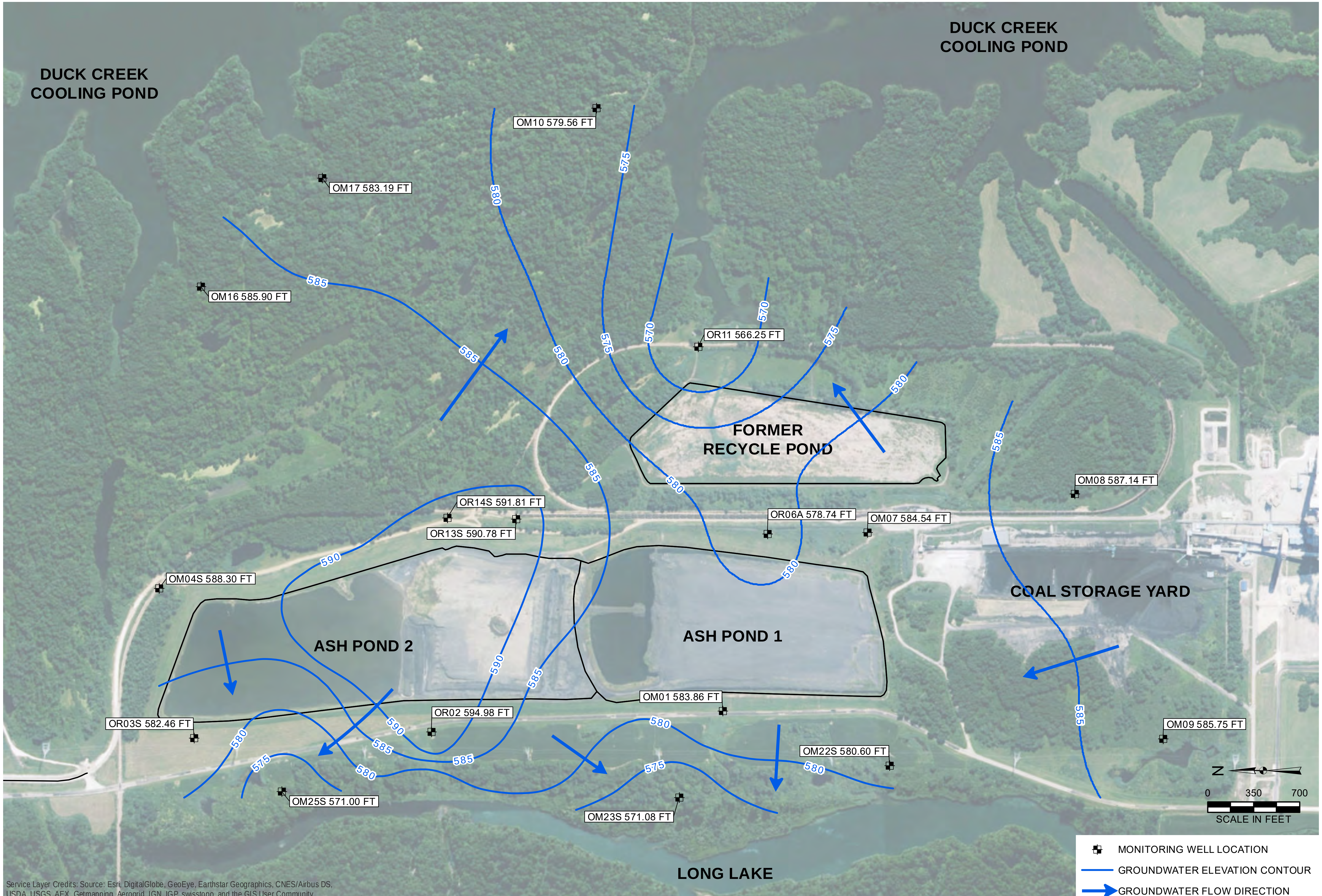
SHALLOW GROUNDWATER ELEVATION CONTOURS - APRIL 2007

SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 2-1

NATURAL RESOURCE TECHNOLOGY



DRAWN BY/DATE: TDC 1/4/2016
REVIEWED BY/DATE: RJK 1/4/2016
APPROVED BY/DATE: SJC 3/24/16

SHALLOW GROUNDWATER ELEVATION CONTOURS - SEPTEMBER 2015

SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 2-1

NATURAL RESOURCE TECHNOLOGY

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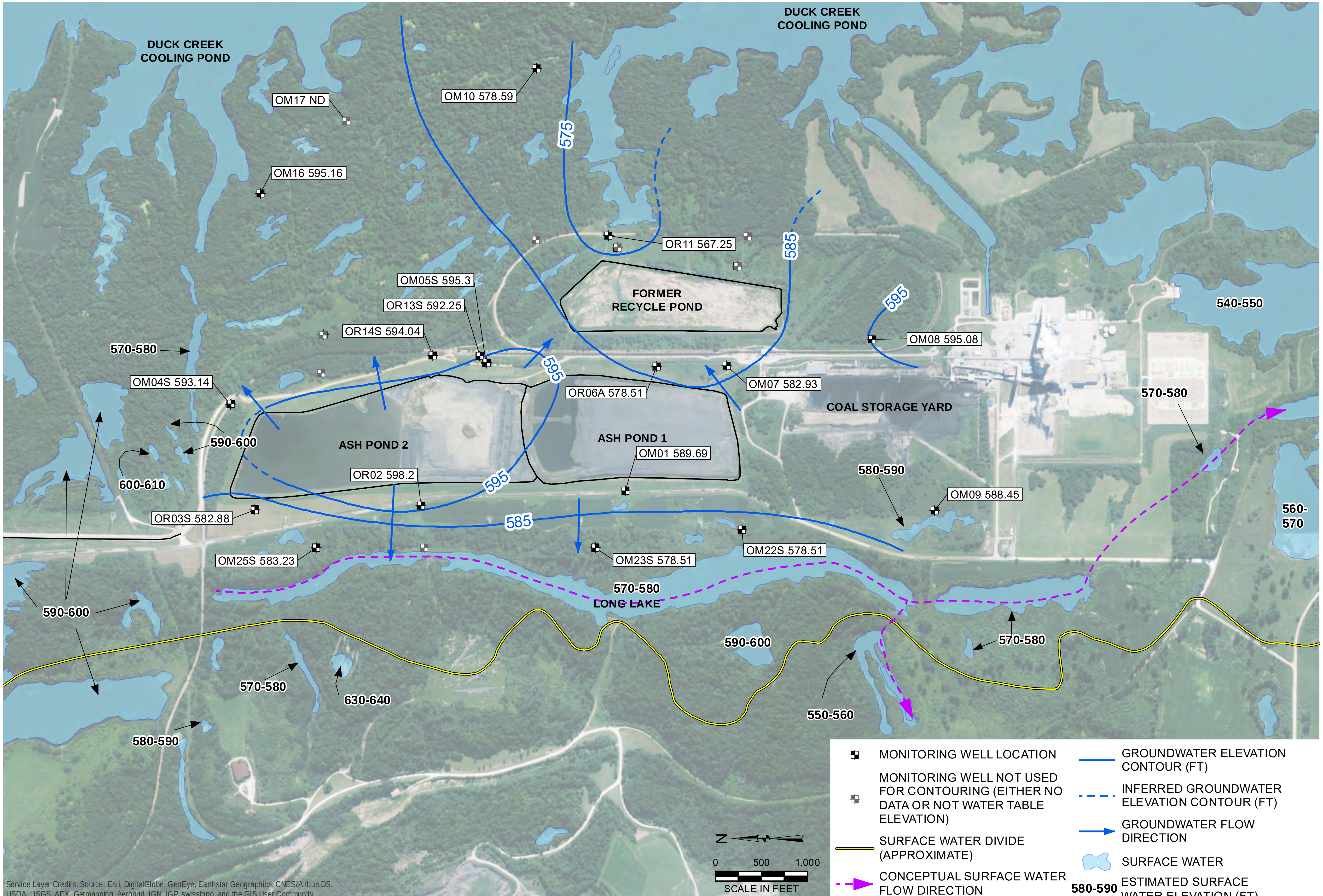

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REVIEWED BY/DATE: RJK 1/6/2016
APPROVED BY/DATE: SJC 3/24/16

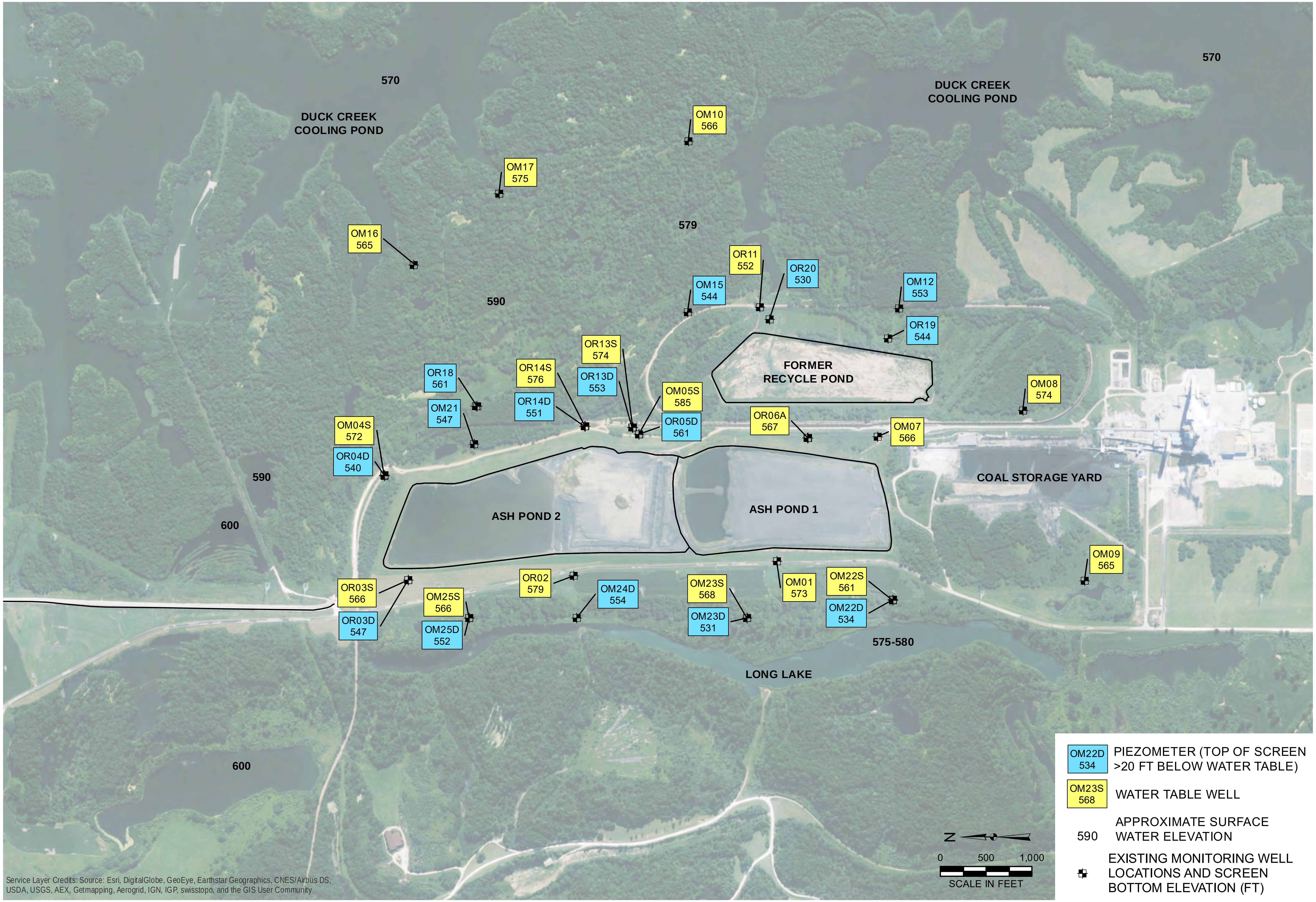
CONCEPTUAL MODEL OF GROUNDWATER FLOW

SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 2-3

NATURAL RESOURCE TECHNOLOGY



DRAWN BY/DATE:
DMD 1/5/2016
REVIEWED BY/DATE:
RJK 1/6/2016
APPROVED BY/DATE:
SJC 3/24/16

MONITORING WELLS AND SCREEN BOTTOM ELEVATIONS

SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 3-1

NATURAL RESOURCE TECHNOLOGY

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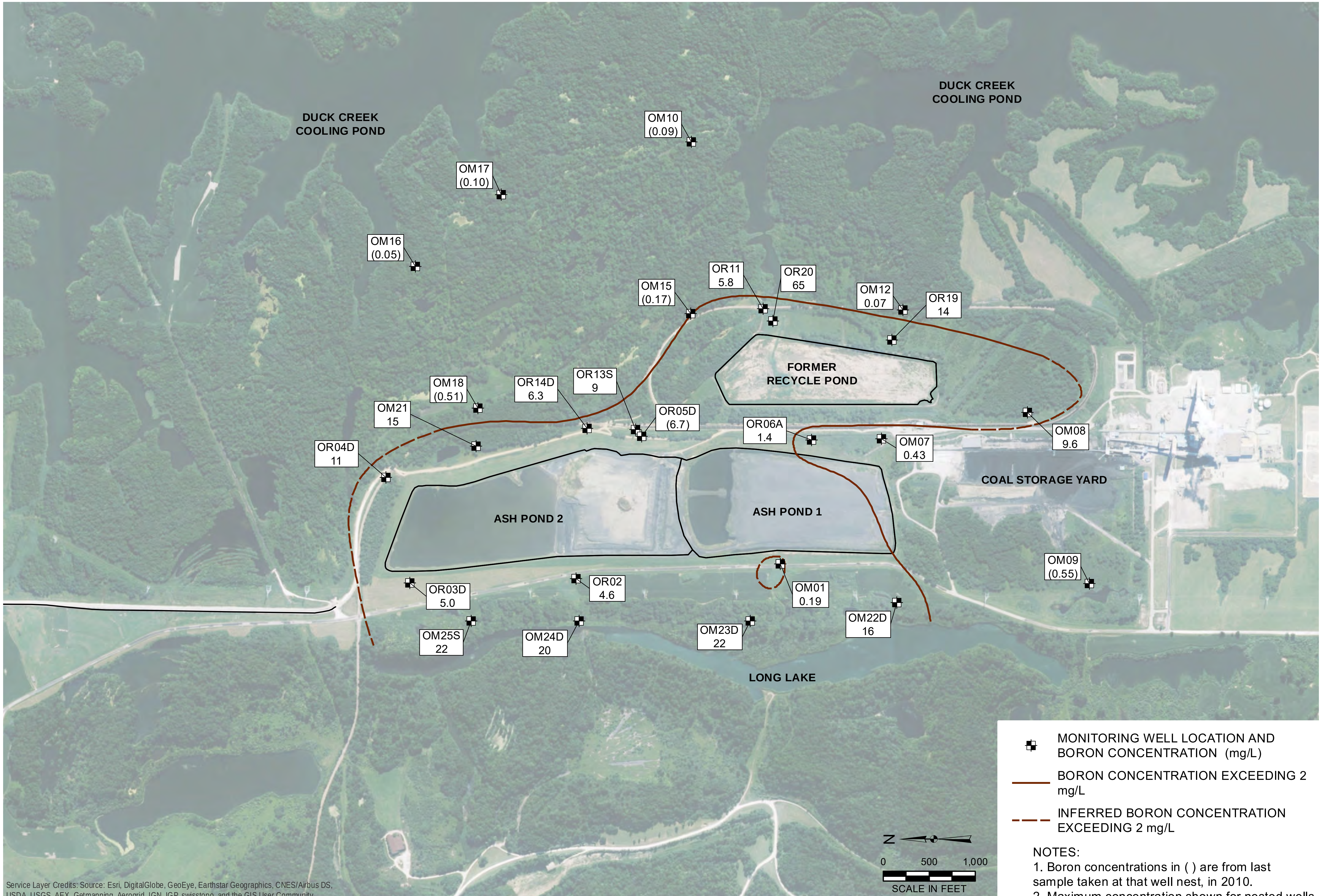


DRAWN BY/DATE: DMD 1/5/2016
REVIEWED BY/DATE: RJK 1/6/2016
APPROVED BY/DATE: SJC 3/24/16

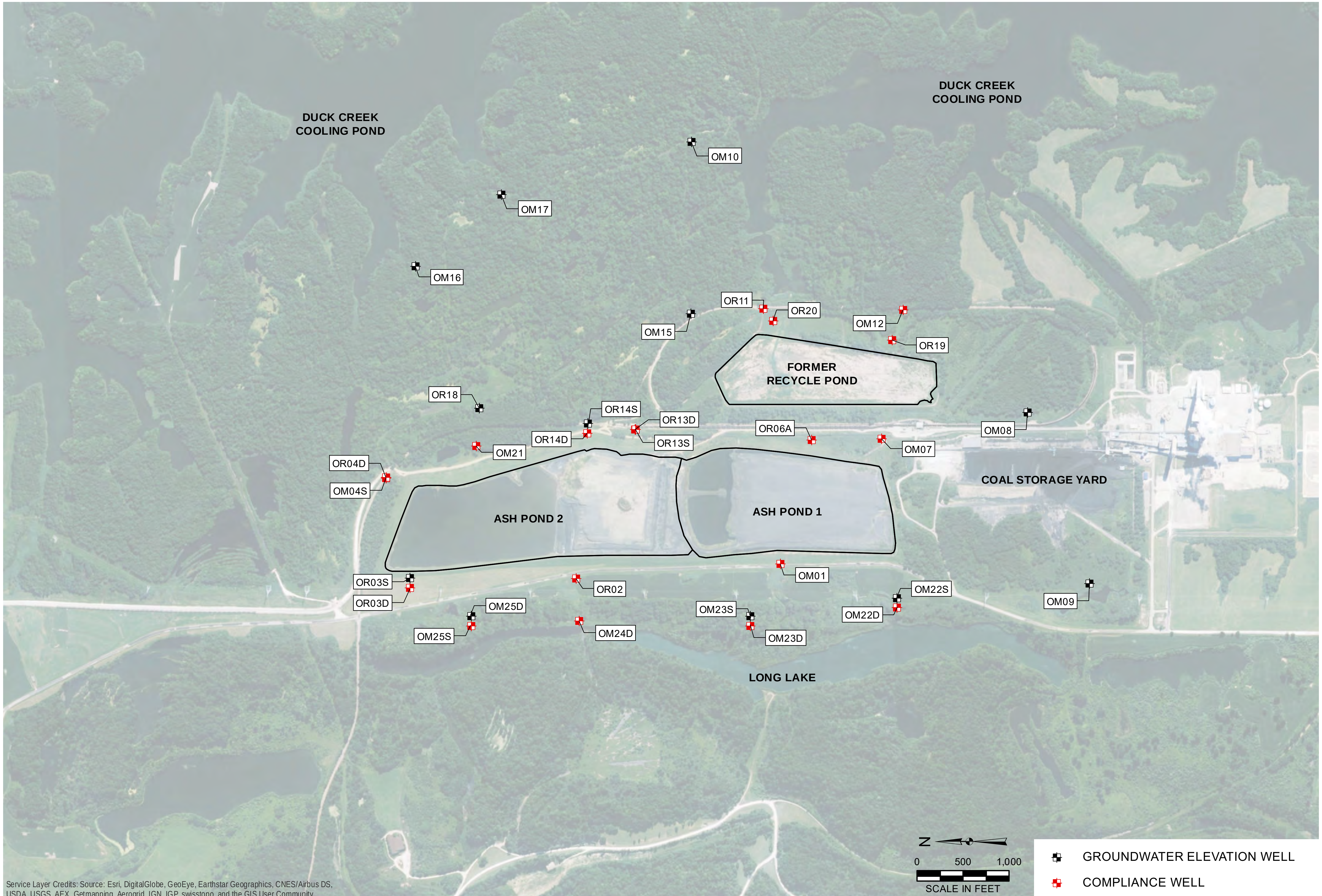
BORON CONCENTRATIONS IN GROUNDWATER - SEPTEMBER 2015

SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 3-2

NATURAL RESOURCE TECHNOLOGY



DRAWN BY/DATE: DMD 1/5/2016
REVIEWED BY/DATE: RJK 1/6/2016
APPROVED BY/DATE: SJC 3/24/16

PROPOSED GROUNDWATER MONITORING NETWORK

SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 4-1

NATURAL RESOURCE TECHNOLOGY

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TABLES

Table 2-1
Changes in Porewater Elevation within the Ash Ponds
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Date	OM26	OM27	OM28
11/9/2010	635.00	628.76	628.08
11/19/2010	634.60	627.36	627.08
6/9/2011	635.90	626.06	626.98
5/16/2012	633.17	623.82	624.86
12/29/2015	637.89	627.57	626.93
Change 2010 to 2012	-1.83	-4.94	-3.22
Change 2012 to 2015	4.72	3.75	2.07

Ash Ponds were taken out of service in 2010
Piezometers installed in 2010
OM-26 located in Ash Pond 2 and OM-27 and OM-28 located in Ash Pond 1

Table 2-2
Changes in Groundwater Elevation
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Average 2008-2009 [1]	Average 2014-2015 [2]	Change
OM01	584.6	583.8	-0.8
OR02	596.5	595.4	-1.1
OR03D	582.1	581.8	-0.3
OR03S	582.1	581.8	-0.3
OR04D	587.5	586.7	-0.8
OM04S	590.3	589.3	-1.0
OR05D	600.5	593.2	-7.3
OM05S	598.7	592.5	-6.2
OR06A	592.4	578.6	-13.7
OM07	588.7	582.9	-5.8
OM08	587.2	585.5	-1.7
OM09	586.3	586.0	-0.3
OM10	574.9	578.4	3.5
OR11	569.8	566.5	-3.3
OM12	578.3	581.8	3.5
OR13D	600.5	593.5	-7.0
OR13S	592.1	591.3	-0.8
OR14D	590.2	590.7	0.5
OR14S	594.2	592.2	-2.0
OM15	578.4	579.0	0.6
OM16	582.3	583.9	1.7
OM17	579.2	581.8	2.6
OR18	594.8	599.9	5.0
OR19	582.5	575.5	-7.0
OR20	574.0	566.4	-7.6
OM21	597.8	598.0	0.2
OM22D	582.4	580.5	-1.8
OM22S	582.3	580.3	-2.0
OM23D	576.9	575.8	-1.1
OM23S	572.3	571.6	-0.7
OM24D	574.7	573.8	-0.9
OM25D	571.1	572.0	0.9
OM25S	571.2	571.3	0.1

Average decreased by 3.0 feet or more
Average increased by 3.0 feet or more
Ash Ponds were taken out of service in 2010
Footnotes:
1. Obtained from Manages database.
2. Obtained from Hanson groundwater elevation table using April 2008 top of well casing survey data.

NATURAL RESOURCE TECHNOLOGY

Table 3-1
Monitored Parameters and Groundwater Quality Standards
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Parameter	Time Interval Monitored	Applicable Standard	
		Wells Other than OM23D and OM25D	OM23D and OM25D
Antimony	2011 to 2014	Class II	Class II
Arsenic	2011 to 2014	Class II	Class II
Barium	2011 to 2014	(2)	Class II
Beryllium	2011 to 2014	Class II	Class II
Boron	1980 to Present	(2)	Class II
Cadmium	2011 to 2014	Class II	Class II
Chloride	1980 to Present	(1), (2)	(1)
Chromium	2011 to 2014	Class II	Class II
Cobalt	2011 to 2014	Class II	Class II
Copper	2011 to 2014	(2)	Class II
Cyanide	2011 to 2014	Class II	Class II
Fluoride	2011 to 2014	Class II	Class II
Hardness	1980 to Present	(3)	(3)
Iron	1980 to Present	(1), (2)	(1)
Lead	2011 to 2014	Class II	Class II
Manganese	1980 to Present	(1), (2)	(1)
Mercury	2011 to 2014	Class II	Class II
Nickel	2011 to 2014	(2)	Class II
Nitrate nitrogen	2011 to 2014	Class II	Class II
pH	1980 to Present	(1), (2)	(1)
Selenium	2011 to 2014	(2)	Class II
Silver	2011 to 2014	(3)	(3)
Specific Conductance	1980 to Present	(3)	(3)
Sulfate	1980 to Present	(1), (2)	(1)
Temperature	1980 to Present	(3)	(3)
Thallium	2011 to 2014	Class II	Class II
Total Dissolved Solids	1980 to Present	(1), (2)	(1)
Zinc	2011 to 2014	(2)	Class II

Notes

Except as noted below, Class II standards are applicable for Class IV groundwater in previously mined areas

(1) Per 35 IAC 620.440(c) the standard for this constituent is the existing concentration.

(2) Per 35 IAC 620.420(a)(3) there is no applicable standard for groundwater monitored in fill placed prior to November 1991.

(3) There is no Class II or Class IV standard for this constituent. Per 35 IAC 620.440(c) the standard for this constituent is the existing concentration.

Table 3-2
Monitoring Well Matrix
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well ID (Permit)	Well ID (Site)	Replacement Well ID	Comments
OM-1	OM01		
OM-2	~~OM02~~	OR02	
OM-3D	~~OM03D~~	OR03D	
OM-3S	~~OM03S~~	OR03S	
OM-4S	OM04S		
OM-4A	OR04D		
OM-5D	OM05D	OR05D	These wells are adjacent to the OR13 well nest and will be abandoned following IEPA approval of the proposed monitoring plan
OM-5S	OM05S		
OM-6A	~~OM06/OM06A~~	OR06A	
OM-7	OM07		
OM-8	OM08		This well is upgradient of the ash ponds and will be used for measurement of elevation only, pending IEPA approval of the proposed monitoring plan.
OM-9	OM09		
OM-10	OM10		
OM-11	~~OM11~~	OR11	
OM-12	OM12		
OM-13D	~~OM13D~~	OR13D	
OM-13S	~~OM13S~~	OR13S	
OM-14	~~OM14~~	OR14D	Original well OM14 damaged during slurry line installation; replaced with wells OR14D and OR14S
		OR14S	
MW-15	OM15		
MW-16	OM16		
MW-17	OM17		
n/a	~~OM18~~	OR18	
n/a	~~OM19~~	OR19	Original well OM19 (formerly OMA), replaced by OR19
n/a	OM20	OR20	Original well OM20 (formerly OMB)
n/a	OM21		Original well OM21 (formerly ORC)
n/a	OM22S		
n/a	OM22D		
n/a	OM23S		
n/a	OM23D		
n/a	OM24D		
n/a	OM25S		
n/a	OM25D		
n/a	OM26		Well used to monitor water level in Ash Pond 2; To be abandoned following IEPA approval of the proposed monitoring plan
n/a	OM27		Well used to monitor water level in Ash Pond 1; To be abandoned following IEPA approval of the proposed monitoring plan
n/a	OM28		Well used to monitor water level in Ash Pond 1; To be abandoned following IEPA approval of the proposed monitoring plan
n/a	OM30		Well used to monitor water level at edge of Ash Pond 2; To be abandoned following IEPA approval of the proposed monitoring plan
n/a	OM31		Well used to monitor water level at edge of Ash Pond 2; To be abandoned following IEPA approval of the proposed monitoring plan
n/a	~~OM50S~~		Monitoring well nest 1.5 miles northwest of Ash Pond 2
n/a	~~OM50D~~		Monitoring well nest 1.5 miles northwest of Ash Pond 2
n/a	~~OM51S~~		Monitoring well nest 1.5 miles south of Ash Pond 1
n/a	~~OM51D~~		Monitoring well nest 1.5 miles south of Ash Pond 1

OM99	Grey shading indicates wells monitored for groundwater elevation and chemistry as of 2012
OM99	Red shading indicates wells monitored for chemistry prior to 2011, and monitored for groundwater water elevation as of 2012
OM99	No shading indicates wells monitored for chemistry and groundwater elevation prior to 2011 that are no longer monitored
~~OM99~~	Strikethrough denotes well has been abandoned

Table 3-3
Low, High and Median Leachate Concentrations
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Parameter	Unit	Ash Pond			Recycle Pond			Porewater			Applicable Standard	Applicable Class II Standard Concentration
		Low	High	Median	Low	High	Median	Ash Pond 1 (AP-1N/OM27)	Ash Pond 2 (AP-2/OM26)	Mean		
Antimony	mg/L							0.0036	<0.003	0.0033	Class II	0.024
Arsenic	mg/L							0.023	0.031	0.027	Class II	0.2
Barium	mg/L							0.18	0.14	0.16	(2)	
Beryllium	mg/L							<0.001	<0.001	<0.001	Class II	0.5
Boron	mg/L	160	390	320	66	390	265	43	180	112	(2)	
Cadmium	mg/L							0.0073	<0.001	0.0042	Class II	0.05
Chloride	mg/L	2,000	4,600	3,900	1,700	4,900	3,550	1,300	2,300	1,800	(1), (2)	
Chromium	mg/L							0.033	0.059	0.046	Class II	1.0
Cobalt	mg/L							0.0020	0.0031	0.0026	Class II	1.0
Copper	mg/L							0.0046	0.0049	0.0048	(2)	
Cyanide	mg/L							<0.005	0.012	0.0085	Class II	0.6
Fluoride	mg/L							<2.5	<2.5	<2.5	Class II	4.0
Hardness	mg/L	3,800	13,000	5,900	2,600	8,516	5,400	3,300	5,000	4,150	(3)	No Standard
Iron	mg/L	<0.01	2.7	0.012	<0.01	1.9	<0.01	0.015	0.16	0.088	(1), (2)	
Lead	mg/L							0.013	<0.001	0.0070	Class II	0.1
Manganese	mg/L	0.07	1.8	0.59	0.033	1.5	0.67	0.012	0.04	0.026	(1), (2)	
Mercury	mg/L							0.00031	<0.0002	0.00026	Class II	0.01
Nickel	mg/L							0.074	0.1	0.087	(2)	
Nitrate	mg/L							<0.2	<0.2	<0.2	Class II	100
Selenium	mg/L							0.055	0.086	0.071	(2)	
Silver	mg/L							<0.005	<0.005	<0.005	(3)	No Standard
Total Dissolved Solids	mg/L	3,200	14,000	10,000	3,800	14,000	10,000	4,500	7,600	6,050	(1), (2)	
Sulfate	mg/L	1,300	2,100	1,600	1,000	2,200	1,500	1,100	1,300	1,200	(1), (2)	
Thallium	mg/L							<0.001	<0.001	<0.001	Class II	0.02
Zinc	mg/L							<0.006	0.0084	0.0072	(2)	

Notes:
Surface water samples were last analyzed for the Ash and Recycle ponds in 2009 and 2010, respectively. Ash ponds were taken out of service in 2010.
The porewater concentrations are based on one sample collected from each of OM27 (AP-1N) and OM26 (AP-2) in 2012.
Except as noted below, Class II standards are applicable for Class IV groundwater in previously mined areas
(1) Per 35 IAC 620.440(c) the standard for this constituent is the existing concentration.
(2) Per 35 IAC 620.420(a)(3) there is no applicable standard for groundwater monitored in fill placed prior to November 1991.
(3) There is no Class II or Class IV standard for this constituent. Per 35 IAC 620.440(c) the standard for this constituent is the existing concentration.

Table 3-4
Low, High and Median Background Groundwater Concentrations
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Parameter	Unit	OM10[1]			OM16[1]			OM17[1]		
		Low	High	Median	Low	High	Median	Low	High	Median
Boron	mg/L	0.024	1.5	0.12	0.025	1.1	0.075	0.05	2.8	0.14
Chloride	mg/L	3.3	26	7.3	4.7	49	7.5	2.0	8.7	2.9
Iron	mg/L	<0.01	13	0.8	0.052	18	5.1	<0.01	11	0.51
Hardness	mg/L	70	2200	1800	2000	3500	2600	460	1400	840
Manganese	mg/L	0.078	6.3	2.8	3.6	7.9	4.5	0.042	2.9	0.76
Sulfate	mg/L	5.5	1300	820	1100	2400	1850	230	820	370
Total Disssolved Solids	mg/L	100	2900	1900	980	3700	3400	330	3700	912

Footnotes:

1. OM10, OM16 and OM17 were last analyzed in September 2010.

Table 3-5
Changes in Average Boron and Chloride Concentration
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Average Boron, mg/L (2008-2009)[1]	Average Boron, mg/L (2014-2015)	Boron Change	Average Chloride, mg/L (2008-2009)[1]	Average Chloride, mg/L (2014-2015)	Chloride Change	Trend Observations
OM01	0.25	0.32	26%	15	21	45%	Increases are relatively small in absolute values
OR02	4.1	4.9	20%	244	248	2%	No apparent trend
OR03D	2.9	2.9	3%	143	82	-42%	No apparent trend
OR04D	87	23	-74%	1177	264	-78%	Decreasing
OM04S	7.9	0.67	-92%	184	14	-92%	No apparent trend; Averages affected by anomalous points
OR06A	1.5	1.4	-8%	23	29	25%	Increasing for Cl, no apparent trend B
OM07	1.5	0.9	-43%	20	15	-28%	Decreasing
OM08	0.13	12	9164%	6	294	5181%	Increasing
OR11	9.5	7.2	-24%	121	55	-54%	Increasing to 2012, then decreasing
OM12	5.1	0.12	-98%	76	6.1	-92%	No apparent trend; Averages affected by anomalous points
OR13D	4.1	2.9	-30%	88	53	-40%	Decreasing
OR13S	8.3	5.0	-40%	224	107	-52%	Decreasing
OR14D	29	6.3	-78%	413	82	-80%	Decreasing
OR19	28	16	-43%	402	168	-58%	Decreasing
OR20	212	73	-65%	2960	774	-74%	Decreasing
OM21	6.3	14	123%	443	502	13%	Increasing, began before pond changes
OM22D [2]	2.7	14	420%	81	478	490%	Increasing
OM23D [2]	1.8	2.1	15%	41	35	-16%	No apparent trend, two anomalous points were excluded
OM24D [2]	23	27	17%	480	710	48%	Increasing to 2014, then decreasing
OM25S [2]	5.1	19	276%	190	486	156%	Increasing

Decreasing concentration trend >30% (yellow)
Increasing concentration trend >30% (green)

Refer to Appendix C4 for boron and chloride time series plots

Footnotes:

1. Ash ponds were removed from service in 2010
2. Averages for 2008-2009 includes only one round of sampling from December 2009 (wells installed August-September 2009).

Table 4-1
Proposed Monitoring Well Network
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well ID (permit)	Compliance Monitoring Wells	Groundwater Elevation Wells	Installed	Ground Surface Elevation (ft) 1	Top of Well Casing Elevation (ft) 1	Top of Screen Elevation (ft)	Bottom of Screen Elevation (ft)	Well Depth (ft below ground surface)	Groundwater Elevation Sept 2015 (ft)	Water Level Above Bottom of Screen (ft)
OM01	X	WT	Sep-80	593.3	595.61	578	573	20.3	583.86	10.86
OR02	X	WT	Apr-08	599.2	601.41	589	579	20.2	594.98	15.98
OR03D	X	PZ	Apr-08	623.7	627.13	557	547	76.7	582.69	35.69
OR03S		WT	Apr-08	623.7	627.16	575	566	57.7	582.46	16.46
OM04S	X	WT	Oct-80	604.8	607.35	582	572	32.8	588.30	16.3
OR04D	X	PZ	Oct-97	604.8	607.58	550	540	64.8	586.97	46.97
OR06A	X	WT	Apr-08	591.6	595.31	576	567	24.6	578.74	11.74
OM07	X	WT	Nov-80	594.4	596.46	576	566	28.4	584.54	18.54
OM08		WT	Nov-80	599.1	601.74	584	574	25.1	587.14	13.14
OM09		WT	Nov-80	590.2	591.61	575	565	25.2	585.75	20.75
OM10		WT	Nov-80	584.1	585.11	576	566	18.1	579.56	13.56
OR11	X	WT	Mar-08	593.6	596.55	562	552	41.6	566.25	14.25
OM12	X	PZ	Nov-80	592.8	595.37	563	553	39.8	583.37	30.37
OR13D [2]	X	PZ	Mar-08	600.3	602.70	563	553	47.3	593.97	40.97
OR13S [2]	X	WT	Mar-08	600.2	602.71	584	574	26.2	590.78	16.78
OR14D	X	PZ	Mar-09	596.2	598.91	560	551	45.2	589.66	38.66
OR14S		WT	Mar-09	596.2	599.26	585	576	20.2	591.81	15.81
OM15		PZ	Jul-94	596.0	598.05	554	544	52.0	580.17	36.17
OM16		WT	Jul-94	605.4	607.93	575	565	40.4	585.90	20.9
OM17		WT	Oct-93	589.3	592.13	585	575	14.3	583.19	8.19
OR18		PZ	Apr-08	611.6	613.85	571	561	50.6	602.21	41.21
OR19	X	PZ	Mar-08	595.7	597.80	554	544	51.7	577.81	33.81
OR20	X	PZ	Mar-08	584.6	587.72	540	530	54.6	566.63	36.63
OM21	X	PZ	Oct-97	604.2	606.60	557	547	57.2	596.77	49.77
OM22S		WT	Aug-09	596.8	599.22	570	561	35.8	580.60	19.6
OM22D	X	PZ	Aug-09	597.1	598.87	539	534	63.1	581.38	47.38
OM23S		WT	Sep-09	610.4	613.14	577	568	42.4	571.08	3.08
OM23D	X	PZ	Sep-09	610.4	613.25	540	531	79.4	576.99	45.99
OM24D	X	PZ	Aug-09	573.9	576.79	563	554	19.9	573.39	19.39
OM25S	X	WT	Aug-09	627.0	629.11	575	566	61.0	571.00	5
OM25D		PZ	Aug-09	627.1	629.19	557	552	75.1	573.69	21.69
Total	19	31								

WT — WT and yellow shading indicates water table wells
PZ — PZ and no shading indicates piezometer wells

Footnotes:
1. Ground Surface and Top of Well Casing Elevation from April 2008, provided by Hanson. All wells will be resurveyed in 2016 and elevations updated on future reports.
2. Ground Surface at OR13D and OR13S are from Nov. 2015 survey to update the surface elevation change.

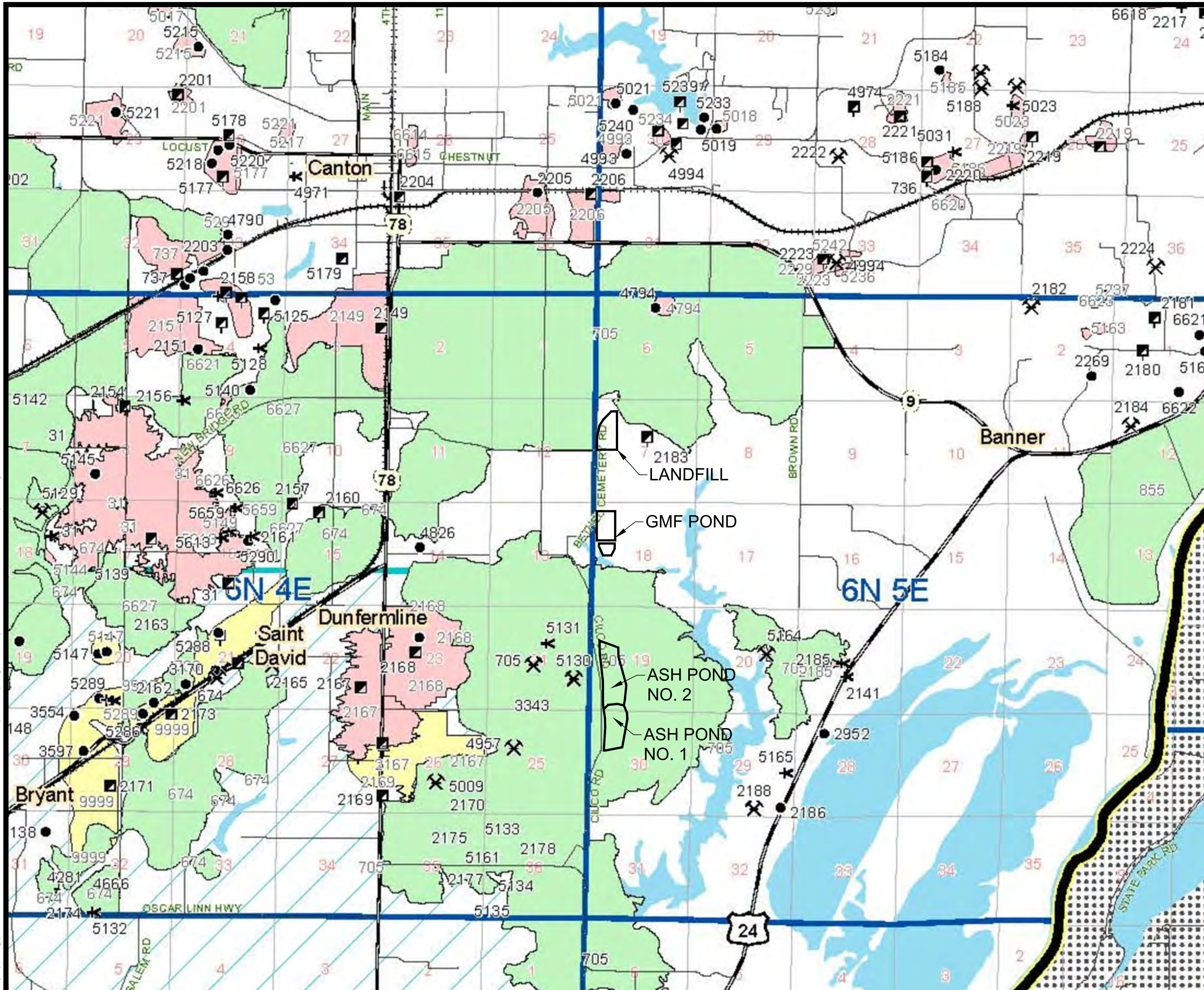
Natural Resource Technology

Table 4-2
Groundwater Monitoring Program Schedule
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Frequency	Duration
Quarterly	Begins: upon approval of this plan.
	Ends: 5 years after completion of cap and upon demonstration that monitoring effectiveness is not compromised and that there are no increasing trends attributable to Ash Ponds 1 and 2.
Semiannual	Begins: after IEPA approves that quarterly monitoring requirements have been satisfied.
	Ends: 5 years after initiation of semiannual monitoring and upon demonstration that monitoring effectiveness is not compromised and that there are no increasing trends attributable to Ash Ponds 1 and 2.
Annual	Begins: after IEPA approves that semiannual monitoring requirements have been satisfied.
	Ends: upon IEPA approval of a certified post-closure care report.

APPENDIX A

SELECTED AECOM (2015) AND HANSON (2010) FIGURES



LEGEND:

- County
- Township
- Section
- Quadrangle study (Available on Website)
- Lake or river
- Coal mine - active
- Underground coal mine - abandoned
- Surface coal mine - abandoned
- Indefinite underground coal mine boundary - abandoned
- Underground industrial mine and surrounding buffer region
- 951, 951 Coal mine index number (polygon label, point label)
- Opening type unknown
- Uncertain location
- Active surface tipple
- Abandoned surface tipple
- Active shaft
- Abandoned shaft
- Active slope
- Abandoned slope
- Active drift
- Abandoned drift
- Underground industrial mine entrance or general location

N

5000 0 5000

SCALE IN FEET

AECOM

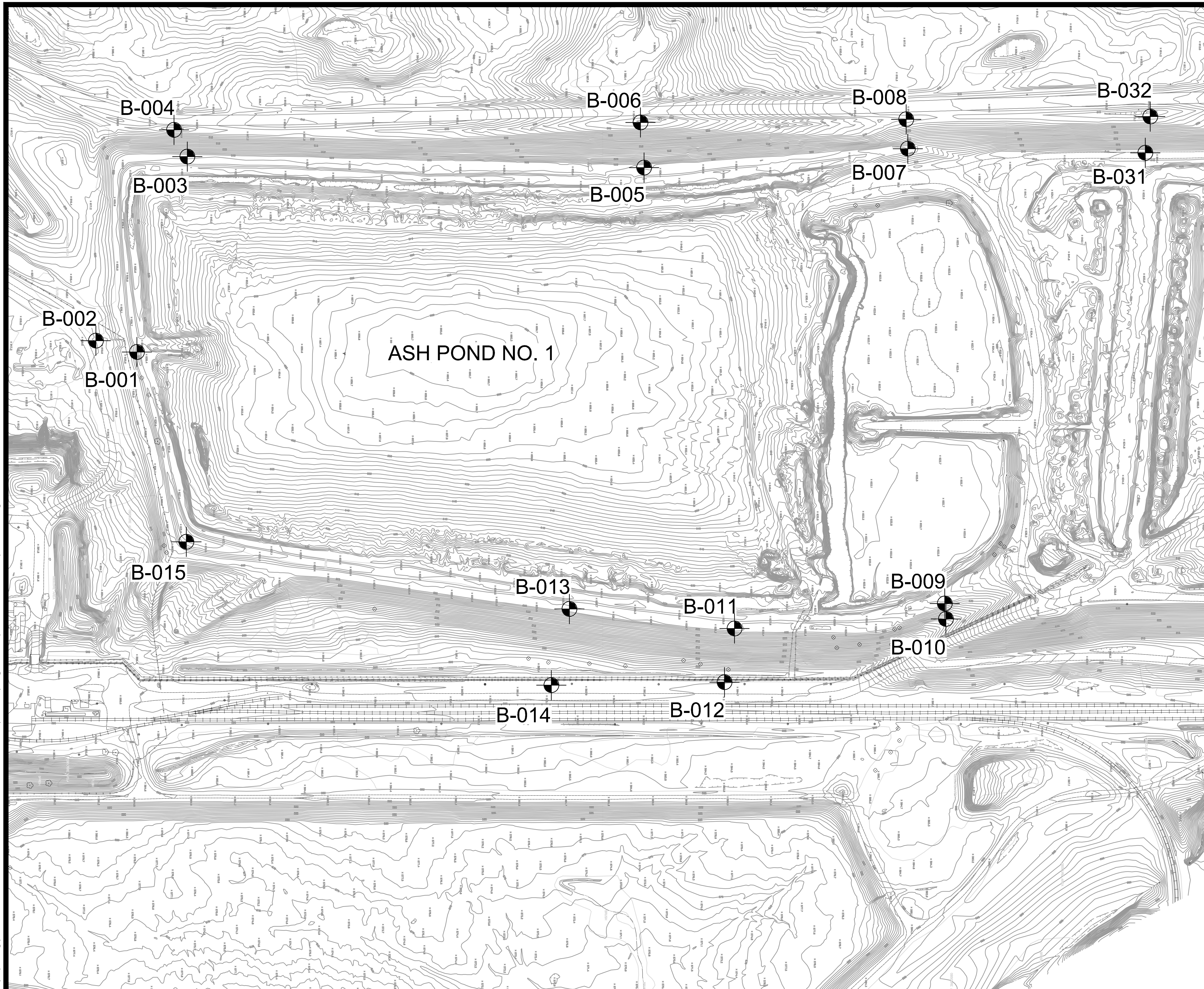
8300 College Boulevard, Suite 200
Overland Park, Kansas 66210

CLIENT: DYNEGY

LOCATION: DUCK CREEK STATION

TITLE: COAL MINES AND UNDERGROUND INDUSTRIAL MINES IN FULTON COUNTY, STATE OF ILLINOIS

DRAWN BY	CHECKED BY	APPROVED BY
TMS	JAA	WDS
PROJECT NO.	DATE	FIGURE NO.
60439301	DEC. 2015	1



LEGEND:

B-011 EXPLORATORY BORING LOCATION AND NUMBER

NOTE:

1. TEMPORARY GROUNDWATER LEVEL MONITORING WELLS (PIEZOMETERS) WERE INSTALLED IN BORING B-003 AND B-011. THE WELLS WERE ABANDONED UPON COMPLETION OF FIELD ACTIVITIES. REFER TO APPENDIX A FOR DETAILS.

N

250 0 250

SCALE IN FEET

AECOM

8300 College Boulevard, Suite 200
Overland Park, Kansas 66210

CLIENT: DYNEGY

LOCATION: DUCK CREEK STATION - CANTON, IL

TITLE:

BORING LOCATION PLAN
DUCK CREEK ASH POND NO. 1

DRAWN BY	CHECKED BY	APPROVED BY
TMS	JAA	WDS
PROJECT NO.	DATE	FIGURE NO.
60439301	DEC. 2015	2A

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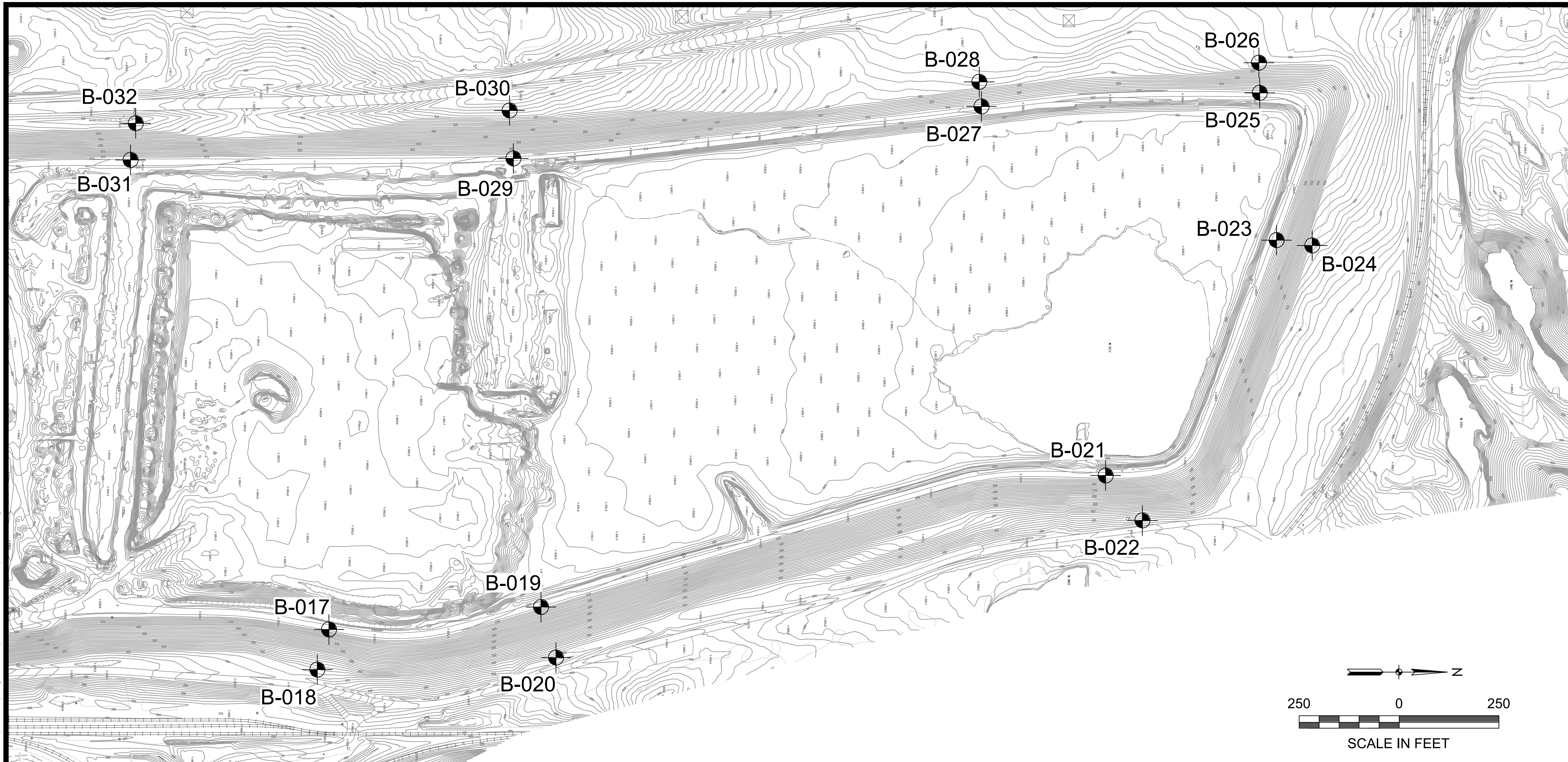

AECOM 8300 College Boulevard, Suite 200
Overland Park, Kansas 66210

CLIENT: DYNEGY

LOCATION: DUCK CREEK STATION

TITLE:
BORING LOCATION PLAN
DUCK CREEK ASH POND NO. 2

DRAWN BY	CHECKED BY	APPROVED BY
TMS	JAA	WDS
PROJECT NO.	DATE	FIGURE NO.
60439301	DEC. 2015	2B

December 8, 2015 4:00.58 pm (mik)
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FEB 26, 2010 3:41 PM BRANS00939
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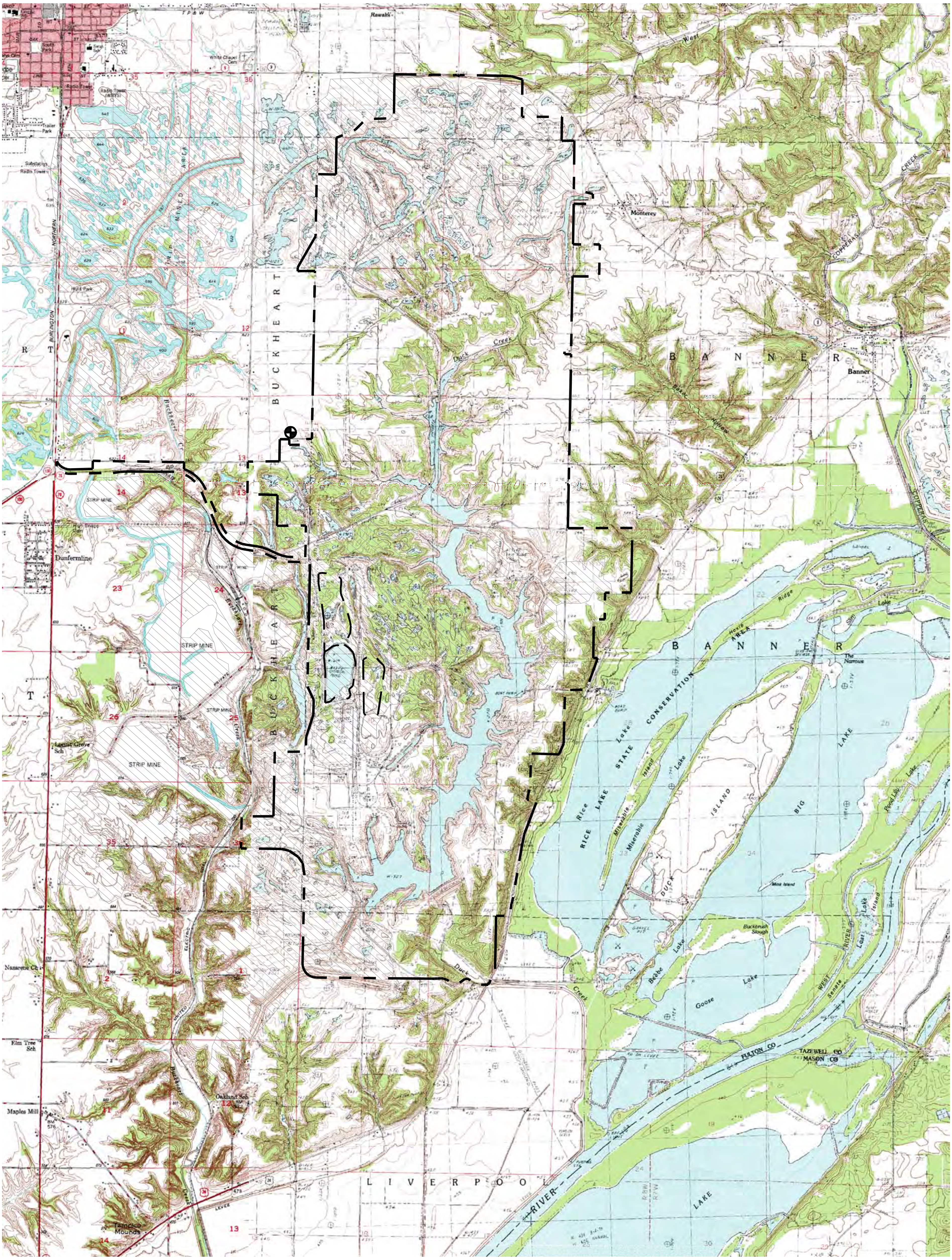


TOPO EXPLANATION

Ameren Property Boundary
Approx. Unit Limits (Pond)

Potable Water Well

Approximate Surface Mine Areas
Per ISGS Mapping (1998)

Approximate Site Location:
W ½ of Sections 19 & 30; T6N, R5E
Duck Creek 7 ½ minute Quadrangle Map

N

4,000' 0 4,000' 8,000'

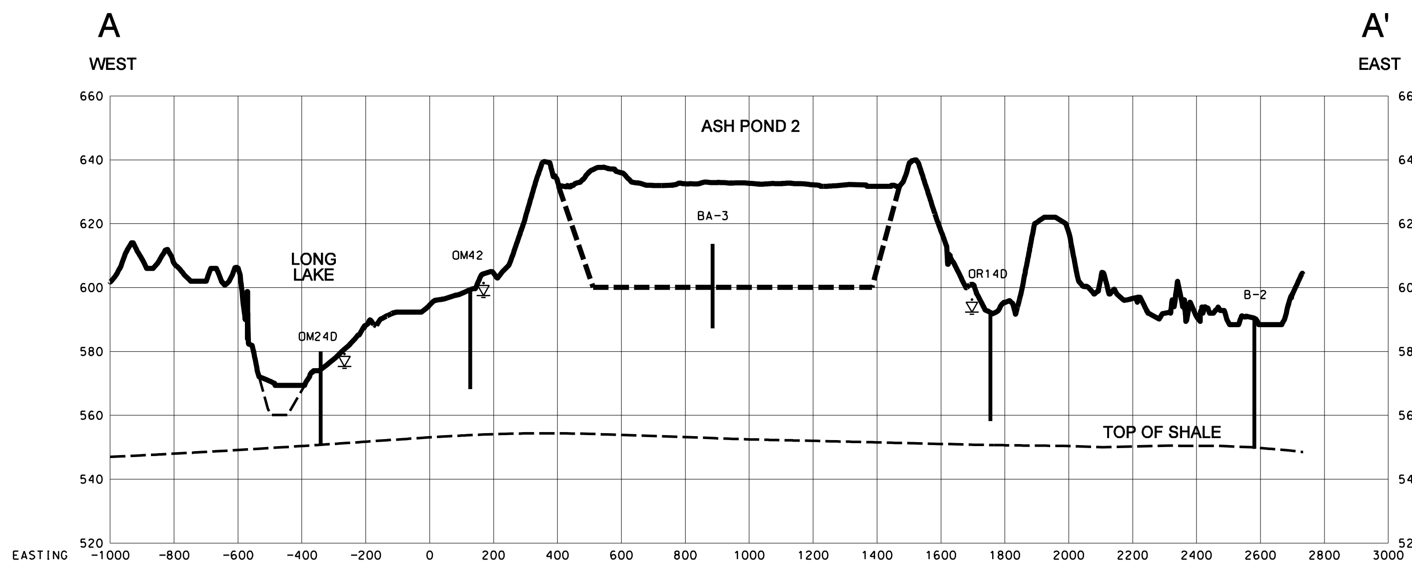
Scale: 1 inch = 4,000 feet Contour interval = 10 feet

HANSON
Hanson Professional Services Inc.

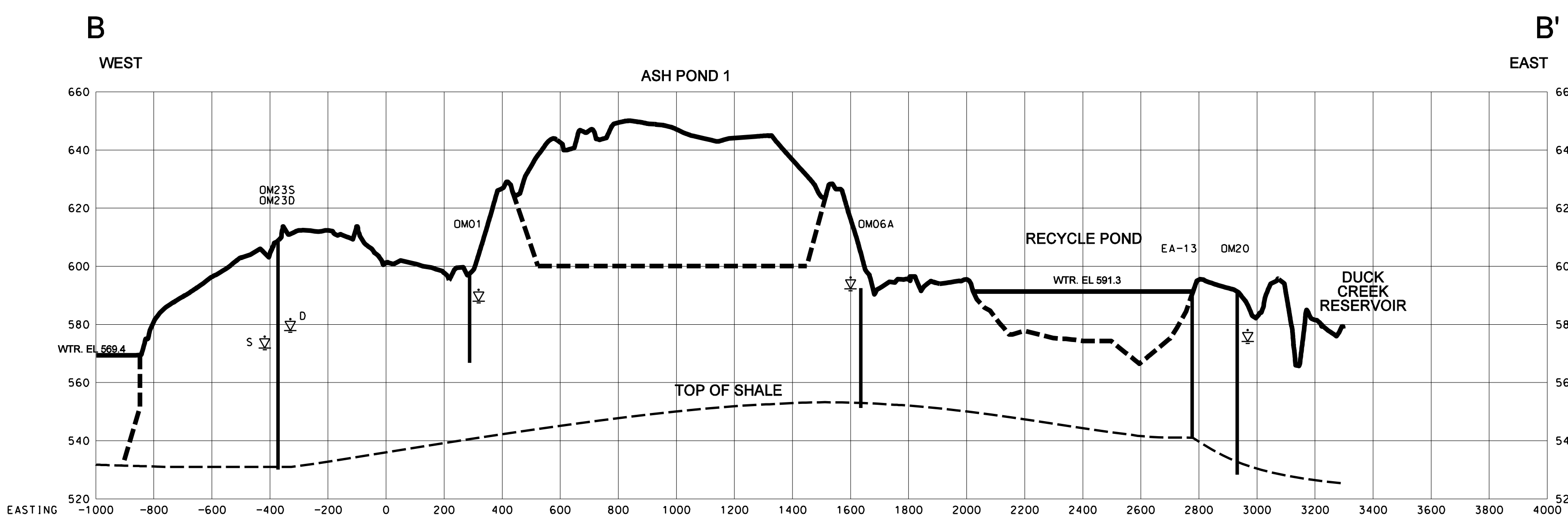
LOCATION MAP

SOLID WASTE MANAGEMENT FACILITY
DUCK CREEK POWER GENERATING STATION
CANTON, FULTON COUNTY, ILLINOIS

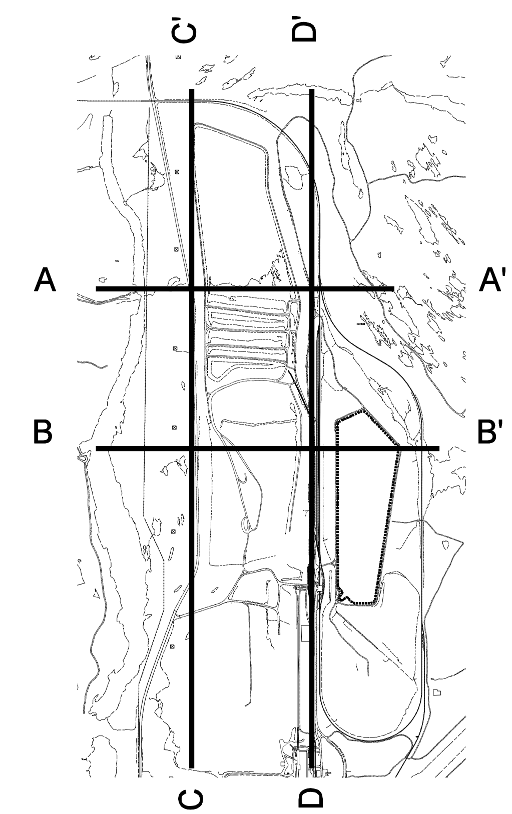
HANSON NO. 03S5010F FIGURE 1



SECTION A-A' (AT N 7500)



SECTION B-B' (AT N 5500)

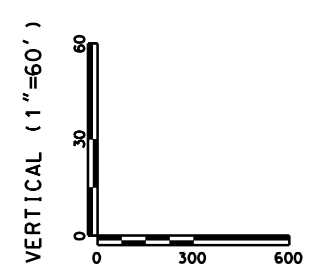


SECTION LOCATION MAP
NTS

(SECTIONS C-C' AND D-D' ARE SHOWN ON FIGURE 5)

NOTES:

1. WATER LEVELS FROM DECEMBER 2009
2. BORING LOCATIONS ARE PROJECTED ONTO CROSS SECTION. ACTUAL ELEVATIONS MAY VARY FROM ORIGINAL LOCATION.
3. NOT ALL GEOLOGIC DETAIL MAY BE SHOWN.



HORIZONTAL (1"=600')
VERTICAL ENHANCEMENT =10x
SCALES

HANSON
Hanson Professional Services Inc.

CROSS SECTIONS A-A' AND B-B'

SOLID WASTE MANAGEMENT FACILITY
DUCK CREEK POWER GENERATING STATION
CANTON, FULTON COUNTY, ILLINOIS

HANSON NO. 03S5010F | FIGURE 4

Brans00939 03\02\2010
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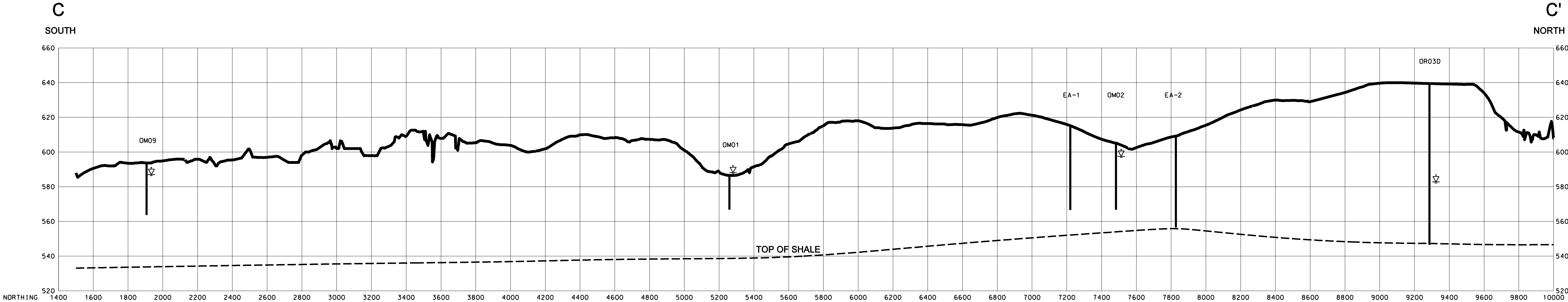
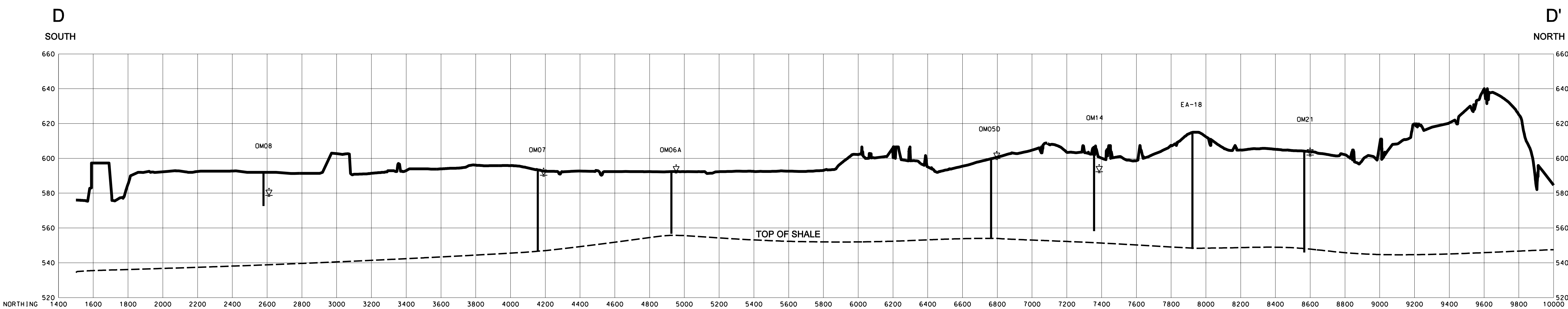


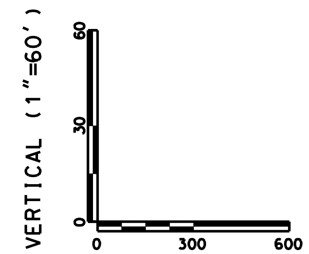
SECTION C-C' (AT E 200)



SECTION D-D' (AT E 1700)

NOTES:

1. WATER LEVELS FROM DECEMBER 2009
2. BORING LOCATIONS ARE PROJECTED ONTO CROSS SECTION. ACTUAL ELEVATIONS MAY VARY FROM ORIGINAL LOCATION.
3. NOT ALL GEOLOGIC DETAIL MAY BE SHOWN.
4. SEE FIGURE 4 FOR SECTION LOCATION MAP.



HORIZONTAL (1"=600')
VERTICAL ENHANCEMENT =10x
SCALES

Hanson Professional Services Inc.

CROSS SECTIOS C-C' AND D-D'

SOLID WASTE MANAGEMENT FACILITY
DUCK CREEK POWER GENERATING STATION
CANTON, FULTON COUNTY, ILLINOIS

HANSON NO. 03S5010F

FIGURE 5

Brans00939 03\02\2010
I:\03 Jobs\03S5010F\CADD\Site\Sheet\Figures\FIG-5_XSC-C-D.dgn

APPENDIX B

HYDRAULIC CONDUCTIVITY TEST RESULTS

APPENDIX B1

ASH POND 1 AND ASH POND 2, AQUIFER EVALUATION IN THE SURFACE (STRIP) MINING AREA, HANSON, FEBRUARY 29, 2016

Ash Pond 1 and Ash Pond 2

Aquifer Evaluation in the Surface (Strip) Mining Area

Duck Creek Power Station
Illinois Power Resources Generating, LLC
Fulton County, Illinois

February 29, 2016

HANSON
Engineering | Planning | Allied Services

Table of Contents

Appendices

Figures and Tables

Figures

Tables

1. Description of Local Geology

Duck Creek Power Station Ash Pond 1 and Ash Pond 2 (Site) are located near Canton in Fulton County, Illinois (see Figure 1). The Site is positioned on the glacial uplands above the Illinois River in the Ancient Illinois Floodplain of the Till Plains Section of the Central Lowland Province (Leighton et al., 1948).

The Site and surrounding area are part of several, large, surface coal mines that have since stopped mining operations (Berg and Kempton, 1988).

Bedrock in the area is identified as Pennsylvanian-age shale deposits that underlie the removed Springfield (No. 5) Coal. The bedrock is typically found at an elevation of 550-555 ft. NGVD, but has been found as deep as 545 ft. NGVD in places.

2. Uppermost Aquifer Requirements

2.1 Definitions

The US Environmental Protection Agency (EPA), as part of its recent rulemaking regarding Disposal of Coal Combustion Residuals (CCR) from Electric Utilities, requires groundwater monitoring to yield groundwater samples from the uppermost aquifer that represent the quality of background groundwater and the quality of groundwater passing the CCR unit waste boundary. [40 CFR 257.90-94] (US EPA, 2015).

"Uppermost aquifer" is defined by US EPA (2015) [40 CFR 257.53] as:

> *the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural ground surface to which the aquifer rises during the wet season.*

US EPA (2015) [40 CFR 257.53] further defines **"aquifer"** to be:

> *a geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs.*

US EPA guidance† concerning the CCR rule's definition of "aquifer" provides that:

> *the quality and value of an aquifer should be a site-specific determination. Usable water in an aquifer typically includes all groundwater currently used or potentially available for drinking water and other beneficial uses (e.g., industrial or agricultural use), whether or not it is particularly vulnerable to contamination. The Agency is unable to judge the resource value of an aquifer based on a generic scale of significance because of the variability of aquifers on a site-by-site basis.*

† US EPA, Top 20 Questions on EPA's CCR Final Rule, Answer to Question #9 (April 2015)

3. Site Hydrogeology

3.1 Shallow (Unlithified) Groundwater

The Hydrogeologic Report (Hanson, 2010) indicates that shallow groundwater at the Site moves through the disturbed mine spoils. The Site groundwater is classified as Class IV: Other Groundwater under the Illinois Groundwater Quality Standards at Title 35, Ill. Admin. Code, Part 620 [35 IAC 620] (IPCB, 1991).

3.1.1 Shallow Groundwater Quantity Evaluation

Hanson recently completed hydraulic conductivity testing (slug testing) of the monitoring wells immediately surrounding Ash Pond 1 and Ash Pond 2. Results of the tests are summarized in Table 1 and the analyses are located in Appendix A. Analyses of the falling head and rising head tests performed at each well (no rising head test at OM05S) were performed using AQTESOLV version 4.50. The Bower-Rice method [B-R] (Bouwer & Rice, 1976) (Bouwer, 1989) and the Kansas Geological Survey method [KGS] (Butler, 1998) unconfined solutions were used for the analyses. Of the 23 tests performed the geometric mean hydraulic conductivity for the mine spoil material is 2.0 x 10^{-4} cm/sec, with values ranging from 1.5 x 10^{-3} cm/sec at OR03D to 5.2 x 10^{-6} cm/sec at OM04S.

Table 1. Hydraulic Conductivity (Slug) Test Summary

Well ID	Falling Head	Rising Head	Geometric Mean	Analysis Method
OM01	0.00045	0.00065	0.00054	B-R
OR02	0.00037	0.00047	0.00042	B-R
OR03D	0.0015	0.00077	0.0011	B-R
OR03S	0.00039	0.0003	0.00034	B-R
OR04D	0.00015	0.00031	0.00022	B-R
OM04S	0.0000052	0.000055	0.000017	B-R
OR05D	0.000034	0.000034	0.000034	KGS
OM05S	0.000095		0.000095	B-R
OR06A	0.00018	0.00054	0.00031	B-R
OM07	0.00011	0.00024	0.00016	B-R
OM09	0.00031	0.00026	0.00028	KGS
OM21	0.00035	0.00036	0.00035	B-R
Geometric Mean =	0.000169	0.000267	0.000200	

Using the mean hydraulic conductivity value as being representative of water movement across the site, Hanson has calculated the capacity of the unlithified mine spoils to supply water to a hypothetical water well. Assuming a well with a 15-inch (1.25 ft.) radius and a screened interval of 50 feet (fully saturated) then using Darcy's Law (flow rate [Q] equals the hydraulic conductivity [k] times the gradient [i] times the area [A]), the groundwater supply rate to this hypothetical well is:

$k = 2.0 \times 10^{-6}$ m/sec,
$i = 0.003$ m/m (from site-specific potentiometric surface maps),
$A = 2\pi rh = 2*3.14*0.381 \text{ m}*15 \text{ m} = 35.9 \text{ m}^2$

$Q = kiA = 2.0 \times 10^{-6} \text{ m/sec} * 0.003 * 35.9 \text{ m}^2 = 2.15 \times 10^{-7} \text{ m}^3\text{/sec} = 4.92$ gal/day.

Several references were used to quantify "usable quantities" as that term is used in the US EPA definition of "aquifer" [40 CFR 257.53]. The US EPA WaterSense‡ web site indicates that an average American family uses over 300 gallons of water per day, and a United Nations study§ indicates that a typical American uses 575 liters (152 gallons) of water per day (so a household of two adults would use 304 gallons of water per day). Moreover, US EPA's RCRA regulations [40 CFR 260.10] define "aquifer" in terms of a geologic formation capable of a "significant yield" of groundwater to wells or springs**, with US EPA RCRA guidance further informing that some US EPA Regions have used local definitions or ranges to establish a significant yield figure, e.g., 5-50 gallons per day.†† Accordingly, based on the quantity of water that an average American household uses per day as the threshold for "usable quantities" under the US EPA definition of "aquifer" [40 CFR 257.53], as well as quantities identified in relevant US EPA RCRA guidance, the Mine Spoil at the Site would not be considered an aquifer.

3.1.2 Shallow Groundwater Quality Evaluation

Groundwater quality data has been collected at the Site since 1985. Since 2010, groundwater in the unlithified (mine spoils) material has had elevated concentrations of Boron (0.6 to 200 mg/L), Chloride (4 to 2100 mg/L), Iron (0.01 to 400 mg/L), Manganese (1.4 to 9500 ug/L), Sulfate (120 to 2900 mg/L), and Total Dissolved Solids (500 to 5800 mg/L). These Appendix III [40 CFR 257] constituents have concentrations that exceed Illinois [35 IAC 620] groundwater standards, US EPA MCLs, or US EPA secondary water quality standards. This water quality does not meet potable quality standards, and would also be difficult to use for industrial or agricultural purposes, without significant treatment, due to the potential caustic nature of the elevated Chloride and Sulfate concentrations.

‡ http://www.epa.gov/watersense/our_water/water_use_today.html

§ United Nations Development Program - Human Development Report 2006 at http://www.data360.org/dsg.aspx?Data_Set_Group_Id=757

** US EPA Comment Summary and Response Document, Hazardous and Solid Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals from Electric Utilities: Proposed Rule, Docket # EPA-HQ-RCRA-2009-0640, Vol.3, C.2.b, at p. 38 (Dec. 2014) (explaining that the 40 CFR 257.53 definition of "aquifer" conforms to the definition of "aquifer" in 40 CFR 260.10).

†† US EPA RCRA/Superfund Hotline Monthly Summary, RCRA Online No. 12323, RPPC No. 9432.1984(06) (Nov. 1, 1984)

3.2 Bedrock Aquifer Evaluation

3.2.1 Pressure (Packer) Testing Methodology

Pressure testing equipment used at OM32 consisted of two pneumatic packers (rubber bladders) with a length of perforated steel pipe between them. The interval between the two packers was approximately 8.5 ft. Additional mild steel pipe (1 inch diameter) was added (or removed) to the packer assembly to reach the desired test interval. Nitrogen gas was used to inflate the packers, once they were lowered to the test depth. Inflation pressures were typically around 300 psi.

Water was pumped down to the test interval through a flow meter so that the amount of water "taken up" by the formation could be quantified. Flow to the sample interval was started before the packers were inflated, so that any leaks or other issues could be more easily identified. Although noted in the results for each sample interval, the first test increment listed is typically ignored. Each test "step" lasted approximately 15 minutes. Supply pressure to the test interval was increased at each step (i.e., 10 psi, 20 psi, and 30 psi). At the completion of the test, the pressures were reduced to the previous level and held for about 5 minutes. This "step down" portion of the test allows the geologist to determine if any water uptakes are real, or if the pressure only expanded the rock bedding/jointing.

3.2.2 Deep (Bedrock) Groundwater

Visocky et al. (1985) indicates that deeper strata in the bedrock can produce water that may be suitable (volume and quality) for a potable water supply. In fact, the Illinois Water Well (ILWATER) database (ISGS, 2015) identifies a bedrock well approximately 2 miles northeast of the Site that obtains water from a sandstone located 250-260 ft. bgs (below ground surface).

The bedrock immediately below the mined-out Springfield (No. 5) Coal at the Site is principally shale, with occasional sandstone, limestone and thin coal horizons. During September 2015, Hanson completed a bedrock boring (OM26B) to a depth of 355 ft. bgs. A boring log for OM26B, showing the unlithified and bedrock units, is included as Appendix B.

At the completion of the coring operations, Hanson pressure (packer) tested 255 ft. of bedrock in boring OM32. Results of the testing are summarized in Table 2, with the complete set of calculations included as Appendix C. The uppermost 100 ft. of bedrock had almost no take during the pressure testing. The only water uptake during the testing was noted (in the bottom 30 ft. of the borehole) at elevation 325-355 ft., with hydraulic conductivity (k) values in the 2 to 5 x 10^{-6} cm^3/cm^2/sec range.

Pressure testing continued up the borehole, but no other (shallower) pressure test measurements exceeded 3 x 10^{-8} cm^3/cm^2/sec (average k for test interval). Based on these results, Hanson concludes that the lowermost 55 ft. of bedrock is not "capable of yielding useable quantities of groundwater to wells or springs" due to the low hydraulic conductivities in the bedrock (low to mid 10^{-6} cm/s range at approximately 300 to 355 ft.) and, therefore, being 2-orders of magnitude lower than the mine spoil, bedrock is not an "aquifer" as defined by the US EPA (2015).

Additionally, the pressure testing indicates that there is almost 200 ft. of bedrock that is acting as a barrier to any potential contaminant migration from the mine spoil to any deeper water-bearing zones. Tests E through U typically had no take (formation was incapable of having any water injected during the tests).

Table 2. Pressure Test (Hydraulic Conductivity) Result Summary

Test No.	Depth (ft.)	Arithmetic Mean of Hydraulic Conductivity ($cm^3/cm^2/s$)	Median of Hydraulic Conductivity ($cm^3/cm^2/s$)
A	351.57	1.7×10^{-6}	1.3×10^{-6}
B	331.64	8.5×10^{-6}	5.8×10^{-6}
C	321.54	5.7×10^{-8}	3.9×10^{-8}
D	300.77	5.0×10^{-7}	2.7×10^{-8}
E	279.77	0.0	0.0
F	269.17	7.1×10^{-9}	0.0
G	258.72	5.9×10^{-7}	4.6×10^{-8}
H	248.62	3.0×10^{-9}	0.0
I	227.61	0.0 *(no take)*	0.0 *(no take)*
J	217.05	3.6×10^{-8}	0.0 *(no take)*
K	206.51	1.5×10^{-9}	0.0
L	196.37	0.0 *(no take)*	0.0 *(no take)*
M	185.77	1.5×10^{-9}	0.0
N	175.55	0.0 *(no take)*	0.0 *(no take)*
O	165.39	4.1×10^{-9}	0.0
P	155.25	0.0 *(no take)*	0.0 *(no take)*
Q	144.75	1.5×10^{-9}	0.0
R	134.15	1.3×10^{-9}	0.0
S	124.04	0.0 *(no take)*	0.0 *(no take)*
T	113.86	0.0 *(no take)*	0.0 *(no take)*
U	103.41	0.0 *(no take)*	0.0 *(no take)*

4. Conclusions

Hanson has reviewed available Site information and has performed additional hydraulic conductivity testing in both the Mine Spoil materials and the in situ bedrock formation(s). Based on the testing and analyses, Hanson concludes that the unlithified Mine Spoil materials are not an aquifer as defined by US EPA (2015) [40 CFR 257.53]. This material is incapable of producing "useable quantities" of groundwater, by both water quantity and quality analyses.

The bedrock formations were also tested, and determined to be incapable of producing "usable" quantities of groundwater. This testing further determined that the upper 200 ft. of bedrock is a barrier to any potential migration of the groundwater found within the Mine Spoil materials to deeper strata.

5. Licensed Professional Signature/Seal

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

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

Seal: LICENSED PROFESSIONAL GEOLOGIST
RHONALD W. HASENYAGER
196-000246
ILLINOIS
Expires 3/31/2017

Signature: ______________________ Date: 29 February 2016

6. References

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Hanson Professional Services Inc.

SITE LOCATION MAP

ASH POND 1 AND ASH POND 2
DUCK CREEK POWER STATION
FULTON COUNTY, ILLINOIS

HANSON NO. 15E0030 FIGURE 1

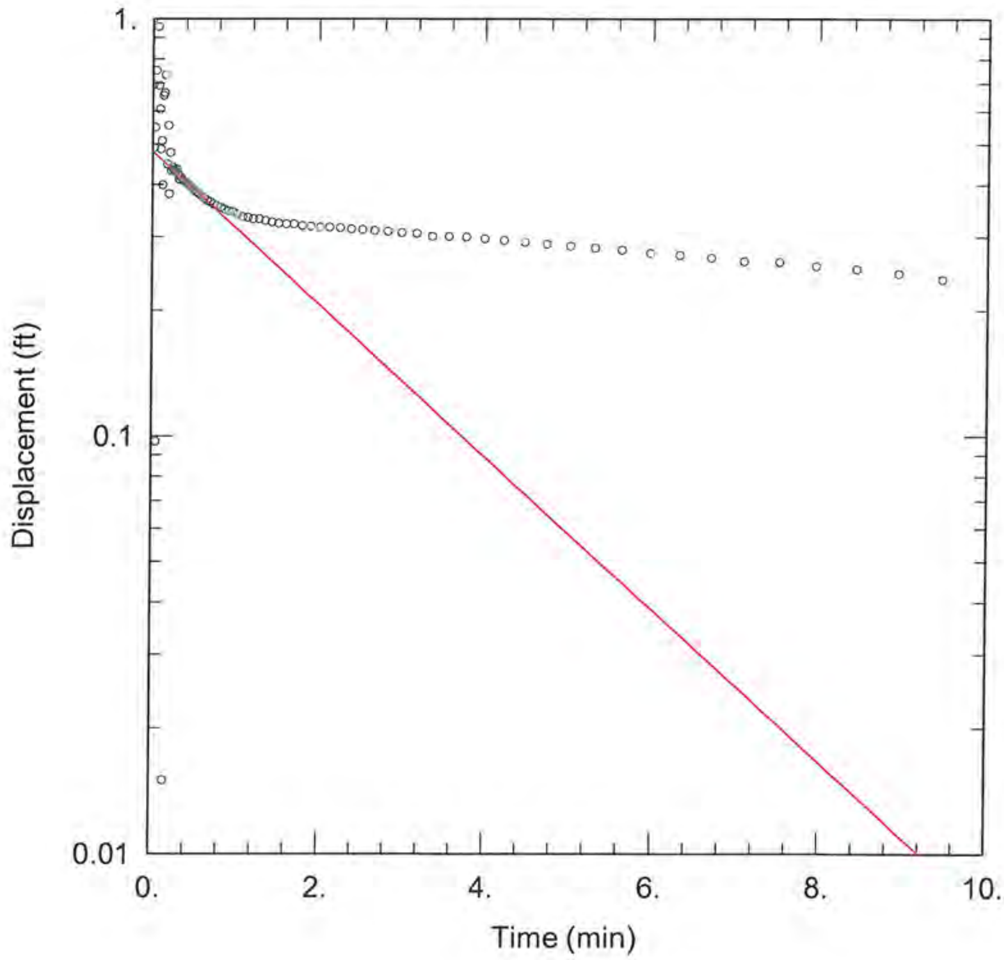
I:\15Jobs\15E0030\Admin\14-Reports\DuckCreek\MAP_SiteLocation_151222.srf

FIGURE 2. Hydraulic Conductivity Testing Locations

Duck Creek Power Station

Appendix A

Hydraulic Conductivity (Slug) Test Results



OM01 FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM01fh.aqt
Date: 12/09/15 Time: 09:16:48

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM01
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 15.72 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM01)

Initial Displacement: 1. ft
Total Well Penetration Depth: 9.22 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 9.22 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
$K = 0.00045$ cm/sec
$y0 = 0.48$ ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM01fh.aqt
Title: OM01 Falling Head Test
Date: 12/09/15
Time: 09:16:48

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OM01

AQUIFER DATA

Saturated Thickness: 15.72 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM01

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1. ft
Static Water Column Height: 9.22 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 5. ft
Total Well Penetration Depth: 9.22 ft

No. of Observations: 110

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0112	0.695	1.606	0.322
0.0223	0.49	1.7	0.322
0.0335	0.548	1.799	0.319
0.0447	0.751	1.904	0.318
0.0558	0.097	2.016	0.316
0.067	0.956	2.134	0.316
0.0782	0.691	2.259	0.315
0.0893	0.606	2.392	0.313
0.1005	0.486	2.532	0.312
0.1117	0.509	2.681	0.31
0.1228	0.399	2.838	0.309
0.134	0.654	3.005	0.307
0.1452	0.664	3.182	0.306
0.1563	0.733	3.369	0.301
0.1675	0.015	3.568	0.301
0.1787	0.448	3.778	0.3
0.1898	0.554	4.	0.297
0.201	0.38	4.236	0.294
0.2122	0.477	4.486	0.291

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.2233	0.432	4.751	0.288
0.235	0.441	5.031	0.285
0.2475	0.435	5.328	0.282
0.2607	0.431	5.643	0.279
0.2747	0.432	5.976	0.274
0.2895	0.435	6.329	0.271
0.3052	0.423	6.702	0.267
0.3218	0.411	7.098	0.262
0.3395	0.416	7.518	0.261
0.3582	0.41	7.962	0.255
0.378	0.408	8.433	0.251
0.399	0.405	8.931	0.245
0.4212	0.401	9.459	0.237
0.4447	0.398	10.02	0.231
0.4695	0.393	10.61	0.227
0.4958	0.389	11.24	0.219
0.5238	0.384	11.9	0.213
0.5535	0.381	12.61	0.206
0.5848	0.376	13.35	0.197
0.618	0.371	14.14	0.19
0.6532	0.367	14.98	0.182
0.6905	0.364	15.87	0.172
0.73	0.359	16.81	0.163
0.7718	0.356	17.8	0.155
0.8162	0.353	18.85	0.143
0.8632	0.349	19.97	0.134
0.913	0.346	21.15	0.123
0.9657	0.344	22.4	0.112
1.022	0.34	23.73	0.1
1.081	0.335	25.14	0.087
1.143	0.334	26.62	0.073
1.21	0.331	28.2	0.062
1.28	0.331	29.87	0.047
1.355	0.328	31.64	0.032
1.434	0.325	33.51	0.018
1.517	0.323	35.5	0.002

SOLUTION

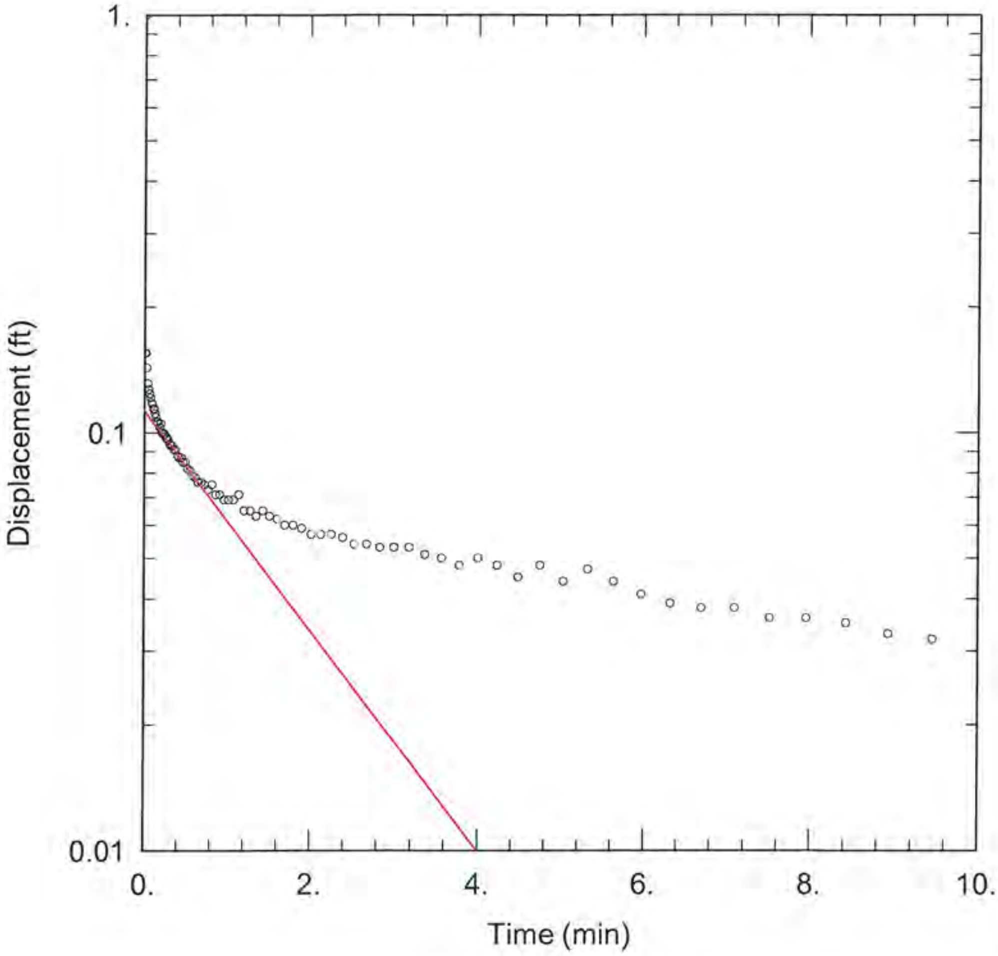
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.038

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00045	cm/sec
y0	0.48	ft

T = K*b = 0.2156 cm²/sec



OM01 RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM01rh.aqt
Date: 12/09/15 Time: 09:16:49

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM01
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 15.72 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM01)

Initial Displacement: 1. ft
Total Well Penetration Depth: 9.22 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 9.22 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00065 cm/sec
y0 = 0.113 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM01rh.aqt
Title: OM01 Rising Head Test
Date: 12/09/15
Time: 09:16:50

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OM01

AQUIFER DATA

Saturated Thickness: 15.72 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM01

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1. ft
Static Water Column Height: 9.22 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 5. ft
Total Well Penetration Depth: 9.22 ft

No. of Observations: 106

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0112	0.155	1.434	0.065
0.0223	0.155	1.517	0.063
0.0335	0.143	1.606	0.062
0.0447	0.131	1.7	0.06
0.0558	0.127	1.799	0.06
0.067	0.124	1.904	0.059
0.0782	0.121	2.016	0.057
0.0893	0.118	2.134	0.057
0.1005	0.117	2.259	0.057
0.1117	0.114	2.392	0.056
0.1228	0.114	2.532	0.054
0.134	0.111	2.681	0.054
0.1452	0.109	2.838	0.053
0.1563	0.106	3.005	0.053
0.1675	0.106	3.182	0.053
0.1787	0.105	3.369	0.051
0.1898	0.103	3.568	0.05
0.201	0.105	3.778	0.048
0.2122	0.1	4.	0.05

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.2233	0.1	4.236	0.048
0.235	0.099	4.486	0.045
0.2475	0.099	4.751	0.048
0.2607	0.097	5.031	0.044
0.2747	0.097	5.328	0.047
0.2895	0.096	5.643	0.044
0.3052	0.094	5.976	0.041
0.3218	0.093	6.329	0.039
0.3395	0.093	6.702	0.038
0.3582	0.091	7.098	0.038
0.378	0.091	7.518	0.036
0.399	0.088	7.962	0.036
0.4212	0.087	8.433	0.035
0.4447	0.087	8.931	0.033
0.4695	0.085	9.459	0.032
0.4958	0.085	10.02	0.032
0.5238	0.082	10.61	0.03
0.5535	0.081	11.24	0.029
0.5848	0.079	11.9	0.029
0.618	0.078	12.61	0.026
0.6532	0.076	13.35	0.026
0.6905	0.076	14.14	0.024
0.73	0.075	14.98	0.023
0.7718	0.073	15.87	0.021
0.8162	0.075	16.81	0.02
0.8632	0.071	17.8	0.018
0.913	0.071	18.85	0.017
0.9657	0.069	19.97	0.013
1.022	0.069	21.15	0.011
1.081	0.069	22.4	0.01
1.143	0.071	23.73	0.01
1.21	0.065	25.14	0.008
1.28	0.065	26.62	0.005
1.355	0.063	28.2	0.004

SOLUTION

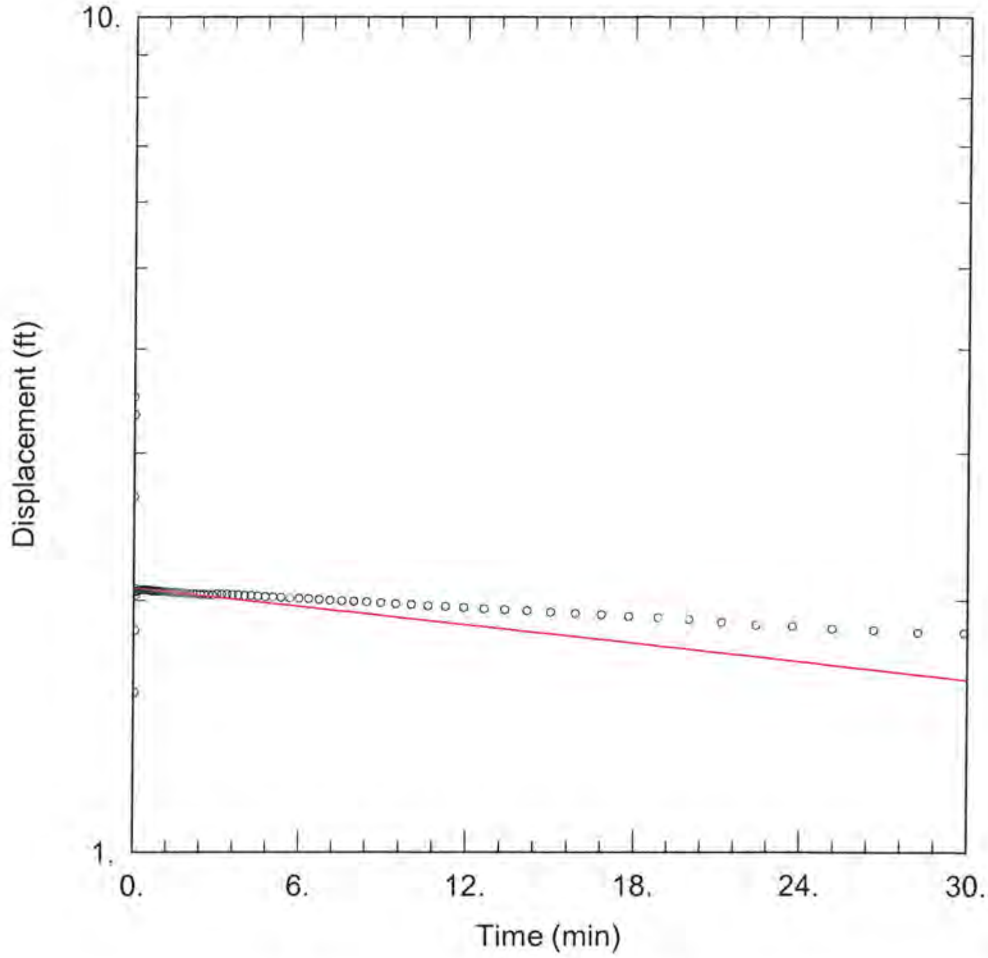
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.038

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00065	cm/sec
y0	0.113	ft

$T = K*b = 0.3114\ cm^2/sec$



OM04S FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM04Sfh.aqt
Date: 12/09/15 Time: 09:16:51

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM04S
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 50.52 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM04S)

Initial Displacement: 3.5 ft
Total Well Penetration Depth: 17.52 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 17.52 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 5.2E-6 cm/sec
y0 = 2.07 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM04Sfh.aqt
Title: OM04S Falling Head Test
Date: 12/09/15
Time: 09:16:51

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OM04S

AQUIFER DATA

Saturated Thickness: 50.52 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM04S

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 3.5 ft
Static Water Column Height: 17.52 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 17.52 ft

No. of Observations: 102

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0165	2.659	1.824	2.042
0.033	3.335	1.929	2.039
0.0495	1.553	2.041	2.037
0.066	1.841	2.159	2.037
0.0825	2.066	2.284	2.036
0.099	2.03	2.416	2.034
0.1155	2.048	2.557	2.033
0.132	2.052	2.706	2.031
0.1485	2.054	2.863	2.03
0.165	2.055	3.03	2.036
0.1815	2.055	3.207	2.033
0.198	2.055	3.394	2.033
0.2145	2.057	3.592	2.031
0.231	2.058	3.803	2.03
0.2475	2.058	4.025	2.027
0.264	2.058	4.261	2.027
0.2805	2.058	4.511	2.023
0.297	2.058	4.776	2.02
0.3135	2.058	5.056	2.018

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.33	2.058	5.353	2.015
0.3467	2.058	5.667	2.012
0.3643	2.06	6.	2.011
0.383	2.058	6.353	2.008
0.4028	2.058	6.727	2.003
0.4238	2.058	7.123	2.
0.446	2.058	7.543	1.997
0.4695	2.058	7.987	1.994
0.4943	2.057	8.457	1.99
0.5207	2.058	8.956	1.985
0.5487	2.057	9.484	1.981
0.5783	2.058	10.04	1.976
0.6097	2.057	10.64	1.97
0.6428	2.055	11.26	1.966
0.678	2.052	11.93	1.961
0.7153	2.054	12.63	1.954
0.7548	2.054	13.38	1.949
0.7967	2.052	14.17	1.944
0.841	2.052	15.01	1.936
0.888	2.051	15.89	1.929
0.9378	2.051	16.83	1.921
0.9905	2.051	17.83	1.914
1.046	2.049	18.88	1.906
1.105	2.049	19.99	1.899
1.168	2.049	21.18	1.882
1.234	2.048	22.43	1.867
1.305	2.046	23.76	1.862
1.379	2.045	25.16	1.851
1.458	2.045	26.65	1.842
1.542	2.045	28.23	1.829
1.631	2.043	29.9	1.827
1.724	2.043	31.66	1.815

SOLUTION

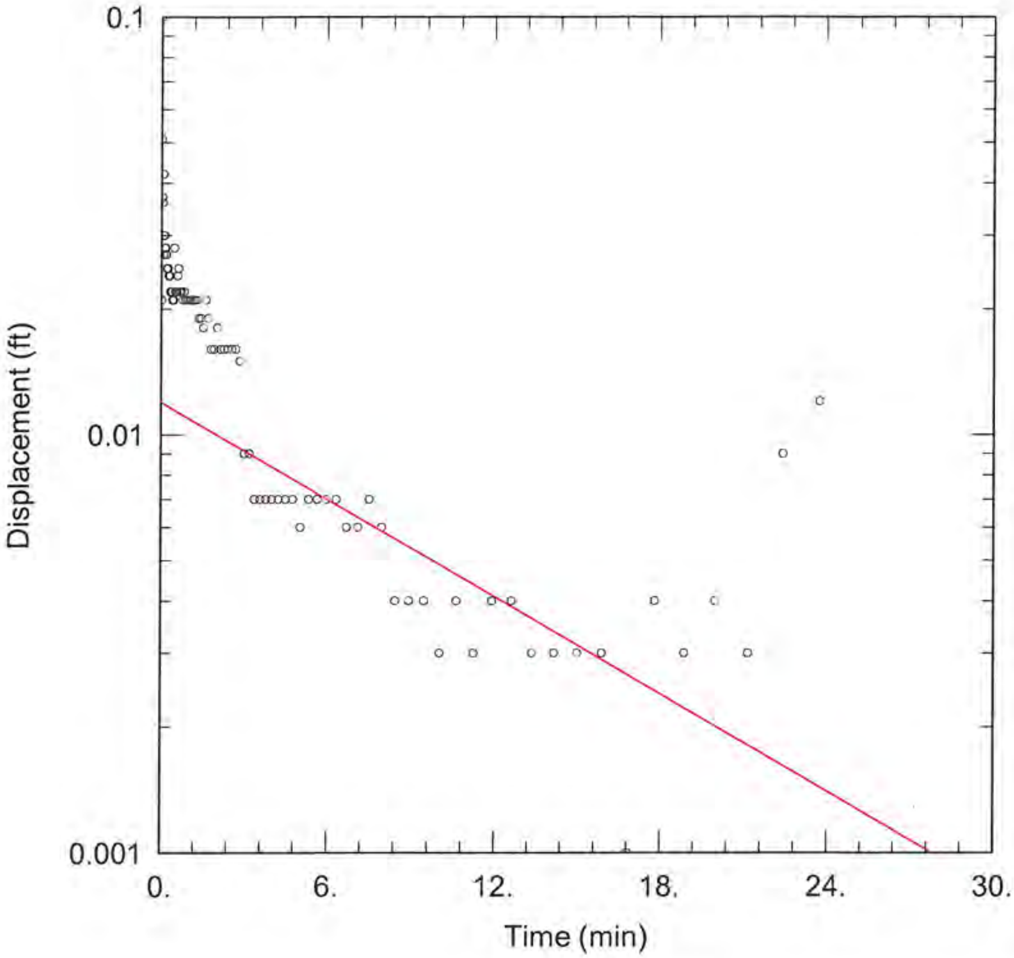
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.492

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	5.2E-6	cm/sec
y0	2.07	ft

T = K*b = 0.008007 cm^2/sec



OM04S RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM04Srh.aqt
Date: 12/21/15 Time: 14:51:43

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM4S
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 50.52 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM04S)

Initial Displacement: 0.1 ft
Total Well Penetration Depth: 17.52 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 17.52 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 5.5E-5 cm/sec
y0 = 0.012 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM04Srh.aqt
Title: OM04S Rising Head Test
Date: 12/21/15
Time: 14:51:44

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OM4S

AQUIFER DATA

Saturated Thickness: 50.52 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM04S

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 0.1 ft
Static Water Column Height: 17.52 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 17.52 ft

No. of Observations: 97

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0163	0.051	1.627	0.021
0.0327	0.021	1.721	0.019
0.049	0.037	1.82	0.016
0.0653	0.036	1.926	0.016
0.0817	0.042	2.037	0.018
0.098	0.027	2.155	0.016
0.1143	0.03	2.281	0.016
0.1307	0.03	2.413	0.016
0.147	0.028	2.554	0.016
0.1633	0.028	2.702	0.016
0.1797	0.027	2.86	0.015
0.196	0.027	3.027	0.009
0.2123	0.025	3.204	0.009
0.2287	0.025	3.391	0.007
0.245	0.025	3.589	0.007
0.2613	0.025	3.799	0.007
0.2777	0.024	4.022	0.007
0.294	0.024	4.258	0.007
0.3103	0.024	4.508	0.007

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.3267	0.024	4.772	0.007
0.3433	0.022	5.053	0.006
0.361	0.022	5.349	0.007
0.3797	0.022	5.664	0.007
0.3995	0.022	5.997	0.007
0.4205	0.021	6.35	0.007
0.4427	0.021	6.724	0.006
0.4662	0.021	7.12	0.006
0.491	0.028	7.539	0.007
0.5173	0.022	7.984	0.006
0.5453	0.022	8.454	0.004
0.575	0.022	8.953	0.004
0.6063	0.024	9.481	0.004
0.6395	0.025	10.04	0.003
0.6747	0.022	10.63	0.004
0.712	0.022	11.26	0.003
0.7515	0.022	11.92	0.004
0.7933	0.021	12.63	0.004
0.8377	0.022	13.37	0.003
0.8847	0.021	14.16	0.003
0.9345	0.021	15.	0.003
0.9872	0.021	15.89	0.003
1.043	0.021	16.83	0.001
1.102	0.021	17.82	0.004
1.165	0.021	18.88	0.003
1.231	0.021	19.99	0.004
1.302	0.021	21.17	0.003
1.376	0.019	22.43	0.009
1.455	0.019	23.75	0.012
1.539	0.018		

SOLUTION

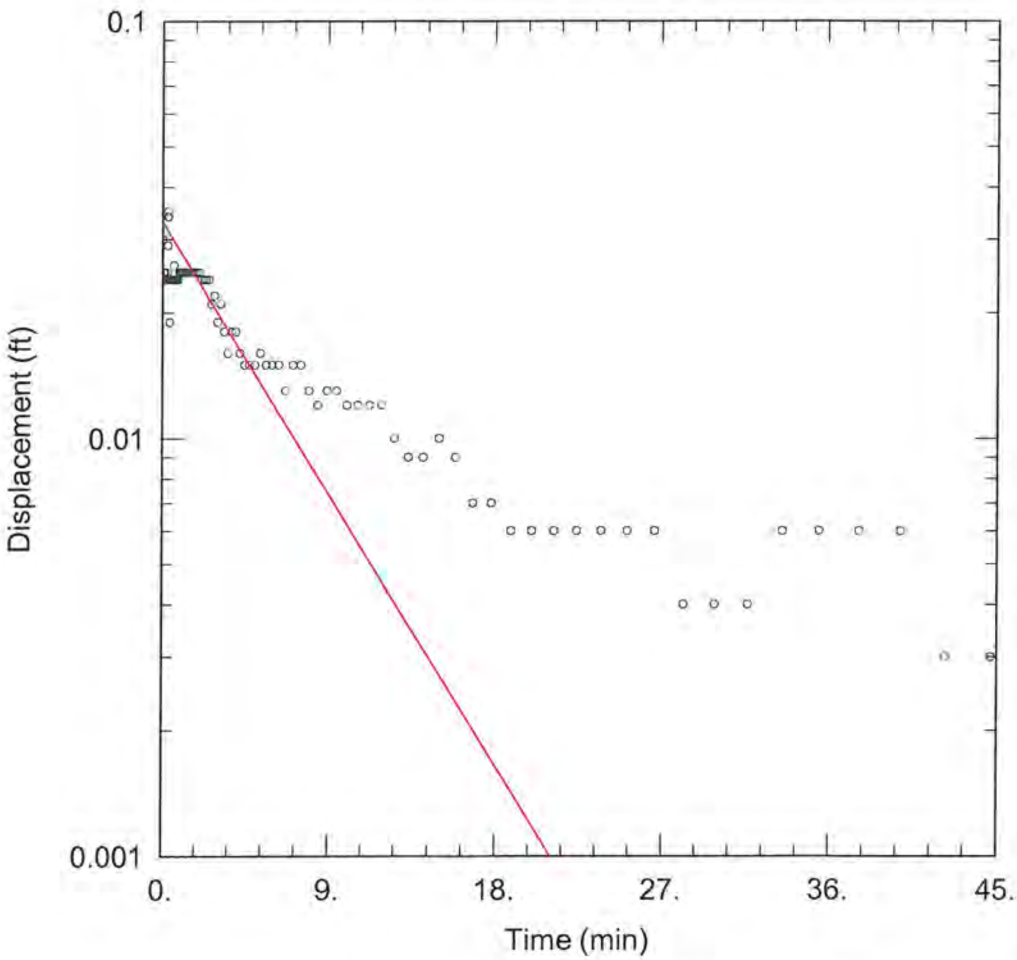
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.492

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	5.5E-5	cm/sec
y0	0.012	ft

T = K*b = 0.08469 cm²/sec



OM05S FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM05Sfh.aqt
Date: 12/09/15 Time: 09:16:54

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM05S
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 37.36 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM05S)

Initial Displacement: 0.03 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08333 ft
Static Water Column Height: 6.86 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 9.5E-5 cm/sec
y0 = 0.033 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM05Sfh.aqt
Title: OM05S Falling Head Test
Date: 12/09/15
Time: 09:16:54

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OM05S

AQUIFER DATA

Saturated Thickness: 37.36 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM05S

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 0.03 ft
Static Water Column Height: 6.86 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 10. ft

No. of Observations: 108

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0163	0.024	2.155	0.024
0.0327	0.024	2.281	0.024
0.049	0.024	2.413	0.024
0.0653	0.024	2.554	0.024
0.0817	0.025	2.702	0.021
0.098	0.024	2.86	0.022
0.1143	0.024	3.027	0.019
0.1307	0.025	3.204	0.021
0.147	0.024	3.391	0.018
0.1633	0.024	3.589	0.016
0.1797	0.024	3.799	0.018
0.196	0.024	4.022	0.018
0.2123	0.024	4.258	0.016
0.2287	0.024	4.508	0.015
0.245	0.024	4.772	0.015
0.2613	0.024	5.053	0.015
0.2777	0.025	5.349	0.016
0.294	0.034	5.664	0.015
0.3103	0.029	5.997	0.015

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.3267	0.035	6.35	0.015
0.3433	0.034	6.724	0.013
0.361	0.024	7.12	0.015
0.3797	0.024	7.539	0.015
0.3995	0.019	7.984	0.013
0.4205	0.024	8.454	0.012
0.4427	0.024	8.953	0.013
0.4662	0.024	9.481	0.013
0.491	0.024	10.04	0.012
0.5173	0.024	10.63	0.012
0.5453	0.024	11.26	0.012
0.575	0.024	11.92	0.012
0.6063	0.024	12.63	0.01
0.6395	0.026	13.37	0.009
0.6747	0.024	14.16	0.009
0.712	0.024	15.	0.01
0.7515	0.024	15.89	0.009
0.7933	0.024	16.83	0.007
0.8377	0.024	17.82	0.007
0.8847	0.024	18.88	0.006
0.9345	0.025	19.99	0.006
0.9872	0.025	21.17	0.006
1.043	0.025	22.43	0.006
1.102	0.025	23.75	0.006
1.165	0.025	25.16	0.006
1.231	0.025	26.65	0.006
1.302	0.025	28.22	0.004
1.376	0.025	29.89	0.004
1.455	0.025	31.66	0.004
1.539	0.025	33.53	0.006
1.627	0.025	35.52	0.006
1.721	0.025	37.62	0.006
1.82	0.025	39.85	0.006
1.926	0.025	42.21	0.003
2.037	0.025	44.71	0.003

SOLUTION

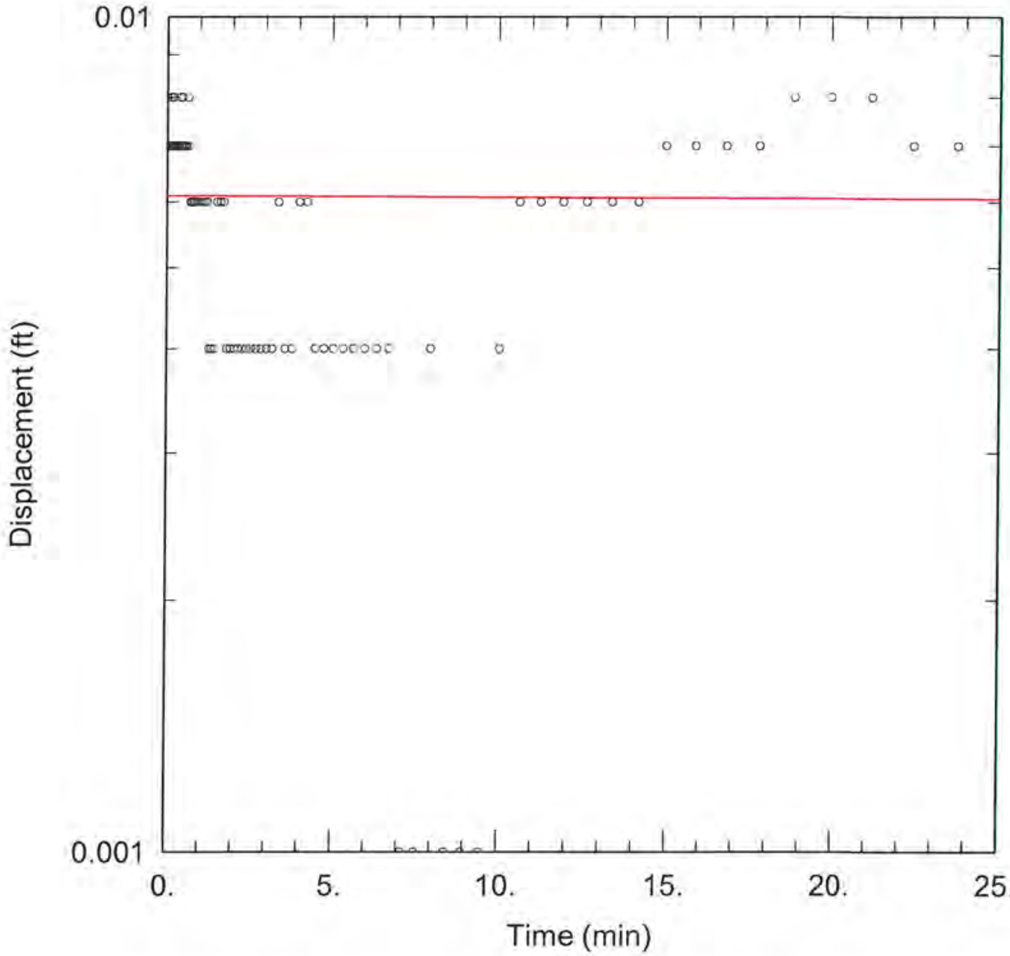
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.234

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	9.5E-5	cm/sec
y0	0.033	ft

$T = K*b = 0.1082\ cm^2/sec$



OM05S RISING HEAD TEST (NO DISPLACEMENT, TEST INVALID)

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM05Srh.aqt
Date: 12/09/15 Time: 09:37:40

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM05S
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 37.36 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM05S)

Initial Displacement: 0.008 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08333 ft
Static Water Column Height: 6.86 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.0E-7 cm/sec
y0 = 0.0061 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM05Srh.aqt
Title: OM05S Rising Head Test (no displacement, test invalid)
Date: 12/09/15
Time: 09:37:41

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OM05S

AQUIFER DATA

Saturated Thickness: 37.36 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM05S

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 0.008 ft
Static Water Column Height: 6.86 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 10. ft

No. of Observations: 107

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0165	0.007	2.159	0.004
0.033	0.007	2.284	0.004
0.0495	0.007	2.416	0.004
0.066	0.007	2.557	0.004
0.0825	0.007	2.706	0.004
0.099	0.007	2.863	0.004
0.1155	0.007	3.03	0.004
0.132	0.008	3.207	0.004
0.1485	0.007	3.394	0.006
0.165	0.007	3.592	0.004
0.1815	0.007	3.803	0.004
0.198	0.008	4.025	0.006
0.2145	0.007	4.261	0.006
0.231	0.007	4.511	0.004
0.2475	0.007	4.776	0.004
0.264	0.007	5.056	0.004
0.2805	0.007	5.353	0.004
0.297	0.007	5.667	0.004
0.3135	0.007	6.	0.004

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.33	0.007	6.353	0.004
0.3467	0.007	6.727	0.004
0.3643	0.007	7.123	0.001
0.383	0.007	7.543	0.001
0.4028	0.008	7.987	0.004
0.4238	0.007	8.457	0.001
0.446	0.007	8.956	0.001
0.4695	0.008	9.484	0.001
0.4943	0.007	10.04	0.004
0.5207	0.007	10.64	0.006
0.5487	0.007	11.26	0.006
0.5783	0.007	11.93	0.006
0.6097	0.007	12.63	0.006
0.6428	0.008	13.38	0.006
0.678	0.007	14.17	0.006
0.7153	0.006	15.01	0.007
0.7548	0.006	15.89	0.007
0.7967	0.006	16.83	0.007
0.841	0.006	17.83	0.007
0.888	0.006	18.88	0.008
0.9378	0.006	19.99	0.008
0.9905	0.006	21.18	0.008
1.046	0.006	22.43	0.007
1.105	0.006	23.76	0.007
1.168	0.006	25.16	0.008
1.234	0.006	26.65	0.008
1.305	0.004	28.23	0.01
1.379	0.004	29.9	0.007
1.458	0.004	31.66	0.008
1.542	0.006	33.54	0.01
1.631	0.006	35.52	0.01
1.724	0.006	37.62	0.01
1.824	0.004	39.85	0.011
1.929	0.004	42.21	0.013
2.041	0.004		

SOLUTION

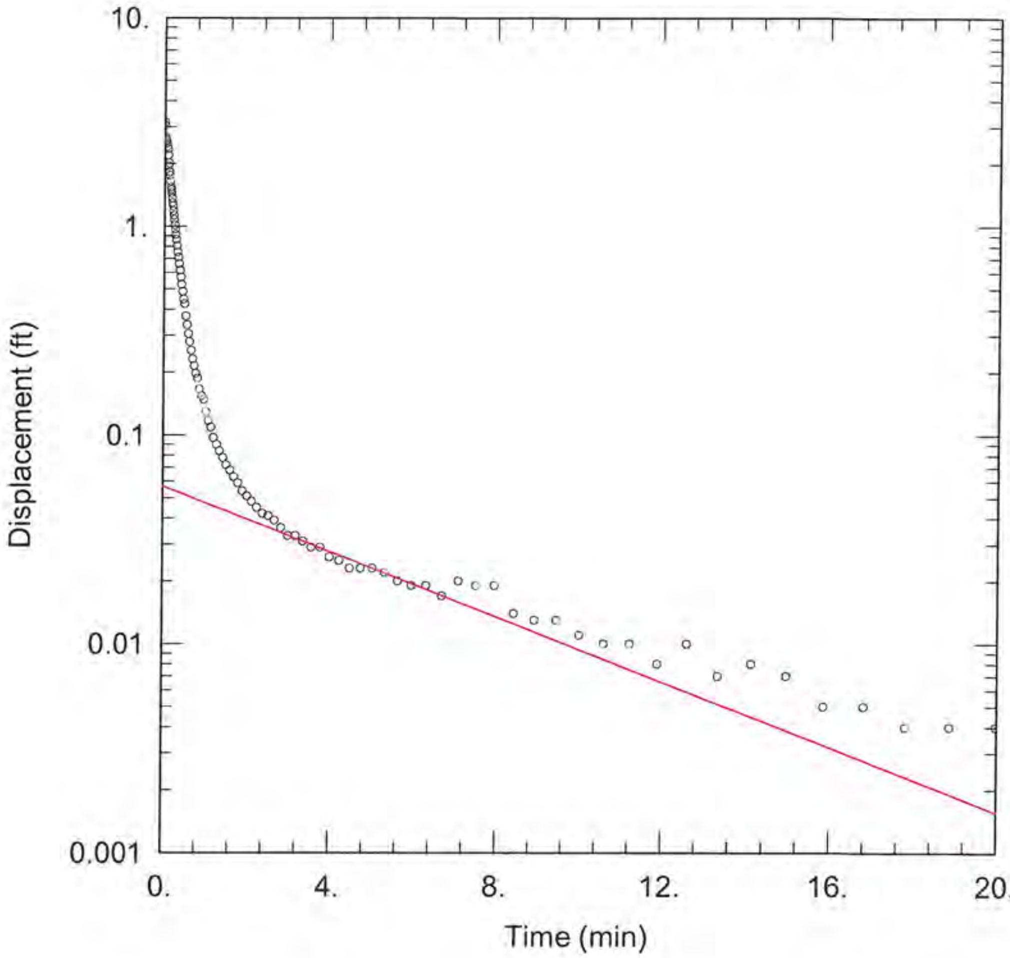
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.234

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	2.0E-7	cm/sec
y0	0.0061	ft

T = K*b = 0.0002277 cm²/sec



OM07 FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM07fh.aqt
Date: 12/09/15 Time: 09:16:56

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM07
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 36.37 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM07)

Initial Displacement: 3.15 ft
Total Well Penetration Depth: 15.37 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 15.37 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00011 cm/sec
y0 = 0.057 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM07fh.aqt
Title: OM07 Falling Head Test
Date: 12/09/15
Time: 09:16:57

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OM07

AQUIFER DATA

Saturated Thickness: 36.37 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM07

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 3.15 ft
Static Water Column Height: 15.37 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 15.37 ft

No. of Observations: 103

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.011	3.034	1.288	0.09
0.022	2.665	1.362	0.084
0.033	2.61	1.441	0.078
0.044	2.578	1.525	0.072
0.055	2.5	1.613	0.068
0.066	2.418	1.707	0.063
0.077	2.346	1.807	0.059
0.088	2.191	1.912	0.054
0.099	1.95	2.023	0.051
0.11	2.001	2.142	0.048
0.121	1.825	2.267	0.045
0.132	1.752	2.399	0.042
0.143	1.642	2.54	0.041
0.154	1.538	2.688	0.039
0.165	1.493	2.846	0.036
0.176	1.447	3.013	0.033
0.187	1.365	3.19	0.033
0.198	1.3	3.377	0.031
0.209	1.252	3.575	0.029

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.22	1.184	3.785	0.029
0.231	1.129	4.008	0.026
0.2427	1.077	4.244	0.025
0.2552	1.016	4.494	0.023
0.2683	0.968	4.758	0.023
0.2823	0.911	5.039	0.023
0.2972	0.864	5.336	0.022
0.3128	0.807	5.65	0.02
0.3295	0.754	5.983	0.019
0.3472	0.709	6.336	0.019
0.3658	0.661	6.71	0.017
0.3857	0.614	7.106	0.02
0.4067	0.571	7.525	0.019
0.4288	0.527	7.97	0.019
0.4523	0.486	8.44	0.014
0.4772	0.447	8.939	0.013
0.5035	0.426	9.467	0.013
0.5315	0.371	10.03	0.011
0.5612	0.337	10.62	0.01
0.5925	0.306	11.25	0.01
0.6257	0.28	11.91	0.008
0.6608	0.254	12.62	0.01
0.6982	0.231	13.36	0.007
0.7377	0.215	14.15	0.008
0.7795	0.197	14.99	0.007
0.8238	0.187	15.87	0.005
0.8708	0.166	16.81	0.005
0.9207	0.154	17.81	0.004
0.9733	0.148	18.86	0.004
1.029	0.129	19.98	0.004
1.088	0.117	21.16	0.004
1.151	0.109	22.41	0.002
1.217	0.097		

SOLUTION

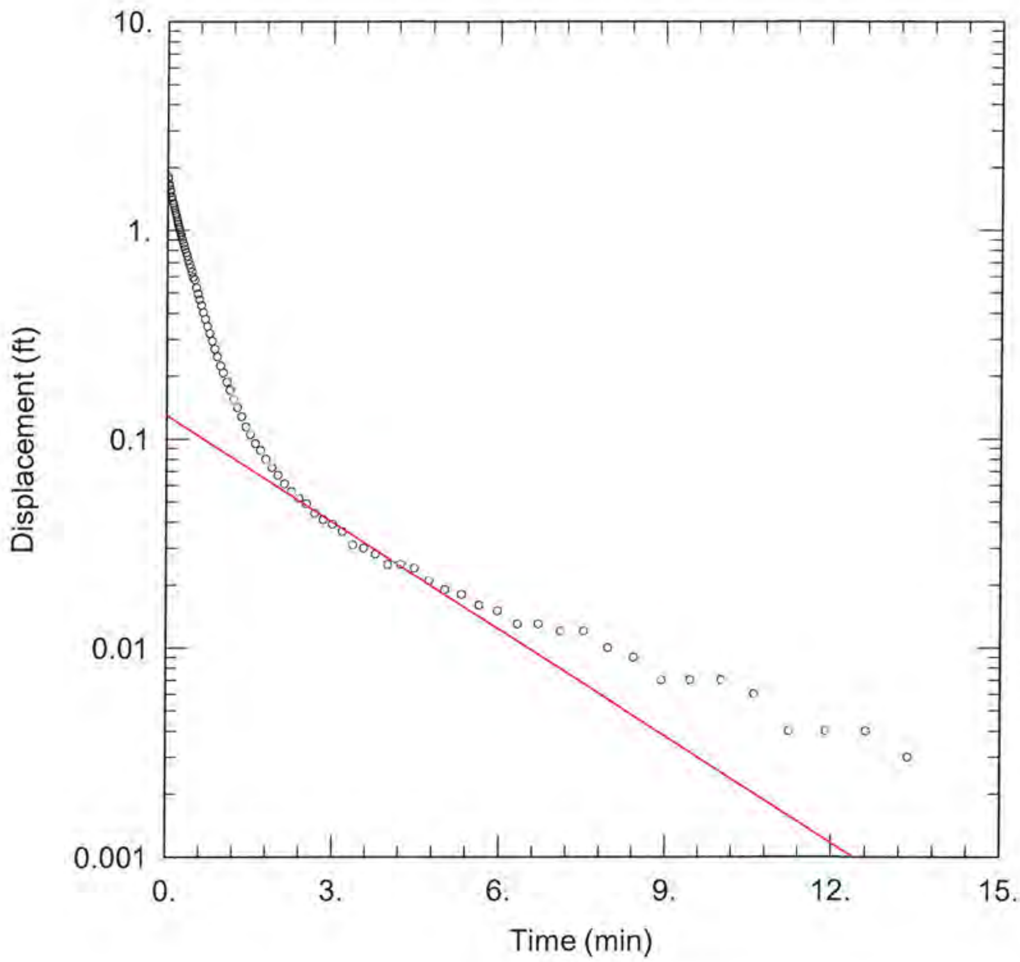
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.466

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00011	cm/sec
y0	0.057	ft

T = K*b = 0.1219 cm²/sec



OM07 RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM07rh.aqt
Date: 12/09/15 Time: 09:16:58

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM07
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 36.37 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM07)

Initial Displacement: 1.8 ft
Total Well Penetration Depth: 15.37 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 15.37 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.00024 cm/sec
y0 = 0.13 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM07rh.aqt
Title: OM07 Rising Head Test
Date: 12/09/15
Time: 09:16:59

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OM07

AQUIFER DATA

Saturated Thickness: 36.37 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM07

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.8 ft
Static Water Column Height: 15.37 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 15.37 ft

No. of Observations: 93

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0112	1.768	1.022	0.207
0.0223	1.673	1.081	0.187
0.0335	1.635	1.143	0.171
0.0447	1.568	1.21	0.155
0.0558	1.52	1.28	0.141
0.067	1.447	1.355	0.128
0.0782	1.432	1.434	0.114
0.0893	1.395	1.517	0.105
0.1005	1.352	1.606	0.095
0.1117	1.321	1.7	0.088
0.1228	1.279	1.799	0.08
0.134	1.254	1.904	0.073
0.1452	1.215	2.016	0.067
0.1563	1.188	2.134	0.061
0.1675	1.153	2.259	0.056
0.1787	1.117	2.392	0.052
0.1898	1.093	2.532	0.049
0.201	1.065	2.681	0.044
0.2122	1.035	2.838	0.041

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.2233	1.01	3.005	0.039
0.235	0.98	3.182	0.036
0.2475	0.95	3.369	0.031
0.2607	0.925	3.568	0.03
0.2747	0.897	3.778	0.028
0.2895	0.866	4.	0.025
0.3052	0.842	4.236	0.025
0.3218	0.811	4.486	0.024
0.3395	0.782	4.751	0.021
0.3582	0.753	5.031	0.019
0.378	0.721	5.328	0.018
0.399	0.687	5.643	0.016
0.4212	0.659	5.976	0.015
0.4447	0.629	6.329	0.013
0.4695	0.595	6.702	0.013
0.4958	0.579	7.098	0.012
0.5238	0.529	7.518	0.012
0.5535	0.495	7.962	0.01
0.5848	0.465	8.433	0.009
0.618	0.436	8.931	0.007
0.6532	0.404	9.459	0.007
0.6905	0.375	10.02	0.007
0.73	0.346	10.61	0.006
0.7718	0.32	11.24	0.004
0.8162	0.294	11.9	0.004
0.8632	0.269	12.61	0.004
0.913	0.247	13.35	0.003
0.9657	0.224		

SOLUTION

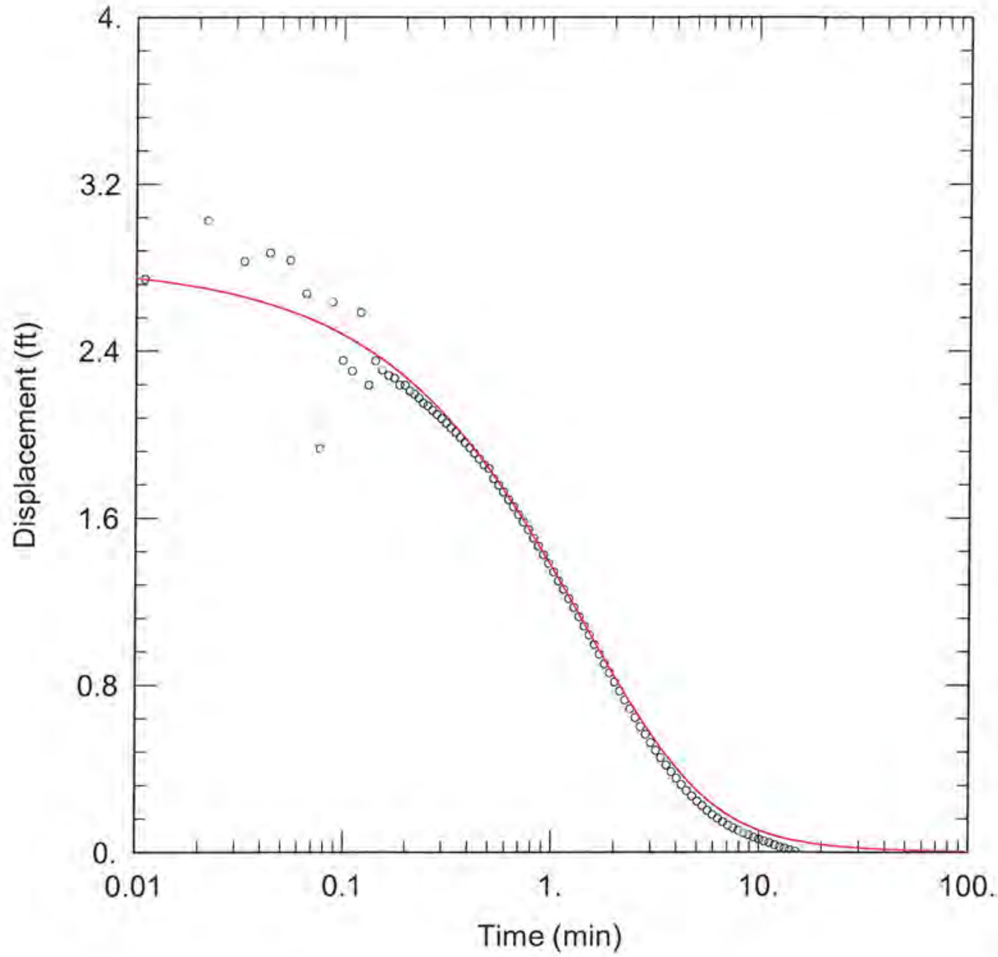
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.466

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00024	cm/sec
y0	0.13	ft

T = K*b = 0.2661 cm²/sec



OM09 FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM09fh.aqt
Date: 12/09/15 Time: 09:16:59

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM09
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 19.99 ft

WELL DATA (OM09)

Initial Displacement: 2.83 ft
Total Well Penetration Depth: 18.49 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 18.49 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

K_r = 0.00031 cm/sec
K_z/K_r = 1.

S_s = 0.001 ft^{-1}

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM09fh.aqt
Title: OM09 Falling Head Test
Date: 12/09/15
Time: 09:17:00

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OM09

AQUIFER DATA

Saturated Thickness: 19.99 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM09

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.83 ft
Static Water Column Height: 18.49 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 18.49 ft

No. of Observations: 96

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.011	2.744	1.029	1.34
0.022	3.024	1.088	1.298
0.033	2.828	1.151	1.257
0.044	2.869	1.217	1.213
0.055	2.834	1.288	1.17
0.066	2.674	1.362	1.126
0.077	1.931	1.441	1.081
0.088	2.633	1.525	1.038
0.099	2.354	1.613	0.992
0.11	2.302	1.707	0.947
0.121	2.583	1.807	0.901
0.132	2.235	1.912	0.858
0.143	2.351	2.023	0.813
0.154	2.308	2.142	0.77
0.165	2.281	2.267	0.727
0.176	2.269	2.399	0.685
0.187	2.236	2.54	0.643
0.198	2.235	2.688	0.6
0.209	2.208	2.846	0.563

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.22	2.192	3.013	0.524
0.231	2.174	3.19	0.487
0.2427	2.15	3.377	0.451
0.2552	2.137	3.575	0.416
0.2683	2.116	3.785	0.384
0.2823	2.096	4.008	0.353
0.2972	2.076	4.244	0.322
0.3128	2.055	4.494	0.293
0.3295	2.031	4.758	0.268
0.3472	2.01	5.039	0.243
0.3658	1.985	5.336	0.222
0.3857	1.961	5.65	0.198
0.4067	1.937	5.983	0.179
0.4288	1.909	6.336	0.16
0.4523	1.882	6.71	0.143
0.4772	1.854	7.106	0.128
0.5035	1.837	7.525	0.115
0.5315	1.787	7.97	0.103
0.5612	1.755	8.44	0.091
0.5925	1.723	8.939	0.082
0.6257	1.687	9.467	0.07
0.6608	1.653	10.03	0.06
0.6982	1.615	10.62	0.051
0.7377	1.58	11.25	0.043
0.7795	1.542	11.91	0.033
0.8238	1.502	12.62	0.024
0.8708	1.464	13.36	0.017
0.9207	1.423	14.15	0.009
0.9733	1.382	14.99	0.002

SOLUTION

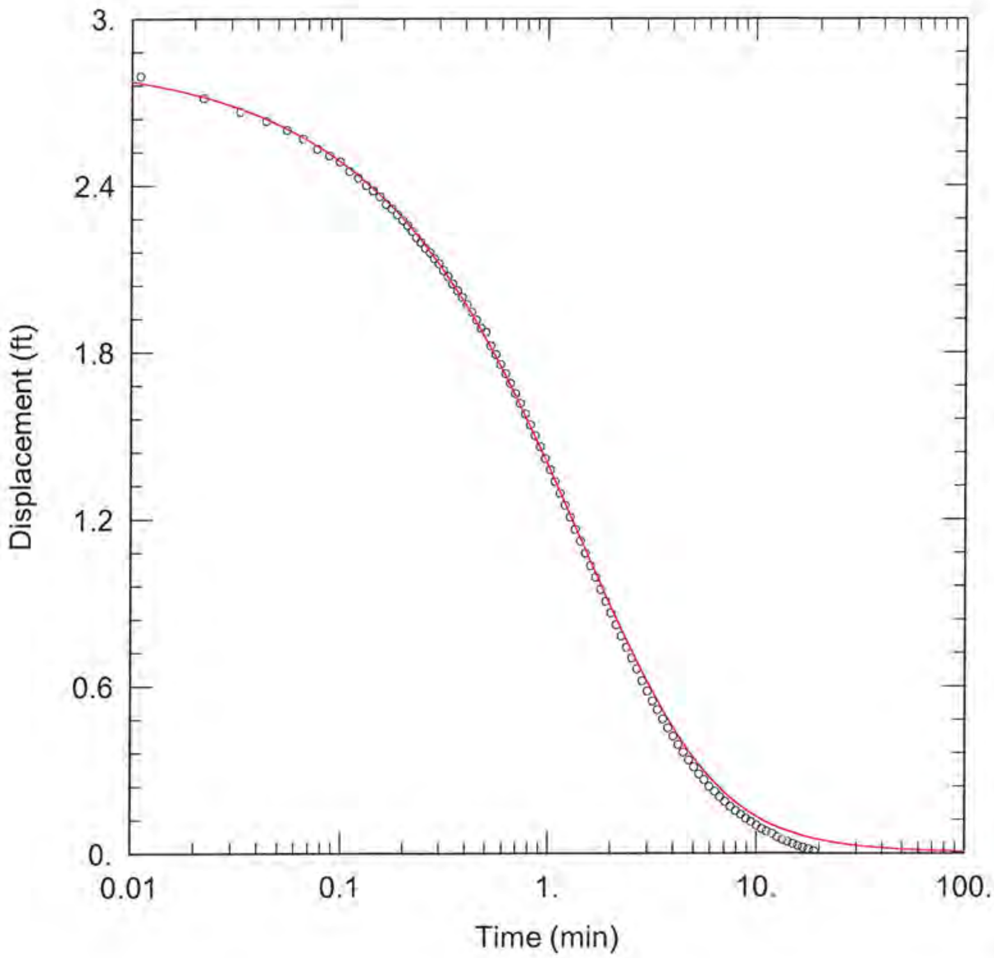
Slug Test
Aquifer Model: Unconfined
Solution Method: KGS Model

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
Kr	0.00031	cm/sec
Ss	0.001	ft^{-1}
Kz/Kr	1.	

T = K*b = 0.1889 cm^2/sec



OM09 RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM09rh.aqt
Date: 12/09/15 Time: 09:17:01

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM09
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 19.99 ft

WELL DATA (OM09)

Initial Displacement: 2.87 ft
Total Well Penetration Depth: 18.49 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 18.49 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Kr = 0.00026 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model
Ss = 0.002 ft^{-1}

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM09rh.aqt
Title: OM09 Rising Head Test
Date: 12/09/15
Time: 09:17:02

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OM09

AQUIFER DATA

Saturated Thickness: 19.99 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM09

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.87 ft
Static Water Column Height: 18.49 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 18.49 ft

No. of Observations: 100

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.011	2.792	1.151	1.292
0.022	2.713	1.217	1.249
0.033	2.664	1.288	1.206
0.044	2.631	1.362	1.163
0.055	2.598	1.441	1.12
0.066	2.567	1.525	1.077
0.077	2.531	1.613	1.032
0.088	2.506	1.707	0.99
0.099	2.485	1.807	0.946
0.11	2.45	1.912	0.904
0.121	2.426	2.023	0.862
0.132	2.399	2.142	0.819
0.143	2.38	2.267	0.779
0.154	2.359	2.399	0.739
0.165	2.332	2.54	0.699
0.176	2.316	2.688	0.66
0.187	2.295	2.846	0.618
0.198	2.274	3.013	0.581
0.209	2.256	3.19	0.545

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.22	2.235	3.377	0.514
0.231	2.212	3.575	0.481
0.2427	2.195	3.785	0.449
0.2552	2.174	4.008	0.419
0.2683	2.158	4.244	0.389
0.2823	2.136	4.494	0.361
0.2972	2.118	4.758	0.334
0.3128	2.094	5.039	0.309
0.3295	2.072	5.336	0.283
0.3472	2.045	5.65	0.263
0.3658	2.021	5.983	0.239
0.3857	1.997	6.336	0.221
0.4067	1.971	6.71	0.202
0.4288	1.944	7.106	0.184
0.4523	1.916	7.525	0.167
0.4772	1.886	7.97	0.151
0.5035	1.872	8.44	0.138
0.5315	1.822	8.939	0.124
0.5612	1.791	9.467	0.112
0.5925	1.756	10.03	0.099
0.6257	1.722	10.62	0.087
0.6608	1.688	11.25	0.078
0.6982	1.651	11.91	0.069
0.7377	1.615	12.62	0.057
0.7795	1.578	13.36	0.048
0.8238	1.538	14.15	0.041
0.8708	1.499	14.99	0.033
0.9207	1.459	15.87	0.026
0.9733	1.417	16.81	0.02
1.029	1.377	17.81	0.014
1.088	1.334	18.86	0.007

SOLUTION

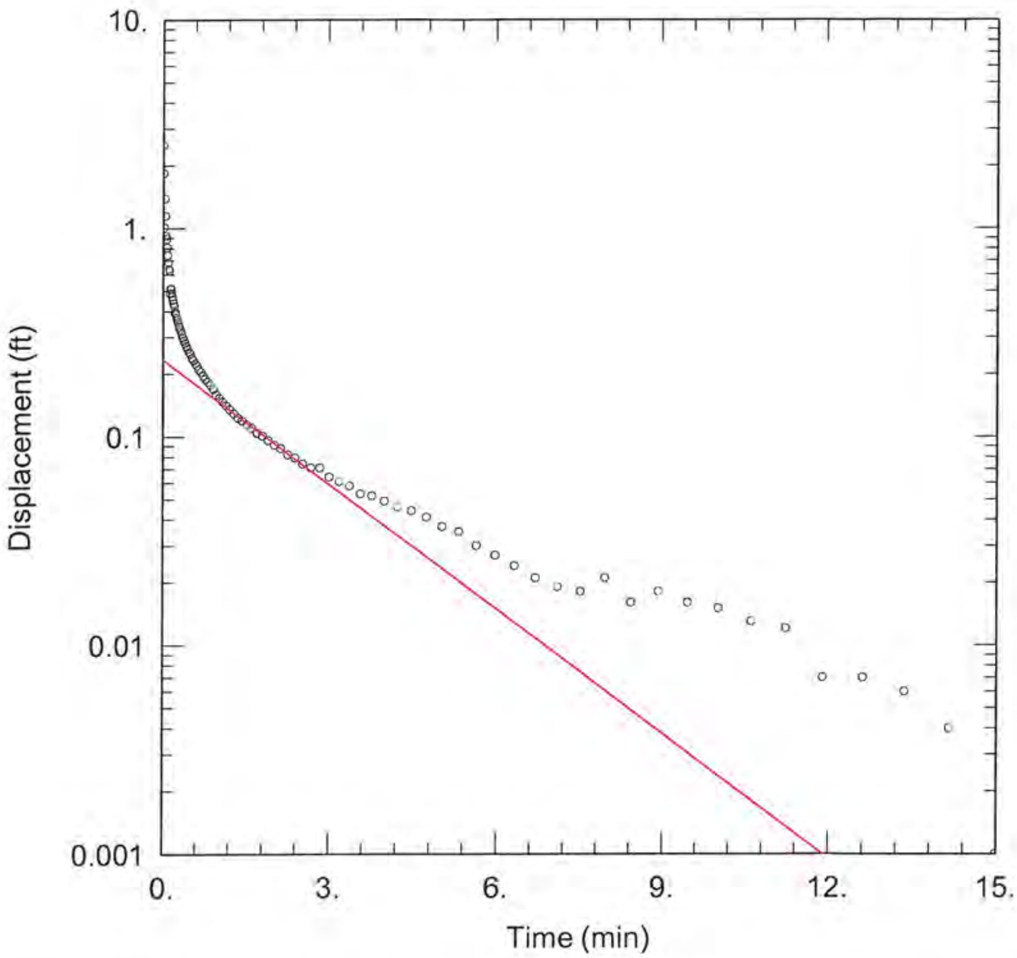
Slug Test
Aquifer Model: Unconfined
Solution Method: KGS Model

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
Kr	0.00026	cm/sec
Ss	0.002	ft^{-1}
Kz/Kr	1.	

T = K*b = 0.1584 cm^2/sec



OM21 FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM21fh.aqt
Date: 12/09/15 Time: 09:17:03

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM21
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 51.03 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM21)

Initial Displacement: 2.5 ft
Total Well Penetration Depth: 49.73 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 49.73 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00035 cm/sec
y0 = 0.235 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM21fh.aqt
Title: OM21 Falling Head Test
Date: 12/09/15
Time: 09:17:03

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OM21

AQUIFER DATA

Saturated Thickness: 51.03 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM21

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.5 ft
Static Water Column Height: 49.73 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 49.73 ft

No. of Observations: 96

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.011	1.838	1.029	0.153
0.022	1.012	1.088	0.147
0.033	1.387	1.151	0.141
0.044	1.149	1.217	0.135
0.055	0.918	1.288	0.129
0.066	0.891	1.362	0.123
0.077	0.81	1.441	0.119
0.088	0.743	1.525	0.114
0.099	0.687	1.613	0.11
0.11	0.638	1.707	0.104
0.121	0.625	1.807	0.101
0.132	0.489	1.912	0.096
0.143	0.512	2.023	0.091
0.154	0.513	2.142	0.088
0.165	0.491	2.267	0.082
0.176	0.47	2.399	0.079
0.187	0.454	2.54	0.074
0.198	0.437	2.688	0.071
0.209	0.422	2.846	0.071

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.22	0.393	3.013	0.064
0.231	0.397	3.19	0.061
0.2427	0.384	3.377	0.058
0.2552	0.373	3.575	0.053
0.2683	0.363	3.785	0.052
0.2823	0.353	4.008	0.049
0.2972	0.339	4.244	0.046
0.3128	0.329	4.494	0.044
0.3295	0.32	4.758	0.041
0.3472	0.311	5.039	0.037
0.3658	0.299	5.336	0.035
0.3857	0.29	5.65	0.03
0.4067	0.281	5.983	0.027
0.4288	0.272	6.336	0.024
0.4523	0.263	6.71	0.021
0.4772	0.254	7.106	0.019
0.5035	0.25	7.525	0.018
0.5315	0.239	7.97	0.021
0.5612	0.232	8.44	0.016
0.5925	0.225	8.939	0.018
0.6257	0.219	9.467	0.016
0.6608	0.21	10.03	0.015
0.6982	0.204	10.62	0.013
0.7377	0.196	11.25	0.012
0.7795	0.189	11.91	0.007
0.8238	0.183	12.62	0.007
0.8708	0.177	13.36	0.006
0.9207	0.169	14.15	0.004
0.9733	0.159	14.99	0.001

SOLUTION

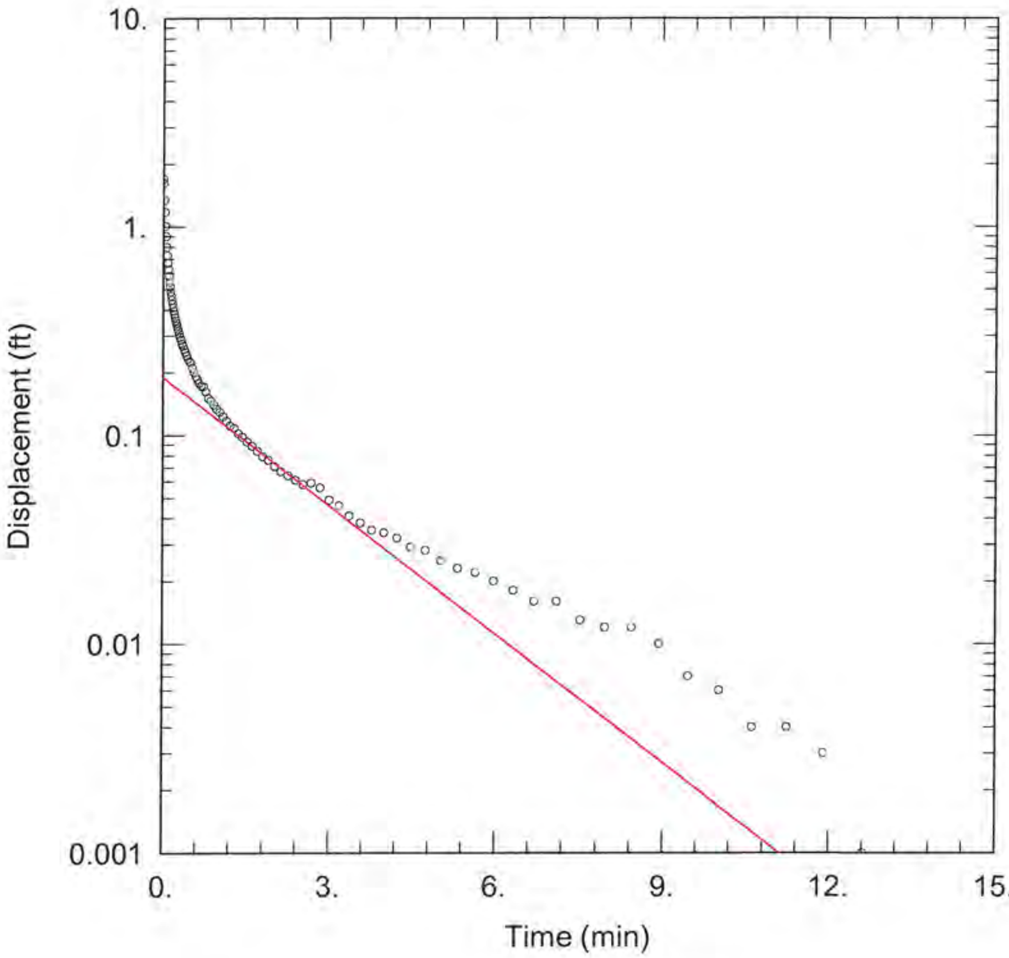
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.329

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00035	cm/sec
y0	0.235	ft

T = K*b = 0.5444 cm^2/sec



OM21 RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM21rh.aqt
Date: 12/09/15 Time: 09:17:04

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM21
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 51.03 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM21)

Initial Displacement: 1.7 ft
Total Well Penetration Depth: 49.73 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 49.73 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.00036 cm/sec
y0 = 0.19 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM21rh.aqt
Title: OM21 Rising Head Test
Date: 12/09/15
Time: 09:17:05

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OM21

AQUIFER DATA

Saturated Thickness: 51.03 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM21

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.7 ft
Static Water Column Height: 49.73 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 49.73 ft

No. of Observations: 93

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.011	1.623	0.9733	0.134
0.022	1.343	1.029	0.129
0.033	1.177	1.088	0.123
0.044	1.007	1.151	0.117
0.055	0.9	1.217	0.111
0.066	0.802	1.288	0.108
0.077	0.727	1.362	0.102
0.088	0.669	1.441	0.098
0.099	0.625	1.525	0.093
0.11	0.58	1.613	0.089
0.121	0.544	1.707	0.084
0.132	0.515	1.807	0.079
0.143	0.488	1.912	0.076
0.154	0.466	2.023	0.071
0.165	0.446	2.142	0.067
0.176	0.427	2.267	0.064
0.187	0.41	2.399	0.061
0.198	0.394	2.54	0.058
0.209	0.381	2.688	0.059

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.22	0.369	2.846	0.056
0.231	0.355	3.013	0.049
0.2427	0.346	3.19	0.046
0.2552	0.336	3.377	0.041
0.2683	0.324	3.575	0.038
0.2823	0.315	3.785	0.035
0.2972	0.306	4.008	0.034
0.3128	0.296	4.244	0.032
0.3295	0.287	4.494	0.029
0.3472	0.275	4.758	0.028
0.3658	0.268	5.039	0.025
0.3857	0.259	5.336	0.023
0.4067	0.251	5.65	0.022
0.4288	0.241	5.983	0.02
0.4523	0.233	6.336	0.018
0.4772	0.226	6.71	0.016
0.5035	0.223	7.106	0.016
0.5315	0.21	7.525	0.013
0.5612	0.201	7.97	0.012
0.5925	0.192	8.44	0.012
0.6257	0.186	8.939	0.01
0.6608	0.178	9.467	0.007
0.6982	0.172	10.03	0.006
0.7377	0.171	10.62	0.004
0.7795	0.162	11.25	0.004
0.8238	0.151	11.91	0.003
0.8708	0.146	12.62	0.001
0.9207	0.14		

SOLUTION

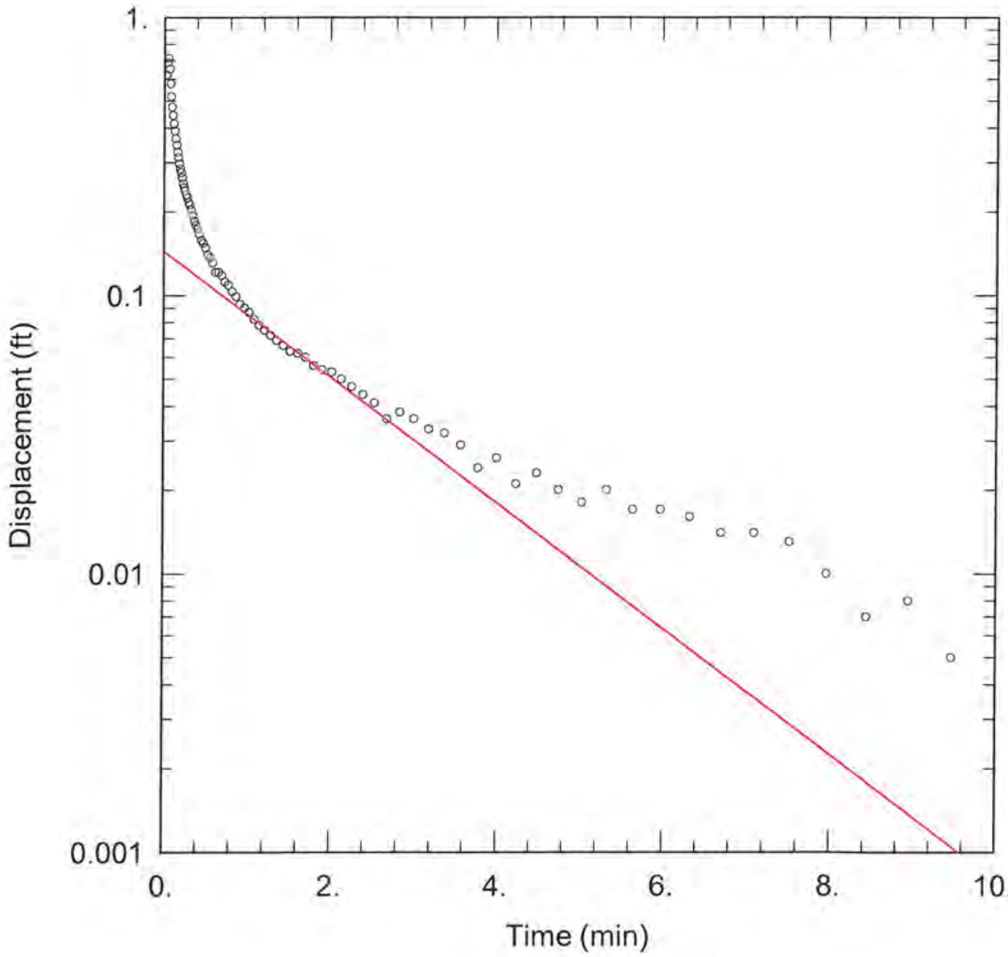
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.329

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00036	cm/sec
y0	0.19	ft

T = K*b = 0.5599 cm^2/sec



OR02 FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR02fh.aqt
Date: 12/09/15 Time: 09:17:36

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR02
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 18.87 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR02)

Initial Displacement: 1.45 ft
Total Well Penetration Depth: 18.09 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 18.09 ft
Screen Length: 9.49 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00037 cm/sec
y0 = 0.145 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR02fh.aqt
Title: OR02 Falling Head Test
Date: 12/09/15
Time: 09:17:36

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OR02

AQUIFER DATA

Saturated Thickness: 18.87 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR02

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.45 ft
Static Water Column Height: 18.09 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.49 ft
Total Well Penetration Depth: 18.09 ft

No. of Observations: 89

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.011	1.431	0.8708	0.099
0.022	1.163	0.9207	0.093
0.033	0.622	0.9733	0.09
0.044	0.687	1.029	0.087
0.055	0.713	1.088	0.082
0.066	0.653	1.151	0.078
0.077	0.577	1.217	0.075
0.088	0.519	1.288	0.072
0.099	0.476	1.362	0.069
0.11	0.444	1.441	0.066
0.121	0.415	1.525	0.063
0.132	0.39	1.613	0.062
0.143	0.366	1.707	0.06
0.154	0.347	1.807	0.056
0.165	0.328	1.912	0.054
0.176	0.313	2.023	0.053
0.187	0.298	2.142	0.05
0.198	0.285	2.267	0.047
0.209	0.277	2.399	0.044

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.22	0.265	2.54	0.041
0.231	0.252	2.688	0.036
0.2427	0.244	2.846	0.038
0.2552	0.238	3.013	0.036
0.2683	0.23	3.19	0.033
0.2823	0.224	3.377	0.032
0.2972	0.216	3.575	0.029
0.3128	0.212	3.785	0.024
0.3295	0.203	4.008	0.026
0.3472	0.194	4.244	0.021
0.3658	0.185	4.494	0.023
0.3857	0.179	4.758	0.02
0.4067	0.173	5.039	0.018
0.4288	0.166	5.336	0.02
0.4523	0.158	5.65	0.017
0.4772	0.154	5.983	0.017
0.5035	0.148	6.336	0.016
0.5315	0.14	6.71	0.014
0.5612	0.137	7.106	0.014
0.5925	0.131	7.525	0.013
0.6257	0.121	7.97	0.01
0.6608	0.121	8.44	0.007
0.6982	0.118	8.939	0.008
0.7377	0.112	9.467	0.005
0.7795	0.109	10.03	0.004
0.8238	0.103		

SOLUTION

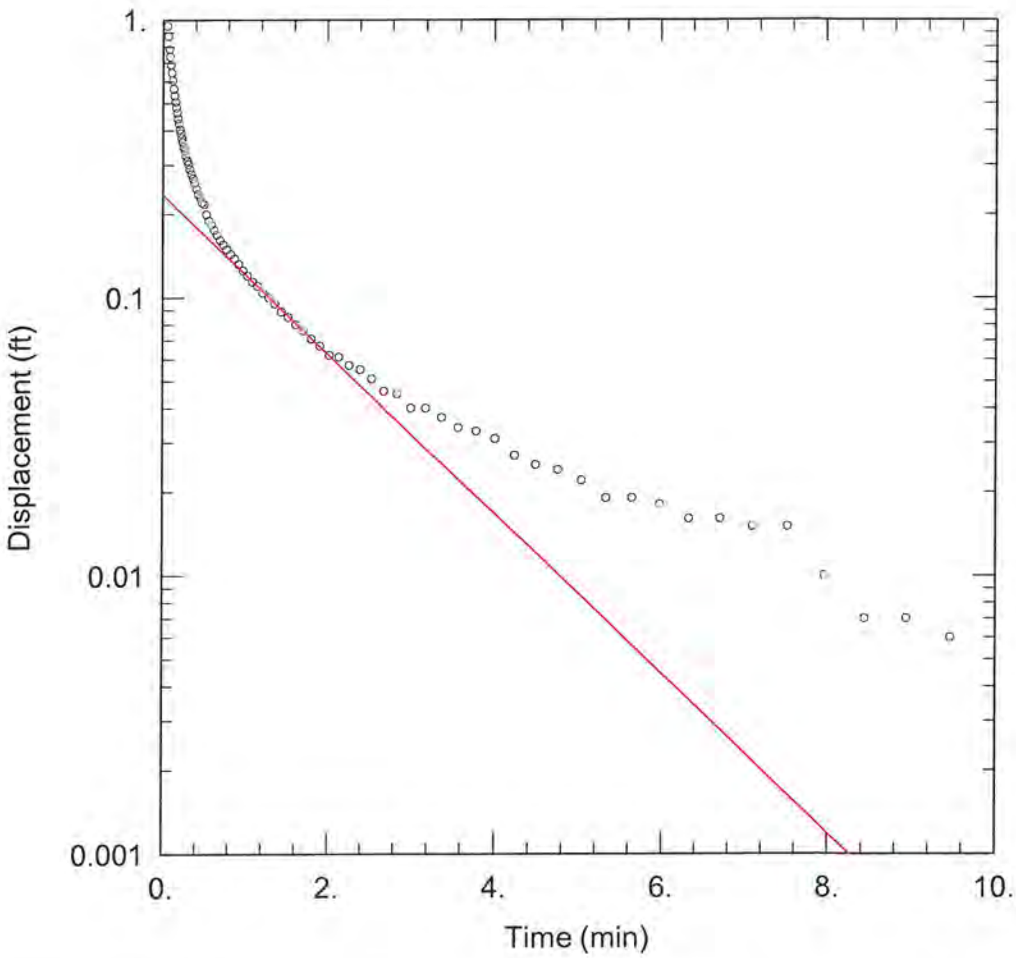
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.827

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00037	cm/sec
y0	0.145	ft

T = K*b = 0.2128 cm^2/sec



OR02 RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR02rh.aqt
Date: 12/09/15 Time: 09:17:37

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR02
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 18.87 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR02)

Initial Displacement: 1.75 ft
Total Well Penetration Depth: 18.09 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 18.09 ft
Screen Length: 9.49 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00047 cm/sec
y0 = 0.235 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR02rh.aqt
Title: OR02 Rising Head Test
Date: 12/09/15
Time: 09:17:38

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OR02

AQUIFER DATA

Saturated Thickness: 18.87 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR02

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.75 ft
Static Water Column Height: 18.09 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.49 ft
Total Well Penetration Depth: 18.09 ft

No. of Observations: 92

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.011	1.523	0.9207	0.132
0.022	1.346	0.9733	0.125
0.033	1.19	1.029	0.12
0.044	1.071	1.088	0.114
0.055	0.951	1.151	0.11
0.066	0.874	1.217	0.104
0.077	0.785	1.288	0.1
0.088	0.739	1.362	0.095
0.099	0.69	1.441	0.089
0.11	0.645	1.525	0.085
0.121	0.605	1.613	0.08
0.132	0.566	1.707	0.076
0.143	0.534	1.807	0.071
0.154	0.507	1.912	0.067
0.165	0.483	2.023	0.062
0.176	0.464	2.142	0.061
0.187	0.441	2.267	0.057
0.198	0.424	2.399	0.055
0.209	0.404	2.54	0.051

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.22	0.391	2.688	0.046
0.231	0.375	2.846	0.045
0.2427	0.363	3.013	0.04
0.2552	0.349	3.19	0.04
0.2683	0.337	3.377	0.037
0.2823	0.324	3.575	0.034
0.2972	0.311	3.785	0.033
0.3128	0.302	4.008	0.031
0.3295	0.29	4.244	0.027
0.3472	0.279	4.494	0.025
0.3658	0.269	4.758	0.024
0.3857	0.259	5.039	0.022
0.4067	0.247	5.336	0.019
0.4288	0.236	5.65	0.019
0.4523	0.229	5.983	0.018
0.4772	0.22	6.336	0.016
0.5035	0.217	6.71	0.016
0.5315	0.199	7.106	0.015
0.5612	0.189	7.525	0.015
0.5925	0.183	7.97	0.01
0.6257	0.175	8.44	0.007
0.6608	0.168	8.939	0.007
0.6982	0.161	9.467	0.006
0.7377	0.155	10.03	0.006
0.7795	0.149	10.62	0.006
0.8238	0.143	11.25	0.006
0.8708	0.138	11.91	0.002

SOLUTION

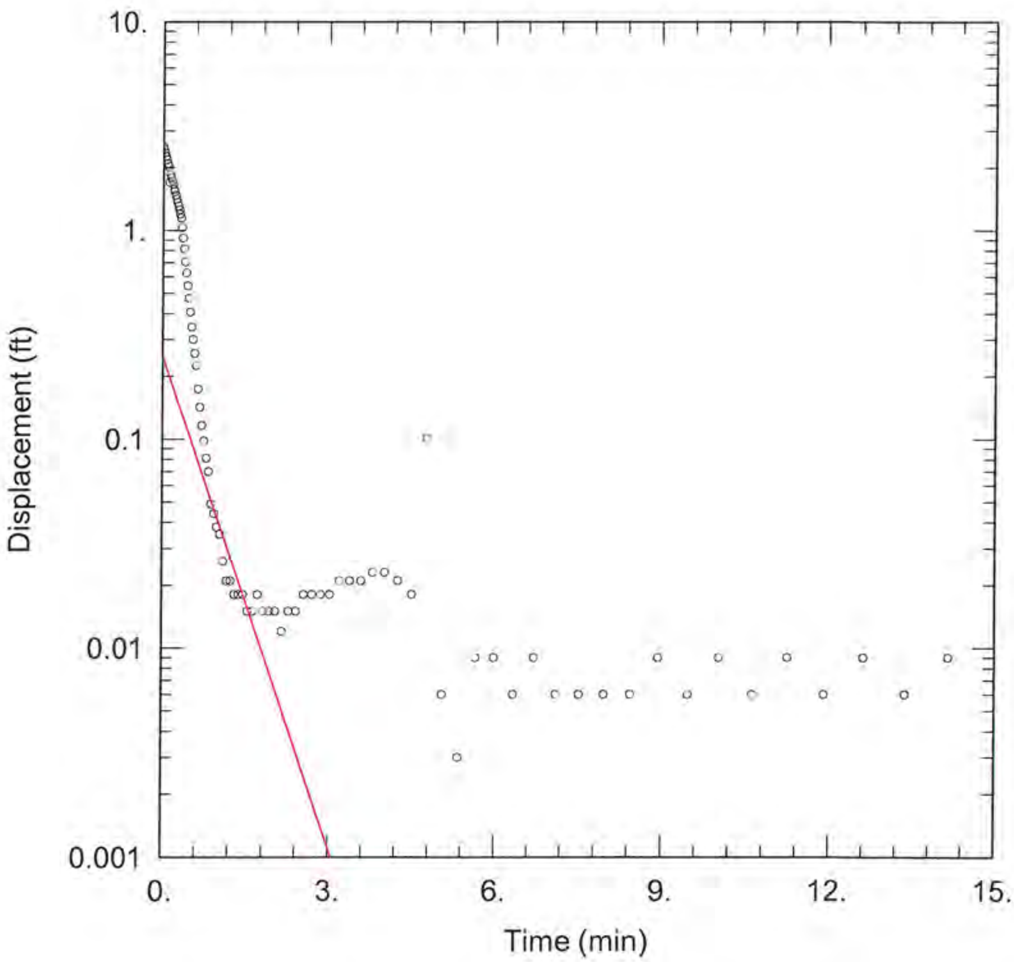
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.827

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00047	cm/sec
y0	0.235	ft

T = K*b = 0.2703 cm²/sec



OR03D FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR03Dfh.aqt
Date: 12/09/15 Time: 09:17:39

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR03D
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 34.69 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR03D)

Initial Displacement: 2.5 ft
Total Well Penetration Depth: 35.7 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 35.7 ft
Screen Length: 9.48 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.0015 cm/sec
y0 = 0.25 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR03Dfh.aqt
Title: OR03D Falling Head Test
Date: 12/09/15
Time: 09:17:39

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OR03D

AQUIFER DATA

Saturated Thickness: 34.69 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR03D

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.5 ft
Static Water Column Height: 35.7 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.48 ft
Total Well Penetration Depth: 35.7 ft

No. of Observations: 91

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0163	2.445	1.376	0.018
0.0327	2.352	1.455	0.018
0.049	2.263	1.539	0.015
0.0653	2.179	1.627	0.015
0.0817	2.093	1.721	0.018
0.098	2.015	1.82	0.015
0.1143	1.7	1.926	0.015
0.1307	1.856	2.037	0.015
0.147	1.792	2.155	0.012
0.1633	1.726	2.281	0.015
0.1797	1.66	2.413	0.015
0.196	1.57	2.554	0.018
0.2123	1.536	2.702	0.018
0.2287	1.472	2.86	0.018
0.245	1.414	3.027	0.018
0.2613	1.359	3.204	0.021
0.2777	1.308	3.391	0.021
0.294	1.253	3.589	0.021
0.3103	1.198	3.799	0.023

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.3267	1.146	4.022	0.023
0.3433	1.033	4.258	0.021
0.361	0.918	4.508	0.018
0.3797	0.814	4.772	0.101
0.3995	0.707	5.053	0.006
0.4205	0.626	5.349	0.003
0.4427	0.543	5.664	0.009
0.4662	0.474	5.997	0.009
0.491	0.407	6.35	0.006
0.5173	0.344	6.724	0.009
0.5453	0.3	7.12	0.006
0.575	0.257	7.539	0.006
0.6063	0.225	7.984	0.006
0.6395	0.174	8.454	0.006
0.6747	0.142	8.953	0.009
0.712	0.116	9.481	0.006
0.7515	0.098	10.04	0.009
0.7933	0.081	10.63	0.006
0.8377	0.07	11.26	0.009
0.8847	0.049	11.92	0.006
0.9345	0.044	12.63	0.009
0.9872	0.038	13.37	0.006
1.043	0.035	14.16	0.009
1.102	0.026	15.	0.006
1.165	0.021	15.89	0.006
1.231	0.021	16.83	0.006
1.302	0.018		

SOLUTION

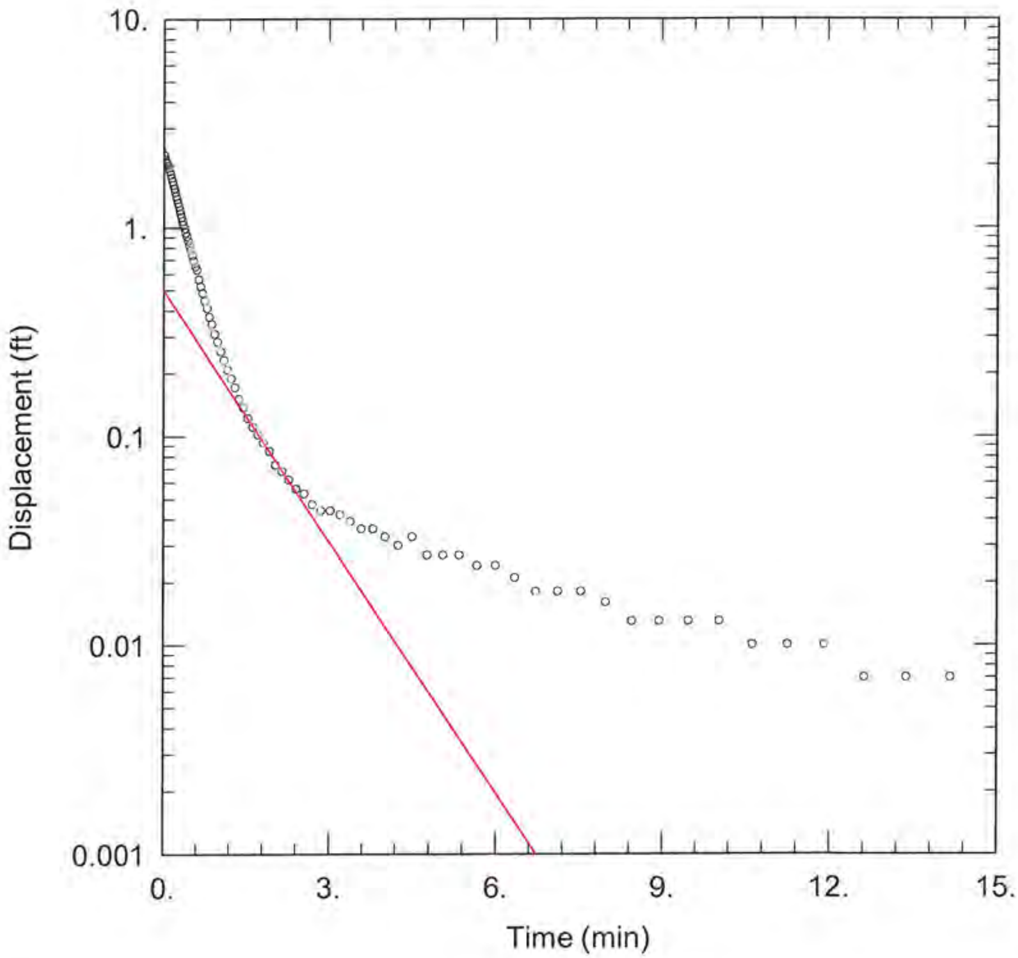
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.479

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0015	cm/sec
y0	0.25	ft

T = K*b = 1.586 cm²/sec



OR03D RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR03Drh.aqt
Date: 12/09/15 Time: 09:17:40

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR03D
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 34.69 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR03D)

Initial Displacement: 2.25 ft
Total Well Penetration Depth: 35.7 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 35.7 ft
Screen Length: 9.48 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00077 cm/sec
y0 = 0.5 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR03Drh.aqt
Title: OR03D Rising Head Test
Date: 12/09/15
Time: 09:17:41

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OR03D

AQUIFER DATA

Saturated Thickness: 34.69 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR03D

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.25 ft
Static Water Column Height: 35.7 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.48 ft
Total Well Penetration Depth: 35.7 ft

No. of Observations: 88

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0163	2.222	1.231	0.189
0.0327	2.13	1.302	0.171
0.049	2.066	1.376	0.151
0.0653	2.035	1.455	0.137
0.0817	1.988	1.539	0.122
0.098	1.934	1.627	0.111
0.1143	1.87	1.721	0.102
0.1307	1.801	1.82	0.093
0.147	1.735	1.926	0.085
0.1633	1.668	2.037	0.073
0.1797	1.602	2.155	0.068
0.196	1.541	2.281	0.062
0.2123	1.481	2.413	0.056
0.2287	1.42	2.554	0.053
0.245	1.368	2.702	0.047
0.2613	1.316	2.86	0.044
0.2777	1.265	3.027	0.044
0.294	1.216	3.204	0.042
0.3103	1.169	3.391	0.039

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.3267	1.123	3.589	0.036
0.3433	1.077	3.799	0.036
0.361	1.034	4.022	0.033
0.3797	0.993	4.258	0.03
0.3995	0.95	4.508	0.033
0.4205	0.91	4.772	0.027
0.4427	0.864	5.053	0.027
0.4662	0.823	5.349	0.027
0.491	0.78	5.664	0.024
0.5173	0.737	5.997	0.024
0.5453	0.693	6.35	0.021
0.575	0.653	6.724	0.018
0.6063	0.627	7.12	0.018
0.6395	0.564	7.539	0.018
0.6747	0.523	7.984	0.016
0.712	0.486	8.454	0.013
0.7515	0.445	8.953	0.013
0.7933	0.411	9.481	0.013
0.8377	0.373	10.04	0.013
0.8847	0.344	10.63	0.01
0.9345	0.31	11.26	0.01
0.9872	0.284	11.92	0.01
1.043	0.255	12.63	0.007
1.102	0.232	13.37	0.007
1.165	0.209	14.16	0.007

SOLUTION

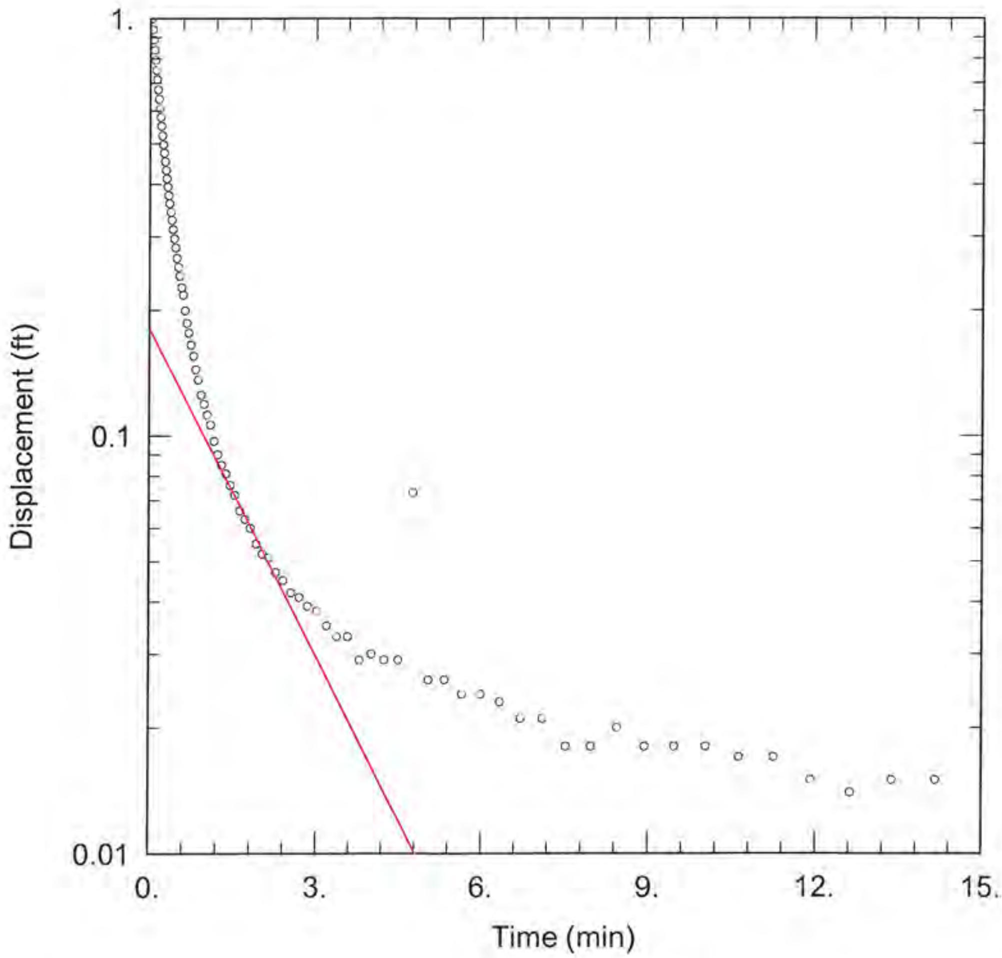
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.479

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00077	cm/sec
y0	0.5	ft

$T = K^*b = 0.8142\ cm^2/sec$



OR03S FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR03Sfh.aqt
Date: 12/09/15 Time: 09:17:42

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR03S
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 34.49 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR03S)

Initial Displacement: 1.1 ft
Total Well Penetration Depth: 16.78 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 16.78 ft
Screen Length: 9.5 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00039 cm/sec
y0 = 0.18 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR03Sfh.aqt
Title: OR03S Falling Head Test
Date: 12/09/15
Time: 09:17:42

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OR03S

AQUIFER DATA

Saturated Thickness: 34.49 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR03S

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.1 ft
Static Water Column Height: 16.78 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.5 ft
Total Well Penetration Depth: 16.78 ft

No. of Observations: 91

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0163	1.06	1.376	0.081
0.0327	0.998	1.455	0.076
0.049	0.94	1.539	0.072
0.0653	0.887	1.627	0.066
0.0817	0.839	1.721	0.063
0.098	0.793	1.82	0.06
0.1143	0.751	1.926	0.055
0.1307	0.713	2.037	0.052
0.147	0.674	2.155	0.051
0.1633	0.64	2.281	0.047
0.1797	0.608	2.413	0.045
0.196	0.579	2.554	0.042
0.2123	0.551	2.702	0.041
0.2287	0.523	2.86	0.039
0.245	0.498	3.027	0.038
0.2613	0.475	3.204	0.035
0.2777	0.453	3.391	0.033
0.294	0.432	3.589	0.033
0.3103	0.413	3.799	0.029

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.3267	0.394	4.022	0.03
0.3433	0.376	4.258	0.029
0.361	0.36	4.508	0.029
0.3797	0.343	4.772	0.073
0.3995	0.328	5.053	0.026
0.4205	0.312	5.349	0.026
0.4427	0.296	5.664	0.024
0.4662	0.282	5.997	0.024
0.491	0.266	6.35	0.023
0.5173	0.253	6.724	0.021
0.5453	0.241	7.12	0.021
0.575	0.226	7.539	0.018
0.6063	0.217	7.984	0.018
0.6395	0.199	8.454	0.02
0.6747	0.186	8.953	0.018
0.712	0.176	9.481	0.018
0.7515	0.165	10.04	0.018
0.7933	0.155	10.63	0.017
0.8377	0.144	11.26	0.017
0.8847	0.136	11.92	0.015
0.9345	0.125	12.63	0.014
0.9872	0.119	13.37	0.015
1.043	0.112	14.16	0.015
1.102	0.106	15.	0.012
1.165	0.097	15.89	0.009
1.231	0.09	16.83	0.008
1.302	0.085		

SOLUTION

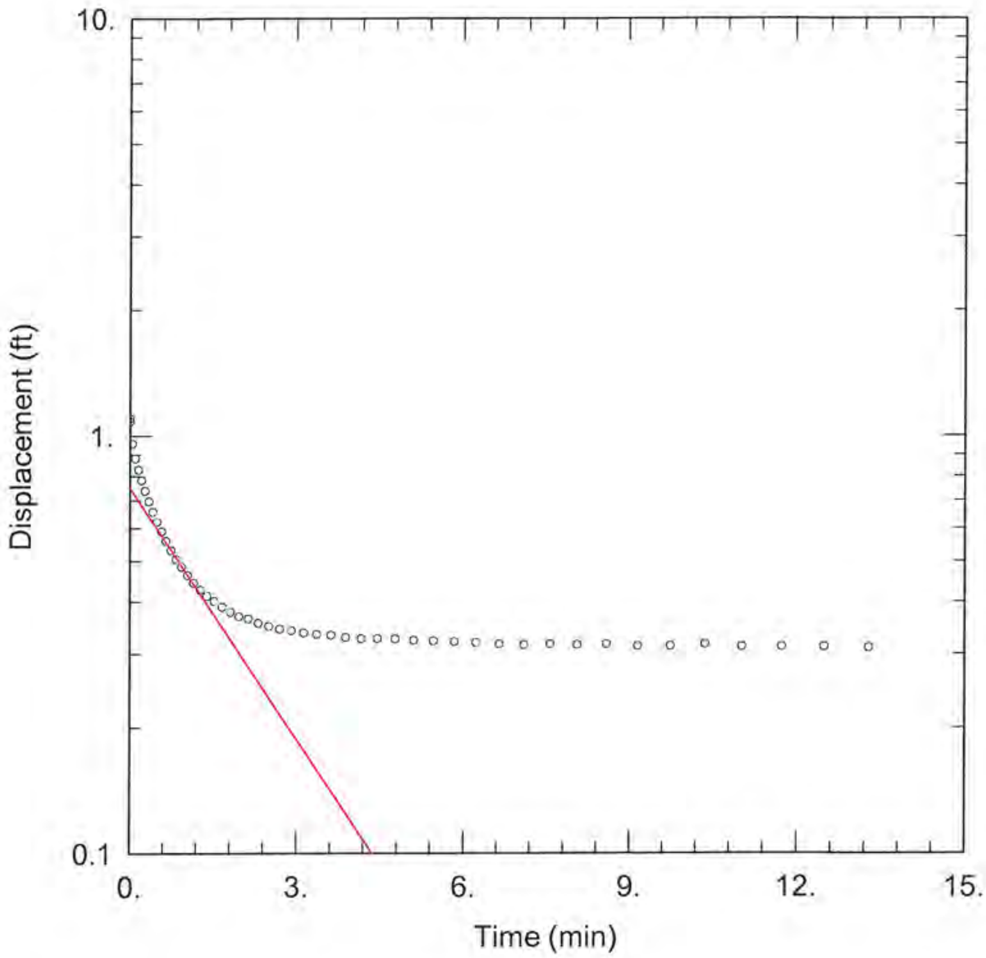
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.502

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00039	cm/sec
y0	0.18	ft

T = K*b = 0.41 cm^2/sec



OR03S RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR03Srh.aqt
Date: 12/09/15 Time: 09:17:43

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR03S
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 34.49 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR03S)

Initial Displacement: 1.1 ft
Total Well Penetration Depth: 16.78 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 16.78 ft
Screen Length: 9.5 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0003 cm/sec
y0 = 0.75 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR03Srh.aqt
Title: OR03S Rising Head Test
Date: 12/09/15
Time: 09:17:44

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OR03S

AQUIFER DATA

Saturated Thickness: 34.49 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR03S

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.1 ft
Static Water Column Height: 16.78 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.5 ft
Total Well Penetration Depth: 16.78 ft

No. of Observations: 50

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0001	1.082	2.705	0.344
0.0499	0.956	2.915	0.341
0.1026	0.881	3.137	0.337
0.1584	0.829	3.373	0.334
0.2176	0.782	3.623	0.332
0.2802	0.737	3.888	0.328
0.3466	0.696	4.168	0.326
0.4169	0.657	4.465	0.326
0.4914	0.622	4.779	0.325
0.5704	0.589	5.113	0.323
0.6541	0.559	5.465	0.322
0.7426	0.531	5.839	0.321
0.8364	0.506	6.235	0.319
0.9357	0.485	6.655	0.316
1.041	0.463	7.099	0.315
1.153	0.444	7.57	0.316
1.271	0.427	8.068	0.315
1.396	0.413	8.596	0.316
1.528	0.401	9.155	0.313

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
1.669	0.389	9.748	0.313
1.818	0.378	10.38	0.316
1.975	0.369	11.04	0.312
2.142	0.364	11.74	0.312
2.319	0.355	12.49	0.312
2.506	0.349	13.28	0.31

SOLUTION

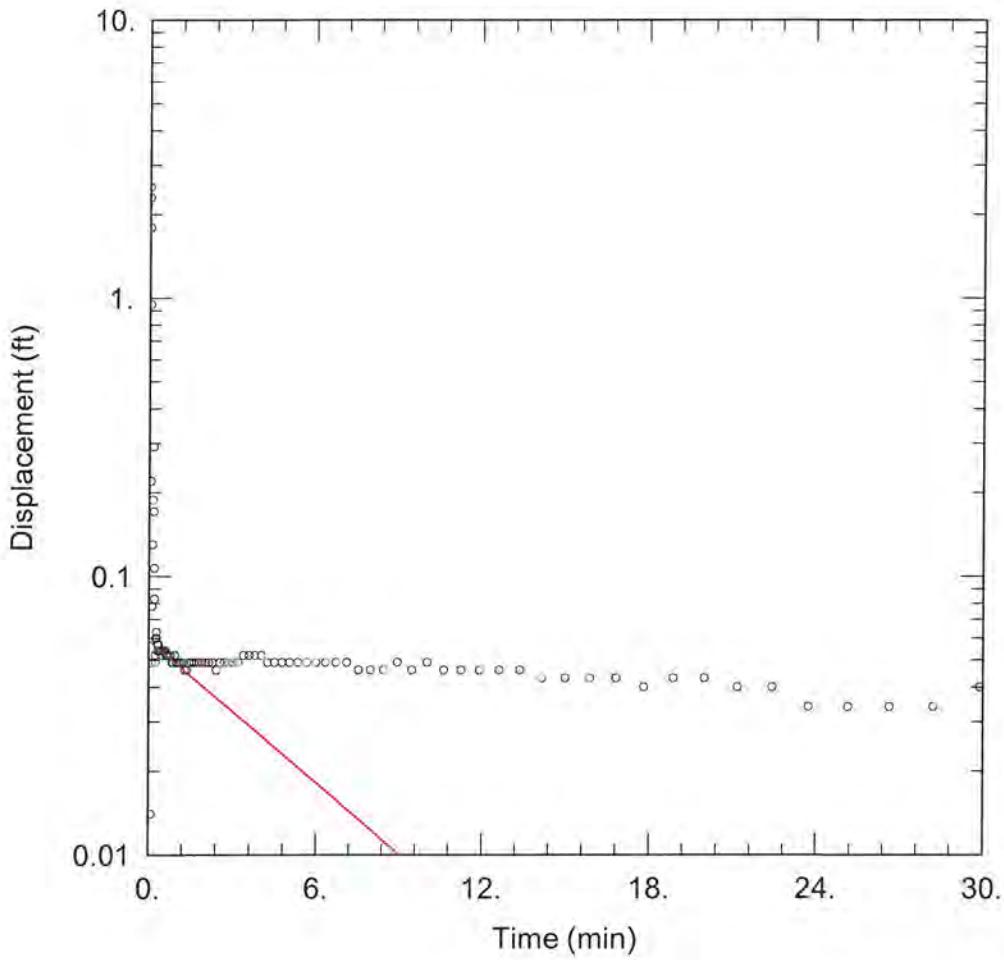
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.502

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0003	cm/sec
y0	0.75	ft

T = K*b = 0.3154 cm^2/sec



OR04D FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR04Dfh.aqt
Date: 12/09/15 Time: 09:17:45

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR04D
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 48.72 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR04D)

Initial Displacement: 2.5 ft
Total Well Penetration Depth: 47.72 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 47.72 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.00015 cm/sec
y0 = 0.059 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR04Dfh.aqt
Title: OR04D Falling Head Test
Date: 12/09/15
Time: 09:17:45

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OR04D

AQUIFER DATA

Saturated Thickness: 48.72 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR04D

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.5 ft
Static Water Column Height: 47.72 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 47.72 ft

No. of Observations: 102

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0165	2.292	1.824	0.049
0.033	1.793	1.929	0.049
0.0495	0.948	2.041	0.049
0.066	0.22	2.159	0.049
0.0825	0.014	2.284	0.049
0.099	0.049	2.416	0.046
0.1155	0.078	2.557	0.049
0.132	0.13	2.706	0.049
0.1485	0.188	2.863	0.049
0.165	0.292	3.03	0.049
0.1815	0.171	3.207	0.049
0.198	0.107	3.394	0.052
0.2145	0.083	3.592	0.052
0.231	0.052	3.803	0.052
0.2475	0.049	4.025	0.052
0.264	0.06	4.261	0.049
0.2805	0.063	4.511	0.049
0.297	0.06	4.776	0.049
0.3135	0.057	5.056	0.049

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.33	0.054	5.353	0.049
0.3467	0.057	5.667	0.049
0.3643	0.057	6.	0.049
0.383	0.054	6.353	0.049
0.4028	0.054	6.727	0.049
0.4238	0.054	7.123	0.049
0.446	0.054	7.543	0.046
0.4695	0.054	7.987	0.046
0.4943	0.052	8.457	0.046
0.5207	0.054	8.956	0.049
0.5487	0.054	9.484	0.046
0.5783	0.054	10.04	0.049
0.6097	0.054	10.64	0.046
0.6428	0.052	11.26	0.046
0.678	0.052	11.93	0.046
0.7153	0.052	12.63	0.046
0.7548	0.052	13.38	0.046
0.7967	0.052	14.17	0.043
0.841	0.049	15.01	0.043
0.888	0.049	15.89	0.043
0.9378	0.052	16.83	0.043
0.9905	0.049	17.83	0.04
1.046	0.049	18.88	0.043
1.105	0.049	19.99	0.043
1.168	0.049	21.18	0.04
1.234	0.049	22.43	0.04
1.305	0.046	23.76	0.034
1.379	0.046	25.16	0.034
1.458	0.049	26.65	0.034
1.542	0.049	28.23	0.034
1.631	0.049	29.9	0.04
1.724	0.049	31.66	0.037

SOLUTION

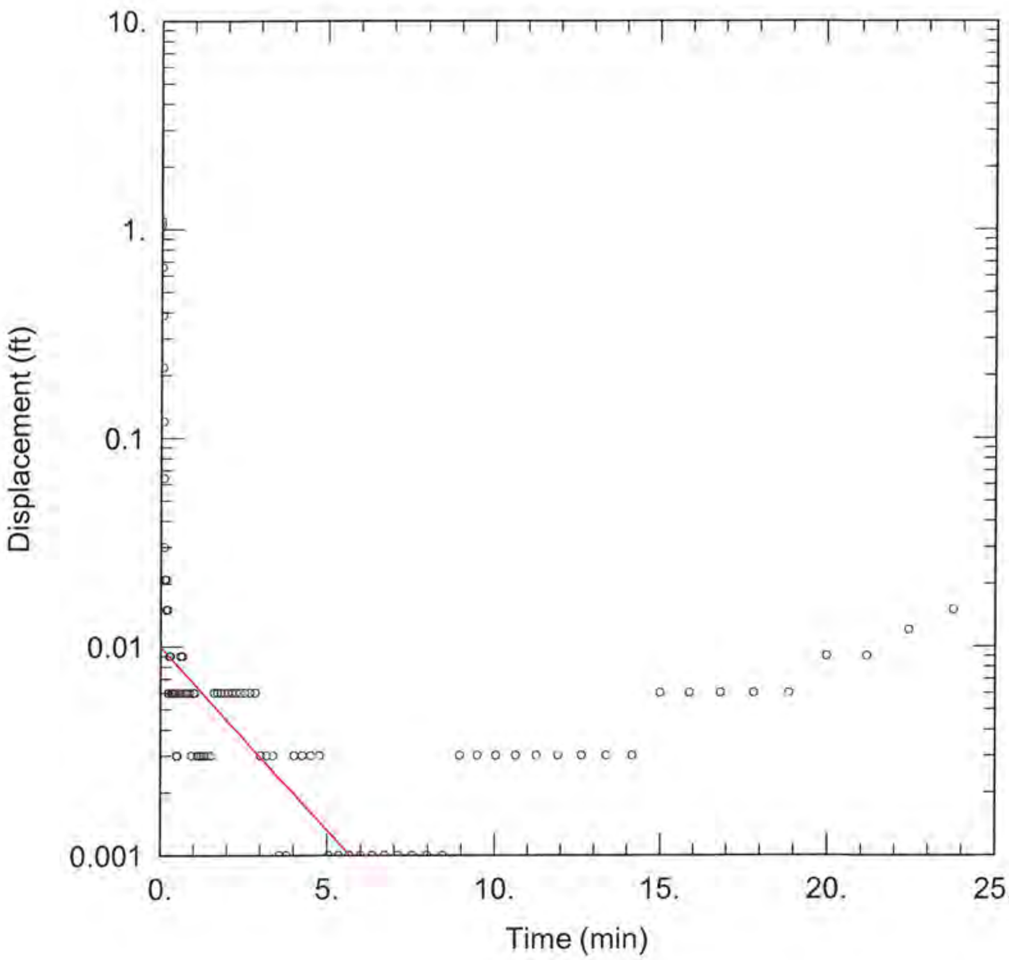
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.341

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00015	cm/sec
y0	0.059	ft

T = K*b = 0.2227 cm²/sec



OR04D RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR04Drh.aqt
Date: 12/09/15 Time: 09:17:46

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR04D
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 48.72 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR04D)

Initial Displacement: 1.1 ft
Total Well Penetration Depth: 47.72 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 47.72 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.00031 cm/sec
y0 = 0.01 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR04Drh.aqt
Title: OR04D Rising Head Test
Date: 12/09/15
Time: 09:17:47

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OR04D

AQUIFER DATA

Saturated Thickness: 48.72 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR04D

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.1 ft
Static Water Column Height: 47.72 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 47.72 ft

No. of Observations: 97

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0163	1.057	1.627	0.006
0.0327	0.659	1.721	0.006
0.049	0.386	1.82	0.006
0.0653	0.218	1.926	0.006
0.0817	0.12	2.037	0.006
0.098	0.064	2.155	0.006
0.1143	0.03	2.281	0.006
0.1307	0.021	2.413	0.006
0.147	0.021	2.554	0.006
0.1633	0.015	2.702	0.006
0.1797	0.015	2.86	0.006
0.196	0.021	3.027	0.003
0.2123	0.015	3.204	0.003
0.2287	0.015	3.391	0.003
0.245	0.006	3.589	0.001
0.2613	0.006	3.799	0.001
0.2777	0.009	4.022	0.003
0.294	0.009	4.258	0.003
0.3103	0.009	4.508	0.003

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.3267	0.006	4.772	0.003
0.3433	0.006	5.053	0.001
0.361	0.006	5.349	0.001
0.3797	0.006	5.664	0.001
0.3995	0.006	5.997	0.001
0.4205	0.006	6.35	0.001
0.4427	0.006	6.724	0.001
0.4662	0.006	7.12	0.001
0.491	0.003	7.539	0.001
0.5173	0.003	7.984	0.001
0.5453	0.006	8.454	0.001
0.575	0.006	8.953	0.003
0.6063	0.009	9.481	0.003
0.6395	0.009	10.04	0.003
0.6747	0.009	10.63	0.003
0.712	0.006	11.26	0.003
0.7515	0.006	11.92	0.003
0.7933	0.006	12.63	0.003
0.8377	0.006	13.37	0.003
0.8847	0.006	14.16	0.003
0.9345	0.003	15.	0.006
0.9872	0.006	15.89	0.006
1.043	0.006	16.83	0.006
1.102	0.003	17.82	0.006
1.165	0.003	18.88	0.006
1.231	0.003	19.99	0.009
1.302	0.003	21.17	0.009
1.376	0.003	22.43	0.012
1.455	0.003	23.75	0.015
1.539	0.003		

SOLUTION

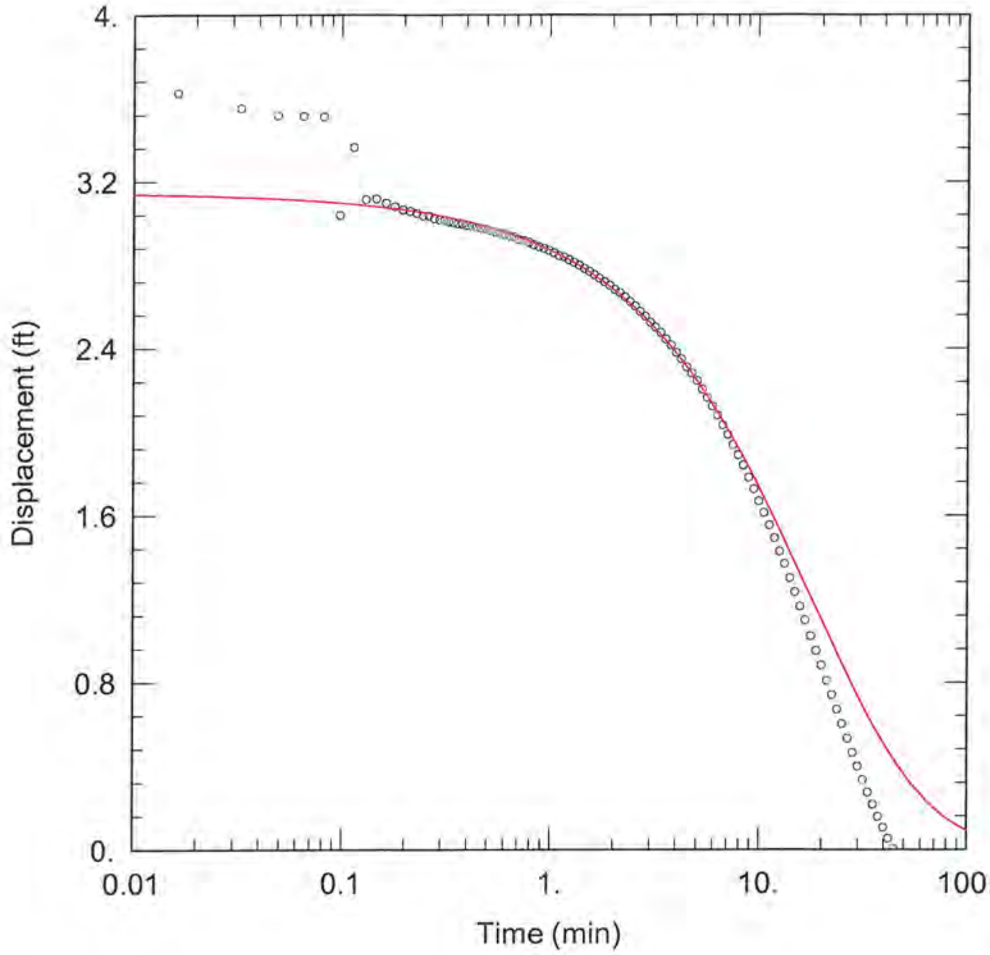
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.341

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00031	cm/sec
y0	0.01	ft

T = K*b = 0.4603 cm²/sec



OR05D FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR05Dfh.aqt
Date: 12/09/15 Time: 09:17:48

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR05D
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 38.33 ft

WELL DATA (OR05D)

Initial Displacement: 3.15 ft
Total Well Penetration Depth: 31.25 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 31.25 ft
Screen Length: 9.48 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Kr = 3.4E-5 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model
Ss = 0.0002 ft^{-1}

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR05Dfh.aqt
Title: OR05D Falling Head Test
Date: 12/09/15
Time: 09:17:49

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OR05D

AQUIFER DATA

Saturated Thickness: 38.33 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR05D

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 3.15 ft
Static Water Column Height: 31.25 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.48 ft
Total Well Penetration Depth: 31.25 ft

No. of Observations: 108

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0163	3.624	2.155	2.667
0.0327	3.551	2.281	2.647
0.049	3.517	2.413	2.624
0.0653	3.514	2.554	2.603
0.0817	3.511	2.702	2.577
0.098	3.038	2.86	2.554
0.1143	3.363	3.027	2.525
0.1307	3.114	3.204	2.502
0.147	3.117	3.391	2.476
0.1633	3.096	3.589	2.444
0.1797	3.079	3.799	2.415
0.196	3.064	4.022	2.38
0.2123	3.056	4.258	2.348
0.2287	3.047	4.508	2.311
0.245	3.035	4.772	2.279
0.2613	3.035	5.053	2.244
0.2777	3.021	5.349	2.203
0.294	3.015	5.664	2.163
0.3103	3.012	5.997	2.122

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.3267	3.006	6.35	2.079
0.3433	3.003	6.724	2.032
0.361	2.998	7.12	1.986
0.3797	2.995	7.539	1.937
0.3995	2.989	7.984	1.887
0.4205	2.986	8.454	1.838
0.4427	2.98	8.953	1.78
0.4662	2.977	9.481	1.725
0.491	2.972	10.04	1.667
0.5173	2.963	10.63	1.612
0.5453	2.957	11.26	1.551
0.575	2.954	11.92	1.49
0.6063	2.945	12.63	1.426
0.6395	2.937	13.37	1.366
0.6747	2.934	14.16	1.299
0.712	2.922	15.	1.232
0.7515	2.916	15.89	1.163
0.7933	2.908	16.83	1.096
0.8377	2.896	17.82	1.021
0.8847	2.887	18.88	0.951
0.9345	2.879	19.99	0.882
0.9872	2.87	21.17	0.809
1.043	2.858	22.43	0.74
1.102	2.844	23.75	0.67
1.165	2.838	25.16	0.601
1.231	2.824	26.65	0.531
1.302	2.812	28.22	0.464
1.376	2.798	29.89	0.398
1.455	2.783	31.66	0.334
1.539	2.769	33.53	0.273
1.627	2.754	35.52	0.215
1.721	2.737	37.62	0.157
1.82	2.719	39.85	0.105
1.926	2.702	42.21	0.053
2.037	2.682	44.71	0.004

SOLUTION

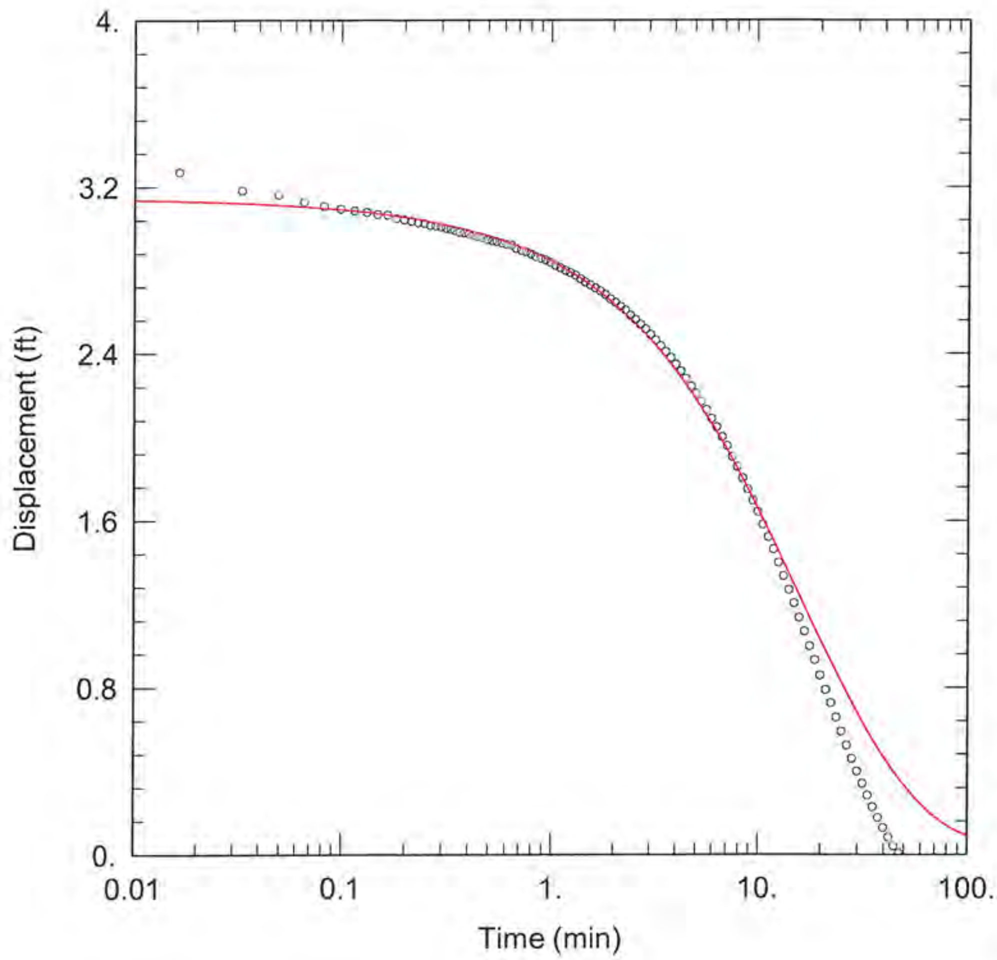
Slug Test
Aquifer Model: Unconfined
Solution Method: KGS Model

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
Kr	3.4E-5	cm/sec
Ss	0.0002	ft^{-1}
Kz/Kr	1.	

