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November 24, 2020

Sent electronically via File Transfer

Mr. Andrew Wheeler
Administrator, US EPA
1200 Pennsylvania Avenue, N.W.
Mail Code: 5304-P
Washington, D.C. 20460

Subject: Request for Site-Specific Alternative Deadline to Initiate Closure of CCR Surface Impoundment
Development of Alternative Capacity is Technically Infeasible Demonstration
SIGECO F.B. Culley Generating Station, Newburgh, Warrick County, Indiana

Dear Mr. Wheeler:

Southern Indiana Gas and Electric Company, Inc. (SIGECO) hereby submits this request for an extension to the "cease receipt" deadline for the F.B. Culley Generating Station (F.B. Culley) East Ash Pond pursuant to the *Development of Alternative Capacity is Technically Infeasible* criteria under 40 CFR § 257.103(f)(1).

The attached report has been prepared in accordance with the requirements of 40 CFR 257.103(f)(1) to demonstrate that obtaining alternative capacity for the CCR and non-CCR flows at the SIGECO F.B. Culley East Ash Pond is infeasible before the April 11, 2021 "cease receipt" deadline provided in 40 CFR § 257.101(a)(1). Accordingly, SIGECO is respectfully requesting an extension of the "cease receipt" deadline to March 1, 2023 for the East Ash Pond. The basis for this request is detailed in the attached document. To aid in your verification of completeness, a regulatory checklist summarizing where each regulatory requirement has been included in the report, immediately following the Table of Contents.

We trust this provides the information you need to process this application. As allowed and preferred by the agency, in lieu of hard copies of the demonstration packet, the submittal format is via email with a file transfer link to Kirsten Hillyer, Frank Behan, and Richard Huggins. Should you need additional information on this submittal, please don't hesitate to contact me at 812-491-4787 or Angela.Casbon-Scheller@centerpointenergy.com.

Sincerely,

Angela Casbon-Scheller
Manager, Environmental Operations
Power Generation

cc: Kirsten Hillyer (Hillyer.Kirsten@epa.gov)
Frank Behan (Behan.Frank@epa.gov)
Richard Huggins (Huggins.Richard@epa.gov)

Submitted to
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Submitted by
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November 24, 2020

Request for Site-Specific Alternative Deadline to Initiate Closure of CCR Surface Impoundment

Development of Alternative Capacity is Technically Infeasible Demonstration (40 CFR § 257.103(f)(1)) for the East Ash Pond at the F.B. Culley Generating Station

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Regulatory Checklist

Regulatory Reference	Description of Requirement	Report Section
257.103 (f)(1)(iv)(A)(1)	*A written narrative discussing the options considered both on and off-site to obtain alternative capacity for each Coal Combustion Residual (CCR) and/or non-CCR wastestreams, 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:*	**5.0**
257.103 (f)(1)(iv)(A)(1)(i)	*An in-depth analysis of the site and any site-specific conditions that led to the decision to select the alternative capacity being developed;*	**5.1.4**
257.103 (f)(1)(iv)(A)(1)(ii)	*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*	**5.1.5**
257.103 (f)(1)(iv)(A)(1)(iii)	*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;*	**5.1.6**
257.103 (f)(1)(iv)(A)(2)	*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:*	**5.2**
257.103 (f)(1)(iv)(A)(2)(i)	*How each phase and the steps within that phase interact with or are dependent on each other and the other phases;*	**5.2**
257.103 (f)(1)(iv)(A)(2)(ii)	*All of the steps and phases that can be completed concurrently;*	**5.2**
257.103 (f)(1)(iv)(A)(2)(iii)	*The total time needed to obtain the alternative capacity and how long each phase and step within each phase will take; and*	**5.2**
257.103 (f)(1)(iv)(A)(2)(iv)	*At a minimum, the following phases: Engineering and design, contractor selection, equipment fabrication and delivery, construction, and start up and implementation.;*	**5.2**
257.103 (f)(1)(iv)(A)(3)	*A narrative discussion of the schedule and visual timeline representation, which must discuss all of the following:*	**5.2**
257.103 (f)(1)(iv)(A)(3)(i)	*Why the length of time for each phase and step is needed and a discussion of the tasks that occur during the specific step;*	**5.2**
257.103 (f)(1)(iv)(A)(3)(ii)	*Why each phase and step shown on the chart must happen in the order it is occurring;*	**5.2**
257.103 (f)(1)(iv)(A)(3)(iii)	*The tasks that occur during each of the steps within the phase; and*	**5.2**
257.103 (f)(1)(iv)(A)(3)(iv)	*Anticipated worker schedules*	**5.2.2.8**
257.103 (f)(1)(iv)(A)(4)	*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.*	**5.3**
257.103 (f)(1)(iv)(B)	*To demonstrate that the criteria in paragraph (f)(1)(iii) of this section have been met, the owner or operator must submit all of the following:*	**6.0**

Regulatory Reference	Description of Requirement	Report Section
257.103 (f)(1)(iv)(B)(1)	*A certification signed by the owner or operator that the facility is in compliance with all of the requirements of this subpart;*	**6.1**
257.103 (f)(1)(iv)(B)(2)	*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:*	**6.2**
257.103 (f)(1)(iv)(B)(2)(i)	*Map(s) of groundwater monitoring well locations in relation to the CCR unit(s);*	**6.2.1**
257.103 (f)(1)(iv)(B)(2)(ii)	*Well construction diagrams and drilling logs for all groundwater monitoring wells; and*	**6.2.2**
257.103 (f)(1)(iv)(B)(2)(iii)	*Maps that characterize the direction of groundwater flow accounting for seasonal variations;*	**6.2.3**
257.103 (f)(1)(iv)(B)(3)	*Constituent concentrations, summarized in table form, at each groundwater monitoring well monitored during each sampling event;*	**6.3**
257.103 (f)(1)(iv)(B)(4)	*A description of site hydrogeology including stratigraphic cross-sections;*	**6.4**
257.103 (f)(1)(iv)(B)(5)	*Any corrective measures assessment conducted as required at 257.96*	**6.5**
257.103 (f)(1)(iv)(B)(6)	*Any progress reports on corrective action remedy selection and design and the report of final remedy at selection required a 257.97 (a)*	**6.6**
257.103 (f)(1)(iv)(B)(7)	*The most recent structural stability assessment required at 257.73 (d)*	**6.7**
257.103 (f)(1)(iv)(B)(8)	*The most recent safety factor assessment required at 257.73 (e)*	**6.8**

