OVEC IKEC

OHIO VALLEY ELECTRIC CORPORATION
INDIANA-KENTUCKY ELECTRIC CORPORATION
3932 U. S. Route 23
P. O. Box 468
Piketon, Ohio 45661
740-289-7200

WRITER'S DIRECT DIAL NO:
740-289-7299

November 30, 2020

Submitted Electronically via Email

Mr. Andrew R. Wheeler, EPA Administrator
Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Mail Code 5304-P
Washington, DC 20460

Re: Ohio Valley Electric Corporation
Kyger Creek Power Station Alternative Closure Demonstration
Revision 2

Dear Administrator Wheeler:

The Ohio Valley Electric Corporation (OVEC) hereby submits an amended request to the U.S. Environmental Protection Agency (EPA) for approval for a site-specific alternative deadline to initiate closure pursuant to 40 C.F.R. § 257.103(f)(1) for the two CCR surface impoundments (South Fly Ash Pond and Boiler Slag Pond) located at the Kyger Creek Power Station near Cheshire, Ohio. OVEC is requesting an extension pursuant to 40 C.F.R. § 257.103(f)(1) to allow the impoundments to continue to receive CCR and non-CCR waste streams after April 11, 2021, in order to retrofit the facility operations sequentially and in a holistic manner to comply with both CCR regulatory requirements as well as new Steam Electric Effluent Limitation Guidelines (ELG) requirements at 40 CFR 423 (final rule published October 13, 2020), applicable to the ash transport water used to sluice boiler slag to the Boiler Slag Pond and fly ash to the South Fly Ash Pond.

Our original submittal was filed electronically on October 15, 2020, and the first amendment was filed on November 11, 2020. This second revision to our demonstration package includes additional descriptions, clarifications and details we shared with USEPA staff during an October 29, 2020, conference call reviewing our initial demonstration submittal, as well as additional data and details addressing feedback received from USEPA following submittal of our first amendment.

In addition to securing applicable environmental permits for construction and system modifications, the South Fly Ash Pond (SFAP) and the Boiler Slag Pond (BSP) modifications include the following activities:

- Installation of a new dry fly ash silo and ancillary dry fly ash handling equipment,
- Construction of a new concrete settling tank to receive the boiler slag material,

- Rerouting boiler slag and mill reject sluice flows to the new concrete settling tank and establishing a high recycle rate system compliant with new ELG requirements,

  Construction of a new lined low volume wastewater treatment system (LVWTS) within a portion of the unlined BSP footprint for treatment of non-CCR wastewater currently treated in the unlined SFAP, and
- Rerouting of all plant non-CCR wastewater flows currently discharging into the SFAP to the new LVWTS.

OVEC can initiate closure of the balance of the BSP once boiler slag sluice flows are routed to the new concrete settling tank but cannot initiate closure of the SFAP until all the above tasks are complete.

Enclosed is a demonstration prepared by Burns & McDonnell that addresses all of the criteria in 40 C.F.R. § 257.103(f)(1)(i)-(iii) and contains the documentation required by 40 C.F.R. § 257.103(f)(1)(iv). As allowed by the agency, in lieu of hard copies of these documents, electronic files were submitted to Kirsten Hillyer, Frank Behan, and Richard Huggins via email.

If you have any questions regarding this submittal, please contact either myself at (740) 289-7299 or mbrown@ovec.com or Gabriel Coriell at (740) 289-7267 or gcoriell@ovec.com.

Sincerely,

J. Michael Brown

J. Michael Brown
Environmental, Safety & Health Director
Ohio Valley Electric Corporation/
Indiana-Kentucky Electric Corporation

JMB:klr

Attachments

cc: Kirsten Hillyer - USEPA
Frank Behan - USEPA
Richard Huggins - USEPA

Kyger Creek Station
CCR Surface Impoundment Demonstration for a Site-Specific Alternative to Initiation of Closure Deadline

Ohio Valley Electric Corporation
Kyger Creek Station
Coal Combustion Residual Rule Compliance

Revision 2
November 30, 2020

Kyger Creek Station CCR Surface Impoundment Demonstration for a Site-Specific Alternative to Initiation of Closure Deadline

Prepared for

Ohio Valley Electric Corporation
Kyger Creek Station
Coal Combustion Residual Rule Compliance
Cheshire, Ohio

Revision 2
November 30, 2020

Prepared by

Burns & McDonnell Engineering Company, Inc.
Kansas City, Missouri

INDEX AND CERTIFICATION

Ohio Valley Electric Corporation
Kyger Creek Station
CCR Surface Impoundment Demonstration for a Site-Specific Alternative to Initiation of Closure Deadline

Report Index

Certification

I hereby certify, as a Professional Engineer in the State of Ohio, that the information in this document was assembled under my direct supervisory control. This report is not intended or represented to be suitable for reuse by the Ohio Valley Electric Corporation or others without specific verification or adaptation by the Engineer.

STATE OF OHIO
MICHAEL
ROUSH
PE.84766
REGISTERED
PROFESSIONAL ENGINEER

Michael Roush, P.E. (OH # 84766)

Date: November 30, 2020

TABLE OF CONTENTS

Page No.

LIST OF TABLES

Page No.

LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
ACM	Assessment of Corrective Measures
ASD	Alternate Source Demonstration
BMcD	Burns & McDonnell
BSHS	Boiler Slag Handling System
BSP	Boiler Slag Pond
CCR	Coal Combustion Residual(s)
CCR Rule	Coal Combustion Residuals Rule
CFR	Code of Federal Regulations
CY	Cubic yards
ELGs	Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category
EPA	Environmental Protection Agency
EPC	Engineer-Procure-Construct
FEED	Front-End Engineering Design
FGD	Flue Gas Desulfurization
GPM	Gallons Per Minute
GWPS	Groundwater Protection Standards
Kyger Creek	Kyger Creek Station
LVWTS	Low Volume Wastewater Treatment System
MGD	Million gallons per day
MW	Megawatt
NPDES	National Pollutant Discharge Elimination System

Abbreviation	**Term/Phrase/Name**
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
OVEC	Ohio Valley Electric Corporation (Owner)
PDC	Power Distribution Center
PDR	Project Definition Report
PSD	Prevention of Significant Deterioration
POTW	Publicly Owned Treatment Works
RCRA	Resource Conservation and Recovery Act
SFAP	South Fly Ash Pond
SSI(s)	Statistically Significant Increase(s)
SSL(s)	Statistically Significant Level(s)
TDS	Total Dissolved Solids
U.S.C.	United States Code

EXECUTIVE SUMMARY

The Ohio Valley Electric Corporation (OVEC) is submitting this Demonstration to the U.S. Environmental Protection Agency (EPA) in order to obtain approval of an alternative site-specific date to initiate closure of the two CCR surface impoundments located at OVEC's Kyger Creek Station in Cheshire, Ohio. Specifically, OVEC requests that EPA establish the alternative deadline of October 17, 2022, for the Kyger Creek Station to cease all waste flows to the Boiler Slag Pond (BSP) and initiate closure of this coal combustion residual (CCR) unit. In addition, OVEC requests approval of an alternative deadline of September 22, 2023, to cease all waste flows and initiate closure of the South Fly Ash Pond (SFAP, which is an eligible unlined CCR surface impoundment). The BSP has an approximate surface area of 30 acres and receives boiler slag sluice flows from Units 1-5 at Kyger Creek Station. The SFAP has an approximate surface area of 68 acres and receives fly ash sluice flows from Units 1-5, as well as all of the non-CCR wastestreams generated from the operation of the plant. The alternative deadline for the SFAP will follow the BSP to allow for the redirection of non-CCR wastewater flow from the SFAP to a new lined low volume wastewater treatment system (LVWTS) to be constructed concurrent with the closure activities of the BSP. Closure of the SFAP will then be initiated once all non-CCR wastewater streams are rerouted and dry fly ash conversion has been completed as required by the Steam Electric Effluent Limitation Guidelines (ELGs) at 40 CFR 423 (80 Fed. Reg. 67838, November 3, 2015).

Prior to the release of the final CCR Rule, OVEC hired Arcadis U.S., Inc., to prepare 30% design drawings for closure of the SFAP. This initial work included identifying options for handling both CCR and non-CCR wastestreams at the Kyger Creek Station took into consideration not only the evolving requirements of the CCR Rule, but also the newly revised ELGs. OVEC began evaluating ELG compliance technology options and CCR handling options in October of 2018 with the assistance of Burns & McDonnell (BMcD). BMcD reviewed the potential feasibility of boiler slag and fly ash handling technologies at the site and identified preferred technologies for further review, which included a remote submerged chain conveyor and concrete settling tank for boiler slag, as well as a traditional single silo vacuum system with two potential arrangements for fly ash. In 2019, OVEC hired BMcD to prepare specification packages and solicit bids for the proposed dry fly ash handling system. In 2020, OVEC hired BMcD to prepare a project definition report (PDR), which covered the scope to install concrete settling tanks and develop a new low-volume wastewater treatment system within the footprint of the existing BSP.

The following primary remaining activities have been identified that must be completed before OVEC can cease all CCR and non-CCR wastestreams to the CCR surface impoundments at Kyger Creek Station:

- Secure applicable environmental permits from the Ohio Environmental Protection Agency (OEPA) and the Ohio Department of Natural Resources (ODNR)
- Install a new dry fly ash silo and ancillary dry fly ash handling equipment
- Construct new concrete settling tanks within the BSP footprint for boiler slag material
- Reroute boiler slag and mill reject sluice flows to the new concrete settling tanks and establish a high recycle rate system
- Construct a new LVWTS within the BSP footprint for treatment of non-CCR wastewater currently treated in the SFAP
- Reroute all plant non-CCR wastewater flows currently discharging into the SFAP to the new LVWTS

OVEC will initiate closure of the BSP once boiler slag sluice flows are routed to the new concrete settling tank but cannot initiate closure of the SFAP until all the above tasks are complete. Alternative offsite disposal capacity is not available for wastestreams currently entering the CCR surface impoundments. As acknowledged previously by EPA, it is not feasible to transport wet CCR to an offsite location and it is also not feasible to transport the large volume of non-CCR wastestreams offsite for disposal. Alternative onsite disposal capacity is not currently available and cannot be made available prior to April 11, 2021. In addition, as a result of the extensive existing power production infrastructure on the site, as well as numerous environmental and site-specific physical constraints such as public roadways, floodplains, streams and wetlands near the plant proper, the Kyger Creek Station lacks an alternative suitable location at the plant site for construction of the LVWTS needed to treat the non-CCR wastestreams, which are currently routed to the SFAP. The other existing impoundments onsite are not large enough to treat all the non-CCR wastestreams without continued use of the CCR surface impoundments. Thus, OVEC determined the best and most feasible location to construct a new LVWTS is within a portion of the footprint of the existing BSP.

Pre-construction activities, which include geotechnical investigation, survey, design, permitting, development of a commercial contract, and procurement of equipment, are underway. Construction of the concrete settling tank is scheduled to commence in Spring of 2021, pending receipt of state-approved permits. Once the concrete settling tanks are installed, the Station can initiate final closure of the BSP and concurrently construct the LVWTS. Once the LVWTS is complete, the new dry fly ash system is installed and operational, and the residual non-CCR wastewater discharging into the SFAP is redirected to the LVWTS, closure of the SFAP may begin. Based on the construction schedule set forth in this

Demonstration, OVEC estimates the LVWTS will be complete and all CCR and non-CCR wastestreams will be redirected to the LVWTS and will cease flowing to the SFAP by September 22, 2023.

As certified herein, the CCR surface impoundments are compliant with all the requirements of the CCR Rule and will remain in compliance until closure of the CCR surface impoundments and any necessary post-closure monitoring efforts are completed. Regular compliance activities, including required groundwater monitoring, are continuing. The SFAP, as well as the BSP, is currently in assessment monitoring. Groundwater monitoring wells at the SFAP have not exhibited any statistically significant levels (SSLs) for Appendix IV parameters, and as a result, the unit will continue in assessment monitoring. An assessment of corrective measures has been completed for the BSP and a selection of remedy is currently underway since an SSL was observed and a definitive alternative source could not be identified. All required documents have been placed into the facility's Operating Record and posted on the publicly available website, with notice provided to the Director of OEPA as appropriate.

Consequently, because of the demonstrated lack of available alternative disposal capacity before April 11, 2021, as well as the compliance status of the CCR surface impoundments, including system interconnections, complexity, and need for sequencing of the pond closure and water redirect activities, combined with OVEC's diligent and good faith efforts to develop alternative disposal capacity in order to close the CCR surface impoundments, OVEC respectfully requests a site-specific alternative deadline of October 17, 2022, to initiate closure of the BSP and September 22, 2023, to initiate closure of the SFAP at Kyger Creek Station.

1.0 INTRODUCTION

On April 17, 2015, the Environmental Protection Agency (EPA) issued the final version of the federal Coal Combustion Residual (CCR) Rule, 40 CFR Part 257, Subpart D, to regulate the disposal of CCR materials generated at coal-fired units. The rule is being administered under Subtitle D of the Resource Conservation and Recovery Act (RCRA, 42 United States Code [U.S.C.] §6901 et seq.).

On August 28, 2020, the EPA Administrator issued revisions to the CCR Rule that require all unlined surface impoundments to cease receipt of CCR and non-CCR waste and initiate closure by April 11, 2021, unless an alternative closure deadline is requested and approved. 40 C.F.R. § 257.101(a)(1) (85 Fed. Reg. 53,516 (Aug. 28, 2020). Specifically, owners and operators of a CCR surface impoundment may seek and obtain an alternative closure deadline by demonstrating that there is currently no alternative capacity available on or off-site and that it is not technically feasible to complete the development of alternative capacity prior to April 11, 2021. 40 C.F.R. § 257.103(f)(1). To make this demonstration, the facility is required to provide detailed information regarding the process the facility is undertaking to develop the alternative capacity. 40 C.F.R. § 257.103(f)(1). Any extensions granted cannot extend past October 15, 2023, except an extension can be granted until October 15, 2024, if the impoundment qualifies as an “eligible unlined CCR surface impoundment” as defined by the rule. 40 C.F.R. § 257.103(f)(1)(vi). Regardless of the maximum time allowed under the rule, EPA explains in the preamble to the Part A rule that each impoundment “must still cease receipt of waste as soon as feasible, and may only have the amount of time [the owner/operator] can demonstrate is genuinely necessary.” 85 Fed. Reg. 53,546.

OVEC’s Kyger Creek Station is subject to the CCR Rule and as such is required to ensure its CCR units maintain compliance with the requirements of the CCR Rule. Pursuant to the requirements set forth in the Rule, this document serves as OVEC’s Demonstration for a Site-Specific Alternative to Initiation of Closure Deadline for the existing CCR surface impoundments at the Kyger Creek Station, which include the BSP and SFAP, located near the town of Cheshire, Ohio in Gallia County. This document seeks EPA approval under 40 CFR §257.103(f)(1) (for “Development of Alternative Capacity Infeasible”) for the Kyger Creek Station CCR surface impoundments to continue to receive CCR and/or non-CCR wastestreams by demonstrating that the CCR and/or non-CCR wastestreams must continue to be managed in the CCR surface impoundments because it is infeasible to complete the measures necessary to provide alternative disposal capacity by April 11, 2021.

To obtain an alternative closure deadline under 40 C.F.R. § 257.103(f)(1), a facility must meet the following three criteria:

1. § 257.103(f)(1)(i) - There is no alternative disposal capacity available on-site or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification;
2. § 257.103(f)(1)(ii) - Each CCR and/or non-CCR wastestream must continue to be managed in that CCR surface impoundment because it was technically infeasible to complete the measures necessary to obtain alternative disposal capacity either on or off-site of the facility by April 11, 2021; and
3. § 257.103(f)(1)(iii) - The facility is in compliance with all the requirements of the CCR rule.

To demonstrate that the first two criteria above have been met, 40 C.F.R. § 257.103(f)(1)(iv)(A) requires the owner or operator to submit a work plan that contains the following elements:

- A written narrative discussing the options considered both on and off-site to obtain alternative capacity for each CCR and/or non-CCR wastestream, the technical infeasibility of obtaining alternative capacity prior to April 11, 2021, and the option selected and justification for the alternative capacity selected. The narrative must also include all of the following:
    - An in-depth analysis of the site and any site-specific conditions that led to the decision to select the alternative capacity being developed;
    - An analysis of the adverse impact to plant operations if the CCR surface impoundment in question were to no longer be available for use; and
    - A detailed explanation and justification for the amount of time being requested and how it is the fastest technically feasible time to complete the development of the alternative capacity.
- A detailed schedule of the fastest technically feasible time to complete the measures necessary for alternative capacity to be available, including a visual timeline representation. The visual timeline must clearly show all of the following:
    - How each phase and the steps within that phase interact with or are dependent on each other and the other phases;
    - All of the steps and phases that can be completed concurrently;
    - The total time needed to obtain the alternative capacity and how long each phase and step within each phase will take; and
    - At a minimum, the following phases: engineering and design, contractor selection, equipment fabrication and delivery, construction, and start up and implementation.

- A narrative discussion of the schedule and visual timeline representation, which must discuss the following:
  - Why the length of time for each phase and step is needed and a discussion of the tasks that occur during the specific step;
  - Why each phase and step shown on the chart must happen in the order it is occurring;
  - The tasks that occur during each of the steps within the phase; and
  - Anticipated worker schedules.
- A narrative discussion of the progress the owner or operator has made to obtain alternative capacity for the CCR and/or non-CCR wastestreams. The narrative must discuss all the steps taken, starting from when the owner or operator initiated the design phase up to the steps occurring when the demonstration is being compiled. It must discuss where the facility currently is on the timeline and the efforts that are currently being undertaken to develop alternative capacity.

To demonstrate that the third criterion above has been met, 40 C.F.R. § 257.103(f)(1)(iv)(B) requires the owner or operator to submit the following information:

- A certification signed by the owner or operator that the facility is in compliance with all of the requirements of 40 C.F.R. Part 257, Subpart D;
- Visual representation of hydrogeologic information at and around the CCR unit(s) that supports the design, construction and installation of the groundwater monitoring system. This includes all of the following:
  - Map(s) of groundwater monitoring well locations in relation to the CCR unit(s);
  - Well construction diagrams and drilling logs for all groundwater monitoring wells; and
  - Maps that characterize the direction of groundwater flow accounting for seasonal variations.
- Constituent concentrations, summarized in table form, at each groundwater monitoring well monitored during each sampling event;
- A description of site hydrogeology including stratigraphic cross-sections;
- Any corrective measures assessment conducted as required at § 257.96;
- Any progress reports on corrective action remedy selection and design and the report of final remedy selection required at § 257.97(a);
- The most recent structural stability assessment required at § 257.73(d); and
- The most recent safety factor assessment required at § 257.73(e).

2.0 WORKPLAN

To demonstrate that the criteria in 40 C.F.R. § 257.103(f)(1)(i) and (ii) have been met, the following is a workplan, consisting of the elements required by § 257.103(f)(1)(iv)(A). **OVEC has elected to install a system of multiple technologies to cease routing flow to the CCR surface impoundments, including dry fly ash handling systems, concrete settling tanks for boiler slag, a physical/chemical wastewater treatment system with water reuse and thermal evaporation system for flue gas desulfurization (FGD) blowdown, and a new lined non-CCR low volume wastewater treatment system for the water balance flows.** This workplan documents that there is no alternative capacity available on or off-site for each of the CCR and/or non-CCR wastestreams that OVEC plans to continue to manage in the CCR surface impoundments throughout the period of this extension and discusses the options considered for alternative disposal capacity. It also provides a detailed schedule for obtaining the selected alternative capacity, including a narrative description of the schedule and an update on the progress already made toward obtaining the alternative capacity.

2.1 § 257.103(f)(1)(iv)(A)(1) - No Alternative Disposal Capacity and Approach to Obtain Alternative Capacity

The Kyger Creek Station is owned and operated by OVEC and is comprised of five operating coal-fired units with a combined 1,086 net MW of generation. The plant is located along the Ohio River in Gallia County, approximately two miles south of Cheshire, Ohio. Kyger Creek Station has two active surface impoundments, the BSP and the SFAP, located as shown on the site plan in Appendix A.

The BSP is part of a larger Bottom Ash Complex, which was constructed in 1955. A splitter dike separates the BSP from the Clearwater Pond, which are approximately 30 acres and 9 acres, respectively. The pond dam is registered with the Ohio Department of Natural Resources (ODNR) under ID number 8712-014. The BSP receives all the boiler slag sluice flows from Units 1-5. Boiler slag sluice flows enter the BSP (identified as Bottom Ash Disposal Units 1-5 on the water balance provided in Appendix A) on the north end and are conveyed through the pond to allow for settling of solids prior to overflowing to the Clearwater Pond (which is not a CCR surface impoundment, but is identified as the South Bottom Ash Pond on the water balance) by way of an outlet structure. After water enters the Clearwater Pond, it is discharged to the Ohio River via an NPDES permitted outfall. The BSP compliance info is summarized in Table 2-1.

The Kyger Creek Station operates under NPDES permit OIB00005, which was most recently issued by OEPA in 2014, was modified effective on October 1, 2018, and was set to expire April 30, 2019. A permit renewal application was completed and submitted to OEPA in a timely manner; however, the current permit has not yet been re-issued, in part due to the fact that the EPA has only recently finalized revisions to the ELGs applicable to the treatment of bottom ash (boiler slag) transport water and other wastewater discharges (85 Fed. Reg. 64,650 (October 13, 2020)). Until the new permit is received, the existing permit is administratively continued and remains in full force and effect. The existing permit does not address implementation of ash transport water requirements, as it predates the 2015 ELGs.

The SFAP was also constructed in 1955 and has a surface area of approximately 68 acres. The pond receives fly ash sluice flows as well as the balance of non-CCR wastewater flows from the plant. Flows are conveyed into the pond via piping entering the surface impoundment from the southeast end and the treated wastewater flows are discharged into Kyger Creek via the NPDES permitted outfall in the southwest corner of the surface impoundment. The pond dam is registered and operated under ODNR ID number 8712-013. The SFAP compliance info is also summarized in Table 2-1. Note that the SFAP meets the criteria for an eligible unlined CCR surface impoundment.

Table 2-1: Kyger Creek Station CCR Surface Impoundment Summary

CCR Surface Impoundment Name	Alternate Designation (see Appendix A)	Year Placed in Service	Impoundment Size (acres) / Storage Volume (acre-feet)	Lined?	Meets Location Restrictions?	Groundwater Status
Boiler Slag Pond	Bottom Ash Disposal Units 1-5	1955	30 / 610	No	Yes	Assessment Monitoring initiated in Sept. 2018. ACM completed in Sept. 2019. In remedy selection process.
South Fly Ash Pond	-	1955	68 / 2,500	No	Yes	Assessment Monitoring initiated in Sept 2018. No exceedances of GWPS and ACM not required at this time.

2.1.1 CCR Wastestreams

As outlined above, the BSP receives boiler slag and mill rejects. Boiler slag is removed from the bottom of the boilers via the existing bottom ash transport water system. Mill rejects from the coal mills are removed in batch operation and sluiced to this impoundment. The SFAP receives fly ash from the plant's electrostatic precipitator hoppers via the existing hydroveyor system. The SFAP also receives treated flow from the current FGD wastewater systems for Kyger Creek Station Units 1-5, which use an existing physical/chemical treatment system to remove FGD solids from the current discharge stream, as well as variety of other low volume process wastewater and storm water runoff flows described in greater detail in Section 2.1.2. These additional flows are considered non-CCR wastestreams.

The CCR surface impoundments must remain available for treatment of the CCR wastestreams until other projects that are currently underway to eliminate the discharge of ash transport water (for ELG compliance) can be completed. These projects are described in detail within Section 2.1.6. Once these efforts are completed, Kyger Creek Station's CCR wastestreams will no longer be routed to the CCR surface impoundments. Table 2-2 summarizes the status of each of the CCR wastestreams throughout the period of the requested extension.

Table 2-2: Kyger Creek Station CCR Wastestreams

CCR Wastestream	Average Flow (MGD)	Description	OVEC Notes
Fly Ash	4.46	Sluiced to existing SFAP	The fly ash transport water is sluicing CCR material, and this stream cannot be routed to any location onsite other than the existing CCR surface impoundment until the dry fly ash conversion construction is complete. The existing sluice system is scheduled to be eliminated in mid-2022 prior to the requested site-specific deadline to initiate closure.
Boiler Slag	2.47	Sluiced to existing Boiler Slag Pond	The boiler slag ash transport water is sluicing CCR material, and this stream cannot be routed to any location onsite other than the existing CCR surface impoundment. OVEC has elected to install a boiler slag settling tanks as part of a high recycle rate system to effectively eliminate this wastestream consistent with updated CCR and ELG regulations by the requested site-specific deadline to initiate closure.

2.1.2 Non-CCR Wastestreams

Currently, Kyger Creek utilizes the SFAP to manage all non-CCR wastestreams on the plant site. The existing water balance is included in Appendix A of this demonstration. OVEC evaluated each non-CCR wastestream placed in the SFAP at Kyger Creek. For the reasons discussed below in Table 2-3, each of the following non-CCR wastestreams must continue to be placed in the SFAP due to lack of alternative capacity both on and off-site.

Table 2-3: Kyger Creek Station non-CCR Wastestreams

<table>
<tr><th colspan="2">Non-CCR Wastestream</th><th>Average Flow (MGD)</th><th>Description</th><th>OVEC Notes</th></tr>
<tr><td rowspan="3">Coal Yard Sump</td><td>Coal Pile Runoff/Coal Handling Equipment Wash Water</td><td>0.037 (estimated 2.10 for 10-year, 24-hour storm)</td><td>Flows collected in the coal yard sump before being pumped to the SFAP.</td><td rowspan="2">There is no existing alternative disposal capacity for this wastestream. This flow will be routed to the new lined LVWTS but must be treated using the SFAP while the LVWTS is being constructed within the footprint of the BSP. Significant surge capacity must be provided for high flows during rain events and this cannot be provided with any of the existing non-CCR impoundments onsite.</td></tr>
<tr><td>Crib House Sump (including RO Reject)</td><td>0.1 + Intermittent Surges during high river levels</td><td>RO Reject and Circulating Water Pump Pit are pumped to Coal Yard Sump and then to the SFAP</td></tr>
<tr><td>Sewage Treatment Plant System Flows</td><td>0.01</td><td>Flows collected in the coal yard sump before being pumped to the SFAP.</td><td>There is no existing alternative disposal capacity for this wastestream. This flow could potentially be rerouted to the Clearwater Pond with additional sumps, pumps, piping, wastewater sampling/characterization, and permit modifications; however, OVEC has chosen to devote its project resources, as well as those of Ohio EPA, to the permanent solution (the necessary construction of the site LVWTS) rather than developing a separate project to reroute this de minimis wastestream away from the SFAP during the requested demonstration.</td></tr>
<tr><td rowspan="2">Boiler Room Sumps</td><td>Turbine Room Sumps</td><td>0.1</td><td>Flows collected from turbine room floor drains, elevator pit drains, air intake tunnels and miscellaneous drains and pumped to boiler room sump before being pumped to SFAP.</td><td rowspan="2">There is no existing alternative disposal capacity for these comingled wastestreams. This flow will be routed to the new lined LVWTS but must be treated using the SFAP while the LVWTS is being constructed within the footprint of the BSP. This flow could potentially be rerouted to the Clearwater Pond with additional sumps, pumps, piping, wastewater sampling/characterization, and permit modifications; however, OVEC has concerns with the available residence time for treating this flow and has chosen to devote its project resources, as well</td></tr>
<tr><td>Transformer Deck Drains</td><td>0.0034</td><td>Flows to oil/water separator before being pumped to boiler room sump and on to SFAP.</td></tr>
</table>

Non-CCR Wastestream		Average Flow (MGD)	Description	OVEC Notes
	Miscellaneous Low Volume Wastes	9.896	Includes boiler blowdown tank condensing water, ash pit sumps, and ash hopper overflow. Pumped to SFAP from Boiler Room Sump	as those of Ohio EPA, to the permanent solution (the necessary construction of the site LVWTS) rather than developing a separate project to reroute this wastestream away from the SFAP during the requested demonstration.
	Miscellaneous Drains	Intermittent	Includes boiler room, roof drains, floor drains, office building sump, and water treating plant sump. Pumped to SFAP from Boiler Room Sump	
Air Heater Wash Water		NA (outage flows only)	Flows collected in the boiler room sumps before being pumped to the SFAP	This flow must be routed to the new LVWTS prior to discharge. There is no existing alternative disposal capacity for this wastestream, and this flow is comingled with the boiler room sump flows from the operating units before being routed to the SFAP. The volume of this combined flow (approximately 7.5 million gallons) is not feasible to segregate and route to temporary treatment measures.
Precipitator Drainage Sump Flows		0.019	Flows pumped to the SFAP. Once the fly ash handling system is converted to dry, this flow is expected to cease.	There is no existing alternative disposal capacity for this wastestream. This flow could potentially be rerouted to the Clearwater Pond with additional sumps, pumps, piping, wastewater sampling/characterization, and permit modifications; however, OVEC has chosen to devote its project resources, as well as those of Ohio EPA, to the permanent solution (the necessary construction of the site LVWTS) rather than developing a separate project to reroute this *de minimis* wastestream away from the SFAP during the requested demonstration.

Non-CCR Wastestream	Average Flow (MGD)	Description	OVEC Notes
FGD Wastewater Treatment Plant Flows	0.39	Flows pumped to the SFAP	There is no existing alternative disposal capacity for this wastestream. This flow could potentially be rerouted to the Clearwater Pond with additional, pumps, piping, wastewater sampling/characterization, and permit modifications; however, OVEC has chosen to devote its project resources, as well as those of Ohio EPA, to the permanent solution (the necessary construction of the site LVWTS) rather than developing a separate project to reroute this *de minimis* wastestream away from the SFAP during the requested demonstration.

The SFAP must remain available for treatment of non-CCR wastestreams until a new non-CCR basin, also referred to as the LVWTS, can be constructed and these flows can be routed to that new facility. Based on the lack of available space at the plant site as discussed in Section 2.1.3 (see also Figure 3 in Appendix A), the LVWTS will be built within a portion of the BSP footprint.

2.1.3 Site-Specific Conditions Supporting Alternative Capacity Approach – § 257.103(f)(1)(iv)(A)(1)(i)

As shown on the site plan in Appendix A, Kyger Creek Station is bounded by the Ohio River to the east, Gavin Power Plant to the north, Kyger Creek to the west and south, and is bisected by Ohio Highway 7. Most of the Kyger Creek property which is outside of the existing floodplain is occupied with critical infrastructure including the CCR surface impoundments, the coal storage pile, the material handling equipment, the pollution control equipment (including electrostatic precipitators, selective catalytic reduction systems, JBR scrubber systems, and the FGD wastewater treatment system), the switchyard, and the above-ground and below-ground transmission lines. Figure 3 in Appendix A provides additional detail of the existing site conditions, including the property boundary, floodplain limits, existing onsite wetland areas, topography, as well as the proposed LVWTS and concrete settling tank footprints.

Based on the limited space available onsite at Kyger Creek Station, it is not possible to construct a new LVWTS with associated piping, chemical feed, and power supply that is large enough to receive non-CCR wastestreams and be outside the CCR surface impoundment footprints. By constructing the new

LVWTS within the existing footprint of the BSP, the Kyger Creek Station would also avoid the need to impact waters of the U.S. and other natural resources in the Kyger Creek watershed as part of this project.

Based on the foregoing facts, OVEC cannot cease the flow of CCR wastestreams and initiate closure of the BSP until the concrete settling tank construction is complete, and OVEC cannot cease the flow of CCR and non-CCR wastestreams and initiate closure of the SFAP until the dry fly ash conversion is complete, the new LVWTS is constructed within the footprint of the BSP, and the non-CCR wastestreams are rerouted to the new LVWTS. Given the complexity of these projects, and the need to sequence the activities as outlined above, those actions cannot be completed prior to April 11, 2021. Thus, the conditions at Kyger Creek Station demonstrate that no alternative disposal capacity is available on-site or off-site, satisfying the requirement of 40 CFR 257.103(f)(1)(i)(A).

2.1.4 Impact to Plant Operations if Alternative Capacity Not Obtained – § 257.103(f)(1)(iv)(A)(1)(ii)

OVEC's entire generating capacity (including capacity from its wholly owned subsidiary, Indiana-Kentucky Electric Corporation (IKEC)), is sold at cost under the FERC approved OVEC-IKEC Power Agreement, and such capacity is exclusively committed and available to OVEC's owners or their affiliates (who are public utilities or electric power cooperatives, collectively referred to herein as the "Sponsoring Companies")[1] under the terms of the FERC approved Inter-Company Power Agreement (ICPA). Under the ICPA, the Sponsoring Companies are responsible for their share of OVEC's costs and expenses, including for debt and other long-term obligations. The Sponsoring Companies and OVEC entered an amended and restated ICPA, effective as of August 11, 2011, which extends its term to June 30, 2040. The OVEC-IKEC Power Agreement has the same extended term.

OVEC also supplies energy to the DOE's Portsmouth Uranium Enrichment facility located in Piketon, Ohio. The DOE is OVEC's only non-ICPA customer for power and energy. OVEC serves the DOE

[1] OVEC's current Sponsoring Companies (and their percentage of obligations under the ICPA) are as follows: Allegheny Energy Supply Company LLC (subsidiary of FirstEnergy Corp (FirstEnergy)), 3.01%; Appalachian Power Company (subsidiary of American Electric Power Company, Inc. (AEP)), 15.69%; Buckeye Power Generating, LLC (subsidiary of Buckeye Power, Inc.), 18.00%; The Dayton Power and Light Company (subsidiary of AES Corp), 4.90%; Duke Energy Ohio, Inc. (subsidiary of Duke Energy Corporation), 9.00%; Energy Harbor Corp, 4.85%; Indiana Michigan Power Company (subsidiary of AEP), 7.85%; Kentucky Utilities Company (subsidiary of PPL Corp (PPL)), 2.50%; Louisville Gas and Electric Company (subsidiary of PPL), 5.63%; Monongahela Power Company (subsidiary of FirstEnergy), 0.49%; Ohio Power Company (subsidiary of AEP), 19.93%; Peninsula Generation Cooperative (subsidiary of Wolverine Power Supply Cooperative, Inc.), 6.65%; and Southern Indiana Gas and Electric Company (subsidiary of CenterPoint Energy, Inc.), 1.50%.

under a cost-based arranged power agreement approved by the Public Utilities Commission of Ohio (PUCO). Under this agreement, OVEC purchases energy from the wholesale energy market and resells such energy to DOE as needed in real time to meet all energy needs of the Portsmouth Uranium Enrichment Facility (which has been in the process of demolition and deconstruction since it permanently ceased operations). OVEC's energy purchases to serve the DOE are made solely from the real-time market managed by the PJM Interconnection LLC (PJM) Regional Transmission Organization.

OVEC is a member of PJM; however, it does not sell electric capacity or energy to anyone other than at wholesale to the Sponsoring Companies under the ICPA, and at retail to the DOE under the PUCO approved agreement through resale of energy available by PJM. Under the terms of the ICPA, the Sponsoring Companies either utilize their allocation of electric capacity and energy for their own retail customers (residential, commercial, and industrial), or sell such electric capacity and energy at wholesale, including in PJM-managed energy and capacity markets. In addition, OVEC maintains in excess of 700 miles of 345 KV transmission lines, all of which are subject to the management of PJM.

The CCR impoundments are the primary component of the existing wastewater treatment systems at the Kyger Creek Station. If the CCR Rule were to require closure of the CCR impoundments at the Kyger Creek Station prior to the requested site-specific deadlines, the Kyger Creek Station would be forced to cease operation, and the Sponsoring Companies would not receive their allocation of electric capacity and energy from the Kyger Creek Station to supply electricity to their retail public utility and electric power cooperative customers in Indiana and many neighboring states (or, as applicable, to allow such Sponsoring Companies to sell their allocation of such capacity or energy into power markets for the benefit of such ratepayers). A cessation of operations at the Kyger Creek Station also could cause increased and accelerated costs to OVEC and IKEC, including accelerated costs of demolition and decommissioning of the Kyger Creek Station and possible efforts by OVEC's creditors and other counter-parties to try to accelerate their collection of existing debt or other long-term obligations, which (in turn) might trigger sizable and accelerated payment obligations for the Sponsoring Companies under the ICPA. In addition, an unplanned loss of such generating capacity might negatively impact grid stability and power markets in the PJM and surrounding region.

As described in Sections 2.1.1, 2.1.2, and 2.1.6 of this demonstration, in order to continue to operate, generate electricity, and ultimately comply with the CCR Rule, the ELGs, and the facility's NPDES permit conditions, the Kyger Creek Station must continue to use the CCR surface impoundments for treatment of both CCR and non-CCR wastestreams until alternative disposal capacity can be developed.

This development includes the following primary activities that must be completed in order to initiate closure of the CCR surface impoundments:

- Secure applicable environmental permits from the OEPA and the ODNR
- Install a new dry fly ash silo and ancillary dry fly ash handling equipment
- Construct new concrete settling tanks within the BSP footprint for boiler slag material
- Reroute boiler slag and mill reject sluice flows to the new concrete settling tank and establish a high recycle rate system
- Construct a new LVWTS within the BSP footprint for treatment of non-CCR wastewater currently treated in the SFAP
- Reroute all plant non-CCR wastewater flows currently discharging into the SFAP to the new LVWTS

2.1.5 Options Considered Both On and Off-Site to Obtain Alternative Capacity

As EPA explained in the preamble of the 2015 rule, it is typically not feasible for sites that sluice CCR material to an impoundment to eliminate the impoundment and dispose of the material offsite. See 80 Fed. Reg. 21,301, 21,423 (Apr. 17, 2015) ("[W]hile it is possible to transport dry ash off-site to [an] alternate disposal facility that is simply not feasible for wet-generated CCR. Nor can facilities immediately convert to dry handling systems."). For these reasons, offsite disposal is not an option for the Kyger Creek Station's CCR wastestreams. It is also not feasible to provide offsite treatment of the large volume of non-CCR wastewaters currently routed to the SFAP. Off-site disposal of these sluiced CCR and non-CCR wastestreams would require both on-site temporary storage and significant daily tanker truck traffic. The required daily tanker trucks (assuming 7,500-gallon capacity per truck) for each of the CCR and non-CCR sluiced wastestreams are summarized as follows:

- <u>Boiler Slag sluice to BSP (2.47 MGD):</u> Approximately 330 daily trucks would be required, if a Publicly Owned Treatment Works (POTW) could be identified to receive it.
- <u>Fly Ash sluice to SFAP (4.46 MGD):</u> Approximately 595 daily trucks would be required; however, the ELG rules (at 40 CFR 423.16(f)) prohibit discharge of this water to a POTW.
- <u>Coal Yard Sump Flows (0.15-2.21 MGD):</u> Approximately 20 daily trucks would be required, increasing to over 290 daily trucks during rain events and increasing to accommodate intermittent surges during high river levels.
- <u>Boiler Room Sump Flows (10.0 MGD):</u> Over 1,300 daily trucks would be required.
- <u>Precipitator Drainage Sump Flows (0.019 MGD):</u> Approximately 25 daily trucks would be required.

The significant daily tanker truck volume for offsite disposal (over 2,300 trucks per day during normal operations and approximately 2,600 trucks per day during rain events) would result in increased potential for safety and noise impacts and further increases in fugitive dust, greenhouse gas emissions and carbon footprint which may require a Prevention of Significant Deterioration (PSD) permit and modification under the Clean Air Act Permit Program if the calculated increases in emissions are over the PSD limits. This increased traffic during rain events is also difficult to plan for and reliably perform in this location, regardless of whether suitable disposal locations can be identified. Setting up contractual arrangements for a local POTW to accept the wastewater would prove to be difficult since they also have to meet NPDES discharge limits. Most POTW's have their own permitting process to allow industry to discharge to their facilities, and they may be required to modify their NPDES discharge permit which would add time to the overall compliance schedule. The potential for leaks/spills from the tank system or transportation of the wastewater offsite does also exist. Furthermore, the temporary wet storage needed to accommodate off-site disposal would require reconfiguration, design, installation, and associated environmental permitting that would extend the overall compliance schedule. Consequently, there are no feasible offsite-disposal options for the wet-generated wastestreams at Kyger.

None of the other ponds onsite (Clearwater Pond, CCP Stackout Pad Pond, or Landfill Leachate Pond) are large enough to independently treat these flows without the continued use of the CCR surface impoundments. The Clearwater Pond currently receives treated boiler slag sluice flows (~2.5 MGD). Rerouting the non-CCR wastestreams to this location would require much of the scope outlined in this demonstration for new pumps, piping, and permit modifications and this pond could not receive the non-CCR flows approximately five times the current treatment capacity without providing additional residence time upstream (as provided by the new LVWTS). The CCP Stackout Pad Pond and the Landfill Leachate Pond are remote from the plant and are similarly designed to receive the volume of flow for the specific wastestreams currently routed to them, and cannot receive and discharge the non-CCR wastestreams without permit modifications, expanded residence time, and new conveyance structures to reach the Ohio River. Thus, OVEC must pursue alternative onsite options for the handling of CCR and non-CCR wastestreams that are currently directed to the CCR surface impoundments.

The options considered for alternative disposal capacity of the wastestreams currently routed to the BSP and SFAP are summarized in Table 2-4. For additional details on the CCR and non-CCR wastestreams, please refer to Table 2-2 and Table 2-3, respectively.

Table 2-4: Kyger Creek Station Alternatives for Disposal Capacity

Alternative Capacity Technology	Average Time (Months)[1]	Feasible at Kyger?	Selected?	OVEC Notes
Conversion to dry handling	33.8	Yes	Yes	OVEC will install a vacuum system for fly ash and new concrete settling tanks as part of a high recycle rate system to handle boiler slag. This solution was selected in May 2020 and is scheduled to be implemented by July and October of 2022, respectively. This is an aggressive schedule for compliance across all five units at the site, and significantly faster than the average time estimated by EPA.
Non-CCR wastewater basin	23.5	Yes	Yes	A new LVWTS is being constructed as one part of the solution to comply with the new requirements. The volume of non-CCR wastestreams cannot be contained within the existing non-CCR basins with adequate residence time to meet discharge limits. There is not adequate real estate onsite (see Figure 3 in Appendix A), or within a reasonable distance, to construct additional non-CCR basins outside the footprint of the BSP (or SFAP), which extends the schedule required for construction of the new LVWTS since this work cannot feasibly start until after the boiler slag handling conversions are completed. Due to the relatively small impoundment size, OVEC must route sluice flow to east portion of the pond area during BSHS construction and maintain remaining active footprint in east BSP to treat boiler slag sluice during BSHS construction. Consequently, the work must be phased to eliminate boiler slag sluice flows prior to starting LVWTS construction in east portion of the pond area. EPA should note that while additional time is required for this construction based on the Kyger site conditions, OVEC will effectively be closing portions of the BSP, and particularly the LVWTS area, during the requested extension.
Wastewater treatment facility	22.3	Yes	Yes	A chemical feed system is being constructed as part of the LVWTS.

Alternative Capacity Technology	Average Time (Months)[1]	Feasible at Kyger?	Selected?	OVEC Notes
New CCR surface impoundment	31	No	No	There is not adequate real estate onsite (see Figure 3 in Appendix A), or within a reasonable distance of the power plant, to construct a new CCR surface impoundment. The only potential area outside the floodplain or the existing CCR surface impoundments at the Kyger Creek site would have significant grading challenges and jurisdictional wetland impacts that are expected to extend this average timeline. Additionally, permitting required to construct a new surface impoundment would delay the cessation of waste streams and closure of the CCR impoundments past the deadline requested, and would not alone provide compliance with ELG.
Retrofit of a CCR surface impoundment	29.8	Yes	No	A retrofit alone would not have allowed for compliance with ELG. This would require complete removal of the CCR from the BSP, which would extend the overall compliance schedule. Based on the construction of dry ash handling systems, this alternative is not required at Kyger Creek Station. The construction of the LVWTS is essentially a retrofit for the continued use of non-CCR wastestreams; however, the LVWTS will not be considered a CCR impoundment moving forward.
Multiple technology system	39.1	Yes	Yes	This is being implemented as described above to include dry fly ash conversion, new concrete settling tanks for boiler slag, and a new LVWTS (non-CCR pond and associated chemical feed system). This solution was selected in May 2020 and is scheduled to be implemented by September of 2023, which is an aggressive schedule for compliance across all five units at the site, but is slightly longer than the range of average times estimated by EPA due to the reuse of a portion of the BSP footprint for this project.
Temporary treatment system	Not defined	No	No	A new temporary treatment system for non-CCR wastestreams would need to handle/treat an average daily flow of 10.56 MGD, not including stormwater contributions. It is not technically feasible to build temporary tanks to provide this level of treatment during the construction of the LVWTS, and as shown in Figure 3 in Appendix A, there is not enough available space to install this temporary equipment. OVEC has chosen to focus on implementing the necessary measures for the selected technologies described above as soon as possible rather than try to develop temporary solutions for certain low volume wastestreams.

[1]From Table 3. See 85 Fed. Reg. at 53,534.

OVEC began evaluating CCR handling technologies in October of 2018 with the assistance of BMcD. The evaluation for Kyger Creek had to consider not only the evolving requirements of the CCR Rule, but also the future revisions to the ELGs that would likely impact the approaches being considered for boiler slag handling. BMcD completed an evaluation that investigated multiple technology options for fly ash handling as described in Table 2-5 and boiler slag handling as described in Table 2-6.

Table 2-5: Kyger Creek Station Alternatives for Fly Ash Handling

Alternative Capacity Technology	Selected?	OVEC Notes
Traditional Single Silo Vacuum System	Yes	Selected
Keep Sluice System and Repurpose the Existing Filter Press System with a Closed Loop	No	Not practical; concerns with closed loop water chemistry and high O&M costs
Repurpose Existing Trona Silos to Fly Ash Silos	No	Not practical; silos required for SO_3 mitigation
Direct Vacuum to Truck System	No	Not practical due to lack of operational flexibility

Table 2-6: Kyger Creek Station Alternatives for Boiler Slag Handling

Alternative Capacity Technology	Selected?	OVEC Notes
Underboiler Drag Chain Conveyor System	No	Not feasible due to space constraints under the boilers
Remote Drag Chain Conveyor System	No	Not selected due to concerns with equipment redundancy for five operating units and due to reliability risks associated with mechanical equipment in a highly abrasive environment
Dry Belt/Tray Conveying System	No	Not feasible due to boiler design

Alternative Capacity Technology	Selected?	OVEC Notes
Proprietary B&W Submerged Grind Conveyor System	No	Not feasible due to space constraints under the boilers
Traditional Water Treatment Style Slag Handling System	No	Not practical; still in conceptual design phase
Pneumatic Conveying System	No	Not feasible due to boiler design
Rapid Remote Dewatering System	No	Not practical; still in conceptual design phase
Composite Liner Retrofit	No	Feasible; however, not compliant with ELG rule for zero discharge of ash transport water
Concrete Settling Tank w/ Water Recirculation System	Yes	Selected

2.1.6 Approach to Obtain Alternative Disposal Capacity

Following the 2018 study, OVEC identified preferred technologies for further review, which included the concrete settling tank for boiler slag and traditional single silo vacuum system for fly ash. This selection was based on comparison of each of the alternatives that were deemed to be technically feasible at Kyger Creek. In 2019, OVEC hired BMcD to prepare specification packages and solicit bids for the proposed fly ash system (to support budgetary estimates for the project) and in 2020 (following EPA release of the proposed ELG and CCR rule revisions), OVEC hired BMcD to prepare a PDR for installing a concrete settling tank, also referred to as the Boiler Slag Handling System (BSHS), and developing a new LVWTS within the footprint of the existing BSP.

The concrete settling tank will consist of three chambers, as shown on Figure 2 in Appendix A, which are sized to settle boiler slag material and mill rejects from the sluice water. Overflow from the chambers will collect in a recycle tank for recirculation back through the boiler slag sluicing system. For this system operation, sluice water will be directed to one of the chambers, with the second chamber being dewatered and cleaned of boiler slag material, and the third chamber in waiting to receive sluice flows or upset flows if needed. The tank will be constructed over existing CCR material. As discussed in more detail in Section 2.3, the footprint of the BSHS will be pre-loaded prior to installing the concrete structure to consolidate the material and reduce the potential for differential settlement and the resulting cracking. The tank is being designed to meet ACI 350-06 requirements for water retaining concrete structures with normal environmental exposure. Normal environmental exposure is defined as exposure to liquids with a pH greater than 5, or exposure to sulfate solutions 1000 ppm or less. The tank location is shown on Figure 2 in Appendix A, as well as typical plan and section sketches.

BMcD has also developed a preliminary concept for the LVWTS design. The LVWTS has been located within the east portion of the existing BSP. The north basin (i.e. the primary basin) has a working capacity of 9.2 million gallons. The south basin (i.e. secondary basin) has a working capacity of 21.3 million gallons which provides over 24 hours of detention time at the average daily flow rate. The LVWTS will overflow to the Clearwater Pond which discharges to the Ohio River through an existing NPDES outfall. The two basins will operate in series except during air heater wash events where wash water will be directed to the primary basin and all other flows will bypass the primary basin and be directed to the secondary basin.

The LVWTS will also be constructed over existing CCR material in order to minimize the overall compliance schedule by limiting the amount of offsite borrow material required to complete the project and to balance cut and fill within the existing basin. Furthermore, removing all of the CCR material from the BSP and constructing a new lined LVWTS is not feasible while all the CCR wastestreams continue to be routed to this CCR unit. Due to the relatively small size of this impoundment, the BSP modifications must occur in sequence such that the LVWTS portion of the BSP is used for continued slag sluicing while the BSHS is constructed and the LVWTS construction will begin after the BSHS is placed in service. The overall compliance schedule would need to be extended considerably if complete removal of the CCR material was required from the BSP footprint, not only for the duration of the removal efforts but also to place the necessary fill below the BSHS to replace any removed CCR material.

The LVWTS will receive a composite liner system. The preliminary cross sections of the LVWTS and details of the composite liner system are provided in Appendix A. The footprint of the new LVWTS will be graded and stabilized prior to installing the liner. In addition to providing containment for the wastestreams discharged to the new LVWTS, the liner will also act as a cover system over underlying CCR materials which remain. BMcD is conducting a geotechnical investigation to better characterize properties of the existing CCR material and determine structural stability characteristics of the LVWTS.

Based on the work completed to date, OVEC and BMcD identified the following primary scope items:

- New concrete settling tank, constructed within the footprint of the existing BSP, to settle boiler slag and mill rejects and recycle water to the boiler slag sluicing system. This tank is shown on Figure 2 in Appendix A. This system is also referred to as the BSHS.
- Re-grading of boiler slag material in the western portion of the BSP to support construction of the new concrete settling tank and construction of a berm to isolate the new LVWTS area.
- A new lined LVWTS, constructed within the eastern portion of the existing BSP, to treat all non-CCR wastestreams generated at Kyger Creek Station. The non-CCR wastestreams will be rerouted from the SFAP to the LVWTS. The LVWTS will overflow into the existing Clearwater Pond for additional treatment. From the Clearwater Pond, water will be discharged to the Ohio River via the existing NPDES permitted outfall. The new LVWTS is shown on Figure 2 in Appendix A.
- Chemical treatment systems for the concrete settling tank and LVWTS to promote settlement of fine particles and adjust pH if required.
- New single silo vacuum system and conveyor system to eliminate wet sluicing of fly ash and capture and store dry fly ash prior to either disposal in the onsite CCR landfill or beneficial use. This equipment is shown on Figure 2 in Appendix A.

Each of the noted scope items is required to provide alternative treatment for the CCR and non-CCR wastestreams that currently flow to the CCR surface impoundments and initiate closure of the unlined CCR surface impoundments as required by the CCR rule. The LVWTS and BSHS design features are designed to prevent migration of wastewaters into the underlying CCR material, and OVEC believes these designs are environmentally responsible and will meet the intent of the Federal and State regulations associated with the closure of the CCR surface impoundments. The remainder of the work required to install the new ash handling technologies and develop the new LVWTS is described further in Section 2.3 of this demonstration.

2.1.7 Technical Infeasibility of Obtaining Alternative Capacity prior to April 11, 2021

Based on the foregoing facts, OVEC cannot cease all CCR and non-CCR wastestreams and initiate closure of the CCR surface impoundments until the dry fly ash handling conversion is complete, the boiler slag handling conversion is complete, the new LVWTS is constructed, and the non-CCR wastewater flows are redirected to the new lined treatment system. OVEC began its selected compliance project execution for Kyger Creek Station with scoping studies in 2018 and is in the process of negotiating either an EPC or a design-bid-build contract to execute this project. This work is in progress but has not yet been completed. It is not technically feasible to procure the equipment, perform the necessary detailed design, and complete the pre-outage construction activities for each the fly ash, boiler slag, and low-volume wastewater projects over the course of the next six months. Consequently, it is not possible to implement the measures discussed above in a manner that would be successful by April 11, 2021.

Thus, the conditions at Kyger Creek Station demonstrate that no alternative disposal capacity is available on-site or off-site, satisfying the requirement of 40 CFR 257.103(f)(1)(i), and OVEC respectfully requests a site-specific extension of the deadline to initiate closure of the CCR surface impoundments until the date on which those actions are expected to be completed.

2.1.8 Justification for Time Needed to Complete Development of Alternative Capacity Approach – § 257.103(f)(1)(iv)(A)(1)(iii)

The schedule for developing alternative disposal capacity is described in more detail in Sections 2.2 and 2.3. The milestones for progress are summarized in Table 2-7, below. OVEC is requesting an alternative site-specific deadline of October 17, 2022 to cease receipt of wastestreams in the Boiler Slag Pond and initiate closure of that CCR unit (as well as construction of the LVWTS) and a deadline September 22, 2023, to cease receipt of wastestreams in the SFAP and initiate closure of that CCR unit. The primary factor affecting the compliance schedule at the Kyger Creek Station is the ability to manage CCR and non-CCR wastestreams throughout construction in a way that allows the plant to continue to meet the NPDES discharge limits. If OVEC were to consider alternative temporary solutions to allow for the SFAP to be removed from service, such a measure would require the use of over 830 frac tanks to provide one day of storage capacity for these flows, not including stormwater contributions. These tanks would require significant site development for containment measures and significant interconnecting piping which would propose an unacceptable amount of potential for leaks. Furthermore, assuming a solids content of 1% in the comingled wastestreams, approximately 8 of these frac tanks would need to be removed and replaced each day. Temporary tanks for storage of millions of gallons of wastestreams are not considered technically feasible to mobilize and allow for simultaneous closure of two site impoundments.

OVEC believes this requested schedule showing sequencing of the Boiler Slag Pond modifications (i.e. construction of the BSHS followed by construction of the LVWTS) represents the fastest technically feasible timeframe for compliance at Kyger Creek Station, and these durations are faster than EPA’s assessment of the average time required to construct a dry ash handling conversion and a non-CCR basin. For Kyger Creek Station’s specific case, these options cannot be completed simultaneously due to site availability and operational constraints. While the BSHS is being constructed in the west portion of the BSP, the boiler slag sluice will be diverted to the east portion of the BSP and overflow to the Clearwater Pond. The LVWTS will be constructed within the east portion of the BSP but cannot be constructed while OVEC is sluicing to that area. There is not enough remaining pond footprint available to be able to sluice the flows around each work area simultaneously and still get adequate settlement of solids upstream of the Clearwater Pond, which is not a CCR pond. OVEC has overlapped the BSP modification activities as much as feasible with the given constraints.

Table 2-7: Compliance Project Progress Milestones

Year or Progress Reporting Period	Status	Milestone Description	OVEC Notes
2020	Completed	Selection of ash handling solution and preparation of request for alternative site-specific deadline for initiation of closure of the CCR Surface Impoundments.	
2020	On Schedule	FEED study and detailed scope development, award primary dry fly ash equipment and silo, and award EPC or detailed design contracts	
April 30, 2021	Scheduled	Dry fly ash equipment submittals approved, fly construction awarded, fly ash deep foundation construction underway, BSHS/LVWTS equipment procurement packages issued for bid, BSHS site prep construction package awarded	
October 31, 2021	Scheduled	Fly ash foundations installed; BSHS site prep construction completed	
April 30, 2022	Scheduled	BSHS/LVWTS construction package bid/awarded and construction underway	

Year or Progress Reporting Period	Status	Milestone Description	OVEC Notes
October 31, 2022	Scheduled	Fly ash construction complete and BSHS operational	Dry fly ash conversion is scheduled to be completed by July 2022. SFAP will continue to receive non-CCR flows until construction of the LVWTS is completed. Boiler slag conversion scheduled to complete in October of 2022. Normal flows of CCR wastewater to the Boiler Slag Pond will cease by this date.
April 30, 2023	Scheduled	LVWTS berm and liner system installation underway	BSP closure is underway as well (those activities are not part of this demonstration)
September 22, 2023	Scheduled	LVWTS operational	Non-CCR wastestreams to the SFAP will cease by this date.

2.2 Detailed Schedule to Obtain Alternative Disposal Capacity - § 257.103(f)(1)(iv)(A)(2)

The required visual timeline representation of the schedule for the activities outlined in Sections 2.1.6 and 2.3 is included in Appendix B of this demonstration.

2.3 Narrative of Schedule and Visual Timeline - § 257.103(f)(1)(iv)(A)(3)

As shown in Appendix B and described in Sections 2.1.6 and 2.4, OVEC has already undertaken significant planning steps towards initiating closure of the CCR surface impoundments. This section of the demonstration is focused on the remaining work necessary to obtain alternative disposal capacity for the CCR and non-CCR wastestreams and initiate CCR surface impoundment closures at the Kyger Creek Station. The durations shown in the schedule in Appendix B are based on a number of factors, including a 50-hour per week construction schedule, the estimated volume of concrete to be installed for the settling tanks, piping quantities for the new concrete settling tanks and LVWTS, and the estimated volume of earthwork required.

Contract Negotiation: OVEC is currently working with BMcD to jointly develop the front-end engineering deliverables for the project, develop specifications to procure the major equipment, perform the required geotechnical/survey/pilot trenching/laser scanning/water sampling activities necessary to support design, refine the project scope, and develop a target price to serve as the basis for either a multiple-subcontract Engineer-Procure-Construct (EPC) contract or a design-bid-build contract. These efforts involve completion of approximately 30% of the project design, as well as award of the contract and are expected to be completed in November of 2020. This contracting method has been selected to facilitate completing the project on a timeline that is as soon as technically feasible, consistent with the CCR Rule.

Fly Ash Handling Modifications: The fly ash equipment specifications (which include the fly ash equipment, conveyor equipment, silo, and PCM specifications) were initially developed as part of the project scoping effort and were issued to bidders in 2019 for budgetary pricing. The updated specifications were then issued for bid in July and August of 2020. The fly ash silo contract has been awarded under an LNTP for engineering to support the project, and the two major fly ash equipment contracts (for mechanical exhausters/ash handling equipment/piping and fly ash conveyors) are anticipated to occur early in the fourth quarter of 2020. The long-lead equipment fabrication and delivery is anticipated to take a total of 13 months from award, mostly associated with the lead time following the equipment supplier's design of the fly ash conveying and silo equipment. During this equipment fabrication and delivery period, and following receipt of the design submittals for the fly ash equipment, the EPC contractor (or the design-bid-build engineer) will finalize the design of the fly ash modifications and award subcontracts or work packages for the project scope including civil work, piling, foundations, equipment erection, steel erection, piping installation, and electrical raceway/cable installation. The durations shown for these activities are BMcD estimates for the design and procurement efforts based on the currently defined project scope and BMcD experience with these types of projects.

Pre-outage construction will begin in March of 2021 (pending receipt of required environmental permits, including the necessary air permit modifications and permits to install from Ohio EPA) with the piling (approximately one month) and site prep and foundation construction (i.e. foundations and underground utilities – taking approximately three months after piling is completed). This includes installation of the power supply duct bank, the PCM foundation, the silo foundation, the conveyor support foundations, and the mechanical exhauster pads. The foundation work in the silo vicinity must be completed before construction of the silo can begin; however, the conveyor foundations can be constructed concurrently with the silo. The fly ash silo erection is anticipated to take eight months based on budgetary input received from the potential furnish/erect suppliers. As the silo is being built, there is an exclusion zone that prevents work by other contractors in the vicinity of the silo for safety reasons. This hold is in effect until the walls and roof are completed and the silo vendor moves indoors to complete the interior floors, which is approximately halfway through the silo construction period. Mechanical construction will begin with pipe routing in the precipitator areas as well as conveyor erection outside of this area; however, the bulk of the work cannot be completed until after the silo is set and the fly ash equipment is delivered and set in place. The mechanical construction duration is based on an estimated 40,000 labor hours for the equipment installation and 8,000 feet of piping required for the project and is based on a crew working 50 hours per week. Piping tie points (wyes and valves) will be installed as available during available unit outages or system outages through the construction period.

The electrical construction will kick off to set the new equipment and route piping, raceway, and cable to these locations following the release of the silo area and following approximately 6 weeks behind the mechanical contractor to allow for equipment to be set and to minimize construction interferences in the same spaces. The electrical construction duration is based on an estimated 35,000 labor hours for the 2,800 feet of raceway and 313,000 feet of cable (and associated terminations) required for the project and is based on a crew working 50 hours per week.

The fly ash equipment startup and commissioning will take place over two months following completion of the mechanical and electrical construction. This allows for sequential integration of Units 1-5 to transfer from wet to dry handling assuming 1-2 weeks per generating unit. At this point, the sluicing of fly ash will cease, and the dry system will be used for future handling of fly ash generated at the Kyger Creek Station.

<u>Boiler Slag Handling and Pond Modifications</u>: Detailed engineering for the boiler slag treatment equipment and LVWTS construction contracts will begin in November of 2020 after the EPC or design-bid-build contract is awarded, and this work is scheduled to be completed in October of 2021 following release of the electrical construction contract for bid. The design will be grouped into multiple work packages and construction subcontracts to facilitate the required construction sequence. These work packages include the site preparation efforts, pond closure, concrete settling tank (i.e. BSHS), and mechanical/electrical construction for the ash transport water recycle system and LVWTS (and associated chemical feed system). Permitting through the OEPA will include securing modifications to the NPDES permit and securing Permits-to Install for the concrete settling tank and the LVWTS (and associated non-CCR wastestream piping reroutes, chemical feed systems, and BSP closure). Permitting will coincide in part with the end of the detailed engineering period for each required phase. These permit modifications must be completed before the associated construction of the BSHS concrete settling tanks, BSP Closure and the new LVWTS berm construction is initiated. The new berm separating the LVWTS from the BSP closure area will also likely require a dam permit from ODNR and authorization from the Huntington District of the Army Corps of Engineers.

Preparation of equipment specifications for the pumps, chem feed system, boiler slag piping, DCS, and electrical equipment will occur concurrently with detailed engineering. The electrical equipment (PCM and associated transformers) is the only long-lead item provided in the schedule, and the remaining equipment procurement activities will be completed concurrent with this duration. The civil construction contract(s) will include site preparation, construction of a temporary ash diversion berm, dewatering the portion of the BSP in the vicinity of the concrete settling tank, installing surcharge load and performing consolidation of subgrade soils (determined to be required during ongoing geotechnical investigation), construction of the concrete settling tanks; construction of the permanent BSP divider berm; construction of the LVWTS; and closure of the CCR surface impoundments. This will likely be divided into two contract scopes to support construction of the concrete settling tanks and redirection of the sluice flows concurrent with the required permitting efforts for the pond closure and LVWTS construction, with the goal of the EPC contractor (or the design-bid-build engineer) to accelerate this effort as much as possible. The mechanical/electrical scope will include installation of the major utility corridors (i.e. piping to/from the concrete settling tank and LVWTS), construction of the electrical Power Distribution Center (PDC) at the concrete settling tank, installation of the new recycle pumps, installation of new raceway/cable to power the new equipment, and completion of balance of plant scope as required for the project.

The BSP modifications and LVWTS construction will require close coordination between plant operations and the contractor. This work will proceed in the following order once construction is underway:

- OVEC will begin lowering the BSP water level (removing free water) in manner that allows the station to meet its NPDES limits and will reroute the CCR surface impoundment influent lines to the eastern end of the impoundment.
- The contractor will install a temporary slag berm to isolate flows to the eastern portion of the impoundment.
- The contractor will dewater the western portion of the BSP, and place CCR material within the footprint of the concrete settling tank as required to support preparation of the subgrade. This area requires pre-loading (i.e. surcharge loading) to consolidate the CCR material and subgrade soils in the area. This activity must occur after the sluice flow is rerouted to the existing lines on the eastern portion of the impoundment and the large sluice volumes are removed from the western portion of the impoundment.
    - The schedule duration is based on the contractor placing approximately 25,000 CY of CCR material to build the temporary berm and dewater the west portion of the pond for approximately four weeks. Approximately 130,000 CY of CCR material will be placed as

part of the surcharge loading effort. After the surcharge material is placed, it will remain for 55 working days (just over two months).

- The contractor will excavate approximately 60,000 CY of surcharge material as required to support the new concrete settling tank foundation construction.
- The contractor will construct the concrete settling tank and recycle tank floor and walls. The construction duration shown in Appendix B for both this task and the supporting system foundations is based on an estimated 70,000 labor hours for the 9,150 CY of concrete (and associated rebar) required for the project and is based on a crew working 50 hours per week. This work cannot start until the Permit-to-Install is received for the BSHS.
- The contractor will backfill the settling tank after the walls are complete. This activity is anticipated to take approximately a month to complete. Following this effort, the contractor will install the foundations and slabs around the perimeter of the tanks including the PCM and transformer foundations, the stackout area slab, and the chemical feed system foundations. The phasing of this work is anticipated to take another six weeks of construction.
- After the foundations are completed and the mechanical construction contract is awarded, the contractor will install the PDC, transformers, and necessary mechanical equipment. This will include installation of the new pumps, chemical feed equipment, piping, and balance of plant items necessary to support recycling the boiler slag ash transport water system. The mechanical construction duration is based on an estimated 77,000 labor hours for the equipment installation and 32,300 feet of piping required for the project and is based on a crew working 50 hours per week. The piping installation will begin before the slag tank construction is completed, but the equipment erection and piping will not be able to complete until at least two months after the tank walls are completed.
- The electrical construction will be performed concurrently, albeit slightly lagged to the mechanical construction. The electrical construction duration is based on an estimated 34,000 labor hours for the 5,000 feet of raceway and 366,000 feet of cable (and associated terminations) required for the project and is based on a crew working 50 hours per week. This work will be completed at least two months after the PCM and transformers are set in place to allow for terminations at those locations.
- The BSHS equipment startup and commissioning will take place over five weeks following completion of the mechanical and electrical construction. This allows for sequential integration of Units 1-5 to transfer from wet to high recycle system handling assuming 1 week per generating unit. At this point, the sluicing of boiler slag to the BSP will cease, and the high recycle rate system will be used for future handling of boiler slag at the Kyger Creek Station.

- Contractor will proceed with construction of the LVWTS, including re-grading the area and installing a composite liner system, slope protection, and new pond outlet structure. CCR material removed from the LVWTS footprint will be used to regrade the pond closure area (west portion) around the concrete settling tank area.
  - The contractor will remove material from the area of the new divider berm between the closed portion of the BSP and the new LVWTS. This material will be re-compacted in lifts as necessary to satisfy applicable dam permit requirements and must be performed after receipt of the dam permit (if required), receipt of the LVWTS permit to install, and award of the LVWTS construction contract. The duration shown is based on a quantity of approximately 236,000 CY of material within the pond footprint. This work will start following award of the LVWTS modifications contract and after startup of the BSHS (after the large volume CCR wastestreams have been removed from the BSP.
  - The contractor will re-grade approximately 300,000 CY of material within the pond footprint. It is assumed the contractor will dewater the working area throughout this time with four weeks of dewatering included upfront, prior to commencing grading operations. This work will be performed concurrently with the berm construction following award of the LVWTS modifications contract and after startup of the BSHS (after the large volume CCR wastestreams have been removed from the BSP). This schedule assumes that the CCR material will not need to be double handled prior to compacting in place.
  - The composite liner system will consist of a geosynthetic clay liner, 60-mil high-density polyethylene geomembrane, geotextile, and 12-inches of suitable fill material. The LVWTS footprint is approximately 14.1 acres. A preliminary cross section of the liner system is provided in Appendix A. Additionally, 18-inches of riprap will be placed on the pond slopes and 6-inches of concrete will be placed over the bottom of the primary basin to facilitate cleanout. This liner system installation will overlap the last month of the grading operations as well as the completion of the berm construction.
- The contractor will install piping to reroute the non-CCR wastestreams to the LVWTS. This activity will happen concurrently with the BSHS construction, and the tie-points (tees and valves) will be installed as necessary during prior outages so that once the pond construction and NPDES permit modifications are completed, the flows to the SFAP can cease and flow to the new LVWTS can be initiated.
- Startup and commissioning of new LVWTS is expected to take three weeks to optimize the chemical feed systems and cease use of the SFAP for non-CCR wastestreams.

Closure of the BSP will officially commence no later than 30 days after the date on which the CCR surface impoundment receives the known final receipt of CCR waste. This work will be performed concurrently with the LVWTS construction; however, those activities are not part of this demonstration and have not been included in the narrative or the schedule included herein. The SFAP will initiate closure within 30 days of both the final receipt of non-CCR flows (redirected to the LVWTS) and completion of the dry fly ash conveying system construction; however, this date may be delayed by a number of factors, including delays in dewatering and re-grading efforts caused by adverse weather, contractor efficiency, outage impacts or potential craft shortages associated with future COVID-19 peaks, and changes to the actual quantities required for CCR re-grading. The SFAP is an eligible unlined CCR surface impoundment, and if a need for a later compliance deadline is determined, OVEC will seek additional time as described in 40 CFR § 257.103(f)(1)(vii).

2.4 Progress Narrative Toward Obtaining Alternative Capacity - § 257.103(f)(1)(iv)(A)(4)

In the preamble to the final Part A rule, EPA explains that this "section [of the workplan] must discuss all of the steps taken, starting from when the owner or operator initiated the design phase all the way up to the current steps occurring while the workplan is being drafted." 85 Fed. Reg. at 53,544. The discussion also must indicate where the facility currently is on the timeline and the processes that are currently being undertaken at the facility to develop alternative capacity. 85 Fed. Reg. at 53,545.

As described in Section 2.1.6 and as shown in Appendix B, OVEC has made considerable progress in developing a path forward for obtaining alternative disposal capacity for the CCR and non-CCR wastestreams at the Kyger Creek Station that are currently managed in the CCR surface impoundments. BMcD and OVEC have completed the project scoping and cost estimate development efforts, have selected the preferred compliance solution for the plant, and are finalizing the contracting approach. The long lead-items have been procured for the dry fly ash system (dry ash handling equipment, conveyors, silo, and the PCM/transformers), water sampling efforts and preliminary design has been completed for the BSHS, laser scans have been completed, and the geotechnical investigation has been completed. OVEC did not have a CCR closure trigger for the SFAP, which is an eligible unlined CCR surface impoundment, and did not have clarity on the regulatory requirements prior to the release of the updated CCR Rule (*A Holistic Approach to Closure Part A: Deadline To Initiate Closure)*, which was proposed (pre-published) on November 4, 2019, and finalized by EPA on August 28, 2020.

The BSP did experience an SSL for an Appendix IV parameter. As a result, an assessment of corrective measures was completed, which identified the most feasible corrective measures for the unit, but also identified additional field work that was needed to better understand site conditions prior to selecting and subsequently implementing the appropriate corrective measure. That field work continues, and includes:

1. Conducting additional characterization of the groundwater near the BSP through a more expansive monitoring scheme. Additional groundwater monitoring wells were installed at the OVEC property line to determine if groundwater leaving the OVEC site exhibited similar concentrations of CCR groundwater parameters to the wells observed to be exceeding GWPS. To date, none of the wells at the OVEC property line have been found to exhibit similar concentrations of the CCR parameters.
2. Continuing to collect groundwater elevation information at various points across the site to help better understand the groundwater dynamics near the unit.
3. Conducting additional and extensive geotechnical exploration to better characterize the site to provide support in selecting the appropriate corrective measure. While the initial phase of field work was completed earlier in 2020, the information gathered during those efforts are still being evaluated. OVEC is reflecting that progress in semiannual Remedy Selection Progress Reports, which will be updated in December 2020.

Separately, OVEC determined it was appropriate to pause before executing its CCR/ELG compliance strategy prior to learning how the continued development of those rules could ultimately impact that strategy. For example, revisions being made to the bottom ash transport water requirements in the ELG rule were anticipated to impact the manner in which OVEC would manage its operation once the rule was issued final. It is imperative given the physical constraints of the facility that OVEC's CCR Rule compliance strategy, which will result in numerous plant modifications, would also enable the plant to meet the requirements of the revised ELG rule (85 Fed. Reg. 64,650 (October 13, 2020).

3.0 DOCUMENTATION AND CERTIFICATION OF COMPLIANCE

To demonstrate that the criteria in 40 C.F.R. § 257.103(f)(1)(iii) has been met, the following information and submissions are submitted pursuant to 40 C.F.R. § 257.103(f)(1)(iv)(B) to demonstrate that the Kyger Creek Station is in compliance with the CCR Rule. The Kyger Creek Station includes the following CCR units:

- The Boiler Slag Pond (one of the two units that are the subject of this demonstration)
- The South Fly Ash Pond (one of the two units that are the subject of this demonstration)
- The CCR Landfill

The CCR Landfill is located over two miles away from the Kyger Creek Station on the other side of Kyger Creek. While this unit could potentially be considered its own facility, OVEC has included the compliance documentation for this landfill as part of this demonstration (in Appendix C).

3.1 Owner's Certification of Compliance - § 257.103(f)(1)(iv)(B)(1)

In accordance with 40 CFR § 257.103(f)(1)(i)(C), I hereby certify that, based on my inquiry of those persons who are immediately responsible for compliance with environmental regulations for the Kyger Creek Station, the facility is in compliance with all of the requirements contained in 40 CFR §257 Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. Kyger Creek's CCR compliance website is up-to-date and contains all the necessary documentation and notification postings.

OHIO VALLEY ELECTRIC CORPORATION

J. Michael Brown

J. Michael Brown
Environmental, Safety & Health Director
November 30, 2020

3.2 Visual Representation of Hydrogeologic Information - § 257.103(f)(1)(iv)(B)(2)

Consistent with the requirements of § 257.103(f)(1)(iv)(B)(2)(i) – (iii), OVEC has attached the following items to this demonstration:

- Map(s) of groundwater monitoring well locations in relation to the CCR units are included in Appendix C1
- Well construction diagrams and drilling logs for all groundwater monitoring wells are included in Appendix C2 (see Appendix C of the attached October 2016 report provided by Applied Geology and Environmental Science, Inc.)
- Well construction diagrams and drilling logs for sentinel wells, which were installed as part of OVEC's Assessment of Corrective Measures (ACM) discussed below, are included in Appendix C5 (see Appendix D of the attached ACM report). Additionally, Figure F-3 found in the ACM depicts the location of the sentinel wells.
- Maps that characterize the direction of groundwater flow accounting for seasonal variations are included in Appendix C3

3.3 Groundwater Monitoring Results - § 257.103(f)(1)(iv)(B)(3)

The groundwater monitoring data through the second 2020 semi-annual sampling event is summarized in the table included as Appendix C4. Data included from the September 2020 sampling event is still under review, and radium 226 and 228 analyses have not yet been completed by the analyzing laboratory for KC-15-03, KC-15-09, KC-15-20, KC-15-21, and KC 15-22.

3.4 Description of Site Hydrogeology - § 257.103(f)(1)(iv)(B)(4)

A description of the site hydrogeology is included in Appendix C2 (see Section 3 of the attached October 2016 report provided by Applied Geology and Environmental Science, Inc.) and stratigraphic cross-sections of the site are included as Appendix C1.

3.5 Corrective Measures Assessment - § 257.103(f)(1)(iv)(B)(5)

Background sampling occurred between October of 2015 and September of 2017 with nine independent samples collected for each CCR surface impoundment (the BSP and SFAP). The first semi-annual detection monitoring samples were collected in February/March of 2018.

During the February/March 2018 event at the SFAP, statistically significant increases (SSIs) were identified for calcium, TDS and sulfate at wells KC-15-19 and KC-15-20, and calcium at well KC-15-21. For this unit, OVEC initially pursued an Alternate Source Demonstration (ASD); however, the results did not clearly indicate an alternate source. Based on these results, OVEC initiated an assessment monitoring program for the SFAP, which began in September 2018. SSIs for various Appendix III constituents were observed in wells KC-15-18 through KC-15-21 in the September 2018, March 2019, and September 2019 monitoring events. None of the results for Appendix IV parameters for any assessment monitoring event have exceed the established Groundwater Protection Standards (GWPS) for the SFAP. Therefore, the SFAP has remained in assessment monitoring and an assessment of corrective measures (ACM) is not currently required.

During the February/March 2018 event at the BSP, SSIs were identified for boron, TDS, and sulfate at KC-15-04 and KC-15-05, and boron, TDS, sulfate, and calcium at KC-15-08. SSIs for various Appendix III constituents were observed in wells KC-15-04, KC-15-05 and KC-15-08 in the September 2018, March 2019, and September 2019 monitoring events. For this unit, OVEC initially pursued an ASD; however, the results did not clearly indicate an alternate source. Consequently, OVEC initiated an assessment monitoring program for the BSP, which began in September 2018. Arsenic has been the only Appendix IV parameter to exceed the established GWPS for the BSP during any assessment monitoring event. Based on these results, OVEC completed ACM at the BSP in September 2019, and the report is included as Appendix C5.

The CCR landfill continues in detection monitoring since no SSIs have been identified. As a result, an ACM is not required. OVEC will continue to perform groundwater monitoring activities at the CCR landfill as prescribed by the CCR Rule.

3.6 Remedy Selection Progress Report - § 257.103(f)(1)(iv)(B)(6)

As noted above, an assessment of corrective measures and the resulting remedy selection efforts are not currently required for the SFAP or the CCR Landfill. The first remedy selection progress report for the BSP (from May 2020) is included as Appendix C6. The second semi-annual progress report is currently being finalized and will be published on OVEC's CCR compliance website while EPA is reviewing this demonstration.

3.7 Structural Stability Assessment - § 257.103(f)(1)(iv)(B)(7)

Pursuant to § 257.73(d), the initial structural stability assessment reports for the CCR surface impoundments were prepared in October 2016 and is included as Appendix C7. As required for compliance, another stability assessment will be completed in October 2021. Periodic structural stability assessments are not required for landfills.

3.8 Safety Factor Assessment - § 257.103(f)(1)(iv)(B)(8)

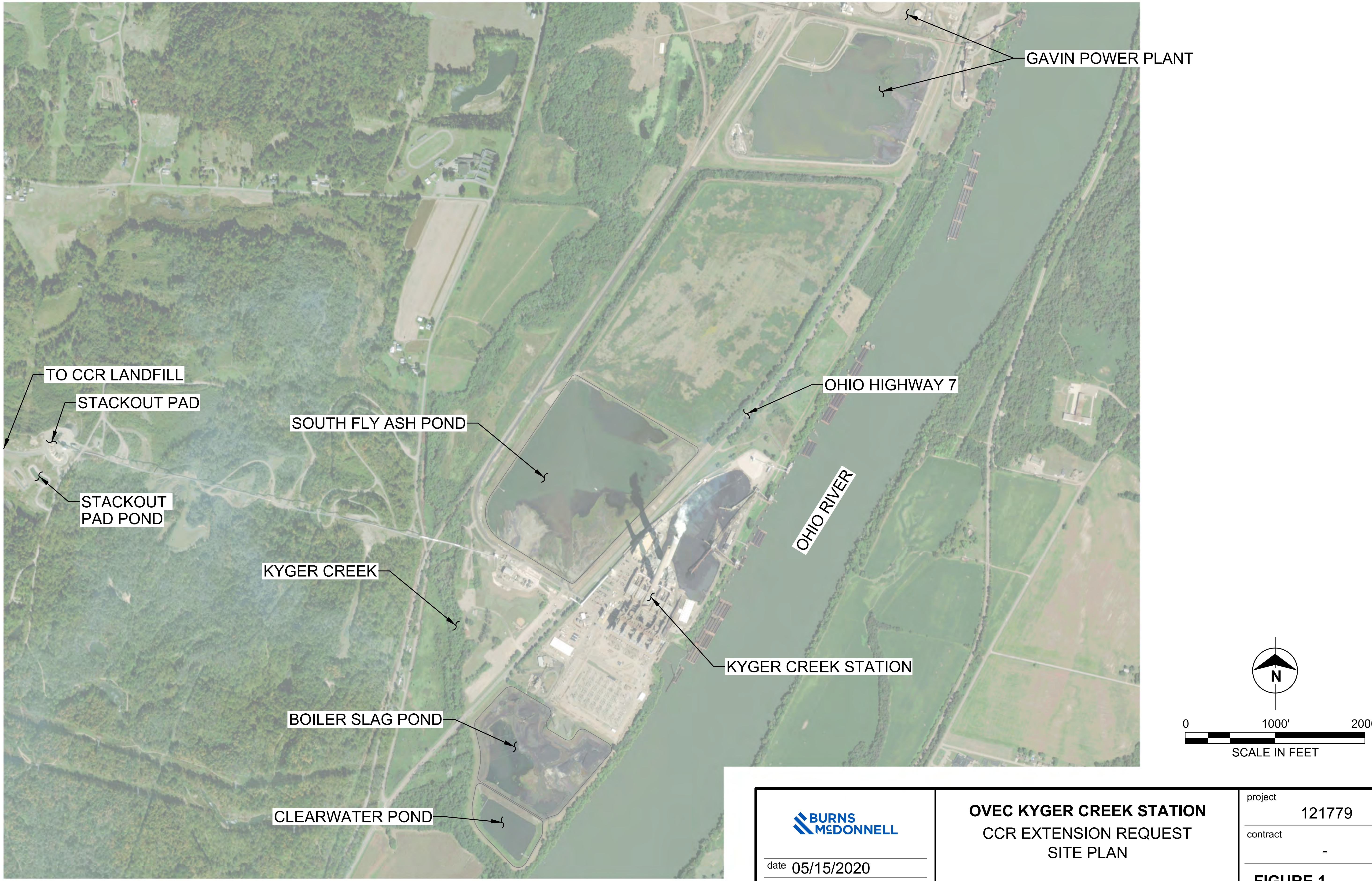
Pursuant to § 257.73(e), the initial safety factor assessment report for the CCR surface impoundments was prepared in October 2016 and is included as Appendix C8. As required for compliance, another stability assessment will be completed in October 2021. Periodic safety factor assessments are not required for landfills.

4.0 CONCLUSION

Based upon the information submitted in this demonstration, it has been shown the CCR surface impoundments at the Kyger Creek Station qualify for a site-specific alternative deadline for the initiation of closure as allowed by 40 CFR 257.103(f)(1).

Therefore, OVEC requests that EPA approve this demonstration, thereby granting the alternative deadline of October 17, 2022, to cease routing all CCR wastestreams to the BSP and initiate closure of this CCR surface impoundment and September 22, 2023, to cease routing all CCR and non-CCR wastestreams to the SFAP and initiate closure of this eligible unlined CCR surface impoundment. Following approval of this demonstration, OVEC will update the closure plan for the impoundments to further reflect the schedule and the methods identified herein. There are several variables that could impact the construction of the concrete settling tanks and LVWTS and the initiation of closure of the CCR surface impoundments, including delays in re-grading efforts associated with weather, contractor efficiency, the actual total volume of earthwork to be completed, as well as unexpected delays in securing applicable environmental permitting required to begin this work. OVEC will update EPA on the project and any potential schedule impacts as part of the semi-annual progress reports required at 40 CFR § 257.103(f)(1)(x), and if a need for a later compliance deadline is determined, OVEC will seek additional time as described in 40 CFR § 257.103(f)(1)(vii).

APPENDIX A – SITE PLANS, WATER BALANCE, AND PRELIMINARY DESIGN FIGURES



BURNS McDONNELL

date 05/15/2020

designed A. MYERS

OVEC KYGER CREEK STATION

CCR EXTENSION REQUEST
SITE PLAN

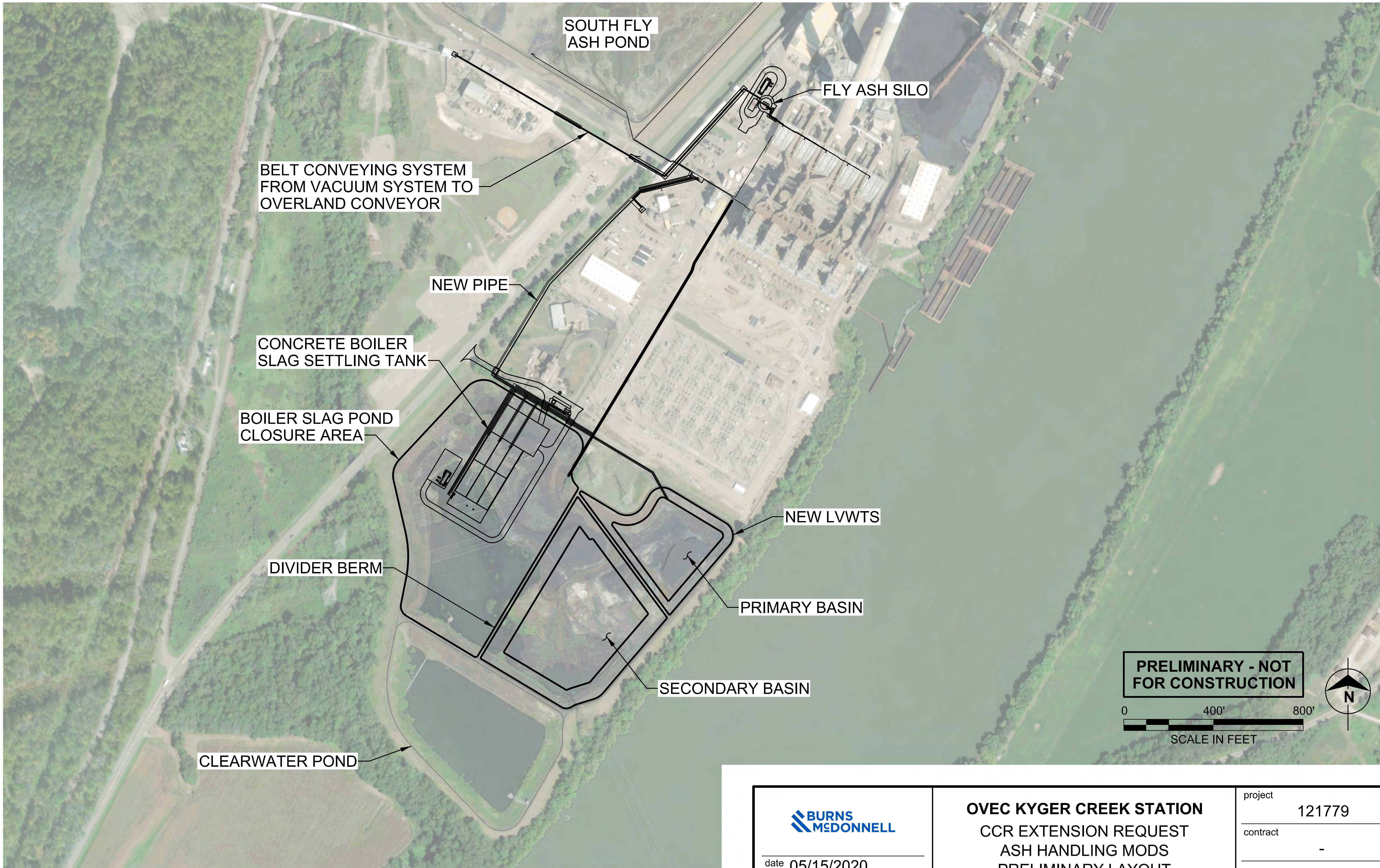
project 121779

contract -

FIGURE 1

10/15/2020

Z:\Clients\ENR\OVEC\121779_KYGERSLAGPDR\Design\Civil\Dwgs\Sketches\Extension Request\121779 Figure 1.dgn



BURNS McDONNELL

date 05/15/2020

designed A. MYERS

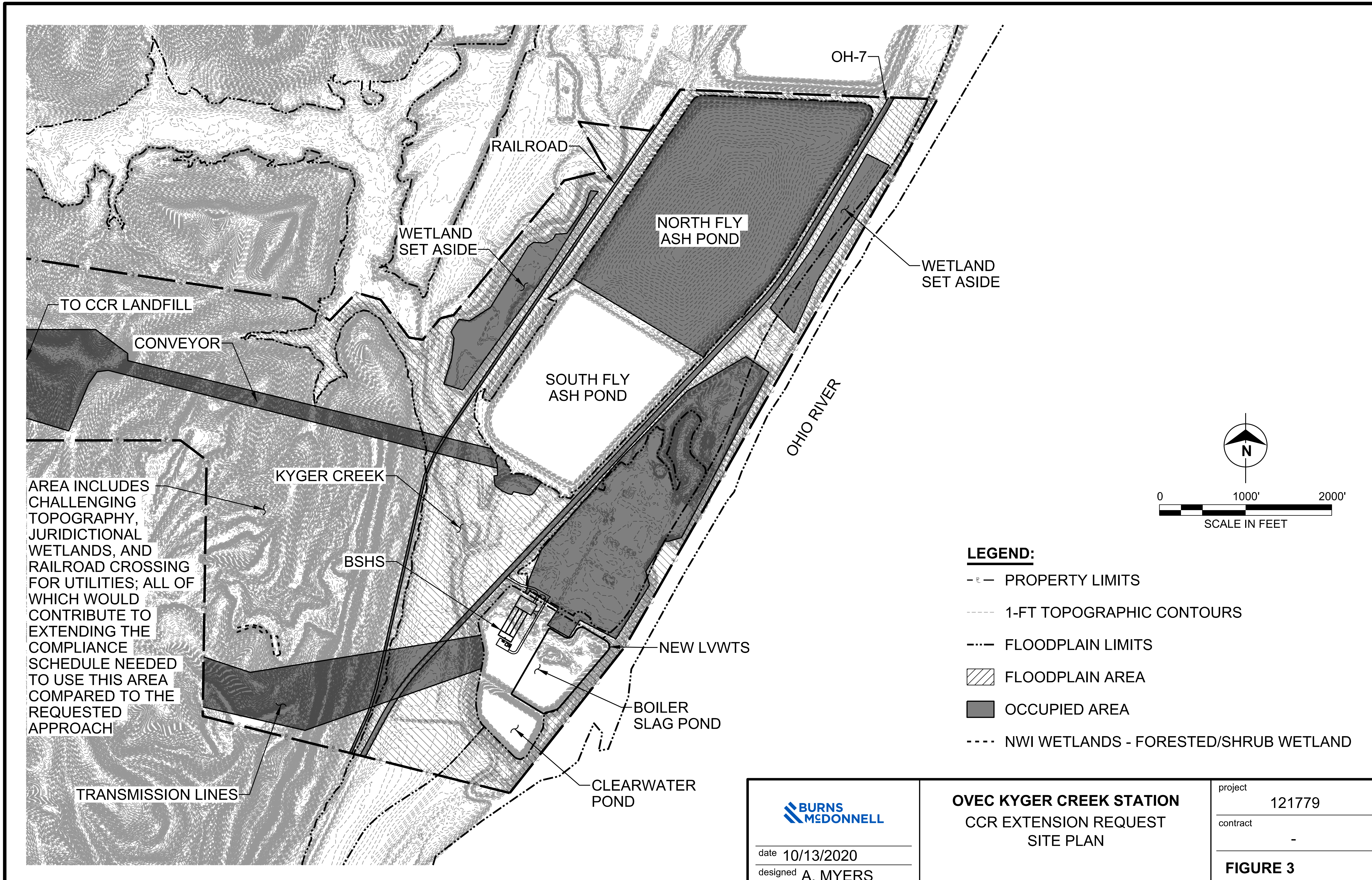
OVEC KYGER CREEK STATION

CCR EXTENSION REQUEST
ASH HANDLING MODS
PRELIMINARY LAYOUT

project 121779

contract -

FIGURE 2



BURNS McDONNELL

date 10/13/2020

designed A. MYERS

OVEC KYGER CREEK STATION

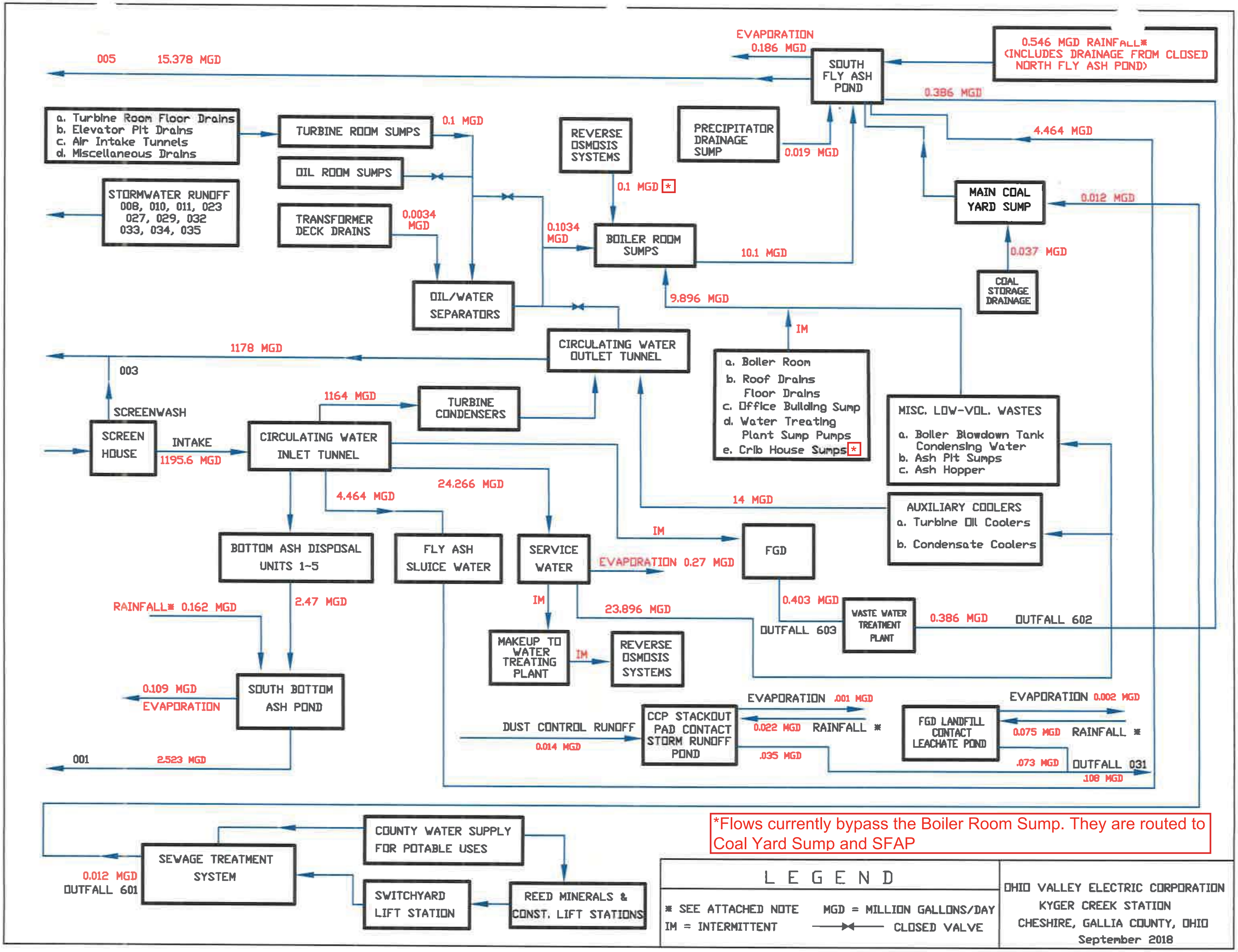
CCR EXTENSION REQUEST

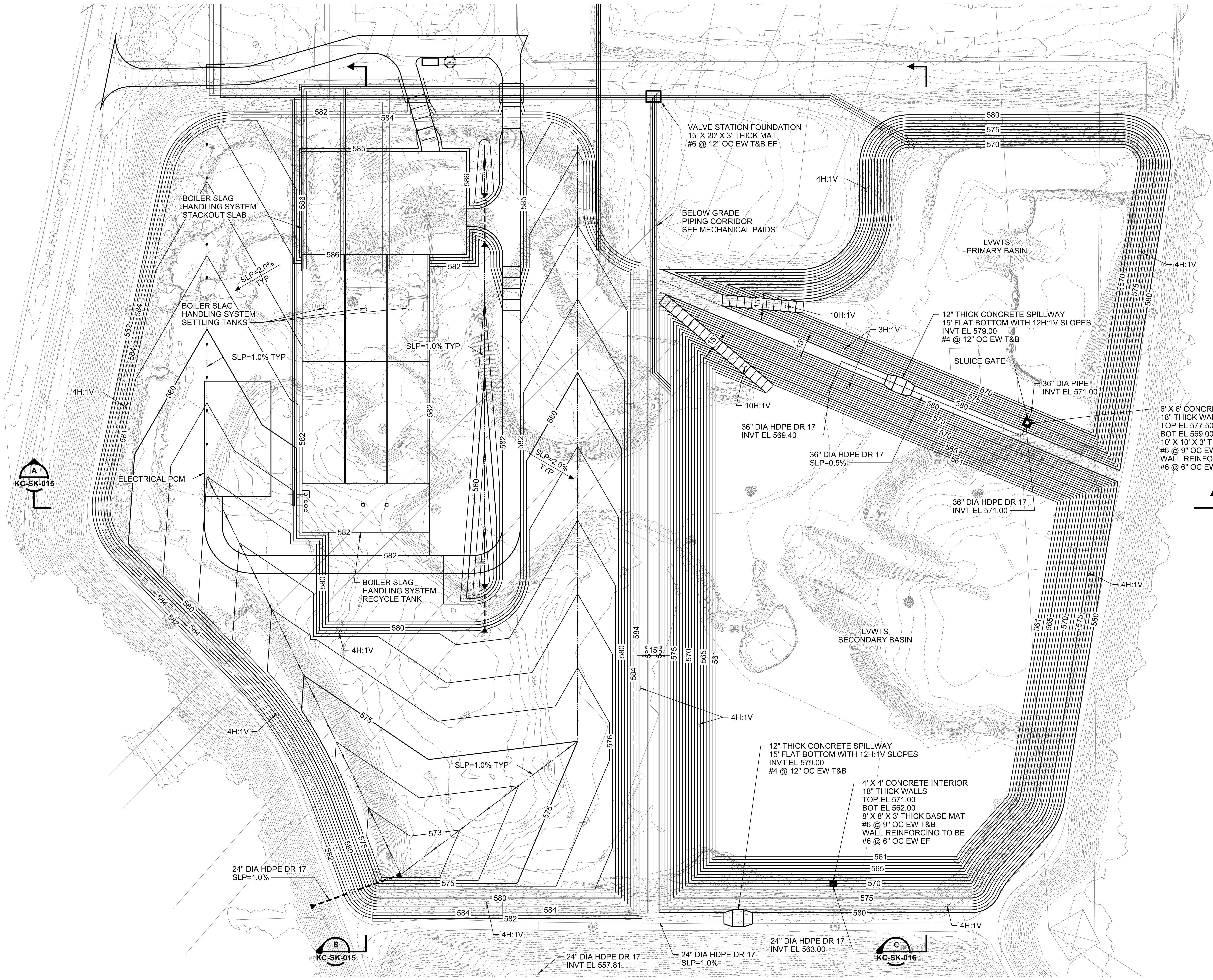
SITE PLAN

project 121779

contract -

FIGURE 3


EVAPORATION
0.186 MGD
005
15.378 MGD
SOUTH FLY ASH POND
0.546 MGD RAINFALL*
(INCLUDES DRAINAGE FROM CLOSED NORTH FLY ASH POND)
0.386 MGD
a. Turbine Room Floor Drains
b. Elevator Pit Drains
c. Air Intake Tunnels
d. Miscellaneous Drains
TURBINE ROOM SUMPS
0.1 MGD
REVERSE OSMOSIS SYSTEMS
PRECIPITATOR DRAINAGE SUMP
0.019 MGD
4.464 MGD
OIL ROOM SUMPS
STORMWATER RUNOFF
008, 010, 011, 023
027, 029, 032
033, 034, 035
0.1 MGD *
MAIN COAL YARD SUMP
0.012 MGD
TRANSFORMER DECK DRAINS
0.0034 MGD
0.1034 MGD
BOILER ROOM SUMPS
10.1 MGD
0.037 MGD
COAL STORAGE DRAINAGE
OIL/WATER SEPARATORS
9.896 MGD
IM
CIRCULATING WATER OUTLET TUNNEL
1178 MGD
003
a. Boiler Room
b. Roof Drains
Floor Drains
c. Office Building Sump
d. Water Treating
Plant Sump Pumps
e. Crib House Sumps *
1164 MGD
TURBINE CONDENSERS
SCREENWASH
MISC. LOW-VOL. WASTES
a. Boiler Blowdown Tank
Condensing Water
b. Ash Pit Sumps
c. Ash Hopper
SCREEN HOUSE
INTAKE
1195.6 MGD
CIRCULATING WATER INLET TUNNEL
24.266 MGD
4.464 MGD
14 MGD
AUXILIARY COOLERS
a. Turbine Oil Coolers
b. Condensate Coolers
IM
BOTTOM ASH DISPOSAL UNITS 1-5
FLY ASH SLUICE WATER
SERVICE WATER
EVAPORATION 0.27 MGD
FGD
RAINFALL* 0.162 MGD
2.47 MGD
IM
23.896 MGD
0.403 MGD
WASTE WATER TREATMENT PLANT
0.386 MGD
OUTFALL 602
OUTFALL 603
MAKEUP TO WATER TREATING PLANT
IM
REVERSE OSMOSIS SYSTEMS
0.109 MGD
EVAPORATION
SOUTH BOTTOM ASH POND
EVAPORATION .001 MGD
EVAPORATION 0.002 MGD
DUST CONTROL RUNOFF
0.014 MGD
CCP STACKOUT PAD CONTACT STORM RUNOFF POND
0.022 MGD
RAINFALL *
.035 MGD
FGD LANDFILL CONTACT LEACHATE POND
0.075 MGD
RAINFALL *
.073 MGD
OUTFALL 031
.108 MGD
001
2.523 MGD
COUNTY WATER SUPPLY FOR POTABLE USES
*Flows currently bypass the Boiler Room Sump. They are routed to Coal Yard Sump and SFAP
SEWAGE TREATMENT SYSTEM
0.012 MGD
OUTFALL 601
SWITCHYARD LIFT STATION
REED MINERALS & CONST. LIFT STATIONS
LEGEND
* SEE ATTACHED NOTE
MGD = MILLION GALLONS/DAY
IM = INTERMITTENT
CLOSED VALVE
OHIO VALLEY ELECTRIC CORPORATION
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
September 2018



NOTES:

1. CONTOURS REPRESENT FINISH GRADING (TOP OF SURFACING) AS SHOWN ON TYPICAL SECTIONS ON DWG KC-SK-017.

NORTH

0 60' 120'
SCALE IN FEET

PRELIMINARY - NOT FOR CONSTRUCTION

no.	date	by	ckd	description
A	10/29/20	DGK	ETT	ISSUED FOR INFORMATION

BURNS McDONNELL
9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400
Burns & McDonnell Engineering Co, Inc.
CERTIFICATE OF AUTHORITY NO. 01557

designed: D. KROGER
detailed: J. RIDDER

OVEC IKEC
Ohio Valley Electric Corporation / Indiana-Kentucky Electric Corporation

CCR / ELG FEED STUDY
KYGER CREEK GENERATING STATION
GALLIA COUNTY, OHIO

LOW-VOLUME WASTEWATER TREATMENT SYSTEM FINISH GRADING PLAN

project: 125241
contract:
drawing: KC-SK-014
rev.: A
sheet of sheets
file 125241 KC-SK-014.DGN

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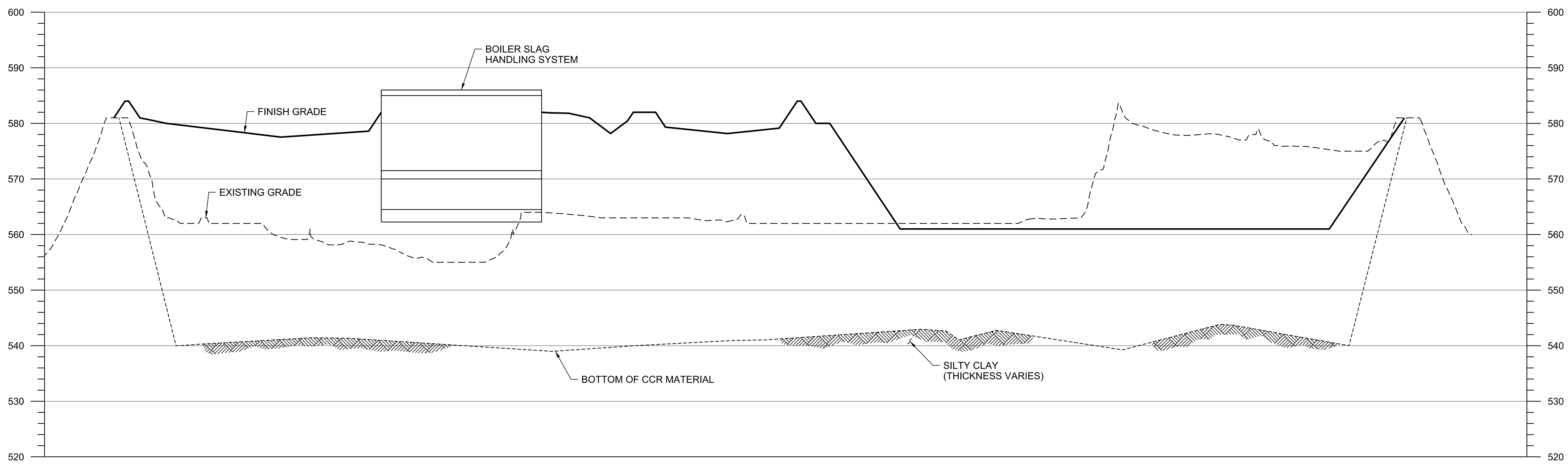
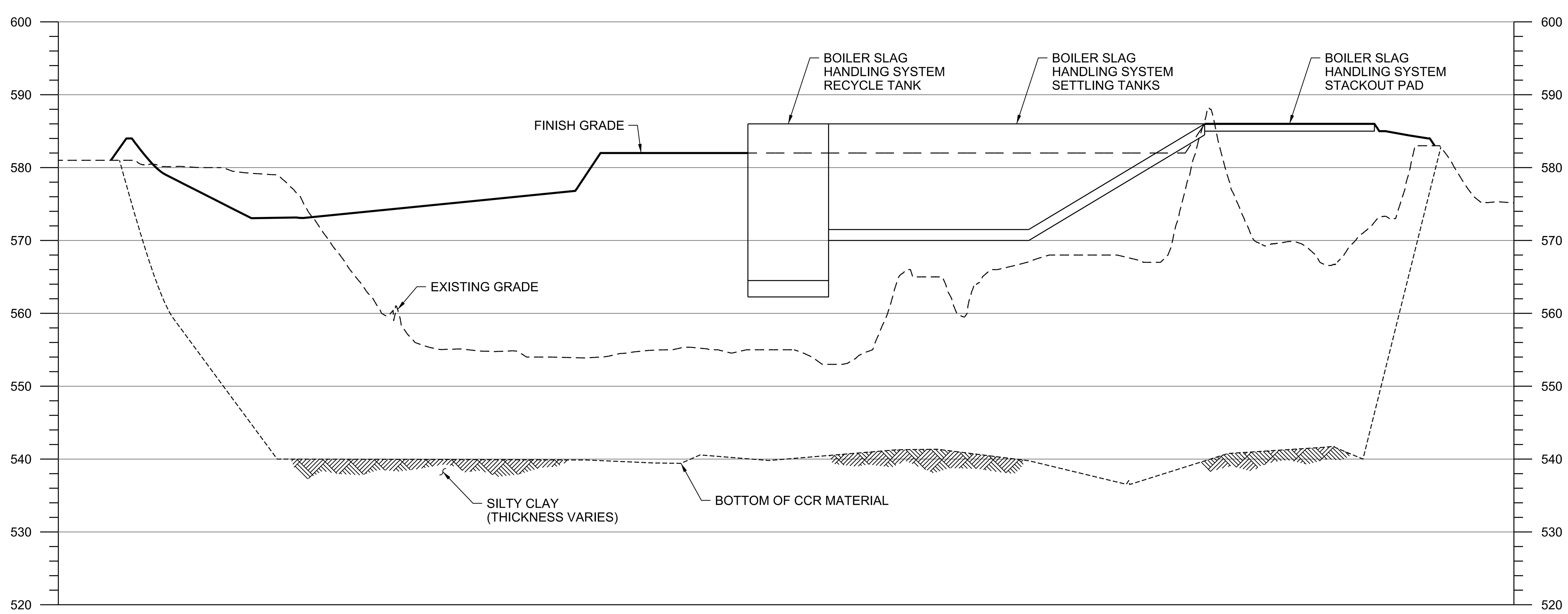
11/5/2020



SECTION A KC-SK-014

HORIZ: 0 60' 120' SCALE IN FEET

VERT: 0 10' 20' SCALE IN FEET



SECTION B KC-SK-014

HORIZ: 0 60' 120' SCALE IN FEET

VERT: 0 10' 20' SCALE IN FEET

NORTH

0 60' 120' SCALE IN FEET

PRELIMINARY - NOT FOR CONSTRUCTION

no.	date	by	ckd	description
A	10/29/20	DGK	ETT	ISSUED FOR INFORMATION

no.	date	by	ckd	description

BURNS McDONNELL
9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400
Burns & McDonnell Engineering Co, Inc.
CERTIFICATE OF AUTHORITY NO. 01557

designed D. KROGER
detailed J. RIDDER

OVEC IKEC
Ohio Valley Electric Corporation / Indiana-Kentucky Electric Corporation

CCR / ELG FEED STUDY
KYGER CREEK GENERATING STATION
GALLIA COUNTY, OHIO

LOW-VOLUME WASTEWATER TREATMENT SYSTEM FINISH GRADING SECTIONS

project 125241
contract

drawing **KC-SK-015** — rev. **A**

sheet of sheets

file 125241 KC-SK-015.DGN

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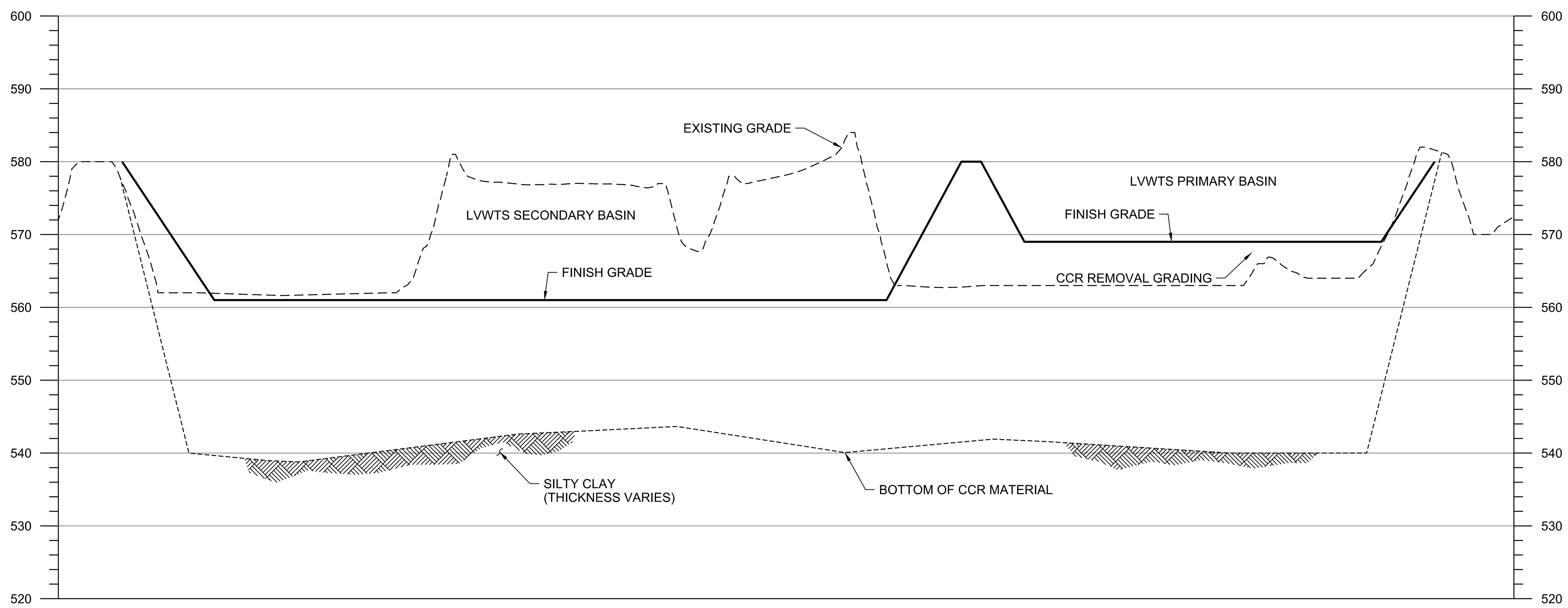
11/5/2020



SECTION C KC-SK-014

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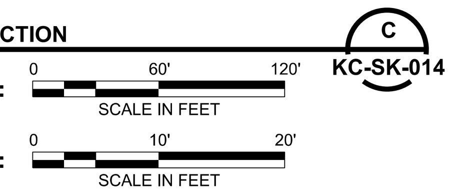

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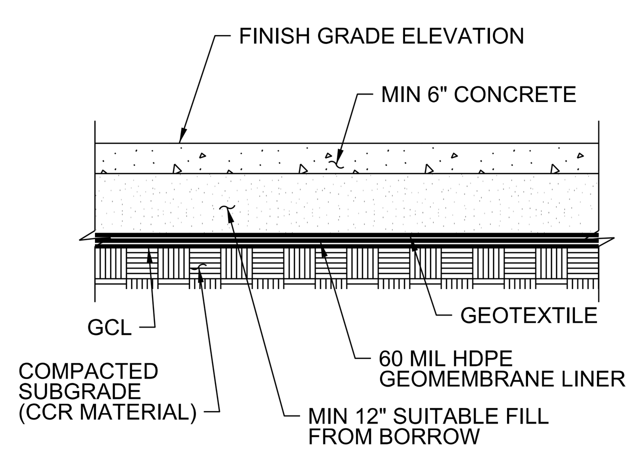
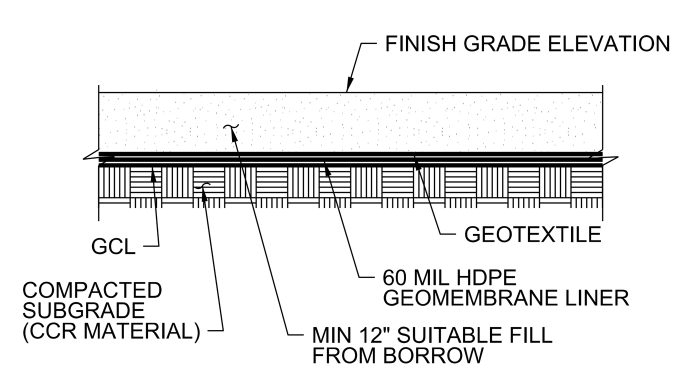


LVWTS PRIMARY BASIN
TYPICAL BOTTOM SURFACING
NOT TO SCALE



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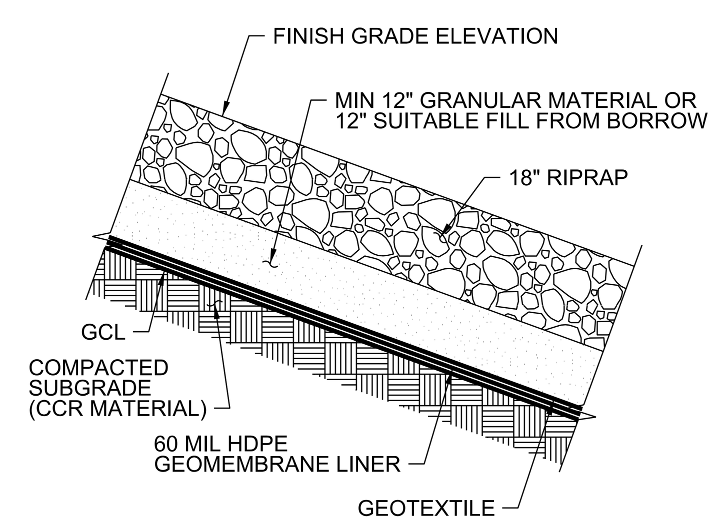
TYPICAL BOTTOM SURFACING
NOT TO SCALE



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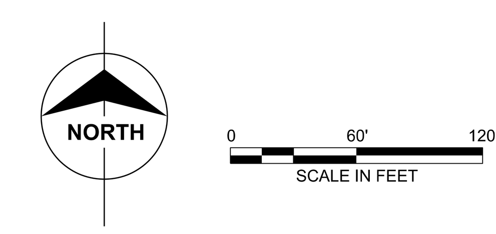
NOT TO SCALE



PRELIMINARY - NOT FOR CONSTRUCTION

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GALLIA COUNTY, OHIO

LOW-VOLUME WASTEWATER
TREATMENT SYSTEM
FINISH GRADING SECTIONS

project 125241 | contract

drawing **KC-SK-016** — rev. **A**

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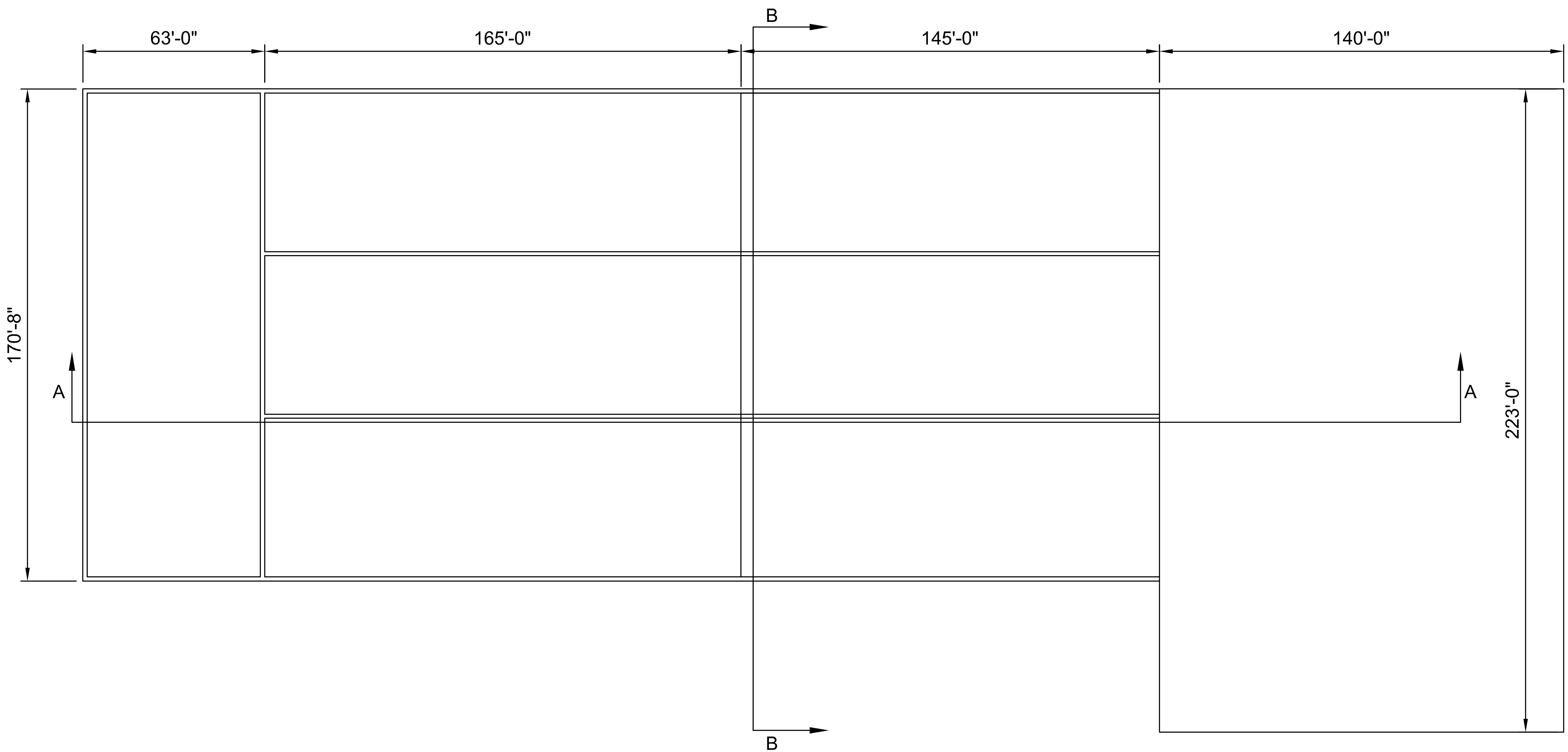


BURNS McDONNELL

date 10/30/2020

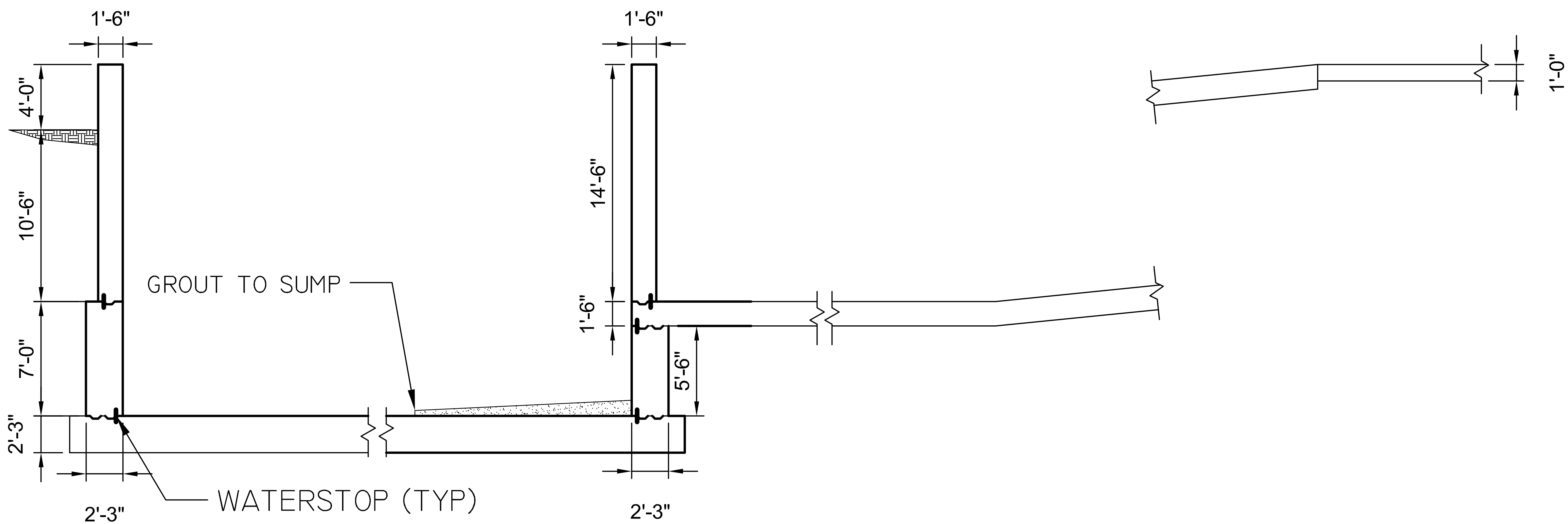
designed R. MAESTRI

KYGER CREEK GENERATING STATION
RECYCLE AND SETTLING TANKS
PLAN VIEW

project 125241

contract

SK - S001



BURNS McDONNELL

date 10/30/2020

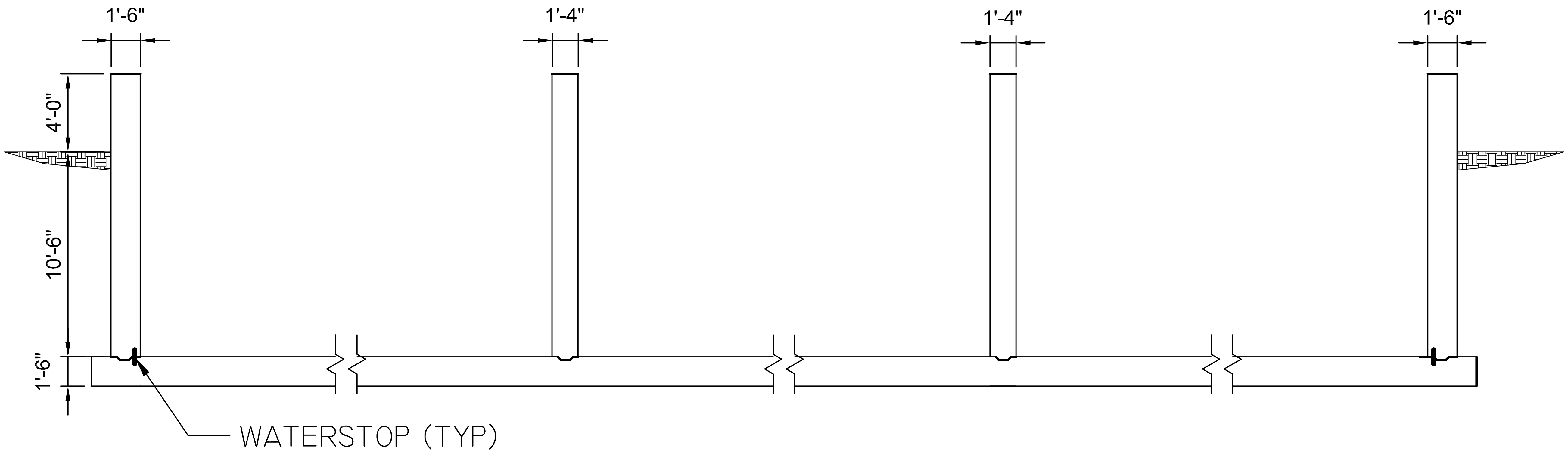
designed R. MAESTRI

KYGER CREEK GENERATING STATION
RECYCLE AND SETTLING TANKS
SECTION A

project 125241

contract

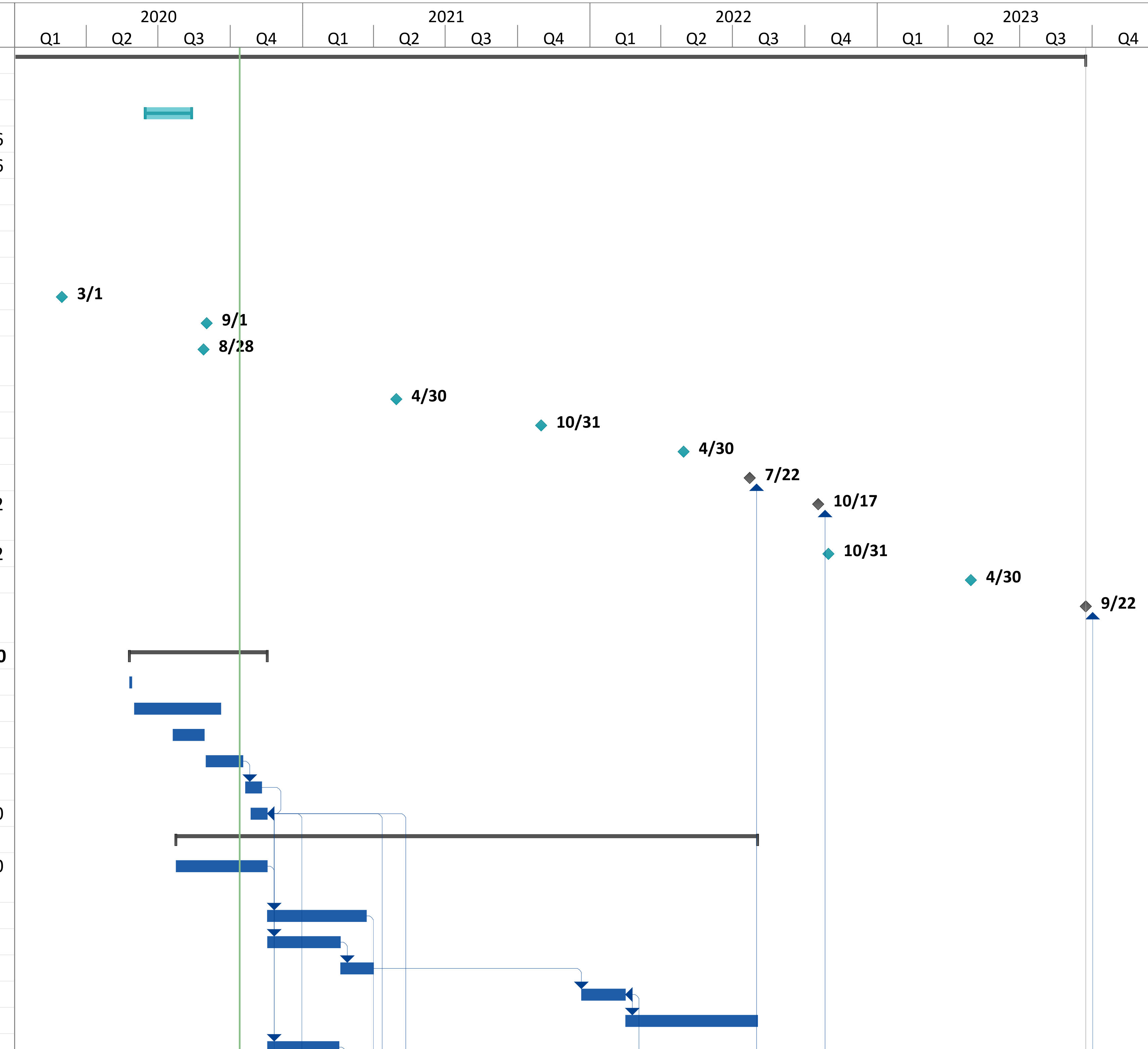
SK - S002



BURNS McDONNELL	KYGER CREEK GENERATING STATION RECYCLE AND SETTLING TANKS SECTION B	project 125241
date 10/30/2020		contract
designed R. MAESTRI		**SK - S003**

APPENDIX B – SCHEDULE

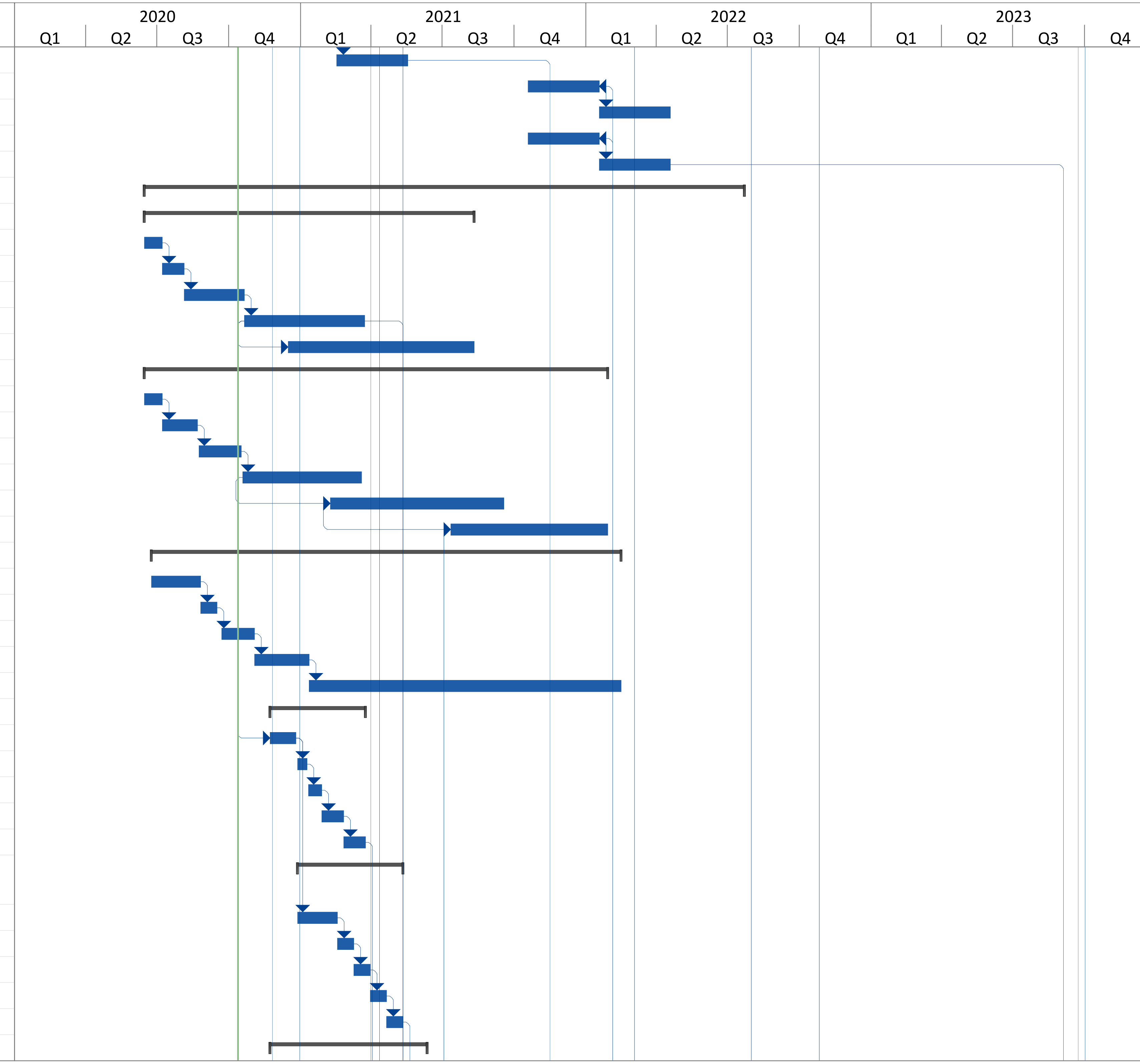
ID	Task Name	Duration	Start	Finish
1	**CCR Compliance Efforts**	**2202 days**	**Fri 4/17/15**	**Fri 9/22/23**
2	Final CCR Rule Published in Federal Register	0 days	Fri 4/17/15	Fri 4/17/15
3	Background Groundwater Sampling	43 days	Mon 6/15/20	Wed 8/12/20
4	Completed Liner Documentation	0 days	Mon 10/10/16	Mon 10/10/16
5	Prepared Surface Impoundment History of Construction	0 days	Mon 10/10/16	Mon 10/10/16
6	First Detection Monitoring Samples	0 days	Thu 10/1/15	Thu 10/1/15
7	Assessment Monitoring Program - First Round	0 days	Sat 9/1/18	Sat 9/1/18
8	Assessment Monitoring Program - Second Round	0 days	Fri 3/1/19	Fri 3/1/19
9	Assessment Monitoring Program - Third Round	0 days	Sun 9/1/19	Sun 9/1/19
10	Assessment Monitoring Program - Fourth Round	0 days	Sun 3/1/20	Sun 3/1/20
11	Assessment Monitoring Program - Fourth Round	0 days	Tue 9/1/20	Tue 9/1/20
12	EPA Published Final ELG Rule and CCR Holistic Approach to Closure Part A Rule	0 days	Fri 8/28/20	Fri 8/28/20
13	Semi-Annual Progress Report #1	0 days	Fri 4/30/21	Fri 4/30/21
14	Semi-Annual Progress Report #2	0 days	Sun 10/31/21	Sun 10/31/21
15	Semi-Annual Progress Report #3	0 days	Sat 4/30/22	Sat 4/30/22
16	Cease Sluicing Fly Ash to SFAP	0 days	Fri 7/22/22	Fri 7/22/22
17	Cease Sluicing Boiler Slag to BSP (BSHS in service) and initiate BSP closure	0 days	Mon 10/17/22	Mon 10/17/22
18	Semi-Annual Progress Report #4	0 days	Mon 10/31/22	Mon 10/31/22
19	Semi-Annual Progress Report #5	0 days	Sun 4/30/23	Sun 4/30/23
20	Redirect non-CCR wastestreams from SFAP to LVWTS and initiate SFAP closure	0 days	Fri 9/22/23	Fri 9/22/23
21	**Budgetary and Feed Study**	**125 days**	**Tue 5/26/20**	**Mon 11/16/20**
22	Perform Laser Scan & Transmit Results	3 days	Tue 5/26/20	Thu 5/28/20
23	Complete Initial Geotechnical Investigation	80 days	Mon 6/1/20	Fri 9/18/20
24	Prepare Scope Documents and Subcontract Packages	30 days	Mon 7/20/20	Fri 8/28/20
25	Subcontractor Budget Quotes	35 days	Mon 8/31/20	Fri 10/16/20
26	Finalize Estimate and Report	15 days	Tue 10/20/20	Mon 11/9/20
27	Owner Review & Board Approval	15 days	Tue 10/27/20	Mon 11/16/20
28	**Permitting**	**527 days**	**Fri 7/24/20**	**Mon 8/1/22**
29	Prepare Air Permit Application (Title V and PTI for Conveyors/Equipment)	82 days	Fri 7/24/20	Mon 11/16/20
30	OEPA Review of Air Permit Application	90 days	Tue 11/17/20	Mon 3/22/21
31	Prepare Dam Permit Initial Application	67 days	Tue 11/17/20	Wed 2/17/21
32	ODNR Review of Initial Dam Permit Application	30 days	Thu 2/18/21	Wed 3/31/21
33	Prepare Dam Permit Final Application	40 days	Tue 12/21/21	Mon 2/14/22
34	ODNR Review/Approval of Final Dam Permit Application	120 days	Tue 2/15/22	Mon 8/1/22
35	OEPA Permit to Install Application - BSHS	65 days	Tue 11/17/20	Mon 2/15/21



Project: Kyger Creek CCR Surface Impoundment Extension Demonstration
Date: Tue 10/13/20

Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Deadline
Progress
Manual Progress

ID	Task Name	Duration	Start	Finish
36	OEPA Permit to Install Approval - BSHS	65 days	Tue 2/16/21	Mon 5/17/21
37	OEPA Permit to Install Application - LVWTS/BSP Closure	65 days	Tue 10/19/21	Mon 1/17/22
38	OEPA Permit to Install Approval - LVWTS/BSP Closure	65 days	Tue 1/18/22	Mon 4/18/22
39	Prepare Application for NPDES Permit Modifications	65 days	Tue 10/19/21	Mon 1/17/22
40	OEPA Review/Approval of NPDES Permit Modification	65 days	Tue 1/18/22	Mon 4/18/22
41	**Fly Ash Handling**	**550 days**	**Mon 6/15/20**	**Fri 7/22/22**
42	**Fly Ash Handling Equipment - Procurement**	**302 days**	**Mon 6/15/20**	**Tue 8/10/21**
43	Develop Commercial Documents/Issue Bid Package	17 days	Mon 6/15/20	Tue 7/7/20
44	Bid Period	20 days	Wed 7/8/20	Tue 8/4/20
45	Review, Negotiate and Award	55 days	Wed 8/5/20	Tue 10/20/20
46	Review and Approve Submittals	110 days	Wed 10/21/20	Tue 3/23/21
47	Fabricate/Deliver to Site	170 days	Wed 12/16/20	Tue 8/10/21
48	**Fly Ash Belt Conveyor - Procurement**	**425 days**	**Mon 6/15/20**	**Fri 1/28/22**
49	Develop Commercial Documents/Issue Bid Package	17 days	Mon 6/15/20	Tue 7/7/20
50	Bid Period	33 days	Wed 7/8/20	Fri 8/21/20
51	Review, Negotiate and Award	40 days	Mon 8/24/20	Fri 10/16/20
52	Review and Approve Submittals	110 days	Mon 10/19/20	Fri 3/19/21
53	Fabricate/Deliver to Site	160 days	Mon 2/8/21	Fri 9/17/21
54	Delivery Window	145 days	Mon 7/12/21	Fri 1/28/22
55	**Fly Ash Major Electrical Equipment (PCM) - Procuremen**	**429 days**	**Wed 6/24/20**	**Mon 2/14/22**
56	Develop Commercial Documents/Issue Bid Package	45 days	Wed 6/24/20	Tue 8/25/20
57	Bid Period	15 days	Wed 8/26/20	Tue 9/15/20
58	Review, Negotiate and Award	30 days	Tue 9/22/20	Mon 11/2/20
59	Review and Approve Submittals	50 days	Tue 11/3/20	Mon 1/11/21
60	Fabricate/Deliver to Site	285 days	Tue 1/12/21	Mon 2/14/22
61	**Fly Ash Deep Foundations Construction - Procurement**	**88 days**	**Mon 11/23/20**	**Wed 3/24/21**
62	Develop Drawings and Specs	25 days	Mon 11/23/20	Fri 12/25/20
63	Owner Review/Issue Bid Package	10 days	Mon 12/28/20	Fri 1/8/21
64	Bid Period	13 days	Mon 1/11/21	Wed 1/27/21
65	Bid Evaluation/Award	20 days	Thu 1/28/21	Wed 2/24/21
66	Pre-Plan, Procure, and Mobilize	20 days	Thu 2/25/21	Wed 3/24/21
67	**Fly Ash Foundations & Underground Utilities Construction - Procurement**	**97 days**	**Mon 12/28/20**	**Tue 5/11/21**
68	Develop Drawings and Specs	37 days	Mon 12/28/20	Tue 2/16/21
69	Owner Review/Issue Bid Package	15 days	Wed 2/17/21	Tue 3/9/21
70	Bid Period	15 days	Wed 3/10/21	Tue 3/30/21
71	Bid Evaluation/Award	15 days	Wed 3/31/21	Tue 4/20/21
72	Pre-Plan, Procure, and Mobilize	15 days	Wed 4/21/21	Tue 5/11/21
73	**Fly Ash Mechanical Construction - Procurement**	**145 days**	**Mon 11/23/20**	**Fri 6/11/21**



Project: Kyger Creek CCR Surface Impoundment Extension Demonstration
Date: Tue 10/13/20

Task	External Tasks	Manual Task	Finish-only
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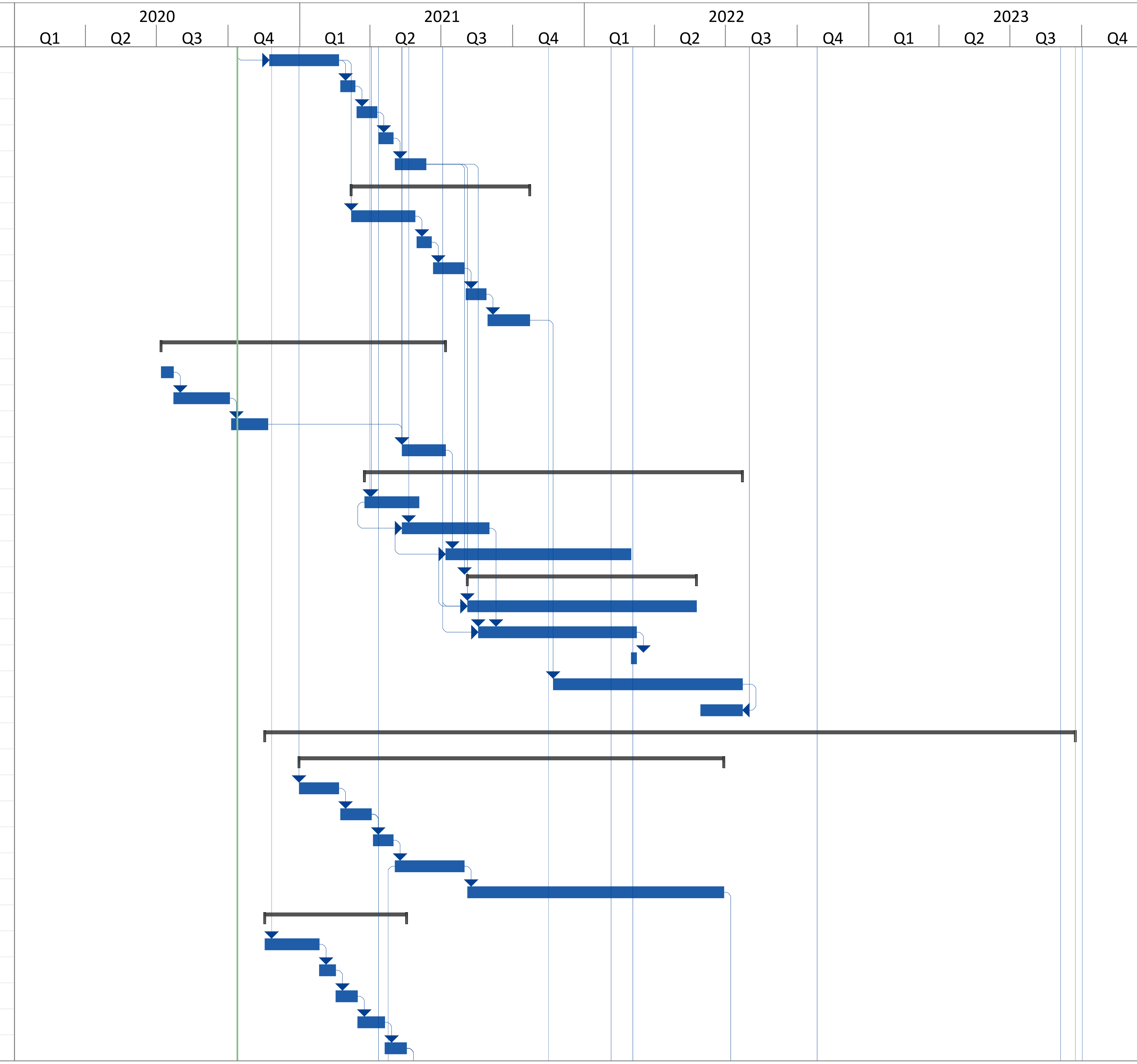
Milestone	Inactive Task	Manual Summary Rollup	Progress
Summary	Inactive Milestone	Manual Summary	Manual Progress
Project Summary	Inactive Summary	Start-only	

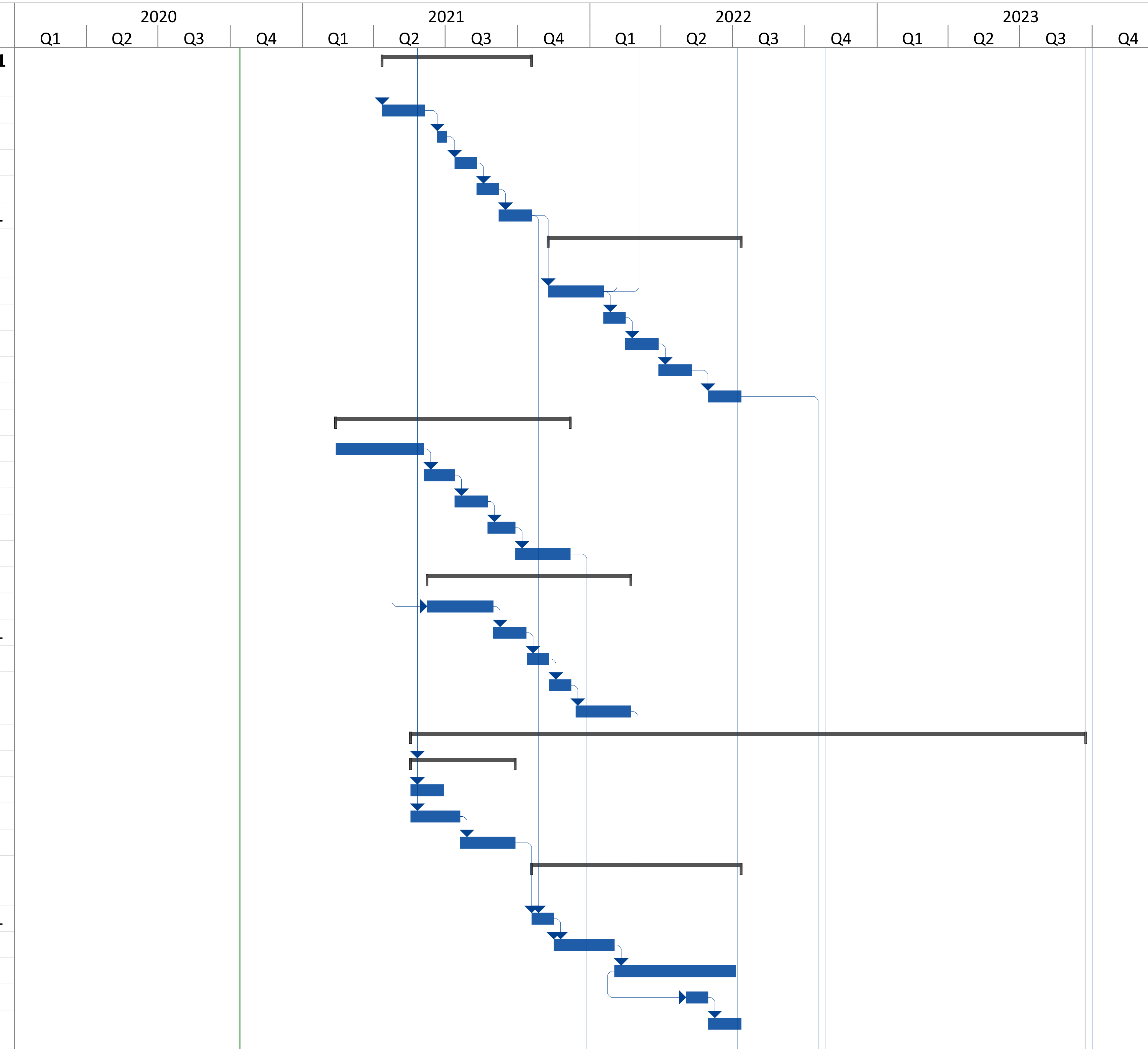
ID	Task Name	Duration	Start	Finish
74	Develop Drawings and Specs	65 days	Mon 11/23/20	Fri 2/19/21
75	Owner Review/Issue Bid Package	15 days	Mon 2/22/21	Fri 3/12/21
76	Bid Period	20 days	Mon 3/15/21	Fri 4/9/21
77	Bid Evaluation/Award	15 days	Mon 4/12/21	Fri 4/30/21
78	Pre-Plan, Procure, and Mobilize	30 days	Mon 5/3/21	Fri 6/11/21
79	**Fly Ash Electrical Construction - Procurement**	**165 days**	**Mon 3/8/21**	**Fri 10/22/21**
80	Develop Drawings and Specs	60 days	Mon 3/8/21	Fri 5/28/21
81	Owner Review/Issue Bid Package	15 days	Mon 5/31/21	Fri 6/18/21
82	Bid Period	30 days	Mon 6/21/21	Fri 7/30/21
83	Bid Evaluation/Award	20 days	Mon 8/2/21	Fri 8/27/21
84	Pre-Plan, Procure, and Mobilize	40 days	Mon 8/30/21	Fri 10/22/21
85	**Fly Ash Silo Construction - Procurement**	**261 days**	**Tue 7/7/20**	**Tue 7/6/21**
86	Bid Period	12 days	Tue 7/7/20	Wed 7/22/20
87	Bid Evaluation/Award	52 days	Thu 7/23/20	Fri 10/2/20
88	Review and Approve Submittals	35 days	Mon 10/5/20	Fri 11/20/20
89	Pre-Plan, Procure, and Mobilize	40 days	Wed 5/12/21	Tue 7/6/21
90	**Fly Ash Handling Construction Activities**	**347 days**	**Thu 3/25/21**	**Fri 7/22/22**
91	Fly Ash Deep Foundations	50 days	Thu 3/25/21	Wed 6/2/21
92	Fly Ash Foundations & Underground Utilities	80 days	Wed 5/12/21	Tue 8/31/21
93	Fly Ash Silo	170 days	Wed 7/7/21	Tue 3/1/22
94	**Fly Ash Mechanical Construction**	**210 days**	**Wed 8/4/21**	**Tue 5/24/22**
95	Fly Ash Mechanical - Piping and BOP	210 days	Wed 8/4/21	Tue 5/24/22
96	Erect Conveyors	145 days	Wed 8/18/21	Tue 3/8/22
97	Set PCM	5 days	Wed 3/2/22	Tue 3/8/22
98	Fly Ash Electrical	175 days	Mon 11/22/21	Fri 7/22/22
99	Fly Ash Startup & Commissioning	40 days	Mon 5/30/22	Fri 7/22/22
100	**BSHS/LVWTS Handling**	**745 days**	**Tue 11/17/20**	**Fri 9/22/23**
101	**BSHS Major Electrical Equipment - Procurement**	**389 days**	**Thu 12/31/20**	**Tue 6/28/22**
102	Develop Bid Documents/Issue Bid Package	37 days	Thu 12/31/20	Fri 2/19/21
103	Bid Period	30 days	Mon 2/22/21	Fri 4/2/21
104	Review, Negotiate and Award	20 days	Mon 4/5/21	Fri 4/30/21
105	Review and Approve Submittals	65 days	Mon 5/3/21	Fri 7/30/21
106	Fabricate/Deliver to Site	235 days	Wed 8/4/21	Tue 6/28/22
107	**BSHS Site Preparation Construction - Procurement**	**130 days**	**Tue 11/17/20**	**Mon 5/17/21**
108	Develop Drawings and Specs	50 days	Tue 11/17/20	Mon 1/25/21
109	Owner Review/Issue Bid Package	15 days	Tue 1/26/21	Mon 2/15/21
110	Bid Period	20 days	Tue 2/16/21	Mon 3/15/21
111	Bid Evaluation/Award	25 days	Tue 3/16/21	Mon 4/19/21
112	Pre-Plan, Procure, and Mobilize	20 days	Tue 4/20/21	Mon 5/17/21



Project: Kyger Creek CCR Surface Impoundment Extension Demonstration
Date: Tue 10/13/20

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Deadline | Progress | Manual Progress

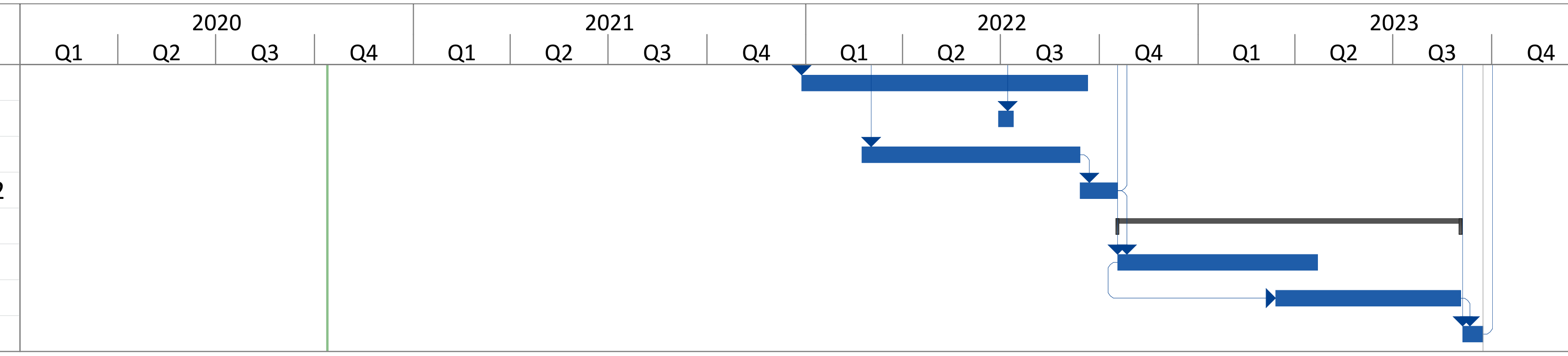
ID	Task Name	Duration	Start	Finish
113	**BSHS/LVWTS Foundations & Underground Utilities Construction - Procurement**	**136 days**	**Mon 4/12/21**	**Mon 10/18/21**
114	Develop Drawings and Specs	40 days	Mon 4/12/21	Fri 6/4/21
115	Owner Review/Issue Bid Package	10 days	Mon 6/21/21	Fri 7/2/21
116	Bid Period	20 days	Tue 7/13/21	Mon 8/9/21
117	Bid Evaluation/Award	20 days	Tue 8/10/21	Mon 9/6/21
118	Pre-Plan, Procure, and Mobilize	30 days	Tue 9/7/21	Mon 10/18/21
119	**BSHS/LVWTS Modifications & Site Finishing Construction - Procurement**	**175 days**	**Tue 11/9/21**	**Mon 7/11/22**
120	Develop Drawings and Specs	50 days	Tue 11/9/21	Mon 1/17/22
121	Owner Review/Issue Bid Package	20 days	Tue 1/18/22	Mon 2/14/22
122	Bid Period	30 days	Tue 2/15/22	Mon 3/28/22
123	Bid Evaluation/Award	30 days	Tue 3/29/22	Mon 5/9/22
124	Pre-Plan, Procure, and Mobilize	30 days	Tue 5/31/22	Mon 7/11/22
125	**BSHS/LVWTS Mechanical Construction - Procurement**	**212 days**	**Fri 2/12/21**	**Mon 12/6/21**
126	Develop Drawings and Specs	80 days	Fri 2/12/21	Thu 6/3/21
127	Owner Review/Issue Bid Package	27 days	Fri 6/4/21	Mon 7/12/21
128	Bid Period	30 days	Tue 7/13/21	Mon 8/23/21
129	Bid Evaluation/Award	25 days	Tue 8/24/21	Mon 9/27/21
130	Pre-Plan, Procure, and Mobilize	50 days	Tue 9/28/21	Mon 12/6/21
131	**BSHS/LVWTS Electrical Construction - Procurement**	**185 days**	**Tue 6/8/21**	**Mon 2/21/22**
132	Develop Drawings and Specs	60 days	Tue 6/8/21	Mon 8/30/21
133	Owner Review/Issue Bid Package	30 days	Tue 8/31/21	Mon 10/11/21
134	Bid Period	20 days	Wed 10/13/21	Tue 11/9/21
135	Bid Evaluation/Award	20 days	Wed 11/10/21	Tue 12/7/21
136	Pre-Plan, Procure, and Mobilize	50 days	Tue 12/14/21	Mon 2/21/22
137	**BSHS/LVWTS Construction Activities**	**615 days**	**Tue 5/18/21**	**Fri 9/22/23**
138	**BSHS Site Preparation - Construction**	**95 days**	**Tue 5/18/21**	**Mon 9/27/21**
139	Build Ash Berm and Dewater Tank Area	30 days	Tue 5/18/21	Mon 6/28/21
140	Stockpile Material for Surcharge	45 days	Tue 5/18/21	Mon 7/19/21
141	Surcharge Loading	50 days	Tue 7/20/21	Mon 9/27/21
142	**BSHS/LVWTS Foundations & Underground Utilities - Construction**	**190 days**	**Tue 10/19/21**	**Mon 7/11/22**
143	Excavate Surcharge Material	20 days	Tue 10/19/21	Mon 11/15/21
144	Build Settling Tank Foundation Slab	55 days	Tue 11/16/21	Mon 1/31/22
145	Build Settling Tank Walls	110 days	Tue 2/1/22	Mon 7/4/22
146	Backfill Settling Tank (after outer walls are complete	20 days	Tue 5/3/22	Mon 5/30/22
147	Stackout Slab, Chem Feed, PCM, and Transformer Foundations	30 days	Tue 5/31/22	Mon 7/11/22



Project: Kyger Creek CCR Surface Impoundment Extension Demonstration
Date: Tue 10/13/20

Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Deadline
Progress
Manual Progress

ID	Task Name	Duration	Start	Finish
148	BSHS/LVWTS Mechanical	190 days	Tue 12/28/21	Mon 9/19/22
149	Set PCM	10 days	Wed 6/29/22	Tue 7/12/22
150	BSHS/LVWTS Electrical	145 days	Tue 2/22/22	Mon 9/12/22
151	BSHS Startup & Commissioning	25 days	Tue 9/13/22	Mon 10/17/22
152	**BSHS/LVWTS Modifications & Site Finishing - Constru**	**230 days**	**Tue 10/18/22**	**Fri 9/1/23**
153	Dewater LVWTS Area and Regrade CCR Material	135 days	Tue 10/18/22	Fri 4/21/23
154	Install LVWTS Composite Liner System	125 days	Tue 3/14/23	Fri 9/1/23
155	LVWTS Startup & Commissioning	15 days	Mon 9/4/23	Fri 9/22/23

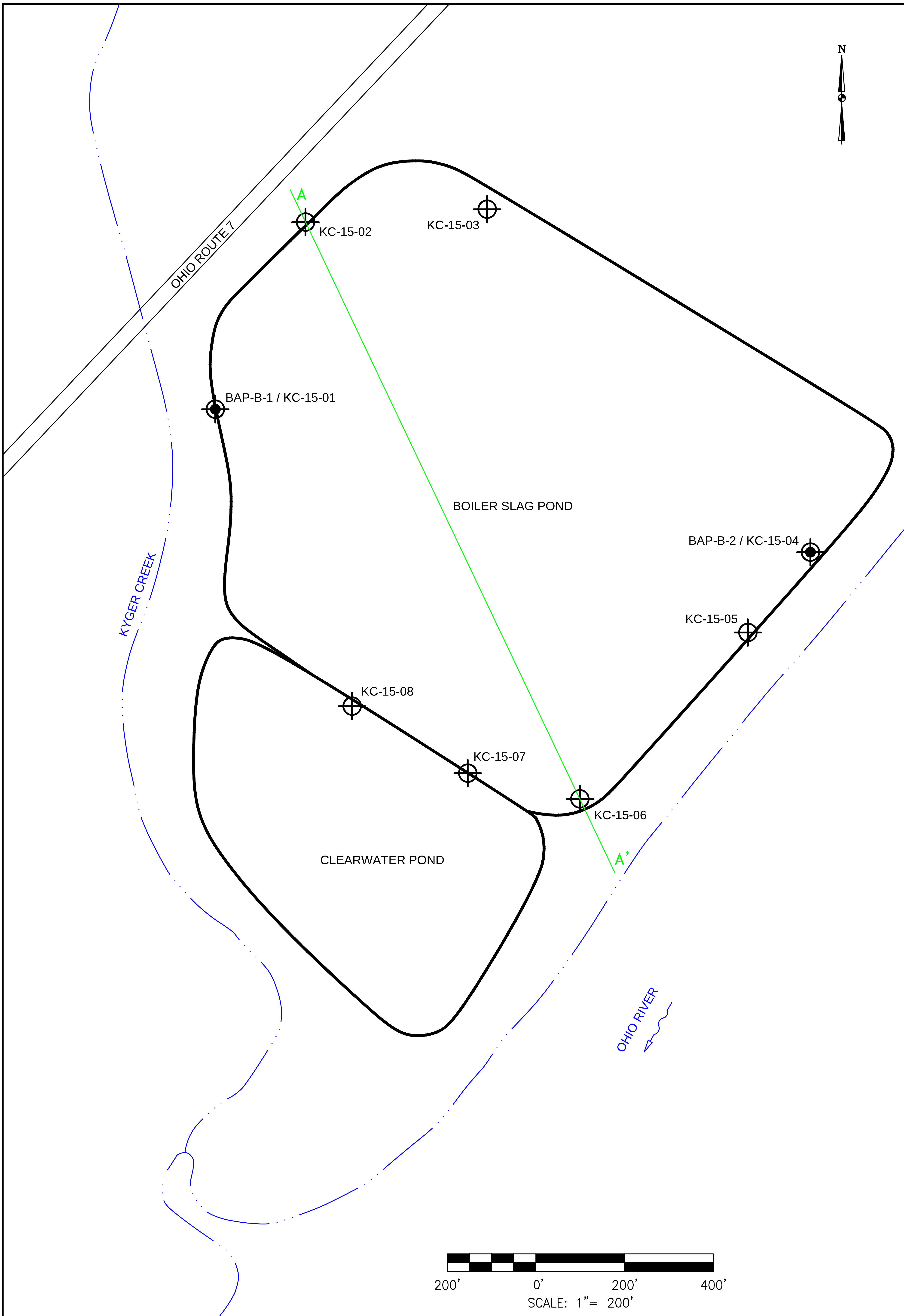


Project: Kyger Creek CCR Surface Impoundment Extension Demonstration
Date: Tue 10/13/20

Task	External Tasks	Manual Task	Finish-only
Split	External Milestone	Duration-only	Deadline
Milestone	Inactive Task	Manual Summary Rollup	Progress
Summary	Inactive Milestone	Manual Summary	Manual Progress
Project Summary	Inactive Summary	Start-only	

APPENDIX C – COMPLIANCE DOCUMENTS

APPENDIX C1 – MONITORING WELL LOCATION MAP & STRATIGRAPHIC CROSS-SECTIONS



LEGEND:

SOIL BORING /MONITORING WELL LOCATION

MONITORING WELL LOCATION

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	KYGER
DWG FILE	GC--KYGER_XSEC LOCS.dwg
DRAWING SCALE	1"=200'

AGES
Applied Geology And Environmental Science, Inc.
2402 Hookstown Grade Road, Suite 200
Clinton, PA 15026
412.264.6453

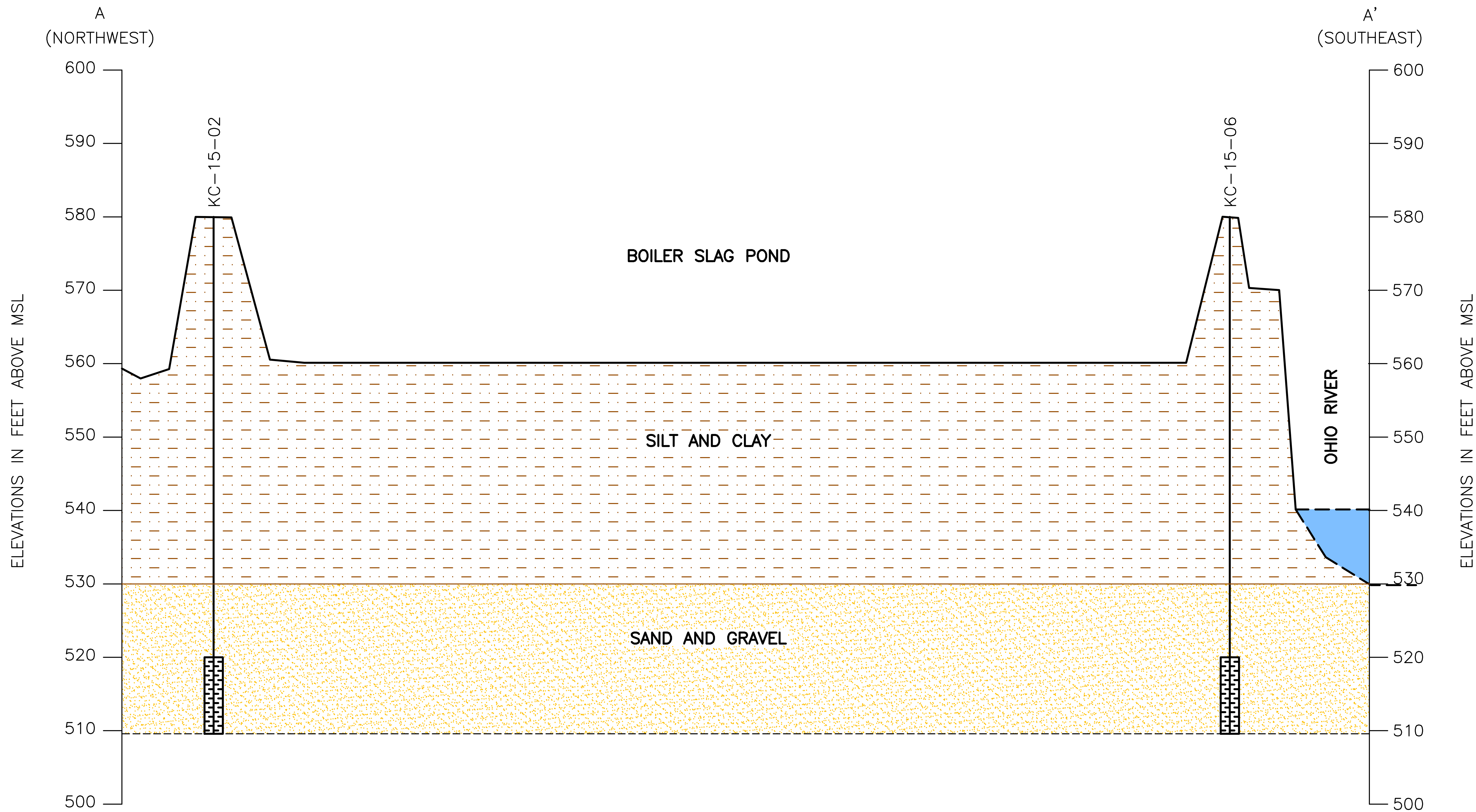
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
LOCATION OF GENERALIZED GEOLOGIC
CROSS-SECTION A-A'

DRAWING NAME

REV. 0

Plot: 10/12/2020 15:56 \GC-xsections_10-12-20\GC--KYGER_XSEC LOCS\BOILER SLAG POND



DRAWN BY	JM
DATE	
CHECKED BY	
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DWG FILE	GC--KYGER_BSP_Cross Sec.dwg
DRAWING SCALE	NOT TO SCALE

AGES
Applied Geology And Environmental Science, Inc.

2402 Hookstown Grade Road, Suite 200
Clinton, PA 15026
412.264.6453

OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GENERALIZED GEOLOGIC CROSS-SECTION A-A'

DRAWING NAME

REV. 0

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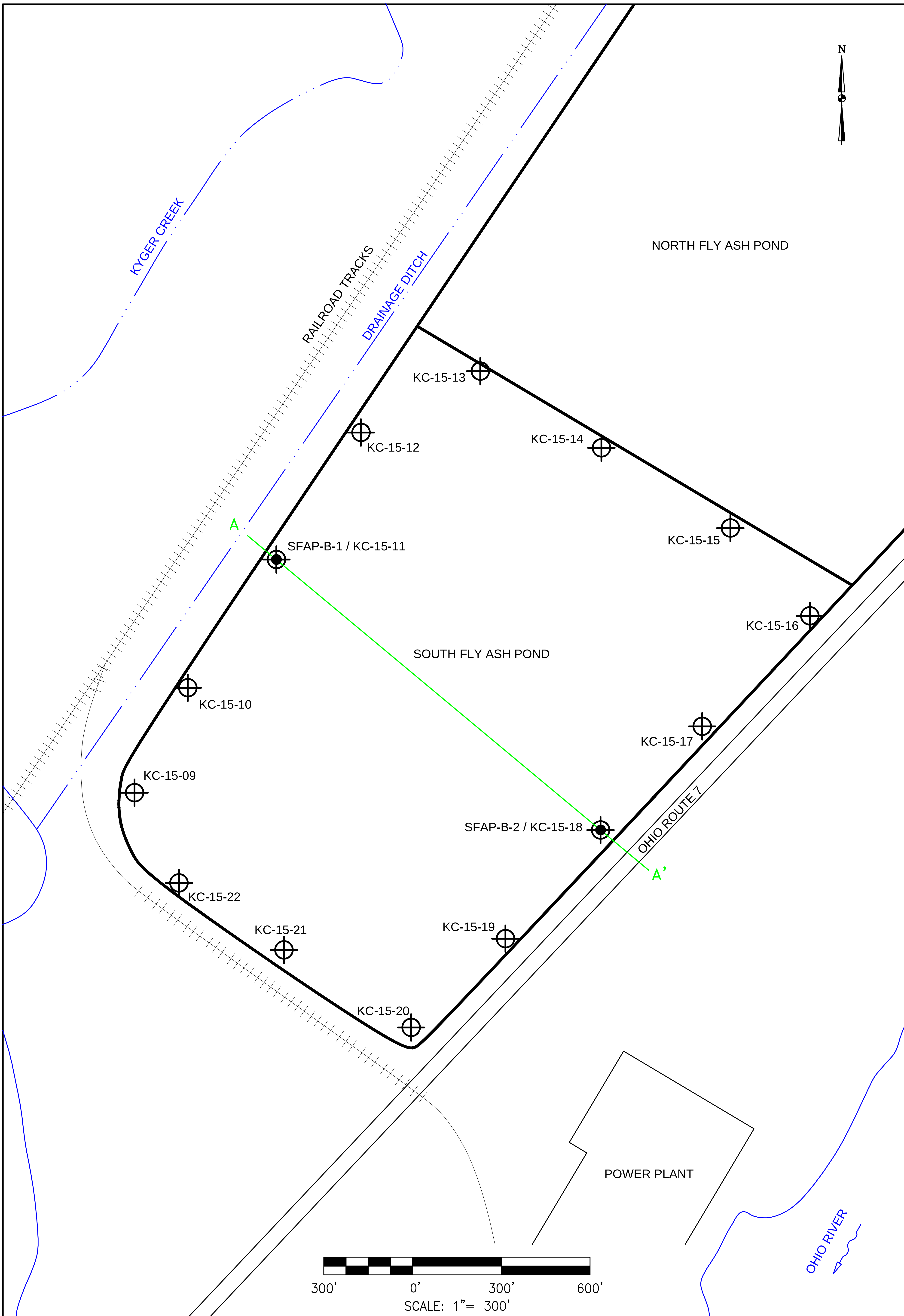
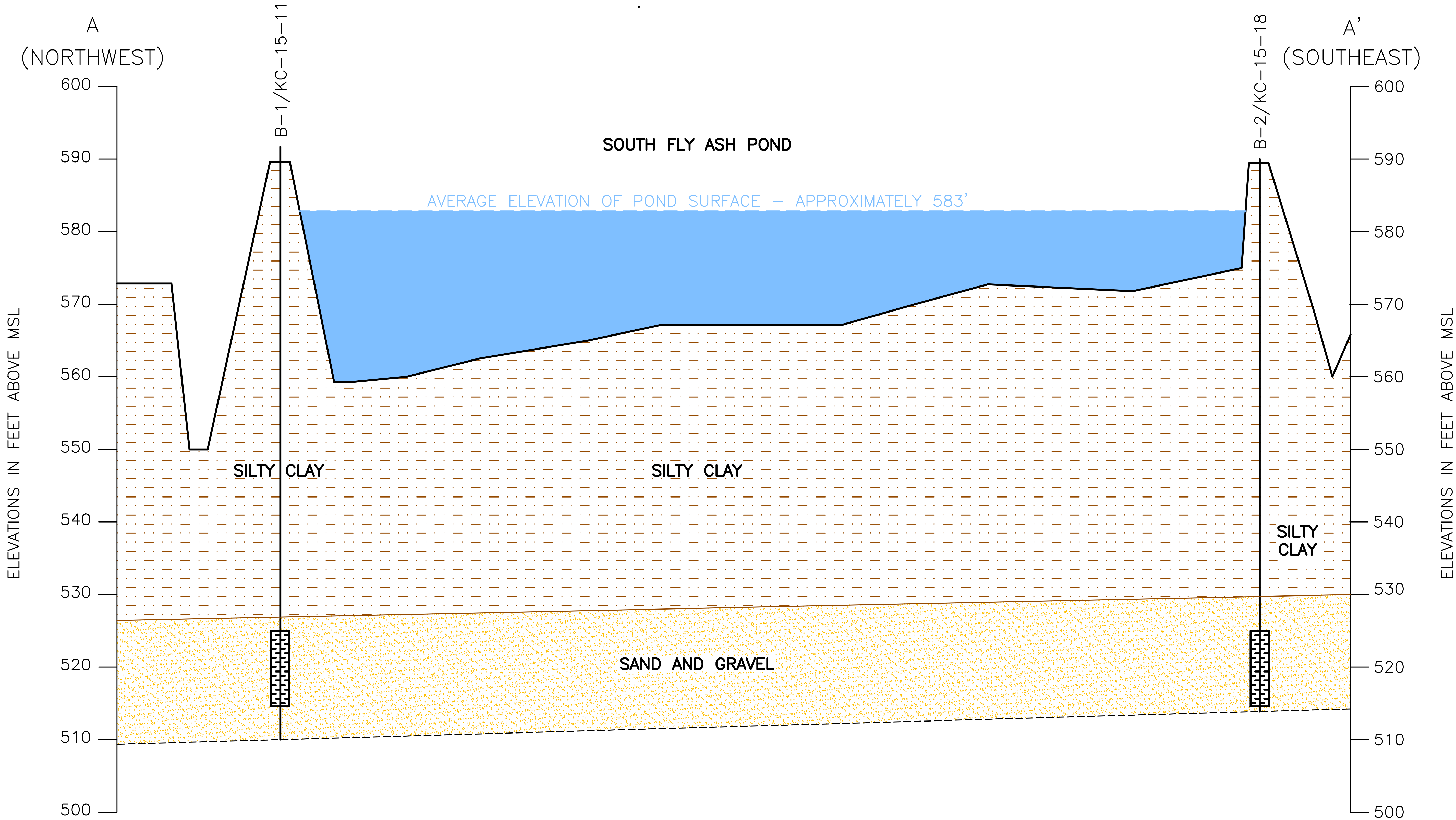


LEGEND:			
SOIL BORING /MONITORING WELL LOCATION	DRAWN BY: JM	AGES Applied Geology And Environmental Science, Inc.	OHIO VALLEY ELECTRIC COMPANY
MONITORING WELL LOCATION	DATE	2402 Hookstown Grade Road, Suite 200 Clinton, PA 15026 412.264.6453	KYGER CREEK STATION CHESHIRE, GALLIA COUNTY, OHIO SOUTH FLY ASH POND LOCATION OF GENERALIZED GEOLOGIC CROSS-SECTION A-A'
	CHECKED BY		DRAWING NAME
	JOB NO.: KYGER		REV.: 0
	DWG FILE: GC--KYGER_XSEC LOCS.dwg		
	DRAWING SCALE: 1"=300'		

Plot: 10/12/2020 16:4 \GC_xsections_10-12-20\GC--KYGER_XSEC LOCS.dwg\FLY ASH POND



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	KYGER
DWG FILE	GC--KYGER_SFAP_Cross Sec.dwg
DRAWING SCALE	NOT TO SCALE

AGES
Applied Geology And Environmental Science, Inc.
2402 Hookstown Grade Road, Suite 200
Clinton, PA 15026
412.264.6453

OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GENERALIZED GEOLOGIC CROSS-SECTION A-A'

DRAWING NAME

REV. 0

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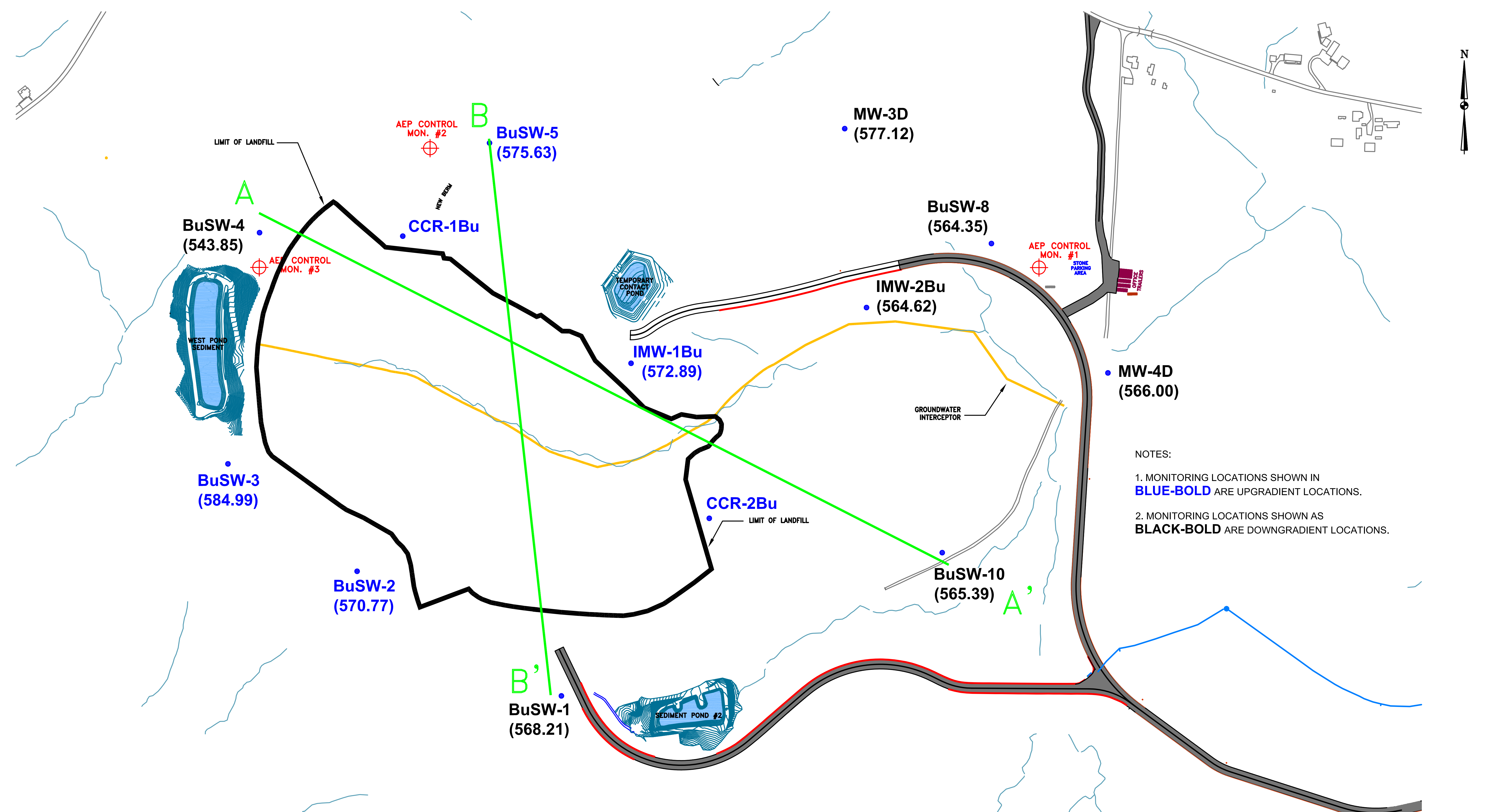


NOTES:

1. MONITORING LOCATIONS SHOWN IN **BLUE-BOLD** ARE UPGRADIENT LOCATIONS.

2. MONITORING LOCATIONS SHOWN AS **BLACK-BOLD** ARE DOWNGRADIENT LOCATIONS.

LEGENDː

● BuSW-1	BUFFALO SANDSTONE WELL
(567.96)	GROUNDWATER ELEVATION

400' 0' 400' 800'
SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015079-KYGER
DWG FILE	KYGER MW INSTALL_MWs BUFFALO b09.dwg
DRAWING SCALE	AS SHOWN

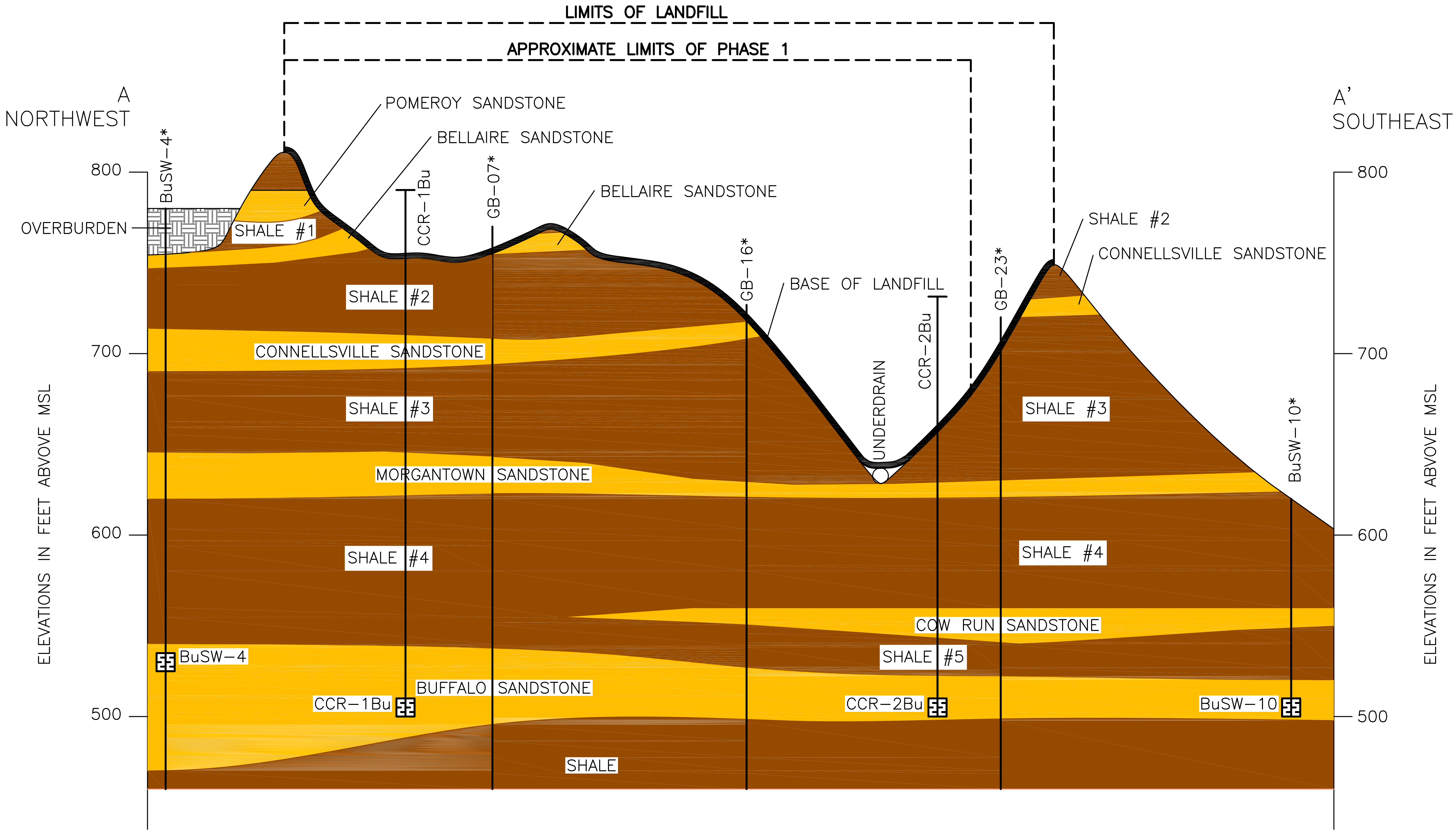
AGES
Applied Geology And Environmental Science, Inc.
2402 Hookstown Grade Road, Suite 200
Clinton, PA 15026
412.264.6453

OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
TYPE III RESIDUAL WASTE LANDFILL
GROUNDWATER MONITORING WELL LOCATIONS

DRAWING NAME: FIGURE 2
REV. 0

Plot: 05/17/2016 13:46 _PROGRAM-KYGER OVEC\Kyger Creek-CCR Program\CAD\WELL INSTALLATION\KYGER MW INSTALL_MWs_BUFFALO b09.dwg\BUFFALO



*GEOLOGIC DATA FROM 2007 HSIR.

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015079-KYGER
DWG FILE	KYGER MW INSTALL_Cross Sec A-A' b10.dwg
DRAWING SCALE	NOT TO SCALE

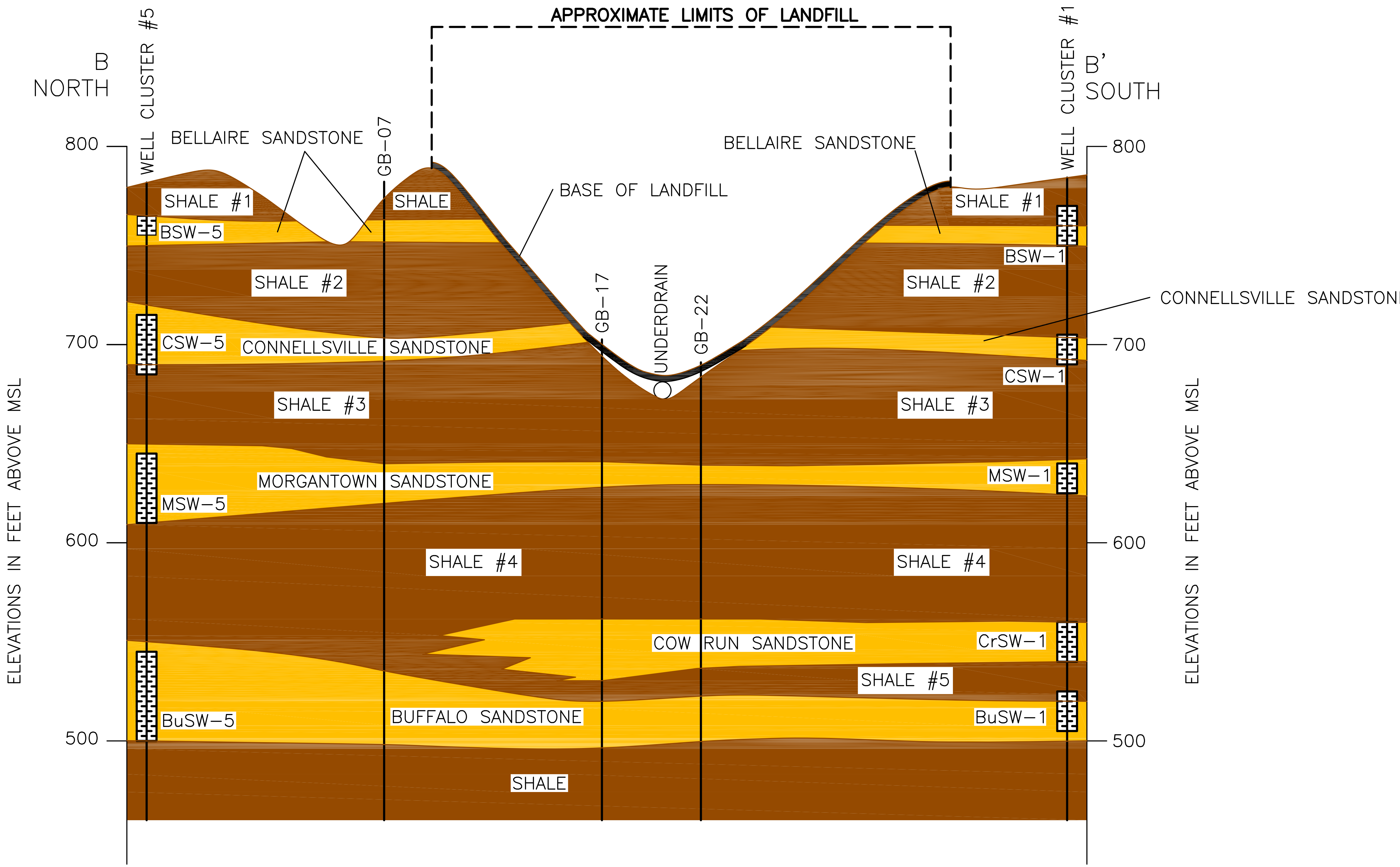
AGES
Applied Geology And Environmental Science, Inc.
2402 Hookstown Grade Road, Suite 200
Clinton, PA 15026
412.264.6453

OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
TYPE III RESIDUAL WASTE LANDFILL
GENERALIZED GEOLOGIC CROSS-SECTION
A-A' (NORTHWEST - SOUTHEAST)

DRAWING NAME: FIGURE 3

REV. 0



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	P2015079-KYGER
DWG FILE	KYGER MW INSTALL_Cross Sec B-B' b10.dwg
DRAWING SCALE	NOT TO SCALE

AGES
Applied Geology And Environmental Science, Inc.
2402 Hookstown Grade Road, Suite 200
Clinton, PA 15026
412.264.6453

OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
TYPE III RESIDUAL WASTE LANDFILL
GENERALIZED GEOLOGIC CROSS-SECTION
B-B' (NORTH - SOUTH)

DRAWING NAME: FIGURE 4

REV. 0

Plot: 05/17/2016 14:55 _PROGRAM-KYGER OVEC\Kyger Creek-CCR Program\CAD\WELL INSTALLATION\KYGER MW INSTALL_Cross Sec B-B' b10.dwg

APPENDIX C2 – GROUNDWATER MONITORING SYSTEM

Stantec Consulting Services Inc.
11687 Lebanon Road, Cincinnati OH 45241

October 16, 2017
File: 175534017
Revision 0

Ohio Valley Electric Corporation
3932 U.S. Route 23
P.O. Box 468
Piketon, Ohio 45661

RE: Groundwater Monitoring System
CCR Landfill, South Fly Ash Pond, and Boiler Slag Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Kyger Creek Station
Cheshire, Gallia County, Ohio

1.0 PURPOSE

This letter documents Stantec's certification of the groundwater monitoring system designed and constructed by Applied Geology and Environmental Science, Inc. (AGES) for the Ohio Valley Electric Corporation (OVEC) Kyger Creek Station's CCR Landfill, South Fly Ash Pond (SFAP), and Boiler Slag Pond (BSP). The EPA Final CCR Rule requires owners or operators of CCR landfills and surface impoundments to install a groundwater monitoring system as per 40 CFR 257.91.

2.0 GROUNDWATER MONITORING SYSTEM - REQUIREMENTS

The performance standard listed in 40 CFR 257.91(a) requires that the groundwater monitoring system consist of sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that:

(1) Accurately represents the quality of background groundwater that has not been affected by leakage from a CCR unit, and

(2) Accurately represents the quality of groundwater passing the waste boundary of the CCR unit, by installing the downgradient monitoring system at the waste boundary ensuring detection of groundwater contamination in the uppermost aquifer. All potential contaminant pathways must be monitored.

In accordance with 40 CFR 257.91(b), the number, spacing, and depths of the monitoring system shall be determined based on site-specific technical information such as:

(1) Aquifer thickness, groundwater flow rate, groundwater flow direction including seasonal and temporal fluctuations in groundwater flow, and

(2) Saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the

Re: **Groundwater Monitoring System**
CCR Landfill, South Fly Ash Pond, and Boiler Slag Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Kyger Creek Station
Cheshire, Gallia County, Ohio

uppermost aquifer, including, but not limited to, thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities, and effective porosities.

40 CFR 257.91(c) states that the groundwater monitoring system must include the minimum number of monitoring wells necessary to meet the performance standards of 40 CFR 257.91(a), based on the site-specific information in 40 CFR 257.91(b). The groundwater monitoring system must consist of a minimum of one upgradient and three downgradient monitoring wells with additional monitoring wells as necessary to accurately represent the quality of background groundwater that has not been affected by leakage from the CCR unit and the quality of groundwater passing the waste boundary of the CCR unit.

40 CFR 257.91(e) states that the monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. The casing must be screened or perforated and packed with gravel or sand, where necessary, to enable collection of groundwater samples. The annular space above the sampling depth must be sealed to prevent contamination of samples and the groundwater.

3.0 SUMMARY OF FINDINGS

Stantec personnel reviewed the *Coal Combustion Residuals Regulation, Monitoring Well Installation Report (MWIR), Ohio Valley Electric Corporation, Kyger Creek Station, Cheshire, Gallia County, Ohio* (AGES, August 2016). Each of the four sections of 40 CFR 257.91, as shown above in Section 2.0 of this certification letter, is detailed below to demonstrate compliance. The sections, tables, figures, and appendices detailed in the following paragraphs refer to the MWIR.

<u>40 CFR 257.91(a)</u>

Performance standard. *The groundwater monitoring system must consist of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that:*

(1) Accurately represents the quality of background groundwater that has not been affected by leakage from a CCR unit, and

(2) Accurately *represent the quality of groundwater passing the waste boundary of the CCR unit. The downgradient monitoring system must be installed at the waste boundary that ensures detection of groundwater contamination in the uppermost aquifer. All potential contaminant pathways must be monitored.*

Re: **Groundwater Monitoring System**
CCR Landfill, South Fly Ash Pond, and Boiler Slag Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Kyger Creek Station
Cheshire, Gallia County, Ohio

This standard is met if §§257.91(b) through (e) are met. §§257.91(a), (b), (c), and (e) are discussed below. §257.91(d) applies to a single groundwater monitoring system installed to monitor multiple CCR units (multiunit). It is not applicable for the Kyger Creek Station groundwater monitoring system.

<u>40 CFR 257.91(b)</u>

The number, spacing, and depths of the monitoring systems shall be determined based on site-specific technical information such as:

(1) Aquifer thickness, groundwater flow rate, groundwater flow direction including seasonal and temporal fluctuations in groundwater flow, and

(2) Saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer, including, but not limited to, thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities, and effective porosities.

The geology and hydrogeology for each CCR unit is discussed based on historical data in Section 3.0. The uppermost aquifer for each is identified using subsurface stratigraphy, well yields from historic sampling events, and existing monitoring well networks. Generalized geologic cross-sections are included as Figures 3, 4, 6, and 8 (AGES, 2016). Tables 5 and 6 are summaries of the slug tests performed for the BSP and SFAP. The hydrogeologic and subsurface investigation report aquifer testing results supporting the CCR Landfill permit-to-install application are included in Appendix A (Hull, 2007).

Section 4.2 outlines the evaluation of the existing well and piezometer data to estimate groundwater depth in the uppermost aquifer and likely groundwater flow direction. Two additional geotechnical borings were performed in both the BSP and the SFAP per Section 4.3. The borings were intended to obtain more detailed subsurface geology for the upgradient and downgradient sides of the two surface impoundments and to identify location, thickness, and composition, of the uppermost aquifer. Soil samples from these borings were the basis of the grain-size analyses used to design the monitoring well screens and filter packs for the BSP and the SFAP (Section 4.4 and Appendix B).

Re: **Groundwater Monitoring System**
CCR Landfill, South Fly Ash Pond, and Boiler Slag Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Kyger Creek Station
Cheshire, Gallia County, Ohio

<u>40 CFR 257.91(c)</u>

> *the groundwater monitoring system must include the minimum number of monitoring wells necessary to meet the performance standards of 40 CFR 257.91(a), based on the site-specific information in 40 CFR 257.91(b). The groundwater monitoring system must consist of a minimum of one upgradient and three downgradient monitoring wells with additional monitoring wells as necessary to accurately represent the quality of background groundwater that has not been affected by leakage from the CCR unit and the quality of groundwater passing the waste boundary of the CCR unit.*

Section 4.6 outlines the monitoring well networks for each CCR unit to meet this requirement.

For the CCR Landfill, the existing groundwater system includes 13 monitoring wells. It was designed for the ultimate waste boundary of a multiple-phased landfill construction. Only the initial phase of landfill construction has been completed. Per Section 3.1, eleven monitoring wells were installed to monitor the Buffalo sandstone as part of the permit-to-install for the CCR Landfill. These are permanent monitoring wells located outside of the ultimate landfill waste boundary. Two temporary downgradient monitoring wells were installed in 2015 at the active phase's limit of waste. It is anticipated that these wells will be abandoned as part of the construction of the next phase of the landfill.

Five downgradient monitoring wells are considered supplemental since they are at least 1,000 feet away from the active landfill phase. Section 4.6.1 and Table 2 lists the remaining eight monitoring wells in the CCR network as four downgradient and four upgradient. Figure 2 shows the groundwater monitoring well locations for the CCR Landfill.

The BSP's groundwater monitoring network is described in Section 4.6.2 and Table 3. Eight monitoring wells were installed around the BSP perimeter in 2015. Three monitoring wells are noted as upgradient, while five are listed as downgradient. Figure 5 shows the groundwater monitoring well locations of the BSP.

Fourteen monitoring wells were installed around the SFAP perimeter in 2015 to serve as the groundwater monitoring network. The wells are described in Section 4.6.3 and Table 4. Four monitoring wells are noted as downgradient, eight as upgradient with two noted as side gradient. Figure 7 shows the groundwater monitoring well locations of the SFAP.

Re: **Groundwater Monitoring System**
CCR Landfill, South Fly Ash Pond, and Boiler Slag Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Kyger Creek Station
Cheshire, Gallia County, Ohio

As discussed in Section 5.0, slug testing was performed in two monitoring wells at the BSP and at the SFAP. The testing was performed to estimate saturated hydraulic conductivity of the uppermost aquifer beneath the surface impoundments and to evaluate groundwater flow velocity. The test results are in Tables 5 and 6 with supporting data in Appendix G.

<u>40 CFR 257.91(e)</u>

> *The monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. The casing must be screened or perforated and packed with gravel or sand, where necessary, to enable collection of groundwater samples. The annular space above the sampling depth must be sealed to prevent contamination of samples and the groundwater.*

The monitoring well installation and development for the three CCR units is discussed in Section 4.5. The second and third paragraphs of Sections 4.5.1 and 4.5.2 discuss the two-inch diameter slotted Schedule 40 PVC screen, 0.40-millimeter quartz sand filter pack, steel casing during well placement, and the four-foot-thick annular bentonite seal above the filter pack in each well. Section 4.4 discusses the design of pre-packed well screens used for the construction of the SFAP and BSP monitoring wells. Monitoring well logs are detailed in Appendix C. Well construction for the monitoring networks of each CCR unit is detailed in terms of well ID, locations, elevations, and date of installation in Tables 2, 3, and 4.

The attached MWIR demonstrates that the groundwater monitoring system was designed and constructed to meet the requirements set forth in 40 CFR 257.91(a), (b), (c), and (e).

Re: **Groundwater Monitoring System**
CCR Landfill, South Fly Ash Pond, and Boiler Slag Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Kyger Creek Station
Cheshire, Gallia County, Ohio

4.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Stan A. Harris, being a Professional Engineer in good standing in the State of Ohio, do hereby certify, to the best of my knowledge, information, and belief:

1. that the information contained in this certification is prepared in accordance with the accepted practice of engineering;
2. that the information contained herein is accurate as of the date of my signature below; and
3. that the groundwater monitoring system for the OVEC Kyger Creek Station's CCR Landfill, South Fly Ash Pond, and Boiler Slag Pond has been designed and constructed to meet the requirements specified in 40 CFR 257.91(a), (b), (c), and (e).

SIGNATURE Stan A. Harris
Stan A. Harris, PE

DATE 10/16/17

ADDRESS: Stantec Consulting Services Inc.
11687 Lebanon Road
Cincinnati, Ohio 45241

TELEPHONE: (513) 842-8200

ATTACHMENTS: Applied Geology and Environmental Science, Inc. (AGES) (2016). Coal Combustion Residuals Regulation, Monitoring Well Installation Report, Ohio Valley Electric Corporation, Kyger Creek Station, Cheshire, Gallia County, Ohio. August.

STATE OF OHIO
STAN A. HARRIS
53083
REGISTERED
PROFESSIONAL ENGINEER
Stan A. Harris 10/16/17

Applied Geology And Environmental Science, Inc.

2402 Hookstown Grade Road, Suite 200
Clinton, PA 15026
www.appliedgeology.net
P 412. 264. 6453
F 412. 264. 6567

COAL COMBUSTION RESIDUALS REGULATION
MONITORING WELL INSTALLATION REPORT

OHIO VALLEY ELECTRIC CORPORATION
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO

AUGUST 2016

Prepared for:

OHIO VALLEY ELECTRIC CORPORATION (OVEC)

By:

APPLIED GEOLOGY AND ENVIRONMENTAL SCIENCE, INC.

COAL COMBUSTION RESIDUALS REGULATION
MONITORING WELL INSTALLATION REPORT
OHIO VALLEY ELECTRIC CORPORATION
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO

AUGUST 2016

Prepared for:

OHIO VALLEY ELECTRIC CORPORATION (OVEC)

Prepared By:

Applied Geology and Environmental Science, Inc.

Diane E. Miller

Diane E. Miller, P.G.
Senior Geologist

Robert W. King

Robert W. King, P.G.
President/Chief Hydrogeologist

COAL COMBUSTION RESIDUALS REGULATION
MONITORING WELL INSTALLATION REPORT
OHIO VALLEY ELECTRIC CORPORATION
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO

TABLE OF CONTENTS

COAL COMBUSTION RESIDUALS REGULATION
MONITORING WELL INSTALLATION REPORT
OHIO VALLEY ELECTRIC CORPORATION
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO

T A B L E O F C O N T E N T S

LIST OF TABLES

FIGURES

APPENDICES

COAL COMBUSTION RESIDUALS REGULATION
MONITORING WELL INSTALLATION REPORT
OHIO VALLEY ELECTRIC CORPORATION
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO

1.0 INTRODUCTION

On December 19, 2014, the United States Environmental Protection Agency (U.S. EPA) issued their final Coal Combustion Residuals (CCR) regulation which regulates CCR as a non-hazardous waste under Subtitle D of Resource Conservation and Recovery Act (RCRA) and became effective six (6) months from the date of its publication (April 17, 2015) in the Federal Register. The rule applies to new and existing landfills, and surface impoundments used to dispose of or otherwise manage CCR generated by electric utilities and independent power producers. Because the rule was promulgated under Subtitle D of RCRA, it does not require regulated facilities to obtain permits, does not require state adoption, and cannot be enforced by U.S. EPA. The only compliance mechanism is for a state or citizen group to bring a RCRA suit in federal district court against any facility that is alleged to be in non-compliance with the new requirements.

All CCR landfills and CCR surface impoundments (including inactive impoundments unless they close within three (3) years from the promulgation date of the rule) are subject to new, and typically more stringent than current, state requirements for groundwater monitoring and, if necessary, corrective action. Within 30 months after the date of publication (April 17, 2015) in the Federal Register, all existing CCR landfills and existing CCR surface impoundments must have installed groundwater monitoring systems, initiated a groundwater detection monitoring program, and begun assessing groundwater monitoring data to evaluate groundwater quality at each CCR unit.

In March 2015, the Ohio Valley Electric Company (OVEC) contracted with Applied Geology and Environmental Science (AGES), Inc. to identify upgrades in the groundwater monitoring program for the Kyger Creek Station located in Cheshire, Ohio that would be necessary for compliance with the CCR regulation. Based on a review of available data and the CCR regulation, AGES, OVEC and staff from Stantec worked together to develop a detailed scope of work and schedule for the groundwater monitoring system upgrades. Field work on the project (monitoring well installation and development) was conducted from August through November 2015.

Presented below are a discussion of the CCR units identified at the station, site geology and hydrogeology, and the well installation and development program.

2.0 BACKGROUND

The Kyger Creek Station, located in Cheshire, Ohio, is a 1.1-gigawatt (GW) coal-fired power station operated by OVEC. The Kyger Creek Station has five (5) 217-megawatt (MW) generating units and has been in operation since 1955. Beginning in 1955, ash products were sluiced to disposal ponds located in the plant site. During the course of plant operations, CCRs have been managed and disposed of in various units at the station. There are three (3) CCR units at the Kyger Creek Station (Figure 1):

- Type III Residual Waste Landfill (Landfill);
- Boiler Slag Pond (BSP); and,
- South Fly Ash Pond (SFAP).

Information regarding the history and hydrogeology of each unit was obtained by reviewing several historic documents listed in Section 7.0 of this report.

2.1 Type III Residual Waste Landfill

The Landfill is a residual solid waste Landfill located approximately one-half mile south of the intersection of Little Kyger Creek Road and Shaver Road in Addison Township, Gallia County, Ohio (Figure 1). The Landfill is bordered on the east by Shaver Road and on the west, north and south by vacant, forested land owned by OVEC. The proposed permitted footprint of the Landfill occupies approximately 98 acres and is capable of managing approximately 20.4 million cubic yards (approximately 4,000 tons per day) of Class III residual waste generated by the coal-powered Kyger Creek Plant located approximately two (2) miles southeast of the Landfill.

2.2 Boiler Slag Pond

The BSP is located at the south end of the Kyger Creek Station and is approximately 32 acres in size (Figure 1). The BSP was built in 1955 to serve, and still currently serves, as a process and disposal area for the coal combustion waste products generated at the station. Overflow from the BSP is carried into a reinforced concrete intake structure at the south end of the Boiler Slag Complex. Water entering the intake structure is discharged into the Clearwater Pond. The Clearwater Pond was built in 1980, is approximately nine (9) acres in size and is located to the southwest end of the BSP. The Clearwater Pond is not a CCR Unit and monitoring is not required.

2.3 South Fly Ash Pond

The SFAP is located at the northwest end of the station (Figure 1). The SFAP was built in 1955 to serve, and still currently serves, as a process and disposal area for the coal combustion waste products generated at the station. This collection pond is approximately 67 acres in size and banked on all sides.

3.0 GEOLOGY & HYDROGEOLOGY

Gallia County is located on the western edge of the Appalachian Basin within the Appalachian Plateau Physiographic Province, Allegheny Section, locally known as the Marietta Plateau. Sedimentary bedrock formations in this area are as much as 7,400 feet thick and range in geologic age from Pennsylvanian to Cambrian. The primary stratigraphic units underlying Gallia County include from youngest to oldest: recent (Holocene) colluvium and alluvium deposits, Pleistocene lacustrine and glacial sand and gravel deposits, and Pennsylvanian age bedrock composed predominantly of shale and sandstone, with occasional thin limestone and coal seams.

The Appalachian Plateau in Gallia County is bordered on its northern margin by the Glaciated Appalachian Plateau some 40-50 miles to the northwest. The geomorphology of the Appalachian Plateau in Gallia County consists of steeply sloping ridges and steep, narrow stream valleys. Upland areas are primarily underlain by sandstone bedrock while valleys are underlain by shale bedrock and colluvial and alluvial sediments. Ground elevation ranges from as much as 1,000 feet along ridge tops to 500 feet near the Ohio River Valley. Generally, surface water drainage is to the south and southeast into the Ohio River.

3.1 Type III Residual Landfill

A Hydrogeologic and Subsurface Investigation Report (HSIR) (Hull, 2007) was completed as part of the Permit to Install (PTI) issued to OVEC by the Ohio Environmental Protection Agency (EPA) in April 2009. Based on information in the HSIR, bedrock is primarily overlain by approximately 20 feet of silty clay. Bedrock in the area is part of the Glenshaw Formation, a Pennsylvanian-age sequence of alternating shale and sandstone units. The HSIR identified six (6) sandstone units that include (from youngest to oldest), the Pomeroy Sandstone, the Bellaire Sandstone, the Connellsville Sandstone, the Morgantown Sandstone, the Cow Run Sandstone, and the Buffalo Sandstone. The Pomeroy Sandstone is not present within the footprint of the Landfill. The Bellaire, Connellsville and Morgantown units have been historically eroded and are not present across the entire site. The Cow Run Sandstone is present across most of the site but is not present across the northern portion of the site, where it decreases in thickness until it pinches out. The Buffalo Sandstone is the only sandstone unit present across the entire site. The layout of the Landfill is shown in Figure 2. Generalized cross-sections (A – A' and B – B') are presented in Figures 3 and 4, respectively.

The HSIR identified both the Cow Run sandstone and Buffalo sandstone as the uppermost aquifers at the site. However, as indicated on tables from the HSIR that summarize the results of aquifer testing (Appendix A), hydraulic conductivity values for the Cow Run range from 10E-8 centimeters per second (cm/sec) (from a packer test) to 10E-3 cm/sec in single well pumping tests. These very low hydraulic conductivity values are not indicative of a unit that meets the U.S. EPA definition of an aquifer:

> *"An aquifer is a geological formation or group of formations or part of a formation that is capable of yielding a significant amount of water to a drinking water well or spring."*

During historic sampling events at the site, several monitoring wells screened in the Cow Run sandstone were regularly purged to dryness and would not recover sufficiently to collect a sample. These very low well yields are the result of the low hydraulic conductivity values and the fact that the Cow Run thins to the north and is not present at all beneath the northern portion of the Landfill (Figures 3 and 4).

Based on the hydrogeological conditions, the estimated maximum sustainable yields and local groundwater usage, the Buffalo Sandstone is designated as the uppermost aquifer beneath the Landfill. The Bellaire, Connellsville, Morgantown and Cow Run Sandstones are designated as significant zones of saturation. Based on information in the HSIR, the base of the Type III Residual Waste Landfill is separated from the Buffalo Sandstone aquifer by more than 100 feet of low permeability silty clay and bedrock. This meets the requirement of the CCR rule that the base of the CCR unit be at least five (5) feet above the top of the uppermost aquifer.

Based on historic data, groundwater flow in the Buffalo Sandstone tends to be variable with the main component of flow being to the northwest toward BUSW-4 located just to the northwest of the limit of the Landfill. Groundwater also tends to flow in a radial direction away from IMW-1BU located just east of the current limit of the Landfill.

Eleven monitoring wells (BUSW-1 through BUSW-5, BUSW-8, BUSW-10, MW-3D, MW-4D, IMW-1BU and IMW-2BU) were installed prior to 2007 to monitor groundwater in the Buffalo sandstone as part of the permit for the Landfill. The Landfill is being constructed in three (3) phases and the existing monitoring network was designed to monitor groundwater quality around the proposed final limits of the Landfill with a temporary monitoring well (IMW-1BU) installed close to the limit of Phase 1 which began operation in early 2011.

3.2 Boiler Slag Pond

Based on available existing data, deposits of silts and clays beneath the base of the BSP range from 15 to over 50 feet thick. The silts and clays transition to a layer of dense sand and gravel where groundwater is present. The layout of the BSP is shown in Figure 5. A generalized cross section (C – C') of the geology beneath the BSP is presented in Figure 6. Based on previously reported physical properties and yield, the sand and gravel unit was determined to be the uppermost aquifer beneath the BSP and is located more than five (5) feet beneath the bottom of the BSP as required by the CCR rule. Based on water level data from the existing wells and piezometers, groundwater was determined to flow primarily toward the south and southwest.

3.3 South Fly Ash Pond

The layout of the SFAP is presented in Figure 7. A generalized cross section (D – D') showing the geology beneath the SFAP is presented in Figure 8. In 1995, as part of the closure of the North Fly Ash Pond (NFAP), a Hydrogeologic Site Investigation Report was prepared to evaluate the hydrogeologic conditions beneath the NFAP and SFAP. The report indicated that the SFAP is directly underlain by 10 to 20 feet of low permeability clayey silty soil above a sand and gravel unconsolidated aquifer, which is designated as the uppermost aquifer at the site. The sand and gravel aquifer is directly underlain by bedrock at depths of approximately 70 to 95 feet below ground surface (bgs). The 1995 report indicated that groundwater beneath the SFAP flowed primarily toward the southeast and the Ohio River.

4.0 GROUNDWATER MONITORING SYSTEM DESIGN & INSTALLATION

4.1 Groundwater Monitoring System Design

Section §257.91 of the CCR Rule states that the groundwater monitoring system for each CCR unit must contain a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit and, accurately represent the quality of groundwater passing the waste boundary of the CCR unit.

Section §257.91(c) requires that the groundwater monitoring system for each CCR unit includes a minimum of one (1) upgradient/background monitoring well to accurately represent the quality of background groundwater that has not been affected by leakage from the CCR unit, and a minimum of three (3) downgradient monitoring wells located as close as practicable to the waste boundary to accurately represent the quality of groundwater passing the waste boundary of the CCR unit.

4.2 Data Review and Evaluation of Existing Wells and Piezometers

To begin the process, AGES reviewed available data for any existing monitoring wells and piezometers that had been installed around each CCR unit. The purpose of this data review was to identify the approximate depth to the uppermost aquifer beneath each CCR unit and to evaluate likely groundwater flow direction to ensure that the new CCR groundwater monitoring network contained the required number of upgradient/background and downgradient monitoring wells.

4.2.1 Type III Residual Waste Landfill

An evaluation of historic groundwater elevations and flow data indicated that the existing monitoring wells screened in the Buffalo Sandstone were determined to be usable for the CCR monitoring program. However, two (2) additional Buffalo Sandstone monitoring wells were required to satisfy the requirements of the CCR Rule. The additional wells (CCR-1BU and CCR-2BU) needed to be installed along the Phase 1 limit of the Landfill to fulfill the requirement of a minimum of three (3) downgradient wells installed as close as practicable to the boundary of the CCR unit. These monitoring wells were to be installed using the same well construction methods as the other wells screened in the Buffalo sandstone.

4.2.2 Boiler Slag Pond

In 2010, a subsurface investigation was conducted as part of a project to evaluate the embankments around the ponds located at Kyger Creek Station. During this investigation, several soil borings were conducted around the BSP. The results of the subsurface investigation indicated that the soil beneath the BSP consisted of lean clay with varying amounts of silt and fine sand. The lean clay was encountered to an elevation of approximately 530 feet above mean sea level (msl). The sand and gravel of the uppermost aquifer were encountered at depths ranging from approximately 25 to 50 feet below ground surface (bgs). During the investigation, three (3) piezometers were installed to monitor water levels at the BSP. Groundwater was generally encountered at depths of between 5 and 22 feet bgs.

In June 2015, water levels were collected from existing wells and piezometers. Based on these water levels, groundwater beneath the BSP was encountered between 4.60 feet bgs in KC-1016 and 39.40 feet bgs in KC-1021. Based on these measurements, groundwater appeared to flow from the south/southwest toward Kyger Creek and the Ohio River. Historic water levels from the BSP are included in Appendix E. Historic groundwater flow maps are included in Appendix F.

4.2.3 South Fly Ash Pond

During the 2010 subsurface investigation of embankments around the ponds located at Kyger Creek Station, several soil borings were also conducted around the SFAP. The results of the subsurface investigation indicated that the soil beneath the SFAP were similar to those beneath the BSP consisting of lean clay with varying amounts of silt and fine sand. The lean clay was encountered to an elevation of approximately 530' msl. The sand and gravel of the uppermost aquifer were encountered at depths ranging from approximately 25 to 50 feet below ground surface. During the investigation, several piezometers were installed to monitor water levels at the SFAP. Groundwater was generally encountered at depths of between 5 and 22 feet bgs.

In June 2015, water levels were collected from existing wells and piezometers around the SFAP and the NFAP. Based on the available information from the existing wells and piezometers, the groundwater flow appeared to be radial away from the SFAP, which had a measured elevation in June 2015 of 583.5 feet above msl.

4.3 Soil Boring Installation

At the BSP and SFAP, most of the existing wells and piezometers were not screened in the uppermost aquifer beneath each CCR Unit. Therefore, OVEC conducted two (2) soil borings each at the BSP and SFAP. One (1) soil boring was installed in the upgradient/background side of each CCR Unit and one (1) soil boring was installed in the downgradient side. The purpose of these borings was to obtain a more detailed description of the subsurface geology and to identify the location, size and composition of the uppermost aquifer beneath the BSP and the SFAP.

To obtain additional geologic information specific to designing the CCR groundwater monitoring networks, two (2) exploratory soil borings (BSP-B-1 and BSP-B-2) were completed at the BSP (Figure 5) and two (2) soil borings (SFAP-B-1 and SFAP-B-2) were conducted around the SFAP (Figure 7). These soil borings were completed to evaluate the subsurface geology beneath each unit and to collect samples from the uppermost aquifer. These soil samples were sent to a geotechnical soil laboratory for grain-size analysis to provide data to be used to design the groundwater monitoring system.

4.4 Grain Size Analysis and Monitoring Well Design

The CCR rule requires that unfiltered groundwater samples be submitted for laboratory analysis of Appendix III and IV constituents. According to the preamble to the rule, the unfiltered sample requirement assumes that groundwater samples with a turbidity of less than 5 NTUs can be obtained from a properly designed monitoring well. The proper design of the sand pack and well screen in each unconsolidated CCR well is therefore critical to obtaining representative samples.

To support CCR well design, representative samples were collected of material from the uppermost aquifer beneath the BSP and the SFAP. These soil samples were submitted to a geotechnical laboratory for grain-size analysis per American Society for Testing and Materials (ASTM) Methods D421 and D422. The results of the grain size analyses were used to design the well screens and filter packs for the monitoring wells. The results of the grain size analyses are included in Appendix B.

In accordance with U.S. EPA monitoring well design guidelines (U.S. EPA, 1991), the grain size of the filter pack was chosen by multiplying the 70% retention (or 30% passing) size of the formation, as determined by the grain size analysis, by a factor of 3 (for fine uniform formations) to 6 (for coarse, non-uniform formations). Table 1 summarizes the results of the grain-size analysis and the 70% retention size for each of the samples collected from each boring.

To reduce turbidity as much as possible, pre-packed well screens were selected for use in the wells around the BSP and the SFAP. The 2-inch diameter 0.01" slotted Schedule 40 PVC pre-packed screens are designed specifically for sampling metals in groundwater. The pre-packed well screens were constructed using an inner filter pack consisting of 0.40 mm clean quartz filter sand between two layers of food-grade plastic mesh to reduce sample turbidity by filtering out smaller particles than is possible with standard filter packed wells and prepack screens. No metal components were used in the constructions of the pre-packed well screens, thus eliminating potential interference with metals analysis.

4.5 Monitoring Well Installation and Development

Well installation and development at the Kyger Station were conducted from August to November 2015 by Bowser-Morner, Inc., under the supervision of AGES. During the field work, AGES oversaw all drilling activities, prepared lithologic descriptions of all soil and bedrock material, and took detailed field notes for all of the work.

To comply with the new CCR rule requiring the groundwater monitoring system for each CCR unit to contain a minimum of one (1) background/upgradient and three (3) downgradient monitoring wells, two (2) new wells were installed at the Landfill, eight (8) new wells were installed at the BSP and 12 new wells were installed around the SFAP. The details regarding the installation of the monitoring wells at each CCR unit are presented below.

4.5.1 Monitoring Well Installation – Type III Residual Waste Landfill

At this CCR unit, two (2) new Landfill monitoring wells (CCR-1BU and CCR-2BU) were installed using the same materials and construction as the existing Landfill wells. Rotary vibratory drilling was used to advance each boring until refusal, at which point the borehole was advanced to completion using rock coring methods. A steel casing was installed as each boring was advanced to keep the borehole open during well installation.

The two (2) new Landfill monitoring wells were constructed using 20 feet of 2-inch diameter, 0.10-inch slot Schedule 40 PVC screen with 2-inch diameter riser pipe from the top of the screen to the ground surface. A filter pack consisting of 0.40 mm clean quartz sand was installed directly around the well screen. The sand was placed as the metal casing was pulled back in one (1)- to two (2)- foot increments to reduce caving effects and ensure proper placement of the filter pack. The filter pack extended four (4)-feet above the top of the well screen.

A four (4)-foot thick annular bentonite seal was installed directly above the filter pack in each well. Once in place, the bentonite seal was allowed to hydrate before the remainder of the annular space around each riser pipe was backfilled from the top of the bentonite seal to ground surface using a grout consisting of portland cement and bentonite. Each monitoring well was completed with an above-ground protective steel casing and a locking well cap. Following installation, each monitoring well was surveyed for elevation and location by OVEC personnel.

Well construction details for all of the Landfill wells, including survey data, are included in Table 2.

4.5.2 Monitoring Well Installation – BSP and SFAP

The monitoring wells around the BSP and the SFAP were installed using a rotary vibratory drilling method. The vibrating drill bit was simultaneously pushed down and rotated, while the drill head was advanced in 10-foot runs through an 8-inch metal casing to keep the borehole open. Continuous soil samples were obtained from the entire length of each 10-foot run and were logged by the AGES geologist (Appendix C).

Once each borehole was advanced to the desired depth, a 10-foot, pre-packed well screen was set into the borehole. An outer filter pack consisting of 0.40 mm clean quartz sand was installed directly around the pre-packed well screen. The sand was placed as the metal casing was pulled back in one (1)- to two (2)- foot increments to reduce caving effects and ensure proper placement of the filter pack. The filter pack extended two (2)-feet above the top of the screen.

A four (4)-foot thick annular bentonite seal was installed above the filter pack in each well. Once in place, the bentonite seal was allowed to hydrate before the remainder of the annular space around each monitoring well was backfilled using a grout consisting of portland cement and bentonite. Each monitoring well was completed with a flush-mount steel well cover with a locking well-cap. Following installation, each monitoring well was surveyed for elevation and location by OVEC personnel.

Well construction details for all of the wells installed at the BSP and SFAP are presented in Tables 3 & 4, respectively. All boring and well logs are included in Appendix C.

4.5.3 Monitoring Well Development

Well development was initiated at least 48 hours after installation of each of the monitoring wells. Development consisted of alternating surging and pumping with a submersible pump. During development of the monitoring wells, field parameters including temperature, specific conductance, pH and turbidity were recorded at regular intervals. Development continued until each parameter stabilized and turbidity was less than 5 NTUs. Well development data for each well is included in Appendix D.

4.6 Groundwater Monitoring Networks

To comply with the CCR Rule, each monitored CCR Unit must have a groundwater monitoring network consisting of a minimum of one (1) upgradient/background monitoring well and a minimum of three (3) downgradient monitoring wells installed as close as practicable to the waste boundary. A discussion of the CCR monitoring well network for each unit is presented below.

4.6.1 Type III Residual Waste Landfill

Based on groundwater level data collected since 2007, groundwater elevations in the Buffalo Sandstone (the uppermost aquifer at the unit) beneath the Landfill have varied over time. Some Buffalo Sandstone wells at the site can be upgradient during one event and then downgradient during a later event. Groundwater levels measured in January 2016, March 2016 and May 2016 are included in Appendix E. Groundwater flow maps for January, March and May 2016 are included in Appendix F. Based on this data, it was determined that a radial network of wells would be most appropriate for the Landfill.