T = K*b = 0.03972 cm^2/sec



OR05D RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR05Drh.aqt
Date: 12/09/15 Time: 09:17:50

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR05D
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 38.33 ft

WELL DATA (OR05D)

Initial Displacement: 3.15 ft
Total Well Penetration Depth: 31.77 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 31.25 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined

Kr = 3.4E-5 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.00025 ft^{-1}

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR05Drh.aqt
Title: OR05D Rising Head Test
Date: 12/09/15
Time: 09:17:50

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OR05D

AQUIFER DATA

Saturated Thickness: 38.33 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR05D

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 3.15 ft
Static Water Column Height: 31.25 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 31.77 ft

No. of Observations: 109

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0165	3.27	2.284	2.607
0.033	3.183	2.416	2.581
0.0495	3.163	2.557	2.561
0.066	3.128	2.706	2.538
0.0825	3.108	2.863	2.515
0.099	3.094	3.03	2.489
0.1155	3.085	3.207	2.463
0.132	3.076	3.394	2.436
0.1485	3.068	3.592	2.408
0.165	3.065	3.803	2.379
0.1815	3.047	4.025	2.347
0.198	3.042	4.261	2.315
0.2145	3.036	4.511	2.28
0.231	3.027	4.776	2.243
0.2475	3.024	5.056	2.208
0.264	3.015	5.353	2.17
0.2805	3.013	5.667	2.13
0.297	3.007	6.	2.086
0.3135	3.001	6.353	2.046

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.33	2.995	6.727	1.999
0.3467	2.989	7.123	1.956
0.3643	2.981	7.543	1.904
0.383	2.978	7.987	1.857
0.4028	2.972	8.457	1.802
0.4238	2.966	8.956	1.75
0.446	2.96	9.484	1.695
0.4695	2.955	10.04	1.64
0.4943	2.946	10.64	1.579
0.5207	2.94	11.26	1.519
0.5487	2.937	11.93	1.461
0.5783	2.929	12.63	1.397
0.6097	2.923	13.38	1.333
0.6428	2.92	14.17	1.267
0.678	2.903	15.01	1.203
0.7153	2.894	15.89	1.133
0.7548	2.888	16.83	1.067
0.7967	2.877	17.83	0.997
0.841	2.865	18.88	0.931
0.888	2.856	19.99	0.858
0.9378	2.848	21.18	0.789
0.9905	2.836	22.43	0.725
1.046	2.822	23.76	0.656
1.105	2.81	25.16	0.589
1.168	2.798	26.65	0.522
1.234	2.787	28.23	0.459
1.305	2.775	29.9	0.398
1.379	2.758	31.66	0.34
1.458	2.743	33.54	0.282
1.542	2.729	35.52	0.227
1.631	2.714	37.62	0.175
1.724	2.7	39.85	0.128
1.824	2.683	42.21	0.082
1.929	2.662	44.71	0.041
2.041	2.645	47.36	0.007
2.159	2.625		

SOLUTION

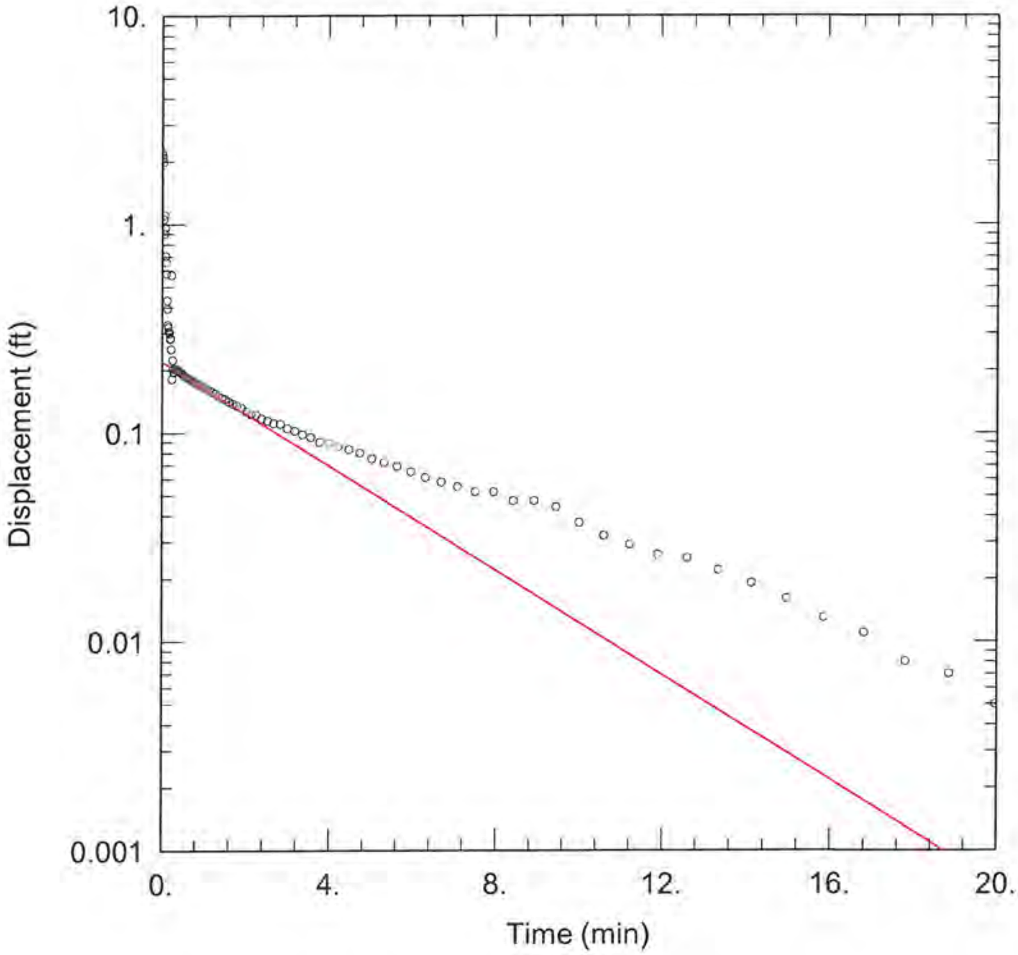
Slug Test
Aquifer Model: Unconfined
Solution Method: KGS Model

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
Kr	3.4E-5	cm/sec
Ss	0.00025	ft^{-1}
Kz/Kr	1.	

T = K*b = 0.03972 cm^2/sec



OR06A FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR06Afh.aqt
Date: 12/09/15 Time: 09:17:51

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR06A
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 21.61 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR06A)

Initial Displacement: 2.2 ft
Total Well Penetration Depth: 11.64 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 11.64 ft
Screen Length: 9.5 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.00018 cm/sec
y0 = 0.22 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR06Afh.aqt
Title: OR06A Falling Head Test
Date: 12/09/15
Time: 09:17:52

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OR06A

AQUIFER DATA

Saturated Thickness: 21.61 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR06A

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.2 ft
Static Water Column Height: 11.64 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.5 ft
Total Well Penetration Depth: 11.64 ft

No. of Observations: 101

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0112	2.15	1.28	0.154
0.0223	2.09	1.355	0.15
0.0335	1.989	1.434	0.147
0.0447	1.056	1.517	0.145
0.0558	1.107	1.606	0.141
0.067	0.904	1.7	0.138
0.0782	0.961	1.799	0.135
0.0893	0.706	1.904	0.132
0.1005	0.659	2.016	0.127
0.1117	0.581	2.134	0.123
0.1228	0.432	2.259	0.122
0.134	0.394	2.392	0.117
0.1452	0.33	2.532	0.114
0.1563	0.321	2.681	0.111
0.1675	0.306	2.838	0.11
0.1787	0.303	3.005	0.105
0.1898	0.299	3.182	0.102
0.201	0.282	3.369	0.098
0.2122	0.285	3.568	0.095

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.2233	0.252	3.778	0.09
0.235	0.571	4.	0.089
0.2475	0.181	4.236	0.086
0.2607	0.223	4.486	0.083
0.2747	0.203	4.751	0.08
0.2895	0.196	5.031	0.075
0.3052	0.196	5.328	0.072
0.3218	0.202	5.643	0.069
0.3395	0.203	5.976	0.065
0.3582	0.203	6.329	0.061
0.378	0.202	6.702	0.058
0.399	0.2	7.098	0.055
0.4212	0.197	7.518	0.052
0.4447	0.196	7.962	0.052
0.4695	0.194	8.433	0.047
0.4958	0.193	8.931	0.047
0.5238	0.19	9.459	0.044
0.5535	0.188	10.02	0.037
0.5848	0.185	10.61	0.032
0.618	0.184	11.24	0.029
0.6532	0.183	11.9	0.026
0.6905	0.18	12.61	0.025
0.73	0.178	13.35	0.022
0.7718	0.177	14.14	0.019
0.8162	0.174	14.98	0.016
0.8632	0.171	15.87	0.013
0.913	0.171	16.81	0.011
0.9657	0.168	17.8	0.008
1.022	0.165	18.85	0.007
1.081	0.162	19.97	0.005
1.143	0.16	21.15	0.004
1.21	0.157		

SOLUTION

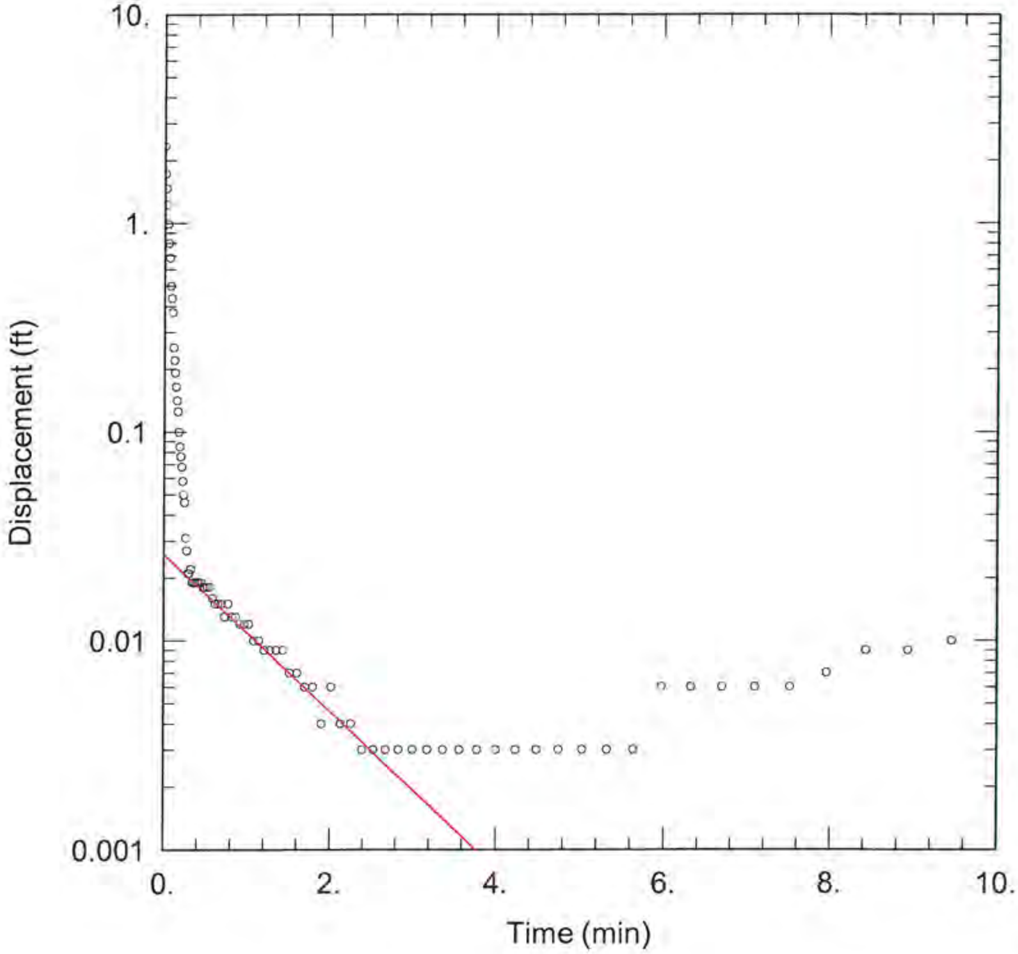
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.367

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00018	cm/sec
y0	0.22	ft

T = K*b = 0.1186 cm²/sec



OR06A RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR06Arh.aqt
Date: 12/09/15 Time: 09:17:52

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR06A
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 21.61 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR06A)

Initial Displacement: 2.33 ft
Total Well Penetration Depth: 11.64 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 11.64 ft
Screen Length: 9.5 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00054 cm/sec
y0 = 0.026 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR06Arh.aqt
Title: OR06A Rising Head Test
Date: 12/09/15
Time: 09:17:53

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OR06A

AQUIFER DATA

Saturated Thickness: 21.61 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR06A

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.33 ft
Static Water Column Height: 11.64 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.5 ft
Total Well Penetration Depth: 11.64 ft

No. of Observations: 90

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0112	1.721	0.913	0.012
0.0223	1.465	0.9657	0.012
0.0335	1.221	1.022	0.012
0.0447	0.991	1.081	0.01
0.0558	0.802	1.143	0.01
0.067	0.683	1.21	0.009
0.0782	0.5	1.28	0.009
0.0893	0.437	1.355	0.009
0.1005	0.373	1.434	0.009
0.1117	0.253	1.517	0.007
0.1228	0.22	1.606	0.007
0.134	0.192	1.7	0.006
0.1452	0.164	1.799	0.006
0.1563	0.141	1.904	0.004
0.1675	0.125	2.016	0.006
0.1787	0.1	2.134	0.004
0.1898	0.085	2.259	0.004
0.201	0.076	2.392	0.003
0.2122	0.068	2.532	0.003

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.2233	0.058	2.681	0.003
0.235	0.05	2.838	0.003
0.2475	0.046	3.005	0.003
0.2607	0.031	3.182	0.003
0.2747	0.027	3.369	0.003
0.2895	0.021	3.568	0.003
0.3052	0.021	3.778	0.003
0.3218	0.022	4.	0.003
0.3395	0.019	4.236	0.003
0.3582	0.019	4.486	0.003
0.378	0.019	4.751	0.003
0.399	0.019	5.031	0.003
0.4212	0.019	5.328	0.003
0.4447	0.019	5.643	0.003
0.4695	0.018	5.976	0.006
0.4958	0.018	6.329	0.006
0.5238	0.018	6.702	0.006
0.5535	0.018	7.098	0.006
0.5848	0.016	7.518	0.006
0.618	0.015	7.962	0.007
0.6532	0.015	8.433	0.009
0.6905	0.015	8.931	0.009
0.73	0.013	9.459	0.01
0.7718	0.015	10.02	0.012
0.8162	0.013	10.61	0.012
0.8632	0.013	11.24	0.012

SOLUTION

Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.367

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00054	cm/sec
y0	0.026	ft

T = K*b = 0.3557 cm^2/sec

Appendix B

Field Boring Log for OM32

FIELD BORING LOG

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
Completion: 355.0 ft. BGS
Station: 3,949.89N
832.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp (tsf)* Failure Type
1A	19/24 *79%*	SS	*4-4 11-1* N=15			*4.50*
1				11		
	0/36 *0%*	BD				
2						
3A	14/24 *58%*	SS	*3-2 2-2* N=4			*1.00*
3				28		
	0/36 *0%*	BD				
4						
5A	10/24 *42%*	SS	*1-1 1-2* N=2			*1.00*
5				25		
	0/36 *0%*	BD				
6						
7A	14/24 *58%*	SS	*1-2 2-2* N=4			*0.50*
7				27		
	0/36 *0%*	BD				
8						
9A	14/24 *58%*	SS	*1-1 2-3* N=3			*0.50*
9				24		
	0/36 *0%*	BD				
10						
11A	20/24 *83%*	SS	*2-3 5-5* N=8			*2.00*
11				18		
	0/36 *0%*	BD				
12						

Depth ft. BGS	Lithologic Description
2, 4	Brown (10YR4/3), dry, hard, SILT with few clay, trace very fine- to fine-grained sand, trace roots, trace slag fragments - FILL.
6, 8	Yellowish brown (10YR5/6) with 40% gray (10YR5/1) mottles, moist, medium, SILT with few clay, trace very fine- to fine-grained sand, trace roots - FILL.
10, 12, 14	Gray (10YR5/1) with 30% yellowish brown (10YR5/6) and 5% black (10YR2/1) mottles, moist, medium, SILT with few clay, trace very fine- to fine-grained sand - FILL.
16, 18	Gray (10YR5/1) and yellowish brown (10YR5/6), moist, medium, SILT with few clay, trace very fine- to fine-grained sand - FILL.
20, 22, 24	Gray (10YR5/1) and yellowish brown (10YR5/6), moist, medium, SILT with few clay, trace very fine- to fine-grained sand, trace coal fragments - FILL.
26, 28, 30	Greenish gray (10G6/1), moist, stiff, SILT with few clay, trace very fine- to fine-grained sand - FILL.

Elevation ft. MSL: 618, 616, 614, 612, 610, 608, 606, 604, 602, 600, 598, 596, 594, 592, 590

Borehole Detail | Remarks

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.	**CONTRACTOR:** Bulldog Drilling, Inc.		
Site: Duck Creek Power Station	**Rig mfg/model:** CME-750 ATV Drill	**BOREHOLE ID:**	OM32
Location: Canton, Illinois	**Drilling Method:** 4 ¼" HSA, split spoon sampler; NQ core	**Well ID:**	n/a
Project: 15E0030		**Surface Elev:**	619.4 ft. MSL
DATES: Start: 08/26/2015	**FIELD STAFF: Driller:** J. Dittmaier	**Completion:**	355.0 ft. BGS
Finish: 09/15/2015	**Helper:** M. Hill	**Station:**	3,949.89N
WEATHER: Sunny, warm, calm, mid-70s	**Eng/Geo:** S. Keim		832.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
13A / 13	19/24 *79%*	SS	*3-4 4-5* N=8	19		*2.00*	32	Gray (10YR5/1) with 10% yellowish brown (10YR5/6) mottles, moist, stiff, SILT with few clay, trace very fine- to fine-grained sand, trace coal fragments - FILL. (to 45.5)	588	
	0/36 *0%*	BD					34		586	
14 / 15A / 15	14/24 *58%*	SS	*5-8 6-7* N=14	12		*2.00*	36		584	
	0/36 *0%*	BD					38		582	
16 / 17A / 17	2/24 *8%*	SS	*6-6 6-8* N=12	16			40 ▼		580, 578	
	0/36 *0%*	BD					42, 44		576	
18 / 19A / 19	18/24 *75%*	SS	*3-5 8-9* N=13	14		*2.75*	46	Gray (10YR5/1), moist, very stiff, SILT with few clay, laminated (weathered shale), trace shale fragments - FILL. (45.5 to 50)	574	
	0/36 *0%*	BD					48		572, 570	
20 / 21A / 21	20/24 *83%*	SS	*1-3 6-7* N=9	25		*1.50*	50, 52	Dark gray (10YR4/1) with 35% light yellowish brown (2.5Y6/4) mottles, moist, stiff, SILT with little clay, trace very fine- to medium-grained sand - FILL. (50 to 55)	568	
	0/36 *0%*	BD					54		566	
22 / 23A / 23	20/24 *83%*	SS	*2-3 7-7* N=10	21		*2.25*	56	Gray (10YR5/1) with 40% yellowish brown (10YR5/6) mottles, moist, very stiff, SILT with trace clay and trace very fine- to fine-grained sand. (55 to 55.8)	564	
	0/36 *0%*	BD					58, 60	Dark gray (10YR4/1), moist, very stiff, SILT with few clay, trace very fine- to coarse-grained sand - FILL. (55.8 to 60)	562, 560	
24										

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
Completion: 355.0 ft. BGS
Station: 3,949.89N
832.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

Number	Recov / Total (in) % Recovery	Type	Blows / 6 in N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
25A / 25	21/24 *88%*	SS	*1-3 6-8* N=9	21		*1.75*	61–65	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) and 20% dark gray (10YR4/1) mottles, moist, stiff, SILT with little clay and trace very fine- to coarse-grained sand.		
26	0/36 *0%*	BD								
27A / 27	16/24 *67%*	SS	*4-6 10-12* N=16	19		*3.50*	65–75	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) and 20% dark gray (10YR4/1) mottles, moist, very stiff, SILT with little clay and trace very fine- to coarse-grained sand, trace shale fragments.		
28	0/36 *0%*	BD								
29A / 29	14/24 *58%*	SS	*5-5 10-10* N=15	17		*3.00*				
30	0/36 *0%*	BD								
31A / 31	21/24 *88%*	SS	*4-7 10-11* N=17	14		*3.00*	75–85	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) and 20% dark gray (10YR4/1) mottles, moist, very stiff, SILT with little clay and trace very fine- to coarse-grained sand and small to large gravel, trace shale and coal fragments.		
32	0/36 *0%*	BD								
33A / 33	24/24 *100%*	SS	*5-6 7-9* N=13	18		*1.75*				Switched to mud rotary at 82.0 ft bgs
34	0/36 *0%*	BD								
35A / 35	12/24 *50%*	SS	*19-34 50/2"*	17			85–86	Dark gray (10YR3/1), moist, hard, SHALE, moderately decomposed, slightly laminated.		Switched to rock core at 86.0 ft bgs
Run 36	36/36 *100%*	RC	**RQD = 40%**				86–89.3	Dark gray, SHALE with coal seams, moderately decomposed, moderate.		
							89.3–90	Dark gray, LIMESTONE with trace inclusions, slightly		

Depth scale (ft. BGS): 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

Elevation scale (ft. MSL): 558, 556, 554, 552, 550, 548, 546, 544, 542, 540, 538, 536, 534, 532, 530

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
Completion: 355.0 ft. BGS
Station: 3,949.89N
832.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								decomposed, slightly fractured, massive, strong.			
								Gray, LIMESTONE, slightly decomposed, stylolites, fossiliferous, slightly fractured, massive, strong.		528	
Run 37	60/60 *100%*	RC	**RQD = 52%**				92				
							94			526	
							96	Dark gray, SHALE with coal and clay seams, moderately decomposed, massive, moderate.		524	
Run 38	60/60 *100%*	RC	**RQD = 58%**				98			522	
							100			520	
								Dark gray, SHALE with clay seams, moderately decomposed, moderate.		518	
Run 39	60/60 *100%*	RC	**RQD = 67%**				102				
							104	Dark gray, LIMESTONE with clay seams, slightly decomposed, stylolites, small joints, vuggy, strong.		516	
							106			514	
Run 40	60/60 *100%*	RC	**RQD = 97%**				108	Dark gray, LIMESTONE, slightly decomposed, stylolites, slightly fractured, massive, strong.		512	
							110			510	
Run 41	60/60 *100%*	RC	**RQD = 88%**				112	Dark gray, LIMESTONE with thin shale interbeds, slightly decomposed, stylolites, slightly fractured, strong.		508	
							114			506	
							116			504	
							118	Dark gray, SHALE, competent, massive, strong.		502	
Run	120/120		**RQD =**				120			500	

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
Completion: 355.0 ft. BGS
Station: 3,949.89N
832.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
42	*100%*	RC	**97%**				120–135	Dark gray, SHALE, competent, massive, strong. *[Continued from previous page]*			
Run 43	120/120 *100%*	RC	**RQD = 98%**								
Run 44	120/120 *100%*	RC	**RQD = 88%**				135–146	Dark gray, SHALE, fossiliferous, competent, massive, strong.			
							146–150	Dark gray, SHALE with clay seams, slightly decomposed, weak.			
Run	120/120		**RQD =**								

Depth scale: 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150

Elevation scale: 498, 496, 494, 492, 490, 488, 486, 484, 482, 480, 478, 476, 474, 472, 470

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core

FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

HANSON

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
Completion: 355.0 ft. BGS
Station: 3,949.89N 832.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	Blows / 6 in N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
45	*100%*	RC	**43%**				150–157	Dark gray, SHALE with clay seams, slightly decomposed, weak. *[Continued from previous page]*		
Run 46	113/120 *94%*	RC	**RQD = 60%**				157–165	Black, SHALE with clay seams, slightly decomposed, moderate.		
							165–170.2	Black, SHALE, competent, blocky, massive, strong.		
Run 47	121/120 *101%*	RC	**RQD = 89%**				170.2–171.4	Black with 30% gray, SHALE with limestone nodules and seams, competent, massive, strong.		
							171.4–180	Dark gray, SHALE laminated with clay seams, competent, moderate.		
Run	118/120		**RQD =**				180			

Depth scale: 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180
Elevation scale: 468, 466, 464, 462, 460, 458, 456, 454, 452, 450, 448, 446, 444, 442, 440

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
Completion: 355.0 ft. BGS
Station: 3,949.89N
832.97E

TOPOGRAPHIC MAP INFORMATION:
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Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
48	*98%*	RC	**71%**				180.5–182.3	Black, COAL, vitreous, cleated.	438	
							182.3–185.0	Gray, SHALE, laminated, competent, moderate.	436	
							185.0–189.1	Gray, interlaminated SHALE and SANDSTONE, competent, calcareous, strong.	434, 432	
Run 49	120/120 *100%*	RC	**RQD = 88%**				189.1–190.1	Gray, very fine- to fine-grained SANDSTONE, competent, strong.	430	
							190.1–195.0	Dark gray, SHALE with gray laminae, signs of dewatering structure.	428, 426	
							195.0–196.9	Interbedded dark gray and gray SHALE and very fine- to fine-grained micaceous SANDSTONE, competent, strong.	424	
							196.9–200.5	Black, SHALE with grayish brown LIMESTONE seams and nodules, competent, strong.	422, 420	
Run 50	120/120 *100%*	RC	**RQD = 94%**				200.5–203.9	Dark gray, SHALE with grayish brown LIMESTONE seams and nodules, competent, strong.	418, 416	
							203.9–206.6	Dark gray SHALE with black coal seams, laminated, competent, moderate.	414	
							206.6–210	Gray, thinly bedded, very fine- to fine-grained SANDSTONE with clay and shale seams, competent, strong.	412, 410	
Run	118/120		**RQD =**				210			

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

HANSON

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Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
Completion: 355.0 ft. BGS
Station: 3,949.89N 832.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
51	*98%*	RC	**84%**				212	Gray, thinly bedded, very fine- to fine-grained SANDSTONE with clay and shale seams, competent, strong. *[Continued from previous page]*	408	
							214	Dark gray, SHALE, laminated, competent, strong.	406	
							216	Dark gray, SHALE, slightly decomposed, laminated, moderate.	404, 402	
							218	Black and gray, SHALE, slightly decomposed, laminated, moderate.	400	
Run 52	107/120 *89%*	RC	**RQD = 54%**				220, 222, 224	Dark gray, SHALE, slightly decomposed, massive, moderate.	398, 396	
							226	Gray, SHALE with clay seams, moderately decomposed, massive, weak.	394	
								Gray, medium- to coarse-grained SANDSTONE, slightly decomposed, strong.	392	
							228	Gray, SHALE, moderately decomposed, massive, moderate.		
								Gray, very fine- to fine-grained SANDSTONE, competent, strong.	390	
Run 53	117/120 *98%*	RC	**RQD = 71%**				230, 232, 234, 236, 238	Dark gray, very fine- to fine-grained SANDSTONE, competent, massive, strong.	388, 386, 384, 382, 380	
Run	120/120		**RQD =**				240			

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

HANSON

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Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
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WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
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BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
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832.97E

TOPOGRAPHIC MAP INFORMATION:
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Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
54	*100%*	RC	**87%**					Dark gray, very fine- to fine-grained SANDSTONE, competent, massive, strong. *[Continued from previous page]*			
							242–247.2	Dark gray, SHALE, slightly decomposed, massive, moderate.		378, 376, 374	
Run 55	60/60 *100%*	RC	**RQD = 90%**				247.2–254.2	Gray, very fine- to fine-grained SANDSTONE and black SHALE, thinly interbedded, slightly decomposed, strong.		372, 370, 368, 366	
Run 56	60/60 *100%*	RC	**RQD = 93%**								
							254.2–256.6	Black, SHALE, slightly decomposed, laminated, moderate.		364	
							256.6–257.6	Black, COAL, vitreous, cleated.		362	
Run 57	120/120 *100%*	RC	**RQD = 86%**				257.6–270	Dark gray, very fine- to fine-grained SANDSTONE, competent, massive, strong.		360, 358, 356, 354, 352, 350	
Run	120/120		**RQD =**				270				

Depth scale: 242, 244, 246, 248, 250, 252, 254, 256, 258, 260, 262, 264, 266, 268, 270

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

HANSON

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
Completion: 355.0 ft. BGS
Station: 3,949.89N
832.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
58	*100%*	RC	**84%**							
							272	Gray, very fine- to fine-grained SANDSTONE with shale seams, competent, strong	348	
							274–279	Dark gray, SHALE, competent, massive, moderate.	346, 344, 342	
Run 59	62/72 *86%*	RC	**RQD = 0%**				278			
							280	Gray, SHALE, slightly decomposed, massive, moderate.	340	
Run 60	46/48 *96%*	RC	**RQD = 96%**				282–291	Black, SHALE, laminated, competent, strong.	338, 336, 334, 332, 330	
Run 61	118/120 *98%*	RC	**RQD = 86%**				290			
							291	Black, COAL.	328	
							292–298	Gray, SHALE, slightly decomposed, massive, moderate.	326, 324, 322	
							298–300	Dark gray, SHALE, slightly decomposed, laminated, strong.	320	
Run	115/120		**RQD =**				300			

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

HANSON

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
Completion: 355.0 ft. BGS
Station: 3,949.89N
832.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
62	*96%*	RC	**40%**				300–311.6	Dark gray, SHALE, slightly decomposed, laminated, strong. *[Continued from previous page]*		
Run 63	118/120 *98%*	RC	**RQD = 82%**				311.6–312.5	Dark gray, SHALE, fossiliferous, competent, massive, strong.		
							312.5–314.2	Dark gray, very fine- to fine-grained SANDSTONE and SHALE, thinly interbedded, competent, strong.		
							314.2–315.2	Gray, SHALE, slightly decomposed, massive, moderate.		
							315.2–319	Light greenish gray, very fine- to fine-grained SANDSTONE, competent, massive, strong.		
Run 64	120/120 *100%*	RC	**RQD = 95%**				319–319.9	Grayish green, SHALE, slightly decomposed, moderate.		
							319.9–321.4	Grayish green, SHALE with sandstone, limestone, and chert nodules (brecciated), slightly decomposed, blocky, strong.		
							321.4–324.1	Dark gray and dark green, SANDSTONE and SHALE with limestone lenses (dewatering structure), slightly decomposed, moderate.		
							324.1–325	Light gray, LIMESTONE, competent, massive, strong.		
							325–327	Grayish green, SHALE and SANDSTONE, thinly interbedded, calcareous, competent, strong.		
							327–330	Gray, LIMESTONE, slightly decomposed, slightly fractured, stylolites, vuggy, strong.		
Run	120/120		**RQD =**							

Depth scale (ft. BGS): 302, 304, 306, 308, 310, 312, 314, 316, 318, 320, 322, 324, 326, 328, 330

Elevation scale (ft. MSL): 318, 316, 314, 312, 310, 308, 306, 304, 302, 300, 298, 296, 294, 292, 290

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

CLIENT: Natural Resource Technology, Inc.	**CONTRACTOR:** Bulldog Drilling, Inc.		
Site: Duck Creek Power Station	**Rig mfg/model:** CME-750 ATV Drill	**BOREHOLE ID:** OM32	
Location: Canton, Illinois	**Drilling Method:** 4 ¼" HSA, split spoon sampler; NQ core	**Well ID:** n/a	
Project: 15E0030		**Surface Elev:** 619.4 ft. MSL	
DATES: Start: 08/26/2015	**FIELD STAFF: Driller:** J. Dittmaier	**Completion:** 355.0 ft. BGS	
Finish: 09/15/2015	**Helper:** M. Hill	**Station:** 3,949.89N	
WEATHER: Sunny, warm, calm, mid-70s	**Eng/Geo:** S. Keim	832.97E	

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
65	*100%*	RC	**98%**				330–335	Gray, LIMESTONE, slightly decomposed, slightly fractured, stylolites, vuggy, strong. *[Continued from previous page]*		
							335–339.2	Gray, LIMESTONE, slightly decomposed, crystalline, slightly fractured, stylolites, strong.		
Run 66	120/120 *100%*	RC	**RQD = 100%**				339.2–345	Gray, LIMESTONE with greenish gray clay seams, slightly decomposed, crystalline, slightly fractured, stylolites, strong.		
							345–350	Gray, LIMESTONE with greenish gray clay seams, slightly decomposed, crystalline, vuggy, stylolites, strong.		
Run 67	120/120 *100%*	RC	**RQD = 93%**				350–351.2	Gray, LIMESTONE with greenish gray clay and sandstone seams, slightly decomposed, crystalline, vuggy, stylolites, strong.		
							351.2–355	Greenish gray, SANDSTONE with shale and limestone lenses, slightly decomposed, calcareous, strong.		

Depth scale: 332, 334, 336, 338, 340, 342, 344, 346, 348, 350, 352, 354
Elevation scale: 288, 286, 284, 282, 280, 278, 276, 274, 272, 270, 268, 266

End of boring = 355.0 feet

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

Appendix C

Pressure Test Results for OM32

Duck Creek Power Station -- Bedrock Packer Test Calculations

Packer Test Solution

"Methods and procedures for defining aquifer parameters" (by John Sevee);
in Practical Handbook of Ground-Water Monitoring (ed. David Nielsen)

"Friction Losses in Pipe" (APPENDIX 17.A.);
in Groundwater and Wells (Fletcher G. Driscoll)

Site Duck Creek Power Station – South End of Ash Pond 1
Boring OM32
0.1250 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

Test #	Depth [Interval midpoint] (feet MSL)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
A 1	351.57	0.15000	40.58	10.00	23.07	0.120	63.527	1.742E-05	
2	351.57	0.30500	40.58	10.00	23.07	0.245	63.402	3.550E-05	
3	351.57	0.18000	40.58	10.00	23.07	0.145	63.502	2.092E-05	
4	351.57	0.13000	40.58	10.00	23.07	0.104	63.543	1.510E-05	
5	351.57	0.09500	40.58	10.00	23.07	0.076	63.571	1.103E-05	
6	351.57	0.02300	40.58	10.00	23.07	0.018	63.629	2.667E-06	
7	351.57	0.00600	40.58	10.00	23.07	0.005	63.642	6.957E-07	
8	351.57	0.00800	40.58	10.00	23.07	0.006	63.641	9.276E-07	
9	351.57	0.01800	40.58	10.00	23.07	0.014	63.633	2.087E-06	
10	351.57	0.01100	40.58	10.00	23.07	0.009	63.638	1.275E-06	
11	351.57	0.00800	40.58	10.00	23.07	0.006	63.641	9.276E-07	
12	351.57	0.00840	40.58	10.00	23.07	0.007	63.640	9.740E-07	
13	351.57	0.00760	40.58	10.00	23.07	0.006	63.641	8.812E-07	
14	351.57	0.00300	40.58	20.00	46.13	0.002	86.712	2.553E-07	
15	351.57	0.00180	40.58	20.00	46.13	0.001	86.713	1.532E-07	
16	351.57	0.00840	40.58	20.00	46.13	0.007	86.707	7.149E-07	
17	351.57	0.11080	40.58	30.00	69.20	0.089	109.692	7.454E-06	
18	351.57	0.07320	40.58	30.00	69.20	0.059	109.722	4.923E-06	
19	351.57	0.02880	40.58	30.00	69.20	0.023	109.758	1.936E-06	
20	351.57	0.00840	40.58	30.00	69.20	0.007	109.774	5.646E-07	
21	351.57	0.01920	40.58	30.00	69.20	0.015	109.766	1.291E-06	
22	351.57	0.01920	40.58	30.00	69.20	0.015	109.766	1.291E-06	
23	351.57	0.01760	40.58	20.00	46.13	0.014	86.700	1.498E-06	*Step down*
24	351.57	0.01880	40.58	20.00	46.13	0.015	86.699	1.600E-06	*Step down*
25	351.57	0.00080	40.58	10.00	23.07	0.001	63.646	9.275E-08	*Step down*
26	351.57	0.00440	40.58	10.00	23.07	0.004	63.643	5.101E-07	*Step down*
B 1	331.64	0.03040	40.58	10.00	23.07	0.023	63.624	3.526E-06	
2	331.64	0.10600	40.58	10.00	23.07	0.080	63.567	1.230E-05	
3	331.64	0.17720	40.58	10.00	23.07	0.134	63.513	2.059E-05	
4	331.64	0.06160	40.58	10.00	23.07	0.047	63.600	7.147E-06	
5	331.64	0.01400	40.58	10.00	23.07	0.011	63.636	1.623E-06	
6	331.64	0.05000	40.58	10.00	23.07	0.038	63.609	5.800E-06	
7	331.64	0.04440	40.58	20.00	46.13	0.034	86.680	3.780E-06	
8	331.64	0.11520	40.58	20.00	46.13	0.087	86.627	9.813E-06	
9	331.64	0.27120	40.58	20.00	46.13	0.205	86.509	2.313E-05	
10	331.64	0.24680	40.58	20.00	46.13	0.187	86.527	2.105E-05	
11	331.64	0.17880	40.58	20.00	46.13	0.135	86.579	1.524E-05	
12	331.64	0.02600	40.58	30.00	69.20	0.020	109.761	1.748E-06	
13	331.64	0.01180	40.58	30.00	69.20	0.009	109.772	7.932E-07	
14	331.64	0.02440	40.58	30.00	69.20	0.018	109.763	1.640E-06	
15	331.64	0.02000	40.58	30.00	69.20	0.015	109.766	1.345E-06	
16	331.64	0.01960	40.58	30.00	69.20	0.015	109.766	1.318E-06	
17	331.64	0.00080	40.58	20.00	46.13	0.001	86.713	6.808E-08	*Step down*
18	331.64	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*Step down*
19	331.64	0.01120	40.58	10.00	23.07	0.008	63.639	1.299E-06	*Step down*

Duck Creek Power Station -- Bedrock Packer Test Calculations

Site Duck Creek Power Station – South End of Ash Pond 1
Boring OM32

0.1250 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

Test #	Depth [Interval midpoint] (feet MSL)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
20	331.64	0.02840	40.58	10.00	23.07	0.022	63.625	3.294E-06	*Step down*
C 1	321.54	0.00080	40.58	10.00	23.07	0.001	63.646	9.275E-08	
2	321.54	0.00020	40.58	10.00	23.07	0.000	63.647	2.319E-08	
3	321.54	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
4	321.54	0.00120	40.58	10.00	23.07	0.001	63.646	1.391E-07	
5	321.54	0.00240	40.58	20.00	46.13	0.002	86.712	2.042E-07	
6	321.54	0.00120	40.58	20.00	46.13	0.001	86.713	1.021E-07	
7	321.54	0.00060	40.58	20.00	46.13	0.000	86.714	5.106E-08	
8	321.54	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	
9	321.54	0.00120	40.58	30.00	69.20	0.001	109.780	8.066E-08	
10	321.54	0.00040	40.58	30.00	69.20	0.000	109.781	2.689E-08	
11	321.54	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
12	321.54	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
13	321.54	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*Step down*
14	321.54	0.00040	40.58	20.00	46.13	0.000	86.714	3.404E-08	*Step down*
15	321.54	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
16	321.54	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
D 1	300.77	0.03760	40.58	10.00	23.07	0.026	63.621	4.361E-06	
2	300.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
3	300.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
4	300.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
5	300.77	0.05900	40.58	20.00	46.13	0.041	86.673	5.023E-06	
6	300.77	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	
7	300.77	0.00040	40.58	20.00	46.13	0.000	86.714	3.404E-08	
8	300.77	0.00040	40.58	20.00	46.13	0.000	86.714	3.404E-08	
9	300.77	0.00440	40.58	30.00	69.20	0.003	109.778	2.958E-07	
10	300.77	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
11	300.77	0.00100	40.58	30.00	69.20	0.001	109.780	6.722E-08	
12	300.77	0.00040	40.58	30.00	69.20	0.000	109.781	2.689E-08	
13	300.77	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*Step down*
14	300.77	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*Step down*
15	300.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
16	300.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
E 1	279.77	0.00700	40.58	10.00	23.07	0.004	63.643	8.116E-07	
2	279.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
3	279.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
4	279.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
5	279.77	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	
6	279.77	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	
7	279.77	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*No take in 15 minutes*
8	279.77	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
9	279.77	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
10	279.77	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
11	279.77	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*Step down*
12	279.77	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*Step down*
13	279.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
14	279.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
						0.000			
F 1	269.17	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
2	269.17	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
3	269.17	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	

Duck Creek Power Station -- Bedrock Packer Test Calculations

Site Duck Creek Power Station – South End of Ash Pond 1
Boring OM32
0.1250 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

Test #	Depth [Interval midpoint] (feet MSL)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
4	269.17	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*No take in 15 minutes*
5	269.17	0.00040	40.58	20.00	46.13	0.000	86.714	3.404E-08	
6	269.17	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	
7	269.17	0.00020	40.58	20.00	46.13	0.000	86.714	1.702E-08	
8	269.17	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	
9	269.17	0.00040	40.58	30.00	69.20	0.000	109.781	2.689E-08	
10	269.17	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
11	269.17	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
12	269.17	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*Step down*
13	269.17	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*Step down*
14	269.17	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
15	269.17	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
G 1	258.72	0.24700	40.58	10.00	23.07	0.146	63.501	2.870E-05	
2	258.72	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
3	258.72	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
4	258.72	0.00040	40.58	10.00	23.07	0.000	63.647	4.637E-08	
5	258.72	0.02600	40.58	25.00	57.67	0.015	98.232	1.953E-06	
6	258.72	0.00100	40.58	25.00	57.67	0.001	98.247	7.511E-08	
7	258.72	0.00080	40.58	25.00	57.67	0.000	98.247	6.009E-08	
8	258.72	0.00000	40.58	25.00	57.67	0.000	98.248	0.000E+00	
9	258.72	0.07600	40.58	40.00	92.27	0.045	132.803	4.223E-06	
10	258.72	0.00000	40.58	40.00	92.27	0.000	132.848	0.000E+00	
11	258.72	0.00060	40.58	40.00	92.27	0.000	132.848	3.333E-08	
12	258.72	0.00140	40.58	40.00	92.27	0.001	132.847	7.776E-08	
13	258.72	0.00000	40.58	25.00	57.67	0.000	98.248	0.000E+00	*Step down*
14	258.72	0.00080	40.58	25.00	57.67	0.000	98.247	6.009E-08	*Step down*
15	258.72	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
16	258.72	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
H 1	248.62	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
2	248.62	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
3	248.62	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*No take in 15 minutes*
4	248.62	0.00040	40.58	25.00	57.67	0.000	98.247	3.004E-08	
5	248.62	0.00000	40.58	25.00	57.67	0.000	98.248	0.000E+00	
6	248.62	0.00000	40.58	25.00	57.67	0.000	98.248	0.000E+00	
7	248.62	0.00000	40.58	25.00	57.67	0.000	98.248	0.000E+00	
8	248.62	0.00000	40.58	40.00	92.27	0.000	132.848	0.000E+00	
9	248.62	0.00000	40.58	40.00	92.27	0.000	132.848	0.000E+00	
10	248.62	0.00000	40.58	40.00	92.27	0.000	132.848	0.000E+00	*No take in 15 minutes*
11	248.62	0.00000	40.58	25.00	57.67	0.000	98.248	0.000E+00	*Step down*
12	248.62	0.00000	40.58	25.00	57.67	0.000	98.248	0.000E+00	*Step down*
13	248.62	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
14	248.62	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
I 1	227.61	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
2	227.61	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	227.61	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*No take in 15 minutes*
4	227.61	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
5	227.61	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	227.61	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
7	227.61	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
8	227.61	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	227.61	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*

Duck Creek Power Station -- Bedrock Packer Test Calculations

Site Duck Creek Power Station – South End of Ash Pond 1
Boring OM32
0.1250 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

Test #	Depth [Interval midpoint] (feet MSL)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
10	227.61	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
11	227.61	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	227.61	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
13	227.61	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
J 1	217.05	0.00080	40.58	15.00	34.60	0.000	75.180	7.852E-08	
2	217.05	0.00160	40.58	15.00	34.60	0.001	75.180	1.570E-07	
3	217.05	0.00160	40.58	15.00	34.60	0.001	75.180	1.570E-07	
4	217.05	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
5	217.05	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
6	217.05	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
7	217.05	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
8	217.05	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
9	217.05	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	217.05	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
11	217.05	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
12	217.05	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	217.05	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
14	217.05	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
15	217.05	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
K 1	206.51	0.00080	40.58	15.00	34.60	0.000	75.180	7.852E-08	
2	206.51	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	206.51	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	206.51	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
5	206.51	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	206.51	0.00020	40.58	30.00	69.20	0.000	109.781	1.344E-08	
7	206.51	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
8	206.51	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	206.51	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	206.51	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
11	206.51	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	206.51	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	206.51	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
14	206.51	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
L 1	196.37	0.00040	40.58	15.00	34.60	0.000	75.180	3.926E-08	
2	196.37	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	196.37	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	196.37	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
5	196.37	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	196.37	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
7	196.37	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
8	196.37	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	196.37	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
10	196.37	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
11	196.37	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	196.37	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
13	196.37	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
M 1	185.77	0.02080	40.58	15.00	34.60	0.009	75.172	2.042E-06	
2	185.77	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	185.77	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	185.77	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	

Duck Creek Power Station -- Bedrock Packer Test Calculations

Site Duck Creek Power Station – South End of Ash Pond 1
Boring OM32
0.1250 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

Test #	Depth [Interval midpoint] (feet MSL)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
5	185.77	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	185.77	0.00020	40.58	30.00	69.20	0.000	109.781	1.344E-08	
7	185.77	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
8	185.77	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	185.77	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	185.77	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
11	185.77	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	185.77	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	185.77	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
14	185.77	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
N 1	175.55	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
2	175.55	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	175.55	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	175.55	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*No take in 15 minutes*
5	175.55	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	175.55	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
7	175.55	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
8	175.55	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	175.55	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	175.55	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
11	175.55	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	175.55	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	175.55	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
14	175.55	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
O 1	165.39	0.19100	40.58	15.00	34.60	0.072	75.108	1.876E-05	
2	165.39	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	165.39	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	165.39	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
5	165.39	0.00040	40.58	30.00	69.20	0.000	109.781	2.689E-08	
6	165.39	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
7	165.39	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
8	165.39	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	165.39	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	165.39	0.00020	40.58	45.00	103.80	0.000	144.381	1.022E-08	
11	165.39	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	165.39	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	165.39	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
14	165.39	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
P 1	155.25	0.00300	40.58	15.00	34.60	0.001	75.179	2.945E-07	
2	155.25	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	155.25	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	155.25	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
5	155.25	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	155.25	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
7	155.25	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
8	155.25	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	155.25	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	155.25	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
11	155.25	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	155.25	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	155.25	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*

Duck Creek Power Station -- Bedrock Packer Test Calculations

Site Duck Creek Power Station – South End of Ash Pond 1
Boring OM32

0.1250 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

Test #	Depth [Interval midpoint] (feet MSL)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
14	155.25	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
Q 1	144.75	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
2	144.75	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	144.75	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*No take in 15 minutes*
4	144.75	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
5	144.75	0.00020	40.58	30.00	69.20	0.000	109.781	1.344E-08	
6	144.75	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
7	144.75	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
8	144.75	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	144.75	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
10	144.75	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
11	144.75	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	144.75	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
13	144.75	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
R 1	134.15	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
2	134.15	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	134.15	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	134.15	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
5	134.15	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	134.15	0.00020	40.58	30.00	69.20	0.000	109.781	1.344E-08	
7	134.15	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
8	134.15	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	134.15	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	134.15	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
11	134.15	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	134.15	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	134.15	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
14	134.15	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
S 1	124.04	0.24000	40.58	15.00	34.60	0.068	75.113	2.358E-05	
2	124.04	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	124.04	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	124.04	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
5	124.04	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	124.04	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
7	124.04	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
8	124.04	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	124.04	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	124.04	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
11	124.04	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	124.04	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	124.04	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
14	124.04	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
T 1	113.86	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
2	113.86	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	113.86	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*No take in 15 minutes*
4	113.86	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
5	113.86	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	113.86	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
7	113.86	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
8	113.86	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	

Duck Creek Power Station -- Bedrock Packer Test Calculations

Site Duck Creek Power Station – South End of Ash Pond 1
Boring OM32
0.1250 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

Test #	Depth [Interval midpoint] (feet MSL)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
9	113.86	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
10	113.86	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
11	113.86	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	113.86	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
13	113.86	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
U 1	103.41	0.06500	40.58	15.00	34.60	0.015	75.165	6.381E-06	
2	103.41	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	103.41	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	103.41	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
5	103.41	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	103.41	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
7	103.41	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
8	103.41	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	103.41	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	103.41	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
11	103.41	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	103.41	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	103.41	-0.00120	40.58	15.00	34.60	0.000	75.181	-1.178E-07	*Step down*
14	103.41	-0.00080	40.58	15.00	34.60	0.000	75.181	-7.852E-08	*Step down*

APPENDIX B2

AECOM ALPHA OMEGA 2015 PERMEAMETER DATA

FALLING HEAD PERMEABILITY REPORT

(Method C: Rising Tail-Water)

ASTM D 5084

ALPHA-OMEGA GEOTECH

PROJECT NAME: Dynegy CCR Ph 3/7-Duck Creek (Ash Pond 1) PROJECT NO.: 15-328T

LOCATION:

BORING NO.: B008 SAMPLE NO.: ST-2 DEPTH: 16' - 17.5'

SAMPLE TYPE: Undisturbed % COMPACTION:

INITIAL DATA			FINAL DATA		
MOISTURE:	22.6	%	MOISTURE:	23.7	%
DRY UNIT WEIGHT:	103.2	pcf	DRY UNIT WEIGHT:	103.2	pcf
HEIGHT:	2.69	inches	HEIGHT:	2.69	inches
DIAMETER:	2.86	inches	DIAMETER:	2.86	inches
WEIGHT:	573.8	grams	WEIGHT:	578.9	grams
SATURATION:	95.8	%	SATURATION:	100.0	%

PERMEANT LIQUID: Deaired tap water "B" value = 98.0%

EFFECTIVE CONSOLIDATION STRESS: Maximum 3.4 psi Minimum 3.0 psi

BACK PRESSURE: 90 psi RANGE OF HYDRAULIC GRADIENT: 3.2 to 2.9

SAMPLE DESCRIPTION: Brown, mottled olive brown, spotted gray, speckled black and reddish brown LEAN CLAY with trace of sand

TEST DATA

DATE	TEST NO.	TIME (sec)	HEAD1 (cm)	HEAD 2 (cm)	TEMP °C
10/12 - 10/13	1	81,720	22.0	20.0	26
10/13 - 10/14	2	81,720	22.0	20.0	26
10/14 - 10/15	3	81,720	22.0	20.0	26
10/15 - 10/16	4	81,720	22.0	20.0	26
AVERAGE		81,720	22.0	20.0	26

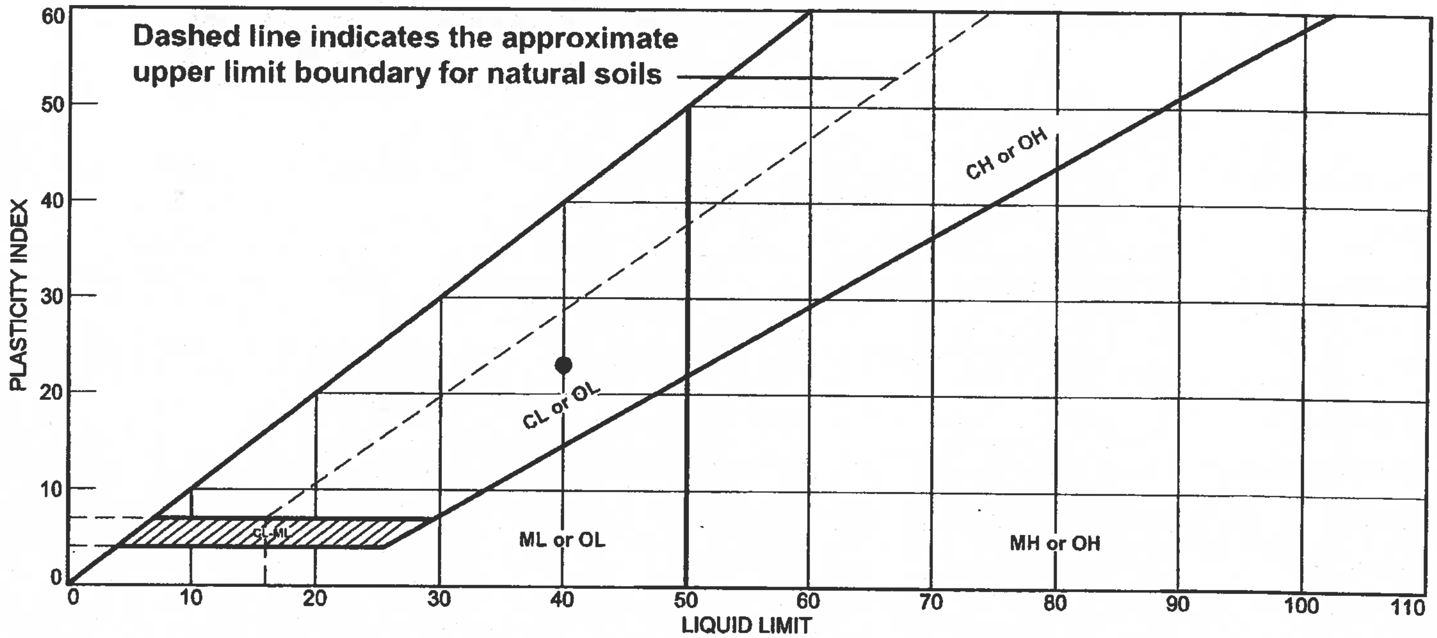
k= 7.8E-08 cm/s n/n20= 0.8694

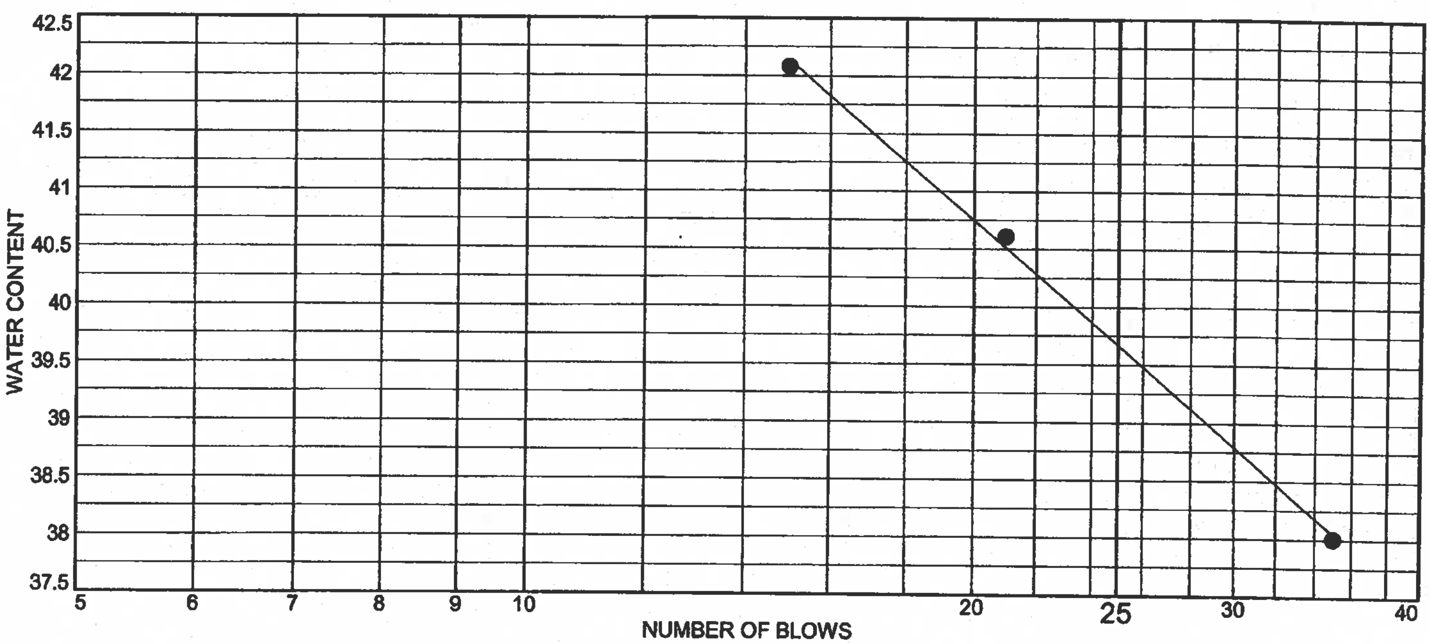
k20= 6.8E-08 cm/s

k = Hydraulic Conductivity before n/n20 correction factor
k20= Hydraulic Conductivity after correction to 20 ° Celsius

This is a laboratory testing result. Field values may vary.

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown, mottled olive brown, spotted gray, speckled black and reddish brown LEAN CLAY with trace of sand	40	17	23			

Project No. 15-328T **Client:** AECOM

Project: Dynegy CCR Ph 3/7 Duck Creek (Ash Pond 1)

Sample Number: B008 ST-2 **Depth:** 16'-17.5'

Remarks:

ALPHA-OMEGA GEOTECH

Figure 1 of 1

Tested By: DB **Checked By:** TB

FALLING HEAD PERMEABILITY REPORT

(Method C: Rising Tail-Water)

ASTM D 5084

ALPHA-OMEGA GEOTECH

PROJECT NAME: Dynegy CCR Ph 3/7-Duck Creek (Ash Pond 1) PROJECT NO.: 15-328T

LOCATION:

BORING NO.: B015 SAMPLE NO.: ST-6 DEPTH: 56' - 57.5'

SAMPLE TYPE: Undisturbed % COMPACTION:

INITIAL DATA			FINAL DATA		
MOISTURE:	15.8	%	MOISTURE:	16.4	%
DRY UNIT WEIGHT:	118.4	pcf	DRY UNIT WEIGHT:	118.4	pcf
HEIGHT:	2.26	inches	HEIGHT:	2.26	inches
DIAMETER:	2.86	inches	DIAMETER:	2.86	inches
WEIGHT:	522.4	grams	WEIGHT:	525.1	grams
SATURATION:	99.9	%	SATURATION:	100.0	%

PERMEANT LIQUID: Deaired tap water "B" value = 98.0%

EFFECTIVE CONSOLIDATION STRESS: Maximum 3.4 psi Minimum 3.0 psi

BACK PRESSURE: 90 psi RANGE OF HYDRAULIC GRADIENT: 3.8 to 3.3

SAMPLE DESCRIPTION: Light gray, speckled black and reddish brown Silty clay with sand and trace of gravel

TEST DATA

DATE	TEST NO.	TIME (sec)	HEAD1 (cm)	HEAD 2 (cm)	TEMP °C
10/12 - 10/13	1	82,080	22.0	19.2	26
10/13 - 10/14	2	82,080	22.0	19.2	26
10/14 - 10/15	3	82,080	22.0	19.2	26
10/15 - 10/16	4	82,080	22.0	19.2	26
AVERAGE		82,080	22.0	19.2	26

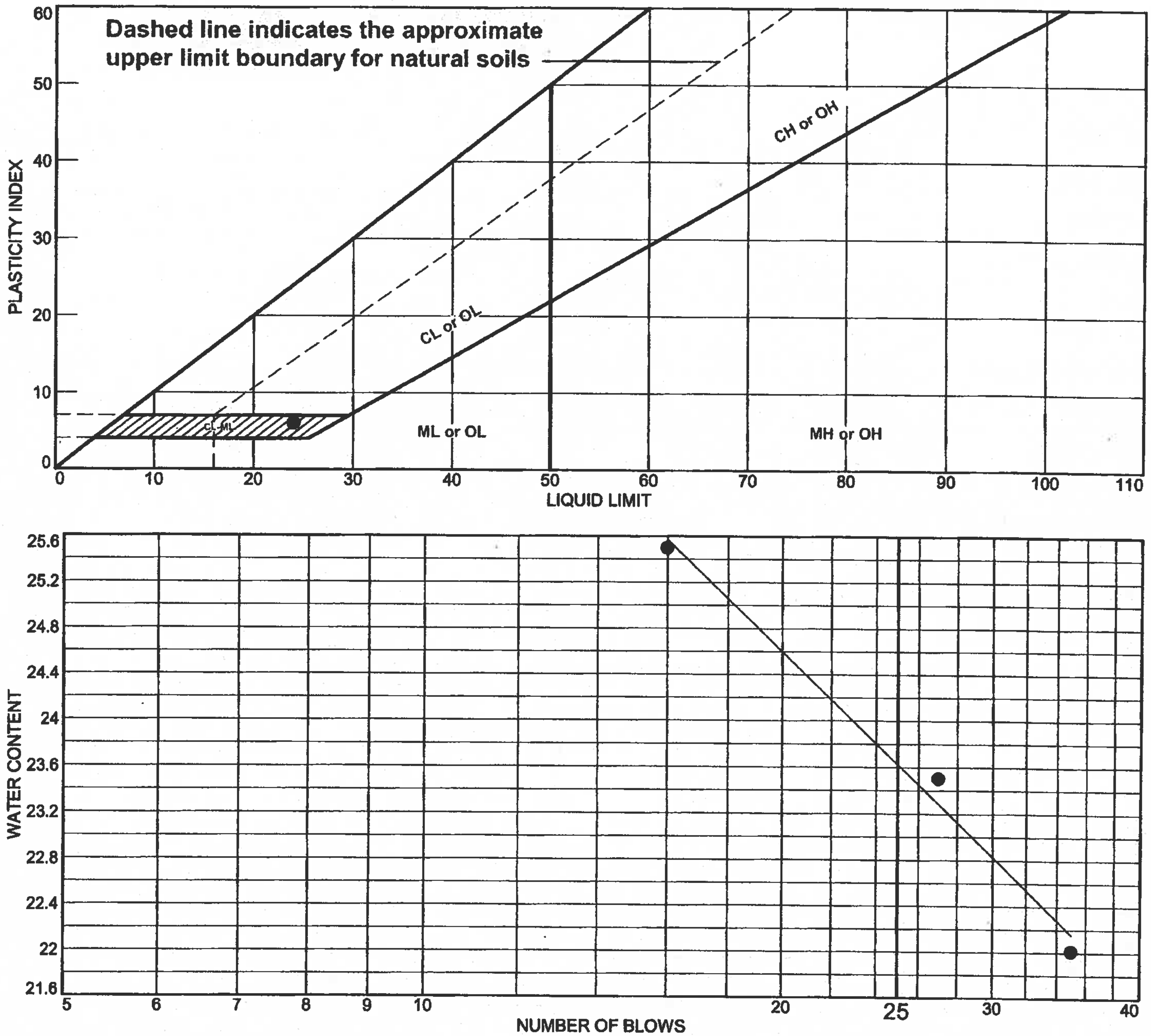
k= 9.3E-08 cm/s n/n20= 0.8694

k20= 8.1E-08 cm/s

k = Hydraulic Conductivity before n/n20 correction factor
k20= Hydraulic Conductivity after correction to 20 ° Celsius

This is a laboratory testing result. Field values may vary.

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Light gray, speckled black and reddish brown Silty clay with sand and trace of gravel	24	18	6			

Project No. 15-328T **Client:** AECOM

Project: Dynegy CCR Ph 3/7 Duck Creek (Ash Pond 1)

Sample Number: B015 ST-6 **Depth:** 56'-57.5'

Remarks:

ALPHA-OMEGA GEOTECH

Figure 1 of 1

Tested By: DB **Checked By:** TB

Ash Pond 2 Laboratory Test Results

FALLING HEAD PERMEABILITY REPORT

(Method C: Rising Tail-Water)

ASTM D 5084

ALPHA-OMEGA GEOTECH

PROJECT NAME: Dynegy CCR Ph 3/7 - Duck Creek (Ash Pond 2) PROJECT NO.: 15-328T

LOCATION:

BORING NO.: B019 SAMPLE NO.: ST-4 DEPTH: 43.5' - 45'

SAMPLE TYPE: Undisturbed % COMPACTION:

INITIAL DATA			FINAL DATA		
MOISTURE:	17.7	%	MOISTURE:	26.8	%
DRY UNIT WEIGHT:	104.3	pcf	DRY UNIT WEIGHT:	104.3	pcf
HEIGHT:	2.05	inches	HEIGHT:	2.05	inches
DIAMETER:	2.84	inches	DIAMETER:	2.84	inches
WEIGHT:	418.3	grams	WEIGHT:	450.6	grams
SATURATION:	77.6	%	SATURATION:	100.0	%

PERMEANT LIQUID: Deaired tap water

EFFECTIVE CONSOLIDATION STRESS: Maximum 5.4 psi Minimum 5.0 psi

BACK PRESSURE: 90 psi RANGE OF HYDRAULIC GRADIENT: 4.2 to 3.8

SAMPLE DESCRIPTION: Gray, mottled dark brown LEAN CLAY with weathered shale

TEST DATA

DATE	TEST NO.	TIME (sec)	HEAD1 (cm)	HEAD 2 (cm)	TEMP °C
11/18/2015	1	12,720	22.0	19.8	26
11/18/2015	2	12,720	22.0	19.8	26
11/19/2015	3	12,720	22.0	19.8	26
11/19/2015	4	12,720	22.0	19.8	26
AVERAGE		12,720	22.0	19.8	26

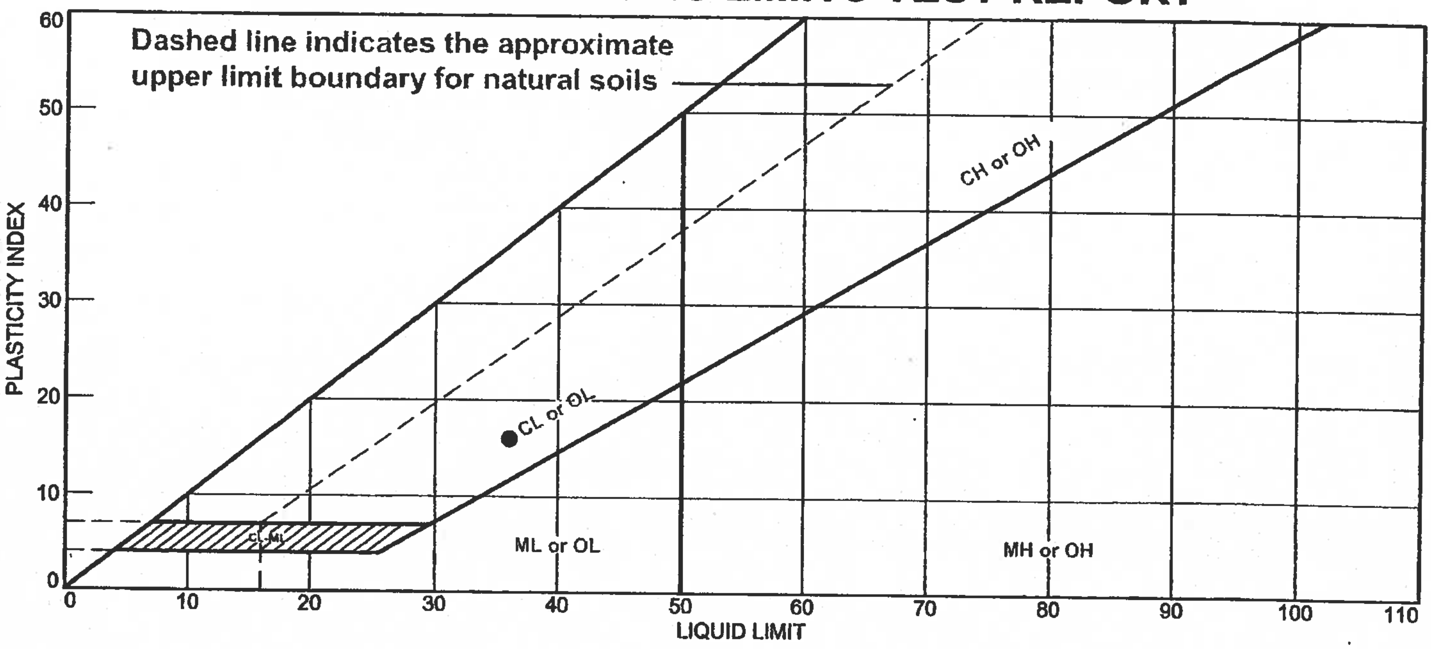
k= 4.3E-07 cm/s n/n20= 0.8694

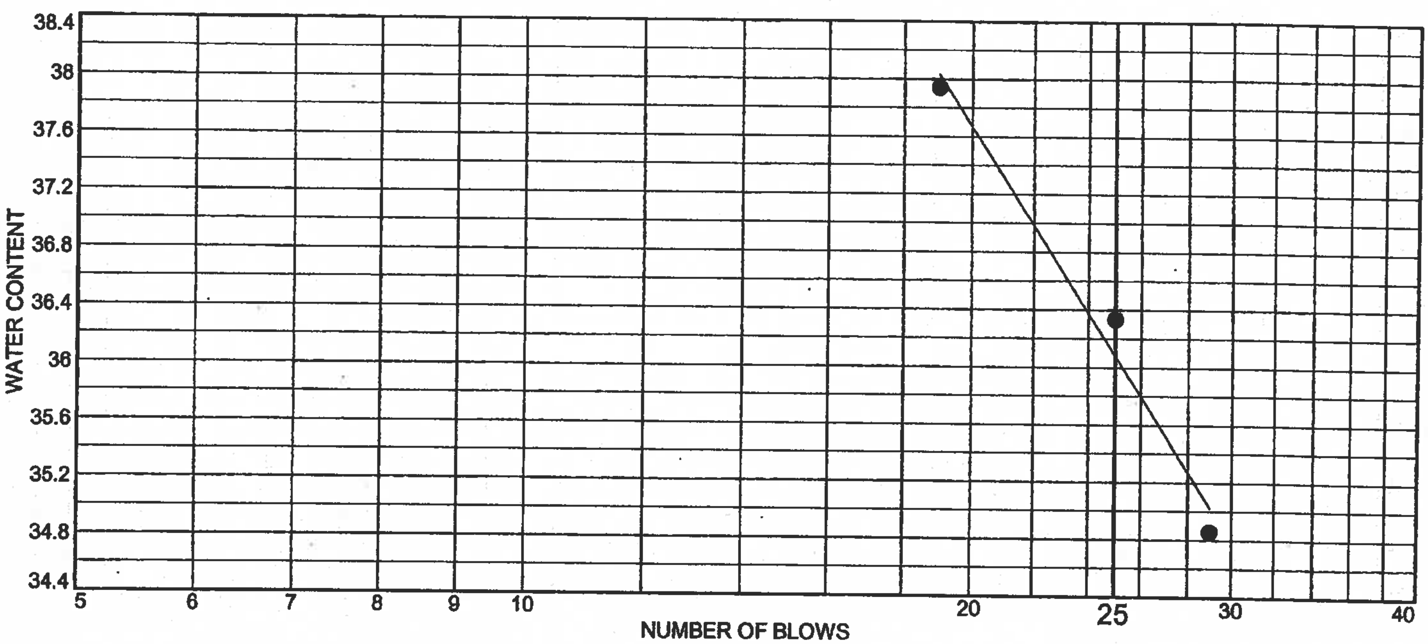
k20= 3.7E-07 cm/s

k = Hydraulic Conductivity before n/n20 correction factor
k20= Hydraulic Conductivity after correction to 20 ° Celsius

This is a laboratory testing result. Field values may vary.

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray, mottled dark brown LEAN CLAY with weathered shale	36	20	16			

Project No. 15-328T **Client:** AECOM

Project: Dynegy CCR Ph 3/7-Duck Creek (Ash Pond 2)

Sample Number: B019 ST-4 **Depth:** 43.5'-45'

ALPHA-OMEGA GEOTECH

Remarks:

Figure 1 of 1

Tested By: D.B. **Checked By:** T.B.

FALLING HEAD PERMEABILITY REPORT

(Method C: Rising Tail-Water)

ASTM D 5084

ALPHA-OMEGA GEOTECH

PROJECT NAME: Dynegy CCR Ph 3/7 - Duck Creek (Ash Pond 2) PROJECT NO.: 15-328T

LOCATION:

BORING NO.: B026 SAMPLE NO.: ST-4 DEPTH: 33.5' - 35'

SAMPLE TYPE: Undisturbed % COMPACTION:

INITIAL DATA			FINAL DATA		
MOISTURE:	21.0	%	MOISTURE:	22.5	%
DRY UNIT WEIGHT:	106.4	pcf	DRY UNIT WEIGHT:	106.4	pcf
HEIGHT:	2.73	inches	HEIGHT:	2.73	inches
DIAMETER:	2.85	inches	DIAMETER:	2.85	inches
WEIGHT:	588.3	grams	WEIGHT:	595.5	grams
SATURATION:	97.1	%	SATURATION:	100.0	%

PERMEANT LIQUID: Deaired tap water

EFFECTIVE CONSOLIDATION STRESS: Maximum 5.4 psi Minimum 5.0 psi

BACK PRESSURE: 90 psi RANGE OF HYDRAULIC GRADIENT: 3.2 to 2.7

SAMPLE DESCRIPTION: Brown, spotted gray, speckled black and reddish brown LEAN CLAY with weathered shale

TEST DATA

DATE	TEST NO.	TIME (sec)	HEAD1 (cm)	HEAD 2 (cm)	TEMP °C
11/12 - 11/13	1	63,480	22.0	18.8	26
11/13 - 11/14	2	63,480	22.0	18.8	26
11/14 - 11/15	3	63,480	22.0	18.8	26
11/15 - 11/16	4	63,480	22.0	18.8	26
AVERAGE		63,480	22.0	18.8	26

k= 1.7E-07 cm/s n/n20= 0.8694

k20= 1.5E-07 cm/s

k = Hydraulic Conductivity before n/n20 correction factor
k20= Hydraulic Conductivity after correction to 20 ° Celsius

This is a laboratory testing result. Field values may vary.

No AL Data Available
WDS

APPENDIX C

ANALYTICAL RESULTS

APPENDIX C1

SURFACE WATER LEACHATE ANALYTICAL RESULTS SINCE 2000

Appendix C-1
Surface Water Leachate Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Sample	Sample Date	TDS (mg/L)	Hardness (mg/L)	Cl, diss (mg/L)	SO4, diss (mg/L)	B, diss (mg/L)	Fe, diss (mg/L)	Mn, diss (mg/L)
ASH POND	4/24/2000	7600	4400	2000	1700	220	0.17	1.4
ASH POND	9/18/2000	8200	4500	2400	1900	230	0.096	0.59
ASH POND	9/13/2001	10000	6900	3500	2100	380	2.7	1.5
ASH POND	4/25/2002	13000	13000	3400	1600	320	1.2	1.4
ASH POND	9/24/2002	10000	8400	3000	1500	380	0.14	1.3
ASH POND	4/18/2003	3200	5800	4000	1500	390	<0.01	1.8
ASH POND	9/24/2003	12000	7100	3900	1700	350	0.35	0.94
ASH POND	4/13/2004	12000	5100	4000	1300	260	<0.01	0.82
ASH POND	9/23/2004	14000	7300	4200	1600	380	<0.01	1.1
ASH POND	4/19/2005	14000	5900	4000	1600	340	<0.1	0.07
ASH POND	9/20/2005	13000	6800	4500	1800	390	0.2	0.27
ASH POND	4/28/2006	13000	5700	4500	1700	340	<0.01	0.086
ASH POND	9/7/2006	12000	7500	3900	1500	290	<0.01	0.23
ASH POND	4/2/2007	9600	6100	3900	1600	320	<0.01	0.17
ASH POND	9/19/2007	12000	5800	4200	1500	320	<0.01	0.079
ASH POND	3/27/2008	9200	5200	3800	1300	270	<0.01	0.082
ASH POND	8/19/2008	4700	6400	4600	1900	370	0.012	0.74
ASH POND	4/29/2009	6500	4600	3700	1400	230	0.021	0.16
ASH POND	9/23/2009	6300	3800	2300	1500	160	0.013	0.3
RECYCLE POND	4/24/2000	7800	4500	1700	2200	200	0.073	1.5
RECYCLE POND	9/18/2000	8200	4500	2700	2200	240	<0.01	0.62
RECYCLE POND	4/24/2001	8580	4700	2300	1700	230	0.88	1.5
RECYCLE POND	9/13/2001	10000	6400	3300	2100	73	1.9	0.4
RECYCLE POND	4/24/2002	13000	8516	3500	1700	310	0.23	1.5
RECYCLE POND	9/24/2002	11000	3600	3900	1900	390	0.33	1.1
RECYCLE POND	4/17/2003	10000	6700	3800	1600	380	<0.01	1.5
RECYCLE POND	9/23/2003	12000	7400	3700	1800	350	0.052	0.94
RECYCLE POND	4/12/2004	8800	6700	4200	1400	260	<0.01	0.78
RECYCLE POND	9/23/2004	13000	5600	2900	1400	180	<0.01	0.24
RECYCLE POND	4/18/2005	7100	5200	2800	1100	180	<0.05	0.47
RECYCLE POND	9/19/2005	14000	7800	4900	1500	380	<0.05	0.65
RECYCLE POND	4/28/2006	12000	6900	4700	1500	340	0.032	0.87
RECYCLE POND	9/7/2006	12000	7600	4400	1800	270	<0.01	0.72
RECYCLE POND	4/2/2007	11000	6800	4100	1400	330	<0.01	1.5
RECYCLE POND	9/19/2007	12000	2600	4400	1800	320	<0.01	0.13
RECYCLE POND	3/26/2008	11000	4000	3600	1100	290	<0.01	0.69
RECYCLE POND	8/19/2008	3800	5600	3700	1400	310	<0.01	0.06
RECYCLE POND	4/29/2009	6200	4000	3300	1400	180	0.016	0.42
RECYCLE POND	9/21/2009	6500	4000	3100	1400	66	0.01	0.033
RECYCLE POND	12/8/2009	6300	3900	2700	1100	180	0.027	0.038
RECYCLE POND	4/27/2010	6400	3500	2200	1000	170	<0.01	0.2

APPENDIX C2

POREWATER LEACHATE ANALYTICAL RESULTS

PDC Laboratories, Inc.
P.O. Box 9071 • Peoria, IL 61612-9071
(309) 692-9688 • (800) 752-6651 • FAX (309) 692-9689

ACCREDITED IN ACCORDANCE WITH nelac

Ameren Illinois Company - Duck Creek
17751 North Cilco Road
Canton, IL 61520-8761
Attn: John Berry

Date Received: 05/18/12 5:15
Report Date: 06/06/12
Customer #: 232857
PO#: 552820

Laboratory Results

Sample No: **2052527-01**

Collect Date: **05/16/12 10:00**
Matrix: **Ground Water Grab**

Sample Description: AP-1N

Parameters	Result		Qual	Prep Date	Analysis Date	Analyst	Method
General Chemistry - PIA							
Cyanide	< 0.0050	mg/L		05/21/12 07:12	05/22/12 16:17	lgtth	335.4
Solids - total dissolved solids (TDS)	4500	mg/L		05/22/12 08:32	05/22/12 09:37	BNS	SM 2540C 18Ed
Soluble Anions - PIA							
Chloride, Dissolved	1300	mg/L		06/04/12 15:46	06/04/12 15:46	PLI	EPA 300.0 R2.1
Fluoride, Dissolved	< 2.5	mg/L		05/21/12 21:39	05/21/12 21:39	SJW	EPA 300.0 R2.1
Nitrate, Dissolved	< 0.20	mg/L	H	05/21/12 21:39	05/21/12 21:39	SJW	EPA 300.0 R2.1
Sulfate, Dissolved	1100	mg/L		06/04/12 15:46	06/04/12 15:46	PLI	EPA 300.0 R2.1
Soluble General Chemistry - PIA							
Hardness	3300	mg CaCO3/L		05/29/12 15:35	05/29/12 15:35	SMP	SM 2340C 18Ed
Soluble Metals - PIA							
Antimony, Dissolved	3.6	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Arsenic, Dissolved	23	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Barium, Dissolved	180	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Beryllium, Dissolved	< 1.0	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Boron, Dissolved	43000	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Cadmium, Dissolved	7.3	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Chromium, Dissolved	33	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Cobalt, Dissolved	2.0	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Copper, Dissolved	4.6	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Iron, Dissolved	15	ug/L		05/24/12 10:28	05/24/12 14:37	JMW	SW 6010B
Lead, Dissolved	13	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Manganese, Dissolved	12	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Mercury, Dissolved	0.31	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Nickel, Dissolved	74	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Selenium, Dissolved	55	ug/L		06/01/12 11:51	06/04/12 07:53	JMW	SW 6020
Silver, Dissolved	< 5.0	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Thallium, Dissolved	< 1.0	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Zinc, Dissolved	< 6.0	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020

PDC Laboratories, Inc.
P.O. Box 9071 • Peoria, IL 61612-9071
(309) 692-9688 • (800) 752-6651 • FAX (309) 692-9689

ACCREDITED IN ACCORDANCE WITH nelac

Ameren Illinois Company - Duck Creek
17751 North Cilco Road
Canton, IL 61520-8761
Attn: John Berry

Date Received: 05/18/12 5:15
Report Date: 06/06/12
Customer #: 232857
PO#: 552820

Laboratory Results

Sample No: **2052527-02**

Collect Date: **05/16/12 10:35**
Matrix: **Ground Water Grab**

Sample Description: AP-2

Parameters	Result		Qual	Prep Date	Analysis Date	Analyst	Method
General Chemistry - PIA							X
Cyanide	0.012	mg/L		05/25/12 12:40	05/29/12 09:53	lgtth	335.4
Solids - total dissolved solids (TDS)	7600	mg/L		05/22/12 08:32	05/22/12 09:37	BNS	SM 2540C 18Ed
Soluble Anions - PIA							
Chloride, Dissolved	2300	mg/L		06/04/12 16:01	06/04/12 16:01	PLI	EPA 300.0 R2.1
Fluoride, Dissolved	< 2.5	mg/L		05/21/12 22:13	05/21/12 22:13	SJW	EPA 300.0 R2.1
Nitrate, Dissolved	< 0.20	mg/L	H	05/21/12 22:30	05/21/12 22:30	PLI	EPA 300.0 R2.1
Sulfate, Dissolved	1300	mg/L		06/04/12 16:01	06/04/12 16:01	PLI	EPA 300.0 R2.1
Soluble General Chemistry - PIA							
Hardness	5000	mg CaCO3/L		05/29/12 15:35	05/29/12 15:35	SMP	SM 2340C 18Ed
Soluble Metals - PIA							
Antimony, Dissolved	< 3.0	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Arsenic, Dissolved	31	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Barium, Dissolved	140	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Beryllium, Dissolved	< 1.0	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Boron, Dissolved	180000	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Cadmium, Dissolved	< 1.0	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Chromium, Dissolved	59	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Cobalt, Dissolved	3.1	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Copper, Dissolved	4.9	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Iron, Dissolved	160	ug/L		05/24/12 10:28	05/24/12 14:43	JMW	SW 6010B
Lead, Dissolved	< 1.0	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Manganese, Dissolved	40	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Mercury, Dissolved	< 0.20	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Nickel, Dissolved	100	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Selenium, Dissolved	86	ug/L		06/01/12 11:51	06/04/12 07:57	JMW	SW 6020
Silver, Dissolved	< 5.0	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Thallium, Dissolved	< 1.0	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Zinc, Dissolved	8.4	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020

PDC Laboratories, Inc.
P.O. Box 9071 • Peoria, IL 61612-9071
(309) 692-9688 • (800) 752-6651 • FAX (309) 692-9689

Ameren Illinois Company - Duck Creek
17751 North Cilco Road
Canton, IL 61520-8761
Attn: John Berry

Date Received: 05/18/12 5:15
Report Date: 06/06/12
Customer #: 232857
PO#: 552820

Laboratory Results

Notes

PDC Laboratories participates in the following accreditation/certification and proficiency programs at the following locations.
Endorsement by Federal or State Governments or their agencies is not implied.

PIA PDC Laboratories - Peoria, IL
NELAC Accreditation for Drinking Water, Wastewater, Hazardous and Solid Wastes Fields of Testing through IL EPA Lab No. 100230
Illinois Department of Public Health Bacteriological Analysis in Drinking Water Approved Laboratory Registry No. 17553
Drinking Water Certifications: Kansas (E-10338); Missouri (870); Wisconsin (998284430); Indiana (C-IL-040); Iowa (240)
Wastewater Certifications: Arkansas (88-0677); Wisconsin (998284430); Iowa (240); Kansas (E-10335)
Hazardous/Solid Waste Certifications; Arkansas (88-0677); Wisconsin (998284430); Iowa (240); Kansas (E-10335)
UST Certification; Iowa (240)

SPM PDC Laboratories - Springfield, MO
EPA DMR-QA Program

STL PDC Laboratories - St. Louis, MO
NELAC Accreditation for Wastewater, Hazardous and Solid Wastes Fields of Testing through KS EPA Lab No. E-10389

X Sulfide positive. Treated.
H Test performed after the expiration of the appropriate regulatory/advisory maximum allowable hold time.

Gail J. Schindler

Certified by: Gail J. Schindler, Project Manager

PDC LABORATORIES, INC.
2231 WEST ALTORFER DRIVE
PEORIA, IL 61615

ASH POND WELLS

PHONE # 800-752-6651
FAX # 309-692-9689

State where samples collected IL.

CHAIN OF CUSTODY RECORD

ALL HIGHLIGHTED AREAS MUST BE COMPLETED BY CLIENT (PLEASE PRINT) - (SAMPLE ACCEPTANCE POLICY ON REVERSE)

1 CLIENT: AMEREN - Duck Creek
ADDRESS: 17751 N. CILCO ROAD.
CITY STATE ZIP: CANTON, IL. 61520
CONTACT PERSON: JOHN BERRY

PROJECT NUMBER:
P.O. NUMBER:
MEANS SHIPPED:
PHONE NUMBER: 668-3868
FAX NUMBER:
DATE SHIPPED:
SAMPLER (PLEASE PRINT): JOHN BERRY / BRIAN CRAIG
SAMPLER'S SIGNATURE: [signature]

MATRIX TYPES:
WW-WASTEWATER
DW-DRINKING WATER
GW-GROUND WATER
WWSL-SLUDGE
NAS-SOLID
LCHT-LEACHATE
OTHER:

3 ANALYSIS REQUESTED

4 (FOR LAB USE ONLY)
LOGIN# 2052527-2
LOGGED BY:
LAB PROJ. #
TEMPLATE: ASH Pond
PROJ. MGR.:

2 SAMPLE DESCRIPTION AS YOU WANT ON REPORT	DATE COLLECTED	TIME COLLECTED	SAMPLE TYPE GRAB	SAMPLE TYPE COMP	MATRIX TYPE	BOTTLE COUNT	REMARKS
AP-1N	5/16/12	10:00	X			3	RUN ASH POND PARAMETERS. See GAIL SCHINDLER
AP-2	5/16/12	10:35	X			3	SEE GAIL SHINDLER

5 TURNAROUND TIME REQUESTED (PLEASE CIRCLE) (RUSH TAT IS SUBJECT TO PDC LABS APPROVAL AND SURCHARGE) NORMAL RUSH
DATE RESULTS NEEDED
RUSH RESULTS VIA (PLEASE CIRCLE) FAX PHONE E-MAIL
FAX # PHONE # EMAIL ADDRESS

6 The sample temperature will be measured upon receipt at the lab. By initialing this area you request that the lab notify you, before proceeding with analysis, if the sample temperature is outside of the range of 0.1-6.0°C. By not initialing this area you allow the lab to proceed with analytical testing regardless of the sample temperature. ______

7 RELINQUISHED BY: (SIGNATURE) [signature] DATE 5-18-12 TIME 1426 RECEIVED BY: (SIGNATURE) [signature] DATE 5-18-12 TIME 1426
RELINQUISHED BY: (SIGNATURE) [signature] DATE 5-18-12 TIME 1515 RECEIVED BY: (SIGNATURE) DATE TIME
RELINQUISHED BY: (SIGNATURE) DATE TIME RECEIVED AT LAB BY: (SIGNATURE) [signature] DATE 5/18/12 TIME 15:15

8 COMMENTS: (FOR LAB USE ONLY)
SAMPLE TEMPERATURE UPON RECEIPT 4 °C
CHILL PROCESS STARTED PRIOR TO RECEIPT Y OR N
SAMPLE(S) RECEIVED ON ICE Y OR N
PROPER BOTTLES RECEIVED IN GOOD CONDITION Y OR N
BOTTLES FILLED WITH ADEQUATE VOLUME Y OR N
SAMPLES RECEIVED WITHIN HOLD TIME(S) (EXCLUDES TYPICAL FIELD PARAMETERS) Y OR N
DATE AND TIME TAKEN FROM SAMPLE BOTTLE ______

Copies: white should accompany samples to PDC Labs. Yellow copy to be retained by the client.

PAGE ____ OF ____

APPENDIX C3

GROUNDWATER ANALYTICAL RESULTS SINCE 2000

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM01	4/25/2000			0.25				10						3.4	2800		10						1900	3400		
OM01	9/19/2000			1.7				8.7						2.9	2500		9.1						2000	3500		
OM01	4/24/2001			0.36				11						6.7	2400		10						1900	3377		
OM01	9/13/2001			0.2				11						3.8	2600		11						2200	3400		
OM01	4/24/2002			0.24				11						1.3	1779		8.4						1600	2900		
OM01	9/24/2002			0.18				11						2.7	2700		11						2000	3300		
OM01	4/17/2003			0.16				13						2.4	2200		9.7						1900	3200		
OM01	9/23/2003			0.2				10						4.6	2500		10						2000	3500		
OM01	4/12/2004			0.15				10						6	3100		8.8						1900	3400		
OM01	9/23/2004			0.18				8.2						8	2900		8.2						1800	3700		
OM01	4/18/2005			0.14				10						5.3	2700		9.2						1800	3000		
OM01	9/19/2005			5.4				75						9.4	2500		10						1600	3700		
OM01	4/28/2006			0.17				10						9.8	2600		9.4						1900	3500		
OM01	9/7/2006			0.17				14						5.4	2300		7.7						1700	3100		
OM01	4/2/2007			0.27				14						5	2400		8.2						1800	3400		
OM01	9/19/2007			0.1				12						6.3	1900		5.6						1800	3200		
OM01	3/26/2008			0.46				12						7.5	1900		9.8						1800	3200		
OM01	6/2/2008			0.15				10						3.6	1700		8.7						1900	3400		
OM01	8/18/2008			0.23				14						6.7	2300		9.3						2000	3300		
OM01	4/29/2009			0.17				18						1.5	2600		8.5						2000	3200		
OM01	9/23/2009			0.18				16						7.2	2600		9.2						2400	3400		
OM01	12/11/2009			0.32				17						0.089	2400		8.1						2100	3300		
OM01	4/27/2010			0.16				16						5.2	2500		8.3						2000	3400		
OM01	9/9/2010			0.22				20						10	2700		9.5						2000	3400		
OM01	2/22/2011	<0.005	<0.001	0.18	0.019	<0.001	<0.001	21	<0.005	0.033	<0.004	<0.003	<0.25	1	2600	<0.0002	9.3	0.055	<0.02	<0.001	<0.003	0.002	1800	3300	<0.001	0.014
OM01	4/28/2011	<0.005	0.002	0.17	0.018	<0.001	<0.001	18	<0.005	0.026	<0.004	<0.003	0.28	3.9	2600	<0.0002	8.6	0.026	<0.02	<0.001	<0.003	0.004	2100	3500	<0.001	0.015
OM01	8/25/2011	<0.005	0.002	0.18	0.02	<0.001	<0.001	24	<0.005	0.035	<0.004	<0.003	<2.5	8.3	2700	<0.0002	9.3	0.054	0.04	<0.001	<0.003	0.007	2000	3200	<0.001	0.017
OM01	10/13/2011	<0.005	0.003	0.16	0.015	<0.001	<0.001	15	<0.005	0.023	<0.004	<0.003	<0.25	9.6	2100	<0.0002	7.7	0.03	0.16	<0.001	<0.003	0.007	1500	2400	<0.001	0.011
OM01	2/22/2012	<0.005	0.003	0.18	0.017	<0.001	<0.001	18	<0.005	0.032	<0.004	<0.003	<0.25	8.1	990	<0.0002	8.3	0.053	0.64	<0.001	<0.003	0.008	1800	3200	<0.001	0.015
OM01	5/3/2012	<0.005	<0.001	0.16	0.017	<0.001	<0.001	18	<0.005	0.032	<0.004	<0.003	<0.25	7.2	3300	<0.0002	9	0.042	<0.02	<0.001	<0.003	0.001	1900	3400	<0.001	0.025
OM01	8/24/2012	<0.005	0.001	0.19	0.015	<0.001	<0.001	9.5	<0.005	0.033	<0.004	<0.003	<0.25	10	2900	<0.0002	8.3	0.077	0.03	<0.001	<0.003	0.002	2400	3400	<0.001	0.01
OM01	11/2/2012	<0.005	0.002	0.67	0.014	<0.001	<0.001	34	<0.005	0.033	<0.004	<0.003	0.49	9.4	2600	<0.0002	8.5	0.04	0.11	<0.001	<0.003	0.004	1800	3200	<0.001	0.016
OM01	2/5/2013	<0.0025	0.001	0.23	0.015	<0.0005	<0.0005	17	<0.005	0.03	<0.002	<0.0015	<0.25	9.7	2700	<0.0001	8.8	0.018	0.05	<0.0005	<0.0015	<0.0005	2000	3400	<0.0005	0.011
OM01	5/2/2013	<0.005	0.003	0.21	0.041	<0.001	<0.001	20	<0.005	0.033	<0.004	<0.003	<0.25	9.3	2600	<0.0002	8.8	0.053	<0.02	<0.001	<0.003	<0.001	2900	3200	<0.001	0.025
OM01	7/29/2013	<0.005	0.002	1.6	0.019	<0.001	<0.001	21	<0.005	0.031	<0.004	<0.003	<0.25	10	2500	<0.0002	8.4	0.045	<0.02	<0.001	<0.003	<0.001	1900	3400	<0.001	0.018
OM01	10/18/2013	<0.005	0.002	0.22	0.017	<0.001	<0.001	21	<0.005	0.027	<0.004	<0.003		11	2200	<0.0001	7.7	0.016	<0.02	<0.001	<0.003	<0.001	2000	3100	<0.001	0.009
OM01	3/30/2014	<0.005	0.003	0.17	0.014	<0.001	<0.001	18	<0.005	0.018	<0.004	<0.003		8.7	1500	<0.0002	5.8	0.012	0.4	<0.001	<0.003	<0.001	1300	2000	<0.001	0.026
OM01	4/23/2014	<0.005	0.002	0.23	0.014	<0.001	<0.001	21	<0.005	0.032	<0.004	<0.003		11	2400	<0.0002	8.8	0.018	<0.02	<0.001	<0.003	0.004	2600	3200	<0.001	0.015
OM01	7/17/2014			0.25				23						10	2400		8.2						2000	3500		
OM01	4/17/2015			0.74				22						0.41	1900		4.5						1600	2500		
OM01	9/14/2015			0.19				21						12	2700		8.7						1800	3200		
OM02	4/25/2000			0.76				66						0.9	870		2.2						280	1100		
OM02	9/19/2000			3				140						1.4	970		2.2						320	1300		
OM02	4/24/2001			2				160						1.3	900		2.3						340	1323		
OM02	9/13/2001			2.4				140						1.5	1100		2.6						370	1300		
OM02	4/25/2002			4.5				110						1.3	897		2.3						280	1200		
OM02	9/24/2002			2.5				110						1.1	820		2.4						280	1100		
OM02	4/17/2003			2.1				150						0.23	890		2.8						290	1200		
OM02	9/23/2003			2.7				150						1.9	750		2.1						340	1400		
OM02	4/12/2004			2.4				170						0.33	920		2.4						320	1300		
OM02	9/23/2004			3.2				190						3.4	1100		1.8						330	1400		
OM02	4/18/2005			3				190						0.95	990		2.5						340	3000		
OM02	9/19/2005			3.6				150						2.2	880		2.8						260	1400		
OM02	4/28/2006			3.3				210						0.74	990		2.7						330	1400		
OM02	9/7/2006			5.3				260						1.9	900		2.4						370	1500		
OM02	4/2/2007			4.4				240						0.98	1000		2.5						380	1500		
OM02	9/19/2007			5.5				230						0.8	1100		2.7						350	1500		
OM02	3/26/2008			6.4				260						0.88	960		3						340	1400		
OM02	6/2/2008			6.6				260						1.3	1000		2.5						340	1500		
OM02	8/18/2008			7.4				270						1.4	940		2.6						350	1500		

NATURAL RESOURCE TECHNOLOGY

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM02	4/29/2009			6.9				290						2.1	1800		2.5						330	1400		
OM02	9/23/2009			7.3				230						1.4	930		2.3						360	1300		
OM02	12/11/2009			7.2				230						0.52	880		2.1						300	1300		
OM02	4/27/2010			6				240						1	940		2.5						310	1300		
OM02	9/9/2010			5.7				200						1.1	890		2.4						260	1300		
OR02	6/2/2008			4				230						1.4	1400		2.6						340	1500		
OR02	8/18/2008			5.2				240						2.2	930		2.8						320	1500		
OR02	4/29/2009			2.2				230						1.6	2400		2.8						330	1400		
OR02	9/23/2009			5.2				270						1.8	970		2.6						350	1400		
OR02	12/11/2009			3.9				250						1.8	1000		2.9						400	1400		
OR02	4/27/2010			3.2				230						3	1000		2.8						320	1500		
OR02	9/9/2010			3.9				250						2.7	1000		2.6						360	1400		
OR02	2/22/2011	<0.005	0.003	3.1	0.032	<0.001	<0.001	220	<0.005	0.007	0.006	<0.003	<0.25	2.8	1100	<0.0002	3.3	0.048	0.22	<0.001	<0.003	0.003	420	1500	<0.001	0.012
OR02	4/28/2011	<0.005	0.004	2.2	0.036	<0.001	<0.001	280	<0.005	0.008	0.01	<0.003	0.3	5.4	3600	<0.0002	3.5	0.035	<0.02	0.001	<0.003	0.007	350	1500	<0.001	0.013
OR02	8/25/2011	<0.005	0.005	4.3	0.054	<0.001	<0.001	250	<0.005	0.007	0.011	0.007	<0.25	4.1	1200	<0.0002	2.7	0.051	<0.02	0.004	<0.003	0.012	300	1300	<0.001	0.02
OR02	10/13/2011	<0.005	0.004	4.4	0.031	<0.001	<0.001	250	<0.005	0.004	0.005	0.003	0.29	1.6	920	<0.0002	2.8	0.036	<0.02	<0.001	<0.003	0.013	290	1300	<0.001	0.007
OR02	2/22/2012	<0.005	0.005	3.2	0.034	<0.001	<0.001	270	<0.005	0.005	0.007	<0.003	0.29	0.067	1200	<0.0002	2.9	0.043	0.43	<0.001	<0.003	0.018	320	1400	<0.001	0.009
OR02	5/3/2012	<0.005	0.003	3.4	0.031	<0.001	<0.001	250	<0.005	0.006	0.005	0.014	0.25	2.1	1200	<0.0002	3	0.039	<0.02	<0.001	<0.003	0.009	340	1400	<0.001	0.013
OR02	8/24/2012	<0.005	0.004	3.1	0.03	<0.001	<0.001	340	<0.005	0.006	0.01	<0.003	<0.25	2.4	1200	<0.0002	2.8	0.057	0.04	<0.001	<0.003	0.013	390	1500	<0.001	0.007
OR02	11/2/2012	<0.005	0.004	2.9	0.028	<0.001	<0.001	290	<0.005	0.007	<0.004	<0.003	<0.25	2.4	1200	<0.0002	3	0.038	0.06	<0.001	<0.003	0.006	430	1500	<0.001	0.009
OR02	2/5/2013	<0.0025	<0.0005	2.2	0.028	<0.0005	<0.0005	320	<0.005	0.006	<0.002	<0.0015	<0.25	0.21	1200	<0.0001	3.4	0.029	0.24	<0.0005	<0.0015	<0.0005	440	1400	<0.0005	0.007
OR02	5/2/2013	<0.005	0.003	3.9	0.021	<0.001	<0.001	370	<0.005	0.005	0.004	<0.003	<0.25	3.7	1200	<0.0002	2.2	0.032	<0.02	<0.001	<0.003	0.002	510	1500	<0.001	0.01
OR02	7/29/2013	<0.005	0.003	4.6	0.025	<0.001	<0.001	230	<0.005	0.005	0.007	<0.003	0.33	1.6	970	<0.0002	2.5	0.036	0.04	<0.001	<0.003	0.003	310	1400	<0.001	0.009
OR02	10/18/2013	<0.005	0.006	4.8	0.062	<0.001	<0.001	210	<0.005	0.006	0.007	0.004		6.4	850	<0.0001	2.3	0.031	<0.02	0.006	<0.003	<0.001	260	1300	<0.001	0.022
OR02	3/30/2014	<0.005	<0.001	4.2	0.033	<0.001	<0.001	240	<0.005	0.005	<0.004	<0.003		0.13	970	<0.0002	2.7	0.028	0.19	<0.001	<0.003	<0.001	330	1300	<0.001	<0.006
OR02	4/23/2014	<0.005	0.001	5	0.029	<0.001	<0.001	240	<0.005	0.005	<0.004	<0.003		2	890	<0.0002	2.7	0.027	<0.02	<0.001	<0.003	0.002	350	1300	<0.001	<0.006
OR02	7/17/2014			4.4				250						0.096	860		2.5						320	1400		
OR02	4/17/2015			6.3				280						0.044	870		2.5						340	1300		
OR02	9/14/2015			4.6				230						1.6	980		2.3						300	1200		
OM03D	4/25/2000			1.6				13						0.65	960		1.4						430	1300		
OM03D	9/19/2000			2				12						1.4	890		1.4						400	1300		
OM03D	4/24/2001			1.6				14						1.2	900		1.3						420	1298.5		
OM03D	9/13/2001			1.5				14						2.1	990		1.2						440	1200		
OM03D	4/24/2002			1.4				13						1.1	728		1.1						270	1200		
OM03D	9/24/2002			1.5				16						0.8	840		1.4						360	1200		
OM03D	4/17/2003			1.4				19						1.2	800		1.2						340	1200		
OM03D	9/23/2003			1.2				14						0.79	820		1.1						330	1200		
OM03D	4/12/2004			1.3				15						0.19	940		1.2						340	1100		
OM03D	9/23/2004			1.3				14						0.19	910		1						330	1200		
OM03D	4/18/2005			1.3				15						0.27	830		1.1						340	1200		
OM03D	9/19/2005			1.3				16						0.54	760		1.2						280	1200		
OM03D	4/28/2006			1.7				18						3.5	890		1.1						360	1200		
OM03D	9/7/2006			1.6				18						0.5	700		1						340	1200		
OM03D	4/2/2007			1.4				18						0.14	780		0.91						340	1100		
OM03D	9/19/2007			1.8				54						0.6	770		1.2						280	1100		
OM03D	3/26/2008			1.4				28						0.56	630		1						290	1100		
OM03S	4/25/2000			0.91				3.7						0.99	950		0.62						320	1100		
OM03S	9/19/2000			1.3				3.2						5.6	930		0.74						260	1100		
OM03S	4/24/2001			0.35				4.5						5.7	750		0.71						160	923		
OM03S	9/13/2001			0.39				6.7						3.5	830		0.62						310	920		
OM03S	4/25/2002			0.72				4.3						3.6	949		0.65						160	970		
OM03S	9/24/2002			0.4				17						3.4	770		0.68						200	920		
OM03S	4/17/2003			0.34				4.2						3.1	680		0.52						180	920		
OM03S	9/23/2003			0.35				<5						4.5	840		0.55						220	980		
OM03S	4/12/2004			0.41				7.9						5.1	880		0.61						310	1100		
OM03S	9/23/2004			0.28				3.3						4.3	880		0.52						170	910		
OM03S	4/18/2005			0.44				3.4						4.7	830		0.62						230	2800		
OM03S	9/19/2005			0.48				11						2.6	780		0.63						180	960		
OM03S	4/28/2006			0.26				4.2						3	780		0.5						150	810		
OM03S	9/7/2006			0.44				4.1						3.6	610		0.58						170	850		

NATURAL RESOURCE TECHNOLOGY

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM03S	4/2/2007			0.46				5.9						1.7	890		0.63						200	910		
OM03S	9/19/2007			0.48				2						3.4	710		0.59						220	970		
OM03S	3/26/2008			0.45				3						3.9	850		0.45						220	950		
OR03D	6/2/2008			3.8				140						1.8	770		1.3						340	1400		
OR03D	8/18/2008			3.5				110						0.94	820		1.6						330	1300		
OR03D	4/29/2009			2.3				280						2.2	1000		1.5						390	1100		
OR03D	9/23/2009			2.3				86						2.6	880		1.4						370	1200		
OR03D	12/11/2009			2.4				100						2.6	840		1.4						440	1200		
OR03D	4/27/2010			2.3				78						2.8	810		1.4						290	1200		
OR03D	9/9/2010			2.3				65						2.7	950		1.3						320	1200		
OR03D	2/22/2011	<0.005	0.005	2.3	0.058	<0.001	<0.001	62	<0.005	<0.002	<0.004	<0.003	<0.25	3.2	1500	<0.0002	1.3	0.017	<0.02	<0.001	<0.003	0.003	310	1200	<0.001	<0.006
OR03D	4/28/2011	<0.005	0.007	3.4	0.063	<0.001	<0.001	86	<0.005	<0.002	<0.004	<0.003	0.27	3.5	890	<0.0002	1.3	0.007	<0.02	<0.001	<0.003	0.004	330	1300	<0.001	<0.006
OR03D	8/25/2011	<0.005	0.008	3.6	0.063	<0.001	<0.001	71	<0.005	0.002	0.005	0.004	<0.25	2.9	1200	<0.0002	1.3	0.019	0.08	<0.001	<0.003	0.008	330	1200	<0.001	<0.006
OR03D	10/13/2011	<0.005	0.004	2.4	0.067	<0.001	<0.001	67	<0.005	<0.002	<0.004	0.009	0.3	1.3	870	<0.0002	1.2	0.013	<0.02	<0.001	<0.003	0.007	320	1100	<0.001	0.014
OR03D	2/22/2012	<0.005	0.007	2.8	0.07	<0.001	<0.001	79	<0.005	<0.002	<0.004	<0.003	<0.25	3.5	910	<0.0002	1.2	0.016	0.05	<0.001	<0.003	0.005	380	1200	<0.001	<0.006
OR03D	5/3/2012	<0.005	0.002	2.9	0.063	<0.001	<0.001	84	<0.005	<0.002	<0.004	0.003	<0.25	0.021	810	<0.0002	0.94	0.012	0.54	<0.001	<0.003	0.007	510	1200	<0.001	0.024
OR03D	8/24/2012	<0.005	0.004	2.5	0.051	<0.001	<0.001	82	<0.005	<0.002	0.004	<0.003	<0.25	0.064	860	<0.0002	1.1	0.022	0.22	<0.001	<0.003	0.008	460	1300	<0.001	<0.006
OR03D	11/2/2012	<0.005	0.005	3.6	0.048	<0.001	<0.001	84	<0.005	<0.002	<0.004	<0.003	<0.25	2.3	950	<0.0002	1.2	0.01	<0.02	<0.001	<0.003	0.003	360	1200	<0.001	<0.006
OR03D	2/5/2013	<0.0025	0.003	2.7	0.046	<0.0005	<0.0005	76	<0.005	0.002	<0.002	<0.0015	<0.25	1.4	930	<0.0001	1.2	0.003	0.13	<0.0005	<0.0015	<0.0005	380	1200	<0.0005	0.004
OR03D	5/1/2013	<0.005	0.001	2.6	0.049	<0.0005	<0.001	74	<0.005	<0.002	<0.004	<0.003	<0.25	0.72	890	<0.0002	1.2	<0.005	0.29	<0.001	<0.003	<0.001	410	1100	<0.001	0.008
OR03D	7/29/2013	<0.005	0.003	2.9	0.047	<0.001	<0.001	69	<0.005	<0.002	<0.004	<0.003	<0.25	0.57	860	<0.0002	1.2	0.012	0.19	<0.001	<0.003	<0.001	330	1200	<0.001	0.007
OR03D	10/18/2013	<0.005	0.002	2.4	0.043	<0.001	<0.001	64	<0.005	<0.002	<0.004	<0.003		0.85	780	<0.0001	0.95	<0.005	0.29	<0.001	<0.003	<0.001	330	1200	<0.001	0.008
OR03D	3/30/2014	<0.005	0.003	2.4	0.051	<0.001	<0.001	68	<0.005	<0.002	<0.004	0.016		0.62	890	<0.0002	1.2	0.008	0.07	<0.001	<0.003	<0.001	340	1200	<0.001	0.007
OR03D	4/23/2014	<0.005	0.005	2.6	0.054	<0.001	<0.001	68	<0.005	<0.002	<0.004	<0.003		2.2	840	<0.0002	1.3	<0.005	<0.02	<0.001	<0.003	<0.001	370	1200	<0.001	<0.006
OR03D	7/17/2014			1.6				44						0.51	1300		8.6						230	860		
OR03D	10/13/2014																1.2									
OR03D	4/17/2015			3.1				82						<0.01	900		1.1						390	1300		
OR03D	9/14/2015			5				150						3.3	11000		0.74						350	1400		
OR03S	6/2/2008			0.53				20						0.56	760		1						200	970		
OR03S	8/18/2008			0.98				17						0.57	740		0.95						210	940		
OR03S	4/29/2009			0.49				19						3	1100		0.7						170	830		
OR03S	9/23/2009			0.51				20						2.6	820		0.65						220	920		
OR03S	12/11/2009			0.52				13						1.6	750		0.61						190	880		
OR03S	4/27/2010			0.41				15						2.5	690		0.59						180	1200		
OR03S	9/9/2010			0.34				18						3.8	700		0.62						160	850		
OR04D	4/24/2000			110				1300						6.5	3200		1.1						1300	5000		
OR04D	9/18/2000			110				1600						6.8	2900		1.1						1600	5600		
OR04D	4/24/2001			110				1200						7.8	2800		1.1						1100	4570		
OR04D	9/13/2001			140				1400						6.8	3400		1.4						1300	5600		
OR04D	4/24/2002			84				770						6.5	3396		1						690	4900		
OR04D	9/24/2002			13				1400						6	3500		1.3						1200	5300		
OR04D	4/17/2003			110				1600						6.4	2900		1.2						1200	5200		
OR04D	9/23/2003			110				1400						6.8	3200		1.1						1200	5200		
OR04D	4/12/2004			91				1400						6.4	3400		1.1						1200	5300		
OR04D	9/24/2004			110				1500						7	3600		1.1						1200	5500		
OR04D	4/18/2005			120				1500						6.4	3100		1.1						1200	5400		
OR04D	9/19/2005			110				1100						5.8	3000		1.2						1000	5100		
OR04D	4/28/2006			100				1300						5.9	2800		1.1						1100	4800		
OR04D	9/7/2006			120				1500						6.6	3100		1.1						1300	5000		
OR04D	4/2/2007			91				1300						1.5	2800		0.8						1200	4800		
OR04D	9/19/2007			120				1400						0.51	3100		1.2						1200	5500		
OR04D	3/27/2008			120				1800						6.6	3000		1.1						1200	5300		
OR04D	6/2/2008			120				1600						6.4	2300		1.2						1200	6400		
OR04D	8/18/2008			110				1200						6.4	2900		1.1						1100	5200		
OR04D	4/29/2009			120				1700						5.7	3800		1.2						1800	5100		
OR04D	9/22/2009			52				750						0.058	1400		0.01						720	2700		
OR04D	12/8/2009			0.12				9.6						3.6	730		2.6						140	830		
OR04D	4/27/2010			63				620						6.4	2400		0.87						890	3500		
OR04D	9/8/2010			60				840						5.6	2300		0.94						1300	3700		
OR04D	2/22/2011	<0.005	0.006	58	0.06	<0.001	<0.001	590	<0.005	0.007	0.017	<0.003	<0.25	6.1	2500	<0.0002	0.84	0.076	<0.02	<0.001	<0.003	0.013	1000	3200	<0.001	<0.006

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Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OR04D	4/29/2011	<0.005	0.006	59	0.063	<0.001	<0.001	570	<0.005	0.004	0.022	<0.003	0.38	4.1	1800	<0.0002	0.59	0.048	0.06	0.014	<0.003	0.02	970	3100	<0.001	<0.006
OR04D	8/25/2011	<0.005	0.007	52	0.12	<0.001	<0.001	530	<0.005	0.004	0.019	0.004	<0.25	1.4	2000	<0.0002	0.31	0.061	1.7	<0.001	<0.003	0.026	690	2300	<0.001	<0.006
OR04D	10/13/2011	<0.005	0.006	45	0.054	<0.001	<0.001	580	<0.005	0.005	0.013	<0.003	<2.5	3.3	1800	<0.0002	0.57	0.053	0.22	<0.001	<0.003	0.028	1100	2700	<0.001	<0.006
OR04D	2/22/2012	<0.005	0.009	46	0.064	<0.001	<0.001	460	<0.005	0.005	0.013	<0.003	<0.25	2.3	1800	<0.0002	0.45	0.061	0.63	<0.001	<0.003	0.03	820	2600	<0.001	0.007
OR04D	5/3/2012	<0.005	0.01	73	0.029	<0.001	<0.001	590	<0.005	<0.002	0.019	<0.003	<0.25	6.3	2600	<0.0002	0.95	0.056	0.04	<0.001	<0.003	0.024	1200	3200	<0.001	0.012
OR04D	8/24/2012	<0.005	0.008	42	0.033	<0.001	<0.001	440	<0.005	0.008	0.015	<0.003	0.41	7.1	2200	<0.0002	0.75	0.086	0.02	<0.001	<0.003	0.019	1200	2900	<0.001	<0.006
OR04D	11/2/2012	<0.005	0.007	36	0.028	<0.001	<0.001	470	<0.005	0.007	0.005	<0.003	<0.25	6.3	1900	<0.0002	0.69	0.053	0.15	<0.001	<0.003	0.009	1100	2700	<0.001	<0.006
OR04D	2/4/2013	<0.0025	<0.0005	38	0.048	<0.0005	<0.0005	350	<0.005	0.006	<0.002	<0.0015	<0.25	0.62	1800	<0.0001	0.58	0.038	0.26	<0.0005	<0.0015	<0.0005	950	2600	<0.0005	0.012
OR04D	5/2/2013	<0.005	0.007	42	0.058	<0.001	<0.001	320	<0.005	0.008	0.008	<0.003	<0.25	6.7	1800	<0.0002	0.7	0.057	<0.02	<0.001	<0.003	0.004	1000	2500	<0.001	<0.006
OR04D	7/31/2013	<0.005	0.007	40	0.031	<0.001	<0.001	440	<0.005	0.002	0.011	<0.003	<0.25	4.3	2000	<0.0002	0.72	0.041	0.07	<0.001	<0.003	0.008	1100	3100	<0.001	0.008
OR04D	10/21/2013	<0.005	0.005	33	0.033	<0.001	<0.001	490	<0.005	<0.002	<0.004	<0.003		4.8	1800	<0.0002	0.75	0.021	0.05	<0.001	<0.003	<0.001	1300	2800	<0.001	<0.006
OR04D	3/30/2014	<0.005	<0.001	29	0.071	<0.001	<0.001	390	<0.005	0.003	<0.004	<0.003		0.065	1600	<0.0002	0.37	0.032	1.6	<0.001	<0.003	<0.001	900	2200	<0.001	0.008
OR04D	4/24/2014	<0.005	<0.001	36	0.034	<0.001	<0.001	310	<0.005	0.005	<0.004	<0.003		3.8	1600	<0.0002	0.67	0.03	<0.02	<0.001	<0.003	0.001	1000	2600	<0.001	<0.006
OR04D	7/18/2014			19				280						0.016	920		0.03						680	1700		
OR04D	4/17/2015			18				210						0.018	730		0.018						610	1200		
OR04D	9/15/2015			11				130						3.2	1800		0.47						690	1700		
OM04S	4/24/2000			100				1900						4.4	3100		1.8						1900	4600		
OM04S	9/18/2000			0.32				9.6						0.61	950		3.2						310	1100		
OM04S	4/24/2001			1				15						0.67	910		3						280	1033		
OM04S	9/13/2001			0.097				8.7						2.1	1000		3.8						310	1100		
OM04S	4/25/2002			0.31				5.3						0.53	852		3						190	1000		
OM04S	9/24/2002			0.82				7.7						0.4	880		3.3						240	940		
OM04S	4/17/2003			0.12				9.4						0.27	760		3						250	1000		
OM04S	9/23/2003			0.74				7.8						1.5	910		3.4						290	1100		
OM04S	4/12/2004			0.97				6.5						1.1	1000		2.6						240	1000		
OM04S	9/23/2004			0.18				6.3						2.1	1100		3						240	1000		
OM04S	4/18/2005			1.4				7.8						1.3	850		2.8						240	980		
OM04S	9/19/2005			0.061				7.6						2	860		3.9						200	1000		
OM04S	4/28/2006			0.13				7.2						0.82	770		2.8						220	930		
OM04S	9/7/2006			0.078				7.8						2.6	700		3						260	990		
OM04S	4/2/2007			0.28				9.8						0.01	690		2.1						190	770		
OM04S	9/19/2007			0.18				5.2						0.9	490		2						140	600		
OM04S	3/27/2008			0.78				14						0.069	920		2.2						220	850		
OM04S	6/2/2008			0.076				8.6						0.011	690		2.5						210	910		
OM04S	8/18/2008			0.24				8.9						1.4	760		3.2						210	960		
OM04S	4/29/2009			0.15				280						<0.01	850		2.4						240	930		
OM04S	9/22/2009			0.095				12						3	740		2.8						190	880		
OM04S	12/8/2009			46				780						0.012	1600		0.012						700	2700		
OM04S	4/27/2010			0.11				10						0.024	700		2						170	820		
OM04S	9/8/2010			0.18				13						2.3	850		3						220	860		
OM04S	2/22/2011	<0.005	<0.001	0.15	0.046	<0.001	<0.001	9.8	<0.005	0.01	<0.004	<0.003	<0.25	3.2	770	<0.0002	3.2	0.02	<0.02	<0.001	<0.003	0.001	200	880	<0.001	0.008
OM04S	4/29/2011	<0.005	<0.001	0.14	0.035	<0.001	<0.001	15	<0.005	0.003	<0.004	<0.003	0.31	0.41	720	<0.0002	2.5	0.01	0.16	<0.001	<0.003	<0.001	160	800	<0.001	0.01
OM04S	8/25/2011	<0.005	<0.001	0.093	0.049	<0.001	<0.001	18	<0.005	0.01	<0.004	0.005	0.25	3.1	1100	<0.0002	3	0.018	<0.02	<0.001	<0.003	0.003	190	860	<0.001	0.006
OM04S	10/13/2011	<0.005	0.001	0.14	0.048	<0.001	<0.001	12	<0.005	0.009	<0.004	<0.003	0.33	3.7	790	<0.0002	3.3	0.014	0.45	<0.001	<0.003	0.002	200	820	<0.001	<0.006
OM04S	2/22/2012	<0.005	0.002	0.63	0.046	<0.001	<0.001	17	<0.005	0.009	<0.004	<0.003	<0.25	4.5	790	<0.0002	2.8	0.017	0.06	<0.001	<0.003	0.004	190	790	<0.001	<0.006
OM04S	5/3/2012	<0.005	<0.001	0.11	0.041	<0.001	<0.001	12	<0.005	0.008	<0.004	<0.003	0.26	3.3	710	<0.0002	2.6	0.011	0.06	<0.001	<0.003	0.002	190	810	<0.001	0.012
OM04S	8/24/2012	<0.005	<0.001	0.091	0.045	<0.001	<0.001	13	<0.005	0.01	<0.004	<0.003	0.26	4	820	<0.0002	3	0.024	0.03	<0.001	<0.003	0.002	190	880	<0.001	<0.006
OM04S	11/2/2012	<0.005	0.001	0.67	0.045	<0.001	<0.001	15	<0.005	0.011	<0.004	<0.003	<0.25	4.1	840	<0.0002	2.9	0.012	<0.02	<0.001	<0.003	<0.001	220	920	<0.001	<0.006
OM04S	2/4/2013	<0.0025	0.001	0.23	0.048	<0.0005	<0.0005	16	<0.005	0.008	<0.002	<0.0015	0.29	2	750	<0.0001	2.8	0.006	<0.02	<0.0005	<0.0015	<0.0005	160	780	<0.0005	<0.003
OM04S	5/2/2013	<0.005	<0.001	0.13	0.034	<0.001	<0.001	14	<0.005	0.008	<0.004	<0.003	0.28	0.25	710	<0.0002	2.2	0.012	<0.02	<0.001	<0.003	<0.001	160	730	<0.001	0.019
OM04S	7/31/2013	<0.005	0.002	0.46	0.043	<0.001	<0.001	14	<0.005	0.01	<0.004	<0.003	0.27	3.6	750	<0.0002	2.7	0.013	<0.02	<0.001	<0.003	<0.001	170	810	<0.001	<0.006
OM04S	10/21/2013	<0.005	0.001	0.26	0.042	<0.001	<0.001	16	<0.005	0.01	<0.004	<0.003		3.5	740	<0.0002	3	0.006	0.04	<0.001	<0.003	<0.001	210	840	<0.001	<0.006
OM04S	3/30/2014	<0.005	0.001	0.14	0.048	<0.001	<0.001	14	<0.005	0.008	<0.004	<0.003		4.3	730	<0.0002	2.8	0.005	<0.02	<0.001	<0.003	<0.001	170	820	<0.001	<0.006
OM04S	4/24/2014	<0.005	<0.001	0.2	0.042	<0.001	<0.001	13	<0.005	0.007	<0.004	<0.003	0.25	0.049	670	<0.0002	2.6	<0.005	0.14	<0.001	<0.003	<0.001	200	760	<0.001	0.007
OM04S	7/18/2014			0.8				18						2.9	660		2.4						170	750		
OM04S	4/17/2015			1.2				14						4.2	720		2.6						150	720		
OM04S	9/15/2015			1				13						6	750		2.8						160	870		
OM05D	4/24/2000			5.5				97						7	1600		0.73						440	1500		
OM05D	9/18/2000			4.8				120						7	970		0.8						530	1500		
OM05D	4/24/2001			4.6				120						7	960		0.72						460	1540		

NATURAL RESOURCE TECHNOLOGY

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM05D	9/13/2001			5.1				140						7.4	1100		0.79						520	1600		
OM05D	4/25/2002			4.6				110						3.7	784		0.41						350	1400		
OM05D	9/25/2002			5.1				160						6.7	1100		0.83						490	1700		
OM05D	4/17/2003			5				270						6.4	990		0.76						470	1200		
OM05D	9/23/2003			5				140						8	1000		1						480	1600		
OM05D	4/12/2004			5.1				160						7.3	1300		0.78						500	1100		
OM05D	9/23/2004			5				160						10	1100		0.99						480	1700		
OM05D	4/18/2005			4.8				150						5.6	980		0.57						470	1600		
OM05D	9/19/2005			5				120						6.6	950		0.9						410	1600		
OM05D	4/28/2006			4.6				150						0.029	1000		0.008						490	1500		
OM05D	9/7/2006			5				150						6.2	740		0.84						500	1500		
OM05D	4/2/2007			5				150						<0.01	1100		0.014						490	1500		
OM05D	9/19/2007			4.7				150						7.2	880		0.92						490	1500		
OM05D	3/27/2008			6.1				180						8.1	870		0.72						460	1500		
OM05D	6/3/2008			7.4				250						4.5	1000		1.2						490	1800		
OM05D	8/18/2008			9				230						8.2	1100		1.3						490	1800		
OM05D	4/30/2009			9.4				240						0.025	1100		0.009						480	1600		
OM05D	9/22/2009			8				280						6.2	1100		1.2						680	1800		
OM05D	12/8/2009			8				240						7.4	1100		1.3						540	1700		
OM05D	4/27/2010			7.8				240						0.075	1000		0.095						500	1700		
OM05D	9/8/2010			6.7				250						6.8	1100		0.94						570	1800		
OM05S	4/24/2000			3.1				13						12	830		0.73						240	1000		
OM05S	9/18/2000			0.73				5.8						13	640		0.78						280	990		
OM05S	4/24/2001			0.82				8						5.4	920		1.2						350	1150		
OM05S	9/13/2001			1				5.8						12	860		0.69						240	1000		
OM05S	4/25/2002			0.5				10						11	1100		0.94						310	1200		
OM05S	9/25/2002			0.62				6.2						12	860		0.73						240	1000		
OM05S	4/17/2003			0.59				6.2						11	700		0.73						240	1000		
OM05S	9/23/2003			0.78				7						12	780		0.67						250	990		
OM05S	4/12/2004			0.51				8.4						11	1100		0.68						290	910		
OM05S	9/23/2004			0.55				7.1						12	780		0.63						240	1000		
OM05S	4/18/2005			0.94				13						9.8	1200		1.4						580	1200		
OM05S	9/19/2005			0.56				7.4						11	740		0.73						210	990		
OM05S	4/28/2006			0.59				6.2						16	760		0.77						230	980		
OM05S	9/7/2006			0.64				8						11	670		0.63						220	930		
OM05S	4/2/2007			1.3				40						0.53	1500		0.86						870	2000		
OM05S	9/19/2007			0.58				6.8						9.4	890		0.64						240	1000		
OM05S	3/27/2008			0.63				7.7						9.3	2300		0.57						220	910		
OM05S	6/3/2008			2.1				8.8						10	960		0.6						250	940		
OM05S	8/18/2008			0.73				9.8						11	770		0.64						220	970		
OM05S	4/30/2009			0.56				59						4.5	2200		1						1100	2400		
OM05S	9/22/2009			0.69				27						10	800		0.63						270	1000		
OM05S	12/8/2009			0.58				32						14	1400		2.4						800	1900		
OM05S	4/27/2010			0.46				14						12	1000		2.4						450	1300		
OM05S	9/8/2010			0.55				13						11	960		1.3						300	1000		
OR05D	6/3/2008			6.5				220						8.9	1200		0.78						470	1700		
OR05D	8/18/2008			4.9				170						10	990		0.78						400	1500		
OR05D	4/30/2009			6.4				190						0.013	1000		0.4						380	1500		
OR05D	9/22/2009			6.3				240						0.062	1100		0.7						480	1600		
OR05D	12/8/2009			6.8				220						0.098	1100		0.73						510	1600		
OR05D	4/27/2010			5.7				180						0.31	980		0.54						440	1500		
OR05D	9/8/2010			3.9				140						5.7	1100		1.2						400	1300		
OM06	9/19/2000			2.1				16						1.8	660		0.97						350	1100		
OM06	4/24/2001			1.8				21						9.3	560		1.1						360	1447		
OM06A	4/24/2000			2.6				18						1.4	650		0.85						340	1200		
OM06A	9/13/2001			2.2				19						2.1	700		0.89						420	1100		
OM06A	4/24/2002			2.6				21						2	606		0.73						280	1100		
OM06A	9/24/2002			2.2				25						2.1	680		0.92						350	1100		
OM06A	4/17/2003			2				26						1	540		0.95						340	1200		
OM06A	9/23/2003			2				23						2	640		0.88						360	1100		

NATURAL RESOURCE TECHNOLOGY

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

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OM06A	4/12/2004			1.8				23						0.2	700		0.63						350	1100		
OM06A	9/23/2004			1.9				22						2.2	816		0.78						350	1200		
OM06A	4/18/2005			1.8				22						0.92	590		0.98						330	1100		
OM06A	9/19/2005			1.9				23						3.3	550		0.87						330	1100		
OM06A	4/28/2006			1.8				22						0.18	570		0.59						330	1100		
OM06A	9/7/2006			1.9				21						1.6	510		0.83						350	1100		
OM06A	4/2/2007			1.9				23						0.21	600		0.86						350	1100		
OM06A	9/19/2007			1.8				17						1.5	490		0.89						340	1100		
OM06A	3/27/2008			1.8				22						1.7	530		0.69						320	1100		
OM06A	6/2/2008			1.9				23						1.2	1100		0.85						340	1100		
OM06A	8/18/2008			1.8				21						1.6	550		0.88						330	1100		
OM06A	4/30/2009			1.9				31						1.6	800		0.89						340	1100		
OM06A	9/22/2009			1.4				22						1.8	690		2.9						370	1100		
OM06A	12/8/2009			2				27						1.1	610		0.97						330	1100		
OM06A	4/27/2010			1.7				23						5.3	600		0.78						350	1200		
OM06A	9/8/2010			1.3				20						2	720		1.2						360	1100		
OR06A	6/2/2008			1.4				24						1	1500		2.6						360	1100		
OR06A	8/18/2008			1.6				23						1.3	650		2.6						350	1100		
OR06A	4/30/2009			1.3				24						0.54	780		2.6						340	1100		
OR06A	9/22/2009			1.9				25						2.4	600		1.2						450	1100		
OR06A	12/8/2009			1.4				21						0.68	660		1.6						360	1100		
OR06A	4/27/2010			1.2				20						1.6	1500		2.6						410	1100		
OR06A	9/8/2010			1.5				25						4.4	910		2.8						420	1200		
OR06A	2/22/2011	<0.005	0.004	1.7	0.067	<0.001	<0.001	28	<0.005	0.009	0.006	0.009	<0.25	11	1000	<0.0002	3.1	0.052	0.13	0.01	<0.003	0.002	370	1200	<0.001	0.032
OR06A	4/29/2011	<0.005	0.008	1.5	0.1	<0.001	<0.001	24	<0.005	0.009	0.006	0.008	<0.25	8	1100	<0.0002	3.1	0.042	<0.02	0.01	<0.003	0.002	370	1100	<0.001	0.025
OR06A	8/26/2011	<0.005	0.005	1.7	0.035	<0.001	<0.001	35	<0.005	0.006	0.005	0.003	<0.25	2.3	820	<0.0002	3	0.036	0.04	<0.001	<0.003	0.006	410	1200	<0.001	<0.006
OR06A	10/14/2011	<0.005	0.006	1.6	0.039	<0.001	<0.001	22	<0.005	0.005	<0.004	0.003	<0.25	2.6	750	<0.0002	3	0.035	<0.02	<0.001	<0.003	0.006	290	1100	<0.001	<0.006
OR06A	2/22/2012	<0.005	0.002	1.6	0.031	<0.001	<0.001	25	<0.005	0.004	<0.004	<0.003	<0.25	0.068	810	<0.0002	2.2	0.03	0.1	<0.001	<0.003	0.009	400	1200	<0.001	<0.006
OR06A	5/4/2012	<0.005	0.003	2.2	0.035	<0.001	<0.001	31	<0.005	0.004	0.005	<0.003	<0.25	0.77	810	<0.0002	2.6	0.032	0.06	<0.001	<0.003	0.002	400	1200	<0.001	0.008
OR06A	8/24/2012	<0.005	0.006	1.5	0.04	<0.001	<0.001	27	<0.005	0.005	<0.004	0.007	<0.25	3.1	890	<0.0002	2.6	0.043	0.02	0.001	<0.003	0.005	390	1200	<0.001	0.018
OR06A	11/1/2012	<0.005	0.006	1.6	0.045	<0.001	<0.001	27	<0.005	0.004	<0.004	<0.003	<0.25	2	800	<0.0002	2.5	0.03	0.03	<0.001	<0.003	0.003	450	1200	<0.001	<0.006
OR06A	2/4/2013	<0.0025	0.001	1.7	0.035	<0.0005	<0.0005	31	<0.005	0.004	<0.002	<0.0015	<0.25	0.16	830	<0.0001	2.5	0.022	<0.02	<0.0005	<0.0015	<0.0005	390	1100	<0.0005	<0.003
OR06A	5/3/2013	<0.005	0.002	1.6	0.041	<0.001	<0.001	30	<0.005	0.002	<0.004	<0.003	<0.25	0.041	840	<0.0002	2.2	0.035	0.13	<0.001	<0.003	0.001	390	1100	<0.001	<0.006
OR06A	7/31/2013	<0.005	0.004	1.7	0.04	<0.001	<0.001	30	<0.005	0.007	<0.004	<0.003	<0.25	2.3	860	<0.0002	2.9	0.028	<0.02	<0.001	<0.003	<0.001	410	1200	<0.001	<0.006
OR06A	10/18/2013	<0.005	0.004	1.6	0.032	<0.001	<0.001	30	<0.005	0.004	<0.004	<0.003		2.3	710	<0.0001	2.2	0.019	<0.02	<0.001	<0.003	<0.001	420	1100	<0.001	<0.006
OR06A	3/30/2014	<0.005	0.002	1.4	0.039	<0.001	<0.001	30	<0.005	0.003	<0.004	0.042		0.33	720	<0.0002	2	0.02	0.09	<0.001	<0.003	<0.001	360	1100	<0.001	<0.006
OR06A	4/24/2014	<0.005	<0.001	1.4	0.029	<0.001	<0.001	25	<0.005	<0.002	<0.004	<0.003	<0.25	0.069	730	<0.0002	1.9	0.017	0.18	<0.001	<0.003	<0.001	350	1100	<0.001	<0.006
OR06A	7/17/2014			1.3				28						2	860		2.5						370	1100		
OR06A	4/17/2015			1.5				32						0.043	2400		2.2						380	1100		
OR06A	9/14/2015			1.4				31						2.9	1600		2.3						320	1100		
OM07	4/24/2000			1.7				16						0.75	870		1.1						660	960		
OM07	9/19/2000			1.7				23						2.3	780		1						140	1600		
OM07	4/24/2001			1.8				23						2	760		1.1						660	1617		
OM07	9/13/2001			1.9				18						2.3	910		0.71						670	1600		
OM07	4/24/2002			1.9				12						2.2	755		0.62						340	1600		
OM07	9/24/2002			1.8				18						1.4	820		1						690	1600		
OM07	4/17/2003			1.7				18						2.2	720		0.73						650	1700		
OM07	9/23/2003			1.3				17						0.51	930		1.7						610	1500		
OM07	4/12/2004			1.5				19						2	840		0.72						680	1600		
OM07	9/23/2004			1.3				17						0.95	970		1.5						660	1600		
OM07	4/18/2005			1.1				15						<0.01	890		0.031						580	1500		
OM07	9/19/2005			1.6				19						0.81	830		1.7						650	1600		
OM07	4/28/2006			1.2				17						0.29	920		0.84						640	1600		
OM07	9/7/2006			1.4				16						0.19	920		2						640	1500		
OM07	4/2/2007			1.2				17						<0.01	870		0.034						620	1400		
OM07	9/19/2007			1.5				18						1.1	690		1.1						720	1700		
OM07	3/27/2008			1.5				19						1.7	700		0.75						690	1600		
OM07	6/2/2008			1.5				18						0.035	830		1.5						700	1600		
OM07	8/19/2008			1.4				20						0.63	1400		1.5						630	1600		
OM07	4/30/2009			1.5				23						0.02	960		0.97						660	1600		

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

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OM07	9/22/2009			1.6				22						0.69	890		2						730	1600		
OM07	12/8/2009			1.6				20						0.51	870		1.5						800	1600		
OM07	4/27/2010			1.5				27						0.017	820		1.2						670	1600		
OM07	9/8/2010			0.8				21						<0.01	940		0.23						530	1300		
OM07	2/22/2011	<0.005	<0.001	0.87	0.027	<0.001	<0.001	19	<0.005	<0.002	<0.004	<0.003	<0.25	0.027	770	<0.0002	0.22	0.014	0.26	<0.001	<0.003	0.001	410	1100	<0.001	0.01
OM07	4/29/2011	<0.005	<0.001	1	0.05	<0.001	<0.001	12	<0.005	<0.002	<0.004	<0.003	<0.25	0.45	820	<0.0002	1.3	0.006	0.12	<0.001	<0.003	0.003	420	1200	<0.001	<0.006
OM07	8/25/2011	<0.005	<0.001	1.5	0.028	<0.001	<0.001	15	<0.005	0.003	<0.004	0.004	0.29	0.46	930	<0.0002	1.4	0.014	<0.02	<0.001	<0.003	0.003	440	1100	<0.001	<0.006
OM07	10/14/2011	<0.005	<0.001	0.92	0.026	<0.001	<0.001	13	<0.005	<0.002	<0.004	0.003	0.29	0.7	780	<0.0002	1.5	0.013	<0.02	<0.001	<0.003	0.002	370	1100	<0.001	<0.006
OM07	2/22/2012	<0.005	0.001	0.75	0.026	<0.001	<0.001	14	<0.005	<0.002	<0.004	<0.003	<0.25	<0.01	790	<0.0002	0.23	0.012	0.24	<0.001	<0.003	0.004	390	1100	<0.001	<0.006
OM07	5/4/2012	<0.005	<0.001	0.8	0.028	<0.001	<0.001	13	<0.005	<0.002	<0.004	<0.003	0.29	0.012	780	<0.0002	1.3	0.009	0.13	<0.001	<0.003	0.003	280	1000	<0.001	<0.006
OM07	8/24/2012	<0.005	<0.001	0.58	0.026	<0.001	<0.001	18	<0.005	<0.002	<0.004	<0.003	0.26	0.027	770	<0.0002	0.65	0.019	0.1	<0.001	<0.003	0.003	390	1000	<0.001	<0.006
OM07	11/1/2012	<0.005	<0.001	0.75	0.028	<0.001	<0.001	15	<0.005	<0.002	<0.004	<0.003	0.26	0.07	760	<0.0002	1.2	0.007	0.05	<0.001	<0.003	0.001	430	1000	<0.001	<0.006
OM07	2/4/2013	<0.0025	<0.0005	0.53	0.026	<0.0005	<0.0005	18	<0.005	<0.001	<0.002	<0.0015	0.29	<0.01	780	<0.0001	0.19	<0.0025	0.26	<0.0005	<0.0015	<0.0005	310	960	<0.0005	<0.003
OM07	5/3/2013	<0.005	<0.001	0.72	0.025	<0.001	<0.001	15	<0.005	<0.002	<0.004	<0.003	0.26	0.074	740	<0.0002	0.92	0.011	0.1	<0.001	<0.003	<0.001	320	930	<0.001	<0.006
OM07	7/31/2013	<0.005	<0.001	0.72	0.03	<0.001	<0.001	12	<0.005	0.003	<0.004	<0.003	0.31	0.38	680	<0.0002	2	0.009	<0.02	<0.001	<0.003	<0.001	330	950	<0.001	<0.006
OM07	10/18/2013	<0.005	<0.001	0.72	0.028	<0.001	<0.001	13	<0.005	0.002	<0.004	<0.003		0.28	680	<0.0001	1.7	<0.005	0.11	<0.001	<0.003	<0.001	430	940	<0.001	0.007
OM07	3/30/2014	<0.005	<0.001	0.87	0.031	<0.001	<0.001	13	<0.005	<0.002	<0.004	<0.003		0.18	700	<0.0002	1.2	<0.005	0.09	<0.001	<0.003	<0.001	290	940	<0.001	<0.006
OM07	4/24/2014	<0.005	<0.001	0.71	0.029	<0.001	<0.001	10	<0.005	<0.002	<0.004	<0.003	<0.25	0.011	630	<0.0002	1.2	<0.005	0.18	<0.001	<0.003	<0.001	300	900	<0.001	<0.006
OM07	7/17/2014			1.3				18						0.14	620		1.6						310	960		
OM07	4/17/2015			1				19						1.2	750		2.9						280	960		
OM07	9/14/2015			0.43				13						1.2	850		2.7						240	940		
OM08	4/25/2000			0.1				4.3						2.6	2400		4.1						1900	3000		
OM08	9/18/2000			0.11				4.7						4	2400		3.7						2100	3200		
OM08	4/24/2001			0.14				5						5.9	2500		5.4						2000	3327		
OM08	9/13/2001			0.12				5.2						5.3	2900		4.7						1900	3500		
OM08	4/25/2002			0.15				5.1						5	2839		4.7						1200	3500		
OM08	9/25/2002			0.15				4.6						2.8	3000		4.9						2000	3600		
OM08	4/18/2003			0.063				4.4						5.5	2200		4.5						1800	3200		
OM08	9/23/2003			0.044				6.2						6.5	2400		4.5						1900	3200		
OM08	4/13/2004			2.7				4.5						5.7	3300		3.5						1800	3200		
OM08	9/23/2004			0.11				5						9.3	2600		3.9						1800	3300		
OM08	4/19/2005			0.13				4						8.9	2600		4.4						2000	3500		
OM08	9/20/2005			0.096				3.8						12	2400		5.2						1800	3400		
OM08	4/28/2006			1.6				21						5.5	2000		4.1						1700	3200		
OM08	9/7/2006			0.093				7.2						13	2400		3.8						1700	3000		
OM08	4/2/2007			0.39				4.4						10	2100		3.2						1700	2900		
OM08	9/19/2007			0.096				2.5						14	2200		4.6						1900	3300		
OM08	3/27/2008			0.099				3.3						9.1	5100		3.2						1600	2800		
OM08	6/3/2008			0.071				4.8						12	2400		4.6						1800	3200		
OM08	8/19/2008			0.09				4.7						13	2500		4.3						1800	3200		
OM08	4/29/2009			0.1				7.9						7.6	3500		4.8						2000	3200		
OM08	9/21/2009			0.17				5						4.8	2400		4.2						1800	3100		
OM08	12/11/2009			0.22				7.7						<0.01	2400		4.4						2000	3100		
OM08	4/27/2010			0.1				3.6						<0.01	2000		4.5						1400	2400		
OM08	9/7/2010			8.7				370						15	3100		4.3						1300	3100		
OM08	2/23/2011	<0.005	0.024	19	0.052	<0.001	<0.001	310	<0.005	0.018	0.022	0.016	0.52	31	2600	<0.0002	5.5	0.072	0.29	0.017	<0.003	0.007	1200	2600	<0.001	0.078
OM08	4/28/2011	<0.005	0.009	18	0.046	<0.001	<0.001	310	<0.005	0.012	0.015	<0.003	0.38	12	3000	<0.0002	5.2	0.026	0.4	<0.001	<0.003	0.015	1200	2900	<0.001	0.022
OM08	8/25/2011	<0.005	0.015	6.2	0.023	<0.001	<0.001	150	<0.005	0.006	0.006	<0.003	<0.25	8.1	1400	<0.0002	2	0.023	0.07	<0.001	<0.003	0.006	620	1400	<0.001	0.008
OM08	10/12/2011	<0.005	0.011	11	0.029	<0.001	<0.001	270	<0.005	0.012	0.009	<0.003	1.4	14	2600	<0.0002	5.6	0.033	0.05	<0.001	<0.003	0.014	1700	3300	<0.001	0.016
OM08	2/24/2012	<0.005	0.012	11	0.026	<0.001	<0.001	180	<0.005	0.011	0.008	<0.003	<0.25	9.9	2300	<0.0002	4.3	0.046	0.1	<0.001	<0.003	0.021	880	2500	<0.001	0.015
OM08	5/4/2012	<0.005	0.009	10	0.025	<0.001	<0.001	200	<0.005	0.012	0.006	<0.003	<2.5	14	2400	<0.0002	4.9	0.038	<0.02	<0.001	<0.003	0.008	1400	3500	<0.001	0.019
OM08	8/24/2012	<0.005	0.01	6.6	0.026	<0.001	<0.001	190	<0.005	0.012	0.007	<0.003	<0.25	14	2500	<0.0002	4.5	0.068	<0.02	<0.001	<0.003	0.01	2400	3300	<0.001	0.012
OM08	11/1/2012	<0.005	0.009	6.9	0.028	<0.001	<0.001	170	<0.005	0.011	<0.004	<0.003	<0.25	13	2400	<0.0002	4.9	0.029	0.03	<0.001	<0.003	0.006	2000	3200	<0.001	0.017
OM08	2/5/2013	<0.0025	0.009	10	0.046	<0.0005	<0.0005	210	<0.005	0.01	0.002	0.003	<0.25	16	2400	<0.0001	4.3	0.014	0.08	0.002	<0.0015	<0.0005	1700	3000	<0.0005	0.026
OM08	5/15/2013	<0.005	0.003	15	0.025	<0.001	<0.001	490	<0.005	0.013	<0.004	<0.003	<0.25	10	2600	<0.0002	5.5	0.016	0.11	<0.001	<0.003	<0.001	2100	3500	<0.001	0.025
OM08	7/26/2013	<0.005	0.011	13	0.039	<0.001	<0.001	370	<0.005	0.013	0.009	0.003	<0.25	13	2900	<0.0002	4.6	0.044	0.05	0.002	<0.003	0.004	1700	3300	<0.001	0.023
OM08	10/21/2013	<0.005	0.009	9.6	0.029	<0.001	<0.001	320	<0.005	0.01	<0.004	<0.003		10	2200	<0.0002	5	0.013	0.18	<0.001	<0.003	<0.001	1900	3200	<0.001	0.009
OM08	3/30/2014	<0.005	0.004	9.3	0.026	<0.001	<0.001	290	<0.005	0.01	<0.004	<0.003		15	2400	<0.0002	4.9	0.013	<0.02	<0.001	<0.003	<0.001	1700	3100	<0.001	0.01
OM08	4/24/2014	<0.005	0.003	13	0.022	<0.001	<0.001	300	<0.005	0.01	<0.004	<0.003		8.9	2300	<0.0002	4.7	0.012	<0.02	<0.001	<0.003	<0.001	1600	3500	<0.001	0.011
OM08	7/17/2014			12				290						11	2000		3.9						1600	3000		

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM08	4/17/2015			14				340						<0.01	2500		4.3						1700	3200		
OM08	9/14/2015			9.6				250						12	2800		4.3						1500	3100		
OM09	4/25/2000			0.54				11						0.28	1100		2						100	1200		
OM09	9/19/2000			0.75				9						3.6	890		1.6						450	1300		
OM09	4/24/2001			0.61				10						1.7	930		1.8						460	1273		
OM09	9/13/2001			0.74				12						3.7	1200		1.8						490	1300		
OM09	4/25/2002			0.66				9.8						3.1	1153		1.6						410	1300		
OM09	9/24/2002			0.7				13						3	1000		1.8						400	1200		
OM09	4/17/2003			0.57				12						2.1	840		1.4						400	1300		
OM09	9/23/2003			0.55				13						3.3	930		1.4						410	1200		
OM09	4/13/2004			0.55				12						2.1	1100		1.4						440	1300		
OM09	9/23/2004			0.96				11						3.5	1100		1.9						400	1300		
OM09	4/18/2005			0.64				11						0.21	930		2.2						420	1300		
OM09	9/19/2005			0.59				14						3.2	910		1.6						380	1200		
OM09	4/28/2006			0.51				11						1.5	970		1.5						390	1200		
OM09	9/7/2006			0.79				12						3.4	720		1.4						410	1200		
OM09	4/2/2007			0.58				12						1.3	1000		1.3						410	1200		
OM09	9/19/2007			0.56				8.1						3	1600		1.4						400	1200		
OM09	3/27/2008			0.46				11						0.16	1200		1.2						360	1100		
OM09	6/3/2008			0.52				9.8						3	990		1.5						420	1200		
OM09	8/19/2008			0.56				12						3.5	2300		1.3						380	1200		
OM09	4/30/2009			0.59				14						1.8	1400		1.8						470	1200		
OM09	9/22/2009			0.57				12						3.8	940		1.5						370	1200		
OM09	12/11/2009			0.67				9.7						0.17	930		1.2						440	1200		
OM09	4/27/2010			0.53				11						4.8	920		1.4						390	1200		
OM09	9/8/2010			0.55				13						4.2	1100		1.4						470	1200		
OM10	4/25/2000			0.1				6.6						<0.01	1800		1.8						950	2000		
OM10	9/19/2000			0.071				7.2						1.6	1800		0.078						820	1900		
OM10	4/24/2001			0.09				11						0.66	1900		1.1						1100	2370		
OM10	9/13/2001			0.17				7.6						4.1	1800		5.7						1200	2100		
OM10	6/13/2002			0.032				6						0.29	1200		0.37						440	1300		
OM10	9/24/2002			0.12				6.9						0.4	1600		4.1						630	1900		
OM10	4/17/2003			0.18				7.3						0.56	1400		2.6						880	1700		
OM10	9/23/2003			0.18				6.5						13	1400		2.8						600	1600		
OM10	4/12/2004			0.54				23						<0.01	1200		1.3						570	1600		
OM10	9/23/2004			0.29				24						4	2200		3.2						1300	2900		
OM10	4/18/2005			0.29				9.3						0.036	1600		0.19						580	1800		
OM10	9/19/2005			1.5				26						0.04	1800		3.7						1100	2400		
OM10	6/2/2008			0.45				8.8						0.8	1800		1.7						1300	2800		
OM10	8/18/2008			0.12				8.6						3	2200		3.3						1000	2400		
OM10	4/29/2009			0.32				10						2.4	1600		3.1						430	1600		
OM10	9/21/2009			0.024				3.3						0.5	70		0.098						5.5	100		
OM10	12/11/2009			0.043				5.9						2.4	710		3.1						190	670		
OM10	4/27/2010			0.038				5.5						8.4	1900		5.8						1000	2400		
OM10	9/7/2010			0.091				4.6						13	2100		6.3						700	1800		
OM11	4/24/2000			47				440						0.57	1400		2.1						550	2000		
OM11	9/19/2000			56				450						0.71	1000		2.3						570	1900		
OM11	4/24/2001			44				400						0.67	1300		2.1						470	1697		
OM11	9/13/2001			53				440						0.3	1600		2.6						580	1900		
OM11	4/25/2002			20				180						1.4	679		1.1						200	810		
OM11	9/25/2002			41				380						0.38	1100		2.2						450	1600		
OM11	4/18/2003			55				610						0.81	1500		2.8						480	2300		
OM11	9/24/2003			58				610						0.46	1400		2.6						430	2000		
OM11	4/13/2004			54				650						0.22	1600		2.3						440	2300		
OM11	9/23/2004			69				590						0.35	1500		3.5						420	2300		
OM11	4/19/2005			38				390						1.6	990		1.7						330	1800		
OM11	9/20/2005			43				360						0.12	1100		2.2						370	1600		
OM11	4/28/2006			26				260						0.18	850		1.5						310	1300		
OM11	9/7/2006			30				290						0.31	750		1.4						330	1300		
OM11	4/2/2007			20				150						0.068	590		0.91						230	900		

Natural Resource Technology

Appendix C-3
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Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

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OM11	9/19/2007			17				130						0.8	450		1.2						220	980		
OM11	3/27/2008			17				130						0.095	540		1						190	850		
OM11	6/3/2008			9.3				150						0.13	570		1.1						180	850		
OM11	8/19/2008			12				150						0.082	540		0.68						150	820		
OM11	4/29/2009			9.5				130						0.028	520		0.45						130	630		
OM11	9/21/2009			5.8				95						<0.01	340		0.2						86	530		
OM11	12/8/2009			7.2				77						0.27	430		1.1						110	550		
OM11	4/27/2010			14				180						0.25	620		1.2						200	980		
OM11	9/7/2010			7.2				99						0.14	480		0.82						140	680		
OR11	6/3/2008			13				160						0.53	1400		0.92						190	910		
OR11	8/19/2008			12				150						0.33	730		0.81						140	800		
OR11	4/29/2009			8.7				150						0.27	920		0.68						120	570		
OR11	9/21/2009			7.5				100						<0.01	380		0.002						110	580		
OR11	12/8/2009			6.1				44						0.067	330		0.34						93	450		
OR11	4/27/2010			8.5				110						0.39	440		0.73						140	690		
OR11	9/7/2010			8.6				110						0.32	500		0.62						150	710		
OR11	2/23/2011	<0.005	0.003	16	0.052	<0.001	<0.001	180	<0.005	<0.002	0.007	<0.003	0.45	0.72	660	<0.0002	1.1	0.023	0.042	<0.001	<0.003	<0.001	210	970	<0.001	<0.006
OR11	4/28/2011	<0.005	0.006	16	0.08	<0.001	<0.001	170	<0.005	0.004	0.013	0.006	0.39	6.3	860	<0.0002	1.3	0.017	<0.02	0.005	<0.003	0.007	220	1000	<0.001	0.019
OR11	8/25/2011	<0.005	0.005	19	0.05	<0.001	<0.001	190	<0.005	<0.002	0.007	<0.003	0.34	1.2	980	<0.0002	1.1	0.019	<0.02	<0.001	<0.003	0.011	240	1100	<0.001	<0.006
OR11	10/12/2011	<0.005	0.005	19	0.039	<0.001	<0.001	200	<0.005	<0.002	0.007	0.008	0.39	1.3	800	<0.0002	1.2	0.06	<0.02	<0.001	<0.003	0.012	240	1100	<0.001	<0.006
OR11	2/24/2012	<0.005	0.007	17	0.043	<0.001	<0.001	150	<0.005	<0.002	0.005	<0.003	0.29	0.82	790	<0.0002	1.1	0.018	<0.02	<0.001	<0.003	0.014	270	1100	<0.001	<0.006
OR11	5/4/2012	<0.005	0.004	16	0.048	<0.001	<0.001	97	<0.005	<0.002	0.004	<0.003	0.37	0.88	760	<0.0002	1.2	0.023	<0.02	<0.001	<0.003	0.007	260	940	<0.001	0.007
OR11	8/24/2012	<0.005	0.005	17	0.035	<0.001	<0.001	220	<0.005	<0.002	0.007	<0.003	0.33	1.4	840	<0.0002	1.1	0.025	<0.02	<0.001	<0.003	0.012	290	1200	<0.001	<0.006
OR11	11/1/2012	<0.005	0.002	13	0.041	<0.001	<0.001	100	<0.005	<0.002	<0.004	<0.003	0.37	0.2	660	<0.0002	0.93	0.011	0.04	<0.001	<0.003	0.003	270	920	<0.001	<0.006
OR11	2/5/2013	<0.0025	0.002	17	0.044	<0.0005	<0.0005	180	<0.005	<0.001	<0.002	<0.0015	0.32	0.94	1200	<0.0001	1.1	0.008	<0.02	<0.0005	<0.0015	<0.0005	350	1000	<0.0005	<0.003
OR11	5/15/2013	<0.005	0.002	8.6	0.035	<0.001	<0.001	57	<0.005	0.002	<0.004	<0.003	0.33	0.46	570	<0.0002	0.8	<0.005	<0.02	<0.001	<0.003	<0.001	210	720	<0.001	<0.006
OR11	7/26/2013	<0.005	0.003	6.4	0.042	<0.001	<0.001	23	<0.005	0.002	<0.004	<0.003	0.44	1.6	500	<0.0002	0.83	0.01	0.03	0.002	<0.003	<0.001	170	540	<0.001	0.008
OR11	10/21/2013	<0.005	0.001	6.1	0.035	<0.001	<0.001	34	<0.005	<0.002	<0.004	<0.003	0.34	0.013	470	<0.0002	0.8	<0.005	0.11	<0.001	<0.003	<0.001	230	600	<0.001	<0.006
OR11	3/30/2014	<0.005	0.002	10	0.039	<0.001	<0.001	110	<0.005	<0.002	<0.004	<0.003		0.88	640	<0.0002	1.1	0.007	<0.02	<0.001	<0.003	<0.001	230	820	<0.001	<0.006
OR11	4/24/2014	<0.005	0.004	11	0.035	<0.001	<0.001	69	<0.005	<0.002	<0.004	<0.003	0.35	1.4	510	<0.0002	0.85	<0.005	<0.02	<0.001	<0.003	<0.001	210	820	<0.001	<0.006
OR11	7/17/2014			4.9				25						0.32	380		0.66						120	500		
OR11	4/17/2015			4.1				27						<0.01	440		0.55						140	540		
OR11	9/14/2015			5.8				46						0.64	660		0.7						140	590		
OM12	4/24/2000			0.19				4.7						21	1300		1.7						450	1500		
OM12	9/19/2000			0.44				3.4						23	1400		1.6						440	1500		
OM12	4/24/2001			0.63				4						22	1300		1.8						440	1490		
OM12	9/13/2001			0.36				6.2						24	1400		1.6						450	1600		
OM12	4/25/2002			0.29				4.7						20	1833		1.7						270	1600		
OM12	9/25/2002			0.34				5						20	1200		1.7						450	1400		
OM12	4/18/2003			0.63				5						25	1200		1.6						380	1400		
OM12	9/24/2003			0.94				5.8						25	1200		1.6						440	1500		
OM12	4/13/2004			1.1				4.6						22	1400		1.4						450	1500		
OM12	9/23/2004			0.77				4.5						22	1400		1.9						420	1600		
OM12	4/19/2005			0.58				5.4						24	1300		1.3						400	1600		
OM12	9/20/2005			0.11				6.2						25	1200		1.6						390	1500		
OM12	4/28/2006			0.058				4.2						24	1200		1.5						370	1500		
OM12	9/7/2006			0.13				5.6						16	1200		1.4						400	1400		
OM12	4/2/2007			3				38						17	1200		1.3						370	660		
OM12	9/19/2007			0.079				4.1						3.4	1100		1.5						380	1400		
OM12	3/27/2008			0.051				3.7						24	1500		1.3						380	1400		
OM12	6/3/2008			0.062				5.5						22	1200		1.5						390	1400		
OM12	8/19/2008			0.2				5.4						22	1300		1.4						380	1400		
OM12	4/29/2009			0.064				67						19	1400		1.4						420	1400		
OM12	9/21/2009			0.2				4.7						1.6	1300		1.3						410	1400		
OM12	12/8/2009			30				370						2.1	2200		0.88						2000	3200		
OM12	4/27/2010			0.17				4.6						0.15	1200		1.4						410	1400		
OM12	9/7/2010			0.12				4.1						25	1200		1.5						340	1400		
OM12	2/23/2011	<0.005	0.032	0.076	0.3	<0.001	<0.001	4.5	<0.005	0.002	<0.004	<0.003	0.32	27	1200	<0.0002	1.5	0.02	0.044	<0.001	<0.003	<0.001	400	1400	<0.001	<0.006
OM12	4/28/2011	<0.005	<0.001	0.39	0.14	<0.001	<0.001	8.3	<0.005	<0.002	<0.004	<0.003	<0.25	0.24	2100	<0.0002	1.4	0.006	1.3	<0.001	<0.003	0.004	370	1400	<0.001	0.012
OM12	8/25/2011	<0.005	0.029	0.086	0.28	<0.001	<0.001	4.8	<0.005	0.002	<0.004	<0.003	0.3	22	1600	<0.0002	1.5	0.021	<0.02	<0.001	<0.003	0.006	390	1300	<0.001	<0.006

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM12	10/12/2011	<0.005	0.031	0.58	0.31	<0.001	<0.001	4.9	<0.005	<0.002	0.005	<0.003	<0.25	24	1300	<0.0002	1.6	0.01	<0.02	<0.001	<0.003	0.006	380	1400	<0.001	0.006
OM12	2/24/2012	<0.005	0.034	0.17	0.13	<0.001	<0.001	5.6	<0.005	<0.002	<0.004	<0.003	<0.25	19	990	<0.0002	1.4	0.018	0.03	<0.001	<0.003	0.009	350	1300	<0.001	<0.006
OM12	5/4/2012	<0.005	0.001	0.44	0.095	<0.001	<0.001	13	<0.005	<0.002	<0.004	<0.003	<0.25	0.027	990	<0.0002	0.8	0.013	4.4	<0.001	<0.003	0.005	320	1200	<0.001	0.02
OM12	8/24/2012	<0.005	0.018	0.3	0.22	<0.001	<0.001	6.2	<0.005	<0.002	<0.004	<0.003	0.26	16	1300	<0.0002	1.3	0.028	0.73	<0.001	<0.003	0.006	460	1400	<0.001	<0.006
OM12	11/1/2012	<0.005	0.029	0.18	0.32	<0.001	<0.001	5.4	<0.005	0.002	<0.004	<0.003	0.31	24	1300	<0.0002	1.6	0.016	0.09	<0.001	<0.003	0.003	400	1400	<0.001	<0.006
OM12	2/5/2013	<0.0025	0.028	0.3	0.28	<0.0005	<0.0005	6.5	<0.005	0.002	<0.002	<0.0015	0.29	26	1300	<0.0001	1.5	<0.0025	<0.02	<0.0005	<0.0015	<0.0005	390	1400	<0.0005	<0.003
OM12	5/15/2013	<0.005	0.009	0.31	0.2	<0.001	<0.001	5.8	<0.005	<0.002	<0.004	<0.003	<0.25	23	1300	<0.0002	1.7	<0.005	0.03	<0.001	<0.003	<0.001	440	1300	<0.001	0.006
OM12	7/26/2013	<0.005	0.026	0.24	0.26	<0.001	<0.001	6.1	<0.005	0.002	<0.004	<0.003	0.31	22	1300	<0.0002	1.6	0.016	0.05	<0.001	<0.003	<0.001	460	1400	<0.001	<0.006
OM12	10/21/2013	<0.005	0.013	0.16	0.19	<0.001	<0.001	6	<0.005	<0.002	<0.004	<0.003		17	1000	<0.0002	1.5	<0.005	0.06	<0.001	<0.003	<0.001	470	1400	<0.001	<0.006
OM12	3/30/2014	<0.005	0.01	0.17	0.19	<0.001	<0.001	7	<0.005	<0.002	<0.004	<0.003		12	1200	<0.0002	1.3	<0.005	0.99	<0.001	<0.003	<0.001	430	1300	<0.001	<0.006
OM12	4/24/2014	<0.005	<0.001	0.12	0.16	<0.001	<0.001	6	<0.005	0.002	<0.004	<0.003		0.03	1100	<0.0002	1.5	<0.005	0.46	<0.001	<0.003	<0.001	440	1400	<0.001	0.015
OM12	7/17/2014			0.1				5.9						0.062	1100		1.4						460	1400		
OM12	4/17/2015			0.16				6.4						24	1300		1.5						480	1400		
OM12	9/14/2015			0.074				5.4						24	3400		1.4						400	1400		
OM13D	4/24/2000			5.4				150						6	1000		0.73						440	1500		
OM13D	9/18/2000			5.7				130						6.2	920		0.73						480	1500		
OM13D	4/24/2001			5.7				140						6.8	860		0.76						430	1537		
OM13D	9/13/2001			5.5				140						6.2	1000		0.69						460	1600		
OM13D	4/25/2002			6.2				150						5.7	1062		0.81						340	1600		
OM13D	9/25/2002			6.9				140						5.7	1100		0.85						440	1400		
OM13D	4/17/2003			6.9				160						5.5	890		0.84						420	1600		
OM13D	9/23/2003			6.7				170						5.5	970		0.71						420	1500		
OM13D	5/13/2004			6.2				150						5.5	890		0.68						450	1600		
OM13D	9/23/2004			5.7				170						6.1	1000		0.67						420	1600		
OM13D	4/18/2005			6.4				170						5.8	950		0.7						420	1600		
OM13D	9/19/2005			6.9				170						4.1	900		0.81						410	1600		
OM13D	4/28/2006			7.2				190						5.3	1100		0.77						410	1600		
OM13D	9/7/2006			8.2				200						6.5	750		0.78						440	1600		
OM13D	4/3/2007			7.9				170						4.6	890		0.73						380	1400		
OM13D	9/19/2007			6.4				150						4.7	750		0.69						350	1400		
OM13S	4/24/2000			5.2				110						6.8	1100		0.76						440	1500		
OM13S	9/18/2000			5.8				140						7.1	860		0.75						480	1532		
OM13S	4/24/2001			5.4				130						7.5	1000		0.77						440	1540		
OM13S	9/13/2001			6.6				140						7.5	1200		0.85						470	1600		
OM13S	4/24/2002			5.4				86						7	1500		0.71						270	1500		
OM13S	9/25/2002			5.8				120						6.6	1000		0.8						480	1700		
OM13S	4/17/2003			6.2				150						7.2	930		0.85						430	1600		
OM13S	9/23/2003			6.5				180						7.4	1000		0.76						450	1600		
OM13S	5/13/2004			6.9				170						7.8	970		0.76						450	1600		
OM13S	9/23/2004			6.3				180						8.2	1100		0.74						450	1700		
OM13S	4/18/2005			6.8				180						16	1100		0.91						440	1700		
OM13S	9/19/2005			7.9				210						7	1000		0.93						440	1700		
OM13S	4/28/2006			7.4				220						7	1000		0.84						460	1700		
OM13S	9/7/2006			8.9				230						6.4	1100		0.84						470	1700		
OR13D	6/3/2008			4.4				93						3.8	620		0.46						270	1200		
OR13D	8/19/2008			4.2				90						3.7	610		0.42						260	1300		
OR13D	4/30/2009			4				89						3.3	770		0.44						220	1200		
OR13D	9/22/2009			3.8				80						3.6	620		0.45						380	1300		
OR13D	4/27/2010			3.5				67						3.3	580		0.42						250	1200		
OR13D	9/8/2010			3.1				72						3.2	690		0.41						330	1200		
OR13D	2/22/2011	<0.005	<0.001	3	0.026	<0.001	<0.001	54	<0.005	<0.002	<0.004	<0.003	<0.25	0.024	440	<0.0002	0.01	0.013	1.4	<0.001	<0.003	0.003	220	1000	<0.001	0.01
OR13D	4/28/2011	<0.005	0.001	3.1	0.028	<0.001	<0.001	53	<0.005	<0.002	<0.004	<0.003	0.31	0.047	440	<0.0002	0.009	<0.005	1.3	<0.001	<0.003	0.004	220	1100	<0.001	<0.006
OR13D	8/26/2011	<0.005	0.001	3.6	0.028	<0.001	<0.001	57	<0.005	<0.002	0.004	0.007	0.28	0.012	470	<0.0002	0.002	0.009	1.3	<0.001	<0.003	0.006	240	1100	<0.001	<0.006
OR13D	10/14/2011	<0.005	0.013	5.5	0.033	<0.001	<0.001	76	<0.005	<0.002	<0.004	0.005	<0.25	4.1	800	<0.0002	0.58	0.017	0.11	<0.001	<0.003	0.01	190	1200	<0.001	<0.006
OR13D	2/24/2012	<0.005	0.004	3.2	0.025	<0.001	<0.001	56	<0.005	<0.002	<0.004	0.004	<0.25	0.18	660	<0.0002	0.01	0.009	1.3	<0.001	<0.003	0.011	170	1000	<0.001	<0.006
OR13D	5/4/2012	<0.005	0.001	3.2	0.028	<0.001	<0.001	51	<0.005	<0.002	<0.004	0.003	0.28	<0.01	540	<0.0002	0.002	0.006	1.4	<0.001	<0.003	0.005	200	1100	<0.001	0.011
OR13D	8/24/2012	<0.005	0.003	2.9	0.027	<0.001	<0.001	61	<0.005	<0.002	<0.004	0.005	0.28	0.094	520	<0.0002	0.006	0.012	1.4	<0.001	<0.003	0.007	310	1100	<0.001	<0.006
OR13D	11/2/2012	<0.005	0.001	3.3	0.026	<0.001	<0.001	55	<0.005	<0.002	<0.004	0.004	<0.25	0.099	500	<0.0002	0.008	0.006	1.4	<0.001	<0.003	0.003	260	1200	<0.001	<0.006
OR13D	2/4/2013	<0.0025	0.001	2.9	0.02	<0.0005	<0.0005	54	<0.005	<0.001	<0.002	<0.0015	0.25	0.059	500	<0.0001	0.068	0.003	1.7	<0.0005	<0.0015	<0.0005	250	1100	<0.0005	<0.003
OR13D	5/2/2013	<0.005	0.002	3.1	0.031	<0.001	<0.001	46	<0.005	<0.002	<0.004	0.005	<0.25	0.085	530	<0.0002	0.013	0.009	1.5	0.004	<0.003	<0.001	270	1100	<0.001	<0.006

NATURAL RESOURCE TECHNOLOGY

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OR13D	7/29/2013	<0.005	<0.001	3.1	0.028	<0.001	<0.001	41	<0.005	<0.002	<0.004	<0.003	<0.25	0.96	540	<0.0002	0.007	0.007	1.6	<0.001	<0.003	<0.001	270	1200	<0.001	<0.006
OR13D	10/21/2013	<0.005	<0.001	2.5	0.028	<0.001	<0.001	44	<0.005	<0.002	<0.004	<0.003		0.022	500	<0.0002	0.003	<0.005	1.8	<0.001	<0.003	<0.001	320	1100	<0.001	<0.006
OR13D	3/30/2014	<0.005	0.002	3.5	0.032	<0.001	<0.001	110	<0.005	<0.002	<0.004	<0.003		0.22	680	<0.0002	0.51	<0.005	0.08	<0.001	<0.003	<0.001	260	1200	<0.001	<0.006
OR13D	4/24/2014	<0.005	0.001	2.9	0.026	<0.001	<0.001	39	<0.005	<0.002	<0.004	<0.003		0.24	490	<0.0002	0.018	<0.005	1.6	<0.001	<0.003	<0.001	300	1200	<0.001	<0.006
OR13D	7/18/2014			2.7				42						0.12	500		0.032						320	1200		
OR13D	4/17/2015			3				41						0.12	540		0.04						330	1200		
OR13D	9/14/2015			2.3				34						0.14	1300		0.34						290	1200		
OR13S	6/3/2008			7.7				230						5.6	1300		0.8						400	1600		
OR13S	8/19/2008			8.3				240						11	2300		0.86						400	1600		
OR13S	4/30/2009			8.4				220						5.9	2000		0.8						400	1500		
OR13S	9/22/2009			8.4				220						3.6	970		0.8						420	1500		
OR13S	12/8/2009			8.5				210						4.9	950		0.8						370	1600		
OR13S	4/27/2010			6.9				170						7.3	840		0.73						360	1500		
OR13S	9/8/2010			5.8				150						2.8	940		0.61						360	1300		
OR13S	2/22/2011	<0.005	0.007	5.3	0.032	<0.001	<0.001	120	<0.005	<0.002	<0.004	<0.003	<0.25	4.3	770	<0.0002	0.59	0.02	<0.02	<0.001	<0.003	0.003	270	1200	<0.001	0.016
OR13S	4/28/2011	<0.005	0.07	5.2	0.054	<0.001	<0.001	100	<0.005	<0.002	<0.004	<0.003	0.29	14	740	<0.0002	0.66	0.01	<0.02	0.004	<0.003	0.006	270	1300	<0.001	0.009
OR13S	8/26/2011	<0.005	0.003	5.9	0.032	<0.001	<0.001	110	<0.005	<0.002	0.007	0.006	0.26	0.046	660	<0.0002	0.46	0.016	0.68	<0.001	<0.003	0.009	290	1200	<0.001	<0.006
OR13S	10/14/2011	<0.005	0.002	3.1	0.027	<0.001	<0.001	51	<0.005	<0.002	<0.004	0.006	0.26	0.016	570	<0.0002	0.003	0.011	1.3	<0.001	<0.003	0.007	220	1100	<0.001	<0.006
OR13S	2/24/2012	<0.005	0.012	5	0.037	<0.001	<0.001	88	<0.005	<0.002	<0.004	0.003	<0.25	4.5	760	<0.0002	0.54	0.016	<0.02	<0.001	<0.003	0.013	220	1200	<0.001	<0.006
OR13S	5/4/2012	<0.005	0.011	5	0.033	<0.001	<0.001	82	<0.005	<0.002	<0.004	<0.003	0.28	4.8	690	<0.0002	0.54	0.011	0.03	<0.001	<0.003	0.003	220	1200	<0.001	0.01
OR13S	8/24/2012	<0.005	0.014	4.4	0.032	<0.001	<0.001	99	<0.005	<0.002	<0.004	0.004	0.26	4.8	700	<0.0002	0.52	0.021	0.26	<0.001	<0.003	0.009	260	1200	<0.001	<0.006
OR13S	11/2/2012	<0.005	0.011	5	0.031	<0.001	<0.001	51	<0.005	<0.002	<0.004	0.003	<0.25	4.2	690	<0.0002	0.49	0.01	0.07	<0.001	<0.003	0.004	130	1200	<0.001	<0.006
OR13S	2/4/2013	<0.0025	0.006	4.6	0.029	<0.0005	<0.0005	90	<0.005	<0.001	<0.002	<0.0015	<0.25	0.92	710	<0.0001	0.52	0.005	0.05	<0.0005	<0.0015	<0.0005	260	1200	<0.0005	<0.003
OR13S	5/2/2013	<0.005	0.003	5.1	0.036	<0.001	<0.001	91	<0.005	<0.002	0.005	0.005	0.29	0.049	700	<0.0002	0.42	0.014	0.03	<0.001	<0.003	0.001	270	1200	<0.001	<0.006
OR13S	7/29/2013	<0.005	0.008	5.1	0.03	<0.001	<0.001	100	<0.005	<0.002	<0.004	<0.003	<0.25	3.7	690	0	0.54	0.011	<0.02	<0.001	<0.003	0.002	270	1200	<0.001	<0.006
OR13S	10/21/2013	<0.005	0.31	3.7	0.12	0.001	<0.001	100	<0.005	0.004	0.005	0.01		37	720	<0.0002	0.83	0.021	0.04	0.043	0.006	0.001	280	1200	<0.001	0.033
OR13S	3/30/2014	<0.005	<0.001	2.6	0.031	<0.001	<0.001	45	<0.005	<0.002	<0.004	<0.003		0.04	540	<0.0002	0.018	<0.005	1.6	<0.001	<0.003	<0.001	290	1200	<0.001	<0.006
OR13S	4/24/2014	<0.005	0.008	4.5	0.036	<0.001	<0.001	100	<0.005	<0.002	<0.004	<0.003		4.8	620	<0.0002	0.53	<0.005	<0.2	<0.001	<0.003	<0.001	270	1200	<0.001	<0.006
OR13S	7/18/2014			4.2				100						3.9	610		0.51						300	1200		
OR13S	4/17/2015			4.6				120						0.045	1200		0.47						290	1300		
OR13S	9/14/2015			9				170						5.4	5500		0.41						290	1300		
OM14	4/24/2000			0.61				5.1						2.3	790		0.61						240	920		
OM14	9/18/2000			0.65				6.9						2.3	640		0.65						200	800		
OM14	4/24/2001			0.63				6.5						2.7	630		0.57						190	807		
OM14	9/13/2001			0.71				7.5						9.5	830		1						210	870		
OM14	4/25/2002			0.57				6.8						2.3	674		0.56						170	830		
OM14	9/25/2002			0.54				6.8						2	700		0.6						170	750		
OM14	4/17/2003			0.58				7.4						2.2	660		0.62						160	770		
OM14	9/23/2003			0.47				7.3						2.2	640		0.68						150	710		
OM14	4/12/2004			0.5				6.2						1.5	860		0.54						160	740		
OM14	9/23/2004			0.54				6.1						2	720		0.59						130	730		
OM14	4/19/2005			0.77				16						2.7	752		0.71						290	970		
OM14	9/19/2005			0.51				7.9						0.97	570		0.36						150	720		
OM14	4/28/2006			0.63				7.6						0.19	650		0.16						160	690		
OM14	9/8/2006			0.59				13						1.8	670		0.63						210	800		
OM14	4/2/2007			1.4				16						<0.01	570		0.011						190	690		
OM14	9/19/2007			0.8				21						<0.01	500		0.005						240	840		
OM14	3/27/2008			14				290						0.023	1100		0.26						580	1900		
OM14	6/3/2008			130				1400						0.017	1700		0.085						950	5500		
OM14	8/19/2008			180				2400						0.035	3500		0.31						910	2500		
OR14D	4/30/2009			34				460						1.6	2200		2.5						980	3200		
OR14D	9/22/2009			27				470						1	1600		2.1						970	2500		
OR14D	12/8/2009			25				310						1.9	1700		2.6						1200	2600		
OR14D	4/27/2010			14				180						9.1	1700		2.5						990	2400		
OR14D	9/8/2010			17				260						0.026	1200		0.011						680	1900		
OR14D	2/22/2011	<0.005	0.001	17	0.038	<0.001	<0.001	230	<0.005	<0.002	0.008	<0.003	0.29	<0.01	1200	<0.0002	0.035	0.023	1.7	<0.001	<0.003	0.006	680	1800	<0.001	0.019
OR14D	4/29/2011	<0.005	0.001	16	0.028	<0.001	<0.001	200	<0.005	<0.002	0.007	<0.003	<0.25	0.026	1300	<0.0002	0.022	0.007	1.3	<0.001	<0.003	0.006	770	1800	<0.001	<0.006
OR14D	8/25/2011																									
OR14D	8/26/2011	<0.005	0.003	16	0.026	<0.001	<0.001	210	<0.005	<0.002	0.009	0.004	0.47	<0.01	1400	<0.0002	0.002	0.022	1.2	<0.001	<0.003	0.012	760	2000	<0.001	0.007
OR14D	10/13/2011	<0.005	0.002	13	0.023	<0.001	<0.001	170	<0.005	<0.002	0.005	<0.003	0.51	0.94	1500	<0.0002	1.6	0.023	0.2	<0.001	<0.003	0.012	940	2100	<0.001	0.009

NATURAL RESOURCE TECHNOLOGY

Appendix C-3
Groundwater Analytical Results Since 2000
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Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OR14D	2/22/2012	<0.005	0.004	13	0.021	<0.001	<0.001	170	<0.005	<0.002	0.005	<0.003	<0.25	<0.01	1300	<0.0002	0.004	0.024	0.92	<0.001	<0.003	0.016	780	1800	<0.001	<0.006
OR14D	5/4/2012	<0.005	0.002	13	0.019	<0.001	<0.001	130	<0.005	<0.002	0.004	<0.003	0.41	<0.01	1500	<0.0002	0.002	0.014	0.74	<0.001	<0.003	0.008	670	1800	<0.001	0.007
OR14D	8/24/2012	<0.005	0.003	11	0.02	<0.001	<0.001	140	<0.005	<0.002	0.005	<0.003	0.29	0.017	1400	<0.0002	0.002	0.032	0.84	<0.001	<0.003	0.011	850	1800	<0.001	<0.006
OR14D	11/2/2012	<0.005	0.002	12	0.019	<0.001	<0.001	190	<0.005	<0.002	<0.004	0.004	<0.25	0.01	1400	<0.0002	0.001	0.012	1.1	<0.001	<0.003	0.005	740	1900	<0.001	<0.006
OR14D	2/4/2013	<0.0025	<0.0005	4.5	0.009	<0.0005	<0.0005	86	<0.005	<0.001	<0.002	<0.0015	0.41	0.011	1200	<0.0001	0.46	<0.0025	0.32	<0.0005	<0.0015	<0.0005	700	1600	<0.0005	<0.003
OR14D	5/2/2013	<0.005	0.002	8.7	0.018	<0.001	<0.001	88	<0.005	<0.002	<0.004	<0.003	0.25	0.013	1200	<0.0002	0.003	0.02	0.42	<0.001	<0.003	<0.001	670	1600	<0.001	<0.006
OR14D	7/29/2013	<0.005	0.001	8.9	0.019	<0.001	<0.001	95	<0.005	<0.002	<0.004	<0.003	0.35	<0.01	1200	<0.0002	0.001	0.015	0.4	<0.001	<0.003	<0.001	710	1700	<0.001	<0.006
OR14D	10/21/2013	<0.005	<0.001	7.2	0.02	<0.001	<0.001	120	<0.005	<0.002	<0.004	<0.003		<0.01	1100	<0.0002	0.002	<0.005	0.44	<0.001	<0.003	<0.001	840	1600	<0.001	<0.006
OR14D	3/30/2014	<0.005	<0.001	5.2	0.018	<0.001	<0.001	73	<0.005	<0.002	<0.004	<0.003		0.02	990	<0.0002	0.088	<0.005	0.28	<0.001	<0.003	<0.001	650	1300	<0.001	<0.006
OR14D	4/24/2014	<0.005	<0.001	6.7	0.017	<0.001	<0.001	71	<0.005	<0.002	<0.004	<0.003	0.38	0.045	910	<0.0002	0.007	<0.005	0.3	<0.001	<0.0015	<0.001	600	1400	<0.001	<0.006
OR14D	7/17/2014			6.3				76						<0.01	950		0.005						640	1400		
OR14D	4/17/2015			7.1				100						0.18	1100		0.056						690	1400		
OR14D	9/15/2015			6.3				92						0.031	1200		0.062						650	1600		
OR14S	4/30/2009			32				450						0.44	2300		3.2						1200	3100		
OR14S	9/22/2009			41				620						3.4	2200		3.4						1200	3200		
OR14S	12/8/2009			22				250						0.34	1700		3.2						1300	2500		
OR14S	4/27/2010			13				160						3.5	1700		2.6						1000	2400		
OR14S	9/8/2010			13				140						0.65	1600		2.8						750	2400		
OM15	4/25/2000			0.84				1.8						2	770		0.19						220	1000		
OM15	9/18/2000			0.78				9.4						2.2	620		0.2						240	970		
OM15	4/24/2001			0.73				8.4						2.5	660		0.18						220	980		
OM15	9/13/2001			0.46				8.3						2.5	820		0.2						260	1000		
OM15	4/24/2002			0.73				9.2						3.8	714		0.24						100	1000		
OM15	9/24/2002			0.71				9.2						2.5	630		0.24						220	1000		
OM15	4/17/2003			0.72				10						2.3	620		0.21						210	1000		
OM15	9/23/2003			0.65				10						0.6	640		0.13						220	950		
OM15	4/12/2004			0.63				9.1						2.2	840		0.19						220	980		
OM15	9/23/2004			0.73				7.5						2.6	940		0.21						210	1000		
OM15	4/18/2005			0.77				8.6						2.5	630		0.23						210	960		
OM15	9/19/2005			0.57				9.8						0.05	590		0.22						200	920		
OM15	4/28/2006			0.73				8.8						2.9	630		0.26						220	970		
OM15	9/8/2006			1.2				14						1.8	700		0.13						240	980		
OM15	4/3/2007			0.99				8.9						2.1	620		0.2						220	1500		
OM15	9/20/2007			0.75				7						0.12	850		0.23						220	970		
OM15	3/27/2008			0.57				7.9						1.2	540		0.33						160	910		
OM15	6/2/2008			0.86				8.5						2.2	900		0.22						200	910		
OM15	8/18/2008			0.85				9.3						2	1200		0.24						200	960		
OM15	4/29/2009			0.76				10						1.8	920		0.2						200	940		
OM15	9/21/2009			0.17				4.8						0.094	200		0.017						29	340		
OM15	12/11/2009			0.094				5.4						0.012	420		0.004						32	430		
OM15	4/27/2010			0.17				3.6						0.21	330		0.017						36	390		
OM16	4/25/2000			0.07				5.7						2.3	2900		4.1						2000	3700		
OM16	9/18/2000			0.065				6.1						2.1	2600		3.9						2400	3633		
OM16	4/24/2001			0.08				6.6						0.79	2000		6.6						1200	2503		
OM16	9/13/2001			0.1				18						0.35	2200		6.6						1500	2800		
OM16	4/24/2002			0.11				6.9						3.7	2412		5.4						1100	2900		
OM16	9/24/2002			0.041				7.4						6.2	2700		6.7						1600	3300		
OM16	4/17/2003			0.46				7.6						6.1	2300		7.9						1400	2800		
OM16	9/23/2003			0.065				8.4						2	2200		7						1400	2300		
OM16	4/12/2004			0.066				9.3						8.3	2400		5.3						1500	2800		
OM16	9/23/2004			0.09				9.9						8.8	2900		3.9						1800	3500		
OM16	4/18/2005			0.41				49						13	2500		4.2						2000	3400		
OM16	9/19/2005			0.025				6.4						11	2600		4.5						1300	3300		
OM16	6/7/2006			0.044				6.2						13	2600		4.3						1900	3600		
OM16	9/8/2006			1.1				26						8.3	2600		5.2						1800	3400		
OM16	4/3/2007			0.32				9.3						6.9	2600		3.6						2000	980		
OM16	9/20/2007			0.36				7.5						14	2200		4.3						1900	3600		
OM16	3/27/2008			0.12				17						18	2500		3.9						1800	3300		
OM16	6/2/2008			0.15				4.7						1.9	2400		3.8						2000	3500		
OM16	8/18/2008			0.048				6.3						5	3500		4.3						2000	3500		

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Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM16	4/29/2009			0.061				9.2						0.4	2800		4						2400	3400		
OM16	9/21/2009			0.042				7.6						3.7	2600		4.5						1900	3300		
OM16	12/11/2009			0.051				5.5						5.2	2700		5.5						2400	3600		
OM16	4/28/2010			0.088				5.9						0.052	2700		4.8						2000	3500		
OM16	9/7/2010			0.052				7.1						0.72	2900		6.1						1600	3400		
OM17	4/25/2000			0.12				2						3.9	890		0.49						460	330		
OM17	9/18/2000			0.17				3.1						4.2	1200		1.1						820	1573		
OM17	4/24/2001			0.05				2.1						8.2	1000		1.2						380	923		
OM17	9/13/2001			2.8				2.5						11	970		1.6						440	1200		
OM17	4/24/2002			0.14				2.6						0.16	1051		0.59						360	1300		
OM17	9/24/2002			0.12				3.2						5.5	1400		1.7						730	1700		
OM17	4/17/2003			0.22				8						1.2	680		0.28						330	860		
OM17	9/23/2003			0.12				3.4						0.59	820		0.93						290	1000		
OM17	4/12/2004			0.31				8.7						0.28	860		0.53						240	720		
OM17	4/18/2005			0.16				2.4						0.026	550		0.42						230	720		
OM17	4/3/2007			0.17				2.6						0.054	820		0.042						460	3700		
OM17	8/18/2008			0.14				2.1						0.21	460		2.9						290	680		
OM17	12/11/2009			0.1				6.9						<0.01	770		0.34						340	900		
OM17	9/7/2010			0.1				4.8						0.42	750		1.2						390	880		
OM18	4/25/2000			0.64				6.2						5.3	890		0.23						220	1000		
OM18	9/18/2000			0.56				4.6						5.8	720		0.22						240	1020		
OM18	4/24/2001			0.72				4.4						6.2	780		0.26						240	1050		
OM18	9/13/2001			0.28				5						5.7	970		0.23						200	1000		
OM18	4/24/2002			0.55				3.7						5.8	862		0.22						170	1000		
OM18	9/24/2002			0.52				4.2						5.5	810		0.24						170	1000		
OM18	4/17/2003			0.47				4						5.6	720		0.19						180	970		
OM18	9/23/2003			0.4				4						2.2	620		0.23						81	730		
OM18	4/12/2004			0.47				4.7						5.4	920		0.18						210	970		
OM18	9/23/2004			0.48				4.3						6	1100		0.21						190	1000		
OM18	4/18/2005			0.45				4						0.014	570		0.34						60	700		
OM18	9/19/2005			0.39				3.8						<0.01	580		0.22						64	680		
OM18	4/28/2006			0.53				4.7						4.9	730		0.16						190	940		
OM18	9/8/2006			0.4				4.3						<0.01	590		0.13						65	740		
OM18	4/3/2007			0.43				4.3						<0.01	510		0.11						62	1000		
OM18	9/20/2007			3.9				51						0.013	450		0.25						68	680		
OM18	3/27/2008			0.44				3.5						4.8	460		0.15						73	650		
OM18	6/2/2008			0.63				7.2						6.3	750		0.18						240	1000		
OM18	8/18/2008			0.66				6						5.4	1100		0.21						240	1000		
OM18	4/29/2009			0.42				26						9.3	810		0.27						110	740		
OM18	9/21/2009			0.43				5.3						<0.01	610		0.16						100	750		
OM18	12/11/2009			0.44				8.6						0.97	640		0.25						91	740		
OM18	4/27/2010			0.44				3.2						<0.01	590		0.19						75	730		
OM18	9/7/2010			0.4				4.9						0.034	610		0.18						91	690		
OR18	6/2/2008			0.76				9.8						4.5	670		0.21						300	1200		
OR18	8/18/2008			0.75				8						5.4	1400		0.21						280	1200		
OR18	4/29/2009			0.51				29						6.2	710		0.44						130	810		
OR18	9/21/2009			0.54				6.4						0.2	650		0.23						100	750		
OR18	12/11/2009			0.57				9						4.6	690		0.19						130	790		
OR18	4/27/2010			0.53				3.3						0.013	630		0.12						82	770		
OR18	9/7/2010			0.51				5						0.027	680		0.16						98	770		
OM19	4/24/2000			44				560						9.9	1600		0.68						1200	3700		
OM19	9/19/2000			54				680						11	2900		0.74						1400	3500		
OM19	4/24/2001			53				710						11	2200		0.77						1100	3520		
OM19	9/13/2001			50				550						10	2200		0.88						1300	4000		
OM19	4/24/2002			30				300						10	1682		0.68						750	3400		
OM19	9/24/2002			38				460						8.9	2000		0.69						1100	3500		
OM19	4/18/2003			41				520						9.8	2100		0.64						1200	3400		
OM19	9/24/2003			39				580						11	2000		0.6						1300	3400		
OM19	4/13/2004			42				640						10	2500		0.65						1200	3700		
OM19	9/23/2004			54				670						11	2500		0.89						1200	3900		