Acronyms

ASD	Alternative Source Demonstration
BOD	Biochemical Oxygen Demand
BOP	Balance of Plant
CbR	Closed (or Closure) by Removal
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
CiP	Closed (or Closure) in Place
CRW	Clarified River Water
DCS	Distributed Control System
ELG	Effluent Limitation Guidelines
EPA	United States Environmental Protection Agency
F.B. Culley	F.B. Culley Generating Station
FGD	Flue Gas Desulfurization
GPD	Gallons Per Day
GWPS	Groundwater Protection Standards
IDEM	Indiana Department of Environmental Management
IFC	Issued for Construction
IRP	Integrated Resource Plan
IURC	Indiana Utility Regulatory Commission
MGD	Million Gallons per Day
MM	Million
MSL	Mean Sea Level
MW	Megawatt
NPDES	National Pollutant Discharge Elimination System
OLQ	Office of Land Quality
POTW	Publicly Owned Treatment Works
RFP	Request for Proposal
SCC	Submerged Chain Conveyor
SDE	Spray Dryer Evaporator
SIGECO	Southern Indiana Gas and Electric Company
SSLs	Statistically Significant Levels
TSS	Total Suspended Solids
WWTF	Wastewater Treatment Facility
ZLD	Zero-Liquid Discharge

1 Executive Summary

Southern Industrial Gas and Electric Company (SIGECO) owns and operates the F.B. Culley Generating Station (F.B. Culley Generating Station or F.B. Culley) located in Warrick County, Indiana, southeast of Newburgh, Indiana. F.B. Culley Generating Station currently operates the East Ash Pond, a unit that receives both Coal Combustion Residual (CCR) and non-CCR flows associated with the operation of two coal-fired generating units; Unit 2 at 100 megawatts (MW) and Unit 3 at 287 MW. The East Ash Pond is a currently operating surface impoundment which is planning for closure in accordance with the requirements of the United States Environmental Protection Agency's (EPA) Final CCR Rule (40 Code of Federal Regulations (CFR) 257, Subpart D or Federal CCR Rule). The CCR Rule (following the Part A updates) requires SIGECO to cease discharge of CCR and non-CCR wastestreams into the East Ash Pond as soon as technically feasible, but no later than April 11, 2021, or seek appropriate extensions under 40 CFR § 257.103 to continue operating. As described in this document, SIGECO is requesting an extension of the April 11, 2021 "cease flow" deadline for operation of the East Ash Pond.

For continued operation of the East Ash Pond beyond April 11, 2021, two extension mechanisms are available under the final Part A: (1) *Development of Alternative Capacity is Technically Infeasible* (40 CFR § 257.103(f)(1)) or (2) *Permanent Cessation of a Coal-Fired Boiler(s) by a Date Certain* (40 CFR § 257.103(f)(2)). SIGECO has prepared this document to demonstrate that obtaining alternative capacity for the CCR and non-CCR flows at the F.B. Culley East Ash Pond is infeasible before the April 11, 2021 deadline, and additional time is needed to operate the East Ash Pond until alternative capacity becomes available under the fastest technically feasible timeline.

Eight alternative capacity options were identified and evaluated based on feasibility and schedule including repurposing existing lined facilities, constructing a new pond, constructing a new wastewater treatment facility, and transporting wastestreams to area treatment facilities. Prior to Part A, SIGECO has been actively implementing a plan for redirection of non-CCR to a new lined contact stormwater pond (nearing construction completion) as well as completing dry bottom ash conversion for Unit 3. In addition, SIGECO has determined the construction of an additional new lined CCR-Rule compliant pond for alternative capacity to allow the cessation of CCR flows to the East Ash Pond is the fastest feasible option for obtaining alternative capacity. As described in this demonstration, these ponds will serve both CCR and non-CCR flows currently managed by the East Ash Pond. The combination of these activities (and others described within the demonstration) is believed to represent the fastest feasible timeline for obtaining alternative capacity. Engineering and design associated with these improvements is ongoing, and the systems are expected to be operational on or prior to the requested "cease flow" date of March 1, 2023.

2 Demonstration Purpose and Objectives

This document has been prepared in accordance with the requirements 40 CFR § 257.103(f)(1) to demonstrate that obtaining alternative capacity for CCR and non-CCR flows at the SIGECO F.B. Culley East Ash Pond is infeasible before the April 11, 2021 “cease receipt” deadline provided in 40 CFR § 257.101(a)(1). Accordingly, SIGECO is respectfully requesting an extension to the deadline for East Ash Pond operations pursuant to the Development of Alternative Capacity is Technically Infeasible criteria under 40 CFR § 257.103(f)(1). This document provides the requested information to support this demonstration.

3 Organization of the Demonstration

For ease of review and verification of completeness, this demonstration has been structured consistent with the specific requirements and criteria under 40 CFR § 257.103(f)(1)(iv). The document structure and contents of each section are as follows:

Section 1 – Executive Summary – This section provides an overview of the document.

Section 2 – Demonstration Purpose and Objectives – This section provides a brief discussion of the document purpose.

Section 3 – Organization of the Demonstration – This section provides a discussion of the document outline and organization, indicating where the various regulatory criteria are addressed.

Section 4 – Facility and CCR Unit Background and Description – This section provides background information associated with the generating station, its current operating scenario, and the CCR unit.

Section 5 – Work Plan for Alternative Capacity – This section addresses the requirements for a work plan described in 40 CFR § 257.103(f)(1)(iv)(A), and includes the following key subsections:

- **Section 5.1 – Evaluation of On-site and Off-site Options for Alternative Capacity –** This section provides a detailed Work Plan for obtaining Alternative Capacity consisting of a narrative discussion of options considered, technical infeasibility demonstrations, and a justification of the option selected (40 CFR § 257.103(f)(1)(iv)(A)(1)).
- **Section 5.2 – Detailed Schedule and Narrative Discussion** – This section provides a detailed schedule of the fastest technically feasible time to complete the measures necessary and a narrative discussion describing the schedule and timeline considerations (40 CFR § 257.103(f)(1)(iv)(A)(2 and 3)).
- **Section 5.3 – Progress Toward Alternative Capacity** - This section provides a narrative discussion of the progress made to obtain alternative capacity thus far (40 CFR § 257.103(f)(1)(iv)(A)(4)).

Section 6 – Compliance Certification and Additional Information – This section provides a signed certification that the facility is operating in compliance with this subpart and a summary reference to the requested hydrogeologic and other information (40 CFR § 257.103(f)(1)(iv)(B)). The requested items are provided in appendices.

The recent "A Holistic Approach to Closure Part A: Deadline to Initiate Closure" (Part A) revision to the Federal CCR Rule requires that demonstrations be submitted to EPA for approval no later than November 30, 2020. Following the submission of this demonstration, SIGECO will place a Notice of Intent to apply for a site-specific alternative to initiation of closure due to development of alternative capacity infeasible, along with a copy of the demonstration, into its operating record and onto the SIGECO CCR Compliance web page (https://www.vectren.com/reporting/ccr) as required by 40 CFR § 257.105(i)(14) and 40 CFR § 257.106(i)(14), respectively.