Of the 11 monitoring wells installed in 2007 for the OEPA groundwater monitoring program, six (6) of those wells are located around the Phase 1 boundary of the waste and are included in the CCR monitoring network:

- BUSW-1 (downgradient)
- BUSW-2 (upgradient)
- BUSW-3 (variable: usually side or downgradient)
- BUSW-4 (downgradient)
- BUSW-5 (upgradient)
- IMW-1BU (upgradient)

The remaining five (5) wells (BUSW-8, BUSW-10, MW-3D, IMW-2BU and MW-4D) are supplemental wells located at least 1,000 feet away from the Phase 1 waste limit and do not satisfy the CCR requirement that downgradient wells be "as close as practicable" to the limit of waste.

In 2015, two (2) additional downgradient monitoring wells (CCR-1BU and CCR-2BU) were installed at the Phase 1 limit of waste. These monitoring wells were designed to be constructed in a manner consistent with the construction of the monitoring wells installed in 2007. The installation of these monitoring wells completed the CCR groundwater monitoring network for Phase 1 of the Landfill. As shown on Table 2, the CCR groundwater monitoring network for the Landfill includes four (4) upgradient monitoring wells (BUSW-2, BUSW-3, BUSW-5 and IMW-1BU) and four (4) downgradient monitoring wells (BUSW-1, BUSW-4, CCR-1BU and CCR-2BU), which satisfies the requirements of the CCR rule. As additional phases of the Landfill are constructed in the future, additional groundwater monitoring wells will need to be installed.

Groundwater levels measured from the wells in January 2016, March 2016 and May 2016 are included in Appendix E. Groundwater flow maps for January, March and May 2016 are included in Appendix F. Based on the first three (3) rounds of groundwater level measurements, groundwater flows in a radial pattern away from the highest water levels, which are typically observed in wells BUSW-2, BUSW-5 and IMW-1BU, toward the lowest water levels typically observed in BUSW-3 and BUSW-4 located along the western boundary of the Landfill, and in the supplemental wells located to the east of the Landfill.

4.6.2 Boiler Slag Pond

In August 2015, eight (8) groundwater monitoring wells were installed around the perimeter of the BSP (Table 3 and Figure 5). Groundwater levels measured from the wells in January 2016, March 2016 and May 2016 are included in Appendix E. Based on the first three (3) rounds of groundwater level measurements, groundwater in the BSP flows from the northwest to the south and southeast towards the Ohio River. Groundwater flow maps for January, March and May 2016 are included in Appendix F. Based on water level data, three (3) monitoring wells (KC-15-01 through KC-15-03) were installed along the northern border of the BSP to serve as the upgradient groundwater monitoring wells. Five (5) wells (KC-15-04 through KC-15-08) were installed along the western, southern and eastern borders of the BSP to serve as the downgradient monitoring locations. These eight (8) wells will serve as the CCR monitoring network for the BSP.

4.6.3 South Fly Ash Pond

A review of available data indicated that groundwater flowed in a radial pattern away from the pond. Therefore, a phased approach was developed to install the proposed CCR monitoring wells. During Phase 1, four (4) wells (KC-15-11, KC-15-14, KC-15-18 and KC-15-21) were installed, one (1) along each side of the pond. After installation, these four (4) wells were surveyed and the water levels were measured to calculate initial groundwater elevations to guide the placement of the remaining proposed monitoring wells.

Based on these initial groundwater elevations, a definitive groundwater flow direction was not apparent. Therefore, it was decided to use a conservative approach and install an additional 10 monitoring wells, evenly spaced, around the entire perimeter of the SFAP.

Based on the first three (3) rounds of groundwater level measurements, groundwater beneath the SFAP flows from the northeast towards the southwest. Groundwater levels measured in January 2016, March 2016 and May 2016 are included in Appendix E. Groundwater flow maps for January, March and May 2016 are included in Appendix F.

The CCR groundwater monitoring network consists of eight (8) upgradient monitoring wells (KC-15-10 through KC-15-17), four (4) downgradient monitoring wells (KC-15-09, KC-15-20, KC-15-21 and KC-15-22) and two (2) side-gradient monitoring wells (KC-15-18 and KC-15-19). As the CCR monitoring program continues, groundwater flow will continue to be monitored and any observed seasonal variations will be noted in the first annual groundwater monitoring report to be published in January 2018. If groundwater flow in the uppermost aquifer remains consistent, it may be possible to reduce the number of monitoring wells sampled during each CCR monitoring event. Construction details for the SFAP groundwater monitoring network wells are summarized on Table 4. Groundwater monitoring well locations are shown on Figure 7.

5.0 AQUIFER TESTING

In May 2016, slug tests were conducted on two (2) wells (KC-15-02 and KC-15-05) at the BSP and two (2) wells (KC-15-14 and KC-15-21) at the SFAP. The slug testing was performed to obtain the saturated hydraulic conductivity (K) for the uppermost aquifer beneath each unit. Both rising and falling head slug tests were performed on each well. The falling head tests were performed by lowering a solid slug with a known volume, into the water column of the well and recording the drop in head over time. The rising head tests were performed by removing the solid slug and recording the rise in head over time. The change of head over time was recorded using a data logger and pressure transducer. Dedicated rope was used for each well and the slug was decontaminated using the procedures specified in the Groundwater Monitoring Program Plan (GMPP) for the Kyger station. Slug testing was performed after well development and three (3) rounds of groundwater sampling.

The slug test data were evaluated using AQTESOLV, a commercially available software package. Data from each monitoring well were analyzed using both the Bouwer-Rice and Hvorslev slug test solutions which are straight-line analytical techniques commonly used to analyze rising and falling head slug test data. The AQTESOLV results for each well are presented in Appendix G.

Slug test results for the BSP and SFAP are summarized on Tables 5 and 6, respectively. The mean K for the uppermost aquifer beneath the BSP is 1.26×10^{-2} cm/sec and the mean K for the uppermost aquifer beneath the SFAP is 2.13×10^{-3} cm/sec. Data from these tests will be used to evaluate groundwater flow velocity at the BSP and SFAP.

6.0 CONCLUSIONS

To meet the requirements of the CCR regulation, two (2) additional groundwater monitoring wells were installed at the Landfill, and new groundwater monitoring networks were installed at the BSP and the SFAP. Based on available historic data and exploratory soil borings conducted around the BSP and the SFAP, the following units were identified as the uppermost aquifer at each CCR unit:

- **Landfill:** The Buffalo Sandstone was identified as the uppermost aquifer beneath the Landfill.

- **Boiler Slag Pond:** A layer of silty sand located approximately 50 feet bgs was identified as the uppermost aquifer beneath the BSP.

- **South Fly Ash Pond:** A layer of silty sand located approximately 60 feet bgs was identified as the uppermost aquifer beneath the SFAP.

To meet the monitoring network requirements of the CCR Rule, two (2) monitoring wells were installed at the Landfill; eight (8) monitoring wells were installed around the BSP; and 14 monitoring wells were installed around the SFAP.

Following installation, development and three (3) rounds of groundwater sampling, slug testing was conducted on two (2) monitoring wells at the BSP and two (2) monitoring wells at the SFAP. Data from the slug testing was used to calculate the mean K of the uppermost aquifer beneath the BSP and the SFAP. The mean K for the uppermost aquifer beneath the BSP is 1.26 x 10^{-2} cm/sec and the mean K for the uppermost aquifer beneath the SFAP is 2.13 x 10^{-3} cm/sec.

To meet the requirements of the CCR, the groundwater monitoring networks at each of the three (3) CCR units at the Kyger Creek station will be sampled in accordance with the GMPP.

7.0 REFERENCES

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Applied Geology and Environmental Science, Inc. (AGES), 2016. Coal Combustion Residuals Regulation Groundwater Monitoring Program Plan, Ohio Valley Electric Corporation, Kyger Creek Station, Cheshire, Gallia County, Ohio. May 2016.

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United States Environmental Protection Agency (U.S. EPA), 1991. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. March 1991.

TABLES

TABLE 1
GRAIN SIZE ANALYSIS RESULTS
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO

CCR Unit	Boring No.	Sample Depth (feet)	70% Retention (30% Passing) Size (mm)	Filter Pack Size (mm)	Screen Mesh (inches)	Unified Soil Classification Symbol & Description	
Boiler Slag Pond	BAP-B-1	62.0 - 70.0	0.80	0.40	0.01	SP-SM	Poorly graded Sand with silt & gravel.
Boiler Slag Pond	BAP-B-2	50.0 - 60.0	0.095	0.40	0.01	SM	Silty Sand.
Boiler Slag Pond	BAP-B-2	60.0 - 70.0	0.17	0.40	0.01	SP-SM	Poorly Graded Sand with silt.
South Fly Ash Pond	B-1	62.0 - 68.0	1.0	0.40	0.01	SW-SM	Well graded Sand with silt and gravel.
South Fly Ash Pond	B-1	70.0 - 78.0	0.5	0.40	0.01	SW-SM	Well graded Sand with silt and gravel.
South Fly Ash Pond	B-2	60.0 - 70.0	0.9	0.40	0.01	SW-SM	Well graded Sand with silt and gravel.

TABLE 2
GROUNDWATER MONITORING NETWORK
TYPE III RESIDUAL WASTE LANDFILL
KYGER CREEK PLANT

Monitoring Well ID	Designation	Date of Installation	Coordinates		Ground Elevation (ft)[2]	Top of Casing Elevation (ft)[2]	Top of Screen Elevation (ft)	Base of Screen Elevation (ft)	Total Depth From Top of Casing (ft)
			Northing	Easting					
CCR Unit Boundary Wells									
BUSW-1	**Downgradient**	6/20/2006	335756.52	2063859.43	781.46	784.21	521.21	508.10	276.11
BUSW-2	**Upgradient**	-	336285.22	2062985.02	792.19	794.98	526.69	506.69	288.56
BUSW-3	**Upgradient**	9/13/2007	336746.19	2062430.81	787.57	790.01	529.57	504.57	283.56
BUSW-4	**Downgradient**	5/17/2006	337738.57	2062566.35	780.99	783.46	535.76	525.76	257.70
BUSW-5	**Upgradient**	8/2/2007	338123.59	2063553.15	781.06	783.27	542.06	502.06	281.12
IMW-1BU	**Upgradient**	9/6/2007	337177.94	2064160.50	699.89	702.29	519.39	499.39	202.97
CCR-1BU	**Downgradient**	10/13/2015	337641.36	2063220.23	783.41	785.80	524.41	504.41	281.39
CCR-2BU	**Downgradient**	10/21/2015	336302.19	2064286.87	742.28	744.69	514.78	494.78	249.91
Supplemental CCR Wells									
BUSW-8	**Downgradient**	4/17/2006	337692.04	2065706.88	630.59	633.48	498.12	498.12	145.36
BUSW-10	**Downgradient**	6/29/2007	336364.75	2065495.79	617.26	619.76	513.85	498.85	120.91
IMW-2BU	**Downgradient**	9/10/2007	337417.23	2065170.91	609.77	612.44	508.96	493.96	118.48
MW-3D	**Downgradient**	5/1/2006	338184.68	2065077.38	741.11	743.53	515.58	505.58	237.95
MW-4D	**Downgradient**	5/10/2006	336365.51	2066044.36	576.87	579.51	504.94	494.94	84.57

Notes:
1. The Well locations are referenced to the Ohio State Plane South, North American Datum (NAD83), east zone coordinate system.
2. Elevations are referenced to the North American Vertical Datum (NAVD) 1988

TABLE 3
GROUNDWATER MONITORING NETWORK
BOILER SLAG POND
KYGER CREEK PLANT

Monitoring Well ID	Designation	Date of Installation	Coordinates		Ground Elevation (ft)²	Top of Casing Elevation (ft)²	Top of Screen Elevation (ft)	Base of Screen Elevation (ft)	Total Depth From Top of Casing (ft)
			Northing	Easting					
KC-15-01	Upgradient	8/5/2015	332114.55	2072393.84	579.77	579.20	519.77	509.77	69.43
KC-15-02	Upgradient	8/7/2012	332500.654	2072569.222	580.79	580.25	520.79	510.79	69.46
KC-15-03	Upgradient	8/12/2015	332546.402	2073001.342	582.03	581.55	520.03	510.03	71.52
KC-15-04	Downgradient	8/12/2015	331782.439	2073755.607	579.89	579.37	519.89	509.89	69.48
KC-15-05	Downgradient	8/19/2015	331569.994	2073574.832	580.52	580.07	520.52	510.52	69.55
KC-15-06	Downgradient	8/18/2015	331218.52	2073210.42	579.98	579.48	519.98	509.98	69.50
KC-15-07	Downgradient	8/11/2015	331291.75	2072957.79	578.54	578.04	508.54	498.54	79.50
KC-15-08	Downgradient	8/10/2015	331460.59	2072675.87	579.41	578.75	509.41	499.41	79.34

Notes:
1. The Well locations are referenced to the Ohio State Plane South, North American Datum (NAD83), east zone coordinate system.
2. Elevations are referenced to the North American Vertical Datum (NAVD) 1988

TABLE 4
GROUNDWATER MONITORING NETWORK
SOUTH FLY ASH POND
KYGER CREEK PLANT

Monitoring Well ID	Designation	Date of Installation	Coordinates		Ground Elevation (ft)²	Top of Casing Elevation (ft)²	Top of Screen Elevation (ft)	Base of Screen Elevation (ft)	Total Depth From Top of Casing (ft)
			Northing	Easting					
KC-15-09	Downgradient	9/15/2015	334631.959	2072494.446	587.85	587.47	516.85	506.85	80.62
KC-15-10	Upgradient	9/16/2015	335018.949	2072695.744	587.75	587.45	523.75	513.75	73.70
KC-15-11	Upgradient	8/20/2015	335426.144	2072970.304	588.07	587.71	524.07	514.07	73.64
KC-15-12	Upgradient	9/17/2015	335867.034	2073268.666	588.40	587.94	524.40	514.40	73.54
KC-15-13	Upgradient	9/1/2015	336047.047	2073665.155	588.23	587.86	521.23	511.23	76.73
KC-15-14	Upgradient	8/20/2015	335808.537	2074057.138	588.85	587.80	524.85	513.85	72.95
KC-15-15	Upgradient	9/2/2015	335558.54	2074472.666	587.95	587.63	523.95	513.95	73.68
KC-15-16	Upgradient	9/3/2015	335223.916	2074799.53	588.82	588.38	524.82	514.82	73.50
KC-15-17	Upgradient	9/3/2015	334881.253	2074480.308	588.68	588.13	524.68	514.68	73.45
KC-15-18	Sidegradient	8/25/2015	334507.455	2074126.888	588.27	587.72	524.27	514.27	73.45
KC-15-19	Sidegradient	9/9/2015	334132.454	2073771.27	588.47	588.18	524.47	514.47	73.71
KC-15-20	Downgradient	8/27/2015	333841.393	2073452.842	589.45	588.72	525.45	515.45	73.26
KC-15-21	Downgradient	8/27/2015	334089.953	2073009.526	588.28	587.84	518.28	508.28	79.56
KC-15-22	Downgradient	9/10/2015	334307.567	2072647.434	587.51	587.27	518.51	508.51	78.76

Notes:
1. The Well locations are referenced to the Ohio State Plane South, North American Datum (NAD83), east zone coordinate system.
2. Elevations are referenced to the North American Vertical Datum (NAVD) 1988

Table 5
SUMMARY OF SLUG TEST RESULTS
Boiler Slag Pond
Kyger Creek Station
Cheshire, Ohio
May 2016

Piezometer	Test	Analytical Method	K (cm/sec)	Mean K (cm/sec)
KC-15-02	Rising Head #1	Bouwer-Rice	1.46 E-2	2.18 E-2
		Hvorslev	1.61 E-2	
	Falling Head #1	Bouwer-Rice	3.58 E-2	
		Hvorslev	2.23 E-2	
	Rising Head #2	Bouwer-Rice	2.00 E-2	
		Hvorslev	2.15 E-2	
	Falling Head #2	Bouwer-Rice	1.72 E-2	
		Hvorslev	1.77 E-2	
KC-15-05	Rising Head #1	Bouwer-Rice	5.83 E-3	3.47 E-3
		Hvorslev	6.48 E-3	
	Falling Head #1	Bouwer-Rice	1.59 E-3	
		Hvorslev	1.79 E-3	
	Rising Head #2	Bouwer-Rice	4.74 E-3	
		Hvorslev	4.91 E-3	
	Falling Head #2	Bouwer-Rice	1.15 E-3	
		Hvorslev	1.27 E-3	
			Mean K (cm/sec)	1.26 E-2

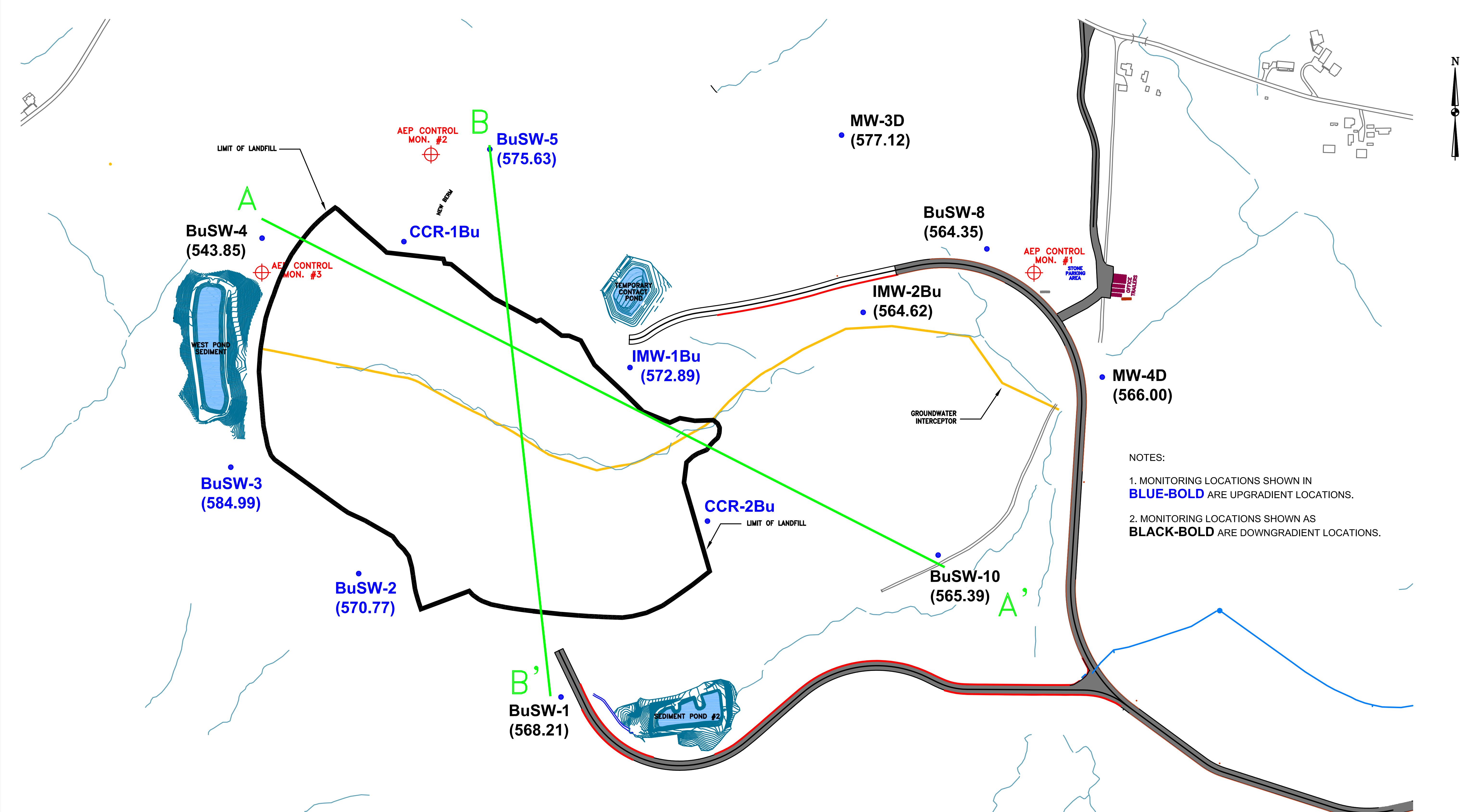
Table 6
SUMMARY OF SLUG TEST RESULTS
South Fly Ash Pond
Kyger Creek Station
Cheshire, Ohio
May 2016

Piezometer	Test	Analytical Method	K (cm/sec)	Mean K (cm/sec)
KC-15-14	Rising Head #1	Bouwer-Rice	3.33 E-3	4.08 E-3
		Hvorslev	3.95 E-3	
	Falling Head #1	Bouwer-Rice	5.41 E-3	
		Hvorslev	4.57 E-3	
	Rising Head #2	Bouwer-Rice	2.88 E-3	
		Hvorslev	3.16 E-3	
	Falling Head #2	Bouwer-Rice	3.96 E-3	
		Hvorslev	4.38 E-3	
KC-15-21	Rising Head #1	Bouwer-Rice	1.57 E-4	1.88 E-4
		Hvorslev	1.71 E-4	
	Falling Head #1	Bouwer-Rice	3.08 E-4	
		Hvorslev	3.35 E-4	
	Rising Head #2	Bouwer-Rice	1.33 E-4	
		Hvorslev	1.45 E-4	
	Falling Head #2	Bouwer-Rice	1.13 E-4	
		Hvorslev	1.43 E-4	
			Mean K (cm/sec)	**2.13 E-3**

FIGURES

DRAWN BY	JM	AGES Applied Geology And Environmental Science, Inc. 2402 Hookstown Grade Road, Suite 200 Clinton, PA 15026 412.264.6453	OHIO VALLEY ELECTRIC COMPANY
DATE			KYGER CREEK STATION CHESHIRE, GALLIA COUNTY, OHIO SITE LOCATION MAP
CHECKED BY			
JOB NO.	2015079-KYG		
DWG FILE	KYGER MW INSTALL_Aerial Site b08.dwg		DRAWING NAME: FIGURE 1
DRAWING SCALE	NOT TO SCALE		REV. 0

Plot: 08/15/2016 14:50 _PROGRAMS-KYGER OVEC\Kyger Creek-CCR Program\CAD\WELL INSTALLATION\KYGER MW INSTALL_Aerial Site b08.dwg



LEGEND:

● BuSW-1	BUFFALO SANDSTONE WELL
(567.96)	GROUNDWATER ELEVATION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015079-KYGER
DWG. FILE	KYGER MW INSTALL_MWs BUFFALO b09.dwg
DRAWING SCALE	AS SHOWN

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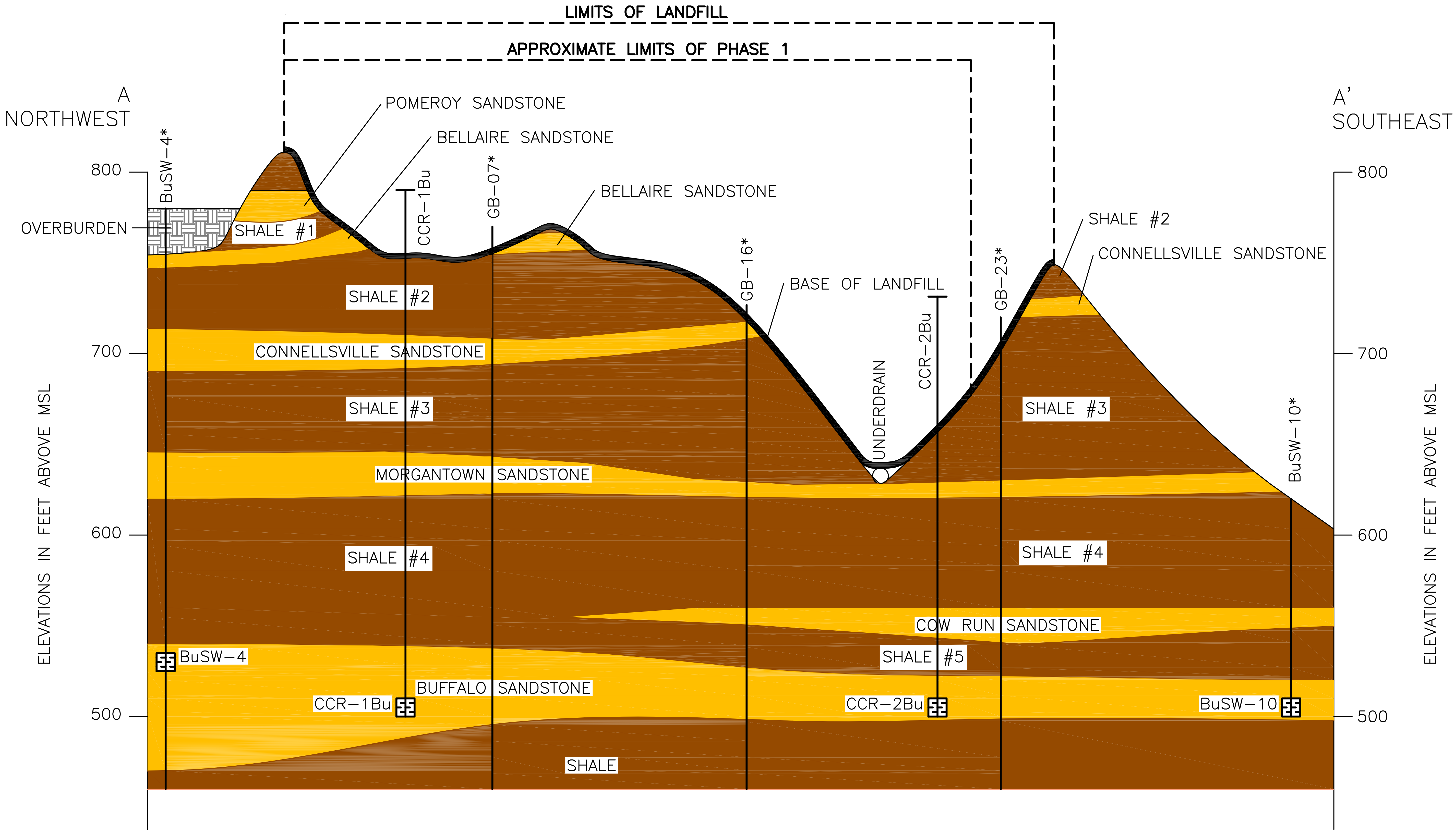
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
TYPE III RESIDUAL WASTE LANDFILL
GROUNDWATER MONITORING WELL LOCATIONS

DRAWING NAME	REV.
FIGURE 2	0

Plot: 05/17/2016 13:46 _PROGRAM-KYGER OVEC\Kyger Creek-CCR Program\CAD\WELL INSTALLATION\KYGER MW INSTALL_MWs_BUFFALO b09.dwg\BUFFALO



*GEOLOGIC DATA FROM 2007 HSIR.

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015079-KYGER
DWG FILE	KYGER MW INSTALL_Cross Sec A-A' b10.dwg
DRAWING SCALE	NOT TO SCALE

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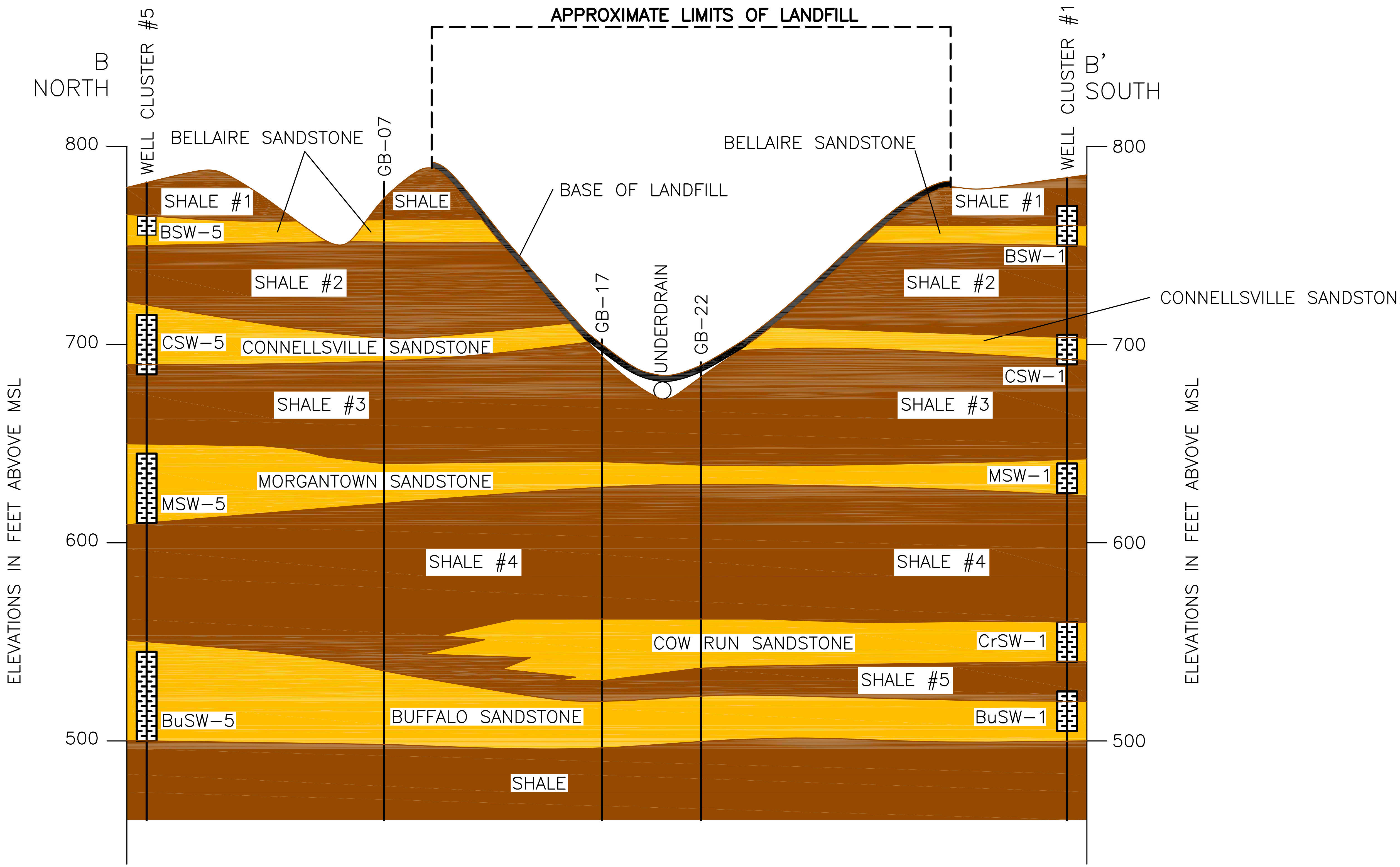
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
TYPE III RESIDUAL WASTE LANDFILL
GENERALIZED GEOLOGIC CROSS-SECTION
A-A' (NORTHWEST – SOUTHEAST)

DRAWING NAME: FIGURE 3

REV. 0



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	P2015079-KYGER
DWG FILE	KYGER MW INSTALL_Cross Sec B-B' b10.dwg
DRAWING SCALE	NOT TO SCALE

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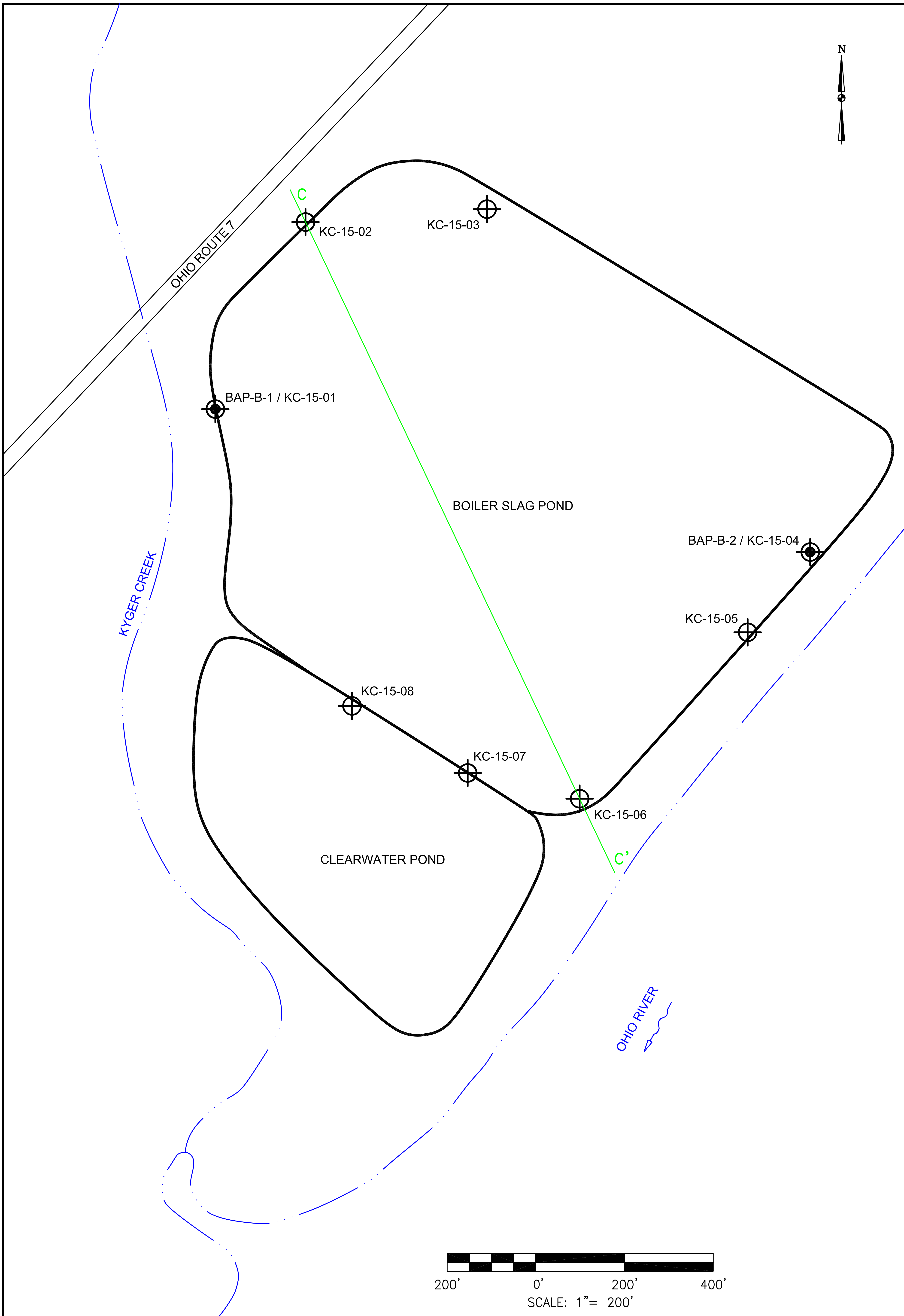
OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
TYPE III RESIDUAL WASTE LANDFILL
GENERALIZED GEOLOGIC CROSS-SECTION
B-B' (NORTH - SOUTH)

DRAWING NAME: FIGURE 4
REV. 0

Plot: 05/17/2016 14:55 _PROGRAM-KYGER OVEC\Kyger Creek-CCR Program\CAD\WELL INSTALLATION\KYGER MW INSTALL_Cross Sec B-B' b10.dwg



LEGEND:
SOIL BORING /MONITORING WELL LOCATION
MONITORING WELL LOCATION

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015079–KYGER
DWG FILE	KYGER MW INSTALL_PONDS+MWs b11.dwg
DRAWING SCALE	1"=200'

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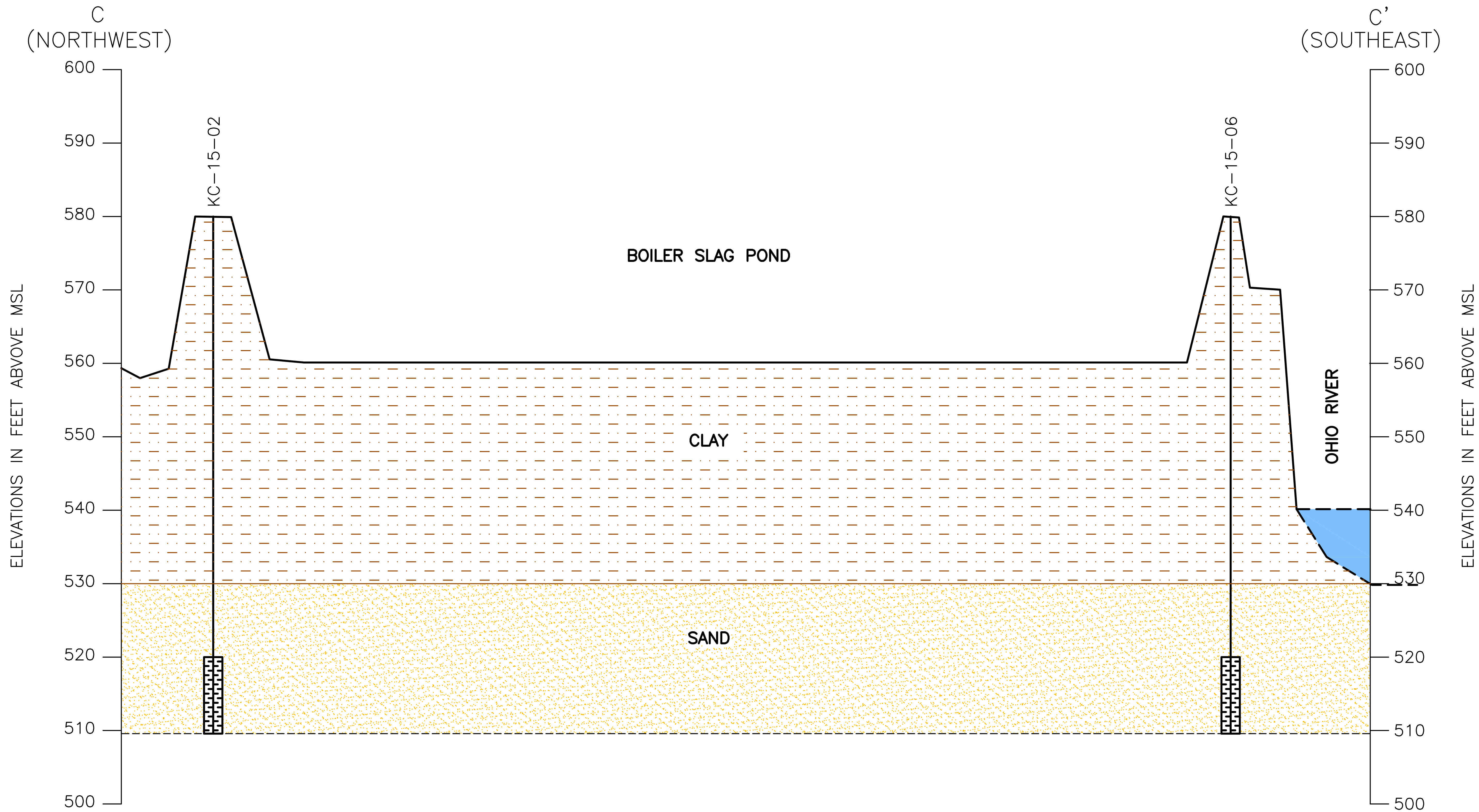
OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
SOIL BORING AND
GROUNDWATER MONITORING WELL LOCATIONS

DRAWING NAME: FIGURE 5
REV. 0

Plot: 08/15/2016 15:03 \Kyger Creek–CCR Program\CAD\WELL INSTALLATION\PONDS_2015 b11\KYGER MW INSTALL_PONDS+MWs b11.dwg\BOILER SLAG POND



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015079-KYGER
DWG FILE	KYGER MW INSTALL_Cross Sec C-C' b12.dwg
DRAWING SCALE	NOT TO SCALE

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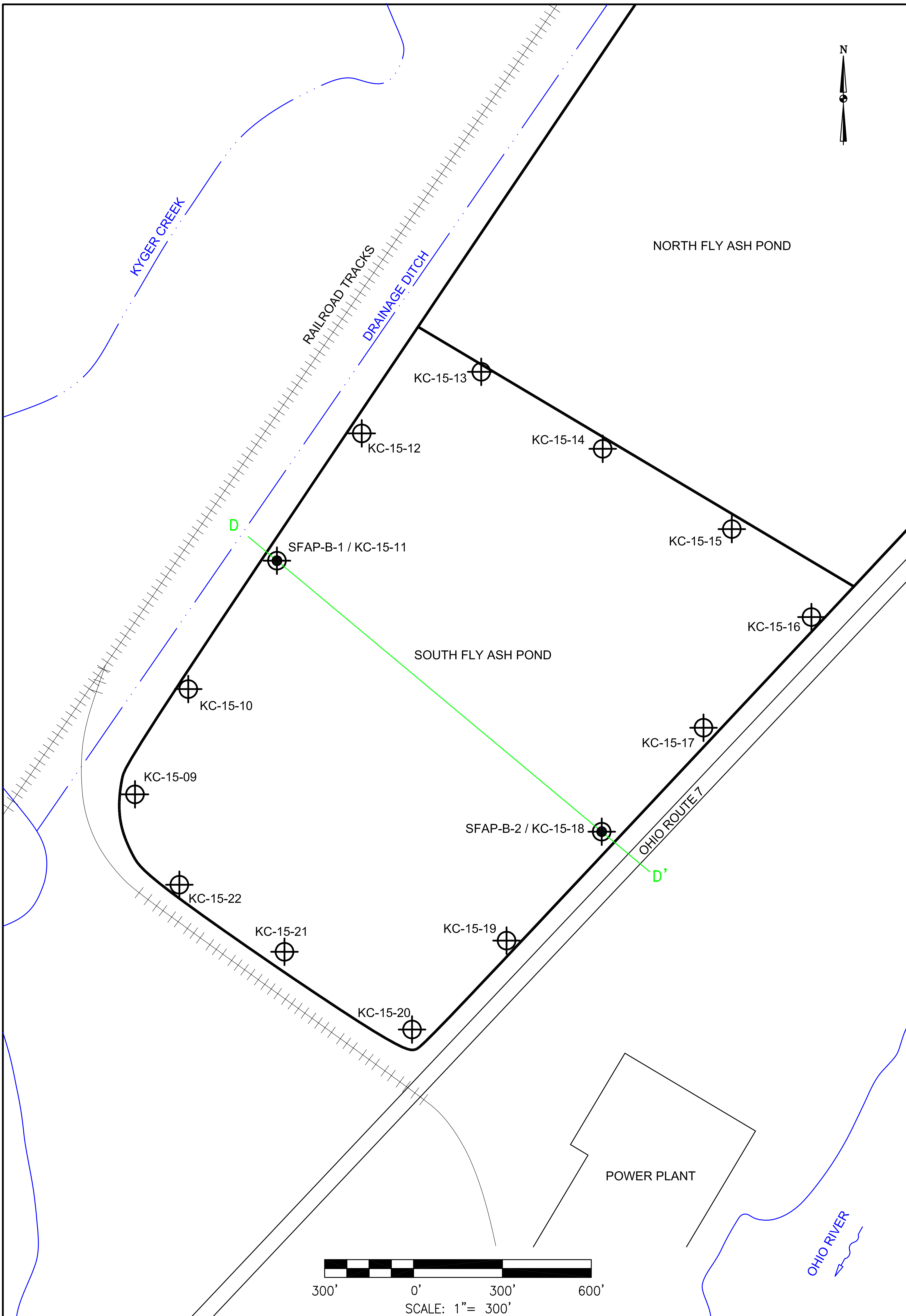
OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GENERALIZED GEOLOGIC CROSS-SECTION
C-C' (NORTHWEST - SOUTHEAST)

DRAWING NAME: FIGURE 6
REV. 0

Plot: 08/15/2016 15:16 _PROGRAM-KYGER OVEC\Kyger Creek-CCR Program\CAD\WELL INSTALLATION\KYGER MW INSTALL_Cross Sec C-C' b12.dwg



LEGEND:
SOIL BORING /MONITORING WELL LOCATION
MONITORING WELL LOCATION

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015079–KYGER
DWG FILE	KYGER MW INSTALL_PONDS+MWs b11.dwg
DRAWING SCALE	1"=300'

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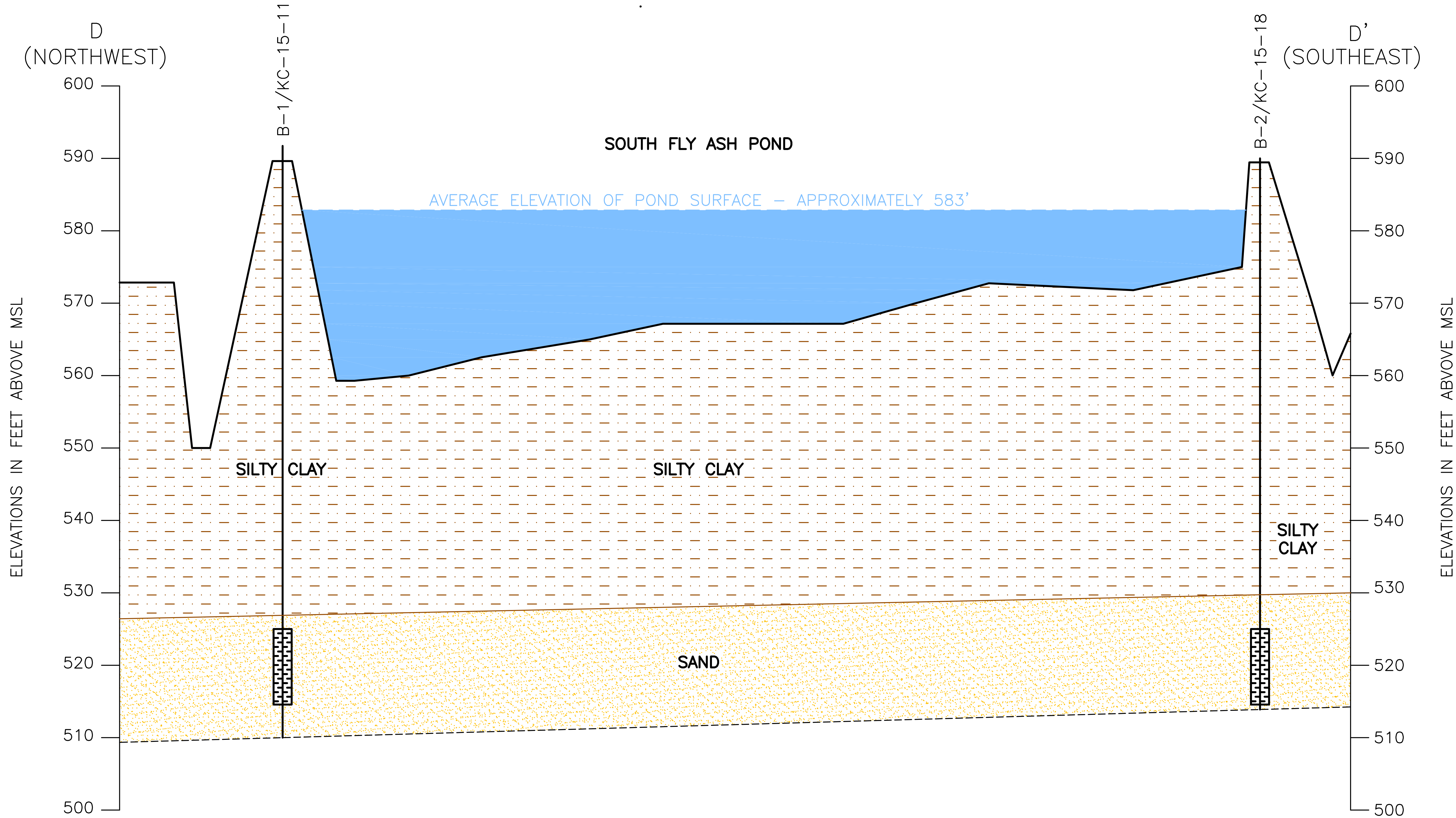
OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
SOIL BORING AND
GROUNDWATER MONITORING WELL LOCATIONS

DRAWING NAME: FIGURE 7
REV. 0

Plot: 08/15/2016 15:10 \Kyger Creek–CCR Program\CAD\WELL INSTALLATION\PONDS_2015 b11\KYGER MW INSTALL_PONDS+MWs b11.dwg\FLY ASH POND



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015079-KYGER
DWG FILE	KYGER MW INSTALL_Cross Sec D-D' b13.dwg
DRAWING SCALE	NOT TO SCALE

AGES Applied Geology And Environmental Science, Inc.

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OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GENERALIZED GEOLOGIC CROSS-SECTION
D-D' (NORTHWEST – SOUTHEAST)

DRAWING NAME: FIGURE 8

REV. 0

Plot: 08/15/2016 15:23 _PROGRAM-KYGER OVEC\Kyger Creek-CCR Program\CAD\WELL INSTALLATION\KYGER MW INSTALL_Cross Sec D-D' b13.dwg

APPENDIX A

2007 HSIR AQUIFER TESTING RESULTS

HYDROGEOLOGIC INVESTIGATION
PROPOSED RESIDUAL WASTE LANDFILL
KYGER CREEK PLANT

TABLE B-5

SUMMARY OF PACKER TEST DATA [1]

Boring ID	Test Interval (ft. bgs)	Approximate Base of Packer Elevevation (ft) [2]	Test Pressure (PSI)	Head change (ft)	Volume water (gal)	Test Duration (min)	r (ft)	Q (ft^3/min)	H (ft)	K (ft/min)	K (cm/sec)	Shale Unit #
GB-05	100-110	673.6	90	0.62	0.01	120	0.135	0.00134	317.63	3.28E-07	1.67E-07	4
	205-215	568.6	90	0.62	0.05	120	0.135	0.00668	422.63	1.23E-06	6.27E-07	2
GB-10	50-60	564.8	60	1.51	2.22	30	0.135	0.00989	213.42	3.61E-06	1.84E-06	4
	65-75	525.1	60	0.53	0.78	60	0.135	0.00174	213.42	6.34E-07	3.22E-07	4
GB-11	40-50	550.1	90	0.58	0.85	60	0.135	0.00190	257.63	5.75E-07	2.92E-07	4
GB-15[3]	110-120	506.1	90	5.08	7.47	23	0.135	0.04340	327.63	1.03E-05	5.25E-06	Cow Run
GB-16	90-100	605.3	60	0.3	0.44	30	0.135	0.00197	238.42	6.43E-07	3.27E-07	4
	90-100	605.3	90	0.6	0.88	30	0.135	0.00393	307.63	9.96E-07	5.06E-07	Duplicate
GB-18	70-80	659.8	60	0.27	0.40	60	0.135	0.00088	218.42	3.16E-07	1.60E-07	3
	130-140	599.8	60	0.16	0.24	50	0.135	0.00063	278.42	1.76E-07	8.95E-08	4
	180-190	549.8	60	0.54	0.79	60	0.135	0.00177	328.42	4.20E-07	2.13E-07	5
GB-21	110-120	657.3	80	0.41	0.60	60	0.135	0.00134	297.64	3.52E-07	1.79E-07	3
	160-170	607.3	80	0.64	0.94	60	0.135	0.00210	354.56	4.61E-07	2.34E-07	4
	239-249	528.3	90	2.97	4.37	60	0.135	0.00973	456.63	1.66E-06	8.44E-07	5
GB-23	80-90	661.7	90	0.62	0.91	60	0.135	0.00203	297.63	5.32E-07	2.70E-07	3
	130-140	611.7	60	0.1	0.15	60	0.135	0.00033	278.42	9.17E-08	4.66E-08	4
	209-219	532.7	90	0.52	0.76	60	0.135	0.00170	426.63	3.11E-07	1.58E-07	5
GB-26	100-110	663.7	90	3.4	5.00	60	0.135	0.01114	317.63	2.73E-06	1.39E-06	3
	170-180	593.7	90	0.1	0.15	60	0.135	0.00033	387.63	6.59E-08	3.35E-08	4
	236-246	537.7	90	1.35	1.98	20	0.135	0.01326	443.63	2.33E-06	1.19E-06	5
CRW-1	60-70	610.9	60	0.01[4]	0.01	10	0.250	0.00019	208.42	5.59E-07	2.83E-08	2
	105-115	665.9	60	0.01[4]	0.01	10	0.250	0.00019	253.42	4.57E-08	2.32E-08	3
CSW-2	45-55	737.2	30	0.48	0.68	10	0.250	0.00903	124.21	4.48E-06	2.27E-06	2
	55-65	727.2	90	0.125	0.18	10	0.250	0.00235	272.63	5.31E-07	2.70E-07	2
CSW-3	40-50	737.7	40	0.05	0.07	10	0.250	0.00094	142.28	4.07E-76	2.07E-07	2
	60-70	717.6	60	0.08	0.11	10	0.250	0.00150	208.42	4.44E-07	2.26E-07	2
CSW-5	110-120	661.1	60	0.04	0.06	10	0.250	0.00752	258.42	1.79E-06	9.11E-07	3
	170-180	601.1	60	0.02	0.03	10	0.250	0.00038	318.42	7.27E-08	3.69E-08	4
IMW-1BU[3]	158-168	531.9	60	0.18	0.25	10	0.165	0.00339	306.42	7.05E-07	3.58E-07	Cow Run
	168-178	521.9	60	0.24	0.34	10	0.165	0.00451	316.42	9.10E-07	4.62E-07	5
[3]	190-200	531.9	40	NA[5]	3.90	10	0.165	0.05214	292.28	1.14E-05	5.78E-06	Buffalo
IMW-2BU	80-90	519.8	60	0.03	0.04	10	0.165	0.00564	228.42	1.58E-07	8.01E-08	5

Notes:
1. Calculations based on Permeability Tests in Individual Drill Holes and Wells, Groundwater Manual, U.S. Department of Interior, 2nd Edition, 1995
2. All elevations for this project are referenced to NAVD88.
3. Denotes packer tests in sandstone units.
4. Estimated flow, no flow measured during test.
5. Not avaliable, flow meter used in place of manometer.

HYDROGEOLOGIC INVESTIGATION
PROPOSED RESIDUAL WASTE LANDFILL
KYGER CREEK PLANT

TABLE B-6

SUMMARY OF SLUG TEST DATA

Well ID	Sandstone Unit	Slug In K (cm/sec)	Slug Out K (cm/sec)
IMW-1Bu	Buffalo	ND [1.]	5.81E-06 [2.]
CRW-2	Cow Run	1.88E-07	2.69E-07
CRW-3	Cow Run	2.71E-07	NM
PZ-2	Cow Run	ND	1.68E-08 [2.]

Notes:

1. Not determined due to poor water level data.
2. Not measured, insufficient water for slug.
3. Data used for analysis is measured water level recovery after well bailed down.

HYDROGEOLOGIC INVESTIGATION
PROPOSED RESIDUAL WASTE LANDFILL
KYGER CREEK PLANT

TABLE B-7

SINGLE-WELL PUMPING TEST SUMMARY TABLE[e]

Well ID	Former Well ID	Sandstone Unit	Depth to water (ft, bgs)	Water Column (ft)	Date Tested	Constant Disharge Rate[a] (gpm)	Constant Discharge Rate (ft^3/day)	Stabilized Drawdown (ft)[b]	Transmissivity (ft^2/day)	Saturated Thickness (ft)	Hydraulic Conductivity (ft/day)	Hydraulic Conductivity (cm/sec)
BSW-1	--	Bellaire	16.59	11.60	4/2/2008	0.060	11.55	11.10	44.83	11.60	3.86	1.36E-03
BSW-2	--	Bellaire	30.41	10.93	4/2/2008	0.008	1.54	10.43	6.36	10.93	0.58	2.05E-04
BSW-3	--	Bellaire	30.86	8.31	4/2/2008	0.040	7.70	7.81	42.47	8.31	5.11	1.80E-03
BSW-5	--	Bellaire	17.85	9.27	4/1/2008	0.045	8.66	8.77	42.55	9.27	4.59	1.62E-03
CSW-3	--	Connellsville	95.55	5.22	4/2/2008	0.025	4.81	4.72	43.92	5.22	8.41	2.97E-03
CSW-3 [c]	--	Connellsville	95.55	5.22	4/1/2008	0.069	13.28	4.72	121.23	5.22	23.22	8.19E-03
CSW-5	--	Connellsville	66.77	27.53	4/1/2008	0.017	3.27	27.03	5.22	27.53	0.19	6.68E-05
MW-3S	NA	Connellsville	50.80	6.61	4/1/2008	0.082	15.79	6.11	111.30	6.61	16.84	5.94E-03
MW-3S [d]	NA	Connellsville	50.80	6.61	4/1/2008	0.073	14.05	6.11	99.08	6.61	14.99	5.29E-03
MSW-2	--	Morgantown	172.20	1.18	4/2/2008	0.001	0.19	0.68	12.20	1.18	10.34	3.65E-03
MSW-3	--	Morgantown	172.67	0.68	4/2/2008	0.036	6.93	0.18	1658.58	0.68	2439.09	8.61E-01
MSW-5	--	Morgantown	165.44	6.96	4/1/2008	0.045	8.66	6.46	57.77	6.96	8.30	2.93E-03
CRW-8	MW-02	Cow Run	49.14	41.21	8/9/2006	0.13	25.03	2.90	371.75	13.5	27.54	9.72E-03
CRW-10	MW-07	Cow Run	41.45	26.10	8/8/2006	0.13	25.03	10.36	104.06	6	17.34	6.12E-03
BuSW-1	MW-06D	Buffalo	214.75	61.36	8/9/2006	0.06	11.55	7.8	63.79	15.5	4.12	1.45E-03
BuSW-8	MW-02D	Buffalo	66.69	78.67	8/9/2006	0.13	25.03	5.42	198.91	22	9.04	3.19E-03
BuSW-10	MW-07D	Buffalo	55.20	65.71	8/9/2006	0.38	73.15	3.75	840.35	23.5	35.76	1.26E-02
MW-01D	MW-01D	Buffalo	31.60	68.20	8/9/2006	0.38	73.15	4.66	676.25	25	27.05	9.54E-03
MW-03D		Buffalo	179.92	58.19	8/9/2006	0.13	25.03	12.59	85.63	15	5.71	2.01E-03
MW-04D		Buffalo	14.09	70.51	8/8/2006	0.50	96.25	6.21	667.71	25	26.71	9.42E-03

Notes:

a. Well yield was calculated by dividing the total volume of groundwater removed from the well once evacuated by the time of the yield test.
b. Stabilized drawdown was calculated by subtracting 0.5 feet from the water column length (ft) from sustainable yield test performed on April 1 and 2, 2008.
c. A conservative maximum sustainable yield using the total data set (2.9 gallons of water removed in 42 minutes) was used to calculate yield.
d. Calculated yield for the fourth hour of the yield test. The maximum rate of pumping was 4.35 gallons per hour during this period.
e. Calculations based on Single Well Pump Tests as described in the Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring, Division of Drinking and Ground Waters, Ohio EPA, February 1995.

APPENDIX B

GRAIN SIZE ANALYSIS RESULTS

Stantec

Summary of Soil Tests

Project Name: Kyger Creek OVEC CCR Rule Eng
Project Number: 175534017
Source: BAP-B-1-62-70, 62.0'-70.0'
Lab ID: 4

Sample Type: SPT
Date Received: 7-21-15
Date Reported: 7-27-15

Test Results

Natural Moisture Content

Test Not Performed
Moisture Content (%): N/A

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
1 1/2"	37.5	100.0
1"	25	97.4
3/4"	19	89.6
3/8"	9.5	71.3
No. 4	4.75	58.4
No. 10	2	44.9
No. 40	0.425	21.1
No. 200	0.075	5.3
	0.02	1.4
	0.005	0.6
	0.002	0.0
estimated	0.001	0.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	41.6	55.1
Coarse Sand	13.5	23.8
Medium Sand	23.8	---
Fine Sand	15.8	15.8
Silt	4.7	5.3
Clay	0.6	0.0

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: NP
Plastic Limit: NP
Plasticity Index: NP
Activity Index: N/A

Moisture-Density Relationship

Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Estimated
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.65

Classification

Unified Group Symbol: SP-SM
Group Name: Poorly graded sand with silt and gravel

AASHTO Classification: A-1-a (0)

Comments:

Reviewed By RJ

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name: Kyger Creek OVEC CCR Rule Eng
Source: BAP-B-1-62-70, 62.0'-70.0'
Project Number: 175534017
Lab ID: 4

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: TA
Test Date: 07-22-2015
Date Received: 07-21-2015

Maximum Particle size: 1 1/2" Sieve

Sieve Size	% Passing
1 1/2"	100.0
1"	97.4
3/4"	89.6
3/8"	71.3
No. 4	58.4
No. 10	44.9

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.65

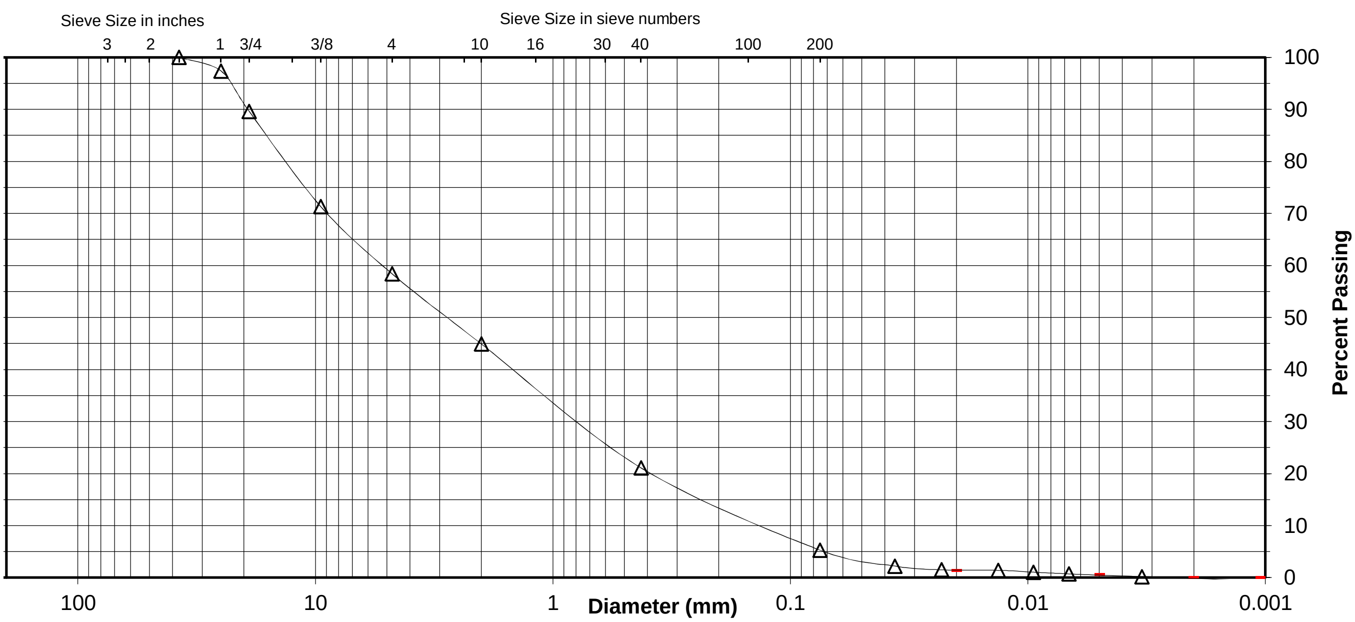
Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	21.1
No. 200	5.3
0.02 mm	1.4
0.005 mm	0.6
0.002 mm	0.0
0.001 mm	0.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	10.4	31.2	13.5	23.8	15.8	4.7	0.6

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	55.1	23.8	15.8	5.3	0.0



Comments ______

Reviewed By RJ

Stantec

Summary of Soil Tests

Project Name: Kyger Creek OVEC CCR Rule Eng
Project Number: 175534017
Source: BAP-B-2-50-60, 50.0'-60.0'
Lab ID: 5

Sample Type: SPT
Date Received: 7-21-15
Date Reported: 7-27-15

Test Results

Natural Moisture Content
Test Not Performed
Moisture Content (%): N/A

Particle Size Analysis
Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
No. 10	2	100.0
No. 40	0.425	99.2
No. 200	0.075	19.9
	0.02	6.8
	0.005	3.9
	0.002	1.4
estimated	0.001	0.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	0.0
Coarse Sand	0.0	0.8
Medium Sand	0.8	---
Fine Sand	79.3	79.3
Silt	16.0	18.5
Clay	3.9	1.4

Atterberg Limits
Test Method: ASTM D 4318 Method A
Prepared: Dry
Liquid Limit: NP
Plastic Limit: NP
Plasticity Index: NP
Activity Index: N/A

Moisture-Density Relationship
Test Not Performed
Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio
Test Not Performed
Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity
Estimated
Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.65

Classification
Unified Group Symbol: SM
Group Name: Silty sand

AASHTO Classification: A-2-4 (0)

Comments:

Reviewed By RJ

Stantec Consulting Services Inc.
Lexington, Kentucky

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	Kyger Creek OVEC CCR Rule Eng	Project Number	175534017
Source	BAP-B-2-50-60, 50.0'-60.0'	Lab ID	5

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: N/A
Particle Hardness: N/A

Tested By: TA
Test Date: 07-22-2015
Date Received: 07-21-2015

Maximum Particle size: No. 10 Sieve

Sieve Size	% Passing
No. 10	100.0

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.65

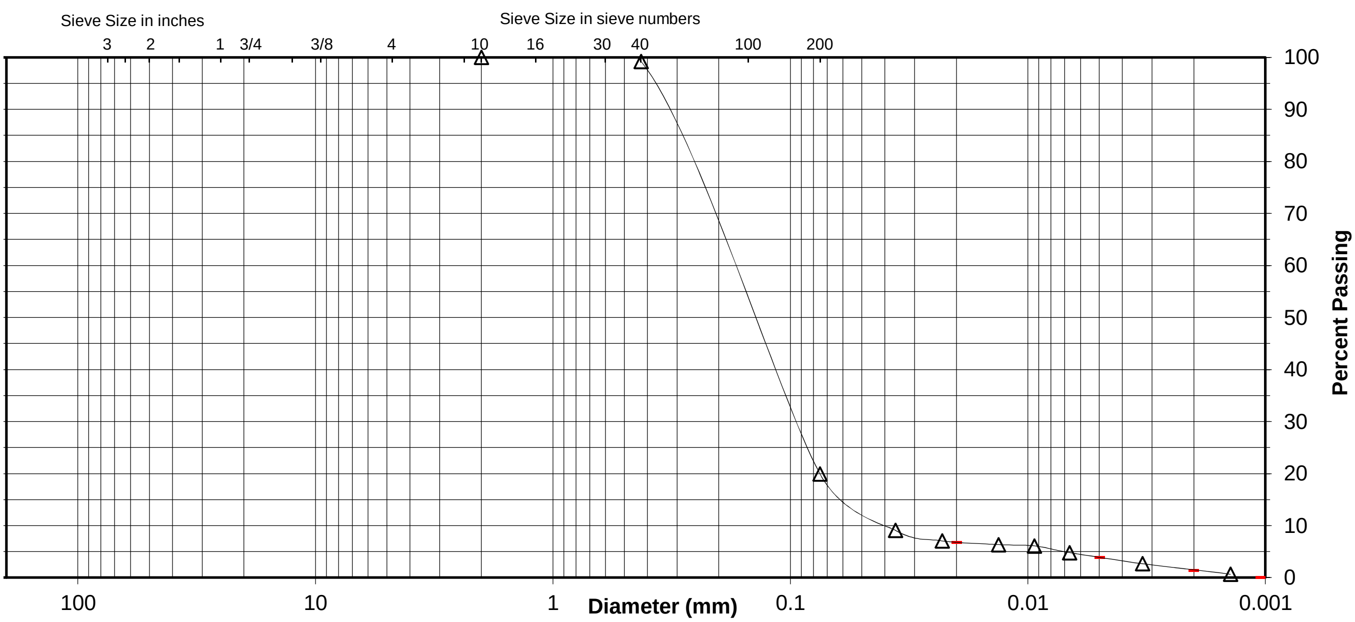
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	99.2
No. 200	19.9
0.02 mm	6.8
0.005 mm	3.9
0.002 mm	1.4
0.001 mm	0.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.0	0.0	0.8	79.3	16.0	3.9

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	0.0	0.8	79.3	18.5	1.4



Comments ______

Reviewed By RJ

Stantec

Summary of Soil Tests

Project Name	Kyger Creek OVEC CCR Rule Eng	Project Number	175534017
Source	BAP-B-2-60-70, 60.0'-70.0'	Lab ID	6
Sample Type	SPT	Date Received	7-21-15
		Date Reported	7-27-15

Test Results

Natural Moisture Content

Test Not Performed

Moisture Content (%): N/A

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
	N/A	
3/4"	19	100.0
3/8"	9.5	97.9
No. 4	4.75	94.0
No. 10	2	83.8
No. 40	0.425	53.3
No. 200	0.075	10.0
	0.02	2.9
	0.005	0.6
	0.002	0.0
estimated	0.001	0.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	6.0	16.2
Coarse Sand	10.2	30.5
Medium Sand	30.5	---
Fine Sand	43.3	43.3
Silt	9.4	10.0
Clay	0.6	0.0

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry

Liquid Limit: NP
Plastic Limit: NP
Plasticity Index: NP
Activity Index: N/A

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.65

Classification

Unified Group Symbol: SP-SM
Group Name: Poorly graded sand with silt

AASHTO Classification: A-3 (0)

Comments:

Reviewed By RJ

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	Kyger Creek OVEC CCR Rule Eng	Project Number	175534017
Source	BAP-B-2-60-70, 60.0'-70.0'	Lab ID	6

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method ASTM D 422
Prepared using ASTM D 421

Particle Shape Angular
Particle Hardness: Hard and Durable

Tested By TA
Test Date 07-22-2015
Date Received 07-21-2015

Maximum Particle size: 3/4" Sieve

Sieve Size	% Passing
3/4"	100.0
3/8"	97.9
No. 4	94.0
No. 10	83.8

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity 2.65

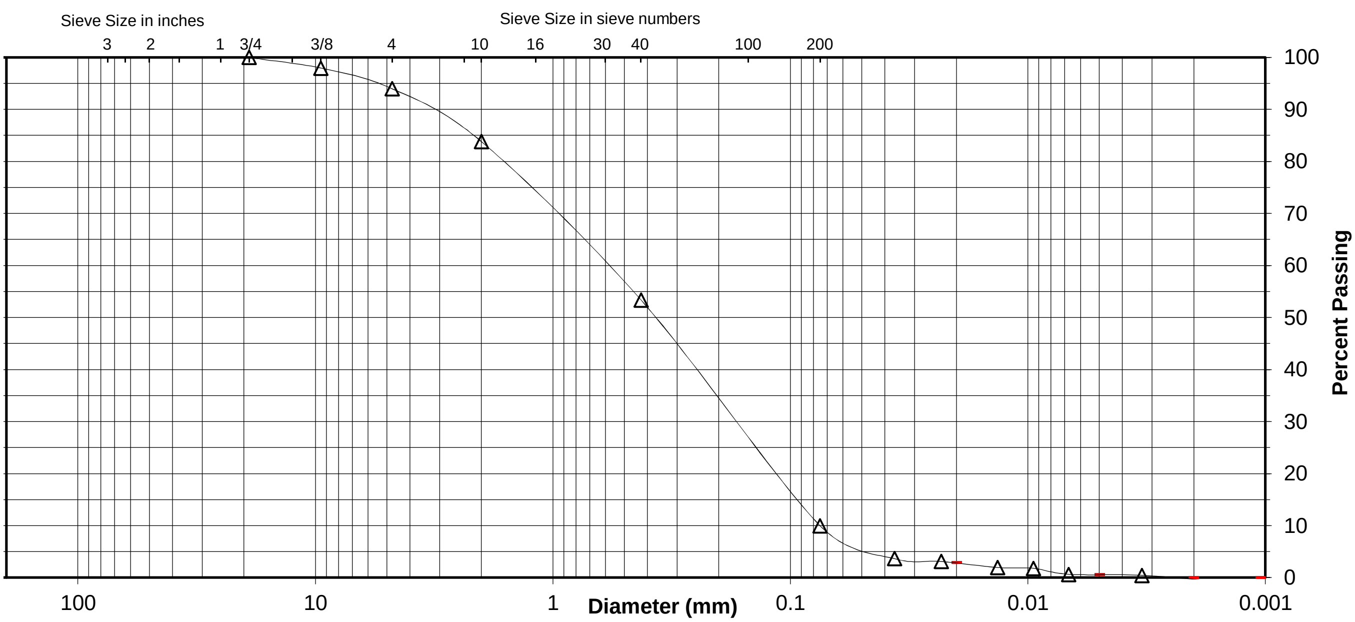
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	53.3
No. 200	10.0
0.02 mm	2.9
0.005 mm	0.6
0.002 mm	0.0
0.001 mm	0.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	6.0	10.2	30.5	43.3	9.4	0.6

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	16.2	30.5	43.3	10.0	0.0



Comments ______

Reviewed By RJ

Stantec

Summary of Soil Tests

Project Name: Kyger Creek OVEC CCR Rule Eng
Project Number: 175534017
Source: SFAP-B-1-62-68, 62.0'-68.0'
Lab ID: 1

Sample Type: SPT
Date Received: 7-21-15
Date Reported: 7-27-15

Test Results

Natural Moisture Content

Test Not Performed

Moisture Content (%): N/A

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	94.8
3/8"	9.5	70.6
No. 4	4.75	55.0
No. 10	2	41.4
No. 40	0.425	18.9
No. 200	0.075	7.5
	0.02	2.0
	0.005	1.4
	0.002	0.6
estimated	0.001	0.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	45.0	58.6
Coarse Sand	13.6	22.5
Medium Sand	22.5	---
Fine Sand	11.4	11.4
Silt	6.1	6.9
Clay	1.4	0.6

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry

Liquid Limit: NP
Plastic Limit: NP
Plasticity Index: NP
Activity Index: N/A

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.65

Classification

Unified Group Symbol: SW-SM
Group Name: Well-graded sand with silt and gravel

AASHTO Classification: A-1-a (0)

Comments:

Reviewed By RJ

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name: Kyger Creek OVEC CCR Rule Eng
Source: SFAP-B-1-62-68, 62.0'-68.0'
Project Number: 175534017
Lab ID: 1

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: TA
Test Date: 07-22-2015
Date Received: 07-21-2015

Maximum Particle size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	94.8
3/8"	70.6
No. 4	55.0
No. 10	41.4

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.65

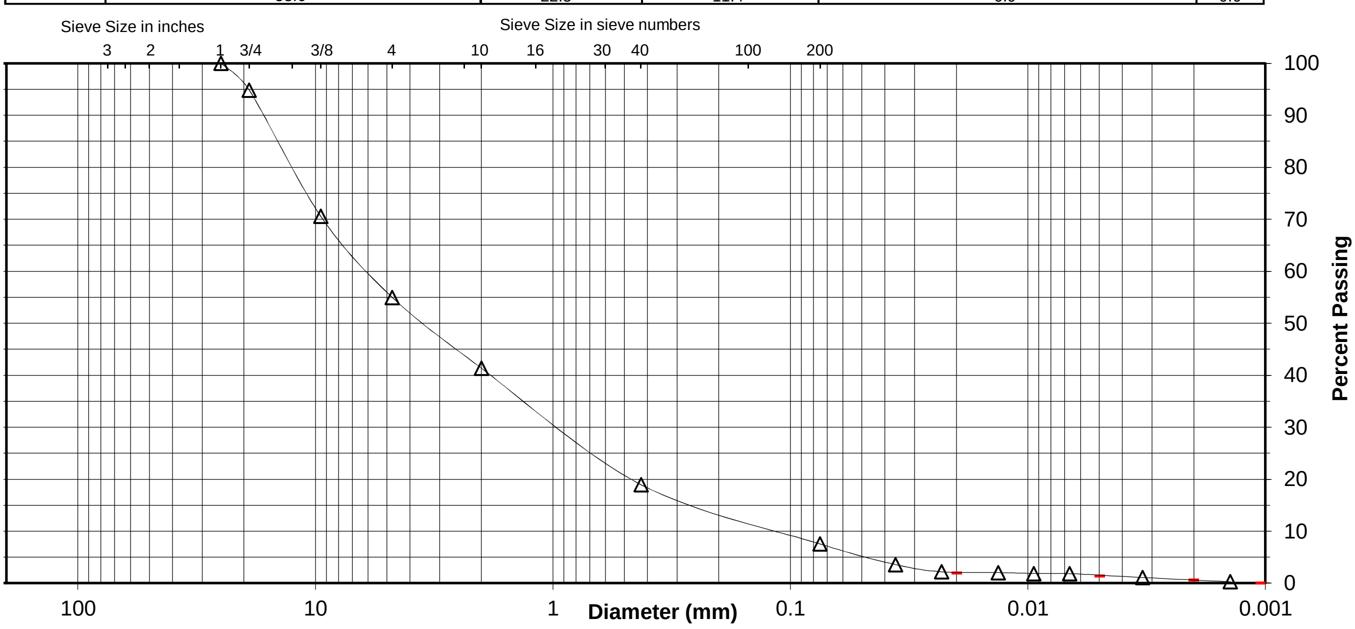
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	18.9
No. 200	7.5
0.02 mm	2.0
0.005 mm	1.4
0.002 mm	0.6
0.001 mm	0.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	5.2	39.8	13.6	22.5	11.4	6.1	1.4

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	58.6	22.5	11.4	6.9	0.6



Comments ____________________

Reviewed By RJ

Stantec

Summary of Soil Tests

Project Name: Kyger Creek OVEC CCR Rule Eng
Project Number: 175534017
Source: SFAP-B-1-70-78, 70.0'-78.0'
Lab ID: 2

Sample Type: SPT
Date Received: 7-21-15
Date Reported: 7-27-15

Test Results

Natural Moisture Content

Test Not Performed
Moisture Content (%): N/A

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	96.3
3/8"	9.5	85.5
No. 4	4.75	73.2
No. 10	2	60.1
No. 40	0.425	23.0
No. 200	0.075	6.9
	0.02	1.1
	0.005	0.0
	0.002	0.0
estimated	0.001	0.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	26.8	39.9
Coarse Sand	13.1	37.1
Medium Sand	37.1	---
Fine Sand	16.1	16.1
Silt	6.9	6.9
Clay	0.0	0.0

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry

Liquid Limit: NP
Plastic Limit: NP
Plasticity Index: NP
Activity Index: N/A

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.65

Classification

Unified Group Symbol: SW-SM
Group Name: Well-graded sand with silt and gravel

AASHTO Classification: A-1-b (0)

Comments:

Reviewed By RJ

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	Kyger Creek OVEC CCR Rule Eng	Project Number	175534017
Source	SFAP-B-1-70-78, 70.0'-78.0'	Lab ID	2

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Rounded
Particle Hardness: Hard and Durable

Tested By: TA
Test Date: 07-22-2015
Date Received: 07-21-2015

Maximum Particle size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	96.3
3/8"	85.5
No. 4	73.2
No. 10	60.1

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.65

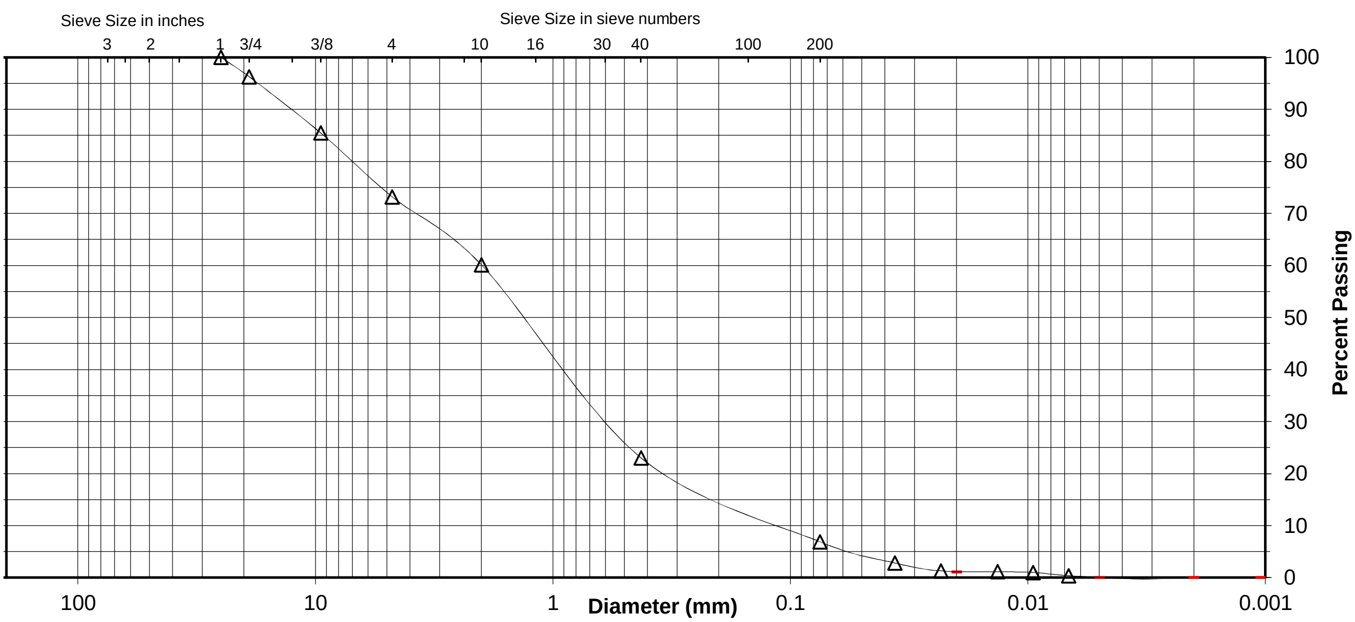
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	23.0
No. 200	6.9
0.02 mm	1.1
0.005 mm	0.0
0.002 mm	0.0
0.001 mm	0.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	3.7	23.1	13.1	37.1	16.1	6.9	0.0

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	39.9	37.1	16.1	6.9	0.0



Comments ______

Reviewed By RJ

File: frm_175534017_sum_2.xlsm
Preparation Date: 1998
Revision Date: 1-2008

Stantec Consulting Services Inc.
Lexington, Kentucky

Laboratory Document
Prepared By: MW
Approved BY: TLK

Stantec

Summary of Soil Tests

Project Name	Kyger Creek OVEC CCR Rule Eng	Project Number	175534017
Source	SFAP-B-2-60-70, 60.0'-70.0'	Lab ID	3
Sample Type	SPT	Date Received	7-21-15
		Date Reported	7-27-15

Test Results

Natural Moisture Content

Test Not Performed

Moisture Content (%): N/A

Particle Size Analysis

Preparation Method: ASTM D 421

Gradation Method: ASTM D 422

Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
1 1/2"	37.5	100.0
1"	25	96.5
3/4"	19	91.9
3/8"	9.5	77.5
No. 4	4.75	63.8
No. 10	2	44.6
No. 40	0.425	18.1
No. 200	0.075	7.4
	0.02	3.0
	0.005	1.4
	0.002	0.8
estimated	0.001	0.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	36.2	55.4
Coarse Sand	19.2	26.5
Medium Sand	26.5	---
Fine Sand	10.7	10.7
Silt	6.0	6.6
Clay	1.4	0.8

Atterberg Limits

Test Method: ASTM D 4318 Method A

Prepared: Dry

Liquid Limit: NP

Plastic Limit: NP

Plasticity Index: NP

Activity Index: N/A

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A

Maximum Dry Density (kg/m^3): N/A

Optimum Moisture Content (%): N/A

Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A

Compacted Dry Density (lb/ft^3): N/A

Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10

Specific Gravity at 20° Celsius: 2.65

Classification

Unified Group Symbol: SW-SM

Group Name: Well-graded sand with silt and gravel

AASHTO Classification: A-1-a (0)

Comments:

Reviewed By RJ

Stantec

Particle-Size Analysis of Soils
ASTM D 422

Project Name	Kyger Creek OVEC CCR Rule Eng	Project Number	175534017
Source	SFAP-B-2-60-70, 60.0'-70.0'	Lab ID	3

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: TA
Test Date: 07-22-2015
Date Received: 07-21-2015

Maximum Particle size: 1 1/2" Sieve

Sieve Size	% Passing
1 1/2"	100.0
1"	96.5
3/4"	91.9
3/8"	77.5
No. 4	63.8
No. 10	44.6

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.65

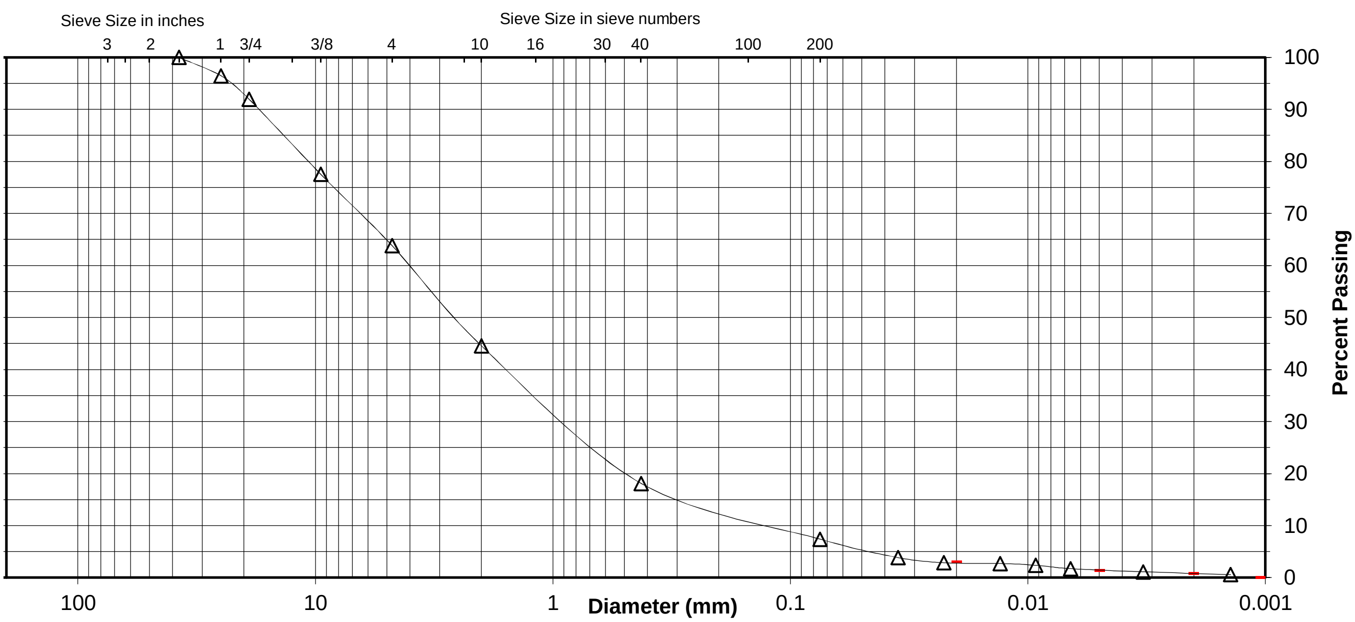
Dispersed using Apparatus A - Mechanical, for 1 minute

Sieve Size	% Passing
No. 40	18.1
No. 200	7.4
0.02 mm	3.0
0.005 mm	1.4
0.002 mm	0.8
0.001 mm	0.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	8.1	28.1	19.2	26.5	10.7	6.0	1.4

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	55.4	26.5	10.7	6.6	0.8



Comments ______

Reviewed By RJ

APPENDIX C

BORING & WELL LOGS

LOG OF BORING GB-27/BuSW-1

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 05/26/2006
Date Completed	: 06/01/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 300.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

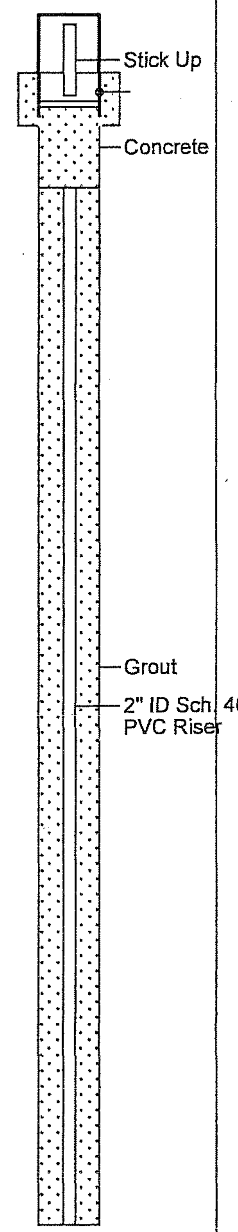
G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-1
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
0	2.0/1.0	SP1/SS1	NA	6-7-8-8	0.0 to 1.0 - Medium dense brown to dark brown sandy SILT, dry, some organics (spoils).
2	2.0/0.7	SP2/SS2	NA	7-6-7-7	2.0 to 2.7 - Medium dense light brown silty SAND, dry (spoils), some weathered grey shale within.
4	2.0/1.3	SP3/SS3	NA	3-4-5-5	4.0 to 5.3 - Medium dense light brown to tan medium to coarse grained SAND, trace silt, slightly moist to very moist.
6	2.0/1.2	SP4/SS4	NA	1-3-4-39	6.0 to 7.2 - Medium dense brown to light brown silty SAND, moist, coal seam at base.
8	2.0/0.3	SP5/SS5	NA	50/4	8.0 to 8.1 - Medium dense brown silty SAND, slightly moist. 8.1 to 8.3 - Soft to medium hard dark grey SHALE, micaceous.
10	0.5/0.3	SP6/SS6	NA	50/3	10.0 to 10.3 - Same As Above (SAA).
10.5	5.0/5.0 RQD = NM	RC1/10MIN	NA	NA	10.5 to 15.5 - SAA: no mica.
15.5	10.0/10.0 RQD = NM	RC2/20MIN	NA	NA	15.5 to 21.3 -SAA: micaceous near base.



REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

LOG OF BORING GB-27/BuSW-1

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 05/26/2006
Date Completed	: 06/01/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 300.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

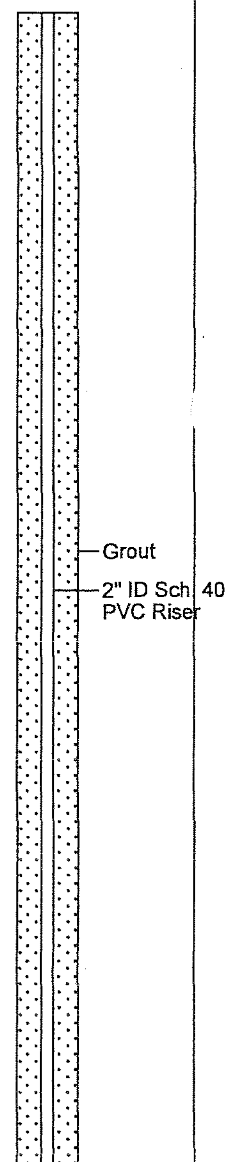
G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-1
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
21.3					21.3 to 25.5 - Hard grey fine grained SANDSTONE.
25.5	10.0/10.0 RQD = NM	RC3/15MIN	NA	NA	25.5 to 26.1 - SAA.
26.1					26.1 to 35.5 - Soft medium to dark grey SHALE, non-micaceous.
35.5	10.0/10.0 RQD = 72	RC4/16MIN	NA	NA	35.5 to 38.5 - SAA.
38.5					38.5 to 39.1 - SAA: dark grey fine grained SANDSTONE interbed, hard coal seam at 37.5.



REMARKS:

Boring backfilled with cement-bentonite grout.

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Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started : 05/26/2006
Date Completed : 06/01/2006
Logged by : C. Forman
Reviewed by : M. McCoy
Drilling Contractor : Pennsylvania Drilling
Drilling Method : S.S., NQ Core, Air Reary
Sampling Method : Split Spoon, Rock Core 2"
Total Depth (ft.) : 300.5'
S. Water Level Date : Not Measured
S. Water Level (ft.) : Not Measured

LOG OF BORING GB-27/BuSW-1

G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-1
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
40–45.5							
45.5	10.0/9.8 RQD = 77.5	RC5/25MIN	NA	NA			39.1 to 45.5 - Soft medium to dark grey SHALE. 45.5 to 55.3 - Very soft to soft grey SHALE, highly weathered from 49.7 to 55.3 (purple and red staining).
55.5	10.0/10.0 RQD = 92	RC6/22MIN	NA	NA			55.5 to 60.2 - SAA: highly weathered.

Depth scale: 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60

Grout

2" ID Sch. 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 05/26/2006
Date Completed	: 06/01/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 300.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-27/BuSW-1

G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-1
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
60.2							60.2 to 64.6 - Medium hard grey SHALE, micaceous at base, slight chemical weathering.
64.6							64.6 to 65.5 - Hard light grey SHALE, slightly fissile.
65.5	10.0/9.8 RQD = 71	RC7/29MIN	NA	NA			65.5 to 75.5 - Medium hard light grey to dark grey SHALE, some chemical weathering (purple/brown staining) from 69.3 to 75.3.
75.5	10.0/8.7 RQD = 85	RC8/35MIN	NA	NA			75.5 to 83.5 - Medium hard light grey to grey SHALE, some weathering, fine grained SANDSTONE interbeds from 76.8 to 78.1' and 79.5 to 80.2'.
76.8							76.8 to 78.1 - Fine grained SANDSTONE.
78.1							78.1 to 83.5 - Medium hard light gray SHALE.

Well construction: Grout; 2" ID Sch. 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 05/26/2006
Date Completed	: 06/01/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 300.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-27/BuSW-1

G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-1
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
83.5					83.5 to 84.2 - Soft red SHALE.
85.5	10.0/10.0 RQD = 91	RC8/26MIN	NA	NA	85.5 to 87.1 - SAA.
87.1					87.1 to 92.1 - Hard grey SHALE.
87.7					87.7 to 88.9 - Fine grained SANDSTONE.
88.9					88.9 to 92.1 - SHALE.
92.1					92.1 to 95.5 - Medium hard red SHALE, chemical weathering (purple/grey staining).
95.5	10.0/3.4 RQD = 0	RC9/90MIN	NA	NA	95.5 to 98.9 - Medium hard red and grey SHALE. Core hammered out of barrel.

Depth scale: 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

Well: Grout; 2" ID Sch. 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

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Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 05/26/2006
Date Completed	: 06/01/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 300.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-27/BuSW-1

G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-1
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
105.5	10.0/10.0 RQD = 58	RC10/22MIN	NA	NA	105.5 to 113.5 - Soft grey SHALE, highly weathered, iron staining.
113.5					113.5 to 115.5 - Soft red SHALE, highly weathered.
115.5	5.1/4.0 RQD = 85	RC11/15MIN	NA	NA	115.5 to 119.6 - SAA.

Depth scale: 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120

Well: Grout; 2" ID Sch. 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.	Date Started	: 05/26/2006	LOG OF BORING GB-27/BuSW-1
Hydro Investigation/ Proposed Residual Waste Landfill Cheshire, Ohio	Date Completed	: 06/01/2006	(Page 7 of 16)
Project Number: APO006	Logged by	: C. Forman	G. Elev. (ft. USGS) :
Project Manager: Steve Gross	Reviewed by	: M. McCoy	
	Drilling Contractor	: Pennsylvania Drilling	
	Drilling Method	: S.S., NQ Core, Air Reary	
	Sampling Method	: Split Spoon, Rock Core 2"	
	Total Depth (ft.)	: 300.5'	
	S. Water Level Date	: Not Measured	
	S. Water Level (ft.)	: Not Measured	

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-1
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
120–125	10.0/4.5 RQD = 36	RC12/150MIN	NA	NA			120.5 to 125.0 - SAA: soft to medium hard, slightly weathered.
130–139	10.0/10.0 RQD = 87	RC13/15MIN	NA	NA			130.5 to 139.2 - SAA: medium hard to hard, slightly weathered.
139–140							139.2 to 140.5 - Medium hard grey SHALE, slightly weathered.

Grout

2" ID Sch 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

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Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 05/26/2006
Date Completed	: 06/01/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 300.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-27/BuSW-1

G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-1
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
140.5	10.0/10.0 RQD = 85	RC14/20MIN	NA	NA	140.5 to 145.7 - Very hard blue-grey SANDSTONE with blue-grey shale interbeds 141 and 142.5.
145.7					145.7 to 150.5 - Soft to medium hard red SHALE, slightly weathered.
150.5	10.0/10.0 RQD = 74	RC15/25MIN	NA	NA	150.5 to 156.5 - Hard blue-grey, fine grained SANDSTONE with soft, red shale interbed from 155.1 to 156.0.
156.5					156.5 to 160.5 - Hard blue-grey SHALE.

Depth scale: 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160

Well construction: Grout; 2" ID Sch 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 05/26/2006
Date Completed	: 06/01/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 300.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-27/BuSW-1

G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-1
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
160–170.5	10.0/10.0 RQD = 60	RC16/14MIN	NA	NA			160.5 to 170.5 - Soft to medium hard grey-blue SHALE, slightly micaceous.
170.5–180	10.0/9.9 RQD = 92	RC17/22MIN	NA	NA			170.5 to 180.5 - Soft to medium hard grey SHALE, increasing iron staining and chemical weathering with depth.

Well construction: Grout; 2" ID Sch 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

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Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 05/26/2006
Date Completed	: 06/01/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 300.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-27/BuSW-1

G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-1
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
180	10.0/9.9 RQD = 68	RC18/31MIN	NA	NA	180.5 to 190.5 - SAA: heavy iron staining and chemical weathering throughout.
190	10.0/10.0 RQD = 41	RC19/25MIN	NA	NA	190.5 to 200.5 - SAA: heavy iron staining and chemical weathering.
200					

Well construction: Grout; 2" ID Sch. 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 05/26/2006
Date Completed	: 06/01/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 300.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-27/BuSW-1

G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-1
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
200	10.0/10.0 RQD = 70	RC20/26MIN	NA	NA			200.5 to 210.5 - SAA: staining softer with depth.
210	10.0/9.6 RQD = 58	RC21/22MIN	NA	NA			210.5 to 216.6 - SAA: heavy iron staining.
216							216.6 to 220.1 - Hard to very hard grey SHALE.
220							

Well construction: Grout; 2" ID Sch. 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started : 05/26/2006
Date Completed : 06/01/2006
Logged by : C. Forman
Reviewed by : M. McCoy
Drilling Contractor : Pennsylvania Drilling
Drilling Method : S.S., NQ Core, Air Reary
Sampling Method : Split Spoon, Rock Core 2"
Total Depth (ft.) : 300.5'
S. Water Level Date : Not Measured
S. Water Level (ft.) : Not Measured

LOG OF BORING GB-27/BuSW-1

G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-1
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
220					
220.5	10.0/10.0 RQD = 75	RC22/22MIN	NA	NA	220.5 to 230.5 - SAA: interbedded with fine grained grey SANDSTONE, calcite cement.
225.4					225.4 to 226.5 - Fine grained SANDSTONE.
226.5					226.5 to 230.5 - Hard to very hard grey SHALE with SANDSTONE interbeds.
230.5	10.0/10.0 RQD = 80	RC23/27MIN	NA	NA	230.5 to 233.0 - Hard grey fine grained SANDSTONE.
233.0					233.0 to 240.5 - Medium hard to hard grey SHALE with fine grained SANDTONE interbeds.
240					

Grout

2" ID Sch 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 05/26/2006
Date Completed	: 06/01/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 300.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-1
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
240	10.0/10.0 RQD = 81	RC24/30MIN	NA	NA			240.5 to 245.0 - Hard grey SHALE.
245							245.0 to 250.5 - Soft to medium hard grey SHALE, highly weathered, iron staining.
250	10.0/10.0 RQD = 67	RC25/19MIN	NA	NA			250.5 to 260.5 - SAA: heavy staining and weathering decreasing with depth.
260							

Well construction: Grout; 2" ID Sch 40 PVC Riser; Bentonite Pellets

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 05/26/2006
Date Completed	: 06/01/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 300.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-27/BuSW-1

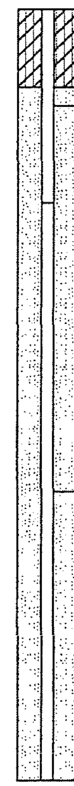
G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-1
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
260.5	10.0/9.8 RQD = 75	RC26/12MIN	NA	NA	260.5 to 261.8 - Medium hard to hard grey SHALE, increasing mica wiht dpeth.
261.8					261.8 to 265.8 - Hard light grey fine grained SANDSTONE, heavy mica.
265.8					265.8 to 270.3 - SAA: medium hard, medium to coarse grained heavy calcite cement.
270.5	10.0/8.8 RQD = 72	RC27/35MIN	NA	NA	270.5 to 277.3 - SAA.
277.3					277.3 to 279.3 - Soft to medium hard grey SHALE, heavy iron staining and chemical weathering.



REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started : 05/26/2006
Date Completed : 06/01/2006
Logged by : C. Forman
Reviewed by : M. McCoy
Drilling Contractor : Pennsylvania Drilling
Drilling Method : S.S., NQ Core, Air Reary
Sampling Method : Split Spoon, Rock Core 2"
Total Depth (ft.) : 300.5'
S. Water Level Date : Not Measured
S. Water Level (ft.) : Not Measured

LOG OF BORING GB-27/BuSW-1

G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-1
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
280	10.0/10.0 RQD = 76	RC28/35MIN	NA	NA	
290	10.0/10.0 RQD = 53	RC29/32MIN	NA	NA	290.5 to 300.5 - Hard to soft grey SHALE, slight weathering, decreasing hardness with depth.
300					

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Date Started	: 05/26/2006
Date Completed	: 06/01/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 300.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-27/BuSW-1

G. Elev. (ft. USGS) :

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: ▼ Static; ▽ During Drilling

Well: BuSW-1
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
300					⊠		EOB @ 300.5' bgs.
301							
302							
303							
304							
305							
306							
307							
308							
309							
310							
311							
312							
313							
314							
315							
316							
317							
318							
319							
320							

REMARKS:

Boring backfilled with cement-bentonite grout.

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Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/30/2007
Date Completed	: 9/04/2007
Logged by	: Jay Read / Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 290'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

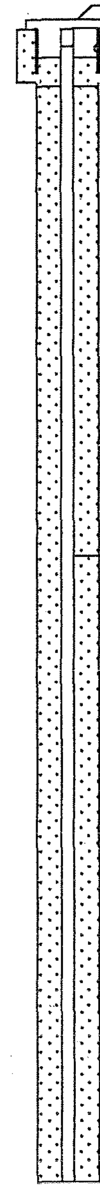
LOG OF BORING BuSW-2

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
0							0.0 - 21.0 - Casing set; no sampling.
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Well: BuSW-2



REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/30/2007
Date Completed	: 9/04/2007
Logged by	: Jay Read / Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 290'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-2

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-2

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
21	4.0 / 4.0	R-1 21.0 - 25.0	96%		21.0 - 25.0 - Hard, gray SANDSTONE; medium grained, slightly weathered, thick bedding, fractures noted, micaceous; coal seam at 21.3 feet.
25	10.0 / 10.0	R-2 25.0 - 35.0	99%		25.0 - 26.9 - Same As Above (SAA).
26.9					26.9 - 30.6 - Soft, gray SHALE; very fine grained, highly weathered, argillaceous, medium bedding, fractures noted.
30.6					30.6 - 35.0 - Hard, gray with little brown staining SANDSTONE; medium grained, micaceous, thick bedding, unfractured.
35	10.0 / 10.0	R-3 35.0 - 45.0	98%		35.0 - 39.2 - SAA.

2" ID Sch 40 PVC Riser

Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/30/2007
Date Completed	: 9/04/2007
Logged by	: Jay Read / Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 290'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-2

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-2

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
40							39.2 - 45.0 - Medium hard to hard, gray interbedded to moderately NE, and SILTSTONE; very fine to medium grained, slightly to moderately weathered, argillaceous, laminated to thin bedding, fractures noted.
45	10.0 / 10.0	R-4 45.0 - 55.0	86%				45.0 - 55.0 - Medium hard to hard, gray to red interbedded SHALE and SILTSTONE with few sandstone laminations; very fine grained, slightly to highly weathered, argillaceous, thin to medium bedding, fractures noted, becomes red and has higher shale content at 53.5 feet.
55	10.0 / 10.0	R-5 55.0 - 65.0	97%				55.0 - 55.6 - SAA: red.
							55.6 - 65.0 - Soft to medium hard, gray to greenish-brown to red SHALE; very fine grained, moderate to highly weathered, argillaceous, medium bedding, fractures noted. Gray from 56.0 to 58.3 feet; greenish-brown from 58.3 to 60.6 feet; red from 60.6 to 65.0 feet.
60							

2" ID Sch 40 PVC Riser

Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started : 8/30/2007
Date Completed : 9/04/2007
Logged by : Jay Read / Matt McCoy
Reviewed by : Steve Gross
Drilling Contractor : Thelen
Drilling Method : HQ Core, Water Rotary
Sampling Method : Rock Core 2.75"
Total Depth (ft.) : 290'
Water Level (ft.) : Not Measured
Ground Elevation (ft.) : N/A

LOG OF BORING BuSW-2

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-2

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
65	10.0 / 10.0	R-6 65.0 - 75.0	89%		65.0 - 74.5 - SAA: red with some greenish-brown mottling and gray.
74.5					74.5 - 75.0 - Hard, gray SANDSTONE; fine to medium grained, slightly weathered, thin bedding, unfractured.
75	10.0 / 10.0	R-7 75.0 - 85.0	98%		75.0 - 76.5 - SSA.
76.5					76.5 - 85.0 - Medium hard, predominately gray with some red and greenish-brown mottling SHALE; very fine grained, highly weathered, argillaceous, medium bedding, fractures noted, contains trace siltstone.

Depth scale: 60–80 ft.

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/30/2007
Date Completed	: 9/04/2007
Logged by	: Jay Read / Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 290'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-2

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-2

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
85	10.0 / 10.0	R-8 85.0 - 95.0	100%		85.0 - 85.7 - SAA.
85.7					85.7 - 92.8 - hard, gray with some red mottling SANDSTONE with few argillaceous laminations; fine grained, slightly weathered, micaceous, medium bedding, unfractured.
92.8					92.8 - 95.0 - Medium hard to hard, gray and red interbedded SHALE and SANDSTONE; fine to very fine grained, slightly weathered, argillaceous, micaceous, thin bedding, unfractured.
95	10.0 / 10.0	R-9 95.0 - 105.0	100%		95.0 - 97.5 - Medium hard, reddish-brown interbedded SILTSTONE and SHALE; very fine grained, slightly to moderately weathered, argillaceous, thin bedding, unfractured.
97.5					97.5 - 105.0 - Hard, gray SANDSTONE moderately interbedded with siltstone; fine to medium grained, slightly weathered, micaceous, medium bedding, fractures noted.

Depth scale: 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/30/2007
Date Completed	: 9/04/2007
Logged by	: Jay Read / Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 290'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-2

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-2

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
100							
105	10.0 / 8.4	R-10 105.0 - 115.0	94%				105.0 - 115.0 - Medium hard to hard, red to greenish-gray interbedded SHALE and SANDSTONE; fine to medium grained, moderately weathered, argillaceous, thin bedding, fractures noted.
115	10.0 / 10.0	R-11 115.0 - 125.0	98%				115.0 - 116.8 - SAA.
116.8							116.8 - 125.0 - Medium hard, gray to red with yellow staining SHALE; very fine grained, highly weathered, argillaceous, medium bedding, fractures noted.
120							

2" ID Sch 40 PVC Riser

Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/30/2007
Date Completed	: 9/04/2007
Logged by	: Jay Read / Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 290'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-2

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-2

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
125	10.0 / 10.0	R-12 125.0 - 135.0	99%				125.0 - 135.0 - Medium hard, red with little brown mottling SHALE with little interbedded siltstone; very fine grained, moderately to highly weathered, argillaceous, medium to think bedding, fractures noted.
135	10.0 / 10.0	R-13 135.0 - 145.0	88%				135.0 - 141.6 - SAA.

Depth scale: 120–140 ft.

2" ID Sch 40 PVC Riser

Grout

REMARKS:

05-30-2008 F:\Clients\APO\APO017\Boring logs\2-BuSW.bor

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started : 8/30/2007
Date Completed : 9/04/2007
Logged by : Jay Read / Matt McCoy
Reviewed by : Steve Gross
Drilling Contractor : Thelen
Drilling Method : HQ Core, Water Rotary
Sampling Method : Rock Core 2.75"
Total Depth (ft.) : 290'
Water Level (ft.) : Not Measured
Ground Elevation (ft.) : N/A

LOG OF BORING BuSW-2

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-2

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6")	DESCRIPTION
141.6					141.6 - 145.0 - Medium hard to hard, red SILTSTONE; very fine grained, slightly weathered, argillaceous, thick bedding, unfractured.
145	10.0 / 9.0	R-14 145.0 - 155.0	88%		145.0 - 155.0 - Hard, brown and gray interbedded SANDSTONE and SILTSTONE; very fine to medium grained, slightly weathered, thin to medium bedding, fractures noted.
155	10.0 / 9.3	R-15 155.0 - 165.0	77%		155.0 - 160.4 - Medium hard, red SHALE with few siltstone interbeds; very fine grained, moderately weathered, argillaceous, thin to medium bedding, fractures noted.

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

LOG OF BORING BuSW-2

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/30/2007
Date Completed	: 9/04/2007
Logged by	: Jay Read / Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 290'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-2

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6")	DESCRIPTION
160.4					160.4 - 162.2 - Hard, gray SANDSTONE; medium grained, slightly weathered, slightly micaceous, medium bedding, unfractured.
162.2					162.2 - 165.0 - Hard, red SILTSTONE; very fine grained, slightly weathered, medium bedding, unfractured.
165	10.0 / 10.0	R-16 165.0 - 175.0	98%		165.0 - 169.4 - Hard, gray SANDSTONE moderately interbedding with shale and siltstone; fine to medium grained, thin to medium bedding, fractures noted.
169.4					169.4 - 171.6 - Medium hard, gray with red mottling SHALE with trace arenaceous lamination; very fine grained, moderately weathered, argillaceous, thin bedding, fractures noted.
171.6					171.6 - 175.0 - Hard, gray SILTSTONE with trace shale and sandstone laminations; very fine grained, slightly weathered, medium bedding, unfractured.
175	10.0 / 10.0	R-17 175.0 - 185.0	95%		175.0 - 180.2 - SAA: little red coloration.

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

05-30-2008 F:\clients\APO\APO017\Boring logs\2-BuSW.bor

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/30/2007
Date Completed	: 9/04/2007
Logged by	: Jay Read / Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 290'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-2

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-2

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
180							180.2 - 185.0 - Medium hard, red SHALE; very fine grained, moderately to highly weathered, argillaceous, thick bedding, fractures noted, little yellow staining.
185	10.0 / 10.0	R-18 185.0 - 195.0	92%				185.0 - 195.0 - SAA: gray, red, and yellowish-brown zones; broken zone at 194.2 to 195.0 feet.
195	10.0 / 9.5	R-19 195.0 - 205.0	97%				195.0 - 204.5 - SAA: highly weathered.
200							

2" ID Sch 40 PVC Riser

Grout

REMARKS:

LOG OF BORING BuSW-2

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/30/2007
Date Completed	: 9/04/2007
Logged by	: Jay Read / Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 290'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-2

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
200							
205	10.0 / 10.0	R-20 205.0 - 215.0	97%				205.0 - 215.0 - SAA: red with some yellow mottling, fractures noted.
215	10.0 / 10.0	R-21 215.0 - 225.0	71%				215.0 - 225.0 - Soft to medium hard, red SHALE; very fine grained, highly weathered, argillaceous, thick bedding, fractures noted.
220							

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

Hull & associates, inc.

LOG OF BORING BuSW-2

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/30/2007
Date Completed	: 9/04/2007
Logged by	: Jay Read / Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 290'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-2

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
225	10.0 / 10.0	R-22 225.0 - 235.0	88%				225.0 - 233.8 - SAA: gray and red.
235	10.0 / 10.0	R-23 235.0 - 245.0	79%				235.0 - 245.0 - Medium hard to hard, gray interbedded SILTSTONE and SHALE with trace sandstone; very fine grained, moderately weathered, argillaceous, thin bedding, fractures noted.
238.8							238.8 - 235.0 - Hard, red SILTSTONE; very fine grained, moderately weathered, few argillaceous laminations, thin bedding, fractures noted.

Depth scale: 220–240 ft.

2" ID Sch 40 PVC Riser

Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started : 8/30/2007
Date Completed : 9/04/2007
Logged by : Jay Read / Matt McCoy
Reviewed by : Steve Gross
Drilling Contractor : Thelen
Drilling Method : HQ Core, Water Rotary
Sampling Method : Rock Core 2.75"
Total Depth (ft.) : 290'
Water Level (ft.) : Not Measured
Ground Elevation (ft.) : N/A

LOG OF BORING BuSW-2

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-2

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
245	10.0 / 9.0	R-24 245.0 - 255.0	90%		245.0 - 248.0 - Hard, gray SILTSTONE with few sandstone interbeds; fine grained, slightly weathered, medium bedding, unfractured.
248					248.0 - 253.8 - Hard, gray SANDSTONE; medium grained, slightly weathered, pyritic, thick bedding, fractures noted.
253.8					253.8 - 255.0 - Hard, brown and gray SILTSTONE.
255	10.0 / 10.0	R-25 255.0 - 265.0	78%		255.0 - 262.4 - Hard, red and gray SHALE; fractures noted.

Well construction: 2" ID Sch 40 PVC Riser; Grout; Bentonite Seal

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/30/2007
Date Completed	: 9/04/2007
Logged by	: Jay Read / Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 290'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

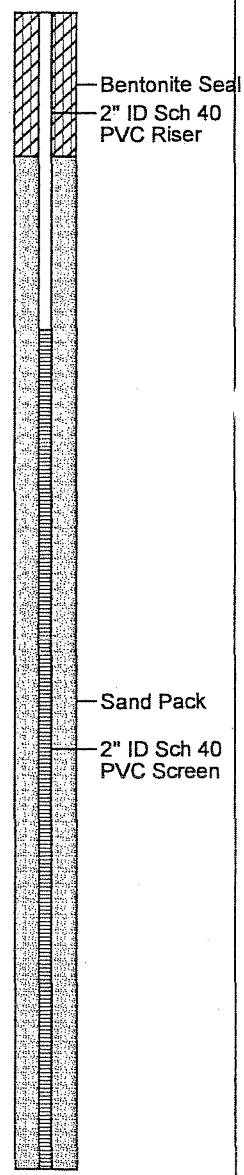
LOG OF BORING BuSW-2

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-2

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
260							
262.4							262.4 - 265.0 - Hard, gray SILTSTONE; argillaceous, becoming a fine grained sandstone.
265	10.0 / 10.0	R-26 265.0 - 275.0	100%				265.0 - 275.0 - Hard, gray, fine grained SANDSTONE; micaceous, thinly bedded.
275	10.0 / 10.0	R-27 275.0 - 285.0	100%				275.0 - 285.0 - Hard, gray, fine to coarse grained SANDSTONE; rounded grains of breccia at 52 inches.
280							



REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/30/2007
Date Completed	: 9/04/2007
Logged by	: Jay Read / Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 290'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

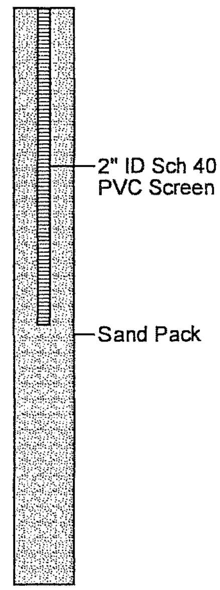
LOG OF BORING BuSW-2

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-2

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
285	5.0 / 5.0	R-28 285.0 - 290.0	90%				285.0 - 285.7 - SAA.
285.7							285.7 - 290.0 - Hard, red and gray SHALE; orange staining.
290							290.0 - Bottom of boring.



REMARKS:

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Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 08/28/07
Date Completed	: 08/29/07
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 313.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

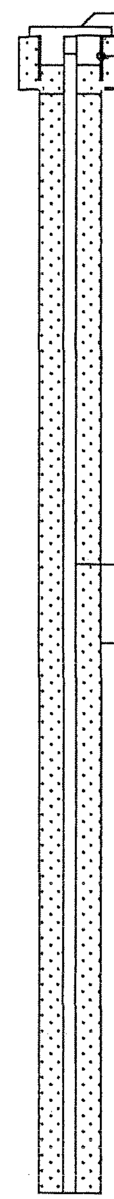
LOG OF BORING BuSW-3

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
0							0.0 - 21.0 - Casing set; no sampling.
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Well: BuSW-3



REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 08/28/07
Date Completed	: 08/29/07
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 313.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-3

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-3

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
21	2.0/1.5	R-1 21.0 - 23.0	9/10				21.0 - 22.5 - Hard gray with brown SANDSTONE, coarse to medium grained, moderately to highly weathered, thin bedding, fractures noted.
23	10.0 / 9.8	R-2 23.0 - 33.0	53%				23.0 - 29.7 - Soft medium hard, brown and gray mottled (23-28.4) to gray (28.4-29.7) SHALE, very fine grained highly weathered, argillaceous, thin to medium bedding, fractures noted.
29.7							29.7 - 31.3 - Hard gray SANDSTONE, fine to medium grained, slghtly weathered, medium bedding, fractures noted.
31.3							31.3 - 32.8 - Soft gray SHALE.
33	10.0 / 9.9	R-3 33.0 - 43.0	93%				33.0 - 35.2 - Soft olive SHALE, very fine grained highly weathered, argillaceous, medium bedding, fractures noted.
35.2							35.2 - 37.0 - Hard gray SANDSTONE, fine to medium grained slightly weathered, medium bedding, unfractured.
37							37.0 - 42.9 - Soft medium hard gray and brown SHALE, with few siltstone interbeds, very fine grained, argillaceous, thin to medium bedding, fractures noted.

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 08/28/07
Date Completed	: 08/29/07
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 313.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-3

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-3

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
43	10.0 / 9.0	R-4 43.0 - 53.0	86%				43.0 - 44.4 - Same As Above (SAA).
44.4							44.4 - 53.0 - Soft red to gray SHALE, very fine grained, moderately weathered, argillaceous, thick bedding, fractures noted.
53	10.0 / 10.0	R-5 53.0 - 63.0	97%				53.0 - 63.0 - Soft medium hard gray and brown mottled to red and brown mottled SHALE, very fine grained, highly weathered argillaceous, medium bedding, fractures noted.

Well construction (40–60 ft): 2" ID Sch 40 PVC Riser; Grout

REMARKS:

05-30-2008 F:\Clients\APO\APO017\Boring logs\3-BuSW.bor

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 08/28/07
Date Completed	: 08/29/07
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 313.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-3

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-3

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
63	10.0 / 10.0	R-6 63.0 - 73.0	91%		63.0 - 73.0 - SAA.
73	10.0 / 9.5	R-7 73.0 - 83.0	87%		73.0 - 76.0 - Soft gray SHALE, very fine grained, highly weathered, argillaceous, medium bedding, unfractured.
76					76.0 - 83.0 - Hard gray SANDSTONE, fine grained, slightly weathered, medium bedding, slightly fractured, containing some argillaceous interbeds.

Depth scale: 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

2" ID Sch 40 PVC Riser

Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 08/28/07
Date Completed	: 08/29/07
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 313.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-3

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-3

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
80							
83	10.0 / 10.0	R-8 83.0 - 93.0	88%				83.0 -84.5 - Medium hard red SHALE.
84.5							84.5 - 85.6 - Hard gray SANDSTONE.
85.6							85.6 - 93.0 - Medium hard to soft red SHALE, very fine grained, highly weathered, argillaceous, thick bedding, fractures noted.
93	10.0 / 10.0	R-9 93.0 - 103.0	90%				93.0 - 98.5 - Hard gray SANDSTONE, fine grained, slightly weathered, thick bedding, unfractured.
98.5							98.5 - 103.0 - Soft medium hard gray to red SHALE, with few argillaceous, laminations, very fine grained, slightly to moderately weathered, thick to medium bedding, fractures noted.
100							

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

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LOG OF BORING BuSW-3

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

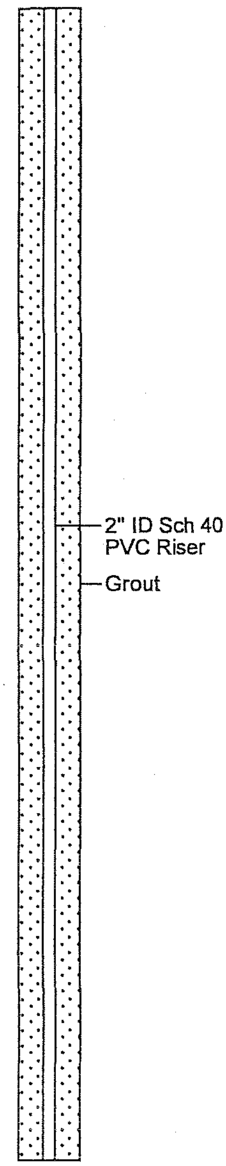
Date Started	: 08/28/07
Date Completed	: 08/29/07
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 313.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-3

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
103	10.0 / 8.4	R-10 103.0 - 113.0	92%		103.0 - 104.5 - Medium hard gray SHALE, some sandstone interbeds.
104.5					104.5 - 113.0 - SAA: hard and olive to purple, olive mottled in color.
113	10.0 / 10.0	R-11 113.0 - 123.0	91%		113.0 - 123.0 - SAA: olive and purple to red.



REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 08/28/07
Date Completed	: 08/29/07
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 313.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-3

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-3

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
123	10.0 / 9.6	R-12 123.0 - 133.0	86%				123.0 - 132.6 - Medium hard red SHALE, very fine grained, moderately to highly weathered argillaceous thick bedding, fractures noted.
133	10.0 / 10.0	R-13 133.0 - 143.0	92%				133.0 - 139.9 - SAA: gray mottling and trace argillaceous laminations.

Depth scale: 120–140 ft.

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 08/28/07
Date Completed	: 08/29/07
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 313.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-3

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
140							139.9 - 143.0 - Hard gray SANDSTONE, medium grained, slightly weathered, micaceous thick bedding, unfractured.
143	10.0 / 9.3	R-14 143.0 - 153.0	83%				143.0 - 146.0 - SAA: trace brown argillaceous laminations.
146							146.0 - 152.3 - Medium hard red SHALE with few gray micaceous laminations, very fine grained, highly weathered, medium bedding, fractures noted.
153	10.0 / 9.3	R-15 153.0 - 163.0	95%				153.0 - 156.6 - SAA: little gray mottling.
156.6							156.6 - 161.0 - Hard gray SANDSTONE, fine to medium grained, slightly weathered, thick bedding, unfractured.

2" ID Sch 40 PVC Riser

Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 08/28/07
Date Completed	: 08/29/07
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 313.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-3

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-3

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
160					
161					161.0 - 163.0 - Hard brown SILTSTONE, very fine grained, slightly weathered, medium bedding, fractures noted.
163	10.0 / 10.0	R-16 163.0 - 173.0			163.0 - 164.3 - SAA.
164.3					164.3 - 166.3 - Medium hard gray SHALE, very fine grained, moderately weathered, argillaceous, pyritic, medium bedding, unfractured.
166.3					166.3 - 170.7 - Hard gray SANDSTONE, medium grained, slightly weathered, micaceous, pyritic, thick bedding, unfractured.
170.7					170.7 - 173.0 - Medium hard gray SHALE, very fine grained, slightly weathered, argillaceous, medium bedding, unfractured.
173	10.0 / 10.0	R-17 173.0 - 183.0	96%		173.0 - 183.0 - SAA: red at 178.0-180.0.
180					

2" ID Sch 40 PVC Riser

Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 08/28/07
Date Completed	: 08/29/07
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 313.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-3

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-3

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
183	10.0 / 10.0	R-18 183.0 - 193.0	95%				183.0 - 193.0 - SAA: mottled green gray purple and greenish brown from 183 -188, red from 188 - 193.
193	10.0 / 9.5	R-19 193.0 - 203.0	85%				193.0 - 203.0 - SAA: gray with a red zone at 194.1

Depth scale: 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200

Well: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 08/28/07
Date Completed	: 08/29/07
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 313.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

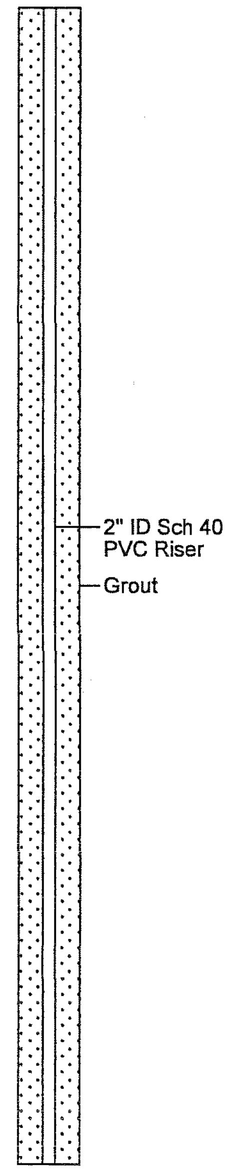
LOG OF BORING BuSW-3

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-3

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
200							
203	10.0 / 10.0	R-20 203.0 - 213.0	91%				203.0 -213.0 - Medium hard gray with brown mottling to red SHALE, very fine grained moderately weathered argillaceous, medium bedding, fractures noted.
213	10.0 / 10.0	R-21 213.0 - 223.0	73%				213.0 - 221.7 - SAA: red to gray.
220							



REMARKS:

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Hull & associates, inc.

Date Started	: 08/28/07
Date Completed	: 08/29/07
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 313.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-3

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-3

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
220					
221.7					221.7 - 223.0 - Hard gray SANDSTONE, medium grained, slightly weathered, medium bedding, unfractured.
223	10.0 / 10.0	R-22 223.0 - 233.0	100%		223.0 - 227.6 - Medium hard to hard gray interbedded SHALE and SILTSTONE, very fine grained, slightly weathered, argillaceous, thin bedding, unfractured.
227.6					227.6 - 233.0 -Hard gray SANDSTONE, with trace argillaceous laminations, fine to medium grained, slightly weathered, trace mica, medium to thick bedding, unfractured.
233	10.0 / 9.6	R-23 233.0 - 243.0	96%		233.0 - 242.6 - SAA: micaceous.
240					

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

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Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 08/28/07
Date Completed	: 08/29/07
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 313.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-3

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-3

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6")	DESCRIPTION
240					
243	10.0 / 10.0	R-24 243.0 - 253.0	96%		243.0 - 251.6 - Hard gray to brown SILTSTONE, some fine grained sandstone beds and few argillaceous laminations, fine grained, slightly weaterhed, thin bedding, fractures noted.
251.6					251.6 - 253.0 - Medium hard red SHALE, with few siltstone interbeds, very fine grained moderately to highly weathered, argillaceous, medium bedding, fractures noted.
253	10.0 / 9.8	R-25 253.0 - 263.0	96%		253.0 - 256.3 - SAA.
256.3					256.3 - 262.8 - Hard gray SANDSTONE, few argillaceous laminations, fine grained, slightly to moderately weathered, thin to medium bedding, fractures noted.
260					

Well construction: Grout; 2" ID Sch 40 PVC Riser; Bentonite Seal; 2" ID Sch 40 PVC Screen; Sand Pack

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 08/28/07
Date Completed	: 08/29/07
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 313.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

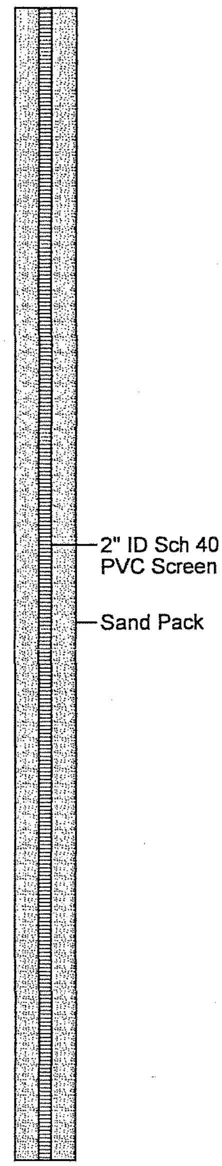
LOG OF BORING BuSW-3

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-3

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
260							
261							
262							
263	10.0 / 10.0	R-26 263.0 -273.0	100%				263.0 - 273.0 -SAA: argillaceous laminations, become rarer with depth, very micaceous @ 269-273.
264							
265							
266							
267							
268							
269							
270							
271							
272							
273	10.0 / 10.0	R-27 273.0 - 283.0	92%				273.0 - 282.2 - Hard gray SANDSTONE, medium grained, slightly weathered, micaceous, thick bedding, unfractured.
274							
275							
276							
277							
278							
279							
280							



REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 08/28/07
Date Completed	: 08/29/07
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 313.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-3

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-3

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
282.2					282.2 - 283.0 - Soft to medium hard gray to brown SHALE, very fine grained, highly weathered, argillaceous, thin bedding, fractures noted.
283	10.0 / 9.3	R-28 283.0 - 293.0	81%		283.0 - 288.6 - Medium hard red with some brown green and purple mottling SHALES, very fine grained, argillaceous, thick bedding, fractures noted.
288.6					288.6 - 293.0 - Hard gray SANDSTONE, frine to medium grained, slightly weathered, micaceous, thick bedding, fractures noted.
293	10.0 / 10.0	R-29 293.0 - 303.0	97%		293.0 - 303.0 - Hard gray SILTSTONE, micaceous laminations, fine grained, slightly weathered, medium bedding, unfractured, broken zone at bottom.

Well construction: 2" ID Sch 40 PVC Screen; Sand Pack

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 08/28/07
Date Completed	: 08/29/07
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 313.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-3

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-3

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
303	10.0 / 10.0	R-30 303.0 - 113.0	92%				303.0 - 310.4 - SAA: some argillaceous laminations.
310.4							310.4 - 313 - Hard light gray LIMESTONE, very fine grained, moderately weathered, calcite medium bedding, fractures noted, oil within rock and seeping from pores.
313							End of boring.

REMARKS:

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Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started : 04/27/06
Date Completed : 05/02/06
Logged by : M. McCoy
Reviewed by : M. McCoy
Drilling Contractor : Pennsylvania Drilling
Drilling Method : S.S., NQ Core, Air Rotary
Sampling Method : Split Spoon, Rock Core 2"
Total Depth (ft.) : 310.5'
S. Water Level Date : Not Measured
S. Water Level (ft.) : Not Measured

LOG OF BORING GB-19/BuSW4

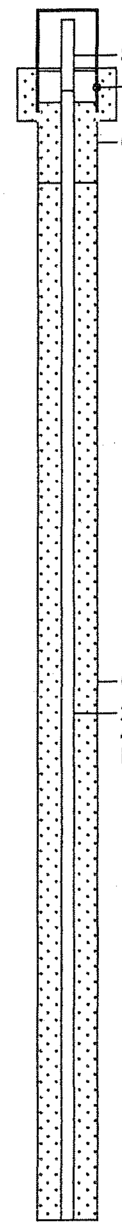
G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
0	2.0/1.3	SP1/SS1	NA	2-3-4-6	0.0 to 1.3 - Loose orange/brown/gray SAND, trace coal and shale, moist.
	2.0/1.2	SP2/SS2	NA	5-4-5-6	2.0 to 3.2 - Same As Above (SAA).
	2.0/1.0	SP3/SS3	NA	NA	4.0 to 5.0 - California Sampler.
	2.0/0.7	SP4/SS4	NA	3-5-6-8	6.0 to 6.7 - SAA: no coal.
	2.0/1.4	SP5/SS5	NA	2-4-6-7	8.0 to 9.4 - SAA: orange/beige, no shale, trace coal.
10	2.0/1.0	SP6/SS6	NA	2-4-5-8	10.0 to 11.0 - SAA.
	2.0/1.4	SP7/SS7	NA	8-11-8-10	12.0 to 13.4 - SAA.
	2.0/1.5	SP8/SS8	NA	4-3-5-6	14.0 to 15.5 - SAA: coal and shale at bottom.
	2.0/0.7	SP9/SS9	NA	1-1-2-2	16.0 to 16.7 - SAA.
	2.0/1.2	SP10/SS10	NA	W/H-1-1-1	18.0 to 19.2 - Soft green/grey clayey SAND, very moist to wet, coal and wood frags.
20					



REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.	Date Started: 04/27/06 Date Completed: 05/02/06 Logged by: M. McCoy Reviewed by: M. McCoy Drilling Contractor: Pennsylvania Drilling Drilling Method: S.S., NQ Core, Air Rotary Sampling Method: Split Spoon, Rock Core 2" Total Depth (ft.): 310.5' S. Water Level Date: Not Measured S. Water Level (ft.): Not Measured	LOG OF BORING GB-19/BuSW4 (Page 2 of 16) G. Elev. (ft. USGS) :
Hydro Investigation/ Proposed Residual Waste Landfill Cheshire, Ohio Project Number: APO006 Project Manager: Steve Gross		

Soil Samples: Sampled Interval; Sample sent to lab.
Water Levels: Static; During Drilling

Well: BuSW4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
20	2.0/1.1	SP11/SS11	NA	3-10-15-8	20.0 to 21.1 - Soft to medium dense clayey SAND, few coal and ss frags, moist, wood frags.
	2.0/1.5	SP12/SS12	NA	4-11-19-26	22.0 to 23.5 - Stiff to very stiff orange grey silty CLAY/weathered SHALE, moist, little sand.
	2.0/1.2	SP13/SS13	NA	7-7-10-14	24.0 to 25.2 - SAA: stiff, black mottling.
	2.0/1.4	SP14/SS14	NA	35-50-50/4	26.0 to 27.4 - Hard brown/light grey SHALE, weathered, iron stained, fissile.
	2.0/1.4	SP15/SS15	NA	18-38-50/4	28.0 to 29.4 - SAA.
30	2.0/0.4	SP16/SS16	NA	50/4	30.0 to 30.4 - Very hard grey SILTSTONE.
	2.0/0.8	SP17/SS17	NA	44-50/4	32.0 to 32.8 - SAA.
	2.0/0.7	SP18/SS18	NA	47-50/4	34.0 to 34.7 - SAA: wet between 34.3 -34.5.
	2.0/0.9	SP19/SS19	NA	23-50-50/4	36.0 to 36.9 - Very hard grey SHALE, slightly moist, fissile.
	2.0/0.8	SP20/SS20	NA	48-50/4	38.0 to 38.9 - SAA: wet.
40					

Grout

2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.	Date Started: 04/27/06 Date Completed: 05/02/06 Logged by: M. McCoy Reviewed by: M. McCoy Drilling Contractor: Pennsylvania Drilling Drilling Method: S.S., NQ Core, Air Rotary Sampling Method: Split Spoon, Rock Core 2" Total Depth (ft.): 310.5' S. Water Level Date: Not Measured S. Water Level (ft.): Not Measured	LOG OF BORING GB-19/BuSW4 (Page 3 of 16) G. Elev. (ft. USGS) :
Hydro Investigation/ Proposed Residual Waste Landfill Cheshire, Ohio Project Number: APO006 Project Manager: Steve Gross		

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6")	DESCRIPTION
40	2.0/0.1	SP21/SS21	NA	50/2	40.0 to 40.1 - SAA.
	10.0/10.0 RQD = 90.0	RC1/	NA	NA	40.5 to 48.5 - Soft dark red to grey moderately weathered SHALE.
					48.5 to 50.5 - SAA.
50	10.0/10.0 RQD = 93.5	RC2/12MIN	NA	NA	50.5 to 57.5 - SAA: red, some orange and grey mottling.
					57.5 to 60.5 - SAA: fracs at 56.7 and 59.5.
60					

Well construction: Grout; 2" ID Sch. 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

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Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/27/06
Date Completed	: 05/02/06
Logged by	: M. McCoy
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 310.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-19/BuSW4

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
60	10.0/10.0 RQD = 99.2	RC3/12MIN	NA	NA			60.5 to 63.5 - SAA: <0.1 silt seams.
							63.5 to 65.3 - Hard grey fine grained SANDSTONE.
							65.3 to 70.5 - Medium hard green/grey, moderately weathered SHALE.
70	10.0/10.0 RQD = 98.7	RC4/14MIN	NA	NA			70.5 to 80.5 - SAA: soft blue grey and burgundy, few 1.0 siltstone seams at 74.6, 77.0, 80.0. Fractures noted.
80							

Grout

2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/27/06
Date Completed	: 05/02/06
Logged by	: M. McCoy
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 310.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-19/BuSW4

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
80	10.0/10.0 RQD = 92.5	RC5/12MIN	NA	NA			80.5 to 85.5 - SAA: siltstones at 82.0, 90.0-90.5.
							85.5 to 89.0 - Hard fine grained SANDSTONE.
90	10.0/10.0 RQD = 94.7	RC6/12MIN	NA	NA			90.0 to 90.5 - Soft red SHALE. 90.5 to 91.3 - SAA: interbedded with red shale. 91.3 to 100.5 - SAA: soft burgundy/red and grey, moderately weathered. Fracs at 91.9, 93.0, 94.1, 97.0.
100							

Well construction: Grout; 2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/27/06
Date Completed	: 05/02/06
Logged by	: M. McCoy
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 310.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-19/BuSW4

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
100	10.0/9.8 RQD = 97.0	RC7/17MIN	NA	NA			100.5 to 106.0 - SAA: soft medium hard burundy and blue grey, few <0.1 siltstone interbeds. Fracs @ 101.4, 102.3, 104.0.
110	10.0/10.0 RQD = 91.9	RC8/12MIN	NA	NA			110.5 to 120.5 - SAA: red, siltstone interbeds at bottom.
120							

Well construction: Grout; 2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

05-30-2008 F:\Clients\APO\APO017\Boring logs\GB-19 BuSW-4.bor

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started : 04/27/06
Date Completed : 05/02/06
Logged by : M. McCoy
Reviewed by : M. McCoy
Drilling Contractor : Pennsylvania Drilling
Drilling Method : S.S., NQ Core, Air Rotary
Sampling Method : Split Spoon, Rock Core 2"
Total Depth (ft.) : 310.5'
S. Water Level Date : Not Measured
S. Water Level (ft.) : Not Measured

LOG OF BORING GB-19/BuSW4

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
120	5.0/4.2 RQD = 64.0	RC9/9MIN	NA	NA	120.5 to 121.5 - Hard blue grey fine grained SANDSTONE, slightly weathered.
					121.5 to 122.6 - Soft red SHALE, moderately weathered.
	5.0/5.0 RQD = 40.8	RC10/10MIN	NA	NA	125.5 to 130.5 - SAA.
130	5.0/1.0 RQD = 100	RC11/12MIN	NA	NA	130.5 to 131.0 - SAA.
	5.0/5.0 RQD = 92.5	RC12/14MIN	NA	NA	135.5 to 138.0 - SAA: ~1.0 fine grained sandstone interbed at 136.0 -137.0, micaceous at bottom.
					138.0 to 140.5 - Fine grained SANDSTONE, micaceous.
140					

Well construction: Grout; 2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/27/06
Date Completed	: 05/02/06
Logged by	: M. McCoy
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 310.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-19/BuSW4

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
140	10./9.5 RQD = 96.9	RC13/14MIN	NA	NA	140.5 to 142.5 - SAA: micaceous
					142.5 to 150.0 - Hard grey and red interbedded SILTSTONE & SHALE, micaceous.
150	10.0/10.0 RQD = 87.3	RC14/10MIN	NA	NA	150.5 to 154.3 - Soft red SHALE, moderately weathered.
					154.3 to 157.5 - Hard blue/grey fine grained SANDSTONE, moderately weathered.
					157.5 to 160.5 - Soft blue grey SILTSTONE, moderately weathered, grain size increasing with depth.
160					

Well: Grout; 2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/27/06
Date Completed	: 05/02/06
Logged by	: M. McCoy
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 310.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-19/BuSW4

G. Elev. (ft. USGS) :

Soil Samples
- Sampled Interval
- Sample sent to lab.

Water Levels
- Static
- During Drilling

Well: BuSW4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
160	10.0/10.0 RQD = 92.9	RC15/10MIN	NA	NA			160.5 to 170.5 - Soft to medium hard blue grey SHALE, moderately weathered.
170	10.0/10.0 RQD = 85.6	RC16/9MIN	NA	NA			170.5 to 180.5 - SAA: soft blue grey to red, mod. weathered, occasional siltstone interbed 170.5-171.0 and 175.5-176.0
180							

Grout

2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

05-30-2008 F:\Clients\APO\APO017\Boring logs\GB-19 BuSW-4.bor

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/27/06
Date Completed	: 05/02/06
Logged by	: M. McCoy
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 310.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-19/BuSW4

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
180	10.0/10.0 RQD = 91.2	RC17/8MIN	NA	NA			180.5 to 190.5 - SAA: siltstone absent, red with grey and orange mottling.
190	10.0/10.0 RQD = 100	RC18/9MIN	NA	NA			190.5 to 200.5 - SAA: red and grey, fractures noted.
200							

Grout

2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

05-30-2008 F:\Clients\APO\APO017\Boring logs\GB-19 BuSW-4.bor

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/27/06
Date Completed	: 05/02/06
Logged by	: M. McCoy
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 310.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-19/BuSW4

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
200	10.0/9.8 RQD = 96.2	RC19/19MIN	NA	NA	200.5 to 209.8 - SAA: soft red grey, occasional ~0.3 siltstone lense, orange mottling, mod weathered.
210	10.0/10.0 RQD = 100	RC20/12MIN	NA	NA	210.5 to 220.5 - SAA: fracture noted.
220					

Well construction: Grout; 2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/27/06
Date Completed	: 05/02/06
Logged by	: M. McCoy
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 310.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-19/BuSW4

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
220	10.0/10.0 RQD = 100	RC21/10MIN	NA	NA	220.5 to 230.5 - Soft grey SHALE, orange mottling, mod. weathered, fracture noted.
230	10.0/10.0 RQD = 81.7	RC22/11MIN	NA	NA	230.5 to 240.5 - SAA: siltstone interbeds between 230.5 - 232.5, 235.0 - 236.5, 240.0 - 240.5, fractures noted.
240					

Grout

2" ID Sch 40 PVC Riser

Bentonite Pellets

REMARKS:

Borings backfilled with cement-bentonite grout.

05-30-2008 F:\Clients\APO\APO017\Boring logs\GB-19 BuSW-4.bor

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/27/06
Date Completed	: 05/02/06
Logged by	: M. McCoy
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 310.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-19/BuSW4

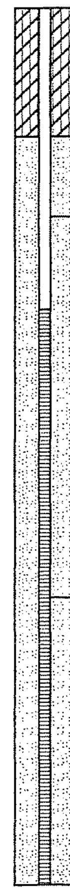
G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
240	10.0/10.0 RQD = 87.7	RC23/8MIN	NA	NA			240.5 to 250.5 - Hard blue grey fine grained SANDSTONE, <0.1 siltstone/shale interbeds, grain size increasing with depth below 249.0.
250	10.0/10.0 RQD = 86.2	RC24/10MIN	NA	NA			250.5 to 259.5 - SAA: occasional coarse grained zone, fissile, calcite inclusions.
260							



REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.	Date Started: 04/27/06 Date Completed: 05/02/06 Logged by: M. McCoy Reviewed by: M. McCoy Drilling Contractor: Pennsylvania Drilling	LOG OF BORING GB-19/BuSW4 (Page 14 of 16)
Hydro Investigation/ Proposed Residual Waste Landfill Cheshire, Ohio Project Number: APO006 Project Manager: Steve Gross	Drilling Method: S.S., NQ Core, Air Rotary Sampling Method: Split Spoon, Rock Core 2" Total Depth (ft.): 310.5' S. Water Level Date: Not Measured S. Water Level (ft.): Not Measured	G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
260	10.0/10.0 RQD = 95.6	RC25/8MIN	NA	NA	260.5 to 261.3 - Soft blue grey SHALE, moderately weathered.
					261.3 to 265.6 - Hard blue grey SILTSTONE, grain size increasing with depth.
					265.6 to 270.5 - Hard blue grey medium grained SANDSTONE, laminations of mica, moderately weathered.
270	10.0/10.0 RQD = 100	RC26/8MIN	NA	NA	270.5 to 280.5 - Hard blue grey medium grained SANDSTONE, mica laminations, occasional coarse grained zone, fractures noted
280					

REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/27/06
Date Completed	: 05/02/06
Logged by	: M. McCoy
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 310.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-19/BuSW4

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
280	10.0/10.0 RQD = NM	RC27/	NA	NA			280.5 to 290.5 - SAA.
290	10.0/10.0 RQD = 91.9	RC28/12MIN	NA	NA			290.5 to 300.5 - SAA.
300							

REMARKS:

Borings backfilled with cement-bentonite grout.

05-30-2008 r:\Clients\APO\APO017\Boring logs\GB-19 BuSW-4.bor

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/27/06
Date Completed	: 05/02/06
Logged by	: M. McCoy
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 310.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-19/BuSW4

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
300							300.5 to 305.8 - SAA; coarse at bottom.
							305.8 to 308.5 - Hard grey/blue fine SANDSTONE/SILTSTONE.
							308.5 to 310.5 - Hard blue grey and burgundy SHALE, friable, fracture noted.
310							End of Boring @ 310.5.
320							

REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.

LOG OF BORING BuSW-5

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/23/2007
Date Completed	: 8/24/2007
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 284.4'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-5
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
0							0.0 - 11.0 - Casing set; no sampling.
11	8.0 / 8.0	R-1 11.0 - 19.0	76%				11.0 - 17.6 - Medium hard, gray SHALE, trace arenaceous laminations; very fine grained, highly weathered, argillaceous, thick bedding, fractures noted.
17.6							17.6 - 19.0 - Hard, gray SANDSTONE; medium grained, moderately weathered, trace argillaceous laminations, medium bedding, fractures noted.
19	10.0 / 9.6	R-2 19.0 - 29.0	96%				

Well construction: Stick Up; Concrete; 2" ID Sch 40 PVC Riser; Grout

REMARKS:

05-30-2008 F:\Clients\APO\APO017\Boring logs\5-BuSW.bor

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/23/2007
Date Completed	: 8/24/2007
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 284.4'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-5

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-5
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
19.0					19.0 - 25.6 - Medium hard to hard, gray interbedded SHALE and SANDSTONE; very fine to medium grained, moderately to highly weathered, argillaceous, arenaceous, thin to medium bedding, fractures noted.
25.6					25.6 - 29.0 - Becomes a SANDSTONE slightly to moderately interbedded with shale.
29	10.0 / 10.0	R-3 29.0 - 39.0	92%		29.0 - 39.0 - Medium hard, gray SHALE slightly interbedded with sandstone and siltstone; very fine grained, moderately weathered, argillaceous, thin to medium bedding, fractures noted.
39	10.0 / 10.0	R-4 39.0 - 49.0	94%		

Well construction (20–40 ft): 2" ID Sch 40 PVC Riser; Grout

REMARKS:

05-30-200_ ...lients\APO\APO017\Boring logs\5-BuSW.bor

Hull & associates, inc.	Date Started : 8/23/2007 Date Completed : 8/24/2007 Logged by : Jay Read Reviewed by : Steve Gross Drilling Contractor : Thelen Drilling Method : HQ Core, Water Rotary Sampling Method : Rock Core 2.75" Total Depth (ft.) : 284.4' Water Level (ft.) : Not Measured Ground Elevation (ft.) : N/A	LOG OF BORING BuSW-5 (Page 3 of 15)
Hydro Investigation Proposed Residual Waste Landfill Cheshire, Ohio Project Number: APO017 Project Manager: Steve Gross		

Soil Samples: Sample Recovered; Sample Sent to Lab
Water Levels: Static; During Drilling
Well: BuSW-5
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
40							39.0 - 49.0 - Soft to medium hard, red to gray SHALE; very fine grained, highly weathered, argillaceous, thick bedding, fractures noted, red in color from 39.6 to 41.7 feet.
49	10.0 / 9.4	R-5 49.0 - 59.0	87%				49.0 - 59.0 - Same as above; red with trace to some brown and gray mottling.
59	10.0 / 10.0	R-6 59.0 - 69.0	100%				59.0 - 62.3 - Same as above.
60							

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

05-30-2008 F:\Clients\APO\APO017\Boring logs\5-BuSW.bor

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/23/2007
Date Completed	: 8/24/2007
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 284.4'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-5

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-5
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
62.3							62.3 - 69.0 - Hard, gray SANDSTONE; fine to medium grained, slighly weathered, micaceous, thick bedding, unfractured.
69	10.0 / 9.5	R-7 69.0 - 79.0	95%				69.0 - 78.0 - Same as above.
78							78.0 - 78.5 - Medium hard, gray SHALE; very fine grained, slightly weathered, argillaceous, thin bedding, unfractured.
79	10.0 / 10.0	R-8 79.0 - 89.0	100%				79.0 - 81.4 - Same as above.

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

05-30-2008 F:\Clients\APO\APO017\Boring logs\5-BuSW.bor

Hull & associates, inc.

Date Started	: 8/23/2007
Date Completed	: 8/24/2007
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 284.4'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-5

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-5
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
81.4					81.4 - 84.7 - Hard, gray SANDSTONE; fine grained, slighly weathered, micaceous, thick bedding, unfractured.
84.7					84.7 - 89.0 - Hard, red with some gray mottling SILTSTONE with trace shale interbeds; very fine grained, slighly weathered, micaceous, argillaceous, thick bedding, unfractured.
89	10.0 / 10.0	R-9 89.0 - 99.0	100%		89.0 - 92.5 - Same as above; few arenaceous laminations.
92.5					92.5 - 99.0 - Medium hard, gray to brown and gray mottled SHALE, trace arenaceous laminations; very fine grained, moderately weathered, medium bedding, fractures noted.
99	10.0 / 9.8	R-10 99.0 - 109.0	91%		

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

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Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/23/2007
Date Completed	: 8/24/2007
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 284.4'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-5

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-5
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
100							99.0 - 108.8 - Medium hard, greenish-gray to purple to red SHALE; very fine grained, very highly eenish-brown and rceous, medium bedding, fractures noted.
109	10.0 / 10.0	R-11 109.0 - 119.0	95%				109.0 - 119.0 - Medium hard, mottled purple, greenish-brown and red SHALE; very fine grained, highly weathered, argillaceous, thin bedding, fractures noted.
119	5.4 / 5.4	R-12 119.0 - 124.4	83%				119.0 - 124.4 - Same as above.
120							

2" ID Sch 40 PVC Riser

Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/23/2007
Date Completed	: 8/24/2007
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 284.4'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-5

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-5
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
124.4	10.0 / 10.0	R-13 124.4 - 134.4	96%				124.4 - 129.6 - Medium hard, brownish-red SHALE; very fine grained, moderately weathered, argillaceous, thick bedding, fractures noted, contains trace arenaceous interbeds in a gray zone at 128.4 to 129.6 feet.
129.6							129.6 - 134.4 - Hard, gray SANDSTONE; fine grained, slightly weathered, very micaceous, thick bedding, unfractured.
134.4	10.0 / 9.2	R-14 134.4 - 144.4	92%				134.4 - 143.6 - Very hard, gray to brownish-red SANDSTONE; fine grained, unweathered, thick bedding, unfractured; contains siltstone interbeds.

Depth scale: 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140

2" ID Sch 40 PVC Riser

Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/23/2007
Date Completed	: 8/24/2007
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 284.4'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-5

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-5
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
144.4	10.0 / 10.0	R-15 144.4 - 154.4	89%				144.4 - 147.0 - Same as above.
147.0							147.0 - 150.0 - Medium hard, red SHALE; very fine grained, highly weathered, argillaceous, medium bedding, fractures noted.
150.0							150.0 - 150.9 - Hard, red SILTSTONE.
150.9							150.9 - 154.4 - Hard, gray SANDSTONE; fine grained, slightly weathered, micaceous, thick bedding, unfractured.
154.4	10.0 / 10.0	R-16 154.4 - 164.4	97%				154.4 - 155.8 - Same as above.
155.8							155.8 - 164.4 - Hard, gray SILTSTONE; very fine grained, slighly weathered, arenaceous, thick bedding, unfractured.

Depth scale: 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160

2" ID Sch 40 PVC Riser

Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started : 8/23/2007
Date Completed : 8/24/2007
Logged by : Jay Read
Reviewed by : Steve Gross
Drilling Contractor : Thelen
Drilling Method : HQ Core, Water Rotary
Sampling Method : Rock Core 2.75"
Total Depth (ft.) : 284.4'
Water Level (ft.) : Not Measured
Ground Elevation (ft.) : N/A

LOG OF BORING BuSW-5

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-5
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
164.4	10.0 / 10.0	R-17 164.4 - 174.4	100%				164.4 - 169.5 - Hard, gray SANDSTONE; fine grained, slightly weathered, micaceous, thick bedding, unfractured.
169.5							169.5 - 174.4 - Medium hard to hard, gray with little red banding SHALE; very fine grained, little arenaceous laminations, slightly to moderately weathered, argillaceous, medium bedding, fractures noted.
174.4	10.0 / 10.0	R-18 174.4 - 184.4	97%				174.4 - 184.4 - Medium hard, predominately gray SHALE with red, purple and greenish-yellow mottling; very fine grained, moderately to highly weathered, argillaceous, thin to medium bedding, fractures noted.

Depth scale: 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180

2" ID Sch 40 PVC Riser

Grout

REMARKS:

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Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/23/2007
Date Completed	: 8/24/2007
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 284.4'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-5

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-5
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
184.4	10.0 / 9.9	R-19 184.4 - 194.4	97%		184.4 - 194.4 - Same as above.
194.4	10.0 / 10.0	R-20 194.4 - 204.4	91%		194.4 - 204.4 - Medium hard, gray SHALE with some red and yellow mottling; very fine grained, moderately to highly weathered, argillaceous, thin to medium bedding, fractures noted.

Depth scale: 180–200 ft.

2" ID Sch 40 PVC Riser

Grout

REMARKS:

LOG OF BORING BuSW-5

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/23/2007
Date Completed	: 8/24/2007
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 284.4'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-5
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
204.4	10.0 / 9.8	R-21 204.4 - 214.4	90%				204.4 - 214.4 - Medium hard to hard, gray SHALE, abundantly interbedded with sandstone; very fine to medium grained, argillaceous, moderately weathered, thin bedding, fractures noted.
214.4	10.0 / 10.0	R-22 214.4 - 224.4	93%				214.4 - 224.4 - Soft to medium hard gray SHALE; very fine grained, moderately to highly weathered, argillaceous, trace arenaceous laminations, medium bedding, fractures noted.

Depth scale: 200–220 ft.

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/23/2007
Date Completed	: 8/24/2007
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 284.4'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-5

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-5
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
224.4	10.0 / 10.0	R-23 224.4 - 234.4	93%				224.4 - 234.4 - Same as above.
234.4	10.0 / 10.0	R-24 234.4 - 244.4	93%				234.4 - 235.1 - Same as above; dark gray.
235.1							235.1 - 244.4 - Hard, gray SANDSTONE; fine to medium grained, slightly weathered, thick bedding, unfractured.

Depth scale: 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240

Well construction: Grout; 2" ID Sch 40 PVC Riser; Bentonite Seal; Sand Pack; 2" ID Sch 40 PVC Screen

REMARKS:

LOG OF BORING BuSW-5

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/23/2007
Date Completed	: 8/24/2007
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 284.4'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-5
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
244.4	10.0 / 10.0	R-25 244.4 - 254.4	100%		244.4 - 254.4 - Same as above; carbonitic (black carbon banding), micaceous.
254.4	10.0 / 10.0	R-26 254.4 - 264.4	100%		254.4 - 259.4 - Same as above; fine grained, few coal seams, micaceous, pyritic.

Depth scale: 240–260 ft.

Well diagram: 2" ID Sch 40 PVC Screen; Sand Pack

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/23/2007
Date Completed	: 8/24/2007
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 284.4'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-5

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-5
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6")	DESCRIPTION
260–264					259.4 - 264.4 - Hard, gray SANDSTONE; medium to coarse grained, slightly weathered, micaceous, pyritic, contains few coal seams, few brecciated zones, medium bedding, unfractured.
264.4	10.0 / 10.0	R-27 264.4 - 274.4	100%		264.4 - 274.4 - Same as above; lacking breccia and pyrite, micaceous.
274.4	10.0 / 10.0	R-28 274.4 - 284.4	86%		274.4 - 278.8 - Same as above.
278.8					278.8 - 281.7 - Medium hard, red SHALE; very fine grained, highly weathered, argillaceous, thick bedding, fractures noted.

Depth scale: 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280

Well construction: 2" ID Sch 40 PVC Screen; Sand Pack

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 8/23/2007
Date Completed	: 8/24/2007
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 284.4'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING BuSW-5

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-5
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
280							
281							
282							281.7 - 284.4 - Same as above, but brown to gray.
283							
284							
285							284.4 - Bottom of boring.
286							
287							
288							
289							
290							
291							
292							
293							
294							
295							
296							
297							
298							
299							
300							

Sand Pack

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 9/5/2007
Date Completed	: 9/5/2007
Logged by	: Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 201.5'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

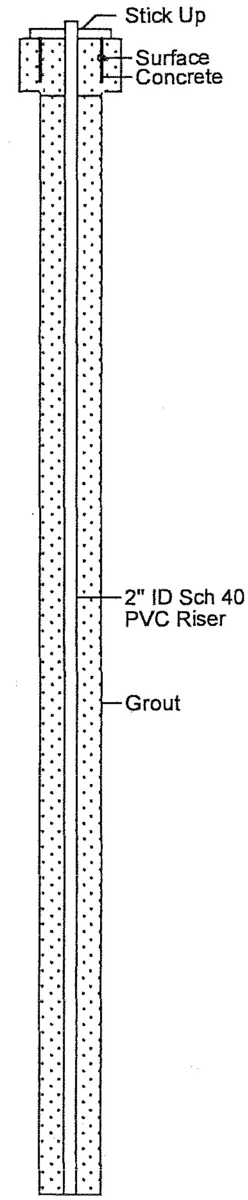
LOG OF BORING IMW-1Bu

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
0							0.0 - 10.5 - Casing set; no sampling.
10.5	2.0 / 2.0	R-1 10.5 - 12.5	80%				10.5 - 12.5 - Hard, red SHALE, blocky structure, fractures noted.
12.5	10.0 / 9.8	R-2 12.5 - 22.3	90%				12.5 - 22.3 - Same As Above (SAA): gray and red, orange staining. Less than 0.1 feet of black shale / coal at 16.9 feet.

Well: IMW-1Bu



REMARKS:

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Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 9/5/2007
Date Completed	: 9/5/2007
Logged by	: Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 201.5'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

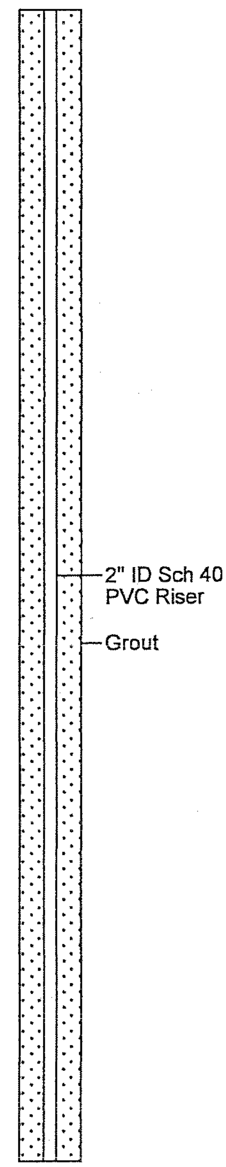
LOG OF BORING IMW-1Bu

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: IMW-1Bu

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
20–32	10.0 / 6.2	R-3 22.5 - 28.7	48%				22.5 - 28.7 - Medium hard, burgandy SHALE, weathered, blocky.
32–40	10.0 / 2.1	R-4 32.5 - 42.5	21%				32.5 - 34.6 - SAA: core stuck in barrel.



REMARKS:

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Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 9/5/2007
Date Completed	: 9/5/2007
Logged by	: Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 201.5'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING IMW-1Bu

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: IMW-1Bu

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
42.5	10.0 / 10.0	R-5 42.5 - 52.5	87%				42.5 - 47.5 - SAA: burgandy to gray, weathering decreasing with depth.
47.5							47.5 - 52.5 - Hard, gray, fine grained SANDSTONE; thinly bedded, micaceous laminations,fractures noted.
52.5	10.0 / 10.0	R-6 52.5 - 62.5	92%				52.5 - 62.5 - SAA: iron staining in bands, fractures noted.

Depth scale: 40–60 ft.

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation Proposed Residual Waste Landfill Cheshire, Ohio Project Number: APO017 Project Manager: Steve Gross	Date Started : 9/5/2007 Date Completed : 9/5/2007 Logged by : Matt McCoy Reviewed by : Steve Gross Drilling Contractor : Thelen Drilling Method : HQ Core, Water Rotary Sampling Method : Rock Core 2.75" Total Depth (ft.) : 201.5' Water Level (ft.) : Not Measured Ground Elevation (ft.) : N/A	LOG OF BORING IMW-1Bu (Page 4 of 11)

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: IMW-1Bu

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
62.5	10.0 / 9.8	R-7 62.5 - 72.5	89%				62.5 - 64.9 - SAA.
64.9							64.9 - 65.7 - Medium hard, gray SHALE, thinly bedded.
65.7							65.7 - 69.5 - Hard, fine grained SANDSTONE grading to SILTSTONE.
69.5							69.5 - 72.5 - Hard, gray SHALE; slightly weathered, orange stained zones, thin silty laminations.
72.5	10.0 / 8.5	R-8 72.5 - 72.8	100%				72.5 - 73.5 - Hard, fine grained SANDSTONE; micaceous.
73.5							73.5 - 82.5 - Hard, gray SILTSTONE; fine grained, thin bedding, trace shale interbeds between 77.0 and 79.4 feet.

Depth scale: 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 9/5/2007
Date Completed	: 9/5/2007
Logged by	: Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 201.5'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING IMW-1Bu

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: IMW-1Bu

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
82.5	10.0 / 10.0	R-9 82.5 - 92.5	90%		82.5 - 92.5 - Hard, gray and red banded interbedded SHALE and SILTSTONE; few pyrite in bottom foot, fractures noted.
92.5	10.0 / 10.0	R-10 92.5 - 102.5	92%		92.5 - 93.6 - SAA.
93.6					93.6 - 102.5 - Medium hard to hard, red and gray ures at clghtly weathered, iron staining, fractures noted.

Depth scale: 80 – 100

2" ID Sch 40 PVC Riser

Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 9/5/2007
Date Completed	: 9/5/2007
Logged by	: Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 201.5'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING IMW-1Bu

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: IMW-1Bu

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
102.5	10.0 / 9.9	R-11 102.5 - 112.5	96%		102.5 - 112.5 - Hard, red and gray SHALE; slightly weathered.
112.5	10.0 / 9.8	R-112 112.5 - 122.5	96%		112.5 - 122.5 - SAA.

Depth scale: 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120

2" ID Sch 40 PVC Riser

Grout

REMARKS:

05-30-2008 F:\Clients\APO\APO017\Boring logs\IMW-1Bu.bor

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 9/5/2007
Date Completed	: 9/5/2007
Logged by	: Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 201.5'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING IMW-1Bu

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: IMW-1Bu

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
122.5	10.0 / 10.0	R-13 122.5 - 132.5	99%				122.5 - 132.5 - Hard, red and gray SHALE; orange staining, fractures noted.
132.5	10.0 / 10.0	R-14 132.5 - 142.5	98%				132.5 - 142.5 - SAA.

Depth scale: 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 9/5/2007
Date Completed	: 9/5/2007
Logged by	: Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 201.5'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING IMW-1Bu

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: IMW-1Bu

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
142.5	10.0 / 9.7	R-15 142.5 - 152.5	79%		142.5 - 152.0 - SAA: pyritic between 144.5 and 147.0 feet.
152.0					152.0 - 152.3 - Hard, gray SILTSTONE; fine grained.
152.5	10.0 / 10.0	R-16 152.5 - 162.5	100%		152.5 - 162.5 - Hard, gray, fine grained SANDSTONE.

Depth scale: 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160

2" ID Sch 40 PVC Riser

Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 9/5/2007
Date Completed	: 9/5/2007
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Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 201.5'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

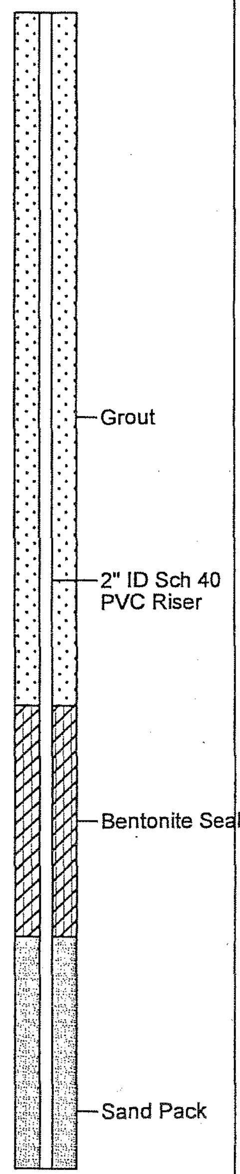
LOG OF BORING IMW-1Bu

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: IMW-1Bu

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
162.5	10.0 / 10.0	R-17 162.5 - 172.5	83%				162.5 - 168.1 - SAA.
168.1							168.1 - 172.5 - Hard, brown-red to red SHALE; gray mottling and orange staining.
172.5	10.0 / 10.0	R-18 172.5 - 182.5	83%				172.5 - 175.7 - SAA.
175.7							175.7 - 182.5 - Hard, gray, fine grained SANDSTONE; thinly bedded, becomes micaceous with depth, small calcite inclusions.



REMARKS:

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Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 9/5/2007
Date Completed	: 9/5/2007
Logged by	: Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 201.5'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

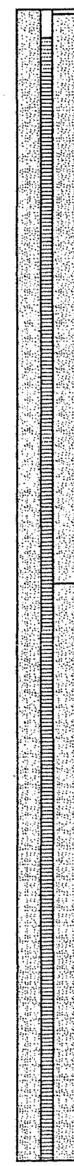
LOG OF BORING IMW-1Bu

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: IMW-1Bu

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
180							
181							
182							
182.5	10.0 / 10.0	R-19 182.5 - 192.5	100%				182.5 - 192.5 - SAA: increasing grain size with depth, micaceous laminations.
183							
184							
185							
186							
187							
188							
189							
190							
191							
192							
192.5	10.0 / 9.9	R-20 192.5 - 205.5	100%				192.5 - 200.5 - SAA.
193							
194							
195							
196							
197							
198							
199							
200							



REMARKS:

Hull & associates, inc.

LOG OF BORING IMW-1Bu

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 9/5/2007
Date Completed	: 9/5/2007
Logged by	: Matt McCoy
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 201.5'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: IMW-1Bu

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
200							
201					X		200.5 - 202.5 - Hard, gray SHALE; red at bottom.
202							
203							202.5 Bottom of boring.

Depth scale: 200–220

2" ID Sch 40 PVC Screen

Sand Pack

REMARKS:

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BORING NO. _ ____CCR-1BU__
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek – Landfill	Drilling Contractor:	Bowser Morner
Drilling Date(s):	9-21-15 to 10-12-15	AGES Geologist:	Mike Gelles

Drilling Method:	Rotosonic/Coring	Coring Device Size:	6”	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	8”	Drilling Fluid Used:	None		
Sampling Interval:	NA	Borehole Depth:	280’	Surface Elevation:	783.41		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0 – 220			Advance casing – no samples.	N/A
220 – 230	6	NA	4’ Brown limestone; 2’ Gray limestone	N/A
230 – 240	10	NA	3’ Brown/Gray limestone; 7’ Gray limestone	N/A
240 – 250	8	NA	4’ Brown limestone; 4’ Gray limestone	N/A
250 – 260	3	NA	2.5’ Gray limestone; 0.5’ Gray fine-medium grained Sandstone	N/A
260 – 270	0	NA		N/A
270 – 280	0	NA		N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. CCR-1BU

Project Number: 2015079

Project Location: Kyger Creek Station – Landfill

Installation Date(s): 10/12/2015

Drilling Method: Rotosonic/Coring
Drilling Contractor: Bowser Morner

Development Date(s): 10/19/2015 – 11/21/2015

Development Method: Bailer
Introducing and purging up to 5 gallons of distilled water on each day of development.

Volume Purged:

Static Water-Level*

Top of Well Casing Elevation: 785.80 ft.(MSL)

Well Purpose:
Groundwater Monitoring
State Plane Coordinates: Northing (Y): 337641.36
Easting (X): 2063220.23

Comments/Notes:
2 inch PVC riser and screen
20 ft of 0.010 screen

Inspector: Mike Gelles

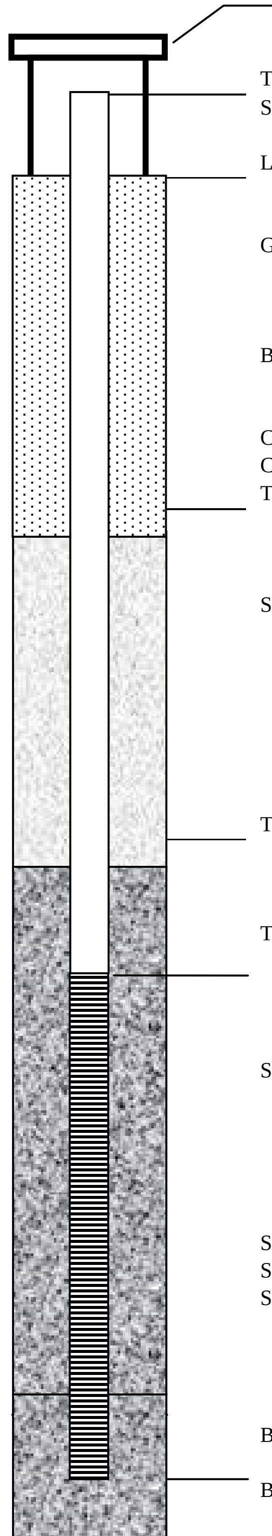
CONSTRUCTION MATERIALS USED:

7 Bags of Sand

1.5 Bags/Buckets Bentonite Pellets

10 Bags Portland for Grout

0 Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 785.80 ft. MSL
Stick-up: 2.39 ft.

Land Surface Elevation: 783.41 ft. MSL

Grout; Type: Portland Grout

Borehole Diameter: 8 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 251 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 255 ft*

Top of Well Screen 259 ft*

Sand/Gravel Pack; Type: 0.40 mm

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 279 ft.*

Base of Borehole: 279 ft.*

Total Depth of Well
Below Top of Casing: 281.39 ft.

*Indicates Depth Below Land Surface

BORING NO. _ ____CCR-2BU__
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek – Landfill	Drilling Contractor:	Bowser Morner
Drilling Date(s):	10-13-15 to 10-21-15	AGES Geologist:	Mike Gelles/John Campbell

Drilling Method:	Rotosonic/Coring	Coring Device Size:	6”	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	8”	Drilling Fluid Used:	None		
Sampling Interval:	NA	Borehole Depth:	247.5	Surface Elevation:	742.28		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0 – 205			Advance casing – no samples.	N/A
205 – 215	7.5	NA	Gray limestone	N/A
215 – 225	4.5	NA	Gray limestone	N/A
225 – 235	2	NA	0.5’ Gray limestone; 1.5’ Brown fine grained sandstone	N/A
235 – 246	2	NA	Gray medium to course grained sandstone	N/A
246 – 247.5		NA	Advance casing – no samples.	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. CCR-2BU

Project Number: 2015079

Project Location: Kyger Creek Station – Landfill

Installation Date(s): 10/21/2015

Drilling Method: Rotosonic/Coring

Drilling Contractor: Bowser Morner

Development Date(s):

Development Method: Bailer

Introducing and purging up to 5 gallons of distilled water on each day of development.

Volume Purged:

Static Water-Level*

Top of Well Casing Elevation: 744.69 ft.(MSL)

Well Purpose:
Ground Water Monitoring

State Plane Coordinates: Northing (Y): 336302.19
Easting (X): 2064286.87

Comments/Notes:
2 inch PVC riser and screen
20 ft of 0.010 screen

Inspector: Mike Gelles/John Campbell

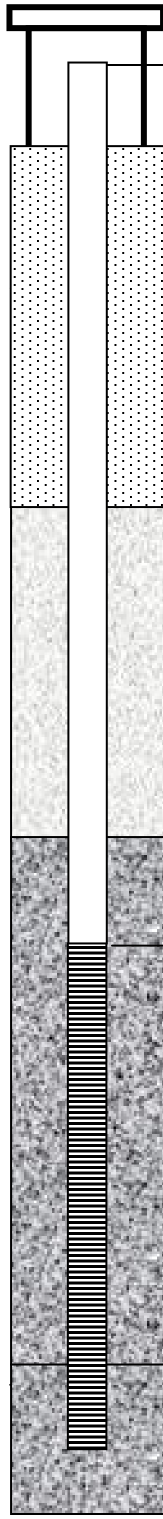
CONSTRUCTION MATERIALS USED:

7 Bags of Sand

1.5 Bags/Buckets Bentonite Pellets

10 Bags Portland for Grout

0 Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 744.69 ft. MS

Stick-up: 2.41 ft.

Land Surface Elevation: 742.28 ft. MS

Grout; Type: Portland Grout

Borehole Diameter: 8 inch

Casing Diameter: 2 Inch

Casing Material: PVC

Top of Seal: 219.5 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 223.5 ft*

Top of Well Screen 227.5 ft*

Sand/Gravel Pack; Type: 0.40 mm

Screen Diameter: 2 Inch

Screen Slot-Size: 0.010 Inch

Screen Material: PVC

Bottom of Well Screen 247.5 ft.*

Base of Borehole: 247.5 ft.*

Total Depth of Well Below Top of Casing: 249.91 ft.

*Indicates Depth Below Land Surface

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started : 04/11/06
Date Completed : 04/11/06
Logged by : M. Begley
Reviewed by : M. McCoy
Drilling Contractor : Pennsylvania Drilling
Drilling Method : S.S., NQ Core, Air Rotary
Sampling Method : Split Spoon, Rock Core 2"
Total Depth (ft.) : 146.5'
S. Water Level Date : Not Measured
S. Water Level (ft.) : Not Measured

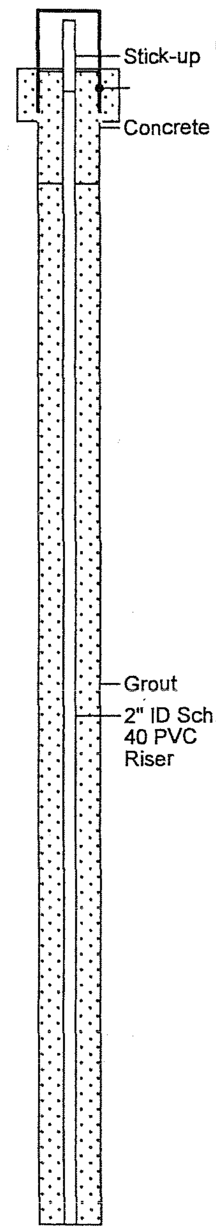
LOG OF BORING GB-3/BuSW-8

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.
Water Levels: Static; During Drilling

Well: BuSW-8
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
0	2.0/1.5	SP1/SS1	NA	1-2-3-4	0.0 to 1.5 - Soft red silty CLAY, moist, plastic.
	2.0/1.1	SP2/SS2	NA	4-8-8-12	2.0 to 3.1 - Same As Above (SAA): grey fractures noted.
	2.0/1.6	SP3/SS3	NA	4-7-12-12	4.0 to 5.0- SAA. 5.0 to 5.6 - SAA: beige/yellow, silty.
	2.0/1.5	SP4/SS4	NA	4-7-10-50/2	6.0 to 6.6 - SAA: burgundy. 6.6 to 7.5 - SAA: orange. Hard to light grey/ green shale in shoe.
	3.0/3.0 RQD = 60.0	RC1/9MIN	NA	35-50/1	8.0 to 8.5 - Hard grey fine SANDSTONE. 8.5 to 9.6 - SAA: iron stained.
10					9.6 to 10.5 - Soft beige/grey SHALE, medium weathered.
	10.0/10.0 RQD = 79.2	RC2/9MIN	NA	NA	10.5 to 11.5 - Hard grey SANDSTONE, iron stained nodules. 11.5 to 14.8 - SAA: fractures noted.
					14.8 to 21.5 - Soft beige to blue grey to burgundy medium weathered SHALE, blue/grey below 19.6.
20					



REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/11/06
Date Completed	: 04/11/06
Logged by	: M. Begley
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 146.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-3/BuSW-8

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW-8
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
20					
	10.0/10.0 RQD = 67.6	RC3/12MIN	NA	NA	21.5 to 21.7 - SAA.
					21.7 to 23.2 - Hard grey micaceous SANDSTONE, slightly weathered (nodules).
					23.2 to 29.2 - Soft grey unweathered SHALE.
					29.2 to 31.5 - SAA: grades to burgundy, little 1-2 cm iron oxide nodules.
30					
	5.8/5.8 RQD = 41.4	RC4/12MIN	NA	NA	31.5 to 37.3 - SAA: nodules decreasing below 34.5.
	4.2/3.8 RQD = 60.0	RC5/12MIN	NA	NA	37.3 to 41.2 - SAA: fractures noted, iron stained and sand filled.
40					

Well construction: Grout; 2" ID Sch 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/11/06
Date Completed	: 04/11/06
Logged by	: M. Begley
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Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 146.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-3/BuSW-8

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW-8
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
40							
	9.0/7.7 RQD = 92.0	RC6/15MIN	NA	NA			41.5 to 49.2 - SAA: nodules, soft, burgundy, fractures noted.
	2.0/1.9 RQD = 46.7	RC7/	NA	NA			49.2 to 51.5 - SAA: medium weathered.
50							
	10.0/10.0 RQD = 46.7	RC8/25MIN	NA	NA			51.5 to 61.5 - SAA: grey/green and burgundy zones. fractures ntoed.
60							

Grout

2" ID Sch 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

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Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/11/06
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Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 146.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-3/BuSW-8

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: ▼ Static; ▽ During Drilling

Well: BuSW-8
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
60					
	10.0/10.0 RQD = 59.1	RC9/23MIN	NA	NA	61.5 to 69.5 - SAA: burgundy, fractures noted.
70	7.0/6.8 RQD = 77.1	RC10/19MIN	NA	NA	69.5 to 73.5 - SAA: grey below 71.5.
					73.5 to 76.5 - Hard blue/grey fine SILTSONE, medium weathered, fractures noted.
	10.0/10.0 RQD = 95.4	RC11/10MIN	NA	NA	76.5 to 79.7 - SAA.
80					

Well: Grout; 2" ID Sch. 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

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Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 146.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-3/BuSW-8

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW-8
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
80					79.7 to 86.5 - Very hard blue grey SANDSTONE, grain size increasing with depth, unweathered, occasional shale seams, fractures noted.
	10.0/10.0 RQD = 99.9	RC12/15MIN	NA	NA	86.5 to 86.9 - SAA.
					86.9 to 96.5 - Medium hard grey SHALE, fractures noted.
90					
	10.0/9.7 RQD = 97.4	RC13/23MIN	NA	NA	96.5 to 104.0 - SAA: fractures noted.
100					

Grout

2" ID Sch 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

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Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/11/06
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Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 146.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-3/BuSW-8

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW-8
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6")	DESCRIPTION
100					
					104.0 to 106.5 - SAA: soft burgundy, grey below 105.8, iron stained, mod weathered, fractures noted.
	7.5/7.1 RQD = 70.3	RC14/31MIN	NA	NA	106.5 to 114.0 - SAA: fractures noted.
110					
	2.5/2.1 RQD = 42.1	RC15/13MIN	NA	NA	114.0 to 116.1 - SAA: blue/grey and burgundy, fractures noted.
	10.0/10.0 RQD = 68.7	RC16/30MIN	NA	NA	116.5 to 125.3 - SAA: grading to fine grey sandstone, burgundy interbeds, fractures noted.
120					

Grout

2" ID Sch 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/11/06
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Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 146.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-3/BuSW-8

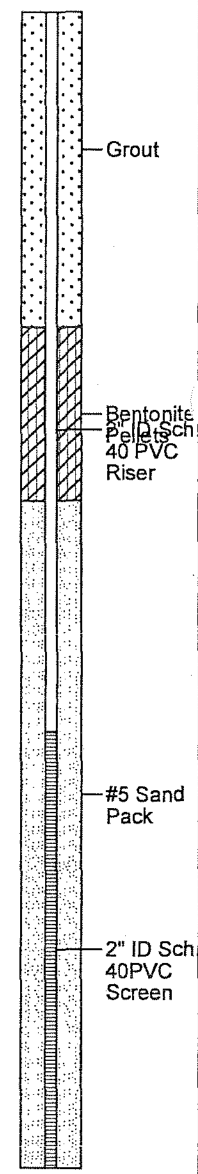
G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW-8
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
120							
							125.3 to 126.5 - Hard grey fine grained SANDSTONE.
	10.0/10.0 RQD = 65.4	RC17/27MIN	NA	NA			126.5 to 136.5 - SAA: porous, red, coarse grained below 135.9.
130							
	5.0/5.0 RQD = 88.7	RC18/11MIN	NA	NA			136.5 to 141.0 - SAA.
140							



REMARKS:

Boring backfilled with cement-bentonite grout.

05-30-2008 F:\Clients\APO\APO017\Boring logs\GB-3 BuSW-8.bor

Hull & associates, inc.

Date Started	: 04/11/06
Date Completed	: 04/11/06
Logged by	: M. Begley
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 146.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-3/BuSW-8

G. Elev. (ft. USGS) :

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: BuSW-8
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
140							
							141.0 to 141.5 - Soft grey SHALE. 141.5 to 142.3 - SAA.
							142.3 to 146.5 - Hard blue/grey fine SANDSTONE.
							End of Boring at 146.5'.
150							
160							

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started : 06/05/2006
Date Completed : 06/06/2006
Logged by : C. Forman
Reviewed by : M. McCoy
Drilling Contractor : Pennsylvania Drilling
Drilling Method : S.S., NQ Core, Air Reary
Sampling Method : Split Spoon, Rock Core
Total Depth (ft.) : 130.5'
S. Water Level Date : Not Measured
S. Water Level (ft.) : Not Measured

LOG OF BORING GB-24/BuSW-10

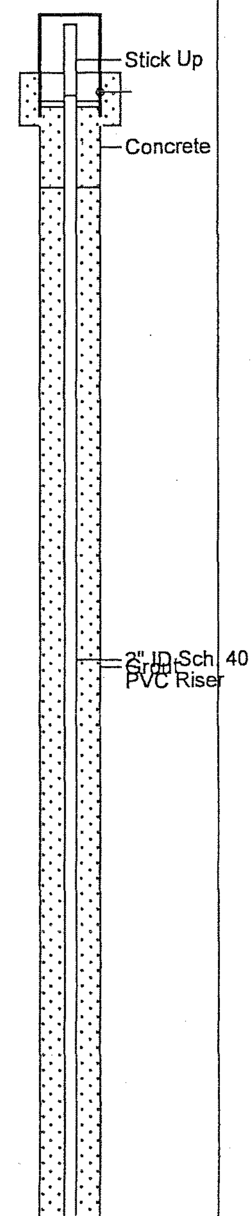
G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
0	2.0 / 1.2	SP1/SS1	N/A	3-4-5-6	0.0 to 1.2 - Moderately stiff, dark brown, silty CLAY, trace sand and gravel, slightly moist.
2	2.0 / 0.6	SP2/SS2	N/A	6-6-7-6	2.0 to 2.6 - Same As Above (SAA): soft, dark brown to light brown, mottled.
4	2.0 / 1.4	SP3/SS3	N/A	2-3-4-19	4.0 to 4.3 - SAA: wet.
					4.3 to 4.4 - Organic material, wet.
					4.4 to 5.3 - Soft light brown/dark brown mottled silty CLAY, slightly moist.
6	2.0 / 1.0	SP4/SS4	N/A	2-10-9-9	5.3 to 5.4 - Soft to medium hard micaceous red SHALE, weathered.
					6.0 to 7.0 - Moderately stiff reddish-brown silty CLAY, trace sand and gravel, dry.
8	2.0 / 1.3	SP5/SS5	N/A	4-10-17-19	8.0 to 8.5 - SAA.
					8.5 to 9.3 - SAA: stiff, light brown.
10	2.0 / 1.2	SP6/SS6	N/A	4-11-29-46	10.0 to 10.2 - SAA.
					10.2 to 11.2 - Soft red SHALE, weathered considerably.
12	2.0 / 0.8	SP7/SS7	N/A	20-50/2	12.0 to 12.8 - SAA.
14	2.0 / 0.3	SP8/SS8	N/A	N/A	14.0 to 14.3 - SAA.
15	5.5/5.5 RQD = 67	RC1/12MIN	NA	NA	15.0 to 20.5 - SAA.
20					

Well: BuSW-10
Elev.:



REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 06/05/2006
Date Completed	: 06/06/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core
Total Depth (ft.)	: 130.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-24/BuSW-10

G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-10
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
20.5	9.8/10.0 RQD = 97	RC2/28MIN	NA	NA	20.5 to 30.3 - Soft red SHALE, iron staining, highly chemically and physically weathered, gradual change to grey shale at 30.0'.
30.5	10.0/10.0 RQD = 58	RC3/26MIN	NA	NA	30.5 to 40.5 - SAA: very weathered, gradual change to red shale at 31.0', sudden change to grey shale at 36.1'.

Depth scale: 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40

Well construction: Grout; 2" ID Sch 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 06/05/2006
Date Completed	: 06/06/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core
Total Depth (ft.)	: 130.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-24/BuSW-10

G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-10
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
40	10.0/10.0 RQD = 62	RC4/20MIN	NA	NA	40.5 to 42.3 - SAA: soft to medium hard.
42					42.3 to 50.5 - SAA: iron staining.
50	10.0/10.0 RQD = 60	RC5/15MIN	NA	NA	50.5 to 60.5 - Medium hard grey SHALE, highly weathered.
59					59.2 to 60.5 - SANDSTONE lense.
60					

Well: Grout; 2" ID Sch. 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 06/05/2006
Date Completed	: 06/06/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core
Total Depth (ft.)	: 130.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-24/BuSW-10

G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-10
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6")	DESCRIPTION
60	10.0/10.0 RQD = 55	RC6/15MIN	NA	NA	60.5 to 64.8 - Medium hard fine to medium grained SANDSTONE, light grey.
64.8					64.8 to 70.5 - Soft grey SHALE, slightly weathered.
70.5	10.0/10.0 RQD = 64	RC7/15MIN	NA	NA	70.5 to 80.5 - SAA: medium hard to hard, grey.

Well construction: Grout; 2" ID Sch. 40 PVC Riser

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 06/05/2006
Date Completed	: 06/06/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core
Total Depth (ft.)	: 130.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-24/BuSW-10

G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-10
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
80.5	10.0/10.0 RQD = 60	RC8/15MIN	NA	NA	80.5 to 82.4 - SAA.
84.2					84.2 to 87.3 - SAA: soft, red, iron staining, highly weathered.
87.3					87.3 to 90.5 - SAA: grey.
90.5	10.0/10.0 RQD =	RC9/16MIN	NA	NA	90.5 to 94.2 - SAA: medium hard, micaceous.
94.2					94.2 to 100.5 - Medium hard light grey micaceous SANDSTONE.

Well construction: Grout; 2" ID Sch. 40 PVC Riser; Bentonite Pellets

REMARKS:

Boring backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 06/05/2006
Date Completed	: 06/06/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core
Total Depth (ft.)	: 130.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-24/BuSW-10

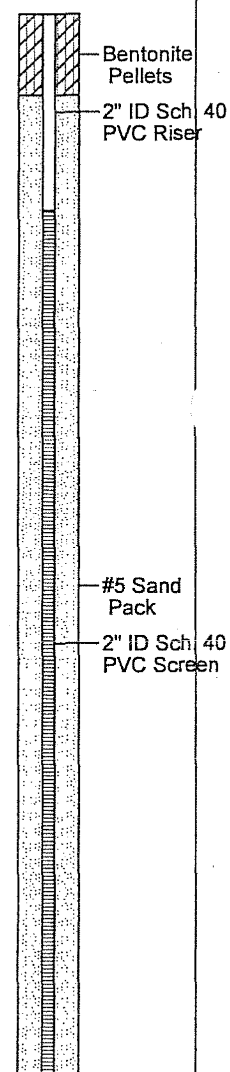
G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-10
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6")	DESCRIPTION
100.5	10.0/10.0 RQD = 48	RC10/34MIN	NA	NA	100.5 to 102.5 - SAA.
102.5					102.5 to 110.5 - SAA: medium to coarse grained, blue-grey, calcite cement.
110.5	10.0/10.0 RQD = 29	RC11/20MIN	NA	NA	110.5 to 117.7 - SAA.
117.7					117.7 to 120.5 - Soft grey weathered SHALE, increasing chemical weathering with depth.



REMARKS:

Boring backfilled with cement-bentonite grout.

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Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 06/05/2006
Date Completed	: 06/06/2006
Logged by	: C. Forman
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Reary
Sampling Method	: Split Spoon, Rock Core
Total Depth (ft.)	: 130.5'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-24/BuSW-10

G. Elev. (ft. USGS) :

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: BuSW-10
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
120							120.5 to 121.3 - SAA: some iron staining.
121							121.3 to 129.7 - SAA: medium hard to hard.
122							
123							
124							
125							
126							
127							
128							
129							
130							EOB @ 130.5' bgs.
131							
132							
133							
134							
135							
136							
137							
138							
139							
140							

REMARKS:

Boring backfilled with cement-bentonite grout.

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Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 9/10/2007
Date Completed	: 9/11/2007
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 117.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

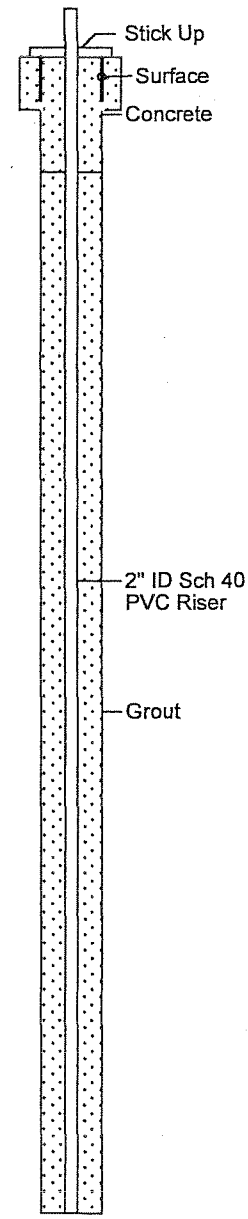
LOG OF BORING IMW-2Bu

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
0							0.0 - 25.5 - Casing set; no sampling.
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Well: IMW-2Bu



REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started : 9/10/2007
Date Completed : 9/11/2007
Logged by : Jay Read
Reviewed by : Steve Gross
Drilling Contractor : Thelen
Drilling Method : HQ Core, Water Rotary
Sampling Method : Rock Core 2.75"
Total Depth (ft.) : 117.0'
Water Level (ft.) : Not Measured
Ground Elevation (ft.) : N/A

LOG OF BORING IMW-2Bu

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: IMW-2Bu

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
25.5	7.2 / 7.2	R-1 25.5 - 32.7	83%				25.5 - 32.7 - Soft to medium hard, gray to red with some brown mottling SHALE; very fine grained, highly weathered, argillaceous, medium bedding, fractures noted.
32.7	10.0 / 10.0	R-2 32.7 - 42.7	100%				32.7 - 42.7 - Same As Above (SAA): red to red and gray mottled.

Depth scale: 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40

2" ID Sch 40 PVC Riser
Grout

REMARKS:

Hull & associates, inc.	Date Started : 9/10/2007 Date Completed : 9/11/2007 Logged by : Jay Read Reviewed by : Steve Gross Drilling Contractor : Thelen Drilling Method : HQ Core, Water Rotary Sampling Method : Rock Core 2.75" Total Depth (ft.) : 117.0' Water Level (ft.) : Not Measured Ground Elevation (ft.) : N/A	LOG OF BORING IMW-2Bu (Page 3 of 6)
Hydro Investigation Proposed Residual Waste Landfill Cheshire, Ohio Project Number: APO017 Project Manager: Steve Gross		

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION	Well: IMW-2Bu
40								
42.7	10.0 / 10.0	R-3 42.7 - 52.7	92%				42.7 - 52.7 - SAA: changes from red to gray at 45.8 feet, trace arenaceous laminations.	
49.5								2" ID Sch 40 PVC Riser Grout
52.1							@ 52.1 to 52.7 feet broken zone.	
52.7	10.0 / 10.0	R-4 52.7 - 62.7	79%				52.7 - 57.4 - Soft to medium hard, red SHALE; very fine grained, highly weathered, argillaceous, thick bedding, fractures noted.	
57.4							57.4 - 60.3 - SAA: gray.	
60								

REMARKS:

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Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 9/10/2007
Date Completed	: 9/11/2007
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 117.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

LOG OF BORING IMW-2Bu

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: IMW-2Bu

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	DESCRIPTION
60.3					60.3 - 62.7 - Hard, gray interbedded SANDSTONE and SILTSTONE, little shale laminations; very fine to medium grained, slightly to moderately weathered, micaceous, thin bedding, fractures noted.
62.7	10.0 / 9.2	R-5 62.7 - 71.9	92%		62.7 - 64.6 - Hard, gray SANDSTONE; medium to coarse grained, slightly weathered, micaceous, thick bedding, unfractured.
64.6					64.6 - 71.9 - Hard, gray interbedded SILTSTONE and SANDSTONE; very fine to fine grained, slightly weathered, micaceous, thin bedding, unfractured.
72.7	10.0 / 9.7	R-6 72.7 - 82.4	97%		72.7 - 77.3 - Hard, gray SILTSTONE with trace sandstone interbeds; very fine grained, slightly weathered, micaceous, medium bedding, unfractured.
77.3					77.3 - 79.0 - Hard, gray to brown SILTSTONE with some argillaceous laminations; very fine grained, moderately weathered, argillaceous, thin bedding, fractures noted.

Well construction: 2" ID Sch 40 PVC Riser; Grout

REMARKS:

Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started : 9/10/2007
Date Completed : 9/11/2007
Logged by : Jay Read
Reviewed by : Steve Gross
Drilling Contractor : Thelen
Drilling Method : HQ Core, Water Rotary
Sampling Method : Rock Core 2.75"
Total Depth (ft.) : 117.0'
Water Level (ft.) : Not Measured
Ground Elevation (ft.) : N/A

LOG OF BORING IMW-2Bu

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: IMW-2Bu

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
80–82							79.0 - 82.4 - Medium hard, red SHALE; very fine grained, moderately to highly weathered, argillaceous, thick bedding, fractures noted.
83	10.0 / 10.0	R-7 82.7 - 92.7	85%				82.7 - 92.2 - SAA.
92							92.2 - 92.7 - Hard, gray fine grained SANDSTONE.
93	10.0 / 10.0	R-8 92.7 - 102.7	100%				92.7 - 99.7 - Hard, gray SILTSTONE with trace sandstone interbeds; very fine grained, slightly weathered, micaceous, thick bedding, unfractured.
100							99.7 - 102.7 - Hard, gray SANDSTONE with few siltstone interbeds, fine to medium grained, slightly weathered, micaceous, medium bedding, unfractured; grain size increases at 102.6 to 102.7 feet and becomes very micaceous.

Grout
2" ID Sch 40 PVC Riser
Bentonite Seal
Sand Pack

REMARKS:

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Hull & associates, inc.

Hydro Investigation
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO017

Project Manager: Steve Gross

Date Started	: 9/10/2007
Date Completed	: 9/11/2007
Logged by	: Jay Read
Reviewed by	: Steve Gross
Drilling Contractor	: Thelen
Drilling Method	: HQ Core, Water Rotary
Sampling Method	: Rock Core 2.75"
Total Depth (ft.)	: 117.0'
Water Level (ft.)	: Not Measured
Ground Elevation (ft.)	: N/A

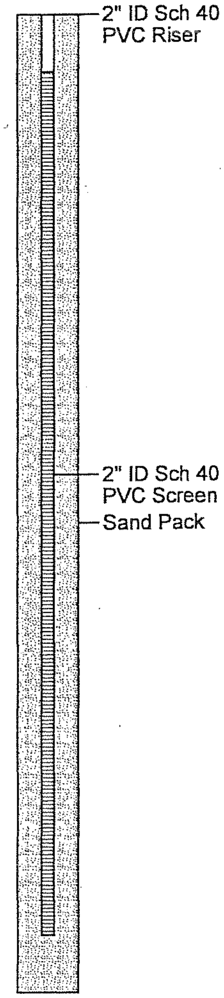
LOG OF BORING IMW-2Bu

Soil Samples: Sample Recovered; Sample Sent to Lab

Water Levels: Static; During Drilling

Well: IMW-2Bu

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	RQD	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
102.7	10.0 / 9.8	R-9 102.7 - 112.5	98%				102.7 - 108.8 - SAA.
108.8							108.8 - 111.1 - Hard, gray SANDSTONE; medium grained, slightly weathered, micaceous, medium bedding, unfractured.
111.1							111.1 - 112.5 - SAA: very coarse grained, very micaceous.
112.7	10.0 / 10.0	R-10 112.7 - 122.7	100%				112.7 - 115.7 - SAA: very coarse grained.
115.7							115.7 - 122.7 - Hard, gray SILTSTONE, moderately interbedded with sandstone; very fine grained, slightly weathered, medium bedding, unfractured.



REMARKS:

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/18/06
Date Completed	: 04/26/06
Logged by	: M. Begley
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 240.0'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-6/MW-3D

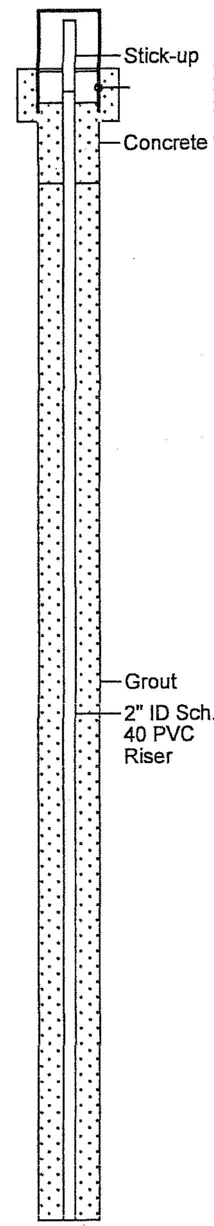
G. Elev. (ft. USGS) :

Soil Samples
- Sampled Interval
- Sample sent to lab.

Water Levels
- Static
- During Drilling

Well: MW-3D
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6")	DESCRIPTION
0	2.0/1.4	SP1/SS1	NA	1-2-3-3	0.0 to 0.3 - TOPSOIL. 0.3 to 1.4 - Stiff reddish brown silty CLAY, few rootlets, moist becoming gray @1.4 bgs.
	2.0/1.3	SP2/SS2	NA	5-5-8-15	2.0 to 3.0 - Same As Above (SAA): medium stiff brownish gray, few vert. fractures w/white mottling, moist. 3.0 to 3.3 - SAA: stiff light brownish gray, becoming highly weathered shale, slightly moist, trace sand.
	2.0/0.7	SP3/SS3	NA	20-50/3	4.0 to 4.7 - Soft light brown and gray heavily weathered SHALE, little sand, trace light gray fracture fill, slightly moist.
	2.0/0.2	SP4/SS4	NA	50/10	6.0 to 6.2 - Soft gray highly weathered SANDSTONE, dry.
	1.0/1.0	SP5/SS5	NA	NA	8.0 to 9.0 - Soft to medium hard light brownish gray interbedded SANDSTONE and SHALE, weathered, dry. Set Augers at 9.0'.
10	3.0/3.0 RQD = 12.5	RC1/8MIN	NA	NA	9.0 to 11.0 - Hard olive brown weathered SANDSTONE, trace white frac fill at 9.5 - 9.8, 11.5 - 12.0 (vertical infilled with red clay).
	10.0/10.0 RQD = 55.0	RC2/16MIN	NA	NA	12.0 to 17.6 - SAA: brownish grey, trace interbedded shale.
					17.6 to 22.0 - Soft alt. light grey and red weathered SHALE, becoming brownish black at 21.8'.
20					



REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/18/06
Date Completed	: 04/26/06
Logged by	: M. Begley
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 240.0'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-6/MW-3D

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: MW-3D
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
20					
	10.0/9.6 RQD = 73.3	RC3/16MIN	NA	NA	22.0 to 24.7 - SAA: Soft mottled light brown grey and red.
					24.7 to 25.8 - Hard blueish grey SANDSTONE, little iron staining.
					25.8 to 27.7 - Soft mottled light brown grey and red weathered SHALE.
					27.7 to 29.7 - SAA: medium hard, blueish grey, sandy.
30					29.7 to 30.8 - SAA: soft light olive grey.
					30.8 to 31.6 - SAA: medium hard, light brownish grey, sandy.
	10.0/9.8 RQD = 50.8	RC4/18MIN	NA	NA	32.0 to 33.8 - SAA: mottled light grey and brown.
					33.8 to 34.5 - SAA: hard, light tan, weathered, sandy.
					34.5 to 41.6 - SAA: soft to medium hard, reddish brown and grey, weathered.
40					

Well: Grout; 2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started : 04/18/06
Date Completed : 04/26/06
Logged by : M. Begley
Reviewed by : M. McCoy
Drilling Contractor : Pennsylvania Drilling
Drilling Method : S.S., NQ Core, Air Rotary
Sampling Method : Split Spoon, Rock Core 2"
Total Depth (ft.) : 240.0'
S. Water Level Date : Not Measured
S. Water Level (ft.) : Not Measured

LOG OF BORING GB-6/MW-3D

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: MW-3D
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
40					
	5.0/5.0 RQD = 62.5	RC5/8MIN	NA	NA	41.6 to 41.8 - Hard dark grey SANDSTONE, trace interbedded shale.
					42.0 to 45.5 - Soft to medium hard reddish brown with little grey weathered SHALE.
					45.5 to 47.0 - Hard olive grey SANDSTONE, top 2" stained red.
	5.0/5.0 RQD = 98.3	RC6/18MIN	NA	NA	47.0 to 48.6 - SAA: olive blueish grey, fractures noted.
					48.6 to 51.2 - Medium hard olive grey and red SHALE.
50					
					51.2 to 52.0 - Hard olive blueish grey SANDSTONE, trace pyrite.
	10.0/10.0 RQD = 61.6	RC7/18MIN	NA	NA	52.0 to 59.0 - Medium hard olive grey and red SHALE.
					59.0 to 62.0 - SAA: hard grey micaceous, brittle.
60					

Well construction: Grout; 2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/18/06
Date Completed	: 04/26/06
Logged by	: M. Begley
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 240.0'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-6/MW-3D

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: MW-3D
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
60					
	10.0/8.7 RQD = 67.3	RC8/29MIN	NA	NA	62.0 to 67.2 - SAA: medium hard light tan and olive grey.
					67.2 to 70.7 - SAA: medium hard to hard reddish brown, few light grey and brownish grey coloring.
70					
	10.0/9.7 RQD = 68.7	RC9/31MIN	NA	NA	72.0 to 81.7 - SAA: soft to medium hard mottled dark red light tan and purple and grey.
80					

Grout

2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.		
Hydro Investigation/ Proposed Residual Waste Landfill Cheshire, Ohio	Date Started : 04/18/06 Date Completed : 04/26/06 Logged by : M. Begley Reviewed by : M. McCoy Drilling Contractor : Pennsylvania Drilling Drilling Method : S.S., NQ Core, Air Rotary Sampling Method : Split Spoon, Rock Core 2" Total Depth (ft.) : 240.0' S. Water Level Date : Not Measured S. Water Level (ft.) : Not Measured	LOG OF BORING GB-6/MW-3D (Page 5 of 12) G. Elev. (ft. USGS) :
Project Number: APO006		
Project Manager: Steve Gross		

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: MW-3D
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
80							
	10.0/9.1 RQD = 93.1	RC10/32MIN	NA	NA			82.0 to 91.1 - SAA: becoming more competant with depth.
90							
	10.0/9.5 RQD = 75.4	RC11/27MIN	NA	NA			92.0 to 99.0 - SAA: hard mottled dark red, grey purple and light tan, trace fractures.
							99.0 to 99.6 - Hard gray interbedded LIMESTONE and SHALE.
100							

Well construction: Grout; 2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

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Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/18/06
Date Completed	: 04/26/06
Logged by	: M. Begley
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 240.0'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-6/MW-3D

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: MW-3D
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
100					99.6 to 101.5 - Hard reddish brown SHALE, very competent.
	10/.0/10.0 RQD = 80.0	RC12/27MIN	NA	NA	102.0 to 103.5 - SAA.
					103.5 to 106.4 - Hard blueish dark grey fine grain SANDSTONE, few interbedded mications, shale layers, little mica, barding, trace pyrite, fractures noted.
					106.4 to 112.0 - Medium to hard reddish brown SHALE, interbedded with grey shale.
110					
	5.0/5.0 RQD = 44.2	RC13/17MIN	NA	NA	112.0 to 114.9 - SAA: blueish.
					114.9 to 115.5 - Hard grey SILTSTONE.
					115.5 to 117.0 - Hard blueish grey fine grained SANDSTONE, little pyrite nodules, and little mica.
	5.0/4.9 RQD = 89.7	RC14/10MIN	NA	NA	117.0 to 121.9 - SAA: little interbedded grey shale, trace calcite deposits.
120					

Grout

2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

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Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started : 04/18/06
Date Completed : 04/26/06
Logged by : M. Begley
Reviewed by : M. McCoy
Drilling Contractor : Pennsylvania Drilling
Drilling Method : S.S., NQ Core, Air Rotary
Sampling Method : Split Spoon, Rock Core 2"
Total Depth (ft.) : 240.0'
S. Water Level Date : Not Measured
S. Water Level (ft.) : Not Measured

LOG OF BORING GB-6/MW-3D

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: MW-3D
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
120					
	8.5/8.5 RQD = 95.1	RC15/7MIN	NA	NA	122.0 to 128.3 - Hard dark grey SHALE, fractures noted.
					128.3 to 130.5 - Hard grey SANDSTONE with interbedded shale.
130	1.5/1.5 RQD = 100	RC16/	NA	NA	130.5 to 132.0 - SAA: some black mica banding, little pyrite nodules.
	10.0/10.0 RQD = 85.0	RC17/27MIN	NA	NA	132.0 to 133.1 - SAA.
					133.1 to 142.0 - Medium hard to hard grey and reddish brown SHALE, few calcite deposits, little interbedded sandstone.
140					

Grout

2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/ Proposed Residual Waste Landfill Cheshire, Ohio	Date Started : 04/18/06	# LOG OF BORING GB-6/MW-3D
Project Number: APO006	Date Completed : 04/26/06	(Page 8 of 12)
Project Manager: Steve Gross	Logged by : M. Begley	G. Elev. (ft. USGS) :
	Reviewed by : M. McCoy	
	Drilling Contractor : Pennsylvania Drilling	
	Drilling Method : S.S., NQ Core, Air Rotary	
	Sampling Method : Split Spoon, Rock Core 2"	
	Total Depth (ft.) : 240.0'	
	S. Water Level Date : Not Measured	
	S. Water Level (ft.) : Not Measured	

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: MW-3D
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
140							
	5.0/5.0 RQD = 76.7	RC18/17MIN	NA	NA			142.0 to 147.0 - Medium hard to hard grey olive grey and reddish brown SHALE.
	5.0/3.8 RQD = 61.4	RC19/20MIN	NA	NA			147.0 to 150.8 - SAA: mottled olive grey reddish brown.
150							
	10.0/9.7 RQD = 45.5	RC20/31MIN	NA	NA			152.0 to 161.7 - SAA: medium hard turning to soft.
160							

Well construction: Grout; 2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

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Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/18/06
Date Completed	: 04/26/06
Logged by	: M. Begley
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 240.0'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-6/MW-3D

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: MW-3D
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
160							160.0 to 170.8 - SAA: few calcite deposits and grainy fractures noted.
	10.0/8.83 RQD = 59.4	RC21/32MIN	NA	NA			
170							
	9.0/9.0 RQD = 77.8	RC22/29MIN	NA	NA			170.0 to 181.0 - SAA: trace pyrite, trace calcite deposit filled vugs, fractures noted.
180							

Grout

2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

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Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started : 04/18/06
Date Completed : 04/26/06
Logged by : M. Begley
Reviewed by : M. McCoy
Drilling Contractor : Pennsylvania Drilling
Drilling Method : S.S., NQ Core, Air Rotary
Sampling Method : Split Spoon, Rock Core 2"
Total Depth (ft.) : 240.0'
S. Water Level Date : Not Measured
S. Water Level (ft.) : Not Measured

LOG OF BORING GB-6/MW-3D

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: MW-3D
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6")	DESCRIPTION
180					
	4.0/4.0 RQD = 85.4	RC23/12MIN	NA	NA	181.0 to 185.0 - SAA: medium hard light grey and brown.
	2.0/2.0 RQD = 36.7	RC24/10MIN	NA	NA	185.0 to 187.0 - SAA: dark grey with trace reddish brown, trace interbedded soft grey shale @ 185.7 and 185.8.
	5.0/5.0 RQD = 36.7	RC25/17MIN	NA	NA	
190					
	7.0/7.0 RQD = 72.6	RC26/19MIN	NA	NA	192.0 to 196.5 - SAA.
					196.5 to 197.0 - Hard grey LIMESTONE, trace calcite filled vugs.
					197.0 to 199.0 - Medium hard to hard grey SHALE, fractures noted with staining sides.
	3.0/3.0 RQD = 94.4	RC27/8MIN	NA	NA	199.0 to 202.0 - SAA: medium hard to hard dark grey.
200					

Well construction: Grout; 2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

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Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/18/06
Date Completed	: 04/26/06
Logged by	: M. Begley
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 240.0'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-6/MW-3D

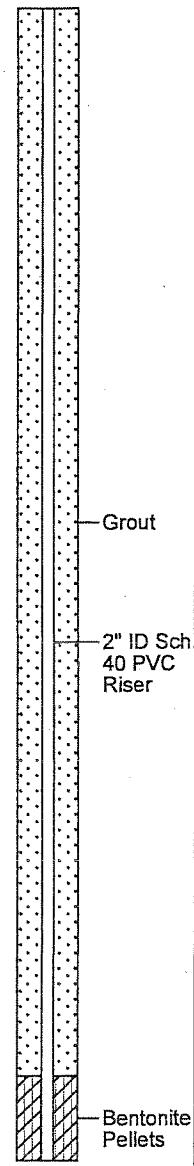
G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: MW-3D
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
200					
	10.0/9.75 RQD = 79.1	RC28/31MIN	NA	NA	202.0 to 211.75 - SAA: medium hard to hard dark grey, little interbedded soft light grey siltstone.
210					
	10.0/10.0 RQD = 96.7	RC29/29MIN	NA	NA	212.0 to 216.6 - SAA: medium hard to hard dark grey.
					216.6 to 222.0 - Medium hard to hard dark grey SHALE, few interbedded grey sandstone, trace interbedded soft grey siltstone.
220					



REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 04/18/06
Date Completed	: 04/26/06
Logged by	: M. Begley
Reviewed by	: M. McCoy
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 240.0'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-6/MW-3D

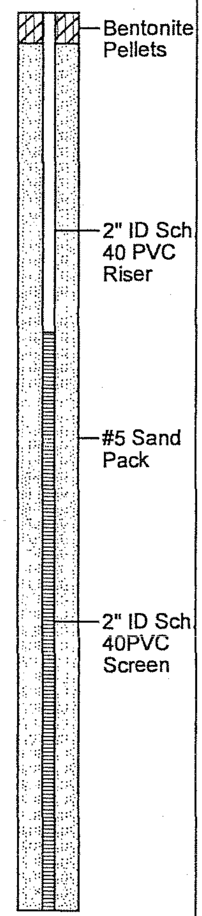
G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: MW-3D
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
220							
	10.0/10.0 RQD = 80.0	RC30/32MIN	NA	NA			222.0 to 227.6 - SAA: medium hard to hard dark grey, trace interbedded grey sandstone beds.
							227.6 to 232.0 - Hard grey coarse SANDSTONE, trace mica banding, trace grey shale interbedding, trace calcite filled vugs.
230							
	8.0/8.0 RQD = 81.3	RC31/24MIN	NA	NA			232.0 to 233.6 - SAA: limestone clasts interbedded in top of foot.
							233.6 to 236.7 - Medium hard to hard grey SHALE, few interbedded grey sandstone.
							236.7 to 239.5 - Soft to medium hard grey and olive brown SHALE.
							239.5 to 240.0 - Hard reddish brown and olive SILTSTONE. End of Boring @ 240.0'.
240							



REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.

Date Started	: 05/05/2006
Date Completed	: 05/05/2006
Logged by	: M. McCoy
Reviewed by	: T. Baehr
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 83.0'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-12/ MW-4

G. Elev. (ft. USGS) :

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

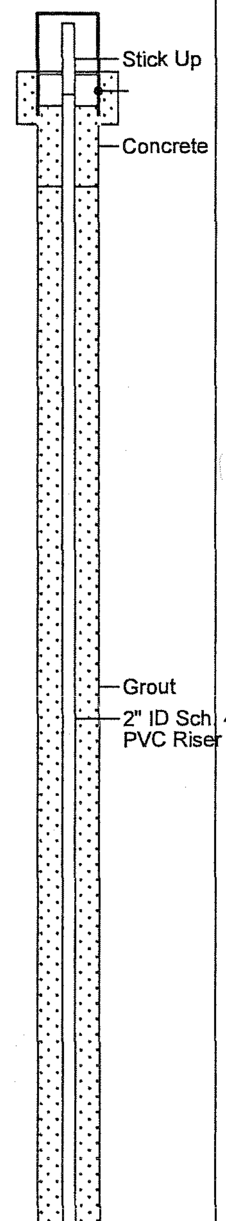
Project Manager: Steve Gross

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
0					See Log of SB010 for more detail.
5.0	2.0/1.2	SP1/SS1	NA	2-2-2-3	5.0 to 5.8 - Soft dark brown/burgundy sandy CLAY, few gravel and ss frags, iron stained, very moist.
5.8					5.8 to 6.2 - Soft grey CLAY, few ss and shale frags, moist, plastic.
10	2.0/1.6	SP2/SS2	NA	2-3-3-5	10.0 to 11.0 - Same As Above (SAA).
11.0					11.0 to 11.5 - Soft blue grey sandy CLAY, little ss frags, little gravel, moist, blue/grey clay in shoe.
15.0	2.0/1.5	SP3/SS3	NA	6-9-7-8	15.0 to 15.5 - Soft to medium stiff blue grey CLAY, trace sand, moist, plastic.
15.5					15.5 to 16.5 - Medium stiff green/grey and brown ss and shale frags in clay matrix, moist.
20					

Well: MW-4
Elev.:



REMARKS:

Borings backfilled with cement-bentonite grout.

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Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 05/05/2006
Date Completed	: 05/05/2006
Logged by	: M. McCoy
Reviewed by	: T. Baehr
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 83.0'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-12/ MW-4

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: MW-4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
20	2.0/1.4	SP4/SS4	NA	6-4-6-8	20.0 to 21.4 - Soft to medium stiff blue grey silty CLAY, trace ss and shale frags, moist, plastic, ss and shale in clay matrix in shoe.
	2.0/0.5	SP5/SS5	NA	52/4	25.0 to 25.5 - Very hard blue grey SHALE.
30	2.6/2.6	SP6/SS6	NA	NA	29.9 to 30.3 - Hard blue grey fine grained SANDSTONE.
					30.3 to 31.5 - Soft grey SILTSTONE to SHALE.
					31.5 to 32.5 - Hard blue grey fine grained SILTSTONE, moderate weathered.
	10.0/10.0 RQD = 76.2	RC1/10MIN	NA	NA	32.5 to 35.3 - SAA.
					35.3 to 36.5 - Hard blue grey medium grained SANDSTONE, moderate weathered.
					36.5 to 42.5 - Hard blue grey SILTSTONE.
40					

Grout

2" ID Sch. 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 05/05/2006
Date Completed	: 05/05/2006
Logged by	: M. McCoy
Reviewed by	: T. Baehr
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 83.0'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-12/ MW-4

G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: MW-4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	DESCRIPTION
40					
	10.0/10.0 RQD = 92.3	RC2/15MIN	NA	NA	42.5 to 43.5 - SAA: grades to hard shale.
					43.5 to 52.5 - Hard blue grey and burgundy SHALE, moderate weathered, soft below 49.0'. Frac at 49.0'.
50					
	10.0/10.0 RQD = 74.2	RC3/13MIN	NA	NA	52.5 to 57.2 - SAA.
					57.2 to 62.5 - Hard blue grey fine and medium grained SANDSTONE, moderate weathered micaceous laminations, calcite inclusions.
60					

Grout

2" ID Sch 40 PVC Riser

REMARKS:

Borings backfilled with cement-bentonite grout.

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Hull & associates, inc.

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Date Started	: 05/05/2006
Date Completed	: 05/05/2006
Logged by	: M. McCoy
Reviewed by	: T. Baehr
Drilling Contractor	: Pennsylvania Drilling
Drilling Method	: S.S., NQ Core, Air Rotary
Sampling Method	: Split Spoon, Rock Core 2"
Total Depth (ft.)	: 83.0'
S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-12/ MW-4

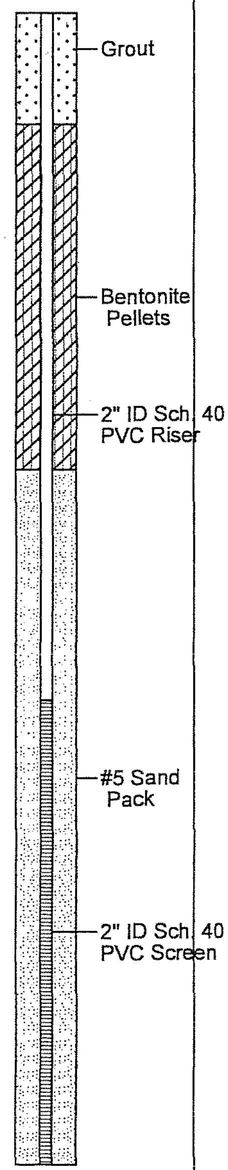
G. Elev. (ft. USGS) :

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: MW-4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
60							
	10.0/10.0 RQD = NM	RC4/6MIN	NA	NA			62.5 to 72.5 - SAA: coarse grained below 65.0'.
70							
	10.0/10.0 RQD = 100	RC5/7MIN	NA	NA			72.5 to 82.5 - Hard, grey, coarse grained SANDSTONE, calcitic cement, trace micas.
80							



REMARKS:

Borings backfilled with cement-bentonite grout.

Hull & associates, inc.

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S. Water Level Date	: Not Measured
S. Water Level (ft.)	: Not Measured

LOG OF BORING GB-12/ MW-4

G. Elev. (ft. USGS) :

Hydro Investigation/
Proposed Residual Waste Landfill
Cheshire, Ohio

Project Number: APO006

Project Manager: Steve Gross

Soil Samples: Sampled Interval; Sample sent to lab.

Water Levels: Static; During Drilling

Well: MW-4
Elev.:

Depth in Feet	Sample Interval/ Sample Recovery	Sampler Type/ Sample Number	PID / FID (ppm)	Blow Count (6"-6"-6"-6")	Samples	GRAPHIC	DESCRIPTION
80							
	0.5/0.5 RQD = 80	RC6/	NA	NA			82.5 to 83.0 - Medium hard, light grey and light tan SHALE.
							EOB @ 83.0' bgs.
90							
100							

#5 Sand Pack
2" ID Sch. 40 PVC Screen

REMARKS:

Borings backfilled with cement-bentonite grout.

BORING NO. KC-15-01
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant – Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	8-4-15 to 8-5-15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt. NA	and Drop NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water
Sampling Interval:	NA	Borehole Depth:	72’	Surface Elevation:	579.77’ MSL

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-58	8	NA	Orange brown clayey sand, fine to medium, wet	N/A
58-60	2	NA	Gray sand, fine to medium, trace silt, wet	N/A
60-72	10	NA	Brown sand, fine to medium, gravel, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-01

Project Number: 2015079

Project Location: Kyger Creek Plant – Boiler Slag Pond

Installation Date(s): 8/5/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 8-18-15 and 8-26-15

Development Method: Submersible Pump
Field parameters stabilized.
Turbidity = 1.64 NTUs

Volume Purged: 245 gallons

Static Water-Level* 39.35’

Top of Well Casing Elevation: 579.20’

Well Purpose:
Groundwater Monitoring
Northing (Y): 332114.55
Easting (X): 2072393.84

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

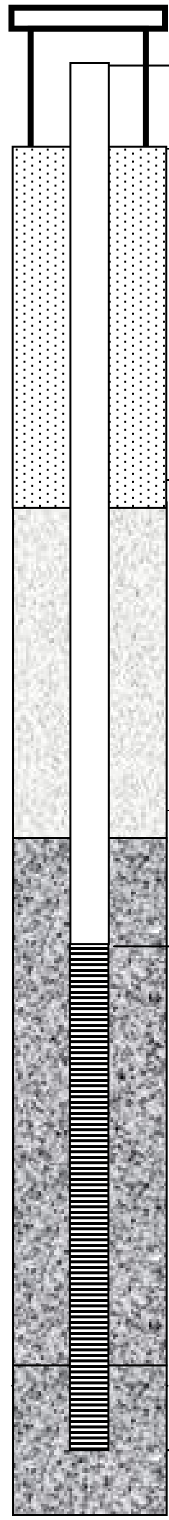
CONSTRUCTION MATERIALS USED:

4 Bags of Sand

2 Bags/Buckets Bentonite Pellets

7.5 Bags Portland for Grout

______ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 579.20 ft.
Stick-up: -0.57 ft.

Land Surface Elevation: 579.77 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 54 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 58 ft*

Top of Well Screen 60 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 70 ft.*

Base of Borehole: 72 ft.*

Total Depth of Well Below Top of Casing: 69.43 ft.

*Indicates Depth Below Land Surface

BORING NO. _____KC-15-02__
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	8-5-15 to 8/7/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	72’	Surface Elevation:	580.79’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-58	8	NA	Orange brown clayey sand, fine to medium, wet	N/A
58-60	2	NA	Orange brown sand, fine to medium, trace silt, wet	N/A
60-72	10	NA	Orange brown sand, fine to medium, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-02

Project Number: 2015079

Project Location: Kyger Creek Plant – Boiler Slag Pond

Installation Date(s): 8/7/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 8/18/15

Development Method: Submersible Pump
Field parameters stabilized.
Turbidity = 2.44 NTUs

Volume Purged: 311 gallons

Static Water-Level* 40.16’

Top of Well Casing Elevation: 580.25’

Well Purpose:
Groundwater Monitoring
Northing (Y): 332500.654
Easting (X): 2072569.222

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

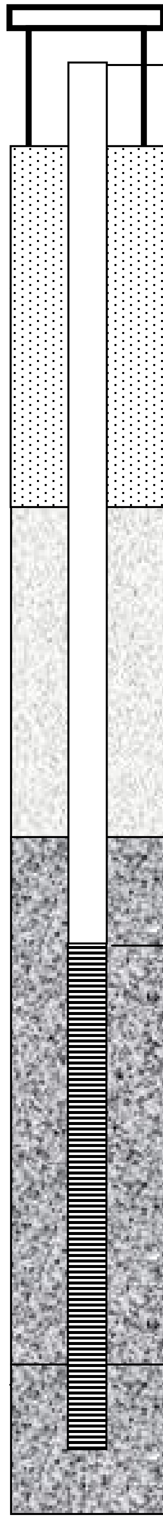
CONSTRUCTION MATERIALS USED:

4 Bags of Sand

2 Bags/Buckets Bentonite Pellets

7.5 Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 580.25 ft.
Stick-up: -0.54 ft.

Land Surface Elevation: 580.79 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 54 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 58 ft*

Top of Well Screen 60 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 70 ft.*

Base of Borehole: 72 ft.*

Total Depth of Well
Below Top of Casing: 69.46 ft.

*Indicates Depth Below Land Surface

BORING NO. KC-15-03
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	8-13-15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	70’	Surface Elevation:	582.03’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-60	10	NA	Orange brown clay, with fine to medium sand, silt, moist	N/A
60-70	10	NA	Orange brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-03

Project Number: 2015079

Project Location: Kyger Creek Plant – Boiler Slag Pond

Installation Date(s): 8/13/15

Drilling Method: Roto-Sonic

Drilling Contractor: Bowser Morner

Development Date(s): 8/18/2015

Development Method: Submersible Pump

Field Parameters stabilized.

Turbidity = 4.89 NTUs

Volume Purged: 230 gallons

Static Water-Level* 40.45'

Top of Well Casing Elevation: 581.55'

Well Purpose:

Groundwater Monitoring

Northing (Y): 332546.402

Easting (X): 2073001.342

Comments/Notes:

2 inch PVC riser and screen

10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

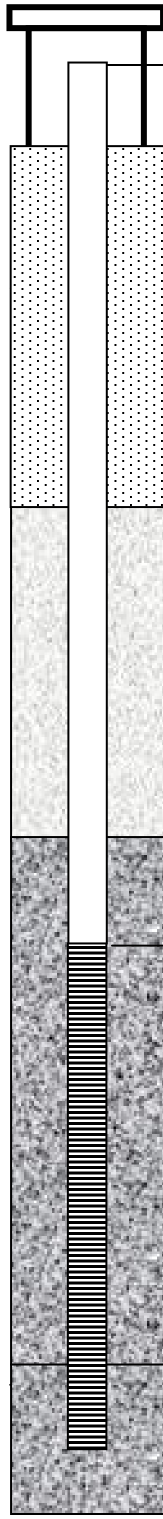
CONSTRUCTION MATERIALS USED:

6 Bags of Sand

2 Bags/Buckets Bentonite Pellets

12 Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 581.55 ft.