Natural Resource Technology

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM19	4/19/2005			17				230						13	2000		0.55						1300	2900		
OM19	9/20/2005			14				140						8.6	1800		0.44						1100	2700		
OM19	4/28/2006			36				680						11	2200		0.67						1200	3700		
OM19	9/7/2006			13				260						2.2	840		0.26						920	2400		
OM19	4/2/2007			18				190						5	1700		0.55						1200	2600		
OM19	9/19/2007			5				96						<0.01	1700		0.028						1200	2600		
OM19	3/27/2008			19				380						7.1	3400		0.51						1200	3200		
OM19	6/3/2008			41				810						11	2000		0.69						1200	4100		
OM19	8/19/2008			10				150						9.3	1900		0.47						1200	2800		
OM19	4/29/2009			6.8				150						8.5	1900		0.46						1300	2600		
OM19	9/21/2009			11				160						<0.01	1800		0.36						1200	2500		
OM19	12/8/2009			13				180						3	1800		0.39						1200	2600		
OM19	4/27/2010			25				320						0.03	1700		0.14						1000	2800		
OM19	9/7/2010			17				270						8.1	1400		0.86						890	2200		
OR19	6/3/2008			68				1000						13	2300		1.3						1200	4800		
OR19	8/19/2008			25				360						12	2200		0.72						1300	3200		
OR19	4/29/2009			22				300						3	2200		0.85						1400	3000		
OR19	9/21/2009			24				340						0.01	2100		0.8						1400	3100		
OR19	12/8/2009			0.87				12						21	1200		1.4						430	1400		
OR19	4/27/2010			34				350						4.8	1700		0.96						1000	2800		
OR19	9/7/2010			18				220						8.8	1600		0.91						980	2200		
OR19	2/23/2011	<0.005	0.004	20	0.022	<0.001	<0.001	200	<0.005	<0.002	0.007	<0.003	0.3	16	1600	<0.0002	0.9	0.027	<0.02	<0.001	<0.003	0.006	830	2200	<0.001	0.007
OR19	4/28/2011	<0.005	0.004	18	0.018	<0.001	<0.001	160	<0.005	<0.002	0.005	<0.003	<0.25	8.5	1600	<0.0002	0.99	0.008	0.17	<0.001	<0.003	0.009	850	2200	<0.001	0.019
OR19	8/25/2011	<0.005	0.003	16	0.019	<0.001	<0.001	140	<0.005	<0.002	0.006	0.004	0.34	8.1	1800	<0.0002	0.87	0.024	<0.02	<0.001	<0.003	0.011	800	2000	<0.001	<0.006
OR19	10/12/2011	<0.005	0.004	16	0.036	<0.001	<0.001	150	<0.005	<0.002	0.005	<0.003	0.48	9.3	1500	<0.0002	0.94	0.015	<0.02	<0.001	<0.003	0.013	820	2000	<0.001	<0.006
OR19	2/24/2012	<0.005	0.006	17	0.037	<0.001	<0.001	130	<0.005	<0.002	0.005	<0.003	0.3	9.2	1600	<0.0002	0.83	0.025	<0.02	<0.001	<0.003	0.016	770	2100	<0.001	<0.006
OR19	5/4/2012	<0.005	0.004	22	0.024	<0.001	<0.001	180	<0.005	<0.002	0.006	<0.003	0.3	9.8	1500	<0.0002	0.74	0.017	<0.02	<0.001	<0.003	0.007	780	2200	<0.001	0.013
OR19	8/24/2012	<0.005	0.005	24	0.019	<0.001	<0.001	240	<0.005	<0.002	0.009	<0.003	<0.25	9.2	1700	<0.0002	0.69	0.037	0.24	<0.001	<0.003	0.016	930	2400	<0.001	<0.006
OR19	11/1/2012	<0.005	0.005	16	0.043	<0.001	<0.001	200	<0.005	<0.002	<0.004	<0.003	0.46	12	1500	<0.0002	0.88	0.015	0.08	<0.001	<0.003	0.005	900	2100	<0.001	0.025
OR19	2/5/2013	<0.0025	0.002	16	0.048	<0.0005	<0.0005	140	<0.005	<0.001	<0.002	<0.0015	0.31	3.1	1500	<0.0001	0.82	0.006	0.07	<0.0005	<0.0015	<0.0005	750	2000	<0.0005	0.026
OR19	5/15/2013	<0.005	<0.001	14	0.023	<0.001	<0.001	170	<0.005	<0.002	<0.004	<0.003	0.27	6.1	1500	<0.0002	0.86	<0.005	<0.02	<0.001	<0.003	<0.001	840	1900	<0.001	<0.006
OR19	7/26/2013	<0.005	0.002	13	0.023	<0.001	<0.001	130	<0.005	<0.002	<0.004	<0.003	0.31	0.47	1700	<0.0002	0.89	0.018	0.04	<0.001	<0.003	0.002	860	2000	<0.001	0.007
OR19	10/21/2013	<0.005	<0.001	12	0.015	<0.001	<0.001	160	<0.005	<0.002	<0.004	<0.003		1.5	1200	<0.0002	0.85	<0.005	<0.02	<0.001	<0.003	<0.001	980	2000	<0.001	<0.006
OR19	3/30/2014	<0.005	<0.001	12	0.025	<0.001	<0.001	140	<0.005	<0.002	<0.004	<0.003		1.4	1400	<0.0002	0.85	<0.005	0.11	<0.001	<0.003	<0.001	820	2000	<0.001	<0.006
OR19	4/24/2014	<0.005	<0.001	16	0.022	<0.001	<0.001	140	<0.005	<0.002	<0.004	<0.003		2.6	1400	<0.0002	0.85	<0.005	0.11	<0.001	<0.0015	<0.001	820	2000	<0.001	0.006
OR19	7/17/2014			18				190						0.015	1400		0.69						920	2200		
OR19	4/17/2015			20				240						0.14	1500		0.78						990	2000		
OR19	9/14/2015			14				130						7.7	1800		0.79						730	2000		
OM20	4/24/2000			210				1800						6.5	4500		2.3						1400	6700		
OM20	9/19/2000			220				1800						6.6	3800		2.4						1400	6500		
OM20	4/24/2001			190				1800						7.4	3800		2.4						1400	5993		
OM20	9/13/2001			210				2000						7	4100		2.6						1500	6600		
OM20	4/24/2002			190				1200						7.4	2991		2.3						790	7700		
OM20	9/24/2002			200				2000						6.9	4400		2.9						1300	7000		
OM20	4/18/2003			240				2400						7.8	4400		2.8						1300	6200		
OM20	9/24/2003			210				2600						8.1	4400		2.8						1400	8100		
OM20	4/13/2004			180				2600						8.1	4500		2.5						1300	9800		
OM20	9/23/2004			260				3000						8.7	5300		3.6						1300	11000		
OM20	4/19/2005			230				2400						5.5	4200		2.2						1300	9900		
OM20	9/20/2005			220				2100						2	4000		2.1						1200	6200		
OM20	4/28/2006			200				4900						8.3	4100		2.9						1300	8000		
OM20	9/7/2006			150				1800						2.2	3200		1.2						1100	5600		
OM20	4/2/2007			140				1400						0.031	2700		0.075						930	4800		
OM20	9/19/2007			220				2800						6.4	4100		2.5						1200	8400		
OM20	3/27/2008			260				3700						8.7	4200		2.7						1300	8600		
OM20	6/3/2008			230				3300						8.1	3500		3						1200	8300		
OM20	8/19/2008			240				3400						8.4	4900		2.9						1200	3200		
OM20	4/29/2009			200				2600						0.38	3900		0.39						1000	5200		
OM20	9/21/2009			45				690						<0.01	1700		<0.001						260	2800		
OM20	12/8/2009			240				3200						7.8	4800		3.1						1200	7200		

NATURAL RESOURCE TECHNOLOGY

Appendix C-3
Groundwater Analytical Results Since 2000
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OM20	4/27/2010			190				2600						7.5	4100		2.4						1100	8700		
OM20	9/7/2010			83				1200						4.2	2300		1.2						840	4000		
OR20	6/3/2008			240				3300						9.8	3300		3.7						1200	8800		
OR20	8/19/2008			250				3500						9	4500		3.4						1200	3300		
OR20	4/29/2009			260				3600						7.9	5700		3.1						1400	8100		
OR20	9/21/2009			90				1200						<0.01	1900		1.5						490	3400		
OR20	12/8/2009			220				3200						8.9	4700		4.2						1400	7300		
OR20	4/27/2010			210				2500						7.9	4600		2.7						1000	9200		
OR20	9/7/2010			130				2100						5.2	3600		1.8						1100	5800		
OR20	2/23/2011	<0.005	0.012	140	0.029	<0.001	<0.001	1700	<0.005	0.003	0.046	<0.003	0.73	5.3	5800	<0.0002	1.6	0.072	<0.02	<0.001	<0.003	0.033	860	4900	<0.001	0.007
OR20	4/28/2011	<0.005	0.014	150	0.026	<0.001	<0.001	1800	<0.005	0.002	0.058	<0.003	0.72	0.1	3000	<0.0002	1.5	0.035	1	<0.001	<0.003	0.059	1100	4900	<0.001	<0.006
OR20	8/25/2011	<0.005	0.02	130	0.029	<0.001	<0.001	1400	<0.005	0.003	0.048	0.008	<0.25	4.3	2600	<0.0002	1.4	0.07	<0.02	<0.001	<0.003	0.059	800	4400	<0.001	0.009
OR20	10/12/2011	<0.005	0.014	130	0.034	<0.001	<0.001	1600	<0.005	0.002	0.031	0.006	<2.5	4.4	2500	<0.0002	1.4	0.043	1.3	<0.001	<0.003	0.056	930	4100	<0.001	<0.006
OR20	2/24/2012	<0.005	0.019	110	0.024	<0.001	<0.001	950	<0.005	0.002	0.037	0.004	0.3	3.5	2400	<0.0002	1.2	0.06	0.08	<0.001	<0.003	0.066	590	3600	<0.001	<0.006
OR20	5/4/2012	<0.005	0.008	160	0.029	<0.001	<0.001	1000	<0.005	<0.002	0.025	0.003	0.67	0.071	2000	<0.0002	1.1	0.044	0.38	<0.001	<0.003	0.033	620	3700	<0.001	0.007
OR20	8/24/2012	<0.005	0.015	100	0.02	<0.001	<0.001	1300	<0.005	0.002	0.042	0.004	<0.25	4.7	2400	<0.0002	1.1	0.086	<0.02	<0.001	<0.003	0.051	960	3600	<0.001	<0.006
OR20	11/1/2012	<0.005	0.011	110	0.023	<0.001	<0.001	1100	<0.005	<0.002	0.013	0.004	<0.25	3.7	2100	<0.0002	1	0.037	<0.02	<0.001	<0.003	0.024	680	3400	<0.001	<0.006
OR20	2/5/2013	<0.0025	0.003	100	0.032	<0.0005	<0.0005	990	<0.005	0.001	<0.002	<0.0015	0.31	3.7	2100	<0.0001	1.1	0.02	<0.02	<0.0005	<0.0015	<0.0005	690	3000	<0.0005	0.003
OR20	5/15/2013	<0.005	<0.001	95	0.031	<0.001	<0.001	1000	<0.005	<0.002	<0.004	<0.003	0.25	0.037	1900	<0.0002	0.97	0.02	0.15	<0.001	<0.003	<0.001	680	3200	<0.001	<0.006
OR20	7/26/2013	<0.005	0.008	83	0.037	<0.001	<0.001	980	<0.005	0.002	0.022	<0.003	0.39	0.053	2100	<0.0002	0.99	0.041	0.12	<0.001	<0.003	0.015	710	3000	<0.001	<0.006
OR20	10/21/2013	<0.005	0.002	68	0.026	<0.001	<0.001	920	<0.005	<0.002	<0.004	<0.003		3	1500	<0.0002	1.1	0.02	<0.02	<0.001	<0.003	<0.001	820	2700	<0.001	<0.006
OR20	3/30/2014	<0.005	0.003	71	0.026	<0.001	<0.001	950	<0.005	<0.002	<0.004	<0.003		3.4	1600	<0.0002	1.1	0.02	<0.02	<0.001	<0.003	<0.001	830	2500	<0.001	<0.006
OR20	4/24/2014	<0.005	<0.001	75	0.022	<0.001	<0.001	710	<0.005	<0.002	<0.004	<0.003		0.033	1400	<0.0002	0.96	0.022	0.6	<0.001	<0.0015	<0.001	570	2900	<0.001	<0.006
OR20	7/17/2014			82				740						<0.01	1300		0.9						630	2700		
OR20	4/17/2015			74				740						0.02	1600		0.88						620	2600		
OR20	9/14/2015			65				730						0.056	1700		0.73						550	2800		
OM21	4/24/2000			5.7				30						10	2100		0.88						1600	3000		
OM21	9/18/2000			3.5				18						5.9	1300		0.32						1300	2400		
OM21	4/24/2001			2.7				44						10	2000		1.2						1500	3133		
OM21	9/13/2001			2.7				14						6.1	1400		0.36						1200	2600		
OM21	4/24/2002			1				59						11	1860		1.6						1200	3200		
OM21	9/24/2002			2.6				16						5.8	1400		0.41						1100	2600		
OM21	4/17/2003			1.3				45						7.2	1500		0.59						1800	2800		
OM21	9/23/2003			1.4				21						3.7	1300		0.31						1200	2500		
OM21	4/12/2004			1.2				55						8.1	1800		0.95						1400	2800		
OM21	9/23/2004			1.4				26						7.1	1800		0.33						1200	2600		
OM21	4/18/2005			1.2				27						0.62	1400		0.34						1100	2500		
OM21	9/19/2005			1.4				25						<0.01	1400		0.29						1000	2400		
OM21	4/28/2006			4.1				310						13	2000		2						1400	3300		
OM21	9/7/2006			2.8				28						<0.01	780		0.23						1100	2400		
OM21	4/2/2007			1.5				28						<0.01	1200		0.14						1200	2400		
OM21	9/19/2007			1.4				42						<0.01	1000		0.31						1100	2400		
OM21	3/27/2008			14				450						9.9	1800		0.94						1200	3200		
OM21	6/3/2008			3.5				390						7.4	1400		0.54						1200	3100		
OM21	8/19/2008			7.5				490						8.6	1900		0.47						1300	3400		
OM21	4/30/2009			4.6				540						11	2300		0.51						1300	3300		
OM21	9/22/2009			3.1				340						0.01	1600		0.43						1400	2800		
OM21	12/8/2009			4.9				450						0.88	1800		0.49						1500	3200		
OM21	4/27/2010			4.2				380						0.012	1800		0.42						1200	3200		
OM21	9/8/2010			6.6				400						0.22	1800		0.65						1200	3100		
OM21	2/22/2011	<0.005	0.003	9.8	0.028	<0.001	<0.001	450	<0.005	<0.002	0.014	<0.003	<0.25	9.3	1900	<0.0002	0.68	0.031	0.032	<0.001	<0.003	0.012	1200	3200	<0.001	0.012
OM21	4/29/2011	<0.005	0.003	11	0.021	<0.001	<0.001	500	<0.005	<0.002	0.018	<0.003	<0.25	7.6	2000	<0.0002	0.71	0.009	0.53	0.001	<0.003	0.014	1200	3200	<0.001	<0.006
OM21	8/25/2011	<0.005	0.004	12	0.019	<0.001	<0.001	470	<0.005	<0.002	0.02	0.009	<0.25	0.081	1900	<0.0002	0.74	0.026	1.1	<0.001	<0.003	0.019	1300	3200	<0.001	0.015
OM21	10/14/2011	<0.005	0.006	10	0.017	<0.001	<0.001	420	<0.005	<0.002	0.016	0.007	<0.25	8.8	1800	<0.0002	0.61	0.024	0.49	<0.001	<0.003	0.021	1000	3000	<0.001	<0.006
OM21	2/24/2012	<0.005	0.007	9.3	0.023	<0.001	<0.001	390	<0.005	<0.002	0.014	0.005	<0.25	0.034	1900	<0.0002	0.55	0.027	4.9	<0.001	<0.003	0.027	1100	3100	<0.001	0.017
OM21	5/3/2012	<0.005	0.003	11	0.019	<0.001	<0.001	440	<0.005	<0.002	0.013	0.004	<0.25	<0.01	1800	<0.0002	0.63	0.017	2.1	<0.001	<0.003	0.013	1200	3100	<0.001	0.018
OM21	8/24/2012	<0.005	0.005	9.5	0.016	<0.001	<0.001	520	<0.005	<0.002	0.018	0.006	0.45	0.019	2000	<0.0002	0.59	0.039	1.1	<0.001	<0.003	0.021	1300	3200	<0.001	<0.006
OM21	11/2/2012	<0.005	0.002	9.3	0.017	<0.001	<0.001	480	<0.005	<0.002	0.005	0.006	<0.25	0.014	2000	<0.0002	0.59	0.014	0.92	<0.001	<0.003	0.008	1300	3100	<0.001	0.012
OM21	2/4/2013	<0.0025	<0.0005	5	0.009	<0.0005	<0.0005	400	<0.005	<0.001	<0.002	<0.0015	0.28	0.017	1800	<0.0001	0.31	<0.0025	1	<0.0005	<0.0015	<0.0005	1200	3000	<0.0005	0.008
OM21	5/2/2013	<0.005	0.005	12	0.021	<0.001	<0.001	490	<0.005	<0.002	0.016	0.007	<0.25	0.029	2000	<0.0002	0.68	0.027	3.3	<0.001	<0.003	0.01	1300	3200	<0.001	0.014

NATURAL RESOURCE TECHNOLOGY

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM21	7/29/2013	<0.005	0.004	14	0.019	<0.001	<0.001	520	<0.005	<0.002	0.012	0.004	<0.25	0.13	2000	<0.0002	0.57	0.021	1.5	<0.001	<0.003	0.009	1200	3300	<0.001	0.011
OM21	10/21/2013	<0.005	<0.001	11	0.02	<0.001	<0.001	550	<0.005	<0.002	<0.004	<0.003		0.96	1600	<0.0002	0.59	<0.005	1.3	<0.001	<0.003	<0.001	1400	3200	<0.001	<0.006
OM21	3/30/2014	<0.005	<0.001	11	0.02	<0.001	<0.001	490	<0.005	<0.002	<0.004	<0.003		<0.01	1900	<0.0002	0.54	<0.005	3.9	<0.001	<0.003	<0.001	1200	3200	<0.001	0.007
OM21	4/24/2014	<0.005	<0.001	14	0.02	<0.001	<0.001	500	<0.005	<0.002	<0.004	<0.003		0.018	1700	<0.0002	0.58	<0.005	4.4	<0.001	<0.0015	<0.001	1300	3300	<0.001	<0.006
OM21	7/18/2014			14				560						<0.01	1800		0.58						1400	3400		
OM21	4/17/2015			16				500						0.16	2000		0.45						1300	3200		
OM21	9/15/2015			15				460						0.028	2100		0.74						1300	3200		
OM22D	12/7/2009			2.7				81						0.024	310		0.24						94	460		
OM22D	4/28/2010			3				84						0.056	340		0.073						120	530		
OM22D	9/9/2010			3.7				100						0.02	370		0.1						170	600		
OM22D	2/22/2011	<0.005	0.002	12	0.05	<0.001	<0.001	260	<0.005	0.01	0.008	<0.003	<0.25	1.4	1200	<0.0002	2.1	0.043	<0.02	<0.001	<0.003	0.003	500	1700	<0.001	0.007
OM22D	4/28/2011	<0.005	<0.001	4.3	0.05	<0.001	<0.001	96	<0.005	<0.002	0.004	<0.003	0.62	0.01	300	<0.0002	0.031	0.009	2	<0.001	<0.003	0.004	150	600	<0.001	0.032
OM22D	8/25/2011																									
OM22D	8/29/2011	<0.005	0.001	5	0.058	<0.001	<0.001	110	<0.005	<0.002	0.004	0.004	0.82	<0.01	450	<0.0002	0.002	0.014	2	<0.001	<0.003	0.009	190	660	<0.001	0.02
OM22D	10/14/2011	<0.005	0.004	8.4	0.085	<0.001	<0.001	110	<0.005	<0.002	0.007	0.007	0.62	<0.01	740	<0.0002	0.56	0.026	1.5	<0.001	<0.003	0.012	180	810	<0.001	0.045
OM22D	2/24/2012	<0.005	0.006	11	0.083	<0.001	<0.001	210	<0.005	0.007	0.009	<0.003	0.31	0.71	1100	<0.0002	2	0.036	0.23	<0.001	<0.003	0.019	420	1400	<0.001	<0.006
OM22D	5/3/2012	<0.005	0.002	12	0.052	<0.001	<0.001	250	<0.005	0.004	0.009	<0.003	0.31	1.3	1100	<0.0002	1.4	0.028	0.11	<0.001	<0.003	0.007	470	1600	<0.001	0.017
OM22D	8/24/2012	<0.005	0.003	11	0.089	<0.001	<0.001	250	<0.005	0.006	0.01	<0.003	0.32	1.1	1100	<0.0002	1.8	0.042	0.17	<0.001	<0.003	0.012	470	1500	<0.001	<0.006
OM22D	11/2/2012	<0.005	0.003	12	0.052	<0.001	<0.001	180	<0.005	0.004	<0.004	<0.003	0.37	1.3	1200	<0.0002	1.4	0.028	1.1	<0.001	<0.003	0.005	330	1200	<0.001	0.007
OM22D	2/5/2013	<0.0025	<0.0005	7	0.068	<0.0005	<0.0005	170	<0.005	0.001	<0.002	0.003	0.76	0.015	650	<0.0001	0.013	0.011	2.6	<0.0005	<0.0015	<0.0005	280	820	<0.0005	0.031
OM22D	5/1/2013	<0.005	0.007	15	0.043	<0.001	<0.001	360	<0.005	0.006	0.009	<0.003	<0.25	3	1300	<0.0002	1.6	0.039	<0.02	<0.001	<0.003	0.006	550	1900	<0.001	<0.006
OM22D	7/29/2013	<0.005	0.007	21	0.027	<0.001	<0.001	480	<0.005	0.002	0.013	<0.003	<0.25	1.9	1500	<0.0002	1.2	0.036	0.03	<0.001	<0.003	0.007	530	2100	<0.001	0.008
OM22D	10/18/2013	<0.005	0.002	19	0.037	<0.001	<0.001	520	<0.005	<0.002	<0.004	<0.003		2	1300	<0.0001	1.1	0.018	<0.02	<0.001	<0.003	<0.001	690	2100	<0.001	<0.006
OM22D	3/30/2014	<0.005	0.002	17	0.025	<0.001	<0.0005	460	<0.005	<0.002	<0.004	<0.0015		2.3	1400	<0.0002	1.2	0.02	<0.02	<0.001	<0.003	<0.001	540	2000	<0.001	<0.006
OM22D	4/23/2014	<0.005	0.003	2.2	0.036	<0.001	<0.001	480	<0.005	<0.002	<0.004	<0.003		3.2	870	<0.0002	1.1	<0.005	0.04	<0.001	<0.003	<0.001	560	2100	<0.001	<0.006
OM22D	7/17/2014			19				510						0.01	1300		1.1						610	2300		
OM22D	4/17/2015			16				460						<0.01	1200		0.46						570	1800		
OM22D	9/28/2015			16				480						1.9	1400		0.97						540	2200		
OM22S	12/7/2009			0.11				4.3						0.013	720		3.7						100	840		
OM22S	4/28/2010			0.12				13						0.04	790		3.2						110	840		
OM22S	9/9/2010			0.19				6.1						0.61	790		3.1						140	800		
OM22S	2/23/2011																									
OM22S	4/28/2011																									
OM22S	8/25/2011																									
OM22S	10/14/2011																									
OM22S	2/24/2012																									
OM23D	12/7/2009			1.8				41						0.56	880		0.98						440	1300		
OM23D	4/28/2010			2.2				38						2.5	820		0.98						430	1400		
OM23D	9/9/2010			2				32						1.6	400		0.88						470	1400		
OM23D	2/22/2011	<0.005	0.002	2.4	0.053	<0.001	<0.001	38	<0.005	<0.002	<0.004	<0.003	0.6	2	800	<0.0002	0.93	0.019	0.02	<0.001	<0.003	<0.001	420	1400	<0.001	<0.006
OM23D	4/28/2011	<0.005	0.001	2.6	0.046	<0.001	<0.001	46	<0.005	<0.002	<0.004	<0.003	0.62	2	720	<0.0002	0.83	0.006	0.06	<0.001	<0.003	0.002	450	1400	<0.001	<0.006
OM23D	8/25/2011																									
OM23D	8/29/2011	<0.005	0.001	2.5	0.053	<0.001	<0.001	32	<0.005	<0.002	<0.004	0.005	0.68	1.9	700	<0.0002	0.86	0.014	0.05	<0.001	<0.003	0.003	400	1300	<0.001	<0.006
OM23D	10/14/2011	<0.005	0.002	2.3	0.047	<0.001	<0.001	37	<0.005	<0.002	<0.004	0.004	0.56	2.5	870	<0.0002	1	0.018	1.2	<0.001	<0.003	0.003	390	1300	<0.001	<0.006
OM23D	2/24/2012	<0.005	0.002	2.3	0.048	<0.001	<0.001	34	<0.005	<0.002	<0.004	<0.003	0.51	2.3	920	<0.0002	1	0.015	<0.02	<0.001	<0.003	0.001	460	1300	<0.001	<0.006
OM23D	5/3/2012	<0.005	0.002	2.7	0.063	<0.001	<0.001	32	<0.005	<0.002	0.004	<0.003	0.68	1.3	770	<0.0002	0.72	0.011	0.06	<0.001	<0.003	0.003	460	1200	<0.001	0.01
OM23D	8/24/2012	<0.005	0.002	2.3	0.031	<0.001	<0.001	33	<0.005	<0.002	<0.004	<0.003	0.34	0.035	1000	<0.0002	1.1	0.021	0.05	<0.001	<0.003	0.004	550	1400	<0.001	<0.006
OM23D	11/2/2012	<0.005	0.001	2.3	0.027	<0.001	<0.001	34	<0.005	<0.002	<0.004	<0.003	<0.25	2.8	1100	<0.0002	1.1	0.01	0.04	<0.001	<0.003	<0.001	400	1400	<0.001	<0.006
OM23D	2/5/2013	<0.0025	0.001	2.4	0.025	<0.0005	<0.0005	32	<0.005	<0.001	<0.002	<0.0015	0.33	3	980	<0.0001	1.1	0.005	0.09	<0.0005	<0.0015	<0.0005	570	1400	<0.0005	<0.003
OM23D	5/1/2013	<0.005	0.001	1.8	0.027	<0.0005	<0.001	30	<0.005	<0.002	<0.004	<0.003	<0.25	2.7	1000	<0.0002	1	<0.005	<0.02	<0.001	<0.003	<0.001	680	1300	<0.001	<0.006
OM23D	10/18/2013	<0.005	<0.001	2.1	0.021	<0.001	<0.001	33	<0.005	<0.002	<0.004	<0.003		2.7	810	<0.0001	0.82	<0.005	0.22	<0.001	<0.003	<0.001	640	1300	<0.001	0.011
OM23D	3/30/2014	<0.005	0.001	1.8	0.024	<0.001	<0.0005	34	<0.005	<0.002	<0.004	0.021		1.3	940	<0.0002	1.1	<0.005	0.19	<0.001	<0.003	<0.001	490	1300	<0.001	<0.006
OM23D	4/23/2014	<0.005	0.002	20	0.032	<0.001	<0.001	32	<0.005	<0.002	<0.004	<0.003		2.2	1300	<0.0002	1.4	0.02	<0.02	<0.001	<0.003	<0.001	530	1200	<0.001	<0.006
OM23D	7/17/2014			2.1				35						2.5	830		1.1						540	1300		
OM23D	4/17/2015			2.3				37						0.042	900		1.1						520	1300		
OM23D	9/28/2015			22				560						0.9	1800		1.3						720	2500		
OM23S	12/7/2009			0.69				19						6.2	1600		2.4						1000	2300		
OM23S	9/9/2010			0.64				21						0.023	410		2.5						1400	2600		
OM24D	12/7/2009			23				480						5.9	1700		2.2						760	2600		
OM24D	4/28/2010			20				530						10	2100		2.5						980	3100		

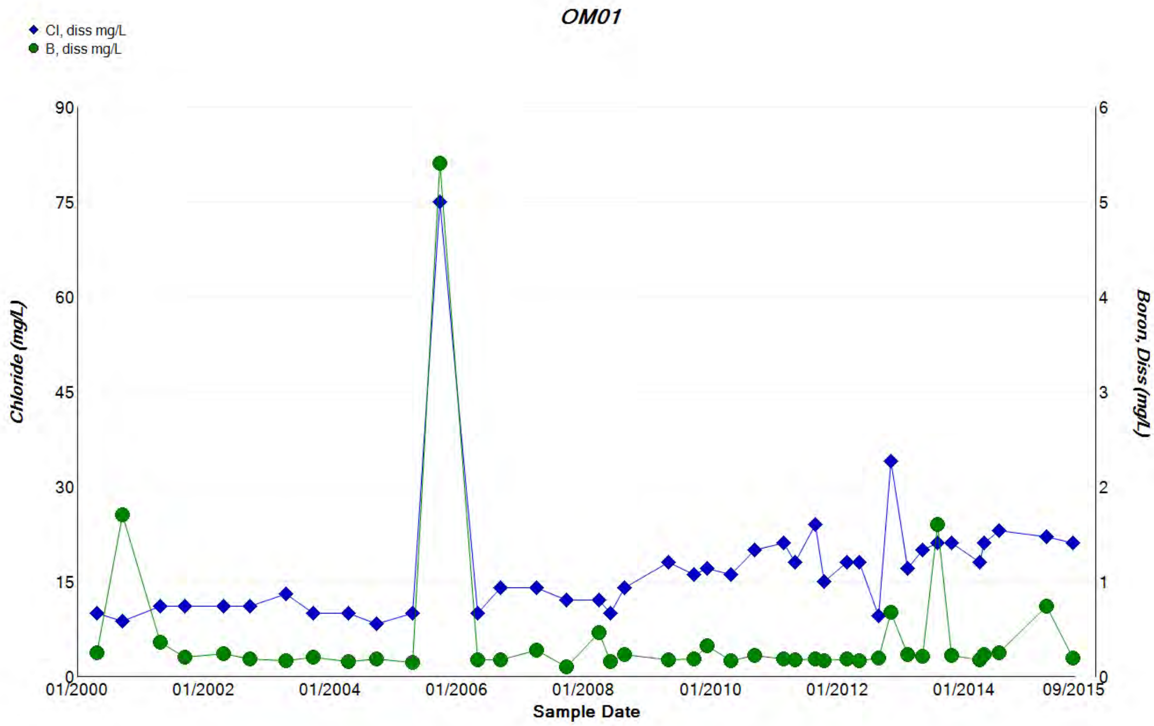
NATURAL RESOURCE TECHNOLOGY

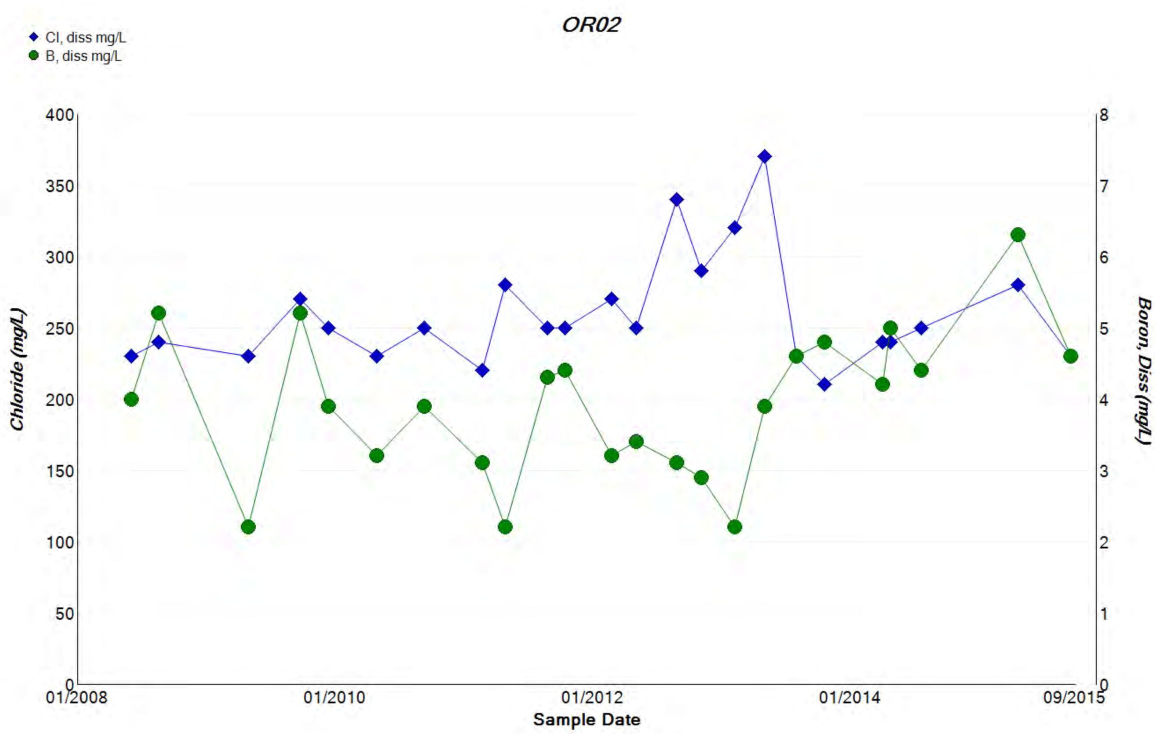
Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

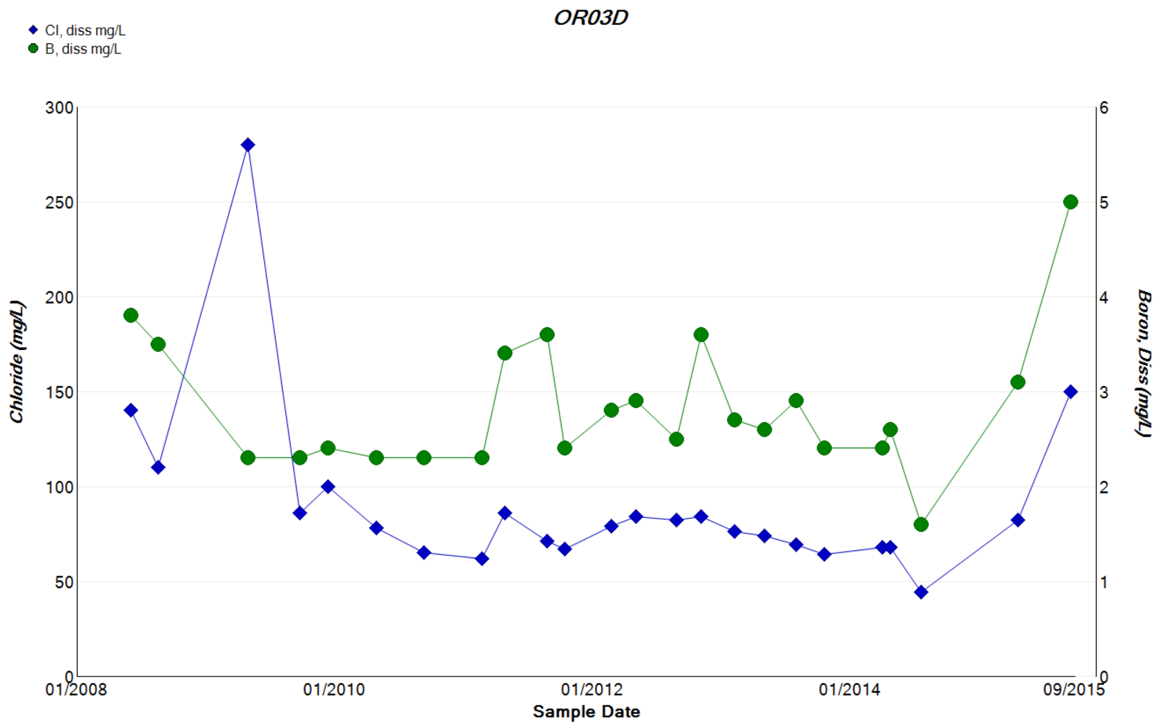
Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM24D	9/9/2010			21				480						6.5	1900		1.8						900	2600		
OM24D	2/22/2011	<0.005	0.005	20	0.015	<0.001	<0.001	470	<0.005	<0.002	0.014	0.021	<0.25	6.1	1500	<0.0002	2	0.04	<0.02	<0.001	<0.003	0.007	680	2300	<0.001	0.016
OM24D	4/28/2011	<0.005	0.02	19	0.11	<0.001	<0.001	440	<0.005	0.011	0.022	0.011	<0.25	25	1900	<0.0002	2.8	0.053	<0.02	0.033	<0.003	0.017	740	2200	<0.001	0.032
OM24D	8/29/2011	<0.005	0.012	20	0.044	<0.001	<0.001	450	<0.005	0.003	0.025	0.005	0.34	6.7	1600	<0.0002	1.6	0.046	0.2	0.005	<0.003	0.028	800	2100	<0.001	0.01
OM24D	10/14/2011	<0.005	0.014	24	0.081	<0.001	<0.001	560	<0.005	0.005	0.021	0.009	<0.25	12	1800	<0.0002	2.5	0.057	0.4	0.009	<0.003	0.029	730	2200	<0.001	0.017
OM24D	2/24/2012	<0.005	0.037	23	0.036	<0.001	<0.001	550	<0.005	<0.002	0.019	0.004	<0.25	40	1800	<0.0002	2.1	0.046	0.45	0.004	<0.003	0.032	770	2600	<0.001	0.017
OM24D	5/3/2012	<0.005	0.007	23	0.016	<0.001	<0.001	670	<0.005	<0.002	0.014	<0.003	<0.25	7	1700	<0.0002	2.1	0.034	0.03	<0.001	<0.003	0.017	860	2600	<0.001	0.009
OM24D	8/24/2012	<0.005	0.013	28	0.018	<0.001	<0.001	880	<0.005	<0.002	0.031	<0.003	0.38	8.8	2300	<0.0002	2.3	0.069	0.04	<0.001	<0.003	0.039	790	3000	<0.001	<0.006
OM24D	11/2/2012	<0.005	0.012	38	0.019	<0.001	<0.001	1000	<0.005	<0.002	0.013	<0.003	<0.25	8.3	2600	<0.0002	2.7	0.041	0.32	<0.001	<0.003	0.022	830	3100	<0.001	<0.006
OM24D	5/1/2013	<0.005	0.004	28	0.037	<0.0005	<0.001	890	<0.005	<0.002	<0.004	<0.003	<0.25	8.2	2000	<0.0002	2.4	0.016	<0.02	<0.001	<0.003	<0.001	1200	2900	<0.001	<0.006
OM24D	7/29/2013	<0.005	0.008	29	0.016	<0.001	<0.001	560	<0.005	<0.002	0.016	<0.003	<0.25	6.2	1900	<0.0002	2.3	0.037	0.11	<0.001	<0.003	0.01	870	3000	<0.001	<0.006
OM24D	10/18/2013	<0.005	0.009	27	0.038	<0.001	<0.001	760	<0.005	<0.002	<0.004	<0.003		4.3	1600	<0.0001	2.3	0.017	0.11	<0.001	<0.003	<0.001	1200	2800	<0.001	<0.006
OM24D	3/30/2014	<0.005	0.003	28	0.027	<0.001	<0.0005	910	<0.005	<0.002	<0.004	<0.0015		4.2	2000	<0.0002	3.3	0.019	0.08	<0.001	<0.003	<0.001	1100	3000	<0.001	<0.006
OM24D	4/23/2014	<0.005	0.004	34	0.018	<0.001	<0.001	960	<0.005	<0.002	<0.004	<0.003		7.4	190	<0.0002	2.5	0.017	<0.02	<0.001	<0.003	<0.001	1100	3000	<0.001	<0.006
OM24D	7/17/2014			29				700						7.6	1700		2.6						910	3100		
OM24D	4/17/2015			23				540						0.014	1800		2						910	2300		
OM24D	9/28/2015			20				440						6.3	1700		2.2						770	2200		
OM25D	12/7/2009			1.7				61						<0.01	740		1.2						280	1100		
OM25D	4/28/2010			2.3				110						1.5	1000		1.4						470	1500		
OM25D	9/9/2010			1.9				81						<0.01	920		1.2						360	1300		
OM25S	12/7/2009			5.1				190						<0.01	690		0.77						280	1200		
OM25S	4/28/2010			11				350						0.016	1200		1.2						520	2000		
OM25S	9/9/2010			9.9				270						<0.01	1200		1.2						600	1900		
OM25S	2/22/2011	<0.005	0.003	19	0.056	<0.001	<0.001	500	<0.005	0.006	0.015	0.021	<0.25	0.028	1600	<0.0002	1.4	0.046	3.2	<0.001	<0.003	0.008	710	2300	<0.001	<0.006
OM25S	4/28/2011	<0.005	<0.001	4.6	0.053	<0.001	<0.001	83	<0.005	<0.002	0.006	<0.003	<0.25	0.032	820	<0.0002	0.49	0.01	0.19	<0.001	<0.003	0.006	250	1100	<0.001	<0.006
OM25S	8/25/2011																									
OM25S	8/29/2011	<0.005	0.004	12	0.049	<0.001	<0.001	290	<0.005	0.005	0.017	0.005	0.39	0.12	1400	<0.0002	1.3	0.035	0.08	<0.001	<0.003	0.02	540	1800	<0.001	0.007
OM25S	10/14/2011	<0.005	0.005	15	0.046	<0.001	<0.001	320	<0.005	0.005	0.013	0.006	<0.25	<0.01	1400	<0.0002	1.3	0.041	0.08	<0.001	<0.003	0.02	550	1900	<0.001	0.012
OM25S	2/24/2012	<0.005	0.005	12	0.049	<0.001	<0.001	290	<0.005	0.004	0.01	0.007	<0.25	0.14	1400	<0.0002	1.2	0.036	1.9	<0.001	<0.003	0.023	600	1900	<0.001	0.014
OM25S	5/3/2012	<0.005	0.003	18	0.047	<0.001	<0.001	550	<0.005	0.004	0.012	<0.003	<0.25	<0.01	1400	<0.0002	1.2	0.037	0.09	<0.001	<0.003	0.015	940	2100	<0.001	0.021
OM25S	8/24/2012	<0.005	0.006	16	0.041	<0.001	<0.001	410	<0.005	0.005	0.017	<0.003	<2.5	<0.01	1700	<0.0002	1.3	0.052	0.06	<0.001	<0.003	0.025	660	2200	<0.001	<0.006
OM25S	11/2/2012	<0.005	0.004	20	0.036	<0.001	<0.001	450	<0.005	0.005	0.007	<0.003	<0.25	0.86	1700	<0.0002	1.3	0.037	0.03	0.001	<0.003	0.012	710	2500	<0.001	0.01
OM25S	2/5/2013	<0.0025	<0.0005	13	0.031	<0.0005	<0.0005	520	<0.005	0.003	<0.002	<0.0015	<0.25	0.13	1400	<0.0001	0.94	0.02	2.9	<0.0005	<0.0015	0.001	900	2000	<0.0005	0.004
OM25S	5/1/2013	<0.005	<0.001	1.1	0.048	<0.0005	<0.001	22	<0.005	<0.002	<0.004	<0.003	0.27	<0.01	560	<0.0002	0.12	<0.005	0.56	<0.001	<0.003	0.003	190	690	<0.001	<0.006
OM25S	7/29/2013	<0.005	0.003	11	0.053	<0.001	<0.001	220	<0.005	0.005	0.008	<0.003	0.29	0.035	1100	<0.0002	1.1	0.025	0.05	<0.001	<0.003	0.003	430	1600	<0.001	<0.006
OM25S	10/18/2013	<0.005	<0.001	18	0.04	<0.001	<0.001	450	<0.005	0.005	<0.004	<0.003		0.13	1300	<0.0001	1.2	0.02	0.06	<0.001	<0.003	<0.001	640	2100	<0.001	0.008
OM25S	3/30/2014	<0.005	<0.001	12	0.047	<0.001	<0.0005	310	<0.005	0.003	<0.004	0.031		<0.01	1400	<0.0002	1	0.019	0.05	<0.001	<0.003	<0.001	560	1800	<0.001	<0.006
OM25S	4/23/2014	<0.005	<0.001	20	0.04	<0.001	<0.001	450	<0.005	0.004	<0.004	<0.003		<0.01	1300	<0.0002	1.1	0.021	0.05	<0.001	<0.003	0.001	640	2000	<0.001	<0.006
OM25S	7/17/2014			23				600						<0.01	1500		1.2						750	2500		
OM25S	4/17/2015			19				440						<0.01	1500		0.97						750	2100		
OM25S	9/28/2015			22				630						0.73	1900		1.1						770	2500		
OM50D	12/7/2009			1.8				13						<0.01	430		0.17						310	830		
OM50D	4/28/2010			2				13						2.1	460		0.38						260	780		
OM50D	9/9/2010			2.2				9.6						7	490		0.3						180	730		
OM50S	12/7/2009			0.11				7.4						0.022	890		0.084						520	1200		
OM50S	4/28/2010			0.096				6.5						0.059	1100		0.01						670	1300		
OM50S	9/9/2010			0.15				5.6						0.14	940		0.035						650	1100		
OM51D	12/7/2009			1.2				17						4	830		0.6						290	1200		
OM51D	4/28/2010			1				13						10	1100		0.71						560	1500		
OM51D	9/9/2010			1.2				22						0.074	630		0.17						220	920		
OM51S	12/7/2009			0.03				6.2						0.04	1100		3.1						410	1400		
OM51S	4/28/2010			0.029				4.3						0.19	1400		3.6						640	1700		
OM51S	9/9/2010			0.054				5.4						0.68	1300		5						690	1500		

APPENDIX C4

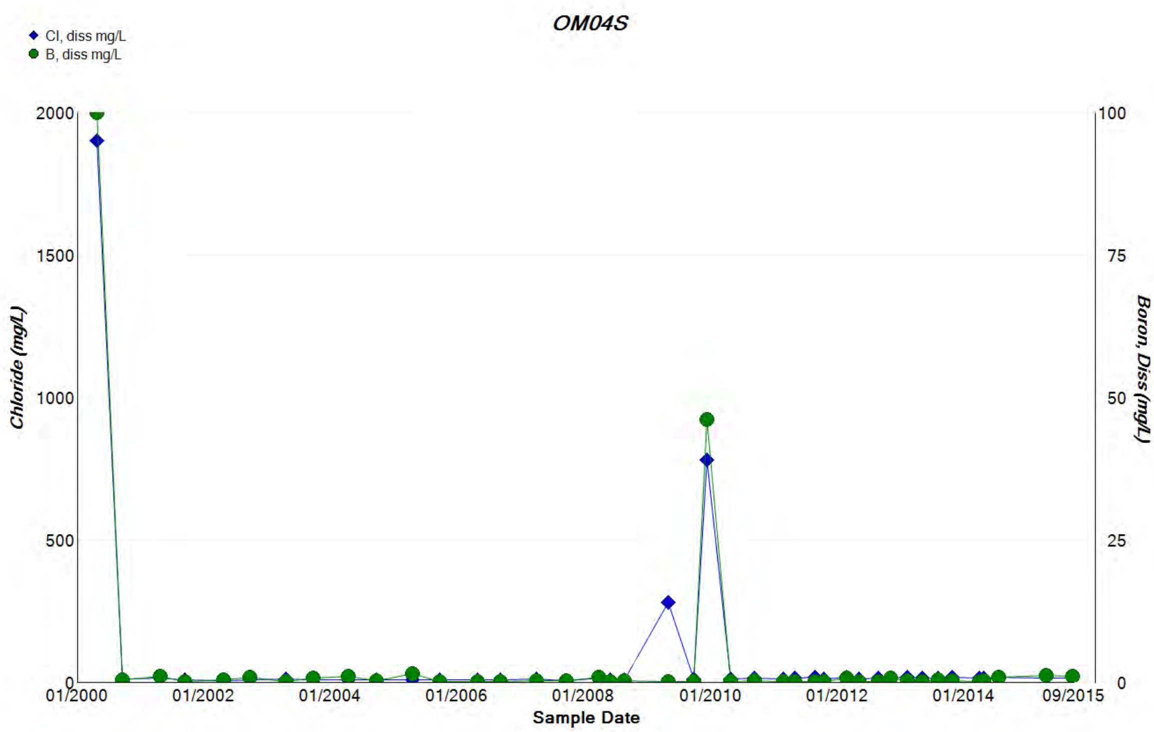
BORON AND CHLORIDE TIME SERIES PLOTS


OM01
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
0
15
30
45
60
75
90
0
1
2
3
4
5
6
01/2000
01/2002
01/2004
01/2006
01/2008
01/2010
01/2012
01/2014
09/2015

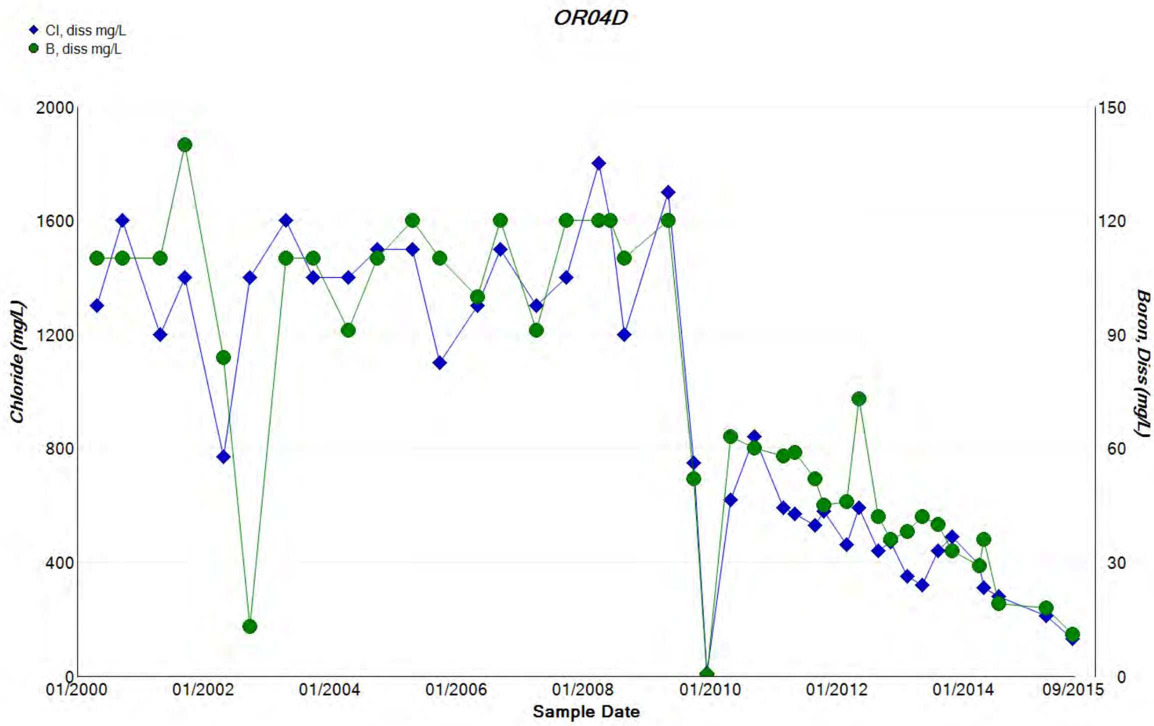

OR02
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
0
50
100
150
200
250
300
350
400
0
1
2
3
4
5
6
7
8
01/2008
01/2010
01/2012
01/2014
09/2015



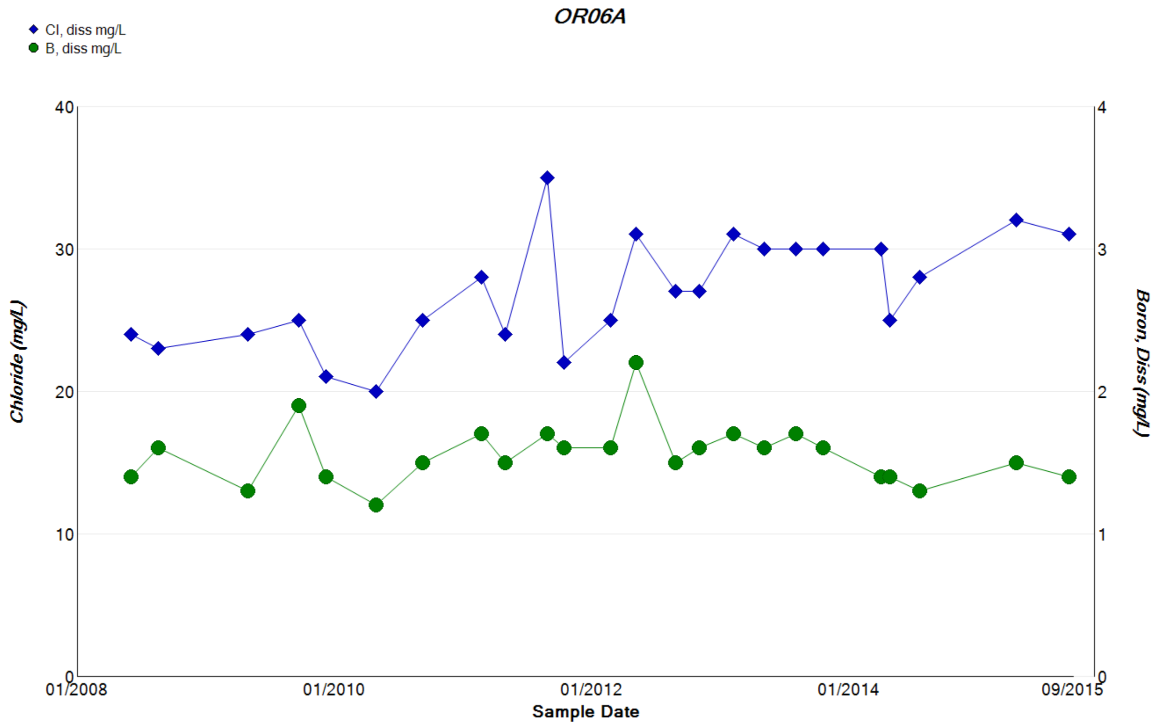
OR03D
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
300
250
200
150
100
50
0
6
5
4
3
2
1
0
01/2008
01/2010
01/2012
01/2014
09/2015
Sample Date

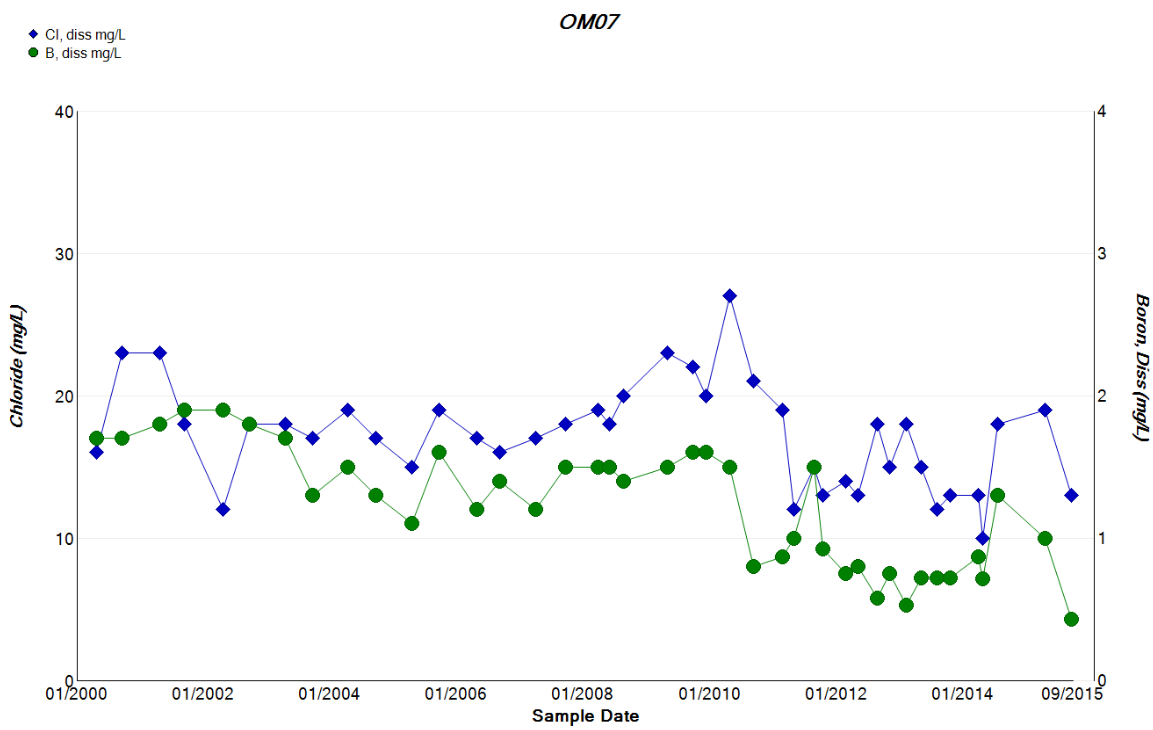


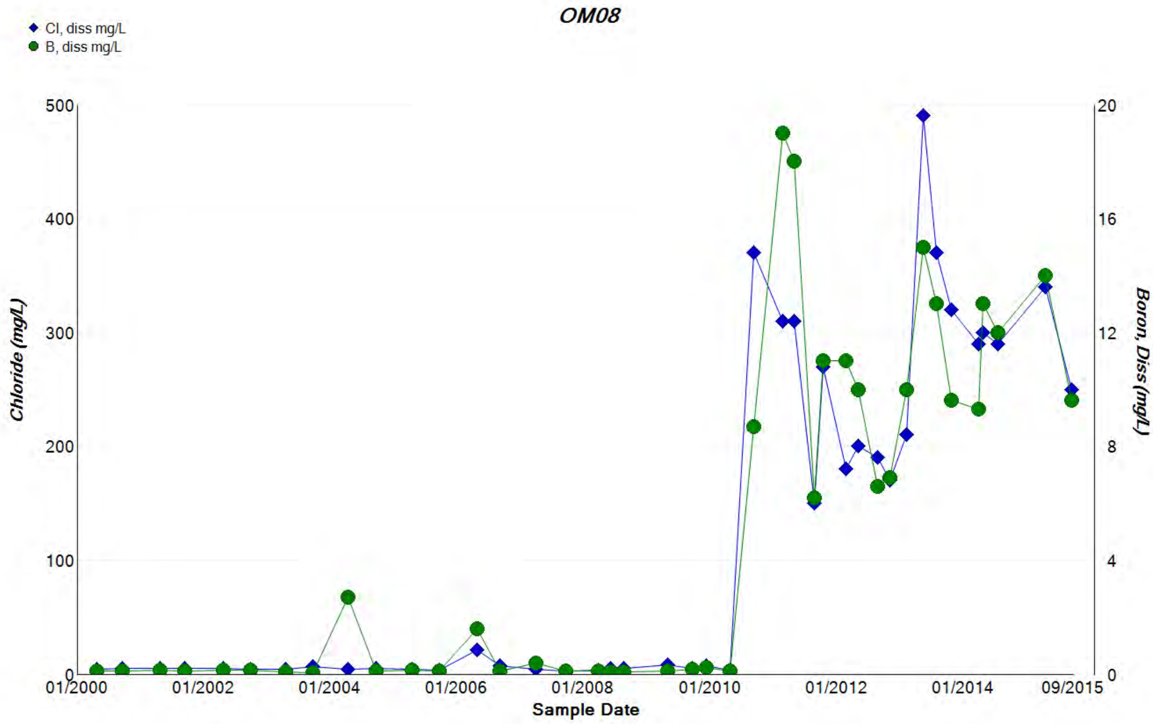
OM04S
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
2000
1500
1000
500
0
100
75
50
25
0
01/2000
01/2002
01/2004
01/2006
01/2008
01/2010
01/2012
01/2014
09/2015
Sample Date



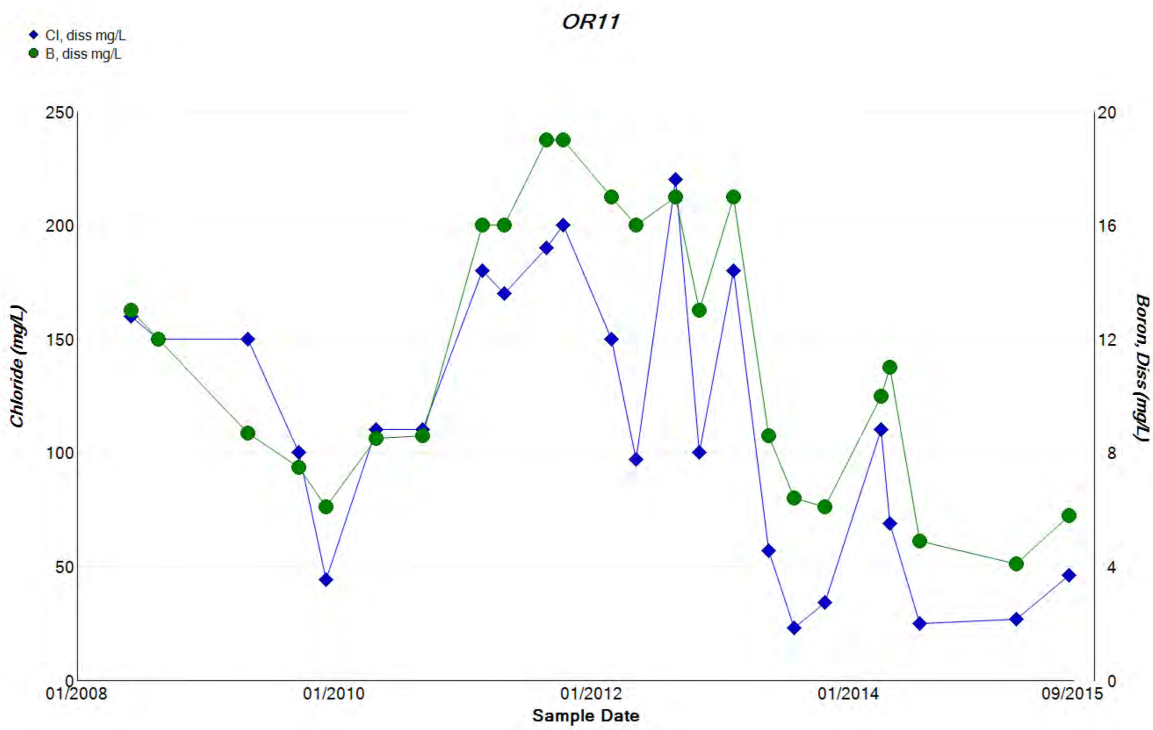
OR04D
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
2000
1600
1200
800
400
0
150
120
90
60
30
0
01/2000
01/2002
01/2004
01/2006
01/2008
01/2010
01/2012
01/2014
09/2015


OR06A
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
40
30
20
10
0
4
3
2
1
0
01/2008
01/2010
01/2012
01/2014
09/2015
Sample Date

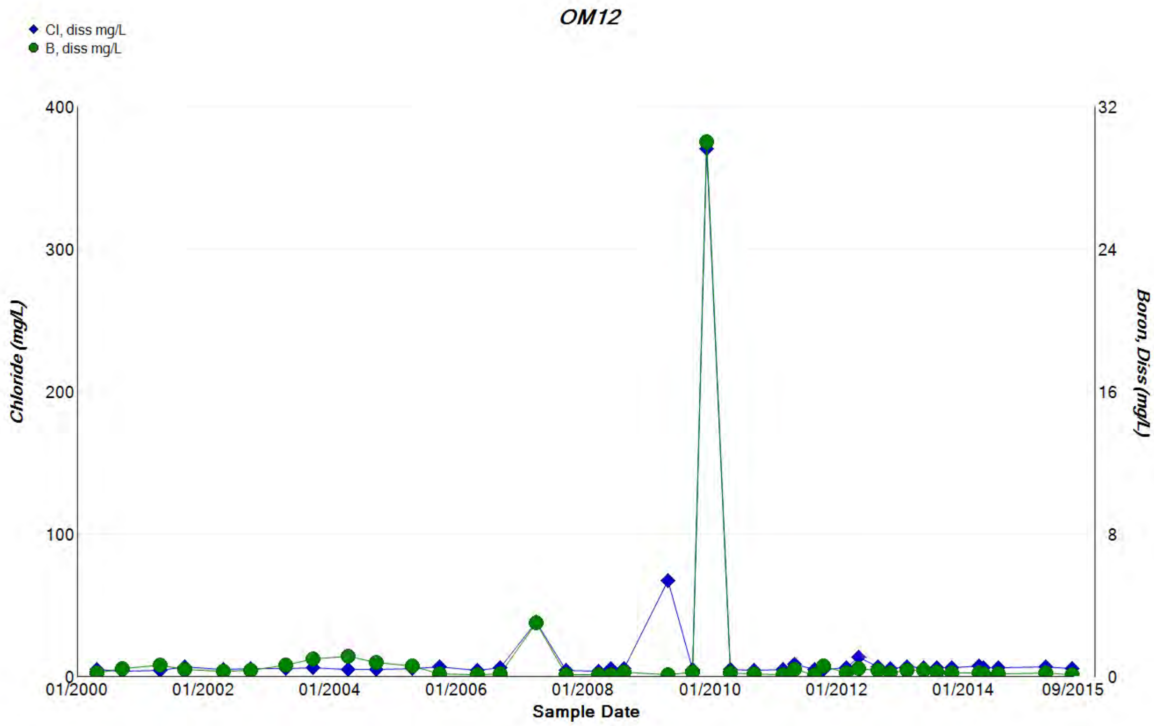

OM07
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
40
30
20
10
0
4
3
2
1
0
01/2000
01/2002
01/2004
01/2006
01/2008
01/2010
01/2012
01/2014
09/2015
Sample Date



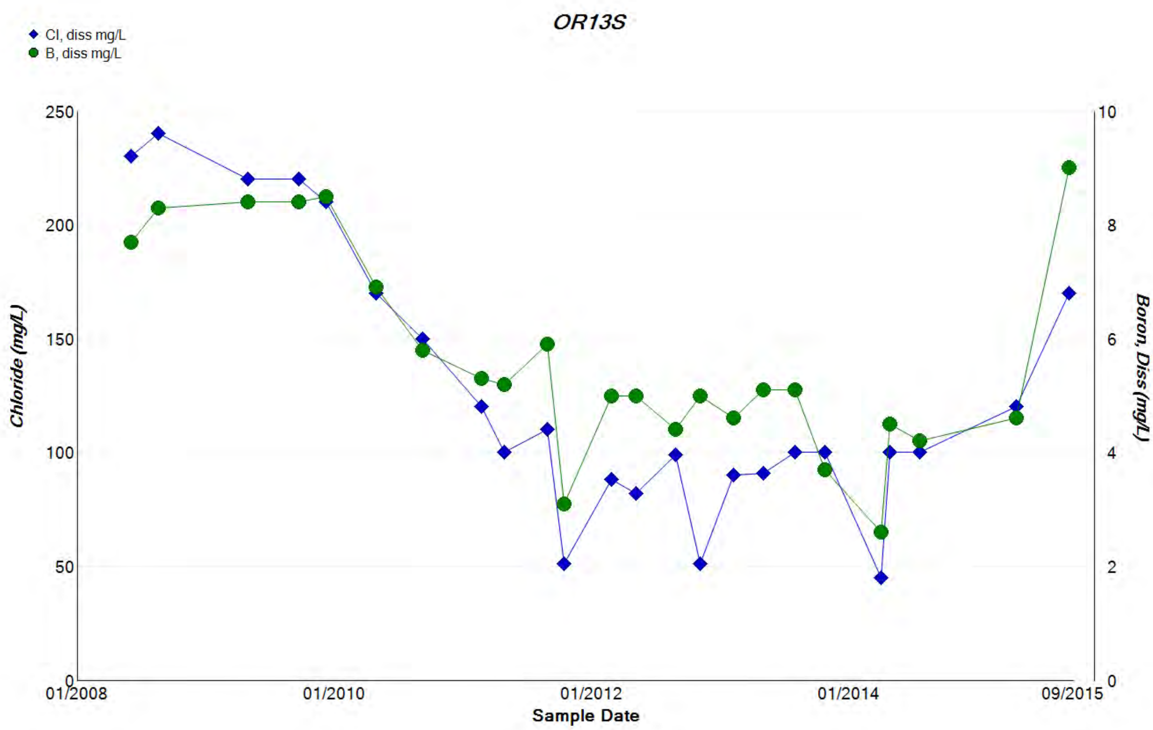
OM08
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
0
100
200
300
400
500
0
4
8
12
16
20
01/2000
01/2002
01/2004
01/2006
01/2008
01/2010
01/2012
01/2014
09/2015
Sample Date



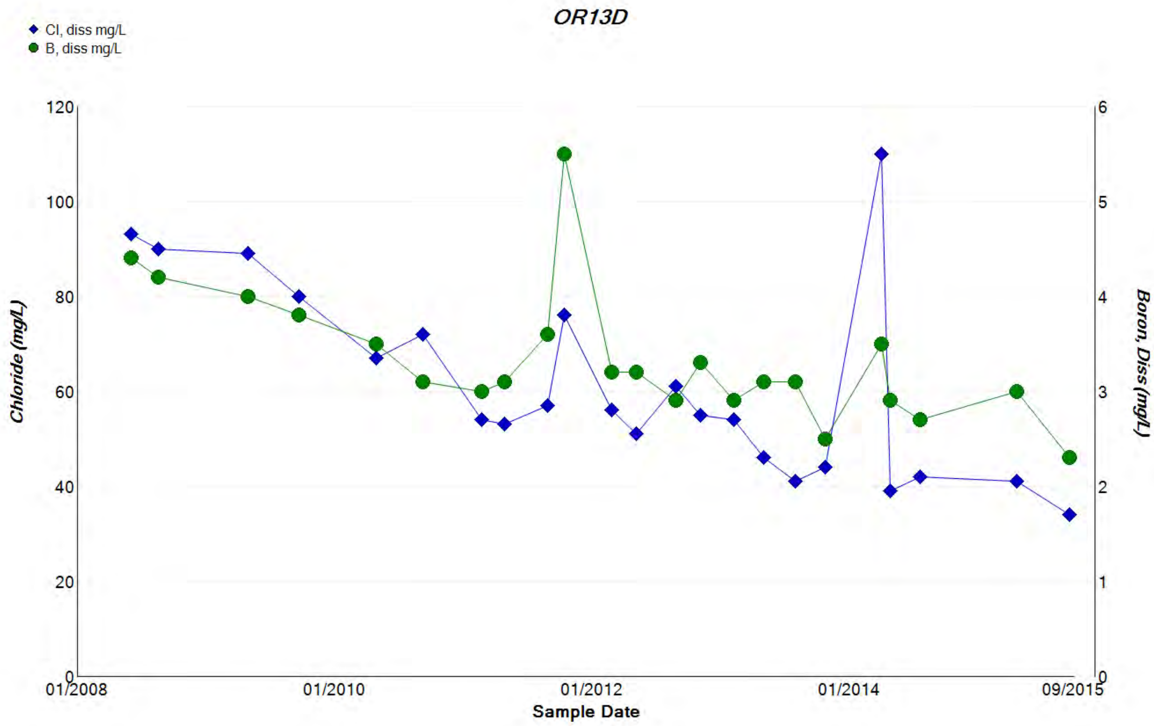
OR11
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
0
50
100
150
200
250
0
4
8
12
16
20
01/2008
01/2010
01/2012
01/2014
09/2015
Sample Date



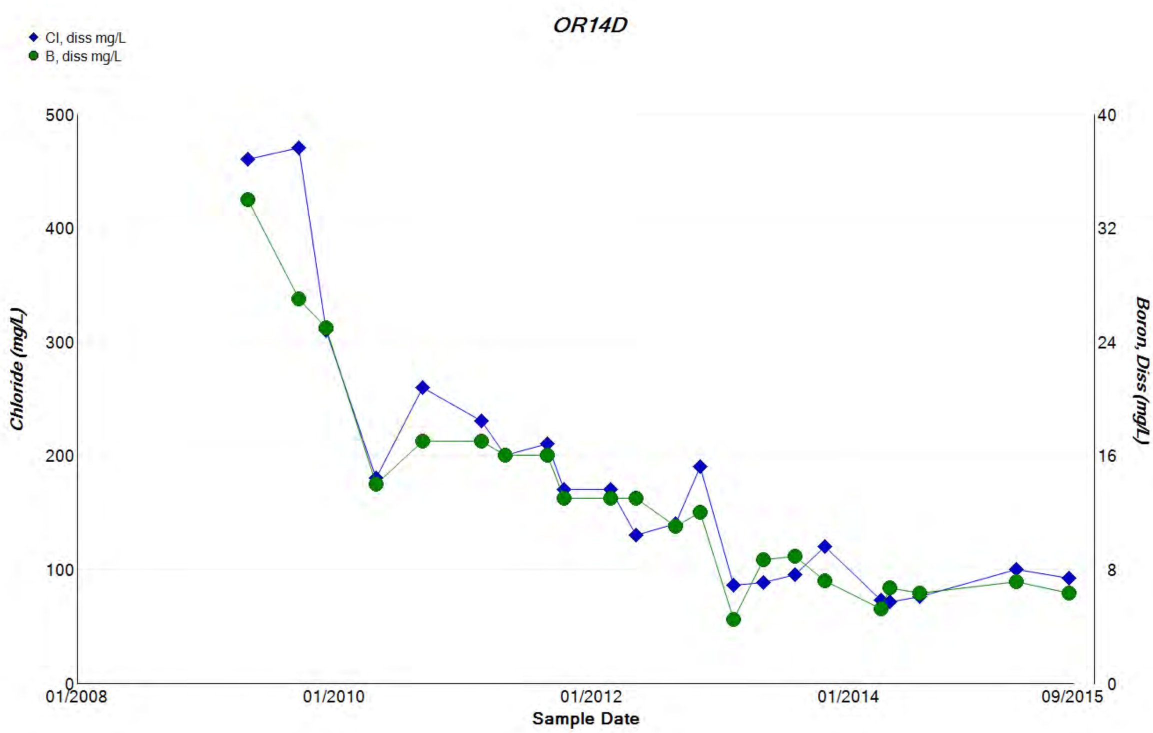
OM12
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
400
300
200
100
0
32
24
16
8
0
01/2000
01/2002
01/2004
01/2006
01/2008
01/2010
01/2012
01/2014
09/2015



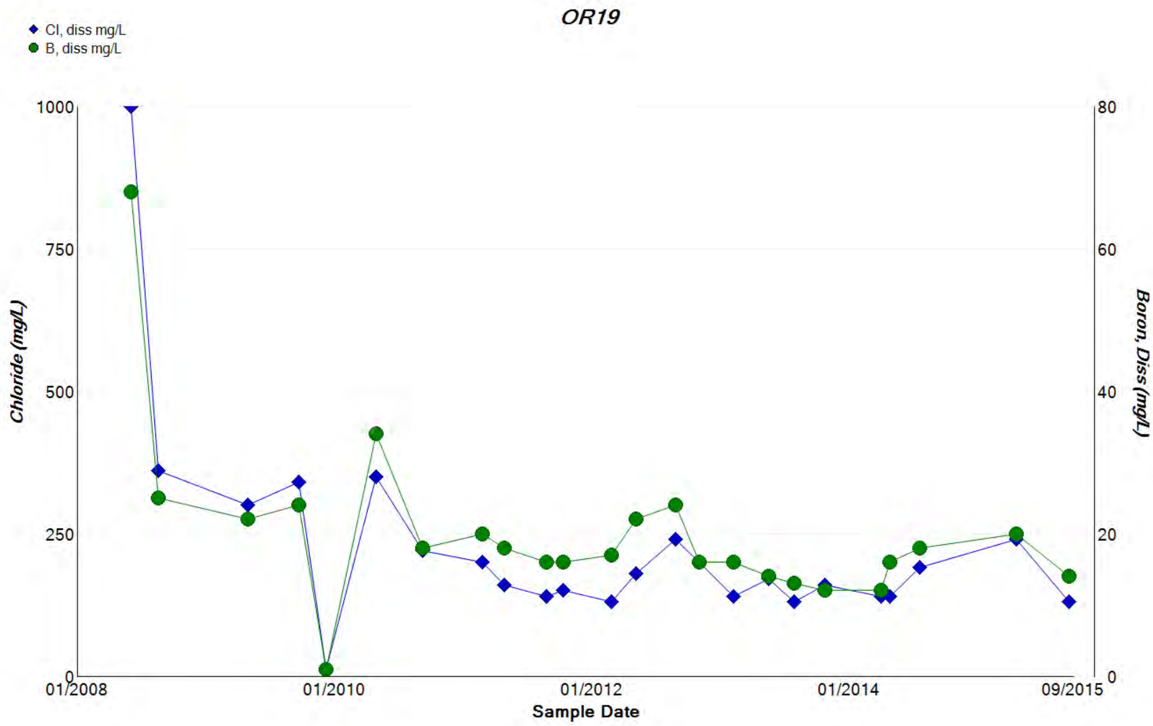
OR13S
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
250
200
150
100
50
0
10
8
6
4
2
0
01/2008
01/2010
01/2012
01/2014
09/2015



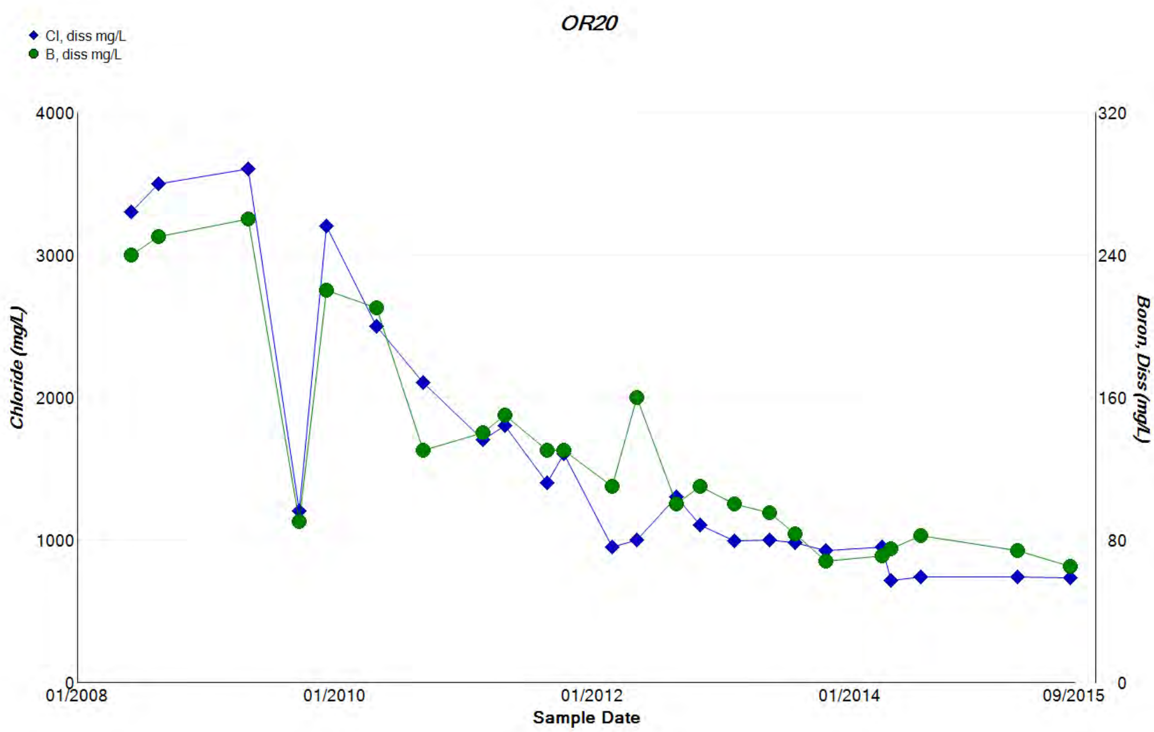
OR13D
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
120
100
80
60
40
20
0
6
5
4
3
2
1
0
01/2008
01/2010
01/2012
01/2014
09/2015
Sample Date



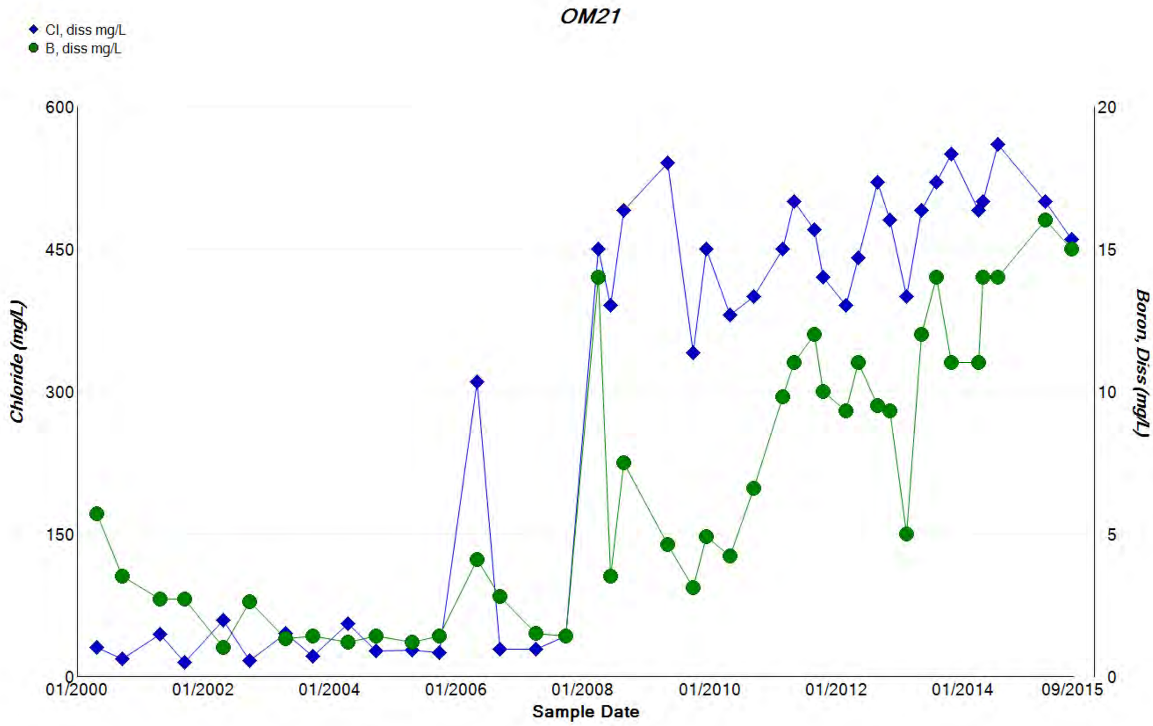
OR14D
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
500
400
300
200
100
0
40
32
24
16
8
0
01/2008
01/2010
01/2012
01/2014
09/2015
Sample Date



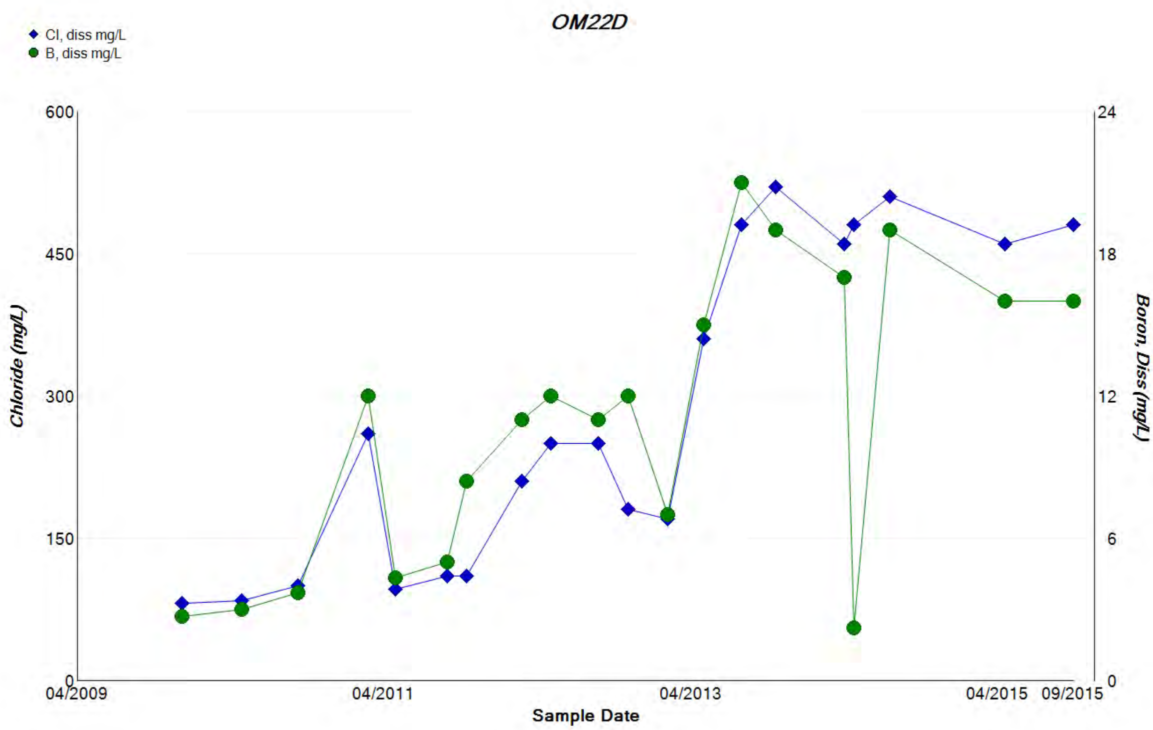
OR19
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
1000
750
500
250
0
80
60
40
20
0
01/2008
01/2010
01/2012
01/2014
09/2015



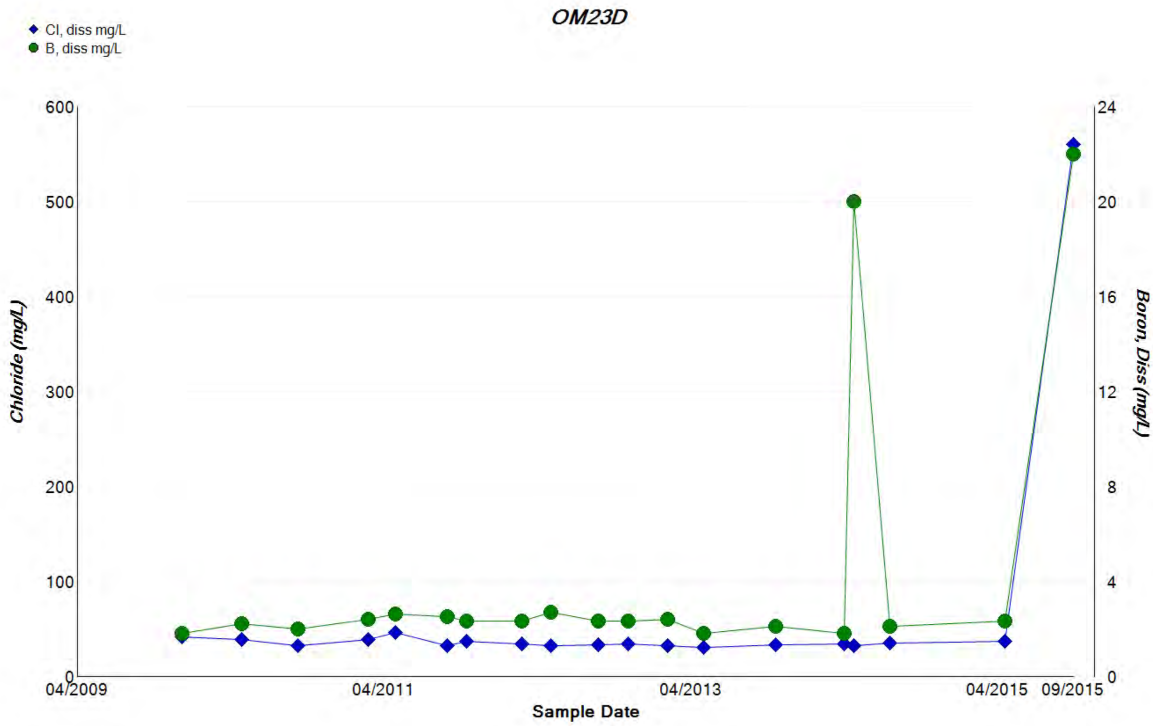
OR20
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
4000
3000
2000
1000
0
320
240
160
80
0
01/2008
01/2010
01/2012
01/2014
09/2015

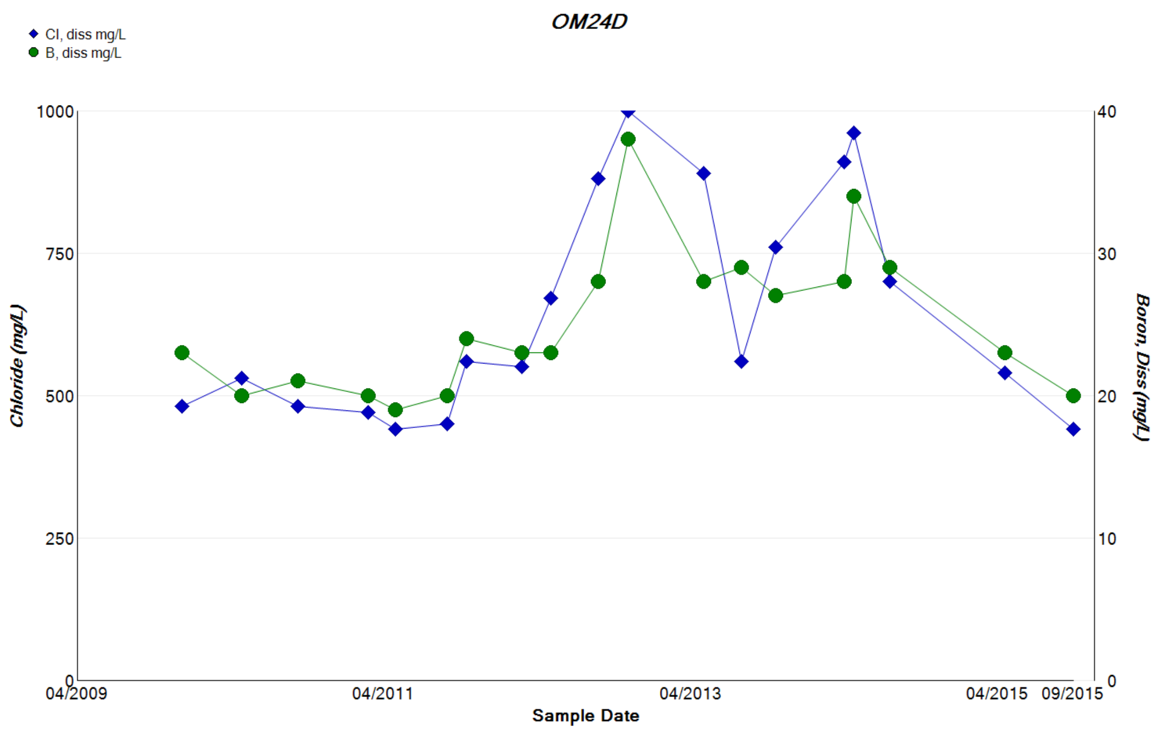


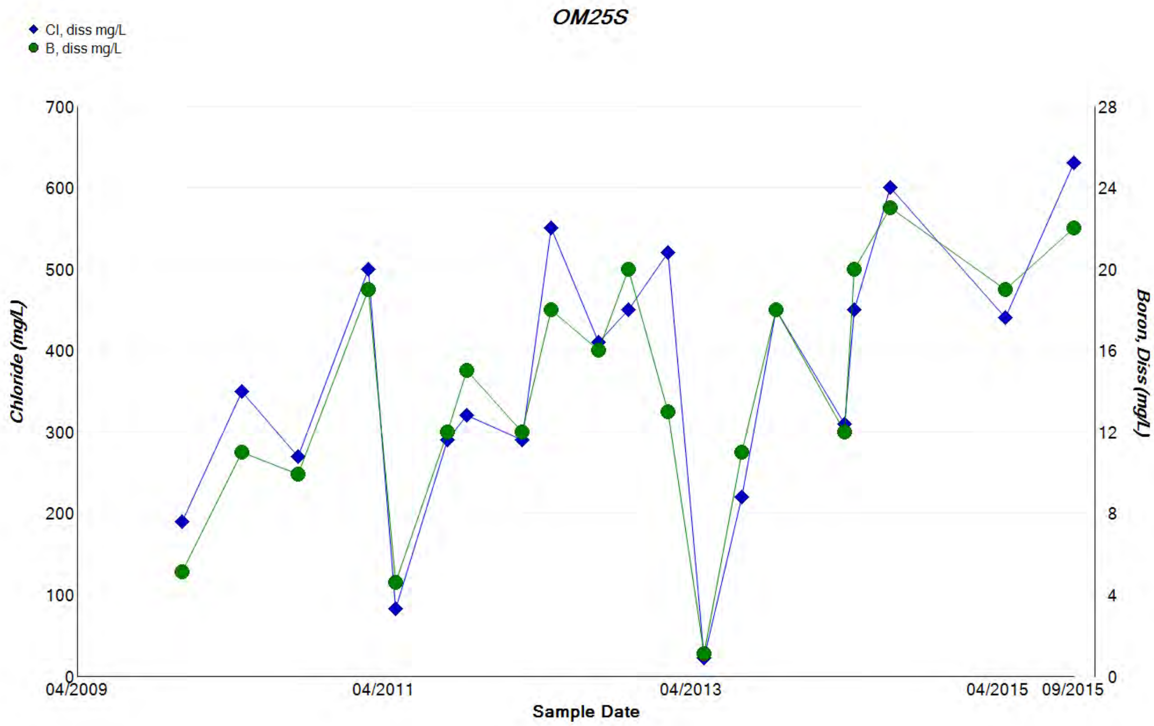
OM21
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
600
450
300
150
0
20
15
10
5
0
01/2000
01/2002
01/2004
01/2006
01/2008
01/2010
01/2012
01/2014
09/2015



OM22D
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
600
450
300
150
0
24
18
12
6
0
04/2009
04/2011
04/2013
04/2015
09/2015


OM23D
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
600
500
400
300
200
100
0
24
20
16
12
8
4
0
04/2009
04/2011
04/2013
04/2015
09/2015
Sample Date


OM24D
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
1000
750
500
250
0
40
30
20
10
0
04/2009
04/2011
04/2013
04/2015
09/2015
Sample Date



OM25S
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
700
600
500
400
300
200
100
0
28
24
20
16
12
8
4
0
04/2009
04/2011
04/2013
04/2015
09/2015

APPENDIX D

BORING LOGS AND MONITORING WELL CONSTRUCTION REPORTS

OM01

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-1

SURFACE ELEVATION 592.8'
COORDINATE 52+60 N
2+93 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET
									5
									10
									15
									20
									25
									30
									35
									40
									45
									50
									55
									60

BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
			STRIP MINE SPOIL
9	⊠	SM	Brown silty SAND: Fine to medium sand with trace of clay, silt, and broken shale. Dry to 12'.
8	⊠		
5	⊠	CL-ML	Brown silty CLAY: A mixture of reworked silty loess with some clay till, some organic material near the surface.
7	⊠		
7	⊠		

FEATURE: Observation and Monitoring Boring
Date Drilled: 9/25/80
Total Depth: 26.5'
Piezometer: Screen from 15.0' to 20.0'
Gravel pack from 13.0' to 26.5'.
Water Level Data: Elevation 579.9 on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

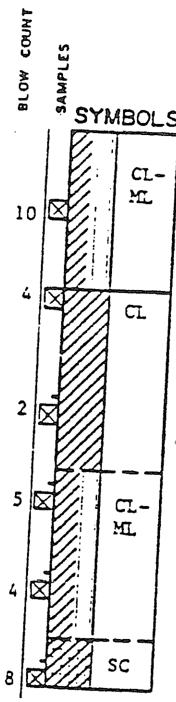
OM02

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-2

SURFACE ELEVATION 599.6'
COORDINATE 74+85 N
1+30 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET
	PN=2.9								5
	PN=1.6								10
									15
									20
									25
	PN=0.5								30
	PN=3.6								35
									40
									45
									50
									55
									60



DESCRIPTION

STRIP MINE SPOIL
Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface.
Dry from 0' to 6'.
Moist from 6' to 14'.
Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.
Wet from 14' to 31.5'.

FEATURE: Observation and Monitoring Well
Date Drilled: 10/2/80
Total Depth: Screen from 10' to 20'.
Gravel pack from 8'to31.5'.
Water Level Data: Elevation 590.1' on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

PLATE 2-2

Illinois Environmental Protection Agency

Well Completion Report

Site #: ______ County: Fulton Well #: OR02

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR02

~~State~~ Plant ~~Plane~~ Coordinate: X 7,475.6 Y 130.6 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: R. Keady

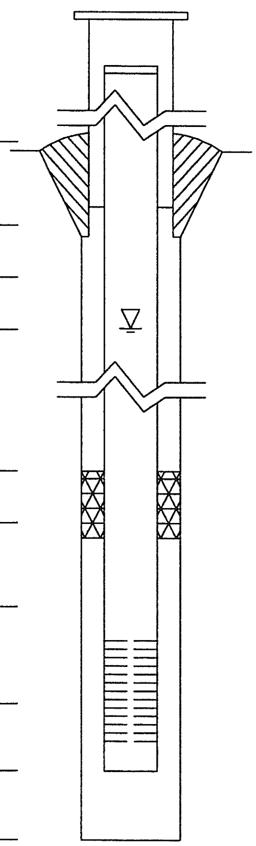
Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 4/2/2008 Date Finished: 4/2/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS



Type of Surface Seal: Concrete

Type of Annular Sealant: ______

Installation Method: ______

Setting Time: ______

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: >24 hours

Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ______

Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
601.61	-2.42	Top of Protective Casing
601.41	-2.22	Top of Riser Pipe
599.19	0.00	Ground Surface
		Top of Annular Sealant
596.60	2.59	Static Water Level (After Completion) 5/15/2008
596.64	2.55	Top of Seal
590.04	9.15	Top of Sand Pack
588.81	10.38	Top of Screen
579.32	19.87	Bottom of Screen
578.54	20.65	Bottom of Well
578.54	20.65	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	12.60
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.49
Total Length of Casing	(feet)	22.87
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

OM03

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-3

SURFACE ELEVATION 622.1'
COORDINATE 92+93N
0+88E

DEPTH IN FEET	ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	BLOW COUNT
0-5		PN=1.5				22.6 17.0				6
5-10		PN=1.3				23.5				6
10-15		PN=0.8				19.3				6
15-20		PN=0.8		34	12	27.5				7
20-25						23.3				9
25-30		PN=0.7				23.5				9
30-35		PN=1.3				22.8				12
35-40										14
40-45										15
45-50		PN>4.5								25
50-55		PN>4.5								18
55-60										

SYMBOLS	DESCRIPTION
CL-ML	STRIP MINE SPOIL Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface. Dry to 6' Moist from 6' to 75'.
CL	
SM	
CL-ML	
CL	Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.
CL-ML	Brown silty Clay to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface.
CL	Gray broken SHALE mine spoil mixed with some reworked clay till and loess, has a silty weathered appearance.

FEATURE: Observation and Monitoring Well

Date Drilled: 9/18/80
Total depth: 85.7'

Installed a deep piezometer (OM-3D)
Screen from 63.5-73.5'
Gravel pack from 40-77.5'
Water level: Elevation 578.8 on 10/8/80

Installed a shallow piezometer (OM-3S) in an adjacent hole
Screem from 42-52'
Gravel pack from 40-52'
Water level: Elevation 579.1 on 10/8/80

LOG OF BORING

Gilbert/Commonwealth

PLATE 2-3

OM03

BORING OM-3

ELEV. IN FEET	OTHER TESTS	STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET	BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
	PN> 4.5									27		CL	Gray broken SHALE mine spoil mixed with some reworked clay till and loess, has a silty weathered appearance.
	PN=3.2								65	25			
	PN>4.5								70	24			
	PN>4.5								75	90 1"			TOP OF SHALE BEDROCK
												SH	SHALE BEDROCK, Carbondale formation Pennsylvanian age, gray, silty shale.
									80	108			
									85	100 .2"			
									90				
									95				
									100				
									105				
									110				
									115				
									120				

LOG OF BORING

Gilbert/Commonwealth

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Fulton Well #: OR03S

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR03S

~~State-~~ Plant ~~Plane~~ Coordinate: X 9,283.0 Y 82.3 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: R. Keady

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 4/3/2008 Date Finished: 4/3/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 28 minutes

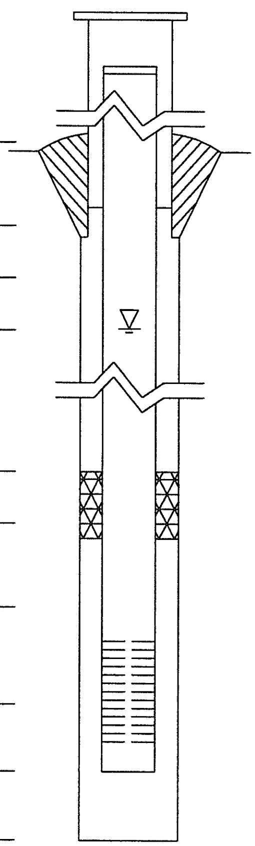
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Mine spoil (if applicable)

Installation Method: Slough



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
627.38	-3.69	Top of Protective Casing
627.16	-3.47	Top of Riser Pipe
623.69	0.00	Ground Surface
621.49	2.20	Top of Annular Sealant
581.91	41.78	Static Water Level (After Completion) 5/15/2008
579.29	44.40	Top of Seal
576.96	46.73	Top of Sand Pack
575.40	48.29	Top of Screen
565.90	57.79	Bottom of Screen
565.11	58.58	Bottom of Well
564.07	59.62	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	51.76
Bottom of Screen to End Cap	(feet)	0.79
Screen Length (1st slot to last slot)	(feet)	9.50
Total Length of Casing	(feet)	62.05
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

Illinois Environmental Protection Agency

Well Completion Report

Site #: ____________ County: Fulton Well #: OR03D

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR03D

~~State~~- Plant ~~Plane~~ Coordinate: X 9,286.1 Y 85.6 (or) Latitude: ____ ° ____ ' ____ " Longitude: ____ ° ____ ' ____ "

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: R. Keady

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 4/4/2008 Date Finished: 4/4/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 41 minutes

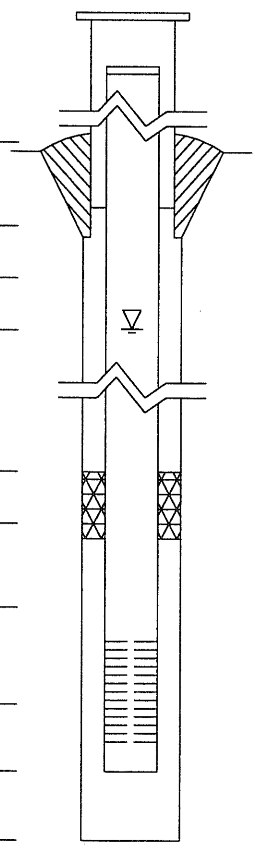
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ____________



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
627.30	-3.58	Top of Protective Casing
627.13	-3.41	Top of Riser Pipe
623.72	0.00	Ground Surface
621.47	2.25	Top of Annular Sealant
581.98	41.74	Static Water Level (After Completion) 5/15/2008
560.89	62.83	Top of Seal
558.68	65.04	Top of Sand Pack
556.69	67.03	Top of Screen
547.21	76.51	Bottom of Screen
546.42	77.30	Bottom of Well
546.42	77.30	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	70.44
Bottom of Screen to End Cap	(feet)	0.79
Screen Length (1st slot to last slot)	(feet)	9.48
Total Length of Casing	(feet)	80.71
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

OM04D/S

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-4

SURFACE ELEVATION 604.9'
COORDINATE 95+50 N
12+27 E

DEEP IN FEET	ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD		BLOW COUNT
0–5		PN=2.4				17.7					13
5–10		PN=1.7				19.8					9
10–15											
15–20						19.2					5
20–25						28.2					4
25–30		PN=0.8				23.9					5
30–35		PN=1.0				18.7					7
35–40		PN=1.1				23.7					9
40–45											29
45–50		PN=3.8		35.4	10.5						22
50–55											18
55–60											33

SYMBOLS	DESCRIPTION
	STRIP MINE SPOIL
CL-ML	Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface. Moist to 66'.
CL	Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.
CL	Gray broken SHALE mine spoil mixed with some reworked clay till and loess, has a silty weathered appearance.

FEATURE: Observation and Monitoring Well (OM-4D)
Date Drilled: 9/12/80
Total Depth: 68.0'
Piezometer: Screen from 51.0' to 61.0'.
Gravel pack from 44.0' to 65.0'.
Water level; Elevation 581.3' on 10/20/80

Installed a second shallow piezometer in an adjacent hole (OM-4S)
Screen from 23-33'
Gravel pack from 20-35'
Water level: Elevation 583.8 on 10/20/80

LOG OF BORING

Gilbert/Commonwealth

PLATE 2-5

OM04

BORING OM-4

ELEV. IN FEET	OTHER TESTS	STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET
	PR >4.5								
									65
									70
									75
									80
									85
									90
									95
									100
									105
									110
									115
									120

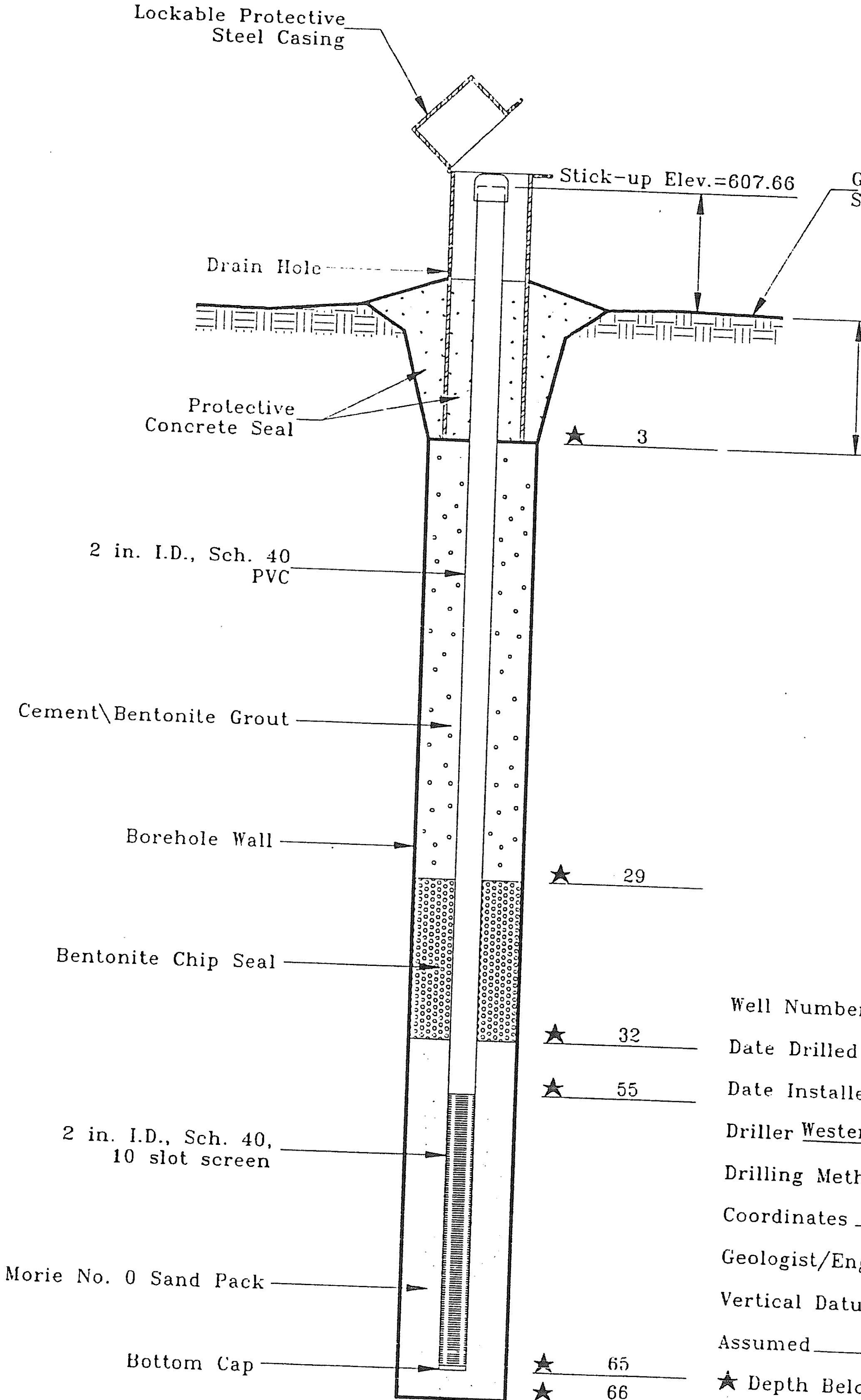
BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
24	☒	CL	
43	☒		TOP OF SHALE BEDROCK
100/2"	☒	SH	SHALE BEDROCK, Carbondale formation Pennsylvanian age, gray, silty shale.

LOG OF BORING

Gilbert/Commonwealth

PLATE 2-6

OR04D



Well Number OM-4a
Date Drilled 10/27/97
Date Installed 10/27/97
Driller Western Env. Services, Inc.
Drilling Method HSA
Coordinates N9548 E1228
Geologist/Engineer BDC
Vertical Datum:
Assumed ______ U.S.G.S. X

★ Depth Below Ground Surface

Not to Scale

J:\DRAWINGS\92S5078A\004.DWG 12/05/97 09:15 Olh

MONITORING WELL OM-4a

HANSON ENGINEERS INCORPORATED

MONITORING WELL INSTALLATION
CILCO - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078A

OR04D

DUCK CREEK STATION | BORING OM-4a | SHEET 1 of 2

DATE STARTED 10/27/97 | DATE COMPLETED 10/27/97 | LOGGED BY BDC | SURFACE EL. 605.1 (ft.)

DRILLING CONTRACTOR: WESTERN ENVIRONMENTAL, INC. | DRILL METHOD: HSA

Depth (ft)	Penetro-meter (TSF)	SOIL/ROCK DESCRIPTION	COMMENTS
0–4	1.0, 1.25	Brown clayey silt w/ tr. sand & gravel; tr. gray colored zones; roots at top.	
4–6	–, –	SAME; so. rust brown & gray mottles; pockets of silty clay.	
6–9	1.0, 1.25	SAME; v. moist; v. little recovery (looks like pushed a cobble); variegated gray & rust brown colors; drilling very easy.	
9–13	–, –, –, –	CORE LOSS	
13–14		SAME; v. moist to wet; v. little recovery (cobble in tip); olive gray color; variegated colors; tr. shale frags; v. soft; drilling v. easy.	▽ 13 ft.
14–18	–, –, –, –	CORE LOSS	
18–19	–	SAME; v. moist to wet; v. little recovery big glacial cobble (w/ striations) in tip; zones which are mostly dk. gray.	
19–23	–, –, –	CORE LOSS	
23–28	0.5, 0.25, 0.25, 0.25	SAME; highly variegated colors (dk. gray, gray, brown, & rust brown); moist; pockets of gray silt (blocky – may be weathered rock).	▼ 22.99 ft. after 8 days.
28–31	0.5, 0.5, 0.25	SAME; becomes all gray at 31 ft. w/ angular siltstone rock frags; wet in zones w/ more rock frags.	

VAPOR CONCENTRATION
Isobutylene Calibration
Gas Equivalent Units (ppm)
10^0 10^1 10^2 10^3

SOIL/ROCK BORING DATA

HANSON ENGINEERS INCORPORATED

Ady 12/5/97
REVIEWED DATE
BDC 12/5/97
APPROVED DATE

MONITORING WELL INSTALLATION
CILCO-DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078A

OR04D

DUCK CREEK STATION		BORING OM-4a	SHEET 2 of 2
DATE STARTED 10/27/97	DATE COMPLETED 10/27/97	LOGGED BY BDC	SURFACE EL. 605.1 (ft.)
DRILLING CONTRACTOR: WESTERN ENVIRONMENTAL, INC.		DRILL METHOD: HSA	

Depth (ft)	Graphic Log	Penetrometer (TSF)	SOIL/ROCK DESCRIPTION	VAPOR CONCENTRATION Isobutylene Calibration Gas Equivalent Units (ppm) 10^0 10^1 10^2 10^3	COMMENTS	Depth (ft)
31		0.25 1.5 1.75 1.5	Gray silt w/ so. clay, sand & gravel; sand & gravel is composed mostly of gray siltstone rock; tr. rust brown mottles; wet in zones w/ rock frags.			31
		– – – –	SAME; rock frags v. common; wet in these zones; clayey silt in areas (v. sticky); siltstone frags are fissile.			
41		– – – –	SAME; water in zones w/ abundant coarse rock; sticky.			41
		– – – –	SAME; tr. brown mottled zones; v. wet; abundant rock; some rock has slickensides.			
51		–	CORE LOSS			51
		– – – –	SAME; coal & organic shale (black) frags from 53.6–53.9 ft; 55.6–55.8 ft. and 57.5–58.0 ft; wet; smaller pieces of black shale disseminated throughout.			
		– – – – –	SAME; black organic shale more common.			
61			SAME; coal frags v. common; refusal at 66 ft.			61
			End of Boring = 66.0'			
71			TILL SPOIL 0-31 ft. TILL/SHALE SPOIL 31-66 ft.			71

SOIL/ROCK BORING DATA

HANSON ENGINEERS INCORPORATED

[signature] 12/5/97
REVIEWER DATE
BDC 12/5/97
APPROVED DATE

MONITORING WELL INSTALLATION
CILCO-DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078A

OM05

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-5

SURFACE ELEVATION 608.0'
COORDINATE 67+62 N
16+82 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET
	PN=3.2				24.2 19.0				5
	PN=1.25				24.9				10
									15
	PN=0.8				26.8				20
	PN=4.0				20.1				25
					17.7				30
	PN=2.1				17.7				35
	PN=0.9				26.8				40
	PN=3.8				21.2				45
	PN=1.9				20.0				50
	PN=1.75				17.7				55
									60

BLOW COUNT: 17, 6, 6, 9, 9, 9, 11, 12, 12, 14, 96/3"

SYMBOLS: CL-ML, ML, CL-ML, ML, CL, CL, SH

DESCRIPTION

STRIP MINE SPOIL

Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface.

Damp to 14'.

Moist to 54'.

Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.

Gray broken SHALE mine spoil mixed with some reworked clay till and loess, has a silty weathered appearance.
50% water loss.

TOP OF SHALE BEDROCK

SHALE BEDROCK, Carbondale formation Pennsylvanian age, gray, silty shale.

FEATURE: Observation and Monitoring Well (OM-5D)
Date Drilled: 9/5/80
Total Depth: 67.0'
Piezometer: Screen from 47.0' to 57.0'
Gravel pack from 45.0' to 67.0'.
Water level: Elevation 594.0' on 11/20/80

Installed a second shallow piezometer in an adjacent hole (OM-5S)
Screen from 13-23'
Gravel pack from 23.5-11'
Water level: 594.4' on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

OM05

BORING OM-5

ELEV. IN FEET	OTHER TESTS	STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET	BLOW COUNT	SAMPLES	SYMBOLS		DESCRIPTION
	Pq >4.5									100/4"	CORE RUN 1		SH	SHALE BEDROCK, Carbondale formation Pennsylvanian age, gray, silty shale. Dry to 67' and 100% water loss.
									65					
									70					
									75					
									80					
									85					
									90					
									95					
									100					
									105					
									110					
									115					
									120					

LOG OF BORING

Gilbert/Commonwealth

Illinois Environmental Protection Agency — Well Completion Report

Site #: ____________ County: Fulton Well #: OR05D

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR05D

~~State-~~ Plant ~~Plane~~ Coordinate: X 6,766.3 Y 1,675.1 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/20/2008 Date Finished: 3/20/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: >24 hours

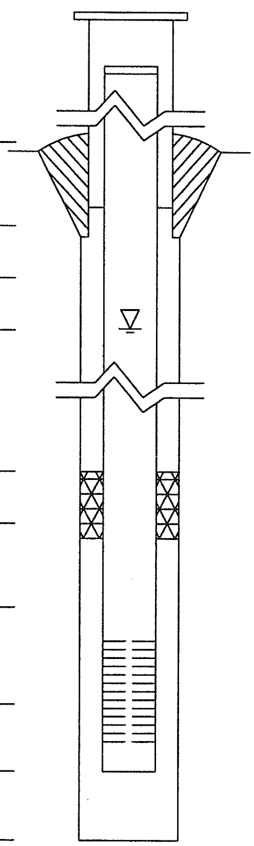
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
611.16	-3.25	Top of Protective Casing
610.96	-3.05	Top of Riser Pipe
607.91	0.00	Ground Surface
605.91	2.00	Top of Annular Sealant
600.77	7.14	Static Water Level (After Completion) 5/15/2008
575.91	32.00	Top of Seal
572.66	35.25	Top of Sand Pack
570.97	36.94	Top of Screen
561.49	46.42	Bottom of Screen
560.91	47.00	Bottom of Well
559.41	48.50	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	39.99
Bottom of Screen to End Cap	(feet)	0.58
Screen Length (1st slot to last slot)	(feet)	9.48
Total Length of Casing	(feet)	50.05
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

OM06

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-6

SURFACE ELEVATION 587.8'
COORDINATE 49+25 N
16+75 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET	BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
									0			CL-ML	STRIP MINE SPOIL Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface. Dry to 12'.
	PN 4.5								5	12	☒		
	PN=3.2								10	12	☒		
												ML	Moist to 34'.
	PN=0.5								15	5	☒		
	PN=1.6								20	5	☒	CL	Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.
	PN=1.5								25	6	☒		
									30	9	☒		
									35	144	☒	SH	TOP OF SHALE BEDROCK SHALE BEDROCK: Carbondale formation Pennsylvanian age, gray, silty shale.
									40				
									45				
									50				
									55				
									60				

FEATURE: Observation and Monitoring Well
Date Drilled: 9/22/80
Total Depth: 38.0'
Piezometer: Screen from 15.0' to 25.0'.
Gravel pack from 13.0' to 33.0'.
Water Level Data: Elevation 576.8 on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

OM06A

BORING OM-6A

SURFACE ELEVATION 590.67
COORDINATE 4925 N
1635 E

DEPTH IN FEET	ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING #200 SIEVE	RECOVERY (%)	RQD	BLOW COUNT
5		PN	4.5								17
10		PN	3.75-4.5+								12
15											6
20											7
25											7
30											16
35											20
40											58/3"
45											
50											
55											
60											

SYMBOLS	DESCRIPTION
ML-CL	MINE SPOIL. Brown clayey silt and silty clay, little fine to medium sand, trace fine gravel; moist, below plastic limit; grades with increasing moisture with depth. 15.0 to 15.7 ft., Yellow-brown clayey silt and fine to medium sand, near saturated.
SH	17.8 ft.,broken shale noted in drilling; water level at 17.8 ft. when pulled auger plug and at 4.0 ft. after ss-4 taken.
ML / ML-CL	20.2 ft.,Yellow-brown to brown silt (Loess) and clayey silt; some fine to medium sand, trace fine gravel (Till), broken shale noted, 21.0 to 24.5 ft.
ML-CL	24.5 ft. gray silty clay, little fine to medium sand, little fine to coarse gravel (Till mixed with broken shale fragments). Water at 4.0 ft. 32.0 ft., 6" shale cobble.
SH	35.0 ft., Black weathered broken shale, moist not saturated. Water level at 14.0 ft. Hard drilling noted
SH	SHALE BEDROCK - 38.0 ft. Gray shale, weathered

MONITORING WELL INSTALLED 10/17/84
10' of #10 slot screen: 15.0 to 25.0 ft.
Gravel Pack : 12.0 to 40.3 ft.
Bentonite Seal : 10.0 to 12.0 ft.
Cement-Bentonite Grout: G.S. to 10.0 ft.

CILCO
DUCK CREEK STATION
WASTE DISPOSAL SYSTEM

Gilbert Commonwealth Companies

LOG OF
BORING OM-6A

PLATE

Illinois Environmental Protection Agency — Well Completion Report

Site #: ____ County: Fulton Well #: OR06A

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR06A

~~State-~~ Plant ~~Plane~~ Coordinate: X 4,917.2 Y 1,635.8 (or) Latitude: ____° ____' ____" Longitude: ____° ____' ____"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

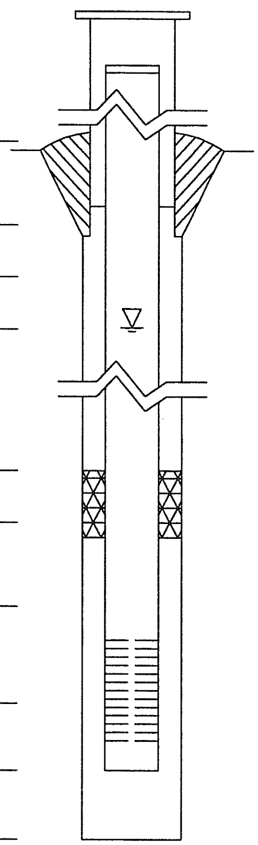
Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 4/1/2008 Date Finished: 4/1/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS



Type of Surface Seal: Concrete

Type of Annular Sealant: ____

Installation Method: ____

Setting Time: ____

Type of Bentonite Seal -- Granular (circled) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: >24 hours

Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ____

	Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
			Top of Protective Casing
	595.31	-3.69	Top of Riser Pipe
	591.62	0.00	Ground Surface
			Top of Annular Sealant
	592.37	-0.75	Static Water Level (After Completion) 5/15/2008
	589.12	2.50	Top of Seal
	577.50	14.12	Top of Sand Pack
	576.09	15.53	Top of Screen
	566.59	25.03	Bottom of Screen
	565.81	25.81	Bottom of Well
	565.81	25.81	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	19.22
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.50
Total Length of Casing	(feet)	29.50
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

OM07

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-7

SURFACE ELEVATION 593.4'
COORDINATE 41+60 N
16+44 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET
	PN=3.8								5
	PN=0.9								10
	PN=1.8								15
	PN=1.0								20
									25
	PN=0.9								30
	PN=2.5								35
									40
	PN >4.5								
	PN=1.5								45
									50
									55
									60

BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
9, 7	⊠	CL-ML	STRIP MINE SPOIL Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface. Dry to 12'. Moist from 12' to 48'.
10, 8	⊠	ML	
10, 13	⊠	CL	Gray broken SHALE mine spoil mixed with some reworked clay till and loess, has a silty weathered appearance.
12	⊠	CL-ML	Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.
17, 20	⊠	CL	Gray broken SHALE mine spoil mixed with some reworked clay till and loess, has a silty weathered appearance.
100/2"	⊠	SH	TOP OF SHALE BEDROCK SHALE BEDROCK, Carbondale formation Pennsylvanian age, gray, silty shale.

FEATURE: Observation and Monitoring Well
Date Drilled: 9/18/80
Total Depth: 53.0'
Piezometer: Screen from 17.0' to 27.0'.
Gravel pack from 15.0' to 46.0' and 49.0' to 53.0'.
Water Level Data: Elevation 581.3 on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

OM08

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-8

SURFACE ELEVATION 599.4'
COORDINATE 25+78' N
19+36' E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD		DEEP IN FEET	BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
														STRIP MINE SPOIL
													CL-ML	Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface.
										5	10	⊠		
	PN=1.3													
										10	8	⊠		Damp to 11'.
													ML	
										15	4	⊠	CL	Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand broken shale.
										20	2	⊠		
	PN=1.1												CL-ML	
										25	6	⊠		
										30				
										35				
										40				
										45				
										50				
										55				
										60				

FEATURE: Observation and Monitoring Well
Date Drilled: 9/23/80
Total Depth: 26.5'
Piezometer; Screen from 15.0' to 25.0'.
Gravel pack from 13.0' to 26.5'.
Water Level Data: Elevation 587.4' on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

OM09

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-9

SURFACE ELEVATION 590.2'
COORDINATE 19+02 N
0+72 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS		FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEPTH IN FEET
			LIQUID LIMIT	PLASTICITY INDEX					
									5
									10
									15
									20
									25
									30
									35
									40
									45
									50
									55
									60

BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
8	☒	CL-ML	STRIP MINE SPOIL Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface. Damp to 9'. Wet to 26'.
3	☒		
2	☒	PT	Dark gray PEAT.
3	☒	CL-ML	
2	☒	CL	Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.
3	☒		

FEATURE: Observation and Monitoring Well
Date Drilled: 9/24/80
Total Depth: 26.5'
Piezometer: Screen from 15.0' to 25.0'
Gravel pack from 13.0'to 25.0'.
Water Level Data: Elevation 586.4' on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

PLATE 2-12

OM10

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-10

SURFACE ELEVATION 584.0'
COORDINATE 62+21'N
48+76'E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS		FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD		DEEP IN FEET	BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
			LIQUID LIMIT	PLASTICITY INDEX										
														STRIP MINE SPOIL
										5	7	⊠	CL-ML	Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface. Dry to 7'. Moist to 20'.
										10	4	⊠		
										15	5	⊠	ML	
										20	5	⊠	CL	Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.
										25				
										30				
										35				
										40				
										45				
										50				
										55				
										60				

FEATURE: Observation and Monitoring Well
Date Drilled: 10/1/80
Total Depth: 20.0'
Piezometer: Screen from 8.0' to 18.0'.
Gravel pack from 7.0' to 20.0'.
Water Level Data: Elevation 570.9' on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

OM11

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-11

SURFACE ELEVATION 594.0'
COORDINATE 54+38'N
30+61'E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD		DEPTH IN FEET	BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
										0–13	11, 11	P	CL-ML	STRIP MINE SPOIL Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface. Dry to 13'.
										13–25	8, 6	P, P	ML	Moist to 43'.
										25–43	16, 9, 11, 13		CL	Gray broken SHALE mine spoil mixed with some reworked clay till and loess, has a silty weathered appearance.

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60

FEATURE: Observation and Monitoring Well
Date Drilled: 10/16/80
Total Depth: 43.0'
Piezometer: Screen from 30.0' to 40.0'
Gravel pack from 28.0' to 43.0'.
Water Level Data: Elevation 563.6' on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Fulton Well #: OR11

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR11

~~State-~~ Plant ~~Plane~~ Coordinate: X 5,448.4 Y 3,059.0 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: B. WIlliamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/25/2008 Date Finished: 3/25/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 30 minutes

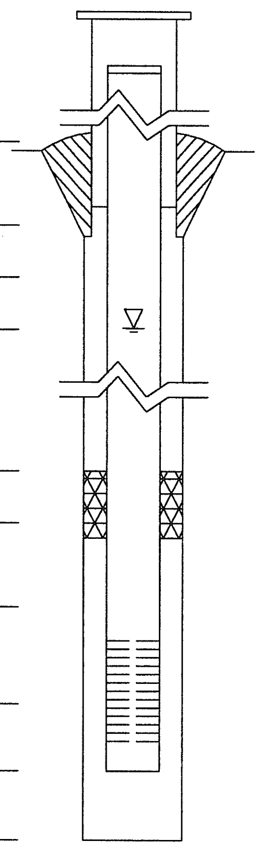
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
596.79	-3.15	Top of Protective Casing
596.55	-2.91	Top of Riser Pipe
593.64	0.00	Ground Surface
591.64	2.00	Top of Annular Sealant
569.42	24.22	Static Water Level (After Completion) 5/15/2008
564.86	28.78	Top of Seal
563.25	30.39	Top of Sand Pack
561.79	31.85	Top of Screen
552.34	41.30	Bottom of Screen
551.56	42.08	Bottom of Well
551.07	42.57	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	34.76
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.45
Total Length of Casing	(feet)	44.99
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

OM12

BORING OM-12

SURFACE ELEVATION 592.6'
COORDINATE 39+26'N
30+53'E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEPTH IN FEET	BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
									0–5			ML	STRIP MINE SPOIL Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till some organic material near the surface.
									10			CL-ML	
									15			CL	Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.
									20				
									25				
									30				
									35			CL-ML	
									40				
									45				
									50				
									55				
									60				

FEATURE: Observation and Monitoring Well
Date Drilled: 10/17/80
Total Depth: 43.5'
Piezometer: Screen from 30.0' to 40.0'
Gravel pack from 28.0' to 43.5'.
Water Level Data: Elevation 576.2' on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

OM13

BORING OM-13

SURFACE ELEVATION 595.8
COORDINATE 6908 N
1632 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING #200 SIEVE	RECOVERY (%)	RQD	DEPTH IN FEET	BLOW COUNT	SAMPLES	SYMBOLS
	PN	2.25								5	10		ML
	PN	0.7								10	3		ML
													ML
													CL
	PN	0.65								15	5		
	PN	1.2								20	7		SH
	PN	2.25									9		
	PN	1.0								25	7		CL
										30	9		
	PN	3.75								35	18		
										40	7		
										45	60		SH
										50			
										55			
										60			

DESCRIPTION

RAILROAD BALLAST: 0-2 ft.; 2.0 to 3.0 ft. Ballast mixed with brown clayey silt.

FILL ? (Based on Penetrometer)
3.0 to 7± ft., brown and gray mottled, silt and clayey silt; saturated.

MINE SPOIL
Brown and gray mottled silt and clayey silt
10.9 ft. grades to gray in color.

15.7 to 15.9 ft. black weathered shale, weathered to stiff clay.

18 ft. brown and gray clayey silt (Loess and Till)

20.8 to 22.5 ft. black broken shale, none to little soil; water flowing to surface.
22.5 ft. gray silty clay and clayey silt (Till), trace to little fine to medium sand, trace to no gravel. Not saturated. Water level dropping as advance boring. 30 ft. water 6 ft. below surface in augers.

35.0 ft. water 16 ft. below surface.
35.0 ft. dark gray clay, weathered shale and till, broken shale fragment 35.3 to 35.4 ft.

40.0 ft. gray clayey silt and black broken shale fragments (saturated in shale)

SHALE BEDROCK: 42.5 ft.
Gray shale, weathered.
Water flowing to surface after pulling auger plug. Flowing clear water at 3 gpm. Seep south stopped flowing.

Boring completed at 45.5 ft. on 10/17/84.

MONITORING WELL INSTALLED 10/17/84
10' of #10 slot screen: 32.5 to 42.5 ft.
Gravel Pack : 17.5 to 45.5 ft.
Bentonite Seal : 15.0 to 17.5 ft.
Cement-Bentonite grout: G.S. to 15.0 ft.

CILCO
DUCK CREEK STATION
WASTE DISPOSAL SYSTEM

Gilbert Commonwealth Companies

LOG OF
BORING OM-13

PLATE

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Fulton Well #: OR13S

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR13S

~~State-~~ Plant ~~Plane~~ Coordinate: X 6,834.3 Y 1,749.6 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: B. WIlliamson

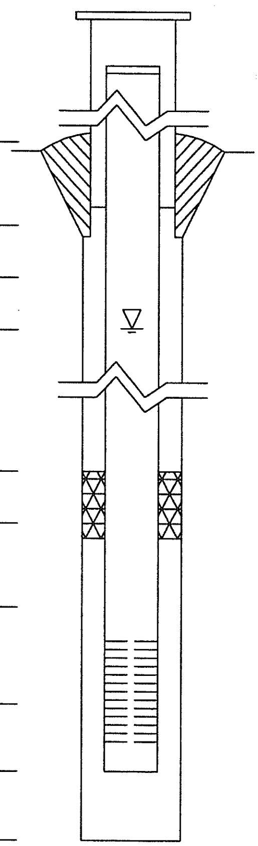
Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 3¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/22/2008 Date Finished: 3/22/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS



Type of Surface Seal: Concrete

Type of Annular Sealant: ______

Installation Method: ______

Setting Time: ______

Type of Bentonite Seal -- Granular (circled) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: >24 hours

Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity

Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
602.91	-7.16	Top of Protective Casing
602.71	-6.96	Top of Riser Pipe
595.75	0.00	Ground Surface
		Top of Annular Sealant
592.15	3.60	Static Water Level (After Completion) 5/15/2008
595.75	0.00	Top of Seal
585.14	10.61	Top of Sand Pack
583.81	11.94	Top of Screen
574.33	21.42	Bottom of Screen
573.54	22.21	Bottom of Well
573.54	22.21	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	7.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	18.90
Bottom of Screen to End Cap	(feet)	0.79
Screen Length (1st slot to last slot)	(feet)	9.48
Total Length of Casing	(feet)	29.17
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

Illinois Environmental Protection Agency

Well Completion Report

Site #: ______ County: Fulton Well #: OR13D

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR13D

~~State-~~ Plant ~~Plane~~ Coordinate: X 6,840.3 Y 1,749.7 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: B. WIlliamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/22/2008 Date Finished: 3/22/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: >24 hours

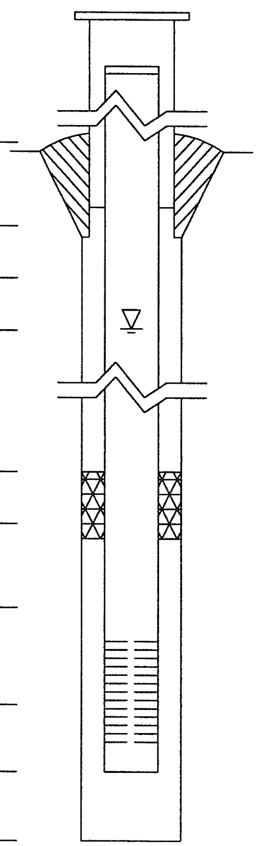
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
602.88	-7.13	Top of Protective Casing
602.70	-6.95	Top of Riser Pipe
595.75	0.00	Ground Surface
595.75	0.00	Top of Annular Sealant
600.79	-5.04	Static Water Level (After Completion) 5/15/2008
573.52	22.23	Top of Seal
564.51	31.24	Top of Sand Pack
562.73	33.02	Top of Screen
553.29	42.46	Bottom of Screen
552.51	43.24	Bottom of Well
552.51	43.24	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	39.97
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.44
Total Length of Casing	(feet)	50.19
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

OM14

BORING OM-14

SURFACE ELEVATION 596.74
COORDINATE 7371 N
1841 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING #200 SIEVE	RECOVERY (%)	RQD	DEPTH IN FEET	BLOW COUNT	SYMBOLS	DESCRIPTION
												ML CL	MINE SPOIL. Brown and gray silty clay to clayey silt, little to some fine to coarse sand, trace fine gravel, damp to moist (Loess and Till)
	PN	0.8								5	10		
										10	4		
	PN	1.0-1.5								15	6		
										20	8	CL	18.5 ft. gray silty clay, little fine to medium sand, trace fine gravel. 19.2 to 20.0 ft. and 24.5 to 25.0 ft. black broken shale fragments and gray till; saturated. Water level at 13.0 ft after ss-4 taken.
										25	7	ML • CL	25.0 ft. Yellow-brown silty clay (till) and gray clayey silt to silt, some black topsoil type material noted, little fine to medium sand, trace fine gravel. Water level at 21.0 ft. before ss-6 taken. 34.0 to 34.5 ft., shale cobble 35.3 to 36.0 ft., gray silty clay and weathered gray shale. Water level at 33.0 ft.
	PN	1.8-2.0								30	12		
	PN	1.5-2.0								35	13		
											20		
										40	11	CL • SH	37.0 to 38.4 ft. black broken shale fragments with gray till. Water level at 24.0 ft. for ss-8 and ss-9. 38.4 ft., gray silty clay and broken shale mixed, shale is saturated, highly weathered at 42.0 ft.
											26		
										45	27		
													Boring completed at 46.0 ft. on 10/17/84.
										50			
										55			
										60			

MONITORING WELL INSTALLED 10/17/84
10' of #10 slot screen:
Gravel Pack : 17.0 to 46.0 ft.
Bentonite Seal : 15.0 to 17.0 ft.
Cement-Bentonite Grout: G.S. to 15.0 ft.

CILCO
DUCK CREEK STATION
WASTE DISPOSAL SYSTEM

Gilbert Commonwealth Companies

LOG OF
BORING OM-14

PLATE

Illinois Environmental Protection Agency — **Well Completion Report**

Site #: ______ County: Fulton Well #: OR14S

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR14S

~~State~~- Plant ~~Plane~~ Coordinate: X 1,760.0 Y 7,350.8 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Andrew D. Canopy IL Registration #: 035-003391

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 3¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/9/2009 Date Finished: 3/9/2009

Report Form Completed By: Suzanna L. Simpson Date: 3/18/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite Chips

Installation Method: Gravity

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: >24 hours

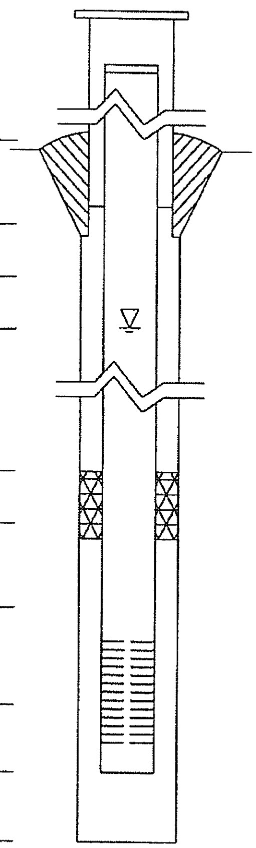
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
599.59	-3.37	Top of Protective Casing
599.26	-3.04	Top of Riser Pipe
596.22	0.00	Ground Surface
594.22	2.00	Top of Annular Sealant
		Static Water Level (After Completion)
594.22	2.00	Top of Seal
586.87	9.35	Top of Sand Pack
584.96	11.26	Top of Screen
575.60	20.62	Bottom of Screen
574.82	21.40	Bottom of Well
574.82	21.40	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	7.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	14.30
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.36
Total Length of Casing	(feet)	24.44
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

Illinois Environmental Protection Agency

Well Completion Report

Site #: ____________ County: Fulton Well #: OR14D

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR14D

~~State-~~ Plant ~~Plane~~ Coordinate: X 1,759.9 Y 7,356.5 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Andrew D. Canopy IL Registration #: 035-003391

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/9/2009 Date Finished: 3/9/2009

Report Form Completed By: Suzanna L. Simpson Date: 3/18/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 40 minutes

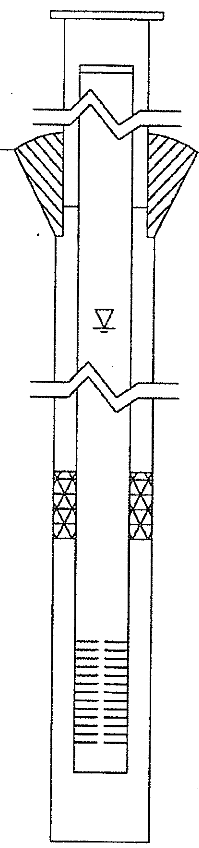
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ____________



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
599.08	-2.86	Top of Protective Casing
598.91	-2.69	Top of Riser Pipe
596.22	0.00	Ground Surface
594.12	2.10	Top of Annular Sealant
		Static Water Level (After Completion)
564.35	31.87	Top of Seal
562.25	33.97	Top of Sand Pack
560.20	36.02	Top of Screen
550.84	45.38	Bottom of Screen
550.36	45.86	Bottom of Well
550.36	45.86	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	38.71
Bottom of Screen to End Cap	(feet)	0.48
Screen Length (1st slot to last slot)	(feet)	9.36
Total Length of Casing	(feet)	48.55
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

OM15

BLACK & VEATCH

LOG OF BORING

BORING NO. BV-20
SHEET 3 OF 3

ILLINOIS LIGHT COMPANY		PROJECT DUCK CREEK NEW ASH POND	PROJECT NO. 23283
LOCATION COUNTY, ILLINOIS	COORDINATES N 6240 E 3010	ELEVATION (DATUM) 595.7 (MSL) / TOTAL DEPTH 75.20 FEET	DATE START 7-12-94
CONDITIONS ER ROAD, BETWEEN TWO PONDS, BRUSH AND REEDS		LOGGED BY D.D. MARLOW	DATE FINISH 7-12-94
CHECKED BY P.L. Nelson		APPROVED BY L.J. Almaleh	

SAMPLING: NUMBER / 1ST 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH IN FEET	CLASSIFICATION OF MATERIAL	REMARKS
18	11	15	26	1.5	61–65	Silty CLAY: gray; very stiff; moist; plastic; trace fine to medium sand intermixed with shale and coal fragments	
11	11	14	25	1.5	66–70		
7	9	12	21	1.5	71–75		
50/2			>100	0.2	75		
					76–89	SHALE: dark gray; firm; fissile (Bedrock)	End of borehole at 75.20 FT. Borehole backfilled with auger cuttings.

OM15

BLACK & VEATCH

LOG OF BORING

BORING NO. BV-20
SHEET 2 OF 3

...LINOIS LIGHT COMPANY		PROJECT DUCK CREEK NEW ASH POND		PROJECT NO. 23283
...CATION ...NTY, ILLINOIS	COORDINATES N 6240 E 3010	ELEVATION (DATUM) 585.7 (MSL)	TOTAL DEPTH 75.20 FEET	DATE START 7-12-94
...DITIONS ...ROAD, BETWEEN TWO PONDS, BRUSH AND REEDS		LOGGED BY D.D. HARLOW		DATE FINISH 7-12-94
CHECKED BY P.L. Nelson		APPROVED BY L.J. Almaleh		

SAMPLING: 1ST 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH IN FEET	CLASSIFICATION OF MATERIAL	REMARKS
CORING: RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD			
6	4	3	7	1.0	30–32	CLAY: gray; firm; moist; plastic; some silt (Mine Spoil-Underclay)	
3	3	5	8	0.7	35–36.5	Intermixed: Clayey SILT: gray; loose; moist; low plasticity; trace fine to medium sand and Underclay fragments (as above)	Seepage water at 37.5 FT.
:	5	10	15	1.5	40–41.5	Silty CLAY: gray; stiff; moist; low to moderate plasticity; traces of fractured shale, coal, and fine sand	
.	10	11	21	0.8	45–46.5	Silty CLAY: gray; very stiff; very moist; plastic; trace fine to medium sand	
.1	18	18	32	1.5	50–51.5	Fragmented Shale from 50.5 to 51.0 FT	
:	8	0	10	1.5	55–56.5	As Above	

Depth scale: 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59

OM15

BLACK & VEATCH LOG OF BORING BORING NO. BV-20

..LINOIS LIGHT COMPANY		PROJECT DUCK CREEK NEW ASH POND		PROJECT NO. 23283
..CATION ..UNTY, ILLINOIS	COORDINATES N 8240 E 3010	ELEVATION (DATUM) 585.7 (MSL)	TOTAL DEPTH 75.20 FEET	DATE START 7-12-84
..NDITIONS ..ROAD, BETWEEN TWO PONDS, BRUSH AND REEDS		LOGGED BY D.O. HARLOW		DATE FINISH 7-12-94
	CHECKED BY P.L. Nelson	APPROVED BY: L.J. Almaleh		

SAMPLING: 1ST 6 INCHES / CORING: RUN LENGTH	2ND 6 INCHES / RUN RECOVERY	3RD 6 INCHES / ROD RECOVERY	N VALUE / PERCENT RECOVERY	SAMPLE RECOVERY / ROD	DEPTH IN FEET	CLASSIFICATION OF MATERIAL	REMARKS
8	11	8	19	1.2	0–2	SILT: light brown; medium dense; dry; non-plastic; some fine to coarse sand; traces of gravel, cobbles, and cinders (Mine Spoil)	Boring advanced with 3 1/2" I.D. hollow stem augers.
5	5	5	10	1.5	3–4	Clayey SILT: orangish brown; medium dense; moist; trace fine to coarse sand	
4	3	5	8	1.1	5–6		
1	2	3	5	1.5	8–9	As Above; but brown and gray; loose	
				2.0	10–12		
:	2	2	4	1.5	15–16	Clayey SILT: brown, gray, and orange; very loose; moist; low plasticity; trace fine sand and fine gravel (occasional limestone fragments)	
:	2	4	6	1.5	20–21	As Above; but gray and brown; loose	
				2.0	25–27		

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29

07/18/94 09:27

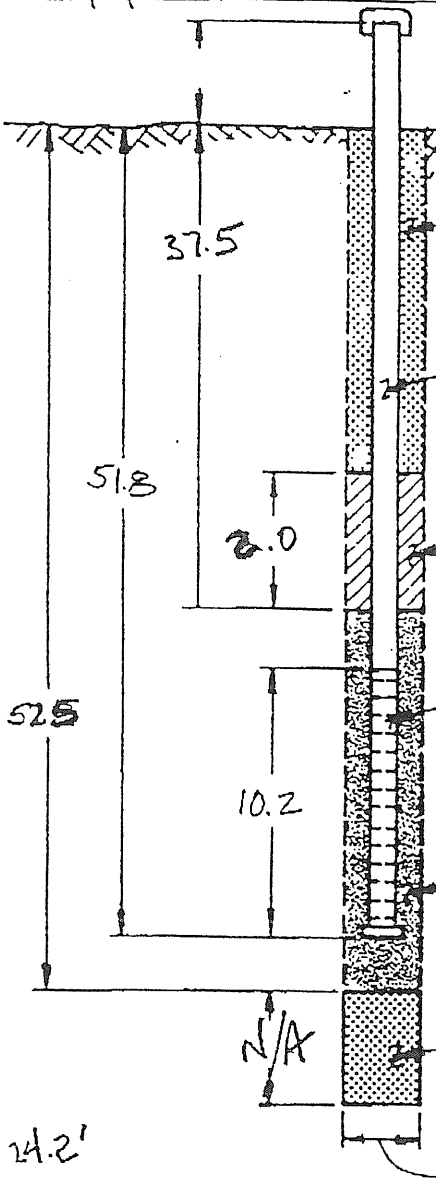
NO.328 P015

BLACK & VEATCH
CONSULTING ENGINEERS

PIEZOMETER INSTALLATION LOG

MW-15 (OM-15)
PIEZOMETER NO.

CLIENT CILCO		PROJECT Duck CREEK - New Ash Pond	PROJECT NO. 23283
PROJECT LOCATION Fulton Co, Illinois	COORDINATES	GROUND ELEVATION 595.7	DATE 13 July 94
STRATUM MONITORED Mine Spoil		INSPECTOR D D Marlow	
CHECKED BY		APPROVED BY	
DRILLING CONTRACTOR Whitney & Associates		DRILL RIG CME 75	DRILLER T. Fehl



TYPE OF SEAL: 3/8" coarse bentonite Baroid Hole plug

O.D. & TYPE OF RISER PIPE: Sch 40 PVC 2" DIA Flush Joint, Threaded

TYPE OF SEAL: Baroid 3/8" Pellets

TYPE AND SIZE OF SCREEN OR OPENINGS: 0.10 slot 2" Sch 40 PVC

TYPE OF FILTER: "Flint shot 4.0" (Silica SAND)

TYPE OF SEAL: ____

H_2O 24.2'

DIAMETER OF BOREHOLE: 8" DIA

METHOD OF INSTALLATION:
Borehole Drilled using 4¼ ID Hollow stem Augers w/ center plug; installed screen & Riser, Place Sand Pack and Seals through hollow stem Augers, ~~[illegible]~~ Remove augers from hole install surface seal and protective casing, Developed well by hand bailing

REMARKS: GW @ 10.00 FT in BV-20 8:30A 13 July 94; ... set BV-20 - 10FT South
8" Dia 0.35 cuft/ft 2" casing 0.02 cuft/ft = .33 cuft/ft Calc 4 Bags Sand
1 Bag = 0.65 cuft

OM16

BLACK & VEATCH LOG OF BORING

BORING NO. BV-21
SHEET 1 OF 2

ILLINOIS LIGHT COMPANY	PROJECT DUCK CREEK NEW ASH POND		PROJECT NO. 23283
LOCATION COUNTY, ILLINOIS	COORDINATES N 8225 E 3520	ELEVATION (DATUM) 805.6 (MSL) / TOTAL DEPTH 51.50 FEET	DATE START 7-13-94
CONDITIONS BRUSH, AND WEEDS ON HILL SIDE		LOGGED BY D.D. MARLOW DDM	DATE FINISH 7-14-94
CHECKED BY P.L. Nelson PLN		APPROVED BY L.J. Almaleh	

SAMPLING NUMBER	1ST 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	CORING NUMBER	RUN LENGTH	RUN RECOVERY	ROD RECOVERY	PERCENT RECOVERY	RQD	DEPTH IN FEET	CLASSIFICATION OF MATERIAL	REMARKS
1	2	2	3	5	1.0							1	Clayey SILT; light brown; loose; dry; low plasticity; trace fine sand, shale fragments, and roots (Mine Spoil)	Boring advanced with 3 1/2" I.D. hollow stem augers.
	6	5	5	10	1.3							3	As Above	
	5	4	6	10	1.2							5	As Above; but with large shale and mudstone fragments	
	7	6	7	13	1.0							8	As Above; but medium dense; trace medium gravel and coal fragments	
	7	6	9	15	1.5							10	Clayey SILT; light brown; medium dense; dry; low plasticity; trace fine to medium sand; occasional seams of silty clay (2"max)	
					1.3							15	As Above	
	4	3	4	7	1.5							20	Clayey SILT; light brown; medium dense; moist; low plasticity; trace fine to medium sand and shale fragments	
	4	2	5	7	1.4							25		14 July 1994

DEPTH IN FEET: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

OM16

OM-16

BLACK & VEATCH LOG OF BORING

BORING NO. BV-21
SHEET 2 OF 2

ILLINOIS LIGHT COMPANY		PROJECT DUCK CREEK NEW ASH POND		PROJECT NO. 23283
LOCATION COUNTY, ILLINOIS	COORDINATES N 8225 E 3520	ELEVATION (DATUM) 805.8 (MSL)	TOTAL DEPTH 51.50 FEET	DATE START 7-13-94
CONDITIONS BRUSH, AND WEEDS ON HILL SIDE		LOGGED BY O.D. MARLOW		DATE FINISH 7-14-94
	CHECKED BY P.L. Nelson		APPROVED BY L.J. Almaleh	

SAMPLING: SET 6 INCHES / CORING: RUN LENGTH	2ND 6 INCHES / RUN RECOVERY	3RD 6 INCHES / RQD RECOVERY	N VALUE / PERCENT RECOVERY	SAMPLE RECOVERY / RQD	DEPTH IN FEET	CLASSIFICATION OF MATERIAL	REMARKS
3	4	5	8	0.5	31–35	Silty CLAY: brown; stiff; very moist; low plasticity; trace fine sand and roots	Seepage water at 26.0 FT.
5	7	10	17	1.5	35–40	As Above; but very stiff; intermixed shale fragments and seams of silt	
				1.8	40–45		
5	28	21	49	1.5	45–50	SHALE: dark gray; firm; fissile; slightly fractured; slightly weathered	Hard drilling from 45 to 50 FT.
2	81	66	147	1.5	50–51		
					52–59		End of borehole at 51.50 FT. Water at 22.0 FT inside the augers. Borehole backfilled with auger cuttings.

07/18/94 09:28

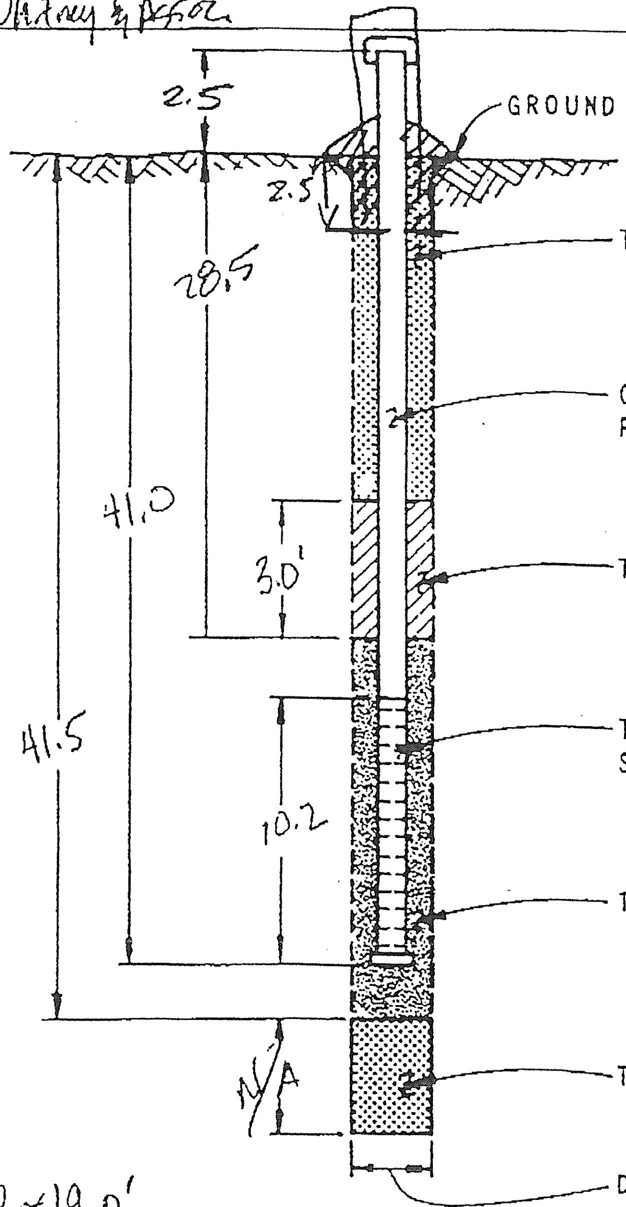
NO.328 P016

BLACK & VEATCH
CONSULTING ENGINEERS

PIEZOMETER INSTALLATION LOG

PIEZOMETER NO. MW-16 (OM-16)

CLIENT: CILCO	PROJECT: Duck Creek New Ash Pond	PROJECT NO. 23283
PROJECT LOCATION: Fulton Co Illinois	COORDINATES: 9230N 3510E	GROUND ELEVATION: 605.6 FT
		DATE: 14 July 94
STRATUM MONITORED: Mine Spoil	INSPECTOR: D D Marlow	
CHECKED BY:	APPROVED BY:	
DRILLING CONTRACTOR: Whitney & Assoc.	DRILL RIG: CME 75	DRILLER: J Fahl



TYPE OF SEAL: Baroid Hole Plug 3/8 coarse bentonite

O.D. & TYPE OF RISER PIPE: 2" Sch 40 Flush Joint threaded PVC

TYPE OF SEAL: Baroid 3/8" Bentonite Pellets

TYPE AND SIZE OF SCREEN OR OPENINGS: 0.10 Slot Sch40 PVC 2"

TYPE OF FILTER: Flint Shot 4.0 (Silica Sand)

TYPE OF SEAL:

DIAMETER OF BOREHOLE: 8" DIA

H_2O @ 19.0'

METHOD OF INSTALLATION: Drill Borehole w/ 4" ID Hollowstem Augers; install Riser, screen sand pack; seal and surface seal through Augers

REMARKS: 4 bags sand, 1 bucket Balls, Hole plug 1½

OM17

DUCK CREEK STATION		BORING MW-1	SHEET 1 of 1
DATE STARTED 10/14/93	DATE COMPLETED 10/14/93	LOGGED BY RAB	SURFACE EL. 590.0 (ft.)
DRILLING CONTRACTOR: FOX DRILLING INC.		DRILL METHOD: HSA	

Depth (ft)	Graphic Log	N-Value	SOIL/ROCK DESCRIPTION	VAPOR CONCENTRATION Isobutylene Calibration Gas Equivalent Units (ppm) 10^0 10^1 10^2 10^3	COMMENTS	Depth (ft)
0			Not sampled.		▼	0
			Mottled brn. and gray silty sandy CLAY, so. f.-m. gravel, moist.		▽	
5			Blk. fractured COAL fragments, wet.			5
			Mottled brn. and gray silty sandy CLAY, so. f.-m. gravel, moist.			
			Gray silty CLAY (weathered shale fragments), moist-wet.			
10			Mottled brn. lt. brn and lt. gray silty sandy CLAY, so. f.-m. gravel, moist-wet.			10
			Brn. c.-vc. SAND, wet.			
			Lt. gray silty CLAY, so. shale fragments, moist.			
			Not Sampled.			
15			End of Boring = 15.0' Glacial Till/Shale Spoil 0.0-15.0'			15
20						20

SOIL/ROCK BORING DATA

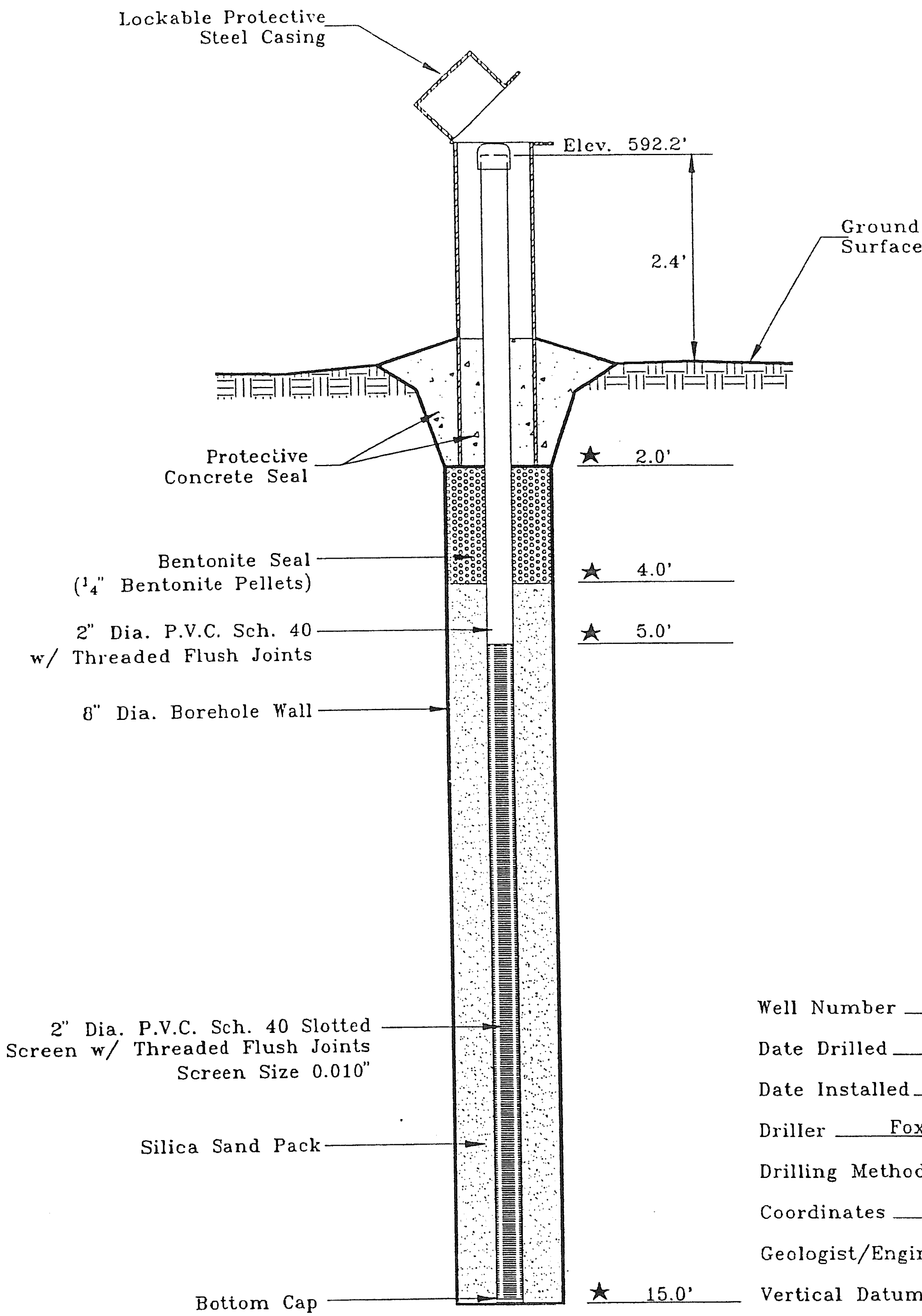
HANSON ENGINEERS INCORPORATED

RAB 3/10/94
REVIEWED DATE
BDC 3/10/94
APPROVED DATE

PHASE II - HYDROGEOLOGICAL INVESTIGATION
CILCO - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078

OM17



Well Number MW-1 (OM-17)

Date Drilled 10/14/93

Date Installed 10/14/93

Driller Fox Drilling, Inc.

Drilling Method HSA

Coordinates

Geologist/Engineer Rich Boyer

Vertical Datum:

Assumed ______ U.S.G.S. 590.0'

★ Depth Below Ground Surface

Not to Scale

MW-1 MONITOR WELL

HANSON ENGINEERS INCORPORATED

PHASE II-HYDROGEOLOGICAL INVESTIGATION
CILCO-DUCK CREEK STATION
CANTON, ILLINOIS

Job No. 92S5078

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OM18

DUCK CREEK STATION		BORING MW-2	SHEET 1 of 2
DATE STARTED 10/12/93	DATE COMPLETED 10/13/93	LOGGED BY RAB	SURFACE EL. 612.0 (ft.)
DRILLING CONTRACTOR: FOX DRILLING INC.		DRILL METHOD: HSA	

Depth (ft)	Graphic Log	N-Value	SOIL/ROCK DESCRIPTION	VAPOR CONCENTRATION Isobutylene Calibration Gas Equivalent Units (ppm) 10^0 10^1 10^2 10^3	COMMENTS	Depth (ft)
0			Mottled brn. and lt. brn. clayey SILT, so. sand, roots, moist.			0
5			Mottled brn., lt. brn., lt. gray silty CLAY, moist.		after 14 hours.	5
10					Perm. Sample (7.1'-7.6')	10
			Gray CLAY, moist.			
			Dk. brn. silty CLAY, organic-rich, moist.			
15			Mottled lt. brn. and lt. gray silty CLAY, moist.			15
			Mottled gray, lt. gray, and lt. brn. silty sandy CLAY, so. f gravel, moist.			
20			Mottled lt. gray and gray CLAY, so. silt, sand, moist.			20
			Lt. gray silty sandy CLAY, so. f.-m. gravel, moist.			
25			Dk. brown silty CLAY, moist, organic-rich.			25
			Mottled lt. gray and gray CLAY, so. sand, silt, tr. f. gravel, moist.			
30			Lt. gray silty sandy CLAY, so. f.-m. gravel, moist.			30
35						35

SOIL/ROCK BORING DATA

HANSON ENGINEERS INCORPORATED

RAB	3/10/94
REVIEWED	DATE
BOC	3/10/94
APPROVED	DATE

PHASE II - HYDROGEOLOGICAL INVESTIGATION
CILCO - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078

OM18

DUCK CREEK STATION	BORING MW-2	SHEET 2 of 2
DATE STARTED 10/12/93	DATE COMPLETED 10/13/93	LOGGED BY RAB
SURFACE EL. 612.0 (ft.)		
DRILLING CONTRACTOR: FOX DRILLING INC.	DRILL METHOD: HSA	

Depth (ft)	Graphic Log	N-Value	SOIL/ROCK DESCRIPTION	VAPOR CONCENTRATION Isobutylene Calibration Gas Equivalent Units (ppm) 10^0 10^1 10^2 10^3	COMMENTS	Depth (ft)
31			Gray sandy CLAY, moist.			31
			Lt. gray v.f. sandy SILT, moist.			
			Gray silty sandy CLAY, so. f.-m. gravel, moist.			
36						36
			Mottled lt. gray, gray, brn., lt. brn., silty sandy CLAY, so. f.-m. gravel, fractured silty shale fragments, fractured coal fragments, loose, wet.		▽	
41						41
			Gray CLAY, moist.			
			Lt. gray silty CLAY, (weathered shale fragments), hard, moist.			
			Blk. fractured bituminous COAL chunks, so. silty clay, wet.			
46						46
			Gray silty CLAY, moist.		Perm. Sample (49.1'–49.5')	
			Gray silty SHALE fragments, so. coal, clay, moist-wet.			
			Gray-brn. silty sandy CLAY, so. f.-m. gravel, moist.			
51						51
			Gray silty CLAY (weathered shale fragments), moist.			
56					Split-spoon refusal at 58.2'.	56
			Dk. gray silty SHALE, hard, moist-dry. (bedrock).			
			End of Boring = 58.2'			
			Glacial Till Spoil 0.0'–39.8'			
			Glacial Till/Shale Spoil 39.8'–56.5'			
61			Shale Bedrock 56.5'			61

SOIL/ROCK BORING DATA

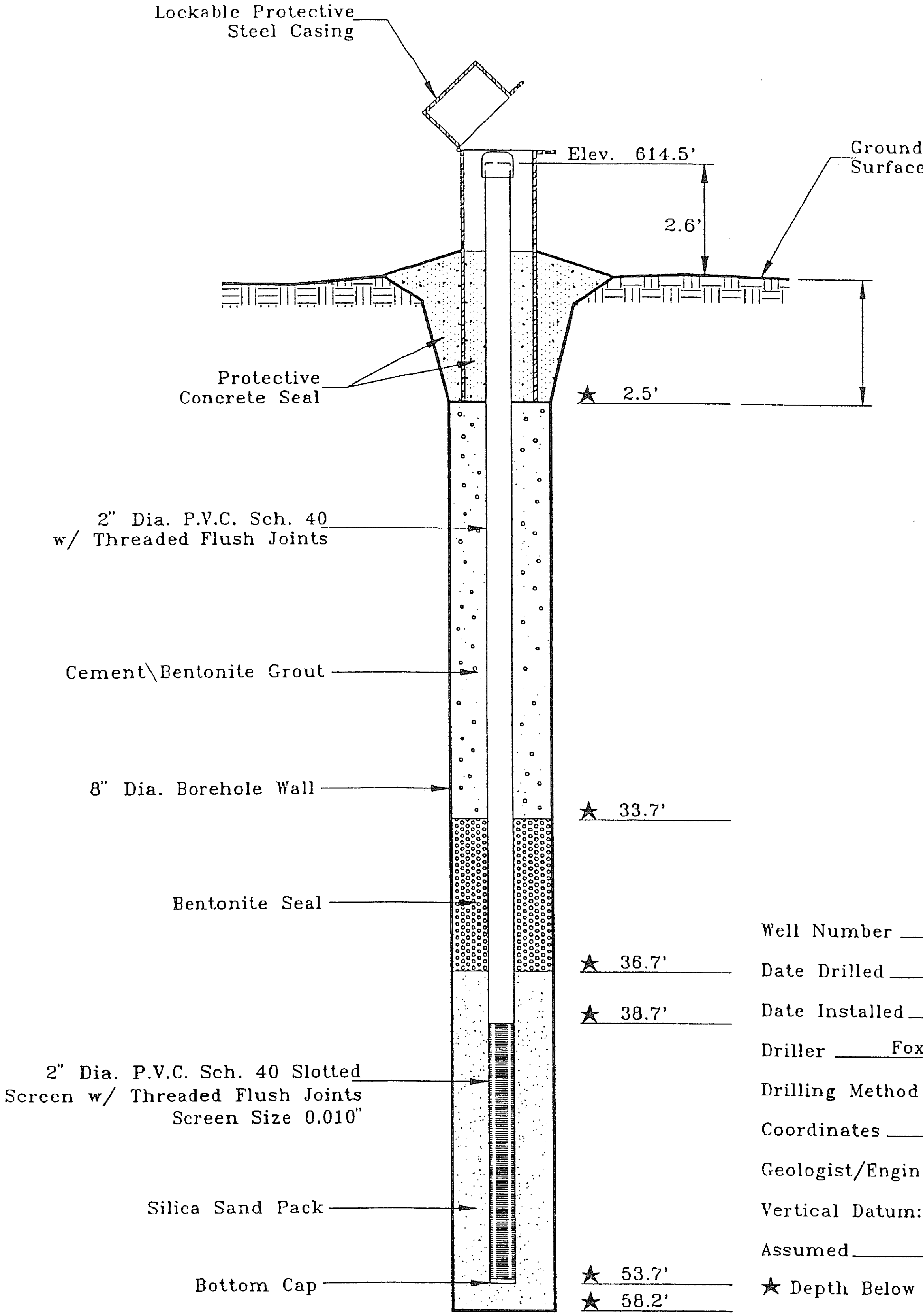
HANSON ENGINEERS INCORPORATED

RAB 3/10/94
REVIEWED DATE
BDC 3/10/94
APPROVED DATE

PHASE II - HYDROGEOLOGICAL INVESTIGATION
CILCO - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078

OM18



Well Number MW-2 (OM-18)

Date Drilled 10/13/93

Date Installed 10/13/93

Driller Fox Drilling, Inc.

Drilling Method HSA

Coordinates

Geologist/Engineer Rich Bover

Vertical Datum:

Assumed ________ U.S.G.S. 612.0'

★ Depth Below Ground Surface

Not to Scale

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MW-2 MONITOR WELL

HANSON ENGINEERS INCORPORATED

PHASE II-HYDROGEOLOGICAL INVESTIGATION
CILCO-DUCK CREEK STATION
CANTON, ILLINOIS

Job No. 92S5078

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Fulton Well #: OR18

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR18

~~State~~- Plant ~~Plane~~Coordinate: X 8,543.8 Y 1,979.0 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: R. Keady

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/31/2008 Date Finished: 4/1/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 32 minutes

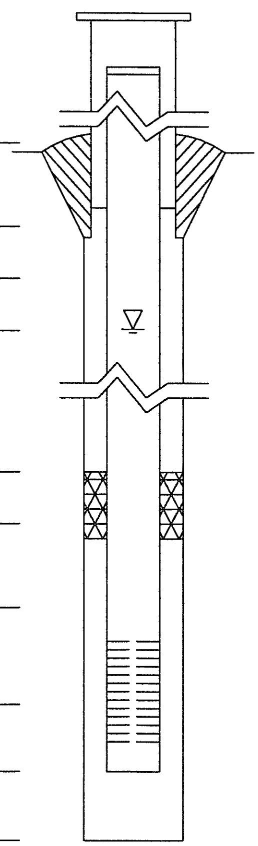
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS) (0.01 ft.)	
614.00	-2.44	Top of Protective Casing
613.85	-2.29	Top of Riser Pipe
611.56	0.00	Ground Surface
609.36	2.20	Top of Annular Sealant
592.53	19.03	Static Water Level (After Completion) 5/15/2008
576.09	35.47	Top of Seal
572.44	39.12	Top of Sand Pack
570.81	40.75	Top of Screen
561.30	50.26	Bottom of Screen
560.52	51.04	Bottom of Well
560.52	51.04	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	43.04
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.51
Total Length of Casing	(feet)	53.33
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

OR19

Illinois Environmental Protection Agency

Well Completion Report

Site #: ______ County: Fulton Well #: OR-A

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR19

~~State-~~ Plant ~~Plane~~ Coordinate: X 4,045.0 Y 2,725.2 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: B. WIlliamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/27/2008 Date Finished: 3/27/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular / Pellet / Slurry (choose one) — Granular circled

Installation Method: Gravity

Setting Time: 28 minutes

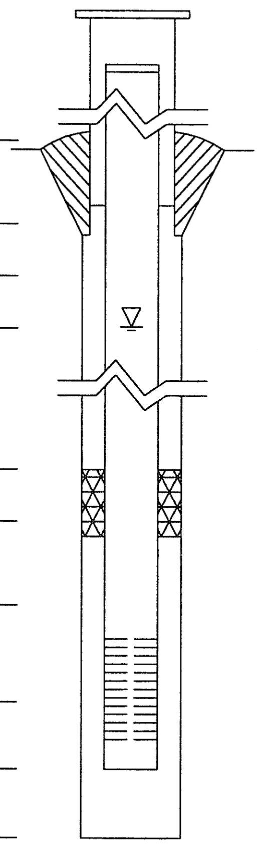
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
597.96	-2.27	Top of Protective Casing
597.80	-2.11	Top of Riser Pipe
595.69	0.00	Ground Surface
593.59	2.10	Top of Annular Sealant
581.28	14.41	Static Water Level (After Completion) 5/15/2008
559.20	36.49	Top of Seal
555.61	40.08	Top of Sand Pack
553.65	42.04	Top of Screen
544.10	51.59	Bottom of Screen
543.31	52.38	Bottom of Well
543.31	52.38	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	44.25
Bottom of Screen to End Cap	(feet)	0.79
Screen Length (1st slot to last slot)	(feet)	9.45
Total Length of Casing	(feet)	54.49
Screen Slot Size **	(inches)	0.010

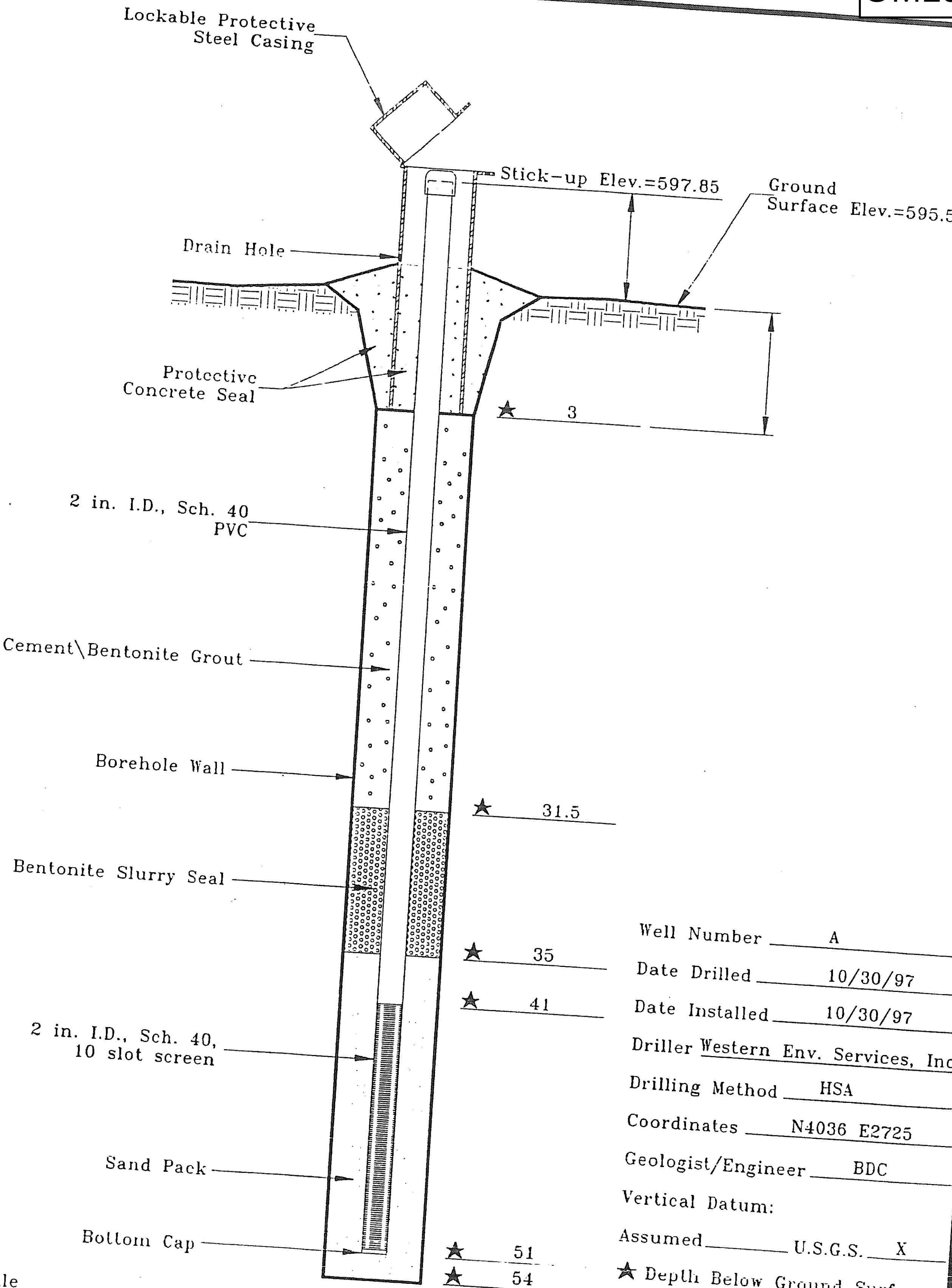
**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

OM19



Well Number A

Date Drilled 10/30/97

Date Installed 10/30/97

Driller Western Env. Services, Inc.

Drilling Method HSA

Coordinates N4036 E2725

Geologist/Engineer BDC

Vertical Datum:

Assumed ______ U.S.G.S. X

★ Depth Below Ground Surface

Not to Scale

MONITORING WELL A

HANSON ENGINEERS INCORPORATED

MONITORING WELL INSTALLATION
CILCO - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078A

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OR20

Illinois Environmental Protection Agency

Well Completion Report

Site #: ______ County: Fulton Well #: OR-B

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR20

~~State-~~ Plant ~~Plane~~ Coordinate: X 5,346.4 Y 2,926.8 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: B. WIlliamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/26/2008 Date Finished: 3/26/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one) — Granular

Installation Method: Gravity

Setting Time: 25 minutes

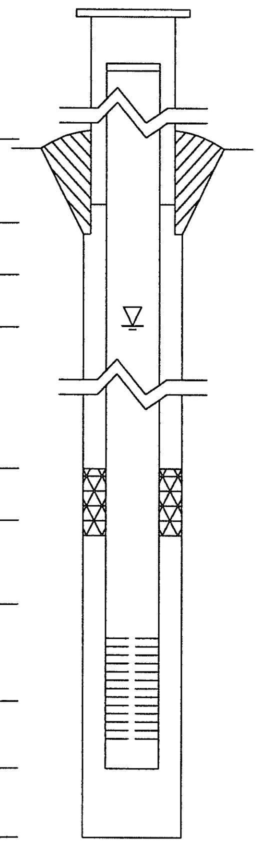
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
587.94	-3.31	Top of Protective Casing
587.72	-3.09	Top of Riser Pipe
584.63	0.00	Ground Surface
581.83	2.80	Top of Annular Sealant
573.64	10.99	Static Water Level (After Completion) 5/15/2008
545.11	39.52	Top of Seal
542.30	42.33	Top of Sand Pack
539.85	44.78	Top of Screen
530.40	54.23	Bottom of Screen
529.62	55.01	Bottom of Well
529.62	55.01	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	47.87
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.45
Total Length of Casing	(feet)	58.10
Screen Slot Size **	(inches)	0.010

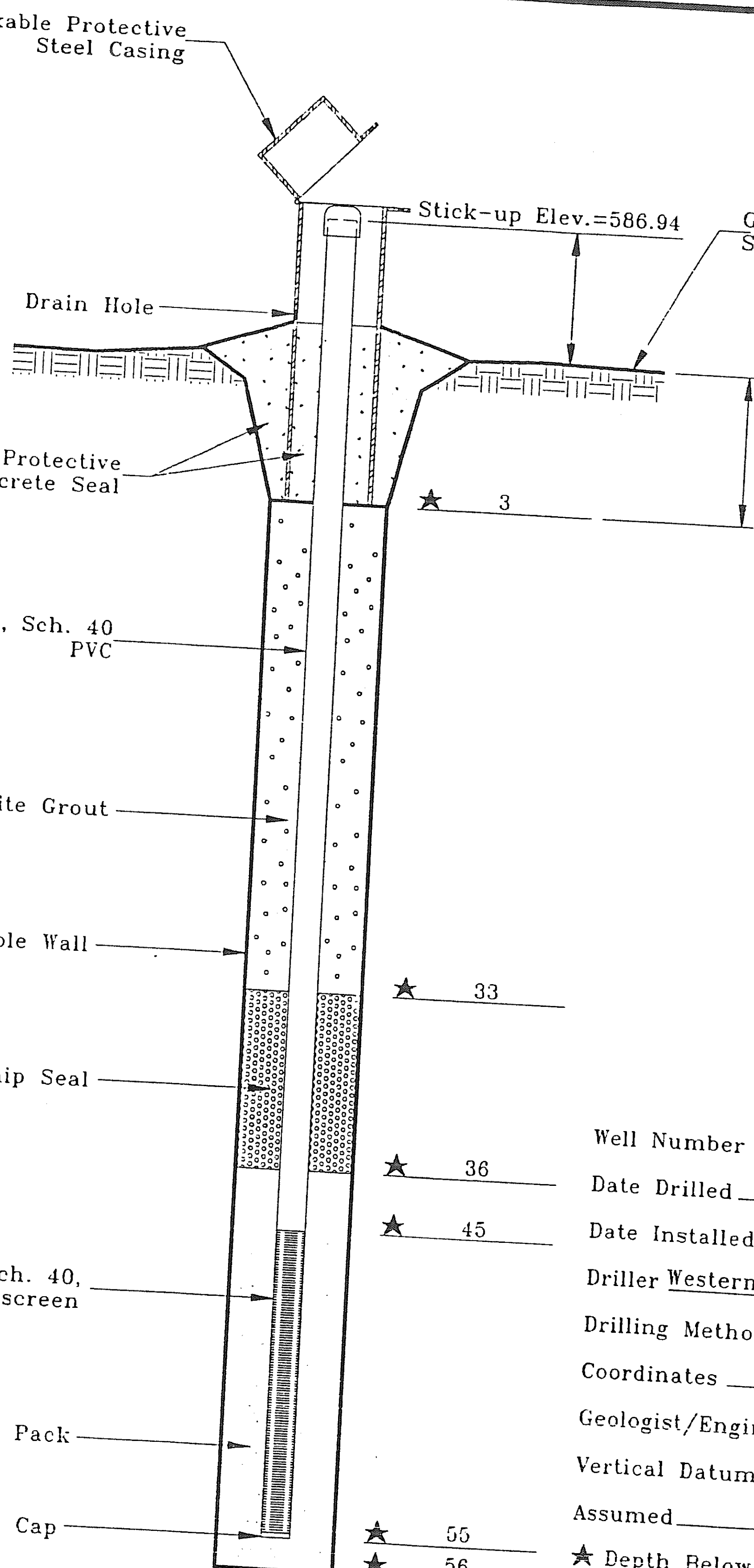
**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

OM20



Well Number B

Date Drilled 10/29/97

Date Installed 10/29/97

Driller Western Env. Services, Inc.

Drilling Method HSA

Coordinates N5340 E2932

Geologist/Engineer BDC

Vertical Datum:

Assumed ____ U.S.G.S. X

★ Depth Below Ground Surface

Not to Scale

MONITORING WELL B

HANSON ENGINEERS INCORPORATED

MONITORING WELL INSTALLATION
CILCO - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078A

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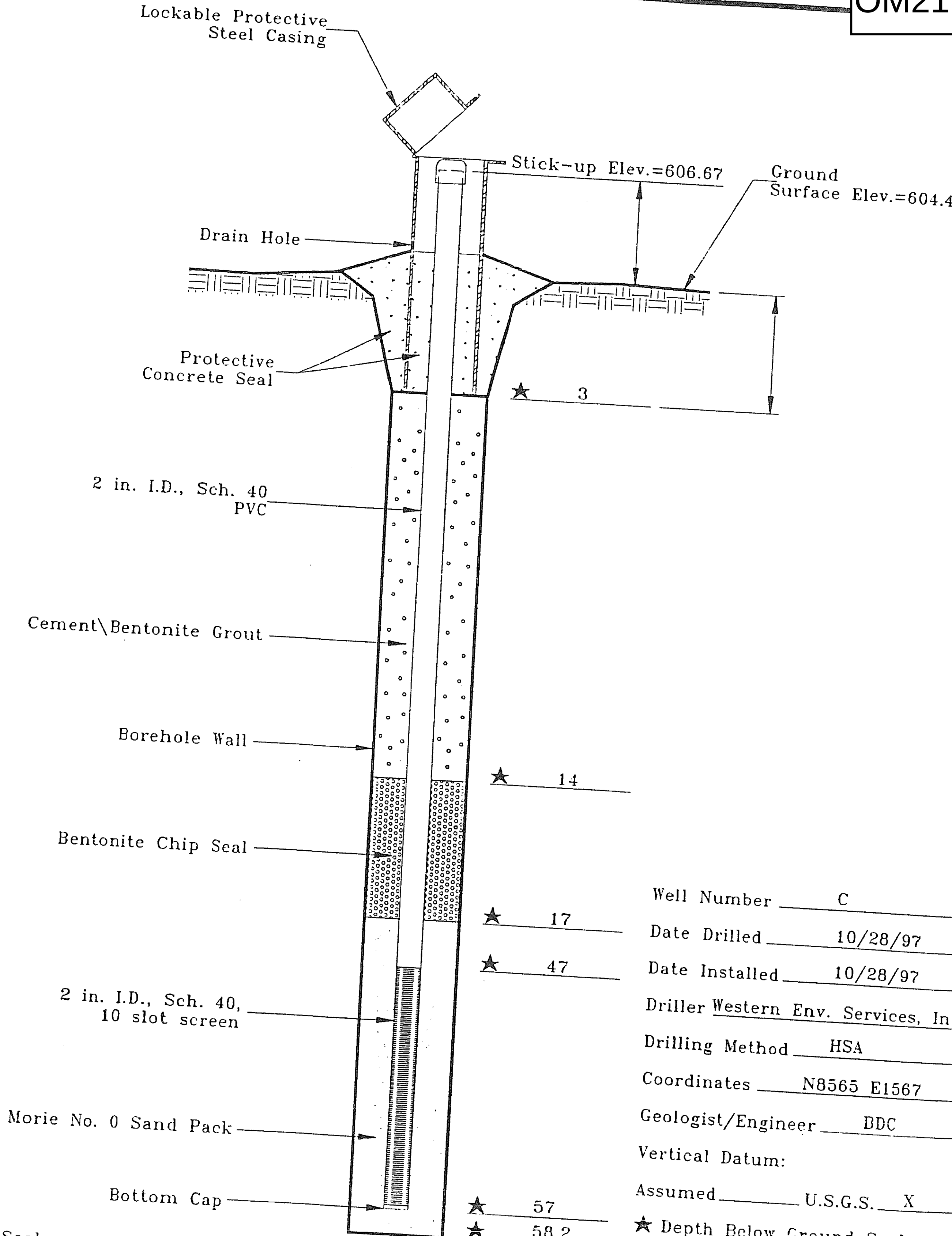
OM21



Well Number C

Date Drilled 10/28/97

Date Installed 10/28/97

Driller Western Env. Services, Inc.

Drilling Method HSA

Coordinates N8565 E1567

Geologist/Engineer DDC

Vertical Datum:

Assumed ____ U.S.G.S. X

★ Depth Below Ground Surface

Not to Scale

I:\DRAWINGS\92S5078A\003.DWG 12/05/97 09:10 0th

MONITORING WELL C

HANSON ENGINEERS INCORPORATED

MONITORING WELL INSTALLATION
CILCO - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078A

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/19/2009
Finish: 8/19/2009
WEATHER: Sunny, warm, humid, lo-80's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM22a
Well ID: OM22S
Surface Elev: 597.07 ft. MSL
Completion: 37.38 ft. BGS
Station: 3,991.50N
-126.95E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 16.18 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) / % Recovery	Type	TESTING: Blows / 6 in / N - Value / RQD	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0–0.7	TOPSOIL - Very dark grayish brown (10YR3/2), moist, soft, silty CLAY with slight trace sand, roots.			
							0.7–5.3	Dark grayish brown (10YR4/2) with 30% gray (10YR6/1) mottles, slightly moist, friable, clayey SILT with slight trace sand and gravel.		596, 594, 592	
							5.3–6.8	Brown (10YR5/3) with 15% gray (10YR5/1) mottles, moist, soft, clayey SILT.			
							6.8–10	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) and 15% brown (10YR4/3) mottles, moist, soft, clayey SILT.		590, 588	
							10–11.2	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) and 15% brown (10YR4/3) mottles, moist, soft, silty CLAY with slight trace sand.		586	
							11.2–15	Brown (10YR4/3) with 10% gray (10YR5/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		584, 582	
							15–20 (▼ 16)	Brown (10YR4/3) with 10% gray (10YR5/1) and 5% dark yellowish brown (10YR4/6) mottles, very moist, soft, silty CLAY with slight trace sand and gravel.		580, 578	

NOTE(S): OM22S installed in blind drilled borehole within 10 ft of OM22D. See OM22 boring log for sample data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/19/2009
Finish: 8/19/2009
WEATHER: Sunny, warm, humid, lo-80's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM22a
Well ID: OM22S
Surface Elev: 597.07 ft. MSL
Completion: 37.38 ft. BGS
Station: 3,991.50N
-126.95E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 16.18 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							22, 24, ▼ 26	Yellowish brown (10YR5/4) with 10% gray (N6/1) mottles, very moist, soft, silty CLAY with slight trace sand and gravel.		576, 574, 572	
							28	Brown (10YR5/3) with 10% gray (10YR5/1) mottles, slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		570, 568	
							30, 32, 34, 36	Dark gray (N4/1), moist, firm, silty CLAY with trace coal and rock fragments.		566, 564, 562	
								Dark gray (N4/1), slightly moist, firm, silty CLAY (weathered SHALE) with trace coal.		560	

EOB = 37.4 ft bgs

NOTE(S): OM22S installed in blind drilled borehole within 10 ft of OM22D. See OM22 boring log for sample data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/18/2009
Finish: 8/19/2009
WEATHER: Sunny, warm, humid, lo-80's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM22
Well ID: OM22D
Surface Elev: 596.76 ft. MSL
Completion: 62.88 ft. BGS
Station: 3,994.82N
-127.08E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 15.82 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) / % Recovery	Type	TESTING: Blows / 6 in / N - Value / RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
							0 - 0.7	TOPSOIL - Very dark grayish brown (10YR3/2), moist, soft, silty CLAY with slight trace sand, roots.	596	
1A	32/60 *53%*	CS		14			0.7 - 5.3	Dark grayish brown (10YR4/2) with 30% gray (10YR6/1) mottles, slightly moist, friable, clayey SILT with slight trace sand and gravel.	594, 592	
2A				23			5.3 - 6.7	Brown (10YR5/3) with 15% gray (10YR5/1) mottles, moist, soft, clayey SILT.	590	
2B	28/60 *47%*	CS		25			6.7 - 10	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) and 15% brown (10YR4/3) mottles, moist, soft, clayey SILT.	588	
3A				24			10 - 11.2	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) and 15% brown (10YR4/3) mottles, moist, soft, silty CLAY with slight trace sand.	586	
3B	26/60 *43%*	CS		20			11.2 - 15	Brown (10YR4/3) with 10% gray (10YR5/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.	584, 582	
4A	16/60 *27%*	CS		19			15 - 20 (▼ 15.82)	Brown (10YR4/3) with 10% gray (10YR5/1) and 5% dark yellowish brown (10YR4/6) mottles, very moist, soft, silty CLAY with slight trace sand and gravel.	580, 578	

NOTE(S): OM22D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/18/2009
Finish: 8/19/2009
WEATHER: Sunny, warm, humid, lo-80's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM22
Well ID: OM22D
Surface Elev: 596.76 ft. MSL
Completion: 62.88 ft. BGS
Station: 3,994.82N
-127.08E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, Tier 6N; Range 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 15.82 - 9/14/09
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) *% Recovery*	SAMPLE: Type	TESTING: Blows / 6 in / N - Value / RQD	TESTING: Moisture (%)	TESTING: Dry Den. (lb/ft^3)	TESTING: Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
5A	20/60 *33%*	CS		28			20–26.8	Yellowish brown (10YR5/4) with 10% gray (N6/1) mottles, very moist, soft, silty CLAY with slight trace sand and gravel.		
6A				26			▼ 26			
6B	30/60 *50%*	CS		11			26.8–30	Brown (10YR5/3) with 10% gray (10YR5/1) mottles, slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		
7A				20			30–36	Dark gray (N4/1), moist, firm, silty CLAY with trace coal and rock fragments.		
7B	36/60 *60%*	CS		15						
8A				18			36–40	Dark gray (N4/1), slightly moist, firm, silty CLAY (weathered SHALE) with trace coal.		
8B	16/60 *27%*	CS		11						

Depth scale: 22, 24, 26, 28, 30, 32, 34, 36, 38, 40
Elevation scale: 576, 574, 572, 570, 568, 566, 564, 562, 560, 558

NOTE(S): OM22D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/18/2009
Finish: 8/19/2009
WEATHER: Sunny, warm, humid, lo-80's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM22
Well ID: OM22D
Surface Elev: 596.76 ft. MSL
Completion: 62.88 ft. BGS
Station: 3,994.82N
-127.08E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

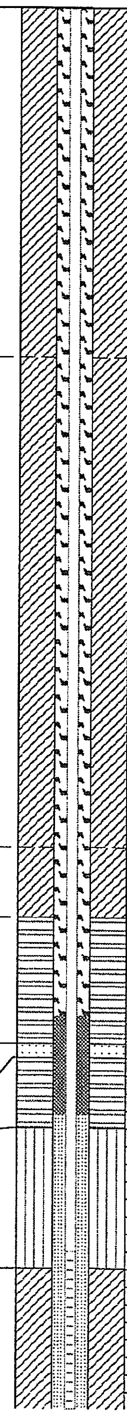
WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 15.82 - 9/14/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) Failure Type
9A	25/60 *42%*	CS		13		
10A	46/60 *77%*	CS		15		
10B				16		
11A	14/24 *58%*	SS		19		
12A	13/24 *54%*	SS		19		
13A	14/24 *58%*	SS		17		
14A	8/24 *33%*	SS		16		
15A	13/24 *54%*	SS		13		

Depth ft. BGS	Lithologic Description
to ~45	Dark gray (N4/1), very moist, soft, silty CLAY (weathered SHALE) with trace coal and rock fragments.
~45 – 52	Dark gray (N4/1), very moist, firm, silty CLAY (weathered SHALE) with trace coal and rock fragments.
52 – ~53	Gray (N5/1), moist, firm, silty CLAY (weathered SHALE).
~53 – ~55	Gray (N5/1), slightly moist, hard, slightly weathered SHALE.
~55 – ~55.5	Greenish gray (10GY6/1), slightly moist, firm, SANDSTONE.
~55.5 – 56	Gray (N5/1), slightly moist, hard, slightly weathered SHALE.
56 – 58	Greenish gray (10Y5/2) with 10% yellowish brown (10YR5/4) mottles, moist, firm, clayey SILT.
58 – 60	Gray (N5/1), moist, firm, silty CLAY (weathered SHALE).