4 Facility and CCR Unit Background and Description

A discussion of the facility, current and future operational scenario, and CCR unit background is provided in the following sections.

4.1 Facility Description and Future Operations

SIGECO owns and operates F.B. Culley located in Warrick County, Indiana, southeast of Newburgh, Indiana (see attached **Figure 1**). F.B. Culley is located along the north bank of the Ohio River, and Little Pigeon Creek is situated along the southeastern-eastern boundary of the facility. Within its operational life, F.B. Culley has operated two (2) CCR surface impoundments referred to as the West Ash Pond and the East Ash Pond (see attached **Figure 2**). However, only the East Ash Pond is currently in operation receiving both CCR and non-CCR wastestreams. The West Ash Pond (described further below) is nearing the completion of closure. Closure of the West Ash Pond is on schedule to be complete by December 17th, 2020.

The East Ash Pond is located in the southeasternmost area of the station and is approximately 10 acres in size. The East Ash Pond was commissioned in approximately 1971 and operates as an unlined CCR impoundment. The East Ash Pond currently receives both CCR and non-CCR flows associated with the operation of two coal-fired generating units: Unit 2 (100 MW) and Unit 3 (287 MW). It should be noted that Unit 1 was previously retired in 2005.

As mentioned above, closure activities for the West Ash Pond are currently underway and nearing completion. As such, neither CCR nor non-CCR flows are currently managed and treated by the West Ash Pond. In order to facilitate closure of the West Ash Pond under the provisions of the Federal CCR Rule, it should be noted that a separate previously-completed project addressed redirection of West Ash Pond flows to the East Ash Pond. Under a closure plan approved by the Indiana Department of Environmental Management (IDEM), a portion of the West Ash Pond is being Closed by Removal (CbR) and a portion of the pond is Closed in Place (CiP) with a final cover system meeting the requirements of the Federal CCR Rule. The CbR portion of the West Ash Pond closure includes construction of a lined Contact Stormwater Pond. As discussed throughout this demonstration, at a future date (July 1, 2021) this lined Contact Stormwater Pond will also manage non-CCR flows currently treated by the East Ash Pond.

A significant amount of planning and engineering is currently underway at F.B. Culley under both the CCR and the ELG rules related to future unit operation and management of flows. There are also a number of current regulatory milestones associated with these efforts. As discussed in the recently issued Integrated Resource Plan (IRP) report, Unit 2 is currently slated for retirement by the end of 2023 and current bottom ash and flue gas desulfurization FGD wastewater streams associated with Unit 2 will cease in conjunction with this unit retirement. It is anticipated that Unit 3 will remain in operation past 2023 and projects are currently underway for dry bottom ash conversion (completed November 2020 prior to the milestone date of December 31, 2020) as well as implementation of a zero-liquid discharge (ZLD) process for management of FGD-related wastewaters (scheduled completion by July 1, 2023). The modification (and associated schedule milestones) for Unit 3 bottom ash transport water (December 31, 2020) is the result of a mandate in the facility's current National Pollutant Discharge Elimination System (NPDES) to cease the discharge of bottom ash transport water no later than December 31, 2020. Additionally, the modifications for the FGD-related wastewaters is the result of a mandate to meet new limits by February 1, 2021, unless the facility commits to retiring Unit 3 or installing a ZLD process, in which case a later compliance date that is no later than December 31, 2023, may be sought. An Order (Cause No. 45052) from the Indiana Utility Regulatory Commission (IURC) was issued on April 24, 2019, in which the IURC authorized the capital expenditure for the ZLD technology on Unit 3 (See **Appendix A**). Issuance of this Order was a necessary step in determining the remaining useful life of Unit 3 and the consequential management of FGD-related wastewater flow. While engineering associated with implementation of ZLD technology is currently underway, SIGECO is also reviewing potential impacts of the recently published (October 13, 2020) ELG Reconsideration Rule and upcoming 2022 IRP study on the future operation of Unit 3. For this reason and as discussed in this demonstration, additional alternative capacity options are being implemented (representing the fastest technically feasible time) that will also address remaining Unit 3 FGD-related wastewaters while SIGECO evaluates its potential compliance options for Unit 3 under the new ELG Reconsideration Rule. As mentioned previously, non-CCR flows currently managed by the East Ash Pond will be diverted to the new lined Contact Stormwater Pond currently under construction within the footprint of the former West Ash Pond which is nearing completion. Design activities for this non-CCR flow diversion are currently underway and the systems will be operational by July 1, 2021.

4.2 CCR Unit Description

The East Ash Pond was commissioned in approximately 1971 and currently operates as an unlined CCR surface impoundment. Earthen embankments were constructed along the south and east sides of the impoundment. Structural fill from the original construction of the F.B. Culley Generating Station in the 1950s was used to construct the earthen embankment along the east and south sides of the unit, forming the East Ash Pond. The east embankment intersects a natural hillside on the east end of the north side of the impoundment. The perimeter of the embankment is approximately 1,200-feet long, 30-feet high, with exterior side slopes covered with grassy vegetation. The surface area of the impoundment is approximately 9.8 acres and the unit has a normal water operating level of 386 feet above mean sea level (MSL).

Following promulgation of the Federal CCR Rule, SIGECO began working with consultants (AECOM and Haley & Aldrich) to evaluate the East Ash Pond's compliance with the new CCR Rule requirements. The East Ash Pond was certified to be compliant with Federal CCR Rule stability and safety factor criteria. The East Ash Pond is also compliant with the wetlands, fault area, seismic impact zone, and unstable area location restrictions. However, the East Ash Pond did not achieve the uppermost aquifer separation criteria. Groundwater monitoring results associated with the East Ash Pond indicate the data exhibits statistically significant levels (SSLs) of molybdenum and arsenic above Groundwater Protection Standards (GWPS). However, arsenic was subsequently addressed by a successful Alternative Source Demonstration (ASD) (**Appendix H**). Given that the unit is unlined, the East Ash Pond is required to cease CCR and non-CCR flows by April 11, 2021 (under the provisions of the recently effective Part A) and either initiate closure or seek appropriate extensions for continued short-term operation.

4.3 Extension Mechanism Selection

The East Ash Pond will operate beyond April 11, 2021, because no alternative capacity currently exists (either on or off-site) and it is infeasible to obtain alternative capacity prior to the April 11, 2021 "cease flow" deadline. For continued operation of the East Ash Pond beyond April 11, 2021, two extension mechanisms are available under the final Part A: (1) Development of Alternative Capacity is Technically Infeasible (40 CFR § 257.103(f)(1)) or (2) Permanent Cessation of a Coal-Fired Boiler(s) by a Date Certain (40 CFR § 257.103(f)(2)). Key considerations for each of these provisions and the basis for extension selection are outlined below.