Stick-up: -0.48 ft.

Land Surface Elevation: 582.03 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6" inch

Casing Diameter: 2 Inch

Casing Material: PVC

Top of Seal: 56 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 60 ft*

Top of Well Screen 62 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch

Screen Slot-Size: 0.010 Inch

Screen Material: PVC

Bottom of Well Screen 72 ft.*

Base of Borehole: 72 ft.*

Total Depth of Well Below Top of Casing: 71.52 ft.

*Indicates Depth Below Land Surface

BORING NO. ____KC-15-04__
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	8-12-15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA and Drop NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water
Sampling Interval:	NA	Borehole Depth:	70’	Surface Elevation:	579.89’ MSL

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-55	10	NA	Orange brown clay, fine to medium sand, silt, moist	N/A
55-58	3	NA	Clayey sand, fine to medium, moist	N/A
58-68	10	NA	Orange brown sand and cobbles, fine to medium, trace silt, wet	N/A
68-70	2	NA	Gray bown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-04

Project Number: 2015079

Project Location: Kyger Creek Plant – Boiler Slag Pond

Installation Date(s): 8/12/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 8/19/2015 & 8/26/2015

Development Method: Submersible Pump
Field parameters stabilized.
Turbidity = 4.02 NTUs

Volume Purged: 285.5’

Static Water-Level* 40.17’

Top of Well Casing Elevation: 579.37’

Well Purpose:
Groundwater Monitoring
Northing (Y): 331782.439
Easting (X): 2073755.607

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

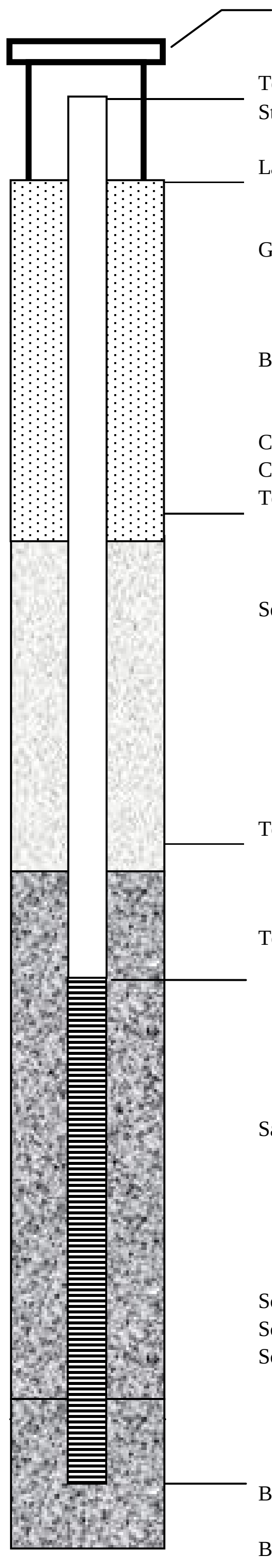
CONSTRUCTION MATERIALS USED:

5.5 Bags of Sand

2 Bags/Buckets Bentonite Pellets

24 Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 579.37 ft.
Stick-up: -0.52 ft.

Land Surface Elevation: 579.89 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6” inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 54 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 58 ft*

Top of Well Screen 60 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 70 ft.*

Base of Borehole: 72 ft.*

Total Depth of Well Below Top of Casing: 69.48 ft.

*Indicates Depth Below Land Surface

BORING NO. KC-15-05
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	8-18-15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	70”	Surface Elevation:	580.52’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-54	4	NA	Brown gray clay, fine sand, trace silt, moist	N/A
54-58	2	NA	Orange brown clay, fine sand, trace silt, moist	N/A
58-70	8	NA	Orange brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-05

Project Number: 2015079

Project Location: Kyger Creek Plant – Boiler Slag Pond

Installation Date(s): 8/20/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s):

Development Method: Submersible Pump
Field Parameters stabilized
Turbidity = 1.52 NTUs

Volume Purged: 222 gallons

Static Water-Level* 42.20’

Top of Well Casing Elevation: 580.07’

Well Purpose:
Groundwater Monitoring
Northing (Y): 331569.994
Easting (X): 2073574.832

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

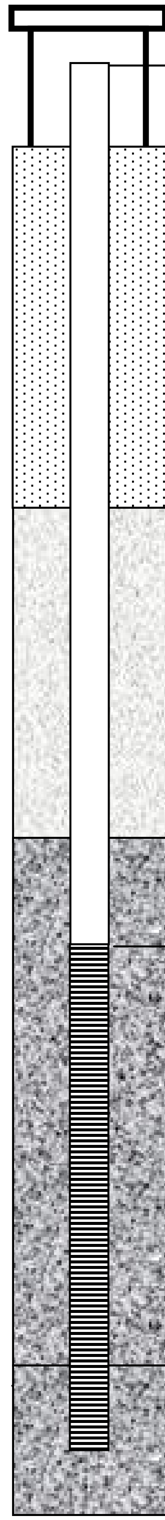
CONSTRUCTION MATERIALS USED:

5.5 Bags of Sand

2 Bags/Buckets Bentonite Pellets

9 Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 580.07 ft.
Stick-up: -0.45 ft.

Land Surface Elevation: 580.52 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6” inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 54 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 58 ft*

Top of Well Screen 60 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 70 ft.*

Base of Borehole: 70 ft.*

Total Depth of Well
Below Top of Casing: 69.55 ft.

*Indicates Depth Below Land Surface

BORING NO. KC-15-06
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	8-17-15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	70’	Surface Elevation:	579.98’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-60	10	NA	Orange brown clayey sand, trace silt, fine to medium, moist	N/A
58-60	2	NA	Orange brown sand, fine to medium, trace silt, wet	N/A
60-68	8	NA	Orange brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
68-70	1	NA	Light brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-06

Project Number: 2015079

Project Location: Kyger Creek Plant – Boiler Slag Pond

Installation Date(s): 8/20/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 8/20/15

Development Method: Submersible Pump
Field Parameters stabilized.
Turbidity = 0.98 NTUs

Volume Purged: 214 gallons

Static Water-Level* 42.02’

Top of Well Casing Elevation: 579.48’

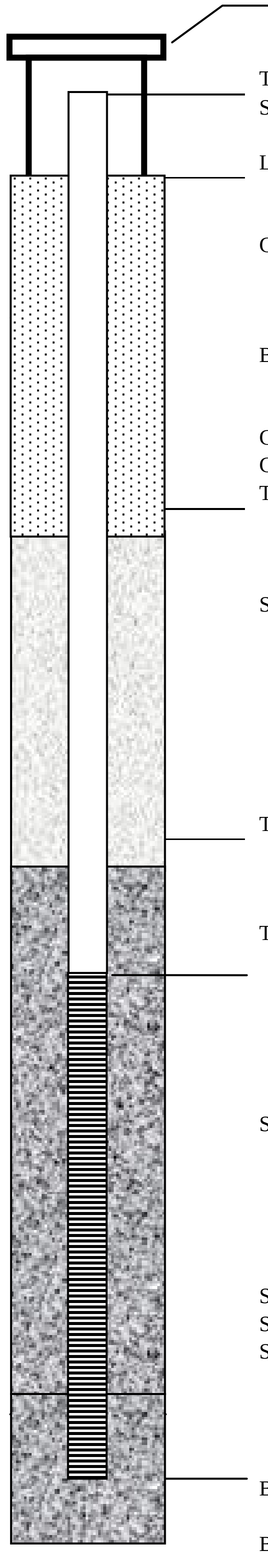
Well Purpose:
Groundwater Monitoring
Northing (Y): 331218.52
Easting (X): 2073210.42

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

CONSTRUCTION MATERIALS USED:

5	Bags of Sand
2	Bags/Buckets Bentonite Pellets
9	Bags Portland for Grout
	Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 579.48 ft.
Stick-up: -0.5 ft.

Land Surface Elevation: 579.98 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6” inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 54 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 58 ft*

Top of Well Screen 60 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 70 ft.*

Base of Borehole: 70 ft.*

Total Depth of Well Below Top of Casing: 69.50 ft.

*Indicates Depth Below Land Surface

BORING NO. _____KC-15-07__
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	8-11-15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt. NA	and Drop NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water
Sampling Interval:	NA	Borehole Depth:	80’	Surface Elevation:	578.54’ MSL

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-60	10	NA	Brown gray clayey silt, moist	N/A
60-68	8	NA	Brown gray clay, trace silt, moist	N/A
68-80	12	NA	Brown gray sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-07

Project Number: 2015079

Project Location: Kyger Creek Plant – Boiler Slag Pond

Installation Date(s): 8/10/15

Drilling Method: Roto-Sonic

Drilling Contractor: Bowser Morner

Development Date(s): 8/19/15

Development Method: Submersible Pump

Field parameters stabilized

Turbidity = 4.06 NTUs

Volume Purged: 220 gallons

Static Water-Level*: 39.45’

Top of Well Casing Elevation: 578.04’

Well Purpose:

Groundwater Monitoring

Northing (Y): 331291.75

Easting (X): 2072957.79

Comments/Notes:

2 inch PVC riser and screen

10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

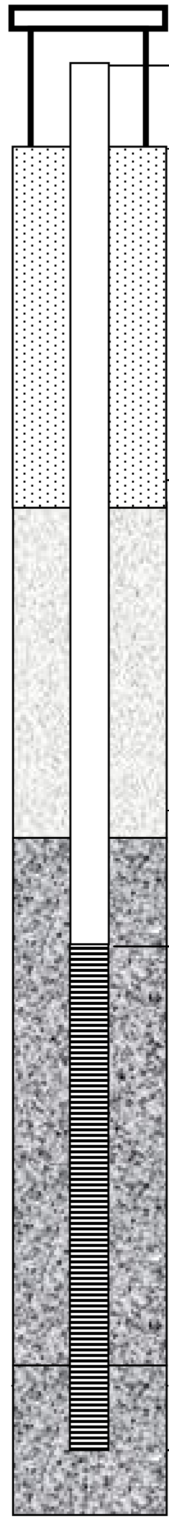
CONSTRUCTION MATERIALS USED:

6 Bags of Sand

2 Bags/Buckets Bentonite Pellets

45 Small Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 578.04 ft.

Stick-up: -0.5 ft.

Land Surface Elevation: 578.54 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6” inch

Casing Diameter: 2 Inch

Casing Material: PVC

Top of Seal: 64 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 68 ft*

Top of Well Screen 70 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch

Screen Slot-Size: 0.010 Inch

Screen Material: PVC

Bottom of Well Screen 80 ft.*

Base of Borehole: 82 ft.*

Total Depth of Well Below Top of Casing: 79.50 ft.

*Indicates Depth Below Land Surface

BORING NO. KC-15-08
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant Boiler Slag Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	8-10-15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	80’	Surface Elevation:	579.41 MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-60	10	NA	Orange brown clayey sand, fine to medium, wet	N/A
60-68	8	NA	Brown gray clay, shell fragments, trace silt	N/A
68-80	12	NA	Brown gray sand, fine to medium, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-08

Project Number: 2015079

Project Location: Kyger Creek Plant West Boiler Slag Pond

Installation Date(s): 8/10/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 8/18/15

Development Method: Submersible Pump
Field parameters stabilized
Turbidity = 2.25 NTUs

Volume Purged: 225 gallons

Static Water-Level*: 39.35’

Top of Well Casing Elevation: 578.75’

Well Purpose:
Groundwater Monitoring
Northing (Y): 331460.59
Easting (X): 2072675.87

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

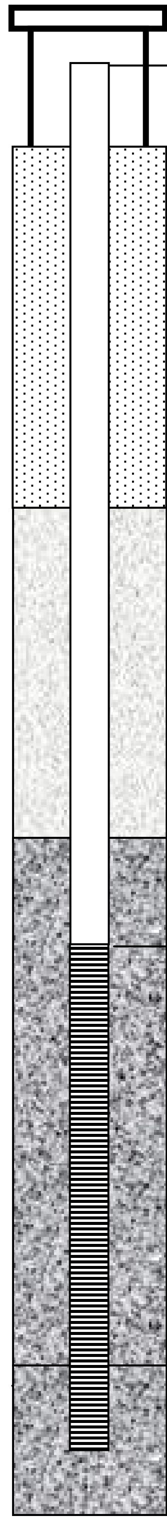
CONSTRUCTION MATERIALS USED:

5.5 Bags of Sand

2 Bags/Buckets Bentonite Pellets

15 Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 578.75 ft.
Stick-up: -0.66 ft.

Land Surface Elevation: 579.41 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6” inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 64 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 68 ft*

Top of Well Screen 70 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 80 ft.*

Base of Borehole: 82 ft.*

Total Depth of Well Below Top of Casing: 79.34 ft.

*Indicates Depth Below Land Surface

BORING NO. _____KC-15-09 _
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1	of	1
Project Location:	Kyger Creek Plant- South Fly Ash Pond	Drilling Contractor:	Bowser Morner		
Drilling Date(s):	9/11/15 to 9/14/15	AGES Geologist:	Mike Gelles		

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	81’	Surface Elevation:	587.85’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-60	10	NA	Gray silty clay with shell fragments, moist	N/A
60-69	9	NA	Gray silty clay with shell fragments, moist	N/A
69-81	4	NA	Gray sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-09

Project Number: 2015079

Project Location: Kyger Creek Plant – South Fly Ash Pond

Installation Date(s): 9/14/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 9/23/15

Development Method: Submersible Pump
Field parameters stabilized.
Turbidity = 4.89 NTUs

Volume Purged: 223 gallons

Static Water-Level*: 46.43’

Top of Well Casing Elevation: 587.47’

Well Purpose:
Groundwater Monitoring
Northing (Y): 334631.959
Easting (X): 2072494.446

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre=packed well screen with an inner filter pack of 0.40 mm clean quarts sand and an outer layer of food grade nylon mesh.

Inspector: Michael Gelles

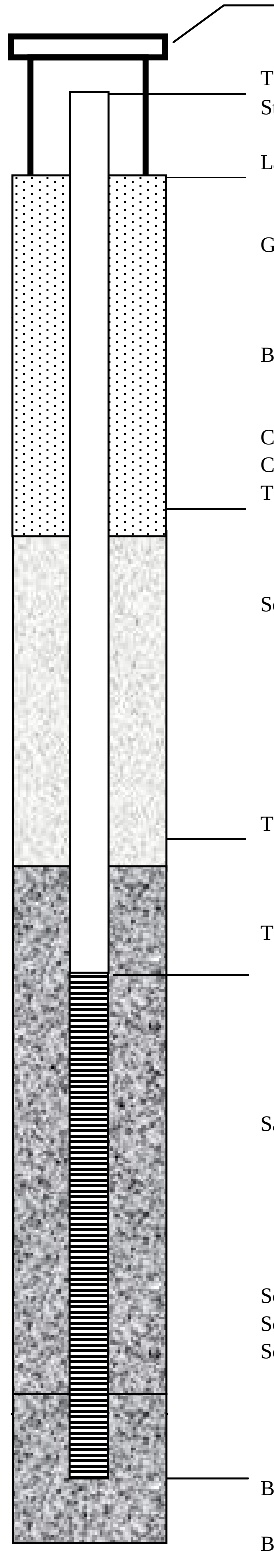
CONSTRUCTION MATERIALS USED:

6 Bags of Sand

2 Bags/Buckets Bentonite Pellets

12 Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 587.47 ft.
Stick-up: -0.38 ft.

Land Surface Elevation: 587.85 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 65 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 69 ft*

Top of Well Screen 71 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 81 ft.*

Base of Borehole: 81 ft.*

Total Depth of Well
Below Top of Casing: 80.62 ft.

*Indicates Depth Below Land Surface

BORING NO. _____KC-15-10 _
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant South Fly Ash Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	9/15/15 to 9/16/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	74”	Surface Elevation:	587.75’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-60	10	NA	Gray silty clay, moist	N/A
60-67	7	NA	Brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
67-74	4	NA	Gray sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-10

Project Number: 2015079

Project Location: Kyger Creek Plant – South Fly Ash Pond

Installation Date(s): 9/16/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 9/23/15

Development Method: Submersible Pump
Field parameters stabilized
Turbidity = 3.82 NTUs

Volume Purged: 295 gallons

Static Water-Level* 46.51’

Top of Well Casing Elevation: 587.45’

Well Purpose:
Groundwater Monitoring
Northing (Y): 335018.949
Easting (X): 20272695.744

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

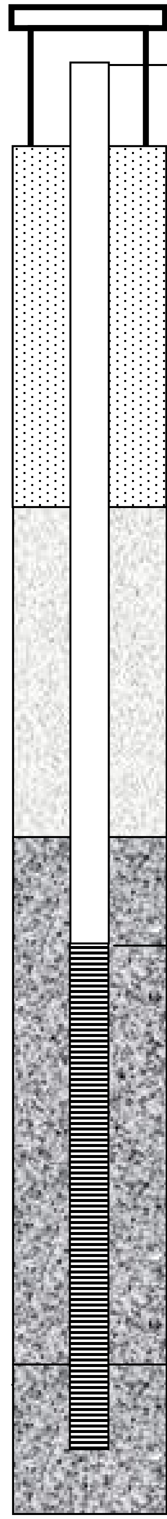
CONSTRUCTION MATERIALS USED:

5.5 Bags of Sand

2 Bags/Buckets Bentonite Pellets

12 Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 587.45 ft.
Stick-up: -0.3 ft.

Land Surface Elevation: 587.75 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6” inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 58 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 62 ft*

Top of Well Screen 64 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 74 ft.*

Base of Borehole: 74 ft.*

Total Depth of Well
Below Top of Casing: 73.70 ft.

*Indicates Depth Below Land Surface

BORING NO. _____SFAP-B-1/KC-15-11 _
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant South Fly Ash Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	8/20/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA and Drop NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water
Sampling Interval:	NA	Borehole Depth:	74”	Surface Elevation:	588.07’ MSL

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-60	10	NA	Brown gray clay, silt, shell fragments, moist	N/A
60-70	5	NA	Orange brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
70-74	2	NA	Gray brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-11

Project Number: 2015079

Project Location: Kyger Creek Plant South Fly Ash Pond

Installation Date(s): 8/20/15

Drilling Method: Roto-Sonic

Drilling Contractor: Bowser Morner

Development Date(s): 8/25/15

Development Method: Submersible Pump

Field parameters stabilized.

Turbidity = 0.87 NTUs

Volume Purged: 242 gallons

Static Water-Level*: 46.07’

Top of Well Casing Elevation: 587.71’

Well Purpose:

Groundwater Monitoring

Northing (Y): 335428.144

Easting (X): 2072970.304

Comments/Notes:

2 inch PVC riser and screen

10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

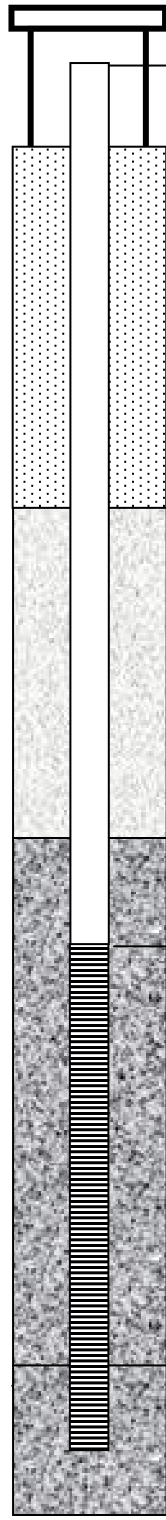
CONSTRUCTION MATERIALS USED:

6.5 Bags of Sand

2 Bags/Buckets Bentonite Pellets

9 Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 587.71 ft.

Stick-up: -0.36 ft.

Land Surface Elevation: 588.07 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6” inch

Casing Diameter: 2 Inch

Casing Material: PVC

Top of Seal: 58 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 62 ft*

Top of Well Screen 64 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch

Screen Slot-Size: 0.010 Inch

Screen Material: PVC

Bottom of Well Screen 74 ft.*

Base of Borehole: 74 ft.*

Total Depth of Well Below Top of Casing: 73.64 ft.

*Indicates Depth Below Land Surface

BORING NO. _ ____KC-15-12 _
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant South Fly Ash Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	9/15/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt. NA	and Drop NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water
Sampling Interval:	NA	Borehole Depth:	74’	Surface Elevation:	588.40’ MSL

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-55	5	NA	Gray silty clay, moist	N/A
55-60	5	NA	Brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
60-66	6	NA	Brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
66-74	5	NA	Gray sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-12

Project Number:	2015079
Project Location:	Kyger Creek Plant South Fly Ash Pond
Installation Date(s):	9/17/15
Drilling Method:	Roto-Sonic
Drilling Contractor:	Bowser Morner
Development Date(s):	9/22/15
Development Method:	Submersible Pump

Field Parameters stabilized.
Turbidity = 2.41 NTUs

Volume Purged:	245 gallons
Static Water-Level*	46.64’
Top of Well Casing Elevation:	587.94’

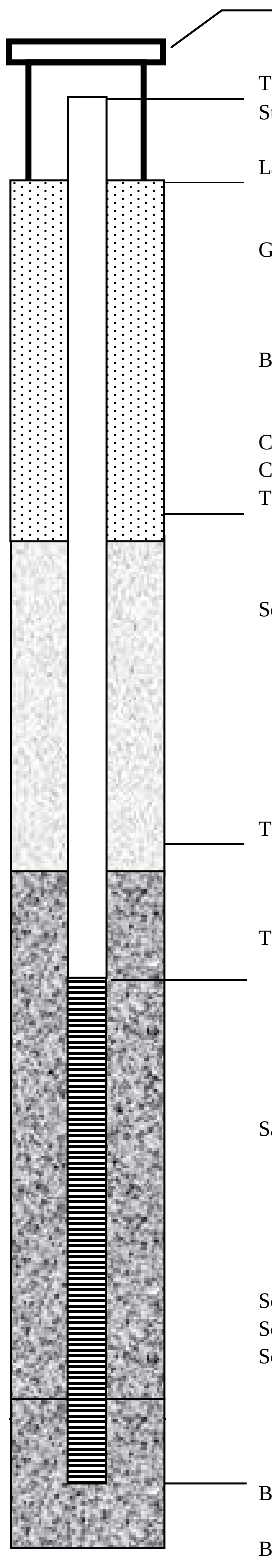
Well Purpose:
Groundwater Monitoring
Northing (Y): 335867.034
Easting (X): 2073268.666

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

CONSTRUCTION MATERIALS USED:

5	Bags of Sand
2	Bags/Buckets Bentonite Pellets
12	Bags Portland for Grout
	Bags Concrete/Sakrete



Top of Casing Elevation: 587.94 ft.
Stick-up: -0.46 ft.
Land Surface Elevation: 588.40 ft.
Grout; Type: Portland cement/ Grout
Borehole Diameter: 6” inch
Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 58 ft*
Seal Type: Bentonite Pellets/Chips
Top of Sand/Gravel Pack: 62 ft*
Top of Well Screen 64 ft*
Sand/Gravel Pack; Type: Global #5
Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC
Bottom of Well Screen 74 ft.*
Base of Borehole: 74 ft.*
Total Depth of Well Below Top of Casing: 73.54 ft.

*Indicates Depth Below Land Surface

BORING NO. KC-15-13
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant South Fly Ash Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	8/31/15 to 9/1/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	77’	Surface Elevation:	588.23’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-60	10	NA	Gray brown clay with silt, moist	N/A
60-65	5	NA	Gray brown clay with silt, moist	N/A
65-67	2	NA	Gray sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
67-74	2	NA	Brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
74-77	3	NA	Brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-13

Project Number: 2015079

Project Location: Kyger Creek Plant South Fly Ash Pond

Installation Date(s): 9/1/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 9/3/15

Development Method: Submersible Pump
Field Parameters stabilized.
Turbidity = 4.69 NTUs

Volume Purged: 220 gallons

Static Water-Level* 45.09’

Top of Well Casing Elevation: 587.86’

Well Purpose:
Groundwater Monitoring
Northing (Y): 336047.047
Easting (X): 2073665.155

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

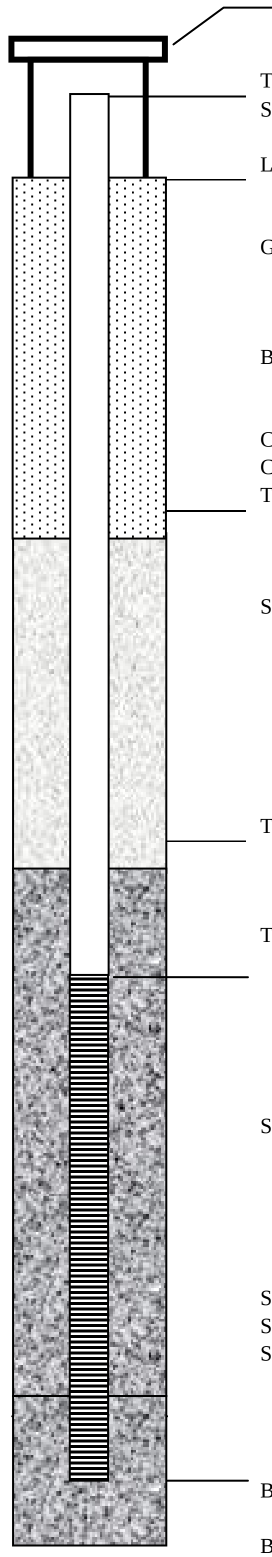
CONSTRUCTION MATERIALS USED:

7 Bags of Sand

2 Bags/Buckets Bentonite Pellets

24 Bags Portland for Grout

_____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 587.86 ft.
Stick-up: -0.27 ft.

Land Surface Elevation: 588.23 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6” inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 61 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 65 ft*

Top of Well Screen 67 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 77 ft.*

Base of Borehole: 77 ft.*

Total Depth of Well Below Top of Casing: 76.73 ft.

*Indicates Depth Below Land Surface

BORING NO. _____KC-15-14__
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant South Fly Ash Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	8/19/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	74’	Surface Elevation:	588.85’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-60	10	NA	Gray brown clay, sand silt, moist	N/A
60-64	4	NA	Gray brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
64-74	8	NA	Orange brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-14

Project Number: 2015079

Project Location: Kyger Creek Plant South Fly Ash Pond

Installation Date(s): 8/19/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 8/21/15

Development Method: Submersible Pump
Field Parameters stabilized.
Turbidity = 1.20 NTUs

Volume Purged: 267 gallons

Static Water-Level* 43.19’

Top of Well Casing Elevation: 587.80

Well Purpose:
Groundwater Monitoring
Northing (Y): 335808.537
Easting (X): 2074057.138

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

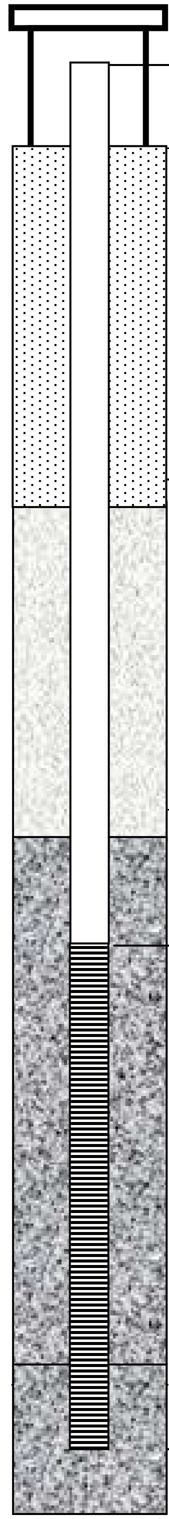
CONSTRUCTION MATERIALS USED:

6 Bags of Sand

2 Bags/Buckets Bentonite Pellets

11 Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 587.80 ft.
Stick-up: -1.05 ft.

Land Surface Elevation: 588.85 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6” inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 58 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 62 ft*

Top of Well Screen 64 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 74 ft.*

Base of Borehole: 74 ft.*

Total Depth of Well Below Top of Casing: 72.95 ft.

*Indicates Depth Below Land Surface

BORING NO. KC-15-15
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant South Fly Ash Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	9/1/15 to 9/2/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt. NA	and Drop NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water
Sampling Interval:	NA	Borehole Depth:	74’	Surface Elevation:	587.95’ MSL

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-59	7	NA	Orange brown silty clay with sand, fine to medium, moist	N/A
59-74	9	NA	Orange brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-15

Project Number: 2015079

Project Location: Kyger Creek Plant South Fly Ash Pond

Installation Date(s): 8/31/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 9/3/15

Development Method: Submersible Pump
Field Parameter Stabilized
Turbidity = 2.59 NTUs

Volume Purged: 225 gallons

Static Water-Level* 46.40’

Top of Well Casing Elevation: 587.63’

Well Purpose:
Groundwater Monitoring
Northing (Y): 335558.54
Easting (X): 2074472.666

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

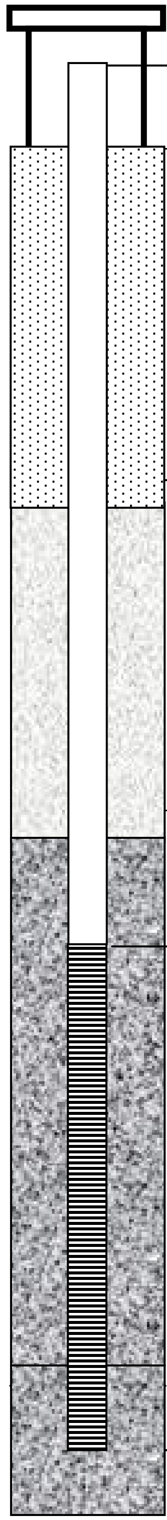
CONSTRUCTION MATERIALS USED:

5 Bags of Sand

2 Bags/Buckets Bentonite Pellets

24 Bags Portland for Grout

___ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 587.63 ft.
Stick-up: -0.32 ft.

Land Surface Elevation: 587.95 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6” inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 58 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 62 ft*

Top of Well Screen 64 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 74 ft.*

Base of Borehole: 74 ft.*

Total Depth of Well
Below Top of Casing: 73.68 ft.

*Indicates Depth Below Land Surface

BORING NO. KC-15-16
SAMPLE/CORE LOG

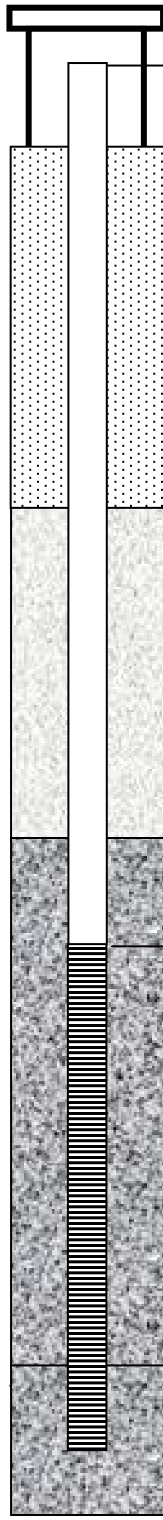
Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant South Fly Ash Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	9/2/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	74’	Surface Elevation:	588.82’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-56	6	NA	Orange brown silty clay with sand, fine to medium, moist	N/A
56-60	4	NA	Gray silty clay with sand, fine to medium, moist	N/A
60-74	11	NA	Orange brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-16



Project Number: 2015079

Project Location: Kyger Creek Plant South Fly Ash Pond

Installation Date(s): 9/2/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 9/4/15

Development Method: Submersible Pump
Field Parameters stabilized.
Turbidity = 0.64 NTUs

Volume Purged: 215 gallons

Static Water-Level* 46.75’

Top of Well Casing Elevation: 588.38’

Well Purpose:
Groundwater Monitoring
Northing (Y): 335223.916
Easting (X): 2074799.53

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

CONSTRUCTION MATERIALS USED:

5 Bags of Sand

2 Bags/Buckets Bentonite Pellets

12 Bags Portland for Grout

___ Bags Concrete/Sakrete

Top of Casing Elevation: 588.38 ft.
Stick-up: -0.5 ft.

Land Surface Elevation: 588.82 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6” inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 58 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 62 ft*

Top of Well Screen 64 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 74 ft.*

Base of Borehole: 74 ft.*

Total Depth of Well
Below Top of Casing: 73.50 ft.

*Indicates Depth Below Land Surface

BORING NO. KC-15-17
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek- South Fly Ash Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	9/3/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	74’	Surface Elevation:	588.68’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-57	7	NA	Orange brown clay with silt and sand, fine to medium, moist	N/A
57-59	2	NA	Gray clay with silt and sand, fine to medium, moist	N/A
59-74	9	NA	Orange brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-17

Project Number: 2015079

Project Location: Kyger Creek Plant South Fly Ash Pond

Installation Date(s): 9/3/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 9/21/15

Development Method: Submersible Pump
Field Parameters stabilized.
Turbidity = 2.90 NTUs

Volume Purged: 232 gallons

Static Water-Level* 47.44'

Top of Well Casing Elevation: 588.13'

Well Purpose:
Groundwater Monitoring
Northing (Y): 334881.253
Easting (X): 2074480.308

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

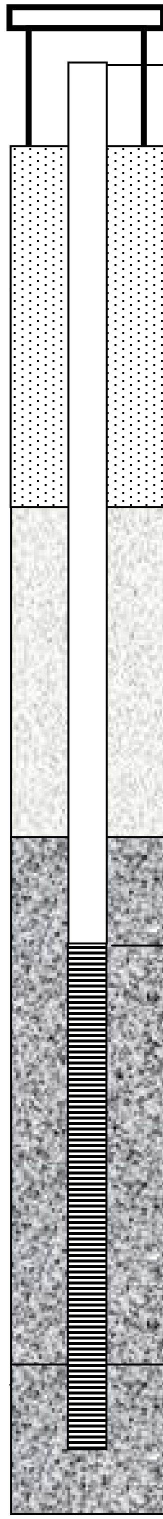
CONSTRUCTION MATERIALS USED:

5 Bags of Sand

2 Bags/Buckets Bentonite Pellets

12 Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 588.13 ft.
Stick-up: -0.55 ft.

Land Surface Elevation: 588.68 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 58 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 62 ft*

Top of Well Screen 64 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 74 ft.*

Base of Borehole: 74 ft.*

Total Depth of Well
Below Top of Casing: 73.45 ft.

*Indicates Depth Below Land Surface

BORING NO. SFAP-B-2/KC-15-18
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant South Fly Ash Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	8/24/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt. NA	and Drop NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water
Sampling Interval:	NA	Borehole Depth:	74’	Surface Elevation:	588.27’ MSL

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-56	6	NA	Orange brown clay, silt, moist	N/A
56-60	4	NA	Gray clay, silt, moist	N/A
60-74	14	NA	Orange brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-18

Project Number: 2015079

Project Location: Kyger Creek Plant South Fly Ash Pond

Installation Date(s): 8/25/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 8/26/15

Development Method: Submersible Pump
Field Parameters stabilized
Turbidity = 2.39 NTUs

Volume Purged: 206 gallons

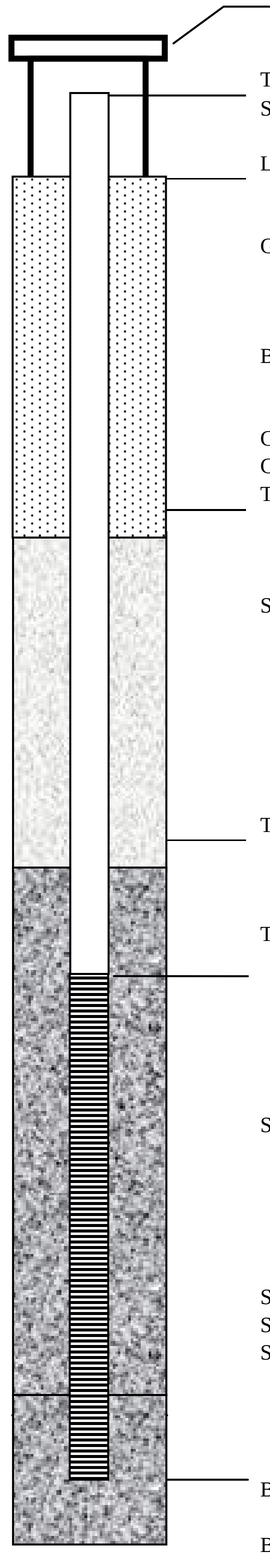
Static Water-Level* 32.66'

Top of Well Casing Elevation: 587.72'

Well Purpose:
Groundwater Monitoring
Northing (Y): 334507.455
Easting (X): 2074126.888

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles



Protective Casing with Locking Cap

Top of Casing Elevation: 587.72 ft.
Stick-up: -0.55 ft.

Land Surface Elevation: 588.27 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 58 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 62 ft*

Top of Well Screen 64 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 74 ft.*

Base of Borehole: 74 ft.*

Total Depth of Well
Below Top of Casing: 73.45 ft.

*Indicates Depth Below Land Surface

CONSTRUCTION MATERIALS USED:

6 Bags of Sand

2 Bags/Buckets Bentonite Pellets

9 Bags Portland for Grout

___ Bags Concrete/Sakrete

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BORING NO. KC-15-19
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant South Fly Ash Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	9/8/15 to 9/9/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA and Drop NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water
Sampling Interval:	NA	Borehole Depth:	74’	Surface Elevation:	588.47’ MSL

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-56	6	NA	Orange brown clay with sand, fine to medium, silt, moist	N/A
56-60	4	NA	Gray clay with sand, fine to medium, silt, moist	N/A
60-74	11	NA	Orange brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-19

Project Number: 2015079

Project Location: Kyger Creek Plant, South Fly Ash Pond

Installation Date(s): 8/31/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 9/21/15

Development Method: Submersible Pump
Field Parameters stabilized.
Turbidity = 3.17 NTUs

Volume Purged: 317 gallons

Static Water-Level*: 43.76'

Top of Well Casing Elevation: 588.18'

Well Purpose:
Groundwater Monitoring
Northing (Y): 334132.454
Easting (X): 2073771.27

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

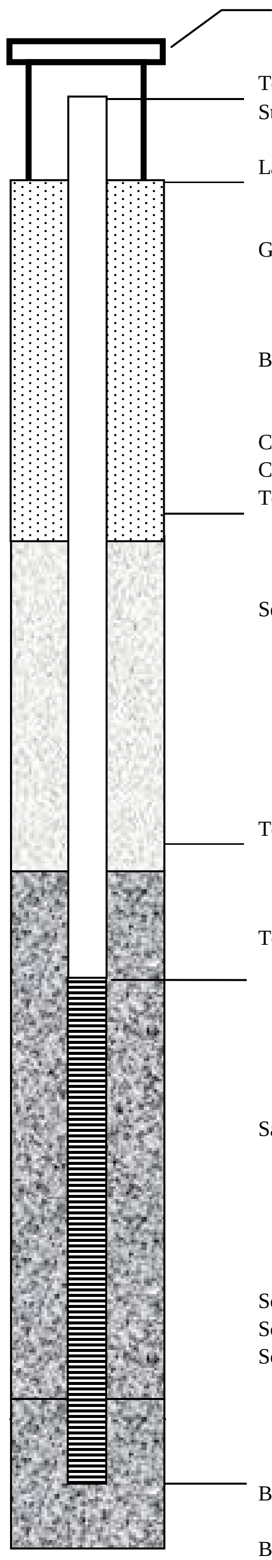
CONSTRUCTION MATERIALS USED:

6 Bags of Sand

2 Bags/Buckets Bentonite Pellets

12 Bags Portland for Grout

____ Bags Concrete/Sakrete



Top of Casing Elevation: 588.18 ft.
Stick-up: -0.29 ft.

Land Surface Elevation: 588.47 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6” inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 58 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 62 ft*

Top of Well Screen 64 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 74 ft.*

Base of Borehole: 74 ft.*

Total Depth of Well Below Top of Casing: 73.71 ft.

*Indicates Depth Below Land Surface

BORING NO. _____KC-15-20 _
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant South Fly Ash Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	8/27/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	84’	Surface Elevation:	589.45’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-60	10	NA	Gray silty clay, moist	N/A
60-61	1	NA	Gray silty clay, moist	N/A
61-74	8	NA	Orange brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
74-79	5	NA	Brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
79-84	5	NA	Gray sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-20

Project Number: 2015079

Project Location: Kyger Creek Plant South Fly Ash Pond

Installation Date(s): 8/27/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 9/2/15

Development Method: Submersible Pump
Field Parameters stabilized.
Turbidity = 4.26 NTUs

Volume Purged: 210 gallons

Static Water-Level*: 48.34’

Top of Well Casing Elevation: 588.72’

Well Purpose:
Groundwater Monitoring
Northing (Y): 333841.393
Easting (X): 2073452.842

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

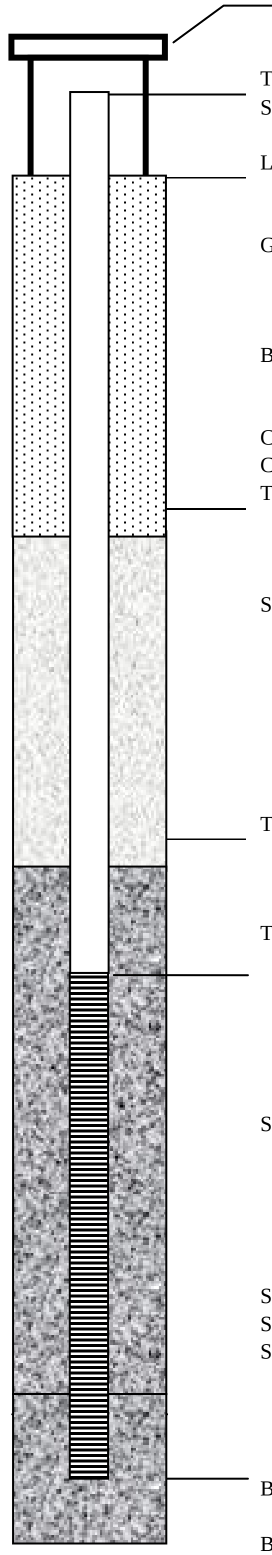
CONSTRUCTION MATERIALS USED:

6 Bags of Sand

2 Bags/Buckets Bentonite Pellets

12 Bags Portland for Grout

_____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 588.72 ft.
Stick-up: -0.74 ft.

Land Surface Elevation: 589.45 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6” inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 58 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 62 ft*

Top of Well Screen 64 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 74 ft.*

Base of Borehole: 74 ft.*

Total Depth of Well
Below Top of Casing: 73.26 ft.

*Indicates Depth Below Land Surface

BORING NO. _____KC-15-21_
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant South Fly Ash Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	8/25/15 to 8/26/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt. NA	and Drop NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water
Sampling Interval:	NA	Borehole Depth:	84’	Surface Elevation:	588.28’ MSL

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-54	4	NA	Brown clay with silt, moist	N/A
54-66	12	NA	Gray clay with silt, moist	N/A
66-74	8	NA	Brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
74-79	5	NA	Brown sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
79-84	5	NA	Gray sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-21

Project Number: 2015079

Project Location: Kyger Creek Plant South Fly Ash Pond

Installation Date(s): 8/25/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 8/27/15

Development Method: Submersible Pump
Field Parameters stabilized.
Turbidity = 3.89 NTUs

Volume Purged: 209 gallons

Static Water-Level*: 28.02’

Top of Well Casing Elevation: 587.84’

Well Purpose:
Groundwater Monitoring
Northing (Y): 334089.953
Easting (X): 207009.526

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

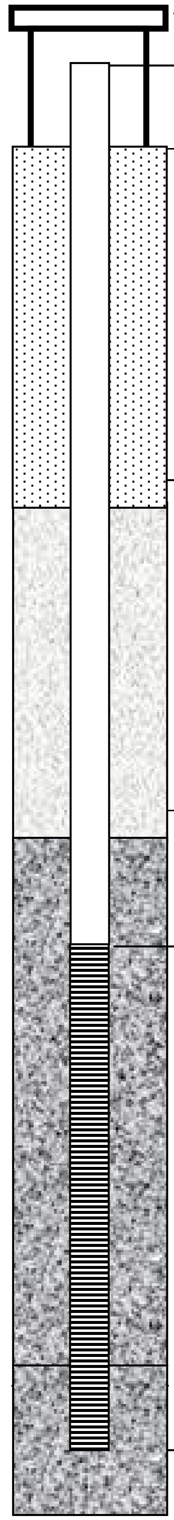
CONSTRUCTION MATERIALS USED:

6 Bags of Sand

2 Bags/Buckets Bentonite Pellets

15 Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 587.84 ft.
Stick-up: -0.44 ft.

Land Surface Elevation: 588.28 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6” inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 64 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 68 ft*

Top of Well Screen 70 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 80 ft.*

Base of Borehole: 84 ft.*

Total Depth of Well
Below Top of Casing: 79.56 ft.

*Indicates Depth Below Land Surface

BORING NO. KC-15-22
SAMPLE/CORE LOG

Project Number:	2015079	Log Page	1 of 1
Project Location:	Kyger Creek Plant South Fly Ash Pond	Drilling Contractor:	Bowser Morner
Drilling Date(s):	9/9/15 to 9/10/15	AGES Geologist:	Mike Gelles

Drilling Method:	Roto-Sonic	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	79’	Surface Elevation:	587.51’ MSL		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-50			Advance casing – no samples	N/A
50-60	17	NA	Gray silty clay with shell fragments, moist	N/A
60-67	14	NA	Gray silty clay with shell fragments, moist	N/A
67-79	11	NA	Gray sand, fine and medium to coarse, cobbles, trace silt, wet	N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A
				N/A

WELL CONSTRUCTION LOG
WELL NO. KC-15-22

Project Number: 2015079

Project Location: Kyger Creek Plant – South Fly Ash Pond

Installation Date(s): 9/10/15

Drilling Method: Roto-Sonic
Drilling Contractor: Bowser Morner

Development Date(s): 9/22/15

Development Method: Submersible Pump
Field parameters stabilized.
Turbidity = 1.83 NTUs

Volume Purged: 222 gallons

Static Water-Level* 41.39’

Top of Well Casing Elevation: 587.27’

Well Purpose:
Groundwter Monitoring
Northing (Y): 334307.567
Easting (X): 2072647.434

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

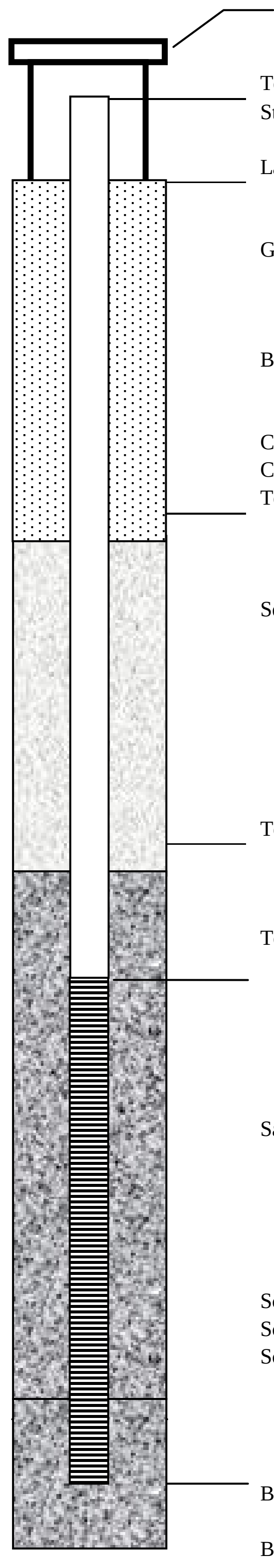
CONSTRUCTION MATERIALS USED:

6 Bags of Sand

2 Bags/Buckets Bentonite Pellets

12 Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 587.27 ft.
Stick-up: -0.24 ft.

Land Surface Elevation: 587.51 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6 inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 63 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 67 ft*

Top of Well Screen 69 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 79 ft.*

Base of Borehole: 79 ft.*

Total Depth of Well
Below Top of Casing: 78.76 ft.

*Indicates Depth Below Land Surface

BORING NO. BAP-B-2
SAMPLE/CORE LOG

Project Number:	2015078	Log Page	1 of 2
Project Location:	Kyger Creek Plant– Boiler Slag Pond	Drilling Contractor:	Stantec
Drilling Date(s):	7/7/15	AGES Geologist:	Mike Gelles

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6.5”	Drilling Fluid Used:	None		
Sampling Interval:	NA	Borehole Depth:	70’	Surface Elevation:	~580’		

NOTES/COMMENTS: Samples collected for grain size analysis @ 50 – 60’ and 60 – 70’

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-2	N/A	N/A	Dark red brown silty clay and ash, dry	N/A
2-16	N/A	N/A	Gray brown silty clay, moist	N/A
16-18	N/A	N/A	Brown silty clay, moist	N/A
18-31	N/A	N/A	Gray silty clay, moist	N/A
31- 32	N/A	N/A	Brown silty clay, moist	N/A
32-34	N/A	N/A	Gray silty clay, most	N/A
34-36	3-3-5-5	2.0	Brown silty clay, stiff, moist	N/A
36-38	3-3-3-5	2.0	36-37.5’ Same as above; 37.5-38’ Brown sandy clay, fine & medium, wet	N/A
38-40	1-1-3-4	2.0	Brown sandy clay, fine, wet	N/A
40-42	1-2-2-3	2.0	Brown sandy clay, fine, wet	N/A
42-44	1-3-3-4	2.0	Brown sandy clay, fine, wet	N/A
44-46	3-3-5-5	2.0	Brown sandy clay, fine, wet	N/A
46-48	3-3-3-3	2.0	Brown sandy clay, fine, wet	N/A
48-50	3-4-5-7	2.0	48-49.5’ Same as above; 49.5-50’ Sand, brown fine & medium, wet, trace silt	N/A
50-52	5-7-13-15	2.0	Sand, brown fine & medium, wet, trace silt	N/A
52-54	8-10-3-4	2.0	Brown sand, fine & medium, wet, trace silt	N/A
54-56	9-12-6-7	2.0	Brown sand, fine & medium, wet, trace silt	N/A

Project No: 2015078 AGES Inspector: Mike Gelles

56-58	7-8-8-8	2.0	Brown sand, fine & medium, wet, trace silt	N/A
58-60	4-7-17-15	2.0	Brown sand, fine & medium, wet, trace silt	N/A
60-62	9-20-21-29	2.0	Brown sand, fine & medium, wet, trace silt	N/A
62-64	19-24-17-13	2.0	Brown sand, fine & medium, wet	N/A
64-66	7-15-13-15	2.0	Brown sand, fine & medium, wet	N/A
66-68	7-7-8-12	2.0	Brown sand fine & medium, wet, gravel round, silt	N/A
68-70	7-9-9-15	2.0	Brown sand fine & medium, wet, trace silt	N/A

Project Number:	2015078	Log Page	1 of 2
Project Location:	Kyger Creek Plant – Boiler Slag Pond	Drilling Contractor:	Stantec
Drilling Date(s):	7/1/2015 -7/2/2015	AGES Geologist:	Mike Gelles

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt.	NA and Drop NA
Sampling Method:	NA	Borehole Diameter:	6.5”	Drilling Fluid Used:	None
Sampling Interval:	NA	Borehole Depth:	72’	Surface Elevation:	~580’

NOTES/COMMENTS: Sample collected for grain size analysis @ 62 – 70’

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-2	N/A	N/A	Red brown silty clay, moist	N/A
2-16	N/A	N/A	Brown silty clay, moist	N/A
16-25	N/A	N/A	Yellow brown silty clay, moist	N/A
25-28	N/A	N/A	Orange brown silty clay, moist	N/A
28-29	N/A	N/A	Brown gray clay, moist	N/A
29-34	N/A	N/A	Brown gray silty clay, moist	N/A
34-36	2.0	2-3-4-4	Orange brown silty clay, moist	N/A
36-38	2.0	1-3-3-4	Orange brown silty clay, moist	N/A
38-40	2.0	3-3-3-4	Orange brown silty clay, moist	N/A
40-42	2.0	1-3-3-4	Orange brown sandy clay fine & medium, moist	N/A
42-44	2.0	3-4-5-6	Orange brown sandy clay fine & medium, moist	N/A
44-46	2.0	1-4-4-5	Sandy clay orange brown fine & medium, wet	N/A
46-48	2.0	3-2-4-4	Sandy clay orange brown fine & medium, wet	N/A
48-50	2.0	4-3-4-5	Sandy clay orange brown fine & medium, wet	N/A
50-52	2.0	1-3-3-3	Clayey sand orange brown fine & medium, wet	N/A
52-54	2.0	1-2-2-3	Clayey sand orange brown fine & medium, wet	N/A
54-56	2.0	1-2-3-2	Clayey sand orange brown fine & medium, wet	N/A

Project No: 2015078 AGES Inspector: Mike Gelles

56-58	2.0	1-2-2-3	Brown gray clayey sand fine & medium, wet	N/A
58-60	2.0	4-2-4-4	Brown gray sandy clay, fine & medium, wet	N/A
60-62	2.0	2-3-3-4	60-61.7’ Same as above; 61.7-62’ Gray clay, shell fragments, trace sand	N/A
62-64	2.0	8-18-24-20	Brown gray sand fine & medium, gravel angular, trace silt, wet	N/A
64-66	1.7	7-20-25-14	Brown gray sand fine & medium, gravel round, trace silt, wet	N/A
66-68	1.3	6-10-25-20	Brown gray sand fine & medium, gravel round & angular, trace silt, wet	N/A
68-70	1.5	5-6-8-10	Brown gray sand fine - medium & course, trace silt, wet	N/A

BORING NO. SFAP-B-1
SAMPLE/CORE LOG

Project Number:	2015078	Log Page	1 of 2
Project Location:	Kyger Creek Plant – South Fly Ash Pond	Drilling Contractor:	Stantec
Drilling Date(s):	6-29-15 to 6-30-15	AGES Geologist:	Mike Gelles

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6.5”	Drilling Fluid Used:	None		
Sampling Interval:	NA	Borehole Depth:	78’	Surface Elevation:	~588’		

NOTES/COMMENTS: Samples collected for grain size analysis @ 62 – 68’ and 70 – 78’

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-0.33	N/A	N/A	Fly ash black, brown silty clay, moist	N/A
0.33 - 6	N/A	N/A	Brown silty clay, moist	N/A
6-10	N/A	N/A	Red brown silty clay, moist	N/A
10-12.5	N/A	N/A	Gray-brown silty clay, moist	N/A
12.5-17.5	N/A	N/A	Red brown silty clay, moist	N/A
17.5-27.5	N/A	N/A	Gray brown silty clay, moist	N/A
27.5-40.0	N/A	N/A	Red brown silty clay, moist	N/A
40.0-52.0	N/A	N/A	Red brown clay with silt, moist	N/A
52.0-54.0	N/A	N/A	Brown gray clay, sand, shell fragments	N/A
54.0-56.0	2.0	1-1-4-5	Brown gray clay, sand , shell fragments, moist, soft	N/A
56.0-58.0	2.0	1-4-4-6	Brown gray clay, sand, shell fragments, moist, stiff	N/A
58.0-60.0	2.0	2-3-3-4	Brown gray clay, sand, shell fragments, moist, stiff	N/A
60.0-62.0	2.0	1-3-5-3	60-61.5’ Brown gray clay, shell fragments, moist, stiff; 61.5-62’ Sand fine & medium, yellow brown, silt, dense, moist	N/A
62.0-64.0	2.0	18-40-50/4	Sand, fine & medium, yellow brown, gravel rounded, trace silt, wet, dense	N/A
64.0-66.0	1.5	18-44-34-26	Sand, fine & medium, yellow brown, gravel rounded, trace silt, wet, dense	N/A
66.0-68.0	1.4	11-16-10-9	Sand, fine & medium & course, yellow brown, gravel rounded, trace silt, wet, dense	N/A
68.0-70.0	0.2	8-8-8-9	Clay, sandstone fragments, poor recovery	N/A

Project No: 2015078 AGES Inspector: Mike Gelles

70.0-72.0	1.1	8-8-8-7	Sand, fine & medium & course, brown, fly ash, trace silt, wet, gravel round	N/A
72.0-74.0	1.2	5-10-13-13	Sand, fine & medium & course, brown, trace silt, wet, gravel round	N/A
74.0-76.0	1.6	9-10-11-15	Sand, fine & medium & course, brown, fly ash, trace silt, wet, some gravel round	N/A
76.0-78.0	1.4	3-4-8-10	Sand, fine & medium & course, brown, some gravel round, trace silt, wet	N/A

BORING NO. SFAP-B-2
SAMPLE/CORE LOG

Project Number:	2015078	Log Page	1 of 2
Project Location:	Kyger Creek Plant - South Fly Ash Pond	Drilling Contractor:	Stantec
Drilling Date(s):	6-30-15 to 7-1-15	AGES Geologist:	Mike Gelles

Drilling Method:	HSA	Coring Device Size:	NA	Hammer Wt. NA	and Drop NA
Sampling Method:	NA	Borehole Diameter:	6.5”	Drilling Fluid Used:	None
Sampling Interval:	NA	Borehole Depth:	70’	Surface Elevation:	~588’

NOTES/COMMENTS: Sample collected for grain size analysis @ 60 – 70’

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-11	N/A	N/A	Red brown silty clay, moist	N/A
11-16	N/A	N/A	Brown gray silty clay, moist	N/A
16-18	N/A	N/A	Red brown silty clay, moist	N/A
18-20	N/A	N/A	Brown gray silty clay, Moist	N/A
20-26	N/A	N/A	Red brown silty clay, moist	N/A
26-28	N/A	N/A	Red brown clay, moist	N/A
28-30	N/A	N/A	Gray brown clay, moist	N/A
30-35	N/A	N/A	Yellow brown sand fine & medium, moist	N/A
35-36	N/A	N/A	Brown gray sand fine & medium, moist	N/A
36-37	N/A	N/A	Gray brown clay, moist	N/A
37-38	N/A	N/A	Yellow brown clay, plastic, moist	N/A
38-41	N/A	N/A	Gray brown silty clay, moist	N/A
41-52	N/A	N/A	Yellow brown clay, moist	N/A
52-56	N/A	N/A	Yellow brown clay, moist	N/A
56-58	0.8	4-3-4-5	Orange brown silty clay, sand, trace clay, moist	N/A
58-60	1.3	5-15-17-21	Brown sand fine & medium, gravel round, trace silt, wet	

BORING NO. SFAP-B-2
CONTINUED SAMPLE/CORE LOG

Project No: 2015078 AGES Inspector: Mike Gelles

60-62	1.4	24-24-22-21	Sand fine & medium, gravel, trace silt, wet, angular gravel	N/A
62-64	1.3	9-27-33-26	Sand fine & medium brown, gravel round, trace silt, wet	N/A
64-66	1.2	13-16-7-12	Sand fine & medium + course brown, gravel round, trace silt, wet	N/A
66-68	0.8	8-12-18-12	Sand fine & medium +course brown, gravel round, trace silt, wet	N/A
68-70	0.9	4-6-8-10	Sand fine & medium +course brown, gravel round, trace silt, wet	N/A

APPENDIX D

WELL DEVELOPMENT DATA

TABLE D-1
SUMMARY OF WELL DEVELOPMENT DATA
KYGER CREEK PLANT
GALLIA COUNTY, OHIO

Well/ Piezometer	Dates	Method	Volume (gal)	Final Turbidity (NTU)
Type III Residual Waste Landfill				
CCR-1BU	10/21/2015 - 11/20/2015	Pump/Bailer	146	2976
CCR-2BU	10/22/2016 - 11/20/2016	Pump/Bailer	215	4066
Boiler Slag Pond				
KC-15-01	8/11/2015 - 8/18/2015	Pump	230	4.52
KC-15-02	8/12/2015 - 8/18/2015	Pump	311	2.44
KC-15-03	8/18/2015	Pump	230	4.89
KC-15-04	8/19/2015	Pump	268	3.81
KC-15-05	8/20/2015	Pump	222	1.52
KC-15-06	8/20/2015	Pump	214	0.98
KC-15-07	8/14/2015 - 8/19/2015	Pump	220	4.06
KC-15-08	8/13/2015 - 8/18/2015	Pump	225	2.25
South Fly Ash Pond				
KC-15-09	9/23/2015	Pump	223	4.89
KC-15-10	9/23/2015	Pump	295	3.82
KC-15-11	8/25/2015	Pump	242	0.87
KC-15-12	9/22/2015	Pump	245	2.41
KC-15-13	9/3/2015	Pump	220	4.69
KC-15-14	8/21/2015	Pump	267	1.2
KC-15-15	9/3/2015	Pump	225	2.59
KC-15-16	9/4/2015	Pump	215	0.64
KC-15-17	9/14/2015 - 9/21/2015	Pump	232	2.90
KC-15-18	8/26/2015	Pump	206	2.39
KC-15-19	9/15/2015 - 9/21/2015	Pump	317	3.17
KC-15-20	9/2/2015	Pump	210	4.26
KC-15-21	8/27/2015	Pump	209	3.89
KC-15-22	9/22/2015	Pump	222	1.83

APPENDIX E

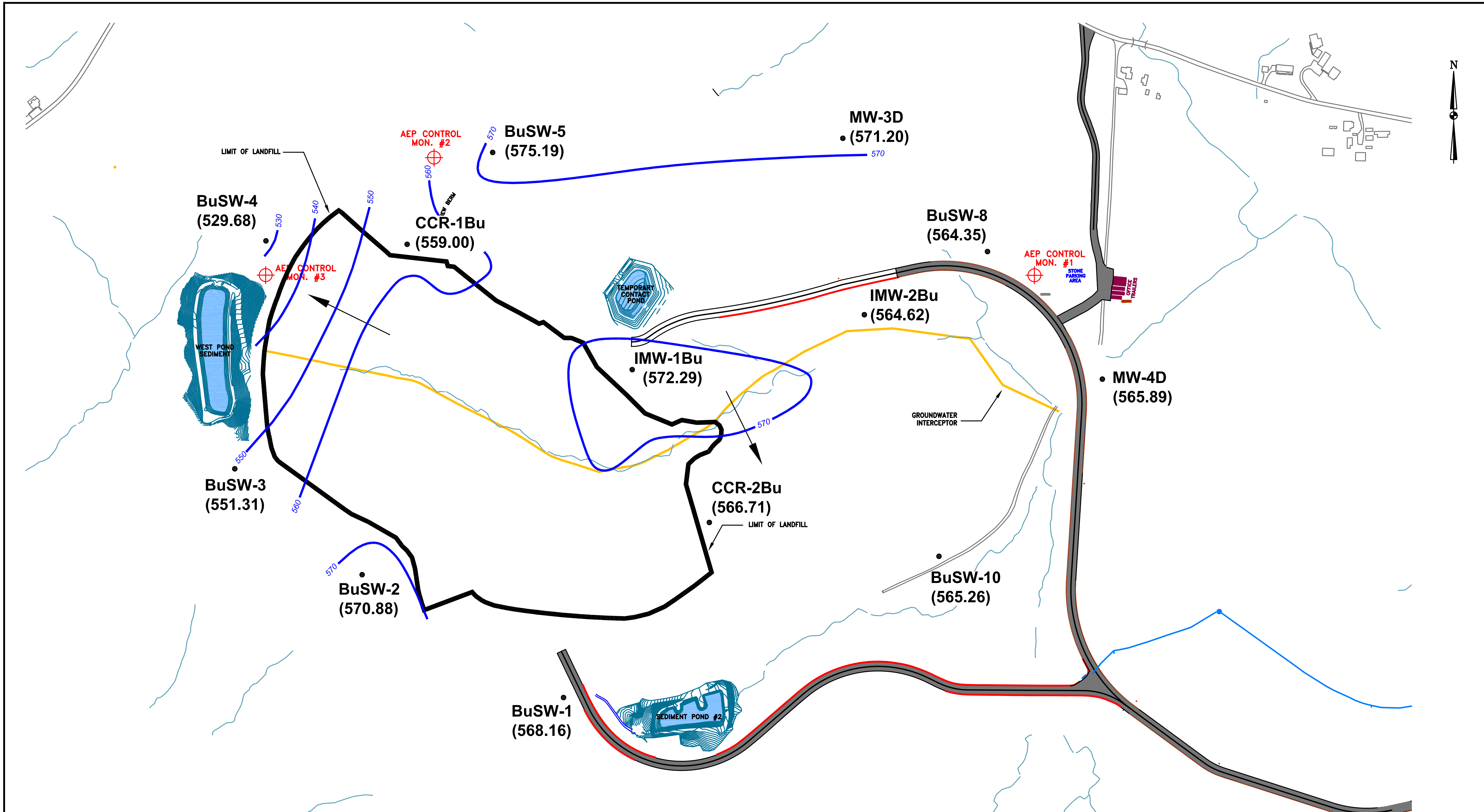
GROUNDWATER LEVELS
January 2016 through May 2016

TABLE E-1
KYGER CREEK PLANT
SUMMARY OF GROUNDWATER ELEVATION DATA
JANUARY 2016 - MAY 2016

Monitoring Well Designation	Jan-16 Groundwater Elevation (ft)	Mar-16 Groundwater Elevation (ft)	May-16 Groundwater Elevation (ft)
LANDFILL			
BuSW-1	568.16	568.21	568.04
BuSW-2	570.88	570.89	570.78
BuSW-3	551.31	548.21	556.72
BuSW-4	529.68	529.35	529.05
BuSW-5	575.19	575.1	574.27
BuSW-8	564.35	564.33	564.21
BuSW-10	565.26	565.38	565.24
1MW-1Bu	572.29	571.92	570.77
IMW-2Bu	564.62	564.57	564.44
MW-4D	565.89	566.2	565.76
MW-3D	571.20	573.05	560.3
CCR-1BU	559.00	575.76	577.45
CCR-2BU	566.71	564.75	566.61
BOILER SLAG POND			
KC-15-01	539.27	540.23	539.56
KC-15-02	539.48	540.46	539.79
KC-15-03	539.32	540.27	539.63
KC-15-04	538.52	539.20	538.52
KC-15-05	538.49	539.12	538.47
KC-15-06	538.39	539.03	538.40
KC-15-07	538.46	539.19	538.54
KC-15-08	538.86	539.68	539.03
SOUTH FLY ASH POND			
KC-15-09	469.729	470.509	469.90
KC-15-10	476.905	477.695	477.10
KC-15-11	477.131	477.911	477.32
KC-15-12	477.201	477.951	477.38
KC-15-13	477.09	477.92	477.42
KC-15-14	477.00	477.82	477.20
KC-15-15	476.76	477.63	476.97
KC-15-16	476.47	477.30	476.75
KC-15-17	476.66	477.46	476.84
KC-15-18	476.39	477.30	476.61
KC-15-19	476.21	477.15	476.46
KC-15-20	476.14	476.97	476.30
KC-15-21	470.38	471.18	470.54
KC-15-22	471.58	472.40	471.74

APPENDIX F

GROUNDWATER CONTOUR MAPS
January 2016 through May 2016



LEGEND:

POTENTIOMETRIC SURFACE CONTOUR

BuSW-1 MONITORING WELL

(570.88) GROUNDWATER ELEVATION

GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015079-KYGER
DWG FILE	KYGER MW INSTALL_CONTOURS 01-16 b14 F1.dwg
DRAWING SCALE	AS SHOWN

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412.264.6453

OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
TYPE III RESIDUAL WASTE LANDFILL
GROUNDWATER CONTOUR MAP
JANUARY 2016

DRAWING NAME: FIGURE F-1 REV. 0

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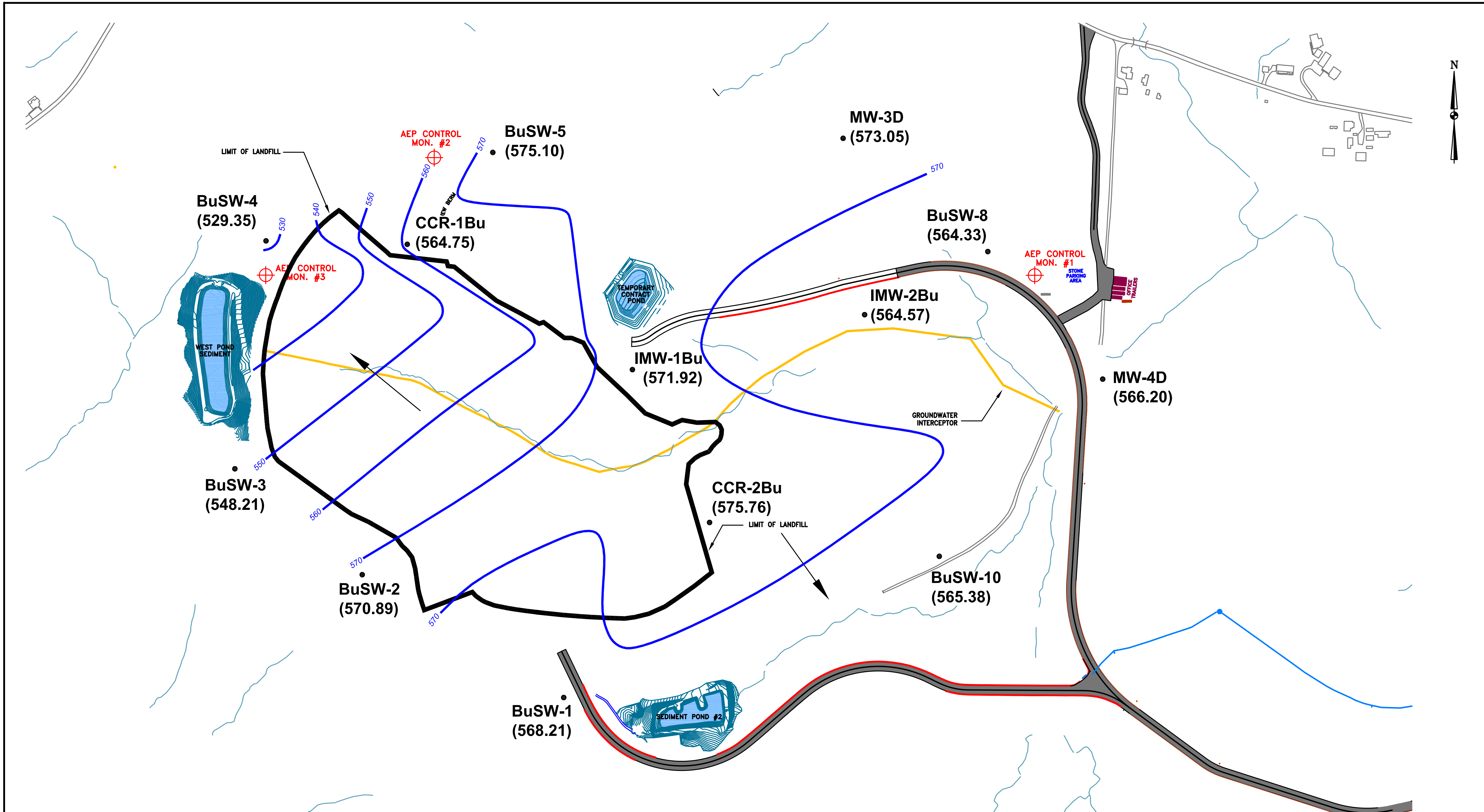

LEGEND:

(blue line)	POTENTIOMETRIC SURFACE CONTOUR
● BuSW–1	MONITORING WELL
(570.89)	GROUNDWATER ELEVATION
←	GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015079–KYGER
DWG FILE	KYGER MW INSTALL_CONTOURS 03–16 b15 F2.dwg
DRAWING SCALE	AS SHOWN

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CHESHIRE, GALLIA COUNTY, OHIO
TYPE III RESIDUAL WASTE LANDFILL
GROUNDWATER CONTOUR MAP
MARCH 2016

DRAWING NAME: FIGURE F–2

REV. 0

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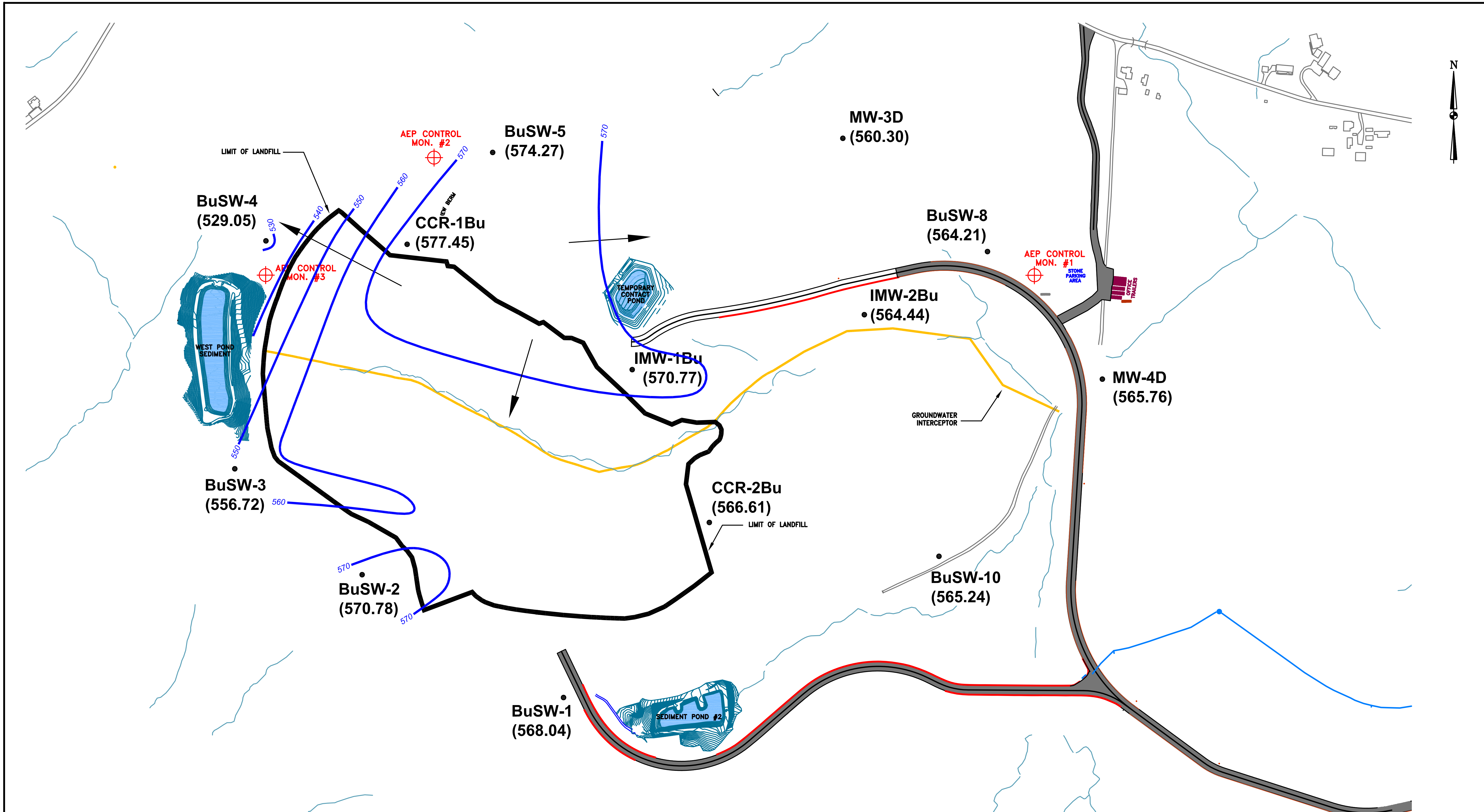

LEGEND:

(blue line)	POTENTIOMETRIC SURFACE CONTOUR
● BuSW-1	MONITORING WELL
(570.89)	GROUNDWATER ELEVATION
←	GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015079–KYGER
DWG FILE	KYGER MW INSTALL_CONTOURS 05–16 b16 F3.dwg
DRAWING SCALE	AS SHOWN

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KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
TYPE III RESIDUAL WASTE LANDFILL
GROUNDWATER CONTOUR MAP
MAY 2016

DRAWING NAME: FIGURE F-3
REV. 0

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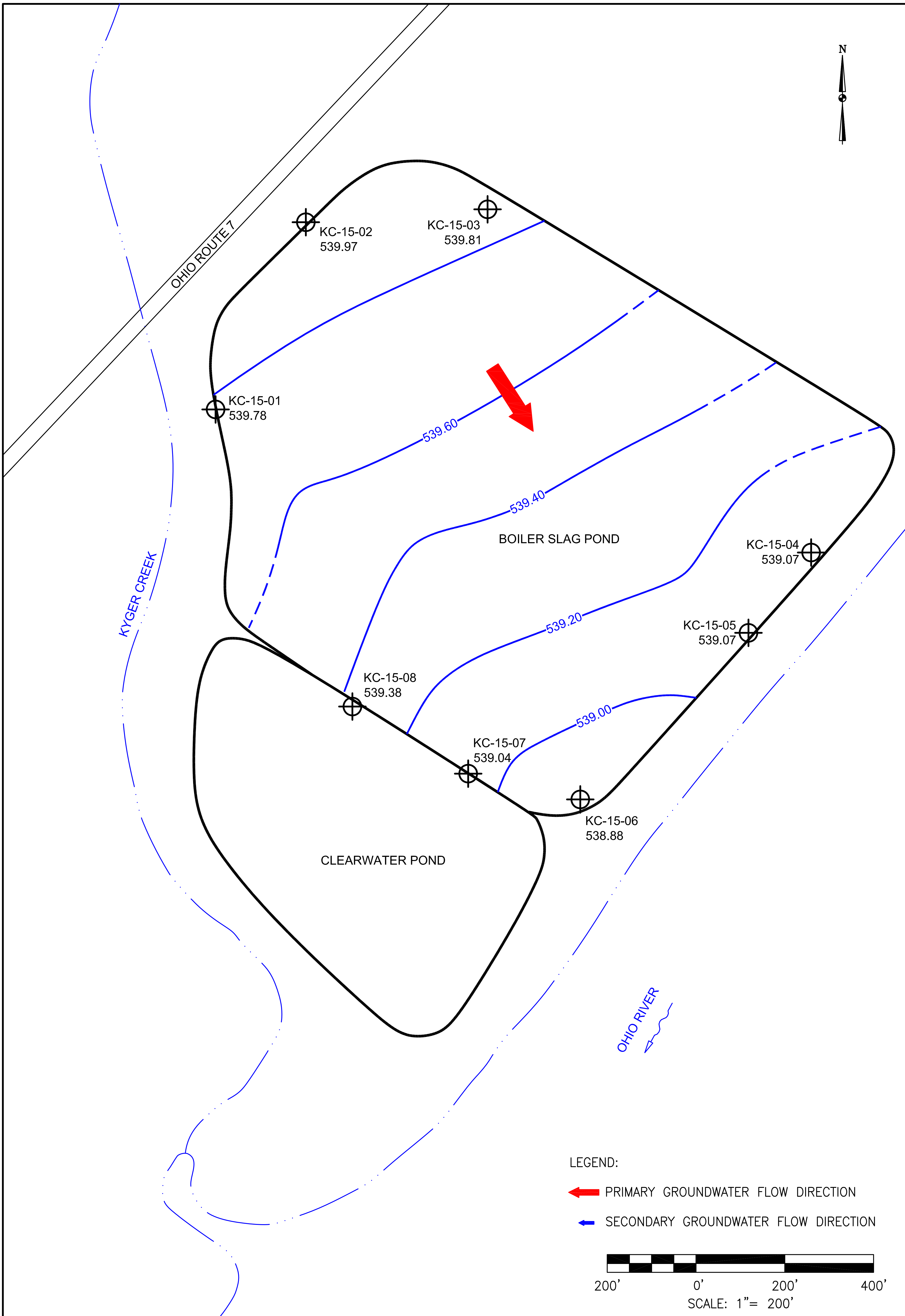

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DRAWING SCALE	1"=200'

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OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER CONTOUR MAP – JANUARY 2016

DRAWING NAME: FIGURE F–4
REV. 0

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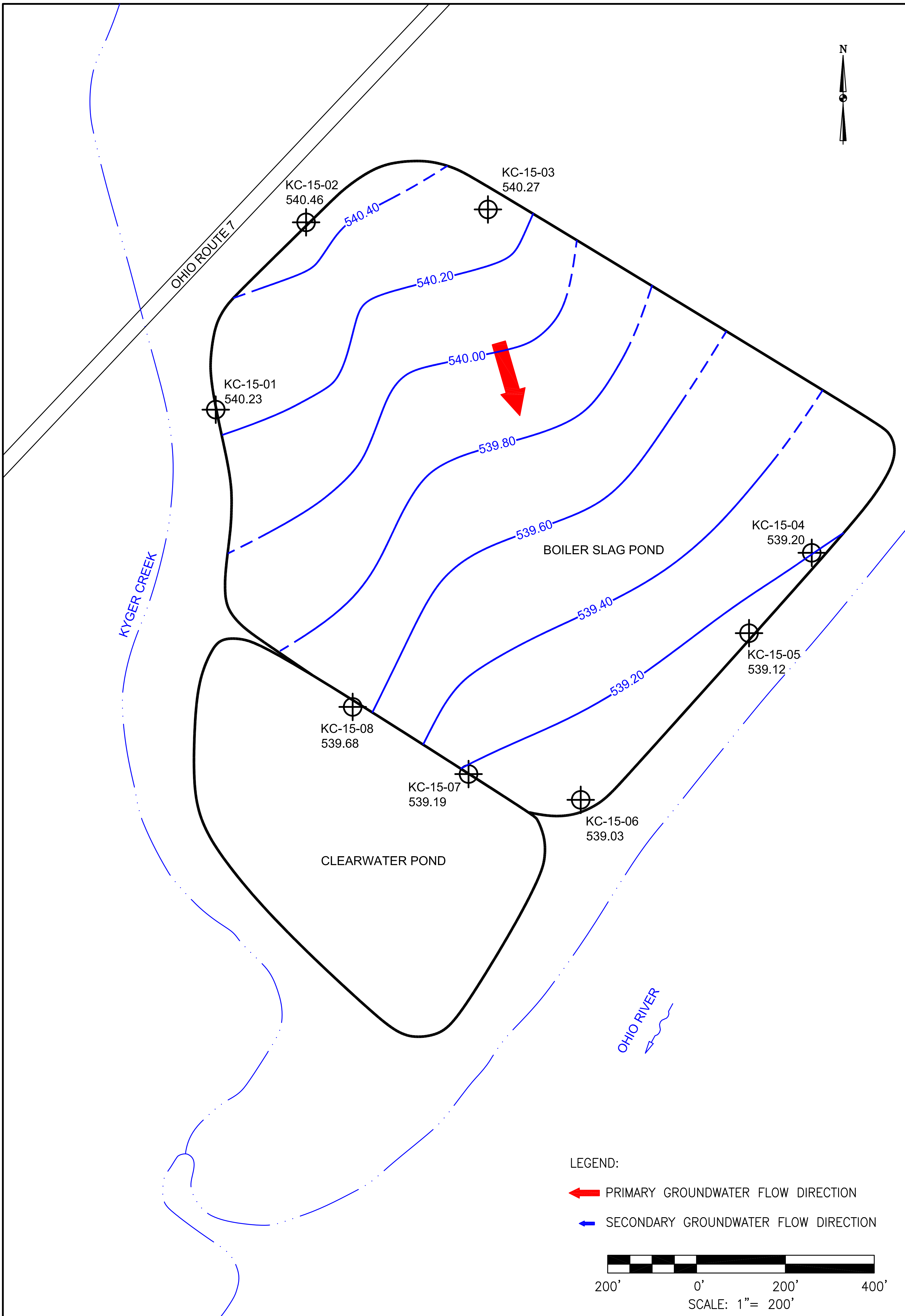

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DRAWING SCALE	1"=200'

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KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER CONTOUR MAP – MARCH 2016

DRAWING NAME: FIGURE F–5

REV. 0

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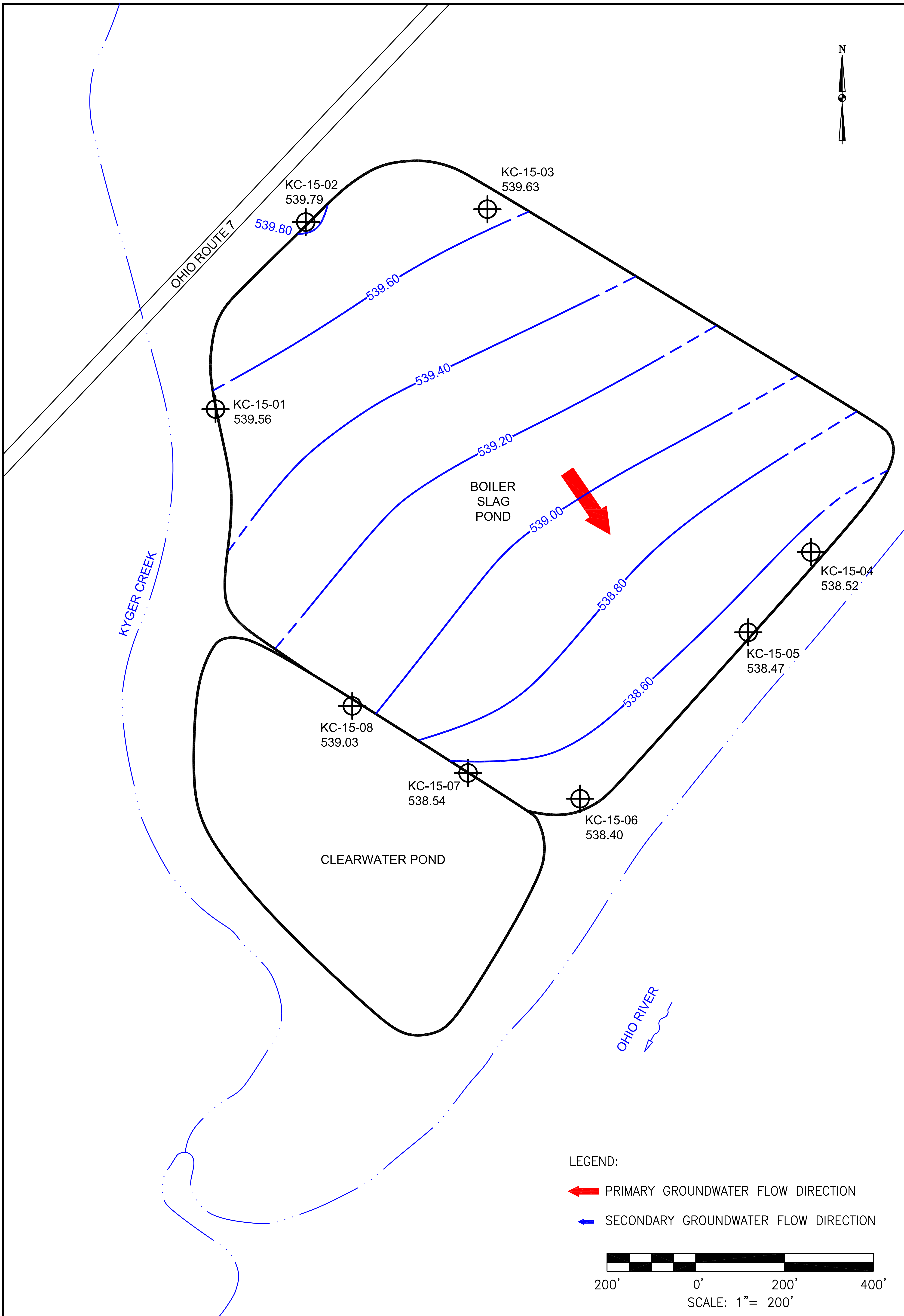

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DRAWING SCALE	1"=200'

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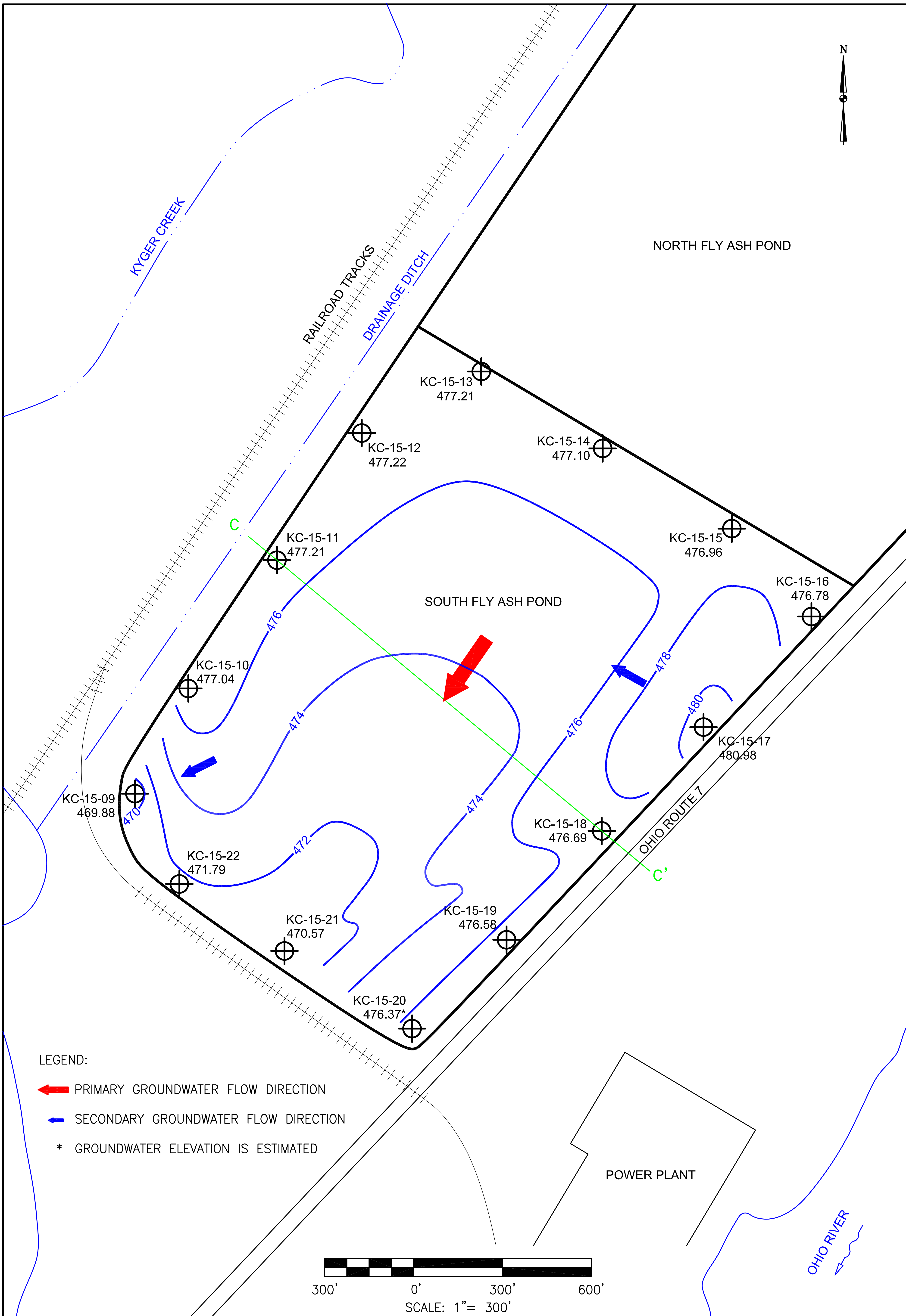
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER CONTOUR MAP – MAY 2016

DRAWING NAME	REV.
FIGURE F–6	0



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DRAWING SCALE	1"=300'

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KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GROUNDWATER CONTOUR MAP – JANUARY 2016

DRAWING NAME: FIGURE F–7 REV. 0

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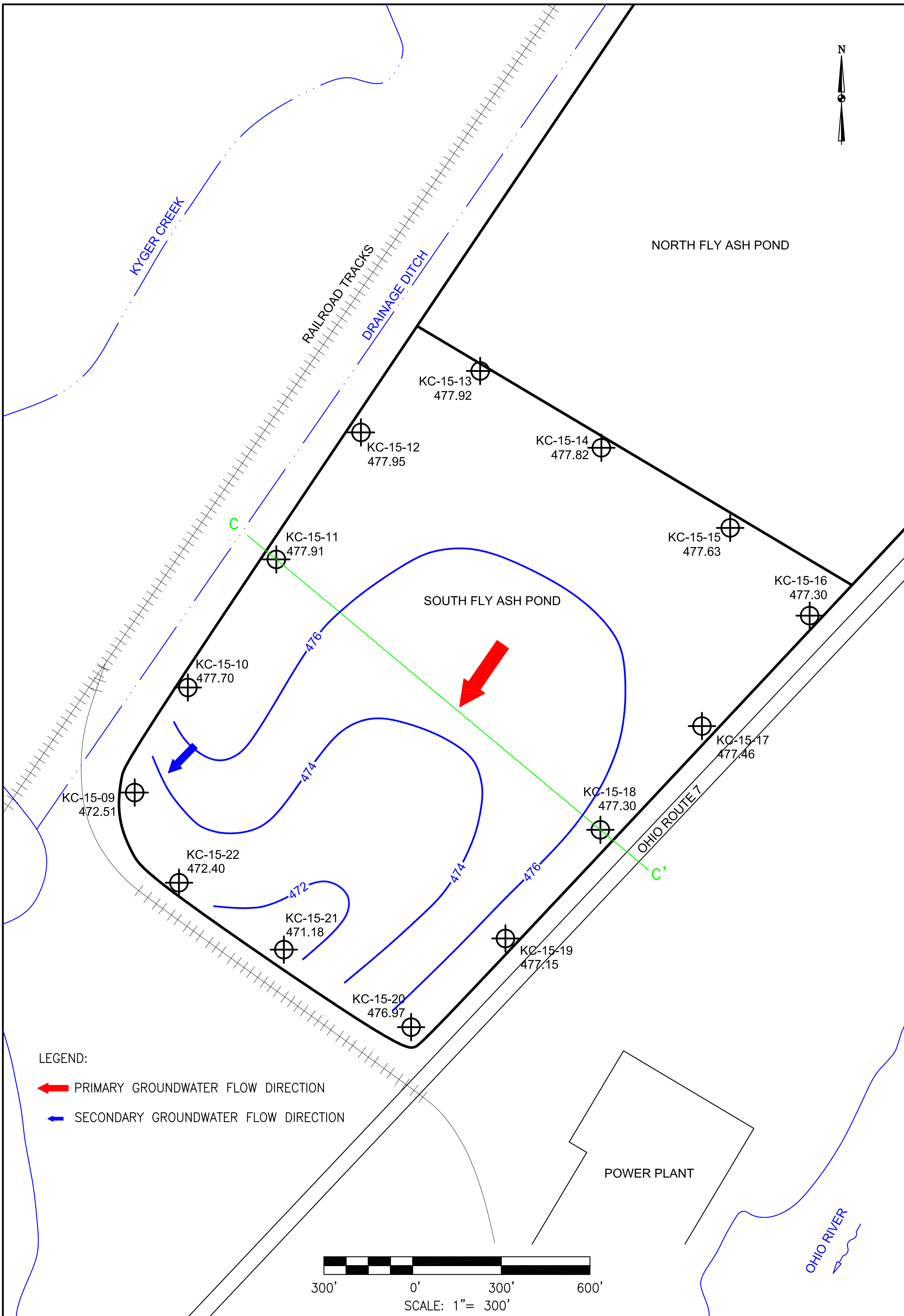

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DATE	
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JOB NO.	2015079–KYGER
DWG FILE	KYGER MW INSTALL_GW CONTOURS 03–2016 FAP b21 F8.dwg
DRAWING SCALE	1"=300'

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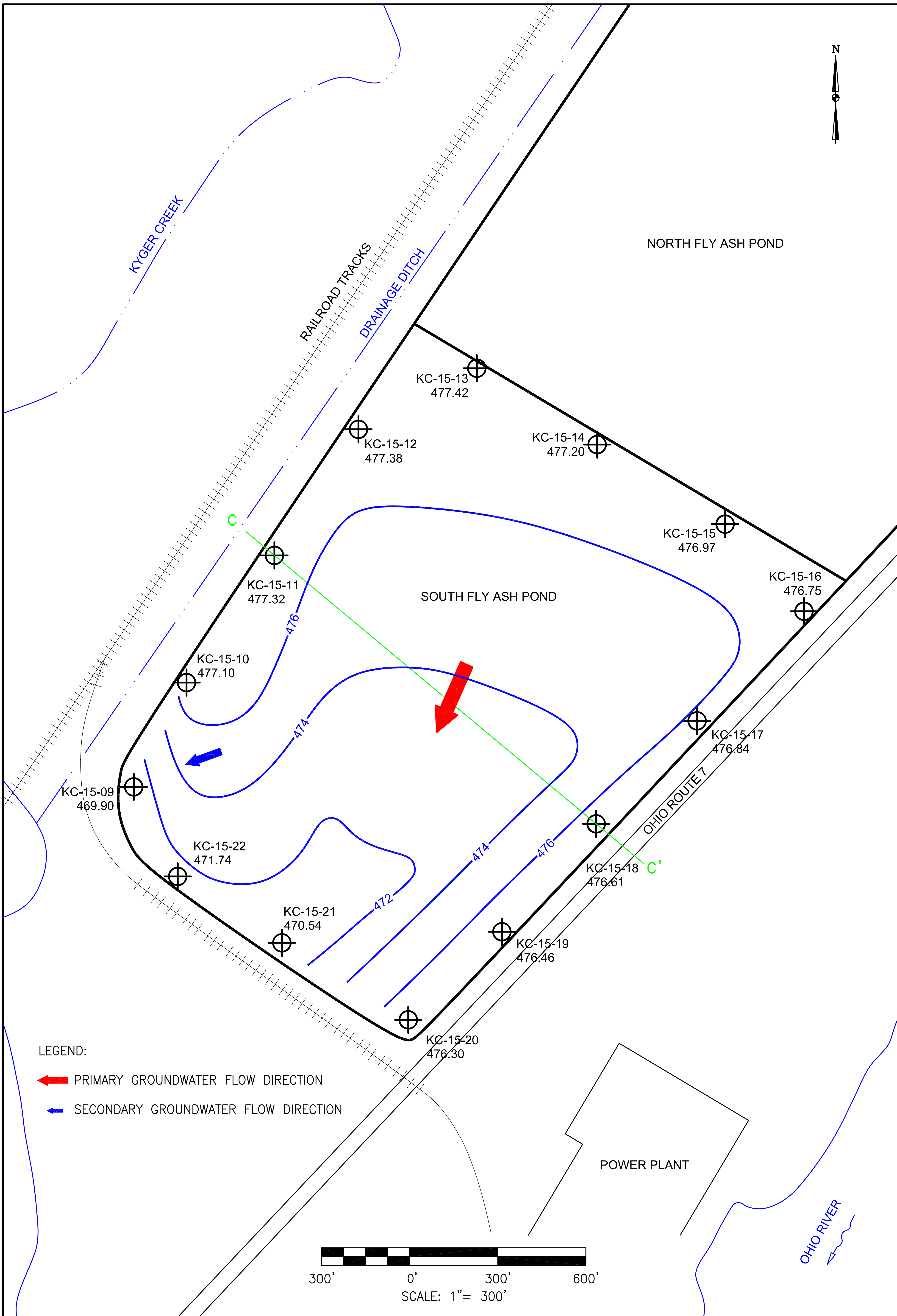
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GROUNDWATER CONTOUR MAP – MARCH 2016

DRAWING NAME: FIGURE F–8

REV. 0

Plot: 08/15/2016 15:52 \Kyger Creek–CCR Program\CAD\WELL INSTALLATION\APPENDIX F\KYGER MW INSTALL_GW CONTOURS 03–2016 FAP b21 F8.dwg\FLY ASH POND



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2015079–KYGER
DWG FILE	KYGER MW INSTALL_GW CONTOURS 05–2016 FAP b22 F9.dwg
DRAWING SCALE	1"=300'

AGES
Applied Geology And Environmental Science, Inc.
2402 Hookstown Grade Road, Suite 200
Clinton, PA 15026
412.264.6453

OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GROUNDWATER CONTOUR MAP – MAY 2016

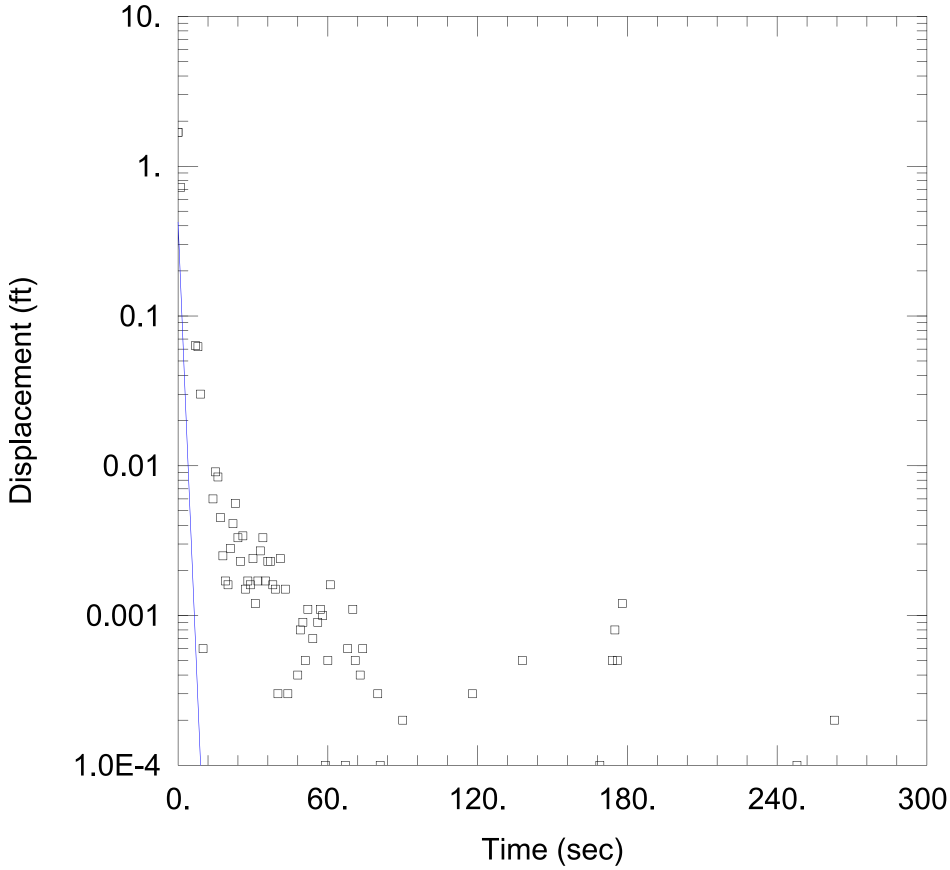
DRAWING NAME: FIGURE F–9

REV.: 0

Plot: 08/15/2016 15:54 \Kyger Creek–CCR Program\CAD\WELL INSTALLATION\APPENDIX F\KYGER MW INSTALL_GW CONTOURS 05–2016 FAP b22 F9.dwg\FLY ASH POND

APPENDIX G

AQUIFER TESTING RESULTS
May 2016



IN-A

Data Set: Y:\...\KC-15-02_IN-A_BR.aqt
Date: 08/18/16 Time: 15:23:41

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - BSP
Test Well: KC-15-02
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 30.11 ft Anisotropy Ratio (Kz/Kr): 1.

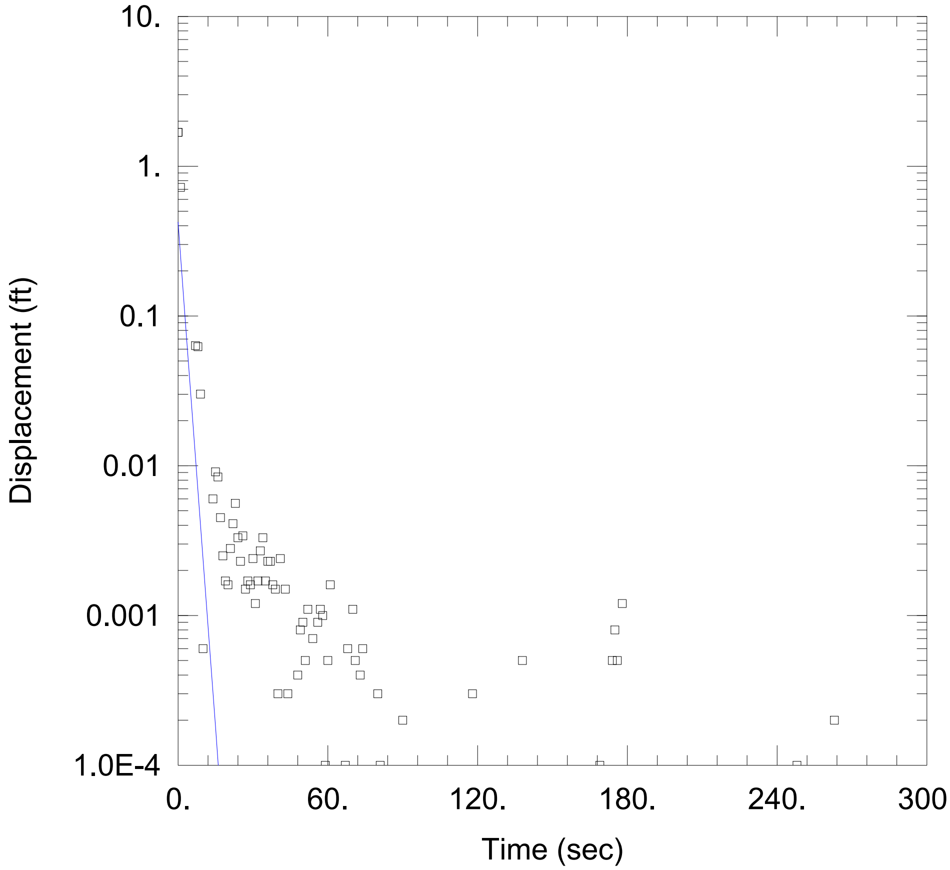
WELL DATA (New Well)

Initial Displacement: 1.682 ft Static Water Column Height: 26.15 ft
Total Well Penetration Depth: 71. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.03584 cm/sec y0 = 0.4234 ft



IN-A

Data Set: Y:\...\KC-15-02_IN-A_H.aqt
Date: 08/18/16 Time: 15:24:43

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - BSP
Test Well: KC-15-02
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 30.11 ft
Anisotropy Ratio (Kz/Kr): 1.

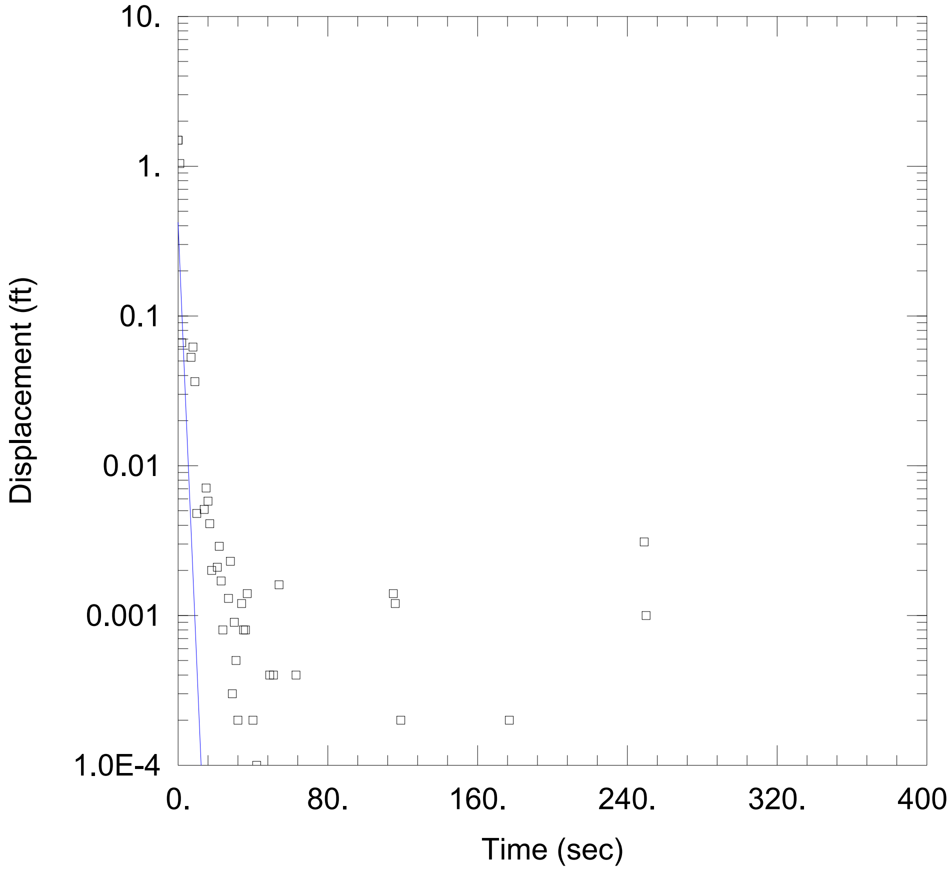
WELL DATA (New Well)

Initial Displacement: 1.682 ft
Static Water Column Height: 26.15 ft
Total Well Penetration Depth: 71. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.02225 cm/sec
y0 = 0.4234 ft



IN-B

Data Set: Y:\...\KC-15-02_IN-B_BR.aqt
Date: 08/18/16 Time: 15:28:00

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - BSP
Test Well: KC-15-02
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 30.11 ft Anisotropy Ratio (Kz/Kr): 1.

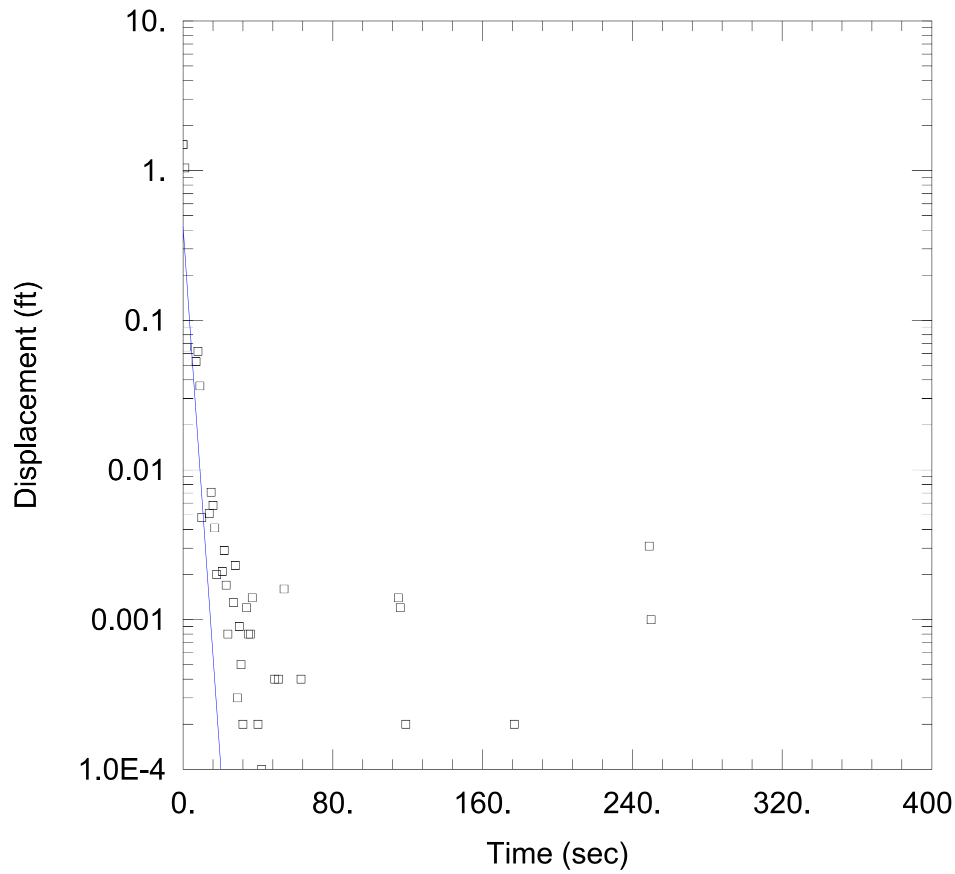
WELL DATA (KC-15-02)

Initial Displacement: 1.491 ft Static Water Column Height: 26.14 ft
Total Well Penetration Depth: 71. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.02623 cm/sec y0 = 0.4207 ft



IN-B

Data Set: Y:\...\KC-15-02_IN-B_H.aqt
Date: 08/18/16 Time: 15:29:06

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - BSP
Test Well: KC-15-02
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 30.11 ft Anisotropy Ratio (Kz/Kr): 1.

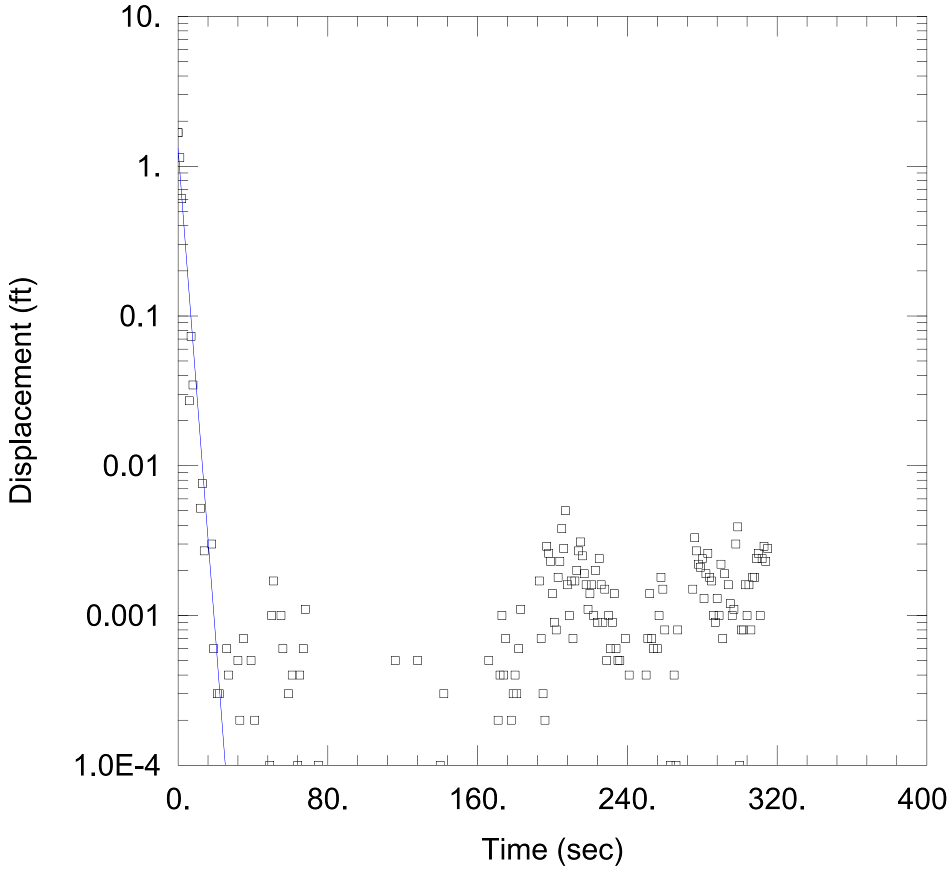
WELL DATA (KC-15-02)

Initial Displacement: 1.491 ft Static Water Column Height: 26.14 ft
Total Well Penetration Depth: 71. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.01774 cm/sec y0 = 0.4207 ft



RISING HEAD #1

Data Set: Y:\...\KC-15-02_OUT-A_BR.aqt
Date: 08/18/16 Time: 15:30:53

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - BSP
Test Well: KC-15-02
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 30.11 ft
Anisotropy Ratio (Kz/Kr): 1.

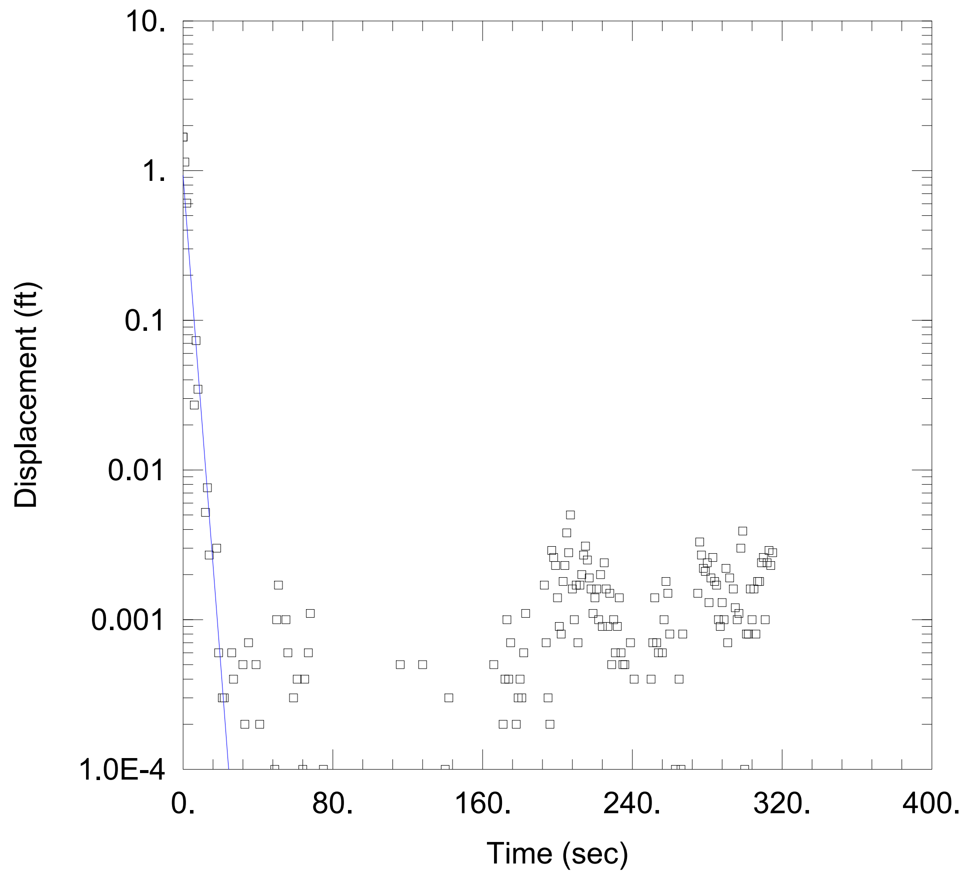
WELL DATA (KC-15-02)

Initial Displacement: 1.675 ft
Static Water Column Height: 26.15 ft
Total Well Penetration Depth: 71. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.01455 cm/sec
y0 = 1.319 ft



RISING HEAD #1

Data Set: Y:\...\KC-15-02_OUT-A_H.aqt
Date: 08/18/16 Time: 15:32:07

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - BSP
Test Well: KC-15-02
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 30.11 ft Anisotropy Ratio (Kz/Kr): 1.

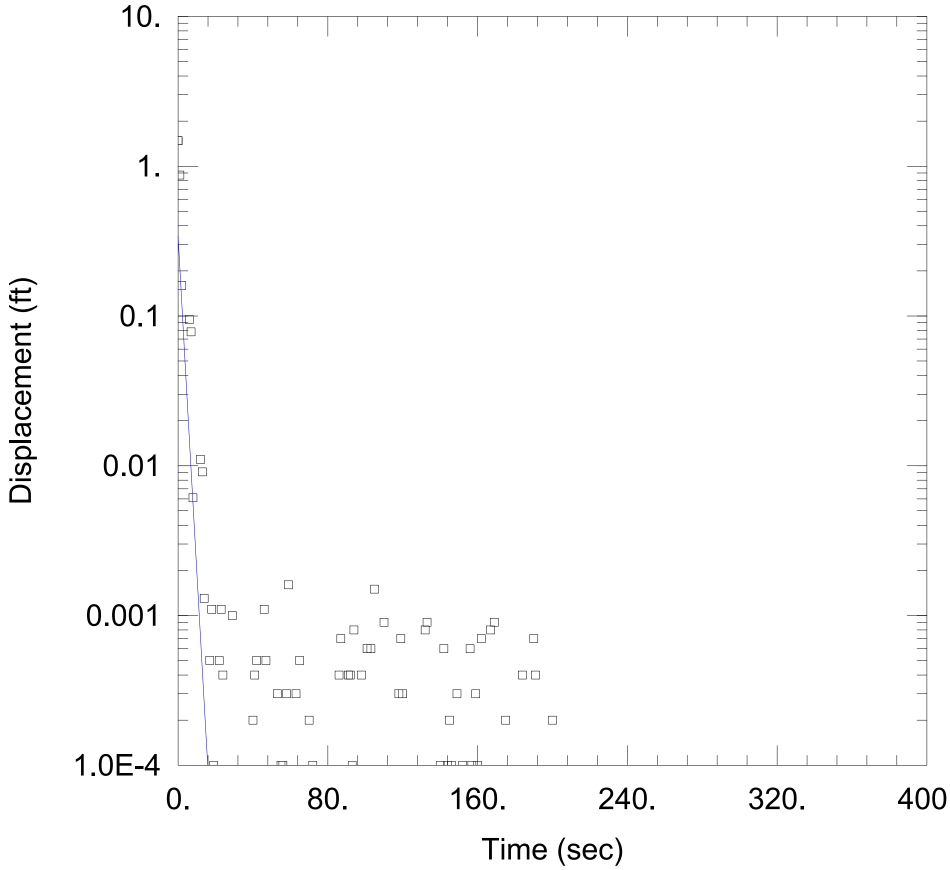
WELL DATA (KC-15-02)

Initial Displacement: 1.675 ft Static Water Column Height: 26.15 ft
Total Well Penetration Depth: 71. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.01609 cm/sec y0 = 0.9277 ft



OUT-B

Data Set: Y:\...\KC-15-02_OUT-B_BR.aqt
Date: 08/18/16 Time: 15:33:54

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - BSP
Test Well: KC-15-02
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 30.11 ft
Anisotropy Ratio (Kz/Kr): 1.

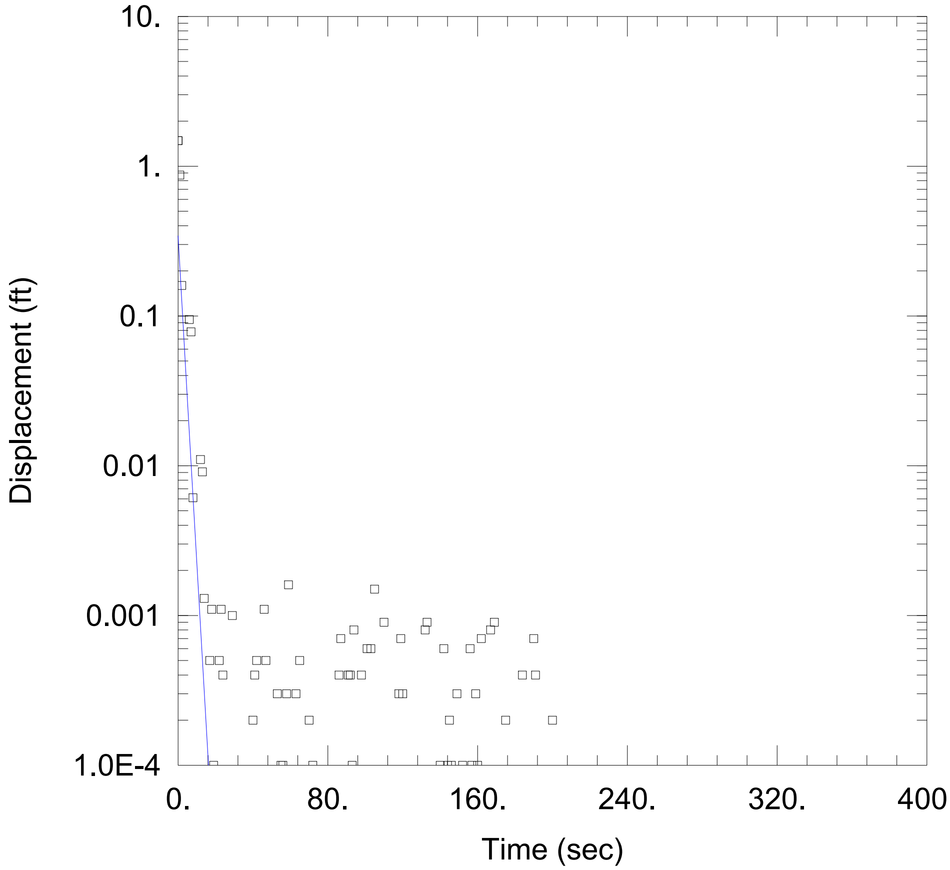
WELL DATA (KC-15-02)

Initial Displacement: 1.479 ft
Static Water Column Height: 26.13 ft
Total Well Penetration Depth: 71. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.01995 cm/sec
y0 = 0.3427 ft



OUT-B

Data Set: Y:\...\KC-15-02_OUT-B_H.aqt
Date: 08/18/16 Time: 15:35:18

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - BSP
Test Well: KC-15-02
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 30.11 ft Anisotropy Ratio (Kz/Kr): 1.

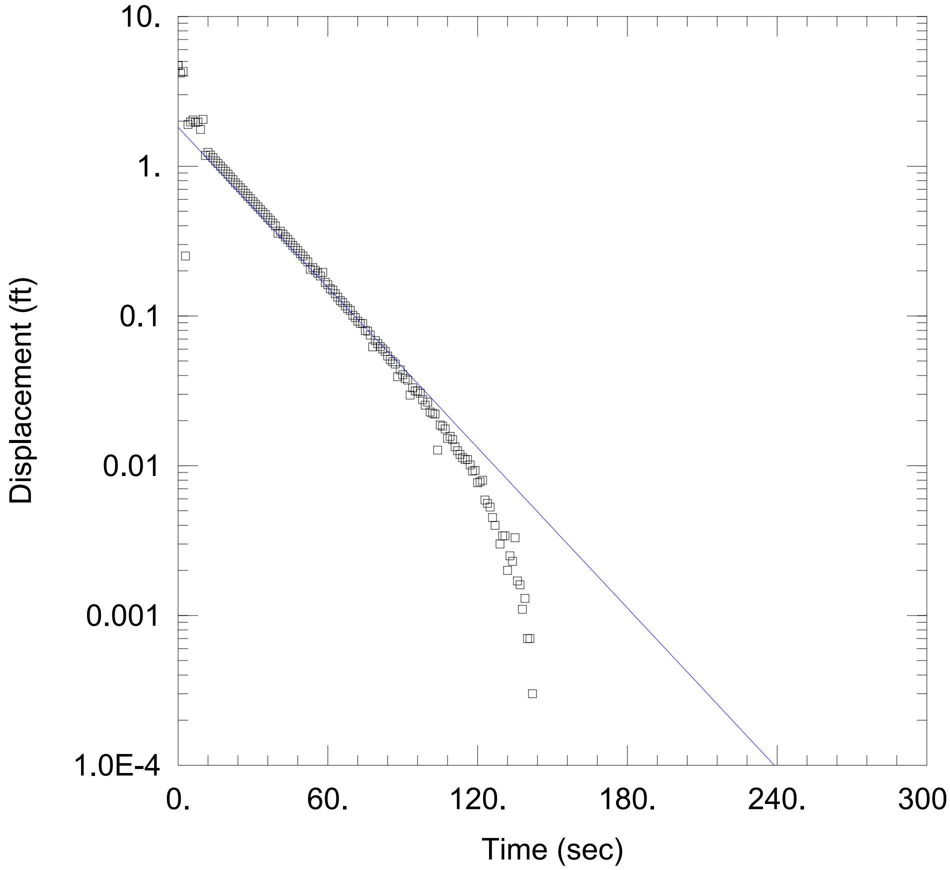
WELL DATA (KC-15-02)

Initial Displacement: 1.479 ft Static Water Column Height: 26.13 ft
Total Well Penetration Depth: 71. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.02153 cm/sec y0 = 0.3427 ft



IN-A

Data Set: Y:\...\KC-15-05_IN-A_BR.aqt
Date: 08/18/16 Time: 15:38:21

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - BSP
Test Well: KC-15-05
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 27.76 ft Anisotropy Ratio (Kz/Kr): 1.

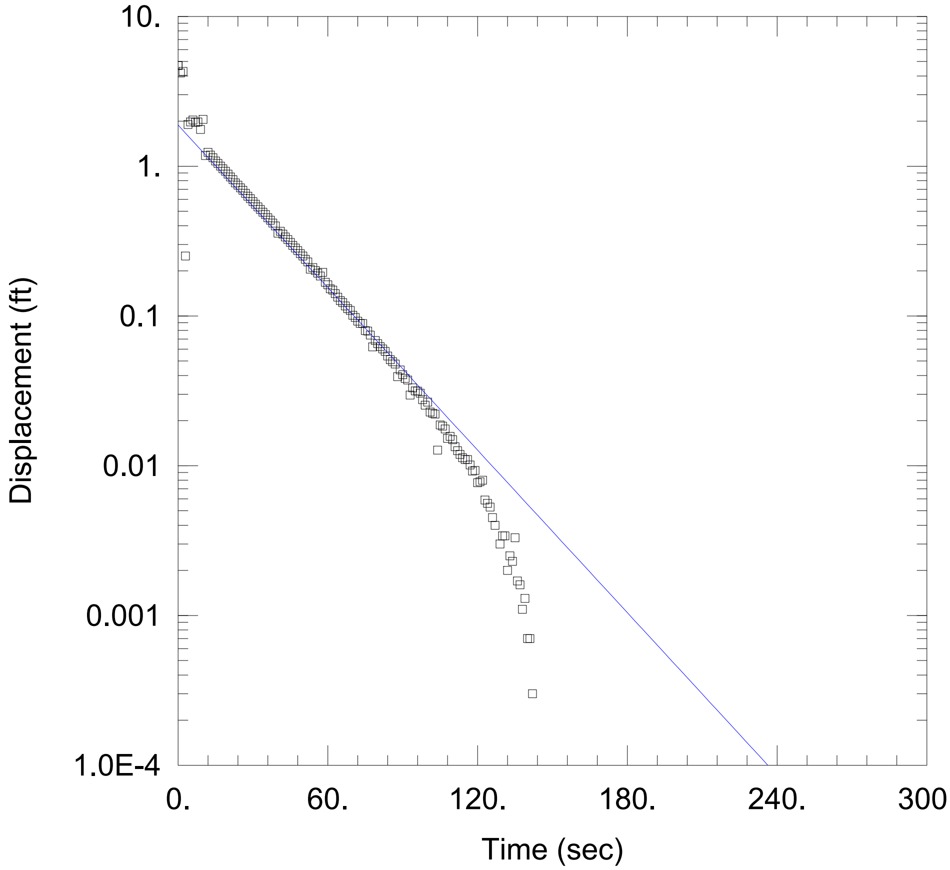
WELL DATA (KC-15-05)

Initial Displacement: 4.705 ft Static Water Column Height: 29.44 ft
Total Well Penetration Depth: 70. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.001589 cm/sec y0 = 1.822 ft



IN-A

Data Set: Y:\...\KC-15-05_IN-A_H.aqt
Date: 08/18/16 Time: 15:40:16

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - BSP
Test Well: KC-15-05
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 27.76 ft Anisotropy Ratio (Kz/Kr): 1.

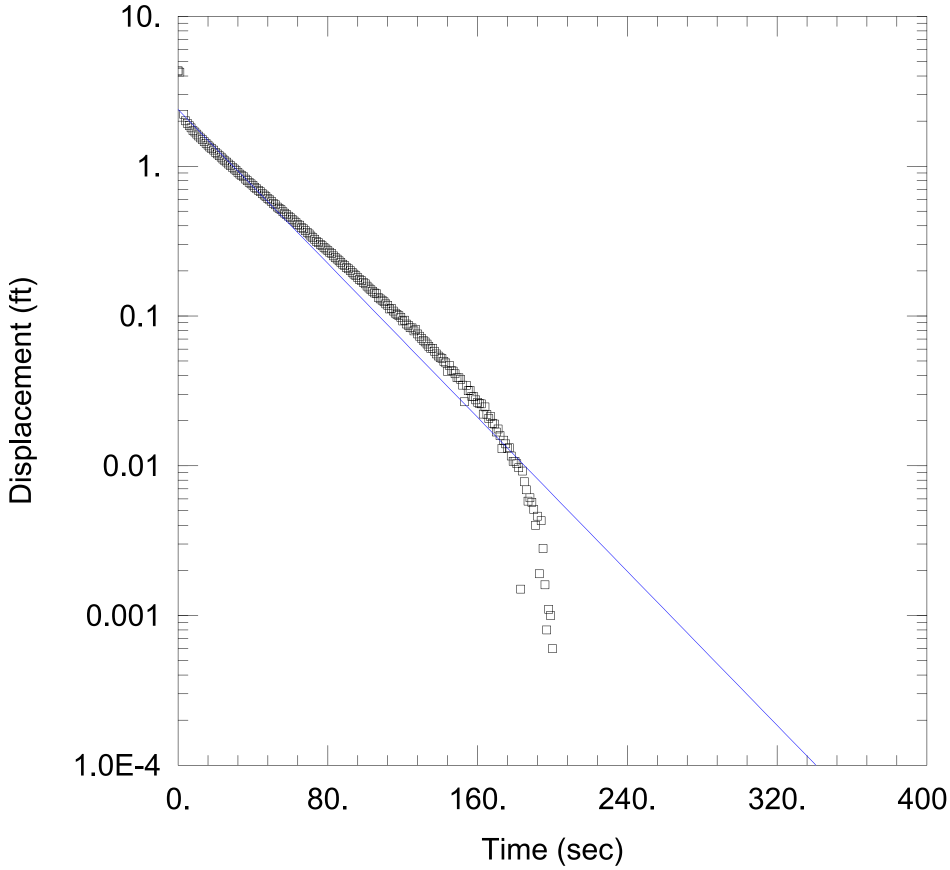
WELL DATA (KC-15-05)

Initial Displacement: 4.705 ft Static Water Column Height: 29.44 ft
Total Well Penetration Depth: 70. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.001791 cm/sec y0 = 1.883 ft



IN-B

Data Set: Y:\...\KC-15-05_IN-B_BR.aqt
Date: 08/18/16 Time: 15:41:39

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - BSP
Test Well: KC-15-05
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 27.76 ft
Anisotropy Ratio (Kz/Kr): 1.

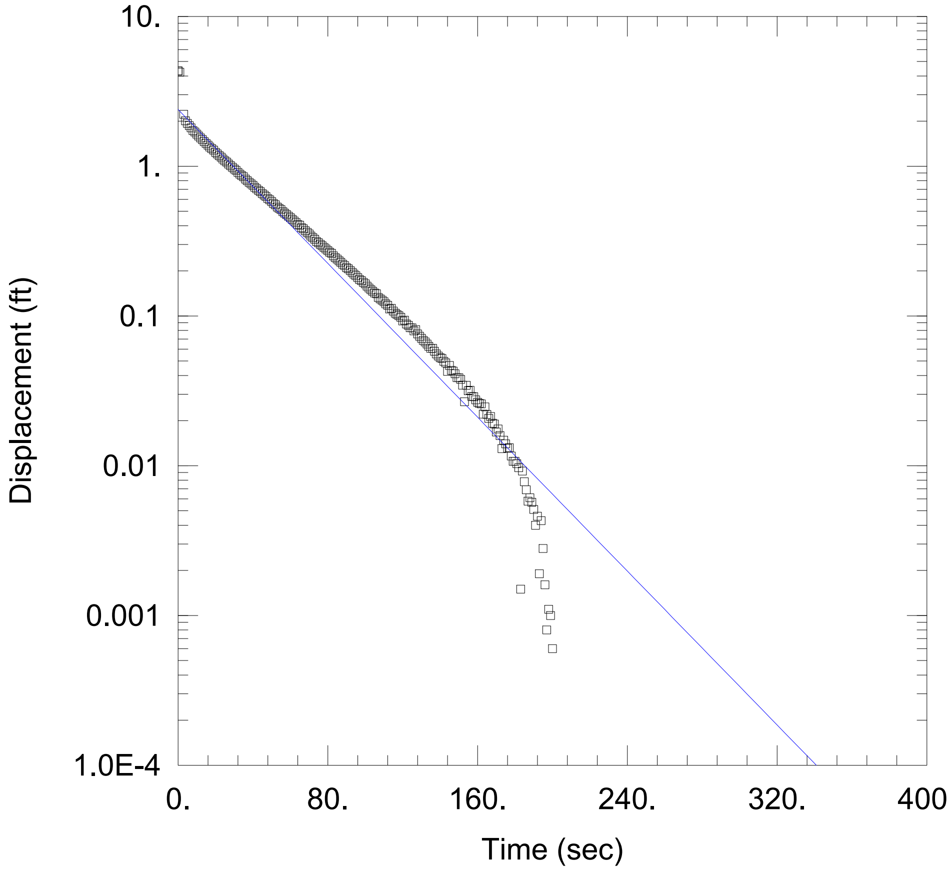
WELL DATA (KC-15-05)

Initial Displacement: 4.329 ft
Static Water Column Height: 29.44 ft
Total Well Penetration Depth: 71. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.001147 cm/sec
y0 = 2.391 ft



IN-B

Data Set: Y:\...\KC-15-05_IN-B_H.aqt
Date: 08/18/16 Time: 15:42:30

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - BSP
Test Well: KC-15-05
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 27.76 ft Anisotropy Ratio (Kz/Kr): 1.

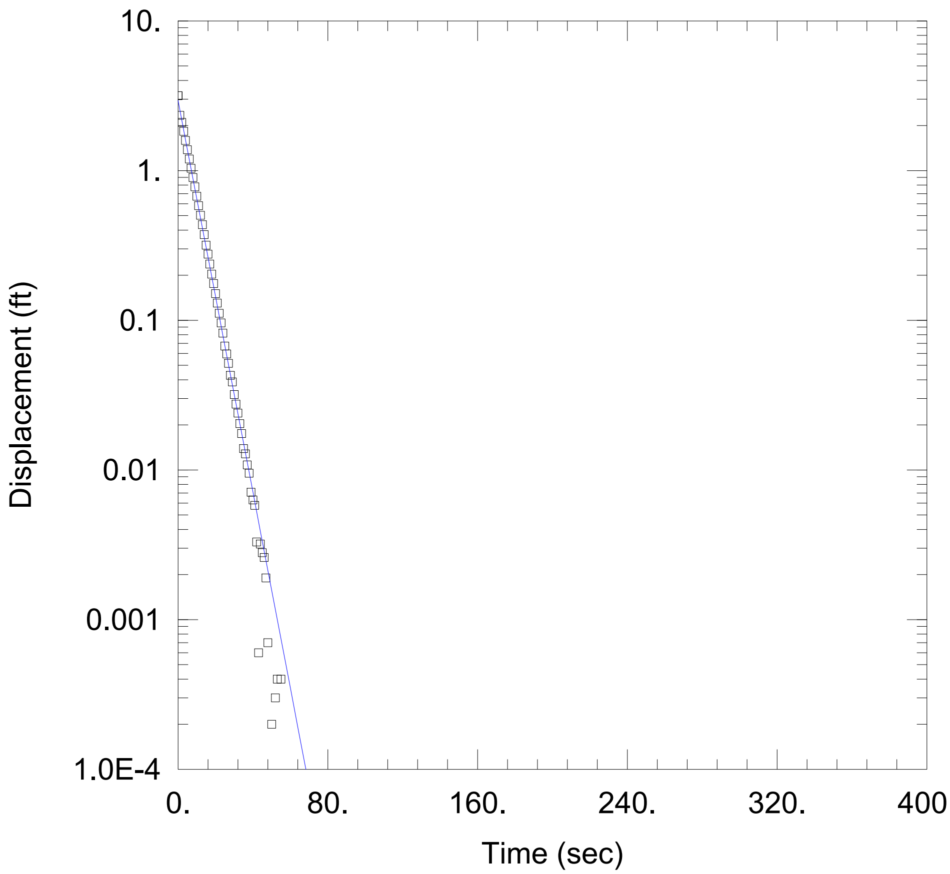
WELL DATA (KC-15-05)

Initial Displacement: 4.329 ft Static Water Column Height: 29.44 ft
Total Well Penetration Depth: 71. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.001271 cm/sec y0 = 2.39 ft



OUT-A

Data Set: Y:\...\KC-15-05_OUT-A_BR.aqt
Date: 08/18/16 Time: 15:43:50

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - BSP
Test Well: KC-15-05
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 27.76 ft
Anisotropy Ratio (Kz/Kr): 1.

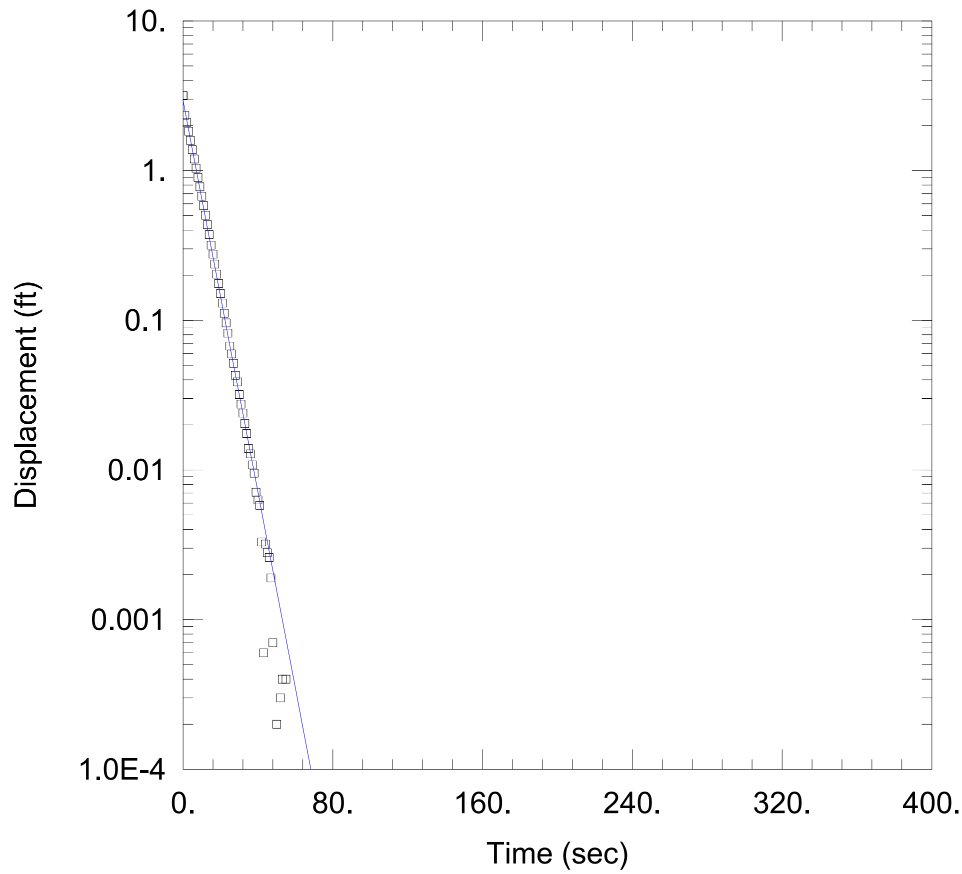
WELL DATA (KC-15-05)

Initial Displacement: 3.163 ft
Static Water Column Height: 29.43 ft
Total Well Penetration Depth: 70. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.00583 cm/sec
y0 = 2.94 ft



OUT-A

Data Set: Y:\...\KC-15-05_OUT-A_H.aqt
Date: 08/18/16 Time: 15:45:11

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - BSP
Test Well: KC-15-05
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 27.76 ft Anisotropy Ratio (Kz/Kr): 1.

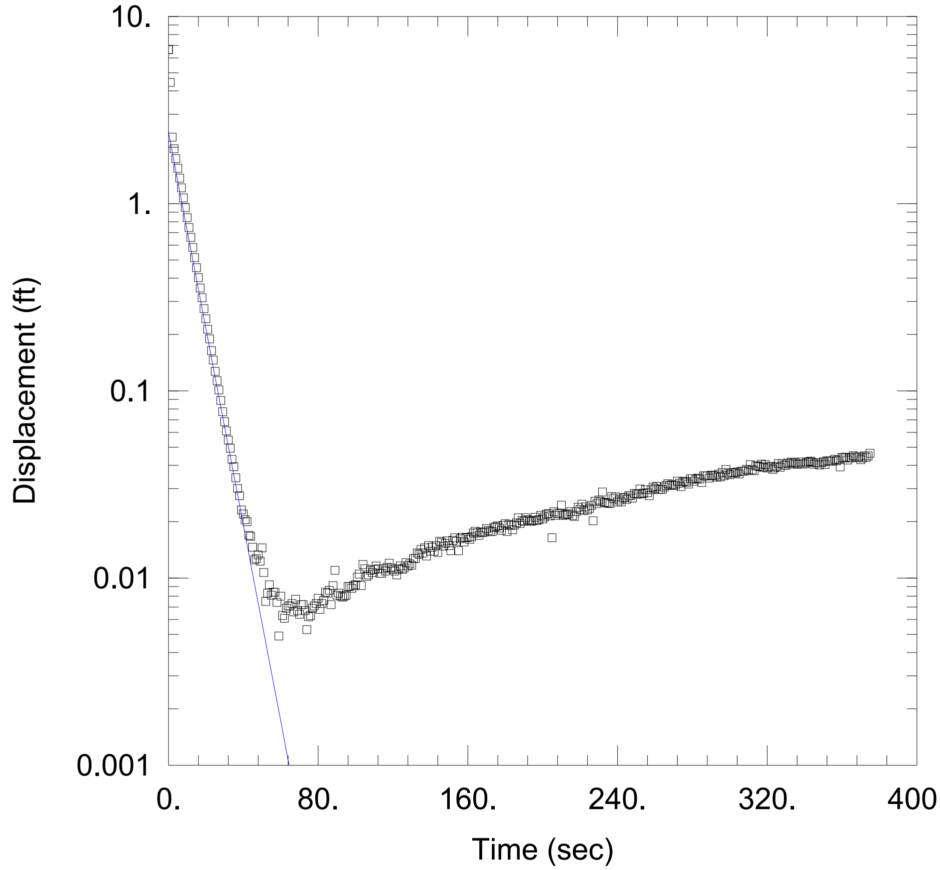
WELL DATA (KC-15-05)

Initial Displacement: 3.163 ft Static Water Column Height: 29.43 ft
Total Well Penetration Depth: 70. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.006477 cm/sec y0 = 2.94 ft



OUT-B

Data Set: Y:\...\KC-15-05_OUT-B_BR.aqt
Date: 08/18/16 Time: 15:46:15

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - BSP
Test Well: KC-15-05
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 27.76 ft
Anisotropy Ratio (Kz/Kr): 1.

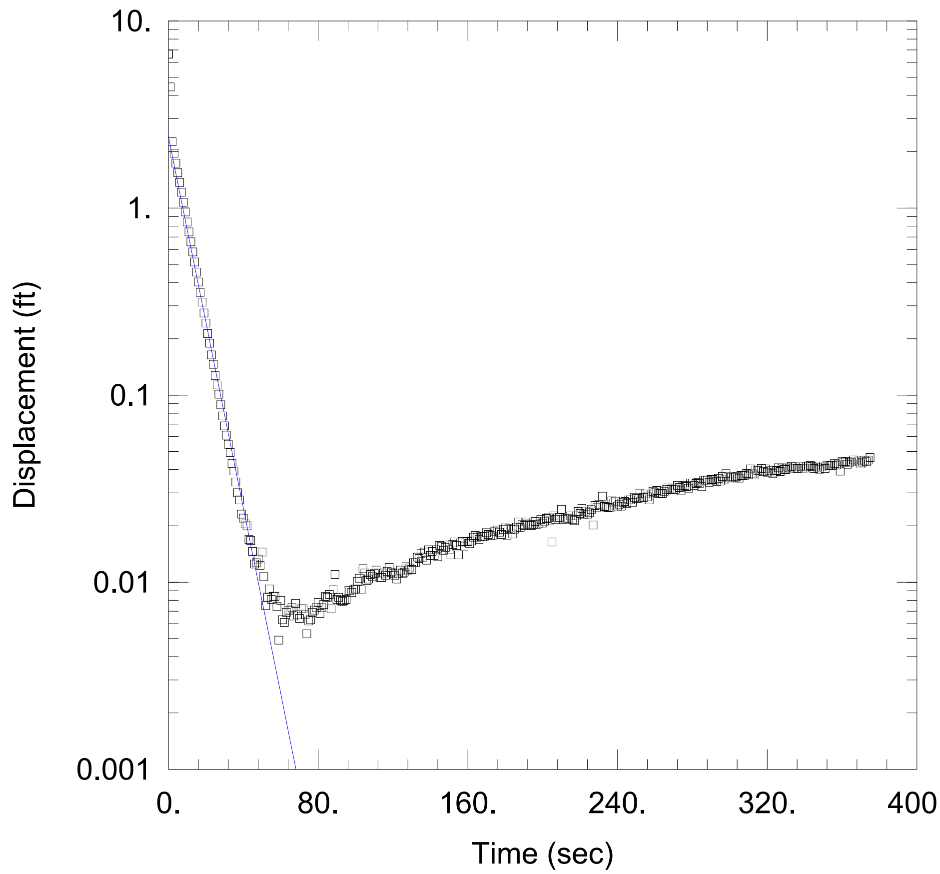
WELL DATA (KC-15-05)

Initial Displacement: 6.646 ft
Static Water Column Height: 29.39 ft
Total Well Penetration Depth: 70. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.004673 cm/sec
y0 = 2.413 ft



OUT-B

Data Set: Y:\...\KC-15-05_OUT-B_H.aqt
Date: 08/18/16 Time: 15:46:40

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - BSP
Test Well: KC-15-05
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 27.76 ft Anisotropy Ratio (Kz/Kr): 1.

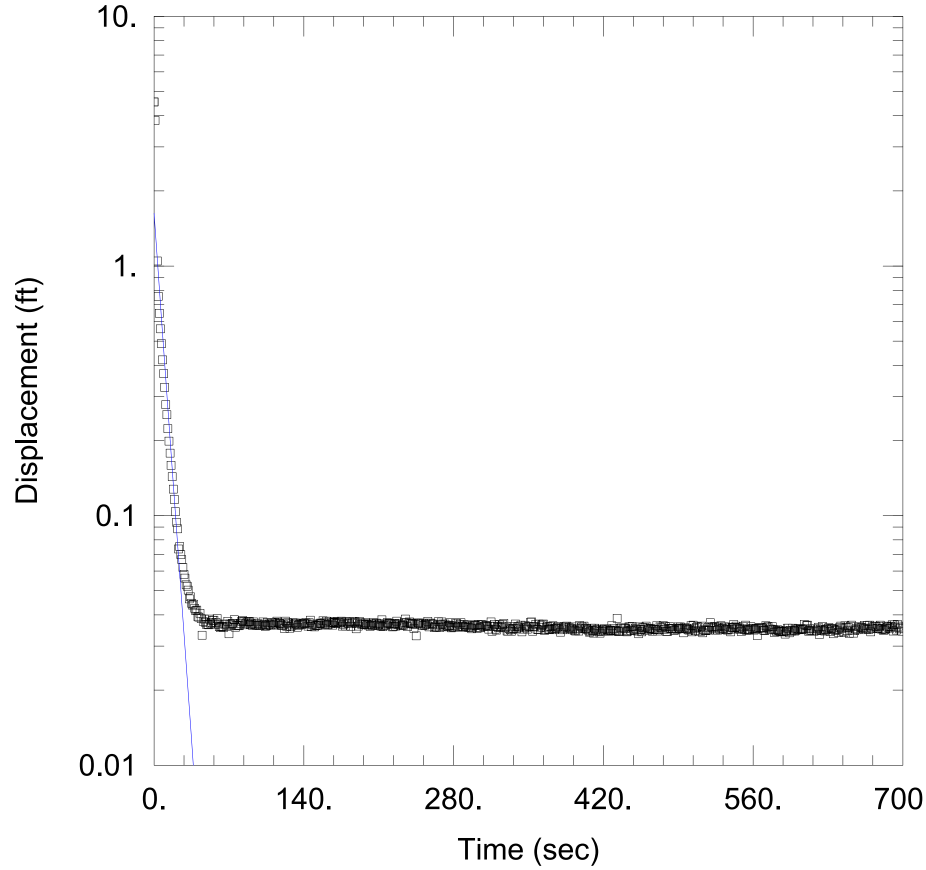
WELL DATA (KC-15-05)

Initial Displacement: 6.646 ft Static Water Column Height: 29.39 ft
Total Well Penetration Depth: 70. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.004912 cm/sec y0 = 2.413 ft



IN-A

Data Set: Y:\...\KC-15-14_IN-A-BR.aqt
Date: 08/18/16 Time: 15:49:09

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - SFAP
Test Well: KC-15-14
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 24.16 ft Anisotropy Ratio (Kz/Kr): 1.

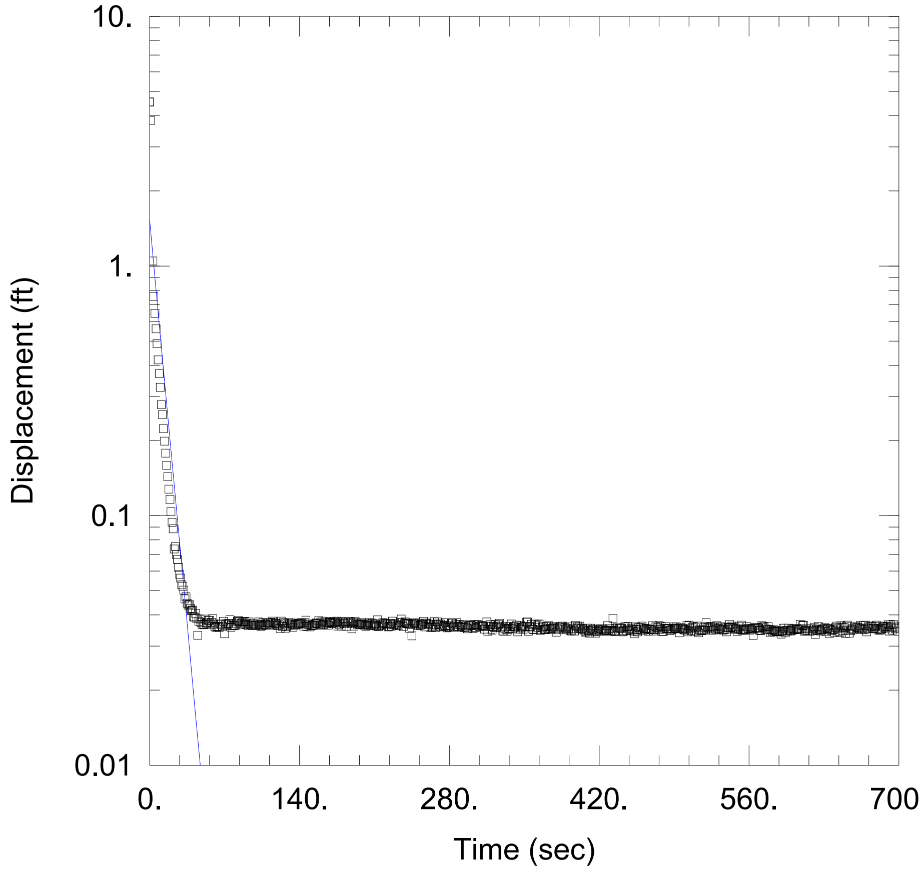
WELL DATA (KC-15-14)

Initial Displacement: 4.543 ft Static Water Column Height: 23.94 ft
Total Well Penetration Depth: 74. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.005407 cm/sec y0 = 1.627 ft



IN-A

Data Set: Y:\...\KC-15-14_IN-A-H.aqt
Date: 08/18/16 Time: 15:49:55

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - SFAP
Test Well: KC-15-14
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 24.16 ft
Anisotropy Ratio (Kz/Kr): 1.

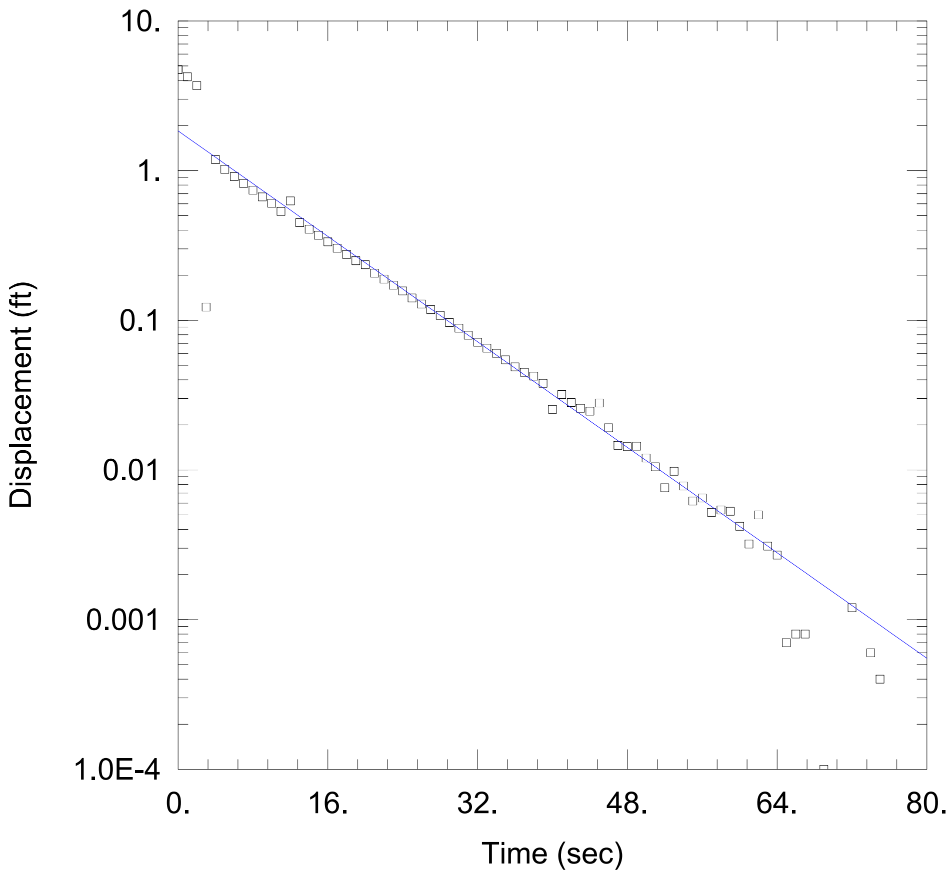
WELL DATA (KC-15-14)

Initial Displacement: 4.543 ft
Static Water Column Height: 23.94 ft
Total Well Penetration Depth: 74. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.004569 cm/sec
y0 = 1.525 ft



IN-B

Data Set: Y:\...\KC-15-14_IN-B-BR.aqt
Date: 08/18/16 Time: 15:51:30

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - SFAP
Test Well: KC-15-14
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 24.16 ft
Anisotropy Ratio (Kz/Kr): 1.

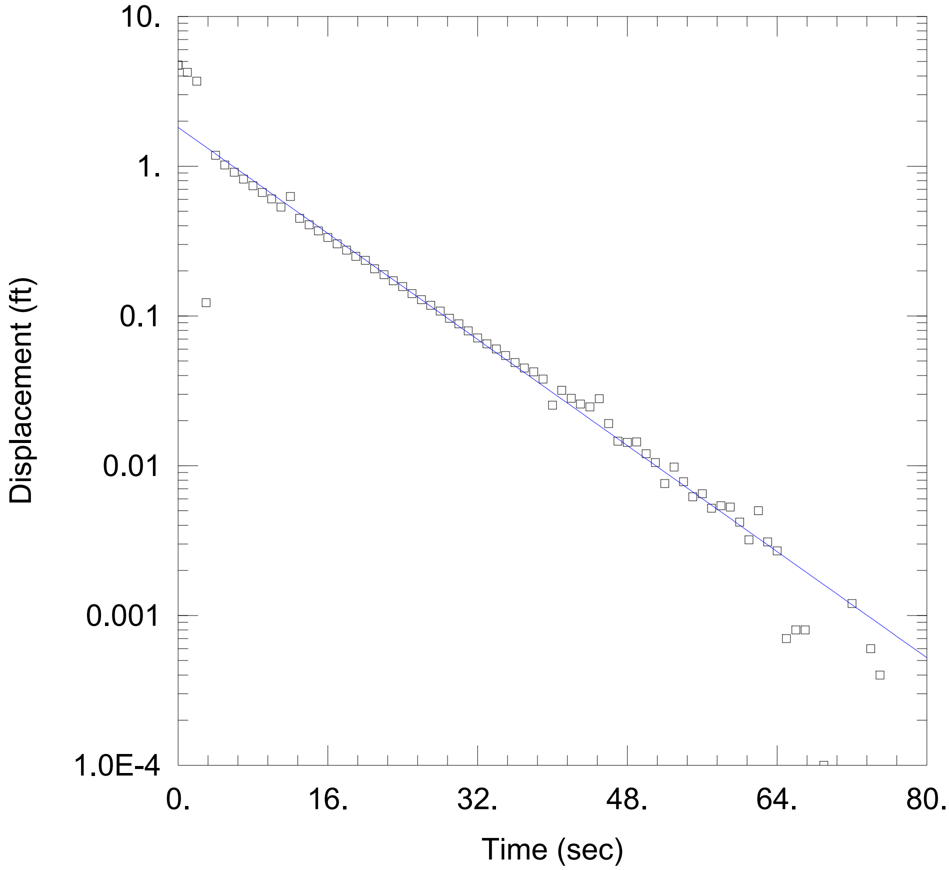
WELL DATA (KC-15-14)

Initial Displacement: 4.722 ft
Total Well Penetration Depth: 74. ft
Casing Radius: 0.083 ft
Static Water Column Height: 23.98 ft
Screen Length: 10. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.003955 cm/sec
y0 = 1.842 ft



IN-B

Data Set: Y:\...\KC-15-14_IN-B-H.aqt
Date: 08/18/16 Time: 15:52:01

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - SFAP
Test Well: KC-15-14
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 24.16 ft Anisotropy Ratio (Kz/Kr): 1.

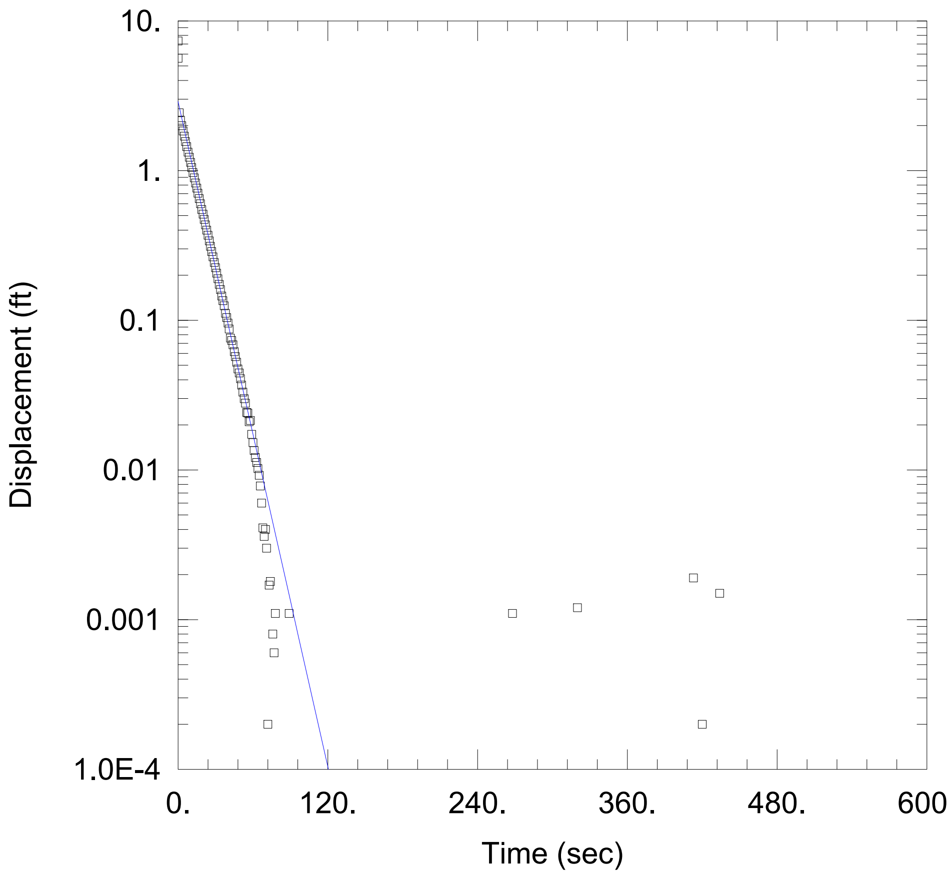
WELL DATA (KC-15-14)

Initial Displacement: 4.722 ft Static Water Column Height: 23.98 ft
Total Well Penetration Depth: 74. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.004383 cm/sec y0 = 1.817 ft



OUT-A

Data Set: Y:\...\KC-15-14_OUT-A-BR.aqt
Date: 08/18/16 Time: 15:52:55

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - SFAP
Test Well: KC-15-14
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 24.16 ft Anisotropy Ratio (Kz/Kr): 1.

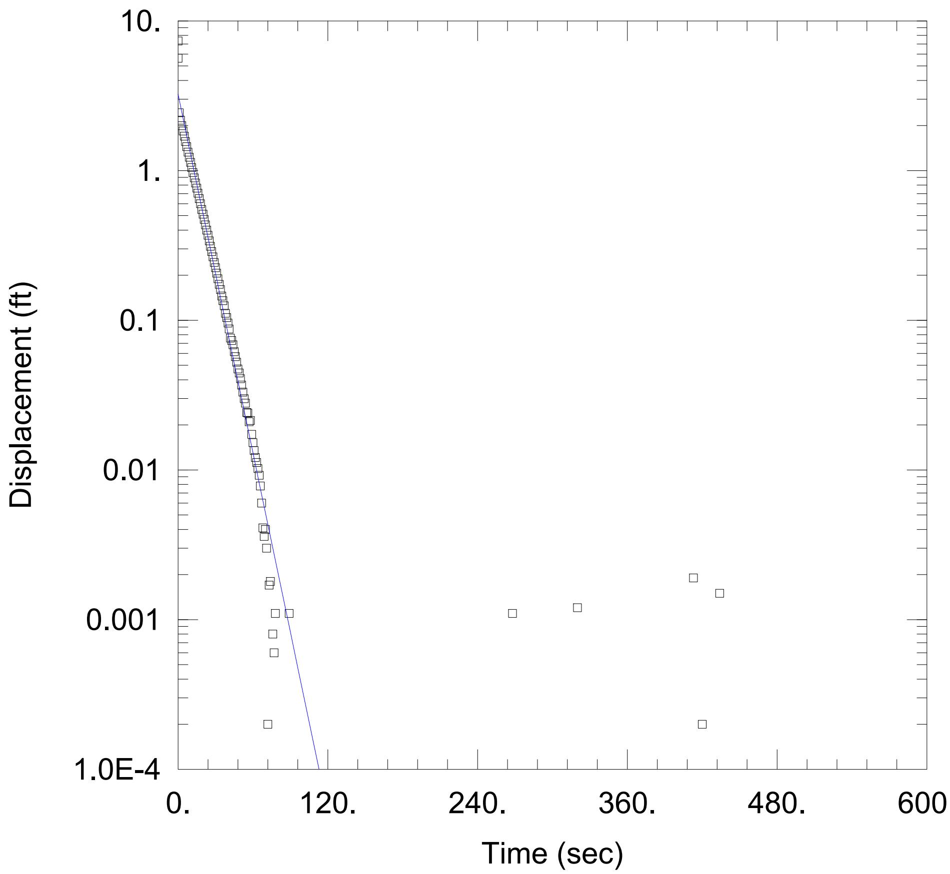
WELL DATA (KC-15-14)

Initial Displacement: 5.635 ft Static Water Column Height: 23.97 ft
Total Well Penetration Depth: 74. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.003327 cm/sec y0 = 2.893 ft



OUT-A

Data Set: Y:\...\KC-15-14_OUT-A-H.aqt
Date: 08/18/16 Time: 15:53:26

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - SFAP
Test Well: KC-15-14
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 24.16 ft
Anisotropy Ratio (Kz/Kr): 1.

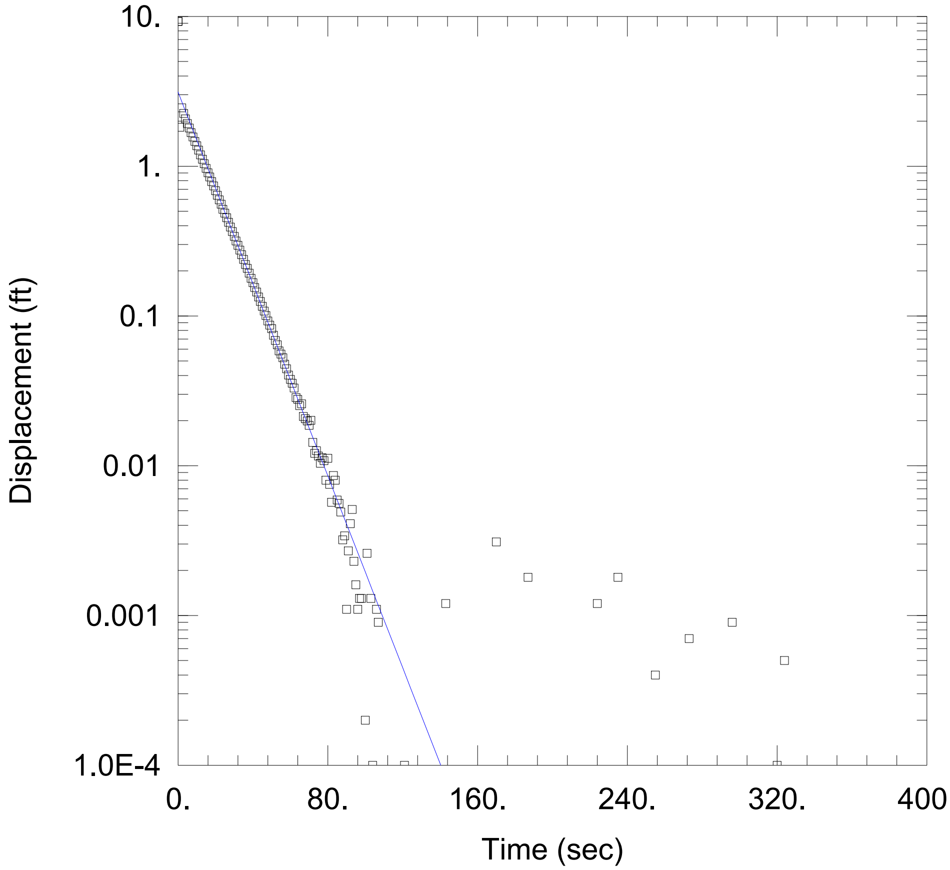
WELL DATA (KC-15-14)

Initial Displacement: 5.635 ft
Total Well Penetration Depth: 74. ft
Casing Radius: 0.083 ft
Static Water Column Height: 23.97 ft
Screen Length: 10. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.003953 cm/sec
y0 = 3.242 ft



OUT-B

Data Set: Y:\...\KC-15-14_OUT-B-BR.aqt
Date: 08/18/16 Time: 15:54:42

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - SFAP
Test Well: KC-15-14
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 24.16 ft
Anisotropy Ratio (Kz/Kr): 1.

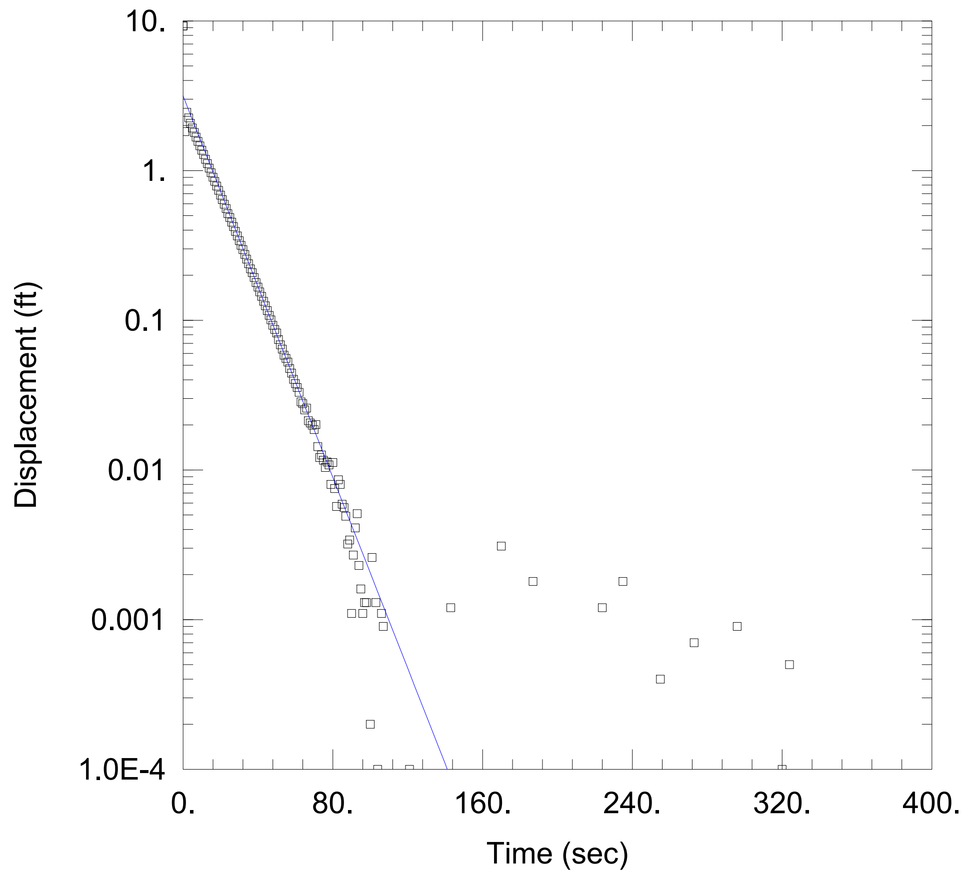
WELL DATA (KC-15-14)

Initial Displacement: 9.258 ft
Static Water Column Height: 23.97 ft
Total Well Penetration Depth: 74. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.002877 cm/sec
y0 = 3.128 ft



OUT-B

Data Set: Y:\...\KC-15-14_OUT-B-H.aqt
Date: 08/18/16 Time: 15:55:41

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - SFAP
Test Well: KC-15-14
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 24.16 ft
Anisotropy Ratio (Kz/Kr): 1.

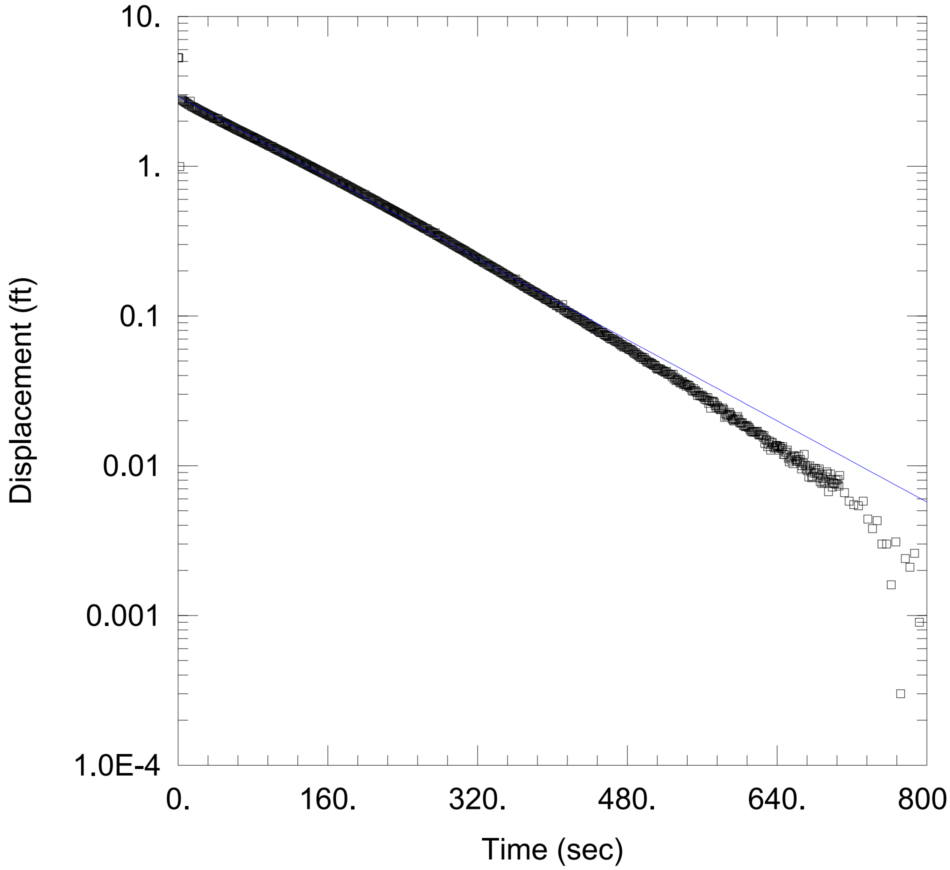
WELL DATA (KC-15-14)

Initial Displacement: 9.258 ft
Static Water Column Height: 23.97 ft
Total Well Penetration Depth: 74. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.003156 cm/sec
y0 = 3.162 ft



IN-A

Data Set: Y:\...\KC-15-21_IN-A-BR.aqt
Date: 08/18/16 Time: 15:57:14

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - SFAP
Test Well: KC-15-21
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 33.33 ft Anisotropy Ratio (Kz/Kr): 1.

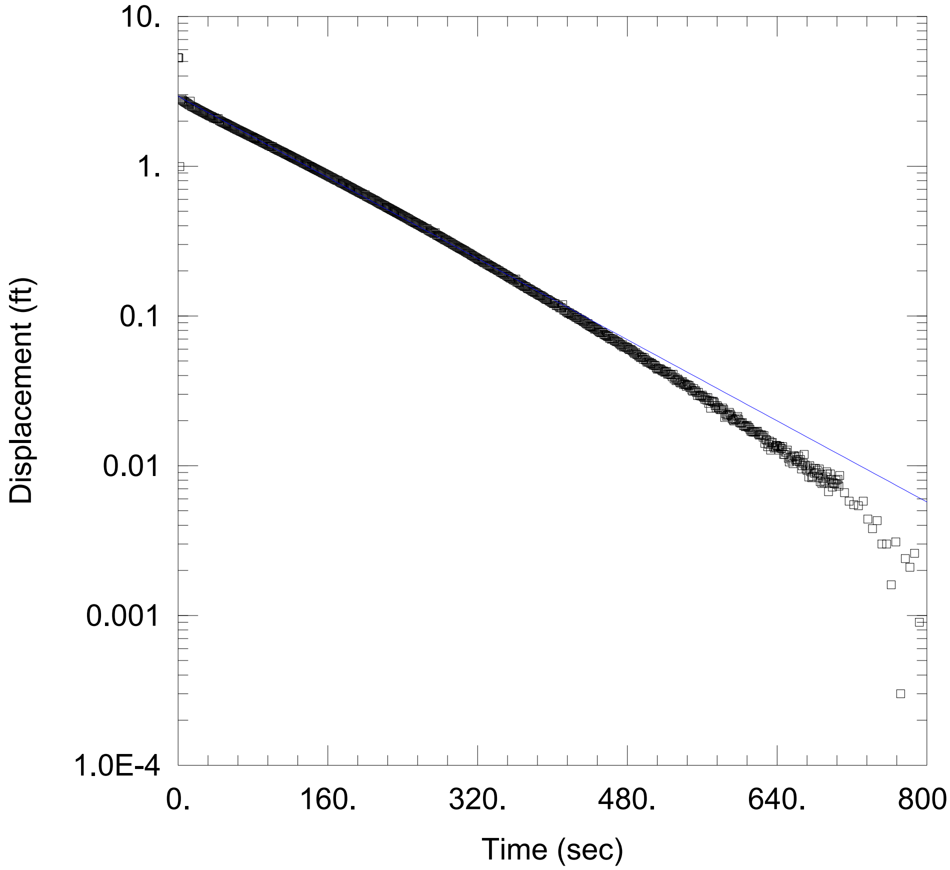
WELL DATA (KC-15-21)

Initial Displacement: 5.308 ft Static Water Column Height: 23.27 ft
Total Well Penetration Depth: 81. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.000308 cm/sec y0 = 2.932 ft



IN-A

Data Set: Y:\...\KC-15-21_IN-A-H.aqt
Date: 08/18/16
Time: 15:58:14

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - SFAP
Test Well: KC-15-21
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 33.33 ft
Anisotropy Ratio (Kz/Kr): 1.

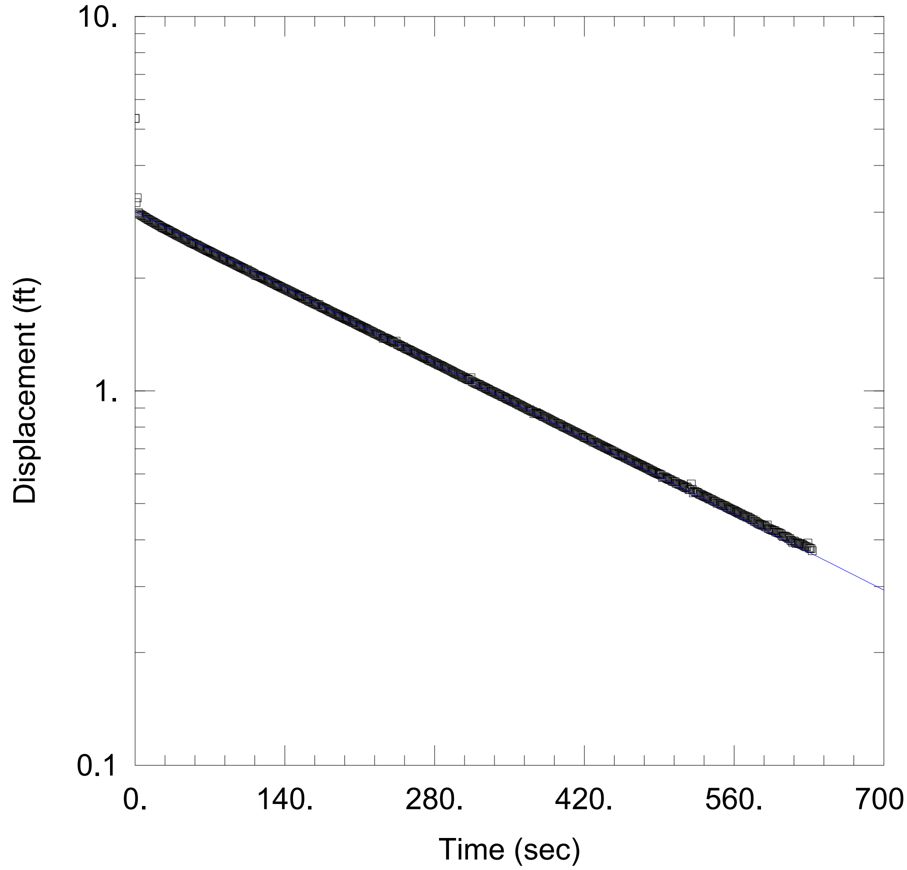
WELL DATA (KC-15-21)

Initial Displacement: 5.308 ft
Static Water Column Height: 23.27 ft
Total Well Penetration Depth: 81. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.0003353 cm/sec
y0 = 2.932 ft



IN-B

Data Set: Y:\...\KC-15-21_IN-B-BR.aqt
Date: 08/18/16 Time: 15:58:52

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - SFAP
Test Well: KC-15-21
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 33.3 ft
Anisotropy Ratio (Kz/Kr): 1.

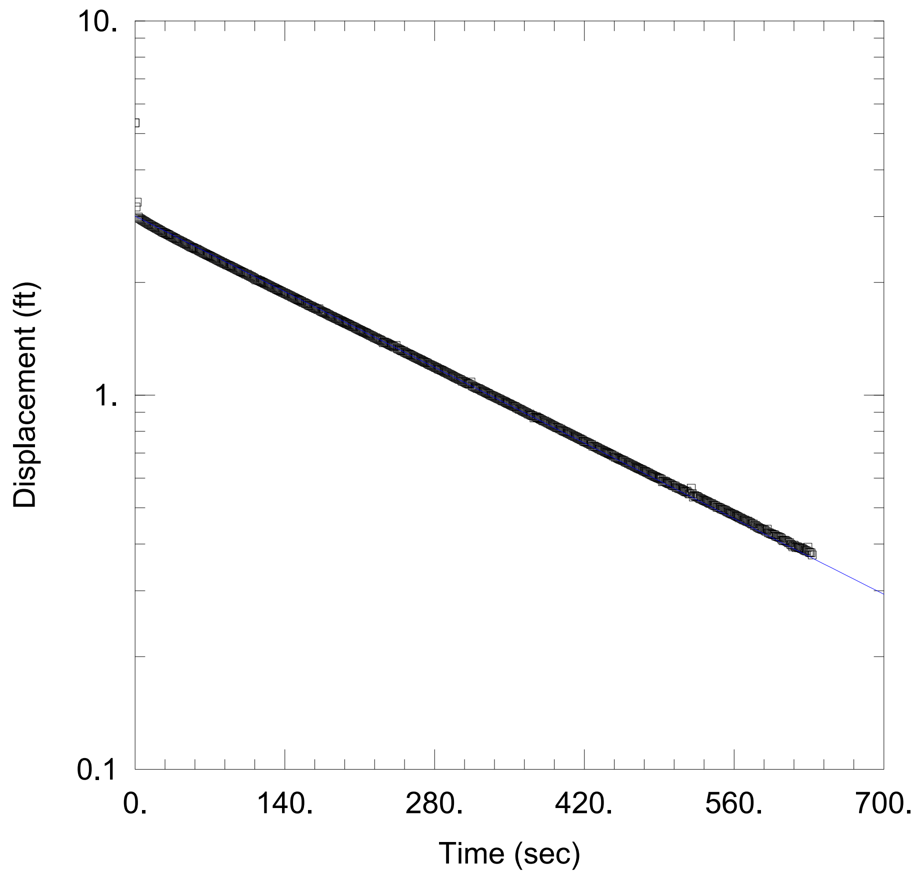
WELL DATA (KC-15-21)

Initial Displacement: 5.34 ft
Static Water Column Height: 23.19 ft
Total Well Penetration Depth: 81. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0001313 cm/sec
y0 = 3.01 ft



IN-B

Data Set: Y:\...\KC-15-21_IN-B-H.aqt
Date: 08/18/16 Time: 15:59:17

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - SFAP
Test Well: KC-15-21
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 33.3 ft Anisotropy Ratio (Kz/Kr): 1.

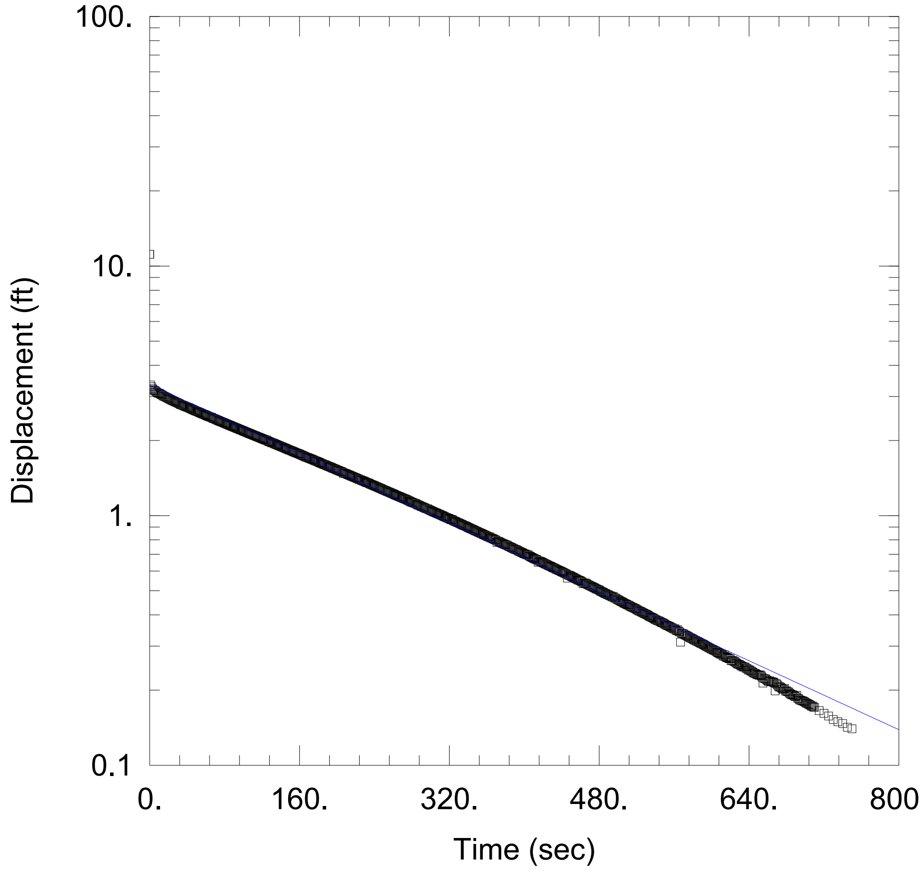
WELL DATA (KC-15-21)

Initial Displacement: 5.34 ft Static Water Column Height: 23.19 ft
Total Well Penetration Depth: 81. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.000143 cm/sec y0 = 3.01 ft



OUT-A

Data Set: Y:\...\KC-15-21_OUT-A-BR.aqt
Date: 08/18/16 Time: 16:00:12

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - SFAP
Test Well: KC-15-21
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 33.3 ft
Anisotropy Ratio (Kz/Kr): 1.

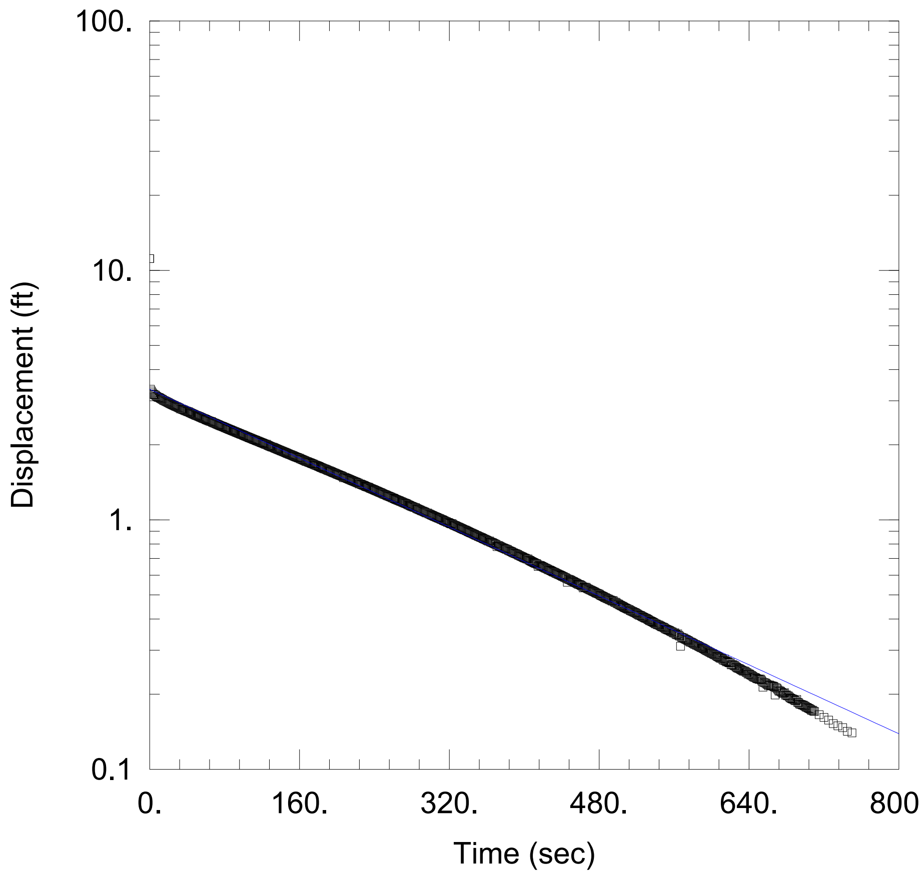
WELL DATA (KC-15-21)

Initial Displacement: 11.15 ft
Static Water Column Height: 23.27 ft
Total Well Penetration Depth: 81. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.000157 cm/sec
y0 = 3.34 ft



OUT-A

Data Set: Y:\...\KC-15-21_OUT-A-H.aqt
Date: 08/18/16 Time: 16:00:56

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - SFAP
Test Well: KC-15-21
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 33.3 ft Anisotropy Ratio (Kz/Kr): 1.

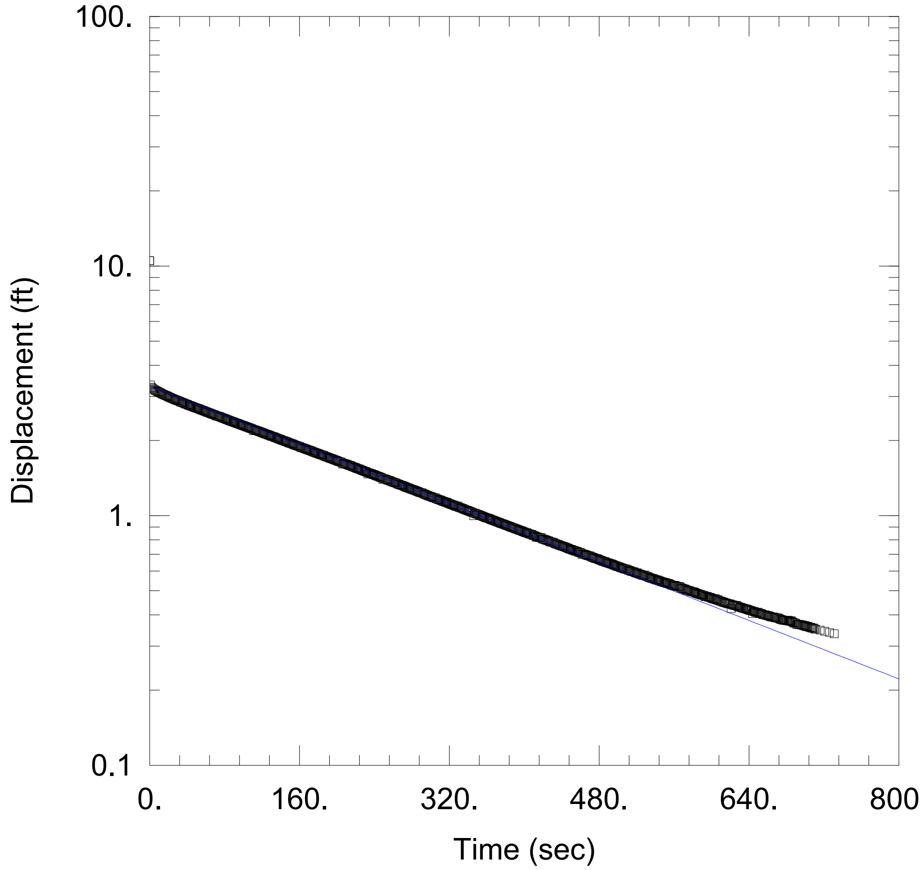
WELL DATA (KC-15-21)

Initial Displacement: 11.15 ft Static Water Column Height: 23.27 ft
Total Well Penetration Depth: 81. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.0001709 cm/sec y0 = 3.34 ft



OUT-B

Data Set: Y:\...\KC-15-21_OUT-B-BR.aqt
Date: 08/18/16 Time: 16:01:29

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - SFAP
Test Well: KC-15-21
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 33.3 ft
Anisotropy Ratio (Kz/Kr): 1.

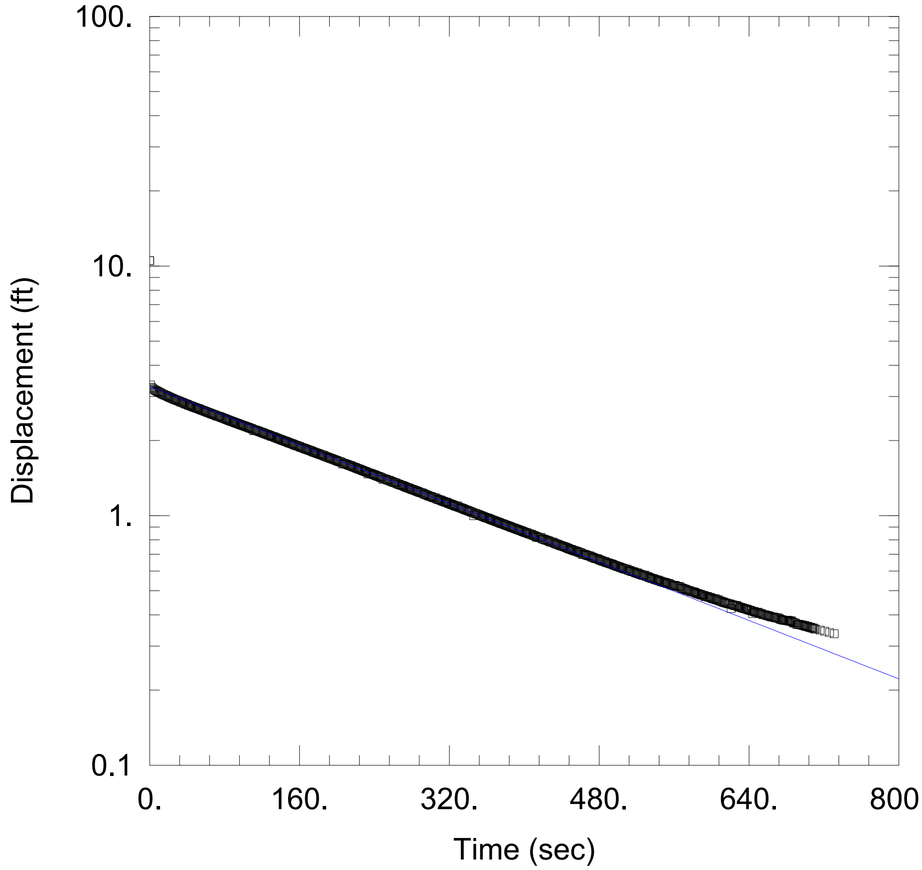
WELL DATA (KC-15-21)

Initial Displacement: 10.5 ft
Static Water Column Height: 23.48 ft
Total Well Penetration Depth: 81. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0001332 cm/sec
y0 = 3.29 ft



OUT-B

Data Set: Y:\...\KC-15-21_OUT-B-H.aqt
Date: 08/18/16 Time: 16:01:55

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2016002
Location: Kyger Creek Station - SFAP
Test Well: KC-15-21
Test Date: 05/18/2016

AQUIFER DATA

Saturated Thickness: 33.3 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (KC-15-21)

Initial Displacement: 10.5 ft Static Water Column Height: 23.48 ft
Total Well Penetration Depth: 81. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

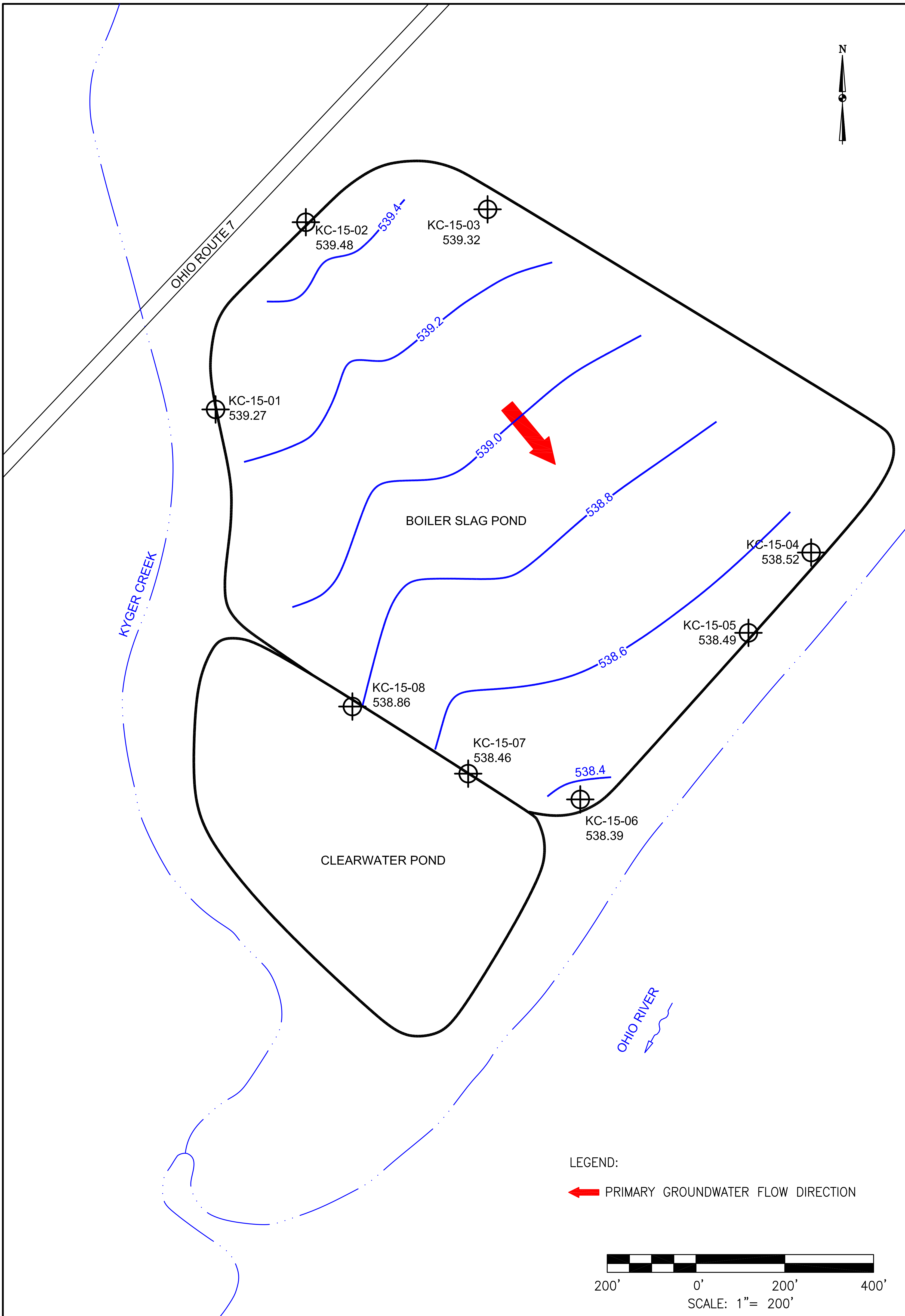
SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.000145 cm/sec y0 = 3.29 ft

APPENDIX C3 – GROUNDWATER CONTOUR MAPS

Boiler Slag Pond



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017110–KYGER
DWG FILE	B–10_KYGER MW INSTALL_CONTOURS 10–15 SLAG b10.dwg
DRAWING SCALE	1"=200'

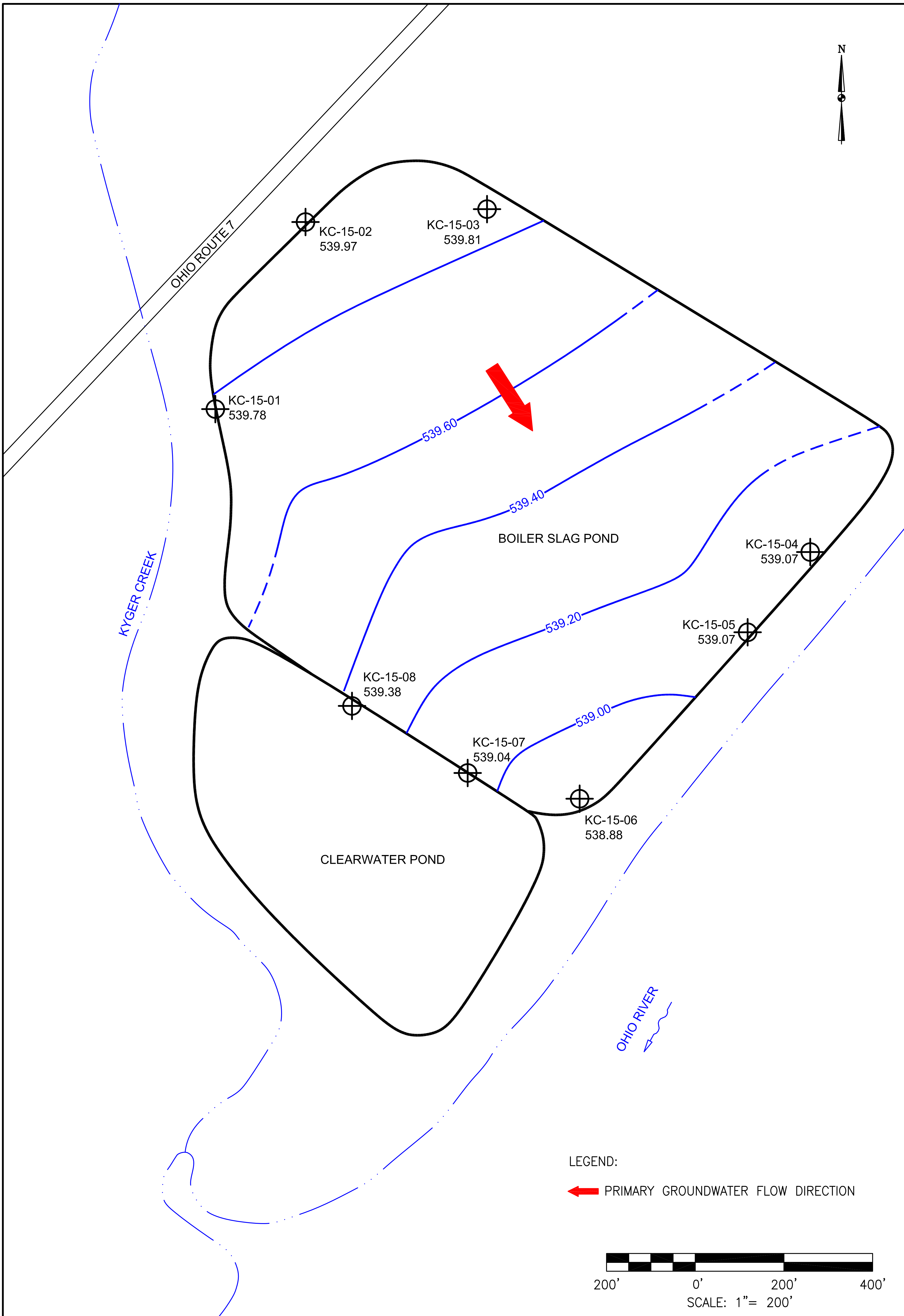
AGES
Applied Geology And Environmental Science, Inc.
2402 Hookstown Grade Road, Suite 200
Clinton, PA 15026
412.264.6453

OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER CONTOUR MAP – OCTOBER 2015

DRAWING NAME: FIGURE B–10
REV. 0

Plot: 01/15/2018 11:40 \Kyger Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt\APPX B\B–10_KYGER MW INSTALL_CONTOURS 10–15 SLAG b10.dwg



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DATE	
CHECKED BY	
JOB NO.	2017110–KYGER
DWG FILE	B–11_KYGER MW INSTALL_CONTOURS 01–16 SLAG b11.dwg
DRAWING SCALE	1"=200'

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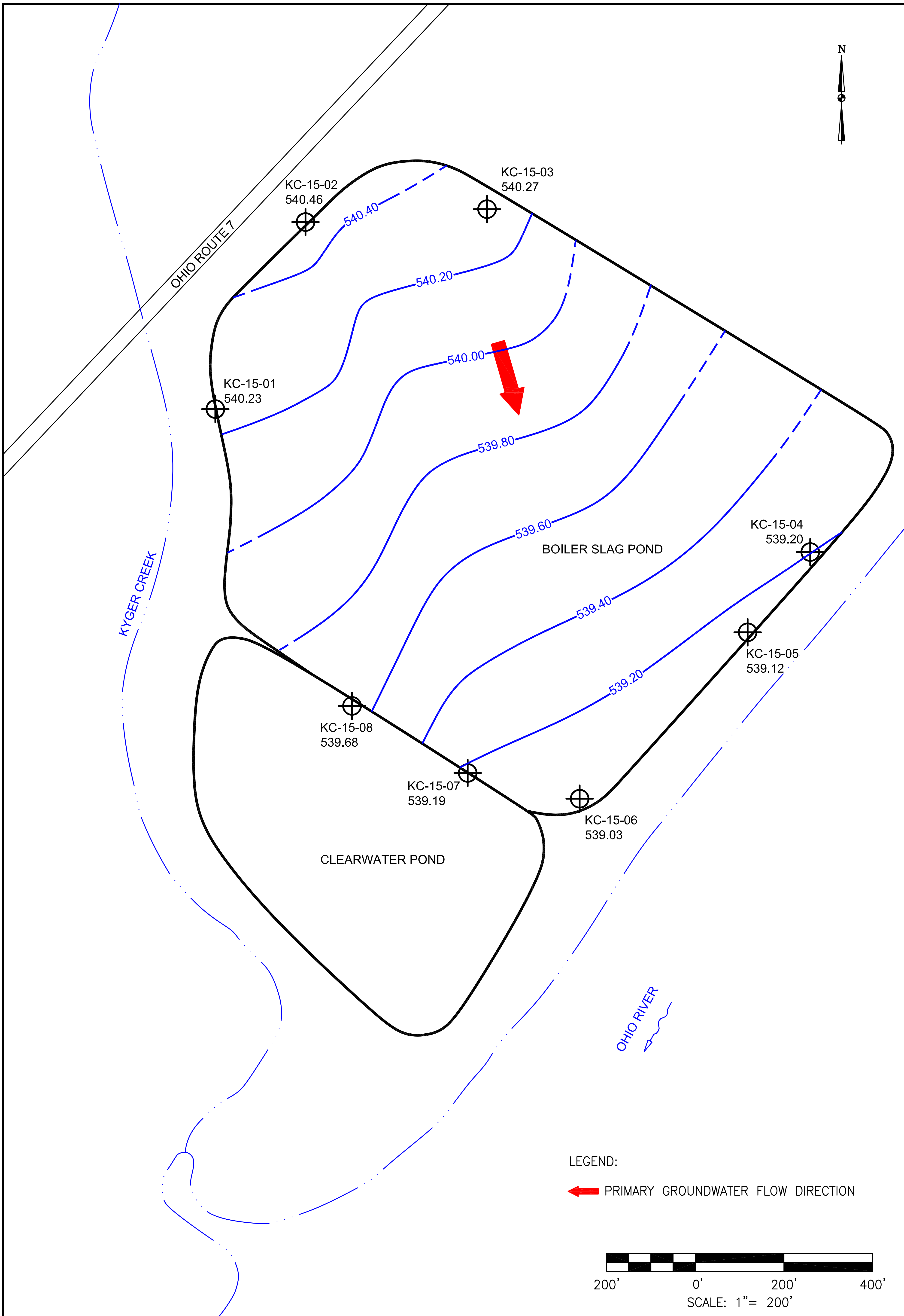
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER CONTOUR MAP – JANUARY 2016

DRAWING NAME	REV.
FIGURE B–11	0

Plot: 01/15/2018 11:43 \Kyger Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt\APPX B\B–11_KYGER MW INSTALL_CONTOURS 01–16 SLAG b11.dwg



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DATE	
CHECKED BY	
JOB NO.	2017110–KYGER
DWG FILE	B–12_KYGER MW INSTALL_CONTOURS 03–16 SLAG b12.dwg
DRAWING SCALE	1"=200'

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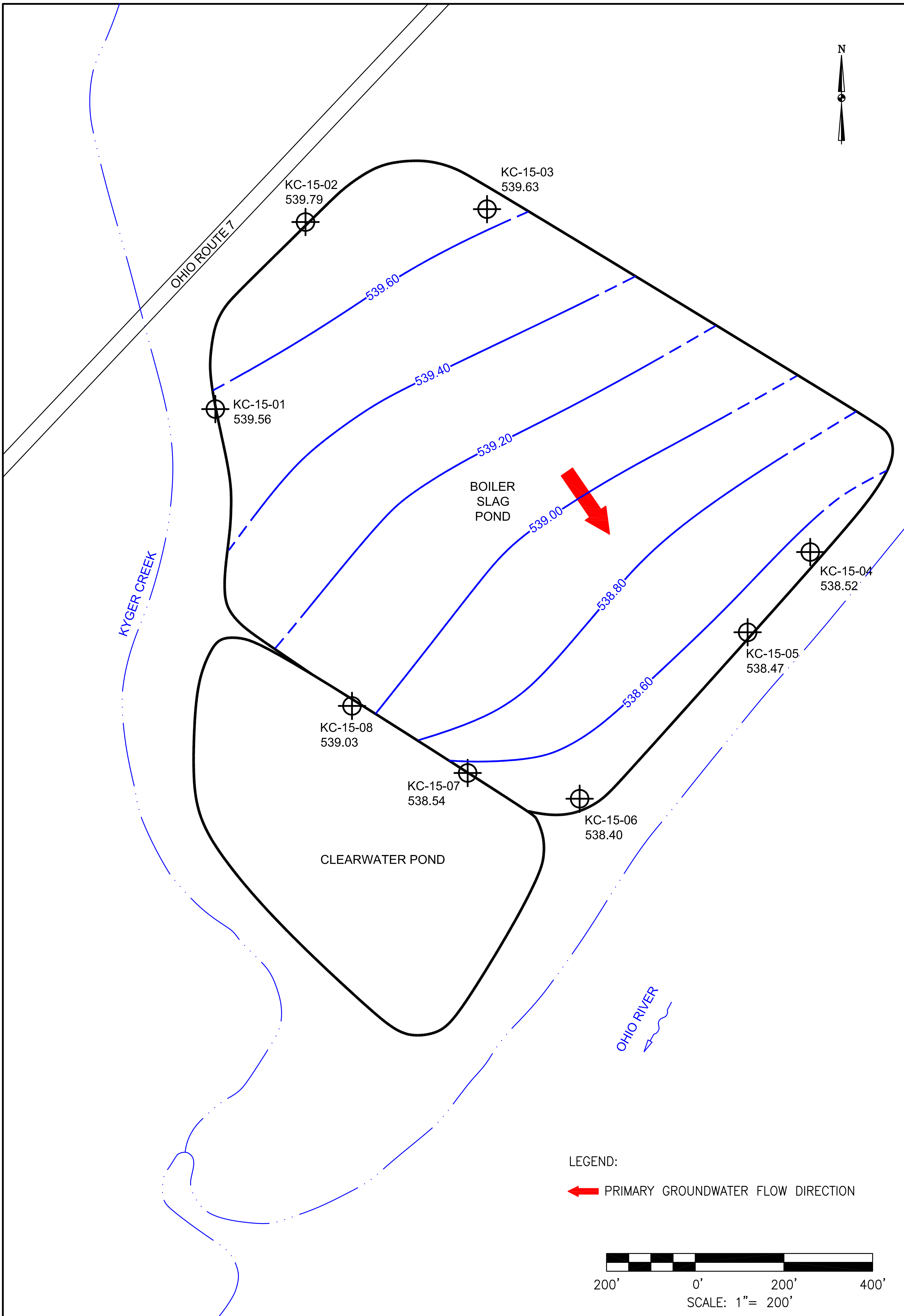
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER CONTOUR MAP – MARCH 2016

DRAWING NAME: FIGURE B–12
REV. 0

Plot: 01/15/2018 13:33 \Kyger Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt\APPX B\B–12_KYGER MW INSTALL_CONTOURS 03–16 SLAG b12.dwg



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DATE	
CHECKED BY	
JOB NO.	2017110–KYGER
DWG FILE	B–13_KYGER MW INSTALL_CONTOURS 05–16 SLAG b13.dwg
DRAWING SCALE	1"=200'

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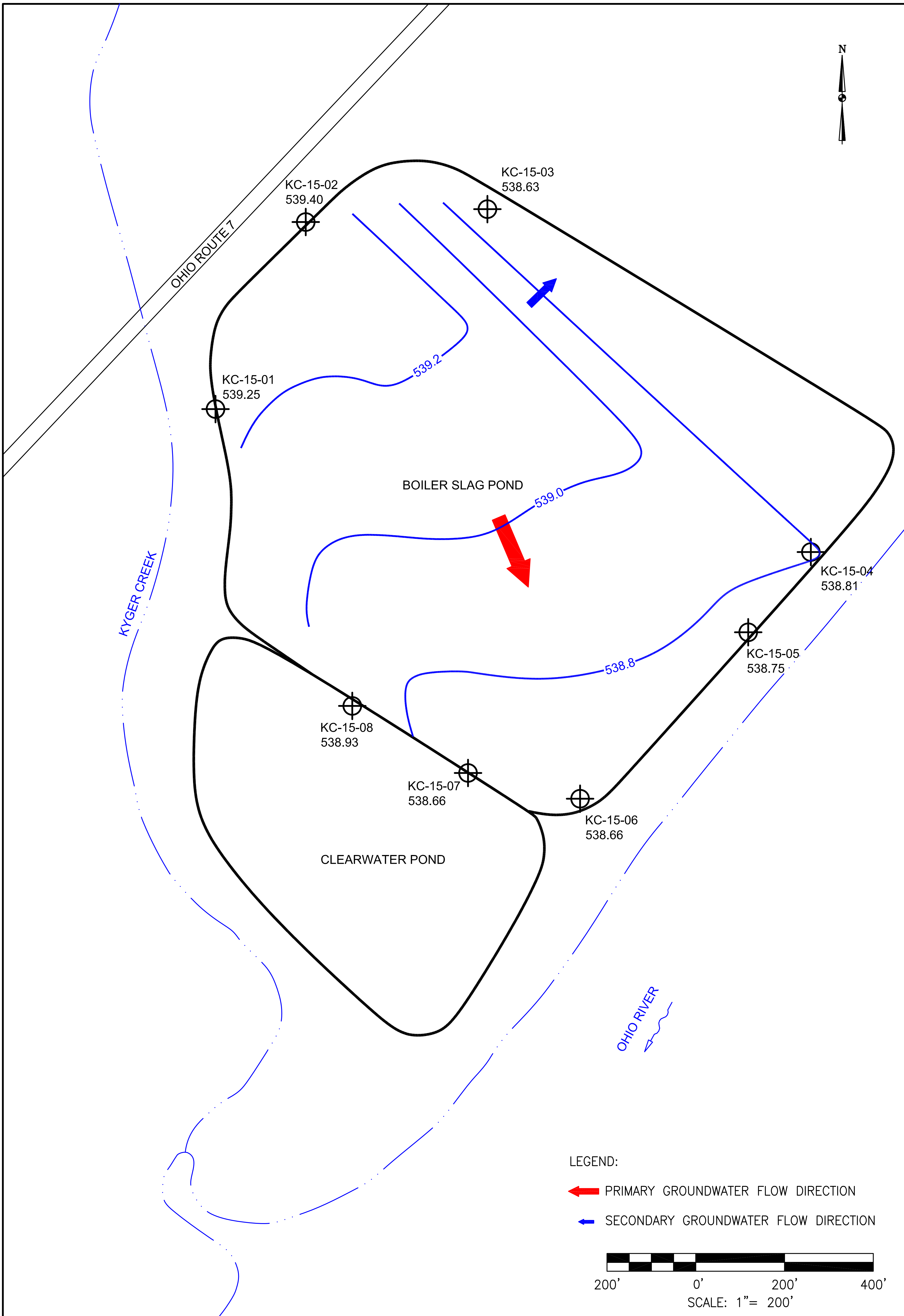
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER CONTOUR MAP – MAY 2016

DRAWING NAME: FIGURE B–13

REV. 0

Plot: 01/15/2018 13:35 \Kyger Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt\APPX B\B–13_KYGER MW INSTALL_CONTOURS 05–16 SLAG b13.dwg



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DATE	
CHECKED BY	
JOB NO.	2017110–KYGER
DWG FILE	B–14_KYGER MW INSTALL_CONTOURS 09–16 SLAG b14.dwg
DRAWING SCALE	1"=200'

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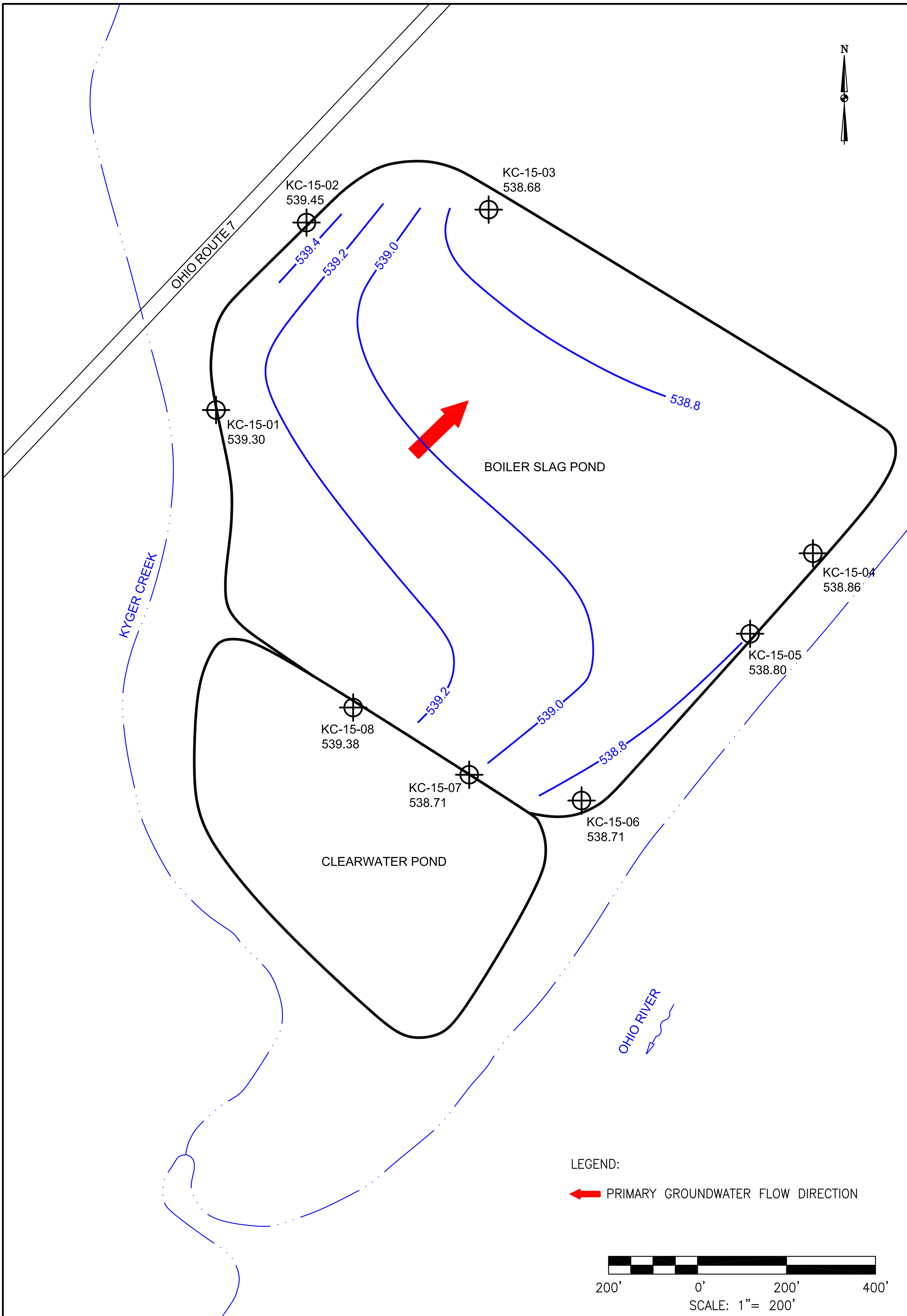
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER CONTOUR MAP – SEPTEMBER 2016

DRAWING NAME: FIGURE B–14
REV. 0

Plot: 01/15/2018 13:40 \Kyger Creek-CCR Program\CAD\2017 GW Monitoring-Corrective Action Rpt\APPX B\B-14_KYGER MW INSTALL_CONTOURS 09-16 SLAG b14.dwg



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CHECKED BY	
JOB NO.	2017110–KYGER
DWG FILE	B–15_KYGER MW INSTALL_CONTOURS 12–16 SLAG b15.dwg
DRAWING SCALE	1"=200'

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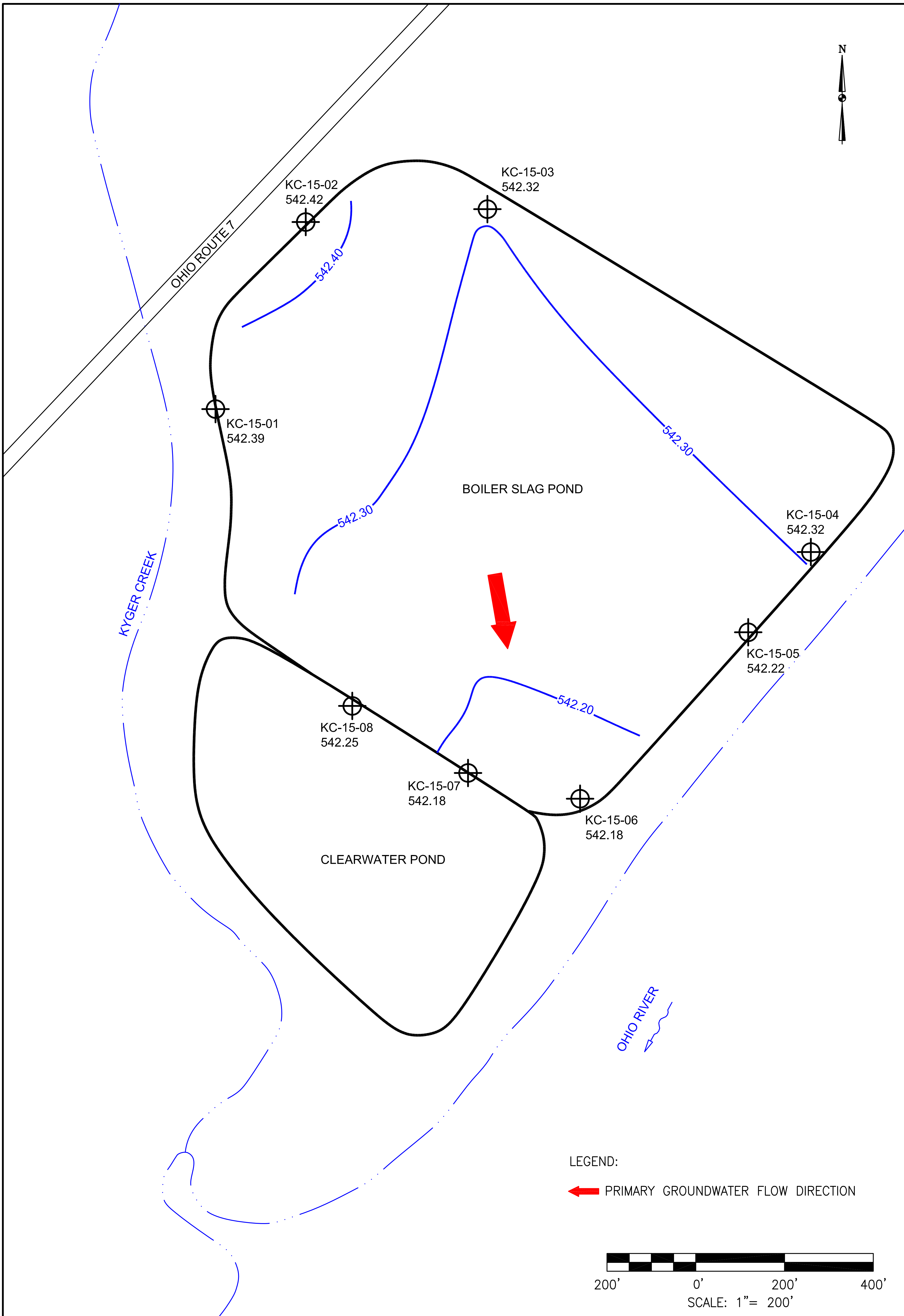
OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER CONTOUR MAP – DECEMBER 2016

DRAWING NAME: FIGURE B–15
REV. 0

Plot: 01/15/2018 13:43 \Kyger Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt\APPX B\B–15_KYGER MW INSTALL_CONTOURS 12–16 SLAG b15.dwg



DRAWN BY	JM
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CHECKED BY	
JOB NO.	2017110-KYGER
DWG FILE	B-16_KYGER MW INSTALL_CONTOURS 03-17 SLAG b16.dwg
DRAWING SCALE	1"=200'

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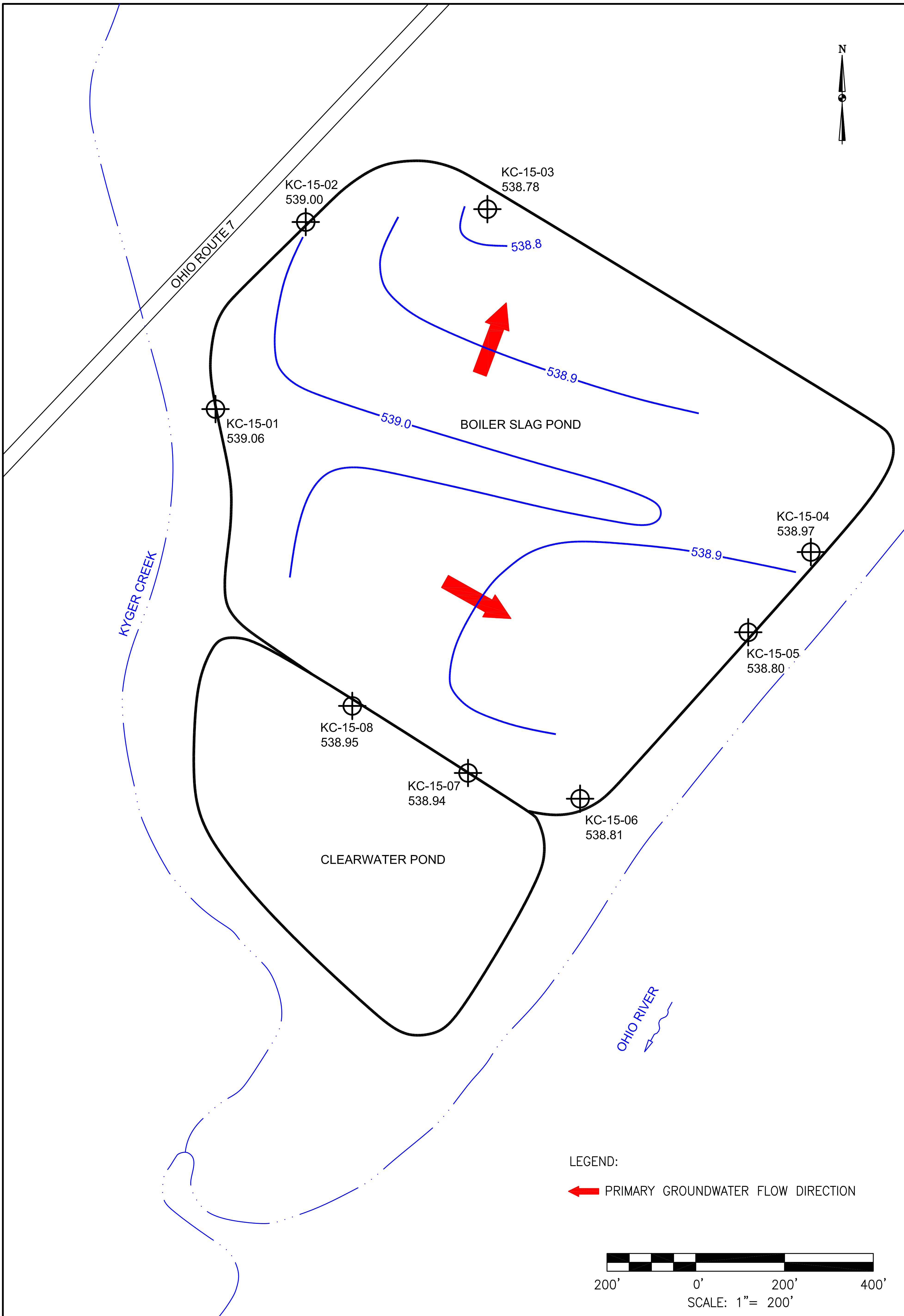
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER CONTOUR MAP – MARCH 2017

DRAWING NAME: FIGURE B-16

REV. 0

Plot: 01/15/2018 13:47 \Kyger Creek-CCR Program\CAD\2017 GW Monitoring-Corrective Action Rpt\APPX B\B-16_KYGER MW INSTALL_CONTOURS 03-17 SLAG b16.dwg



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017110–KYGER
DWG FILE	B–17_KYGER MW INSTALL_CONTOURS 06–17 SLAG b17.dwg
DRAWING SCALE	1"=200'

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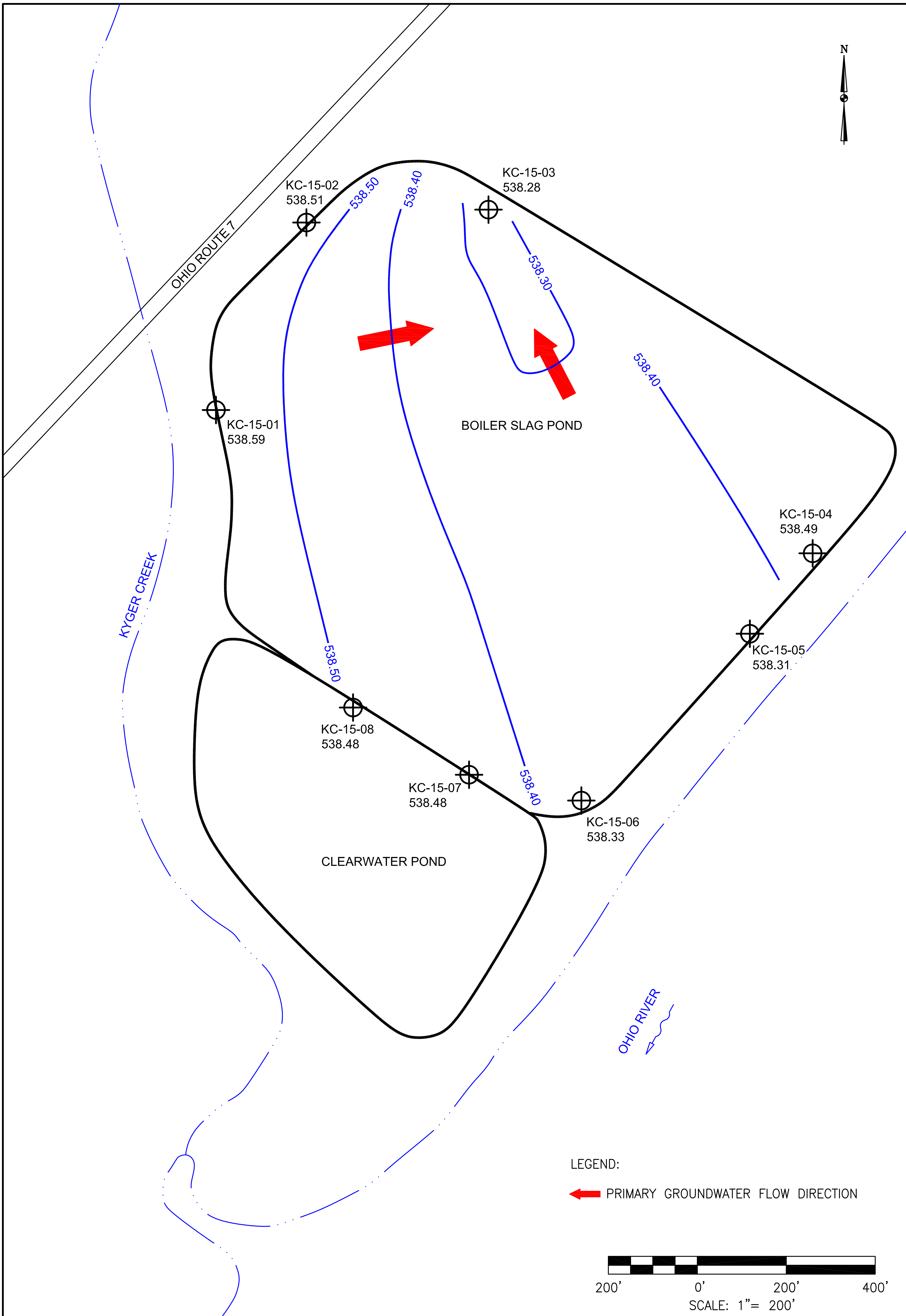
OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER CONTOUR MAP – JUNE 2017

DRAWING NAME: FIGURE B–17
REV. 0

Plot: 01/15/2018 13:50 \Kyger Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt\APPX B\B–17_KYGER MW INSTALL_CONTOURS 06–17 SLAG b17.dwg



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017110–KYGER
DWG FILE	B–18_KYGER MW INSTALL_CONTOURS 09–17 SLAG b18.dwg
DRAWING SCALE	1"=200'

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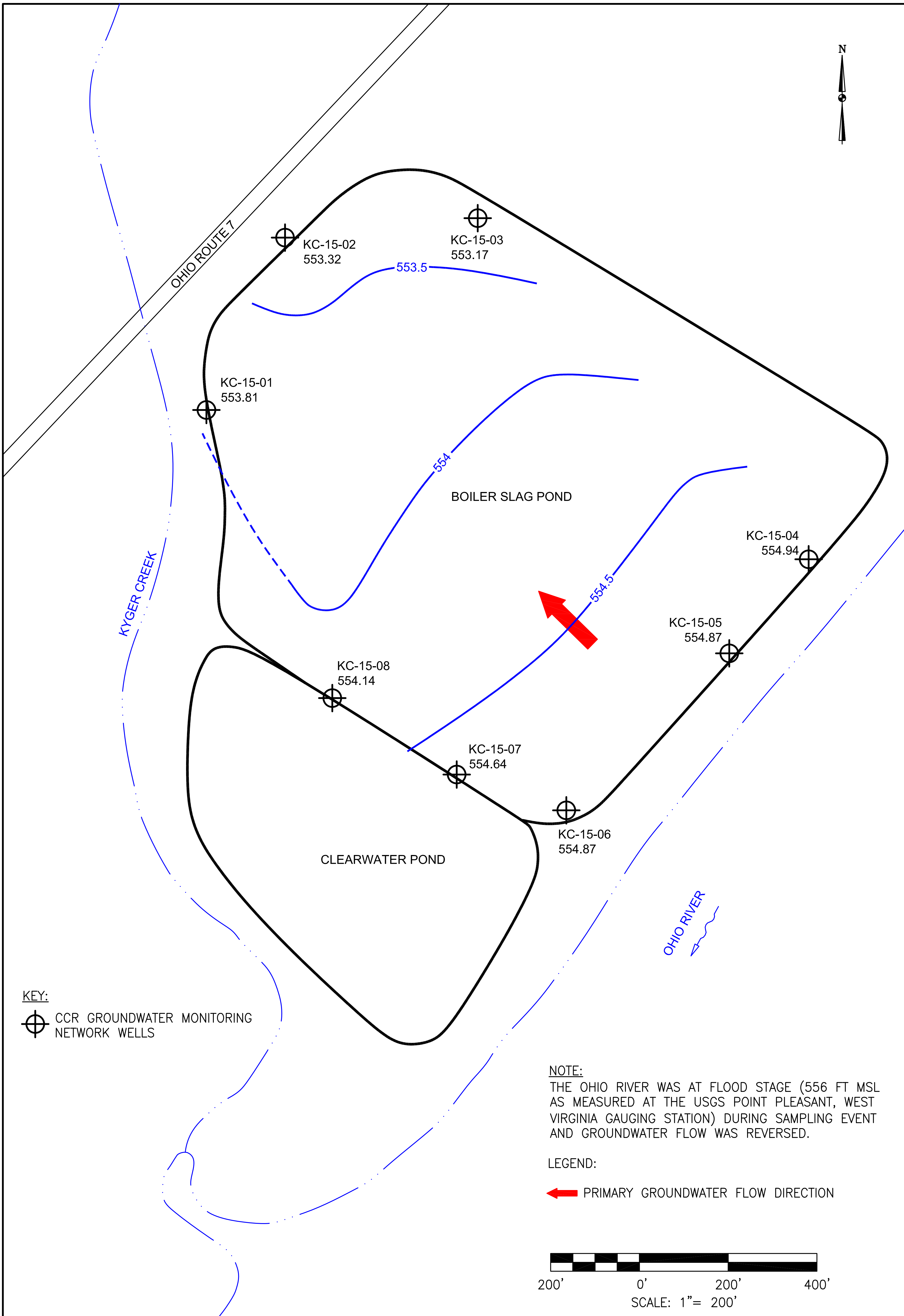
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER CONTOUR MAP – SEPTEMBER 2017

DRAWING NAME: FIGURE B–18

REV. 0

Plot: 01/15/2018 13:53 \Kyger Creek-CCR Program\CAD\2017 GW Monitoring-Corrective Action Rpt\APPX B\B-18_KYGER MW INSTALL_CONTOURS 09-17 SLAG b18.dwg



KEY:

CCR GROUNDWATER MONITORING NETWORK WELLS

NOTE:
THE OHIO RIVER WAS AT FLOOD STAGE (556 FT MSL AS MEASURED AT THE USGS POINT PLEASANT, WEST VIRGINIA GAUGING STATION) DURING SAMPLING EVENT AND GROUNDWATER FLOW WAS REVERSED.