Depth ft. BGS: 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

Borehole Detail



Elevation ft. MSL: 556, 554, 552, 550, 548, 546, 544, 542, 540, 538

Remarks

NOTE(S): OM22D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/18/2009
Finish: 8/19/2009
WEATHER: Sunny, warm, humid, lo-80's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM22
Well ID: OM22D
Surface Elev: 596.76 ft. MSL
Completion: 62.88 ft. BGS
Station: 3,994.82N -127.08E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 15.82 - 9/14/09
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
16A	7/24 *29%*	SS		14				Gray (N5/1), moist, firm, silty CLAY (weathered SHALE). *[Continued from previous page]*	536	
17A	6/6 *100%*	SS		14			62			
18A	5/5 *100%*	SS		13				Dark gray (N4/1), slightly moist, very hard, SHALE.	534	

EOB = 62.9 ft bgs

NOTE(S): OM22D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 9/3/2009
Finish: 9/3/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM23a
Well ID: OM23S
Surface Elev: 610.40 ft. MSL
Completion: 43.38 ft. BGS
Station: 5,591.13N
-371.63E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.00 - during drilling
▼ = 38.59 - 9/14/09
▽ =

SAMPLE			TESTING								
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0 – 1.25	Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand, roots.		610	
							1.25 – 5	Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand, roots.		608, 606	
							5 – 7.8	Yellowish brown (10YR5/4) with 5% gray (10YR6/1), 5% dark yellowish brown (10YR4/6) and 5% Very dark gray (10YR3/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		604	
							7.8 – 12	Yellowish brown (10YR5/4) with 5% gray (10YR6/1), 5% dark yellowish brown (10YR4/6) and 5% Very dark gray (10YR3/1) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		602, 600	
							12 – 15.5	Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		598, 596	
							15.5 – 20	Greenish gray (10Y5/1), slightly moist, friable, clayey SILT with shale, sandstone, and coal fragments.		594, 592	

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

NOTE(S): OM23S installed in blind drilled borehole within 10 ft of OM23D. See OM23 boring log for sample data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 9/3/2009
Finish: 9/3/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM23a
Well ID: OM23S
Surface Elev: 610.40 ft. MSL
Completion: 43.38 ft. BGS
Station: 5,591.13N
-371.63E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.00 - during drilling
▼ = 38.59 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							20–23.2	Greenish gray (10Y5/1), slightly moist, friable, clayey SILT with shale, sandstone, and coal fragments. *[Continued from previous page]*			
							23.2–24	Gray (N5/1), slightly moist, firm, laminated, weathered SHALE.			
							24–30	Greenish gray (10Y5/1), slightly moist, friable, clayey SILT with shale fragments.			
							30–35	Greenish gray (10Y6/1), slightly moist, friable, clayey SILT with shale and trace coal fragments.			
							35–40	Gray (N5/1), slightly moist, hard, laminated, weathered SHALE with coal fragments.			

Depth scale: 22, 24, 26, 28, 30, 32, 34, 36, 38, 40 (▼ at 38.59, ▼ at 40)
Elevation scale: 590, 588, 586, 584, 582, 580, 578, 576, 574, 572

NOTE(S): OM23S installed in blind drilled borehole within 10 ft of OM23D. See OM23 boring log for sample data.

FIELD BORING LOG

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 9/3/2009
Finish: 9/3/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

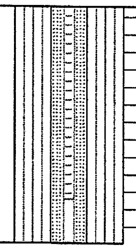
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

HANSON

BOREHOLE ID: OM23a
Well ID: OM23S
Surface Elev: 610.40 ft. MSL
Completion: 43.38 ft. BGS
Station: 5,591.13N
-371.63E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.00 - during drilling
▼ = 38.59 - 9/14/09
▽ =

SAMPLE			TESTING								
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							42	Greenish gray (10Y6/1), slightly moist, firm, clayey SILT with shale and coal fragments.		570 568	

EOB = 43.4 ft bgs

NOTE(S): OM23S installed in blind drilled borehole within 10 ft of OM23D. See OM23 boring log for sample data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 9/1/2009
Finish: 9/2/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM23
Well ID: OM23D
Surface Elev: 610.41 ft. MSL
Completion: 80.32 ft. BGS
Station: 5,585.76N
-371.66E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, Tier 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.00 - during drilling
▼ = 34.69 - 9/14/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0–1.3	Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand, roots.		610	
1A	35/60 58%	CS		24			1.3–5	Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand, roots.		608, 606	
2A	47/60 78%	CS		16			5–7.8	Yellowish brown (10YR5/4) with 5% gray (10YR6/1), 5% dark yellowish brown (10YR4/6) and 5% Very dark gray (10YR3/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		604	
2B				16			7.8–12	Yellowish brown (10YR5/4) with 5% gray (10YR6/1), 5% dark yellowish brown (10YR4/6) and 5% Very dark gray (10YR3/1) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		602, 600	
3A	37/60 62%	CS		17							
3B				17			12–15.6	Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		598, 596	
4A	50/60 83%	CS		17							
4B				11			15.6–21	Greenish gray (10Y5/1), slightly moist, friable, clayey SILT with shale, sandstone, and coal fragments.		594, 592, 590	

NOTE(S): OM23D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 9/1/2009
Finish: 9/2/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

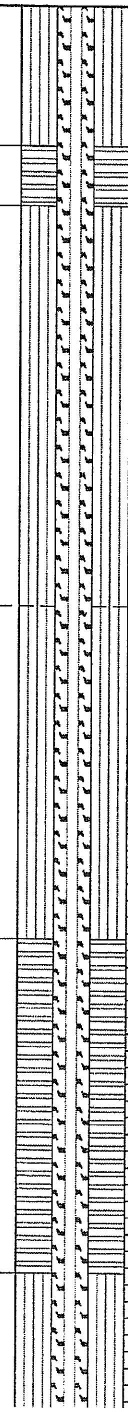
BOREHOLE ID: OM23
Well ID: OM23D
Surface Elev: 610.41 ft. MSL
Completion: 80.32 ft. BGS
Station: 5,585.76N
-371.66E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.00 - during drilling
▼ = 34.69 - 9/14/09
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) *% Recovery*	SAMPLE: Type	TESTING: *Blows / 6 in* N - Value **RQD**	TESTING: Moisture (%)	TESTING: Dry Den. (lb/ft³)	TESTING: Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description
5A	49/60 *82%*	CS		10			22	Greenish gray (10Y5/1), slightly moist, friable, clayey SILT with shale, sandstone, and coal fragments. *[Continued from previous page]*
5B				9			24	Gray (N5/1), slightly moist, firm, laminated, weathered SHALE.
6A	38/60 *63%*	CS		10			26, 28	Greenish gray (10Y5/1), slightly moist, friable, clayey SILT with shale fragments.
7A	34/60 *57%*	CS		11			30, 32, 34	Greenish gray (10Y6/1), slightly moist, friable, clayey SILT with shale and trace coal fragments.
8A	10/60 *17%*	CS		12			36, 38	Gray (N5/1), slightly moist, hard, laminated, weathered SHALE with coal fragments.
9A				15			40, 42	Greenish gray (10Y6/1), slightly moist, firm, clayey SILT with shale and coal fragments.

Borehole Detail



Elevation ft. MSL: 588, 586, 584, 582, 580, 578, 576, 574, 572, 570

Remarks

NOTE(S): OM23D installed in borehole.

FIELD BORING LOG

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 9/1/2009
Finish: 9/2/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

HANSON

BOREHOLE ID: OM23
Well ID: OM23D
Surface Elev: 610.41 ft. MSL
Completion: 80.32 ft. BGS
Station: 5,585.76N
-371.66E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.00 - during drilling
▼ = 34.69 - 9/14/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
	5/60 8%	CS							568	
							44		566	
10A	10/12 83%	SS	3 6 N=9	21			46	Greenish gray (10Y6/1), slightly moist, firm, clayey SILT with shale and coal fragments. *[Continued from previous page]*	564	
11A	16/24 67%	SS	6-9 19-21 N=28	16			48		562	
12A	20/24 83%	SS	4-7 8-10 N=15	15			50	Gray (N5/1), slightly moist, hard, laminated, weathered SHALE.		
								Greenish gray (10Y6/1), slightly moist, firm, clayey SILT.	560	
13A	18/24 75%	SS	4-5 9-12 N=14	11				Gray (N5/1), slightly moist, firm, weathered SHALE.		
							52	Dark gray (N4/1), slightly moist, firm, laminated, weathered SHALE.		
14A				14					558	
14B	14/24 58%	SS	9-8 8-9 N=16	16				Yellowish brown (10YR5/4) with 15% dark yellowish brown (10YR4/6) and 5% dark gray (10YR4/1) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		
15A	8/24 33%	SS	6-9 13-20 N=22	12			54	Olive gray (5Y5/2), moist, soft, silty CLAY with trace sand and slight trace gravel.	556	
16A	7/24 29%	SS	7-14 18-14 N=32	12			56	Gray (N6/1), slightly moist, firm, weathered SHALE.	554	
17A	13/24 54%	SS	7-17 14-16 N=31	15			58	Gray (N6/1), slightly moist, firm, laminated, weathered SHALE.	552	
18A	18/24 75%	SS	4-10 10-13 N=20	16			60	Gray (N6/1), slightly moist, firm, weathered SHALE.	550	
19A	8/24		22-28	13			62		548	

NOTE(S): OM23D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 9/1/2009
Finish: 9/2/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM23
Well ID: OM23D
Surface Elev: 610.41 ft. MSL
Completion: 80.32 ft. BGS
Station: 5,585.76N
-371.66E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.00 - during drilling
▼ = 34.69 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) / *% Recovery*	Type	TESTING: *Blows / 6 in* / N - Value / **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) / *Failure Type*	Depth ft. BGS	Lithologic Description
	33%	SS	*17-21* N=45				63–64	Gray (N6/1), slightly moist, firm, weathered SHALE. *[Continued from previous page]*
20A	11/24 *46%*	SS	*14-14 10-12* N=24	18			64–66	Gray (N6/1), slightly moist, firm, weathered SHALE with some coal.
21A	12/24 *50%*	SS	*9-9 12-13* N=21	14			66–68	Gray (N5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, firm, weahtered SHALE.
22A	17/24 *71%*	SS	*2-6 12-16* N=18	14			68–70	Dark gray (N4/1), slightly moist, firm, laminated, weathered SHALE.
23A	16/24 *67%*	SS	*2-7 8-8* N=15	21			70–74.3	Dark gray (N4/1), slightly moist, firm, weathered SHALE.
24A	14/24 *58%*	SS	*10-13 34-16* N=47	15				
25A	14/17 *82%*	SS	*25-80 100/5"*				74.3–80.3	Very dark gray (N3/1), slightly moist, very hard, SHALE.
	0/52 *0%*	BD						

Depth scale: 64, 66, 68, 70, 72, 74, 76, 78, 80
Elevation ft. MSL: 546, 544, 542, 540, 538, 536, 534, 532

Borehole Detail | Remarks

EOB = 80.3 ft bgs

NOTE(S): OM23D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/25/2009
Finish: 8/25/2009
WEATHER: Sunny, warm, humid, lo-80's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 3¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM24
Well ID: OM24D
Surface Elev: 573.90 ft. MSL
Completion: 23.00 ft. BGS
Station: 7,523.62N
-341.39E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

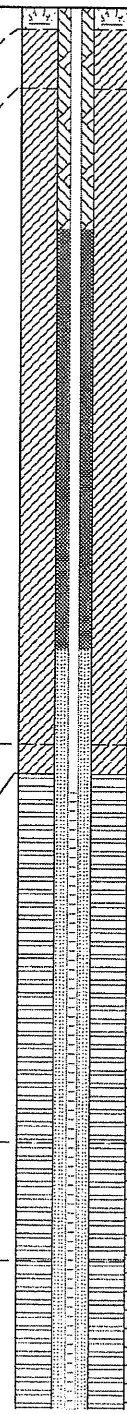
WATER LEVEL INFORMATION:
▼ = 10.00 - during drilling
▼ = -0.31 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*
1A				16		
1B	24/60 *40%*	cs		27		
2A	14/60 *23%*	cs		27		
3A	10/36 *28%*	cs		21		
4A	16/18 *89%*	ss	*36-31 100/5"*	15		
5A	8/10 *80%*	ss	*25-100/4"*	9		
6A	22/24 *92%*	ss	*5-44 38-42* N=82	12		

Depth ft. BGS	Lithologic Description
0	TOPSOIL - Black (10YR2/1), moist, soft, silty CLAY with slight trace sand, roots.
	Black (10YR2/1) with 30% gray (10YR5/1) and 20% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel, trace roots.
	Dark greenish gray (10Y4/1) with 20% dark yellowish brown (10YR4/6), 10% greenish gray (5GY6/1), and 5% black (N 2.5/1) mottles, moist, soft, silty CLAY with slight trace sand, coal fragments, slight trace roots.
10	Light brownish gray (2.5Y6/2) with 5% dark yellowish brown (10YR4/6) mottles, moist soft, silty CLAY with trace sand and gravel.
	Very dark gray (N3/1), slightly moist, friable, laminated, weathered SHALE.
	Very dark gray (N3/1), slightly moist, hard, laminated, SHALE with coal interbeds.
	Dark gray (N4/1), slightly moist, hard, laminated, weathered SHALE.

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

Borehole Detail



Elevation ft. MSL: 572, 570, 568, 566, 564, 562, 560, 558, 556

Remarks

NOTE(S): OM24D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/25/2009
Finish: 8/25/2009
WEATHER: Sunny, warm, humid, lo-80's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 3¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM24
Well ID: OM24D
Surface Elev: 573.90 ft. MSL
Completion: 23.00 ft. BGS
Station: 7,523.62N
-341.39E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 10.00 - during drilling
▼ = -0.31 - 9/14/09
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
7A	16/24 *67%*	SS	*5-14* *32-34* N=46	12			20	Dark gray (N4/1), slightly moist, hard, laminated, weathered SHALE. *[Continued from previous page]*		554	
8A	18/24 *75%*	SS	*17-60* *68-79* N=128	17			22	Dark gray (N4/1), slightly moist, very hard, SHALE.		552	
8B				16							

EOB = 23.0 ft bgs

NOTE(S): OM24D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/1/1937
Finish: 8/31/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM25a
Well ID: OM25S
Surface Elev: 627.14 ft. MSL
Completion: 61.67 ft. BGS
Station: 8,616.31N
-321.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 55.60 - during drilling
▼ = 56.05 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0–0.9	Dark yellowish brown (10YR4/4) with 20% gray (10YR6/1) mottles, moist, soft, clayey SILT with slight trace sand and gravel, roots.		626	
							2	Grayish brown (10YR5/2) with 35% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel, slight trace roots.		624	
							4				
								Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT with slight trace sand, slight trace roots.		622	
							6	Yellowish brown (10YR5/4) with 10% gray (10YR5/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.			
							8	Greenish gray (10Y5/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		620 / 618	
							10 / 12 / 14	Yellowish brown (10YR5/4) with 30% greenish gray (10Y5/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		616 / 614	
							16	Yellowish brown (10YR5/4) with 25% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		612	
							18 / 20	Light brownish gray (10YR6/2) with 15% dark yellowish brown (10YR4/6) and 5% gray (10YR5/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		610 / 608	

NOTE(S): OM25S installed in blind drilled borehole within 10 ft of OM25D. See OM25 boring log for sample data.

FIELD BORING LOG

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/1/1937
Finish: 8/31/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

HANSON

BOREHOLE ID: OM25a
Well ID: OM25S
Surface Elev: 627.14 ft. MSL
Completion: 61.67 ft. BGS
Station: 8,616.31N -321.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 55.60 - during drilling
▼ = 56.05 - 9/14/09
∇ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Yellowish brown (10YR5/4) with 15% gray (10YR6/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		606	
							22	Gray (10YR5/1) with 20% yellowish brown (10YR5/4) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		604	
							24				
								Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT with slight trace sand.		602	
							26	Dark gray (10YR4/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.			
							28	Yellowish brown (10YR5/4) with 10% dark gray (10YR4/1) and 10% grayish brown (10YR5/2) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		600 / 598	
							30–36	Gray (N5/1), slightly moist, firm, silty CLAY with trace coal and rock fragments.		596 / 594 / 592	
							38–40	Gray (N5/1), slightly moist, hard, silty CLAY with shale and coal fragments.		590 / 588	

NOTE(S): OM25S installed in blind drilled borehole within 10 ft of OM25D. See OM25 boring log for sample data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/1/1937
Finish: 8/31/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM25a
Well ID: OM25S
Surface Elev: 627.14 ft. MSL
Completion: 61.67 ft. BGS
Station: 8,616.31N
-321.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 55.60 - during drilling
▼ = 56.05 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							40–46.5	Gray (N5/1), slightly moist, firm, friable, silty CLAY with trace shale and coal fragments.		586, 584, 582	
							46.5–48	Gray (N5/1), slightly moist, hard, silty CLAY with trace shale and coal fragments.		580	
							48–50	Gray (N5/1), slightly moist, hard, laminated, friable, weathered SHALE.		578	
							50–54.3	Gray (N5/1), slightly moist, firm, friable, weathered SHALE with coal fragments.		576, 574	
							54.3–56.3	Gray (N5/1), slightly moist, hard, friable, laminated, weathered SHALE.		572	
							56.3–57.5	Gray (N6/1), slightly moist, firm, silty CLAY (weathered SHALE).		570	
							57.5–58.6	Gray (N5/1), slightly moist, very hard, laminated, SHALE.			
							58.6–60	Dark gray (N4/1), slightly moist, hard, friable, clayey SILT (weathered SHALE).		568	

Depth scale: 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

NOTE(S): OM25S installed in blind drilled borehole within 10 ft of OM25D. See OM25 boring log for sample data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/1/1937
Finish: 8/31/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM25a
Well ID: OM25S
Surface Elev: 627.14 ft. MSL
Completion: 61.67 ft. BGS
Station: 8,616.31N
-321.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 55.60 - during drilling
▼ = 56.05 - 9/14/09
▽ =

SAMPLE			TESTING								
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark gray (N4/1), slightly moist, firm, friable, laminated, weathered SHALE.		566	

EOB = 61.7 ft bgs

NOTE(S): OM25S installed in blind drilled borehole within 10 ft of OM25D. See OM25 boring log for sample data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/26/2009
Finish: 8/27/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM25
Well ID: OM25D
Surface Elev: 627.02 ft. MSL
Completion: 76.00 ft. BGS
Station: 8,620.05N
-321.35E

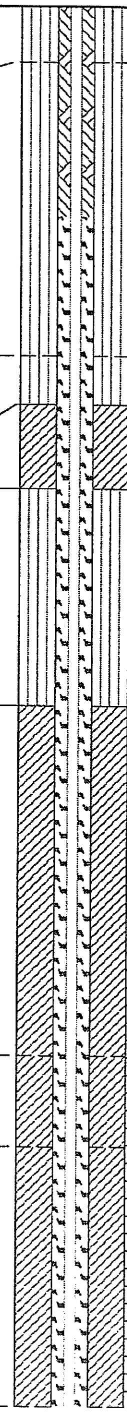
TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 55.60 - during drilling
▼ = 56.21 - 9/14/09
▽ =

SAMPLE			TESTING			
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*
1A				21		
	36/60 *60%*	cs				
1B				23		
2A				23		
2B	35/60 *58%*	cs		15		
3A				14		
	5/60 *8%*	cs				
4A				21		
	40/60 *67%*	cs				
4B				25		

Depth ft. BGS	Lithologic Description
0	Dark yellowish brown (10YR4/4) with 20% gray (10YR6/1) mottles, moist, soft, clayey SILT with slight trace sand and gravel, roots.
2 – 4	Grayish brown (10YR5/2) with 35% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel, slight trace roots.
	Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT with slight trace sand, slight trace roots.
6	Yellowish brown (10YR5/4) with 10% gray (10YR5/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.
8	Greenish gray (10Y5/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.
10 – 14	Yellowish brown (10YR5/4) with 30% greenish gray (10Y5/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.
16	Yellowish brown (10YR5/4) with 25% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.
18 – 20	Light brownish gray (10YR6/2) with 15% dark yellowish brown (10YR4/6) and 5% gray (10YR5/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.

Borehole Detail



Elevation ft. MSL: 626, 624, 622, 620, 618, 616, 614, 612, 610, 608

Remarks

NOTE(S): OM25D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/26/2009
Finish: 8/27/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM25
Well ID: OM25D
Surface Elev: 627.02 ft. MSL
Completion: 76.00 ft. BGS
Station: 8,620.05N
-321.35E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 55.60 - during drilling
▼ = 56.21 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
5A				22				Yellowish brown (10YR5/4) with 15% gray (10YR6/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.	606	
5B	37/60 62%	CS		26			22			
							24	Gray (10YR5/1) with 20% yellowish brown (10YR5/4) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.	604	
6A				21				Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT with slight trace sand.	602	
							26	Dark gray (10YR4/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		
6B	38/60 63%	CS		18			28	Yellowish brown (10YR5/4) with 10% dark gray (10YR4/1) and 10% grayish brown (10YR5/2) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.	600, 598	
7A				20			30		596	
7B	37/60 62%	CS		15			32, 34	Gray (N5/1), slightly moist, firm, silty CLAY with trace coal and rock fragments.	594, 592	
8A				15			36		590	
8B	40/60 67%	CS		13			38, 40	Gray (N5/1), slightly moist, hard, silty CLAY with shale and coal fragments.	588	

NOTE(S): OM25D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/26/2009
Finish: 8/27/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM25
Well ID: OM25D
Surface Elev: 627.02 ft. MSL
Completion: 76.00 ft. BGS
Station: 8,620.05N
-321.35E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 55.60 - during drilling
▼ = 56.21 - 9/14/09
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING Blows / 6 in N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*
9A	14/60 *23%*	cs		10		
10A	13/18 *72%*	cs		12		
11A	12/18 *67%*	ss	*17-40* *26* N=66	12		
12A	19/24 *79%*	ss	*10-22* *24-18* N=46	8		
13A	17/24 *71%*	ss	*2-12* *8-7* N=20	10		
14A	16/24 *67%*	ss	*12-17* *14-15* N=31	10		
15A	18/24 *75%*	ss	*13-17* *16-34* N=33	3		
16A	20/24 *83%*	ss	*8-8* *9-48* N=17	13		
17A				10		
17B	17/24 *71%*	ss	*75-30* *27-24* N=57	12		

Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
40.5–46.5	Gray (N5/1), slightly moist, firm, friable, silty CLAY with trace shale and coal fragments.	586, 584, 582	
46.5–48	Gray (N5/1), slightly moist, hard, silty CLAY with trace shale and coal fragments.	580	
48–50	Gray (N5/1), slightly moist, hard, laminated, friable, weathered SHALE.	578	
50–54.3	Gray (N5/1), slightly moist, firm, friable, weathered SHALE with coal fragments.	576, 574	
54.3–56.3	Gray (N5/1), slightly moist, hard, friable, laminated, weathered SHALE.	572	
56.3–57.5	Gray (N6/1), slightly moist, firm, silty CLAY (weathered SHALE).	570	
57.5–58.6	Gray (N5/1), slightly moist, very hard, laminated, SHALE.		
58.6–60	Dark gray (N4/1), slightly moist, hard, friable, clayey SILT (weathered SHALE).	568	

Depth scale: 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

NOTE(S): OM25D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/26/2009
Finish: 8/27/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM25
Well ID: OM25D
Surface Elev: 627.02 ft. MSL
Completion: 76.00 ft. BGS
Station: 8,620.05N
-321.35E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 55.60 - during drilling
▼ = 56.21 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*
18A	19/24 *79%*	SS	*7-9 12-9* N=21	8		
19A	16/24 *67%*	SS	*3-6 9-30* N=15	12		
20A	14/24 *58%*	SS	*4-5 4-6* N=9	17		
21A	14/24 *58%*	SS	*3-9 61-36* N=70	14		
22A	19/24 *79%*	SS	*11-10 34-19* N=44	17		
22B				7		
23A	12/24 *50%*	SS	*14-27 11-16* N=38	12		
24A	16/24 *67%*	SS	*7-10 12-13* N=22	16		
25A	12/24 *50%*	SS	*12-16 20-17* N=36	11		

Depth ft. BGS: 62, 64, 66, 68, 70, 72, 74, 76
Elevation ft. MSL: 566, 564, 562, 560, 558, 556, 554, 552

Lithologic Description (Borehole Detail; Remarks)

Dark gray (N4/1), slightly moist, firm, friable, laminated, weathered SHALE.

Gray (N6/1), slightly moist, firm, clayey SILT (weathered SHALE).

Very dark gray (N3/1), slightly moist, hard, laminated, weathered SHALE.

Gray (N6/1), moist, firm, clayey SILT with shale fragments.

Gray (N5/1), slightly moist, hard, laminated, SHALE.

Gray (N5/1), moist, firm, clayey SILT with rock fragments.

EOB = 76.0 ft bgs

NOTE(S): OM25D installed in borehole.

Surface Elevation: ______

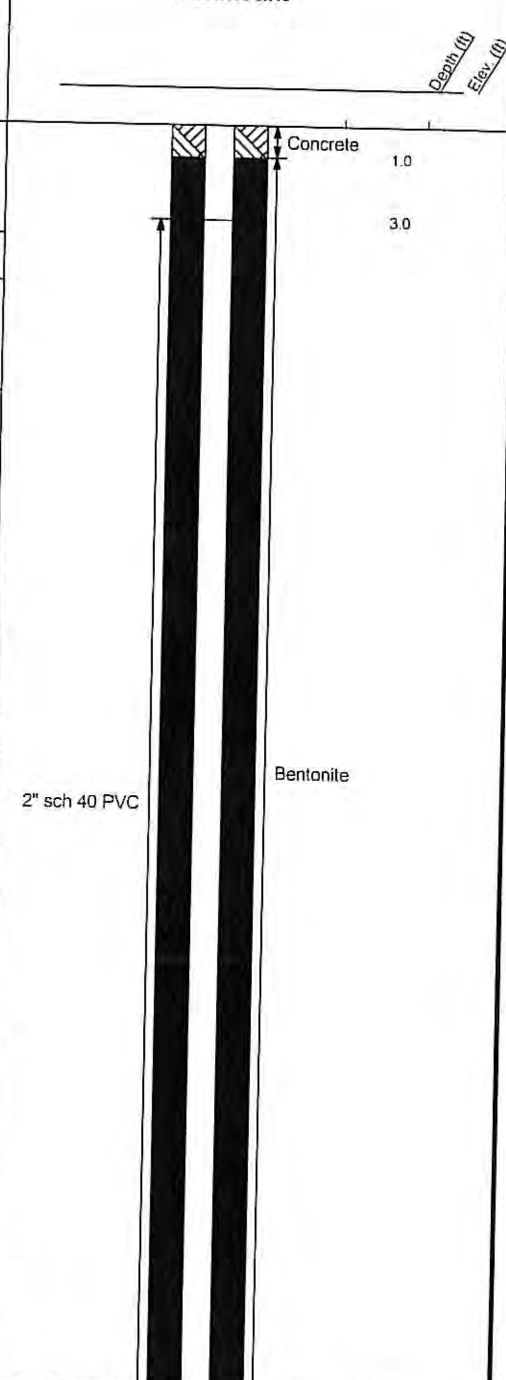
Datum: msl

Completion Date: 7/14/10

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Stiff, gray and black ASH			
5			3-4-8	SS1
5	Soft, gray and black ASH			
10			1-2-2	SS2
10	Soft to very soft, gray and black ASH			
15	▽		0-0-0	SS3
20			0-0-0	SS4
25			0-0-0	SS5
30			0-1-2	SS6
35			0-0-0	SS7
40			2-1-2	SS8

WELL DIAGRAM

Flushmount



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 15 FEET ▽

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by:	App'vd. by:
Date: 8/13/10	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Duck Creek, Illinois

LOG OF BORING: OM-26

Project No. J017150.01

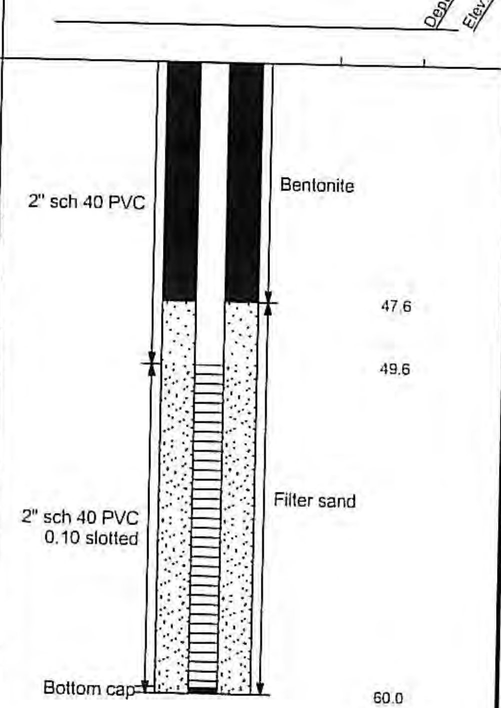
Surface Elevation: ______ Completion Date: 7/14/10

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Soft to very soft, gray and black ASH *(continued)*			
45			0-0-1	SS9
50			0-0-1	SS10
55	Soft, gray ASH with brown, silty CLAY		0-0-1	SS11
60			0-0-2	SS12
				ST13
65	Medium stiff, gray and black, silty CLAY with ash - CL		3-3-5	SS14
	Boring terminated at 66.5 feet.			
70				
75				

WELL DIAGRAM

Flushmount



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

LOG OF BORING 2002 WL J01750.01 - DUCK CREEK.GPJ GTINC 0638301.GPJ 11/3/10

GROUNDWATER DATA

ENCOUNTERED AT 15 FEET ▽

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by:	App'vd. by:
Date: 8/13/10	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Duck Creek, Illinois

CONTINUATION OF
LOG OF BORING: OM-26

Project No. J017150.01

Surface Elevation: ______

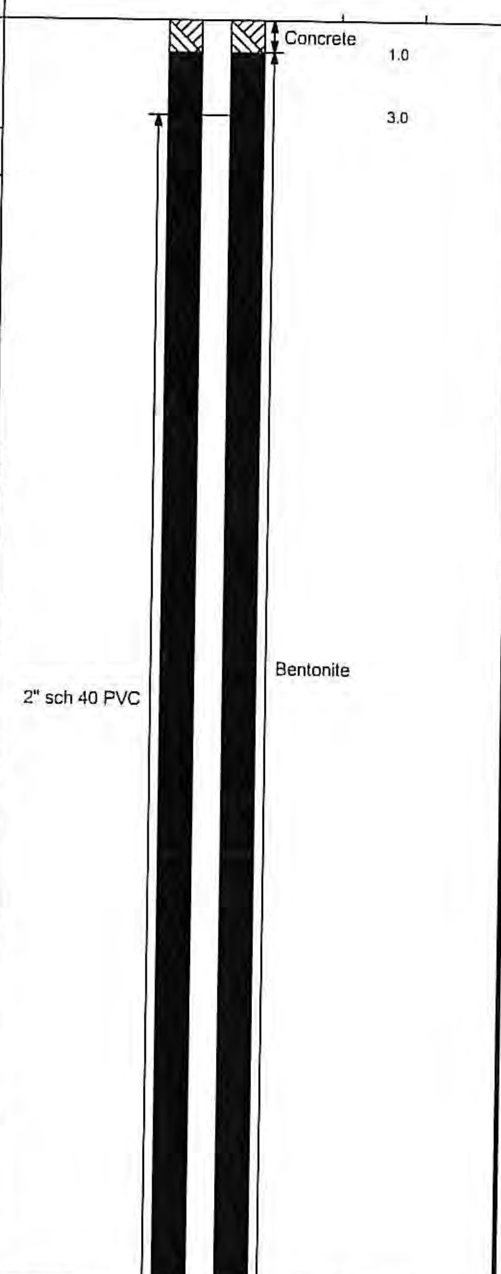
Datum msl

Completion Date: 7/15/10

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Stiff, black ASH		
5		2-3-7	SS1
5	Soft to very soft, black and gray ASH		
10		0-0-1	SS2
15		0-1-1	SS3
20		0-0-1	SS4
25		0-1-2	SS5
25	Soft, black and gray ASH		
30 (∇)		1-1-3	SS6
35		0-1-2	SS7
40		0-0-1	SS8

WELL DIAGRAM

Flushmount



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 30 FEET ∇

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by:	App'vd. by:
Date: 8/13/10	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Duck Creek, Illinois

LOG OF BORING: OM-27

Project No. J017150.01

Surface Elevation: ______

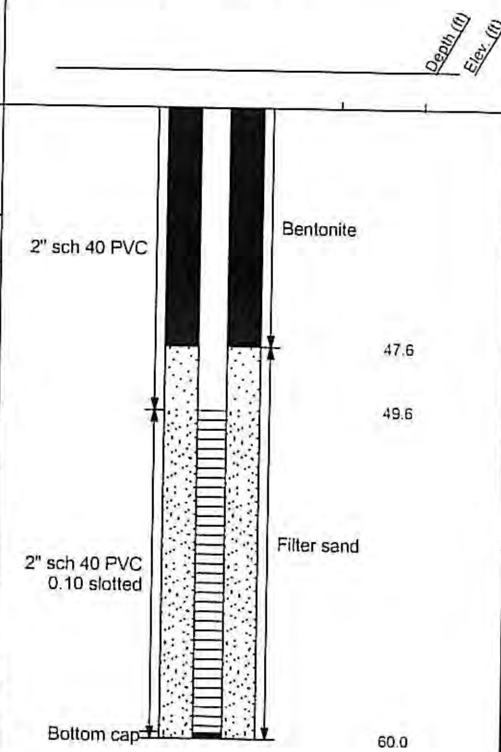
Datum msl

Completion Date: 7/15/10

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Soft, gray ASH			
45			0-0-2	SS9
50			0-0-3	SS10
55			0-0-2	SS11
	Very soft, gray and black ASH with brown, silty CLAY			
60			0-0-1	SS12
	Very stiff, brown and tan, silty CLAY - CL			ST13
65			3-8-12	SS14
	Boring terminated at 65 feet.			
70				
75				

WELL DIAGRAM

Flushmount



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 30 FEET ∇

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by:	App'vd. by:
Date: 8/13/10	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Duck Creek, Illinois

CONTINUATION OF
LOG OF BORING: OM-27

Project No. J017150.01

LOG OF BORING 2002 WL J01750.01 - DUCK CREEK.GPJ GTINC 0538301.GPJ 11/3/10

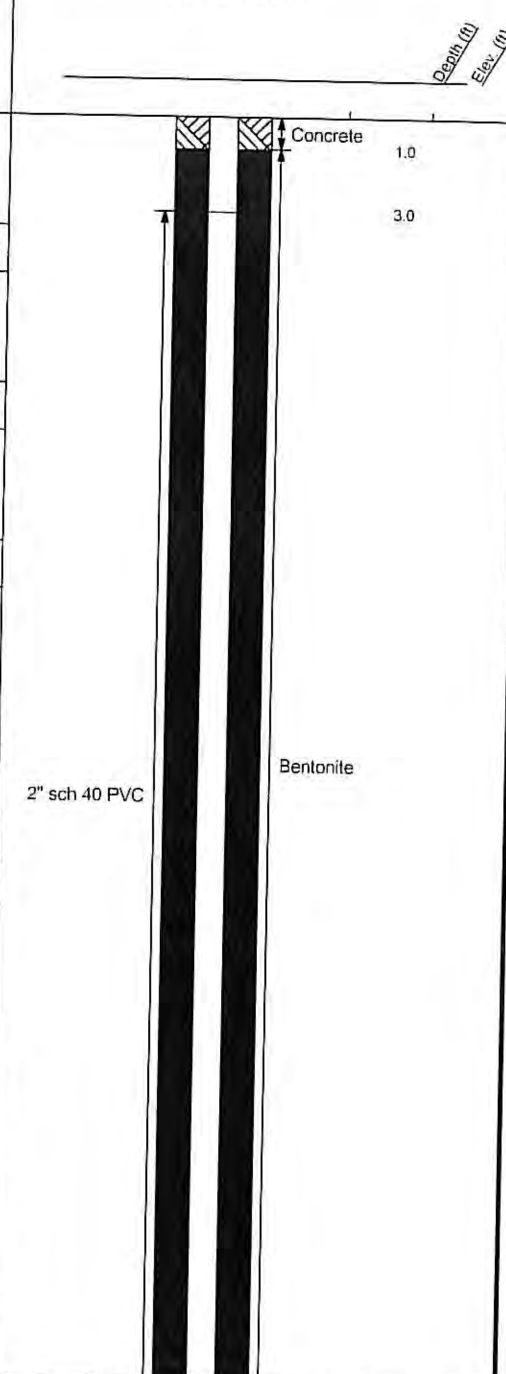
Surface Elevation: ______ Completion Date: 7/16/10

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Soft to medium stiff, black ASH			
5			1-2-2	SS1
10			1-4-3	SS2
15			0-2-1	SS3
20			5-7-8	SS4
25			1-3-3	SS5
25	Very stiff to hard, black ASH			
30			4-7-10	SS6
35			15-20-16	SS7
35	Soft to very soft, black and gray ASH			
40			0-1-1	SS8

WELL DIAGRAM

Flushmount



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 40 FEET ∇

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by:	App'vd. by:
Date: 8/13/10	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Duck Creek, Illinois

LOG OF BORING: OM-28

Project No. J017150.01

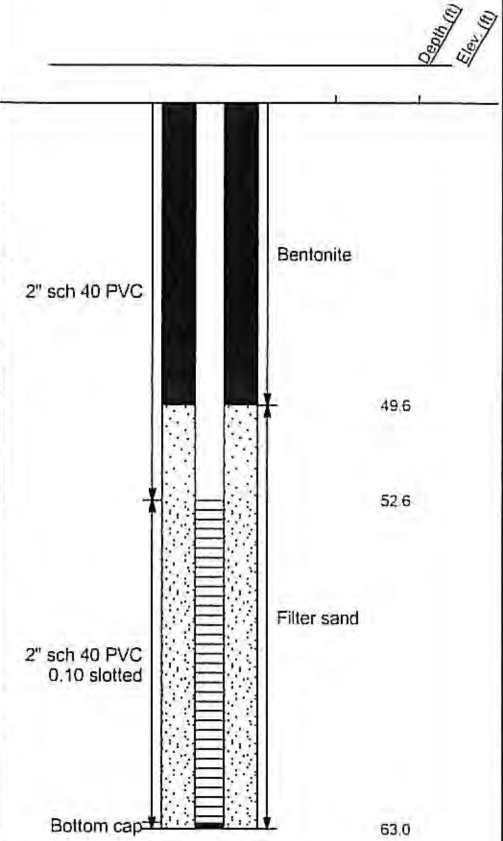
Surface Elevation: ______ Datum msl

Completion Date: 7/16/10

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Soft to very soft, black and gray ASH *(continued)*		
45		0-1-1	SS9
50		1-1-2	SS10
55		0-0-1	SS11
60		0-0-1	SS12
60	Very stiff, brown, silty CLAY - CL		
65		6-11-15	ST13
	Medium stiff, brown, silty CLAY - CL		SS14
70		1-2-5	SS15
70	Boring terminated at 70 feet.		
75			

WELL DIAGRAM

Flushmount



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 40 FEET ∇

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by:	App'vd. by:
Date: 8/13/10	Date:	Date:

GEOTECHNOLOGY INC FROM THE GROUND UP

Ameren Power Plant
Duck Creek, Illinois

CONTINUATION OF
LOG OF BORING: OM-28

Project No. J017150.01

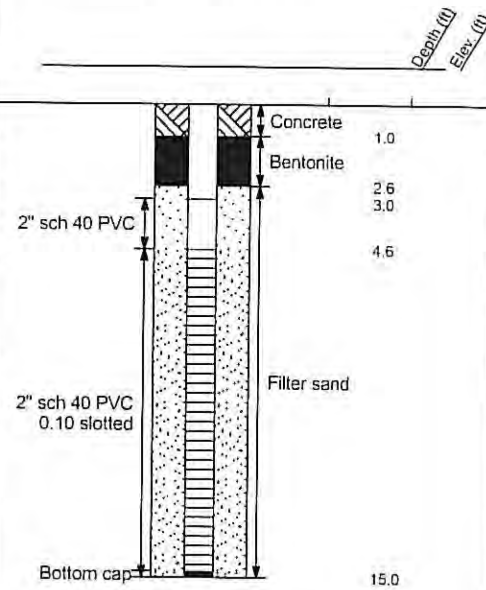
Surface Elevation: ______ Datum msl

Completion Date: 7/13/10

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	FILL: silty clay, some ash			
			1-3-5	SS1
			3-3-5	SS2
5				
	Black, clayey ASH			ST3
10	Medium stiff, gray, silty CLAY - CL			
			2-3-5	SS4
15	Boring terminated at 15 feet.			
20				
25				
30				
35				

WELL DIAGRAM

Flushmount



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

LOG OF BORING 2002 WL J01750.01 - DUCK CREEK.GPJ GTINC 0638301.GPJ 11/3/10

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by:	App'vd. by:
Date: 8/13/10	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Duck Creek, Illinois

LOG OF BORING: OM-30

Project No. J017150.01

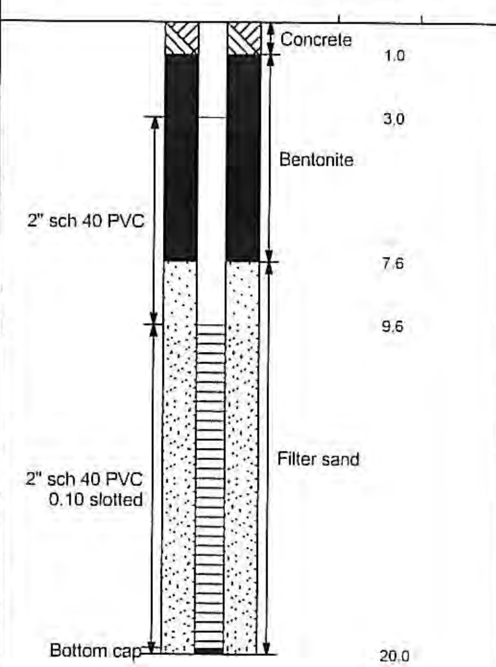
Surface Elevation: ______ Datum msl

Completion Date: 7/15/10

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Stiff to medium stiff, brown, silty CLAY, some fill - CL			
5			3-7-6	SS1
10			3-3-5	SS2
15			3-3-3	SS3
	Tan and gray, silty CLAY - CL			ST4
	Medium stiff, brown, silty CLAY, trace organics - CL			
20			1-2-5	SS5
	Boring terminated at 20 feet.			
25				
30				
35				

WELL DIAGRAM

Flushmount



GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by:	App'vd. by:
Date: 8/13/10	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Duck Creek, Illinois

LOG OF BORING: OM-31

Project No. J017150.01

LOG OF BORING 2002 WL J01750.01 - DUCK CREEK.GPJ GTINC 0638301.GPJ 11/3/10 NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 2/18/2009
Finish: 2/18/2009
WEATHER: cool, overcast, windy, mid-30's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM50a
Well ID: OM50S
Surface Elev: 601.2 ft. MSL
Completion: 18.4 ft. BGS
Station: 13,557.77N
-6,682.00E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 14, **Tier** 6N.; **Range** 5E.

WATER LEVEL INFORMATION:
▼ = 10.30 - during drilling
▼ =
▽ =

SAMPLE			TESTING								
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark gray (10YR4/1), moist, firm, clayey SILT with trace sand and gravel.			
							2	Yellowish brown (10YR5/6), moist, hard, clayey SILT with trace sand and slight trace gravel.		600	
							4	Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		598	
							6	Light brownish gray (10YR6/2) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		596	
							8	Dark yellowish brown (10YR4/6) with 10% light brownish gray (10YR6/2) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		594	
							▼ 10	Yellowish brown (10YR5/6), moist, very soft, silty CLAY with slight trace sand and gravel.		592	
							12	Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, wet, soft, clayey SILT.		590	
							14	Dark yellowish brown (10YR4/6), very moist, medium dense, silty, fine- to coarse-grained SAND with slight trace gravel.		588	
								Grayish brown (10YR5/2) with 20% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		586	
							16, 18	Gray (10YR5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		584	

EOB = 18.44 ft bgs

NOTE(S): OM50S was installed within 5' of OM50D. See OM50D boring log for sample and testing data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 2/17/2009
Finish: 2/18/2009
WEATHER: cool, overcast, windy, mid-30's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM50
Well ID: OM50D
Surface Elev: 601.2 ft. MSL
Completion: 46.6 ft. BGS
Station: 13,557.44N
-6,685.64E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 14, **Tier** 6N.; **Range** 5E.

WATER LEVEL INFORMATION:
▼ = 10.30 - during drilling
▼ =
▽ =

Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
							0	Dark gray (10YR4/1), moist, firm, clayey SILT with trace sand and gravel.		
1A	14/24 *58%*	SS	*5-6 11-13* N=17	6				Yellowish brown (10YR5/6), moist, hard, clayey SILT with trace sand and slight trace gravel.	600	
2A	17/24 *71%*	SS	*7-40 21-6* N=61	7			2			
								Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.	598	
3A	19/24 *79%*	SS	*3-2 3-3* N=5	23			4	Light brownish gray (10YR6/2) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.	596	
4A	20/24 *83%*	SS	*4-5 4-6* N=9	21			6			
4B				24				Dark yellowish brown (10YR4/6) with 10% light brownish gray (10YR6/2) mottles, moist, soft, silty CLAY with slight trace sand and gravel.	594	
5A	17/24 *71%*	SS	*6-2 2-1* N=4	20			8	Yellowish brown (10YR5/6), moist, very soft, silty CLAY with slight trace sand and gravel.	592	
6A	19/24 *79%*	SS	*0-1 3-4* N=4	25			10 ▼	Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, wet, soft, clayey SILT.	590	
7A	22/24 *92%*	SS	*5-5 12-12* N=17	25			12			
7B				15				Dark yellowish brown (10YR4/6), very moist, medium dense, silty, fine- to coarse-grained SAND with slight trace gravel.	588	
8A	19/24 *79%*	SS	*5-7 12-13* N=19	12			14	Grayish brown (10YR5/2) with 20% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.	586	
9A	20/24 *83%*	SS	*10-17 14-18* N=31	10			16	Gray (10YR5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.	584	
10A	19/24 *79%*	SS	*4-6 12-13* N=18	12			18	Yellowish brown (10YR5/4), very moist, medium dense, silty, fine- to coarse-grained SAND.	582	
							20			

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 2/17/2009
Finish: 2/18/2009
WEATHER: cool, overcast, windy, mid-30's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM50
Well ID: OM50D
Surface Elev: 601.2 ft. MSL
Completion: 46.6 ft. BGS
Station: 13,557.44N
-6,685.64E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 14, **Tier** 6N.; **Range** 5E.

WATER LEVEL INFORMATION:
▼ = 10.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type
11A	23/24 96%	SS	4-7 11-8 N=18	10		
12A	24/24 100%	SS	8-16 16-16 N=32	10		
13A	20/24 83%	SS	3-6 6-13 N=12	19		
14A	18/24 75%	SS	14-17 19-50 N=36	17		
15A	18/24 75%	SS	17-13 21-23 N=34	16		
16A	19/24 79%	SS	3-12 19-33 N=31	20		
17A	20/22 91%	SS	18-20 35-50/4" N=55	19		
18A	20/22 91%	SS	15-22 50-50/4" N=72	13		
19A	2/1 200%	SS	50/1"	14		
20A	10/9 111%	SS	33-50/3"	20		

Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
20–24.8	Grayish brown (10YR5/2) with 20% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel. *[Continued from previous page]*	580, 578	
24.8–26.4	Gray (N5/1), slightly moist, hard, clayey SILT.	576	
26.4–30.2	Gray (N6/1), slightly moist, very hard, SHALE.	574, 572	Trace coal fragments.
30.2–32	Gray (N5/1) with very dark gray (N3/1) laminae, slightly moist, hard, SHALE.	570	
32–34	Gray (N5/1), slightly moist, hard, SHALE.	568	
34–38	Gray (N6/1), slightly moist, hard, SHALE.	566, 564	
38–40	Dark gray (N4/1), dry, very hard, SHALE.	562	

Depth scale: 22, 24, 26, 28, 30, 32, 34, 36, 38, 40

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 2/17/2009
Finish: 2/18/2009
WEATHER: cool, overcast, windy, mid-30's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM50
Well ID: OM50D
Surface Elev: 601.2 ft. MSL
Completion: 46.6 ft. BGS
Station: 13,557.44N
-6,685.64E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 14, **Tier** 6N.; **Range** 5E.

WATER LEVEL INFORMATION:
▼ = 10.30 - during drilling
▼ =
▽ =

SAMPLE			TESTING									
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
21A	8/8 *100%*	SS	*49-50/2"*	7				Dark gray (N4/1), dry, very hard, SHALE. *[Continued from previous page]*		560	
22A	9/9 *100%*	SS	*10-50/3"*	8			42			558	
23A	8/8 *100%*	SS	*39-50/2"*	13			44			556	
24A	7/7 *100%*	SS	*49-50/1"*	7			46	Gray (N6/1), dry, very hard, SHALE.			

EOB = 46.6 ft bgs

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 3/16/2009
Finish: 3/16/2009
WEATHER: sunny, mild, 50's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM51
Well ID: N/A
Surface Elev: 583.8 ft. MSL
Completion: 59.7 ft. BGS
Station: N
E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 31, **Tier** 6N.; **Range** 5E.

WATER LEVEL INFORMATION:
▼ = 36.00 - during drilling
▼ =
▽ =

SAMPLE			TESTING			
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*
	22/24 *92%*	SS	*3-4 5-5* N=9			
1B				24		
2A	20/24 *83%*	SS	*2-4 4-6* N=8	21		
2B				23		
3A	18/24 *75%*	SS	*3-6 6-8* N=12	22		
4A	24/24 *100%*	SS	*7-7 8-7* N=15	22		
5A	23/24 *96%*	SS	*2-1 2-3* N=3	23		
5B				24		
5C				25		
6A	16/24 *67%*	SS	*woh-1 2-2* N=3	24		
7A	24/24 *100%*	SS	*4-4 5-4* N=9	27		
8A	20/24 *83%*	SS	*1-1 2-2* N=3	32		
8B				42		
9A				29		
9B	24/24 *100%*	SS	*3-3 4-5* N=7	26		
10A	22/24 *92%*	SS	*woh-2 2-3* N=4	24		
10B				30		

Depth ft. BGS / Lithologic Description / Borehole Detail / Elevation ft. MSL / Remarks

Dark yellowish brown (10YR4/6), moist, soft, silty CLAY with slight trace sand and roots.

Dark grayish brown (10YR4/2) with 20% yellowish brown (10YR5/6) mottles, moist, firm, silty CLAY with slight trace sand and roots.

Dark grayish brown (10YR4/2) with 30% very dark greenish gray (5BG3/1) mottles, moist, firm, silty CLAY.

Dark yellowish brown (10YR4/4), very moist, soft, clayey SILT with slight trace sand.

Very dark greenish gray (5BG3/1) with very dark gray (N3/1) mottles, moist, firm, silty CLAY.

Brown (10YR4/3), moist, soft, clayey SILT with slight trace sand.

Gray (N5/1), very moist, soft, silty CLAY with very dark gray (10YR3/1) peat.

Very dark gray (N3/1) with 30% dark greenish gray (5BG4/1) mottles, moist, soft, silty CLAY.

Very dark gray (N3/1) with 20% yellowish brown (10YR5/6) mottles, moist, very soft, clayey SILT with slight trace sand.

Black (10YR2/1) moist, soft, clayey SILT with organics (peat).

Greenish gray (5BG5/1), moist, soft, silty CLAY.

Very dark gray (N3/1) with 30% yellowish brown (10YR5/6) mottles, very moist to wet, soft, clayey SILT with slight trace sand.

Greenish gray (5BG5/1), moist, soft, silty CLAY.

Very dark gray (10YR3/1) with 10% yellowish brown (10YR5/6) mottles, moist, soft, clayey SILT with slight trace sand.

Depth ft. BGS	Elevation ft. MSL
2	582
4	580
6	578
8	576
10	574
12	572
14	570
16	568
18	566
20	564

NOTE(S): Borehole was abandoned using bentonite grout.

FIELD BORING LOG

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 3/16/2009
Finish: 3/16/2009
WEATHER: sunny, mild, 50's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

HANSON

BOREHOLE ID: OM51
Well ID: N/A
Surface Elev: 583.8 ft. MSL
Completion: 59.7 ft. BGS
Station: N
E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 31, **Tier** 6N.; **Range** 5E.

WATER LEVEL INFORMATION:
▼ = 36.00 - during drilling
▼ =
▽ =

Number	Recov / Total (in) % Recovery	Type	Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	18/24 75%	SS	1-1 2-3 N=3	31				Very dark gray (10YR3/1) with 10% yellowish brown (10YR5/6) mottles, moist, soft, clayey SILT with slight trace sand. *[Continued from previous page]*			
							22			562	
12A	24/24 100%	SS	2-2 3-4 N=5	34			24	Very dark gray (10YR3/1) with 25% yellowish brown (10YR5/6) and 5% greenish gray (5BG5/1) mottles, moist, soft, clayey SILT with slight trace sand and some intermittent very dark grayish brown (10YR3/2) peat.		560	
13A	23/24 96%	SS	2-2 4-5 N=6	30							
13B				24			26	Greenish gray (5BG5/1) with 10% very dark gray (N3/1) mottles, moist, firm, silty CLAY.		558	
14A	24/24 100%	SS	2-2 3-5 N=5	33			28	Very dark gray (10YR3/1) with 30% yellowish brown (10YR5/6) and 10% very dark gray (N3/1) mottles, very moist, soft, clayey SILT with slight trace sand and some intermittent very dark grayish brown (10YR3/2) peat.		556	
15A	24/24 100%	SS	1-1 2-4 N=3	44							
15B				30			30			554	
16A	22/24 92%	SS	2-2 3-3 N=5	21			32	Greenish gray (5BG5/1) with 10% very dark grayish brown (10YR3/2) peat, moist, firm, silty CLAY with sand.		552	
17A	24/24 100%	SS	6-7 8-11 N=15	23							
17B				18			34	Gray (N5/1), wet, firm, silty CLAY with coal and some shale fragments.		550	
18A				17				Gray (N6/1), dry, hard, SHALE.			
18B	18/24 75%	SS	2-3 12-7 N=15	19				Gray (N6/1) with black (N2.5/1) coal fragments, wet, hard, broken SHALE and coal.			
							▼ 36			548	
19A	24/24 100%	SS	15-34 25-32 N=59	13			38	Gray (N5/1), moist, hard, SHALE.		546	
								Gray (N6/1), SANDSTONE.			
20A	12/24 50%	SS	1-3 5-3 N=8	24			40	Gray (N6/1), moist, soft, SHALE.		544	

NOTE(S): Borehole was abandoned using bentonite grout.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 3/16/2009
Finish: 3/16/2009
WEATHER: sunny, mild, 50's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM51
Well ID: N/A
Surface Elev: 583.8 ft. MSL
Completion: 59.7 ft. BGS
Station: N
E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 31, **Tier** 6N.; **Range** 5E.

WATER LEVEL INFORMATION:
▼ = 36.00 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type
21A	11/24 46%	SS	2-2 4-4 N=6	17		
22A	5/5 100%	SS	50/5"	15		
23A	18/24 75%	SS	11-6 5-7 N=11	16		
24A	14/24 58%	SS	3-3 4-5 N=7	16		
25A	18/24 75%	SS	4-5 4-8 N=9	13		
26A	14/24 58%	SS	2-4 6-8 N=10	24		
27A	20/24 83%	SS	4-6 4-3 N=10	26		
28A	16/24 67%	SS	10-10 7-22 N=17	14		
29A	17/24 71%	SS	44-11 17-27 N=28	13		
30A	18/24 75%	SS	5-14 8-14 N=22	20		
30B				21		

Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
42	Gray (N6/1), wet, soft, weathered SHALE and sandstone fragments.	542	
44	Gray (N6/1), very moist, firm, weathered SHALE with slight trace sand.	540	
46	Light yellowish brown (2.5Y6/3), very moist, soft, clayey SILT with trace sand.	538	
	Gray (N6/1), SHALE.		
48	Light yellowish brown (2.5Y6/3), very moist to wet, soft, clayey SILT with trace sand.	536	
	Gray (N6/1), wet, hard, SANDSTONE.		
50	Gray (N6/1), wet, soft, weathered, sandy SHALE.	534	
52	Light yellowish brown (2.5Y6/3) with 30% gray (N6/1) mottles, wet, soft, clayey SILT with trace sand and sandstone fragments.	532	
54		530	
56	Gray (N6/1), moist, hard, micaceous SHALE.	528	
58	Gray (N5/1), moist, hard, SHALE with trace sand.	526	
	Gray (N6/1), moist, hard, micaceous SANDSTONE.		
	Gray (N5/1), moist, hard, weathered SHALE.		
	EOB = 59.7 ft bgs		

NOTE(S): Borehole was abandoned using bentonite grout.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 3/16/2009
Finish: 3/16/2009
WEATHER: sunny, mild, 50's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM51b
Well ID: OM51S
Surface Elev: 583.8 ft. MSL
Completion: 22.2 ft. BGS
Station: -4,231.82N
-488.56E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 31, Tier 6N.; Range 5E.

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

Number	Recov / Total (in) % Recovery	Type	Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark yellowish brown (10YR4/6), moist, soft, silty CLAY with slight trace sand and roots.			
							2	Dark grayish brown (10YR4/2) with 20% yellowish brown (10YR5/6) mottles, moist, firm, silty CLAY with slight trace sand and roots.		582	
								Dark grayish brown (10YR4/2) with 30% very dark greenish gray (5BG3/1) mottles, moist, firm, silty CLAY.			
							4	Dark yellowish brown (10YR4/4), very moist, soft, clayey SILT with slight trace sand.		580	
							6			578	
							8	Very dark greenish gray (5BG3/1) with very dark gray (N3/1) mottles, moist, firm, silty CLAY.		576	
								Brown (10YR4/3), moist, soft, clayey SILT with slight trace sand.			
							10	Gray (N5/1), very moist, soft, silty CLAY with very dark gray (10YR3/1) peat.		574	
								Very dark gray (N3/1) with 30% dark greenish gray (5BG4/1) mottles, moist, soft, silty CLAY.			
							12	Very dark gray (N3/1) with 20% yellowish brown (10YR5/6) mottles, moist, very soft, clayey SILT with slight trace sand.		572	
							14			570	
								Black (10YR2/1) moist, soft, clayey SILT with organics (peat).			
							16	Greenish gray (5BG5/1), moist, soft, silty CLAY.		568	
								Very dark gray (N3/1) with 30% yellowish brown (10YR5/6) mottles, very moist to wet, soft, clayey SILT with slight trace sand.			
							18	Greenish gray (5BG5/1), moist, soft, silty CLAY.		566	
								Very dark gray (10YR3/1) with 10% yellowish brown (10YR5/6) mottles, moist, soft, clayey SILT with slight trace sand.			
							20			564	

NOTE(S): OM51S was installed within 5' of boring OM51. See OM51 boring log for sample and testing data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 3/16/2009
Finish: 3/16/2009
WEATHER: sunny, mild, 50's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM51b
Well ID: OM51S
Surface Elev: 583.8 ft. MSL
Completion: 22.2 ft. BGS
Station: -4,231.82N
-488.56E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 31, Tier 6N.; Range 5E.

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

SAMPLE			TESTING									
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Very dark gray (10YR3/1) with 10% yellowish brown (10YR5/6) mottles, moist, soft, clayey SILT with slight trace sand. *[Continued from previous page]*			
							22	Very dark gray (10YR3/1) with 25% yellowish brown (10YR5/6) and 5% greenish gray (5BG5/1) mottles, moist, soft, clayey SILT with slight trace sand and some intermittent very dark grayish brown (10YR3/2) peat.		562	

EOB = 22.18 ft bgs

NOTE(S): OM51S was installed within 5' of boring OM51. See OM51 boring log for sample and testing data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 3/16/2009
Finish: 3/17/2009
WEATHER: sunny, mild, 50's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM51a
Well ID: OM51D
Surface Elev: 583.8 ft. MSL
Completion: 47.5 ft. BGS
Station: -4,226.56N
-488.40E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 31, Tier 6N.; Range 5E.

WATER LEVEL INFORMATION:
▼ = 36.00 - during drilling
▼ =
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark yellowish brown (10YR4/6), moist, soft, silty CLAY with slight trace sand and roots.			
							2	Dark grayish brown (10YR4/2) with 20% yellowish brown (10YR5/6) mottles, moist, firm, silty CLAY with slight trace sand and roots.		582	
								Dark grayish brown (10YR4/2) with 30% very dark greenish gray (5BG3/1) mottles, moist, firm, silty CLAY.			
							4	Dark yellowish brown (10YR4/4), very moist, soft, clayey SILT with slight trace sand.		580	
							6			578	
							8	Very dark greenish gray (5BG3/1) with very dark gray (N3/1) mottles, moist, firm, silty CLAY.		576	
								Brown (10YR4/3), moist, soft, clayey SILT with slight trace sand.			
							10	Gray (N5/1), very moist, soft, silty CLAY with very dark gray (10YR3/1) peat.		574	
								Very dark gray (N3/1) with 30% dark greenish gray (5BG4/1) mottles, moist, soft, silty CLAY.			
							12	Very dark gray (N3/1) with 20% yellowish brown (10YR5/6) mottles, moist, very soft, clayey SILT with slight trace sand.		572	
							14			570	
								Black (10YR2/1) moist, soft, clayey SILT with organics (peat).			
							16	Greenish gray (5BG5/1), moist, soft, silty CLAY.		568	
								Very dark gray (N3/1) with 30% yellowish brown (10YR5/6) mottles, very moist to wet, soft, clayey SILT with slight trace sand.			
							18	Greenish gray (5BG5/1), moist, soft, silty CLAY.		566	
								Very dark gray (10YR3/1) with 10% yellowish brown (10YR5/6) mottles, moist, soft, clayey SILT with slight trace sand.			
							20			564	

NOTE(S): OM51D was installed within 5' of boring OM51. See OM51 boring log for sample and testing data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 3/16/2009
Finish: 3/17/2009
WEATHER: sunny, mild, 50's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM51a
Well ID: OM51D
Surface Elev: 583.8 ft. MSL
Completion: 47.5 ft. BGS
Station: -4,226.56N -488.40E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 31, **Tier** 6N.; **Range** 5E.

WATER LEVEL INFORMATION:
▼ = 36.00 - during drilling
▼ =
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							to 22	Very dark gray (10YR3/1) with 10% yellowish brown (10YR5/6) mottles, moist, soft, clayey SILT with slight trace sand. *[Continued from previous page]*		562	
							22–25.8	Very dark gray (10YR3/1) with 25% yellowish brown (10YR5/6) and 5% greenish gray (5BG5/1) mottles, moist, soft, clayey SILT with slight trace sand and some intermittent very dark grayish brown (10YR3/2) peat.		560	
							25.8–26.5	Greenish gray (5BG5/1) with 10% very dark gray (N3/1) mottles, moist, firm, silty CLAY.		558	
							26.5–29.3	Very dark gray (10YR3/1) with 30% yellowish brown (10YR5/6) and 10% very dark gray (N3/1) mottles, very moist, soft, clayey SILT with slight trace sand and some intermittent very dark grayish brown (10YR3/2) peat.		556	
							29.3–33.2	Greenish gray (5BG5/1) with 10% very dark grayish brown (10YR3/2) peat, moist, firm, silty CLAY with sand.		554, 552	
							33.2–34.6	Gray (N5/1), wet, firm, silty CLAY with coal and some shale fragments.		550	
							34.6–35.1	Gray (N6/1), dry, hard, SHALE.			
							35.1–36	Gray (N6/1) with black (N2.5/1) coal fragments, wet, hard, broken SHALE and coal.		548	
							36–38.2	Gray (N5/1), moist, hard, weathered SHALE.		546	
							38.2–38.5	Gray (N6/1), SANDSTONE.			
							38.5–40	Gray (N6/1), moist, soft, weathered SHALE.		544	

NOTE(S): OM51D was installed within 5' of boring OM51. See OM51 boring log for sample and testing data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 3/16/2009
Finish: 3/17/2009
WEATHER: sunny, mild, 50's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM51a
Well ID: OM51D
Surface Elev: 583.8 ft. MSL
Completion: 47.5 ft. BGS
Station: -4,226.56N
-488.40E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 31, Tier 6N.; Range 5E.

WATER LEVEL INFORMATION:
▼ = 36.00 - during drilling
▼ =
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							42	Gray (N6/1), wet, soft, weathered SHALE and sandstone fragments.		542	
							44	Gray (N6/1), very moist, firm, weathered SHALE with slight trace sand.		540	
							46	Light yellowish brown (2.5Y6/3), very moist, soft, clayey SILT with trace sand.		538	
								Gray (N6/1), weathered SHALE.			

EOB = 47.47 ft bgs

NOTE(S): OM51D was installed within 5' of boring OM51. See OM51 boring log for sample and testing data.

APPENDIX E

GROUNDWATER ELEVATION DATA – 2014, 2015

Appendix E
Groundwater Elevation Data – 2014, 2015
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well ID	Well Location		Well Elevations		Groundwater Elevations			
	East (Apr 08)	North (Apr 08)	Gnd_Elev (Apr 08)	Pipe_Elev (Apr 08)	24-Apr-14	18-Jul-14	17-Apr-15	15-Sep-15
OM01	288.1	5259.0	593.30	595.61	582.90	585.05	583.57	583.86
OR02	130.6	7475.6	599.19	601.41	595.49	595.60	595.54	594.98
OR03D	85.6	9286.1	623.72	627.13	581.62	581.57	581.41	582.69
OR03S	82.3	9283.0	623.69	627.16	581.49	581.54	581.61	582.46
OM04S	1224.8	9551.1	604.81	607.35	590.64	588.96	589.23	588.30
OR04D	1229.1	9548.7	604.80	607.58	586.73	586.63	586.58	586.97
OR05D	1675.1	6766.3	607.91	610.96	593.24	593.08	592.96	593.32
OM05S	1679.1	6768.3	607.91	610.76	591.85	592.28	592.62	593.41
OR06A	1635.8	4917.2	591.62	595.31	588.26	578.53	579.00	578.74
OM07	1647.1	4157.2	594.38	596.46	581.46	582.32	583.40	584.54
OM08	1936.7	2579.0	599.11	601.74	586.89	580.59	587.41	587.14
OM09	77.8	1906.6	590.16	591.61	585.19		587.04	585.75
OM10	4875.2	6221.4	584.09	585.11	576.56		578.95	579.56
OR11	3059.0	5448.4	593.64	596.55	566.05	567.71	566.01	566.25
OM12	3052.2	3927.0	592.78	595.37	579.50	580.64	583.77	583.37
OR13D	1749.7	6840.3	595.75	602.70	593.32	593.17	593.72	593.97
OR13S	1749.6	6834.3	595.75	602.71	591.63	591.20	591.71	590.78
OR14D	1759.9	7356.5	596.22	598.91	590.46	590.26	592.30	589.66
OR14S	1760.0	7350.8	596.22	599.26	593.06	592.83	591.28	591.81
OM15	3011.1	6227.4	596.00	598.05	577.73	578.25	579.74	580.17
OM16	3518.2	9228.9	605.36	607.93	580.76	582.29	586.75	585.90
OM17	4301.7	8291.8	589.30	592.13	580.76	580.40	582.77	583.19
OR18	1979.0	8543.8	611.56	613.85	597.87	598.22	601.11	602.21
OR19	2725.2	4045.0	595.69	597.80	572.96	574.81	576.33	577.81
OR20	2926.8	5346.4	584.63	587.72	565.87	566.74	566.49	566.63
OM21	1567.7	8565.7	604.15	606.60	598.29	597.52	599.47	596.77
OM22D	-126.95	3991.5	597.07	598.87	579.73	581.13	579.91	581.38
OM22S	-127.08	3994.82	596.76	599.22	579.70	581.18	579.89	580.60
OM23D	-371.63	5591.13	610.4	613.25	574.91	576.01	575.23	576.99
OM23S	-371.66	5585.76	610.41	613.14	571.69	572.23	571.48	571.08
OM24D	-341.39	7523.62	573.90	576.79	574.08	573.66	574.17	573.39
OM25D	-321.61	8616.31	627.14	629.19	571.44	571.66	571.29	573.69
OM25S	-321.35	8620.05	627.02	629.11	571.40	571.52	571.18	571.00

APPENDIX F

GROUNDWATER SAMPLING PROTOCOL

GROUNDWATER SAMPLING PROTOCOL
ASH PONDS 1 AND 2 CLOSURE
DUCK CREEK POWER STATION

1.0 SAMPLING PROTOCOL

These procedures will be used during routine groundwater sampling at the above referenced facility. A worksheet will be used for recording relevant information regarding each monitoring well and will be submitted to the facility for their records.

If conditions at the time of groundwater sampling could influence the results, groundwater sampling will be postponed until a later date. However, sample collection will not deviate from the schedule provided in the site-specific Groundwater Monitoring Plan.

2.0 WATER LEVELS

Groundwater elevations shall be obtained in each monitoring well prior to purging and/or sampling. Groundwater elevations in the monitoring well will be obtained as close together of a timeframe as practical, to reduce time distortion of the water surface data. Groundwater elevation procedures follow:

1. Record the general monitoring well condition. This includes the condition of the casing, the lock, evidence of tampering, condition of the concrete pad, and any standing water.

2. Remove the lock and open the well. Note the condition of the interior of the casing and the condition of the well cap and riser. Open the cap, taking care not to allow dirt or foreign material into the well.

3. Decontaminate the water level indicator.

4. Slowly lower the water level indicator into the well until the water surface has been reached.

5. Record the time and depth to water (to the nearest 0.01 foot).

6. Lower the water level indicator to the bottom of the monitoring well. If a dedicated pump is installed in the well, perform this step during regularly scheduled maintenance of the monitoring wells. Record the depth of the monitoring well (to the nearest 0.01 foot). Monitoring well depth will be

measured on an annual basis at wells that do not contain dedicated pumps and once every five years for monitoring wells with dedicated pumps.

7. Slowly remove the water level indicator from the well.

8. Replace the cap. Close and lock the well.

3.0 LOW-FLOW PURGING

This facility uses low-flow sampling techniques to obtain groundwater samples from the monitoring well network. Each monitoring well will be purged using a dedicated pump prior to groundwater sample collection. The pumps will consist of inert materials consistent with the monitoring well construction (e.g., stainless steel pump bodies installed in stainless steel wells). Groundwater sampling will begin with the monitoring wells that have not been historically impacted before sampling impacted monitoring wells.

Each monitoring well will be purged prior to groundwater sampling. Flow rates for low-flow sampling typically are below 0.5 liters/minute, with a goal of less than 0.3 feet reduction in groundwater elevation. These goals may not be practical based on the hydrogeology at the facility.

Purging will continue until the measured pH, temperature, and specific conductance stabilize within ±10 percent over three consecutive readings. The equipment used to measure these indicator parameters will be calibrated daily and decontaminated before use at each monitoring well. If low-flow stabilization does not occur, four well volumes will be removed prior to sampling. Field indicator parameters used for stabilization will be recorded.

4.0 LOW-FLOW SAMPLING

Establish a “clean area” near the monitoring well where the sample containers and equipment can be stored while not in use. Sampling equipment and containers should not contact the ground surface. If needed, a disposable plastic tarp can be used as ground cover.

One blind duplicate and one equipment blank sample will be collected and analyzed for each day of sampling. If dedicated sampling equipment is used, then equipment blank samples will not be collected.

Groundwater samples will be field-filtered (using a new 0.45 micron disposable filter for each monitoring well); and the groundwater sample will be collected in laboratory-provided sampling containers with preservatives as required by the USEPA. All groundwater samples will be labeled, packed to reduce the chance of breakage, and placed in a cooler with ice to maintain a temperature of less than 4º Celsius during transport to the analytical laboratory.

The samples will be accompanied by a chain-of-custody record. The sampler retains a copy of the record and forwards the original with the samples to the analytical laboratory. Once the laboratory has received the samples, a representative from the laboratory will complete the record, retain the original, and return a copy with the chemical analysis reports to the sampler. The chain-of-custody contains the facility name, the wells sampled, time and date of sampling, members of sampling party, type of samples, number of sample bottles, and requested analyses.

ATTACHMENT I

ENVIRONMENT
& HEALTH

Illinois Power Resources Generating, LLC
17751 North Cilco Rd
Canton, IL 61520

Groundwater Monitoring Plan Addendum for Ash Pond No. 1 and Ash Pond No. 2
Duck Creek Power Plant, Canton, IL

October 25, 2021

Ramboll
234 W. Florida Street
Fifth Floor
Milwaukee, WI 53204
USA

T 414-837-3607
F 414-837-3608
www.ramboll.com

Ref. 1940100806-003

Ramboll Americas Engineering Solutions, Inc. (Ramboll) is providing the attached Addendum to the Groundwater Monitoring Plan (GMP) for inclusion in the Operating Permit Applications as required under Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.230 and allowed under 35 I.A.C. § 845.210(d)(1). The GMP was previously submitted to and approved by Illinois Environmental Protection Agency (IEPA) as part of the *Closure and Post-Closure Care Plan for Ash Ponds Nos. 1 and 2* (Closure Plan; AECOM, 2016) submitted for the Duck Creek Power Plant (DCPP) Ash Pond No. 1 (AP1; Vistra Identification [ID] Number [No.] 201, IEPA ID No. W0578010001-01, and National Inventory of Dams [NID] No. IL50715) and Ash Pond No. 2 (AP2; Vistra ID No. 202, IEPA ID No. W0578010001-02, and NID No. IL50014).

The Addendum to the DCPP AP1 and AP2 GMP (Attachment 1), modifies the existing monitoring program and network (Attachment 2) to align with Part 845. Upon issuance of the Operating Permit, groundwater monitoring will be performed as specified in the Addendum.

BACKGROUND

AECOM submitted the Closure Plan for the DCPP AP1 and AP2 on March 2016. Included in Appendix A of that report was the Supplemental Hydrogeologic Site Characterization Study and Groundwater Monitoring Plan. The groundwater monitoring plan defined groundwater monitoring for AP1 and AP2 following approval of the Closure Plan. IEPA provided comments on the Closure Plan in a letter dated August 9, 2016. A response to comment letter submitted by Illinois Power Resources Generating LLC (IPRG) with proposed changes was dated August 12, 2016. Revisions to the Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan were submitted in September 2016 (Attachment 2). The Closure Plan was approved by IEPA in a letter dated November 23, 2016. Closure of AP1 and AP2 was completed on December 22, 2020.

On April 21, 2021, 35 I.A.C. § 845 became effective, and 35 I.A.C. § 845.100(i) provides the following with respect to certain CCR units closed prior to the effective date:

> *i) If a CCR surface impoundment has completed an Agency-approved closure before April 21, 2021, this Part does not require the owner or operator of the CCR surface impoundment to resubmit to the Agency any closure plan, closure report, or closure certification for that completed closure.*

SUBMITTALS

The attached documents are being provided to address requirements of 35 I.A.C. § 845.230 as follows:

- Addendum to the DCPP AP1 and AP2 GMP (new submittal, Attachment 1). This Addendum includes revisions to the monitoring well network, analytical parameters, and statistical procedures included in the previously submitted Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan (Natural Resource Technology, Inc. [NRT], 2016 and revisions dated September 15, 2016). These modifications are proposed to meet and fulfill the requirements in 35 I.A.C. § 845.630 and 35 I.A.C. § 845.640 (Groundwater Monitoring Systems and Statistical Procedures); and 35 I.A.C. § 845.650(b) (background samples). The proposed modifications were identified and developed using existing and previously approved documents, but additional information has been provided where necessary.
- Revisions to the Supplemental Hydrogeologic Report and Groundwater Monitoring Plan (Attachment 2). This attachment provides a copy of the existing groundwater monitoring plan as it was approved by IEPA.

Sincerely,

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ATTACHMENTS:

Attachment 1 Addendum to the Groundwater Monitoring Plan
Attachment 2 Revisions to the Supplemental Hydrogeologic Report and Groundwater Monitoring Plan

ATTACHMENT 1
ADDENDUM TO THE GROUNDWATER MONITORING PLAN

Intended for
Illinois Power Resources Generating, LLC

Date
October 25, 2021

Project No.
1940100806-003

ADDENDUM TO THE GROUNDWATER MONITORING PLAN

ASH POND NO. 1 AND ASH POND NO. 2
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL Bright ideas. Sustainable change.

ADDENDUM TO THE GROUNDWATER MONITORING PLAN DUCK CREEK POWER PLANT ASH POND NO. 1 AND ASH POND NO. 2

Project Name	**Duck Creek Power Plant Ash Pond No. 1 and Ash Pond No. 2**
Project No.	**1940100806-003**
Recipient	**Illinois Power Resources Generating, LLC**
Document Type	**Addendum to the Groundwater Monitoring Plan**
Revision	**FINAL**
Date	**October 25, 2021**

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LICENSED PROFESSIONAL CERTIFICATIONS

35 I.A.C. § 845.630 Groundwater Monitoring Systems (PE)

I, Eric J. Tlachac, a qualified professional engineer in good standing in the State of Illinois, certify that the groundwater monitoring system described in this document (Addendum to the Groundwater Monitoring Plan, Duck Creek Power Plant Ash Pond No. 1 and Ash Pond No. 2), meets the intent of 35 I.A.C. § 845.630. The monitoring system was developed based on information included in the IEPA approved Hydrogeologic Site Characterization Report submitted with the IEPA approved Closure and Post Closure Care Plan.

Eric J. Tlachac
Qualified Professional Engineer
062-063091
Illinois
Date: October 25, 2021

LICENSED PROFESSIONAL ENGINEER
ERIC J. TLACHAC
062-063091
STATE OF ILLINOIS

35 I.A.C. § 845.630 Groundwater Monitoring Systems (PG)

I, Brian G. Hennings, a qualified professional geologist in good standing in the State of Illinois, certify that the groundwater monitoring system described in this document (Addendum to the Groundwater Monitoring Plan, Duck Creek Power Plant Ash Pond No. 1 and Ash Pond No. 2), meets the intent of 35 I.A.C. § 845.630. The monitoring system was developed based on information included in the IEPA approved Hydrogeologic Site Characterization Report submitted with the IEPA approved Closure and Post Closure Care Plan.

Brian G. Hennings
Professional Geologist
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Date: October 25, 2021

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CONTENTS

TABLES (IN TEXT)

TABLES (ATTACHED)

FIGURES (ATTACHED)

APPENDICES

ACRONYMS AND ABBREVIATIONS

§	Section
35 I.A.C.	Title 35 of the Illinois Administrative Code
77 I.A.C.	Title 77 of the Illinois Administrative Code
ASD	Alternate Source Demonstration
AP1	Ash Pond No. 1
AP2	Ash Pond No. 2
bgs	below ground surface
CCR	coal combustion residuals
Closure Plan	*Closure and Post-Closure Care Plan for Ash Ponds Nos. 1 and 2*
DCPP	Duck Creek Power Plant
GMP	Groundwater Monitoring Plan
GWPS	groundwater protection standards
ID	identification
IEPA	Illinois Environmental Protection Agency
IPRG	Illinois Power Resources Generating, LLC
MS	mine spoils
NID	National Inventory of Dams
No.	number
NRT	Natural Resource Technology, Inc.
Part 845	Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845
QA/QC	quality assurance/quality control
Ramboll	Ramboll Americas Engineering Solutions, Inc.
RL	reporting limit
SI	surface impoundment
TDS	total dissolved solids
UA	uppermost aquifer
USEPA	United States Environmental Protection Agency

1. INTRODUCTION

1.1 Overview

In accordance with requirements of the Standards for the Disposal of Coal Combustion Residuals (CCR) in Surface Impoundments (SIs): Title 35 of the Illinois Administrative Code (35 I.A.C.) Section (§) 845 (Part 845) (Illinois Environmental Protection Agency [IEPA], April 15 2021), Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Addendum to the Groundwater Monitoring Plan (GMP) on behalf of Duck Creek Power Plant (DCPP) (**Figure 1-1**), operated by Illinois Power Resources Generating, LLC (IPRG). This Addendum applies specifically to the CCR Units referred to as Ash Pond Number (No.) 1 (AP1; Vistra identification [ID] No. 201, IEPA ID No. W0578010001-01, and National Inventory of Dams [NID] No. IL50715) and the Ash Pond No. 2 (AP2; Vistra ID No. 202, IEPA ID No. W0578010001-02, and NID No. IL50014). AP1 and AP2 are closed, unlined CCR SIs that were previously used to manage CCR and non-CCR waste streams at the DCPP. The locations of AP1 and AP2 are presented in **Figure 1-2**.

AECOM submitted the *Closure and Post-Closure Care Plan for Ash Ponds Nos. 1 and 2* (Closure Plan) dated March 2016, which was approved by IEPA on November 23, 2016. The Closure Plan included the *Supplemental Hydrogeologic Site Characterization Study and GMP* (Natural Resource Technology, Inc. [NRT], 2016a) dated March 31, 2016 which defined groundwater monitoring for AP1 and AP2 following approval of the Closure Plan. IEPA provided comments to the Closure Plan in a letter dated August 9, 2016 (IEPA, 2016a). A response comment letter submitted by IPRG with proposed changes was dated August 12, 2016. Revisions to the GMP and a Groundwater Management Zone Application were submitted on September 15, 2016 (NRT, 2016b). The Closure Plan was approved by IEPA in a letter dated November 23, 2016 (IEPA, 2016b). Closure of AP1 and AP2 was completed on December 22, 2020.

On April 21, 2021, Part 845 became effective, and for CCR units closed prior to the effective date the following section was included (35 I.A.C. § 845.100(i)):

> *If a CCR surface impoundment has completed an Agency-approved closure before April 21, 2021, this Part does not require the owner or operator of the CCR surface impoundment to resubmit to the Agency any closure plan, closure report, or closure certification for that completed closure.*

This Addendum includes modifications to the previously approved GMP to provide content required by 35 I.A.C. § 845.630 (Groundwater Monitoring System), 35 I.A.C. § 845.640 (Groundwater Sampling and Analysis), and 35 I.A.C. § 845.650 (Groundwater Monitoring Program) for AP1 and AP2. Specifically, this Addendum incorporates monitoring parameters specified in 35 I.A.C. § 845.600.

1.2 Purpose and Scope

The purpose of this Addendum is to provide updated GMP text, tables, and figures to incorporate modifications made to the existing monitoring program to comply with Part 845. Following issuance of the Part 845 Operating Permit, the application for which this Addendum is attached, groundwater monitoring specific to AP1 and AP2 will include the following:

- Part 845 Monitoring (proposed)

Details of the monitoring programs (schedules and parameters), monitoring well networks, and analysis (statistical methods) are included in this Addendum. No changes are proposed to the monitoring networks utilized for the current IEPA Closure Plan Monitoring program; however, those details have been included for completeness. Additional information regarding the hydrogeology and groundwater quality were included with the Closure Plan and are not reproduced in this Addendum.

2. GROUNDWATER MONITORING SYSTEMS

The Part 845 groundwater monitoring network for AP1 and AP2 was developed to monitor post-closure groundwater quality and trends and demonstrate compliance with the applicable groundwater quality standards identified in **Section 3**. The existing and proposed groundwater monitoring well networks consist of a sufficient number of wells, installed at appropriate locations and depths, to monitor post-closure compliance with groundwater quality standards for 35 I.A.C. § 845.600.

The monitoring wells are designed and constructed in a manner consistent with the standards of 40 C.F.R. § 257 and Title 77 of the Illinois Administrative Code (77 I.A.C.) § 920.170, as required by 35 I.A.C. § 845.630(e), including the following:

- All monitoring wells are cased in a manner that maintains the integrity of the boreholes.
- Wells are screened to allow sampling only at the specified interval.
- All wells are covered with vented caps, unless located in flood-prone areas, and equipped with devices to protect against tampering and damage.

Consistent with applicable standards, the monitoring well networks described above fulfill the following goals:

- Enable the collection of groundwater samples that represent the quality of background water that has not been affected by AP1 or AP2.
- Enable the collection of groundwater samples that represent the quality of downgradient groundwater.
- Include wells that are located within the stratigraphic unit(s) that may serve as potential chemical migration pathways.

Groundwater monitoring at AP1 and AP2 is currently being performed in accordance with the GMP that was approved in the Closure Plan. The Closure Plan specified a monitoring network to evaluate groundwater quality and demonstrate compliance with groundwater quality standards for Class IV - Other Groundwater, per 35 I.A.C. § 620.440.

This Addendum is being provided to propose a groundwater monitoring network and monitoring program specific to AP1 and AP2 that will comply with Part 845. Monitoring networks and programs that apply to other units are not discussed in this Addendum. Those programs will continue to be performed as specified in IEPA approvals. Upon approval of the Operating Permit applications (and by extension the Groundwater Monitoring Plans) for AP1 and AP2, the monitoring program required by the approved Closure Plan will be discontinued following approval of a future permit modification submittal and will be replaced by the proposed Part 845 monitoring program. The remaining discussion in this document will include only the networks and monitoring programs that are applicable and specific to AP1 and AP2, specifically the Closure Plan and proposed Part 845 monitoring network.

2.1 IEPA Closure Plan Monitoring Program

The IEPA Closure Plan monitoring well network consists of 19 compliance monitoring wells screened within the heterogenous mine spoils (OM01, OR02, OR03D, OM04S, OR04D, OR06A, OM07, OR11, OM12, OR13D, OR13S, OR14D, OR19, OR20, OM21, OM22D, OM23D, OM24D, and

OM25S). An additional 12 wells (OR03S, OM08, OM09, OM10, OR14S, OM15, OM16, OM17, OR18, OM22S, OM23S, and OM25D) are monitored for water levels only.

The GMP that was in the approved Closure Plan established a monitoring program that meets the requirements for Special Condition No. 4 of IEPA Water Pollution Control Permit 2020-EB-65025 and groundwater samples are collected quarterly and analyzed for the parameters listed in **Table A** below.

Table A. IEPA Closure Plan Groundwater Monitoring Program Parameters

Field Parameters		
pH	Specific Conductance	Temperature
Inorganics and Metals (Dissolved)		
Chloride	Boron	

As discussed in Sections 5 and 6 of the GMP attached to the IEPA-approved Closure Plan, DC AP1 and AP2 are located within previously mined areas and other parameters are not monitored for the following reasons (NRT, 2016):

- Their Class IV - Other Groundwater standard is the existing concentration of the constituent in groundwater (total dissolved solids [TDS], iron, manganese, sulfate), and they are not indicator constituents for leachate migration from the ash ponds; therefore, there is no basis for which to compare the data.
- Groundwater monitoring results indicated that the inorganic constituents antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, cyanide, fluoride, lead, mercury, nickel, nitrate, selenium, silver, thallium and zinc currently meet the Class II - General Resource Groundwater standards and are not associated with the chemical characteristics of DC AP1 and AP2.

2.2 Proposed Part 845 Monitoring Well Network

The groundwater monitoring network proposed in this plan will include 21 wells (OM01, OR02, OR03D, OM04S, OR04D, OR06A, OM07, OR11, OM12, OR13D, OR13S, OR14D, OM16, OM17, OR19, OR20, OM21, OM22D, OM23D, OM24D, and OM25S) screened within the heterogenous mine spoils at AP1 and AP2 and one well (BA06) screened within the uppermost aquifer at the DCPP Bottom Ash Basin, for a total of 22 wells. The proposed network is summarized in **Table B** below and displayed on **Figure 2-1**. Twenty-two wells (three background and 19 compliance) will be used to monitor groundwater concentrations within the mine spoils.

The groundwater samples collected from the 22 wells will be used to monitor and evaluate groundwater quality and demonstrate compliance with the groundwater quality standards listed in 35 I.A.C. § 845.600(a). The proposed monitoring wells will yield groundwater samples that represent the quality of downgradient groundwater at the CCR boundary (as required in 35 I.A.C. § 845.630(a)(2)). Monitoring well depths and construction details are listed in **Table 2-1** and summarized in **Table B** below.

Table B. Proposed Part 845 Monitoring Well Network

Well ID	Monitored Unit	Well Screen Interval (feet bgs)	Well Type[1]
BA06	UA	32.3 – 41.9	Background
OM01	MS	15.3 – 20.3	Compliance
OR02	MS	10.2 – 20.2	Compliance
OR03D	MS	66.7 – 76.7	Compliance
OM04S	MS	22.8 – 32.8	Compliance
OR04D	MS	54.8 – 64.8	Compliance
OR06A	MS	15.6 – 24.6	Compliance
OM07	MS	18.4 – 28.4	Compliance
OR11	MS	31.6 – 41.6	Compliance
OM12	MS	29.8 – 39.8	Compliance
OR13D	MS	37.3 – 47.3	Compliance
OR13S	MS	16.2 – 26.2	Compliance
OR14D	MS	36.2 – 45.2	Compliance
OM16	MS	30.4 – 40.4	Background
OM17	MS	4.2 – 14.3	Background
OR19	MS	41.7 – 51.7	Compliance
OR20	MS	44.6 – 54.6	Compliance
OM21	MS	47.2 – 57.2	Compliance
OM22D	MS	58.1 – 63.1	Compliance
OM23D	MS	70.4 – 79.4	Compliance
OM24D	MS	10.9 – 19.9	Compliance
OM25S	MS	52.0 – 61.0	Compliance

[1] Well type refers to the role of the well in the monitoring network.
bgs = below ground surface
MS = mine spoils
UA = uppermost aquifer

2.3 Well Abandonment

No wells are currently proposed for abandonment.

3. APPLICABLE GROUNDWATER QUALITY STANDARDS

3.1 Groundwater Classification

The 35 I.A.C. § 620 groundwater classification at AP1 and AP2 was presented in the GMP that was in the approved Closure Plan and is summarized here. AP1 and AP2 are located within a previously mined area and monitoring has demonstrated that the groundwater is not capable of consistently meeting the standards for Class I - Potable Resource Groundwater (35 I.A.C. § 620.410) or Class II - General Resource Groundwater (35 I.A.C. § 620.420). Therefore, the applicable classification of groundwater at AP1 and AP2 is Class IV - Other Groundwater (35 I.A.C. § 620.420(g)).

3.2 Statistical Evaluation of Background Groundwater Data

A Statistical Analysis Plan (**Appendix A**) has been developed to describe procedures that will be used to establish background conditions and implement compliance monitoring as necessary and required by 35 I.A.C. § 845.640 and 35 I.A.C. § 845.650. The Statistical Analysis Plan was prepared in accordance with the requirements of 35 I.A.C. § 845.640(f), with reference to the acceptable statistical procedures provided in United States Environmental Protection Agency's (USEPA's) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance,* March 2009), and is intended to provide a logical process and framework for conducting the statistical analysis of the data obtained during groundwater monitoring.

In accordance with 35 I.A.C. § 845.640(f)(1), the statistical method chosen for analysis of background groundwater quality will be the tolerance interval or the prediction interval procedure for each constituent listed in 35 I.A.C. § 845.600(a)(1) at this CCR unit per 35 I.A.C. § 845.640(f)(1)(C). Background groundwater quality will be established through statistical evaluation following completion of eight quarterly rounds of background groundwater sampling over a two-year period beginning the quarter following issuance of the Operating Permit, as discussed during March 30, 2021 virtual meeting between IPRG and IEPA (personal communication, IEPA, March 30, 2021).

3.3 Applicable Groundwater Quality Standards

The applicable groundwater protection standards (GWPSs) will be established in accordance with 35 I.A.C. § 845.600(a) (greater of the background concentration or numerical limit specified in 35 I.A.C. § 845.600(a)(1)). The results of the statistical analysis of background groundwater data will be completed and where background concentrations are less than the groundwater quality standards listed in 35 I.A.C. § 845.600(a)(1) the groundwater quality standards listed in 35 I.A.C. § 845.600(a)(1) will be applied to the results from the proposed groundwater monitoring network. Where background concentrations are greater than the 35 I.A.C. § 845.600(a)(1)) standards the GWPS will be the background concentration.

Under most circumstances, the GWPS will be compared to the lower confidence limit for the observed concentrations for each constituent in each compliance well. Exceptions are when there are high percentages (greater than 50 percent) of non-detects in compliance well data, for which a future mean (for 50 to 70 percent non-detects) or median (for greater than 70 percent non-detects) will be compared to the GWPS. Consistent with the *Unified Guidance*, the same general statistical method of confidence interval testing against a fixed GWPS is recommended in compliance and corrective action programs. Confidence intervals provide a flexible and statistically accurate method to test how a parameter estimated from a single sample compares to a fixed numerical limit. Confidence intervals explicitly account for variation and uncertainty in the sample data used to construct them.

Evaluation of the applicable standards will occur in conjunction with the analysis of groundwater quality results. Background calculations and the resulting concentrations may be updated as appropriate, in accordance with the Statistical Analysis Plan included in **Appendix A.**

4. GROUNDWATER MONITORING PLAN

The groundwater monitoring plan will monitor and evaluate groundwater quality to demonstrate compliance with the groundwater quality standards included in 35 I.A.C. § 845.600. The groundwater monitoring program will include sampling and analysis procedures that are consistent and provide an accurate representation of groundwater quality at the background and compliance wells as required by 35 I.A.C. § 845.630. As discussed within **Section 2**, there is one monitoring program, the Closure Plan monitoring program, specific to AP1 and AP2. It is expected that upon acceptance and approval of the Operating Permit applications (and by extension the GMPs) for the DCPP, the proposed Part 845 monitoring program will supersede the Closure Plan monitoring program.

4.1 Monitoring Networks and Parameters

4.1.1 Closure Plan Groundwater Monitoring

The existing Closure Plan monitoring program was discussed in **Section 2.1**. Groundwater monitoring wells used to monitor AP1 and AP2, include 19 compliance sampling monitoring wells (OM01, OR02, OR03D, OM04S, OR04D, OR06A, OM07, OR11, OM12, OR13D, OR13S, OR14D, OR19, OR20, OM21, OM22D, OM23D, OM24D, and OM25S) and 12 water level only wells (OR03S, OM08, OM09, OM10, OR14S, OM15, OM16, OM17, OR18, OM22S, OM23S, and OM25D), which are sampled on a quarterly frequency for the parameters listed in Special Condition No. 4 of IEPA Water Pollution Control Permit 2020-EB-65025. Well locations and parameters will continue to be monitored and reported as required by the Closure Plan until IEPA approves the proposed Part 845 monitoring network.

4.1.2 Part 845 Groundwater Monitoring

The proposed Part 845 Monitoring Network will consist of three background monitoring wells (BA06, OM16, and OM17) and 19 compliance wells (OM01, OR02, OR03D, OM04S, OR04D, OR06A, OM07, OR11, OM12, OR13D, OR13S, OR14D, OR19, OR20, OM21, OM22D, OM23D, OM24D, and OM25S) to monitor potential impacts from AP1 and AP2 (**Figure 2-1**). These monitoring wells are screened within the heterogenous mine spoils at AP1 and AP2 (OM01, OR02, OR03D, OM04S, OR04D, OR06A, OM07, OR11, OM12, OR13D, OR13S, OR14D, OM16, OM17, OR19, OR20, OM21, OM22D, OM23D, OM24D, and OM25S) and within the uppermost aquifer upgradient of the Bottom Ash Basin (BA06). Groundwater samples will be collected and analyzed for the laboratory and field parameters summarized in **Table C** below.

Table C. Part 845 Groundwater Monitoring Program Parameters

Field Parameters[1]			
Groundwater Elevation	pH	Turbidity	
Metals (Total)			
Antimony	Boron	Cobalt	Molybdenum
Arsenic	Cadmium	Lead	Selenium
Barium	Calcium	Lithium	Thallium
Beryllium	Chromium	Mercury	
Inorganics (Total, except TDS)			
Fluoride	Sulfate	Chloride	TDS
Other (Total)			
Radium 226 and 228 combined			

[1] Dissolved oxygen, temperature, specific conductance, and oxidation/reduction potential will be recorded during sample collection.

4.2 Sampling Schedule

Groundwater sampling for the approved Closure Plan will be maintained until IEPA approval of the Part 845 GMP. Groundwater sampling for the Part 845 monitoring well network will initially be performed quarterly according to the schedule below in **Table D**.

Table D. Part 845 Sampling Schedule

Frequency	Duration
Monthly (groundwater elevations only)	Begins: the quarter following approval of this plan and issuance of the Operating Permit.
	Ends: Following the 30-year post closure care period and following IEPA approval of documentation that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and concentrations exceeding background are not increasing and meet requirements in 35 I.A.C. § 845.780 (c)(2)(B)(i) and (ii).
Quarterly (groundwater quality)	Begins: the quarter following approval of this plan and issuance of the Operating Permit.
	Ends: Following the 30-year post closure care period and following IEPA approval of documentation that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and concentrations exceeding background are not increasing and meet requirements in 35 I.A.C. § 845.780 (c)(2)(B)(i) and (ii), or upon IEPA approval of an alternate schedule as allowed by 35 I.A.C. § 845.650(b)(4).
Semi-annual (groundwater quality)	Begins: Following 5 years of quarterly groundwater monitoring and IEPA approval of a demonstration that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and not exhibiting statistically-significant increasing trends, monitoring effectiveness is not compromised by a semi-annual schedule, and sufficient data has been collected to characterize groundwater.
	Ends: Following detection of a statistically-significant increasing trend in groundwater concentrations or an exceedance of the standards in 35 I.A.C. § 845.600 (quarterly monitoring shall be resumed in these circumstances), or following the 30-year post closure care period and following IEPA approval of documentation that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and concentrations exceeding background are not increasing and meet requirements in 35 I.A.C. § 845.780 (c)(2)(B)(i) and (ii).

4.3 Groundwater Sample Collection

Groundwater sampling procedures have been developed and the collection of groundwater samples is being implemented to meet the requirements of 35 I.A.C. § 845.640. In addition to groundwater well samples, quality assurance samples will be collected as described in **Section 4.5** (**Table 4-1**).

4.4 Laboratory Analysis

Laboratory analysis will be performed consistent with the requirements of 35 I.A.C. § 845.640(j) by a state-certified laboratory using methods approved by IEPA and USEPA. Laboratory methods may be modified based on laboratory equipment availability or procedures, but the Reporting Limit (RL) for all parameters analyzed, regardless of method, will be lower than the applicable groundwater quality standard. RLs for the applicable parameters are summarized in **Table 4-2**. Concentrations lower than the RL will be reported as less than the RL.

4.5 Quality Assurance Program

Consistent with the requirements of 35 I.A.C. § 845.640(a)(5), the sampling and analysis program includes procedures and techniques for quality assurance/quality control (QA/QC). Additional quality assurance samples to be collected will include the following:

- Field duplicates will be collected at a frequency of one per group of ten or fewer investigative water samples.
- One equipment blank sample will be collected and analyzed for each day of sampling. If dedicated sampling equipment is used, then equipment blank samples will not be collected.
- The duplicate and equipment blank quality assurance samples will be supplemented by the laboratory QA/QC program, which typically includes:
  - Regular generation of instrument calibration curves to assure instrument reliability
  - Laboratory control samples and/or quality control check standards that have been spiked, and analyses to monitor the performance of the analytical method
  - Matrix spike/matrix spike duplicate analyses to determine percent recoveries and relative percent differences for each of the parameters detected
  - Analysis of replicate samples to check the precision of the instrumentation and/or methodology employed for all analytical methods
  - Analysis of method blanks to assure that the system is free of contamination

Water quality meters used to measure pH and turbidity will be calibrated according to manufacturer's specifications. At a minimum, it is recommended that calibration of pH occur daily prior to sampling and checked for accuracy at the end of each day. Unusual or suspect pH measurements during sampling events will be flagged, evaluated, and additional calibration may be performed throughout the sampling events. Turbidity meters will be checked daily, prior to and following sampling. Unusual measurements or erratic meter performance will be flagged and evaluated for overall effects on the data prior to reporting.

4.6 Groundwater Monitoring System Maintenance Plan

Consistent with the requirements of 35 I.A.C. § 845.630(e)(2), maintenance will be performed as needed to assure that the monitoring wells provide representative groundwater samples. Monitoring wells will be inspected during each groundwater sampling event; inspections will consist of the following:

- Visual inspection, clearing of vegetation, replacement of markers, and painting of protective casings as needed to assure that monitoring wells are clearly marked and accessible.
- Visual inspection and repair or replacement of well aprons as needed to assure that they are intact, drain water away from the well, and have not heaved.
- Visual inspection and repair or replacement of protective casings as needed to assure that they are undamaged, and that locks are present and functional.
- Checks to assure that well caps are intact and vented, unless in flood-prone areas in which case caps will not be vented.
- Annual measurement of monitoring well depths to determine the degree of siltation within the wells. Wells will be redeveloped as needed to remove siltation from the screened interval if it impedes flow of water into the well.
- Checks to assure that wells are clear of internal obstructions, and flow freely.

If maintenance of a monitoring well cannot address an identified deficiency, a replacement well will be installed.

4.7 Statistical Analysis

Statistical analysis will be consistent with procedures listed in 35 I.A.C. § 845.640(f). A Statistical Analysis Plan, provided in **Appendix A**, has been developed to summarize the statistical procedures that will be used to evaluate the groundwater results.

4.8 Data Reporting

Groundwater monitoring and analysis completed in accordance with the Part 845 monitoring under an approved monitoring program will be reported to IEPA within 60 days after completion of sampling and place the data in the facility's operating record as required by 35 I.A.C. § 845.610(b)(3)(D). Within 14 days of posting to the operating record, information will be posted to the publicly accessible internet site "Illinois CCR Rule Compliance Data and Information" as required by 35 I.A.C. § 845.810(d). Information will also be submitted to IEPA annually by January 31 as required by 35 I.A.C. § 845.550, for data collected the preceding year. The report will include the status of the groundwater monitoring and corrective action plan for the DCPP AP1 and AP2 in addition to other requirements detailed in 35 I.A.C. § 845.610(e).

4.9 Compliance with Applicable On-site Groundwater Protection Standards

In accordance with 35 I.A.C. § 845.600(a)(1), the groundwater protection standard at the waste boundary will be the higher of either the 35 I.A.C. § 845.600 standard or the concentration determined by background groundwater monitoring.

As provided in 35 I.A.C. § 845.780(c)(2), at the end of the 30-year post-closure care period, groundwater monitoring will continue to be conducted in post-closure care until the groundwater results show the concentrations are:

- Below the GWPS in 35 I.A.C. § 845.600; and
- Not increasing for those constituents over background, using the statistical procedures and performance standards in 35 I.A.C. § 845.640(f) and (g), provided that:
  - Concentrations have been reduced to the maximum extent feasible; and
  - Concentrations are protective of human health and the environment.

Following detection of an exceedance of the GWPS, an Alternate Source Demonstration (ASD) will be evaluated as described in **Section 4.10**.

4.10 Alternate Source Demonstrations

As allowed in 35 I.A.C. § 845.650(e), following detection of an exceedance of the GWPS, an ASD will be evaluated and, if completed, submitted to IEPA within 60 days. The ASD will provide lines of evidence that a source other than AP1 or AP2 caused the contamination and AP1 or AP2 did not contribute to the contamination, or that the exceedance of the GWPS resulted from error in sampling, analysis, statistical evaluation, natural variation in groundwater quality, or a change in the potentiometric surface and groundwater flow direction.

The ASD will include information and analysis that supports the conclusions and a certification of accuracy by a qualified professional engineer. Once the ASD is approved by IEPA, the Part 845 groundwater monitoring will continue as defined in **Section 4.1.2**.

If an ASD is not completed and submitted, or IEPA does not approve the ASD, a notification of the exceedance will be provided to IEPA and placed in the operating record. Additional actions will also be completed as required by 35 I.A.C § 845.650(d)(1) through (3), including initiation of an assessment of corrective measures under 35 I.A.C § 845.660. As allowed in 35 I.A.C § 845.650(e)(7), a petition for review of IEPA's non-concurrence under 35 I.A.C. § 105 may also be filed.

5. REFERENCES

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TABLES

TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT
ASH POND NO. 1 AND ASH POND NO. 2
CANTON, ILLINOIS

Well Number	Type	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
BA06	B	UA	08/03/2016	--	595.63	Top of Disk	593.12	32.32	41.93	560.58	550.97	42.40	548.90	9.6	2	40.469324	-89.980961
OM01	C	MS	09/25/1980	595.44	595.44	Top of Riser	593.30	15.00	20.00	578.30	573.30	20.00	566.80	5	--	40.47871	-89.989619
OM04S	C	MS	09/12/1980	607.24	607.24	Top of Riser	604.93	23.00	33.00	581.93	571.93	33.00	569.90	10	--	40.490486	-89.986224
OM07	C	MS	09/18/1980	596.40	596.40	Top of Riser	594.58	17.00	27.00	577.58	567.58	27.00	541.60	10	--	40.475679	-89.984739
OM12	C	MS	11/20/1980	595.27	595.27	Top of Riser	593.05	30.00	40.00	563.05	553.05	40.00	549.60	10	--	40.47504	-89.97969
OM16	B	MS	07/14/1994	607.76	607.76	Top of Riser	605.55	30.80	41.00	574.75	564.55	41.00	564.00	10.2	2	40.48959	-89.977981
OM17	B	MS	10/14/1993	591.97	591.97	Top of Riser	589.74	5.00	15.00	584.74	574.74	15.00	574.70	10	2	40.487056	-89.975017
OM21	C	MS	10/28/1997	606.44	606.44	Top of Riser	604.23	47.00	57.00	557.23	547.23	57.00	546.00	10	2	40.487779	-89.984997
OM22D	C	MS	08/19/2009	598.86	598.86	Top of Riser	597.14	57.75	62.25	539.39	534.89	62.90	534.30	4.5	2	40.47524	-89.991118
OM23D	C	MS	09/02/2009	613.05	613.05	Top of Riser	610.50	70.36	79.87	540.14	530.63	80.30	530.20	9.5	2	40.479608	-89.991988
OM24D	C	MS	08/25/2009	576.72	576.72	Top of Riser	574.20	10.65	20.14	563.55	554.06	20.62	551.20	9.5	2	40.484929	-89.991868
OM25S	C	MS	08/31/2009	628.75	628.75	Top of Riser	627.22	51.69	61.18	575.53	566.04	61.67	565.50	9.5	2	40.487926	-89.99179
OR02	C	MS	04/02/2008	601.31	601.31	Top of Riser	599.20	10.38	19.87	588.82	579.33	20.65	578.50	9.5	2	40.484794	-89.990171
OR03D	C	MS	04/04/2008	627.95	627.95	Top of Riser	623.93	67.03	76.51	556.91	547.43	77.30	546.60	9.5	2	40.489764	-89.990321
OR04D	C	MS	10/27/1997	607.49	607.49	Top of Riser	605.00	55.00	65.00	550.00	540.00	65.00	539.00	10	2	40.490479	-89.986209
OR06A	C	MS	04/01/2008	595.28	595.28	Top of Riser	593.57	15.53	25.03	578.04	568.54	25.81	567.80	9.5	2	40.477764	-89.984775
OR11	C	MS	03/25/2008	596.55	596.55	Top of Riser	593.85	31.85	41.30	562.00	552.55	42.08	551.30	9.5	2	40.479216	-89.979656
OR13S	C	MS	03/22/2008	602.54	602.54	Top of Riser	600.02	11.94	21.42	588.09	578.61	22.20	577.80	9.5	2	40.483027	-89.984354
OR13D	C	--	03/22/2008	602.52	602.52	Top of Riser	600.11	33.02	42.46	567.09	557.65	43.24	556.90	9.4	2	40.483043	-89.984353
OR14D	C	MS	03/09/2009	598.75	598.75	Top of Riser	596.09	36.02	45.38	560.07	550.71	45.90	550.20	9.4	2	40.484443	-89.984312
OR19	C	MS	03/27/2008	597.73	597.73	Top of Riser	595.83	42.04	51.59	553.79	544.24	52.40	543.50	9.6	2	40.475365	-89.980864
OR20	C	MS	03/26/2008	587.57	587.57	Top of Riser	584.71	44.78	54.23	539.93	530.48	55.00	529.70	9.5	2	40.478937	-89.980131

TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT
ASH POND NO. 1 AND ASH POND NO. 2
CANTON, ILLINOIS

Well Number	Type	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)

Notes:
All elevation data are presented relative to the North American Vertical Datum 1988 (NAVD88), GEOID 12A
Type refers to the role of the well in the monitoring network: background (B), compliance (C), or water level measurements only (WLO)
WLO wells are temporary pending implementation of impoundment closure per an approved Construction Permit application
-- = data not available
BGS = below ground surface
ft = foot or feet
HSU = Hydrostratigraphic Unit
MS = mine spoils
PVC = polyvinyl chloride
UA = uppermost aquifer

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TABLE 4-1. SAMPLING AND ANALYSIS SUMMARY
ADDENDUM TO THE GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT
ASH POND NO. 1 AND ASH POND NO. 2
CANTON, ILLINOIS

Parameter	Analytical Method [1]	Number of Samples	Field Duplicates [2]	Field Blanks [3]	Equipment Blanks [3]	MS/MSD [4]	Total	Container Type	Minimum Volume [5]	Preservation (Cool to 4 °C for all samples)	Sample Hold Time from Collection Date
Metals											
Metals [6]	6020, Li - EPA 200.7	22	3	0	0	2	27	plastic	600 mL	HNO_3 to pH<2	6 months
Mercury	7470A or 6020	22	3	0	0	2	27	plastic	400 mL	HNO_3 to pH<2	28 days
Inorganic Parameters											
Fluoride	9214 or EPA 300	22	3	0	0	2	27	plastic	300 mL	Cool to 4 °C	28 days
Chloride	9251 or EPA 300	22	3	0	0	2	27	plastic	100 mL	Cool to 4 °C	28 days
Sulfate	9036 or EPA 300	22	3	0	0	2	27	plastic	50 mL	Cool to 4 °C	28 days
Total Dissolved Solids	SM 2540 C	22	3	0	0	2	27	plastic	200 mL	Cool to 4 °C	7 days
Radium											
Radium 226	9315 or EPA 903	22	0	0	0	0	22	plastic	1000 mL	HNO_3 to pH<2	6 months
Radium 228	9320 or EPA 904	22	0	0	0	0	22	plastic	1000 mL	HNO_3 to pH<2	6 months
Field Parameters											
pH	SM 4500-H+ B	22	NA	NA	NA	NA	22	flow-through cell	NA	none	immediately
Dissolved Oxygen [8]	SM 4500-O/405.1	22	NA	NA	NA	NA	22	flow-through cell	NA	none	immediately
Temperature [8]	SM 2550	22	NA	NA	NA	NA	22	flow-through cell	NA	none	immediately
Oxidation/Reduction Potential [8]	SM 2580 B	22	NA	NA	NA	NA	22	flow-through cell	NA	none	immediately
Specific Conductance [8]	SM 2510 B	22	NA	NA	NA	NA	22	flow-through cell	NA	none	immediately
Turbidity [7]	SM 2130 B	22	NA	NA	NA	NA	22	flow-through cell or hand-held turbidity meter	NA	none	immediately

[O: CJC 09/27/21; C: LDC 10/06/21]

Notes:

[1] Analytical method numbers are from SW-846 unless otherwise indicated. Analytical methods may be updated with more recent versions as appropriate.
[2] Field duplicates will be collected at a frequency of one per group of 10 or fewer investigative water samples. Field duplicates will not be collected for radium analysis.
[3] Field blanks will be collected at the discretion of the project manager; Equipment blanks will be collected at a rate of 1 per sampling event if non-dedicated equipment is used.
[4] Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples will be collected at a frequency of one per group of 20 or fewer investigative water samples per CCR unit/multi-unit. Additional volume to be determined by laboratory.
[5] Sample volume is estimated and will be determined by the laboratory.
[6] Metals = antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, lead, lithium, molybdenum, selenium, thallium. Metals may be analyzed via ICP/ ICP-MS USEPA methods 6010 or 6020 depending on laboratory instrument availability.
[7] If turbidity exceeds 10 NTUs, a duplicate sample filtered through a .45 micron filter may be collected for metals analysis in addition to the unfiltered sample. Both samples would be submitted for analysis.
[8] Parameter collected for quality assurance and quality control for field sampling purposes only; not required to be collected or reported under Part 845; collection of parameter may be discontinued without notification.
< = less than
°C = degrees Celsius
HNO_3 = nitric acid
mL = milliliter
NA = not applicable
NTU = nephelometric turbidity unit

TABLE 4-2. DETECTION AND REPORTING LIMITS FOR PART 845 PARAMETERS

ADDENDUM TO THE GROUNDWATER MONITORING PLAN

DUCK CREEK POWER PLANT

ASH POND NO. 1 AND NO. 2

CANTON, ILLINOIS

Constituent	CAS	Unit	Analytical Methods [1]	USEPA MCL [2]	35 I.A.C. § 845.600	RL [4, 5]	MDL [5]
Metals							
Antimony	7440-36-0	mg/L	6020	0.006	0.006	0.003	0.00036
Arsenic	7440-38-2	mg/L	6020	0.01	0.01	0.001	0.00013
Barium	7440-39-3	mg/L	6020	2	2	0.001	0.00028
Beryllium	7440-41-7	mg/L	6020	0.004	0.004	0.001	0.000017
Boron	7440-42-8	mg/L	6020	NS	2	0.01	0.0023
Cadmium	7440-43-9	mg/L	6020	0.005	0.005	0.001	0.000042
Calcium	7440-70-2	mg/L	6020	NS	NS	0.15	0.15
Chromium	7440-47-3	mg/L	6020	0.1	0.1	0.004	0.00027
Cobalt	7440-48-4	mg/L	6020	0.006	0.006	0.002	0.000017
Lead	7439-92-1	mg/L	6020	0.015	0.0075	0.001	0.000025
Lithium	7439-93-2	mg/L	6020 or EPA 200.7	0.04	0.04	0.02	0.0001
Mercury	7439-97-6	mg/L	6020 or 7470A	0.002	0.002	0.0002	0.000078
Molybdenum	7439-98-7	mg/L	6020	0.1	0.1	0.001	0.000063
Selenium	7782-49-2	mg/L	6020	0.05	0.05	0.001	0.00032
Thallium	7440-28-0	mg/L	6020	0.002	0.002	0.001	0.000062
Inorganics							
Fluoride	7681	mg/L	9214 or EPA 300	4	4	0.25	0.065
Chloride	16887-00-6	mg/L	9251 or EPA 300	250 [3]	200	1	0.15
Sulfate	18785-72-3	mg/L	9036 or EPA 300	250 [3]	400	1	0.24
Total Dissolved Solids	10052	mg/L	SM 2540C	500 [3]	1200	17	--
Other							
Radium 226 and 226 combined	7440-14-4	pCi/L	9315/9320 or EPA 903/904	5	5	-- [6]	-- [7]
Field							
pH	NA	SU	SM 4500-H+ B	NS	6.5-9.0	NA	NA
Oxidation/Reduction Potential	NA	mV	SM 2580 B	NS	NS	NA	NA
Dissolved Oxygen	NA	mg/L	SM 4500-O/405.1	NS	NS	NA	NA
Temperature	NA	°C	SM 2550	NS	NS	NA	NA
Specific Conductivity	NA	µS/cm	SM 2510 B	NS	NS	NA	NA

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TABLE 4-2. DETECTION AND REPORTING LIMITS FOR PART 845 PARAMETERS

ADDENDUM TO THE GROUNDWATER MONITORING PLAN

DUCK CREEK POWER PLANT

ASH POND NO. 1 AND NO. 2

CANTON, ILLINOIS

Constituent	CAS	Unit	Analytical Methods [1]	USEPA MCL [2]	35 I.A.C. § 845.600	RL [4, 5]	MDL [5]
Turbidity	NA	NTU	SM 2130 B	NS	NS	NA	NA

[O: CJC 08/18/21; C: LDC 10/06/21]

Notes:

[1] Analytical method numbers are from SW-846 unless otherwise indicated. Metals will be analyzed via Method 6020 or 6010 depending on laboratory equipment availability. Selected method will ensure reporting limits (RL) are below Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.600 groundwater protection standards.

[2] USEPA MCL = United States Environmental Protection Agency Maximum Contaminant Level.

[3] USEPA SMCL = United States Environmental Protection Agency Secondary Maximum Contaminant Level.

[4] RLs will be less than the 35 I.A.C. § 845.600 groundwater protection standards.

[5] RLs and method detection limits (MDL) will vary depending on the laboratory performing the work.

[6] All radium results will be reported (values may be positive or negative) and will include uncertainty and the calculated MDC.

[7] Laboratories calculate a minimum detectable concentration (MDC) based on the sample.

°C = degrees Celsius

μS/cm = microSiemens per centimeter

CAS = Chemical Abstract Number

MDL = Method detection limit as established by the laboratory

mg/L = milligrams per liter

mV = millivolts

NA = Not applicable

NS = No standard

NTU = nephelometric turbidity unit

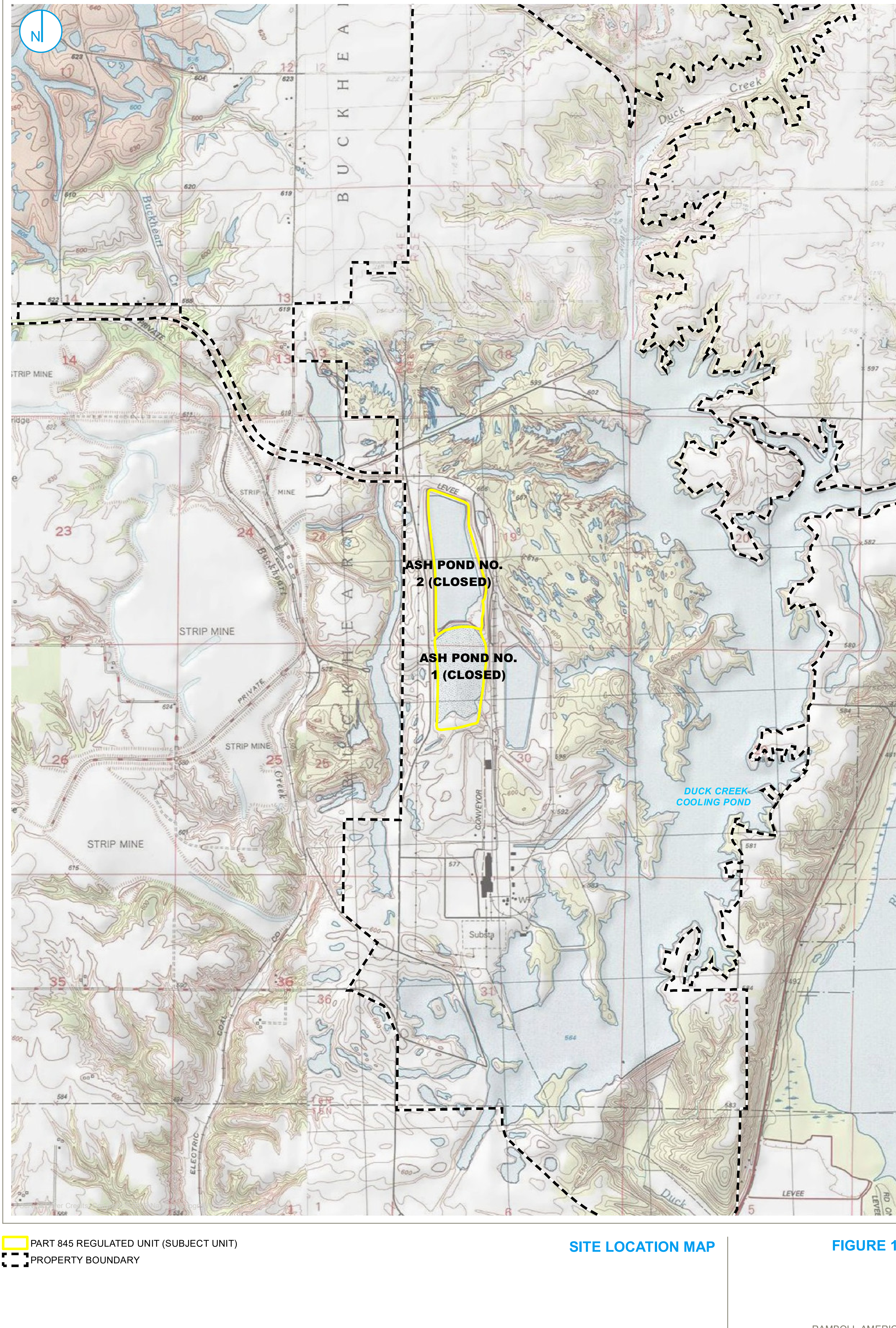
pCi/L = picoCuries per liter

RL = Reporting limit as established by the laboratory

SM = Standard Methods for the Examination of Water and Wastewater

SU = standard units

FIGURES



PART 845 REGULATED UNIT (SUBJECT UNIT)
PROPERTY BOUNDARY

0 1,000 2,000 Feet

SITE LOCATION MAP

FIGURE 1-1

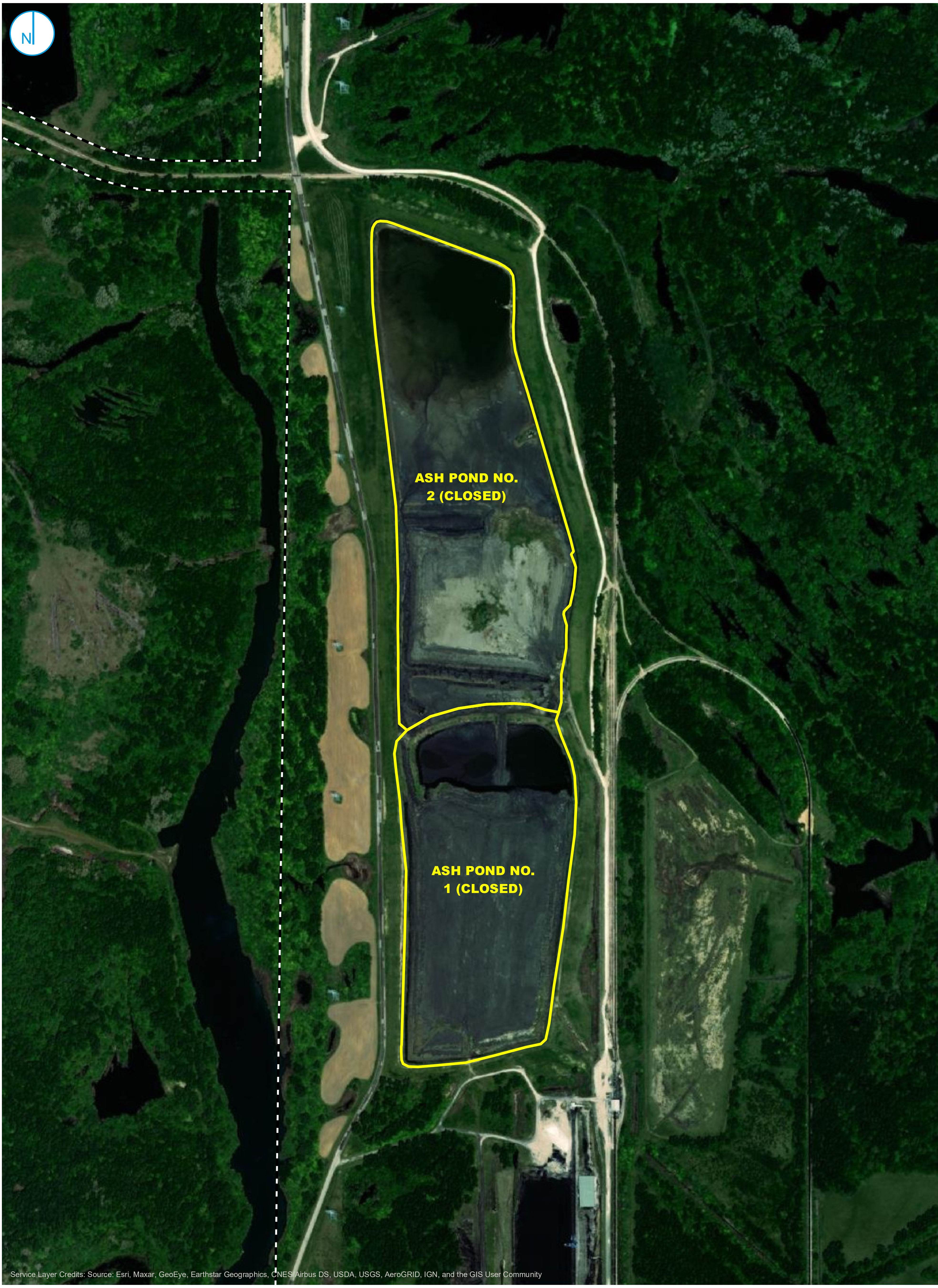
ADDENDUM TO THE GROUNDWATER MONITORING PLAN
ASH POND NO. 1 AND ASH POND NO. 2
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

PROJECT: 169000XXXX | DATED: 10/6/2021 | DESIGNER: STOLZSD

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Duck_Creek\AP12_GMP\Figure 1-2_Site Map.mxd



PART 845 REGULATED UNIT (SUBJECT UNIT)

PROPERTY BOUNDARY

0 300 600 Feet

SITE MAP

FIGURE 1-2

ADDENDUM TO THE GROUNDWATER MONITORING PLAN
ASH POND NO. 1 AND ASH POND NO. 2
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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BACKGROUND WELL
COMPLIANCE WELL
PART 845 REGULATED UNIT (SUBJECT UNIT)
PROPERTY BOUNDARY

0 300 600 Feet

PROPOSED PART 845 GROUNDWATER MONITORING WELL NETWORK

FIGURE 2-1

ADDENDUM TO THE GROUNDWATER MONITORING PLAN
ASH POND NO. 1 AND ASH POND NO. 2
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

APPENDIX A
STATISTICAL ANALYSIS PLAN

Prepared for
Illinois Power Resources Generating, LLC

Date
October 25, 2021

Project No.
1940100806-003

STATISTICAL ANALYSIS PLAN

ASH POND NO. 1 AND ASH POND NO. 2
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

Bright ideas. Sustainable change.

STATISTICAL ANALYSIS PLAN DUCK CREEK POWER PLANT ASH POND NO. 1 AND ASH POND NO. 2

Project Name	**Duck Creek Power Plant Ash Pond No. 1 and Ash Pond No. 2**
Project No.	**1940100806-003**
Recipient	**Illinois Power Resources Generating, LLC**
Document Type	**Statistical Analysis Plan**
Version	**FINAL**
Date	**October 25, 2021**

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Brian G. Hennings, PG
Senior Managing Hydrogeologist

Eric J. Tlachac, PE
Senior Managing Engineer

Rachel A. Banoff, EIT
Project Statistician

LICENSED PROFESSIONAL CERTIFICATIONS

This certification is based on the description of the statistical methods selected to evaluate groundwater as presented in the following Statistical Analysis Plan; Duck Creek Power Plant Ash Pond No. 1 and Ash Pond No. 2. The procedures described in the plan will be used to establish background conditions and implement compliance monitoring as necessary and required by 35 I.A.C. § 845.640 and 35 I.A.C. § 845.650. The Statistical Analysis Plan was prepared in accordance with the requirements of 35 I.A.C. § 845.640(f), with reference to the acceptable statistical procedures provided in the United States Environmental Protection Agency (USEPA)'s *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance,* March 2009), and is intended to provide a logical process and framework for conducting the statistical analysis of the data obtained during groundwater monitoring. In accordance with 35 I.A.C. § 845.640(f)(1), the statistical method chosen for analysis of background groundwater quality will be either the tolerance interval or the prediction interval procedure for each constituent listed in 35 I.A.C. § 845.600(a)(1) at this CCR unit per 35 I.A.C. § 845.640(f)(1)(C). Groundwater Protection Standards (GWPS) will be established in accordance with 35 I.A.C. § 845.600(a) (greater of the background concentration or numerical limit specified in 35 I.A.C. § 845.600(a)(1)). The GWPS will be compared to the lower confidence limit for the observed concentrations for each constituent in each compliance well. Consistent with the *Unified Guidance*, the same general statistical method of confidence interval testing against a fixed GWPS is recommended in compliance and corrective action programs. Confidence intervals provide a flexible and statistically accurate method to test how a parameter estimated from a single sample compares to a fixed numerical limit. Confidence intervals explicitly account for variation and uncertainty in the sample data used to construct them.

Description of the statistical methods chosen for analysis of groundwater monitoring data and application of these methods for determining exceedances of the GWPS identified in 35 I.A.C. § 845.600(a) is provided in this Statistical Analysis Plan.

35 I.A.C. § 845.640 Statistical Analysis (PE)

I, Eric J. Tlachac, a qualified professional engineer in good standing in the State of Illinois, certify that the statistical methods summarized above and described in this document (Statistical Analysis Plan; Duck Creek Power Plant Ash Pond No. 1 and Ash Pond No. 2) are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § 845.640.

Eric J. Tlachac
Qualified Professional Engineer
062-063091
Illinois
Date: October 25, 2021

35 I.A.C. § 845.640 Statistical Analysis (PG)

I, Brian G. Hennings, a qualified professional geologist in good standing in the State of Illinois, certify that the statistical methods described in this document (Statistical Analysis Plan; Duck Creek Power Plant Ash Pond No. 1 and Ash Pond No. 2) are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § *845.640.*

Brian G. Hennings
Professional Geologist
196.001482
Illinois
Date: October 25, 2021

LICENSED PROFESSIONAL GEOLOGIST
BRIAN G. HENNINGS
196.001482
ILLINOIS

35 I.A.C. § 845.640 Statistical Analysis

I, Rachel A. Banoff, a qualified professional, certify that the statistical methods described in this document (Statistical Analysis Plan; Duck Creek Power Plant Ash Pond No. 1 and Ash Pond No. 2), are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § *845.640.*

Rachel A. Banoff, EIT
Project Statistician
Date: October 25, 2021

CONTENTS

TABLES (IN TEXT)

ACRONYMS AND ABBREVIATIONS

§	Section
35 I.A.C.	Title 35 of the Illinois Administrative Code
ANOVA	analysis of variance
CCR	coal combustion residuals
COC	constituents of concern
GWPS	groundwater protection standard
IEPA	Illinois Environmental Protection Agency
LCL	lower confidence limit
LTL	lower tolerance limit
MSE	mean squared error
P	probability
Part 845	Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845
RCRA	Resource Conservation and Recovery Act
RL	reporting limit
ROS	regression on order statistics
SI	surface impoundment
SSI	statistically significant increase
SWFPR	site-wide false positive rate
Unified Guidance	*Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (USEPA, 2009)
UPL	upper prediction limit
USEPA	United States Environmental Protection Agency
UTL	upper tolerance limit

1. INTRODUCTION

In April 2021, the Illinois Environmental Protection Agency (IEPA) issued a final rule for the regulation and management of Coal Combustion Residuals (CCR) in surface impoundments (SIs) under the Standards for the Disposal of CCR in Surface Impoundments: Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845 (Part 845). Facilities regulated under Part 845 are required to develop and sample a groundwater monitoring well network to evaluate whether impounded CCR materials are impacting downgradient groundwater quality. The groundwater quality evaluation must include selection and certification by a qualified professional engineer of the statistical procedures to be used. The procedures described in the evaluation will be used to establish background conditions and implement compliance and corrective action monitoring as necessary and required by 35 I.A.C. § 845.640 and 35 I.A.C. § 845.650. This Statistical Analysis Plan was prepared in accordance with the requirements of 35 I.A.C. § 845.640(f), with reference to the acceptable statistical procedures provided in United States Environmental Protection Agency's (USEPA's) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance*) (March 2009).

This Statistical Analysis Plan does not include procedures for groundwater sample collection and analysis, as these activities are conducted in accordance with the Sampling and Analysis Plan prepared for each CCR unit in accordance with 35 I.A.C. § 845.640. This Statistical Analysis Plan will be used as the primary reference for evaluating groundwater quality during operation and post-closure care.

1.1 Statistical Analysis Objectives

This Statistical Analysis Plan is intended to provide a logical process and framework for conducting the statistical analyses of data obtained during groundwater monitoring conducted in accordance with the Sampling and Analysis Plan for each CCR unit. The Statistical Analysis Plan will enable a qualified professional engineer to certify that the selected statistical methods are appropriate for evaluating the groundwater monitoring data for the applicable CCR unit(s).

1.2 Statistical Analysis Plan Approach

The main sections of this Statistical Analysis Plan should be viewed as a "generic" outline of statistical methods utilized for each CCR unit and constituent required to be monitored. The statistical analysis of the groundwater monitoring data, however, will be conducted on an individual-constituent or well basis, and may involve the use of appropriate statistical procedures depending on multiple factors such as detection frequency and normality distributions.

The CCR Rule outlines two phases of groundwater monitoring:

- Background Monitoring in accordance with 35 I.A.C. § 845.650(b)(1)
- Compliance Monitoring in accordance with 35 I.A.C. § 845.650

Each phase of the groundwater monitoring program requires specific statistical procedures to accomplish the intended purpose. During the background monitoring phase, background groundwater quality will be established utilizing upgradient and background wells and downgradient groundwater quality data will be collected to facilitate statistics in subsequent phases. Compliance Monitoring is then initiated through the evaluation of the downgradient groundwater monitoring data for exceedances of the groundwater protection standard (GWPS) established by Part 845 (concentration specified in 35 I.A.C. § 845.600 or an IEPA-approved background concentration). The developed statistical analysis plan will be implemented for each monitoring phase and in accordance with the statistical procedures.

2. BACKGROUND MONITORING AND DATA PREPARATION

The background and compliance monitoring wells will be sampled and analyzed for constituents, as listed in Part 845 (antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chloride, chromium, cobalt, fluoride, lead, lithium, mercury, molybdenum, pH, radium 226 and 228 combined, selenium, sulfate, thallium, total dissolved solids, and turbidity), during the baseline phase of the groundwater monitoring program.

The background monitoring well(s) were placed upgradient of the CCR unit, or at an alternative background location, where they are not affected by potential leakage from the CCR unit. Compliance monitoring wells were placed at the waste boundary of the CCR unit, along the same groundwater flow path. As 35 I.A.C. § 845.630(a) specifies, the location of these wells ensures that background accurately represents the quality of unaffected groundwater, while compliance wells accurately represent groundwater quality at the waste boundary and monitor all potential contaminant pathways.

Eight quarterly rounds of baseline sampling will be completed over a two-year period following approval of this Addendum to the Groundwater Monitoring Plan by IEPA and issuance of the Operating Permit. As outlined, groundwater sampling procedures will include sampling of the background and compliance wells using low-flow sampling methods, collection of one field quality control sample per event, and groundwater samples will not be field filtered before laboratory analysis of total recoverable metals.

Following completion of the eight sampling events, background groundwater quality will be established for Part 845 constituents. Groundwater monitoring will be conducted quarterly for at least the first five years. In accordance with 35 I.A.C. § 845.650(b)(4), after the first five years, a request to reduce the monitoring frequency to semiannual may be submitted to IEPA if all of the following can be demonstrated:

- Groundwater monitoring effectiveness will not be compromised by the reduced frequency
- Sufficient data has been collected to characterize groundwater
- Monitoring to date does not show any statistically significant increasing trends
- The concentrations of monitored constituents at the compliance monitoring wells are below the applicable GWPSs established in 35 I.A.C. § 845.600

The following subsections outline the statistical tests and procedures (methods) that will be utilized to evaluate data collected for each constituent in both background and compliance wells for Background and Compliance Monitoring. When necessary and contingent upon equivalent statistical power, an alternative test not included in this Statistical Analysis Plan may be chosen due to site-specific data requirements.

2.1 Sample Independence

Independence of sample results is a major assumption for most statistical analyses. To ensure physical independence of groundwater sampling results, the minimum time between sampling events must be longer than the time required for groundwater to move through the monitoring well. The sampling schedules for both the baseline and compliance monitoring periods are specified in 35 I.A.C. § 845.650(b) and may conflict with the statistical assumption of independence of sample results.

2.2 Non-Detect Data Processing

The reporting limit (RL) will be used as the lower level for the reporting of non-detected groundwater quality data. For all summary statistics (box plots, timeseries, etc.), the RL will be substituted for concentrations reported below the RL, including non-detects. With professional judgement, analytical results between the RL and the method detection limit, *i.e.,* estimated values, typically identified with a "J" flag, may be utilized if provided by the laboratory.

For all statistical test procedures:

- If the frequency of non-detect data are less than or equal to 15 percent, half of the RL will be substituted for these data
- If the non-detect frequency is between 15 percent and 50 percent, either the Kaplan-Meier or robust regression on order statistics (ROS) will be used to estimate the mean and standard deviation adjusted for the presence of left-censored values
- If the non-detect frequency is greater than 50 percent, a non-parametric test will be used
- If only one background result is detected that value will be used as the non-parametric upper prediction limit (UPL)

2.3 Testing for Normality

Many statistical analyses assume that sample data are normally distributed (parametric). However, environmental data are frequently not normally distributed (nonparametric). 35 I.A.C. § 845.640(g) requires the knowledge of the background data distribution for comparison to compliance results. The *Unified Guidance* document recommends the Shapiro-Wilk normality test for sample sizes of 50 or less, and the Shapiro-Francia normality test for sample sizes greater than 50.

When possible, transformation of datasets to achieve normal distributions is preferred.

2.4 Testing for Outliers

Part 845 constituents will be screened for the existence of outliers using a method described by the *Unified Guidance*. Outliers are extreme data points that may represent an anomaly or erroneous data point. To test for outliers, one or more of the following outlier tests will be utilized:

- Dixon's test, for well-constituent pairs with less than 25 samples, assumes normally distributed data.
- Rosner's test, for well-constituent pairs with more than 20 samples, assumes normally distributed data.
- Grubb's test for well-constituent pairs with seven or more samples, assumes normally distributed data.
- Time series, box-whisker plots, and probability plots provide visual tools to identify potential outliers, and evaluation of seasonal, spatial, or temporal variability for both normally and non-normally distributed data.

Data quality control, groundwater geochemistry, and sampling procedures will be evaluated as potential sources of error leading to an outlier result. The outlier tests cannot be used alone to determine whether a value is a true outlier that should be excluded from future statistical analysis. Corroborating evidence needed to exclude values includes a discrete data reporting or analytical error, or potential laboratory bias. Absent corroborating evidence, the flagged values are considered true, but extreme, values in the data set. Professional judgement will be used to exclude extreme outliers from further statistical analyses. Outliers will be retained in the database.

With professional judgement, a confirmatory sample may be collected to allow for the distinction between an outlier and a true representation of groundwater quality at the monitoring point. If re-sampling is conducted, this sample will be collected within 90 days following outlier identification. If the confirmatory sample indicates the original result as an outlier, it will be reported as such.

2.5 Trend Analysis

Statistical analyses supporting the lack of trend are a fundamental step to confirm the assumption that groundwater quality values are stationary or constant over time at a CCR unit. These analyses allow for evaluation of variation in the background and compliance data for each constituent over time. A statistically significant increasing trend in background data could indicate an existing release from the CCR unit or alternate source, requiring further investigation. In addition, statistically significant trending background data can result in increased standard deviation and, therefore, greater prediction or control limits. Consequently, the increased prediction or control limit will have less power or ability to identify a release from the CCR unit.

A linear regression, coupled with a t-test for slope significance at a 95 percent confidence level (0.05 significance level), may be used on datasets for each constituent with few non-detects and a normally distributed variance of the mean to evaluate time trends. The Theil-Sen trend line, coupled with the Mann-Kendall test for slope significance at a 95 percent confidence level (0.05 significance level), will be used for datasets with frequent non-detects or non-normal variance. Similarly, trend analyses could also be used on compliance data to evaluate a possible release from the CCR unit.

2.6 Spatial Variation

Spatial trends and/or variation between background wells could indicate an existing release from a CCR unit. If the spatial variability is not due to an existing release, intrawell comparisons in compliance wells may be used to account for spatial variability and monitor for a future release. However, the CCR unit being monitored was placed into service prior to the start of groundwater monitoring and it is unknown whether a previous release has occurred. Accordingly, intrawell comparisons in compliance wells cannot be used to determine the occurrence of a future release. Interwell comparisons between compliance wells and background wells will be used.

2.7 Temporal Variation

Time series plots can be used to identify temporal dependence. Potentially significant temporal components of variability can be identified by graphing single constituent data from multiple wells together on a time series plot. With temporal dependence, the time series plot as a pattern of parallel traces, in which the individual wells will tend to rise and fall together across the sequence of sampling dates. Time series plots can be helpful by plotting multiple constituents over time for the same well, or averaging values for each constituent across wells on each sampling event and then plotting the averages over time. In either case, the plots can signify whether the general concentration pattern over time is simultaneously observed for different constituents. If so, it may indicate that a group of constituents is highly correlated in groundwater or that the same artifacts of sampling and/or lab analysis impacted the results of several monitoring parameters.

Hydrologic factors such as drought, recharge patterns or regular (*e.g.,* seasonal) water table fluctuations may be responsible for the temporal variation. In these cases, it may be useful to test for the presence of a significant temporal effect by first constructing a parallel time series plot and then running a formal one-way analysis of variance (ANOVA) ($\alpha = 0.05$) for temporal effects. A one-way ANOVA for temporal effects considers multiple well data sets for individual sampling events or seasons as the relevant statistical factor. If event-specific analytical differences or seasonality appear to be an important temporal factor, the one-way ANOVA for temporal effects can be used to formally identify seasonality, parallel trends, or changes in lab performance that affect other temporal effects. The one-way ANOVA for temporal effects assumes that the data groups are normally distributed with constant variance. It is also assumed that for each of a series of background wells, measurements are collected at each well on sampling events or dates common to all the wells. Results of the ANOVA can also be used to create temporally stationary residuals, where the temporal effect has been 'subtracted from' the original measurements. These stationary residuals may be used to replace the original data in subsequent statistical testing.

If the data cannot be normalized, a similar test for a temporal or seasonal effect can be performed using the Kruskal-Wallis test ($\alpha = 0.05$). Each sampling event should be treated as a separate 'well,' while each well is treated as a separate 'sampling event.' In this case, no residuals can be computed since the Kruskal-Wallis test employs ranks of the data rather than the measurements themselves.

Where both spatial and temporal variation occur, two-way ANOVA can be considered where both well location and sampling event/season are treated as statistical factors. This procedure is described in Davis (1994).

2.8 Updating Background

Updating the background dataset periodically by adding recent results to an existing background dataset can improve the statistical power and accuracy of the statistical analysis, especially for non-parametric prediction intervals. The *Unified Guidance* recommends updating statistical limits (background) when at least four to eight new measurements (every 1 to 2 years under a quarterly monitoring program), are available for comparison to historical data. Professional judgement will be used to evaluate whether any background data appear to be affected by a release and need to be excluded from a background update. A t-test for equal means (if normal data distribution) or appropriate non-parametric test (if non-normal data distribution) such as a Mann-Whitney (or Wilcoxon) rank-sum or box-whisker plots, will be conducted to evaluate whether the two groups of background sample populations are statistically different prior to updating any background datasets. A 0.05 significance level will be utilized when evaluating the two populations, with the null hypothesis that they are equivalent. In addition, time series graphs or other trend evaluation statistics will be conducted on the new background dataset to verify the absence of a release or changing groundwater quality. If the tests indicate that there are no statistical differences between the two background populations, the new data will be combined with the existing dataset. If the two populations are found to be different, the data will be reviewed to evaluate the cause of the difference. If the differences appear to be caused by a release (if the new data are significantly higher, or lower for pH), then the previous background dataset may continue to be used. Furthermore, verified outliers will not be added to an existing background dataset. In accordance with the *Unified Guidance*, continual background updates will not be conducted due to the lack of sufficient samples for a statistical comparison.

3. COMPLIANCE MONITORING

Compliance monitoring is designed to monitor groundwater for evidence of a release by comparing Part 845 constituents in compliance wells to both background concentrations and the GWPS. Compliance Monitoring will begin the quarter following completion of baseline groundwater sampling described above in **Section 2**. The selected Compliance Monitoring statistical method used to compare compliance groundwater quality data for each constituent to the GWPS will provide for adequate statistical power, error levels and individual test false positive rates, and be appropriate for the distribution and detection frequency of the background dataset. Statistical power is the ability of a statistical test to detect a true exceedance.

In accordance with 35 I.A.C. § 845.610(b)(3)(D), compliance monitoring statistical analyses will be completed and submitted to IEPA within 60 days after completion of sampling.

3.1 GWPS Establishment and Exceedance Determination

In accordance with 35 I.A.C. § 845.600(a), the GWPS will be the constituent concentrations specified in 35 I.A.C. § 845.600(a)(1) except for when the background concentration is greater, or no concentration is specified (*i.e.,* for calcium and turbidity), in which case the GWPS will be the background concentration. The GWPS based on background concentration will be calculated using a parametric upper tolerance limit (UTL), a parametric UPL for a future mean, or a non-parametric UPL for a future median.

Statistical calculations that will be utilized in Compliance Monitoring procedures are summarized in **Table A** below and listed in **Sections 3.1.1** through **3.1.7**. Depending on the distribution of the data and the percentage of non-detects, it may be more appropriate to use a parametric model over a non-parametric model. As necessary, other techniques as mentioned in the *Unified Guidance* and/or new methods will be implemented.

Table A. Statistical Calculations Used in Compliance Monitoring Procedures

Compliance Monitoring						
Significant Trend?	Background Data			Compliance Data		
	Percent Non-Detects	Distribution	GWPS Determination	Percent Non-Detects	Distribution	Method to Determine Exceedance
No	0 ≤ 50	Normal	35 I.A.C § 845.600(a)(1) constituent concentration or The Upper Tolerance Limit	≤75	Normal	Parametric Lower Confidence Limit around a Normal Mean
				≤75	Log-Normal	Parametric Lower Confidence Limit around a Lognormal Geometric Mean
				NA	Non-Normal	Non-Parametric Lower Confidence Limit around a Median
				>75	Unknown/ Cannot be determined	
	50 ≤ 70	Normal	The Upper Prediction Limit for a Future Mean	NA	NA	Future mean
	>70	Non-Normal	Upper Prediction Limit for a Future Median	NA	NA	Future median
	100	Non-Normal	Double Quantification Rule	NA	NA	Individual Retesting Values
Yes	0 ≤ 50	Normal	UCL of Confidence Band around Linear Regression	≤75	Residuals after subtracting trend are normal, equal variance	Lower Limit from Confidence Band around Linear Regression
	50 ≤ 100	Non-Normal	UCL of Confidence Band around Thiel-Sen trend line	≤75	Residuals not normal	Lower Limit from Confidence Band around Thiel-Sen

3.1.1 The Upper Tolerance Limit

The UTL will be used to calculate the GWPS when pooled background data are normally distributed, with a non-detect frequency of 50 percent or less. When non-detect frequency is 15 percent or less, half the RL will be substituted for non-detects. The *Unified Guidance* recommends 95 percent confidence level and 95 percent coverage (95/95 tolerance interval).

- When non-detect frequency is 15 percent or less, half the RL will be substituted for non-detects (simple substitution), and the normal mean and standard deviation will be calculated.

- The Kaplan-Meier or the ROS method will be used when the detection frequency is between 15 percent and 50 percent. The Kaplan-Meier method assesses the linearity of a censored probability plot to determine whether the background sample can be approximately normalized. If so, then the Kaplan-Meier method will be used to compute estimates of the mean and standard deviation adjusted for the presence of left-censored values. The Kaplan-Meier or ROS estimate of the mean and standard deviation will be substituted for the sample mean and standard deviation.
- If background normality cannot be achieved, non-parametric UTLs will not be calculated until a minimum of 60 background samples have been collected (to achieve 95 percent coverage).

The parametric UTL on a future mean will be calculated from the background dataset as follows:

$$UTL = \overline{x} + \kappa\,(n, \gamma, \alpha - 1) \cdot s$$

$\overline{x}$ = background sample mean

s = background sample standard deviation

$\kappa\,(n, \gamma, \alpha - 1)$ = one-sided normal tolerance factor based on the chosen coverage (γ) and confidence level (α -1) and the size of the background dataset (n). Values are tabulated in Table 17-3 in Appendix D of the *Unified Guidance*. If exact values are not provided, then κ values can be estimated by linear interpolation.

If the UTL is constructed on the logarithms of original observations to achieve normality, where $\overline{y}$ and s_y are the log-mean and log-standard deviation, the limit will be exponentiated for back-transformation to the concentration scale as follows:

$$UTL = \exp\left[\overline{y} + \kappa\,(n, \gamma, \alpha - 1) \cdot s_y\right]$$

$\overline{y}$ = background sample log-mean

s_y = background sample log-standard deviation

When the GWPS is based on the 35 I.A.C. § 845.600(a)(1) constituent concentrations or a UTL derived from the background dataset, an exceedance in compliance wells relative to the GWPS will be evaluated using confidence intervals. A confidence interval defines the upper and lower bound of the true mean of a constituent concentration in groundwater within a specified confidence range.

- Non-detects in compliance data will be handled similarly to upgradient analyses, with half the RL substituted for non-detects when the frequency is 15 percent or less.
- The Kaplan-Meier, or the ROS method, will be used when the detection frequency is between 15 percent and 50 percent to compute estimates of the mean and standard deviation adjusted for the presence of left-censored values. These estimates will then be substituted for the sample mean and standard deviation.

Once the GWPS is established for background data using the UTL, either parametric or non-parametric confidence intervals will be computed for each constituent in compliance wells to identify GWPS exceedances.

3.1.2 Parametric Confidence Intervals around a Mean

If compliance data are approximately normal, one-sided parametric confidence intervals around a sample mean will be constructed for each constituent and well pair. The lower confidence limit (LCL) will be calculated as:

$$LCL_{1-\alpha} = \overline{x} - t_{1-\alpha,n-1} \cdot \frac{s}{\sqrt{n}}$$

$\overline{x}$ = compliance sample mean

s = compliance sample standard deviation

n = compliance sample size

$t_{1-\alpha,n-1}$ = obtained from a Student's t-table with (n–1) degrees of freedom (Table 16-1 in Appendix D of the *Unified Guidance*)

The chosen t value will aim to achieve both a low false-positive rate, and high statistical power. Minimum α values are tabulated in Table 22-2 of Appendix D of the *Unified Guidance*. The selected minimum α value, from which the t value will be derived, will have at least 80 percent power (1-β = 0.8) when the underlying mean concentration is twice the GWPS.

If compliance data are distributed lognormally, the LCL will be computed around the lognormal geometric mean as:

$$LCL_{1-\alpha} = \exp\left(\overline{y} - t_{1-\alpha,n-1} \cdot \frac{s_y}{\sqrt{n}}\right)$$

$\overline{y}$ = compliance sample log-mean

s_y = compliance sample log-standard deviation

3.1.3 Non-Parametric Confidence Intervals around a Median

Non-parametric confidence intervals around the median will be computed if the compliance data contain greater than 50 percent non-detects or are not normally distributed. The mathematical algorithm used to construct non-parametric confidence intervals is based on the probability (*P*) that any randomly selected measurement in a sample of n concentration measurements will be less than an unknown *P* x 100th percentile of interest (where *P* is between 0 and 1). Then the probability that the measurement will exceed the *P* x 100th percentile is (1–*P*). The number of sample values falling below the *P* x 100th percentile out of a set of n should follow a binomial distribution with parameters n and success probability *P*, where 'success' is defined as the event that a sample measurement is below the *P* x 100th percentile. The probability that the interval formed by a given pair of order statistics will contain the percentile of interest will then be determined by a cumulative binomial distribution *Bin(x;n,p)*, representing the probability of *x* or fewer successes occurring in *n* trials with success probability p. *P* will be set to 0.50 for an interval around the median.

The sample size n will be ordered from least to greatest. Given *P* = 0.50, candidate interval endpoints will be chosen by ordered data values with ranks close to the product of (n+1) x 0.50. If the result of (n+1) x 0.50 is a fraction (for even-numbered sample sizes), the rank values immediately above and below will be selected as possible candidate endpoints. If the result of (n+1) x 0.50 is an integer (for odd-numbered sample sizes), one will be added to and subtracted from the result to get the upper and lower candidate endpoints. The ranks of the endpoints will be denoted L* and U*. For a one-sided LCL, the confidence level associated with endpoint L* will be computed as:

$$1 - \alpha = Bin(L^{*} - 1; n, 0.50) = \sum_{x=L^{*}}^{n} \binom{n}{x} \left(\frac{1}{2}\right)^{n}$$

If the candidate endpoint(s) do not achieve the desired confidence level, new candidate endpoints (L*–1) and (U*+1) and achieved confidence levels will be calculated. If one candidate endpoint equals the data minimum or maximum, only the rank of the other endpoint will be changed. Achievable confidence levels are tabulated using these equations in Table 21-11 in Appendix D of the *Unified Guidance*.

Both parametric and non-parametric confidence limits will then be compared to the GWPS. The CCR unit is considered to be in compliance if the LCL is equal to or lower than the GWPS for all detected constituents at all compliance monitoring wells. A GWPS exceedance is determined if the LCL exceeds the GWPS.

3.1.4 The Upper Prediction Limit for a Future Mean

The parametric UPL for a future mean will be used to calculate the GWPS if the pooled background data contain 50 to 70 percent non-detects and normality can be achieved. The Kaplan-Meier or ROS methods will be used to estimate the mean and standard deviation. The non-parametric UPL for a future median will be calculated as the GWPS if background samples cannot be normalized or contain greater than 70 percent non-detects. The parametric UPL for a future mean will be calculated from the background dataset at follows:

$$UPL_{1-\alpha} = \overline{x} + \kappa s$$

$\overline{x}$ = background sample mean

s = background standard deviation

κ = multiplier based on the order (p) of the future mean to be predicted, the number of compliance wells to be tested (w), the background sample size (n) the number (c) of constituents of concern (COCs), the "1-of-m" retesting scheme, and the evaluation schedule (annual, semi-annual, quarterly). Values are tabulated in 19-5 to 19-9 in Appendix D of the *Unified Guidance*.

The mean of order p will be computed for each well and compared against the UPL. For any compliance point mean that exceeds the limit, p additional resamples may be collected at that well for a 1-of-2 retesting scheme. Resample means will then be compared to the UPL. A GWPS exceedance has been deemed to occur at a compliance well when the initial mean and all resample means exceed the UPL.

3.1.5 The Non-Parametric Upper Prediction Limit for a Future Median

The non-parametric UPL for a future median will be used to calculate the GWPS if the pooled background data contain greater than 70 percent non-detects and normality cannot be achieved. Non-parametric methods assume that the data does not have an underlying distribution. To calculate the non-parametric UPL on a future value, the target per-constituent false positive rate (a_{const}) will be determined as follows:

$$\alpha_{const} = 1 - (1 - \alpha)^{1/c}$$

α = the site-wide false positive rate (SWFPR) of 0.10 recommended by the *Unified Guidance*

c = the number of monitoring constituents

The number of yearly statistical evaluation (nE) will be multiplied by the number of compliance wells (w) to determine the look-up table entry, w*. The background sample size (n) and w* will be used to select an achievable per-constituent false positive rate value in Table 19-24 of Appendix D in the *Unified Guidance*. The chosen achievable per-constituent false positive rate value will determine the type of non-parametric prediction limit (maximum or 2nd highest value in background) and a retesting scheme for a future median. The background data will be sorted in ascending order, and the upper prediction limit will be set to the appropriate order statistic previously determined by the achievable per-constituent false positive rate value in Table 19-24. If all constituent measurements in a background sample are non-detect, the Double Quantification rule will be used. The use of the Double Quantification rule in Compliance Monitoring will only be applicable if the RL is above the 35 I.A.C. § 845.600(a)(1) constituent concentration or a constituent concentration is not specified in § 845.600(a)(1). This scenario is highly unlikely. The constituent will also be removed from calculations identifying the target false positive rate.

Two initial measurements per compliance well will be collected. If both do not exceed the upper prediction limit, a third initial measurement will not be collected since the median of order 3 will also not exceed the limit. If both exceed the prediction limit, a third initial measurement will not be collected since the median will also exceed the limit. If one initial measurement is above and one below the limit, a third initial observation may be collected to determine the position of the median relative to the UPL. Up to three resamples will be collected in order to assess the resample median. In all cases, if two or more of the compliance point observations are non-detect, the median will be set equal to the RL. The median value for each compliance well will be compared to the UPL. For the 1-of-2 retesting scheme, if any compliance point median exceeds the limit, up to three additional resamples will may be collected from that well. The resample median will be computed and compared to the UPL. A GWPS exceedance has been deemed to occur at a compliance well when either the initial median, or both the initial median and resample median exceed the UPL.

If the concentrations of detected constituents are below the established GWPS, Compliance Monitoring will continue.

3.1.6 Parametric Linear Regression and Confidence Band

If the t-test detects a significant trend in the parametric linear regression line using either background or compliance data for a particular constituent, confidence bands accounting for trends will be constructed to account for the trend-induced variation. If this is not accounted for, a wider confidence interval will inevitably be calculated for a given confidence level and sample size (n). A wider confidence interval will result in less statistical power, or ability to demonstrate an exceedance or return to compliance. When a linear trend line has been estimated, a series of confidence intervals is estimated at each point along the trend. This creates a simultaneous confidence band that follows the trend line. As the underlying population mean increases or decreases, the confidence band does also to reflect this change at that point in time.

Linear regression will be used when background or compliance data are approximately normally distributed, with a constant sample variance around the mean, and the frequency of non-detects is low. The linear regression of concentration against sampling date (time) will be computed as follows:

$$\hat{b} = \sum_{i=1}^{n} (t_i - \bar{t}) \cdot x_i / (n-1) \cdot s_t^2$$

x_i = i^{th} concentration value and

t_i = i^{th} sampling date

$\bar{t}$ = sampling mean date

s_t^2 = variance of the sampling dates

This estimate leads to the following regression equation:

$$\hat{x} = \bar{x} + \hat{b} \cdot (\mathrm{t} - \bar{t})$$

$\bar{x}$ = mean concentration level

$\hat{x}$ = estimated mean concentration at time t

The regression residuals will also be computed at each sampling event to ensure uniformity and lack of significant skewness. Regression residuals will be computed at each sampling event as follows:

$$r_i = x_i - \hat{x}_i$$

The estimated variance around the regression line, or mean squared error (MSE) will be computed as follows:

$$s_e^2 = \frac{1}{n-2} \sum_{i=1}^{n} r_i^2$$

The confidence intervals around a linear regression trend line given confidence level (1-ɑ) and a point in time (t_0), will be computed as follows:

$$LCL_{1-\alpha} = \hat{x}_0 - \sqrt{2 s_e^2 \cdot F_{1-2\alpha,2,\mathrm{n}-1} \cdot \left[\frac{1}{n} + \frac{\left(t_0 - \bar{t}\right)^2}{(n-1) \cdot s_t^2} \right]}$$

$$UCL_{1-\alpha} = \hat{x}_0 - \sqrt{2 s_e^2 \cdot F_{1-2\alpha,2,\mathrm{n}-2} \cdot \left[\frac{1}{n} + \frac{\left(t_0 - \bar{t}\right)^2}{(n-1) \cdot s_t^2} \right]}$$

$\hat{x}_0$ = estimated mean concentration from the regression equation at time t_0

$F_{1-2\alpha,2,\mathrm{n}-2}$ = upper $(1\text{-}2\alpha)^{\text{th}}$ percentage point from an F-distribution with 2 and (n-2) degrees of freedom

For background data, the UCL around the linear regression line will be used as the GWPS for the trending constituent. For compliance data, confidence bands around the linear regression line will be compared to the GWPS. The CCR unit is considered to be in compliance if the LCL is equal to or lower than the GWPS for all detected constituents at all compliance wells. A GWPS exceedance is determined when the LCL based on the trend line first exceeds the GWPS.

3.1.7 Non-Parametric Thiel-Sen Trend Line and Confidence Band

If the Mann-Kendall test detects a significant trend in the non-parametric Thiel-Sen line using either background or compliance data for a particular constituent, confidence bands accounting for trends will be constructed to account for the trend-induced variation. The Thiel-Sen trend line will be used as a non-parametric alternative to linear regression when trend residuals cannot be normalized or if there are a higher percentage of non-detects in either background or compliance data. The Thiel-Sen trend line estimates the median concentration over time by combining the median pairwise slope with the median concentration value and the median sample date. To compute the Thiel-Sen line, the data will first be ordered by sampling event x1, x2, xn. All possible distinct pairs of measurements (x_i, x_j) for j > i will be considered and the simple pairwise slope estimate will be computed for each pair as follows:

$$m_{ij} = (x_j - x_i)/(j - i)$$

With a sample size of n, there will be a total of N = n(n-1)/2 pairwise estimates (m_{ij}). If a given observation is a non-detect, half the RL will be substituted. The N pairwise slope estimates (m_{ij}) will be ordered from least to greatest (renamed m(1), m(2),..m(N)). The Thiel-Sen estimate of slope (Q) will be calculated as the median value of the list depending on whether N is even or odd as follows:

$$Q = \begin{cases} m_{([N+1]/2)} \; if \; N \; is \; odd \\ (m_{(N/2)} + m_{([N+2]/2)})/2 \; if \; N \; is \; even \end{cases}$$

The sample concentration magnitude will be ordered from least to greatest, x(1), x(2), to x(n) and the median concentration will be calculated as follows:

$$\tilde{x} = \begin{cases} x_{([n+1]/2)} \; if \; n \; is \; odd \\ (x_{(n/2)} + x_{([n+2]/2)})/2 \; if \; n \; is \; even \end{cases}$$

The median sampling date ($\tilde{t}$) with ordered times (t(1), t(2), to t(n)) will also be determined in this way. The Thiel-Sen trend line will then be computed for an estimate at any time (t) of the expected median concentration (x) as follows:

$$x = \tilde{x} + Q \cdot (\mathrm{t} - \tilde{t}) = (\tilde{x} - Q \cdot \tilde{t}) + Q \cdot \mathrm{t}$$

To construct a confidence band around the Thiel-Sen line, sample pairs (ti, xi) will be formed with a sample date (ti) and the concentration measurement from that date (xi). Bootstrap samples (B) will be formed by repeatedly sampling n pairs at random with replacement from the original sample pairs. This will be repeated 500 times. For each bootstrap sample, a Thiel-Sen trend line will be constructed using the equation above. A series of equally spaced time points (tj) will be identified along the range of sampling dates represented in the original sample, j =1 to m. The Thiel-Sen trend line associated with each bootstrap replicate will be used to compute an estimated concentration ($\hat{x}_j^B$). An LCL will be constructed for the lower α^{th} percentile $\hat{x}_j^{[\alpha]}$ from the distribution of estimated concentrations at each time point (tj). For a UCL, compute the upper $(1-\alpha)^{th}$ percentile, $\hat{x}_j^{[1-\alpha]}$ at each time point (tj).

For background data, the UCL around the Thiel-Sen trend line will be used as the GWPS for the trending constituent. For compliance data, confidence bands around the Thiel-Sen trend line will be compared to the GWPS. The CCR unit is considered to be in compliance if the LCL is equal to or lower than the GWPS for all detected constituents at all compliance wells. A GWPS exceedance is confirmed when the LCL based on the trend line first exceeds the GWPS.

3.2 Determination of Statistically Significant Increases over Background

In accordance with 35 I.A.C. §§ 845.610(b)(3)(B) and 845.640(h), individual monitoring event concentrations for each constituent detected in the compliance monitoring wells during compliance monitoring sampling events will be compared to the background concentration as determined by the methods described above. An exceedance of the background concentration for any constituent measured at any compliance monitoring well, or constituent detection if not detected in the background samples, constitutes a Statistically Significant Increase (SSI). An exception to this method is pH, where two-sided (upper and lower) tolerance limits are established from the distribution of the background groundwater quality data. An exceedance of either the UTL or lower tolerance limit (LTL) would constitute an SSI for pH.

4. REFERENCES

Davis, C.B., 1994. *Environmental Regulatory Statistics.* In GP Patil & CR Rao (Eds.) *Handbook of Statistics, Volume 12: Environmental Statistics*, Chapter 26. New York: Elsevier Science B.V.

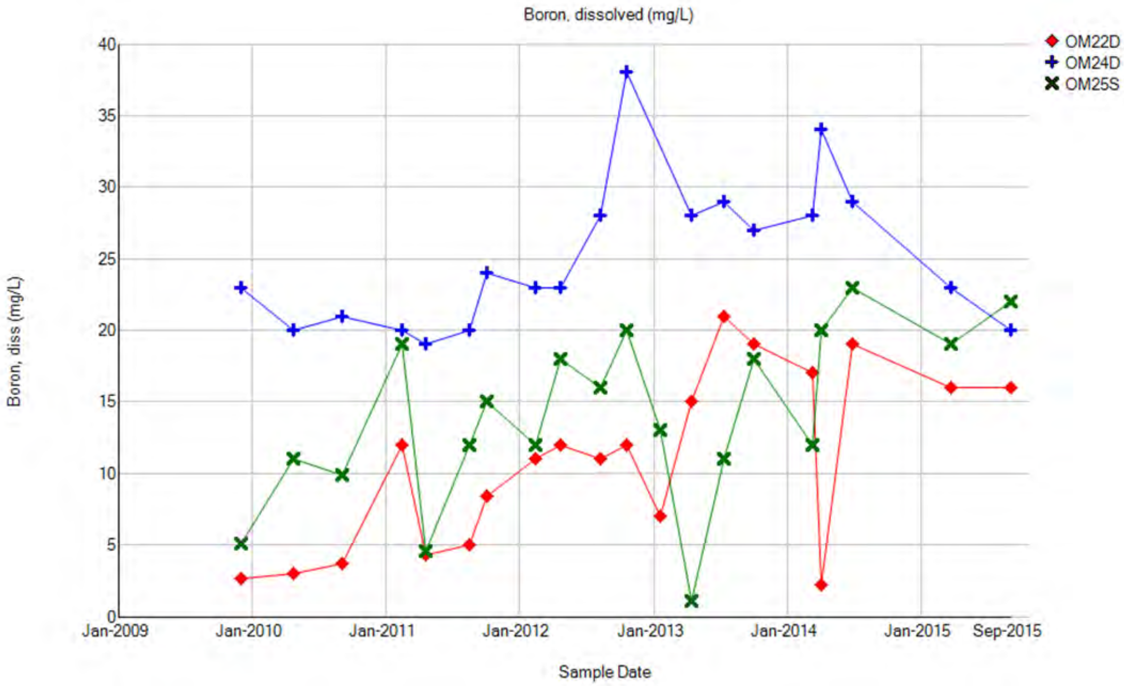
United States Environmental Protection Agency (USEPA), 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance*. EPA 530-R-09-007. March 2009.

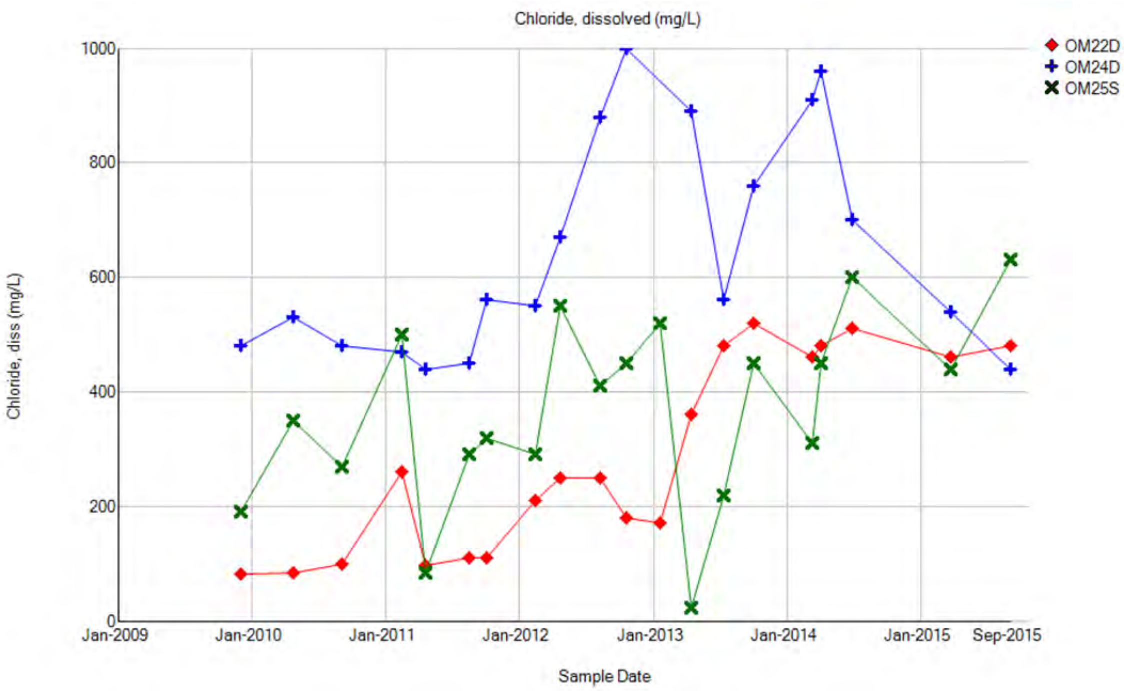
ATTACHMENT 2
REVISION TO THE SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION AND GROUNDWATER MONITORING PLAN AND GROUNDWATER MANAGEMENT ZONE APPLICATION

SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATON AND GROUNDWATER MONITORING PLAN
Duck Creek Ash Ponds 1 and 2
Duck Creek Energy Center
Canton, Illinois
Project No: 2333
March 31, 2016

Revised pages submitted in September 2016:

- 3-5
- 5-1 and 5-2
- 6-1 and 6-2
- Table 3-1





As previously noted in Section 3.3, background boron concentrations in the coal mine spoils can be as high as 2 mg/L.

5 APPLICABLE GROUNDWATER QUALITY STANDARDS

5.1 Groundwater Classification

The Duck Creek Ash Ponds 1 and 2 are located within a previously mined area and monitoring has demonstrated that the groundwater is not capable of consistently meeting the standards for Class I: Potable Resource Groundwater (35 IAC 620.410) or Class II: General Resource Groundwater (35 IAC 620.420). Therefore, the applicable classification of groundwater at the site is Class IV: Other Groundwater (35 IAC 620.240(g)).

5.2 Applicable Groundwater Quality Standards

For groundwater within a previously mined area, the applicable groundwater quality standards for the site are the standards for Class IV: Other Groundwater. The groundwater quality standards for Class IV: Other Groundwater cannot be exceeded (35 IAC 620.440(c)) except as provided below:

- The groundwater quality standards for TDS, chloride, iron, manganese, sulfate, and pH, are the existing concentrations (35 IAC 620.440(c)).
- Except as provided above, Class IV: Other Groundwater standards are equal to the existing concentrations of constituents in groundwater (35 IAC 620.440(c)).

The list of applicable groundwater quality standards for the site is shown on Table 3-1. Off-site groundwater also occurs within mine spoils, and is therefore Class IV: Other Groundwater. Applicable off-site groundwater quality standards will be the same as described above.

5.3 Proposed Exceptions to the Groundwater Quality Standards

Based on the results of groundwater monitoring performed at the site to date, the following exceptions to the above applicable Class II: General Resource Groundwater standards are proposed:

- Leachate (Appendices C-1, C-2) and groundwater (Appendix C-3) samples collected at the site do not indicate exceedances of the groundwater quality standards for Class II General Resource Groundwater inorganic constituents listed in 35 IAC 620.420(a)(1). The analyzed constituents include antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, cyanide, fluoride, lead, mercury, nitrate, and thallium.[2] These constituents will not be monitored because they currently meet the standards for Class II General Resource

[2] Perchlorate and vanadium are parameters listed in 35 IAC 620.420(a)(1) but have not been analyzed.

Groundwater and are not associated with the chemical characteristics of the Duck Creek ash ponds.[3]

- Leachate (Appendices C-1, C-2) and groundwater (Appendix C-3) samples collected at the site do not indicate exceedances of the groundwater quality standards for Class II General Resource Groundwater for inorganic constituents copper, nickel, selenium, silver, and zinc listed in 35 IAC 620.420(a)(2). These constituents will not be monitored at wells OM23D and OM25D because they currently meet the standards for Class II General Resource Groundwater and are not associated with the chemical characteristics of the Duck Creek ash ponds.

The proposed groundwater monitoring parameters for the Duck Creek ash ponds are discussed in Section 6.1.

[3] An anomalous arsenic concentration of 0.31 ug/L was observed on October 21, 2013 at OR13S; all other results (thirteen sampling events) at this location exhibited As concentrations below 0.015 ug/L, which are well below the Class II groundwater quality standard of 0.2 ug/L.

6 GROUNDWATER MONITORING PLAN

The groundwater monitoring plan will monitor and evaluate groundwater quality to demonstrate compliance with the groundwater quality standards for Class IV: Other Groundwater[4]. The post-closure groundwater sampling network is proposed to consist of three background monitoring wells and 19 compliance monitoring wells. Table 4-1 provides a list of the wells and their intended use for the monitoring program.

6.1 Monitoring Parameters

Groundwater samples will be collected and laboratory-analyzed for the following parameters that are indicator constituents for coal ash leachate from the ash ponds:

- Boron (dissolved)
- Chloride (dissolved)

The following field parameters will be also measured for each groundwater sample:

- pH
- Specific conductance
- Temperature

The depth to groundwater and total well depth will also be recorded during each sampling event.

As discussed in Section 5, other parameters regulated under 35 IAC 620 will be not be monitored because either:

- Their Class II: General Resource Groundwater standard is the existing concentration of the constituent in groundwater (TDS, iron, manganese, sulfate), and they are not indicator constituents for leachate migration from the ash ponds; therefore, there is no basis to which compare the data
- Groundwater monitoring results to date indicates that the inorganic constituents antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, cyanide, fluoride, lead, mercury, nickel, nitrate, selenium, silver, thallium and zinc currently meet the Class II: General Resource Groundwater standards and are not associated with the chemical characteristics of the Duck Creek ash ponds.

[4] Based on the conclusions of the Hanson (2016a) report in Appendix B1, there is no Uppermost Aquifer as defined by the US EPA (2015) [40 CFR 257.53].

Upon Illinois EPA's request, pH and additional inorganic chemicals listed in 35 IAC 620.410 will be added to the list of reported groundwater monitoring parameters for one or more scheduled sampling events.

6.2 Sampling Schedule

Groundwater sampling will initially be performed quarterly according to the schedule provided in Table 4-2. Five years after approval of the Closure Plan, a request may be made to modify the post-closure care plan to reduce the frequency of groundwater monitoring to semi-annual sampling by demonstrating all of the following:

- Monitoring effectiveness will not be compromised by the reduced frequency of monitoring
- Sufficient data has been collected to characterize groundwater
- Concentrations of constituents monitored at the downgradient boundaries show no statistically significant increasing trends that can be attributed to the former ash ponds

If concentrations of parameters of concern at the downgradient boundaries of the site show no statistically significant increasing trends that can be attributed to the ash ponds for the five years after reducing the monitoring frequency to semi-annual, a request may be made to modify the post-closure care plan to reduce monitoring frequency to annual sampling by demonstrating the same items above as for the reduction to semi-annual monitoring.

Groundwater monitoring may be discontinued upon IEPA's approval of a certified post-closure care report. Specifically, when no statistically significant increase is detected in the concentration of any constituent above that measured and recorded during the immediately preceding scheduled sampling for four consecutive years after changing to an annual monitoring frequency.

6.3 Groundwater Sample Collection

Groundwater samples will be collected according to the protocol included in Appendix F. The procedure is summarized below.

All groundwater elevations will be measured on a single day, in conjunction with sampling of the wells. Monitoring wells will be sampled using either a peristaltic pump or bladder pump. Each well will be purged utilizing low flow techniques, and until the measured pH, temperature, and specific conductance have stabilized within ±10 percent. If low-flow stabilization is not possible, either a submersible pump or bailer will be used to remove four well volumes and/or bail the well dry. Field parameters will be collected following purging of the well. Field parameters will be recorded in the logbook.

Boron samples will be field-filtered (using a 0.45 micron disposable filter); and the sample will be collected in laboratory-provided high-density polyethylene (HDPE) bottles with the appropriate preservatives. All

Table 3-1
Monitored Parameters and Groundwater Quality Standards
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Parameter	Time Interval Monitored	Applicable Groundwater Quality Standard
Antimony	2011 to 2014	Class II
Arsenic	2011 to 2014	Class II
Barium	2011 to 2014	Class II
Beryllium	2011 to 2014	Class II
Boron	1980 to Present	Class II
Cadmium	2011 to 2014	Class II
Chloride	1980 to Present	(1)
Chromium	2011 to 2014	Class II
Cobalt	2011 to 2014	Class II
Copper	2011 to 2014	Class II
Cyanide	2011 to 2014	Class II
Fluoride	2011 to 2014	Class II
Hardness	1980 to Present	(2)
Iron	1980 to Present	(1)
Lead	2011 to 2014	Class II
Manganese	1980 to Present	(1)
Mercury	2011 to 2014	Class II
Nickel	2011 to 2014	Class II
Nitrate nitrogen	2011 to 2014	Class II
pH	1980 to Present	(1)
Selenium	2011 to 2014	Class II
Silver	2011 to 2014	(2)
Specific Conductance	1980 to Present	(2)
Sulfate	1980 to Present	(1)
Temperature	1980 to Present	(2)
Thallium	2011 to 2014	Class II
Total Dissolved Solids	1980 to Present	(1)
Zinc	2011 to 2014	Class II

Notes

Except as noted below, Class II standards are applicable for Class IV groundwater in previously mined areas

(1) Per 35 IAC 620.440(c) the standard for this constituent is the existing concentration.

(2) There is no Class II or Class IV standard for this constituent. Per 35 IAC 620.440(c)

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SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION AND GROUNDWATER MONITORING PLAN

Duck Creek Ash Ponds 1 and 2
Duck Creek Energy Center
Canton, Illinois

Project No: 2333

March 31, 2016

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SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION AND GROUNDWATER MONITORING PLAN

DUCK CREEK ASH PONDS 1 AND 2
DUCK CREEK ENERGY CENTER
CANTON, ILLINOIS

Project No. 2333

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TABLE OF CONTENTS

Natural Resource Technology

FIGURES

TABLES

APPENDICES

1 INTRODUCTION

1.1 Overview

This Supplemental Hydrogeologic Site Characterization and Groundwater Monitoring Plan was prepared for Illinois Power Resources Generating, LLC (IPRG) to develop hydrogeologic information in support of a Closure Plan for the Duck Creek Energy Center Ash Ponds 1 and 2.

Numerous site-specific subsurface investigations were performed at the Duck Creek Energy Center over the past 30 years, in compliance with various State and Federal environmental monitoring requirements. Hanson Professional Services, Inc., (Hanson) prepared a Hydrogeologic Report in March 2010, which Ameren[1] subsequently submitted to IEPA on March 25, 2010. The Hanson (2010) report provided documentation of background information, a description of subsurface geology, and discussions of groundwater analytical trends and hydrogeologic conditions while Ash Pond 1, Ash Pond 2, and Recycle Pond were in service.

The Hanson (2010) report is supplemented herein with additional information on the site geology and hydrogeology as well as groundwater analytical trends. The results of hydrostatic equilibrium modeling of the closure of Ash Ponds 1 and 2 will be submitted independent of this report.

1.2 Site Location and History

The Duck Creek Energy Center is located in Sections 19 and 30 of Township 6 North, Range 5 East, southeast of Canton, in Fulton County, Illinois. Figure 1-1 depicts the location, topography, and surrounding land use near the power plant. Figure 1-2 is an aerial photograph that identifies the locations of Ash Pond 1, Ash Pond 2, the previously clean-closed Recycle Pond (collectively referred to herein as the “ash ponds”), coal storage yard, generating facility, and nearby surface water bodies, including Duck Creek Cooling Pond, which is used as a source of cooling water for the Duck Creek power generation units, and Long Lake, a remnant of the area’s surface mining history.

Prior to construction of the power plant and associated facilities, strip mining of coal took place within the boundaries of the Duck Creek Energy Center, specifically in the area now occupied by the ash ponds, and on land immediately surrounding the ash ponds. Mining occurred at the Buckheart Mine No. 17, from

[1] IPRG has owned and operated the Duck Creek Energy Center since December 2, 2013. As relevant herein, Ameren Energy Resources Generating Company (Ameren) owned and operated the Duck Creek Energy Center up to December 2, 2013.

1937 to 1984, originally operated by United Electric Coal Company (1937 to 1975), and then later by Freeman United Coal Mining Company (1975 to 1984). As a result of these mining activities, subsurface investigations have encountered a mixture of mining spoils with native materials–mostly silt, clay, and broken shale bedrock–as evidence of past mining activities (Hanson, 2010).

Ash Pond 1 was constructed and permitted in 1976, concurrent with the commissioning of the Duck Creek Energy Center. The structure is as an above ground impoundment with raised berms covering approximately 60 acres. At an average depth of 21 feet, Ash Pond 1 has a design capacity of 1,230 acre feet (acre-ft). Ash Pond 2 was constructed in 1984, also as an above ground impoundment covering approximately 80 acres with an average depth of 40 feet. Ash Pond 2 has a design capacity of 3,200 acre-ft. The Recycle Pond was constructed below grade at an average depth of 3½ feet over approximately 40 acres resulting in a capacity of 140 acre-ft.

Fly ash was sluiced to Ash Pond 1 between 1976 and 1986, while Ash Pond 2 accepted fly ash beginning in 1984. Clean closure activities at the Recycle Pond were completed in 2010, when Ash Pond 1 and Ash Pond 2 were removed from service. Ash from the Recycle Pond was excavated and placed in Ash Ponds 1 and 2. AECOM Figures 2A and 2B (Appendix A) show the current topography of the ash ponds.

IPRG no longer sluices fly ash at the Duck Creek Energy Center, and has obtained permits and constructed landfill facilities to manage fly ash and FGD residue, and a new lined basin to treat bottom ash transport water and miscellaneous low volume wastewater.

2 SUMMARY OF SITE GEOLOGY AND HYDROGEOLOGY

2.1 Site Geology

The site-specific geology was described by Hanson (2010). Regionally, the upper unconsolidated materials consist of Wisconsinan Stage materials overlying Illinoian Stage deposits. The undisturbed unconsolidated materials near the Site consist of loess, diamictons, and lacustrine/alluvial deposits (Willman, 1975). These materials are present in the strip mine spoil material, but have been excavated and mixed due to the surface mining activities. The Site and surrounding area are part of several, large, surface coal mines that have since stopped mining operations (Berg and Kempton, 1988). AECOM Figure 1 (Appendix A) shows the approximate limits of mining activities within and surrounding the Site.

Previous site investigations completed and reports prepared for the Site indicate that bedrock in the area is overlain by mine spoil ranging in thickness from approximately 10 ft (at monitoring well OM24D) to 75 feet (at OM15). The mine spoil consists of excavated bedrock (weathered shale, shale fragments, and some coal fines) mixed with the sand, silts and silty clays of the unconsolidated glacial and aeolian deposits. In general, the depth to bedrock increases to the south and east. However, there appears to be a bedrock ridge that lies approximately midway (north-south axis) beneath Ash Pond 2 (Hanson, 2010).

AECOM (2015) completed a geotechnical investigation that included an additional 31 borings that were reported in the 30% design data package for theAsh Ponds 1 and 2. Soils encountered were typically described as mottled grey to reddish brown lean clay. Representative samples from the borings were submitted to Alpha-Omega Geotech, Inc. (Alpha-Omega) for laboratory determination of soil geotechnical properties, including, but not limited to, Atterberg Limits, natural moisture (%), unconfined compression strength, void ratio, hydraulic conductivity and triaxial compression tests. The geotechnical information is being submitted as a separate report for the ash pond closure plan.

The uppermost bedrock consists of a Carbondale Formation shale unit that lies stratigraphically beneath the Springfield (No. 5) Coal Member that was mined. The near surface bedrock at the Site generally consists of shale, siltstone, sandstone, and coal. Geologic cross-sections are shown on Hanson Figures 4 and 5 (Appendix A).

2.2 Site Hydrology

The Site topography and drainage is shown on Figure 1-1. Surface water drainage over much of the Site flows into the Duck Creek Cooling Pond, the cooling water impoundment for the Station. The western-most portion of the Site (west of the ash ponds) slopes toward the west. Surface water runoff from this area of the Site drains to a surface mining remnant known as Long Lake. The lake is an end-cut or last-cut lake formed when a mine operator leaves the last mining excavation or cut open, instead of backfilling with earth or other mined spoils. Long Lake lies on property currently owned by Freeman United Coal Company.

2.3 Site Hydrogeology

2.3.1 Groundwater Flow within Coal Mine Spoils

As described in the Hanson (2010) report, shallow groundwater at the site occurs within coal mine spoils. During the period of operation of Ash Pond 1 and Ash Pond 2, the ponded surface water created mounding of the water table and generated a radial pattern of flow beneath the ponds. Groundwater flowed to the east toward the Duck Creek Cooling Pond, to lowland areas to the north and in a westerly direction toward Long Lake. A water table contour map for April 2007, prior to removal of service of the ash ponds, is shown on Figure 2-1.

Following closure of the Recycle Pond and removal of Ash Ponds 1 and 2 from service, changes in groundwater elevation were observed within the ash ponds (Table 2-1) and at multiple monitoring wells (Table 2-2). Porewater elevations measured in wells within the ash ponds decreased by 1.8 to 4.9 ft between November 2010 and May 2012. Large decreases in average groundwater elevation were recorded at wells adjacent to the ash ponds, with the largest average decreases (greater than 5 ft) occurring at wells located between the Recycle Pond and Ash Ponds 1 and 2 (OR05D, OM05S, OR06A, OM07, OR13D). Large decreases in groundwater elevations (3 to 7 ft) were also noted at wells OR11, OR19 and OM20/OR20 located immediately east of the Recycle Pond.

Increases in average groundwater elevation ranging from 0.5 to 5.0 ft were typically noted in wells located in lowland areas east of the ash ponds (Table 2-2, OM10, OM12, OR14D, OM15, OM16, OM17 and OR18). These increases are not related to closure of the Recycle Pond or removal of Ash Ponds 1 and 2 from service.

Representative hydrographs of wells between the closed Recycle Pond and Ash Pond 2 (OR6A), wells located immediately east of the Recycle Pond (OR20), and wells located in lowland areas east of the ash ponds (OM16) are shown below.

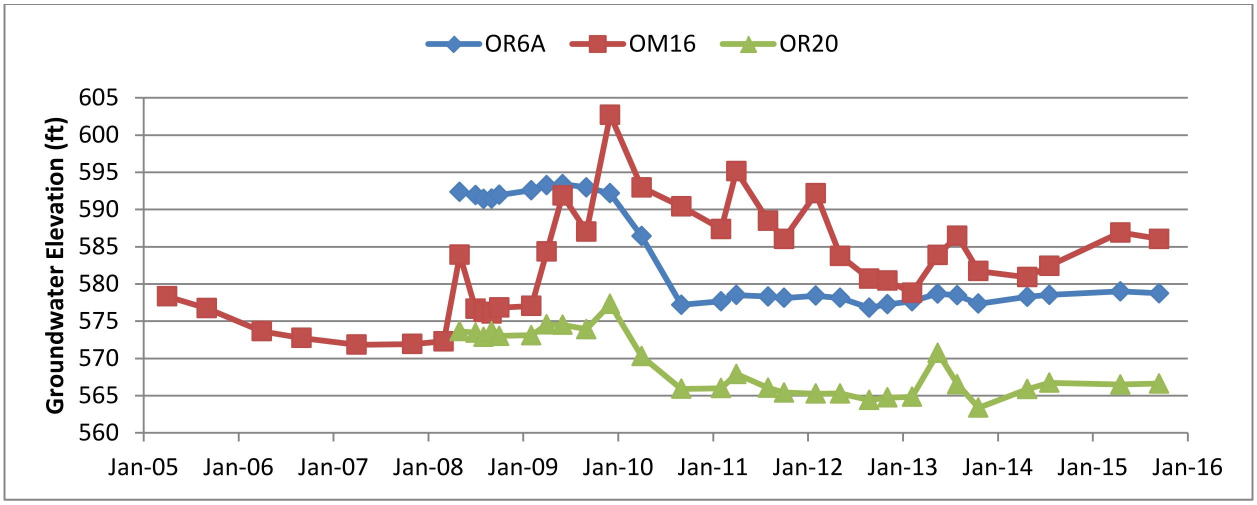


Figure 2-2 shows water table elevation contours and flow directions in September 2015, approximately five years following closure of the Recycle Pond and removal of Ash Ponds 1 and 2 from service in 2010. Comparison of the April 2007 and September 2015 water table elevation contour maps indicates that while the pond closure activities have lowered porewater heads within the ash, groundwater mounding within the ash ponds maintains a general radial flow pattern. However, the groundwater quality data (discussed in Section 3) suggests there may be an increased component of flow in a westerly direction toward Long Lake, based on increasing boron and/or chloride concentrations in selected wells.

2.3.2 Hydraulic Conductivity within Coal Mine Spoils

Hanson (2016a) completed hydraulic conductivity testing (slug testing) of the monitoring wells immediately surrounding Ash Pond 1 and Ash Pond 2. Analyses of the falling head and rising head tests performed at each well were performed using the Bower-Rice method [B-R] (Bouwer & Rice, 1976; Bouwer, 1989) and the Kansas Geological Survey method [KGS] (Butler, 1998) unconfined solutions. The geometric mean hydraulic conductivity for the 23 tests performed within mine spoil material was 2.0 x 10^{-4} cm/sec, with values ranging from 1.5 x 10^{-3} cm/sec at OR03D to 5.2 x 10^{-6} cm/sec at OM04S. Test methods and details are provided in Appendix B1 and the results are summarized below.

Field Hydraulic Conductivity Test Results (cm/sec)

Well Number	Falling Head	Rising Head	Geometric Mean	Analysis Method
OM01	0.00045	0.00065	0.00054	B-R
OR02	0.00037	0.00047	0.00042	B-R
OR03D	0.0015	0.00077	0.0011	B-R
OR03S	0.00039	0.00030	0.00034	B-R
OR04D	0.00015	0.00031	0.00021	B-R
OM04S	0.0000052	0.000055	0.000017	B-R
OR05D	0.000034	0.000034	0.000034	KGS
OM05S	0.000095		0.000095	B-R
OR06A	0.00018	0.00054	0.00031	B-R
OM07	0.00011	0.00024	0.00016	B-R
OM09	0.00031	0.00026	0.00028	KGS
OM21	0.00035	0.00036	0.00035	B-R
Geometric Mean =	1.7×10^{-4}	2.7×10^{-4}	2.0×10^{-4}	

Four falling head permeability tests (ASTM D5084 Method C) were also performed in the Alpha-Omega laboratory on undisturbed soil samples collected from the AECOM (2015) geotechnical borings B008, B015, B019 and B026. Sample locations are shown on AECOM Figures 2A and 2B Ash Pond Borehole Location maps in Appendix A. Test methods and details are provided in Appendix B2 and the results are summarized below.

Laboratory Hydraulic Conductivity Test Results (cm/sec)

Boring Number	Sample Depth (feet)	Hydraulic Conductivity
B008	16 – 17.5	6.8×10^{-8}
B015	56 – 57.5	8.1×10^{-8}
B019	43.5 - 45	3.7×10^{-7}
B026	33.5 – 35	1.5×10^{-7}
Geometric Mean =		1.3×10^{-7}

The geometric mean hydraulic conductivity of 1.3×10^{-7} for the 4 laboratory tests performed within mine spoil material was several orders of magnitude lower than the field test results. The falling head permeability tests on undisturbed soil samples measure hydraulic conductivity in a vertical orientation whereas the field tests measure a much larger section of saturated soil in a horizontal orientation. Slug tests in the field at this site will encounter discontinuous lenses of sand and silt within the disturbed mine spoil that will exhibit localized higher hydraulic conductivity. Given this anisotropy of the mine spoil material, a range of horizontal hydraulic conductivities measured in the field that is several orders of magnitude higher than the range of vertical hydraulic conductivity measured in the laboratory is not unexpected. These results suggest groundwater will preferentially flow laterally through the mine spoils rather than vertically and that the rate of lateral groundwater flow will be highly variable.

2.3.3 Potential for Saturated Ash

As previously discussed, groundwater mounding within the ash ponds persists since the ponds have been removed from service in 2010. Porewater levels measured in piezometers screened within the coal ash (Table 2-1) indicate head fluctuations of about 3 ft. Boring logs for OM26, OM27, and OM28, which were drilled in the center of Ash Ponds 1 and 2, indicated an ash thickness of 60 to 63 ft below ash surface elevations of 650 to 660 feet. This places the base of ash at an elevation of approximately 590 feet. Given porewater elevations of 627 to 638 ft measured in December 2015, the current thickness of saturated ash is roughly 40 to 50 ft.

These porewater elevations are roughly 30 to 40 ft higher than in monitoring wells located in the surrounding berms. As previously noted, it appears groundwater levels in selected wells have been decreasing, due to the site regrading and the reduction of surface water in the ash ponds (Table 2-2). Groundwater elevations are expected to continue to dissipate after the cap is constructed. It is possible that ash will not be saturated once the cap is applied and the mound dissipates.

A more detailed analysis of the post-closure hydrostatic equilibrium groundwater elevations beneath the ash ponds is provided in the modeling report prepared by Hanson (2016b).

2.3.4 Groundwater in Bedrock

During September 2015, Hanson (2016a) completed boring OM26B to a depth of 355 ft below ground surface (bgs). Bedrock was encountered at a depth of 85 ft. At the completion of the coring operations, the lower 255 ft. of bedrock in the boring was pressure (packer) tested. The interval between the two packers was approximately 8.5 ft. Flow to the bedrock test interval (i.e. hydraulic conductivity) was measured at several increasing and decreasing pressures. As shown below, the mean hydraulic conductivity values decreased as pressure testing continued up the borehole. The greatest water uptake during the testing was noted in the bottom 20 ft. of the borehole with mean hydraulic conductivity values ranging from 2 to 9 x 10^{-6} cm /sec. The uppermost 100 ft. of bedrock tested had almost no water uptake during the pressure testing.

Field Packer Test Hydraulic Conductivity Results (cm/sec)

Test No.	Depth (ft.)	Arithmetic Mean of Hydraulic Conductivity	Median of Hydraulic Conductivity
A	351.57	1.7×10^{-6}	1.3×10^{-6}
B	331.64	8.5×10^{-6}	5.8×10^{-6}
C	321.54	5.7×10^{-8}	3.9×10^{-8}
D	300.77	5.0×10^{-7}	2.7×10^{-8}
E	279.77	0.0	0.0
F	269.17	7.1×10^{-9}	0.0
G	258.72	5.9×10^{-7}	4.6×10^{-8}
H	248.62	3.0×10^{-9}	0.0
I	227.61	0.0 *(no take)*	0.0 *(no take)*
J	217.05	3.6×10^{-8}	0.0 *(no take)*
K	206.51	1.5×10^{-9}	0.0
L	196.37	0.0 *(no take)*	0.0 *(no take)*
M	185.77	1.5×10^{-9}	0.0
N	175.55	0.0 *(no take)*	0.0 *(no take)*
O	165.39	4.1×10^{-9}	0.0
P	155.25	0.0 *(no take)*	0.0 *(no take)*
Q	144.75	1.5×10^{-9}	0.0
R	134.15	1.3×10^{-9}	0.0
S	124.04	0.0 *(no take)*	0.0 *(no take)*
T	113.86	0.0 *(no take)*	0.0 *(no take)*
U	103.41	0.0 *(no take)*	0.0 *(no take)*

Based on these results, the bedrock is acting as an aquitard to vertical migration of groundwater. Details of the packer testing and boring log are provided in the Hanson (2016a) report in Appendix B1.

2.3.5 Proximity of Potable Wells

Hanson (2010) identified one domestic water supply well approximately one mile north-northwest of Ash Pond 2 as shown on Hanson Figure 1 (Appendix A). This well is sufficiently distant that it cannot be considered downgradient of the site. The boring log for the potable well indicates that it was completed to a total depth of 50 feet bgs. Water is obtained from clay at a depth of 48 feet, and a reported pumping capacity of 10 gallons per minute. The well is located within an area where the unconsolidated deposits have not been disturbed by mining.

3 GROUNDWATER QUALITY

3.1 Summary of Groundwater Monitoring Activities

Groundwater monitoring has been performed at the site since 1980. Sampling was initially performed semi-annually for the parameters specified in the facility's IEPA, Subpart B permit. Samples are currently collected semi-annually from 20 of the site’s 31 monitoring wells in accordance with Site Operating Permit 2010-EO-0296 for analysis of boron, chloride, hardness, iron, manganese, sulfate and total dissolved solids (TDS) as well as field parameters pH, specific conductance and temperature. Samples of porewater and surface water from the ash ponds were also historically collected and analyzed. Table 3-1 lists monitored parameters and the time interval over which the parameters have been sampled and analyzed. Table 3-2 is a list of existing monitoring wells at the facility and the period each well has been monitored for groundwater elevation and/or chemistry. Figure 3-1 shows the monitoring well locations and elevations of the bottom of the well screens.

3.2 Leachate Concentrations

Appendix C-1 lists leachate sample results for surface water from Ash Ponds 1 and 2 and former Recycle Pond, and Appendix C-2 provides porewater leachate sample analytical laboratory reports from two piezometers screened in the ash ponds. Table 3-3 lists the low, high and median concentrations for the constituents analyzed in Ash Ponds 1 and 2 and the Recycle Pond as well as the porewater leachate samples.