1) *Development of Alternative Capacity is Technically Infeasible*: Under this provision, Owner/Operators are required to demonstrate to EPA that obtaining alternative capacity on-site or off-site is infeasible before April 11, 2021, and that additional time is needed to secure additional capacity. In summary, the demonstration must provide information and technical justification that no alternative capacity exists on-site or off-site and must provide a detailed workplan and schedule that includes technical and narrative discussions of how F.B. Culley will obtain alternative capacity. Following public comment and EPA approval, this provision allows for approval of continued operations up to October 15th, 2023 (for non-eligible unlined CCR surface impoundments) or October 15th, 2024 (for eligible unlined CCR surface impoundments). Under the provisions of Part A, the East Ash Pond is a non-eligible unlined CCR surface impoundment.

2) <u>*Permanent Cessation of a Coal-Fired Boiler(s) by a Date Certain*</u>: Under this provision, a CCR unit may continue to receive flows if the owner or operator also commits to coal-fired boiler closure. As discussed in Part A, the facility must commit to coal-fired boiler retirement and cease flows/complete CCR unit closure by October 17th, 2023 (for units less than or equal to 40 acres). Because it is currently anticipated that Unit 3 will continue operation beyond October 17, 2023, F.B. Culley would not qualify for this extension mechanism and it is not discussed further in this demonstration.

Based on the considerations above, SIGECO has prepared this extension based on the requirements for the *Development of Alternative Capacity is Technically Infeasible* extension provision of Part A. As discussed throughout this demonstration, this selection meets the following criteria for *Development of Alternative Capacity is Technical Infeasible* as referenced in 40 CFR § 257.103(f)(1):

- No alternative disposal capacity is available on or off-site (40 CFR § 257.103(f)(1)(i))

- CCR and non-CCR waste streams must continue to be managed in the CCR surface impoundment because it is technically infeasible to complete the measures necessary to obtain alternative disposal capacity either on or off-site of the facility by April 11, 2021 (40 CFR § 257.103(f)(1)(ii)).

5 Work Plan for Alternative Capacity (40 CFR § 257.103(f)(1)(iv)(A)(1))

The Part A demonstration criteria presented in 40 CFR § 257.103(f)(1)(iv)(A)(1) requires a written narrative discussing the options considered both on- and off-site to obtain alternative capacity for each CCR and/or non-CCR waste stream, the technical infeasibility of obtaining alternative capacity prior to April 11, 2021, and the option selection and justification for the alternative capacity selected. The options considered are further discussed in the following sections.

5.1 Evaluation of On-site and Off-site Options for Alternative Capacity

The East Ash Pond has a current storage capacity of 28.2 acre-feet (9,175,000 gallons) and serves a primary role for plant operations with key functions including solids removal by settling and hydraulic surge. The East Ash Pond, as currently operating, receives an average of approximately 1.65 million gallons per day (MGD) of influent from various plant sources. Several of the flows to the East Ash Pond from Units 2 and 3 (such as FGD wastewater-related flows) are comingled. Unit 1 at F.B Culley Station was retired in 2005; however, the basement sump that serves Units 1 & 2 remains in service.

The flowrates of the primary streams are summarized in **Table 1**.

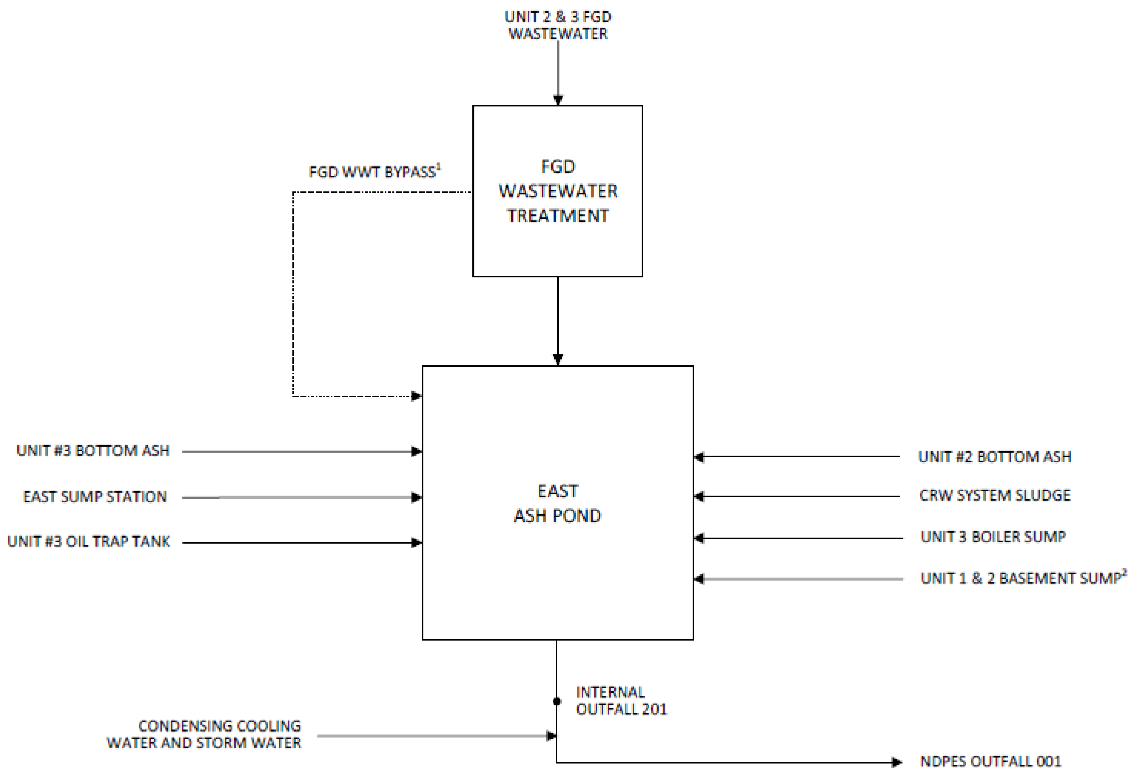
Table 1: East Ash Pond Inflows

CCR Flows			
Source	**MGD**	**Current Management**	**Future Management**
Unit 2 Bottom Ash Sluice Water	0.138	East Ash Pond	New Lined CCR Pond
Unit 3 Bottom Ash Sluice Water	0.321	East Ash Pond	Dry conversion complete 12/31/2020
Unit 2 FGD Wastewater	0.095	East Ash Pond	New Lined CCR Pond
Unit 3 FGD Wastewater			
Non- CCR Flows			
Clarified River Water (CRW) Sludge	0.035	East Ash Pond	New Lined Contact Stormwater Pond
Unit 3 Boiler Sump	0.173	East Ash Pond	New Lined Contact Stormwater Pond
East Sump Station	0.792	East Ash Pond	New Lined Contact Stormwater Pond
Units 1 & 2 Basement Sump	0.088	East Ash Pond	New Lined Contact Stormwater Pond
Mix Tank/ Unit 3 Oil Trap	0.0123	East Ash Pond	New Lined Contact Stormwater Pond
Total	**1.65**		

[1]Note Unit 1 has previously been retired.