LEGEND:

PRIMARY GROUNDWATER FLOW DIRECTION

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017110–KYGER
DWG FILE	B–3 KYGER_CCR_Slag_Contours b10R_FEB–18.dwg
DRAWING SCALE	1"=200'

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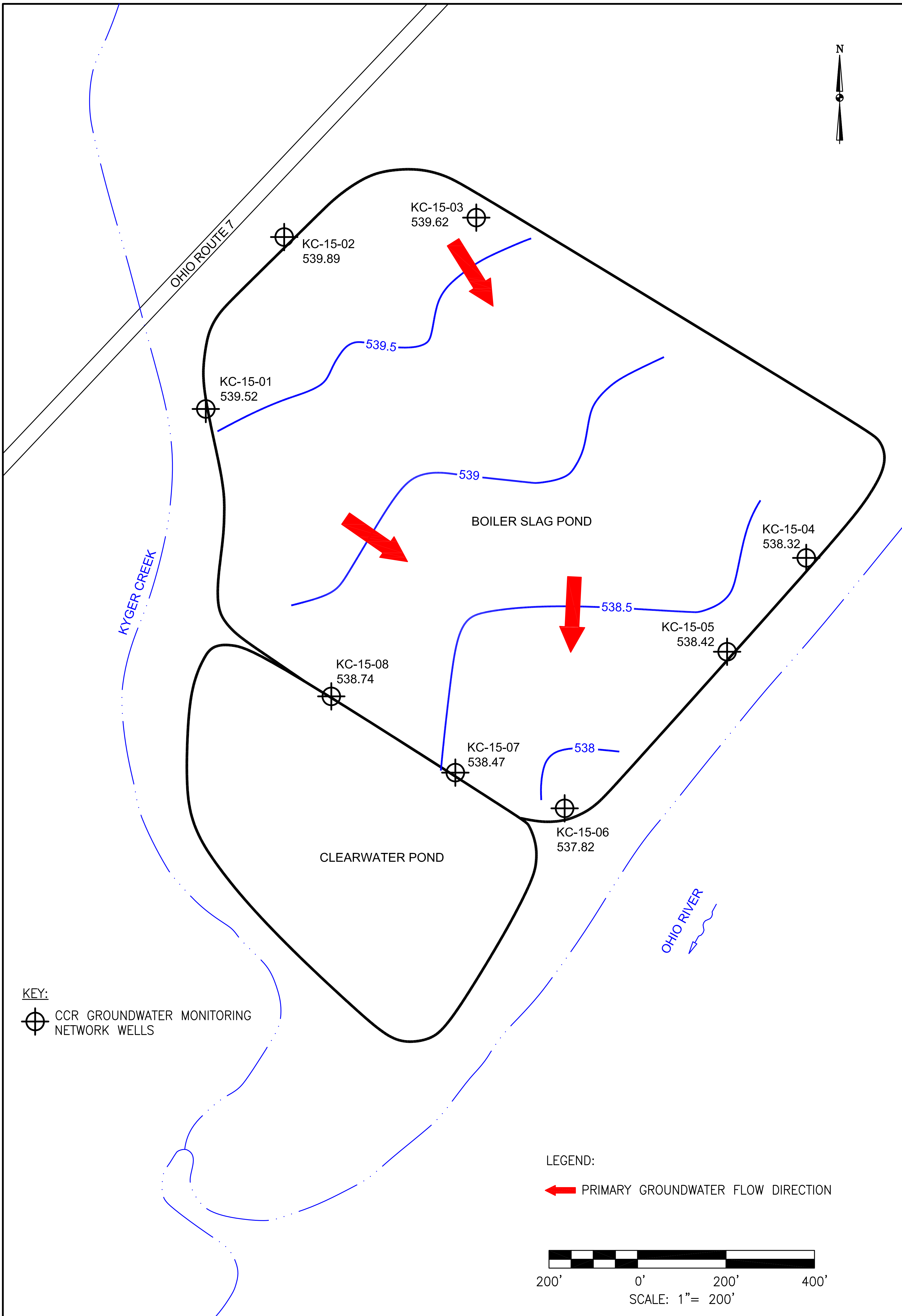
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER CONTOUR MAP – FEBRUARY 2018

DRAWING NAME: FIGURE B–3
REV.: 0

Plot: 01/16/2019 09:59 _PROGRAM–KYGER OVEC\Kyger Creek–CCR Program\CAD\2018 GW Monitoring–Corrective Action Rpt\Appx B\B–3 KYGER_CCR_Slag_Contours b10R_FEB–18.dwg



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017110–KYGER
DWG FILE	B–4 KYGER_CCR_Slag_Contours b10R_SEPT–18.dwg
DRAWING SCALE	1"=200'

AGES
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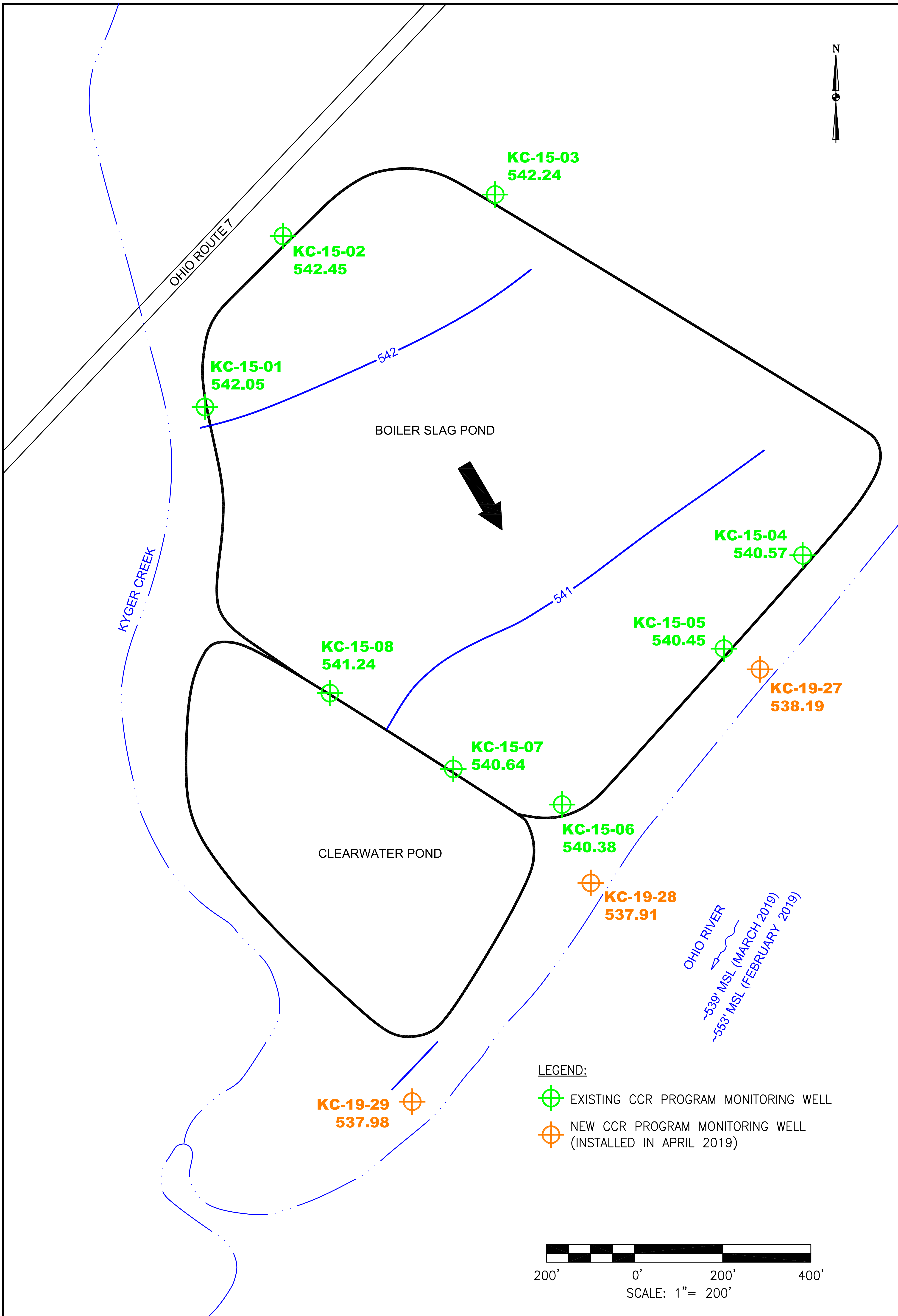
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER CONTOUR MAP – SEPTEMBER 2018

DRAWING NAME: FIGURE B–4
REV.: 0

Plot: 01/11/2019 14:42 _PROGRAM–KYGER OVEC\Kyger Creek–CCR Program\CAD\2018 GW Monitoring–Corrective Action Rpt\Appx B\B–4 KYGER_CCR_Slag_Contours b10R_SEPT–18.dwg



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2019018–KYGER
DWG FILE	KYGER_CCR_2019 Annual GW Rpt_BSP_GW Flow_MAR2019.dwg
DRAWING SCALE	1"=200'

AGES
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Clinton, PA 15026
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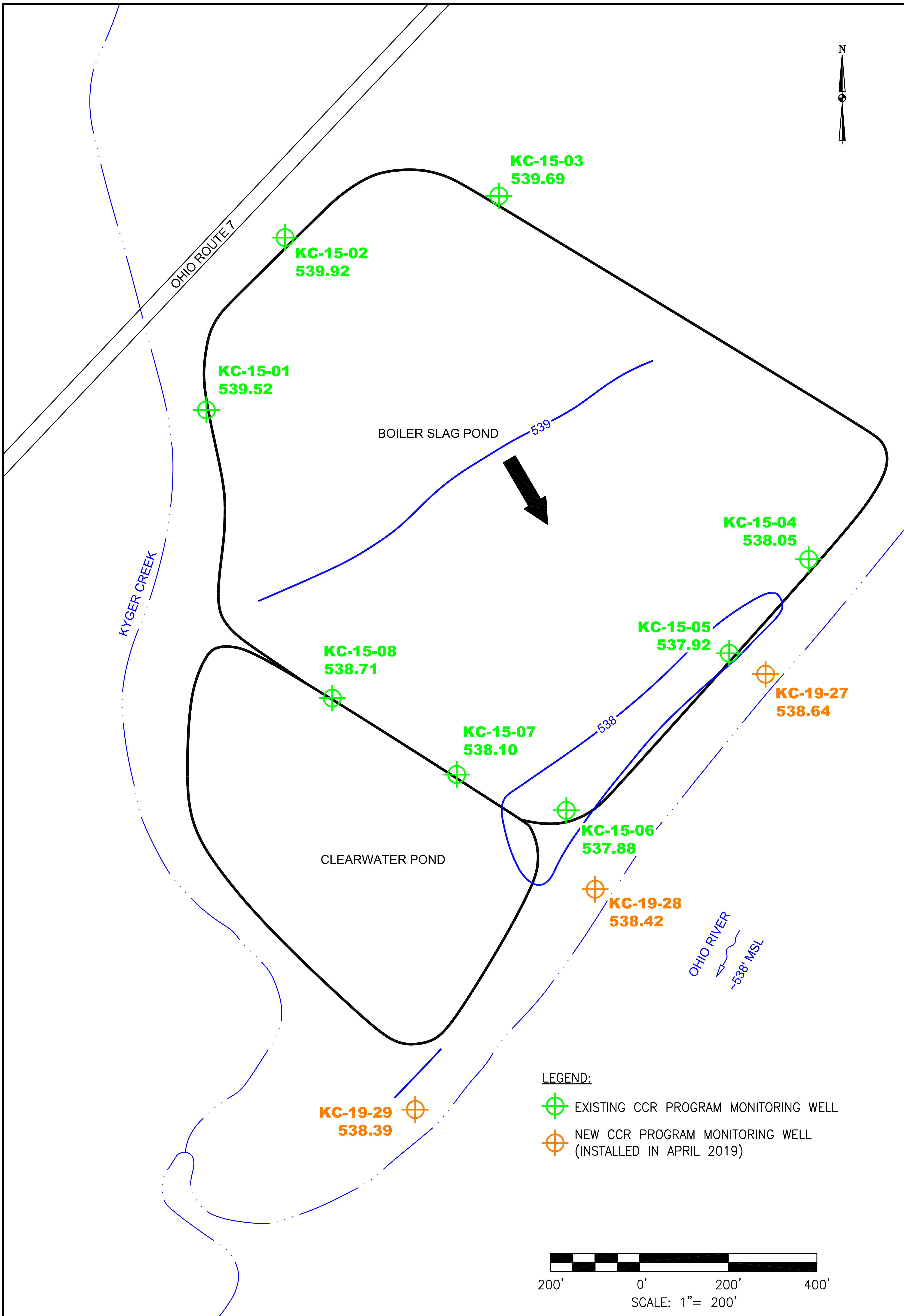
OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER LEVELS AND FLOW DIRECTION
MARCH 2019

DRAWING NAME	REV.
FIGURE B–3	0

Plot: 01/17/2020 11:52 \Kyger Creek–CCR Program\CAD\2019 GW Monitoring–Corrective Action Rpt\Appx B\KYGER_CCR_2019 Annual GW Rpt_BSP_GW Flow_MAR2019.dwg



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2019018–KYGER
DWG FILE	KYGER_CCR_2019 Annual GW Rpt_BSP_GW Flow_SEPT2019.dwg
DRAWING SCALE	1"=200'

AGES
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2402 Hookstown Grade Road, Suite 200
Clinton, PA 15026
412.264.6453

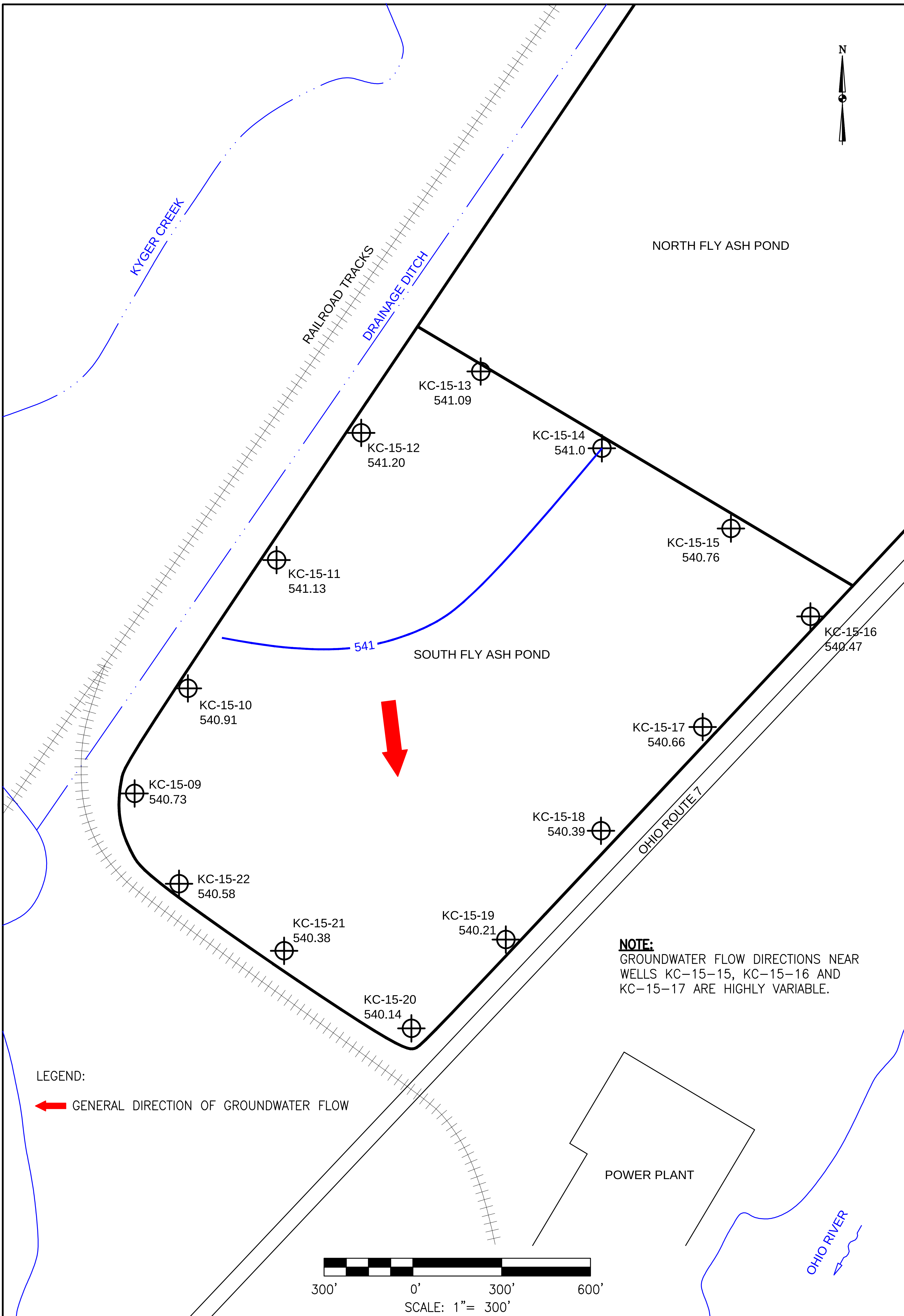
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER LEVELS AND FLOW DIRECTION
SEPTEMBER 2019

DRAWING NAME: FIGURE B–4
REV. 0

Plot: 01/17/2020 11:56 \Kyger Creek–CCR Program\CAD\2019 GW Monitoring–Corrective Action Rpt\Appx B\KYGER_CCR_2019 Annual GW Rpt_BSP_GW Flow_SEPT2019.dwg

South Fly Ash Pond



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2020016–KYG
DWG FILE	B–19_RVSD_KYGER_SFAP_GW FLOW_OCT15.dwg
DRAWING SCALE	1"=300'

AGES
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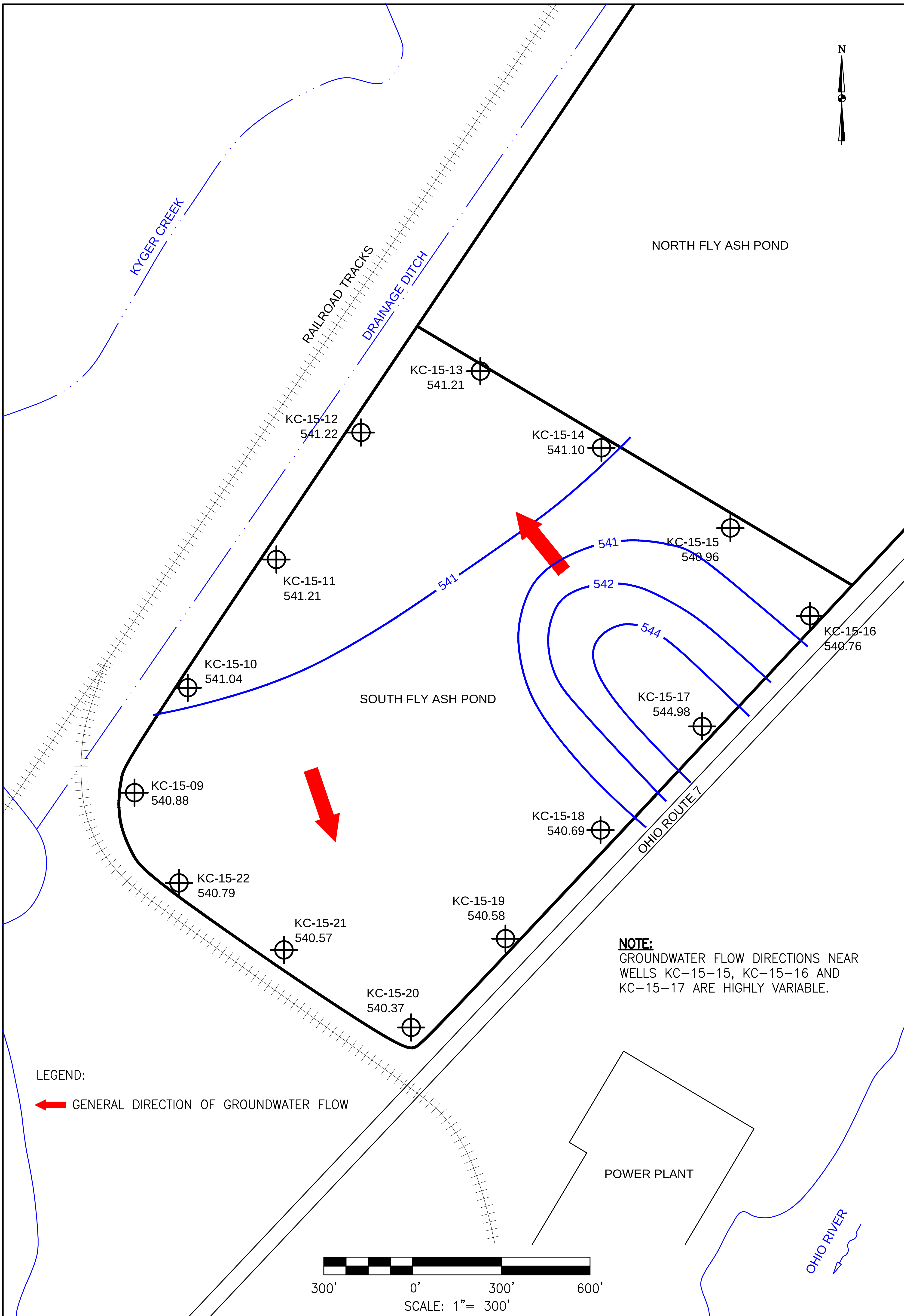
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GROUNDWATER CONTOUR MAP – OCTOBER 2015

DRAWING NAME: FIGURE B–19
REV. 0

Plot: 10/09/2020 09:18 \Kyger Creek-CCR Program\CAD_REVISED 2017 GW Monitoring & Corrective Action Rept\B-19_RVSD_KYGER_SFAP_GW FLOW_OCT15.dwg



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2020016-KYG
DWG FILE	B-20_RVSD_KYGER_SFAP_GW FLOW_JAN16.dwg
DRAWING SCALE	1"=300'

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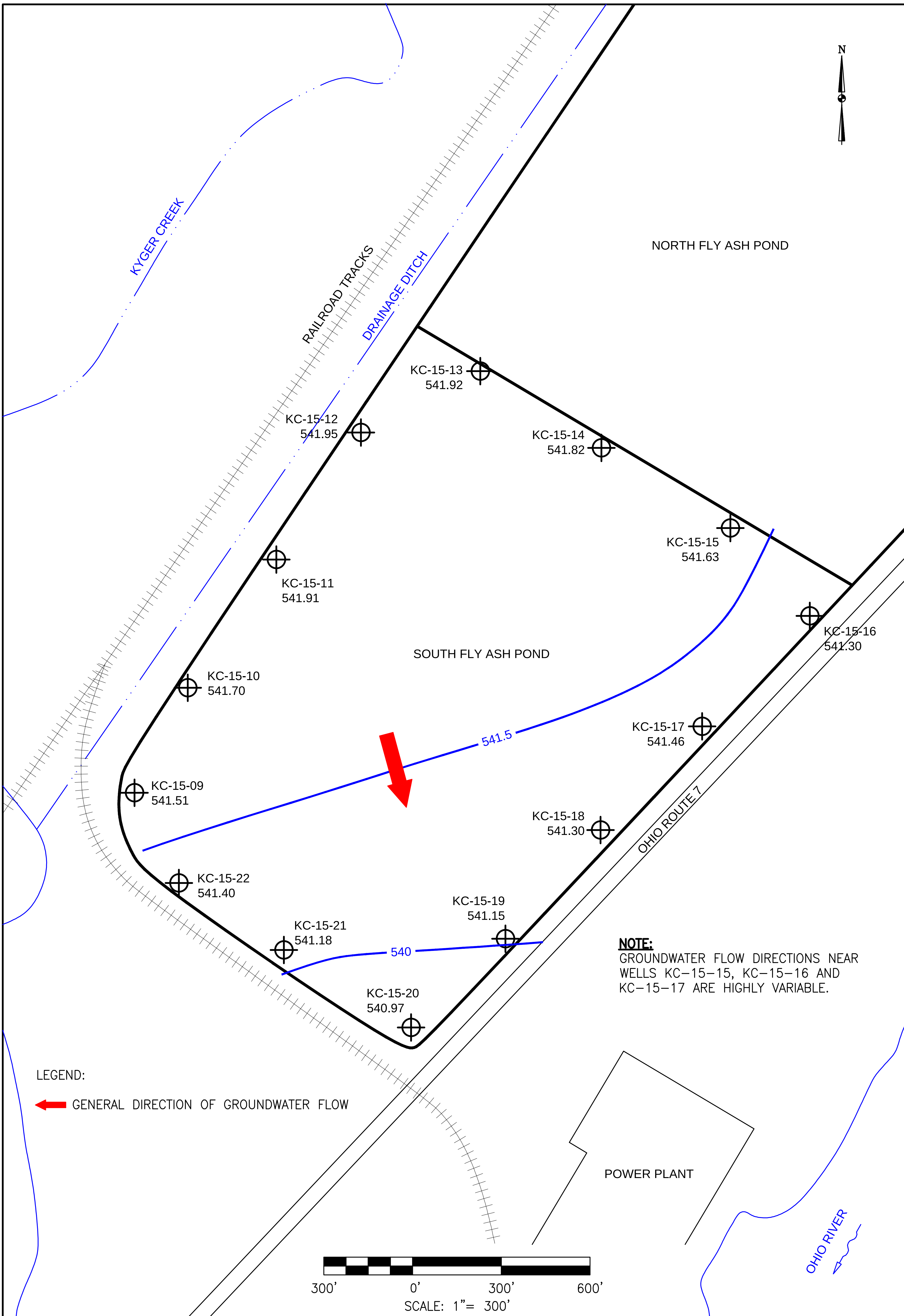
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GROUNDWATER CONTOUR MAP – JANUARY 2016

DRAWING NAME: FIGURE B-20
REV.: 0



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JOB NO.	2020016-KYG
DWG FILE	B-21_RVSD_KYGER_SFAP_GW FLOW_MAR16.dwg
DRAWING SCALE	1"=300'

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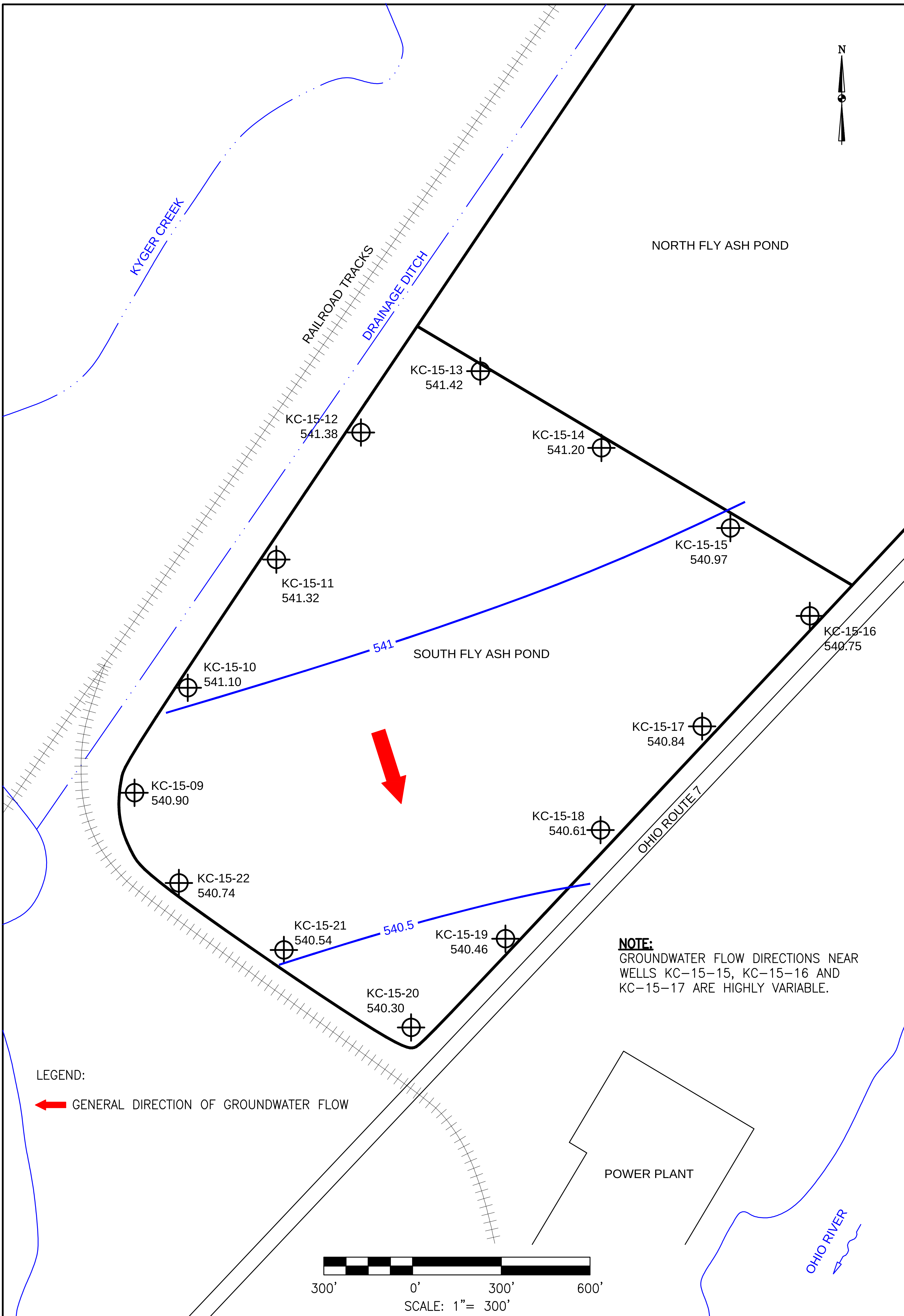
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GROUNDWATER CONTOUR MAP – MARCH 2016

DRAWING NAME: FIGURE B-21
REV. 0

Plot: 10/09/2020 09:25 \Kyger Creek-CCR Program\CAD_REVISED 2017 GW Monitoring & Corrective Action Rept\B-21_RVSD_KYGER_SFAP_GW FLOW_MAR16.dwg



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2020016−KYG
DWG FILE	B−22_RVSD_KYGER_SFAP_GW FLOW_MAY16.dwg
DRAWING SCALE	1"=300'

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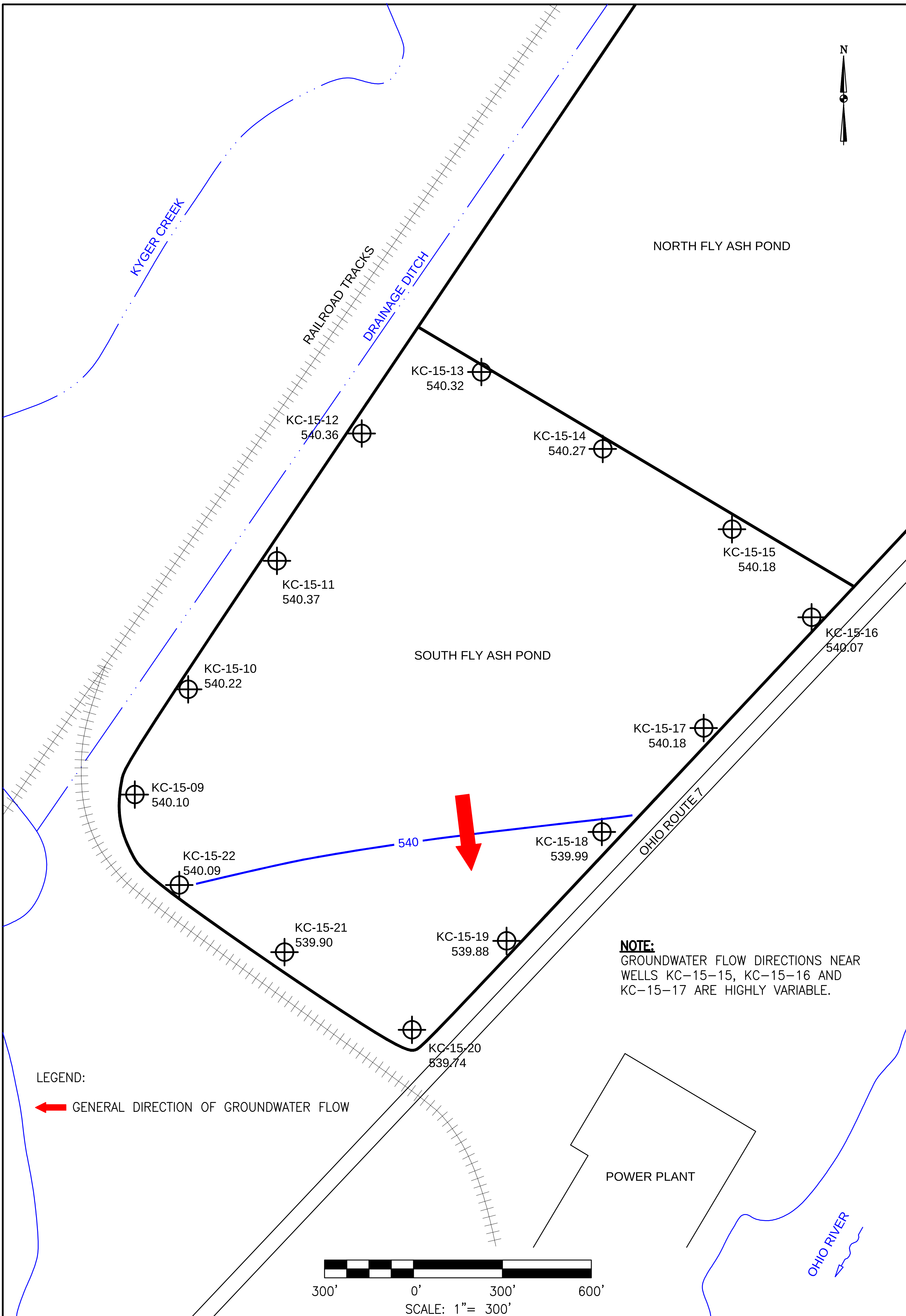
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GROUNDWATER CONTOUR MAP − MAY 2016

DRAWING NAME: FIGURE B−22
REV. 0

Plot: 10/09/2020 09:27 \Kyger Creek-CCR Program\CAD_REVISED 2017 GW Monitoring & Corrective Action Rept\B-22_RVSD_KYGER_SFAP_GW FLOW_MAY16.dwg



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DATE	
CHECKED BY	
JOB NO.	2020016−KYG
DWG FILE	B−23_RVSD_KYGER_SFAP_GW FLOW_SEP16.dwg
DRAWING SCALE	1"=300'

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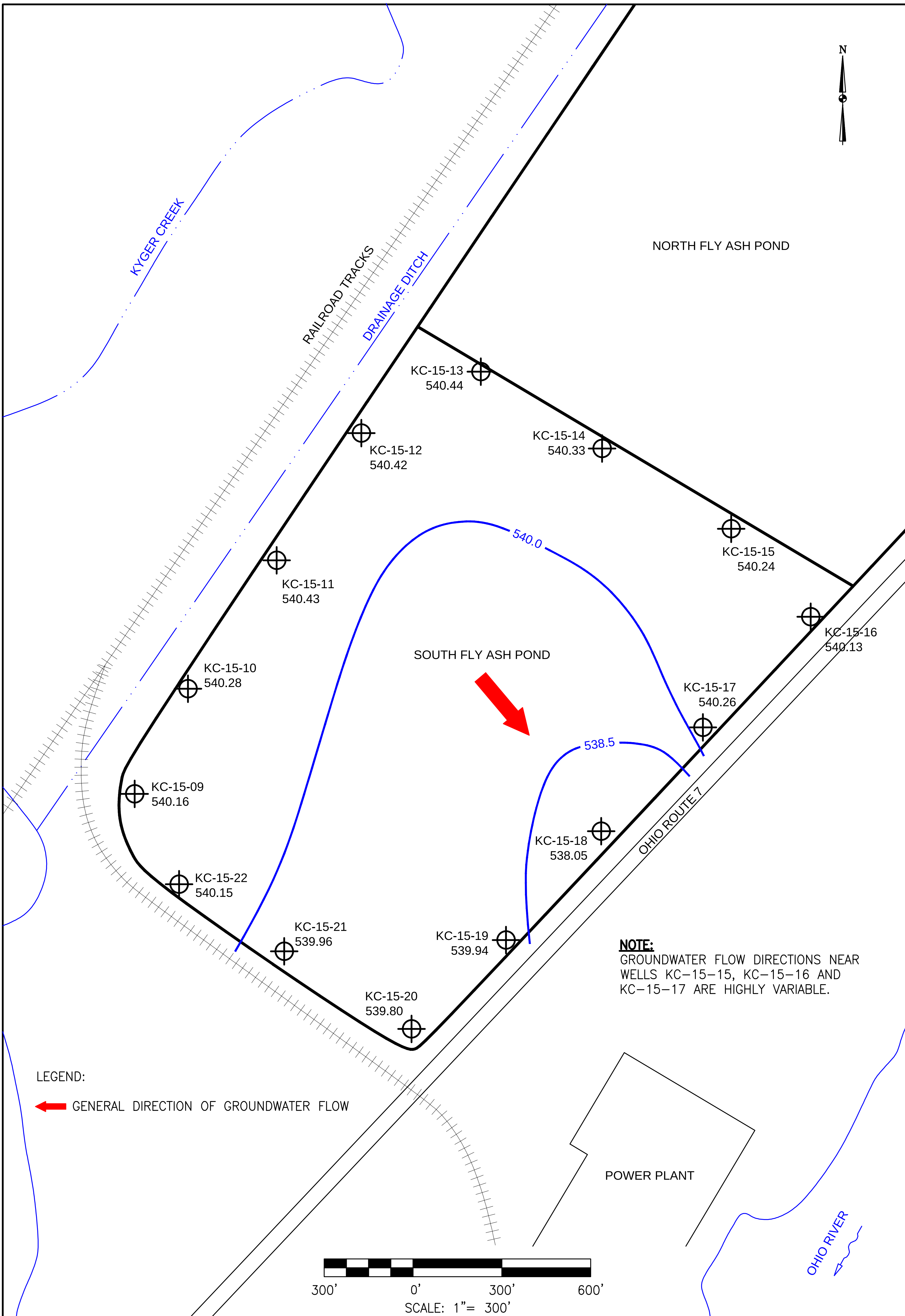
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GROUNDWATER CONTOUR MAP − SEPTEMBER 2016

DRAWING NAME: FIGURE B−23 | REV. 0

Plot: 10/09/2020 09:28 \Kyger Creek-CCR Program\CAD_REVISED 2017 GW Monitoring & Corrective Action Rept\B-23_RVSD_KYGER_SFAP_GW FLOW_SEP16.dwg



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2020016-KYG
DWG FILE	B-24_RVSD_KYGER_SFAP_GW FLOW_DEC16.dwg
DRAWING SCALE	1"=300'

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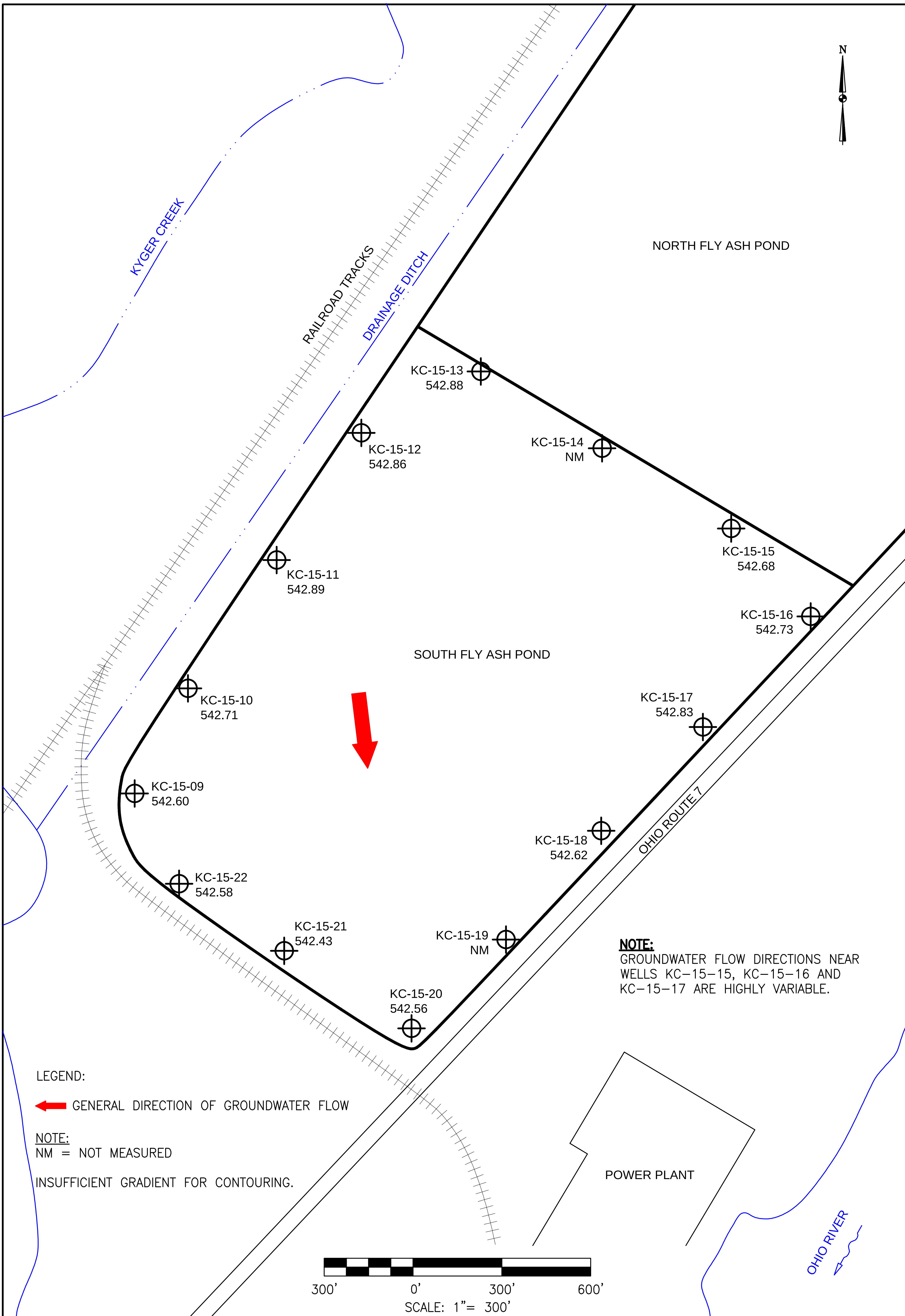
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GROUNDWATER CONTOUR MAP – DECEMBER 2016

DRAWING NAME: FIGURE B–24
REV. 0



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2020016-KYG
DWG FILE	B-25_RVSD_KYGER_SFAP_GW FLOW_MAR17.dwg
DRAWING SCALE	1"=300'

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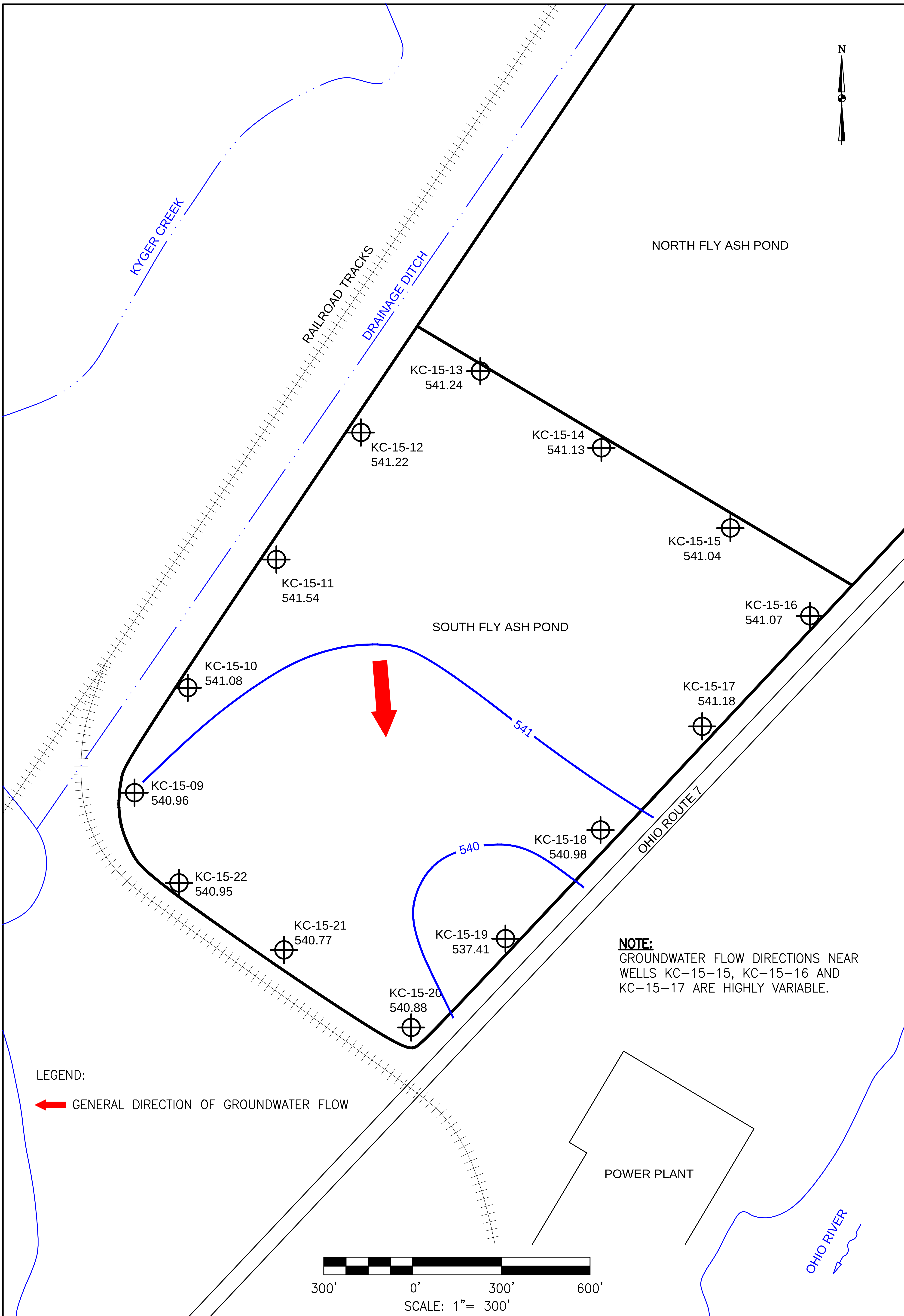
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GROUNDWATER CONTOUR MAP – MARCH 2017

DRAWING NAME: FIGURE B-25 | REV. 0

Plot: 10/09/2020 09:33 \Kyger Creek-CCR Program\CAD_REVISED 2017 GW Monitoring & Corrective Action Rept\B-25_RVSD_KYGER_SFAP_GW FLOW_MAR17.dwg



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2020016-KYG
DWG FILE	B-26_RVSD_KYGER_SFAP_GW FLOW_JUN17.dwg
DRAWING SCALE	1"=300'

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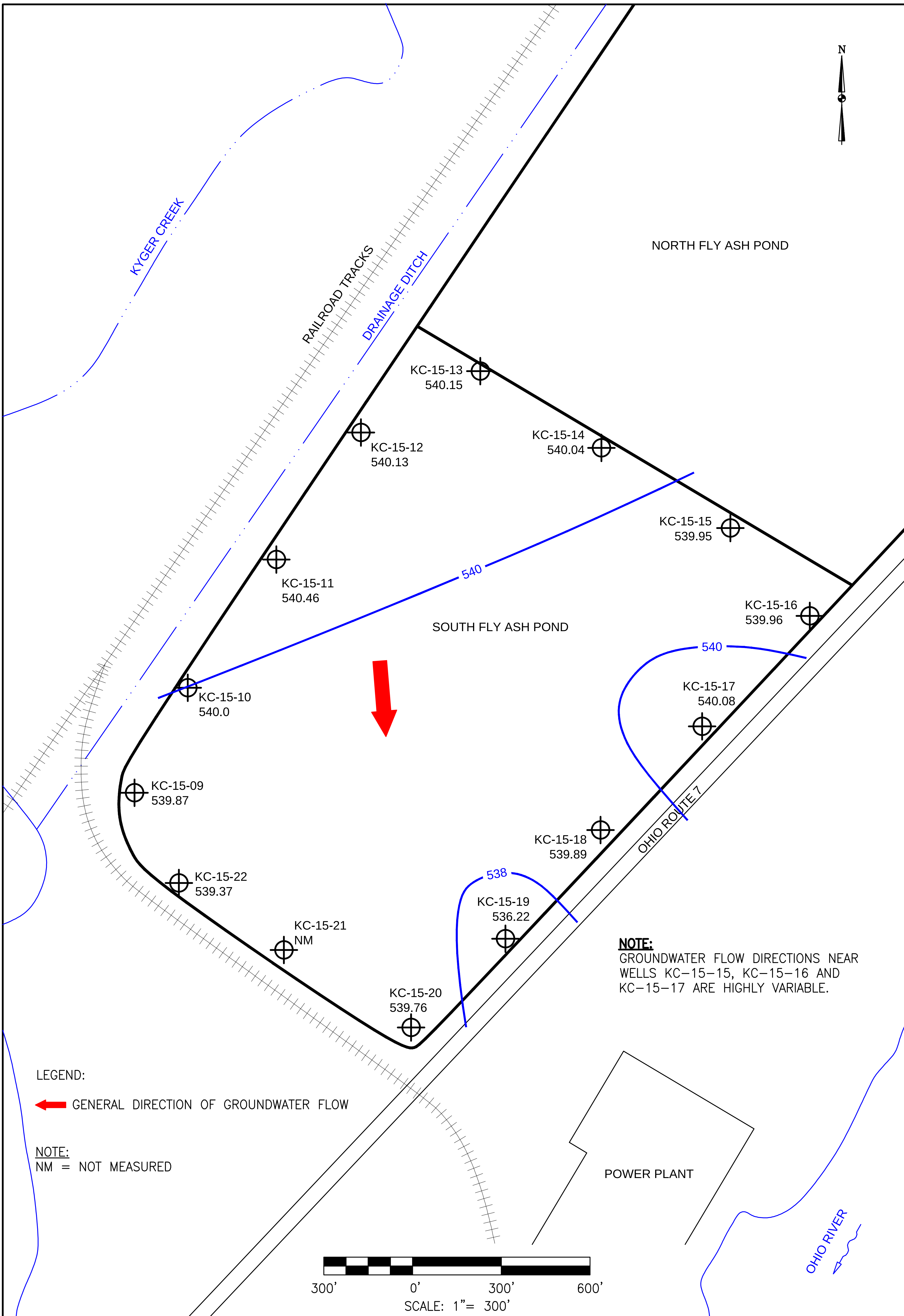
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GROUNDWATER CONTOUR MAP – JUNE 2017

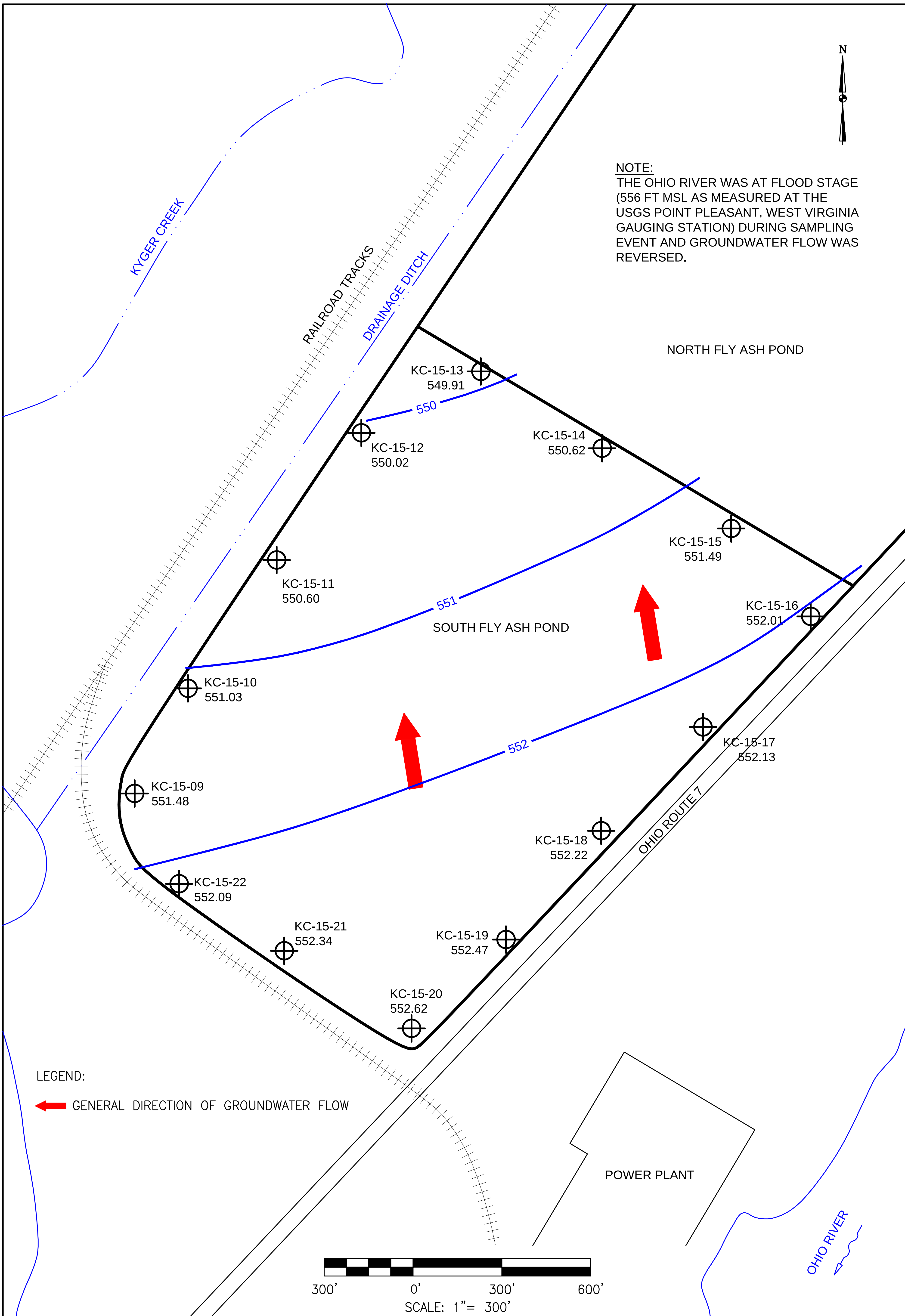
DRAWING NAME: FIGURE B-26
REV. 0

Plot: 10/09/2020 09:35 \Kyger Creek-CCR Program\CAD_REVISED 2017 GW Monitoring & Corrective Action Rept\B-26_RVSD_KYGER_SFAP_GW FLOW_JUN17.dwg



DRAWN BY: JM	AGES Applied Geology And Environmental Science, Inc. 2402 Hookstown Grade Road, Suite 200 Clinton, PA 15026 412.264.6453	OHIO VALLEY ELECTRIC COMPANY
DATE		KYGER CREEK STATION CHESHIRE, GALLIA COUNTY, OHIO SOUTH FLY ASH POND GROUNDWATER CONTOUR MAP – SEPTEMBER 2017
CHECKED BY		
JOB NO.: 2020016–KYG		DRAWING NAME: FIGURE B–27
DWG FILE: B–27_RVSD_KYGER_SFAP_GW FLOW_SEP17.dwg		REV.: 0
DRAWING SCALE: 1"=300'		

Plot: 10/09/2020 09:37 \Kyger Creek–CCR Program\CAD_REVISED 2017 GW Monitoring & Corrective Action Rept\B–27_RVSD_KYGER_SFAP_GW FLOW_SEP17.dwg



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2020016-KYG
DWG FILE	B-5_RVSD_KYGER_SFAP_GW FLOW_FEB18.dwg
DRAWING SCALE	1"=300'

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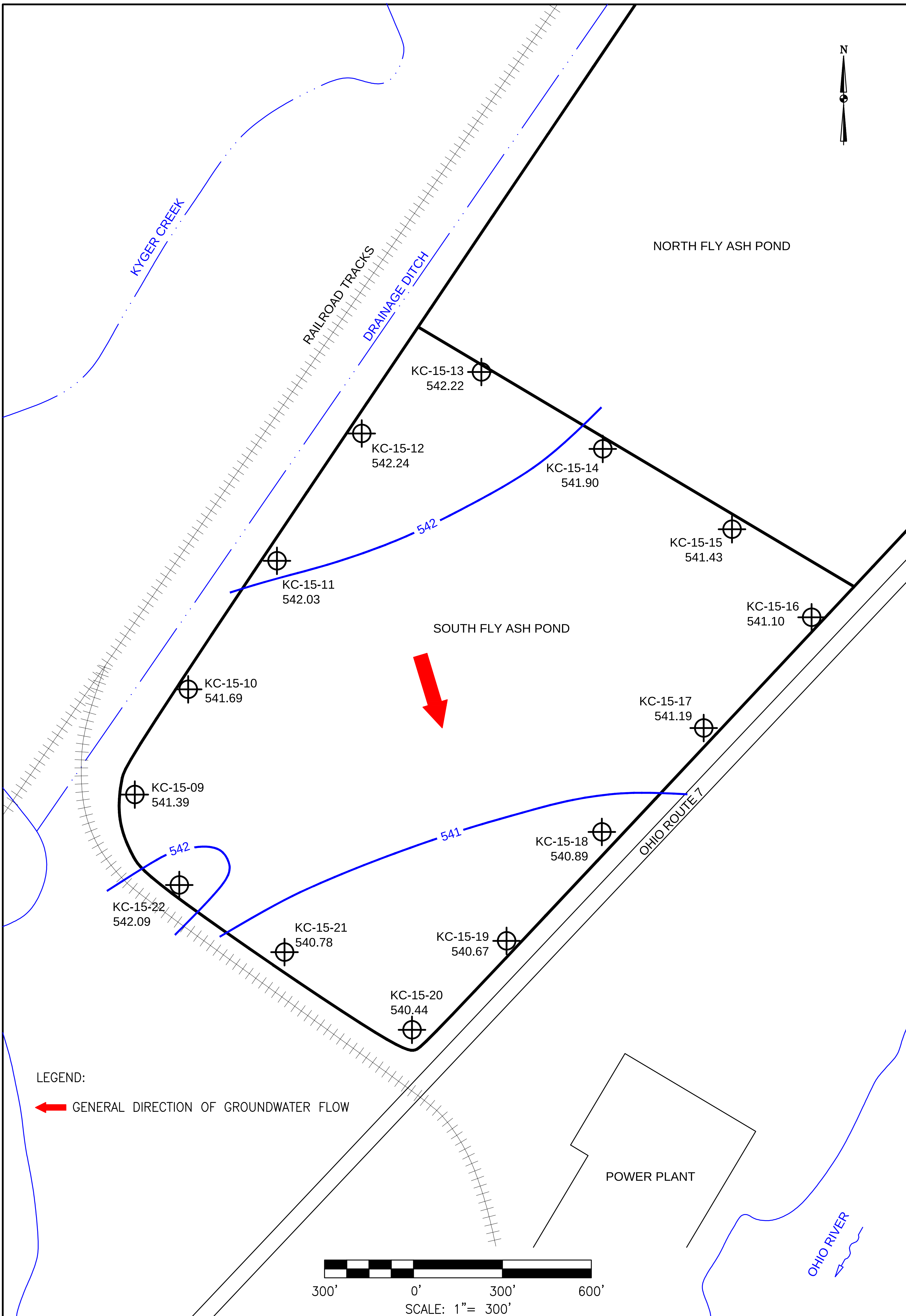
OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GROUNDWATER CONTOUR MAP–FEBRUARY 2018

DRAWING NAME: FIGURE B–5
REV. 0

Plot: 10/08/2020 16:10 \Kyger Creek-CCR Program\CAD_REVISED 2018 GW Monitoring & Corrective Action Rept\B-5_RVSD_KYGER_SFAP_GW FLOW_FEB18.dwg



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2020016–KYG
DWG FILE	B–6_RVSD_KYGER_SFAP_GW FLOW_SEP18.dwg
DRAWING SCALE	1"=300'

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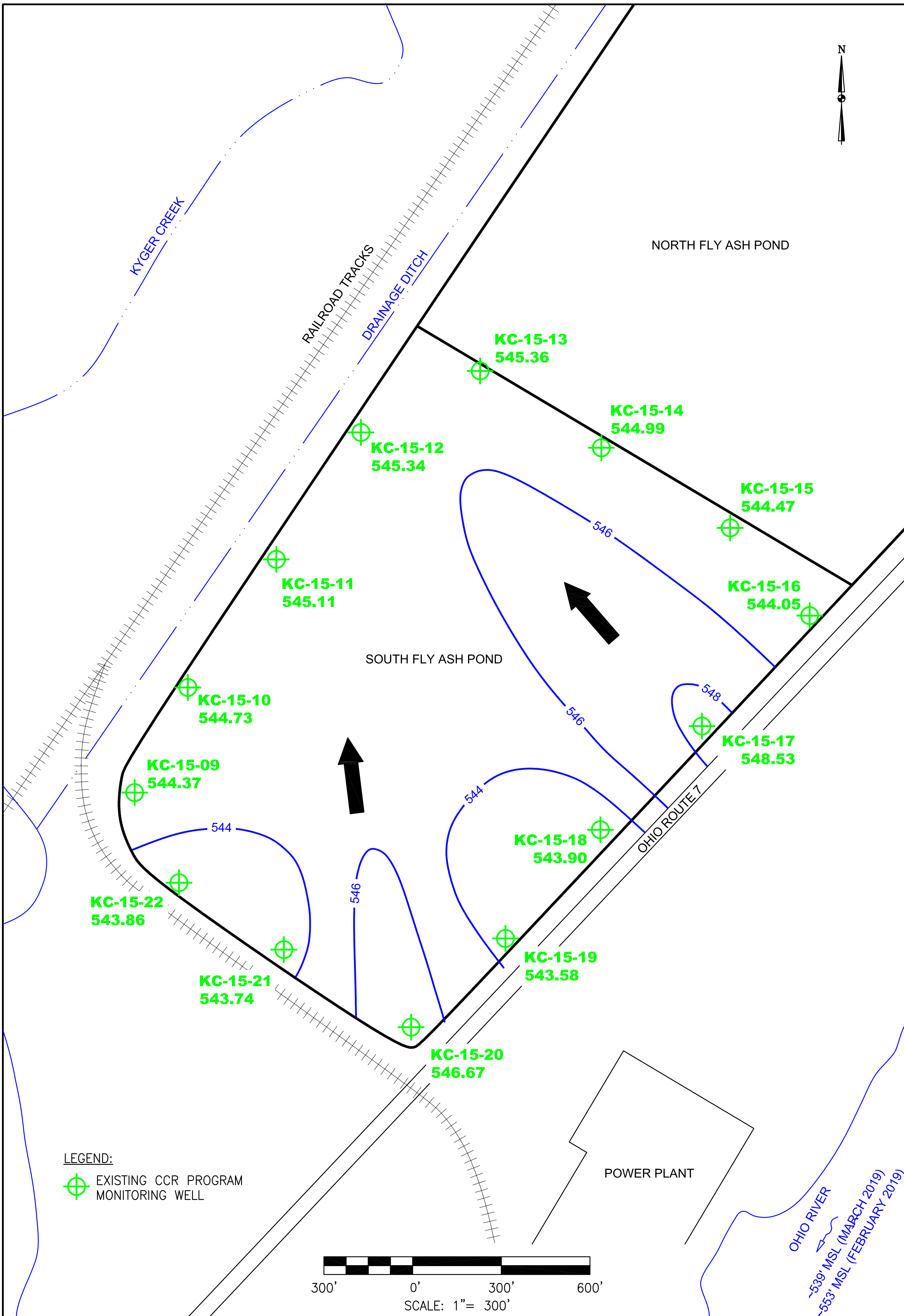
OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GROUNDWATER CONTOUR MAP–SEPTEMBER 2018

DRAWING NAME: FIGURE B–6
REV.: 0

Plot: 10/08/2020 14:05 \Kyger Creek–CCR Program\CAD_REVISED 2018 GW Monitoring & Corrective Action Rept\B–6_RVSD_KYGER_SFAP_GW FLOW_SEP18.dwg



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2019018–KYG
DWG FILE	KYGER_CCR_2019 Annual GW Rpt_SFAP_GW Flow_MAR2019.dwg
DRAWING SCALE	1"=300'

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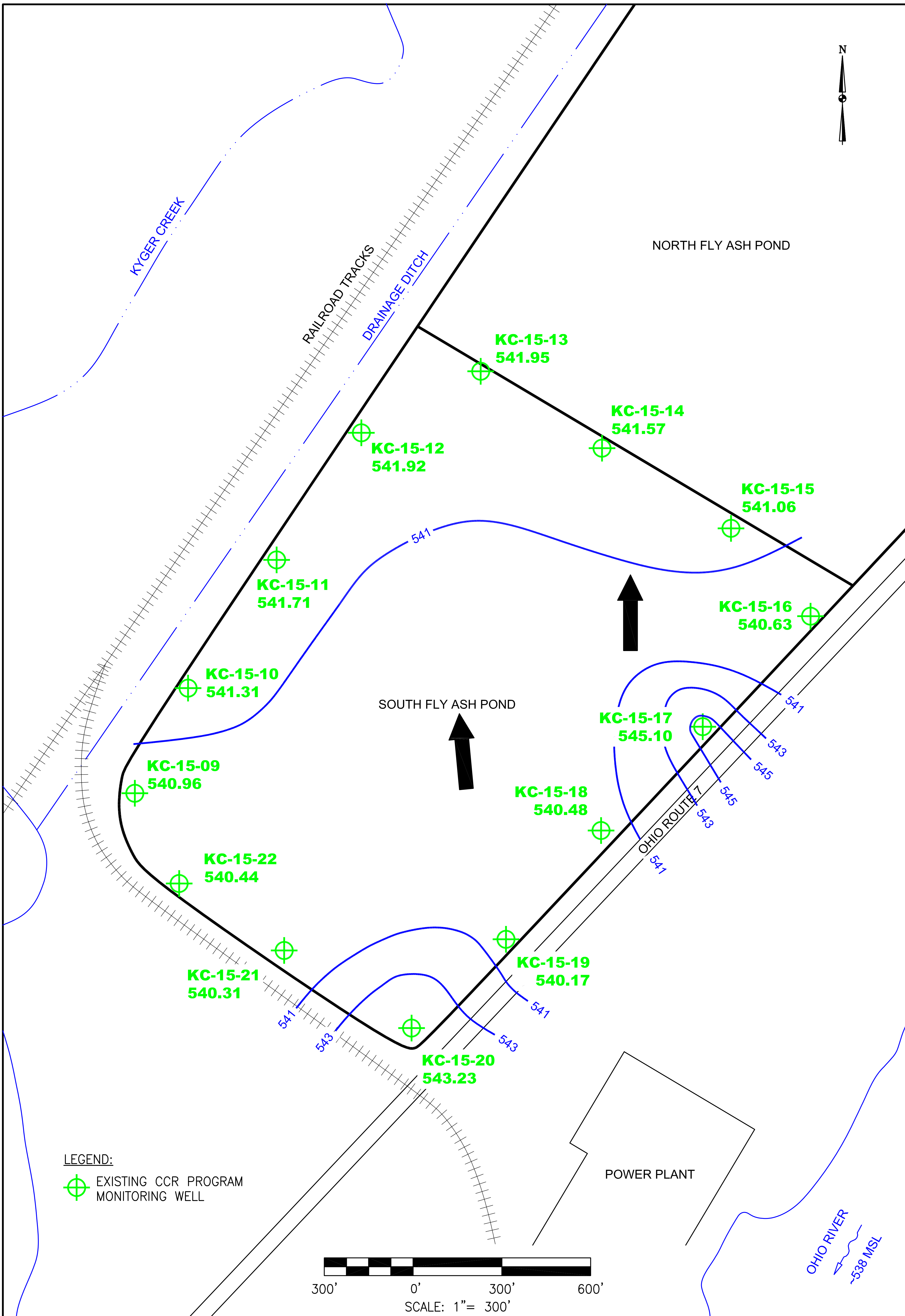
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GROUNDWATER LEVELS AND FLOW DIRECTION
MARCH 2019

DRAWING NAME: FIGURE B–5
REV. 0

Plot: 01/17/2020 15:55 \Kyger Creek–CCR Program\CAD\2019 GW Monitoring–Corrective Action Rpt\Appx B\KYGER_CCR_2019 Annual GW Rpt_SFAP_GW Flow_MAR2019.dwg



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2019018–KYG
DWG FILE	KYGER_CCR_2019 Annual GW Rpt_SFAP_GW Flow_SEPT2019.dwg
DRAWING SCALE	1"=300'

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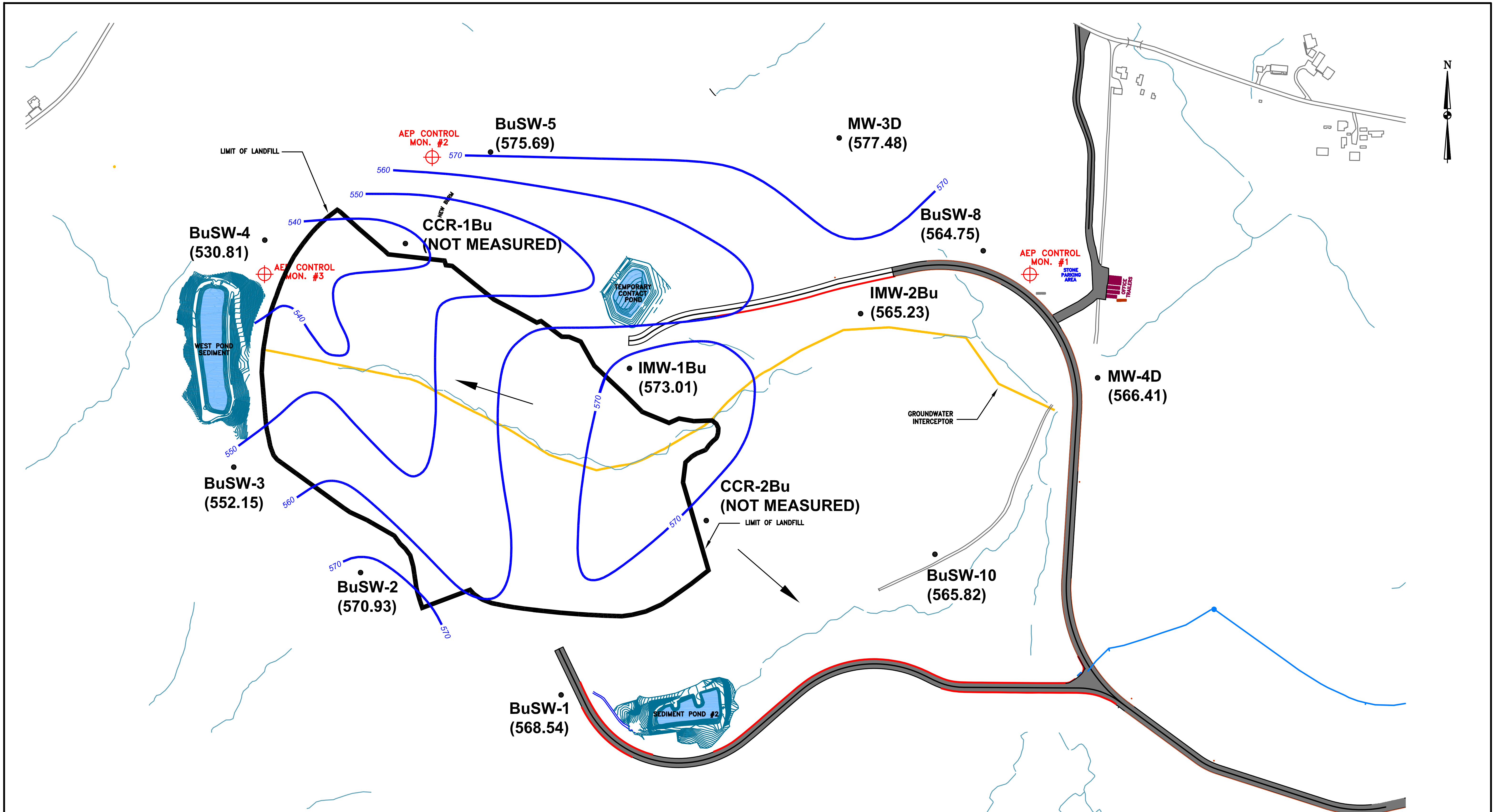
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SOUTH FLY ASH POND
GROUNDWATER LEVELS AND FLOW DIRECTION
SEPTEMBER 2019

DRAWING NAME	REV.
FIGURE B–6	0

Plot: 01/22/2020 15:25 \Kyger Creek–CCR Program\CAD\2019 GW Monitoring–Corrective Action Rpt\Appx B\KYGER_CCR_2019 Annual GW Rpt_SFAP_GW Flow_SEPT2019.dwg

LANDFILL



LEGEND:

POTENTIOMETRIC SURFACE CONTOUR

BuSW-1 MONITORING WELL

(570.89) GROUNDWATER ELEVATION

GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017110-KYGER
DWG FILE	B-1_KYGER GW CONTOURS_OCT 2015_BUFFALO b01.dwg
DRAWING SCALE	AS SHOWN

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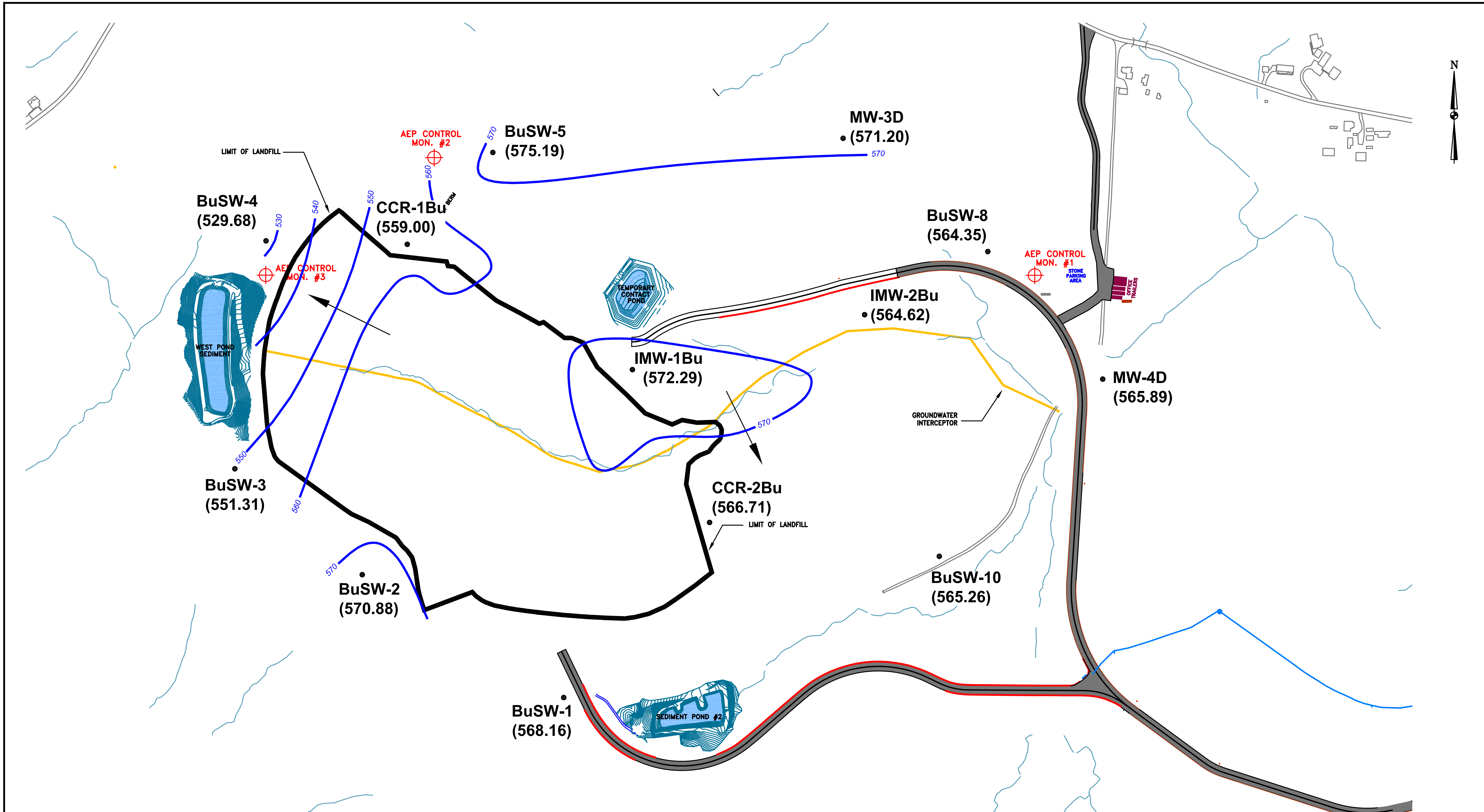
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
CLASS III RESIDUAL WASTE LANDFILL
GROUNDWATER CONTOUR MAP – OCTOBER 2015

DRAWING NAME: FIGURE B-1

REV.: 0

Plot: 01/15/2018 10:27 _PROGRAM-KYGER OVEC\Kyger Creek-CCR Program\CAD\2017 GW Monitoring-Corrective Action Rpt\APPX B\B-1_KYGER GW CONTOURS_OCT15_BUFFALO b01.dwg



LEGEND:

(blue line)	POTENTIOMETRIC SURFACE CONTOUR
● BuSW-1	MONITORING WELL
(570.88)	GROUNDWATER ELEVATION
(arrow)	GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017110–KYGER
DWG FILE	B-2_KYGER GW CONTOURS_JAN16_BUFFALO b02.dwg
DRAWING SCALE	AS SHOWN

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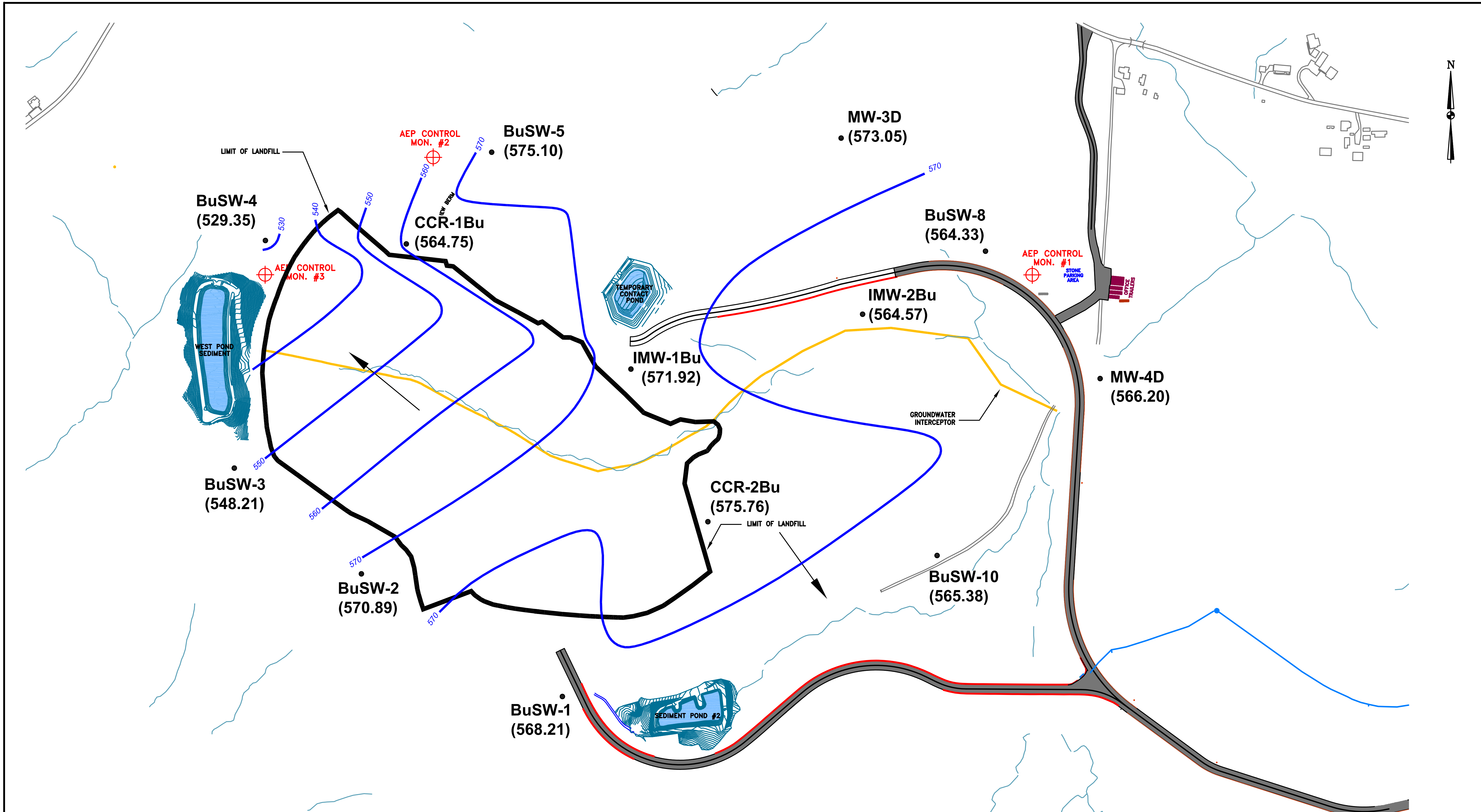
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
CLASS III RESIDUAL WASTE LANDFILL
GROUNDWATER CONTOUR MAP – JANUARY 2016

DRAWING NAME: FIGURE B-2

REV. 0



LEGEND:

POTENTIOMETRIC SURFACE CONTOUR

BuSW-1 MONITORING WELL

(570.89) GROUNDWATER ELEVATION

GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017110-KYGER
DWG FILE	B-3_KYGER GW CONTOURS_MAR16_BUFFALO b03.dwg
DRAWING SCALE	AS SHOWN

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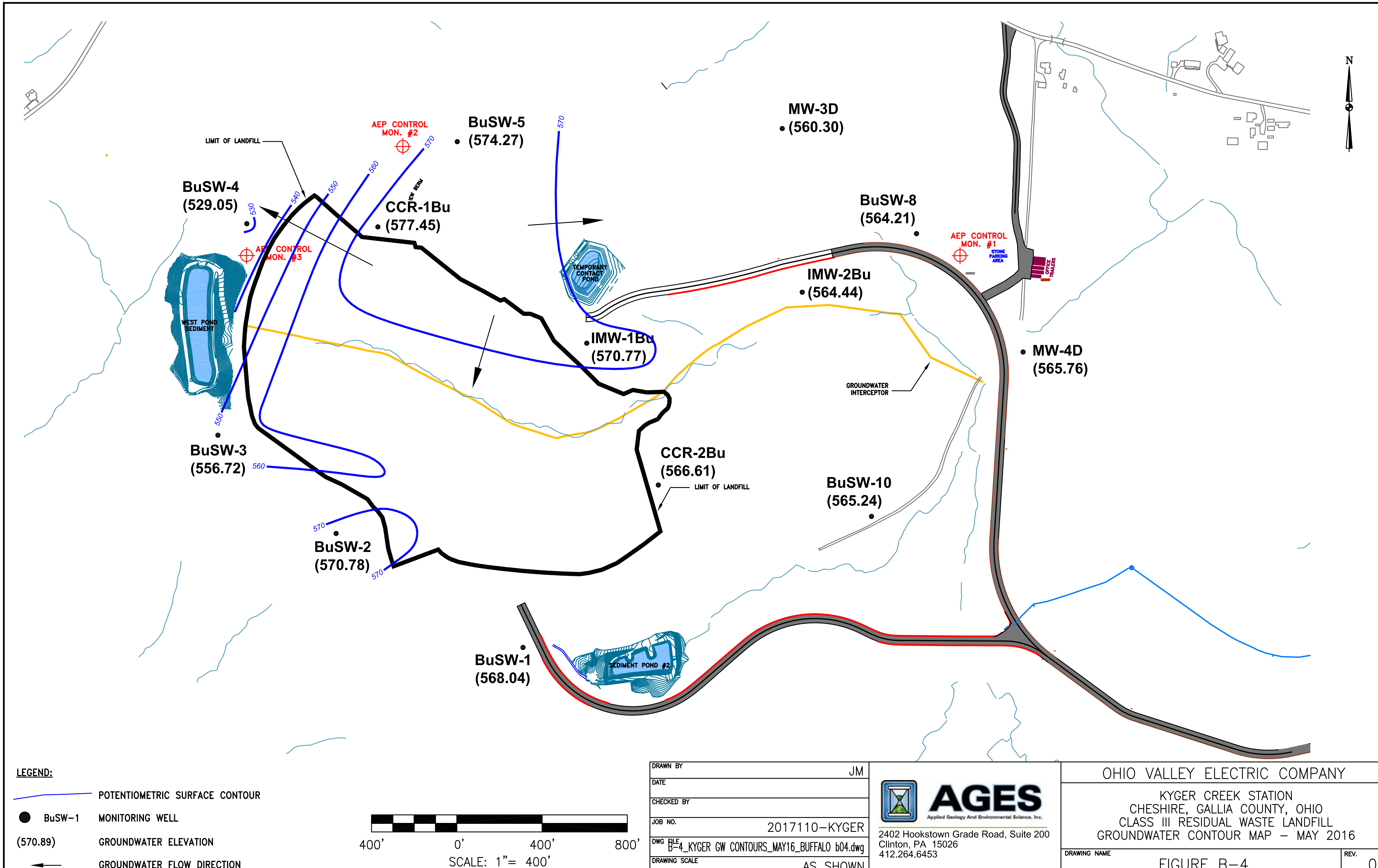
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
CLASS III RESIDUAL WASTE LANDFILL
GROUNDWATER CONTOUR MAP – MARCH 2016

DRAWING NAME: FIGURE B-3

REV. 0

Plot: 01/15/2018 10:38 _PROGRAM-KYGER OVEC\Kyger Creek-CCR Program\CAD\2017 GW Monitoring-Corrective Action Rpt\APPX B\B-3_KYGER GW CONTOURS_MAR16_BUFFALO b03



DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017110–KYGER
DWG FILE	B-4_KYGER GW CONTOURS_MAY16_BUFFALO b04.dwg
DRAWING SCALE	AS SHOWN

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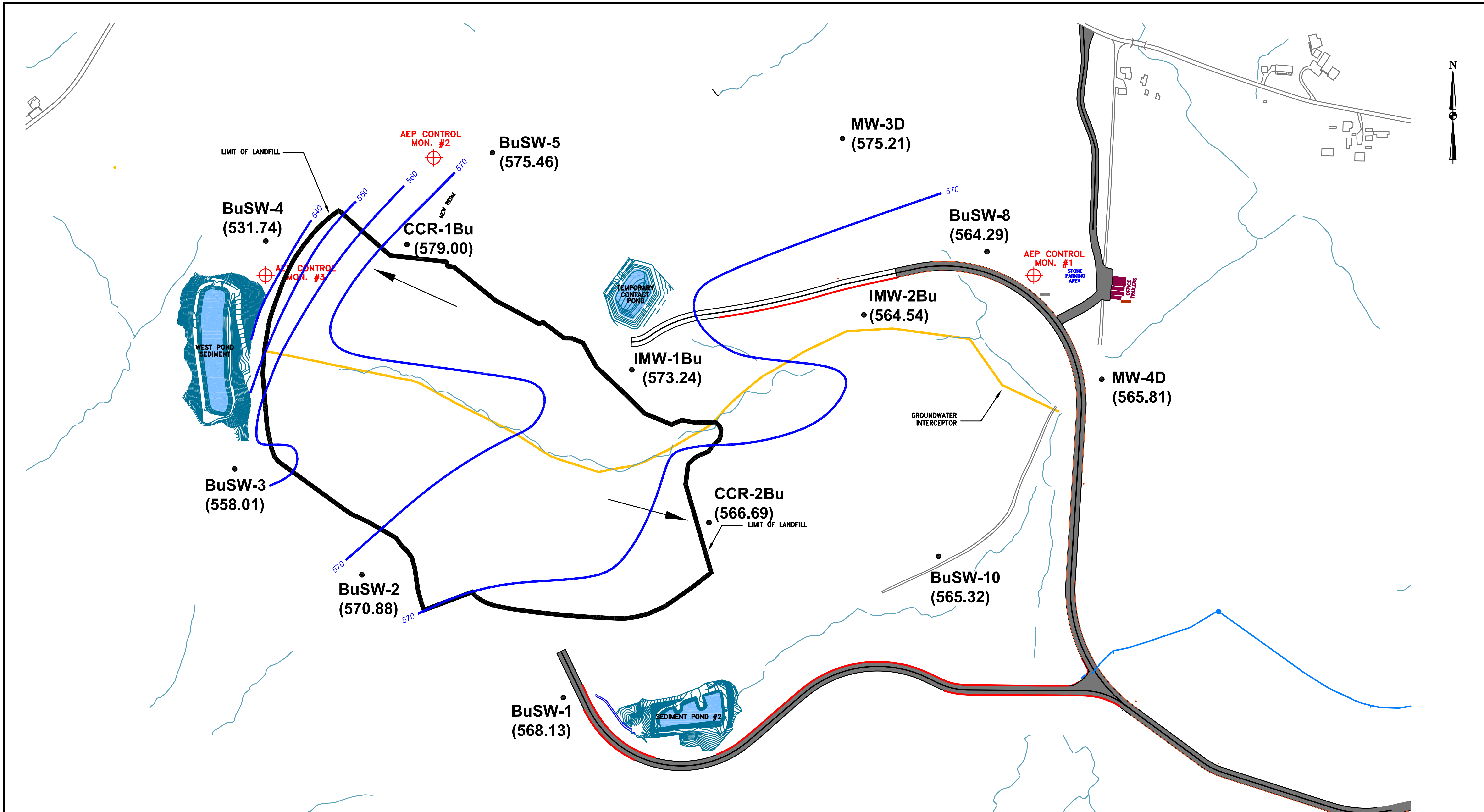
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
CLASS III RESIDUAL WASTE LANDFILL
GROUNDWATER CONTOUR MAP – MAY 2016

DRAWING NAME: FIGURE B–4
REV. 0



LEGEND:

(blue line)	POTENTIOMETRIC SURFACE CONTOUR
● BuSW-1	MONITORING WELL
(570.89)	GROUNDWATER ELEVATION
←	GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017110-KYGER
DWG. FILE	B-5_KYGER GW CONTOURS_SEPT16_BUFFALO b05.dwg
DRAWING SCALE	AS SHOWN

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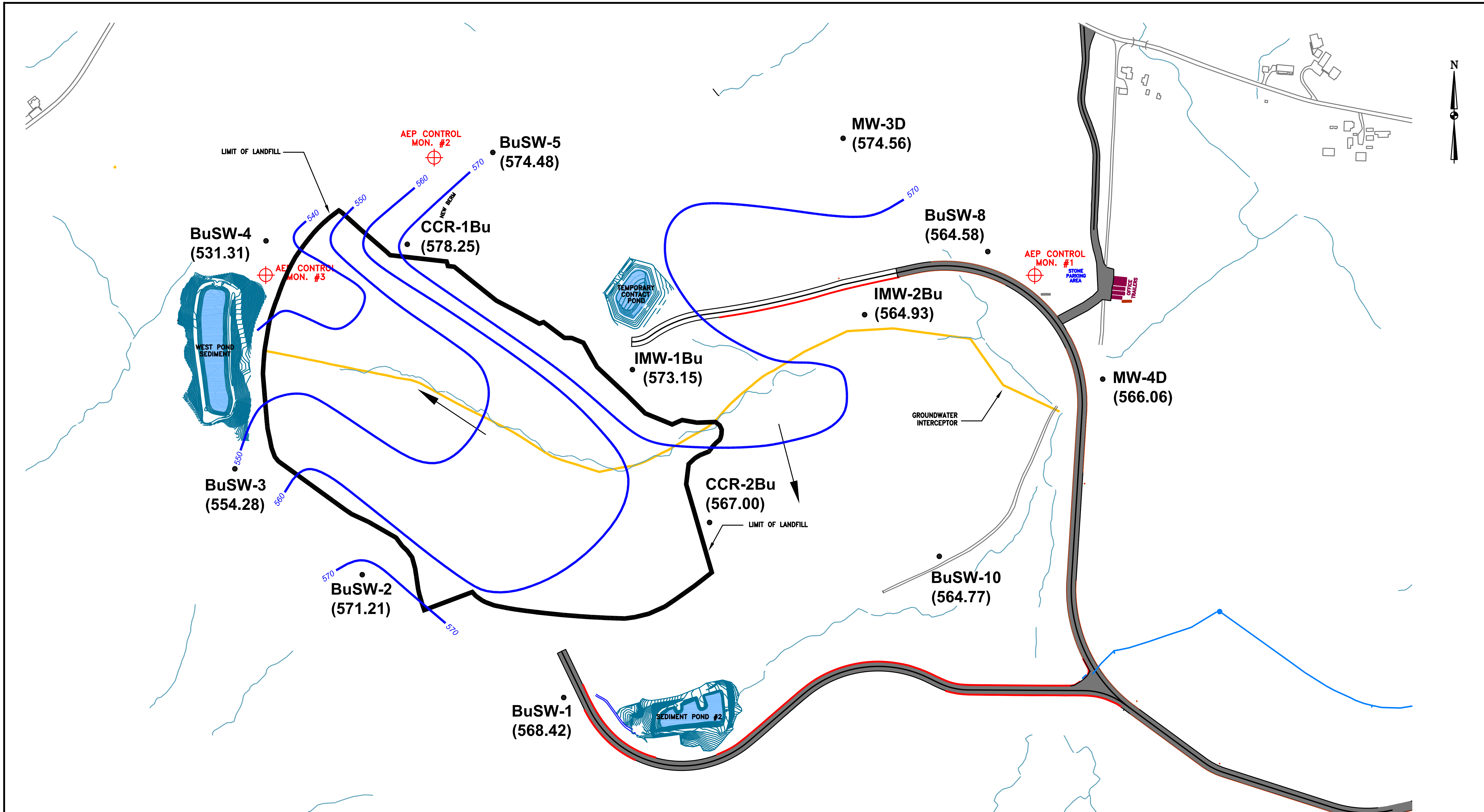
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
CLASS III RESIDUAL WASTE LANDFILL
GROUNDWATER CONTOUR MAP – SEPTEMBER 2016

DRAWING NAME: FIGURE B-5

REV. 0

Plot: 01/15/2018 11:07 _PROGRAM-KYGER OVEC\Kyger Creek-CCR Program\CAD\2017 GW Monitoring-Corrective Action Rpt\APPX B\B-5_KYGER GW CONTOURS_SEPT16_BUFFALO b05.dwg



LEGEND:

POTENTIOMETRIC SURFACE CONTOUR

BuSW-1 MONITORING WELL

(570.89) GROUNDWATER ELEVATION

GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017110–KYGER
DWG FILE	B-6_KYGER GW CONTOURS_DEC16_BUFFALO b06.dwg
DRAWING SCALE	AS SHOWN

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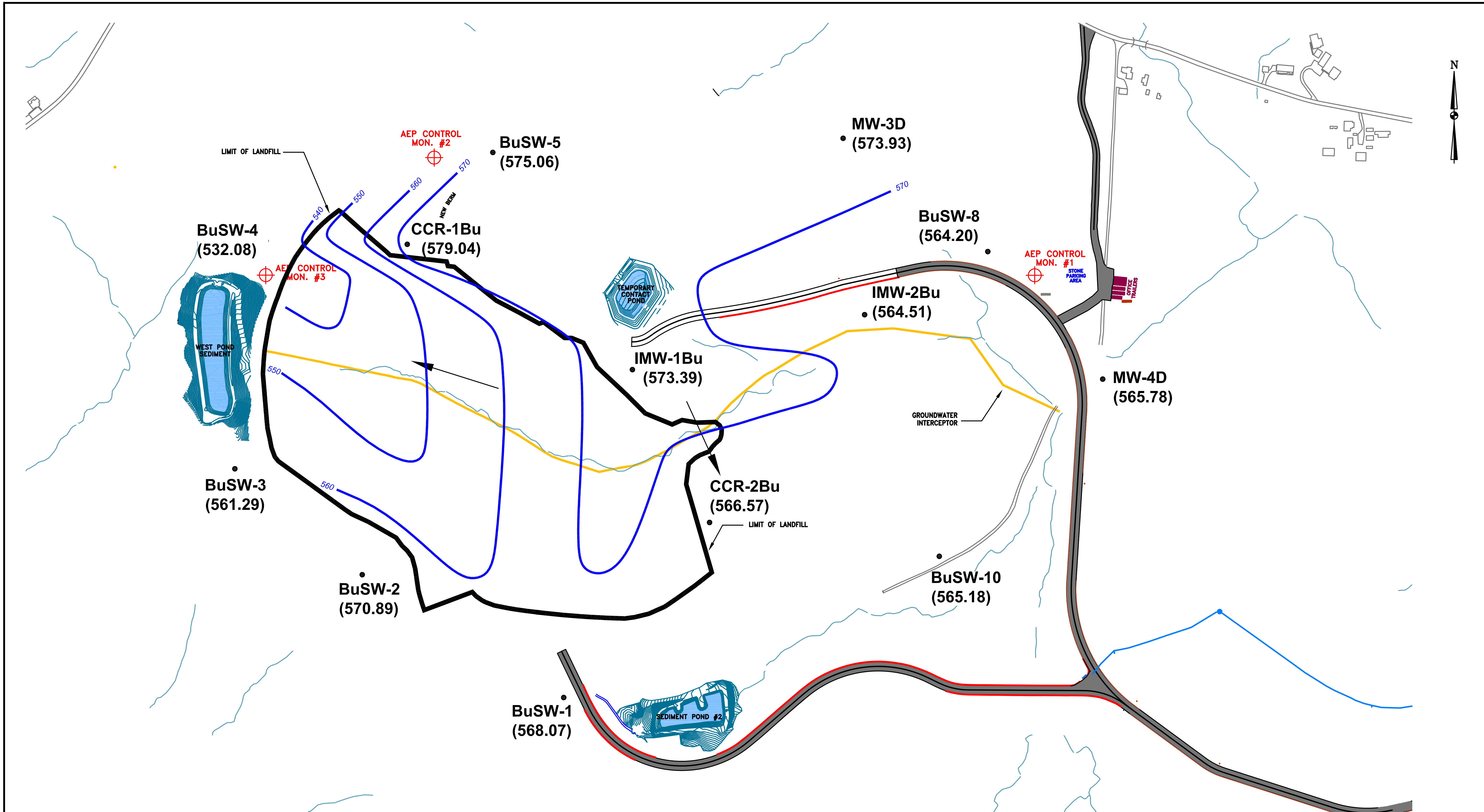
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
CLASS III RESIDUAL WASTE LANDFILL
GROUNDWATER CONTOUR MAP – DECEMBER 2016

DRAWING NAME: FIGURE B-6 REV. 0

Plot: 01/15/2018 11:14 _PROGRAM-KYGER OVEC\Kyger Creek-CCR Program\CAD\2017 GW Monitoring-Corrective Action Rpt\APPX B\B-6_KYGER GW CONTOURS_DEC16_BUFFALO b06



LEGEND:

	POTENTIOMETRIC SURFACE CONTOUR
BuSW-1	MONITORING WELL
(570.89)	GROUNDWATER ELEVATION
	GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017110-KYGER
DWG FILE	B-7_KYGER GW CONTOURS_MAR17_BUFFALO b07.dwg
DRAWING SCALE	AS SHOWN

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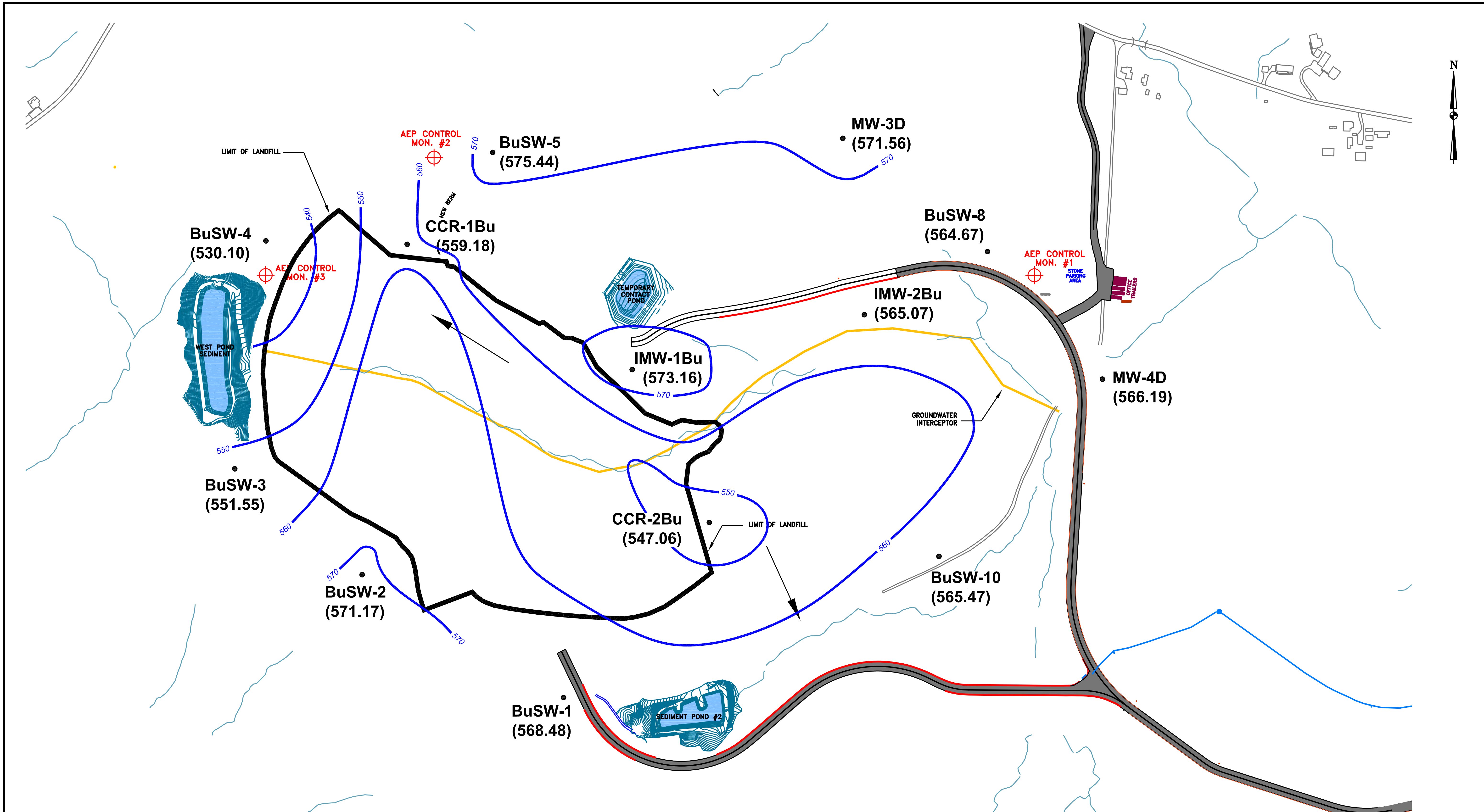
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
CLASS III RESIDUAL WASTE LANDFILL
GROUNDWATER CONTOUR MAP – MARCH 2017

DRAWING NAME: FIGURE B-7

REV. 0

Plot: 01/15/2018 11:24 _PROGRAM-KYGER OVEC\Kyger Creek-CCR Program\CAD\2017 GW Monitoring-Corrective Action Rpt\APPX B\B-7_KYGER GW CONTOURS_MAR17_BUFFALO b07



LEGEND:

POTENTIOMETRIC SURFACE CONTOUR

BuSW–1 MONITORING WELL

(570.89) GROUNDWATER ELEVATION

GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017110–KYGER
DWG FILE	B–8_KYGER GW CONTOURS_JUN17_BUFFALO b08.dwg
DRAWING SCALE	AS SHOWN

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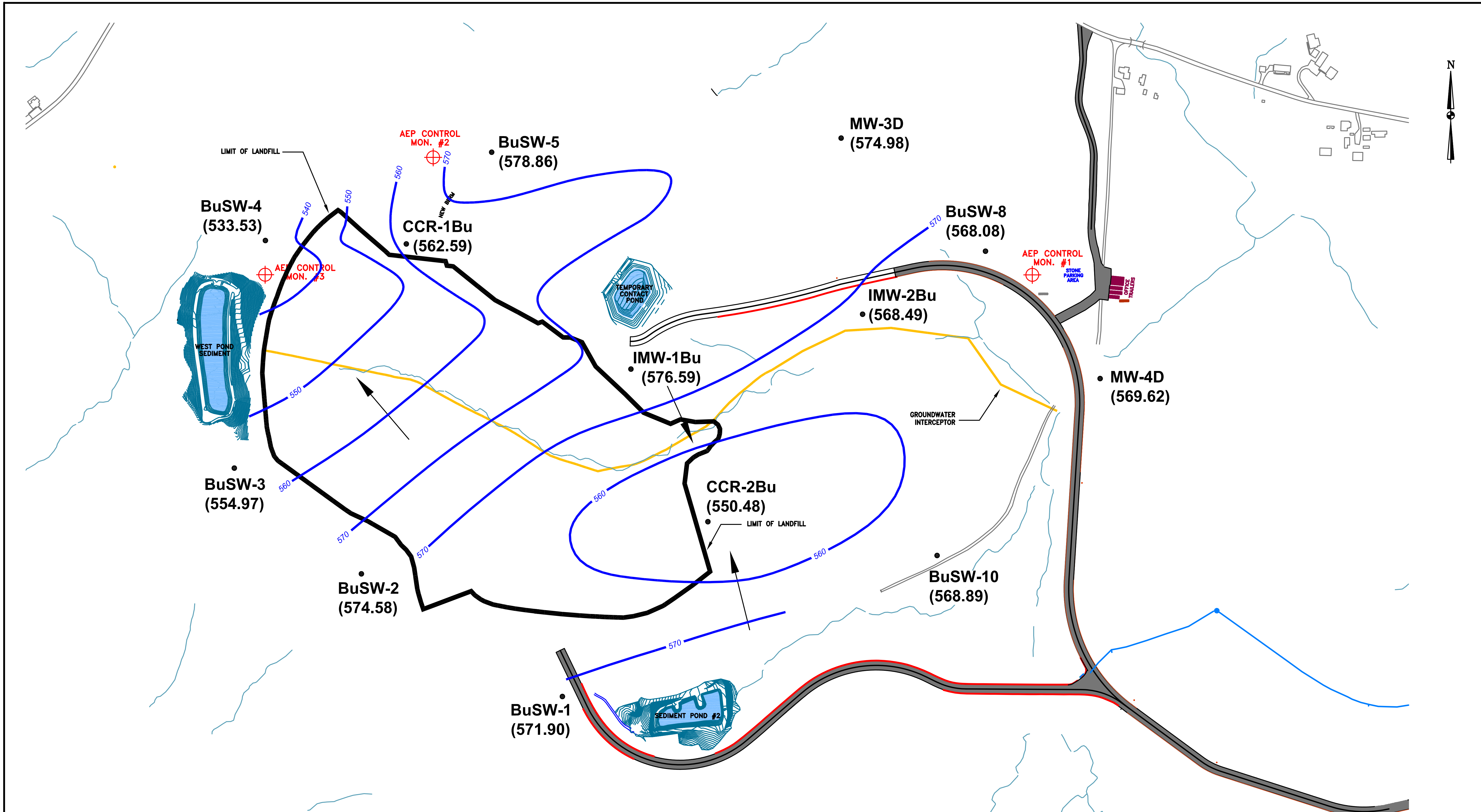
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
CLASS III RESIDUAL WASTE LANDFILL
GROUNDWATER CONTOUR MAP – JUNE 2017

DRAWING NAME: FIGURE B–8

REV. 0

Plot: 01/15/2018 11:30 _PROGRAM–KYGER OVEC\Kyger Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt\APPX B\B–8_KYGER GW CONTOURS_JUN17_BUFFALO b08



LEGEND:

	POTENTIOMETRIC SURFACE CONTOUR
● BuSW–1	MONITORING WELL
(570.89)	GROUNDWATER ELEVATION
←	GROUNDWATER FLOW DIRECTION

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017110–KYGER
DWG. FILE	B–9_KYGER GW CONTOURS_SEPT17_BUFFALO b09.dwg
DRAWING SCALE	AS SHOWN

AGES
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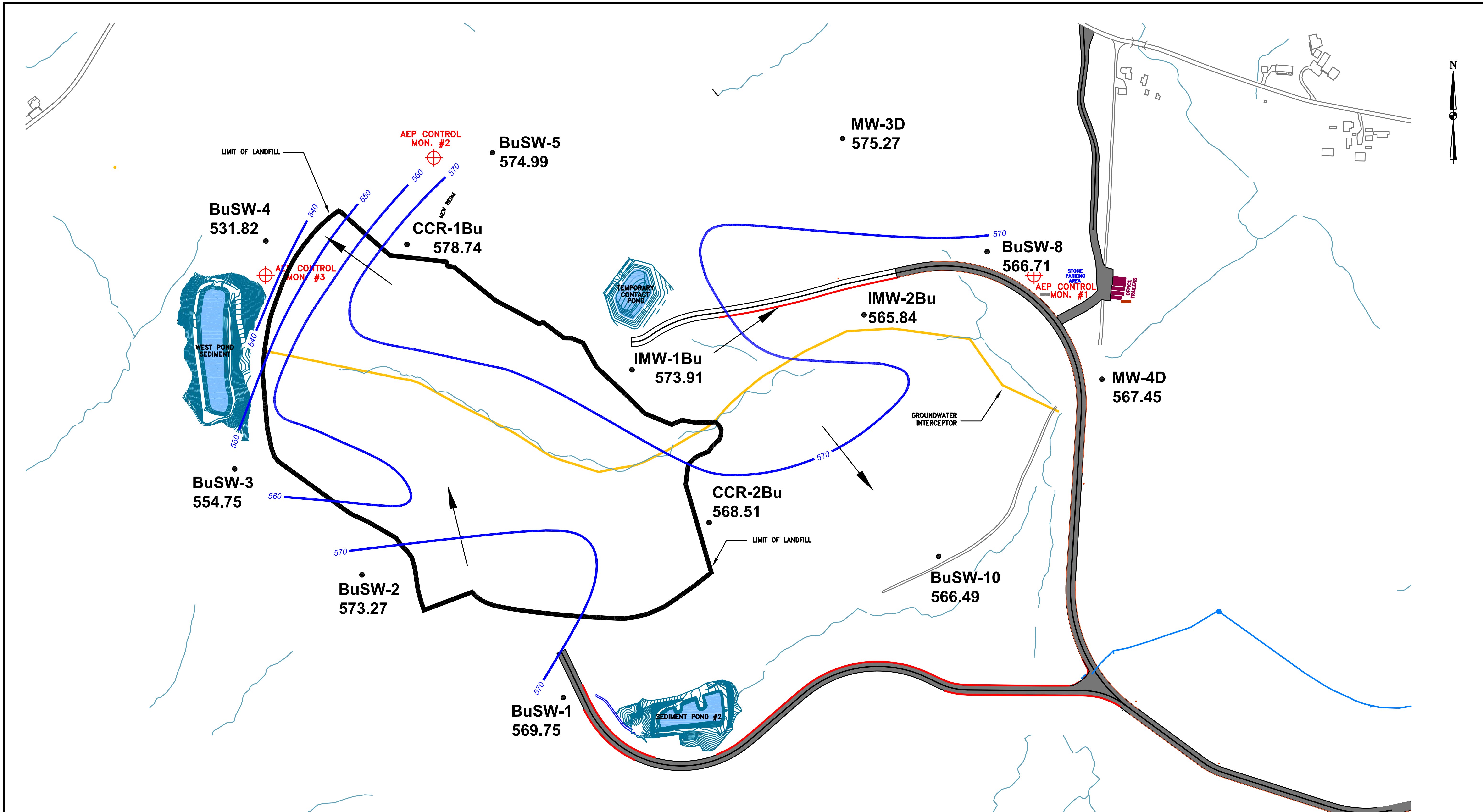
2402 Hookstown Grade Road, Suite 200
Clinton, PA 15026
412.264.6453

OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
CLASS III RESIDUAL WASTE LANDFILL
GROUNDWATER CONTOUR MAP – SEPTEMBER 2017

DRAWING NAME: FIGURE B–9 REV. 0

Plot: 01/15/2018 11:36 _PROGRAM–KYGER OVEC\Kyger Creek–CCR Program\CAD\2017 GW Monitoring–Corrective Action Rpt\APPX B \B–9_KYGER GW CONTOURS_SEPT17_BUFFALO b09



LEGEND:

● BuSW-1 BUFFALO SANDSTONE WELL

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017110-KYGER
DWG. FILE	B-1 KYGER_CCR_Contours b02_SITE_FEB-18.dwg
DRAWING SCALE	AS SHOWN

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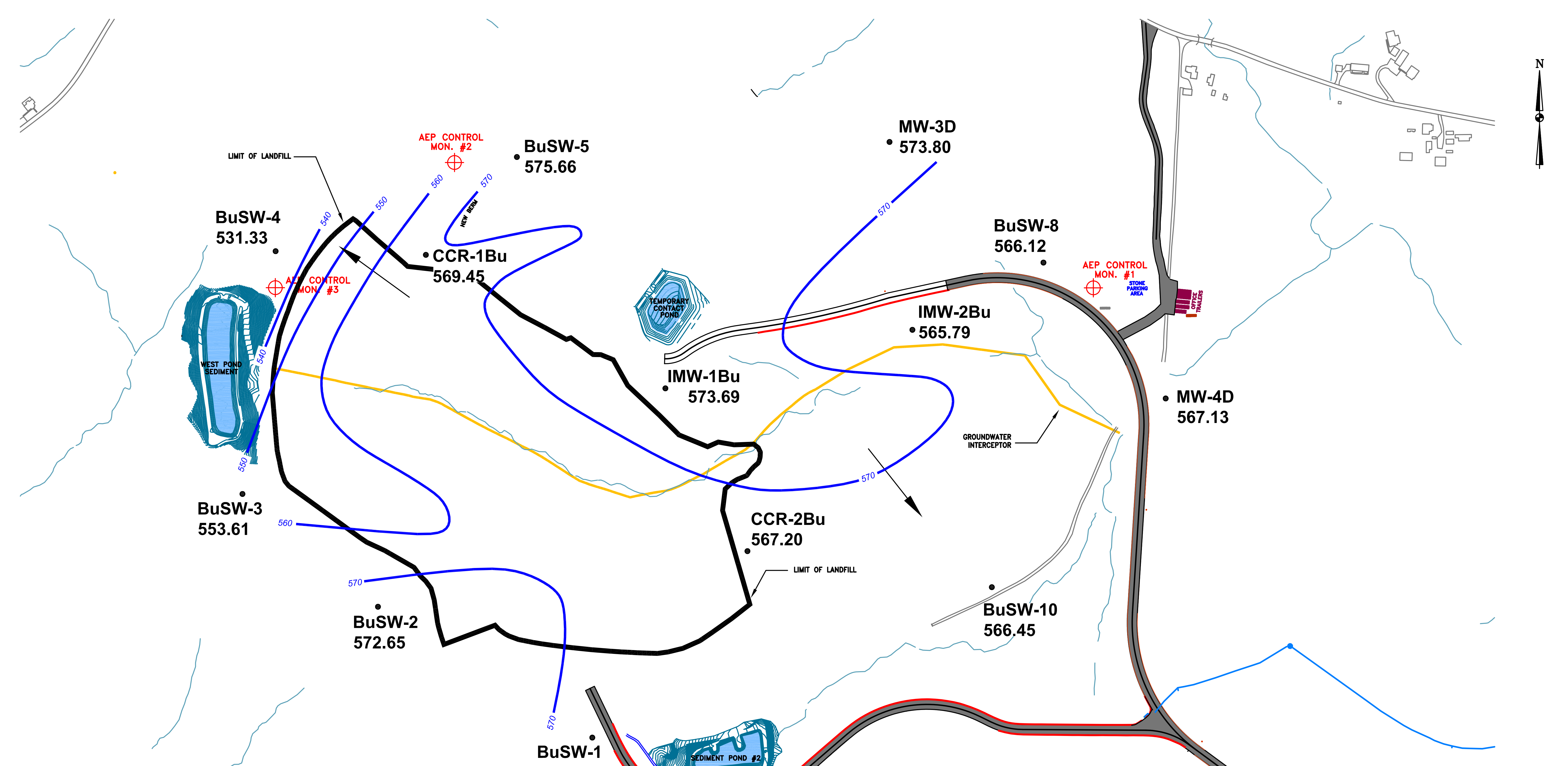
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
CLASS III RESIDUAL WASTE LANDFILL
GROUNDWATER CONTOUR MAP – FEBRUARY 2018

DRAWING NAME: FIGURE B-1

REV. 0

Plot: 01/14/2019 15:30 _PROGRAMS-KYGER OVEC\Kyger Creek-CCR Program\CAD\2018 GW Monitoring-Corrective Action Rpt\Appx B\B-1 KYGER_CCR_Contours b02_SITE_FEB-18.dwg



NOTE:
DUE TO AN EQUIPMENT MALFUNCTION DURING THE MEASUREMENT OF WATER LEVELS IN SEPTEMBER 2018, A SECOND COMPLETE ROUND OF WATER LEVELS WAS COLLECTED IN NOVEMBER 2018 AND WAS USED TO GENERATE THE GROUNDWATER FLOW MAP FOR THE LANDFILL.

LEGEND:

● BuSW-1 BUFFALO SANDSTONE WELL

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2017110–KYGER
DWG FILE	B-2 KYGER_CCR_Contours b02_SITE_NOV-18.dwg
DRAWING SCALE	AS SHOWN

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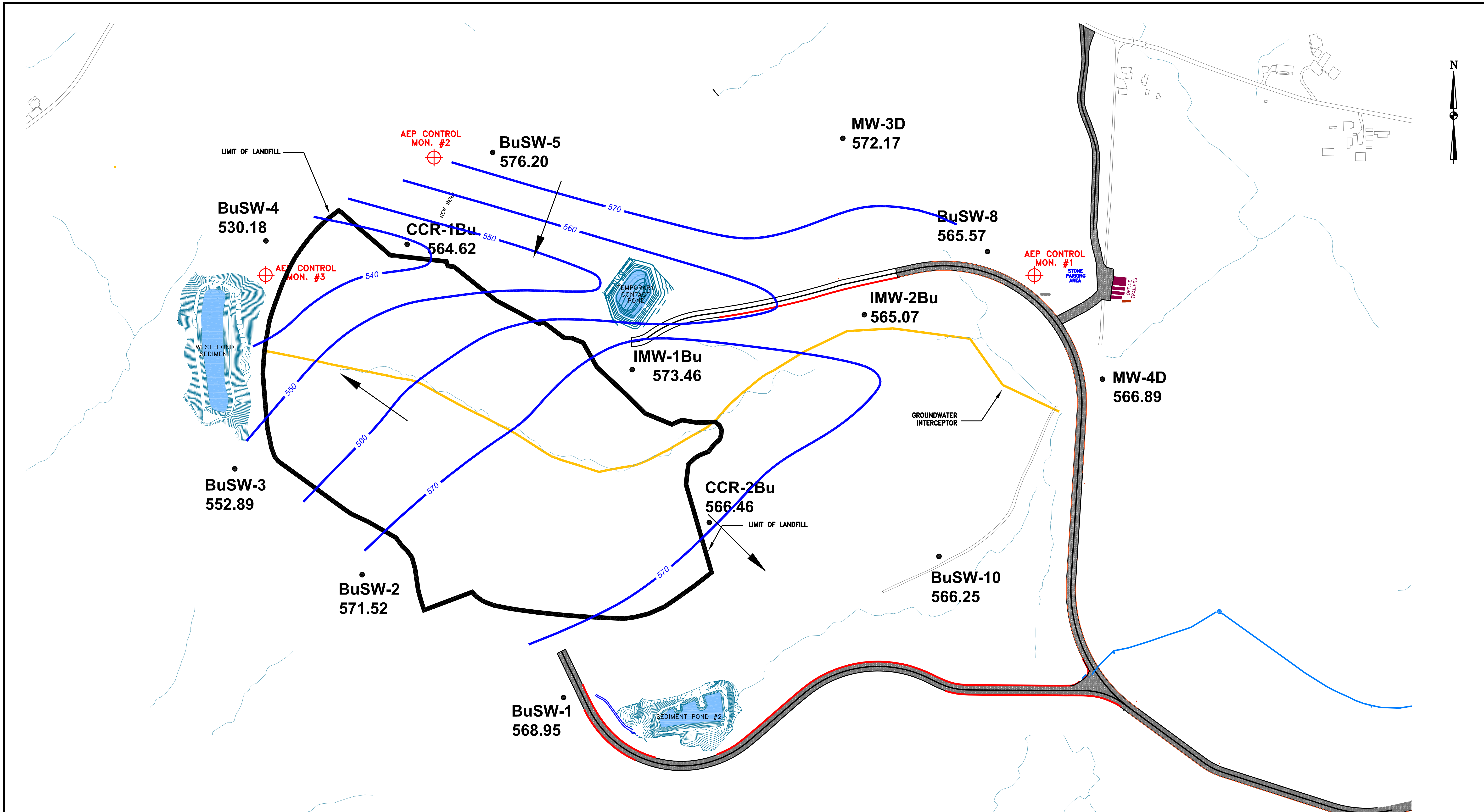
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
CLASS III RESIDUAL WASTE LANDFILL
GROUNDWATER CONTOUR MAP – NOVEMBER 2018

DRAWING NAME: FIGURE B-2

REV. 0



LEGEND:

● BuSW–1 BUFFALO SANDSTONE WELL

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2019018–KYGER
DWG FILE	KYGER_CCR_2019 Annual GW Rpt_GW Flow_MAR2019.dwg
DRAWING SCALE	AS SHOWN

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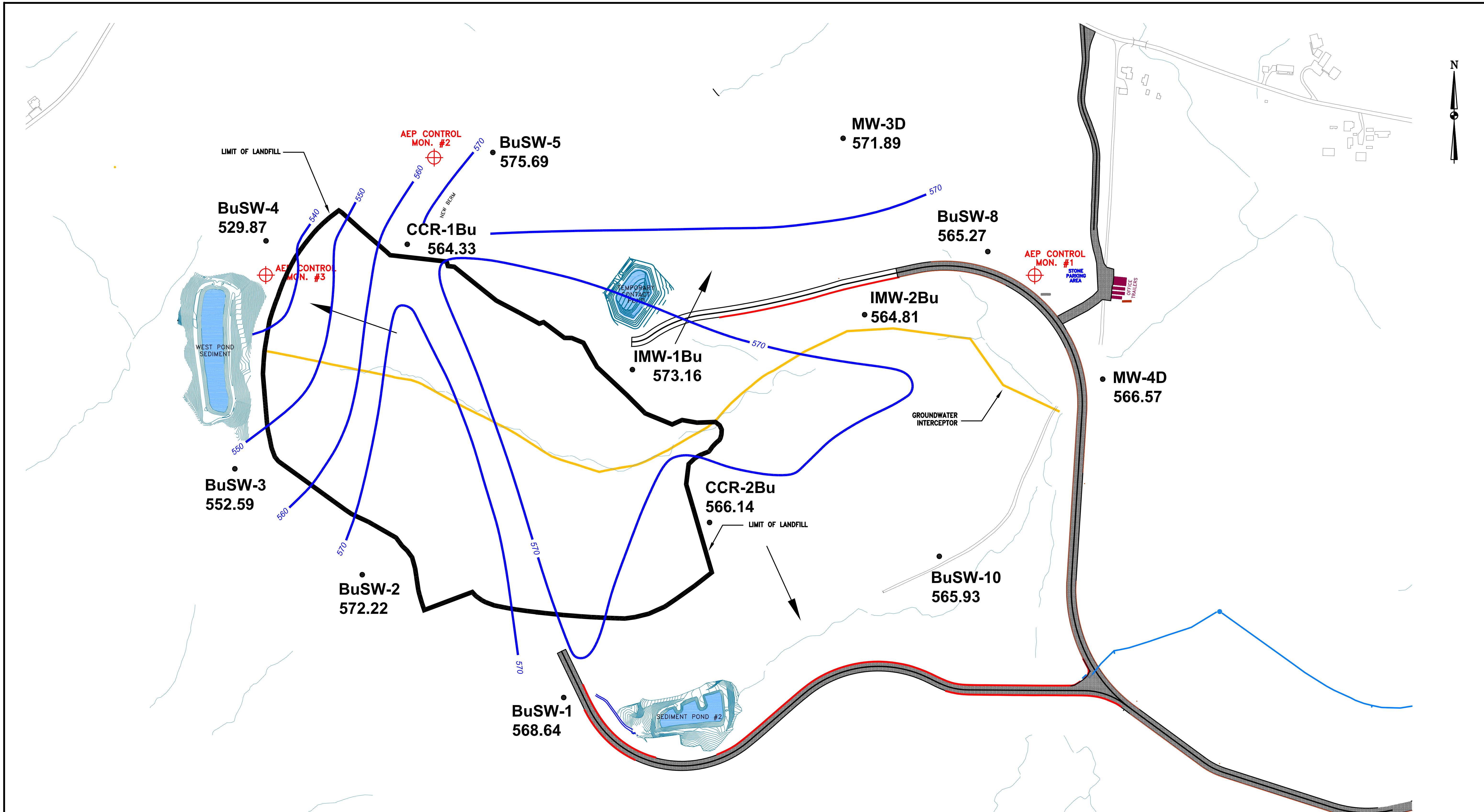
OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
CLASS III RESIDUAL WASTE LANDFILL
GROUNDWATER ELEVATIONS AND FLOW MAP
MARCH 2019

DRAWING NAME: FIGURE B–1
REV. 0

Plot: 01/27/2020 11:50 _PROGRAMS–KYGER OVEC\Kyger Creek–CCR Program\CAD\2019 GW Monitoring–Corrective Action Rpt\Appx B\KYGER_CCR_2019 Annual GW Rpt_GW Flow_MAR2019.dwg



LEGEND:

● BuSW-1 BUFFALO SANDSTONE WELL

400' 0' 400' 800'

SCALE: 1"= 400'

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2019018-KYGER
DWG FILE	KYGER_CCR_2019 Annual GW Rpt_GW Flow_SEPT2019.dwg
DRAWING SCALE	AS SHOWN

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OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
CLASS III RESIDUAL WASTE LANDFILL
GROUNDWATER ELEVATIONS AND FLOW MAP
SEPTEMBER 2019

DRAWING NAME: FIGURE B-2 REV. 0

Plot: 01/27/2020 11:54 _PROGRAMS-KYGER OVEC\Kyger Creek-CCR Program\CAD\2019 GW Monitoring-Corrective Action Rpt\Appx B\KYGER_CCR_2019 Annual GW Rpt_GW Flow_SEPT2019.dwg

APPENDIX C4 – GROUNDWATER MONITORING RESULTS

BuSW-1
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.439	0.306	0.318	0.341	0.344	0.271	0.316
Calcium, Ca	mg/L	7.93	8.54	10.6	16.6	13.1	15.8	14.6
Chloride, Cl	mg/L	1900	1870	2010	2150	1960	1890	1860
Fluoride, F	mg/L	1.08	1.13	1.23	1.14	1.26	1.17	1.11
pH	s.u.	9.1	7.4	8.93	8.86	9.08	9.54	8.47
Sulfate, SO4	mg/L	120	120	90.7	75.4	95.1	120	109
Total Dissolved Solids (TDS)	mg/L	3520	3470	3760	3850	3770	3490	3590
Appendix IV Constituents								
Antimony, Sb	ug/L	0.2 J	0.2 J	0.16	0.15	0.16	0.19	1.09
Arsenic, As	ug/L	96.1	84.6	76.5	67.9	79.5	94.8	95.3
Barium, Ba	ug/L	105	129	152	257	203	188	207
Beryllium, Be	ug/L	0.009 J	0.005 J	0.04 U	0.01 J	0.06 U	0.02 J	0.095
Cadmium, Cd	ug/L	0.1 U	0.1 U	0.04 U	0.04 U	0.06 U	0.01 J	0.03 J
Chromium, Cr	ug/L	0.5	0.5	0.6	1	3.2	7.33	9.2
Cobalt, Co	ug/L	0.062	0.059	0.07	0.125	0.225	0.482	1.02
Fluoride, F	mg/L	1.08	1.13	1.23	1.14	1.26	1.17	1.11
Lithium, Li	mg/L	0.102	0.077	0.064	0.074	0.07	0.077	0.073
Lead, Pb	ug/L	0.115	0.095	0.174	0.113	0.125	0.243	0.95
Mercury, Hg	ug/L	0.002 J	0.005 U	0.005 U	0.002 J	0.002 J	0.004 J	0.002 J
Molybdenum, Mo	ug/L	24.5	21.9	17.1	14.8	18.9	24.5	25.9
Radium 226 & 228 (combined)	pCi/L	0.969	1.768	1.11	2.034	1.458	4.282	2.235
Selenium, Se	ug/L	0.08 J	0.2 U	0.2 U	0.2 U	0.3 U	0.1 J	0.07 J
Thallium, Tl	ug/L	0.04 U	0.04 U	0.1 U	0.03 J	0.2 U	0.02 J	0.03 J

Notes:
NA: Sampling not required for this parameter or well dry.

BuSW-1
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.361	0.4	0.411	0.38	0.35	0.34	0.36	0.3
Calcium, Ca	12.8	12.9	13.5	11.5	14	16	14	22
Chloride, Cl	2040	2000	2100	2030	2200	2100	2200	1800
Fluoride, F	1.03	1.1	1.09	1.27	1.3	1.2	1.4	1.3
pH	8.21	7.34	9.12	7.45	7.91	7.23	7.05	7.06
Sulfate, SO4	87.6	82.9	79.1	104	84	75	75	110
Total Dissolved Solids (TDS)	3770	3750	3720	3560	3300	2500	2900	2700
Appendix IV Constituents								
Antimony, Sb	0.2 J	0.1 J	NA	NA	NA	NA	NA	NA
Arsenic, As	81	76.7	NA	NA	NA	NA	NA	NA
Barium, Ba	191	195	NA	NA	NA	NA	NA	NA
Beryllium, Be	0.08 U	0.08 U	NA	NA	NA	NA	NA	NA
Cadmium, Cd	0.08 U	0.08 U	NA	NA	NA	NA	NA	NA
Chromium, Cr	1.96	1.27	NA	NA	NA	NA	NA	NA
Cobalt, Co	0.254	0.17	NA	NA	NA	NA	NA	NA
Fluoride, F	1.03	1.1	NA	NA	NA	NA	NA	NA
Lithium, Li	0.066	0.079	NA	NA	NA	NA	NA	NA
Lead, Pb	0.179	0.136	NA	NA	NA	NA	NA	NA
Mercury, Hg	1.04	0.002 J	NA	NA	NA	NA	NA	NA
Molybdenum, Mo	20.4	17	NA	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	2.078	1.666	NA	NA	NA	NA	NA	NA
Selenium, Se	0.4 U	0.4 U	NA	NA	NA	NA	NA	NA
Thallium, Tl	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this paramet

BuSW-2
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.478	0.367	0.341	0.424	0.428	0.417	0.429
Calcium, Ca	mg/L	33.6	32.4	30.4	31.4	28.8	42.5	41.2
Chloride, Cl	mg/L	2500	2680	2520	2520	2500	2700	2870
Fluoride, F	mg/L	1.14	1.17	1.25	1.18	1.09	1.1	1.05
pH	s.u.	8.26	8.06	8.37	7.28	7.68	6.21	7.09
Sulfate, SO4	mg/L	2 J	2 U	7.8	3.6	2.7	57.4	23.9
Total Dissolved Solids (TDS)	mg/L	4480	4720	4480	4390	4450	4360	5050
Appendix IV Constituents								
Antimony, Sb	ug/L	0.2 J	0.2 U	0.35	0.2 U	0.88	0.06 J	0.2 U
Arsenic, As	ug/L	5.86	6.61	2.87	5.42	4.38	6.79	6.82
Barium, Ba	ug/L	1570	1890	1310	1460	1600	1780	1720
Beryllium, Be	ug/L	0.005 J	0.006 J	0.04 U	0.08 U	0.094	0.02 J	0.08 U
Cadmium, Cd	ug/L	0.04 J	0.1 U	0.04 U	0.08 U	0.01 J	0.02 J	0.02 J
Chromium, Cr	ug/L	0.5	1.3	0.8	1.1	4	1.63	17.1
Cobalt, Co	ug/L	0.24	0.167	0.388	0.439	0.963	1.27	2.24
Fluoride, F	mg/L	1.14	1.17	1.25	1.18	1.09	1.1	1.05
Lithium, Li	mg/L	0.093	0.072	0.053	0.072	0.076	0.074	0.079
Lead, Pb	ug/L	0.197	0.136	0.181	0.262	1.39	0.115	0.357
Mercury, Hg	ug/L	0.003 J	0.005 U	0.005 U	0.005 U	0.002 J	0.005 U	0.005 U
Molybdenum, Mo	ug/L	1.04	1.13	3.79	2.63	12.5	7.06	7.58
Radium 226 & 228 (combined)	pCi/L	12.07	12.3	11.14	6.94	7.194	13	11.44
Selenium, Se	ug/L	0.2 U	0.2 U	0.2 U	0.4 U	0.1	0.2 J	0.4 U
Thallium, Tl	ug/L	0.04 U	0.009 J	0.1 U	0.2 U	0.02 J	0.06 J	0.2 U

Notes:
NA: Sampling not required for this parameter or well dry.

BuSW-2
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.419	0.439	0.471	0.498	0.42	0.43	0.4	0.42
Calcium, Ca	37.5	38.7	39.8	36.1	39	37	35	42
Chloride, Cl	2740	2970	2980	2890	3100	3000	2900	4300
Fluoride, F	0.99	1.16	1.03	1.26	1.4	1.4	1.6	1.4
pH	7.89	7.59	8.19	7.43	6.92	7.58	7.62	8.21
Sulfate, SO4	10.4	2	0.7	0.5 U	7.5	4.2 J	6.9	2.4
Total Dissolved Solids (TDS)	4890	4980	5100	4660	5200	3500	4200	4900
Appendix IV Constituents								
Antimony, Sb	0.09 J	0.2 U	NA	NA	NA	NA	NA	NA
Arsenic, As	7.78	6.39	NA	NA	NA	NA	NA	NA
Barium, Ba	1520	2190	NA	NA	NA	NA	NA	NA
Beryllium, Be	0.1 U	0.03 J	NA	NA	NA	NA	NA	NA
Cadmium, Cd	0.1 U	0.1 U	NA	NA	NA	NA	NA	NA
Chromium, Cr	11	2.79	NA	NA	NA	NA	NA	NA
Cobalt, Co	2.35	0.461	NA	NA	NA	NA	NA	NA
Fluoride, F	0.99	1.16	NA	NA	NA	NA	NA	NA
Lithium, Li	0.078	0.085	NA	NA	NA	NA	NA	NA
Lead, Pb	0.326	0.28	NA	NA	NA	NA	NA	NA
Mercury, Hg	0.724	0.005 U	NA	NA	NA	NA	NA	NA
Molybdenum, Mo	321	3.23	NA	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	12.75	13.75	NA	NA	NA	NA	NA	NA
Selenium, Se	0.5 U	0.5 U	NA	NA	NA	NA	NA	NA
Thallium, Tl	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this paramet

BuSW-3
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.482	0.403	0.402	0.453	0.398	0.328	0.405
Calcium, Ca	mg/L	1330	770	802	900	700	1060	689
Chloride, Cl	mg/L	21500	17300	17500	16500	16000	20200	16500
Fluoride, F	mg/L	2 U	60 U	0.8 U	0.8 U	2 U	0.3 J	2 U
pH	s.u.	6.77	6.56	7.29	7.36	6.89	6.19	6.53
Sulfate, SO4	mg/L	126	128	136	114	101	71.9	77.7
Total Dissolved Solids (TDS)	mg/L	35000	27100	27900	29500	26900	31200	26500
Appendix IV Constituents								
Antimony, Sb	ug/L	2 U	2 U	1 U	1 U	1 U	1 U	1 U
Arsenic, As	ug/L	8.32	5.95	5.44	4.69	5.6	7.48	6.92
Barium, Ba	ug/L	2560	777	946	1040	939	4280	1450
Beryllium, Be	ug/L	0.04 J	0.2 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Cadmium, Cd	ug/L	1 U	1 U	0.09 J	0.1 J	0.4 U	0.1 J	0.09 J
Chromium, Cr	ug/L	2.9	0.9 J	1 J	1	1.4	6.22	2.09
Cobalt, Co	ug/L	4.76	5.84	5.7	5.54	6.33	6.22	6.08
Fluoride, F	mg/L	2 U	60 U	0.8 U	0.8 U	2 U	0.3 J	2 U
Lithium, Li	mg/L	0.41	0.47	0.357	0.39	0.429	0.478	0.471
Lead, Pb	ug/L	1.46	1.22	1.06	1.2	0.922	0.807	0.989
Mercury, Hg	ug/L	0.004 J	0.003 J	0.002 J	0.004 J	0.005 U	0.005	0.005 U
Molybdenum, Mo	ug/L	7.62	38.4	33.2	14.8	88.8	15.9	41.6
Radium 226 & 228 (combined)	pCi/L	27.43	16.42	10.12	11.59	4.939	22.92	8.73
Selenium, Se	ug/L	2 U	2 U	2 U	2 U	0.6 J	0.6 J	2 U
Thallium, Tl	ug/L	0.09 J	0.08 J	0.3 J	1 U	1 U	1 U	0.2 J

Notes:
NA: Sampling not required for this parameter or well dry.

BuSW-3
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.424	0.42	0.471	0.529	0.47	0.45	0.4	0.42
Calcium, Ca	770	772	877	956	1100	920	1000	950
Chloride, Cl	18100	18700	17900	18500	19000	19000	18000	20000
Fluoride, F	2 U	3 U	2 U	2 U	2.5 U	2.5 U	2.5 U	1
pH	6.51	6.75	8.92	6.89	6.07	6.76	7.43	7.19
Sulfate, SO4	71.5	39.5	50.7	39.7	43 J	33 J	34 J	32
Total Dissolved Solids (TDS)	31300	29200	27300	28900	30000	38000	29000	18000
Appendix IV Constituents								
Antimony, Sb	2 U	2 U	NA	NA	NA	NA	NA	NA
Arsenic, As	6.89	7.84	NA	NA	NA	NA	NA	NA
Barium, Ba	2580	2660	NA	NA	NA	NA	NA	NA
Beryllium, Be	0.8 U	0.6 U	NA	NA	NA	NA	NA	NA
Cadmium, Cd	0.3 J	0.6 U	NA	NA	NA	NA	NA	NA
Chromium, Cr	3.27	2.68	NA	NA	NA	NA	NA	NA
Cobalt, Co	5.63	5.2	NA	NA	NA	NA	NA	NA
Fluoride, F	2 U	3 U	NA	NA	NA	NA	NA	NA
Lithium, Li	0.437	0.48	NA	NA	NA	NA	NA	NA
Lead, Pb	1.26	1.08	NA	NA	NA	NA	NA	NA
Mercury, Hg	0.817	0.005 U	NA	NA	NA	NA	NA	NA
Molybdenum, Mo	30.1	26.3	NA	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	15.04	16.43	NA	NA	NA	NA	NA	NA
Selenium, Se	4 U	3 U	NA	NA	NA	NA	NA	NA
Thallium, Tl	0.8 J	2 U	NA	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this paramet

BuSW-4
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.323	0.385	0.431	0.408	0.373	0.418	0.427
Calcium, Ca	mg/L	948	995	990	1090	952	974	611
Chloride, Cl	mg/L	19600	19300	18800	19100	18700	18900	18200
Fluoride, F	mg/L	2 U	2 U	0.8 U	2 U	2 U	2 U	0.8 U
pH	s.u.	7.1	7.07	7.1	7.38	7.32	6.02	6.74
Sulfate, SO4	mg/L	4 J	8 J	14.3	18.9	13.4	2 J	5.3
Total Dissolved Solids (TDS)	mg/L	32500	29500	29700	30000	30300	28100	28800
Appendix IV Constituents								
Antimony, Sb	ug/L	0.6 J	2 U	0.5 J	0.5 J	1 U	0.2 J	2.05
Arsenic, As	ug/L	3.51	3.16	5.18	2.85	3.36	1.96	18.7
Barium, Ba	ug/L	40400	30200	19500	15800	18300	29200	429000
Beryllium, Be	ug/L	0.2 U	0.05 J	0.3 J	0.4 U	0.2 J	0.4 U	0.2 J
Cadmium, Cd	ug/L	1 U	0.7 J	1.19	0.67	0.68	0.4 J	1.78
Chromium, Cr	ug/L	12.1	1 J	9.9	11.3	3.6	0.3 J	8.59
Cobalt, Co	ug/L	1.59	3.99	9.59	5.03	6.99	4.22	35.8
Fluoride, F	mg/L	2 U	2 U	0.8 U	2 U	2 U	2 U	0.8 U
Lithium, Li	mg/L	0.37	0.415	0.352	0.31	0.361	0.407	0.407
Lead, Pb	ug/L	3.52	0.998	8.3	0.401	6.17	0.3 J	6.59
Mercury, Hg	ug/L	0.585	0.004 J	0.018	0.003 J	0.013	0.005 U	0.007
Molybdenum, Mo	ug/L	11.6	5.63	2.51	8.18	2.44	2.34	28.1
Radium 226 & 228 (combined)	pCi/L	NA	67.3	58.9	NA	NA	35.42	NA
Selenium, Se	ug/L	2 U	3.5	3.2	2.9	3.7	1 J	4.2
Thallium, Tl	ug/L	0.4 U	0.2 J	0.3 J	0.2 J	0.3 J	0.4 J	2.34

Notes:
NA: Sampling not required for this parameter or well dry.

BuSW-4
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	**Jun-17**	**Sep-17**	**Mar-18**	**Sep-18**	**Mar-19**	**Sep-19**	**Mar-20**	**Sep-20**
Appendix III Constituents								
Boron, B	0.368	0.405	0.05 U	0.409	0.41	0.37	0.34	0.39
Calcium, Ca	887	852	830	961	990	980	1000	1000
Chloride, Cl	19900	19600	18700	18300	19000	21000	20000	19000
Fluoride, F	2 U	3 U	0.7 J	2 U	2.5 U	2.5 U	2.5 U	0.5 U
pH	7.25	6.68	7.15	7.06	6.38	7.03	7.07	7.31
Sulfate, SO4	3.2	13.2	14.8	22.2	19 J	32 J	29 J	15
Total Dissolved Solids (TDS)	33100	33500	29000	31300	25000	37000	33000	25000
Appendix IV Constituents								
Antimony, Sb	2 U	2 U	NA	NA	NA	NA	NA	NA
Arsenic, As	3.69	2.35	NA	NA	NA	NA	NA	NA
Barium, Ba	42400	35300	NA	NA	NA	NA	NA	NA
Beryllium, Be	0.2 J	0.8 U	NA	NA	NA	NA	NA	NA
Cadmium, Cd	0.8 U	0.3 J	NA	NA	NA	NA	NA	NA
Chromium, Cr	9.5	2 J	NA	NA	NA	NA	NA	NA
Cobalt, Co	4.86	5.29	NA	NA	NA	NA	NA	NA
Fluoride, F	2 U	3 U	NA	NA	NA	NA	NA	NA
Lithium, Li	0.397	0.408	NA	NA	NA	NA	NA	NA
Lead, Pb	3.31	1.04	NA	NA	NA	NA	NA	NA
Mercury, Hg	1.35	0.005 J	NA	NA	NA	NA	NA	NA
Molybdenum, Mo	5.22	3 J	NA	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	NA	NA	NA	NA	NA	NA	NA	NA
Selenium, Se	2 J	4 U	NA	NA	NA	NA	NA	NA
Thallium, Tl	0.6 J	2 U	NA	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this paramet

BuSW-5
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.443	0.308	0.368	0.61	0.324	0.251	0.321
Calcium, Ca	mg/L	764	872	735	1040	1000	833	701
Chloride, Cl	mg/L	15700	18100	14500	20300	19700	20600	17800
Fluoride, F	mg/L	2 U	0.5 U	0.3 J	0.8 U	2 U	2 U	0.3 J
pH	s.u.	7.11	6.28	7.28	7.03	7.49	6.39	9.57
Sulfate, SO4	mg/L	10 U	0.4 J	13.4	2	2 U	2 U	1.3
Total Dissolved Solids (TDS)	mg/L	25100	28900	22600	32900	32500	33300	27100
Appendix IV Constituents								
Antimony, Sb	ug/L	2 U	2 U	0.52	0.5 U	1 U	1 U	0.6 J
Arsenic, As	ug/L	8.06	8	3.22	5.32	7.29	6.3	4.2
Barium, Ba	ug/L	26100	43100	15800	50800	53100	53600	33800
Beryllium, Be	ug/L	0.2 U	0.2 U	0.2 U	0.2 U	0.4 U	0.4 U	0.4 U
Cadmium, Cd	ug/L	1 U	1 U	0.2 U	0.2 U	0.4 U	0.4 U	0.4 U
Chromium, Cr	ug/L	0.8 J	0.7 J	1.2	0.5	0.7 J	0.5 J	1.22
Cobalt, Co	ug/L	0.29	0.1 J	0.818	0.263	0.274	0.479	0.516
Fluoride, F	mg/L	2 U	0.5 U	0.3 J	0.8 U	2 U	2 U	0.3 J
Lithium, Li	mg/L	0.316	0.337	0.263	0.278	0.368	0.298	0.309
Lead, Pb	ug/L	0.162	1.34	0.42	0.1 J	0.2 J	0.2 J	0.484
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.004 J
Molybdenum, Mo	ug/L	4.36	2.17	10.1	2.68	2.58	2.19	4.65
Radium 226 & 228 (combined)	pCi/L	108.8	230	75.1	163.1	75.7	99.99	52.82
Selenium, Se	ug/L	0.6 J	2 U	1 U	1 U	2 U	2 U	2 U
Thallium, Tl	ug/L	0.4 U	0.4 U	0.5 U	0.2 J	1 U	1 U	1 U

Notes:
NA: Sampling not required for this parameter or well dry.

BuSW-5
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.377	0.39	0.348	0.406	0.42	0.38	0.36	0.37
Calcium, Ca	912	907	790	753	640	650	810	530
Chloride, Cl	20900	20200	16000	16300	16000	16000	16000	15000
Fluoride, F	2 U	2 U	2 U	2 U	2.5 U	2.5 U	2.5 U	0.43 J
pH	8.12	6.57	9.8	7.21	6.47	7.12	7.73	7.68
Sulfate, SO4	2.7	2 U	2.9	2 U	50 U	50 U	50 U	10 U
Total Dissolved Solids (TDS)	35000	36000	26100	25600	22000	32000	27000	19000
Appendix IV Constituents								
Antimony, Sb	2 U	2 U	NA	NA	NA	NA	NA	NA
Arsenic, As	6.33	5.81	NA	NA	NA	NA	NA	NA
Barium, Ba	43200	55800	NA	NA	NA	NA	NA	NA
Beryllium, Be	0.8 U	0.8 U	NA	NA	NA	NA	NA	NA
Cadmium, Cd	0.8 U	0.8 U	NA	NA	NA	NA	NA	NA
Chromium, Cr	1 J	4.24	NA	NA	NA	NA	NA	NA
Cobalt, Co	0.5 J	0.7 J	NA	NA	NA	NA	NA	NA
Fluoride, F	2 U	2 U	NA	NA	NA	NA	NA	NA
Lithium, Li	0.37	0.406	NA	NA	NA	NA	NA	NA
Lead, Pb	0.2 J	1.3	NA	NA	NA	NA	NA	NA
Mercury, Hg	0.764	0.005 U	NA	NA	NA	NA	NA	NA
Molybdenum, Mo	7.76	3 J	NA	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	46.96	55.2	NA	NA	NA	NA	NA	NA
Selenium, Se	4 U	4 U	NA	NA	NA	NA	NA	NA
Thallium, Tl	2 U	2 U	NA	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this paramet

BuSW-8
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.362	0.332	0.344	0.336	0.317	0.237	0.243
Calcium, Ca	mg/L	492	479	598	463	497	375	395
Chloride, Cl	mg/L	14800	13600	13600	13300	13500	13600	13100
Fluoride, F	mg/L	1 U	1 U	0.8 U	0.8 U	2 U	0.4 J	0.3 J
pH	s.u.	7.15	6.43	7.44	7.17	7.38	7.84	7.35
Sulfate, SO4	mg/L	3 J	2 J	2.5	3.6	2 U	2 U	1.7
Total Dissolved Solids (TDS)	mg/L	23600	21800	23000	22800	20800	20800	20900
Appendix IV Constituents								
Antimony, Sb	ug/L	1 U	1 U	0.5 U	0.2 J	1 U	1 U	1 U
Arsenic, As	ug/L	19.6	24.4	24.3	14.6	18.4	19.6	13.6
Barium, Ba	ug/L	20000	22300	20900	23700	21400	22400	22700
Beryllium, Be	ug/L	0.1 U	0.1 U	0.2 U	0.2 U	0.4 U	0.4 U	0.4 U
Cadmium, Cd	ug/L	0.5 U	0.5 U	0.2 U	0.2 U	0.4 U	0.4 U	0.4 U
Chromium, Cr	ug/L	3.7	2.5	1.2	0.5 U	1.3	0.5 J	1.18
Cobalt, Co	ug/L	3.24	3.98	3.7	3.6	3.17	3.48	3.95
Fluoride, F	mg/L	1 U	1 U	0.8 U	0.8 U	2 U	0.4 J	0.3 J
Lithium, Li	mg/L	0.309	0.314	0.221	0.27	0.269	0.185	0.198
Lead, Pb	ug/L	0.437	0.08	0.315	0.09 J	0.2 J	0.4 U	0.3 J
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.003 J	0.005 U
Molybdenum, Mo	ug/L	3.84	3.58	3.54	3.21	6.44	3.07	3.66
Radium 226 & 228 (combined)	pCi/L	164.6	144	206	185.5	74.31	93.61	69.88
Selenium, Se	ug/L	1 U	1 U	1 U	0.3 J	0.9 J	2 U	2 U
Thallium, Tl	ug/L	0.06 J	0.2 U	0.5 U	0.5 U	1 U	1 U	1 U

Notes:
NA: Sampling not required for this parameter or well dry.

BuSW-8
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.371	0.424	0.372	0.434	0.41	0.39	0.35	0.37
Calcium, Ca	485	454	577	528	500	540	490	470
Chloride, Cl	14000	14200	12700	13500	14000	14000	14000	15000
Fluoride, F	0.8 U	3 U	0.8 U	2 U	2.5 U	2.5 U	2.5 U	0.34
pH	7.13	6.82	9.93	7.47	6.56	7.07	7.46	7.85
Sulfate, SO4	22.2	5 U	9.4	2 U	50 U	50 U	50 U	10
Total Dissolved Solids (TDS)	21500	22100	21300	22100	18000	24000	23000	15000
Appendix IV Constituents								
Antimony, Sb	1 U	1 U	NA	NA	NA	NA	NA	NA
Arsenic, As	23.5	23.8	NA	NA	NA	NA	NA	NA
Barium, Ba	23100	25500	NA	NA	NA	NA	NA	NA
Beryllium, Be	0.4 U	0.4 U	NA	NA	NA	NA	NA	NA
Cadmium, Cd	0.4 U	0.4 U	NA	NA	NA	NA	NA	NA
Chromium, Cr	1.57	1.01	NA	NA	NA	NA	NA	NA
Cobalt, Co	4.88	4.28	NA	NA	NA	NA	NA	NA
Fluoride, F	0.8 U	3 U	NA	NA	NA	NA	NA	NA
Lithium, Li	0.248	0.254	NA	NA	NA	NA	NA	NA
Lead, Pb	0.3 J	0.3 J	NA	NA	NA	NA	NA	NA
Mercury, Hg	0.005 U	0.005 U	NA	NA	NA	NA	NA	NA
Molybdenum, Mo	6.12	26.4	NA	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	84.37	0.2892	NA	NA	NA	NA	NA	NA
Selenium, Se	2 U	2 U	NA	NA	NA	NA	NA	NA
Thallium, Tl	0.2 J	1 U	NA	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this paramet

BuSW-10
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.383	0.362	0.375	0.396	0.36	0.402	0.373
Calcium, Ca	mg/L	34.5	32.6	38.1	36.6	33.5	32.9	34.7
Chloride, Cl	mg/L	3130	2980	2960	3080	2970	2880	3000
Fluoride, F	mg/L	1.1	1.05	1.07	1.1	1.19	1.22	1.02
pH	s.u.	7.69	7.56	7.38	7.44	7.71	8.01	8.15
Sulfate, SO4	mg/L	2	1 J	1.4	1.4	0.5 U	0.3 J	0.8
Total Dissolved Solids (TDS)	mg/L	4980	5160	5120	5070	5160	4930	5140
Appendix IV Constituents								
Antimony, Sb	ug/L	0.2 U	0.3 U	0.1 U	0.2 U	0.2 U	0.1 J	0.2 U
Arsenic, As	ug/L	2.98	2.75	2.84	2.47	2.89	2.86	3.44
Barium, Ba	ug/L	1250	1250	1210	1360	1390	1320	1290
Beryllium, Be	ug/L	0.02 U	0.03 U	0.04 U	0.06 U	0.06 U	0.06 U	0.06 U
Cadmium, Cd	ug/L	0.1 U	0.2 U	0.04 U	0.06 U	0.06 U	0.01 J	0.06 U
Chromium, Cr	ug/L	3.8	0.3 J	0.9	0.5	1	2.36	1.47
Cobalt, Co	ug/L	0.234	0.102	0.08	0.098	0.177	0.276	0.127
Fluoride, F	mg/L	1.1	1.05	1.07	1.1	1.19	1.22	1.02
Lithium, Li	mg/L	0.073	0.082	0.071	0.073	0.076	0.089	0.094
Lead, Pb	ug/L	0.103	0.111	0.064	0.04 J	0.186	0.183	0.132
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.003 J	0.005 U	0.005 U	0.005 U
Molybdenum, Mo	ug/L	2.23	1.35	1.3	1.5	1.8	1.64	1.57
Radium 226 & 228 (combined)	pCi/L	24.1	22.4	21.9	24.58	22.25	24.35	20.66
Selenium, Se	ug/L	0.2 U	0.3 U	0.2 U	0.3 U	0.3 U	0.1 J	0.3 U
Thallium, Tl	ug/L	0.01 J	0.06 U	0.1 U	0.2 U	0.2 U	0.2 U	0.2 U

Notes:
NA: Sampling not required for this parameter or well dry.

BuSW-10
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.393	0.513	0.379	0.405	0.38	0.38	0.37	0.43
Calcium, Ca	36	36.6	34.7	33.2	33	33	40	36
Chloride, Cl	3070	3020	3090	3030	3100	3200	3200	3000
Fluoride, F	0.8 J	1.05	1 J	1.22	1.3	1.3	1.4	1.1
pH	7.98	7.76	7.74	7.6	7.07	7.64	7.32	7.19
Sulfate, SO4	2 U	0.5 J	9.8	1 U	8.4	4.9 J	6.6	4.1
Total Dissolved Solids (TDS)	5100	5250	5050	4380	4900	5400	4600	4700
Appendix IV Constituents								
Antimony, Sb	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA
Arsenic, As	3.15	3.59	NA	NA	NA	NA	NA	NA
Barium, Ba	1550	1970	NA	NA	NA	NA	NA	NA
Beryllium, Be	0.08 U	0.1 U	NA	NA	NA	NA	NA	NA
Cadmium, Cd	0.08 U	0.1 U	NA	NA	NA	NA	NA	NA
Chromium, Cr	2.78	1.02	NA	NA	NA	NA	NA	NA
Cobalt, Co	0.194	0.139	NA	NA	NA	NA	NA	NA
Fluoride, F	0.8 J	1.05	NA	NA	NA	NA	NA	NA
Lithium, Li	0.07	0.08	NA	NA	NA	NA	NA	NA
Lead, Pb	0.152	0.133	NA	NA	NA	NA	NA	NA
Mercury, Hg	0.882	0.005 U	NA	NA	NA	NA	NA	NA
Molybdenum, Mo	2.14	19	NA	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	25.61	21.44	NA	NA	NA	NA	NA	NA
Selenium, Se	0.4 U	0.5 U	NA	NA	NA	NA	NA	NA
Thallium, Tl	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this paramet

CCR-1BU
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.192	0.185	0.228	0.908	0.209	0.222	0.287
Calcium, Ca	mg/L	628	733	949	604	244	420	224
Chloride, Cl	mg/L	9100	11800	12400	10300	6480	1740	6880
Fluoride, F	mg/L	1 U	1 U	2 U	0.8 U	0.5 J	0.4 J	0.4 J
pH	s.u.	--	8.8	7.63	7.19	7.95	6.95	7.39
Sulfate, SO4	mg/L	27.3	18.7	15.8	20.6	27.4	19.5	13.9
Total Dissolved Solids (TDS)	mg/L	15800	19500	20100	17500	10900	13500	10900
Appendix IV Constituents								
Antimony, Sb	ug/L	0.5 J	0.4 J	0.2 J	0.07 J	0.2 J	0.5 U	0.5 U
Arsenic, As	ug/L	4.25	3.34	4.89	3.89	2.29	4.52	3.95
Barium, Ba	ug/L	7280	12500	12100	9510	3200	7350	3520
Beryllium, Be	ug/L	0.1 U	0.1 U	0.2 U	0.04 U	0.2 U	0.2 U	0.05 J
Cadmium, Cd	ug/L	0.5 U	0.2 J	0.2 U	0.04 U	0.07 J	0.2 U	0.2 U
Chromium, Cr	ug/L	0.3 J	1.2	0.4 J	1.2	0.5 J	0.81	2.04
Cobalt, Co	ug/L	2.03	3.3	2.66	2.54	1.41	1.12	0.971
Fluoride, F	mg/L	1 U	1 U	2 U	0.8 U	0.5 J	0.4 J	0.4 J
Lithium, Li	mg/L	0.148	0.188	0.196	0.16	0.119	0.169	0.15
Lead, Pb	ug/L	0.164	0.816	0.323	0.267	0.1 J	0.1 J	0.252
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.003 J	0.005 U
Molybdenum, Mo	ug/L	14.5	19.9	13.2	15.7	21.9	16.4	16.2
Radium 226 & 228 (combined)	pCi/L	43.4	58.2	88.1	171.6	12.27	28.64	10.54
Selenium, Se	ug/L	0.4 J	0.3 J	1 U	0.1 J	1 U	1 U	1 U
Thallium, Tl	ug/L	0.1 J	0.1 J	0.3 J	0.1 U	0.1 J	0.5 U	0.5 U

Notes:
NA: Sampling not required for this parameter or well dry.

CCR-1BU
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.281	0.284	0.336	0.324	0.3	0.3	0.25	0.28
Calcium, Ca	240	317	329	421	500	540	620	580
Chloride, Cl	7530	8610	8990	10400	12000	13000	13000	14000
Fluoride, F	0.5 J	0.5 J	0.8 U	0.8 U	2.5 U	2.5 U	2.5 U	1 U
pH	7.52	7.35	9.99	7.61	6.77	7.27	7.97	7.68
Sulfate, SO4	12.8	8	7.5	3.8	50 U	50 U	50 U	20 U
Total Dissolved Solids (TDS)	12500	14500	14600	17900	19000	24000	23000	14000
Appendix IV Constituents								
Antimony, Sb	1 U	0.5 U	NA	NA	NA	NA	NA	NA
Arsenic, As	2.17	3.89	NA	NA	NA	NA	NA	NA
Barium, Ba	4680	6210	NA	NA	NA	NA	NA	NA
Beryllium, Be	0.4 U	0.2 U	NA	NA	NA	NA	NA	NA
Cadmium, Cd	0.4 U	0.2 U	NA	NA	NA	NA	NA	NA
Chromium, Cr	3.62	1.32	NA	NA	NA	NA	NA	NA
Cobalt, Co	0.675	1	NA	NA	NA	NA	NA	NA
Fluoride, F	0.5 J	0.5 J	NA	NA	NA	NA	NA	NA
Lithium, Li	0.147	0.17	NA	NA	NA	NA	NA	NA
Lead, Pb	0.58	0.22	NA	NA	NA	NA	NA	NA
Mercury, Hg	0.857	0.005 U	NA	NA	NA	NA	NA	NA
Molybdenum, Mo	19.3	12.9	NA	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	8.75	16.11	NA	NA	NA	NA	NA	NA
Selenium, Se	2 U	1 U	NA	NA	NA	NA	NA	NA
Thallium, Tl	1 U	0.1 J	NA	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this paramet

CCR-2BU
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.179	0.188	0.168	0.217	0.28	0.174	0.302
Calcium, Ca	mg/L	9.48	13.1	8.02	6.1	18	3.51	28.2
Chloride, Cl	mg/L	335	506	521	524	1110	64.9	1320
Fluoride, F	mg/L	1.86	1.7	1.48	1.6	0.92	1.37	1.09
pH	s.u.	--	7.87	10.22	9.99	8.86	10.64	8.23
Sulfate, SO4	mg/L	97.8	88.2	76.2	66	41.8	52.5	22.5
Total Dissolved Solids (TDS)	mg/L	878	1170	1210	1020	2020	1220	2350
Appendix IV Constituents								
Antimony, Sb	ug/L	1.64	1.36	0.8 J	0.56	0.2	0.86	0.09 J
Arsenic, As	ug/L	207	107	104	103	52.5	72.8	55.5
Barium, Ba	ug/L	119	169	119	117	419	145	608
Beryllium, Be	ug/L	0.09	0.067	0.4 U	0.2 U	0.01 J	0.009 J	0.01 J
Cadmium, Cd	ug/L	0.05 U	0.02 J	0.4 U	0.2 U	0.02 U	0.007 J	0.04 U
Chromium, Cr	ug/L	1.6	2.2	0.6 J	1.3	2	11.9	1.2
Cobalt, Co	ug/L	0.577	0.552	0.2 J	0.233	0.721	0.639	0.291
Fluoride, F	mg/L	1.86	1.7	1.48	1.6	0.92	1.37	1.09
Lithium, Li	mg/L	0.009	0.012	0.08	0.108	0.051	0.116	0.042
Lead, Pb	ug/L	0.492	0.562	0.2 J	0.2 J	0.142	0.151	0.226
Mercury, Hg	ug/L	0.002 J	0.005 U	0.005 U	0.002 J	0.002 J	0.005 J	0.005 U
Molybdenum, Mo	ug/L	163	211	166	147	161	153	127
Radium 226 & 228 (combined)	pCi/L	1.078	0.408 U	0.431	0.987	1.947	0.572	1.765
Selenium, Se	ug/L	0.2	0.1	2 U	1 U	0.1	0.1	0.06 J
Thallium, Tl	ug/L	0.02 J	0.02 J	1 U	0.5 U	0.05 U	0.02 J	0.03 J

Notes:
NA: Sampling not required for this parameter or well dry.

CCR-2BU
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.251	0.3	0.265	0.288	0.26	0.26	0.29	0.13
Calcium, Ca	32.3	34.1	5.93	46.9	48	43	47	160
Chloride, Cl	1400	1560	981	1880	2000	2200	2500	780
Fluoride, F	1	0.98	1.03	1.13	1.1	1.4	1.5	0.7
pH	8.15	6.24	7.96	7.09	7.77	6.52	7.76	7.34
Sulfate, SO4	36.7	35.9	32.7	52.6	57	50	49	26
Total Dissolved Solids (TDS)	2540	2860	1740	3200	3100	2900	4900	1900
Appendix IV Constituents								
Antimony, Sb	0.06 J	0.04 J	NA	NA	NA	NA	NA	NA
Arsenic, As	36.5	35.7	NA	NA	NA	NA	NA	NA
Barium, Ba	614	669	NA	NA	NA	NA	NA	NA
Beryllium, Be	0.01 J	0.06 U	NA	NA	NA	NA	NA	NA
Cadmium, Cd	0.04 U	0.06 U	NA	NA	NA	NA	NA	NA
Chromium, Cr	9.59	3.18	NA	NA	NA	NA	NA	NA
Cobalt, Co	0.909	0.874	NA	NA	NA	NA	NA	NA
Fluoride, F	1	0.98	NA	NA	NA	NA	NA	NA
Lithium, Li	0.043	0.049	NA	NA	NA	NA	NA	NA
Lead, Pb	0.287	0.152	NA	NA	NA	NA	NA	NA
Mercury, Hg	1.25	0.005 U	NA	NA	NA	NA	NA	NA
Molybdenum, Mo	115	103	NA	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	1.616	2.97	NA	NA	NA	NA	NA	NA
Selenium, Se	0.2 U	0.3 U	NA	NA	NA	NA	NA	NA
Thallium, Tl	0.1 U	0.2 U	NA	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this paramet

IMW-1BU
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.432	0.309	0.372	0.389	0.335	0.307	1.09
Calcium, Ca	mg/L	303	277	259	335	312	175	243
Chloride, Cl	mg/L	8860	9220	8470	10000	10100	7740	9760
Fluoride, F	mg/L	0.6 J	1 U	0.7 J	0.4 J	0.6 J	0.9 J	0.5 J
pH	s.u.	7.59	7.37	7.68	8.37	7.51	9.18	9.48
Sulfate, SO4	mg/L	17.6	3 J	3.6	6.8	2 U	16.9	2.1
Total Dissolved Solids (TDS)	mg/L	13700	15100	13800	16600	16500	12000	15500
Appendix IV Constituents								
Antimony, Sb	ug/L	1 U	1 U	0.5 U	0.5 U	0.5 U	0.1 J	0.1 J
Arsenic, As	ug/L	4.14	5.16	5.01	4.87	3.97	4.65	3.87
Barium, Ba	ug/L	6180	10800	8920	11900	12000	5700	10900
Beryllium, Be	ug/L	0.1 U	0.1 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Cadmium, Cd	ug/L	0.5 U	0.5 U	0.2 U	0.2 U	0.2 U	0.05 J	0.2 U
Chromium, Cr	ug/L	0.4 J	0.6 J	1.9	0.5 J	2.1	2.1	0.748
Cobalt, Co	ug/L	0.526	0.325	0.316	0.574	0.43	0.353	0.256
Fluoride, F	mg/L	0.6 J	1 U	0.7 J	0.4 J	0.6 J	0.9 J	0.5 J
Lithium, Li	mg/L	0.231	0.204	0.172	0.236	0.229	0.17	0.218
Lead, Pb	ug/L	0.366	0.475	0.246	0.1 J	0.507	0.2 J	0.271
Mercury, Hg	ug/L	0.005 U	0.005 U	0.002 J	0.005 U	0.005 U	0.002 J	0.005 U
Molybdenum, Mo	ug/L	2.2	1.9	1.13	2.79	7.2	1.65	1.68
Radium 226 & 228 (combined)	pCi/L	56.1	95.9	98.7	52.2	52.25	46.14	83.92
Selenium, Se	ug/L	0.4 J	1 U	1 U	1 U	0.6 J	1 U	1 U
Thallium, Tl	ug/L	0.2 J	0.2 U	0.5 U	0.5 U	0.5 U	0.3 J	0.2 J

Notes:
NA: Sampling not required for this parameter or well dry.

IMW-1BU
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.37	0.354	0.438	0.432	0.41	0.4	0.4	0.4
Calcium, Ca	253	302	186	252	220	230	180	140
Chloride, Cl	9450	11000	7190	8370	7900	8200	6600	6600
Fluoride, F	0.7 J	0.6 J	0.9 J	0.8 J	0.85	0.77	1.1	1
pH	8.75	7.1	6.59	7.59	7.03	7.26	7.71	7.95
Sulfate, SO4	9.8	2 U	6.9	2 U	12	9.3 J	7	12
Total Dissolved Solids (TDS)	14200	17200	10700	13800	13000	13000	11000	8900
Appendix IV Constituents								
Antimony, Sb	1 U	1 U	NA	NA	NA	NA	NA	NA
Arsenic, As	5.48	4.49	NA	NA	NA	NA	NA	NA
Barium, Ba	7390	16300	NA	NA	NA	NA	NA	NA
Beryllium, Be	0.4 U	0.4 U	NA	NA	NA	NA	NA	NA
Cadmium, Cd	0.4 U	0.4 U	NA	NA	NA	NA	NA	NA
Chromium, Cr	0.8 J	1.44	NA	NA	NA	NA	NA	NA
Cobalt, Co	1.85	0.496	NA	NA	NA	NA	NA	NA
Fluoride, F	0.7 J	0.6 J	NA	NA	NA	NA	NA	NA
Lithium, Li	0.21	0.241	NA	NA	NA	NA	NA	NA
Lead, Pb	0.474	0.4 J	NA	NA	NA	NA	NA	NA
Mercury, Hg	0.01 U	0.003 J	NA	NA	NA	NA	NA	NA
Molybdenum, Mo	2.73	2.7	NA	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	56.76	86.55	NA	NA	NA	NA	NA	NA
Selenium, Se	1 J	2 U	NA	NA	NA	NA	NA	NA
Thallium, Tl	1 U	1 U	NA	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this paramet

IMW-2BU
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.396	0.35	0.35	0.378	0.321	0.293	0.487
Calcium, Ca	mg/L	625	515	706	609	535	374	457
Chloride, Cl	mg/L	14800	13600	14200	14100	14000	12400	13900
Fluoride, F	mg/L	1 U	1 U	0.8 U	0.8 U	2 U	0.6 J	0.3 J
pH	s.u.	7.51	7	7.46	7.6	7.46	8.01	9.76
Sulfate, SO4	mg/L	2 J	2 J	2.3	0.9 J	2 U	2 U	1 U
Total Dissolved Solids (TDS)	mg/L	22300	22100	23100	24600	23300	20200	21500
Appendix IV Constituents								
Antimony, Sb	ug/L	1 U	1 U	0.5 U	0.5 U	1 U	1 U	1 U
Arsenic, As	ug/L	3.83	1.28	2.99	2.36	2.45	1.25	2.86
Barium, Ba	ug/L	27400	28500	28800	29100	28400	24000	29100
Beryllium, Be	ug/L	0.1 U	0.1 U	0.2 U	0.2 U	0.4 U	0.4 U	0.1 J
Cadmium, Cd	ug/L	0.5 U	0.5 U	0.2 U	0.2 U	0.4 U	0.4 U	0.4 U
Chromium, Cr	ug/L	0.6 J	0.4 J	0.6	0.8	0.4 J	0.7 J	5.59
Cobalt, Co	ug/L	0.117	0.08 J	0.114	0.09 J	0.1 J	0.1 J	0.319
Fluoride, F	mg/L	1 U	1 U	0.8 U	0.8 U	2 U	0.6 J	0.3 J
Lithium, Li	mg/L	0.302	0.314	0.264	0.248	0.302	0.223	0.277
Lead, Pb	ug/L	0.615	0.084	0.375	0.1 J	0.1 J	0.09 J	0.407
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.002 J	0.005 U
Molybdenum, Mo	ug/L	0.7 J	0.7 J	0.9 J	0.6 J	6.46	0.7 J	1 J
Radium 226 & 228 (combined)	pCi/L	219.8	197.7	302	218.6	76.87	98.73	89.53
Selenium, Se	ug/L	1 U	1 U	1 U	1 U	1 J	2 U	2 U
Thallium, Tl	ug/L	0.06 J	0.256	0.5 U	0.5 U	1 U	0.3 J	0.2 J

Notes:
NA: Sampling not required for this parameter or well dry.

IMW-2BU
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.389	0.333	0.434	0.353	0.36	0.4	0.38	0.39
Calcium, Ca	427	487	369	553	560	570	480	580
Chloride, Cl	12600	15100	10500	14200	14000	14000	13000	14000
Fluoride, F	0.49	2 U	2 U	2 U	2.5 U	2.5 U	2.5 U	2.5
pH	9.01	6.87	7.54	7.51	6.76	7.05	7.37	7.74
Sulfate, SO4	1.8	2 U	3.1	2 U	50 U	50 U	50 U	50
Total Dissolved Solids (TDS)	19600	23200	15600	22400	20000	24000	22000	27000
Appendix IV Constituents								
Antimony, Sb	1 U	1 U	NA	NA	NA	NA	NA	NA
Arsenic, As	2.19	2.99	NA	NA	NA	NA	NA	NA
Barium, Ba	21300	31400	NA	NA	NA	NA	NA	NA
Beryllium, Be	0.4 U	0.4 U	NA	NA	NA	NA	NA	NA
Cadmium, Cd	0.4 U	0.4 U	NA	NA	NA	NA	NA	NA
Chromium, Cr	2.69	0.8 J	NA	NA	NA	NA	NA	NA
Cobalt, Co	0.1 J	0.2 J	NA	NA	NA	NA	NA	NA
Fluoride, F	0.49	2 U	NA	NA	NA	NA	NA	NA
Lithium, Li	0.262	0.28	NA	NA	NA	NA	NA	NA
Lead, Pb	0.3 J	0.442	NA	NA	NA	NA	NA	NA
Mercury, Hg	0.708	0.005 U	NA	NA	NA	NA	NA	NA
Molybdenum, Mo	2 J	1 J	NA	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	81.8	81.18	NA	NA	NA	NA	NA	NA
Selenium, Se	2 U	2 U	NA	NA	NA	NA	NA	NA
Thallium, Tl	1 U	1 U	NA	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this paramet

MW-3D
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.396	0.303	0.36	0.361	0.32	0.24	0.315
Calcium, Ca	mg/L	1160	972	996	1150	1020	841	859
Chloride, Cl	mg/L	21200	20200	20200	20200	19800	20300	20000
Fluoride, F	mg/L	2 U	1 U	0.8 U	0.8 U	2 U	2 U	0.8 U
pH	s.u.	6.81	6.91	7.4	7.37	7.52	6.58	6.72
Sulfate, SO4	mg/L	10 U	2 J	2.4	1.4	2 U	2 U	1 U
Total Dissolved Solids (TDS)	mg/L	32800	32400	31400	33300	33600	30100	31500
Appendix IV Constituents								
Antimony, Sb	ug/L	2 U	2 U	1 U	1 U	1 U	1 U	1 U
Arsenic, As	ug/L	5.76	2.83	3.42	6.05	2.28	6.04	6.45
Barium, Ba	ug/L	50900	49400	52500	51500	49400	52700	52300
Beryllium, Be	ug/L	0.2 U	0.2 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Cadmium, Cd	ug/L	1 U	1 U	0.2 J	0.4 U	0.4 U	0.4 U	0.4 U
Chromium, Cr	ug/L	1 J	1 J	1.5	0.9 J	1 U	0.8 J	1.23
Cobalt, Co	ug/L	0.205	0.419	0.667	0.435	0.331	0.339	0.474
Fluoride, F	mg/L	2 U	1 U	0.8 U	0.8 U	2 U	2 U	0.8 U
Lithium, Li	mg/L	0.327	0.365	0.291	0.326	0.378	0.271	0.28
Lead, Pb	ug/L	0.149	0.87	0.489	0.407	0.4 U	0.2 J	0.3 J
Mercury, Hg	ug/L	0.005 U	0.002 J	0.002 J	0.003 J	0.005 U	0.005 U	0.005 U
Molybdenum, Mo	ug/L	2.41	3.15	3.4	2.53	3.91	2 J	3
Radium 226 & 228 (combined)	pCi/L	181	93.1	231.1	155.9	50.02	75.21	47.86
Selenium, Se	ug/L	2 U	2 U	2 U	2 U	2 U	0.8 J	2 U
Thallium, Tl	ug/L	0.4 U	0.06 J	0.4 J	1 U	1 U	1 U	1 U

Notes:
NA: Sampling not required for this parameter or well dry.

MW-3D
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.343	0.56	0.353	0.352	0.42	0.39	0.3	0.38
Calcium, Ca	808	835	1150	1120	1100	1000	1000	1000
Chloride, Cl	21500	21100	19500	20000	21000	22000	23000	18000
Fluoride, F	0.8 U	3 U	2 U	2 U	2.5 U	2.5 U	2.5 U	0.28 J
pH	6.77	6.63	9.59	7.16	6.32	6.83	7.63	7.66
Sulfate, SO4	1.4	5 U	1 J	2 U	50 U	50 U	50 U	10 U
Total Dissolved Solids (TDS)	32700	30800	31400	33400	28000	44000	35000	25000
Appendix IV Constituents								
Antimony, Sb	2 U	2 U	NA	NA	NA	NA	NA	NA
Arsenic, As	5.24	4.49	NA	NA	NA	NA	NA	NA
Barium, Ba	51200	61500	NA	NA	NA	NA	NA	NA
Beryllium, Be	0.6 U	0.8 U	NA	NA	NA	NA	NA	NA
Cadmium, Cd	0.6 U	0.8 U	NA	NA	NA	NA	NA	NA
Chromium, Cr	6.29	4.2	NA	NA	NA	NA	NA	NA
Cobalt, Co	0.799	0.7 J	NA	NA	NA	NA	NA	NA
Fluoride, F	0.8 U	3 U	NA	NA	NA	NA	NA	NA
Lithium, Li	0.355	0.406	NA	NA	NA	NA	NA	NA
Lead, Pb	0.3 J	0.4 J	NA	NA	NA	NA	NA	NA
Mercury, Hg	0.005 U	0.002 J	NA	NA	NA	NA	NA	NA
Molybdenum, Mo	5.23	503	NA	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	59.2	47.75	NA	NA	NA	NA	NA	NA
Selenium, Se	3 U	4 U	NA	NA	NA	NA	NA	NA
Thallium, Tl	2 U	2 U	NA	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this paramet

MW-4D
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.416	0.366	0.312	0.372	0.36	0.462	0.409
Calcium, Ca	mg/L	3.44	3.18	3.14	3.35	3.47	4.1	3.49
Chloride, Cl	mg/L	233	218	199	220	219	223	218
Fluoride, F	mg/L	1.85	1.94	1.85	1.56	1.63	1.73	1.47
pH	s.u.	7.69	6.63	7.68	7.5	7.58	9.47	9.17
Sulfate, SO4	mg/L	276	272	249	276	277	277	275
Total Dissolved Solids (TDS)	mg/L	1230	1190	1200	1180	1190	1190	1220
Appendix IV Constituents								
Antimony, Sb	ug/L	0.1 U	0.1 U	0.01 J	0.01 J	0.04 J	0.01 J	0.03 J
Arsenic, As	ug/L	0.94	0.7	0.67	1.28	0.88	0.62	0.74
Barium, Ba	ug/L	31.4	30.7	28.4	37	28.8	39.4	28.9
Beryllium, Be	ug/L	0.003 J	0.01 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Cadmium, Cd	ug/L	0.05 U	0.05 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Chromium, Cr	ug/L	2.9	0.5	0.3	0.1	0.2	0.278	0.155
Cobalt, Co	ug/L	0.165	0.037	0.025	0.073	0.028	0.02	0.024
Fluoride, F	mg/L	1.85	1.94	1.85	1.56	1.63	1.73	1.47
Lithium, Li	mg/L	0.019	0.015	0.012	0.014	0.018	0.021	0.041
Lead, Pb	ug/L	0.077	0.058	0.034	0.131	0.084	0.024	0.056
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.002 J	0.005 U
Molybdenum, Mo	ug/L	0.95	0.56	0.51	0.53	0.52	0.46	0.47
Radium 226 & 228 (combined)	pCi/L	0.417	0.491	0.343	0.629	0.812	1.347	0.722
Selenium, Se	ug/L	0.1 U	0.1 U	0.1 U	0.1 U	0.04 J	0.1 U	0.1 U
Thallium, Tl	ug/L	0.008 J	0.02 U	0.05 U	0.01 J	0.05 U	0.05 U	0.05 U

Notes:
NA: Sampling not required for this parameter or well dry.

MW-4D
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.402	0.398	0.375	0.459	0.43	0.43	0.43	0.4
Calcium, Ca	3.12	3.14	3.26	10.5	5.8	3.2 J	3.8 J	3.5 J
Chloride, Cl	213	213	239	380	290	220	240	210
Fluoride, F	1.55	1.68	1.64	1.79	1.6	1.5	1.4	1.2
pH	6.67	7.01	11.29	7.31	7.55	8.57	7.23	7.16
Sulfate, SO4	269	269	275	268	290	290	320	290
Total Dissolved Solids (TDS)	1160	1150	1210	1350	1300	1100	920	1000
Appendix IV Constituents								
Antimony, Sb	0.01 J	0.01 J	NA	NA	NA	NA	NA	NA
Arsenic, As	0.49	0.43	NA	NA	NA	NA	NA	NA
Barium, Ba	27.4	24.7	NA	NA	NA	NA	NA	NA
Beryllium, Be	0.02 U	0.02 U	NA	NA	NA	NA	NA	NA
Cadmium, Cd	0.02 U	0.008 J	NA	NA	NA	NA	NA	NA
Chromium, Cr	0.809	0.229	NA	NA	NA	NA	NA	NA
Cobalt, Co	0.035	0.024	NA	NA	NA	NA	NA	NA
Fluoride, F	1.55	1.68	NA	NA	NA	NA	NA	NA
Lithium, Li	0.014	0.018	NA	NA	NA	NA	NA	NA
Lead, Pb	0.04	0.039	NA	NA	NA	NA	NA	NA
Mercury, Hg	1.05	0.005 U	NA	NA	NA	NA	NA	NA
Molybdenum, Mo	0.86	0.55	NA	NA	NA	NA	NA	NA
Radium 226 & 228 (combined)	1.114	1.207	NA	NA	NA	NA	NA	NA
Selenium, Se	0.1 U	0.1 U	NA	NA	NA	NA	NA	NA
Thallium, Tl	0.05 U	0.05 U	NA	NA	NA	NA	NA	NA

Notes:
NA: Sampling not required for this paramet

KC-15-01
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.265	0.398	0.266	0.395	0.317	0.228	0.292
Calcium, Ca	mg/L	81.6	74.4	81.5	77	77.4	51.9	56.4
Chloride, Cl	mg/L	34.3	29.6	32.5	29.9	30	17.8	17.6
Fluoride, F	mg/L	0.03 J	0.2 U	0.06 J	0.2 U	0.2 U	0.07	0.05 J
pH	s.u.	6.51	5.7	6.45	6.7	7.62	5.57	8.09
Sulfate, SO4	mg/L	210	273	189	290	236	172	167
Total Dissolved Solids (TDS)	mg/L	468	486	452	498	476	344	340
Appendix IV Constituents								
Antimony, Sb	ug/L	0.04 J	0.1 U	0.02 J	0.05 U	0.05 J	0.17	0.07
Arsenic, As	ug/L	3.24	0.93	3.58	0.66	1.54	0.8	0.88
Barium, Ba	ug/L	25.7	22.4	28.5	22.2	22.6	26.5	22.8
Beryllium, Be	ug/L	0.037	0.094	0.023	0.079	0.056	0.052	0.06
Cadmium, Cd	ug/L	0.05 U	0.01 J	0.02 U	0.008 J	0.03	0.12	0.02
Chromium, Cr	ug/L	0.2	0.3	0.1	0.3	0.4	1.32	1.07
Cobalt, Co	ug/L	3.62	3.59	2.56	3.39	3.05	1.44	2.12
Fluoride, F	mg/L	0.03 J	0.2 U	0.06 J	0.2 U	0.2 U	0.07	0.05 J
Lithium, Li	mg/L	0.007	0.003 J	0.007	0.003	0.002	0.008	0.004
Lead, Pb	ug/L	0.123	0.241	0.069	0.134	0.197	0.441	0.245
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.004 J	0.005 U
Molybdenum, Mo	ug/L	0.49	0.08 J	0.29	0.11	0.37	4.84	0.95
Radium 226 & 228 (combined)	pCi/L	0.4647	0.297 U	0.586 U	0.1357	0.57	0.784	1.427
Selenium, Se	ug/L	0.06 J	0.04 J	0.05 J	0.07 J	0.1	0.4	0.2
Thallium, Tl	ug/L	0.004 J	0.007 J	0.05 U	0.05 U	0.01 J	0.03 J	0.03 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-01
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.212	0.279	0.35	0.416	0.33	0.48	0.13	0.39
Calcium, Ca	84.7	87	85	77.6	85	90	96	86
Chloride, Cl	33.9	33.1	30.2	24.9	32	26	30	25
Fluoride, F	0.05 J	0.05 J	0.04 J	0.04 J	0.049 J	0.068	0.087	0.034 J
pH	6.74	6.14	9.09	5.64	6.06	5.59	5.98	5.7
Sulfate, SO4	234	239	239	257	270	330	170	310
Total Dissolved Solids (TDS)	480	454	460	453	510	520	460	520
Appendix IV Constituents								
Antimony, Sb	0.05 U	0.01 J	NA	0.07	2 U	2 U	2 U	2 U
Arsenic, As	3.15	2.21	NA	0.33	0.85 J	0.87 J	2.7 J	5 U
Barium, Ba	31.6	22.1	NA	23.4	26	25	42	37
Beryllium, Be	0.023	0.046	NA	0.067	1 U	0.49 J	1 U	1 U
Cadmium, Cd	0.008 J	0.009 J	NA	0.02	1 U	1 U	1 U	1 U
Chromium, Cr	0.086	0.17	NA	0.171	2 U	2 U	2 U	2.4
Cobalt, Co	2.87	3.83	NA	4.3	5.7	7.1	2.8	8.1
Fluoride, F	0.05 J	0.05 J	NA	0.04 J	0.049 J	0.068	0.087	0.034 J
Lithium, Li	0.005	0.01	NA	0.018	0.0036 J	0.0058 J	0.0038 J	0.0055 J
Lead, Pb	0.027	0.104	NA	0.06	1 U	1 U	1 U	0.86 J
Mercury, Hg	1.15	0.005 U	NA	0.005	0.2 U	0.2 U	0.2 U	0.2 U
Molybdenum, Mo	0.32	0.2	NA	0.29	5 U	5 U	5 U	5 U
Radium 226 & 228 (combined)	0.732	0.23	NA	2.0065	0.255 U	5 U	5 U	5 U
Selenium, Se	0.06 J	0.08 J	NA	0.1	5 U	5 U	5 U	5 U
Thallium, Tl	0.05 U	0.05 U	NA	0.03 J	1 U	0.65 J	1 U	1 U

Notes:
NA: Sampling not required for this paramet

KC-15-02
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.023	0.031	0.188	0.041	0.023	0.019	0.055
Calcium, Ca	mg/L	96.2	101	87.1	100	102	79.3	92.7
Chloride, Cl	mg/L	35	36	27.9	32	36	52.1	27.8
Fluoride, F	mg/L	0.2 J	0.1 J	0.1 J	0.11	0.14	0.1 J	0.1 J
pH	s.u.	6.93	6.82	6.76	7.17	7.62	6.34	8.83
Sulfate, SO4	mg/L	95.4	89.7	90	112	90.5	94.7	82.7
Total Dissolved Solids (TDS)	mg/L	446	436	396	466	454	376	398
Appendix IV Constituents								
Antimony, Sb	ug/L	0.21	0.1 J	0.07	0.04 J	0.02 J	0.06	0.05
Arsenic, As	ug/L	3.1	3.21	3.08	2.58	3.83	0.62	2.89
Barium, Ba	ug/L	103	118	90.4	89.1	108	85.4	82.7
Beryllium, Be	ug/L	0.007 J	0.016	0.006 J	0.02 U	0.006 J	0.007 J	0.01 J
Cadmium, Cd	ug/L	0.01 J	0.02 J	0.04	0.04	0.03	0.15	0.07
Chromium, Cr	ug/L	2.5	1.5	0.7	0.3	0.7	0.649	0.927
Cobalt, Co	ug/L	1.9	1.79	1.8	2.06	1.8	6.03	1.76
Fluoride, F	mg/L	0.2 J	0.1 J	0.1 J	0.11	0.14	0.1 J	0.1 J
Lithium, Li	mg/L	0.005	0.002 J	0.007	0.004	0.006	0.005	0.005
Lead, Pb	ug/L	0.237	0.392	0.142	0.042	0.171	0.08	0.218
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.002 J	0.004 J
Molybdenum, Mo	ug/L	4.36	2.13	3.17	2.51	1.38	2.92	2.09
Radium 226 & 228 (combined)	pCi/L	0.612	0.409	0.397 U	0.783	0.639	0.826	1.851
Selenium, Se	ug/L	0.2	0.1	0.2	0.2	0.06 J	0.06 J	0.1
Thallium, Tl	ug/L	0.02 J	0.01 J	0.02 J	0.01 J	0.05 U	0.02 J	0.02 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-02
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.094	0.033	0.03	0.128	0.041 J	0.068 J	0.055 J	0.12
Calcium, Ca	109	112	112	101	110	110	110	120
Chloride, Cl	34.1	34.2	34.1	36.4	33	35	31	33
Fluoride, F	0.09 J	0.13	0.1 J	0.1 J	0.12	0.21	0.13	0.13
pH	7.55	5.65	12.44	6.42	6.64	6.5	6.3	6.67
Sulfate, SO4	95.5	99.1	109	105	120	130	120	140
Total Dissolved Solids (TDS)	452	442	478	452	480	530	510	520
Appendix IV Constituents								
Antimony, Sb	0.02 J	0.02 J	NA	0.03 J	2 U	2 U	2 U	2 U
Arsenic, As	4.8	3.81	NA	2.39	2.7 J	2.7 J	3.1 J	3.1 J
Barium, Ba	118	125	NA	85.7	100	100	110	110
Beryllium, Be	0.02 U	0.004 J	NA	0.009 J	1 U	1 U	1 U	1 U
Cadmium, Cd	0.03	0.04	NA	0.14	1 U	1 U	1 U	1 U
Chromium, Cr	0.149	0.274	NA	0.391	2 U	2 U	2 U	2 U
Cobalt, Co	0.781	0.717	NA	2.26	1.4	1	1.1	0.71 J
Fluoride, F	0.09 J	0.13	NA	0.1 J	0.12	0.21	0.13	0.13
Lithium, Li	0.008	0.006	NA	0.0007 J	0.0034 J	0.006 J	0.0044 J	0.0048 J
Lead, Pb	0.049	0.115	NA	0.189	1 U	1 U	1 U	1 U
Mercury, Hg	0.005 U	0.005 U	NA	0.003 J	0.2 U	0.2 U	0.2 U	0.2 U
Molybdenum, Mo	1.23	1.08	NA	1.25	1.7 J	1.2 J	1.1 J	1.2 J
Radium 226 & 228 (combined)	1.334	0.859	NA	0.976	0.604	5 U	0.454	1.1
Selenium, Se	0.1 U	0.07 J	NA	0.08 J	5 U	5 U	5 U	5 U
Thallium, Tl	0.05 U	0.05 U	NA	0.02 J	0.26 J	1 U	1 U	0.25 J

Notes:
NA: Sampling not required for this parame

KC-15-03
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.082	0.053	0.056	0.057	0.06	0.028	0.053
Calcium, Ca	mg/L	109	100	91.6	92.3	107	75.1	102
Chloride, Cl	mg/L	29.5	28.1	29	27.9	28.1	31.2	28.8
Fluoride, F	mg/L	0.17	1.29	0.1 J	0.1 J	0.11	0.1 J	0.1
pH	s.u.	7.02	6.55	6.68	7.14	7.48	7.65	6.12
Sulfate, SO4	mg/L	171	182	186	182	192	194	190
Total Dissolved Solids (TDS)	mg/L	520	534	490	504	504	448	444
Appendix IV Constituents								
Antimony, Sb	ug/L	0.04 J	0.03 J	0.41	0.05	0.03 J	0.04 J	0.02 J
Arsenic, As	ug/L	6.71	6.1	7.72	4.15	3.98	2.29	4.81
Barium, Ba	ug/L	118	97.7	111	90.1	80.3	70.8	73.1
Beryllium, Be	ug/L	0.01	0.012	0.01 J	0.006 J	0.02 U	0.02 U	0.02 U
Cadmium, Cd	ug/L	0.01 J	0.05 U	0.009 J	0.01 J	0.01 J	0.03	0.007 J
Chromium, Cr	ug/L	0.3	0.3	1.2	0.6	0.3	0.54	0.461
Cobalt, Co	ug/L	3.27	4.79	6.09	6.6	8.03	10.6	6.28
Fluoride, F	mg/L	0.17	1.29	0.1 J	0.1 J	0.11	0.1 J	0.1
Lithium, Li	mg/L	0.004 J	0.002 J	0.001 J	0.007	0.013	0.009	0.0003 J
Lead, Pb	ug/L	0.151	0.566	0.191	0.075	0.036	0.022	0.032
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.004 J	0.005 U
Molybdenum, Mo	ug/L	5.4	2.97	7.02	2.71	2.38	2.31	1.83
Radium 226 & 228 (combined)	pCi/L	0.449	0.247	0.486	0.665	1.472	0.548	1.163
Selenium, Se	ug/L	0.1	0.08 J	0.3	0.1	0.06 J	0.05 J	0.1 U
Thallium, Tl	ug/L	0.009 J	0.004 J	0.01 J	0.05 U	0.05 U	0.01 J	0.05 U

Notes:

NA: Sampling not required for this parameter or well dry.