The leachate is characterized by boron concentrations greater than 100 mg/L, chloride, sulfate and hardness concentrations greater than 1,000 mg/L, and low concentrations for most trace metals. Boron and chloride are the most likely indicators of the presence of ash pond leachate constituents in groundwater for this site. As discussed further below, these constituents have high concentrations in leachate relative to background.

3.3 Background Groundwater Quality

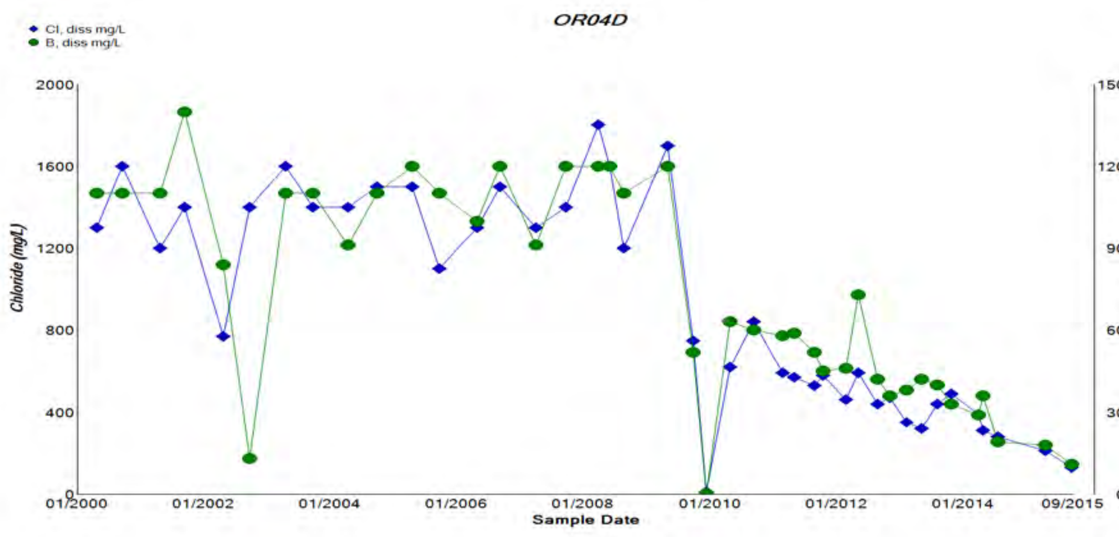
Appendix C-3 lists groundwater analytical results for samples collected from all monitoring wells since 2000. Boron and chloride concentrations monitored in wells distant (more than 2,000 feet) from the ash ponds (OM10, OM16, OM17) are low with median concentrations less than 0.2 mg/L boron and 10 mg/L chloride (Table 3-4), indicating that these wells represent background groundwater quality within the mine spoils. Hardness, sulfate and TDS concentrations in these wells are high and occur within the concentration ranges of these constituents in leachate. Median iron and manganese concentrations are higher than leachate concentrations. These results indicate that hardness, sulfate, TDS, iron and manganese are not useful indicator constituents for determining the extent of leachate migration from the ash ponds.

Additional background samples were collected from the well nests OM50 and OM51 in 2009-2010, which were located 1.5 miles northwest and south, respectively, of the ash ponds in areas where no power plant activities occur. With the exception of boron in the deep wells, concentrations from these wells had ranges similar to the ranges observed in OM10, OM16, and OM17. Median boron concentrations in OM50D and OM51D (2.0 and 1.2 mg/L, respectively) were not within the range of values observed at OM10, OM16, and OM17 (Table 3-4). Inspection of geologic logs for these wells (Appendix D) showed that OM50D and OM51D were screened in mine spoils consisting largely of shale, which has been documented elsewhere as a source for boron concentrations greater than 1 mg/L in groundwater (Rowe, 1999). Data from OM50D and OM51D indicate that shale within the mine spoils at this site are capable of leaching boron at concentrations up to 2 mg/L. The OM50 and OM51 well nests have been abandoned.

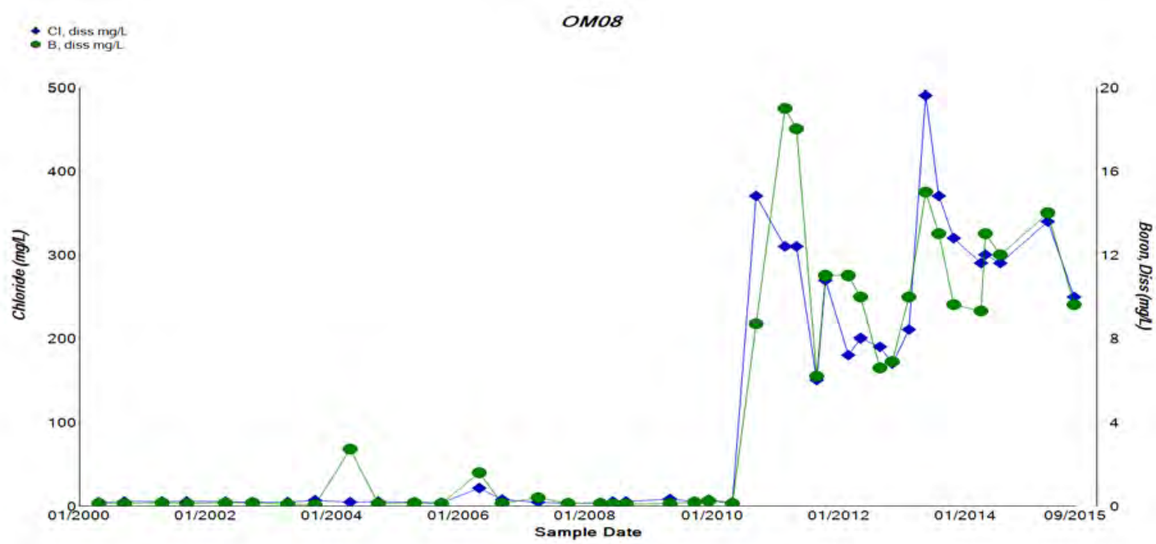
3.4 Changes in Groundwater Quality Since 2010

Table 3-5 compares average boron and chloride concentrations immediately before closure of the Recycling Pond and removal of Ash Ponds 1 and 2 from service (2008-2009) to the period March 2014 through September 2015 for wells sampled during both monitoring periods. Time-series plots of boron and chloride concentrations for all currently monitored wells are provided in Appendix C-4. The concentration averages during the two time periods and the time-series plots of boron and chloride concentrations indicate the following:

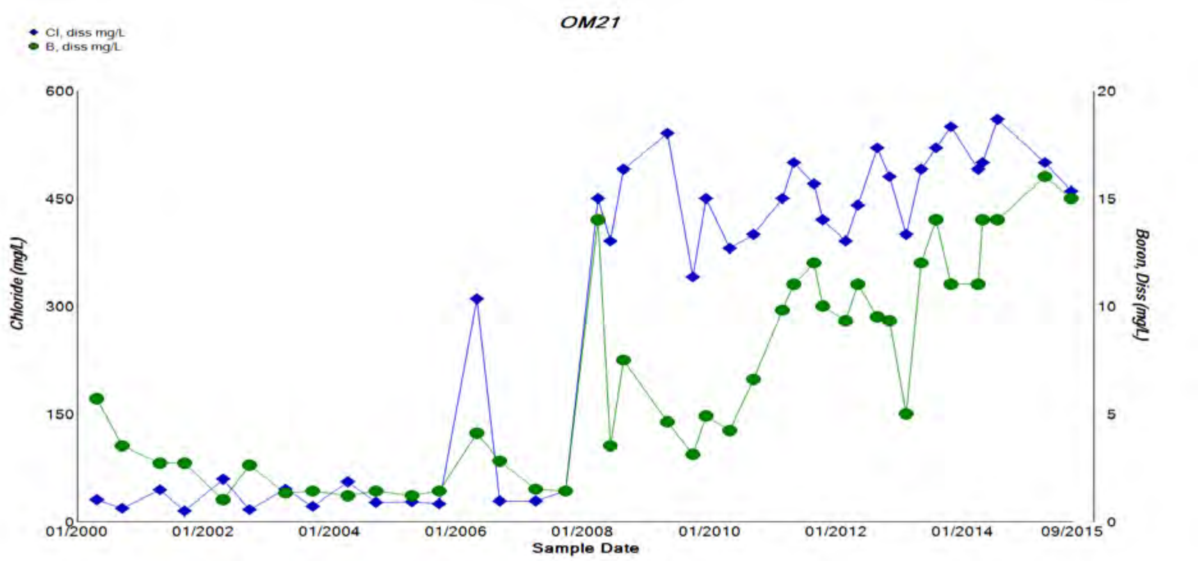
- Changes and trends in boron and chloride concentrations are closely aligned. The similarities in the trends of these constituents at all well locations (Appendix C-4) reinforce their usefulness as indicator parameters of ash leachate presence and migration in groundwater.
- Average concentration decreases of 28 to 98 percent were observed in seven monitoring wells (OR04D, OM07, OR13S, OR13D, OR14D, OR19, OR20) after closure of the Recycle Pond and removing Ash Ponds 1 and 2 from service. All of these wells are located east of the ash ponds and concentration trends suggest decreases will continue beyond 2015 (see plot for OR04D below).



- Concentrations increased at OM08 and OR11 following removal of the recycle pond. OM08 was side-gradient of the ash ponds prior to 2010 and is now upgradient of the ash ponds. There are no apparent groundwater flow mechanisms to explain the relatively large concentration increase observed at this monitoring point (see plot for OM08 below). In the case of OR11, the increase was relatively small in absolute value and temporary. Decreasing concentration trends were observed at OR11 beginning in 2013 and may represent a shift in groundwater flow direction caused by removal of the Recycle Pond.



- Average concentration increases greater than 40% percent for boron and/or chloride were observed in monitoring wells OM21, OM22D, OM24D and OM25S. The plot for OM21 located east of the ash ponds, shown below, exhibits increasing concentration trends in 2008, prior to removing Ash Ponds 1 and 2 from service. Concentration trends suggest boron and chloride may stabilize or decrease beyond 2015. Similar observations cannot be confirmed at OM22D, OM24D and OM25S because sampling of these wells did not commence until December 2009. Additional discussion of these wells west of the ash ponds is provided below.



3.5 Potential for Off-Site Migration

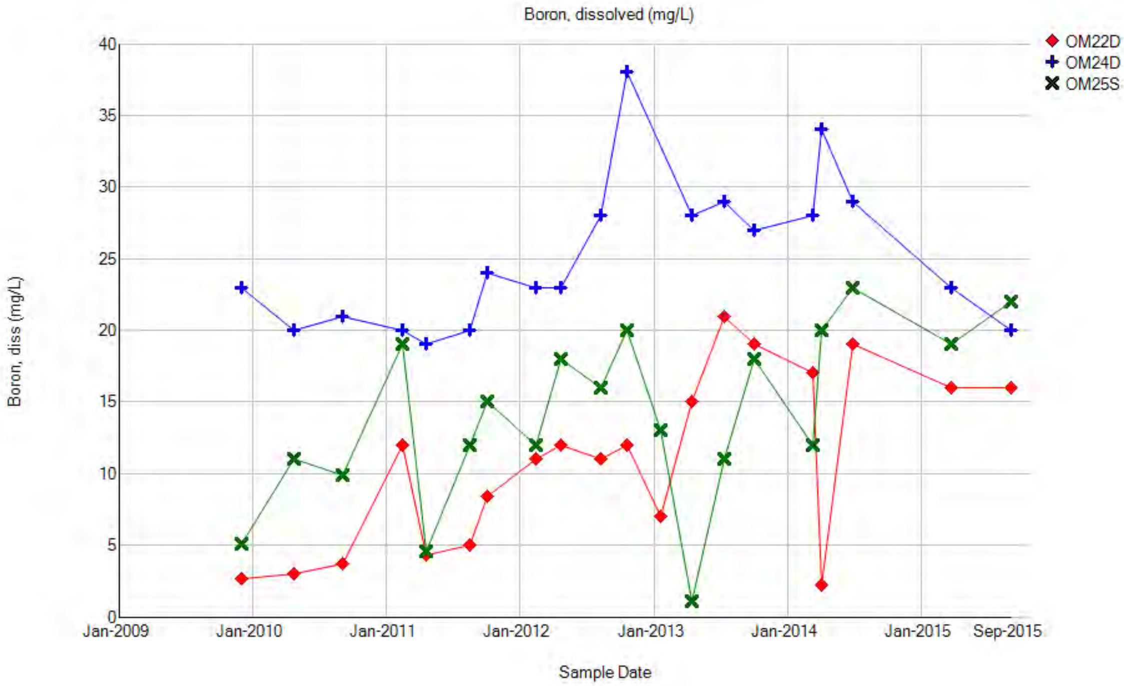
Monitoring wells OM22D, OM22S, OM23D, OM23S, OM24D, OM25D, and OM25S are located west of the ash ponds along the west property boundary. Boron concentrations in these monitoring wells range from less than 2 to 38 mg/L and chloride concentrations range from less than 20 to 1,000 mg/L.

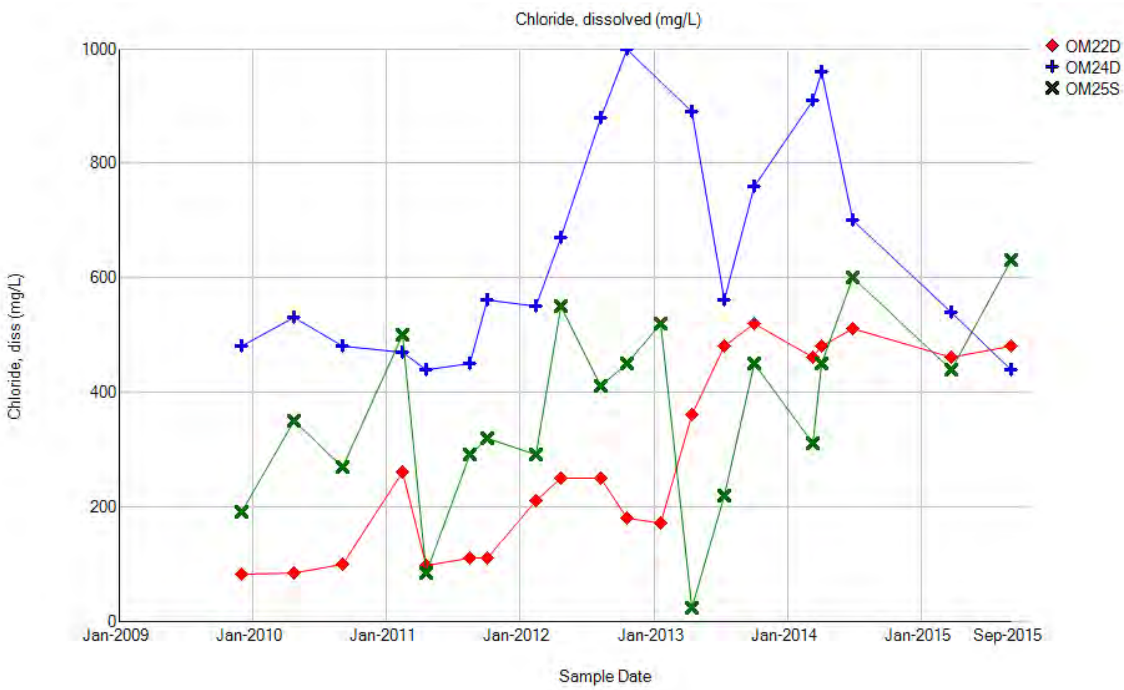
- Wells OM22S and OM23S are screened in mine spoils predominantly consisting of silt and clay. When last sampled in 2010, boron concentrations in these wells were lower than 2 mg/L and chloride concentrations were 21 mg/L or less, indicating that these wells are not measurably affected by leachate from the ash ponds.

- Wells OM23D and OM25D are screened beneath mine spoils containing shale. Boron concentrations in these wells are typically about 2 mg/L and chloride concentrations are typically about 35 mg/L at OM23D and 100 mg/L at OM25D. The boron concentrations are at levels similar to the background concentrations observed at OM50D and OM51D. Chloride concentrations are higher than background (10 mg/L), suggesting the possible presence of ash pond leachate.

- As previously noted, concentration increases of boron and/or chloride were observed in monitoring wells OM22D, OM24D, and OM25S. These wells have boron concentrations greater than 10 mg/L and chloride concentrations greater than 100 mg/L, suggesting that these wells are monitoring groundwater mixed with leachate from the ash ponds. Since hydraulic gradients previously mapped in this area are toward the west, boron concentrations may be higher than 2 mg/L west of these monitoring wells and the west property boundary (see plots below).

NATURAL RESOURCE TECHNOLOGY





While the Class II groundwater quality standard for boron is 2 mg/L, this standard is not applicable for the site monitoring wells that sample groundwater within disturbed coal spoil fill. As previously noted in Section 3.3, background boron concentrations in the coal mine spoils can be as high as 2 mg/L.

Therefore, boron concentrations higher than 2 mg/L may indicate the presence of ash pond constituents in groundwater. Figure 3-2 shows the boron concentrations detected in samples collected during the September 2015 groundwater monitoring event. To the north, south, and east of the ash ponds, the extent of boron concentrations greater than 2 mg/L is limited to an area within the property boundary and within 1,000 feet of the boundaries of ash ponds. Along the west property boundary, concentrations higher than 2 mg/L are observed in at least one monitoring well at each monitoring well nest (OM22 through OM25), suggesting that concentrations may exceed 2 mg/L off-site towards Long Lake.

3.6 Conceptual Site Model

A groundwater model can be useful for estimating the time over which water quality will improve after closure and for evaluating the extent of ash pond constituents in areas that are otherwise inaccessible for groundwater monitoring.

The coal mine spoils at the Site are heterogeneous over a small scale, and any single boring log may encounter highly variable sequences of silt, clay, and shale fragments randomly placed over the former mine surface. This geologic heterogeneity results in a groundwater flow pathway that is complex and tortuous as well as an inconsistent distribution of boron and chloride concentrations. Even with the large number of boring logs available at this Site, calibrating a numerical flow and transport model to match the complex groundwater flow and concentration distribution at this Site will require estimation of hydraulic conductivity and effective porosity zones that will not be supported by field data, resulting in a low confidence level in the model results.

Since this Site cannot be numerically modeled with confidence, a conceptual model of groundwater flow was developed to evaluate the potential off-site extent of ash pond constituents. There are numerous small ponds surrounding the Site within the coal spoils that fill closed depressions. These ponds are typically surface expressions of the water table, and the elevations of these ponds, as depicted on topographic maps, are the elevations of the water table at the time that the map was generated. The most-recent USGS topographic map for this area was generated in 2012. Figure 2-3 shows the elevation of surface waters—as interpreted from the 2012 USGS topographic map—to the north, west, and south of the ash ponds. These elevations provide an approximate (±10 feet) elevation of the water table that can be used to interpret high points and low points in the water table, enabling interpretation of the flow paths that groundwater may follow through these deposits on a larger scale. Based on the surface and groundwater elevation data and information provided in this supplemental hydrogeologic site characterization, the conceptual model for groundwater flow at the Site is as follows:

- Groundwater flowing to the east from the ash ponds discharges to various small surface waters and ultimately to the Duck Creek Cooling Pond.

- Long Lake lies between the ash ponds to the east and a watershed divide to the west. Groundwater flowing to the west from the ash ponds discharges to Long Lake. As noted previously, the lake is an end-cut or last-cut lake formed when a mine operator leaves the last mining excavation or cut open, instead of backfilling with earth or other mined spoils.

- Surface waters to the north have elevations higher than Long Lake and the Duck Creek Cooling Pond. The groundwater mound and radial flow from the former ash ponds will cause groundwater from the north to flow either west or south toward Long Lake or east toward the Duck Creek Cooling Pond.

- Surface water flow out of Long Lake will likely migrate via groundwater southward, consistent with the regional drainage.

- Hydraulic conductivity testing indicates groundwater flow through the disturbed mine spoils will be preferentially horizontal. The shale bedrock unit underlying the Springfield Coal Member that was mined has been demonstrated by packer testing to be an aquitard that will minimize vertical migration of ash pond constituents.

4 GROUNDWATER MONITORING SYSTEM

A groundwater monitoring system is proposed for the site to monitor groundwater, evaluate post-closure groundwater quality and trends, and to demonstrate compliance with the applicable groundwater quality standards identifed in Section 5.

The proposed groundwater monitoring well network consists of a sufficient number of wells, installed at appropriate locations and depths to monitor post-closure compliance with groundwater quality standards for Class IV: Other Groundwater. The groundwater monitoring well network on-site utilizes 31 previously installed groundwater monitoring wells. Nineteen of these monitoring wells will be used for compliance sampling and analytical testing. Groundwater elevation will also be measured in twelve additional wells (31 wells total).

The proposed groundwater monitoring system has been modified from the system proposed by Hanson (2010) and the monitoring program currently being employed. The proposed groundwater monitoring system is summarized on Table 3-2 and is being modified as follows:

- Wells OR05D and OM05S are not currently used for monitoring groundwater quality and are in close proximity to the OR13 well nest. Wells OR05D and OM05S will be abandoned following IEPA approval of the proposed monitoring plan.
- Monitoring well OM08 is upgradient of the ash ponds (see Figure 2-2) and shows elevated groundwater concentrations that cannot be due to groundwater migration from the ash ponds. Therefore, groundwater sampling at this well will be discontinued and it will be used for measurement of elevation only, pending IEPA approval of the proposed monitoring plan.
- Wells OM26, OM27, OM28, OM30 and OM31 are located within or immediately adjacent to the ash ponds and have not been monitored since 2011. These wells will be abandoned following IEPA approval of the proposed monitoring plan.

Boring logs and monitoring well construction reports for the groundwater monitoring system are provided in Appendix D. Monitoring well locations are shown on Figure 4-1. Well screen intervals, total well depths and September 2015 groundwater elevations at the proposed monitoring well network locations are summarized in Table 4-1. The depth that the bottom of the monitoring well is screened below the water table is also shown. Monitoring wells that are screened within the upper 20 ft of groundwater will be utilized to construct water table contour maps. Deeper nested monitoring wells (designated by the suffix ‘D’) and wells screened at depths greater than about 20 ft below the water table are piezometers that will be utilized to monitor potential deeper migration pathways of ash pond constituents and vertical hydraulic gradients. Historical groundwater elevations for the period of 2014 and 2015 at the proposed monitoring well locations are provided in Appendix E.

The monitoring wells are designed and constructed in accordance with applicable standards, including the following:

- All monitoring wells are cased in a manner that maintains the integrity of the boreholes.
- Wells are screened to allow sampling only at the specified interval.
- All wells are covered with vented caps, unless located in flood-prone areas, and equipped with devices to protect against tampering and damage.

The monitoring well network fulfills the following goals:

- Enables the collection of groundwater samples that represent the quality of groundwater that has not been affected by the ash ponds
- Enables the collection of groundwater samples that represent the quality of downgradient groundwater
- Includes wells that are located within the stratigraphic unit(s) that may serve as potential chemical migration pathways

5 APPLICABLE GROUNDWATER QUALITY STANDARDS

5.1 Groundwater Classification

The Duck Creek Ash Ponds 1 and 2 are located within a previously mined area and monitoring has demonstrated that the groundwater is not capable of consistently meeting the standards for Class I: Potable Resource Groundwater (35 IAC 620.410) or Class II: General Resource Groundwater (35 IAC 620.420). Therefore, the applicable classification of groundwater at the site is Class IV: Other Groundwater (35 IAC 620.240(g)).

5.2 Applicable Groundwater Quality Standards

For groundwater within a previously mined area, the applicable groundwater quality standards for the site are the standards for Class IV: Other Groundwater. The groundwater quality standards for Class IV: Other Groundwater cannot be exceeded (35 IAC 620.440(c)) except as provided below:

- The groundwater quality standards for TDS, chloride, iron, manganese, sulfate, and pH, are the existing concentrations (35 IAC 620.440(c)).
- Groundwater quality standards for Class II General Resource Groundwater do not apply for pH, barium, boron, chloride, copper, iron, manganese, nickel, selenium, TDS, sulfate, and zinc when groundwater is either within fill or in parent material within 10 feet of fill, if the fill was placed prior to November 25, 1991 (35 IAC 620.420(a)(3)(A)). The coal spoils were placed prior to 1991 and all monitoring wells except for OM23D and OM25D are either screened within coal spoil or in native material within 10 vertical feet of coal spoil. Therefore, these analytical parameters are only applicable to monitoring wells OM23D and OM25D.
- Except as provided above, Class IV: Other Groundwater standards are equal to the existing concentrations of constituents in groundwater (35 IAC 620.440(c)).

The list of applicable groundwater quality standards for the site is shown on Table 3-1. Off-site groundwater also occurs within mine spoils, and is therefore Class IV: Other Groundwater. Applicable off-site groundwater quality standards will be the same as described above.

5.3 Proposed Exceptions to the Groundwater Quality Standards

Based on the results of groundwater monitoring performed at the site to date, the following exceptions to the above applicable Class II: General Resource Groundwater standards are proposed:

- Leachate (Appendices C-1, C-2) and groundwater (Appendix C-3) samples collected at the site do not indicate exceedances of the groundwater quality standards for Class II General

Resource Groundwater inorganic constituents listed in 35 IAC 620.420(a)(1). The analyzed constituents include antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, cyanide, fluoride, lead, mercury, nitrate, and thallium.[2] These constituents will not be monitored because they currently meet the standards for Class II General Resource Groundwater and are not associated with the chemical characteristics of the Duck Creek ash ponds.[3]

- Leachate (Appendices C-1, C-2) and groundwater (Appendix C-3) samples collected at the site do not indicate exceedances of the groundwater quality standards for Class II General Resource Groundwater for inorganic constituents copper, nickel, selenium, silver, and zinc listed in 35 IAC 620.420(a)(2). These constituents will not be monitored at wells OM23D and OM25D because they currently meet the standards for Class II General Resource Groundwater and are not associated with the chemical characteristics of the Duck Creek ash ponds.

The proposed groundwater monitoring parameters for the Duck Creek ash ponds are discussed in Section 6.1.

[2] Perchlorate and vanadium are parameters listed in 35 IAC 620.420(a)(1) but have not been analyzed.

[3] An anomalous arsenic concentration of 0.31 ug/L was observed on October 21, 2013 at OR13S; all other results (thirteen sampling events) at this location exhibited As concentrations below 0.015 ug/L, which are well below the Class II groundwater quality standard of 0.2 ug/L.

6 GROUNDWATER MONITORING PLAN

The groundwater monitoring plan will monitor and evaluate groundwater quality to demonstrate compliance with the groundwater quality standards for Class IV: Other Groundwater[4]. The post-closure groundwater sampling network is proposed to consist of three background monitoring wells and 19 compliance monitoring wells. Table 4-1 provides a list of the wells and their intended use for the monitoring program.

6.1 Monitoring Parameters

Groundwater samples will be collected and laboratory-analyzed for the following parameters that are indicator constituents for coal ash leachate from the ash ponds:

- Boron (dissolved)
- Chloride (dissolved)

The following field parameters will be also measured for each groundwater sample:

- pH
- Specific conductance
- Temperature

The depth to groundwater and total well depth will also be recorded during each sampling event.

As discussed in Section 5, other parameters regulated under 35 IAC 620 will be not be monitored because either:

- Their Class II: General Resource Groundwater standard is the existing concentration of the constituent in groundwater (TDS, iron, manganese, sulfate), and they are not indicator constituents for leachate migration from the ash ponds; therefore, there is no basis to which compare the data
- There is no applicable standard for the constituent in groundwater monitored in fill placed prior to November 1991
- Groundwater monitoring results to date indicates that the inorganic constituents antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, cyanide, fluoride, lead, mercury, nickel, nitrate, selenium, silver, thallium and zinc currently meet the Class II:

[4] Based on the conclusions of the Hanson (2016a) report in Appendix B1, there is no Uppermost Aquifer as defined by the US EPA (2015) [40 CFR 257.53].

General Resource Groundwater standards and are not associated with the chemical characteristics of the Duck Creek ash ponds.

6.2 Sampling Schedule

Groundwater sampling will initially be performed quarterly according to the schedule provided in Table 4-2. Five years after approval of the Closure Plan, a request may be made to modify the post-closure care plan to reduce the frequency of groundwater monitoring to semi-annual sampling by demonstrating all of the following:

- Monitoring effectiveness will not be compromised by the reduced frequency of monitoring
- Sufficient data has been collected to characterize groundwater
- Concentrations of constituents monitored at the downgradient boundaries show no statistically significant increasing trends that can be attributed to the former ash ponds

If concentrations of parameters of concern at the downgradient boundaries of the site show no statistically significant increasing trends that can be attributed to the ash ponds for the five years after reducing the monitoring frequency to semi-annual, a request may be made to modify the post-closure care plan to reduce monitoring frequency to annual sampling by demonstrating the same items above as for the reduction to semi-annual monitoring.

Groundwater monitoring may be discontinued upon IEPA’s approval of a certified post-closure care report. Specifically, when no statistically significant increase is detected in the concentration of any constituent above that measured and recorded during the immediately preceding scheduled sampling for four consecutive years after changing to an annual monitoring frequency.

6.3 Groundwater Sample Collection

Groundwater samples will be collected according to the protocol included in Appendix F. The procedure is summarized below.

All groundwater elevations will be measured on a single day, in conjunction with sampling of the wells. Monitoring wells will be sampled using either a peristaltic pump or bladder pump. Each well will be purged utilizing low flow techniques, and until the measured pH, temperature, and specific conductance have stabilized within ±10 percent. If low-flow stabilization is not possible, either a submersible pump or bailer will be used to remove four well volumes and/or bail the well dry. Field parameters will be collected following purging of the well. Field parameters will be recorded in the logbook.

Boron samples will be field-filtered (using a 0.45 micron disposable filter); and the sample will be collected in laboratory-provided high-density polyethylene (HDPE) bottles with the appropriate preservatives. All

samples will be placed in a cooler with ice to maintain a temperature of less than 4º Celsius during transport to the analytical laboratory.

In addition to groundwater well samples, quality assurance samples will be collected as described in Section 5.5.

6.4 Laboratory Analysis

Laboratory analysis will be performed by a state-certified laboratory using methods approved by IEPA. The constituents to be monitored, analytical methods and the Practical Quantitation Limits (PQL) are as follows:

Parameter	USEPA Analytical Method	PQL (mg/L)
Boron	SW 6020	0.010
Chloride	EPA 300.0	1.0

Concentrations lower than the practical quantitation limit (PQL) will be reported as less than the PQL. The PQL for all parameters analyzed will be lower than the applicable groundwater quality standard. The Class IV Groundwater Quality Standards for the site are discussed in detail in Section 5.

6.5 Quality Assurance Program

Additional quality assurance samples to be collected will include the following:

- Two blind duplicate groundwater samples from randomly selected monitoring wells
- One equipment blank sample will be collected and analyzed for each day of sampling. If dedicated sampling equipment is used, than equipment blank samples will not be collected.

The duplicate and equipment blank quality assurance samples will be supplemented by the laboratory QA/QC program, which typically includes:

- Regular generation of instrument calibration curves to assure instrument reliability
- Laboratory control samples and/or quality control check standards that have been spiked, and analyses to monitor the performance of the analytical method
- Matrix spike/matrix spike duplicate analyses to determine percent recoveries and relative percent differences for each of the parameters detected
- Analysis of replicate samples to check the precision of the instrumentation and/or methodology employed for all analytical methods
- Analysis of method blanks to assure that the system is free of contamination

6.6 Groundwater Monitoring System Maintenance Plan

Monitoring wells will be inspected during each groundwater sampling event. Maintenance will be performed as needed to assure that the monitoring wells provide representative groundwater samples. Monitoring well inspections will consist of the following:

- Visual inspection, clearing of vegetation, replacement of markers, and painting of protective casings as needed to assure that monitoring wells are clearly marked and accessible
- Visual inspection and repair or replacement of well aprons as needed to assure that they are intact, drain water away from the well, and have not heaved
- Visual inspection and repair or replacement of protective casings as needed to assure that they are undamaged, and that locks are present and functional
- Checks to assure that well caps are intact and vented, unless in flood-prone areas in which case caps will not be vented
- Annual measurement of monitoring well depths to determine the degree of siltation within the wells. Wells will be redeveloped as needed to remove siltation from the screened interval if it impedes flow of water into the well
- Checks that wells are clear of internal obstructions, and flow freely

If maintenance of a monitoring well cannot address an identified deficiency, a replacement well will be installed.

6.7 Annual Statistical Analysis

Trend analysis will be performed annually for each of the parameters of concern. Sen's Estimate of Slope will be applied to a minimum of four consecutive quarterly monitoring results. If there are increasing trends during closure and post-closure care periods, they will be further investigated as described below.

- If the results of sampling and analysis show an increasing trend at any compliance monitoring well, a Mann-Kendall analysis will be performed at 95 percent confidence to determine whether or not the increasing trend is statistically significant.
- If a statistically significant increasing trend occurs during post-closure care, further investigation of monitored concentrations will be performed as well as more frequent inspections of the surface of the cover system.
- If the investigation attributes a statistically significant increasing trend to a source other than the Duck Creek Energy Center ash ponds, then the IEPA will be notified in writing, stating the cause of the increasing trend and providing the rationale used in such a determination.
- If there is not an alternative source causing the statistically significant increasing concentration and the sampling frequency had been reduced to semi-annual or annual sampling, a quarterly sampling schedule will be reestablished. The frequency of sampling will return to either semi-annual or annual, once four consecutive quarterly samples show no statistically significant increasing trend.

Notifications concerning statistically significant increasing trends and revisions of the sampling frequency will be reported to IEPA in writing within 30 days after making the determinations.

6.8 Data Reporting

Sampling and analysis data from quarterly, semi-annual and/or annual groundwater monitoring will be reported to IEPA within 60 days after completion of sampling.

Statistical analysis of the laboratory analytical data will be reported to IEPA with the annual report for the facility.

6.9 Compliance with Applicable On-Site Groundwater Quality Standards

Compliance with on-site groundwater quality standards will be achieved when there are no statistically significant increasing trends that are attributed to the Duck Creek Energy Center ash ponds for parameters detected at the downgradient boundaries.

6.10 Corrective Action

If a statistically significant increasing trend is observed to continue over a period of two or more years following completion of the final cover, and a subsequent hydrogeologic site investigation demonstrates that such exceedances are due to a release from the Duck Creek Energy Center ash ponds and corrective actions are appropriate to mitigate such releases, a corrective action plan will be proposed as a modification to the post-closure care plan. A corrective action plan will be submitted to IEPA within 180 days after completion of the investigation activities. The plan will propose corrective actions to be undertaken to mitigate the impacts associated with the constituents of concern which exceed applicable groundwater standards.

7 REFERENCES

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Hanson, March 2010. Hydrogeologic Report Ameren Duck Creek Power Generating Station Solid Waste Disposal System (Ash Pond 1, Ash Pond 2, and Recycle Pond).

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Rowe, G. 1999. Surveying boron and naturally soft groundwater with a computer database: Journal of Environmental Health, 62, (5) 14-18.

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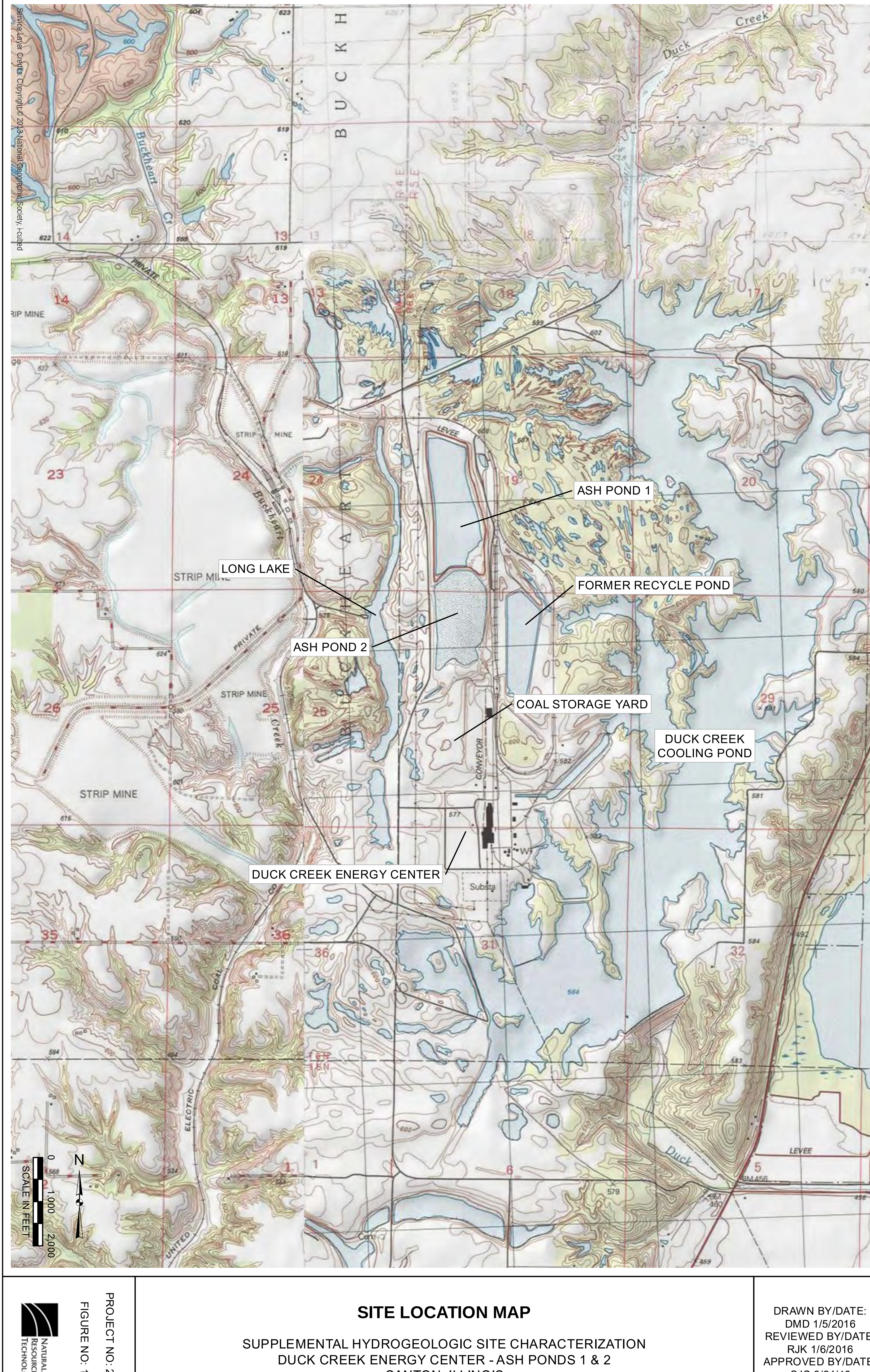
Willman, H. B., E. Atherton, T.C. Buschbach, C. Collinson, J.C. Frye, M.E. Hopkins, J.A. Lineback, and J. A. Simon, 1975. “Handbook of Illinois Stratigraphy”, Bulletin 95, Illinois State Geological Survey, Urbana, IL, 261 pp.

FIGURES



SITE LOCATION MAP

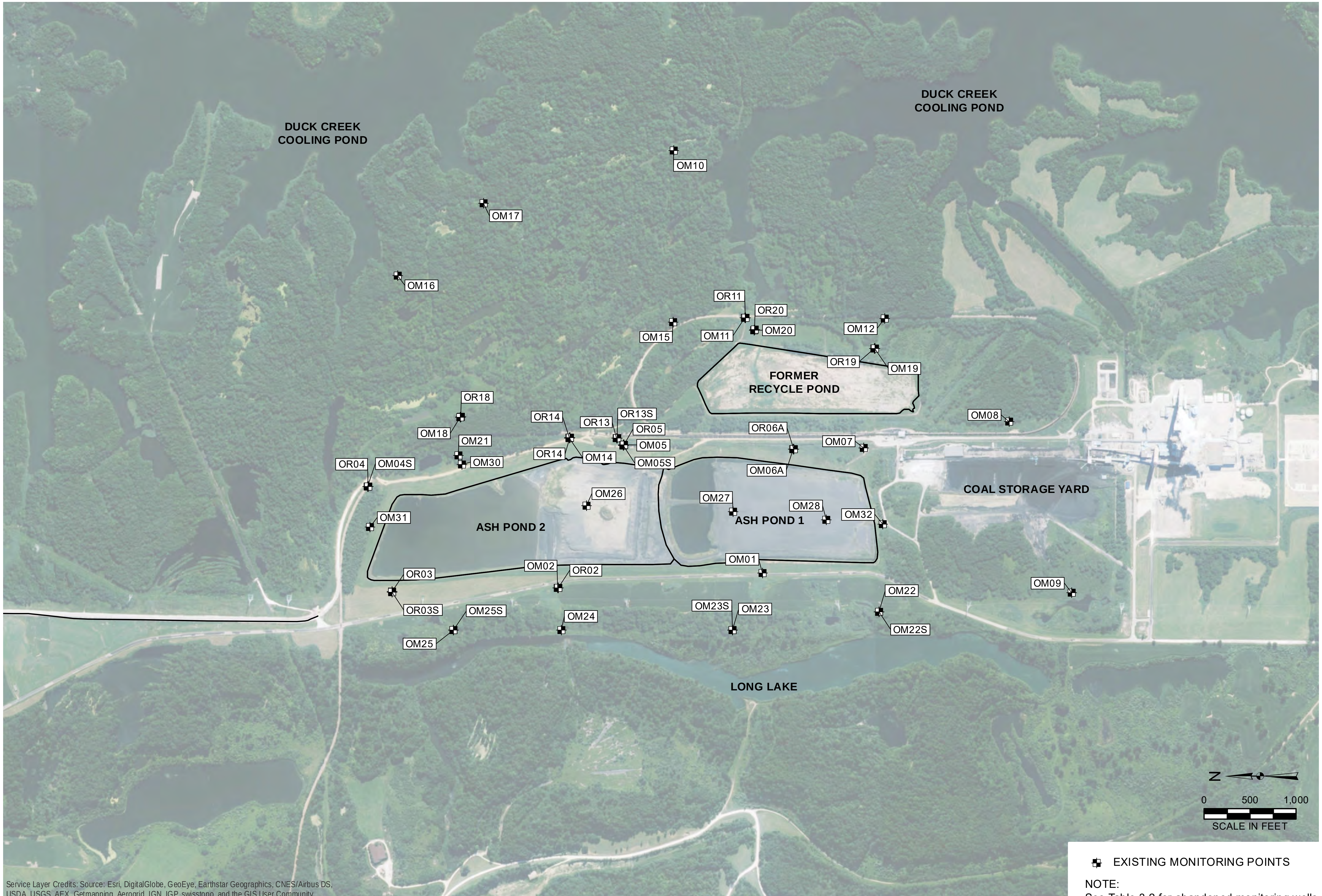
SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

DRAWN BY/DATE:
DMD 1/5/2016
REVIEWED BY/DATE:
RJK 1/6/2016
APPROVED BY/DATE:
SJC 3/24/16

PROJECT NO: 2333

FIGURE NO: 1-1

NATURAL RESOURCE TECHNOLOGY



EXISTING MONITORING POINTS

NOTE:
See Table 3-2 for abandoned monitoring wells

DRAWN BY/DATE:
DMD 1/5/2016
REVIEWED BY/DATE:
RJK 1/6/2016
APPROVED BY/DATE:
SJC 3/24/16

SITE MAP

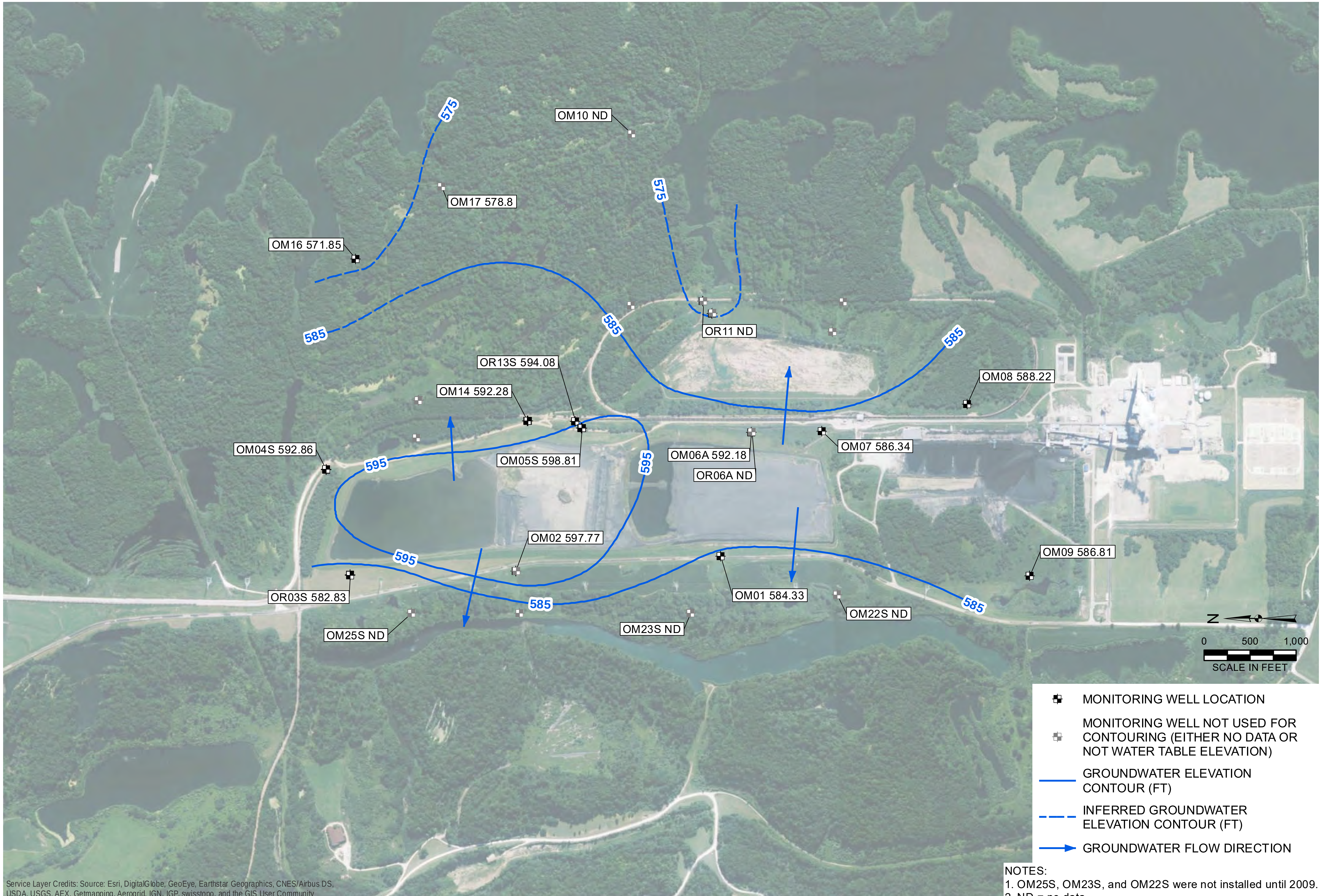
SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 1-2

NATURAL RESOURCE TECHNOLOGY

Y:\Mapping\Projects\23\2333\MXD\Supplemental Hydrogeo Site Char\Figure 1-2_Site Map.mxd Author: sstolz; Date/Time: 3/31/2016, 9:49:56 AM



MONITORING WELL LOCATION

MONITORING WELL NOT USED FOR CONTOURING (EITHER NO DATA OR NOT WATER TABLE ELEVATION)

GROUNDWATER ELEVATION CONTOUR (FT)

INFERRED GROUNDWATER ELEVATION CONTOUR (FT)

GROUNDWATER FLOW DIRECTION

NOTES:
1. OM25S, OM23S, and OM22S were not installed until 2009.
2. ND = no data

DRAWN BY/DATE: DMD 1/5/2016
REVIEWED BY/DATE: RJK 1/6/2016
APPROVED BY/DATE: SJC 3/24/16

SHALLOW GROUNDWATER ELEVATION CONTOURS - APRIL 2007

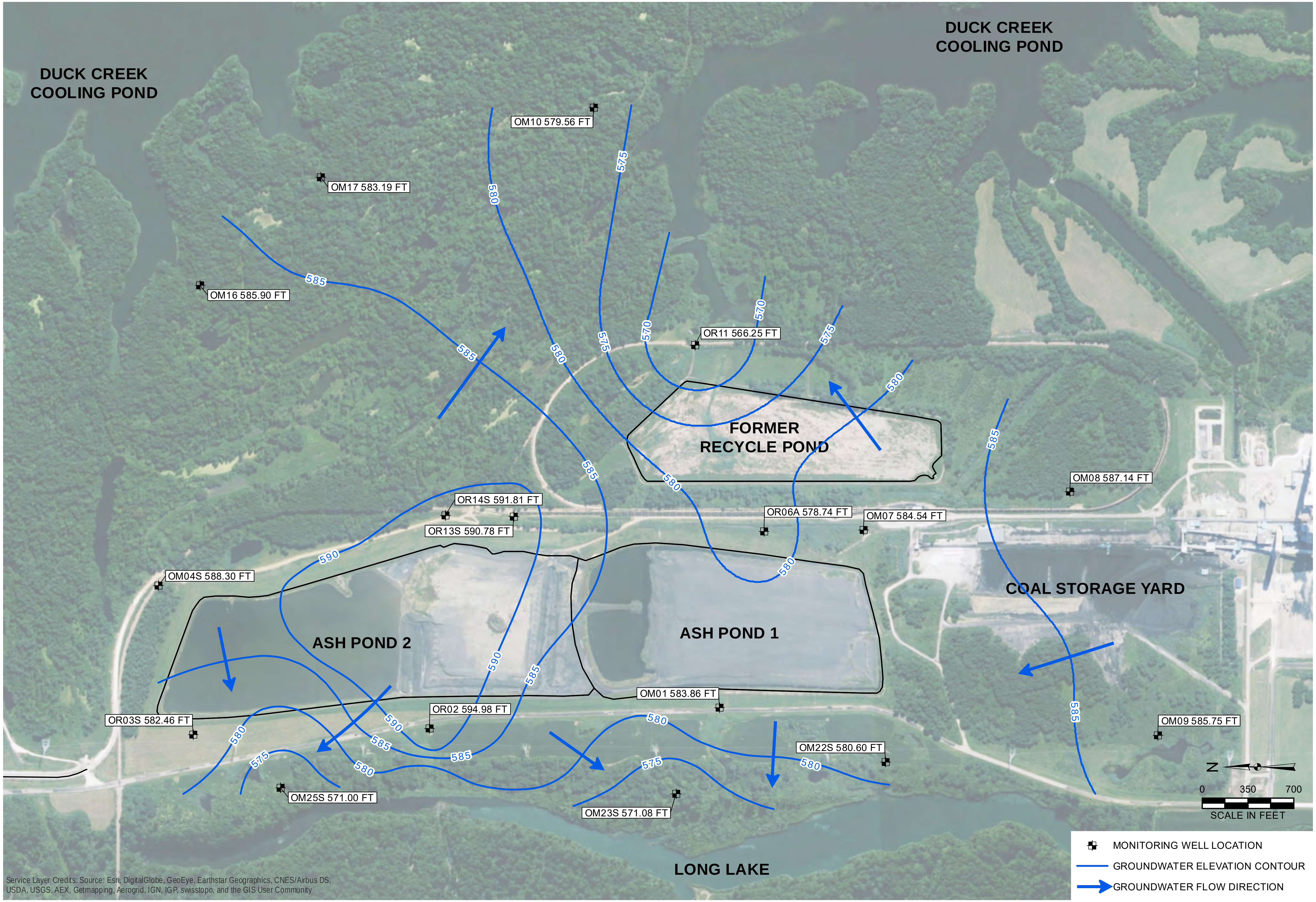
SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 2-1

NATURAL RESOURCE TECHNOLOGY

Y:\Mapping\Projects\23\2333\MXD\Supplemental Hydrogeo Site Char\Figure 2-1_GW Elevation Contours_April 2007.mxd Author: lcushman; Date/Time: 3/24/2016, 9:24:55 AM



DRAWN BY/DATE: TDC 1/4/2016
REVIEWED BY/DATE: RJK 1/4/2016
APPROVED BY/DATE: SJC 3/24/16

SHALLOW GROUNDWATER ELEVATION CONTOURS - SEPTEMBER 2015

SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 2-1

NATURAL RESOURCE TECHNOLOGY

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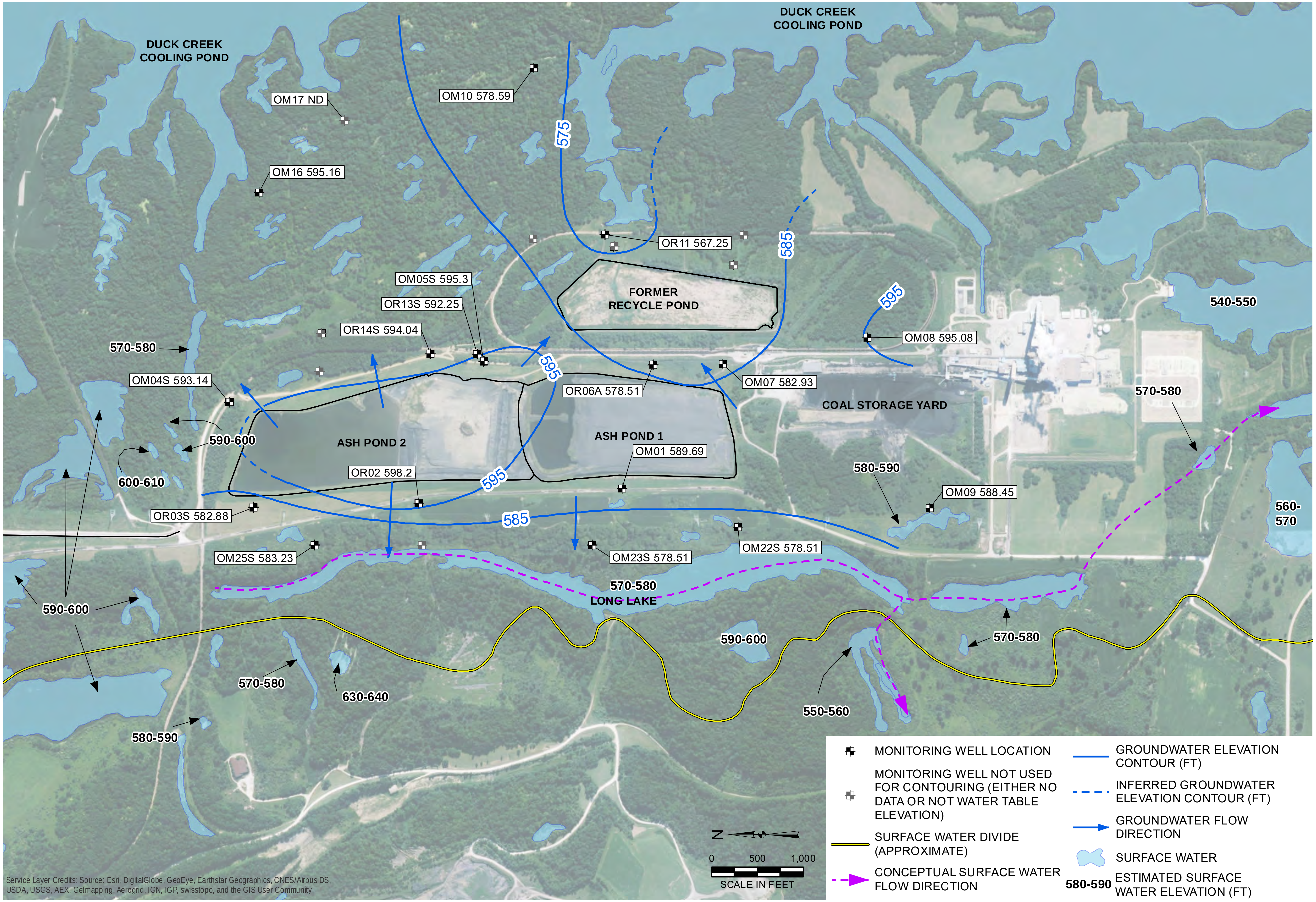

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APPROVED BY/DATE: SJC 3/24/16

CONCEPTUAL MODEL OF GROUNDWATER FLOW

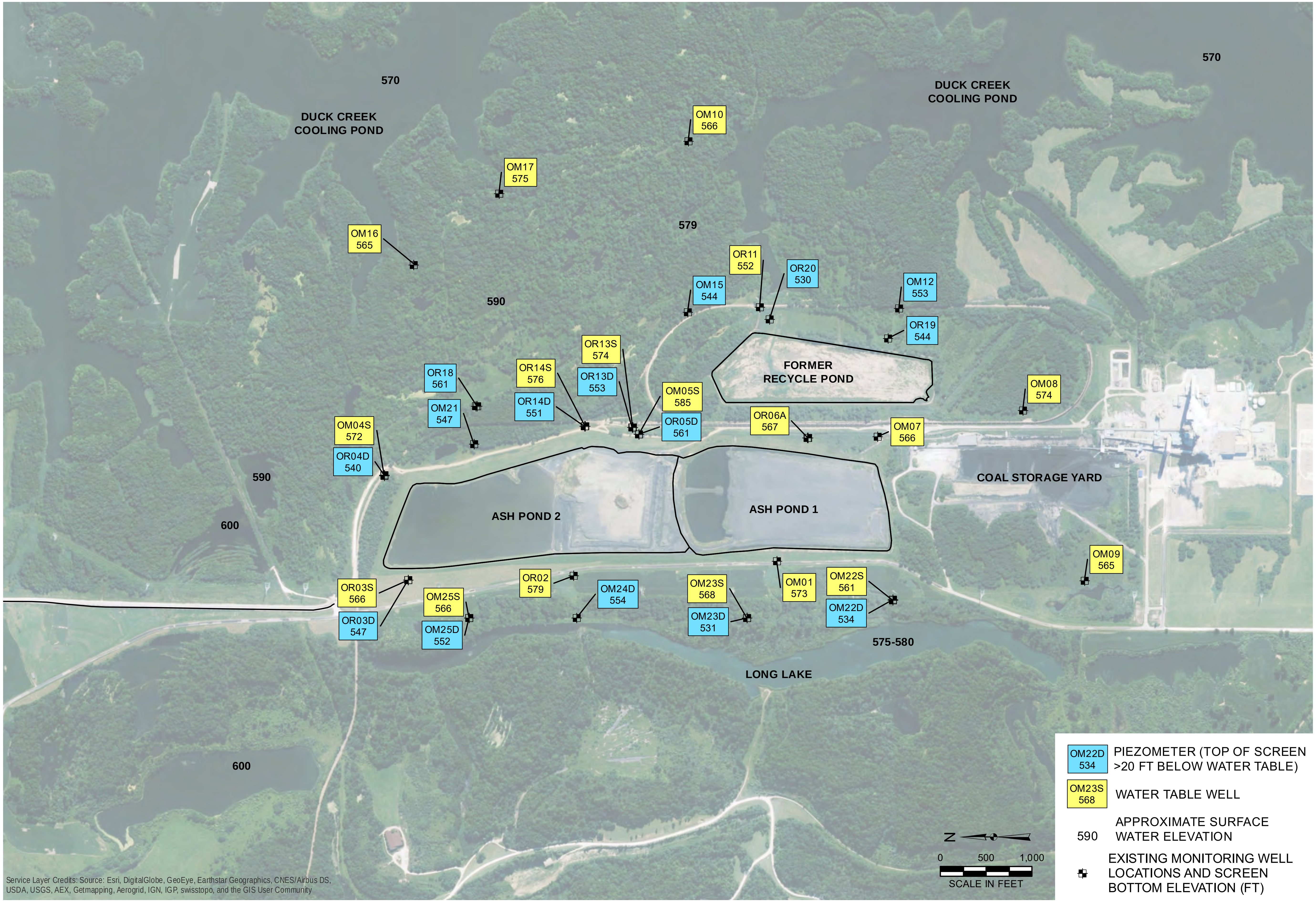
SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 2-3

NATURAL RESOURCE TECHNOLOGY

Y:\Mapping\Projects\23\2333\MXD\Supplemental Hydrogeo Site Char\Figure 2-3_Conceptual Model of Groundwater Flow.mxd Author: sstotz; Date/Time: 3/31/2016, 9:54:57 AM



DRAWN BY/DATE: DMD 1/5/2016
REVIEWED BY/DATE: RJK 1/6/2016
APPROVED BY/DATE: SJC 3/24/16

MONITORING WELLS AND SCREEN BOTTOM ELEVATIONS

SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 3-1

NATURAL RESOURCE TECHNOLOGY

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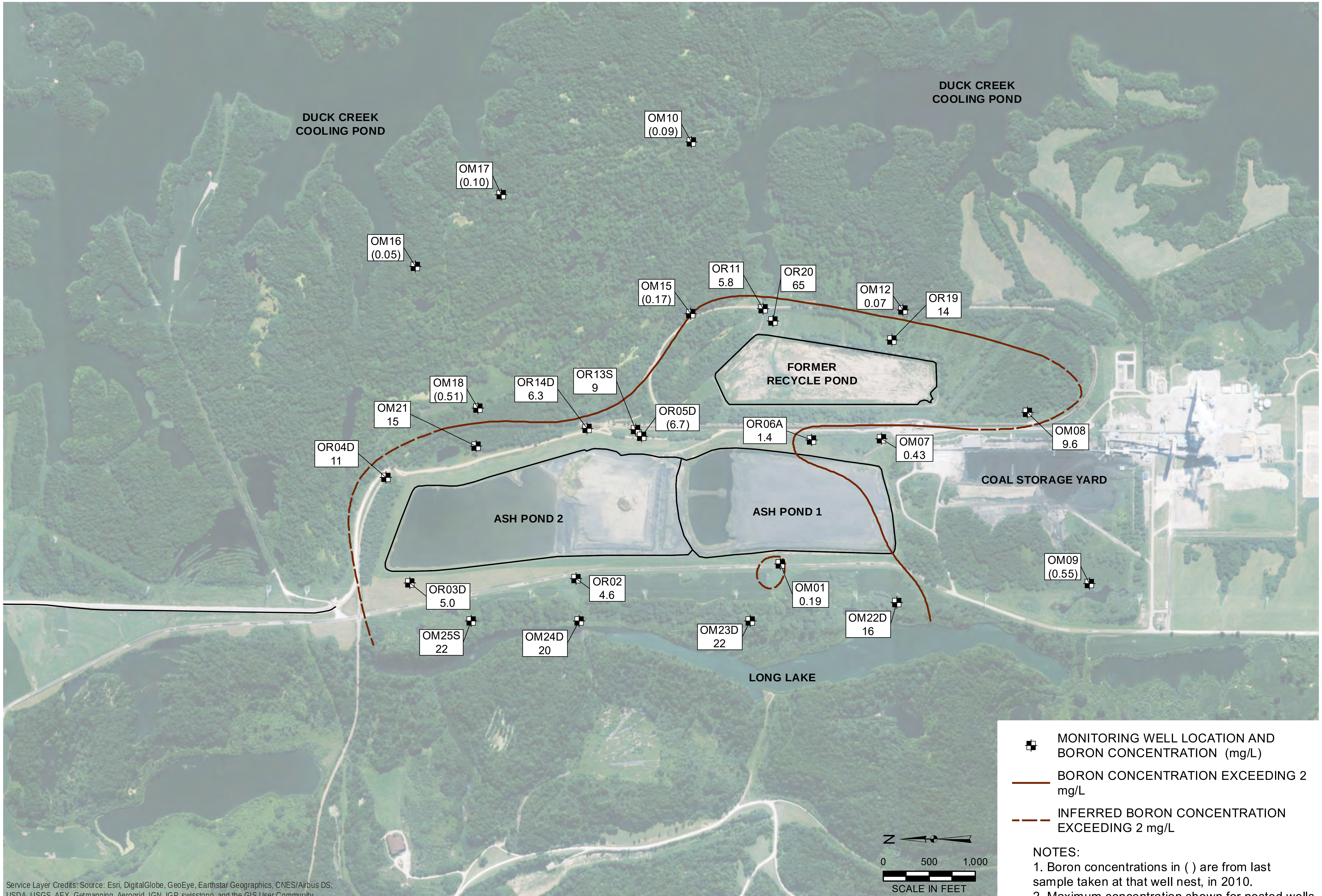


DRAWN BY/DATE: DMD 1/5/2016
REVIEWED BY/DATE: RJK 1/6/2016
APPROVED BY/DATE: SJC 3/24/16

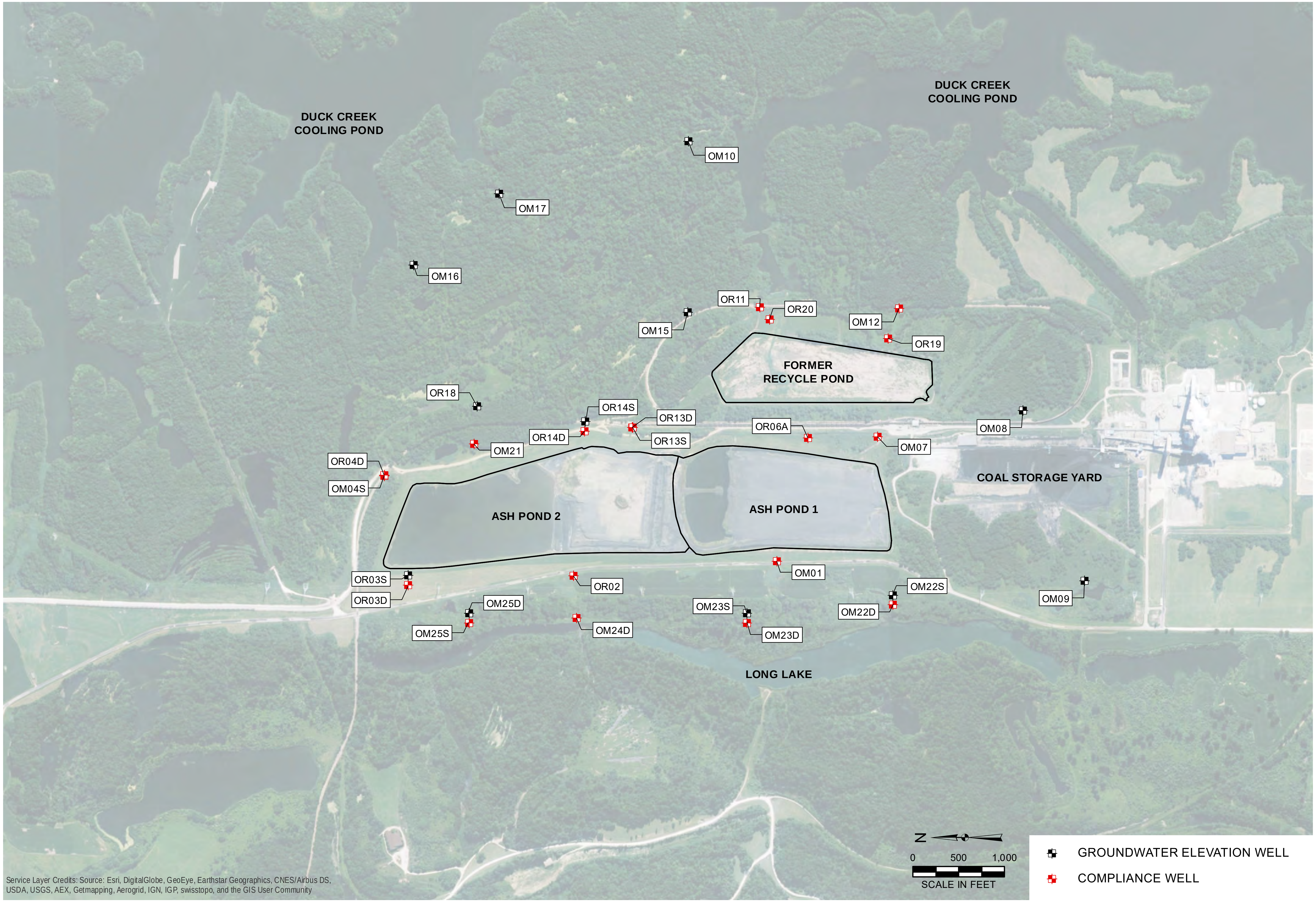
BORON CONCENTRATIONS IN GROUNDWATER - SEPTEMBER 2015

SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 3-2

NATURAL RESOURCE TECHNOLOGY



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DMD 1/5/2016
REVIEWED BY/DATE:
RJK 1/6/2016
APPROVED BY/DATE:
SJC 3/24/16

PROPOSED GROUNDWATER MONITORING NETWORK

SUPPLEMENTAL HYDROGEOLOGIC SITE CHARACTERIZATION
DUCK CREEK ENERGY CENTER - ASH PONDS 1 & 2
CANTON, ILLINOIS

PROJECT NO: 2333

FIGURE NO: 4-1

NATURAL RESOURCE TECHNOLOGY

Y:\Mapping\Projects\23\2333\MXD\Supplemental Hydrogeo Site Char\Figure 4-1_Proposed Groundwater Monitoring Network.mxd Author: sstolz; Date/Time: 3/31/2016, 9:58:16 AM

TABLES

Table 2-1
Changes in Porewater Elevation within the Ash Ponds
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Date	OM26	OM27	OM28
11/9/2010	635.00	628.76	628.08
11/19/2010	634.60	627.36	627.08
6/9/2011	635.90	626.06	626.98
5/16/2012	633.17	623.82	624.86
12/29/2015	637.89	627.57	626.93
Change 2010 to 2012	-1.83	-4.94	-3.22
Change 2012 to 2015	4.72	3.75	2.07

Ash Ponds were taken out of service in 2010
Piezometers installed in 2010
OM-26 located in Ash Pond 2 and OM-27 and OM-28 located in Ash Pond 1

Table 2-2
Changes in Groundwater Elevation
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Average 2008-2009 [1]	Average 2014-2015 [2]	Change
OM01	584.6	583.8	-0.8
OR02	596.5	595.4	-1.1
OR03D	582.1	581.8	-0.3
OR03S	582.1	581.8	-0.3
OR04D	587.5	586.7	-0.8
OM04S	590.3	589.3	-1.0
OR05D	600.5	593.2	-7.3
OM05S	598.7	592.5	-6.2
OR06A	592.4	578.6	-13.7
OM07	588.7	582.9	-5.8
OM08	587.2	585.5	-1.7
OM09	586.3	586.0	-0.3
OM10	574.9	578.4	3.5
OR11	569.8	566.5	-3.3
OM12	578.3	581.8	3.5
OR13D	600.5	593.5	-7.0
OR13S	592.1	591.3	-0.8
OR14D	590.2	590.7	0.5
OR14S	594.2	592.2	-2.0
OM15	578.4	579.0	0.6
OM16	582.3	583.9	1.7
OM17	579.2	581.8	2.6
OR18	594.8	599.9	5.0
OR19	582.5	575.5	-7.0
OR20	574.0	566.4	-7.6
OM21	597.8	598.0	0.2
OM22D	582.4	580.5	-1.8
OM22S	582.3	580.3	-2.0
OM23D	576.9	575.8	-1.1
OM23S	572.3	571.6	-0.7
OM24D	574.7	573.8	-0.9
OM25D	571.1	572.0	0.9
OM25S	571.2	571.3	0.1

Average decreased by 3.0 feet or more
Average increased by 3.0 feet or more
Ash Ponds were taken out of service in 2010
Footnotes:
1. Obtained from Manages database.
2. Obtained from Hanson groundwater elevation table using April 2008 top of well casing survey data.

Natural Resource Technology

Table 3-1
Monitored Parameters and Groundwater Quality Standards
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Parameter	Time Interval Monitored	Applicable Standard	
		Wells Other than OM23D and OM25D	OM23D and OM25D
Antimony	2011 to 2014	Class II	Class II
Arsenic	2011 to 2014	Class II	Class II
Barium	2011 to 2014	(2)	Class II
Beryllium	2011 to 2014	Class II	Class II
Boron	1980 to Present	(2)	Class II
Cadmium	2011 to 2014	Class II	Class II
Chloride	1980 to Present	(1), (2)	(1)
Chromium	2011 to 2014	Class II	Class II
Cobalt	2011 to 2014	Class II	Class II
Copper	2011 to 2014	(2)	Class II
Cyanide	2011 to 2014	Class II	Class II
Fluoride	2011 to 2014	Class II	Class II
Hardness	1980 to Present	(3)	(3)
Iron	1980 to Present	(1), (2)	(1)
Lead	2011 to 2014	Class II	Class II
Manganese	1980 to Present	(1), (2)	(1)
Mercury	2011 to 2014	Class II	Class II
Nickel	2011 to 2014	(2)	Class II
Nitrate nitrogen	2011 to 2014	Class II	Class II
pH	1980 to Present	(1), (2)	(1)
Selenium	2011 to 2014	(2)	Class II
Silver	2011 to 2014	(3)	(3)
Specific Conductance	1980 to Present	(3)	(3)
Sulfate	1980 to Present	(1), (2)	(1)
Temperature	1980 to Present	(3)	(3)
Thallium	2011 to 2014	Class II	Class II
Total Dissolved Solids	1980 to Present	(1), (2)	(1)
Zinc	2011 to 2014	(2)	Class II

Notes

Except as noted below, Class II standards are applicable for Class IV groundwater in previously mined areas

(1) Per 35 IAC 620.440(c) the standard for this constituent is the existing concentration.

(2) Per 35 IAC 620.420(a)(3) there is no applicable standard for groundwater monitored in fill placed prior to November 1991.

(3) There is no Class II or Class IV standard for this constituent. Per 35 IAC 620.440(c) the standard for this constituent is the existing concentration.

Table 3-2
Monitoring Well Matrix
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well ID (Permit)	Well ID (Site)	Replacement Well ID	Comments
OM-1	OM01		
OM-2	~~OM02~~	OR02	
OM-3D	~~OM03D~~	OR03D	
OM-3S	~~OM03S~~	OR03S	
OM-4S	OM04S		
OM-4A	OR04D		
OM-5D	OM05D	OR05D	These wells are adjacent to the OR13 well nest and will be abandoned following IEPA approval of the proposed monitoring plan
OM-5S	OM05S		
OM-6A	~~OM06/OM06A~~	OR06A	
OM-7	OM07		
OM-8	OM08		This well is upgradient of the ash ponds and will be used for measurement of elevation only, pending IEPA approval of the proposed monitoring plan.
OM-9	OM09		
OM-10	OM10		
OM-11	~~OM11~~	OR11	
OM-12	OM12		
OM-13D	~~OM13D~~	OR13D	
OM-13S	~~OM13S~~	OR13S	
OM-14	~~OM14~~	OR14D OR14S	Original well OM14 damaged during slurry line installation; replaced with wells OR14D and OR14S
MW-15	OM15		
MW-16	OM16		
MW-17	OM17		
n/a	~~OM18~~	OR18	
n/a	~~OM19~~	OR19	Original well OM19 (formerly OMA), replaced by OR19
n/a	OM20	OR20	Original well OM20 (formerly OMB)
n/a	OM21		Original well OM21 (formerly ORC)
n/a	OM22S		
n/a	OM22D		
n/a	OM23S		
n/a	OM23D		
n/a	OM24D		
n/a	OM25S		
n/a	OM25D		
n/a	OM26		Well used to monitor water level in Ash Pond 2; To be abandoned following IEPA approval of the proposed monitoring plan
n/a	OM27		Well used to monitor water level in Ash Pond 1; To be abandoned following IEPA approval of the proposed monitoring plan
n/a	OM28		Well used to monitor water level in Ash Pond 1; To be abandoned following IEPA approval of the proposed monitoring plan
n/a	OM30		Well used to monitor water level at edge of Ash Pond 2; To be abandoned following IEPA approval of the proposed monitoring plan
n/a	OM31		Well used to monitor water level at edge of Ash Pond 2; To be abandoned following IEPA approval of the proposed monitoring plan
n/a	~~OM50S~~		Monitoring well nest 1.5 miles northwest of Ash Pond 2
n/a	~~OM50D~~		Monitoring well nest 1.5 miles northwest of Ash Pond 2
n/a	~~OM51S~~		Monitoring well nest 1.5 miles south of Ash Pond 1
n/a	~~OM51D~~		Monitoring well nest 1.5 miles south of Ash Pond 1

OM99	Grey shading indicates wells monitored for groundwater elevation and chemistry as of 2012
OM99	Red shading indicates wells monitored for chemistry prior to 2011, and monitored for groundwater water elevation as of 2012
OM99	No shading indicates wells monitored for chemistry and groundwater elevation prior to 2011 that are no longer monitored
~~OM99~~	Strikethrough denotes well has been abandoned

NATURAL RESOURCE TECHNOLOGY

Table 3-3
Low, High and Median Leachate Concentrations
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Parameter	Unit	Ash Pond			Recycle Pond			Porewater			Applicable Standard	Applicable Class II Standard Concentration
		Low	High	Median	Low	High	Median	Ash Pond 1 (AP-1N/OM27)	Ash Pond 2 (AP-2/OM26)	Mean		
Antimony	mg/L							0.0036	<0.003	0.0033	Class II	0.024
Arsenic	mg/L							0.023	0.031	0.027	Class II	0.2
Barium	mg/L							0.18	0.14	0.16	(2)	
Beryllium	mg/L							<0.001	<0.001	<0.001	Class II	0.5
Boron	mg/L	160	390	320	66	390	265	43	180	112	(2)	
Cadmium	mg/L							0.0073	<0.001	0.0042	Class II	0.05
Chloride	mg/L	2,000	4,600	3,900	1,700	4,900	3,550	1,300	2,300	1,800	(1), (2)	
Chromium	mg/L							0.033	0.059	0.046	Class II	1.0
Cobalt	mg/L							0.0020	0.0031	0.0026	Class II	1.0
Copper	mg/L							0.0046	0.0049	0.0048	(2)	
Cyanide	mg/L							<0.005	0.012	0.0085	Class II	0.6
Fluoride	mg/L							<2.5	<2.5	<2.5	Class II	4.0
Hardness	mg/L	3,800	13,000	5,900	2,600	8,516	5,400	3,300	5,000	4,150	(3)	No Standard
Iron	mg/L	<0.01	2.7	0.012	<0.01	1.9	<0.01	0.015	0.16	0.088	(1), (2)	
Lead	mg/L							0.013	<0.001	0.0070	Class II	0.1
Manganese	mg/L	0.07	1.8	0.59	0.033	1.5	0.67	0.012	0.04	0.026	(1), (2)	
Mercury	mg/L							0.00031	<0.0002	0.00026	Class II	0.01
Nickel	mg/L							0.074	0.1	0.087	(2)	
Nitrate	mg/L							<0.2	<0.2	<0.2	Class II	100
Selenium	mg/L							0.055	0.086	0.071	(2)	
Silver	mg/L							<0.005	<0.005	<0.005	(3)	No Standard
Total Dissolved Solids	mg/L	3,200	14,000	10,000	3,800	14,000	10,000	4,500	7,600	6,050	(1), (2)	
Sulfate	mg/L	1,300	2,100	1,600	1,000	2,200	1,500	1,100	1,300	1,200	(1), (2)	
Thallium	mg/L							<0.001	<0.001	<0.001	Class II	0.02
Zinc	mg/L							<0.006	0.0084	0.0072	(2)	

Notes:
Surface water samples were last analyzed for the Ash and Recycle ponds in 2009 and 2010, respectively. Ash ponds were taken out of service in 2010.
The porewater concentrations are based on one sample collected from each of OM27 (AP-1N) and OM26 (AP-2) in 2012.
Except as noted below, Class II standards are applicable for Class IV groundwater in previously mined areas
(1) Per 35 IAC 620.440(c) the standard for this constituent is the existing concentration.
(2) Per 35 IAC 620.420(a)(3) there is no applicable standard for groundwater monitored in fill placed prior to November 1991.
(3) There is no Class II or Class IV standard for this constituent. Per 35 IAC 620.440(c) the standard for this constituent is the existing concentration.

Table 3-4
Low, High and Median Background Groundwater Concentrations
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Parameter	Unit	OM10[1]			OM16[1]			OM17[1]		
		Low	High	Median	Low	High	Median	Low	High	Median
Boron	mg/L	0.024	1.5	0.12	0.025	1.1	0.075	0.05	2.8	0.14
Chloride	mg/L	3.3	26	7.3	4.7	49	7.5	2.0	8.7	2.9
Iron	mg/L	<0.01	13	0.8	0.052	18	5.1	<0.01	11	0.51
Hardness	mg/L	70	2200	1800	2000	3500	2600	460	1400	840
Manganese	mg/L	0.078	6.3	2.8	3.6	7.9	4.5	0.042	2.9	0.76
Sulfate	mg/L	5.5	1300	820	1100	2400	1850	230	820	370
Total Disssolved Solids	mg/L	100	2900	1900	980	3700	3400	330	3700	912

Footnotes:
1. OM10, OM16 and OM17 were last analyzed in September 2010.

Table 3-5
Changes in Average Boron and Chloride Concentration
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Average Boron, mg/L (2008-2009)[1]	Average Boron, mg/L (2014-2015)	Boron Change	Average Chloride, mg/L (2008-2009)[1]	Average Chloride, mg/L (2014-2015)	Chloride Change	Trend Observations
OM01	0.25	0.32	26%	15	21	45%	Increases are relatively small in absolute values
OR02	4.1	4.9	20%	244	248	2%	No apparent trend
OR03D	2.9	2.9	3%	143	82	-42%	No apparent trend
OR04D	87	23	-74%	1177	264	-78%	Decreasing
OM04S	7.9	0.67	-92%	184	14	-92%	No apparent trend; Averages affected by anomalous points
OR06A	1.5	1.4	-8%	23	29	25%	Increasing for Cl, no apparent trend B
OM07	1.5	0.9	-43%	20	15	-28%	Decreasing
OM08	0.13	12	9164%	6	294	5181%	Increasing
OR11	9.5	7.2	-24%	121	55	-54%	Increasing to 2012, then decreasing
OM12	5.1	0.12	-98%	76	6.1	-92%	No apparent trend; Averages affected by anomalous points
OR13D	4.1	2.9	-30%	88	53	-40%	Decreasing
OR13S	8.3	5.0	-40%	224	107	-52%	Decreasing
OR14D	29	6.3	-78%	413	82	-80%	Decreasing
OR19	28	16	-43%	402	168	-58%	Decreasing
OR20	212	73	-65%	2960	774	-74%	Decreasing
OM21	6.3	14	123%	443	502	13%	Increasing, began before pond changes
OM22D [2]	2.7	14	420%	81	478	490%	Increasing
OM23D [2]	1.8	2.1	15%	41	35	-16%	No apparent trend, two anomalous points were excluded
OM24D [2]	23	27	17%	480	710	48%	Increasing to 2014, then decreasing
OM25S [2]	5.1	19	276%	190	486	156%	Increasing

(yellow) Decreasing concentration trend >30%
(green) Increasing concentration trend >30%
Refer to Appendix C4 for boron and chloride time series plots
Footnotes:
1. Ash ponds were removed from service in 2010
2. Averages for 2008-2009 includes only one round of sampling from December 2009 (wells installed August-September 2009).

Table 4-1
Proposed Monitoring Well Network
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well ID (permit)	Compliance Monitoring Wells	Groundwater Elevation Wells	Installed	Ground Surface Elevation (ft) [1]	Top of Well Casing Elevation (ft) [1]	Top of Screen Elevation (ft)	Bottom of Screen Elevation (ft)	Well Depth (ft below ground surface)	Groundwater Elevation Sept 2015 (ft)	Water Level Above Bottom of Screen (ft)
OM01	X	WT	Sep-80	593.3	595.61	578	573	20.3	583.86	10.86
OR02	X	WT	Apr-08	599.2	601.41	589	579	20.2	594.98	15.98
OR03D	X	PZ	Apr-08	623.7	627.13	557	547	76.7	582.69	35.69
OR03S		WT	Apr-08	623.7	627.16	575	566	57.7	582.46	16.46
OM04S	X	WT	Oct-80	604.8	607.35	582	572	32.8	588.30	16.3
OR04D	X	PZ	Oct-97	604.8	607.58	550	540	64.8	586.97	46.97
OR06A	X	WT	Apr-08	591.6	595.31	576	567	24.6	578.74	11.74
OM07	X	WT	Nov-80	594.4	596.46	576	566	28.4	584.54	18.54
OM08		WT	Nov-80	599.1	601.74	584	574	25.1	587.14	13.14
OM09		WT	Nov-80	590.2	591.61	575	565	25.2	585.75	20.75
OM10		WT	Nov-80	584.1	585.11	576	566	18.1	579.56	13.56
OR11	X	WT	Mar-08	593.6	596.55	562	552	41.6	566.25	14.25
OM12	X	PZ	Nov-80	592.8	595.37	563	553	39.8	583.37	30.37
OR13D [2]	X	PZ	Mar-08	600.3	602.70	563	553	47.3	593.97	40.97
OR13S [2]	X	WT	Mar-08	600.2	602.71	584	574	26.2	590.78	16.78
OR14D	X	PZ	Mar-09	596.2	598.91	560	551	45.2	589.66	38.66
OR14S		WT	Mar-09	596.2	599.26	585	576	20.2	591.81	15.81
OM15		PZ	Jul-94	596.0	598.05	554	544	52.0	580.17	36.17
OM16		WT	Jul-94	605.4	607.93	575	565	40.4	585.90	20.9
OM17		WT	Oct-93	589.3	592.13	585	575	14.3	583.19	8.19
OR18		PZ	Apr-08	611.6	613.85	571	561	50.6	602.21	41.21
OR19	X	PZ	Mar-08	595.7	597.80	554	544	51.7	577.81	33.81
OR20	X	PZ	Mar-08	584.6	587.72	540	530	54.6	566.63	36.63
OM21	X	PZ	Oct-97	604.2	606.60	557	547	57.2	596.77	49.77
OM22S		WT	Aug-09	596.8	599.22	570	561	35.8	580.60	19.6
OM22D	X	PZ	Aug-09	597.1	598.87	539	534	63.1	581.38	47.38
OM23S		WT	Sep-09	610.4	613.14	577	568	42.4	571.08	3.08
OM23D	X	PZ	Sep-09	610.4	613.25	540	531	79.4	576.99	45.99
OM24D	X	PZ	Aug-09	573.9	576.79	563	554	19.9	573.39	19.39
OM25S	X	WT	Aug-09	627.0	629.11	575	566	61.0	571.00	5
OM25D		PZ	Aug-09	627.1	629.19	557	552	75.1	573.69	21.69
Total	19	31								

WT — WT and yellow shading indicates water table wells
PZ — PZ and no shading indicates piezometer wells

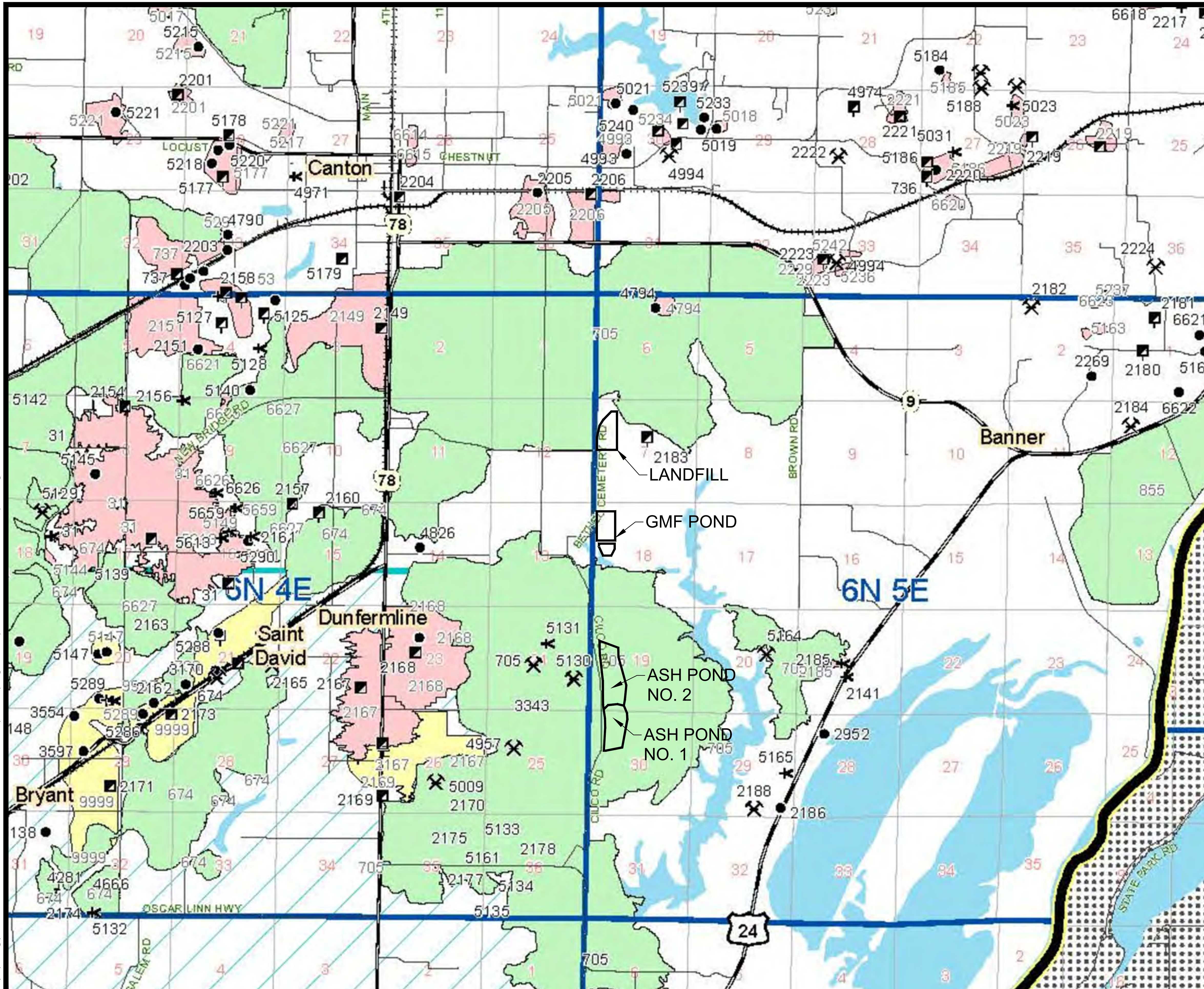
Footnotes:
1. Ground Surface and Top of Well Casing Elevation from April 2008, provided by Hanson. All wells will be resurveyed in 2016 and elevations updated on future reports.
2. Ground Surface at OR13D and OR13S are from Nov. 2015 survey to update the surface elevation change.

Table 4-2
Groundwater Monitoring Program Schedule
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Frequency	Duration
Quarterly	Begins: upon approval of this plan.
	Ends: 5 years after completion of cap and upon demonstration that monitoring effectiveness is not compromised and that there are no increasing trends attributable to Ash Ponds 1 and 2.
Semiannual	Begins: after IEPA approves that quarterly monitoring requirements have been satisfied.
	Ends: 5 years after initiation of semiannual monitoring and upon demonstration that monitoring effectiveness is not compromised and that there are no increasing trends attributable to Ash Ponds 1 and 2.
Annual	Begins: after IEPA approves that semiannual monitoring requirements have been satisfied.
	Ends: upon IEPA approval of a certified post-closure care report.

APPENDIX A

SELECTED AECOM (2015) AND HANSON (2010) FIGURES



LEGEND:

- County
- Township
- Section
- Quadrangle study (Available on Website)
- Lake or river
- Coal mine - active
- Underground coal mine - abandoned
- Surface coal mine - abandoned
- Indefinite underground coal mine boundary - abandoned
- Underground industrial mine and surrounding buffer region
- 951, 951 Coal mine index number (polygon label, point label)
- Opening type unknown
- Uncertain location
- Active surface tipple
- Abandoned surface tipple
- Active shaft
- Abandoned shaft
- Active slope
- Abandoned slope
- Active drift
- Abandoned drift
- Underground industrial mine entrance or general location

N

5000 0 5000

SCALE IN FEET

AECOM

8300 College Boulevard, Suite 200
Overland Park, Kansas 66210

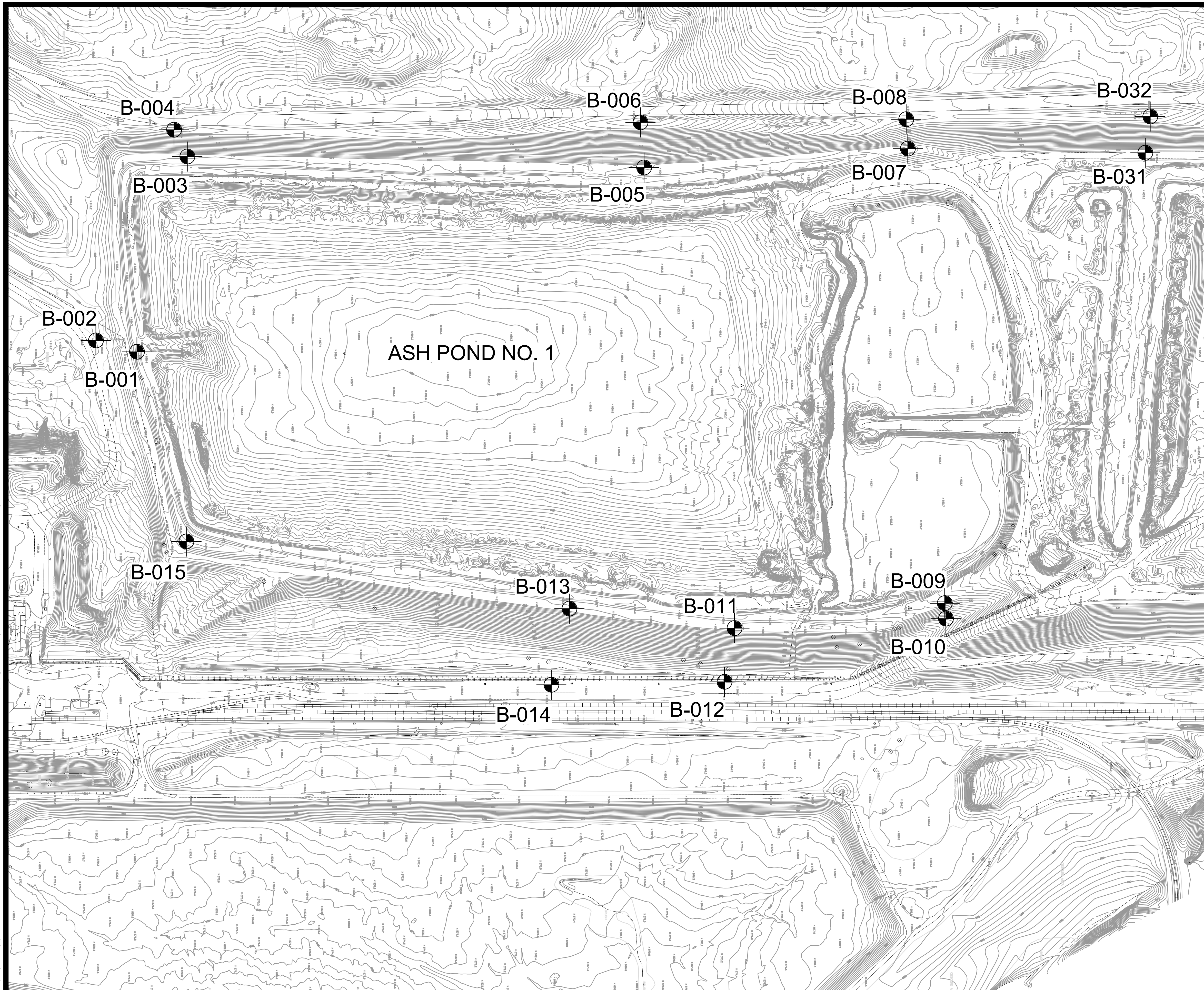
CLIENT: DYNEGY

LOCATION: DUCK CREEK STATION

TITLE: COAL MINES AND UNDERGROUND INDUSTRIAL MINES IN FULTON COUNTY, STATE OF ILLINOIS

DRAWN BY	CHECKED BY	APPROVED BY
TMS	JAA	WDS
PROJECT NO.	DATE	FIGURE NO.
60439301	DEC. 2015	1

December 8, 2015 2:29.26 pm (mik)
J:\Dynegy Duck Creek Ash Pond Closure\CAD\Figures\Ponds on Coal Map.dwg



LEGEND:

B-011 EXPLORATORY BORING LOCATION AND NUMBER

NOTE:
1. TEMPORARY GROUNDWATER LEVEL MONITORING WELLS (PIEZOMETERS) WERE INSTALLED IN BORING B-003 AND B-011. THE WELLS WERE ABANDONED UPON COMPLETION OF FIELD ACTIVITIES. REFER TO APPENDIX A FOR DETAILS.

N

250 0 250

SCALE IN FEET

AECOM

8300 College Boulevard, Suite 200
Overland Park, Kansas 66210

CLIENT: DYNEGY

LOCATION: DUCK CREEK STATION - CANTON, IL

TITLE:
BORING LOCATION PLAN
DUCK CREEK ASH POND NO. 1

DRAWN BY	CHECKED BY	APPROVED BY
TMS	JAA	WDS
PROJECT NO.	DATE	FIGURE NO.
60439301	DEC. 2015	2A

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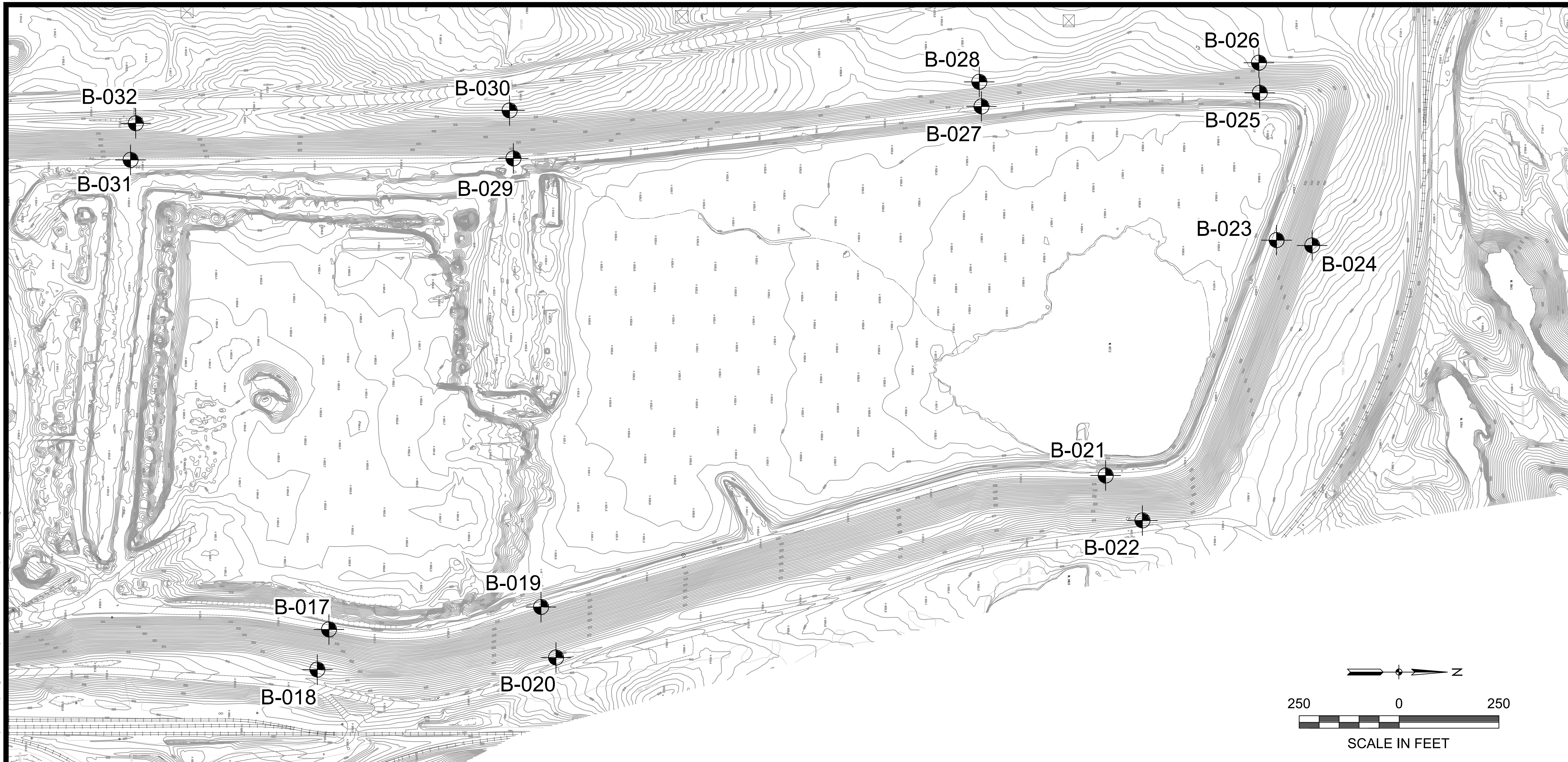

AECOM
8300 College Boulevard, Suite 200
Overland Park, Kansas 66210

CLIENT: DYNEGY

LOCATION: DUCK CREEK STATION

TITLE:
BORING LOCATION PLAN
DUCK CREEK ASH POND NO. 2

DRAWN BY	CHECKED BY	APPROVED BY
TMS	JAA	WDS
PROJECT NO.	DATE	FIGURE NO.
60439301	DEC. 2015	2B

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FEB 26, 2010 3:41 PM BRANS00939
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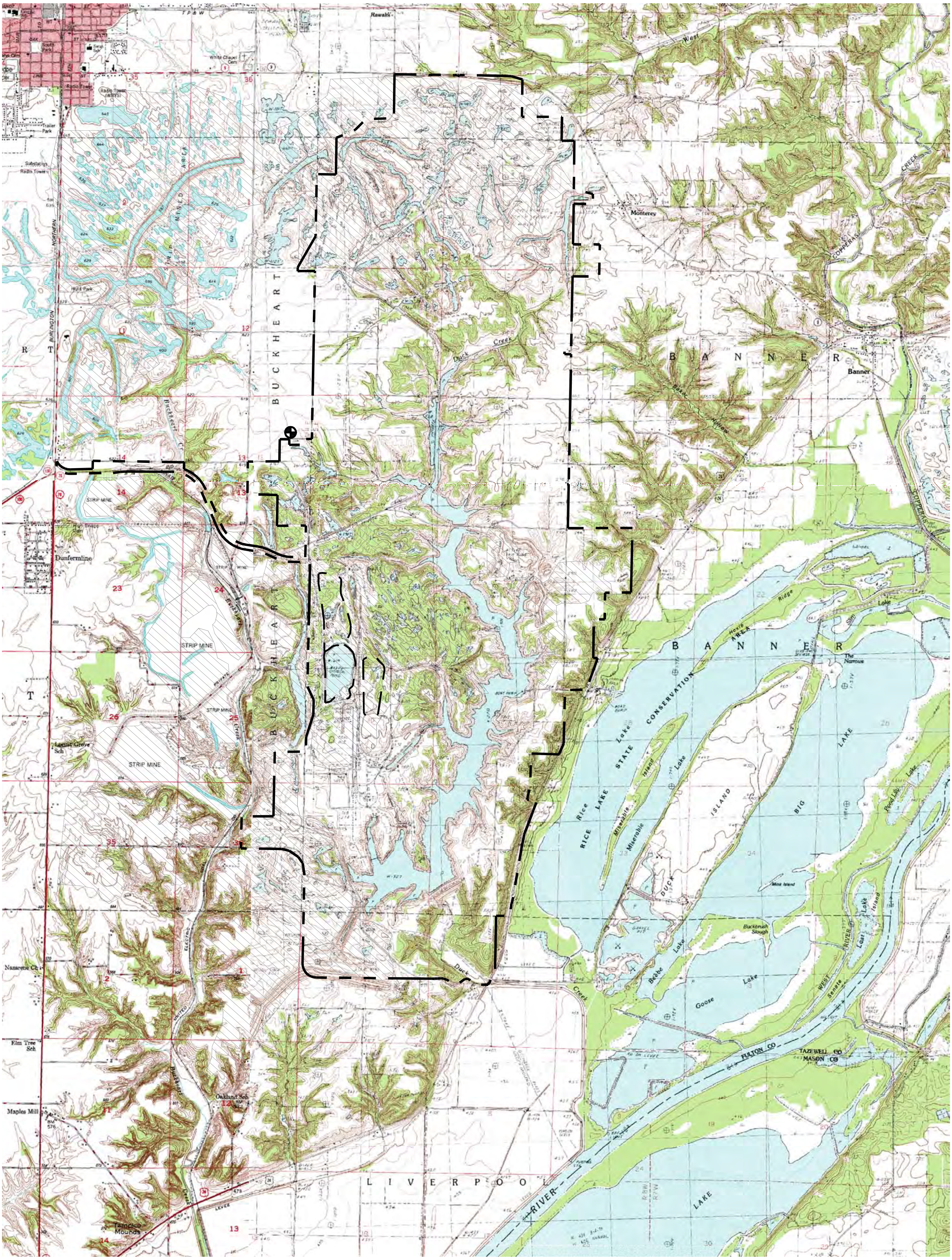


TOPO EXPLANATION

Ameren Property Boundary
Approx. Unit Limits (Pond)

Potable Water Well

Approximate Surface Mine Areas
Per ISGS Mapping (1998)

Approximate Site Location:
W ½ of Sections 19 & 30; T6N, R5E
Duck Creek 7 ½ minute Quadrangle Map

N

4,000' 0 4,000' 8,000'

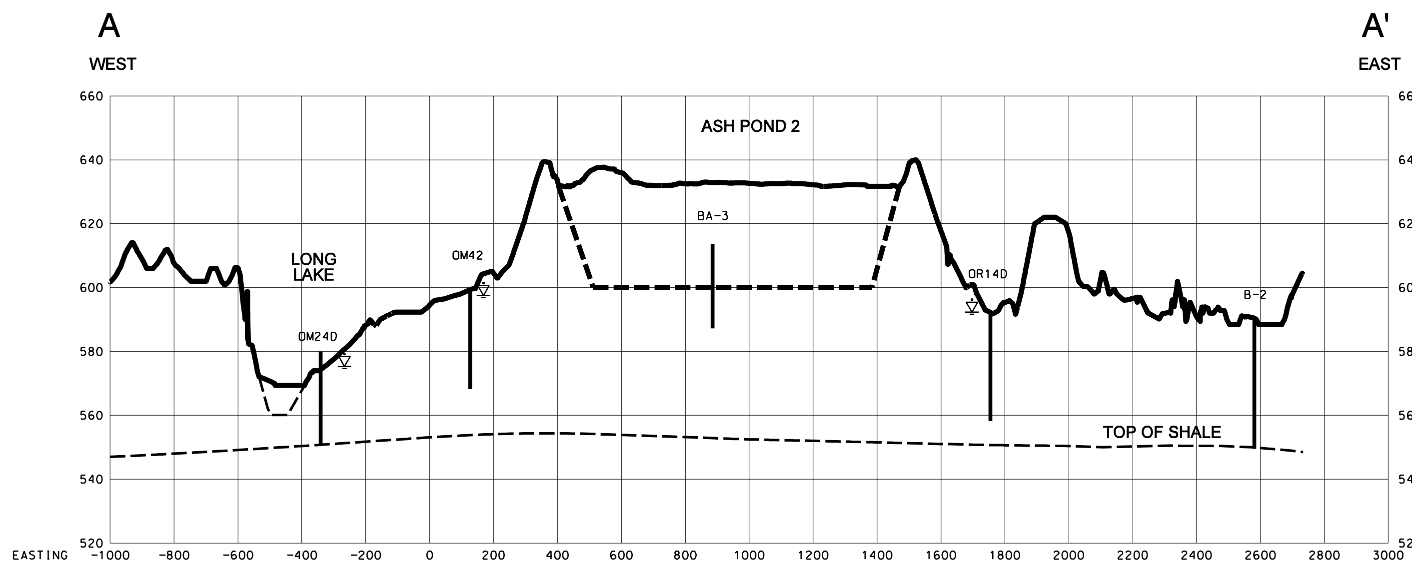
Scale: 1 inch = 4,000 feet Contour interval = 10 feet

HANSON
Hanson Professional Services Inc.

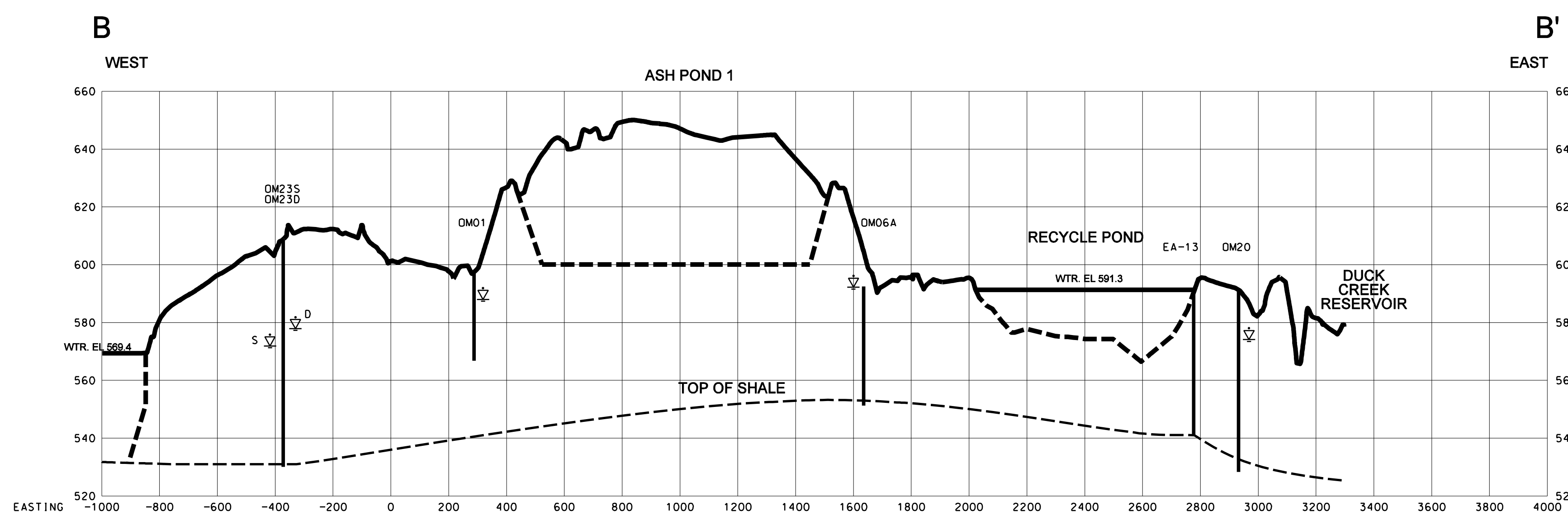
LOCATION MAP

SOLID WASTE MANAGEMENT FACILITY
DUCK CREEK POWER GENERATING STATION
CANTON, FULTON COUNTY, ILLINOIS

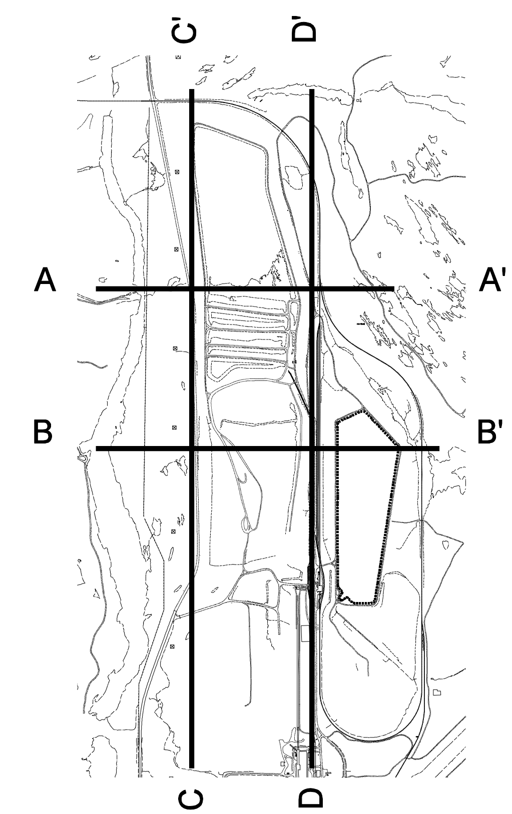
HANSON NO. 03S5010F FIGURE 1



SECTION A-A' (AT N 7500)



SECTION B-B' (AT N 5500)



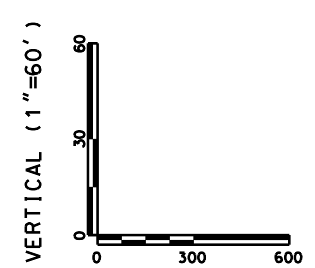
SECTION LOCATION MAP

NTS

(SECTIONS C-C' AND D-D' ARE SHOWN ON FIGURE 5)

NOTES:

1. WATER LEVELS FROM DECEMBER 2009
2. BORING LOCATIONS ARE PROJECTED ONTO CROSS SECTION. ACTUAL ELEVATIONS MAY VARY FROM ORIGINAL LOCATION.
3. NOT ALL GEOLOGIC DETAIL MAY BE SHOWN.



HORIZONTAL (1"=600')

VERTICAL ENHANCEMENT =10x

SCALES

HANSON

Hanson Professional Services Inc.

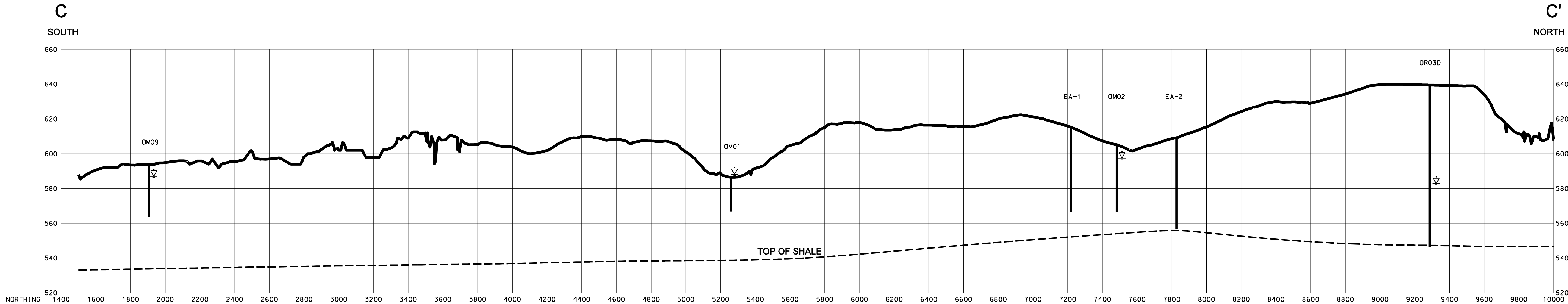
CROSS SECTIONS A-A' AND B-B'

SOLID WASTE MANAGEMENT FACILITY
DUCK CREEK POWER GENERATING STATION
CANTON, FULTON COUNTY, ILLINOIS

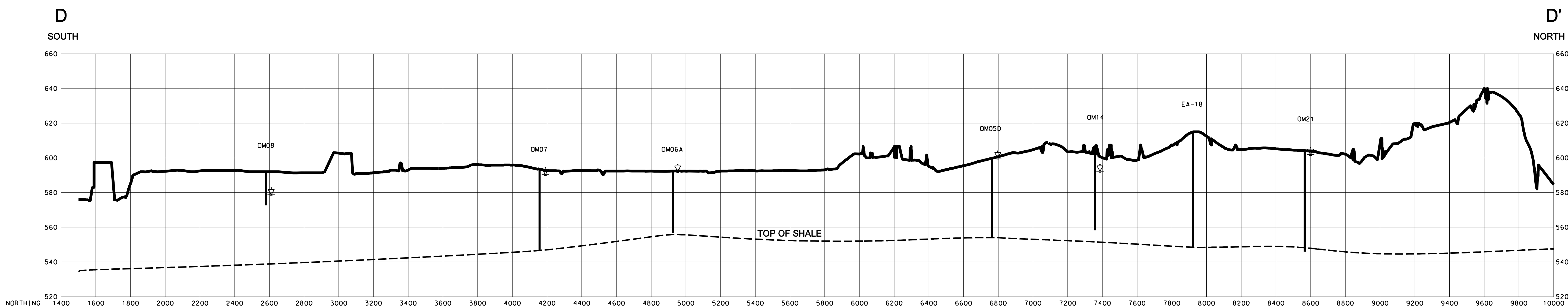
HANSON NO. 03S5010F

FIGURE 4

Brans00939 03\02\2010
I:\03 Jobs\03S5010F\CADD\Site\Sheet\Figures\FIG-4_XSC-A-B.dgn



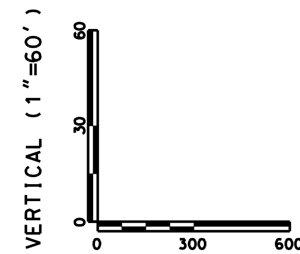
SECTION C-C' (AT E 200)



SECTION D-D' (AT E 1700)

NOTES:

1. WATER LEVELS FROM DECEMBER 2009
2. BORING LOCATIONS ARE PROJECTED ONTO CROSS SECTION. ACTUAL ELEVATIONS MAY VARY FROM ORIGINAL LOCATION.
3. NOT ALL GEOLOGIC DETAIL MAY BE SHOWN.
4. SEE FIGURE 4 FOR SECTION LOCATION MAP.



HORIZONTAL (1"=600')
VERTICAL ENHANCEMENT =10x
SCALES

HANSON
Hanson Professional Services Inc.

CROSS SECTIOS C-C' AND D-D'

SOLID WASTE MANAGEMENT FACILITY
DUCK CREEK POWER GENERATING STATION
CANTON, FULTON COUNTY, ILLINOIS

HANSON NO. 03S5010F

FIGURE 5

Brans00939 03\02\2010
I:\03Jobs\03S5010F\CADD\Site\Sheet\Figures\FIG-5_XSC-C-D.dgn

APPENDIX B

HYDRAULIC CONDUCTIVITY TEST RESULTS

APPENDIX B1

ASH POND 1 AND ASH POND 2, AQUIFER EVALUATION IN THE SURFACE (STRIP) MINING AREA, HANSON, FEBRUARY 29, 2016

Ash Pond 1 and Ash Pond 2

Aquifer Evaluation in the Surface (Strip) Mining Area

Duck Creek Power Station
Illinois Power Resources Generating, LLC
Fulton County, Illinois

February 29, 2016

HANSON
Engineering | Planning | Allied Services

Table of Contents

Figures and Tables

Figures

Tables

1. Description of Local Geology

Duck Creek Power Station Ash Pond 1 and Ash Pond 2 (Site) are located near Canton in Fulton County, Illinois (see Figure 1). The Site is positioned on the glacial uplands above the Illinois River in the Ancient Illinois Floodplain of the Till Plains Section of the Central Lowland Province (Leighton et al., 1948).

The Site and surrounding area are part of several, large, surface coal mines that have since stopped mining operations (Berg and Kempton, 1988).

Bedrock in the area is identified as Pennsylvanian-age shale deposits that underlie the removed Springfield (No. 5) Coal. The bedrock is typically found at an elevation of 550-555 ft. NGVD, but has been found as deep as 545 ft. NGVD in places.

2. Uppermost Aquifer Requirements

2.1 Definitions

The US Environmental Protection Agency (EPA), as part of its recent rulemaking regarding Disposal of Coal Combustion Residuals (CCR) from Electric Utilities, requires groundwater monitoring to yield groundwater samples from the uppermost aquifer that represent the quality of background groundwater and the quality of groundwater passing the CCR unit waste boundary. [40 CFR 257.90-94] (US EPA, 2015).

"Uppermost aquifer" is defined by US EPA (2015) [40 CFR 257.53] as:

> *the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural ground surface to which the aquifer rises during the wet season.*

US EPA (2015) [40 CFR 257.53] further defines **"aquifer"** to be:

> *a geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs.*

US EPA guidance† concerning the CCR rule's definition of "aquifer" provides that:

> *the quality and value of an aquifer should be a site-specific determination. Usable water in an aquifer typically includes all groundwater currently used or potentially available for drinking water and other beneficial uses (e.g., industrial or agricultural use), whether or not it is particularly vulnerable to contamination. The Agency is unable to judge the resource value of an aquifer based on a generic scale of significance because of the variability of aquifers on a site-by-site basis.*

† US EPA, Top 20 Questions on EPA's CCR Final Rule, Answer to Question #9 (April 2015)

3. Site Hydrogeology

3.1 Shallow (Unlithified) Groundwater

The Hydrogeologic Report (Hanson, 2010) indicates that shallow groundwater at the Site moves through the disturbed mine spoils. The Site groundwater is classified as Class IV: Other Groundwater under the Illinois Groundwater Quality Standards at Title 35, Ill. Admin. Code, Part 620 [35 IAC 620] (IPCB, 1991).

3.1.1 Shallow Groundwater Quantity Evaluation

Hanson recently completed hydraulic conductivity testing (slug testing) of the monitoring wells immediately surrounding Ash Pond 1 and Ash Pond 2. Results of the tests are summarized in Table 1 and the analyses are located in Appendix A. Analyses of the falling head and rising head tests performed at each well (no rising head test at OM05S) were performed using AQTESOLV version 4.50. The Bower-Rice method [B-R] (Bouwer & Rice, 1976) (Bouwer, 1989) and the Kansas Geological Survey method [KGS] (Butler, 1998) unconfined solutions were used for the analyses. Of the 23 tests performed the geometric mean hydraulic conductivity for the mine spoil material is 2.0 x 10^{-4} cm/sec, with values ranging from 1.5 x 10^{-3} cm/sec at OR03D to 5.2 x 10^{-6} cm/sec at OM04S.

Table 1. Hydraulic Conductivity (Slug) Test Summary

Well ID	Falling Head	Rising Head	Geometric Mean	Analysis Method
OM01	0.00045	0.00065	0.00054	B-R
OR02	0.00037	0.00047	0.00042	B-R
OR03D	0.0015	0.00077	0.0011	B-R
OR03S	0.00039	0.0003	0.00034	B-R
OR04D	0.00015	0.00031	0.00022	B-R
OM04S	0.0000052	0.000055	0.000017	B-R
OR05D	0.000034	0.000034	0.000034	KGS
OM05S	0.000095		0.000095	B-R
OR06A	0.00018	0.00054	0.00031	B-R
OM07	0.00011	0.00024	0.00016	B-R
OM09	0.00031	0.00026	0.00028	KGS
OM21	0.00035	0.00036	0.00035	B-R
Geometric Mean =	0.000169	0.000267	0.000200	

Using the mean hydraulic conductivity value as being representative of water movement across the site, Hanson has calculated the capacity of the unlithified mine spoils to supply water to a hypothetical water well. Assuming a well with a 15-inch (1.25 ft.) radius and a screened interval of 50 feet (fully saturated) then using Darcy's Law (flow rate [Q] equals the hydraulic conductivity [k] times the gradient [i] times the area [A]), the groundwater supply rate to this hypothetical well is:

$k = 2.0 \times 10^{-6}$ m/sec,
$i = 0.003$ m/m (from site-specific potentiometric surface maps),
$A = 2\pi rh = 2*3.14*0.381 \text{ m}*15 \text{ m} = 35.9 \text{ m}^2$

$Q = kiA = 2.0 \times 10^{-6} \text{ m/sec} * 0.003 * 35.9 \text{ m}^2 = 2.15 \times 10^{-7} \text{ m}^3\text{/sec} = 4.92$ gal/day.

Several references were used to quantify "usable quantities" as that term is used in the US EPA definition of "aquifer" [40 CFR 257.53]. The US EPA WaterSense‡ web site indicates that an average American family uses over 300 gallons of water per day, and a United Nations study§ indicates that a typical American uses 575 liters (152 gallons) of water per day (so a household of two adults would use 304 gallons of water per day). Moreover, US EPA's RCRA regulations [40 CFR 260.10] define "aquifer" in terms of a geologic formation capable of a "significant yield" of groundwater to wells or springs**, with US EPA RCRA guidance further informing that some US EPA Regions have used local definitions or ranges to establish a significant yield figure, e.g., 5-50 gallons per day.†† Accordingly, based on the quantity of water that an average American household uses per day as the threshold for "usable quantities" under the US EPA definition of "aquifer" [40 CFR 257.53], as well as quantities identified in relevant US EPA RCRA guidance, the Mine Spoil at the Site would not be considered an aquifer.

3.1.2 Shallow Groundwater Quality Evaluation

Groundwater quality data has been collected at the Site since 1985. Since 2010, groundwater in the unlithified (mine spoils) material has had elevated concentrations of Boron (0.6 to 200 mg/L), Chloride (4 to 2100 mg/L), Iron (0.01 to 400 mg/L), Manganese (1.4 to 9500 ug/L), Sulfate (120 to 2900 mg/L), and Total Dissolved Solids (500 to 5800 mg/L). These Appendix III [40 CFR 257] constituents have concentrations that exceed Illinois [35 IAC 620] groundwater standards, US EPA MCLs, or US EPA secondary water quality standards. This water quality does not meet potable quality standards, and would also be difficult to use for industrial or agricultural purposes, without significant treatment, due to the potential caustic nature of the elevated Chloride and Sulfate concentrations.

‡ http://www.epa.gov/watersense/our_water/water_use_today.html

§ United Nations Development Program - Human Development Report 2006 at http://www.data360.org/dsg.aspx?Data_Set_Group_Id=757

** US EPA Comment Summary and Response Document, Hazardous and Solid Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals from Electric Utilities: Proposed Rule, Docket # EPA-HQ-RCRA-2009-0640, Vol.3, C.2.b, at p. 38 (Dec. 2014) (explaining that the 40 CFR 257.53 definition of "aquifer" conforms to the definition of "aquifer" in 40 CFR 260.10).

†† US EPA RCRA/Superfund Hotline Monthly Summary, RCRA Online No. 12323, RPPC No. 9432.1984(06) (Nov. 1, 1984)

3.2 Bedrock Aquifer Evaluation

3.2.1 Pressure (Packer) Testing Methodology

Pressure testing equipment used at OM32 consisted of two pneumatic packers (rubber bladders) with a length of perforated steel pipe between them. The interval between the two packers was approximately 8.5 ft. Additional mild steel pipe (1 inch diameter) was added (or removed) to the packer assembly to reach the desired test interval. Nitrogen gas was used to inflate the packers, once they were lowered to the test depth. Inflation pressures were typically around 300 psi.

Water was pumped down to the test interval through a flow meter so that the amount of water “taken up” by the formation could be quantified. Flow to the sample interval was started before the packers were inflated, so that any leaks or other issues could be more easily identified. Although noted in the results for each sample interval, the first test increment listed is typically ignored. Each test “step” lasted approximately 15 minutes. Supply pressure to the test interval was increased at each step (i.e., 10 psi, 20 psi, and 30 psi). At the completion of the test, the pressures were reduced to the previous level and held for about 5 minutes. This “step down” portion of the test allows the geologist to determine if any water uptakes are real, or if the pressure only expanded the rock bedding/jointing.

3.2.2 Deep (Bedrock) Groundwater

Visocky et al. (1985) indicates that deeper strata in the bedrock can produce water that may be suitable (volume and quality) for a potable water supply. In fact, the Illinois Water Well (ILWATER) database (ISGS, 2015) identifies a bedrock well approximately 2 miles northeast of the Site that obtains water from a sandstone located 250-260 ft. bgs (below ground surface).

The bedrock immediately below the mined-out Springfield (No. 5) Coal at the Site is principally shale, with occasional sandstone, limestone and thin coal horizons. During September 2015, Hanson completed a bedrock boring (OM26B) to a depth of 355 ft. bgs. A boring log for OM26B, showing the unlithified and bedrock units, is included as Appendix B.

At the completion of the coring operations, Hanson pressure (packer) tested 255 ft. of bedrock in boring OM32. Results of the testing are summarized in Table 2, with the complete set of calculations included as Appendix C. The uppermost 100 ft. of bedrock had almost no take during the pressure testing. The only water uptake during the testing was noted (in the bottom 30 ft. of the borehole) at elevation 325-355 ft., with hydraulic conductivity (k) values in the 2 to 5 x 10^{-6} cm^3/cm^2/sec range.

Pressure testing continued up the borehole, but no other (shallower) pressure test measurements exceeded 3 x 10^{-8} cm^3/cm^2/sec (average k for test interval). Based on these results, Hanson concludes that the lowermost 55 ft. of bedrock is not “capable of yielding useable quantities of groundwater to wells or springs” due to the low hydraulic conductivities in the bedrock (low to mid 10^{-6} cm/s range at approximately 300 to 355 ft.) and, therefore, being 2-orders of magnitude lower than the mine spoil, bedrock is not an “aquifer” as defined by the US EPA (2015).

Additionally, the pressure testing indicates that there is almost 200 ft. of bedrock that is acting as a barrier to any potential contaminant migration from the mine spoil to any deeper water-bearing zones. Tests E through U typically had no take (formation was incapable of having any water injected during the tests).

Table 2. Pressure Test (Hydraulic Conductivity) Result Summary

Test No.	Depth (ft.)	Arithmetic Mean of Hydraulic Conductivity ($cm^3/cm^2/s$)	Median of Hydraulic Conductivity ($cm^3/cm^2/s$)
A	351.57	1.7×10^{-6}	1.3×10^{-6}
B	331.64	8.5×10^{-6}	5.8×10^{-6}
C	321.54	5.7×10^{-8}	3.9×10^{-8}
D	300.77	5.0×10^{-7}	2.7×10^{-8}
E	279.77	0.0	0.0
F	269.17	7.1×10^{-9}	0.0
G	258.72	5.9×10^{-7}	4.6×10^{-8}
H	248.62	3.0×10^{-9}	0.0
I	227.61	0.0 *(no take)*	0.0 *(no take)*
J	217.05	3.6×10^{-8}	0.0 *(no take)*
K	206.51	1.5×10^{-9}	0.0
L	196.37	0.0 *(no take)*	0.0 *(no take)*
M	185.77	1.5×10^{-9}	0.0
N	175.55	0.0 *(no take)*	0.0 *(no take)*
O	165.39	4.1×10^{-9}	0.0
P	155.25	0.0 *(no take)*	0.0 *(no take)*
Q	144.75	1.5×10^{-9}	0.0
R	134.15	1.3×10^{-9}	0.0
S	124.04	0.0 *(no take)*	0.0 *(no take)*
T	113.86	0.0 *(no take)*	0.0 *(no take)*
U	103.41	0.0 *(no take)*	0.0 *(no take)*

4. Conclusions

Hanson has reviewed available Site information and has performed additional hydraulic conductivity testing in both the Mine Spoil materials and the in situ bedrock formation(s). Based on the testing and analyses, Hanson concludes that the unlithified Mine Spoil materials are not an aquifer as defined by US EPA (2015) [40 CFR 257.53]. This material is incapable of producing "useable quantities" of groundwater, by both water quantity and quality analyses.

The bedrock formations were also tested, and determined to be incapable of producing "usable" quantities of groundwater. This testing further determined that the upper 200 ft. of bedrock is a barrier to any potential migration of the groundwater found within the Mine Spoil materials to deeper strata.

5. Licensed Professional Signature/Seal

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

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

Seal: LICENSED PROFESSIONAL GEOLOGIST
RHONALD W. HASENYAGER
196-000246
ILLINOIS
Expires 3/31/2017

Signature: ______________________ Date: 29 February 2016

6. References

Berg, R.C. and J.P. Kempton, 1988. "Stack-unit Mapping of Geological Materials in Illinois to a Depth of 15 Meters" Circular 542, Illinois State Geological Survey, Urbana, IL, 23 pp. + 4 maps.

Bouwer, H. and R.C. Rice, 1976. "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells". Water Resources Research, vol. 27, no. 3, American Geophysical Union, Washington, D.C. p. 423-428.

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Butler, J.J., Jr., 1998. The Design, Performance, and Analysis of Slug Tests. CRC Press LLC, Boca Raton, FL. 252 pp.

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IPCB, 1991. “Groundwater Quality Standards, Title 35, Illinois Administrative Code, Part 620”. Rulemaking R89-14B, Illinois Pollution Control Board, Springfield, IL. 80 pp.

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Visocky, A.P., M.G. Sherrill, and K. Cartwright, 1985. “Geology, Hydrology and Water Quality of the Cambrian and Ordovician Systems in Northern Illinois”, Cooperative Groundwater Report 10, Illinois State Geological Survey and Illinois State Water Survey, Champaign, IL. 136 pp.

Hanson Professional Services Inc.

SITE LOCATION MAP

ASH POND 1 AND ASH POND 2
DUCK CREEK POWER STATION
FULTON COUNTY, ILLINOIS

HANSON NO. 15E0030

FIGURE 1

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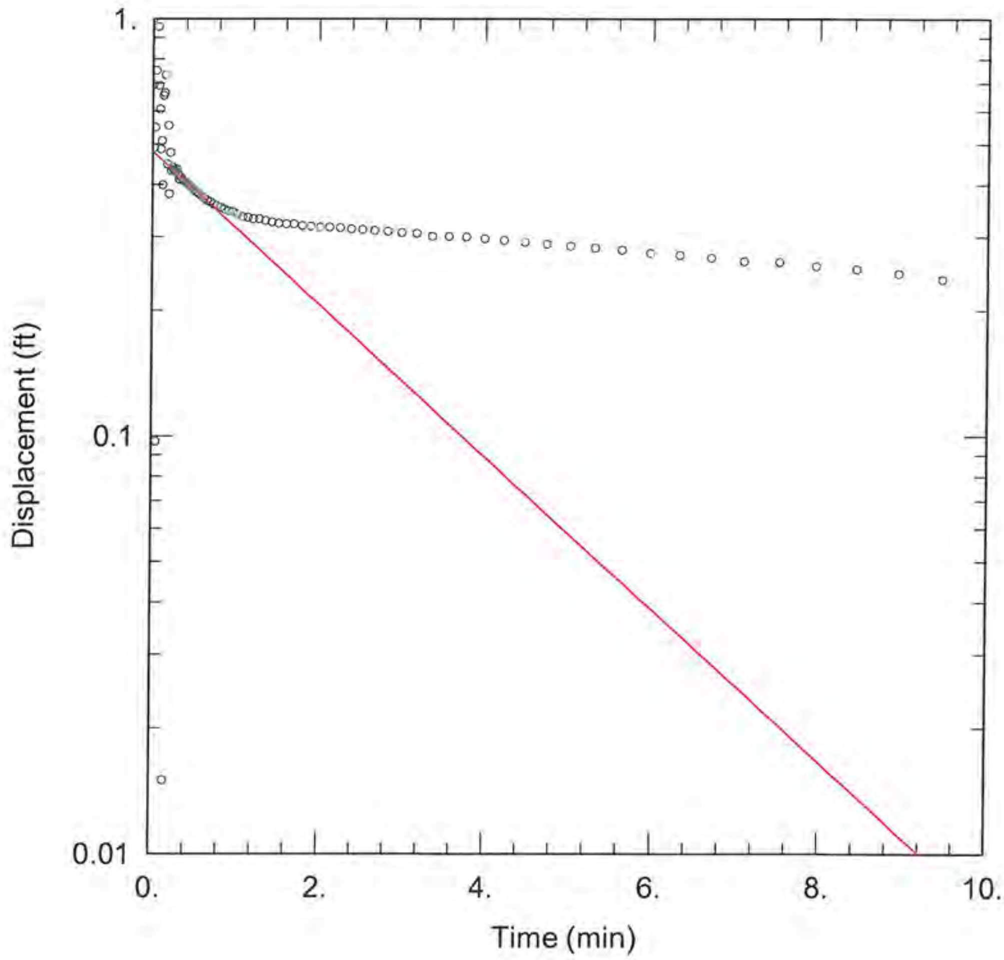
FIGURE 2. Hydraulic Conductivity Testing Locations
Duck Creek Power Station

Appendix A

Hydraulic Conductivity (Slug) Test Results

HANSON



OM01 FALLING HEAD TEST

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PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM01
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 15.72 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM01)

Initial Displacement: 1. ft
Total Well Penetration Depth: 9.22 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 9.22 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00045 cm/sec
y0 = 0.48 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM01fh.aqt
Title: OM01 Falling Head Test
Date: 12/09/15
Time: 09:16:48

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OM01

AQUIFER DATA

Saturated Thickness: 15.72 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM01

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1. ft
Static Water Column Height: 9.22 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 5. ft
Total Well Penetration Depth: 9.22 ft

No. of Observations: 110

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0112	0.695	1.606	0.322
0.0223	0.49	1.7	0.322
0.0335	0.548	1.799	0.319
0.0447	0.751	1.904	0.318
0.0558	0.097	2.016	0.316
0.067	0.956	2.134	0.316
0.0782	0.691	2.259	0.315
0.0893	0.606	2.392	0.313
0.1005	0.486	2.532	0.312
0.1117	0.509	2.681	0.31
0.1228	0.399	2.838	0.309
0.134	0.654	3.005	0.307
0.1452	0.664	3.182	0.306
0.1563	0.733	3.369	0.301
0.1675	0.015	3.568	0.301
0.1787	0.448	3.778	0.3
0.1898	0.554	4.	0.297
0.201	0.38	4.236	0.294
0.2122	0.477	4.486	0.291

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.2233	0.432	4.751	0.288
0.235	0.441	5.031	0.285
0.2475	0.435	5.328	0.282
0.2607	0.431	5.643	0.279
0.2747	0.432	5.976	0.274
0.2895	0.435	6.329	0.271
0.3052	0.423	6.702	0.267
0.3218	0.411	7.098	0.262
0.3395	0.416	7.518	0.261
0.3582	0.41	7.962	0.255
0.378	0.408	8.433	0.251
0.399	0.405	8.931	0.245
0.4212	0.401	9.459	0.237
0.4447	0.398	10.02	0.231
0.4695	0.393	10.61	0.227
0.4958	0.389	11.24	0.219
0.5238	0.384	11.9	0.213
0.5535	0.381	12.61	0.206
0.5848	0.376	13.35	0.197
0.618	0.371	14.14	0.19
0.6532	0.367	14.98	0.182
0.6905	0.364	15.87	0.172
0.73	0.359	16.81	0.163
0.7718	0.356	17.8	0.155
0.8162	0.353	18.85	0.143
0.8632	0.349	19.97	0.134
0.913	0.346	21.15	0.123
0.9657	0.344	22.4	0.112
1.022	0.34	23.73	0.1
1.081	0.335	25.14	0.087
1.143	0.334	26.62	0.073
1.21	0.331	28.2	0.062
1.28	0.331	29.87	0.047
1.355	0.328	31.64	0.032
1.434	0.325	33.51	0.018
1.517	0.323	35.5	0.002

SOLUTION

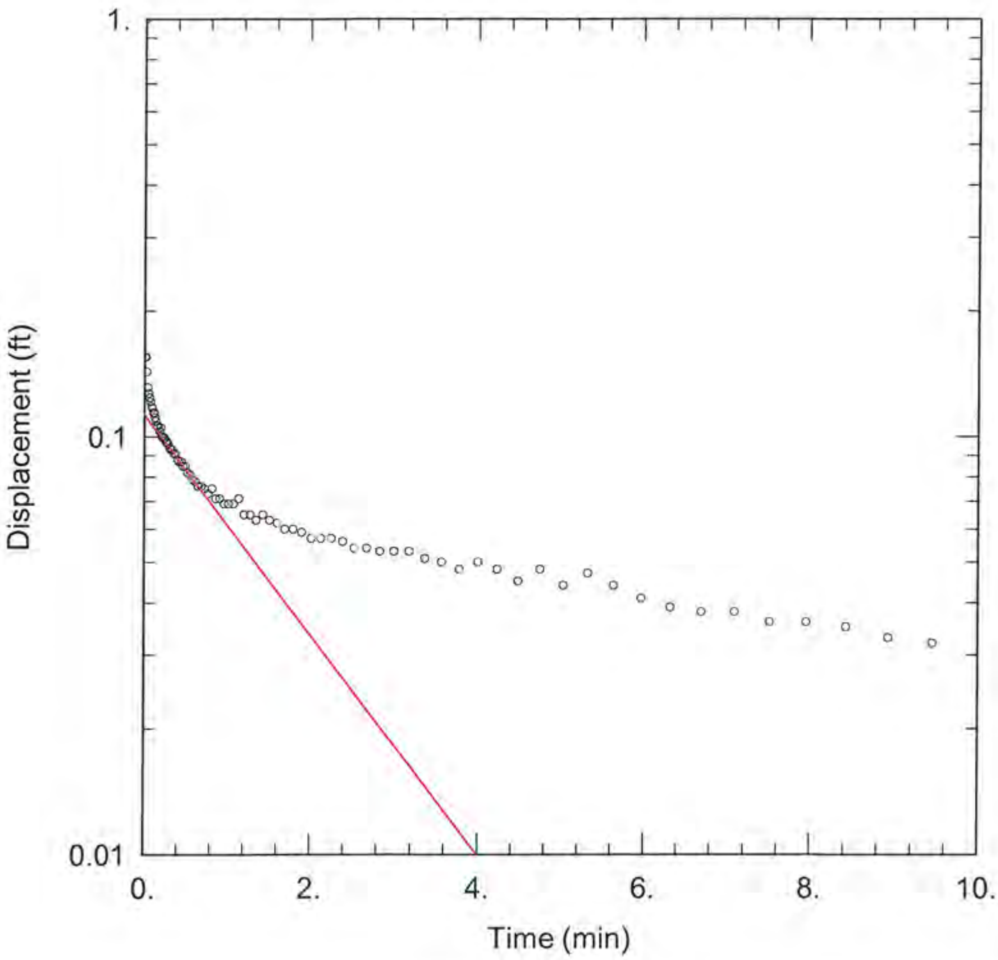
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.038

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00045	cm/sec
y0	0.48	ft

T = K*b = 0.2156 cm^2/sec



OM01 RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM01rh.aqt
Date: 12/09/15 Time: 09:16:49

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM01
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 15.72 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM01)

Initial Displacement: 1. ft
Total Well Penetration Depth: 9.22 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 9.22 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00065 cm/sec
y0 = 0.113 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM01rh.aqt
Title: OM01 Rising Head Test
Date: 12/09/15
Time: 09:16:50

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OM01

AQUIFER DATA

Saturated Thickness: 15.72 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM01

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1. ft
Static Water Column Height: 9.22 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 5. ft
Total Well Penetration Depth: 9.22 ft

No. of Observations: 106

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0112	0.155	1.434	0.065
0.0223	0.155	1.517	0.063
0.0335	0.143	1.606	0.062
0.0447	0.131	1.7	0.06
0.0558	0.127	1.799	0.06
0.067	0.124	1.904	0.059
0.0782	0.121	2.016	0.057
0.0893	0.118	2.134	0.057
0.1005	0.117	2.259	0.057
0.1117	0.114	2.392	0.056
0.1228	0.114	2.532	0.054
0.134	0.111	2.681	0.054
0.1452	0.109	2.838	0.053
0.1563	0.106	3.005	0.053
0.1675	0.106	3.182	0.053
0.1787	0.105	3.369	0.051
0.1898	0.103	3.568	0.05
0.201	0.105	3.778	0.048
0.2122	0.1	4.	0.05

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.2233	0.1	4.236	0.048
0.235	0.099	4.486	0.045
0.2475	0.099	4.751	0.048
0.2607	0.097	5.031	0.044
0.2747	0.097	5.328	0.047
0.2895	0.096	5.643	0.044
0.3052	0.094	5.976	0.041
0.3218	0.093	6.329	0.039
0.3395	0.093	6.702	0.038
0.3582	0.091	7.098	0.038
0.378	0.091	7.518	0.036
0.399	0.088	7.962	0.036
0.4212	0.087	8.433	0.035
0.4447	0.087	8.931	0.033
0.4695	0.085	9.459	0.032
0.4958	0.085	10.02	0.032
0.5238	0.082	10.61	0.03
0.5535	0.081	11.24	0.029
0.5848	0.079	11.9	0.029
0.618	0.078	12.61	0.026
0.6532	0.076	13.35	0.026
0.6905	0.076	14.14	0.024
0.73	0.075	14.98	0.023
0.7718	0.073	15.87	0.021
0.8162	0.075	16.81	0.02
0.8632	0.071	17.8	0.018
0.913	0.071	18.85	0.017
0.9657	0.069	19.97	0.013
1.022	0.069	21.15	0.011
1.081	0.069	22.4	0.01
1.143	0.071	23.73	0.01
1.21	0.065	25.14	0.008
1.28	0.065	26.62	0.005
1.355	0.063	28.2	0.004

SOLUTION

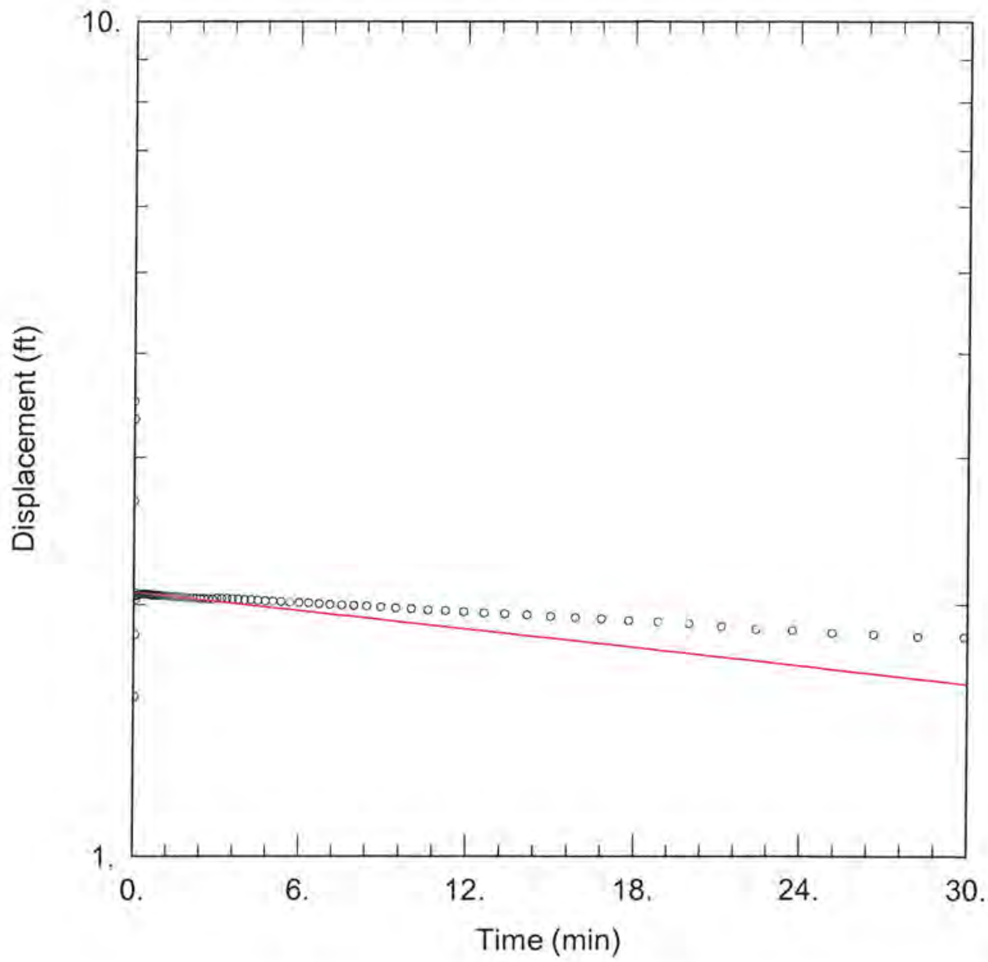
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.038

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00065	cm/sec
y0	0.113	ft

T = K*b = 0.3114 cm^2/sec



OM04S FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM04Sfh.aqt
Date: 12/09/15 Time: 09:16:51

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM04S
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 50.52 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM04S)

Initial Displacement: 3.5 ft
Total Well Penetration Depth: 17.52 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 17.52 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 5.2E-6 cm/sec
y0 = 2.07 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM04Sfh.aqt
Title: OM04S Falling Head Test
Date: 12/09/15
Time: 09:16:51

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OM04S

AQUIFER DATA

Saturated Thickness: 50.52 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM04S

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 3.5 ft
Static Water Column Height: 17.52 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 17.52 ft

No. of Observations: 102

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0165	2.659	1.824	2.042
0.033	3.335	1.929	2.039
0.0495	1.553	2.041	2.037
0.066	1.841	2.159	2.037
0.0825	2.066	2.284	2.036
0.099	2.03	2.416	2.034
0.1155	2.048	2.557	2.033
0.132	2.052	2.706	2.031
0.1485	2.054	2.863	2.03
0.165	2.055	3.03	2.036
0.1815	2.055	3.207	2.033
0.198	2.055	3.394	2.033
0.2145	2.057	3.592	2.031
0.231	2.058	3.803	2.03
0.2475	2.058	4.025	2.027
0.264	2.058	4.261	2.027
0.2805	2.058	4.511	2.023
0.297	2.058	4.776	2.02
0.3135	2.058	5.056	2.018

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.33	2.058	5.353	2.015
0.3467	2.058	5.667	2.012
0.3643	2.06	6.	2.011
0.383	2.058	6.353	2.008
0.4028	2.058	6.727	2.003
0.4238	2.058	7.123	2.
0.446	2.058	7.543	1.997
0.4695	2.058	7.987	1.994
0.4943	2.057	8.457	1.99
0.5207	2.058	8.956	1.985
0.5487	2.057	9.484	1.981
0.5783	2.058	10.04	1.976
0.6097	2.057	10.64	1.97
0.6428	2.055	11.26	1.966
0.678	2.052	11.93	1.961
0.7153	2.054	12.63	1.954
0.7548	2.054	13.38	1.949
0.7967	2.052	14.17	1.944
0.841	2.052	15.01	1.936
0.888	2.051	15.89	1.929
0.9378	2.051	16.83	1.921
0.9905	2.051	17.83	1.914
1.046	2.049	18.88	1.906
1.105	2.049	19.99	1.899
1.168	2.049	21.18	1.882
1.234	2.048	22.43	1.867
1.305	2.046	23.76	1.862
1.379	2.045	25.16	1.851
1.458	2.045	26.65	1.842
1.542	2.045	28.23	1.829
1.631	2.043	29.9	1.827
1.724	2.043	31.66	1.815

SOLUTION

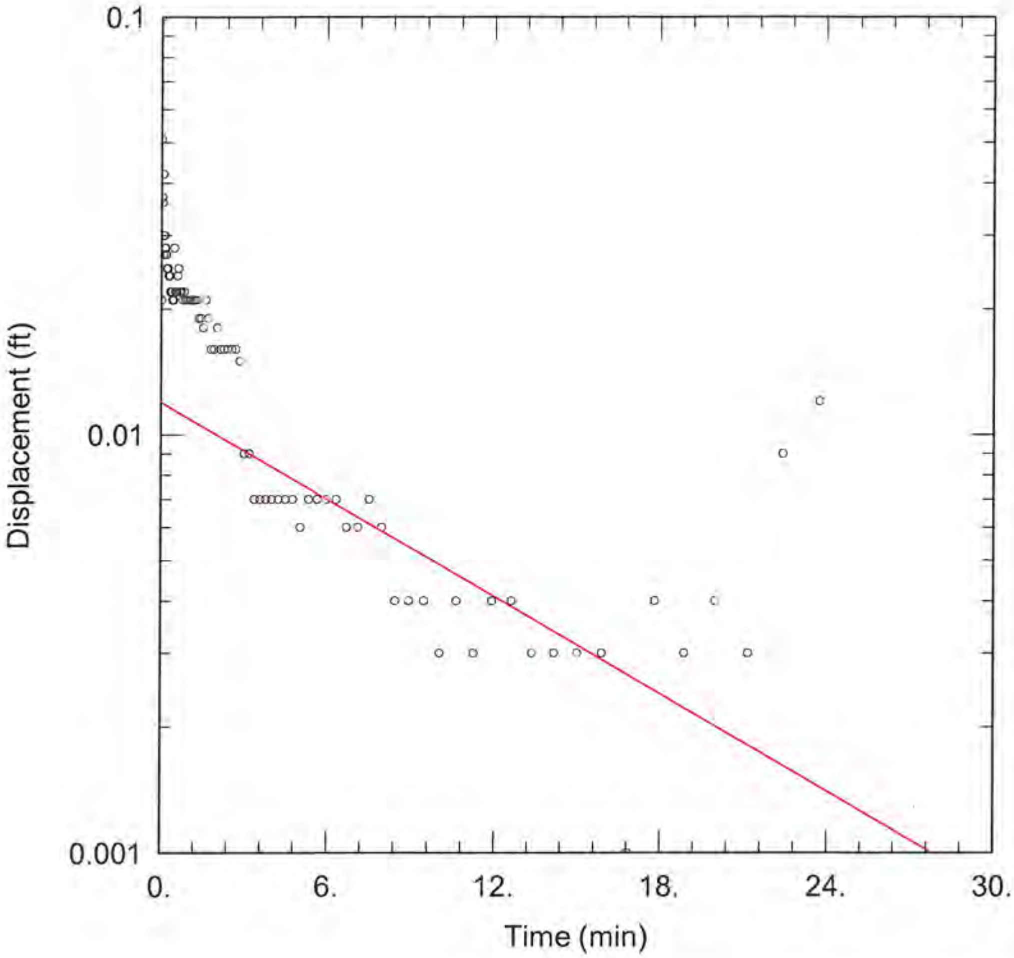
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.492

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	5.2E-6	cm/sec
y0	2.07	ft

T = K*b = 0.008007 cm²/sec



OM04S RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM04Srh.aqt
Date: 12/21/15 Time: 14:51:43

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM4S
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 50.52 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM04S)

Initial Displacement: 0.1 ft
Total Well Penetration Depth: 17.52 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 17.52 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 5.5E-5 cm/sec
y0 = 0.012 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM04Srh.aqt
Title: OM04S Rising Head Test
Date: 12/21/15
Time: 14:51:44

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OM4S

AQUIFER DATA

Saturated Thickness: 50.52 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM04S

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 0.1 ft
Static Water Column Height: 17.52 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 17.52 ft

No. of Observations: 97

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0163	0.051	1.627	0.021
0.0327	0.021	1.721	0.019
0.049	0.037	1.82	0.016
0.0653	0.036	1.926	0.016
0.0817	0.042	2.037	0.018
0.098	0.027	2.155	0.016
0.1143	0.03	2.281	0.016
0.1307	0.03	2.413	0.016
0.147	0.028	2.554	0.016
0.1633	0.028	2.702	0.016
0.1797	0.027	2.86	0.015
0.196	0.027	3.027	0.009
0.2123	0.025	3.204	0.009
0.2287	0.025	3.391	0.007
0.245	0.025	3.589	0.007
0.2613	0.025	3.799	0.007
0.2777	0.024	4.022	0.007
0.294	0.024	4.258	0.007
0.3103	0.024	4.508	0.007

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.3267	0.024	4.772	0.007
0.3433	0.022	5.053	0.006
0.361	0.022	5.349	0.007
0.3797	0.022	5.664	0.007
0.3995	0.022	5.997	0.007
0.4205	0.021	6.35	0.007
0.4427	0.021	6.724	0.006
0.4662	0.021	7.12	0.006
0.491	0.028	7.539	0.007
0.5173	0.022	7.984	0.006
0.5453	0.022	8.454	0.004
0.575	0.022	8.953	0.004
0.6063	0.024	9.481	0.004
0.6395	0.025	10.04	0.003
0.6747	0.022	10.63	0.004
0.712	0.022	11.26	0.003
0.7515	0.022	11.92	0.004
0.7933	0.021	12.63	0.004
0.8377	0.022	13.37	0.003
0.8847	0.021	14.16	0.003
0.9345	0.021	15.	0.003
0.9872	0.021	15.89	0.003
1.043	0.021	16.83	0.001
1.102	0.021	17.82	0.004
1.165	0.021	18.88	0.003
1.231	0.021	19.99	0.004
1.302	0.021	21.17	0.003
1.376	0.019	22.43	0.009
1.455	0.019	23.75	0.012
1.539	0.018		

SOLUTION

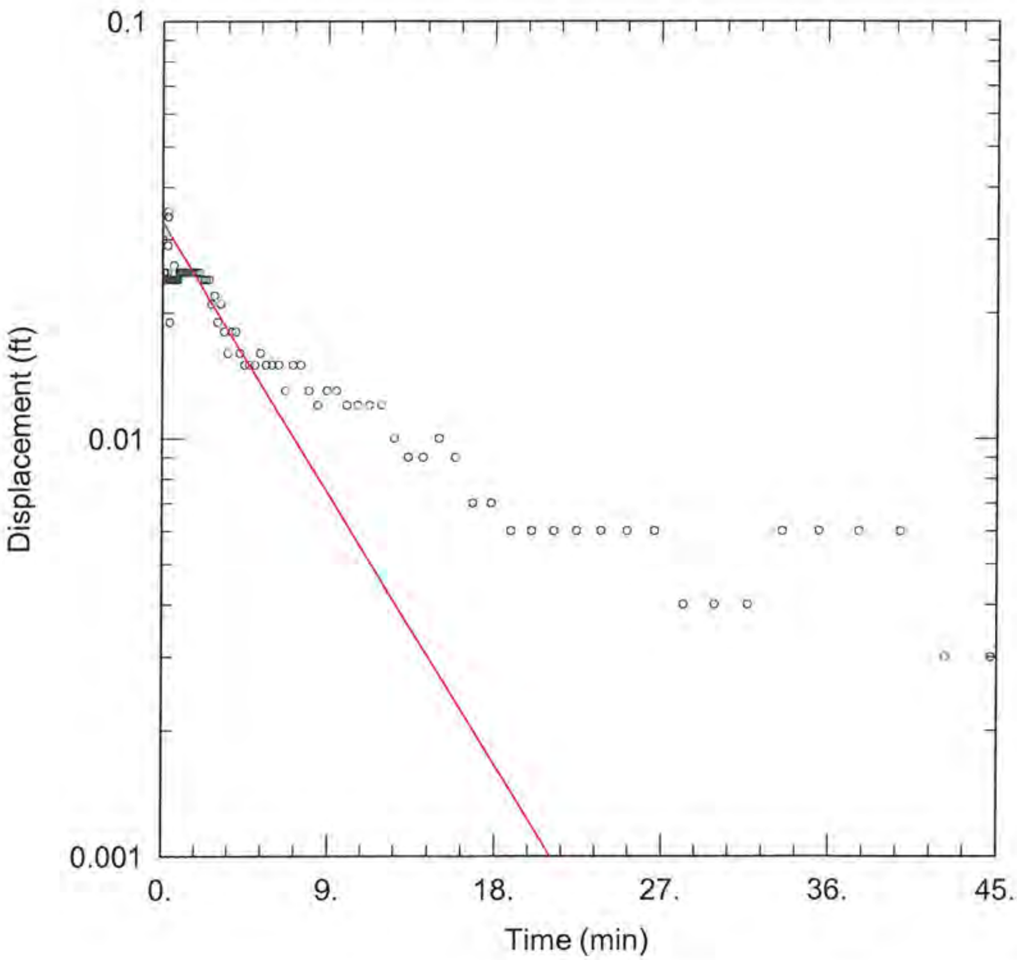
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.492

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	5.5E-5	cm/sec
y0	0.012	ft

T = K*b = 0.08469 cm²/sec



OM05S FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM05Sfh.aqt
Date: 12/09/15 Time: 09:16:54

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM05S
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 37.36 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM05S)

Initial Displacement: 0.03 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08333 ft
Static Water Column Height: 6.86 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 9.5E-5 cm/sec
y0 = 0.033 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM05Sfh.aqt
Title: OM05S Falling Head Test
Date: 12/09/15
Time: 09:16:54

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OM05S

AQUIFER DATA

Saturated Thickness: 37.36 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM05S

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 0.03 ft
Static Water Column Height: 6.86 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 10. ft

No. of Observations: 108

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0163	0.024	2.155	0.024
0.0327	0.024	2.281	0.024
0.049	0.024	2.413	0.024
0.0653	0.024	2.554	0.024
0.0817	0.025	2.702	0.021
0.098	0.024	2.86	0.022
0.1143	0.024	3.027	0.019
0.1307	0.025	3.204	0.021
0.147	0.024	3.391	0.018
0.1633	0.024	3.589	0.016
0.1797	0.024	3.799	0.018
0.196	0.024	4.022	0.018
0.2123	0.024	4.258	0.016
0.2287	0.024	4.508	0.015
0.245	0.024	4.772	0.015
0.2613	0.024	5.053	0.015
0.2777	0.025	5.349	0.016
0.294	0.034	5.664	0.015
0.3103	0.029	5.997	0.015

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.3267	0.035	6.35	0.015
0.3433	0.034	6.724	0.013
0.361	0.024	7.12	0.015
0.3797	0.024	7.539	0.015
0.3995	0.019	7.984	0.013
0.4205	0.024	8.454	0.012
0.4427	0.024	8.953	0.013
0.4662	0.024	9.481	0.013
0.491	0.024	10.04	0.012
0.5173	0.024	10.63	0.012
0.5453	0.024	11.26	0.012
0.575	0.024	11.92	0.012
0.6063	0.024	12.63	0.01
0.6395	0.026	13.37	0.009
0.6747	0.024	14.16	0.009
0.712	0.024	15.	0.01
0.7515	0.024	15.89	0.009
0.7933	0.024	16.83	0.007
0.8377	0.024	17.82	0.007
0.8847	0.024	18.88	0.006
0.9345	0.025	19.99	0.006
0.9872	0.025	21.17	0.006
1.043	0.025	22.43	0.006
1.102	0.025	23.75	0.006
1.165	0.025	25.16	0.006
1.231	0.025	26.65	0.006
1.302	0.025	28.22	0.004
1.376	0.025	29.89	0.004
1.455	0.025	31.66	0.004
1.539	0.025	33.53	0.006
1.627	0.025	35.52	0.006
1.721	0.025	37.62	0.006
1.82	0.025	39.85	0.006
1.926	0.025	42.21	0.003
2.037	0.025	44.71	0.003

SOLUTION

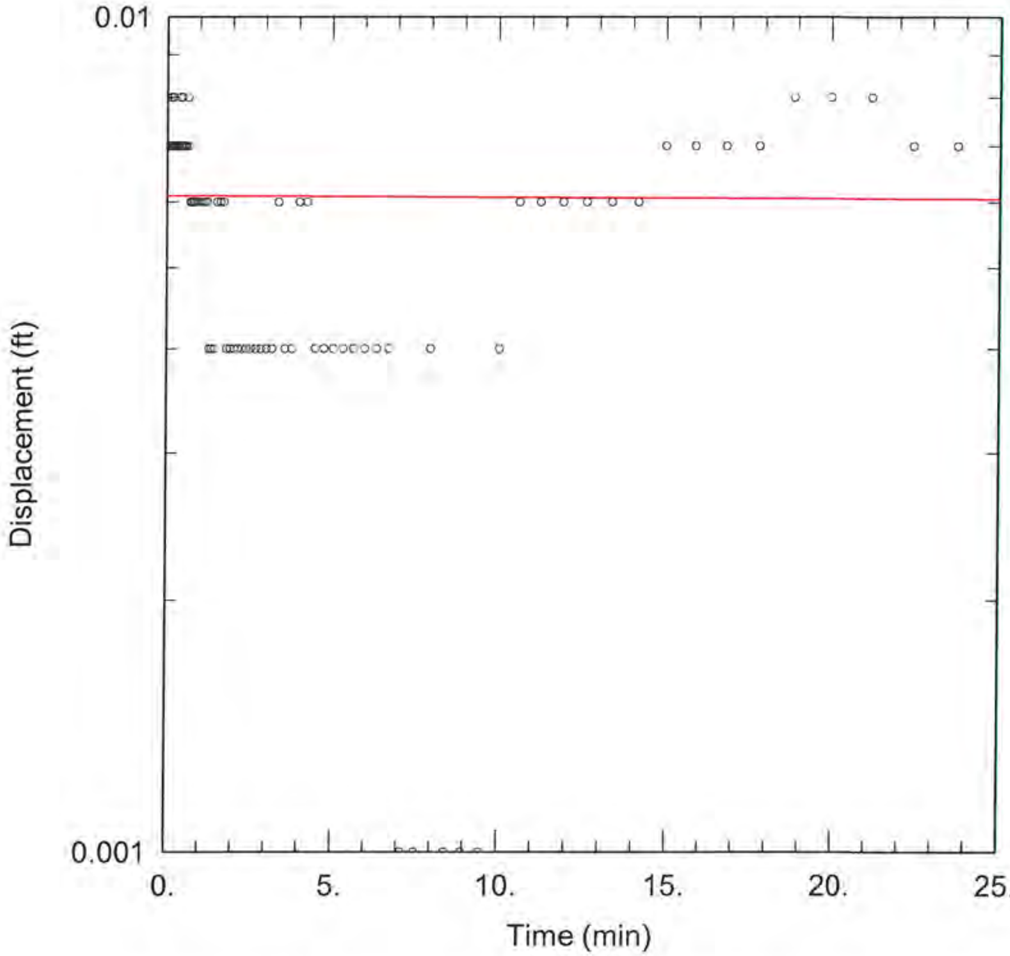
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.234

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	9.5E-5	cm/sec
y0	0.033	ft

$T = K^*b = 0.1082\ cm^2/sec$



OM05S RISING HEAD TEST (NO DISPLACEMENT, TEST INVALID)

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM05Srh.aqt
Date: 12/09/15 Time: 09:37:40

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM05S
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 37.36 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM05S)

Initial Displacement: 0.008 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08333 ft
Static Water Column Height: 6.86 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.0E-7 cm/sec
y0 = 0.0061 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM05Srh.aqt
Title: OM05S Rising Head Test (no displacement, test invalid)
Date: 12/09/15
Time: 09:37:41

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OM05S

AQUIFER DATA

Saturated Thickness: 37.36 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM05S

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 0.008 ft
Static Water Column Height: 6.86 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 10. ft

No. of Observations: 107

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0165	0.007	2.159	0.004
0.033	0.007	2.284	0.004
0.0495	0.007	2.416	0.004
0.066	0.007	2.557	0.004
0.0825	0.007	2.706	0.004
0.099	0.007	2.863	0.004
0.1155	0.007	3.03	0.004
0.132	0.008	3.207	0.004
0.1485	0.007	3.394	0.006
0.165	0.007	3.592	0.004
0.1815	0.007	3.803	0.004
0.198	0.008	4.025	0.006
0.2145	0.007	4.261	0.006
0.231	0.007	4.511	0.004
0.2475	0.007	4.776	0.004
0.264	0.007	5.056	0.004
0.2805	0.007	5.353	0.004
0.297	0.007	5.667	0.004
0.3135	0.007	6.	0.004

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.33	0.007	6.353	0.004
0.3467	0.007	6.727	0.004
0.3643	0.007	7.123	0.001
0.383	0.007	7.543	0.001
0.4028	0.008	7.987	0.004
0.4238	0.007	8.457	0.001
0.446	0.007	8.956	0.001
0.4695	0.008	9.484	0.001
0.4943	0.007	10.04	0.004
0.5207	0.007	10.64	0.006
0.5487	0.007	11.26	0.006
0.5783	0.007	11.93	0.006
0.6097	0.007	12.63	0.006
0.6428	0.008	13.38	0.006
0.678	0.007	14.17	0.006
0.7153	0.006	15.01	0.007
0.7548	0.006	15.89	0.007
0.7967	0.006	16.83	0.007
0.841	0.006	17.83	0.007
0.888	0.006	18.88	0.008
0.9378	0.006	19.99	0.008
0.9905	0.006	21.18	0.008
1.046	0.006	22.43	0.007
1.105	0.006	23.76	0.007
1.168	0.006	25.16	0.008
1.234	0.006	26.65	0.008
1.305	0.004	28.23	0.01
1.379	0.004	29.9	0.007
1.458	0.004	31.66	0.008
1.542	0.006	33.54	0.01
1.631	0.006	35.52	0.01
1.724	0.006	37.62	0.01
1.824	0.004	39.85	0.011
1.929	0.004	42.21	0.013
2.041	0.004		

SOLUTION

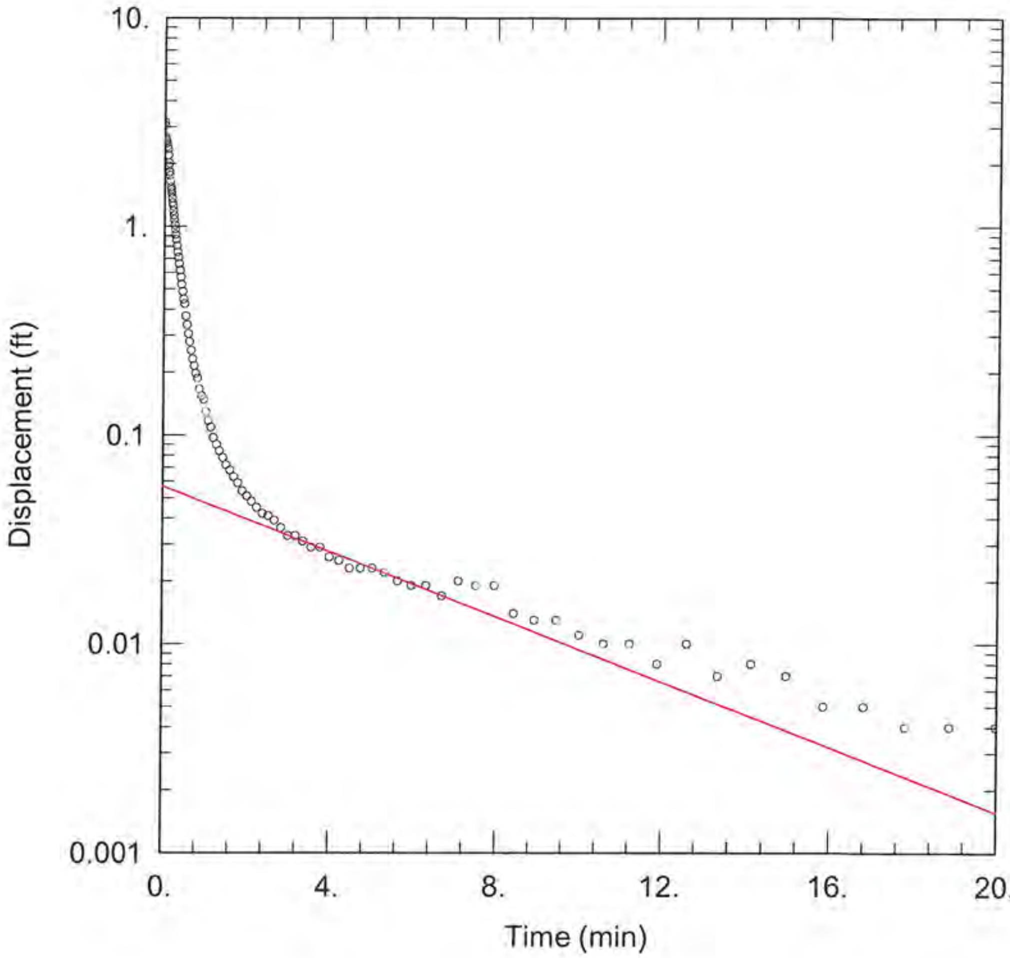
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.234

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	2.0E-7	cm/sec
y0	0.0061	ft

T = K*b = 0.0002277 cm²/sec



OM07 FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM07fh.aqt
Date: 12/09/15 Time: 09:16:56

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM07
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 36.37 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM07)

Initial Displacement: 3.15 ft
Total Well Penetration Depth: 15.37 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 15.37 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00011 cm/sec
y0 = 0.057 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM07fh.aqt
Title: OM07 Falling Head Test
Date: 12/09/15
Time: 09:16:57

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OM07

AQUIFER DATA

Saturated Thickness: 36.37 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM07

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 3.15 ft
Static Water Column Height: 15.37 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 15.37 ft

No. of Observations: 103

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.011	3.034	1.288	0.09
0.022	2.665	1.362	0.084
0.033	2.61	1.441	0.078
0.044	2.578	1.525	0.072
0.055	2.5	1.613	0.068
0.066	2.418	1.707	0.063
0.077	2.346	1.807	0.059
0.088	2.191	1.912	0.054
0.099	1.95	2.023	0.051
0.11	2.001	2.142	0.048
0.121	1.825	2.267	0.045
0.132	1.752	2.399	0.042
0.143	1.642	2.54	0.041
0.154	1.538	2.688	0.039
0.165	1.493	2.846	0.036
0.176	1.447	3.013	0.033
0.187	1.365	3.19	0.033
0.198	1.3	3.377	0.031
0.209	1.252	3.575	0.029

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.22	1.184	3.785	0.029
0.231	1.129	4.008	0.026
0.2427	1.077	4.244	0.025
0.2552	1.016	4.494	0.023
0.2683	0.968	4.758	0.023
0.2823	0.911	5.039	0.023
0.2972	0.864	5.336	0.022
0.3128	0.807	5.65	0.02
0.3295	0.754	5.983	0.019
0.3472	0.709	6.336	0.019
0.3658	0.661	6.71	0.017
0.3857	0.614	7.106	0.02
0.4067	0.571	7.525	0.019
0.4288	0.527	7.97	0.019
0.4523	0.486	8.44	0.014
0.4772	0.447	8.939	0.013
0.5035	0.426	9.467	0.013
0.5315	0.371	10.03	0.011
0.5612	0.337	10.62	0.01
0.5925	0.306	11.25	0.01
0.6257	0.28	11.91	0.008
0.6608	0.254	12.62	0.01
0.6982	0.231	13.36	0.007
0.7377	0.215	14.15	0.008
0.7795	0.197	14.99	0.007
0.8238	0.187	15.87	0.005
0.8708	0.166	16.81	0.005
0.9207	0.154	17.81	0.004
0.9733	0.148	18.86	0.004
1.029	0.129	19.98	0.004
1.088	0.117	21.16	0.004
1.151	0.109	22.41	0.002
1.217	0.097		

SOLUTION

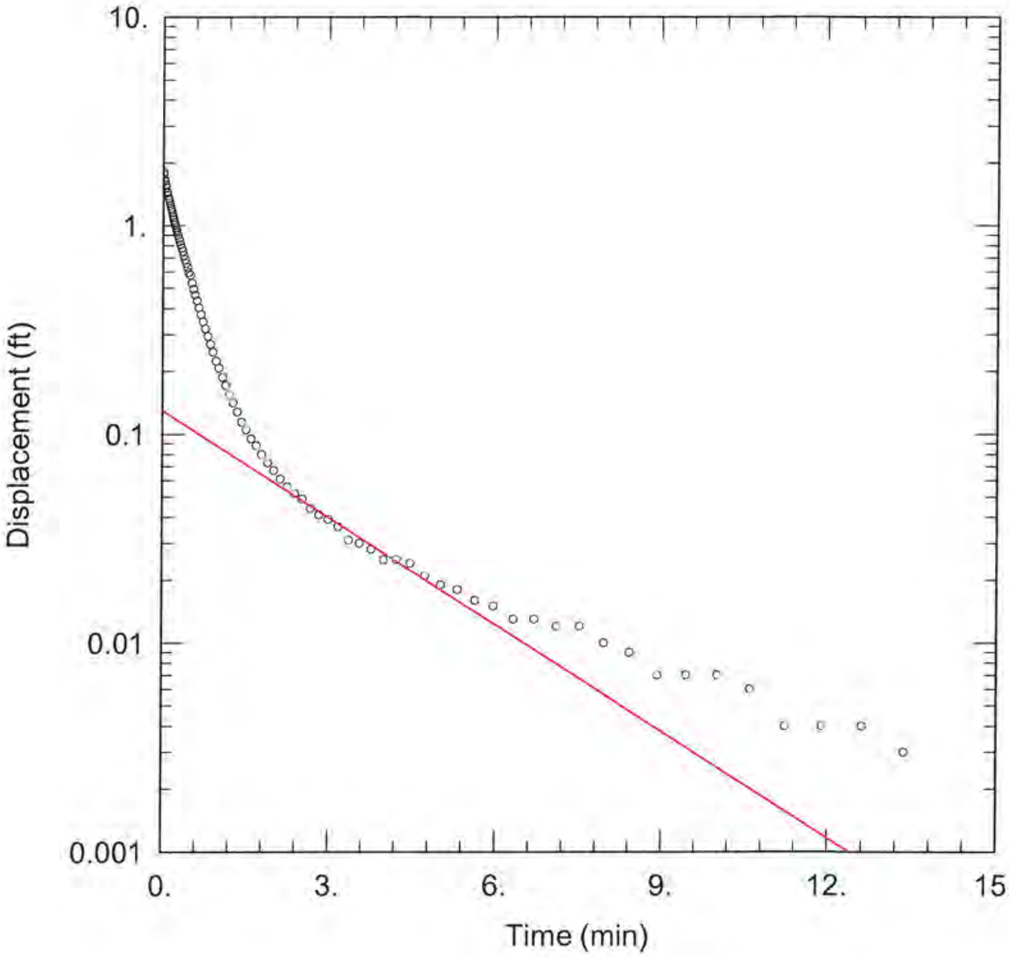
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.466

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00011	cm/sec
y0	0.057	ft

T = K*b = 0.1219 cm²/sec



OM07 RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM07rh.aqt
Date: 12/09/15 Time: 09:16:58

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM07
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 36.37 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM07)

Initial Displacement: 1.8 ft
Total Well Penetration Depth: 15.37 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 15.37 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00024 cm/sec
y0 = 0.13 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM07rh.aqt
Title: OM07 Rising Head Test
Date: 12/09/15
Time: 09:16:59

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OM07

AQUIFER DATA

Saturated Thickness: 36.37 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM07

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.8 ft
Static Water Column Height: 15.37 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 15.37 ft

No. of Observations: 93

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0112	1.768	1.022	0.207
0.0223	1.673	1.081	0.187
0.0335	1.635	1.143	0.171
0.0447	1.568	1.21	0.155
0.0558	1.52	1.28	0.141
0.067	1.447	1.355	0.128
0.0782	1.432	1.434	0.114
0.0893	1.395	1.517	0.105
0.1005	1.352	1.606	0.095
0.1117	1.321	1.7	0.088
0.1228	1.279	1.799	0.08
0.134	1.254	1.904	0.073
0.1452	1.215	2.016	0.067
0.1563	1.188	2.134	0.061
0.1675	1.153	2.259	0.056
0.1787	1.117	2.392	0.052
0.1898	1.093	2.532	0.049
0.201	1.065	2.681	0.044
0.2122	1.035	2.838	0.041

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.2233	1.01	3.005	0.039
0.235	0.98	3.182	0.036
0.2475	0.95	3.369	0.031
0.2607	0.925	3.568	0.03
0.2747	0.897	3.778	0.028
0.2895	0.866	4.	0.025
0.3052	0.842	4.236	0.025
0.3218	0.811	4.486	0.024
0.3395	0.782	4.751	0.021
0.3582	0.753	5.031	0.019
0.378	0.721	5.328	0.018
0.399	0.687	5.643	0.016
0.4212	0.659	5.976	0.015
0.4447	0.629	6.329	0.013
0.4695	0.595	6.702	0.013
0.4958	0.579	7.098	0.012
0.5238	0.529	7.518	0.012
0.5535	0.495	7.962	0.01
0.5848	0.465	8.433	0.009
0.618	0.436	8.931	0.007
0.6532	0.404	9.459	0.007
0.6905	0.375	10.02	0.007
0.73	0.346	10.61	0.006
0.7718	0.32	11.24	0.004
0.8162	0.294	11.9	0.004
0.8632	0.269	12.61	0.004
0.913	0.247	13.35	0.003
0.9657	0.224		

SOLUTION

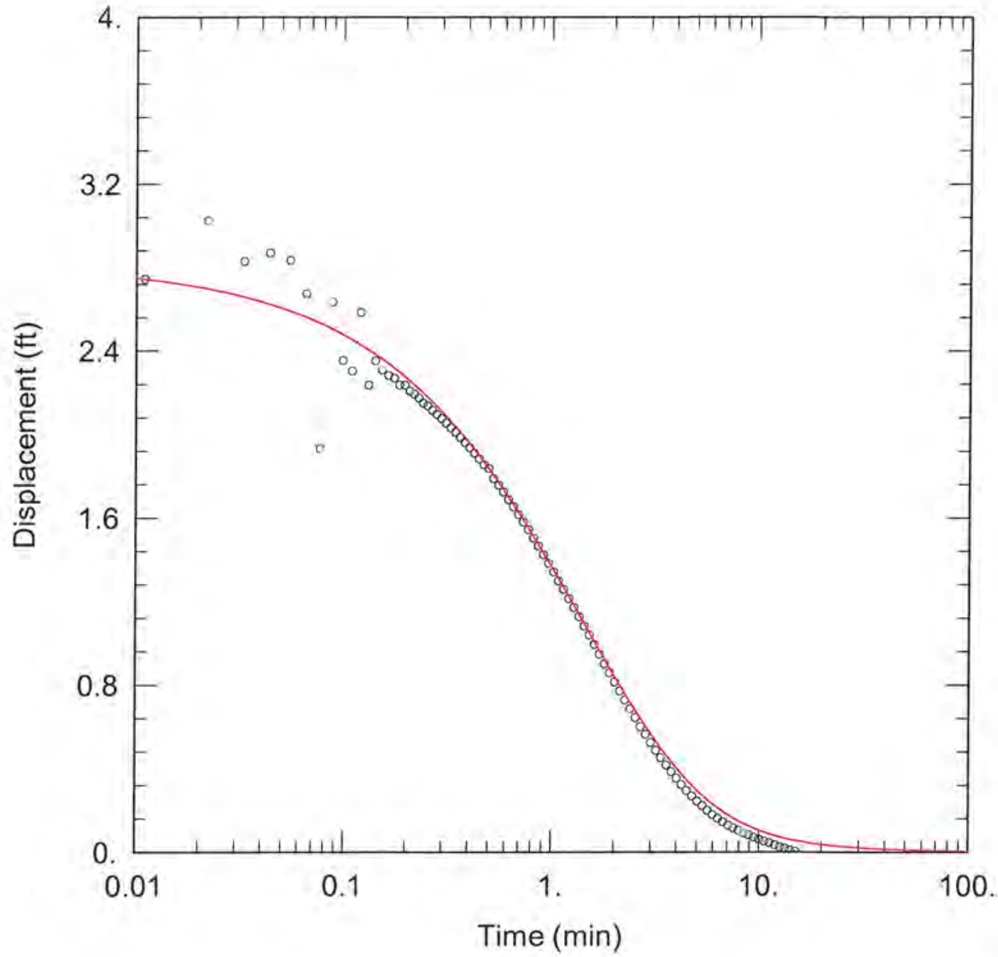
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.466

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00024	cm/sec
y0	0.13	ft

T = K*b = 0.2661 cm²/sec



OM09 FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM09fh.aqt
Date: 12/09/15 Time: 09:16:59

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM09
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 19.99 ft

WELL DATA (OM09)

Initial Displacement: 2.83 ft
Total Well Penetration Depth: 18.49 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 18.49 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 0.00031 cm/sec
Kz/Kr = 1.

Ss = 0.001 ft^{-1}

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM09fh.aqt
Title: OM09 Falling Head Test
Date: 12/09/15
Time: 09:17:00

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OM09

AQUIFER DATA

Saturated Thickness: 19.99 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM09

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.83 ft
Static Water Column Height: 18.49 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 18.49 ft

No. of Observations: 96

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.011	2.744	1.029	1.34
0.022	3.024	1.088	1.298
0.033	2.828	1.151	1.257
0.044	2.869	1.217	1.213
0.055	2.834	1.288	1.17
0.066	2.674	1.362	1.126
0.077	1.931	1.441	1.081
0.088	2.633	1.525	1.038
0.099	2.354	1.613	0.992
0.11	2.302	1.707	0.947
0.121	2.583	1.807	0.901
0.132	2.235	1.912	0.858
0.143	2.351	2.023	0.813
0.154	2.308	2.142	0.77
0.165	2.281	2.267	0.727
0.176	2.269	2.399	0.685
0.187	2.236	2.54	0.643
0.198	2.235	2.688	0.6
0.209	2.208	2.846	0.563

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.22	2.192	3.013	0.524
0.231	2.174	3.19	0.487
0.2427	2.15	3.377	0.451
0.2552	2.137	3.575	0.416
0.2683	2.116	3.785	0.384
0.2823	2.096	4.008	0.353
0.2972	2.076	4.244	0.322
0.3128	2.055	4.494	0.293
0.3295	2.031	4.758	0.268
0.3472	2.01	5.039	0.243
0.3658	1.985	5.336	0.222
0.3857	1.961	5.65	0.198
0.4067	1.937	5.983	0.179
0.4288	1.909	6.336	0.16
0.4523	1.882	6.71	0.143
0.4772	1.854	7.106	0.128
0.5035	1.837	7.525	0.115
0.5315	1.787	7.97	0.103
0.5612	1.755	8.44	0.091
0.5925	1.723	8.939	0.082
0.6257	1.687	9.467	0.07
0.6608	1.653	10.03	0.06
0.6982	1.615	10.62	0.051
0.7377	1.58	11.25	0.043
0.7795	1.542	11.91	0.033
0.8238	1.502	12.62	0.024
0.8708	1.464	13.36	0.017
0.9207	1.423	14.15	0.009
0.9733	1.382	14.99	0.002

SOLUTION

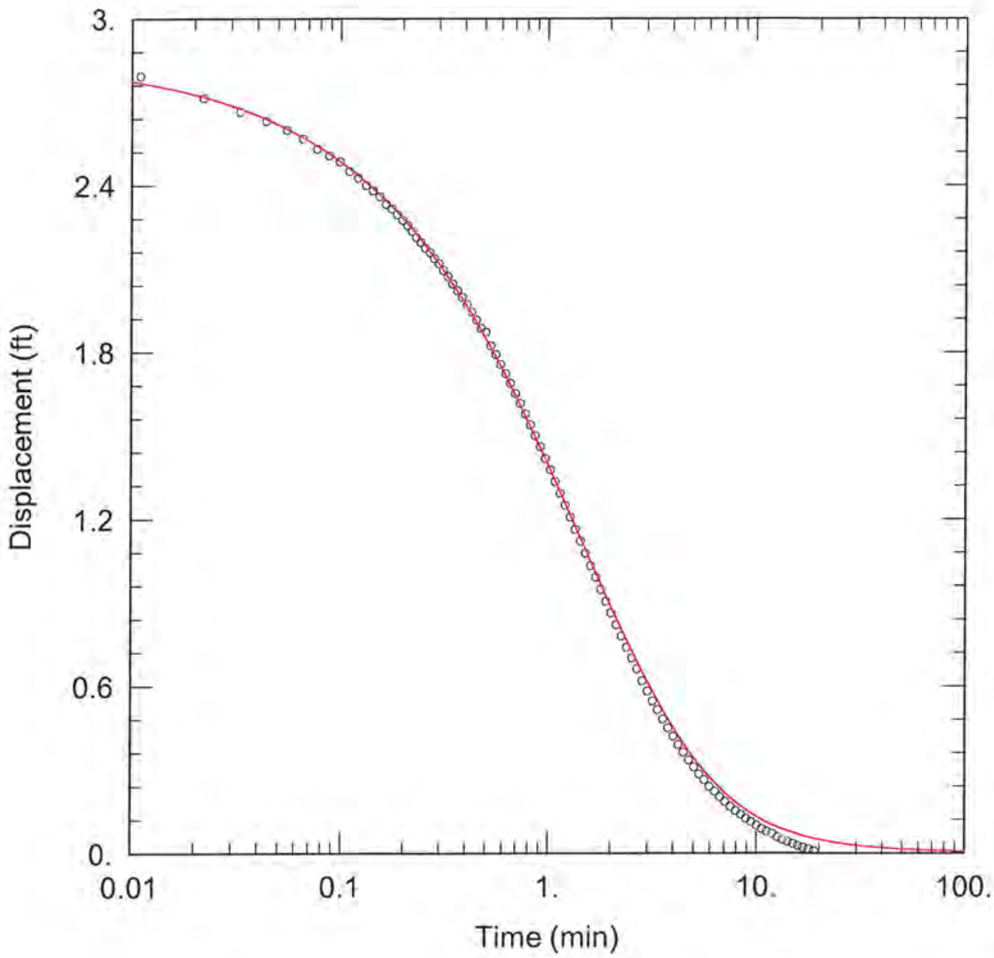
Slug Test
Aquifer Model: Unconfined
Solution Method: KGS Model

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
Kr	0.00031	cm/sec
Ss	0.001	ft^{-1}
Kz/Kr	1.	

T = K*b = 0.1889 cm^2/sec



OM09 RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM09rh.aqt
Date: 12/09/15 Time: 09:17:01

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM09
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 19.99 ft

WELL DATA (OM09)

Initial Displacement: 2.87 ft
Total Well Penetration Depth: 18.49 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 18.49 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.00026 cm/sec
Kz/Kr = 1.
Ss = 0.002 ft^{-1}

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM09rh.aqt
Title: OM09 Rising Head Test
Date: 12/09/15
Time: 09:17:02

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OM09

AQUIFER DATA

Saturated Thickness: 19.99 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM09

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.87 ft
Static Water Column Height: 18.49 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 18.49 ft

No. of Observations: 100

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.011	2.792	1.151	1.292
0.022	2.713	1.217	1.249
0.033	2.664	1.288	1.206
0.044	2.631	1.362	1.163
0.055	2.598	1.441	1.12
0.066	2.567	1.525	1.077
0.077	2.531	1.613	1.032
0.088	2.506	1.707	0.99
0.099	2.485	1.807	0.946
0.11	2.45	1.912	0.904
0.121	2.426	2.023	0.862
0.132	2.399	2.142	0.819
0.143	2.38	2.267	0.779
0.154	2.359	2.399	0.739
0.165	2.332	2.54	0.699
0.176	2.316	2.688	0.66
0.187	2.295	2.846	0.618
0.198	2.274	3.013	0.581
0.209	2.256	3.19	0.545

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.22	2.235	3.377	0.514
0.231	2.212	3.575	0.481
0.2427	2.195	3.785	0.449
0.2552	2.174	4.008	0.419
0.2683	2.158	4.244	0.389
0.2823	2.136	4.494	0.361
0.2972	2.118	4.758	0.334
0.3128	2.094	5.039	0.309
0.3295	2.072	5.336	0.283
0.3472	2.045	5.65	0.263
0.3658	2.021	5.983	0.239
0.3857	1.997	6.336	0.221
0.4067	1.971	6.71	0.202
0.4288	1.944	7.106	0.184
0.4523	1.916	7.525	0.167
0.4772	1.886	7.97	0.151
0.5035	1.872	8.44	0.138
0.5315	1.822	8.939	0.124
0.5612	1.791	9.467	0.112
0.5925	1.756	10.03	0.099
0.6257	1.722	10.62	0.087
0.6608	1.688	11.25	0.078
0.6982	1.651	11.91	0.069
0.7377	1.615	12.62	0.057
0.7795	1.578	13.36	0.048
0.8238	1.538	14.15	0.041
0.8708	1.499	14.99	0.033
0.9207	1.459	15.87	0.026
0.9733	1.417	16.81	0.02
1.029	1.377	17.81	0.014
1.088	1.334	18.86	0.007

SOLUTION

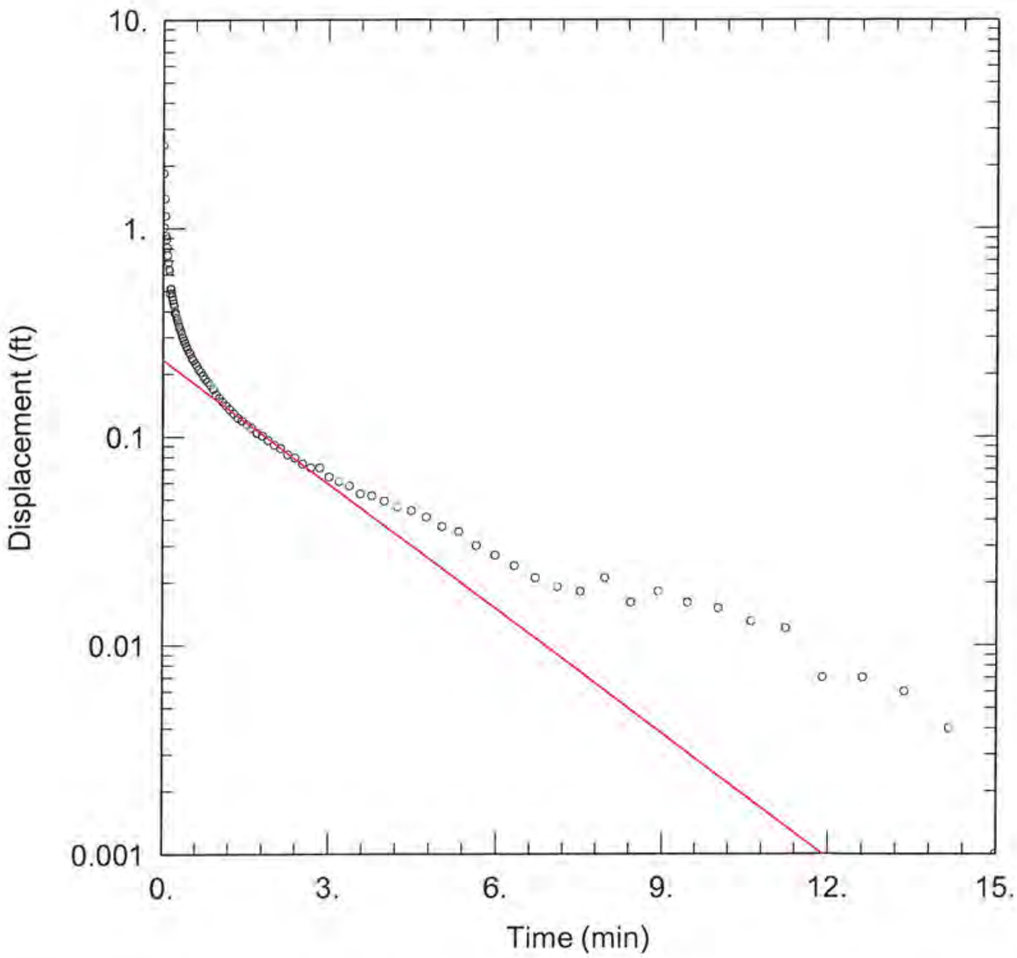
Slug Test
Aquifer Model: Unconfined
Solution Method: KGS Model

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
Kr	0.00026	cm/sec
Ss	0.002	ft^{-1}
Kz/Kr	1.	