The flows into the East Ash Pond are discharged through Internal Outfall 201, then combined with condenser cooling water and stormwater and discharged through NPDES Outfall 001. A block flow diagram of the current flows to and from the East Ash Pond is shown in **Figure 3**.

Figure 3: Flow Diagram of Current Flows to/from East Ash Pond



[1.] FGD Wastewater Treatment (WWT). Bypass for emergency use only. [2.] Note Unit 1 was retired in 2005.

The cessation of CCR and non-CCR flows to the East Ash Pond requires alternative capacity to replace the operational functions of the pond, or the plant must be modified to operate without the East Ash Pond. Primary functions of the East Ash Pond that must be replaced include removal of solids and hydraulic storage. As required by Part A, both on-site and off-site options were evaluated as potential paths to alternative capacity. The following sections detail the options considered and justification for the selected alternative as the fastest feasible timeline for obtaining the needed alternative capacity.

When considering the current operations at the F.B. Culley and the process for obtaining alternative capacity for the East Ash Pond, the following considerations are key:

- **Unit 3 Bottom Ash Flows** – The East Ash Pond has managed Unit 3 Bottom Ash Sluice Water (0.321 MGD). The facility's NPDES permit requires elimination of these flows by December 31, 2020 and a project was completed in November 2020 to convert Unit 3 bottom ash handling operations to a dry handling system using a submerged chain conveyor (SCC). Because this flow has been eliminated prior to the April 11, 2021 "cease flow" deadline, alternative capacity for the Unit 3 Bottom Ash Sluice Water is not discussed further in this report.

- **Unit 2 & 3 FGD-Related CCR Flows** – The current CCR flows to the East Ash Pond include Unit 2 Bottom Ash Sluice Water (0.138 MGD) and Unit 2 and 3 FGD Wastewater (0.095 MGD). The process of obtaining alternative capacity for the non-CCR and Unit 2 & 3 FGD-related wastewater flows is considered "critical path" and the alternative capacity discussions within this report will focus primarily on these flows.

- **Unit 2 Bottom Ash Flows** – The East Ash Pond currently manages Unit 2 bottom ash sluice water at an average flow rate of 0.138 MGD. It is worth noting that the capacity factor for Unit 2 was 15.3% in 2019, 32.1% in 2018, and 22.2% in 2017. Whereas it is anticipated that retirement of Unit 2 will occur by the end of 2023, this flow has also been considered in this evaluation of alternative capacity and fastest feasible timeline. However, feasible options for alternate capacity of this bottom ash stream that can be completed before October 15, 2023 are limited and include only an alternative lined CCR pond or a SCC (similar to that being installed on Unit 3). Complications associated with installation of a SCC for the physical configuration of Unit 2 renders this option technically infeasible in a timeframe less than 36 months. For this reason, this technical evaluation has focused on the critical path of addressing Unit 2 and 3 FGD-related wastewaters. Accordingly, each option has also been given consideration for potential management of the Unit 2 bottom ash wastestream.

The options and process for obtaining alternative capacity for the non-CCR and CCR flows, (FGD-related wastewater flows, and Unit 2 bottom ash flows) is discussed in the following sections.

Non-CCR Flows

Since approximately 2017, efforts have been in place for the redirection of non-CCR flows managed by the East Ash Pond to the lined contact stormwater pond being constructed as part of the West Ash Pond closure activities. These non-CCR wastestreams are summarized in **Table 2**.

Table 2. Redirected East Ash Pond Non-CCR Inflows

Non- CCR Flows		
Source	**MGD**	**Future Management**
Clarified River Water (CRW) Sludge	0.035	New Lined Contact Stormwater Pond
Unit 3 Boiler Sump	0.173	New Lined Contact Stormwater Pond
East Sump Station	0.792	New Lined Contact Stormwater Pond
Unit 1 & 2 Basement Sump[1]	0.088	New Lined Contact Stormwater Pond
Mix Tank/ Unit 3 Oil Trap	0.0123	New Lined Contact Stormwater Pond
Total	**1.100**	

1. Note Unit 1 is retired as of 2005.

Based on commitments to IDEM as part of a variance from a requirement of the 2015 CCR rule (40 CFR 257.101(a)(1)), which is currently still in effect in Indiana, engineering is currently underway and these non-CCR flows to the East Ash Pond are scheduled to cease by July 1, 2021, following construction of infrastructure to redirect these flows to the new lined Contact Stormwater Pond. Re-routing of these non-CCR streams to the new Contact Stormwater Pond was underway well before the final Part A and represents the fastest technically feasible alternative for management of these non-CCR flows.

Unit 2 and 3 FGD-Related Wastewater Stream and Unit 2 Bottom Ash Stream

As mentioned previously, it is SIGECO's current intent to retire Unit 2 by the end of 2023 as discussed in the recent IRP. Nevertheless, Part A requires evaluation of the "fastest technically feasible timeline" for obtaining alternative capacity. For this reason, both Unit 2 and Unit 3 flows managed by the East Ash Pond have been considered in this evaluation of alternative capacity. Considering the current activities for management of non-CCR flows in the new lined Contact Stormwater Pond and dry conversion of Unit 3 bottom ash system, the remaining flows to the East Ash Pond are the FGD wastewater stream from Unit 2 and Unit 3, as well as the Unit 2 bottom ash wastestream. As mentioned previously, this evaluation focuses on alternatives for management of the Unit 2 and 3 FGD-related wastewaters, but also gives consideration to management of Unit 2 bottom ash flows within each alternative.

Units 2 and 3 are served by a common FGD system producing one wastewater stream discharge to the East Ash Pond. The FGD wastewater discharged to the East Ash Pond is nominally 95,000 gallons per day (GPD). In evaluating alternative capacity options for the FGD wastewater stream, the NPDES permit requirements for this discharge were considered. New numeric effluent limitations for the FGD wastewater discharge take effect in the near future unless the facility commits to retire Unit 3 or proceed with ZLD for FGD-related wastewaters, in which case, a request can be made to modify the NPDES compliance date to not later than December 31, 2023. As SIGECO intends to operate Unit 3 into the future (past December 31, 2023), the focus on obtaining alternative capacity has been directed toward a ZLD system for FGD-related wastewaters. As discussed previously, the receipt of the IURC Order in April 2019, which approved the capital investment, was a necessary step in the process of determining the means of managing the FGD-related wastewater flow. While the order approved the capital expenditure for Unit 3, the future of Unit 2 was subject to the outcome of the required 2019-2020 IRP study and subsequent approvals. Nevertheless, Unit 2 flows have been addressed in this evaluation based on the consideration of ceasing flows to the East Ash Pond and the fastest technically feasible timeline for completing this process.