KC-15-03
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.094	0.108	0.096	0.131	0.18	0.18	0.21	0.24
Calcium, Ca	109	108	109	105	120	120	120	98
Chloride, Cl	27.5	27.5	28.1	29.1	29	29	29	28
Fluoride, F	0.08 J	0.09 J	0.08	0.1 J	0.089	0.094	0.11	0.092
pH	6.56	6.46	11	6.31	6.31	6.21	6.05	6.03
Sulfate, SO4	182	186	192	181	190	200	200	210
Total Dissolved Solids (TDS)	584	468	490	472	490	550	530	520
Appendix IV Constituents								
Antimony, Sb	0.22	0.04 J	NA	0.02 J	2 U	2 U	2 U	2 U
Arsenic, As	6.36	2.53	NA	1.44	1.3 J	1.6 J	2 J	1.1 J
Barium, Ba	85	73	NA	66.5	69	67	59	55
Beryllium, Be	0.006 J	0.004 J	NA	0.02 U	1 U	1 U	1 U	1 U
Cadmium, Cd	0.01 J	0.06	NA	0.06	1 U	1 U	1 U	1 U
Chromium, Cr	0.444	0.301	NA	0.103	2 U	2 U	1 J	2 U
Cobalt, Co	5.13	9.24	NA	7.58	4.6	4.3	3.9	4
Fluoride, F	0.08 J	0.09 J	NA	0.1 J	0.089	0.094	0.11	0.092
Lithium, Li	0.008	0.01	NA	0.032	0.0045 J	0.0096	0.0063 J	0.0042 J
Lead, Pb	0.107	0.052	NA	0.02 J	1 U	1 U	1 U	1 U
Mercury, Hg	0.005 U	0.005 U	NA	0.003 J	0.2 U	0.2 U	0.2 U	0.2 U
Molybdenum, Mo	3.32	1.72	NA	0.89	5 U	5 U	5 U	5 U
Radium 226 & 228 (combined)	0.618	1.067	NA	0.285	0.501	5 U	5 U	--
Selenium, Se	0.08 J	0.04 J	NA	0.1 U	5 U	5 U	5 U	5 U
Thallium, Tl	0.03 J	0.01 J	NA	0.05 U	1 U	1 U	1 U	1 U

Notes:
NA: Sampling not required for this paramet

KC-15-04
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.656	0.706	0.673	0.896	0.846	0.769	0.612
Calcium, Ca	mg/L	100	108	91.7	97.8	117	108	97.7
Chloride, Cl	mg/L	33.2	31.8	32.1	32	30.8	29.7	25.2
Fluoride, F	mg/L	0.12	0.1 J	0.09	0.09	0.12	0.08	0.08
pH	s.u.	6.78	6.49	6.47	7.41	7.46	5.7	6.19
Sulfate, SO4	mg/L	298	334	315	326	344	344	306
Total Dissolved Solids (TDS)	mg/L	608	614	594	600	550	740	430
Appendix IV Constituents								
Antimony, Sb	ug/L	0.06 J	0.02 J	0.04 J	0.02 J	0.01 J	0.03 J	0.05 J
Arsenic, As	ug/L	7.56	6.31	3.38	5.04	5.24	5.03	3.4
Barium, Ba	ug/L	155	138	112	104	91.9	89.5	77.5
Beryllium, Be	ug/L	0.016	0.019	0.027	0.007 J	0.01 J	0.02 J	0.027
Cadmium, Cd	ug/L	0.05 U	0.05 U	0.02	0.008 J	0.02 U	0.009 J	0.08
Chromium, Cr	ug/L	0.4	0.3	0.7	0.2	0.2	0.499	0.872
Cobalt, Co	ug/L	4.05	4.12	5.45	4.93	5.34	5.68	6.89
Fluoride, F	mg/L	0.12	0.1 J	0.09	0.09	0.12	0.08	0.08
Lithium, Li	mg/L	0.012	0.008	0.007	0.01	0.021	0.012	0.003
Lead, Pb	ug/L	0.231	0.225	0.507	0.047	0.056	0.211	0.537
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.002 J	0.007
Molybdenum, Mo	ug/L	3.43	1.95	1.31	1.27	1.06	0.86	0.93
Radium 226 & 228 (combined)	pCi/L	0.118	0.724	0.624 U	0.7	0.806	1.075	0.763
Selenium, Se	ug/L	0.04 J	0.1 U	0.1 J	0.1 U	0.04 J	0.2	0.1
Thallium, Tl	ug/L	0.026	0.003 J	0.02 J	0.01 J	0.05 U	0.05 U	0.03 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-04
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	May-18	Sep-18	Dec-18	Mar-19	Jun-19
Appendix III Constituents								
Boron, B	0.788	0.722	0.717	1.01	0.924	0.781	0.79	0.85
Calcium, Ca	109	125	105	NA	109	NA	100	NA
Chloride, Cl	28.5	32.5	24.6	NA	28.3	NA	30	NA
Fluoride, F	0.08	0.09 J	0.06	NA	0.09	NA	0.071	NA
pH	6.24	8.46	10.2	6.49	6.34	NA	5.56	NA
Sulfate, SO4	381	388	344	369	358	300	330	380
Total Dissolved Solids (TDS)	680	660	600	660	600	585	620	610
Appendix IV Constituents								
Antimony, Sb	0.04 J	0.05 U	NA	NA	0.17	NA	2 U	NA
Arsenic, As	3.07	4.02	NA	NA	1.66	NA	2.4 J	NA
Barium, Ba	80	80.4	NA	NA	58.3	NA	76	NA
Beryllium, Be	0.039	0.01 J	NA	NA	0.01 J	NA	1 U	NA
Cadmium, Cd	0.02 J	0.02 U	NA	NA	0.03	NA	1 U	NA
Chromium, Cr	1.01	0.142	NA	NA	0.161	NA	2 U	NA
Cobalt, Co	6.33	7.57	NA	NA	8.83	NA	11	9.1
Fluoride, F	0.08	0.09 J	NA	NA	0.09	NA	0.071	NA
Lithium, Li	0.013	0.015	NA	NA	0.014	NA	0.011	NA
Lead, Pb	0.635	0.094	NA	NA	0.081	NA	1 U	NA
Mercury, Hg	1.4	0.005 U	NA	NA	0.003 J	NA	0.2 U	NA
Molybdenum, Mo	0.56	0.55	NA	NA	0.52	NA	5 U	NA
Radium 226 & 228 (combined)	3.2002	1.058	NA	NA	0.403	NA	0.486	NA
Selenium, Se	0.2	0.04 J	NA	NA	0.1	NA	5 U	NA
Thallium, Tl	0.02 J	0.05 U	NA	NA	0.02 J	NA	1 U	NA

Notes:
NA: Sampling not required for this parame

KC-15-04
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Sep-19	Mar-20	Jun-20	Sep-20
Appendix III Constituents				
Boron, B	0.79	0.54	NA	0.67
Calcium, Ca	100	93	NA	93
Chloride, Cl	30	29	NA	29
Fluoride, F	0.082	0.093	NA	0.082
pH	5.96	6.08	NA	6.27
Sulfate, SO4	340	320	340	320
Total Dissolved Solids (TDS)	610	930	630	580
Appendix IV Constituents				
Antimony, Sb	2 U	2 U	NA	2 U
Arsenic, As	1.9 J	1.5 J	NA	1.5 J
Barium, Ba	56	45	NA	44
Beryllium, Be	1 U	1 U	NA	1 U
Cadmium, Cd	1 U	1 U	NA	1 U
Chromium, Cr	2 U	2 U	NA	2 U
Cobalt, Co	7.9	8.5	NA	8.8
Fluoride, F	0.082	0.093	NA	0.082
Lithium, Li	0.01	0.01	NA	0.011
Lead, Pb	0.59 J	1 U	NA	1 U
Mercury, Hg	0.2 U	0.2 U	NA	0.2 U
Molybdenum, Mo	5 U	5 U	NA	5 U
Radium 226 & 228 (combined)	0.521	5 U	NA	0.686
Selenium, Se	5 U	5 U	NA	5 U
Thallium, Tl	1 U	1 U	NA	1 U

Notes:
NA: Sampling not required for this parame

KC-15-05
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.758	0.695	0.71	1.02	0.764	0.774	0.521
Calcium, Ca	mg/L	127	98.2	112	119	135	134	110
Chloride, Cl	mg/L	32.6	31.1	31.6	32.2	31.2	31	27.2
Fluoride, F	mg/L	0.1 J	0.1 J	0.1	0.1	0.1 J	0.1	0.1 J
pH	s.u.	6.86	6.81	6.52	7.48	7.57	5.84	6.51
Sulfate, SO4	mg/L	354	348	385	384	383	369	291
Total Dissolved Solids (TDS)	mg/L	696	728	734	700	760	712	566
Appendix IV Constituents								
Antimony, Sb	ug/L	0.06 J	0.08 J	0.03 J	0.05	0.07	0.06	0.03 J
Arsenic, As	ug/L	7.16	5.68	6.32	4.79	2.56	2.78	2.42
Barium, Ba	ug/L	101	72.2	72.3	65.3	60.1	58.1	45.7
Beryllium, Be	ug/L	0.011	0.013	0.007 J	0.01 J	0.02 J	0.01 J	0.02 J
Cadmium, Cd	ug/L	0.05 U	0.01 J	0.006 J	0.02 J	0.04	0.06	0.05
Chromium, Cr	ug/L	0.2	1.1	0.3	0.6	0.7	0.425	0.881
Cobalt, Co	ug/L	5.76	6.15	6.47	6.45	5.42	6.39	5.58
Fluoride, F	mg/L	0.1 J	0.1 J	0.1	0.1	0.1 J	0.1	0.1 J
Lithium, Li	mg/L	0.002 J	0.022	0.005 U	0.01	0.005	0.008	0.003
Lead, Pb	ug/L	0.115	0.203	0.069	0.204	0.327	0.17	0.316
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.003 J	0.003 J
Molybdenum, Mo	ug/L	2.2	2.38	1.29	0.94	1.04	0.81	0.72
Radium 226 & 228 (combined)	pCi/L	1.162	0.303	0.403	0.73	0.436	0.7655	0.055
Selenium, Se	ug/L	0.06 J	0.1	0.1 U	0.07 J	0.1	0.06 J	0.1
Thallium, Tl	ug/L	0.008 J	0.008 J	0.05 U	0.02 J	0.03 J	0.03 J	0.03 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-05
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	May-18	Sep-18	Dec-18	Mar-19	Jun-19
Appendix III Constituents								
Boron, B	0.612	0.788	0.889	0.815	0.762	NA	0.86	1
Calcium, Ca	130	152	136	109	129	129	120	NA
Chloride, Cl	31.7	31.4	27.9	NA	28.9	NA	32	NA
Fluoride, F	0.1 J	0.1 J	0.09	NA	0.13	NA	0.12	NA
pH	6.29	8.1	9.01	6.57	6.35	NA	6.11	NA
Sulfate, SO4	367	414	363	318	346	333	390	460
Total Dissolved Solids (TDS)	742	772	691	652	664	689	760	720
Appendix IV Constituents								
Antimony, Sb	0.03 J	0.02 J	NA	NA	0.02 J	NA	2 U	NA
Arsenic, As	1.88	1.77	NA	NA	0.88	NA	5 U	NA
Barium, Ba	45.4	47.1	NA	NA	35.4	NA	37	NA
Beryllium, Be	0.009 J	0.007 J	NA	NA	0.005 J	NA	1 U	NA
Cadmium, Cd	0.05	0.06	NA	NA	0.07	NA	1 U	NA
Chromium, Cr	0.238	0.098	NA	NA	0.21	NA	2 U	NA
Cobalt, Co	4.36	7.11	NA	NA	5.27	NA	5.5	NA
Fluoride, F	0.1 J	0.1 J	NA	NA	0.13	NA	0.12	NA
Lithium, Li	0.007	0.01	NA	NA	0.027	NA	0.0027 J	NA
Lead, Pb	0.123	0.054	NA	NA	0.07	NA	1 U	NA
Mercury, Hg	1.55	0.005 U	NA	NA	0.004 J	NA	0.2 U	NA
Molybdenum, Mo	0.55	0.43	NA	NA	0.57	NA	5 U	NA
Radium 226 & 228 (combined)	5.677	1.436	NA	NA	3.086	NA	0.587	NA
Selenium, Se	0.07 J	0.1 U	NA	NA	0.1	NA	5 U	NA
Thallium, Tl	0.02 J	0.02 J	NA	NA	0.04 J	NA	0.23 J	NA

Notes:
NA: Sampling not required for this parame

KC-15-05
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Sep-19	Nov-19	Mar-20	Jun-20	Sep-20
Appendix III Constituents					
Boron, B	1.1	1.1	0.98	0.9	0.93
Calcium, Ca	140	130	130	120	120
Chloride, Cl	32	NA	29	NA	31
Fluoride, F	0.14	NA	0.14	NA	0.13
pH	6.33	NA	6.09	NA	6.28
Sulfate, SO4	410	390	360	330	350
Total Dissolved Solids (TDS)	760	750	730	680	700
Appendix IV Constituents					
Antimony, Sb	2 U	NA	2 U	NA	2 U
Arsenic, As	5 U	NA	2.1 J	NA	1.7 J
Barium, Ba	39	NA	39	NA	37
Beryllium, Be	1 U	NA	1 U	NA	1 U
Cadmium, Cd	1 U	NA	1 U	NA	1 U
Chromium, Cr	2 U	NA	2 U	NA	2 U
Cobalt, Co	6.2	NA	6	NA	6.4
Fluoride, F	0.14	NA	0.14	NA	0.13
Lithium, Li	0.0041 J	NA	0.011	NA	0.0042 J
Lead, Pb	0.46 J	NA	1 U	NA	1 U
Mercury, Hg	0.2 U	NA	0.2 U	NA	0.2 U
Molybdenum, Mo	5 U	NA	1.2 J	NA	5 U
Radium 226 & 228 (combined)	5 U	NA	5 U	NA	0.523
Selenium, Se	5 U	NA	5 U	NA	5 U
Thallium, Tl	1 U	NA	1 U	NA	1 U

Notes:
NA: Sampling not required for this parame

KC-15-06
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.182	0.191	0.183	0.198	0.203	0.226	0.192
Calcium, Ca	mg/L	92.3	93.1	84.3	92.6	84.6	112	86.8
Chloride, Cl	mg/L	36.7	35.6	36.6	36.8	33	36.7	31.2
Fluoride, F	mg/L	0.09 J	0.1 J	0.1 J	0.1 J	0.07 J	0.08 J	0.09 J
pH	s.u.	6.78	6.62	6.62	7.28	7.57	6.04	6.35
Sulfate, SO4	mg/L	143	146	150	154	134	175	136
Total Dissolved Solids (TDS)	mg/L	470	440	460	478	464	504	437
Appendix IV Constituents								
Antimony, Sb	ug/L	0.04 J	0.1 U	0.02 J	0.06	0.02 J	0.02 J	0.04 J
Arsenic, As	ug/L	4.95	4.05	5.89	5.98	1.95	12.6	3.19
Barium, Ba	ug/L	114	89.3	114	122	72.8	157	79.9
Beryllium, Be	ug/L	0.01	0.006 J	0.02 U	0.006 J	0.02 U	0.008 J	0.02 J
Cadmium, Cd	ug/L	0.04 J	0.04 J	0.03	0.05	0.11	0.02	0.19
Chromium, Cr	ug/L	0.8	0.3	0.3	0.5	0.3	0.283	0.886
Cobalt, Co	ug/L	3.46	3.24	2.85	1.74	4.26	2.37	3.39
Fluoride, F	mg/L	0.09 J	0.1 J	0.1 J	0.1 J	0.07 J	0.08 J	0.09 J
Lithium, Li	mg/L	0.008	0.002 J	0.005 U	0.007	0.005	0.006	0.009
Lead, Pb	ug/L	0.304	0.132	0.117	0.197	0.104	0.101	0.329
Mercury, Hg	ug/L	0.002 J	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 J
Molybdenum, Mo	ug/L	1.88	1.28	1.15	1.29	0.7	0.74	0.72
Radium 226 & 228 (combined)	pCi/L	1.25	0.25	0.315 U	2.657	0.9095	0.692	0.835
Selenium, Se	ug/L	0.08 J	0.04 J	0.06 J	0.08 J	0.08 J	0.1	0.1
Thallium, Tl	ug/L	0.01 J	0.01 J	0.02 J	0.01 J	0.02 J	0.02 J	0.02 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-06
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.276	0.218	0.275	0.306	0.31	0.34	0.41	0.41
Calcium, Ca	106	90.8	108	94.8	92	94	110	87
Chloride, Cl	36.7	33.1	38	36.1	34	34	39	37
Fluoride, F	0.08 J	0.1 J	0.09 J	0.1 J	0.095	0.091	0.13	0.097
pH	6.39	6.49	9.33	6.52	6.77	7.16	6.46	6.97
Sulfate, SO4	160	148	177	144	180	170	190	180
Total Dissolved Solids (TDS)	504	452	502	465	490	490	520	480
Appendix IV Constituents								
Antimony, Sb	0.01 J	0.02 J	NA	0.01 J	2 U	2 U	2 U	2 U
Arsenic, As	8.53	1.27	NA	1.58	2.6 J	3.2 J	7.3	2.2 J
Barium, Ba	153	71.9	NA	110	110	96	170	85
Beryllium, Be	0.007 J	0.01 J	NA	0.02 U	1 U	0.58 J	1 U	1 U
Cadmium, Cd	0.04	0.2	NA	0.13	0.29 J	1 U	1 U	0.21 J
Chromium, Cr	0.308	0.54	NA	0.238	2 U	1.3 J	2 U	2 U
Cobalt, Co	1.55	3.78	NA	2.76	4.3	4.6	1.4	2.9
Fluoride, F	0.08 J	0.1 J	NA	0.1 J	0.095	0.091	0.13	0.097
Lithium, Li	0.001	0.006	NA	0.001	0.003 J	0.006 J	0.0049 J	0.0048 J
Lead, Pb	0.168	0.239	NA	0.044	1 U	0.53 J	1 U	1 U
Mercury, Hg	1.1	0.005 U	NA	0.002 J	0.2 U	0.2 U	0.2 U	0.2 U
Molybdenum, Mo	0.46	0.43	NA	0.37	5 U	1.5 J	5 U	5 U
Radium 226 & 228 (combined)	0.429	1.517	NA	0.916	0.417	5 U	0.742	5 U
Selenium, Se	0.08 J	0.08 J	NA	0.06 J	5 U	3.7 J	5 U	5 U
Thallium, Tl	0.05 U	0.02 J	NA	0.02 J	0.25 J	0.56 J	0.37 J	0.25 J

Notes:
NA: Sampling not required for this paramet

KC-15-07
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.128	0.143	0.116	0.11	0.12	0.089	0.102
Calcium, Ca	mg/L	111	111	94.4	97.5	80.8	88.3	96.7
Chloride, Cl	mg/L	35.5	33.1	33.6	32.3	30.7	31.6	32.7
Fluoride, F	mg/L	0.1 J	0.1 J	0.09 J	0.07 J	0.07 J	0.06 J	0.08 J
pH	s.u.	6.88	6.66	6.52	7.25	7.54	6.04	6.47
Sulfate, SO4	mg/L	153	145	135	106	71.6	86.5	94
Total Dissolved Solids (TDS)	mg/L	542	480	488	350	444	446	437
Appendix IV Constituents								
Antimony, Sb	ug/L	0.22	0.04 J	0.03 J	0.1 U	0.02 J	0.02 J	0.02 J
Arsenic, As	ug/L	29	60.1	104	112	135	133	123
Barium, Ba	ug/L	287	338	451	444	543	501	465
Beryllium, Be	ug/L	0.017	0.008 J	0.01 J	0.04 U	0.02 U	0.008 J	0.007 J
Cadmium, Cd	ug/L	0.01 J	0.05 U	0.01 J	0.04 U	0.005 J	0.009 J	0.007 J
Chromium, Cr	ug/L	1.1	0.4	0.6	0.3	0.3	0.319	0.217
Cobalt, Co	ug/L	1.5	0.497	0.516	0.311	0.245	0.333	0.319
Fluoride, F	mg/L	0.1 J	0.1 J	0.09 J	0.07 J	0.07 J	0.06 J	0.08 J
Lithium, Li	mg/L	0.01	0.003 J	0.003 J	0.002	0.001	0.01	0.001
Lead, Pb	ug/L	0.328	0.161	0.207	0.03 J	0.024	0.051	0.034
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.002 J	0.005 U	0.003 J	0.004 J
Molybdenum, Mo	ug/L	3.24	1.27	1.11	0.8	0.92	0.84	0.84
Radium 226 & 228 (combined)	pCi/L	-0.554	0.898	0.786	0.843	1.374	2.004	2.25
Selenium, Se	ug/L	0.1	0.08 J	0.1	0.07 J	0.1 J	0.1	0.08 J
Thallium, Tl	ug/L	0.004 J	0.003 J	0.03 J	0.1 U	0.02 J	0.03 J	0.05 U

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-07
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	May-18	Sep-18	Dec-18	Mar-19	Jun-19
Appendix III Constituents								
Boron, B	0.15	0.092	0.256	NA	0.078	NA	0.12	NA
Calcium, Ca	99.9	71.5	123	78.8	69.3	NA	88	NA
Chloride, Cl	35.7	28.3	39.8	NA	30.9	NA	33	NA
Fluoride, F	0.06 J	0.06 J	0.08 J	NA	0.07 J	NA	0.064	NA
pH	6.38	6.52	8.45	6.02	6.27	NA	6.6	NA
Sulfate, SO4	119	26.2	191	NA	46.1	NA	87	NA
Total Dissolved Solids (TDS)	450	316	544	NA	367	NA	410	NA
Appendix IV Constituents								
Antimony, Sb	0.08	0.02 J	NA	NA	0.01 J	NA	2 U	NA
Arsenic, As	66.9	153	NA	NA	152	15.3	160	120
Barium, Ba	411	506	NA	NA	510	40	560	NA
Beryllium, Be	0.008 J	0.008 J	NA	NA	0.006 J	NA	1 U	NA
Cadmium, Cd	0.006 J	0.01 J	NA	NA	0.01 J	NA	1 U	NA
Chromium, Cr	0.27	0.292	NA	NA	0.189	NA	2 U	NA
Cobalt, Co	0.665	0.201	NA	NA	0.132	NA	0.27 J	NA
Fluoride, F	0.06 J	0.06 J	NA	NA	0.07 J	NA	0.064	NA
Lithium, Li	0.006	0.006	NA	NA	0.004	NA	0.0024 J	NA
Lead, Pb	0.095	0.049	NA	NA	0.01 J	NA	1 U	NA
Mercury, Hg	0.005 U	0.005 U	NA	NA	0.004 J	NA	0.2 U	NA
Molybdenum, Mo	0.98	0.86	NA	NA	0.75	NA	5 U	NA
Radium 226 & 228 (combined)	1.405	2.576	NA	NA	1.62	NA	1.29	NA
Selenium, Se	0.1 J	0.1	NA	NA	0.09 J	NA	5 U	NA
Thallium, Tl	0.05 U	0.05 U	NA	NA	0.01 J	NA	1 U	NA

Notes:
NA: Sampling not required for this paramet

KC-15-07
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Sep-19	Nov-19	Mar-20	Jun-20	Sep-20
Appendix III Constituents					
Boron, B	0.13	NA	0.16	NA	0.13
Calcium, Ca	100	NA	100	NA	90
Chloride, Cl	34	NA	34	NA	34
Fluoride, F	0.075	NA	0.083	NA	0.063
pH	6.48	NA	6.38	NA	6.56
Sulfate, SO4	120	NA	130	NA	87
Total Dissolved Solids (TDS)	500	NA	460	NA	380
Appendix IV Constituents					
Antimony, Sb	2 U	NA	2 U	NA	2 U
Arsenic, As	120	160	82	170	130
Barium, Ba	450	NA	390	NA	490
Beryllium, Be	1 U	NA	1 U	NA	1 U
Cadmium, Cd	1 U	NA	1 U	NA	1 U
Chromium, Cr	2 U	NA	2 U	NA	1.6 J
Cobalt, Co	0.69 J	NA	0.66 J	NA	0.73 J
Fluoride, F	0.075	NA	0.083	NA	0.063
Lithium, Li	0.0054 J	NA	0.0042 J	NA	0.0042 J
Lead, Pb	1 U	NA	1 U	NA	1 U
Mercury, Hg	0.2 U	NA	0.2 U	NA	0.2 U
Molybdenum, Mo	5 U	NA	5 U	NA	5 U
Radium 226 & 228 (combined)	1.39	NA	1.01	NA	1.64
Selenium, Se	1.4 J	NA	5 U	NA	5 U
Thallium, Tl	1 U	NA	1 U	NA	1 U

Notes:
NA: Sampling not required for this paramet

KC-15-08
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.489	0.521	0.411	0.399	0.379	0.374	0.46
Calcium, Ca	mg/L	277	290	219	215	183	200	246
Chloride, Cl	mg/L	41.4	40.1	38.9	38.5	38.6	40.3	40.5
Fluoride, F	mg/L	0.1 J	0.1 J	0.1 J	0.09 J	0.1 J	0.12	0.1 J
pH	s.u.	6.97	6.97	6.71	7.17	7.55	6	7.09
Sulfate, SO4	mg/L	807	817	654	571	542	541	615
Total Dissolved Solids (TDS)	mg/L	1420	1420	1200	1070	1040	1030	1190
Appendix IV Constituents								
Antimony, Sb	ug/L	0.25	0.14	0.03 J	0.07	0.13	0.07	0.06
Arsenic, As	ug/L	10.6	9.01	8.91	6.17	6	7.44	10.2
Barium, Ba	ug/L	72.7	61.3	66	63.6	53.6	54.7	56.2
Beryllium, Be	ug/L	0.004 J	0.004 J	0.005 J	0.02 U	0.02 U	0.02 U	0.008 J
Cadmium, Cd	ug/L	0.05 U	0.05 U	0.02 U	0.005 J	0.007 J	0.01 J	0.01 J
Chromium, Cr	ug/L	0.4	0.2	0.3	0.3	0.8	0.43	0.324
Cobalt, Co	ug/L	2.78	1.38	2.53	3.22	3.34	4	2.9
Fluoride, F	mg/L	0.1 J	0.1 J	0.1 J	0.09 J	0.1 J	0.12	0.1 J
Lithium, Li	mg/L	0.006	0.002 J	0.005 U	0.011	0.04	0.029	0.01
Lead, Pb	ug/L	0.083	0.072	0.138	0.053	0.047	0.031	0.063
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.003 J	0.004 J
Molybdenum, Mo	ug/L	3.47	2.59	1.71	1.23	1.53	1.97	1.18
Radium 226 & 228 (combined)	pCi/L	0.577	0.807	0.475	0.583	1.302	1.499	0.933
Selenium, Se	ug/L	0.07 J	0.04 J	0.03 J	0.07 J	0.1 J	0.03 J	0.04 J
Thallium, Tl	ug/L	0.02 U	0.02 U	0.05 U	0.01 J	0.05 U	0.05 U	0.01 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-08
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	May-18	Sep-18	Dec-18	Mar-19	Jun-19
Appendix III Constituents								
Boron, B	0.555	0.455	0.58	0.495	0.332	NA	0.51	NA
Calcium, Ca	252	218	245	187	153	105	210	210
Chloride, Cl	43	40.8	42.9	NA	39.7	NA	45	NA
Fluoride, F	0.1 J	0.1 J	0.08	NA	0.12	NA	0.092	NA
pH	6.74	6.78	8.45	6.25	6.85	NA	6.8	NA
Sulfate, SO4	700	530	599	510	375	150	550	610
Total Dissolved Solids (TDS)	1320	1060	1130	1070	842	510	1000	1100
Appendix IV Constituents								
Antimony, Sb	0.05	0.01 J	NA	NA	0.02 J	NA	2 U	NA
Arsenic, As	11.5	10.3	NA	NA	3.86	NA	11	10
Barium, Ba	50.1	55.2	NA	NA	50.2	NA	54	NA
Beryllium, Be	0.008 J	0.006 J	NA	NA	0.02 U	NA	1 U	NA
Cadmium, Cd	0.009 J	0.01 J	NA	NA	0.02	NA	1 U	NA
Chromium, Cr	0.386	0.249	NA	NA	0.479	NA	2 U	NA
Cobalt, Co	2.36	5.12	NA	NA	5.99	NA	5	NA
Fluoride, F	0.1 J	0.1 J	NA	NA	0.12	NA	0.092	NA
Lithium, Li	0.017	0.015	NA	NA	0.024	NA	0.0046 J	NA
Lead, Pb	0.094	0.049	NA	NA	0.02 J	NA	1 U	NA
Mercury, Hg	0.005 U	0.005 U	NA	NA	0.003 J	NA	0.2 U	NA
Molybdenum, Mo	0.88	0.65	NA	NA	0.56	NA	5 U	NA
Radium 226 & 228 (combined)	1.312	2.429	NA	NA	0.582	NA	0.539	NA
Selenium, Se	0.07 J	0.1 U	NA	NA	0.04 J	NA	5 U	NA
Thallium, Tl	0.05 U	0.05 U	NA	NA	0.01 J	NA	1 U	NA

Notes:
NA: Sampling not required for this paramet

KC-15-08
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Sep-19	Nov-19	Mar-20	Jun-20	Sep-20
Appendix III Constituents					
Boron, B	0.5	NA	0.58	0.17	0.57
Calcium, Ca	210	220	220	34	220
Chloride, Cl	45	NA	44	NA	47
Fluoride, F	0.12	NA	0.12	NA	0.1
pH	6.55	NA	6.67	NA	6.96
Sulfate, SO4	530	560	580	170	550
Total Dissolved Solids (TDS)	1000	1100	1200	450	1100
Appendix IV Constituents					
Antimony, Sb	2 U	NA	2 U	NA	2 U
Arsenic, As	9.4	NA	11	2.3 J	12
Barium, Ba	47	NA	43	NA	51
Beryllium, Be	0.53 J	NA	1 U	NA	1 U
Cadmium, Cd	1 U	NA	1 U	NA	1 U
Chromium, Cr	2 U	NA	2 U	NA	1.3 J
Cobalt, Co	5.4	NA	3.4	NA	4.8
Fluoride, F	0.12	NA	0.12	NA	0.1
Lithium, Li	0.0095	NA	0.0092	NA	0.007 J
Lead, Pb	1 U	NA	1 U	NA	1 U
Mercury, Hg	0.2 U	NA	0.2 U	NA	0.2 U
Molybdenum, Mo	1.7 J	NA	5 U	NA	5 U
Radium 226 & 228 (combined)	0.657	NA	0.804	NA	5 U
Selenium, Se	3.2 J	NA	5 U	NA	5 U
Thallium, Tl	0.62 J	NA	1 U	NA	1 U

Notes:
NA: Sampling not required for this paramet

KC-19-27
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Sep-19	Mar-20	Sep-20
Appendix IV Constituents				
Arsenic, As	ug/L	7.2	5.4	9.3

KC-19-28
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Sep-19	Mar-20	Sep-20
Appendix IV Constituents				
Arsenic, As	ug/L	5 U	5 U	1.3 J

KC-19-29
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Sep-19	Mar-20	Sep-20
Appendix IV Constituents				
Arsenic, As	ug/L	5 U	1 J	4.6 J

KC-15-09
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.043	0.033	0.077	0.022	0.038	0.026	0.059
Calcium, Ca	mg/L	82	58.4	54	66.7	76.8	70.7	45
Chloride, Cl	mg/L	17.8	13.4	7.62	10.8	10.7	9.97	3.47
Fluoride, F	mg/L	0.32	0.2 J	0.18	0.16	0.17	0.1 J	0.08 J
pH	s.u.	7.01	6.97	7.11	6.9	5.69	6.91	6.87
Sulfate, SO4	mg/L	48.7	55.6	72.8	61.6	54	55.4	61.9
Total Dissolved Solids (TDS)	mg/L	328	306	318	306	306	298	234
Appendix IV Constituents								
Antimony, Sb	ug/L	0.06 J	0.07 J	0.09	0.03 J	0.03 J	0.05 J	0.15
Arsenic, As	ug/L	2.98	1.81	3.78	3.28	2.26	2.52	1.09
Barium, Ba	ug/L	179	143	114	109	70.7	74.2	36.4
Beryllium, Be	ug/L	0.008 J	0.008 J	0.051	0.028	0.006 J	0.02 J	0.034
Cadmium, Cd	ug/L	0.05 U	0.05 U	0.03	0.01 J	0.006 J	0.008 J	0.01 J
Chromium, Cr	ug/L	0.2	0.3	1.7	1.1	0.7	0.956	1.57
Cobalt, Co	ug/L	0.672	0.645	1.43	2.49	2.08	2.27	0.621
Fluoride, F	mg/L	0.32	0.2 J	0.18	0.16	0.17	0.1 J	0.08 J
Lithium, Li	mg/L	0.024	0.013	0.008	0.007	0.011	0.009	0.002
Lead, Pb	ug/L	0.112	0.143	1.21	0.61	0.175	0.324	0.576
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.002 J	0.002 J
Molybdenum, Mo	ug/L	11.1	5.61	5.26	2.72	1.7	1.94	4.65
Radium 226 & 228 (combined)	pCi/L	0.43	0.296 U	2 U	0.49	0.446	1.467	1.036
Selenium, Se	ug/L	0.05 J	0.08 J	0.3	0.2	0.06 J	0.1	0.3
Thallium, Tl	ug/L	0.02 J	0.02 U	0.03 J	0.05 U	0.01 J	0.01 J	0.04 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-09
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.053	0.089	0.045	0.097	0.027 J	0.1 U	0.1 U	0.043 J
Calcium, Ca	72.1	71.5	92	52.4	71	77	78	61
Chloride, Cl	10.7	6.47	12.1	5.81	9.6	12	12	9.4
Fluoride, F	0.1 J	0.1 J	0.13	0.11	0.15	0.18	0.2	0.17
pH	7.53	7.65	6.77	7.14	6.75	6.81	8.05	8.08
Sulfate, SO4	51.2	31.4	65	47.2	62	65	64	55
Total Dissolved Solids (TDS)	316	400 U	346	228	290	400	300	260
Appendix IV Constituents								
Antimony, Sb	0.06	0.02 J	NA	0.04 J	2 U	2 U	2 U	2 U
Arsenic, As	0.57	1.31	NA	0.6	5 U	5 U	1 J	5 U
Barium, Ba	55.5	59.1	NA	37.2	42	34	32	37
Beryllium, Be	0.007 J	0.004 J	NA	0.008 J	1 U	1 U	1 U	1 U
Cadmium, Cd	0.05	0.04	NA	0.02 J	1 U	1 U	1 U	1 U
Chromium, Cr	0.284	0.129	NA	0.298	2 U	2 U	2 U	2 U
Cobalt, Co	2.8	2.89	NA	1.3	1.8	2.5	2.2	2.4
Fluoride, F	0.1 J	0.1 J	NA	0.11	0.15	0.18	0.2	0.17
Lithium, Li	0.004	0.01	NA	0.003	0.0034 J	0.0054 J	0.0048 J	0.0097
Lead, Pb	0.069	0.025	NA	0.098	1 U	1 U	1 U	1 U
Mercury, Hg	0.005 U	0.005 U	NA	0.004 J	0.2 U	0.2 U	0.2 U	0.2 U
Molybdenum, Mo	1.31	1.05	NA	0.77	1.2 J	5 U	5 U	1.4 J
Radium 226 & 228 (combined)	0.36731	0.6546	NA	1.184	0.0941 U	5 U	0.565	--
Selenium, Se	0.07 J	0.1 U	NA	0.08 J	5 U	5 U	5 U	5 U
Thallium, Tl	0.02 J	0.02 J	NA	0.05 J	1 U	1 U	0.52 J	1 U

Notes:
NA: Sampling not required for this paramet

KC-15-10
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.022	0.083	0.047	0.013	0.059	0.012	0.014
Calcium, Ca	mg/L	64	59.4	60.7	53.4	69.3	54.2	66.3
Chloride, Cl	mg/L	9.9	9.22	9	8.81	8.56	8.93	9.9
Fluoride, F	mg/L	0.18	0.2 J	0.19	0.17	0.19	0.15	0.18
pH	s.u.	6.66	6.55	6.77	6.42	6.14	6.31	9.48
Sulfate, SO4	mg/L	61.9	60.7	59	64.8	58.3	59.3	60.8
Total Dissolved Solids (TDS)	mg/L	291	265	288	270	292	288	302
Appendix IV Constituents								
Antimony, Sb	ug/L	0.05 J	0.1 U	0.02 J	0.05 U	0.02 J	0.02 J	0.01 J
Arsenic, As	ug/L	4.37	3.28	4.08	2.43	2.7	2.92	3.37
Barium, Ba	ug/L	73.7	56.6	56	44	42.6	42.9	43.7
Beryllium, Be	ug/L	0.015	0.016	0.02 J	0.01 J	0.01 J	0.01 J	0.01 J
Cadmium, Cd	ug/L	0.05 U	0.05 U	0.02 U	0.02 U	0.008 J	0.02 U	0.02 U
Chromium, Cr	ug/L	0.3	0.2	0.3	0.2	0.3	0.295	0.178
Cobalt, Co	ug/L	2.31	1.7	1.88	1.26	1.4	1.41	1.28
Fluoride, F	mg/L	0.18	0.2 J	0.19	0.17	0.19	0.15	0.18
Lithium, Li	mg/L	0.009	0.003 J	0.008	0.007	0.008	0.009	0.005
Lead, Pb	ug/L	0.237	0.242	0.251	0.173	0.172	0.147	0.135
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.002 J	0.005 U
Molybdenum, Mo	ug/L	1.52	0.48	0.48	0.18	0.26	0.23	6.56
Radium 226 & 228 (combined)	pCi/L	0.888	0.179 U	0.79 U	0.5241	0.9117	0.681	0.586
Selenium, Se	ug/L	0.04 J	0.05 J	0.07 J	0.05 J	0.1 U	0.03 J	0.05 J
Thallium, Tl	ug/L	0.004 J	0.006 J	0.05 U	0.05 U	0.01 J	0.02 J	0.05 U

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-10
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.092	0.103	0.051	0.128	0.1 U	0.1 U	0.1 U	0.1 U
Calcium, Ca	57.2	55.8	104	59.8	63	54	64	46
Chloride, Cl	8.8	8.94	10.2	9.7	9.4	9.9	9.4	8.7
Fluoride, F	0.15	0.16	0.19	0.2	0.18	0.26	0.21	0.17
pH	7.03	6.39	6.78	6.78	6.44	6.34	7.74	6.17
Sulfate, SO4	59.7	65.6	77.2	61.9	74	73	68	59
Total Dissolved Solids (TDS)	290	256	358	266	300	290	270	230
Appendix IV Constituents								
Antimony, Sb	0.05 U	0.05 U	NA	0.05 U	2 U	2 U	2 U	2 U
Arsenic, As	2.19	2.35	NA	1.87	2.1 J	2 J	2.2 J	1.3 J
Barium, Ba	39.6	38.6	NA	32.2	42	33	32	27
Beryllium, Be	0.01 J	0.01 J	NA	0.01 J	1 U	1 U	0.38 J	1 U
Cadmium, Cd	0.006 J	0.009 J	NA	0.01 J	1 U	1 U	1 U	1 U
Chromium, Cr	0.112	0.118	NA	0.197	2 U	2 U	2 U	2 U
Cobalt, Co	1.14	1.19	NA	1.02	1.1	1	1	0.9 J
Fluoride, F	0.15	0.16	NA	0.2	0.18	0.26	0.21	0.17
Lithium, Li	0.006	0.008	NA	0.022	0.0051 J	0.0065 J	0.0059 J	0.0059 J
Lead, Pb	0.07	0.079	NA	0.117	1 U	1 U	1 U	1 U
Mercury, Hg	0.005 U	0.005 U	NA	0.003 J	0.2 U	0.2 U	0.2 U	0.2 U
Molybdenum, Mo	0.12	0.2	NA	0.09 J	5 U	5 U	5 U	5 U
Radium 226 & 228 (combined)	0.569	0.729	NA	NA	0.0245 U	5 U	0.554	5 U
Selenium, Se	0.04 J	0.05 J	NA	0.05 J	5 U	5 U	5 U	5 U
Thallium, Tl	0.05 U	0.05 U	NA	0.05 U	1 U	1 U	0.74 J	1 U

Notes:
NA: Sampling not required for this paramet

KC-15-11
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.016	0.084	0.047	0.031	0.051	0.015	0.031
Calcium, Ca	mg/L	55.2	63.3	70	61.6	63.1	56.8	81.9
Chloride, Cl	mg/L	10.7	10.3	10.4	10.8	10.7	10.9	11.2
Fluoride, F	mg/L	0.16	0.2 J	0.22	0.14	0.17	0.16	0.2
pH	s.u.	6.55	6.54	6.8	6.4	5.29	5.8	7.55
Sulfate, SO4	mg/L	82.8	81	80	79.1	74.6	74.5	74.7
Total Dissolved Solids (TDS)	mg/L	312	284	322	290	256	238	332
Appendix IV Constituents								
Antimony, Sb	ug/L	0.03 J	0.02 J	0.02 J	0.04 J	0.02 J	0.15	0.02 J
Arsenic, As	ug/L	0.99	1.04	1.43	1.47	0.79	1.05	1.12
Barium, Ba	ug/L	34.6	34	35.1	36.2	31.7	34.4	34.9
Beryllium, Be	ug/L	0.017	0.011	0.007 J	0.024	0.008 J	0.009 J	0.01 J
Cadmium, Cd	ug/L	0.03 J	0.03 J	0.02 J	0.19	0.1	0.04	0.07
Chromium, Cr	ug/L	0.4	0.2	0.1	0.7	0.2	0.169	0.198
Cobalt, Co	ug/L	1.62	1.68	1.49	1.88	1.07	1.28	1.35
Fluoride, F	mg/L	0.16	0.2 J	0.22	0.14	0.17	0.16	0.2
Lithium, Li	mg/L	0.006	0.004 J	0.007	0.004	0.008	0.008	0.003
Lead, Pb	ug/L	0.352	0.13	0.083	0.461	0.116	0.033	0.123
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Molybdenum, Mo	ug/L	0.39	0.3	0.5	0.26	0.22	0.73	0.31
Radium 226 & 228 (combined)	pCi/L	0.1217	0.394	0.532 U	-0.5506	0.1892	0.113	0.737
Selenium, Se	ug/L	0.04 J	0.1 U	0.05 J	0.08 J	0.03 J	0.06 J	0.04 J
Thallium, Tl	ug/L	0.02 J	0.02 J	0.03 J	0.02 J	0.04 J	0.02 J	0.02 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-11
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.035	0.067	0.112	0.041	0.031 J	0.033 J	0.1 U	0.03 J
Calcium, Ca	56.3	57.9	109	70.7	75	56	69	54
Chloride, Cl	11.7	12	11.9	12	11	10	11	11
Fluoride, F	0.14	0.16	0.14	0.19	0.18	0.17	0.21	0.16
pH	7.41	6.78	6.87	6.74	6.5	6.39	7.65	6.19
Sulfate, SO4	67.8	72.3	76.3	73.8	89	82	80	80
Total Dissolved Solids (TDS)	278	275	385	344	320	250	330	270
Appendix IV Constituents								
Antimony, Sb	0.02 J	0.02 J	NA	0.02 J	2 U	2 U	2 U	2 U
Arsenic, As	0.87	0.44	NA	0.63	0.87 J	1.3 J	5 U	0.93 J
Barium, Ba	35.4	29.2	NA	35.3	43	33	24	32
Beryllium, Be	0.01 J	0.01 J	NA	0.01 J	1 U	1 U	1 U	1 U
Cadmium, Cd	0.12	0.12	NA	0.14	1.1	0.22 J	1 U	1 U
Chromium, Cr	0.419	0.189	NA	0.22	2 U	1.2 J	2 U	2 U
Cobalt, Co	1.53	1.04	NA	1.37	1.4	1.6	0.89 J	1.3
Fluoride, F	0.14	0.16	NA	0.19	0.18	0.17	0.21	0.16
Lithium, Li	0.016	0.007	NA	0.001 U	0.0045 J	0.0075 J	0.0048 J	0.0077 J
Lead, Pb	0.192	0.11	NA	0.174	1 U	0.78 J	1 U	1 U
Mercury, Hg	1.12	0.005 U	NA	0.003 J	0.2 U	0.2 U	0.2 U	0.18 J
Molybdenum, Mo	0.24	0.15	NA	0.13	5 U	5 U	5 U	5 U
Radium 226 & 228 (combined)	1.237	0.648	NA	0.348	0.721	5 U	0.646	5 U
Selenium, Se	0.05 J	0.04 J	NA	0.1 U	5 U	5 U	5 U	5 U
Thallium, Tl	0.02 J	0.02 J	NA	0.02 J	1 U	1 U	0.25 J	0.34 J

Notes:
NA: Sampling not required for this paramet

KC-15-12
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.104	0.32	0.263	0.111	0.32	0.779	1.23
Calcium, Ca	mg/L	90	91.5	89.9	95.3	86	91.8	116
Chloride, Cl	mg/L	15.1	16.6	16.5	14.3	20.1	42.5	52.7
Fluoride, F	mg/L	0.1 J	0.1 J	0.16	0.13	0.12	0.1 J	0.1
pH	s.u.	7.18	6.82	6.96	7.11	7.46	6.12	5.72
Sulfate, SO4	mg/L	69.9	74.3	75	67.7	79.2	141	182
Total Dissolved Solids (TDS)	mg/L	388	364	354	364	396	474	541
Appendix IV Constituents								
Antimony, Sb	ug/L	0.11	0.03 J	0.02 J	0.02 J	0.04 J	0.04 J	0.05 J
Arsenic, As	ug/L	2.59	3.09	3.61	2.09	1.74	1.58	1.6
Barium, Ba	ug/L	96	93.2	90.5	87	65.6	79.8	89.9
Beryllium, Be	ug/L	0.002 J	0.005 J	0.02 U	0.006 J	0.02 U	0.006 J	0.022
Cadmium, Cd	ug/L	0.02 J	0.05 U	0.005 J	0.009 J	0.02 J	0.02	0.17
Chromium, Cr	ug/L	0.09 J	0.3	0.1	0.5	1.4	0.736	0.796
Cobalt, Co	ug/L	1.51	1.92	1.91	1.36	3.42	4.05	2.83
Fluoride, F	mg/L	0.1 J	0.1 J	0.16	0.13	0.12	0.1 J	0.1
Lithium, Li	mg/L	0.004 J	0.003 J	0.006	0.005	0.02	0.011	0.005
Lead, Pb	ug/L	0.049	0.107	0.046	0.138	0.095	0.103	0.291
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.003 J	0.002 J
Molybdenum, Mo	ug/L	2.77	1.68	1.54	1.37	1.36	0.79	0.84
Radium 226 & 228 (combined)	pCi/L	0.48	1.156	0.476	0.3113	0.4876	0.471	0.073
Selenium, Se	ug/L	0.1 U	0.07 J	0.04 J	0.04 J	0.08 J	0.05 J	0.1
Thallium, Tl	ug/L	0.004 J	0.008 J	0.05 U	0.05 U	0.098	0.02 J	0.02 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-12
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	0.224	0.225	1.48	0.339	0.31	0.099 J	0.2	0.047 J
Calcium, Ca	81.2	100	137	95.2	94	83	92	89
Chloride, Cl	21.6	20.9	60.5	25.3	21	13	15	12
Fluoride, F	0.09 J	0.13	0.1 J	0.1 J	0.1	0.13	0.13	0.13
pH	6.97	7.3	6.59	7.05	6.93	6.81	6.78	6.75
Sulfate, SO4	80.5	78.7	218	94.7	97	69	77	69
Total Dissolved Solids (TDS)	386	382	573	399	370	300	360	340
Appendix IV Constituents								
Antimony, Sb	0.03 J	0.03 J	NA	0.02 J	2 U	2 U	2 U	2 U
Arsenic, As	0.93	0.82	NA	0.63	5 U	1.2 J	5 U	1.2 J
Barium, Ba	62.2	68.4	NA	63.3	74	72	74	78
Beryllium, Be	0.009 J	0.007 J	NA	0.007 J	1 U	1 U	1 U	1 U
Cadmium, Cd	0.03	0.05	NA	0.05	1 U	1 U	1 U	1 U
Chromium, Cr	0.945	0.36	NA	0.221	2 U	2 U	2 U	2 U
Cobalt, Co	2.36	1.29	NA	1.68	1	0.75 J	0.72 J	0.64 J
Fluoride, F	0.09 J	0.13	NA	0.1 J	0.1	0.13	0.13	0.13
Lithium, Li	0.022	0.005	NA	0.01	0.0029 J	0.0051 J	0.0047 J	0.0044 J
Lead, Pb	0.148	0.144	NA	0.077	1 U	1 U	1 U	1 U
Mercury, Hg	1.24	0.005 U	NA	0.003 J	0.2 U	0.2 U	0.2 U	0.17 J
Molybdenum, Mo	1.23	1.1	NA	0.75	5 U	5 U	5 U	5 U
Radium 226 & 228 (combined)	0.82	0.5515	NA	0.493	0.247 U	0.734	5 U	5 U
Selenium, Se	0.07 J	0.05 J	NA	0.04 J	5 U	5 U	5 U	5 U
Thallium, Tl	0.01 J	0.01 J	NA	0.02 J	1 U	1 U	1 U	1 U

Notes:
NA: Sampling not required for this paramet

KC-15-13
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	3.58	3.81	3.09	2.98	3.67	2.74	8.21
Calcium, Ca	mg/L	82	88.5	81	76.5	91	89.6	74.1
Chloride, Cl	mg/L	46.8	46.4	44.1	44.7	45.3	42.8	42.1
Fluoride, F	mg/L	0.09 J	0.08 J	0.09	0.05 J	0.09	0.07 J	0.08 J
pH	s.u.	6.43	6.24	6.27	6.01	5.55	6.27	8.18
Sulfate, SO4	mg/L	328	321	330	288	298	316	336
Total Dissolved Solids (TDS)	mg/L	708	622	644	560	618	550	647
Appendix IV Constituents								
Antimony, Sb	ug/L	0.07 J	0.06 J	0.04 J	0.04 J	0.02 J	0.02 J	0.02 J
Arsenic, As	ug/L	5.38	3.44	4.44	3.23	2.94	3.14	0.27
Barium, Ba	ug/L	110	117	113	107	104	112	21.4
Beryllium, Be	ug/L	0.013	0.024	0.02 J	0.026	0.01 J	0.021	0.01 J
Cadmium, Cd	ug/L	0.05 U	0.01 J	0.01 J	0.02	0.006 J	0.01 J	1.2
Chromium, Cr	ug/L	0.2	0.4	0.4	0.7	0.2	0.296	0.201
Cobalt, Co	ug/L	5.33	7.17	4.38	6.02	6.12	5.8	9.17
Fluoride, F	mg/L	0.09 J	0.08 J	0.09	0.05 J	0.09	0.07 J	0.08 J
Lithium, Li	mg/L	0.015	0.014	0.016	0.012	0.014	0.019	0.015
Lead, Pb	ug/L	0.244	0.554	0.485	0.562	0.164	0.307	0.075
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.002 J	0.005 U
Molybdenum, Mo	ug/L	4.51	1.92	1.87	1.13	0.74	1.34	0.06 J
Radium 226 & 228 (combined)	pCi/L	0.786	0.268	0.437 U	2.4	0.899	0.652	2.02
Selenium, Se	ug/L	0.08 J	0.1	0.2	0.1	0.05 J	0.09 J	0.07 J
Thallium, Tl	ug/L	0.003 J	0.007 J	0.05 U	0.05 U	0.01 J	0.05 U	0.02 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-13
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	3.52	4.58	3.28	3.78	4.3	6.1	0.056 J	4.3
Calcium, Ca	75.8	82.2	82.7	84.1	86	110	27	85
Chloride, Cl	45.1	58.1	46.6	53.5	61	38	0.4 J	41
Fluoride, F	0.06 J	0.1 J	0.06 J	0.1 J	0.069	0.073	0.087	0.065
pH	7.48	7.84	6.12	6.4	6.02	6.92	6.98	6.02
Sulfate, SO4	344	305	299	320	320	410	24	340
Total Dissolved Solids (TDS)	592	548	564	618	650	800	170	600
Appendix IV Constituents								
Antimony, Sb	0.02 J	0.01 J	NA	0.03 J	2 U	2 U	2 U	2 U
Arsenic, As	2.54	2.31	NA	2.8	1.8 J	1.5 J	0.78 J	1.2 J
Barium, Ba	96.9	97.9	NA	63.5	57	62	20	52
Beryllium, Be	0.02 J	0.02 J	NA	0.022	1 U	1 U	1 U	1 U
Cadmium, Cd	0.02	0.01 J	NA	0.03	1 U	1 U	1 U	1 U
Chromium, Cr	0.278	0.125	NA	0.422	2 U	2 U	5.3	2 U
Cobalt, Co	6.18	6.61	NA	7.98	9.1	9.5	0.94 J	10
Fluoride, F	0.06 J	0.1 J	NA	0.1 J	0.069	0.073	0.087	0.065
Lithium, Li	0.015	0.011	NA	0.02	0.0084	0.011	0.03	0.024
Lead, Pb	0.213	0.108	NA	0.345	1 U	1 U	1 U	1 U
Mercury, Hg	0.005 U	0.005 U	NA	0.004 J	0.2 U	0.2 U	0.2 U	0.2 U
Molybdenum, Mo	0.47	0.36	NA	0.77	5 U	5 U	2.3 J	5 U
Radium 226 & 228 (combined)	1.446	0.764	NA	1.722	0.323	5 U	5 U	5 U
Selenium, Se	0.08 J	0.08 J	NA	0.2	5 U	5 U	5 U	5 U
Thallium, Tl	0.05 U	0.02 J	NA	0.04 J	1 U	1 U	0.54 J	1 U

Notes:
NA: Sampling not required for this paramet

KC-15-14
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	13.3	14.6	13.9	12.8	15.4	12.6	15.2
Calcium, Ca	mg/L	100	106	94.6	94.8	103	92.9	105
Chloride, Cl	mg/L	40.4	38.8	38.8	37.5	38.9	39.5	41.6
Fluoride, F	mg/L	0.1 J	0.2 J	0.17	0.1 J	0.14	0.17	0.16
pH	s.u.	6.68	6.54	6.39	7.13	5.91	6.38	9.08
Sulfate, SO4	mg/L	397	372	368	338	345	351	427
Total Dissolved Solids (TDS)	mg/L	796	720	700	646	662	608	720
Appendix IV Constituents								
Antimony, Sb	ug/L	0.09 J	0.04 J	0.06	0.02 J	0.02 J	0.04 J	0.03 J
Arsenic, As	ug/L	2.91	4.99	4.97	4.14	3.88	4.37	3.73
Barium, Ba	ug/L	66.2	58.9	59.8	53.6	48.8	50.1	48.1
Beryllium, Be	ug/L	0.009 J	0.01 J	0.028	0.01 J	0.02 J	0.031	0.025
Cadmium, Cd	ug/L	0.05 U	0.05 U	0.01 J	0.005 J	0.008 J	0.01 J	0.06
Chromium, Cr	ug/L	0.09 J	0.1	0.7	0.2	0.3	0.75	0.463
Cobalt, Co	ug/L	6.22	7.3	6.85	5.51	6.63	8.18	12.7
Fluoride, F	mg/L	0.1 J	0.2 J	0.17	0.1 J	0.14	0.17	0.16
Lithium, Li	mg/L	0.017	0.02	0.023	0.017	0.026	0.024	0.011
Lead, Pb	ug/L	0.052	0.071	0.468	0.157	0.173	0.398	0.205
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.004 J	0.005 U
Molybdenum, Mo	ug/L	2.37	2.54	2.13	1.7	1.32	1.91	2.21
Radium 226 & 228 (combined)	pCi/L	0.1502	0.487	0.755 U	0.3155	0.544	0.2316	0.2275
Selenium, Se	ug/L	0.05 J	0.05 J	0.1	0.08 J	0.04 J	0.1	0.04 J
Thallium, Tl	ug/L	0.004 J	0.004 J	0.01 J	0.01 J	0.02 J	0.02 J	0.03 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-14
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	16.2	17.1	15.2	13.5	15	11	11	10
Calcium, Ca	111	116	98.5	104	97	64	68	65
Chloride, Cl	44.4	43.8	48.4	36.8	43	39	45	51
Fluoride, F	0.1 J	0.17	0.17	0.1	0.1	0.12	0.12	0.13
pH	7.3	7.61	6.28	6.36	6.21	6.49	6.61	6.05
Sulfate, SO4	508	476	447	384	360	230	220	210
Total Dissolved Solids (TDS)	830	816	744	676	690	500	490	480
Appendix IV Constituents								
Antimony, Sb	0.02 J	0.03 J	NA	0.04 J	2 U	2 U	2 U	2 U
Arsenic, As	3	2.65	NA	1.32	1.7 J	2.4 J	2.6 J	2 J
Barium, Ba	42.8	37.5	NA	53.3	51	23	46	31
Beryllium, Be	0.01 J	0.02 J	NA	0.01 J	1 U	0.49 J	1 U	1 U
Cadmium, Cd	0.08	0.08	NA	0.38	1 U	1 U	1 U	1 U
Chromium, Cr	0.345	0.337	NA	0.05	2 U	2 U	1.3 J	2 U
Cobalt, Co	7.81	7.33	NA	5.18	5.2	2.7	4.2	2.6
Fluoride, F	0.1 J	0.17	NA	0.1	0.1	0.12	0.12	0.13
Lithium, Li	0.025	0.024	NA	0.011	0.015	0.017	0.016	0.017
Lead, Pb	0.152	0.22	NA	0.01 J	1 U	0.5 J	0.5 J	1 U
Mercury, Hg	0.005 U	0.005 U	NA	0.003 J	0.2 U	0.2 U	0.2 U	0.2 U
Molybdenum, Mo	1.19	0.69	NA	0.72	5 U	1.2 J	5 U	5 U
Radium 226 & 228 (combined)	0.32521	0.4753	NA	1.214	0.58	0.517	5 U	5 U
Selenium, Se	0.07 J	0.1	NA	0.04 J	5 U	5 U	5 U	5 U
Thallium, Tl	0.03 J	0.04 J	NA	0.069	1 U	0.67 J	1 U	1 U

Notes:
NA: Sampling not required for this parame

KC-15-15
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	13.2	12.7	11.3	13.1	14.4	8.9	2.38
Calcium, Ca	mg/L	67.6	68.2	69	66	74.1	79.2	90.9
Chloride, Cl	mg/L	51.5	50.6	59	49.6	50.5	78.5	77.5
Fluoride, F	mg/L	0.2 U	0.08 J	0.06 J	0.05 J	0.07	0.08 J	0.08 J
pH	s.u.	6.17	6.36	6.09	5.89	5.76	5.44	8.14
Sulfate, SO4	mg/L	226	231	241	231	234	271	265
Total Dissolved Solids (TDS)	mg/L	420	474	488	468	518	544	548
Appendix IV Constituents								
Antimony, Sb	ug/L	0.02 J	0.1	0.01 J	0.01 J	0.01 J	0.04 J	0.04 J
Arsenic, As	ug/L	0.74	0.95	0.29	0.4	0.33	0.24	3.6
Barium, Ba	ug/L	35	25.8	23.1	20.6	20.8	23.1	101
Beryllium, Be	ug/L	0.017	0.023	0.01 J	0.01 J	0.01 J	0.01 J	0.036
Cadmium, Cd	ug/L	0.21	0.72	0.73	0.74	1	0.91	0.02 J
Chromium, Cr	ug/L	0.1	0.4	0.1	0.1	0.2	0.125	0.952
Cobalt, Co	ug/L	10.5	11	11.1	11.2	12.5	13	6.4
Fluoride, F	mg/L	0.2 U	0.08 J	0.06 J	0.05 J	0.07	0.08 J	0.08 J
Lithium, Li	mg/L	0.026	0.027	0.027	0.018	0.028	0.026	0.014
Lead, Pb	ug/L	0.077	0.424	0.049	0.073	0.175	0.048	0.848
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.003 J	0.005 U
Molybdenum, Mo	ug/L	0.16	0.21	0.04 J	0.05 J	0.08 J	0.47	5.72
Radium 226 & 228 (combined)	pCi/L	0.4702	0.458	0.961 U	-0.587	0.2455	0.6218	2.737
Selenium, Se	ug/L	0.04 J	0.1	0.1 J	0.07 J	0.07 J	0.09 J	0.2
Thallium, Tl	ug/L	0.021	0.031	0.02 J	0.02 J	0.03 J	0.02 J	0.05 U

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-15
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	9.52	11	7.85	11.8	13	14	12	14
Calcium, Ca	65.1	58.9	67.3	59.2	70	75	69	74
Chloride, Cl	83.1	57.5	72.2	59	59	52	67	56
Fluoride, F	0.06 J	0.07 J	0.05 J	0.09	0.15	0.092	0.072	0.093
pH	7	7.58	5.67	5.62	6.06	6.74	7.03	5.26
Sulfate, SO4	249	212	282	203	250	280	240	270
Total Dissolved Solids (TDS)	524	414	535	418	530	280	520	540
Appendix IV Constituents								
Antimony, Sb	0.02 J	0.01 J	NA	0.01 J	2 U	2 U	2 U	2 U
Arsenic, As	0.25	0.18	NA	0.14	5 U	5 U	0.76 J	5 U
Barium, Ba	40.4	16.4	NA	18.3	25	27	21	22
Beryllium, Be	0.01 J	0.01 J	NA	0.01 J	1 U	1 U	1 U	1 U
Cadmium, Cd	0.78	0.56	NA	0.58	0.91 J	0.58 J	1.7	0.99 J
Chromium, Cr	0.192	0.159	NA	0.05 J	2 U	2 U	2 U	2 U
Cobalt, Co	8.9	8.59	NA	11.5	9.7	13	24	14
Fluoride, F	0.06 J	0.07 J	NA	0.09	0.15	0.092	0.072	0.093
Lithium, Li	0.019	0.015	NA	0.018	0.018	0.021	0.016	0.02
Lead, Pb	0.087	0.032	NA	0.035	1 U	1 U	1 U	1 U
Mercury, Hg	0.005 U	0.005 U	NA	0.004 J	0.2 U	0.2 U	0.2 U	0.2 U
Molybdenum, Mo	0.17	0.05 J	NA	0.03 J	5 U	5 U	5 U	5 U
Radium 226 & 228 (combined)	1.617	1.364	NA	0.972	0.272 U	5 U	5 U	0.582
Selenium, Se	0.07 J	0.07 J	NA	0.04 J	5 U	5 U	5 U	5 U
Thallium, Tl	0.04 J	0.03 J	NA	0.03 J	1 U	0.2 J	1 U	0.3 J

Notes:
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KC-15-16
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	9.02	9.04	9.66	8.09	9.66	9.47	7.73
Calcium, Ca	mg/L	80.8	76.9	82.9	70.8	84.6	84.3	86.9
Chloride, Cl	mg/L	60.6	59.6	59.7	61	64.2	64.2	59.8
Fluoride, F	mg/L	0.23	0.2 J	0.16	0.09 J	0.06 J	0.04 J	0.02 J
pH	s.u.	7.07	6.88	6.71	6.64	6.26	6.56	6.39
Sulfate, SO4	mg/L	162	174	186	194	202	209	209
Total Dissolved Solids (TDS)	mg/L	408	428	420	432	476	434	460
Appendix IV Constituents								
Antimony, Sb	ug/L	0.05 J	0.03 J	0.06	0.02 J	0.02 J	0.02 J	0.05
Arsenic, As	ug/L	3.33	2.99	2.57	2.7	1.95	2.47	2.5
Barium, Ba	ug/L	136	148	145	108	73.9	66.9	57
Beryllium, Be	ug/L	0.008 J	0.004 J	0.005 J	0.01 J	0.005 J	0.009 J	0.01 J
Cadmium, Cd	ug/L	0.05 U	0.05 U	0.01 J	0.006 J	0.005 J	0.01 J	0.07
Chromium, Cr	ug/L	0.3	0.2	0.4	0.7	0.2	0.447	0.732
Cobalt, Co	ug/L	1.48	1.06	2.22	3.99	4.95	5.53	4.83
Fluoride, F	mg/L	0.23	0.2 J	0.16	0.09 J	0.06 J	0.04 J	0.02 J
Lithium, Li	mg/L	0.013	0.006	0.012	0.007	0.008	0.01	0.01
Lead, Pb	ug/L	0.149	0.065	0.109	0.22	0.078	0.125	0.243
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.002 J	0.002 J
Molybdenum, Mo	ug/L	10.7	8.59	7.19	2.85	1.71	1.35	1.61
Radium 226 & 228 (combined)	pCi/L	0.4	0.98	2 U	0.7711	0.689	0.824	0.3969
Selenium, Se	ug/L	0.06 J	0.1 U	0.06 J	0.06 J	0.04 J	0.08 J	0.09 J
Thallium, Tl	ug/L	0.01 J	0.004 J	0.05 U	0.05 U	0.05 U	0.01 J	0.02 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-16
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	9.36	9.34	7.4	8.52	9.9	9.8	7.9	8.7
Calcium, Ca	101	106	119	145	150	130	140	150
Chloride, Cl	75.1	79.4	68.9	67.4	77	81	77	84
Fluoride, F	0.05 J	0.07	0.03 J	0.06 J	0.037 J	0.036 J	0.045 J	0.034 J
pH	7.78	7.88	6.46	6.92	6.18	7.07	7.61	5.9
Sulfate, SO4	291	299	384	422	470	390	430	460
Total Dissolved Solids (TDS)	556	572	700	820	820	750	810	860
Appendix IV Constituents								
Antimony, Sb	0.02 J	0.02 J	NA	0.02 J	2 U	2 U	2 U	2 U
Arsenic, As	3.03	4.05	NA	2.15	1.5 J	1.2 J	2.4 J	1.6 J
Barium, Ba	74.4	78.6	NA	58	48	30	68	52
Beryllium, Be	0.005 J	0.01 J	NA	0.1 U	1 U	1 U	1 U	1 U
Cadmium, Cd	0.04	0.04	NA	0.12	1 U	0.2 J	0.25 J	0.23 J
Chromium, Cr	0.722	0.601	NA	0.216	2 U	2 U	2.4	31
Cobalt, Co	5.75	6.03	NA	8.87	8.6	7.7	4.3	5.3
Fluoride, F	0.05 J	0.07	NA	0.06 J	0.037 J	0.036 J	0.045 J	0.034 J
Lithium, Li	0.01	0.016	NA	0.02 J	0.011	0.0098	0.0084	0.011
Lead, Pb	0.031	0.211	NA	0.09 J	1 U	1 U	0.65 J	1 U
Mercury, Hg	0.005 U	0.005 U	NA	0.006 J	0.2 U	0.2 U	0.2 U	0.2 U
Molybdenum, Mo	1.63	1.54	NA	1 J	5 U	5 U	5 U	1.2 J
Radium 226 & 228 (combined)	2.537	1.037	NA	0.651	0.438	5 U	5 U	5 U
Selenium, Se	0.1 U	0.09 J	NA	0.07 J	5 U	5 U	5 U	5 U
Thallium, Tl	0.02 J	0.03 J	NA	0.5 U	0.47 J	1 U	1 U	1 U

Notes:
NA: Sampling not required for this parame

KC-15-17
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	15.9	17.7	16.9	14.9	15.9	13.1	15.3
Calcium, Ca	mg/L	153	175	172	154	210	234	231
Chloride, Cl	mg/L	55.7	58.2	62.2	55.8	76.4	84.6	91.5
Fluoride, F	mg/L	0.08 J	0.2 J	0.07 J	0.2 U	0.08 J	0.07 J	0.2 U
pH	s.u.	6.85	6.64	6.65	7.15	5.86	6.72	6.28
Sulfate, SO4	mg/L	454	492	495	517	611	681	745
Total Dissolved Solids (TDS)	mg/L	828	884	908	884	1110	1200	1290
Appendix IV Constituents								
Antimony, Sb	ug/L	0.04 J	0.04 J	0.04 J	0.02 J	0.03 J	0.04 J	0.03 J
Arsenic, As	ug/L	9.78	9.45	12.4	12.2	10	11.3	9.5
Barium, Ba	ug/L	68.8	85.1	86.6	81.2	79.6	82.3	71.8
Beryllium, Be	ug/L	0.009 J	0.015	0.009 J	0.01 J	0.02 J	0.029	0.009 J
Cadmium, Cd	ug/L	0.02 J	0.04 J	0.03	0.03	0.1	0.1	0.06
Chromium, Cr	ug/L	0.2	0.4	0.2	0.3	0.5	0.911	0.287
Cobalt, Co	ug/L	13.5	16.6	14.9	16.8	23.1	23.7	20.9
Fluoride, F	mg/L	0.08 J	0.2 J	0.07 J	0.2 U	0.08 J	0.07 J	0.2 U
Lithium, Li	mg/L	0.029	0.024	0.02	0.024	0.028	0.029	0.029
Lead, Pb	ug/L	0.114	0.281	0.119	0.115	0.283	0.541	0.098
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.004 J	0.005 U
Molybdenum, Mo	ug/L	9.71	7.82	8.51	6.33	3.04	3.12	3.11
Radium 226 & 228 (combined)	pCi/L	0.1252	0.379	2 U	0.1733	0.7652	1.222	0.443
Selenium, Se	ug/L	0.1 U	0.08 J	0.07 J	0.06 J	0.08 J	0.2	0.06 J
Thallium, Tl	ug/L	0.005 J	0.006 J	0.01 J	0.01 J	0.01 J	0.02 J	0.01 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-17
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Sep-19	Mar-20	Sep-20
Appendix III Constituents								
Boron, B	15.3	14.9	14.4	16.1	20	20	19	18
Calcium, Ca	237	226	214	271	230	240	260	310
Chloride, Cl	116	122	99.9	113	110	110	120	130
Fluoride, F	0.05 J	0.06 J	0.2 U	0.06 J	0.047 J	0.049 J	0.048 J	0.04 J
pH	7.79	7.36	6.65	6.65	6.4	6.87	7.95	5.99
Sulfate, SO4	908	954	843	1080	1100	1100	1100	1100
Total Dissolved Solids (TDS)	1540	1580	1360	1780	1600	1800	1700	1700
Appendix IV Constituents								
Antimony, Sb	0.1 U	0.01 J	NA	0.1 U	2 U	2 U	2 U	2 U
Arsenic, As	8.67	6.94	NA	3.22	2.6 J	3.1 J	2.7 J	2.4 J
Barium, Ba	67.7	57	NA	37.2	33	28	34	30
Beryllium, Be	0.01 J	0.01 J	NA	0.1 U	1 U	1 U	1 U	1 U
Cadmium, Cd	0.07	0.11	NA	0.37	0.29 J	0.39 J	0.43 J	0.52 J
Chromium, Cr	0.296	0.069	NA	0.05 J	2 U	1.8 J	2 U	7.8
Cobalt, Co	22.8	22.7	NA	29.3	26	27	27	30
Fluoride, F	0.05 J	0.06 J	NA	0.06 J	0.047 J	0.049 J	0.048 J	0.04 J
Lithium, Li	0.034	0.039	NA	0.037	0.028	0.029	0.026	0.025
Lead, Pb	0.097	0.057	NA	0.03 J	1 U	1	1 U	1 U
Mercury, Hg	0.005 U	0.002 J	NA	0.01 U	0.2 U	0.2 U	0.2 U	0.2 U
Molybdenum, Mo	2.64	2.75	NA	1 J	1.3 J	1.4 J	1.3 J	5 U
Radium 226 & 228 (combined)	4.093	0.715	NA	0.801	0.167 U	5 U	0.585	0.718
Selenium, Se	0.1 J	0.08 J	NA	0.1 J	5 U	5 U	5 U	5 U
Thallium, Tl	0.04 J	0.03 J	NA	0.5 U	0.24 J	1 U	1 U	1 U

Notes:
NA: Sampling not required for this paramet

KC-15-18
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	16	15	16.7	14.5	15.8	13.7	14.8
Calcium, Ca	mg/L	150	136	151	126	137	144	123
Chloride, Cl	mg/L	45	44.4	42.3	45	45.6	46.9	44.4
Fluoride, F	mg/L	0.1 J	0.1 J	0.1 J	0.08 J	0.09 J	0.09 J	0.08 J
pH	s.u.	6.71	6.63	6.63	7.16	5.94	6.72	6.29
Sulfate, SO4	mg/L	492	487	476	478	463	460	436
Total Dissolved Solids (TDS)	mg/L	848	883	840	832	818	812	766
Appendix IV Constituents								
Antimony, Sb	ug/L	0.07 J	0.08 J	0.07	0.04 J	0.02 J	0.05 J	0.05 J
Arsenic, As	ug/L	2.84	2.95	3.82	2.79	2.25	3.64	4.44
Barium, Ba	ug/L	58.1	57.1	53.1	42.3	35.8	35.3	34.5
Beryllium, Be	ug/L	0.008 J	0.006 J	0.006 J	0.007 J	0.008 J	0.009 J	0.01 J
Cadmium, Cd	ug/L	0.02 J	0.02 J	0.01 J	0.02	0.03	0.02	0.03
Chromium, Cr	ug/L	0.2	0.3	0.3	0.4	0.3	0.547	0.612
Cobalt, Co	ug/L	3.36	3.81	4.01	4.72	4.77	5.64	6.29
Fluoride, F	mg/L	0.1 J	0.1 J	0.1 J	0.08 J	0.09 J	0.09 J	0.08 J
Lithium, Li	mg/L	0.03	0.02	0.032	0.025	0.023	0.027	0.028
Lead, Pb	ug/L	0.025	0.066	0.057	0.044	0.058	0.095	0.078
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.003 J	0.005 U
Molybdenum, Mo	ug/L	5.75	4.85	4.56	2.73	1.69	2.32	2.94
Radium 226 & 228 (combined)	pCi/L	0.3668	1.37	2 U	1.621	0.315	0.125	0.5948
Selenium, Se	ug/L	0.04 J	0.1 U	0.07 J	0.06 J	0.05 J	0.1 U	0.1
Thallium, Tl	ug/L	0.004 J	0.004 J	0.02 J	0.05 U	0.05 U	0.106	0.01 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-18
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Jun-19	Sep-19	Nov-19
Appendix III Constituents								
Boron, B	16.7	17.6	12.3	14.5	15	NA	15	NA
Calcium, Ca	134	132	104	129	120	130	130	140
Chloride, Cl	47.6	49.6	36.6	56.6	63	NA	78	78
Fluoride, F	0.07 J	0.09 J	0.06 J	0.09	0.089	NA	0.069	NA
pH	7.16	7.16	6.58	6.49	6.57	NA	6.91	NA
Sulfate, SO4	449	425	313	401	380	NA	410	NA
Total Dissolved Solids (TDS)	782	740	591	782	680	NA	910	NA
Appendix IV Constituents								
Antimony, Sb	0.02 J	0.02 J	NA	0.1 U	2 U	NA	2 U	NA
Arsenic, As	4.63	5.06	NA	2.5	3.7 J	NA	1.8 J	NA
Barium, Ba	30.6	28.4	NA	25	27	NA	22	NA
Beryllium, Be	0.007 J	0.006 J	NA	0.1 U	1 U	NA	1 U	NA
Cadmium, Cd	0.01 J	0.008 J	NA	0.13	1 U	NA	0.21 J	NA
Chromium, Cr	0.262	0.471	NA	0.1 J	2 U	NA	2 U	NA
Cobalt, Co	4.84	5.76	NA	6.23	8.4	NA	7.4	NA
Fluoride, F	0.07 J	0.09 J	NA	0.09	0.089	NA	0.069	NA
Lithium, Li	0.027	0.037	NA	0.037	0.031	NA	0.036	NA
Lead, Pb	0.046	0.088	NA	0.03 J	1 U	NA	1 U	NA
Mercury, Hg	0.005 U	0.005 U	NA	0.004 J	0.2 U	NA	0.2 U	NA
Molybdenum, Mo	2.06	2.4	NA	1 J	2.6 J	NA	5 U	NA
Radium 226 & 228 (combined)	3.441	78.09	NA	0.618	0.27 U	NA	0.509	NA
Selenium, Se	0.08 J	0.07 J	NA	0.04 J	5 U	NA	5 U	NA
Thallium, Tl	0.05 U	0.05 U	NA	0.5 U	1 U	NA	1 U	NA

Notes:
NA: Sampling not required for this paramet

KC-15-18
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Mar-20	Jun-20	Sep-20
Appendix III Constituents			
Boron, B	15	NA	14
Calcium, Ca	140	140	130
Chloride, Cl	92	93	91
Fluoride, F	0.085	NA	0.064
pH	7.71	NA	6.07
Sulfate, SO4	460	NA	440
Total Dissolved Solids (TDS)	850	NA	850
Appendix IV Constituents			
Antimony, Sb	2 U	NA	2 U
Arsenic, As	2.2 J	NA	2.2 J
Barium, Ba	23	NA	23
Beryllium, Be	1 U	NA	1 U
Cadmium, Cd	0.27 J	NA	0.26 J
Chromium, Cr	2 U	NA	3.7
Cobalt, Co	7.5	NA	11
Fluoride, F	0.085	NA	0.064
Lithium, Li	0.029	NA	0.065
Lead, Pb	1 U	NA	1 U
Mercury, Hg	0.2 U	NA	0.13 J
Molybdenum, Mo	5 U	NA	1.1 J
Radium 226 & 228 (combined)	5 U	NA	5 U
Selenium, Se	5 U	NA	5 U
Thallium, Tl	1 U	NA	1 U

Notes:
NA: Sampling not required for this paramet

KC-15-19
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	13.7	13	13.1	11.7	14.1	14.5	12.2
Calcium, Ca	mg/L	223	219	208	193	229	227	191
Chloride, Cl	mg/L	35.2	34.7	33.1	33.3	36	35.5	31.7
Fluoride, F	mg/L	0.08 J	0.08 J	0.1 J	0.08 J	0.1 J	0.08 J	0.08 J
pH	s.u.	6.86	6.54	6.66	7.13	5.87	5.99	6.26
Sulfate, SO4	mg/L	782	800	738	726	781	744	653
Total Dissolved Solids (TDS)	mg/L	1260	1270	1240	1210	1320	1220	1060
Appendix IV Constituents								
Antimony, Sb	ug/L	0.11	0.05 J	0.07	0.05 J	0.03 J	0.16	0.06
Arsenic, As	ug/L	2.85	3.09	2.34	2.07	1.64	3.72	1.38
Barium, Ba	ug/L	50.3	37.1	34	27.4	23.3	26.4	19.6
Beryllium, Be	ug/L	0.013	0.013	0.01 J	0.02 J	0.01 J	0.022	0.025
Cadmium, Cd	ug/L	0.01 J	0.01 J	0.04	0.04	0.05	0.2	0.13
Chromium, Cr	ug/L	0.2	0.3	0.5	0.6	0.3	0.772	0.631
Cobalt, Co	ug/L	11.5	13.3	14.7	13	12.6	20.8	13.2
Fluoride, F	mg/L	0.08 J	0.08 J	0.1 J	0.08 J	0.1 J	0.08 J	0.08 J
Lithium, Li	mg/L	0.013	0.015	0.035	0.024	0.017	0.02	0.007
Lead, Pb	ug/L	0.151	0.241	0.352	0.323	0.174	0.532	0.337
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.003 J	0.005 U
Molybdenum, Mo	ug/L	1.83	1.51	1.17	1.18	0.91	2.34	1.3
Radium 226 & 228 (combined)	pCi/L	1.998	0.22	0.373 U	0.47	0.68	1.259	0.671
Selenium, Se	ug/L	0.07 J	0.07 J	0.1	0.1 J	0.1	0.1 J	0.08 J
Thallium, Tl	ug/L	0.02 J	0.005 J	0.02 J	0.03 J	0.06	0.158	0.05 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-19
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Jun-19	Sep-19	Nov-19
Appendix III Constituents								
Boron, B	14.8	15.2	13.9	13	13	NA	17	NA
Calcium, Ca	214	210	203	216	190	190	200	190
Chloride, Cl	36.5	37.2	34.8	37.7	36	NA	43	NA
Fluoride, F	0.08 J	0.1 J	0.07	0.11	0.1	NA	0.098	NA
pH	7.28	7.65	6.24	6.53	6.51	NA	6.67	NA
Sulfate, SO4	735	735	644	706	660	790	710	670
Total Dissolved Solids (TDS)	1210	1180	1060	1210	1100	1200	1200	1200
Appendix IV Constituents								
Antimony, Sb	0.02 J	0.02 J	NA	0.1 U	2 U	NA	2 U	NA
Arsenic, As	1.06	0.76	NA	0.45	5 U	NA	5 U	NA
Barium, Ba	18.9	17.6	NA	16.3	15	NA	16	NA
Beryllium, Be	0.01 J	0.008 J	NA	0.1 U	1 U	NA	1 U	NA
Cadmium, Cd	0.09	0.11	NA	0.18	0.34 J	NA	0.25 J	NA
Chromium, Cr	0.319	0.062	NA	0.09 J	2 U	NA	2 U	NA
Cobalt, Co	12	11.6	NA	10.6	12	NA	11	NA
Fluoride, F	0.08 J	0.1 J	NA	0.11	0.1	NA	0.098	NA
Lithium, Li	0.019	0.026	NA	0.02 J	0.012	NA	0.015	NA
Lead, Pb	0.16	0.073	NA	0.04 J	1 U	NA	1 U	NA
Mercury, Hg	0.005 U	0.005 U	NA	0.005 J	0.2 U	NA	0.2 U	NA
Molybdenum, Mo	0.73	1.18	NA	0.5 J	5 U	NA	5 U	NA
Radium 226 & 228 (combined)	3.562	0.907	NA	0.648	0.134 U	NA	5 U	NA
Selenium, Se	0.06 J	0.08 J	NA	0.06 J	5 U	NA	5 U	NA
Thallium, Tl	0.05 J	0.04 J	NA	0.5 U	1 U	NA	1 U	NA

Notes:
NA: Sampling not required for this parame

KC-15-19
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	**Mar-20**	**Jun-20**	**Sep-20**
Appendix III Constituents			
Boron, B	16	NA	16
Calcium, Ca	190	180	180
Chloride, Cl	44	NA	43
Fluoride, F	0.097	NA	0.096
pH	7.88	NA	6.1
Sulfate, SO4	660	620	580
Total Dissolved Solids (TDS)	1000	1000	1000
Appendix IV Constituents			
Antimony, Sb	2 U	NA	2 U
Arsenic, As	5 U	NA	5 U
Barium, Ba	15	NA	16
Beryllium, Be	1 U	NA	1 U
Cadmium, Cd	0.29 J	NA	1.2
Chromium, Cr	2 U	NA	1.3 J
Cobalt, Co	12	NA	17
Fluoride, F	0.097	NA	0.096
Lithium, Li	0.016	NA	0.015
Lead, Pb	1 U	NA	1 U
Mercury, Hg	0.2 U	NA	0.2 U
Molybdenum, Mo	5 U	NA	5 U
Radium 226 & 228 (combined)	5 U	NA	0.465
Selenium, Se	5 U	NA	5 U
Thallium, Tl	1 U	NA	0.23 J

Notes:
NA: Sampling not required for this parame

KC-15-20
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	7.66	7.2	8	6.94	8.73	9.08	8.25
Calcium, Ca	mg/L	203	174	193	189	219	217	212
Chloride, Cl	mg/L	32.1	30.6	30.6	30.8	31.6	31.2	32
Fluoride, F	mg/L	0.1 J	0.2 J	0.1 J	0.09 J	0.1 J	0.08 J	0.09 J
pH	s.u.	7.12	7.06	6.8	7.17	6.17	5.95	6.44
Sulfate, SO4	mg/L	596	565	602	618	633	580	600
Total Dissolved Solids (TDS)	mg/L	1010	1020	1080	1060	1140	1090	1100
Appendix IV Constituents								
Antimony, Sb	ug/L	0.04 J	0.07 J	0.04 J	0.06	0.02 J	0.03 J	0.04 J
Arsenic, As	ug/L	2.54	2.97	2.56	2.79	3.33	3.9	2.67
Barium, Ba	ug/L	83.3	97.8	72.9	76.8	50.6	50.5	48.3
Beryllium, Be	ug/L	0.006 J	0.012	0.005 J	0.026	0.007 J	0.02 J	0.01 J
Cadmium, Cd	ug/L	0.05 U	0.05 U	0.02 U	0.01 J	0.008 J	0.01 J	0.01 J
Chromium, Cr	ug/L	0.6	0.9	0.3	1.4	0.2	0.853	0.699
Cobalt, Co	ug/L	2.1	1.09	2.54	2.3	3.03	3.04	2.43
Fluoride, F	mg/L	0.1 J	0.2 J	0.1 J	0.09 J	0.1 J	0.08 J	0.09 J
Lithium, Li	mg/L	0.02	0.061	0.037	0.028	0.016	0.036	0.04
Lead, Pb	ug/L	0.438	0.251	0.139	0.506	0.06	0.282	0.188
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.002 J	0.005 U
Molybdenum, Mo	ug/L	11.2	13.1	4.99	4.7	3.13	3.2	2.82
Radium 226 & 228 (combined)	pCi/L	-0.2688	0.596	0.245 U	0.2547	0.279	0.683	0.2904
Selenium, Se	ug/L	0.04 J	0.1	0.07 J	0.1 J	0.07 J	0.06 J	0.04 J
Thallium, Tl	ug/L	0.01 J	0.004 J	0.05 U	0.05 U	0.095	0.05 U	0.03 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-20
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Jun-19	Sep-19	Nov-19
Appendix III Constituents								
Boron, B	9.02	9.3	10.1	10.2	10	NA	12	NA
Calcium, Ca	217	232	213	215	210	200	210	200
Chloride, Cl	32	33.2	32.3	34.3	35	NA	38	NA
Fluoride, F	0.08 J	0.09 J	0.06	0.1	0.085	NA	0.098	NA
pH	6.22	7.5	6.68	6.85	6.48	NA	6.82	NA
Sulfate, SO4	609	655	637	637	630	670	610	5 U
Total Dissolved Solids (TDS)	1150	1140	1120	1110	1100	1000	1100	1100
Appendix IV Constituents								
Antimony, Sb	0.02 J	0.01 J	NA	0.1 U	2 U	NA	2 U	NA
Arsenic, As	3.64	3.42	NA	2.48	1.9 J	NA	1.8 J	NA
Barium, Ba	38.8	40.6	NA	35.3	34	NA	27	NA
Beryllium, Be	0.01 J	0.005 J	NA	0.1 U	1 U	NA	0.36 J	NA
Cadmium, Cd	0.01 J	0.007 J	NA	0.02 J	1 U	NA	1 U	NA
Chromium, Cr	0.576	0.051	NA	0.07 J	2 U	NA	2 U	NA
Cobalt, Co	2.61	3.12	NA	3.8	4	NA	3.6	NA
Fluoride, F	0.08 J	0.09 J	NA	0.1	0.085	NA	0.098	NA
Lithium, Li	0.017	0.018	NA	0.01 J	0.024	NA	0.013	NA
Lead, Pb	0.231	0.01 J	NA	0.1 U	1 U	NA	1 U	NA
Mercury, Hg	1.37	0.005 U	NA	0.002 J	0.2 U	NA	0.2 U	NA
Molybdenum, Mo	2.16	2.87	NA	1 J	1.5 J	NA	1.9 J	NA
Radium 226 & 228 (combined)	3.085	1.351	NA	0.5732	0.384	NA	5 U	NA
Selenium, Se	0.05 J	0.1 U	NA	0.2 U	5 U	NA	5 U	NA
Thallium, Tl	0.05 U	0.05 U	NA	0.5 U	1 U	NA	0.56 J	NA

Notes:
NA: Sampling not required for this paramet

KC-15-20
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Mar-20	Jun-20	Sep-20
Appendix III Constituents			
Boron, B	11	NA	11
Calcium, Ca	200	190	190
Chloride, Cl	40	NA	41
Fluoride, F	0.1	NA	0.1
pH	7.96	NA	6.18
Sulfate, SO4	580	540	630
Total Dissolved Solids (TDS)	980	1000	980
Appendix IV Constituents			
Antimony, Sb	2 U	NA	2 U
Arsenic, As	1.5 J	NA	2.6 J
Barium, Ba	29	NA	40
Beryllium, Be	1 U	NA	1 U
Cadmium, Cd	1 U	NA	1 U
Chromium, Cr	2 U	NA	2.6
Cobalt, Co	3.6	NA	4.2
Fluoride, F	0.1	NA	0.1
Lithium, Li	0.015	NA	0.012
Lead, Pb	1 U	NA	1.1
Mercury, Hg	0.2 U	NA	0.2 U
Molybdenum, Mo	5 U	NA	1.1 J
Radium 226 & 228 (combined)	5 U	NA	--
Selenium, Se	5 U	NA	5 U
Thallium, Tl	1 U	NA	1 U

Notes:
NA: Sampling not required for this paramet

KC-15-21
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	3.24	0.249	3.12	3.2	4.18	4.11	3.6
Calcium, Ca	mg/L	139	99.2	124	118	136	122	146
Chloride, Cl	mg/L	25.4	17.7	22.4	25.5	24.9	25.8	24.2
Fluoride, F	mg/L	0.08 J	0.1 J	0.1 J	0.1 J	0.15	0.1 J	0.1 J
pH	s.u.	6.85	7.08	6.92	6.79	7.52	6.88	10.51
Sulfate, SO4	mg/L	279	92.4	285	270	275	257	323
Total Dissolved Solids (TDS)	mg/L	572	414	606	630	620	630	660
Appendix IV Constituents								
Antimony, Sb	ug/L	0.04 J	0.2	0.06	0.02 J	0.03 J	0.03 J	0.05 J
Arsenic, As	ug/L	5.44	2.41	5.36	6.16	5.21	7.57	4.71
Barium, Ba	ug/L	111	107	102	106	88.8	97.2	52.2
Beryllium, Be	ug/L	0.01 J	0.014	0.01 J	0.029	0.006 J	0.022	0.05
Cadmium, Cd	ug/L	0.05 U	0.05 U	0.007 J	0.006 J	0.008 J	0.02 U	0.02
Chromium, Cr	ug/L	0.1	0.7	1.2	0.7	0.2	0.43	2.39
Cobalt, Co	ug/L	3.44	0.332	3.16	3.68	3.49	5.42	5.67
Fluoride, F	mg/L	0.08 J	0.1 J	0.1 J	0.1 J	0.15	0.1 J	0.1 J
Lithium, Li	mg/L	0.007	0.016	0.008	0.005	0.01	0.006	0.006
Lead, Pb	ug/L	0.118	0.284	0.213	0.507	0.038	0.308	1.07
Mercury, Hg	ug/L	0.005 U	0.005 U	0.005 U	0.2 U	0.005 U	0.002 J	0.002 J
Molybdenum, Mo	ug/L	2.26	1.47	4.41	2.67	3.03	2.85	1.96
Radium 226 & 228 (combined)	pCi/L	-0.147	0.186 U	-.0119 U	0.906	0.8	1.027	0.7229
Selenium, Se	ug/L	0.07 J	0.09 J	0.1	0.1	0.03 J	0.1	0.3
Thallium, Tl	ug/L	0.004 J	0.004 J	0.055	0.04 J	0.02 J	0.05 U	0.02 J

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-21
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	Sep-18	Mar-19	Jun-19	Sep-19	Nov-19
Appendix III Constituents								
Boron, B	4.28	4.55	4.6	4.97	4.8	NA	6.1	NA
Calcium, Ca	127	127	140	128	130	140	120	NA
Chloride, Cl	25.7	27.1	27	27.4	27	NA	29	NA
Fluoride, F	0.1 J	0.1 J	0.1 J	0.13	0.11	NA	0.11	NA
pH	7.16	7.8	5.59	6.78	6.3	NA	6.81	NA
Sulfate, SO4	326	313	314	290	290	NA	270	NA
Total Dissolved Solids (TDS)	684	634	718	644	670	NA	630	NA
Appendix IV Constituents								
Antimony, Sb	0.01 J	0.02 J	NA	0.1 U	2 U	NA	2 U	NA
Arsenic, As	4.28	5.32	NA	2.72	3.8 J	NA	2.5 J	NA
Barium, Ba	51.9	52.2	NA	36.8	45	NA	31	NA
Beryllium, Be	0.008 J	0.006 J	NA	0.1 U	1 U	NA	1 U	NA
Cadmium, Cd	0.01 J	0.01 J	NA	0.01 J	1 U	NA	1 U	NA
Chromium, Cr	0.304	0.24	NA	0.1 J	2 U	NA	2 U	NA
Cobalt, Co	8.63	13.7	NA	12.8	10	NA	12	NA
Fluoride, F	0.1 J	0.1 J	NA	0.13	0.11	NA	0.11	NA
Lithium, Li	0.008	0.009	NA	0.01 J	0.0055 J	NA	0.0074 J	NA
Lead, Pb	0.122	0.061	NA	0.07 J	1 U	NA	1 U	NA
Mercury, Hg	1.75	0.005 U	NA	0.003 J	0.2 U	NA	0.2 U	NA
Molybdenum, Mo	1.79	2.22	NA	1 J	1.4 J	NA	5 U	NA
Radium 226 & 228 (combined)	0.2196	0.69	NA	0.2198	0.208 U	NA	5 U	NA
Selenium, Se	0.07 J	0.05 J	NA	0.03 J	5 U	NA	5 U	NA
Thallium, Tl	0.02 J	0.01 J	NA	0.5 U	1 U	NA	1 U	NA

Notes:
NA: Sampling not required for this paramet

KC-15-21
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Mar-20	Jun-20	Sep-20
Appendix III Constituents			
Boron, B	4.9	NA	5.5
Calcium, Ca	160	160	140
Chloride, Cl	23	NA	29
Fluoride, F	0.22	NA	0.16
pH	7.9	NA	6.2
Sulfate, SO4	480	NA	350
Total Dissolved Solids (TDS)	800	NA	650
Appendix IV Constituents			
Antimony, Sb	2 U	NA	2 U
Arsenic, As	1.5 J	NA	1.8 J
Barium, Ba	27	NA	28
Beryllium, Be	1 U	NA	1 U
Cadmium, Cd	1 U	NA	1 U
Chromium, Cr	2 U	NA	2 U
Cobalt, Co	8.1	NA	8.8
Fluoride, F	0.22	NA	0.16
Lithium, Li	0.0051 J	NA	0.0047 J
Lead, Pb	1 U	NA	1 U
Mercury, Hg	0.2 U	NA	0.2 U
Molybdenum, Mo	1.3 J	NA	5 U
Radium 226 & 228 (combined)	0.373	NA	--
Selenium, Se	5 U	NA	5 U
Thallium, Tl	0.42 J	NA	1 U

Notes:
NA: Sampling not required for this paramet

KC-15-22
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	Oct-15	Jan-16	Mar-16	May-16	Sep-16	Dec-16	Mar-17
Appendix III Constituents								
Boron, B	mg/L	0.261	3.3	0.307	0.125	0.214	0.469	0.841
Calcium, Ca	mg/L	114	130	93.8	96.7	97.5	116	129
Chloride, Cl	mg/L	16.7	25.6	14.6	15	13.5	18.3	20.8
Fluoride, F	mg/L	0.08 J	0.1 J	0.1 J	0.1 J	0.12	0.09	0.1
pH	s.u.	7.08	6.75	6.99	7.11	7.54	6.96	10.1
Sulfate, SO4	mg/L	98	277	99.6	81.6	105	138	209
Total Dissolved Solids (TDS)	mg/L	404	664	414	418	384	458	536
Appendix IV Constituents								
Antimony, Sb	ug/L	0.02 J	0.03 J	0.06	0.05 U	0.03 J	0.02 J	0.03 J
Arsenic, As	ug/L	1.47	7.1	2.3	2.19	1.74	2.63	2.2
Barium, Ba	ug/L	124	116	98.3	86.3	63.6	112	143
Beryllium, Be	ug/L	0.002 J	0.012	0.027	0.006 J	0.02 U	0.01 J	0.006 J
Cadmium, Cd	ug/L	0.05 U	0.05 U	0.01 J	0.02 U	0.008 J	0.006 J	0.008 J
Chromium, Cr	ug/L	0.1	0.1	1.5	0.3	0.7	0.293	0.363
Cobalt, Co	ug/L	0.109	3.94	0.569	0.109	0.193	0.119	0.129
Fluoride, F	mg/L	0.08 J	0.1 J	0.1 J	0.1 J	0.12	0.09	0.1
Lithium, Li	mg/L	0.011	0.005 J	0.011	0.005	0.033	0.008	0.005
Lead, Pb	ug/L	0.018	0.153	0.506	0.098	0.063	0.162	0.104
Mercury, Hg	ug/L	0.005 U	0.005 U	0.002 J	0.005 U	0.005 U	0.005 U	0.005 U
Molybdenum, Mo	ug/L	1.18	2.49	0.98	0.58	1.05	0.65	0.43
Radium 226 & 228 (combined)	pCi/L	0.674	0.257 U	0.296 U	0.557	0.729	1.129	2.016
Selenium, Se	ug/L	0.1 U	0.06 J	0.2	0.05 J	0.1	0.1 J	0.1 U
Thallium, Tl	ug/L	0.02 U	0.02 U	0.05 U	0.01 J	0.03 J	0.075	0.05 U

Notes:
NA: Sampling not required for this parameter or well dry.

KC-15-22
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Jun-17	Sep-17	Mar-18	May-18	Sep-18	Mar-19	Sep-19	Mar-20
Appendix III Constituents								
Boron, B	0.406	0.429	2.8	NA	0.433	0.48	0.2	0.54
Calcium, Ca	108	121	845	116	117	110	110	120
Chloride, Cl	17.8	18	13	NA	16.7	17	14	20
Fluoride, F	0.09	0.11	0.11	NA	0.12	0.11	0.13	0.13
pH	7.11	7.84	6.96	NA	7.35	6.56	6.87	7.98
Sulfate, SO4	116	143	120	NA	121	120	82	140
Total Dissolved Solids (TDS)	480	458	359	NA	472	460	440	360
Appendix IV Constituents								
Antimony, Sb	0.01 J	0.05 U	NA	NA	0.1 U	2 U	2 U	2 U
Arsenic, As	2.38	2.62	NA	NA	2.97	2.9 J	2.8 J	2.2 J
Barium, Ba	100	95.1	NA	NA	85.4	90	71	68
Beryllium, Be	0.009 J	0.02 U	NA	NA	0.1 U	1 U	0.34 J	1 U
Cadmium, Cd	0.02 U	0.02 U	NA	NA	0.05 U	1 U	1 U	1 U
Chromium, Cr	0.31	0.04 J	NA	NA	0.1 J	2 U	2 U	2 U
Cobalt, Co	0.121	0.033	NA	NA	0.057	1 U	1 U	0.53 J
Fluoride, F	0.09	0.11	NA	NA	0.12	0.11	0.13	0.13
Lithium, Li	0.008	0.01	NA	NA	0.02 J	0.0046 J	0.0061 J	0.0042 J
Lead, Pb	0.146	0.01 J	NA	NA	0.07 J	1 U	1 U	1 U
Mercury, Hg	0.005 U	0.005 U	NA	NA	0.003 J	0.2 U	0.2 U	0.2 U
Molybdenum, Mo	0.38	0.42	NA	NA	2 U	5 U	5 U	4.6 J
Radium 226 & 228 (combined)	1.325	1.242	NA	NA	0.2705	0.597	0.601	5 U
Selenium, Se	0.06 J	0.1 U	NA	NA	0.2 U	5 U	5 U	5 U
Thallium, Tl	0.05 U	0.01 J	NA	NA	0.5 U	1 U	0.42 J	1 U

Notes:
NA: Sampling not required for this paramet

KC-15-22
SUMMARY OF 2015-2020 ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Sep-20
Appendix III Constituents	
Boron, B	0.48
Calcium, Ca	110
Chloride, Cl	11
Fluoride, F	0.14
pH	7.92
Sulfate, SO4	110
Total Dissolved Solids (TDS)	410
Appendix IV Constituents	
Antimony, Sb	2 U
Arsenic, As	3.1 J
Barium, Ba	60
Beryllium, Be	1 U
Cadmium, Cd	1 U
Chromium, Cr	1.2 J
Cobalt, Co	0.28 J
Fluoride, F	0.14
Lithium, Li	0.0086
Lead, Pb	1 U
Mercury, Hg	0.2 U
Molybdenum, Mo	2.8 J
Radium 226 & 228 (combined)	--
Selenium, Se	5 U
Thallium, Tl	1 U

Notes:
NA: Sampling not required for this paramet

APPENDIX C5 – ASSESSMENT OF CORRECTIVE MEASURES REPORT (BOILER SLAG POND)

Applied Geology And Environmental Science, Inc.

2402 Hookstown Grade Road, Suite 200
Clinton, PA 15026
www.appliedgeology.net
P 412. 264. 6453
F 412. 264. 6567

COAL COMBUSTION RESIDUALS REGULATION
ASSESSMENT OF CORRECTIVE MEASURES REPORT

BOILER SLAG POND (BSP)
OHIO VALLEY ELECTRIC CORPORATION
KYGER CREEK STATION
CHESHIRE, OHIO

SEPTEMBER 2019
NOVEMBER 2020 REVISON 1.0

Prepared for:

OHIO VALLEY ELECTRIC CORPORATION (OVEC)

By:

APPLIED GEOLOGY AND ENVIRONMENTAL SCIENCE, INC.

COAL COMBUSTION RESIDUALS REGULATION
ASSESSMENT OF CORRECTIVE MEASURES REPORT
BOILER SLAG POND (BSP)
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CHESHIRE, OHIO

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APPLIED GEOLOGY AND ENVIRONMENTAL SCIENCE, INC.

Bethany Flaherty

Bethany Flaherty
Senior Scientist I

Robert W. King

Robert W. King, P.G.
President/Chief Hydrogeologist

COAL COMBUSTION RESIDUALS REGULATION
ASSESSMENT OF CORRECTIVE MEASURES REPORT
BOILER SLAG POND (BSP)
OHIO VALLEY ELECTRIC CORPORATION
KYGER CREEK STATION
CHESHIRE, OHIO

T A B L E O F C O N T E N T S

COAL COMBUSTION RESIDUALS REGULATION
ASSESSMENT OF CORRECTIVE MEASURES REPORT
BOILER SLAG POND (BSP)
OHIO VALLEY ELECTRIC CORPORATION
KYGER CREEK STATION
CHESHIRE, OHIO

TABLE OF CONTENTS
(continued)

COAL COMBUSTION RESIDUALS REGULATION
ASSESSMENT OF CORRECTIVE MEASURES REPORT
BOILER SLAG POND (BSP)
OHIO VALLEY ELECTRIC CORPORATION
KYGER CREEK STATION
CHESHIRE, OHIO

T A B L E O F C O N T E N T S
(continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

AGES	Applied Geology and Environmental Science, Inc.
ACM	Assessment of Corrective Measures
ASD	Alternate Source Demonstration
ASTM	American Society for Testing and Materials
bgs	Below Ground Surface
BSP	Boiler Slag Pond
CCR	Coal Combustion Residuals
ft/day	Feet Per Day
ft/sec	Feet Per Second
°C	Degrees Celsius
GMPP	Groundwater Monitoring Program Plan
GWPS	Groundwater Protection Standard
HSA	Hollow Stem Auger
K	Hydraulic Conductivity
Landfill	Class III Residual Waste Landfill
MCL	Maximum Contaminant Level
mg/kg	Milligrams Per Kilogram
mm	Millimeter
MNA	Monitored Natural Attenuation
mV	Millivolt
MW	Megawatt
NPDES	National Pollution Discharge Elimination System
NTU	Nephelometric Unit
O&M	Operations and Maintenance
Ohio EPA	Ohio Environmental Protection Agency
ORP	Oxidation Reduction Potential
OVEC	Ohio Valley Electric Corporation
PRB	Permeable Reactive Barrier
PVC	Polyvinyl Chloride
RCRA	Resource Conservation and Recovery Act
SFAP	South Fly Ash Pond
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
Stantec	Stantec Consulting Services, Inc.
StAP	Statistical Analysis Plan
S.U.	Standard Unit
TDS	Total Dissolved Solids
ug/L	Micrograms Per Liter
U.S. EPA	United States Environmental Protection Agency

COAL COMBUSTION RESIDUALS REGULATION
ASSESSMENT OF CORRECTIVE MEASURES REPORT
BOILER SLAG POND (BSP)
OHIO VALLEY ELECTRIC CORPORATION
KYGER CREEK STATION
CHESHIRE, OHIO

1.0 INTRODUCTION

On December 19, 2014, the United States Environmental Protection Agency (U.S. EPA) issued their final Coal Combustion Residuals (CCR) regulation which regulates CCR as a non-hazardous waste under Subtitle D of Resource Conservation and Recovery Act (RCRA) and became effective six (6) months from the date of its publication (April 17, 2015) in the Federal Register, referred to as the “CCR Rule.” The rule applies to new and existing landfills, and surface impoundments used to dispose of or otherwise manage CCR generated by electric utilities and independent power producers. Because the rule was promulgated under Subtitle D of RCRA, it does not require regulated facilities to obtain permits, does not require state adoption, and cannot be enforced by U.S. EPA.

The CCR Rule in 40 CFR § 257.96(a) requires that an owner or operator initiate an Assessment of Corrective Measures (ACM) to prevent further release, to remediate any releases, and to restore affected area(s) to original conditions in the event that any Appendix IV constituent has been detected at a Statistically Significant Level (SSL) greater than a Groundwater Protection Standard (GWPS). The ACM must be completed within 90 days after initiation. The CCR Rule allows up to an additional 60 days to complete the ACM if a demonstration shows that more time is needed because of site-specific conditions or circumstances. A certification from a qualified professional engineer attesting that the demonstration is accurate is required. As required by 40 CFR § 257.90(e), the certified demonstration that more time was needed will be included in the 2019 Groundwater Monitoring and Corrective Action Report.

This ACM Report has been prepared to comply with 40 CFR § 257.90(c) of the CCR Rule and documents the results that are the basis for the evaluation of potential corrective measure remedial technologies. This report includes a summary of groundwater monitoring conducted to date, along with the results of site characterization activities. Finally, potential remedial technologies are identified in this report and evaluated against requirements, as specified in the CCR Rule.

2.0 SITE BACKGROUND

The Kyger Creek Station, located in Cheshire, Ohio, is a 1.1 gigawatt coal-fired generating station operated by Ohio Valley Electric Corporation (OVEC). The Kyger Creek Station has five (5), 217-

megawatt (MW) generating units and has been in operation since 1955. Beginning in 1955, CCRs were sluiced to surface impoundments located in the plant site. During the course of plant operations, CCRs have been managed in various units at the station.

There are three (3) CCR units at the Kyger Creek Station (Figure 2-1):

- Class III Residual Waste Landfill (Landfill);
- Boiler Slag Pond (BSP); and,
- South Fly Ash Pond (SFAP).

Under the CCR program, OVEC installed a groundwater monitoring system at each unit in accordance with the requirements of the CCR Rule. From October 2015 through September 2017, nine (9) rounds of background groundwater monitoring were conducted at all of the CCR units. The first round of Detection Monitoring was performed in March 2018. Based on groundwater monitoring conducted to date, no Statistically Significant Increases (SSIs) have been identified for Appendix III constituents at the Landfill. Therefore, this unit has remained in Detection Monitoring under the CCR program.

During the March 2019 Detection Monitoring event at the SFAP, Appendix III SSIs for Calcium, Sulfate and Total Dissolved Solids (TDS) were identified. OVEC is preparing an Alternate Source Demonstration (ASD) report to show that the SFAP is not the source of the Appendix III constituents. Based on the results of the ASD, the SFAP is anticipated to remain in Detection Monitoring.

During the March 2018 Detection Monitoring event, SSIs were identified for the BSP and it entered into Assessment Monitoring in September 2018. Further action was therefore required for this unit under the CCR program. Details regarding these efforts are presented in the following sections of this report.

3.0 GEOLOGY AND HYDROGEOLOGY

3.1 Regional Setting

Gallia County is located on the western edge of the Appalachian Basin within the Appalachian Plateau Physiographic Province, Allegheny Section, locally known as the Marietta Plateau. Sedimentary bedrock formations in this area are as much as 7,400 feet thick and range in geologic age from Pennsylvanian to Cambrian. The primary stratigraphic units underlying Gallia County include, from youngest to oldest: recent (Holocene) colluvium and alluvium deposits, Pleistocene lacustrine and glacial sand and gravel deposits, and Pennsylvanian age bedrock composed predominantly of shale and sandstone, with occasional thin limestone and coal seams.

The Appalachian Plateau in Gallia County is bordered on its northern margin by the Glaciated Appalachian Plateau 40 to 50 miles to the northwest. The geomorphology of the Appalachian Plateau in Gallia County consists of steeply sloping ridges and steep, narrow stream valleys. Upland areas are primarily underlain by sandstone bedrock while valleys are underlain by shale bedrock and colluvial and alluvial sediments. Ground elevation ranges from as much as 1,000 feet along ridge tops to 500 feet near the Ohio River Valley. Generally, surface water drainage is to the south and southeast into the Ohio River.

3.2 Unit-Specific Setting

Based on available existing data, deposits of silts and clays beneath the base of the BSP range from 15 to over 50 feet thick. The silts and clays transition to a layer of sand and gravel where groundwater is present. A generalized cross section of the geology beneath the BSP is presented in Figure 3-1. Based on previously reported physical properties and yield, the sand and gravel unit was determined to be the uppermost aquifer beneath the BSP and is located more than five (5) feet beneath the bottom of the BSP as required by the CCR Rule. Based on water level data from the existing wells, groundwater was determined to flow primarily toward the south and southwest.

Regional groundwater flows to the south and southeast towards the Ohio River. Appendix A includes groundwater flow maps from February and September 2018. Local groundwater flow beneath the BSP generally flows from the northwest to the south and southeast towards the Ohio River (Figure A-2 in Appendix A). During periods when the water level in the Ohio River rises significantly and flooding occurs, groundwater flow in the uppermost aquifer will temporarily reverse with groundwater flowing toward the north and east beneath the BSP. This flow reversal is evident in groundwater levels measured in February 2018 (Figure A-1 in Appendix A).

4.0 SUMMARY OF GROUNDWATER MONITORING PROGRAM: BOILER SLAG POND

In accordance with 40 CFR § 257.90(e) of the CCR Rule, a Groundwater Monitoring and Corrective Action Report was prepared for the Kyger Creek Station. The report documented the status of the groundwater monitoring and corrective action program for each CCR unit, summarized the key actions completed during 2018, described any problems encountered, discussed actions to resolve the problems, and projected key activities for the upcoming year (Applied Geology and Environmental Science, Inc. [AGES] 2019). Applicable details of the report are presented below in Sections 4.1, 4.2 and 4.3.

4.1 Groundwater Monitoring Network

As detailed in the Monitoring Well Installation Report (AGES 2016a), the CCR groundwater monitoring network for the BSP consists of the following eight (8) monitoring wells:

- KC-15-01 (Upgradient);
- KC-15-02 (Upgradient);
- KC-15-03 (Variable);
- KC-15-04 (Downgradient);
- KC-15-05 (Downgradient);
- KC-15-06 (Downgradient);
- KC-15-07 (Downgradient); and
- KC-15-08 (Downgradient).

The locations of all the wells in the groundwater monitoring network are shown on Figure 4-1. As listed above and shown on Table 4-1, the CCR groundwater monitoring network includes three (3) upgradient and five (5) downgradient monitoring wells, which satisfies the requirements of the CCR Rule. Groundwater flow maps for the two (2) monitoring events completed in 2018 are included in Appendix A.

4.2 Groundwater Sampling

In accordance with 40 CFR § 257.94 of the CCR Rule, the first round of Detection Monitoring was conducted in February and March 2018 and resampling was conducted in May 2018. Based on the results of the statistical evaluation of the Detection Monitoring data, the BSP entered into Assessment Monitoring on September 11, 2018. The first round of Assessment Monitoring samples was collected in September 2018 and resampling was conducted in December 2018.

All groundwater samples were collected in accordance with the Groundwater Monitoring Program Plan (GMPP) (AGES 2016b). The Detection Monitoring samples were analyzed for all Appendix III constituents, and the Assessment Monitoring samples were analyzed for all Appendix III and Appendix IV constituents. All samples were shipped to an analytical laboratory to be analyzed for all of the parameters listed in Appendix III and/or Appendix IV of the CCR Rule.

4.3 Analytical Results

The analytical results for groundwater samples collected in 2018 are summarized in Appendix B. Upon receipt, the February/March 2018 groundwater monitoring data were statistically evaluated in accordance with 40 CFR § 257.93(f) of the CCR Rule and the Statistical Analysis Plan (StAP) (Stantec Consulting Services, Inc. [Stantec] 2018). This initial statistical evaluation of the Detection Monitoring data identified potential SSIs for Boron, Calcium, pH, TDS, and Sulfate in five (5) wells (KC-15-04 through KC-15-08).

As discussed in the 2018 Groundwater Monitoring and Corrective Action Report (AGES 2019), a faulty pH meter was suspected of causing the SSIs for pH. In accordance with the StAP, in May 2018 the wells were resampled for all Appendix III constituents with potential SSIs. Based on the results of the resampling, the following Appendix III SSIs were confirmed:

- KC-15-04: Boron, TDS and Sulfate;
- KC-15-05: Boron, TDS and Sulfate; and
- KC-15-08: Boron, Calcium, TDS and Sulfate.

A partial ASD was completed in September 2018 for the Appendix III constituents identified at the BSP (AGES 2018). The ASD demonstrated that the source of the Calcium, TDS, and Sulfate was likely the active gas production wells located adjacent to the west/northwest of the BSP. However, an alternate source for Boron could not be established by the ASD. Therefore, the BSP entered into Assessment Monitoring under the CCR Rule in September 2018.

The first round of Assessment Monitoring groundwater samples was collected in September 2018, in accordance with § 257.95 of the CCR Rule and the GMPP (AGES 2016b) and analyzed for all Appendix III and Appendix IV constituents. Upon receipt of the September 2018 analytical results, the groundwater monitoring data were statistically evaluated in accordance with 40 CFR § 257.93(f) of the CCR Rule and the StAP (Stantec 2018). The initial statistical evaluation identified potential Appendix III SSIs of Boron, Calcium, TDS and Sulfate in wells KC-15-04, KC-15-05 and KC-15-08. In accordance with the StAP, the wells were resampled for those constituents in December 2018. Based on the results of the resampling, Appendix III SSIs were confirmed at the BSP for TDS in well KC-15-04 and Calcium, TDS and Sulfate in well KC-15-05 (Table 4-2).

As Appendix IV constituents were detected in downgradient wells during Assessment Monitoring, OVEC began the process of establishing GWPSs for any detected Appendix IV constituents.

4.4 Groundwater Protection Standards-BSP

In accordance with 40 CFR § 257.95(h)(1) through 40 CFR § 257.95(h)(3), OVEC established a GWPS for each Appendix IV constituent that was detected in groundwater (Table 4-3). Results for all Appendix IV constituents were less than the applicable GWPSs, except for Arsenic in well KC-15-07 in September 2018 (152 micrograms per liter [ug/L]) and December 2018 (15.3 ug/L), which exceeded the GWPS of 10 ug/L. Arsenic in the other four (4) downgradient wells, KC-15-04 (1.66 ug/L), KC-15-05 (0.88 ug/L), KC-15-06 (1.58 ug/L) and KC-15-08 (3.86 ug/L), did not exceed the GWPS in September 2018.

Based on the results in well KC-15-07, OVEC proceeded to characterize the nature and extent of the release, completed required notifications, and initiated an ACM in accordance with 40 CFR § 257.95(g). Results of these activities are presented in the following sections of this report.

5.0 CCR SITE CHARACTERIZATION ACTIVITIES

As specified in the CCR Rule in 40 CFR § 257.95(g)(1), further characterization of the nature and extent of the release to groundwater at the BSP was required. The objectives of the characterization were to:

- Install additional monitoring wells necessary to define the contaminant plume(s);
- Collect data on the nature of material released including specific information on Arsenic and the level at which the constituent is present in the material released;
- Install at least one (1) additional monitoring well at the facility boundary in the direction of contaminant migration and sample this well in accordance with § 257.95(d)(1); and
- Sample all wells in accordance with § 257.95(d)(1) to characterize the nature and extent of the release.

This section details the work conducted between March and June 2019 to collect additional data to aid in characterization of the release and assessment of corrective measures. To evaluate the extent of the Arsenic impacts, three (3) additional wells (KC-19-27, KC-19-28 and KC-19-29) were installed in the uppermost aquifer at the property boundary downgradient from the BSP (Figure 5-1). The wells were developed, hydraulically tested and sampled for analysis of Arsenic.

Details regarding this work are presented in the following sections of this report.

5.1 Grain Size Analysis and Monitoring Well Design

The CCR Rule requires that unfiltered groundwater samples be submitted for laboratory analysis. According to the preamble to the CCR Rule, the unfiltered sample requirement assumes that groundwater samples with a turbidity of less than five (5) nephelometric turbidity units (NTUs) can be obtained from a properly designed monitoring well. The proper design of the sand pack and well screen in each unconsolidated CCR well is therefore critical to obtaining representative samples.

The three (3) new monitoring wells were designed and installed using the same methods and materials used during the installation of the other wells in the CCR groundwater monitoring network and in accordance with the GMPP (AGES 2016b). During installation, representative samples of the aquifer material were collected from each well boring. These soil samples were submitted to a geotechnical laboratory for grain-size analysis per American Society for Testing and Materials (ASTM) Methods D421 and D422. The results of the grain size analyses were used to confirm that the design of the well screens and filter packs was appropriate for the CCR monitoring program. In accordance with U.S. EPA monitoring well design guidelines (U.S. EPA 1991), the grain size of the filter pack was chosen by multiplying the 70% retention (or 30% passing) size of the formation, as determined by the grain size analysis, by a factor of three (3) (for fine uniform formations) to six (6) (for coarse, non-uniform formations). Table 5-1 summarizes the results of the grain-size analysis and the 70% retention size for each of the samples collected from each boring. The laboratory reports are included in Appendix C.

Two (2)-inch diameter 0.01" slotted Schedule 40 polyvinyl chloride (PVC) pre-packed screens designed specifically for sampling metals in groundwater were selected for use in the wells at the BSP to reduce turbidity. The pre-packed well screens were constructed using an inner filter pack consisting of 0.40 millimeter (mm) clean quartz filter sand between two layers of food-grade plastic mesh to reduce sample turbidity by filtering out smaller particles than is possible with standard filter packed wells and prepack screens. No metal components were used in the construction of the pre-packed well screens, thus eliminating potential interference with metals analysis.

5.2 Monitoring Well Installation, Development, Sampling and Testing

5.2.1 Monitoring Well Installation

From April 3 through April 5, 2019, a total of three (3) monitoring wells were installed at the BSP using hollow stem auger (HSA) drilling methods (Figure 5-1). During drilling, the drill bit was simultaneously pushed down and rotated. Continuous split-spoon samples were logged by the AGES geologist. The augers were used to advance each boring to the desired depth and were kept in place to keep the borehole open during well installation. The augers were removed as well installation progressed.

Once each borehole was advanced to the desired depth, a 10-foot pre-packed well screen was set into the borehole. An outer filter pack consisting of 0.40 mm clean quartz sand was installed directly around the pre-packed well screen. The sand was placed as the augers were pulled back in one (1)- to two (2)- foot increments to reduce caving effects and ensure proper placement of the filter pack. The filter pack extended one (1)-foot above the top of the screen.

A two (2)-foot thick annular bentonite seal was installed above the filter pack in each well. Once in place, the bentonite seal was allowed to hydrate before the remainder of the annular space around each monitoring well was backfilled using a grout consisting of Portland cement and bentonite. Each monitoring well was completed with an above-ground protective steel casing and a locking well cap. Following installation, each monitoring well was surveyed for elevation and location by OVEC personnel.

Well construction details for the three (3) new wells installed at the BSP are presented in Table 5-2. All well boring and construction logs are included in Appendix D.

5.2.2 Monitoring Well Development

Well development was initiated at least 48 hours after installation of each of the monitoring wells. Development consisted of alternating surging and pumping with a submersible pump. During development of the monitoring wells, field parameters including temperature, specific conductance, pH and turbidity were recorded at regular intervals. Development continued until each parameter stabilized and turbidity was less than five (5) NTUs. Well development data for each well is summarized on Table 5-3.

5.2.3 Groundwater Sampling

On April 16, 2019, the three (3) new monitoring wells were sampled in accordance with the GMPP (AGES 2016b). The monitoring wells were purged using a submersible pump to remove stagnant water in the casing and to ensure that a representative groundwater sample was collected.

Samples were collected in laboratory-provided, pre-preserved (if necessary) bottleware. All bottles were labeled with the unique sample number, time and date of sample collection, and the identity of the sampling fraction. Field parameters were measured and recorded on purging forms at the time of sample collection.

Following sample collection, the samples were packed in ice in insulated coolers to maintain a temperature of less than four degrees centigrade (4ºC) and shipped to the TestAmerica analytical laboratory located in Canton, Ohio.

5.2.4 Aquifer Testing

In April 2019, both falling and rising head slug tests were conducted on two (2) of the new wells (KC-19-27 and KC-19-28) to obtain data required to calculate the saturated hydraulic conductivity (K) for the uppermost aquifer beneath the BSP. The falling head tests were performed by lowering a prefabricated solid slug with a known volume, into the water column of the well and recording the drop in head over time. The rising head tests were performed by removing the slug and recording the rise in head over time. The change in head over time was recorded using a data logger and pressure transducer. Dedicated rope was used for each well and the slug was decontaminated between wells using the procedures specified in the GMPP (AGES 2016b).

The slug test data were evaluated using AQTESOLV, a commercially available software package. Data from each monitoring well were analyzed using both the Bouwer-Rice and Hvorslev slug test solutions (with automatic curve matching) which are straight-line analytical techniques commonly used to analyze rising and falling head slug test data. The AQTESOLV data for each well are presented in Appendix E.

5.3 Results of Site Characterization

5.3.1 Site Geology Updates

Based on the results of the site characterization, an update to the information about the geology at the unit was not necessary. The soil boring logs prepared during monitoring well installation confirmed that the BSP is underlain by deposits of silt and clay ranging from 15 to over 50 feet thick (Appendix D). The uppermost aquifer beneath the BSP is a layer of sand and gravel beneath the deposits of silt and clay (Figure 3-1).

5.3.2 Groundwater Flow

A complete round of groundwater level data was collected in June 2019 (Table 5-4). The groundwater flow map generated using these data indicates that groundwater beneath the BSP flows to the southeast toward the Ohio River (Figure 5-2). A review of historic groundwater elevation data indicated that groundwater flow beneath the BSP is affected by the flow and water level in the Ohio River and evidence of several flow reversals has been observed in the historic data (AGES 2018). Data regarding groundwater flow at the unit is consistent with historic results.

5.3.3 Slug Testing

Slug test results from testing completed in May 2016 and April 2019 are summarized on Table 5-5. The updated mean K for the uppermost aquifer beneath the BSP is 6.28×10^{-4} feet per second (ft/sec). Published literature indicates that this is a reasonable K value for unconsolidated deposits of fine to medium sand and gravel (Fetter 1980).

5.3.4 Groundwater Flow Velocity

Using water level data collected in June 2019 (Table 5-4) and slug test data collected in May 2016 and April 2019 (Table 5-5), AGES calculated the average groundwater velocity beneath the BSP as 0.197 feet per day (ft/day) (Table 5-6). The distance between wells KC-15-02 and KC-19-28 is approximately 1,600 feet. Given the calculated flow rate and the distance between the wells, the travel time for groundwater to flow from well KC-15-02 (northwest) to well KC-19-28 (southeast) is approximately 22 years. This travel time is likely greater than 22 years due to documented flow reversals (Appendix A), which would significantly increase the travel time between the two (2) wells.

5.3.5 Groundwater Sampling Results

March and April 2019 analytical results for the previously installed CCR wells and for the three (3) new wells are shown on Table 5-7. As shown on Figure 5-3, Arsenic concentrations in existing wells (KC-15-01 through KC-15-08) around the BSP ranged from Non-Detect in well KC-15-05 to 160 ug/L in well KC-15-07. Arsenic concentrations in the three (3) new wells ranged from

0.84 ug/L in well KC-19-29 to 1.8 ug/L in well KC-19-27. Based on these results, Arsenic concentrations exceeding the GWPS of 10 ug/L are confined to the site and are not reaching the Ohio River. However, to address Arsenic concentrations in the uppermost aquifer, an ACM is required.

6.0 ASSESSMENT OF CORRECTIVE MEASURES

Groundwater monitoring of the uppermost aquifer at the BSP has identified Arsenic (an Appendix IV constituent) at concentrations that exceed the GWPS defined under 40 CFR § 257.95(h); therefore, an ACM is necessary. The ACM will require identification and evaluation of technologies and methods that may be used as elements of remedial actions to meet the requirements of the CCR Rule. These elements include potential source control methods and various groundwater remedial technologies that may be applicable to the BSP. Additional remedial technologies may also be evaluated at a later date, if determined to be applicable and appropriate.

Presented below is a discussion of the objectives of the ACM, the potential source control measures, a list of remedial technologies, a summary of the assessment process, and the detailed ACM evaluation.

6.1 Objectives of Remedial Technology Evaluation

Per 40 CFR § 257.96(a), the objectives of the corrective measures evaluated in this ACM Report are "to prevent further releases, to remediate any releases, and to restore affected area to original conditions." As required in 40 CFR § 257.97(b), corrective measures, at minimum, must:

(1) Be protective of human health and the environment;

(2) Attain the groundwater protection standard as specified pursuant to § 257.95(h);

(3) Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents in Appendix IV to this part into the environment;

(4) Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems;

(5) Comply with standards for management of wastes as specified in § 257.98(d).

6.2 Potential Source Control Measures

The objective of source control measures is to prevent further releases from the source (i.e., the BSP). According to 40 CFR § 257:

"Remedies must control the source of the contamination to reduce or eliminate further releases by identifying and locating the cause of the release. Source control measures may include the following: Modifying the operational procedures (e.g., banning waste disposal); undertaking more extensive and effective maintenance activities (e.g., excavate waste to repair a liner failure); or, in extreme cases, excavation of deposited wastes for treatment and/ or offsite disposal. Construction and operation requirements also should be evaluated."

The detailed evaluation of source control measures at the BSP is provided in Table 6-1. Three (3) technologies are included in this evaluation:

- Dewatering of Pond Water;
- Engineered Cover System; and
- Excavation of Boiler Slag.

Per state and federal regulatory requirements and timelines, OVEC tentatively plans to close the BSP. The method and timing of closure of the unit will depend on receipt of approval from the Ohio EPA. Source control through closure will likely initially include the cessation of ongoing placement of material into the BSP, a combination of passive and active decanting of ponded water within the unit, and interstitial dewatering of boiler slag pore-water within the unit.

Groundwater quality near the BSP is anticipated to significantly improve over time as a result of the above-referenced closure activities. Ceasing placement of material in the BSP will reduce the amount of Arsenic being loaded to the unit and thereby reduce the source of Arsenic available to impact groundwater. Decanting of any ponded water will decrease the hydraulic head in the BSP and thereby reduce infiltration of water from the unit to the underlying groundwater. Finally, dewatering of the boiler slag will reduce the contact-time for Arsenic with the boiler slag pore-water, which should reduce the mobility of the Arsenic. Groundwater monitoring over time is necessary to fully evaluate the positive impact that closure of the BSP will have on groundwater quality.

6.3 Potential Remedial Technologies

The focus of corrective measures for the BSP is to address Arsenic in groundwater that exceeded the GWPS. To accomplish this, the following three (3) types of technologies will be presented in Sections 6.3.1 through 6.3.3:

- In-Situ Groundwater Remedial Technologies;
- Ex-Situ Groundwater Remedial Technologies; and
- Treatment of Extracted Groundwater.

As described in Section 6.2, groundwater quality near the BSP is anticipated to significantly improve over time as a result of planned closure activities. Therefore, a flexible and adaptive approach to groundwater remediation that begins with post-closure groundwater monitoring at the unit is planned. During the post-closure monitoring period, the positive impacts of closure and the effects of natural attenuation on groundwater quality will be fully evaluated. The need for more active remedial measures (as discussed below) will be determined after sufficient post-closure groundwater quality data has been collected and evaluated. The final selection of a remedy will be made based on the results of the post-closure groundwater monitoring program.

6.3.1 In-Situ Groundwater Remedial Technologies

In-situ groundwater remediation approach involves treating the groundwater where it is presently situated, rather than removing and transferring it elsewhere for treatment and disposal. Long-term groundwater monitoring would be required to evaluate the effectiveness of any of these technologies. In-situ groundwater remediation technologies are discussed below.

6.3.1.1 Monitored Natural Attenuation (MNA)

Monitored natural attenuation (MNA) is a strategy and set of procedures used to demonstrate that physical, chemical and/or biological processes in an aquifer will reduce concentrations of constituents to levels below applicable standards. These processes attenuate the concentrations of inorganics in groundwater by physical and chemical means (e.g., dispersion, dilution, sorption, and/or precipitation). Dilution from recharge to shallow groundwater, mineral precipitation, and constituent adsorption will occur over time, which will further reduce constituent concentrations through attenuation. Regular monitoring of select groundwater monitoring wells is conducted to ensure constituent concentrations in groundwater are attenuating over time.

6.3.1.2 Groundwater Migration Barriers

Low permeability barriers can be installed below the ground surface to prevent groundwater flow from reaching locations that pose a threat to receptors. Barriers can be installed with continuous trenching techniques using bentonite or other slurries as a barrier material to prevent migration of groundwater. Barriers of cement/concrete and sheet piling can also be used.

Barriers are most effective at preventing flow to relatively small areas or to protect specific receptors. Protecting larger areas is possible if the constituent of concern is not highly soluble and cannot follow a diverted groundwater flow pattern. The barrier will change the groundwater flow conditions, and at some point the increased head (pressure) will cause a change in flow patterns. This will generally be around the flanks or beneath the barrier. To ensure that groundwater will not flow beneath the barrier, it must be sealed at an underlying impermeable layer such as a clay layer.

Groundwater migration barriers are often used in conjunction with groundwater extraction systems. The barriers are used to restrict flow to allow extraction systems upgradient of the barrier to collect groundwater. However, the challenges discussed above for creating a competent seal with any underlying unit may still apply.

6.3.1.3 Permeable Reactive Barriers (PRBs)

Permeable reactive barriers (PRBs) can be an effective in-situ groundwater treatment technology. General design involves excavation of a narrow trench perpendicular to groundwater flow similar to migration barriers and then backfilling the trench with a reactive material that either removes or transforms the constituents as the groundwater passes through the PRB. Unlike simple barriers, the PRB can be designed to include impermeable sections to funnel the flow through a more narrow and permeable reactive zone. The ability to maintain adequate and reactive reagent concentrations at depth over an extended period of time is a significant operational and performance assurance challenge. As with other in-situ approaches, reconstruction or regeneration may be needed on a periodic basis.

6.3.1.4 In-Situ Chemical Stabilization

The placement of chemical reactants to immobilize dissolved phase constituents through precipitation or sorption can be an effective approach to reducing downgradient migration. Reagents such as ferrous sulfate, calcium polysulfide, zero-valent iron, organo-phosphorous mixtures, and sodium dithionate have been evaluated as potentially effective for CCR-related constituents.

Two (2) issues that must be considered with this technology are permanence of the reaction product insolubility and the ability to inject the reactants sufficiently to ensure adequate contact with the constituents. Most stabilization reactions can be reversible depending on environmental conditions such as pH and oxidation state. Given the long periods of time for which the reaction products must remain insoluble, it may be difficult to predict future conditions sufficiently to ensure permanence of this technology. Recurring treatment, based on routine testing, may be an option. Contact between reagents and the constituents must also be evaluated. This technology may need to be considered more as a source reduction technology than a capture or barrier technology, as the reactants may not be viable over an extended period of time.

6.3.2 Ex-Situ Groundwater Remedial Technologies

Ex-situ remedial technologies require groundwater extraction to remove constituent mass from the groundwater and can provide hydraulic control to reduce or prevent groundwater constituent migration. Groundwater can be removed from the aquifer through the use of conventional vertical extraction wells, horizontal wells, collection trenches and associated pumping systems. The type of well or trench system selected is based upon site-specific conditions. Long-term groundwater monitoring would be required to evaluate the effectiveness of any of these technologies. Ex-situ groundwater remediation technologies are discussed below.

6.3.2.1 Conventional Vertical Well System

Conventional vertical wells can usually be used in most cases unless accessibility is an issue. Well spacing and depths depend upon the aquifer characteristics. If flow production from the aquifer is extremely limited, conventional wells may not be feasible due to the extremely close spacing that would be required. Vertical wells may be used at any depth and can be screened in unconsolidated soils or completed as open-hole borings in bedrock.

6.3.2.2 Horizontal Well Systems

The use of horizontal recovery wells has increased due to development of more efficient horizontal drilling techniques. These systems can cover a significant horizontal cross-section and may be much more efficient than conventional vertical wells. They are not well suited to aquifers with wide variation in water levels, as the horizontal well may end up being dry.

6.3.2.3 Trenching Systems

Horizontal collection trenches function similarly to horizontal wells but are installed with excavation techniques. They can be more effective at shallow depths and with higher flow regimes. However, they may not be practical for deeper installations.

6.3.3 Treatment of Extracted Groundwater

Several technologies exist for treatment of extracted groundwater to remove or immobilize constituents ex-situ. The following technologies would be considered if treatment of extracted groundwater became necessary prior to a permitted discharge:

- Precipitation;
- Adsorption;
- Exchange;
- Filtration; and
- Biological & Oxidation.

Brief overviews of these technologies are presented below.

6.3.3.1 Precipitation

Treating impacted groundwater through the precipitation of metals is a well proven and often-used technology. In this process, soluble (dissolved) constituents are converted to insoluble particles that will precipitate such as hydroxides, carbonates, or sulfides. Insoluble particles are then removed by physical methods like clarification and/or filtration. The process typically involves pH adjustment, addition of a precipitant, and flocculation. The details of the process are driven by the solubility of the constituents and the effluent limit requirements. For many constituents, low effluent concentrations can be achieved; however, this technology has not been extensively used for all constituents related to CCR sites.

6.3.3.2 Adsorption

Groundwater containing dissolved constituents can be treated with adsorption media to reduce their concentration in the bulk fluid phase. The column must be regenerated or disposed of and replaced with new media, on a routine basis. Common adsorbent media include activated alumina, copper-zinc granules, granular ferric hydroxide, ferric oxide-coated sand, greensand, zeolite, and other proprietary materials. This technology may also generate a significant regeneration waste stream.

6.3.3.3 Exchange

Ion exchange is a well proven technology for removing metals from groundwater. With some constituents, ion exchange can achieve very low effluent concentrations. Ion exchange is a physical process in which ions held electrostatically on the surface of a solid are exchanged for target ions of similar charge in a solution. The medium used for ion exchange is typically a resin made from synthetic organic materials, inorganic materials, or natural polymeric materials that contain ionic functional groups to which exchangeable ions are attached. The resin must be regenerated routinely, which involves treatment of the resin with a concentrated solution, often containing sodium or hydrogen ions (acid). There must be a feasible method to dispose of the regeneration effluent for this technology. Pretreatment may be required, based on site specific conditions.

6.3.3.4 Filtration

There are a number of permeable membrane technologies that can be used to treat impacted groundwater for metals and other constituents. The most common is reverse osmosis, although microfiltration, ultrafiltration, and nanofiltration are also used. All of these technologies use pressure to force impacted water through a permeable membrane which rejects the target constituents. The differences in the technologies are based on the size of the molecules rejected and the corresponding pressures needed to allow the permeate to pass through. These technologies can capture a number of target compounds simultaneously and can achieve low effluent concentrations, but they are also very sensitive to fouling and often require a pretreatment step.

Like ion exchange, they also result in a relatively high volume reject effluent which may require additional treatment prior to disposal.

6.3.3.5 Biological & Oxidation

Several biological treatment methods and other oxidation methods have been used to treat metals and other CCR constituents. For Arsenic removal, biological systems can require a relatively long residence time (several hours) (Reinsel 2015). Other systems to remove Arsenic use biological formation of Bioscorodite ($FeAsO4 \cdot 2\ H2O$); in this process bacteria oxidize Iron and available Arsenic to Ferric Iron and Arsenate. In general, biological systems are used to alter the oxidation state of the constituents so that it is less soluble and may be removed through adsorption or other means.

6.4 Evaluation to Meet Requirements in 40 CFR § 257.96(c)

For this evaluation, each of the potential remedial technologies identified above will be screened against evaluation criteria requirements in 40 CFR § 257.96(c) listed below:

The assessment under paragraph (a) of this section must include an analysis of the effectiveness of potential corrective measures in meeting all of the requirements and objectives of the remedy as described under § 257.97 addressing at least the following:

(1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;

(2) The time required to begin and complete the remedy;

(3) The institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(s).

The ACM evaluation is provided in Table 6-2 and summarized below.

6.4.1 Performance

This criterion includes the ability of the technology to effectively achieve the specified goal of corrective measures to prevent further releases, to remediate any releases, and to restore the affected area to original conditions.

6.4.1.1 In-Situ Groundwater Remedial Technologies

MNA is a proven technology that can be implemented to reduce constituent concentrations over time through natural processes of geochemical and physical attenuation. Typical attenuation mechanisms that could affect Arsenic would include sorption, microbial activity and dispersion. Sorption to solid phases is a primary mechanism for removing Arsenic from groundwater. Hydroxides of Iron, Aluminum and Manganese, Sulfide Minerals, and organic matter are known to significantly adsorb Arsenic in groundwater (Wang and Mulligan 2006). The rate and amount of sorption is influenced by groundwater pH, redox potential, other ions, and the associated species of Arsenic (Ford, Wilkin and Puls 2007). Microbial activity may also catalyze the transformation of Arsenic species, or impact redox reactions; this would also influence the mobility of the Arsenic.

In the environment, Arsenic is more mobile at pH values greater than 8.5 Standard Units (SU), when it will desorb from mineral oxides (Smedley and Kinniburgh 2002). Highly reducing conditions at near neutral pH would also lead to mobilization of Arsenic as it desorbs from oxides. In groundwater with high concentrations of Arsenic III and Iron II and low Sulfate concentrations, the reductive dissolution of Iron and Manganese Oxides can also release Arsenic to the environment.

At the BSP, Oxidation Reduction Potential (ORP) values varied significantly in 2018 with ranges of -101 millivolts (mV) to 154 mV at KC-15-07, and -10.1 mV to 48 mV at KC-15-06 (AGES 2019). The pH values at the BSP were more consistent ranging from 6.02 to 6.71 SU at both wells over the course of 2018. The range of ORP values are likely related to flood events when the groundwater flow direction reverses and water from the Ohio River recharges groundwater at the site. In the environment, Arsenic is not extremely mobile in this range of pH and ORP values.

Dispersion, the mixing and spreading of constituents due to microscopic variations in velocity within and between interstitial voids in the aquifer, and dilution would reduce Arsenic concentrations but would not destroy the Arsenic. Given groundwater flow conditions, with periodic flood events and flow reversals, dispersion and dilution of Arsenic would likely be a major factor in natural attenuation.

At the BSP, the existing well network would be used to monitor constituent trends over time. Given that Arsenic concentrations are less than the GWPS at the property boundary, a long-term timeframe would likely be acceptable.

Although migration barriers, PRBs, and in-situ chemical stabilization are proven technologies, conditions at the BSP would limit the performance of each of these approaches. A groundwater extraction system may be coupled with these technologies to increase their long-term effectiveness. To be effective, a migration barrier would need to be tied into a lower competent unit at the BSP. Given that the uppermost aquifer extends to a depth of at least 50 feet below ground surface (bgs) and the unit is located along the banks of the Ohio River, these conditions are not practical for a migration barrier or PRB. Periodic flooding of the area by the Ohio River would also adversely impact the performance of these technologies.

Given site conditions, in-situ chemical stabilization reagents could be injected into the uppermost aquifer and distributed to where impacts occur. It would be critical to fully evaluate future groundwater conditions (i.e., pH, ORP, etc.) to maintain this approach. As with the barrier technologies above, periodic flooding of the area by the Ohio River would also impact the performance of in-situ chemical stabilization through dilution of the reagents.

6.4.1.2 Ex-Situ Groundwater Remedial Technologies

Groundwater extraction is a proven technology that has been successfully implemented for decades at many sites. Conventional vertical wells are the most often used approach; although the use of horizontal wells has been increasing. At the BSP, a series of vertical recovery wells can likely be installed and operated to address impacted groundwater. Horizontal wells operate in a similar manner to vertical wells but are less effective in areas with significant water level fluctuations, like the BSP. The performance of both types of wells would be significantly impacted by the Iron content of groundwater, which can lead to clogging. Significant levels of operation and maintenance would likely be necessary. Periodic flooding of the area by the Ohio River would also impact the performance of these ex-situ technologies.

Trenching systems are often used when groundwater impacts are encountered in a shallow unit. The depth to groundwater at the BSP is approximately 40 feet bgs, which would likely preclude the use of a trench at the unit.

6.4.1.3 Treatment of Extracted Groundwater

Groundwater treatment is required as a supplemental technology to be used in conjunction with groundwater extraction. The need for treatment depends on permit requirements for discharge of the treated water via a National Pollution Discharge Elimination System (NPDES) permit. The concentrations of Arsenic would need to be reduced to less than the required permit limits. Treatment for other constituents may also be required based on permit requirements.

Treatment of extracted groundwater can be performed as several proven methods for Arsenic treatment exist. Precipitation is a frequently used and proven technology to treat Arsenic in water at various concentrations (U.S. EPA 2002). As the effectiveness of adsorption and ion exchange can be impacted by the presence of other constituents, these technologies are often used when Arsenic is the only constituent requiring treatment. Filtration is used less frequently because it tends to have higher costs and produce a larger volume of residuals than other technologies that are available for treatment of Arsenic. Several biological treatment methods and other oxidation methods have been used to treat Arsenic. However, most would not likely be practical at the scope of this project.

Filtration, adsorption, and ion exchange systems may require modification if permit-required discharge limits are at or less than the Maximum Contaminant Level (MCL) of 10 ug/L. System changes may include addition of an adsorption media bed, more frequent regeneration or replacement of ion exchange media, or use of a membrane with a smaller molecular weight cutoff. These technologies could also be supplemental or used in tandem to achieve the required discharge limits.

6.4.2 Reliability

This criterion includes the degree of certainty that the technology will consistently work toward and achieve the specified goal of corrective measures over time.

6.4.2.1 In-Situ Groundwater Remedial Technologies

As the process of MNA is based on natural processes, this approach would be considered to be reliable. However, as groundwater geochemistry can vary over time, routine monitoring is required to evaluate conditions and ensure the ongoing effectiveness of the MNA process. Geochemical changes in groundwater could significantly impact the effectiveness of MNA, which could lead to the need to implement other remedial measures at the BSP.

Migration barriers and PRBs are typically reliable technologies; the primary issue being the potential for altered groundwater flow directions and further migration of constituents. In addition, maintaining adequate and reactive reagent concentrations at depth over an extended period of time in a PRB can also be a significant Operational and Maintenance (O&M) issue.

For in-situ chemical stabilization, reagents must be injected uniformly and consistently to adequately distribute them into the aquifer. Lack of a uniform and consistent approach could lead to reliability issues. Finally, changes in the geochemistry of the aquifer can lead to the need for adjustments in reagent type, concentrations and injection approach.

6.4.2.2 Ex-Situ Groundwater Remedial Technologies

Groundwater extraction solutions are generally considered reliable at controlling and removing constituents from the subsurface. At the BSP, conventional vertical wells would be the more reliable approach, as the large water level fluctuations at the unit would significantly impact the reliability of horizontal wells. There can be significant O&M issues associated with both conventional vertical or horizontal wells but these issues are well understood and can be readily addressed. Once in the place, trenching systems would also be reliable at the BSP although long term O&M would be required.

6.4.2.3 Treatment of Extracted Groundwater

Treatment of Arsenic in extracted groundwater would be reliable as long as the treatment processes are properly implemented.

6.4.3 Ease of Implementation

This criterion includes the ease with which the technologies can be implemented at the BSP.

6.4.3.1 In-Situ Groundwater Remedial Technologies

MNA is among the easiest of corrective measures to implement at a site. A sufficient number of monitoring wells already exist at the BSP, which could be used to monitor the effectiveness of MNA.

Due to the significant amount of time, effort, and disturbance required for implementation at the BSP, migration barrier and PRB implementation would be difficult. Difficulties in construction would be related to the depth of installation and the lack of an impermeable layer at depth. In-situ chemical stabilization may require less time and effort than a migration barrier or PRB.

6.4.3.2 Ex-Situ Technologies for Groundwater Extraction

Implementation of both conventional vertical and horizontal wells at the BSP would require drilling and limited field construction; however, the conventional vertical wells would be the more easily implemented. The orientation of the horizontal wells could present potential installation issues. Trenching systems would require significant construction and would be difficult to implement at the BSP, given site conditions.

6.4.3.3 Treatment of Extracted Groundwater

Treatment of Arsenic in extracted groundwater is implementable, as long as proper processes are used.

6.4.4 Potential Safety Impacts

This criterion includes potential safety impacts that may result from implementation and use of the technology at the BSP.

6.4.4.1 In-Situ Groundwater Remedial Technologies

Potential safety impacts associated with MNA are very minimal; especially as no additional well installation is required. Minimal safety concerns are therefore associated with the ongoing groundwater monitoring program.

Migration barriers and PRBs require a significant construction effort and use of construction equipment, which would entail a relatively high risk of potential safety impacts. However, neither technology would have any potential significant safety impacts following construction. Potential safety concerns related to in-situ chemical stabilization are moderate. The potential for incidents during injection well construction or unintended worker contact with the chemicals used for treatment would be the primary safety concerns with this technology.

6.4.4.2 Ex-Situ Groundwater Remedial Technologies

Groundwater extraction through use of wells (conventional vertical or horizontal) would involve drilling, construction, and installation of extraction wells, pumps, and associated control wiring and piping. Potential safety concerns exist with the activities associated with installation of these wells, as well as the ongoing O&M of the system, including inspection, maintenance, or replacement of the various system components.

Trenching systems would require use of significant construction equipment and present worker safety concerns, especially with the depth of the trench. Ongoing operation of the system would present minimal safety concerns.

6.4.4.3 Treatment of Extracted Groundwater

Treatment of extracted Arsenic in groundwater would have minimal safety concerns.

6.4.5 Potential Cross-Media Impacts

This criterion includes the ability to control cross-media impacts during implementation and use of the technology at the BSP.

6.4.5.1 In-Situ Groundwater Remedial Technologies

MNA poses no significant cross-media impact potential. Migration barriers and PRBs pose minimal risk of cross-media impacts, as they primarily involve an intended modification in groundwater flow. For a barrier technology, there could be some risk with the migration of impacted groundwater to other areas of the site; this concern is minimal. In the case of PRBs, constituents are removed from the groundwater through use of reagents; this includes minimal potential for cross-media impacts.

6.4.5.2 Ex-Situ Groundwater Remedial Technologies

Well and trench systems pose a moderate risk of cross-media impacts.

6.4.5.3 Treatment of Extracted Groundwater

Treatment of extracted groundwater for Arsenic would pose minimal risk of cross-media impacts.

6.4.6 Potential Impacts from Control of Exposure to Residual Constituents

This criterion includes the ability to control exposure of humans and the environment to residual constituents through implementation and use of the technology at the BSP.

6.4.6.1 In-Situ Groundwater Remedial Technologies

MNA poses no significant potential for human or environmental exposure to impacted groundwater. Overall, in-situ technologies involve placement or injection of a structure or reagent to treat impacted groundwater in-place. Consequently, there is no risk of exposure of humans and the environment to residual contamination.

6.4.6.2 Ex-Situ Groundwater Remedial Technologies

Groundwater extraction involves bringing impacted groundwater from the subsurface to the surface for potential treatment and discharge. This would slightly increase the potential for exposure of humans or the environment to impacted groundwater. The groundwater would be conveyed through an engineered system designed to prevent the release of water into the environment and to limit the potential for human or environmental exposure to the impacted groundwater. The potential for exposure to residual contamination associated with this technology is therefore unlikely.

6.4.6.3 Treatment of Extracted Groundwater

Treatment of extracted groundwater for Arsenic would pose minimal risk of exposure to residual contamination.

6.4.7 Time Required to Begin Remedy

This criterion includes the time necessary for planning, pilot testing, design, permitting, procurement, installation, and startup of this technology at the BSP. Timeframes presented below and in Table 6-2 are the times to begin the remedy after closure of the unit.

6.4.7.1 In-Situ Groundwater Remedial Technologies

A MNA program could be implemented at the BSP within three (3) months, as a sufficient monitoring well network already exists at the site and a monitoring program is already established. This potential remedy would require the least amount of time to implement of the technologies considered.

Migration barriers, in-situ chemical stabilization, and PRBs could take a significant amount of time to design and install. Either technology would also involve a significant amount of regulatory permitting. The design and implementation time could take 1 to 1.5 years.

6.4.7.2 Ex-Situ Groundwater Remedial Technologies

Design and installation of groundwater extraction systems could be completed in six (6) months to one (1) year. This could vary depending on potential groundwater modeling efforts and regulatory approval and permitting.

6.4.7.3 Treatment of Extracted Groundwater

Design and installation of the system, including bench-scale and pilot testing, could be completed in six (6) months to one (1) year. This would depend on the regulatory approval and permitting process.

6.4.8 Time Required to Complete Remedy

This criterion includes the estimated time necessary to achieve the stated goals of corrective measures to prevent further releases from the BSP, to remediate any releases, and to restore the affected area to original conditions.

6.4.8.1 In-Situ Groundwater Remedial Technologies

As MNA does not require additional physical or chemical remedial treatment, the timeframe is the longest period to reach remedial goals. A groundwater model would be useful to more accurately predict the anticipated time required to complete the remediation.

A significant amount of time is expected to be required to meet remedial goals with migration barriers and PRB. However, as groundwater modeling has not been performed for the site, an accurate estimate cannot be developed at this time. If in-situ chemical stabilization option can effectively treat Arsenic at the unit boundary, this approach has the potential to treat groundwater more quickly than a barrier or PRB.

6.4.8.2 Ex-Situ Groundwater Remedial Technologies

A significant amount of time is expected to be required to meet remedial goals with ex-situ technologies. However, as groundwater modeling has not been performed for the site, an accurate estimate cannot be developed at this time.

6.4.8.3 Treatment of Extracted Groundwater

The time required to meet remedial goals depends on the type of groundwater extraction system implemented. The time required for treatment of extracted groundwater is insignificant.

6.4.9 State, Local, or Other Environmental Permit Requirements That May Impact Implementation

This criterion includes anticipation of any state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the technology at the BSP.

6.4.9.1 In-Situ Groundwater Remedial Technologies

A MNA program would likely require coordination with the Ohio Environmental Protection Agency (Ohio EPA) but likely not formal approval. Therefore, it could be implemented in as little as (3) months, as a sufficient monitoring well network already exists at the site.

Migration barriers, in-situ chemical stabilization, and PRBs would require installation of barrier walls and associated components in the aquifer and/or chemical injections, which may require permitting through Ohio EPA. This would require an anticipated minimum of 1 to 1.5 years of review and approval.

6.4.9.2 Ex-Situ Groundwater Remedial Technologies

A groundwater extraction system would require the installation of new wells and a treatment system at the BSP, which may require permitting through Ohio EPA. This would require an anticipated minimum of 1 to 1.5 years of review and approval.

6.4.9.3 Treatment of Extracted Groundwater

The selection of a treatment system may require permitting through Ohio EPA, especially if a NPDES permit is required. This would require an anticipated minimum of 1 to 1.5 years of review and approval.

6.5 Conclusions

For this evaluation, several in-situ and ex-situ remedial technologies to address Arsenic in groundwater at the BSP were screened against evaluation criteria requirements in 40 CFR § 257.96(c). As presented in Table 6-2, during the screening, the technologies were ranked as High, Medium or Low using professional judgement and past experience. Based on these rankings, the two (2) technologies that appear to be most likely for selection as a remedy were:

- MNA; and
- Conventional Vertical Well System (Groundwater Extraction) (Ex-Situ).

Groundwater treatment would be required as a supplemental technology in conjunction with a Conventional Vertical Well System. The selection of a treatment technology would be based on conditions at the time of selection of a final remedy.

The technologies that appear to be less likely for selection as a remedy were:

- Groundwater Migration Barriers (In-Situ);
- PRB (In-Situ);
- In-Situ Chemical Stabilization (In-Situ);
- Horizontal Well Systems (Ex-Situ); and
- Trenching Systems (Ex-Situ).

As groundwater quality near the BSP is anticipated to significantly improve over time as a result of planned closure activities, a flexible and adaptive approach to groundwater remediation that begins with post-closure groundwater monitoring at the unit is planned. During the post-closure monitoring period, the positive impacts of closure and the effects of natural attenuation on groundwater quality will be fully evaluated. The need for more active remedial measures will be determined after sufficient post-closure groundwater quality data has been collected and evaluated. The final selection of a remedy will be made based on the results of post-closure groundwater monitoring program.

Additional remedial technologies may also be evaluated at a later date if determined to be applicable and appropriate.

7.0 SELECTION OF REMEDY PROCESS

The remedy selection begins following completion of the ACM Report. Per 40 CFR § 257.97(a):

Based on the results of the corrective measures assessment conducted under § 257.96, the owner or operator must, as soon as feasible, select a remedy that, at a minimum, meets the standards listed in paragraph (b) of this section. This requirement applies to, not in place of, any applicable *standards under the Occupational Safety and Health Act. The owner or operator must prepare a semiannual report describing the progress in selecting and designing the remedy. Upon selection of a remedy, the owner or operator must prepare a final report describing the selected remedy and how it meets the standards specified in paragraph (b) of this section. The owner or operator must obtain a certification from a qualified professional engineer that the remedy selected meets the requirements of this section. The report has been completed when it is placed in the operating record as required by § 257.105(h)(12).*

This ACM Report provides a high-level assessment of groundwater remedial technologies that could potentially address Arsenic concentrations in groundwater that exceed the GWPS at the BSP. With the submittal of this report, OVEC began the remedy selection process and will ultimately select a remedy. The remedy selection process and selected remedy will satisfy standards listed in 40 CFR § 257.97(b) with consideration to evaluation factors listed in 40 CFR § 257.97(c). The progress toward selecting a remedy will be documented in semiannual reports.

Over the course of 2020, the ongoing groundwater monitoring program continued at the site. The results of this program have been used to develop a 2020 Update on Groundwater Conditions at the unit (Appendix F). This update includes a detailed evaluation of groundwater flow and Arsenic concentrations at the BSP and the impact that these conditions have on the remedy selection process.

7.1 Data Gaps

Based on a review of data to date, the following recommendations for additional data collection/evaluation have been identified:

- With the results of the monitoring program from 2018 through 2020, sufficient data is now available to develop a three-dimensional (3-D) groundwater model of the site using Modflow or another commercially available software. This model would be useful in supporting the evaluation of the positive impact of the closure of the BSP and ongoing natural attenuation on groundwater quality and the application of various potential remedial techniques at the site.

- Ongoing sampling of monitoring wells prior to and after closure of the BSP should continue to evaluate whether Arsenic concentrations in groundwater are increasing, decreasing or are asymptotic. This data will be useful in supporting potential groundwater modeling efforts and the final selection of a remedy for the BSP.

- Additional hydraulic testing near the BSP would provide more accurate data regarding the hydraulic conductivity and storage coefficient of the uppermost aquifer. This data will be useful in supporting the potential groundwater modeling effort.

- Given the dynamic nature of groundwater flow at the BSP, additional depth-to-groundwater data from wells in the area would be useful to support the potential groundwater modeling effort. This data can be most efficiently collected by installing downhole transducers in select wells near the BSP.

7.2 Selection of Remedy

As noted above, OVEC began the process of selecting a remedy following submittal of the ACM Report. Per 40 CFR § 257.97, the remedy will be selected and implemented as soon as feasible and progress toward selecting the remedy will be documented in semiannual reports. As of the process, one or more preferred remedial approaches will be developed based upon technology effectiveness under site conditions, implementability and other considerations. As discussed above, a flexible and adaptive approach to groundwater remediation that begins with post-closure monitoring is planned.

7.3 Public Meeting Requirement in 40 CFR § 257.96(e)

Per 40 CFR § 257.96(e), OVEC held a public meeting in November 2019 to discuss ACM results, the remedy selection process, and selection of one or more preferred remedial approaches. The public meeting was be conducted at least 30 days prior to selection of a final remedy, in accordance with the above-referenced rule. Prior to the meeting, citizen and governmental stakeholders were formally notified as to the schedule for the public meeting.

7.4 Final Remedy Selection

After selection of a remedy, a report documenting the remedy selection process will be prepared. The report will demonstrate how the remedy selection process was performed and how the selected remedial approach satisfies 40 CFR § 257.97 requirements.

8.0 REFERENCES

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TABLES

TABLE 4-1
GROUNDWATER MONITORING NETWORK
BOILER SLAG POND
KYGER CREEK STATION
CHESHIRE, OHIO

Well ID	Designation	Date of Installation	Coordinates		Ground Elevation (ft)²	Top of Casing Elevation (ft)²	Top of Screen Elevation (ft)	Base of Screen Elevation (ft)	Total Depth From Top of Casing (ft)
			Northing	Easting					
KC-15-01	Upgradient	8/5/2015	332114.55	2072393.84	579.77	579.20	519.77	509.77	69.43
KC-15-02	Upgradient	8/7/2012	332500.654	2072569.222	580.79	580.25	520.79	510.79	69.46
KC-15-03	Variable	8/12/2015	332546.402	2073001.342	582.03	581.55	520.03	510.03	71.52
KC-15-04	Downgradient	8/12/2015	331782.439	2073755.607	579.89	579.37	519.89	509.89	69.48
KC-15-05	Downgradient	8/19/2015	331569.994	2073574.832	580.52	580.07	520.52	510.52	69.55
KC-15-06	Downgradient	8/18/2015	331218.52	2073210.42	579.98	579.48	519.98	509.98	69.50
KC-15-07	Downgradient	8/11/2015	331291.75	2072957.79	578.54	578.04	508.54	498.54	79.50
KC-15-08	Downgradient	8/10/2015	331460.59	2072675.87	579.41	578.75	509.41	499.41	79.34

Notes:
1. The well locations are referenced to the Ohio State Plane South, North American Datum (NAD83), east zone coordinate system.
2. Elevations are referenced to the North American Vertical Datum (NAVD) 1988.

TABLE 4-2
SUMMARY OF POTENTIAL AND CONFIRMED APPENDIX III SSIs
BOILER SLAG POND
KYGER CREEK STATION
CHESHIRE, OHIO

Well Id	Parameter	1st Detection Monitoring Event February/March 2018	1st Detection Monitoring Resampling May 2018	1st Assessment Monitoring Event September 2018	1st Assessment Monitoring Resampling December 2018
		Potential SSI	Confirmed SSI (Yes/No)	Potential SSI	Confirmed SSI (Yes/No)
KC-15-04	Boron	**Yes**	**Yes**	**Yes**	**No**
	pH	**Yes**	No	No	--
	TDS	**Yes**	**Yes**	**Yes**	**Yes**
	Sulfate	**Yes**	**Yes**	**Yes**	**No**
KC-15-05	Boron	**Yes**	**Yes**	No	--
	Calcium	**Yes**	No	**Yes**	**Yes**
	pH	**Yes**	No	No	--
	TDS	**Yes**	**Yes**	**Yes**	**Yes**
	Sulfate	**Yes**	**Yes**	**Yes**	**Yes**
KC-15-06	pH	**Yes**	No	No	--
KC-15-07	Calcium	**Yes**	No	No	--
	pH	**Yes**	No	No	--
KC-15-08	Boron	**Yes**	**Yes**	No	--
	Calcium	**Yes**	**Yes**	**Yes**	**No**
	pH	**Yes**	No	No	--
	TDS	**Yes**	**Yes**	**Yes**	**No**
	Sulfate	**Yes**	**Yes**	**Yes**	**No**

Notes:
SSI: Statistically Significant Increase
-- : Not evaluated

TABLE 4-3
GROUNDWATER PROTECTION STANDARDS
BOILER SLAG POND
KYGER CREEK STATION
CHESHIRE, OHIO

Appendix IV Constituents			
Constituent	**Background**	**MCL/SMCL**	**GWPS**
Antimony, Sb	0.3273 (ug/L)	6 (ug/L)	6 (ug/L)
Arsenic, As	7.604 (ug/L)	10 (ug/L)	10 (ug/L)
Barium, Ba	133.7 (ug/L)	2000 (ug/L)	2000 (ug/L)
Beryllium, Be	0.094 (ug/L)	4 (ug/L)	4 (ug/L)
Cadmium, Cd	0.1482 (ug/L)	5 (ug/L)	5 (ug/L)
Chromium, Cr	1.959 (ug/L)	100 (ug/L)	100 (ug/L)
Cobalt, Co	9.745 (ug/L)	6 (ug/L)*	9.745 (ug/L)
Fluoride, F	1.29 (mg/L)	4 (mg/L)	4 (mg/L)
Lithium, Li	0.0125 (ug/L)	40 (ug/L)*	40 (ug/L)
Lead, Pb	0.5159 (ug/L)	15 (ug/L)*	15 (ug/L)
Mercury, Hg	0.25 (ug/L)	2 (ug/L)	2 (ug/L)
Molybdenum, Mo	6.122 (ug/L)	100 (ug/L)*	100 (ug/L)
Radium 226 & 228 (combined)	1.695(pCi/L)	5(pCi/L)	5(pCi/L)
Selenium, Se	0.4 (ug/L)	50 (ug/L)	50 (ug/L)
Thallium, Tl	0.03 (ug/L)	2 (ug/L)	2 (ug/L)

Notes:
GWPS: Groundwater Protection Standard
MCL: Maximum Contaminant Level
SMCL: Secondary Maximum Contaminant Level
ug/L: Micrograms per liter
pCi/L: Pico Curies per Liter
* Established by EPA as part of 2018 decision.

TABLE 5-1
GRAIN SIZE ANALYSIS RESULTS
BOILER SLAG POND
KYGER CREEK STATION
CHESHIRE, OHIO

Boring Number	Sample Depth (feet)	70% Retention (30% Passing) Size (mm)	Filter Pack Size (mm)	Screen Mesh (inches)	Unified Soil Classification Symbol & Description	
KC-19-27	28 - 38	0.079	0.40	0.01	SM	Silty Sand
KC-19-28	30 - 40	0.11	0.40	0.01	SM	Silty Sand
KC-19-29	32 - 42	0.091	0.40	0.01	SM	Silty Sand

Notes:
mm: Millimeters

TABLE 5-2
NEW MONITORING WELL CONSTRUCTION DETAILS
BOILER SLAG POND
KYGER CREEK STATION
CHESHIRE, OHIO

Well ID	Designation	Date of Installation	Coordinates [1]		Ground Elevation[2] (feet)	Top of Casing Elevation[2] (feet)	Top of Screen bgs (feet)	Base of Screen bgs (feet)	Total Depth bgs (feet)
			Northing	Easting					
KC-19-27	Downgradient	4/5/2019	331507.38	2073611.953	558.22	561.13	28.00	38.00	38.00
KC-19-28	Downgradient	4/4/2019	331064.431	2073270.027	558.41	561.10	32.00	42.00	42.00
KC-19-29	Downgradient	4/3/2019	330558.936	2072840.947	561.13	564.17	31.00	41.00	41.00

Notes:
1. Well locations are referenced to the North American Datum (NAD83), east zone coordinate system.
2. Elevations are referenced to the North American Vertical Datum (NAVD) 1988

bgs: Below Ground Surface

TABLE 5-3
SUMMARY OF WELL DEVELOPMENT DATA
BOILER SLAG POND
KYGER CREEK PLANT
CHESHIRE, OHIO

Well ID	Dates	Method	Volume (gallons)	Final Turbidity (NTU)
KC-19-27	4/8/2019	Pump	213	4.89
KC-19-28	4/9/2019	Pump	232	4.7
KC-19-29	4/10/2019	Pump	106	4.51

Notes:
NTU: Nephelometric Turbidity Unit

TABLE 5-4
SUMMARY OF GROUNDWATER ELEVATION DATA
JUNE 2019
BOILER SLAG POND
KYGER CREEK PLANT
CHESHIRE, OHIO

Well ID	Top of Casing Elevation (feet)	Depth to Groundwater (feet)	Groundwater Elevation (feet)
KC-15-01	579.20	39.49	539.71
KC-15-02	580.25	40.20	540.05
KC-15-03	581.55	41.70	539.85
KC-15-04	579.37	41.06	538.31
KC-15-05	580.07	41.84	538.23
KC-15-06	579.48	41.34	538.14
KC-15-07	578.04	39.66	538.38
KC-15-08	578.75	39.74	539.01
KC-19-27	561.13	22.94	538.19
KC-19-28	561.10	23.19	537.91
KC-19-29	564.17	26.19	537.98

TABLE 5-5
SUMMARY OF SLUG TEST RESULTS
BOILER SLAG POND
KYGER CREEK STATION
CHESHIRE, OHIO

Well ID	Test	Analytical Method	K (ft/sec)	Mean K
Slug Tests Conducted May 2016				
KC-15-02	Rising Head #1	Bouwer-Rice	4.79E-04	6.77E-04
		Hvorslev	5.28E-04	
	Falling Head #1	Bouwer-Rice	1.17E-03	
		Hvorslev	7.31E-04	
	Rising Head #2	Bouwer-Rice	6.56E-04	
		Hvorslev	7.05E-04	
	Falling Head #2	Bouwer-Rice	5.64E-04	
		Hvorslev	5.81E-04	
KC-15-05	Rising Head #1	Bouwer-Rice	1.91E-04	1.14E-04
		Hvorslev	2.13E-04	
	Falling Head #1	Bouwer-Rice	5.22E-05	
		Hvorslev	5.87E-05	
	Rising Head #2	Bouwer-Rice	1.55E-04	
		Hvorslev	1.61E-04	
	Falling Head #2	Bouwer-Rice	3.77E-05	
		Hvorslev	4.17E-05	
Slug Tests Conducted April 2019				
KC-19-27	Falling Head #1	Bouwer-Rice	8.31E-05	7.45E-05
		Hvorslev	9.95E-05	
	Rising Head #1	Bouwer-Rice	5.14E-05	
		Hvorslev	6.14E-05	
	Falling Head #2	Bouwer-Rice	7.76E-05	
		Hvorslev	9.29E-05	
	Rising Head #2	Bouwer-Rice	5.92E-05	
		Hvorslev	7.08E-05	
KC-19-28	Falling Head #1	Bouwer-Rice	3.22E-03	1.65E-03
		Hvorslev	4.12E-03	
	Rising Head #1	Bouwer-Rice	7.38E-04	
		Hvorslev	8.75E-04	
	Falling Head #2	Bouwer-Rice	1.17E-03	
		Hvorslev	1.39E-03	
	Rising Head #2	Bouwer-Rice	7.57E-04	
		Hvorslev	8.96E-04	
			Mean K (ft/sec)	**6.28E-04**

Notes:
ft/sec: Feet per second
K: Hydraulic Conductivity

TABLE 5-6
SUMMARY OF GROUNDWATER VELOCITY CALCULATIONS
JUNE 2019
BOILER SLAG POND
KYGER CREEK STATION
CHESHIRE, OHIO

Well Pair		h_1 (feet)	h_2 (feet)	d (feet)	K (feet/day)	n	i	V (feet/day)
KC-15-02 (h_1)	KC-15-06 (h_2)	540.05	538.14	1400	54.26	0.25	0.001364	0.296
KC-15-05 (h_1)	KC-19-27 (h_2)	538.23	538.19	90	54.26	0.25	0.00044	0.095
KC-15-06 (h_1)	KC-19-28 (h_2)	538.14	537.91	180	54.26	0.25	0.00128	0.278
KC-15-07 (h_1)	KC-19-29 (h_2)	538.38	537.98	740	54.26	0.25	0.00054	0.117
							Average V =	**0.197**

Notes:

h_1 = Head elevation in well #1
h_2 = Head elevation in well #2
d = distance between wells
K = Hydraulic conductivity
n = effective porosity
i = Horizontal Hydraulic Gradient
V = Groundwater Velocity

Horizontal Hydraulic Gradient:

$$i = \frac{h_1 - h_2}{d}$$

Groundwater Velocity:

$$V = K\left(\frac{i}{n}\right)$$

TABLE 5-7
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
MARCH AND APRIL 2019
BOILER SLAG POND
KYGER CREEK STATION
CHESHIRE, OHIO

Well ID Parameter	Units	GWPS	KC-15-01 Mar-19	KC-15-02 Mar-19	KC-15-03 Mar-19	KC-15-04 Mar-19	KC-15-05 Mar-19	KC-15-06 Mar-19	KC-15-07 Mar-19	KC-15-08 Mar-19	KC-19-27 Apr-19	KC-19-28 Apr-19	KC-19-29 Apr-19
Appendix III Constituents													
Boron, B	mg/L	--	0.33	0.041 J	0.18	0.79	0.86	0.31	0.12	0.51	--	--	--
Calcium, Ca	mg/L	--	85	110	120	100	120	92	88	210	--	--	--
Chloride, Cl	mg/L	--	32	33	29	30	32	34	33	45	--	--	--
Fluoride, F	mg/L	--	0.049 J	0.12	0.089	0.071	0.12	0.095	0.064	0.092	--	--	--
pH	s.u.	--	6.06	6.64	6.31	5.56	6.11	6.77	6.6	6.8	--	--	--
Sulfate, SO4	mg/L	--	270	120	190	330	390	180	87	550	--	--	--
Total Dissolved Solids (TDS)	mg/L	--	510	480	490	620	760	490	410	1000	--	--	--
Appendix IV Constituents													
Antimony, Sb	ug/L	6	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	--	--	--
Arsenic, As	ug/L	10	0.85 J	2.7 J	1.3 J	2.4 J	<5.0	2.6 J	160	11	1.8	0.94	0.84
Barium, Ba	ug/L	2000	26	100	69	76	37	110	560	54	--	--	--
Beryllium, Be	ug/L	4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	--	--
Cadmium, Cd	ug/L	5	<1.0	<1.0	<1.0	<1.0	<1.0	0.29 J	<1.0	<1.0	--	--	--
Chromium, Cr	ug/L	100	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	--	--	--
Cobalt, Co	ug/L	9.745	5.7	1.4	4.6	11	5.5	4.3	0.27 J	5	--	--	--
Fluoride, F	mg/L	4	0.049 J	0.12	0.089	0.071	0.12	0.095	0.064	0.092	--	--	--
Lithium, Li	mg/L	0.04	0.0036 J	0.0034 J	0.0045 J	0.011	0.0027 J	0.003 J	0.0024 J	0.0046 J	--	--	--
Lead, Pb	ug/L	15	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	--	--
Mercury, Hg	ug/L	2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	--	--	--
Molybdenum, Mo	ug/L	100	<5.0	1.7 J	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	--	--	--
Radium 226 & 228 (combined)	pCi/L	5	0.255 U	0.604	0.501	0.486	0.587	0.417	1.29	0.539	--	--	--
Selenium, Se	ug/L	50	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	--	--	--
Thallium, Tl	ug/L	2	<1.0	0.26 J	<1.0	<1.0	0.23 J	0.25 J	<1.0	<1.0	--	--	--

Notes:
GWPS: Groundwater Protection Standard
mg/L: Milligrams per liter
s.u.: Standard Units
ug/L: Micrograms per liter
pCi/L: Picocuries per liter

TABLE 6-1
SOURCE CONTROL TECHNOLOGIES SCREENING MATRIX - 40 CFR § 257.96(c) REQUIREMENTS
BOILER SLAG POND
KYGER CREEK STATION
CHESHIRE, OHIO

	Source Control Technologies		
	Dewatering of Pond Water	**Engineered Cover System**	**Excavation of Boiler Slag**
257.96(c)(1)			
Performance	Low	Medium	High
Reliability	Low	Medium	High
Ease of Implementation	Low Water Removal, Treatment & Discharge Required	Medium Field Construction Required	High Field Construction Required
Potential Safety Impacts	Low Field Construction Required	Medium Field Construction Required	High Field Construction Required
Potential Cross-Media Impacts	Medium	Low	Medium
Potential Impacts from Control of Exposure to Residual Constituents	Low	Low	Low
257.96(c)(2)			
Time To Begin Remedy	6 months to 1 year	1 to 1.5 years	1 to 1.5 years
Time To Complete Remedy	6 months to 1 year	1 to 2.5 years	2 to 3 years
257.96(c)(3)			
State, Local or other Environmental Permit Requirements that May Impact Implementation	Requires Approval from Ohio EPA	Requires Approval from Ohio EPA	Requires Approval from Ohio EPA
Additional Information	Required for In-Place Closure or Closure by Removal	Ash Remains in Place as Long-Term Source for Groundwater	Groundwater Issues Need to be Addressed

Notes:

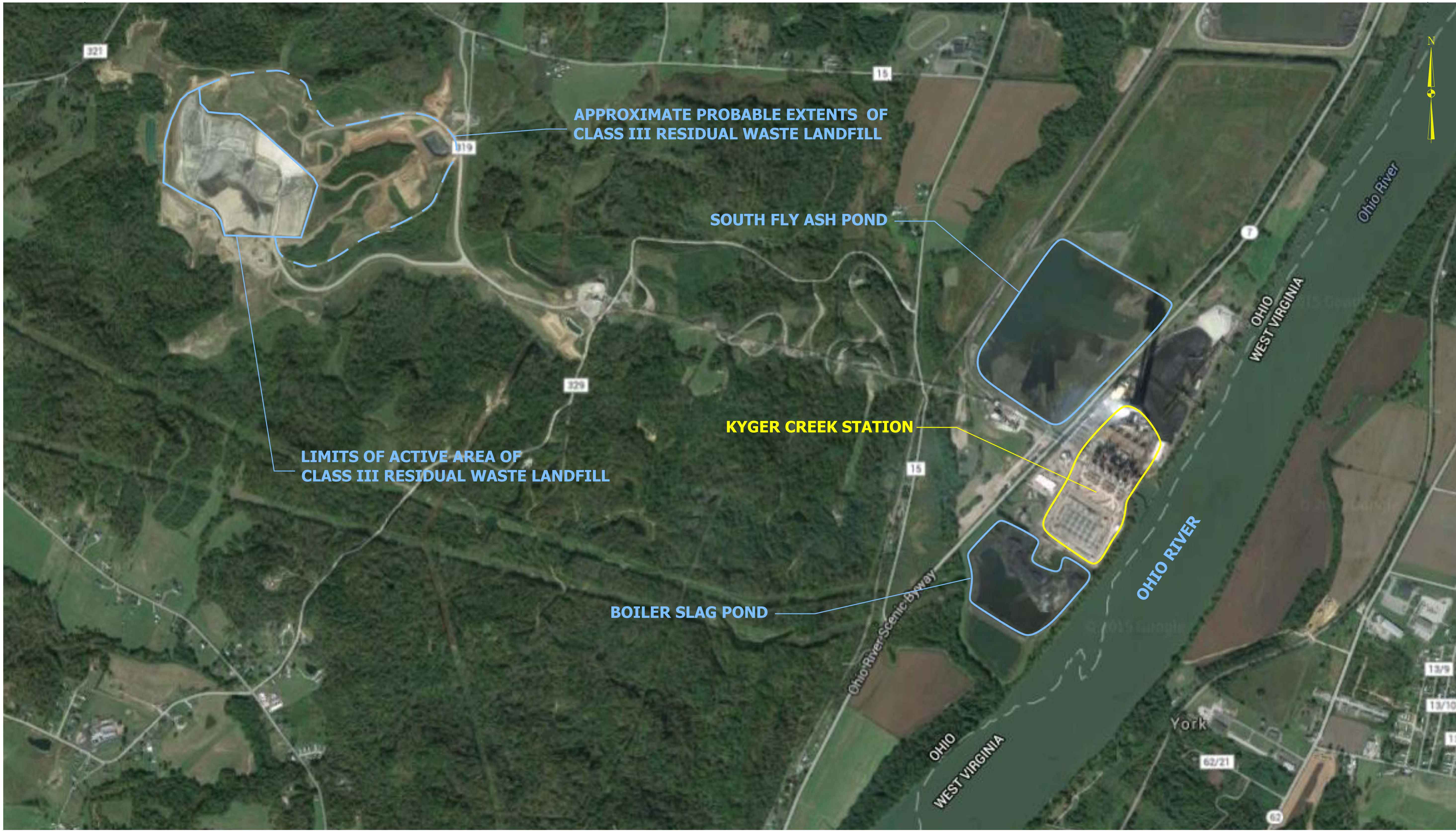
Relative assessments (low, medium, high) are based on experience and professional judgement

TABLE 6-2
IN-SITU AND EX-SITU GROUNDWATER REMEDIAL TECHNOLOGIES SCREENING MATRIX - 40 CFR § 257.96(c) REQUIREMENTS
BOILER SLAG POND
KYGER CREEK STATION
CHESHIRE, OHIO

	In-Situ Groundwater Remedial Technologies				*Ex-Situ Groundwater Remedial Technologies*		
	Monitored Natural Attenuation	**Groundwater Migration Barriers**	**In-situ Chemical Stabilization**	**Permeable Reactive Barrier**	**Conventional Well System**	**Horizontal Well System**	**Trenching System**
257.96(c)(1)							
Performance	High	Low	Low	Low	High	Low Significant Water Level Fluctuations Reduce Effectiveness of Horizontal Wells	High
Reliability	High	Low	Medium	Medium	High Long Term O&M Required	Low Significant Issues with Water Level Fluctuations	High Long Term O&M Required
Ease of Implementation	High	Low	Low	Low	High Drilling and Limited Field Construction Required	Medium Drilling and Limited Field Construction Required	Low Trench Construction Required
Potential Safety Impacts	Low	Medium Field Construction Required	Medium Field Construction Required	Medium Field Construction Required	Medium Drilling Required	Medium Drilling Required	Medium Trench Construction Required
Potential Cross-Media Impacts	Low	Medium	Low	Low	Medium	Medium	Medium
Potential Impacts from Control of Exposure to Residual Constituents	Low	Low	Low	Low	Low	Low	Low
257.96(c)(2)							
Time To Begin Remedy*	3 months	1 to 1.5 years	1 to 1.5 years	1 to 1.5 years	6 months to 1 year	6 months to 1 year	6 months to 1 year
Time To Complete Remedy	Highly Variable Further Evaluation Required	Highly Variable Further Evaluation Required	Highly Variable Further Evaluation Required	Highly Variable Further Evaluation Required	Highly Variable Further Evaluation Required	Highly Variable Further Evaluation Required	Highly Variable Further Evaluation Required
257.96(c)(3)							
State, Local or other Environmental Permit Requirements that May Impact Implementation	Requires Coordination with Ohio EPA	Requires Approval from Ohio EPA	Requires Approval from Ohio EPA	Requires Approval from Ohio EPA	Requires Approval from Ohio EPA	Requires Approval from Ohio EPA	Requires Approval from Ohio EPA
Additional Information	Groundwater F&T Modeling Required to Evaluate the Timing for This Approach for Arsenic	Lack of Competent Lower Unit Likely Precludes This Approach	Pilot Testing Required for This Approach	Lack of Competent Lower Unit Likely Precludes This Approach	Groundwater Flow Modeling Required to Fully Evaluate This Approach	Groundwater Flow Modeling Required to Fully Evaluate This Approach	Groundwater Flow Modeling Required to Fully Evaluate This Approach

Notes:
Relative assessments (low, medium, high) are based on experience and professional judgement
*The time to begin the remedy is based on the time after closure of the unit.

FIGURES



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CHECKED BY	
JOB NO.	2019109-1-KYG
DWG FILE	2019 ACM_KYGER_Fig 2-1_Aerial Site.dwg
DRAWING SCALE	NOT TO SCALE

AGES
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Clinton, PA 15026
412.264.6453

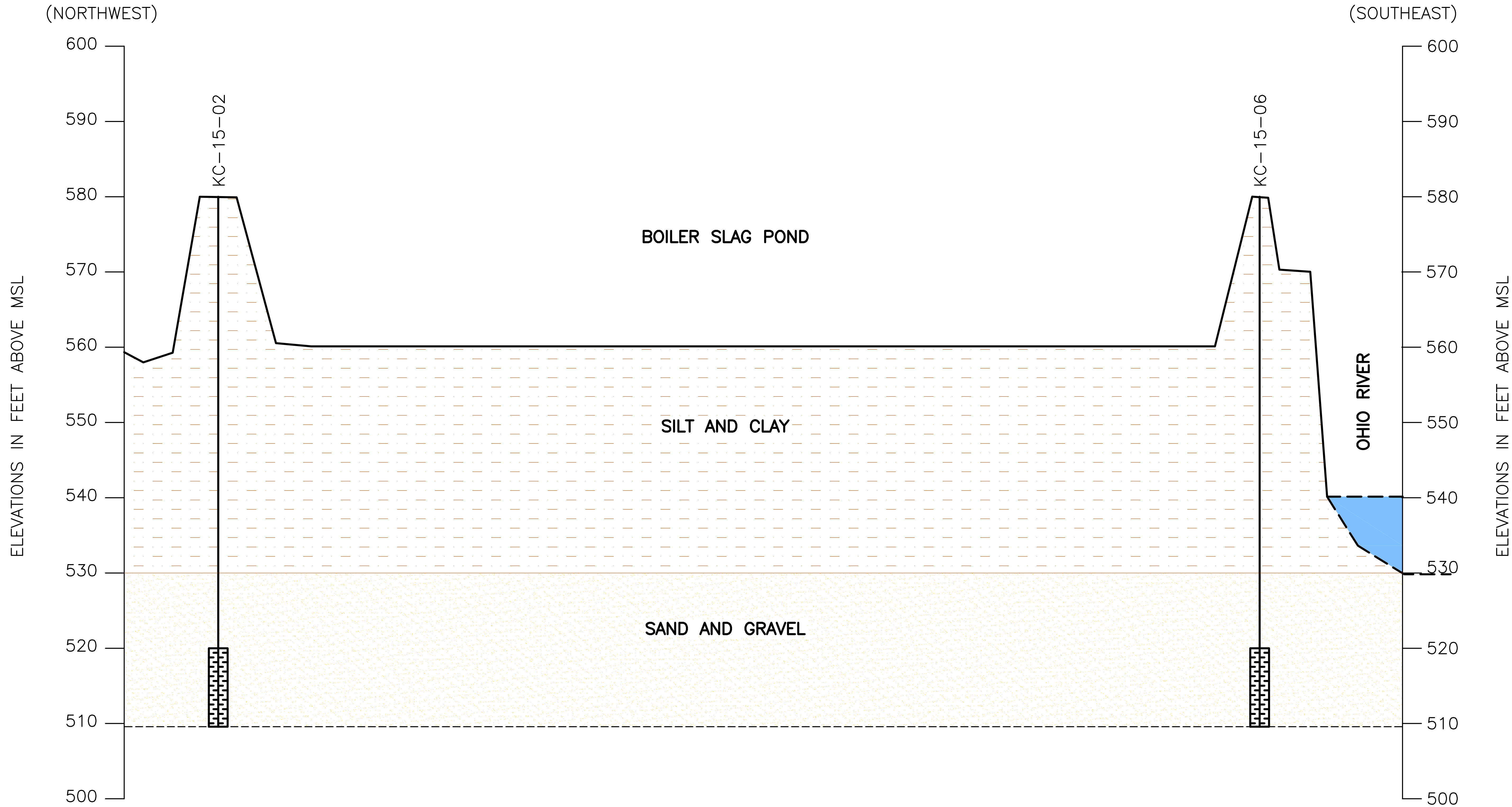
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
SITE LOCATION MAP

DRAWING NAME: FIGURE 2-1

REV. 0

Plot: 08/13/2019 11:03 _PROGRAMS-KYGER OVEC\Kyger Creek-CCR Program\CAD\2019 Assessment of Corrective Measures\2019 ACM_KYGER_Fig 2-1_Aerial Site.dwg



NOTE:
THE APPROXIMATE LOCATION OF THE CROSS-SECTION
IS ILLUSTRATED ON FIGURE 4-1.

DRAWN BY	JM
DATE	
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JOB NO.	2019109-1-KYGER
DWG FILE	2019 ACM_KYGER_Fig 3-1_BSP_Cross Sec.dwg
DRAWING SCALE	NOT TO SCALE

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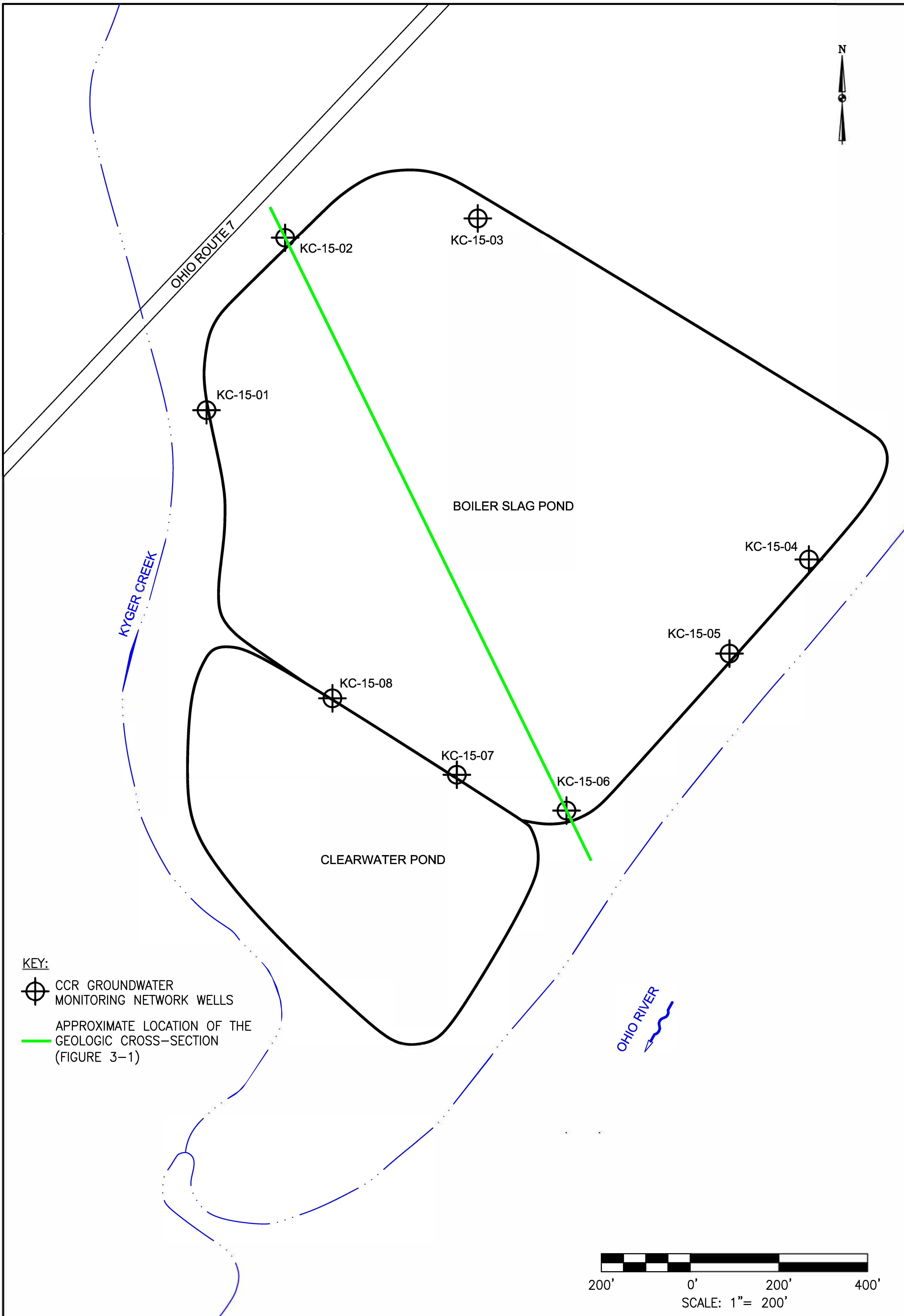
OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GENERALIZED GEOLOGIC CROSS-SECTION
(NORTHWEST – SOUTHEAST)

DRAWING NAME: FIGURE 3-1
REV. 0

Plot: 09/10/2019 10:41 _PROGRAM-KYGER OVEC\Kyger Creek-CCR Program\CAD\2019 Assessment of Corrective Measures\2019 ACM_KYGER_Fig 3-1_BSP_Cross Sec.dwg



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JOB NO.	2019109-1-KYGER
DWG FILE	2019 ACM_KYGER_Fig 4-1_BSP_MW LOCs.dwg
DRAWING SCALE	1"=200'

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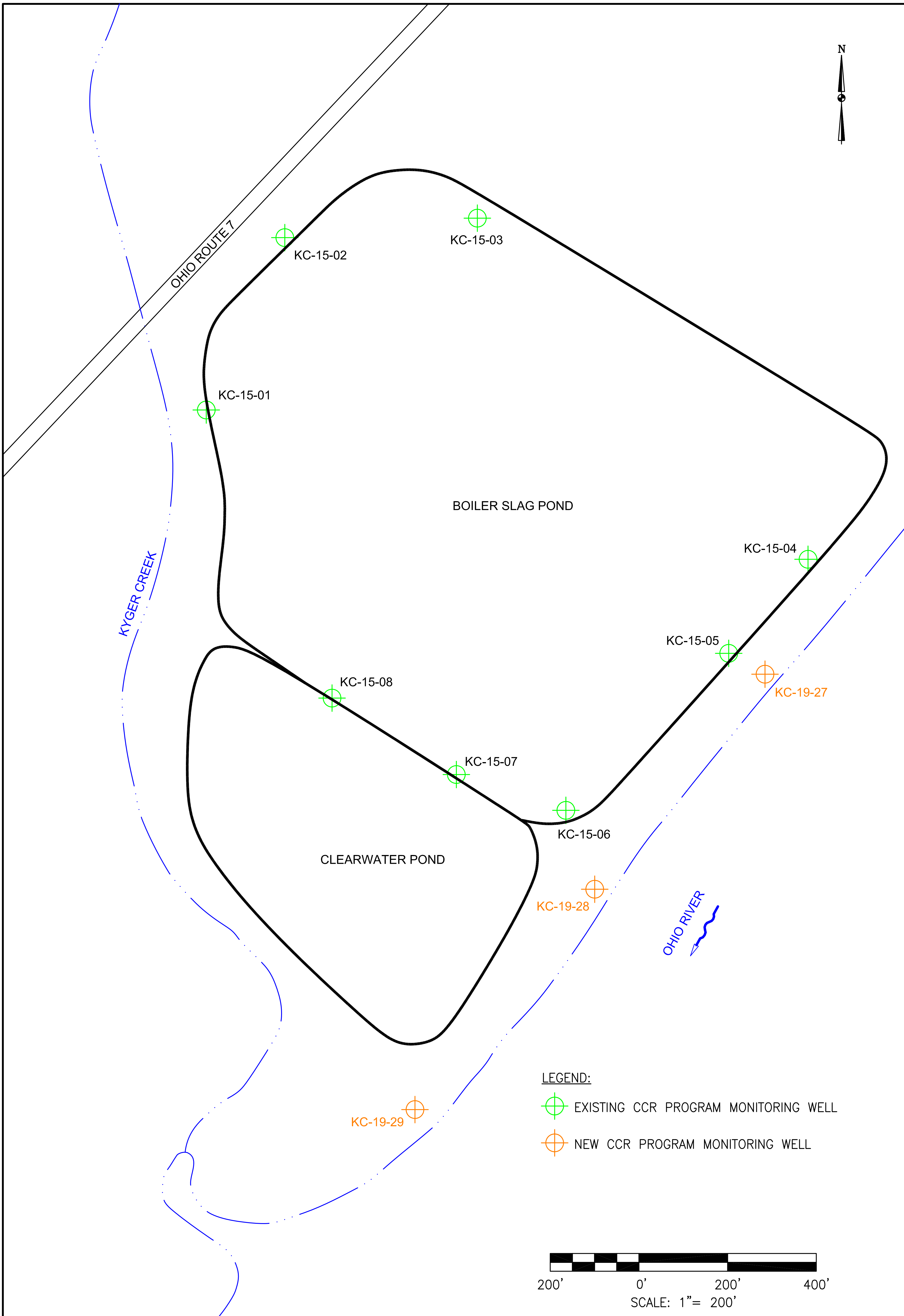
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
EXISTING MONITORING WELL LOCATION MAP

DRAWING NAME: FIGURE 4-1
REV.: 0

Plot: 12/25/2020 13:25 _PROGRAM-KYGER OVEC\Kyger Creek-CCR Program\CAD\2019 Assessment of Corrective Measures\2019 ACM_KYGER_Fig 4-1_BSP_MW LOCs.dwg



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CHECKED BY	
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DWG FILE	2019 ACM_KYGER_Fig 5-1_BSP_MWs&SBs.dwg
DRAWING SCALE	1"=200'

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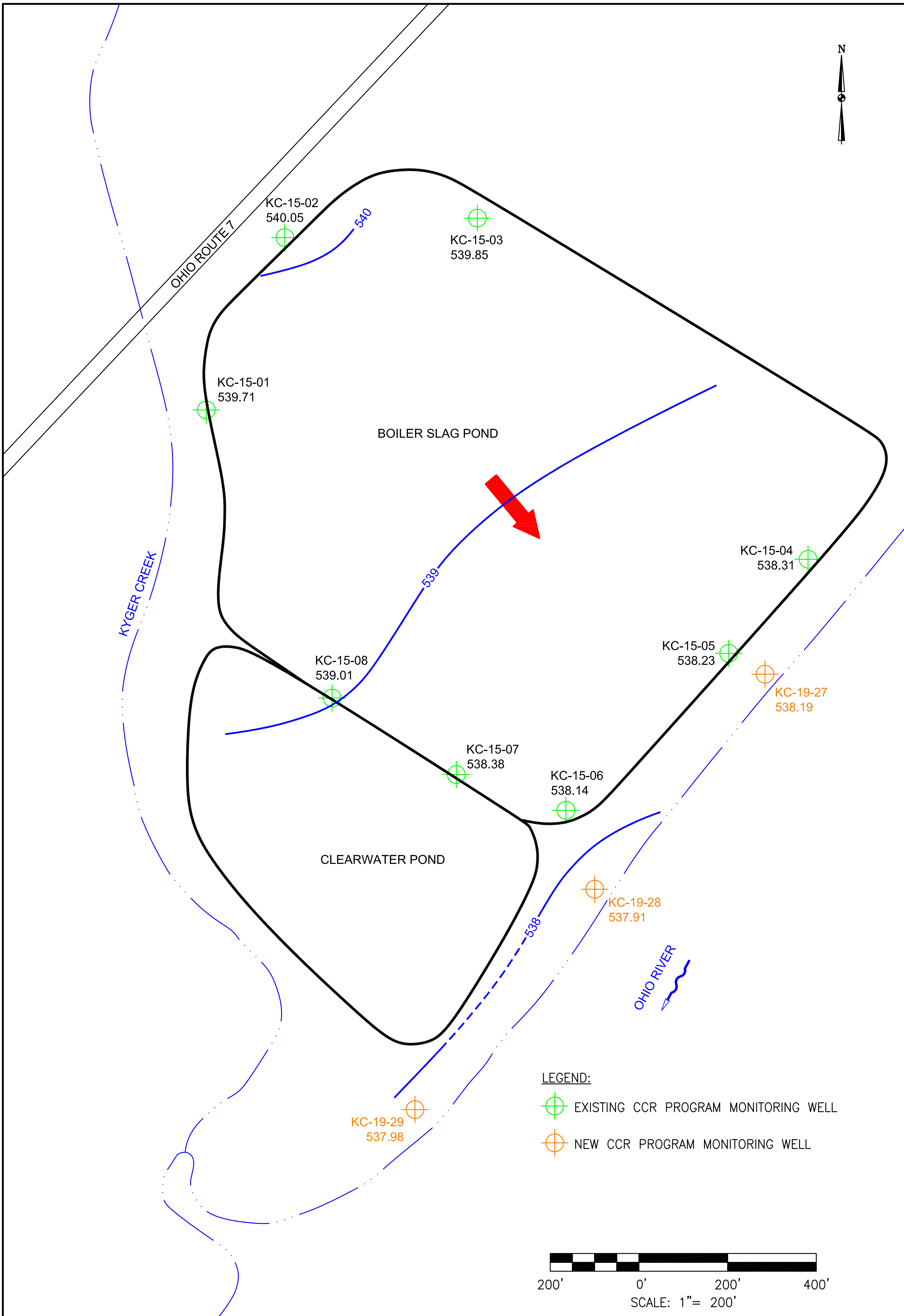
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
EXISTING AND NEW MONITORING WELL LOCATIONS

DRAWING NAME: FIGURE 5-1
REV. 0

Plot: 11/25/2020 13:28 _PROGRAM-KYGER OVEC\Kyger Creek-CCR Program\CAD\2019 Assessment of Corrective Measures\2019 ACM_KYGER_Fig 5-1_BSP_MWs&SBs.dwg



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DRAWING SCALE	1"=200'

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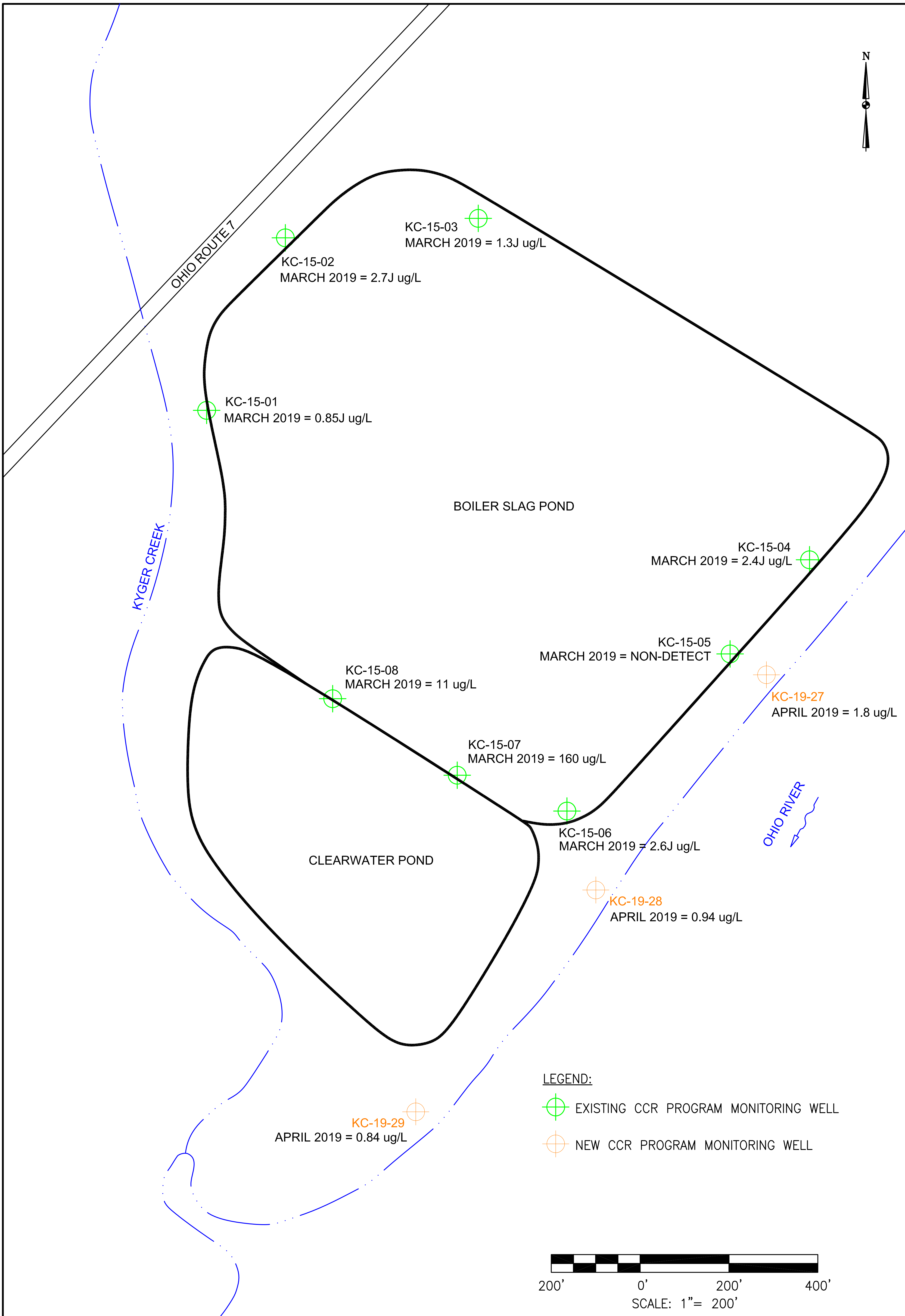
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER ELEVATIONS AND FLOW MAP
JUNE 2019

DRAWING NAME: FIGURE 5-2

REV. 0

Plot: 11/25/2020 12:53 \Kyger Creek-CCR Program\CAD\2019 Assessment of Corrective Measures\2019 ACM_KYGER_Fig 5-2_BSP_GW Contours_JUN19.dwg



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DATE	
CHECKED BY	
JOB NO.	2019109-1-KYGER
DWG FILE	2019 ACM_KYGER_Fig 5-3_BSP_Arsenic.dwg
DRAWING SCALE	1"=200'

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OHIO VALLEY ELECTRIC COMPANY

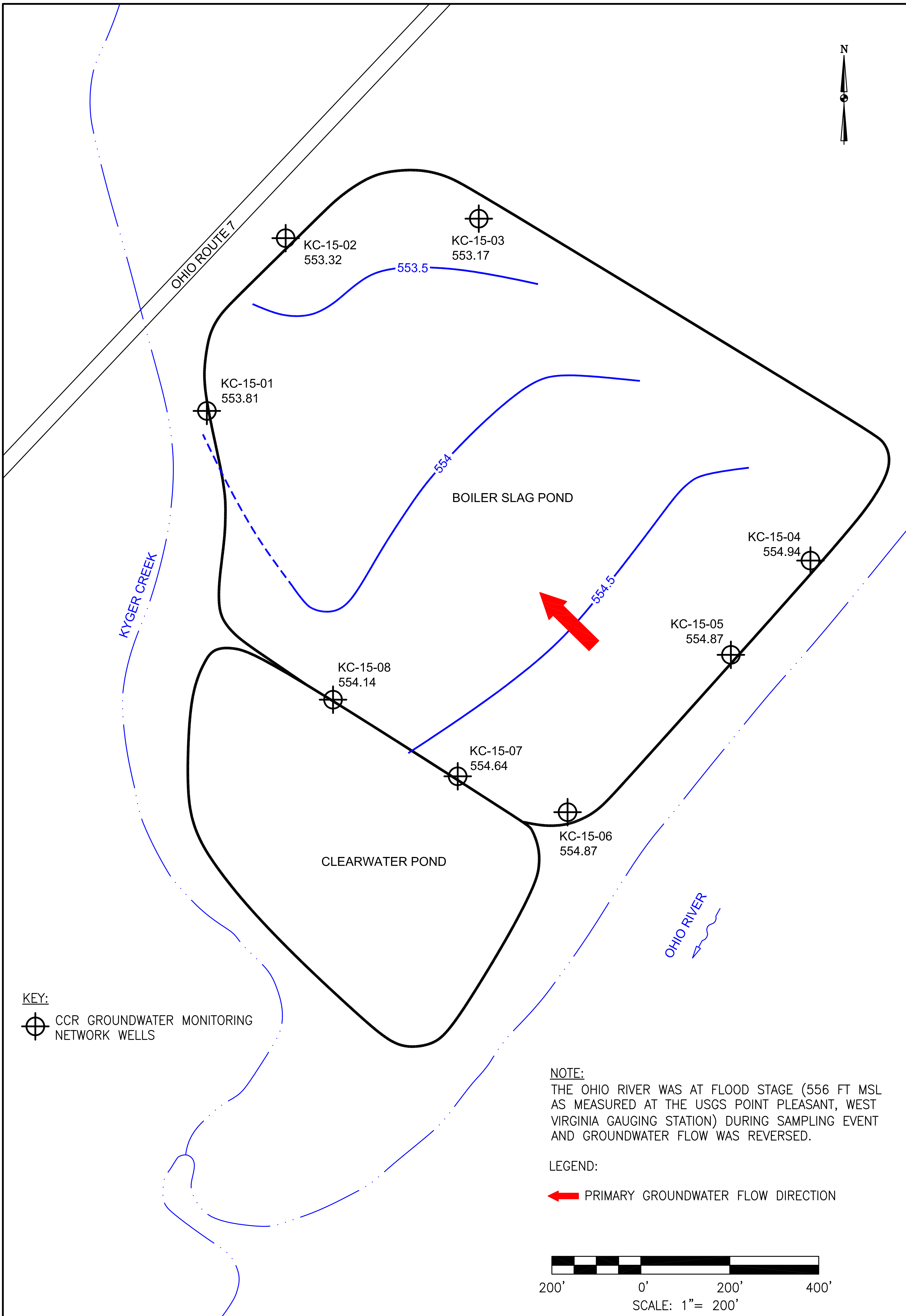
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
ARSENIC IN GROUNDWATER RESULTS
MARCH 2019 AND APRIL 2019

DRAWING NAME: FIGURE 5-3
REV. 0

Plot: 09/10/2019 11:02 _PROGRAMS-KYGER OVEC\Kyger Creek-CCR Program\CAD\2019 Assessment of Corrective Measures\2019 ACM_KYGER_Fig 5-3_BSP_Arsenic.dwg

APPENDIX A

GROUNDWATER FLOW MAPS FOR 2018



KEY:

CCR GROUNDWATER MONITORING NETWORK WELLS

NOTE:
THE OHIO RIVER WAS AT FLOOD STAGE (556 FT MSL AS MEASURED AT THE USGS POINT PLEASANT, WEST VIRGINIA GAUGING STATION) DURING SAMPLING EVENT AND GROUNDWATER FLOW WAS REVERSED.

LEGEND:

PRIMARY GROUNDWATER FLOW DIRECTION

DRAWN BY	JM
DATE	
CHECKED BY	
JOB NO.	2019109-1-KYGER
DWG FILE	2019 ACM_KYGER_Fig A-1_BSP_Contours_FEB-18.dwg
DRAWING SCALE	1"=200'

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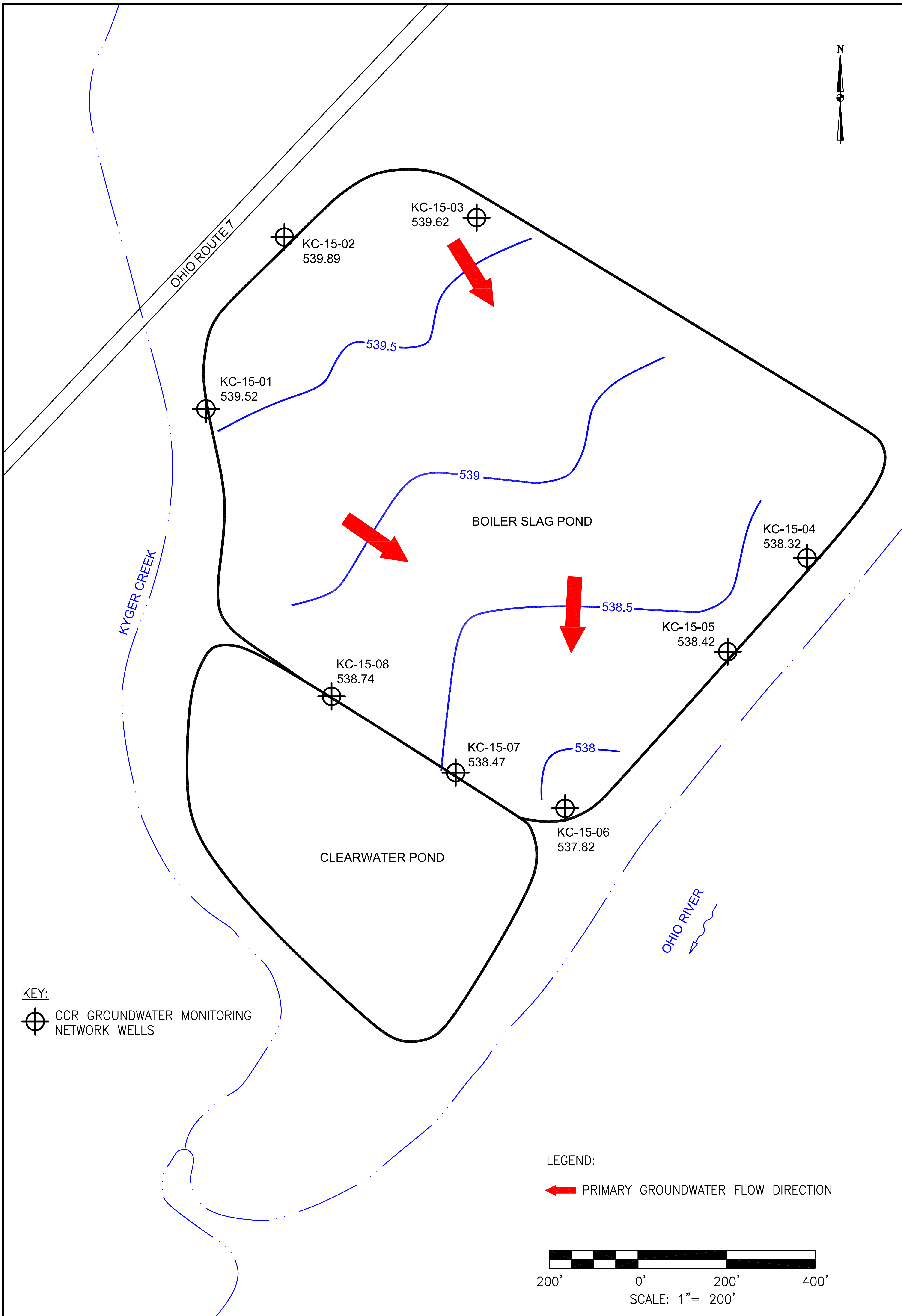
OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER CONTOUR MAP – FEBRUARY 2018

DRAWING NAME	REV.
FIGURE A-1	0



DRAWN BY	JM
DATE	
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JOB NO.	2019109-1-KYGER
DWG FILE	2019 ACM_KYGER_Fig A-2_BSP_Contours_SEPT-18.dwg
DRAWING SCALE	1"=200'

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OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER CONTOUR MAP – SEPTEMBER 2018

DRAWING NAME: FIGURE A-2 | REV. 0

Plot: 08/13/2019 12:18 _PROGRAM-KYGER OVEC\Kyger Creek-CCR Program\CAD\2019 Assessment of Corrective Measures\Appx A\2019 ACM_KYGER_Fig A-2_BSP_Contours_SEPT-18.dwg

APPENDIX B

ANALYTICAL RESULTS FOR 2018 GROUNDWATER MONITORING

KC-15-01
SUMMARY OF ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	GWPS	Detection Monitoring	Assessment Monitoring
			Mar-18	Sep-18
Appendix III Constituents				
Boron, B	mg/L	--	0.35	0.416
Calcium, Ca	mg/L	--	85	77.6
Chloride, Cl	mg/L	--	30.2	24.9
Fluoride, F	mg/L	--	0.04 J	0.04 J
pH	s.u.	--	9.09	5.64
Sulfate, SO4	mg/L	--	239	257
Total Dissolved Solids (TDS)	mg/L	--	460	453
Appendix IV Constituents				
Antimony, Sb	ug/L	6	NA	0.07
Arsenic, As	ug/L	10	NA	0.33
Barium, Ba	ug/L	2000	NA	23.4
Beryllium, Be	ug/L	4	NA	0.067
Cadmium, Cd	ug/L	5	NA	0.02
Chromium, Cr	ug/L	100	NA	0.171
Cobalt, Co	ug/L	9.745	NA	4.3
Fluoride, F	mg/L	4	NA	0.04 J
Lithium, Li	mg/L	0.04	NA	0.018
Lead, Pb	ug/L	15	NA	0.06
Mercury, Hg	ug/L	2	NA	0.005
Molybdenum, Mo	ug/L	100	NA	0.29
Radium 226 & 228 (combined)	pCi/L	5	NA	2.0065
Selenium, Se	ug/L	50	NA	0.1
Thallium, Tl	ug/L	2	NA	0.03 J

Notes:
Yellow highlight indicates compound exceeds
NA = Sample not analyzed for the parameter
-- = not applicable

KC-15-02
SUMMARY OF ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	GWPS	Detection Monitoring	Assessment Monitoring
			Mar-18	Sep-18
Appendix III Constituents				
Boron, B	mg/L	--	0.03	0.128
Calcium, Ca	mg/L	--	112	101
Chloride, Cl	mg/L	--	34.1	36.4
Fluoride, F	mg/L	--	0.1 J	0.1 J
pH	s.u.	--	12.44	6.42
Sulfate, SO4	mg/L	--	109	105
Total Dissolved Solids (TDS)	mg/L	--	478	452
Appendix IV Constituents				
Antimony, Sb	ug/L	6	NA	0.03 J
Arsenic, As	ug/L	10	NA	2.39
Barium, Ba	ug/L	2000	NA	85.7
Beryllium, Be	ug/L	4	NA	0.009 J
Cadmium, Cd	ug/L	5	NA	0.14
Chromium, Cr	ug/L	100	NA	0.391
Cobalt, Co	ug/L	9.745	NA	2.26
Fluoride, F	mg/L	4	NA	0.1 J
Lithium, Li	mg/L	0.04	NA	0.0007 J
Lead, Pb	ug/L	15	NA	0.189
Mercury, Hg	ug/L	2	NA	0.003 J
Molybdenum, Mo	ug/L	100	NA	1.25
Radium 226 & 228 (combined)	pCi/L	5	NA	0.976
Selenium, Se	ug/L	50	NA	0.08 J
Thallium, Tl	ug/L	2	NA	0.02 J

Notes:
Yellow highlight indicates compound exceeds
NA = Sample not analyzed for the parameter
-- = not applicable

KC-15-03
SUMMARY OF ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	GWPS	Detection Monitoring	Assessment Monitoring
			Mar-18	Sep-18
Appendix III Constituents				
Boron, B	mg/L	--	0.096	0.131
Calcium, Ca	mg/L	--	109	105
Chloride, Cl	mg/L	--	28.1	29.1
Fluoride, F	mg/L	--	0.08	0.1 J
pH	s.u.	--	11	6.31
Sulfate, SO4	mg/L	--	192	181
Total Dissolved Solids (TDS)	mg/L	--	490	472
Appendix IV Constituents				
Antimony, Sb	ug/L	6	NA	0.02 J
Arsenic, As	ug/L	10	NA	1.44
Barium, Ba	ug/L	2000	NA	66.5
Beryllium, Be	ug/L	4	NA	0.02 U
Cadmium, Cd	ug/L	5	NA	0.06
Chromium, Cr	ug/L	100	NA	0.103
Cobalt, Co	ug/L	9.745	NA	7.58
Fluoride, F	mg/L	4	NA	0.1 J
Lithium, Li	mg/L	0.04	NA	0.032
Lead, Pb	ug/L	15	NA	0.02 J
Mercury, Hg	ug/L	2	NA	0.003 J
Molybdenum, Mo	ug/L	100	NA	0.89
Radium 226 & 228 (combined)	pCi/L	5	NA	0.285
Selenium, Se	ug/L	50	NA	0.1 U
Thallium, Tl	ug/L	2	NA	0.05 U

Notes:
Yellow highlight indicates compound exceeds
NA = Sample not analyzed for the parameter
-- = not applicable

KC-15-04
SUMMARY OF ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	GWPS	Detection Monitoring		Assessment Monitoring	
			Mar-18	May-18	Sep-18	Dec-18
Appendix III Constituents						
Boron, B	mg/L	--	0.717	1.01	0.924	0.781
Calcium, Ca	mg/L	--	105	NA	109	NA
Chloride, Cl	mg/L	--	24.6	NA	28.3	NA
Fluoride, F	mg/L	--	0.06	NA	0.09	NA
pH	s.u.	--	10.2	6.49	6.34	NA
Sulfate, SO4	mg/L	--	344	369	358	300
Total Dissolved Solids (TDS)	mg/L	--	600	660	600	585
Appendix IV Constituents						
Antimony, Sb	ug/L	6	NA	NA	0.17	NA
Arsenic, As	ug/L	10	NA	NA	1.66	NA
Barium, Ba	ug/L	2000	NA	NA	58.3	NA
Beryllium, Be	ug/L	4	NA	NA	0.01 J	NA
Cadmium, Cd	ug/L	5	NA	NA	0.03	NA
Chromium, Cr	ug/L	100	NA	NA	0.161	NA
Cobalt, Co	ug/L	9.745	NA	NA	8.83	NA
Fluoride, F	mg/L	4	NA	NA	0.09	NA
Lithium, Li	mg/L	0.04	NA	NA	0.014	NA
Lead, Pb	ug/L	15	NA	NA	0.081	NA
Mercury, Hg	ug/L	2	NA	NA	0.003 J	NA
Molybdenum, Mo	ug/L	100	NA	NA	0.52	NA
Radium 226 & 228 (combined)	pCi/L	5	NA	NA	0.403	NA
Selenium, Se	ug/L	50	NA	NA	0.1	NA
Thallium, Tl	ug/L	2	NA	NA	0.02 J	NA

Notes:
Yellow highlight indicates compound exceeds
NA = Sample not analyzed for the parameter
-- = not applicable

KC-15-05
SUMMARY OF ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	GWPS	Detection Monitoring		Assessment Monitoring	
			Mar-18	May-18	Sep-18	Dec-18
Appendix III Constituents						
Boron, B	mg/L	--	0.889	0.815	0.762	NA
Calcium, Ca	mg/L	--	136	109	129	129
Chloride, Cl	mg/L	--	27.9	NA	28.9	NA
Fluoride, F	mg/L	--	0.09	NA	0.13	NA
pH	s.u.	--	9.01	6.57	6.35	NA
Sulfate, SO4	mg/L	--	363	318	346	333
Total Dissolved Solids (TDS)	mg/L	--	691	652	664	689
Appendix IV Constituents						
Antimony, Sb	ug/L	6	NA	NA	0.02 J	NA
Arsenic, As	ug/L	10	NA	NA	0.88	NA
Barium, Ba	ug/L	2000	NA	NA	35.4	NA
Beryllium, Be	ug/L	4	NA	NA	0.005 J	NA
Cadmium, Cd	ug/L	5	NA	NA	0.07	NA
Chromium, Cr	ug/L	100	NA	NA	0.21	NA
Cobalt, Co	ug/L	9.745	NA	NA	5.27	NA
Fluoride, F	mg/L	4	NA	NA	0.13	NA
Lithium, Li	mg/L	0.04	NA	NA	0.027	NA
Lead, Pb	ug/L	15	NA	NA	0.07	NA
Mercury, Hg	ug/L	2	NA	NA	0.004 J	NA
Molybdenum, Mo	ug/L	100	NA	NA	0.57	NA
Radium 226 & 228 (combined)	pCi/L	5	NA	NA	3.086	NA
Selenium, Se	ug/L	50	NA	NA	0.1	NA
Thallium, Tl	ug/L	2	NA	NA	0.04 J	NA

Notes:
Yellow highlight indicates compound exceeds
NA = Sample not analyzed for the parameter
-- = not applicable

KC-15-06
SUMMARY OF ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	GWPS	Detection Monitoring	Assessment Monitoring
			Mar-18	Sep-18
Appendix III Constituents				
Boron, B	mg/L	--	0.275	0.306
Calcium, Ca	mg/L	--	108	94.8
Chloride, Cl	mg/L	--	38	36.1
Fluoride, F	mg/L	--	0.09 J	0.1 J
pH	s.u.	--	9.33	6.52
Sulfate, SO4	mg/L	--	177	144
Total Dissolved Solids (TDS)	mg/L	--	502	465
Appendix IV Constituents				
Antimony, Sb	ug/L	6	NA	0.01 J
Arsenic, As	ug/L	10	NA	1.58
Barium, Ba	ug/L	2000	NA	110
Beryllium, Be	ug/L	4	NA	0.02 U
Cadmium, Cd	ug/L	5	NA	0.13
Chromium, Cr	ug/L	100	NA	0.238
Cobalt, Co	ug/L	9.745	NA	2.76
Fluoride, F	mg/L	4	NA	0.1 J
Lithium, Li	mg/L	0.04	NA	0.001
Lead, Pb	ug/L	15	NA	0.044
Mercury, Hg	ug/L	2	NA	0.002 J
Molybdenum, Mo	ug/L	100	NA	0.37
Radium 226 & 228 (combined)	pCi/L	5	NA	0.916
Selenium, Se	ug/L	50	NA	0.06 J
Thallium, Tl	ug/L	2	NA	0.02 J

Notes:
Yellow highlight indicates compound exceeds
NA = Sample not analyzed for the parameter
-- = not applicable

KC-15-07
SUMMARY OF ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	GWPS	Detection Monitoring		Assessment Monitoring	
			Mar-18	May-18	Sep-18	Dec-18
Appendix III Constituents						
Boron, B	mg/L	--	0.256	NA	0.078	NA
Calcium, Ca	mg/L	--	123	78.8	69.3	NA
Chloride, Cl	mg/L	--	39.8	NA	30.9	NA
Fluoride, F	mg/L	--	0.08 J	NA	0.07 J	NA
pH	s.u.	--	8.45	6.02	6.27	NA
Sulfate, SO4	mg/L	--	191	NA	46.1	NA
Total Dissolved Solids (TDS)	mg/L	--	544	NA	367	NA
Appendix IV Constituents						
Antimony, Sb	ug/L	6	NA	NA	0.01 J	NA
Arsenic, As	ug/L	10	NA	NA	152	15.3
Barium, Ba	ug/L	2000	NA	NA	510	NA
Beryllium, Be	ug/L	4	NA	NA	0.006 J	NA
Cadmium, Cd	ug/L	5	NA	NA	0.01 J	NA
Chromium, Cr	ug/L	100	NA	NA	0.189	NA
Cobalt, Co	ug/L	9.745	NA	NA	0.132	NA
Fluoride, F	mg/L	4	NA	NA	0.07 J	NA
Lithium, Li	mg/L	0.04	NA	NA	0.004	NA
Lead, Pb	ug/L	15	NA	NA	0.01 J	NA
Mercury, Hg	ug/L	2	NA	NA	0.004 J	NA
Molybdenum, Mo	ug/L	100	NA	NA	0.75	NA
Radium 226 & 228 (combined)	pCi/L	5	NA	NA	1.62	NA
Selenium, Se	ug/L	50	NA	NA	0.09 J	NA
Thallium, Tl	ug/L	2	NA	NA	0.01 J	NA

Notes:
Yellow highlight indicates compound exceeds
NA = Sample not analyzed for the parameter
-- = not applicable

KC-15-08
SUMMARY OF ANALYTICAL RESULTS
Ohio Valley Electric Corporation
Kyger Creek Station
Gallia County, Ohio

Parameter	Units	GWPS	Detection Monitoring		Assessment Monitoring	
			Mar-18	May-18	Sep-18	Dec-18
Appendix III Constituents						
Boron, B	mg/L	--	0.58	0.495	0.332	NA
Calcium, Ca	mg/L	--	245	187	153	105
Chloride, Cl	mg/L	--	42.9	NA	39.7	NA
Fluoride, F	mg/L	--	0.08	NA	0.12	NA
pH	s.u.	--	8.45	6.25	6.85	NA
Sulfate, SO4	mg/L	--	599	510	375	150
Total Dissolved Solids (TDS)	mg/L	--	1130	1070	842	510
Appendix IV Constituents						
Antimony, Sb	ug/L	6	NA	NA	0.02 J	NA
Arsenic, As	ug/L	10	NA	NA	3.86	NA
Barium, Ba	ug/L	2000	NA	NA	50.2	NA
Beryllium, Be	ug/L	4	NA	NA	0.02 U	NA
Cadmium, Cd	ug/L	5	NA	NA	0.02	NA
Chromium, Cr	ug/L	100	NA	NA	0.479	NA
Cobalt, Co	ug/L	9.745	NA	NA	5.99	NA
Fluoride, F	mg/L	4	NA	NA	0.12	NA
Lithium, Li	mg/L	0.04	NA	NA	0.024	NA
Lead, Pb	ug/L	15	NA	NA	0.02 J	NA
Mercury, Hg	ug/L	2	NA	NA	0.003 J	NA
Molybdenum, Mo	ug/L	100	NA	NA	0.56	NA
Radium 226 & 228 (combined)	pCi/L	5	NA	NA	0.582	NA
Selenium, Se	ug/L	50	NA	NA	0.04 J	NA
Thallium, Tl	ug/L	2	NA	NA	0.01 J	NA

Notes:
Yellow highlight indicates compound exceeds
NA = Sample not analyzed for the parameter
-- = not applicable

APPENDIX C

GRAIN SIZE ANALYSIS LAB REPORTS

Stantec

Summary of Soil Tests

Project Name	Kyger Creek CCR Rule - Groundwater	Project Number	175534017
Source	KC-19-27-28-38	Lab ID	7
Sample Type	BULK	Date Received	4-9-19
		Date Reported	4-15-19

Test Results

Natural Moisture Content
Test Method: ASTM D 2216
Moisture Content (%): 27.6

Particle Size Analysis
Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
No. 4	4.75	100.0
No. 10	2	99.9
No. 40	0.425	99.1
No. 200	0.075	28.3
	0.02	15.9
	0.005	9.8
	0.002	7.2
estimated	0.001	5.9

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	0.1
Coarse Sand	0.1	0.8
Medium Sand	0.8	---
Fine Sand	70.8	70.8
Silt	18.5	21.1
Clay	9.8	7.2

Atterberg Limits
Test Method: ASTM D 4318 Method A
Prepared: Dry

Liquid Limit: NP
Plastic Limit: NP
Plasticity Index: NP
Activity Index: N/A

Moisture-Density Relationship
Test Not Performed

Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio
Test Not Performed

Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity
Estimated

Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.70

Classification
Unified Group Symbol: SM
Group Name: Silty sand

AASHTO Classification: A-2-4 (0)

Comments:

Reviewed By JS

Template: tmp_sum_input.xlsm
Version: 20170217
Approved By: RJ

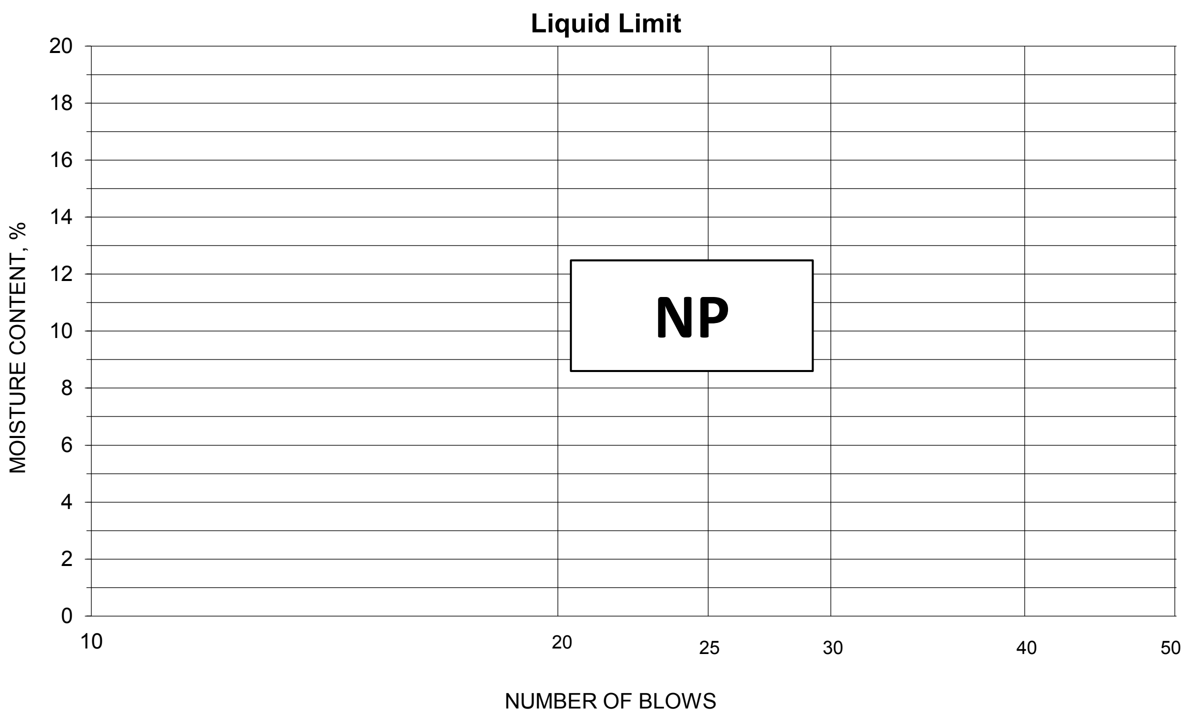
Stantec Consulting Services Inc.