T = K*b = 0.1584 cm^2/sec



OM21 FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM21fh.aqt
Date: 12/09/15 Time: 09:17:03

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM21
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 51.03 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM21)

Initial Displacement: 2.5 ft
Total Well Penetration Depth: 49.73 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 49.73 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00035 cm/sec
y0 = 0.235 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM21fh.aqt
Title: OM21 Falling Head Test
Date: 12/09/15
Time: 09:17:03

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OM21

AQUIFER DATA

Saturated Thickness: 51.03 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM21

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.5 ft
Static Water Column Height: 49.73 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 49.73 ft

No. of Observations: 96

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.011	1.838	1.029	0.153
0.022	1.012	1.088	0.147
0.033	1.387	1.151	0.141
0.044	1.149	1.217	0.135
0.055	0.918	1.288	0.129
0.066	0.891	1.362	0.123
0.077	0.81	1.441	0.119
0.088	0.743	1.525	0.114
0.099	0.687	1.613	0.11
0.11	0.638	1.707	0.104
0.121	0.625	1.807	0.101
0.132	0.489	1.912	0.096
0.143	0.512	2.023	0.091
0.154	0.513	2.142	0.088
0.165	0.491	2.267	0.082
0.176	0.47	2.399	0.079
0.187	0.454	2.54	0.074
0.198	0.437	2.688	0.071
0.209	0.422	2.846	0.071

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.22	0.393	3.013	0.064
0.231	0.397	3.19	0.061
0.2427	0.384	3.377	0.058
0.2552	0.373	3.575	0.053
0.2683	0.363	3.785	0.052
0.2823	0.353	4.008	0.049
0.2972	0.339	4.244	0.046
0.3128	0.329	4.494	0.044
0.3295	0.32	4.758	0.041
0.3472	0.311	5.039	0.037
0.3658	0.299	5.336	0.035
0.3857	0.29	5.65	0.03
0.4067	0.281	5.983	0.027
0.4288	0.272	6.336	0.024
0.4523	0.263	6.71	0.021
0.4772	0.254	7.106	0.019
0.5035	0.25	7.525	0.018
0.5315	0.239	7.97	0.021
0.5612	0.232	8.44	0.016
0.5925	0.225	8.939	0.018
0.6257	0.219	9.467	0.016
0.6608	0.21	10.03	0.015
0.6982	0.204	10.62	0.013
0.7377	0.196	11.25	0.012
0.7795	0.189	11.91	0.007
0.8238	0.183	12.62	0.007
0.8708	0.177	13.36	0.006
0.9207	0.169	14.15	0.004
0.9733	0.159	14.99	0.001

SOLUTION

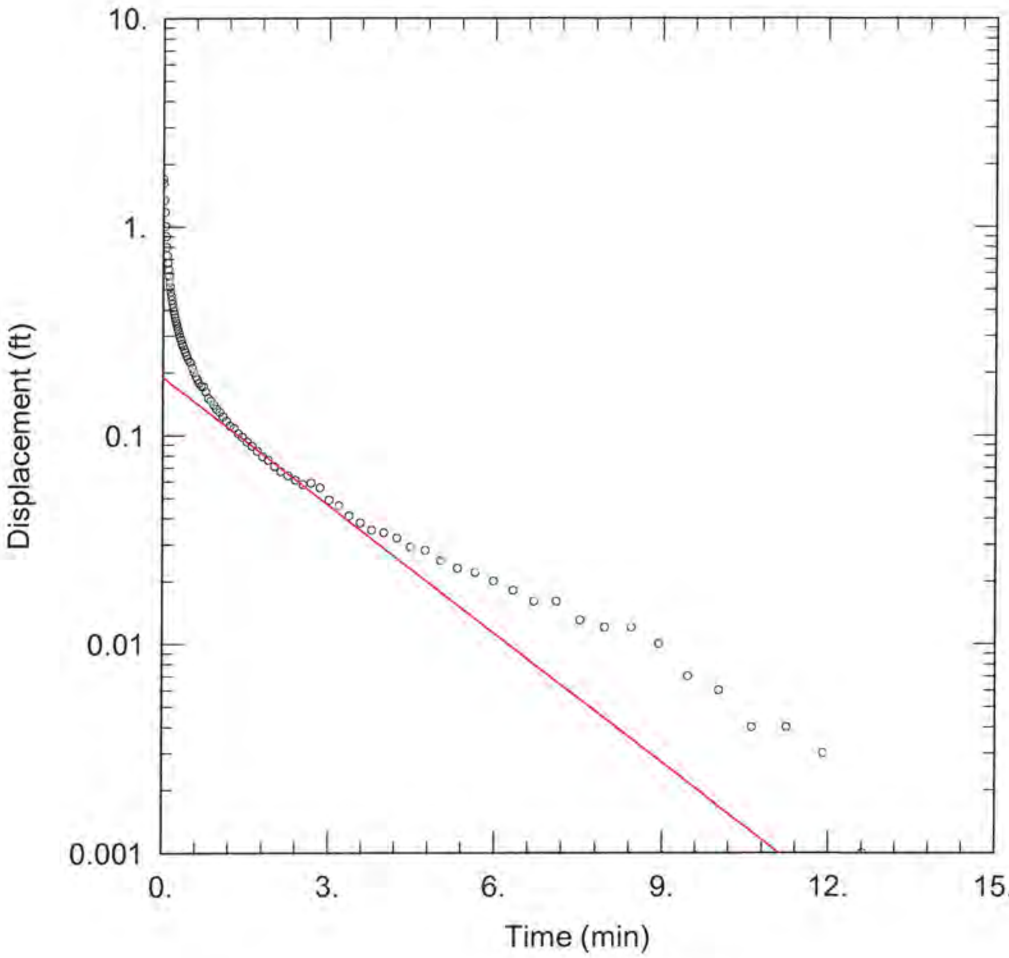
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.329

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00035	cm/sec
y0	0.235	ft

T = K*b = 0.5444 cm²/sec



OM21 RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM21rh.aqt
Date: 12/09/15 Time: 09:17:04

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OM21
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 51.03 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OM21)

Initial Displacement: 1.7 ft
Total Well Penetration Depth: 49.73 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 49.73 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.00036 cm/sec
y0 = 0.19 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OM21rh.aqt
Title: OM21 Rising Head Test
Date: 12/09/15
Time: 09:17:05

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OM21

AQUIFER DATA

Saturated Thickness: 51.03 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OM21

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.7 ft
Static Water Column Height: 49.73 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 49.73 ft

No. of Observations: 93

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.011	1.623	0.9733	0.134
0.022	1.343	1.029	0.129
0.033	1.177	1.088	0.123
0.044	1.007	1.151	0.117
0.055	0.9	1.217	0.111
0.066	0.802	1.288	0.108
0.077	0.727	1.362	0.102
0.088	0.669	1.441	0.098
0.099	0.625	1.525	0.093
0.11	0.58	1.613	0.089
0.121	0.544	1.707	0.084
0.132	0.515	1.807	0.079
0.143	0.488	1.912	0.076
0.154	0.466	2.023	0.071
0.165	0.446	2.142	0.067
0.176	0.427	2.267	0.064
0.187	0.41	2.399	0.061
0.198	0.394	2.54	0.058
0.209	0.381	2.688	0.059

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.22	0.369	2.846	0.056
0.231	0.355	3.013	0.049
0.2427	0.346	3.19	0.046
0.2552	0.336	3.377	0.041
0.2683	0.324	3.575	0.038
0.2823	0.315	3.785	0.035
0.2972	0.306	4.008	0.034
0.3128	0.296	4.244	0.032
0.3295	0.287	4.494	0.029
0.3472	0.275	4.758	0.028
0.3658	0.268	5.039	0.025
0.3857	0.259	5.336	0.023
0.4067	0.251	5.65	0.022
0.4288	0.241	5.983	0.02
0.4523	0.233	6.336	0.018
0.4772	0.226	6.71	0.016
0.5035	0.223	7.106	0.016
0.5315	0.21	7.525	0.013
0.5612	0.201	7.97	0.012
0.5925	0.192	8.44	0.012
0.6257	0.186	8.939	0.01
0.6608	0.178	9.467	0.007
0.6982	0.172	10.03	0.006
0.7377	0.171	10.62	0.004
0.7795	0.162	11.25	0.004
0.8238	0.151	11.91	0.003
0.8708	0.146	12.62	0.001
0.9207	0.14		

SOLUTION

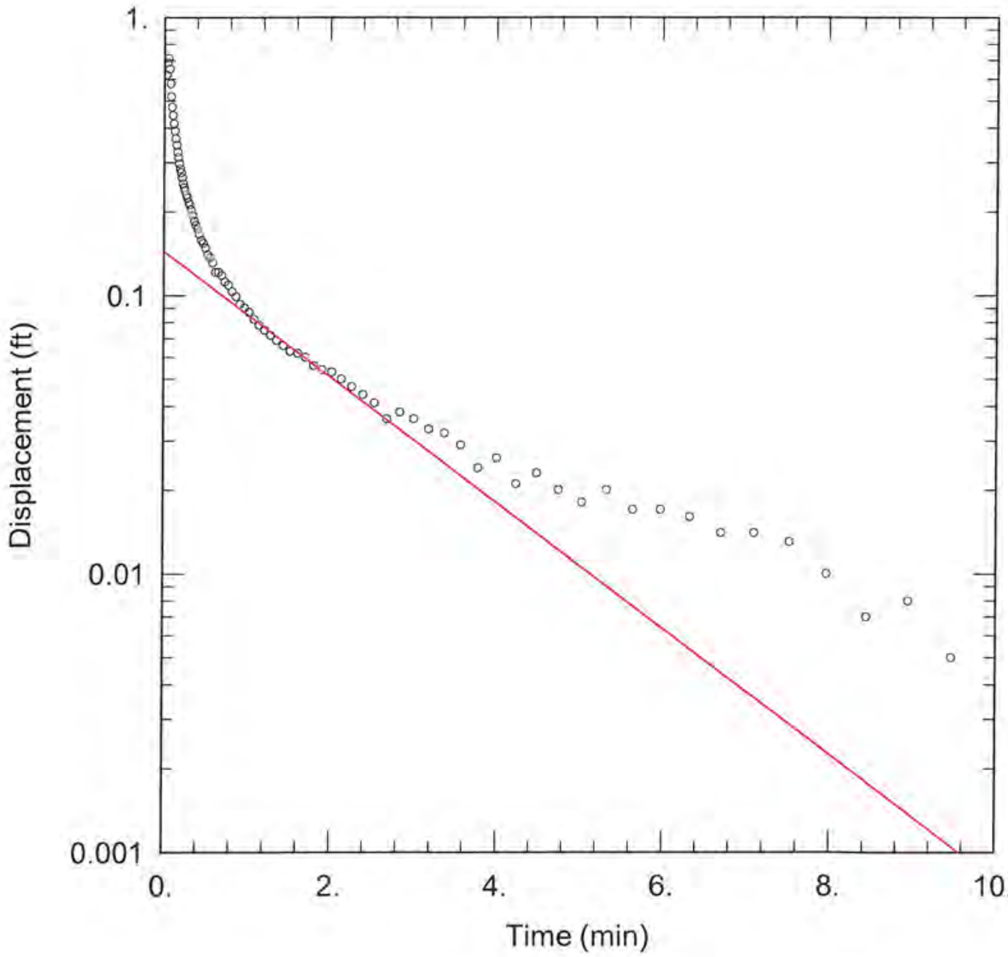
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.329

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00036	cm/sec
y0	0.19	ft

T = K*b = 0.5599 cm²/sec



OR02 FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR02fh.aqt
Date: 12/09/15 Time: 09:17:36

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR02
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 18.87 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR02)

Initial Displacement: 1.45 ft
Total Well Penetration Depth: 18.09 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 18.09 ft
Screen Length: 9.49 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.00037 cm/sec y0 = 0.145 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR02fh.aqt
Title: OR02 Falling Head Test
Date: 12/09/15
Time: 09:17:36

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OR02

AQUIFER DATA

Saturated Thickness: 18.87 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR02

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.45 ft
Static Water Column Height: 18.09 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.49 ft
Total Well Penetration Depth: 18.09 ft

No. of Observations: 89

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.011	1.431	0.8708	0.099
0.022	1.163	0.9207	0.093
0.033	0.622	0.9733	0.09
0.044	0.687	1.029	0.087
0.055	0.713	1.088	0.082
0.066	0.653	1.151	0.078
0.077	0.577	1.217	0.075
0.088	0.519	1.288	0.072
0.099	0.476	1.362	0.069
0.11	0.444	1.441	0.066
0.121	0.415	1.525	0.063
0.132	0.39	1.613	0.062
0.143	0.366	1.707	0.06
0.154	0.347	1.807	0.056
0.165	0.328	1.912	0.054
0.176	0.313	2.023	0.053
0.187	0.298	2.142	0.05
0.198	0.285	2.267	0.047
0.209	0.277	2.399	0.044

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.22	0.265	2.54	0.041
0.231	0.252	2.688	0.036
0.2427	0.244	2.846	0.038
0.2552	0.238	3.013	0.036
0.2683	0.23	3.19	0.033
0.2823	0.224	3.377	0.032
0.2972	0.216	3.575	0.029
0.3128	0.212	3.785	0.024
0.3295	0.203	4.008	0.026
0.3472	0.194	4.244	0.021
0.3658	0.185	4.494	0.023
0.3857	0.179	4.758	0.02
0.4067	0.173	5.039	0.018
0.4288	0.166	5.336	0.02
0.4523	0.158	5.65	0.017
0.4772	0.154	5.983	0.017
0.5035	0.148	6.336	0.016
0.5315	0.14	6.71	0.014
0.5612	0.137	7.106	0.014
0.5925	0.131	7.525	0.013
0.6257	0.121	7.97	0.01
0.6608	0.121	8.44	0.007
0.6982	0.118	8.939	0.008
0.7377	0.112	9.467	0.005
0.7795	0.109	10.03	0.004
0.8238	0.103		

SOLUTION

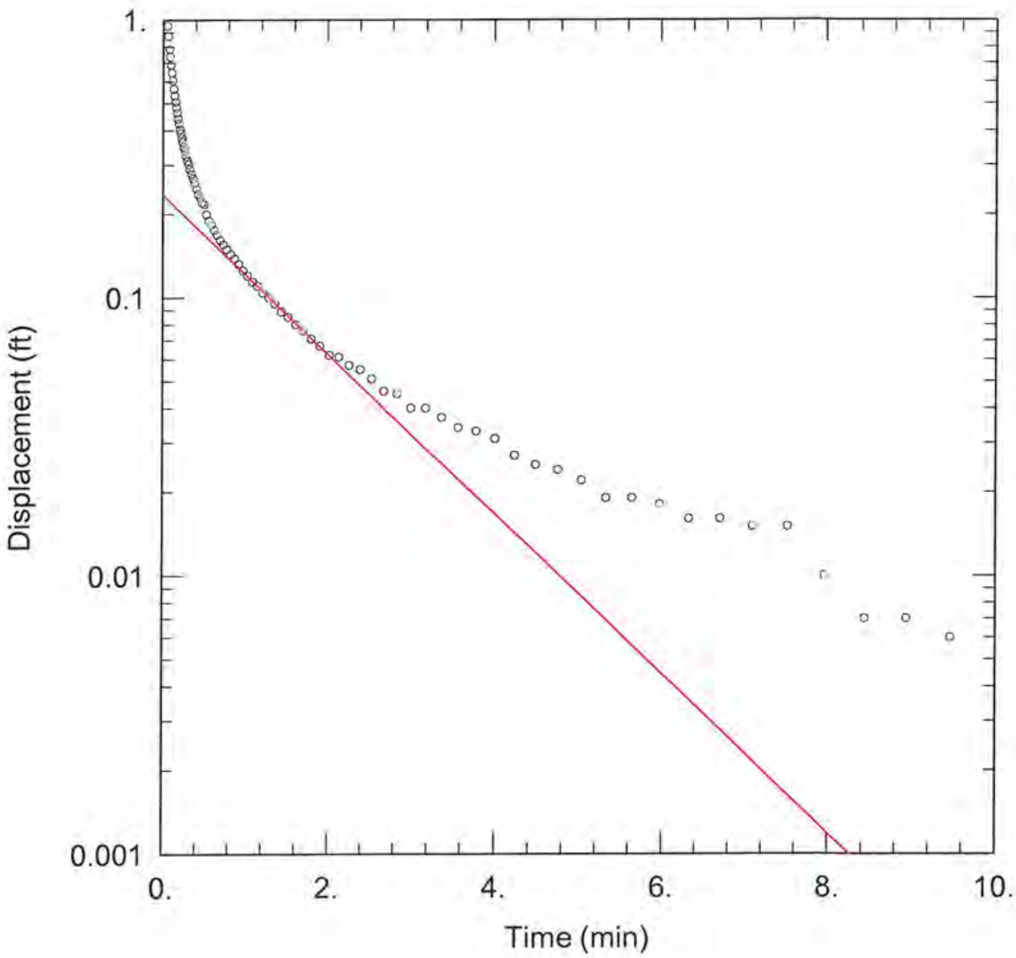
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.827

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00037	cm/sec
y0	0.145	ft

T = K*b = 0.2128 cm²/sec



OR02 RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR02rh.aqt
Date: 12/09/15 Time: 09:17:37

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR02
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 18.87 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR02)

Initial Displacement: 1.75 ft
Total Well Penetration Depth: 18.09 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 18.09 ft
Screen Length: 9.49 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00047 cm/sec
y0 = 0.235 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR02rh.aqt
Title: OR02 Rising Head Test
Date: 12/09/15
Time: 09:17:38

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OR02

AQUIFER DATA

Saturated Thickness: 18.87 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR02

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.75 ft
Static Water Column Height: 18.09 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.49 ft
Total Well Penetration Depth: 18.09 ft

No. of Observations: 92

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.011	1.523	0.9207	0.132
0.022	1.346	0.9733	0.125
0.033	1.19	1.029	0.12
0.044	1.071	1.088	0.114
0.055	0.951	1.151	0.11
0.066	0.874	1.217	0.104
0.077	0.785	1.288	0.1
0.088	0.739	1.362	0.095
0.099	0.69	1.441	0.089
0.11	0.645	1.525	0.085
0.121	0.605	1.613	0.08
0.132	0.566	1.707	0.076
0.143	0.534	1.807	0.071
0.154	0.507	1.912	0.067
0.165	0.483	2.023	0.062
0.176	0.464	2.142	0.061
0.187	0.441	2.267	0.057
0.198	0.424	2.399	0.055
0.209	0.404	2.54	0.051

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.22	0.391	2.688	0.046
0.231	0.375	2.846	0.045
0.2427	0.363	3.013	0.04
0.2552	0.349	3.19	0.04
0.2683	0.337	3.377	0.037
0.2823	0.324	3.575	0.034
0.2972	0.311	3.785	0.033
0.3128	0.302	4.008	0.031
0.3295	0.29	4.244	0.027
0.3472	0.279	4.494	0.025
0.3658	0.269	4.758	0.024
0.3857	0.259	5.039	0.022
0.4067	0.247	5.336	0.019
0.4288	0.236	5.65	0.019
0.4523	0.229	5.983	0.018
0.4772	0.22	6.336	0.016
0.5035	0.217	6.71	0.016
0.5315	0.199	7.106	0.015
0.5612	0.189	7.525	0.015
0.5925	0.183	7.97	0.01
0.6257	0.175	8.44	0.007
0.6608	0.168	8.939	0.007
0.6982	0.161	9.467	0.006
0.7377	0.155	10.03	0.006
0.7795	0.149	10.62	0.006
0.8238	0.143	11.25	0.006
0.8708	0.138	11.91	0.002

SOLUTION

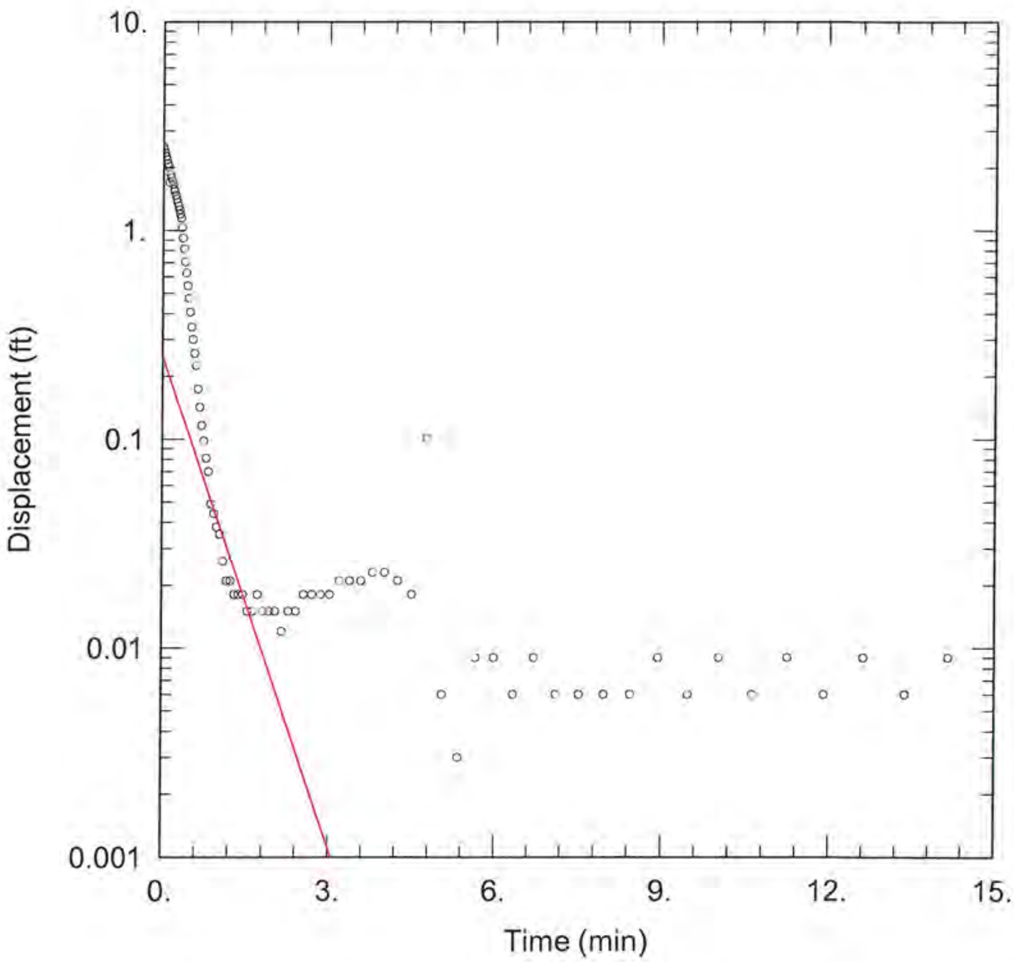
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.827

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00047	cm/sec
y0	0.235	ft

T = K*b = 0.2703 cm²/sec



OR03D FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR03Dfh.aqt
Date: 12/09/15 Time: 09:17:39

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR03D
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 34.69 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR03D)

Initial Displacement: 2.5 ft
Total Well Penetration Depth: 35.7 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 35.7 ft
Screen Length: 9.48 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.0015 cm/sec
y0 = 0.25 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR03Dfh.aqt
Title: OR03D Falling Head Test
Date: 12/09/15
Time: 09:17:39

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OR03D

AQUIFER DATA

Saturated Thickness: 34.69 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR03D

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.5 ft
Static Water Column Height: 35.7 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.48 ft
Total Well Penetration Depth: 35.7 ft

No. of Observations: 91

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0163	2.445	1.376	0.018
0.0327	2.352	1.455	0.018
0.049	2.263	1.539	0.015
0.0653	2.179	1.627	0.015
0.0817	2.093	1.721	0.018
0.098	2.015	1.82	0.015
0.1143	1.7	1.926	0.015
0.1307	1.856	2.037	0.015
0.147	1.792	2.155	0.012
0.1633	1.726	2.281	0.015
0.1797	1.66	2.413	0.015
0.196	1.57	2.554	0.018
0.2123	1.536	2.702	0.018
0.2287	1.472	2.86	0.018
0.245	1.414	3.027	0.018
0.2613	1.359	3.204	0.021
0.2777	1.308	3.391	0.021
0.294	1.253	3.589	0.021
0.3103	1.198	3.799	0.023

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.3267	1.146	4.022	0.023
0.3433	1.033	4.258	0.021
0.361	0.918	4.508	0.018
0.3797	0.814	4.772	0.101
0.3995	0.707	5.053	0.006
0.4205	0.626	5.349	0.003
0.4427	0.543	5.664	0.009
0.4662	0.474	5.997	0.009
0.491	0.407	6.35	0.006
0.5173	0.344	6.724	0.009
0.5453	0.3	7.12	0.006
0.575	0.257	7.539	0.006
0.6063	0.225	7.984	0.006
0.6395	0.174	8.454	0.006
0.6747	0.142	8.953	0.009
0.712	0.116	9.481	0.006
0.7515	0.098	10.04	0.009
0.7933	0.081	10.63	0.006
0.8377	0.07	11.26	0.009
0.8847	0.049	11.92	0.006
0.9345	0.044	12.63	0.009
0.9872	0.038	13.37	0.006
1.043	0.035	14.16	0.009
1.102	0.026	15.	0.006
1.165	0.021	15.89	0.006
1.231	0.021	16.83	0.006
1.302	0.018		

SOLUTION

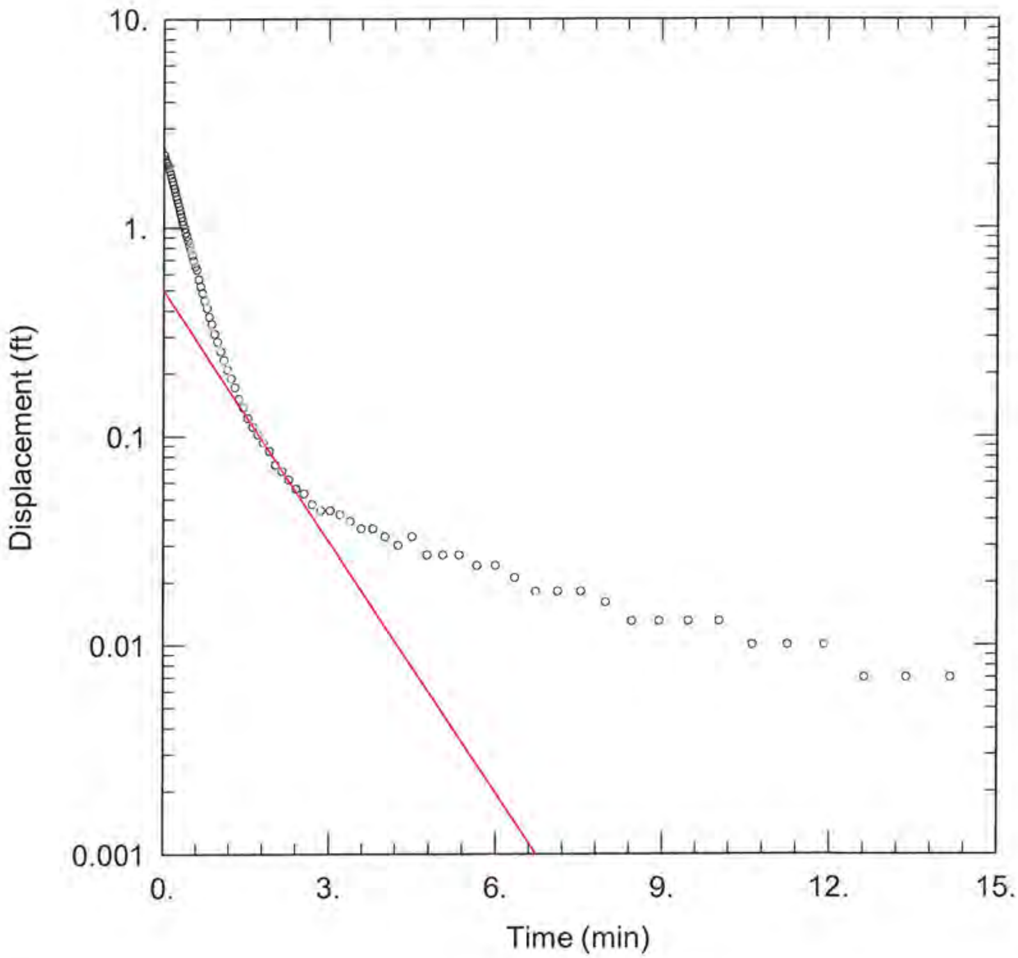
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.479

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0015	cm/sec
y0	0.25	ft

T = K*b = 1.586 cm²/sec



OR03D RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR03Drh.aqt
Date: 12/09/15 Time: 09:17:40

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR03D
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 34.69 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR03D)

Initial Displacement: 2.25 ft
Total Well Penetration Depth: 35.7 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 35.7 ft
Screen Length: 9.48 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.00077 cm/sec
y0 = 0.5 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR03Drh.aqt
Title: OR03D Rising Head Test
Date: 12/09/15
Time: 09:17:41

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OR03D

AQUIFER DATA

Saturated Thickness: 34.69 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR03D

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.25 ft
Static Water Column Height: 35.7 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.48 ft
Total Well Penetration Depth: 35.7 ft

No. of Observations: 88

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0163	2.222	1.231	0.189
0.0327	2.13	1.302	0.171
0.049	2.066	1.376	0.151
0.0653	2.035	1.455	0.137
0.0817	1.988	1.539	0.122
0.098	1.934	1.627	0.111
0.1143	1.87	1.721	0.102
0.1307	1.801	1.82	0.093
0.147	1.735	1.926	0.085
0.1633	1.668	2.037	0.073
0.1797	1.602	2.155	0.068
0.196	1.541	2.281	0.062
0.2123	1.481	2.413	0.056
0.2287	1.42	2.554	0.053
0.245	1.368	2.702	0.047
0.2613	1.316	2.86	0.044
0.2777	1.265	3.027	0.044
0.294	1.216	3.204	0.042
0.3103	1.169	3.391	0.039

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.3267	1.123	3.589	0.036
0.3433	1.077	3.799	0.036
0.361	1.034	4.022	0.033
0.3797	0.993	4.258	0.03
0.3995	0.95	4.508	0.033
0.4205	0.91	4.772	0.027
0.4427	0.864	5.053	0.027
0.4662	0.823	5.349	0.027
0.491	0.78	5.664	0.024
0.5173	0.737	5.997	0.024
0.5453	0.693	6.35	0.021
0.575	0.653	6.724	0.018
0.6063	0.627	7.12	0.018
0.6395	0.564	7.539	0.018
0.6747	0.523	7.984	0.016
0.712	0.486	8.454	0.013
0.7515	0.445	8.953	0.013
0.7933	0.411	9.481	0.013
0.8377	0.373	10.04	0.013
0.8847	0.344	10.63	0.01
0.9345	0.31	11.26	0.01
0.9872	0.284	11.92	0.01
1.043	0.255	12.63	0.007
1.102	0.232	13.37	0.007
1.165	0.209	14.16	0.007

SOLUTION

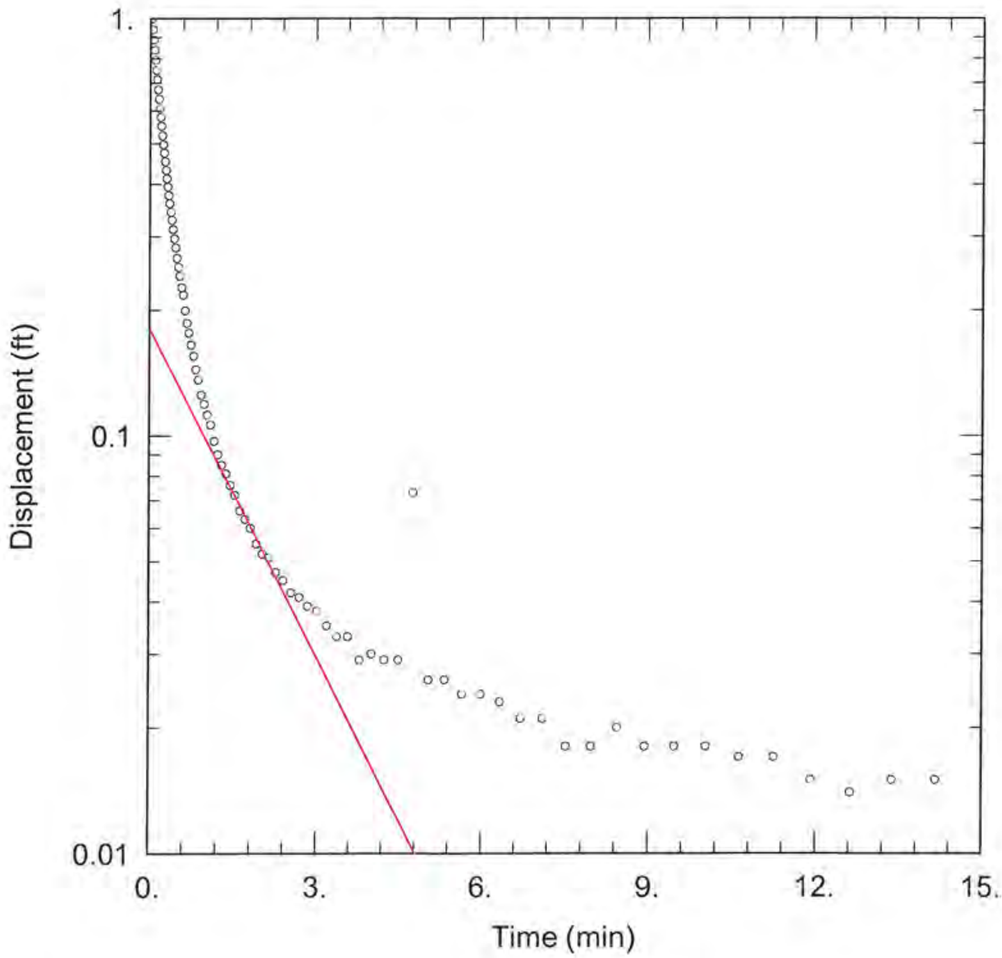
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.479

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00077	cm/sec
y0	0.5	ft

T = K*b = 0.8142 cm^2/sec



OR03S FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR03Sfh.aqt
Date: 12/09/15 Time: 09:17:42

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR03S
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 34.49 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR03S)

Initial Displacement: 1.1 ft
Total Well Penetration Depth: 16.78 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 16.78 ft
Screen Length: 9.5 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00039 cm/sec
y0 = 0.18 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR03Sfh.aqt
Title: OR03S Falling Head Test
Date: 12/09/15
Time: 09:17:42

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OR03S

AQUIFER DATA

Saturated Thickness: 34.49 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR03S

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.1 ft
Static Water Column Height: 16.78 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.5 ft
Total Well Penetration Depth: 16.78 ft

No. of Observations: 91

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0163	1.06	1.376	0.081
0.0327	0.998	1.455	0.076
0.049	0.94	1.539	0.072
0.0653	0.887	1.627	0.066
0.0817	0.839	1.721	0.063
0.098	0.793	1.82	0.06
0.1143	0.751	1.926	0.055
0.1307	0.713	2.037	0.052
0.147	0.674	2.155	0.051
0.1633	0.64	2.281	0.047
0.1797	0.608	2.413	0.045
0.196	0.579	2.554	0.042
0.2123	0.551	2.702	0.041
0.2287	0.523	2.86	0.039
0.245	0.498	3.027	0.038
0.2613	0.475	3.204	0.035
0.2777	0.453	3.391	0.033
0.294	0.432	3.589	0.033
0.3103	0.413	3.799	0.029

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.3267	0.394	4.022	0.03
0.3433	0.376	4.258	0.029
0.361	0.36	4.508	0.029
0.3797	0.343	4.772	0.073
0.3995	0.328	5.053	0.026
0.4205	0.312	5.349	0.026
0.4427	0.296	5.664	0.024
0.4662	0.282	5.997	0.024
0.491	0.266	6.35	0.023
0.5173	0.253	6.724	0.021
0.5453	0.241	7.12	0.021
0.575	0.226	7.539	0.018
0.6063	0.217	7.984	0.018
0.6395	0.199	8.454	0.02
0.6747	0.186	8.953	0.018
0.712	0.176	9.481	0.018
0.7515	0.165	10.04	0.018
0.7933	0.155	10.63	0.017
0.8377	0.144	11.26	0.017
0.8847	0.136	11.92	0.015
0.9345	0.125	12.63	0.014
0.9872	0.119	13.37	0.015
1.043	0.112	14.16	0.015
1.102	0.106	15.	0.012
1.165	0.097	15.89	0.009
1.231	0.09	16.83	0.008
1.302	0.085		

SOLUTION

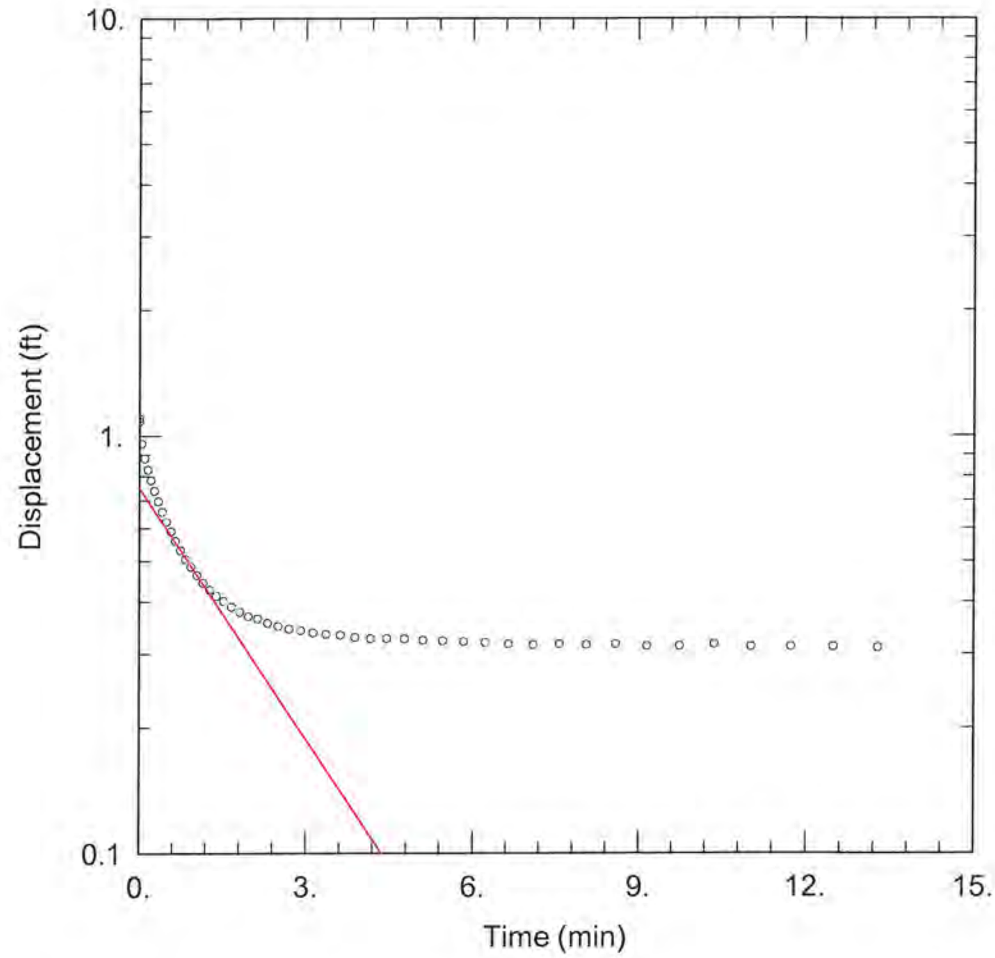
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.502

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00039	cm/sec
y0	0.18	ft

$T = K^*b = 0.41\ cm^2/sec$



OR03S RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR03Srh.aqt
Date: 12/09/15 Time: 09:17:43

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR03S
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 34.49 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR03S)

Initial Displacement: 1.1 ft
Total Well Penetration Depth: 16.78 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 16.78 ft
Screen Length: 9.5 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0003 cm/sec
y0 = 0.75 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR03Srh.aqt
Title: OR03S Rising Head Test
Date: 12/09/15
Time: 09:17:44

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OR03S

AQUIFER DATA

Saturated Thickness: 34.49 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR03S

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.1 ft
Static Water Column Height: 16.78 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.5 ft
Total Well Penetration Depth: 16.78 ft

No. of Observations: 50

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0001	1.082	2.705	0.344
0.0499	0.956	2.915	0.341
0.1026	0.881	3.137	0.337
0.1584	0.829	3.373	0.334
0.2176	0.782	3.623	0.332
0.2802	0.737	3.888	0.328
0.3466	0.696	4.168	0.326
0.4169	0.657	4.465	0.326
0.4914	0.622	4.779	0.325
0.5704	0.589	5.113	0.323
0.6541	0.559	5.465	0.322
0.7426	0.531	5.839	0.321
0.8364	0.506	6.235	0.319
0.9357	0.485	6.655	0.316
1.041	0.463	7.099	0.315
1.153	0.444	7.57	0.316
1.271	0.427	8.068	0.315
1.396	0.413	8.596	0.316
1.528	0.401	9.155	0.313

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
1.669	0.389	9.748	0.313
1.818	0.378	10.38	0.316
1.975	0.369	11.04	0.312
2.142	0.364	11.74	0.312
2.319	0.355	12.49	0.312
2.506	0.349	13.28	0.31

SOLUTION

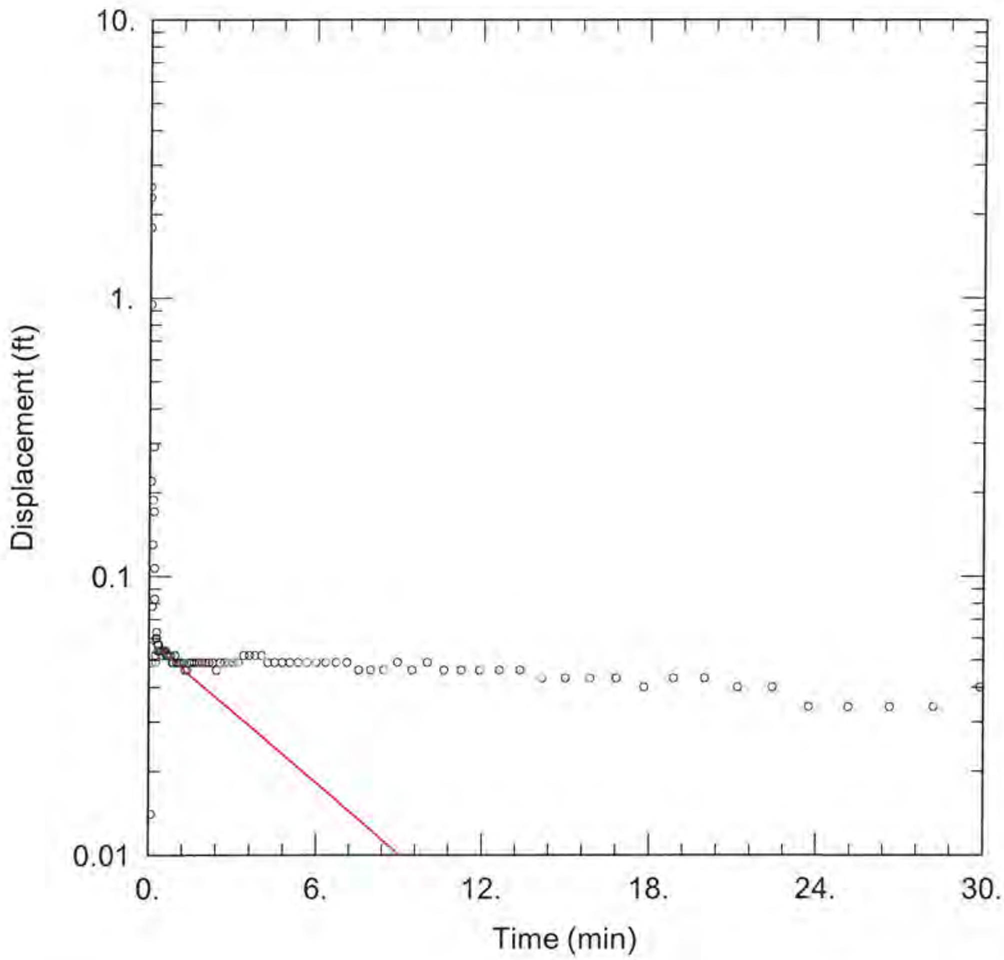
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.502

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0003	cm/sec
y0	0.75	ft

T = K*b = 0.3154 cm^2/sec



OR04D FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR04Dfh.aqt
Date: 12/09/15 Time: 09:17:45

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR04D
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 48.72 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR04D)

Initial Displacement: 2.5 ft
Total Well Penetration Depth: 47.72 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 47.72 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00015 cm/sec
y0 = 0.059 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR04Dfh.aqt
Title: OR04D Falling Head Test
Date: 12/09/15
Time: 09:17:45

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OR04D

AQUIFER DATA

Saturated Thickness: 48.72 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR04D

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.5 ft
Static Water Column Height: 47.72 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 47.72 ft

No. of Observations: 102

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0165	2.292	1.824	0.049
0.033	1.793	1.929	0.049
0.0495	0.948	2.041	0.049
0.066	0.22	2.159	0.049
0.0825	0.014	2.284	0.049
0.099	0.049	2.416	0.046
0.1155	0.078	2.557	0.049
0.132	0.13	2.706	0.049
0.1485	0.188	2.863	0.049
0.165	0.292	3.03	0.049
0.1815	0.171	3.207	0.049
0.198	0.107	3.394	0.052
0.2145	0.083	3.592	0.052
0.231	0.052	3.803	0.052
0.2475	0.049	4.025	0.052
0.264	0.06	4.261	0.049
0.2805	0.063	4.511	0.049
0.297	0.06	4.776	0.049
0.3135	0.057	5.056	0.049

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.33	0.054	5.353	0.049
0.3467	0.057	5.667	0.049
0.3643	0.057	6.	0.049
0.383	0.054	6.353	0.049
0.4028	0.054	6.727	0.049
0.4238	0.054	7.123	0.049
0.446	0.054	7.543	0.046
0.4695	0.054	7.987	0.046
0.4943	0.052	8.457	0.046
0.5207	0.054	8.956	0.049
0.5487	0.054	9.484	0.046
0.5783	0.054	10.04	0.049
0.6097	0.054	10.64	0.046
0.6428	0.052	11.26	0.046
0.678	0.052	11.93	0.046
0.7153	0.052	12.63	0.046
0.7548	0.052	13.38	0.046
0.7967	0.052	14.17	0.043
0.841	0.049	15.01	0.043
0.888	0.049	15.89	0.043
0.9378	0.052	16.83	0.043
0.9905	0.049	17.83	0.04
1.046	0.049	18.88	0.043
1.105	0.049	19.99	0.043
1.168	0.049	21.18	0.04
1.234	0.049	22.43	0.04
1.305	0.046	23.76	0.034
1.379	0.046	25.16	0.034
1.458	0.049	26.65	0.034
1.542	0.049	28.23	0.034
1.631	0.049	29.9	0.04
1.724	0.049	31.66	0.037

SOLUTION

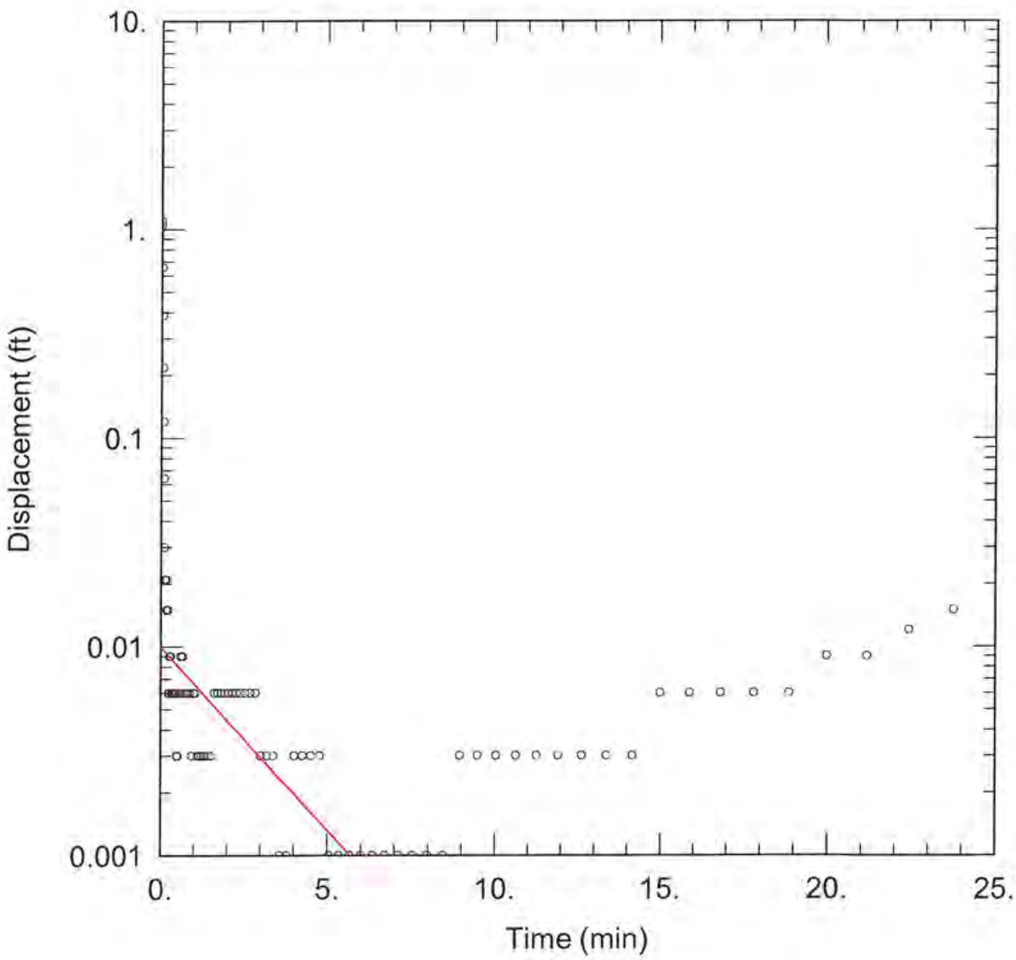
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.341

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00015	cm/sec
y0	0.059	ft

T = K*b = 0.2227 cm²/sec



OR04D RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR04Drh.aqt
Date: 12/09/15 Time: 09:17:46

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR04D
Test Date: 2 Dec 2015

AQUIFER DATA

Saturated Thickness: 48.72 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR04D)

Initial Displacement: 1.1 ft
Total Well Penetration Depth: 47.72 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 47.72 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.00031 cm/sec
y0 = 0.01 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR04Drh.aqt
Title: OR04D Rising Head Test
Date: 12/09/15
Time: 09:17:47

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 2 Dec 2015
Test Well: OR04D

AQUIFER DATA

Saturated Thickness: 48.72 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR04D

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.1 ft
Static Water Column Height: 47.72 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 47.72 ft

No. of Observations: 97

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0163	1.057	1.627	0.006
0.0327	0.659	1.721	0.006
0.049	0.386	1.82	0.006
0.0653	0.218	1.926	0.006
0.0817	0.12	2.037	0.006
0.098	0.064	2.155	0.006
0.1143	0.03	2.281	0.006
0.1307	0.021	2.413	0.006
0.147	0.021	2.554	0.006
0.1633	0.015	2.702	0.006
0.1797	0.015	2.86	0.006
0.196	0.021	3.027	0.003
0.2123	0.015	3.204	0.003
0.2287	0.015	3.391	0.003
0.245	0.006	3.589	0.001
0.2613	0.006	3.799	0.001
0.2777	0.009	4.022	0.003
0.294	0.009	4.258	0.003
0.3103	0.009	4.508	0.003

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.3267	0.006	4.772	0.003
0.3433	0.006	5.053	0.001
0.361	0.006	5.349	0.001
0.3797	0.006	5.664	0.001
0.3995	0.006	5.997	0.001
0.4205	0.006	6.35	0.001
0.4427	0.006	6.724	0.001
0.4662	0.006	7.12	0.001
0.491	0.003	7.539	0.001
0.5173	0.003	7.984	0.001
0.5453	0.006	8.454	0.001
0.575	0.006	8.953	0.003
0.6063	0.009	9.481	0.003
0.6395	0.009	10.04	0.003
0.6747	0.009	10.63	0.003
0.712	0.006	11.26	0.003
0.7515	0.006	11.92	0.003
0.7933	0.006	12.63	0.003
0.8377	0.006	13.37	0.003
0.8847	0.006	14.16	0.003
0.9345	0.003	15.	0.006
0.9872	0.006	15.89	0.006
1.043	0.006	16.83	0.006
1.102	0.003	17.82	0.006
1.165	0.003	18.88	0.006
1.231	0.003	19.99	0.009
1.302	0.003	21.17	0.009
1.376	0.003	22.43	0.012
1.455	0.003	23.75	0.015
1.539	0.003		

SOLUTION

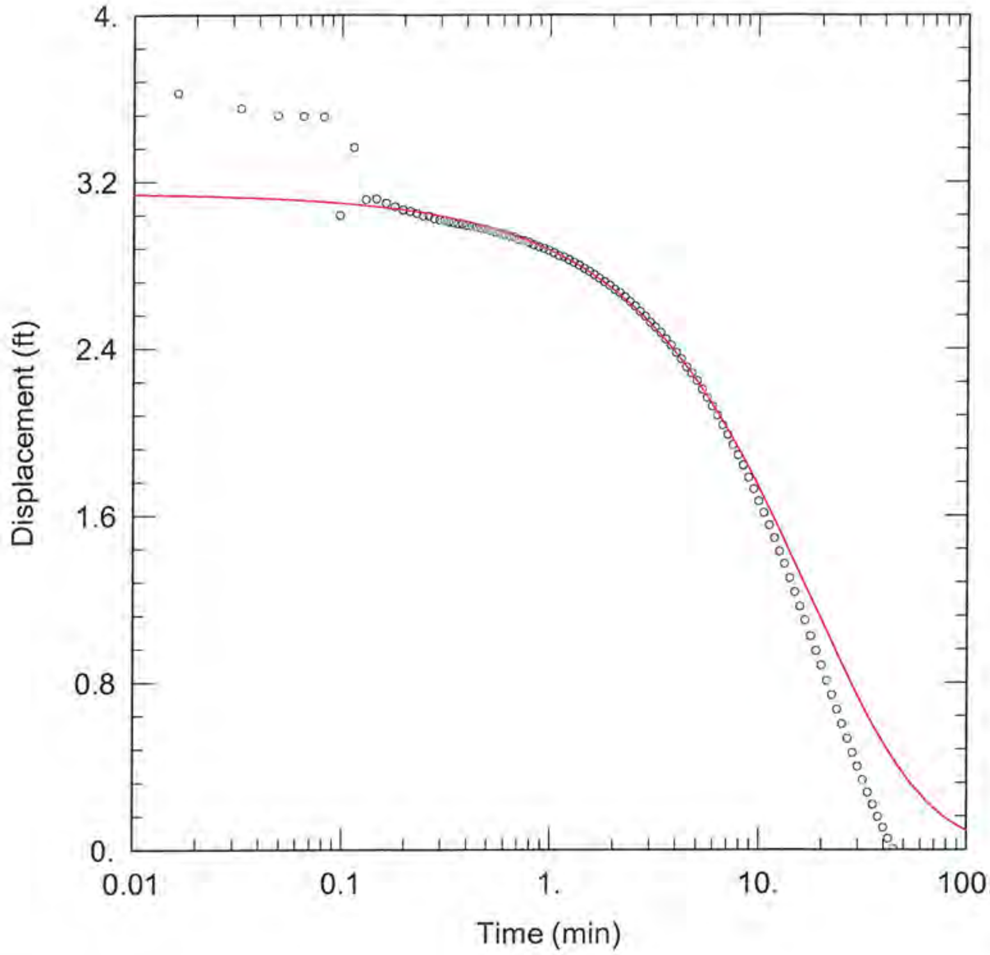
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.341

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00031	cm/sec
y0	0.01	ft

T = K*b = 0.4603 cm^2/sec



OR05D FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR05Dfh.aqt
Date: 12/09/15 Time: 09:17:48

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR05D
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 38.33 ft

WELL DATA (OR05D)

Initial Displacement: 3.15 ft
Total Well Penetration Depth: 31.25 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 31.25 ft
Screen Length: 9.48 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined

Kr = 3.4E-5 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.0002 ft^{-1}

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR05Dfh.aqt
Title: OR05D Falling Head Test
Date: 12/09/15
Time: 09:17:49

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OR05D

AQUIFER DATA

Saturated Thickness: 38.33 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR05D

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 3.15 ft
Static Water Column Height: 31.25 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.48 ft
Total Well Penetration Depth: 31.25 ft

No. of Observations: 108

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0163	3.624	2.155	2.667
0.0327	3.551	2.281	2.647
0.049	3.517	2.413	2.624
0.0653	3.514	2.554	2.603
0.0817	3.511	2.702	2.577
0.098	3.038	2.86	2.554
0.1143	3.363	3.027	2.525
0.1307	3.114	3.204	2.502
0.147	3.117	3.391	2.476
0.1633	3.096	3.589	2.444
0.1797	3.079	3.799	2.415
0.196	3.064	4.022	2.38
0.2123	3.056	4.258	2.348
0.2287	3.047	4.508	2.311
0.245	3.035	4.772	2.279
0.2613	3.035	5.053	2.244
0.2777	3.021	5.349	2.203
0.294	3.015	5.664	2.163
0.3103	3.012	5.997	2.122

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.3267	3.006	6.35	2.079
0.3433	3.003	6.724	2.032
0.361	2.998	7.12	1.986
0.3797	2.995	7.539	1.937
0.3995	2.989	7.984	1.887
0.4205	2.986	8.454	1.838
0.4427	2.98	8.953	1.78
0.4662	2.977	9.481	1.725
0.491	2.972	10.04	1.667
0.5173	2.963	10.63	1.612
0.5453	2.957	11.26	1.551
0.575	2.954	11.92	1.49
0.6063	2.945	12.63	1.426
0.6395	2.937	13.37	1.366
0.6747	2.934	14.16	1.299
0.712	2.922	15.	1.232
0.7515	2.916	15.89	1.163
0.7933	2.908	16.83	1.096
0.8377	2.896	17.82	1.021
0.8847	2.887	18.88	0.951
0.9345	2.879	19.99	0.882
0.9872	2.87	21.17	0.809
1.043	2.858	22.43	0.74
1.102	2.844	23.75	0.67
1.165	2.838	25.16	0.601
1.231	2.824	26.65	0.531
1.302	2.812	28.22	0.464
1.376	2.798	29.89	0.398
1.455	2.783	31.66	0.334
1.539	2.769	33.53	0.273
1.627	2.754	35.52	0.215
1.721	2.737	37.62	0.157
1.82	2.719	39.85	0.105
1.926	2.702	42.21	0.053
2.037	2.682	44.71	0.004

SOLUTION

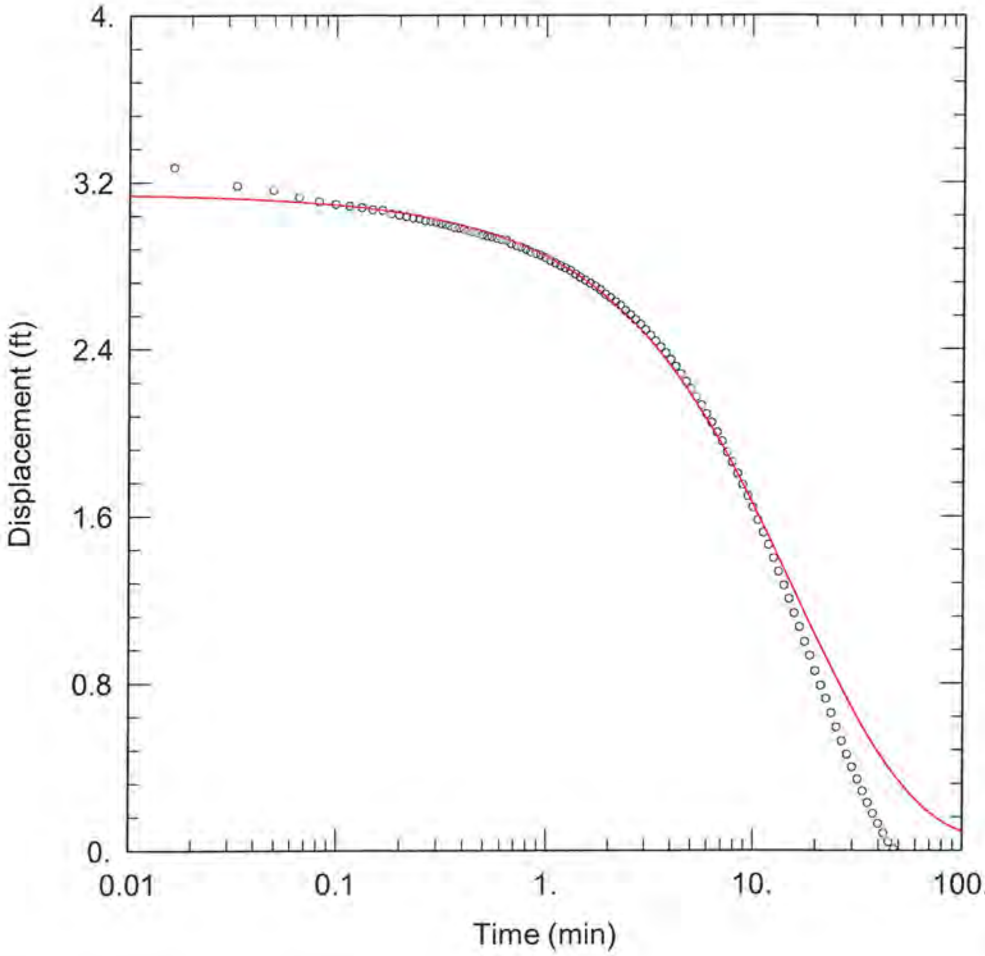
Slug Test
Aquifer Model: Unconfined
Solution Method: KGS Model

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
Kr	3.4E-5	cm/sec
Ss	0.0002	ft^{-1}
Kz/Kr	1.	

T = K*b = 0.03972 cm^2/sec



OR05D RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR05Drh.aqt
Date: 12/09/15 Time: 09:17:50

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR05D
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 38.33 ft

WELL DATA (OR05D)

Initial Displacement: 3.15 ft
Total Well Penetration Depth: 31.77 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 31.25 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined

Kr = 3.4E-5 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.00025 ft^{-1}

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR05Drh.aqt
Title: OR05D Rising Head Test
Date: 12/09/15
Time: 09:17:50

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OR05D

AQUIFER DATA

Saturated Thickness: 38.33 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR05D

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 3.15 ft
Static Water Column Height: 31.25 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 31.77 ft

No. of Observations: 109

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0165	3.27	2.284	2.607
0.033	3.183	2.416	2.581
0.0495	3.163	2.557	2.561
0.066	3.128	2.706	2.538
0.0825	3.108	2.863	2.515
0.099	3.094	3.03	2.489
0.1155	3.085	3.207	2.463
0.132	3.076	3.394	2.436
0.1485	3.068	3.592	2.408
0.165	3.065	3.803	2.379
0.1815	3.047	4.025	2.347
0.198	3.042	4.261	2.315
0.2145	3.036	4.511	2.28
0.231	3.027	4.776	2.243
0.2475	3.024	5.056	2.208
0.264	3.015	5.353	2.17
0.2805	3.013	5.667	2.13
0.297	3.007	6.	2.086
0.3135	3.001	6.353	2.046

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.33	2.995	6.727	1.999
0.3467	2.989	7.123	1.956
0.3643	2.981	7.543	1.904
0.383	2.978	7.987	1.857
0.4028	2.972	8.457	1.802
0.4238	2.966	8.956	1.75
0.446	2.96	9.484	1.695
0.4695	2.955	10.04	1.64
0.4943	2.946	10.64	1.579
0.5207	2.94	11.26	1.519
0.5487	2.937	11.93	1.461
0.5783	2.929	12.63	1.397
0.6097	2.923	13.38	1.333
0.6428	2.92	14.17	1.267
0.678	2.903	15.01	1.203
0.7153	2.894	15.89	1.133
0.7548	2.888	16.83	1.067
0.7967	2.877	17.83	0.997
0.841	2.865	18.88	0.931
0.888	2.856	19.99	0.858
0.9378	2.848	21.18	0.789
0.9905	2.836	22.43	0.725
1.046	2.822	23.76	0.656
1.105	2.81	25.16	0.589
1.168	2.798	26.65	0.522
1.234	2.787	28.23	0.459
1.305	2.775	29.9	0.398
1.379	2.758	31.66	0.34
1.458	2.743	33.54	0.282
1.542	2.729	35.52	0.227
1.631	2.714	37.62	0.175
1.724	2.7	39.85	0.128
1.824	2.683	42.21	0.082
1.929	2.662	44.71	0.041
2.041	2.645	47.36	0.007
2.159	2.625		

SOLUTION

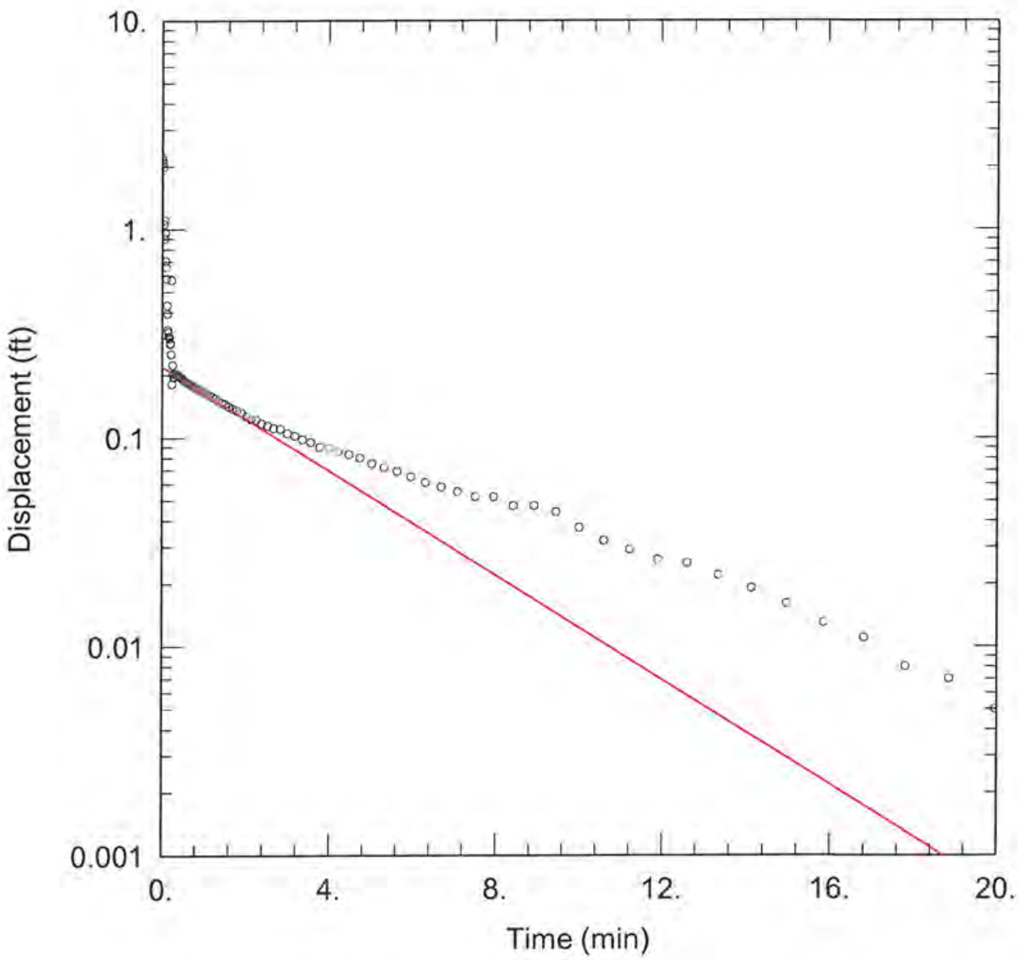
Slug Test
Aquifer Model: Unconfined
Solution Method: KGS Model

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
Kr	3.4E-5	cm/sec
Ss	0.00025	ft^{-1}
Kz/Kr	1.	

T = K*b = 0.03972 cm^2/sec



OR06A FALLING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR06Afh.aqt
Date: 12/09/15 Time: 09:17:51

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR06A
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 21.61 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR06A)

Initial Displacement: 2.2 ft
Total Well Penetration Depth: 11.64 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 11.64 ft
Screen Length: 9.5 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00018 cm/sec
y0 = 0.22 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR06Afh.aqt
Title: OR06A Falling Head Test
Date: 12/09/15
Time: 09:17:52

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OR06A

AQUIFER DATA

Saturated Thickness: 21.61 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR06A

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.2 ft
Static Water Column Height: 11.64 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.5 ft
Total Well Penetration Depth: 11.64 ft

No. of Observations: 101

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0112	2.15	1.28	0.154
0.0223	2.09	1.355	0.15
0.0335	1.989	1.434	0.147
0.0447	1.056	1.517	0.145
0.0558	1.107	1.606	0.141
0.067	0.904	1.7	0.138
0.0782	0.961	1.799	0.135
0.0893	0.706	1.904	0.132
0.1005	0.659	2.016	0.127
0.1117	0.581	2.134	0.123
0.1228	0.432	2.259	0.122
0.134	0.394	2.392	0.117
0.1452	0.33	2.532	0.114
0.1563	0.321	2.681	0.111
0.1675	0.306	2.838	0.11
0.1787	0.303	3.005	0.105
0.1898	0.299	3.182	0.102
0.201	0.282	3.369	0.098
0.2122	0.285	3.568	0.095

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.2233	0.252	3.778	0.09
0.235	0.571	4.	0.089
0.2475	0.181	4.236	0.086
0.2607	0.223	4.486	0.083
0.2747	0.203	4.751	0.08
0.2895	0.196	5.031	0.075
0.3052	0.196	5.328	0.072
0.3218	0.202	5.643	0.069
0.3395	0.203	5.976	0.065
0.3582	0.203	6.329	0.061
0.378	0.202	6.702	0.058
0.399	0.2	7.098	0.055
0.4212	0.197	7.518	0.052
0.4447	0.196	7.962	0.052
0.4695	0.194	8.433	0.047
0.4958	0.193	8.931	0.047
0.5238	0.19	9.459	0.044
0.5535	0.188	10.02	0.037
0.5848	0.185	10.61	0.032
0.618	0.184	11.24	0.029
0.6532	0.183	11.9	0.026
0.6905	0.18	12.61	0.025
0.73	0.178	13.35	0.022
0.7718	0.177	14.14	0.019
0.8162	0.174	14.98	0.016
0.8632	0.171	15.87	0.013
0.913	0.171	16.81	0.011
0.9657	0.168	17.8	0.008
1.022	0.165	18.85	0.007
1.081	0.162	19.97	0.005
1.143	0.16	21.15	0.004
1.21	0.157		

SOLUTION

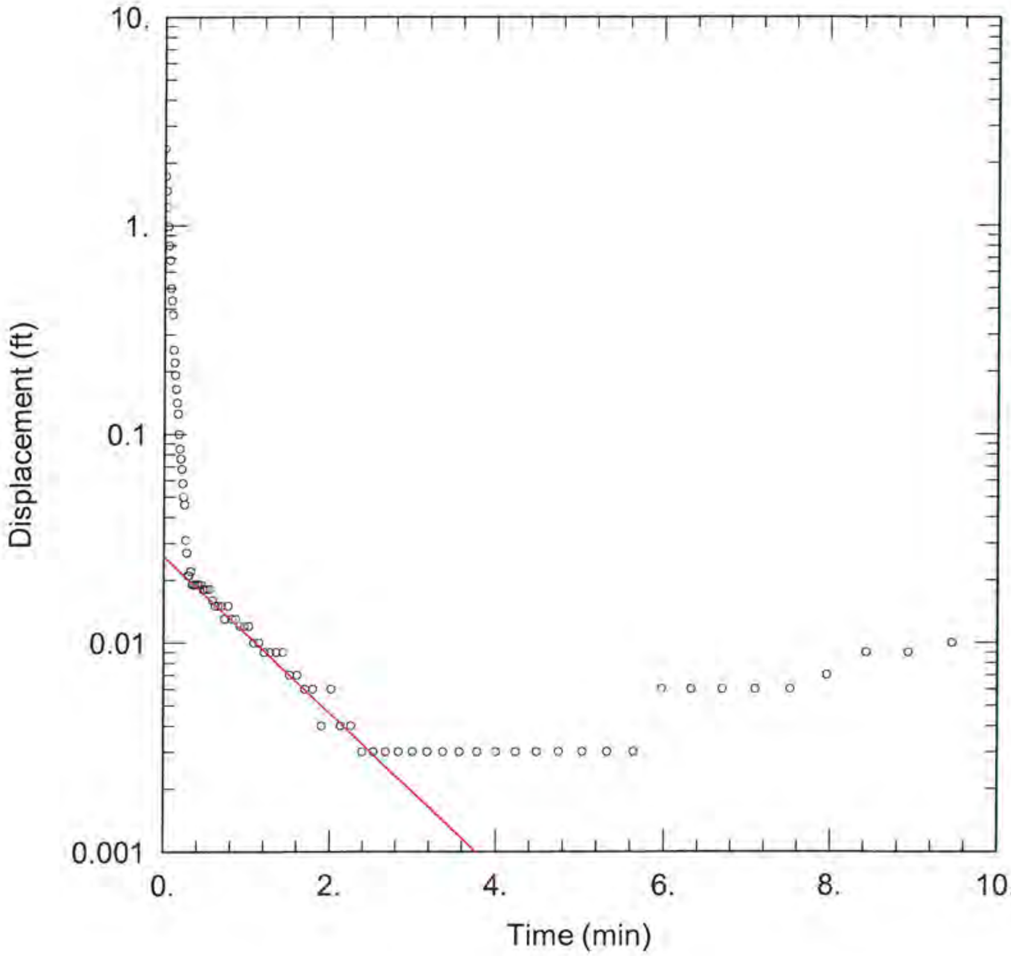
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.367

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00018	cm/sec
y0	0.22	ft

T = K*b = 0.1186 cm²/sec



OR06A RISING HEAD TEST

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR06Arh.aqt
Date: 12/09/15 Time: 09:17:52

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Well: OR06A
Test Date: 3 Dec 2015

AQUIFER DATA

Saturated Thickness: 21.61 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OR06A)

Initial Displacement: 2.33 ft
Total Well Penetration Depth: 11.64 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 11.64 ft
Screen Length: 9.5 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00054 cm/sec
y0 = 0.026 ft

Data Set: I:\15Jobs\15E0030A\Admin\15-Field-Laboratory Data\SlugTests\OR06Arh.aqt
Title: OR06A Rising Head Test
Date: 12/09/15
Time: 09:17:53

PROJECT INFORMATION

Company: Hanson Professional Services
Client: NRT/Dynegy
Project: 15E0030A/0500
Location: Duck Creek Power Station
Test Date: 3 Dec 2015
Test Well: OR06A

AQUIFER DATA

Saturated Thickness: 21.61 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: OR06A

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.33 ft
Static Water Column Height: 11.64 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.333 ft
Screen Length: 9.5 ft
Total Well Penetration Depth: 11.64 ft

No. of Observations: 90

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.0112	1.721	0.913	0.012
0.0223	1.465	0.9657	0.012
0.0335	1.221	1.022	0.012
0.0447	0.991	1.081	0.01
0.0558	0.802	1.143	0.01
0.067	0.683	1.21	0.009
0.0782	0.5	1.28	0.009
0.0893	0.437	1.355	0.009
0.1005	0.373	1.434	0.009
0.1117	0.253	1.517	0.007
0.1228	0.22	1.606	0.007
0.134	0.192	1.7	0.006
0.1452	0.164	1.799	0.006
0.1563	0.141	1.904	0.004
0.1675	0.125	2.016	0.006
0.1787	0.1	2.134	0.004
0.1898	0.085	2.259	0.004
0.201	0.076	2.392	0.003
0.2122	0.068	2.532	0.003

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.2233	0.058	2.681	0.003
0.235	0.05	2.838	0.003
0.2475	0.046	3.005	0.003
0.2607	0.031	3.182	0.003
0.2747	0.027	3.369	0.003
0.2895	0.021	3.568	0.003
0.3052	0.021	3.778	0.003
0.3218	0.022	4.	0.003
0.3395	0.019	4.236	0.003
0.3582	0.019	4.486	0.003
0.378	0.019	4.751	0.003
0.399	0.019	5.031	0.003
0.4212	0.019	5.328	0.003
0.4447	0.019	5.643	0.003
0.4695	0.018	5.976	0.006
0.4958	0.018	6.329	0.006
0.5238	0.018	6.702	0.006
0.5535	0.018	7.098	0.006
0.5848	0.016	7.518	0.006
0.618	0.015	7.962	0.007
0.6532	0.015	8.433	0.009
0.6905	0.015	8.931	0.009
0.73	0.013	9.459	0.01
0.7718	0.015	10.02	0.012
0.8162	0.013	10.61	0.012
0.8632	0.013	11.24	0.012

SOLUTION

Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.367

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00054	cm/sec
y0	0.026	ft

T = K*b = 0.3557 cm^2/sec

Appendix B

Field Boring Log for OM32

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
Completion: 355.0 ft. BGS
Station: 3,949.89N
832.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp (tsf)* Failure Type
1A	19/24 *79%*	SS	*4-4 11-1* N=15			*4.50*
1				11		
	0/36 *0%*	BD				
2						
3A	14/24 *58%*	SS	*3-2 2-2* N=4			*1.00*
3				28		
	0/36 *0%*	BD				
4						
5A	10/24 *42%*	SS	*1-1 1-2* N=2			*1.00*
5				25		
	0/36 *0%*	BD				
6						
7A	14/24 *58%*	SS	*1-2 2-2* N=4			*0.50*
7				27		
	0/36 *0%*	BD				
8						
9A	14/24 *58%*	SS	*1-1 2-3* N=3			*0.50*
9				24		
	0/36 *0%*	BD				
10						
11A	20/24 *83%*	SS	*2-3 5-5* N=8			*2.00*
11				18		
	0/36 *0%*	BD				
12						

Depth ft. BGS: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Elevation ft. MSL: 618, 616, 614, 612, 610, 608, 606, 604, 602, 600, 598, 596, 594, 592, 590

Lithologic Description	Borehole Detail	Remarks
Brown (10YR4/3), dry, hard, SILT with few clay, trace very fine- to fine-grained sand, trace roots, trace slag fragments - FILL.		
Yellowish brown (10YR5/6) with 40% gray (10YR5/1) mottles, moist, medium, SILT with few clay, trace very fine- to fine-grained sand, trace roots - FILL.		
Gray (10YR5/1) with 30% yellowish brown (10YR5/6) and 5% black (10YR2/1) mottles, moist, medium, SILT with few clay, trace very fine- to fine-grained sand - FILL.		
Gray (10YR5/1) and yellowish brown (10YR5/6), moist, medium, SILT with few clay, trace very fine- to fine-grained sand - FILL.		
Gray (10YR5/1) and yellowish brown (10YR5/6), moist, medium, SILT with few clay, trace very fine- to fine-grained sand, trace coal fragments - FILL.		
Greenish gray (10G6/1), moist, stiff, SILT with few clay, trace very fine- to fine-grained sand - FILL.		

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
Completion: 355.0 ft. BGS
Station: 3,949.89N
832.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
∇ =

Number	Recov / Total (in) % Recovery	Type	Blows / 6 in N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
13A / 13	19/24 *79%*	SS	*3-4* *4-5* N=8	19		*2.00*	32		588	
	0/36 *0%*	BD					34		586	
14 / 15A / 15	14/24 *58%*	SS	*5-8* *6-7* N=14	12		*2.00*	36		584	
	0/36 *0%*	BD					38	Gray (10YR5/1) with 10% yellowish brown (10YR5/6) mottles, moist, stiff, SILT with few clay, trace very fine- to fine-grained sand, trace coal fragments - FILL.	582, 580	
16 / 17A / 17	2/24 *8%*	SS	*6-6* *6-8* N=12	16			40, 42		578	
	0/36 *0%*	BD					44		576	
18 / 19A / 19	18/24 *75%*	SS	*3-5* *8-9* N=13	14		*2.75*	46		574	
	0/36 *0%*	BD					48	Gray (10YR5/1), moist, very stiff, SILT with few clay, laminated (weathered shale), trace shale fragments - FILL.	572, 570	
20 / 21A / 21	20/24 *83%*	SS	*1-3* *6-7* N=9	25		*1.50*	50, 52	Dark gray (10YR4/1) with 35% light yellowish brown (2.5Y6/4) mottles, moist, stiff, SILT with little clay, trace very fine- to medium-grained sand - FILL.	568	
	0/36 *0%*	BD					54		566	
22 / 23A / 23	20/24 *83%*	SS	*2-3* *7-7* N=10	21		*2.25*	56	Gray (10YR5/1) with 40% yellowish brown (10YR5/6) mottles, moist, very stiff, SILT with trace clay and trace very fine- to fine-grained sand.	564	
	0/36 *0%*	BD					58	Dark gray (10YR4/1), moist, very stiff, SILT with few clay, trace very fine- to coarse-grained sand - FILL.	562, 560	
24							60			

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
Completion: 355.0 ft. BGS
Station: 3,949.89N
832.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp (tsf)* Failure Type
25A 25	21/24 *88%*	SS	*1-3* *6-8* N=9	21		*1.75*
26	0/36 *0%*	BD				
27A 27	16/24 *67%*	SS	*4-6* *10-12* N=16	19		*3.50*
28	0/36 *0%*	BD				
29A 29	14/24 *58%*	SS	*5-5* *10-10* N=15	17		*3.00*
30	0/36 *0%*	BD				
31A 31	21/24 *88%*	SS	*4-7* *10-11* N=17	14		*3.00*
32	0/36 *0%*	BD				
33A 33	24/24 *100%*	SS	*5-6* *7-9* N=13	18		*1.75*
34	0/36 *0%*	BD				
35A 35	12/24 *50%*	SS	*19-34* *50/2"*	17		
Run 36	36/36 *100%*	RC	**RQD = 40%**			

Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
62–64	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) and 20% dark gray (10YR4/1) mottles, moist, stiff, SILT with little clay and trace very fine- to coarse-grained sand.	558, 556	
66–74	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) and 20% dark gray (10YR4/1) mottles, moist, very stiff, SILT with little clay and trace very fine- to coarse-grained sand, trace shale fragments.	554, 552, 550, 548, 546	
76–84	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) and 20% dark gray (10YR4/1) mottles, moist, very stiff, SILT with little clay and trace very fine- to coarse-grained sand and small to large gravel, trace shale and coal fragments.	544, 542, 540, 538, 536	Switched to mud rotary at 82.0 ft bgs
	Dark gray (10YR3/1), moist, hard, SHALE, moderately decomposed, slightly laminated.	534	
86–88	Dark gray, SHALE with coal seams, moderately decomposed, moderate.	532	Switched to rock core at 86.0 ft bgs
90	Dark gray, LIMESTONE with trace inclusions, slightly	530	

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

HANSON

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
Completion: 355.0 ft. BGS
Station: 3,949.89N
832.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
								decomposed, slightly fractured, massive, strong.		
								Gray, LIMESTONE, slightly decomposed, stylolites, fossiliferous, slightly fractured, massive, strong.	528	
Run 37	60/60 *100%*	RC	**RQD = 52%**				92			
							94		526	
							96	Dark gray, SHALE with coal and clay seams, moderately decomposed, massive, moderate.	524	
Run 38	60/60 *100%*	RC	**RQD = 58%**				98		522	
							100		520	
								Dark gray, SHALE with clay seams, moderately decomposed, moderate.	518	
Run 39	60/60 *100%*	RC	**RQD = 67%**				102			
							104	Dark gray, LIMESTONE with clay seams, slightly decomposed, stylolites, small joints, vuggy, strong.	516	
							106	Dark gray, LIMESTONE, slightly decomposed, stylolites, slightly fractured, massive, strong.	514	
Run 40	60/60 *100%*	RC	**RQD = 97%**				108		512	
							110		510	
								Dark gray, LIMESTONE with thin shale interbeds, slightly decomposed, stylolites, slightly fractured, strong.	508	
Run 41	60/60 *100%*	RC	**RQD = 88%**				112			
							114		506	
							116	Dark gray, SHALE, competent, massive, strong.	504	
							118		502	
Run	120/120		**RQD =**				120		500	

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
Completion: 355.0 ft. BGS
Station: 3,949.89N
832.97E

TOPOGRAPHIC MAP INFORMATION:
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Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
42	*100%*	RC	**97%**				120–135	Dark gray, SHALE, competent, massive, strong. *[Continued from previous page]*			
Run 43	120/120 *100%*	RC	**RQD = 98%**								
							135–146	Dark gray, SHALE, fossiliferous, competent, massive, strong.			
Run 44	120/120 *100%*	RC	**RQD = 88%**								
							146–150	Dark gray, SHALE with clay seams, slightly decomposed, weak.			
Run	120/120		**RQD =**								

Depth scale (ft. BGS): 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150

Elevation scale (ft. MSL): 498, 496, 494, 492, 490, 488, 486, 484, 482, 480, 478, 476, 474, 472, 470

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
Completion: 355.0 ft. BGS
Station: 3,949.89N
832.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
45	*100%*	RC	**43%**				152–157	Dark gray, SHALE with clay seams, slightly decomposed, weak. *[Continued from previous page]*		468–462	
Run 46	113/120 *94%*	RC	**RQD = 60%**				157–165	Black, SHALE with clay seams, slightly decomposed, moderate.		462–454	
Run 47	121/120 *101%*	RC	**RQD = 89%**				165–170.2	Black, SHALE, competent, blocky, massive, strong.		454–450	
							170.2–171.4	Black with 30% gray, SHALE with limestone nodules and seams, competent, massive, strong.		448	
							171.4–180	Dark gray, SHALE laminated with clay seams, competent, moderate.		446–440	
Run	118/120		**RQD =**				180				

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.	**CONTRACTOR:** Bulldog Drilling, Inc.		
Site: Duck Creek Power Station	**Rig mfg/model:** CME-750 ATV Drill	**BOREHOLE ID:** OM32	
Location: Canton, Illinois	**Drilling Method:** 4 ¼" HSA, split spoon sampler; NQ core	**Well ID:** n/a	
Project: 15E0030		**Surface Elev:** 619.4 ft. MSL	
DATES: Start: 08/26/2015	**FIELD STAFF: Driller:** J. Dittmaier	**Completion:** 355.0 ft. BGS	
Finish: 09/15/2015	**Helper:** M. Hill	**Station:** 3,949.89N	
WEATHER: Sunny, warm, calm, mid-70s	**Eng/Geo:** S. Keim	832.97E	

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp (tsf)* Failure Type	Lithologic Description	Remarks
48	*98%*	RC	**71%**				Black, COAL, vitreous, cleated.	
							Gray, SHALE, laminated, competent, moderate.	
							Gray, interlaminated SHALE and SANDSTONE, competent, calcareous, strong.	
Run 49	120/120 *100%*	RC	**RQD = 88%**				Gray, very fine- to fine-grained SANDSTONE, competent, strong.	
							Dark gray, SHALE with gray laminae, signs of dewatering structure.	
							Interbedded dark gray and gray SHALE and very fine- to fine-grained micaceous SANDSTONE, competent, strong.	
							Black, SHALE with grayish brown LIMESTONE seams and nodules, competent, strong.	
Run 50	120/120 *100%*	RC	**RQD = 94%**				Dark gray, SHALE with grayish brown LIMESTONE seams and nodules, competent, strong.	
							Dark gray SHALE with black coal seams, laminated, competent, moderate.	
							Gray, thinly bedded, very fine- to fine-grained SANDSTONE with clay and shale seams, competent, strong.	
Run	118/120		**RQD =**					

Depth ft. BGS: 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204, 206, 208, 210

Elevation ft. MSL: 438, 436, 434, 432, 430, 428, 426, 424, 422, 420, 418, 416, 414, 412, 410

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
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HANSON
BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
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832.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
51	*98%*	RC	**84%**				– 212	Gray, thinly bedded, very fine- to fine-grained SANDSTONE with clay and shale seams, competent, strong. *[Continued from previous page]*	408	
							212 – 215	Dark gray, SHALE, laminated, competent, strong.	406	
							215 – 218	Dark gray, SHALE, slightly decomposed, laminated, moderate.	404, 402	
							218 – 219.6	Black and gray, SHALE, slightly decomposed, laminated, moderate.	400	
Run 52	107/120 *89%*	RC	**RQD = 54%**				220 – 225	Dark gray, SHALE, slightly decomposed, massive, moderate.	398, 396	
							225 – 226.5	Gray, SHALE with clay seams, moderately decomposed, massive, weak.	394	
							226.5 – 227.4	Gray, medium- to coarse-grained SANDSTONE, slightly decomposed, strong.	392	
							227.4 – 228.8	Gray, SHALE, moderately decomposed, massive, moderate.		
							228.8 – 229.7	Gray, very fine- to fine-grained SANDSTONE, competent, strong.	390	
Run 53	117/120 *98%*	RC	**RQD = 71%**				229.7 – 240	Dark gray, very fine- to fine-grained SANDSTONE, competent, massive, strong.	388, 386, 384, 382, 380	
Run	120/120		**RQD =**				240			

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
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Station: 3,949.89N
832.97E

TOPOGRAPHIC MAP INFORMATION:
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WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp (tsf)* Failure Type
54	*100%*	RC	**87%**			
Run 55	60/60 *100%*	RC	**RQD = 90%**			
Run 56	60/60 *100%*	RC	**RQD = 93%**			
Run 57	120/120 *100%*	RC	**RQD = 86%**			
Run	120/120		**RQD =**			

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
to ~241.4	Dark gray, very fine- to fine-grained SANDSTONE, competent, massive, strong. *[Continued from previous page]*	
~241.4 – ~247.2	Dark gray, SHALE, slightly decomposed, massive, moderate.	
~247.2 – ~254.2	Gray, very fine- to fine-grained SANDSTONE and black SHALE, thinly interbedded, slightly decomposed, strong.	
~254.2 – ~256.6	Black, SHALE, slightly decomposed, laminated, moderate.	
~256.6 – ~257.6	Black, COAL, vitreous, cleated.	
~257.6 – 270	Dark gray, very fine- to fine-grained SANDSTONE, competent, massive, strong.	

Depth scale: 242, 244, 246, 248, 250, 252, 254, 256, 258, 260, 262, 264, 266, 268, 270
Elevation scale: 378, 376, 374, 372, 370, 368, 366, 364, 362, 360, 358, 356, 354, 352, 350

Borehole Detail | Remarks

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
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BOREHOLE ID: OM32
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Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) *% Recovery*	SAMPLE: Type	TESTING: *Blows / 6 in* N - Value **RQD**	TESTING: Moisture (%)	TESTING: Dry Den. (lb/ft³)	TESTING: Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
58	*100%*	RC	**84%**								
							272	Gray, very fine- to fine-grained SANDSTONE with shale seams, competent, strong		348	
							274	Dark gray, SHALE, competent, massive, moderate.		346	
							276			344	
Run 59	62/72 *86%*	RC	**RQD = 0%**				278			342	
							280	Gray, SHALE, slightly decomposed, massive, moderate.		340	
							282	Black, SHALE, laminated, competent, strong.		338	
Run 60	46/48 *96%*	RC	**RQD = 96%**				284			336	
							286			334	
							288			332	
Run 61	118/120 *98%*	RC	**RQD = 86%**				290			330	
								Black, COAL.		328	
							292	Gray, SHALE, slightly decomposed, massive, moderate.		326	
							294				
							296			324	
							298	Dark gray, SHALE, slightly decomposed, laminated, strong.		322	
Run	115/120		**RQD =**				300			320	

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
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HANSON

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
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832.97E

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WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
62	*96%*	RC	**40%**				300–311.6	Dark gray, SHALE, slightly decomposed, laminated, strong. *[Continued from previous page]*		
Run 63	118/120 *98%*	RC	**RQD = 82%**				311.6–312.5	Dark gray, SHALE, fossiliferous, competent, massive, strong.		
							312.5–314.2	Dark gray, very fine- to fine-grained SANDSTONE and SHALE, thinly interbedded, competent, strong.		
							314.2–315.2	Gray, SHALE, slightly decomposed, massive, moderate.		
							315.2–319	Light greenish gray, very fine- to fine-grained SANDSTONE, competent, massive, strong.		
Run 64	120/120 *100%*	RC	**RQD = 95%**				319–319.9	Grayish green, SHALE, slightly decomposed, moderate.		
							319.9–321.4	Grayish green, SHALE with sandstone, limestone, and chert nodules (brecciated), slightly decomposed, blocky, strong.		
							321.4–324.1	Dark gray and dark green, SANDSTONE and SHALE with limestone lenses (dewatering structure), slightly decomposed, moderate.		
							324.1–325	Light gray, LIMESTONE, competent, massive, strong.		
							325–327	Grayish green, SHALE and SANDSTONE, thinly interbedded, calcareous, competent, strong.		
							327–330	Gray, LIMESTONE, slightly decomposed, slightly fractured, stylolites, vuggy, strong.		
Run	120/120		**RQD =**				330			

Depth scale: 302, 304, 306, 308, 310, 312, 314, 316, 318, 320, 322, 324, 326, 328, 330
Elevation scale: 318, 316, 314, 312, 310, 308, 306, 304, 302, 300, 298, 296, 294, 292, 290

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 08/26/2015
Finish: 09/15/2015
WEATHER: Sunny, warm, calm, mid-70s

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler; NQ core
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: S. Keim

BOREHOLE ID: OM32
Well ID: n/a
Surface Elev: 619.4 ft. MSL
Completion: 355.0 ft. BGS
Station: 3,949.89N 832.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.71 - 8/27/2015
▼ = 40.58 - 9/16/2015
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
65	*100%*	RC	**98%**				330–335	Gray, LIMESTONE, slightly decomposed, slightly fractured, stylolites, vuggy, strong. *[Continued from previous page]*	289.4–284.4	
							335–339.2	Gray, LIMESTONE, slightly decomposed, crystalline, slightly fractured, stylolites, strong.		
Run 66	120/120 *100%*	RC	**RQD = 100%**				339.2–345	Gray, LIMESTONE with greenish gray clay seams, slightly decomposed, crystalline, slightly fractured, stylolites, strong.		
							345–350	Gray, LIMESTONE with greenish gray clay seams, slightly decomposed, crystalline, vuggy, stylolites, strong.		
Run 67	120/120 *100%*	RC	**RQD = 93%**				350–351.1	Gray, LIMESTONE with greenish gray clay and sandstone seams, slightly decomposed, crystalline, vuggy, stylolites, strong.		
							351.1–355	Greenish gray, SANDSTONE with shale and limestone lenses, slightly decomposed, calcareous, strong.	–264.4	

Depth scale: 332, 334, 336, 338, 340, 342, 344, 346, 348, 350, 352, 354
Elevation scale: 288, 286, 284, 282, 280, 278, 276, 274, 272, 270, 268, 266

End of boring = 355.0 feet

NOTE(S): Borehole sealed with high-solids bentonite grout placed by tremie pipe from bottom of borehole.

Appendix C

Pressure Test Results for OM32

Packer Test Solution

"Methods and procedures for defining aquifer parameters" (by John Sevee);
in Practical Handbook of Ground-Water Monitoring (ed. David Nielsen)

"Friction Losses in Pipe" (APPENDIX 17.A.);
in Groundwater and Wells (Fletcher G. Driscoll)

Site Duck Creek Power Station – South End of Ash Pond 1
Boring OM32
0.1250 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

Test #	Depth [Interval midpoint] (feet MSL)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
A 1	351.57	0.15000	40.58	10.00	23.07	0.120	63.527	1.742E-05	
2	351.57	0.30500	40.58	10.00	23.07	0.245	63.402	3.550E-05	
3	351.57	0.18000	40.58	10.00	23.07	0.145	63.502	2.092E-05	
4	351.57	0.13000	40.58	10.00	23.07	0.104	63.543	1.510E-05	
5	351.57	0.09500	40.58	10.00	23.07	0.076	63.571	1.103E-05	
6	351.57	0.02300	40.58	10.00	23.07	0.018	63.629	2.667E-06	
7	351.57	0.00600	40.58	10.00	23.07	0.005	63.642	6.957E-07	
8	351.57	0.00800	40.58	10.00	23.07	0.006	63.641	9.276E-07	
9	351.57	0.01800	40.58	10.00	23.07	0.014	63.633	2.087E-06	
10	351.57	0.01100	40.58	10.00	23.07	0.009	63.638	1.275E-06	
11	351.57	0.00800	40.58	10.00	23.07	0.006	63.641	9.276E-07	
12	351.57	0.00840	40.58	10.00	23.07	0.007	63.640	9.740E-07	
13	351.57	0.00760	40.58	10.00	23.07	0.006	63.641	8.812E-07	
14	351.57	0.00300	40.58	20.00	46.13	0.002	86.712	2.553E-07	
15	351.57	0.00180	40.58	20.00	46.13	0.001	86.713	1.532E-07	
16	351.57	0.00840	40.58	20.00	46.13	0.007	86.707	7.149E-07	
17	351.57	0.11080	40.58	30.00	69.20	0.089	109.692	7.454E-06	
18	351.57	0.07320	40.58	30.00	69.20	0.059	109.722	4.923E-06	
19	351.57	0.02880	40.58	30.00	69.20	0.023	109.758	1.936E-06	
20	351.57	0.00840	40.58	30.00	69.20	0.007	109.774	5.646E-07	
21	351.57	0.01920	40.58	30.00	69.20	0.015	109.766	1.291E-06	
22	351.57	0.01920	40.58	30.00	69.20	0.015	109.766	1.291E-06	
23	351.57	0.01760	40.58	20.00	46.13	0.014	86.700	1.498E-06	*Step down*
24	351.57	0.01880	40.58	20.00	46.13	0.015	86.699	1.600E-06	*Step down*
25	351.57	0.00080	40.58	10.00	23.07	0.001	63.646	9.275E-08	*Step down*
26	351.57	0.00440	40.58	10.00	23.07	0.004	63.643	5.101E-07	*Step down*
B 1	331.64	0.03040	40.58	10.00	23.07	0.023	63.624	3.526E-06	
2	331.64	0.10600	40.58	10.00	23.07	0.080	63.567	1.230E-05	
3	331.64	0.17720	40.58	10.00	23.07	0.134	63.513	2.059E-05	
4	331.64	0.06160	40.58	10.00	23.07	0.047	63.600	7.147E-06	
5	331.64	0.01400	40.58	10.00	23.07	0.011	63.636	1.623E-06	
6	331.64	0.05000	40.58	10.00	23.07	0.038	63.609	5.800E-06	
7	331.64	0.04440	40.58	20.00	46.13	0.034	86.680	3.780E-06	
8	331.64	0.11520	40.58	20.00	46.13	0.087	86.627	9.813E-06	
9	331.64	0.27120	40.58	20.00	46.13	0.205	86.509	2.313E-05	
10	331.64	0.24680	40.58	20.00	46.13	0.187	86.527	2.105E-05	
11	331.64	0.17880	40.58	20.00	46.13	0.135	86.579	1.524E-05	
12	331.64	0.02600	40.58	30.00	69.20	0.020	109.761	1.748E-06	
13	331.64	0.01180	40.58	30.00	69.20	0.009	109.772	7.932E-07	
14	331.64	0.02440	40.58	30.00	69.20	0.018	109.763	1.640E-06	
15	331.64	0.02000	40.58	30.00	69.20	0.015	109.766	1.345E-06	
16	331.64	0.01960	40.58	30.00	69.20	0.015	109.766	1.318E-06	
17	331.64	0.00080	40.58	20.00	46.13	0.001	86.713	6.808E-08	*Step down*
18	331.64	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*Step down*
19	331.64	0.01120	40.58	10.00	23.07	0.008	63.639	1.299E-06	*Step down*

Duck Creek Power Station -- Bedrock Packer Test Calculations

Site Duck Creek Power Station – South End of Ash Pond 1
Boring OM32
0.1250 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

Test #	Depth [Interval midpoint] (feet MSL)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
20	331.64	0.02840	40.58	10.00	23.07	0.022	63.625	3.294E-06	*Step down*
C 1	321.54	0.00080	40.58	10.00	23.07	0.001	63.646	9.275E-08	
2	321.54	0.00020	40.58	10.00	23.07	0.000	63.647	2.319E-08	
3	321.54	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
4	321.54	0.00120	40.58	10.00	23.07	0.001	63.646	1.391E-07	
5	321.54	0.00240	40.58	20.00	46.13	0.002	86.712	2.042E-07	
6	321.54	0.00120	40.58	20.00	46.13	0.001	86.713	1.021E-07	
7	321.54	0.00060	40.58	20.00	46.13	0.000	86.714	5.106E-08	
8	321.54	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	
9	321.54	0.00120	40.58	30.00	69.20	0.001	109.780	8.066E-08	
10	321.54	0.00040	40.58	30.00	69.20	0.000	109.781	2.689E-08	
11	321.54	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
12	321.54	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
13	321.54	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*Step down*
14	321.54	0.00040	40.58	20.00	46.13	0.000	86.714	3.404E-08	*Step down*
15	321.54	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
16	321.54	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
D 1	300.77	0.03760	40.58	10.00	23.07	0.026	63.621	4.361E-06	
2	300.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
3	300.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
4	300.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
5	300.77	0.05900	40.58	20.00	46.13	0.041	86.673	5.023E-06	
6	300.77	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	
7	300.77	0.00040	40.58	20.00	46.13	0.000	86.714	3.404E-08	
8	300.77	0.00040	40.58	20.00	46.13	0.000	86.714	3.404E-08	
9	300.77	0.00440	40.58	30.00	69.20	0.003	109.778	2.958E-07	
10	300.77	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
11	300.77	0.00100	40.58	30.00	69.20	0.001	109.780	6.722E-08	
12	300.77	0.00040	40.58	30.00	69.20	0.000	109.781	2.689E-08	
13	300.77	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*Step down*
14	300.77	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*Step down*
15	300.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
16	300.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
E 1	279.77	0.00700	40.58	10.00	23.07	0.004	63.643	8.116E-07	
2	279.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
3	279.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
4	279.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
5	279.77	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	
6	279.77	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	
7	279.77	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*No take in 15 minutes*
8	279.77	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
9	279.77	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
10	279.77	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
11	279.77	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*Step down*
12	279.77	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*Step down*
13	279.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
14	279.77	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
						0.000			
F 1	269.17	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
2	269.17	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
3	269.17	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	

Duck Creek Power Station -- Bedrock Packer Test Calculations

Site Duck Creek Power Station – South End of Ash Pond 1
Boring OM32
0.1250 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

Test #	Depth [Interval midpoint] (feet MSL)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
4	269.17	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*No take in 15 minutes*
5	269.17	0.00040	40.58	20.00	46.13	0.000	86.714	3.404E-08	
6	269.17	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	
7	269.17	0.00020	40.58	20.00	46.13	0.000	86.714	1.702E-08	
8	269.17	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	
9	269.17	0.00040	40.58	30.00	69.20	0.000	109.781	2.689E-08	
10	269.17	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
11	269.17	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
12	269.17	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*Step down*
13	269.17	0.00000	40.58	20.00	46.13	0.000	86.714	0.000E+00	*Step down*
14	269.17	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
15	269.17	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
G 1	258.72	0.24700	40.58	10.00	23.07	0.146	63.501	2.870E-05	
2	258.72	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
3	258.72	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
4	258.72	0.00040	40.58	10.00	23.07	0.000	63.647	4.637E-08	
5	258.72	0.02600	40.58	25.00	57.67	0.015	98.232	1.953E-06	
6	258.72	0.00100	40.58	25.00	57.67	0.001	98.247	7.511E-08	
7	258.72	0.00080	40.58	25.00	57.67	0.000	98.247	6.009E-08	
8	258.72	0.00000	40.58	25.00	57.67	0.000	98.248	0.000E+00	
9	258.72	0.07600	40.58	40.00	92.27	0.045	132.803	4.223E-06	
10	258.72	0.00000	40.58	40.00	92.27	0.000	132.848	0.000E+00	
11	258.72	0.00060	40.58	40.00	92.27	0.000	132.848	3.333E-08	
12	258.72	0.00140	40.58	40.00	92.27	0.001	132.847	7.776E-08	
13	258.72	0.00000	40.58	25.00	57.67	0.000	98.248	0.000E+00	*Step down*
14	258.72	0.00080	40.58	25.00	57.67	0.000	98.247	6.009E-08	*Step down*
15	258.72	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
16	258.72	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
H 1	248.62	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
2	248.62	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	
3	248.62	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*No take in 15 minutes*
4	248.62	0.00040	40.58	25.00	57.67	0.000	98.247	3.004E-08	
5	248.62	0.00000	40.58	25.00	57.67	0.000	98.248	0.000E+00	
6	248.62	0.00000	40.58	25.00	57.67	0.000	98.248	0.000E+00	
7	248.62	0.00000	40.58	25.00	57.67	0.000	98.248	0.000E+00	
8	248.62	0.00000	40.58	40.00	92.27	0.000	132.848	0.000E+00	
9	248.62	0.00000	40.58	40.00	92.27	0.000	132.848	0.000E+00	
10	248.62	0.00000	40.58	40.00	92.27	0.000	132.848	0.000E+00	*No take in 15 minutes*
11	248.62	0.00000	40.58	25.00	57.67	0.000	98.248	0.000E+00	*Step down*
12	248.62	0.00000	40.58	25.00	57.67	0.000	98.248	0.000E+00	*Step down*
13	248.62	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
14	248.62	0.00000	40.58	10.00	23.07	0.000	63.647	0.000E+00	*Step down*
I 1	227.61	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
2	227.61	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	227.61	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*No take in 15 minutes*
4	227.61	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
5	227.61	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	227.61	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
7	227.61	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
8	227.61	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	227.61	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*

Duck Creek Power Station -- Bedrock Packer Test Calculations

Site Duck Creek Power Station – South End of Ash Pond 1
Boring OM32
0.1250 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

Test #	Depth [Interval midpoint] (feet MSL)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
10	227.61	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
11	227.61	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	227.61	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
13	227.61	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
J 1	217.05	0.00080	40.58	15.00	34.60	0.000	75.180	7.852E-08	
2	217.05	0.00160	40.58	15.00	34.60	0.001	75.180	1.570E-07	
3	217.05	0.00160	40.58	15.00	34.60	0.001	75.180	1.570E-07	
4	217.05	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
5	217.05	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
6	217.05	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
7	217.05	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
8	217.05	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
9	217.05	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	217.05	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
11	217.05	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
12	217.05	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	217.05	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
14	217.05	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
15	217.05	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
K 1	206.51	0.00080	40.58	15.00	34.60	0.000	75.180	7.852E-08	
2	206.51	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	206.51	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	206.51	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
5	206.51	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	206.51	0.00020	40.58	30.00	69.20	0.000	109.781	1.344E-08	
7	206.51	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
8	206.51	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	206.51	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	206.51	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
11	206.51	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	206.51	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	206.51	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
14	206.51	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
L 1	196.37	0.00040	40.58	15.00	34.60	0.000	75.180	3.926E-08	
2	196.37	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	196.37	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	196.37	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
5	196.37	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	196.37	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
7	196.37	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
8	196.37	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	196.37	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
10	196.37	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
11	196.37	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	196.37	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
13	196.37	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
M 1	185.77	0.02080	40.58	15.00	34.60	0.009	75.172	2.042E-06	
2	185.77	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	185.77	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	185.77	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	

Duck Creek Power Station -- Bedrock Packer Test Calculations

Site Duck Creek Power Station – South End of Ash Pond 1
Boring OM32
0.1250 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

Test #	Depth [Interval midpoint] (feet MSL)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
5	185.77	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	185.77	0.00020	40.58	30.00	69.20	0.000	109.781	1.344E-08	
7	185.77	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
8	185.77	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	185.77	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	185.77	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
11	185.77	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	185.77	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	185.77	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
14	185.77	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
N 1	175.55	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
2	175.55	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	175.55	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	175.55	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*No take in 15 minutes*
5	175.55	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	175.55	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
7	175.55	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
8	175.55	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	175.55	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	175.55	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
11	175.55	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	175.55	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	175.55	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
14	175.55	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
O 1	165.39	0.19100	40.58	15.00	34.60	0.072	75.108	1.876E-05	
2	165.39	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	165.39	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	165.39	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
5	165.39	0.00040	40.58	30.00	69.20	0.000	109.781	2.689E-08	
6	165.39	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
7	165.39	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
8	165.39	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	165.39	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	165.39	0.00020	40.58	45.00	103.80	0.000	144.381	1.022E-08	
11	165.39	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	165.39	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	165.39	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
14	165.39	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
P 1	155.25	0.00300	40.58	15.00	34.60	0.001	75.179	2.945E-07	
2	155.25	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	155.25	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	155.25	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
5	155.25	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	155.25	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
7	155.25	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
8	155.25	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	155.25	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	155.25	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
11	155.25	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	155.25	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	155.25	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*

Duck Creek Power Station -- Bedrock Packer Test Calculations

Site Duck Creek Power Station – South End of Ash Pond 1
Boring OM32
0.1250 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

Test #	Depth [Interval midpoint] (feet MSL)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
14	155.25	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
Q 1	144.75	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
2	144.75	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	144.75	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*No take in 15 minutes*
4	144.75	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
5	144.75	0.00020	40.58	30.00	69.20	0.000	109.781	1.344E-08	
6	144.75	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
7	144.75	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
8	144.75	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	144.75	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
10	144.75	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
11	144.75	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	144.75	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
13	144.75	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
R 1	134.15	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
2	134.15	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	134.15	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	134.15	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
5	134.15	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	134.15	0.00020	40.58	30.00	69.20	0.000	109.781	1.344E-08	
7	134.15	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
8	134.15	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	134.15	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	134.15	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
11	134.15	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	134.15	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	134.15	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
14	134.15	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
S 1	124.04	0.24000	40.58	15.00	34.60	0.068	75.113	2.358E-05	
2	124.04	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	124.04	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	124.04	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
5	124.04	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	124.04	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
7	124.04	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
8	124.04	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	124.04	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	124.04	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
11	124.04	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	124.04	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	124.04	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
14	124.04	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
T 1	113.86	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
2	113.86	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	113.86	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*No take in 15 minutes*
4	113.86	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
5	113.86	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	113.86	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
7	113.86	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
8	113.86	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	

Duck Creek Power Station -- Bedrock Packer Test Calculations

Site Duck Creek Power Station – South End of Ash Pond 1
Boring OM32
0.1250 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

Test #	Depth [Interval midpoint] (feet MSL)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
9	113.86	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
10	113.86	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
11	113.86	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	113.86	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
13	113.86	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	*Step down*
U 1	103.41	0.06500	40.58	15.00	34.60	0.015	75.165	6.381E-06	
2	103.41	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
3	103.41	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
4	103.41	0.00000	40.58	15.00	34.60	0.000	75.181	0.000E+00	
5	103.41	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
6	103.41	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	
7	103.41	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*No take in 15 minutes*
8	103.41	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
9	103.41	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	
10	103.41	0.00000	40.58	45.00	103.80	0.000	144.382	0.000E+00	*No take in 15 minutes*
11	103.41	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
12	103.41	0.00000	40.58	30.00	69.20	0.000	109.781	0.000E+00	*Step down*
13	103.41	-0.00120	40.58	15.00	34.60	0.000	75.181	-1.178E-07	*Step down*
14	103.41	-0.00080	40.58	15.00	34.60	0.000	75.181	-7.852E-08	*Step down*

APPENDIX B2

AECOM ALPHA OMEGA 2015 PERMEAMETER DATA

FALLING HEAD PERMEABILITY REPORT

(Method C: Rising Tail-Water)

ASTM D 5084

ALPHA-OMEGA GEOTECH

PROJECT NAME: Dynegy CCR Ph 3/7-Duck Creek (Ash Pond 1) PROJECT NO.: 15-328T

LOCATION:

BORING NO.: B008 SAMPLE NO.: ST-2 DEPTH: 16' - 17.5'

SAMPLE TYPE: Undisturbed % COMPACTION:

INITIAL DATA			FINAL DATA		
MOISTURE:	22.6	%	MOISTURE:	23.7	%
DRY UNIT WEIGHT:	103.2	pcf	DRY UNIT WEIGHT:	103.2	pcf
HEIGHT:	2.69	inches	HEIGHT:	2.69	inches
DIAMETER:	2.86	inches	DIAMETER:	2.86	inches
WEIGHT:	573.8	grams	WEIGHT:	578.9	grams
SATURATION:	95.8	%	SATURATION:	100.0	%

PERMEANT LIQUID: Deaired tap water "B" value = 98.0%

EFFECTIVE CONSOLIDATION STRESS: Maximum 3.4 psi Minimum 3.0 psi

BACK PRESSURE: 90 psi RANGE OF HYDRAULIC GRADIENT: 3.2 to 2.9

SAMPLE DESCRIPTION: Brown, mottled olive brown, spotted gray, speckled black and reddish brown LEAN CLAY with trace of sand

TEST DATA

DATE	TEST NO.	TIME (sec)	HEAD1 (cm)	HEAD 2 (cm)	TEMP °C
10/12 - 10/13	1	81,720	22.0	20.0	26
10/13 - 10/14	2	81,720	22.0	20.0	26
10/14 - 10/15	3	81,720	22.0	20.0	26
10/15 - 10/16	4	81,720	22.0	20.0	26
AVERAGE		81,720	22.0	20.0	26

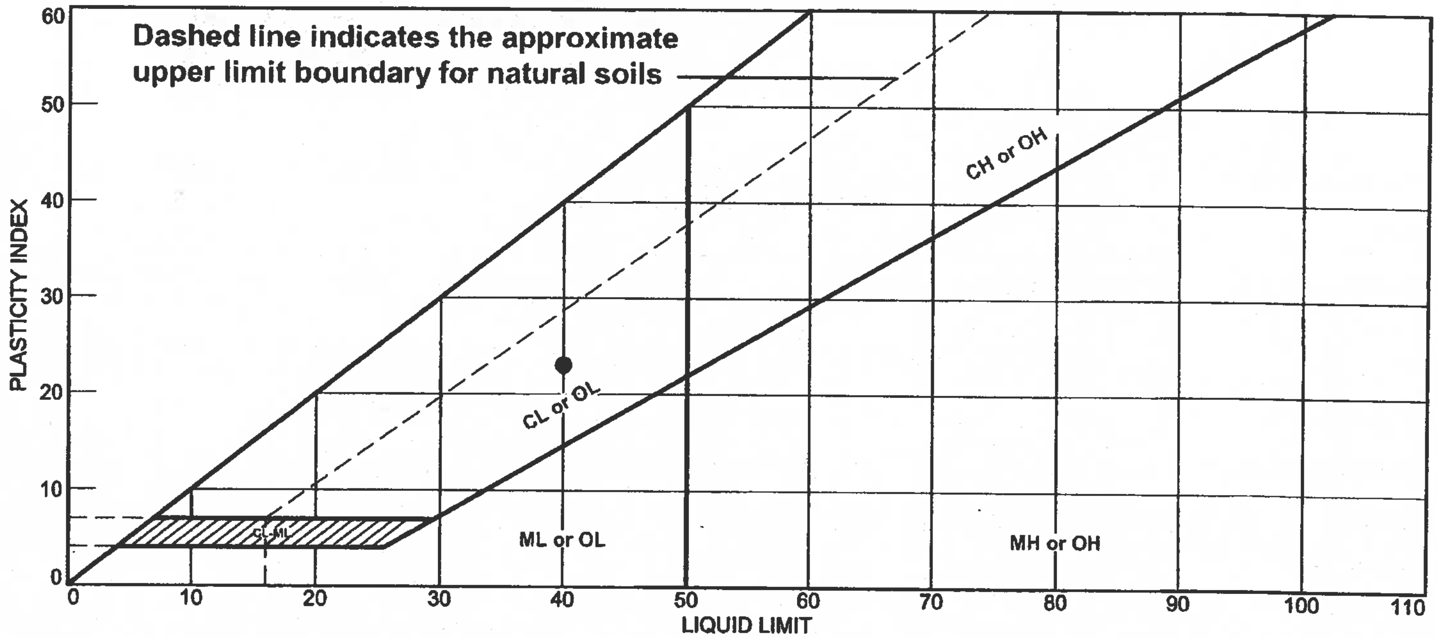
k= 7.8E-08 cm/s n/n20= 0.8694

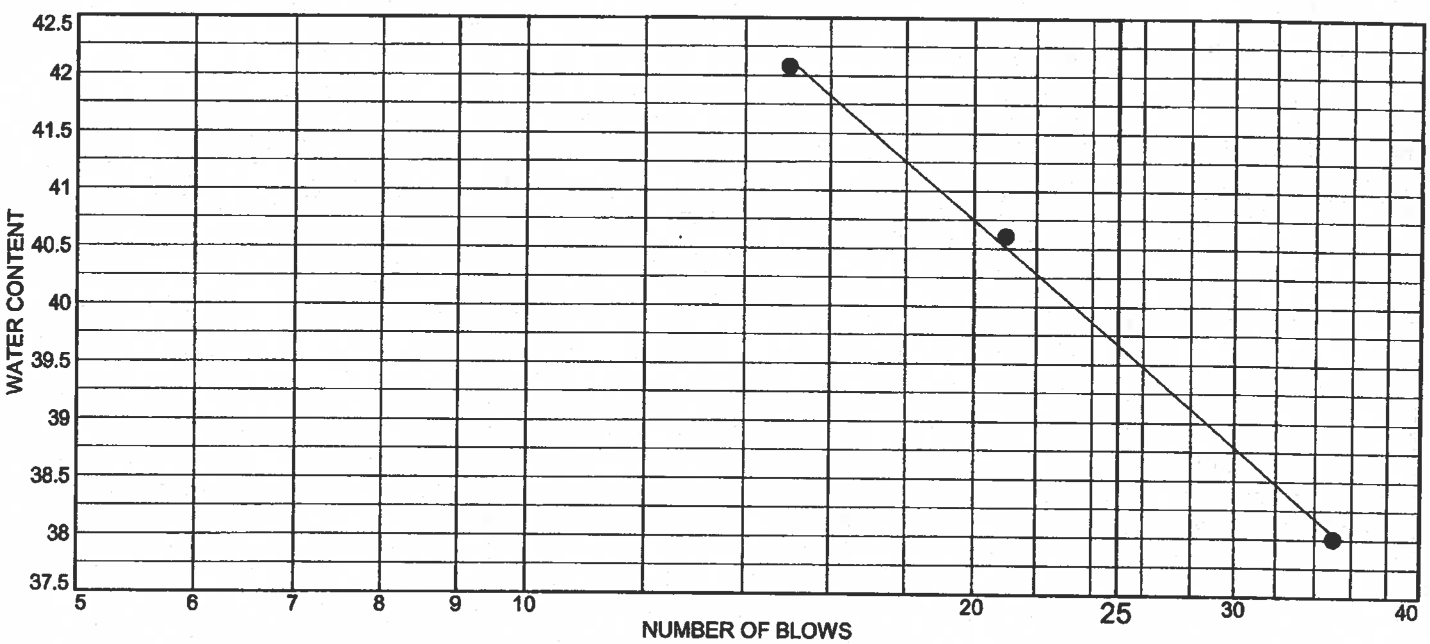
k20= 6.8E-08 cm/s

k = Hydraulic Conductivity before n/n20 correction factor
k20= Hydraulic Conductivity after correction to 20 ° Celsius

This is a laboratory testing result. Field values may vary.

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown, mottled olive brown, spotted gray, speckled black and reddish brown LEAN CLAY with trace of sand	40	17	23			

Project No. 15-328T **Client:** AECOM

Project: Dynegy CCR Ph 3/7 Duck Creek (Ash Pond 1)

Sample Number: B008 ST-2 **Depth:** 16'-17.5'

ALPHA-OMEGA GEOTECH

Remarks:

Figure 1 of 1

Tested By: DB **Checked By:** TB

FALLING HEAD PERMEABILITY REPORT

(Method C: Rising Tail-Water)

ASTM D 5084

ALPHA-OMEGA GEOTECH

PROJECT NAME: Dynegy CCR Ph 3/7-Duck Creek (Ash Pond 1) PROJECT NO.: 15-328T

LOCATION:

BORING NO.: B015 SAMPLE NO.: ST-6 DEPTH: 56' - 57.5'

SAMPLE TYPE: Undisturbed % COMPACTION:

INITIAL DATA			FINAL DATA		
MOISTURE:	15.8	%	MOISTURE:	16.4	%
DRY UNIT WEIGHT:	118.4	pcf	DRY UNIT WEIGHT:	118.4	pcf
HEIGHT:	2.26	inches	HEIGHT:	2.26	inches
DIAMETER:	2.86	inches	DIAMETER:	2.86	inches
WEIGHT:	522.4	grams	WEIGHT:	525.1	grams
SATURATION:	99.9	%	SATURATION:	100.0	%

PERMEANT LIQUID: Deaired tap water "B" value = 98.0%

EFFECTIVE CONSOLIDATION STRESS: Maximum 3.4 psi Minimum 3.0 psi

BACK PRESSURE: 90 psi RANGE OF HYDRAULIC GRADIENT: 3.8 to 3.3

SAMPLE DESCRIPTION: Light gray, speckled black and reddish brown Silty clay with sand and trace of gravel

TEST DATA

DATE	TEST NO.	TIME (sec)	HEAD1 (cm)	HEAD 2 (cm)	TEMP °C
10/12 - 10/13	1	82,080	22.0	19.2	26
10/13 - 10/14	2	82,080	22.0	19.2	26
10/14 - 10/15	3	82,080	22.0	19.2	26
10/15 - 10/16	4	82,080	22.0	19.2	26
AVERAGE		82,080	22.0	19.2	26

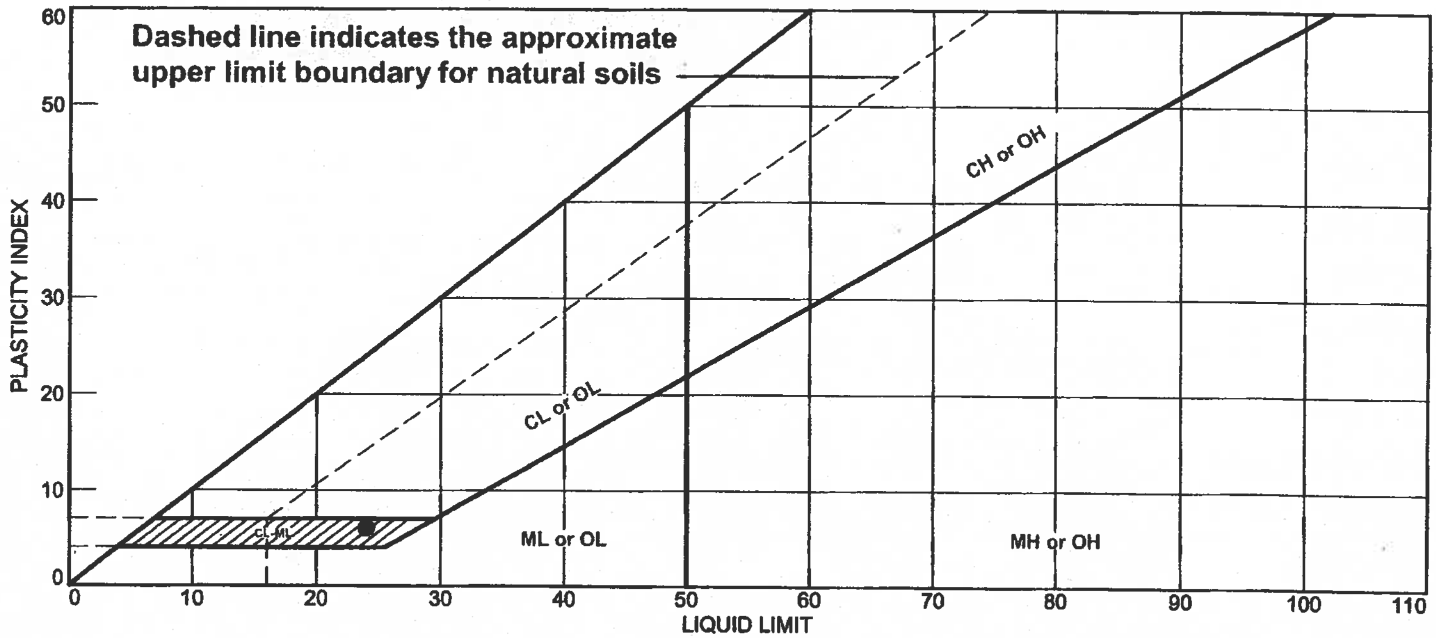
k= 9.3E-08 cm/s n/n20= 0.8694

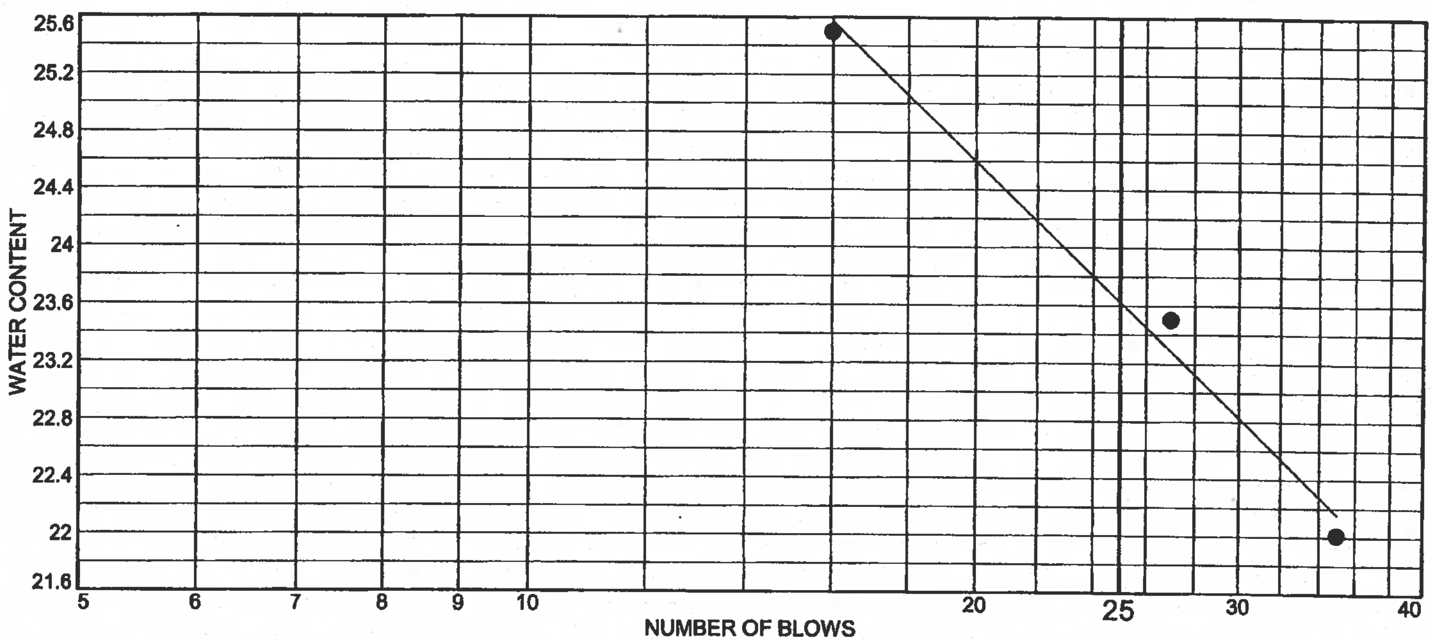
k20= 8.1E-08 cm/s

k = Hydraulic Conductivity before n/n20 correction factor
k20= Hydraulic Conductivity after correction to 20 ° Celsius

This is a laboratory testing result. Field values may vary.

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Light gray, speckled black and reddish brown Silty clay with sand and trace of gravel	24	18	6			

Project No. 15-328T **Client:** AECOM

Project: Dynegy CCR Ph 3/7 Duck Creek (Ash Pond 1)

Sample Number: B015 ST-6 **Depth:** 56'-57.5'

Remarks:

ALPHA-OMEGA GEOTECH

Figure 1 of 1

Tested By: DB **Checked By:** TB

FALLING HEAD PERMEABILITY REPORT

(Method C: Rising Tail-Water)

ASTM D 5084

ALPHA-OMEGA GEOTECH

PROJECT NAME: Dynegy CCR Ph 3/7 - Duck Creek (Ash Pond 2) PROJECT NO.: 15-328T

LOCATION:

BORING NO.: B019 SAMPLE NO.: ST-4 DEPTH: 43.5' - 45'

SAMPLE TYPE: Undisturbed % COMPACTION:

INITIAL DATA			FINAL DATA		
MOISTURE:	17.7	%	MOISTURE:	26.8	%
DRY UNIT WEIGHT:	104.3	pcf	DRY UNIT WEIGHT:	104.3	pcf
HEIGHT:	2.05	inches	HEIGHT:	2.05	inches
DIAMETER:	2.84	inches	DIAMETER:	2.84	inches
WEIGHT:	418.3	grams	WEIGHT:	450.6	grams
SATURATION:	77.6	%	SATURATION:	100.0	%

PERMEANT LIQUID: Deaired tap water

EFFECTIVE CONSOLIDATION STRESS: Maximum 5.4 psi Minimum 5.0 psi

BACK PRESSURE: 90 psi RANGE OF HYDRAULIC GRADIENT: 4.2 to 3.8

SAMPLE DESCRIPTION: Gray, mottled dark brown LEAN CLAY with weathered shale

TEST DATA

DATE	TEST NO.	TIME (sec)	HEAD1 (cm)	HEAD 2 (cm)	TEMP °C
11/18/2015	1	12,720	22.0	19.8	26
11/18/2015	2	12,720	22.0	19.8	26
11/19/2015	3	12,720	22.0	19.8	26
11/19/2015	4	12,720	22.0	19.8	26
AVERAGE		12,720	22.0	19.8	26

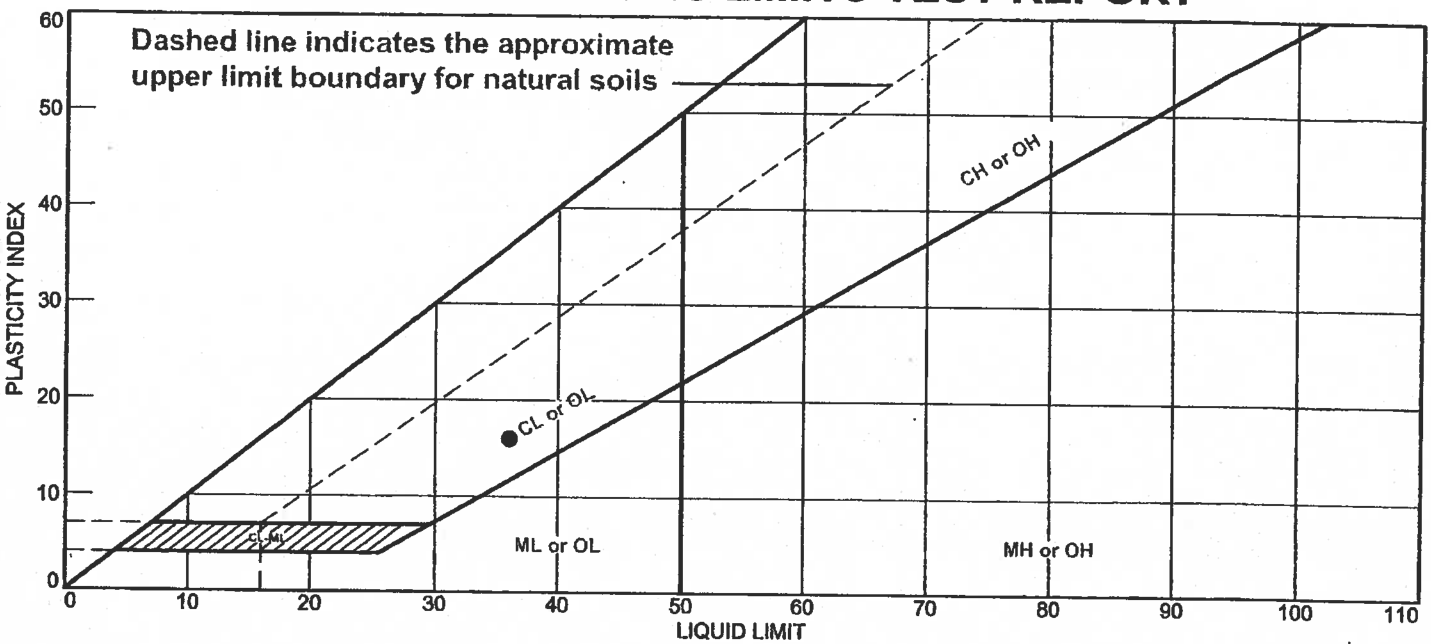
k= 4.3E-07 cm/s n/n20= 0.8694

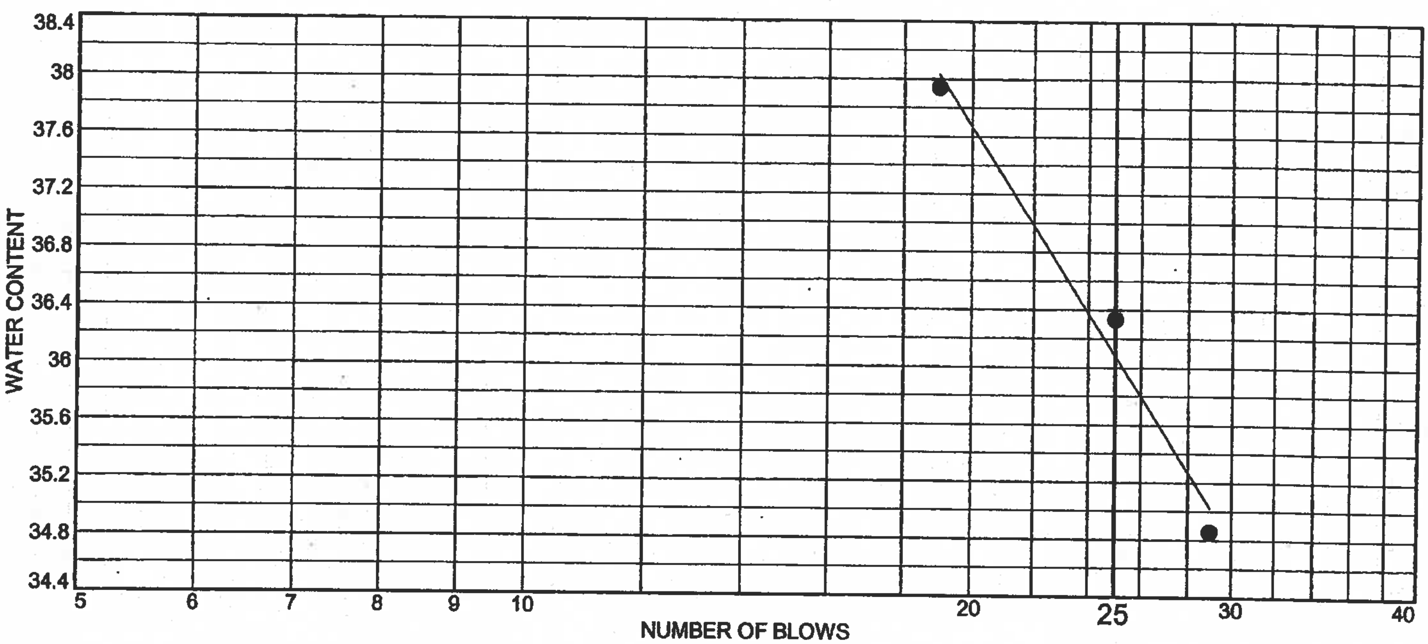
k20= 3.7E-07 cm/s

k = Hydraulic Conductivity before n/n20 correction factor
k20= Hydraulic Conductivity after correction to 20 ° Celsius

This is a laboratory testing result. Field values may vary.

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray, mottled dark brown LEAN CLAY with weathered shale	36	20	16			

Project No. 15-328T **Client:** AECOM

Project: Dynegy CCR Ph 3/7-Duck Creek (Ash Pond 2)

Sample Number: B019 ST-4 **Depth:** 43.5'-45'

ALPHA-OMEGA GEOTECH

Remarks:

Figure 1 of 1

Tested By: D.B. **Checked By:** T.B.

FALLING HEAD PERMEABILITY REPORT

(Method C: Rising Tail-Water)

ASTM D 5084

ALPHA-OMEGA GEOTECH

PROJECT NAME: Dynegy CCR Ph 3/7 - Duck Creek (Ash Pond 2) PROJECT NO.: 15-328T

LOCATION:

BORING NO.: B026 SAMPLE NO.: ST-4 DEPTH: 33.5' - 35'

SAMPLE TYPE: Undisturbed % COMPACTION:

INITIAL DATA			FINAL DATA		
MOISTURE:	21.0	%	MOISTURE:	22.5	%
DRY UNIT WEIGHT:	106.4	pcf	DRY UNIT WEIGHT:	106.4	pcf
HEIGHT:	2.73	inches	HEIGHT:	2.73	inches
DIAMETER:	2.85	inches	DIAMETER:	2.85	inches
WEIGHT:	588.3	grams	WEIGHT:	595.5	grams
SATURATION:	97.1	%	SATURATION:	100.0	%

PERMEANT LIQUID: Deaired tap water

EFFECTIVE CONSOLIDATION STRESS: Maximum 5.4 psi Minimum 5.0 psi

BACK PRESSURE: 90 psi RANGE OF HYDRAULIC GRADIENT: 3.2 to 2.7

SAMPLE DESCRIPTION: Brown, spotted gray, speckled black and reddish brown LEAN CLAY with weathered shale

TEST DATA

DATE	TEST NO.	TIME (sec)	HEAD1 (cm)	HEAD 2 (cm)	TEMP °C
11/12 - 11/13	1	63,480	22.0	18.8	26
11/13 - 11/14	2	63,480	22.0	18.8	26
11/14 - 11/15	3	63,480	22.0	18.8	26
11/15 - 11/16	4	63,480	22.0	18.8	26
AVERAGE		63,480	22.0	18.8	26

k= 1.7E-07 cm/s n/n20= 0.8694

k20= 1.5E-07 cm/s

k = Hydraulic Conductivity before n/n20 correction factor
k20= Hydraulic Conductivity after correction to 20 ° Celsius

This is a laboratory testing result. Field values may vary.

No AL Data Available
WDS

APPENDIX C

ANALYTICAL RESULTS

APPENDIX C1

SURFACE WATER LEACHATE ANALYTICAL RESULTS SINCE 2000

Appendix C-1
Surface Water Leachate Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Sample	Sample Date	TDS (mg/L)	Hardness (mg/L)	Cl, diss (mg/L)	SO4, diss (mg/L)	B, diss (mg/L)	Fe, diss (mg/L)	Mn, diss (mg/L)
ASH POND	4/24/2000	7600	4400	2000	1700	220	0.17	1.4
ASH POND	9/18/2000	8200	4500	2400	1900	230	0.096	0.59
ASH POND	9/13/2001	10000	6900	3500	2100	380	2.7	1.5
ASH POND	4/25/2002	13000	13000	3400	1600	320	1.2	1.4
ASH POND	9/24/2002	10000	8400	3000	1500	380	0.14	1.3
ASH POND	4/18/2003	3200	5800	4000	1500	390	<0.01	1.8
ASH POND	9/24/2003	12000	7100	3900	1700	350	0.35	0.94
ASH POND	4/13/2004	12000	5100	4000	1300	260	<0.01	0.82
ASH POND	9/23/2004	14000	7300	4200	1600	380	<0.01	1.1
ASH POND	4/19/2005	14000	5900	4000	1600	340	<0.1	0.07
ASH POND	9/20/2005	13000	6800	4500	1800	390	0.2	0.27
ASH POND	4/28/2006	13000	5700	4500	1700	340	<0.01	0.086
ASH POND	9/7/2006	12000	7500	3900	1500	290	<0.01	0.23
ASH POND	4/2/2007	9600	6100	3900	1600	320	<0.01	0.17
ASH POND	9/19/2007	12000	5800	4200	1500	320	<0.01	0.079
ASH POND	3/27/2008	9200	5200	3800	1300	270	<0.01	0.082
ASH POND	8/19/2008	4700	6400	4600	1900	370	0.012	0.74
ASH POND	4/29/2009	6500	4600	3700	1400	230	0.021	0.16
ASH POND	9/23/2009	6300	3800	2300	1500	160	0.013	0.3
RECYCLE POND	4/24/2000	7800	4500	1700	2200	200	0.073	1.5
RECYCLE POND	9/18/2000	8200	4500	2700	2200	240	<0.01	0.62
RECYCLE POND	4/24/2001	8580	4700	2300	1700	230	0.88	1.5
RECYCLE POND	9/13/2001	10000	6400	3300	2100	73	1.9	0.4
RECYCLE POND	4/24/2002	13000	8516	3500	1700	310	0.23	1.5
RECYCLE POND	9/24/2002	11000	3600	3900	1900	390	0.33	1.1
RECYCLE POND	4/17/2003	10000	6700	3800	1600	380	<0.01	1.5
RECYCLE POND	9/23/2003	12000	7400	3700	1800	350	0.052	0.94
RECYCLE POND	4/12/2004	8800	6700	4200	1400	260	<0.01	0.78
RECYCLE POND	9/23/2004	13000	5600	2900	1400	180	<0.01	0.24
RECYCLE POND	4/18/2005	7100	5200	2800	1100	180	<0.05	0.47
RECYCLE POND	9/19/2005	14000	7800	4900	1500	380	<0.05	0.65
RECYCLE POND	4/28/2006	12000	6900	4700	1500	340	0.032	0.87
RECYCLE POND	9/7/2006	12000	7600	4400	1800	270	<0.01	0.72
RECYCLE POND	4/2/2007	11000	6800	4100	1400	330	<0.01	1.5
RECYCLE POND	9/19/2007	12000	2600	4400	1800	320	<0.01	0.13
RECYCLE POND	3/26/2008	11000	4000	3600	1100	290	<0.01	0.69
RECYCLE POND	8/19/2008	3800	5600	3700	1400	310	<0.01	0.06
RECYCLE POND	4/29/2009	6200	4000	3300	1400	180	0.016	0.42
RECYCLE POND	9/21/2009	6500	4000	3100	1400	66	0.01	0.033
RECYCLE POND	12/8/2009	6300	3900	2700	1100	180	0.027	0.038
RECYCLE POND	4/27/2010	6400	3500	2200	1000	170	<0.01	0.2

APPENDIX C2

POREWATER LEACHATE ANALYTICAL RESULTS

PDC Laboratories, Inc.
P.O. Box 9071 • Peoria, IL 61612-9071
(309) 692-9688 • (800) 752-6651 • FAX (309) 692-9689

ACCREDITED IN ACCORDANCE WITH nelac

Ameren Illinois Company - Duck Creek
17751 North Cilco Road
Canton, IL 61520-8761
Attn: John Berry

Date Received: 05/18/12 5:15
Report Date: 06/06/12
Customer #: 232857
PO#: 552820

Laboratory Results

Sample No: **2052527-01**

Collect Date: **05/16/12 10:00**
Matrix: **Ground Water Grab**

Sample Description: AP-1N

Parameters	Result		Qual	Prep Date	Analysis Date	Analyst	Method
General Chemistry - PIA							
Cyanide	< 0.0050	mg/L		05/21/12 07:12	05/22/12 16:17	lgtth	335.4
Solids - total dissolved solids (TDS)	4500	mg/L		05/22/12 08:32	05/22/12 09:37	BNS	SM 2540C 18Ed
Soluble Anions - PIA							
Chloride, Dissolved	1300	mg/L		06/04/12 15:46	06/04/12 15:46	PLI	EPA 300.0 R2.1
Fluoride, Dissolved	< 2.5	mg/L		05/21/12 21:39	05/21/12 21:39	SJW	EPA 300.0 R2.1
Nitrate, Dissolved	< 0.20	mg/L	H	05/21/12 21:39	05/21/12 21:39	SJW	EPA 300.0 R2.1
Sulfate, Dissolved	1100	mg/L		06/04/12 15:46	06/04/12 15:46	PLI	EPA 300.0 R2.1
Soluble General Chemistry - PIA							
Hardness	3300	mg CaCO3/L		05/29/12 15:35	05/29/12 15:35	SMP	SM 2340C 18Ed
Soluble Metals - PIA							
Antimony, Dissolved	3.6	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Arsenic, Dissolved	23	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Barium, Dissolved	180	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Beryllium, Dissolved	< 1.0	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Boron, Dissolved	43000	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Cadmium, Dissolved	7.3	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Chromium, Dissolved	33	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Cobalt, Dissolved	2.0	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Copper, Dissolved	4.6	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Iron, Dissolved	15	ug/L		05/24/12 10:28	05/24/12 14:37	JMW	SW 6010B
Lead, Dissolved	13	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Manganese, Dissolved	12	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Mercury, Dissolved	0.31	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Nickel, Dissolved	74	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Selenium, Dissolved	55	ug/L		06/01/12 11:51	06/04/12 07:53	JMW	SW 6020
Silver, Dissolved	< 5.0	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Thallium, Dissolved	< 1.0	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020
Zinc, Dissolved	< 6.0	ug/L		06/01/12 11:51	06/01/12 13:45	JMW	SW 6020

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ACCREDITED IN ACCORDANCE WITH nelac

Ameren Illinois Company - Duck Creek
17751 North Cilco Road
Canton, IL 61520-8761
Attn: John Berry

Date Received: 05/18/12 5:15
Report Date: 06/06/12
Customer #: 232857
PO#: 552820

Laboratory Results

Sample No: **2052527-02**

Collect Date: **05/16/12 10:35**
Matrix: **Ground Water Grab**

Sample Description: AP-2

Parameters	Result		Qual	Prep Date	Analysis Date	Analyst	Method
General Chemistry - PIA							X
Cyanide	0.012	mg/L		05/25/12 12:40	05/29/12 09:53	lgtth	335.4
Solids - total dissolved solids (TDS)	7600	mg/L		05/22/12 08:32	05/22/12 09:37	BNS	SM 2540C 18Ed
Soluble Anions - PIA							
Chloride, Dissolved	2300	mg/L		06/04/12 16:01	06/04/12 16:01	PLI	EPA 300.0 R2.1
Fluoride, Dissolved	< 2.5	mg/L		05/21/12 22:13	05/21/12 22:13	SJW	EPA 300.0 R2.1
Nitrate, Dissolved	< 0.20	mg/L	H	05/21/12 22:30	05/21/12 22:30	PLI	EPA 300.0 R2.1
Sulfate, Dissolved	1300	mg/L		06/04/12 16:01	06/04/12 16:01	PLI	EPA 300.0 R2.1
Soluble General Chemistry - PIA							
Hardness	5000	mg CaCO3/L		05/29/12 15:35	05/29/12 15:35	SMP	SM 2340C 18Ed
Soluble Metals - PIA							
Antimony, Dissolved	< 3.0	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Arsenic, Dissolved	31	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Barium, Dissolved	140	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Beryllium, Dissolved	< 1.0	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Boron, Dissolved	180000	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Cadmium, Dissolved	< 1.0	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Chromium, Dissolved	59	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Cobalt, Dissolved	3.1	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Copper, Dissolved	4.9	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Iron, Dissolved	160	ug/L		05/24/12 10:28	05/24/12 14:43	JMW	SW 6010B
Lead, Dissolved	< 1.0	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Manganese, Dissolved	40	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Mercury, Dissolved	< 0.20	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Nickel, Dissolved	100	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Selenium, Dissolved	86	ug/L		06/01/12 11:51	06/04/12 07:57	JMW	SW 6020
Silver, Dissolved	< 5.0	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Thallium, Dissolved	< 1.0	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020
Zinc, Dissolved	8.4	ug/L		06/01/12 11:51	06/01/12 13:51	JMW	SW 6020

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Ameren Illinois Company - Duck Creek
17751 North Cilco Road
Canton, IL 61520-8761
Attn: John Berry

Date Received: 05/18/12 5:15
Report Date: 06/06/12
Customer #: 232857
PO#: 552820

Laboratory Results

Notes

PDC Laboratories participates in the following accreditation/certification and proficiency programs at the following locations. Endorsement by Federal or State Governments or their agencies is not implied.

PIA PDC Laboratories - Peoria, IL
NELAC Accreditation for Drinking Water, Wastewater, Hazardous and Solid Wastes Fields of Testing through IL EPA Lab No. 100230
Illinois Department of Public Health Bacteriological Analysis in Drinking Water Approved Laboratory Registry No. 17553
Drinking Water Certifications: Kansas (E-10338); Missouri (870); Wisconsin (998284430); Indiana (C-IL-040); Iowa (240)
Wastewater Certifications: Arkansas (88-0677); Wisconsin (998284430); Iowa (240); Kansas (E-10335)
Hazardous/Solid Waste Certifications; Arkansas (88-0677); Wisconsin (998284430); Iowa (240); Kansas (E-10335)
UST Certification; Iowa (240)

SPM PDC Laboratories - Springfield, MO
EPA DMR-QA Program

STL PDC Laboratories - St. Louis, MO
NELAC Accreditation for Wastewater, Hazardous and Solid Wastes Fields of Testing through KS EPA Lab No. E-10389

X Sulfide positive. Treated.
H Test performed after the expiration of the appropriate regulatory/advisory maximum allowable hold time.

Gail J. Schindler

Certified by: Gail J. Schindler, Project Manager

PDC LABORATORIES, INC.
2231 WEST ALTORFER DRIVE
PEORIA, IL 61615

ASH POND WELLS

PHONE # 800-752-6651
FAX # 309-692-9689

State where samples collected IL.

CHAIN OF CUSTODY RECORD

ALL HIGHLIGHTED AREAS MUST BE COMPLETED BY CLIENT (PLEASE PRINT) - (SAMPLE ACCEPTANCE POLICY ON REVERSE)

1

CLIENT: AMEREN - Duck Creek
ADDRESS: 17751 N. CILCO ROAD.
CITY STATE ZIP: CANTON, IL. 61520
CONTACT PERSON: JOHN BERRY

PROJECT NUMBER:
P.O. NUMBER:
MEANS SHIPPED:
PHONE NUMBER: 668-3868
FAX NUMBER:
DATE SHIPPED:
SAMPLER (PLEASE PRINT): JOHN BERRY / BRIAN CRAWG
SAMPLER'S SIGNATURE:

MATRIX TYPES:
WW-WASTEWATER
DW-DRINKING WATER
GW-GROUND WATER
WWSL-SLUDGE
NAS-SOLID
LCHT-LEACHATE
OTHER:

3 ANALYSIS REQUESTED

4 (FOR LAB USE ONLY)
LOGIN# 2052527-2
LOGGED BY:
LAB PROJ. #
TEMPLATE: ASH Pond
PROJ. MGR.:

2

SAMPLE DESCRIPTION AS YOU WANT ON REPORT	DATE COLLECTED	TIME COLLECTED	SAMPLE TYPE GRAB	SAMPLE TYPE COMP	MATRIX TYPE	BOTTLE COUNT	REMARKS
AP-1N	5/16/12	10:00	X			3	RUN ASH POND PARAMETERS. See GAIL SCHINDLER
AP-2	5/16/12	10:35	X			3	SEE GAIL SCHINDLER

5 TURNAROUND TIME REQUESTED (PLEASE CIRCLE) NORMAL RUSH
(RUSH TAT IS SUBJECT TO PDC LABS APPROVAL AND SURCHARGE)
DATE RESULTS NEEDED
RUSH RESULTS VIA (PLEASE CIRCLE) FAX PHONE E-MAIL
FAX # PHONE # EMAIL ADDRESS

6 The sample temperature will be measured upon receipt at the lab. By initialing this area you request that the lab notify you, before proceeding with analysis, if the sample temperature is outside of the range of 0.1-6.0°C. By not initialing this area you allow the lab to proceed with analytical testing regardless of the sample temperature. ______

7

RELINQUISHED BY: (SIGNATURE)	DATE 5-17-12 TIME 1426	RECEIVED BY: (SIGNATURE)	DATE 5-18-12	TIME 1426
RELINQUISHED BY: (SIGNATURE)	DATE 5-17-12 TIME 1515	RECEIVED BY: (SIGNATURE)	DATE	TIME
RELINQUISHED BY: (SIGNATURE)	DATE TIME	RECEIVED AT LAB BY: (SIGNATURE)	DATE 5/18/12	TIME 15:15

8 COMMENTS: (FOR LAB USE ONLY)

SAMPLE TEMPERATURE UPON RECEIPT 4 °C
CHILL PROCESS STARTED PRIOR TO RECEIPT Y OR N
SAMPLE(S) RECEIVED ON ICE Y OR N
PROPER BOTTLES RECEIVED IN GOOD CONDITION Y OR N
BOTTLES FILLED WITH ADEQUATE VOLUME Y OR N
SAMPLES RECEIVED WITHIN HOLD TIME(S) (EXCLUDES TYPICAL FIELD PARAMETERS) Y OR N
DATE AND TIME TAKEN FROM SAMPLE BOTTLE ______

Copies: white should accompany samples to PDC Labs. Yellow copy to be retained by the client.

PAGE ____ OF ____

APPENDIX C3

GROUNDWATER ANALYTICAL RESULTS SINCE 2000

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM01	4/25/2000			0.25				10						3.4	2800		10						1900	3400		
OM01	9/19/2000			1.7				8.7						2.9	2500		9.1						2000	3500		
OM01	4/24/2001			0.36				11						6.7	2400		10						1900	3377		
OM01	9/13/2001			0.2				11						3.8	2600		11						2200	3400		
OM01	4/24/2002			0.24				11						1.3	1779		8.4						1600	2900		
OM01	9/24/2002			0.18				11						2.7	2700		11						2000	3300		
OM01	4/17/2003			0.16				13						2.4	2200		9.7						1900	3200		
OM01	9/23/2003			0.2				10						4.6	2500		10						2000	3500		
OM01	4/12/2004			0.15				10						6	3100		8.8						1900	3400		
OM01	9/23/2004			0.18				8.2						8	2900		8.2						1800	3700		
OM01	4/18/2005			0.14				10						5.3	2700		9.2						1800	3000		
OM01	9/19/2005			5.4				75						9.4	2500		10						1600	3700		
OM01	4/28/2006			0.17				10						9.8	2600		9.4						1900	3500		
OM01	9/7/2006			0.17				14						5.4	2300		7.7						1700	3100		
OM01	4/2/2007			0.27				14						5	2400		8.2						1800	3400		
OM01	9/19/2007			0.1				12						6.3	1900		5.6						1800	3200		
OM01	3/26/2008			0.46				12						7.5	1900		9.8						1800	3200		
OM01	6/2/2008			0.15				10						3.6	1700		8.7						1900	3400		
OM01	8/18/2008			0.23				14						6.7	2300		9.3						2000	3300		
OM01	4/29/2009			0.17				18						1.5	2600		8.5						2000	3200		
OM01	9/23/2009			0.18				16						7.2	2600		9.2						2400	3400		
OM01	12/11/2009			0.32				17						0.089	2400		8.1						2100	3300		
OM01	4/27/2010			0.16				16						5.2	2500		8.3						2000	3400		
OM01	9/9/2010			0.22				20						10	2700		9.5						2000	3400		
OM01	2/22/2011	<0.005	<0.001	0.18	0.019	<0.001	<0.001	21	<0.005	0.033	<0.004	<0.003	<0.25	1	2600	<0.0002	9.3	0.055	<0.02	<0.001	<0.003	0.002	1800	3300	<0.001	0.014
OM01	4/28/2011	<0.005	0.002	0.17	0.018	<0.001	<0.001	18	<0.005	0.026	<0.004	<0.003	0.28	3.9	2600	<0.0002	8.6	0.026	<0.02	<0.001	<0.003	0.004	2100	3500	<0.001	0.015
OM01	8/25/2011	<0.005	0.002	0.18	0.02	<0.001	<0.001	24	<0.005	0.035	<0.004	<0.003	<2.5	8.3	2700	<0.0002	9.3	0.054	0.04	<0.001	<0.003	0.007	2000	3200	<0.001	0.017
OM01	10/13/2011	<0.005	0.003	0.16	0.015	<0.001	<0.001	15	<0.005	0.023	<0.004	<0.003	<0.25	9.6	2100	<0.0002	7.7	0.03	0.16	<0.001	<0.003	0.007	1500	2400	<0.001	0.011
OM01	2/22/2012	<0.005	0.003	0.18	0.017	<0.001	<0.001	18	<0.005	0.032	<0.004	<0.003	<0.25	8.1	990	<0.0002	8.3	0.053	0.64	<0.001	<0.003	0.008	1800	3200	<0.001	0.015
OM01	5/3/2012	<0.005	<0.001	0.16	0.017	<0.001	<0.001	18	<0.005	0.032	<0.004	<0.003	<0.25	7.2	3300	<0.0002	9	0.042	<0.02	<0.001	<0.003	0.001	1900	3400	<0.001	0.025
OM01	8/24/2012	<0.005	0.001	0.19	0.015	<0.001	<0.001	9.5	<0.005	0.033	<0.004	<0.003	<0.25	10	2900	<0.0002	8.3	0.077	0.03	<0.001	<0.003	0.002	2400	3400	<0.001	0.01
OM01	11/2/2012	<0.005	0.002	0.67	0.014	<0.001	<0.001	34	<0.005	0.033	<0.004	<0.003	0.49	9.4	2600	<0.0002	8.5	0.04	0.11	<0.001	<0.003	0.004	1800	3200	<0.001	0.016
OM01	2/5/2013	<0.0025	0.001	0.23	0.015	<0.0005	<0.0005	17	<0.005	0.03	<0.002	<0.0015	<0.25	9.7	2700	<0.0001	8.8	0.018	0.05	<0.0005	<0.0015	<0.0005	2000	3400	<0.0005	0.011
OM01	5/2/2013	<0.005	0.003	0.21	0.041	<0.001	<0.001	20	<0.005	0.033	<0.004	<0.003	<0.25	9.3	2600	<0.0002	8.8	0.053	<0.02	<0.001	<0.003	<0.001	2900	3200	<0.001	0.025
OM01	7/29/2013	<0.005	0.002	1.6	0.019	<0.001	<0.001	21	<0.005	0.031	<0.004	<0.003	<0.25	10	2500	<0.0002	8.4	0.045	<0.02	<0.001	<0.003	<0.001	1900	3400	<0.001	0.018
OM01	10/18/2013	<0.005	0.002	0.22	0.017	<0.001	<0.001	21	<0.005	0.027	<0.004	<0.003		11	2200	<0.0001	7.7	0.016	<0.02	<0.001	<0.003	<0.001	2000	3100	<0.001	0.009
OM01	3/30/2014	<0.005	0.003	0.17	0.014	<0.001	<0.001	18	<0.005	0.018	<0.004	<0.003		8.7	1500	<0.0002	5.8	0.012	0.4	<0.001	<0.003	<0.001	1300	2000	<0.001	0.026
OM01	4/23/2014	<0.005	0.002	0.23	0.014	<0.001	<0.001	21	<0.005	0.032	<0.004	<0.003		11	2400	<0.0002	8.8	0.018	<0.02	<0.001	<0.003	0.004	2600	3200	<0.001	0.015
OM01	7/17/2014			0.25				23						10	2400		8.2						2000	3500		
OM01	4/17/2015			0.74				22						0.41	1900		4.5						1600	2500		
OM01	9/14/2015			0.19				21						12	2700		8.7						1800	3200		
OM02	4/25/2000			0.76				66						0.9	870		2.2						280	1100		
OM02	9/19/2000			3				140						1.4	970		2.2						320	1300		
OM02	4/24/2001			2				160						1.3	900		2.3						340	1323		
OM02	9/13/2001			2.4				140						1.5	1100		2.6						370	1300		
OM02	4/25/2002			4.5				110						1.3	897		2.3						280	1200		
OM02	9/24/2002			2.5				110						1.1	820		2.4						280	1100		
OM02	4/17/2003			2.1				150						0.23	890		2.8						290	1200		
OM02	9/23/2003			2.7				150						1.9	750		2.1						340	1400		
OM02	4/12/2004			2.4				170						0.33	920		2.4						320	1300		
OM02	9/23/2004			3.2				190						3.4	1100		1.8						330	1400		
OM02	4/18/2005			3				190						0.95	990		2.5						340	3000		
OM02	9/19/2005			3.6				150						2.2	880		2.8						260	1400		
OM02	4/28/2006			3.3				210						0.74	990		2.7						330	1400		
OM02	9/7/2006			5.3				260						1.9	900		2.4						370	1500		
OM02	4/2/2007			4.4				240						0.98	1000		2.5						380	1500		
OM02	9/19/2007			5.5				230						0.8	1100		2.7						350	1500		
OM02	3/26/2008			6.4				260						0.88	960		3						340	1400		
OM02	6/2/2008			6.6				260						1.3	1000		2.5						340	1500		
OM02	8/18/2008			7.4				270						1.4	940		2.6						350	1500		

NATURAL RESOURCE TECHNOLOGY

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM02	4/29/2009			6.9				290						2.1	1800		2.5						330	1400		
OM02	9/23/2009			7.3				230						1.4	930		2.3						360	1300		
OM02	12/11/2009			7.2				230						0.52	880		2.1						300	1300		
OM02	4/27/2010			6				240						1	940		2.5						310	1300		
OM02	9/9/2010			5.7				200						1.1	890		2.4						260	1300		
OR02	6/2/2008			4				230						1.4	1400		2.6						340	1500		
OR02	8/18/2008			5.2				240						2.2	930		2.8						320	1500		
OR02	4/29/2009			2.2				230						1.6	2400		2.8						330	1400		
OR02	9/23/2009			5.2				270						1.8	970		2.6						350	1400		
OR02	12/11/2009			3.9				250						1.8	1000		2.9						400	1400		
OR02	4/27/2010			3.2				230						3	1000		2.8						320	1500		
OR02	9/9/2010			3.9				250						2.7	1000		2.6						360	1400		
OR02	2/22/2011	<0.005	0.003	3.1	0.032	<0.001	<0.001	220	<0.005	0.007	0.006	<0.003	<0.25	2.8	1100	<0.0002	3.3	0.048	0.22	<0.001	<0.003	0.003	420	1500	<0.001	0.012
OR02	4/28/2011	<0.005	0.004	2.2	0.036	<0.001	<0.001	280	<0.005	0.008	0.01	<0.003	0.3	5.4	3600	<0.0002	3.5	0.035	<0.02	0.001	<0.003	0.007	350	1500	<0.001	0.013
OR02	8/25/2011	<0.005	0.005	4.3	0.054	<0.001	<0.001	250	<0.005	0.007	0.011	0.007	<0.25	4.1	1200	<0.0002	2.7	0.051	<0.02	0.004	<0.003	0.012	300	1300	<0.001	0.02
OR02	10/13/2011	<0.005	0.004	4.4	0.031	<0.001	<0.001	250	<0.005	0.004	0.005	0.003	0.29	1.6	920	<0.0002	2.8	0.036	<0.02	<0.001	<0.003	0.013	290	1300	<0.001	0.007
OR02	2/22/2012	<0.005	0.005	3.2	0.034	<0.001	<0.001	270	<0.005	0.005	0.007	<0.003	0.29	0.067	1200	<0.0002	2.9	0.043	0.43	<0.001	<0.003	0.018	320	1400	<0.001	0.009
OR02	5/3/2012	<0.005	0.003	3.4	0.031	<0.001	<0.001	250	<0.005	0.006	0.005	0.014	0.25	2.1	1200	<0.0002	3	0.039	<0.02	<0.001	<0.003	0.009	340	1400	<0.001	0.013
OR02	8/24/2012	<0.005	0.004	3.1	0.03	<0.001	<0.001	340	<0.005	0.006	0.01	<0.003	<0.25	2.4	1200	<0.0002	2.8	0.057	0.04	<0.001	<0.003	0.013	390	1500	<0.001	0.007
OR02	11/2/2012	<0.005	0.004	2.9	0.028	<0.001	<0.001	290	<0.005	0.007	<0.004	<0.003	<0.25	2.4	1200	<0.0002	3	0.038	0.06	<0.001	<0.003	0.006	430	1500	<0.001	0.009
OR02	2/5/2013	<0.0025	<0.0005	2.2	0.028	<0.0005	<0.0005	320	<0.005	0.006	<0.002	<0.0015	<0.25	0.21	1200	<0.0001	3.4	0.029	0.24	<0.0005	<0.0015	<0.0005	440	1400	<0.0005	0.007
OR02	5/2/2013	<0.005	0.003	3.9	0.021	<0.001	<0.001	370	<0.005	0.005	0.004	<0.003	<0.25	3.7	1200	<0.0002	2.2	0.032	<0.02	<0.001	<0.003	0.002	510	1500	<0.001	0.01
OR02	7/29/2013	<0.005	0.003	4.6	0.025	<0.001	<0.001	230	<0.005	0.005	0.007	<0.003	0.33	1.6	970	<0.0002	2.5	0.036	0.04	<0.001	<0.003	0.003	310	1400	<0.001	0.009
OR02	10/18/2013	<0.005	0.006	4.8	0.062	<0.001	<0.001	210	<0.005	0.006	0.007	0.004		6.4	850	<0.0001	2.3	0.031	<0.02	0.006	<0.003	<0.001	260	1300	<0.001	0.022
OR02	3/30/2014	<0.005	<0.001	4.2	0.033	<0.001	<0.001	240	<0.005	0.005	<0.004	<0.003		0.13	970	<0.0002	2.7	0.028	0.19	<0.001	<0.003	<0.001	330	1300	<0.001	<0.006
OR02	4/23/2014	<0.005	0.001	5	0.029	<0.001	<0.001	240	<0.005	0.005	<0.004	<0.003		2	890	<0.0002	2.7	0.027	<0.02	<0.001	<0.003	0.002	350	1300	<0.001	<0.006
OR02	7/17/2014			4.4				250						0.096	860		2.5						320	1400		
OR02	4/17/2015			6.3				280						0.044	870		2.5						340	1300		
OR02	9/14/2015			4.6				230						1.6	980		2.3						300	1200		
OM03D	4/25/2000			1.6				13						0.65	960		1.4						430	1300		
OM03D	9/19/2000			2				12						1.4	890		1.4						400	1300		
OM03D	4/24/2001			1.6				14						1.2	900		1.3						420	1298.5		
OM03D	9/13/2001			1.5				14						2.1	990		1.2						440	1200		
OM03D	4/24/2002			1.4				13						1.1	728		1.1						270	1200		
OM03D	9/24/2002			1.5				16						0.8	840		1.4						360	1200		
OM03D	4/17/2003			1.4				19						1.2	800		1.2						340	1200		
OM03D	9/23/2003			1.2				14						0.79	820		1.1						330	1200		
OM03D	4/12/2004			1.3				15						0.19	940		1.2						340	1100		
OM03D	9/23/2004			1.3				14						0.19	910		1						330	1200		
OM03D	4/18/2005			1.3				15						0.27	830		1.1						340	1200		
OM03D	9/19/2005			1.3				16						0.54	760		1.2						280	1200		
OM03D	4/28/2006			1.7				18						3.5	890		1.1						360	1200		
OM03D	9/7/2006			1.6				18						0.5	700		1						340	1200		
OM03D	4/2/2007			1.4				18						0.14	780		0.91						340	1100		
OM03D	9/19/2007			1.8				54						0.6	770		1.2						280	1100		
OM03D	3/26/2008			1.4				28						0.56	630		1						290	1100		
OM03S	4/25/2000			0.91				3.7						0.99	950		0.62						320	1100		
OM03S	9/19/2000			1.3				3.2						5.6	930		0.74						260	1100		
OM03S	4/24/2001			0.35				4.5						5.7	750		0.71						160	923		
OM03S	9/13/2001			0.39				6.7						3.5	830		0.62						310	920		
OM03S	4/25/2002			0.72				4.3						3.6	949		0.65						160	970		
OM03S	9/24/2002			0.4				17						3.4	770		0.68						200	920		
OM03S	4/17/2003			0.34				4.2						3.1	680		0.52						180	920		
OM03S	9/23/2003			0.35				<5						4.5	840		0.55						220	980		
OM03S	4/12/2004			0.41				7.9						5.1	880		0.61						310	1100		
OM03S	9/23/2004			0.28				3.3						4.3	880		0.52						170	910		
OM03S	4/18/2005			0.44				3.4						4.7	830		0.62						230	2800		
OM03S	9/19/2005			0.48				11						2.6	780		0.63						180	960		
OM03S	4/28/2006			0.26				4.2						3	780		0.5						150	810		
OM03S	9/7/2006			0.44				4.1						3.6	610		0.58						170	850		

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Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM03S	4/2/2007			0.46				5.9						1.7	890		0.63						200	910		
OM03S	9/19/2007			0.48				2						3.4	710		0.59						220	970		
OM03S	3/26/2008			0.45				3						3.9	850		0.45						220	950		
OR03D	6/2/2008			3.8				140						1.8	770		1.3						340	1400		
OR03D	8/18/2008			3.5				110						0.94	820		1.6						330	1300		
OR03D	4/29/2009			2.3				280						2.2	1000		1.5						390	1100		
OR03D	9/23/2009			2.3				86						2.6	880		1.4						370	1200		
OR03D	12/11/2009			2.4				100						2.6	840		1.4						440	1200		
OR03D	4/27/2010			2.3				78						2.8	810		1.4						290	1200		
OR03D	9/9/2010			2.3				65						2.7	950		1.3						320	1200		
OR03D	2/22/2011	<0.005	0.005	2.3	0.058	<0.001	<0.001	62	<0.005	<0.002	<0.004	<0.003	<0.25	3.2	1500	<0.0002	1.3	0.017	<0.02	<0.001	<0.003	0.003	310	1200	<0.001	<0.006
OR03D	4/28/2011	<0.005	0.007	3.4	0.063	<0.001	<0.001	86	<0.005	<0.002	<0.004	<0.003	0.27	3.5	890	<0.0002	1.3	0.007	<0.02	<0.001	<0.003	0.004	330	1300	<0.001	<0.006
OR03D	8/25/2011	<0.005	0.008	3.6	0.063	<0.001	<0.001	71	<0.005	0.002	0.005	0.004	<0.25	2.9	1200	<0.0002	1.3	0.019	0.08	<0.001	<0.003	0.008	330	1200	<0.001	<0.006
OR03D	10/13/2011	<0.005	0.004	2.4	0.067	<0.001	<0.001	67	<0.005	<0.002	<0.004	0.009	0.3	1.3	870	<0.0002	1.2	0.013	<0.02	<0.001	<0.003	0.007	320	1100	<0.001	0.014
OR03D	2/22/2012	<0.005	0.007	2.8	0.07	<0.001	<0.001	79	<0.005	<0.002	<0.004	<0.003	<0.25	3.5	910	<0.0002	1.2	0.016	0.05	<0.001	<0.003	0.005	380	1200	<0.001	<0.006
OR03D	5/3/2012	<0.005	0.002	2.9	0.063	<0.001	<0.001	84	<0.005	<0.002	<0.004	0.003	<0.25	0.021	810	<0.0002	0.94	0.012	0.54	<0.001	<0.003	0.007	510	1200	<0.001	0.024
OR03D	8/24/2012	<0.005	0.004	2.5	0.051	<0.001	<0.001	82	<0.005	<0.002	0.004	<0.003	<0.25	0.064	860	<0.0002	1.1	0.022	0.22	<0.001	<0.003	0.008	460	1300	<0.001	<0.006
OR03D	11/2/2012	<0.005	0.005	3.6	0.048	<0.001	<0.001	84	<0.005	<0.002	<0.004	<0.003	<0.25	2.3	950	<0.0002	1.2	0.01	<0.02	<0.001	<0.003	0.003	360	1200	<0.001	<0.006
OR03D	2/5/2013	<0.0025	0.003	2.7	0.046	<0.0005	<0.0005	76	<0.005	0.002	<0.002	<0.0015	<0.25	1.4	930	<0.0001	1.2	0.003	0.13	<0.0005	<0.0015	<0.0005	380	1200	<0.0005	0.004
OR03D	5/1/2013	<0.005	0.001	2.6	0.049	<0.0005	<0.001	74	<0.005	<0.002	<0.004	<0.003	<0.25	0.72	890	<0.0002	1.2	<0.005	0.29	<0.001	<0.003	<0.001	410	1100	<0.001	0.008
OR03D	7/29/2013	<0.005	0.003	2.9	0.047	<0.001	<0.001	69	<0.005	<0.002	<0.004	<0.003	<0.25	0.57	860	<0.0002	1.2	0.012	0.19	<0.001	<0.003	<0.001	330	1200	<0.001	0.007
OR03D	10/18/2013	<0.005	0.002	2.4	0.043	<0.001	<0.001	64	<0.005	<0.002	<0.004	<0.003		0.85	780	<0.0001	0.95	<0.005	0.29	<0.001	<0.003	<0.001	330	1200	<0.001	0.008
OR03D	3/30/2014	<0.005	0.003	2.4	0.051	<0.001	<0.001	68	<0.005	<0.002	<0.004	0.016		0.62	890	<0.0002	1.2	0.008	0.07	<0.001	<0.003	<0.001	340	1200	<0.001	0.007
OR03D	4/23/2014	<0.005	0.005	2.6	0.054	<0.001	<0.001	68	<0.005	<0.002	<0.004	<0.003		2.2	840	<0.0002	1.3	<0.005	<0.02	<0.001	<0.003	<0.001	370	1200	<0.001	<0.006
OR03D	7/17/2014			1.6				44						0.51	1300		8.6						230	860		
OR03D	10/13/2014																1.2									
OR03D	4/17/2015			3.1				82						<0.01	900		1.1						390	1300		
OR03D	9/14/2015			5				150						3.3	11000		0.74						350	1400		
OR03S	6/2/2008			0.53				20						0.56	760		1						200	970		
OR03S	8/18/2008			0.98				17						0.57	740		0.95						210	940		
OR03S	4/29/2009			0.49				19						3	1100		0.7						170	830		
OR03S	9/23/2009			0.51				20						2.6	820		0.65						220	920		
OR03S	12/11/2009			0.52				13						1.6	750		0.61						190	880		
OR03S	4/27/2010			0.41				15						2.5	690		0.59						180	1200		
OR03S	9/9/2010			0.34				18						3.8	700		0.62						160	850		
OR04D	4/24/2000			110				1300						6.5	3200		1.1						1300	5000		
OR04D	9/18/2000			110				1600						6.8	2900		1.1						1600	5600		
OR04D	4/24/2001			110				1200						7.8	2800		1.1						1100	4570		
OR04D	9/13/2001			140				1400						6.8	3400		1.4						1300	5600		
OR04D	4/24/2002			84				770						6.5	3396		1						690	4900		
OR04D	9/24/2002			13				1400						6	3500		1.3						1200	5300		
OR04D	4/17/2003			110				1600						6.4	2900		1.2						1200	5200		
OR04D	9/23/2003			110				1400						6.8	3200		1.1						1200	5200		
OR04D	4/12/2004			91				1400						6.4	3400		1.1						1200	5300		
OR04D	9/24/2004			110				1500						7	3600		1.1						1200	5500		
OR04D	4/18/2005			120				1500						6.4	3100		1.1						1200	5400		
OR04D	9/19/2005			110				1100						5.8	3000		1.2						1000	5100		
OR04D	4/28/2006			100				1300						5.9	2800		1.1						1100	4800		
OR04D	9/7/2006			120				1500						6.6	3100		1.1						1300	5000		
OR04D	4/2/2007			91				1300						1.5	2800		0.8						1200	4800		
OR04D	9/19/2007			120				1400						0.51	3100		1.2						1200	5500		
OR04D	3/27/2008			120				1800						6.6	3000		1.1						1200	5300		
OR04D	6/2/2008			120				1600						6.4	2300		1.2						1200	6400		
OR04D	8/18/2008			110				1200						6.4	2900		1.1						1100	5200		
OR04D	4/29/2009			120				1700						5.7	3800		1.2						1800	5100		
OR04D	9/22/2009			52				750						0.058	1400		0.01						720	2700		
OR04D	12/8/2009			0.12				9.6						3.6	730		2.6						140	830		
OR04D	4/27/2010			63				620						6.4	2400		0.87						890	3500		
OR04D	9/8/2010			60				840						5.6	2300		0.94						1300	3700		
OR04D	2/22/2011	<0.005	0.006	58	0.06	<0.001	<0.001	590	<0.005	0.007	0.017	<0.003	<0.25	6.1	2500	<0.0002	0.84	0.076	<0.02	<0.001	<0.003	0.013	1000	3200	<0.001	<0.006

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OR04D	4/29/2011	<0.005	0.006	59	0.063	<0.001	<0.001	570	<0.005	0.004	0.022	<0.003	0.38	4.1	1800	<0.0002	0.59	0.048	0.06	0.014	<0.003	0.02	970	3100	<0.001	<0.006
OR04D	8/25/2011	<0.005	0.007	52	0.12	<0.001	<0.001	530	<0.005	0.004	0.019	0.004	<0.25	1.4	2000	<0.0002	0.31	0.061	1.7	<0.001	<0.003	0.026	690	2300	<0.001	<0.006
OR04D	10/13/2011	<0.005	0.006	45	0.054	<0.001	<0.001	580	<0.005	0.005	0.013	<0.003	<2.5	3.3	1800	<0.0002	0.57	0.053	0.22	<0.001	<0.003	0.028	1100	2700	<0.001	<0.006
OR04D	2/22/2012	<0.005	0.009	46	0.064	<0.001	<0.001	460	<0.005	0.005	0.013	<0.003	<0.25	2.3	1800	<0.0002	0.45	0.061	0.63	<0.001	<0.003	0.03	820	2600	<0.001	0.007
OR04D	5/3/2012	<0.005	0.01	73	0.029	<0.001	<0.001	590	<0.005	<0.002	0.019	<0.003	<0.25	6.3	2600	<0.0002	0.95	0.056	0.04	<0.001	<0.003	0.024	1200	3200	<0.001	0.012
OR04D	8/24/2012	<0.005	0.008	42	0.033	<0.001	<0.001	440	<0.005	0.008	0.015	<0.003	0.41	7.1	2200	<0.0002	0.75	0.086	0.02	<0.001	<0.003	0.019	1200	2900	<0.001	<0.006
OR04D	11/2/2012	<0.005	0.007	36	0.028	<0.001	<0.001	470	<0.005	0.007	0.005	<0.003	<0.25	6.3	1900	<0.0002	0.69	0.053	0.15	<0.001	<0.003	0.009	1100	2700	<0.001	<0.006
OR04D	2/4/2013	<0.0025	<0.0005	38	0.048	<0.0005	<0.0005	350	<0.005	0.006	<0.002	<0.0015	<0.25	0.62	1800	<0.0001	0.58	0.038	0.26	<0.0005	<0.0015	<0.0005	950	2600	<0.0005	0.012
OR04D	5/2/2013	<0.005	0.007	42	0.058	<0.001	<0.001	320	<0.005	0.008	0.008	<0.003	<0.25	6.7	1800	<0.0002	0.7	0.057	<0.02	<0.001	<0.003	0.004	1000	2500	<0.001	<0.006
OR04D	7/31/2013	<0.005	0.007	40	0.031	<0.001	<0.001	440	<0.005	0.002	0.011	<0.003	<0.25	4.3	2000	<0.0002	0.72	0.041	0.07	<0.001	<0.003	0.008	1100	3100	<0.001	0.008
OR04D	10/21/2013	<0.005	0.005	33	0.033	<0.001	<0.001	490	<0.005	<0.002	<0.004	<0.003		4.8	1800	<0.0002	0.75	0.021	0.05	<0.001	<0.003	<0.001	1300	2800	<0.001	<0.006
OR04D	3/30/2014	<0.005	<0.001	29	0.071	<0.001	<0.001	390	<0.005	0.003	<0.004	<0.003		0.065	1600	<0.0002	0.37	0.032	1.6	<0.001	<0.003	<0.001	900	2200	<0.001	0.008
OR04D	4/24/2014	<0.005	<0.001	36	0.034	<0.001	<0.001	310	<0.005	0.005	<0.004	<0.003		3.8	1600	<0.0002	0.67	0.03	<0.02	<0.001	<0.003	0.001	1000	2600	<0.001	<0.006
OR04D	7/18/2014			19				280						0.016	920		0.03						680	1700		
OR04D	4/17/2015			18				210						0.018	730		0.018						610	1200		
OR04D	9/15/2015			11				130						3.2	1800		0.47						690	1700		
OM04S	4/24/2000			100				1900						4.4	3100		1.8						1900	4600		
OM04S	9/18/2000			0.32				9.6						0.61	950		3.2						310	1100		
OM04S	4/24/2001			1				15						0.67	910		3						280	1033		
OM04S	9/13/2001			0.097				8.7						2.1	1000		3.8						310	1100		
OM04S	4/25/2002			0.31				5.3						0.53	852		3						190	1000		
OM04S	9/24/2002			0.82				7.7						0.4	880		3.3						240	940		
OM04S	4/17/2003			0.12				9.4						0.27	760		3						250	1000		
OM04S	9/23/2003			0.74				7.8						1.5	910		3.4						290	1100		
OM04S	4/12/2004			0.97				6.5						1.1	1000		2.6						240	1000		
OM04S	9/23/2004			0.18				6.3						2.1	1100		3						240	1000		
OM04S	4/18/2005			1.4				7.8						1.3	850		2.8						240	980		
OM04S	9/19/2005			0.061				7.6						2	860		3.9						200	1000		
OM04S	4/28/2006			0.13				7.2						0.82	770		2.8						220	930		
OM04S	9/7/2006			0.078				7.8						2.6	700		3						260	990		
OM04S	4/2/2007			0.28				9.8						0.01	690		2.1						190	770		
OM04S	9/19/2007			0.18				5.2						0.9	490		2						140	600		
OM04S	3/27/2008			0.78				14						0.069	920		2.2						220	850		
OM04S	6/2/2008			0.076				8.6						0.011	690		2.5						210	910		
OM04S	8/18/2008			0.24				8.9						1.4	760		3.2						210	960		
OM04S	4/29/2009			0.15				280						<0.01	850		2.4						240	930		
OM04S	9/22/2009			0.095				12						3	740		2.8						190	880		
OM04S	12/8/2009			46				780						0.012	1600		0.012						700	2700		
OM04S	4/27/2010			0.11				10						0.024	700		2						170	820		
OM04S	9/8/2010			0.18				13						2.3	850		3						220	860		
OM04S	2/22/2011	<0.005	<0.001	0.15	0.046	<0.001	<0.001	9.8	<0.005	0.01	<0.004	<0.003	<0.25	3.2	770	<0.0002	3.2	0.02	<0.02	<0.001	<0.003	0.001	200	880	<0.001	0.008
OM04S	4/29/2011	<0.005	<0.001	0.14	0.035	<0.001	<0.001	15	<0.005	0.003	<0.004	<0.003	0.31	0.41	720	<0.0002	2.5	0.01	0.16	<0.001	<0.003	<0.001	160	800	<0.001	0.01
OM04S	8/25/2011	<0.005	<0.001	0.093	0.049	<0.001	<0.001	18	<0.005	0.01	<0.004	0.005	0.25	3.1	1100	<0.0002	3	0.018	<0.02	<0.001	<0.003	0.003	190	860	<0.001	0.006
OM04S	10/13/2011	<0.005	0.001	0.14	0.048	<0.001	<0.001	12	<0.005	0.009	<0.004	<0.003	0.33	3.7	790	<0.0002	3.3	0.014	0.45	<0.001	<0.003	0.002	200	820	<0.001	<0.006
OM04S	2/22/2012	<0.005	0.002	0.63	0.046	<0.001	<0.001	17	<0.005	0.009	<0.004	<0.003	<0.25	4.5	790	<0.0002	2.8	0.017	0.06	<0.001	<0.003	0.004	190	790	<0.001	<0.006
OM04S	5/3/2012	<0.005	<0.001	0.11	0.041	<0.001	<0.001	12	<0.005	0.008	<0.004	<0.003	0.26	3.3	710	<0.0002	2.6	0.011	0.06	<0.001	<0.003	0.002	190	810	<0.001	0.012
OM04S	8/24/2012	<0.005	<0.001	0.091	0.045	<0.001	<0.001	13	<0.005	0.01	<0.004	<0.003	0.26	4	820	<0.0002	3	0.024	0.03	<0.001	<0.003	0.002	190	880	<0.001	<0.006
OM04S	11/2/2012	<0.005	0.001	0.67	0.045	<0.001	<0.001	15	<0.005	0.011	<0.004	<0.003	<0.25	4.1	840	<0.0002	2.9	0.012	<0.02	<0.001	<0.003	<0.001	220	920	<0.001	<0.006
OM04S	2/4/2013	<0.0025	0.001	0.23	0.048	<0.0005	<0.0005	16	<0.005	0.008	<0.002	<0.0015	0.29	2	750	<0.0001	2.8	0.006	<0.02	<0.0005	<0.0015	<0.0005	160	780	<0.0005	<0.003
OM04S	5/2/2013	<0.005	<0.001	0.13	0.034	<0.001	<0.001	14	<0.005	0.008	<0.004	<0.003	0.28	0.25	710	<0.0002	2.2	0.012	<0.02	<0.001	<0.003	<0.001	160	730	<0.001	0.019
OM04S	7/31/2013	<0.005	0.002	0.46	0.043	<0.001	<0.001	14	<0.005	0.01	<0.004	<0.003	0.27	3.6	750	<0.0002	2.7	0.013	<0.02	<0.001	<0.003	<0.001	170	810	<0.001	<0.006
OM04S	10/21/2013	<0.005	0.001	0.26	0.042	<0.001	<0.001	16	<0.005	0.01	<0.004	<0.003		3.5	740	<0.0002	3	0.006	0.04	<0.001	<0.003	<0.001	210	840	<0.001	<0.006
OM04S	3/30/2014	<0.005	0.001	0.14	0.048	<0.001	<0.001	14	<0.005	0.008	<0.004	<0.003		4.3	730	<0.0002	2.8	0.005	<0.02	<0.001	<0.003	<0.001	170	820	<0.001	<0.006
OM04S	4/24/2014	<0.005	<0.001	0.2	0.042	<0.001	<0.001	13	<0.005	0.007	<0.004	<0.003	0.25	0.049	670	<0.0002	2.6	<0.005	0.14	<0.001	<0.003	<0.001	200	760	<0.001	0.007
OM04S	7/18/2014			0.8				18						2.9	660		2.4						170	750		
OM04S	4/17/2015			1.2				14						4.2	720		2.6						150	720		
OM04S	9/15/2015			1				13						6	750		2.8						160	870		
OM05D	4/24/2000			5.5				97						7	1600		0.73						440	1500		
OM05D	9/18/2000			4.8				120						7	970		0.8						530	1500		
OM05D	4/24/2001			4.6				120						7	960		0.72						460	1540		

Appendix C-3
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Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM05D	9/13/2001			5.1				140						7.4	1100		0.79						520	1600		
OM05D	4/25/2002			4.6				110						3.7	784		0.41						350	1400		
OM05D	9/25/2002			5.1				160						6.7	1100		0.83						490	1700		
OM05D	4/17/2003			5				270						6.4	990		0.76						470	1200		
OM05D	9/23/2003			5				140						8	1000		1						480	1600		
OM05D	4/12/2004			5.1				160						7.3	1300		0.78						500	1100		
OM05D	9/23/2004			5				160						10	1100		0.99						480	1700		
OM05D	4/18/2005			4.8				150						5.6	980		0.57						470	1600		
OM05D	9/19/2005			5				120						6.6	950		0.9						410	1600		
OM05D	4/28/2006			4.6				150						0.029	1000		0.008						490	1500		
OM05D	9/7/2006			5				150						6.2	740		0.84						500	1500		
OM05D	4/2/2007			5				150						<0.01	1100		0.014						490	1500		
OM05D	9/19/2007			4.7				150						7.2	880		0.92						490	1500		
OM05D	3/27/2008			6.1				180						8.1	870		0.72						460	1500		
OM05D	6/3/2008			7.4				250						4.5	1000		1.2						490	1800		
OM05D	8/18/2008			9				230						8.2	1100		1.3						490	1800		
OM05D	4/30/2009			9.4				240						0.025	1100		0.009						480	1600		
OM05D	9/22/2009			8				280						6.2	1100		1.2						680	1800		
OM05D	12/8/2009			8				240						7.4	1100		1.3						540	1700		
OM05D	4/27/2010			7.8				240						0.075	1000		0.095						500	1700		
OM05D	9/8/2010			6.7				250						6.8	1100		0.94						570	1800		
OM05S	4/24/2000			3.1				13						12	830		0.73						240	1000		
OM05S	9/18/2000			0.73				5.8						13	640		0.78						280	990		
OM05S	4/24/2001			0.82				8						5.4	920		1.2						350	1150		
OM05S	9/13/2001			1				5.8						12	860		0.69						240	1000		
OM05S	4/25/2002			0.5				10						11	1100		0.94						310	1200		
OM05S	9/25/2002			0.62				6.2						12	860		0.73						240	1000		
OM05S	4/17/2003			0.59				6.2						11	700		0.73						240	1000		
OM05S	9/23/2003			0.78				7						12	780		0.67						250	990		
OM05S	4/12/2004			0.51				8.4						11	1100		0.68						290	910		
OM05S	9/23/2004			0.55				7.1						12	780		0.63						240	1000		
OM05S	4/18/2005			0.94				13						9.8	1200		1.4						580	1200		
OM05S	9/19/2005			0.56				7.4						11	740		0.73						210	990		
OM05S	4/28/2006			0.59				6.2						16	760		0.77						230	980		
OM05S	9/7/2006			0.64				8						11	670		0.63						220	930		
OM05S	4/2/2007			1.3				40						0.53	1500		0.86						870	2000		
OM05S	9/19/2007			0.58				6.8						9.4	890		0.64						240	1000		
OM05S	3/27/2008			0.63				7.7						9.3	2300		0.57						220	910		
OM05S	6/3/2008			2.1				8.8						10	960		0.6						250	940		
OM05S	8/18/2008			0.73				9.8						11	770		0.64						220	970		
OM05S	4/30/2009			0.56				59						4.5	2200		1						1100	2400		
OM05S	9/22/2009			0.69				27						10	800		0.63						270	1000		
OM05S	12/8/2009			0.58				32						14	1400		2.4						800	1900		
OM05S	4/27/2010			0.46				14						12	1000		2.4						450	1300		
OM05S	9/8/2010			0.55				13						11	960		1.3						300	1000		
OR05D	6/3/2008			6.5				220						8.9	1200		0.78						470	1700		
OR05D	8/18/2008			4.9				170						10	990		0.78						400	1500		
OR05D	4/30/2009			6.4				190						0.013	1000		0.4						380	1500		
OR05D	9/22/2009			6.3				240						0.062	1100		0.7						480	1600		
OR05D	12/8/2009			6.8				220						0.098	1100		0.73						510	1600		
OR05D	4/27/2010			5.7				180						0.31	980		0.54						440	1500		
OR05D	9/8/2010			3.9				140						5.7	1100		1.2						400	1300		
OM06	9/19/2000			2.1				16						1.8	660		0.97						350	1100		
OM06	4/24/2001			1.8				21						9.3	560		1.1						360	1447		
OM06A	4/24/2000			2.6				18						1.4	650		0.85						340	1200		
OM06A	9/13/2001			2.2				19						2.1	700		0.89						420	1100		
OM06A	4/24/2002			2.6				21						2	606		0.73						280	1100		
OM06A	9/24/2002			2.2				25						2.1	680		0.92						350	1100		
OM06A	4/17/2003			2				26						1	540		0.95						340	1200		
OM06A	9/23/2003			2				23						2	640		0.88						360	1100		

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM06A	4/12/2004			1.8				23						0.2	700		0.63						350	1100		
OM06A	9/23/2004			1.9				22						2.2	816		0.78						350	1200		
OM06A	4/18/2005			1.8				22						0.92	590		0.98						330	1100		
OM06A	9/19/2005			1.9				23						3.3	550		0.87						330	1100		
OM06A	4/28/2006			1.8				22						0.18	570		0.59						330	1100		
OM06A	9/7/2006			1.9				21						1.6	510		0.83						350	1100		
OM06A	4/2/2007			1.9				23						0.21	600		0.86						350	1100		
OM06A	9/19/2007			1.8				17						1.5	490		0.89						340	1100		
OM06A	3/27/2008			1.8				22						1.7	530		0.69						320	1100		
OM06A	6/2/2008			1.9				23						1.2	1100		0.85						340	1100		
OM06A	8/18/2008			1.8				21						1.6	550		0.88						330	1100		
OM06A	4/30/2009			1.9				31						1.6	800		0.89						340	1100		
OM06A	9/22/2009			1.4				22						1.8	690		2.9						370	1100		
OM06A	12/8/2009			2				27						1.1	610		0.97						330	1100		
OM06A	4/27/2010			1.7				23						5.3	600		0.78						350	1200		
OM06A	9/8/2010			1.3				20						2	720		1.2						360	1100		
OR06A	6/2/2008			1.4				24						1	1500		2.6						360	1100		
OR06A	8/18/2008			1.6				23						1.3	650		2.6						350	1100		
OR06A	4/30/2009			1.3				24						0.54	780		2.6						340	1100		
OR06A	9/22/2009			1.9				25						2.4	600		1.2						450	1100		
OR06A	12/8/2009			1.4				21						0.68	660		1.6						360	1100		
OR06A	4/27/2010			1.2				20						1.6	1500		2.6						410	1100		
OR06A	9/8/2010			1.5				25						4.4	910		2.8						420	1200		
OR06A	2/22/2011	<0.005	0.004	1.7	0.067	<0.001	<0.001	28	<0.005	0.009	0.006	0.009	<0.25	11	1000	<0.0002	3.1	0.052	0.13	0.01	<0.003	0.002	370	1200	<0.001	0.032
OR06A	4/29/2011	<0.005	0.008	1.5	0.1	<0.001	<0.001	24	<0.005	0.009	0.006	0.008	<0.25	8	1100	<0.0002	3.1	0.042	<0.02	0.01	<0.003	0.002	370	1100	<0.001	0.025
OR06A	8/26/2011	<0.005	0.005	1.7	0.035	<0.001	<0.001	35	<0.005	0.006	0.005	0.003	<0.25	2.3	820	<0.0002	3	0.036	0.04	<0.001	<0.003	0.006	410	1200	<0.001	<0.006
OR06A	10/14/2011	<0.005	0.006	1.6	0.039	<0.001	<0.001	22	<0.005	0.005	<0.004	0.003	<0.25	2.6	750	<0.0002	3	0.035	<0.02	<0.001	<0.003	0.006	290	1100	<0.001	<0.006
OR06A	2/22/2012	<0.005	0.002	1.6	0.031	<0.001	<0.001	25	<0.005	0.004	<0.004	<0.003	<0.25	0.068	810	<0.0002	2.2	0.03	0.1	<0.001	<0.003	0.009	400	1200	<0.001	<0.006
OR06A	5/4/2012	<0.005	0.003	2.2	0.035	<0.001	<0.001	31	<0.005	0.004	0.005	<0.003	<0.25	0.77	810	<0.0002	2.6	0.032	0.06	<0.001	<0.003	0.002	400	1200	<0.001	0.008
OR06A	8/24/2012	<0.005	0.006	1.5	0.04	<0.001	<0.001	27	<0.005	0.005	<0.004	0.007	<0.25	3.1	890	<0.0002	2.6	0.043	0.02	0.001	<0.003	0.005	390	1200	<0.001	0.018
OR06A	11/1/2012	<0.005	0.006	1.6	0.045	<0.001	<0.001	27	<0.005	0.004	<0.004	<0.003	<0.25	2	800	<0.0002	2.5	0.03	0.03	<0.001	<0.003	0.003	450	1200	<0.001	<0.006
OR06A	2/4/2013	<0.0025	0.001	1.7	0.035	<0.0005	<0.0005	31	<0.005	0.004	<0.002	<0.0015	<0.25	0.16	830	<0.0001	2.5	0.022	<0.02	<0.0005	<0.0015	<0.0005	390	1100	<0.0005	<0.003
OR06A	5/3/2013	<0.005	0.002	1.6	0.041	<0.001	<0.001	30	<0.005	0.002	<0.004	<0.003	<0.25	0.041	840	<0.0002	2.2	0.035	0.13	<0.001	<0.003	0.001	390	1100	<0.001	<0.006
OR06A	7/31/2013	<0.005	0.004	1.7	0.04	<0.001	<0.001	30	<0.005	0.007	<0.004	<0.003	<0.25	2.3	860	<0.0002	2.9	0.028	<0.02	<0.001	<0.003	<0.001	410	1200	<0.001	<0.006
OR06A	10/18/2013	<0.005	0.004	1.6	0.032	<0.001	<0.001	30	<0.005	0.004	<0.004	<0.003		2.3	710	<0.0001	2.2	0.019	<0.02	<0.001	<0.003	<0.001	420	1100	<0.001	<0.006
OR06A	3/30/2014	<0.005	0.002	1.4	0.039	<0.001	<0.001	30	<0.005	0.003	<0.004	0.042		0.33	720	<0.0002	2	0.02	0.09	<0.001	<0.003	<0.001	360	1100	<0.001	<0.006
OR06A	4/24/2014	<0.005	<0.001	1.4	0.029	<0.001	<0.001	25	<0.005	<0.002	<0.004	<0.003	<0.25	0.069	730	<0.0002	1.9	0.017	0.18	<0.001	<0.003	<0.001	350	1100	<0.001	<0.006
OR06A	7/17/2014			1.3				28						2	860		2.5						370	1100		
OR06A	4/17/2015			1.5				32						0.043	2400		2.2						380	1100		
OR06A	9/14/2015			1.4				31						2.9	1600		2.3						320	1100		
OM07	4/24/2000			1.7				16						0.75	870		1.1						660	960		
OM07	9/19/2000			1.7				23						2.3	780		1						140	1600		
OM07	4/24/2001			1.8				23						2	760		1.1						660	1617		
OM07	9/13/2001			1.9				18						2.3	910		0.71						670	1600		
OM07	4/24/2002			1.9				12						2.2	755		0.62						340	1600		
OM07	9/24/2002			1.8				18						1.4	820		1						690	1600		
OM07	4/17/2003			1.7				18						2.2	720		0.73						650	1700		
OM07	9/23/2003			1.3				17						0.51	930		1.7						610	1500		
OM07	4/12/2004			1.5				19						2	840		0.72						680	1600		
OM07	9/23/2004			1.3				17						0.95	970		1.5						660	1600		
OM07	4/18/2005			1.1				15						<0.01	890		0.031						580	1500		
OM07	9/19/2005			1.6				19						0.81	830		1.7						650	1600		
OM07	4/28/2006			1.2				17						0.29	920		0.84						640	1600		
OM07	9/7/2006			1.4				16						0.19	920		2						640	1500		
OM07	4/2/2007			1.2				17						<0.01	870		0.034						620	1400		
OM07	9/19/2007			1.5				18						1.1	690		1.1						720	1700		
OM07	3/27/2008			1.5				19						1.7	700		0.75						690	1600		
OM07	6/2/2008			1.5				18						0.035	830		1.5						700	1600		
OM07	8/19/2008			1.4				20						0.63	1400		1.5						630	1600		
OM07	4/30/2009			1.5				23						0.02	960		0.97						660	1600		