The following alternative options were considered for the FGD wastewater flows:

1. Alternative 1 – Repurposing Existing Lined Facilities.
2. Alternative 2 – Construction of a New On-site CCR Rule-Compliant Pond – Area to North of New Lined Contact Stormwater Pond
3. Alternative 3 – Construction of a New On-site CCR Rule-Compliant Pond – Area to North of East Ash Pond
4. Alternative 4 - Alternative Capacity Off-site
5. Alternative 5 – Temporary Wastewater Treatment Facility
6. Alternative 6 – Brine Concentrator
7. Alternative 7 – Membrane Separation
8. Alternative 8 – Wastewater Spray Dryer

Descriptions of each treatment alternative and discussion of feasibility at F.B. Culley are provided in the sections below.

5.1.1 On-site Alternative Capacity – Pond Systems

Alternatives 1, 2, and 3 consider on-site alternatives involving repurposing of existing ponds or construction of a new pond system. These options are discussed further in the following sections.

Alternative 1 – Repurposing Existing Lined Facilities

For completeness in the alternative capacity option development process, consideration was given to repurposing existing lined facilities for management of FGD-related wastewater flows from Unit 2 and 3 and bottom ash flows from Unit 2. The only potential option would be management of these wastewater flows in the new lined Contact Stormwater Pond as no other ponds currently exist on-site. However, several considerations and limitations render this option technically infeasible. First, FGD wastewater flows and the Unit 2 bottom ash flow would be considered a CCR flow and the new lined Contact Stormwater Pond (currently nearing completion of construction and on schedule to be in service by the end of 2020) was not designed for management of CCR flows and would not meet the requirements for a composite liner system under the Federal CCR Rule (40 CFR § 257.72). Significant retrofit of the liner system would be required that would take considerable time and not be achievable by the July 1, 2021 regulatory milestone contained in the IDEM variance for continued use of the East Ash Pond. In addition, this new lined stormwater pond has not been sized for the flows associated with the FGD-related wastewater streams and Unit 2 bottom ash stream. Accommodation of these streams within the new lined Contact Stormwater Pond would require significant expansion to provide the settling capacity required to manage and treat these additional CCR flows. Further, this new lined Contact Stormwater Pond was included as a component of the IDEM closure plan approval for the West Ash Pond. This option would require both modification of the current closure plan approval for the West Ash Pond (6-month process) as well as an approval from the IDEM Office of Land Quality (OLQ) for operation of a new CCR surface impoundment (12-month process). In addition to these timeline considerations, a CCR compliant monitoring well network would also require installation and monitoring prior to construction/permit approval. For these regulatory and technical reasons, this option is considered technically infeasible within the available timeframe.

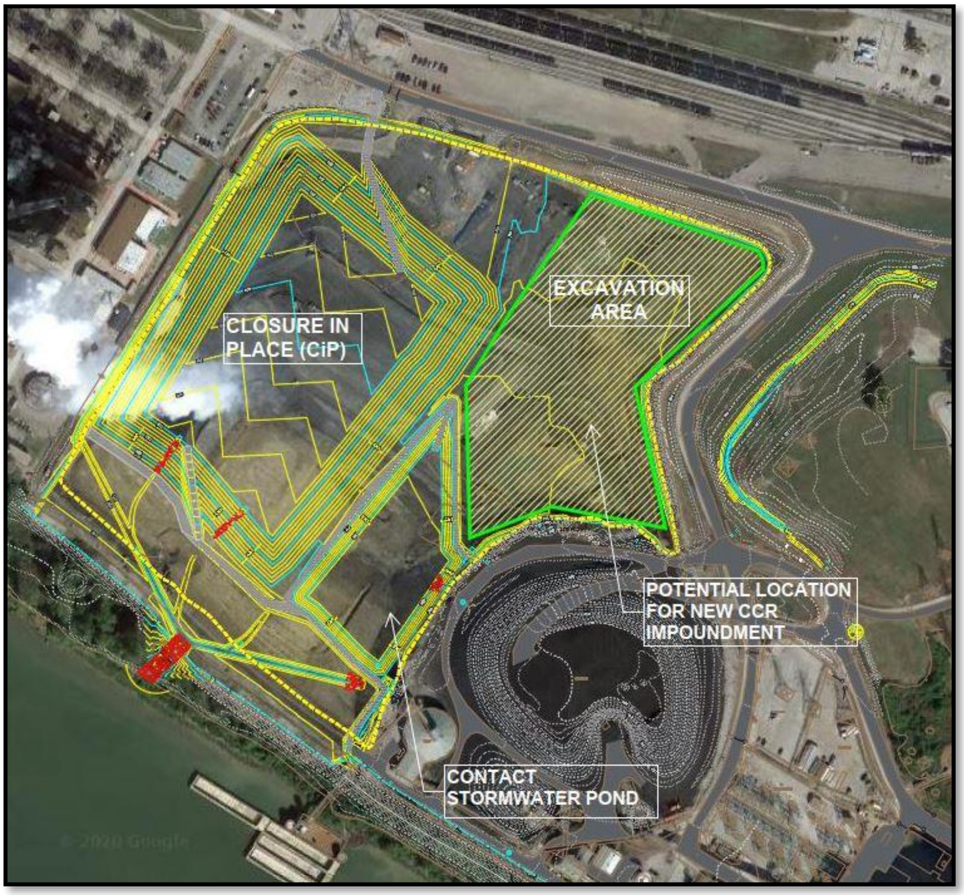
Alternative 2 – Construction of a New On-site CCR Rule-Compliant Pond – Area to North of New Lined Contact Stormwater Pond

Construction of a new lined CCR Pond (impoundment) in the area to the north of the new lined Contact Stormwater Pond has been evaluated and is the preferred alternative for this analysis as it represents the fastest technically feasible timeframe to obtain alternative capacity and flow cessation to the East Ash Pond. The (CbR) *Excavation Area* of the West Ash Pond closure (area currently complete) has been evaluated as a potential location for a new lined CCR Pond. The new pond would be constructed immediately north of the lined Contact Stormwater Pond that is nearing construction completion and is on schedule to be in service by the end of 2020. In concept, the new lined CCR Pond would be constructed upgradient of and discharge through the lined Contact Stormwater Pond for polishing and flow equalization considerations.

In this proposed area, the CCR materials from the former West Ash Pond footprint have been completely removed and verified, and structural fill has been placed over the excavation grades to create a network of stormwater conveyance channels that manage clean (non-contact) stormwater flows from contributing drainage areas across the plant property. These clean stormwater flows are conveyed through a piping network and ultimately discharged through a NPDES permitted stormwater outfall.