Stantec

ATTERBERG LIMITS

Project	Kyger Creek CCR Rule - Groundwater	Project No.	175534017
Source	KC-19-27-28-38	Lab ID	7
		% + No. 40	1
Tested By	MP	Test Method	ASTM D 4318 Method A
Date Received	04-09-2019		
Test Date	04-11-2019	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index

Remarks: ______

Reviewed By JS

Particle-Size Analysis of Soils
ASTM D 422

Project Name	Kyger Creek CCR Rule - Groundwater	Project Number	175534017
Source	KC-19-27-28-38	Lab ID	7

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: GW
Test Date: 04-10-2019
Date Received: 04-09-2019

Maximum Particle size: No. 4 Sieve

Sieve Size	% Passing
No. 4	100.0
No. 10	99.9

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.7

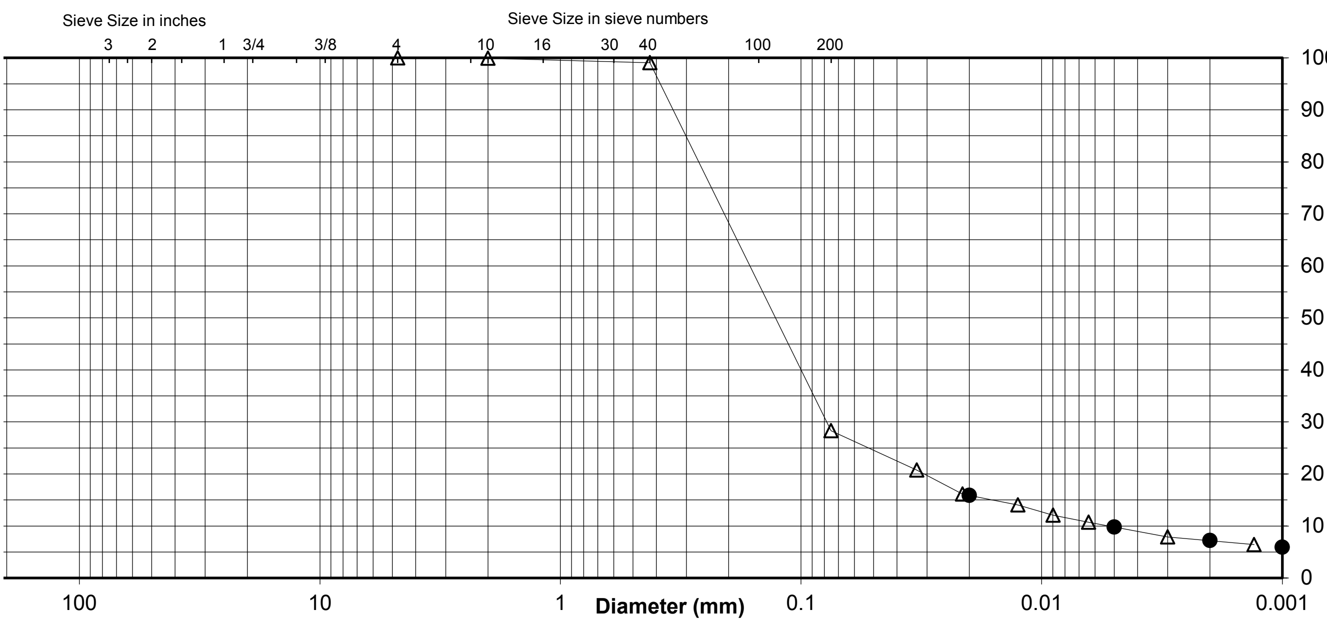
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	99.1
No. 200	28.3
0.02 mm	15.9
0.005 mm	9.8
0.002 mm	7.2
0.001 mm	5.9

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.0	0.1	0.8	70.8	18.5	9.8

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	0.1	0.8	70.8	21.1	7.2



Comments ____________________

Reviewed By JS

Template: tmp_sum_input.xlsm
Version: 20170217
Approved By: RJ

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Summary of Soil Tests

Project Name: Kyger Creek CCR Rule - Groundwater
Project Number: 175534017
Source: KC-19-28-30-40
Lab ID: 8

Sample Type: BULK
Date Received: 4-9-19
Date Reported: 4-15-19

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
Moisture Content (%): 20.5

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
3/8"	9.5	100.0
No. 4	4.75	99.8
No. 10	2	99.5
No. 40	0.425	95.9
No. 200	0.075	13.4
	0.02	7.4
	0.005	4.5
	0.002	3.2
estimated	0.001	2.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.2	0.5
Coarse Sand	0.3	3.6
Medium Sand	3.6	---
Fine Sand	82.5	82.5
Silt	8.9	10.2
Clay	4.5	3.2

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry

Liquid Limit: NP
Plastic Limit: NP
Plasticity Index: NP
Activity Index: N/A

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.70

Classification

Unified Group Symbol: SM
Group Name: Silty sand

AASHTO Classification: A-2-4 (0)

Comments:

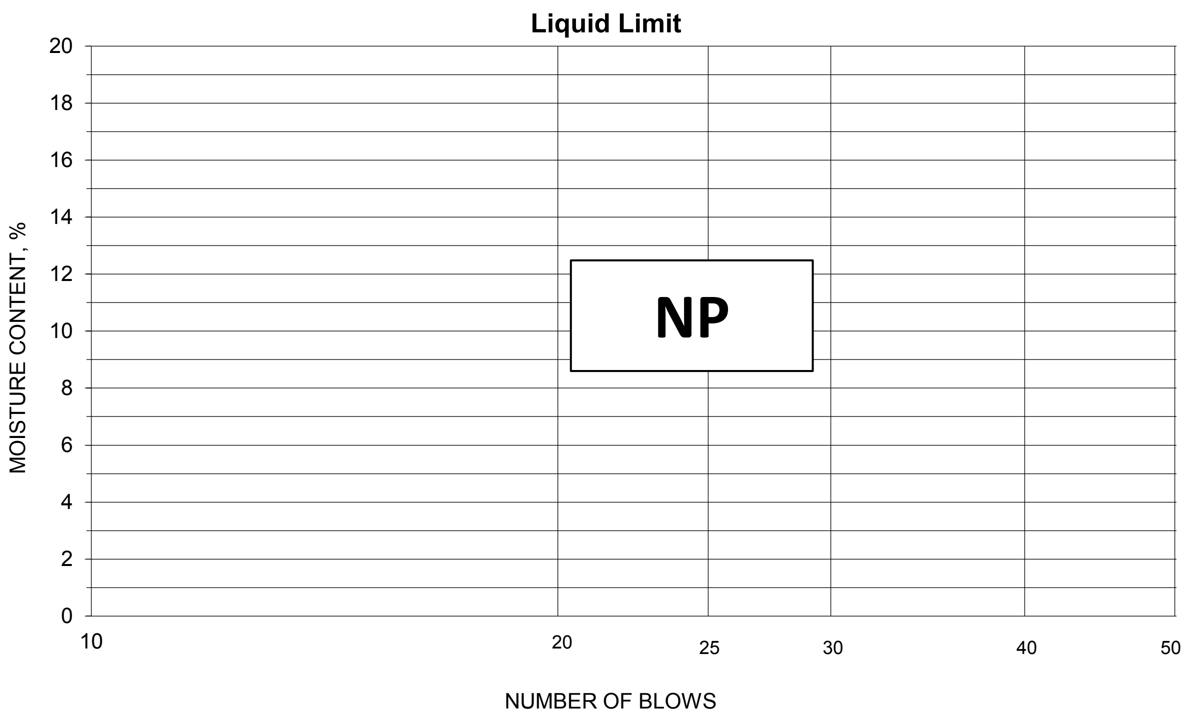
Reviewed By JS

Stantec

ATTERBERG LIMITS

Project	Kyger Creek CCR Rule - Groundwater	Project No.	175534017
Source	KC-19-28-30-40	Lab ID	8
		% + No. 40	4
Tested By	MP	Test Method	ASTM D 4318 Method A
Date Received	04-09-2019		
Test Date	04-11-2019	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index

Remarks: ______________________

Reviewed By JS

Stantec

Particle-Size Analysis of Soils

ASTM D 422

Project Name: Kyger Creek CCR Rule - Groundwater

Project Number: 175534017

Source: KC-19-28-30-40

Lab ID: 8

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422

Prepared using: ASTM D 421

Particle Shape: Angular

Particle Hardness: Hard and Durable

Tested By: GW

Test Date: 04-10-2019

Date Received: 04-09-2019

Maximum Particle size: 3/8" Sieve

Sieve Size	% Passing
3/8"	100.0
No. 4	99.8
No. 10	99.5

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.7

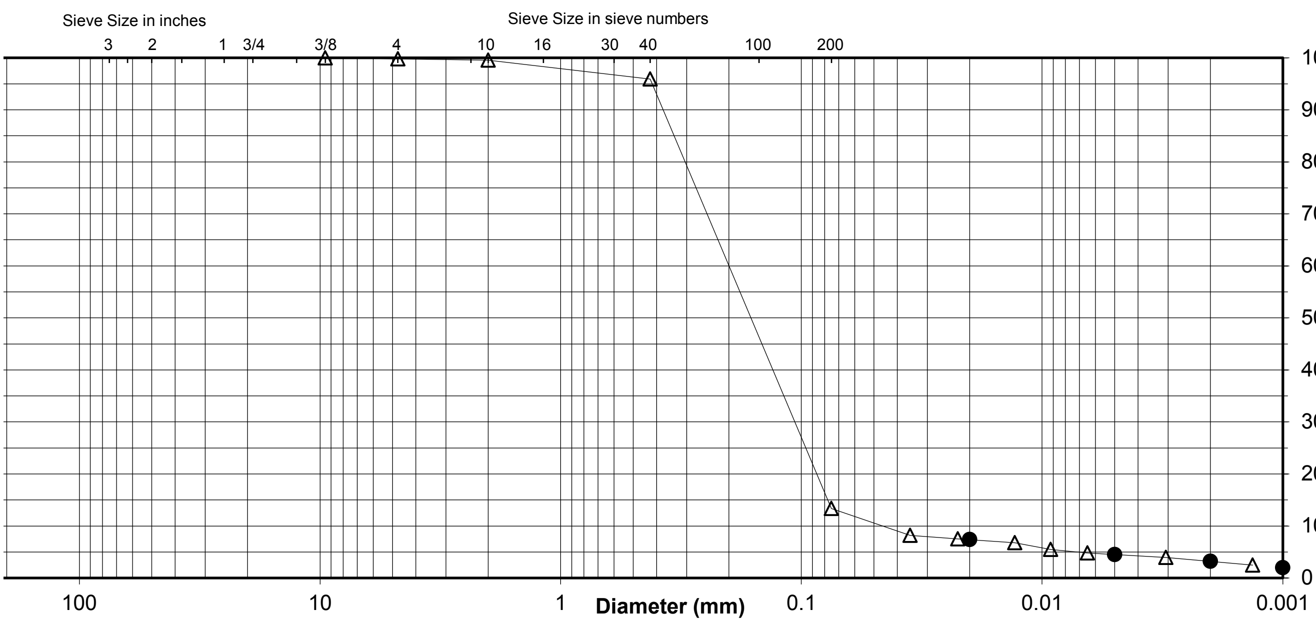
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	95.9
No. 200	13.4
0.02 mm	7.4
0.005 mm	4.5
0.002 mm	3.2
0.001 mm	2.0

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.2	0.3	3.6	82.5	8.9	4.5

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	0.5	3.6	82.5	10.2	3.2



Comments ______

Reviewed By: JS

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Version: 20170217
Approved By: RJ

Stantec

Summary of Soil Tests

Project Name: Kyger Creek CCR Rule - Groundwater
Project Number: 175534017
Source: KC-19-29-32-42
Lab ID: 9

Sample Type: BULK
Date Received: 4-9-19
Date Reported: 4-15-19

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
Moisture Content (%): 21.3

Particle Size Analysis

Preparation Method: ASTM D 421
Gradation Method: ASTM D 422
Hydrometer Method: ASTM D 422

Particle Size: Sieve Size	Particle Size: (mm)	% Passing
	N/A	
	N/A	
	N/A	
	N/A	
	N/A	
3/8"	9.5	100.0
No. 4	4.75	100.0
No. 10	2	99.9
No. 40	0.425	99.2
No. 200	0.075	20.8
	0.02	10.7
	0.005	6.6
	0.002	5.2
estimated	0.001	4.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	0.1
Coarse Sand	0.1	0.7
Medium Sand	0.7	---
Fine Sand	78.4	78.4
Silt	14.2	15.6
Clay	6.6	5.2

Atterberg Limits

Test Method: ASTM D 4318 Method A
Prepared: Dry

Liquid Limit: NP
Plastic Limit: NP
Plasticity Index: NP
Activity Index: N/A

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.70

Classification

Unified Group Symbol: SM
Group Name: Silty sand

AASHTO Classification: A-2-4 (0)

Comments:

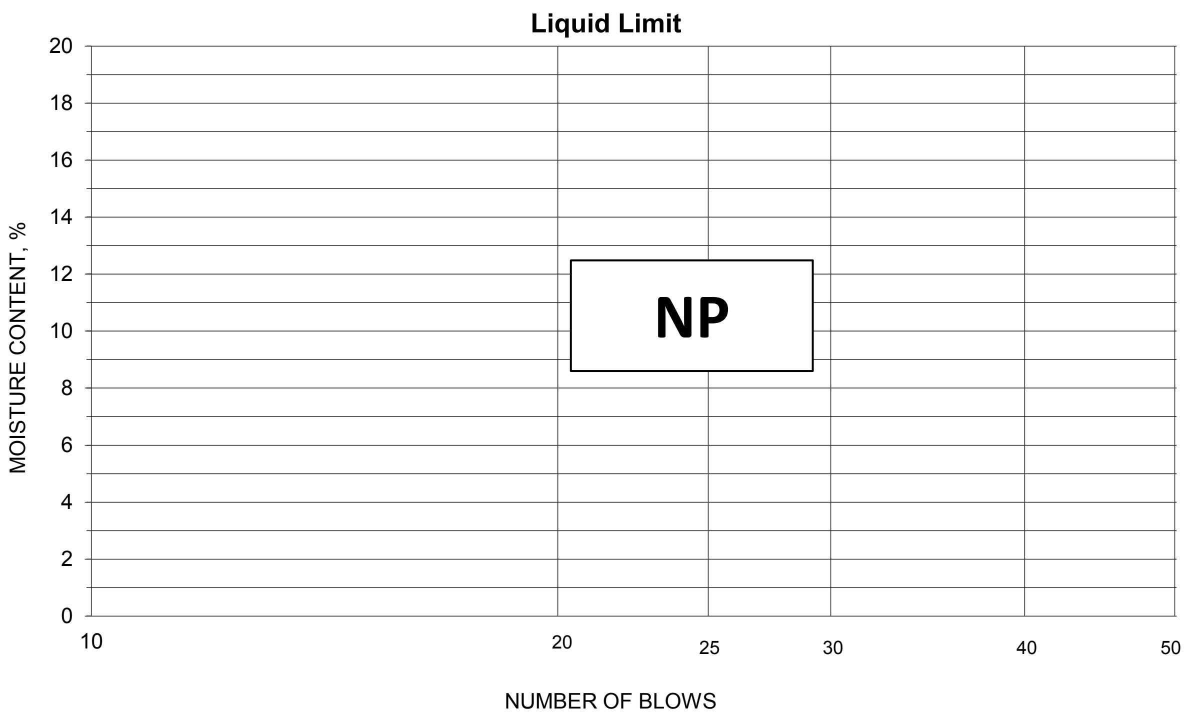
Reviewed By JS

Stantec

ATTERBERG LIMITS

Project	Kyger Creek CCR Rule - Groundwater	Project No.	175534017
Source	KC-19-29-32-42	Lab ID	9
		% + No. 40	1
Tested By	MP	Test Method	ASTM D 4318 Method A
Date Received	04-09-2019		
Test Date	04-11-2019	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index

Remarks: ______________________

Reviewed By JS

Particle-Size Analysis of Soils

ASTM D 422

Project Name	Kyger Creek CCR Rule - Groundwater	Project Number	175534017
Source	KC-19-29-32-42	Lab ID	9

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
Prepared using: ASTM D 421

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: GW
Test Date: 04-10-2019
Date Received: 04-09-2019

Maximum Particle size: 3/8" Sieve

Sieve Size	% Passing
3/8"	100.0
No. 4	100.0
No. 10	99.9

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on -3 inch fraction only

Specific Gravity: 2.7

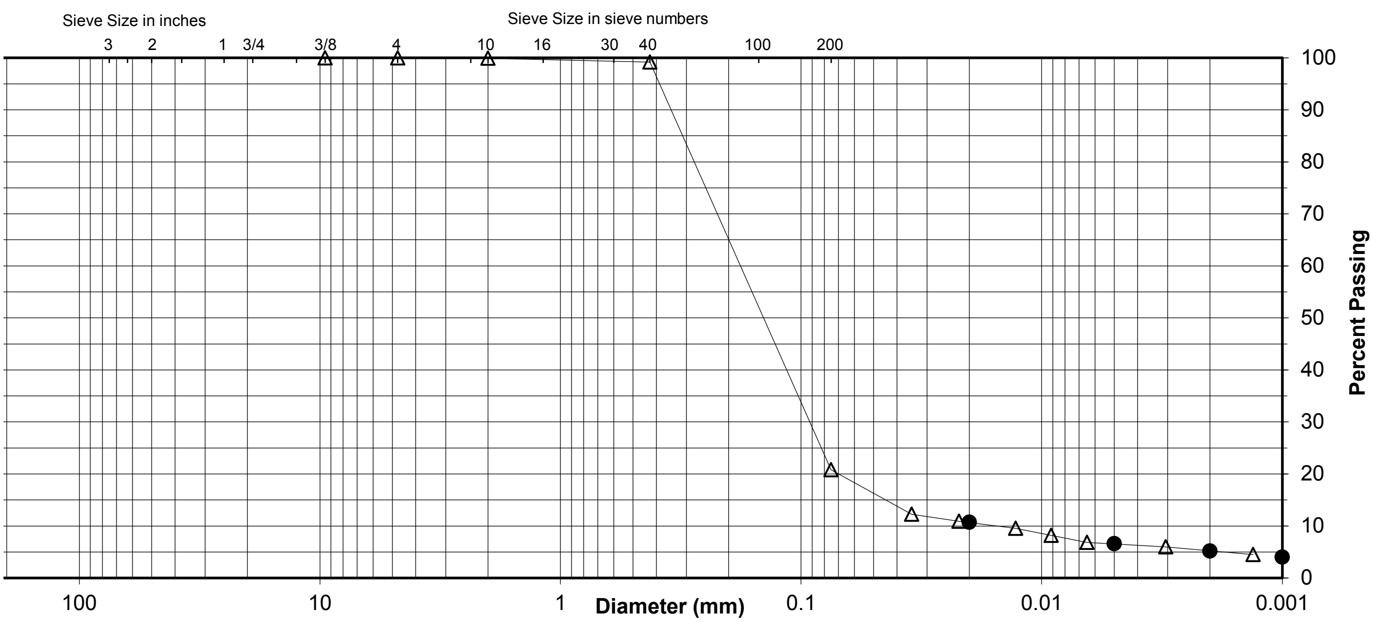
Dispersed using Apparatus A - Mechanical, for 1 minute

No. 40	99.2
No. 200	20.8
0.02 mm	10.7
0.005 mm	6.6
0.002 mm	5.2
0.001 mm	4.0

Particle Size Distribution

	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
ASTM	0.0	0.0	0.1	0.7	78.4	14.2	6.6

	Gravel	Coarse Sand	Fine Sand	Silt	Clay
AASHTO	0.1	0.7	78.4	15.6	5.2



Comments ____________________

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Version: 20170217
Approved By: RJ

APPENDIX D

WELL BORING AND CONSTRUCTION LOGS

Project Number:	2019052	Log Page	1 of 2
Project Location:	Kyger Creek Plant Boiler Slag Pond	Drilling Contractor:	HAD
Drilling Date(s):	4/4/2019 to 4/5/2019	AGES Geologist:	Mike Gelles

Drilling Method:	Hollow Stem Auger	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	38’	Surface Elevation:	558.22’ msl		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-2	1.6	4-5-6-6	Brown silty clay, moist	N/A
2-4	1	Wt/h(2)-3-4	Brown silty clay, moist	N/A
4-6	1.4	2-2-4-6	Brown silty clay, moist	N/A
6-8	1.6	2-3-5-6	Brown silty clay, moist	N/A
8-10	1.6	1-3-4-6	Brown silty clay, moist	N/A
10-12	1.6	2-4-5-7	Brown silty clay, moist	N/A
12-14	1.6	2-5-6-7	Brown silty clay, moist	N/A
14-16	1.6	1-3-5-5	Brown silty clay, plastic, moist	N/A
16-18	2	2-3-4-5	Brown silty clay, plastic, moist	N/A
18-20	2	4-6-4-6	Brown silty clay, plastic, moist	N/A
20-22	1.4	Wt/h(2)-2-3	Brown silty clay, plastic, moist	N/A
22-24	1.4	Wt/h-2-3-3	Brown silty clay, plastic, moist, trace sand	N/A
24-26	2	2-2-3-2	24.0-25.0’ Brown silty clay, plastic, moist; 25.0’-26.0’ Brown sand, fine and medium, wet	N/A
26-28	2	1-1-1-3	Brown sand, fine and medium, wet	N/A
28-30	2	1-1-2-3	Brown sand, fine and medium, wet, loose	N/A
30-32	2	1-2-3-4	Brown sand, fine and medium, wet, loose	N/A
32-34	2	2-2-4-6	Brown sand, fine and medium, wet, loose	N/A

CONTINUED SAMPLE/CORE LOG
BORING NO. KC-19-27

Project No: 2019052 Geologist: Mike Gelles

34-36	2	2-3-3-4	Brown sand, fine and medium, wet, loose, some gray sandy clay	N/A
36-38	2	1-1-4-5	Brown sand, fine and medium, wet, loose, some gray sand, fine and medium	N/A

WELL CONSTRUCTION LOG
WELL NO. KC-19-27

Project Number: 2019052

Project Location: Kyger Creek Plant – Boiler Slag Pond

Installation Date(s): 4/4/2019-4/5/2019

Drilling Method: Hollow Stem Auger
Drilling Contractor: HAD

Development Date(s): 4/8/2019

Development Method: Pump & Surge until Field Parameters stabilized
Turbidity = 4.89 NTUs

Volume Purged: 213 gallons

Static Water-Level*: 22.25'

Top of Well Casing Elevation: 561.13' msl

Well Purpose:
Groundwater Monitoring
Northing (Y): 331507.38
Easting (X): 2073611.935

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

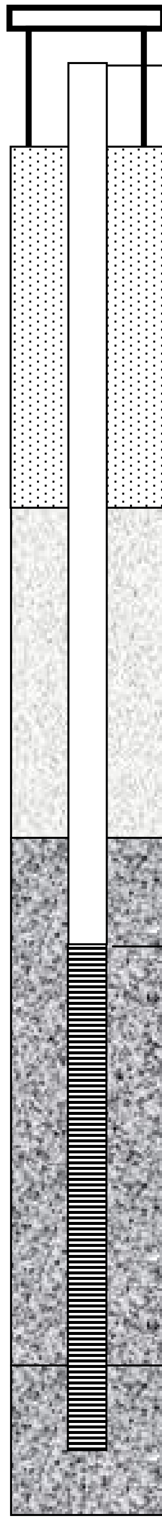
CONSTRUCTION MATERIALS USED:

3 Bags of Sand

1 Bags/Buckets Bentonite Pellets

8 Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 561.13 ft.
Stick-up: 2.91 ft.

Land Surface Elevation: 558.22 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6" inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 24 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 26 ft*

Top of Well Screen 28 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 38 ft.*

Base of Borehole: 38 ft.*

Total Depth of Well Below Top of Casing: 40.91 ft.

*Indicates Depth Below Land Surface

BORING NO. KC-19-28
SAMPLE/CORE LOG

Project Number:	2019052	Log Page	1 of 2
Project Location:	Kyger Creek Boiler Slag Pond	Drilling Contractor:	HAD
Drilling Date(s):	4/4/2019	AGES Geologist:	Mike Gelles

Drilling Method:	Hollow Stem Auger	Coring Device Size:	NA	Hammer Wt.	NA	and Drop	NA
Sampling Method:	NA	Borehole Diameter:	6”	Drilling Fluid Used:	Water		
Sampling Interval:	NA	Borehole Depth:	42’	Surface Elevation:	558.41’ msl		

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-2	1.6	2-3-5-7	Brown silty clay, moist	N/A
2-4	1.6	3-4-6-4	Brown silty clay, moist	N/A
4-6	1	1-1-3-4	Brown silty clay, moist	N/A
6-8	1.4	1-2-3-5	Brown silty clay, moist	N/A
8-10	0.4	2-2-3-4	Brown silty clay, moist	N/A
10-12	1.6	2-3-4-5	Brown silty clay, moist	N/A
12-14	2	1-1-3-4	Brown silty clay, moist	N/A
14-16	2	2-3-3-5	Brown silty clay, moist	N/A
16-18	2	2-3-4-6	Brown silty clay, moist	N/A
18-20	2	2-3-4-4	Brown silty clay, moist	N/A
20-22	2	5-Wt/h(3)	Brown silty clay, moist	N/A
22-24	2	2-3-4-4	Brown silty clay, plastic, moist	N/A
24-26	2	2-2-3-4	Brown silty clay, plastic, moist	N/A
26-28	2	1-1-2-4	Brown silty clay, plastic, moist	N/A
28-30	2	1-2-2-3	Brown silty clay, plastic, moist	N/A
30-32	1.4	Wt/h(4)	Brown sand, fine and medium, trace gravel, trace clay, wet	N/A
32-34	2	1-2-2-2	Brown sand, fine and medium, some gravel, wet	N/A
34-36	2	1-1-3-3	Brown sand, fine and medium, wet	N/A

CONTINUED SAMPLE/CORE LOG
BORING NO. KC-15-28

Project No: 2019052 Geologist: Mike Gelles

36-38	2	2-5-7-13	Brown sand, fine and medium, wet	N/A
38-40	2	2-3-5-9	Brown sand, fine and medium, wet	N/A

WELL CONSTRUCTION LOG
WELL NO. KC-19-28

Project Number: 2019052

Project Location: Kyger Creek Plant – Boiler Slag Pond

Installation Date(s): 4/4/2019

Drilling Method: Hollow Stem Auger
Drilling Contractor: HAD

Development Date(s): 4/9/2019

Development Method: Pump & Surge until Field Parameters stabilized.
Turbidity = 4.7 NTUs

Volume Purged: 232 gallons

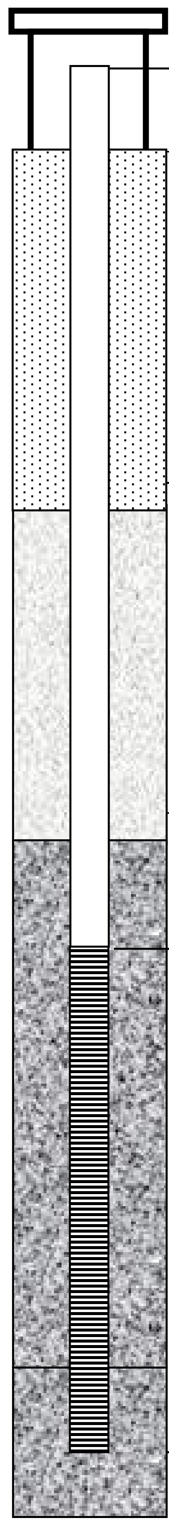
Static Water-Level* 22.95’

Top of Well Casing Elevation: 561.10’ msl

Well Purpose:
Groundwater Monitoring
Northing (Y): 331064.431
Easting (X): 2073270.027

Comments/Notes:
2 inch PVC riser and screen
10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles



Protective Casing with Locking Cap

Top of Casing Elevation: 561.10 ft.
Stick-up: 2.69 ft.

Land Surface Elevation: 558.41 ft.

Grout; Type: Portland cement/ Grout

Borehole Diameter: 6” inch

Casing Diameter: 2 Inch
Casing Material: PVC
Top of Seal: 28 ft*

Seal Type: Bentonite Pellets/Chips

Top of Sand/Gravel Pack: 30 ft*

Top of Well Screen 32 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch
Screen Slot-Size: 0.010 Inch
Screen Material: PVC

Bottom of Well Screen 42 ft.*

Base of Borehole: 42 ft.*

Total Depth of Well Below Top of Casing: 42 ft.

*Indicates Depth Below Land Surface

CONSTRUCTION MATERIALS USED:

3 Bags of Sand

1 Bags/Buckets Bentonite Pellets

8 Bags Portland for Grout

____ Bags Concrete/Sakrete

WELL BORING NO. KC-19-29
SAMPLE/CORE LOG

Project Number:	2019052	Log Page	1 of 2
Project Location:	Kyger Creek Plant – Boiler Slag Pond	Drilling Contractor:	HAD
Drilling Date(s):	4/3/2019	Geologist:	Michael Gelles

Drilling Method:	Hollow Stem Auger	Coring Device Size:	NA	Hammer Wt.	160 lbs and Drop 30”
Sampling Method:	Split Spoon	Borehole Diameter:	6”	Drilling Fluid Used:	Water
Sampling Interval:	2’	Borehole Depth:	42’	Surface Elevation:	561.13’ msl

NOTES/COMMENTS:

Depth Interval (feet)	Sample Recovery (feet)	Penetration (Hyd. Pres. or Blow Counts)	Sample/Core Description	PID (PPM)
0-2	1.2	1-1-2-4	Orange brown silty clay, moist	NA
2-4	1.6	2-4-7-8	Orange brown silty clay, moist	NA
4-6	1.6	6-10-7-9	Orange brown silty clay, moist	NA
6-8	1.6	1-3-4-5	Orange brown silty clay, moist	NA
8-10	1.6	1-2-4-4	Orange brown silty clay, moist	NA
10-12	1.6	2-2-4-4	Orange brown silty clay, moist	NA
12-14	1.6	1-2-3-3	Orange brown silty clay, moist	NA
14-16	2	1-1-2-1	Orange brown silty clay, moist	NA
16-18	2	2-2-2-2	Orange brown silty clay, moist	NA
18-20	2	1-2-2-2	Orange brown silty clay, moist	NA
20-22	2	1-1-3-4	Orange brown silty clay, plastic, moist	NA
22-24	2	1-1-3-5	Orange brown silty clay, plastic, moist	NA
24-26	2	1-1-2-3	Orange brown silty clay, plastic, moist	NA
26-28	2	1-2-3-5	Orange brown silty clay, plastic, moist	NA
28-30	2	2-3-4-5	Orange brown silty clay, plastic, moist	NA
30-32	2	7-6-8-7	Orange brown sand fine to medium, loose, wet	NA
32-34	2	7-8-7-7	Orange brown sand fine to medium, trace clay, loose, wet	NA
34-36	2	Wt/h-1-3-3	Orange brown sand fine to medium, trace clay, loose, wet	NA

36-38	2	4-3-3-5	Orange brown sand fine to medium, loose, wet	NA
38-40	2	Wt/h(4)	Orange brown sand fine to medium, loose, wet	NA
40-42	2	2-5-4-8	Orange brown sand fine to medium, loose, wet	NA

WELL CONSTRUCTION LOG
WELL NO. KC-19-29

Project Number: 2019052

Project Location: Kyger Creek Plant – Boiler Slag Pond

Installation Date(s): 4/3/2019

Drilling Method: Hollow Stem Auger

Drilling Contractor: HAD

Development Date(s): 4/10/2019

Development Method: Pump & Surge until Field Parameters Stabilized

Turbidity = 4.51 NTUs

Volume Purged: 106 gallons

Static Water-Level* 22.25'

Top of Well Casing Elevation: 564.17' msl

Well Purpose:
Groundwater Monitoring

Northing (Y): 330558.936

Easting (X): 2072840.947

Comments/Notes:
2 inch PVC riser and screen

10 ft of 0.010 pre-packed well screen with an inner filter pack of 0.40 mm clean quartz sand and an outer layer of food-grade nylon mesh.

Inspector: Michael Gelles

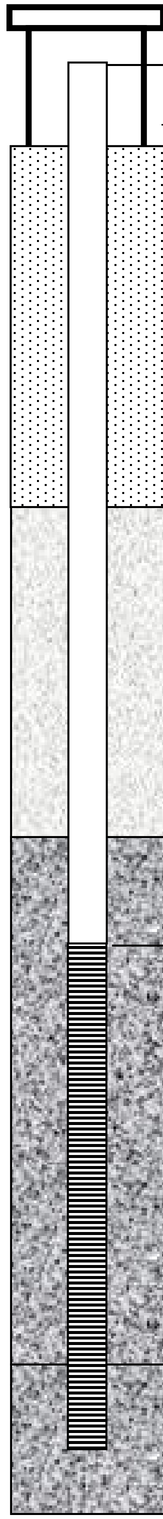
CONSTRUCTION MATERIALS USED:

3 Bags of Sand

1 Bags/Buckets Bentonite Pellets

8 Bags Portland for Grout

____ Bags Concrete/Sakrete



Protective Casing with Locking Cap

Top of Casing Elevation: 564.17 ft.

Stick-up: 3.04 ft.

Land Surface Elevation: 561.13 ft.

Grout; Type: Portland cement/Grout

Borehole Diameter: 6" inch

Casing Diameter: 2 Inch

Casing Material: PVC

Top of Seal: 27 ft*

Seal Type: Bentonite Pellets

Top of Sand/Gravel Pack: 29 ft*

Top of Well Screen 31 ft*

Sand/Gravel Pack; Type: Global #5

Screen Diameter: 2 Inch

Screen Slot-Size: 0.010 Inch

Screen Material: PVC

Bottom of Well Screen 41 ft.*

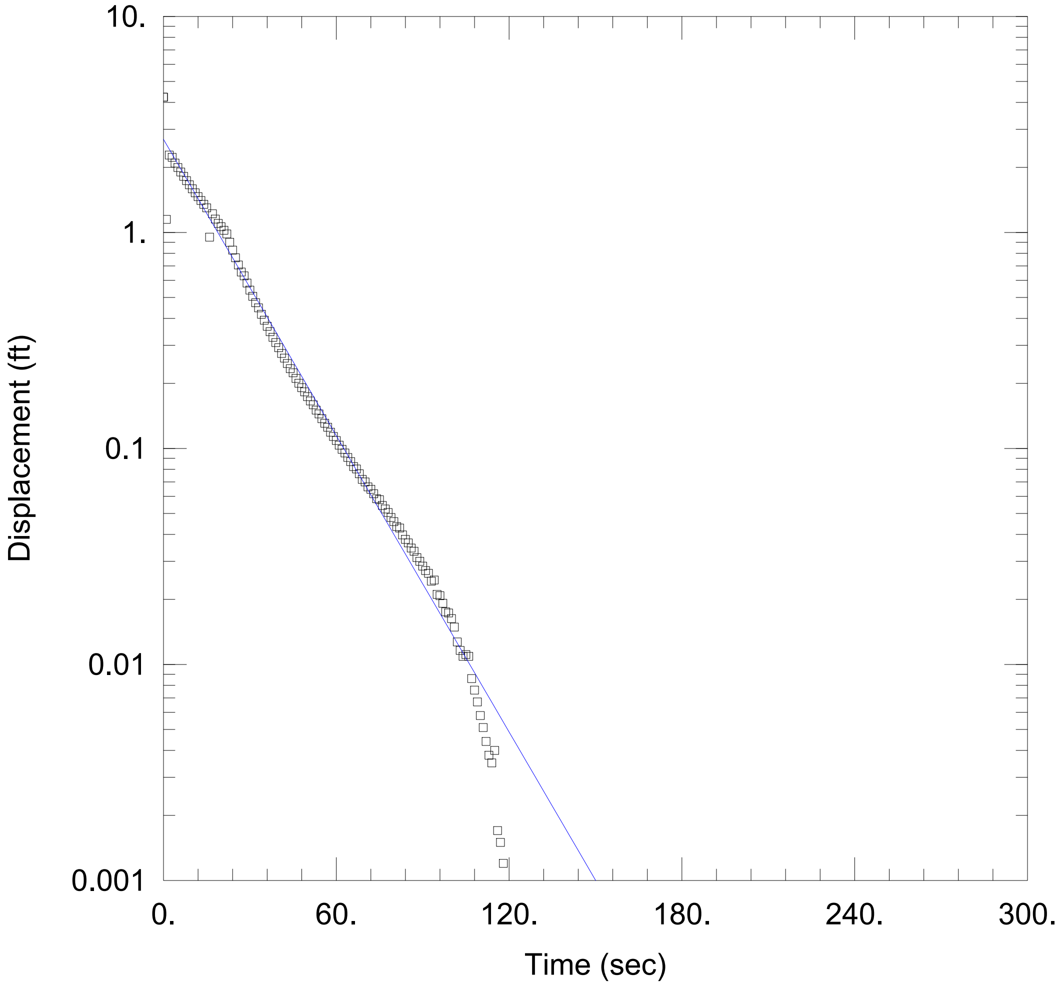
Base of Borehole: 42 ft.*

Total Depth of Well Below Top of Casing: 41 ft.

*Indicates Depth Below Land Surface

APPENDIX E

SLUG TEST RESULTS



KC-19-27-IN1

Data Set: \...\KC-19-27-IN1.aqt
Date: 05/30/19 Time: 11:14:19

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019052-05
Location: Kyger Creek
Test Well: KC-19-27
Test Date: 4/17/2019

AQUIFER DATA

Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

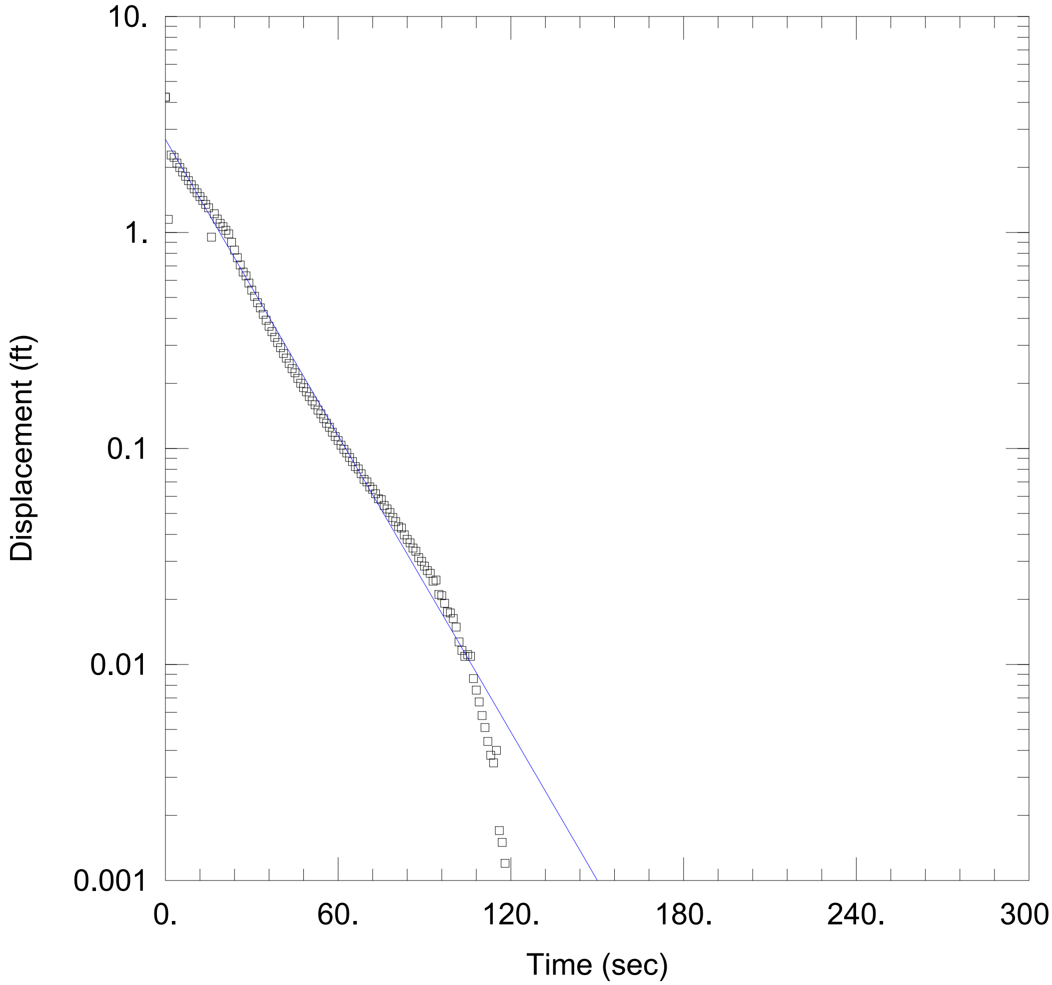
WELL DATA (KC-19-27)

Initial Displacement: 4.231 ft
Static Water Column Height: 22.75 ft
Total Well Penetration Depth: 41.15 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 8.307E-5 ft/sec
y0 = 2.698 ft



KC-19-27-IN1

Data Set: \...\KC-19-27-IN1.aqt
Date: 05/30/19 Time: 11:15:27

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019052-05
Location: Kyger Creek
Test Well: KC-19-27
Test Date: 4/17/2019

AQUIFER DATA

Saturated Thickness: 13. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (KC-19-27)

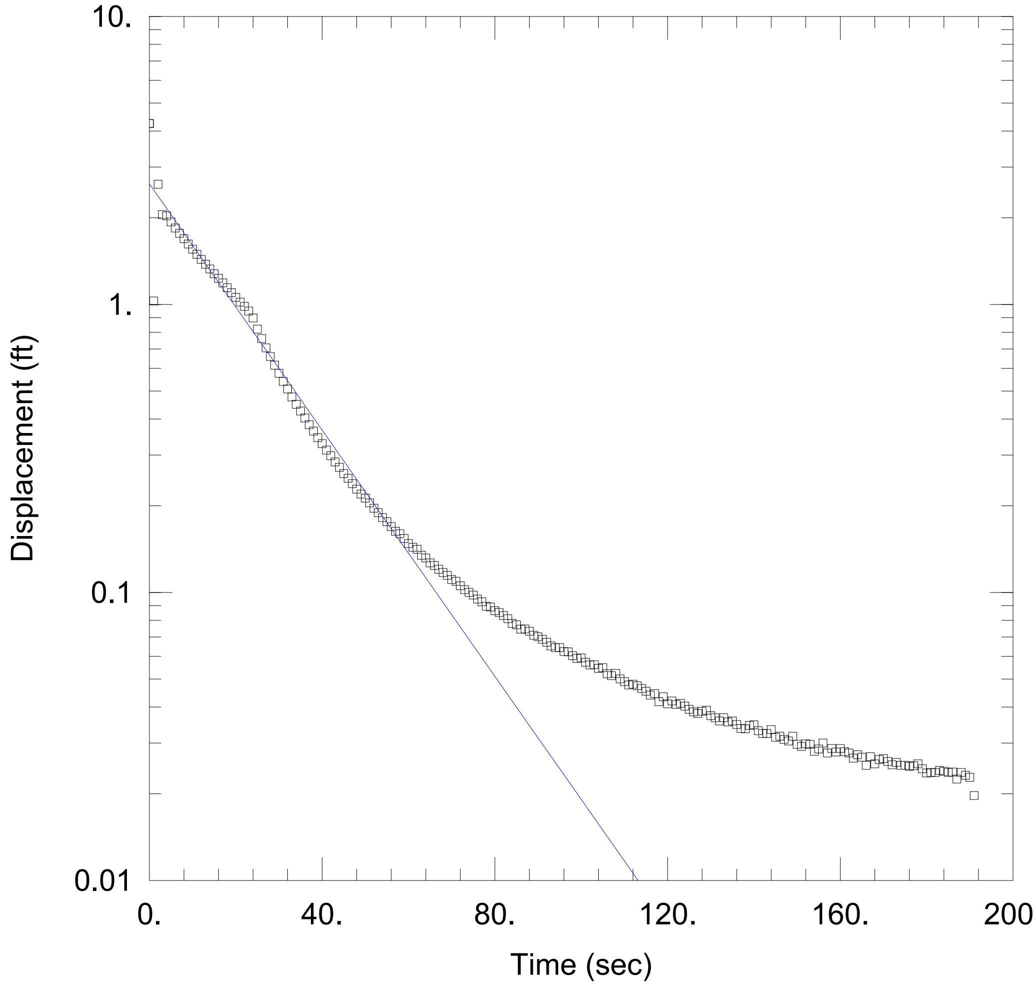
Initial Displacement: 4.231 ft
Total Well Penetration Depth: 41.15 ft
Casing Radius: 0.083 ft

Static Water Column Height: 22.75 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 9.946E-5 ft/sec y0 = 2.698 ft



KC-19-27-IN2

Data Set: \...\KC-19-27-IN2.aqt
Date: 05/30/19 Time: 11:17:47

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019052-05
Location: Kyger Creek
Test Well: KC-19-27
Test Date: 4/17/2019

AQUIFER DATA

Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

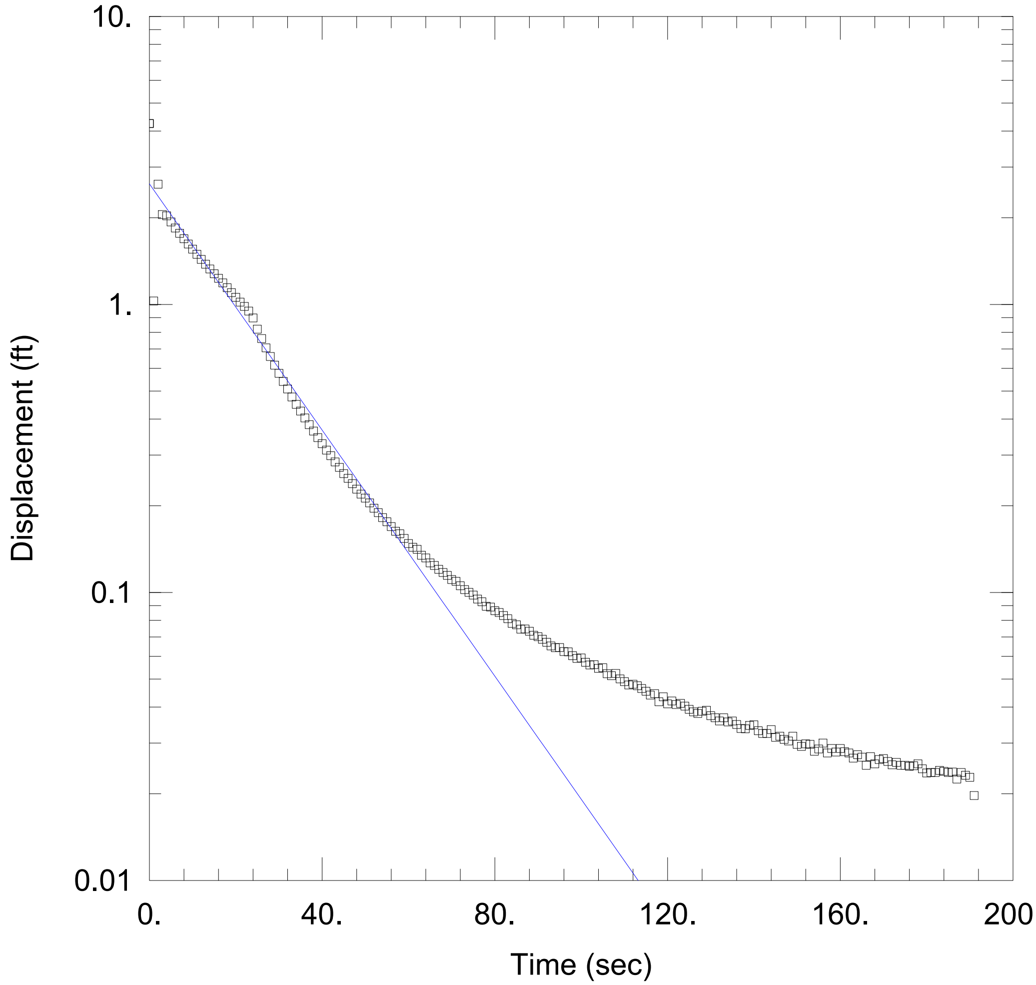
WELL DATA (KC-19-27)

Initial Displacement: 4.248 ft
Total Well Penetration Depth: 41.15 ft
Casing Radius: 0.083 ft
Static Water Column Height: 22.75 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 7.764E-5 ft/sec
y0 = 2.621 ft



KC-19-27-IN2

Data Set: \...\KC-19-27-IN2.aqt
Date: 05/30/19
Time: 11:18:30

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019052-05
Location: Kyger Creek
Test Well: KC-19-27
Test Date: 4/17/2019

AQUIFER DATA

Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

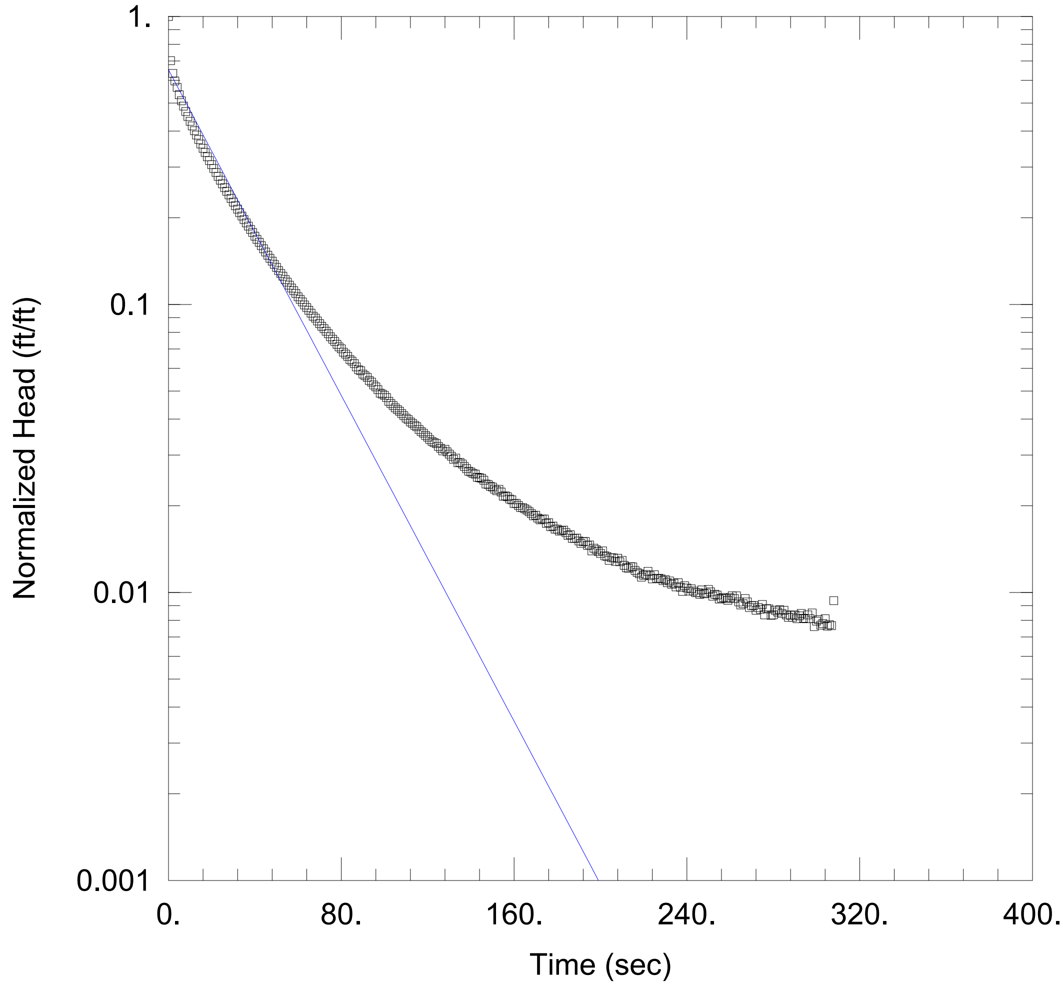
WELL DATA (KC-19-27)

Initial Displacement: 4.248 ft
Total Well Penetration Depth: 41.15 ft
Casing Radius: 0.083 ft
Static Water Column Height: 22.75 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 9.294E-5 ft/sec
y0 = 2.62 ft



KC-19-27-OUT1

Data Set: \...\KC-19-27-OUT1.aqt
Date: 05/30/19
Time: 11:20:38

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019052-05
Location: Kyger Creek
Test Well: KC-19-27
Test Date: 4/17/2019

AQUIFER DATA

Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

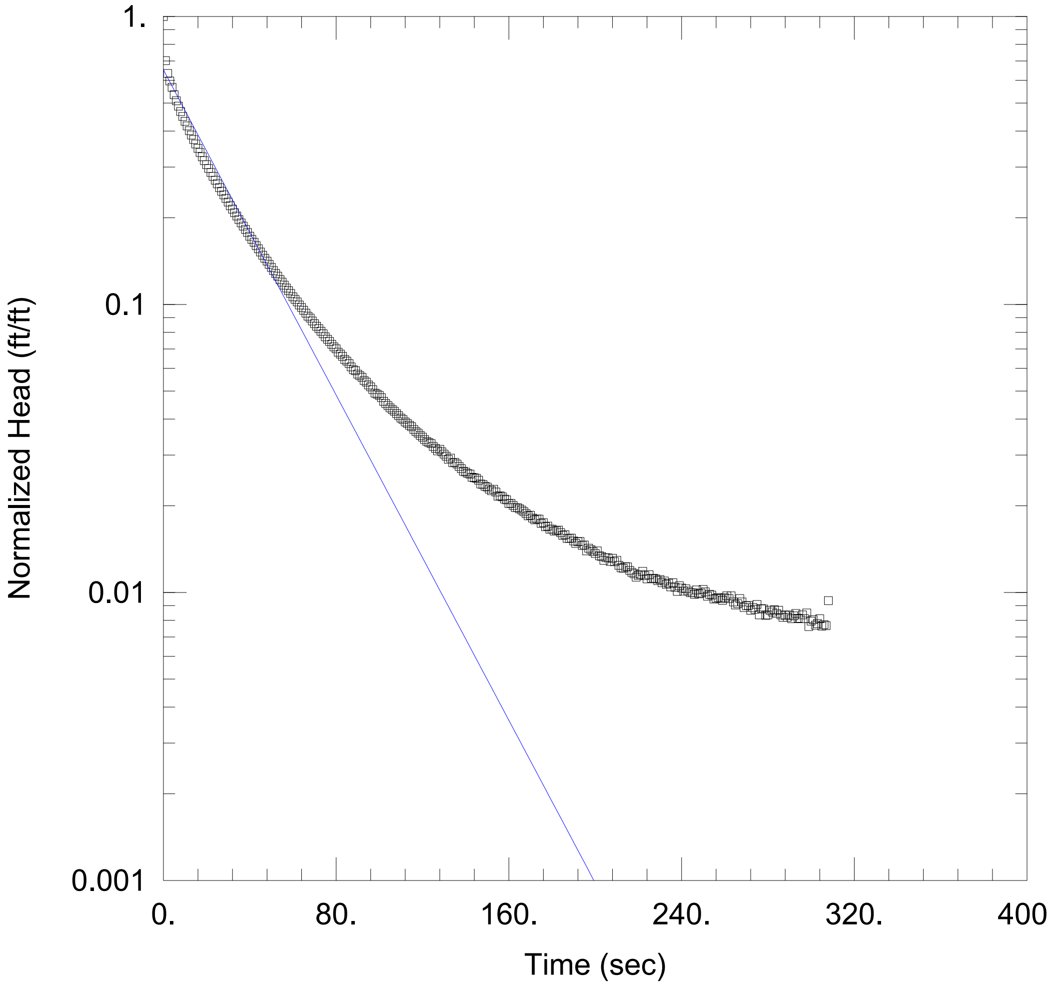
WELL DATA (KC-19-27)

Initial Displacement: -3.195 ft
Total Well Penetration Depth: 41.15 ft
Casing Radius: 0.083 ft
Static Water Column Height: 22.75 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 5.136E-5 ft/sec
y0 = -2.086 ft



KC-19-27-OUT1

Data Set: \...\KC-19-27-OUT1.aqt
Date: 05/30/19 Time: 11:21:18

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019052-05
Location: Kyger Creek
Test Well: KC-19-27
Test Date: 4/17/2019

AQUIFER DATA

Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

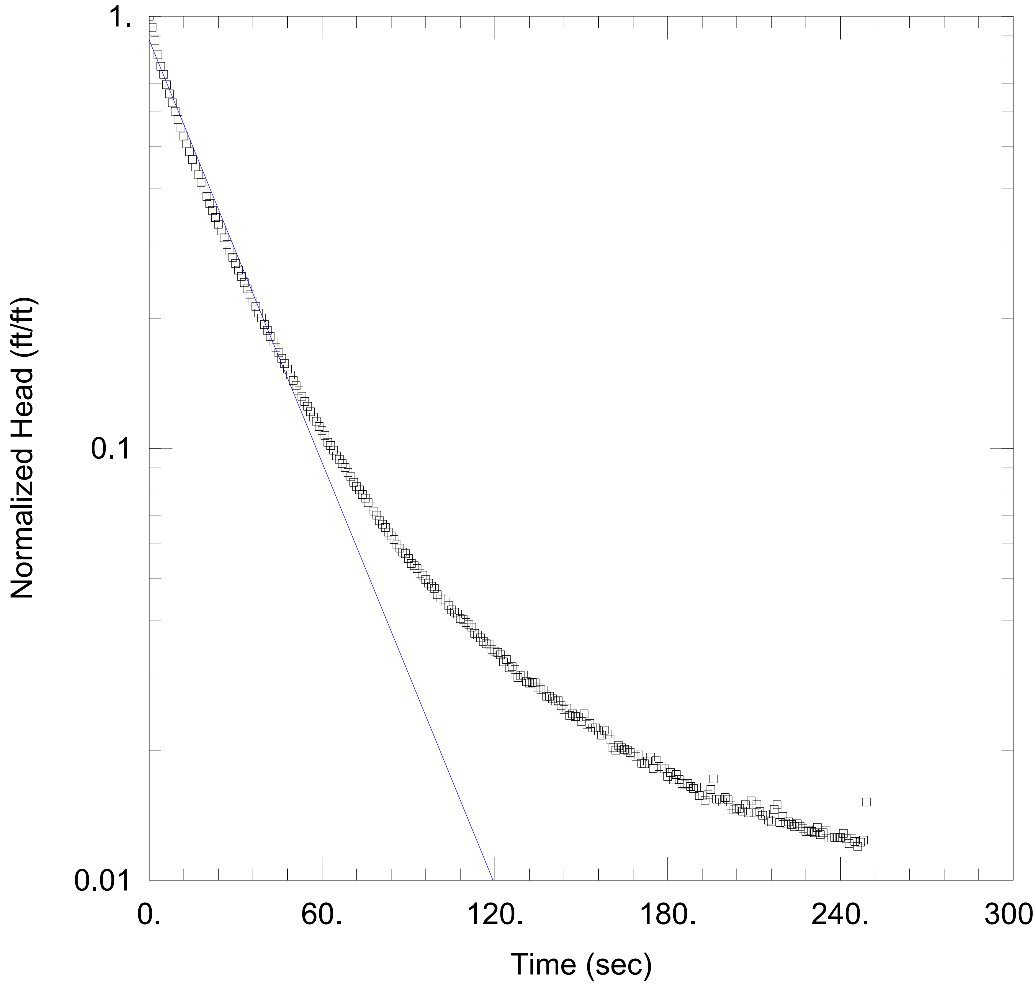
WELL DATA (KC-19-27)

Initial Displacement: -3.195 ft
Total Well Penetration Depth: 41.15 ft
Casing Radius: 0.083 ft
Static Water Column Height: 22.75 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 6.14E-5 ft/sec
y0 = -2.084 ft



KC-19-27-OUT2

Data Set: \...\KC-19-27-OUT2.aqt
Date: 05/30/19 Time: 11:23:38

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019052-05
Location: Kyger Creek
Test Well: KC-19-27
Test Date: 4/17/2019

AQUIFER DATA

Saturated Thickness: 13. ft Anisotropy Ratio (Kz/Kr): 1.

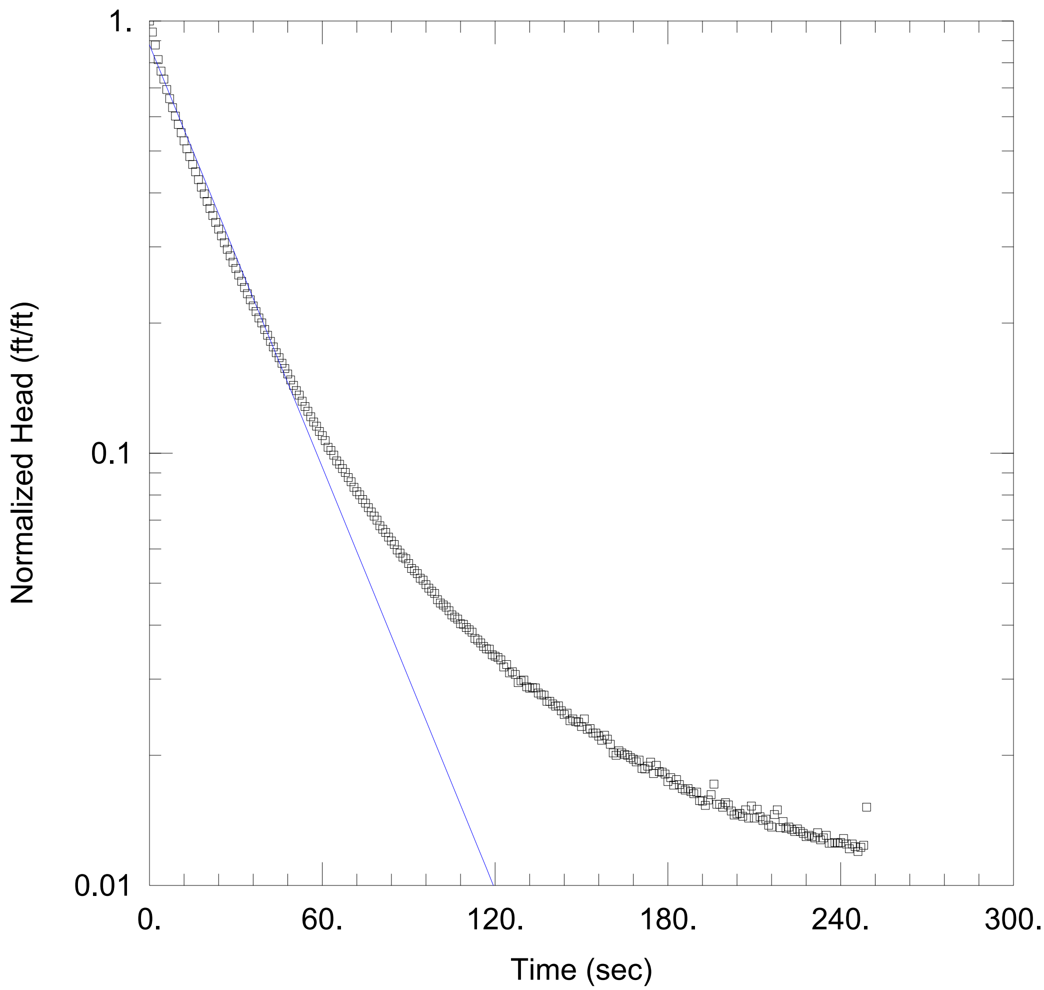
WELL DATA (KC-19-27)

Initial Displacement: -2.221 ft
Total Well Penetration Depth: 41.15 ft
Casing Radius: 0.083 ft
Static Water Column Height: 22.75 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 5.918E-5 ft/sec y0 = -1.954 ft



KC-19-27-OUT2

Data Set: \...\KC-19-27-OUT2.aqt
Date: 05/30/19 Time: 11:24:29

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019052-05
Location: Kyger Creek
Test Well: KC-19-27
Test Date: 4/17/2019

AQUIFER DATA

Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

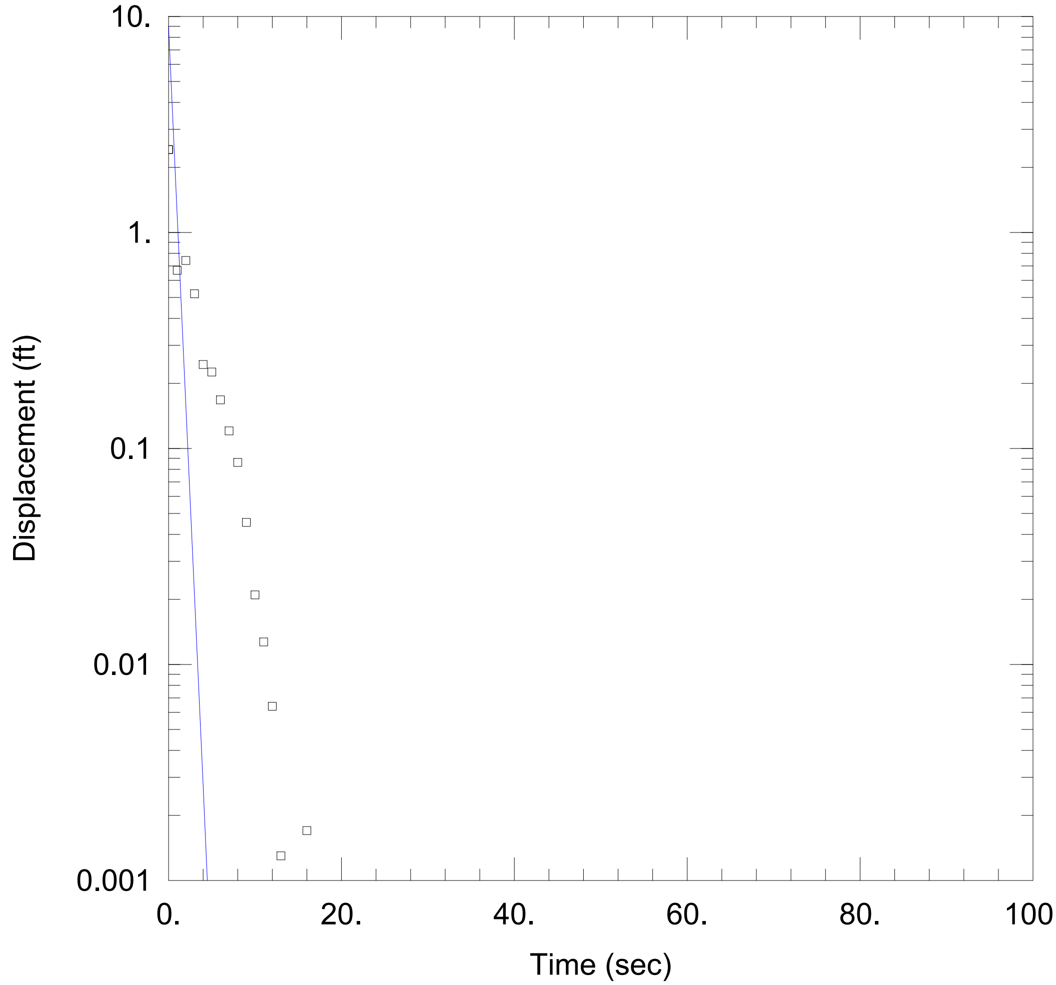
WELL DATA (KC-19-27)

Initial Displacement: -2.221 ft
Total Well Penetration Depth: 41.15 ft
Casing Radius: 0.083 ft
Static Water Column Height: 22.75 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 7.081E-5 ft/sec
y0 = -1.953 ft



KC-19-28-IN1

Data Set: \...\KC-19-28-IN1.aqt
Date: 05/30/19 Time: 11:26:52

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019052-05
Location: Kyger Creek
Test Well: KC-19-28
Test Date: 4/17/2019

AQUIFER DATA

Saturated Thickness: 12. ft
Anisotropy Ratio (Kz/Kr): 1.

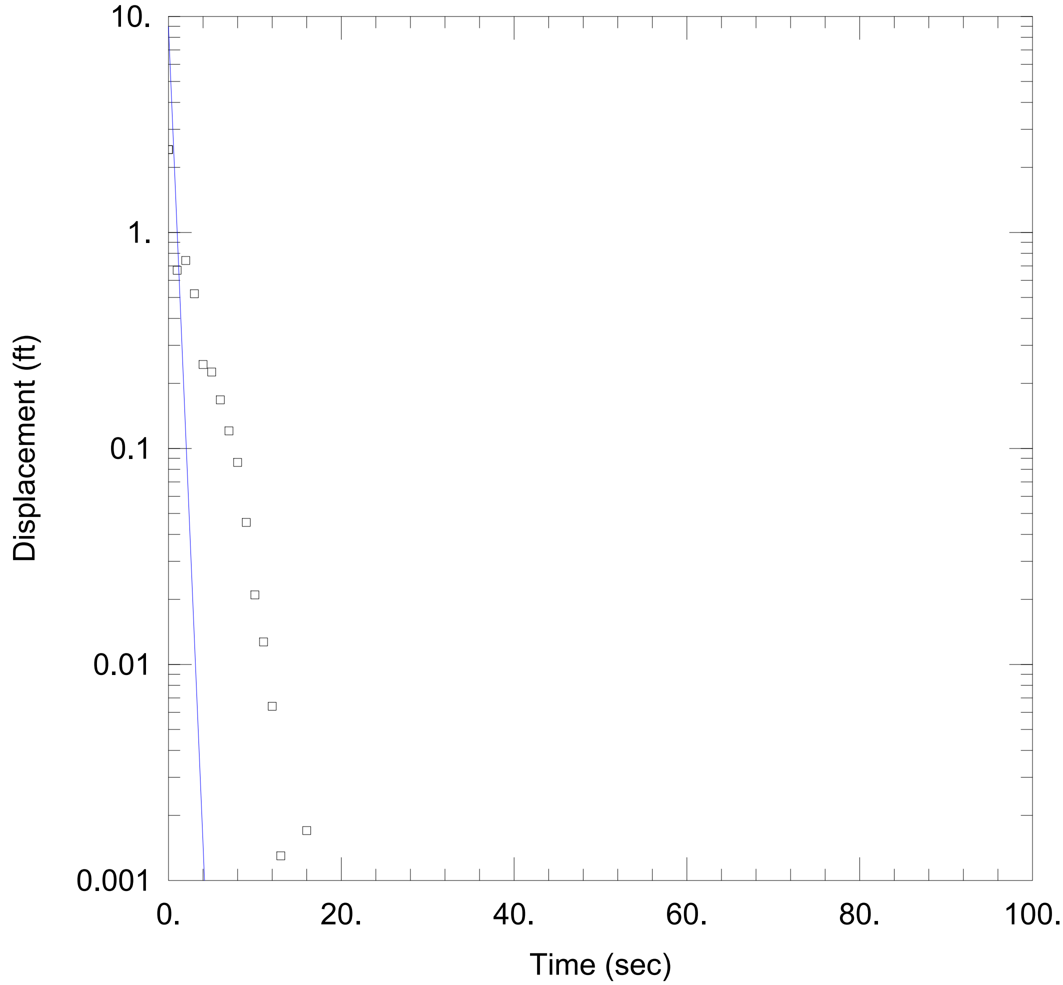
WELL DATA (KC-19-28)

Initial Displacement: 2.416 ft
Total Well Penetration Depth: 44.48 ft
Casing Radius: 0.083 ft
Static Water Column Height: 25.97 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.003224 ft/sec
y0 = 8.965 ft



KC-19-28-IN1

Data Set: \...\KC-19-28-IN1.aqt
Date: 05/30/19
Time: 11:27:52

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019052-05
Location: Kyger Creek
Test Well: KC-19-28
Test Date: 4/17/2019

AQUIFER DATA

Saturated Thickness: 12. ft
Anisotropy Ratio (Kz/Kr): 1.

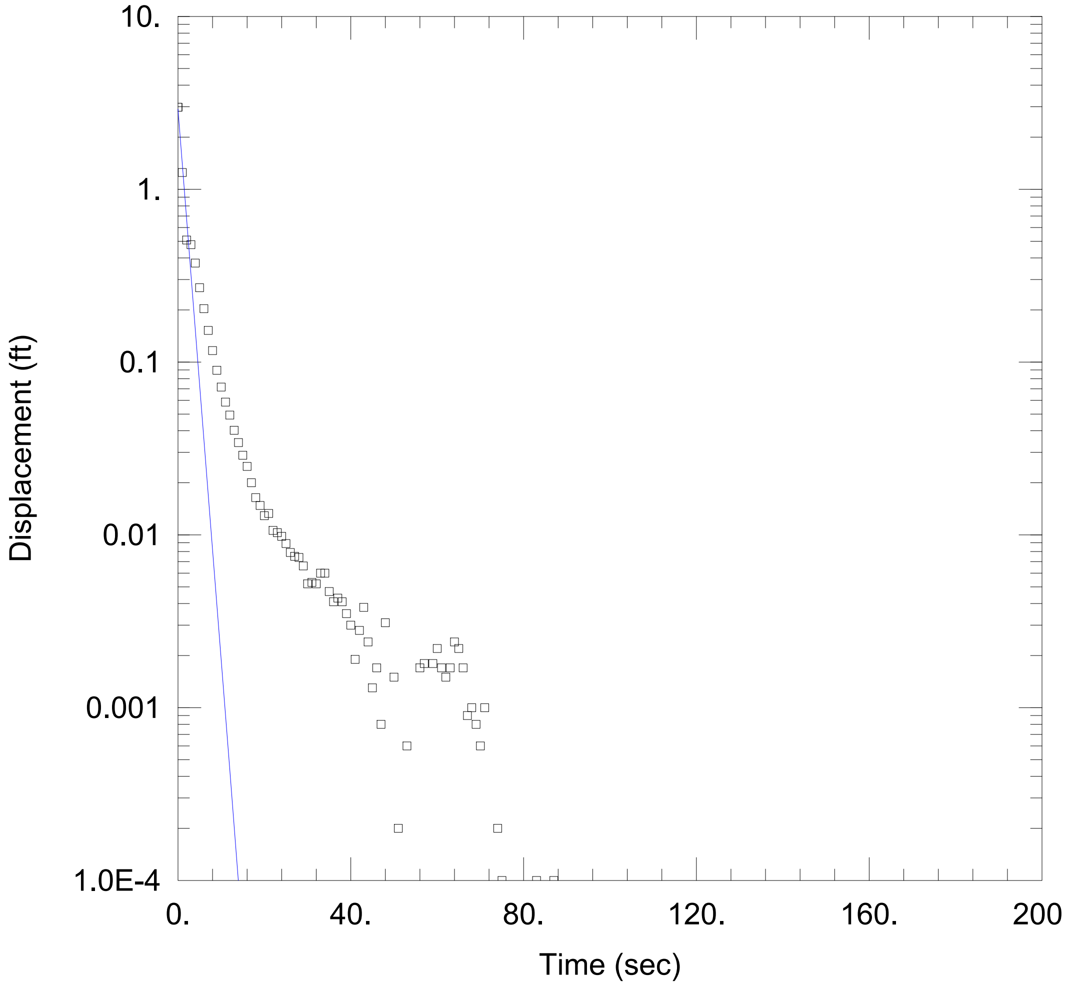
WELL DATA (KC-19-28)

Initial Displacement: 2.416 ft
Total Well Penetration Depth: 44.48 ft
Casing Radius: 0.083 ft
Static Water Column Height: 25.97 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.004117 ft/sec
y0 = 8.965 ft



KC-19-28-IN2

Data Set: \...\KC-19-28-IN2.aqt
Date: 05/30/19 Time: 11:31:49

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019052-05
Location: Kyger Creek
Test Well: KC-19-28
Test Date: 4/17/2019

AQUIFER DATA

Saturated Thickness: 12. ft Anisotropy Ratio (Kz/Kr): 1.

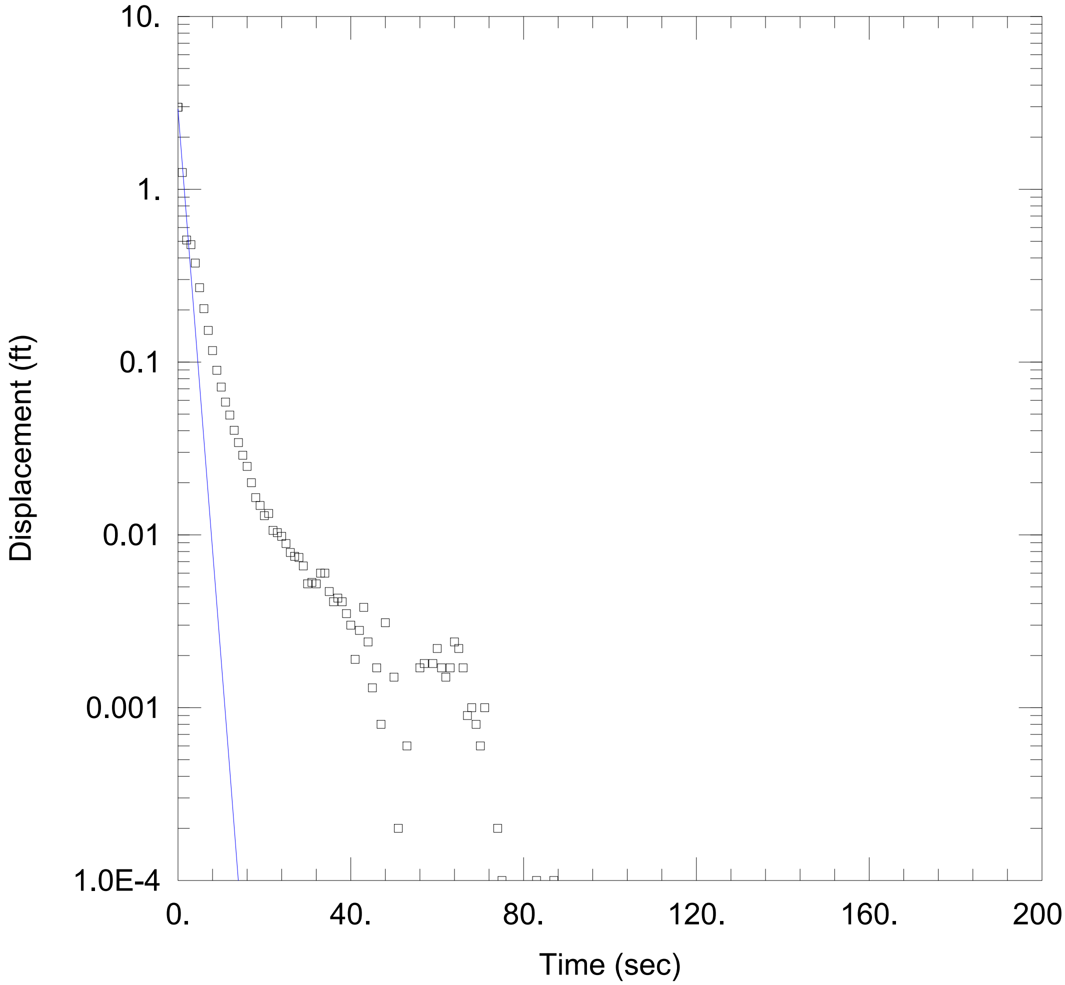
WELL DATA (KC-19-28)

Initial Displacement: 2.979 ft
Total Well Penetration Depth: 44.48 ft
Casing Radius: 0.083 ft
Static Water Column Height: 25.97 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.00117 ft/sec y0 = 2.909 ft



KC-19-28-IN2

Data Set: \...\KC-19-28-IN2.aqt
Date: 05/30/19 Time: 11:32:56

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019052-05
Location: Kyger Creek
Test Well: KC-19-28
Test Date: 4/17/2019

AQUIFER DATA

Saturated Thickness: 12. ft
Anisotropy Ratio (Kz/Kr): 1.

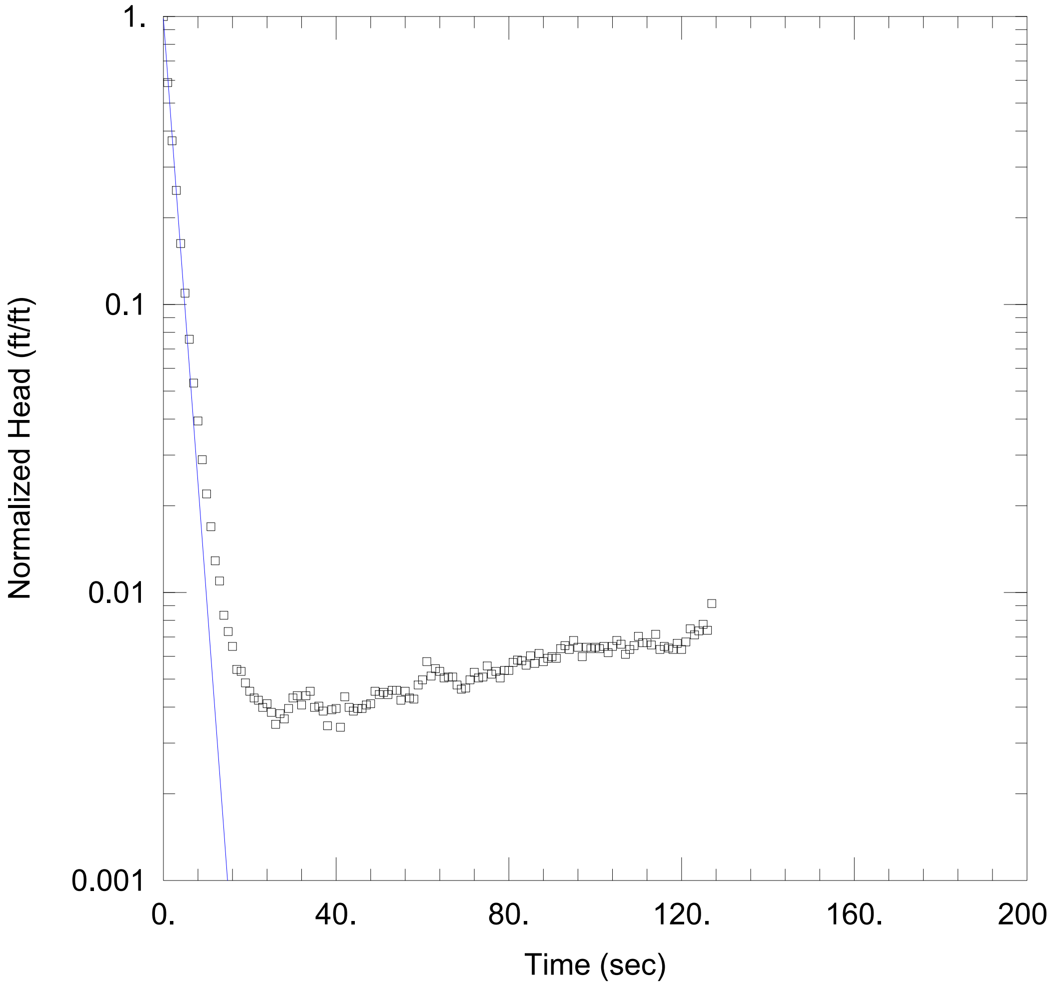
WELL DATA (KC-19-28)

Initial Displacement: 2.979 ft
Total Well Penetration Depth: 44.48 ft
Casing Radius: 0.083 ft
Static Water Column Height: 25.97 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.001387 ft/sec
y0 = 2.909 ft



KC-19-28-OUT1

Data Set: \...\KC-19-28-OUT1.aqt
Date: 05/30/19
Time: 11:36:27

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019052-05
Location: Kyger Creek
Test Well: KC-19-28
Test Date: 4/17/2019

AQUIFER DATA

Saturated Thickness: 12. ft
Anisotropy Ratio (Kz/Kr): 1.

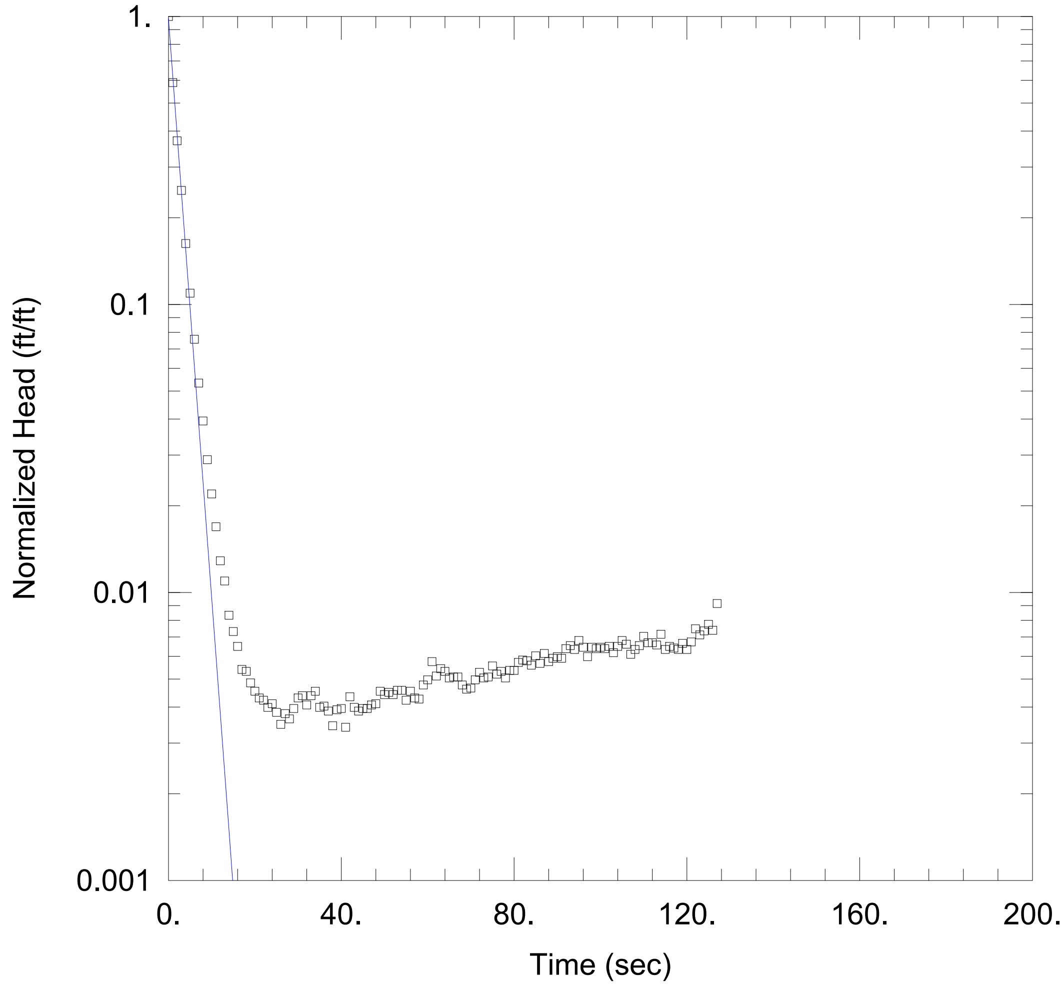
WELL DATA (KC-19-28)

Initial Displacement: -2.557 ft
Total Well Penetration Depth: 44.48 ft
Casing Radius: 0.083 ft
Static Water Column Height: 25.97 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0007384 ft/sec
y0 = -2.508 ft



KC-19-28-OUT1

Data Set: \...\KC-19-28-OUT1.aqt
Date: 05/30/19 Time: 11:37:17

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019052-05
Location: Kyger Creek
Test Well: KC-19-28
Test Date: 4/17/2019

AQUIFER DATA

Saturated Thickness: 12. ft
Anisotropy Ratio (Kz/Kr): 1.

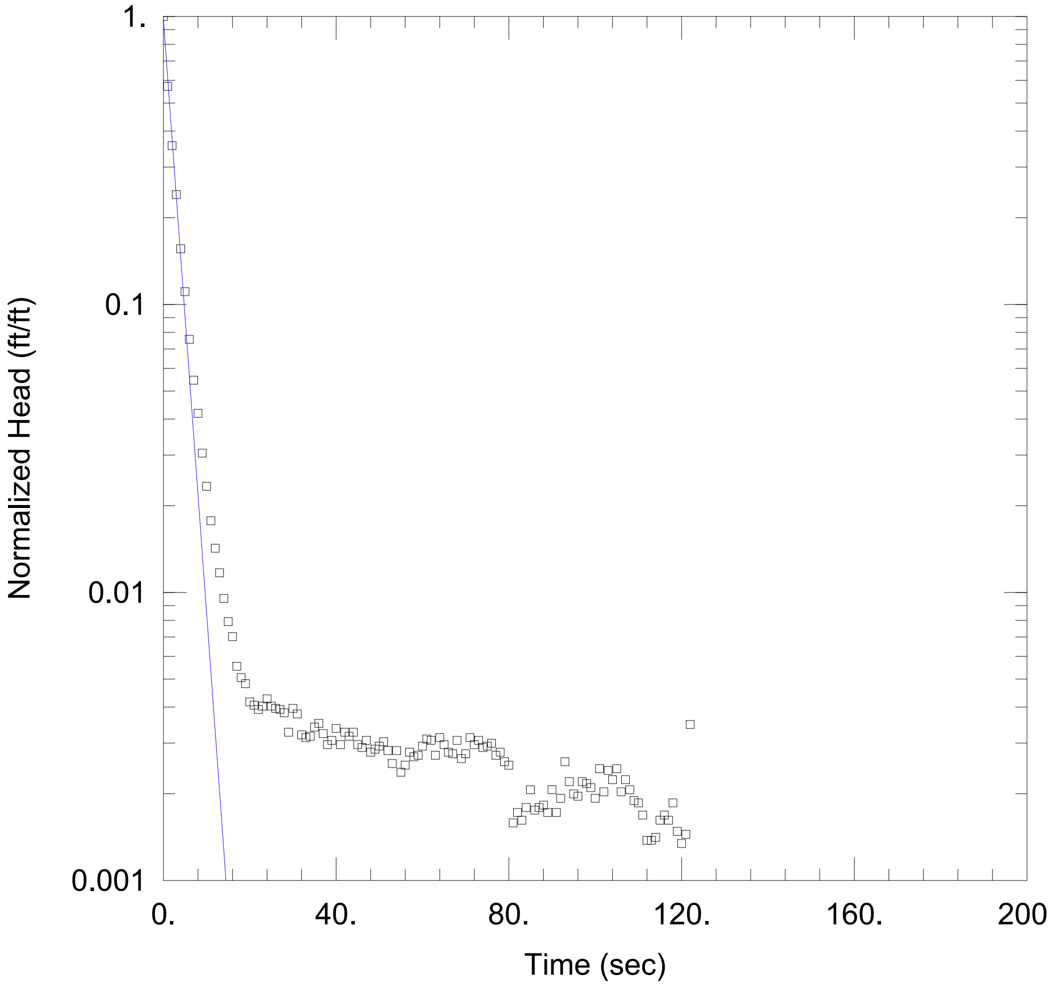
WELL DATA (KC-19-28)

Initial Displacement: -2.557 ft
Total Well Penetration Depth: 44.48 ft
Casing Radius: 0.083 ft
Static Water Column Height: 25.97 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.000875 ft/sec
y0 = -2.508 ft



KC-19-28-OUT2

Data Set: \...\KC-19-28-OUT2.aqt
Date: 05/30/19 Time: 11:43:10

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019052-05
Location: Kyger Creek
Test Well: KC-19-28
Test Date: 4/17/2019

AQUIFER DATA

Saturated Thickness: 12. ft
Anisotropy Ratio (Kz/Kr): 1.

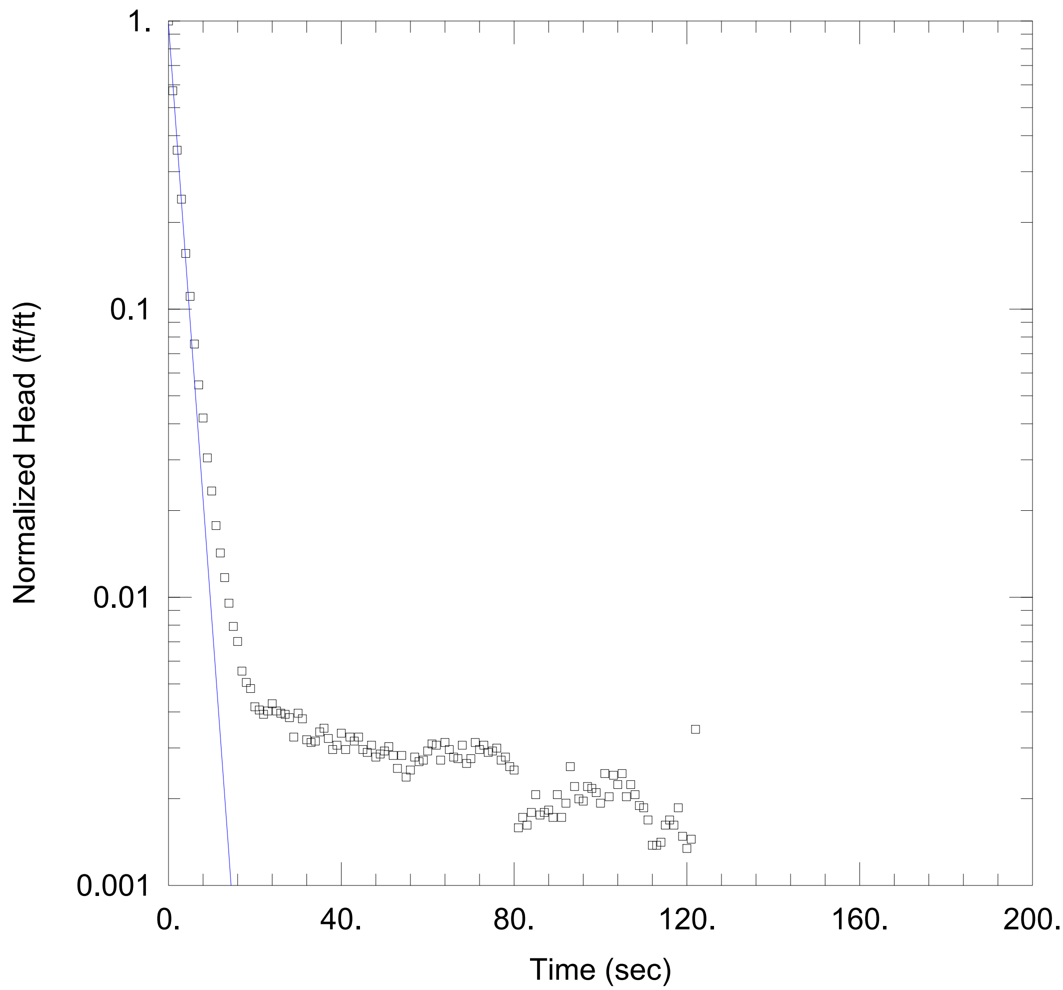
WELL DATA (KC-19-28)

Initial Displacement: -2.905 ft
Total Well Penetration Depth: 44.48 ft
Casing Radius: 0.083 ft
Static Water Column Height: 25.97 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.0007565 ft/sec
y0 = -2.838 ft



KC-19-28-OUT2

Data Set: \...\KC-19-28-OUT2.aqt
Date: 05/30/19 Time: 11:44:14

PROJECT INFORMATION

Company: AGES, Inc.
Client: OVEC
Project: 2019052-05
Location: Kyger Creek
Test Well: KC-19-28
Test Date: 4/17/2019

AQUIFER DATA

Saturated Thickness: 12. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (KC-19-28)

Initial Displacement: -2.905 ft
Total Well Penetration Depth: 44.48 ft
Casing Radius: 0.083 ft
Static Water Column Height: 25.97 ft
Screen Length: 10. ft
Well Radius: 0.083 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.0008964 ft/sec y0 = -2.837 ft

APPENDIX F

2020 UPDATE ON GROUNDWATER CONDITIONS
BSP

2020 UPDATE ON GROUNDWATER CONDITIONS
BOILER SLAG POND (BSP)
OHIO VALLEY ELECTRIC CORPORATION
KYGER CREEK STATION
CHESHIRE, OHIO

1.0 INTRODUCTION

The purpose of this 2020 Update Report is to provide an update on groundwater conditions at the Boiler Slag Pond (BSP) at the Kyger Creek Station, located in Cheshire, Ohio. An Assessment of Corrective Measures (ACM) Report for the BSP was prepared in September 2019 to comply with 40 CFR § 257.90(c) of the CCR Rule. That report documented the results of site characterization activities and ongoing monitoring that were the basis for the evaluation of potential corrective measure remedial technologies to address Arsenic in shallow groundwater at the BSP.

A groundwater monitoring program has been ongoing at the site since 2015; the locations of CCR wells at the site are shown on Figure F-1. As required by the CCR Rule, the results of these events have been documented in annual groundwater monitoring and corrective action reports and in the ACM Report for the BSP. This 2020 Update Report includes an evaluation of results of groundwater monitoring conducted during the characterization event at the BSP in March/April 2019 and monitoring events conducted a year later in March 2020 and September 2020, and the impact of these results on selection of a remedy to address Arsenic in shallow groundwater at the site.

Presented below are an evaluation of shallow groundwater flow (including impacts of flooding from the nearby Ohio River) and a discussion of the extent of Arsenic in shallow groundwater from March/April 2019 through September 2020. A discussion of the impact that these results have on the selection of remedy process at the site is then presented.

2.0 UPDATE ON SITE GEOLOGY & HYDROGEOLOGY

As presented in Section 3 of the ACM Report, deposits of silts and clays beneath the base of the BSP range from 15 to over 50 feet thick. The silts and clays transition to a layer of sand and gravel where groundwater is present. A generalized cross section of the geology beneath the BSP is presented in Figure F-2. The sand and gravel unit has been determined to be the uppermost aquifer beneath the BSP.

3.0 REVIEW OF GROUNDWATER FLOW AT THE SITE

Complete rounds of groundwater level data were collected at the BSP in March/April 2019 (the site characterization event) and during routine monitoring in March 2020 and September 2020

(Attachment F-1). Groundwater flow maps generated using these data indicates that groundwater in the uppermost aquifer beneath the BSP flows from the northwest to the south and southeast towards the Ohio River (Attachment F-2). Historic groundwater elevation data indicates that groundwater flow beneath the BSP is affected by the flow and water level in the Ohio River and several flow reversals have been observed in the historic data (AGES 2018). Based on the results of groundwater monitoring since 2015, groundwater flow directions at the site have remained extremely consistent.

Based on previous slug tests at the site, the mean K (hydraulic conductivity) value for the uppermost aquifer beneath the BSP is 54.26 feet per day (ft/day) (AGES 2019). Using water level data collected in March/April 2019, March 2020 and September 2020, and this mean K value, the groundwater velocity for the uppermost aquifer beneath the BSP was calculated using the following equation:

$$\mathbf{V=K\ (i/n)}$$

Where:
K=Hydraulic Conductivity (ft/day)
i=Mean Gradient (Dimensionless)
n=25% (Effective Porosity-From Fetter 1980)

The results are summarized below:

Sampling Event	Groundwater Flow Velocity (ft/day)
March/April 2019	0.20
March 2020	0.27
September 2020	0.15
Mean	**0.21**

With a mean flow velocity of 0.21 ft/day and a distance between wells KC-15-02 and KC-19-28 of approximately 1,600 feet, the travel time for groundwater to flow from KC-15-02 (northwest) to KC-19-28 (southeast) is approximately 21 years. This travel time is likely greater than 21 years due to documented flow reversals, which would significantly increase the travel time between the two (2) wells. Calculations of groundwater flow velocity were performed using the same approach as presented in Section 5 of the ACM Report.

4.0 EXTENT OF ARSENIC IN UPPERMOST AQUIFER

All monitoring wells at the BSP were sampled for analysis of Arsenic during the three (3) events noted below. Results for the two (2) wells (KC-15-07 and KC-15-08) where Arsenic exceeded the

Groundwater Protection Standard (GWPS) of 10 micrograms per liter (ug/L) and associated downgradient wells are presented below:

Arsenic Concentrations (ug/L)						
Sampling Event	**KC-15-06**	**KC-15-07**	**KC-15-08**	**KC-19-27**	**KC-19-28**	**KC-19-29**
March/April 2019	2.6	160	11	1.8	0.94	0.84
March 2020	7.3	82	11	5.4	Non-Detect	1.0
September 2020	2.2	130	12	9.3	1.3	4.6

Note: ug/L = micrograms per liter.

As shown, Arsenic concentrations only exceed the GWPS in wells KC-15-07 and KC-15-08. At KC-15-07, Arsenic concentrations ranged from 82 ug/L to 160 ug/L; at KC-15-08, Arsenic concentrations slightly exceeded the GWPS at 11 ug/L and 12 ug/L (Figure F-3).

All Arsenic results for the three (3) shallow wells at the property boundary (KC-19-27, KC-19-28 and KC-19-29) were less than the GWPS during all events. Based on these results, Arsenic concentrations in the uppermost aquifer exceeding the GWPS of 10 ug/L are confined to the site and are not reaching the Ohio River.

To evaluate Arsenic concentrations in groundwater over time, time-series graphs for wells KC-15-06, KC-15-07 and KC-15-08 were developed for 2015 through 2020 and are presented in Attachment F-3. As shown, Arsenic concentrations in well CF-15-06 exceeded the GWPS once in 2016 but have decreased and remained stable since 2017. All Arsenic results for well CF-15-07 have exceeded the GWPS since 2015 but have been relatively stable since 2017. In well CF-15-08, Arsenic results have periodically exceeded the GWPS but with the exception of one (1) result (September 2018) have stable within a range of 6 ug/L to 12 ug/L. Overall, no significant downward or upward trends are apparent in the data, indicating relatively stable plume conditions in the area.

As shown on Figure F-3, the two (2) wells with Arsenic exceedances of the GWPS (KC-15-07 and KC-15-08) are located on a berm between the BSP and the adjacent Clearwater Pond. Well KC-15-06 is located downgradient of these wells; the Arsenic result for well KC-15-06 is less than the GWPS. Due to the presence of the Clearwater Pond, additional wells could not be installed immediately south of wells KC-15-07 and KC-15-08. The lack of wells, coupled with the fact that the Clearwater Pond is a source of recharge to the uppermost aquifer, makes it impractical to accurately estimate the mass of Arsenic in the uppermost aquifer at the BPS.

5.0 IMPACT OF RESULTS ON SELECTION OF REMEDY PROCESS

As presented in the ACM Report, the two (2) technologies that appear to be most likely for selection as a remedy were:

- Monitored Natural Attenuation (MNA); and
- Conventional Vertical Well System (Groundwater Extraction) (Ex-Situ).

Groundwater treatment would be required as a supplemental technology in conjunction with a Conventional Vertical Well System. The selection of a treatment technology would be based on conditions at the time of selection of a final remedy.

5.1 Review of MNA

As detailed above, the Arsenic plume at the BSP appears to be relatively stable with neither a significant downward or upward trend in concentrations over the past years. These observed stable concentration conditions indicate that natural attenuation, likely via dispersion and the mixing and spreading of constituents due to microscopic variations in velocity within and between interstitial voids in the uppermost aquifer, and dilution are likely acting to reduce Arsenic concentrations in groundwater.

Although the BSP is anticipated to be a current and ongoing source of Arsenic to groundwater in the area, Arsenic concentrations observed in the wells noted above are not representative of the typical waste characteristics of boiler slag. As a result, a limited subsurface investigation was conducted in 2019 to evaluate whether an alternate source of Arsenic was present. That investigation did not provide any conclusive information. Additional subsurface investigation was conducted across the area of the BSP in mid-2020; that information is currently in the process of being evaluated.

Upon closure of the BSP, Arsenic levels in groundwater are anticipated to significantly decrease as a result. In combination with the observed natural attenuation processes, closure of the BSP should provide a flexible and effective approach to groundwater remediation at the site. During the post-closure monitoring period, the positive impacts of closure and the effects of natural attenuation on groundwater quality can be fully evaluated and, if needed, other remedial technologies may be evaluated.

5.2 Review of Groundwater Extraction (Ex-Situ)

As discussed above, groundwater elevation data indicates that groundwater flow beneath the BSP is affected by the flow and water level of the Ohio River and, as discussed above, evidence of several flow reversals and routine flooding of the land surface have been observed at the site. This type of flooding would have a significant impact on any groundwater extraction system that was installed south of the BSP. While a conventional well system can be designed to accommodate fluctuations in groundwater elevations, flooding at the land surface would overrun the system and allow for a breakthrough of impacted groundwater. In addition, land surface flooding would result in extreme maintenance issues with operation of the system and its reliability. This type of issue would effectively preclude the installation of an effective groundwater extraction system at the BSP.

Another issue associated with groundwater extraction at the BSP is that the presence of the Clearwater Pond would impact the effectiveness of that remedy in the area. As noted above, both wells with Arsenic exceedances are located on a berm between the BSP and the Clearwater Pond; the Arsenic exceedances are confined to this immediate area. With the Clearwater Pond being a source of recharge to the uppermost aquifer, pumping in this area would more likely capture recharge from the Clearwater Pond than impacted groundwater. Further evaluation is needed to address this issue.

Due to these same issues, it was not appropriate to install a temporary groundwater extraction system at the site but to work toward final closure of the BSP.

5.3 Planned Work

Additional work needs to be performed to fully support the selection of the appropriate remedy for the site. That work will include, but may not be limited to:

- Continued sampling and analysis as part of the routine semi-annual program;
- Development of a three-dimensional site model;
- Continued evaluation of the effects of flood events on the site;
- Evaluation of newly obtained subsurface information to determine its impact on the final selected remedy;
- Continued development of time-series graphs to support site evaluation; and,
- Investigation of site geology and hydrogeology, as needed, to support the final closure and selection of a final remedy.

5.4 Conclusion

Based on the results of monitoring conducted from March/April 2019 through September 2020, the use of MNA as the selected remedy for the site is still supported, though additional evaluation is underway; the use of groundwater extraction appears to be a less applicable technology. Data collected during the ongoing monitoring programs will be useful in confirming these conclusions.

6.0 REFERENCES

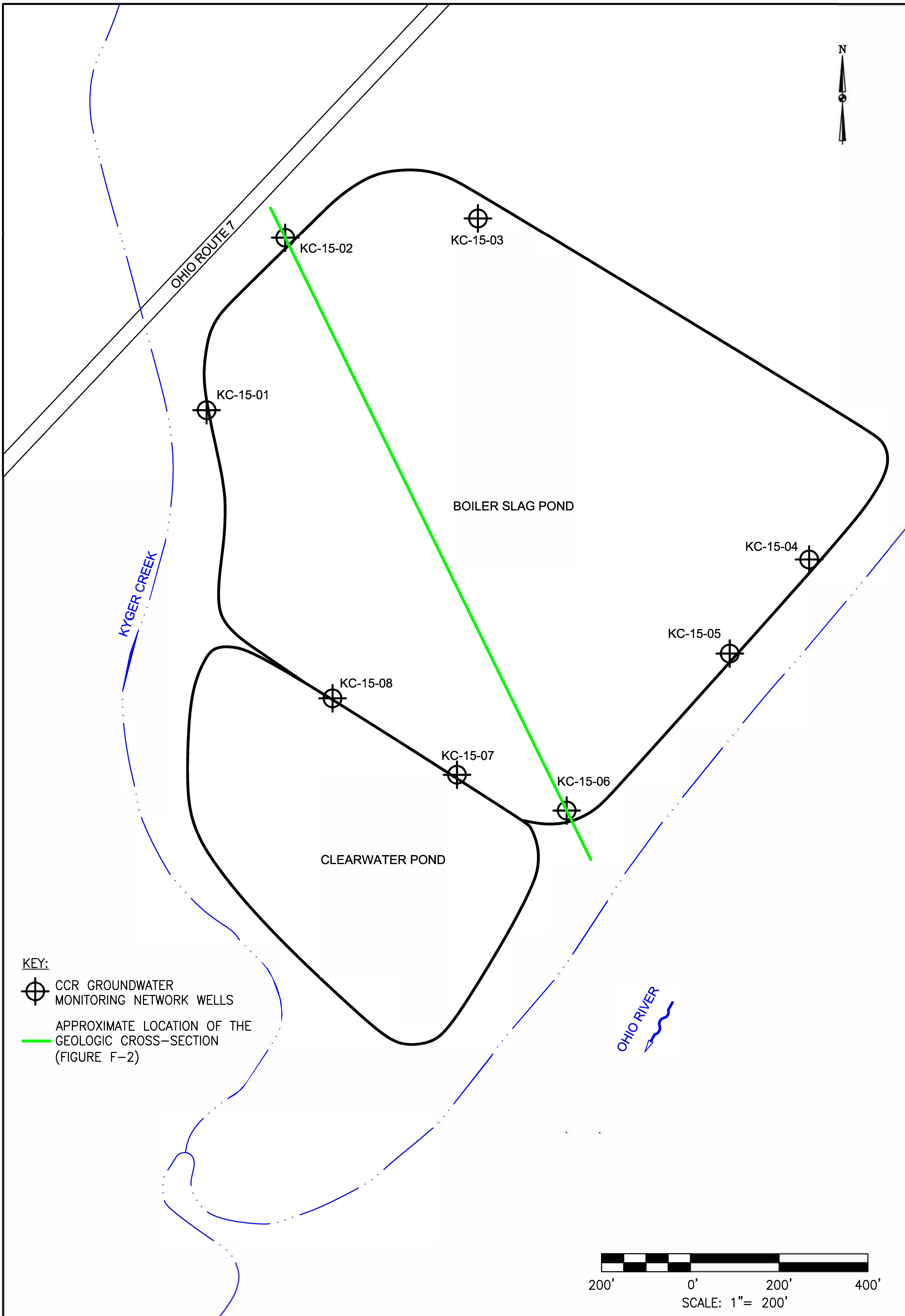
Applied Geology and Environmental Science, Inc. (AGES) 2018. Coal Combustion Residuals Regulation 2017 Groundwater Monitoring and Corrective Action Report. Ohio Valley Electric Corporation, Kyger Creek Station, Cheshire, Gallia County, Ohio. January 2018.

Applied Geology and Environmental Science, Inc. (AGES) 2019. Coal Combustion Residuals Regulation 2017 Assessment of Corrective Measures Report. Ohio Valley Electric Corporation, Kyger Creek Station, Cheshire, Gallia County, Ohio. September 2019.

Fetter, Charles W. 1980. Applied Hydrogeology. Merrill, 1980.

ATTACHMENT F

FIGURES



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CHECKED BY	
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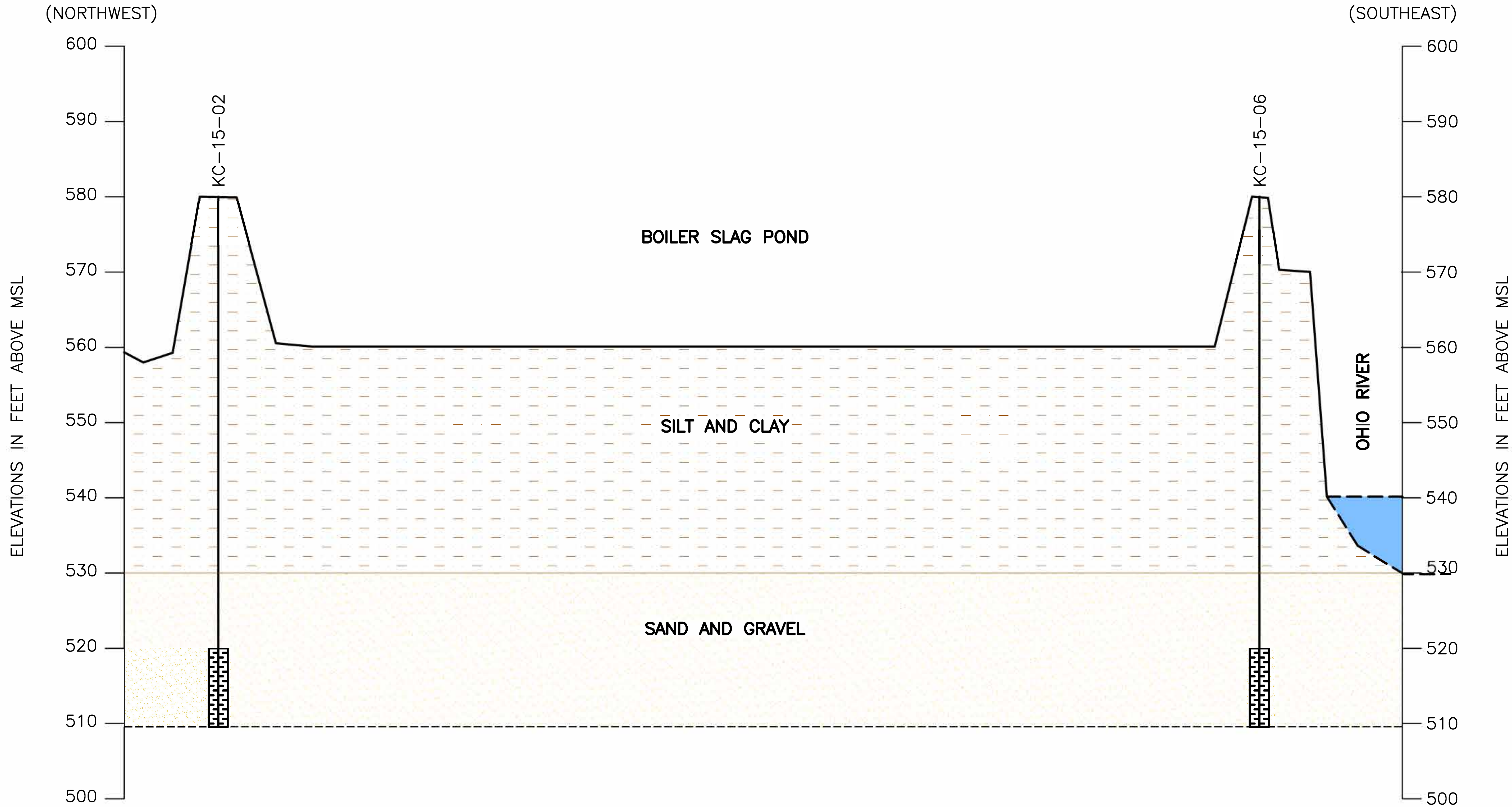
DWG FILE	2019 ACM_KYGER_Fig 4–1_BSP_MW LOCs.dwg
DRAWING SCALE	1"=200'

AGES
Applied Geology And Environmental Science, Inc.
2402 Hookstown Grade Road, Suite 200
Clinton, PA 15026
412.264.6453

OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
EXISTING MONITORING WELL LOCATION MAP

DRAWING NAME: FIGURE F–1
REV. 0

Plot: 12/25/2020 13:25 _PROGRAM–KYGER OVEC\Kyger Creek–CCR Program\CAD\2019 Assessment of Corrective Measures\2019 ACM_KYGER_Fig 4–1_BSP_MW LOCs.dwg



NOTE:
THE APPROXIMATE LOCATION OF THE CROSS-SECTION IS ILLUSTRATED ON FIGURE F-1.

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CHECKED BY	
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DRAWING SCALE	NOT TO SCALE

AGES
Applied Geology And Environmental Science, Inc.
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Clinton, PA 15026
412.264.6453

OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GENERALIZED GEOLOGIC CROSS-SECTION
(NORTHWEST – SOUTHEAST)

DRAWING NAME: FIGURE F-2
REV. 0

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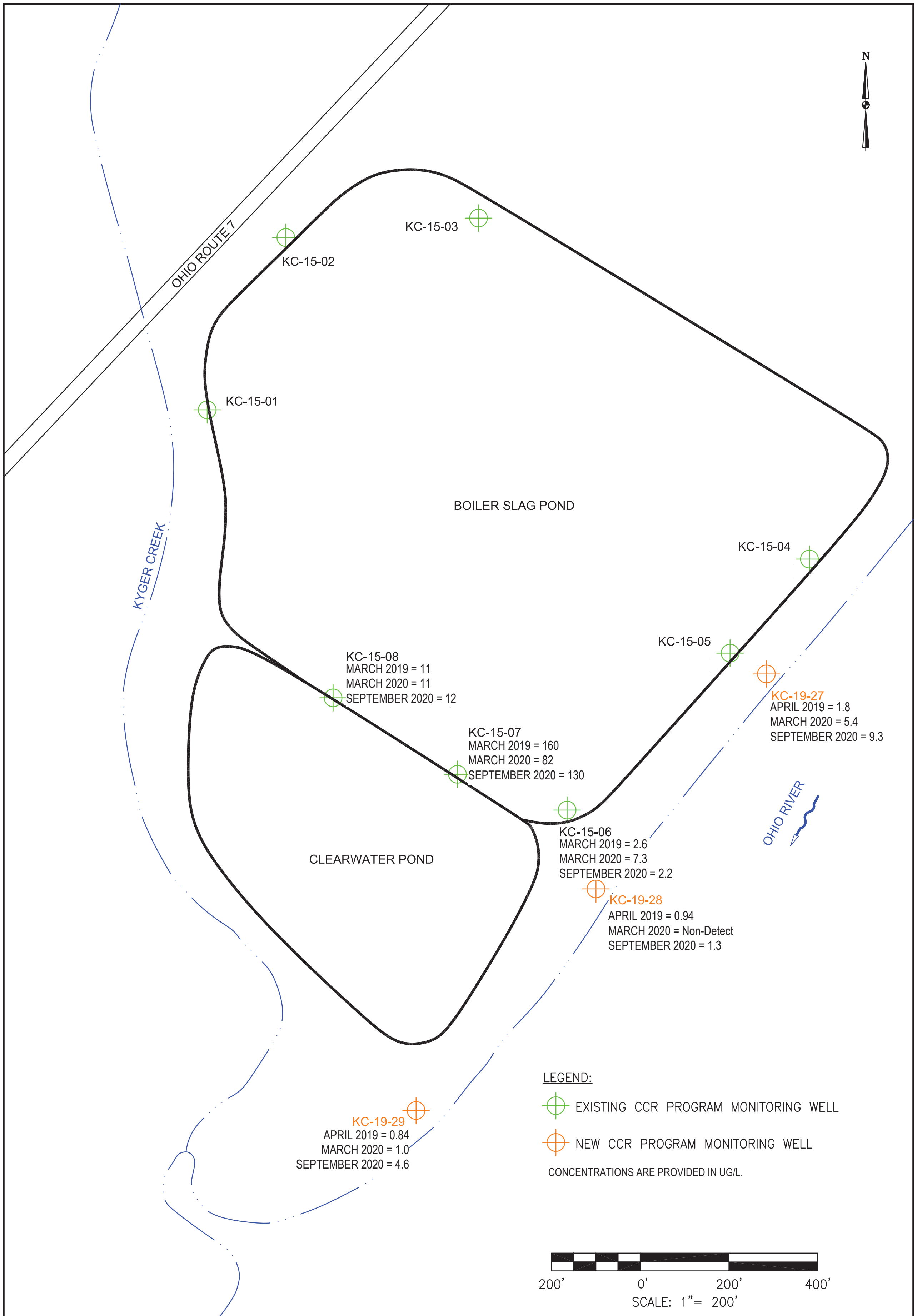

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DRAWING SCALE	1"=200'

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Clinton, PA 15026
412.264.6453

OHIO VALLEY ELECTRIC COMPANY

KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
ARSENIC IN GROUNDWATER RESULTS
MARCH 2019 THROUGH SEPTEMBER 2020

DRAWING NAME: FIGURE F-3
REV. 0

Plot: 11/25/2020 13:03 _PROGRAMS-KYGER OVEC\Kyger Creek-CCR Program\CAD\2020 Assessment of Corrective Measures\2020 ACM_KYGER_Fig F-3_BSP_Arsenic.dwg

ATTACHMENT F-1

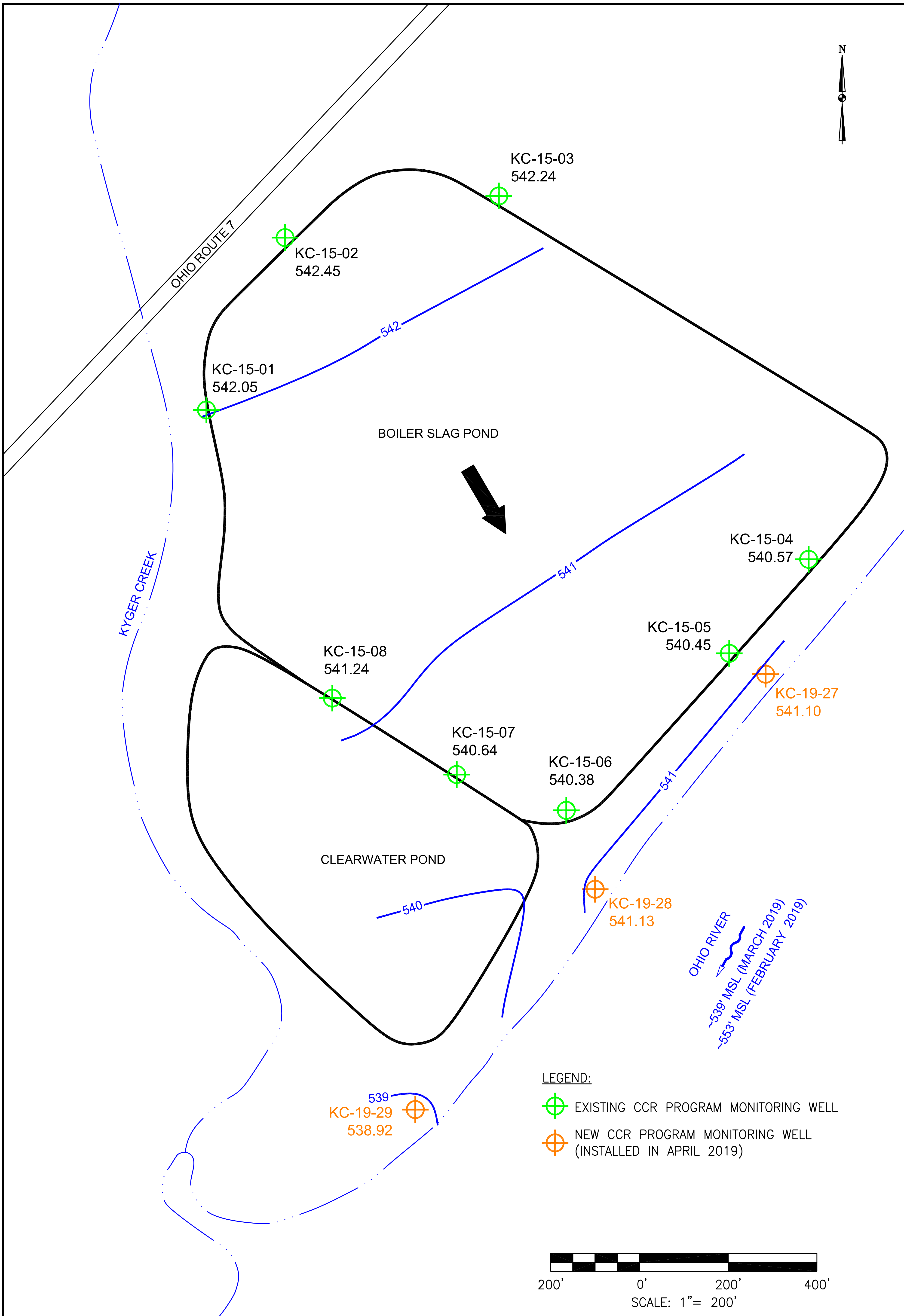
GROUNDWATER ELEVATION DATA

ATTACHMENT F-1
SUMMARY OF GROUNDWATER ELEVATION DATA
BOILER SLAG POND
CCR GROUNDWATER MONITORING PROGRAM
KYGER CREEK STATION
CHESHIRE, OHIO

Well ID	Mar-19	Mar-20	Sep-20
	Groundwater Elevation (ft)	Groundwater Elevation (ft)	Groundwater Elevation (ft)
KC-15-01	542.05	540.85	541.10
KC-15-02	542.45	541.10	539.70
KC-15-03	542.24	543.35	539.35
KC-15-04	540.57	538.37	538.59
KC-15-05	540.45	539.26	537.97
KC-15-06	540.38	539.23	538.48
KC-15-07	540.64	539.54	538.54
KC-15-08	541.24	540.15	538.85
KC-19-27	541.10	539.30	538.75
KC-19-28	541.13	538.90	538.30
KC-19-29	538.92	539.17	538.37

ATTACHMENT F-2

GENERALIZED GROUNDWATER FLOW MAPS



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JOB NO.	2020245–KYGER
DWG FILE	2020 ACM_KYGER_Att F–2 Fig 1_BSP_GW Flow_MAR2019.dwg
DRAWING SCALE	1"=200'

AGES
Applied Geology And Environmental Science, Inc.
2402 Hookstown Grade Road, Suite 200
Clinton, PA 15026
412.264.6453

OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER LEVELS AND FLOW DIRECTION
MARCH/APRIL 2019

DRAWING NAME: ATTACHMENT F–2 FIGURE 1 — REV. 0

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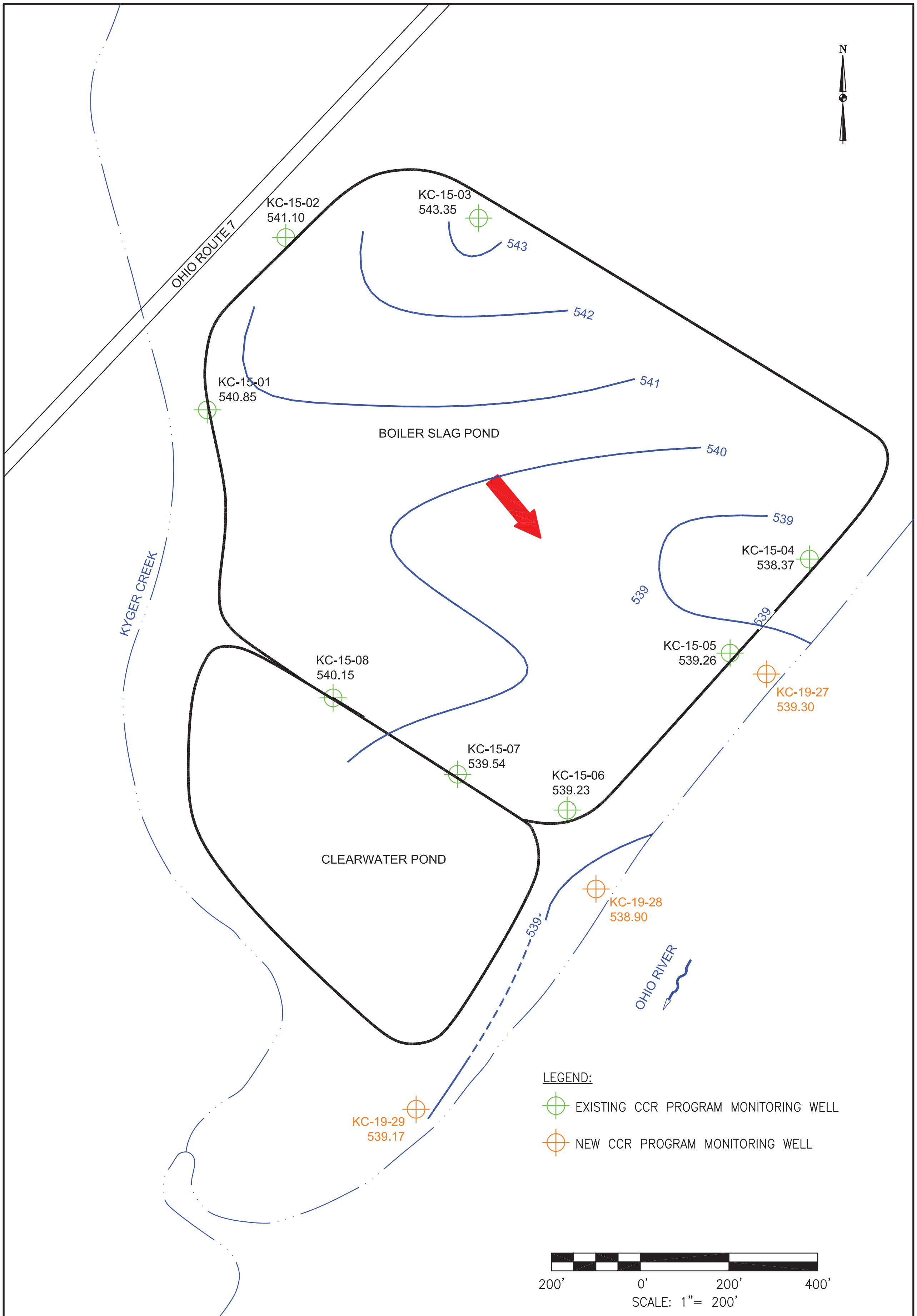

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JOB NO.	2020245-1-KYGER
DWG FILE	March 2020 ACM_KYGER_Fig F-1_BSP_GW Contours.dwg
DRAWING SCALE	1"=200'

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412.264.6453

OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER ELEVATIONS AND FLOW MAP
MARCH 2020

DRAWING NAME: ATTACHMENT F-2 FIGURE 2

REV. 0

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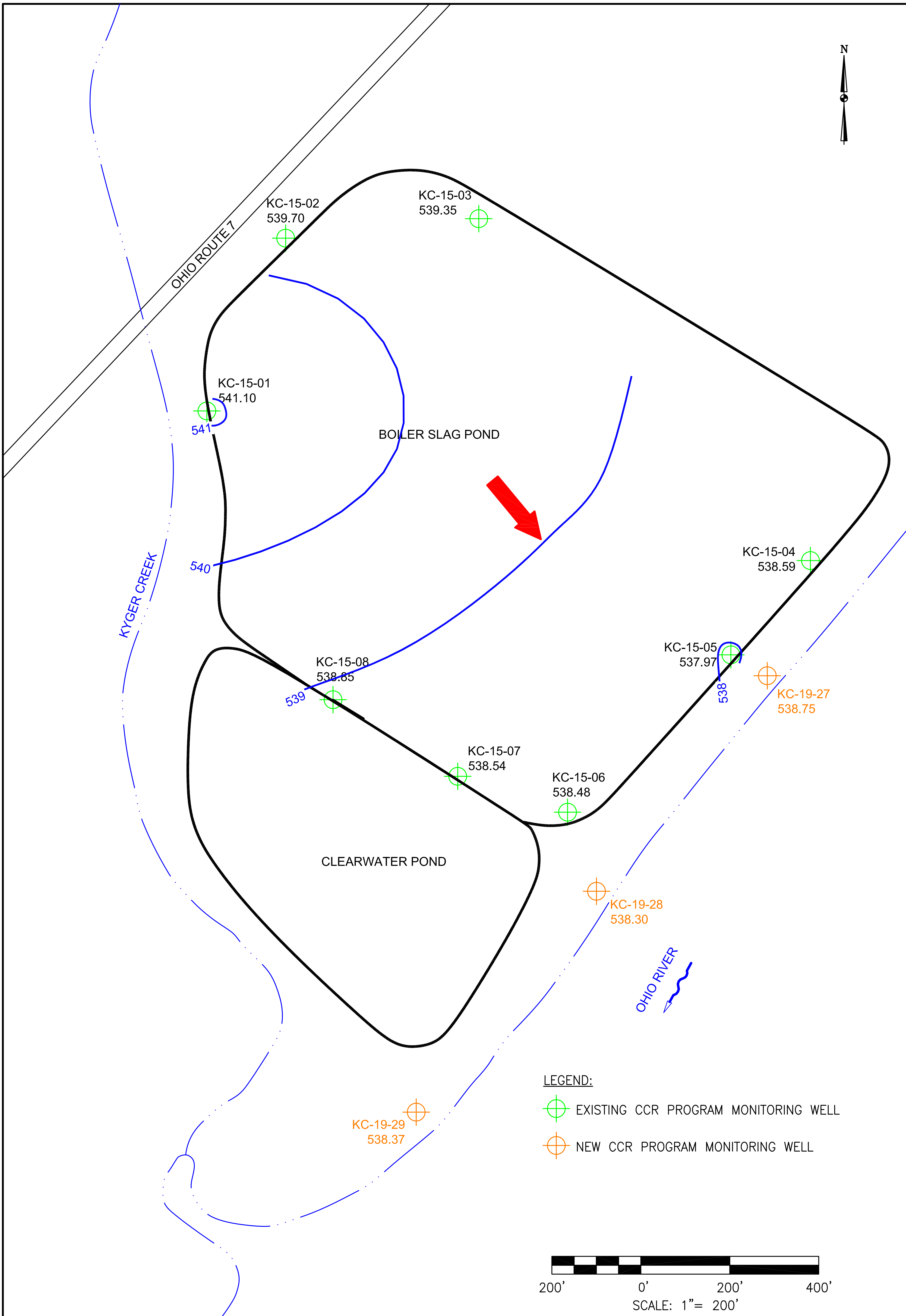

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AGES
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412.264.6453

OHIO VALLEY ELECTRIC COMPANY
KYGER CREEK STATION
CHESHIRE, GALLIA COUNTY, OHIO
BOILER SLAG POND
GROUNDWATER ELEVATIONS AND FLOW MAP
SEPTEMBER 2020

DRAWING NAME: ATTACHMENT F-2 FIGURE 3
REV. 0

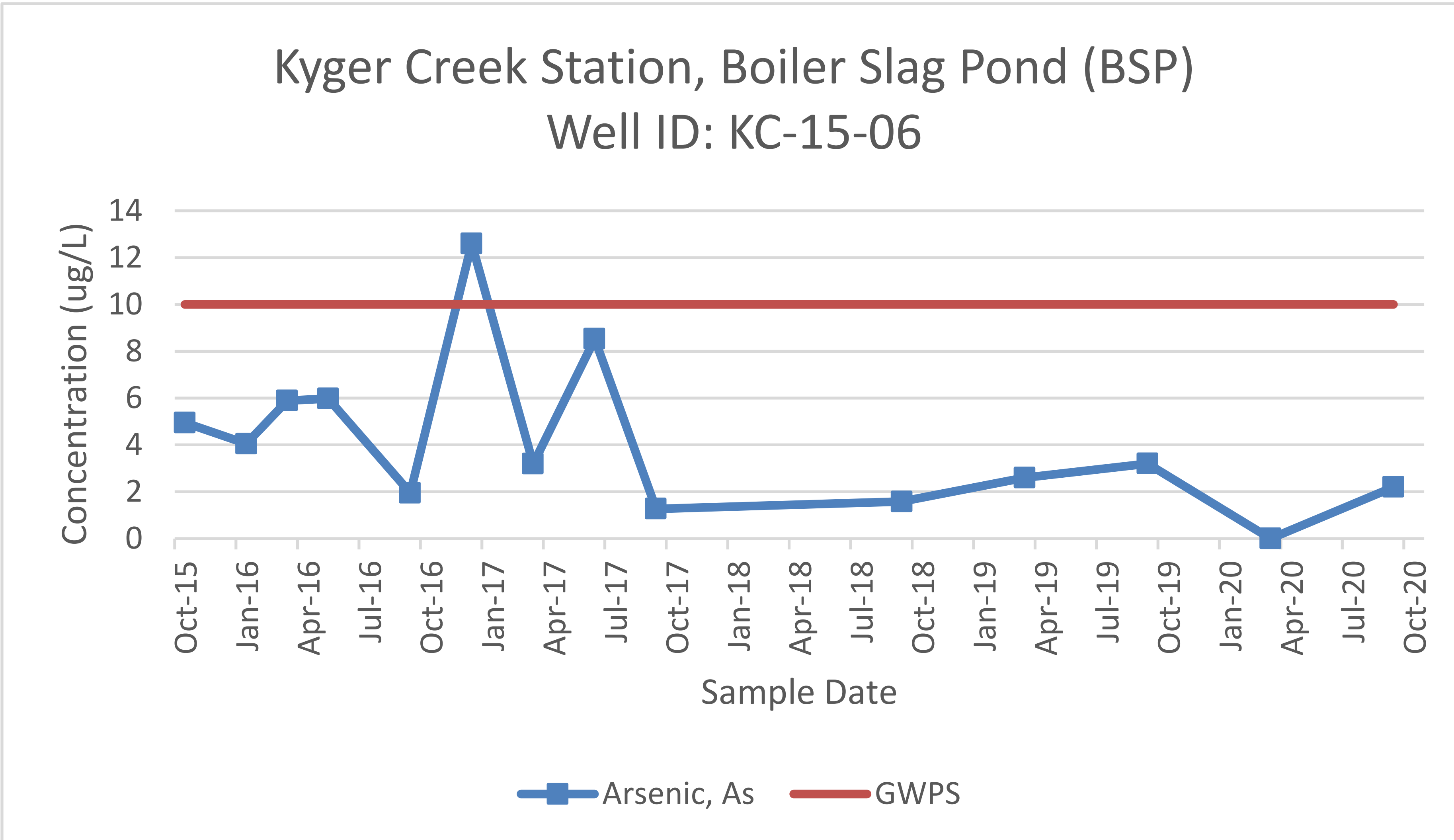
ATTACHMENT F-3

TIME-SERIES GRAPHS

ATTACHMENT F-3
SUMMARY OF ARSENIC CONCENTRATIONS IN GROUNDWATER
BOILER SLAG POND
CCR GROUNDWATER MONITORING PROGRAM
KYGER CREEK STATION
CHESHIRE, OHIO

Well ID / Sampling Event	KC-15-06	KC-15-07	KC-15-08
Oct-15	4.95	29	10.6
Jan-16	4.05	60.1	9.0
Mar-16	5.89	104	8.9
May-16	5.98	112	6.2
Sep-16	1.95	135	6.0
Dec-16	12.6	133	7.4
Mar-17	3.19	123	10.2
Jun-17	8.53	66.9	11.5
Sep-17	1.27	153	10.3
Sep-18	1.58	152	3.9
Mar-19	2.6	160	11
Sep-19	3.2	120	9.4
Mar-20	7.3	82	11
Sep-20	2.2	130	12

1. Concentrations are provided in ug/L.
2. The results from SSI resampling event are not included.



Kyger Creek Station, Boiler Slag Pond (BSP)
Well ID: KC-15-06
Concentration (ug/L)
0
2
4
6
8
10
12
14
Oct-15
Jan-16
Apr-16
Jul-16
Oct-16
Jan-17
Apr-17
Jul-17
Oct-17
Jan-18
Apr-18
Jul-18
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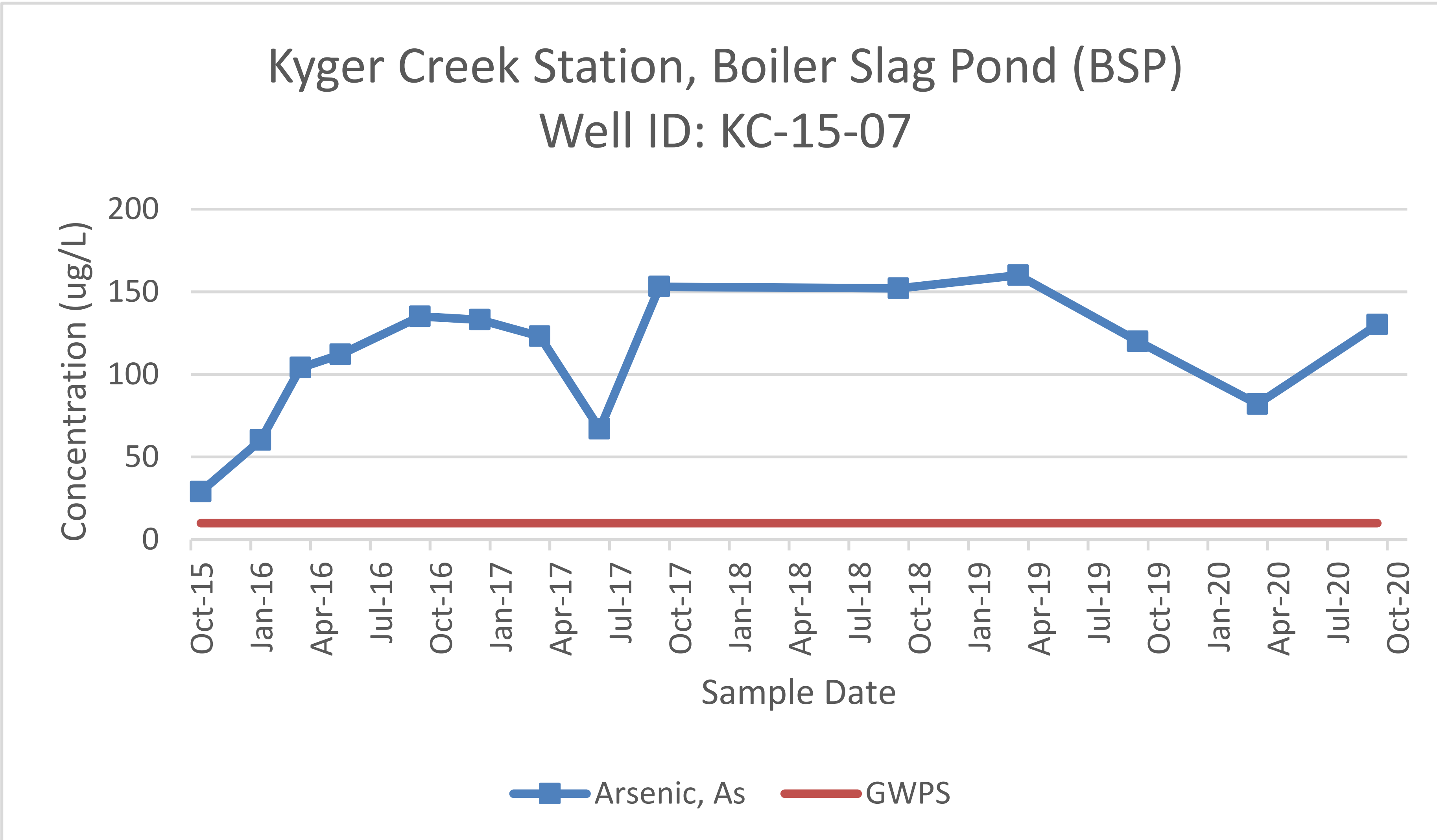
Oct-20
Sample Date
Arsenic, As
GWPS


Kyger Creek Station, Boiler Slag Pond (BSP)
Well ID: KC-15-07
Concentration (ug/L)
200
150
100
50
0
Oct-15
Jan-16
Apr-16
Jul-16
Oct-16
Jan-17
Apr-17
Jul-17
Oct-17
Jan-18
Apr-18
Jul-18
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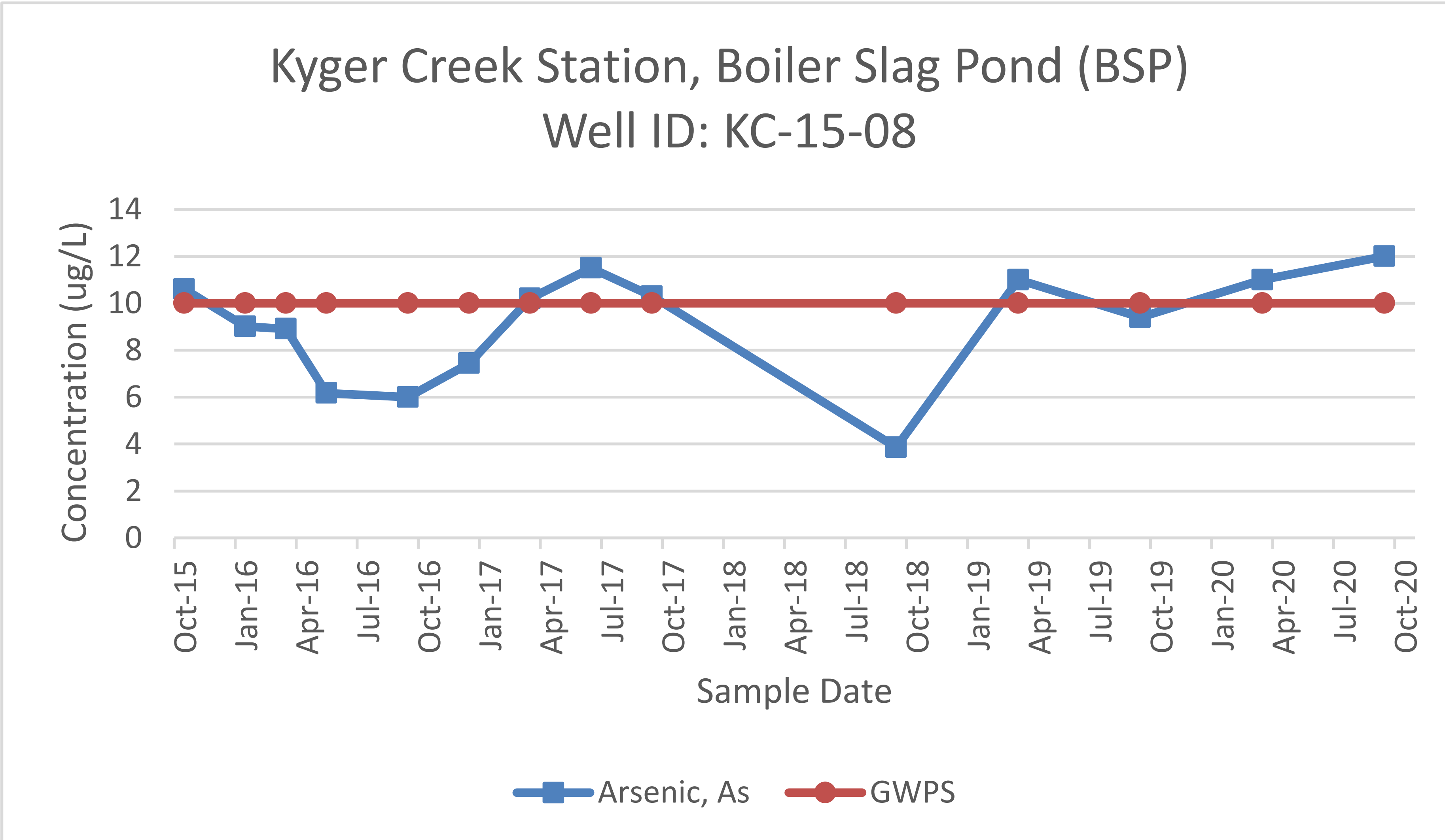
Sample Date
Arsenic, As
GWPS


Kyger Creek Station, Boiler Slag Pond (BSP)
Well ID: KC-15-08
Concentration (ug/L)
0
2
4
6
8
10
12
14
Oct-15
Jan-16
Apr-16
Jul-16
Oct-16
Jan-17
Apr-17
Jul-17
Oct-17
Jan-18
Apr-18
Jul-18
Oct-18
Jan-19
Apr-19
Jul-19
Oct-19
Jan-20
Apr-20
Jul-20
Oct-20
Sample Date
Arsenic, As
GWPS

APPENDIX C6 – 2020 SEMI-ANNUAL SELECTION OF REMEDY PROGRESS REPORT (BOILER SLAG POND)

OHIO VALLEY ELECTRIC CORPORATION
3932 U. S. Route 23
P. O. Box 468
Piketon, Ohio 45661
740-289-7200

WRITER'S DIRECT DIAL NO:
740-897-7768

June 1, 2020

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Ms. Laurie Stevenson, Director
Ohio Environmental Protection Agency
50 West Town Street, Suite 700
P.O. Box 1049
Columbus, OH 43216-1049

Dear Ms. Stevenson:

Re: Ohio Valley Electric Corporation
2020 Semi-Annual Selection of Remedy Report

As required by 40 CFR 257.106(h)(9), the Ohio Valley Electric Corporation is providing notification to the Director of the Ohio Environmental Protection Agency that the first Semi-Annual Selection of Remedy report has been completed in compliance with 40 CFR 257.97(a) for Kyger Creek Station's Boiler Slag Pond (BSP). The intent of the report is to provide a six-month update on the progress of selecting a remedy for confirmed Appendix IV SSIs above the groundwater protection standard in the groundwater at the BSP. The report has been placed in the facility's operating record in accordance with 40 CFR 257.105(h)(12), as well as, on the company's publicly accessible internet site in accordance with 40 CFR 257.107(h)(9), which can be viewed at https://www.ovec.com/CCRCompliance.php.

If you have any questions, or require any additional information, please call me at (740) 897-7768.

Sincerely,

Tim Fulk

Tim Fulk
Engineer II

TLF:klr

Semiannual Report on the Progress of Remedy Selection

40 CFR 257.97(a)

Boiler Slag Pond

Kyger Creek Station

Cheshire, Ohio

May 2020

Prepared by: Ohio Valley Electric Corporation

3932 U.S. Route 23

Piketon, OH 45661

Ohio Valley Electric Corporation / Indiana-Kentucky Electric Corporation

TABLE OF CONTENTS

1 INTRODUCTION

In accordance with 40 CFR § 257.97(a), the Ohio Valley Electric Corporation (OVEC) has prepared this Semi-Annual report to document progress toward remedy selection, design and implementation of corrective actions associated with groundwater monitoring exceedances at the Kyger Creek Station's Boiler Slag Pond (BSP). This report summarizes activities during the period of December 6, 2019, through June 6, 2020. Updates to the report will be published semi-annually, until such time a remedy has been selected. Upon selection, a final report will be prepared describing the selected remedy and how it meets the standards specified in the rule.

1.1 REGULATORY BACKGROUND

On December 19, 2014, the United States Environmental Protection Agency (U.S. EPA) issued their final Coal Combustion Residuals (CCR) regulation which regulates CCR as a non-hazardous waste under Subtitle D of Resource Conservation and Recovery Act (RCRA) and became effective six (6) months from the date of its publication (April 17, 2015) in the Federal Register, referred to as the "CCR Rule." The rule applies to new and existing landfills, and surface impoundments used to dispose of or otherwise manage CCR generated by electric utilities and independent power producers. The rule includes requirements for monitoring groundwater and assessing corrective measures if constituents listed in Appendix IV of the rule are detected in groundwater samples collected from downgradient monitoring wells at Statistically Significant Levels (SSL) greater than the established GWPS.

In May 2019, OVEC initiated an Assessment of Corrective Measures (ACM) at the Kyger Creek BSP as a result of a confirmed SSL of Appendix IV constituent Arsenic in monitoring well KC-15-07 during September 2018 Assessment Monitoring Activities, as required by 40 CFR § 257.97(a). In accordance with 40 CFR § 257.96(a), OVEC prepared an ACM report for the Kyger Creek BSP. It was placed in the facility's operating record and uploaded to OVEC's Publicly Accessible Internet Site on September 19, 2019. The ACM Report provided an assessment of the effectiveness of potential corrective measures in achieving the criteria provided in 40 CFR § 257.96(c). Multiple strategies were evaluated to address groundwater exhibiting concentrations of Arsenic above the GWPS, with two technically feasible options identified. Both feasible options require dewatering of the pond, followed by the execution of an engineered cap and closure of the BSP facility, and are as follows:

- Monitored Natural Attenuation (MNA); and
- Conventional Vertical Well System (Groundwater Extraction and Treatment) (Ex-Situ)

Following the completion of the ACM Report, OVEC hosted a public meeting to present the options for remediation on November 6, 2019, in Gallipolis, Ohio. OVEC then observed a 30-day public comment period, per 40 CFR § 257.97(a), prior to beginning the process of selecting a remedy. No comments were received during this time period.

Semi-annual reports are required pursuant to 40 CFR § 257.97(a) to document progress toward remedy selection and design. The CCR Rule provides flexibility for more field investigation, data analysis and consideration prior to the selection of a remedy. OVEC will continue to review new data as it becomes available and implement changes to the groundwater monitoring and corrective action program as necessary to maintain compliance with the rule.

1.2 Report Contents

The first semi-annual progress report provides regulatory background, an overview of site characteristics and ACM findings, and summarizes activities supporting the selection and implementation of a remedy during the period of December 6, 2019, through June 6, 2020.

2 Site Background

The Kyger Creek Station, located in Cheshire, Ohio, is a 1.1-gigawatt coal-fired generating station operated by OVEC. The Kyger Creek Station has five (5), 217-megawatt generating units and has been in operation since 1955. CCRs were sluiced to surface impoundments located in the plant site since it began operation. The Kyger Creek BSP is located at the south end of the Kyger Creek Station and is approximately 32 acres in size. The BSP was built to serve as a process and disposal area for coal combustion waste products generated at the station. Overflow from the BSP is carried into a reinforced concrete intake structure at the south end of the Boiler Slag Complex. Water entering the intake structure is discharged into the Clearwater Pond. Built in 1980, the Clearwater Pond is approximately nine (9) acres in size and is located to the southwest end of BSP. The Clearwater Pond is not a CCR unit and monitoring is not required.

2.1 Unit Specific Geology and Hydrogeology

Available data show, deposits of silts and clays beneath the base of the BSP range from 15 to over 50 feet thick. The silts and clays transition to a layer of sand and gravel where groundwater is present. Based on previously reported physical properties and yield, the sand and gravel unit was determined to be the uppermost aquifer beneath the BSP and is located more than five (5) feet beneath the bottom of the BSP as required by the CCR Rule. Water level data from the existing wells illustrate groundwater flowing primarily toward the south and southwest.

Regional groundwater flows to the south and southeast towards the Ohio River. Local groundwater flow beneath the BSP generally flows from the northwest to the south and southeast towards the Ohio River. During periods when the water level in the Ohio River rises significantly and flooding occurs, groundwater flow in the uppermost aquifer will temporarily reverse with groundwater flowing toward the north and east beneath the BSP. This flow reversal is evident in groundwater levels measured in February 2018.

2.2 Potential Receptor Review

OVEC completed an assessment of the proximity of public and private drinking water supplies to the BSP in response to SSLs above the GWPS. It was determined that the closest withdrawal wells designated by the Ohio Department of Natural Resources (ODNR) as drinking water wells were located greater than one mile from the facility, and were not hydraulically connected to the groundwater at the BSP facility.

3 Groundwater Assessment Monitoring Program

Groundwater assessment monitoring for the Kyger Creek BSP is conducted in accordance with 40 CFR § 257.95.

3.1 Groundwater Monitoring Well Network

In compliance with 40 CFR § 257.91, the CCR groundwater monitoring network for the BSP consists of the following eight (8) wells:

- KC-15-01 (Upgradient);
- KC-15-02 (Upgradient);
- KC-15-03 (Upgradient);
- KC-15-04 (Downgradient);
- KC-15-05 (Downgradient);
- KC-15-06 (Downgradient);
- KC-15-07 (Downgradient); and
- KC-15-08 (Downgradient).

Additionally, three (3) monitoring wells that were installed as part of the additional assessment activities for the BSP were added to the CCR groundwater monitoring network for the BSP
as follows:

- KC-19-27 (Downgradient);
- KC-19-28 (Downgradient); and
- KC-19-29 (Downgradient).

3.2 Groundwater Characterization

Groundwater assessment monitoring was first conducted at the Kyger BSP during September 2018 sampling. Arsenic, an Appendix IV constituent, was detected and confirmed to exceed the GWPS of 10 µg/L at well KC-15-07. In response, OVEC was required to characterize the extent of the release, pursuant to 40 CFR § 257.95(g)(1), and installed additional monitoring wells at the property boundary (wells KC-19-27, KC-19-28, KC-19-28). It was determined that Arsenic was not leaving the property at levels higher than the GWPS, and therefore the potential remediation zone was confined to the BSP complex (AGES, 2019).

4 Assessment of Corrective Measures

In accordance with 40 CFR § 257.96(a), OVEC prepared an ACM report for the Kyger Creek BSP and placed it in the facility's operating record. It was uploaded to OVEC's Publicly Accessible Internet Site on September 19, 2019. The ACM Report provided an assessment of the effectiveness of potential corrective measures in achieving the criteria provided in 40 CFR § 257.96(c).

4.1 Planned Source Control Measures

Per 40 CFR § 257.96(a), the objectives of the corrective measures evaluated in this ACM Report are "to prevent further releases, to remediate any releases, and to restore affected area to original conditions." As required in 40 CFR § 257.97(b), corrective measures, at minimum, must:

(1) Be protective of human health and the environment;

(2) Attain the groundwater protection standard as specified pursuant to § 257.95(h);

(3) Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents in Appendix IV to this part into the environment;

(4) Remove from the environment as much of the contaminated material that was Released from the CCR unit as is feasible, taking into account factors such as avoiding in appropriate disturbance of sensitive ecosystems;

(5) Comply with standards for management of wastes as specified in § 257.98(d).

During the ACM development process, several in-situ and ex-situ remedial technologies were evaluated to address Arsenic in groundwater at the BSP, and screened against evaluation criteria requirements in 40 CFR § 257.96(c). The two (2) technologies that appear to be most technically feasible, and therefore most likely for selection as a remedy were:

- Monitored Natural Attenuation; and
- Conventional Vertical Well System (Groundwater Extraction) (Ex-Situ).

Both feasible options require dewatering of the pond, followed by the execution of an engineered cap and closure of the BSP facility. OVEC is committed to continued compliance with the requirements and timeframes of the CCR Rule, and will close the Kyger BSP in accordance with 40 CFR § 257.102 prior to implementation of further groundwater remediation measures. OVEC, with the assistance of its Qualified professional Engineer, has evaluated its site and available resources, and determined that no alternative capacity is available to receive the boiler slag. As a result, closure of the BSP will not commence until OVEC has constructed alternative capacity. This will likely involve the construction of concrete dewatering tanks and a new lined low volume waste pond in the immediate area of the existing BSP in order to manage Kyger Creek Station's boiler slag waste stream and other non-CCR low volume waste waters. Once the proposed equipment and management ponds are operational, the BSP can be removed from operation and closure operations will be completed. A projected date for final closure and ceasing operation is unknown at this time, and subject to USEPA approval.

The initial closure methods described above will reduce the potential for releases and migration of CCR constituents. Groundwater assessment monitoring as required by 40 CFR § 257.96(b) will continue until a remedy is selected and implemented. The monitoring will be conducted to track changes in groundwater conditions as a result of these closures and operational changes. These data will also be considered in the selection and design of a remedy in accordance with 40 CFR § 257.97.

4.2 Potential Remedial Technologies

As a source control measure, the Kyger Creek BSP will be closed in accordance with CFR § 257.102 prior to implementation of further groundwater remediation efforts. In addition to source control measures, two primary strategies were identified to address groundwater exhibiting concentrations of Arsenic above the GWPS, including:

- Monitored Natural Attenuation; and
- Conventional Vertical Well System (Groundwater Extraction) (Ex-Situ).

The ACM report titled "Kyger Creek BSP- Assessment of Corrective Measures Report" (AGES, 2019), which is available on OVEC's publicly accessible internet site, provides a more detailed description of these corrective measures. The effectiveness of each potential corrective measure was assessed in accordance with 40 CFR § 257.96 (c), and both options listed above are considered technically feasible, and appropriate for groundwater remediation efforts at the BSP.

5 SELECTION OF REMEDY: CURRENT PROGRESS

As noted in the ACM Report, OVEC determined that source control would be best achieved by leaving the CCR material in place and installing a CCR compliant cap system.

During the period covered by this semi-annual report, OVEC evaluated the construction duration and constraints associated with closure in place. A preliminary cost estimate and project schedule has been developed for this portion of corrective measure activities.

OVEC's hydrogeologist conducted the semi-annual groundwater sampling and testing during this report period. In addition to sampling the monitoring wells in the CCR groundwater monitoring network, the sentinel wells installed to aid in ACM activities were also sampled. A total of 11 wells (8 Network and 3 Sentinel) were sampled near the BSP and the results summarized in the report, "2019 – Kyger Creek CCR Annual Groundwater Monitoring and Corrective Action Report, (AGES, 2020)"

5.1 PLANNED WORK

OVEC's consultant or hydrogeologist will sample and test all of the monitoring wells as part of the semi-annual requirement.

OVEC will file a site-specific extension request with US EPA to identifying a technically feasible timeline for closure of the BSP since there is no alternative capacity to receive the CCR and non-CCR waste streams.

OVEC and their CCR hydrogeologist will continue evaluate the technology options identified in the ACM, and engage the site's Qualified Professional Engineer to ensure the alternatives meet the criteria set forth in 40 CFR 257.97.

OVEC will submit the next progress report by December 6, 2020.

A final report will be prepared after the remedy is selected. This report will describe the proposed solution and how it meets the standards specified in 40 CFR § 257.97(b) and 257.97(c). Recordkeeping requirements specified in 40 CFR § 257.105(h), notification requirements specified in 40 CFR § 257.106(h), and internet requirements specified in 40 CFR § 257.107(h) will be complied with as required by 40 CFR § 257.96(f).

APPENDIX C7 – STRUCTURAL STABILITY ASSESSMENT

Stantec Consulting Services Inc.
11687 Lebanon Road, Cincinnati OH 45241

October 17, 2016
File: 175534017
Revision 0

Ohio Valley Electric Corporation
3932 U.S. Route 23
P.O. Box 468
Piketon, Ohio 45661

RE: Initial Structural Stability Assessment
Boiler Slag Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Kyger Creek Station
Cheshire, Gallia County, Ohio

1.0 PURPOSE

This letter documents Stantec's certification of the initial structural stability assessment for the Ohio Valley Electric Corporation (OVEC) Kyger Creek Station's Boiler Slag Pond. Based on this assessment, the Boiler Slag Pond is in compliance with the structural stability requirements in the EPA Final CCR Rule at 40 CFR 257.73(d).

2.0 INITIAL STRUCTURAL STABILITY ASSESSMENT

As described in 40 CFR 257.73(d), documentation is required on how the Boiler Slag Pond has been designed, constructed, operated, and maintained according to the structural stability requirements listed in the section. The combined capacity of all spillways must also be designed, constructed, operated, and maintained to adequately manage flow from the 1,000-year storm event based upon a hazard potential classification of "significant."

3.0 SUMMARY OF FINDINGS

The attached report presents the initial structural stability assessment of the Boiler Slag Pond. The results show that the impoundment meets the structural stability requirements set forth in 40 CFR 257.73(d)(1)-(2).

4.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Stan A. Harris, being a Professional Engineer in good standing in the State of Ohio, do hereby certify, to the best of my knowledge, information, and belief:

1. that the information contained in this certification is prepared in accordance with the accepted practice of engineering;

2. that the information contained herein is accurate as of the date of my signature below; and

3. that the initial structural stability assessment for the OVEC Kyger Creek Station's Boiler Slag Pond meets the requirements specified in 40 CFR 257.73(d)(1)-(2).

SIGNATURE DATE 10/17/16

ADDRESS: Stantec Consulting Services Inc.
11687 Lebanon Road
Cincinnati, Ohio 45241

TELEPHONE: (513) 842-8200

ATTACHMENTS: Kyger Creek Boiler Slag Pond Initial Structural Stability Assessment Report

STATE OF OHIO
STAN A. HARRIS
53083
REGISTERED
PROFESSIONAL ENGINEER
10/17/16

Initial Structural Stability Assessment

Kyger Creek Station
Boiler Slag Pond
Cheshire, Gallia County, Ohio

Prepared for:
Ohio Valley Electric Corporation
Piketon, Ohio

Prepared by:
Stantec Consulting Services Inc.
Cincinnati, Ohio

October 17, 2016

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 PROJECT BACKGROUND

On April 17, 2015 the "Disposal of Coal Combustion Residuals (CCR) from Electric Utilities" (EPA Final CCR Rule) was published in the Federal Register. Stantec Consulting Services, Inc. (Stantec) was contracted by the Ohio Valley Electric Corporation (OVEC) to analyze the structural stability of the Kyger Creek Station's Boiler Slag Pond (BSP) evaluate its compliance with §257.73 of the EPA Final CCR Rule.

As required by §257.73 of the EPA Final CCR Rule, an initial structural integrity evaluation is required by October 17, 2016 and must include an initial structural stability assessment for each existing CCR surface impoundment that meets the conditions of paragraph (b) as follows:

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.

2.0 UNIT DESCRIPTION

The Kyger Creek Station is located on the north shore of the Ohio River downstream of Cheshire, Ohio. The station consists of five coal-fired electric generating units, each nominally rated at 217 megawatts. The Kyger Creek Station is directly accessible from State Route 7.

The Boiler Slag Pond is located south of the station adjacent to the Ohio River. It part of the Bottom Ash Complex, composed of the Boiler Slag Pond and the Clearwater Pond. Constructed in 1955, the complex was created by building a perimeter dike to enclose an area of approximately 40 acres. A splitter dike separates the Bottom Ash Complex into two ponds with the Boiler Slag Pond at 30.1 acres and the Clearwater Pond at 9.39 acres. Boiler slag is sluiced to the north end of the Boiler Slag Pond for settling. Overflow is conveyed through an outlet structure at the Boiler Slag Pond's south end into the Clearwater Pond for polishing. Water discharges into the Ohio River through a NPDES-permitted outlet structure in the southeastern end of the Clearwater Pond (AEPSC, 2016). The Boiler Slag Pond is bounded by State Route 7 to the west, a substation to the north, the Ohio River to the east, and Kyger Creek and agricultural land to the south.

The subsections under §257.73(d) address conditions of appurtenances categorized as embankments, spillways, or hydraulic structures. Sections 2.1 to 2.3 below provide descriptions of the individual unit elements that fall within these appurtenance categories. Appendix A includes a plan view of the Kyger Creek Station.

Note that all elevations included in this document and appendices are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

2.1 EMBANKMENTS

2.1.1 BSP Perimeter Dike

The BSP Perimeter Dike was built between 1954 and 1955 during construction of the Kyger Creek Station. The dike encompasses the entire Bottom Ash Complex. The splitter dike between the two ponds was built in 1980. The rolled earth dike is approximately 5,800 feet long with a maximum height of 41 feet. The crest wide is estimated as 20 feet with an elevation of 582 feet (CHA, 2009). The interior embankment has a slope of 2.25H:1V, while the exterior slope is 2.5H:1V to 3H:1V. The bottom of the ponds is at elevation 541 feet (Terracon, 2014).

2.2 SPILLWAYS

2.2.1 Primary Spillway System

The configuration of the primary spillway system for the Bottom Ash Complex is documented by CHA (2009) and by construction drawings (AEPSC, 2016). The Boiler Slag Pond discharges into the Clearwater Pond through a reinforced concrete intake structure composed of a 36-inch pipe with a 42-inch by 39-inch riser at elevation 557.0 feet. Water entering the intake structure is discharged into the Clearwater Pond through a 30-inch diameter reinforced concrete pipe near the western end of the splitter dike. The outlet invert for this discharge pipe is elevation 551.0 feet (Terracon, 2014; CHA, 2009). A similar reinforced concrete intake structure and discharge pipe are located in the southeastern portion of the Clearwater Pond to discharge into the Ohio River (CHA, 2009).

2.3 HYDRAULIC STRUCTURES

Other than the primary spillway described above, no hydraulic structures are located at the SFAP.

3.0 FOUNDATIONS AND ABUTMENTS (§257.73(d)(1)(i))

Per §257.73(d)(1)(i), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with stable foundations and abutments. The Boiler Slag Pond has the following features that fall within this requirement:

- BSP Perimeter Dike

Assessment of the foundations and abutments associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

- Review inspection reports of the facility, considering frequency of inspections, and if the inspections included review and/or assessment of features including cracking, settlement, deformation, or erosion of the foundations/abutments. Inspections should indicate that there are no significant signs of tension cracking, settlement, depressions, erosion, and/or deformations at the crest, slope, and toe of the structure.

- Confirm that an assessment of seepage conditions of the foundation, with considerations of heave and vertical exit gradient, has been performed. Verify that the seepage assessment follows appropriate methodologies (such as USACE EM 1110-2-1901) and that the foundations exhibit acceptable performance (e.g. FS for piping greater than or equal to 3.0).

3.1 BSP PERIMETER DIKE

3.1.1 Background

The Boiler Slag Pond is formed by a perimeter dike system; therefore, there are no natural abutments. The station is in an unglaciated area of Ohio on the Marietta Plateau. Alluvium covers the site with a thickness of 16 to 40 feet. It is clay interbedded with sand lenses. Glacial outwash deposits of variable thickness lie between the alluvium and bedrock. Bedrock is estimated at elevation 494 to 497 feet. It is a shale and sandstone of Pennsylvanian-age Conemaugh Group (Terracon, 2014).

DLZ (2011) encountered bedrock refusal at elevation 499 feet, noting a soft to medium hard gray siltstone interbedded with shale. Foundation soils were a soft to medium stiff lean clay from the ground surface to approximately elevation 530 feet. The clay layer had lenses of silt and varying amounts of fine to medium sand. A medium dense to dense granular layer was encountered from elevation 531.2 to 513.8 feet.

3.1.2 Assessment

A qualified person performs inspections of the Boiler Slag Pond weekly, monthly, quarterly, and annually. Regular site inspections have been conducted and documented for the Boiler Slag Pond from 1985 to 2016. These inspections include observations related to foundation and abutment conditions with respect to observable cracking, settlement, depressions, erosion, and deformation.

AEPSC (2015) noted no signs of new sloughing, depressions or areas of wetness and no seeps. No significant settlement, misalignment, potholes, or noticeable sign of distress was noted. No bulging or settlement, seepage or wet areas were observed on the exterior slope.

CHA (2009) observed no slumps or bulges in the interior or exterior slopes. Occasional erosion rills were noted in the bottom ash interior slope. The exterior embankment toe was probed along State Route 7 and noted to be relatively firm. Vegetation obscured portions of the slopes, but no scarps, sloughs, toe bulges were noted were the slope was visible. The eastern portion of the perimeter dike along the Ohio River exhibited some vegetation loss and erosion rills on the exterior slope at the time of the field visit.

A seepage analysis for the original dike construction is not available. As part of the geotechnical exploration in 2011, DLZ noted that the piezometer data indicates very low phreatic surfaces through the perimeter dike and at the downstream toe. Groundwater levels were generally 12 to 24 feet below the impounded water level below the perimeter dike of the surface impoundments. This was assumed to be based on rapid hydraulic head dissipation in the clay soil consistent with very low permeability laboratory test results. At the downstream toes of the perimeter dikes, groundwater was typically 5 to 22 feet below the ground surface. DLZ concluded that seepage of water through or under the dams should not be a concern (2011).

3.1.1 Conclusion

Based on the assessment of the foundation and abutments for the BSP Perimeter Dike, the EPA Final CCR Rule-related criteria listed above have been met.

4.0 SLOPE PROTECTION (§257.73(d)(1)(ii))

Per §257.73(d)(1)(ii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown. The Boiler Slag Pond has the following features that fall within this requirement:

- BSP Perimeter Dike

Assessment of the slope protection associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. *Regular (weekly) inspections for erosion. Inspections should show there are no significant signs of deterioration in the slope protection configuration of the Item.*

2. *Appropriate slope protection shall be provided based on anticipated flow velocities. [Hydrologic/hydraulic calculations of flow velocities on the slope of the Item for the appropriate erosive forces. Some common slope protection measures include: riprap, gabions, paving (concrete or asphalt), or appropriate vegetative cover.]*

3. *If slope protection is riprap, filter layer(s) under the riprap shall be designed according to established filter criteria. However, existing riprap cover may be evaluated based on performance and observations during inspections.*

4.1 BSP PERIMETER DIKE

4.1.1 Background

Slope protection for the BSP Perimeter Dike consists of grass on the exterior slopes. The toes of the north and eastern slope also contain trees and brush. The interior slope is bottom ash lined. The splitter dike is bottom ash lined. Flow from the primary spillway's discharge pipe is adequately dissipated through a gradual pipe slope and discharge elevation into the receiving stream (AEPSC, 2015).

4.1.1 Assessment

As reported by the CHA (2009), regular drive-by inspections are performed with a checklist inspection quarterly, and an annual inspection by AEPSC. The spillway is regularly visited to take water quality samples, while the instrumentation in the dams are read monthly. Areas of erosion are prioritized for appropriate repairs. Regular site inspections performed by a registered professional engineer have been conducted and documented for the Boiler Slag Pond from 1985 to 2016. Site inspection reports generally indicate appropriate maintenance of slope protection features of the dam.

The exterior slope of the BSP Perimeter Dike is vegetated with maintained grass. Trees and brush are present at the toe of slope. The interior slope of the pond is bottom ash due to the current operational nature of the Bottom Slag Pond. The interior slopes are redressed to maintain slope integrity and address areas of erosion.

4.1.1 Conclusion

Based on the assessment of the slope protection for the BSP Perimeter Dike, the EPA Final CCR Rule-related criteria listed above have been met.

5.0 EMBANKMENT DIKE COMPACTION (§257.73(d)(1)(iii))

Per §257.73(d)(1)(iii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit. The Boiler Slag Pond has the following features that fall within this requirement:

- BSP Perimeter Dike

Assessment of the dike compaction associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. Documentation showing the dike was mechanically compacted. Acceptable documentation may include construction drawings, field notes, construction photographs, correspondences, or any evidence showing the dike was mechanically compacted during construction.

2. If no construction documentation is available specific data from geotechnical explorations of dike may be used. Geotechnical borings with continuous SPTs may be used to assess compaction of the dike. Appropriate methodology correlating blow counts and compaction (density) should be used.

5.1 BSP PERIMETER DIKE

5.1.1 Background

The Bottom Ash Complex was designed by Sargent Lundy Engineers of Chicago, Illinois and constructed by George B. Herring & Sons, Inc. of Mansfield, Ohio. Arthur and Leo Casagrande of Cambridge, Massachusetts were also retained during the construction phase and reportedly made a number of site visits as the embankment and appurtenances were being built. Only limited design drawings exist for the BSP Perimeter Dike. Technical memoranda and letters between the Casagrande firm and the plant during the design and construction of the plant and other structures do exist. Construction photos are available showing period-appropriate large construction equipment working on the site. Subsurface explorations of the dike were also available that provided SPT data used in the assessment.

5.1.1 Assessment

Historical construction photographs, technical memoranda, and letters provide documentation of compaction requirements related to the construction of the BSP Perimeter Dike. Construction criteria related to dike embankment materials and dike compaction as noted on this documentation include:

- A discussion proposed dike materials and the need for proper moisture control and compaction in thin layers with heavy, rubber-tired equipment slightly on the dry side of optimum (A. Casagrande, 1952).

Two previous geotechnical explorations were available to review as part of this assessment (DLZ, 2011 and DLZ, 2015). Each was a geotechnical exploration and slope stability evaluation of the BSP Perimeter dike. The programs included drilling and laboratory testing.

DLZ (2011) stated that results of the subsurface investigations indicated subsurface conditions were similar for the Boiler Slag Pond and the South Fly Ash Pond. Embankment fill was stiff to very stiff lean clay with varying amounts of silt and fine sand. Standard penetration testing within the borings indicated blow count N_{60} values ranging from 5 to 30 with an average of 13. The N_{60} values have been adjusted to account for hammer efficiency and field procedures. Based on laboratory testing results, DLZ assigned the embankment clay fill drained shear strength parameters of 100 psf cohesion and an internal friction angle of 32 degrees with a wet unit weight of 125 pounds per cubic foot (pcf). Correlating these results using NAVFAC DM-7.2 indicate that appropriate compaction exists within the embankment of the WBSP Perimeter Dike (NAVFAC, 1986).

5.1.2 Conclusion

Based on the assessment of the embankment dike compaction for the BSP Perimeter Dike, the EPA Final CCR Rule-related criteria listed above have been met.

6.0 VEGETATED SLOPES (§257.73(d)(1)(iv))

Per §257.73(d)(1)(iv), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with vegetated slopes of dikes and surrounding areas, except for slopes which have an alternate form or forms of slope protection. The Boiler Slag Pond has the following features that fall within this requirement:

- BSP Perimeter Dike

Assessment of the vegetated slopes associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. Regular inspection records showing vegetative cover sufficient to prevent surface erosion while allowing an unobstructed view to visually inspect the slope.

6.1 BACKGROUND

The BSP Perimeter Dike is vegetated along the exterior slope. Trees and brush are present at the toe of slope. The interior slope of the pond is bottom ash due to the current operational nature of the Bottom Ash Complex.

6.2 ASSESSMENT

Slope protection for the BSP Perimeter Dike exterior slope consists of grass or riprap with trees and brush present at the toe of slope. Bottom ash lines the interior of the dike due to the operational nature of the Boiler Slag Pond. Erosion is addressed as a maintenance concern. Erosion of clay dike soils is not visible (AEPSC, 2016).

6.3 CONCLUSION

Based on the assessment of the vegetated slopes for the BSP Perimeter Dike, the EPA Final CCR Rule-related criteria listed above have been met.

7.0 SPILLWAY CONDITION AND CAPACITY(§257.73(d)(1)(v))

Per §257.73(d)(1)(v), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with a single spillway or combination of spillways that meet the condition and capacity requirements as outlined in this section of the EPA Final CCR Rule. The combined capacity of all spillways are to be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in this section. The Boiler Slag Pond has the following features that fall within this requirement:

- Boiler Slag Pond Primary Spillway System

Assessment of the spillway condition and capacity associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. Outlet channel must be of non-erodible material designed to carry sustained flow velocities based on the required flood events. [Estimate flow velocities and select appropriate material using hydraulic analysis for the following flood events: PMF (high hazard potential unit), 1000-year flood (Significant hazard unit), 100-year flood (low hazard potential unit).]

2. Must adequately manage flow during and following the peak discharge. [Estimate size of outlet structure based of hydraulic analysis for the following flood events: PMF (High hazard potential unit), 1000-year flood (Significant hazard potential unit), and 100-year flood (low hazard potential unit).]

3. Must be structurally stable. [Assess stability of structure using stability and stress analyses according to an appropriate methodology. Some acceptable methodologies may include: EM 1110-2-2400, EM 1110-2-2100, ACI 350, etc.]

4. Must maintain structural integrity. [Structural integrity may be warranted by periodic inspections of existing conduits. Inspections must show no significant presence of deformation, distortions, cracks, joint separation, etc.]

5. Must be free from significant amounts of obstruction and anomaly which may affect the operation of the hydraulic structure [Perform periodic pipe inspections to detect deterioration, deformation, distortion, bedding deficiencies, and sediment, and debris accumulations.]

7.1 PRIMARY SPILLWAY SYSTEM

7.1.1 Background

The Boiler Slag Pond is classified as a significant hazard structure requiring the combined capacity of all spillways be adequate to manage the flow during and following the peak discharge from a 1000-year flood.

7.1.2 Assessment

7.1.2.1 Spillway Capacity

The Inflow Design Flood Control System Plan for the Boiler Slag Pond demonstrates the Boiler Slag Pond meets the capacity requirements outlined in §257.73(d)(1)(v) of the EPA Final CCR Rule. During the October 2015 annual dam and dike inspection, the overflow discharge pipe was flowing unobstructed into the Clearwater Pond. No spalling or deterioration of the concrete structure was observed. The spillway intake structure in the Clearwater Pond and outfall into the Ohio River were also in good functioning condition with no signs of deterioration. The wooden trestle supporting the discharge pipe through the splitter dike and the discharge pipe entering the Clearwater Pond were in poor condition at the time of the site visit (AEPSC, 2015). The overflow discharge pipe structure is being redesigned as part of 2016 maintenance operations.

7.1.2.2 Structural Stability

The Boiler Slag Pond overflows into a reinforced concrete intake structure at the southwestern end of the splitter dike separating the pond from the Clearwater Pond. The intake structure is rectangular in shape with a 24-inch by 39-inch cross section. Flow discharges through a 30-inch concrete pipe at elevation 557 feet into the Clearwater Pond (CHA, 2009).

The primary spillway intake structure for the Clearwater Pond is also rectangular in shape with a 24-inch by 39-inch cross section. Flow discharges through a 30-inch concrete pipe at elevation into the Ohio River (CHA, 2009). The outlet is a reinforced concrete head wall.

The Bottom Ash Complex's spillway system is inspected monthly during water quality sampling and annually as part of the dam and dike inspection. Physical condition, flow through the pipe, and maintenance concerns are noted and addressed. For the spillway intake structure connecting the Boiler Slag and Clearwater Ponds, video camera inspections of the structure were performed in 2015 and March 2016. The outlet of the spillway structure was video inspected in 2013 and 2015. A root was removed from the reinforced concrete pipe in November 2015.

7.1.3 Conclusion

Based on the assessment of the Bottom Ash Complex Primary Spillway System condition and capacity for the Boiler Slag Pond, the EPA Final CCR Rule-related criteria listed above have been met.

8.0 SUDDEN DRAWDOWN ASSESSMENT (§257.73(d)(1)(vii))

Per §257.73(d)(1)(vii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with downstream slopes that can be inundated by an adjacent water body (such as a river, stream, or lake) to determine is structural stability is maintained during low pool or sudden drawdown of the adjacent water body. The following features from Kyger Creek Station fall within this requirement:

- BSP Perimeter Dike

Assessment of the sudden drawdown associated with these features was completed considering the following criteria related to the CCR rule:

1. Maintain slope stability during sudden drawdown of adjacent water body.

Guidance provided by the USEPA (2015) described the basis of the CCR Rule's factor of safety criteria and methodology as EM 1110-2-1902 (USACE, 2003) or other appropriate methodologies. Table 3-1 of EM 1110-2-1902 (USACE, 2003) recommends a required minimum factor of safety of 1.1 for maximum surcharge pool under rapid drawdown conditions.

8.1 PERIMETER DIKES

8.1.1 Background

The Boiler Slag Pond has potential sudden drawdown loading from the Ohio River and Kyger Creek. A sudden drawdown slope stability analysis of the downstream slope is required under the CCR Rule §257.73(d)(1)(vii). The sudden drawdown slope stability analysis was performed based on the static safety factor assessment discussed in DLZ (2015).

8.1.2 Assessment

8.1.2.1 Material Properties

DLZ performed a geotechnical exploration in 2010 to characterize the dikes of the South Fly Ash Pond and the Boiler Slag Pond (DLZ 2011). A laboratory testing program was performed to determine the pertinent soil parameters for stability analyses. The strength parameters derived using the laboratory data and used in this sudden drawdown slope stability evaluation are presented in Table 1. The results of the laboratory testing and derivation of the strength parameters can be found in DLZ (2011 and 2015).

Table 1 Strength Parameters for Stability Analysis

Soil Horizon	Unit Weight (pcf)	Effective Stress Strength Parameters		Total Stress Strength Parameters	
		c' (psf)	ϕ' (degrees)	c (psf)	ϕ (degrees)
Embankment Clay Fill	125	100	32	350	20
Stiff to Very Stiff Clay	125	100	32	500	16
Soft to Medium Stiff Clay	125	100	28	300	16
Dense Sand/Gravel (Boiler Slag Pond)	125	0	30	0	35

8.1.2.2 Critical Cross Section Selection

Slope stability analyses were available from DLZ (2011 and 2015). Five cross sections from the Boiler Slag Pond (including the Clearwater Pond) were analyzed under static, steady-state conditions using the maximum surcharge pool. The five sections that were analyzed were labeled Sections 1 through 5 and are shown below in Figure 1.

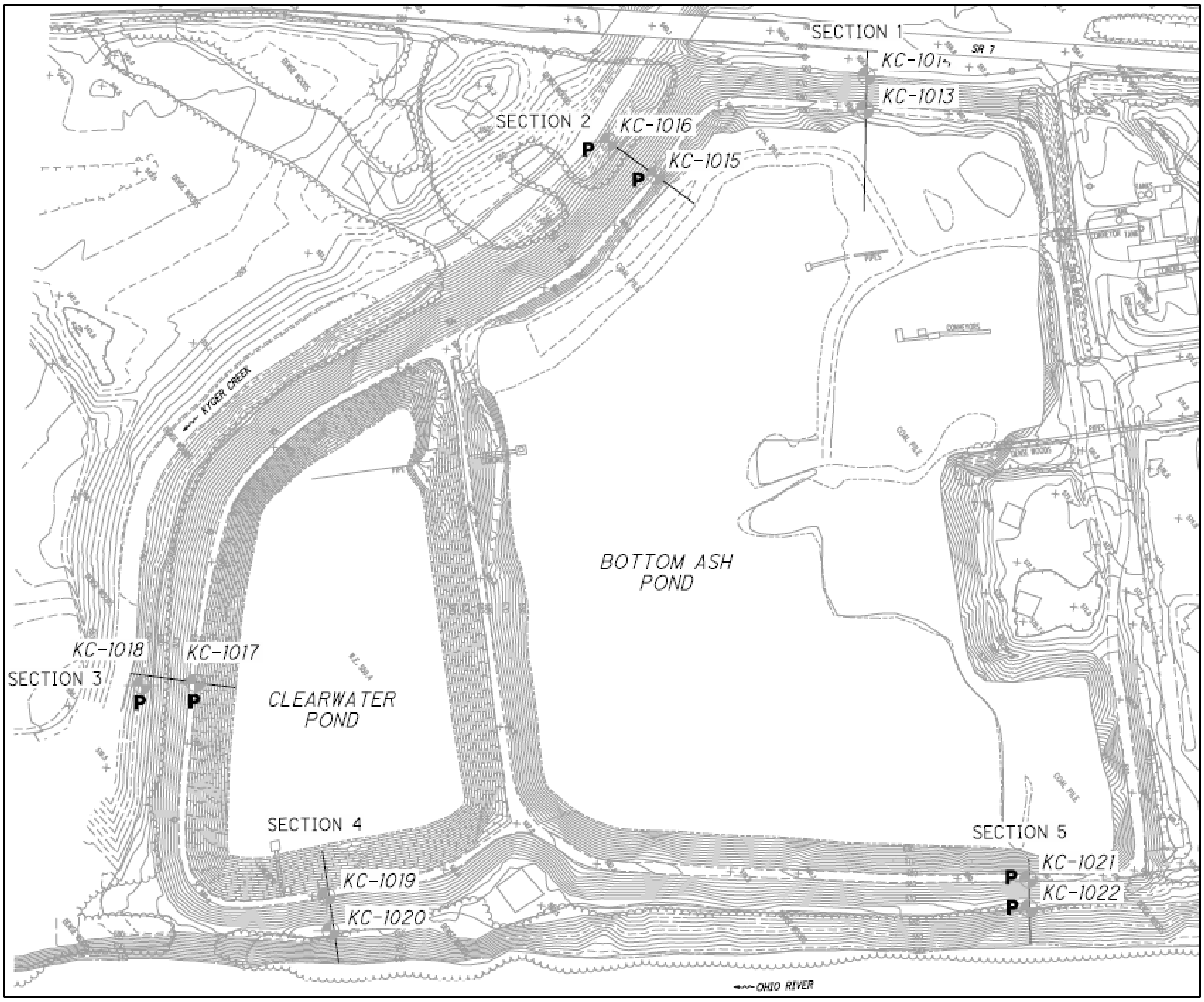


Figure 1 Kyger Creek Station Boiler Slag Pond – Plan View of Cross Sections *(DLZ, 2015)*

The summary of the slope stability results from DLZ (2015) is listed in Table 2. The pond levels were set at the 50% PMF elevation (559.3 feet for the Boiler Slag Pond and 558.6 feet for the Clearwater Pond). The tailwater was set near the surface of the toe.

Table 2 Static Slope Stability Results

Facility	Cross Section	Maximum Surcharge Pool Factor of Safety
Boiler Slag Pond	1	2.54
Boiler Slag Pond	2	1.71
Clearwater Pond	3	1.85
Clearwater Pond	4	2.55
Boiler Slag Pond	5	1.83

This analysis indicate that Section 2 is the critical cross section. A sudden drawdown stability analysis was performed for Section 2 of the Boiler Slag Pond based on the proposed water levels discussed in Section 8.1.2.3.

8.1.2.3 Water Levels

Kyger Creek Station's CCR surface impoundments are classified as significant hazard. Under the EPA Final CCR Rule, the inflow design flood for a significant hazard potential CCR surface impoundment is the 1,000-year flood (§257.82(a)(3)(ii)). A rainfall amount for the 1,000-year storm event (5.61 inches) was obtained from the "Precipitation Frequency Atlas of the United States, NOAA Atlas 14" using a precipitation event duration of 6 hours (Bonnin et al, 2016).

DLZ (2015) presents the hydrologic and hydraulic data for the Boiler Slag Pond assuming the 50-percent probable maximum flood (PMF) event for the maximum storage pool. A rainfall depth for the six-hour, 1 square mile probable maximum precipitation (PMP) of 19 inches was used in the analysis (DLZ, 2015 and AWA, 2013).

The sudden drawdown analysis has been performed assuming a maximum surcharge pool within the surface impoundment equal to the 50- percent PMF and a long-term maximum storage pool equal to the operating pool elevation reported in DLZ (2015).

Tailwater for the model is Kyger Creek, which flows into the Ohio River. The 100-year flood level for the Ohio River was used for the tailwater flood pool elevation (FEMA, 2011). The normal pool for the Ohio River was determined from the elevations provided by Ohio River Valley Water Sanitation Commission (ORSANCO) for Ohio River navigational dams (ORSANCO, 2016). Table 3 lists the headwater and tailwater elevations used for analysis.

Table 3 Kyger Creek Station Water Elevations for Stability Modeling

CCR Rule Criteria	Headwater Boiler Slag Pond Elevation (feet)	Tailwater Ohio River Elevation (feet)
Long-term maximum storage pool loading condition	557.0	538.0
Maximum surcharge pool loading condition	559.3	572.2

8.1.2.4 Analysis Methodology

Stantec performed the sudden drawdown slope stability analyses using the GeoStudio 2007, Version 7.23 software package developed by GEO-SLOPE International, Ltd. of Calgary, Alberta, Canada (GEO-SLOPE International, Ltd., 2007). This package includes the SLOPE/W module for slope stability analysis. The analyses were performed in accordance with the recommendations and criteria outlined in the USACE Design Manuals EM 1110-2-1902 "Slope Stability" (USACE, 2003) and in the Stantec Engineer's Certification of Safety Factor Assessment Report (Stantec, 2015).

8.1.2.5 Acceptance Criteria

A minimum factor of safety is not explicitly specified within the EPA Final CCR Rule §257.73(d)(1)(vii). In the CCR Rule discussion, USACE (2003) is considered the basis for the slope stability analyses. Table 3-1, Minimum Required Factors of Safety: New Earth and Rock-Fill Dams, requires a factor of safety of 1.1 for a rapid drawdown condition from maximum surcharge pool (USACE, 2003).

8.1.2.6 Analysis Results

The slope stability assessments presented in this report are focused on the potential for slope failures of significant mass, which could directly impact potential release of water and CCR materials from the South Fly Ash Pond or the Boiler Slag Pond. The search for a critical slip surface in the slope stability assessments is thus restricted to consider only potential surfaces where the depth (measured at the base of at least one slice) is more than ten feet vertically below the ground surface. Table 4 summarizes the sudden drawdown safety factor evaluation results at the Boiler Slag Pond. The results of the analyses are included in Appendix B.

Table 4 Factor of Safety Assessment Results

Facility	Cross Section	EPA Final CCR Rule Criteria	Recommended Factor of Safety Criteria	Calculated Factor of Safety
Boiler Slag Pond	2	Sudden Drawdown	1.1	1.2

8.1.3 Conclusion

Based on the assessment of the sudden drawdown for the BSP Perimeter Dike, the EPA Final CCR Rule-related criteria listed above have been met.

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Appendix A PLAN VIEW OF KYGER CREEK STATION

Appendix B SUDDEN DRAWDOWN ASSESSMENT

APPENDIX A
PLAN VIEW OF KYGER CREEK STATION

Figure No.
A-1

Title
Plan View of Kyger Creek Station

Client/Project
Kyger Creek Station - Structural Stability
South Fly Ash Pond and Boiler Slag Pond

Project Location 175534017
Cheshire
Gallia County, OH

Prepared by AP on 2016-10-13
Technical Review by JH on 2016-10-13
Independent Review by SH on 2016-10-13

0 300 600 Feet
1:3,600 (At original document size of 11x17)

Notes
1. Coordinate System: NAD 1983 StatePlane Ohio South FIPS 3402 Feet
2. Ohio Statewide Imagery Program (OSIP) - 2014

Stantec OVEC IKEC

V:\1755\active\175534017\gis\image\kyger_22x34_A-1.mxd Revised: 2016-10-14 By: apooler

APPENDIX B
SUDDEN DRAWDOWN ASSESSMENT

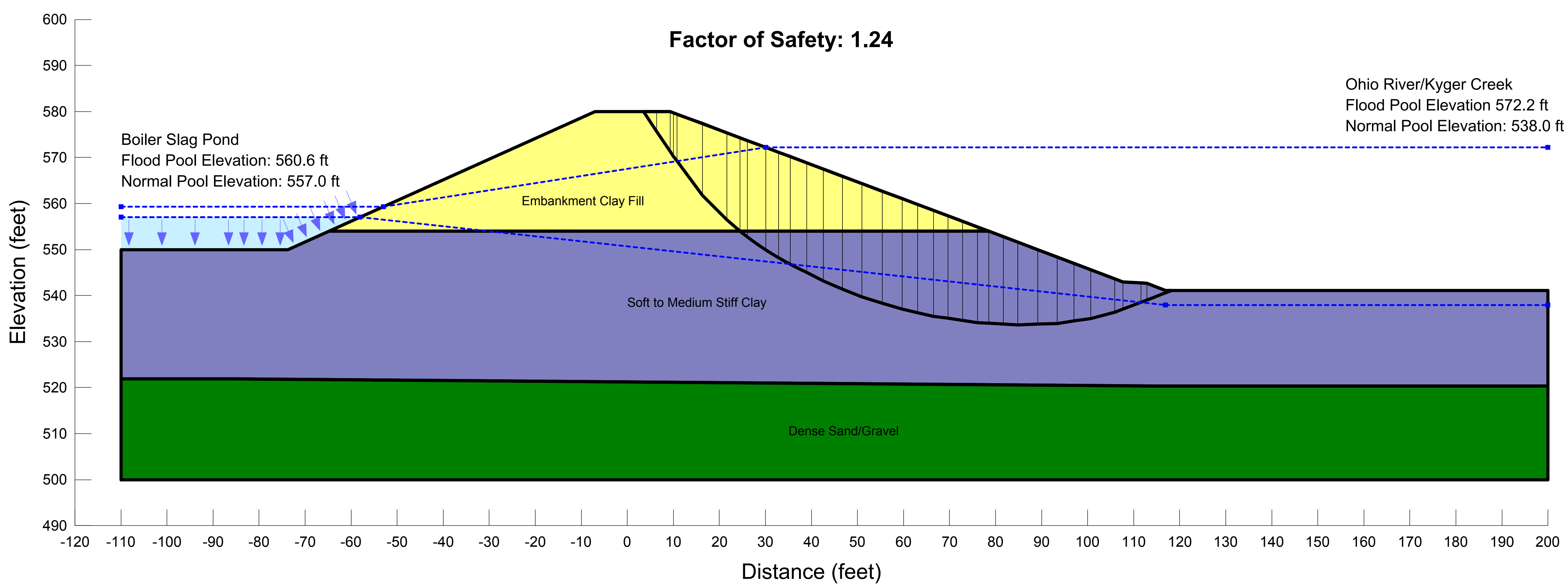
Ohio Valley Electric Corporation
Kyger Creek Station
Boiler Slag Pond
Cheshire, Ohio
Section 2

Sudden Drawdown

Existing Geometry
Sudden Drawdown
Undrained, Sudden Drawdown Strengths

Material Type	Unit Wt.	Effective Cohesion	Effective Friction Angle	Total Cohesion	Total Friction Angle
Embankment Clay Fill	125 pcf	100 psf	32 °	350 psf	20 °
Soft to Medium Stiff Clay	125 pcf	100 psf	28 °	300 psf	16 °
Dense Sand/Gravel	125 pcf	0 psf	30 °	0 psf	35 °

Note:
The results of this analysis are based on available subsurface information, field and laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.



Stantec

Stantec Consulting Services Inc.
11687 Lebanon Road, Cincinnati OH 45241

October 17, 2016
File: 175534017
Revision 0

Ohio Valley Electric Corporation
3932 U.S. Route 23
P.O. Box 468
Piketon, Ohio 45661

RE: Initial Structural Stability Assessment
South Fly Ash Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Kyger Creek Station
Cheshire, Gallia County, Ohio

1.0 PURPOSE

This letter documents Stantec's certification of the initial structural stability assessment for the Ohio Valley Electric Corporation (OVEC) Kyger Creek Station's South Fly Ash Pond. Based on this assessment, the South Fly Ash Pond is in compliance with the structural stability requirements in the EPA Final CCR Rule at 40 CFR 257.73(d).

2.0 INITIAL STRUCTURAL STABILITY ASSESSMENT

As described in 40 CFR 257.73(d), documentation is required on how the South Fly Ash Pond has been designed, constructed, operated, and maintained according to the structural stability requirements listed in the section. The combined capacity of all spillways must also be designed, constructed, operated, and maintained to adequately manage flow from the 1,000-year storm event based upon a hazard potential classification of "significant."

3.0 SUMMARY OF FINDINGS

The attached report presents the initial structural stability assessment of the South Fly Ash Pond. The results show that the impoundment meets the structural stability requirements set forth in 40 CFR 257.73(d)(1)-(2).

4.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Stan A. Harris, being a Professional Engineer in good standing in the State of Ohio, do hereby certify, to the best of my knowledge, information, and belief:

1. that the information contained in this certification is prepared in accordance with the accepted practice of engineering;

2. that the information contained herein is accurate as of the date of my signature below; and

3. that the initial structural stability assessment for the OVEC Kyger Creek Station's South Fly Ash Pond meets the requirements specified in 40 CFR 257.73(d)(1)-(2).

SIGNATURE ______________________ DATE 10/17/16

ADDRESS: Stantec Consulting Services Inc.
11687 Lebanon Road
Cincinnati, Ohio 45241

TELEPHONE: (513) 842-8200

ATTACHMENTS: Kyger Creek South Fly Ash Pond Initial Structural Stability Assessment Report

STATE OF OHIO
STAN AL HARRIS
53083
REGISTERED
PROFESSIONAL ENGINEER

10/17/16

Initial Structural Stability Assessment

Kyger Creek Station
South Fly Ash Pond
Cheshire, Gallia County, Ohio

Prepared for:
Ohio Valley Electric Corporation
Piketon, Ohio

Prepared by:
Stantec Consulting Services Inc.
Cincinnati, Ohio

October 17, 2016

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 PROJECT BACKGROUND

On April 17, 2015 the "Disposal of Coal Combustion Residuals (CCR) from Electric Utilities" (EPA Final CCR Rule) was published in the Federal Register. Stantec Consulting Services, Inc. (Stantec) was contracted by the Ohio Valley Electric Corporation (OVEC) to analyze the structural stability of the Kyger Creek Station's South Fly Ash Pond (SFAP) evaluate its compliance with §257.73 of the EPA Final CCR Rule.

As required by §257.73 of the EPA Final CCR Rule, an initial structural integrity evaluation is required by October 17, 2016 and must include an initial structural stability assessment for each existing CCR surface impoundment that meets the conditions of paragraph (b) as follows:

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.

2.0 UNIT DESCRIPTION

The Kyger Creek Station is located on the north shore of the Ohio River downstream of Cheshire, Ohio. The station consists of five coal-fired electric generating units, each nominally rated at 217 megawatts. The Kyger Creek Station is directly accessible from State Route 7.

The South Fly Ash Pond is located west of the station across State Route 7. Upon commencing operations in 1955, the station sluiced CCRs into the South Fly Ash Pond for storage. Originally the pond received bottom ash, but is now currently used to storage fly ash. The South Fly Ash Pond was created by building a perimeter dike to enclose an area of approximately 68 acres. It is bounded by State Route 7 to the east, the closed North Ash Pond to the north, a railroad line and plant road to the west, and a plant road and flue gas desulfurization (FGD) wastewater treatment plant to the south.

The subsections under §257.73(d) address conditions of appurtenances categorized as embankments, spillways, or hydraulic structures. Sections 2.1 to 2.3 below provide descriptions of the individual unit elements that fall within these appurtenance categories. Appendix A includes a plan view of the Kyger Creek Station.

Note that all elevations included in this document and appendices are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

2.1 EMBANKMENTS

2.1.1 SFAP Perimeter Dike

The SFAP Perimeter Dike was built between 1954 and 1955 during construction of the Kyger Creek Station. The dike encompasses the entire surface impoundment. To the north, the South Fly Ash Pond abuts the closed North Fly Ash Pond facility. The rolled earth dike is approximately 6,750 feet long with a maximum height of 40 feet. The crest wide is estimated as 12 feet with an elevation of 590 feet. The interior embankment has a slope of 2H:1V, while the exterior slope is 2.25H:1V to 3H:1V. As designed, the bottom of the South Fly Ash Pond is elevation 550 feet (Terracon, 2014).

2.2 SPILLWAYS

2.2.1 Primary Spillway System

The configuration of the primary spillway system for the South Fly Ash Pond is documented by CHA (2009) and by construction drawings (AEPSC, 2016). The SFAP primary intake structure is a 36-inch steel-reinforced concrete pipe with a 42-inch by 39-inch steel-reinforced concrete riser. The elevation of the spillway is 582 feet. Concrete stop logs are used to raise the spillway elevation to 587 feet (CHA, 2009).

2.3 HYDRAULIC STRUCTURES

Other than the primary spillway described above, no hydraulic structures are located at the SFAP.

3.0 FOUNDATIONS AND ABUTMENTS (§257.73(d)(1)(i))

Per §257.73(d)(1)(i), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with stable foundations and abutments. The South Fly Ash Pond has the following features that fall within this requirement:

- SFAP Perimeter Dike

Assessment of the foundations and abutments associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

- Review inspection reports of the facility, considering frequency of inspections, and if the inspections included review and/or assessment of features including cracking, settlement, deformation, or erosion of the foundations/abutments. Inspections should indicate that there are no significant signs of tension cracking, settlement, depressions, erosion, and/or deformations at the crest, slope, and toe of the structure.

- Confirm that an assessment of seepage conditions of the foundation, with considerations of heave and vertical exit gradient, has been performed. Verify that the seepage assessment follows appropriate methodologies (such as USACE EM 1110-2-1901) and that the foundations exhibit acceptable performance (e.g. FS for piping greater than or equal to 3.0).

3.1 SFAP PERIMETER DIKE

3.1.1 Background

The South Fly Ash Pond is formed by a perimeter dike system; therefore, there are no natural abutments. The station is in an unglaciated area of Ohio on the Marietta Plateau. Alluvium covers the site with a thickness of 16 to 40 feet. It is clay interbedded with sand lenses. Glacial outwash deposits of variable thickness lie between the alluvium and bedrock. Bedrock is estimated at elevation 494 to 497 feet. It is a shale and sandstone of Pennsylvanian-age Conemaugh Group (Terracon, 2014).

DLZ (2011) encountered bedrock refusal at elevation 499 feet, noting a soft to medium hard gray siltstone interbedded with shale. Foundation soils were a soft to medium stiff lean clay from the ground surface to approximately elevation 530 feet. The clay layer had lenses of silt and varying amounts of fine to medium sand. A medium dense to dense granular layer was encountered from elevation 531.2 to 513.8 feet.

3.1.2 Assessment

A qualified person performs inspections of the South Fly Ash Pond weekly, monthly, quarterly, and annually. Regular site inspections have been conducted and documented from 1985 to 2016. These inspections include observations related to foundation conditions with respect to observable cracking, settlement, depressions, erosion, and deformation.

AEPSC (2015) noted no signs of settlement, deformation, or cracks on the north dike. A few minor shoreline sloughing on the interior slope were observed. No signs of settlement, deformation, or cracks were observed on the crest, interior, or exterior slopes of the east, west, and south dike. A small depression was observed above the outlet pipe of the principal spillway. It was attributed to minor ground surface undulations.

CHA (2009) observed no changes in horizontal alignment or evidence of patchwork/failures on the dikes. An isolated small slump, an isolated grassed-over slough, and an isolated abandoned vector hole were noted on the exterior slope of the dike.

A seepage analysis for the original dike construction is not available. As part of the geotechnical exploration in 2011, DLZ noted that the piezometer data indicates very low phreatic surfaces through the perimeter dike and at the downstream toe. Groundwater levels were generally 12 to 24 feet below the impounded water level below the perimeter dike of the surface impoundments. This was assumed to be based on rapid hydraulic head dissipation in the clay soil consistent with very low permeability laboratory test results. At the downstream toes of the perimeter dikes, groundwater was typically 5 to 22 feet below the ground surface. Two piezometers indicated groundwater levels at or slightly below the ground surface. DLZ concluded that seepage of water through or under the dams should not be a concern (2011).

AEPSC (2015) monitored existing seepage repairs on the face of the east dike, the south side of the west dike, and the north side of the west dike. Flow was monitored to compare to previous annual inspections. The repairs performed since the 2014 inspection included sand and gravel drainage blankets to prevent piping and erosion of the seep.

3.1.1 Conclusion

Based on the assessment of the foundation for the SFAP Perimeter Dike, the EPA Final CCR Rule-related criteria listed above have been met.

4.0 SLOPE PROTECTION (§257.73(d)(1)(ii))

Per §257.73(d)(1)(ii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown. The South Fly Ash Pond has the following features that fall within this requirement:

- SFAP Perimeter Dike

Assessment of the slope protection associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. *Regular (weekly) inspections for erosion. Inspections should show there are no significant signs of deterioration in the slope protection configuration of the Item.*

2. *Appropriate slope protection shall be provided based on anticipated flow velocities. [Hydrologic/hydraulic calculations of flow velocities on the slope of the Item for the appropriate erosive forces. Some common slope protection measures include: riprap, gabions, paving (concrete or asphalt), or appropriate vegetative cover.]*

3. *If slope protection is riprap, filter layer(s) under the riprap shall be designed according to established filter criteria. However, existing riprap cover may be evaluated based on performance and observations during inspections.*

4.1 SFAP PERIMETER DIKE

4.1.1 Background

Slope protection for the SFAP Perimeter Dike consists of grass on the exterior slopes. Due to the operational nature of the pond, the interior slopes are granular and dressed and maintained as part of dredging operations. Flow from the primary spillway's discharge pipe is adequately dissipated through a gradual pipe slope and discharge elevation into the receiving stream (AEPSC, 2015).

4.1.1 Assessment

As reported by the CHA (2009), regular drive-by inspections are performed with a checklist inspection quarterly, and an annual inspection by AEPSC. The spillway is regularly visited to take water quality samples, while the instrumentation in the dams are read monthly. Areas of erosion are prioritized for appropriate repairs. Regular site inspections performed by a registered professional engineer have been conducted and documented for the South Fly Ash Pond from 1976 to 2015. Site inspection reports generally indicate appropriate maintenance of slope protection features of the dam.

The exterior slope of the SFAP Perimeter Dike is vegetated with maintained grass. The interior slope is dressed and maintained as part of the dredging activities. A few locations of the shoreline show signs of minor sloughing on the interior slope that can be addressed as maintenance. The last annual dam and dike inspection observed erosion due to wave action from 2014 had been repaired (AEPSC, 2015). Riprap has been placed along approximately 100 feet of the north interior slope to protect against wave erosion.

4.1.1 Conclusion

Based on the assessment of the slope protection for the SFAP Perimeter Dike, the EPA Final CCR Rule-related criteria listed above have been met.

5.0 EMBANKMENT DIKE COMPACTION (§257.73(d)(1)(iii))

Per §257.73(d)(1)(iii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit. The South Fly Ash Pond has the following features that fall within this requirement:

- SFAP Perimeter Dike

Assessment of the dike compaction associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. Documentation showing the dike was mechanically compacted. Acceptable documentation may include construction drawings, field notes, construction photographs, correspondences, or any evidence showing the dike was mechanically compacted during construction.

2. If no construction documentation is available specific data from geotechnical explorations of dike may be used. Geotechnical borings with continuous SPTs may be used to assess compaction of the dike. Appropriate methodology correlating blow counts and compaction (density) should be used.

5.1 SFAP PERIMETER DIKE

5.1.1 Background

The South Fly Ash Pond was designed by Sargent Lundy Engineers of Chicago, Illinois and constructed by George B. Herring & Sons, Inc. of Mansfield, Ohio. Arthur and Leo Casagrande of Cambridge, Massachusetts were also retained during the construction phase and reportedly made a number of site visits as the embankment and appurtenances were being built. Only limited design drawings exist for the SFAP Perimeter Dike. Technical memoranda and letters between the Casagrande firm and the plant during the design and construction of the plant and other structures do exist. Construction photos are available showing period-appropriate large construction equipment working on the site. Subsurface explorations of the dike were also available that provided SPT data used in the assessment.

5.1.1 Assessment

Historical construction photographs, technical memoranda, and letters provide documentation of compaction requirements related to the construction of the SFAP Perimeter Dike. Construction criteria related to dike embankment materials and dike compaction as noted on this documentation include:

- A discussion of proposed dike materials and the need for proper moisture control and compaction in thin layers with heavy, rubber-tired equipment slightly on the dry side of optimum (A. Casagrande, 1952).

Two previous geotechnical explorations were available to review as part of this assessment (DLZ, 2011 and DLZ, 2015). Each was a geotechnical exploration and slope stability evaluation of the SFAP Perimeter Dike. The programs included drilling and laboratory testing.

DLZ (2011) stated that results of the subsurface investigations indicated subsurface conditions were similar for the Boiler Slag Pond and the South Fly Ash Pond. Embankment fill was stiff to very stiff lean clay with varying amounts of silt and fine sand. Standard penetration testing within the borings indicated blow count N_{60} values ranging from 5 to 30 with an average of 13. The N_{60} values have been adjusted to account for hammer efficiency and field procedures. Based on laboratory testing results, DLZ assigned the embankment clay fill drained shear strength parameters of 100 psf cohesion and an internal friction angle of 32 degrees with a wet unit weight of 125 pounds per cubic foot (pcf). Correlating these results using NAVFAC DM-7.2 indicate that appropriate compaction exists within the embankment of the SFAP Perimeter Dike (NAVFAC, 1986).

5.1.2 Conclusion

Based on the assessment of the embankment dike compaction for the SFAP Perimeter Dike, the EPA Final CCR Rule-related criteria listed above have been met.

6.0 VEGETATED SLOPES (§257.73(d)(1)(iv))

Per §257.73(d)(1)(iv), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with vegetated slopes of dikes and surrounding areas, except for slopes which have an alternate form or forms of slope protection. The South Fly Ash Pond has the following features that fall within this requirement:

- SFAP Perimeter Dike

Assessment of the vegetated slopes associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. Regular inspection records showing vegetative cover sufficient to prevent surface erosion while allowing an unobstructed view to visually inspect the slope.

6.1 BACKGROUND

The SFAP Perimeter Dike is vegetated along exterior slopes. The South Fly Ash Pond is being actively dredged to dry and remove fly ash for the CCR Landfill. The interior slopes are granular with limited to moderate vegetation (CHA, 2009). AEPSC (2015) observed the vegetation cover as good and recently mowed.

6.2 ASSESSMENT

Slope protection for the SFAP Perimeter Dike exterior slope consists of grass with some riprap along the drainage channel on the western exterior toe. The South Fly Ash Pond's interior slope is granular with some vegetation due to operations.

6.3 CONCLUSION

Based on the assessment of the vegetated slopes for the SFAP Perimeter Dike, the EPA Final CCR Rule-related criteria listed above have been met.

7.0 SPILLWAY CONDITION AND CAPACITY(§257.73(d)(1)(v))

Per §257.73(d)(1)(v), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with a single spillway or combination of spillways that meet the condition and capacity requirements as outlined in this section of the EPA Final CCR Rule. The combined capacity of all spillways are to be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in this section. The South Fly Ash Pond has the following features that fall within this requirement:

- South Fly Ash Pond Primary Spillway System

Assessment of the spillway condition and capacity associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. Outlet channel must be of non-erodible material designed to carry sustained flow velocities based on the required flood events. [Estimate flow velocities and select appropriate material using hydraulic analysis for the following flood events: PMF (high hazard potential unit), 1000-year flood (Significant hazard unit), 100-year flood (low hazard potential unit).]

2. Must adequately manage flow during and following the peak discharge. [Estimate size of outlet structure based of hydraulic analysis for the following flood events: PMF (High hazard potential unit), 1000-year flood (Significant hazard potential unit), and 100-year flood (low hazard potential unit).]

3. Must be structurally stable. [Assess stability of structure using stability and stress analyses according to an appropriate methodology. Some acceptable methodologies may include: EM 1110-2-2400, EM 1110-2-2100, ACI 350, etc.]

4. Must maintain structural integrity. [Structural integrity may be warranted by periodic inspections of existing conduits. Inspections must show no significant presence of deformation, distortions, cracks, joint separation, etc.]

5. Must be free from significant amounts of obstruction and anomaly which may affect the operation of the hydraulic structure [Perform periodic pipe inspections to detect deterioration, deformation, distortion, bedding deficiencies, and sediment, and debris accumulations.]

7.1 PRIMARY SPILLWAY SYSTEM

7.1.1 Background

The South Fly Ash Pond is classified as a significant hazard structure requiring the combined capacity of all spillways be adequate to manage the flow during and following the peak discharge from a 1000-year flood.

7.1.2 Assessment

7.1.2.1 Spillway Capacity

The Inflow Design Flood Control System Plan for the South Fly Ash Pond demonstrates the South Fly Ash Pond meets the capacity requirements outlined in §257.73(d)(1)(v) of the EPA Final CCR Rule. During the October 2015 annual dam and dike inspection, the overflow discharge pipe was flowing unobstructed into Kyger Creek. No spalling or deterioration of the concrete structure was observed. The metal walkway leading to the outlet pipe was in good condition. (AEPSC, 2015).

7.1.2.2 Structural Stability

The South Fly Ash Pond primary spillway intake structure is located at the northwestern corner of the pond. The intake structure is rectangular in shape with a 24-inch by 39-inch cross section. Flow discharges through a 30-inch concrete pipe at elevation 558.33 feet into Kyger Creek Pond (CHA, 2009). The outlet is a reinforced concrete head wall.

The South Fly Ash Pond's spillway system is inspected monthly during water quality sampling and annually as part of the dam and dike inspection. Physical condition, flow through the pipe, and maintenance concerns are noted and addressed. A video camera inspection of the structure were performed in 2013, but was limited in quality due to the high flow through the structure.

7.1.3 Conclusion

Based on the assessment of the Primary Spillway System condition and capacity for the South Fly Ash Pond, the EPA Final CCR Rule-related criteria listed above have been met.

8.0 SUDDEN DRAWDOWN ASSESSMENT (§257.73(d)(1)(vii))

Per §257.73(d)(1)(vii), the initial structural stability assessment must document whether the unit has been designed, constructed, operated, and maintained with downstream slopes that can be inundated by an adjacent water body (such as a river, stream, or lake) to determine is structural stability is maintained during low pool or sudden drawdown of the adjacent water body. The South Fly Ash Pond has the following feature that falls within this requirement:

- SFAP Perimeter Dike

Assessment of the sudden drawdown associated with these features was completed considering the following criteria related to the EPA Final CCR Rule:

1. Maintain slope stability during sudden drawdown of adjacent water body.

Guidance provided by the USEPA (2015) described the basis of the EPA Final CCR Rule's factor of safety criteria and methodology as EM 1110-2-1902 (USACE, 2003) or other appropriate methodologies. Table 3-1 of EM 1110-2-1902 (USACE, 2003) recommends a required minimum factor of safety of 1.1 for maximum surcharge pool under rapid drawdown conditions.

8.1 PERIMETER DIKES

8.1.1 Background

The South Fly Ash Pond has a potential sudden drawdown loading from the Ohio River and Kyger Creek. A sudden drawdown slope stability analysis of the downstream slope is required under the EPA Final CCR Rule §257.73(d)(1)(vii). The sudden drawdown slope stability analysis was performed based on the static safety factor assessment discussed in DLZ (2015).

8.1.2 Assessment

8.1.2.1 Material Properties

DLZ performed a 2010 geotechnical exploration to characterize the dikes of the South Fly Ash Pond and the Boiler Slag Pond (DLZ, 2011). A laboratory testing program was performed to support derivation of soil parameters for stability analyses. The strength parameters derived using the laboratory data and used in this sudden drawdown slope stability evaluation are presented in Table 1. The results of the laboratory testing and derivation of the strength parameters can be found in DLZ (2011 and 2015).

Table 1 Strength Parameters for Stability Analysis

Soil Horizon	Unit Weight (pcf)	Effective Stress Strength Parameters		Total Stress Strength Parameters	
		c' (psf)	ϕ' (degrees)	c (psf)	ϕ (degrees)
Embankment Clay Fill	125	100	32	350	20
Stiff to Very Stiff Clay	125	100	32	500	16
Soft to Medium Stiff Clay	125	100	28	300	16
Dense Sand/Gravel	125	0	35	0	35

8.1.2.2 Critical Cross Section Selection

Slope stability analyses were available from DLZ (2015). Six cross sections from the South Fly Ash Pond were analyzed under static, steady-state conditions using the maximum surcharge pool. The six sections that were analyzed were labeled Sections 1 through 6 and are shown below in Figure 1.

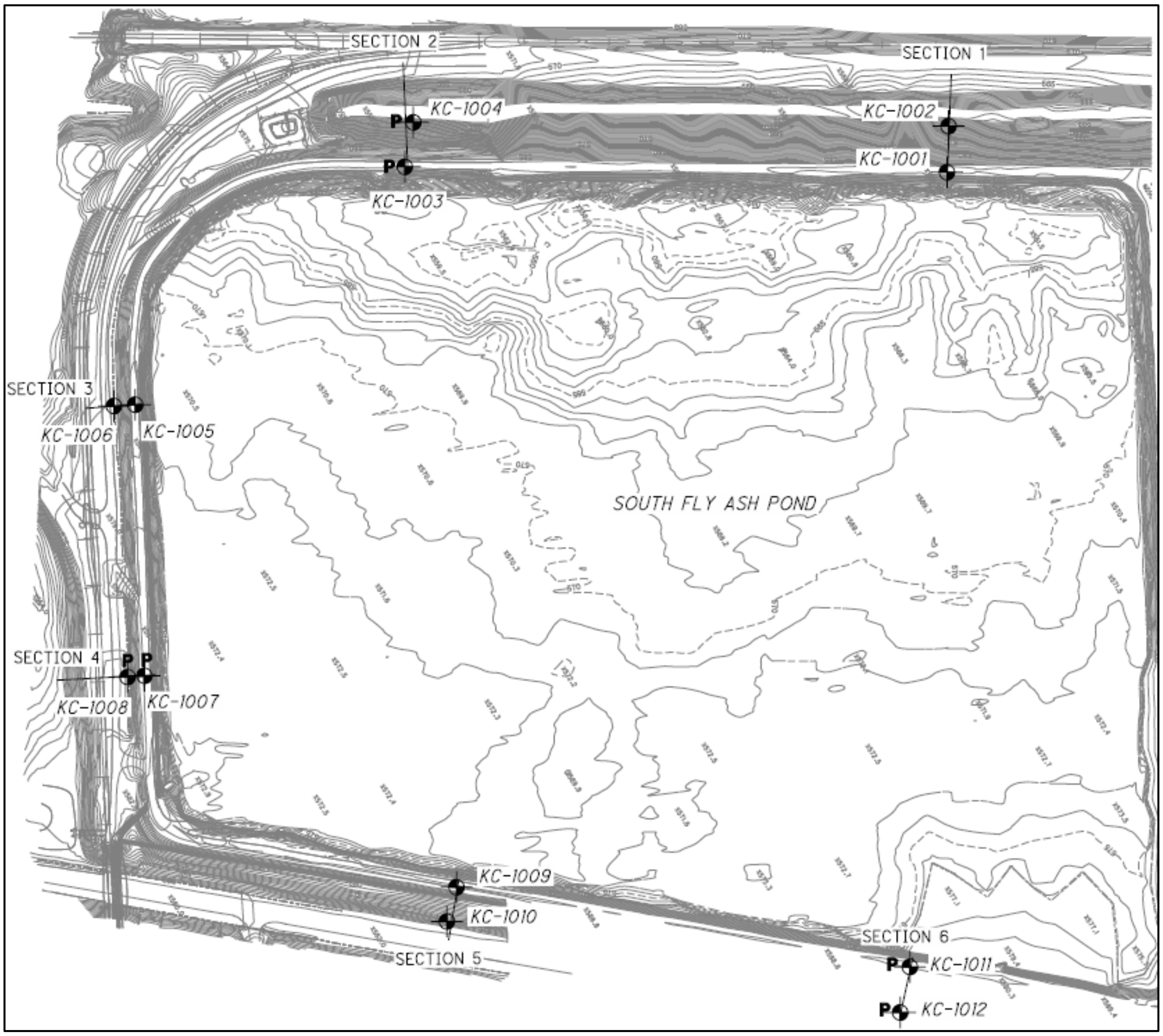


Figure 1 Kyger Creek Station South Fly Ash Pond – Plan View of Cross Sections *(DLZ, 2015)*

The summary of the slope stability results from DLZ (2015) is listed in Table 2. The pond levels were set at the 50% PMF elevation (586.0 feet for the South Fly Ash Pond). The tailwater was set near the surface of the toe.

Table 2 Static Slope Stability Results

Facility	Cross Section	Maximum Surcharge Pool Factor of Safety
South Fly Ash Pond	1	1.60
South Fly Ash Pond	2	1.51
South Fly Ash Pond	3	3.24
South Fly Ash Pond	4	3.26
South Fly Ash Pond	5	2.02
South Fly Ash Pond	6	2.22

This analysis indicate that Section 2 is the critical cross section. A sudden drawdown stability analysis was performed for Section 2 of the South Fly Ash Pond based on the proposed water levels discussed in Section 8.1.2.3.

8.1.2.3 Water Levels

Kyger Creek Station's CCR surface impoundments are classified as significant hazard. Under the EPA Final CCR Rule, the inflow design flood for a significant hazard potential CCR surface impoundment is the 1,000-year flood (§257.82(a)(3)(ii)). A rainfall amount for the 1,000-year storm event (5.61 inches) was obtained from the "Precipitation Frequency Atlas of the United States, NOAA Atlas 14" using a precipitation event duration of 6 hours (Bonnin et al, 2016).

DLZ (2015) presents the hydrologic and hydraulic data for the South Fly Ash Pond assuming the 50-percent probable maximum flood (PMF) event for the maximum storage pool. A rainfall depth for the six-hour, 1 square mile probable maximum precipitation (PMP) of 19 inches was used in the analysis (DLZ, 2015 and AWA, 2013).

The sudden drawdown analysis has been performed assuming a maximum surcharge pool within the surface impoundment equal to the 50- percent PMF and a long-term maximum storage pool equal to the operating pool elevation reported in DLZ (2015).

Tailwater for the model is Kyger Creek, which flows into the Ohio River. The 100-year flood level for the Ohio River was used for the tailwater flood pool elevation (FEMA, 2011). The normal pool for the Ohio River was determined from the elevations provided by Ohio River Valley Water Sanitation Commission (ORSANCO) for Ohio River navigational dams (ORSANCO, 2016). Table 3 lists the headwater and tailwater elevations used for analysis.

Table 3 Kyger Creek Station Water Elevations for Stability Modeling

CCR Rule Criteria	Headwater South Fly Ash Pond Elevation (feet)	Tailwater Ohio River Elevation (feet)
Long-term maximum storage pool loading condition	582.0	538.0
Maximum surcharge pool loading condition	586.0	571.8

8.1.2.4 Analysis Methodology

Stantec performed the sudden drawdown slope stability analyses using the GeoStudio 2007, Version 7.23 software package developed by GEO-SLOPE International, Ltd. of Calgary, Alberta, Canada (GEO-SLOPE International, Ltd., 2007). This package includes the SLOPE/W module for slope stability analysis. The analyses were performed in accordance with the recommendations and criteria outlined in the USACE Design Manuals EM 1110-2-1902 "Slope Stability" (USACE, 2003).

8.1.2.5 Acceptance Criteria

A minimum factor of safety is not explicitly specified within the EPA Final CCR Rule §257.73(d)(1)(vii). In the EPA Final CCR Rule discussion, USACE (2003) is considered the basis for the slope stability analyses. Table 3-1, Minimum Required Factors of Safety: New Earth and Rock-Fill Dams, requires a factor of safety of 1.1 for a rapid drawdown condition from maximum surcharge pool.

8.1.2.6 Analysis Results

The slope stability assessment presented in this report is focused on the potential for slope failures of significant mass, which could directly impact potential release of water and CCR materials from the South Fly Ash Pond. The search for a critical slip surface in the slope stability assessments is thus restricted to consider only potential surfaces where the depth (measured at the base of at least one slice) is more than ten feet vertically below the ground surface. Table 4 summarizes the sudden drawdown safety factor evaluation results at the South Fly Ash.

The results show that the sudden drawdown factor of safety assuming the 50-percent PMF event meets the criteria; therefore, the design is also acceptable for the 1000-year event and the requirements set forth in 40 CFR 257.73(d)(1)(vii).

Table 4 Factor of Safety Assessment Results

Facility	Cross Section	EPA Final CCR Rule Criteria	Recommended Factor of Safety Criteria	Calculated Factor of Safety
South Fly Ash Pond	2	Sudden Drawdown	1.1	1.3

8.1.3 Conclusion

Based on the assessment of the sudden drawdown for the SFAP Perimeter Dike, the EPA Final CCR Rule-related criteria listed above has been met.

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Appendix A PLAN VIEW OF KYGER CREEK STATION

Appendix B SUDDEN DRAWDOWN ASSESSMENT

APPENDIX A
PLAN VIEW OF KYGER CREEK STATION

Figure No.
A-1

Title
Plan View of Kyger Creek Station

Client/Project
Kyger Creek Station - Structural Stability
South Fly Ash Pond and Boiler Slag Pond

Project Location 175534017
Cheshire
Gallia County, OH

Prepared by AP on 2016-10-13
Technical Review by JH on 2016-10-13
Independent Review by SH on 2016-10-13

0 300 600
Feet
1:3,600 (At original document size of 11x17)

Notes
1. Coordinate System: NAD 1983 StatePlane Ohio South FIPS 3402 Feet
2. Ohio Statewide Imagery Program (OSIP) - 2014

Stantec OVEC IKEC

V:\1755\active\175534017\gis\image\kyger_22x34_A-1.mxd Revised: 2016-10-14 By: apoofer

APPENDIX B
SUDDEN DRAWDOWN ASSESSMENT

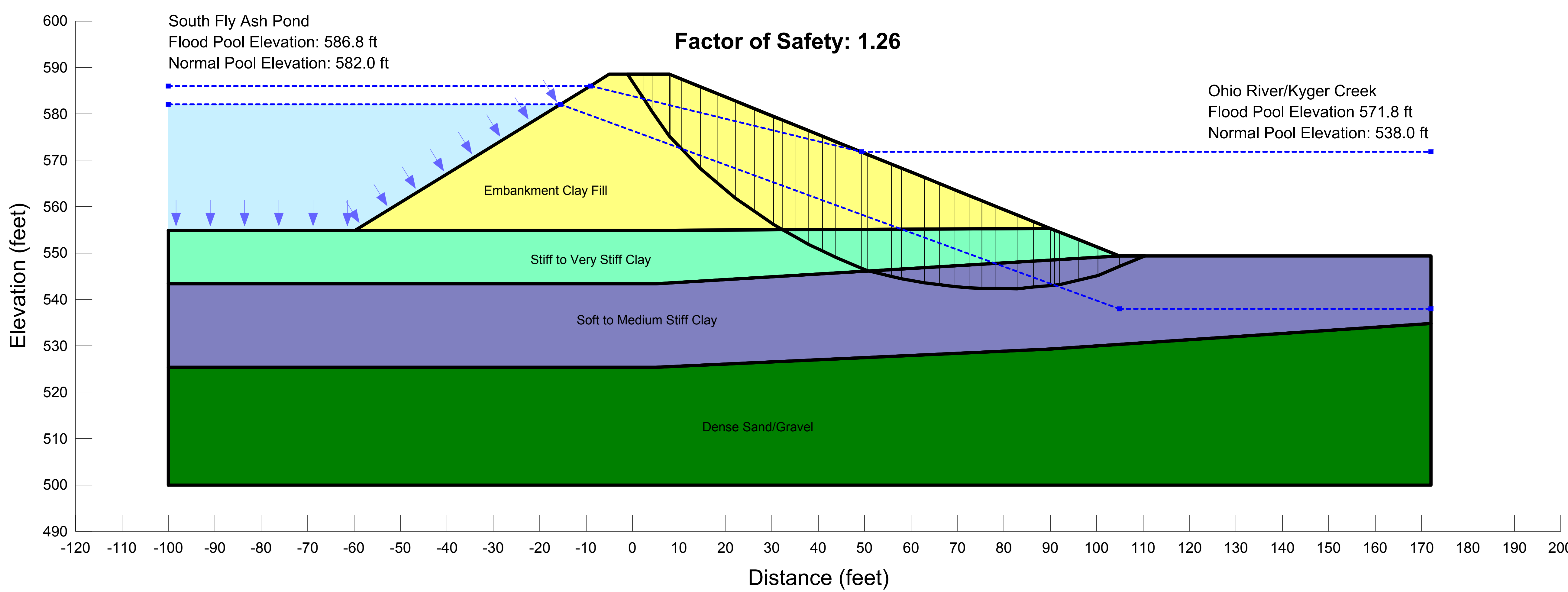
Ohio Valley Electric Corporation
Kyger Creek Station
South Fly Ash Pond
Cheshire, Ohio
Section 2

Sudden Drawdown

Material Type	Unit Wt.	Effective Cohesion	Effective Friction Angle	Total Cohesion	Total Friction Angle
Embankment Clay Fill	125 pcf	100 psf	32 °	350 psf	20 °
Stiff to Very Stiff Clay	125 pcf	100 psf	32 °	500 psf	16 °
Soft to Medium Stiff Clay	125 pcf	100 psf	28 °	300 psf	16 °
Dense Sand/Gravel	125 pcf	0 psf	35 °	0 psf	35 °

Existing Geometry
Sudden Drawdown
Undrained, Sudden Drawdown Strengths

Note:
The results of this analysis are based on available subsurface information, field and laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions between the borings.



APPENDIX C8 – SAFETY FACTOR ASSESSMENT

Professional Engineer Certification Report for:

South Fly Ash Pond and Boiler Slag Pond Embankments at the Ohio Valley Electric Corporation Kyger Creek Station

Gallipolis, Ohio

Prepared for:

American Electric Power
1 Riverside Plaza
Columbus, Ohio 43215-2373

DLZ Ohio, Inc.

6121 Huntley Road
Columbus, Ohio 43229-1003
Phone: (614) 888-0040
Fax: (614) 888-6415

DLZ Job No. 1521-3007.00

December 8, 2015

Prepared by:

DLZ

PROFESSIONAL ENGINEER CERTIFICATION REPORT

FOR

SOUTH FLY ASH POND, BOILER SLAG POND, AND CLEARWATER EMBANKMENTS

AT THE

OHIO VALLEY ELECTRIC CORPORATION (OVEC)

KYGER CREEK STATION

GALLOPOLIS, OHIO

For:

American Electric Power
1 Riverside Plaza
Columbus, Ohio 43215

By:

DLZ OHIO, INC.
6121 Huntley Road
Columbus, OH 43229

DLZ Job. No. 1521-3007.00

December 8, 2015

TABLE OF CONTENTS

APPENDIX V

Exhibit 6 – USGS 2014 Seismic Hazard Map for the United States and Detailed Calculations of Seismic Coefficient

APPENDIX VI

Results of Slope Stability Analyses

APPENDIX VII

Exhibit 7 – Liquefaction Analysis of Granular Soils
Exhibit 8 – USGS Map, "Earthquakes in Ohio and Vicinity, 1776-2007"
Exhibit 9 – Liquefaction Analysis of Fine-grained Soils
Exhibit 10 – Additional Liquefaction Analysis of Potentially Liquefiable Fine-grained Soils,
AGMU Memo 10.1 – Liquefaction Analysis, dated January 2010, from the Illinois DOT,
USACE Slope Stability, Engineering Manual 1110-2-1902. October, 2003, page 1-6,
Chapter 5 "Liquefaction Potential Evaluation and Analysis" of EPA/600/R-95/051

1.0 INTRODUCTION

DLZ Ohio, Inc. (DLZ) has completed the engineering services for Professional Engineer Certification of the South Fly Ash Pond, Boiler Slag Pond, and Clearwater Pond embankments at the Ohio Valley Electric Corporation's (OVEC's) Kyger Creek Station located near Gallipolis, Ohio. The engineering services were performed in accordance with DLZ's May 14, 2015 proposal for the project.

2.0 SCOPE OF WORK

The scope of the work was developed by American Electric Power (AEP) in consideration of the recently mandated coal combustion residuals (CCR) rule that require a licensed Professional Engineer (P.E.) to certify that CCR impoundments have met the rule's minimum factor of safety requirements for embankment stability specified in the Federal Register 40 CFR Parts 257 and 261, Vol. 80, No. 74, dated April 17, 2015. According to the CCR rules, the minimum factor of safety requirements for the static, seismic, and liquefaction conditions are summarized in the following table.

Minimum Safety Factors Required

Load Case	Required Minimum Factor of Safety
Long Term, Maximum Storage Pool Condition	1.5
Maximum Surcharge Pool (50% PMF) Condition	1.4
Seismic Conditions from Maximum Operating Pool Elevation	1.0
Liquefaction	1.2

3.0 GENERAL PROJECT INFORMATION

The Kyger Creek Station is located along the Ohio River in Gallia County, Ohio, south of the town of Cheshire, Ohio. The Ohio River is located directly east of the facility and Kyger Creek flows along the west and south side of the facility. **Exhibit 1** shows the general location of the plant and is included in **Appendix I**.

The plant currently has two process and disposal areas for the coal combustion waste products generated at the plant, known as the Boiler Slag Pond and the South Fly Ash Pond. Overflow from the Boiler Slag Pond is carried into a reinforced concrete intake structure at the south end of the Boiler Slag Complex. Water entering the intake structure is discharged into a Clearwater Pond located to the southwest end of the Boiler Slag Pond. The Boiler Slag Pond and the Clearwater Pond is separated by a splitter dike. **Exhibits 2 and 3** show a more detailed layout of the ponds and are included in **Appendix I**. The configurations and the hydrologic and hydraulic data for the South Fly Ash Pond, the Boiler Slag Pond, and the Clearwater Pond, based on the historical information available, are summarized in the following tables.

Configurations of the Ponds[1]

Pond	Year Constructed	Height (feet)	Crest Elevation (MSL)[2]	Inboard Slope	Outboard Slope[3]
South Fly Ash	1955	40	590	2H:1V	2.3H:1V to 2.9H:1V
Boiler Slag	1955	41	582	2.25H:1V	2.6H:1V to 3H:1V
Clearwater	1980	30-45[1]	582	2.5H:1V to 3H:1V	2.5H:1V to 3H:1V

Note: 1)The pond information is based on the US EPA Assessment of Dam Safety of Coal Combustion Surface Impoundments (Task 3) Final Report prepared by Clough Harbor and Associates (CHA), dated February 24, 2010 and the 2009 Dam and Dike Inspection Report for Kyger Creek Power Station, Gallipolis, Ohio prepared by Stantec, dated April 21, 2009.
2)Elevations are in reference to NGVD 29.
3)The outboard slopes are based on the survey performed by DLZ in 2010.

Summary of Hydrologic and Hydraulic Data for the Ponds[1]

Pond	Drainage Area (acres)	Peak Flow Rate In (cfs)	50% PMF Storage Volume (ac-ft)	50% PMF Storage Peak Elevation (ft)
South Fly Ash	67.3	627.1	72.9	584.0
Boiler Slag	32.3	300.6	34.6	559.3
Clearwater	939	92.3	10.8	558.6

Note: 1)The hydrologic and hydraulic data is based on the US EPA Assessment of Dam Safety of Coal Combustion Surface Impoundments (Task 3) Final Report prepared by Clough Harbor and Associates (CHA), dated February 24, 2010.

Summary of Elevation Data for the Ponds (in 2010)

Pond	Top of Pond Elevation (feet)[1]	50% PMF Storage Peak Elevation (ft)[2]	Free-board (feet)	Normal Pool Elevation (feet)[3]
South Fly Ash	588 to 589	584.0	4 to 5	585
Boiler Slag	580 to 581	559.3	20.7 to 21.7	558
Clearwater	580	558.6	21.4	552

Note: 1) Elevation data is based on the elevations of the borings on the dike crest surveyed by DLZ in 2010.
2) Elevations are from the CHA's report.
3) Elevation data is from Gary Zych of AEP in 2010.

4.0 PREVIOUS SUBSURFACE EXPLORATION AND ENGINEERING ANALYSES

DLZ performed a subsurface exploration and various engineering analyses of the ash pond embankments, including the Clearwater Pond embankments, in 2010 to assess the stability requirements as recommended in the US EPA Assessment of Dam Safety of Coal Combustion Surface Impoundments (Task 3) Final Report prepared by Clough Harbor and Associates (CHA), dated February 24, 2010. A total of twenty-two borings and twelve piezometers were installed during the 2010 subsurface exploration. **Exhibits 4 and 5** show the approximate boring locations at pond dikes and are included in **Appendix II**. Logs of the borings are also included in **Appendix II**. Ground surface elevations at the borings and the embankment cross-sections at the boring locations were surveyed by DLZ. The elevations in the 2010 subsurface exploration were reported in reference to the National Geodetic Vertical Datum of 1929 (NGVD 29) in consistent with the historical information for the project.