NATURAL RESOURCE TECHNOLOGY

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM07	9/22/2009			1.6				22						0.69	890		2						730	1600		
OM07	12/8/2009			1.6				20						0.51	870		1.5						800	1600		
OM07	4/27/2010			1.5				27						0.017	820		1.2						670	1600		
OM07	9/8/2010			0.8				21						<0.01	940		0.23						530	1300		
OM07	2/22/2011	<0.005	<0.001	0.87	0.027	<0.001	<0.001	19	<0.005	<0.002	<0.004	<0.003	<0.25	0.027	770	<0.0002	0.22	0.014	0.26	<0.001	<0.003	0.001	410	1100	<0.001	0.01
OM07	4/29/2011	<0.005	<0.001	1	0.05	<0.001	<0.001	12	<0.005	<0.002	<0.004	<0.003	<0.25	0.45	820	<0.0002	1.3	0.006	0.12	<0.001	<0.003	0.003	420	1200	<0.001	<0.006
OM07	8/25/2011	<0.005	<0.001	1.5	0.028	<0.001	<0.001	15	<0.005	0.003	<0.004	0.004	0.29	0.46	930	<0.0002	1.4	0.014	<0.02	<0.001	<0.003	0.003	440	1100	<0.001	<0.006
OM07	10/14/2011	<0.005	<0.001	0.92	0.026	<0.001	<0.001	13	<0.005	<0.002	<0.004	0.003	0.29	0.7	780	<0.0002	1.5	0.013	<0.02	<0.001	<0.003	0.002	370	1100	<0.001	<0.006
OM07	2/22/2012	<0.005	0.001	0.75	0.026	<0.001	<0.001	14	<0.005	<0.002	<0.004	<0.003	<0.25	<0.01	790	<0.0002	0.23	0.012	0.24	<0.001	<0.003	0.004	390	1100	<0.001	<0.006
OM07	5/4/2012	<0.005	<0.001	0.8	0.028	<0.001	<0.001	13	<0.005	<0.002	<0.004	<0.003	0.29	0.012	780	<0.0002	1.3	0.009	0.13	<0.001	<0.003	0.003	280	1000	<0.001	<0.006
OM07	8/24/2012	<0.005	<0.001	0.58	0.026	<0.001	<0.001	18	<0.005	<0.002	<0.004	<0.003	0.26	0.027	770	<0.0002	0.65	0.019	0.1	<0.001	<0.003	0.003	390	1000	<0.001	<0.006
OM07	11/1/2012	<0.005	<0.001	0.75	0.028	<0.001	<0.001	15	<0.005	<0.002	<0.004	<0.003	0.26	0.07	760	<0.0002	1.2	0.007	0.05	<0.001	<0.003	0.001	430	1000	<0.001	<0.006
OM07	2/4/2013	<0.0025	<0.0005	0.53	0.026	<0.0005	<0.0005	18	<0.005	<0.001	<0.002	<0.0015	0.29	<0.01	780	<0.0001	0.19	<0.0025	0.26	<0.0005	<0.0015	<0.0005	310	960	<0.0005	<0.003
OM07	5/3/2013	<0.005	<0.001	0.72	0.025	<0.001	<0.001	15	<0.005	<0.002	<0.004	<0.003	0.26	0.074	740	<0.0002	0.92	0.011	0.1	<0.001	<0.003	<0.001	320	930	<0.001	<0.006
OM07	7/31/2013	<0.005	<0.001	0.72	0.03	<0.001	<0.001	12	<0.005	0.003	<0.004	<0.003	0.31	0.38	680	<0.0002	2	0.009	<0.02	<0.001	<0.003	<0.001	330	950	<0.001	<0.006
OM07	10/18/2013	<0.005	<0.001	0.72	0.028	<0.001	<0.001	13	<0.005	0.002	<0.004	<0.003		0.28	680	<0.0001	1.7	<0.005	0.11	<0.001	<0.003	<0.001	430	940	<0.001	0.007
OM07	3/30/2014	<0.005	<0.001	0.87	0.031	<0.001	<0.001	13	<0.005	<0.002	<0.004	<0.003		0.18	700	<0.0002	1.2	<0.005	0.09	<0.001	<0.003	<0.001	290	940	<0.001	<0.006
OM07	4/24/2014	<0.005	<0.001	0.71	0.029	<0.001	<0.001	10	<0.005	<0.002	<0.004	<0.003	<0.25	0.011	630	<0.0002	1.2	<0.005	0.18	<0.001	<0.003	<0.001	300	900	<0.001	<0.006
OM07	7/17/2014			1.3				18						0.14	620		1.6						310	960		
OM07	4/17/2015			1				19						1.2	750		2.9						280	960		
OM07	9/14/2015			0.43				13						1.2	850		2.7						240	940		
OM08	4/25/2000			0.1				4.3						2.6	2400		4.1						1900	3000		
OM08	9/18/2000			0.11				4.7						4	2400		3.7						2100	3200		
OM08	4/24/2001			0.14				5						5.9	2500		5.4						2000	3327		
OM08	9/13/2001			0.12				5.2						5.3	2900		4.7						1900	3500		
OM08	4/25/2002			0.15				5.1						5	2839		4.7						1200	3500		
OM08	9/25/2002			0.15				4.6						2.8	3000		4.9						2000	3600		
OM08	4/18/2003			0.063				4.4						5.5	2200		4.5						1800	3200		
OM08	9/23/2003			0.044				6.2						6.5	2400		4.5						1900	3200		
OM08	4/13/2004			2.7				4.5						5.7	3300		3.5						1800	3200		
OM08	9/23/2004			0.11				5						9.3	2600		3.9						1800	3300		
OM08	4/19/2005			0.13				4						8.9	2600		4.4						2000	3500		
OM08	9/20/2005			0.096				3.8						12	2400		5.2						1800	3400		
OM08	4/28/2006			1.6				21						5.5	2000		4.1						1700	3200		
OM08	9/7/2006			0.093				7.2						13	2400		3.8						1700	3000		
OM08	4/2/2007			0.39				4.4						10	2100		3.2						1700	2900		
OM08	9/19/2007			0.096				2.5						14	2200		4.6						1900	3300		
OM08	3/27/2008			0.099				3.3						9.1	5100		3.2						1600	2800		
OM08	6/3/2008			0.071				4.8						12	2400		4.6						1800	3200		
OM08	8/19/2008			0.09				4.7						13	2500		4.3						1800	3200		
OM08	4/29/2009			0.1				7.9						7.6	3500		4.8						2000	3200		
OM08	9/21/2009			0.17				5						4.8	2400		4.2						1800	3100		
OM08	12/11/2009			0.22				7.7						<0.01	2400		4.4						2000	3100		
OM08	4/27/2010			0.1				3.6						<0.01	2000		4.5						1400	2400		
OM08	9/7/2010			8.7				370						15	3100		4.3						1300	3100		
OM08	2/23/2011	<0.005	0.024	19	0.052	<0.001	<0.001	310	<0.005	0.018	0.022	0.016	0.52	31	2600	<0.0002	5.5	0.072	0.29	0.017	<0.003	0.007	1200	2600	<0.001	0.078
OM08	4/28/2011	<0.005	0.009	18	0.046	<0.001	<0.001	310	<0.005	0.012	0.015	<0.003	0.38	12	3000	<0.0002	5.2	0.026	0.4	<0.001	<0.003	0.015	1200	2900	<0.001	0.022
OM08	8/25/2011	<0.005	0.015	6.2	0.023	<0.001	<0.001	150	<0.005	0.006	0.006	<0.003	<0.25	8.1	1400	<0.0002	2	0.023	0.07	<0.001	<0.003	0.006	620	1400	<0.001	0.008
OM08	10/12/2011	<0.005	0.011	11	0.029	<0.001	<0.001	270	<0.005	0.012	0.009	<0.003	1.4	14	2600	<0.0002	5.6	0.033	0.05	<0.001	<0.003	0.014	1700	3300	<0.001	0.016
OM08	2/24/2012	<0.005	0.012	11	0.026	<0.001	<0.001	180	<0.005	0.011	0.008	<0.003	<0.25	9.9	2300	<0.0002	4.3	0.046	0.1	<0.001	<0.003	0.021	880	2500	<0.001	0.015
OM08	5/4/2012	<0.005	0.009	10	0.025	<0.001	<0.001	200	<0.005	0.012	0.006	<0.003	<2.5	14	2400	<0.0002	4.9	0.038	<0.02	<0.001	<0.003	0.008	1400	3500	<0.001	0.019
OM08	8/24/2012	<0.005	0.01	6.6	0.026	<0.001	<0.001	190	<0.005	0.012	0.007	<0.003	<0.25	14	2500	<0.0002	4.5	0.068	<0.02	<0.001	<0.003	0.01	2400	3300	<0.001	0.012
OM08	11/1/2012	<0.005	0.009	6.9	0.028	<0.001	<0.001	170	<0.005	0.011	<0.004	<0.003	<0.25	13	2400	<0.0002	4.9	0.029	0.03	<0.001	<0.003	0.006	2000	3200	<0.001	0.017
OM08	2/5/2013	<0.0025	0.009	10	0.046	<0.0005	<0.0005	210	<0.005	0.01	0.002	0.003	<0.25	16	2400	<0.0001	4.3	0.014	0.08	0.002	<0.0015	<0.0005	1700	3000	<0.0005	0.026
OM08	5/15/2013	<0.005	0.003	15	0.025	<0.001	<0.001	490	<0.005	0.013	<0.004	<0.003	<0.25	10	2600	<0.0002	5.5	0.016	0.11	<0.001	<0.003	<0.001	2100	3500	<0.001	0.025
OM08	7/26/2013	<0.005	0.011	13	0.039	<0.001	<0.001	370	<0.005	0.013	0.009	0.003	<0.25	13	2900	<0.0002	4.6	0.044	0.05	0.002	<0.003	0.004	1700	3300	<0.001	0.023
OM08	10/21/2013	<0.005	0.009	9.6	0.029	<0.001	<0.001	320	<0.005	0.01	<0.004	<0.003		10	2200	<0.0002	5	0.013	0.18	<0.001	<0.003	<0.001	1900	3200	<0.001	0.009
OM08	3/30/2014	<0.005	0.004	9.3	0.026	<0.001	<0.001	290	<0.005	0.01	<0.004	<0.003		15	2400	<0.0002	4.9	0.013	<0.02	<0.001	<0.003	<0.001	1700	3100	<0.001	0.01
OM08	4/24/2014	<0.005	0.003	13	0.022	<0.001	<0.001	300	<0.005	0.01	<0.004	<0.003		8.9	2300	<0.0002	4.7	0.012	<0.02	<0.001	<0.003	<0.001	1600	3500	<0.001	0.011
OM08	7/17/2014			12				290						11	2000		3.9						1600	3000		

NATURAL RESOURCE TECHNOLOGY

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM08	4/17/2015			14				340						<0.01	2500		4.3						1700	3200		
OM08	9/14/2015			9.6				250						12	2800		4.3						1500	3100		
OM09	4/25/2000			0.54				11						0.28	1100		2						100	1200		
OM09	9/19/2000			0.75				9						3.6	890		1.6						450	1300		
OM09	4/24/2001			0.61				10						1.7	930		1.8						460	1273		
OM09	9/13/2001			0.74				12						3.7	1200		1.8						490	1300		
OM09	4/25/2002			0.66				9.8						3.1	1153		1.6						410	1300		
OM09	9/24/2002			0.7				13						3	1000		1.8						400	1200		
OM09	4/17/2003			0.57				12						2.1	840		1.4						400	1300		
OM09	9/23/2003			0.55				13						3.3	930		1.4						410	1200		
OM09	4/13/2004			0.55				12						2.1	1100		1.4						440	1300		
OM09	9/23/2004			0.96				11						3.5	1100		1.9						400	1300		
OM09	4/18/2005			0.64				11						0.21	930		2.2						420	1300		
OM09	9/19/2005			0.59				14						3.2	910		1.6						380	1200		
OM09	4/28/2006			0.51				11						1.5	970		1.5						390	1200		
OM09	9/7/2006			0.79				12						3.4	720		1.4						410	1200		
OM09	4/2/2007			0.58				12						1.3	1000		1.3						410	1200		
OM09	9/19/2007			0.56				8.1						3	1600		1.4						400	1200		
OM09	3/27/2008			0.46				11						0.16	1200		1.2						360	1100		
OM09	6/3/2008			0.52				9.8						3	990		1.5						420	1200		
OM09	8/19/2008			0.56				12						3.5	2300		1.3						380	1200		
OM09	4/30/2009			0.59				14						1.8	1400		1.8						470	1200		
OM09	9/22/2009			0.57				12						3.8	940		1.5						370	1200		
OM09	12/11/2009			0.67				9.7						0.17	930		1.2						440	1200		
OM09	4/27/2010			0.53				11						4.8	920		1.4						390	1200		
OM09	9/8/2010			0.55				13						4.2	1100		1.4						470	1200		
OM10	4/25/2000			0.1				6.6						<0.01	1800		1.8						950	2000		
OM10	9/19/2000			0.071				7.2						1.6	1800		0.078						820	1900		
OM10	4/24/2001			0.09				11						0.66	1900		1.1						1100	2370		
OM10	9/13/2001			0.17				7.6						4.1	1800		5.7						1200	2100		
OM10	6/13/2002			0.032				6						0.29	1200		0.37						440	1300		
OM10	9/24/2002			0.12				6.9						0.4	1600		4.1						630	1900		
OM10	4/17/2003			0.18				7.3						0.56	1400		2.6						880	1700		
OM10	9/23/2003			0.18				6.5						13	1400		2.8						600	1600		
OM10	4/12/2004			0.54				23						<0.01	1200		1.3						570	1600		
OM10	9/23/2004			0.29				24						4	2200		3.2						1300	2900		
OM10	4/18/2005			0.29				9.3						0.036	1600		0.19						580	1800		
OM10	9/19/2005			1.5				26						0.04	1800		3.7						1100	2400		
OM10	6/2/2008			0.45				8.8						0.8	1800		1.7						1300	2800		
OM10	8/18/2008			0.12				8.6						3	2200		3.3						1000	2400		
OM10	4/29/2009			0.32				10						2.4	1600		3.1						430	1600		
OM10	9/21/2009			0.024				3.3						0.5	70		0.098						5.5	100		
OM10	12/11/2009			0.043				5.9						2.4	710		3.1						190	670		
OM10	4/27/2010			0.038				5.5						8.4	1900		5.8						1000	2400		
OM10	9/7/2010			0.091				4.6						13	2100		6.3						700	1800		
OM11	4/24/2000			47				440						0.57	1400		2.1						550	2000		
OM11	9/19/2000			56				450						0.71	1000		2.3						570	1900		
OM11	4/24/2001			44				400						0.67	1300		2.1						470	1697		
OM11	9/13/2001			53				440						0.3	1600		2.6						580	1900		
OM11	4/25/2002			20				180						1.4	679		1.1						200	810		
OM11	9/25/2002			41				380						0.38	1100		2.2						450	1600		
OM11	4/18/2003			55				610						0.81	1500		2.8						480	2300		
OM11	9/24/2003			58				610						0.46	1400		2.6						430	2000		
OM11	4/13/2004			54				650						0.22	1600		2.3						440	2300		
OM11	9/23/2004			69				590						0.35	1500		3.5						420	2300		
OM11	4/19/2005			38				390						1.6	990		1.7						330	1800		
OM11	9/20/2005			43				360						0.12	1100		2.2						370	1600		
OM11	4/28/2006			26				260						0.18	850		1.5						310	1300		
OM11	9/7/2006			30				290						0.31	750		1.4						330	1300		
OM11	4/2/2007			20				150						0.068	590		0.91						230	900		

Natural Resource Technology

Appendix C-3
Groundwater Analytical Results Since 2000
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Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM11	9/19/2007			17				130						0.8	450		1.2						220	980		
OM11	3/27/2008			17				130						0.095	540		1						190	850		
OM11	6/3/2008			9.3				150						0.13	570		1.1						180	850		
OM11	8/19/2008			12				150						0.082	540		0.68						150	820		
OM11	4/29/2009			9.5				130						0.028	520		0.45						130	630		
OM11	9/21/2009			5.8				95						<0.01	340		0.2						86	530		
OM11	12/8/2009			7.2				77						0.27	430		1.1						110	550		
OM11	4/27/2010			14				180						0.25	620		1.2						200	980		
OM11	9/7/2010			7.2				99						0.14	480		0.82						140	680		
OR11	6/3/2008			13				160						0.53	1400		0.92						190	910		
OR11	8/19/2008			12				150						0.33	730		0.81						140	800		
OR11	4/29/2009			8.7				150						0.27	920		0.68						120	570		
OR11	9/21/2009			7.5				100						<0.01	380		0.002						110	580		
OR11	12/8/2009			6.1				44						0.067	330		0.34						93	450		
OR11	4/27/2010			8.5				110						0.39	440		0.73						140	690		
OR11	9/7/2010			8.6				110						0.32	500		0.62						150	710		
OR11	2/23/2011	<0.005	0.003	16	0.052	<0.001	<0.001	180	<0.005	<0.002	0.007	<0.003	0.45	0.72	660	<0.0002	1.1	0.023	0.042	<0.001	<0.003	<0.001	210	970	<0.001	<0.006
OR11	4/28/2011	<0.005	0.006	16	0.08	<0.001	<0.001	170	<0.005	0.004	0.013	0.006	0.39	6.3	860	<0.0002	1.3	0.017	<0.02	0.005	<0.003	0.007	220	1000	<0.001	0.019
OR11	8/25/2011	<0.005	0.005	19	0.05	<0.001	<0.001	190	<0.005	<0.002	0.007	<0.003	0.34	1.2	980	<0.0002	1.1	0.019	<0.02	<0.001	<0.003	0.011	240	1100	<0.001	<0.006
OR11	10/12/2011	<0.005	0.005	19	0.039	<0.001	<0.001	200	<0.005	<0.002	0.007	0.008	0.39	1.3	800	<0.0002	1.2	0.06	<0.02	<0.001	<0.003	0.012	240	1100	<0.001	<0.006
OR11	2/24/2012	<0.005	0.007	17	0.043	<0.001	<0.001	150	<0.005	<0.002	0.005	<0.003	0.29	0.82	790	<0.0002	1.1	0.018	<0.02	<0.001	<0.003	0.014	270	1100	<0.001	<0.006
OR11	5/4/2012	<0.005	0.004	16	0.048	<0.001	<0.001	97	<0.005	<0.002	0.004	<0.003	0.37	0.88	760	<0.0002	1.2	0.023	<0.02	<0.001	<0.003	0.007	260	940	<0.001	0.007
OR11	8/24/2012	<0.005	0.005	17	0.035	<0.001	<0.001	220	<0.005	<0.002	0.007	<0.003	0.33	1.4	840	<0.0002	1.1	0.025	<0.02	<0.001	<0.003	0.012	290	1200	<0.001	<0.006
OR11	11/1/2012	<0.005	0.002	13	0.041	<0.001	<0.001	100	<0.005	<0.002	<0.004	<0.003	0.37	0.2	660	<0.0002	0.93	0.011	0.04	<0.001	<0.003	0.003	270	920	<0.001	<0.006
OR11	2/5/2013	<0.0025	0.002	17	0.044	<0.0005	<0.0005	180	<0.005	<0.001	<0.002	<0.0015	0.32	0.94	1200	<0.0001	1.1	0.008	<0.02	<0.0005	<0.0015	<0.0005	350	1000	<0.0005	<0.003
OR11	5/15/2013	<0.005	0.002	8.6	0.035	<0.001	<0.001	57	<0.005	0.002	<0.004	<0.003	0.33	0.46	570	<0.0002	0.8	<0.005	<0.02	<0.001	<0.003	<0.001	210	720	<0.001	<0.006
OR11	7/26/2013	<0.005	0.003	6.4	0.042	<0.001	<0.001	23	<0.005	0.002	<0.004	<0.003	0.44	1.6	500	<0.0002	0.83	0.01	0.03	0.002	<0.003	<0.001	170	540	<0.001	0.008
OR11	10/21/2013	<0.005	0.001	6.1	0.035	<0.001	<0.001	34	<0.005	<0.002	<0.004	<0.003	0.34	0.013	470	<0.0002	0.8	<0.005	0.11	<0.001	<0.003	<0.001	230	600	<0.001	<0.006
OR11	3/30/2014	<0.005	0.002	10	0.039	<0.001	<0.001	110	<0.005	<0.002	<0.004	<0.003		0.88	640	<0.0002	1.1	0.007	<0.02	<0.001	<0.003	<0.001	230	820	<0.001	<0.006
OR11	4/24/2014	<0.005	0.004	11	0.035	<0.001	<0.001	69	<0.005	<0.002	<0.004	<0.003	0.35	1.4	510	<0.0002	0.85	<0.005	<0.02	<0.001	<0.003	<0.001	210	820	<0.001	<0.006
OR11	7/17/2014			4.9				25						0.32	380		0.66						120	500		
OR11	4/17/2015			4.1				27						<0.01	440		0.55						140	540		
OR11	9/14/2015			5.8				46						0.64	660		0.7						140	590		
OM12	4/24/2000			0.19				4.7						21	1300		1.7						450	1500		
OM12	9/19/2000			0.44				3.4						23	1400		1.6						440	1500		
OM12	4/24/2001			0.63				4						22	1300		1.8						440	1490		
OM12	9/13/2001			0.36				6.2						24	1400		1.6						450	1600		
OM12	4/25/2002			0.29				4.7						20	1833		1.7						270	1600		
OM12	9/25/2002			0.34				5						20	1200		1.7						450	1400		
OM12	4/18/2003			0.63				5						25	1200		1.6						380	1400		
OM12	9/24/2003			0.94				5.8						25	1200		1.6						440	1500		
OM12	4/13/2004			1.1				4.6						22	1400		1.4						450	1500		
OM12	9/23/2004			0.77				4.5						22	1400		1.9						420	1600		
OM12	4/19/2005			0.58				5.4						24	1300		1.3						400	1600		
OM12	9/20/2005			0.11				6.2						25	1200		1.6						390	1500		
OM12	4/28/2006			0.058				4.2						24	1200		1.5						370	1500		
OM12	9/7/2006			0.13				5.6						16	1200		1.4						400	1400		
OM12	4/2/2007			3				38						17	1200		1.3						370	660		
OM12	9/19/2007			0.079				4.1						3.4	1100		1.5						380	1400		
OM12	3/27/2008			0.051				3.7						24	1500		1.3						380	1400		
OM12	6/3/2008			0.062				5.5						22	1200		1.5						390	1400		
OM12	8/19/2008			0.2				5.4						22	1300		1.4						380	1400		
OM12	4/29/2009			0.064				67						19	1400		1.4						420	1400		
OM12	9/21/2009			0.2				4.7						1.6	1300		1.3						410	1400		
OM12	12/8/2009			30				370						2.1	2200		0.88						2000	3200		
OM12	4/27/2010			0.17				4.6						0.15	1200		1.4						410	1400		
OM12	9/7/2010			0.12				4.1						25	1200		1.5						340	1400		
OM12	2/23/2011	<0.005	0.032	0.076	0.3	<0.001	<0.001	4.5	<0.005	0.002	<0.004	<0.003	0.32	27	1200	<0.0002	1.5	0.02	0.044	<0.001	<0.003	<0.001	400	1400	<0.001	<0.006
OM12	4/28/2011	<0.005	<0.001	0.39	0.14	<0.001	<0.001	8.3	<0.005	<0.002	<0.004	<0.003	<0.25	0.24	2100	<0.0002	1.4	0.006	1.3	<0.001	<0.003	0.004	370	1400	<0.001	0.012
OM12	8/25/2011	<0.005	0.029	0.086	0.28	<0.001	<0.001	4.8	<0.005	0.002	<0.004	<0.003	0.3	22	1600	<0.0002	1.5	0.021	<0.02	<0.001	<0.003	0.006	390	1300	<0.001	<0.006

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM12	10/12/2011	<0.005	0.031	0.58	0.31	<0.001	<0.001	4.9	<0.005	<0.002	0.005	<0.003	<0.25	24	1300	<0.0002	1.6	0.01	<0.02	<0.001	<0.003	0.006	380	1400	<0.001	0.006
OM12	2/24/2012	<0.005	0.034	0.17	0.13	<0.001	<0.001	5.6	<0.005	<0.002	<0.004	<0.003	<0.25	19	990	<0.0002	1.4	0.018	0.03	<0.001	<0.003	0.009	350	1300	<0.001	<0.006
OM12	5/4/2012	<0.005	0.001	0.44	0.095	<0.001	<0.001	13	<0.005	<0.002	<0.004	<0.003	<0.25	0.027	990	<0.0002	0.8	0.013	4.4	<0.001	<0.003	0.005	320	1200	<0.001	0.02
OM12	8/24/2012	<0.005	0.018	0.3	0.22	<0.001	<0.001	6.2	<0.005	<0.002	<0.004	<0.003	0.26	16	1300	<0.0002	1.3	0.028	0.73	<0.001	<0.003	0.006	460	1400	<0.001	<0.006
OM12	11/1/2012	<0.005	0.029	0.18	0.32	<0.001	<0.001	5.4	<0.005	0.002	<0.004	<0.003	0.31	24	1300	<0.0002	1.6	0.016	0.09	<0.001	<0.003	0.003	400	1400	<0.001	<0.006
OM12	2/5/2013	<0.0025	0.028	0.3	0.28	<0.0005	<0.0005	6.5	<0.005	0.002	<0.002	<0.0015	0.29	26	1300	<0.0001	1.5	<0.0025	<0.02	<0.0005	<0.0015	<0.0005	390	1400	<0.0005	<0.003
OM12	5/15/2013	<0.005	0.009	0.31	0.2	<0.001	<0.001	5.8	<0.005	<0.002	<0.004	<0.003	<0.25	23	1300	<0.0002	1.7	<0.005	0.03	<0.001	<0.003	<0.001	440	1300	<0.001	0.006
OM12	7/26/2013	<0.005	0.026	0.24	0.26	<0.001	<0.001	6.1	<0.005	0.002	<0.004	<0.003	0.31	22	1300	<0.0002	1.6	0.016	0.05	<0.001	<0.003	<0.001	460	1400	<0.001	<0.006
OM12	10/21/2013	<0.005	0.013	0.16	0.19	<0.001	<0.001	6	<0.005	<0.002	<0.004	<0.003		17	1000	<0.0002	1.5	<0.005	0.06	<0.001	<0.003	<0.001	470	1400	<0.001	<0.006
OM12	3/30/2014	<0.005	0.01	0.17	0.19	<0.001	<0.001	7	<0.005	<0.002	<0.004	<0.003		12	1200	<0.0002	1.3	<0.005	0.99	<0.001	<0.003	<0.001	430	1300	<0.001	<0.006
OM12	4/24/2014	<0.005	<0.001	0.12	0.16	<0.001	<0.001	6	<0.005	0.002	<0.004	<0.003		0.03	1100	<0.0002	1.5	<0.005	0.46	<0.001	<0.003	<0.001	440	1400	<0.001	0.015
OM12	7/17/2014			0.1				5.9						0.062	1100		1.4						460	1400		
OM12	4/17/2015			0.16				6.4						24	1300		1.5						480	1400		
OM12	9/14/2015			0.074				5.4						24	3400		1.4						400	1400		
OM13D	4/24/2000			5.4				150						6	1000		0.73						440	1500		
OM13D	9/18/2000			5.7				130						6.2	920		0.73						480	1500		
OM13D	4/24/2001			5.7				140						6.8	860		0.76						430	1537		
OM13D	9/13/2001			5.5				140						6.2	1000		0.69						460	1600		
OM13D	4/25/2002			6.2				150						5.7	1062		0.81						340	1600		
OM13D	9/25/2002			6.9				140						5.7	1100		0.85						440	1400		
OM13D	4/17/2003			6.9				160						5.5	890		0.84						420	1600		
OM13D	9/23/2003			6.7				170						5.5	970		0.71						420	1500		
OM13D	5/13/2004			6.2				150						5.5	890		0.68						450	1600		
OM13D	9/23/2004			5.7				170						6.1	1000		0.67						420	1600		
OM13D	4/18/2005			6.4				170						5.8	950		0.7						420	1600		
OM13D	9/19/2005			6.9				170						4.1	900		0.81						410	1600		
OM13D	4/28/2006			7.2				190						5.3	1100		0.77						410	1600		
OM13D	9/7/2006			8.2				200						6.5	750		0.78						440	1600		
OM13D	4/3/2007			7.9				170						4.6	890		0.73						380	1400		
OM13D	9/19/2007			6.4				150						4.7	750		0.69						350	1400		
OM13S	4/24/2000			5.2				110						6.8	1100		0.76						440	1500		
OM13S	9/18/2000			5.8				140						7.1	860		0.75						480	1532		
OM13S	4/24/2001			5.4				130						7.5	1000		0.77						440	1540		
OM13S	9/13/2001			6.6				140						7.5	1200		0.85						470	1600		
OM13S	4/24/2002			5.4				86						7	1500		0.71						270	1500		
OM13S	9/25/2002			5.8				120						6.6	1000		0.8						480	1700		
OM13S	4/17/2003			6.2				150						7.2	930		0.85						430	1600		
OM13S	9/23/2003			6.5				180						7.4	1000		0.76						450	1600		
OM13S	5/13/2004			6.9				170						7.8	970		0.76						450	1600		
OM13S	9/23/2004			6.3				180						8.2	1100		0.74						450	1700		
OM13S	4/18/2005			6.8				180						16	1100		0.91						440	1700		
OM13S	9/19/2005			7.9				210						7	1000		0.93						440	1700		
OM13S	4/28/2006			7.4				220						7	1000		0.84						460	1700		
OM13S	9/7/2006			8.9				230						6.4	1100		0.84						470	1700		
OR13D	6/3/2008			4.4				93						3.8	620		0.46						270	1200		
OR13D	8/19/2008			4.2				90						3.7	610		0.42						260	1300		
OR13D	4/30/2009			4				89						3.3	770		0.44						220	1200		
OR13D	9/22/2009			3.8				80						3.6	620		0.45						380	1300		
OR13D	4/27/2010			3.5				67						3.3	580		0.42						250	1200		
OR13D	9/8/2010			3.1				72						3.2	690		0.41						330	1200		
OR13D	2/22/2011	<0.005	<0.001	3	0.026	<0.001	<0.001	54	<0.005	<0.002	<0.004	<0.003	<0.25	0.024	440	<0.0002	0.01	0.013	1.4	<0.001	<0.003	0.003	220	1000	<0.001	0.01
OR13D	4/28/2011	<0.005	0.001	3.1	0.028	<0.001	<0.001	53	<0.005	<0.002	<0.004	<0.003	0.31	0.047	440	<0.0002	0.009	<0.005	1.3	<0.001	<0.003	0.004	220	1100	<0.001	<0.006
OR13D	8/26/2011	<0.005	0.001	3.6	0.028	<0.001	<0.001	57	<0.005	<0.002	0.004	0.007	0.28	0.012	470	<0.0002	0.002	0.009	1.3	<0.001	<0.003	0.006	240	1100	<0.001	<0.006
OR13D	10/14/2011	<0.005	0.013	5.5	0.033	<0.001	<0.001	76	<0.005	<0.002	<0.004	0.005	<0.25	4.1	800	<0.0002	0.58	0.017	0.11	<0.001	<0.003	0.01	190	1200	<0.001	<0.006
OR13D	2/24/2012	<0.005	0.004	3.2	0.025	<0.001	<0.001	56	<0.005	<0.002	<0.004	0.004	<0.25	0.18	660	<0.0002	0.01	0.009	1.3	<0.001	<0.003	0.011	170	1000	<0.001	<0.006
OR13D	5/4/2012	<0.005	0.001	3.2	0.028	<0.001	<0.001	51	<0.005	<0.002	<0.004	0.003	0.28	<0.01	540	<0.0002	0.002	0.006	1.4	<0.001	<0.003	0.005	200	1100	<0.001	0.011
OR13D	8/24/2012	<0.005	0.003	2.9	0.027	<0.001	<0.001	61	<0.005	<0.002	<0.004	0.005	0.28	0.094	520	<0.0002	0.006	0.012	1.4	<0.001	<0.003	0.007	310	1100	<0.001	<0.006
OR13D	11/2/2012	<0.005	0.001	3.3	0.026	<0.001	<0.001	55	<0.005	<0.002	<0.004	0.004	<0.25	0.099	500	<0.0002	0.008	0.006	1.4	<0.001	<0.003	0.003	260	1200	<0.001	<0.006
OR13D	2/4/2013	<0.0025	0.001	2.9	0.02	<0.0005	<0.0005	54	<0.005	<0.001	<0.002	<0.0015	0.25	0.059	500	<0.0001	0.068	0.003	1.7	<0.0005	<0.0015	<0.0005	250	1100	<0.0005	<0.003
OR13D	5/2/2013	<0.005	0.002	3.1	0.031	<0.001	<0.001	46	<0.005	<0.002	<0.004	0.005	<0.25	0.085	530	<0.0002	0.013	0.009	1.5	0.004	<0.003	<0.001	270	1100	<0.001	<0.006

Natural Resource Technology

Appendix C-3
Groundwater Analytical Results Since 2000
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Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OR13D	7/29/2013	<0.005	<0.001	3.1	0.028	<0.001	<0.001	41	<0.005	<0.002	<0.004	<0.003	<0.25	0.96	540	<0.0002	0.007	0.007	1.6	<0.001	<0.003	<0.001	270	1200	<0.001	<0.006
OR13D	10/21/2013	<0.005	<0.001	2.5	0.028	<0.001	<0.001	44	<0.005	<0.002	<0.004	<0.003		0.022	500	<0.0002	0.003	<0.005	1.8	<0.001	<0.003	<0.001	320	1100	<0.001	<0.006
OR13D	3/30/2014	<0.005	0.002	3.5	0.032	<0.001	<0.001	110	<0.005	<0.002	<0.004	<0.003		0.22	680	<0.0002	0.51	<0.005	0.08	<0.001	<0.003	<0.001	260	1200	<0.001	<0.006
OR13D	4/24/2014	<0.005	0.001	2.9	0.026	<0.001	<0.001	39	<0.005	<0.002	<0.004	<0.003		0.24	490	<0.0002	0.018	<0.005	1.6	<0.001	<0.003	<0.001	300	1200	<0.001	<0.006
OR13D	7/18/2014			2.7				42						0.12	500		0.032						320	1200		
OR13D	4/17/2015			3				41						0.12	540		0.04						330	1200		
OR13D	9/14/2015			2.3				34						0.14	1300		0.34						290	1200		
OR13S	6/3/2008			7.7				230						5.6	1300		0.8						400	1600		
OR13S	8/19/2008			8.3				240						11	2300		0.86						400	1600		
OR13S	4/30/2009			8.4				220						5.9	2000		0.8						400	1500		
OR13S	9/22/2009			8.4				220						3.6	970		0.8						420	1500		
OR13S	12/8/2009			8.5				210						4.9	950		0.8						370	1600		
OR13S	4/27/2010			6.9				170						7.3	840		0.73						360	1500		
OR13S	9/8/2010			5.8				150						2.8	940		0.61						360	1300		
OR13S	2/22/2011	<0.005	0.007	5.3	0.032	<0.001	<0.001	120	<0.005	<0.002	<0.004	<0.003	<0.25	4.3	770	<0.0002	0.59	0.02	<0.02	<0.001	<0.003	0.003	270	1200	<0.001	0.016
OR13S	4/28/2011	<0.005	0.07	5.2	0.054	<0.001	<0.001	100	<0.005	<0.002	<0.004	<0.003	0.29	14	740	<0.0002	0.66	0.01	<0.02	0.004	<0.003	0.006	270	1300	<0.001	0.009
OR13S	8/26/2011	<0.005	0.003	5.9	0.032	<0.001	<0.001	110	<0.005	<0.002	0.007	0.006	0.26	0.046	660	<0.0002	0.46	0.016	0.68	<0.001	<0.003	0.009	290	1200	<0.001	<0.006
OR13S	10/14/2011	<0.005	0.002	3.1	0.027	<0.001	<0.001	51	<0.005	<0.002	<0.004	0.006	0.26	0.016	570	<0.0002	0.003	0.011	1.3	<0.001	<0.003	0.007	220	1100	<0.001	<0.006
OR13S	2/24/2012	<0.005	0.012	5	0.037	<0.001	<0.001	88	<0.005	<0.002	<0.004	0.003	<0.25	4.5	760	<0.0002	0.54	0.016	<0.02	<0.001	<0.003	0.013	220	1200	<0.001	<0.006
OR13S	5/4/2012	<0.005	0.011	5	0.033	<0.001	<0.001	82	<0.005	<0.002	<0.004	<0.003	0.28	4.8	690	<0.0002	0.54	0.011	0.03	<0.001	<0.003	0.003	220	1200	<0.001	0.01
OR13S	8/24/2012	<0.005	0.014	4.4	0.032	<0.001	<0.001	99	<0.005	<0.002	<0.004	0.004	0.26	4.8	700	<0.0002	0.52	0.021	0.26	<0.001	<0.003	0.009	260	1200	<0.001	<0.006
OR13S	11/2/2012	<0.005	0.011	5	0.031	<0.001	<0.001	51	<0.005	<0.002	<0.004	0.003	<0.25	4.2	690	<0.0002	0.49	0.01	0.07	<0.001	<0.003	0.004	130	1200	<0.001	<0.006
OR13S	2/4/2013	<0.0025	0.006	4.6	0.029	<0.0005	<0.0005	90	<0.005	<0.001	<0.002	<0.0015	<0.25	0.92	710	<0.0001	0.52	0.005	0.05	<0.0005	<0.0015	<0.0005	260	1200	<0.0005	<0.003
OR13S	5/2/2013	<0.005	0.003	5.1	0.036	<0.001	<0.001	91	<0.005	<0.002	0.005	0.005	0.29	0.049	700	<0.0002	0.42	0.014	0.03	<0.001	<0.003	0.001	270	1200	<0.001	<0.006
OR13S	7/29/2013	<0.005	0.008	5.1	0.03	<0.001	<0.001	100	<0.005	<0.002	<0.004	<0.003	<0.25	3.7	690	0	0.54	0.011	<0.02	<0.001	<0.003	0.002	270	1200	<0.001	<0.006
OR13S	10/21/2013	<0.005	0.31	3.7	0.12	0.001	<0.001	100	<0.005	0.004	0.005	0.01		37	720	<0.0002	0.83	0.021	0.04	0.043	0.006	0.001	280	1200	<0.001	0.033
OR13S	3/30/2014	<0.005	<0.001	2.6	0.031	<0.001	<0.001	45	<0.005	<0.002	<0.004	<0.003		0.04	540	<0.0002	0.018	<0.005	1.6	<0.001	<0.003	<0.001	290	1200	<0.001	<0.006
OR13S	4/24/2014	<0.005	0.008	4.5	0.036	<0.001	<0.001	100	<0.005	<0.002	<0.004	<0.003		4.8	620	<0.0002	0.53	<0.005	<0.2	<0.001	<0.003	<0.001	270	1200	<0.001	<0.006
OR13S	7/18/2014			4.2				100						3.9	610		0.51						300	1200		
OR13S	4/17/2015			4.6				120						0.045	1200		0.47						290	1300		
OR13S	9/14/2015			9				170						5.4	5500		0.41						290	1300		
OM14	4/24/2000			0.61				5.1						2.3	790		0.61						240	920		
OM14	9/18/2000			0.65				6.9						2.3	640		0.65						200	800		
OM14	4/24/2001			0.63				6.5						2.7	630		0.57						190	807		
OM14	9/13/2001			0.71				7.5						9.5	830		1						210	870		
OM14	4/25/2002			0.57				6.8						2.3	674		0.56						170	830		
OM14	9/25/2002			0.54				6.8						2	700		0.6						170	750		
OM14	4/17/2003			0.58				7.4						2.2	660		0.62						160	770		
OM14	9/23/2003			0.47				7.3						2.2	640		0.68						150	710		
OM14	4/12/2004			0.5				6.2						1.5	860		0.54						160	740		
OM14	9/23/2004			0.54				6.1						2	720		0.59						130	730		
OM14	4/19/2005			0.77				16						2.7	752		0.71						290	970		
OM14	9/19/2005			0.51				7.9						0.97	570		0.36						150	720		
OM14	4/28/2006			0.63				7.6						0.19	650		0.16						160	690		
OM14	9/8/2006			0.59				13						1.8	670		0.63						210	800		
OM14	4/2/2007			1.4				16						<0.01	570		0.011						190	690		
OM14	9/19/2007			0.8				21						<0.01	500		0.005						240	840		
OM14	3/27/2008			14				290						0.023	1100		0.26						580	1900		
OM14	6/3/2008			130				1400						0.017	1700		0.085						950	5500		
OM14	8/19/2008			180				2400						0.035	3500		0.31						910	2500		
OR14D	4/30/2009			34				460						1.6	2200		2.5						980	3200		
OR14D	9/22/2009			27				470						1	1600		2.1						970	2500		
OR14D	12/8/2009			25				310						1.9	1700		2.6						1200	2600		
OR14D	4/27/2010			14				180						9.1	1700		2.5						990	2400		
OR14D	9/8/2010			17				260						0.026	1200		0.011						680	1900		
OR14D	2/22/2011	<0.005	0.001	17	0.038	<0.001	<0.001	230	<0.005	<0.002	0.008	<0.003	0.29	<0.01	1200	<0.0002	0.035	0.023	1.7	<0.001	<0.003	0.006	680	1800	<0.001	0.019
OR14D	4/29/2011	<0.005	0.001	16	0.028	<0.001	<0.001	200	<0.005	<0.002	0.007	<0.003	<0.25	0.026	1300	<0.0002	0.022	0.007	1.3	<0.001	<0.003	0.006	770	1800	<0.001	<0.006
OR14D	8/25/2011																									
OR14D	8/26/2011	<0.005	0.003	16	0.026	<0.001	<0.001	210	<0.005	<0.002	0.009	0.004	0.47	<0.01	1400	<0.0002	0.002	0.022	1.2	<0.001	<0.003	0.012	760	2000	<0.001	0.007
OR14D	10/13/2011	<0.005	0.002	13	0.023	<0.001	<0.001	170	<0.005	<0.002	0.005	<0.003	0.51	0.94	1500	<0.0002	1.6	0.023	0.2	<0.001	<0.003	0.012	940	2100	<0.001	0.009

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OR14D	2/22/2012	<0.005	0.004	13	0.021	<0.001	<0.001	170	<0.005	<0.002	0.005	<0.003	<0.25	<0.01	1300	<0.0002	0.004	0.024	0.92	<0.001	<0.003	0.016	780	1800	<0.001	<0.006
OR14D	5/4/2012	<0.005	0.002	13	0.019	<0.001	<0.001	130	<0.005	<0.002	0.004	<0.003	0.41	<0.01	1500	<0.0002	0.002	0.014	0.74	<0.001	<0.003	0.008	670	1800	<0.001	0.007
OR14D	8/24/2012	<0.005	0.003	11	0.02	<0.001	<0.001	140	<0.005	<0.002	0.005	<0.003	0.29	0.017	1400	<0.0002	0.002	0.032	0.84	<0.001	<0.003	0.011	850	1800	<0.001	<0.006
OR14D	11/2/2012	<0.005	0.002	12	0.019	<0.001	<0.001	190	<0.005	<0.002	<0.004	0.004	<0.25	0.01	1400	<0.0002	0.001	0.012	1.1	<0.001	<0.003	0.005	740	1900	<0.001	<0.006
OR14D	2/4/2013	<0.0025	<0.0005	4.5	0.009	<0.0005	<0.0005	86	<0.005	<0.001	<0.002	<0.0015	0.41	0.011	1200	<0.0001	0.46	<0.0025	0.32	<0.0005	<0.0015	<0.0005	700	1600	<0.0005	<0.003
OR14D	5/2/2013	<0.005	0.002	8.7	0.018	<0.001	<0.001	88	<0.005	<0.002	<0.004	<0.003	0.25	0.013	1200	<0.0002	0.003	0.02	0.42	<0.001	<0.003	<0.001	670	1600	<0.001	<0.006
OR14D	7/29/2013	<0.005	0.001	8.9	0.019	<0.001	<0.001	95	<0.005	<0.002	<0.004	<0.003	0.35	<0.01	1200	<0.0002	0.001	0.015	0.4	<0.001	<0.003	<0.001	710	1700	<0.001	<0.006
OR14D	10/21/2013	<0.005	<0.001	7.2	0.02	<0.001	<0.001	120	<0.005	<0.002	<0.004	<0.003		<0.01	1100	<0.0002	0.002	<0.005	0.44	<0.001	<0.003	<0.001	840	1600	<0.001	<0.006
OR14D	3/30/2014	<0.005	<0.001	5.2	0.018	<0.001	<0.001	73	<0.005	<0.002	<0.004	<0.003		0.02	990	<0.0002	0.088	<0.005	0.28	<0.001	<0.003	<0.001	650	1300	<0.001	<0.006
OR14D	4/24/2014	<0.005	<0.001	6.7	0.017	<0.001	<0.001	71	<0.005	<0.002	<0.004	<0.003	0.38	0.045	910	<0.0002	0.007	<0.005	0.3	<0.001	<0.0015	<0.001	600	1400	<0.001	<0.006
OR14D	7/17/2014			6.3				76						<0.01	950		0.005						640	1400		
OR14D	4/17/2015			7.1				100						0.18	1100		0.056						690	1400		
OR14D	9/15/2015			6.3				92						0.031	1200		0.062						650	1600		
OR14S	4/30/2009			32				450						0.44	2300		3.2						1200	3100		
OR14S	9/22/2009			41				620						3.4	2200		3.4						1200	3200		
OR14S	12/8/2009			22				250						0.34	1700		3.2						1300	2500		
OR14S	4/27/2010			13				160						3.5	1700		2.6						1000	2400		
OR14S	9/8/2010			13				140						0.65	1600		2.8						750	2400		
OM15	4/25/2000			0.84				1.8						2	770		0.19						220	1000		
OM15	9/18/2000			0.78				9.4						2.2	620		0.2						240	970		
OM15	4/24/2001			0.73				8.4						2.5	660		0.18						220	980		
OM15	9/13/2001			0.46				8.3						2.5	820		0.2						260	1000		
OM15	4/24/2002			0.73				9.2						3.8	714		0.24						100	1000		
OM15	9/24/2002			0.71				9.2						2.5	630		0.24						220	1000		
OM15	4/17/2003			0.72				10						2.3	620		0.21						210	1000		
OM15	9/23/2003			0.65				10						0.6	640		0.13						220	950		
OM15	4/12/2004			0.63				9.1						2.2	840		0.19						220	980		
OM15	9/23/2004			0.73				7.5						2.6	940		0.21						210	1000		
OM15	4/18/2005			0.77				8.6						2.5	630		0.23						210	960		
OM15	9/19/2005			0.57				9.8						0.05	590		0.22						200	920		
OM15	4/28/2006			0.73				8.8						2.9	630		0.26						220	970		
OM15	9/8/2006			1.2				14						1.8	700		0.13						240	980		
OM15	4/3/2007			0.99				8.9						2.1	620		0.2						220	1500		
OM15	9/20/2007			0.75				7						0.12	850		0.23						220	970		
OM15	3/27/2008			0.57				7.9						1.2	540		0.33						160	910		
OM15	6/2/2008			0.86				8.5						2.2	900		0.22						200	910		
OM15	8/18/2008			0.85				9.3						2	1200		0.24						200	960		
OM15	4/29/2009			0.76				10						1.8	920		0.2						200	940		
OM15	9/21/2009			0.17				4.8						0.094	200		0.017						29	340		
OM15	12/11/2009			0.094				5.4						0.012	420		0.004						32	430		
OM15	4/27/2010			0.17				3.6						0.21	330		0.017						36	390		
OM16	4/25/2000			0.07				5.7						2.3	2900		4.1						2000	3700		
OM16	9/18/2000			0.065				6.1						2.1	2600		3.9						2400	3633		
OM16	4/24/2001			0.08				6.6						0.79	2000		6.6						1200	2503		
OM16	9/13/2001			0.1				18						0.35	2200		6.6						1500	2800		
OM16	4/24/2002			0.11				6.9						3.7	2412		5.4						1100	2900		
OM16	9/24/2002			0.041				7.4						6.2	2700		6.7						1600	3300		
OM16	4/17/2003			0.46				7.6						6.1	2300		7.9						1400	2800		
OM16	9/23/2003			0.065				8.4						2	2200		7						1400	2300		
OM16	4/12/2004			0.066				9.3						8.3	2400		5.3						1500	2800		
OM16	9/23/2004			0.09				9.9						8.8	2900		3.9						1800	3500		
OM16	4/18/2005			0.41				49						13	2500		4.2						2000	3400		
OM16	9/19/2005			0.025				6.4						11	2600		4.5						1300	3300		
OM16	6/7/2006			0.044				6.2						13	2600		4.3						1900	3600		
OM16	9/8/2006			1.1				26						8.3	2600		5.2						1800	3400		
OM16	4/3/2007			0.32				9.3						6.9	2600		3.6						2000	980		
OM16	9/20/2007			0.36				7.5						14	2200		4.3						1900	3600		
OM16	3/27/2008			0.12				17						18	2500		3.9						1800	3300		
OM16	6/2/2008			0.15				4.7						1.9	2400		3.8						2000	3500		
OM16	8/18/2008			0.048				6.3						5	3500		4.3						2000	3500		

NATURAL RESOURCE TECHNOLOGY

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

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OM16	4/29/2009			0.061				9.2						0.4	2800		4						2400	3400		
OM16	9/21/2009			0.042				7.6						3.7	2600		4.5						1900	3300		
OM16	12/11/2009			0.051				5.5						5.2	2700		5.5						2400	3600		
OM16	4/28/2010			0.088				5.9						0.052	2700		4.8						2000	3500		
OM16	9/7/2010			0.052				7.1						0.72	2900		6.1						1600	3400		
OM17	4/25/2000			0.12				2						3.9	890		0.49						460	330		
OM17	9/18/2000			0.17				3.1						4.2	1200		1.1						820	1573		
OM17	4/24/2001			0.05				2.1						8.2	1000		1.2						380	923		
OM17	9/13/2001			2.8				2.5						11	970		1.6						440	1200		
OM17	4/24/2002			0.14				2.6						0.16	1051		0.59						360	1300		
OM17	9/24/2002			0.12				3.2						5.5	1400		1.7						730	1700		
OM17	4/17/2003			0.22				8						1.2	680		0.28						330	860		
OM17	9/23/2003			0.12				3.4						0.59	820		0.93						290	1000		
OM17	4/12/2004			0.31				8.7						0.28	860		0.53						240	720		
OM17	4/18/2005			0.16				2.4						0.026	550		0.42						230	720		
OM17	4/3/2007			0.17				2.6						0.054	820		0.042						460	3700		
OM17	8/18/2008			0.14				2.1						0.21	460		2.9						290	680		
OM17	12/11/2009			0.1				6.9						<0.01	770		0.34						340	900		
OM17	9/7/2010			0.1				4.8						0.42	750		1.2						390	880		
OM18	4/25/2000			0.64				6.2						5.3	890		0.23						220	1000		
OM18	9/18/2000			0.56				4.6						5.8	720		0.22						240	1020		
OM18	4/24/2001			0.72				4.4						6.2	780		0.26						240	1050		
OM18	9/13/2001			0.28				5						5.7	970		0.23						200	1000		
OM18	4/24/2002			0.55				3.7						5.8	862		0.22						170	1000		
OM18	9/24/2002			0.52				4.2						5.5	810		0.24						170	1000		
OM18	4/17/2003			0.47				4						5.6	720		0.19						180	970		
OM18	9/23/2003			0.4				4						2.2	620		0.23						81	730		
OM18	4/12/2004			0.47				4.7						5.4	920		0.18						210	970		
OM18	9/23/2004			0.48				4.3						6	1100		0.21						190	1000		
OM18	4/18/2005			0.45				4						0.014	570		0.34						60	700		
OM18	9/19/2005			0.39				3.8						<0.01	580		0.22						64	680		
OM18	4/28/2006			0.53				4.7						4.9	730		0.16						190	940		
OM18	9/8/2006			0.4				4.3						<0.01	590		0.13						65	740		
OM18	4/3/2007			0.43				4.3						<0.01	510		0.11						62	1000		
OM18	9/20/2007			3.9				51						0.013	450		0.25						68	680		
OM18	3/27/2008			0.44				3.5						4.8	460		0.15						73	650		
OM18	6/2/2008			0.63				7.2						6.3	750		0.18						240	1000		
OM18	8/18/2008			0.66				6						5.4	1100		0.21						240	1000		
OM18	4/29/2009			0.42				26						9.3	810		0.27						110	740		
OM18	9/21/2009			0.43				5.3						<0.01	610		0.16						100	750		
OM18	12/11/2009			0.44				8.6						0.97	640		0.25						91	740		
OM18	4/27/2010			0.44				3.2						<0.01	590		0.19						75	730		
OM18	9/7/2010			0.4				4.9						0.034	610		0.18						91	690		
OR18	6/2/2008			0.76				9.8						4.5	670		0.21						300	1200		
OR18	8/18/2008			0.75				8						5.4	1400		0.21						280	1200		
OR18	4/29/2009			0.51				29						6.2	710		0.44						130	810		
OR18	9/21/2009			0.54				6.4						0.2	650		0.23						100	750		
OR18	12/11/2009			0.57				9						4.6	690		0.19						130	790		
OR18	4/27/2010			0.53				3.3						0.013	630		0.12						82	770		
OR18	9/7/2010			0.51				5						0.027	680		0.16						98	770		
OM19	4/24/2000			44				560						9.9	1600		0.68						1200	3700		
OM19	9/19/2000			54				680						11	2900		0.74						1400	3500		
OM19	4/24/2001			53				710						11	2200		0.77						1100	3520		
OM19	9/13/2001			50				550						10	2200		0.88						1300	4000		
OM19	4/24/2002			30				300						10	1682		0.68						750	3400		
OM19	9/24/2002			38				460						8.9	2000		0.69						1100	3500		
OM19	4/18/2003			41				520						9.8	2100		0.64						1200	3400		
OM19	9/24/2003			39				580						11	2000		0.6						1300	3400		
OM19	4/13/2004			42				640						10	2500		0.65						1200	3700		
OM19	9/23/2004			54				670						11	2500		0.89						1200	3900		

NATURAL RESOURCE TECHNOLOGY

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

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OM19	4/19/2005			17				230						13	2000		0.55						1300	2900		
OM19	9/20/2005			14				140						8.6	1800		0.44						1100	2700		
OM19	4/28/2006			36				680						11	2200		0.67						1200	3700		
OM19	9/7/2006			13				260						2.2	840		0.26						920	2400		
OM19	4/2/2007			18				190						5	1700		0.55						1200	2600		
OM19	9/19/2007			5				96						<0.01	1700		0.028						1200	2600		
OM19	3/27/2008			19				380						7.1	3400		0.51						1200	3200		
OM19	6/3/2008			41				810						11	2000		0.69						1200	4100		
OM19	8/19/2008			10				150						9.3	1900		0.47						1200	2800		
OM19	4/29/2009			6.8				150						8.5	1900		0.46						1300	2600		
OM19	9/21/2009			11				160						<0.01	1800		0.36						1200	2500		
OM19	12/8/2009			13				180						3	1800		0.39						1200	2600		
OM19	4/27/2010			25				320						0.03	1700		0.14						1000	2800		
OM19	9/7/2010			17				270						8.1	1400		0.86						890	2200		
OR19	6/3/2008			68				1000						13	2300		1.3						1200	4800		
OR19	8/19/2008			25				360						12	2200		0.72						1300	3200		
OR19	4/29/2009			22				300						3	2200		0.85						1400	3000		
OR19	9/21/2009			24				340						0.01	2100		0.8						1400	3100		
OR19	12/8/2009			0.87				12						21	1200		1.4						430	1400		
OR19	4/27/2010			34				350						4.8	1700		0.96						1000	2800		
OR19	9/7/2010			18				220						8.8	1600		0.91						980	2200		
OR19	2/23/2011	<0.005	0.004	20	0.022	<0.001	<0.001	200	<0.005	<0.002	0.007	<0.003	0.3	16	1600	<0.0002	0.9	0.027	<0.02	<0.001	<0.003	0.006	830	2200	<0.001	0.007
OR19	4/28/2011	<0.005	0.004	18	0.018	<0.001	<0.001	160	<0.005	<0.002	0.005	<0.003	<0.25	8.5	1600	<0.0002	0.99	0.008	0.17	<0.001	<0.003	0.009	850	2200	<0.001	0.019
OR19	8/25/2011	<0.005	0.003	16	0.019	<0.001	<0.001	140	<0.005	<0.002	0.006	0.004	0.34	8.1	1800	<0.0002	0.87	0.024	<0.02	<0.001	<0.003	0.011	800	2000	<0.001	<0.006
OR19	10/12/2011	<0.005	0.004	16	0.036	<0.001	<0.001	150	<0.005	<0.002	0.005	<0.003	0.48	9.3	1500	<0.0002	0.94	0.015	<0.02	<0.001	<0.003	0.013	820	2000	<0.001	<0.006
OR19	2/24/2012	<0.005	0.006	17	0.037	<0.001	<0.001	130	<0.005	<0.002	0.005	<0.003	0.3	9.2	1600	<0.0002	0.83	0.025	<0.02	<0.001	<0.003	0.016	770	2100	<0.001	<0.006
OR19	5/4/2012	<0.005	0.004	22	0.024	<0.001	<0.001	180	<0.005	<0.002	0.006	<0.003	0.3	9.8	1500	<0.0002	0.74	0.017	<0.02	<0.001	<0.003	0.007	780	2200	<0.001	0.013
OR19	8/24/2012	<0.005	0.005	24	0.019	<0.001	<0.001	240	<0.005	<0.002	0.009	<0.003	<0.25	9.2	1700	<0.0002	0.69	0.037	0.24	<0.001	<0.003	0.016	930	2400	<0.001	<0.006
OR19	11/1/2012	<0.005	0.005	16	0.043	<0.001	<0.001	200	<0.005	<0.002	<0.004	<0.003	0.46	12	1500	<0.0002	0.88	0.015	0.08	<0.001	<0.003	0.005	900	2100	<0.001	0.025
OR19	2/5/2013	<0.0025	0.002	16	0.048	<0.0005	<0.0005	140	<0.005	<0.001	<0.002	<0.0015	0.31	3.1	1500	<0.0001	0.82	0.006	0.07	<0.0005	<0.0015	<0.0005	750	2000	<0.0005	0.026
OR19	5/15/2013	<0.005	<0.001	14	0.023	<0.001	<0.001	170	<0.005	<0.002	<0.004	<0.003	0.27	6.1	1500	<0.0002	0.86	<0.005	<0.02	<0.001	<0.003	<0.001	840	1900	<0.001	<0.006
OR19	7/26/2013	<0.005	0.002	13	0.023	<0.001	<0.001	130	<0.005	<0.002	<0.004	<0.003	0.31	0.47	1700	<0.0002	0.89	0.018	0.04	<0.001	<0.003	0.002	860	2000	<0.001	0.007
OR19	10/21/2013	<0.005	<0.001	12	0.015	<0.001	<0.001	160	<0.005	<0.002	<0.004	<0.003		1.5	1200	<0.0002	0.85	<0.005	<0.02	<0.001	<0.003	<0.001	980	2000	<0.001	<0.006
OR19	3/30/2014	<0.005	<0.001	12	0.025	<0.001	<0.001	140	<0.005	<0.002	<0.004	<0.003		1.4	1400	<0.0002	0.85	<0.005	0.11	<0.001	<0.003	<0.001	820	2000	<0.001	<0.006
OR19	4/24/2014	<0.005	<0.001	16	0.022	<0.001	<0.001	140	<0.005	<0.002	<0.004	<0.003		2.6	1400	<0.0002	0.85	<0.005	0.11	<0.001	<0.0015	<0.001	820	2000	<0.001	0.006
OR19	7/17/2014			18				190						0.015	1400		0.69						920	2200		
OR19	4/17/2015			20				240						0.14	1500		0.78						990	2000		
OR19	9/14/2015			14				130						7.7	1800		0.79						730	2000		
OM20	4/24/2000			210				1800						6.5	4500		2.3						1400	6700		
OM20	9/19/2000			220				1800						6.6	3800		2.4						1400	6500		
OM20	4/24/2001			190				1800						7.4	3800		2.4						1400	5993		
OM20	9/13/2001			210				2000						7	4100		2.6						1500	6600		
OM20	4/24/2002			190				1200						7.4	2991		2.3						790	7700		
OM20	9/24/2002			200				2000						6.9	4400		2.9						1300	7000		
OM20	4/18/2003			240				2400						7.8	4400		2.8						1300	6200		
OM20	9/24/2003			210				2600						8.1	4400		2.8						1400	8100		
OM20	4/13/2004			180				2600						8.1	4500		2.5						1300	9800		
OM20	9/23/2004			260				3000						8.7	5300		3.6						1300	11000		
OM20	4/19/2005			230				2400						5.5	4200		2.2						1300	9900		
OM20	9/20/2005			220				2100						2	4000		2.1						1200	6200		
OM20	4/28/2006			200				4900						8.3	4100		2.9						1300	8000		
OM20	9/7/2006			150				1800						2.2	3200		1.2						1100	5600		
OM20	4/2/2007			140				1400						0.031	2700		0.075						930	4800		
OM20	9/19/2007			220				2800						6.4	4100		2.5						1200	8400		
OM20	3/27/2008			260				3700						8.7	4200		2.7						1300	8600		
OM20	6/3/2008			230				3300						8.1	3500		3						1200	8300		
OM20	8/19/2008			240				3400						8.4	4900		2.9						1200	3200		
OM20	4/29/2009			200				2600						0.38	3900		0.39						1000	5200		
OM20	9/21/2009			45				690						<0.01	1700		<0.001						260	2800		
OM20	12/8/2009			240				3200						7.8	4800		3.1						1200	7200		

Appendix C-3
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Supplemental Hydrogeologic Site Characterization Report
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Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM20	4/27/2010			190				2600						7.5	4100		2.4						1100	8700		
OM20	9/7/2010			83				1200						4.2	2300		1.2						840	4000		
OR20	6/3/2008			240				3300						9.8	3300		3.7						1200	8800		
OR20	8/19/2008			250				3500						9	4500		3.4						1200	3300		
OR20	4/29/2009			260				3600						7.9	5700		3.1						1400	8100		
OR20	9/21/2009			90				1200						<0.01	1900		1.5						490	3400		
OR20	12/8/2009			220				3200						8.9	4700		4.2						1400	7300		
OR20	4/27/2010			210				2500						7.9	4600		2.7						1000	9200		
OR20	9/7/2010			130				2100						5.2	3600		1.8						1100	5800		
OR20	2/23/2011	<0.005	0.012	140	0.029	<0.001	<0.001	1700	<0.005	0.003	0.046	<0.003	0.73	5.3	5800	<0.0002	1.6	0.072	<0.02	<0.001	<0.003	0.033	860	4900	<0.001	0.007
OR20	4/28/2011	<0.005	0.014	150	0.026	<0.001	<0.001	1800	<0.005	0.002	0.058	<0.003	0.72	0.1	3000	<0.0002	1.5	0.035	1	<0.001	<0.003	0.059	1100	4900	<0.001	<0.006
OR20	8/25/2011	<0.005	0.02	130	0.029	<0.001	<0.001	1400	<0.005	0.003	0.048	0.008	<0.25	4.3	2600	<0.0002	1.4	0.07	<0.02	<0.001	<0.003	0.059	800	4400	<0.001	0.009
OR20	10/12/2011	<0.005	0.014	130	0.034	<0.001	<0.001	1600	<0.005	0.002	0.031	0.006	<2.5	4.4	2500	<0.0002	1.4	0.043	1.3	<0.001	<0.003	0.056	930	4100	<0.001	<0.006
OR20	2/24/2012	<0.005	0.019	110	0.024	<0.001	<0.001	950	<0.005	0.002	0.037	0.004	0.3	3.5	2400	<0.0002	1.2	0.06	0.08	<0.001	<0.003	0.066	590	3600	<0.001	<0.006
OR20	5/4/2012	<0.005	0.008	160	0.029	<0.001	<0.001	1000	<0.005	<0.002	0.025	0.003	0.67	0.071	2000	<0.0002	1.1	0.044	0.38	<0.001	<0.003	0.033	620	3700	<0.001	0.007
OR20	8/24/2012	<0.005	0.015	100	0.02	<0.001	<0.001	1300	<0.005	0.002	0.042	0.004	<0.25	4.7	2400	<0.0002	1.1	0.086	<0.02	<0.001	<0.003	0.051	960	3600	<0.001	<0.006
OR20	11/1/2012	<0.005	0.011	110	0.023	<0.001	<0.001	1100	<0.005	<0.002	0.013	0.004	<0.25	3.7	2100	<0.0002	1	0.037	<0.02	<0.001	<0.003	0.024	680	3400	<0.001	<0.006
OR20	2/5/2013	<0.0025	0.003	100	0.032	<0.0005	<0.0005	990	<0.005	0.001	<0.002	<0.0015	0.31	3.7	2100	<0.0001	1.1	0.02	<0.02	<0.0005	<0.0015	<0.0005	690	3000	<0.0005	0.003
OR20	5/15/2013	<0.005	<0.001	95	0.031	<0.001	<0.001	1000	<0.005	<0.002	<0.004	<0.003	0.25	0.037	1900	<0.0002	0.97	0.02	0.15	<0.001	<0.003	<0.001	680	3200	<0.001	<0.006
OR20	7/26/2013	<0.005	0.008	83	0.037	<0.001	<0.001	980	<0.005	0.002	0.022	<0.003	0.39	0.053	2100	<0.0002	0.99	0.041	0.12	<0.001	<0.003	0.015	710	3000	<0.001	<0.006
OR20	10/21/2013	<0.005	0.002	68	0.026	<0.001	<0.001	920	<0.005	<0.002	<0.004	<0.003		3	1500	<0.0002	1.1	0.02	<0.02	<0.001	<0.003	<0.001	820	2700	<0.001	<0.006
OR20	3/30/2014	<0.005	0.003	71	0.026	<0.001	<0.001	950	<0.005	<0.002	<0.004	<0.003		3.4	1600	<0.0002	1.1	0.02	<0.02	<0.001	<0.003	<0.001	830	2500	<0.001	<0.006
OR20	4/24/2014	<0.005	<0.001	75	0.022	<0.001	<0.001	710	<0.005	<0.002	<0.004	<0.003		0.033	1400	<0.0002	0.96	0.022	0.6	<0.001	<0.0015	<0.001	570	2900	<0.001	<0.006
OR20	7/17/2014			82				740						<0.01	1300		0.9						630	2700		
OR20	4/17/2015			74				740						0.02	1600		0.88						620	2600		
OR20	9/14/2015			65				730						0.056	1700		0.73						550	2800		
OM21	4/24/2000			5.7				30						10	2100		0.88						1600	3000		
OM21	9/18/2000			3.5				18						5.9	1300		0.32						1300	2400		
OM21	4/24/2001			2.7				44						10	2000		1.2						1500	3133		
OM21	9/13/2001			2.7				14						6.1	1400		0.36						1200	2600		
OM21	4/24/2002			1				59						11	1860		1.6						1200	3200		
OM21	9/24/2002			2.6				16						5.8	1400		0.41						1100	2600		
OM21	4/17/2003			1.3				45						7.2	1500		0.59						1800	2800		
OM21	9/23/2003			1.4				21						3.7	1300		0.31						1200	2500		
OM21	4/12/2004			1.2				55						8.1	1800		0.95						1400	2800		
OM21	9/23/2004			1.4				26						7.1	1800		0.33						1200	2600		
OM21	4/18/2005			1.2				27						0.62	1400		0.34						1100	2500		
OM21	9/19/2005			1.4				25						<0.01	1400		0.29						1000	2400		
OM21	4/28/2006			4.1				310						13	2000		2						1400	3300		
OM21	9/7/2006			2.8				28						<0.01	780		0.23						1100	2400		
OM21	4/2/2007			1.5				28						<0.01	1200		0.14						1200	2400		
OM21	9/19/2007			1.4				42						<0.01	1000		0.31						1100	2400		
OM21	3/27/2008			14				450						9.9	1800		0.94						1200	3200		
OM21	6/3/2008			3.5				390						7.4	1400		0.54						1200	3100		
OM21	8/19/2008			7.5				490						8.6	1900		0.47						1300	3400		
OM21	4/30/2009			4.6				540						11	2300		0.51						1300	3300		
OM21	9/22/2009			3.1				340						0.01	1600		0.43						1400	2800		
OM21	12/8/2009			4.9				450						0.88	1800		0.49						1500	3200		
OM21	4/27/2010			4.2				380						0.012	1800		0.42						1200	3200		
OM21	9/8/2010			6.6				400						0.22	1800		0.65						1200	3100		
OM21	2/22/2011	<0.005	0.003	9.8	0.028	<0.001	<0.001	450	<0.005	<0.002	0.014	<0.003	<0.25	9.3	1900	<0.0002	0.68	0.031	0.032	<0.001	<0.003	0.012	1200	3200	<0.001	0.012
OM21	4/29/2011	<0.005	0.003	11	0.021	<0.001	<0.001	500	<0.005	<0.002	0.018	<0.003	<0.25	7.6	2000	<0.0002	0.71	0.009	0.53	0.001	<0.003	0.014	1200	3200	<0.001	<0.006
OM21	8/25/2011	<0.005	0.004	12	0.019	<0.001	<0.001	470	<0.005	<0.002	0.02	0.009	<0.25	0.081	1900	<0.0002	0.74	0.026	1.1	<0.001	<0.003	0.019	1300	3200	<0.001	0.015
OM21	10/14/2011	<0.005	0.006	10	0.017	<0.001	<0.001	420	<0.005	<0.002	0.016	0.007	<0.25	8.8	1800	<0.0002	0.61	0.024	0.49	<0.001	<0.003	0.021	1000	3000	<0.001	<0.006
OM21	2/24/2012	<0.005	0.007	9.3	0.023	<0.001	<0.001	390	<0.005	<0.002	0.014	0.005	<0.25	0.034	1900	<0.0002	0.55	0.027	4.9	<0.001	<0.003	0.027	1100	3100	<0.001	0.017
OM21	5/3/2012	<0.005	0.003	11	0.019	<0.001	<0.001	440	<0.005	<0.002	0.013	0.004	<0.25	<0.01	1800	<0.0002	0.63	0.017	2.1	<0.001	<0.003	0.013	1200	3100	<0.001	0.018
OM21	8/24/2012	<0.005	0.005	9.5	0.016	<0.001	<0.001	520	<0.005	<0.002	0.018	0.006	0.45	0.019	2000	<0.0002	0.59	0.039	1.1	<0.001	<0.003	0.021	1300	3200	<0.001	<0.006
OM21	11/2/2012	<0.005	0.002	9.3	0.017	<0.001	<0.001	480	<0.005	<0.002	0.005	0.006	<0.25	0.014	2000	<0.0002	0.59	0.014	0.92	<0.001	<0.003	0.008	1300	3100	<0.001	0.012
OM21	2/4/2013	<0.0025	<0.0005	5	0.009	<0.0005	<0.0005	400	<0.005	<0.001	<0.002	<0.0015	0.28	0.017	1800	<0.0001	0.31	<0.0025	1	<0.0005	<0.0015	<0.0005	1200	3000	<0.0005	0.008
OM21	5/2/2013	<0.005	0.005	12	0.021	<0.001	<0.001	490	<0.005	<0.002	0.016	0.007	<0.25	0.029	2000	<0.0002	0.68	0.027	3.3	<0.001	<0.003	0.01	1300	3200	<0.001	0.014

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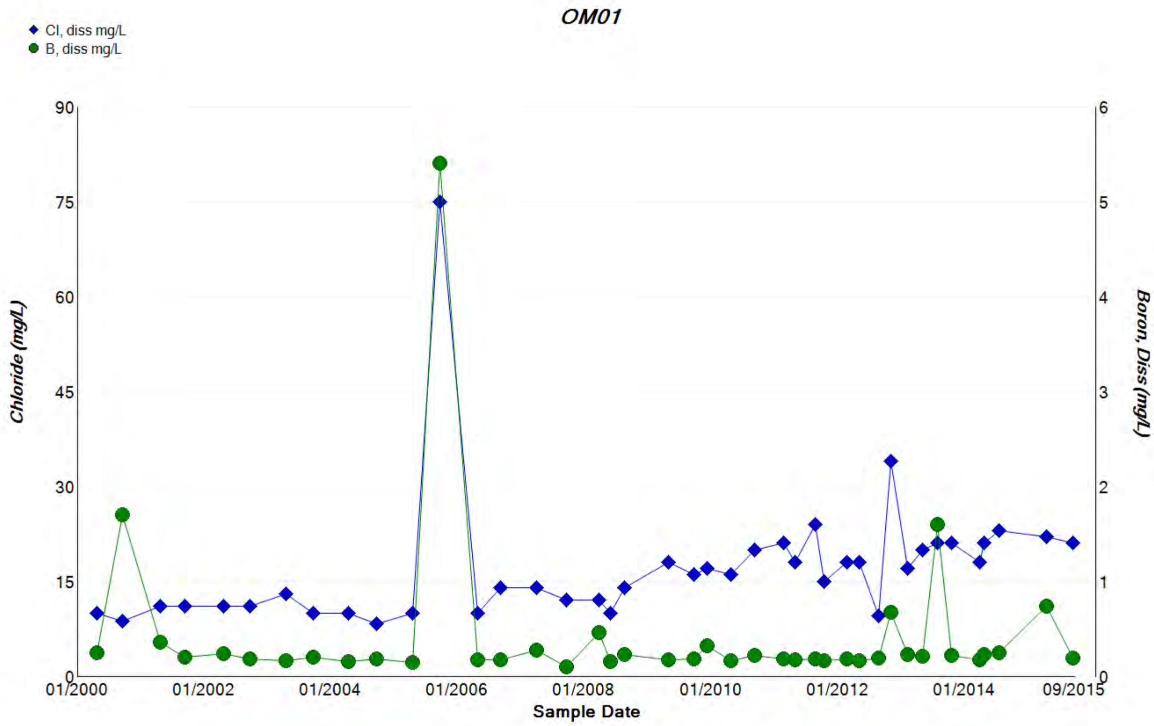
Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM21	7/29/2013	<0.005	0.004	14	0.019	<0.001	<0.001	520	<0.005	<0.002	0.012	0.004	<0.25	0.13	2000	<0.0002	0.57	0.021	1.5	<0.001	<0.003	0.009	1200	3300	<0.001	0.011
OM21	10/21/2013	<0.005	<0.001	11	0.02	<0.001	<0.001	550	<0.005	<0.002	<0.004	<0.003		0.96	1600	<0.0002	0.59	<0.005	1.3	<0.001	<0.003	<0.001	1400	3200	<0.001	<0.006
OM21	3/30/2014	<0.005	<0.001	11	0.02	<0.001	<0.001	490	<0.005	<0.002	<0.004	<0.003		<0.01	1900	<0.0002	0.54	<0.005	3.9	<0.001	<0.003	<0.001	1200	3200	<0.001	0.007
OM21	4/24/2014	<0.005	<0.001	14	0.02	<0.001	<0.001	500	<0.005	<0.002	<0.004	<0.003		0.018	1700	<0.0002	0.58	<0.005	4.4	<0.001	<0.0015	<0.001	1300	3300	<0.001	<0.006
OM21	7/18/2014			14				560						<0.01	1800		0.58						1400	3400		
OM21	4/17/2015			16				500						0.16	2000		0.45						1300	3200		
OM21	9/15/2015			15				460						0.028	2100		0.74						1300	3200		
OM22D	12/7/2009			2.7				81						0.024	310		0.24						94	460		
OM22D	4/28/2010			3				84						0.056	340		0.073						120	530		
OM22D	9/9/2010			3.7				100						0.02	370		0.1						170	600		
OM22D	2/22/2011	<0.005	0.002	12	0.05	<0.001	<0.001	260	<0.005	0.01	0.008	<0.003	<0.25	1.4	1200	<0.0002	2.1	0.043	<0.02	<0.001	<0.003	0.003	500	1700	<0.001	0.007
OM22D	4/28/2011	<0.005	<0.001	4.3	0.05	<0.001	<0.001	96	<0.005	<0.002	0.004	<0.003	0.62	0.01	300	<0.0002	0.031	0.009	2	<0.001	<0.003	0.004	150	600	<0.001	0.032
OM22D	8/25/2011																									
OM22D	8/29/2011	<0.005	0.001	5	0.058	<0.001	<0.001	110	<0.005	<0.002	0.004	0.004	0.82	<0.01	450	<0.0002	0.002	0.014	2	<0.001	<0.003	0.009	190	660	<0.001	0.02
OM22D	10/14/2011	<0.005	0.004	8.4	0.085	<0.001	<0.001	110	<0.005	<0.002	0.007	0.007	0.62	<0.01	740	<0.0002	0.56	0.026	1.5	<0.001	<0.003	0.012	180	810	<0.001	0.045
OM22D	2/24/2012	<0.005	0.006	11	0.083	<0.001	<0.001	210	<0.005	0.007	0.009	<0.003	0.31	0.71	1100	<0.0002	2	0.036	0.23	<0.001	<0.003	0.019	420	1400	<0.001	<0.006
OM22D	5/3/2012	<0.005	0.002	12	0.052	<0.001	<0.001	250	<0.005	0.004	0.009	<0.003	0.31	1.3	1100	<0.0002	1.4	0.028	0.11	<0.001	<0.003	0.007	470	1600	<0.001	0.017
OM22D	8/24/2012	<0.005	0.003	11	0.089	<0.001	<0.001	250	<0.005	0.006	0.01	<0.003	0.32	1.1	1100	<0.0002	1.8	0.042	0.17	<0.001	<0.003	0.012	470	1500	<0.001	<0.006
OM22D	11/2/2012	<0.005	0.003	12	0.052	<0.001	<0.001	180	<0.005	0.004	<0.004	<0.003	0.37	1.3	1200	<0.0002	1.4	0.028	1.1	<0.001	<0.003	0.005	330	1200	<0.001	0.007
OM22D	2/5/2013	<0.0025	<0.0005	7	0.068	<0.0005	<0.0005	170	<0.005	0.001	<0.002	0.003	0.76	0.015	650	<0.0001	0.013	0.011	2.6	<0.0005	<0.0015	<0.0005	280	820	<0.0005	0.031
OM22D	5/1/2013	<0.005	0.007	15	0.043	<0.001	<0.001	360	<0.005	0.006	0.009	<0.003	<0.25	3	1300	<0.0002	1.6	0.039	<0.02	<0.001	<0.003	0.006	550	1900	<0.001	<0.006
OM22D	7/29/2013	<0.005	0.007	21	0.027	<0.001	<0.001	480	<0.005	0.002	0.013	<0.003	<0.25	1.9	1500	<0.0002	1.2	0.036	0.03	<0.001	<0.003	0.007	530	2100	<0.001	0.008
OM22D	10/18/2013	<0.005	0.002	19	0.037	<0.001	<0.001	520	<0.005	<0.002	<0.004	<0.003		2	1300	<0.0001	1.1	0.018	<0.02	<0.001	<0.003	<0.001	690	2100	<0.001	<0.006
OM22D	3/30/2014	<0.005	0.002	17	0.025	<0.001	<0.0005	460	<0.005	<0.002	<0.004	<0.0015		2.3	1400	<0.0002	1.2	0.02	<0.02	<0.001	<0.003	<0.001	540	2000	<0.001	<0.006
OM22D	4/23/2014	<0.005	0.003	2.2	0.036	<0.001	<0.001	480	<0.005	<0.002	<0.004	<0.003		3.2	870	<0.0002	1.1	<0.005	0.04	<0.001	<0.003	<0.001	560	2100	<0.001	<0.006
OM22D	7/17/2014			19				510						0.01	1300		1.1						610	2300		
OM22D	4/17/2015			16				460						<0.01	1200		0.46						570	1800		
OM22D	9/28/2015			16				480						1.9	1400		0.97						540	2200		
OM22S	12/7/2009			0.11				4.3						0.013	720		3.7						100	840		
OM22S	4/28/2010			0.12				13						0.04	790		3.2						110	840		
OM22S	9/9/2010			0.19				6.1						0.61	790		3.1						140	800		
OM22S	2/23/2011																									
OM22S	4/28/2011																									
OM22S	8/25/2011																									
OM22S	10/14/2011																									
OM22S	2/24/2012																									
OM23D	12/7/2009			1.8				41						0.56	880		0.98						440	1300		
OM23D	4/28/2010			2.2				38						2.5	820		0.98						430	1400		
OM23D	9/9/2010			2				32						1.6	400		0.88						470	1400		
OM23D	2/22/2011	<0.005	0.002	2.4	0.053	<0.001	<0.001	38	<0.005	<0.002	<0.004	<0.003	0.6	2	800	<0.0002	0.93	0.019	0.02	<0.001	<0.003	<0.001	420	1400	<0.001	<0.006
OM23D	4/28/2011	<0.005	0.001	2.6	0.046	<0.001	<0.001	46	<0.005	<0.002	<0.004	<0.003	0.62	2	720	<0.0002	0.83	0.006	0.06	<0.001	<0.003	0.002	450	1400	<0.001	<0.006
OM23D	8/25/2011																									
OM23D	8/29/2011	<0.005	0.001	2.5	0.053	<0.001	<0.001	32	<0.005	<0.002	<0.004	0.005	0.68	1.9	700	<0.0002	0.86	0.014	0.05	<0.001	<0.003	0.003	400	1300	<0.001	<0.006
OM23D	10/14/2011	<0.005	0.002	2.3	0.047	<0.001	<0.001	37	<0.005	<0.002	<0.004	0.004	0.56	2.5	870	<0.0002	1	0.018	1.2	<0.001	<0.003	0.003	390	1300	<0.001	<0.006
OM23D	2/24/2012	<0.005	0.002	2.3	0.048	<0.001	<0.001	34	<0.005	<0.002	<0.004	<0.003	0.51	2.3	920	<0.0002	1	0.015	<0.02	<0.001	<0.003	0.001	460	1300	<0.001	<0.006
OM23D	5/3/2012	<0.005	0.002	2.7	0.063	<0.001	<0.001	32	<0.005	<0.002	0.004	<0.003	0.68	1.3	770	<0.0002	0.72	0.011	0.06	<0.001	<0.003	0.003	460	1200	<0.001	0.01
OM23D	8/24/2012	<0.005	0.002	2.3	0.031	<0.001	<0.001	33	<0.005	<0.002	<0.004	<0.003	0.34	0.035	1000	<0.0002	1.1	0.021	0.05	<0.001	<0.003	0.004	550	1400	<0.001	<0.006
OM23D	11/2/2012	<0.005	0.001	2.3	0.027	<0.001	<0.001	34	<0.005	<0.002	<0.004	<0.003	<0.25	2.8	1100	<0.0002	1.1	0.01	0.04	<0.001	<0.003	<0.001	400	1400	<0.001	<0.006
OM23D	2/5/2013	<0.0025	0.001	2.4	0.025	<0.0005	<0.0005	32	<0.005	<0.001	<0.002	<0.0015	0.33	3	980	<0.0001	1.1	0.005	0.09	<0.0005	<0.0015	<0.0005	570	1400	<0.0005	<0.003
OM23D	5/1/2013	<0.005	0.001	1.8	0.027	<0.0005	<0.001	30	<0.005	<0.002	<0.004	<0.003	<0.25	2.7	1000	<0.0002	1	<0.005	<0.02	<0.001	<0.003	<0.001	680	1300	<0.001	<0.006
OM23D	10/18/2013	<0.005	<0.001	2.1	0.021	<0.001	<0.001	33	<0.005	<0.002	<0.004	<0.003		2.7	810	<0.0001	0.82	<0.005	0.22	<0.001	<0.003	<0.001	640	1300	<0.001	0.011
OM23D	3/30/2014	<0.005	0.001	1.8	0.024	<0.001	<0.0005	34	<0.005	<0.002	<0.004	0.021		1.3	940	<0.0002	1.1	<0.005	0.19	<0.001	<0.003	<0.001	490	1300	<0.001	<0.006
OM23D	4/23/2014	<0.005	0.002	20	0.032	<0.001	<0.001	32	<0.005	<0.002	<0.004	<0.003		2.2	1300	<0.0002	1.4	0.02	<0.02	<0.001	<0.003	<0.001	530	1200	<0.001	<0.006
OM23D	7/17/2014			2.1				35						2.5	830		1.1						540	1300		
OM23D	4/17/2015			2.3				37						0.042	900		1.1						520	1300		
OM23D	9/28/2015			22				560						0.9	1800		1.3						720	2500		
OM23S	12/7/2009			0.69				19						6.2	1600		2.4						1000	2300		
OM23S	9/9/2010			0.64				21						0.023	410		2.5						1400	2600		
OM24D	12/7/2009			23				480						5.9	1700		2.2						760	2600		
OM24D	4/28/2010			20				530						10	2100		2.5						980	3100		

Appendix C-3
Groundwater Analytical Results Since 2000
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

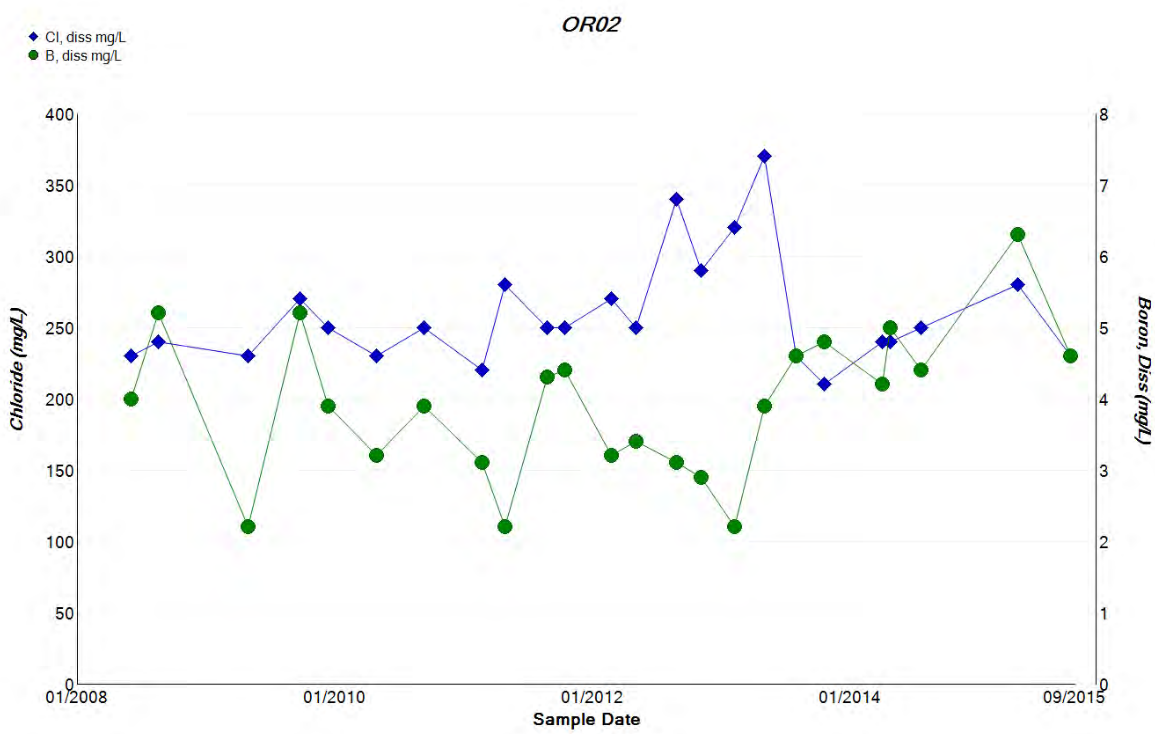
Well	Sample Date	Ag, diss (mg/L)	As, diss (mg/L)	B, diss (mg/L)	Ba, diss (mg/L)	Be, diss (mg/L)	Cd, diss (mg/L)	Cl, diss (mg/L)	CN, total (mg/L)	Co, diss (mg/L)	Cr, diss (mg/L)	Cu, diss (mg/L)	F, diss (mg/L)	Fe, diss (mg/L)	Hardness (mg/L)	Hg, diss (mg/L)	Mn, diss (mg/L)	Ni, diss (mg/L)	NO3, diss (mg/L)	Pb, diss (mg/L)	Sb, diss (mg/L)	Se, diss (mg/L)	SO4, diss (mg/L)	TDS (mg/L)	Tl, diss (mg/L)	Zn, diss (mg/L)
OM24D	9/9/2010			21				480						6.5	1900		1.8						900	2600		
OM24D	2/22/2011	<0.005	0.005	20	0.015	<0.001	<0.001	470	<0.005	<0.002	0.014	0.021	<0.25	6.1	1500	<0.0002	2	0.04	<0.02	<0.001	<0.003	0.007	680	2300	<0.001	0.016
OM24D	4/28/2011	<0.005	0.02	19	0.11	<0.001	<0.001	440	<0.005	0.011	0.022	0.011	<0.25	25	1900	<0.0002	2.8	0.053	<0.02	0.033	<0.003	0.017	740	2200	<0.001	0.032
OM24D	8/29/2011	<0.005	0.012	20	0.044	<0.001	<0.001	450	<0.005	0.003	0.025	0.005	0.34	6.7	1600	<0.0002	1.6	0.046	0.2	0.005	<0.003	0.028	800	2100	<0.001	0.01
OM24D	10/14/2011	<0.005	0.014	24	0.081	<0.001	<0.001	560	<0.005	0.005	0.021	0.009	<0.25	12	1800	<0.0002	2.5	0.057	0.4	0.009	<0.003	0.029	730	2200	<0.001	0.017
OM24D	2/24/2012	<0.005	0.037	23	0.036	<0.001	<0.001	550	<0.005	<0.002	0.019	0.004	<0.25	40	1800	<0.0002	2.1	0.046	0.45	0.004	<0.003	0.032	770	2600	<0.001	0.017
OM24D	5/3/2012	<0.005	0.007	23	0.016	<0.001	<0.001	670	<0.005	<0.002	0.014	<0.003	<0.25	7	1700	<0.0002	2.1	0.034	0.03	<0.001	<0.003	0.017	860	2600	<0.001	0.009
OM24D	8/24/2012	<0.005	0.013	28	0.018	<0.001	<0.001	880	<0.005	<0.002	0.031	<0.003	0.38	8.8	2300	<0.0002	2.3	0.069	0.04	<0.001	<0.003	0.039	790	3000	<0.001	<0.006
OM24D	11/2/2012	<0.005	0.012	38	0.019	<0.001	<0.001	1000	<0.005	<0.002	0.013	<0.003	<0.25	8.3	2600	<0.0002	2.7	0.041	0.32	<0.001	<0.003	0.022	830	3100	<0.001	<0.006
OM24D	5/1/2013	<0.005	0.004	28	0.037	<0.0005	<0.001	890	<0.005	<0.002	<0.004	<0.003	<0.25	8.2	2000	<0.0002	2.4	0.016	<0.02	<0.001	<0.003	<0.001	1200	2900	<0.001	<0.006
OM24D	7/29/2013	<0.005	0.008	29	0.016	<0.001	<0.001	560	<0.005	<0.002	0.016	<0.003	<0.25	6.2	1900	<0.0002	2.3	0.037	0.11	<0.001	<0.003	0.01	870	3000	<0.001	<0.006
OM24D	10/18/2013	<0.005	0.009	27	0.038	<0.001	<0.001	760	<0.005	<0.002	<0.004	<0.003		4.3	1600	<0.0001	2.3	0.017	0.11	<0.001	<0.003	<0.001	1200	2800	<0.001	<0.006
OM24D	3/30/2014	<0.005	0.003	28	0.027	<0.001	<0.0005	910	<0.005	<0.002	<0.004	<0.0015		4.2	2000	<0.0002	3.3	0.019	0.08	<0.001	<0.003	<0.001	1100	3000	<0.001	<0.006
OM24D	4/23/2014	<0.005	0.004	34	0.018	<0.001	<0.001	960	<0.005	<0.002	<0.004	<0.003		7.4	190	<0.0002	2.5	0.017	<0.02	<0.001	<0.003	<0.001	1100	3000	<0.001	<0.006
OM24D	7/17/2014			29				700						7.6	1700		2.6						910	3100		
OM24D	4/17/2015			23				540						0.014	1800		2						910	2300		
OM24D	9/28/2015			20				440						6.3	1700		2.2						770	2200		
OM25D	12/7/2009			1.7				61						<0.01	740		1.2						280	1100		
OM25D	4/28/2010			2.3				110						1.5	1000		1.4						470	1500		
OM25D	9/9/2010			1.9				81						<0.01	920		1.2						360	1300		
OM25S	12/7/2009			5.1				190						<0.01	690		0.77						280	1200		
OM25S	4/28/2010			11				350						0.016	1200		1.2						520	2000		
OM25S	9/9/2010			9.9				270						<0.01	1200		1.2						600	1900		
OM25S	2/22/2011	<0.005	0.003	19	0.056	<0.001	<0.001	500	<0.005	0.006	0.015	0.021	<0.25	0.028	1600	<0.0002	1.4	0.046	3.2	<0.001	<0.003	0.008	710	2300	<0.001	<0.006
OM25S	4/28/2011	<0.005	<0.001	4.6	0.053	<0.001	<0.001	83	<0.005	<0.002	0.006	<0.003	<0.25	0.032	820	<0.0002	0.49	0.01	0.19	<0.001	<0.003	0.006	250	1100	<0.001	<0.006
OM25S	8/25/2011																									
OM25S	8/29/2011	<0.005	0.004	12	0.049	<0.001	<0.001	290	<0.005	0.005	0.017	0.005	0.39	0.12	1400	<0.0002	1.3	0.035	0.08	<0.001	<0.003	0.02	540	1800	<0.001	0.007
OM25S	10/14/2011	<0.005	0.005	15	0.046	<0.001	<0.001	320	<0.005	0.005	0.013	0.006	<0.25	<0.01	1400	<0.0002	1.3	0.041	0.08	<0.001	<0.003	0.02	550	1900	<0.001	0.012
OM25S	2/24/2012	<0.005	0.005	12	0.049	<0.001	<0.001	290	<0.005	0.004	0.01	0.007	<0.25	0.14	1400	<0.0002	1.2	0.036	1.9	<0.001	<0.003	0.023	600	1900	<0.001	0.014
OM25S	5/3/2012	<0.005	0.003	18	0.047	<0.001	<0.001	550	<0.005	0.004	0.012	<0.003	<0.25	<0.01	1400	<0.0002	1.2	0.037	0.09	<0.001	<0.003	0.015	940	2100	<0.001	0.021
OM25S	8/24/2012	<0.005	0.006	16	0.041	<0.001	<0.001	410	<0.005	0.005	0.017	<0.003	<2.5	<0.01	1700	<0.0002	1.3	0.052	0.06	<0.001	<0.003	0.025	660	2200	<0.001	<0.006
OM25S	11/2/2012	<0.005	0.004	20	0.036	<0.001	<0.001	450	<0.005	0.005	0.007	<0.003	<0.25	0.86	1700	<0.0002	1.3	0.037	0.03	0.001	<0.003	0.012	710	2500	<0.001	0.01
OM25S	2/5/2013	<0.0025	<0.0005	13	0.031	<0.0005	<0.0005	520	<0.005	0.003	<0.002	<0.0015	<0.25	0.13	1400	<0.0001	0.94	0.02	2.9	<0.0005	<0.0015	0.001	900	2000	<0.0005	0.004
OM25S	5/1/2013	<0.005	<0.001	1.1	0.048	<0.0005	<0.001	22	<0.005	<0.002	<0.004	<0.003	0.27	<0.01	560	<0.0002	0.12	<0.005	0.56	<0.001	<0.003	0.003	190	690	<0.001	<0.006
OM25S	7/29/2013	<0.005	0.003	11	0.053	<0.001	<0.001	220	<0.005	0.005	0.008	<0.003	0.29	0.035	1100	<0.0002	1.1	0.025	0.05	<0.001	<0.003	0.003	430	1600	<0.001	<0.006
OM25S	10/18/2013	<0.005	<0.001	18	0.04	<0.001	<0.001	450	<0.005	0.005	<0.004	<0.003		0.13	1300	<0.0001	1.2	0.02	0.06	<0.001	<0.003	<0.001	640	2100	<0.001	0.008
OM25S	3/30/2014	<0.005	<0.001	12	0.047	<0.001	<0.0005	310	<0.005	0.003	<0.004	0.031		<0.01	1400	<0.0002	1	0.019	0.05	<0.001	<0.003	<0.001	560	1800	<0.001	<0.006
OM25S	4/23/2014	<0.005	<0.001	20	0.04	<0.001	<0.001	450	<0.005	0.004	<0.004	<0.003		<0.01	1300	<0.0002	1.1	0.021	0.05	<0.001	<0.003	0.001	640	2000	<0.001	<0.006
OM25S	7/17/2014			23				600						<0.01	1500		1.2						750	2500		
OM25S	4/17/2015			19				440						<0.01	1500		0.97						750	2100		
OM25S	9/28/2015			22				630						0.73	1900		1.1						770	2500		
OM50D	12/7/2009			1.8				13						<0.01	430		0.17						310	830		
OM50D	4/28/2010			2				13						2.1	460		0.38						260	780		
OM50D	9/9/2010			2.2				9.6						7	490		0.3						180	730		
OM50S	12/7/2009			0.11				7.4						0.022	890		0.084						520	1200		
OM50S	4/28/2010			0.096				6.5						0.059	1100		0.01						670	1300		
OM50S	9/9/2010			0.15				5.6						0.14	940		0.035						650	1100		
OM51D	12/7/2009			1.2				17						4	830		0.6						290	1200		
OM51D	4/28/2010			1				13						10	1100		0.71						560	1500		
OM51D	9/9/2010			1.2				22						0.074	630		0.17						220	920		
OM51S	12/7/2009			0.03				6.2						0.04	1100		3.1						410	1400		
OM51S	4/28/2010			0.029				4.3						0.19	1400		3.6						640	1700		
OM51S	9/9/2010			0.054				5.4						0.68	1300		5						690	1500		

APPENDIX C4

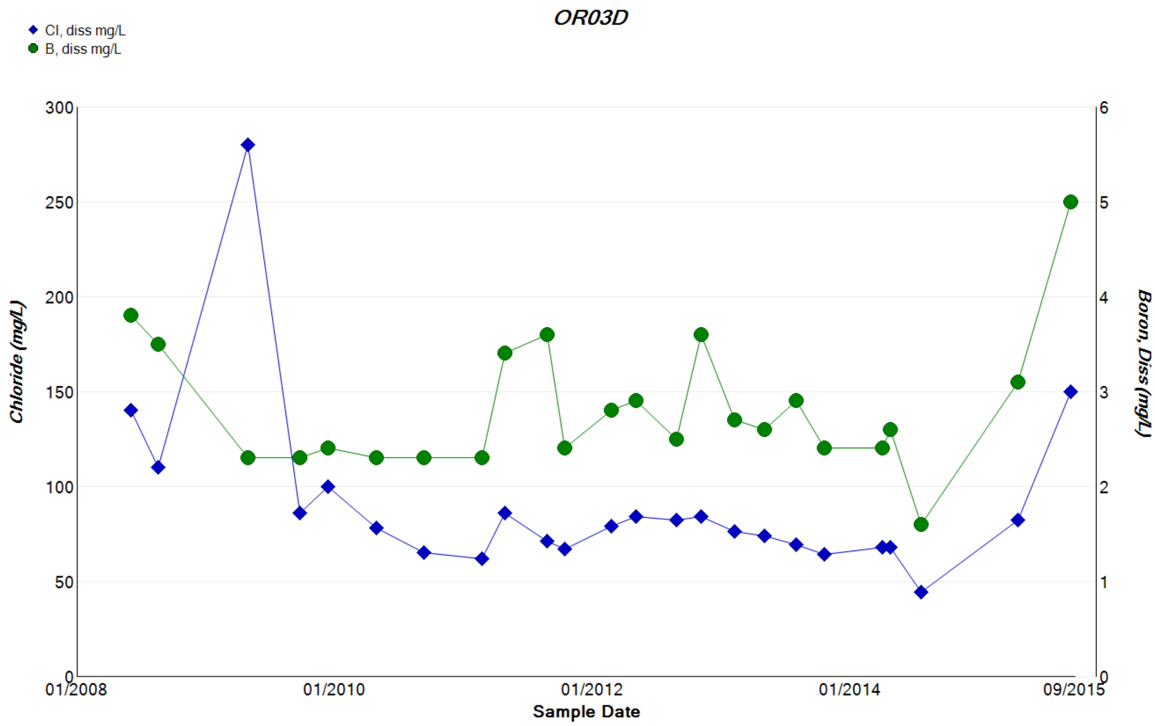
BORON AND CHLORIDE TIME SERIES PLOTS



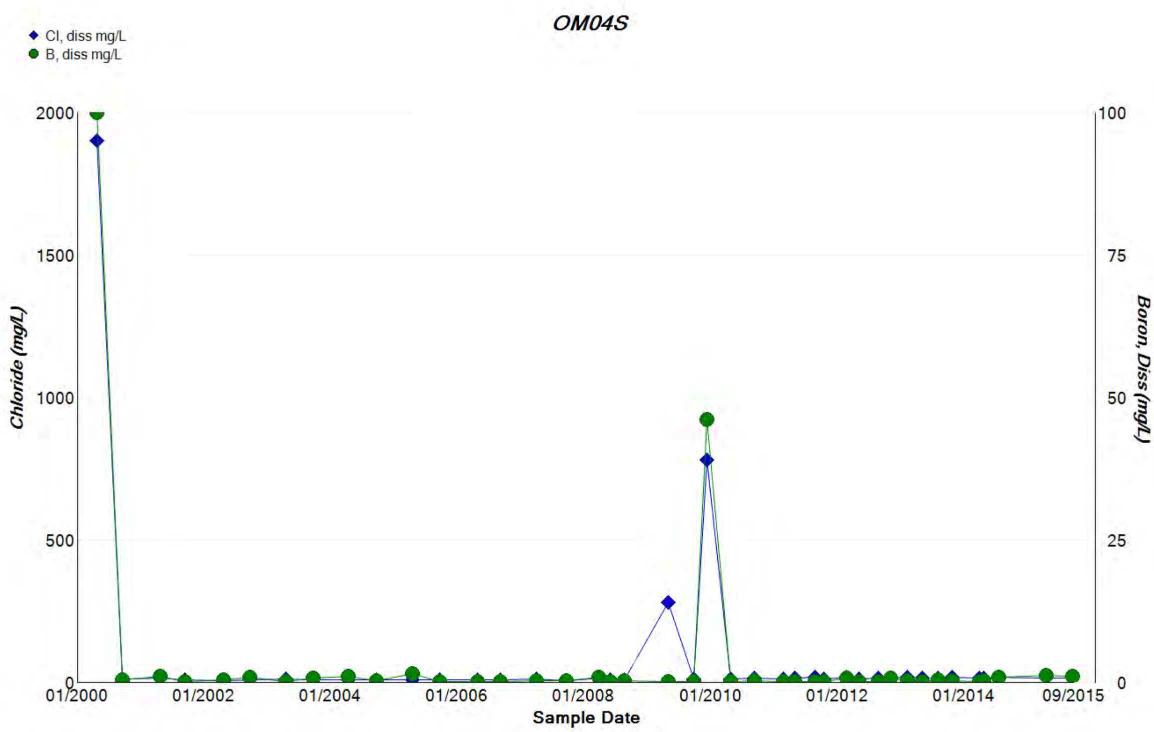
OM01
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
0
15
30
45
60
75
90
0
1
2
3
4
5
6
01/2000
01/2002
01/2004
01/2006
01/2008
01/2010
01/2012
01/2014
09/2015



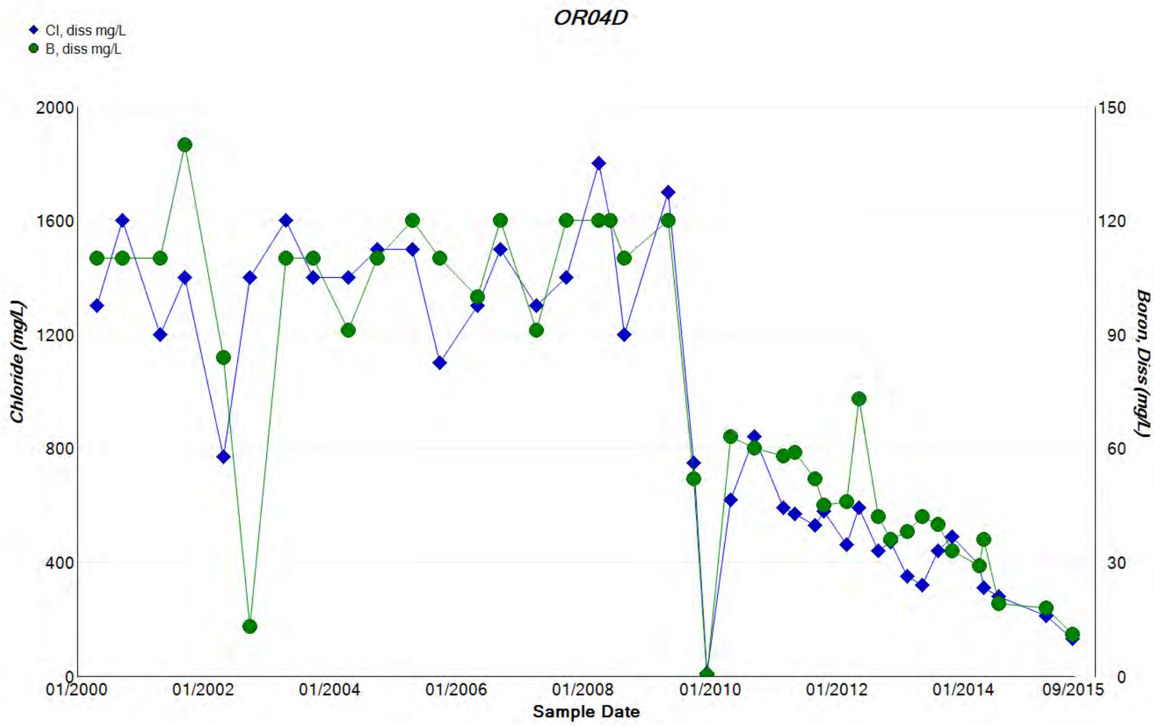
OR02
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
0
50
100
150
200
250
300
350
400
0
1
2
3
4
5
6
7
8
01/2008
01/2010
01/2012
01/2014
09/2015

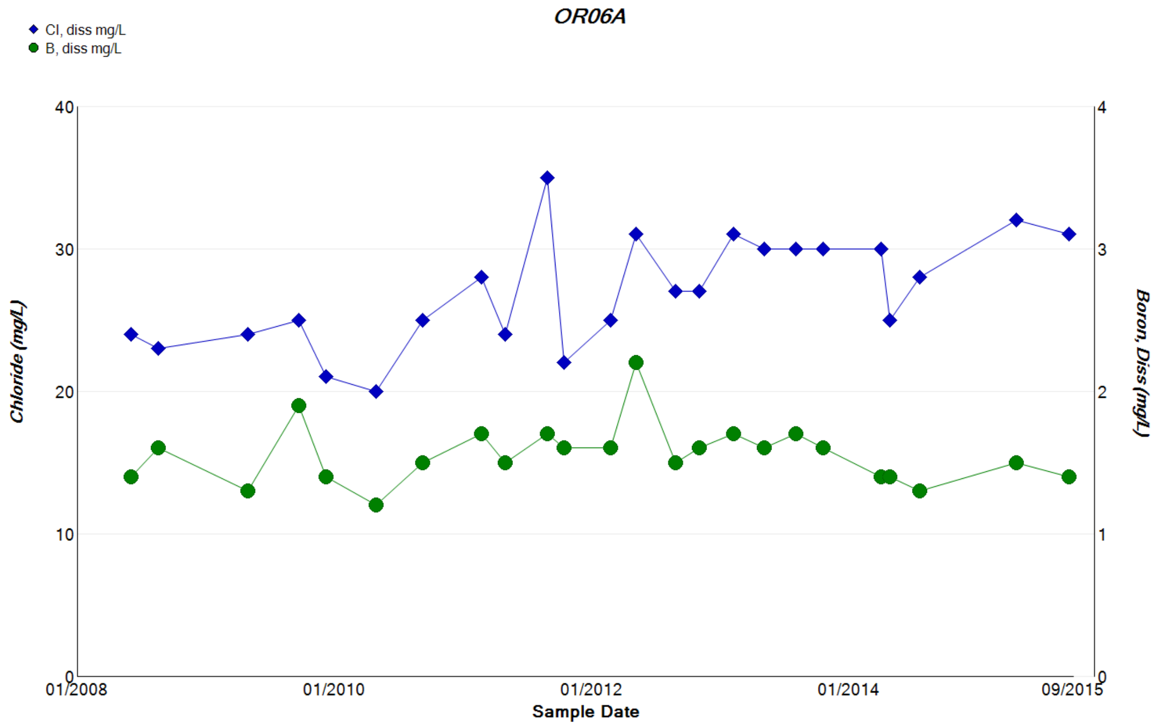


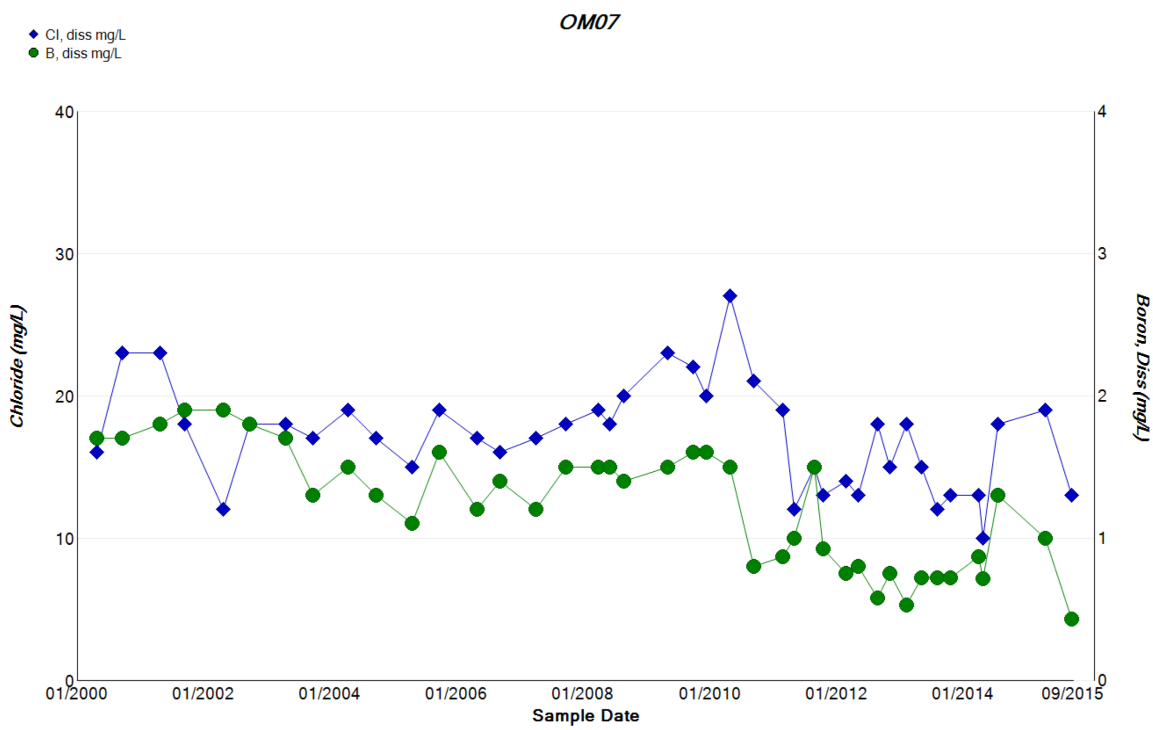
OR03D
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
300
250
200
150
100
50
0
6
5
4
3
2
1
0
01/2008
01/2010
01/2012
01/2014
09/2015

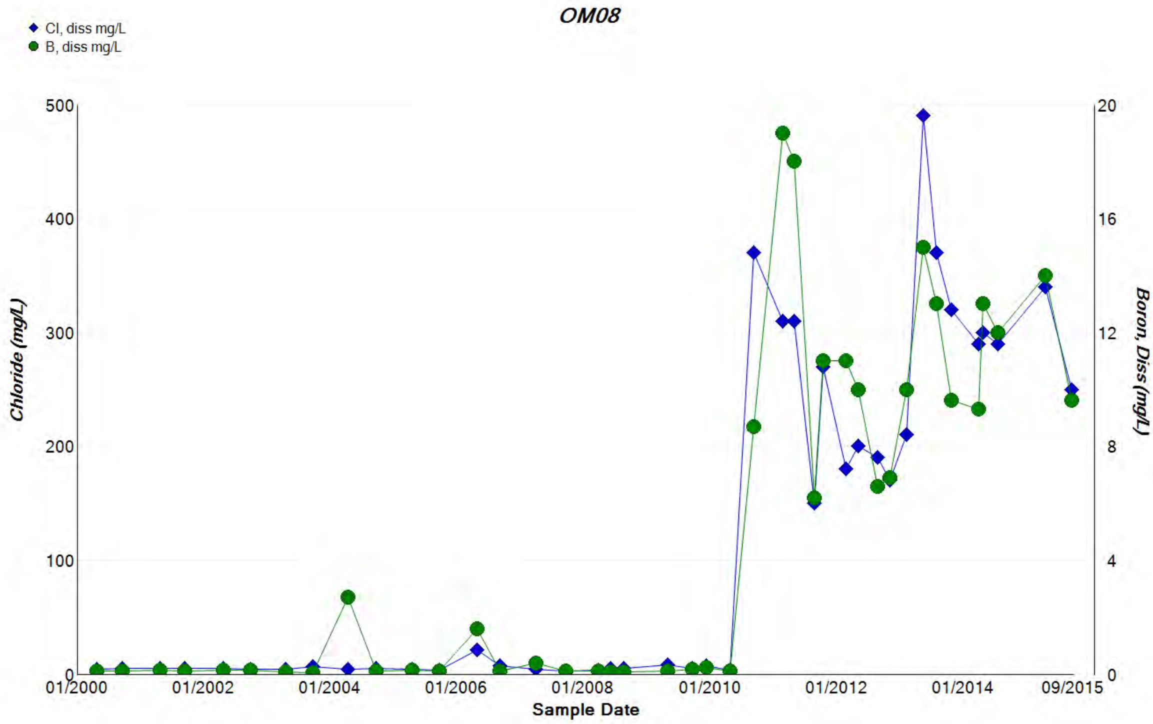


OM04S
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
2000
1500
1000
500
0
100
75
50
25
0
01/2000
01/2002
01/2004
01/2006
01/2008
01/2010
01/2012
01/2014
09/2015

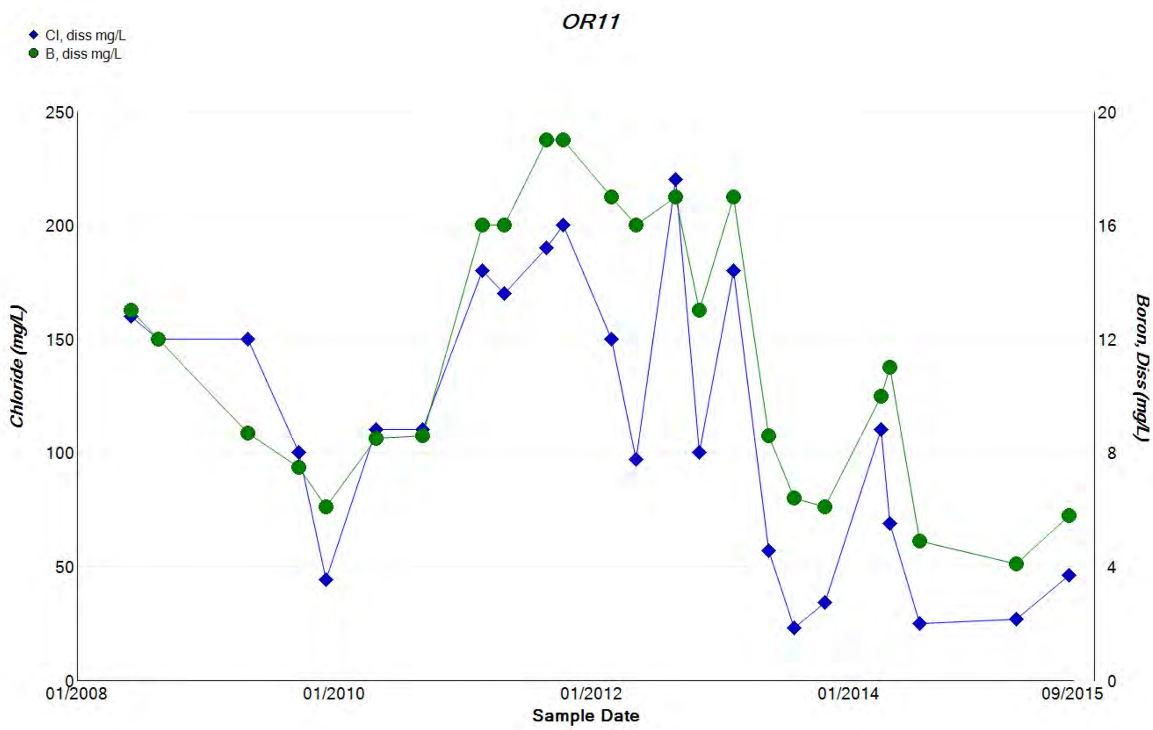

OR04D
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
2000
1600
1200
800
400
0
150
120
90
60
30
0
01/2000
01/2002
01/2004
01/2006
01/2008
01/2010
01/2012
01/2014
09/2015
Sample Date


OR06A
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
40
30
20
10
0
4
3
2
1
0
01/2008
01/2010
01/2012
01/2014
09/2015
Sample Date

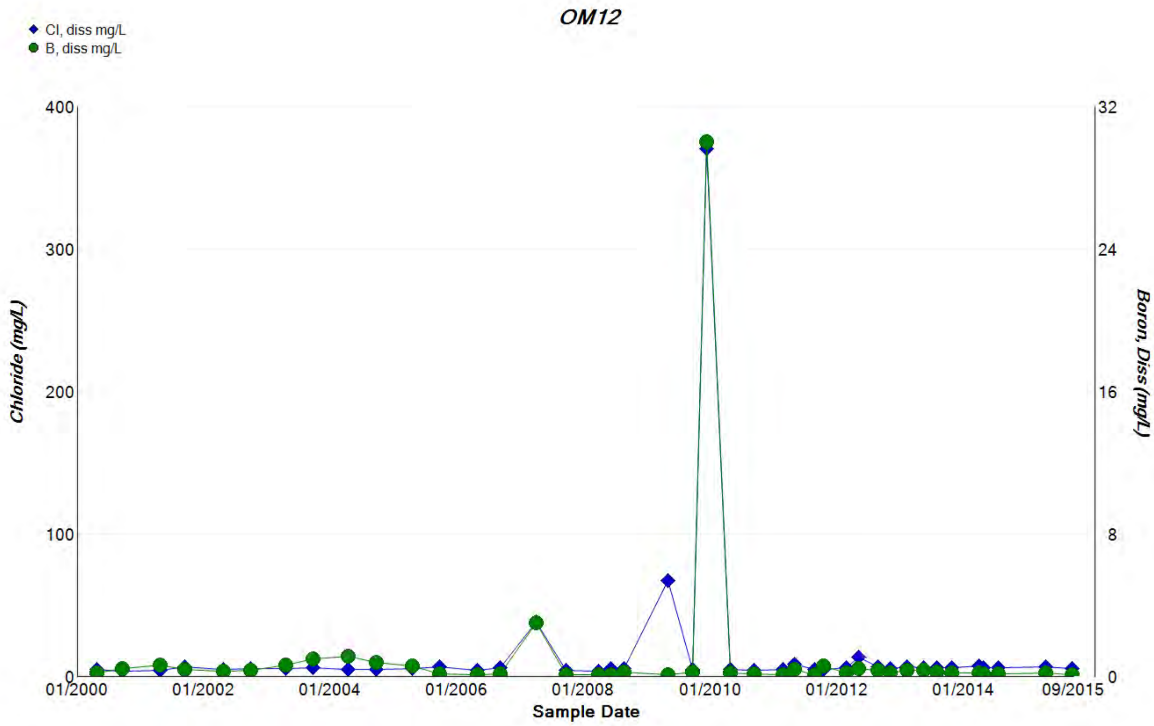

OM07
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
40
30
20
10
0
4
3
2
1
0
01/2000
01/2002
01/2004
01/2006
01/2008
01/2010
01/2012
01/2014
09/2015
Sample Date

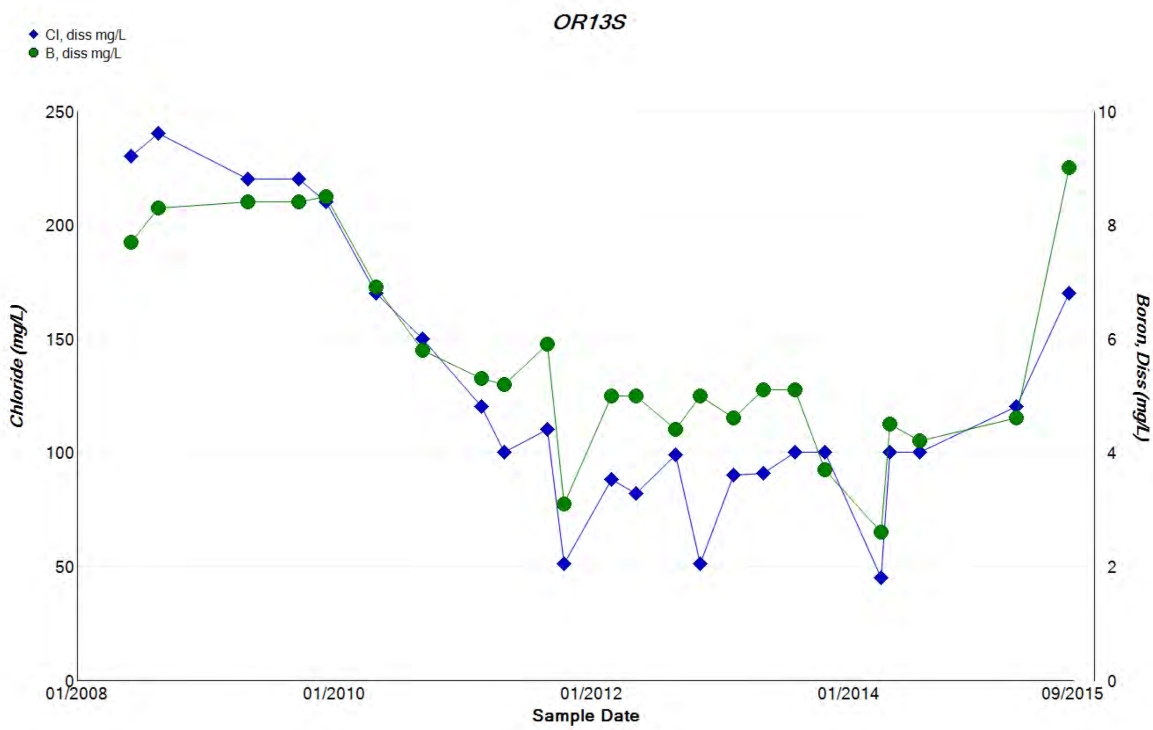


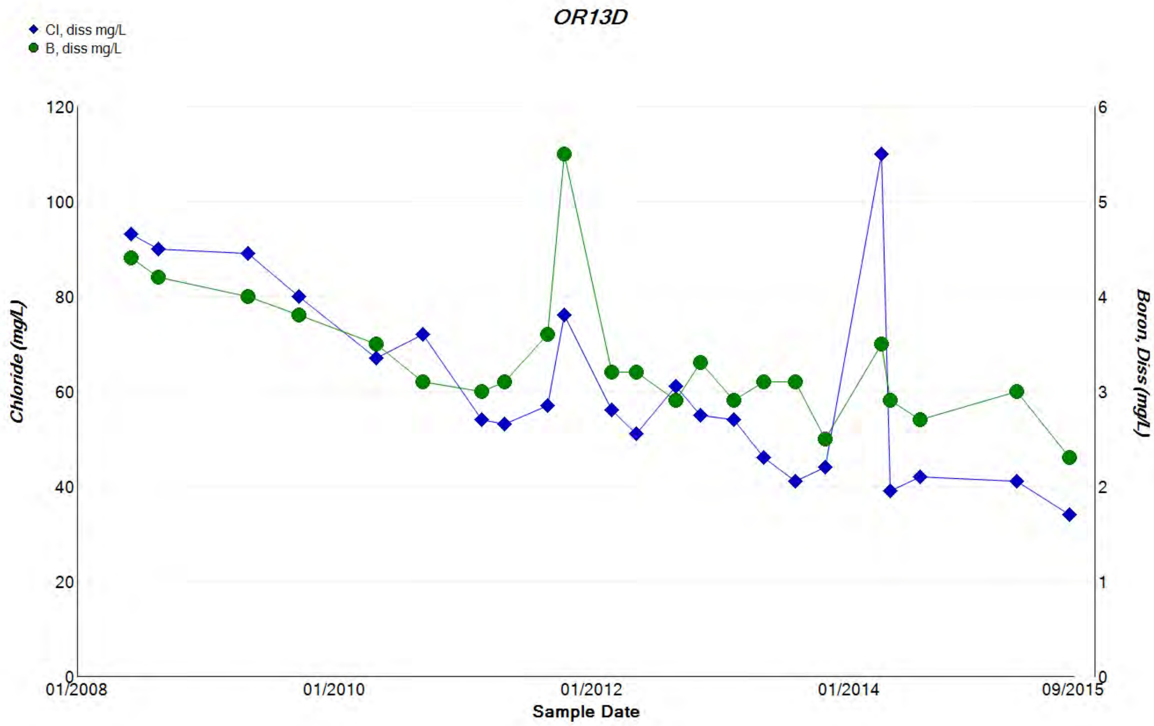
OM08
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
500
400
300
200
100
0
20
16
12
8
4
0
01/2000
01/2002
01/2004
01/2006
01/2008
01/2010
01/2012
01/2014
09/2015
Sample Date



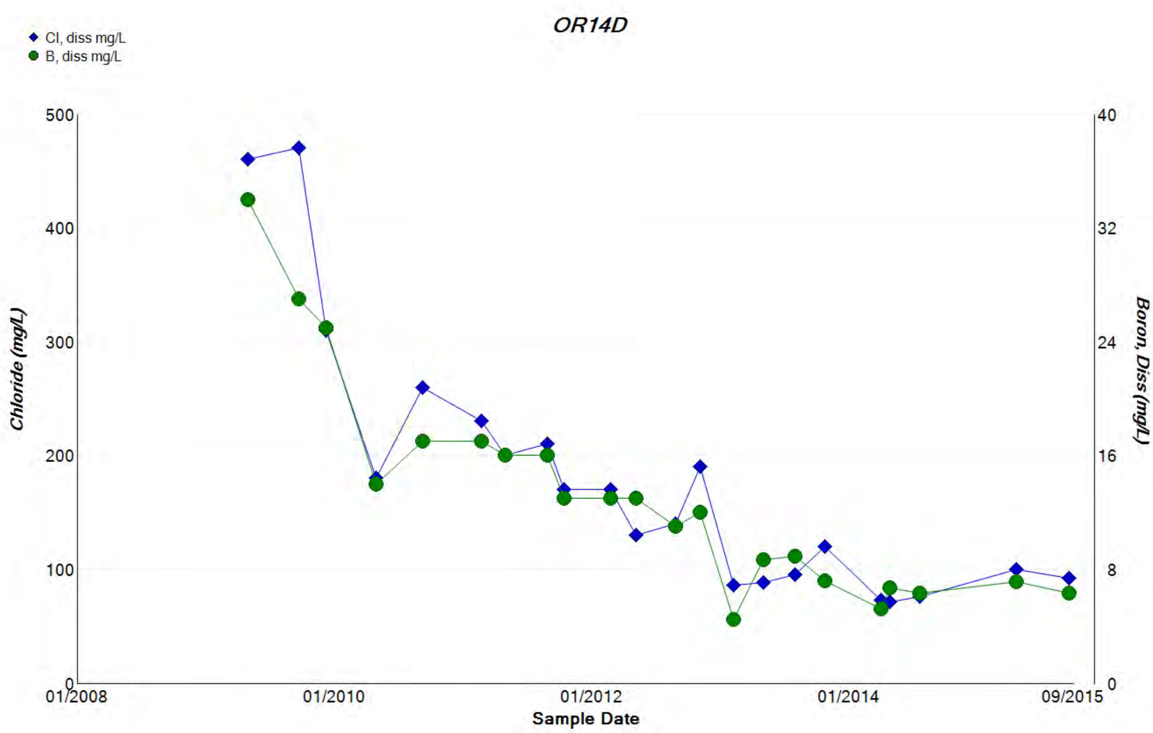
OR11
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
250
200
150
100
50
0
20
16
12
8
4
0
01/2008
01/2010
01/2012
01/2014
09/2015
Sample Date


OM12
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
400
300
200
100
0
32
24
16
8
0
01/2000
01/2002
01/2004
01/2006
01/2008
01/2010
01/2012
01/2014
09/2015

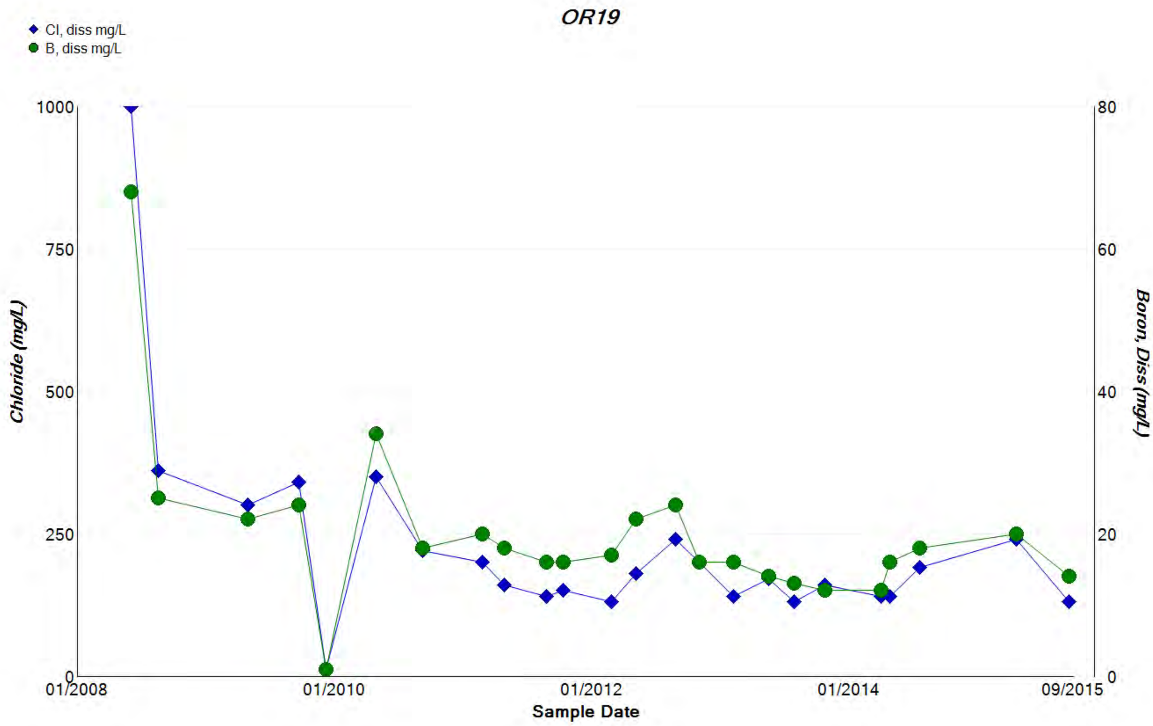

OR13S
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
250
200
150
100
50
0
10
8
6
4
2
0
01/2008
01/2010
01/2012
01/2014
09/2015

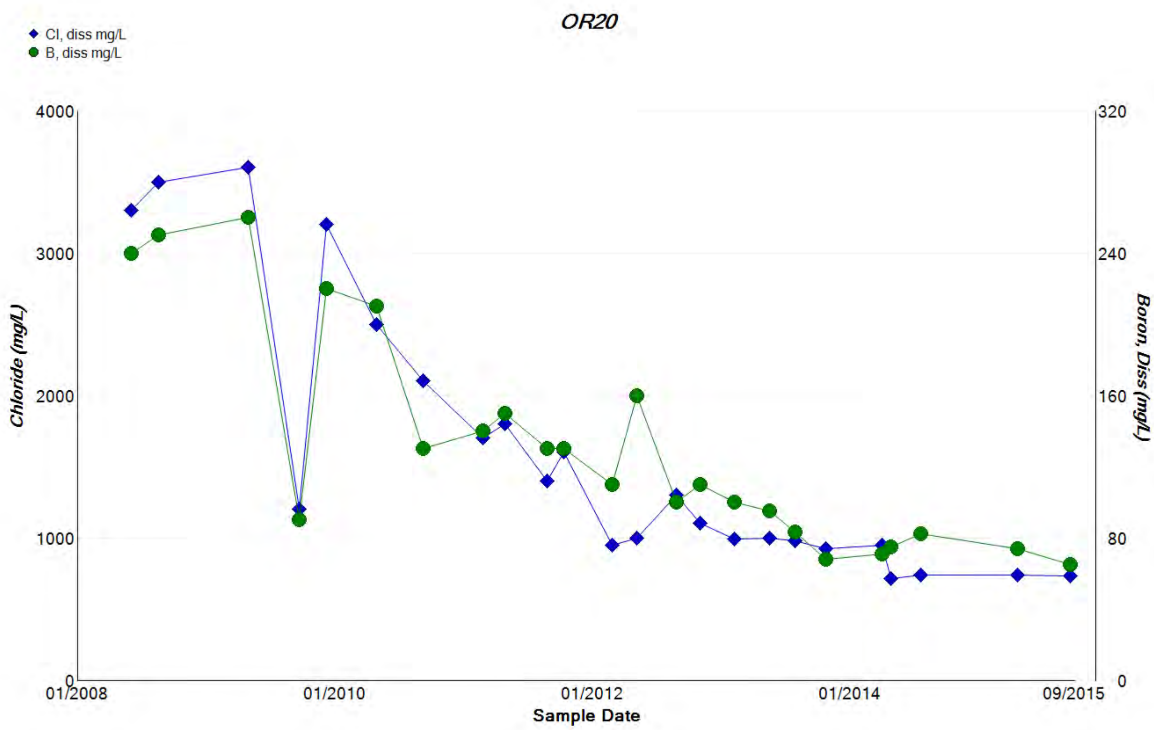


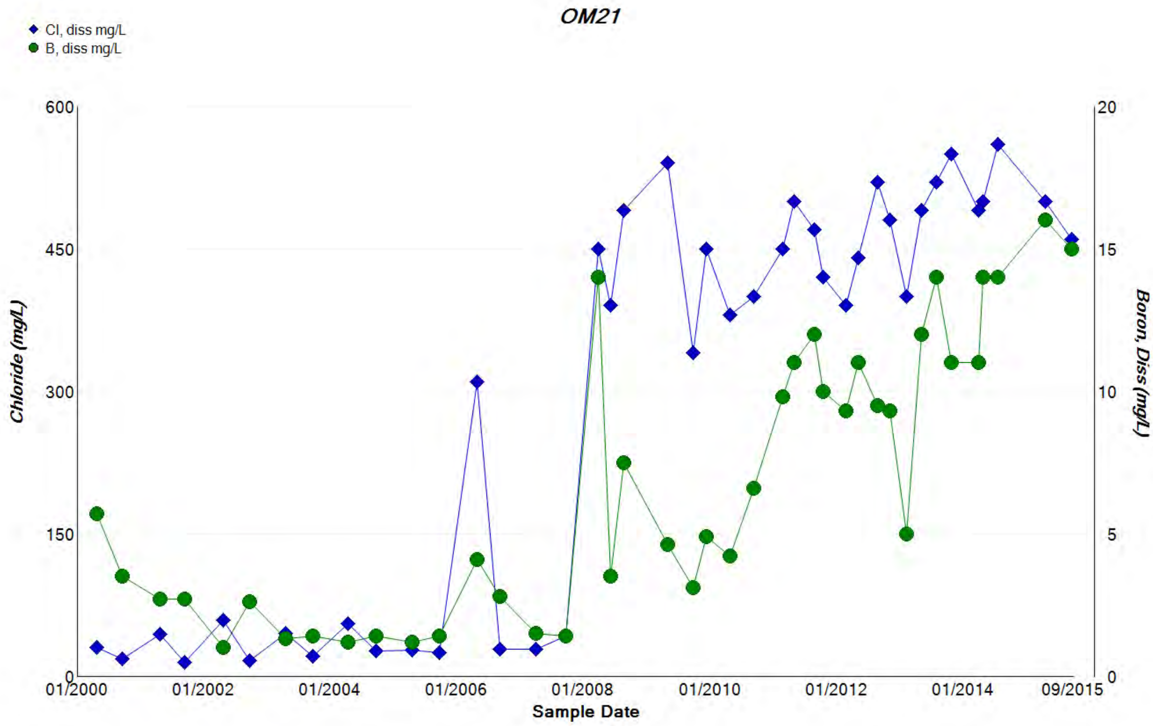
OR13D
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
120
100
80
60
40
20
0
6
5
4
3
2
1
0
01/2008
01/2010
01/2012
01/2014
09/2015

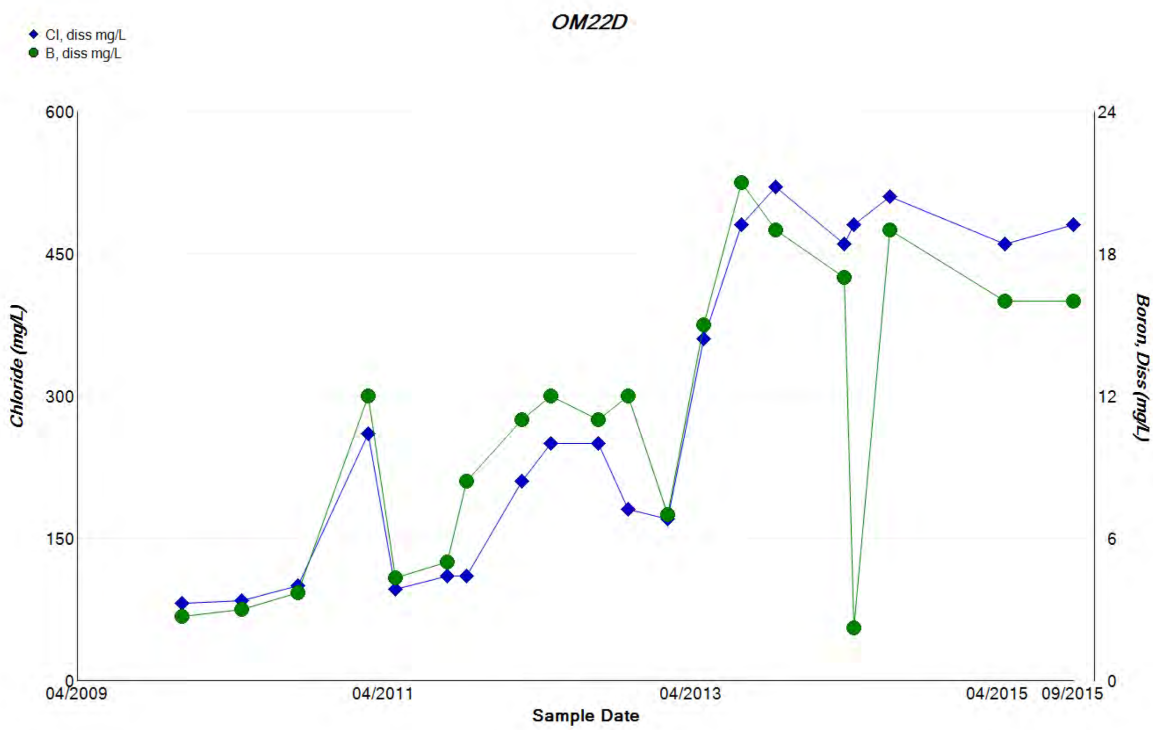


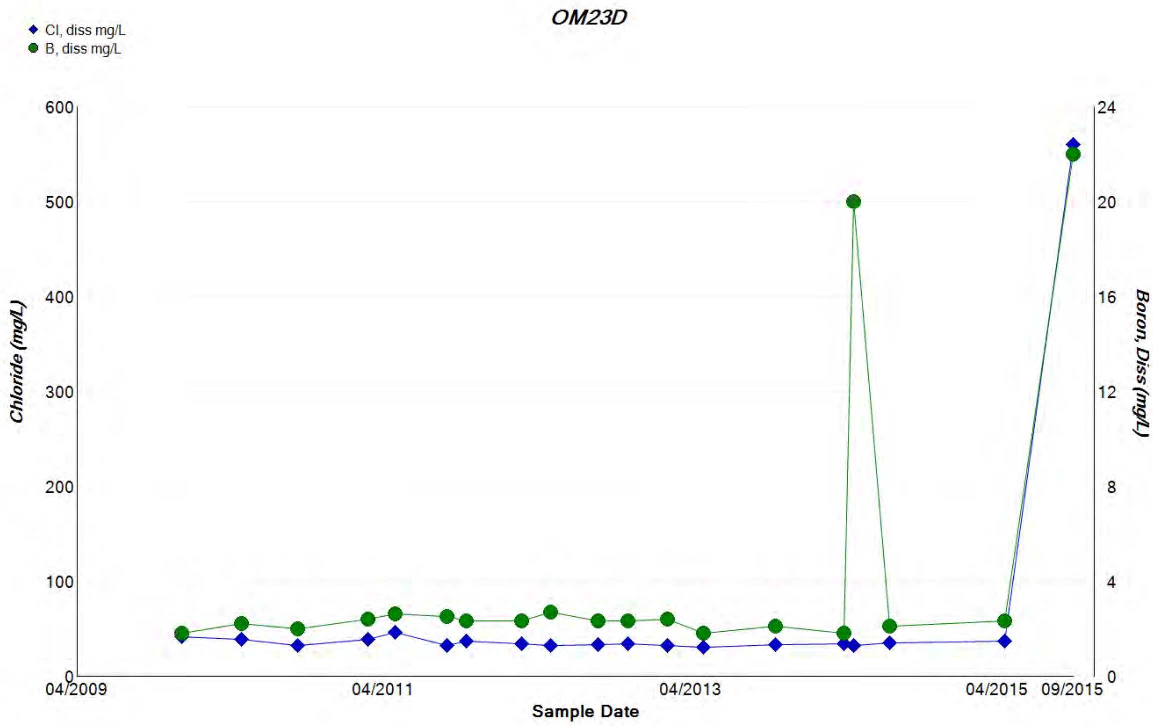
OR14D
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
500
400
300
200
100
0
40
32
24
16
8
0
01/2008
01/2010
01/2012
01/2014
09/2015

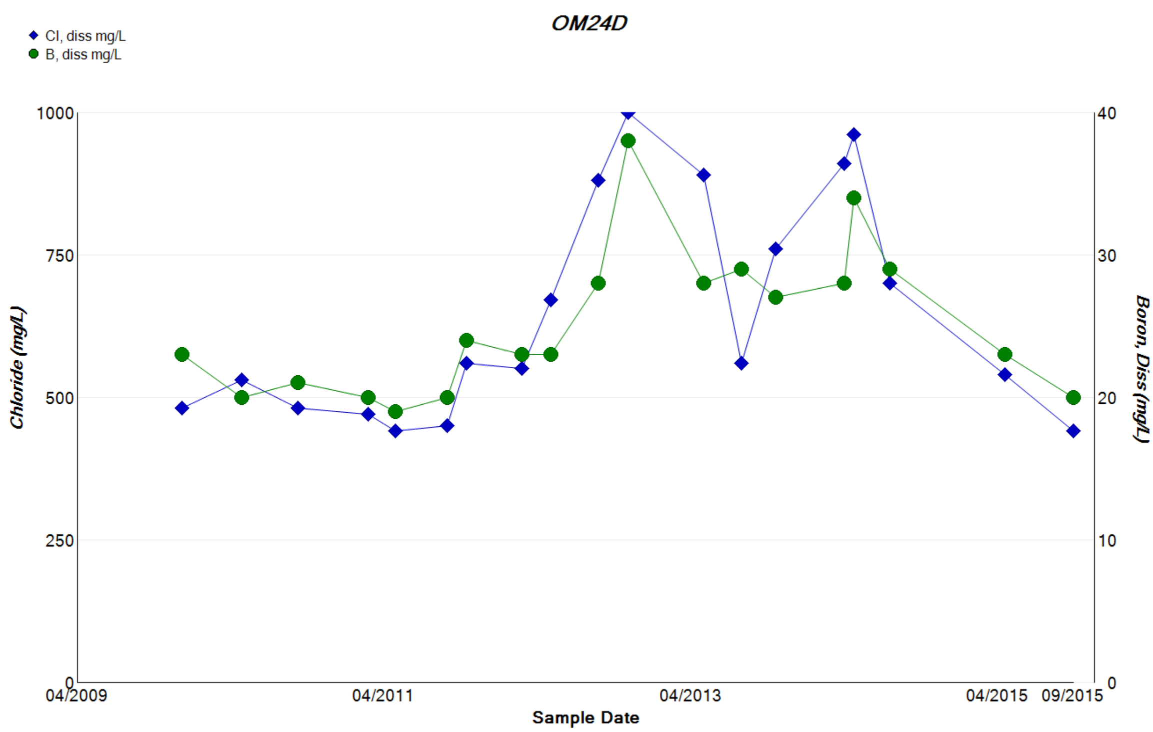

OR19
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
1000
750
500
250
0
80
60
40
20
0
01/2008
01/2010
01/2012
01/2014
09/2015
Sample Date


OR20
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
4000
3000
2000
1000
0
320
240
160
80
0
01/2008
01/2010
01/2012
01/2014
09/2015
Sample Date

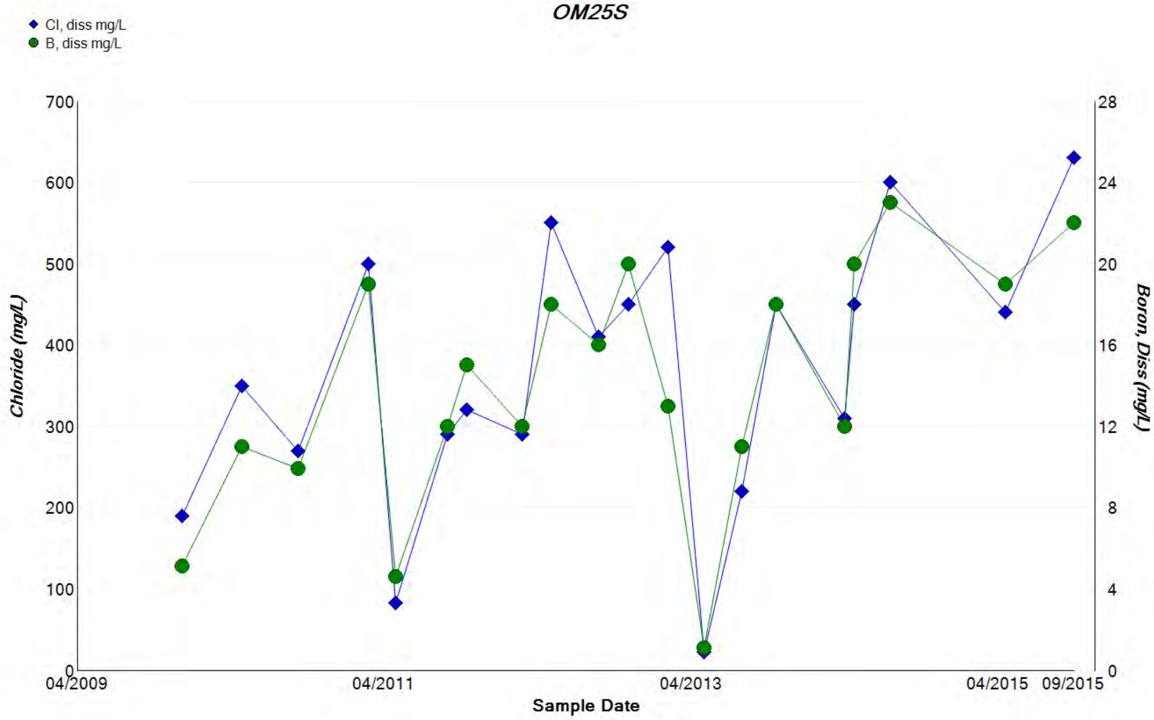

OM21
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
600
450
300
150
0
20
15
10
5
0
01/2000
01/2002
01/2004
01/2006
01/2008
01/2010
01/2012
01/2014
09/2015
Sample Date


OM22D
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
600
450
300
150
0
24
18
12
6
0
04/2009
04/2011
04/2013
04/2015
09/2015
Sample Date


OM23D
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
600
500
400
300
200
100
0
24
20
16
12
8
4
0
04/2009
04/2011
04/2013
04/2015
09/2015


OM24D
Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
1000
750
500
250
0
40
30
20
10
0
04/2009
04/2011
04/2013
04/2015
09/2015

OM25S


Cl, diss mg/L
B, diss mg/L
Chloride (mg/L)
Boron, Diss (mg/L)
Sample Date
0
100
200
300
400
500
600
700
0
4
8
12
16
20
24
28
04/2009
04/2011
04/2013
04/2015
09/2015

APPENDIX D

BORING LOGS AND MONITORING WELL CONSTRUCTION REPORTS

OM01

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-1

SURFACE ELEVATION 592.8'
COORDINATE 52+60 N
2+93 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET
									5
									10
									15
									20
									25
									30
									35
									40
									45
									50
									55
									60

BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
9, 8	⊠, ⊠	SM	STRIP MINE SPOIL Brown silty SAND: Fine to medium sand with trace of clay, silt, and broken shale. Dry to 12'.
5, 7, 7	⊠, ⊠, ⊠	CL-ML	Brown silty CLAY: A mixture of reworked silty loess with some clay till, some organic material near the surface.

FEATURE: Observation and Monitoring Boring
Date Drilled: 9/25/80
Total Depth: 26.5'
Piezometer: Screen from 15.0' to 20.0'
Gravel pack from 13.0' to 26.5'.
Water Level Data: Elevation 579.9 on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

OM02

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-2

SURFACE ELEVATION 599.6'
COORDINATE 74+85 N
1+30 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET
	PN=2.9								5
	PN=1.6								10
									15
									20
	PN=0.5								25
	PN=3.6								30
									35
									40
									45
									50
									55
									60

BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
10	☒	CL-ML	STRIP MINE SPOIL Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface. Dry from 0' to 6'.
4	☒	CL	Moist from 6' to 14'. Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale. Wet from 14' to 31.5'.
2	☒		
5	☒	CL-ML	
4	☒		
8	☒	SC	

FEATURE: Observation and Monitoring Well
Date Drilled: 10/2/80
Total Depth: Screen from 10' to 20'.
Gravel pack from 8'to31.5'.
Water Level Data: Elevation 590.1' on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Fulton Well #: OR02

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR02

~~State~~ Plant ~~Plane~~ Coordinate: X 7,475.6 Y 130.6 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: R. Keady

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 4/2/2008 Date Finished: 4/2/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: ______

Installation Method: ______

Setting Time: ______

Type of Bentonite Seal -- Granular (circled) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: >24 hours

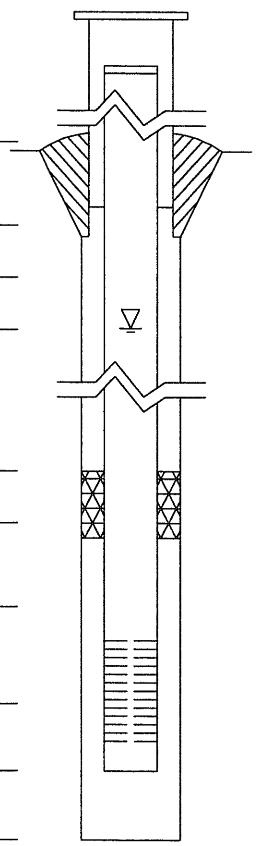
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
601.61	-2.42	Top of Protective Casing
601.41	-2.22	Top of Riser Pipe
599.19	0.00	Ground Surface
		Top of Annular Sealant
596.60	2.59	Static Water Level (After Completion) 5/15/2008
596.64	2.55	Top of Seal
590.04	9.15	Top of Sand Pack
588.81	10.38	Top of Screen
579.32	19.87	Bottom of Screen
578.54	20.65	Bottom of Well
578.54	20.65	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	12.60
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.49
Total Length of Casing	(feet)	22.87
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

OM03

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-3

SURFACE ELEVATION 622.1'
COORDINATE 92+93N
0+88E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET
	PN=1.5				22.6 17.0				0–5
	PN=1.3				23.5				5–10
									10–15
	PN=0.8				19.3				15–20
	PN=0.8		34	12	27.5				20–25
					23.3				25–30
	PN=0.7				23.5				30–35
	PN=1.3				22.8				35–40
									40–45
									45–50
	PN>4.5								50–55
	PN>4.5								55–60

DEEP IN FEET	BLOW COUNT	SYMBOLS	DESCRIPTION
0–10	6, 6	CL-ML	STRIP MINE SPOIL Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface. Dry to 6' Moist from 6' to 75'.
10–12		CL	
12–14		SM	
14–18	6	CL-ML	
18–24	7, 9	CL	Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.
24–38	9, 12	CL-ML	Brown silty Clay to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface.
38–60	14, 15, 25, 18	CL	Gray broken SHALE mine spoil mixed with some reworked clay till and loess, has a silty weathered appearance.

FEATURE: Observation and Monitoring Well

Date Drilled: 9/18/80
Total depth: 85.7'

Installed a deep piezometer (OM-3D)
Screen from 63.5-73.5'
Gravel pack from 40-77.5'
Water level: Elevation 578.8 on 10/8/80

Installed a shallow piezometer (OM-3S) in an adjacent hole
Screem from 42-52'
Gravel pack from 40-52'
Water level: Elevation 579.1 on 10/8/80

LOG OF BORING

Gilbert/Commonwealth

PLATE 2-3

OM03

BORING OM-3

ELEV. IN FEET	OTHER TESTS	STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET	BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
	PN> 4.5									27	☒	CL	Gray broken SHALE mine spoil mixed with some reworked clay till and loess, has a silty weathered appearance.
	PN=3.2								65	25	☒		
	PN>4.5								70	24	☒		
	PN>4.5								75	90 / 1"			TOP OF SHALE BEDROCK
												SH	SHALE BEDROCK, Carbondale formation Pennsylvanian age, gray, silty shale.
									80	108			
									85	100 / .2"			
									90				
									95				
									100				
									105				
									110				
									115				
									120				

LOG OF BORING

Gilbert/Commonwealth

PLATE 2-4

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Fulton Well #: OR03S

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR03S

~~State~~ Plant ~~Plane~~ Coordinate: X 9,283.0 Y 82.3 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: R. Keady

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 4/3/2008 Date Finished: 4/3/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 28 minutes

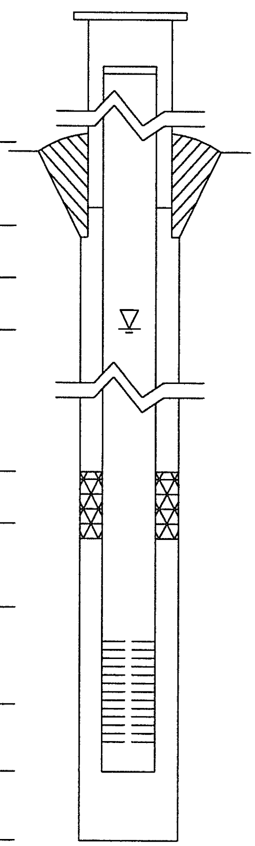
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Mine spoil (if applicable)

Installation Method: Slough



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
627.38	-3.69	Top of Protective Casing
627.16	-3.47	Top of Riser Pipe
623.69	0.00	Ground Surface
621.49	2.20	Top of Annular Sealant
581.91	41.78	Static Water Level (After Completion) 5/15/2008
579.29	44.40	Top of Seal
576.96	46.73	Top of Sand Pack
575.40	48.29	Top of Screen
565.90	57.79	Bottom of Screen
565.11	58.58	Bottom of Well
564.07	59.62	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	51.76
Bottom of Screen to End Cap	(feet)	0.79
Screen Length (1st slot to last slot)	(feet)	9.50
Total Length of Casing	(feet)	62.05
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

Illinois Environmental Protection Agency

Well Completion Report

Site #: ______ County: Fulton Well #: OR03D

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR03D

~~State~~ Plant ~~Plane~~ Coordinate: X 9,286.1 Y 85.6 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: R. Keady

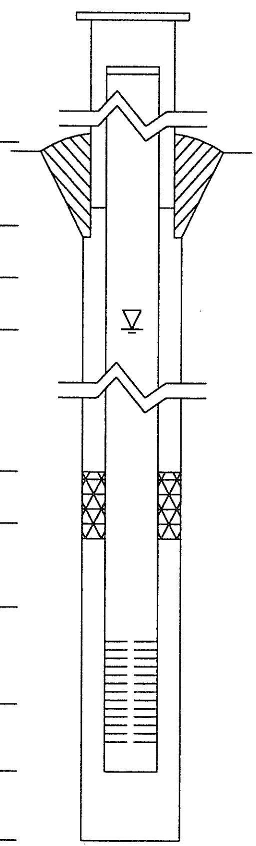
Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 4/4/2008 Date Finished: 4/4/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS



Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one) [Granular circled]

Installation Method: Gravity

Setting Time: 41 minutes

Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ______

Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
627.30	-3.58	Top of Protective Casing
627.13	-3.41	Top of Riser Pipe
623.72	0.00	Ground Surface
621.47	2.25	Top of Annular Sealant
581.98	41.74	Static Water Level (After Completion) 5/15/2008
560.89	62.83	Top of Seal
558.68	65.04	Top of Sand Pack
556.69	67.03	Top of Screen
547.21	76.51	Bottom of Screen
546.42	77.30	Bottom of Well
546.42	77.30	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	70.44
Bottom of Screen to End Cap	(feet)	0.79
Screen Length (1st slot to last slot)	(feet)	9.48
Total Length of Casing	(feet)	80.71
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

OM04D/S

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-4

SURFACE ELEVATION 604.9'
COORDINATE 95+50 N
12+27 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET	BLOW COUNT
	PN=2.4				17.7				5	13
	PN=1.7				19.8				10	9
									15	5
					19.2				20	4
					28.2				25	5
	PN=0.8				23.9				30	7
	PN=1.0				18.7				35	9
	PN=1.1				23.7				40	29
									45	22
	PN=3.8		35.4	10.5					50	18
									55	33
									60	

SYMBOLS	DESCRIPTION
	STRIP MINE SPOIL
CL-ML	Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface. Moist to 66'.
CL	Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.
CL	Gray broken SHALE mine spoil mixed with some reworked clay till and loess, has a silty weathered appearance.

FEATURE: Observation and Monitoring Well (OM-4D)
Date Drilled: 9/12/80
Total Depth: 68.0'
Piezometer: Screen from 51.0' to 61.0'.
Gravel pack from 44.0' to 65.0'.
Water level; Elevation 581.3' on 10/20/80

Installed a second shallow piezometer in an adjacent hole (OM-4S)
Screen from 23-33'
Gravel pack from 20-35'
Water level: Elevation 583.8 on 10/20/80

LOG OF BORING

Gilbert/Commonwealth

OM04

BORING OM-4

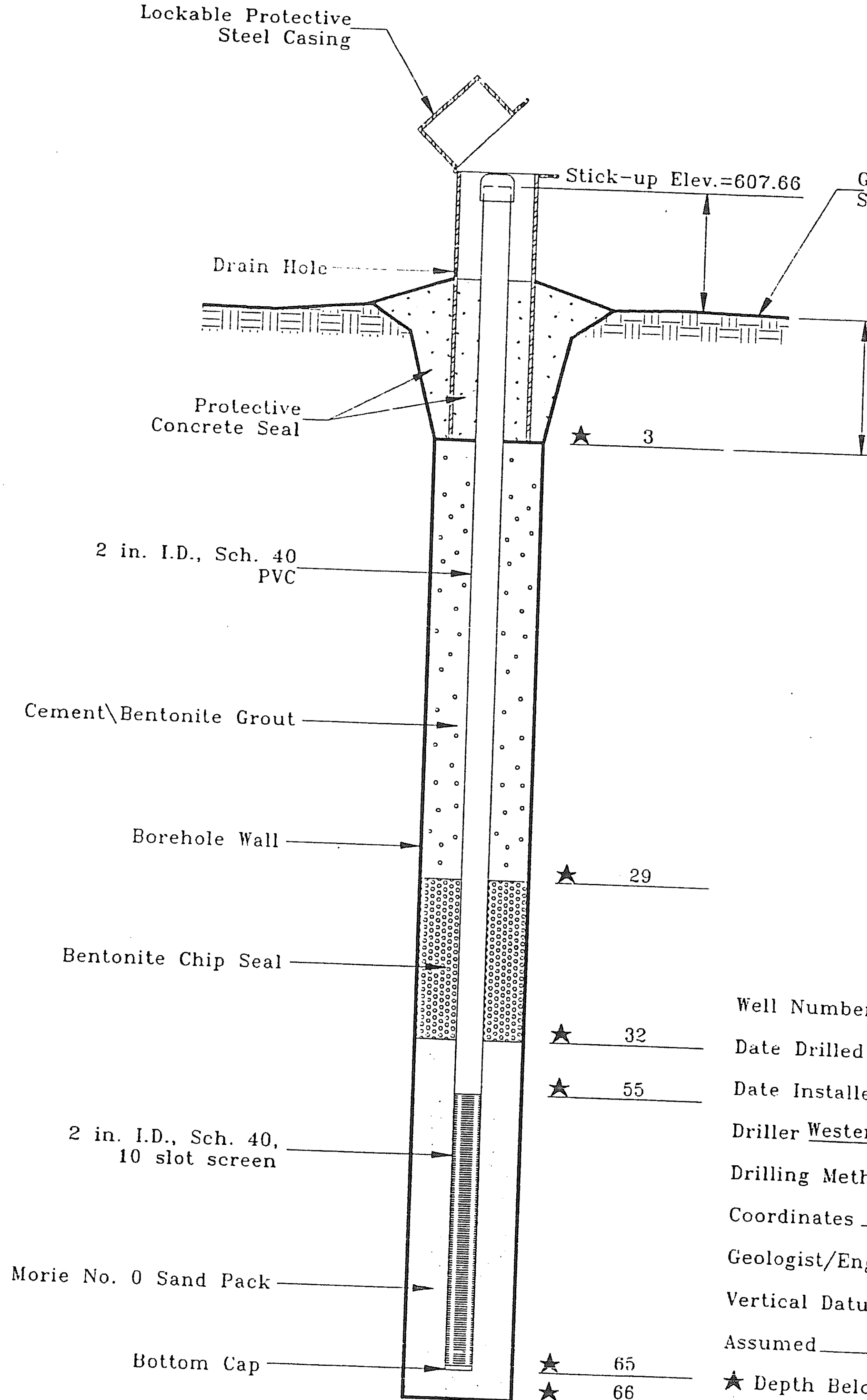
ELEV. IN FEET	OTHER TESTS	STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET	BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
	PN >4.5									24	☒	CL	
									65	43	☒		TOP OF SHALE BEDROCK
										100/2"	☒	SH	SHALE BEDROCK, Carbondale formation Pennsylvanian age, gray, silty shale.
									70				
									75				
									80				
									85				
									90				
									95				
									100				
									105				
									110				
									115				
									120				

LOG OF BORING

Gilbert/Commonwealth

PLATE 2-6

OR04D



Well Number OM-4a

Date Drilled 10/27/97

Date Installed 10/27/97

Driller Western Env. Services, Inc.

Drilling Method HSA

Coordinates N9548 E1228

Geologist/Engineer BDC

Vertical Datum:

Assumed ____ U.S.G.S. X

★ Depth Below Ground Surface

Not to Scale

J:\DRAWINGS\92S5078A\004.DWG 12/05/97 09:15 Oth

MONITORING WELL OM-4a

HANSON ENGINEERS INCORPORATED

MONITORING WELL INSTALLATION
CILCO - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078A

OR04D

DUCK CREEK STATION		BORING OM-4a		SHEET 1 of 2
DATE STARTED 10/27/97	DATE COMPLETED 10/27/97		LOGGED BY BDC	SURFACE EL. 605.1 (ft.)
DRILLING CONTRACTOR: WESTERN ENVIRONMENTAL, INC.			DRILL METHOD: HSA	

Depth (ft)	Graphic Log	Penetro-meter (TSF)	SOIL/ROCK DESCRIPTION	VAPOR CONCENTRATION Isobutylene Calibration Gas Equivalent Units (ppm) 10^0 10^1 10^2 10^3	COMMENTS	Depth (ft)
0–8		1.0 1.25 – – 1.0 1.25	Brown clayey silt w/ tr. sand & gravel; tr. gray colored zones; roots at top. SAME; so. rust brown & gray mottles; pockets of silty clay. SAME; v. moist; v. little recovery (looks like pushed a cobble); variegated gray & rust brown colors; drilling very easy.			0 5
8–12.5		– – – –	CORE LOSS			10
12.5–14			SAME; v. moist to wet; v. little recovery (cobble in tip); olive gray color; variegated colors; tr. shale frags; v. soft; drilling v. easy.		∇ 13 ft.	
14–18		– – – –	CORE LOSS			15
18–19		–	SAME; v. moist to wet; v. little recovery big glacial cobble (w/ striations) in tip; zones which are mostly dk. gray.			
19–23		– – –	CORE LOSS			20
23–31		0.5 0.25 0.25 0.25 0.5 0.5 0.25	SAME; highly variegated colors (dk. gray, gray, brown, & rust brown); moist; pockets of gray silt (blocky – may be weathered rock). SAME; becomes all gray at 31 ft. w/ angular siltstone rock frags; wet in zones w/ more rock frags.		▼ 22.99 ft. after 8 days.	25 30
35						35

SOIL/ROCK BORING DATA

HANSON ENGINEERS INCORPORATED

Ady 12/5/97
REVIEWED DATE

BDC 12/5/97
APPROVED DATE

MONITORING WELL INSTALLATION
CILCO-DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078A

OR04D

DUCK CREEK STATION | BORING OM-4a | SHEET 2 of 2

DATE STARTED 10/27/97 | DATE COMPLETED 10/27/97 | LOGGED BY BDC | SURFACE EL. 605.1 (ft.)

DRILLING CONTRACTOR: WESTERN ENVIRONMENTAL, INC. | DRILL METHOD: HSA

Depth (ft)	Penetrometer (TSF)	SOIL/ROCK DESCRIPTION	VAPOR CONCENTRATION Isobutylene Calibration Gas Equivalent Units (ppm) 10^0 10^1 10^2 10^3	COMMENTS	Depth (ft)
31	0.25 1.5 1.75 1.5	Gray silt w/ so. clay, sand & gravel; sand & gravel is composed mostly of gray siltstone rock; tr. rust brown mottles; wet in zones w/ rock frags.			31
	– – – –	SAME; rock frags v. common; wet in these zones; clayey silt in areas (v. sticky); siltstone frags are fissile.			
41	– – – –	SAME; water in zones w/ abundant coarse rock; sticky.			41
	– – –	SAME; tr. brown mottled zones; v. wet; abundant rock; some rock has slickensides.			
51	–	CORE LOSS			51
	– – – –	SAME; coal & organic shale (black) frags from 53.6–53.9 ft; 55.6–55.8 ft. and 57.5–58.0 ft; wet; smaller pieces of black shale disseminated throughout.			
	– – – – –	SAME; black organic shale more common.			
61		SAME; coal frags v. common; refusal at 66 ft.			61
		End of Boring = 66.0'			
71		TILL SPOIL 0-31 ft. TILL/SHALE SPOIL 31-66 ft.			71

SOIL/ROCK BORING DATA

HANSON ENGINEERS INCORPORATED

[signature] REVIEWER 12/5/97 DATE

BDC APPROVED 12/5/97 DATE

MONITORING WELL INSTALLATION
CILCO-DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078A

OM05

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-5

SURFACE ELEVATION 608.0'
COORDINATE 67+62 N
16+82 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET	BLOW COUNT	SYMBOLS
					24.2						CL-ML
	PN=3.2				19.0				5	17	CL-ML
	PN=1.25				24.9				10	6	CL-ML / ML
	PN=0.8				26.8				15	6	ML / CL-ML
	PN=4.0				20.1				20	9	CL-ML
					17.7				25	9	CL-ML
	PN=2.1				17.7				30	9	CL-ML
	PN=0.9				26.8				35	11	ML
	PN=3.8				21.2				40	12	CL
	PN=1.9				20.0				45	12	CL
	PN=1.75				17.7				50	14	CL
									55	96 / 3"	SH
									60		SH

DESCRIPTION

STRIP MINE SPOIL

CL-ML: Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface.

Damp to 14'.

ML

Moist to 54'.

CL-ML

ML

CL: Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.

CL: Gray broken SHALE mine spoil mixed with some reworked clay till and loess, has a silty weathered appearance.
50% water loss.

TOP OF SHALE BEDROCK

SH: SHALE BEDROCK, Carbondale formation Pennsylvanian age, gray, silty shale.

FEATURE: Observation and Monitoring Well (OM-5D)
Date Drilled: 9/5/80
Total Depth: 67.0'
Piezometer: Screen from 47.0' to 57.0'
Gravel pack from 45.0' to 67.0'.
Water level: Elevation 594.0' on 11/20/80

Installed a second shallow piezometer in an adjacent hole (OM-5S)
Screen from 13-23'
Gravel pack from 23.5-11'
Water level: 594.4' on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

OM05

BORING OM-5

ELEV. IN FEET	OTHER TESTS	STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD		DEEP IN FEET	BLOW COUNT	SAMPLES	SYMBOLS		DESCRIPTION
	P_Q >4.5										100/4"	CORE RUN 1		SH	SHALE BEDROCK, Carbondale formation Pennsylvanian age, gray, silty shale. Dry to 67' and 100% water loss.
										65					
										70					
										75					
										80					
										85					
										90					
										95					
										100					
										105					
										110					
										115					
										120					

LOG OF BORING

Gilbert/Commonwealth

PLATE 2-8

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Fulton Well #: OR05D

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR05D

~~State-~~ Plant ~~Plane~~ Coordinate: X 6,766.3 Y 1,675.1 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/20/2008 Date Finished: 3/20/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one) — selected: Granular

Installation Method: Gravity

Setting Time: >24 hours

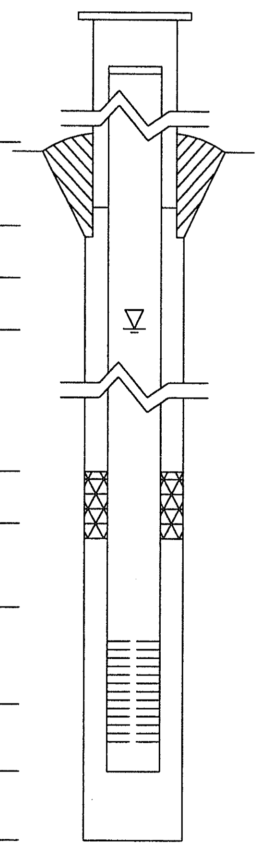
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
611.16	-3.25	Top of Protective Casing
610.96	-3.05	Top of Riser Pipe
607.91	0.00	Ground Surface
605.91	2.00	Top of Annular Sealant
600.77	7.14	Static Water Level (After Completion) 5/15/2008
575.91	32.00	Top of Seal
572.66	35.25	Top of Sand Pack
570.97	36.94	Top of Screen
561.49	46.42	Bottom of Screen
560.91	47.00	Bottom of Well
559.41	48.50	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	39.99
Bottom of Screen to End Cap	(feet)	0.58
Screen Length (1st slot to last slot)	(feet)	9.48
Total Length of Casing	(feet)	50.05
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

OM06

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-6

SURFACE ELEVATION 587.8'
COORDINATE 49+25 N
16+75 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD		DEEP IN FEET	BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
	PN 4.5									5	12	⊠	CL-ML	STRIP MINE SPOIL Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface. Dry to 12'.
	PN=3.2									10	12	⊠		Moist to 34'.
	PN=0.5									15	5	⊠	ML	
	PN=1.6									20	5	⊠	CL	Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.
	PN=1.5									25	6	⊠		
										30	9	⊠		
										35	144	⊠	SH	TOP OF SHALE BEDROCK SHALE BEDROCK: Carbondale formation Pennsylvanian age, gray, silty shale.
										40				
										45				
										50				
										55				
										60				

FEATURE: Observation and Monitoring Well
Date Drilled: 9/22/80
Total Depth: 38.0'
Piezometer: Screen from 15.0' to 25.0'.
Gravel pack from 13.0' to 33.0'.
Water Level Data: Elevation 576.8 on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

OM06A

BORING OM-6A

SURFACE ELEVATION 590.67
COORDINATE 4925 N
1635 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING #200 SIEVE	RECOVERY (%)	RQD	DEPTH IN FEET	BLOW COUNT	SAMPLES	SYMBOLS
	PN	4.5								5	17	X	ML-CL
	PN	3.75-4.5+								10	12	X	
										15	6	X	
										20	7	X	SH / ML / ML-CL
										25	7	X	ML-CL
										30	16	X	
										35	20	X	SH
										40	58/3"	X	SH
										45			
										50			
										55			
										60			

DESCRIPTION

MINE SPOIL.
Brown clayey silt and silty clay, little fine to medium sand, trace fine gravel; moist, below plastic limit; grades with increasing moisture with depth.

15.0 to 15.7 ft., Yellow-brown clayey silt and fine to medium sand, near saturated.
17.8 ft.,broken shale noted in drilling; water level at 17.8 ft. when pulled auger plug and at 4.0 ft. after ss-4 taken.
20.2 ft.,Yellow-brown to brown silt (Loess) and clayey silt; some fine to medium sand, trace fine gravel (Till), broken shale noted, 21.0 to 24.5 ft.
24.5 ft. gray silty clay, little fine to medium sand, little fine to coarse gravel (Till mixed with broken shale fragments). Water at 4.0 ft.
32.0 ft., 6" shale cobble.

35.0 ft., Black weathered broken shale, moist not saturated. Water level at 14.0 ft. Hard drilling noted

SHALE BEDROCK - 38.0 ft.
Gray shale, weathered

MONITORING WELL INSTALLED 10/17/84
10' of #10 slot screen: 15.0 to 25.0 ft.
Gravel Pack : 12.0 to 40.3 ft.
Bentonite Seal : 10.0 to 12.0 ft.
Cement-Bentonite Grout: G.S. to 10.0 ft.

CILCO
DUCK CREEK STATION
WASTE DISPOSAL SYSTEM

Gilbert Commonwealth Companies

LOG OF
BORING OM-6A

PLATE

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Fulton Well #: OR06A

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR06A

~~State~~- Plant ~~Plane~~ Coordinate: X 4,917.2 Y 1,635.8 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

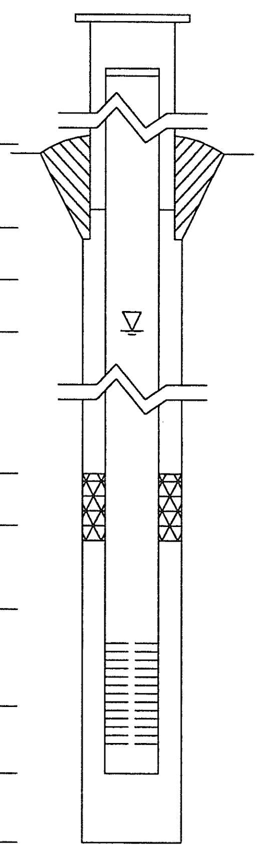
Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 4/1/2008 Date Finished: 4/1/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS



Type of Surface Seal: Concrete

Type of Annular Sealant: ______

Installation Method: ______

Setting Time: ______

Type of Bentonite Seal -- Granular (circled) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: >24 hours

Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ______

	Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
			Top of Protective Casing
	595.31	-3.69	Top of Riser Pipe
	591.62	0.00	Ground Surface
			Top of Annular Sealant
	592.37	-0.75	Static Water Level (After Completion) 5/15/2008
	589.12	2.50	Top of Seal
	577.50	14.12	Top of Sand Pack
	576.09	15.53	Top of Screen
	566.59	25.03	Bottom of Screen
	565.81	25.81	Bottom of Well
	565.81	25.81	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	19.22
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.50
Total Length of Casing	(feet)	29.50
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-7

SURFACE ELEVATION 593.4'
COORDINATE 41+60 N
16+44 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET	BLOW COUNT	SAMPLES
	PN=3.8								5	9	☒
	PN=0.9								10	7	☒
	PN=1.8								15	10	☒
	PN=1.0								20	8	☒
									25	10	☒
	PN=0.9								30	13	☒
	PN=2.5								35	12	☒
									40	17	☒
	PN >4.5										
	PN=1.5								45	20	☒
									50	100/2"	☒
									55		
									60		

SYMBOLS	DESCRIPTION
	STRIP MINE SPOIL
CL-ML	Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface. Dry to 12'. Moist from 12' to 48'.
ML	
CL	Gray broken SHALE mine spoil mixed with some reworked clay till and loess, has a silty weathered appearance.
CL-ML	Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.
CL	Gray broken SHALE mine spoil mixed with some reworked clay till and loess, has a silty weathered appearance.
SH	TOP OF SHALE BEDROCK SHALE BEDROCK, Carbondale formation Pennsylvanian age, gray, silty shale.

FEATURE: Observation and Monitoring Well
Date Drilled: 9/18/80
Total Depth: 53.0'
Piezometer: Screen from 17.0' to 27.0'.
Gravel pack from 15.0' to 46.0' and 49.0' to 53.0'.
Water Level Data: Elevation 581.3 on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

OM08

BORING OM-8

SURFACE ELEVATION 599.4'
COORDINATE 25+78' N
19+36' E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD		DEEP IN FEET
										5
	PN=1.3									10
										15
										20
										25
	PN=1.1									30
										35
										40
										45
										50
										55
										60

BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
			STRIP MINE SPOIL
10	☒	CL-ML	Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface.
8	☒		Damp to 11'.
		ML	
4	☒	CL	Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand broken shale.
2	☒		
6	☒	CL-ML	

FEATURE: Observation and Monitoring Well
Date Drilled: 9/23/80
Total Depth: 26.5'
Piezometer; Screen from 15.0' to 25.0'.
Gravel pack from 13.0' to 26.5'.
Water Level Data: Elevation 587.4' on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

OM09

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-9

SURFACE ELEVATION 590.2'
COORDINATE 19+02 N
0+72 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS		FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET	BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
			LIQUID LIMIT	PLASTICITY INDEX									
									5	8	☒	CL-ML	STRIP MINE SPOIL Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface. Damp to 9'. Wet to 26'.
									10	3 2	☒ ☒	PT	Dark gray PEAT.
									15	3	☒	CL-ML	
									20	2	☒	CL	Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.
									25	3	☒		
									30				
									35				
									40				
									45				
									50				
									55				
									60				

FEATURE: Observation and Monitoring Well
Date Drilled: 9/24/80
Total Depth: 26.5'
Piezometer: Screen from 15.0' to 25.0'
Gravel pack from 13.0' to 25.0'.
Water Level Data: Elevation 586.4' on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

OM10

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

BORING OM-10

SURFACE ELEVATION 584.0'
COORDINATE 62+21'N
48+76'E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEEP IN FEET

DEEP IN FEET: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60

BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
			STRIP MINE SPOIL
7	☒	CL-ML	Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface. Dry to 7'. Moist to 20'.
4	☒		
5	☒	ML	
5	☒	CL	Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.

FEATURE: Observation and Monitoring Well
Date Drilled: 10/1/80
Total Depth: 20.0'
Piezometer: Screen from 8.0' to 18.0'.
Gravel pack from 7.0' to 20.0'.
Water Level Data: Elevation 570.9' on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

OM11

BORING OM-11

SURFACE ELEVATION 594.0'
COORDINATE 54+38'N
30+61'E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD		DEPTH IN FEET
										5
										10
										15
										20
										25
										30
										35
										40
										45
										50
										55
										60

BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
11	☒	CL-ML	STRIP MINE SPOIL Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till, some organic material near the surface.
11	☒		Dry to 13'.
P			
			Moist to 43'.
8	☒	ML	
P			
6	☒		
P			
16	☒	CL	Gray broken SHALE mine spoil mixed with some reworked clay till and loess, has a silty weathered appearance.
9	☒		
11	☒		
13	☒		

FEATURE: Observation and Monitoring Well
Date Drilled: 10/16/80
Total Depth: 43.0'
Piezometer: Screen from 30.0' to 40.0'
Gravel pack from 28.0' to 43.0'.
Water Level Data: Elevation 563.6' on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

Illinois Environmental Protection Agency — Well Completion Report

Site #: ____________ County: Fulton Well #: OR11

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR11

~~State-~~ Plant ~~Plane~~ Coordinate: X 5,448.4 Y 3,059.0 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: B. WIlliamson

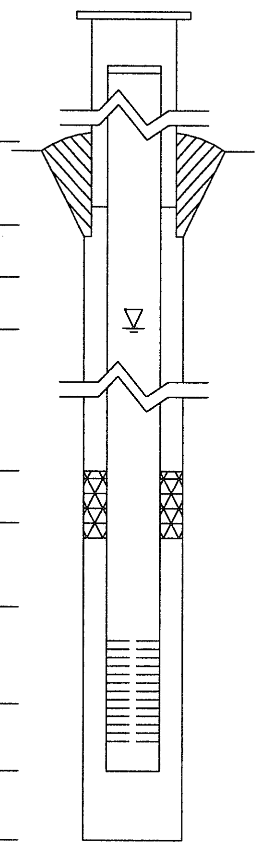
Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/25/2008 Date Finished: 3/25/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS



Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 30 minutes

Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity

Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
596.79	-3.15	Top of Protective Casing
596.55	-2.91	Top of Riser Pipe
593.64	0.00	Ground Surface
591.64	2.00	Top of Annular Sealant
569.42	24.22	Static Water Level (After Completion) 5/15/2008
564.86	28.78	Top of Seal
563.25	30.39	Top of Sand Pack
561.79	31.85	Top of Screen
552.34	41.30	Bottom of Screen
551.56	42.08	Bottom of Well
551.07	42.57	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	34.76
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.45
Total Length of Casing	(feet)	44.99
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

CENTRAL ILLINOIS LIGHT COMPANY
DUCK CREEK POWER STATION
WASTE DISPOSAL AREA

OM12

BORING OM-12

SURFACE ELEVATION 592.6'
COORDINATE 39+26'N
30+53'E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT RECOVERY (%)	RQD	DEPTH IN FEET	BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTION
												ML	STRIP MINE SPOIL Brown silty CLAY to clayey SILT: A mixture of reworked silty loess with some clay till some organic material near the surface.
									5				
									10			CL-ML	
									15			CL	Brown and gray CLAY: A mixture of reworked clay till and silt, trace to some sand and broken shale.
									20				
									25				
									30				
									35			CL-ML	
									40				
									45				
									50				
									55				
									60				

FEATURE: Observation and Monitoring Well
Date Drilled: 10/17/80
Total Depth: 43.5'
Piezometer: Screen from 30.0' to 40.0'
Gravel pack from 28.0' to 43.5'.
Water Level Data: Elevation 576.2' on 11/20/80

LOG OF BORING

Gilbert/Commonwealth

PLATE 2-15

OM13

BORING OM-13

SURFACE ELEVATION 595.8
COORDINATE 6908 N
1632 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING #200 SIEVE	RECOVERY (%)	RQD	DEPTH IN FEET	BLOW COUNT
	PN	2.25								5	10
	PN	0.7								10	3
	PN	0.65								15	5
	PN	1.2								20	7
	PN	2.25									9
	PN	1.0								25	7
										30	9
	PN	3.75								35	18
										40	7
										45	60
										50	
										55	
										60	

SAMPLES — SYMBOLS — DESCRIPTION

RAILROAD BALLAST: 0-2 ft.; 2.0 to 3.0 ft. Ballast mixed with brown clayey silt.

ML — FILL ? (Based on Penetrometer) 3.0 to 7± ft., brown and gray mottled, silt and clayey silt; saturated.

ML — MINE SPOIL
Brown and gray mottled silt and clayey silt
ML, CL — 10.9 ft. grades to gray in color.

15.7 to 15.9 ft. black weathered shale, weathered to stiff clay.

18 ft. brown and gray clayey silt (Loess and Till)

SH — 20.8 to 22.5 ft. black broken shale, none to little soil; water flowing to surface.

CL — 22.5 ft. gray silty clay and clayey silt (Till), trace to little fine to medium sand, trace to no gravel. Not saturated. Water level dropping as advance boring. 30 ft. water 6 ft. below surface in augers.

35.0 ft. water 16 ft. below surface.
35.0 ft. dark gray clay, weathered shale and till, broken shale fragment 35.3 to 35.4 ft.

40.0 ft. gray clayey silt and black broken shale fragments (saturated in shale)

SH — SHALE BEDROCK: 42.5 ft.
Gray shale, weathered.
Water flowing to surface after pulling auger plug. Flowing clear water at 3 gpm. Seep south stopped flowing.

Boring completed at 45.5 ft. on 10/17/84.

MONITORING WELL INSTALLED 10/17/84
10' of #10 slot screen: 32.5 to 42.5 ft.
Gravel Pack : 17.5 to 45.5 ft.
Bentonite Seal : 15.0 to 17.5 ft.
Cement-Bentonite grout: G.S. to 15.0 ft.

CILCO
DUCK CREEK STATION
WASTE DISPOSAL SYSTEM

Gilbert Commonwealth Companies

LOG OF
BORING OM-13

PLATE

Illinois Environmental Protection Agency | **Well Completion Report**

Site #: ____ County: Fulton Well #: OR13S

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR13S

~~State-~~ Plant ~~Plane~~ Coordinate: X 6,834.3 Y 1,749.6 (or) Latitude: ___ ° ___ ' ___ " Longitude: ___ ° ___ ' ___ "

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: B. WIlliamson

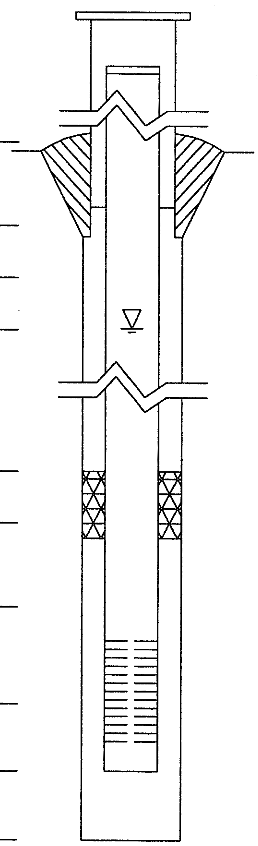
Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 3¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/22/2008 Date Finished: 3/22/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS



Type of Surface Seal: Concrete

Type of Annular Sealant: ____

Installation Method: ____

Setting Time: ____

Type of Bentonite Seal -- Granular (circled) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: >24 hours

Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Quartz sand (if applicable)

Installation Method: Gravity

Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
602.91	-7.16	Top of Protective Casing
602.71	-6.96	Top of Riser Pipe
595.75	0.00	Ground Surface
		Top of Annular Sealant
592.15	3.60	Static Water Level (After Completion) 5/15/2008
595.75	0.00	Top of Seal
585.14	10.61	Top of Sand Pack
583.81	11.94	Top of Screen
574.33	21.42	Bottom of Screen
573.54	22.21	Bottom of Well
573.54	22.21	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	7.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	18.90
Bottom of Screen to End Cap	(feet)	0.79
Screen Length (1st slot to last slot)	(feet)	9.48
Total Length of Casing	(feet)	29.17
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Fulton Well #: OR13D

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR13D

~~State-~~ Plant ~~Plane~~ Coordinate: X 6,840.3 Y 1,749.7 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: B. WIlliamson

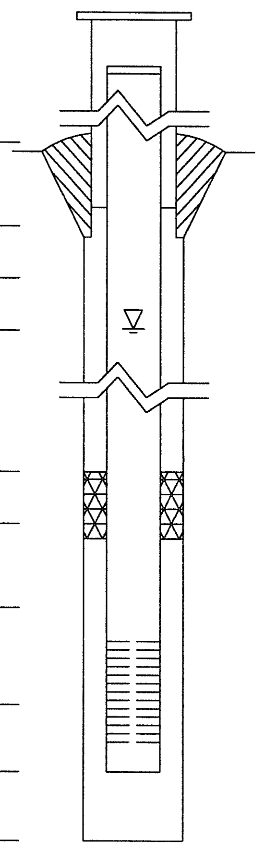
Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/22/2008 Date Finished: 3/22/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS



Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: >24 hours

Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ______

Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
602.88	-7.13	Top of Protective Casing
602.70	-6.95	Top of Riser Pipe
595.75	0.00	Ground Surface
595.75	0.00	Top of Annular Sealant
600.79	-5.04	Static Water Level (After Completion) 5/15/2008
573.52	22.23	Top of Seal
564.51	31.24	Top of Sand Pack
562.73	33.02	Top of Screen
553.29	42.46	Bottom of Screen
552.51	43.24	Bottom of Well
552.51	43.24	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	39.97
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.44
Total Length of Casing	(feet)	50.19
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

OM14

BORING OM-14

SURFACE ELEVATION 596.74
COORDINATE 7371 N
1841 E

ELEV IN FEET	OTHER TESTS	SHEAR STRENGTH TEST (PSF)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FIELD MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING #200 SIEVE	RECOVERY (%)	RQD	DEPTH IN FEET	BLOW COUNT	SYMBOLS
	PN	0.8								5	10	ML CL
										10	4	
	PN	1.0-1.5								15	6	
										20	8	CL
										25	7	ML • CL
	PN	1.8-2.0								30	12	
	PN	1.5-2.0								35	13, 20	
										40	11, 26	CL • SH
										45	27	
										50		
										55		
										60		

DESCRIPTION

MINE SPOIL.
Brown and gray silty clay to clayey silt, little to some fine to coarse sand, trace fine gravel, damp to moist (Loess and Till)

18.5 ft. gray silty clay, little fine to medium sand, trace fine gravel. 19.2 to 20.0 ft. and 24.5 to 25.0 ft. black broken shale fragments and gray till; saturated. Water level at 13.0 ft after ss-4 taken.

25.0 ft. Yellow-brown silty clay (till) and gray clayey silt to silt, some black topsoil type material noted, little fine to medium sand, trace fine gravel. Water level at 21.0 ft. before ss-6 taken.
34.0 to 34.5 ft., shale cobble
35.3 to 36.0 ft., gray silty clay and weathered gray shale. Water level at 33.0 ft.

37.0 to 38.4 ft. black broken shale fragments with gray till. Water level at 24.0 ft. for ss-8 and ss-9.
38.4 ft., gray silty clay and broken shale mixed, shale is saturated, highly weathered at 42.0 ft.

Boring completed at 46.0 ft. on 10/17/84.

MONITORING WELL INSTALLED 10/17/84
10' of #10 slot screen:
Gravel Pack : 17.0 to 46.0 ft.
Bentonite Seal : 15.0 to 17.0 ft.
Cement-Bentonite Grout: G.S. to 15.0 ft.

CILCO
DUCK CREEK STATION
WASTE DISPOSAL SYSTEM

Gilbert Commonwealth Companies

LOG OF
BORING OM-14

PLATE

Illinois Environmental Protection Agency

Well Completion Report

Site #: ______ County: Fulton Well #: OR14S

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR14S

~~State-~~ Plant ~~Plane~~ Coordinate: X 1,760.0 Y 7,350.8 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Andrew D. Canopy IL Registration #: 035-003391

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

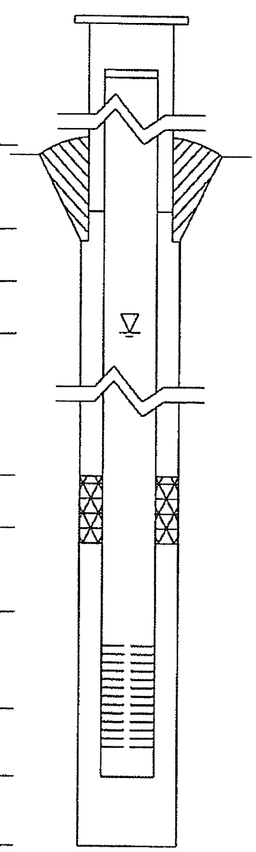
Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 3¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/9/2009 Date Finished: 3/9/2009

Report Form Completed By: Suzanna L. Simpson Date: 3/18/2009

ANNULAR SPACE DETAILS



	Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
	599.59	-3.37	Top of Protective Casing
	599.26	-3.04	Top of Riser Pipe
Type of Surface Seal: Concrete	596.22	0.00	Ground Surface
Type of Annular Sealant: Bentonite Chips	594.22	2.00	Top of Annular Sealant
Installation Method: Gravity			
Setting Time: >24 hours			Static Water Level (After Completion)
Type of Bentonite Seal -- Granular / Pellet / Slurry (choose one)			
Installation Method: Gravity	594.22	2.00	Top of Seal
Setting Time: >24 hours	586.87	9.35	Top of Sand Pack
Type of Sand Pack: Quartz sand			
Grain Size: 10/20 (sieve size)	584.96	11.26	Top of Screen
Installation Method: Gravity			
	575.60	20.62	Bottom of Screen
Type of Backfill Material: n/a (if applicable)	574.82	21.40	Bottom of Well
Installation Method:	574.82	21.40	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	7.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	14.30
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.36
Total Length of Casing	(feet)	24.44
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

Illinois Environmental Protection Agency

Well Completion Report

Site #: ______ County: Fulton Well #: OR14D

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR14D

~~State~~ Plant ~~Plane~~ Coordinate: X 1,759.9 Y 7,356.5 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Andrew D. Canopy IL Registration #: 035-003391

Drilling Contractor: Testing Service Corporation Driller: B. Williamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/9/2009 Date Finished: 3/9/2009

Report Form Completed By: Suzanna L. Simpson Date: 3/18/2009

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 40 minutes

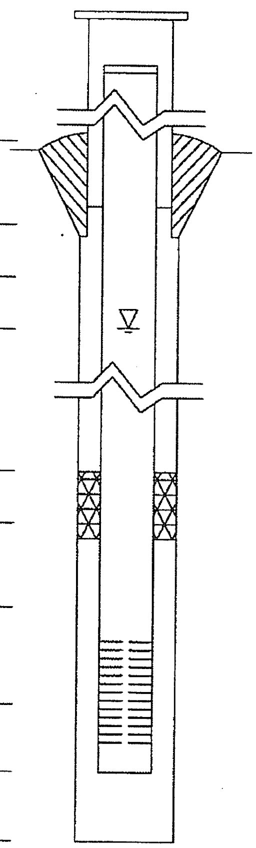
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
599.08	-2.86	Top of Protective Casing
598.91	-2.69	Top of Riser Pipe
596.22	0.00	Ground Surface
594.12	2.10	Top of Annular Sealant
		Static Water Level (After Completion)
564.35	31.87	Top of Seal
562.25	33.97	Top of Sand Pack
560.20	36.02	Top of Screen
550.84	45.38	Bottom of Screen
550.36	45.86	Bottom of Well
550.36	45.86	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	38.71
Bottom of Screen to End Cap	(feet)	0.48
Screen Length (1st slot to last slot)	(feet)	9.36
Total Length of Casing	(feet)	48.55
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

Well Completion Form (revised 02/06/02)

OM15

BLACK & VEATCH

LOG OF BORING

BORING NO. BV-20

ILLINOIS LIGHT COMPANY		PROJECT DUCK CREEK NEW ASH POND	PROJECT NO. 23283
LOCATION COUNTY, ILLINOIS	COORDINATES N 6240 E 3010	ELEVATION (DATUM) 595.7 (MSL) / TOTAL DEPTH 75.20 FEET	DATE START 7-12-94
CONDITIONS ER ROAD, BETWEEN TWO PONDS, BRUSH AND REEDS		LOGGED BY D.D. MARLOW	DATE FINISH 7-12-94
	CHECKED BY P.L. Nelson	APPROVED BY L.J. Almaleh	

SAMPLING: NUMBER	1ST 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH IN FEET	CLASSIFICATION OF MATERIAL	REMARKS
CORING: NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD			
[illegible]	18	11	15	26	1.5	61–65	Silty CLAY: gray; very stiff; moist; plastic; trace fine to medium sand intermixed with shale and coal fragments	
[illegible]	11	11	14	25	1.5	65–70		
	7	8	12	21	1.5	70–74		
1	50/2			>100	0.2	75		
						75–76	SHALE: dark gray; firm; fissile (Bedrock)	End of borehole at 75.20 FT. Borehole backfilled with auger cuttings.