The new lined CCR Pond would be sized for management of FGD-related wastewater flows from Unit 2 and 3 and Bottom Ash discharge flows from Unit 2. Since these flows would be considered CCR flows, the new lined CCR Pond will need to meet the requirements for a composite liner system under the Federal CCR Rule (40 CFR § 257.72) as well as achieve the location restrictions of 40 CFR § 257.60-64. Based on a fatal flaw analysis of these requirements, the potential location (**Figure 4)** is expected to be suitable for construction of a new CCR Rule-compliant surface impoundment.

Figure 4: Potential Location of New CCR Rule-Compliant Pond



As depicted in **Figure 4**, approximately 7 acres of land north of the new lined Contact Stormwater Pond is currently available for a new pond. This would require the clean stormwater flow network to be modified during construction of the new pond in this location. To create an equivalent settling capacity provided by the East Ash Pond, a 7-day retention period is being assumed for the combined Unit 2 bottom ash and Unit 2 and 3 FGD wastewater flows. Since the daily flow is cumulatively 233,000 gallons, approximately 1.63 million gallons (5 acre-feet) of storage is necessary to provide the required settling. To evaluate the sizing requirements for the pond, the volume of a rectangular pond was calculated as follows:

i) This pond was assumed to have the shape of an upside-down rectangular truncated pyramid, with 3:1 H:V (horizontal : vertical) interior side slopes, and a conservative depth of 5 feet that provides a minimum freeboard of 2 feet.

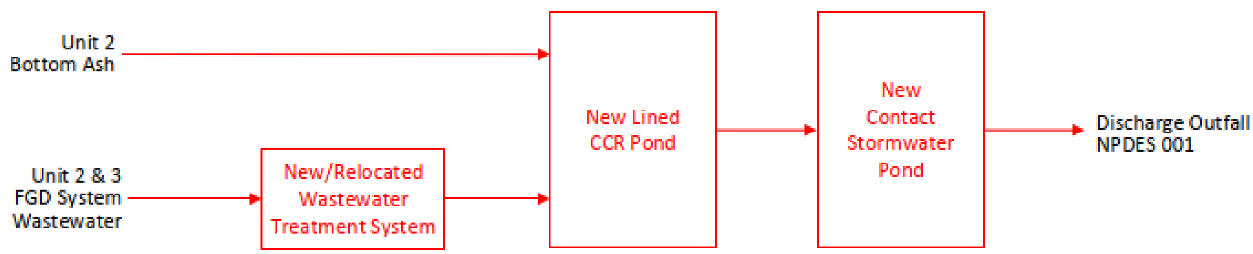
ii) The total area of the pond would be approximately 2 acres and the outer boundary of the pond would be 440 feet by 200 feet, sloping down to a rectangle bottom 410 feet by 170 feet on each side. These dimensions would conservatively provide a total settling volume of approximately 3.10 million gallons (9.5 acre-feet) including freeboard.

Based on these considerations, construction of a pond of sufficient size to address the CCR flows managed by the East Ash Pond would be technically feasible.

Pursuant to 40 C.F.R. § 257.60(a), new CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five feet) above the upper limit of the uppermost aquifer, or must demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high water table). Installation of wells to address CCR Rule requirements (as needed) and groundwater monitoring to establish water levels will be conducted to provide a minimum elevation for the base of the future CCR-pond liner system. In the event the water levels prohibit a 1.52 meter separation while maintaining necessary storage capacity, the liner system will be designed in a manner that insures no hydraulic connection between any portion of the base of the unit and the uppermost aquifer.

The existing CCR flows to the East Ash Pond, Unit 2 and 3 FGD wastewater and Unit 2 bottom ash sluice, will be re-routed to the new lined CCR pond. A flow diagram of the new configuration is shown in Figure 5. Modifications of the existing system are shown in red.

Figure 5: Flow Diagram for New Lined CCR Pond



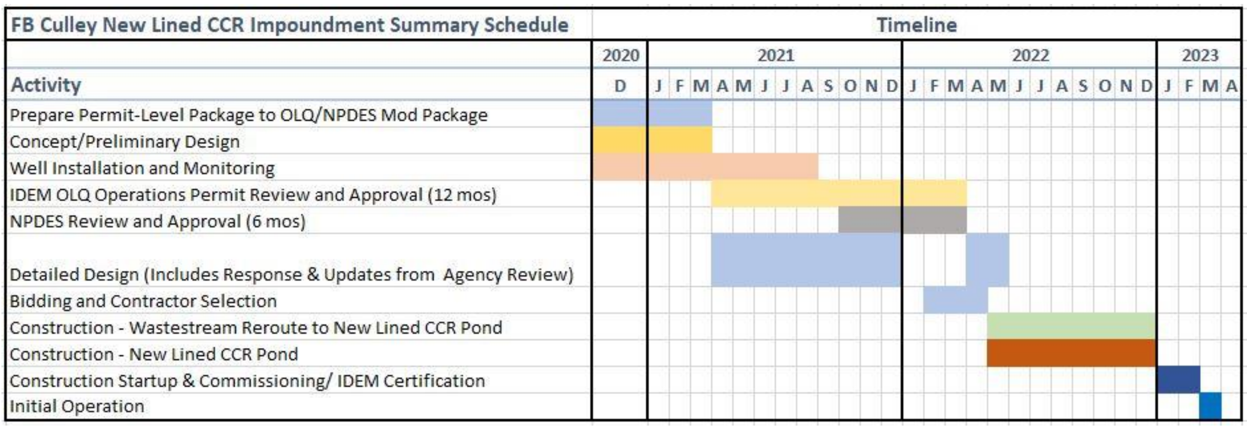
Rerouting of CCR flows from the East Ash Pond requires the design and installation of new transfer lines to the new lined CCR pond and lines from the New Lined CCR pond to the Contact Storm Water Pond, then discharge through permitted Internal Outfall 101 and ultimately through NPDES permitted Outfall 001. The new lined CCR Pond would flow by gravity through the new Contact Stormwater Pond and ultimately discharge through Outfall 001. The existing FGD wastewater treatment system at the East Ash Pond will be replaced or relocated to the new lined CCR Pond area. New electrical and controls infrastructure will be installed at the new lined CCR Pond to support the new equipment and Wastewater Treatment System in this area. To implement this alternative, the following steps would be performed:

- Groundwater Monitoring – Design, Installation, Data Collection and Evaluation
- Conceptual Design
- Preliminary Design
- Permitting - IDEM OLQ Operations Permit and NPDES Major Modification
- Detailed Design
- Engineered Equipment Procurement
    - Pumps
    - Power Distribution Center (PDC), Transformers
    - Distributed Control System (DCS) Integration
- Structural, Mechanical, Electrical and Controls Contractor Bid, Selection and Award
- Structural, Mechanical, Electrical and Controls Construction
    - Reroute of Unit 2 Bottom Ash and FGD wastewater lines to new pond area
    - Installation of new FGD wastewater treatment system
    - Discharge pumping system and ancillary components

    - Electrical, controls and balance of plant (BOP) scope
- Civil Earthworks Contractor Bid, Selection, and Award
- Procurement
- Civil & Earthworks Construction
    - Reroute of clean stormwater conveyance in pond footprint
    - Construct pond embankment
    - Subgrade Preparation
    - Construct composite CCR Pond Liner
    - Construct lines and/or pump stations for flow redirection (concurrently with other features)
    - Provide flow equalization connection between new lined CCR Pond and Contact Stormwater Pond
- Start-up and Commissioning
- Initial Operation

The approximate durations of key activities are summarized in **Figure 6**.