It should be noted that elevations presented in this document are referenced to the 1929 datum (NGVD 29) unless noted otherwise.

As part of the 2010 pond embankment evaluations, slope stability and liquefaction analyses were conducted to assess the stability of the South Fly Ash Pond and the Boiler Slag Pond using the loading conditions recommended by CHA. Results of the analyses indicated that the embankments exhibited factors of safety exceeding the required minimum values recommended by CHA. In addition, the fine-grained soils at the pond locations were found to be not susceptible to liquefaction. Details of the subsurface exploration and results of the engineering analyses were summarized in a report titled "*Final Report for Kyger Creek Power Plant – Subsurface Investigation and Analysis of Ash Pond Embankments*" dated January 12, 2011.

5.0 PROFESSIONAL ENGINEER CERTIFICATION

5.1 Site Visit and Information Gathering

Personnel from DLZ visited the ash pond embankments on July 22, 2015. During the site visit, OVEC and AEP representatives were interviewed to gather current design information for the stability assessment and liquefaction evaluation.

Reportedly, there had not been significant changes in the overall conditions of the ash pond embankments since the 2010 subsurface exploration. However, seepage was observed at isolated locations on the east and west outboard slopes of the South Fly Ash Pond during the routine walk-through of the embankments over the past few years. Inverted filters/drains have been installed at the seep locations with approvals from the Ohio Department of Natural Resources. The observed seepage quantities appeared to be minor and did not appear to have adversely affected the integrity of the embankments.

5.2 Hydrologic and Hydraulic Evaluations

Hydrologic and hydraulic (H&H) evaluations were performed to ascertain the compliance of the ash pond embankments with the mandated CCR rules with regard to the H&H capacity requirements for surface impoundments. Based on the available hydraulic data for the ponds, the pool elevations at the South Fly Ash Pond and the Boiler Slag Pond under the required loading conditions were calculated and are summarized in the following table. Details of the H&H evaluations are included in **Appendix III**.

Summary of Elevation Data for the Ponds (PE Certification)

Pond	Present (Normal) Pool Elevation (feet)	Maximum Storage Pool Elevation (Maximum Operating Pool Elevation) (feet)[3]	Maximum Surcharge Pool (Flood) Elevation (feet)[2]
South Fly Ash	582.0	585.0[1]	586.0
Boiler Slag	557.0	558.0[1]	559.3
Clearwater	552.0	553.0[1]	558.6

[1]Per e-mail communication with personnel from AEP.
[2]Maximum surcharge pool (flood) elevations are the 50% PMF.

5.3 Stability Evaluations

Reportedly, there had not been any changes to the overall conditions of the embankments since the 2010 subsurface explorations. Consequently, the stability evaluations for the PE certification were performed essentially based on the information gathered in 2010.

The embankment stability evaluations were performed using UTEXAS3 Version 1.204. UTEXAS3 is a computer program used extensively by the Corps of Engineers and was developed by Stephen Wright of the University of Texas for the evaluation of slope stability. This program uses limit equilibrium to solve slope stability problems using the method of slices. Stability analyses were performed using Spencer's method, assuming circular failure surfaces. The phreatic surface used in these analyses was based on the highest water levels measured in the piezometers between August 2010 and September 2014. The water level readings were provided by AEP and are included in **Appendix IV**. The shear strength parameters used in the stability analyses are presented in the following table. A summary of the laboratory testing and the results of strength tests on selected samples performed in the 2010 subsurface investigation are included in **Appendix IV**.

Shear Strength Parameters for Slope Stability Analyses

Soil Stratum	γ_{wet} (pcf)	Total		Effective	
		c, psf	Φ,degree	c', psf	Φ',degree
Embankment Clay Fill	125	350	20	100	32
Very Soft Clay	120	250	16	50	26
Soft to Medium Stiff Clay	125	300	16	100	28
Medium Stiff to Stiff Clay	125	350	16	100	30
Stiff to Very Stiff Clay	125	500	16	100	32
Medium Dense to Dense Granular Soils	125	0	28 to 35, mostly 35	0	28 to 35, mostly 35

Pseudo-static slope stability analyses were performed for the seismic evaluation. According to the CCR rules, the seismic stability during and following a seismic event with a 2% probability of exceedance in 50 years and a horizontal spectral response acceleration for 1.0-second period (5% of Critical Damping) should be evaluated. Using these criteria, the United States Geological Survey (USGS) 2014 Seismic Hazard Map for the United States indicates that the Peak Ground Acceleration (PGA) for the site area is approximately 0.04g. It should be noted that the PGA of 0.04g is the peak ground acceleration for a uniform firm rock site condition (760 meters per second shear wave velocity in the upper 30 meter). Using the ground acceleration correlation between rock sites and soil sites and the correlation between the pseudo-static coefficient and the peak ground acceleration, a seismic coefficient of 0.06g was determined and used for the stability analyses. The USGS 2014 Seismic Hazard Map for the United States and the detailed calculations of the seismic coefficient are presented in **Exhibit 6** in **Appendix V**.

For seismic conditions, UTEXAS uses a pseudo-static analysis where a horizontal destabilizing force due to the ground acceleration of an earthquake is added to the total sliding force. This horizontal force is equal to the weight of the sliding mass times the seismic coefficient for the design seismic event for the site. The program applies the multistage analysis technique developed by Duncan and Wright (1990) and Shinoak Software (1991) to search for the most critical surface of sliding that gives the least factor of safety against such a failure. A three-stage stability computation was used for this investigation. The first set of computations is to compute the effective stresses along the shear surface to which the soil is consolidated prior to the seismic event. These consolidation stresses are used to estimate undrained shear strengths for the second-stage computations, when the earthquake occurs. These undrained shear strengths were calculated based on the procedure developed by Duncan and Wright (1990). The third set of computations is performed to check the possibility that drainage may occur and the drained strength may be lower than the calculated undrained strength. A comparison is made between the calculated drained strength and the calculated undrained strength. A conservative factor of safety is computed using the lower of the calculated drained or undrained strength.

Based on the available hydraulic data for the ponds, the pool elevations at the South Fly Ash Pond, the Boiler Slag Pond, and the Clearwater Pond under the required loading conditions were calculated and are summarized Section 5.2 of this report. These pool elevations were used in the stability analyses for this PE certification.

According to AEP, the ponds have always been operating at the maximum storage pool levels. Consequently, the maximum operating pool elevations, instead of the normal pool elevations, were used in the stability analyses for the seismic condition. Results of the stability analyses for the maximum surcharge pool condition indicated that the embankments exhibit factors of safety of 1.5 or greater for all sections analyzed. Consequently, stability analyses for the normal pool (long term) condition were not analyzed. A summary of the stability analyses is presented in the following tables. The graphic results of the stability analyses are included in **Appendix VI**.

Summary of Results of Stability Analyses

Pond/Section	Pool Elevation Used for Analysis (feet)[1]	Critical Factor of Safety Calculated for Maximum Surcharge Pool Condition	Required Minimum Factor of Safety		Pool Elevation for Seismic Case (feet)[2]	Computed Factor of Safety for Seismic Case (Required Minimum F.S.)	Criteria Meet?
			Long Term, Normal Pool Condition	Maximum Surcharge Pool Condition			
South Fly Ash (Critical Section 2)	586	1.51	1.5	1.4	585	1.18 (1.0)	Yes
Boiler Slag (Critical Section 2)	559.3	1.71	1.5	1.4	558	1.30 (1.0)	Yes
Clearwater (Critical Section 3)	558.6	1.85	1.5	1.4	553	1.36 (1.0)	Yes

[1]Maximum surcharge pool elevations.
[2]The ponds have always been operating at the maximum operating pool levels.

5.4 Liquefaction Evaluations`

Liquefaction evaluations were performed in the 2010 subsurface exploration. According to the map, "Earthquakes in Ohio and Vicinity 1776 – 2007," prepared by USGS, the earthquake moment magnitude M_w for the site area is between 3.0 and 3.9. For the liquefaction analysis, an M_w of 3.9 was assumed. Additionally, the phreatic surface was conservatively assumed to be at the ground surface at the boring locations during an earthquake event. **Using the PGA of 0.06g for the site, as previously noted, the**

factors of safety are greater than 3.0 against liquefaction of the granular soils at the various depths encountered in the borings. Consequently, the granular soils are not susceptible to liquefaction for the assumed M_w of 3.9. For liquefaction evaluation of fine-grained soils, the guidelines from the Illinois Department of Transportation (IDOT), the US Army Corps of Engineers and the Ohio EPA were used. Results of the liquefaction evaluations indicated that the majority of the fine-grained soils at the site were not potentially liquefiable. However, a total of thirteen samples was identified to be potentially liquefiable using the IDOT criteria. Additional analyses using the "Simplified Method" by Youd et al (2001) were performed to further evaluate the liquefaction potential of these soils for the assumed earthquake magnitude and peak ground acceleration. Results of the "Simplified Method" indicated that the fine-grained soils were not susceptible to liquefaction. Reportedly, there have not been changes to the overall conditions of the embankments since the 2010 subsurface exploration; therefore, the results of the liquefaction evaluations performed in 2010 were used for the PE certification. Details of the liquefaction evaluations are included in **Appendix VII**.

6.0 CONCLUSIONS

Slope stability analyses and liquefaction evaluations have been conducted to assess the stability of the South Fly Ash Pond, the Boiler Slag Pond, and the Clearwater Pond using the loading conditions required by the current CCR rules specified in the Federal Register 40 CFR Parts 257 and 261, Vol. 80, No. 74, dated April 17, 2015. Results of the analyses indicate that the embankments exhibit factors of safety exceeding the required minimum values required by the current CCR rules.

7.0 REFERENCES

U.S. Army Corps of Engineers. Slope Stability. Engineering Manual 1110-2-1902. October, 2003.

United States Geological Survey (USGS). Documentation for the 2008 Update of the United States National Seismic Hazard Maps, 2008.

Youd, et. al. (2001). "Liquefaction Resistance of Soils": Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils" Journal of Geotechnical and Geoenvironmental Engineering, October 2001.

Design Guide, AGMU Memo 10.01 – Liquefaction Analysis. January 14, 2010. Illinois Department of Transportation.

United States Geological Survey (USGS) Map. Earthquakes in Ohio and Vicinity 1776-2007.

RCRA Subtitle D (258) Seismic Design Guidance for Muncipal Solid Waste Landfill Facilities, EPA/600/R-95/051, April 1995, Chapter 5 "Liquefaction Potential Evaluation and Analysis."

UTEXASED4, A Computer Program for Slope Stability Calculations, by Stephen G. Wright, 2004.

8.0 PROFESSIONAL ENGINEER CERTIFICATION

DLZ has completed the engineering services for Professional Engineer Certification of the South Fly Ash Pond, the Boiler Slag Pond, and the Clearwater Pond Embankments at the OVEC Kyger Creek Station.

Results of the stability analyses and liquefaction evaluations indicate that the embankments has met the coal combustion residuals (CCR) rule's minimum factor of safety requirements for embankment stability under the static, seismic, and liquefaction conditions as specified in the Federal Register 40 CFR Parts 257 and 261, Vol. 80, No. 74, dated April 17, 2015.

DLZ Ohio, Inc.

Eric Tse, P.E.
Senior Geotechnical Engineer

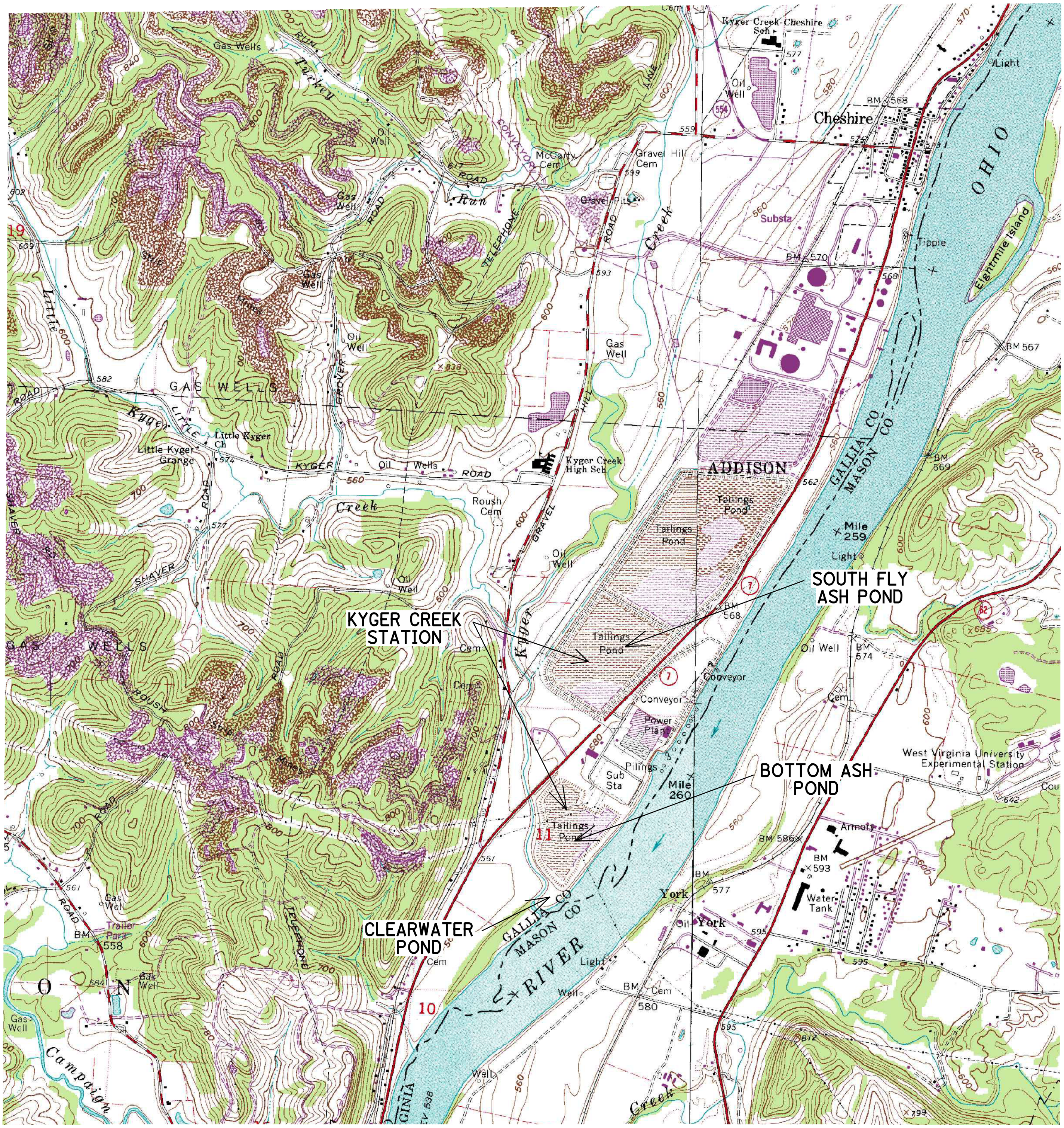
STATE OF OHIO
ERIC WAI KEUNG TSE
PE. 70726
REGISTERED
PROFESSIONAL ENGINEER

Mookencheril Cherian, P.E.
Senior Project Manager

STATE OF OHIO
MOOKENCHERIL P. CHERIAN
61076
REGISTERED
PROFESSIONAL ENGINEER

APPENDIX I

Exhibit 1 – General Site Location Map
Exhibit 2 – Layout of the South Fly Ash Pond
Exhibit 3 – Layout of the Boiler Slag Pond and the Clearwater Pond



N

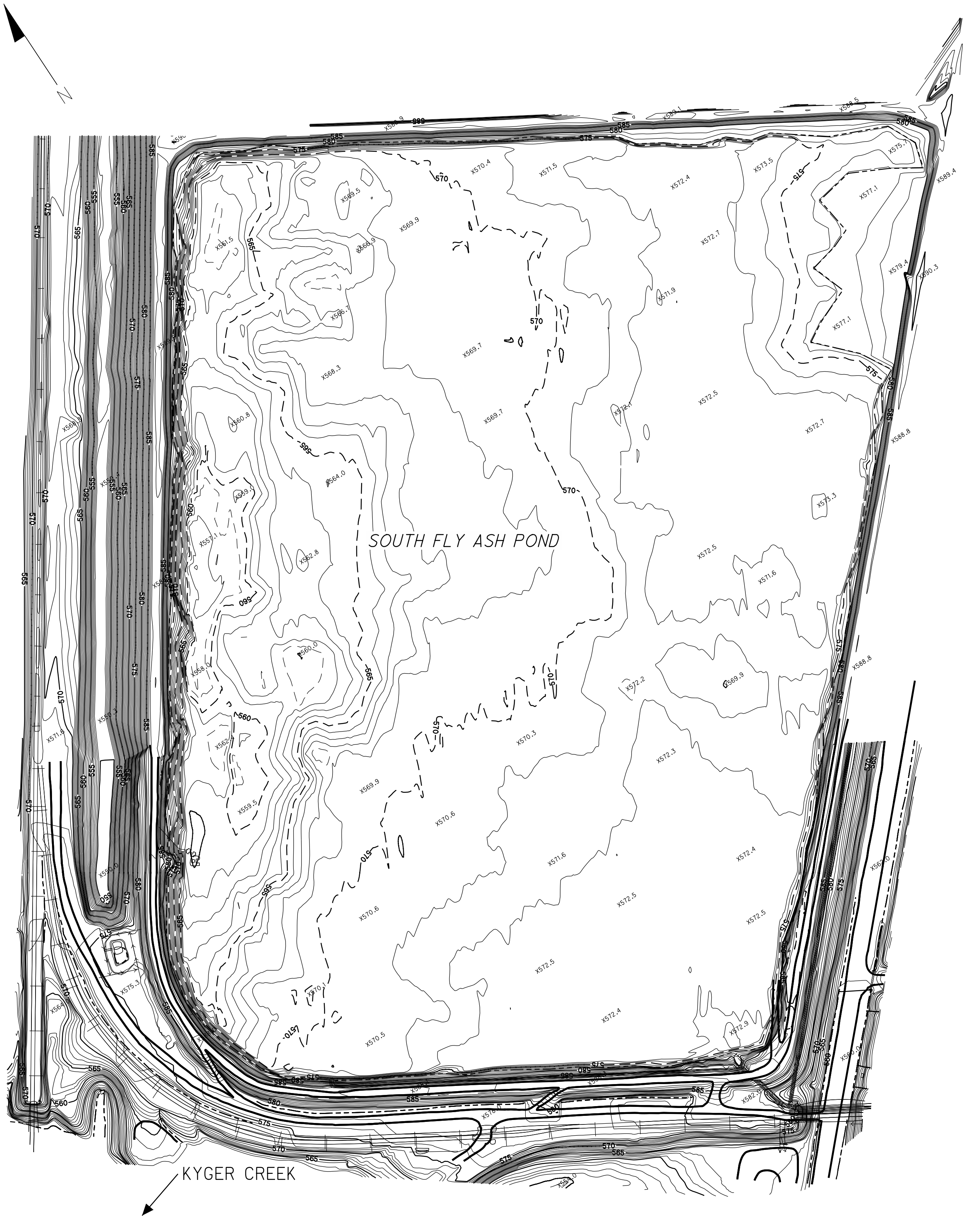
SCALE: 1"=1/2MILE

DLZ

SITE LOCATION MAP

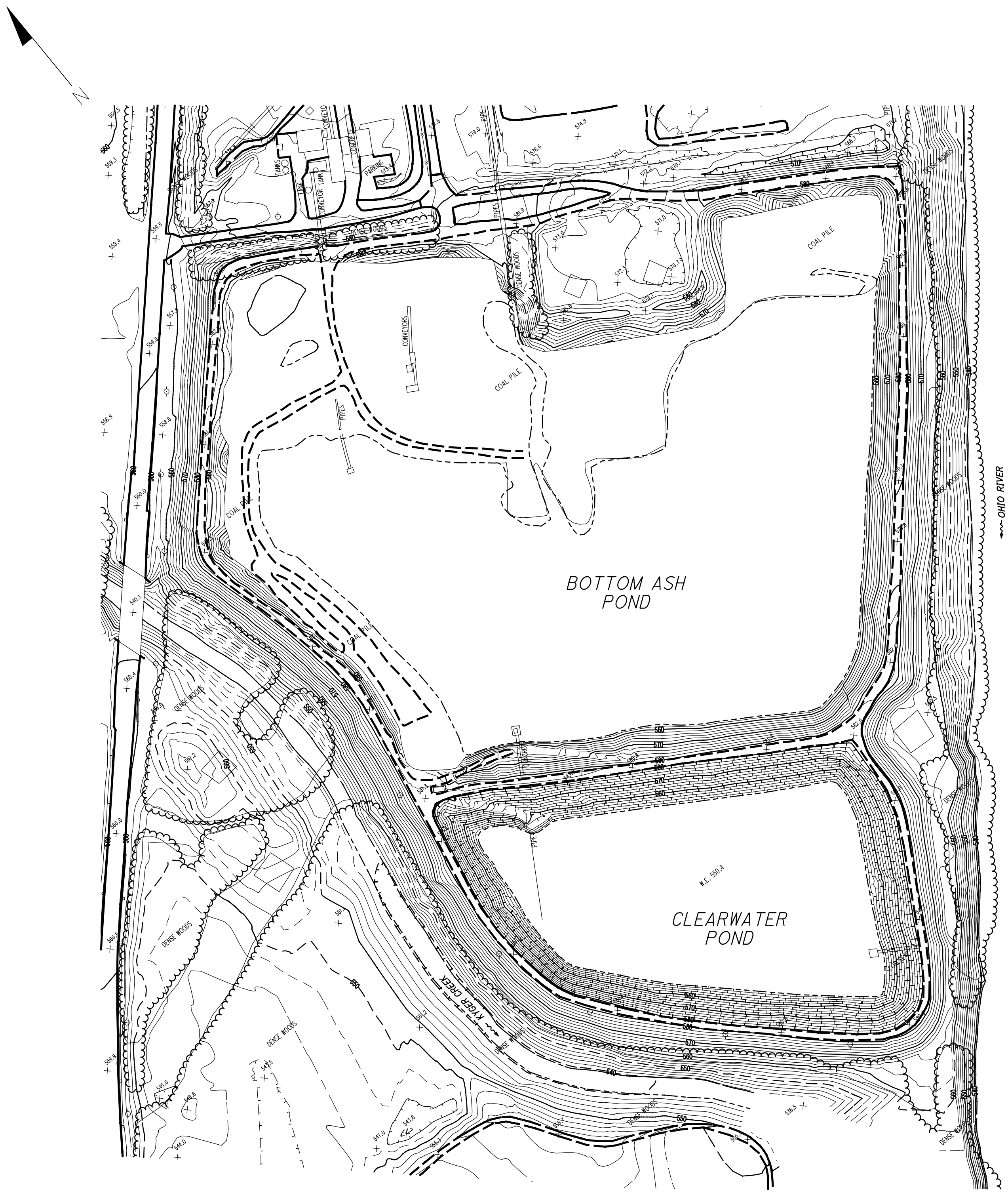
KYGER CREEK PLANT
OHIO VALLEY ELECTRIC CORP.
GALLIPOLIS, OHIO

PROJECT NO. 1021-3003.00	
DATE: 11/12/2010	
EXHIBIT 1	



SCALE: 1"=300'

DLZ	SOUTH FLY ASH POND KYGER CREEK PLANT OHIO VALLEY ELECTRIC CORP. GALLIPOLIS, OHIO	PROJECT NO. 1021-3003.00 DATE: 11/12/2010 EXHIBIT 2



SCALE: 1"=300'

Bottom Ash Pond is also known as
Boiler Slag Pond

DLZ

BOTTOM ASH POND

KYGER CREEK PLANT
OHIO VALLEY ELECTRIC CORP.
GALLIPOLIS, OHIO

PROJECT NO.
1021-3003.00

DATE: 11/12/2010

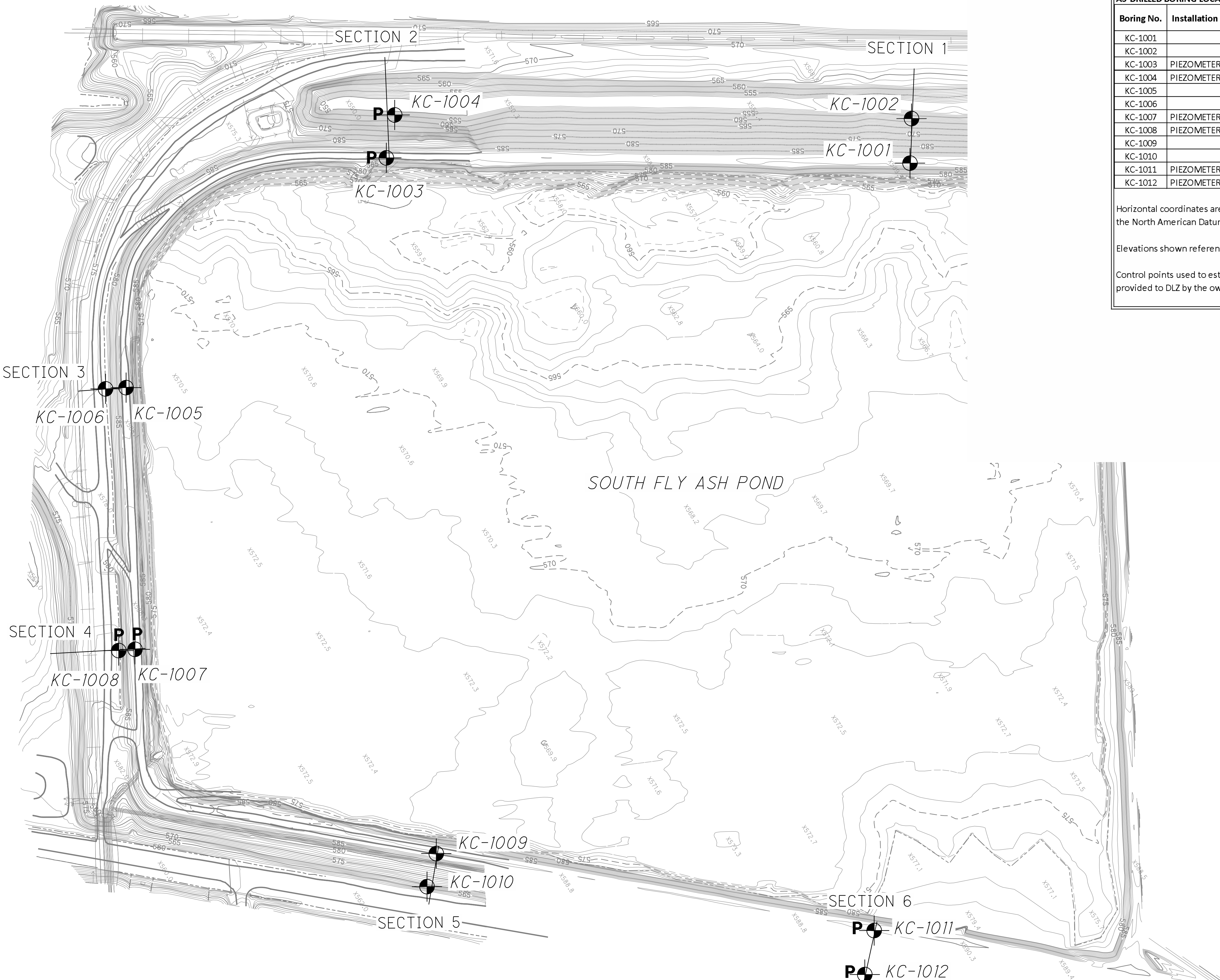
EXHIBIT 3

APPENDIX II

Exhibit 4 – Boring Location Plan for the South Fly Ash Pond

Exhibit 5 – Boring Location Plan for the Boiler Slag Pond and the Clearwater Pond

Logs of Borings Performed in the 2010 Subsurface Investigation



AS-DRILLED BORING LOCATIONS

Boring No.	Installation	NORTHING	EASTING	ELEVATION (RISER)	ELEVATION (CASING)	ELEVATION (GROUND)
KC-1001		335792.74	2104707.66	-	-	589.27
KC-1002		335845.29	2104633.74	-	-	558.28
KC-1003	PIEZOMETER	334909.65	2104111.75	588.09	588.41	588.41
KC-1004	PIEZOMETER	334971.92	2104048.18	557.99	558.35	555.31
KC-1005		334210.21	2104210.16	-	-	588.24
KC-1006		334173.91	2104189.26	-	-	576.37
KC-1007	PIEZOMETER	333931.89	2104664.58	588.83	589.03	589.03
KC-1008	PIEZOMETER	333902.86	2104648.40	580.61	580.90	580.90
KC-1009		334214.40	2105349.14	-	-	589.16
KC-1010		334161.58	2105394.90	-	-	565.11
KC-1011	PIEZOMETER	334871.45	2105970.70	588.99	589.19	589.19
KC-1012	PIEZOMETER	334806.18	2106034.91	562.67	562.96	562.96

Horizontal coordinates are State Plane Grid, Ohio South Zone, and reference the North American Datum of 1927 (NAD 27)

Elevations shown reference the National Geodetic Vertical Datum of 1929 (NGVD 29)

Control points used to establish the coordinates on the respective datums were provided to DLZ by the owner (OVEC/AEP) at the time of the survey.

AS-DRILLED BORING

P PIEZOMETERS INSTALLED IN BORINGS AS INDICATED IN TABLE ABOVE

NOTE: TOPOGRAPHIC SURVEY INFORMATION SHOWN ON THIS PLAN IS FOR REFERENCE ONLY. TOPO INFORMATION WAS PROVIDED BY AEP/OVEC AND IS BASED ON AERIAL MAPPING (1994) AND FIELD SURVEY (1997). CURRENT ELEVATIONS MAY BE DIFFERENT THAN THOSE SHOWN ON PLAN.

0 50 100 200
HORIZONTAL SCALE IN FEET

DRAWN RKL
CHECKED SJR

SOUTH FLY ASH POND GENERAL SITE PLAN

KYGER CREEK

1 / 6

EXHIBIT 4

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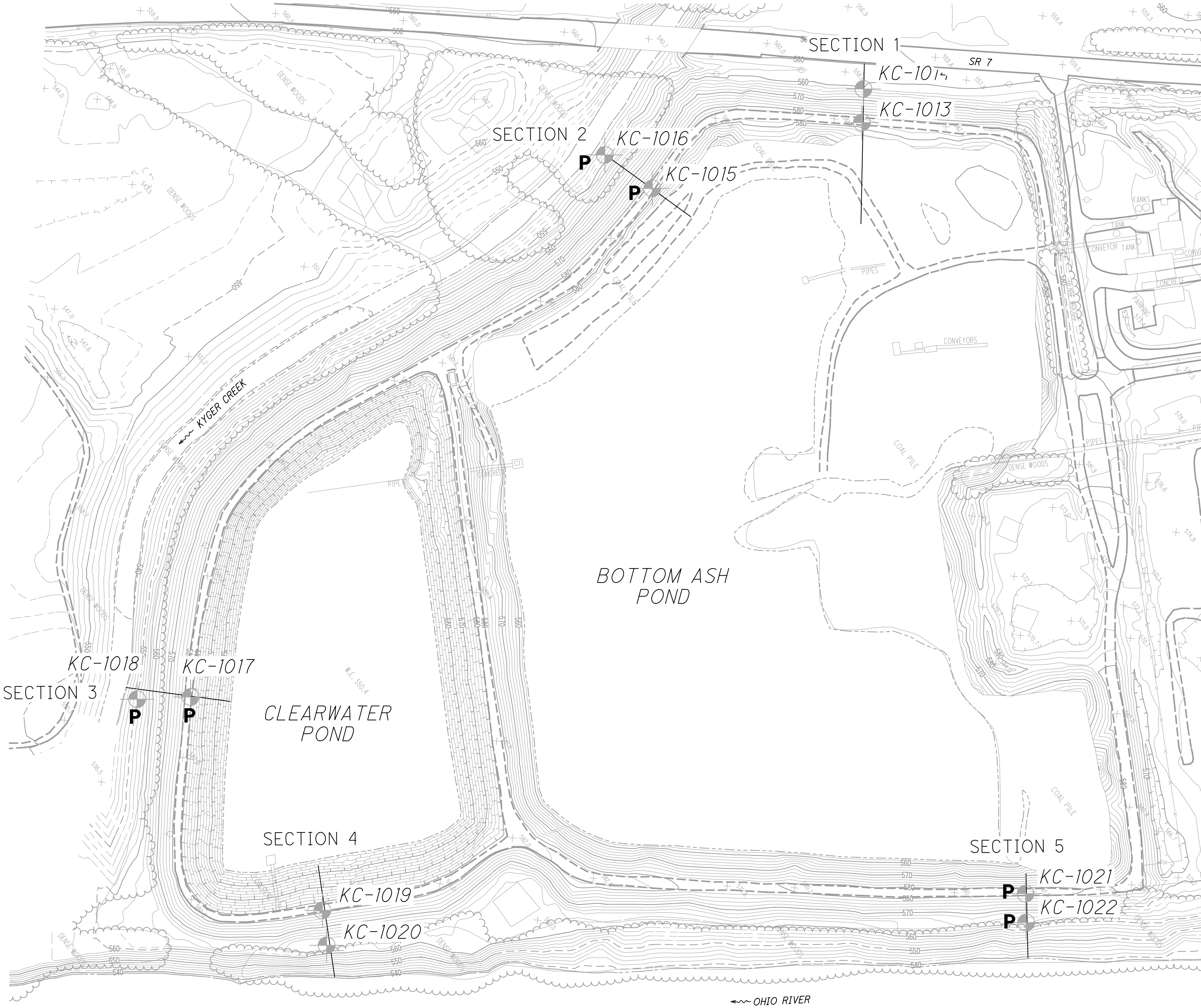


AS-DRILLED BORING LOCATIONS						
Boring No.	**Installation**	**NORTHING**	**EASTING**	**ELEVATION (RISER)**	**ELEVATION (CASING)**	**ELEVATION (GROUND)**
KC-1013		332435.80	2104006.56	-	-	581.27
KC-1014		332476.01	2103962.06	-	-	558.59
KC-1015	PIEZOMETER	332073.06	2103860.39	580.07	580.41	580.41
KC-1016	PIEZOMETER	332045.57	2103760.75	546.70	546.87	543.80
KC-1017	PIEZOMETER	330862.99	2104039.31	579.69	580.07	580.07
KC-1018	PIEZOMETER	330786.90	2103981.94	550.10	550.35	547.34
KC-1019		330803.17	2104482.03	-	-	580.73
KC-1020		330769.60	2104534.81	-	-	559.51
KC-1021	PIEZOMETER	331789.94	2105253.04	579.92	580.18	580.18
KC-1022	PIEZOMETER	331758.02	2105293.51	565.54	565.75	562.69

Horizontal coordinates are State Plane Grid, Ohio South Zone, and reference the North American Datum of 1927 (NAD 27)

Elevations shown reference the National Geodetic Vertical Datum of 1929 (NGVD 29)

Control points used to establish the coordinates on the respective datums were provided to DLZ by the owner (OVEC/AEP) at the time of the survey.

AS-DRILLED BORING

P PIEZOMETERS INSTALLED IN BORINGS AS INDICATED IN TABLE ABOVE

NOTE: TOPOGRAPHIC SURVEY INFORMATION SHOWN ON THIS PLAN IS FOR REFERENCE ONLY. TOPO INFORMATION WAS PROVIDED BY AEP/OVEC AND IS BASED ON AERIAL MAPPING (1994) AND FIELD SURVEY (1997). CURRENT ELEVATIONS MAY BE DIFFERENT THAN SHOWN ON PLAN.

Bottom Ash Pond is also known as Boiler Slag Pond

EXHIBIT 5

0 50 100 200
HORIZONTAL SCALE IN FEET

DRAWN RKL
CHECKED SJR

BOTTOM ASH POND GENERAL SITE PLAN

KYGER CREEK

2 / 6

M:\proj\1021\3003\Kyger Creek\Draft Report (11-18-10)\Kyger_Creek_plan02.dgn 11/22/2010 9:41:19 AM etse

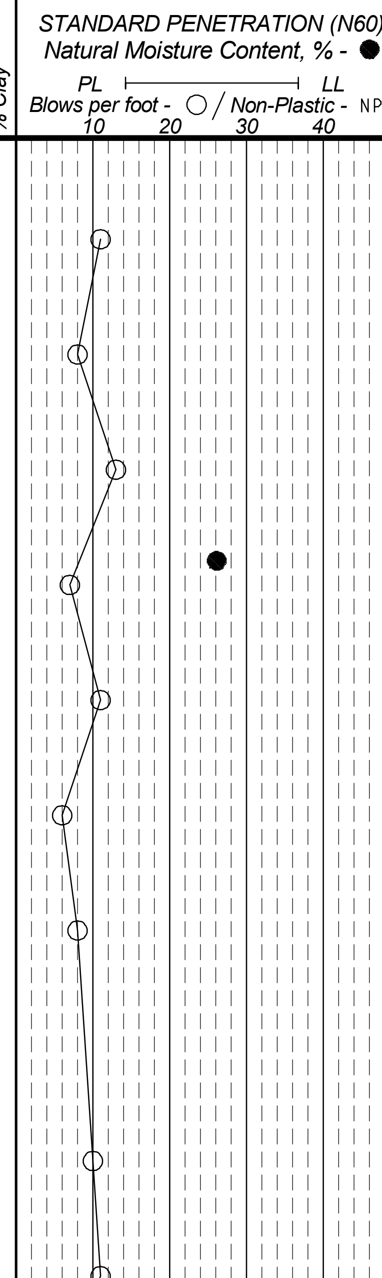
Client: OVEC-AEP	*Project:* Kyger Creek - Ash Impoundment Stability Analysis	*Job No.* 1021-3003.00
LOG OF: Boring KC-1001	*Location:* As per plan	*Date Drilled:* 8/19/2010

WATER OBSERVATIONS:
Water seepage at: *46'-65'*
Water level at completion: *53.6' Prior to adding water.*
49.3 Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Began adding drilling water at 50' to counteract heave.

Depth (ft)	Elev. (ft) 589.3	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION
0.3	589.0						3" Gravel
		1 4 5	18	S-1		3.5	FILL: Stiff to very stiff brown and gray LEAN CLAY with sand (CL); moist.
5		1 3 4	10	S-2		1.5	
6.0	583.3						
		3 6 5	18	S-3		4.0	FILL: Stiff to very stiff brown and gray LEAN CLAY with sand (CL); moist.
10		2 2 4	15	S-4		1.0	
		1 4 5	18	S-5		3.0	
15		2 2 3	18	S-6		1.0	
		3 2 5	18	S-7		1.25	
20					ST-1		
		1 4 4	18	S-8		3.0	
25	564.3	2 4 5	18	S-9		2.25	

GRADATION: Graphic Log | % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay



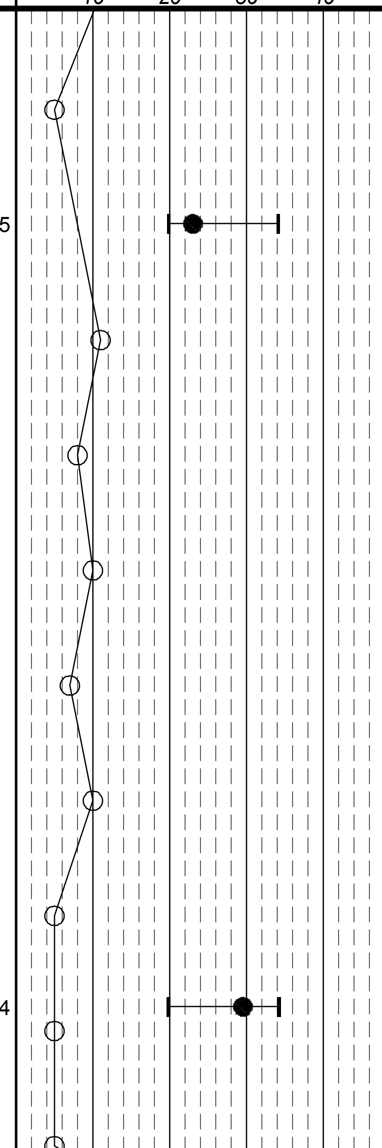
Client: OVEC-AEP | Project: Kyger Creek - Ash Impoundment Stability Analysis | Job No. 1021-3003.00

LOG OF: **Boring KC-1001** | Location: As per plan | Date Drilled: 8/19/2010

WATER OBSERVATIONS:
Water seepage at: 46'-65'
Water level at completion: 53.6' Prior to adding water.
49.3 Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Began adding drilling water at 50' to counteract heave.

Depth (ft)	Elev. (ft) 564.3	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
		1 1 3	18	S-10		1.5	FILL: Stifff brown and gray LEAN CLAY with sand (CL); moist.						
28.5	560.8				ST-2	2.5	FILL: Very stiff brown and gray LEAN CLAY (CL), trace fine to medium sand; moist.	0	0	1	7	47	45
31.0	558.3	2 4 5	18	S-11		2.5	FILL: Stiff to very stiff brown and gray sandy LEAN CLAY (CL); damp to moist.						
		2 3 4	18	S-12		1.0							
35.0	554.3	2 4 4	18	S-13		2.5	POSSIBLE FILL: Stiff to very stiff brown and gray sandy LEAN CLAY (CL); damp to moist.						
		1 3 3	18	S-14		1.25							
		WOH 2 6	18	S-15		1.5							
43.5	545.8	WOH WOH 4	18	S-16		0.75	Medium stiff brown LEAN CLAY with sand (CL); damp to moist.						
46.0	543.3	WOH WOH 4	18	S-17		1.5	Stiff brown LEAN CLAY (CL), trace fine sand; moist. @ 47.0' Clayey sand seam layer	0	0	0	8	58	34
48.5	540.8	WOH WOH		S-18A		0.75	Medium stiff gray sandy LEAN CLAY (CL); moist.						
49.4	539.9	4	18	S-18B			Loose gray silty SAND (SM); wet.						
	539.3												



Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: **Boring KC-1001**	Location: As per plan	Date Drilled: 8/19/2010

WATER OBSERVATIONS:
Water seepage at: 46'-65'
Water level at completion: 53.6' Prior to adding water.
49.3 Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Began adding drilling water at 50' to counteract heave.

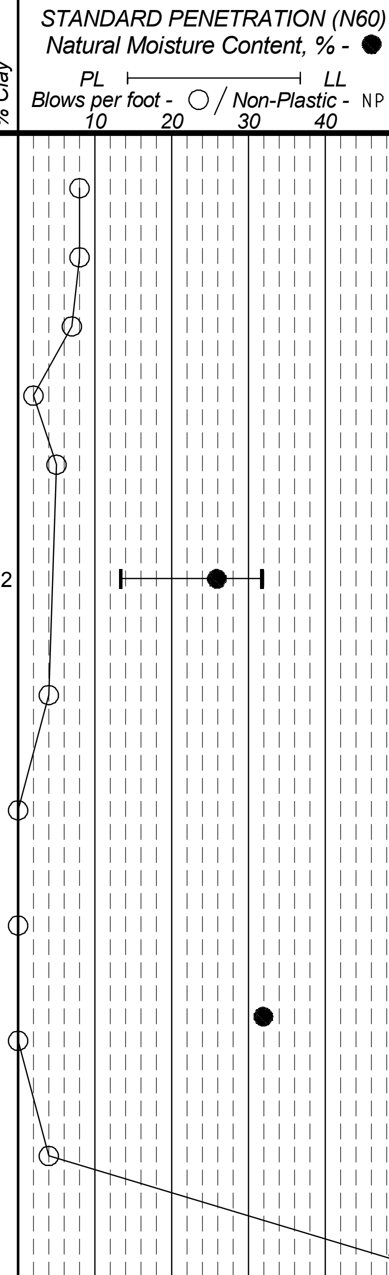
Depth (ft)	Elev. (ft) 539.3	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60)
							Loose gray silty SAND (SM); wet.							
52.0	537.3						Dense light brown SAND with gravel (SW), trace silt; wet.							
55		10 16 33	18	S-19				42	17	18	21	--3--		NP; 59
57.0	532.3						Very dense light brown silty SAND with gravel (SM); wet.							
60		33 43 35	12	S-20										94
63.5	525.8	18 14 19	10	S-21			Dense light brown GRAVEL with silt with sand (GP-GM); wet.							
65.0	524.3													
							Bottom of Boring - 65.0'							

Client: OVEC-AEP | **Project:** Kyger Creek - Ash Impoundment Stability Analysis | **Job No.** 1021-3003.00

LOG OF: Boring KC-1002 | **Location:** As per plan | **Date Drilled:** 8/25/2010

WATER OBSERVATIONS:
Water seepage at: 6.0-7.5, 13.5-58.5
Water level at completion: 18.0' Prior to adding water
FIELD NOTES:

Depth (ft)	Elev. (ft) 558.3	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.2	558.1	1 4 3	18	S-1		3.5	Topsoil - 2" FILL: Very stiff brown sandy LEAN CLAY (CL); damp to moist.						
		2 3 4	3	S-2		3.5							
		2 3 3	6	S-3		2.5							
5.0	553.3	2 1 1	2	S-4			POSSIBLE FILL: Very loose to loose brown SAND with silt (SP-SM); moist to wet.						
		2 2 2	2	S-5									
8.5	549.8				ST-1		Very soft to soft brown sandy LEAN CLAY (CL); moist to wet.	0	0	0	16	52	32
		WOH 1 2	18	S-6		0.5							
		WOH WOH WOH	18	S-7		0.25							
		WOH WOH WOH	18	S-8		0.25							
		WOH WOH WOH	18	S-9		<0.25							
		1 1 2	18	S-10		0.5	@ 21.0', gray.						
23.5	534.8	WOH 12 33	6	S-11			Medium dense to dense gray GRAVEL with silt with sand (GW-GM); wet.						
25	533.3												



Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

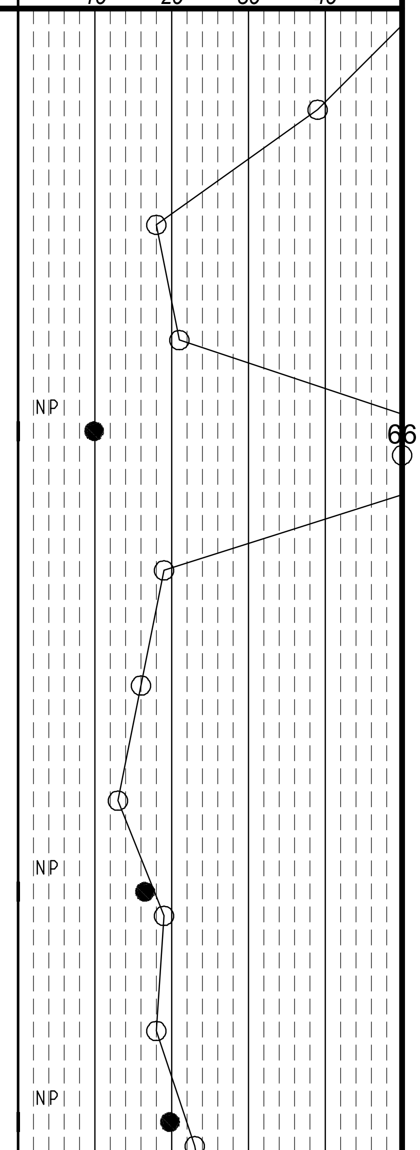
LOG OF: Boring KC-1002 | *Location:* As per plan | *Date Drilled:* 8/25/2010

WATER OBSERVATIONS:
Water seepage at: 6.0-7.5, 13.5-58.5
Water level at completion: 18.0' Prior to adding water

FIELD NOTES:

Depth (ft)	Elev. (ft) 533.3	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
		13 20 12	18	S-12			Medium dense to dense gray GRAVEL with silt with sand (GW-GM); wet.						
30		3 6 9	10	S-13									
		2 7 10	10	S-14									
33.0	525.3												
35		25 30 25	18	S-15			Very dense gray SAND with silt with gravel (SW-SM); wet.	45	12	17	18	--8--	
36.0	522.3												
		6 7 9	8	S-16			Medium dense to dense gray GRAVEL with silt with sand (GW-GM); wet.						
40		7 8 5	5	S-17									
		3 4 7	1	S-18									
43.5	514.8												
45		11 5 11	8	S-19			Medium dense gray SAND with silt with gravel (SP-SM); wet.	18	11	23	41	--7--	
46.0	512.3												
		7 5 10	14	S-20			Medium dense gray SAND (SW), trace gravel; wet.						
50	508.3	5 7 12	12	S-21				4	20	67	9	--0--	

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



Client: OVEC-AEP	*Project:* Kyger Creek - Ash Impoundment Stability Analysis	*Job No.* 1021-3003.00
LOG OF: Boring KC-1002	*Location:* As per plan	*Date Drilled:* 8/25/2010

WATER OBSERVATIONS:
Water seepage at: 6.0-7.5, 13.5-58.5
Water level at completion: 18.0' Prior to adding water
FIELD NOTES:

Depth (ft)	Elev. (ft) 508.3	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60)
50.5	507.8						Medium dense gray SAND (SW), trace gravel; wet.								
		10 10 13	1	S-22											
58.5	499.8														
59.3	499.0	20 50/3"	2	S-23			Soft to medium hard gray SILTSTONE interbedded with SHALE; highly weathered to decomposed, argillaceous, micaceous.								50+
							Bottom of Boring - 59.3'								

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

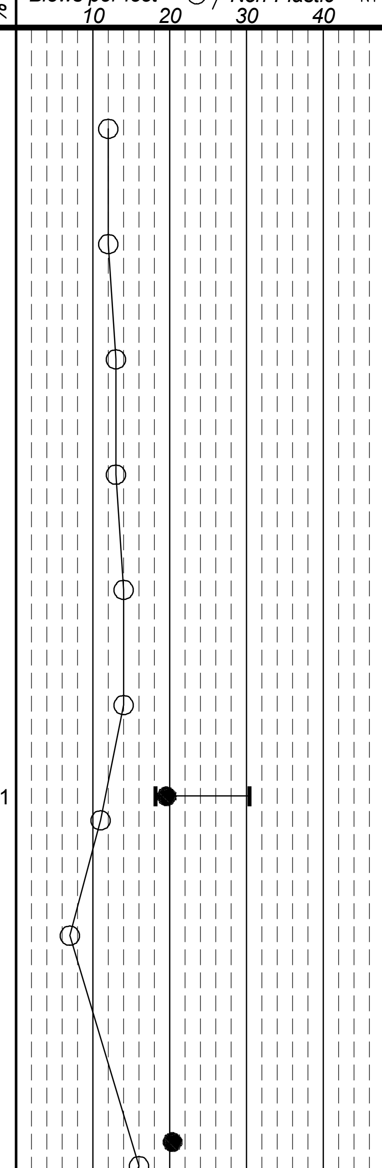
LOG OF: Boring KC-1003 | *Location:* As per plan | *Date Drilled:* 8/18/2010

WATER OBSERVATIONS:
Water seepage at: 43'-65'
Water level at completion: 48.1' Prior to adding water.
41.1' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Installed piezometer in offset boring.

Depth (ft)	Elev. (ft) 588.4	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	588.1						3" GRAVEL						
		3 4 6	18	S-1		3.5	FILL: Very stiff brown SILTY CLAY with sand (CL-ML); contains organic material; damp.						
5		3 4 6	18	S-2		3.0							
		3 5 6	18	S-3		1.25	@ 6.0' brown and gray						
8.5	579.9												
10		3 5 6	18	S-4		4.5+	FILL: Very stiff to hard brown and gray LEAN CLAY with sand (CL); moist.						
		3 5 7	18	S-5		2.0							
15		3 4 8	18	S-6		4.25							
		3 4 5	18	S-7		2.25		0	0	1	23	45	31
18.5	569.9												
20		2 3 3	18	S-8		2.5	FILL: Very stiff brown and gray LEAN CLAY (CL), trace sand; moist.						
					ST-1								
25	563.4	4 5 8	18	S-9		2.5							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○ / Non-Plastic - NP



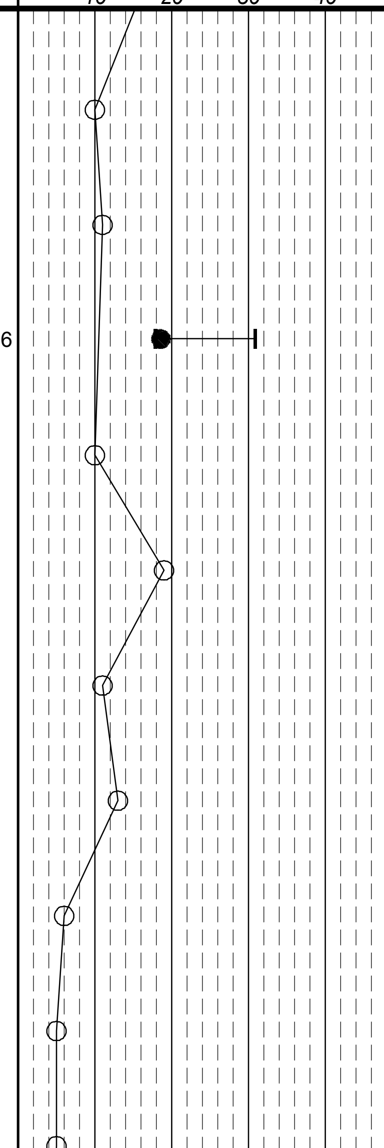
Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: Boring KC-1003	Location: As per plan	Date Drilled: 8/18/2010

WATER OBSERVATIONS:
Water seepage at: 43'-65'
Water level at completion: 48.1' Prior to adding water.
41.1' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Installed piezometer in offset boring.

Depth (ft)	Elev. (ft) 563.4	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
		2 3 5	18	S-10		3.0	FILL: Very stiff brown and gray LEAN CLAY (CL), trace sand; contains organic material; moist.							
28.5	559.9	2 3 6	18	S-11		1.5	FILL: Stiff to very stiff brown LEAN CLAY (CL), trace sand; moist.							
30					ST-2	4.0	@31.0'-33.0', with fine sand.		0	0	0	17	47	36
33.5	554.9	2 3 5	18	S-12		4.0	Stiff to very stiff brown LEAN CLAY (CL), trace sand; moist.							
35		4 7 9	18	S-13		3.5								
40		2 3 6	18	S-14		2.5								
		2 3 8	18	S-15		1.5								
43.0	545.4	1 2 3	18	S-16		1.5	Stiff brown and gray LEAN CLAY with sand (CL); moist.							
45.0 (45)	543.4	WOH 1 3	18	S-17		0.25	Very soft to soft dark gray LEAN CLAY with sand (CL), contains shell fragments; moist.							
48.5	539.9	WOH 1 3	18	S-18		1.25	Stiff dark gray LEAN CLAY with sand (CL), contains shell fragments; moist.							
50	538.4													

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: Boring KC-1003	Location: As per plan	Date Drilled: 8/18/2010

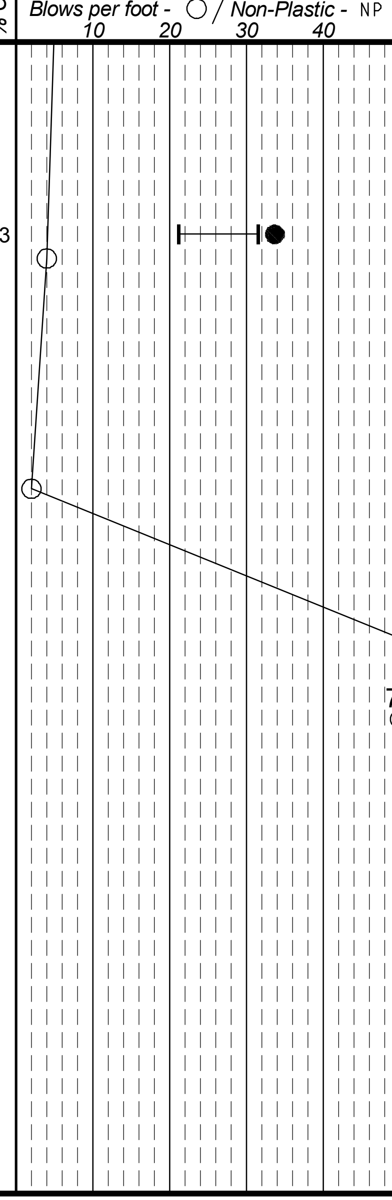
WATER OBSERVATIONS:
Water seepage at: 43'-65'
Water level at completion: 48.1' Prior to adding water. 41.1' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Installed piezometer in offset boring.

Depth (ft)	Elev. (ft) 538.4	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
							Soft to medium stiff dark gray LEAN CLAY with sand (CL), contains shell fragments; moist.						
55		WOH WOH 3	18	S-19		0.5	@53.5'-55.0', wet.	0	0	0	17	50	33
59.5	528.9	WOH WOH 2	18	S-20		0.75							
60							Medium stiff dark gray sandy LEAN CLAY (CL); contains organic material and shell fragments; moist. Began adding drilling water at 60' to counteract heave.						
63.0	525.4						Very dense brown SAND with silt (SW-SM); wet.						
65.0	523.4	27 33 30	10	S-21									
							Bottom of Boring - 65.0'						

Depth scale: 55, 60, 65, 70, 75

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

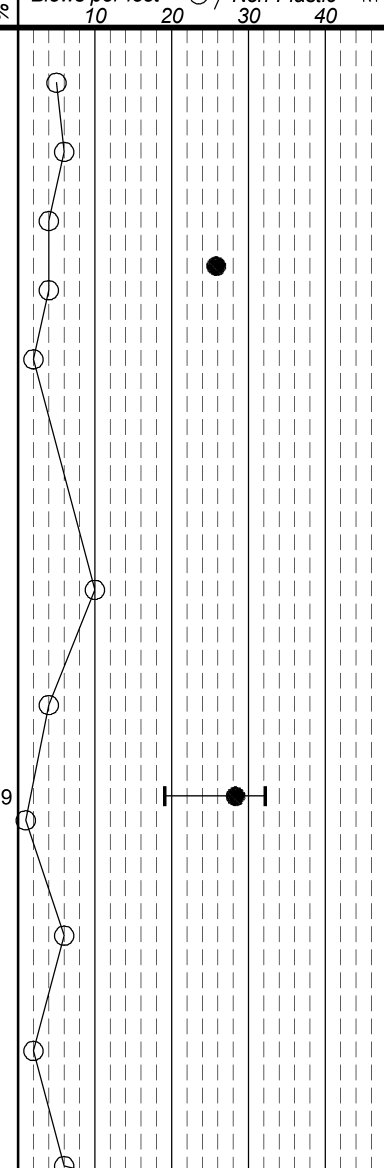
Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

LOG OF: Boring KC-1004 | *Location:* As per plan | *Date Drilled:* 8/26/2010

WATER OBSERVATIONS:
Water seepage at: 11.0'-30.0'
Water level at completion: 15.9' Prior to adding water.
FIELD NOTES:

Depth (ft)	Elev. (ft) 555.3	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	555.0						Topsoil - 4"						
		2 2 2	9	S-1		1.0	Medium stiff to stiff brown sandy LEAN CLAY (CL); moist.						
		2 3 2	18	S-2		1.5							
		2 1 2	18	S-3		0.5							
5		WOH 1 2	18	S-4		0.5							
		WOH 1 1	18	S-5		0.5							
10					ST-1								
11.0	544.3	1 3 5	18	S-6		0.75	Medium stiff brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams up to 2" in thickness; moist to wet.						
15		WOH 1 2	18	S-7		1.0							
15.5	539.8	WOH WOH 1	18	S-8		0.75	Medium stiff brown LEAN CLAY with sand (CL); moist.	0	0	0	20	51	29
17.5	537.8	WOH 2 3	18	S-9		0.75	Medium stiff brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams up to 2" in thickness; moist to wet.						
20		4 1 1	12	S-10		0.5	@ 21.0', gray.						
25	530.3	1 2 3	18	S-11		1.0							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○ / Non-Plastic - NP

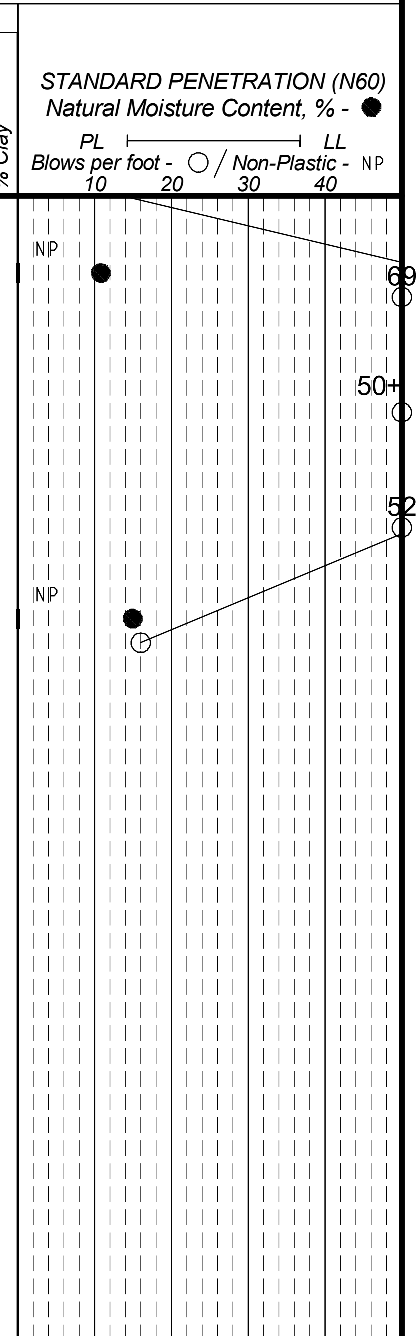


DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: OVEC-AEP	*Project:* Kyger Creek - Ash Impoundment Stability Analysis	*Job No.* 1021-3003.00
LOG OF: Boring KC-1004	*Location:* As per plan	*Date Drilled:* 8/26/2010

WATER OBSERVATIONS:
Water seepage at: 11.0'-30.0'
Water level at completion: 15.9' Prior to adding water.
FIELD NOTES:

Depth (ft)	Elev. (ft) 530.3	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
26.0	529.3	2 17 40	18	S-12			Very dense brown SAND with silt with gravel (SW-SM); wet.		40	15	22	17	--6--	
		50/5"	5	S-13										
31.0	524.3	24 18 25	18	S-14			Medium dense brown GRAVEL with silt with sand (GW-GM); wet.							
33.5	521.8	3 6 7	10	S-15			Medium dense grayish brown SAND with gravel (SW), trace silt; wet.		33	26	27	12	--2--	
35.0	520.3						Bottom of Boring - 35.0'							



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

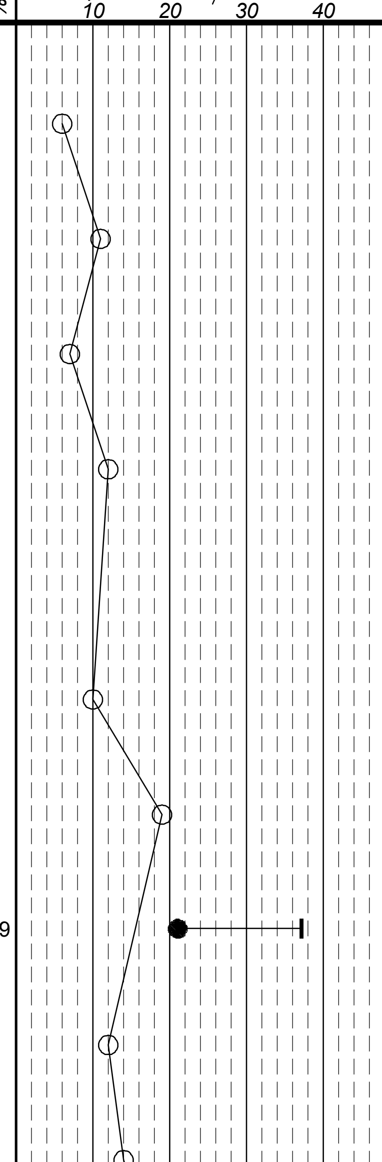
Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: **Boring KC-1005**	Location: As per plan	Date Drilled: 8/17/2010

WATER OBSERVATIONS:
Water seepage at: 48.5'-65.0'
Water level at completion: 57.4' Prior to adding water.
17.0' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.

Depth (ft)	Elev. (ft) 588.2	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	587.9						3" GRAVEL						
		2 2 3	18	S-1		4.25	FILL: Stiff to very stiff to hard brown SILTY CLAY with sand (CL-ML); damp. @1.0'-2.5', hard.						
5		1 4 5	10	S-2		1.5							
		2 2 4	18	S-3		2.5	@ 6.0' brown and gray						
8.5	579.7												
10		3 5 5	18	S-4		3.75	FILL: Very stiff brown and gray LEAN CLAY with sand (CL); moist.						
					ST-1								
13.5	574.7												
15		1 3 5	18	S-5		2.5	FILL: Very stiff to hard light brown and gray LEAN CLAY (CL), trace sand; moist.						
		3 7 9	18	S-6		4.5+							
20					ST-2	4.0	@18.5'-20.5', little fine and medium sand.	0	0	2	11	48	39
		2 4 6	18	S-7		3.0							
25	563.2	2 4 8	18	S-8		3.75							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├───┤ LL
Blows per foot - ○ / Non-Plastic - NP



Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

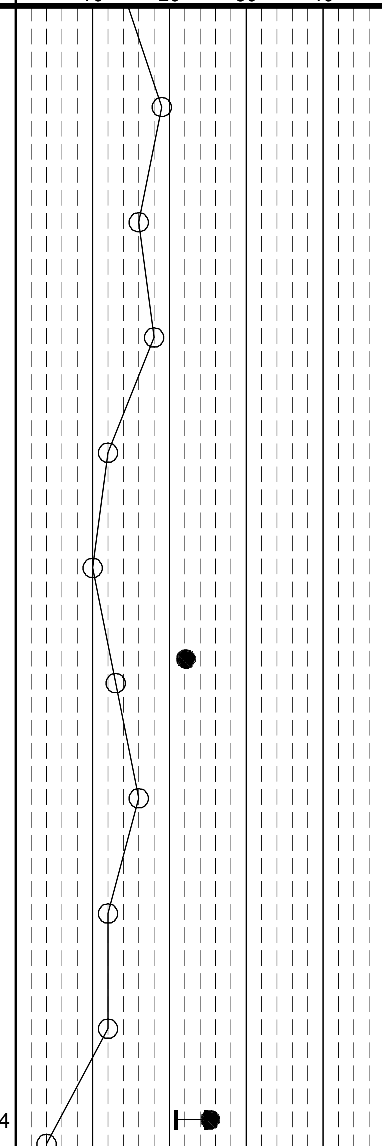
LOG OF: Boring KC-1005 | *Location:* As per plan | *Date Drilled:* 8/17/2010

WATER OBSERVATIONS:
Water seepage at: 48.5'-65.0'
Water level at completion: 57.4' Prior to adding water.
17.0' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.

Depth (ft)	Elev. (ft) 563.2	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
		4 6 10	18	S-9		4.0	FILL: Stiff to very stiff light brown and gray LEAN CLAY (CL), trace sand; moist.							
28.5	559.7													
30		3 6 7	18	S-10		3.5	POSSIBLE FILL: Stiff to very stiff light brown and gray LEAN CLAY (CL), trace sand; moist.							
		5 7 8	18	S-11		3.5								
35		2 4 6	18	S-12		3.0	@ 33.5' trace roots							
		2 3 5	18	S-13		2.0	@ 36.5' contains black particles							
40		2 5 6	18	S-14		3.5								
		3 5 8	18	S-15		3.25								
45		1 5 5	18	S-16		1.5								
		2 4 6	18	S-17		1.5								
48.0	540.2													
50	538.2	WOH 1 2	18	S-18		0.25	Stiff to very stiff brown LEAN CLAY (CL), trace sand; moist.		0	0	0	30	46	24

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

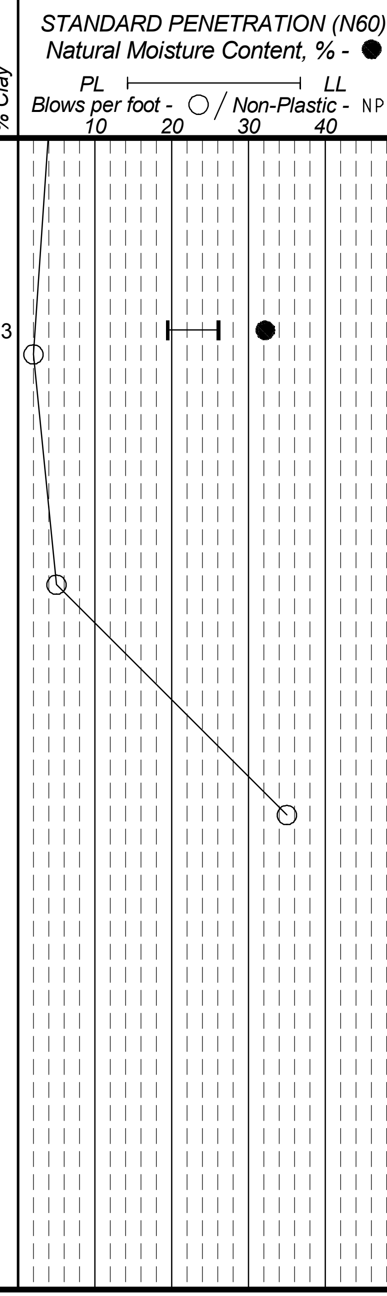


Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

LOG OF: Boring KC-1005 | *Location:* As per plan | *Date Drilled:* 8/17/2010

WATER OBSERVATIONS:
Water seepage at: 48.5'-65.0'
Water level at completion: 57.4' Prior to adding water.
17.0' Final including drilling water.
FIELD NOTES:
Sealed borehole with bentonite grout.

Depth (ft)	Elev. (ft) 538.2	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
							Stiff to very stiff brown LEAN CLAY (CL), trace sand; moist. @48.5'-64.5', wet interlaminating silty sand layers less than 1".						
53.5	534.7	WOH WOH 2	12	S-19		0.25	Soft gray SILTY CLAY with sand (CL-ML); contains shell particles; wet.	0	0	0	26	51	23
57.0	531.2	1 1 3	16	S-20			Very loose to loose gray clayey SAND (SC); moist.						
63.5	524.7	1 9 20	18	S-21A S-21B			Medium dense brown and gray SAND with silt with gravel (SW-SM); wet.						
65.0	523.2						Bottom of Boring - 65.0'						

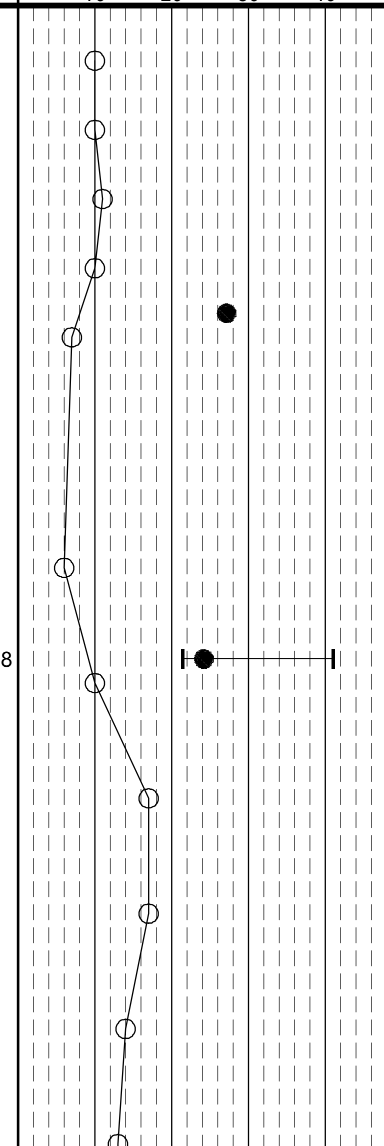


Client: OVEC-AEP	*Project:* Kyger Creek - Ash Impoundment Stability Analysis	*Job No.* 1021-3003.00
LOG OF: Boring KC-1006	*Location:* As per plan	*Date Drilled:* 8/24/2010

WATER OBSERVATIONS:
Water seepage at: 38.5'-50.0'
Water level at completion: 49.0' Prior to adding water.
FIELD NOTES:

Depth (ft)	Elev. (ft) 576.4	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	576.2						Aggregate - 3"						
1.5	574.9	6 4 4	18	S-1			FILL: Medium dense dark gray to black SAND with silt with gravel (SP-SM); contains cinders; moist.						
		3 4 4	13	S-2		1.5	FILL: Stiff to very stiff mottled brown and gray LEAN CLAY with sand (CL); damp to moist.						
		3 3 6	12	S-3		2.75							
5		2 2 6	18	S-4		2.5							
		2 2 4	6	S-5		1.0							
10					ST-1								
		WOH 2 3	18	S-6		2.5							
13.0	563.4						FILL: Very stiff mottled brown and gray LEAN CLAY (CL), trace fine to medium sand; moist.						
15		2 3 5	18	S-7		2.5		0	0	2	8	42	48
16.0	560.4						POSSIBLE FILL: Very stiff brown LEAN CLAY with sand (CL); damp to moist.						
		3 6 8	18	S-8		3.75							
18.5	557.9						POSSIBLE FILL: Hard brown LEAN CLAY (CL); contains cinders; damp.						
20		3 6 8	18	S-9		4.5+							
21.0	555.4						Stiff to very stiff mottled brown and gray LEAN CLAY with sand (CL); damp.						
		5 5 7	18	S-10		2.5							
25	551.4	3 5 6	18	S-11		1.5							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP

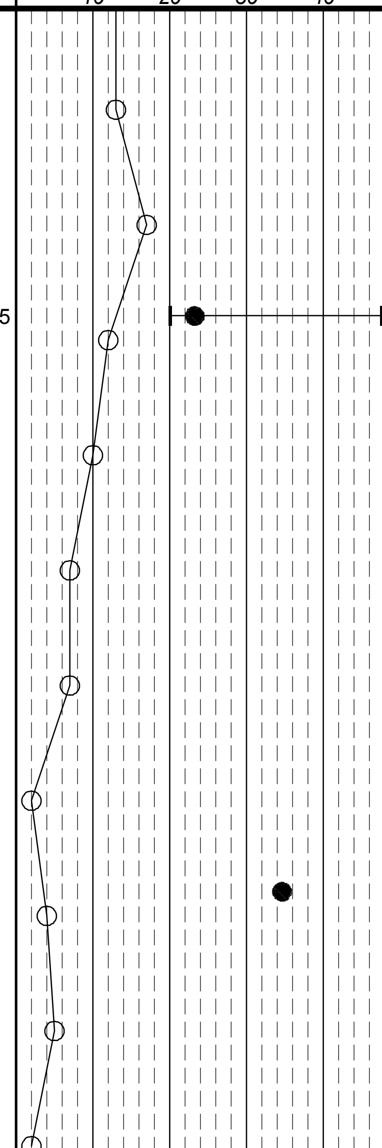


Client: OVEC-AEP	*Project:* Kyger Creek - Ash Impoundment Stability Analysis	*Job No.* 1021-3003.00
LOG OF: Boring KC-1006	*Location:* As per plan	*Date Drilled:* 8/24/2010

WATER OBSERVATIONS:
Water seepage at: *38.5'-50.0'*
Water level at completion: *49.0' Prior to adding water.*
FIELD NOTES:

Depth (ft)	Elev. (ft) 551.4	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
		2 4 7	18	S-12		3.5	Stiff to very stiff mottled brown and gray LEAN CLAY with sand (CL); damp.							
30		4 6 8	18	S-13		2.75	@ 28.0'-31.0', brown.							
		4 5 5	18	S-14		1.5			0	0	2	18	45	35
35		2 4 4	18	S-15		1.5								
		1 2 4	18	S-16		0.75	@ 36.0'-38.5', medium stiff, gray.							
38.5	537.9													
40		WOH 3 3	18	S-17		0.75	Medium stiff gray sandy LEAN CLAY (CL); contains moist to wet sandy silt seams up to 1" in thickness; moist to wet.							
		WOH 1 1	18	S-18		0.5								
45		WOH 1 2	18	S-19		0.75								
		WOH 1 3	18	S-20		0.75								
50.0	526.4	WOH WOH 2	3	S-21		0.5	Bottom of Boring - 50.0'							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



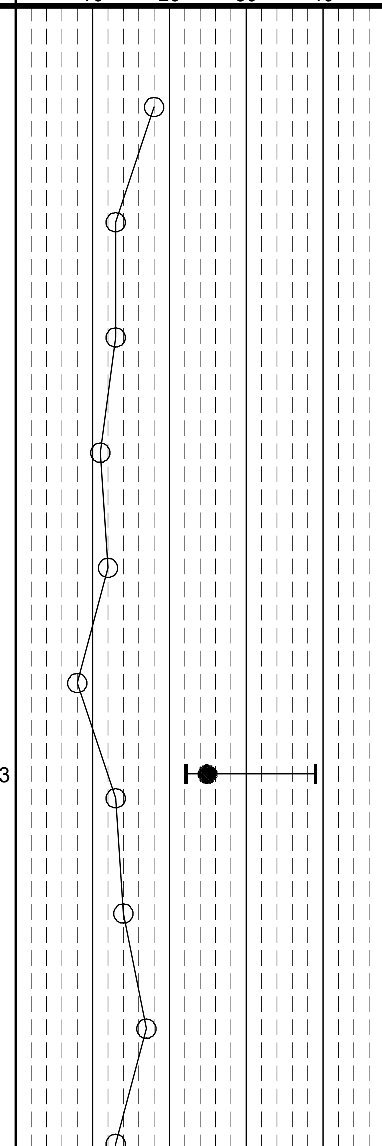
Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: Boring KC-1007	Location: As per plan	Date Drilled: 8/16/2010 to 8/17/2010

WATER OBSERVATIONS:
Water seepage at: 53.5'-65.0'
Water level at completion: 49.0' Prior to adding water.
27.4' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Installed piezometer in offset boring.

Depth (ft)	Elev. (ft) 589.0	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.2	588.8						2" GRAVEL						
		4 7 8	1	S-1			FILL: Very stiff brown and gray LEAN CLAY with sand (CL); damp to moist.						
5		4 5 6	18	S-2		3.5							
		3 5 6	10	S-3		3.5							
8.5	580.5												
10		3 3 6	18	S-4		3.25	FILL: Very stiff brown LEAN CLAY (CL), trace sand; damp to moist.						
		3 5 5	18	S-5		4.0							
13.5	575.5												
15		3 3 4	18	S-6		3.0	FILL: Very stiff light brown and gray LEAN CLAY (CL), trace sand; damp to moist. @15.0'-17.5', little fine to medium sand.						
		3 5 6	18	S-7		3.0		0	0	3	10	44	43
20		4 5 7	18	S-8		2.5							
		5 5 9	18	S-9		2.5							
25	564.0	5 5 6	18	S-10		3.0							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├───┤ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



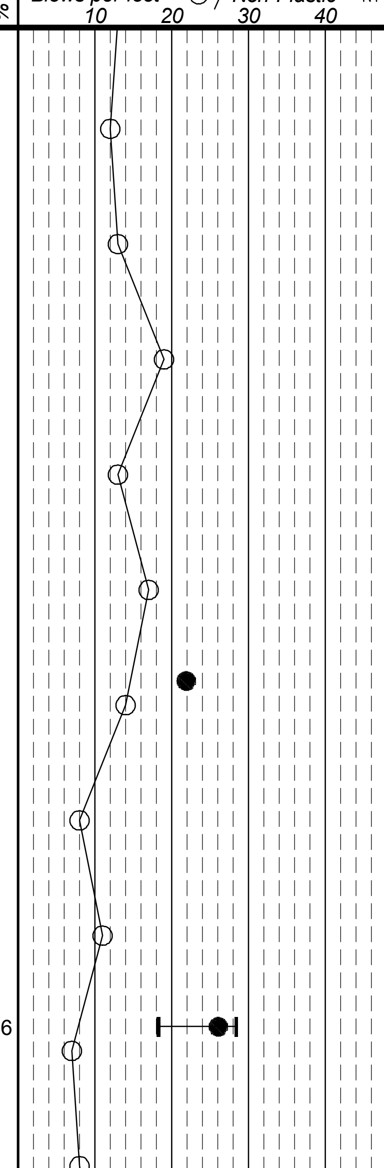
Client: OVEC-AEP	*Project:* Kyger Creek - Ash Impoundment Stability Analysis	*Job No.* 1021-3003.00
LOG OF: Boring KC-1007	*Location:* As per plan	*Date Drilled:* 8/16/2010 to 8/17/2010

WATER OBSERVATIONS:
Water seepage at: 53.5'-65.0'
Water level at completion: 49.0' Prior to adding water.
27.4' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Installed piezometer in offset boring.

Depth (ft)	Elev. (ft) 564.0	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
		4 5 5	18	S-11		2.0	FILL: Very stiff light brown and gray LEAN CLAY (CL), trace sand; damp to moist. @ 26.0'-27.5' gray, trace organics							
28.5	560.5													
30		3 4 7	18	S-12		1.5	Stiff brown and gray LEAN CLAY with sand (CL); moist.							
31.0	558.0													
		3 7 9	18	S-13		4.5+	Hard gray LEAN CLAY (CL), trace sand; trace organics; moist.							
33.5	555.5													
35		3 5 6	18	S-14		3.75	Very stiff brown and gray LEAN CLAY (CL), trace sand; moist.							
		3 6 8	18	S-15		3.5								
38.5	550.5													
40		4 6 6	18	S-16		2.5	Very stiff brown and gray LEAN CLAY with sand (CL); moist.							
		1 3 4	18	S-17		2.5								
43.5	545.5													
45		2 4 5	18	S-18		2.0	Medium stiff brown and gray sandy LEAN CLAY (CL); moist.							
45.5	543.5													
		2 3 3	18	S-19		0.5	Soft to medium stiff brown and gray LEAN CLAY with sand (CL); moist.		0	0	0	22	52	26
48.0	541.0													
50	539.0	2 3 4	18	S-20		1.5	Medium stiff brown and gray sandy LEAN CLAY (CL); moist.							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○ / Non-Plastic - NP



Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

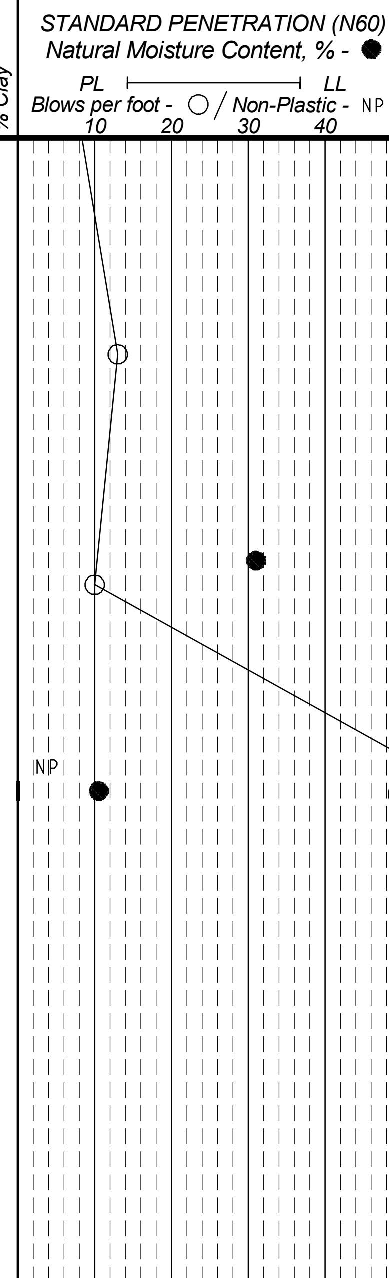
LOG OF: Boring KC-1007 | *Location:* As per plan | *Date Drilled:* 8/16/2010 to 8/17/2010

WATER OBSERVATIONS:
Water seepage at: *53.5'-65.0'*
Water level at completion: *49.0' Prior to adding water.*
27.4' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Installed piezometer in offset boring.

Depth (ft)	Elev. (ft) 539.0	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
							Stiff brown and gray sandy LEAN CLAY (CL); moist.							
				S-21B			@ 53.0' gray, trace shells							
54.5	534.5	2 4 7	18	S-21A		1.5								
							Medium dense gray silty SAND (SM); moist.							
57.0	532.0						Stiff gray sandy LEAN CLAY (CL); moist.							
		3 4 4	18	S-22		1.5	@ 58.5'-60.0' wet silty sand lenses < 1"							
63.0	526.0						Very dense brown SAND with silt with gravel (SW-SM); moist to wet.							
65.0	524.0	17 31 22	10	S-23			@ 63.5', encountered 3 feet of sand heave after pulling drill rod.		33	19	20	19	--9--	
							Bottom of Boring - 65.0'							

Depth scale: 55, 60, 65, 70, 75



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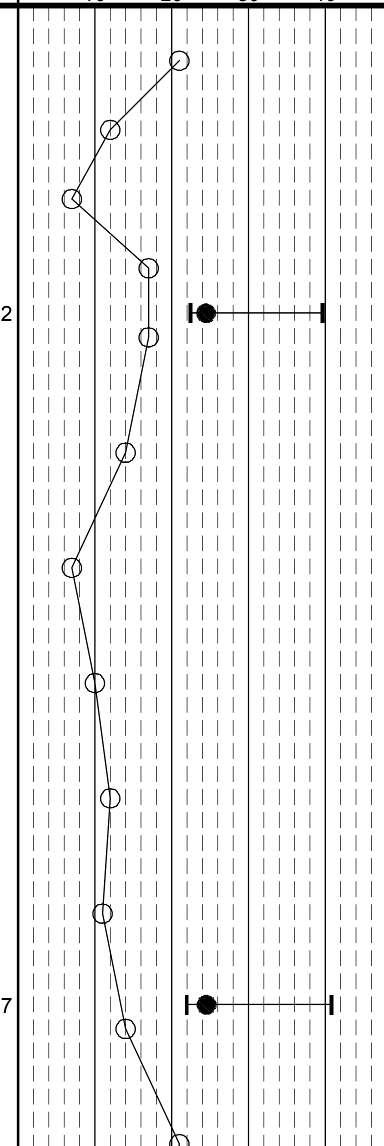
Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: Boring KC-1008	Location: As per plan	Date Drilled: 8/24/2010

WATER OBSERVATIONS:
Water seepage at: 35.5'-40.0'
Water level at completion: NFW

FIELD NOTES:

Depth (ft)	Elev. (ft) 580.9	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.2	580.7						Aggregate - 2"						
1.5	579.4	7 6 11	18	S-1			FILL: Medium stiff dark gray to black silty, clayey GRAVEL with sand (GC-GM); contains cinders; damp.						
3.0	577.9	10 7 3	13	S-2			FILL: Medium dense dark gray to black SAND with silt with gravel (SP-SM); contains cinders; moist.						
		2 3 3	8	S-3		1.5	FILL: Stiff to very stiff brown sandy LEAN CLAY (CL); damp to moist.						
5		3 6 8	18	S-4		3.5							
		4 7 7	18	S-5		3.5	@6.0'-7.5', trace sand; moist.	0	0	0	5	53	42
10		3 4 8	18	S-6		2.5							
13.5	567.4	1 3 3	18	S-7		1.25							
15		3 4 4	18	S-8		1.5	FILL: Stiff gray LEAN CLAY (CL); moist.						
16.0	564.9												
		2 4 6	18	S-9		2.5	FILL: Very stiff brown LEAN CLAY (CL); damp to moist.						
20		2 4 5	18	S-10		2.25							
21.0	559.9												
		4 6 6	18	S-11		3.5	Very stiff brown LEAN CLAY (CL), trace fine to medium sand; damp to moist	0	0	1	5	47	47
25	555.9	4 8 9	18	S-12		4.0	@ 23.5', brownish gray.						

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP



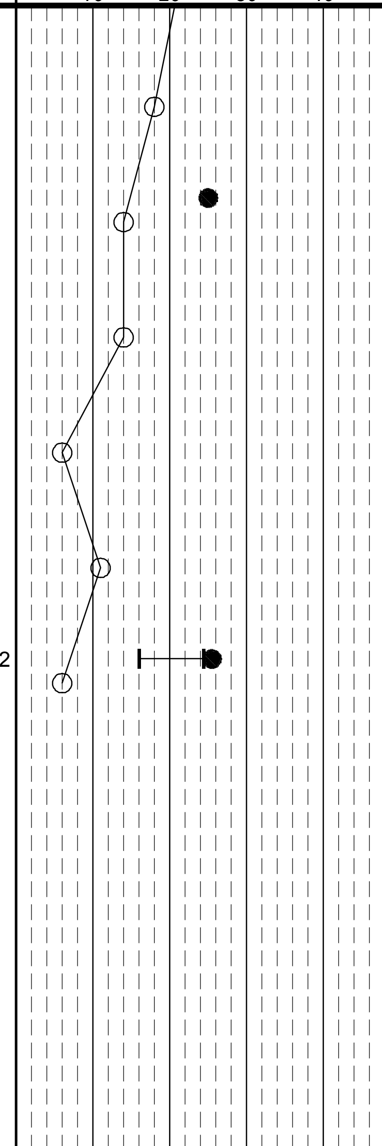
Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

LOG OF: Boring KC-1008 | *Location:* As per plan | *Date Drilled:* 8/24/2010

WATER OBSERVATIONS:
Water seepage at: 35.5'-40.0'
Water level at completion: NFW
FIELD NOTES:

Depth (ft)	Elev. (ft) 555.9	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
25.5	555.4													
		6 7 8	18	S-13		4.5+	Very stiff brown LEAN CLAY (CL); damp to moist. @ 26.0'-28.5', hard.							
30		2 5 7	18	S-14		3.5								
		4 5 7	18	S-15		3.5								
33.5	547.4													
35		2 2 3	18	S-16		1.25	Stiff brown sandy LEAN CLAY (CL); moist.							
36.0	544.9													
		3 4 5	18	S-17		0.5	Medium stiff brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.							
40.0	540.9	1 2 3	18	S-18		0.5			0	0	0	35	43	22
							Bottom of Boring - 40.0'							
45														
50														

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



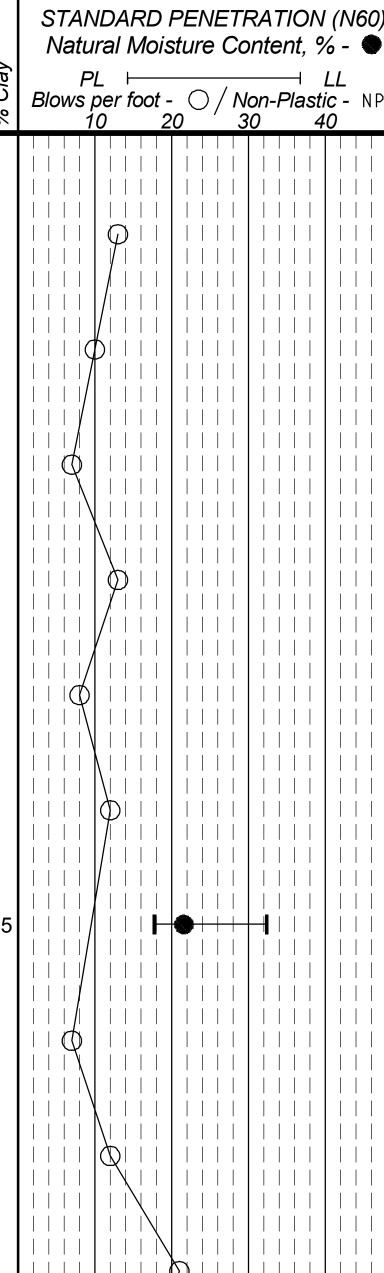
Client: OVEC-AEP | **Project:** Kyger Creek - Ash Impoundment Stability Analysis | **Job No.** 1021-3003.00

LOG OF: Boring KC-1009 | **Location:** As per plan | **Date Drilled:** 8/19/2010 to 8/20/2010

WATER OBSERVATIONS:
Water seepage at: 43.5'-65.0'
Water level at completion: 47.0' Prior to adding water.
38.2' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Began adding drilling water at 50' to counteract heave.

Depth (ft)	Elev. (ft) 589.2	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.2	589.0						2" GRAVEL						
		3 5 6	18	S-1		4.5+	FILL: Hard dark brown LEAN CLAY (CL), trace sand, trace organics; damp to moist.						
5		4 4 4	18	S-2		4.5+							
		2 2 4	18	S-3		2.0	@6.0'-8.5', stiff to very stiff.						
8.5	580.7	2 4 7	7	S-4		2.25	FILL: Very stiff brown LEAN CLAY with sand (CL), trace gravel; moist.						
10													
11.0	578.2	4 5 2	18	S-5		4.5+	FILL: Very stiff to hard brown and gray LEAN CLAY (CL), trace sand; moist.						
15		1 4 6	10	S-6		3.5							
16.0	573.2				ST-1	2.25	FILL: Very stiff brown LEAN CLAY with sand (CL); moist.	0	0	1	28	36	35
20		1 2 4	18	S-7		2.5							
		2 3 7	18	S-8		2.5							
23.5	565.7	4 6 11	18	S-9		4.5+	FILL: Hard brown and gray LEAN CLAY (CL), trace sand; damp to moist.						
25	564.2												



Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

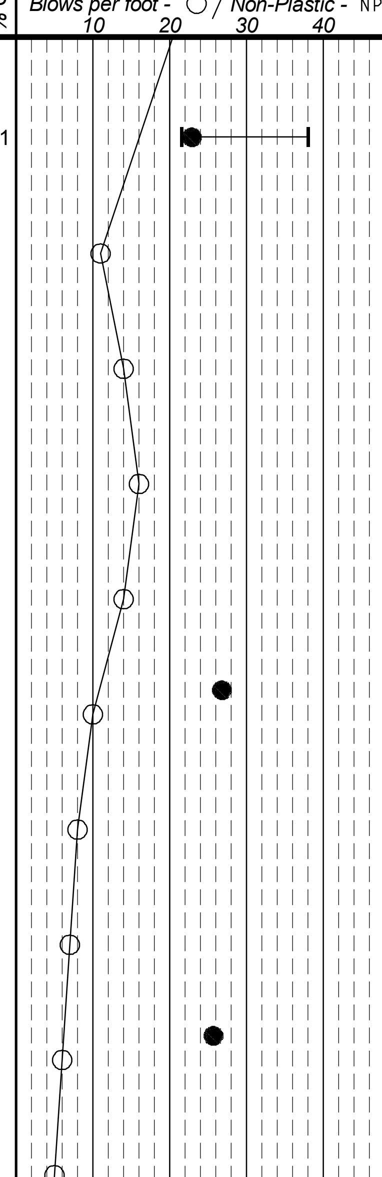
LOG OF: Boring KC-1009 | *Location:* As per plan | *Date Drilled:* 8/19/2010 to 8/20/2010

WATER OBSERVATIONS:
Water seepage at: 43.5'-65.0'
Water level at completion: 47.0' Prior to adding water.
38.2' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Began adding drilling water at 50' to counteract heave.

Depth (ft)	Elev. (ft) 564.2	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
					ST-2	4.0	FILL: Very stiff brown and gray LEAN CLAY (CL), trace sand; damp to moist.	0	0	1	6	52	41
28.5	560.7												
30		3 4 5	18	S-10		2.0	Very stiff brown and gray LEAN CLAY (CL), trace sand; damp to moist.						
		3 5 7	14	S-11		2.25							
35		3 5 8	18	S-12		2.0	@ 34.0' trace organics						
36.0	553.2												
		2 5 7	18	S-13		2.0	Stiff brown LEAN CLAY (CL), trace sand; moist to wet.						
40		2 3 5	18	S-14		1.0							
		WOH 3 4	18	S-15		1.0							
43.0	546.2												
45		WOH 3 3	18	S-16		1.25	Medium stiff brown sandy LEAN CLAY (CL); contains small silty sand layers; moist to wet.						
		WOH 1 4	18	S-17		0.75							
48.5	540.7												
50	539.2	WOH 1 3	18	S-18		1.0	Stiff brown LEAN CLAY with sand (CL); wet.						

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○ / Non-Plastic - NP



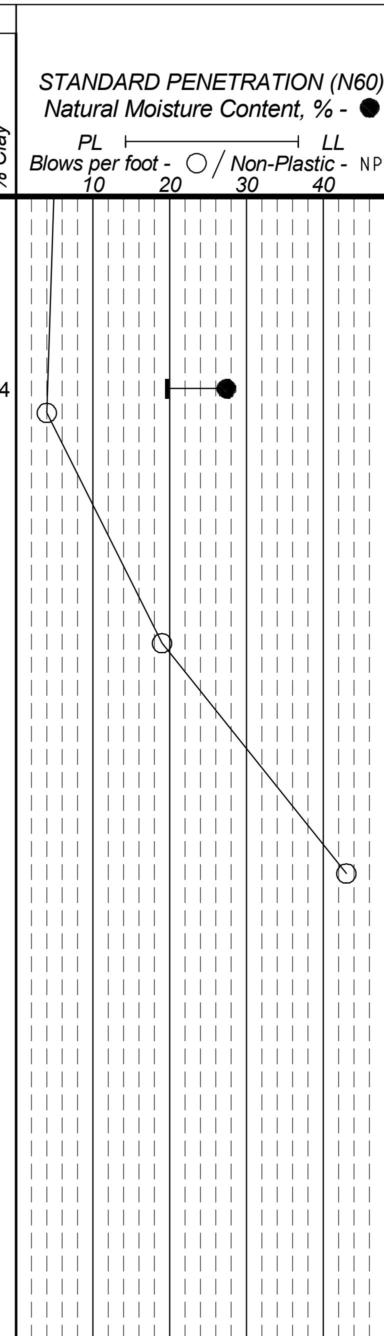
Client: OVEC-AEP | **Project:** Kyger Creek - Ash Impoundment Stability Analysis | **Job No.** 1021-3003.00

LOG OF: Boring KC-1009 | **Location:** As per plan | **Date Drilled:** 8/19/2010 to 8/20/2010

WATER OBSERVATIONS:
Water seepage at: 43.5'-65.0'
Water level at completion: 47.0' Prior to adding water.
38.2' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Began adding drilling water at 50' to counteract heave.

Depth (ft)	Elev. (ft) 539.2	Blows per 6"	Recovery	Sample No. Drive	Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
							Stiff brown LEAN CLAY with sand (CL); contains small silty sand layers; wet.						
53.5	535.7	WOH 1 2	18	S-19		0.5	Medium stiff brown and gray sandy LEAN CLAY (CL); contains small wet silty sand layers; wet.	0	0	0	31	45	24
		WOH 2 14	18	S-20		1.0							
61.0	528.2						Dense brown SAND with silt with gravel (SW-SM); wet.						
65.0	524.2	20 19 17	12	S-21									
							Bottom of Boring - 65.0'						



Client: OVEC-AEP | Project: Kyger Creek - Ash Impoundment Stability Analysis | Job No. 1021-3003.00

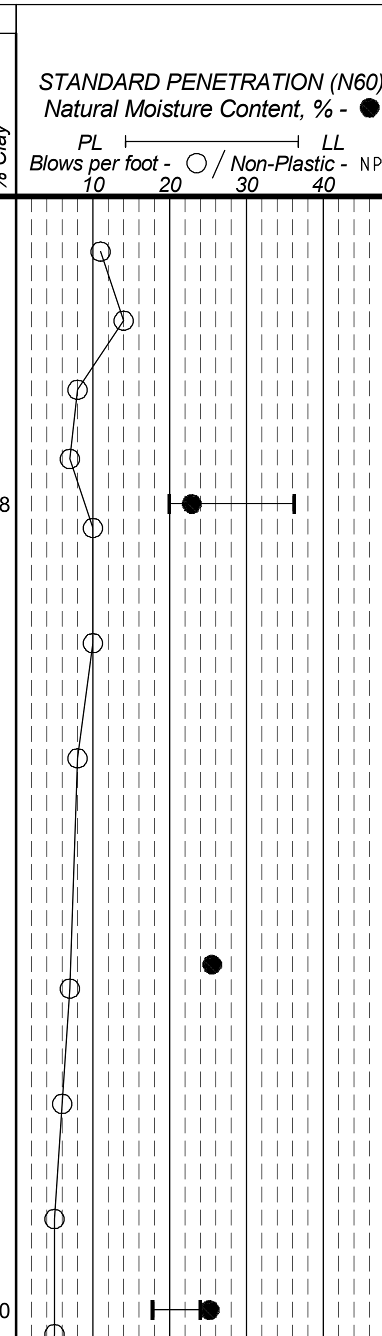
LOG OF: Boring KC-1010 | Location: As per plan | Date Drilled: 9/10/2010

WATER OBSERVATIONS:
Water seepage at: 21.0'-45.0'
Water level at completion: 32.8' Prior to adding water.
21' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Began adding drilling water at 37.5' to counteract heave.

Depth (ft)	Elev. (ft) 565.1	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	564.9	2 4 5	7	S-1		3.5	Topsoil - 3"						
							FILL: Stiff to very stiff brown LEAN CLAY with sand (CL); damp to moist.						
3.0	562.1	4 6 6	12	S-2		3.0							
		3 3 4	18	S-3		1.5	FILL: Stiff to very stiff brown LEAN CLAY with sand (CL); damp to moist.						
5													
6.0	559.1	1 3 3	4	S-4		1.5							
		2 4 4	10	S-5		1.75	Stiff to very stiff brown LEAN CLAY with sand (CL); damp to moist. @6.0'-7.5', trace sand; moist.	0	0	0	4	58	38
10		2 3 5	11	S-6		1.75							
		2 3 4	18	S-7		1.25							
15					ST-1								
		1 3 3	18	S-8		1.5							
18.5	546.6												
20		1 2 3	18	S-9		0.75	Soft to medium stiff brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.						
		1 2 2	18	S-10		0.5							
25	540.1	1 2 2	18	S-11		0.5		0	0	0	44	35	20

Graphic Log



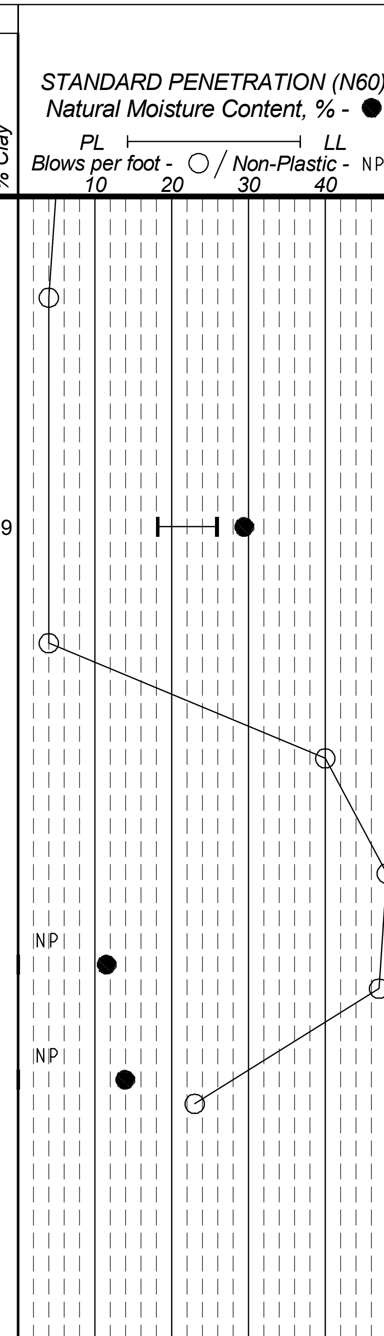
Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

LOG OF: Boring KC-1010 | *Location:* As per plan | *Date Drilled:* 9/10/2010

WATER OBSERVATIONS:
Water seepage at: 21.0'-45.0'
Water level at completion: 32.8' Prior to adding water. 21' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Began adding drilling water at 37.5' to counteract heave.

Depth (ft)	Elev. (ft) 540.1	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
		WOH 1 2	18	S-12		<0.25	Soft to medium stiff brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet. @26.0'-28.0', very soft.						
							@ 28.5'-30.0', Shelby tube press attempted, insuffecent recovery.						
30					ST-2	0.75		0	0	0	31	50	19
		WOH 1 2	18	S-13		0.5	@ 33.5'-36.0', gray.						
36.0	529.1	9 15 18	8	S-14			Dense gray GRAVEL with silt with sand (GW-GM); wet.						
		9 17 23	10	S-15									
41.0	524.1	8 19 20	16	S-16			Dense gray GRAVEL (GW) with sand, trace silt; wet.	54	12	21	10	--3--	
43.5	521.6	7 9 10	5	S-17			Medium dense gray SAND with silt with gravel (SW-SM); wet.	23	15	41	14	--7--	
45.0	520.1						Bottom of Boring - 45.0'						



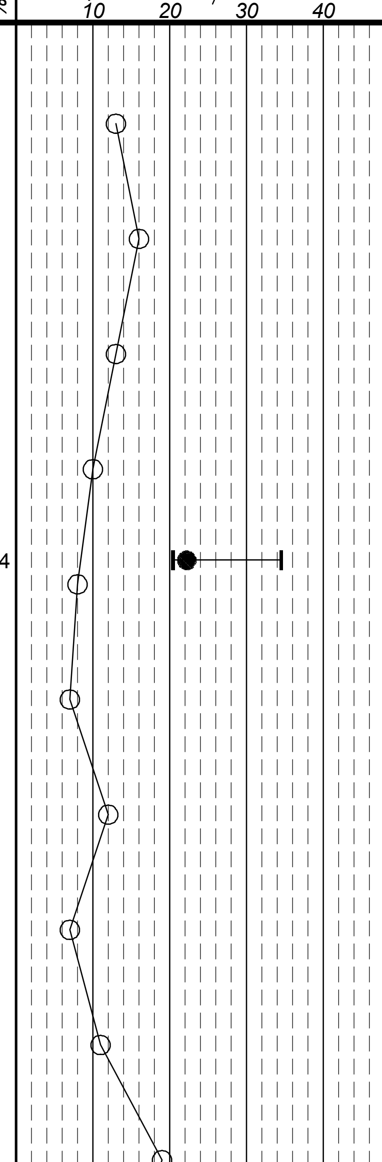
Client: OVEC-AEP | Project: Kyger Creek - Ash Impoundment Stability Analysis | Job No. 1021-3003.00

LOG OF: Boring KC-1011 | Location: As per plan | Date Drilled: 8/20/2010 to 8/23/2010

WATER OBSERVATIONS:
Water seepage at: 43.5'-70.0'
Water level at completion: 49.5' Prior to adding water.
FIELD NOTES:

Depth (ft)	Elev. (ft) 589.2	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	589.0						Aggregate - 3"							
		4 5 6	18	S-1		4.5+	FILL: Hard brown LEAN CLAY with sand (CL); damp.							
5		5 6 7	11	S-2		4.5+								
6.0	583.2													
		5 5 6	18	S-3		4.0	FILL: Very stiff brown LEAN CLAY (CL); damp.							
10		3 4 4	18	S-4		3.5								
		3 3 4	18	S-5		2.0	@ 11.0'-16.0', stiff, little fine sand; moist.		0	0	0	11	55	34
15		1 3 3	16	S-6		1.0								
		1 3 7	18	S-7		4.5+	@ 16.0', hard.							
18.5	570.7													
20		1 3 3	18	S-8		2.75	FILL: Very stiff brown LEAN CLAY with sand (CL); damp to moist.							
		2 4 5	18	S-9		3.0								
23.5	565.7													
25	564.2	6 7 9	18	S-10		3.5	FILL: Very stiff brownish gray LEAN CLAY (CL); damp.							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP



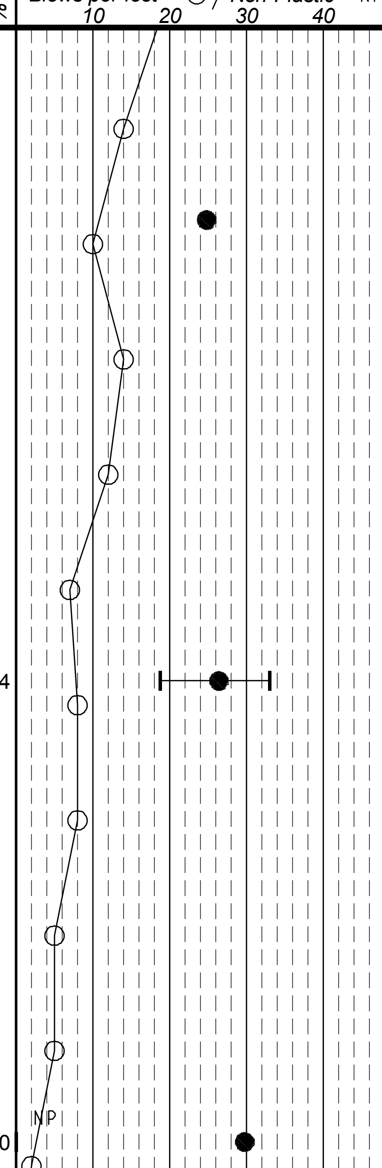
DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: **Boring KC-1011**	Location: As per plan	Date Drilled: 8/20/2010 to 8/23/2010

WATER OBSERVATIONS:
Water seepage at: 43.5'-70.0'
Water level at completion: 49.5' Prior to adding water.
FIELD NOTES:

Depth (ft)	Elev. (ft) 564.2	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
26.0	563.2						FILL: Very stiff gray LEAN CLAY with sand (CL); damp.						
		4 6 6	18	S-11		2.5							
28.5	560.7						Very stiff brown LEAN CLAY (CL); damp to moist.						
30		2 2 6	18	S-12		2.5							
		3 5 7	18	S-13		2.25							
33.5	555.7						Stiff brown LEAN CLAY with sand (CL); damp to moist.						
35		2 4 6	18	S-14		1.75							
		1 3 3	18	S-15		1.0							
40		WOH 3 4	18	S-16		1.25		0	0	0	15	51	34
		WOH 3 4	18	S-17		1.0							
43.5	545.7						Soft brownish gray sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.						
45		WOH 2 2	18	S-18		0.5							
		WOH 1 3	18	S-19		0.25							
48.5	540.7						Very loose gray sandy SILT (ML); moist to wet.						
50	539.2	WOH WOH 2	18	S-20				0	0	0	42	38	20

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP

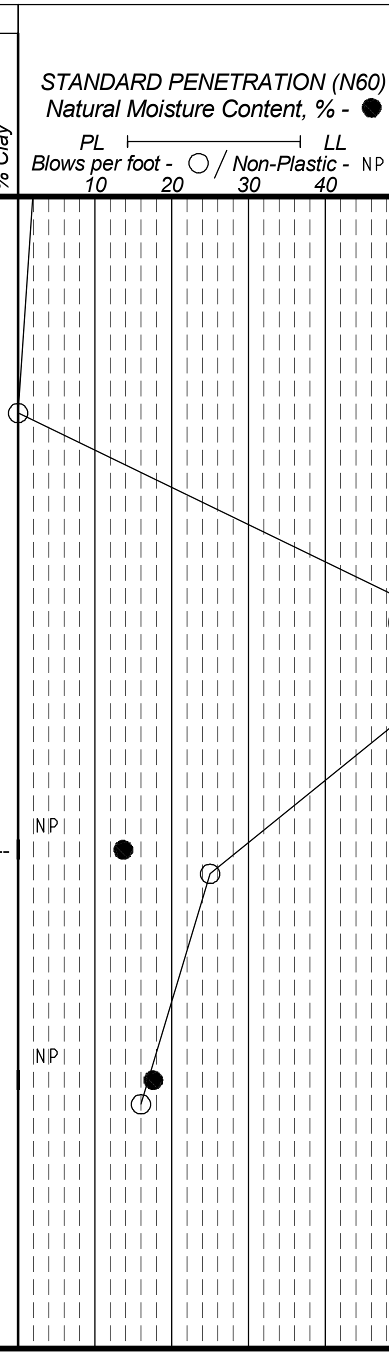


Client: OVEC-AEP | Project: Kyger Creek - Ash Impoundment Stability Analysis | Job No. 1021-3003.00

LOG OF: Boring KC-1011 | Location: As per plan | Date Drilled: 8/20/2010 to 8/23/2010

WATER OBSERVATIONS:
Water seepage at: 43.5'-70.0'
Water level at completion: 49.5' Prior to adding water.
FIELD NOTES:

Depth (ft)	Elev. (ft) 539.2	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
50.5	538.7						Soft brownish gray sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.						
53.5	535.7	WOH WOH WOH	18	S-21		<0.25	Very soft brown LEAN CLAY (CL); damp to moist.						
58.5	530.7	23 28 23	7	S-22			Medium dense to very dense brown SAND with silt with gravel (SW-SM); wet. @58.5'-60.0', very dense.						
		9 10 11	10	S-23				20	10	36	22	--12--	
68.5	520.7	4 7 6	7	S-24			Medium dense brown SAND with silt with gravel (SP-SM); wet.	15	3	28	48	--6--	
70.0	519.2						Bottom of Boring - 70.0'						



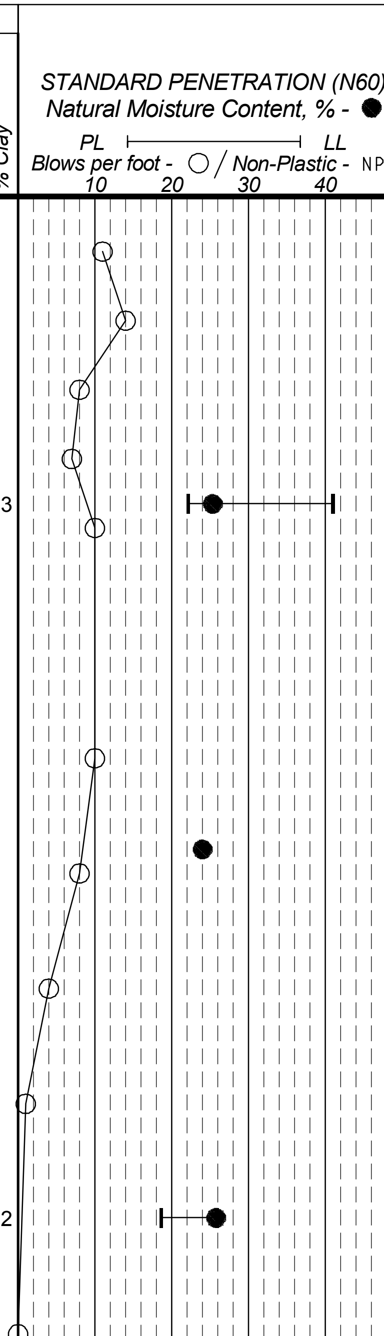
Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

LOG OF: Boring KC-1012 | *Location:* As per plan | *Date Drilled:* 9/9/2010

WATER OBSERVATIONS:
Water seepage at: 16.0'-40.0'
Water level at completion: 21.9' Prior to adding water. 7.6' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Installed piezometer in offset boring.

Depth (ft)	Elev. (ft) 563.0	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	562.7						Topsoil - 4"						
1.5	561.5	2 4 5	18	S-1		0.25	FILL: Soft brown LEAN CLAY with sand (CL); wet.						
		4 6 6	18	S-2		1.5	Stiff to very stiff brown LEAN CLAY with sand (CL); moist.						
		3 3 4	12	S-3		2.5							
5		1 3 3	18	S-4		2.25	@ 4.5', damp.						
		2 4 4	18	S-5		2	@6.0'-7.5', trace sand; moist.	0	0	0	1	56	43
10					ST-1								
		2 3 5	18	S-6		1.75							
15		2 3 4	18	S-7		2							
16.0	547.0	1 1 2	18	S-8		0.25	Very soft to soft to brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.						
20		WOH WOH 1	18	S-9		0.5							
					ST-2			0	0	0	35	43	22
25	538.0	WOH WOH WOH	18	S-10		0.25	@ 23.6'-26.0', gray.						



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Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

LOG OF: Boring KC-1012 | *Location:* As per plan | *Date Drilled:* 9/9/2010

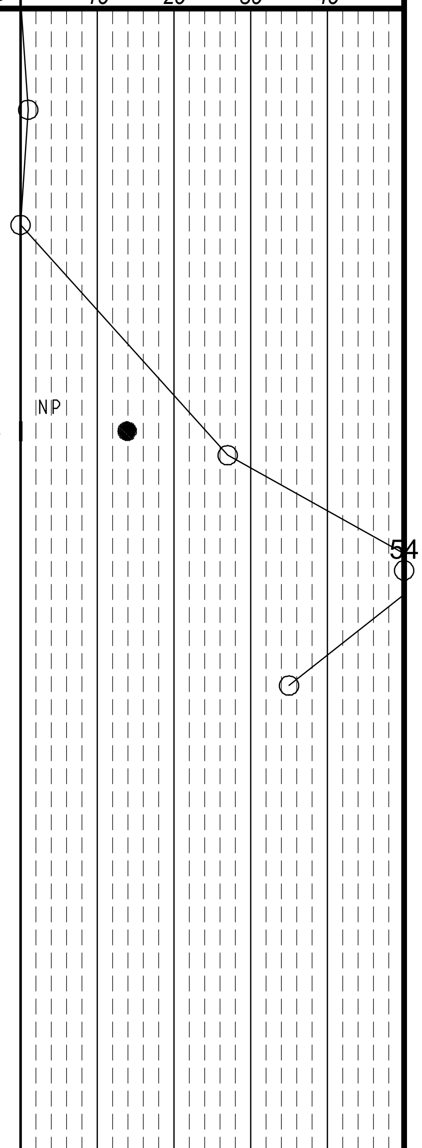
WATER OBSERVATIONS:
Water seepage at: 16.0'-40.0'
Water level at completion: 21.9' Prior to adding water.
7.6' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Installed piezometer in offset boring.

Depth (ft)	Elev. (ft) 538.0	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
		WOH WOH 1	18	S-11		0.25	Very soft to soft brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.						
30		WOH WOH WOH	18	S-12		<0.25							
					ST-3								
33.5	529.5	3 8 14	10	S-13			Medium dense to dense brown sandy GRAVEL (GP); wet. Began adding drilling water at 35' to counteract heave.	59	16	14	7	--4--	
		8 22 23	3	S-14									
38.5	524.5	8 14 15	6	S-15			Medium dense brown SAND with gravel (SW); wet.						
40.0	523.0						Bottom of Boring - 40.0'						

Depth scale: 30, 35, 40, 45, 50

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



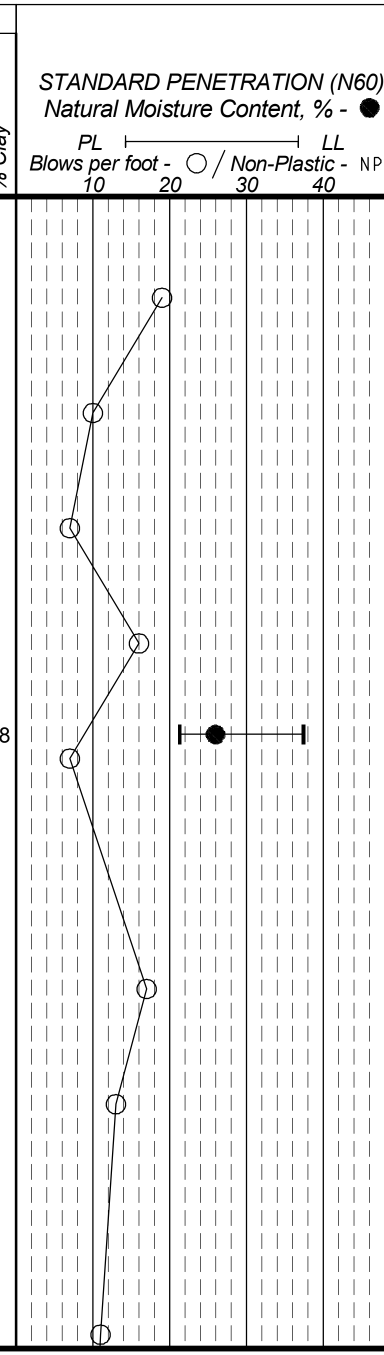
DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: OVEC-AEP | Project: Kyger Creek - Ash Impoundment Stability Analysis | Job No. 1021-3003.00

LOG OF: Boring KC-1013 | Location: As per plan | Date Drilled: 8/30/2010 to 9/1/2010

WATER OBSERVATIONS:
Water seepage at: 46.0'-60.0'
Water level at completion: 42.7' Prior to adding water.
FIELD NOTES:

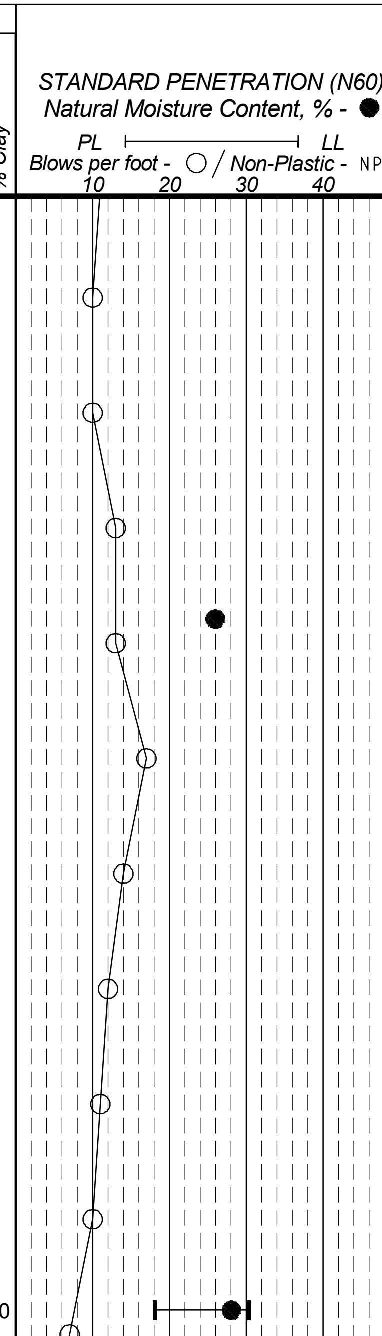
Depth (ft)	Elev. (ft) 581.3	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	581.1						Aggregate - 3"						
		5 7 9	1	S-1			FILL: Very stiff brownish gray sandy LEAN CLAY (CL); damp to moist. @ 1.0'-2.5', low recovery, drove gravel.						
5		4 4 4	18	S-2		3.00							
6.0	575.3	2 3 3	18	S-3		1.50	FILL: Stiff to very stiff brownish gray LEAN CLAY with sand (CL); slightly organic; damp to moist. @ 6.0'-7.5', sample contains tree root.						
10		4 6 7	18	S-4		4.5+	@ 8.5'-11.0', hard.						
		3 3 3	18	S-5		3.00	@11.0'-12.5', trace gravel.	2	0	1	7	52	38
15					ST-1	2.5							
16.0	565.3	5 6 8	18	S-6	ST-2	3.25	FILL: Very stiff brown sandy LEAN CLAY (CL); slightly organic; damp.						
18.5	562.8	3 5 6	18	S-7		2.50	FILL: Stiff to very stiff brownish gray to gray LEAN CLAY with sand (CL); slightly organic; damp to moist.						
20													
25	556.3	2 4 5	18	S-8		1.00							



Client: OVEC-AEP	*Project:* Kyger Creek - Ash Impoundment Stability Analysis	*Job No.* 1021-3003.00
LOG OF: Boring KC-1013	*Location:* As per plan	*Date Drilled:* 8/30/2010 to 9/1/2010

WATER OBSERVATIONS:
Water seepage at: *46.0'-60.0'*
Water level at completion: *42.7' Prior to adding water.*
FIELD NOTES:

Depth (ft)	Elev. (ft) 556.3	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
		3 4 4	18	S-9		1.50	Stiff to very stiff brownish gray to gray LEAN CLAY with sand (CL); slightly organic; damp to moist.							
30		2 4 4	18	S-10		2.50	@ 28.5', brown, trace organic.							
		2 5 6	18	S-11		2.00								
35		4 5 6	18	S-12		1.50								
		4 6 8	18	S-13		2.00								
40		2 5 7	18	S-14		2.50								
		1 5 5	18	S-15		1.50								
45		1 4 5	18	S-16		1.50								
46.0	535.3													
		WOH 3 5	18	S-17		0.50	Soft to medium stiff brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.							
50	531.3	1 3 3	18	S-18		0.75			0	0	0	23	47	30

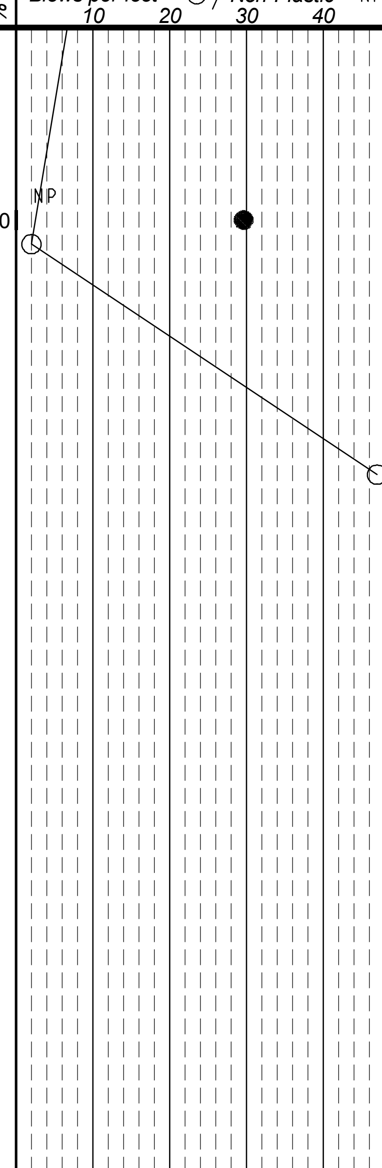


Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: Boring KC-1013	Location: As per plan	Date Drilled: 8/30/2010 to 9/1/2010

WATER OBSERVATIONS:
Water seepage at: 46.0'-60.0'
Water level at completion: 42.7' Prior to adding water.
FIELD NOTES:

Depth (ft)	Elev. (ft) 531.3	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
							Soft to medium stiff brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.						
53.5	527.8	WOH 1 1	18	S-19			Very loose gray sandy SILT (ML); wet.	0	0	0	44	36	20
					ST-3								
58.5	522.8	20 21 18	7	S-20			Dense brown GRAVEL with silt with sand (GP-GM); wet.						
60.0	521.3						Bottom of Boring - 60.0'						

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○ / Non-Plastic - NP



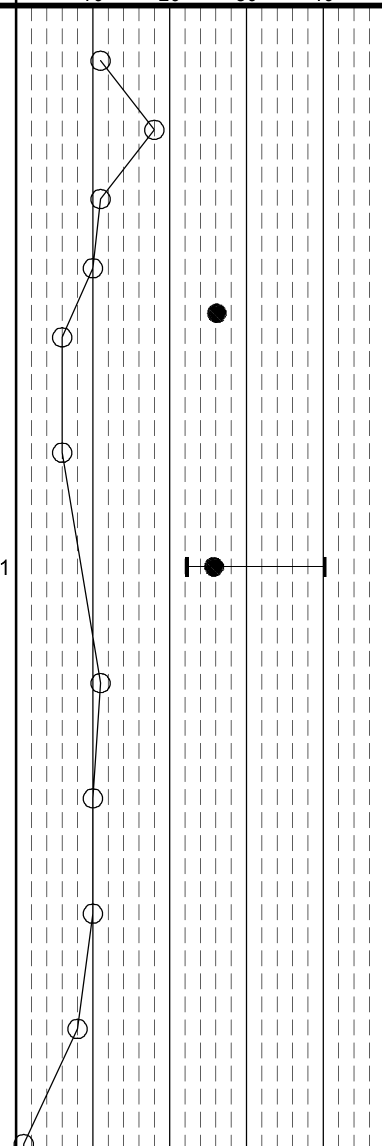
Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

LOG OF: Boring KC-1014 | *Location:* As per plan | *Date Drilled:* 9/9/2010

WATER OBSERVATIONS:
Water seepage at: 7.5-8.5, 28.5'-40.0'
Water level at completion: 19.4' Final, no drilling water added.
FIELD NOTES:
Sealed borehole with bentonite grout.

Depth (ft)	Elev. (ft) 558.6	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	558.4	2 3 6	9	S-1		3	Topsoil - 3"						
		6 6 9	18	S-2		4.5+	FILL: Very stiff to hard brown LEAN CLAY with sand (CL); damp to moist.						
3.0	555.6	3 4 5	18	S-3		2.5	Very stiff to hard brown LEAN CLAY with sand (CL); damp to moist.						
5		3 3 5	18	S-4		2.5							
		1 2 3	18	S-5		2.25	@7.5' - 8.5', possible seepage encountered.						
10		2 2 3	18	S-6		2	@ 8.5'-10.0', Shelby tube press attempted, drove SPT through interval.						
11.0	547.6				ST-1	2.25	Very stiff brown LEAN CLAY (CL), trace fine sand; moist.	0	0	0	2	57	41
13.0	545.6	2 4 5	18	S-7		1.75	Medium stiff to stiff brown LEAN CLAY with sand (CL); damp to moist.						
15		2 3 5	18	S-8		2							
20		2 4 4	18	S-9		2							
		1 3 4	18	S-10		2							
25	533.6	WOH WOH 1	18	S-11		0.75	@ 23.5', medium stiff, moist to wet.						

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

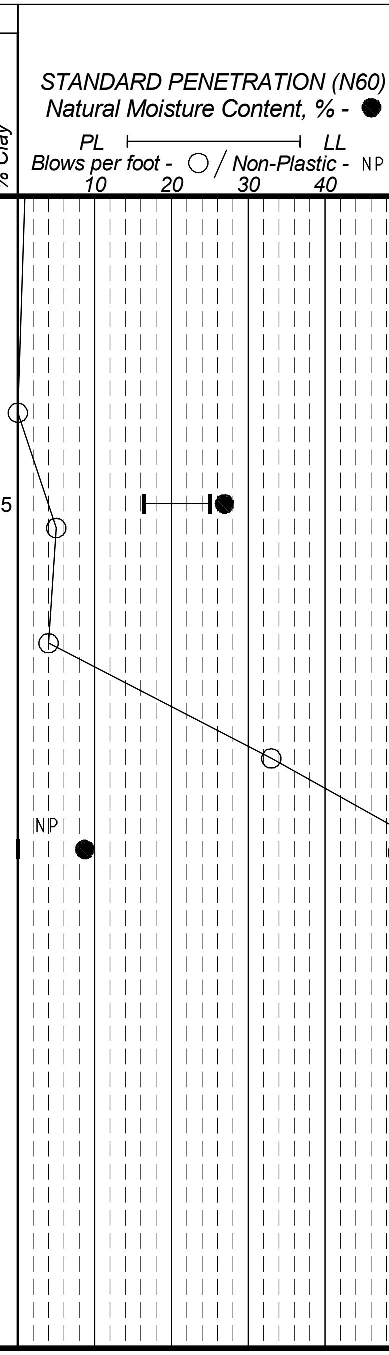


Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

LOG OF: Boring KC-1014 | *Location:* As per plan | *Date Drilled:* 9/9/2010

WATER OBSERVATIONS:
Water seepage at: 7.5-8.5, 28.5'-40.0'
Water level at completion: 19.4' Final, no drilling water added.
FIELD NOTES:
Sealed borehole with bentonite grout.

Depth (ft)	Elev. (ft) 533.6	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
26.0	532.6				ST-2		Very soft to soft brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.						
		WOH WOH WOH	18	S-12		0.25							
		2 2 2	18	S-13		0.25		0	0	0	32	43	25
		1 1 2	18	S-14		<0.25	@ 33.5', gray.						
36.0	522.6	8 13 14	18	S-15			Medium dense to dense brownish gray GRAVEL with silt with sand (GW-GM); wet.						
40.0	518.6	14 24 26	18	S-16				52	11	19	12	--6--	
							Bottom of Boring - 40.0'						



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

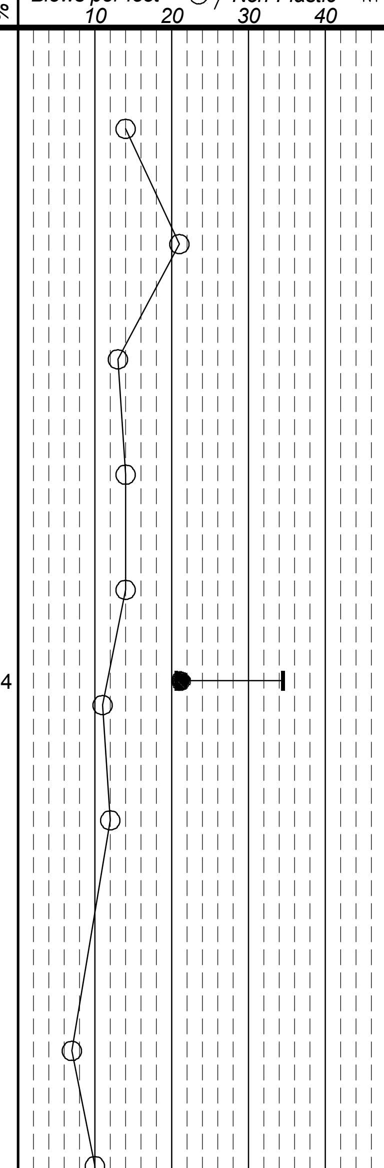
Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: Boring KC-1015	Location: As per plan	Date Drilled: 8/31/2010

WATER OBSERVATIONS:
Water seepage at: 38.5'-60.0'
Water level at completion: 42.6' Prior to adding water.

FIELD NOTES:

Depth (ft)	Elev. (ft) 580.4	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.2	580.2						Aggregate - 2"							
		3 6 6	10	S-1		4.00	FILL: Very stiff to hard brown sandy LEAN CLAY (CL); damp.							
5		6 9 8	11	S-2		4.5+								
		4 5 6	14	S-3		2.50								
10		3 5 7	15	S-4		4.5+								
		2 5 7	18	S-5		3.00								
15		2 4 5	16	S-6		2.75	@13.5'-15.0', trace sand.		0	0	0	12	54	34
		1 4 6	18	S-7		2.00								
20					ST-1									
		2 2 4	15	S-8		3.50								
23.5	556.9													
25	555.4	2 3 5	18	S-9		3	FILL: Very stiff brownish gray LEAN CLAY with sand (CL); slightly organic; damp to moist.							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○ / Non-Plastic - NP

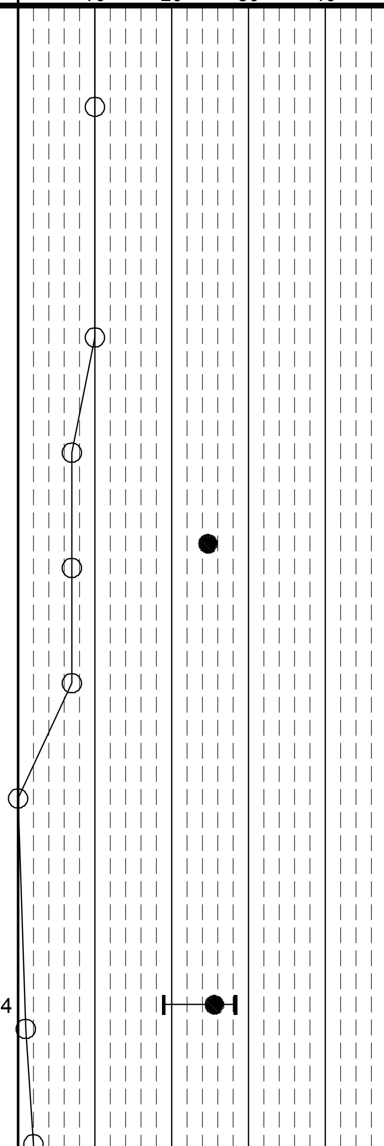


Client: OVEC-AEP	*Project:* Kyger Creek - Ash Impoundment Stability Analysis	*Job No.* 1021-3003.00
LOG OF: Boring KC-1015	*Location:* As per plan	*Date Drilled:* 8/31/2010

WATER OBSERVATIONS:
Water seepage at: 38.5'-60.0'
Water level at completion: 42.6' Prior to adding water.
FIELD NOTES:

Depth (ft)	Elev. (ft) 555.4	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
26.0	554.4						POSSIBLE FILL: Stiff to very stiff brown LEAN CLAY with sand (CL); slightly organic; damp to moist.						
		1 4 4	18	S-10		2.50							
					ST-2								
		2 4 4	18	S-11		2.00							
33.5	546.9						Stiff brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.						
		1 3 3	18	S-12		1.50							
		1 2 4	18	S-13		1.00							
38.5	541.9						Very soft to soft brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.						
		1 3 3	18	S-14		0.50							
		WOH WOH WOH	18	S-15		<0.25							
					ST-3								
		WOH WOH 1	18	S-16		0.50		0	0	0	32	44	24
		WOH 1 1	18	S-17		0.75							
50	530.4												

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○ / Non-Plastic - NP



Client: OVEC-AEP | Project: Kyger Creek - Ash Impoundment Stability Analysis | Job No. 1021-3003.00

LOG OF: Boring KC-1015 | Location: As per plan | Date Drilled: 8/31/2010

WATER OBSERVATIONS:
Water seepage at: 38.5'-60.0'
Water level at completion: 42.6' Prior to adding water.

FIELD NOTES:

Depth (ft)	Elev. (ft) 530.4	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ├──┤ LL Blows per foot - ○ / Non-Plastic - NP
					ST-4		Medium stiff brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.								
55		WOH WOH 2	18	S-18		0.75	@ 53.5', medium stiff.								
58.5	521.9														
60.0	520.4	1 17 16	7	S-19			Dense brown SAND with silt with gravel (SW-SM); wet.		43	8	21	22	--6--		NP
							Bottom of Boring - 60.0'								

Depth scale: 55, 60, 65, 70, 75

Chart scale: 10, 20, 30, 40

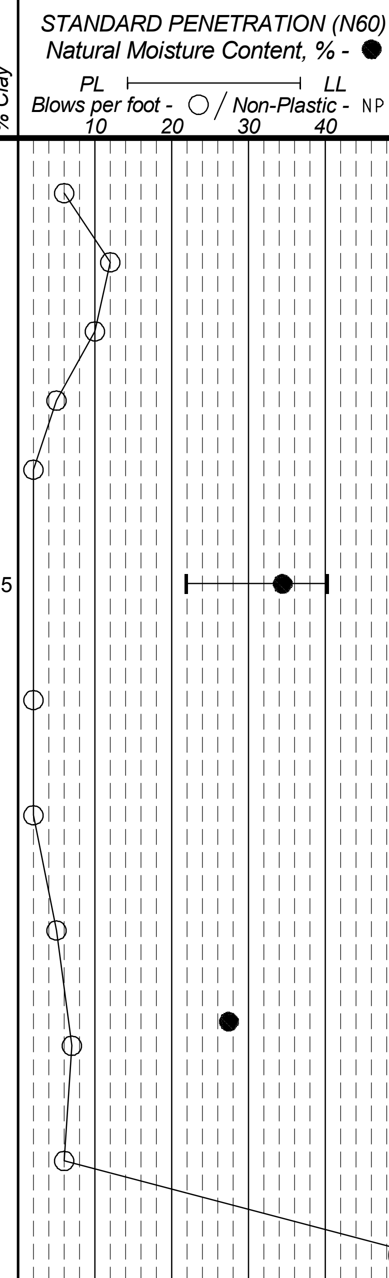
Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

LOG OF: Boring KC-1016 | *Location:* As per plan | *Date Drilled:* 9/8/2010

WATER OBSERVATIONS:
Water seepage at: 23.0'-30.0'
Water level at completion: 5.5' Prior to adding water.
4.2' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Installed piezometer in offset boring.

Depth (ft)	Elev. (ft) 543.8	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	543.6						Topsoil - 3"							
		2, 2, 3	10	S-1		2.00	FILL: Very stiff to hard brown LEAN CLAY with sand (CL); damp to moist.							
		6, 4, 6	18	S-2		4.5+								
3.0	540.8	4, 4, 4	16	S-3		2.00	Very stiff to hard brown LEAN CLAY with sand (CL); damp to moist.							
5.4	538.4	3, 2, 2	18	S-4a / S-4b		2.0 / 0.25	Soft to medium stiff gray LEAN CLAY with sand (CL); damp to moist.							
		WOH, 1, 1	10	S-5		2.0								
					ST-1		@8.5'-10.5', trace sand.		0	0	0	1	54	45
		WOH, 1, 1	18	S-6		1.25	@ 8.5'-13.5', stiff.							
		WOH, WOH, 2	18	S-7		0.75								
		WOH, 1, 3	18	S-8		0.75								
		1, 1, 5	18	S-9		1.50	@ 18.5'-21.0', stiff.							
		WOH, 2, 3	18	S-10		1.00								
23.5	520.3	15, 22, 30	18	S-11			Very dense SAND with silt with gravel (SW-SM); wet. Began adding drilling water at 25' to counteract heave.							
25	518.8													



Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

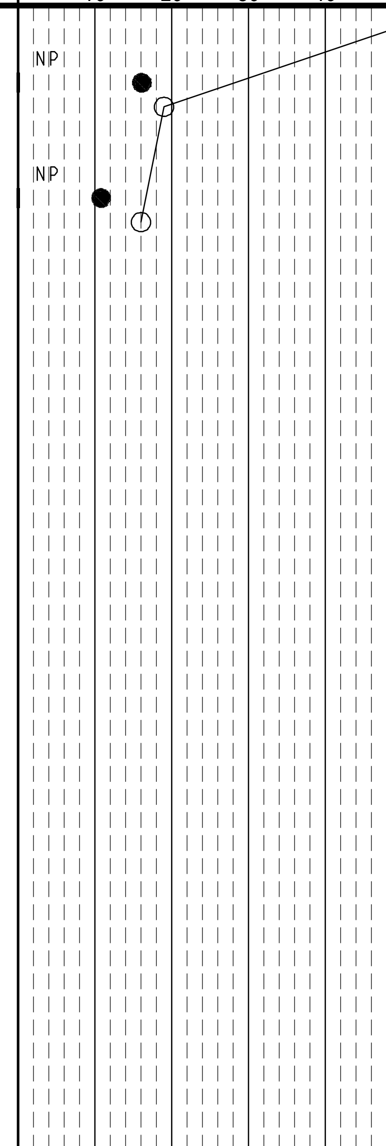
LOG OF: Boring KC-1016 | *Location:* As per plan | *Date Drilled:* 9/8/2010

WATER OBSERVATIONS:
Water seepage at: 23.0'-30.0'
Water level at completion: 5.5' Prior to adding water.
4.2' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Installed piezometer in offset boring.

Depth (ft)	Elev. (ft) 518.8	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
		10 10 6	8	S-12			Medium dense to dense brown SAND with silt with gravel (SW-SM); wet.		34	16	31	13	--6--	
28.5	515.3	4 5 8	4	S-13			Medium dense brownish gray GRAVEL with sand (GW), trace silt; wet.		53	13	21	10	--3--	
30.0	513.8						Bottom of Boring - 30.0'							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP



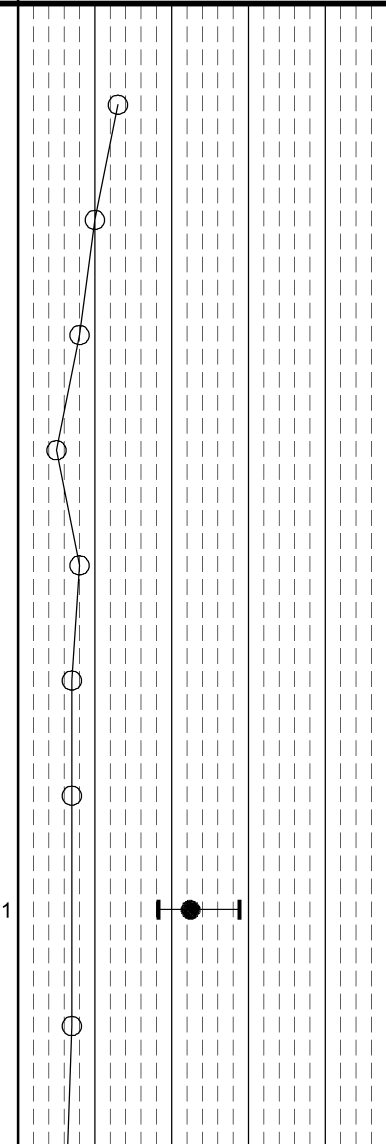
Depth scale: 30, 35, 40, 45, 50

Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

LOG OF: Boring KC-1017 | *Location:* As per plan | *Date Drilled:* 8/30/2010

WATER OBSERVATIONS:
Water seepage at: none
Water level at completion: NFW
FIELD NOTES:

Depth (ft)	Elev. (ft) 580.1	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.2	579.9						Aggregate - 2"						
		2 5 6	18	S-1		2.50	FILL: Stiff to very stiff brown sandy LEAN CLAY (CL); damp.						
5		2 4 4	18	S-2		1.25							
6.0	574.1	3 3 4	18	S-3		2.00	FILL: Very stiff brown LEAN CLAY with sand (CL); moist.						
8.5	571.6	1 2 2	18	S-4		1.00	FILL: Stiff to very stiff brown sandy LEAN CLAY (CL); moist.						
10		2 3 4	18	S-5		1.00							
15		1 3 3	18	S-6		2.25							
		1 2 4	10	S-7		1.00							
20					ST-1	1.5		0	0	0	23	46	31
21.0	559.1	1 1 5	18	S-8		1.25	FILL: Stiff brown LEAN CLAY with sand (CL); moist.						
25	555.1												



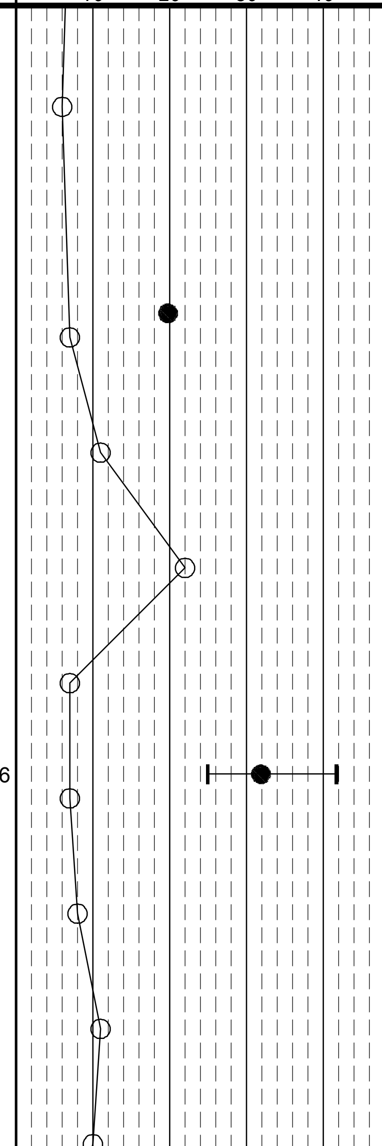
Client: OVEC-AEP | Project: Kyger Creek - Ash Impoundment Stability Analysis | Job No. 1021-3003.00

LOG OF: Boring KC-1017 | Location: As per plan | Date Drilled: 8/30/2010

WATER OBSERVATIONS:
Water seepage at: none
Water level at completion: NFW
FIELD NOTES:

Depth (ft)	Elev. (ft) 555.1	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
26.0	554.1						Stiff to very stiff brown sandy LEAN CLAY (CL); moist.							
		WOH 1 4	18	S-10		1.00								
30					ST-2									
		2 3 3	18	S-11		2.00								
35		1 3 6	3	S-12		2.50								
		4 8 10	18	S-13		3.00								
38.5	541.6						Stiff gray LEAN CLAY with sand (CL); slightly organic; moist.							
40		1 3 3	18	S-14		1.75								
		1 2 4	18	S-15		1.00	@41.0'-42.5', trace sand.		0	0	0	3	51	46
45		WOH 3 4	18	S-16		1.50	@ 43.5', brownish gray, trace organic.							
		2 4 5	18	S-17		1.75								
50	530.1	1 3 5	18	S-18		1.50								

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

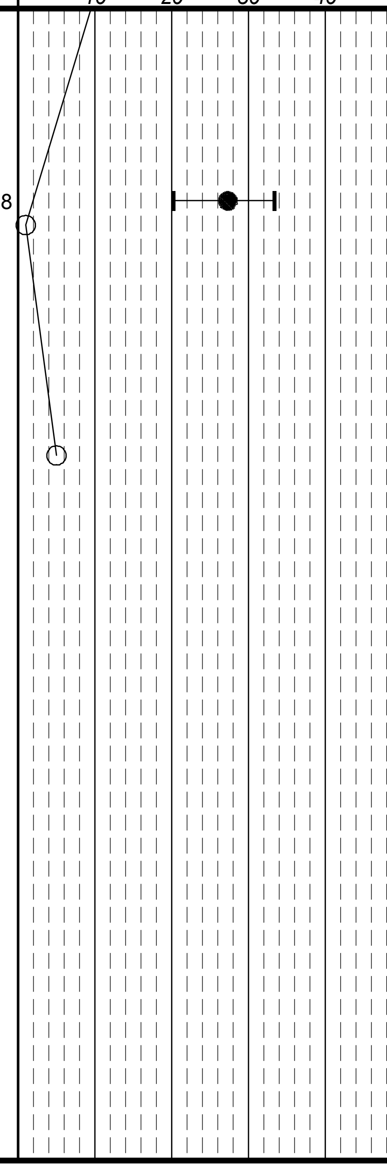


Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: Boring KC-1017	Location: As per plan	Date Drilled: 8/30/2010

WATER OBSERVATIONS:
Water seepage at: none
Water level at completion: NFW
FIELD NOTES:

Depth (ft)	Elev. (ft) 530.1	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
							Stiff brownish gray LEAN CLAY with sand (CL); moist.						
53.5	526.6												
55		WOH WOH 1	18	S-19		0.75	Medium stiff brownish gray sandy LEAN CLAY (CL); moist.	0	0	0	18	54	28
					ST-3								
60.0	520.1	WOH 2 2	18	S-20		1.0							
							Bottom of Boring - 60.0'						
65													
70													
75													

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

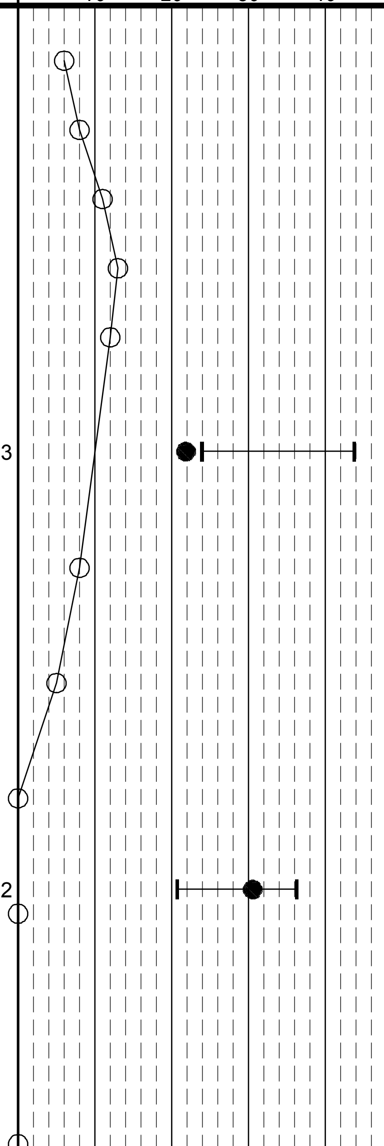
LOG OF: Boring KC-1018 | *Location:* As per plan | *Date Drilled:* 9/7/2010

WATER OBSERVATIONS:
Water seepage at: 28.5'-48.0'
Water level at completion: 17.3' Prior to adding water.
8.7' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Installed piezometer in offset boring.

Depth (ft)	Elev. (ft) 547.3	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	547.0	1 3 2	10	S-1		3.00	Topsoil - 4"						
							Very stiff to hard brown LEAN CLAY with sand (CL); damp.						
		2 3 4	8	S-2		3.00							
		5 4 5	12	S-3		4.5+							
5		7 6 5	14	S-4		3.00							
		4 5 5	9	S-5		3.50							
8.5	538.8												
						4.5	Hard brown LEAN CLAY (CL), trace fine sand; damp.						
10					ST-1			0	0	0	4	53	43
11.0	536.3												
		1 2 5	5	S-6		1.00	Soft to medium stiff gray to brownish gray sandy LEAN CLAY (CL); moist.						
15		1 2 2	18	S-7		1.0							
		WOH WOH WOH	18	S-8		0.5							
18.0	529.3												
							Soft brownish gray LEAN CLAY (CL), trace fine sand; moist.						
20		WOH WOH WOH	18	S-9		0.25		0	0	0	5	63	32
21.0	526.3												
					ST-2		Soft to medium stiff gray to brownish gray sandy LEAN CLAY (CL); moist.						
25	522.3	WOH WOH WOH	18	S-10		0.50							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP



Client: OVEC-AEP | Project: Kyger Creek - Ash Impoundment Stability Analysis | Job No. 1021-3003.00

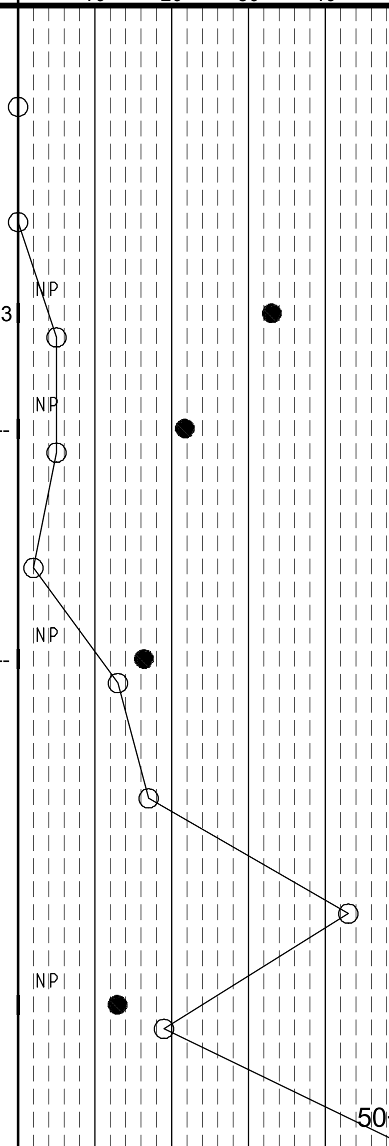
LOG OF: Boring KC-1018 | Location: As per plan | Date Drilled: 9/7/2010

WATER OBSERVATIONS:
Water seepage at: 28.5'-48.0'
Water level at completion: 17.3' Prior to adding water. 8.7' Final including drilling water.

FIELD NOTES:
Sealed borehole with bentonite grout.
Installed piezometer in offset boring.

Depth (ft)	Elev. (ft) 522.3	Blows per 6"	Recovery	Sample No. Drive	Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60)
26.0	521.3	WOH WOH WOH	12	S-11		0.75	Medium stiff to stiff gray sandy LEAN CLAY (CL); contains wet sandy silt seams; moist to wet.							
30		WOH WOH WOH	18	S-12		1.0	@ 28.5'-31.0', contains wet sandy silt seams. Began adding drilling water at 30' to counteract heave.							
31.0	516.3	WOH 1 3	18	S-13			Very loose to loose gray sandy SILT (ML); wet.	0	0	0	48	39	13	NP
33.5	513.8	WOH 1 3	18	S-14			Loose gray SAND with silt (SW-SM), trace gravel; wet.	1	3	54	31	--11--		NP
36.0	511.3	WOH 1 1	18	S-15			Very loose gray silty, clayey SAND (SC-SM); wet.							
38.5	508.8	7 6 5	5	S-16			Medium dense gray GRAVEL with silt with sand (GP-GM); wet.	52	13	13	12	--10--		NP
41.0	506.3	3 6 8	3	S-17			Medium dense gray GRAVEL with sand (GW); wet.							
43.5	503.8	9 14 22	13	S-18			Dense to dense gray SAND with silt (SW-SM); wet.							
46.0	501.3	3 6 10	10	S-19			Medium dense gray SAND with gravel (SW), trace silt; wet.	38	20	31	8	--3--		NP
48.5	498.8	50/2"	2	S-20										50+
48.7	498.6						Soft gray SILTSTONE interbedded with SHALE; highly weathered to decomposed, argillaceous, micaceous.							

STANDARD PENETRATION (N60): Natural Moisture Content, % - ●; PL ⊢—⊣ LL; Blows per foot - ○ / Non-Plastic - NP; 10 20 30 40



Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: **Boring KC-1018**	Location: As per plan	Date Drilled: 9/7/2010

WATER OBSERVATIONS:
Water seepage at: 28.5'-48.0'
Water level at completion: 17.3' Prior to adding water.
8.7' Final including drilling water.

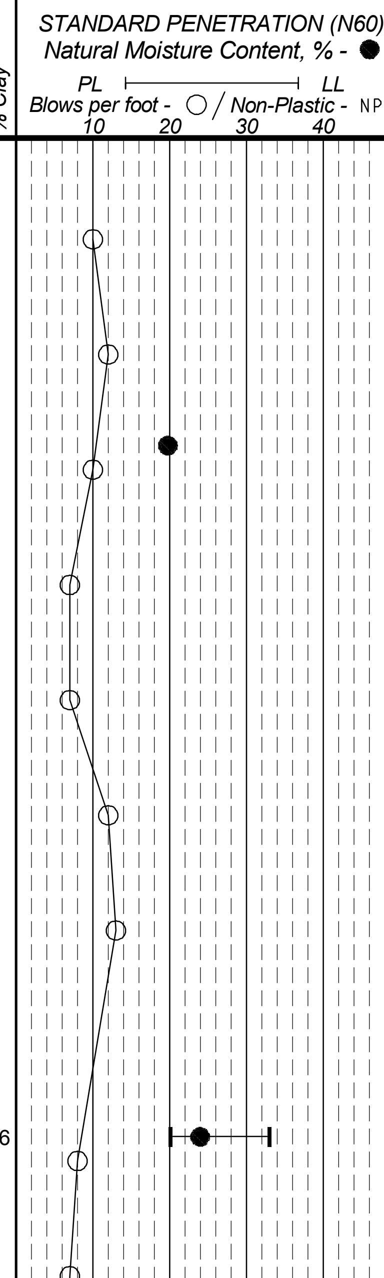
FIELD NOTES:
Sealed borehole with bentonite grout.
Installed piezometer in offset boring.

Depth (ft)	Elev. (ft) 497.3	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢⊣ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
							Bottom of Boring - 48.7'								
55															
60															
65															
70															
75															

Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: Boring KC-1019	Location: As per plan	Date Drilled: 8/27/2010

WATER OBSERVATIONS:
Water seepage at: 45'-50.'
Water level at completion: 48.7' Prior to adding water.
FIELD NOTES:

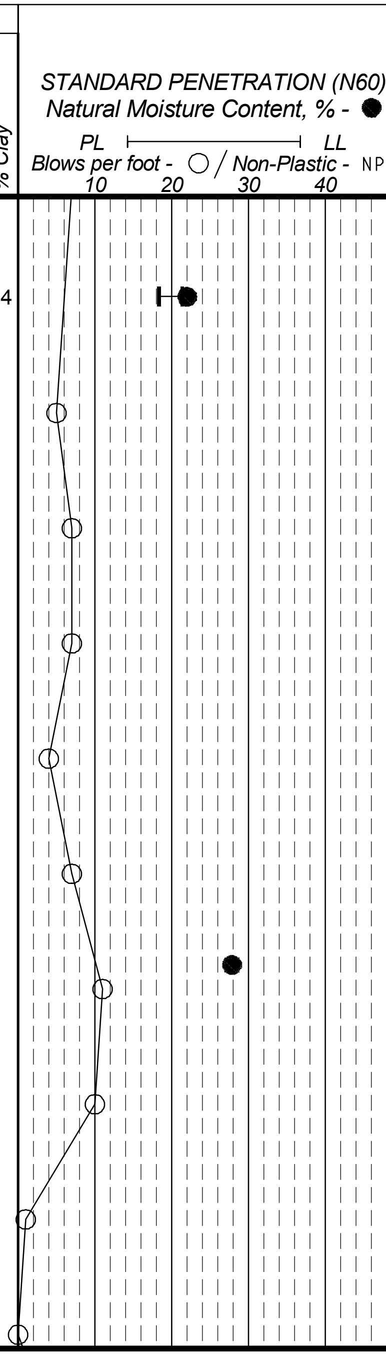
Depth (ft)	Elev. (ft) 580.7	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.2	580.5						Aggregate - 2"						
		2 4 4	10	S-1		3.0	FILL: Stiff to very stiff brown sandy LEAN CLAY (CL); damp.						
		4 4 6	18	S-2		2.5							
6.0	574.7	2 3 5	18	S-3		3.0	FILL: Very stiff brown LEAN CLAY with sand (CL); damp.						
8.5	572.2	2 2 4	18	S-4		2.0	FILL: Stiff to very stiff brown sandy LEAN CLAY (CL); damp.						
		2 2 4	18	S-5		2.0							
		2 4 6	18	S-6		3.0	@ 13.5', gray.						
		3 4 7	18	S-7		3.5							
					ST-1	--							
21.0	559.7	1 2 5	18	S-8		1.25	Stiff brown LEAN CLAY (CL), little fine sand; moist.	0	0	0	13	51	36
23.5	557.2	1 3 3	18	S-9		--	Medium stiff gray sandy SILTY CLAY (CL-ML); moist.						
25	555.7												



Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: Boring KC-1019	Location: As per plan	Date Drilled: 8/27/2010

WATER OBSERVATIONS:
Water seepage at: 45'-50.'
Water level at completion: 48.7' Prior to adding water.
FIELD NOTES:

Depth (ft)	Elev. (ft) 555.7	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
					ST-2		Soft gray sandy SILT (ML); moist to wet.	0	0	0	38	38	24
28.5	552.2												
30		WOH 1 3	18	S-10		--	Medium stiff gray sandy SILTY CLAY (CL-ML); moist.						
		WOH 2 4	18	S-11		--							
33.5	547.2												
35		WOH 2 4	18	S-12		1.75	Stiff grayish brown LEAN CLAY with sand (CL); damp.						
36.0	544.7												
		WOH 1 2	18	S-13		0.75	Medium stiff grayish brown sandy LEAN CLAY (CL); moist.						
38.5	542.2												
40		1 2 4	18	S-14		1.5	Stiff brown LEAN CLAY with sand (CL); damp to moist.						
		WOH 4 5	18	S-15		1.25							
45		WOH 3 5	18	S-16		1.75							
46.0	534.7												
		WOH WOH 1	18	S-17		1.0	Soft to medium stiff brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist.						
50	530.7	WOH WOH WOH	18	S-18		0.25	@ 48.5', wet.						

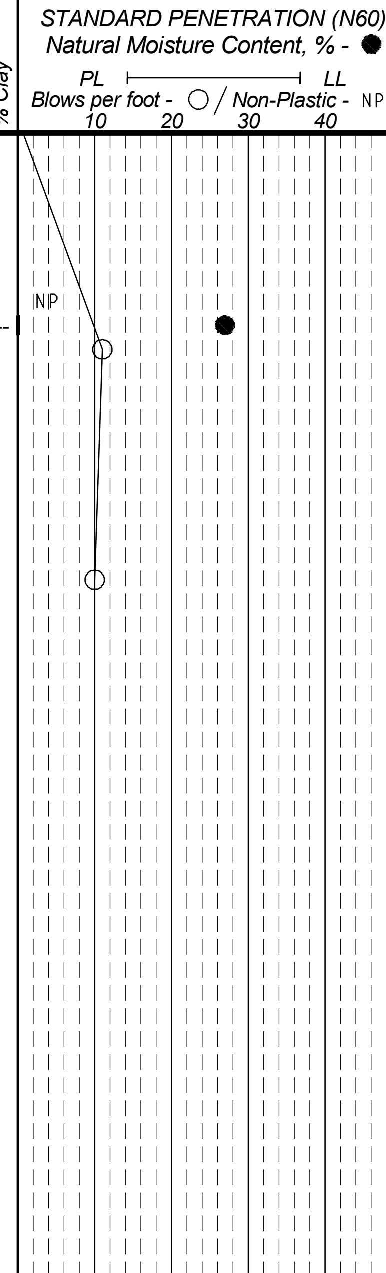


Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

LOG OF: Boring KC-1019 | *Location:* As per plan | *Date Drilled:* 8/27/2010

WATER OBSERVATIONS:
Water seepage at: 45'-50.'
Water level at completion: 48.7' Prior to adding water.
FIELD NOTES:

Depth (ft)	Elev. (ft) 530.7	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
50.5	530.2						Soft to medium stiff brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist.							
53.5	527.2	1 4 5	18	S-19			Loose brown SAND with silt (SP-SM); wet.		0	0	1	89	--10--	
		WOH 3 5	18	S-20										
60.0	520.7						Bottom of Boring - 60.0'							

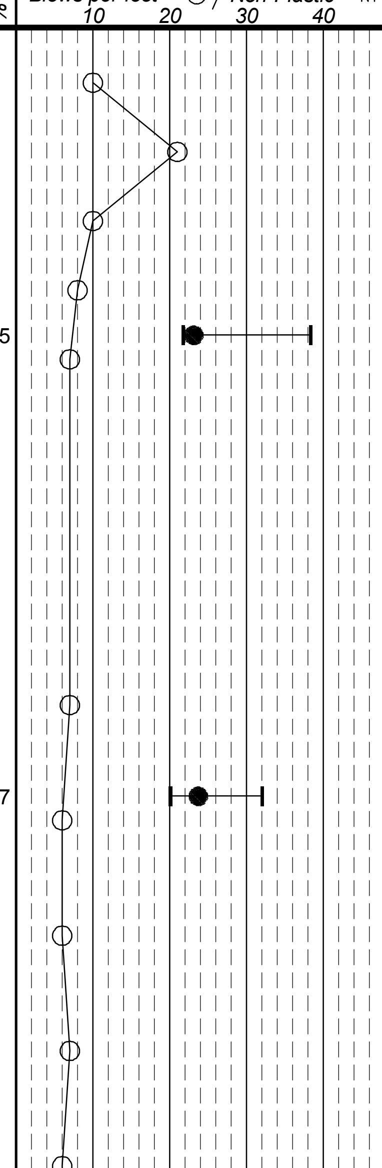


Client: OVEC-AEP	*Project:* Kyger Creek - Ash Impoundment Stability Analysis	*Job No.* 1021-3003.00
LOG OF: Boring KC-1020	*Location:* As per plan	*Date Drilled:* 9/2/2010

WATER OBSERVATIONS:
Water seepage at: 23.0'-40.0'
Water level at completion: 26.8' Prior to adding water.
FIELD NOTES:

Depth (ft)	Elev. (ft) 559.5	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	559.3	3 3 5	10	S-1		4.5+	Topsoil - 3"						
							Hard brown sandy LEAN CLAY (CL); damp.						
3.0	556.5	8 8 9	7	S-2		1.50	@ 1.5', stiff.						
		4 4 4	5	S-3			Loose brown silty SAND (SM); damp.						
6.0	553.5	3 3 4	15	S-4									
		2 3 3	18	S-5		2.00	Stiff to very stiff brown sandy LEAN CLAY (CL); damp to moist. @6.0'-7.5', trace sand.	0	0	0	7	58	35
					ST-1		@ 8.5'-10.5', unsuccessful attempt to collect press tube sample.						
		1 3 3	18	S-6		2.5							
18.5	541.0	1 2 3	18	S-7		1.00		0	0	0	19	54	27
		1 1 4	18	S-8		1.5	Stiff brown LEAN CLAY with sand (CL); moist.						
23.5	536.0	1 2 4	18	S-9		1.50							
25	534.5	1 2 3	18	S-10		1.25	Stiff brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.						

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

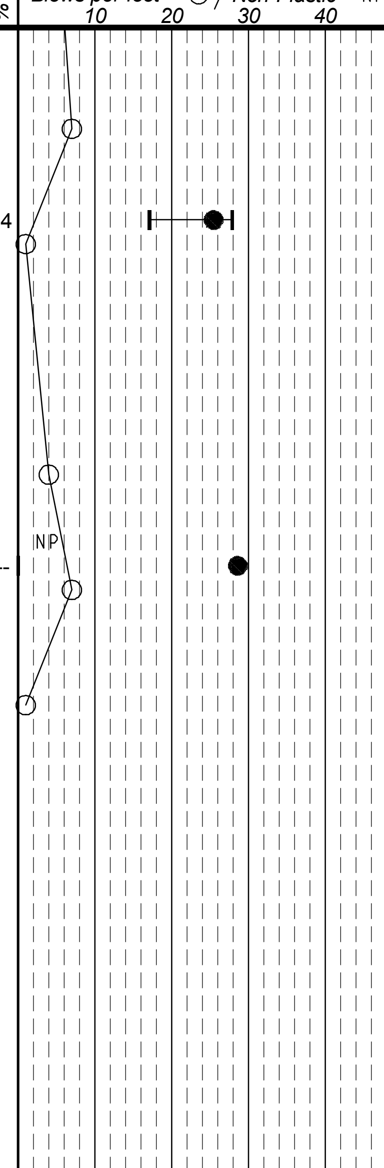
Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: Boring KC-1020	Location: As per plan	Date Drilled: 9/2/2010

WATER OBSERVATIONS:
Water seepage at: 23.0'-40.0'
Water level at completion: 26.8' Prior to adding water.

FIELD NOTES:

Depth (ft)	Elev. (ft) 534.5	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
		WOH 2 4	18	S-11		1.00	Stiff brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.							
		WOH WOH 1	18	S-12		1.0			0	0	0	30	46	24
31.0	528.5				ST-2		Very loose to loose brown silty SAND (SM), trace gravel; wet.							
		1 1 2	18	S-13										
		1 2 4	18	S-14					0	0	2	84	--14--	
40.0	519.5	WOH WOH 1	18	S-15										
							Bottom of Boring - 40.0'							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○ / Non-Plastic - NP



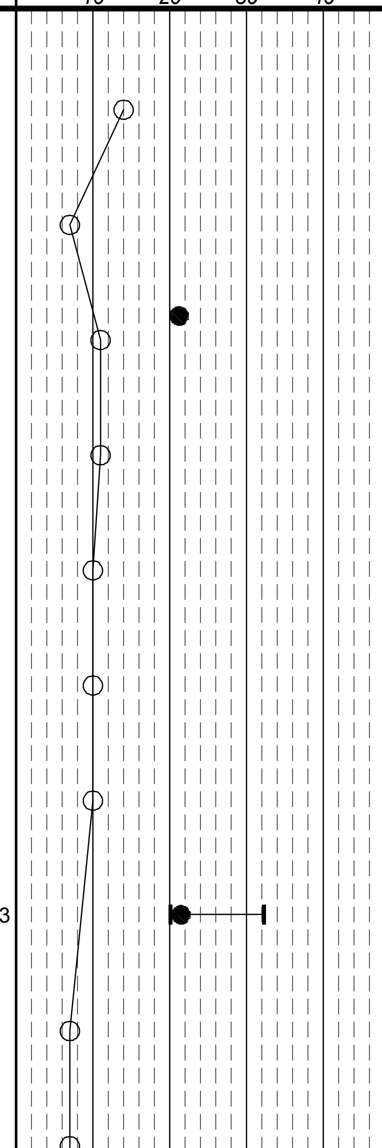
Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: Boring KC-1021	Location: As per plan	Date Drilled: 8/26/2010

WATER OBSERVATIONS:
Water seepage at: 33.5'-60.0'
Water level at completion: 47.0' Prior to adding water.

FIELD NOTES:

Depth (ft)	Elev. (ft) 580.2	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	580.0						Aggregate - 3"						
		6 6 6	10	S-1		4.5+	FILL: Hard brown sandy LEAN CLAY (CL); damp.						
3.5	576.7												
5		3 3 3	18	S-2		2.5	FILL: Stiff to very stiff brown LEAN CLAY with sand (CL); damp.						
		4 4 5	18	S-3		3.0							
10		2 4 5	18	S-4		2.5							
		2 3 5	18	S-5		1.5	@ 11.0', stiff, gray, contains black cinders.						
15		1 4 4	6	S-6		1.0							
		2 3 5	18	S-7		1.5							
18.5	561.7												
20					ST-1	2.5	FILL: Very stiff gray sandy LEAN CLAY (CL); damp.	0	0	0	21	46	33
21.0	559.2												
		3 3 3	18	S-8		2.0	FILL: Stiff to very stiff gray LEAN CLAY with sand (CL); moist.						
25	555.2	2 2 4	18	S-9		2.5							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP



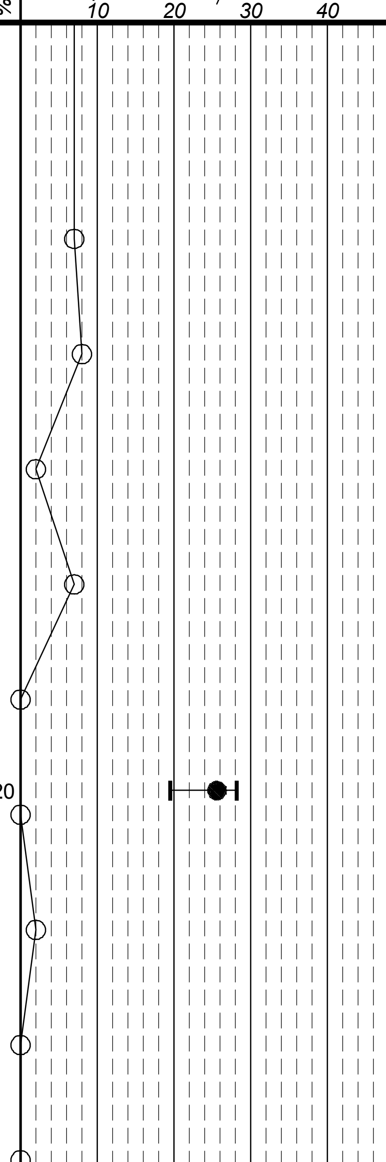
Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

LOG OF: Boring KC-1021 | *Location:* As per plan | *Date Drilled:* 8/26/2010

WATER OBSERVATIONS:
Water seepage at: *33.5'-60.0'*
Water level at completion: *47.0' Prior to adding water.*
FIELD NOTES:

Depth (ft)	Elev. (ft) 555.2	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
					ST-2		Stiff to very stiff gray LEAN CLAY with sand (CL); moist.							
28.5	551.7													
30		1 2 4	18	S-10		1.5	Stiff gray LEAN CLAY with sand (CL); moist.							
31.0	549.2													
		WOH 3 4	18	S-11		0.75	Medium stiff brown LEAN CLAY (CL); moist.							
33.5	546.7													
35		WOH WOH 2	18	S-12		0.5	Medium stiff brownish gray sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.							
36.0	544.2													
		WOH 2 4	18	S-13		1.25	Stiff brown LEAN CLAY with sand (CL); moist.							
38.5	541.7													
40		WOH WOH WOH	18	S-14		0.5	Medium stiff brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.							
		WOH WOH WOH	18	S-15		0.75			0	0	0	34	46	20
45		WOH WOH 2	18	S-16		0.25								
		WOH WOH WOH	18	S-17		1.0								
50	530.2	WOH WOH WOH	18	S-18		0.5	@ 48.5', gray.							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP



Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: Boring KC-1021	Location: As per plan	Date Drilled: 8/26/2010

WATER OBSERVATIONS:
Water seepage at: 33.5'-60.0'
Water level at completion: 47.0' Prior to adding water.
FIELD NOTES:

Depth (ft)	Elev. (ft) 530.2	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	Standard Penetration (N60) / Natural Moisture Content, %
50.5	529.7						Soft gray sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.							
		1 1 3	18	S-19		0.25								
58.5	521.7						Medium dense gray silty SAND (SM); wet.							NP
60.0	520.2	1 4 7	18	S-20				0	1	12	74	--13--		
							Bottom of Boring - 60.0'							

Depth scale: 55, 60, 65, 70, 75

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: OVEC-AEP | *Project:* Kyger Creek - Ash Impoundment Stability Analysis | *Job No.* 1021-3003.00

LOG OF: Boring KC-1022 | *Location:* As per plan | *Date Drilled:* 9/1/2010

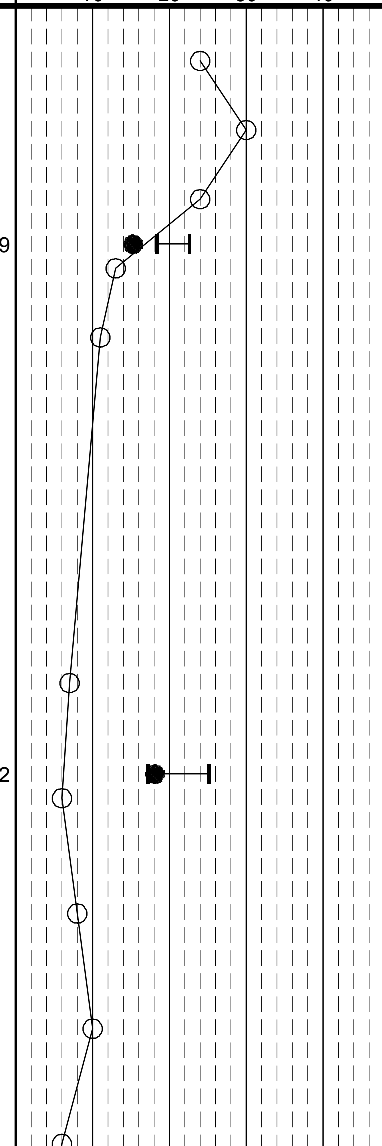
WATER OBSERVATIONS:
Water seepage at: 23.5'-40.0'
Water level at completion: 29.0' Prior to adding water.

FIELD NOTES:

Depth (ft)	Elev. (ft) 562.7	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	562.5						Topsoil - 3"						
		7 / 9 / 11	4	S-1		4.5+	FILL: Hard brown sandy LEAN CLAY (CL); contains cinders; damp.						
		7 / 10 / 15	12	S-2		4.5+							
4.5	558.2	6 / 10 / 10	14	S-3		4.5+							
5		5 / 5 / 6	10	S-4		1.0	FILL: Stiff to very stiff brown sandy SILTY CLAY (CL-ML); damp.	0	0	0	41	40	19
		1 / 5 / 4	18	S-5		2.5							
10							@ 8.5'-10.5', unsuccessful attempt to collect press tube sample.						
11.0	551.7				ST-1		Very stiff brown LEAN CLAY with sand (CL); damp.						
15		1 / 3 / 3	18	S-6		2.5							
16.0	546.7	1 / 2 / 3	18	S-7		1.50	Stiff brown sandy LEAN CLAY (CL); damp to moist.	0	0	0	40	38	22
20		3 / 3 / 4	18	S-8									
		3 / 4 / 4	18	S-9		1.75							
23.5	539.2						Medium stiff brown sandy LEAN CLAY (CL); contains moist to wet sandy silt seams; moist to wet.						
25	537.7	1 / 2 / 3	18	S-10									

Graphic Log

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



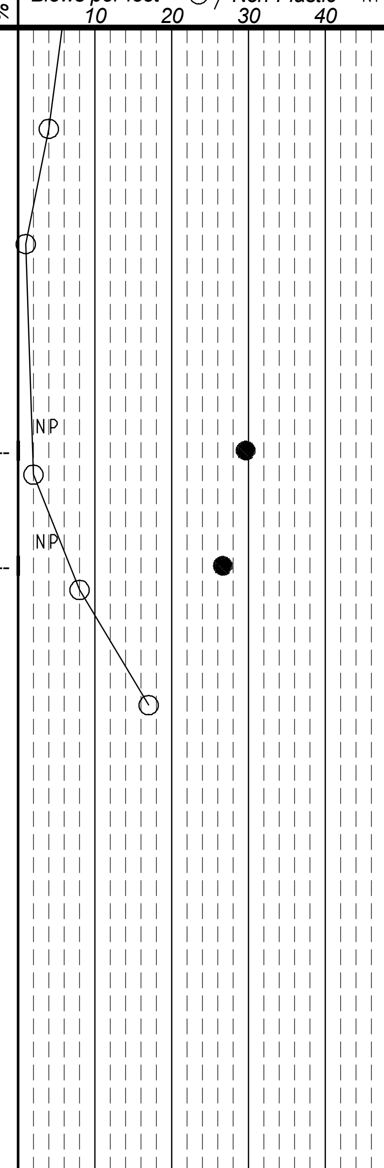
Client: OVEC-AEP	Project: Kyger Creek - Ash Impoundment Stability Analysis	Job No. 1021-3003.00
LOG OF: Boring KC-1022	Location: As per plan	Date Drilled: 9/1/2010

WATER OBSERVATIONS:
Water seepage at: 23.5'-40.0'
Water level at completion: 29.0' Prior to adding water.
FIELD NOTES:

Depth (ft)	Elev. (ft) 537.7	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
26.0	536.7	WOH WOH 3	18	S-11		1.0	Medium stiff brown LEAN CLAY with sand (CL); moist.						
28.5	534.2	WOH WOH 1	18	S-12		0.50	Medium stiff brown sandy LEAN CLAY (CL); wet.						
					ST-2								
33.5	529.2	WOH WOH 2	18	S-13			Very loose to loose brown silty SAND (SM), trace gravel; wet.	0	0	1	80	--19--	
		WOH 3 4	18	S-14				0	0	1	74	--25--	
40.0	522.7	1 6 8	18	S-15			@ 38.5', medium dense.						

Bottom of Boring - 40.0'

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○ / Non-Plastic - NP



APPENDIX III

Hydrologic and Hydraulic Evaluations

Hydrologic and Hydraulic Analysis Related to Compliance Requirements
South Fly Ash Pond, Boiler Slag Pond and Clearwater Pond
Kyger Creek Power Plant, Gallia County, Ohio

General

The intent of this section is to ascertain the compliance of the South Fly Ash Pond, Boiler Slag Pond, and Clearwater Pond with the recently mandated coal combustion residuals (CCR) rules with regard to the hydrologic and hydraulic capacity requirements for surface impoundments (Ref 1). All three impoundments are up ground reservoirs which function as tailings ponds for the Ohio Valley Electric Corporation's (OVEC's) Kyger Creek Power Plant. A site map is shown in Figure 1.

The CCR rules require that the impoundments undergo periodic hazard potential classification. Currently, South Fly Ash Pond and Boiler Slag Pond (which includes Clearwater Pond) are listed under the Class II Hazard Classification for dams in the State of Ohio. This classification is somewhat different from the hazard classification listed in Section 257.73 (a) (2) of the CCR but may be construed as equivalent to a significant hazard potential CCR surface impoundment. As per Section 257.82 (a) (3) (ii) the inflow design flood for a significant hazard CCR surface impoundment is the 1,000-yr flood. However, since the primary classification is the State of Ohio Class II Hazard classification, the minimum design flood for such structures as per Ohio Administrative Code Rule 1501:21-13-02 is the 50% probable maximum flood (50% PMF). In addition, the 50% PMP depths for this location are larger than the 1000-yr rainfall depths for the same duration and thus the use of the 50% PMP for this analysis is conservative. Consequently, the inflow design flood chosen to determine the hydraulic capacity requirement is the 50% PMF.

The CCR rules also only state that the CCR unit must adequately manage the flow into and from the unit during and after the inflow design flood. No specific criterion for freeboard in the CCR unit is specifically listed. However, Ohio Administrative Code Rule 1501:21-13-07 for Class II dams that are up ground reservoirs specifically states that the minimum elevation of the embankment crest shall be 5 feet higher than the elevation of the designed maximum operating pool level. As part of this compliance certification, checks are conducted to verify that the 5 ft freeboard criterion for the top of dam as compared to the operating pool level is met. In addition, surcharge elevations associated with the inflow of the 50% PMF with maximum operating pool as the initial condition are also determined to ensure adequate storage capacity of the tailings ponds.

PMP Estimates

The rainfall depth for the 6-hr 1 sq. mile PMP for the Kyger Creek Plant as per the latest guidelines (Ref 2) developed by the Ohio Department of Natural Resources (ODNR) is 19 inches. Since the drainage areas to the ponds are relatively small and the associated time of concentrations will be much less than 6 hours, it is reasonable to use the 6-hr 1 sq. mile value for the PMP. It should be noted that the point 1000-yr 6-hr rainfall depth for the area is 5.6 inches as compared to the 0.5 PMP depth of 9.5 inches.

Topographic Data

Topographic data for all three ponds were generated using the 2007 LiDAR information for the project site that is available online from the Ohio Geographically Referenced Information Program (OGRIP) website. The drainage areas and elevation-area data for each of the ponds were developed using the above data. It should be noted that the elevations with the LiDAR data are referenced to the NAVD 88 vertical datum. Since the historical information for the ponds are based on the NGVD 29 datum, all elevations based on this data are converted to the NGVD 29 elevations by adding 0.7 ft, which is the appropriate correction factor for the project area. All elevations in this document are referenced to the NGVD 29 datum unless otherwise expressly stated.

Historic Data and Previous Studies

Historic data on the tailing ponds were primarily taken from several previous studies (Refs 3 and 4). This includes outlet structure information and normal pool elevations. Information was also obtained from communications with OVEC and American Electric Power (AEP) personnel. A site visit was also conducted on 7/22/15 to observe the various facilities on site.

South Fly Ash Pond

The drainage area for the South Fly Ash Pond is approximately 67.7 acres. The outlet structure for South Fly Ash Pond is located near the south west corner of the pond and consists of a 36-inch concrete pipe, with a 42 inch by 39 inch concrete riser pipe with the principal spillway at elevation 582 ft. As per OVEC and AEP personnel, the maximum operating pool is at elevation 585 ft.

The site visit revealed that the Kyger Creek Plant's coal yard drainage as well as storm drainage from a portion of the plant site is pumped to the pond. This information is not available from any of the previous reports. Discussions with OVEC and AEP personnel revealed that originally four Goyne pumps each rated at 5,000 GPM delivered the drainage flow to the ponds. Currently, only two are working and there are no current plans to replace the other two. For the purpose of this study, it is assumed that two pumps will be active during storm events. The combined coal yard/plant drainage area is approximately 38 acres as per OVEC and AEP personnel.

Conservatively, it is assumed that the outlet structure is blocked during the occurrence of the 0.5 PMP event, the initial pond elevation is at the maximum operating pool, and that the direct inflow to the reservoir from the 0.5 PMP rainfall and the associated pumped drainage from the coal yard/plant area are instantaneously imposed on the pond.

Assuming no losses, the direct inflow volume to the pond = 0.5*19/12*67.7 = 53.6 ac-ft. Drainage volume to the pond from the pumps will be the minimum of the pump delivery or the flow volume associated with the drainage area. Maximum pump delivery during the 6-he PMP will be the rated pump capacity multiplied by the 6-hr duration. Maximum pump volume = 5,000*2*60*6/7.48/43,560 = 11.0 ac-ft. Assuming no losses, the maximum volume from the 38 acre coal yard/plant drainage area during the 0.5 PMP = 0.5*19/12*38 = 30 ac-ft. It appears that flow from the drainage area will be limited by the pump capacity which may not be the case in reality since there will be losses associated with the rainfall over the coal/plant yard. A runoff coefficient of approximately 0.37 will make the runoff volume almost the same as the pump capacity. Conservatively, the total volume to the pond can be estimated as 53.6+11.0 = 64.6 ac-ft.

The resulting water surface elevation is calculated to be 586.0 ft (see Table 1). The top elevation of the embankment around the pond is considered to be at elevation 590 ft, though the 2007 LIDAR data indicate variations in the elevations. Therefore, the freeboard for the 0.5 PMP event (assuming the initial water level is at maximum operating pool) is of the order of 4 ft.

Also, there is a freeboard of 5 ft above the maximum operating level, which satisfies the minimum freeboard requirements of the State of Ohio for up ground reservoirs.

Boiler Slag Pond

The drainage area for the Boiler Slag Pond is approximately 30.1 acres. The outlet structure for Boiler Slag Pond is located at the southern end of the pond adjacent to the west end of the splitter dike between Boiler Slag Pond and the associated Clearwater Pond. The outlet consists of a 36-inch concrete pipe with a 42 inch by 39 inch concrete riser pipe with the principal spillway at elevation 557 ft. Water entering the outlet structure is discharged to Clearwater Pond, through a 30-inch CMP which passes through the splitter dike. There is no drainage from other sources entering Boiler Slag Pond. The maximum operating pool level is reported by OVEC and AEP personnel to be approximately 558 ft.

Conservatively, it is assumed that the outlet structure is blocked during the occurrence of the 0.5 PMP event, the initial pond elevation is at maximum operating pool, and that the inflow to the reservoir is only from the 0.5 PMP rainfall. Assuming no losses, the direct inflow volume to the pond = 0.5*19/12*30.1 = 23.8 ac-ft. The initial storage in the pond corresponding to the maximum operating pool elevation of 558.0 ft is 17.7 ac-ft, so the total storage in the pond corresponding to the 0.5 PMP is 41.5 ac-ft. The resulting water surface elevation in the pond due to the 0.5 PMP event is 559.3 ft.

The top elevation of the embankment around the pond is considered to be at elevation 582 ft, though the 2007 LIDAR data indicate variations in the elevations. Therefore, the freeboard for the 0.5 PMP event is of the order of 22.7 ft. The detailed calculations are shown in Table 2.

Clearwater Pond

The drainage area for the Clearwater Pond is 9.9 acres. The outlet structure for Clearwater Pond is located at the southeast corner of the pond and is discharged to the Ohio River through a 30-inch CMP. Details of the outlet structure do not appear to be available. The maximum operating pool level is reported by OVEC and AEP personnel to be approximately 553 ft. The only incoming flow to Clearwater Pond is from direct rainfall to the pond as well as the inflow from Boiler Slag Pond.

Clearwater Pond is not strictly a CCR unit since the purpose of Boiler Slag Pond is to store CCRs.

Assuming no losses, the combined inflow volume from the drainage areas of both Boiler Slag Pond and Clearwater Pond is = 0.5*19/12*(30.1+9.99) = 31.7 ac-ft. It is also assumed that the initial storage of 17.7 ac-ft in Boiler Slag Pond corresponding to the maximum operating pool there will drain to Clearwater Pond. In addition, since the initial elevation in Clearwater Pond is assumed to be at the maximum operating level of 553 ft, there is an initial storage in Clearwater Pond of 5.5 ac-ft. Thus the total storage volume in Clearwater Pond for these conditions assuming that the outlet is blocked is 54.9 ac-ft.

It should be noted that if the pool elevation at Clearwater Pond exceeds 557 ft (spillway elevation at Boiler Slag Pond), the storage in Boiler Slag Pond above this elevation will also be activated in addition to the storage in Clearwater Pond. The resulting water surface elevation in the pond for the 0.5 PMP event assuming that the outlet is blocked is 558.6 ft.

The top elevation of the embankment around the pond is considered to be at elevation 582 ft, though the 2007 LIDAR data indicate variations in the elevations. Therefore, the freeboard for the 0.5 PMP event is of the order of 23.4 ft. The detailed calculations are shown in Table 3.

Summary and Conclusions

A summary table of the water level conditions in the three ponds is given in Table 4. It is concluded that South Fly Ash Pond, Boiler Slag Pond and Clearwater Pond have sufficient storage capacity and freeboard to satisfy the minimum requirements of CCR rules as well as the dam safety requirements of the State of Ohio.

References

1. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule, 40 CFR Parts 257 and 261, Environmental Protection Agency, Part II, Federal Register, Vol. 80, No.74, Friday, April 17, 2015..

2. Probable Maximum Precipitation Study for the State of Ohio, Ohio Department of Natural Resources, February 2013.

3. Assessment of Dam Safety of Coal Combustion Surface Impoundments (Task 3) Final Report, Ohio Valley Electric Corporation, Kyger Creek Power Station, Gallipolis, Ohio, February 24, 2010.

4. Report on Dam Safety Inspection, Kyger Creek Fly Ash and Bottom Ash Ponds, Kyger Creek Generation Plant, Addison, Ohio, February 1985.

Figure 1 Areal View of Project Site

Table 1: Detailed Calculations for South Fly Ash Pond

South Fly Ash Pond

Drainage Area 67.7 acres

Feature	Elevation (ft)	Surface Area (ac)	Incr Storage (ac-ft)
Principal Spillway	582.0	64.3	0.0
	582.7	64.6	45.1
	583.7	64.9	109.8
	584.7	65.2	174.9
	585.0	65.3	194.4
	585.7	65.5	240.2
	586.7	65.9	305.9
	587.7	66.3	371.9
	588.7	66.8	438.5
	589.7	68.1	505.9
Top of Dam	590.0	68.7	526.4

Inflow Volumes

(Calculations assume that outlet structure is inoperable)

50% 6hr-1sq mile PMP volume to South Fly Ash Pond	53.6	ac-ft
Coal yard drainage max pump vol for 6 hrs	11.0	ac-ft
Drainage volume from 38 acre coal yard for 50% 6-hr PMP	30.1	ac-ft
Combined flow volume from 50% 6-hr PMP to South Fly Ash Pond	64.6	ac-ft
Storage in South Fly Ash Pond due to 50% 6-hr PMP	64.6	ac-ft
Assumed initial level (maximum operating pool)	585.0	ft
Initial storage	194.4	ac-ft
Total storage in South Fly Ash Pond	259.0	ac-ft
Max South Fly Ash Pond elevation	586.0	ft
Freeboard	4.0	ft

Table 2: Detailed Calculations for Boiler Slag Pond

Boiler Slag Pond

Drainage Area 30.1 acres

Feature	Elevation (ft)	Surface Area (ac)	Incr Storage (ac-ft)
Principal Spillway	557.0	16.7	0.0
	560.7	19.5	67.0
	570.7	26.3	296.0
	579.7	29.0	544.5
Top of Dam	582.0	29.2	611.4

Inflow Volumes

(Calculations assume that outlet structure is inoperable)

50% 6hr-1sq mile PMP volume	23.8	ac-ft
Storage in Boiler Slag Pond due to 50% 6-hr PMP	23.8	ac-ft
Assumed initial level (maximum operating pool)	558.0	ft
Initial storage (curve fit)	17.7	ac-ft
Total storage in Boiler Slag Pond	41.5	ac-ft
Max Boiler Slag Pond elevation (curve fit)	559.3	ft
Freeboard	22.7	ft

Table 3: Detailed Calculations for Clearwater Pond

Clearwater Pond

Drainage Area 9.99 acres

Feature	Elevation (ft)	Surface Area (ac)	Incremental Storage (ac-ft)	Add Storage Boiler Slag Pond (ac-ft)	Total Storage (ac-ft)
Principal Spillway	552.0	5.7	0.0		0.0
	552.7	5.8	4.0		4.0
	556.7	6.4	28.4		28.4
	557.0	6.4	30.4	0.0	30.4
	560.7	6.9	54.9	67.0	122.0
	570.7	8.2	130.5	296.0	426.5
	579.7	9.6	210.7	544.5	755.2
Top of Dam	582.0	10.3	233.6	611.4	845.0

Inflow Volumes

(Calculations assume that outlet structure is inoperable)

50% 6hr-1sq mile PMP volume from Clearwater Pond	7.9	ac-ft
50% 6hr-1sq mile PMP volume from Boiler Slag Pond	23.8	ac-ft
Initial flow volume in Boiler Slag Pond	17.7	ac-ft
Combined Flow Volume to Clearwater Pond	49.4	ac-ft
Assumed initial level (maximum operating pool)	553.0	ft
Initial storage (curve fit)	5.5	ac-ft
Total storage in Clearwater Pond	54.9	ac-ft
Max Clearwater Pond elevation (curve fit)	558.6	ft
Freeboard	23.4	ft

Table 4: Summary Table of Elevations

Summary Table

	Elevation (ft) – NGVD 29			Freeboard (ft)		Top of Embankment Elevation(ft) – NGVD 29
Feature	Normal Pool	Max Operating Pool	50% PMP Elevation	50% PMP Event	Max Operating Pool	
South Fly Ash Pond	582.0	585.0	586.0	4.0	5.0	590.0
Boiler Slag Pond	557.0	558.0	559.3	22.7	24.0	582.0
Clearwater Pond	552.0	553.0	558.6	23.4	29.0	582.0

Note: Initial pond elevation for 50% PMP event assumed to be the maximum operating pool

APPENDIX IV

Piezometer Readings and Pool Elevation Data Provided by AEP
A Summary of the Laboratory Testing and the Results of Strength Tests Performed in the 2010 Subsurface Investigation

Table 3 - South Fly Ash Pond Static Water Elevations

Dates	Elevation (ft)					
	KC-1003	KC-1004	KC-1007	KC-1008	KC-1011	KC-1012
8/20/2010	558.09	ND	559.23	Dry	ND	ND
8/23/2010	561.35	ND	559.22	Dry	ND	ND
8/25/2010	561.35	ND	559.28	Dry	ND	ND
8/26/2010	561.43	551.24	559.27	Dry	ND	ND
8/30/2010	561.61	549.95	559.51	Dry	567.31	ND
9/1/2010	561.7	549.96	559.58	Dry	567.23	ND
9/7/2010	561.91	549.64	560.15	Dry	567.09	ND
9/8/2010	561.91	549.63	560.2	Dry	566.96	ND
9/9/2010	561.94	549.64	560.26	Dry	566.89	ND
9/10/2010	562.04	549.57	560.34	Dry	566.89	561.77
9/13/2010	562.24	549.49	560.64	Dry	567.07	561.67
9/14/2010	562.21	549.44	560.72	Dry	566.94	561.71
9/15/2010	562.27	549.43	560.83	Dry	567.04	561.75
5/20/2011	568.49	551.09	569.93	Dry	567.89	561.47
8/19/2011	566.94	ND	ND	Dry	ND	ND
9/27/2011	564.37	550.39	576.73	Dry	567.28	561.39
3/20/2012	567.29	550.46	573.48	Dry	567.18	561.42
6/1/2012	567.32	549.74	572.63	Dry	565.27	561.6
8/3/2012	567.68	549.35	572.65	Dry	564.61	560.78
10/25/2012	570.04	548.89	573.43	554.81	564.77	560.57
2/21/2013	ND	549.99	581.71	557.21	564.99	560.47
5/23/2013	572.59	549.34	576.33	554.01	565.49	560.47
8/16/2013	572.69	549.59	574.63	552.21	566.69	560.77
11/15/2013	572.79	549.79	575.63	Dry	566.79	560.67
3/7/2014	572.39	550.99	576.03	Dry	566.99	560.77
6/12/14	570.89	550.49	570.83	Dry	566.49	560.67
9/9/14	570.79	550.59	571.83	559.81	566.19	560.77

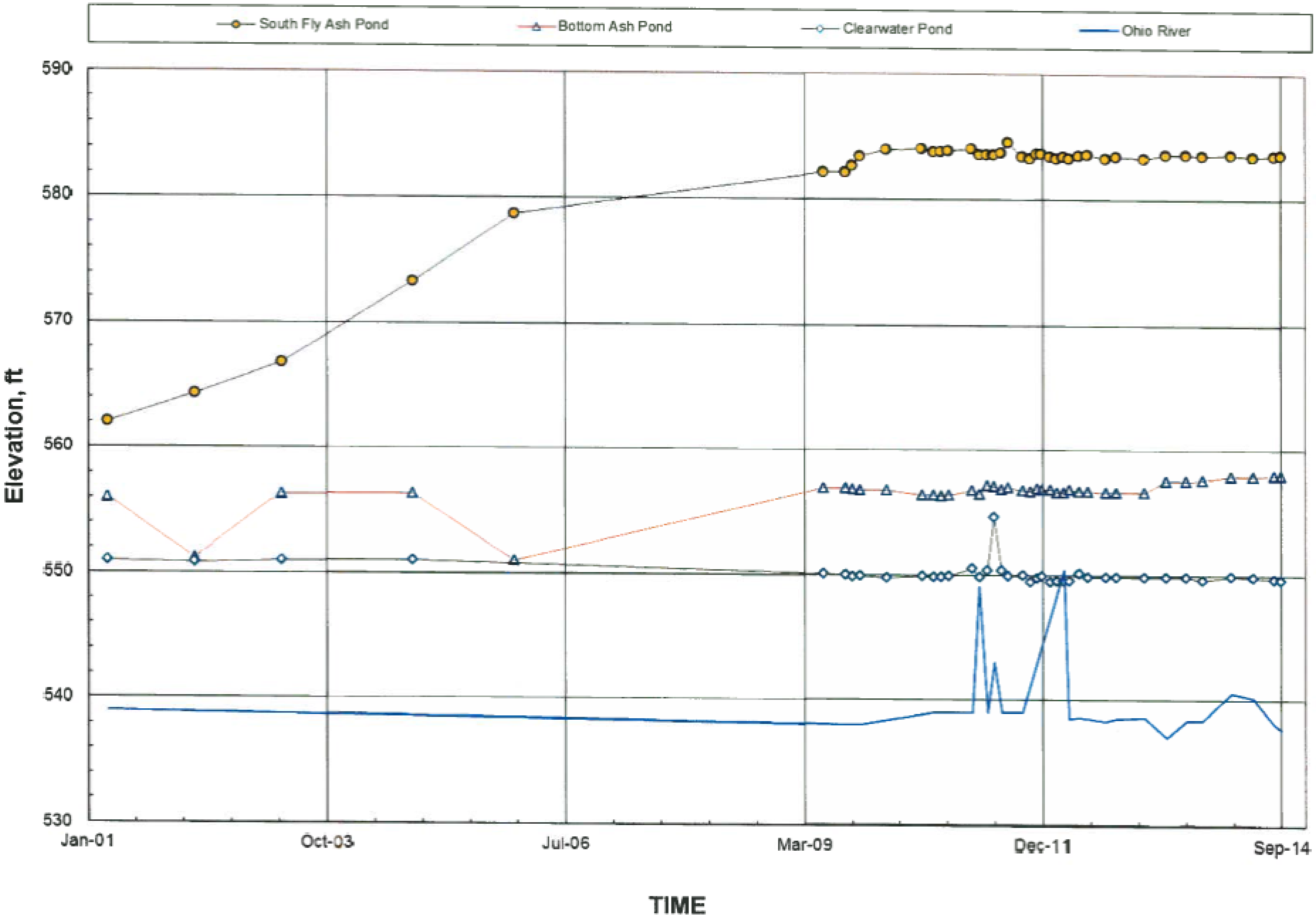


Figure 9 – Ponds Water Elevations

Table 2 - Bottom Ash Pond Static Water Elevations

Dates	Elevation (ft)					
	KC-1015	KC-1016	KC-1017	KC-1018	KC-1021	KC-1022
8/30/2010	ND	ND	ND	ND	539.83	ND
9/1/2010	545.98	ND	ND	ND	539.85	ND
9/7/2010	545.83	ND	535.3	ND	539.76	538.79
9/8/2010	545.86	ND	535.5	530.6	539.73	538.78
9/9/2010	545.82	536.3	535.74	531.85	539.72	538.84
9/10/2010	545.81	538.85	536	533.09	539.75	538.89
9/13/2010	546.02	539.3	537.06	535.85	539.72	539.04
9/14/2010	545.89	539.25	537.29	536.3	539.72	539
9/15/2010	546.02	539.15	537.59	536.7	539.72	538.94
5/20/2011	550.52	ND	549.79	ND	545.32	545.94
6/7/2011	ND	539.15	ND	536.7	ND	ND
9/27/2011	546.97	537.98	546	541.65	540.01	539.36
3/20/2012	547.65	541.1	550.79	537.5	542.38	541.74
6/1/2012	544.75	537.28	549.89	538.9	540.21	539.73
8/3/2012	546.41	536.78	547.41	536.86	539.52	539
10/25/2012	546.02	536.95	548.29	535.05	539.82	538.99
2/21/2013	546.47	539.1	549.39	539.2	541.52	540.14
5/23/2013	545.85	539.27	549.59	534.41	540.22	539.56
8/16/2013	546.67	537.9	548.99	534.8	540.02	539.24
11/15/2013	546.77	538.4	548.69	534.3	539.92	539.34
3/7/2014	548.27	539.5	556.49	539.7	544.22	541.34
6/12/2014	547.07	538.8	551.59	534.2	540.62	535.74
Sep-14	546.47	538.9	551.19	536.5	539.42	538.84

ND - No Data

Bottom Ash Pond is also known as Boiler Slag Pond

Table 1 - SUMMARIZED WATER ELEVATION DATA.

Dates	Elevation (ft)			
	SFAP	BAP	CWP	Ohio River
Apr-01	562	556	551	539
Apr-02	564.25	551.2	550.8	
Apr-03	566.75	556.3	551	
Oct-04	573.31	556.3	551	
Dec-05	578.7	551	ND	
Jun-09	582.18	556.92	550.03	
Sep-09	582.11	556.87	549.97	
Oct-09	582.68	556.8	549.82	
Nov-09	583.43	556.78	549.94	538
Mar-10	583.97	556.72	549.75	
Aug-10	584.01	556.39	549.87	
Sep-10	583.85	556.34	549.79	539
Oct-10	583.8	556.3	549.83	ND
Nov-10	583.86	556.36	549.89	539
Mar-11	584.06	556.76	550.5	539
Apr-11	583.56	556.43	549.83	549
May-11	583.59	557.09	550.33	539
Jun-11	583.56	557.03	554.62	543
Jul-11	583.76	556.84	550.33	539
Aug-11	584.6	556.96	549.91	539
Sep-11	583.41	556.76	549.95	539
Nov-11	583.3	556.68	549.45	
Nov-11	583.66	556.87	549.77	
Dec-11	583.63	556.79	549.9	
Jan-12	583.45	556.8	549.46	
Feb-12	583.3	556.63	549.5	
Mar-12	583.4	556.6	549.51	550.4
Apr-12	583.3	556.8	549.5	538.5
May-12	583.5	556.7	550.1	538.6
Jun-12	583.6	556.7	549.8	538.5
Sep-12	583.3	556.6	549.8	538.3
Oct-12	583.4	556.6	549.8	538.5
Feb-13	583.3	556.6	549.8	538.6
May-13	583.6	557.5	549.8	537
Aug-13	583.6	557.5	549.8	538.4
Oct-13	583.5	557.6	549.6	538.4
Feb-14	583.6	557.9	549.9	540.6
May-14	583.4	557.9	549.8	540.2
Aug-14	583.5	558	549.7	538.1
Sep-14	583.6	558	549.6	537.7

SFAP - South Fly Ash Pond -Crest Elevation :588
BAP - Bottom Ash Pond -Crest Elevation :582
CWP - Clearwater Pond -Crest Elevation :582
ND - No Data

Table 1 - SUMMARIZED WATER ELEVATION DATA.

Dates	Elevation (ft)			
	SFAP	BAP	CWP	Ohio River
Apr-01	562	556	551	539
Apr-02	564.25	551.2	550.8	
Apr-03	566.75	556.3	551	
Oct-04	573.31	556.3	551	
Dec-05	578.7	551	ND	
Jun-09	582.18	556.92	550.03	
Sep-09	582.11	556.87	549.97	
Oct-09	582.68	556.8	549.82	
Nov-09	583.43	556.78	549.94	538
Mar-10	583.97	556.72	549.75	
Aug-10	584.01	556.39	549.87	
Sep-10	583.85	556.34	549.79	539
Oct-10	583.8	556.3	549.83	ND
Nov-10	583.86	556.36	549.89	539
Mar-11	584.06	556.76	550.5	539
Apr-11	583.56	556.43	549.83	549
May-11	583.59	557.09	550.33	539
Jun-11	583.56	557.03	554.62	543
Jul-11	583.76	556.84	550.33	539
Aug-11	584.6	556.96	549.91	539
Sep-11	583.41	556.76	549.95	539
Nov-11	583.3	556.68	549.45	
Nov-11	583.66	556.87	549.77	
Dec-11	583.63	556.79	549.9	
Jan-12	583.45	556.8	549.46	
Feb-12	583.3	556.63	549.5	
Mar-12	583.4	556.6	549.51	550.4
Apr-12	583.3	556.8	549.5	538.5
May-12	583.5	556.7	550.1	538.6
Jun-12	583.6	556.7	549.8	538.5
Sep-12	583.3	556.6	549.8	538.3
Oct-12	583.4	556.6	549.8	538.5
Feb-13	583.3	556.6	549.8	538.6
May-13	583.6	557.5	549.8	537
Aug-13	583.6	557.5	549.8	538.4
Oct-13	583.5	557.6	549.6	538.4
Feb-14	583.6	557.9	549.9	540.6
May-14	583.4	557.9	549.8	540.2
Aug-14	583.5	558	549.7	538.1
Sep-14	583.6	558	549.6	537.7

SFAP - South Fly Ash Pond -Crest Elevation :588
BAP - Bottom Ash Pond -Crest Elevation :582
CWP - Clearwater Pond -Crest Elevation :582
ND - No Data

Bottom Ash Pond is also known as Boiler Slag Pond

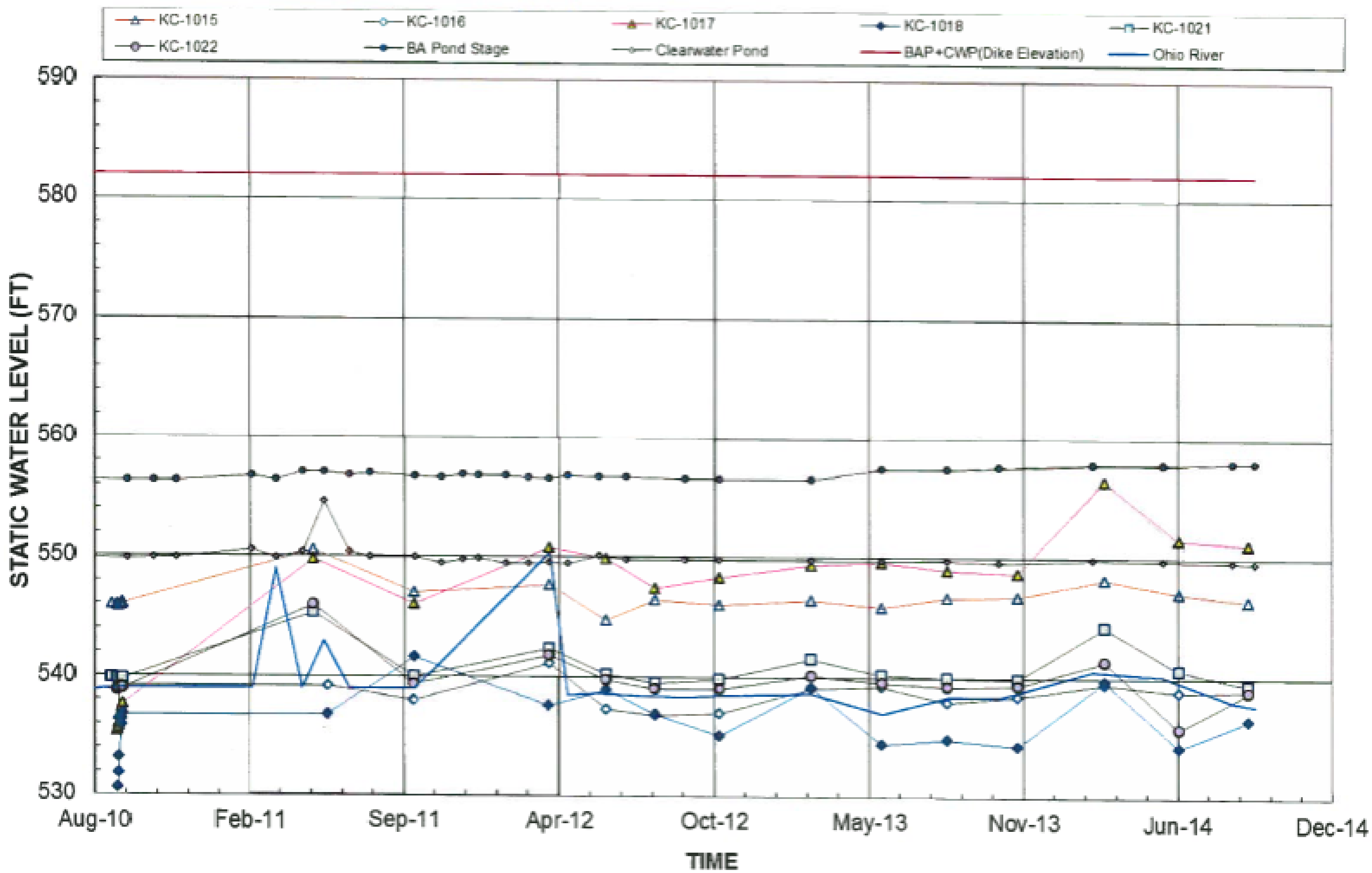


Figure 12 – Bottom Ash Pond Static Water Elevations

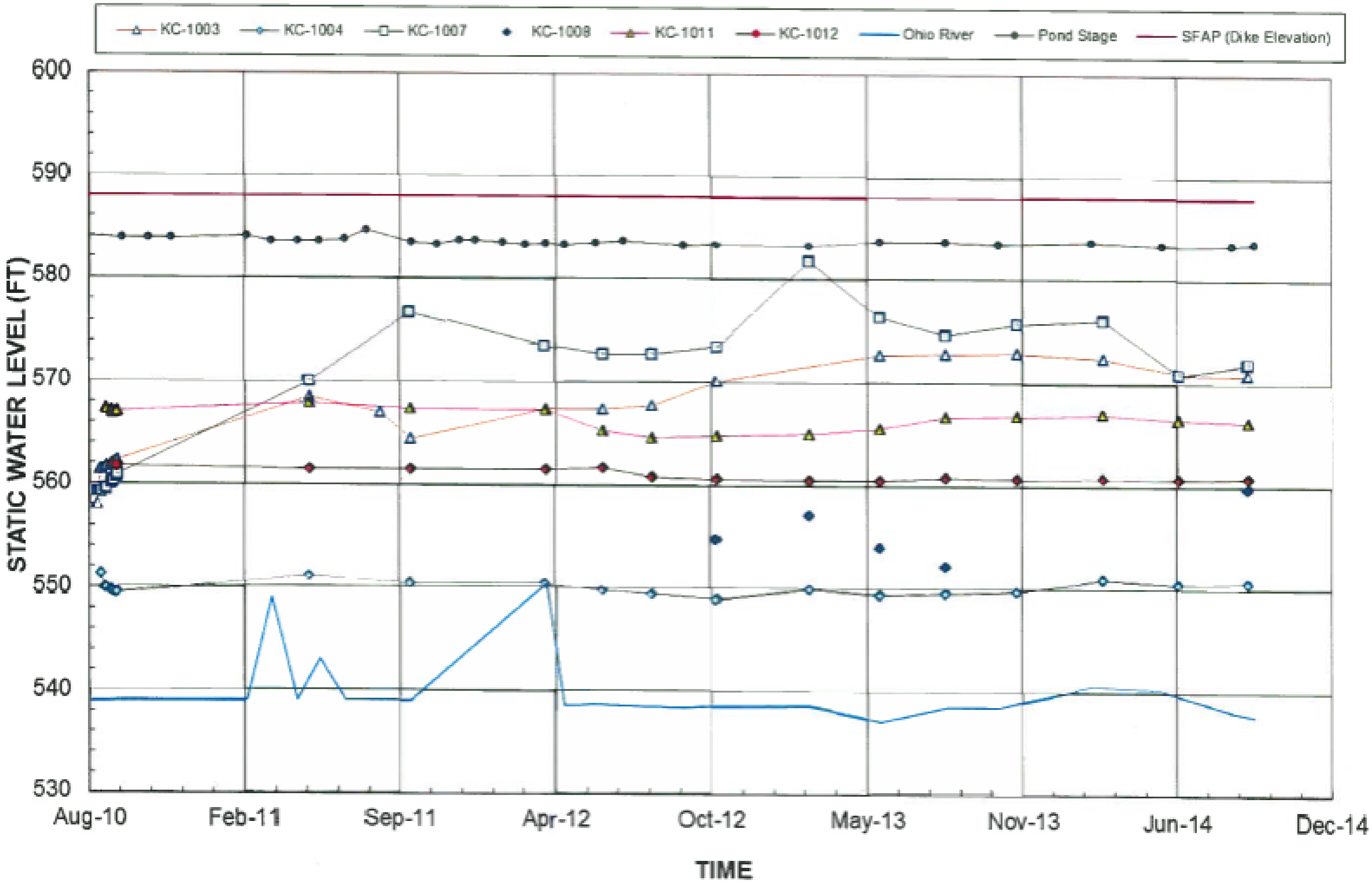


Figure 13 – South Fly Ash Pond Static Water Elevations

Shah Baig, P.E.
Civil/Geotechnical Engineering
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, OH 43215
PH: (614) 716-2241
Audinet: 200-2241

Table 3 - South Fly Ash Pond Static Water Elevations

Dates	Elevation (ft)					
	KC-1003	KC-1004	KC-1007	KC-1008	KC-1011	KC-1012
8/20/2010	558.09	ND	559.23	Dry	ND	ND
8/23/2010	561.35	ND	559.22	Dry	ND	ND
8/25/2010	561.35	ND	559.28	Dry	ND	ND
8/26/2010	561.43	551.24	559.27	Dry	ND	ND
8/30/2010	561.61	549.95	559.51	Dry	567.31	ND
9/1/2010	561.7	549.96	559.58	Dry	567.23	ND
9/7/2010	561.91	549.64	560.15	Dry	567.09	ND
9/8/2010	561.91	549.63	560.2	Dry	566.96	ND
9/9/2010	561.94	549.64	560.26	Dry	566.89	ND
9/10/2010	562.04	549.57	560.34	Dry	566.89	561.77
9/13/2010	562.24	549.49	560.64	Dry	567.07	561.67
9/14/2010	562.21	549.44	560.72	Dry	566.94	561.71
9/15/2010	562.27	549.43	560.83	Dry	567.04	561.75
5/20/2011	568.49	551.09	569.93	Dry	567.89	561.47
8/19/2011	566.94	ND	ND	Dry	ND	ND
9/27/2011	564.37	550.39	576.73	Dry	567.28	561.39
3/20/2012	567.29	550.46	573.48	Dry	567.18	561.42
6/1/2012	567.32	549.74	572.63	Dry	565.27	561.6
8/3/2012	567.68	549.35	572.65	Dry	564.61	560.78
10/25/2012	570.04	548.89	573.43	554.81	564.77	560.57
2/21/2013	ND	549.99	581.71	557.21	564.99	560.47
5/23/2013	572.59	549.34	576.33	554.01	565.49	560.47
8/16/2013	572.69	549.59	574.63	552.21	566.69	560.77
11/15/2013	572.79	549.79	575.63	Dry	566.79	560.67
3/7/2014	572.39	550.99	576.03	Dry	566.99	560.77
6/12/14	570.89	550.49	570.83	Dry	566.49	560.67
9/9/14	570.79	550.59	571.83	559.81	566.19	560.77

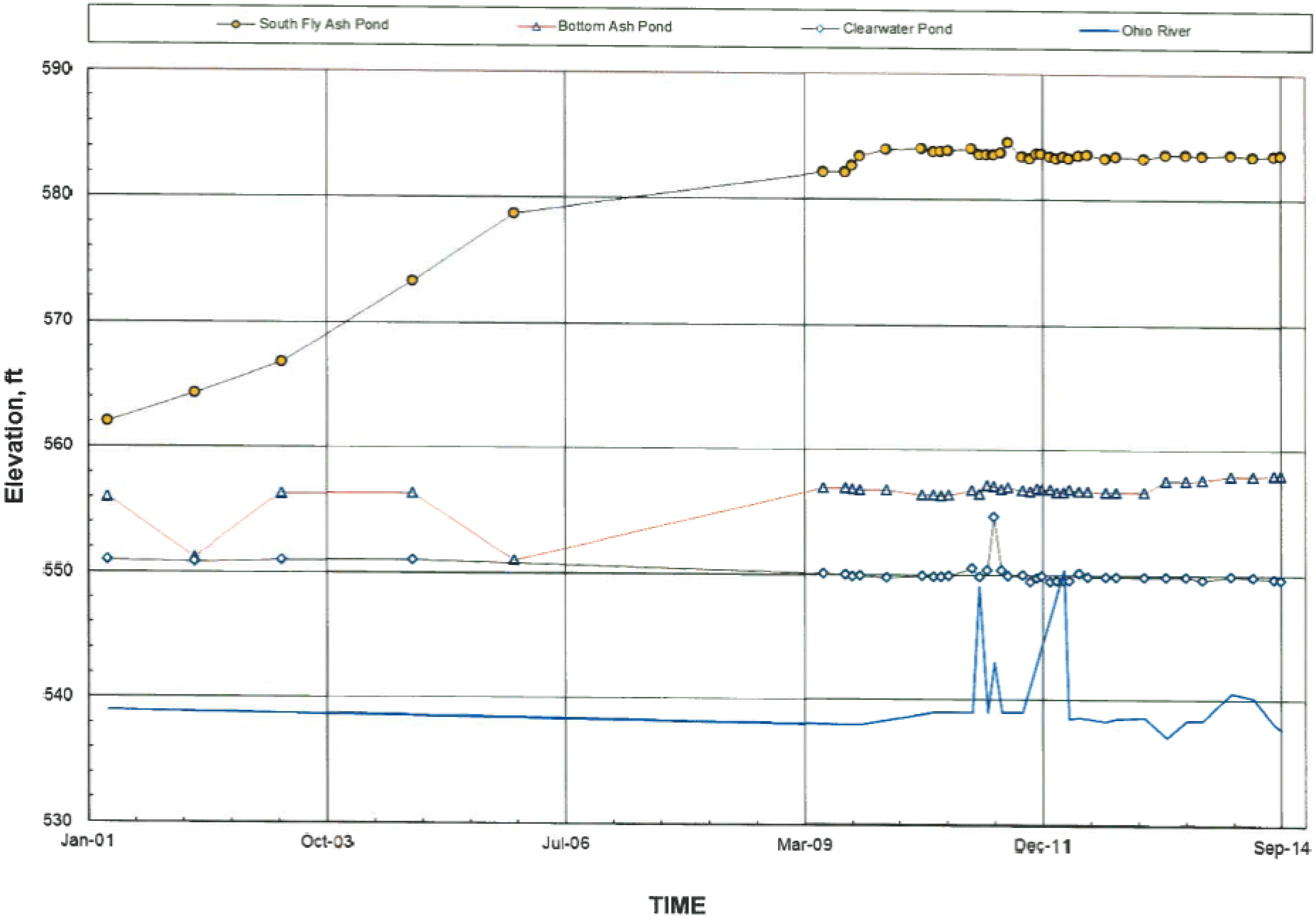
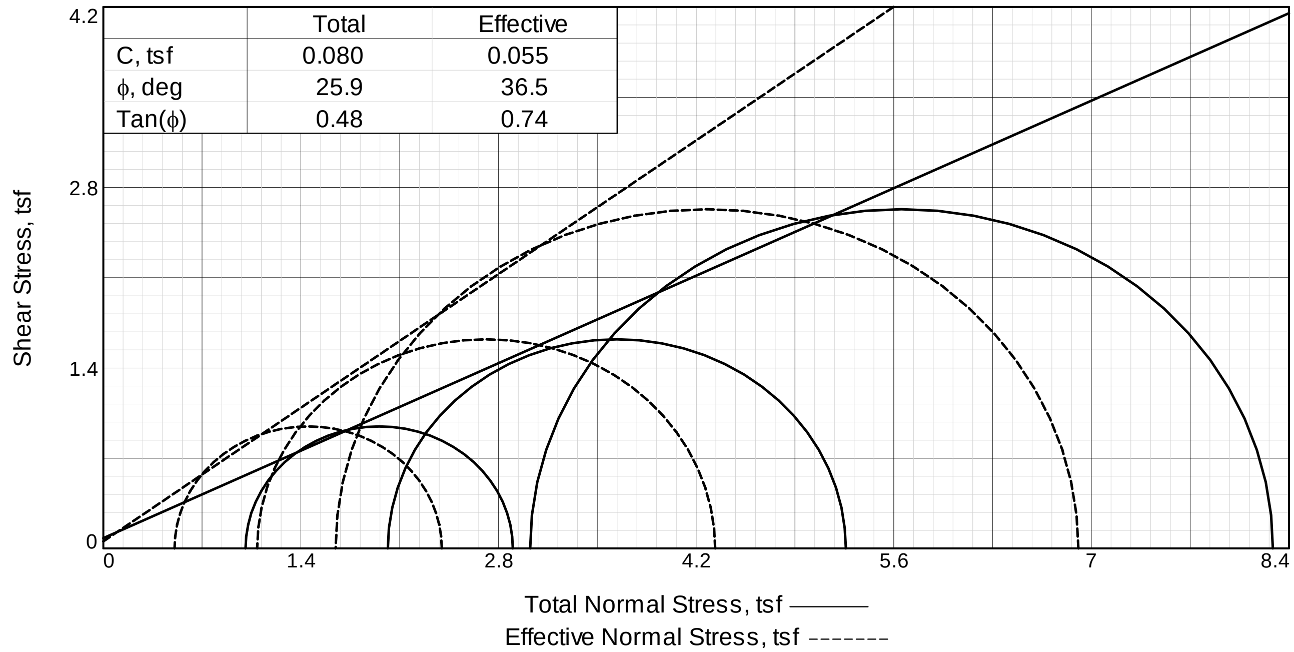
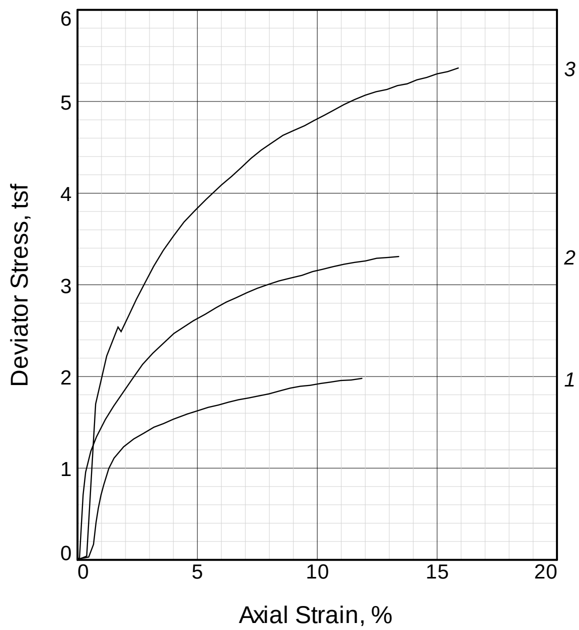


Figure 9 – Ponds Water Elevations



	Total	Effective
C, tsf	0.080	0.055
ϕ, deg	25.9	36.5
Tan(ϕ)	0.48	0.74



Sample No.		1	2	3
Initial	Water Content,	23.0	22.9	22.0
	Dry Density, pcf	101.6	105.5	106.0
	Saturation,	91.8	100.4	98.0
	Void Ratio	0.6899	0.6267	0.6189
	Diameter, in.	2.82	2.83	2.83
	Height, in.	5.53	5.26	5.53
At Test	Water Content,	24.6	21.4	19.6
	Dry Density, pcf	102.5	108.1	111.6
	Saturation,	100.0	100.0	100.0
	Void Ratio	0.6756	0.5884	0.5385
	Diameter, in.	2.81	2.81	2.78
	Height, in.	5.51	5.22	5.43
Strain rate, in./min.		0.01	0.01	0.01
Back Pressure, tsf		1.30	1.30	1.30
Cell Pressure, tsf		2.30	3.31	4.32
Fail. Stress, tsf		1.89	3.24	5.26
Total Pore Pr., tsf		1.80	2.22	2.67
Ult. Stress, tsf		1.98	3.31	5.37
Total Pore Pr., tsf		1.75	2.11	2.59
$\bar{\sigma}_1$ Failure, tsf		2.40	4.33	6.91
$\bar{\sigma}_3$ Failure, tsf		0.50	1.09	1.65

Type of Test:
CU with Pore Pressures

Sample Type: 3" press tube

Description: Light brown lean clay, damp, decreasing moisture with increasing depth, stiff at

LL= 34 **PL=** 20 **PI=** 14

Specific Gravity= 2.75

Remarks: Actual strain rate = 0.0120 in/min.