DEPTH IN FEET: 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89

OM15

BLACK & VEATCH

LOG OF BORING

BORING NO. BV-20

SHEET 2 OF 3

...LINOIS LIGHT COMPANY	PROJECT: DUCK CREEK NEW ASH POND	PROJECT NO. 23283
...CATION: ...NTY, ILLINOIS	COORDINATES: N 6240 E 3010	ELEVATION (DATUM): 585.7 (MSL)
TOTAL DEPTH: 75.20 FEET	DATE START: 7-12-94	
...NDITIONS: ...ROAD, BETWEEN TWO PONDS, BRUSH AND REEDS	LOGGED BY: D.D. HARLOW	DATE FINISH: 7-12-94
CHECKED BY: P.L. Nelson	APPROVED BY: L.J. Almaleh	

Sampling: ... Set 6 Inches	2nd 6 Inches	3rd 6 Inches	N Value	Sample Recovery	Depth in Feet	Classification of Material	Remarks
6	4	3	7	1.0	31		
					32–34	CLAY: gray; firm; moist; plastic; some silt (Mine Spoil-Underclay)	
1	3	5	8	0.7	35–39	Intermixed: Clayey SILT: gray; loose; moist; low plasticity; trace fine to medium sand and Underclay fragments (as above)	Seepage water at 37.5 FT.
:	5	10	15	1.5	40–44	Silty CLAY: gray; stiff; moist; low to moderate plasticity; traces of fractured shale, coal, and fine sand	
	10	11	21	0.8	45–49	Silty CLAY: gray; very stiff; very moist; plastic; trace fine to medium sand	
	18	18	32	1.5	50–54	Fragmented Shale from 50.5 to 51.0 FT	
	8	0	10	1.5	55–59	As Above	

Coring columns (empty): Run Length, Run Recovery, RQD Recovery, Percent Recovery, RQD. Other columns: Sample Type, Graphic Log.

BLACK & VEATCH — LOG OF BORING

BORING NO. BV-20
SHEET 1 OF 3

...LINOIS LIGHT COMPANY

PROJECT DUCK CREEK NEW ASH POND

PROJECT NO. 23283

LOCATION ...UNTY, ILLINOIS

COORDINATES N 6240 E 3010

ELEVATION (DATUM) 595.7 (MSL)

TOTAL DEPTH 75.20 FEET

DATE START 7-12-94

CONDITIONS ...ROAD, BETWEEN TWO PONDS, BRUSH AND REEDS

LOGGED BY D.O. HARLOW

DATE FINISH 7-12-94

CHECKED BY P.L. Nelson

APPROVED BY L.J. Almaleh

SAMPLING: 1ST 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH IN FEET	CLASSIFICATION OF MATERIAL	REMARKS
8	11	8	19	1.2	1–2	SILT: light brown; medium dense; dry; non-plastic; some fine to coarse sand; traces of gravel, cobbles, and cinders (Mine Spoil)	Boring advanced with 3 1/2" I.D. hollow stem augers.
5	5	5	10	1.5	3–4	Clayey SILT: orangish brown; medium dense; moist; trace fine to coarse sand	
4	3	5	8	1.1	5–6		
1	2	3	5	1.5	8–9	As Above; but brown and gray; loose	
				2.0	10–12		
[illegible]	2	2	4	1.5	15–16	Clayey SILT: brown, gray, and orange; very loose; moist; low plasticity; trace fine sand and fine gravel (occasional limestone fragments)	
[illegible]	2	4	6	1.5	20–21	As Above; but gray and brown; loose	
				2.0	25–27		

CORING: RUN LENGTH | RUN RECOVERY | RQD RECOVERY | PERCENT RECOVERY | RQD

DEPTH IN FEET | SAMPLE TYPE | GRAPHIC LOG

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

07/18/94 09:27

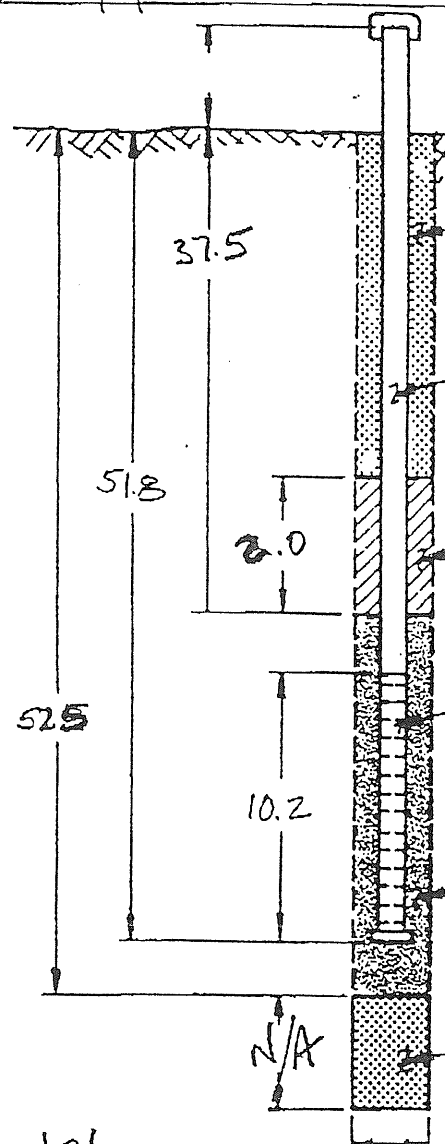
NO.328 P015

BLACK & VEATCH
CONSULTING ENGINEERS

PIEZOMETER INSTALLATION LOG

MW-15 (OM-15)
PIEZOMETER NO.

CLIENT: CILCO		PROJECT: Duck CREEK - New Ash Pond	PROJECT NO.: 23283
PROJECT LOCATION: Fulton Co, Illinois	COORDINATES:	GROUND ELEVATION: 595.7	DATE: 13 July 94
STRATUM MONITORED: Mine Spoil		INSPECTOR: D D Marlow	
CHECKED BY:		APPROVED BY:	
DRILLING CONTRACTOR: Whitney & Associates		DRILL RIG: CME 75	DRILLER: T. Fehl



TYPE OF SEAL: 3/8" coarse bentonite Baroid Hole plug

O.D. & TYPE OF RISER PIPE: Sch 40 PVC 2" DIA Flush Joint, Threaded

TYPE OF SEAL: Baroid 3/8" Pellets

TYPE AND SIZE OF SCREEN OR OPENINGS: 0.10 slot 2". Sch 40 PVC

TYPE OF FILTER: "Flint Shot 4.0" (Silica SAND)

TYPE OF SEAL: ______

H_2O 24.2'

DIAMETER OF BOREHOLE: 8" DIA

METHOD OF INSTALLATION:
Borehole Drilled using 4¼ ID Hollow stem Augers w/ center plug; installed screen & Riser, Place Sand Pack and Seals through hollow stem Augers, ~~Remove~~ Remove augers from hole install surface seal and protective casing, Developed well by hand bailing

REMARKS:
GW @ 10.00 FT in BV-20 8:30A 13 July 94; ~~set~~ set BV-20 - 10FT South
8" Dia 0.35 cuft/ft 2" casing 0.0? cuft/ft = .39 cuft/ft Calc. 4 Bags Sand
1 Bag = 0.65 cuft

OM16

BLACK & VEATCH — LOG OF BORING

BORING NO. BV-21
SHEET 1 OF 2

…ILLINOIS LIGHT COMPANY	PROJECT: DUCK CREEK NEW ASH POND		PROJECT NO. 23283
LOCATION: …COUNTY, ILLINOIS	COORDINATES: N 8225 E 3520	ELEVATION (DATUM): 805.8 (MSL)	TOTAL DEPTH: 51.50 FEET
…CONDITIONS: …BRUSH, AND WEEDS ON HILL SIDE	LOGGED BY: D.D. MARLOW		DATE START: 7-13-94
CHECKED BY: P.L. Nelson	APPROVED BY: L.J. Almaleh		DATE FINISH: 7-14-94

SAMPLING: 1ST 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH IN FEET	CLASSIFICATION OF MATERIAL	REMARKS
2	2	3	5	1.0	1–2	Clayey SILT: light brown; loose; dry; low plasticity; trace fine sand, shale fragments, and roots (Mine Spoil)	Boring advanced with 3 1/2" I.D. hollow stem augers.
6	5	5	10	1.3	3–4	As Above	
5	4	6	10	1.2	5–6	As Above; but with large shale and mudstone fragments	
7	6	7	13	1.0	8–9	As Above; but medium dense; trace medium gravel and coal fragments	
7	6	9	15	1.5	10–11	Clayey SILT: light brown; medium dense; dry; low plasticity; trace fine to medium sand; occasional seams of silty clay (2"max)	
				1.3	15–17	As Above	
4	3	4	7	1.5	20–21	Clayey SILT: light brown; medium dense; moist; low plasticity; trace fine to medium sand and shale fragments	
4	2	5	7	1.4	25–26		14 July 1994

CORING columns (NUMBER, RUN LENGTH, RUN RECOVERY, RQD RECOVERY, PERCENT RECOVERY, RQD), SAMPLE TYPE and GRAPHIC LOG columns; depth scale 1–29 ft.

OM16

OM-16

BLACK & VEATCH — LOG OF BORING

BORING NO. BV-21
SHEET 2 OF 2

ILLINOIS LIGHT COMPANY	PROJECT: DUCK CREEK NEW ASH POND		PROJECT NO.: 23283
LOCATION: COUNTY, ILLINOIS	COORDINATES: N 8225 E 3520	ELEVATION (DATUM): 805.8 (MSL) / TOTAL DEPTH: 51.50 FEET	DATE START: 7-13-94
CONDITIONS: BRUSH, AND WEEDS ON HILL SIDE	LOGGED BY: O.D. MARLOW		DATE FINISH: 7-14-94
	CHECKED BY: P.L. Nelson	APPROVED BY: L.J. Almaleh	

SAMPLING: 1ST 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH IN FEET	CLASSIFICATION OF MATERIAL	REMARKS
3	4	5	9	0.5	30–31.5	Silty CLAY: brown; stiff; very moist; low plasticity; trace fine sand and roots	Seepage water at 26.0 FT.
5	7	10	17	1.5	35–36.5	As Above; but very stiff; intermixed shale fragments and seams of silt	
				1.8	40–42		
5	28	21	49	1.5	45–46.5	SHALE: dark gray; firm; fissile; slightly fractured; slightly weathered	Hard drilling from 45 to 50 FT.
2	81	66	147	1.5	50–51.5		

CORING: RUN LENGTH | RUN RECOVERY | ROD RECOVERY | PERCENT RECOVERY | RQD

Depth scale: 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59

End of borehole at 51.50 FT. Water at 22.0 FT inside the augers. Borehole backfilled with auger cuttings.

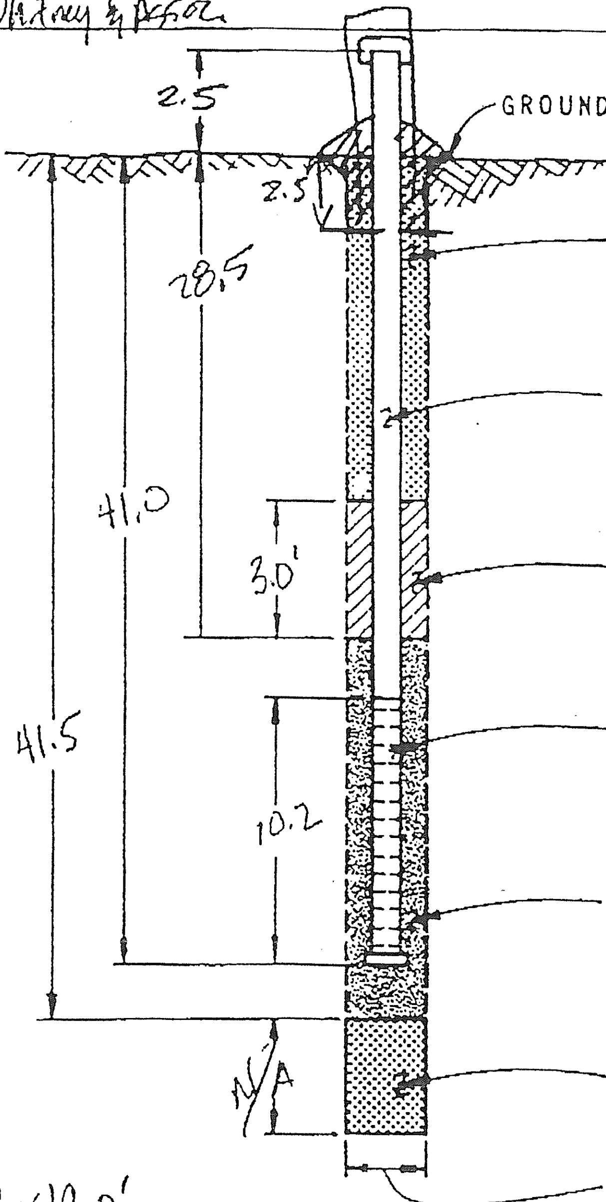
07/18/94 09:28 NO.328 P016

BLACK & VEATCH
CONSULTING ENGINEERS

PIEZOMETER INSTALLATION LOG

PIEZOMETER NO. MW-16 (OM-16)

CLIENT: CILCO	PROJECT: Duck Creek New Ash Pond	PROJECT NO.: 23283
PROJECT LOCATION: Fulton Co Illinois	COORDINATES: 9230 N 3510 E	GROUND ELEVATION: 605.6 FT
DATE: 14 July 94	STRATUM MONITORED: Mine Spoil	INSPECTOR: D D Marlow
CHECKED BY:	APPROVED BY:	
DRILLING CONTRACTOR: Whitney & Assoc.	DRILL RIG: CME 75	DRILLER: J Fahl



TYPE OF SEAL: Baroid Hole Plug 3/8 coarse bentonite

O.D. & TYPE OF RISER PIPE: 2" Sch 40 Flush Joint threaded PVC

TYPE OF SEAL: Baroid 3/8" Bentonite Pellets

TYPE AND SIZE OF SCREEN OR OPENINGS: 0.10 Slot Sch 40 PVC 2"

TYPE OF FILTER: Flint Shot 4.0 (Silica Sand)

TYPE OF SEAL:

DIAMETER OF BOREHOLE: 8" DIA

H_2O ≈ 19.0'

METHOD OF INSTALLATION: Drill Borehole w/ 4" ID Hollowstem Augers; install Riser, screen sand pack; seal and pellet seal through Augers

REMARKS: 4 bags sand, 1 bucket Balls, Hole plug 1½

OM17

DUCK CREEK STATION	BORING MW−1	SHEET 1 of 1

DATE STARTED 10/14/93	DATE COMPLETED 10/14/93	LOGGED BY RAB	SURFACE EL. 590.0 (ft.)

DRILLING CONTRACTOR: FOX DRILLING INC.	DRILL METHOD: HSA

Depth (ft)	Graphic Log	N−Value	SOIL/ROCK DESCRIPTION	VAPOR CONCENTRATION Isobutylene Calibration Gas Equivalent Units (ppm) 10^0 10^1 10^2 10^3	COMMENTS	Depth (ft)
0			Not sampled.		▼	0
			Mottled brn. and gray silty sandy CLAY, so. f.−m. gravel, moist.		▽	
5			Blk. fractured COAL fragments, wet.			5
			Mottled brn. and gray silty sandy CLAY, so. f.−m. gravel, moist.			
			Gray silty CLAY (weathered shale fragments), moist−wet.			
10			Mottled brn. lt. brn and lt. gray silty sandy CLAY, so. f.−m. gravel, moist-wet.			10
			Brn. c.−vc. SAND, wet.			
			Lt. gray silty CLAY, so. shale fragments, moist.			
			Not Sampled.			
15			End of Boring = 15.0' Glacial Till/Shale Spoil 0.0−15.0'			15
20						20

SOIL/ROCK BORING DATA

HANSON ENGINEERS INCORPORATED

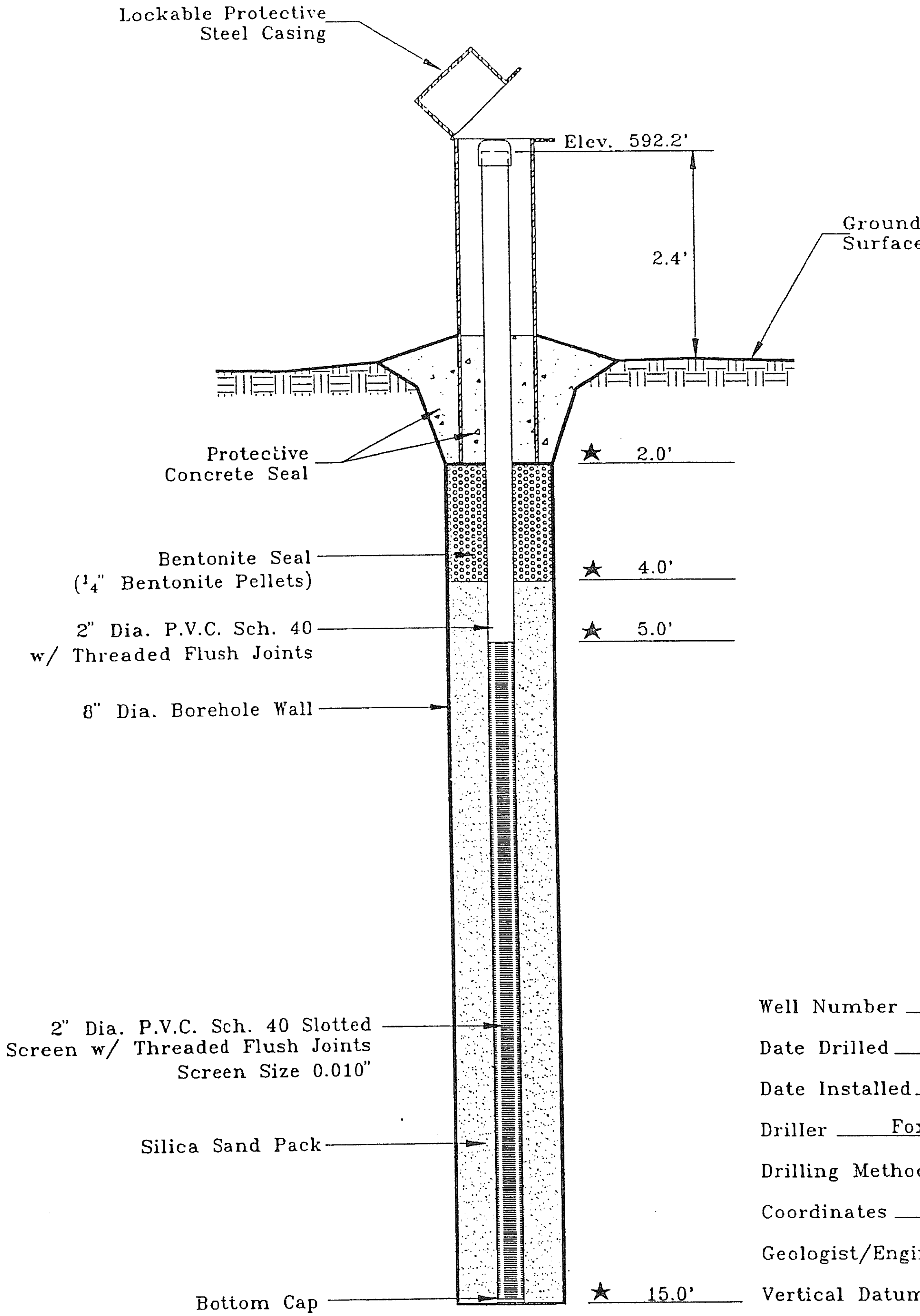
RAB 3/10/94
REVIEWED DATE

BDC 3/10/94
APPROVED DATE

PHASE II - HYDROGEOLOGICAL INVESTIGATION
CILCO - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078

OM17



Well Number MW-1 (OM-17)

Date Drilled 10/14/93

Date Installed 10/14/93

Driller Fox Drilling, Inc.

Drilling Method HSA

Coordinates

Geologist/Engineer Rich Boyer

Vertical Datum:

Assumed ________ U.S.G.S. 590.0'

★ Depth Below Ground Surface

Not to Scale

MW-1 MONITOR WELL

HANSON ENGINEERS INCORPORATED

PHASE II-HYDROGEOLOGICAL INVESTIGATION
CILCO-DUCK CREEK STATION
CANTON, ILLINOIS

Job No. 92S5078

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OM18

DUCK CREEK STATION	BORING MW-2	SHEET 1 of 2	
DATE STARTED 10/12/93	DATE COMPLETED 10/13/93	LOGGED BY RAB	SURFACE EL. 612.0 (ft.)
DRILLING CONTRACTOR: FOX DRILLING INC.		DRILL METHOD: HSA	

Depth (ft)	Graphic Log	N-Value	SOIL/ROCK DESCRIPTION	VAPOR CONCENTRATION Isobutylene Calibration Gas Equivalent Units (ppm) 10^0 10^1 10^2 10^3	COMMENTS	Depth (ft)
0			Mottled brn. and lt. brn. clayey SILT, so. sand, roots, moist.			0
5			Mottled brn., lt. brn., lt. gray silty CLAY, moist.		after 14 hours.	5
10					Perm. Sample (7.1'–7.6')	10
			Gray CLAY, moist.			
			Dk. brn. silty CLAY, organic-rich, moist.			
15			Mottled lt. brn. and lt. gray silty CLAY, moist.			15
			Mottled gray, lt. gray, and lt. brn. silty sandy CLAY, so. f gravel, moist.			
20			Mottled lt. gray and gray CLAY, so. silt, sand, moist.			20
			Lt. gray silty sandy CLAY, so. f.–m. gravel, moist.			
25			Dk. brown silty CLAY, moist, organic-rich.			25
			Mottled lt. gray and gray CLAY, so. sand, silt, tr. f. gravel, moist.			
30			Lt. gray silty sandy CLAY, so. f.–m. gravel, moist.			30
35						35

SOIL/ROCK BORING DATA

HANSON ENGINEERS INCORPORATED

RAB 3/10/94
REVIEWED DATE

BOC 3/10/94
APPROVED DATE

PHASE II - HYDROGEOLOGICAL INVESTIGATION
CILCO - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078

OM18

DUCK CREEK STATION	BORING MW-2	SHEET 2 of 2
DATE STARTED 10/12/93	DATE COMPLETED 10/13/93	LOGGED BY RAB · SURFACE EL. 612.0 (ft.)
DRILLING CONTRACTOR: FOX DRILLING INC.	DRILL METHOD: HSA	

Depth (ft)	Graphic Log	N-Value	SOIL/ROCK DESCRIPTION	VAPOR CONCENTRATION Isobutylene Calibration Gas Equivalent Units (ppm) 10^0 10^1 10^2 10^3	COMMENTS	Depth (ft)
31			Gray sandy CLAY, moist.			31
			Lt. gray v.f. sandy SILT, moist.			
36			Gray silty sandy CLAY, so. f.-m. gravel, moist.			36
			Mottled lt. gray, gray, brn., lt. brn., silty sandy CLAY, so. f.-m. gravel, fractured silty shale fragments, fractured coal fragments, loose, wet.		∇	
41			Gray CLAY, moist.			41
			Lt. gray silty CLAY, (weathered shale fragments), hard, moist.			
46			Blk. fractured bituminous COAL chunks, so. silty clay, wet.			46
			Gray silty CLAY, moist.		Perm. Sample (49.1'-49.5')	
			Gray silty SHALE fragments, so. coal, clay, moist-wet.			
51			Gray-brn. silty sandy CLAY, so. f.-m. gravel, moist.			51
			Gray silty CLAY (weathered shale fragments), moist.			
56			Dk. gray silty SHALE, hard, moist-dry. (bedrock).		Split-spoon refusal at 58.2'.	56
61			End of Boring = 58.2' Glacial Till Spoil 0.0'-39.8' Glacial Till/Shale Spoil 39.8'-56.5' Shale Bedrock 56.5'			61

SOIL/ROCK BORING DATA

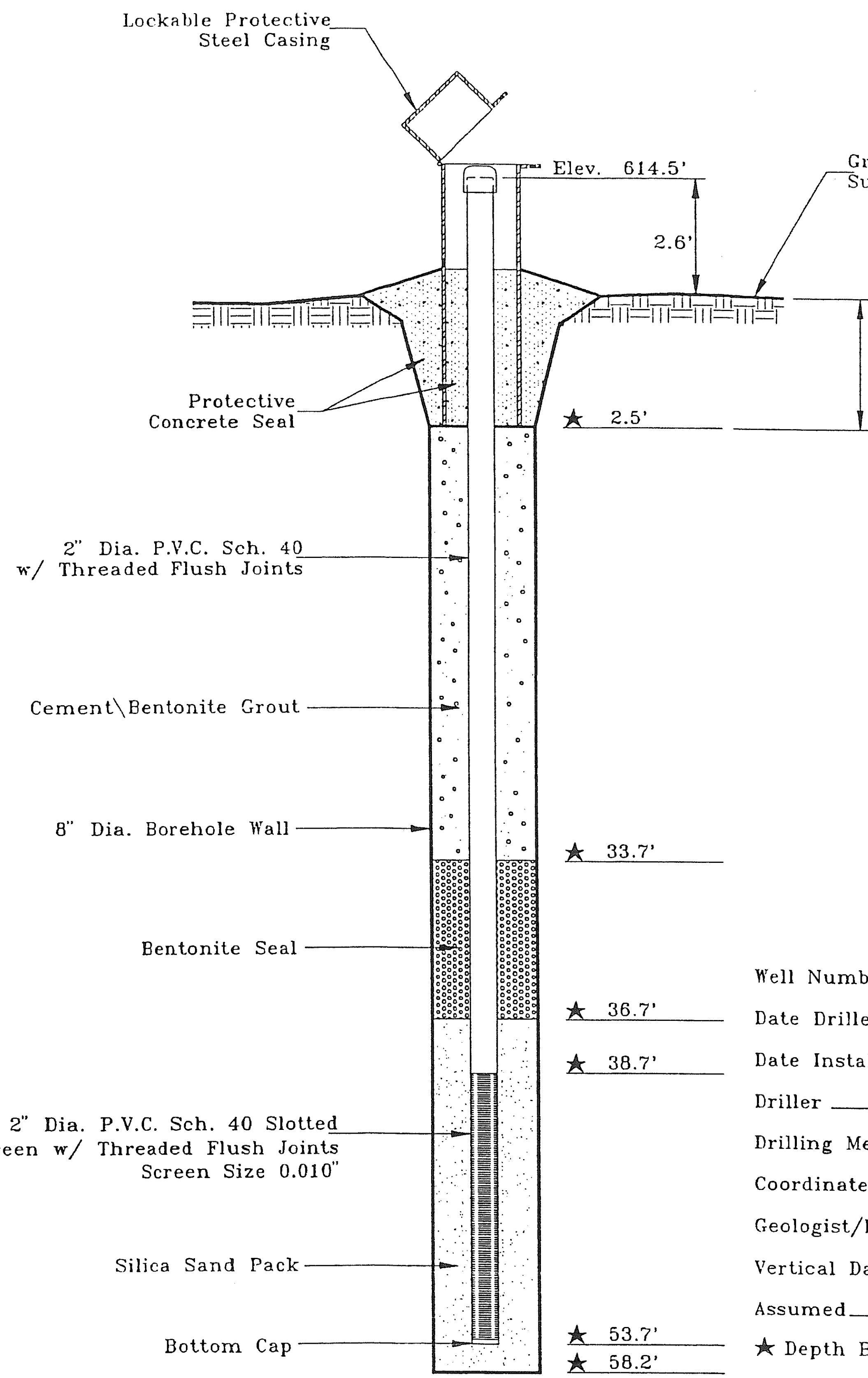
HANSON ENGINEERS INCORPORATED

RAB 3/10/94
REVIEWED DATE
BDC 3/10/94
APPROVED DATE

PHASE II - HYDROGEOLOGICAL INVESTIGATION
CILCO - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078

OM18



Well Number MW-2 (OM-18)

Date Drilled 10/13/93

Date Installed 10/13/93

Driller Fox Drilling, Inc.

Drilling Method HSA

Coordinates

Geologist/Engineer Rich Bover

Vertical Datum:

Assumed ______ U.S.G.S. 612.0'

★ Depth Below Ground Surface

Not to Scale

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MW-2 MONITOR WELL

HANSON ENGINEERS INCORPORATED

PHASE II-HYDROGEOLOGICAL INVESTIGATION
CILCO-DUCK CREEK STATION
CANTON, ILLINOIS

Job No. 92S5078

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Fulton Well #: OR18

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR18

~~State-~~ Plant ~~Plane~~ Coordinate: X 8,543.8 Y 1,979.0 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: R. Keady

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/31/2008 Date Finished: 4/1/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one) — Granular

Installation Method: Gravity

Setting Time: 32 minutes

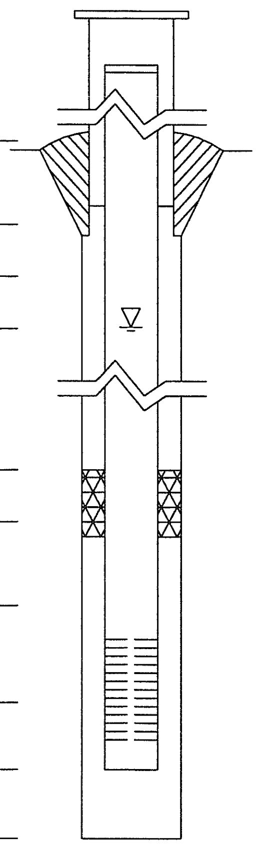
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
614.00	-2.44	Top of Protective Casing
613.85	-2.29	Top of Riser Pipe
611.56	0.00	Ground Surface
609.36	2.20	Top of Annular Sealant
592.53	19.03	Static Water Level (After Completion) 5/15/2008
576.09	35.47	Top of Seal
572.44	39.12	Top of Sand Pack
570.81	40.75	Top of Screen
561.30	50.26	Bottom of Screen
560.52	51.04	Bottom of Well
560.52	51.04	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	43.04
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.51
Total Length of Casing	(feet)	53.33
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

OR19

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Fulton Well #: OR-A

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR19

~~State-~~ Plant ~~Plane~~ Coordinate: X 4,045.0 Y 2,725.2 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: B. WIlliamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/27/2008 Date Finished: 3/27/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 28 minutes

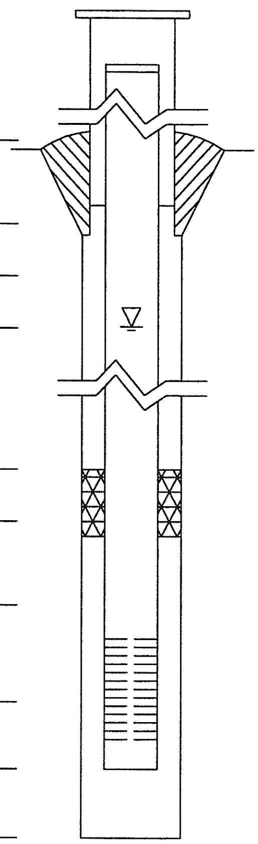
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
597.96	-2.27	Top of Protective Casing
597.80	-2.11	Top of Riser Pipe
595.69	0.00	Ground Surface
593.59	2.10	Top of Annular Sealant
581.28	14.41	Static Water Level (After Completion) 5/15/2008
559.20	36.49	Top of Seal
555.61	40.08	Top of Sand Pack
553.65	42.04	Top of Screen
544.10	51.59	Bottom of Screen
543.31	52.38	Bottom of Well
543.31	52.38	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	44.25
Bottom of Screen to End Cap	(feet)	0.79
Screen Length (1st slot to last slot)	(feet)	9.45
Total Length of Casing	(feet)	54.49
Screen Slot Size **	(inches)	0.010

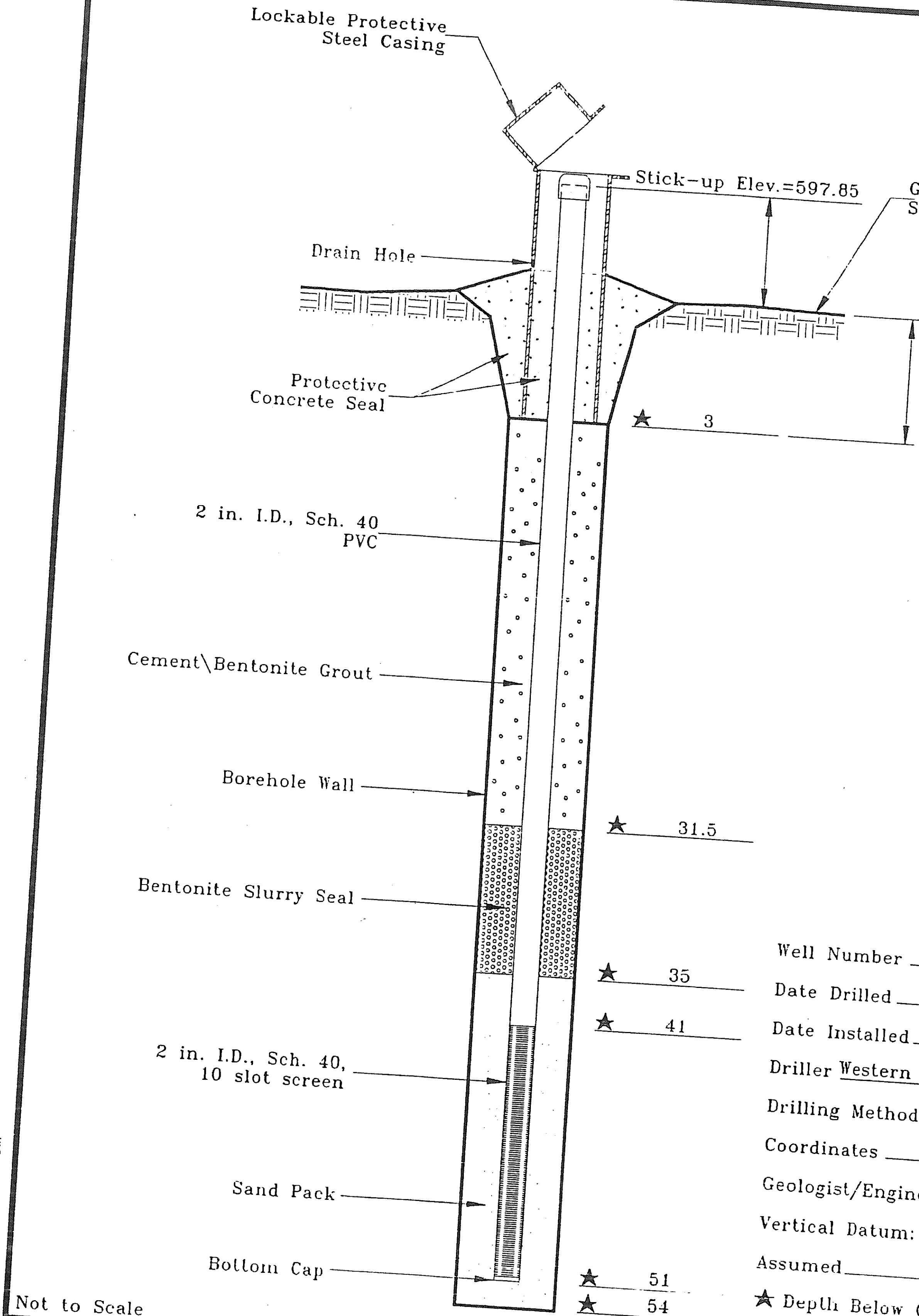
**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

OM19



Well Number A

Date Drilled 10/30/97

Date Installed 10/30/97

Driller Western Env. Services, Inc.

Drilling Method HSA

Coordinates N4036 E2725

Geologist/Engineer BDC

Vertical Datum:

Assumed ______ U.S.G.S. X

★ Depth Below Ground Surface

MONITORING WELL A

HANSON ENGINEERS INCORPORATED

MONITORING WELL INSTALLATION
CILCO - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078A

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OR20

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Fulton Well #: OR-B

Site Name: Ameren Energy Resources Generating Co. Duck Creek Ash Ponds 1 and 2 Borehole #: OR20

~~State Plane~~ Plant Coordinate: X 5,346.4 Y 2,926.8 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Testing Service Corporation Driller: B. WIlliamson

Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: 4¼" hollow stem auger Drilling Fluid (Type): n/a

Logged By: Rhonald W. Hasenyager Date Started: 3/26/2008 Date Finished: 3/26/2008

Report Form Completed By: Rhonald W. Hasenyager Date: 5/22/2008

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 minutes

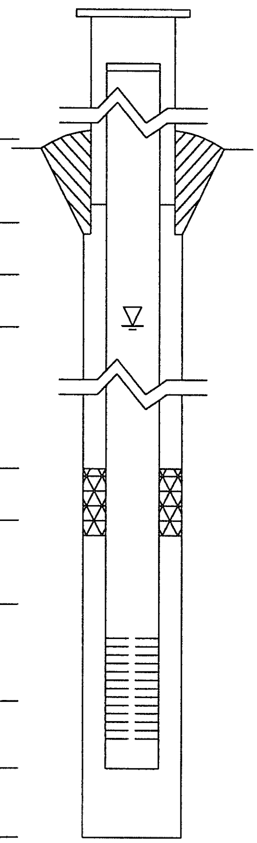
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
587.94	-3.31	Top of Protective Casing
587.72	-3.09	Top of Riser Pipe
584.63	0.00	Ground Surface
581.83	2.80	Top of Annular Sealant
573.64	10.99	Static Water Level (After Completion) 5/15/2008
545.11	39.52	Top of Seal
542.30	42.33	Top of Sand Pack
539.85	44.78	Top of Screen
530.40	54.23	Bottom of Screen
529.62	55.01	Bottom of Well
529.62	55.01	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	47.87
Bottom of Screen to End Cap	(feet)	0.78
Screen Length (1st slot to last slot)	(feet)	9.45
Total Length of Casing	(feet)	58.10
Screen Slot Size **	(inches)	0.010

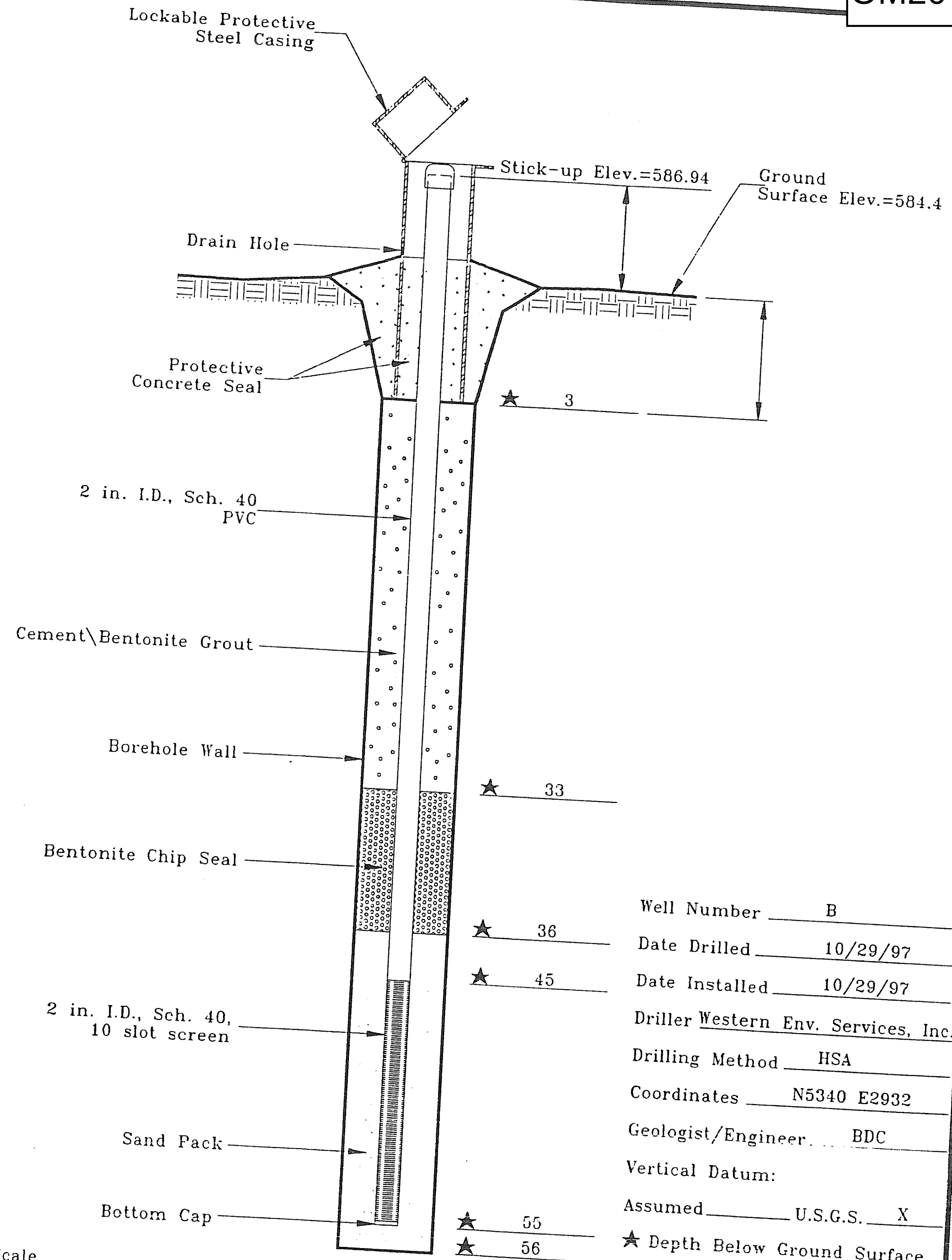
**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

Protective Casing	SS304	SS316	PTFE	PVC	OTHER: Steel
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC	OTHER:
Screen	SS304	SS316	PTFE	PVC	OTHER:

OM20



Well Number B

Date Drilled 10/29/97

Date Installed 10/29/97

Driller Western Env. Services, Inc.

Drilling Method HSA

Coordinates N5340 E2932

Geologist/Engineer BDC

Vertical Datum:

Assumed _____ U.S.G.S. X

★ Depth Below Ground Surface

Not to Scale

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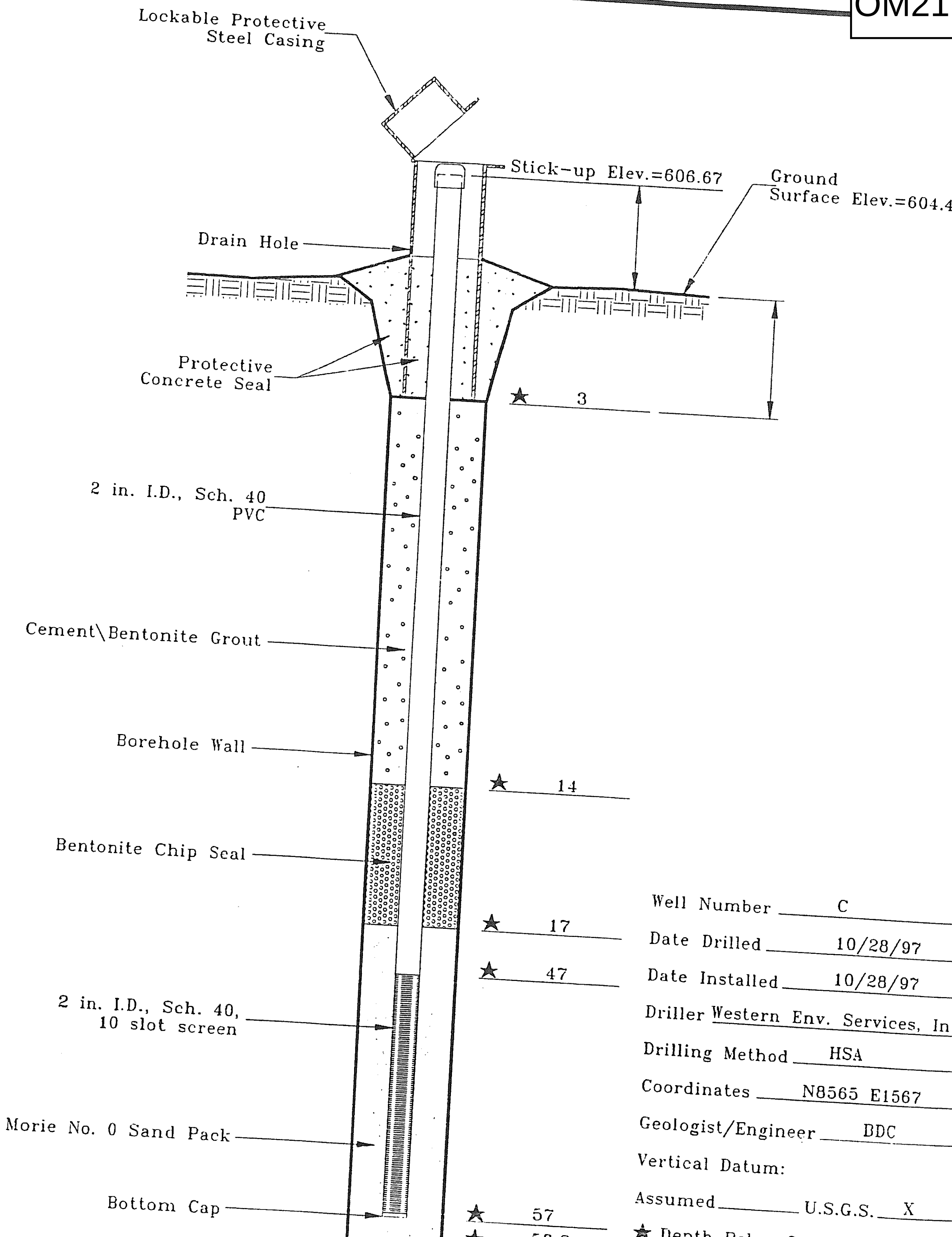
MONITORING WELL B

HANSON ENGINEERS INCORPORATED

MONITORING WELL INSTALLATION
CILCO - DUCK CREEK STATION
CANTON, ILLINOIS

JOB NO. 92S5078A

OM21



Not to Scale

Well Number C

Date Drilled 10/28/97

Date Installed 10/28/97

Driller Western Env. Services, Inc.

Drilling Method HSA

Coordinates N8565 E1567

Geologist/Engineer DDC

Vertical Datum:

Assumed _____ U.S.G.S. X

★ Depth Below Ground Surface

MONITORING WELL C

HANSON ENGINEERS INCORPORATED

MONITORING WELL INSTALLATION CILCO - DUCK CREEK STATION CANTON, ILLINOIS

JOB NO. 92S5078A

I:\DRAWINGS\92S5078A\003.DWG 12/05/97 09:10 Oth

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/19/2009
Finish: 8/19/2009
WEATHER: Sunny, warm, humid, lo-80's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM22a
Well ID: OM22S
Surface Elev: 597.07 ft. MSL
Completion: 37.38 ft. BGS
Station: 3,991.50N
-126.95E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 16.18 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	TOPSOIL - Very dark grayish brown (10YR3/2), moist, soft, silty CLAY with slight trace sand, roots.		597.07	
								Dark grayish brown (10YR4/2) with 30% gray (10YR6/1) mottles, slightly moist, friable, clayey SILT with slight trace sand and gravel.		596, 594, 592	
							6	Brown (10YR5/3) with 15% gray (10YR5/1) mottles, moist, soft, clayey SILT.			
							8	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) and 15% brown (10YR4/3) mottles, moist, soft, clayey SILT.		590, 588	
							10	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) and 15% brown (10YR4/3) mottles, moist, soft, silty CLAY with slight trace sand.		586	
							12	Brown (10YR4/3) with 10% gray (10YR5/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		584, 582	
							▼ 16	Brown (10YR4/3) with 10% gray (10YR5/1) and 5% dark yellowish brown (10YR4/6) mottles, very moist, soft, silty CLAY with slight trace sand and gravel.		580, 578	
							20				

NOTE(S): OM22S installed in blind drilled borehole within 10 ft of OM22D. See OM22 boring log for sample data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/19/2009
Finish: 8/19/2009
WEATHER: Sunny, warm, humid, lo-80's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM22a
Well ID: OM22S
Surface Elev: 597.07 ft. MSL
Completion: 37.38 ft. BGS
Station: 3,991.50N
-126.95E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 16.18 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							~20.2–26.9	Yellowish brown (10YR5/4) with 10% gray (N6/1) mottles, very moist, soft, silty CLAY with slight trace sand and gravel.			
							26.9–30.0	Brown (10YR5/3) with 10% gray (10YR5/1) mottles, slightly moist, hard, clayey SILT with trace sand and slight trace gravel.			
							30.0–36.1	Dark gray (N4/1), moist, firm, silty CLAY with trace coal and rock fragments.			
							36.1–37.4	Dark gray (N4/1), slightly moist, firm, silty CLAY (weathered SHALE) with trace coal.			

Depth scale: 22, 24, ▼ 26, 28, 30, 32, 34, 36
Elevation scale: 576, 574, 572, 570, 568, 566, 564, 562, 560

EOB = 37.4 ft bgs

NOTE(S): OM22S installed in blind drilled borehole within 10 ft of OM22D. See OM22 boring log for sample data.

FIELD BORING LOG

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/18/2009
Finish: 8/19/2009
WEATHER: Sunny, warm, humid, lo-80's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

HANSON

BOREHOLE ID: OM22
Well ID: OM22D
Surface Elev: 596.76 ft. MSL
Completion: 62.88 ft. BGS
Station: 3,994.82N -127.08E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 15.82 - 9/14/09
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0–0.7	TOPSOIL - Very dark grayish brown (10YR3/2), moist, soft, silty CLAY with slight trace sand, roots.		596	
1A	32/60 *53%*	CS		14			2, 4	Dark grayish brown (10YR4/2) with 30% gray (10YR6/1) mottles, slightly moist, friable, clayey SILT with slight trace sand and gravel.		594, 592	
2A				23			6	Brown (10YR5/3) with 15% gray (10YR5/1) mottles, moist, soft, clayey SILT.			
2B	28/60 *47%*	CS		25			8	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) and 15% brown (10YR4/3) mottles, moist, soft, clayey SILT.		590, 588	
3A				24			10	Gray (10YR5/1) with 15% dark yellowish brown (10YR4/6) and 15% brown (10YR4/3) mottles, moist, soft, silty CLAY with slight trace sand.		586	
3B	26/60 *43%*	CS		20			12, 14	Brown (10YR4/3) with 10% gray (10YR5/1) and 5% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		584, 582	
4A	16/60 *27%*	CS		19			▼ 16, 18, 20	Brown (10YR4/3) with 10% gray (10YR5/1) and 5% dark yellowish brown (10YR4/6) mottles, very moist, soft, silty CLAY with slight trace sand and gravel.		580, 578	

NOTE(S): OM22D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/18/2009
Finish: 8/19/2009
WEATHER: Sunny, warm, humid, lo-80's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM22
Well ID: OM22D
Surface Elev: 596.76 ft. MSL
Completion: 62.88 ft. BGS
Station: 3,994.82N -127.08E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, Tier 6N; Range 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 15.82 - 9/14/09
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
5A	20/60 *33%*	cs		28			20–26.9	Yellowish brown (10YR5/4) with 10% gray (N6/1) mottles, very moist, soft, silty CLAY with slight trace sand and gravel.		
6A				26			▼ 26			
6B	30/60 *50%*	cs		11			26.9–30	Brown (10YR5/3) with 10% gray (10YR5/1) mottles, slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		
7A				20			30–36	Dark gray (N4/1), moist, firm, silty CLAY with trace coal and rock fragments.		
7B	36/60 *60%*	cs		15						
8A				18			36–40	Dark gray (N4/1), slightly moist, firm, silty CLAY (weathered SHALE) with trace coal.		
8B	16/60 *27%*	cs		11						

Depth scale: 22, 24, 26, 28, 30, 32, 34, 36, 38, 40
Elevation scale: 576, 574, 572, 570, 568, 566, 564, 562, 560, 558

NOTE(S): OM22D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/18/2009
Finish: 8/19/2009
WEATHER: Sunny, warm, humid, lo-80's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM22
Well ID: OM22D
Surface Elev: 596.76 ft. MSL
Completion: 62.88 ft. BGS
Station: 3,994.82N
-127.08E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

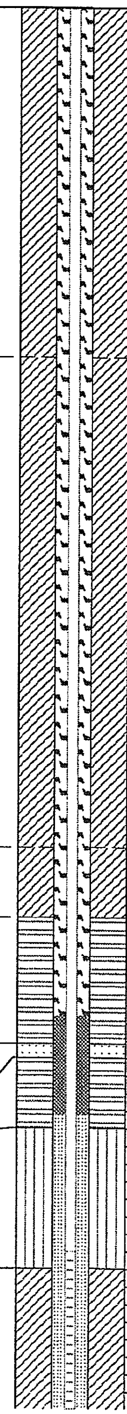
WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 15.82 - 9/14/09
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*
9A	25/60 *42%*	CS		13		
10A	46/60 *77%*	CS		15		
10B				16		
11A	14/24 *58%*	SS		19		
12A	13/24 *54%*	SS		19		
13A	14/24 *58%*	SS		17		
14A	8/24 *33%*	SS		16		
15A	13/24 *54%*	SS		13		

Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
to 45.0	Dark gray (N4/1), very moist, soft, silty CLAY (weathered SHALE) with trace coal and rock fragments.			
45.0–52.0	Dark gray (N4/1), very moist, firm, silty CLAY (weathered SHALE) with trace coal and rock fragments.			
52.0–53.0	Gray (N5/1), moist, firm, silty CLAY (weathered SHALE).			
53.0–54.8	Gray (N5/1), slightly moist, hard, slightly weathered SHALE.			
54.8–55.4	Greenish gray (10GY6/1), slightly moist, firm, SANDSTONE.			
55.4–56.0	Gray (N5/1), slightly moist, hard, slightly weathered SHALE.			
56.0–58.0	Greenish gray (10Y5/2) with 10% yellowish brown (10YR5/4) mottles, moist, firm, clayey SILT.			
58.0–60	Gray (N5/1), moist, firm, silty CLAY (weathered SHALE).			

Depth scale: 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

Elevation scale: 556, 554, 552, 550, 548, 546, 544, 542, 540, 538



NOTE(S): OM22D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT:	Ameren Energy Resources Generating Co.
Site:	Duck Creek Ash Ponds 1 & 2
Location:	Canton, Fulton County, Illinois
Project:	03S5010F 6100
DATES: Start:	8/18/2009
Finish:	8/19/2009
WEATHER:	Sunny, warm, humid, lo-80's

CONTRACTOR:	Testing Service Corporation
Rig mfg/model:	CME 550 ATV Drill
Drilling Method:	4¼" hollow stem auger w/split spoon sampler
FIELD STAFF: Driller:	B. Williamson
Helper:	D. Crump
Eng/Geo:	S. Simpson

BOREHOLE ID:	OM22
Well ID:	OM22D
Surface Elev:	596.76 ft. MSL
Completion:	62.88 ft. BGS
Station:	3,994.82N -127.08E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 26.00 - during drilling
▼ = 15.82 - 9/14/09
▽ =

SAMPLE			TESTING								
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
16A	7/24 *29%*	SS		14				Gray (N5/1), moist, firm, silty CLAY (weathered SHALE). *[Continued from previous page]*		536	
17A	6/6 *100%*	SS		14			62				
18A	5/5 *100%*	SS		13				Dark gray (N4/1), slightly moist, very hard, SHALE.		534	
								EOB = 62.9 ft bgs			

NOTE(S): OM22D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 9/3/2009
Finish: 9/3/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM23a
Well ID: OM23S
Surface Elev: 610.40 ft. MSL
Completion: 43.38 ft. BGS
Station: 5,591.13N
-371.63E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.00 - during drilling
▼ = 38.59 - 9/14/09
∇ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0–1.3	Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand, roots.		610	
							1.3–5	Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand, roots.		608, 606	
							5–7.8	Yellowish brown (10YR5/4) with 5% gray (10YR6/1), 5% dark yellowish brown (10YR4/6) and 5% Very dark gray (10YR3/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		604	
							7.8–12.1	Yellowish brown (10YR5/4) with 5% gray (10YR6/1), 5% dark yellowish brown (10YR4/6) and 5% Very dark gray (10YR3/1) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		602, 600	
							12.1–15.6	Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		598, 596	
							15.6–20	Greenish gray (10Y5/1), slightly moist, friable, clayey SILT with shale, sandstone, and coal fragments.		594, 592	

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

NOTE(S): OM23S installed in blind drilled borehole within 10 ft of OM23D. See OM23 boring log for sample data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 9/3/2009
Finish: 9/3/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM23a
Well ID: OM23S
Surface Elev: 610.40 ft. MSL
Completion: 43.38 ft. BGS
Station: 5,591.13N
-371.63E

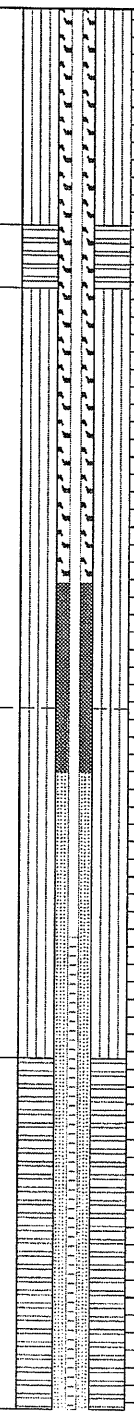
TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.00 - during drilling
▼ = 38.59 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
							20–23.2	Greenish gray (10Y5/1), slightly moist, friable, clayey SILT with shale, sandstone, and coal fragments. *[Continued from previous page]*	590, 588	
							23.2–24	Gray (N5/1), slightly moist, firm, laminated, weathered SHALE.		
							24–30	Greenish gray (10Y5/1), slightly moist, friable, clayey SILT with shale fragments.	586, 584, 582	
							30–35	Greenish gray (10Y6/1), slightly moist, friable, clayey SILT with shale and trace coal fragments.	580, 578, 576	
							35–40	Gray (N5/1), slightly moist, hard, laminated, weathered SHALE with coal fragments.	574, 572	

Depth scale: 22, 24, 26, 28, 30, 32, 34, 36, 38, ▼ 40

Borehole Detail



NOTE(S): OM23S installed in blind drilled borehole within 10 ft of OM23D. See OM23 boring log for sample data.

FIELD BORING LOG

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 9/3/2009
Finish: 9/3/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

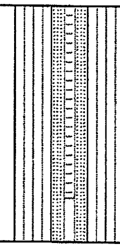
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

HANSON

BOREHOLE ID: OM23a
Well ID: OM23S
Surface Elev: 610.40 ft. MSL
Completion: 43.38 ft. BGS
Station: 5,591.13N
-371.63E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.00 - during drilling
▼ = 38.59 - 9/14/09
▽ =

SAMPLE			TESTING									
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							42	Greenish gray (10Y6/1), slightly moist, firm, clayey SILT with shale and coal fragments.		570 568	

EOB = 43.4 ft bgs

NOTE(S): OM23S installed in blind drilled borehole within 10 ft of OM23D. See OM23 boring log for sample data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 9/1/2009
Finish: 9/2/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM23
Well ID: OM23D
Surface Elev: 610.41 ft. MSL
Completion: 80.32 ft. BGS
Station: 5,585.76N
-371.66E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.00 - during drilling
▼ = 34.69 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
							0–1.3	Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand, roots.	610	
1A	35/60 *58%*	CS		24			1.3–5	Yellowish brown (10YR5/4) with 15% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand, roots.	608, 606	
2A	47/60 *78%*	CS		16			5–7.8	Yellowish brown (10YR5/4) with 5% gray (10YR6/1), 5% dark yellowish brown (10YR4/6) and 5% Very dark gray (10YR3/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.	604	
2B				16			7.8–12	Yellowish brown (10YR5/4) with 5% gray (10YR6/1), 5% dark yellowish brown (10YR4/6) and 5% Very dark gray (10YR3/1) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.	602, 600	
3A	37/60 *62%*	CS		17						
3B				17			12–15.8	Yellowish brown (10YR5/4) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.	598, 596	
4A	50/60 *83%*	CS		17						
4B				11			15.8–21	Greenish gray (10Y5/1), slightly moist, friable, clayey SILT with shale, sandstone, and coal fragments.	594, 592, 590	

NOTE(S): OM23D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 9/1/2009
Finish: 9/2/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM23
Well ID: OM23D
Surface Elev: 610.41 ft. MSL
Completion: 80.32 ft. BGS
Station: 5,585.76N
-371.66E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.00 - during drilling
▼ = 34.69 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
5A	49/60 *82%*	CS		10			22–23.2	Greenish gray (10Y5/1), slightly moist, friable, clayey SILT with shale, sandstone, and coal fragments. *[Continued from previous page]*	588	
5B				9			23.2–24	Gray (N5/1), slightly moist, firm, laminated, weathered SHALE.	586	
6A	38/60 *63%*	CS		10			24–30	Greenish gray (10Y5/1), slightly moist, friable, clayey SILT with shale fragments.	584, 582	
7A	34/60 *57%*	CS		11			30–35	Greenish gray (10Y6/1), slightly moist, friable, clayey SILT with shale and trace coal fragments.	580, 578, 576	
8A	10/60 *17%*	CS		12			35–40	Gray (N5/1), slightly moist, hard, laminated, weathered SHALE with coal fragments.	574, 572	
9A				15			40–42	Greenish gray (10Y6/1), slightly moist, firm, clayey SILT with shale and coal fragments.	570	

NOTE(S): OM23D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 9/1/2009
Finish: 9/2/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM23
Well ID: OM23D
Surface Elev: 610.41 ft. MSL
Completion: 80.32 ft. BGS
Station: 5,585.76N
-371.66E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.00 - during drilling
▼ = 34.69 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*
	5/60 *8%*	CS				
10A	10/12 *83%*	SS	*3* *6* N=9	21		
11A	16/24 *67%*	SS	*6-9* *19-21* N=28	16		
12A	20/24 *83%*	SS	*4-7* *8-10* N=15	15		
13A	18/24 *75%*	SS	*4-5* *9-12* N=14	11		
14A				14		
14B	14/24 *58%*	SS	*9-8* *8-9* N=16	16		
15A	8/24 *33%*	SS	*6-9* *13-20* N=22	12		
16A	7/24 *29%*	SS	*7-14* *18-14* N=32	12		
17A	13/24 *54%*	SS	*7-17* *14-16* N=31	15		
18A	18/24 *75%*	SS	*4-10* *10-13* N=20	16		
19A	8/24		*22-28*	13		

Depth ft. BGS	Lithologic Description
44–50	Greenish gray (10Y6/1), slightly moist, firm, clayey SILT with shale and coal fragments. *[Continued from previous page]*
50	Gray (N5/1), slightly moist, hard, laminated, weathered SHALE.
	Greenish gray (10Y6/1), slightly moist, firm, clayey SILT.
	Gray (N5/1), slightly moist, firm, weathered SHALE.
52	Dark gray (N4/1), slightly moist, firm, laminated, weathered SHALE.
	Yellowish brown (10YR5/4) with 15% dark yellowish brown (10YR4/6) and 5% dark gray (10YR4/1) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.
54	Olive gray (5Y5/2), moist, soft, silty CLAY with trace sand and slight trace gravel.
56–58	Gray (N6/1), slightly moist, firm, weathered SHALE.
	Gray (N6/1), slightly moist, firm, laminated, weathered SHALE.
60–62	Gray (N6/1), slightly moist, firm, weathered SHALE.

Borehole Detail | Elevation ft. MSL: 568, 566, 564, 562, 560, 558, 556, 554, 552, 550, 548 | Remarks

NOTE(S): OM23D installed in borehole.

FIELD BORING LOG

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 9/1/2009
Finish: 9/2/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Simpson

HANSON

BOREHOLE ID: OM23
Well ID: OM23D
Surface Elev: 610.41 ft. MSL
Completion: 80.32 ft. BGS
Station: 5,585.76N
-371.66E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 40.00 - during drilling
▼ = 34.69 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
	33%	SS	*17-21* N=45					Gray (N6/1), slightly moist, firm, weathered SHALE. *[Continued from previous page]*		
20A	11/24 *46%*	SS	*14-14 10-12* N=24	18			64	Gray (N6/1), slightly moist, firm, weathered SHALE with some coal.	546	
21A	12/24 *50%*	SS	*9-9 12-13* N=21	14			66	Gray (N5/1) with 10% dark yellowish brown (10YR4/6) mottles, moist, firm, weahtered SHALE.	544	
22A	17/24 *71%*	SS	*2-6 12-16* N=18	14			68	Dark gray (N4/1), slightly moist, firm, laminated, weathered SHALE.	542	
23A	16/24 *67%*	SS	*2-7 8-8* N=15	21			70	Dark gray (N4/1), slightly moist, firm, weathered SHALE.	540	
24A	14/24 *58%*	SS	*10-13 34-16* N=47	15			72		538	
25A	14/17 *82%*	SS	*25-80 100/5"*				74	Very dark gray (N3/1), slightly moist, very hard, SHALE.	536	
	0/52 *0%*	BD					76, 78, 80		534, 532	

EOB = 80.3 ft bgs

NOTE(S): OM23D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/25/2009
Finish: 8/25/2009
WEATHER: Sunny, warm, humid, lo-80's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 3¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM24
Well ID: OM24D
Surface Elev: 573.90 ft. MSL
Completion: 23.00 ft. BGS
Station: 7,523.62N
-341.39E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 10.00 - during drilling
▼ = -0.31 - 9/14/09
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*
1A				16		
1B	24/60 *40%*	CS		27		
2A	14/60 *23%*	CS		27		
3A	10/36 *28%*	CS		21		
4A	16/18 *89%*	SS	*36-31 100/5"*	15		
5A	8/10 *80%*	SS	*25-100/4"*	9		
6A	22/24 *92%*	SS	*5-44 38-42* N=82	12		

Depth ft. BGS | Lithologic Description | Borehole Detail | Elevation ft. MSL | Remarks

Depth: 2, 4, 6, 8, 10, 12, 14, 16, 18
Elevation: 572, 570, 568, 566, 564, 562, 560, 558, 556

TOPSOIL - Black (10YR2/1), moist, soft, silty CLAY with slight trace sand, roots.

Black (10YR2/1) with 30% gray (10YR5/1) and 20% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel, trace roots.

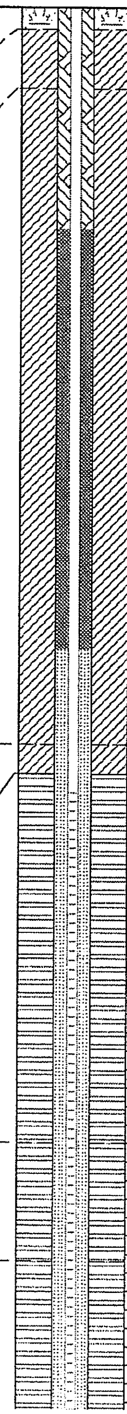
Dark greenish gray (10Y4/1) with 20% dark yellowish brown (10YR4/6), 10% greenish gray (5GY6/1), and 5% black (N 2.5/1) mottles, moist, soft, silty CLAY with slight trace sand, coal fragments, slight trace roots.

Light brownish gray (2.5Y6/2) with 5% dark yellowish brown (10YR4/6) mottles, moist soft, silty CLAY with trace sand and gravel.

Very dark gray (N3/1), slightly moist, friable, laminated, weathered SHALE.

Very dark gray (N3/1), slightly moist, hard, laminated, SHALE with coal interbeds.

Dark gray (N4/1), slightly moist, hard, laminated, weathered SHALE.



NOTE(S): OM24D installed in borehole.

FIELD BORING LOG

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/25/2009
Finish: 8/25/2009
WEATHER: Sunny, warm, humid, lo-80's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 3¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

HANSON

BOREHOLE ID: OM24
Well ID: OM24D
Surface Elev: 573.90 ft. MSL
Completion: 23.00 ft. BGS
Station: 7,523.62N
-341.39E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 10.00 - during drilling
▼ = -0.31 - 9/14/09
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
7A	16/24 *67%*	SS	*5-14* *32-34* N=46	12			20	Dark gray (N4/1), slightly moist, hard, laminated, weathered SHALE. *[Continued from previous page]*		554	
8A	18/24 *75%*	SS	*17-60* *68-79* N=128	17			22	Dark gray (N4/1), slightly moist, very hard, SHALE.		552	
8B				16							

EOB = 23.0 ft bgs

NOTE(S): OM24D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/1/1937
Finish: 8/31/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM25a
Well ID: OM25S
Surface Elev: 627.14 ft. MSL
Completion: 61.67 ft. BGS
Station: 8,616.31N
-321.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 55.60 - during drilling
▼ = 56.05 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0	Dark yellowish brown (10YR4/4) with 20% gray (10YR6/1) mottles, moist, soft, clayey SILT with slight trace sand and gravel, roots.		626	
							2	Grayish brown (10YR5/2) with 35% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel, slight trace roots.		624	
							4	Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT with slight trace sand, slight trace roots.		622	
							6	Yellowish brown (10YR5/4) with 10% gray (10YR5/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		620	
							8	Greenish gray (10Y5/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.		618	
							10–14	Yellowish brown (10YR5/4) with 30% greenish gray (10Y5/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		616, 614	
							16	Yellowish brown (10YR5/4) with 25% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		612	
							18–20	Light brownish gray (10YR6/2) with 15% dark yellowish brown (10YR4/6) and 5% gray (10YR5/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		610, 608	

NOTE(S): OM25S installed in blind drilled borehole within 10 ft of OM25D. See OM25 boring log for sample data.

FIELD BORING LOG

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/1/1937
Finish: 8/31/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

HANSON

BOREHOLE ID: OM25a
Well ID: OM25S
Surface Elev: 627.14 ft. MSL
Completion: 61.67 ft. BGS
Station: 8,616.31N -321.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 55.60 - during drilling
▼ = 56.05 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Yellowish brown (10YR5/4) with 15% gray (10YR6/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		606	
							22	Gray (10YR5/1) with 20% yellowish brown (10YR5/4) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.		604	
							24				
								Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT with slight trace sand.		602	
							26	Dark gray (10YR4/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.			
							28	Yellowish brown (10YR5/4) with 10% dark gray (10YR4/1) and 10% grayish brown (10YR5/2) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		600 / 598	
							30–36	Gray (N5/1), slightly moist, firm, silty CLAY with trace coal and rock fragments.		596 / 594 / 592	
							38–40	Gray (N5/1), slightly moist, hard, silty CLAY with shale and coal fragments.		590 / 588	

NOTE(S): OM25S installed in blind drilled borehole within 10 ft of OM25D. See OM25 boring log for sample data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/1/1937
Finish: 8/31/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM25a
Well ID: OM25S
Surface Elev: 627.14 ft. MSL
Completion: 61.67 ft. BGS
Station: 8,616.31N
-321.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 55.60 - during drilling
▼ = 56.05 - 9/14/09
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							~40.0–46.5	Gray (N5/1), slightly moist, firm, friable, silty CLAY with trace shale and coal fragments.		586, 584, 582	
							46.5–48.0	Gray (N5/1), slightly moist, hard, silty CLAY with trace shale and coal fragments.		580	
							48.0–50.0	Gray (N5/1), slightly moist, hard, laminated, friable, weathered SHALE.		578	
							50.0–54.3	Gray (N5/1), slightly moist, firm, friable, weathered SHALE with coal fragments.		576, 574	
							54.3–56.3 (▼ 55.60, ▼ 56.05)	Gray (N5/1), slightly moist, hard, friable, laminated, weathered SHALE.		572	
							56.3–57.5	Gray (N6/1), slightly moist, firm, silty CLAY (weathered SHALE).		570	
							57.5–58.6	Gray (N5/1), slightly moist, very hard, laminated, SHALE.			
							58.6–60	Dark gray (N4/1), slightly moist, hard, friable, clayey SILT (weathered SHALE).		568	

Depth scale: 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

NOTE(S): OM25S installed in blind drilled borehole within 10 ft of OM25D. See OM25 boring log for sample data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.	**CONTRACTOR:** Testing Service Corporation		
Site: Duck Creek Ash Ponds 1 & 2	**Rig mfg/model:** CME 550 ATV Drill	**BOREHOLE ID:** OM25a	
Location: Canton, Fulton County, Illinois	**Drilling Method:** 4¼" hollow stem auger	**Well ID:** OM25S	
Project: 03S5010F 6100		**Surface Elev:** 627.14 ft. MSL	
DATES: Start: 8/1/1937	**FIELD STAFF: Driller:** R. Keedy	**Completion:** 61.67 ft. BGS	
Finish: 8/31/2009	**Helper:** D. Crump	**Station:** 8,616.31N	
WEATHER: Sunny, warm, humid, lo-70's	**Eng/Geo:** S. Simpson	-321.61E	

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 55.60 - during drilling
▼ = 56.05 - 9/14/09
▽ =

SAMPLE			TESTING								
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark gray (N4/1), slightly moist, firm, friable, laminated, weathered SHALE.		566	

EOB = 61.7 ft bgs

NOTE(S): OM25S installed in blind drilled borehole within 10 ft of OM25D. See OM25 boring log for sample data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/26/2009
Finish: 8/27/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM25
Well ID: OM25D
Surface Elev: 627.02 ft. MSL
Completion: 76.00 ft. BGS
Station: 8,620.05N
-321.35E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 55.60 - during drilling
▼ = 56.21 - 9/14/09
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark yellowish brown (10YR4/4) with 20% gray (10YR6/1) mottles, moist, soft, clayey SILT with slight trace sand and gravel, roots.			
1A				21						626	
	36/60 *60%*	cs					2				
1B				23				Grayish brown (10YR5/2) with 35% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel, slight trace roots.		624	
							4				
								Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT with slight trace sand, slight trace roots.		622	
2A				23			6	Yellowish brown (10YR5/4) with 10% gray (10YR5/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.			
2B	35/60 *58%*	cs		15						620	
							8	Greenish gray (10Y5/1) with 20% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with trace sand and slight trace gravel.			
										618	
							10				
3A				14						616	
	5/60 *8%*	cs					12	Yellowish brown (10YR5/4) with 30% greenish gray (10Y5/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.		614	
							14				
								Yellowish brown (10YR5/4) with 25% gray (10YR6/1) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		612	
4A				21			16				
	40/60 *67%*	cs								610	
4B				25			18	Light brownish gray (10YR6/2) with 15% dark yellowish brown (10YR4/6) and 5% gray (10YR5/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.			
										608	
							20				

NOTE(S): OM25D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/26/2009
Finish: 8/27/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM25
Well ID: OM25D
Surface Elev: 627.02 ft. MSL
Completion: 76.00 ft. BGS
Station: 8,620.05N
-321.35E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, Tier 6N; Range 5E

WATER LEVEL INFORMATION:
▼ = 55.60 - during drilling
▼ = 56.21 - 9/14/09
∇ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
5A				22				Yellowish brown (10YR5/4) with 15% gray (10YR6/1) mottles, moist, soft, silty CLAY with slight trace sand and gravel.	606	
5B	37/60 62%	CS		26			22–24	Gray (10YR5/1) with 20% yellowish brown (10YR5/4) and 10% dark yellowish brown (10YR4/6) mottles, moist, soft, clayey SILT with slight trace sand.	604	
6A				21				Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, very moist, soft, clayey SILT with slight trace sand.	602	
							26	Dark gray (10YR4/1) with 15% dark yellowish brown (10YR4/6) mottles, moist, firm, silty CLAY with trace sand and slight trace gravel.		
6B	38/60 63%	CS		18			28	Yellowish brown (10YR5/4) with 10% dark gray (10YR4/1) and 10% grayish brown (10YR5/2) mottles, moist, soft, silty CLAY with trace sand and slight trace gravel.	600, 598	
7A				20			30–36	Gray (N5/1), slightly moist, firm, silty CLAY with trace coal and rock fragments.	596	
7B	37/60 62%	CS		15			32–34		594, 592	
8A				15			36			
8B	40/60 67%	CS		13			38–40	Gray (N5/1), slightly moist, hard, silty CLAY with shale and coal fragments.	590, 588	

NOTE(S): OM25D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/26/2009
Finish: 8/27/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

BOREHOLE ID: OM25
Well ID: OM25D
Surface Elev: 627.02 ft. MSL
Completion: 76.00 ft. BGS
Station: 8,620.05N
-321.35E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 55.60 - during drilling
▼ = 56.21 - 9/14/09
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING Blows / 6 in N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
9A	14/60 *23%*	CS		10			40–46.5	Gray (N5/1), slightly moist, firm, friable, silty CLAY with trace shale and coal fragments.		
10A	13/18 *72%*	CS		12						
11A	12/18 *67%*	SS	*17-40* *26* N=66	12			46.5–48	Gray (N5/1), slightly moist, hard, silty CLAY with trace shale and coal fragments.		
12A	19/24 *79%*	SS	*10-22* *24-18* N=46	8			48–50	Gray (N5/1), slightly moist, hard, laminated, friable, weathered SHALE.		
13A	17/24 *71%*	SS	*2-12* *8-7* N=20	10			50–54.3	Gray (N5/1), slightly moist, firm, friable, weathered SHALE with coal fragments.		
14A	16/24 *67%*	SS	*12-17* *14-15* N=31	10						
15A	18/24 *75%*	SS	*13-17* *16-34* N=33	3			54.3–56.3	Gray (N5/1), slightly moist, hard, friable, laminated, weathered SHALE.		
16A	20/24 *83%*	SS	*8-8* *9-48* N=17	13			56.3–57.5	Gray (N6/1), slightly moist, firm, silty CLAY (weathered SHALE).		
17A				10			57.5–58.6	Gray (N5/1), slightly moist, very hard, laminated, SHALE.		
17B	17/24 *71%*	SS	*75-30* *27-24* N=57	12			58.6–60	Dark gray (N4/1), slightly moist, hard, friable, clayey SILT (weathered SHALE).		

Depth scale: 42, 44, 46, 48, 50, 52, 54, 56, 58, 60. Elevation scale: 586, 584, 582, 580, 578, 576, 574, 572, 570, 568.

NOTE(S): OM25D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 & 2
Location: Canton, Fulton County, Illinois
Project: 03S5010F 6100
DATES: Start: 8/26/2009
Finish: 8/27/2009
WEATHER: Sunny, warm, humid, lo-70's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: R. Keedy
Helper: D. Crump
Eng/Geo: S. Simpson

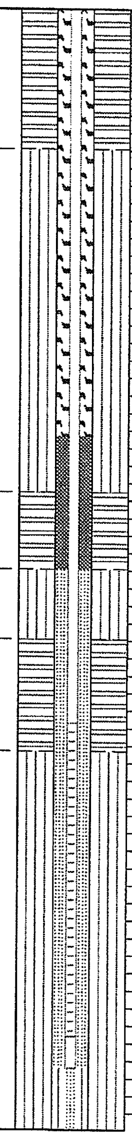
BOREHOLE ID: OM25
Well ID: OM25D
Surface Elev: 627.02 ft. MSL
Completion: 76.00 ft. BGS
Station: 8,620.05N
-321.35E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 19, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 55.60 - during drilling
▼ = 56.21 - 9/14/09
▽ =

SAMPLE			TESTING			
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*
18A	19/24 *79%*	SS	*7-9* *12-9* N=21	8		
19A	16/24 *67%*	SS	*3-6* *9-30* N=15	12		
20A	14/24 *58%*	SS	*4-5* *4-6* N=9	17		
21A	14/24 *58%*	SS	*3-9* *61-36* N=70	14		
22A	19/24 *79%*	SS	*11-10* *34-19* N=44	17		
22B				7		
23A	12/24 *50%*	SS	*14-27* *11-16* N=38	12		
24A	16/24 *67%*	SS	*7-10* *12-13* N=22	16		
25A	12/24 *50%*	SS	*12-16* *20-17* N=36	11		

Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	Dark gray (N4/1), slightly moist, firm, friable, laminated, weathered SHALE.		566	
62	Gray (N6/1), slightly moist, firm, clayey SILT (weathered SHALE).		564	
64			562	
66	Very dark gray (N3/1), slightly moist, hard, laminated, weathered SHALE.		560	
68	Gray (N6/1), moist, firm, clayey SILT with shale fragments.			
	Gray (N5/1), slightly moist, hard, laminated, SHALE.		558	
70	Gray (N5/1), moist, firm, clayey SILT with rock fragments.		556	
72			554	
74			552	
76	**EOB = 76.0 ft bgs**			



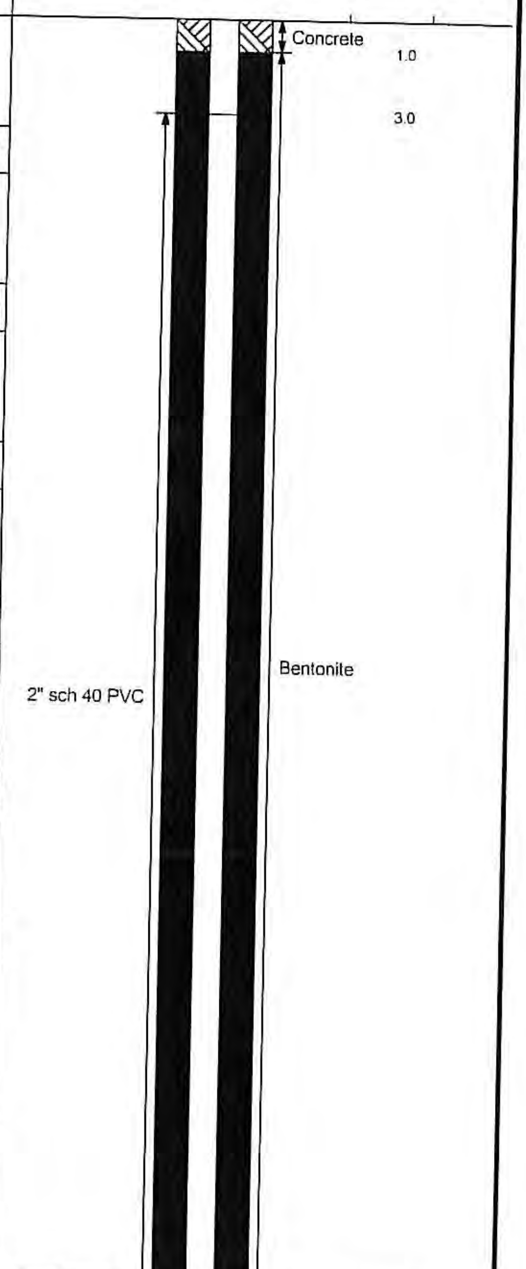
NOTE(S): OM25D installed in borehole.

Surface Elevation: ______ Completion Date: 7/14/10

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Stiff, gray and black ASH			
5	Soft, gray and black ASH		3-4-8	SS1
10	Soft to very soft, gray and black ASH		1-2-2	SS2
15		∇	0-0-0	SS3
20			0-0-0	SS4
25			0-0-0	SS5
30			0-1-2	SS6
35			0-0-0	SS7
			2-1-2	SS8

WELL DIAGRAM



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 15 FEET ∇

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by:	App'vd. by:
Date: 8/13/10	Date:	Date:

GEOTECHNOLOGY INC FROM THE GROUND UP

Ameren Power Plant
Duck Creek, Illinois

LOG OF BORING: OM-26

Project No. J017150.01

LOG OF BORING 2002 WL J01750.01 - DUCK CREEK.GPJ GTINC 0638301.GPJ 11/3/10

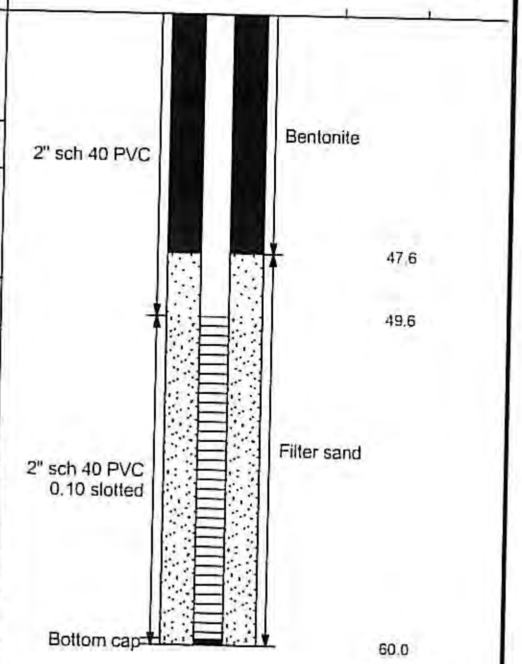
Surface Elevation: ______ Completion Date: 7/14/10

Datum msl

WELL DIAGRAM

Flushmount

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Soft to very soft, gray and black ASH *(continued)*			
45			0-0-1	SS9
50			0-0-1	SS10
55	Soft, gray ASH with brown, silty CLAY		0-0-1	SS11
60			0-0-2	SS12
				ST13
65	Medium stiff, gray and black, silty CLAY with ash - CL		3-3-5	SS14
	Boring terminated at 66.5 feet.			
70				
75				



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 15 FEET ▽

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by:	App'vd. by:
Date: 8/13/10	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Duck Creek, Illinois

CONTINUATION OF
LOG OF BORING: OM-26

Project No. J017150.01

Surface Elevation: ______

Datum msl

Completion Date: 7/15/10

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Stiff, black ASH			
5			2-3-7	SS1
	Soft to very soft, black and gray ASH			
10			0-0-1	SS2
15			0-1-1	SS3
20			0-0-1	SS4
25			0-1-2	SS5
	Soft, black and gray ASH			
30	∇		1-1-3	SS6
35			0-1-2	SS7
			0-0-1	SS8

WELL DIAGRAM

Flushmount

Depth (ft) Elev. (ft)

Concrete 1.0

3.0

2" sch 40 PVC

Bentonite

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 30 FEET ∇

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by:	App'vd. by:
Date: 8/13/10	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Duck Creek, Illinois

LOG OF BORING: OM-27

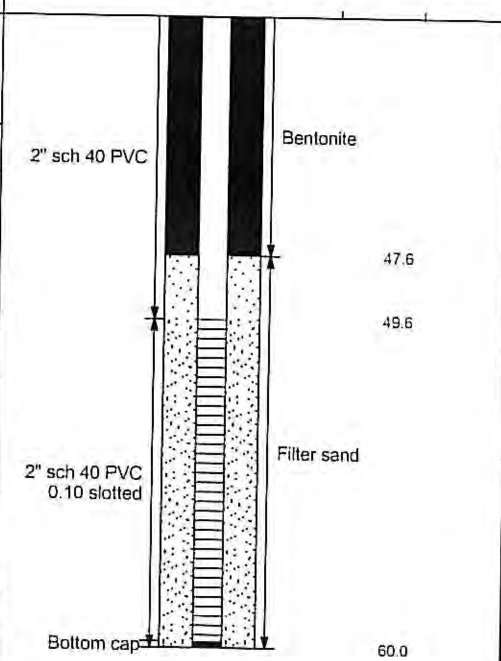
Project No. J017150.01

Surface Elevation: ______ Completion Date: 7/15/10

Datum msl

WELL DIAGRAM

Flushmount



DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Soft, gray ASH		
45		0-0-2	SS9
50		0-0-3	SS10
55		0-0-2	SS11
	Very soft, gray and black ASH with brown, silty CLAY		
60		0-0-1	SS12
	Very stiff, brown and tan, silty CLAY - CL		ST13
65		3-8-12	SS14
	Boring terminated at 65 feet.		
70			
75			

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 30 FEET ∇

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by:	App'vd. by:
Date: 8/13/10	Date:	Date:

GEOTECHNOLOGY INC FROM THE GROUND UP

Ameren Power Plant
Duck Creek, Illinois

CONTINUATION OF
LOG OF BORING: OM-27

Project No. J017150.01

Surface Elevation: ______ Completion Date: 7/16/10

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Soft to medium stiff, black ASH			
5			1-2-2	SS1
10			1-4-3	SS2
15			0-2-1	SS3
20			5-7-8	SS4
25			1-3-3	SS5
25	Very stiff to hard, black ASH			
30			4-7-10	SS6
35			15-20-16	SS7
35	Soft to very soft, black and gray ASH			
40			0-1-1	SS8

WELL DIAGRAM

Flushmount

Depth (ft) Elev. (ft)

Concrete 1.0

3.0

2" sch 40 PVC

Bentonite

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 40 FEET ∇

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by:	App'vd. by:
Date: 8/13/10	Date:	Date:

GEOTECHNOLOGY INC FROM THE GROUND UP

Ameren Power Plant
Duck Creek, Illinois

LOG OF BORING: OM-28

Project No. J017150.01

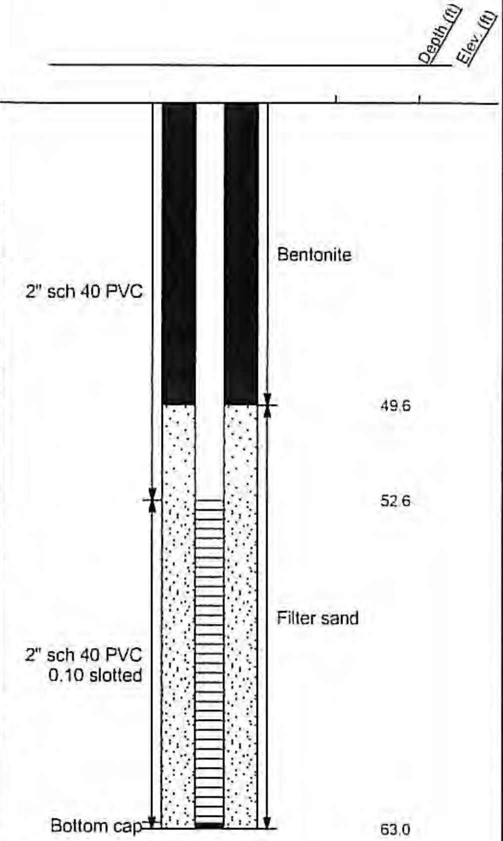
Surface Elevation: ______ Completion Date: 7/16/10

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Soft to very soft, black and gray ASH *(continued)*			
			0-1-1	SS9
45				
			1-1-2	SS10
50				
			0-0-1	SS11
55				
			0-0-1	SS12
60	Very stiff, brown, silty CLAY - CL			
			6-11-15	ST13
65				
	Medium stiff, brown, silty CLAY - CL			SS14
			1-2-5	SS15
70	Boring terminated at 70 feet.			
75				

WELL DIAGRAM

Flushmount



GROUNDWATER DATA

ENCOUNTERED AT 40 FEET ▽

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by:	App'vd. by:
Date: 8/13/10	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Duck Creek, Illinois

CONTINUATION OF
LOG OF BORING: OM-28

Project No. J017150.01

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

LOG OF BORING 2002 WL J01750.01 - DUCK CREEK.GPJ GTINC 0538301.GPJ 11/3/10

Surface Elevation: ______ Completion Date: 7/13/10

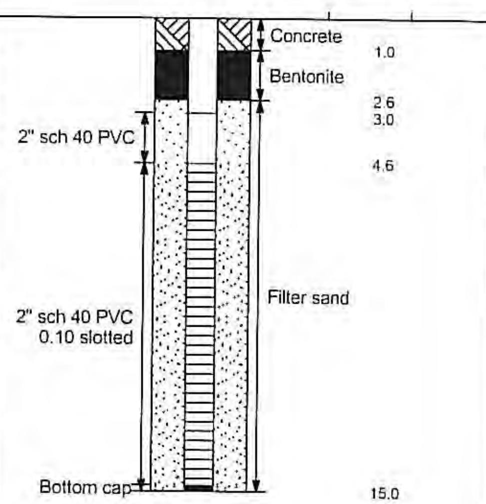
Datum msl

LOG OF BORING: OM-30

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	FILL: silty clay, some ash			
			1-3-5	SS1
5			3-3-5	SS2
8	Black, clayey ASH			ST3
10	Medium stiff, gray, silty CLAY - CL			
			2-3-5	SS4
15	Boring terminated at 15 feet.			

WELL DIAGRAM

Flushmount



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by:	App'vd. by:
Date: 8/13/10	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Duck Creek, Illinois

LOG OF BORING: OM-30

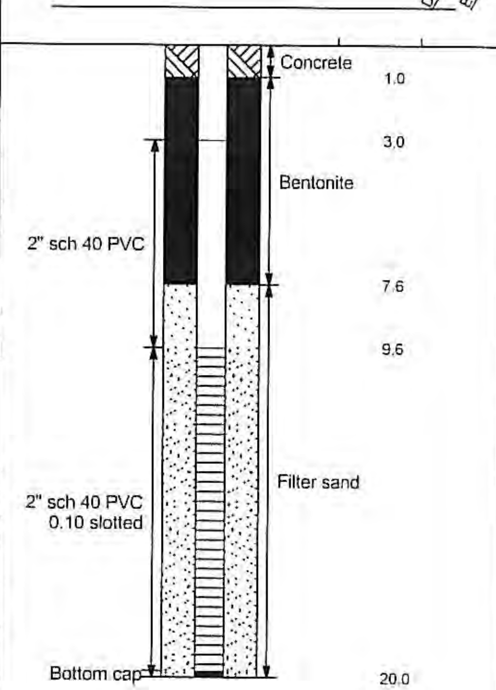
Project No. J017150.01

Surface Elevation: ______ Completion Date: 7/15/10

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Stiff to medium stiff, brown, silty CLAY, some fill - CL			
5			3-7-6	SS1
10			3-3-5	SS2
15			3-3-3	SS3
15	Tan and gray, silty CLAY - CL			ST4
	Medium stiff, brown, silty CLAY, trace organics - CL			
20			1-2-5	SS5
20	Boring terminated at 20 feet.			
25				
30				
35				

WELL DIAGRAM



GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER JPC LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by:	App'vd. by:
Date: 8/13/10	Date:	Date:

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren Power Plant
Duck Creek, Illinois

LOG OF BORING: OM-31

Project No. J017150.01

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

LOG OF BORING 2002 WL J01750.01 - DUCK CREEK.GPJ GTINC 0638301.GPJ 11/3/10

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 2/18/2009
Finish: 2/18/2009
WEATHER: cool, overcast, windy, mid-30's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM50a
Well ID: OM50S
Surface Elev: 601.2 ft. MSL
Completion: 18.4 ft. BGS
Station: 13,557.77N
-6,682.00E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 14, **Tier** 6N.; **Range** 5E.

WATER LEVEL INFORMATION:
▼ = 10.30 - during drilling
▼ =
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark gray (10YR4/1), moist, firm, clayey SILT with trace sand and gravel.			
							2	Yellowish brown (10YR5/6), moist, hard, clayey SILT with trace sand and slight trace gravel.		600	
							4	Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.		598	
							6	Light brownish gray (10YR6/2) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		596	
							8	Dark yellowish brown (10YR4/6) with 10% light brownish gray (10YR6/2) mottles, moist, soft, silty CLAY with slight trace sand and gravel.		594	
							10 ▼	Yellowish brown (10YR5/6), moist, very soft, silty CLAY with slight trace sand and gravel.		592	
							12	Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, wet, soft, clayey SILT.		590	
							14	Dark yellowish brown (10YR4/6), very moist, medium dense, silty, fine- to coarse-grained SAND with slight trace gravel.		588	
								Grayish brown (10YR5/2) with 20% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		586	
							16, 18	Gray (10YR5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.		584	

EOB = 18.44 ft bgs

NOTE(S): OM50S was installed within 5' of OM50D. See OM50D boring log for sample and testing data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 2/17/2009
Finish: 2/18/2009
WEATHER: cool, overcast, windy, mid-30's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM50
Well ID: OM50D
Surface Elev: 601.2 ft. MSL
Completion: 46.6 ft. BGS
Station: 13,557.44N -6,685.64E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 14, **Tier** 6N.; **Range** 5E.

WATER LEVEL INFORMATION:
▼ = 10.30 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type
1A	14/24 58%	SS	5-6 11-13 N=17	6		
2A	17/24 71%	SS	7-40 21-6 N=61	7		
3A	19/24 79%	SS	3-2 3-3 N=5	23		
4A	20/24 83%	SS	4-5 4-6 N=9	21		
4B				24		
5A	17/24 71%	SS	6-2 2-1 N=4	20		
6A	19/24 79%	SS	0-1 3-4 N=4	25		
7A	22/24 92%	SS	5-5 12-12 N=17	25		
7B				15		
8A	19/24 79%	SS	5-7 12-13 N=19	12		
9A	20/24 83%	SS	10-17 14-18 N=31	10		
10A	19/24 79%	SS	4-6 12-13 N=18	12		

Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
0	Dark gray (10YR4/1), moist, firm, clayey SILT with trace sand and gravel.	600	
2	Yellowish brown (10YR5/6), moist, hard, clayey SILT with trace sand and slight trace gravel.	598	
4	Yellowish brown (10YR5/4) with 5% dark yellowish brown (10YR4/6) mottles, moist, firm, clayey SILT.	596	
6	Light brownish gray (10YR6/2) with 10% dark yellowish brown (10YR4/6) mottles, moist, soft, silty CLAY with slight trace sand and gravel.	594	
8	Dark yellowish brown (10YR4/6) with 10% light brownish gray (10YR6/2) mottles, moist, soft, silty CLAY with slight trace sand and gravel.	592	
10 ▼	Yellowish brown (10YR5/6), moist, very soft, silty CLAY with slight trace sand and gravel.	590	
12	Gray (10YR6/1) with 20% dark yellowish brown (10YR4/6) mottles, wet, soft, clayey SILT.	588	
14	Dark yellowish brown (10YR4/6), very moist, medium dense, silty, fine- to coarse-grained SAND with slight trace gravel.	586	
	Grayish brown (10YR5/2) with 20% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel.		
16	Gray (10YR5/1), slightly moist, hard, clayey SILT with trace sand and slight trace gravel.	584	
18	Yellowish brown (10YR5/4), very moist, medium dense, silty, fine- to coarse-grained SAND.	582	
20			

NOTE(S):

FIELD BORING LOG

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 2/17/2009
Finish: 2/18/2009
WEATHER: cool, overcast, windy, mid-30's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

HANSON

BOREHOLE ID: OM50
Well ID: OM50D
Surface Elev: 601.2 ft. MSL
Completion: 46.6 ft. BGS
Station: 13,557.44N
-6,685.64E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 14, Tier 6N.; Range 5E.

WATER LEVEL INFORMATION:
▼ = 10.30 - during drilling
▼ =
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) % Recovery	SAMPLE: Type	TESTING: Blows / 6 in N - Value RQD	TESTING: Moisture (%)	TESTING: Dry Den. (lb/ft³)	TESTING: Qu (tsf) Failure Type
11A	23/24 96%	SS	4-7 11-8 N=18	10		
12A	24/24 100%	SS	8-16 16-16 N=32	10		
13A	20/24 83%	SS	3-6 6-13 N=12	19		
14A	18/24 75%	SS	14-17 19-50 N=36	17		
15A	18/24 75%	SS	17-13 21-23 N=34	16		
16A	19/24 79%	SS	3-12 19-33 N=31	20		
17A	20/22 91%	SS	18-20 35-50/4" N=55	19		
18A	20/22 91%	SS	15-22 50-50/4" N=72	13		
19A	2/1 200%	SS	50/1"	14		
20A	10/9 111%	SS	33-50/3"	20		

Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
to ~25.0	Grayish brown (10YR5/2) with 20% dark yellowish brown (10YR4/6) mottles, slightly moist, firm, clayey SILT with slight trace sand and gravel. *[Continued from previous page]*		
~25.0–26.3	Gray (N5/1), slightly moist, hard, clayey SILT.		
~26.3–30.2	Gray (N6/1), slightly moist, very hard, SHALE.		Trace coal fragments.
~30.2–32.0	Gray (N5/1) with very dark gray (N3/1) laminae, slightly moist, hard, SHALE.		
32–34	Gray (N5/1), slightly moist, hard, SHALE.		
34–38	Gray (N6/1), slightly moist, hard, SHALE.		
38–40	Dark gray (N4/1), dry, very hard, SHALE.		

Depth scale: 22, 24, 26, 28, 30, 32, 34, 36, 38, 40
Elevation scale: 580, 578, 576, 574, 572, 570, 568, 566, 564, 562

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 2/17/2009
Finish: 2/18/2009
WEATHER: cool, overcast, windy, mid-30's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM50
Well ID: OM50D
Surface Elev: 601.2 ft. MSL
Completion: 46.6 ft. BGS
Station: 13,557.44N
-6,685.64E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 14, **Tier** 6N.; **Range** 5E.

WATER LEVEL INFORMATION:
▼ = 10.30 - during drilling
▼ =
▽ =

SAMPLE			TESTING								
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
21A	8/8 *100%*	SS	*49-50/2"*	7				Dark gray (N4/1), dry, very hard, SHALE. *[Continued from previous page]*		560	
22A	9/9 *100%*	SS	*10-50/3"*	8			42			558	
23A	8/8 *100%*	SS	*39-50/2"*	13			44			556	
24A	7/7 *100%*	SS	*49-50/1"*	7			46	Gray (N6/1), dry, very hard, SHALE.			

EOB = 46.6 ft bgs

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 3/16/2009
Finish: 3/16/2009
WEATHER: sunny, mild, 50's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM51
Well ID: N/A
Surface Elev: 583.8 ft. MSL
Completion: 59.7 ft. BGS
Station: N
E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 31, **Tier** 6N.; **Range** 5E.

WATER LEVEL INFORMATION:
▼ = 36.00 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type
	22/24 92%	SS	3-4 5-5 N=9			
1B				24		
2A	20/24 83%	SS	2-4 4-6 N=8	21		
2B				23		
3A	18/24 75%	SS	3-6 6-8 N=12	22		
4A	24/24 100%	SS	7-7 8-7 N=15	22		
5A	23/24 96%	SS	2-1 2-3 N=3	23		
5B				24		
5C				25		
6A	16/24 67%	SS	woh-1 2-2 N=3	24		
7A	24/24 100%	SS	4-4 5-4 N=9	27		
8A	20/24 83%	SS	1-1 2-2 N=3	32		
8B				42		
9A				29		
9B	24/24 100%	SS	3-3 4-5 N=7	26		
10A	22/24 92%	SS	woh-2 2-3 N=4	24		
10B				30		

Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
0–1	Dark yellowish brown (10YR4/6), moist, soft, silty CLAY with slight trace sand and roots.		
1–2.5	Dark grayish brown (10YR4/2) with 20% yellowish brown (10YR5/6) mottles, moist, firm, silty CLAY with slight trace sand and roots.	582	
2.5–3	Dark grayish brown (10YR4/2) with 30% very dark greenish gray (5BG3/1) mottles, moist, firm, silty CLAY.		
3–6	Dark yellowish brown (10YR4/4), very moist, soft, clayey SILT with slight trace sand.	580, 578	
6–9.5	Very dark greenish gray (5BG3/1) with very dark gray (N3/1) mottles, moist, firm, silty CLAY.	576	
9.5–10	Brown (10YR4/3), moist, soft, clayey SILT with slight trace sand.	574	
10–10.5	Gray (N5/1), very moist, soft, silty CLAY with very dark gray (10YR3/1) peat.		
10.5–11	Very dark gray (N3/1) with 30% dark greenish gray (5BG4/1) mottles, moist, soft, silty CLAY.		
11–15	Very dark gray (N3/1) with 20% yellowish brown (10YR5/6) mottles, moist, very soft, clayey SILT with slight trace sand.	572, 570	
15–15.5	Black (10YR2/1) moist, soft, clayey SILT with organics (peat).		
15.5–16.5	Greenish gray (5BG5/1), moist, soft, silty CLAY.	568	
16.5–18	Very dark gray (N3/1) with 30% yellowish brown (10YR5/6) mottles, very moist to wet, soft, clayey SILT with slight trace sand.	566	
18–18.5	Greenish gray (5BG5/1), moist, soft, silty CLAY.		
18.5–20	Very dark gray (10YR3/1) with 10% yellowish brown (10YR5/6) mottles, moist, soft, clayey SILT with slight trace sand.	564	

NOTE(S): Borehole was abandoned using bentonite grout.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 3/16/2009
Finish: 3/16/2009
WEATHER: sunny, mild, 50's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM51
Well ID: N/A
Surface Elev: 583.8 ft. MSL
Completion: 59.7 ft. BGS
Station: N
E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 31, **Tier** 6N.; **Range** 5E.

WATER LEVEL INFORMATION:
▼ = 36.00 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	18/24 75%	SS	1-1 2-3 N=3	31				Very dark gray (10YR3/1) with 10% yellowish brown (10YR5/6) mottles, moist, soft, clayey SILT with slight trace sand. *[Continued from previous page]*			
							22			562	
12A	24/24 100%	SS	2-2 3-4 N=5	34				Very dark gray (10YR3/1) with 25% yellowish brown (10YR5/6) and 5% greenish gray (5BG5/1) mottles, moist, soft, clayey SILT with slight trace sand and some intermittent very dark grayish brown (10YR3/2) peat.			
							24			560	
13A	23/24 96%	SS	2-2 4-5 N=6	30							
13B				24			26	Greenish gray (5BG5/1) with 10% very dark gray (N3/1) mottles, moist, firm, silty CLAY.		558	
14A	24/24 100%	SS	2-2 3-5 N=5	33				Very dark gray (10YR3/1) with 30% yellowish brown (10YR5/6) and 10% very dark gray (N3/1) mottles, very moist, soft, clayey SILT with slight trace sand and some intermittent very dark grayish brown (10YR3/2) peat.			
							28			556	
15A	24/24 100%	SS	1-1 2-4 N=3	44							
15B				30			30			554	
16A	22/24 92%	SS	2-2 3-3 N=5	21				Greenish gray (5BG5/1) with 10% very dark grayish brown (10YR3/2) peat, moist, firm, silty CLAY with sand.			
							32			552	
17A	24/24 100%	SS	6-7 8-11 N=15	23							
17B				18				Gray (N5/1), wet, firm, silty CLAY with coal and some shale fragments.			
18A				17			34			550	
18B	18/24 75%	SS	2-3 12-7 N=15	19				Gray (N6/1), dry, hard, SHALE.			
								Gray (N6/1) with black (N2.5/1) coal fragments, wet, hard, broken SHALE and coal.			
							▼ 36			548	
19A	24/24 100%	SS	15-34 25-32 N=59	13				Gray (N5/1), moist, hard, SHALE.			
							38			546	
								Gray (N6/1), SANDSTONE.			
20A	12/24 50%	SS	1-3 5-3 N=8	24				Gray (N6/1), moist, soft, SHALE.			
							40			544	

NOTE(S): Borehole was abandoned using bentonite grout.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 3/16/2009
Finish: 3/16/2009
WEATHER: sunny, mild, 50's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM51
Well ID: N/A
Surface Elev: 583.8 ft. MSL
Completion: 59.7 ft. BGS
Station: N
E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 31, **Tier** 6N.; **Range** 5E.

WATER LEVEL INFORMATION:
▼ = 36.00 - during drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
21A	11/24 46%	SS	2-2 4-4 N=6	17			42	Gray (N6/1), wet, soft, weathered SHALE and sandstone fragments.	542	
22A	5/5 100%	SS	50/5"	15						
							44	Gray (N6/1), very moist, firm, weathered SHALE with slight trace sand.	540	
23A	18/24 75%	SS	11-6 5-7 N=11	16			46		538	
								Light yellowish brown (2.5Y6/3), very moist, soft, clayey SILT with trace sand.		
24A	14/24 58%	SS	3-3 4-5 N=7	16				Gray (N6/1), SHALE.		
							48	Light yellowish brown (2.5Y6/3), very moist to wet, soft, clayey SILT with trace sand.	536	
25A	18/24 75%	SS	4-5 4-8 N=9	13				Gray (N6/1), wet, hard, SANDSTONE.		
							50	Gray (N6/1), wet, soft, weathered, sandy SHALE.	534	
26A	14/24 58%	SS	2-4 6-8 N=10	24			52		532	
27A	20/24 83%	SS	4-6 4-3 N=10	26			54	Light yellowish brown (2.5Y6/3) with 30% gray (N6/1) mottles, wet, soft, clayey SILT with trace sand and sandstone fragments.	530	
28A	16/24 67%	SS	10-10 7-22 N=17	14			56	Gray (N6/1), moist, hard, micaceous SHALE.	528	
29A	17/24 71%	SS	44-11 17-27 N=28	13			58		526	
								Gray (N5/1), moist, hard, SHALE with trace sand.		
30A	18/24 75%	SS	5-14 8-14 N=22	20				Gray (N6/1), moist, hard, micaceous SANDSTONE.		
30B				21				Gray (N5/1), moist, hard, weathered SHALE.		

EOB = 59.7 ft bgs

NOTE(S): Borehole was abandoned using bentonite grout.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 3/16/2009
Finish: 3/16/2009
WEATHER: sunny, mild, 50's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

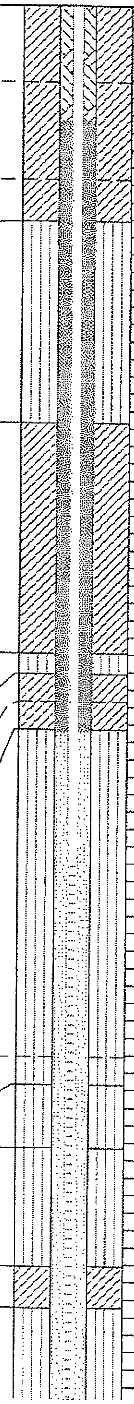
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM51b
Well ID: OM51S
Surface Elev: 583.8 ft. MSL
Completion: 22.2 ft. BGS
Station: -4,231.82N
-488.56E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 31, Tier 6N.; Range 5E.

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

SAMPLE			TESTING									
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark yellowish brown (10YR4/6), moist, soft, silty CLAY with slight trace sand and roots.			
							2	Dark grayish brown (10YR4/2) with 20% yellowish brown (10YR5/6) mottles, moist, firm, silty CLAY with slight trace sand and roots.		582	
								Dark grayish brown (10YR4/2) with 30% very dark greenish gray (5BG3/1) mottles, moist, firm, silty CLAY.			
							4	Dark yellowish brown (10YR4/4), very moist, soft, clayey SILT with slight trace sand.		580	
							6			578	
							8	Very dark greenish gray (5BG3/1) with very dark gray (N3/1) mottles, moist, firm, silty CLAY.		576	
								Brown (10YR4/3), moist, soft, clayey SILT with slight trace sand.			
							10	Gray (N5/1), very moist, soft, silty CLAY with very dark gray (10YR3/1) peat.		574	
								Very dark gray (N3/1) with 30% dark greenish gray (5BG4/1) mottles, moist, soft, silty CLAY.			
							12	Very dark gray (N3/1) with 20% yellowish brown (10YR5/6) mottles, moist, very soft, clayey SILT with slight trace sand.		572	
							14			570	
								Black (10YR2/1) moist, soft, clayey SILT with organics (peat).			
							16	Greenish gray (5BG5/1), moist, soft, silty CLAY.		568	
								Very dark gray (N3/1) with 30% yellowish brown (10YR5/6) mottles, very moist to wet, soft, clayey SILT with slight trace sand.			
							18	Greenish gray (5BG5/1), moist, soft, silty CLAY.		566	
								Very dark gray (10YR3/1) with 10% yellowish brown (10YR5/6) mottles, moist, soft, clayey SILT with slight trace sand.			
							20			564	



NOTE(S): OM51S was installed within 5' of boring OM51. See OM51 boring log for sample and testing data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 3/16/2009
Finish: 3/16/2009
WEATHER: sunny, mild, 50's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM51b
Well ID: OM51S
Surface Elev: 583.8 ft. MSL
Completion: 22.2 ft. BGS
Station: -4,231.82N
-488.56E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 31, **Tier** 6N.; **Range** 5E.

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

SAMPLE			TESTING									
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Very dark gray (10YR3/1) with 10% yellowish brown (10YR5/6) mottles, moist, soft, clayey SILT with slight trace sand. *[Continued from previous page]*			
							22	Very dark gray (10YR3/1) with 25% yellowish brown (10YR5/6) and 5% greenish gray (5BG5/1) mottles, moist, soft, clayey SILT with slight trace sand and some intermittent very dark grayish brown (10YR3/2) peat.		562	

EOB = 22.18 ft bgs

NOTE(S): OM51S was installed within 5' of boring OM51. See OM51 boring log for sample and testing data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 3/16/2009
Finish: 3/17/2009
WEATHER: sunny, mild, 50's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM51a
Well ID: OM51D
Surface Elev: 583.8 ft. MSL
Completion: 47.5 ft. BGS
Station: -4,226.56N
-488.40E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 31, Tier 6N.; Range 5E.

WATER LEVEL INFORMATION:
▼ = 36.00 - during drilling
▼ =
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark yellowish brown (10YR4/6), moist, soft, silty CLAY with slight trace sand and roots.			
							2	Dark grayish brown (10YR4/2) with 20% yellowish brown (10YR5/6) mottles, moist, firm, silty CLAY with slight trace sand and roots.		582	
								Dark grayish brown (10YR4/2) with 30% very dark greenish gray (5BG3/1) mottles, moist, firm, silty CLAY.			
							4	Dark yellowish brown (10YR4/4), very moist, soft, clayey SILT with slight trace sand.		580	
							6			578	
							8	Very dark greenish gray (5BG3/1) with very dark gray (N3/1) mottles, moist, firm, silty CLAY.		576	
								Brown (10YR4/3), moist, soft, clayey SILT with slight trace sand.			
							10	Gray (N5/1), very moist, soft, silty CLAY with very dark gray (10YR3/1) peat.		574	
								Very dark gray (N3/1) with 30% dark greenish gray (5BG4/1) mottles, moist, soft, silty CLAY.			
							12			572	
								Very dark gray (N3/1) with 20% yellowish brown (10YR5/6) mottles, moist, very soft, clayey SILT with slight trace sand.			
							14			570	
								Black (10YR2/1) moist, soft, clayey SILT with organics (peat).			
							16	Greenish gray (5BG5/1), moist, soft, silty CLAY.		568	
								Very dark gray (N3/1) with 30% yellowish brown (10YR5/6) mottles, very moist to wet, soft, clayey SILT with slight trace sand.			
							18			566	
								Greenish gray (5BG5/1), moist, soft, silty CLAY.			
								Very dark gray (10YR3/1) with 10% yellowish brown (10YR5/6) mottles, moist, soft, clayey SILT with slight trace sand.			
							20			564	

NOTE(S): OM51D was installed within 5' of boring OM51. See OM51 boring log for sample and testing data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 3/16/2009
Finish: 3/17/2009
WEATHER: sunny, mild, 50's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM51a
Well ID: OM51D
Surface Elev: 583.8 ft. MSL
Completion: 47.5 ft. BGS
Station: -4,226.56N
-488.40E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 31, **Tier** 6N.; **Range** 5E.

WATER LEVEL INFORMATION:
▼ = 36.00 - during drilling
▼ =
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
								Very dark gray (10YR3/1) with 10% yellowish brown (10YR5/6) mottles, moist, soft, clayey SILT with slight trace sand. *[Continued from previous page]*		
							22		562	
							24	Very dark gray (10YR3/1) with 25% yellowish brown (10YR5/6) and 5% greenish gray (5BG5/1) mottles, moist, soft, clayey SILT with slight trace sand and some intermittent very dark grayish brown (10YR3/2) peat.	560	
							26	Greenish gray (5BG5/1) with 10% very dark gray (N3/1) mottles, moist, firm, silty CLAY.	558	
							28	Very dark gray (10YR3/1) with 30% yellowish brown (10YR5/6) and 10% very dark gray (N3/1) mottles, very moist, soft, clayey SILT with slight trace sand and some intermittent very dark grayish brown (10YR3/2) peat.	556	
							30		554	
								Greenish gray (5BG5/1) with 10% very dark grayish brown (10YR3/2) peat, moist, firm, silty CLAY with sand.		
							32		552	
							34	Gray (N5/1), wet, firm, silty CLAY with coal and some shale fragments.	550	
								Gray (N6/1), dry, hard, SHALE.		
								Gray (N6/1) with black (N2.5/1) coal fragments, wet, hard, broken SHALE and coal.		
							▼ 36		548	
								Gray (N5/1), moist, hard, weathered SHALE.		
							38		546	
								Gray (N6/1), SANDSTONE.		
								Gray (N6/1), moist, soft, weathered SHALE.		
							40		544	

NOTE(S): OM51D was installed within 5' of boring OM51. See OM51 boring log for sample and testing data.

FIELD BORING LOG

HANSON

CLIENT: Ameren Energy Resources Generating Co.
Site: Duck Creek Ash Ponds 1 and 2
Location: Canton, Fulton Co., IL
Project: 03S5010 / 5500
DATES: Start: 3/16/2009
Finish: 3/17/2009
WEATHER: sunny, mild, 50's

CONTRACTOR: Testing Service Corporation
Rig mfg/model: CME 550 ATV Drill
Drilling Method: 4¼" hollow stem auger

FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: R. Hasenyager

BOREHOLE ID: OM51a
Well ID: OM51D
Surface Elev: 583.8 ft. MSL
Completion: 47.5 ft. BGS
Station: -4,226.56N
-488.40E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Banner
Township: Banner
Section 31, Tier 6N.; Range 5E.

WATER LEVEL INFORMATION:
▼ = 36.00 - during drilling
▼ =
▽ =

SAMPLE			TESTING								
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Failure Type*	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							42	Gray (N6/1), wet, soft, weathered SHALE and sandstone fragments.		542	
							44	Gray (N6/1), very moist, firm, weathered SHALE with slight trace sand.		540	
							46	Light yellowish brown (2.5Y6/3), very moist, soft, clayey SILT with trace sand.		538	
								Gray (N6/1), weathered SHALE.			

EOB = 47.47 ft bgs

NOTE(S): OM51D was installed within 5' of boring OM51. See OM51 boring log for sample and testing data.

APPENDIX E

GROUNDWATER ELEVATION DATA – 2014, 2015

Appendix E
Groundwater Elevation Data – 2014, 2015
Supplemental Hydrogeologic Site Characterization Report
Duck Creek Energy Center

Well ID	Well Location		Well Elevations		Groundwater Elevations			
	East (Apr 08)	North (Apr 08)	Gnd_Elev (Apr 08)	Pipe_Elev (Apr 08)	24-Apr-14	18-Jul-14	17-Apr-15	15-Sep-15
OM01	288.1	5259.0	593.30	595.61	582.90	585.05	583.57	583.86
OR02	130.6	7475.6	599.19	601.41	595.49	595.60	595.54	594.98
OR03D	85.6	9286.1	623.72	627.13	581.62	581.57	581.41	582.69
OR03S	82.3	9283.0	623.69	627.16	581.49	581.54	581.61	582.46
OM04S	1224.8	9551.1	604.81	607.35	590.64	588.96	589.23	588.30
OR04D	1229.1	9548.7	604.80	607.58	586.73	586.63	586.58	586.97
OR05D	1675.1	6766.3	607.91	610.96	593.24	593.08	592.96	593.32
OM05S	1679.1	6768.3	607.91	610.76	591.85	592.28	592.62	593.41
OR06A	1635.8	4917.2	591.62	595.31	588.26	578.53	579.00	578.74
OM07	1647.1	4157.2	594.38	596.46	581.46	582.32	583.40	584.54
OM08	1936.7	2579.0	599.11	601.74	586.89	580.59	587.41	587.14
OM09	77.8	1906.6	590.16	591.61	585.19		587.04	585.75
OM10	4875.2	6221.4	584.09	585.11	576.56		578.95	579.56
OR11	3059.0	5448.4	593.64	596.55	566.05	567.71	566.01	566.25
OM12	3052.2	3927.0	592.78	595.37	579.50	580.64	583.77	583.37
OR13D	1749.7	6840.3	595.75	602.70	593.32	593.17	593.72	593.97
OR13S	1749.6	6834.3	595.75	602.71	591.63	591.20	591.71	590.78
OR14D	1759.9	7356.5	596.22	598.91	590.46	590.26	592.30	589.66
OR14S	1760.0	7350.8	596.22	599.26	593.06	592.83	591.28	591.81
OM15	3011.1	6227.4	596.00	598.05	577.73	578.25	579.74	580.17
OM16	3518.2	9228.9	605.36	607.93	580.76	582.29	586.75	585.90
OM17	4301.7	8291.8	589.30	592.13	580.76	580.40	582.77	583.19
OR18	1979.0	8543.8	611.56	613.85	597.87	598.22	601.11	602.21
OR19	2725.2	4045.0	595.69	597.80	572.96	574.81	576.33	577.81
OR20	2926.8	5346.4	584.63	587.72	565.87	566.74	566.49	566.63
OM21	1567.7	8565.7	604.15	606.60	598.29	597.52	599.47	596.77
OM22D	-126.95	3991.5	597.07	598.87	579.73	581.13	579.91	581.38
OM22S	-127.08	3994.82	596.76	599.22	579.70	581.18	579.89	580.60
OM23D	-371.63	5591.13	610.4	613.25	574.91	576.01	575.23	576.99
OM23S	-371.66	5585.76	610.41	613.14	571.69	572.23	571.48	571.08
OM24D	-341.39	7523.62	573.90	576.79	574.08	573.66	574.17	573.39
OM25D	-321.61	8616.31	627.14	629.19	571.44	571.66	571.29	573.69
OM25S	-321.35	8620.05	627.02	629.11	571.40	571.52	571.18	571.00

APPENDIX F

GROUNDWATER SAMPLING PROTOCOL

GROUNDWATER SAMPLING PROTOCOL
ASH PONDS 1 AND 2 CLOSURE
DUCK CREEK POWER STATION

1.0 SAMPLING PROTOCOL

These procedures will be used during routine groundwater sampling at the above referenced facility. A worksheet will be used for recording relevant information regarding each monitoring well and will be submitted to the facility for their records.

If conditions at the time of groundwater sampling could influence the results, groundwater sampling will be postponed until a later date. However, sample collection will not deviate from the schedule provided in the site-specific Groundwater Monitoring Plan.

2.0 WATER LEVELS

Groundwater elevations shall be obtained in each monitoring well prior to purging and/or sampling. Groundwater elevations in the monitoring well will be obtained as close together of a timeframe as practical, to reduce time distortion of the water surface data. Groundwater elevation procedures follow:

1. Record the general monitoring well condition. This includes the condition of the casing, the lock, evidence of tampering, condition of the concrete pad, and any standing water.

2. Remove the lock and open the well. Note the condition of the interior of the casing and the condition of the well cap and riser. Open the cap, taking care not to allow dirt or foreign material into the well.

3. Decontaminate the water level indicator.

4. Slowly lower the water level indicator into the well until the water surface has been reached.

5. Record the time and depth to water (to the nearest 0.01 foot).

6. Lower the water level indicator to the bottom of the monitoring well. If a dedicated pump is installed in the well, perform this step during regularly scheduled maintenance of the monitoring wells. Record the depth of the monitoring well (to the nearest 0.01 foot). Monitoring well depth will be

measured on an annual basis at wells that do not contain dedicated pumps and once every five years for monitoring wells with dedicated pumps.

7. Slowly remove the water level indicator from the well.

8. Replace the cap. Close and lock the well.

3.0 LOW-FLOW PURGING

This facility uses low-flow sampling techniques to obtain groundwater samples from the monitoring well network. Each monitoring well will be purged using a dedicated pump prior to groundwater sample collection. The pumps will consist of inert materials consistent with the monitoring well construction (e.g., stainless steel pump bodies installed in stainless steel wells). Groundwater sampling will begin with the monitoring wells that have not been historically impacted before sampling impacted monitoring wells.

Each monitoring well will be purged prior to groundwater sampling. Flow rates for low-flow sampling typically are below 0.5 liters/minute, with a goal of less than 0.3 feet reduction in groundwater elevation. These goals may not be practical based on the hydrogeology at the facility.

Purging will continue until the measured pH, temperature, and specific conductance stabilize within ±10 percent over three consecutive readings. The equipment used to measure these indicator parameters will be calibrated daily and decontaminated before use at each monitoring well. If low-flow stabilization does not occur, four well volumes will be removed prior to sampling. Field indicator parameters used for stabilization will be recorded.

4.0 LOW-FLOW SAMPLING

Establish a “clean area” near the monitoring well where the sample containers and equipment can be stored while not in use. Sampling equipment and containers should not contact the ground surface. If needed, a disposable plastic tarp can be used as ground cover.

One blind duplicate and one equipment blank sample will be collected and analyzed for each day of sampling. If dedicated sampling equipment is used, then equipment blank samples will not be collected.

Groundwater samples will be field-filtered (using a new 0.45 micron disposable filter for each monitoring well); and the groundwater sample will be collected in laboratory-provided sampling containers with preservatives as required by the USEPA. All groundwater samples will be labeled, packed to reduce the chance of breakage, and placed in a cooler with ice to maintain a temperature of less than 4º Celsius during transport to the analytical laboratory.

The samples will be accompanied by a chain-of-custody record. The sampler retains a copy of the record and forwards the original with the samples to the analytical laboratory. Once the laboratory has received the samples, a representative from the laboratory will complete the record, retain the original, and return a copy with the chemical analysis reports to the sampler. The chain-of-custody contains the facility name, the wells sampled, time and date of sampling, members of sampling party, type of samples, number of sample bottles, and requested analyses.

ATTACHMENT J

Memorandum

BURNS McDONNELL

Date: 25 October 2021

Subject: 35 I.A.C. Section 845.430 – Slope Maintenance Documentation for Ash Ponds No. 1 & No. 2 at Duck Creek Power Plant

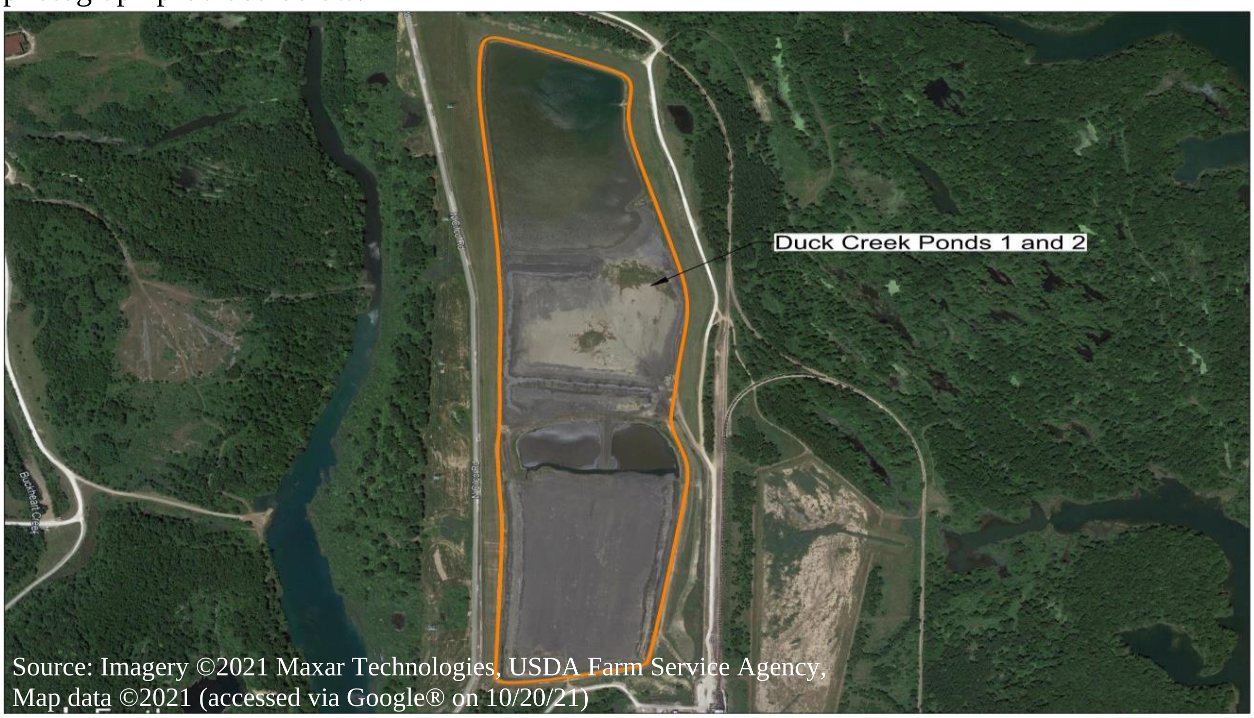
Illinois Power resources Generating, LLC operates the coal-fired Duck Creek Power Plant located in Fulton County, Illinois. The Duck Creek Ash Ponds No. 1 & No. 2 are closed inactive surface impoundments storing coal combustion residuals (CCR). The requirements for the Duck Creek Ash Ponds No. 1 & No. 2 are found in 35 Ill. Admin. Code Part 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845).

Pursuant to Part 845, Section 845.230(d)(3)(C), the initial operating permit application for inactive closed CCR surface impoundments that have completed an Agency approved closure before prior to July 30, 2021, must contain documentation that the CCR surface impoundment, if not incised, will be operated, and maintained with one of the forms of slope protection specified in Section 845.430. This statement addresses the requirements of Part 845, Section 845.430 Slope Maintenance, which states:

> <u>*Section 845.430:*</u> *The slopes and pertinent surrounding areas of the CCR surface impoundment must be designed, constructed, operated, and maintained with one of the forms of slope protection specified in subsection (a) that meets all the performance standards of subsection (b).*
>
> <u>*Section 845.430(a):*</u> *Slope protection must consist of one of the following: 1) A vegetative cover consisting of grassy vegetation; 2) An engineered cover consisting of a single form or combination of forms of engineered slope protection measures; or 3) A combination of the forms of cover specified in subsections (a)(1) or (a)(2).*
>
> <u>*Section 845.430(b):*</u> *Any form of cover for slope protection must meet the following performance standards: 1) The cover must be installed and maintained on the slopes and pertinent surrounding areas of the CCR surface impoundment; 2) The cover must provide protection against surface erosion, wave action, and adverse effects of rapid drawdown; 3) The cover must be maintained to allow for the observation of, and access to, the slopes and pertinent surrounding areas during routine and emergency events; 4) Woody vegetation must be removed from the slopes or pertinent surrounding areas. Any removal of woody vegetation with a diameter greater than 1/2 inch must be directed by a person familiar with the design and operation of the CCR surface impoundment and in consideration of the complexities of removal of a tree or a shrubbery, who must ensure the removal does not create a risk of destabilizing the CCR surface impoundment or otherwise adversely affect the stability and safety of the CCR surface impoundment or*

> *personnel undertaking the removal; and 5) The height of vegetation must not exceed 12 inches.*

Slope protection, consisting of vegetative cover, was installed on the slopes and pertinent surrounding areas of the Duck Creek Ash Ponds No. 1 & No. 2, and is inspected, maintained, and repaired as needed. Based on observations from weekly inspections conducted in accordance with Section 845.540(a), and the 2020 annual inspections conducted by Hanson Professional Services Inc., the vegetative cover is described to be in good working condition with a maximum vegetation height of 12 inches. The owner's Operations and Maintenance Plan (O&M Plan) provides details for maintaining grass and removing woody vegetation and addressing erosion features on the slopes. Based on a review of the documentation described above, the owner is implementing the O&M Plan, including the completion of repairs and maintenance as needed and when issues are identified during weekly and/or annual inspections. The slope maintenance portion of the O&M Plan and the Annual Inspection performed by Hanson in 2020 are included in Attachment J. The surface impoundment slope protection (vegetative cover) installed and maintained on the slopes and pertinent areas around the slopes is depicted in the aerial photograph provided below.



Source: Imagery ©2021 Maxar Technologies, USDA Farm Service Agency, Map data ©2021 (accessed via Google® on 10/20/21)

Dam Inspection Report

Name of Dam: Duck Creek Ash Pond #1 Dam ID No.: NA

Permit Number: NA Class of Dam: NA

Location: NW 1/4 Section: 30 Township: 23N Range: 5E

Owner: Dynegy Midwest Generation (Name) 309-633-2836 (Telephone Number (Day))

17751 North Cilco Road (Street) 309-633-2836 (Telephone Number (Night))

Canton (City) 61520 (Zip Code) County: Fulton

Type of Dam: Earth Embanment

Type of Spillway: Pumped Into Ash Pond #2

Date(s) Inspected: 10-Nov-20

Weather When Inspected: Cloudy

Temperature When Inspected: 50 F

Pool Elevation When Inspected: NA

Tailwater Elevation When Inspected: NA

Inspection Personnel:

Name	Title
James P. Knutelski, P.E.	Geotechnical Engineer
Jason Campbell, P.E.	Dynegy Dam Safety
Daryl Johnson	Dynegy Plant
Paul Mauer	IDNR-OWR

LICENSED PROFESSIONAL ENGINEER
JAMES P. KNUTELSKI
062-054206
OF ILLINOIS

12/31/2020

Professional Engineer's Seal

Exp 11/30/21

The Department of Nautural Resources is requesting information that is necessary to accomplish the statutory purpose as outlined under the River, Lakes and Streams Act, 615 ILCS 5. Submittal of this information is REQUIRED. Failure to provide the required information could result in the initiation of non-compliance procedures as outlined in Section 3702.160 of the "Rules for Construction and Maintenance of Dams".

CONDITION CODES

NE - No evidence of a problem

GC - Good condition

MM - Item needing minor maintenance and/or repairs within the year, the safety or integrity of the item is not yet imperiled

IM - Item needing immediate maintenance to restore or ensure its safety or integrity

EC - Emergency condition which if not immediately repaired or other appropriate measures taken could lead to failure of the dam

OB - Condition requires regular observation to ensure that the condition Earth Embanment

NA - Not Applicable

NI - Not inspected - list the reason for non-inspection under deficiencies

EARTH EMBANKMENT

ITEM	CONDITION CODE	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES AND IMPLEMENTATION SCHEDULE
Surface Cracks	NE		
Vertical and Horizontal Alignment of Crest	GC		
Unusual Movement or Cracking At or Beyond Toe	NE		
Sloughing or Erosion of Embankment and Abutment Slopes	GC		
Upstream Face Slope Protection	NA		
Seepage	NA		
Filter and Filter Drains	NA		

EARTH EMBANKMENT
(Continued)

ITEM	CONDITION CODE	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES AND IMPLEMENTATION SCHEDULE
Animal Damage	NE		
Embankment Drainage Ditches	GC		
Vegetative Cover	OB	Growth from new grading in progress,	Observe and re-seed if necesssary.
Pool Level	NA		
Interior Perimeter Ditches	GC		
Unwanted Vegetation	NE		
Armored Let-down Channels	NE		

SUMMARY OF MAINTENANCE DONE AND/OR

REPAIRS MADE SINCE THE LAST INSPECTION

DATE OF PRESENT INSPECTION	10-Nov-20
DATE OF LAST INSPECTION	5-Nov-19

1. EARTH EMBANKMENT DAMS
   Closure construction in progress during inspection. Grading, seeding, and drop structures 95% complete.

2. CONCRETE MASONRY DAMS
   NA

3. PRINCIPAL SPILLWAY
   None.

4. OUTLET WORKS
   NA

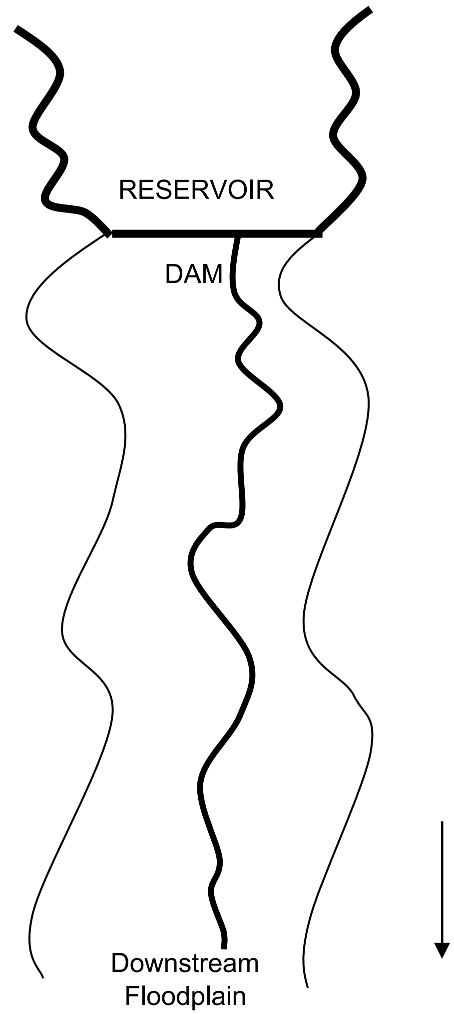
5. EMERGENCY SPILLWAY
   NA

DOWNSTREAM DEVELOPMENT

APPROXIMATE WIDTH OF AFFECTED FLOODPLAIN NA MILES

MILES DOWNSTREAM FROM DAM	DOWNSTREAM DEVELOPMENT												Loss of Life Potential			Economic Loss Potential		
	OCCUPIED HOMES	UNOCCUPIED HOMES	AGRICULTURAL BUILDINGS	INDUSTRIAL BUILDINGS	COMMERCIAL BUILDINGS	SCHOOLS	HOSPITALS	ROADS & BRIDGES	DAMS	OVERHEAD UTILITIES	OTHER DEVELOPMENT (Name	OTHER DEVELOPMENT (Name	NONE	1 TO 10	OVER 10	MINIMAL EXPECTED	APPRECIABLE EXPECTED	EXCESSIVE EXPECTED
0 to 1/4	0	0	0	0	0	0	0	1		1	0	0		X		X		
1/4 to 1/2																		
1/2 to 3/4																		
3/4 to 1																		
1 to 1-1/4																		
1-1/4 to 1-1/2																		
1-1/2 to 1-3/4									1									
1-3/4 to 2																		
OVER 2																		

SKETCH IN DEVELOPMENTS DOWNSTREAM OF THE DAM



The number of homes, buildings, or other items in the floodplain downstream of the dam should be placed in the appropriate row and column to designate their location.

Owner's Maintenance Statement

I, ____________________________________, owner of DC Ash Pond #1 dam,

Dam Identification Number NA , in Fulton County,

am maintaining the dam in accordance with the accepted maintenance plan which is part of

Permit Number NA .

____
Signature

____
Date

Owner's Operation and Maintenance Plan Statement

I, ____________________________________, owner of DC Ash Pond #1 dam,

Dam Identification Number NA , in Fulton County,

have reviewed the operation and maintenance plan including the Emergency Action Plan (EAP),

which is part of, Permit Number NA .

I _____ have enclosed the appropriate revisions or

_____ have determined that no revisions to the plan are necessary.

____
Signature

____
Date

The Department of Nautural Resources is requesting information that is necessary to accomplish the statutory purpose as outlined under the River, Lakes and Streams Act, 615 ILCS 5. Submittal of this information is REQUIRED. Failure to provide the required information could result in the initiation of non-compliance procedures as outlined in Section 3702.160 of the "Rules for Construction and Maintenance of Dams".

Ponds 1 and 2 interior

East side – grading in progress


East side and let-down structure


South side


West side and let-down structure


West side

Dam Inspection Report

Name of Dam: Duck Creek Ash Pond #2 — Dam ID No. IL50014

Permit Number: DS2014020 — Class of Dam: III

Location: SW 1/4 Section 19 Township 6N Range 5E

Owner: Dynegy Midwest Generation (Name) — 309-633-2836 (Telephone Number (Day))

17751 North Cilco Road (Street) — 309-633-2836 (Telephone Number (Night))

Canton (City) — 61520 (Zip Code) — County: Fulton

Type of Dam: Earth Embankment

Type of Spillway: Drop inlet

Date(s) Inspected: 10-Nov-20

Weather When Inspected: Cloudy

Temperature When Inspected: 50 F

Pool Elevation When Inspected: NA

Tailwater Elevation When Inspected: NA

Inspection Personnel:

Name	Title
James P. Knutelski, P.E.	Geotechnical Engineer
Jason Campbell, P.E.	Dynegy Dam Safety
Daryl Johnson	Dynegy Plant
Paul Mauer	IDNR-OWR

LICENSED PROFESSIONAL ENGINEER
JAMES P. KNUTELSKI
062-054206
OF ILLINOIS

12/31/20

Professional Engineer's Seal

Exp 11/30/21

The Department of Nautural Resources is requesting information that is necessary to accomplish the statutory purpose as outlined under the River, Lakes and Streams Act, 615 ILCS 5. Submittal of this information is REQUIRED. Failure to provide the required information could result in the initiation of non-compliance procedures as outlined in Section 3702.160 of the "Rules for Construction and Maintenance of Dams".

CONDITION CODES

NE -	No evidence of a problem
GC -	Good condition
MM -	Item needing minor maintenance and/or repairs within the year, the safety or integrity of the item is not yet imperiled
IM -	Item needing immediate maintenance to restore or ensure its safety or integrity
EC -	Emergency condition which if not immediately repaired or other appropriate measures taken could lead to failure of the dam
OB -	Condition requires regular observation to ensure that the condition does not become worse
NA -	Not applicable to this dam
NI -	Not inspected - list the reason for non-inspection under deficiencies

EARTH EMBANKMENT

ITEM	CONDITION CODE	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES AND IMPLEMENTATION SCHEDULE
Surface Cracks			Closure construction in progress during inspection. All items are responsibility of contractor.
Vertical and Horizontal Alignment of Crest			
Unusual Movement or Cracking At or Beyond Toe			
Sloughing or Erosion of Embankment and Abutment Slopes			
Upstream Face Slope Protection			
Seepage			
Filter and Filter Drains			

EARTH EMBANKMENT
(Continued)

ITEM	CONDITION CODE	DEFICIENCIES	RECOMMENDED REMEDIAL MEASURES AND IMPLEMENTATION SCHEDULE
Animal Damage			Closure construction in progress during inspection. All items are responsibility of contractor.
Interior Perimeter Ditches			
Vegetative Cover			
Armored Let-down Channels			
Other			
Other			
Other			

SUMMARY OF MAINTENANCE DONE AND/OR

REPAIRS MADE SINCE THE LAST INSPECTION

DATE OF PRESENT INSPECTION 10-Nov-20

DATE OF LAST INSPECTION 5-Nov-18

1. EARTH EMBANKMENT DAMS
   Closure construction in progress during inspection. All items are responsibility of contractor. Mowed.

2. CONCRETE MASONRY DAMS
   NA

3. PRINCIPAL SPILLWAY
   None.

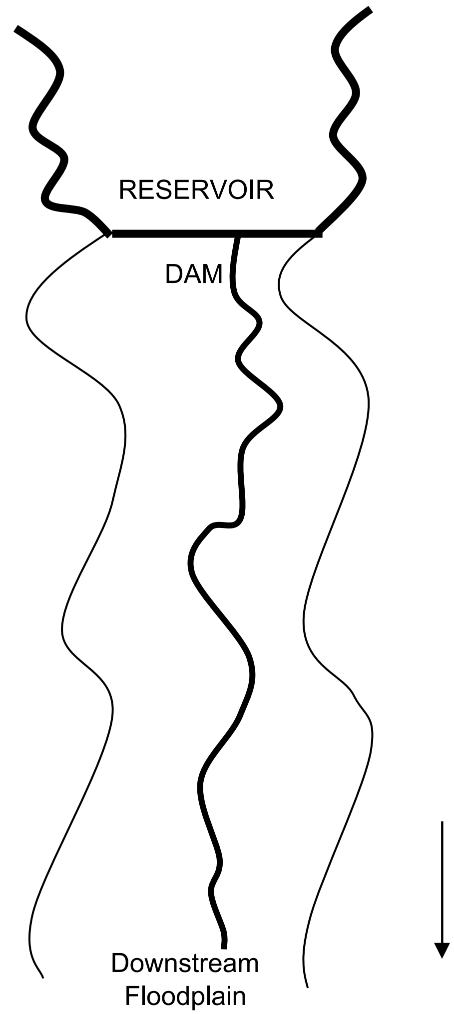
4. OUTLET WORKS
   NA

5. EMERGENCY SPILLWAY
   NA

DOWNSTREAM DEVELOPMENT
APPROXIMATE WIDTH OF AFFECTED FLOODPLAIN ___NA___ MILES

MILES DOWNSTREAM FROM DAM	DOWNSTREAM DEVELOPMENT												Loss of Life Potential			Economic Loss Potential		
	OCCUPIED HOMES	UNOCCUPIED HOMES	AGRICULTURAL BUILDINGS	INDUSTRIAL BUILDINGS	COMMERCIAL BUILDINGS	SCHOOLS	HOSPITALS	ROADS & BRIDGES	DAMS	OVERHEAD UTILITIES	OTHER DEVELOPMENT (Name	OTHER DEVELOPMENT (Name	NONE	1 TO 10	OVER 10	MINIMAL EXPECTED	APPRECIABLE EXPECTED	EXCESSIVE EXPECTED
0 to 1/4	0	0	0	0	0	0	0	1		1	0			X		X		
1/4 to 1/2																		
1/2 to 3/4																		
3/4 to 1																		
1 to 1-1/4																		
1-1/4 to 1-1/2																		
1-1/2 to 1-3/4																		
1-3/4 to 2									1									
OVER 2																		

SKETCH IN DEVELOPMENTS DOWNSTREAM OF THE DAM



The number of homes, buildings, or other items in the floodplain downstream of the dam should be placed in the appropriate row and column to designate their location.

Owner's Maintenance Statement

I, ______________________________________, owner of DC Ash Pond #2 dam,

Dam Identification Number IL50014, in Fulton County,

am maintaining the dam in accordance with the accepted maintenance plan which is part of

Permit Number DS2014020.

____
Signature

____
Date

Owner's Operation and Maintenance Plan Statement

I, ______________________________________, owner of DC Ash Pond #2 dam,

Dam Identification Number IL50014, in Fulton County,

have reviewed the operation and maintenance plan including the Emergency Action Plan (EAP),

which is part of, Permit Number DS2014020.

I _____ have enclosed the appropriate revisions or

_____ have determined that no revisions to the plan are necessary.

____
Signature

____
Date

The Department of Nautural Resources is requesting information that is necessary to accomplish the statutory purpose as outlined under the River, Lakes and Streams Act, 615 ILCS 5. Submittal of this information is REQUIRED. Failure to provide the required information could result in the initiation of non-compliance procedures as outlined in Section 3702.160 of the "Rules for Construction and Maintenance of Dams".

North side grading

East side – north end grading

East side let-down structure

East side exterior and crest


Pond interior east side


Pond interior east side


Pond interior east side


Pond interior

Pond interior

West side and let-down structure

West side

Excerpt from the Duck Creek Operations and Maintenance Manual

1.1 OPERATION AND MAINTENANCE INSPECTION

"Walk-around" inspections of the dams and appurtenant works are to be made by the dam Operator. During these inspections, a checklist of items to be maintained and items to be observed should be recorded. The checklist provided in Appendix B shall be utilized for these inspections. **If any of the following items are found to be unusual or are cause for concern, Shift Supervisor should be immediately notified.**

Frequency: Weekly. Also, during and after unusual events such as heavy rainfall or after an earthquake.

Inspection Items: During each inspection the following items should be noted.

1. Water Level - Maximum levels because of heavy rainfall should be recorded.

2. Earth Embankment - Walk the crest, side slopes and downstream toe of the dam concentrating on surface erosion, seepage, cracks, settlement, slumps, slides, and animal burrows. These are described as follows:

   - Surface Erosion - Removal of vegetative cover by water action or pedestrian or vehicle usage forming deep ruts or gullies.

   - Seepage - The passage of water through and/or underneath the earth embankment abutment and natural groundline or at the contact between the embankment and outlet works. It can be indicated by cattails or other wet environmental vegetation, erosion, channelization, or slumping on the embankment face.

   - Cracks - Deep cracks usually indicate the movement of the dam and/or the foundation and can be in either the longitudinal (along the length of the dam) or transverse (across the dam) directions. Cracking can be an indicator of the beginning of slumps. Shallow cracks may develop during the summer when the surface soils of the embankment become severely dried and are usually of no concern regarding the safety of the dam.

   - Settlement - Settlement is indicated by depressions or low spots and can be signs of consolidation of the dam or foundation or the loss of material beneath the settlement area.

   - Slumps/Slides - A slow or sudden movement of the earth embankment slope on either face toward the toe of the dam.

- If seepage indicates the presence of soil particles, or if deep cracks, settlement, slumps, or slides are noticed, a qualified engineer should be contacted immediately for consultation.

- Animal Burrows - Animal burrows result in a loss of earth embankment material and can provide seepage paths for water through the embankment.

3. Gypsum Embankment - Walk the crest, side slopes and downstream toe of the dam concentrating on surface erosion, seepage, cracks, settlement, slumps, slides, and animal burrows. The descriptions for these are the same as for earth embankment.

4. Vegetation - Grass should be a thick vigorous growth to stabilize the earth embankment soils and prevent erosion from occurring. Note the height of the grass, if greater than 1-foot a mowing of the area should be scheduled before the next inspection. There should be NO trees on the earth embankment and NONE within a minimum of 20 ft of the embankment toes or other structures. The gypsum embankment will not be seeded and is not expected to have any vegetation.

5. Gypsum Stack piezometers should be inspected for any damage or loss of function. Damaged piezometers must be promptly repaired or replaced since their function is critical to ensuring stability of the gypsum stack.

6. The water level in each Gypsum Stack piezometer must be measured and recorded. If the water level in any piezometer is above the "critical elevation" as discussed in Section **Error! Reference source not found.**, Ameren should be notified, and the **design engineer should be immediately consulted for guidance on an appropriate course of action**.

7. Gypsum Stack LD/LCRS Drains - The change in location or amount of flow discharging from the Leak Detection/Leachate Collection Recovery System (LD/LCRS) should be recorded. If a significant change has occurred, a qualified engineer should be contacted for consultation.

8. Gypsum Stack Ring Drains - The change in location or amount of flow discharging from the Ring Drains should be recorded. If a significant change has occurred, a qualified engineer should be contacted for consultation.

9. Gypsum Stack Fixed Decant – Check the alignment and supports for the pipe. Record the amount of flow discharging from the pipe and any erosion or scour around the discharge point.

10. Gypsum Stack Perimeter Ditch – The perimeter ditch should have a consistent prismatic shape for the entire length. Inspect the perimeter ditch for evidence of erosion, sediment deposition and irregularity in channel geometry, especially in the vicinity of siphon, decant or ring drain outfall structures. If irregularities are noted, repairs should be scheduled and completed.

11. Stop Logs - Check to make sure that the stop logs in the transfer ditch are undamaged, and, if installed, are operating well, and allowing for the free flow of water over them.

12. Transfer Channel - Check for any debris or other obstructions which may block or restrict the free flow of water. Check for any pools or undulation of the floor of the channel.

13. Recycle Pond Decant - Check for any debris or other obstructions around the Recycle Pond decant which may block or restrict the free flow of water. The emergency dewatering valve should be lubricated. If there is no return water in the pipe, the emergency dewatering valve should be exercised. Record the physical and operating conditions of the system.

14. Recycle Pond Drop Inlet Spillways - Check for any debris or other obstructions around the inlet crest and at the bottom of the drop inlet which may block or restrict the free flow of water. Check for the development of any rusty areas on the concrete, and seepage, cracking, breaking, or spalling of the concrete. Check for settlement or cracking of the crest. Check for any debris in the pipes which may restrict the flow of water. Check for any tears or leaks in the HDPE liner covering the concrete.

15. Recycle Pond Rip Rap Basin - Check for any debris or other obstructions in the riprap basin which may block or restrict the free flow of water. Check to make sure that the rip rap is remaining in a uniform position. Freeze/thaw action or flow over the rip rap may tend to lift or fracture, thus requiring replacement or leveling to maintain the necessary level of protection. NO trees or woody vegetation should be growing through the rip rap.

16. Fences - Check for damage, accumulated debris, operation of gates and locks, and adequacy of locations (this may change with time as people access the area or development occurs in the area).

17. Perimeter - Check the perimeter of the dams for a distance of at least 100 ft beyond the toe for signs of seepage or boils.

18. HDPE Liner – Wherever exposed, the HDPE Liner should be inspected for tears, gouges, protrusions under the liner and abrasion.

ATTACHMENT K

POST-CLOSURE PLAN FOR EXISTING CCR SURFACE IMPOUNDMENT40 C.F.R. § 257.104 and 35 I.A.C. 845.780
REV 0 – 10/30/2021

SITE INFORMATION

Site Name / Address	Duck Creek Power Plant / 17751 North Cilco Road, Canton, IL 62234		
Owner Name / Address	Illinois Power Resources Generating, LLC / 6555 Sierra Drive Irving, Texas 75039		
CCR Unit	Ash Ponds No. 1 & 2	Closure Method and Final Cover Type	Closed In-Place Clayey Soil Cover with Vegetation

POST-CLOSURE PLAN DESCRIPTION

40 C.F.R. § 257.104(c)(1) and 35 I.A.C. 845.780(c)(1) – Length of post-closure care period.	Post-closure care will be conducted for a period of 30 years as required by 40 C.F.R. § 257.104(c)(1) and 35 I.A.C. 845.780(c)(1), except as provided by 40 C.F.R. § 257.104(c)(2) and 35 I.A.C. 845.780(c)(2).
40 C.F.R. § 257.104(c)(2) and 35 I.A.C. 845.780(c)(2) – Circumstances extending the post closure care period.	If at the end of the post-closure care period the CCR unit is operating under assessment monitoring in accordance with §257.95, the post-closure care as described in this plan will returning to detection monitoring in accordance with §257.95. Under 35 I.A.C. 845.780(c)(2), the post-closure care period will be extended until groundwater monitoring data demonstrate that concentrations are below the groundwater protection standards in Section 845.600 and are not increasing for those constituents over background, using the statistical procedures and performance standards in Section 845.640(f) and (g), provided that concentrations have been reduced to the maximum extent feasible and concentrations are protective of human health and the environment.
40 C.F.R. § 257.104(d)(1)(i) and 35 I.A.C. 845.780(d)(1)(A) – A description of the monitoring and maintenance activities required in 40 C.F.R. § 257.104(b) and 35 I.A.C. 845.780(b), and the frequency at which these activities will be performed, to maintain the integrity and effectiveness of the final cover system, maintain the groundwater monitoring system and monitor the groundwater.	Pursuant to § 257.104(b)(1) and 35 I.A.C. 845.780(b)(1), throughout the post-closure care period, periodic visual observations of the final cover system and stormwater management system will be performed at least annually for evidence of settlement, subsidence, erosion, or other damage that may adversely affect the integrity and effectiveness of the final cover system. When practical, visual observations of the final cover will be made concurrent with groundwater monitoring activities. Noted evidence of damage, such as rills, surface cracks and settlement, will be repaired to maintain the integrity and effectiveness of the final cover system. Vegetation will be established and maintained on the final cover system, including storm drainage areas, where appropriate, to provide long-term erosion control. Established vegetation and the slope design of the final cover system will prevent potential erosion and damage that may be caused by run-on and run-off. Repair activities may include, but are not limited to, replacing and compacting soil cover, repairing drainage channels that have been eroded, filling in depressions with soil, regrading, and reseeding areas of failed vegetation, as necessary.

	Pursuant to § 257.104(b)(3) and 35 I.A.C. 845.780(b)(3), the groundwater monitoring system will be maintained, and groundwater will be monitored as required by 40 C.F.R. § 257.90 through 40 C.F.R. § 257.98 and 35 I.A.C. 845.600 through 845.680. Monitoring wells will be inspected during each groundwater sampling event. Monitoring wells and associated instrumentation will be maintained so that they perform to the design specifications throughout the life of the monitoring program. Groundwater monitoring frequency will be at least quarterly, except as provided in 40 C.F.R. § 257.94(d), 257.94(c), and 35 I.A.C. 845.650(b)(4).
40 C.F.R. § 257.104(d)(1)(ii) and 35 I.A.C. 845.780(d)(1)(B) – The name, address, telephone number and email address of the person or office to contact about the facility during the post-closure care period.	Illinois Power Resources Generating, LLC 6555 Sierra Drive Irving, Texas 75039 800.633.4704 ccr@dynegy.com
40 C.F.R. § 257.104(d)(1)(iii) and 35 I.A.C. 845.780(d)(1)(C) – A description of the planned uses of the property during the post-closure period.	The CCR unit is located at a retired electric generation facility. Planned uses of the property during the post-closure period are currently unknown, except for post-closure care of the CCR unit. Post-closure use of the property will not disturb the integrity of the final cover system or other components of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements of 40 C.F.R. Part § 257, Subpart D and 35 I.A.C. Part 845. Any other disturbance will be conducted following a demonstration that it will not increase the potential threat to human health or the environment, as required by 40 C.F.R. § 257.104(d)(1)(iii) and 35and 35 I.A.C. 845.780 (d)(1)(C). The demonstration will be certified by a qualified professional engineer and submitted to the Illinois Environmental Protection Agency (IEPA). Per 40 C.F.R. § 257.104(d)(1)(iii) notification shall be provided to the State Director that the demonstration has been placed in the operating record and on the owners or operator's publicly accessible internet site. This CCR unit is closed. A notation on the deed to the property, or some other instrument that is normally examined during title search, will be recorded in accordance with 40 C.F.R. § 257.102(i) and 35 I.A.C. 845.760(h). The notation will notify potential purchasers of the property that the land has been used as a CCR unit and its use is restricted under the post- closure care requirements in 40 C.F.R. § 257.104(d)(1)(iii) and 35 I.A.C. 845.780(d)(1)(C) or groundwater monitoring requirements per 35 I.A.C. 845.740(b). Within 30 days of recording the deed notation, a notification stating that the notation has been recorded will be submitted to the IEPA and placed in the facility's operating record per 35 I.A.C. 845.760(h)(3). The notification will be placed on the owner or operator's publicly accessible CCR Web site in accordance with 40 C.F.R. § 257.107(i)(9) and 35 I.A.C. 845.810(e) and placed in the facility's operating record as required by 35 I.A.C. 845.800(d)(26) and §257.105(i)(9).
40 C.F.R. § 257.104(d)(3) and 35 I.A.C. 845.780(d)(3) – Amendments to the initial or subsequent written post-closure plan.	Pursuant to 40 C.F.R. § 257.104(d), the initial post closure care plan for the Duck Creek Ash Ponds No. 1&2 was prepared on October 17, 2016. That plan is being amended pursuant to 40 C.F.R. § 257.104(d)(3)(i). This plan also serves as the initial post-closure care plan, prepared in accordance with 35 I.A.C. 845.780(d). Pursuant to § 257.104(d)(3) and 35 I.A.C. 845.780(d)(3), an operating permit modification application to amend the initial or any subsequent

	written post-closure care plan developed under 35 I.A.C. 845.780 (d)(1) and § 257.104(d)(1) will be submitted to IEPA. The written post-closure care plan will be amended whenever there is a change in the operation of the CCR surface impoundment that would substantially affect the written post-closure care plan in effect; or unanticipated events necessitate a revision of the written post-closure care plan, after post-closure activities have started. The written post-closure care plan will be amended at least 60 days before a planned change in the operation of the facility or CCR surface impoundment, or within 60 days after an unanticipated event requires the need to revise the existing plan. If the plan is revised after post-closure activities have started, a request to modify the operating permit, including an amended written post-closure care plan, will be submitted to the IEPA within 30 days following the triggering event.
40 C.F.R. § 257.104(d)(4) and 35 I.A.C. 845.780(d)(4) – Qualified professional engineering certification.	Certification by a qualified professional engineer will be appended to this plan and any amendment of this plan.
35 I.A.C. 845.780(e) – Termination of post-closure care	Upon completion of the post-closure period, a request to terminate post-closure care will be submitted to the IEPA. The request will include a certification by a qualified professional engineer verifying that post-closure care has been completed in accordance with the post-closure care plan specified in 35 I.A.C. 845.780(d) and the requirements of 35 I.A.C. 845.780.
40 C.F.R. § 257.104(e) and 35 I.A.C. 845.780(f) – Notification of completion of the post-closure care period.	A notification of completion of post-closure care will be prepared and placed in the facility's operating record within 30 days after IEPA approval of the request to terminate post-closure care. The notification will be placed in the facility's operating record in accordance with 35 I.A.C. 845.800(d)(31) and § 257.105(i)(13). The notification will be placed on the owner or operator's publicly accessible CCR Internet site in accordance with the requirements of § 257.107(i)(13) and 35 I.A.C. 845.810(e). The IEPA will be notified when the notification has been placed in the operating record and on the owner or operator's publicly accessible Internet site in accordance with the requirements of § 257.106(i)(13).

Certification Statement 40 C.F.R. § 257.104 (d)(4) and 35 I.A.C. 845.780(d)(4) – Amended/Initial Written Post Closure Plan for a CCR Surface Impoundment

CCR Unit: Illinois Power Resources Generating, LLC; Duck Creek Power Plant; Ash Ponds No.1 & 2

I, John R. Hesemann, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above referenced CCR Unit, that the information contained in the amended/initial written post closure plan, dated October 30, 2021, meets the requirements of 40 C.F.R. § 257.104 and 35 I.A.C. 845.780.

John R. Hesemann

Printed Name

9/28/2021

Date

JOHN ROBERT HESEMANN
062-058523
LICENSED PROFESSIONAL ENGINEER OF
ILLINOIS

J. R. Hesemann
Exp.: 11/30/2021

ATTACHMENT M

HISTORY OF POTENTIAL EXCEEDANCES

This presentation of the History of Potential Exceedances, and any corrective action taken to remediate groundwater, is provided to meet the requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.230(d)(2)(M) for the Duck Creek Power Plant Ash Pond No. 1 and Ash Pond No. 2, Illinois Environmental Protection Agency (IEPA) ID Nos. W0578010001-01 and W0578010001-02.

Note

Groundwater concentrations observed from 2015 to 2021 have been evaluated and summarized in the following table and are considered potential exceedances because the methodology used to determine them is proposed in the Statistical Analysis Plan (Appendix A to Groundwater Monitoring Plan [GMP]), which has not been reviewed or approved by IEPA at the time of submittal of the 35 I.A.C. § 845 Operating Permit application.

As noted in the GMP, background concentrations will be calculated after the first eight sampling events following IEPA approval of the GMP. Consequently, for this presentation of potential exceedances, available data (total or dissolved concentrations in groundwater) have been compared to the standards in 35 I.A.C. § 845.600(a)(1). The results are considered potential exceedances because they were compared directly to the standard and did not include an evaluation of background groundwater quality or apply the statistical methodologies proposed in the GMP. Exceedances will be determined following IEPA approval of the GMP and collection of background data. Further, alternate sources for potential exceedances as allowed by 35 I.A.C. § 845.650(e) have not yet been evaluated. These will be evaluated and presented in future submittals to IEPA as appropriate.

Table 1 summarizes the potential exceedances.

Corrective Action

A Closure and Post-Closure Care Plan for Duck Creek Ash Ponds Nos. 1 and 2 (Closure Plan) was submitted to IEPA in March 2016 and approved on November 23, 2016. The Closure Plan indicated that Ash Ponds Nos. 1 and 2 would be closed in place with a with a final cover system of earthen material. Closure construction was completed on December 22, 2020.

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
HISTORY OF POTENTIAL EXCEEDANCES
DUCK CREEK POWER PLANT
ASH POND NO. 1 AND ASH POND NO. 2
CANTON, ILLINOIS

Location	Sample Date	Boron, dissolved (mg/L)	Chloride, dissolved (mg/L)	pH (field) (SU)	Sulfate, dissolved (mg/L)	Specific Conductance (micromhos/cm)	Temperature (°F)
35 I.A.C. 845.600	Lower	0	0	6.5	0	NA	NA
	Upper	2	200	9.0	400	NA	NA
Class IV Standard		2	SEC	SEC	SEC	NA	NA
OM01	04/17/2015	0.74	22	6.6	**1600**	3390	56.8
OM01	09/14/2015	0.19	21	**6.3**	**1800**	1765	63
OM01	04/26/2016	1.1	31	--	**600**	--	--
OM01	10/25/2016	0.22	22	--	**1500**	--	--
OM01	04/27/2017	0.23	25	--	**2000**	--	--
OM01	10/20/2017	0.44	90	--	**1800**	--	--
OM01	01/31/2018	0.2	28	--	--	--	--
OM01	04/16/2018	0.21	23	--	--	--	--
OM01	07/23/2018	0.19	25	--	--	--	--
OM01	10/22/2018	0.21	30	--	--	--	--
OM01	01/28/2019	0.21	26	--	--	--	--
OM01	04/02/2019	0.49	46	--	--	--	--
OM01	07/05/2019	0.23	29	--	--	--	--
OM01	11/15/2019	0.21	38	--	--	--	--
OM01	01/09/2020	0.21	31	--	--	--	--
OM01	04/15/2020	0.17	27	--	--	--	--
OM01	08/13/2020	0.19	28	--	--	--	--
OM01	11/17/2020	0.94	27	**6.4**	--	3531	55.4
OM01	02/24/2021	0.19	31	6.6	--	3545	51.6
OM01	05/13/2021	0.33	32	7.0	--	3346	59.9
OM01	08/12/2021	0.21	31	**6.3**	--	3343	60.6
OM04S	04/17/2015	1.2	14	6.8	150	1171	56.5
OM04S	09/15/2015	1	13	7.0	160	880	57
OM04S	04/30/2016	0.98	<50	--	220	--	--
OM04S	10/25/2016	0.19	16	--	130	--	--
OM04S	04/28/2017	0.13	18	--	170	--	--
OM04S	10/19/2017	0.063	14	--	140	--	--
OM04S	02/02/2018	0.16	20	--	--	--	--
OM04S	04/16/2018	0.85	15	--	--	--	--
OM04S	07/24/2018	0.16	16	--	--	--	--
OM04S	10/26/2018	0.13	15	--	--	--	--
OM04S	01/28/2019	0.074	16	--	--	--	--
OM04S	04/02/2019	0.14	16	--	--	--	--
OM04S	07/02/2019	0.22	17	--	--	--	--
OM04S	11/15/2019	0.059	15	--	--	--	--
OM04S	01/09/2020	0.094	15	--	--	--	--
OM04S	04/15/2020	0.078	14	--	--	--	--
OM04S	08/13/2020	0.096	14	--	--	--	--
OM04S	11/17/2020	0.047	15	6.7	--	1225	52.7
OM04S	02/23/2021	0.077	18	6.7	--	1156	56.1
OM04S	05/14/2021	0.063	18	7.0	--	1163	61.3
OM04S	08/11/2021	**52**	**630**	6.9	--	1174	56.1
OM07	04/17/2015	1	19	7.0	280	1338	58.5
OM07	09/14/2015	0.43	13	6.9	240	957	64
OM07	04/27/2016	0.39	7.2	--	280	--	--
OM07	10/25/2016	0.37	14	--	270	--	--
OM07	04/27/2017	0.34	14	--	250	--	--
OM07	10/19/2017	0.35	11	--	230	--	--
OM07	02/02/2018	0.43	12	--	--	--	--
OM07	04/16/2018	0.69	13	--	--	--	--
OM07	07/24/2018	0.49	14	--	--	--	--
OM07	10/25/2018	0.53	11	--	--	--	--
OM07	01/28/2019	0.47	10	--	--	--	--
OM07	04/01/2019	0.87	14	--	--	--	--
OM07	07/02/2019	0.67	11	--	--	--	--
OM07	11/15/2019	0.71	11	--	--	--	--
OM07	01/10/2020	0.61	10	--	--	--	--
OM07	04/16/2020	0.47	10	--	--	--	--
OM07	08/17/2020	0.48	9	--	--	--	--
OM07	11/17/2020	0.49	11	7.0	--	1286	53.2
OM07	02/22/2021	1.2	14	7.0	--	1837	50
OM07	05/13/2021	1.2	15	7.0	--	1877	55.8
OM07	08/12/2021	1	13	7.0	--	1174	61.7
OM12	04/17/2015	0.16	6.4	6.6	**480**	1790	55.8
OM12	09/14/2015	0.074	5.4	6.7	400	1669	64
OM12	04/30/2016	0.15	9.9	--	**470**	--	--
OM12	10/31/2016	0.24	7.9	--	**540**	--	--
OM12	04/28/2017	0.14	<10	--	**560**	--	--

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
HISTORY OF POTENTIAL EXCEEDANCES
DUCK CREEK POWER PLANT
ASH POND NO. 1 AND ASH POND NO. 2
CANTON, ILLINOIS

Location	Sample Date	Boron, dissolved (mg/L)	Chloride, dissolved (mg/L)	pH (field) (SU)	Sulfate, dissolved (mg/L)	Specific Conductance (micromhos/cm)	Temperature (°F)
35 I.A.C. 845.600	Lower	0	0	6.5	0	NA	NA
	Upper	2	200	9.0	400	NA	NA
Class IV Standard		2	SEC	SEC	SEC	NA	NA
OM12	10/20/2017	**6.4**	**320**	--	**420**	--	--
OM12	02/01/2018	**8**	83	--	--	--	--
OM12	04/17/2018	0.13	6.5	--	--	--	--
OM12	07/25/2018	**4**	20	--	--	--	--
OM12	10/25/2018	0.17	6.6	--	--	--	--
OM12	02/04/2019	**3.6**	41	--	--	--	--
OM12	04/09/2019	0.18	16	--	--	--	--
OM12	07/08/2019	0.086	5.9	--	--	--	--
OM12	11/14/2019	0.22	5.1	--	--	--	--
OM12	01/09/2020	0.16	6.2	--	--	--	--
OM12	04/14/2020	**12**	5.2	--	--	--	--
OM12	08/17/2020	0.061	3.5	--	--	--	--
OM12	11/17/2020	0.19	6.1	6.6	--	2055	52.9
OM12	02/22/2021	0.22	4	6.7	--	1923	54.7
OM12	05/13/2021	0.13	6	6.8	--	1951	55.2
OM12	08/13/2021	0.11	2.9	6.6	--	1914	55.7
OM21	04/17/2015	**16**	**500**	7.0	**1300**	4010	56.3
OM21	09/15/2015	**15**	**460**	**6.4**	**1300**	1758	56
OM21	04/30/2016	**13**	**510**	--	**1300**	--	--
OM21	10/31/2016	**15**	**470**	--	**1500**	--	--
OM21	04/28/2017	**13**	**450**	--	**1200**	--	--
OM21	10/20/2017	**14**	**360**	--	**1200**	--	--
OM21	02/01/2018	**12**	**390**	--	--	--	--
OM21	04/16/2018	**13**	**460**	--	--	--	--
OM21	07/25/2018	**13**	**360**	--	--	--	--
OM21	10/25/2018	**16**	180	--	--	--	--
OM21	01/28/2019	**12**	**300**	--	--	--	--
OM21	04/01/2019	**14**	**660**	--	--	--	--
OM21	07/02/2019	1	**330**	--	--	--	--
OM21	11/15/2019	**10**	**390**	--	--	--	--
OM21	01/09/2020	**12**	**380**	--	--	--	--
OM21	04/14/2020	0.064	**320**	--	--	--	--
OM21	08/17/2020	**10**	**280**	--	--	--	--
OM21	11/17/2020	**8.3**	**290**	6.7	--	3682	52.9
OM21	02/23/2021	**9.5**	**310**	6.6	--	3503	50
OM21	05/14/2021	**11**	**290**	6.7	--	3763	57.2
OM21	08/11/2021	**11**	33	6.8	--	3572	58.9
OM22D	04/17/2015	**16**	**460**	6.9	**570**	2580	62.2
OM22D	09/28/2015	**16**	**480**	6.9	**540**	1986	60
OM22D	04/26/2016	**17**	**440**	--	**490**	--	--
OM22D	10/31/2016	**21**	**490**	--	**650**	--	--
OM22D	04/27/2017	**19**	**500**	--	**650**	--	--
OM22D	10/20/2017	**20**	**450**	--	**750**	--	--
OM22D	01/31/2018	**18**	**500**	--	--	--	--
OM22D	04/17/2018	**19**	**490**	--	--	--	--
OM22D	07/23/2018	**27**	**550**	--	--	--	--
OM22D	10/22/2018	**13**	**350**	--	--	--	--
OM22D	01/28/2019	0.27	29	--	--	--	--
OM22D	04/02/2019	**43**	**910**	--	--	--	--
OM22D	07/03/2019	**20**	**410**	--	--	--	--
OM22D	11/14/2019	**25**	**570**	--	--	--	--
OM22D	01/08/2020	**44**	**660**	--	--	--	--
OM22D	04/15/2020	**36**	**720**	--	--	--	--
OM22D	08/17/2020	**25**	**450**	--	--	--	--
OM22D	11/18/2020	**33**	**680**	6.7	--	3481	53.4
OM22D	02/24/2021	**50**	**1000**	6.8	--	4461	53.4
OM22D	05/14/2021	**51**	**1000**	6.7	--	4300	63.7
OM22D	08/13/2021	**48**	**710**	**5.7**	--	3610	56.7
OM23D	04/17/2015	**2.3**	37	6.8	**520**	1668	63.3
OM23D	09/28/2015	**22**	**560**	6.9	**720**	1545	61
OM23D	04/26/2016	**12**	**250**	--	**550**	--	--
OM23D	10/31/2016	**22**	**550**	--	**760**	--	--
OM23D	04/27/2017	**19**	**460**	--	**770**	--	--
OM23D	10/20/2017	**19**	**430**	--	**780**	--	--
OM23D	01/31/2018	**21**	**580**	--	--	--	--
OM23D	04/17/2018	**2.2**	37	--	--	--	--
OM23D	07/23/2018	**29**	**580**	--	--	--	--
OM23D	10/22/2018	1	51	--	--	--	--

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
HISTORY OF POTENTIAL EXCEEDANCES
DUCK CREEK POWER PLANT
ASH POND NO. 1 AND ASH POND NO. 2
CANTON, ILLINOIS

Location	Sample Date	Boron, dissolved (mg/L)	Chloride, dissolved (mg/L)	pH (field) (SU)	Sulfate, dissolved (mg/L)	Specific Conductance (micromhos/cm)	Temperature (°F)
35 I.A.C. 845.600	Lower	0	0	6.5	0	NA	NA
	Upper	2	200	9.0	400	NA	NA
Class IV Standard		2	SEC	SEC	SEC	NA	NA
OM23D	01/28/2019	**2.2**	190	--	--	--	--
OM23D	04/03/2019	1.9	27	--	--	--	--
OM23D	07/08/2019	**2.6**	29	--	--	--	--
OM23D	11/14/2019	**2.2**	32	--	--	--	--
OM23D	01/08/2020	1.9	28	--	--	--	--
OM23D	04/15/2020	2	26	--	--	--	--
OM23D	08/13/2020	2	26	--	--	--	--
OM23D	11/17/2020	**2.1**	30	6.9	--	1757	54.7
OM23D	02/24/2021	1.9	27	6.9	--	1786	52.5
OM23D	05/13/2021	**2.1**	39	6.9	--	1694	62.4
OM23D	08/13/2021	2	27	**5.8**	--	1697	57.6
OM24D	04/17/2015	**23**	**540**	6.7	**910**	3160	60.4
OM24D	09/28/2015	**20**	**440**	6.7	**770**	2507	61
OM24D	04/26/2016	**20**	**450**	--	**870**	--	--
OM24D	10/31/2016	**20**	**520**	--	**1000**	--	--
OM24D	04/27/2017	**20**	**500**	--	**1000**	--	--
OM24D	10/20/2017	**20**	**400**	--	**780**	--	--
OM24D	01/31/2018	**39**	**960**	--	--	--	--
OM24D	04/17/2018	**28**	**660**	--	--	--	--
OM24D	07/23/2018	**29**	**600**	--	--	--	--
OM24D	10/22/2018	**29**	**660**	--	--	--	--
OM24D	01/28/2019	**12**	**330**	--	--	--	--
OM24D	04/02/2019	**24**	**550**	--	--	--	--
OM24D	07/08/2019	**25**	**450**	--	--	--	--
OM24D	11/14/2019	**27**	**590**	--	--	--	--
OM24D	01/08/2020	**26**	**500**	--	--	--	--
OM24D	04/15/2020	**19**	**350**	--	--	--	--
OM24D	08/13/2020	**19**	**350**	--	--	--	--
OM24D	11/17/2020	**20**	**390**	6.6	--	3028	52.7
OM24D	03/04/2021	**20**	**370**	6.8	--	2897	49.6
OM24D	05/13/2021	**18**	**340**	6.9	--	2614	60.1
OM24D	08/12/2021	**21**	**310**	6.6	--	2643	60.4
OM25S	04/17/2015	**19**	**440**	6.7	**750**	3010	61.3
OM25S	09/28/2015	**22**	**630**	6.7	**770**	2281	60
OM25S	04/26/2016	**20**	**470**	--	**650**	--	--
OM25S	10/31/2016	**25**	**600**	--	**940**	--	--
OM25S	04/27/2017	**23**	**570**	--	**770**	--	--
OM25S	10/20/2017	**17**	**380**	--	**700**	--	--
OM25S	01/31/2018	**29**	**720**	--	--	--	--
OM25S	04/17/2018	**23**	**510**	--	--	--	--
OM25S	07/23/2018	**25**	**490**	--	--	--	--
OM25S	10/22/2018	**2.8**	140	--	--	--	--
OM25S	01/28/2019	**21**	**490**	--	--	--	--
OM25S	04/02/2019	**8.2**	180	--	--	--	--
OM25S	07/03/2019	**21**	**430**	--	--	--	--
OM25S	11/14/2019	**18**	**420**	--	--	--	--
OM25S	01/08/2020	**23**	**520**	--	--	--	--
OM25S	04/15/2020	**24**	**480**	--	--	--	--
OM25S	08/13/2020	**27**	**460**	--	--	--	--
OM25S	11/17/2020	**23**	**530**	6.6	--	3249	54
OM25S	02/24/2021	**30**	**220**	6.5	--	3235	53.6
OM25S	05/13/2021	**41**	**610**	6.8	--	3362	63.9
OM25S	08/12/2021	**33**	**560**	6.5	--	3228	60.3
OR02	04/17/2015	**6.3**	**280**	6.8	340	2710	53.2
OR02	09/14/2015	**4.6**	**230**	6.5	300	1289	66
OR02	04/26/2016	**5**	180	--	240	--	--
OR02	10/31/2016	**5**	**220**	--	270	--	--
OR02	04/27/2017	**3.9**	**210**	--	380	--	--
OR02	10/20/2017	**4.7**	180	--	240	--	--
OR02	02/02/2018	**3.9**	**220**	--	--	--	--
OR02	04/16/2018	**3.1**	43	--	--	--	--
OR02	07/23/2018	**4.1**	**220**	--	--	--	--
OR02	10/22/2018	**4.5**	**230**	--	--	--	--
OR02	01/28/2019	**2.3**	**210**	--	--	--	--
OR02	04/02/2019	**2.6**	**250**	--	--	--	--
OR02	07/05/2019	**4.4**	**210**	--	--	--	--
OR02	11/15/2019	**4.2**	200	--	--	--	--
OR02	01/09/2020	**4**	200	--	--	--	--

RAMBOLL

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
HISTORY OF POTENTIAL EXCEEDANCES
DUCK CREEK POWER PLANT
ASH POND NO. 1 AND ASH POND NO. 2
CANTON, ILLINOIS

Location	Sample Date	Boron, dissolved (mg/L)	Chloride, dissolved (mg/L)	pH (field) (SU)	Sulfate, dissolved (mg/L)	Specific Conductance (micromhos/cm)	Temperature (°F)
35 I.A.C. 845.600	Lower	0	0	6.5	0	NA	NA
	Upper	2	200	9.0	400	NA	NA
Class IV Standard		2	SEC	SEC	SEC	NA	NA
OR02	04/15/2020	**4**	**210**	--	--	--	--
OR02	08/13/2020	**3.9**	**210**	--	--	--	--
OR02	11/17/2020	**4.9**	**210**	6.8	--	1942	54.5
OR02	02/24/2021	**4.1**	4.1	6.7	--	2009	54.5
OR02	05/13/2021	**3.8**	**240**	7.0	--	1987	57.6
OR02	08/12/2021	**5.3**	**220**	6.6	--	1884	59.4
OR03D	04/17/2015	**3.1**	82	6.9	390	1653	59
OR03D	09/14/2015	**5**	150	6.6	350	1617	63
OR03D	04/26/2016	**2.5**	78	--	330	--	--
OR03D	10/31/2016	**2.7**	79	--	390	--	--
OR03D	04/27/2017	**2.5**	77	--	380	--	--
OR03D	10/20/2017	**2.1**	88	--	**420**	--	--
OR03D	02/02/2018	**2.1**	73	--	--	--	--
OR03D	04/16/2018	**2.6**	67	--	--	--	--
OR03D	07/23/2018	**2.6**	74	--	--	--	--
OR03D	10/25/2018	**2.5**	65	--	--	--	--
OR03D	01/28/2019	0.47	20	--	--	--	--
OR03D	04/03/2019	2	65	--	--	--	--
OR03D	07/05/2019	**5.9**	**230**	--	--	--	--
OR03D	11/15/2019	**5.9**	**240**	--	--	--	--
OR03D	01/10/2020	**14**	**560**	--	--	--	--
OR03D	04/14/2020	**34**	**890**	--	--	--	--
OR03D	08/13/2020	**28**	**660**	--	--	--	--
OR03D	11/17/2020	**27**	**600**	6.6	--	2915	49.1
OR03D	02/25/2021	**49**	**1100**	6.5	--	4745	54.5
OR03D	05/14/2021	**45**	**1200**	6.8	--	4855	64.4
OR03D	08/13/2021	**48**	**1100**	6.6	--	4541	58.5
OR04D	04/17/2015	**18**	**210**	8.7	**610**	1474	57
OR04D	09/15/2015	**11**	130	**6.4**	**690**	1280	56
OR04D	04/30/2016	**9.6**	**250**	--	**1400**	--	--
OR04D	10/25/2016	**8.6**	100	--	**540**	--	--
OR04D	04/28/2017	**7.5**	98	--	**460**	--	--
OR04D	10/19/2017	**5.6**	76	--	400	--	--
OR04D	02/02/2018	**7.6**	86	--	--	--	--
OR04D	04/16/2018	**11**	120	--	--	--	--
OR04D	07/24/2018	**7.2**	72	--	--	--	--
OR04D	10/26/2018	**9.5**	99	--	--	--	--
OR04D	01/28/2019	**26**	**310**	--	--	--	--
OR04D	04/02/2019	**36**	**500**	--	--	--	--
OR04D	07/02/2019	**50**	**330**	--	--	--	--
OR04D	11/15/2019	**54**	**670**	--	--	--	--
OR04D	01/09/2020	**47**	**560**	--	--	--	--
OR04D	04/15/2020	**30**	**360**	--	--	--	--
OR04D	08/13/2020	**44**	**490**	--	--	--	--
OR04D	11/17/2020	**87**	**840**	6.6	--	4647	54.9
OR04D	02/25/2021	**88**	**990**	6.8	--	5114	56.1
OR04D	05/14/2021	**44**	**620**	7.0	--	3876	63.7
OR04D	08/11/2021	0.089	16	6.8	--	4215	58
OR06A	04/17/2015	1.5	32	6.8	380	1488	60.8
OR06A	09/14/2015	1.4	31	6.8	320	900	65
OR06A	04/27/2016	1.1	31	--	340	--	--
OR06A	10/25/2016	1.3	32	--	320	--	--
OR06A	04/27/2017	1.2	33	--	310	--	--
OR06A	10/19/2017	1.1	31	--	270	--	--
OR06A	02/02/2018	1.2	35	--	--	--	--
OR06A	04/17/2018	1	33	--	--	--	--
OR06A	07/24/2018	1.3	34	--	--	--	--
OR06A	10/25/2018	1.3	34	--	--	--	--
OR06A	01/28/2019	0.72	16	--	--	--	--
OR06A	04/09/2019	0.74	15	--	--	--	--
OR06A	07/03/2019	0.64	15	--	--	--	--
OR06A	11/15/2019	1.6	33	--	--	--	--
OR06A	01/10/2020	0.72	15	--	--	--	--
OR06A	04/16/2020	0.55	12	--	--	--	--
OR06A	03/04/2021	0.82	30	6.8	--	1524	54.1
OR06A	05/14/2021	0.98	65	7.2	--	1555	62.1
OR06A	08/12/2021	**17**	**210**	6.7	--	1919	62.2
OR11	04/17/2015	**4.1**	27	7.2	140	880	62.2

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DUCK CREEK POWER PLANT
ASH POND NO. 1 AND ASH POND NO. 2
CANTON, ILLINOIS

Location	Sample Date	Boron, dissolved (mg/L)	Chloride, dissolved (mg/L)	pH (field) (SU)	Sulfate, dissolved (mg/L)	Specific Conductance (micromhos/cm)	Temperature (°F)
35 I.A.C. 845.600	Lower	0	0	6.5	0	NA	NA
	Upper	2	200	9.0	400	NA	NA
Class IV Standard		2	SEC	SEC	SEC	NA	NA
OR11	09/14/2015	**5.8**	46	7.1	140	916	62
OR11	04/30/2016	**3.4**	27	--	140	--	--
OR11	10/31/2016	**3.9**	30	--	200	--	--
OR11	04/28/2017	**4**	26	--	160	--	--
OR11	10/20/2017	0.19	17	--	360	--	--
OR11	02/01/2018	0.34	6	--	--	--	--
OR11	04/17/2018	**5.6**	53	--	--	--	--
OR11	07/25/2018	0.087	5.5	--	--	--	--
OR11	10/25/2018	**5.8**	39	--	--	--	--
OR11	02/04/2019	0.12	57	--	--	--	--
OR11	04/09/2019	**2.8**	13	--	--	--	--
OR11	07/05/2019	**5.4**	28	--	--	--	--
OR11	11/14/2019	**6.3**	48	--	--	--	--
OR11	01/09/2020	**7.6**	44	--	--	--	--
OR11	04/14/2020	**4.7**	33	--	--	--	--
OR11	08/17/2020	**6.6**	39	--	--	--	--
OR11	11/17/2020	**7.3**	59	7.1	--	1132	53.2
OR11	02/22/2021	**8.4**	74	7.1	--	1147	50.7
OR11	05/14/2021	**5.1**	58	7.1	--	793	55.6
OR11	08/12/2021	**6.3**	39	7.2	--	916	58.3
OR13S	04/17/2015	**4.6**	120	7.0	290	1778	60.3
OR13S	09/14/2015	**9**	170	7.0	290	1800	62
OR13S	04/27/2016	**3.6**	120	--	270	--	--
OR13S	10/25/2016	**3.9**	110	--	260	--	--
OR13S	04/28/2017	**4**	130	--	320	--	--
OR13S	10/19/2017	**3.5**	110	--	250	--	--
OR13S	02/01/2018	**3.9**	120	--	--	--	--
OR13S	04/17/2018	**3.4**	91	--	--	--	--
OR13S	07/24/2018	**2.4**	40	--	--	--	--
OR13S	10/25/2018	**2.4**	110	--	--	--	--
OR13S	01/28/2019	**4.1**	110	--	--	--	--
OR13S	04/01/2019	**3.7**	89	--	--	--	--
OR13S	07/02/2019	**4.1**	120	--	--	--	--
OR13S	11/15/2019	**4.4**	140	--	--	--	--
OR13S	01/10/2020	**4.5**	140	--	--	--	--
OR13S	04/15/2020	**4**	130	--	--	--	--
OR13S	08/17/2020	**3.7**	140	--	--	--	--
OR13S	11/17/2020	**3.9**	140	6.9	--	2024	54.9
OR13S	02/23/2021	**4.1**	150	6.8	--	2113	54
OR13S	05/14/2021	**4.5**	140	6.9	--	2358	54.7
OR13S	08/11/2021	**4.2**	130	7.0	--	2032	58
OR13D	04/17/2015	**3**	41	7.3	330	1597	59
OR13D	09/14/2015	**2.3**	34	7.3	290	1460	63
OR13D	04/27/2016	**3.2**	48	--	330	--	--
OR13D	10/25/2016	**2.5**	37	--	330	--	--
OR13D	04/28/2017	**2.4**	37	--	310	--	--
OR13D	10/19/2017	1.9	32	--	300	--	--
OR13D	02/01/2018	**2.3**	40	--	--	--	--
OR13D	04/17/2018	2	35	--	--	--	--
OR13D	07/24/2018	**3.8**	99	--	--	--	--
OR13D	10/25/2018	**4.4**	36	--	--	--	--
OR13D	01/28/2019	**2.1**	35	--	--	--	--
OR13D	04/01/2019	**2.2**	42	--	--	--	--
OR13D	07/02/2019	**2.3**	34	--	--	--	--
OR13D	11/15/2019	**2.3**	39	--	--	--	--
OR13D	01/10/2020	**2.1**	43	--	--	--	--
OR13D	04/16/2020	2	37	--	--	--	--
OR13D	08/17/2020	1.9	38	--	--	--	--
OR13D	11/17/2020	1.8	40	7.0	--	1882	54.1
OR13D	02/23/2021	1.9	45	6.9	--	1878	54.5
OR13D	05/13/2021	2	63	7.0	--	1896	59.3
OR13D	08/11/2021	2	40	7.1	--	1907	58.4
OR14D	04/17/2015	**7.1**	<100	7.3	**690**	1631	57.4
OR14D	09/15/2015	**6.3**	92	6.6	**650**	1237	60
OR14D	04/27/2016	**5.9**	100	--	**690**	--	--
OR14D	10/25/2016	**5.6**	61	--	**920**	--	--
OR14D	04/28/2017	**5.3**	89	--	**570**	--	--
OR14D	10/20/2017	**4.6**	79	--	**680**	--	--

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
HISTORY OF POTENTIAL EXCEEDANCES
DUCK CREEK POWER PLANT
ASH POND NO. 1 AND ASH POND NO. 2
CANTON, ILLINOIS

Location	Sample Date	Boron, dissolved (mg/L)	Chloride, dissolved (mg/L)	pH (field) (SU)	Sulfate, dissolved (mg/L)	Specific Conductance (micromhos/cm)	Temperature (°F)
35 I.A.C. 845.600	Lower	0	0	6.5	0	NA	NA
	Upper	2	200	9.0	400	NA	NA
Class IV Standard		2	SEC	SEC	SEC	NA	NA
OR14D	02/01/2018	**5.3**	92	--	--	--	--
OR14D	04/16/2018	**4.7**	88	--	--	--	--
OR14D	07/25/2018	**5.4**	90	--	--	--	--
OR14D	10/26/2018	**4.1**	72	--	--	--	--
OR14D	01/28/2019	**5.7**	63	--	--	--	--
OR14D	04/01/2019	**5.9**	70	--	--	--	--
OR14D	07/02/2019	**6.2**	68	--	--	--	--
OR14D	11/15/2019	**4.2**	36	--	--	--	--
OR14D	01/10/2020	**4.2**	40	--	--	--	--
OR14D	04/16/2020	**3.9**	37	--	--	--	--
OR14D	08/17/2020	**3.2**	38	--	--	--	--
OR14D	11/17/2020	**3.3**	34	6.9	--	1918	54.9
OR14D	02/23/2021	**21**	**550**	6.7	--	3425	61.2
OR14D	05/14/2021	**17**	**420**	6.8	--	3115	59.1
OR14D	08/12/2021	**18**	**290**	6.6	--	2648	60.1
OR19	04/17/2015	**20**	**240**	6.8	**990**	2870	63.1
OR19	09/14/2015	**14**	130	6.7	**730**	1939	63
OR19	04/30/2016	**12**	150	--	**750**	--	--
OR19	10/31/2016	**14**	150	--	**990**	--	--
OR19	04/28/2017	**15**	170	--	**740**	--	--
OR19	10/20/2017	**13**	**290**	--	**840**	--	--
OR19	02/01/2018	**13**	170	--	--	--	--
OR19	04/17/2018	**13**	140	--	--	--	--
OR19	07/25/2018	**15**	140	--	--	--	--
OR19	10/26/2018	**11**	**340**	--	--	--	--
OR19	02/04/2019	**19**	**260**	--	--	--	--
OR19	04/09/2019	**15**	160	--	--	--	--
OR19	07/08/2019	**13**	100	--	--	--	--
OR19	11/14/2019	**13**	160	--	--	--	--
OR19	01/09/2020	**15**	170	--	--	--	--
OR19	04/14/2020	**12**	130	--	--	--	--
OR19	08/17/2020	**13**	120	--	--	--	--
OR19	11/17/2020	**13**	140	6.6	--	2659	52.9
OR19	02/22/2021	**19**	200	6.8	--	2845	54
OR19	05/13/2021	**14**	180	6.8	--	2605	61.1
OR19	08/12/2021	**16**	140	6.7	--	2551	56.4
OR20	04/17/2015	**74**	**740**	6.9	**620**	3520	60.1
OR20	09/14/2015	**65**	**730**	6.9	**550**	2231	63
OR20	04/30/2016	**55**	**760**	--	**570**	--	--
OR20	10/31/2016	**36**	**770**	--	**720**	--	--
OR20	04/28/2017	**76**	**780**	--	**570**	--	--
OR20	10/20/2017	**66**	**640**	--	**490**	--	--
OR20	02/01/2018	**72**	**910**	--	--	--	--
OR20	04/17/2018	**86**	**790**	--	--	--	--
OR20	07/25/2018	**57**	**590**	--	--	--	--
OR20	10/25/2018	**70**	**590**	--	--	--	--
OR20	02/04/2019	**57**	95	--	--	--	--
OR20	04/09/2019	**56**	**620**	--	--	--	--
OR20	07/05/2019	**65**	**590**	--	--	--	--
OR20	11/14/2019	**51**	**550**	--	--	--	--
OR20	01/09/2020	**56**	**560**	--	--	--	--
OR20	04/14/2020	**47**	**550**	--	--	--	--
OR20	08/17/2020	**46**	**530**	--	--	--	--
OR20	11/17/2020	**38**	**480**	6.9	--	2943	54.1
OR20	02/22/2021	**42**	**530**	6.9	--	2978	52.3
OR20	05/14/2021	**40**	**460**	7.0	--	2795	58.3
OR20	08/12/2021	**46**	**440**	7.0	--	2737	56.5

RAMBOLL

TABLE 1. DETERMINATION OF POTENTIAL EXCEEDANCES
HISTORY OF POTENTIAL EXCEEDANCES
DUCK CREEK POWER PLANT
ASH POND NO. 1 AND ASH POND NO. 2
CANTON, ILLINOIS

Location	Sample Date	Boron, dissolved (mg/L)	Chloride, dissolved (mg/L)	pH (field) (SU)	Sulfate, dissolved (mg/L)	Specific Conductance (micromhos/cm)	Temperature (°F)
35 I.A.C. 845.600	Lower	0	0	6.5	0	NA	NA
	Upper	2	200	9.0	400	NA	NA
Class IV Standard		2	SEC	SEC	SEC	NA	NA

Notes:

1. AP1 and AP2 are located within a previously mined area and monitoring has demonstrated that the groundwater is not capable of consistently meeting the standards for Class I - Potable Resource Groundwater (35 I.A.C. § 620.410) or Class II - General Resource Groundwater (35 I.A.C. § 620.420). Therefore, the applicable classification of groundwater at AP1 and AP2 is Class IV - Other Groundwater (35 I.A.C. § 620.420(g))

2. Potential Exceedances presented on this table were determined by comparing dissolved or total concentration results directly to 35 I.A.C. § 845.600 Groundwater Protection Standards (GWPS). The results are considered potential exceedances because concentrations were compared directly to the standard, background data are not available which did not allow for the application of statistical methodologies in accordance with 35 I.A.C 845.640, and potential alternative sources have not been presented. Following Illinois Environmental Protection Agency approval, exceedances will be determined in accordance with the Addendum to the Groundwater Monitoring Plan Ash Pond No. 1 and Ash Pond No. 2 (Ramboll, 2021) included in the Operating Permit to which this history of potential exceedances is attached.

Detected at concentration greater than the GWPS and applicable Class IV Standard.
Detected at concentration greater than the 845.600 GWPS
-- = data not available
< = concentration is less than the concentration shown, which corresponds to the reporting limit for the method. Estimated concentrations below the reporting limit and associated qualifiers are not provided since they are not utilized in statistics to determine exceedances above Part 845 standards.
°F = degrees Fahrenheit
35 I.A.C. 845.600 = Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845
Class IV Standard = Groundwater Quality: Title 35 of the Illinois Administrative Code § 620.440
cm = centimeter
mg/L = milligrams per liter
NA = no standard applicable
SEC = Standard is the existing concentrations
SU = standard units

ATTACHMENT N

Certification of Financial Assurance Requirements

On June 17, 2021, Illinois Power Resources Generating, LLC provided financial assurance in the form of performance bonds to the Illinois Environmental Protection Agency in the amount of $20,670,871 for Ash Pond 1, Ash Pond 2, the Bottom Ash Basin, and the GMF Pond at the Duck Creek Power Plant.[1]

I, Matthew A. Goering, Senior Vice President of Illinois Power Resources Generating, LLC, do hereby certify to the best of my knowledge for the above referenced CCR Units that the financial assurance instruments satisfy the requirements of 35 I.A.C. Part 845, Subpart I.

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Matthew A. Goering
Senior Vice President
Illinois Power Resources Generating, LLC

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[1] In the operating permit applications, the Ash Pond 1 is referred to as the Ash Pond No. 1, and the Ash Pond 2 is referred to as the Ash Pond No. 2.

October 2021