Figure ________

Client: OVEC/AEP

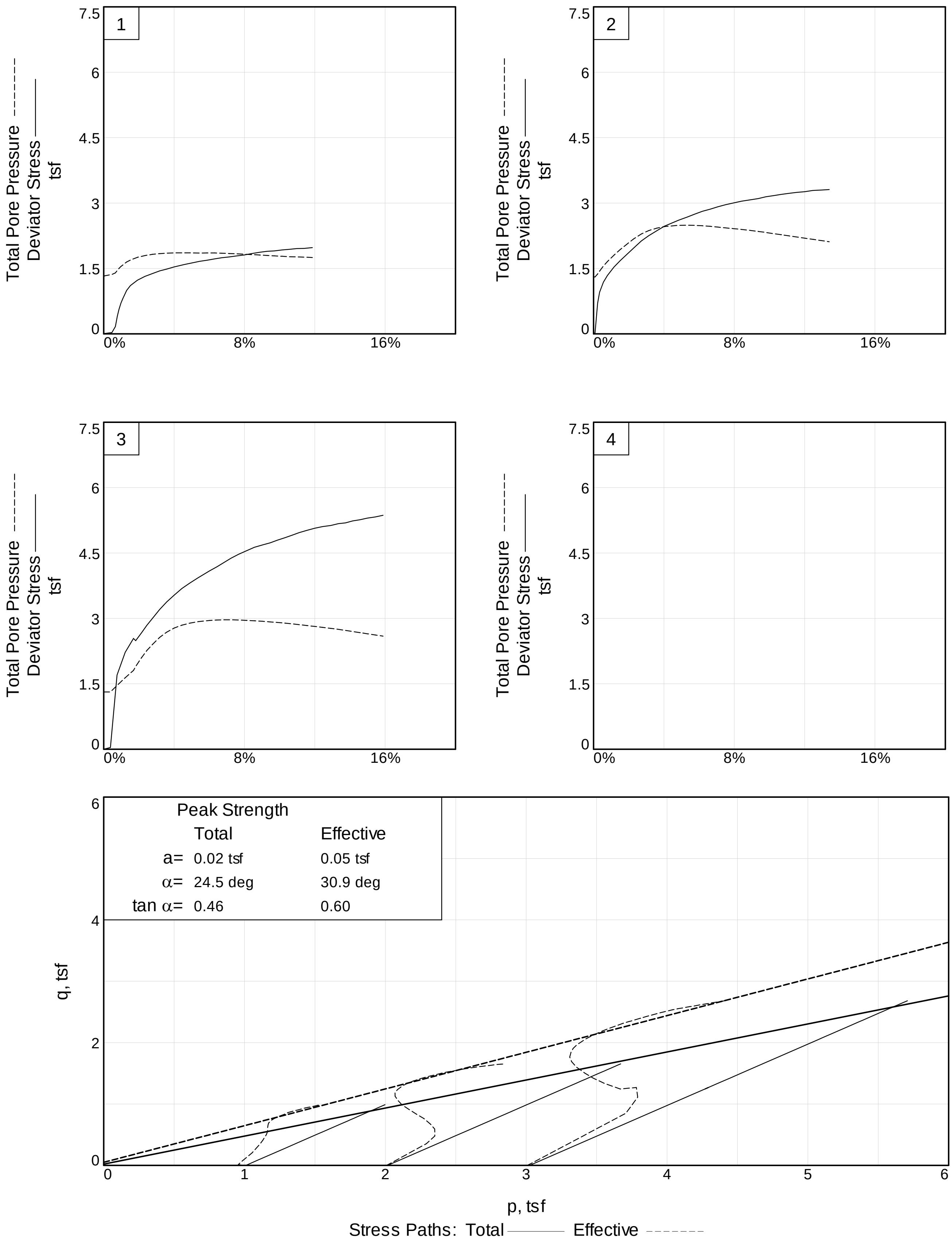
Project: OVEC: Kyger Creek - Ash Inpoundment Stability Analysis
DLZ Project No: 1021-3003.00

Source of Sample: KC-1001 **Depth:** 28.5'-30.0'

Sample Number: ST-2

Proj. No.: 1021-3003.00 **Date:** 9/30/2010

DLZ



Client: OVEC/AEP

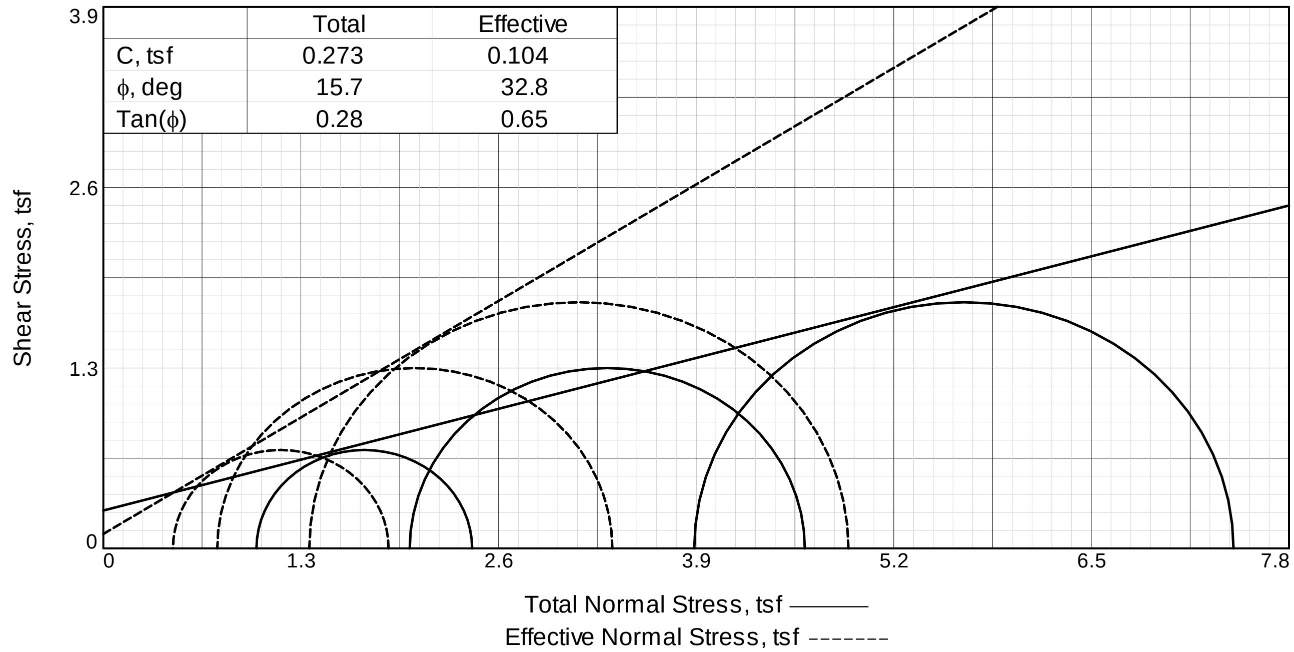
Project: OVEC: Kyger Creek - Ash Inpoundment Stability Analysis

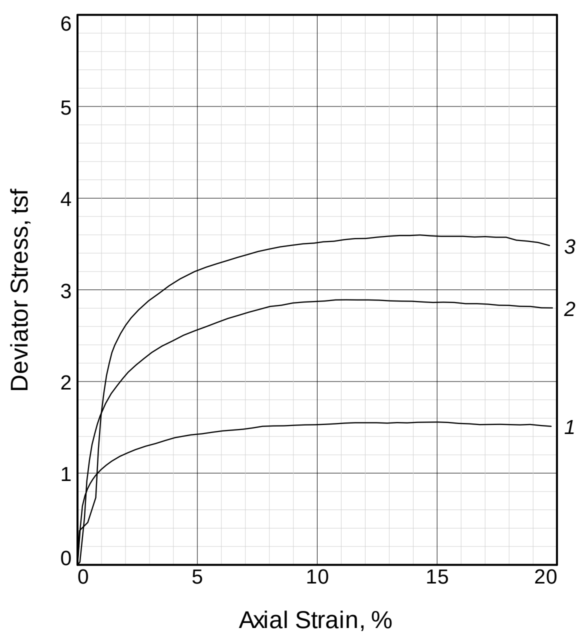
Source of Sample: KC-1001 **Depth:** 28.5'-30.0' **Sample Number:** ST-2

Project No.: 1021-3003.00 **Figure** ________

DLZ, INC.

KYGER CREEK - SUMMARY OF RESULTS OF LABORATORY TESTING																						
								Particle Size Distribution				Atterberg Limits			Percent		Hand	Permea-				
	Cross-section	Boring	Sample			Soil Classification		Percent	Percent	Percent	Percent	Liquid	Plastic	Plasticity	Moisture,	N60	Penetro-	bility	Consolidation-Undrained Parameters			
Location	No.	No.	No.	Depth, ft	Elevation, ft	Textural	USCS	Gravel	Sand	Silt	Clay	Limit, LL	Limit, PL	Index, PI	Wc	N-values	meter,tsf	cm/sec	C, psf	ϕ, degree	C', psf	ϕ', degree
South Fly Ash Pond	1	KC-1001	ST-2	28.5	560.8	Lean Clay	CL	0	8	47	45	34	20	14	23	N/A	2.5		160	25.9	110	36.5
South Fly Ash Pond	1	KC-1001	S-17	46	543.3	Lean Clay	CL	0	8	58	34	34	20	14	29.5	5	1.5					
South Fly Ash Pond	1	KC-1001	S-19	53.5	535.8	Sand with gravel	SW	42	56	3	0		Non-plastic		8.9	59	N/A					
South Fly Ash Pond	1	KC-1002	ST-1	8.5	549.8	Sandy Lean Clay	CL	0	16	52	32	32	13	19	25.8	N/A	--					
South Fly Ash Pond	1	KC-1002	S-15	33.5	525.3	Sand with silt with gravel	SW-SM	45	47	8	0		Non-plastic		9.9	56	N/A					
South Fly Ash Pond	1	KC-1002	S-19	43.5	514.8	Sand with silt with gravel	SP-SM	18	75	7	0		Non-plastic		16.5	19	N/A					
South Fly Ash Pond	1	KC-1002	S-21	48.5	509.8	Sand	SW	4	96	0	0		Non-plastic		19.7	23	N/A					
South Fly Ash Pond	2	KC-1003	S-7	16	572.4	Lean Clay	CL	0	24	45	31	30	18	12	19.5	11	2.25					
South Fly Ash Pond	2	KC-1003	ST-2	31	557.4	Lean Clay	CL	0	17	47	36	31	18	13	18.6	N/A	4	1.8x10-7				
South Fly Ash Pond	2	KC-1003	S-19	53.5	534.9	Lean Clay with sand	CL	0	17	50	33	31	21	10	33.7	4	0.5					
South Fly Ash Pond	2	KC-1004	S-8	16	539.8	Lean Clay with sand	CL	0	20	51	29	32	19	13	28.3	1	0.75					
South Fly Ash Pond	2	KC-1004	S-12	26	529.3	Sand with silt with gravel	SW-SM	40	54	6	0		Non-plastic		10.8	69	N/A					
South Fly Ash Pond	2	KC-1004	S-15	33.5	521.8	Sand with gravel	SW	33	65	2	0		Non-plastic		14.9	16	N/A					
South Fly Ash Pond	3	KC-1005	ST-2	18.5	569.7	Lean Clay	CL	0	13	48	39	37	21	16	21	N/A	4	4.5x10-8				
South Fly Ash Pond	3	KC-1005	S-18	48.5	540.2	Sandy Silty Clay	CL-ML	0	30	46	24	25	21	4	25.3	4	0.25					
South Fly Ash Pond	3	KC-1005	S-19	53.5	534.7	Silty Clay with sand	CL-ML	0	26	51	23	26	19	7	32.1	2	0.25					
South Fly Ash Pond	3	KC-1006	S-7	13.5	563.4	Lean Clay	CL	0	10	42	48	41	21	20	24.2	10	2.5					
South Fly Ash Pond	3	KC-1006	S-14	31	545.4	Lean Clay with sand	CL	0	20	45	35	48	20	28	23.2	12	1.5					
South Fly Ash Pond	4	KC-1007	S-7	16	573	Lean Clay	CL	0	13	44	43	39	22	17	24.9	13	3.00					
South Fly Ash Pond	4	KC-1007	S-19	46	543.5	Lean Clay with sand	CL	0	22	52	26	28	18	10	26	7	0.5					
South Fly Ash Pond	4	KC-1007	S-23	63.5	526	Sand with silt with gravel	SW-SM	33	58	9	0		Non-plastic			64	N/A					
South Fly Ash Pond	4	KC-1008	S-5	6	574.9	Lean Clay	CL	0	5	53	42	40	22	17	24.4	17	3.5					
South Fly Ash Pond	4	KC-1008	S-11	21	559.9	Lean Clay	CL	0	6	47	47	41	22	19	24.5	14	3.5					
South Fly Ash Pond	4	KC-1008	S-18	38.5	542.4	Sandy Lean Clay	CL	0	35	43	22	24	16	8	25.5	6	0.5					
South Fly Ash Pond	5	KC-1009	ST-1	16	573.2	Lean Clay	CL	0	29	36	35	32	18	14	21.5	N/A	2.25	1.9x10-8				
South Fly Ash Pond	5	KC-1009	ST-2	26	563.2	Lean Clay	CL	0	7	52	41	38	22	16	22.9	N/A	4					
South Fly Ash Pond	5	KC-1009	S-19	53.5	535.7	Sandy Lean Clay	CL	0	31	45	24	28	20	8	27.4	4	0.5					
South Fly Ash Pond	5	KC-1010	S-5	6	559.1	Lean Clay with sand	CL	0	4	58	38	36	20	16	22.8	10	1.75					
South Fly Ash Pond	5	KC-1010	S-11	23.5	541.6	Sandy Lean Clay	CL	0	44	35	20	24	18	6	25.2	5	0.5					
South Fly Ash Pond	5	KC-1010	ST-2	31	534.1	Sandy Lean Clay	CL	0	31	50	19	29.4	26	18	8	N/A	0.75	1.8x10-7				
South Fly Ash Pond	5	KC-1010	S-16	41	524.1	Gravel	Gw	54	43	3	0		Non-plastic		11.5	47	N/A					
South Fly Ash Pond	5	KC-1010	S-17	43.5	521.6	Sand with silt with gravel	SW-SM	23	70	7	0		Non-plastic		13.9	23	N/A					
South Fly Ash Pond	6	KC-1011	S-5	11	578.2	Lean Clay	CL	0	11	55	34	34	20	14	22.2	8	2.00					
South Fly Ash Pond	6	KC-1011	S-16	38.5	550.7	Lean Clay with sand	CL	0	15	51	34	33	19	14	26.4	8	1.25					
South Fly Ash Pond	6	KC-1011	S-20	48.5	540.7	Sandy Silt	ML	0	42	38	20		Non-plastic		29.7	2	N/A					
South Fly Ash Pond	6	KC-1011	S-23	63.5	525.7	Sand with silt with gravel	SW-SM	20	68	12	0		Non-plastic		13.7	25	N/A					
South Fly Ash Pond	6	KC-1011	S-24	68.5	520.7	Sand with silt with gravel	SP-SM	15	79	6	0		Non-plastic		17.5	16	N/A					
South Fly Ash Pond	6	KC-1012	S-5	6	557	Lean Clay with sand	CL	0	1	56	43	41	22	19	25.3	10	2.00					
South Fly Ash Pond	6	KC-1012	ST-2	21	542	Sandy Lean Clay	CL	0	35	43	22	26	19	7	25.7	N/A	--		546	15.7	208	32.8
South Fly Ash Pond	6	KC-1012	S-13	33.5	529.5	Sandy Gravel	GP	59	37	4	0		Non-plastic		13.9	27	N/A					
Bottom Ash Pond	1	KC-1013	S-5	11	570.3	Lean Clay with sand	CL	2	8	52	38	37	21	16	25.9	7	3					
Bottom Ash Pond	1	KC-1013	S-18	48.5	532.8	Sandy Lean Clay	CL	0	23	47	30	30	18	12	28	7	0.75					
Bottom Ash Pond	1	KC-1013	S-19	53.5	527.8	Sandy Silt	ML	0	44	36	20		Non-plastic			2	N/A					
Bottom Ash Pond	1	KC-1014	ST-1	11	547.6	Lean Clay	CL	0	2	57	41	40	22	18	25.7	N/A	2.25	2.2x10^{-8}				
Bottom Ash Pond	1	KC-1014	S-13	31	527.6	Sandy Lean Clay	CL	0	32	43	25	25	16	9	26.9	5	0.25					
Bottom Ash Pond	1	KC-1014	S-16	38.5	520.1	Gravel with silt with sand	GW-GM	52	42	6	0		Non-plastic		8.7	60	N/A					
Bottom Ash Pond	2	KC-1015	S-6	13.5	566.9	Sandy Lean Clay	CL	0	12	54	34	34	20	14	21.1	11	2.75					
Bottom Ash Pond	2	KC-1015	S-16	46	534.4	Sandy Lean Clay	CL	0	32	44	24	28	19	9	25.5	1	0.5					
Bottom Ash Pond	2	KC-1015	S-19	58.5	521.9	Sand with silt with gravel	SW-SM	43	51	6	0		Non-plastic		13.4	40	N/A					
Bottom Ash Pond	2	KC-1016	ST-1	8.5	535.3	Lean Clay with sand	CL	0	1	54	45	40	22	18	34.4	N/A	--		356	16.2	276	32.2
Bottom Ash Pond	2	KC-1016	S-12	26	517.8	Sand with silt with gravel	SW-SM	34	60	6	0		Non-plastic		16.1	19	N/A					
Bottom Ash Pond	2	KC-1016	S-13	28.5	515.3	Gravel with sand	GW	53	44	3	0		Non-plastic		10.8	16	N/A					
Clearwater Pond	3	KC-1017	ST-1	18.5	561.6	Sandy Lean Clay	CL	0	23	46	31	29	18	11	22.4	N/A	1.5		356	20.3	216	37.2
Clearwater Pond	3	KC-1017	S-15	41	539.1	Lean Clay	CL	0	3	51	46	42	25	17	31.9	7	1					
Clearwater Pond	3	KC-1017	S-19	53.5	526.6	Sandy Lean Clay	CL	0	18	54	28	33	20	13	27.3	1	0.75					
Clearwater Pond	3	KC-1018	ST-1	8.5	538.8	Lean Clay	CL	0	4	53	43	44	24	20	21.8	N/A	4.5	9.3x10^{-6}				
Clearwater Pond	3	KC-1018	S-9	18.5	529.3	Lean Clay	CL	0	5	63	32	36	21	15	30.5	0	0.25					
Clearwater Pond	3	KC-1018	S-13	31	516.3	Sandy Silt	ML	0	48	39	13		Non-plastic		33	5	N/A					
Clearwater Pond	3	KC-1018	S-14	33.5	513.8	Sand with silt	SW-SM	1	88	11	0		Non-plastic		21.7	5	N/A					
Clearwater Pond	3	KC-1018	S-16	38.5	508.8	Gravel with silt with sand	GP-GM	52	38	10	0		Non-plastic		16.3	13	N/A					
Clearwater Pond	3	KC-1018	S-19	46	501.3	Sand with gravel	SW	38	59	3	0		Non-plastic		12.9	19	N/A					
Clearwater Pond	4	KC-1019	S-8	21	559.7	Lean Clay	CL	0	13	51	36	33	20	13	23.9	8	1.25					
Clearwater Pond	4	KC-1019	ST-2	26	554.7	Sandy Silt	ML	0	38	38	24	21	18	3	22	N/A	0	3.3x10^{-4}				
Clearwater Pond	4	KC-1019	S-19	53.5	527.2	Sand with silt	SP-SM	0	90	10	0		Non-plastic		26.9	11	N/A					
Clearwater Pond	4	KC-1020	S-5	6	553.5	Lean Clay	CL	0	7	58	35	38	22	17	23.1	7	2					
Clearwater Pond	4	KC-1020	S-7	16	543.5	Sandy Lean Clay	CL	0	19	54	27	32	20	12	23.7	6	1					
Clearwater Pond	4	KC-1020	S-12	28.5	531	Sandy Lean Clay	CL	0	30	46	24	28	17	11	25.4	1	1					
Clearwater Pond	4	KC-1020	S-14	36	523.5	Silty Sand	SM	0	86	14	0		Non-plastic		28.6	7	N/A					
Bottom Ash Pond	5	KC-1021	ST-1	18.5	561.7	Sandy Lean Clay	CL	0	21	46	33	32	20	12	21.4	N/A	2.5	8x10^{-8}				
Bottom Ash Pond	5	KC-1021	S-15	41	539.2	Sandy Lean Clay	CL	0	34	46	20	28	19	9	25.6	0	0.75					
Bottom Ash Pond	5	KC-1021	S-20	58.5	521.7	Silty Sand	SM	0	87	13	0		Non-plastic		27.8	13	N/A					
Bottom Ash Pond	5	KC-1022	S-4	4.5	558.2	Sandy Silty Clay	CL-ML	0	41	40	19	22	18	4	15.2	13	1					
Bottom Ash Pond	5	KC-1022	S-7	16	546.7	Sandy Lean Clay	CL	0	40	38	22	25	17	8	18.1	6	1.5					
Bottom Ash Pond	5	KC-1022	S-13	33.5	529.2	Silty Sand	SM	0	81	19	0		Non-plastic		29.6	2	N/A					
Bottom Ash Pond	5	KC-1022	S-14	36	526.7	Silty Sand	SM	0	75	25			Non-plastic		26.6	8	N/A					





Sample No.		1	2	3
Initial	Water Content,	28.6	28.6	28.6
	Dry Density, pcf	96.3	96.0	96.4
	Saturation,	100.6	99.8	100.7
	Void Ratio	0.7826	0.7884	0.7818
	Diameter, in.	2.85	2.84	2.84
	Height, in.	5.53	5.27	5.48
At Test	Water Content,	25.2	25.9	22.4
	Dry Density, pcf	101.4	100.2	106.3
	Saturation,	100.0	100.0	100.0
	Void Ratio	0.6925	0.7128	0.6147
	Diameter, in.	2.79	2.80	2.76
	Height, in.	5.48	5.19	5.25
Strain rate, in./min.		0.01	0.01	0.01
Back Pressure, tsf		2.59	2.59	2.59
Cell Pressure, tsf		3.60	4.61	6.48
Fail. Stress, tsf		1.42	2.60	3.55
Total Pore Pr., tsf		3.14	3.86	5.12
Ult. Stress, tsf		1.42	2.60	3.55
Total Pore Pr., tsf		3.14	3.86	5.12
$\overline{\sigma}_1$ Failure, tsf		1.88	3.35	4.90
$\overline{\sigma}_3$ Failure, tsf		0.46	0.75	1.36

Type of Test:
CU with Pore Pressures

Sample Type: 3" press tube

Description:

Specific Gravity= 2.75

Remarks: Actual strain rate = 0.0120 in/min

Figure ________

Client: OVEC/AEP

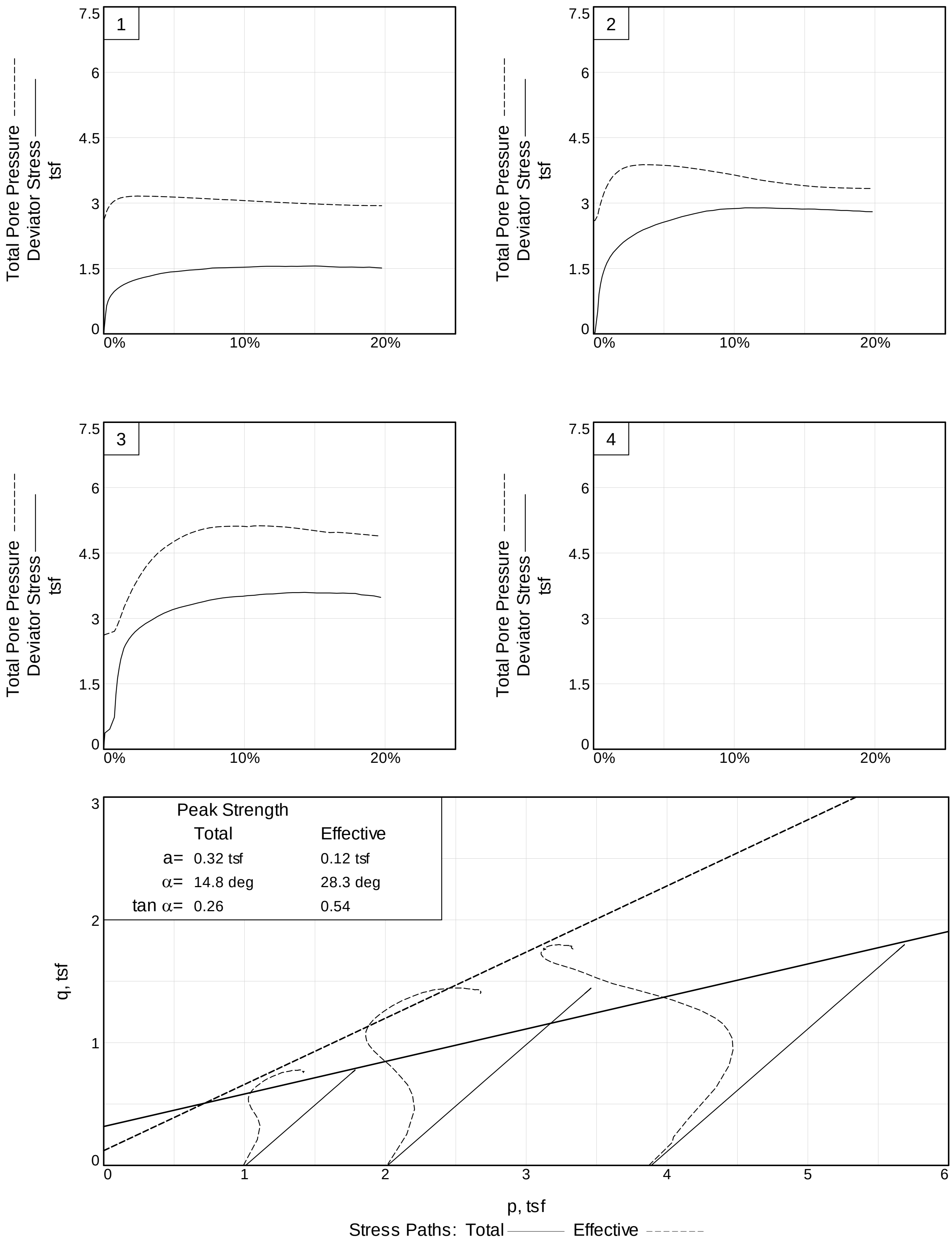
Project: OVEC: Kyger Creek - Ash Inpoundment Stability Analysis
DLZ Project No: 1021-3003.00

Source of Sample: KC-1012 **Depth:** 21.0'-23.0'

Sample Number: ST-2

Proj. No.: 1021-3003.00 **Date:**

DLZ



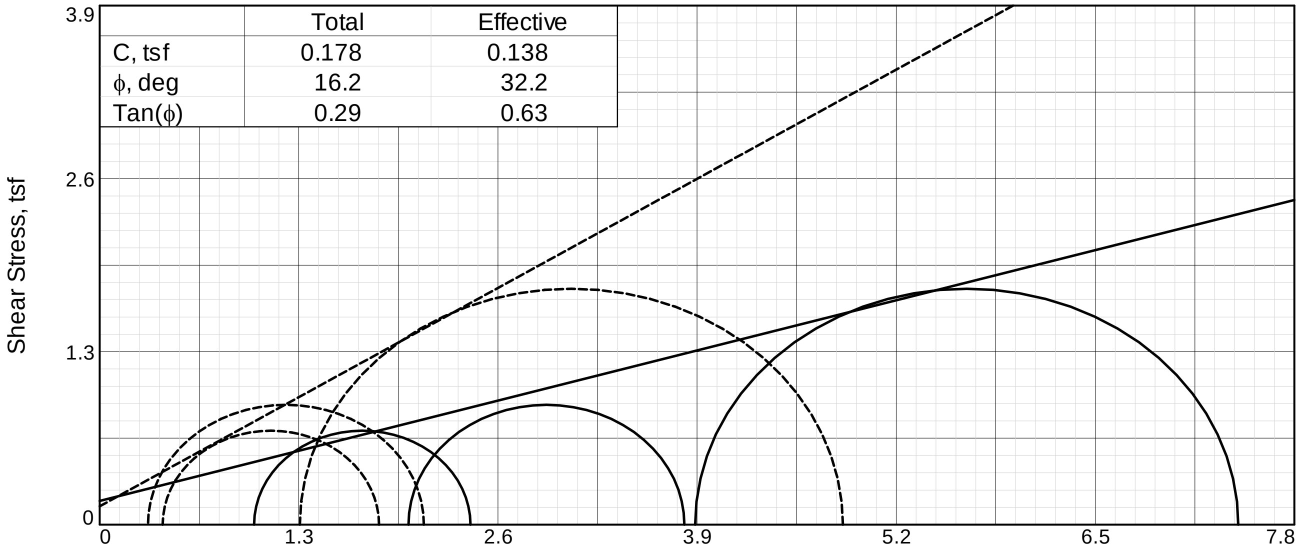
Client: OVEC/AEP

Project: OVEC: Kyger Creek - Ash Inpoundment Stability Analysis

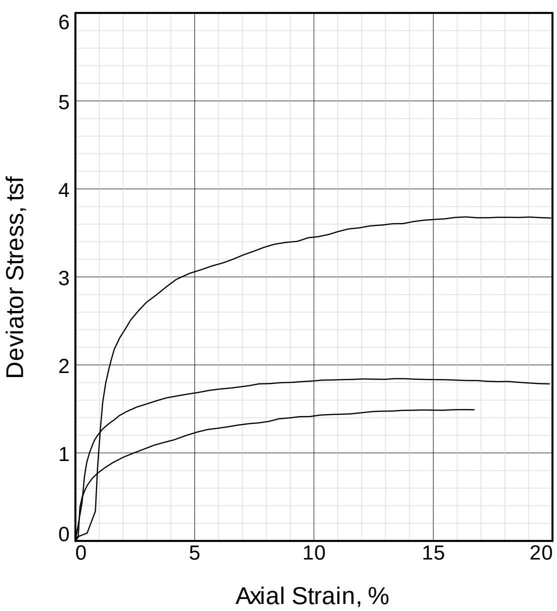
Source of Sample: KC-1012 **Depth:** 21.0'-23.0' **Sample Number:** ST-2

Project No.: 1021-3003.00 **Figure** ________

DLZ, INC.



	Total	Effective
C, tsf	0.178	0.138
ϕ, deg	16.2	32.2
Tan(ϕ)	0.29	0.63



	Sample No.	1	2	3
Initial	Water Content,	35.1	35.5	30.8
	Dry Density, pcf	87.6	86.8	92.3
	Saturation,	100.5	99.8	98.4
	Void Ratio	0.9607	0.9784	0.8607
	Diameter, in.	2.82	2.83	2.83
	Height, in.	5.52	5.50	5.44
At Test	Water Content,	31.6	30.4	26.5
	Dry Density, pcf	91.8	93.5	99.3
	Saturation,	100.0	100.0	100.0
	Void Ratio	0.8692	0.8371	0.7288
	Diameter, in.	2.76	2.75	2.77
	Height, in.	5.46	5.43	5.28
	Strain rate, in./min.	0.01	0.01	0.01
	Back Pressure, tsf	2.59	2.59	2.59
	Cell Pressure, tsf	3.60	4.61	6.48
	Fail. Stress, tsf	1.41	1.80	3.55
	Total Pore Pr., tsf	3.19	4.29	5.17
	Ult. Stress, tsf	1.41	1.80	3.55
	Total Pore Pr., tsf	3.19	4.29	5.17
	$\bar{\sigma}_1$ Failure, tsf	1.82	2.12	4.85
	$\bar{\sigma}_3$ Failure, tsf	0.41	0.32	1.31

Type of Test:
CU with Pore Pressures

Sample Type: 3" press tube

Description: Light brown lean clay (CL) Very stiff @ top & middle to stiff @ bottom, damp

LL= 40 **PL=** 22 **PI=** 18

Assumed Specific Gravity= 2.75

Remarks: Actual strain rate = 0.055 in/min.
Hand Penetrometer: Top = 2.25 TSF
Middle = 2.50 TSF
Bottom = 1.25 TSF

Figure ________

Client: OVEC/AEP

Project: OVEC: Kyger Creek - Ash Inpoundment Stability Analysis
DLZ Project No: 1021-3003.00

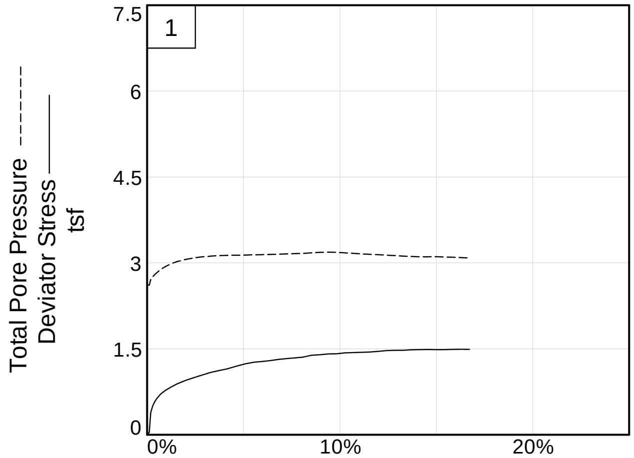
Source of Sample: KC-1016 **Depth:** 8.5'-10.5'

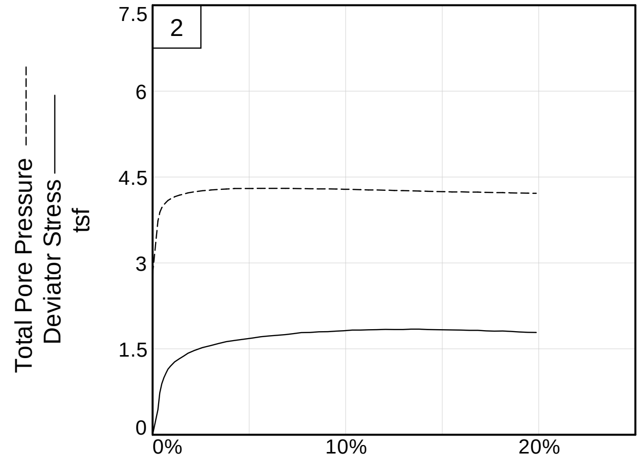
Sample Number: ST-1

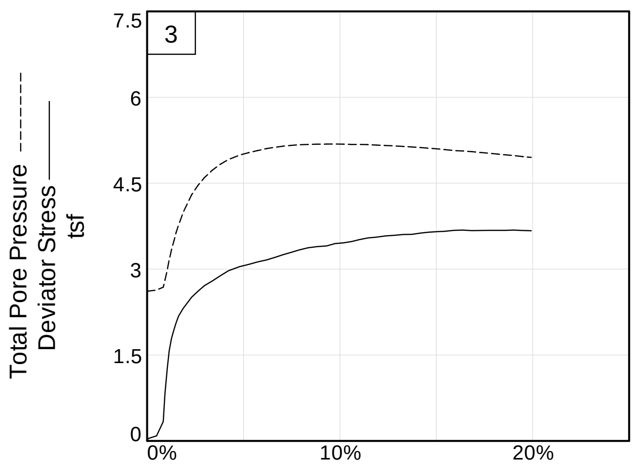
Proj. No.: 1021-3003.00 **Date:** 10/16/2010

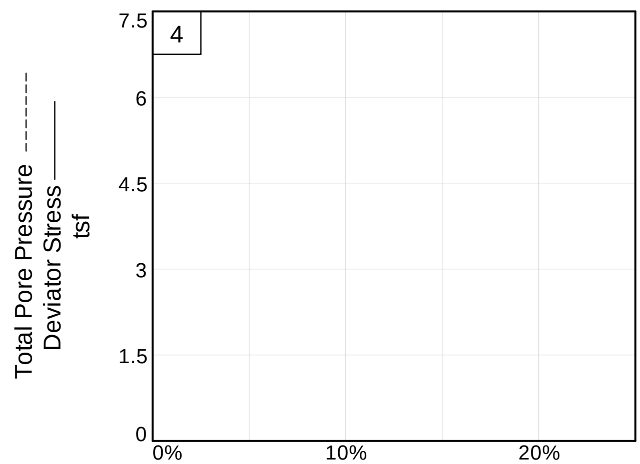
DLZ

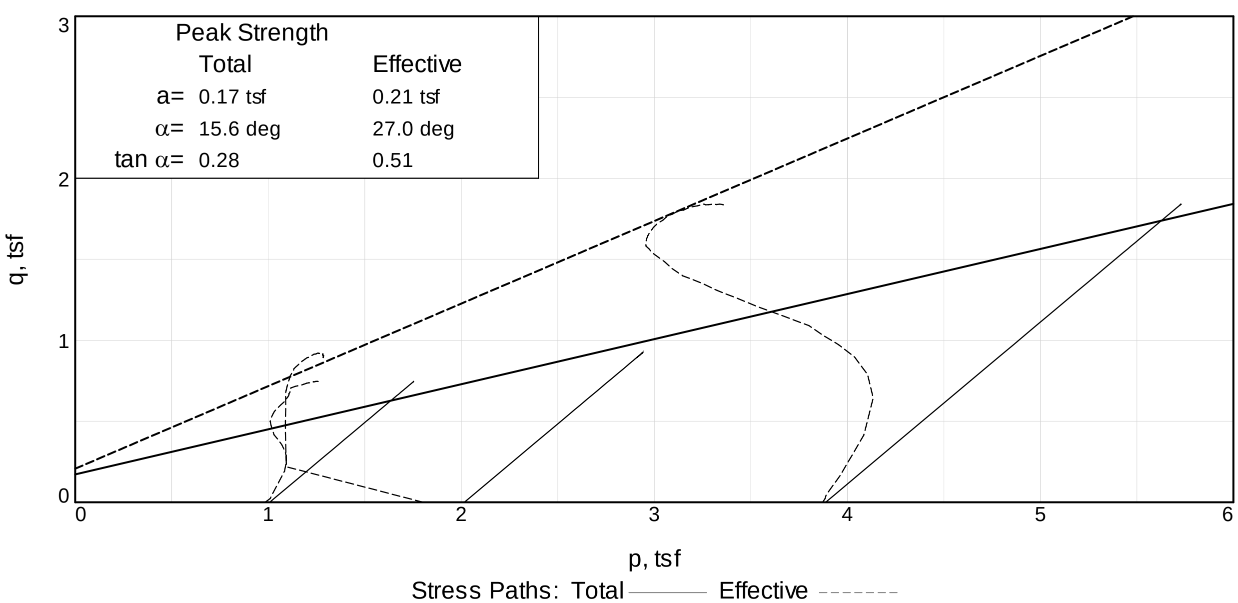
Tested By: Justin Bukey **Checked By:** Barry Wong











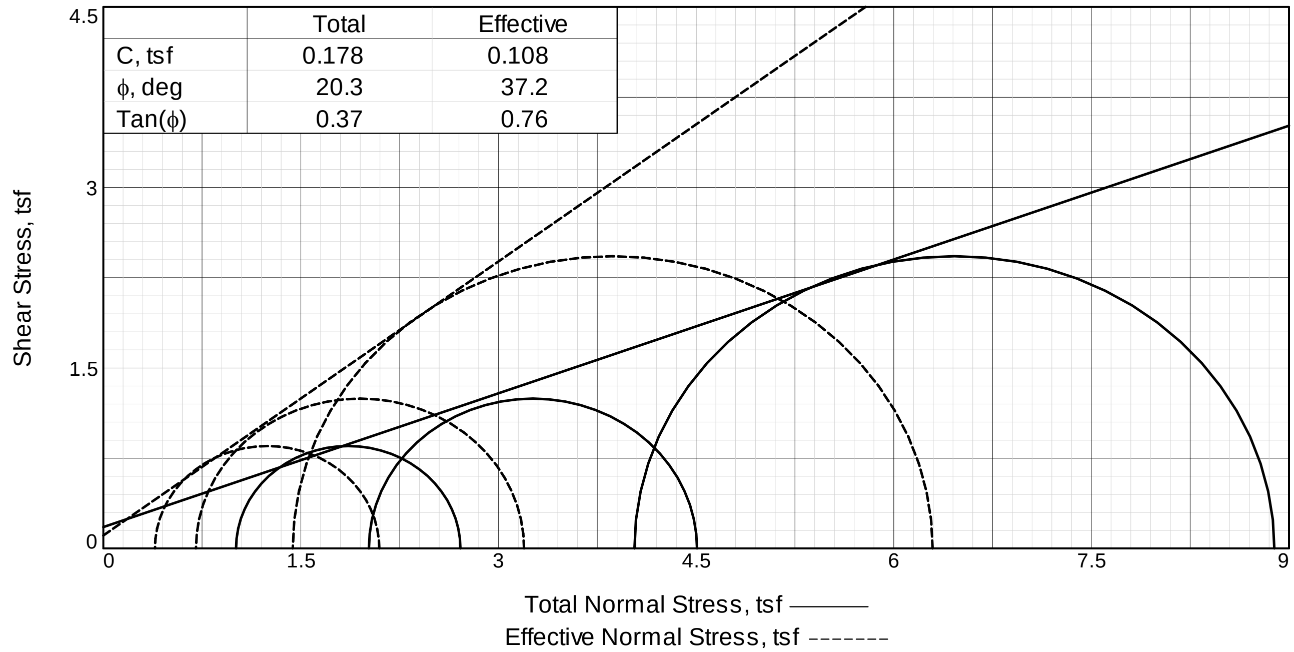
Client: OVEC/AEP

Project: OVEC: Kyger Creek - Ash Inpoundment Stability Analysis

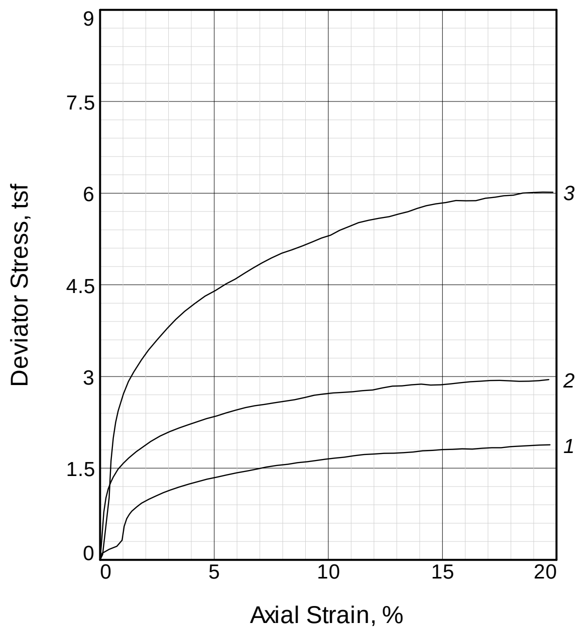
Source of Sample: KC-1016 **Depth:** 8.5'-10.5' **Sample Number:** ST-1

Project No.: 1021-3003.00 **Figure** ________ **DLZ, INC.**

Tested By: Justin Bukey **Checked By:** Barry Wong



	Total	Effective
C, tsf	0.178	0.108
ϕ, deg	20.3	37.2
Tan(ϕ)	0.37	0.76



Sample No.		1	2	3
Initial	Water Content,	22.4	22.4	22.0
	Dry Density, pcf	104.2	102.6	106.9
	Saturation,	95.1	91.6	99.6
	Void Ratio	0.6483	0.6730	0.6061
	Diameter, in.	2.84	2.84	2.84
	Height, in.	5.53	5.57	5.56
At Test	Water Content,	21.9	22.4	17.7
	Dry Density, pcf	107.1	106.1	115.4
	Saturation,	100.0	100.0	100.0
	Void Ratio	0.6032	0.6174	0.4873
	Diameter, in.	2.80	2.80	2.74
	Height, in.	5.52	5.52	5.50
Strain rate, in./min.		0.01	0.01	0.01
Back Pressure, tsf		2.59	2.59	2.59
Cell Pressure, tsf		3.60	4.61	6.62
Fail. Stress, tsf		1.70	2.49	4.86
Total Pore Pr., tsf		3.21	3.90	5.19
Ult. Stress, tsf		1.83	2.85	5.82
Total Pore Pr., tsf		3.09	3.73	4.94
$\overline{\sigma}_1$ Failure, tsf		2.10	3.19	6.30
$\overline{\sigma}_3$ Failure, tsf		0.39	0.70	1.44

Type of Test:
CU with Pore Pressures

Sample Type: 3" press tube

Description: Light brown lean clay with sand, damp to moist, little to some very fine sand, medium stiff

LL= 29 **PL=** 18 **PI=** 11

Specific Gravity= 2.75

Remarks: Actual strain rate = 0.0120 in/min.

Figure ________

Client: OVEC/AEP

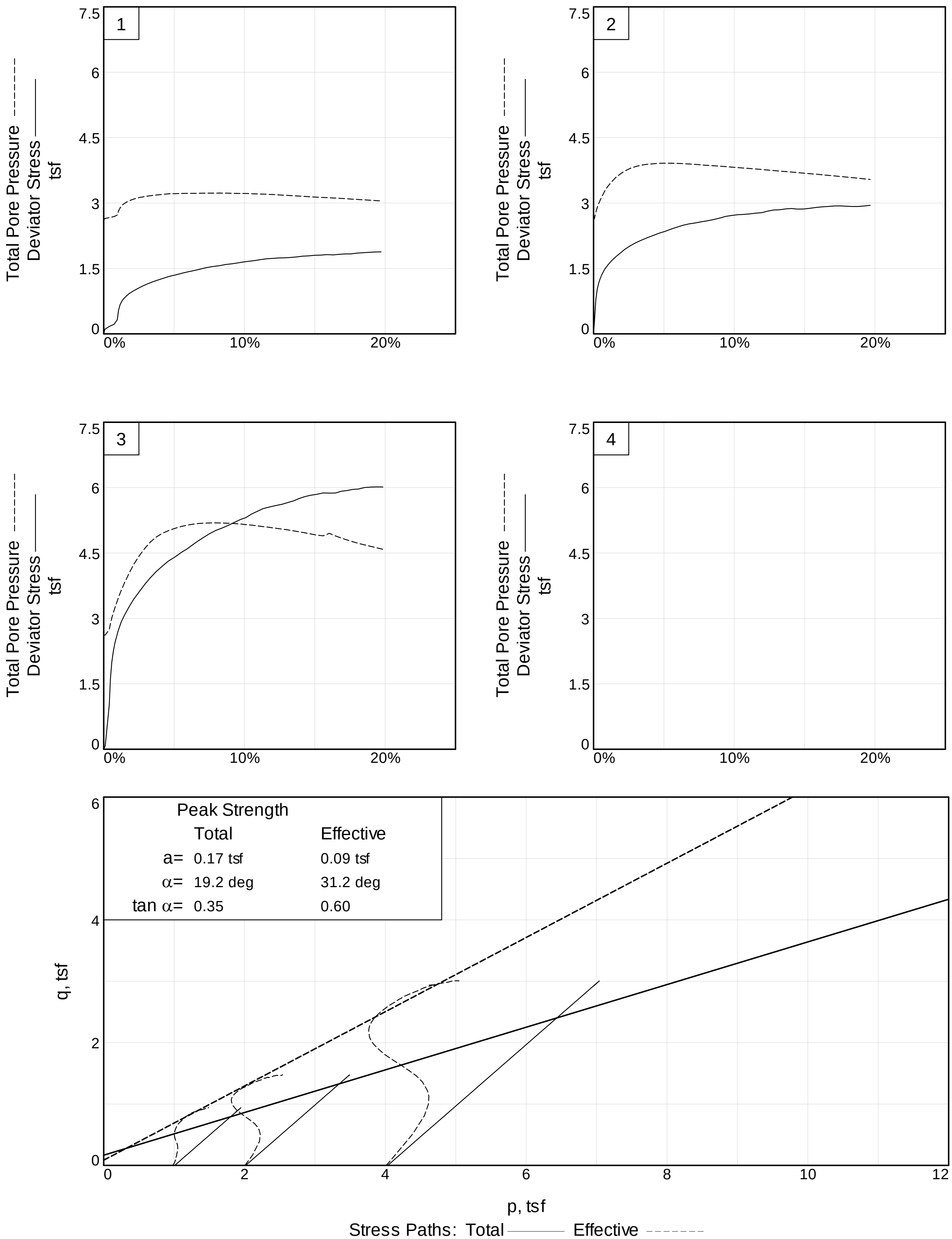
Project: OVEC: Kyger Creek - Ash Inpoundment Stability Analysis
DLZ Project No: 1021-3003.00

Source of Sample: KC-1017 **Depth:** 18.5'-20.5'

Sample Number: ST-1

Proj. No.: 1021-3003.00 **Date:** 10/4/2010

DLZ



Client: OVEC/AEP

Project: OVEC: Kyger Creek - Ash Inpoundment Stability Analysis

Source of Sample: KC-1017 **Depth:** 18.5'-20.5' **Sample Number:** ST-1

Project No.: 1021-3003.00 **Figure** ________

DLZ, INC.

APPENDIX V

Exhibit 6 – USGS 2014 Seismic Hazard Map for the United States and Detailed Calculations of Seismic Coefficient

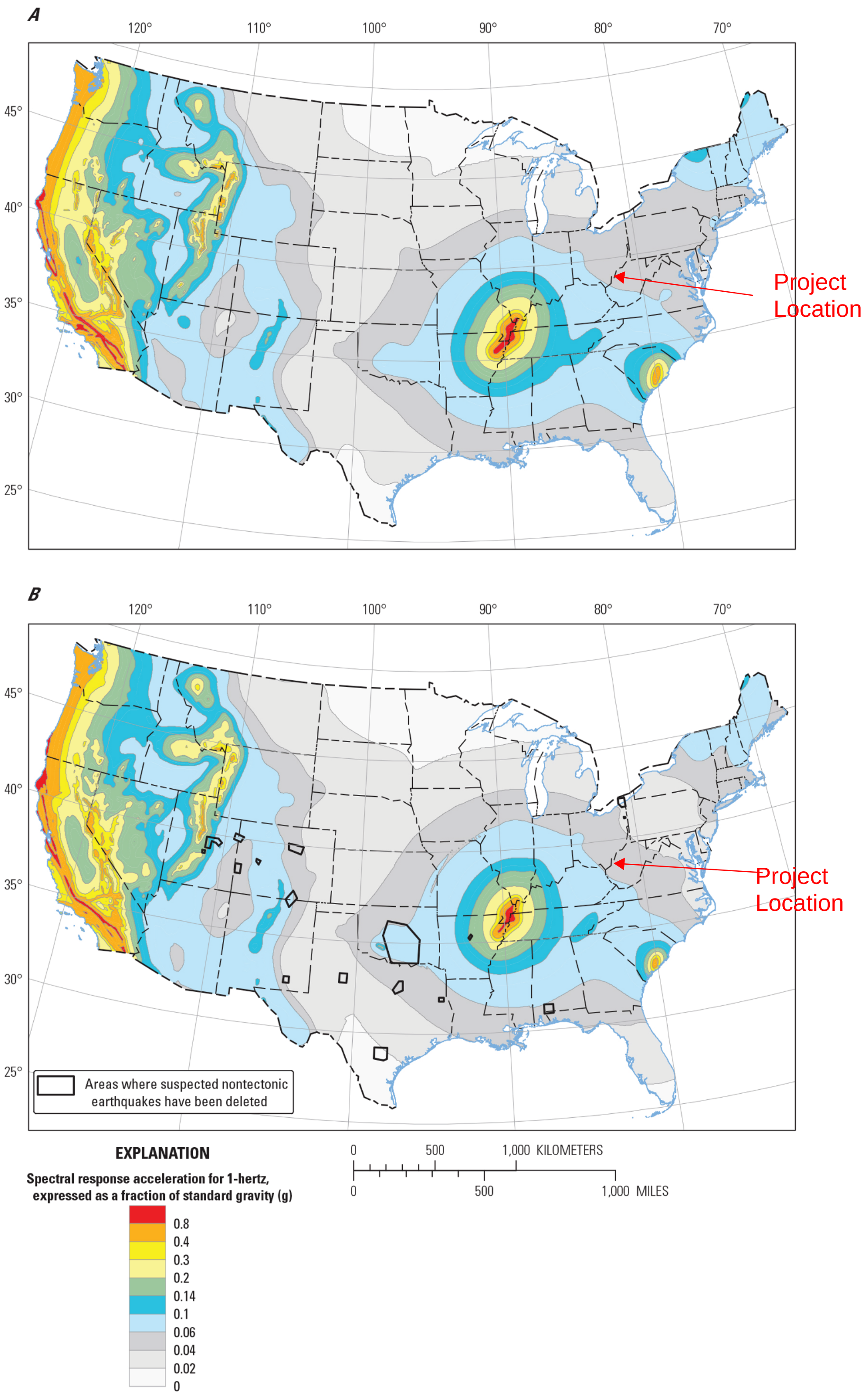


Figure 3. Maps showing 1-hertz (1-second) spectral acceleration for 2-percent probability of exceedance in 50 years and V_{S30} site condition of 760 meters per second. *A*, 2008 version of the national seismic hazard maps and *B*, 2014 version.

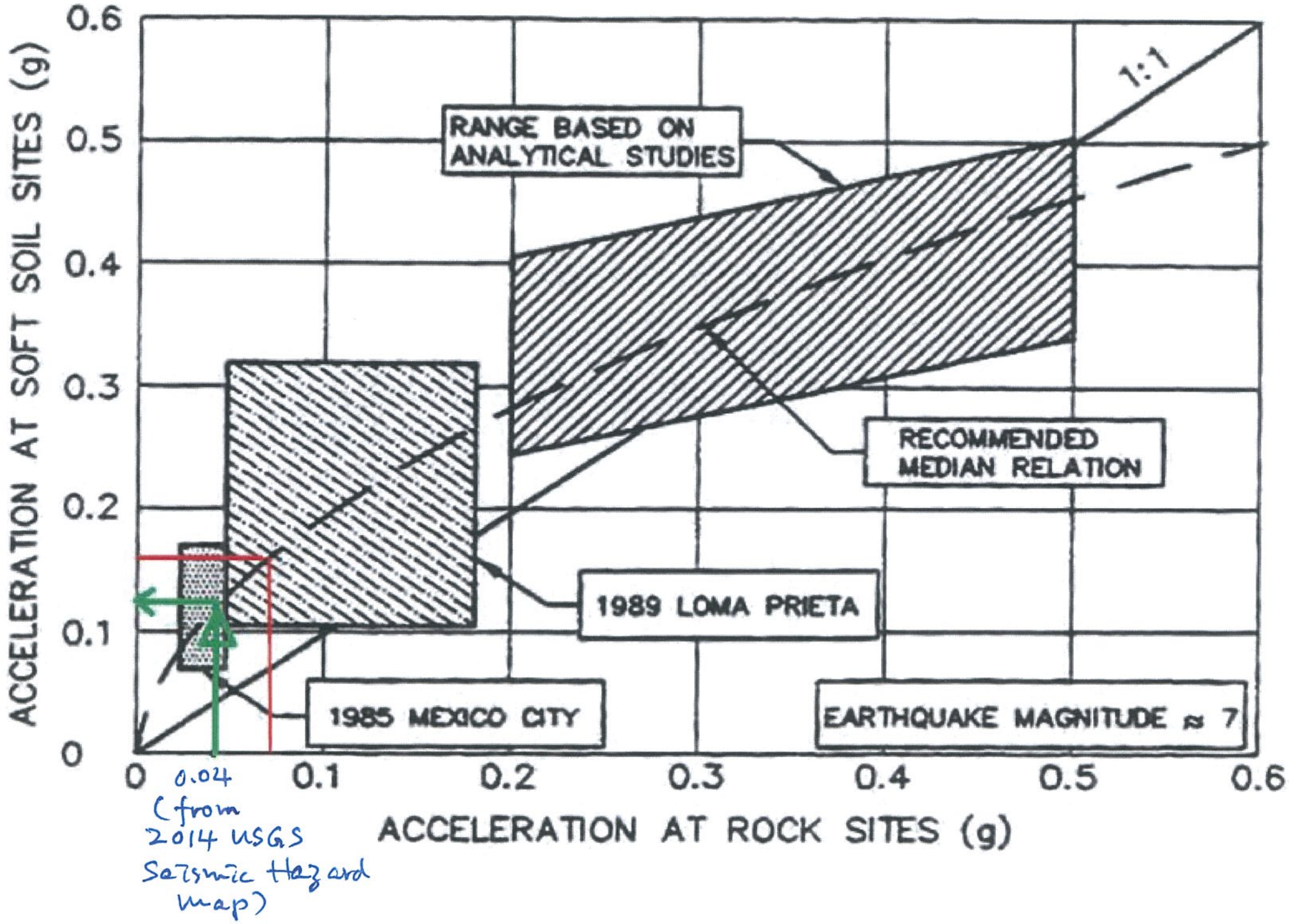
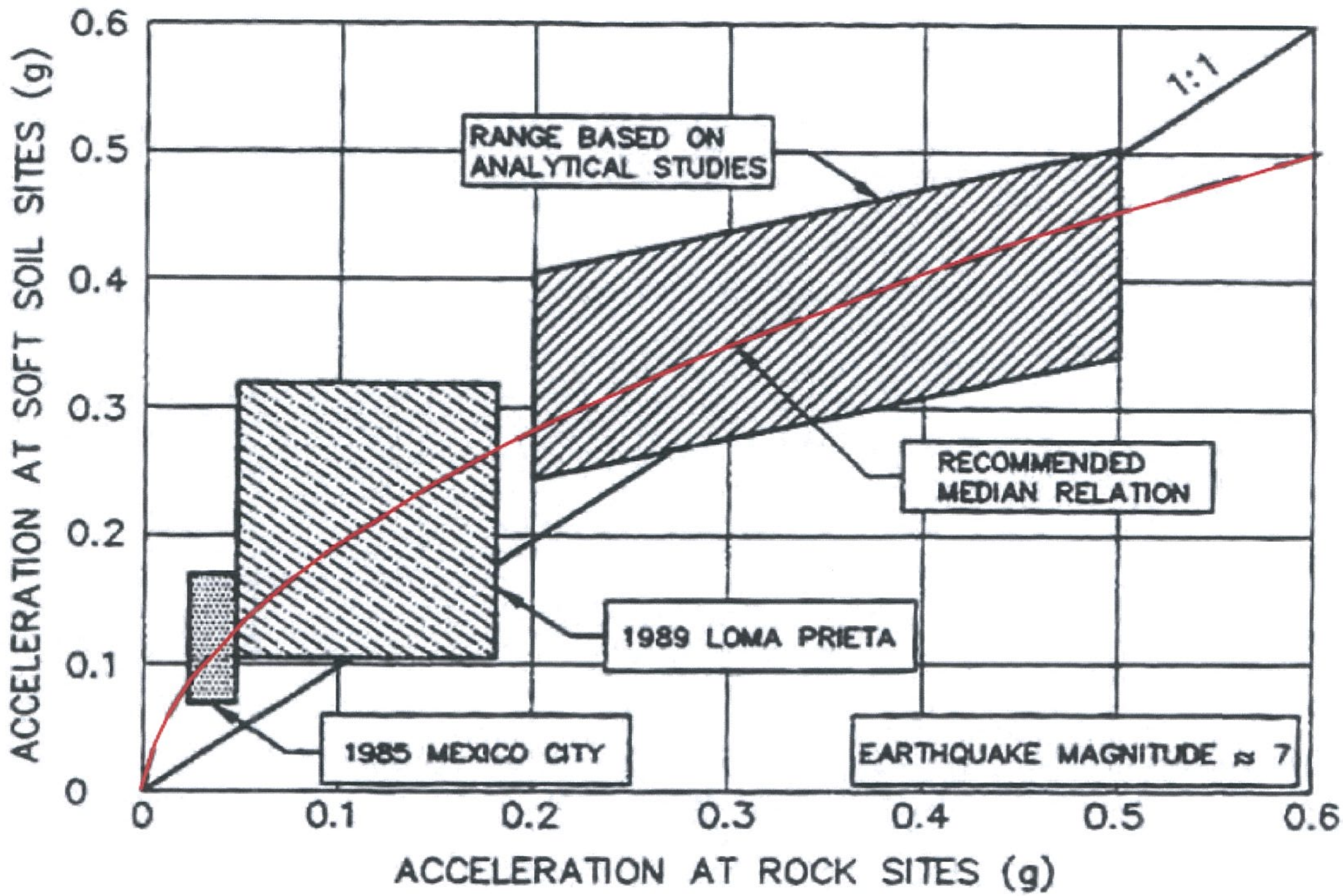


Figure 5-4 Relationship between PHGA on Rock and on Soft Soil Sites (Idriss, 1990)

$a = 0.5\,PGA$

For $PGA = 0.12g$ (Above) & $a = 0.5 \times 0.12g = 0.06g$

$k = a/g = 0.06g/g = \underline{\underline{0.06}}$



For the determination of the factor in equation 1. And based on my research to the available work on the subject
I recommend the use of a factor of 0.5 in the pseudo static slope stability analysis for Dams.
Equation 1 becomes **a=0.5 PGA**

Please also see below the section of the GEOTECHNICAL EARTHQUAKE ENGINEERING HANDBOOK (2002) which summarize
The state of the art of the subject:

period, and is consistent with federal dam safety guidance, specifically FEMA. FEMA recommends in *Federal Guidelines for Dam Safety* that dams be formally assessed at a frequency not to exceed five years by a qualified professional engineer. EPA has adopted this timeframe to maintain consistency with FEMA guidance. The inspection and assessment requirements in this rule will ensure that there are consistent and uniform inspection and assessment practices across states and facilities and will ensure that problems related to their stability will be promptly identified and remediated as necessary.

b. Static, Seismic, and Liquefaction Factors of Safety

(1) Static Factors of Safety.

Factor of safety (FOS) means the ratio of the forces tending to resist the failure of a structure, as compared to the forces tending to cause such failure as determined by accepted engineering practice. This analysis is used to determine whether a CCR surface impoundment's dikes are engineered to withstand the specific loading conditions that can be reasonably anticipated to occur during the lifetime of the unit without failure of the dike, if accepted good engineering practices are employed. Static factors of safety refer to the factors of safety (FOS) under static loading conditions that can reasonably be anticipated to occur during the lifetime of the unit. Static loading conditions are unique from other loading conditions (*e.g.*, seismic, liquefaction) in that static loading conditions are those which are in equilibrium, meaning the load is at rest or is applied with constant velocity.

EPA reviewed a series of USACE guidance documents addressing how to determine static FOS. These documents included, but were not limited to, Engineer Manual EM 1110–2–1902 "Slope Stability" (October 2003), and EM 1110–2–1902 "Stability of Earth and Rock-Fill Dams." The Agency also assessed the recommendations on how to conduct static analysis contained in the Engineering and Design Manual for Coal Refuse Disposal Facilities, originally published by the Mining Enforcement and Safety Administration (MESA) in 1975 and updated for MSHA in May 2009, and in particular Chapter 6, "Geotechnical Exploration, Material Testing, Engineering Analysis and Design." Based on recommendations from ASDSO, among others, the Agency adopted the USACE guidance to determine static FOS, both in the Assessment Program and in this rulemaking, as these manuals are recognized throughout industry as the standard routinely used in field assessment of structural integrity.

In EPA's Assessment Program all CCR units were assessed to determine their static FOS. Each assessment classified a CCR unit as having sufficient structural stability under static loading conditions if analysis of critical sections of embankments demonstrated FOS that met or exceeded the values defined by USACE for static specific loading conditions. EPA found that most CCR surface impoundments exhibited sufficient calculated factors of safety under static loading conditions. EPA also found that in those CCR units which insufficient factors of safety against failure due to static loading were calculated, the owner or operator was able to implement actions which increased the factors of safety under static loading conditions to acceptable levels. Oftentimes, these implemented actions were of a simple nature, such as installing riprap (rock armoring the slopes) or buttressing the slopes.

Similarly, this rule adopts the static FOS from USACE Engineer Manual EM 1110–2–1902 "Slope Stability," with the exception of the rapid drawdown loading condition,[11] which was determined not to be relevant to CCR surface impoundments. EPA found the factors of safety identified by EM 1110–2–1902, specifically the Maximum Storage pool, Maximum Surcharge pool, and End-Of-Construction loading conditions, provided consistent, achievable levels of safety in CCR surface impoundment dikes, comprehensively assessed static stability, and provided sufficient consideration of compounding stresses on dikes (*e.g.*, factors of safety values greater than 1.00 to account for unanticipated loadings acting in conjunction or misidentified strength of materials).

(2) Seismic Factor of Safety.

Seismic FOS means the FOS determined using analysis under earthquake conditions for a seismic loading event, based on the U.S. Geological Survey (USGS) seismic hazard maps for seismic events with a specified return period for the location where the CCR surface impoundment is located. The seismic FOS analysis is used to determine whether a dam would remain stable during an earthquake or other seismic event. The Agency relied on guidance from USACE and MSHA to evaluate the appropriate methods to determine if a dam would remain stable during a seismic event. This includes the USACE guidance Engineer Circular 1110–2–6061: Safety of Dams—Policy and Procedures 2204, Engineer Circular 1110–2–6000: Selection of Design Earthquakes and Associated Ground Motions 2008, and Engineer Circular 1110–2–6001: Dynamic Stability of Embankment Dams 2004). EPA also reviewed MSHA's 2009 Engineering and Design Manual for Coal Refuse Disposal Facilities, in particular Chapter 7, "Seismic Design: Stability and Deformation Analyses." These documents are viewed by ASDSO, FEMA and MSHA as generally accepted guidance on how to conduct seismic stability analyses.

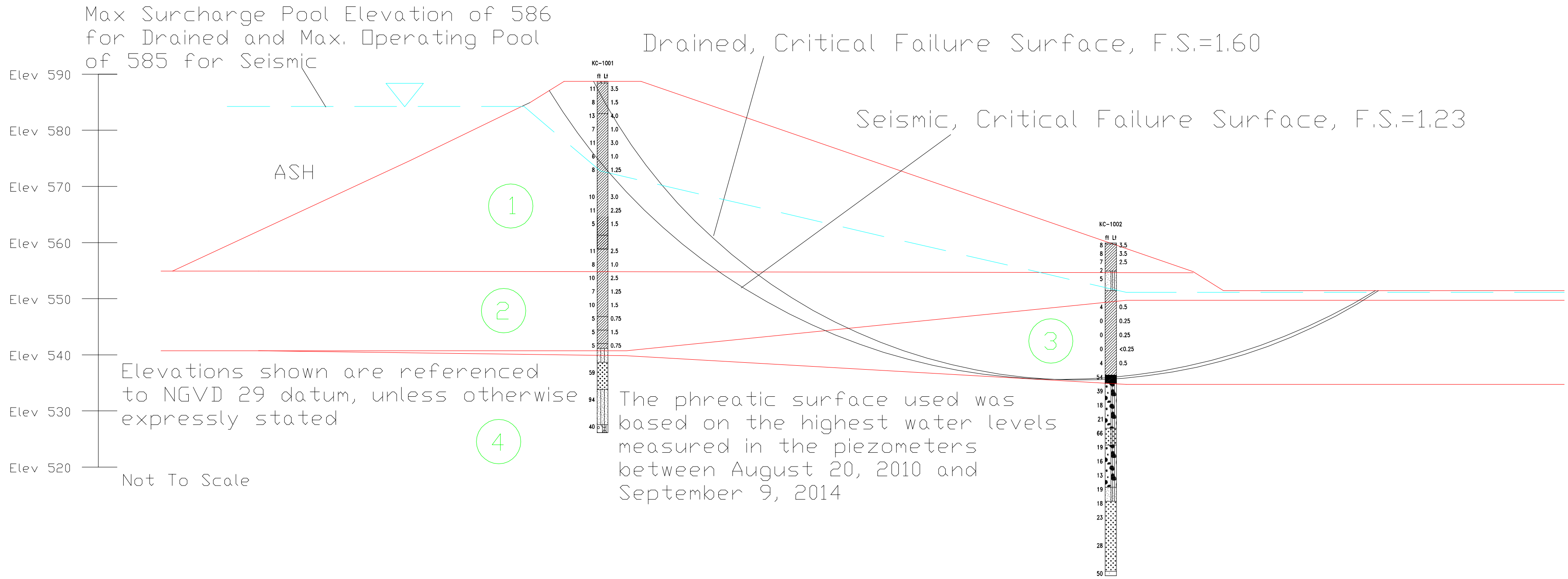
As noted earlier, in performing the assessments, EPA directed its engineering contractors to assess seismic stability of CCR impoundments during and following a seismic event with a 2% probability of exceedance in 50 years (*i.e.* probable earthquake within approximately 2,500 years) and a horizontal spectral response acceleration for 1.0-second period (5% of Critical Damping). EPA selected this return period for determining the maximum design earthquake (MDE) by first considering the operating life anticipated for CCR surface impoundments. EPA has identified the operating life of CCR surface impoundments to range between 40–80 years. EPA then consulted the United States Geological Survey (USGS) and ASDSO to determine a conservative probability that should be used in the assessments.[12] To reduce the likelihood of a CCR unit failing during a seismic

[11] Rapid (or sudden) drawdown is a condition in earthen dikes that may develop when the embankment becomes saturated through seepage during a high pool elevation in the reservoir. Rapid drawdown becomes a threat to the dike when the reservoir pool is drawn down or lowered at a rate significantly higher than the excess poor water pressure within the dike can dissipate. Typically, rapid drawdown scenarios are considered for dikes with reservoirs used for water supply and management or agricultural supply. In these scenarios, a high pool elevation is maintained in the reservoir in storage months. Subsequently, the water supply is drawn on in months where there is a demand for the reservoirs contents. This drawing down of the pool can present issues for the structural integrity of the unit. However, the management of CCR surface impoundments differs from that of conventional water supply reservoirs. CCR surface impoundments are never used for water supply, and the only instance in which EPA determined through its Assessment Program that rapid drawdown loading conditions would be relevant to CCR surface impoundments was in the event that the CCR surface impoundment had already released the contents of the impoundment through a breach of the dike or emergency discharge. Since the threat of release of CCR and the reservoir has already been realized, any failure due to rapid drawdown of the embankment is no longer critical to the overall containment of the now-released contents of the CCR unit.

[12] Wieland, M., "Seismic Design and Performance Criteria for Large Storage Dams", Proc. 15th World Conf. on Earthquake Engineering, Lisbon, Portugal, Sep. 24–28, 2012.

APPENDIX VI
Results of Slope Stability Analyses

Material	Consistency	Soil Type	Undrained C (psf)	Undrained Φ (deg)	Drained C' (psf)	Drained Φ' (deg)	γ (pcf)
Material 1	Stiff/Very Stiff	Emb. Fill	350	20	100	32	125
Material 2	Med. Stiff/Stiff	Clay	350	16	100	30	125
Material 3	Very Soft	Clay	250	16	50	26	120
Material 4	Dense	Sand/Gravel	0	35	0	35	125

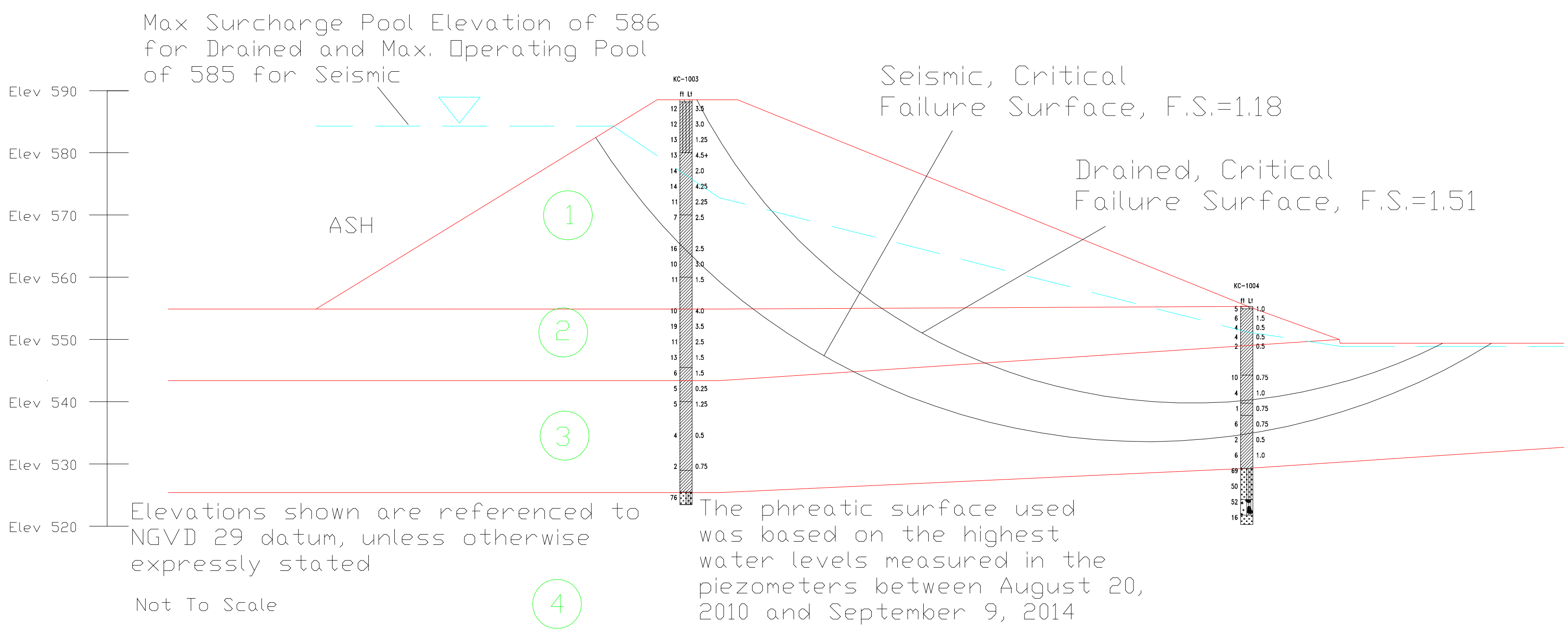


KYGER CREEK - ASH IMPOUNDMENT
STABILITY ANALYSIS

SOUTH FLY ASH POND SECTION 1

PROJECT NO. 1521-3007.00	CALC: EWT	DATE 12/8/15

Material	Consistency	Soil Type	Undrained C (psf)	Undrained Φ (deg)	Drained C' (psf)	Drained Φ' (deg)	γ (pcf)
Material 1	Stiff/Very Stiff	Emb. Fill	350	20	100	32	125
Material 2	Stiff/Very Stiff	Clay	500	16	100	32	125
Material 3	Soft/Med. Stiff	Clay	300	16	100	28	125
Material 4	Dense	Sand/Gravel	0	35	0	35	125

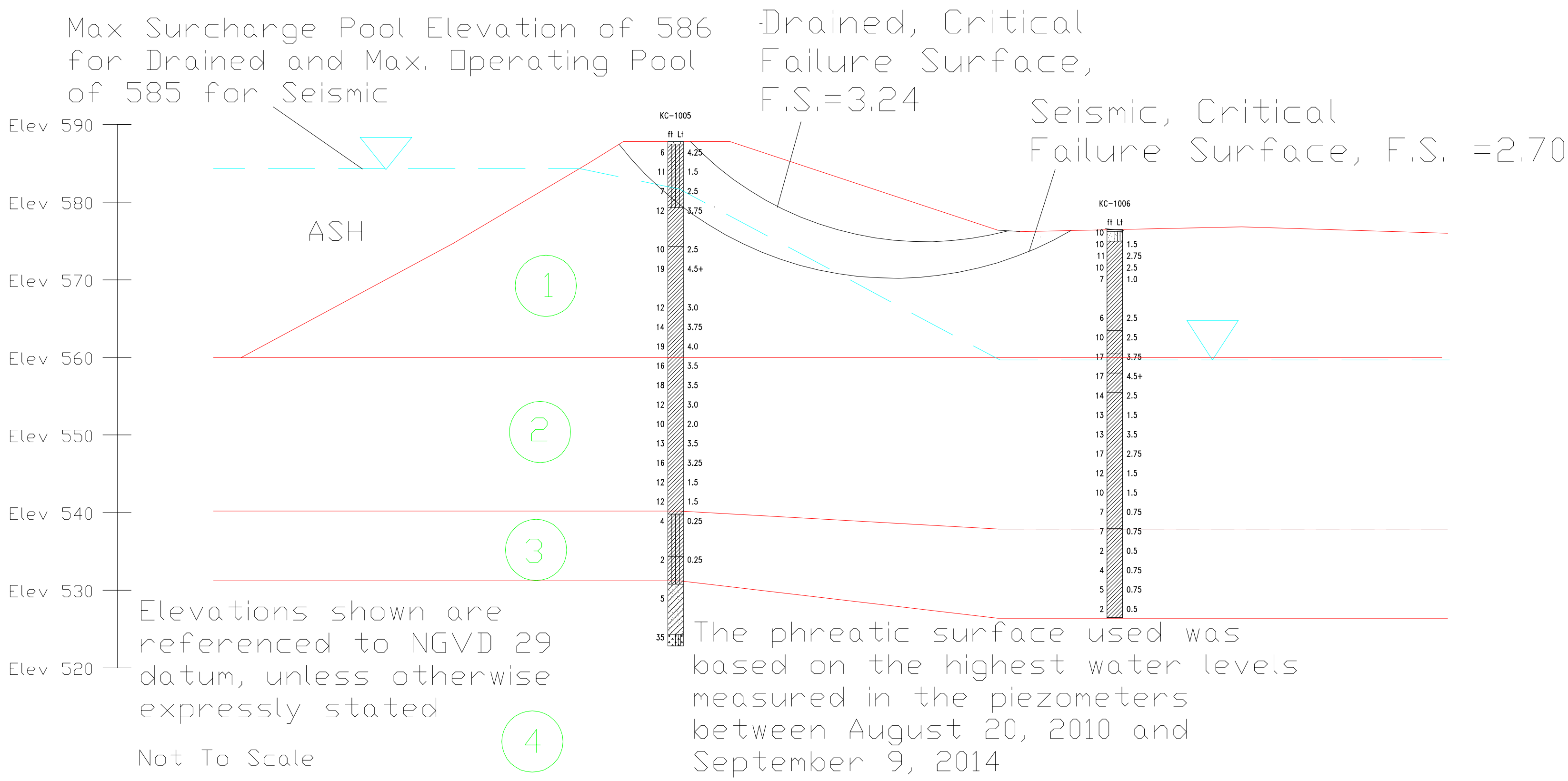


KYGER CREEK - ASH IMPOUNDMENT
STABILITY ANALYSIS

SOUTH FLY ASH POND SECTION 2

PROJECT NO. 1521-3007.00	CALC: EWT	DATE 12/8/15

Material	Consistency	Soil Type	Undrained C (psf)	Undrained Φ (deg)	Drained C' (psf)	Drained Φ' (deg)	γ (pcf)
Material 1	Stiff/Very Stiff	Emb. Fill	350	20	100	32	125
Material 2	Stiff/Very Stiff	Clay	500	16	100	32	125
Material 3	Soft/Med. Stiff	Clay	300	16	100	28	125
Material 4	Dense	Sand/Gravel	0	35	0	35	125

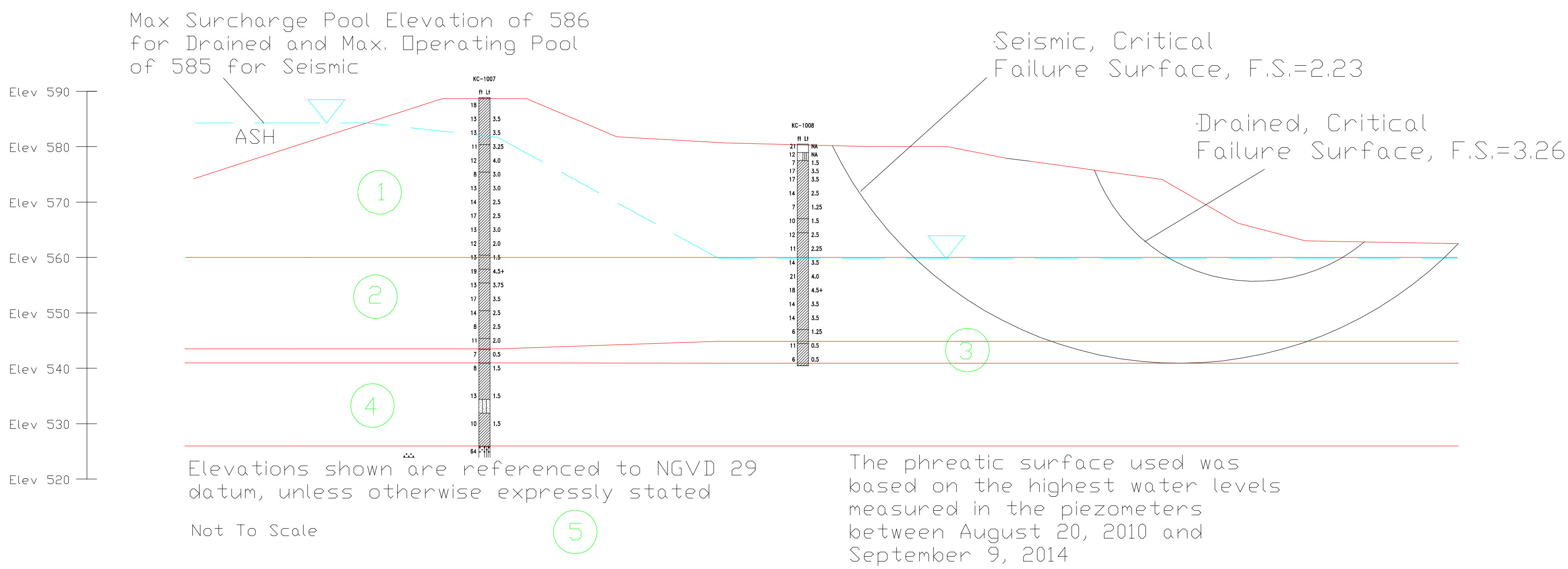


KYGER CREEK - ASH IMPOUNDMENT
STABILITY ANALYSIS

SOUTH FLY ASH POND SECTION 3

PROJECT NO. 1521-3007.00	CALC: EWT	DATE 12/8/15

Material	Consistency	Soil Type	Undrained C (psf)	Undrained Φ (deg)	Drained C' (psf)	Drained Φ' (deg)	γ (pcf)
Material 1	Stiff/Very Stiff	Emb. Fill	350	20	100	32	125
Material 2	Stiff/Very Stiff	Clay	500	16	100	32	125
Material 3	Soft/Med. Stiff	Clay	300	16	100	28	125
Material 4	Med. Stiff/Stiff	Clay	350	16	0	30	125
Material 5	Dense	Sand/Gravel	0	35	0	35	125

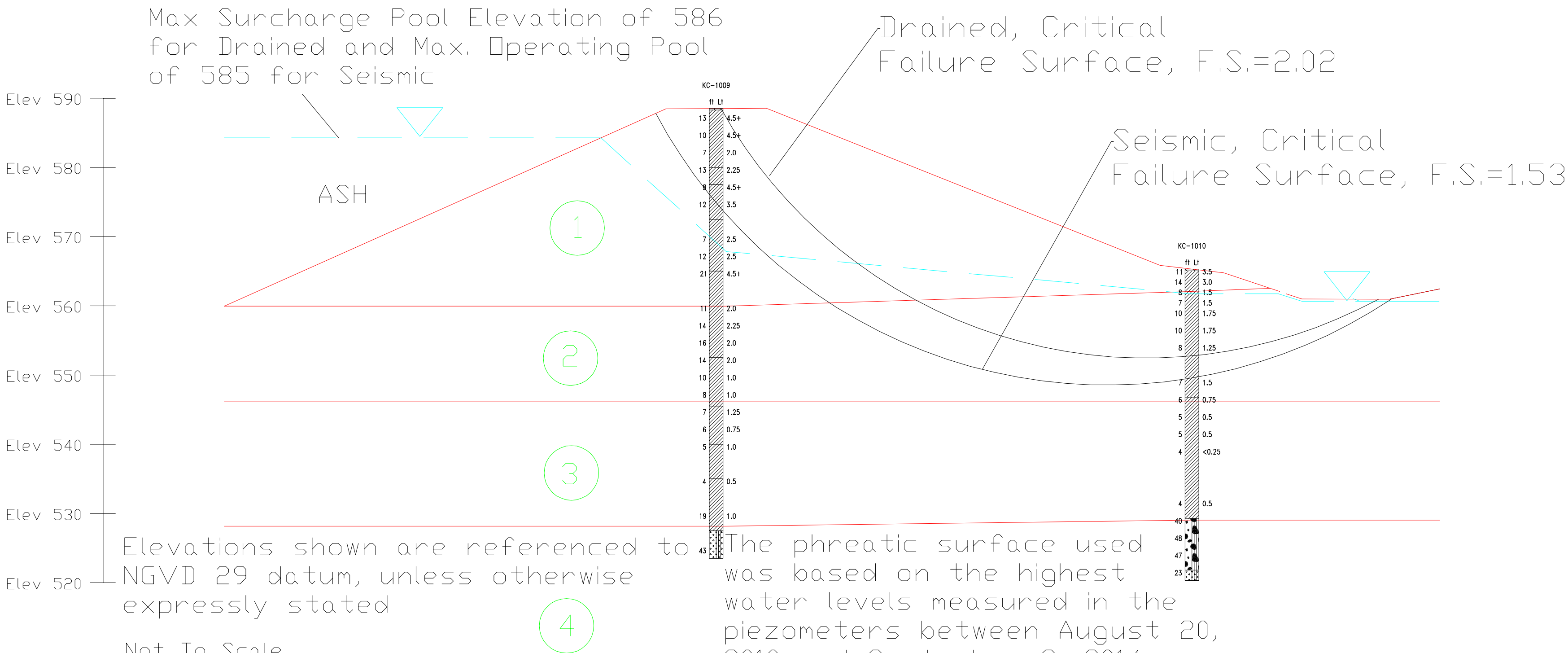


KYGER CREEK - ASH IMPOUNDMENT
STABILITY ANALYSIS

SOUTH FLY ASH POND SECTION 4

PROJECT NO. 1521-3007.00	CALC: EWT	DATE 12/8/15

Material	Consistency	Soil Type	Undrained C (psf)	Undrained Φ (deg)	Drained C' (psf)	Drained Φ' (deg)	γ (pcf)
Material 1	Stiff/Very Stiff	Emb. Fill	350	20	100	32	125
Material 2	Med. Stiff/Stiff	Clay	350	16	100	30	125
Material 3	Soft/Med. Stiff	Clay	300	16	100	28	125
Material 4	Dense	Sand/Gravel	0	35	0	35	125



Elevations shown are referenced to NGVD 29 datum, unless otherwise expressly stated

Not To Scale

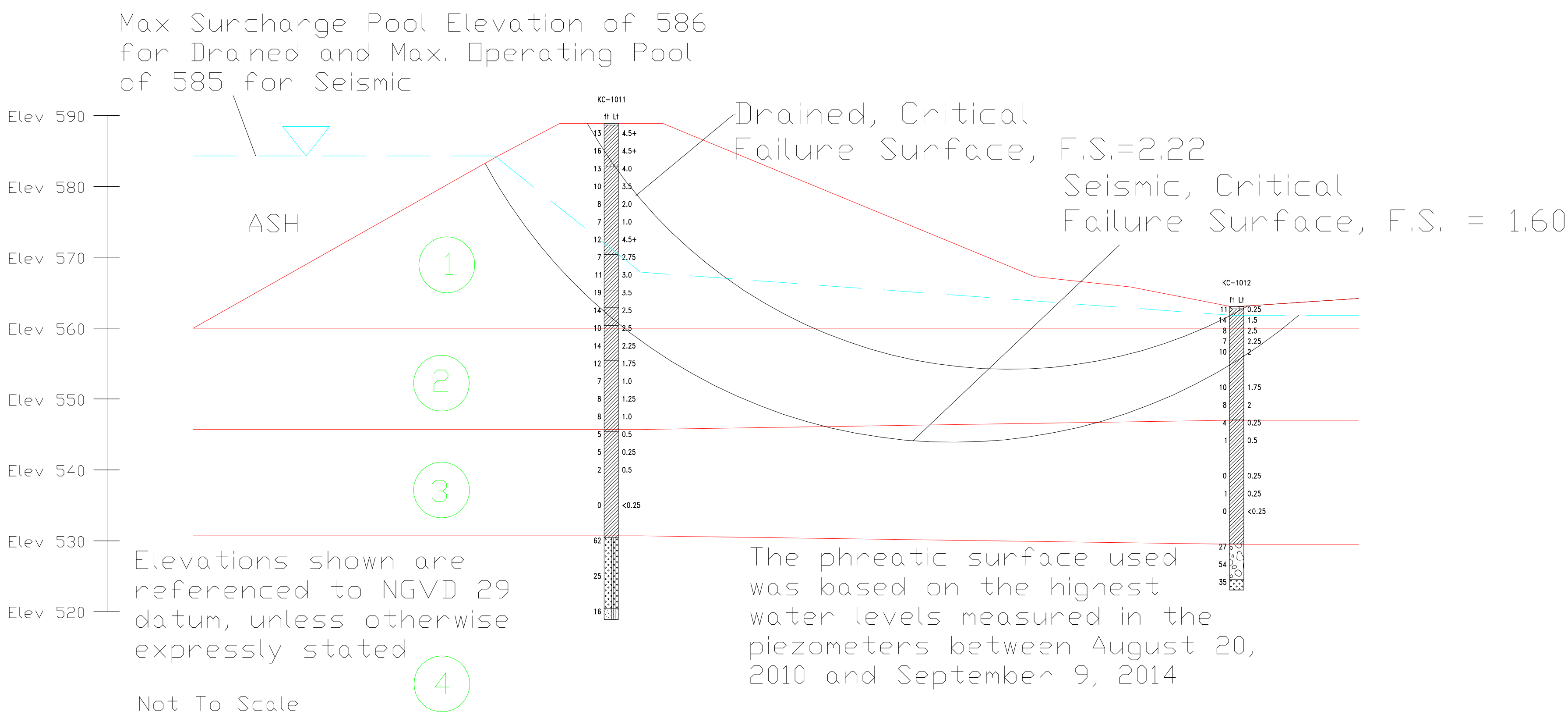
The phreatic surface used was based on the highest water levels measured in the piezometers between August 20, 2010 and September 9, 2014

KYGER CREEK - ASH IMPOUNDMENT STABILITY ANALYSIS

SOUTH FLY ASH POND SECTION 5

PROJECT NO. 1521-3007.00	CALC: EWT	DATE 12/8/15

			Undrained		Drained		
Material	Consistency	Soil Type	C (psf)	Φ (deg)	C' (psf)	Φ' (deg)	γ (pcf)
Material 1	Stiff/Very Stiff	Emb. Fill	350	20	100	32	125
Material 2	Med. Stiff/Stiff	Clay	350	16	100	30	125
Material 3	Soft/Med. Stiff	Clay	300	16	100	28	125
Material 4	Dense	Sand/Gravel	0	35	0	35	125

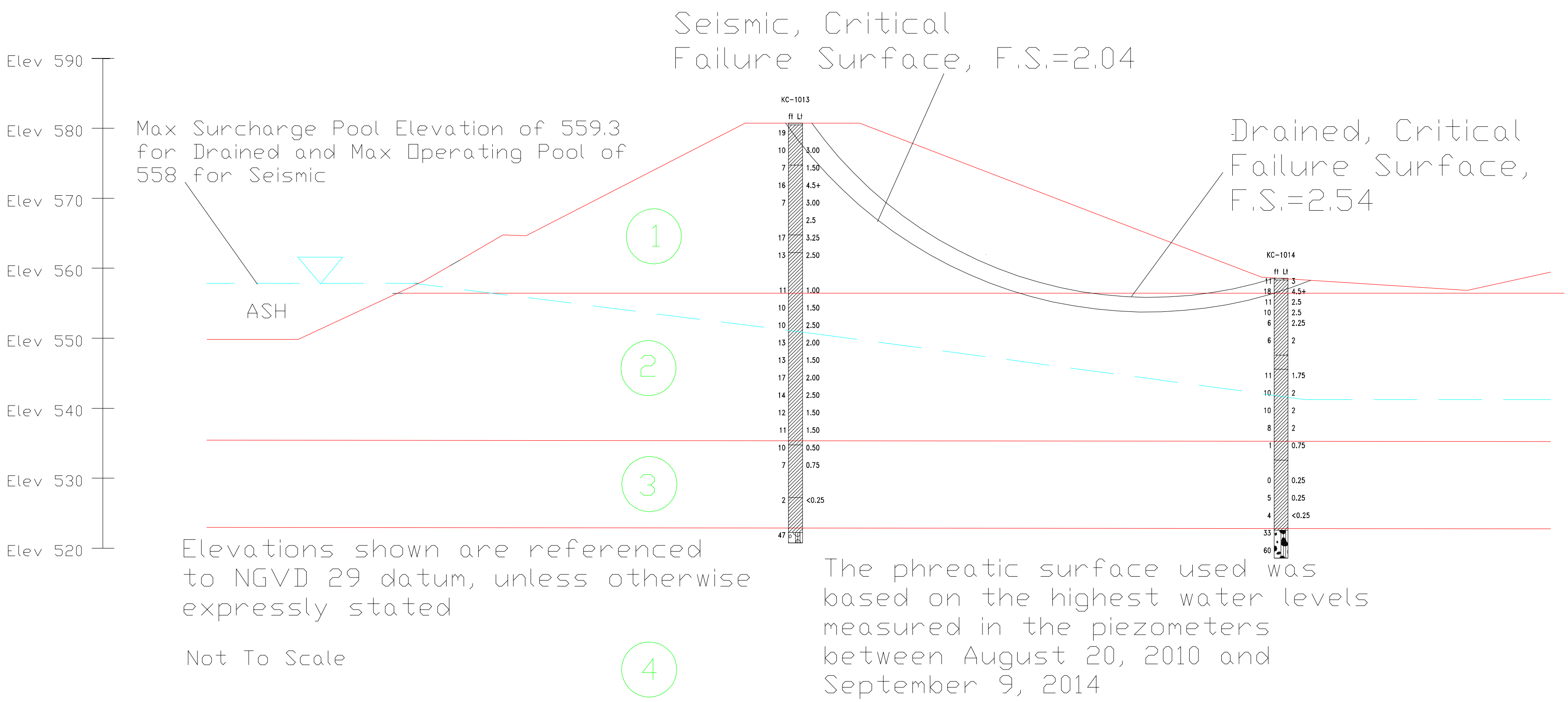


KYGER CREEK - ASH IMPOUNDMENT
STABILITY ANALYSES

SOUTH FLY ASH POND SECTION 6

PROJECT NO. 1521-3007.00	CALC: EWT	DATE 12/8/15

Material	Consistency	Soil Type	Undrained C (psf)	Undrained ϕ (deg)	Drained C' (psf)	Drained ϕ' (deg)	γ (pcf)
Material 1	Stiff/Very Stiff	Emb. Fill	350	20	100	32	125
Material 2	Stiff/Very Stiff	Clay	500	16	100	32	125
Material 3	Soft/Med. Stiff	Clay	300	16	100	28	125
Material 4	Dense	Sand/Gravel	0	35	0	35	125



Elevations shown are referenced to NGVD 29 datum, unless otherwise expressly stated

Not To Scale

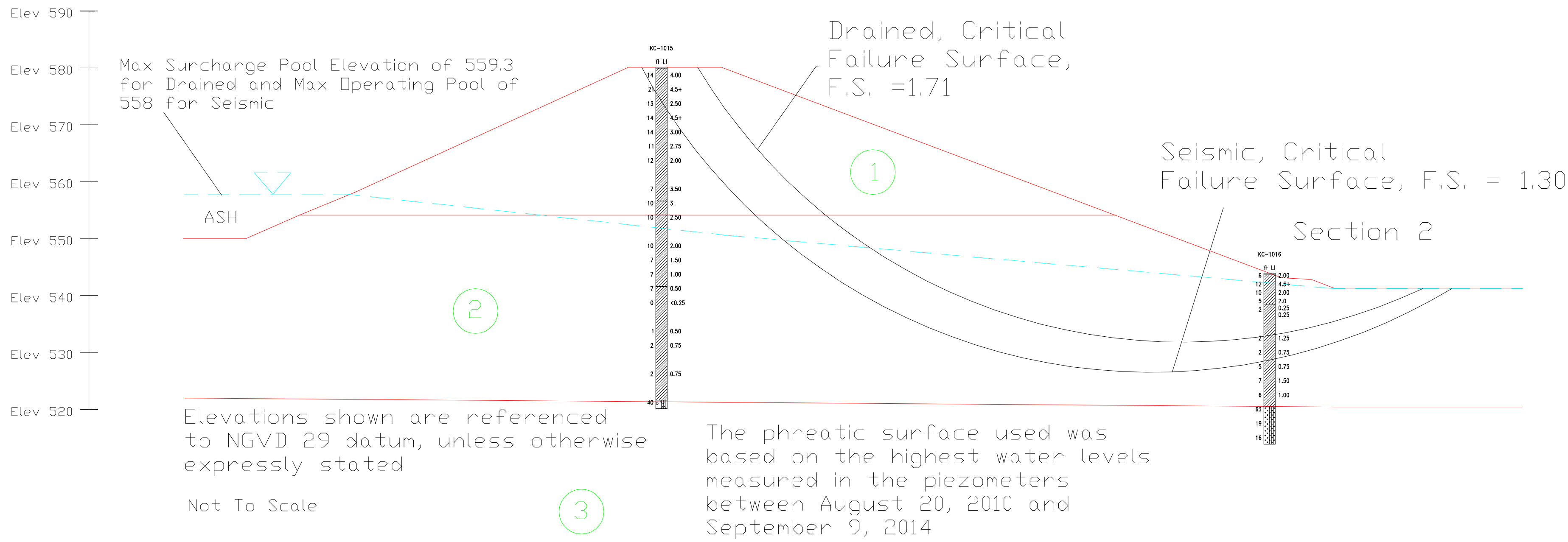
The phreatic surface used was based on the highest water levels measured in the piezometers between August 20, 2010 and September 9, 2014

KYGER CREEK - ASH IMPOUNDMENT
STABILITY ANALYSIS

BOTTOM ASH POND SECTION 1

PROJECT NO. 1521-3007.00 | CALC: EWT | DATE 12/8/15

			Undrained		Drained		
Material	Consistency	Soil Type	C (psf)	Φ (deg)	C' (psf)	Φ' (deg)	γ (pcf)
Material 1	Stiff/Very Stiff	Emb. Fill	350	20	100	32	125
Material 2	Soft/Med. Stiff	Clay	300	16	100	28	125
Material 3	Dense	Sand/Gravel	0	35	0	30	125

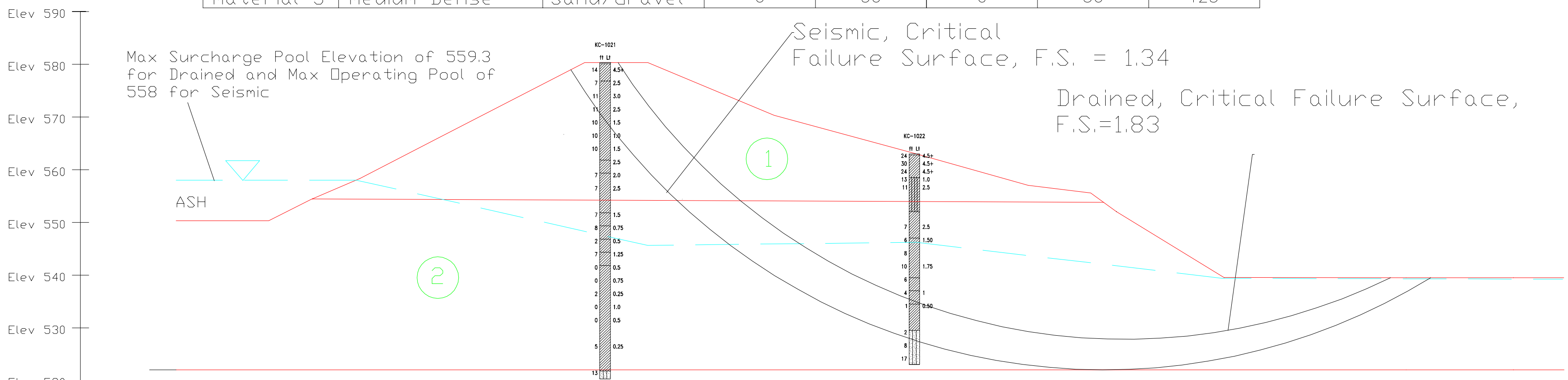


KYGER CREEK - ASH IMPOUNDMENT
STABILITY ANALYSIS

BOTTOM ASH POND SECTION 2

PROJECT NO. 1521-3007.00	CALC: EWT	DATE 12/8/15

Material	Consistency	Soil Type	Undrained C (psf)	Undrained Φ (deg)	Drained C' (psf)	Drained Φ' (deg)	γ (pcf)
Material 1	Stiff/Very Stiff	Emb. Fill	350	20	100	32	125
Material 2	Soft/Med. Stiff	Clay	300	16	100	28	125
Material 3	Medium Dense	Sand/Gravel	0	30	0	30	125



Elevations shown are referenced to NGVD 29 datum, unless otherwise expressly stated

Not To Scale

3

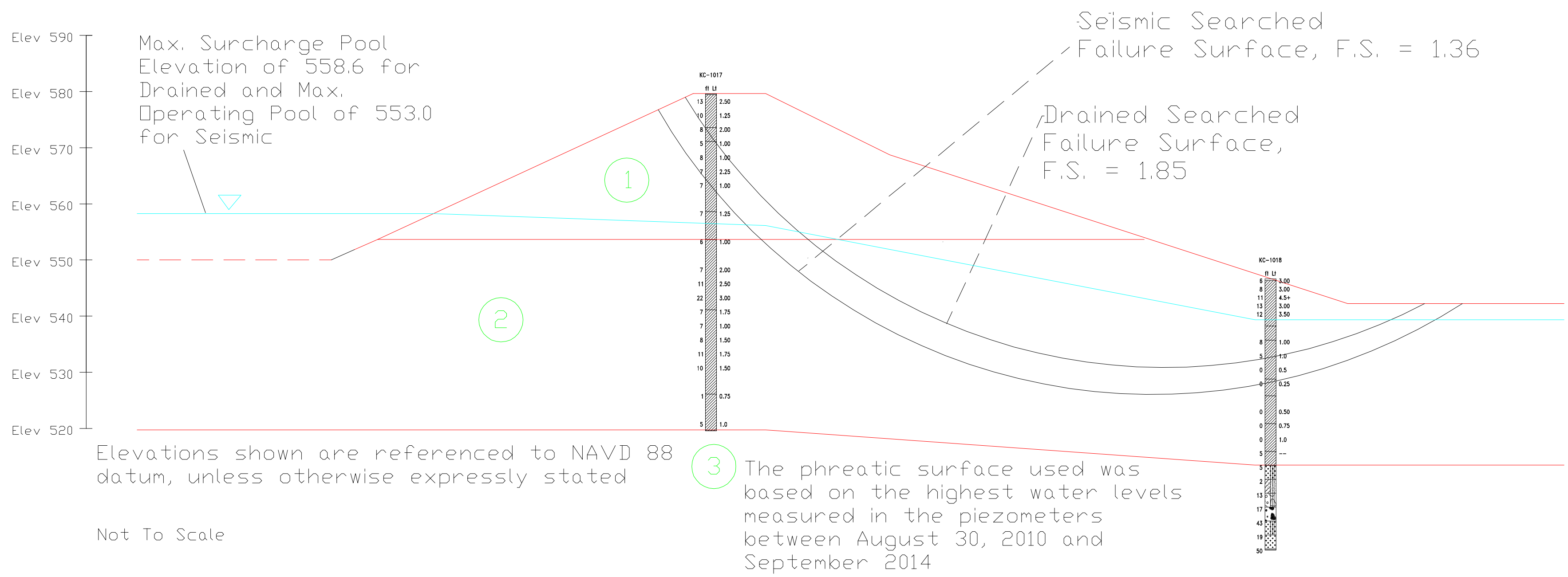
The phreatic surface used was based on the highest water levels measured in the piezometers between August 20, 2010 and September 9, 2014

KYGER CREEK - ASH IMPOUNDMENT
STABILITY ANALYSIS

BOTTOM ASH POND SECTION 5

PROJECT NO. 1521-3007.00	CALC: EWT	DATE 12/8/15

			Undrained		Drained		
Material	Consistency	Soil Type	C (psf)	Φ (deg)	C' (psf)	Φ' (deg)	γ (pcf)
Material 1	Stiff/Very Stiff	Emb. Fill	350	20	100	32	125
Material 2	Soft/Med. Stiff	Clay	300	16	100	28	125
Material 3	Medium Dense	Sand/Gravel	0	30	0	30	125

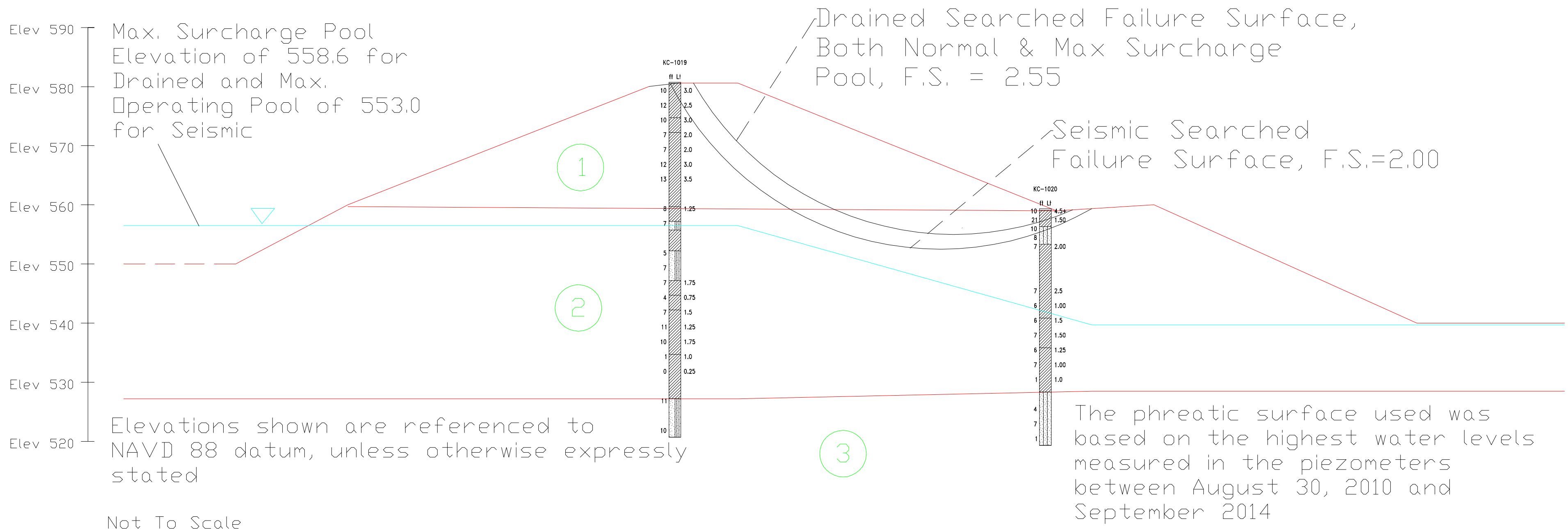


KYGER CREEK - ASH IMPOUNDMENT
STABILITY ANALYSIS

CLEARWATER POND SECTION 3

PROJECT NO. 1521-3007.00	CALC: EWT	DATE 12/8/15

Material	Consistency	Soil Type	Undrained C (psf)	Undrained Φ (deg)	Drained C' (psf)	Drained Φ' (deg)	γ (pcf)
Material 1	Stiff/Very Stiff	Emb. Fill	350	20	100	32	125
Material 2	Med. Stiff/Stiff	Clay	350	16	100	30	125
Material 3	Medium Dense	Sand/Gravel	0	28	0	28	125



KYGER CREEK - ASH IMPOUNDMENT
STABILITY ANALYSIS

CLEARWATER POND SECTION 4

PROJECT NO. 1521-3007.00	CALC: EWT	DATE 12/8/15

APPENDIX VII

Exhibit 7 – Liquefaction Analysis of Granular Soils
Exhibit 8 – USGS Map, “Earthquakes in Ohio and Vicinity, 1776-2007”
Exhibit 9 – Liquefaction Analysis of Fine-grained Soils
Exhibit 10 – Additional Liquefaction Analysis of Potentially Liquefiable Fine-grained Soils
AGMU Memo 10.1 – Liquefaction Analysis, dated January 2010, from the Illinois DOT
USACE Slope Stability, Engineering Manual 1110-2-1902. October, 2003, page 1-6
Chapter 5 “Liquefaction Potential Evaluation and Analysis” of EPA/600/R-95/051

EXHIBIT 7 - KYGER CREEK ASH IMPOUNDMENT - LIQUEFACTION ANALYSIS OF GRANULAR SOILS

Location	Cross-section No.	Boring No.	Depth to Top of Layer (ft, bgs)	Depth to Bottom of Layer (ft, bgs)	Mid-point Depth of Layer (ft, bgs)	Mid-point Depth of Layer (m, bgs)	Elevation to Top of Layer (ft, bgs)	Sampler Type	Soil Type	Groundwater Level During Seismic Event (ft, bgs)	Total Overburden Stress, σ, psf	Effective Overburden Stress, σ', psf	N_m, field N-Values	C_N	CE	CB	CR	CS	$(N_1)_{60}$ (blows/ft)	Fine Content (%)	α	β	$(N_1)_{60\,cs}$ (blows/ft)	r_d	CSR	$(CRR)_{7.5}$	MSF	FS_{Liq}	Liquefaction Potential
South Fly Ash Pond	1	KC-1001	49.4	52	50.7	15.21	539.9	SS	SM	0	6084	2920.32	4	0.85	1.21	1.00	1.00	1.00	4.11	13.00	1.89	2.82	13.49	0.75	0.06	0.15	5.33	12.65	NO
South Fly Ash Pond	1	KC-1001	52	57	54.5	16.35	537.3	SS	SW	0	6540	3139.2	49	0.82	1.21	1.00	1.00	1.00	48.61	3.00	0.00	0.00	0.00	0.72	0.06	0.05	5.33	4.50	NO
South Fly Ash Pond	1	KC-1001	57	63.5	60.25	18.075	532.3	SS	SM	0	7230	3470.4	78	0.78	1.21	1.00	1.00	1.00	73.59	13.00	1.89	2.82	209.44	0.66	0.05	No Liquefaction	5.33	No Liquefaction	NO
South Fly Ash Pond	1	KC-1001	63.5	65	64.25	19.275	525.8	SS	GP-GM	0	7710	3700.8	33	0.76	1.21	1.00	1.00	1.00	30.15	5.00	0.00	0.00	0.00	0.63	0.05	0.05	5.33	5.08	NO
South Fly Ash Pond	1	KC-1002	5	8.5	6.75	2.025	553.3	SS	SP-SM	0	810	388.8	3	1.70	1.21	1.00	1.00	1.00	6.16	5.00	0.00	0.00	0.00	0.99	0.08	0.05	5.33	3.27	NO
South Fly Ash Pond	1	KC-1002	23.5	33	28.25	8.475	534.8	SS	GW-GM	0	3390	1627.2	27	1.14	1.21	1.00	1.00	1.00	37.20	5.00	0.00	0.00	0.00	0.93	0.08	0.05	5.33	3.46	NO
South Fly Ash Pond	1	KC-1002	33	36	34.5	10.35	525.3	SS	SW-SM	0	4140	1987.2	55	1.03	1.21	1.00	1.00	1.00	68.57	8.00	0.30	2.75	189.07	0.90	0.07	No Liquefaction	5.33	No Liquefaction	NO
South Fly Ash Pond	1	KC-1002	36	43.5	39.75	11.925	522.3	SS	GW-GM	0	4770	2289.6	13	0.96	1.21	1.00	1.00	1.00	15.10	5.00	0.00	0.00	0.00	0.86	0.07	0.05	5.33	3.75	NO
South Fly Ash Pond	1	KC-1002	43.5	46	44.75	13.425	514.8	SS	SP-SM	0	5370	2577.6	16	0.91	1.21	1.00	1.00	1.00	17.52	7.00	0.12	2.74	48.14	0.81	0.07	No Liquefaction	5.33	No Liquefaction	NO
South Fly Ash Pond	1	KC-1002	46	58.5	52.25	15.675	512.3	SS	SW	0	6270	3009.6	19	0.84	1.21	1.00	1.00	1.00	19.25	0.00	0.00	0.00	0.00	0.74	0.06	0.05	5.33	4.36	NO
South Fly Ash Pond	2	KC-1003	63	65	64	19.2	525.4	SS	SW-SM	0	7680	3686.4	63	0.76	1.21	1.00	1.00	1.00	57.67	5.00	0.00	0.00	0.00	0.64	0.05	0.05	5.33	5.07	NO
South Fly Ash Pond	2	KC-1004	26	31	28.5	8.55	529.3	SS	SW-SM	0	3420	1641.6	54	1.14	1.21	1.00	1.00	1.00	74.07	6.00	0.03	2.73	202.33	0.93	0.08	No Liquefaction	5.33	No Liquefaction	NO
South Fly Ash Pond	2	KC-1004	31	33.5	32.25	9.675	524.3	SS	GW-GM	0	3870	1857.6	43	1.07	1.21	1.00	1.00	1.00	55.45	5.00	0.00	0.00	0.00	0.91	0.07	0.05	5.33	3.54	NO
South Fly Ash Pond	2	KC-1004	33.5	35	34.25	10.275	521.8	SS	SW	0	4110	1972.8	13	1.04	1.21	1.00	1.00	1.00	16.27	2.00	0.00	0.00	0.00	0.90	0.07	0.05	5.33	3.58	NO
South Fly Ash Pond	3	KC-1005	57	63.5	60.25	18.075	531.2	SS	SC	0	7230	3470.4	4	0.78	1.21	1.00	1.00	1.00	3.77	13.00	1.89	2.82	12.53	0.66	0.05	0.14	5.33	13.43	NO
South Fly Ash Pond	3	KC-1005	63.5	65	64.25	19.275	524.7	SS	SW-SM	0	7710	3700.8	29	0.76	1.21	1.00	1.00	1.00	26.49	5.00	0.00	0.00	0.00	0.63	0.05	0.05	5.33	5.08	NO
South Fly Ash Pond	3	KC-1006	0.3	1.5	0.9	0.27	576.2	SS	SP-SM	0	108	51.84	8	1.70	1.21	1.00	1.00	1.00	16.43	5.00	0.00	0.00	0.00	1.00	0.08	0.05	5.33	3.22	NO
South Fly Ash Pond	4	KC-1007	54.5	57	55.75	16.725	534.5	SS	SM	0	6690	3211.2	11	0.81	1.21	1.00	1.00	1.00	10.79	13.00	1.89	2.82	32.32	0.70	0.06	No Liquefaction	5.33	No Liquefaction	NO
South Fly Ash Pond	4	KC-1007	63	65	64	19.2	526	SS	SW-SM	0	7680	3686.4	53	0.76	1.21	1.00	1.00	1.00	48.52	9.00	0.56	2.76	134.70	0.64	0.05	No Liquefaction	5.33	No Liquefaction	NO
South Fly Ash Pond	4	KC-1008	0.2	1.5	0.85	0.255	580.7	SS	GC-GM	0	102	48.96	17	1.70	1.21	1.00	1.00	1.00	34.91	13.00	1.89	2.82	100.35	1.00	0.08	No Liquefaction	5.33	No Liquefaction	NO
South Fly Ash Pond	4	KC-1008	1.5	3	2.25	0.675	579.4	SS	SP-SM	0	270	129.6	10	1.70	1.21	1.00	1.00	1.00	20.54	5.00	0.00	0.00	0.00	1.00	0.08	0.05	5.33	3.23	NO
South Fly Ash Pond	5	KC-1009	61	65	63	18.9	528.2	SS	SW-SM	0	7560	3628.8	36	0.76	1.21	1.00	1.00	1.00	33.21	5.00	0.00	0.00	0.00	0.64	0.05	0.05	5.33	5.01	NO
South Fly Ash Pond	5	KC-1010	36	41	38.5	11.55	529.1	SS	GW-GM	0	4620	2217.6	36	0.98	1.21	1.00	1.00	1.00	42.49	5.00	0.00	0.00	0.00	0.87	0.07	0.05	5.33	3.71	NO
South Fly Ash Pond	5	KC-1010	41	43.5	42.25	12.675	524.1	SS	GW	0	5070	2433.6	39	0.93	1.21	1.00	1.00	1.00	43.94	3.00	0.00	0.00	0.00	0.84	0.07	0.05	5.33	3.85	NO
South Fly Ash Pond	5	KC-1010	43.5	45	44.25	13.275	521.6	SS	SW-SM	0	5310	2548.8	19	0.91	1.21	1.00	1.00	1.00	20.92	7.00	0.12	2.74	57.46	0.82	0.07	No Liquefaction	5.33	No Liquefaction	NO
South Fly Ash Pond	6	KC-1011	48.5	50	49.25	14.775	540.7	SS	ML	0	5910	2836.8	2	0.86	1.21	1.00	1.00	1.00	2.09	58.00	5.00	1.20	7.50	0.77	0.06	0.09	5.33	7.84	NO
South Fly Ash Pond	6	KC-1011	58.5	68.5	63.5	19.05	530.7	SS	SW-SM	0	7620	3657.6	36	0.76	1.21	1.00	1.00	1.00	33.08	12.00	1.55	2.81	94.37	0.64	0.05	No Liquefaction	5.33	No Liquefaction	NO
South Fly Ash Pond	6	KC-1011	68.5	70	69.25	20.775	520.7	SS	SP-SM	0	8310	3988.8	13	0.73	1.21	1.00	1.00	1.00	11.44	6.00	0.03	2.73	31.27	0.60	0.05	No Liquefaction	5.33	No Liquefaction	NO
South Fly Ash Pond	6	KC-1012	33.5	38.4	35.95	10.785	529.5	SS	GP	0	4314	2070.72	33	1.01	1.21	1.00	1.00	1.00	40.31	4.00	0.00	0.00	0.00	0.89	0.07	0.05	5.33	3.63	NO
South Fly Ash Pond	6	KC-1012	38.5	40	39.25	11.775	524.5	SS	SW	0	4710	2260.8	29	0.97	1.21	1.00	1.00	1.00	33.90	0.00	0.00	0.00	0.00	0.86	0.07	0.05	5.33	3.73	NO
Bottom Ash Pond	1	KC-1013	53.5	55	54.25	16.275	527.8	SS	ML	0	6510	3124.8	2	0.82	1.21	1.00	1.00	1.00	1.99	56.00	5.00	1.20	7.39	0.72	0.06	0.09	5.33	8.29	NO
Bottom Ash Pond	1	KC-1013	58.5	60	59.25	17.775	522.8	SS	GP-GM	0	7110	3412.8	39	0.79	1.21	1.00	1.00	1.00	37.10	5.00	0.00	0.00	0.00	0.67	0.05	0.05	5.33	4.79	NO
Bottom Ash Pond	1	KC-1014	36	40	38	11.4	522.6	SS	GW-GM	0	4560	2188.8	38	0.98	1.21	1.00	1.00	1.00	45.14	6.00	0.03	2.73	123.32	0.87	0.07	No Liquefaction	5.33	No Liquefaction	NO
Bottom Ash Pond	2	KC-1015	58.5	60	59.25	17.775	521.9	SS	SW-SM	0	7110	3412.8	33	0.79	1.21	1.00	1.00	1.00	31.40	6.00	0.03	2.73	85.77	0.67	0.05	No Liquefaction	5.33	No Liquefaction	NO
Bottom Ash Pond	2	KC-1016	23.5	28.5	26	7.8	520.3	SS	SW-SM	0	3120	1497.6	34	1.19	1.21	1.00	1.00	1.00	48.83	6.00	0.03	2.73	133.39	0.94	0.08	No Liquefaction	5.33	No Liquefaction	NO
Bottom Ash Pond	2	KC-1016	28.5	30	29.25	8.775	515.3	SS	GW	0	3510	1684.8	13	1.12	1.21	1.00	1.00	1.00	17.60	3.00	0.00	0.00	0.00	0.93	0.08	0.05	5.33	3.48	NO
Clearwater Pond	3	KC-1018	31	33.5	32.25	9.675	516.3	SS	ML	0	3870	1857.6	4	1.07	1.21	1.00	1.00	1.00	5.16	52.00	5.00	1.20	11.19	0.91	0.07	0.12	5.33	8.91	NO
Clearwater Pond	3	KC-1018	33.5	36	34.75	10.425	513.8	SS	SW-SM	0	4170	2001.6	4	1.03	1.21	1.00	1.00	1.00	4.97	11.00	1.21	2.79	15.08	0.90	0.07	0.16	5.33	11.78	NO
Clearwater Pond	3	KC-1018	36	38.5	37.25	11.175	511.3	SS	SC-SM	0	4470	2145.6	2	0.99	1.21	1.00	1.00	1.00	2.40	13.00	1.89	2.82	8.66	0.88	0.07	0.10	5.33	7.58	NO
Clearwater Pond	3	KC-1018	38.5	41	39.75	11.925	508.8	SS	GP-GM	0	4770	2289.6	11	0.96	1.21	1.00	1.00	1.00	12.78	10.00	0.87	2.78	36.36	0.86	0.07	No Liquefaction	5.33	No Liquefaction	NO
Clearwater Pond	3	KC-1018	41	43.5	42.25	12.675	506.3	SS	GW	0	5070	2433.6	14	0.93	1.21	1.00	1.00	1.00	15.77	0.00	0.00	0.00	0.00	0.84	0.07	0.05	5.33	3.85	NO
Clearwater Pond	3	KC-1018	43.5	46	44.75	13.425	503.8	SS	SW-SM	0	5370	2577.6	36	0.91	1.21	1.00	1.00	1.00	39.41	5.00	0.00	0.00	0.00	0.81	0.07	0.05	5.33	3.96	NO
Clearwater Pond	3	KC-1018	46	48.5	47.25	14.175	501.3	SS	SW	0	5670	2721.6	16	0.88	1.21	1.00	1.00	1.00	17.05	3.00	0.00	0.00	0.00	0.79	0.06	0.05	5.33	4.09	NO
Clearwater Pond	4	KC-1019	23.5	25	24.25	7.275	557.2	SS	SP-SM	0	2910	1396.8	6	1.23	1.21	1.00	1.00	1.00	8.92	5.00	0.00	0.00	0.00	0.95	0.08	0.05	5.33	3.41	NO
Clearwater Pond	4	KC-1019	28.5	33.5	31	9.3	552.2	SS	SP-SM	0	3720	1785.6	5	1.09	1.21	1.00	1.00	1.00	6.58	5.00	0.00	0.00	0.00	0.92	0.07	0.05	5.33	3.51	NO
Clearwater Pond	4	KC-1019	53.5	60	56.75	17.025	527.2	SS	SP-SM	0	6810	3268.8	8	0.80	1.21	1.00	1.00	1.00	7.78	10.00	0.87	2.78	22.47	0.70	0.06	0.25	5.33	23.49	NO
Clearwater Pond	4	KC-1020	3	6	4.5	1.35	556.5	SS	SM	0	540	259.2	7	1.70	1.21	1.00	1.00	1.00	14.38	13.00	1.89	2.82	42.43	0.99	0.08	No Liquefaction	5.33	No Liquefaction	NO
Clearwater Pond	4	KC-1020	31	40	35.5	10.65	528.5	SS	SM	0	4260	2044.8	3	1.02	1.21	1.00	1.00	1.00	3.69	14.00	2.20	2.84	12.66	0.89	0.07	0.14	5.33	10.12	NO
Bottom Ash Pond	5	KC-1021	58.5	60	59.25	17.775	521.7	SS	SM	0	7110	3412.8	11	0.79	1.21	1.00	1.00	1.00	10.47	13.00	1.89	2.82	31.40	0.67	0.05	No Liquefaction	5.33	No Liquefaction	NO
Bottom Ash Pond	5	KC-1022	33.5	40	36.75	11.025	529.2	SS	SM	0	4410	2116.8	7	1.00	1.21	1.00	1.00	1.00	8.46	19.00	3.43	2.92	28.16	0.88	0.07	0.38	5.33	27.91	NO

Note:
1. The "Simplified Method" described by Youd et al (2001) was used.
2. An earthquake moment magnitude (Mw) of 3.9 was assumed.
3. A peak ground acceleration of 0.06 g was used.

Bottom Ash Pond is also known
as Boiler Slag Pond

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 2008–1221

Prepared in cooperation with the Ohio Department of Natural Resources, Division of Geological Survey

Earthquakes in Ohio and Vicinity 1776–2007

Compiled by **Richard L. Dart[1] and Michael C. Hansen[2]**

2008

This map summarizes more than 200 years of Ohio earthquake history. The history of Ohio earthquakes was derived from letters, journals, diaries, newspaper accounts, scholarly articles and, beginning in the early twentieth century, instrumental recordings (seismograms). All historical (pre-instrumental) earthquakes that were large enough to be felt have been located based on anecdotal accounts. Some of these events caused damage to buildings and their contents. The more recent widespread use of seismographs has allowed many small earthquakes, previously undetected, to be recorded and accurately located. The seismicity map (right) shows the historically located and instrumentally recorded earthquakes in and near Ohio.

EARTHQUAKES

Earthquakes occur as a result of slip on faults, typically many kilometers underground, and most earthquakes occur along the boundaries of moving crustal plates. Ohio is within the North American plate, far away from any plate boundaries. Usually it is not possible to determine exactly which fault causes an earthquake. Accordingly, the most direct indicators of earthquake hazards are the earthquakes themselves, not the faults on which they occur nor the motions of crustal plates.

Before earthquakes were instrumentally recorded, estimated locations were typically within a few tens of kilometers of the actual epicenters. Even with modern instrumentation, however, earthquake locations within the Earth are only approximations, usually within several kilometers of their actual locations. However, in areas where networks of closely spaced recording instruments exist earthquakes can be more accurately located. Despite location uncertainties earthquakes have occurred in most parts of Ohio during the last 200 years.

Magnitude (M) is the most common measure of an earthquake's size. An earthquake's magnitude reflects the total energy released as seismic waves. There are several methods to measure earthquake magnitude. The first and most frequently cited is the "Richter scale." The different methods used can give slightly different magnitude values for the same earthquake. As a result, differences of several tenths of a magnitude may be reported.

Although the size of an earthquake is characterized by its *magnitude*, a single number, the levels of ground shaking are characterized by a range of *intensity* values, which vary over the affected area. The Modified Mercalli Intensity (MMI) scale defines recognized intensity values from I (barely felt or not felt) to XII (total destruction; see table at far right). Modified Mercalli Intensity VI marks the onset of slight damage to poorly built structures, whereas MMI VII or higher generally results in considerable damage to buildings—even their collapse. An earthquake's intensity usually decreases away from its epicenter location. Earthquake isoseismal (intensity) maps show this pattern of decreasing seismic shaking away from the place where the earthquake occurred. Isoseismal maps also illustrate how different ground conditions affect intensity values resulting in intensity patterns that are more irregular than might be expected. Two isoseismal maps for Ohio earthquakes are shown (far right).

EASTERN U.S. EARTHQUAKES

Earthquakes are less common east of the Rocky Mountains than in Pacific coast states, such as California. However, because of differences in crustal properties, an earthquake that occurs in the eastern U. S. of the same magnitude as a west coast earthquake can affect a much larger area. A magnitude 4.0 eastern U.S. earthquake typically can be felt 100 km (60 mi) from where it occurred and will frequently cause damage near its source. A magnitude 5.5 eastern U.S. earthquake usually can be felt 500 km (300 mi) from where it occurred and can sometimes cause damage as far away as 40 km (25 mi).

EARTHQUAKES IN OHIO AND VICINITY

In terms of tectonic setting, Ohio is part of a much larger geographic area known as the Stable Continental Region (Wheeler, 2003). This region includes all of eastern North America. Exclusive of several selected areas, such as the New Madrid seismic zone, this region experiences infrequent earthquakes. Earthquakes, as previously stated, are generated as the result of movement on faults often thousands of feet below ground. Although there are many known faults within the Stable Continental Region, few of the earthquakes that occur here are associated with known faults.

Ohio has experienced more than 160 felt earthquakes since 1776. Most of these events caused no damage or injuries. However, 15 Ohio earthquakes resulted in property damage and some minor injuries. The largest historic earthquake in the State occurred in 1937. This event had an estimated magnitude of 5.4 and caused considerable damage in the town of Anna and in several other western Ohio communities. At least 40 earthquakes have been felt in this area since 1875. Northeastern Ohio, east of Cleveland, is another area of seismic interest. There a 5.0 magnitude event in 1986 caused moderate damage. In southern Ohio more than 30 earthquakes have been felt. Due to a lack of information and location uncertainty, two early felt events in 1776 and 1779 (Hansen, 2006) are not plotted on this map.

The origins of Ohio earthquakes, as with earthquakes throughout the central and eastern U.S., are poorly understood. However, Ohio earthquakes appear to be associated with ancient zones of weakness within the North American continental crust. These zones of weakness are characterized by deeply buried and poorly documented faults. Some of these weak zones periodically release accumulated strain in the form of earthquakes.

Ohio is on the periphery of the New Madrid seismic zone, site of the 1811–1812 earthquake sequence, the largest earthquake sequence to occur in historical times in the continental U.S. Some of the events in this sequence had magnitudes in the range of 8.0 and were felt throughout all of the eastern U.S. The intensity of ground shaking generated by these large earthquakes toppled chimneys as far away from the epicenter as Cincinnati.

The table below lists notable earthquakes, magnitude 3.5 and greater, located in Ohio and vicinity. On the earthquake location map at right, these events, with one exception, are labeled with their dates of occurrence. The single exception is the earliest recorded earthquake in the State, a magnitude 4.0 event, that occurred in the summer of 1776 near the Muskingum River in south-central Ohio. The location for this event is an approximation and is not considered accurate. It is not listed in the table.

NOTABLE OHIO AND VICINITY EARTHQUAKES MAGNITUDE ≥ 3.5

YR	MO	DY	LAT (°N)	LON (°W)	MAG	SOURCE
1824	7	15	39.7	80.5	4.1	NCEER
1834	11	20	39.6	84.3	3.5	OSN
1834	11	20	38.65	83.8	3.5	OSN
1843	6	19	40.1	83.8	3.5	OSN
1848	4	6	39.65	82.53	3.7	NCEER
1854	1	11	39.4	83.7	3.5	CERI
1857	2	27	42.31	80.94	4.1	OSN
1873	1	4	40.2	83.0	3.8	NCEER
1875	6	18	40.2	84.0	4.7	NCEER
1884	9	19	40.7	84.1	4.8	PDE
1885	1	18	41.15	81.55	3.8	NCEER
1886	5	3	39.36	82.24	3.8	NCEER/OSN
1892	4	15	40.55	84.57	3.8	NCEER
1894	11	24	39.27	81.56	3.8	OSN
1901	5	17	38.73	82.99	4.3	NCEER
1926	11	5	39.1	82.1	3.6	NCEER
1929	3	8	40.4	84.2	3.7	NCEER
1930	9	30	40.3	84.3	4.2	NCEER
1931	9	20	40.43	84.27	4.7	NCEER
1937	3	2	40.49	84.27	4.9	NCEER
1937	3	9	40.47	84.28	5.4	NCEER/PDE
1943	3	9	41.63	81.31	4.4	NCEER
1944	11	13	40.4	84.4	4.1	NCEER
1947	8	10	41.93	85.0	4.5	NCEER
1952	6	20	39.64	82.02	3.9	NCEER
1953	6	12	41.7	83.6	3.5	NCEER
1956	1	27	40.5	84.0	3.7	NCEER
1956	1	27	40.4	84.2	3.7	NCEER
1961	2	22	41.2	83.3	3.7	NCEER
1967	4	8	39.65	82.53	3.7	NCEER
1974	10	20	39.06	81.61	3.8	NCEER
1979	11	9	38.49	82.81	3.8	NCEER/OSN
1983	8	17	38.47	82.77	3.5	NCEER/OSN
1986	1	31	41.65	81.16	5.0	PDE
1986	7	12	40.55	84.39	4.5	ASN
1987	7	13	41.896	80.767	3.8	PDE
1991	1	26	41.61	81.594	3.5	JCU
1993	10	16	41.698	81.012	3.6	PDE
1995	2	19	39.12	83.47	3.6	PDE
1998	9	25	41.495	80.388	5.2	PDE
2001	1	26	41.942	80.802	4.3	PDE
2003	6	30	41.8	81.2	3.6	PDE
2006	6	20	41.84	81.23	3.8	PDE

OHIO SEISMIC NETWORK

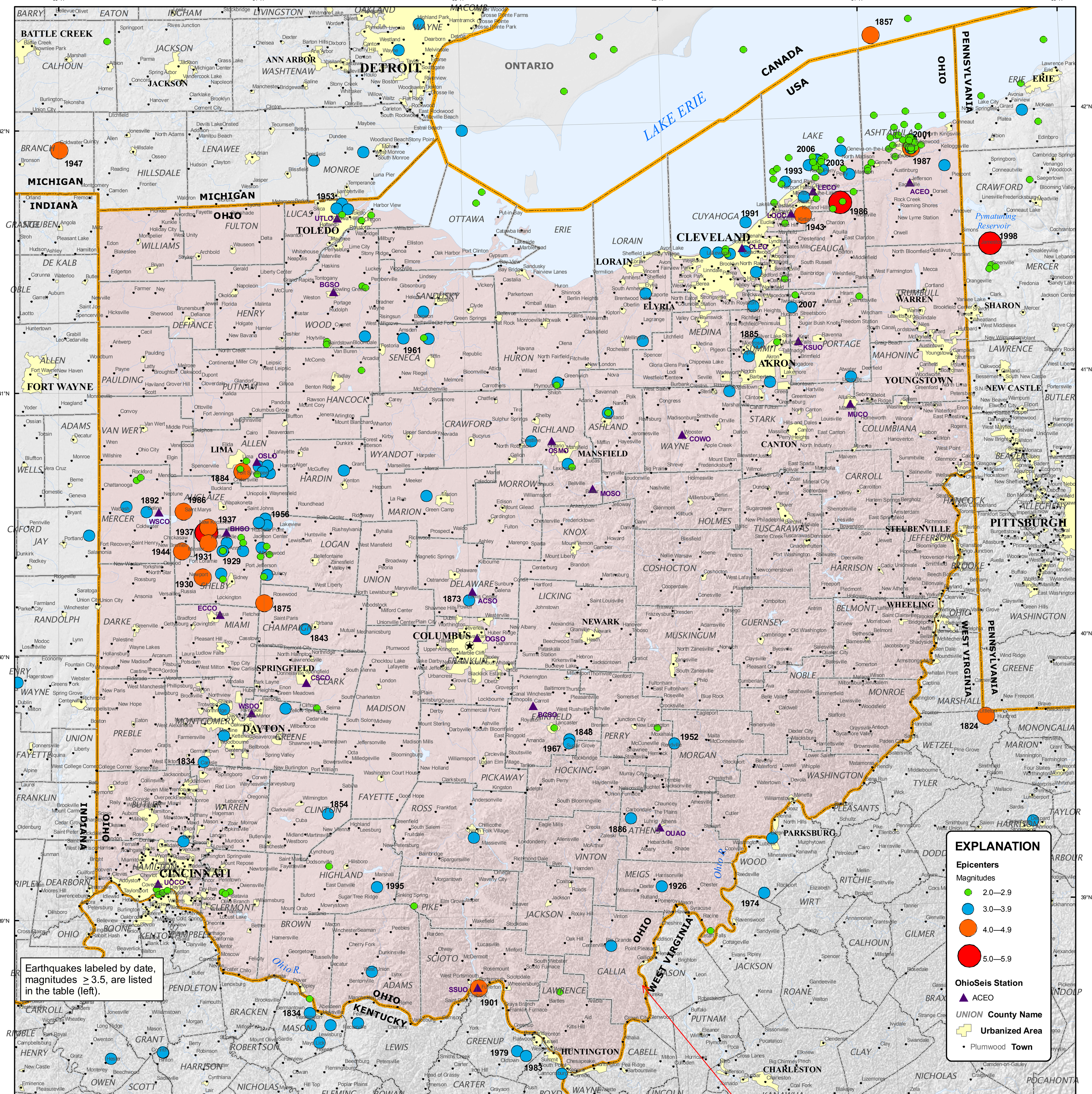
The Division of Geological Survey of the Ohio Department of Natural Resources coordinates a 25-station cooperative network of seismograph stations (OhioSeis) in order to continuously record earthquake activity in the state and the surrounding region as shown on the map. These stations are located across the state at colleges, universities, and other institutions, but are concentrated in the most seismically active areas or in areas that provide optimal conditions for detecting and locating small earthquakes. Small earthquakes are important because they occur more frequently than larger earthquakes and help to identify faults that may periodically produce larger, potentially damaging earthquakes.

The Ohio Division of Geological Survey coordinates the seismic network and operates from the Ohio Earthquake Information Center at the Division's Laboratory at Alum Creek State Park, north of Columbus. This seismograph system allows earthquakes anywhere in the state to be rapidly located and their magnitudes to be quickly calculated.

The OhioSeis network was established with the purposes of accurately locating and evaluating Ohio earthquakes, providing information to the public, and defining areas of seismic risk. The network is a joint State and Federal project, part of the National Earthquake Hazards Reduction Program (NEHRP, http://www.nehrp.gov/).

[1] U. S. Geological Survey, Box 25046, MS 966, Denver, CO 80225, USA
[2] Department of Geological Sciences, University of South Carolina, 701 Sumter Street, EWS 617, Colunbia, SC 29208, USA

Earthquake Locations



Base from U.S. Geological Survey National Elevation Dataset, National Hydrologic Database, and Digital Chart of the World (ESRI, 1993)

Albers equal-area conic projection, standard parallels 30° 20′ 00′′ and 35° 40′ 00′′, central meridian -85° 00′ 00′′, latitude of origin 0° 00′ 00′′

SCALE 1:1,000,000

GENERAL SITE LOCATION

EARTHQUAKE CATALOGS

Various institutions and agencies compile catalogs of earthquake data. Each uses different criteria in determining the catalog's content. The earthquake locations shown on the map were taken from several catalogs. To some extent, these catalogs cover overlapping time periods. An attempt has been made to locate and remove duplicate events. In the case of event duplication the order of catalog preference, as listed, was generally applied:

- OSN, Ohio Seismic Network, 1999–2007
- ASN, Anna Seismic Network, 1977–1992
- JCU, John Carrol University Seismological Observatory, 1900–1992
- UTLO, University of Toledo seismic station
- UK, University of Kentucky
- LCSN, Lamont-Doherty Cooperative Seismic Network, 1990–2005
- DNAG, Decade of North American Geology, 1534–1985
- NCEER, National Center for Earthquake Engineering Research, 1627–1985
- SIGUS, *Significant Earthquakes in the U.S.* (Stover and Coffman, 1993), 1568–1989
- PDE, Preliminary Determination of Epicenters, 1973–2007
- CERI, Center for Earthquake Research and Information, 1974–2007

The catalogs used may contain mining-related and other types of non-earthquake events. Mining events are typically of small magnitude and may not be easily differentiated from small earthquakes (Street and others, 2002). An attempt was made to exclude non-earthquake events.

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SEISMIC HAZARD

Some level of seismic hazard from earthquake ground shaking exists in every part of the United States. The severity of the ground shaking, however, can vary greatly from place to place. Seismic hazard maps, like the one shown at right, illustrate this variation. The risk level shown on seismic hazard maps is based on a variety of factors, such as earthquake rate of occurrence, magnitude, extent of affected area, strength and pattern of ground shaking, and geologic setting.

Seismic hazard maps are tools for determining acceptable risk. As such, they are critical in helping to save lives and preserve property. They provide information essential to the creation and updating of seismic design provisions for local building codes. Because most buildings and other structures in the central United States were not built to withstand severe ground shaking, damage could be catastrophic in the event of a powerful earthquake. The work of seismic-hazard scientists and engineers provides the groundwork for future urban environments that will be safer if large magnitude earthquakes occur. Additional applications of the information derived from these maps include insurance-rates setting, estimating hillside stability and landslide potential, and estimating assistance funds needed for earthquake education and preparedness.

Seismic hazard maps are an estimation of how the ground in a particular area is likely to respond to local and regional earthquakes. They differ from isoseismal maps in that they are probability maps. They illustrate what shaking levels are likely, or example a 2 percent probability that it will be worse over a stated time period (for example, 50 years).

The seismic energy released during an earthquake radiates in all directions as waves. As the seismic waves move upward they are amplified or de-amplified as they travel through the sediment layers near the ground surface. Seismic wave amplification or de-amplification can significantly affect the way the ground shakes during an earthquake.

An additional factor in determining how the ground will respond during an earthquake is the rate of shaking. As a seismic wave passes a given map location, the ground will vibrate. If ground vibration (oscillation) is rapid (short-period motion), the seismic wave's energy will dissipate quickly. Conversely, if the ground vibration is slow (long-period motion), the wave's energy will dissipate less rapidly. Long-period waves propagate farther and retain their energy over longer distances than do short-period waves.

A final factor in determining ground response to earthquake shaking is the strength of shaking. If ground shaking is particularly violent, sediments may break apart, preventing seismic waves from continuing to be transmitted through them. This would have the beneficial effect of limiting shaking, but such extreme shaking could result in catastrophic ground failure.

The generalized seismic-hazard map (right) is a computer-generated contour map. It portrays seismic hazard calculated by the U.S. Geological Survey as bands of color (cooler blues and grays for less hazard, warmer greens and yellows for greater hazard). Shaking level is expressed as percentage of the acceleration of gravity (%*g*), and seismic hazard values are computed for particular time intervals (here, 50 years) and probability of exceedance (here, 2 percent). For example, the hazard value in Cincinnati is between 6%*g* and 8%*g*. That means a structure built on firm rock has 1 in 50 odds (2 percent probability) of undergoing ground shaking of 6% – 8%*g* or higher in the next 50 years. In terms of shaking, the acceleration a person or object experiences is proportional to the force applied to it by the passing seismic wave.

OHIO SEISMIC ZONES

Anna Seismic Zone

This small seismic zone in western Ohio (right) has had moderately frequent earthquakes at least since the first one was reported in 1875. The two largest earthquakes (March 2 and 9, 1937) located in the zone caused damage. Moderately damaging earthquakes occur in the Anna seismic zone every two or three decades, and smaller earthquakes are felt here two or three times per decade. Historically, seismicity has been episodic with periods of frequent activity and periods of low activity.

Some of the Anna seismic zone earthquakes appear to coincide with the known faults, while others do not. At earthquake depths the positions of even known faults are uncertain, and many small or deeply buried faults may remain undetected. Accordingly, few earthquakes in the seismic zone can be linked to known faults and it is difficult to determine if a specific known fault is active and capable of generating an earthquake.

The Anna seismic zone lacks paleoseismological evidence for faulting younger than Paleozoic. However, north-, north-northeast-, and northwest-striking faults in lower Paleozoic and Precambrian crystalline rocks have been mapped and are part of the Precambrian-age East Continental Rift Zone. No evidence has been found that the zone has had an earthquake larger than magnitude 7 in the past several thousand years.

Northeast Ohio Seismic Zone

The Northeast Ohio seismic zone (map at upper right) has had moderately frequent earthquakes at least since the first one was reported in 1836. The largest earthquake in this zone (magnitude 5.0) occurred in 1986. This event produced Modified Mercalli intensities of VI in the epicentral region. A damaging earthquake (magnitude 5.2) occurred in 1998 near Pymatuning in northwestern Pennsylvania, just east of the Ohio border. An earthquake in the Ashtabula, Ohio, area (magnitude 4.3) in 2001 caused minor damage. Historically this zone has recorded only a few earthquakes per decade, but felt earthquakes have been reported more frequently in recent decades. This is probably a result of increased population, greater public awareness, improved communications, and perhaps episodic seismicity.

NEARBY SEISMIC ZONES

Eastern Tennessee Seismic Zone

The Eastern Tennessee seismic zone (map at upper right) is one of the most active earthquake areas in the southeastern United States. A few earthquakes located within this zone have caused property damage. The largest recorded earthquake in this zone (magnitude 4.6) occurred in 2003, near Fort Payne, Alabama. Felt earthquakes occur about once a year in this seismic zone, and seismographs have recorded hundreds of smaller, unfelt earthquakes in recent decades.

The Eastern Tennessee seismic zone contains many known faults. However, the locations of these faults are poorly known at earthquake depths. Few, if any, earthquakes in the Eastern Tennessee seismic zone can be linked to known faults, and it is difficult to determine if any known faults are seismically active.

Giles County Seismic Zone

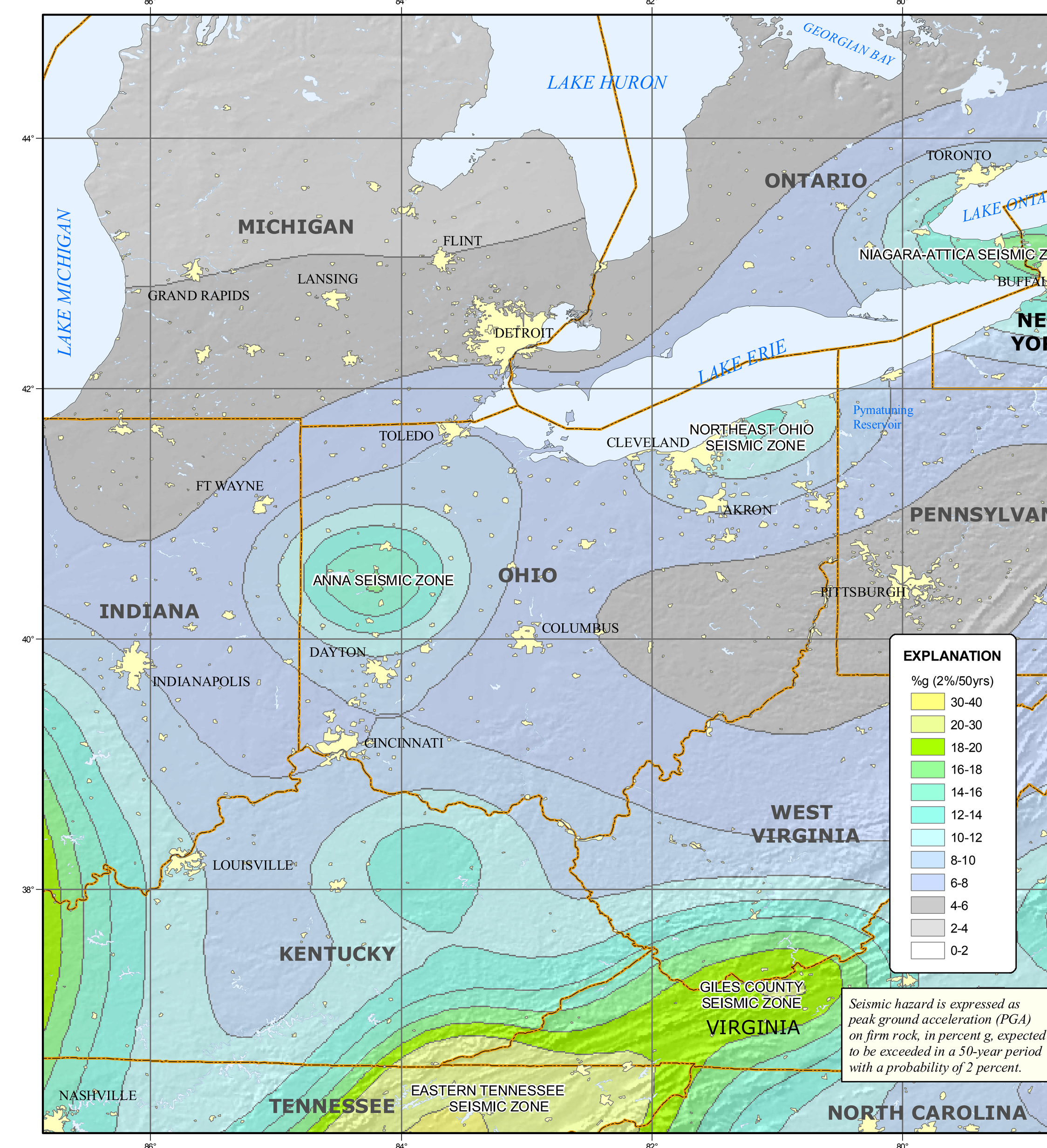
Since at least 1828, earthquakes have been reported in the Giles County seismic zone. The largest known damaging earthquake (M5.6) in the zone occurred in 1897. Smaller earthquakes are felt or cause light damage once or twice a decade (Tarr and Wheeler, 2006).

Niagara-Attica Seismic Zone, New York-Ontario

The Niagara-Attica seismic zone in southern Ontario and western New York State (map at upper right) has had moderately frequent earthquakes at least since the first one was reported in 1840. The largest event (magnitude 4.9) in the zone caused moderate damage in 1929 near Attica, New York. Earthquakes too small to cause damage are felt roughly three or four times per decade.

In this zone many faults are known, but few have been traced to earthquake depths; and only a few earthquakes in the zone can be associated with named faults. It is, therefore, difficult to determine if any known faults are seismically active. Numerous smaller or deeply buried faults may remain undetected.

Regional Seismic Hazard



Base from U.S. Geological Survey National Elevation Dataset, National Hydrologic Database, and Digital Chart of the World (ESRI, 1993)

Geographic projection, Datum: D North American 1983

SCALE 1:2,500,000

ABBREVIATED MODIFIED MERCALLI INTENSITY SCALE

Expressed as Roman numerals, earthquake intensities are not instrumentally derived values. They are instead assigned based on descriptive reports from intensity.

I. Not felt except by a very few under especially favorable conditions.
II. Felt only by a few persons at rest, especially on upper floors of buildings.
III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings with partial collapse. Buildings shifted off foundations.
X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

INTENSITY AND MAGNITUDE

Intensity is an estimation of earthquake shaking level based on effects on people, buildings, and the landscape expressed here by using the Modified Mercalli Intensity Scale (table at left). During an earthquake, intensity will vary over the affected region. Intensity values for different locations are derived from written accounts (letters, journals and diaries) and published records (newspapers and official reports). These values diminish from a maximum, usually observed near the earthquake's epicenter, to the lowest levels of the scale near the edge of the felt area.

Although an earthquake has a wide distribution of intensity values (isoseismal maps, below left), it has only one *magnitude*. An earthquake's magnitude represents the total energy released. The magnitudes of pre-instrumental earthquakes are estimates based on intensity values recorded at the time of the earthquake or shortly after. The earthquake symbols plotted on the large state map (far left) represent the best estimates of time, location, and magnitude tabulated using several earthquake catalogs.

NOTES ON THE ISOSEISMAL MAPS

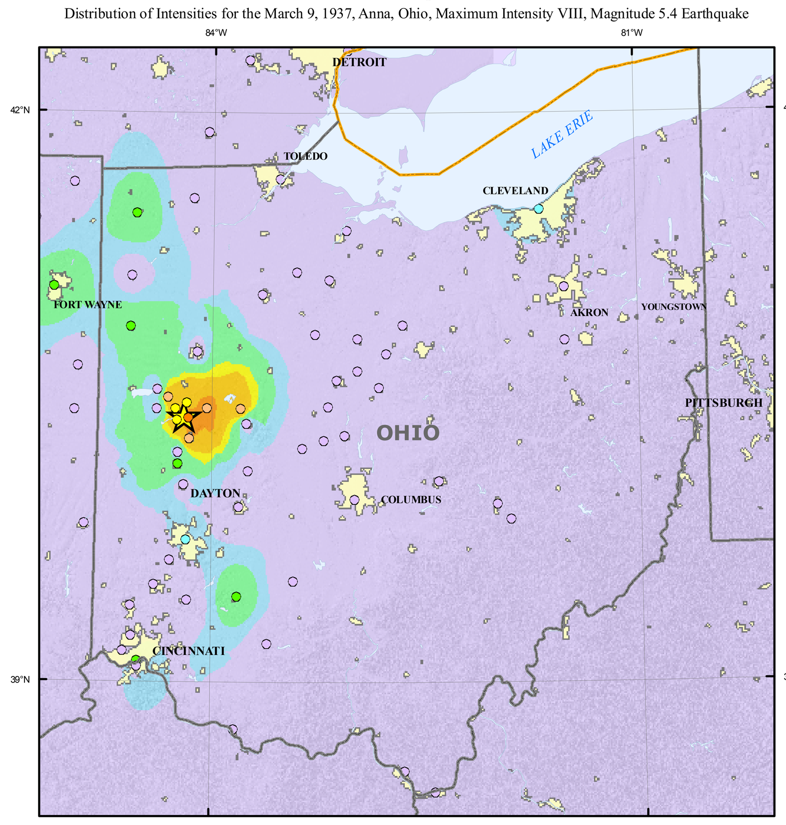
Isoseismal maps illustrate the level of ground shaking that occurred at various locations during a particular earthquake. The distributions of intensity values in Ohio and vicinity for two earthquakes are shown on the isoseismal maps (left). These events are the March 9, 1937, maximum intensity VII, magnitude 5.4, Anna earthquake and the January 31, 1986, maximum intensity VI, magnitude 5.0, northeast Ohio earthquake.

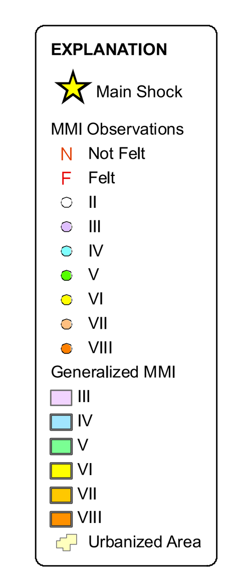
Contemporary accounts from newspapers of earthquake effects in cities and towns over a broad region were the sources of the intensity observations plotted on the isoseismal maps. The intensity observations are shown as color-coded circles. Each observation was assigned a Modified Mercalli Intensity (MMI) and the results were contoured. The mapped intensity values (integers) correspond to the Roman numeral values in the table (above left). An observation coded "F" is a location where shaking was felt but no MMI value was assigned and "N" if source document indicated that the event was not felt.

Contouring of the assigned intensity values, shown as circles on the maps (left), was computer generated using an inverse-distance weighted algorithm. The assigned values are from Neumann (1937) for the Anna earthquake and from Stover and Brewer (1994) for the northeast Ohio earthquake.

Isoseismal Map

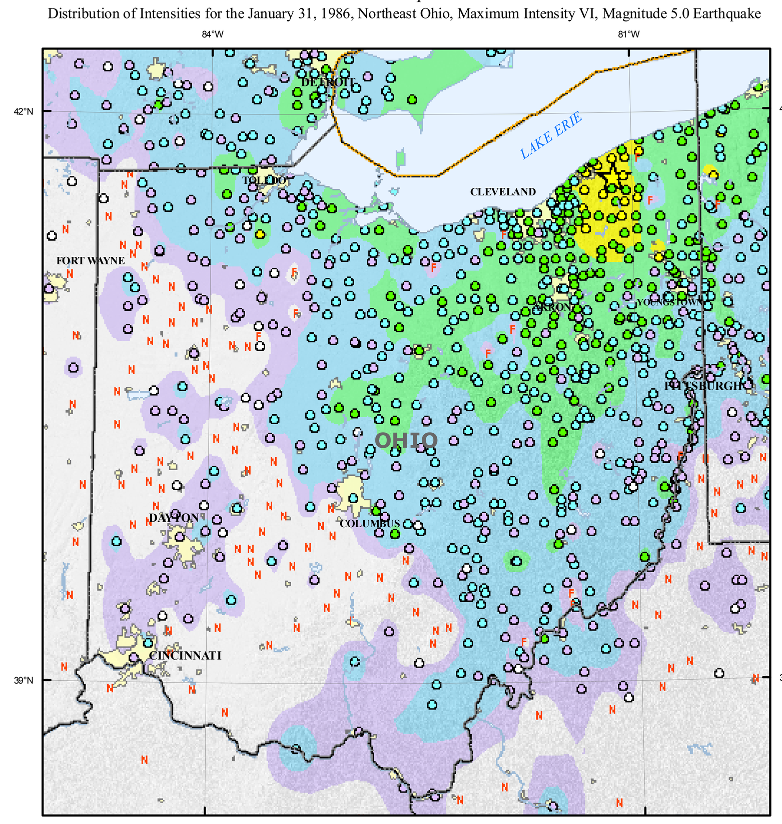
Distribution of Intensities for the March 9, 1937, Anna, Ohio, Maximum Intensity VIII, Magnitude 5.4 Earthquake





Isoseismal Map

Distribution of Intensities for the January 31, 1986, Northeast Ohio, Maximum Intensity VI, Magnitude 5.0 Earthquake



Author's Note

The information presented here was derived from existing sources and earlier publications. Specifically, general information on earthquake occurrence and seismic hazard came from Tarr and Wheeler, 2006. This downloadable report is available at http://pubs.usgs.gov/of/2006/1017/. Several additional publications provided detailed information on Ohio earthquake history. They include Stover and Coffman, 1993; Crone and Wheeler, 2000; Wheeler, 2003; Hansen, 2006.

CITATION

Dart, R.L., and Hansen, M.C., 2008, Earthquakes in Ohio and Vicinity 1776–2007: U.S. Geological Survey Open-File Report 2008–1221.

DISCLAIMER

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A PDF of this report is available at: http://pubs.usgs.gov/of/2008/1221

EXHIBIT 8

EXHIBIT 9 - KYGER CREEK ASH IMPOUNDMENT - LIQUEFACTION ANALYSIS OF FINE-GRAINED SOILS

						Soil Classification		Particle Size Distribution				Atterberg Limits				ILLINOIS DOT[1]			USACE Recommendation[2]				OHIO EPA Recommendations[3]			
Location	Cross-section No.	Boring No.	Sample No.	Depth, ft	Elevation, ft	Textural	USCS	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index, PI	Percent Moisture, Wc	IS PI<12	IS Wc/LL > 0.85	Is Soil Liquefiable	Is Fine Contents >20%	Is LL >=34	Is PI >=14	Is Soil Liquefiable	Is Fine Contents <15%	Is LL <35	IS Wc >0.9LL	Is Soil Liquefiable
South Fly Ash Pond	1	KC-1001	ST-2	28.5	560.8	Lean Clay	CL	0	8	47	45	34	20	14	23	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO
South Fly Ash Pond	1	KC-1001	S-17	46	543.3	Lean Clay	CL	0	8	58	34	34	20	14	29.5	NO	YES	NO	NO	NO	NO	NO	NO	YES	NO	NO
South Fly Ash Pond	1	KC-1002	ST-1	8.5	549.8	Sandy Lean Clay	CL	0	16	52	32	32	13	19	25.8	NO	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO
South Fly Ash Pond	2	KC-1003	S-7	16	572.4	Lean Clay	CL	0	24	45	31	30	18	12	19.5	NO	NO	NO	NO	YES	YES	NO	NO	YES	NO	NO
South Fly Ash Pond	2	KC-1003	ST-2	31	557.4	Lean Clay	CL	0	17	47	36	31	18	13	18.6	NO	NO	NO	NO	YES	YES	NO	NO	YES	NO	NO
South Fly Ash Pond	2	KC-1003	S-19	53.5	534.9	Lean Clay with sand	CL	0	17	50	33	31	21	10	33.7	YES*	YES*	YES*	NO	YES	YES	NO	NO	YES	YES	NO
South Fly Ash Pond	2	KC-1004	S-8	16	539.8	Lean Clay with sand	CL	0	20	51	29	32	19	13	28.3	NO	YES	NO	NO	YES	YES	NO	NO	YES	NO	NO
South Fly Ash Pond	3	KC-1005	ST-2	18.5	569.7	Lean Clay	CL	0	13	48	39	37	21	16	21	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
South Fly Ash Pond	3	KC-1005	S-18	48.5	540.2	Sandy Silty Clay	CL-ML	0	30	46	24	25	21	4	25.3	YES*	YES*	YES*	NO	YES	YES	NO	NO	YES	YES	NO
South Fly Ash Pond	3	KC-1005	S-19	53.5	534.7	Silty Clay with sand	CL-ML	0	26	51	23	26	19	7	32.1	YES*	YES*	YES*	NO	YES	YES	NO	NO	YES	YES	NO
South Fly Ash Pond	3	KC-1006	S-7	13.5	563.4	Lean Clay	CL	0	10	42	48	41	21	20	24.2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
South Fly Ash Pond	3	KC-1006	S-14	31	545.4	Lean Clay with sand	CL	0	20	45	35	48	20	28	23.2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
South Fly Ash Pond	4	KC-1007	S-7	16	573	Lean Clay	CL	0	13	44	43	39	22	17	24.9	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
South Fly Ash Pond	4	KC-1007	S-19	46	543.5	Lean Clay with sand	CL	0	22	52	26	28	18	10	26	YES*	YES*	YES*	NO	YES	YES	NO	NO	YES	YES	NO
South Fly Ash Pond	4	KC-1008	S-5	6	574.9	Lean Clay	CL	0	5	53	42	40	22	17	24.4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
South Fly Ash Pond	4	KC-1008	S-11	21	559.9	Lean Clay	CL	0	6	47	47	41	22	19	24.5	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
South Fly Ash Pond	4	KC-1008	S-18	38.5	542.4	Sandy Lean Clay	CL	0	35	43	22	24	16	8	25.5	YES*	YES*	YES*	NO	YES	YES	NO	NO	YES	YES	NO
South Fly Ash Pond	5	KC-1009	ST-1	16	573.2	Lean Clay	CL	0	29	36	35	32	18	14	21.5	NO	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO
South Fly Ash Pond	5	KC-1009	ST-2	26	563.2	Lean Clay	CL	0	7	52	41	38	22	16	22.9	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
South Fly Ash Pond	5	KC-1009	S-19	53.5	535.7	Sandy Lean Clay	CL	0	31	45	24	28	20	8	27.4	YES*	YES*	YES*	NO	YES	YES	NO	NO	YES	YES	NO
South Fly Ash Pond	5	KC-1010	S-5	6	559.1	Lean Clay with sand	CL	0	4	58	38	36	20	16	22.8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
South Fly Ash Pond	5	KC-1010	S-11	23.5	541.6	Sandy Lean Clay	CL	0	44	35	20	24	18	6	25.2	YES*	YES*	YES*	NO	YES	YES	NO	NO	YES	YES	NO
South Fly Ash Pond	5	KC-1010	ST-2	31	534.1	Sandy Lean Clay	CL	0	31	50	19	29.4	26	18	8	NO	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO
South Fly Ash Pond	6	KC-1011	S-5	11	578.2	Lean Clay	CL	0	11	55	34	34	20	14	22.2	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO
South Fly Ash Pond	6	KC-1011	S-16	38.5	550.7	Lean Clay with sand	CL	0	15	51	34	33	19	14	26.4	NO	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO
South Fly Ash Pond	6	KC-1012	S-5	6	557	Lean Clay with sand	CL	0	1	56	43	41	22	19	25.3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
South Fly Ash Pond	6	KC-1012	ST-2	21	542	Sandy Lean Clay	CL	0	35	43	22	26	19	7	25.7	YES*	YES*	YES*	NO	YES	YES	NO	NO	YES	YES	NO
Bottom Ash Pond	1	KC-1013	S-5	11	570.3	Lean Clay with sand	CL	2	8	52	38	37	21	16	25.9	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Bottom Ash Pond	1	KC-1013	S-18	48.5	532.8	Sandy Lean Clay	CL	0	23	47	30	30	18	12	28	NO	YES	NO	NO	YES	YES	NO	NO	YES	YES	NO
Bottom Ash Pond	1	KC-1014	ST-1	11	547.6	Lean Clay	CL	0	2	57	41	40	22	18	25.7	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Bottom Ash Pond	1	KC-1014	S-13	31	527.6	Sandy Lean Clay	CL	0	32	43	25	25	16	9	26.9	YES*	YES*	YES*	NO	YES	YES	NO	NO	YES	YES	NO
Bottom Ash Pond	2	KC-1015	S-6	13.5	566.9	Sandy Lean Clay	CL	0	12	54	34	34	20	14	21.1	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO
Bottom Ash Pond	2	KC-1015	S-16	46	534.4	Sandy Lean Clay	CL	0	32	44	24	28	19	9	25.5	YES*	YES*	YES*	NO	YES	YES	NO	NO	YES	YES	NO
Bottom Ash Pond	2	KC-1016	ST-1	8.5	535.3	Lean Clay with sand	CL	0	1	54	45	40	22	18	34.4	NO	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO
Clearwater Pond	3	KC-1017	ST-1	18.5	561.6	Sandy Lean Clay	CL	0	23	46	31	29	18	11	22.4	YES	NO	NO	NO	YES	YES	NO	NO	YES	NO	NO
Clearwater Pond	3	KC-1017	S-15	41	539.1	Lean Clay	CL	0	3	51	46	42	25	17	31.9	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Clearwater Pond	3	KC-1017	S-19	53.5	526.6	Sandy Lean Clay	CL	0	18	54	28	33	20	13	27.3	NO	NO	NO	NO	YES	YES	NO	NO	YES	NO	NO
Clearwater Pond	3	KC-1018	ST-1	8.5	538.8	Lean Clay	CL	0	4	53	43	44	24	20	21.8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Clearwater Pond	3	KC-1018	S-9	18.5	529.3	Lean Clay	CL	0	5	63	32	36	21	15	30.5	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Clearwater Pond	4	KC-1019	S-8	21	559.7	Lean Clay	CL	0	13	51	36	33	20	13	23.9	NO	NO	NO	NO	YES	YES	NO	NO	YES	NO	NO
Clearwater Pond	4	KC-1019	ST-2	26	554.7	Sandy Silt	ML	0	38	38	24	21	18	3	22	YES*	YES*	YES*	NO	YES	YES	NO	NO	YES	YES	NO
Clearwater Pond	4	KC-1020	S-5	6	553.5	Lean Clay	CL	0	7	58	35	38	22	17	23.1	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Clearwater Pond	4	KC-1020	S-7	16	543.5	Sandy Lean Clay	CL	0	19	54	27	32	20	12	23.7	NO	NO	NO	NO	YES	YES	NO	NO	YES	NO	NO
Clearwater Pond	4	KC-1020	S-12	28.5	531	Sandy Lean Clay	CL	0	30	46	24	28	17	11	25.4	YES*	YES*	YES*	NO	YES	YES	NO	NO	YES	YES	NO
Bottom Ash Pond	5	KC-1021	ST-1	18.5	561.7	Sandy Lean Clay	CL	0	21	46	33	32	20	12	21.4	NO	NO	NO	NO	YES	YES	NO	NO	YES	NO	NO
Bottom Ash Pond	5	KC-1021	S-15	41	539.2	Sandy Lean Clay	CL	0	34	46	20	28	19	9	25.6	YES*	YES*	YES*	NO	YES	YES	NO	NO	YES	YES	NO
Bottom Ash Pond	5	KC-1022	S-4	4.5	558.2	Sandy Silty Clay	CL-ML	0	41	40	19	22	18	4	15.2	YES	NO	NO	NO	YES	YES	NO	NO	YES	NO	NO
Bottom Ash Pond	5	KC-1022	S-7	16	546.7	Sandy Lean Clay	CL	0	40	38	22	25	17	8	18.1	YES	NO	NO	NO	YES	YES	NO	NO	YES	NO	NO

*See Spreadsheet for Additional Liquefaction Analyses of Potentially Liquefiable Fine-grained Soils for Fnal Results

Note: 1) Illinois DOT - AGMU Memo 10.1-Liquefaction Analysis, dated January 14, 2010, from the Illinois Department of Transportation.
2) USACE Recommendations - U.S. Army Corps of Engineers. Slope Stability. Engineering Manual 1110-2-1902. October, 2003, page 1-6.
3) OHIO EPA Recommendations - Chapter 5, Liquefaction Potential Evaluation and Analysis, RCRA Subtitle D (258) Seismic Design Guidance for Muncipal Solid Waste Landfill Facilities, EPA/600/R-95/051, April 1995.

Bottom Ash Pond is also known as
Boiler Slag Pond

EXHIBIT 10 - KYGER CREEK ASH IMPOUNDMENT - ADDITIONAL LIQUEFACTION ANALYSES OF POTENTIALLY LIQUEFIABLE FINE-GRAINED SOILS																												
Location	Cross-section No.	Boring No.	Depth to Top of Layer (ft, bgs)	Depth to Bottom of Layer (ft, bgs)	Mid-point Depth of Layer (ft, bgs)	Mid-point Depth of Layer (m, bgs)	Elevation to Top of Layer (ft, bgs)	Sampler Type	Soil Type	Groundwater Level During Seismic Event (ft, bgs)	Total Overburden Stress, σ, psf	Effective Overburden Stress, σ', psf	N_m, field N-Values	C_N	CE	CB	CR	CS	$(N_1)_{60}$ (blows/ft)	Fine Content (%)	α	β	$(N_1)_{60\,cs}$ (blows/ft)	r_d	CSR	$(CRR)_{7.5}$	MSF	FS_{Liq}	Liquefaction Potential
South Fly Ash Pond	2	KC-1003	53.5	55.5	54.5	16.35	534.9	SS	CL	0	6540	3139.2	3	0.82	1.21	1.00	1.00	1.00	2.98	83.00	5.00	1.20	8.57	0.72	0.06	0.10	5.33	9.23	NO
South Fly Ash Pond	3	KC-1005	48.5	53.5	51	15.3	540.2	SS	CL-ML	0	6120	2937.6	3	0.85	1.21	1.00	1.00	1.00	3.08	70.00	5.00	1.20	8.69	0.75	0.06	0.10	5.33	8.90	NO
South Fly Ash Pond	3	KC-1005	53.5	57	55.25	16.575	534.7	SS	CL-ML	0	6630	3182.4	2	0.82	1.21	1.00	1.00	1.00	1.97	74.00	5.00	1.20	7.36	0.71	0.06	0.09	5.33	8.39	NO
South Fly Ash Pond	4	KC-1007	46	48	47	14.1	543	SS	CL	0	5640	2707.2	6	0.88	1.21	1.00	1.00	1.00	6.41	78.00	5.00	1.20	12.69	0.79	0.06	0.14	5.33	11.42	NO
South Fly Ash Pond	4	KC-1008	38.5	40	39.25	11.775	542.4	SS	CL	0	4710	2260.8	5	0.97	1.21	1.00	1.00	1.00	5.84	65.00	5.00	1.20	12.01	0.86	0.07	0.13	5.33	9.99	NO
South Fly Ash Pond	5	KC-1009	53.5	55.5	54.5	16.35	535.7	SS	CL	0	6540	3139.2	3	0.82	1.21	1.00	1.00	1.00	2.98	69.00	5.00	1.20	8.57	0.72	0.06	0.10	5.33	9.23	NO
South Fly Ash Pond	5	KC-1010	23.5	25.5	24.5	7.35	541.6	SS	CL	0	2940	1411.2	4	1.22	1.21	1.00	1.00	1.00	5.92	55.00	5.00	1.20	12.10	0.94	0.08	0.13	5.33	9.18	NO
South Fly Ash Pond	6	KC-1012	21	23	22	6.6	542	SS	CL	0	2640	1267.2	1	1.29	1.21	1.00	1.00	1.00	1.56	65.00	5.00	1.20	6.87	0.95	0.08	0.09	5.33	5.97	NO
Bottom Ash Pond	1	KC-1014	31	32	31.5	9.45	527.6	SS	CL	0	3780	1814.4	4	1.08	1.21	1.00	1.00	1.00	5.22	68.00	5.00	1.20	11.26	0.92	0.07	0.12	5.33	8.92	NO
Bottom Ash Pond	2	KC-1015	46	47.5	46.75	14.025	534.4	SS	CL	0	5610	2692.8	1	0.89	1.21	1.00	1.00	1.00	1.07	68.00	5.00	1.20	6.29	0.79	0.06	0.08	5.33	6.78	NO
Clearwater Pond	4	KC-1019[4]	26	28	27	8.1	554.7	SS	ML	0	3240	1555.2	4	1.17	1.21	1.00	1.00	1.00	5.64	62.00	5.00	1.20	11.76	0.94	0.08	0.13	5.33	9.05	NO
Clearwater Pond	4	KC-1020	28.5	31	29.75	8.925	531	SS	CL	0	3570	1713.6	1	1.11	1.21	1.00	1.00	1.00	1.34	70.00	5.00	1.20	6.61	0.92	0.08	0.08	5.33	6.00	NO
Bottom Ash Pond	5	KC-1021	41	42	41.5	12.45	539.2	SS	CL	0	4980	2390.4	0	0.94	1.21	1.00	1.00	1.00	0.00	66.00	5.00	1.20	5.00	0.84	0.07	0.07	5.33	5.61	NO

Note:
1. The "Simplified Method" described by Youd et al (2001) was used.
2. An earthquake moment magnitude (Mw) of 3.9 was assumed.
3. A peak ground acceleration of 0.06g was used.
4. The sample is a Shelby tube sample but was assumed as a split spoon sample for analysis.

Bottom Ash Pond is also known as
Boiler Slag Pond

Liquefaction Analysis

This design guide illustrates the Department's recommended procedures for analyzing the liquefaction potential of soil during a seismic event considering Article 10.5.4.2 of the 2009 Interim Revisions for the AASHTO LRFD Bridge Design Specifications and various research. The phenomenon of liquefaction and how it should be evaluated continues to be the subject of considerable study and debate. It is expected that enhancements will evolve and modify how liquefaction should be evaluated and accounted for in design. This design guide outlines the Department's current recommended procedure for identifying potentially liquefiable soils. Also included are recommendations for characterizing the properties and behavior of liquefiable soils so that substructure stiffness and embankment response to seismic loading can be modeled.

Liquefaction Description and Design

Saturated loose to medium dense cohesionless soils and low plasticity silts tend to densify and consolidate when subjected to cyclic shear deformations inherent with large seismic ground motions. Pore-water pressures within such layers increase as the soils are cyclically loaded, resulting in a decrease in vertical effective stress and shear strength. If the shear strength drops below the applied cyclic shear loadings, the layer is expected to transition to a semi fluid state until the excess pore-water pressure dissipates.

Embankments and foundations are particularly susceptible to damage, depending on the location and extent of the liquefied soil layers. Such soils may adequately carry everyday loadings, however once liquefied, retain insufficient capacity for such loads or additional seismic forces. Substructure foundations shall either be designed to withstand the liquefaction or ground improvement techniques shall be used to achieve the IDOT performance objectives of no loss of life or loss of span. End slopes and roadway embankments on liquefiable soils require an analysis to determine the likely extent of pavement/slope damage so that the cost of ground improvement techniques can be compared to alternatives such as re-routing traffic around the damaged lanes or quickly effecting emergency repairs.

The stiffness of liquefiable soils supporting foundations is anticipated to degrade over the duration of the seismic event and reduces the lateral stiffness of the substructure. The reduced stiffness results in increased deflection and moment arm, concern for buckling, and potentially additional loading on adjacent substructures. The lateral stiffness, moments and forces carried by such foundations supported by liquefiable soils is best determined using programs such as COM624 or LPILE. The liquefied soil layers can be modeled in these programs with reduced strength parameters or the p-y curves can be modified to reflect the residual strength of the liquefied layers. Note that the estimated fixity depths indicated in Design Guide 3.15 (Seismic Design) should not be used for analyzing substructures with liquefiable soils.

Vertical ground settlement should be expected to occur following liquefaction. As such, spread footings should not be specified at sites expected to liquefy unless ground improvement techniques are employed to mitigate liquefaction. For driven pile and drilled shaft foundations, the vertical settlement will result in a loss of skin friction capacity and an added negative skin friction (NSF) downdrag load when the liquefiable layers are overlain by non-liquefiable soils. Geotechnical losses from liquefaction and any liquefaction induced NSF loadings shall only be considered with the Extreme Event I limit state group loading, since the strength limit state group loadings represent the conditions prior to, not after a seismic event.

Since liquefaction may or may not fully occur while the peak seismic bridge loadings are applied, structures at sites where liquefaction is anticipated must be analyzed and designed to resist the seismic loadings with nonliquefied conditions as well as a configuration that reflects the locations, extent and reduced strength of the liquefiable layers. However, the design spectra used for both configurations shall be the spectra determined for the nonliquefied configuration.

Embankments and bridge cones are susceptible to lateral movements in addition to vertical settlement during a seismic event. When the seismic slope stability factor of safety approaches 1.0, slope deformations become likely and when liquefaction is expected, these movements can be substantial. The ability of embankments and bridge cones to resist such failures when liquefiable soils are present should be investigated using the slope geometry and static stresses along with residual strength properties for the liquefied soils as described later in the design guide. A new AGMU Memo 10.3 (Slope Stability Design Criteria for Bridges and Roadways) is expected to be issued this year to provide further guidance on the seismic analysis of embankments.

Liquefaction Analysis Criteria

All sites located in Seismic Performance Zones (SPZ) 3 and 4 as well as sites located in SPZ 2 with a peak seismic ground surface acceleration, A_S (PGA modified by the zero-period site factor, F_{pga}), equal to or greater than 0.15, require liquefaction analysis. The exception to this is when the all liquefaction susceptible soils at a site have corrected standard penetration test (SPT) blow counts $(N_1)_{60}$ above 25 blows/ft. or the anticipated groundwater is not within 50 ft of the ground surface. The groundwater elevation used in the analysis should be the seasonally averaged groundwater elevation for the site which may not be equal to that encountered during the soil boring drilling.

Low plasticity silts and clays may experience pore-water pressure increases, softening, and strength loss during earthquake shaking similar to cohesionless soils. Fine-grained soils with a plasticity index (PI) less than 12 and water content (w_c) to liquid limit (LL) ratio greater than 0.85 are considered potentially liquefiable and require liquefaction analysis. While PI is regularly investigated for pavement subgrades, it has rarely been considered in the past for structure soil borings. However, in order to investigate liquefaction susceptibility of fine-grained soils, the plasticity of such soils should be examined when conducting structure soil borings. Drillers should inspect and describe the plasticity of fine-grained soil samples. Low plasticity fine-grained soils, particularly loams and silty loams, should be retained for the Atterberg Limit testing with the results indicated on the soil boring log.

For typical projects, liquefaction analysis shall be limited to the upper 60 ft of the geotechnical profile measured from the existing or final ground surface (whichever is lower). This depth encompasses a significant number of past liquefaction observations used to develop the simplified liquefaction analysis procedure described below. If the liquefaction analysis indicates that the factor of safety (FS) against liquefaction is greater than or equal to 1.0, no further concern for liquefaction is necessary. However, if soil layers are present indicating a FS less than 1.0, the potential for these layers to liquefy and the effect on the slope or foundation but be further evaluated.

Liquefaction Analysis Procedure

The method described below is provided to assist Geotechnical Engineers in facilitating liquefaction analysis for typical or routine projects. For simplicity, numerical expressions or directions are provided for determining values of the variables necessary to conduct the liquefaction analysis for such projects. Non-linear site response analysis programs can be used to determine more exacting values for some of the variables, however this should only be considered necessary for large or unique projects where a more refined liquefaction analysis is desired.

The “Simplified Method” described by Youd et al. (2001) as well as refinements suggested by Cetin et al. (2004) shall be used to estimate liquefaction potential as contained herein. The simplified method compares the resistance of a soil layer against liquefaction (Cyclic Resistance Ratio, CRR) to the seismic demand on a soil layer (Cyclic Stress Ratio, CSR) to estimate the FS of a given soil layer against triggering liquefaction. The FS for each soil sample should be computed to allow thin, isolated layers to be discounted and the specific locations and extent of those determined liquefiable to be indicated in the SGR and accounted for in design.

An Excel spreadsheet that performs these calculations has been prepared to assist Geotechnical Engineers with conducting a liquefaction analysis and may be downloaded from IDOT’s website.

$$FS = \frac{CRR}{CSR}$$

Where:

$$CRR = CRR_{7.5} K_{\sigma} K_{\alpha} MSF$$

$$CSR = 0.65 A_S \left(\frac{\sigma_{vo}}{\sigma'_{vo}} \right) r_d$$

$CRR_{7.5}$ = cyclic resistance ratio for magnitude 7.5 earthquake

$$= \frac{1}{34-(N_1)_{60cs}} + \frac{(N_1)_{60cs}}{135} + \frac{50}{[10(N_1)_{60cs}+45]^2} - \frac{1}{200}$$

K_σ = overburden correction factor

$$= \left(\frac{\sigma'_{vo}}{2.12}\right)^{(f-1)} \text{ and } 1.5 \le K_\sigma \le 9^{(f-1)}$$

f = soil relative density factor

$$= 0.831 - \frac{(N_1)_{60cs}}{160} \text{ and } 0.6 \le f \le 0.8$$

K_α = sloping ground correction factor

= 1.0 for generally level ground surfaces or slopes flatter than 6 degrees. See the following discussions for liquefaction evaluation of slopes and embankments.

MSF = magnitude scaling factor

= $87.2(M_w)^{-2.215}$

M_w = earthquake moment magnitude.

A_S = peak horizontal acceleration coefficient at the ground surface

= $F_{pga}\,PGA$

F_{pga} = site amplification factor for zero-period spectral acceleration (LRFD Article 3.10.3.2)

PGA = peak seismic ground acceleration on rock.

σ_{vof} = total vertical soil pressure for final condition (ksf)

σ'_{vof} = effective vertical soil pressure for final condition (ksf)

σ_{vof}, σ'_{vof}, and σ'_{voi} may be calculated using the following correlations for estimating the unit weight of soil (kcf):

Above water table: $\gamma_{granular} = 0.095N_m^{0.095}$

$\gamma_{cohesive} = 0.1215Q_u^{0.095}$

Below water table: $\gamma_{granular} = 0.105N_m^{0.07} - 0.0624$

$\gamma_{cohesive} = 0.1215Q_u^{0.095} - 0.0624$

Fill soils being modeled for the final condition may be assumed to have unit weights of 0.120 kcf and 0.058 kcf above and below the water table.

r_d = soil shear mass participation factor

$$= \frac{\left[1+\dfrac{-23.013-2.949A_S+0.999M_w+0.016V^*_{s,40'}}{16.258+0.201e^{0.104\left(-d+0.0785V^*_{s,40'}+24.888\right)}}\right]}{\left[1+\dfrac{-23.013-2.949A_S+0.999M_w+0.016V^*_{s,40'}}{16.258+0.201e^{0.104\left(0.0785V^*_{s,40'}+24.888\right)}}\right]} \text{ for d < 65 ft}$$

$$= \frac{\left[1+\dfrac{-23.013-2.949A_S+0.999M_w+0.016V^*_{s,40'}}{16.258+0.201e^{0.104\left(-65+0.0785V^*_{s,40'}+24.888\right)}}\right]}{\left[1+\dfrac{-23.013-2.949A_S+0.999M_w+0.016V^*_{s,40'}}{16.258+0.201e^{0.104\left(0.0785V^*_{s,40'}+24.888\right)}}\right]}-0.0014(d-65) \text{ for } d \geq 65 \text{ ft}$$

$V^*_{s,40'}$ = average shear wave velocity within the top 40 ft of the finished grade (ft/sec).

$$= \frac{40}{\sum_{i=1}^{n}\dfrac{d_i}{v_{si}}}$$

v_{si} = shear wave velocity of individual soil layer (ft/sec)

$= 169N_m^{0.516}$

Fill soils may be assumed to have a shear wave velocity of 600 ft/sec.

d_i = thickness of individual soil layer (ft)

d = depth of soil sample below finished grade (ft)

$(N_1)_{60cs}$ = $(N_1)_{60}$ adjusted to an equivalent clean sand value (blows/ft)

$= \alpha + \beta(N_1)_{60}$

α = clean sand adjustment factor coefficient

= 0 for $FC \leq 5\%$

$= e^{\left(1.76-\frac{190}{FC^2}\right)}$ for $5\% < FC < 35\%$

= 5 for $FC \geq 35\%$

β = clean sand adjustment factor coefficient

= 1.0 for $FC \leq 5\%$

$= 0.99+\dfrac{FC^{1.5}}{1000}$ for $5\% < FC < 35\%$

= 1.2 for $FC \geq 35\%$

FC = % passing No. 200 sieve

$(N_1)_{60}$ = corrected SPT blow count (blows/ft)

$= N_m C_N C_E C_B C_R C_S$

N_m = field measured SPT blow count recorded on the boring logs (blows/ft)

C_N = overburden correction factor

$$= \frac{2.2}{\left(1.2 + \frac{\sigma'_{voi}}{2.12}\right)} \leq 1.7$$

σ'_{voi} = effective vertical soil pressure during drilling (ksf)

C_E = hammer energy rating correction factor

$= \frac{ER}{60}$; ER = hammer efficiency rating (%)

C_B = borehole diameter correction factor

= 1.0 for boreholes approximately $2\frac{1}{2}$ to $4\frac{1}{2}$ inches in diameter

= 1.05 for boreholes approximately 6 inches in diameter

= 1.15 for boreholes approximately 8 inches in diameter

C_R = rod length correction factor

$$= (-2.1033 \times 10^{-11})\ell^6 + (7.9025 \times 10^{-9})\ell^5 - (1.2008 \times 10^{-6})\ell^4 + (9.4538 \times 10^{-5})\ell^3$$
$$- (4.0911 \times 10^{-3})\ell^2 + (9.3996 \times 10^{-2})\ell + 0.0615 \text{ and } 0.75 \leq C_R \leq 1.0$$

C_S = split-spoon sampler lining correction factor

= 1.0 for samplers with liners

$= 1 + \frac{C_N N_m}{100}$ for samplers without liners where $1.1 \leq C_S \leq 1.3$

ER = hammer efficiency rating (%)

Unless more exacting information is available, use 73% for automatic type hammers and 60% for conventional drop type hammers.

ℓ = drill rod length (ft) measured from the point of hammer impact to tip of sampler. ℓ may be estimated as the depth below the top of boring for the soil sample under consideration plus 5 ft to account for protrusion of the drill rod above the top of borehole.

For soils explorations conducted by IDOT, boreholes are typically advanced using hollow stem augers that are 8 inches in diameter or using wash boring methods with a cutting bit that results in approximately a 4½ inch diameter borehole. The diameter and methods of advancing the borehole can vary between Districts and Consultants performing soils explorations for IDOT. As such, it is recommended that the borehole diameter be included on the soil boring log in addition to the drilling procedure (hollow stem auger, mud rotary, etc.). Geotechnical engineers conducting a liquefaction analysis and calculating the borehole diameter correction factor (C_B) should inquire with the soils exploration provider if the borehole diameter is not provided.

SPT tests are generally conducted in accordance with AASHTO T 206 and the split-spoon samplers are designed to accept a metal or plastic liner for collecting and transporting soil samples to the laboratory. Omitting the liner provides an enlarged internal barrel diameter that reduces friction between the soil sample and interior of the sampler, resulting in a reduced SPT blow count. Past experience indicates that interior liners are seldom used and the AASHTO T 206 specification indicates that the use of liners is to be noted on the penetration record. Thus, it shall be assumed in the calculation of the split-spoon sampler lining correction factor (C_S) that liners were not used unless otherwise indicated the soil boring log.

The field measured SPT blow count values obtained in Illinois commonly use an automatic type hammer which typically offer hammer efficiency (ER) values greater than the standard 60% associated with drop type hammers. For soils exploration conducted with automatic type hammers, an ER of 73% may be assumed unless more exacting information is available.

Liquefaction resistance improves with increased fines content. As such, sieve analysis should be conducted for low plasticity fine-grained loams and silts below the anticipated groundwater elevation and within the upper 60 ft when the $(N_1)_{60}$ is less than or equal to 25 blows/ft to determine percent passing a No. 200 sieve (Fines Content, FC). These data should be included in the SGR and/or reported on the soil boring log.

M_w and PGA Values for Liquefaction Analysis

The spectral accelerations for the 0.0 second, 0.2 second and 1.0 second structure period are typically used by the structural engineer to conduct a pseudo-static seismic analysis and design of the bridge and foundation elements. These are commonly obtained from U.S. Geological Survey (USGS) maps which were developed using a probabilistic seismic hazard analysis (PSHA). PSHA estimates the likelihood that various seismic accelerations will be exceeded at a given site, over a future specific period of time, by analyzing various potential seismic sources, earthquake magnitudes, site to source distances, and estimated rates of occurrence. With this methodology, as the desired probability of exceedance is decreased (or design return period is increased), the corresponding spectral accelerations increase. The 0.0 second spectral acceleration is commonly considered as the PGA (hereafter referred to as the PSHA PGA) for the structure's design return period.

In addition to PGA, duration of shaking is a key factor in triggering liquefaction and is represented in the liquefaction analysis procedure by the earthquake Moment Magnitude (M_w). In the past, IDOT used the PSHA PGA with the Mean Earthquake Moment Magnitude ($\overline{M_W}$) provided by the USGS for the site location and design return period. However, this PGA and M_w combination will not properly indentify a site's liquefaction potential for the design return period. Portions of Illinois considered multi-modal, meaning that there are multiple earthquake scenarios that have a significant contribution to the overall hazard, require liquefaction potential be checked for multiple PGA and M_w pairs to determine the controlling values. Multi-modal conditions are often characterized by a distant seismic source, capable of producing a large M_w with a smaller PGA, and a near-site source capable of producing a smaller M_w with a larger PGA. The distant seismic source will almost always be the New Madrid seismic zone (NMSZ). The near-site source will typically be the "background seismicity" sources gridded by the USGS, although the Wabash Valley seismic zone (WVSZ) will control the near-site source for some sites in southeastern Illinois. Sites near the southern most portion of the state become less multi-modal and are solely controlled the NMSZ. The PGA and M_w values to be checked must be determined using the USGS 2008 PSHA deaggregation data, located at: http://eqint.cr.usgs.gov/deaggint/2008/, which summarizes the contribution of various earthquake scenarios to the hazard.

The distant seismic source (NMSZ) is typically represented by the Modal source-site distance (R*) and magnitude (M_w*) values provided at the base of the deaggregation, which reflect the largest contribution to the overall site hazard. The PGA to be used with this source must be calculated using the R*, M_w* and the ground motion prediction equations (GMPE's) used by the USGS for the NMSZ. The USGS uses a weighted average of 8 different ground GMPE's for the NMSZ, which due to their complexity, are not presented herein. They are provided in IDOT's Liquefaction Analysis Excel spreadsheet and used to compute the distant seismic source PGA with input of R*, M_w*, and selecting "NMSZ" for the proper ground motion prediction equations.

The R and M_w values representing the near-site sources can be identified by evaluating the "ALL_EPS" and source-site distance "DIST(KM)" columns of the deaggregation data. The ALL_EPS column indicates the percent contribution each earthquake scenario adds to the overall hazard. Scenarios contributing more than 5% to the hazard with a source-site distance not extending to the NMSZ should be selected as near-site sources to be investigated. The PGA to be used with each selected near-site R and M_w pair shall be calculated using the USGS ground motion prediction equations for the Central Eastern United States (CEUS). The USGS uses a weighted average of 7 different GMPE's to for the CEUS. These GMPE's are also programmed into the IDOT Liquefaction Analysis spreadsheet to provide near-site PGA values for each selected R, and M_w when the "CEUS" is input as the proper ground motion prediction equations.

Two examples for interpreting the deaggregation data and determining the PGA and M_w pairs to be used for the liquefaction analysis are included at the end of the design guide.

Liquefaction Analysis Procedure for Slopes and Embankments

The liquefaction resistance of dense granular materials under low confining stress (dilative soils) tends to increase with increased static shear stresses. Such static shear stresses are typically the result of ground surface inclinations associated with slopes and embankments. Conversely, the liquefaction resistance of loose soils under high confining stress (contractive soils) tends to decrease with increased static shear stresses. Such soils are susceptible to undrained strain softening. The effects of sloping ground and static shear stresses on the liquefaction resistance of soils is accounted for in the previously described Simplified Procedure by use of the sloping ground correction factor, K_α.

K_α is a function of the static shear stress to effective overburden pressure ratio and relative density of the soil. Graphical curves have been published that correlate K_α with these variables (Harder and Boulanger 1997). With the exception of earth masses of a constant slope, the ratio of the static shear stress to effective overburden pressure will vary at different points under an embankment, and most slopes, making it difficult to determine an appropriate K_α. Researchers that developed the Simplified Procedure have indicated that there is a wide range of proposed K_α values indicating a lack of convergence and need for additional research. It is recommended that the graphical curves that have been published for establishing K_α not be used by nonspecialists in geotechnical earthquake engineering or in routine engineering practice.

Olson and Stark (2003) have presented an alternative approach for analyzing the effects of static shear stress due to sloping ground on the liquefaction resistance of soils. A detailed description of the method is not included herein and Geotechnical Engineers should obtain a copy of the reference document for further information.

The method provides a numerical relationship for determining whether soils are contractive or dilative. If soils are determined to be contractive, an additional analysis should be conducted to investigate the effects of static shear stress on the liquefaction resistance of soils. The additional analysis is an extension of a traditional slope stability analysis typically performed with commercial software, and can be readily facilitated with the use of a spreadsheet and data obtained from the slope stability software. If the additional analysis indicates soil layers with a FS < 1.0 against liquefaction, a post-liquefaction slope stability analysis should be conducted with residual shear strengths assigned to the soil layers expected to liquefy. While Olson and Stark (2003) present one acceptable method for estimating the residual shear strength of liquefied soil layers, there are also a number of other methods presented in various reference documents concerning liquefaction.

The Department's Liquefaction Analysis spreadsheet that estimates liquefaction resistance of soil using the Simplified Method described above also estimates whether soils are contractive or dilative based upon the relationship provided by Olson and Stark (2003). As the classification of contractive or dilative soils is affected by overburden pressure, the presence of such soils should be assessed considering a soil column that starts at the top of the embankment/slope and another soil column that begins at the base of the embankment/slope.

Note that the method provided by Olson and Stark (2003) also includes an equation for estimating the seismic shear stress on a soil layer (Eq. 3a in the reference document). The variable C_M included in the referenced equation shall be replaced with the variable MSF and both variables MSF and r_d shall be calculated using the equations outlined above for the Simplified Method.

Examples for Determining M_w and PGA Values

The first of two examples is for a location near Grayville, Illinois and the corresponding deaggregation data, obtained from the USGS website, is provided in below in Figure 1. In this case, the five earthquake scenarios highlighted in the figures have an “ALL_EPS” contribution to the total hazard greater than 5%.

```
*** Deaggregation of Seismic Hazard at One Period of Spectral Accel. ***
*** Data from U.S.G.S. National Seismic Hazards Mapping Project, 2008 version ***
PSHA Deaggregation. %contributions. site: Grayville,_IL long:  88.015 W., lat: 38.257 N.
 Vs30(m/s)= 760.0 CEUS atten. model site cl BC(firm) or A(hard).
NSHMP 2007-08  See USGS OFR 2008-1128. dM=0.2 below
Return period: 975   yrs. Exceedance PGA =0.2147   g. Weight * Computed_Rate_Ex 0.104E-02
#Pr[at least one eq with median motion>=PGA in 50 yrs]=0.02123
#This deaggregation corresponds to Mean Hazard w/all GMPEs
DIST(KM) MAG(MW) ALL_EPS EPSILON>2  1<EPS<2 0<EPS<1 -1<EPS<0 -2<EPS<-1 EPS<-2
   11.6   4.60   3.493    0.343    1.627    1.385    0.139    0.000    0.000
   28.5   4.61   0.589    0.466    0.123    0.000    0.000    0.000    0.000
   12.1   4.80   7.215    0.564    3.247    2.915    0.488    0.000    0.000
   29.2   4.81   1.674    1.065    0.609    0.000    0.000    0.000    0.000
   12.6   5.03   6.111    0.365    2.177    2.831    0.738    0.000    0.000
   30.0   5.04   2.112    0.981    1.129    0.002    0.000    0.000    0.000
   55.8   5.05   0.086    0.086    0.000    0.000    0.000    0.000    0.000
   13.0   5.21   2.627    0.130    0.780    1.338    0.378    0.001    0.000
   30.6   5.21   1.205    0.427    0.731    0.047    0.000    0.000    0.000
   57.6   5.21   0.081    0.081    0.000    0.000    0.000    0.000    0.000
   13.4   5.39   4.419    0.189    1.130    2.343    0.735    0.022    0.000
   31.1   5.40   2.638    0.692    1.677    0.269    0.000    0.000    0.000
   58.8   5.40   0.262    0.262    0.000    0.000    0.000    0.000    0.000
   13.7   5.61   2.434    0.089    0.532    1.315    0.473    0.024    0.000
   31.9   5.62   1.959    0.336    1.190    0.434    0.000    0.000    0.000
   59.7   5.62   0.288    0.267    0.020    0.000    0.000    0.000    0.000
   13.9   5.80   2.291    0.077    0.459    1.152    0.562    0.042    0.000
   32.3   5.81   2.234    0.289    1.267    0.678    0.000    0.000    0.000
   60.1   5.81   0.395    0.313    0.082    0.000    0.000    0.000    0.000
   88.4   5.82   0.052    0.052    0.000    0.000    0.000    0.000    0.000
   12.9   6.01   1.740    0.050    0.301    0.757    0.569    0.063    0.000
   32.6   6.01   2.166    0.196    1.036    0.911    0.023    0.000    0.000
   61.2   6.01   0.434    0.252    0.182    0.000    0.000    0.000    0.000
   88.5   6.01   0.078    0.078    0.000    0.000    0.000    0.000    0.000
   12.5   6.21   1.725    0.047    0.279    0.700    0.619    0.080    0.000
   34.1   7.39   0.999    0.031    0.183    0.461    0.314    0.010    0.000
   59.4   7.40   0.369    0.020    0.120    0.222    0.007    0.000    0.000
   85.0   7.38   0.168    0.017    0.101    0.050    0.000    0.000    0.000
  120.6   7.39   0.144    0.027    0.113    0.004    0.000    0.000    0.000
  155.1   7.44   5.773    1.406    3.581    0.786    0.000    0.000    0.000
   14.4   7.59   0.060    0.001    0.008    0.021    0.021    0.008    0.000
   34.3   7.59   0.158    0.005    0.027    0.068    0.055    0.003    0.000
   62.2   7.59   0.062    0.003    0.018    0.038    0.004    0.000    0.000
  155.1   7.70  15.821    2.080    7.962    5.779    0.000    0.000    0.000
  155.1   8.00   7.989    0.623    3.017    3.584    0.765    0.000    0.000

Summary statistics for above PSHA PGA  deaggregation, R=distance, e=epsilon:
Contribution from this GMPE(%):  100.0
 Mean src-site R=   64.9 km; M= 6.33; eps0=   0.12. Mean calculated for all sources.
Modal src-site R=  155.1 km; M= 7.70; eps0=   0.67 from peak (R,M) bin
 MODE R*= 155.1km; M*= 7.70; EPS.INTERVAL: 1 to 2 sigma  % CONTRIB.=  7.962

Principal sources (faults, subduction, random seismicity having > 3% contribution)
Source Category:                 % contr.  R(km)    M   epsilon0 (mean values).
New Madrid SZ no clustering        29.53   155.1   7.73    0.63
CEUS gridded                       70.47    27.1   5.75   -0.09
Individual fault hazard details if its contribution to mean hazard > 2%:
Fault ID                         % contr.   Rcd(km)   M   epsilon0 Site-to-src azimuth(d)
New Madrid FZ, midwest              2.91   155.9   7.73    0.63     -139.1
New Madrid FZ, central             21.22   153.6   7.73    0.61     -143.6
New Madrid FZ, mideast              2.80   158.3   7.73    0.66     -146.9
#*********End of deaggregation corresponding to Mean Hazard w/all GMPEs  *********#
```

Figure 1. Grayville Deaggregation Data.

Three of the five sites have source-to-site distances indicative of the NMSZ and thus, the Modal source-site distance (R*) and magnitude (M_w*) values can be used to represent the distant seismic source. The remaining two earthquake scenarios are considered near-site sources which both requiring further investigation. The PGA for each of the three earthquake scenarios is then calculated using the indicated R and M_w values with selection of the proper GMPE model programmed in the IDOT Liquefaction Analysis spreadsheet.

- EQ Scenario #1, Dist. (R) = 155.1 km, M_w = 7.70 $\rightarrow$ PGA = 0.115 (NMSZ Model)
- EQ Scenario #2, Dist. (R) = 12.1 km, M_w = 4.80 $\rightarrow$ PGA = 0.175 (CEUS Model)
- EQ Scenario #3, Dist. (R) = 12.6 km, M_w = 5.03 $\rightarrow$ PGA = 0.209 (CEUS Model)

In this instance, it is clear that EQ Scenario #3 will control over EQ Scenario #2 and as such, EQ Scenario #2 does not require further consideration for the liquefaction analysis. The PGA and M_w pairs for EQ Scenario's #1 and #3 serve as an example of the potential multi-modal nature of some locations.

There will be many instances where the deaggregation data indicates that there are no near-site sources that contribute at least 5% to the hazard that need to be considered for liquefaction analysis. In such cases, the hazard is likely dominated by the NMSZ and only the Modal combination needs to be considered.

The second example is for a location near Cairo, Illinois and the site deaggregation data is provided in below in Figure 2.

There are three highlighted earthquake scenarios where the “ALL_EPS” contribution is greater than 5%.

```
*** Deaggregation of Seismic Hazard at One Period of Spectral Accel. ***
*** Data from U.S.G.S. National Seismic Hazards Mapping Project, 2008 version ***
PSHA Deaggregation. %contributions. site: Cairo,_IL long:  89.181 W., lat: 37.005 N.
 Vs30(m/s)= 760.0 CEUS atten. model site cl BC(firm) or A(hard).
NSHMP 2007-08  See USGS OFR 2008-1128. dM=0.2 below
Return period: 975   yrs. Exceedance PGA =1.1619   g. Weight * Computed_Rate_Ex 0.101E-02
#Pr[at least one eq with median motion>=PGA in 50 yrs]=0.04009
#This deaggregation corresponds to Mean Hazard w/all GMPEs
DIST(KM) MAG(MW) ALL_EPS EPSILON>2  1<EPS<2 0<EPS<1 -1<EPS<0 -2<EPS<-1 EPS<-2
    6.9     4.61     0.075     0.046     0.029     0.000     0.000     0.000     0.000
    7.6     4.80     0.203     0.114     0.090     0.000     0.000     0.000     0.000
    8.5     5.04     0.238     0.117     0.121     0.000     0.000     0.000     0.000
    9.2     5.21     0.132     0.064     0.068     0.000     0.000     0.000     0.000
   10.0     5.40     0.287     0.135     0.137     0.015     0.000     0.000     0.000
   11.1     5.62     0.218     0.083     0.110     0.024     0.000     0.000     0.000
   11.8     5.81     0.258     0.089     0.134     0.035     0.000     0.000     0.000
   11.7     6.02     0.315     0.079     0.169     0.067     0.000     0.000     0.000
   11.4     6.22     0.423     0.087     0.206     0.130     0.000     0.000     0.000
   12.4     6.42     0.377     0.065     0.184     0.128     0.000     0.000     0.000
   12.2     6.59     0.257     0.036     0.120     0.101     0.000     0.000     0.000
   12.1     6.79     0.404     0.038     0.187     0.178     0.001     0.000     0.000
   31.0     6.76     0.070     0.049     0.021     0.000     0.000     0.000     0.000
   14.0     7.00     0.370     0.035     0.168     0.164     0.003     0.000     0.000
   14.7     7.19     0.223     0.019     0.100     0.101     0.003     0.000     0.000
   11.4     7.42    31.476     1.447     8.511    17.760     3.758     0.000     0.000
   29.8     7.39     0.271     0.079     0.192     0.000     0.000     0.000     0.000
   11.5     7.70    48.171     2.025    12.040    27.292     6.814     0.000     0.000
   29.4     7.70     0.708     0.115     0.471     0.121     0.000     0.000     0.000
   11.5     8.00    14.768     0.594     3.535     8.424     2.215     0.000     0.000
   27.0     8.00     0.593     0.047     0.237     0.309     0.000     0.000     0.000

Summary statistics for above PSHA PGA  deaggregation, R=distance, e=epsilon:
Contribution from this GMPE(%):  100.0
 Mean src-site R=   11.8 km; M= 7.59; eps0=  -0.24. Mean calculated for all sources.
Modal src-site R=   11.5 km; M= 7.70; eps0=  -0.32 from peak (R,M) bin
 MODE R*=  11.4km; M*= 7.70; EPS.INTERVAL: 0 to 1 sigma  % CONTRIB.= 27.292

Principal sources (faults, subduction, random seismicity having > 3% contribution)
Source Category:                  % contr.  R(km)     M    epsilon0 (mean values).
New Madrid SZ no clustering         95.65    11.7   7.66    -0.28
CEUS gridded                         4.35    13.5   6.24     0.76
Individual fault hazard details if its contribution to mean hazard > 2%:
Fault ID                          % contr.   Rcd(km)  M    epsilon0 Site-to-src azimuth(d)
New Madrid FZ, midwest               7.47    17.4   7.68    -0.02      -50.3
New Madrid FZ, central              74.16    10.3   7.65    -0.35      -47.2
New Madrid FZ, mideast               9.94    12.1   7.66    -0.29      132.6
New Madrid FZ, east                  2.63    22.5   7.69     0.33      131.2
#*********End of deaggregation corresponding to Mean Hazard w/all GMPEs   *********#
```

Figure 2. Cairo Deaggregation Data.

By inspection, they all have source-to-site distances indicative of the NMSZ and can be represented by a single check of the Modal R and M combination. With no near-site scenarios contributing more than 5% to the hazard, only the single distant seismic source need be investigated.

- EQ Scenario #1, Dist. (R) = 11.5 km, M_w = 7.70 $\rightarrow$ PGA = 1.528 (NMSZ Model)

Similar to Example #1, the PGA value for the earthquake scenario has been determined using the IDOT Liquefaction Analysis Excel spreadsheet and the indicated GMPE model.

Relevant References

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CHAPTER 5

LIQUEFACTION POTENTIAL EVALUATION AND ANALYSIS

This chapter provides information to use when evaluating and analyzing the potential for failure due to liquefaction during a seismic event at an Ohio *waste containment facility*. Ohio EPA requires that the *soil units* at any *waste containment facility* be able to withstand the effects of a plausible earthquake and rule out the possibility of liquefaction. This is because it is generally expected that the engineered components of a *waste containment facility* will lose their integrity and no longer be able to function if a foundation soil layer liquefies.

> Soil liquefaction occurs in loose, *saturated* cohesionless *soil units* (sands and silts) and sensitive clays when a sudden loss of strength and loss of stiffness is experienced, sometimes resulting in large, permanent displacements of the ground. Even thin lenses of loose *saturated* silts and sands may cause an overlying sloping soil mass to slide laterally along the liquefied layer during earthquakes. Liquefaction beneath and in the vicinity of a *waste containment unit* can result in localized bearing capacity failures, lateral spreading, and excessive settlement that can have severe consequences upon the integrity of *waste containment systems*. Liquefaction-associated lateral spreading and flow failures can also affect the global stability of a *waste containment facility*.

REPORTING

This section describes the information that should be submitted to demonstrate that a facility is not susceptible to liquefaction. Ohio EPA recommends that the following information be included in its own section of a geotechnical and stability analyses report. At a minimum, the following information about the liquefaction evaluation and analysis should be reported to Ohio EPA:

> Any drawings or cross sections referred to in this policy that are already present in another part of the geotechnical and stability analyses report can be referenced rather than duplicated in each section. It is helpful if the *responsible* party ensures the referenced items are easy to locate and marked to show the appropriate information.

- A narrative and tabular summary of the findings of the liquefaction evaluation and analysis including all *soil units* evaluated.

- A detailed discussion of the liquefaction evaluation including:

    - A discussion and evaluation of the geologic age and origin, fines content, plasticity index, saturation, depth below ground surface, and soil penetration resistance of each of the *soil units* that comprise the *soil stratigraphy* of the *waste containment facility*,

- The scope, extent, and findings of the subsurface investigation as they pertain to the liquefaction potential evaluation.

- A narrative description of each potentially liquefiable layer, if any, at the facility, and

- All figures, drawings, or references relied upon during the evaluation marked to show how they relate to the facility.

- If the liquefaction evaluation identifies potentially liquefiable layers, then the following information should be included in the report:

  - A narrative and tabular summary of the results of the analysis of each potentially liquefiable layer,

  - Plan views of the facility that include the northings and eastings, the lateral extent of the potentially liquefiable layers, and the limits of the *waste containment unit(s)*,

  - Cross sections of the facility showing *soil units*, full depictions of the potentially liquefiable layers, and the following:

    - location of engineered components of the facility,

    - material types, shear strengths, and boundaries,

    - geologic age and origin,

    - fines content and plasticity index,

    - depth below ground surface,

    - soil penetration resistance,

    - temporal high *phreatic surfaces* and *piezometric surfaces*, and

    - in situ field densities and, where applicable, the in situ *saturated* field densities.

  - The scope, extent, and findings of the subsurface investigation as they pertain to the analysis of potentially liquefiable layers,

  - A description of the methods used to calculate the factor of safety against liquefaction,

  - Liquefaction analysis input parameters and assumptions, including a rationale for selecting the maximum expected horizontal ground acceleration,

  - The actual calculations and/or computer inputs and outputs, and

  - All figures, drawings, or references relied upon during the analysis marked to show how they relate to the facility.

FACTOR OF SAFETY

The following factor of safety should be used, unless superseded by rule, when demonstrating that a facility will resist failures due to liquefaction.

> The number of digits after the decimal point indicates that rounding can only occur to establish the last digit. For example, 1.579 can be rounded to 1.58, but not 1.6.

Liquefaction analysis: FS $\geq$ 1.00

The above factor of safety is appropriate, only if the design assumptions are conservative; site-specific, *higher quality data* are used; and the calculation methods chosen are shown to be valid and appropriate for the facility. It should be noted, however, that historically, occasions of liquefaction-induced instability have occurred when factors of safety using these methods and assumptions were calculated to be greater than 1.00. Therefore, the use of a factor of safety against liquefaction higher than 1.00 may be warranted whenever:

- A failure would have a catastrophic effect upon human health or the environment,
- Uncertainty exists regarding the accuracy, consistency, or validity of data, and no opportunity exists to conduct additional testing to improve or verify the quality of the data,
- Large uncertainty exists about the effects that changes to the site conditions over time may have on the stability of the facility, and no engineered controls can be carried out that will significantly reduce the uncertainty.

> Designers may want to consider increasing the required factor of safety if repairing a facility after a failure would create a hardship for the *responsible parties* or the waste disposal customers.

Using a factor of safety less than 1.00 against liquefaction is not considered a sound engineering practice. This is because a factor of safety less than 1.00 indicates failure is likely to occur. Furthermore, performing a deformation analysis to quantify the risks and damage expected to the *waste containment facility* should liquefaction occur is not considered justification for using a factor of safety less than 1.00 against liquefaction. This is because the strains allowed by deformation analysis are likely to result in decreased performance and loss of integrity in the engineering components. Thus, any failure to the *waste containment facility* due to liquefaction is likely to be substantial and very likely to increase the potential for harm to human health and the environment. If a facility has a factor of safety against liquefaction less than 1.00, mitigation of the liquefiable layers will be necessary, or another site not at risk of liquefaction will need to be used.

> If the liquefaction analysis does not result in a factor of safety of at least 1.00, consideration may be given to performing a more sophisticated liquefaction potential assessment, or to liquefaction mitigation measures such as eliminating the liquefiable layer, or choosing an alternative site.
>
> A variety of techniques exist to remediate potentially liquefiable soils and mitigate the liquefaction hazard. Liquefaction of Soils During Earthquakes (National Research Council, Committee of Earthquake Engineering, 1985) includes a table summarizing available methods for improvement of liquefiable soil foundation conditions. However, Ohio EPA approval must be obtained prior to use of any methods for mitigation of liquefiable layers.

The *responsible party* should ensure that the designs and specifications in all authorizing documents and the quality assurance and quality control (QA/QC) plans clearly require that the assumptions and specifications used in the liquefaction analysis for the facility will be followed during construction, operations, and closure. If the *responsible party* does not do this, it is likely that Ohio EPA will require the assumptions and specifications from the liquefaction analysis to be used during construction, operations, and closure of a facility through such means as are appropriate (e.g., regulatory compliance requirements, approval conditions, orders, settlement agreements).

From time to time, changes to the facility design may be needed that will alter the assumptions and specifications used in the liquefaction analysis. If this occurs, a request to change the facility design is required to be submitted for Ohio EPA approval in accordance with applicable rules. The request to change the facility design must include a new liquefaction analysis that uses assumptions and specifications appropriate for the change.

LIQUEFACTION EVALUATION

Ohio EPA requires the assessment of liquefaction potential as a key element in the seismic design of a *waste containment facility*. To determine the liquefaction potential, Ohio EPA recommends using the five screening criteria included in the U.S. EPA guidance document titled RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities, EPA/600/R-95/051, April 1995, published by the Office of Research and Development. As of the writing of this policy, the U.S. EPA guidance document is available at www.epa.gov/clhtml/pubtitle.html on the U.S. EPA Web site.

Recommended Screening Criteria for Liquefaction Potential

The following five screening criteria, from the above reference, are recommended by Ohio EPA for completing a liquefaction evaluation:

- Geologic age and origin. If a soil layer is a fluvial, lacustrine or aeolian deposit of Holocene age, a greater potential for liquefaction exists than for till, residual deposits, or older deposits.

- Fines content and plasticity index. Liquefaction potential in a soil layer increases with decreasing fines content and plasticity of the soil. Cohesionless soils having less than 15 percent (by weight) of particles smaller than 0.005 mm, a liquid limit less than 35 percent, and an in situ water content greater than 0.9 times the liquid limit may be susceptible to liquefaction (Seed and Idriss, 1982).

- Saturation. Although low water content soils have been reported to liquefy, at least 80 to 85 percent saturation is generally deemed to be a necessary condition for soil liquefaction. The highest anticipated temporal *phreatic surface* elevations should be considered when evaluating saturation.

- Depth below ground surface. If a soil layer is within 50 feet of the ground surface, it is more likely to liquefy than deeper layers.

- Soil Penetration Resistance. Seed et al, 1985, state that soil layers with a normalized SPT blowcount [$(N_1)_{60}$] less than 22 have been known to liquefy. Marcuson et al, 1990, suggest an SPT value of [$(N_1)_{60}$] less than 30 as the threshold to use for suspecting liquefaction potential. Liquefaction has also been shown to occur if the normalized CPT cone resistance (q_c) is less than 157 tsf (15 MPa) (Shibata and Taparaska, 1988).

> In some cases, it is necessary to stabilize a borehole due to heaving soils. The use of hollow-stem augers or drilling mud has been proven effective for stabilizing a borehole without affecting the blow counts from a standard penetration test. Casing off the borehole as it is advanced has also been used, but it has been found that for non-cohesive soils, such as sands, it has an adverse effect on the standard penetration test results (Edil, 2002).

If three or more of the above criteria indicate that liquefaction is not likely, the potential for liquefaction can be dismissed. Otherwise, a more rigorous analysis of the liquefaction potential at a facility is required. However, it is possible that other information, especially historical evidence of past liquefaction or *sample* testing data collected during the subsurface investigation, may raise enough of a concern that a full liquefaction analysis would be appropriate even if three or more of the liquefaction evaluation criteria indicate that liquefaction is unlikely.

LIQUEFACTION ANALYSIS

If potential exists for liquefaction at a facility, additional subsurface investigation may be necessary. Once all testing is complete, a factor of safety against liquefaction is then calculated for each *critical layer* that may liquefy.

A liquefaction analysis should, at a minimum, address the following:

- Developing a detailed understanding of site conditions, the *soil stratigraphy*, material properties and their variability, and the areal extent of potential *critical layers*. Developing simplified cross sections amenable to analysis. SPT and CPT procedures are widely used in practice to characterize the soil (field data are easier to obtain on loose cohesionless soils than trying to obtain and test undisturbed *samples*). The data needs to be corrected as necessary, for example, using the normalized SPT blowcount [$(N_1)_{60}$] or the normalized CPT. The total vertical stress (σ_0) and effective vertical stress (σ_0') in each stratum also need to be evaluated. This should take into account the changes in overburden stress across the lateral extent of each *critical layer*, and the temporal high *phreatic* and *piezometric surfaces*,

- Calculation of the force required to liquefy the critical zones, based on the characteristics of the critical zone(s) (e.g., fines content, normalized standardized blowcount, overburden stresses, level of saturation),

- Calculation of the design earthquake's effect on each potentially liquefiable layer should be performed using the site-specific in situ soil data and an understanding of the earthquake magnitude potential for the facility, and

- Computing the factor of safety against liquefaction for each liquefaction susceptible *critical layer*.

Liquefaction Potential Analysis - Example Method

The most common procedure used in practice for liquefaction potential analysis, the "Simplified Procedure," was developed by H. B. Seed & I. M. Idriss. Details of this procedure can be found in RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities (U.S.EPA, 1995). As of the publication date of this policy, the U.S. EPA guidance document was available from www.epa.gov/clhtml/pubtitle.html on the U.S. EPA Web site. Due to the expected range of ground motion in Ohio, the Simplified Procedure is applicable. However, if the expected peak horizontal ground acceleration is larger than 0.5 g, more sophisticated, truly nonlinear effective stress-based analytical approaches should be considered, for which there are computer programs available. The simplified procedure comprises the following four steps:

1. Identify the potentially liquefiable layers to be analyzed.

2. Calculate the shear stress required to cause liquefaction (resisting forces). Based on the characteristics of the potentially liquefiable layers (e.g., fines content, normalized standardized blowcount), the critical (cyclic) stress ratio (CSR_L) can be determined using the graphical methods included in the U.S. EPA guidance referenced above. Note: this determination is typically based on an earthquake of magnitude 7.5. If the design earthquake is of a different magnitude, or if the site is not level, the CSR_L will need to be corrected as follows.

$$CSR_{L(M-M)} = CSR_{L(M=7.5)} \cdot k_M \cdot k_\sigma \cdot k_\alpha \quad (5.1)$$

where

$CSR_{L(M-M)}$ = corrected critical stress ratio resisting liquefaction,
$CSR_{L(M=7.5)}$ = critical stress ratio resisting liquefaction for a magnitude 7.5 earthquake,
k_M = magnitude correction factor,
$k\sigma$ = correction factor for stress levels exceeding 1 tsf, and
k_α = correction factor for the driving static shear stress if sloping ground conditions exist at the facility. Special expertise is required for evaluation of liquefaction resistance beneath ground sloping more than six percent (Youd, 2001).

The k-values are available from tabled or graphical sources in the referenced materials.

> The correction factors can be obtained from different sources, such as the 1995, U.S. EPA, Seismic Design Guidance, or the summary report from the 1996 and 1998 NCEER/NSF Liquefaction Workshops. The U.S. EPA document tends to be somewhat more conservative for earthquakes with a magnitude less than 6.5. In 1999, I.M. Idriss proposed yet a different method for calculating the empirical stress reduction factor (r_d), which was less conservative than the method included in the U.S. EPA guidance, but more conservative than the method included in the NCEER method. Designers should select correction factors based on site-specific circumstances and include documentation explaining their choices in submittals to Ohio EPA.

3. Calculation of the design earthquake's effect on the critical zone (driving force). The following equation can be used.

$$CSR_{EQ} = 0.65\left(\frac{a_{\max,z}}{g}\right) r_d \left(\frac{\sigma_0}{\sigma_0'}\right) \quad (5.2)$$

where CSR_{eq} = equivalent uniform cyclic stress ratio induced by the earthquake,
σ_0 = total vertical overburden stress,
σ_0' = effective vertical overburden stress,
$a_{max,z}$ = the maximum horizontal ground acceleration, and
g = the acceleration of gravity.

Liquefaction Potential Analysis - Example Method (cont.)

$$a_{\max,z} = (a_{\max})(r_d) \qquad (5.3)$$

where $a_{max,z}$ = the maximum horizontal ground acceleration,
a_{max} = peak ground surface acceleration, and
r_d = empirical stress reduction factor.

$$r_d = \frac{a_{\max@depth\ D}}{\sigma_{0@depth\ D}\left(\frac{a_{\max@surface}}{g}\right)} \qquad (5.4)$$

4. Calculate the factor of safety against liquefaction (resisting force divided by driving force).

$$FS_L = \frac{CSR_{L(M-M)}}{CSR_{EQ}} \geq 1.00 \qquad (5.5)$$

where FS_L = factor of safety against liquefaction,
$CSR_{L(M-M)}$ = shear stress ratio required to cause liquefaction, and
CSR_{EQ} = equivalent uniform cyclic stress ratio.

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the embankment or foundation may be excessive. It may be necessary in such cases to use the shearing resistance mobilized at 10 or 15 percent strain, rather than peak strengths, or to limit placement water contents to the dry side of optimum to reduce the magnitudes of failure strains. However, if cohesive soils are compacted too dry, and they later become wetter while under load, excessive settlement may occur. Also, compaction of cohesive soils dry of optimum water content may result in brittle stress-strain behavior and cracking of the embankment. Cracks can have adverse effects on stability and seepage. When large strains are required to develop shear strengths, surface movement measurement points and piezometers should be installed to monitor movements and pore water pressures during construction, in case it becomes necessary to modify the cross section or the rate of fill placement.

d. Liquefaction. The phenomenon of soil liquefaction, or significant reduction in soil strength and stiffness as a result of shear-induced increase in pore water pressure, is a major cause of earthquake damage to embankments and slopes. Most instances of liquefaction have been associated with saturated loose sandy or silty soils. Loose gravelly soil deposits are also vulnerable to liquefaction (e.g., Coulter and Migliaccio 1966; Chang 1978; Youd et al. 1984; and Harder 1988). Cohesive soils with more than 20 percent of particles finer than 0.005 mm, or with liquid limit (LL) of 34 or greater, or with the plasticity index (PI) of 14 or greater are generally considered not susceptible to liquefaction. The methodology to evaluate liquefaction susceptibility will be presented in an Engineer Circular, "Dynamic Analysis of Embankment Dams," which is still in draft form.

e. Piping. Erosion and piping can occur when hydraulic gradients at the downstream end of a hydraulic structure are large enough to move soil particles. Analyses to compute hydraulic gradients and procedures to control piping are contained in EM 1110-2-1901.

f. Other types of slope movements. Several types of slope movements, including rockfalls, topples, lateral spreading, flows, and combinations of these, are not controlled by shear strength (Huang 1983). These types of mass movements are not discussed in this manual, but the possibility of their occurrence should not be ignored.

Burns & McDonnell World Headquarters
9400 Ward Parkway
Kansas City, MO 64114
O 816-333-9400
F 816-333-3690
www.burnsmcd.com