Figure 6. Estimated Simplified Schedule for New CCR Pond in *Excavation Area*



The expected timeframe to complete these efforts is 27 months from December 1, 2020, with an estimated completion date of March 1, 2023. IDEM requires that an operations permit be issued for operation of a new CCR surface impoundment. Based on recent IDEM discussions, they indicated that a 12-month period is the current timeframe for review and issuance of this approval. As such, the schedule includes a 12-month duration for this permit review. Detailed design, equipment procurement and construction not related to civil earthwork for the new lined CCR Pond will be performed concurrent with the OLQ review. Again, Figure 6 represents a simplification of key activities in the overall timeline. For a detailed critical path schedule, schedule see **Appendix C**.

Alternative 3 – Construction of a New On-site CCR Rule-Compliant Pond – Area to North of East Ash Pond

Based on site property availability, construction of a new lined CCR pond in the area north of the East Ash Pond was also considered as part of the options analysis. The potential area north of the East Ash Pond is not currently utilized for plant operations and could be a potential location for such a pond. **Figure 7** below demonstrates the proposed location of the new pond.

The potential area of the new lined CCR pond is not ideal and has steep hill slopes that would require significant earthwork to construct a new pond. The area of the new pond is at an elevation significantly higher than the current East Ash Pond, which would make the re-routing of flows more difficult and would include additional pumps and replacement of existing infrastructure. A proposed pond in this area would also encroach on existing drainage features and potentially require Section 401/404 permitting. Based on recent experience, a Section 401/404 permit can take on the order of one year to obtain. Similar to Alternative 2, this proposed pond would also require an operations permit issued by IDEM OLQ. Considering these complications, a new pond in this proposed area would likely require 36 months to complete, significantly longer than Alternative 2. Based on these considerations, this option is not considered the fastest technically feasible alternative and has been eliminated from consideration.

Figure 7. Potential Location of New On-site CCR Rule-Compliant Pond

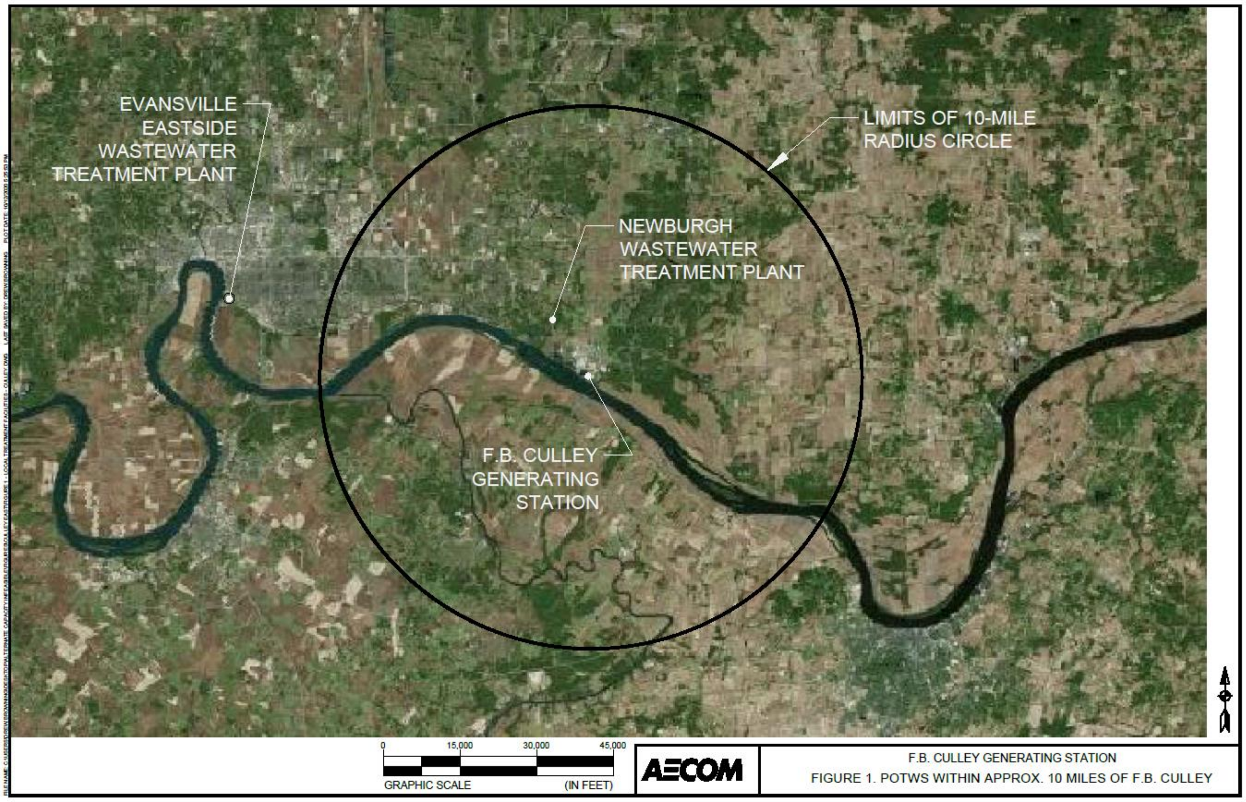
5.1.2 Off-site Alternative Capacity

As required by Part A, off-site options for alternative capacity were also considered. Alternative 4 (described below) was developed to address a potential off-site management option.

Alternative 4 –Alternative Capacity Off-site

Alternatives for off-site treatment of the FGD wastewater flow discharged to the East Ash Pond were evaluated. For this alternative, the FGD wastewater would be transported to either a publicly owned treatment works (POTW) or a private facility capable of managing the wastestream. A 10-mile radius from F.B. Culley was surveyed for POTWs or private facilities that may be capable of treating the waste flows. This radius is shown below, overlaid on the area surrounding the station. The POTW of Newburgh, Indiana, is located approximately within this radius, as shown in **Figure 8.**

Figure 8. POTWs Within 10 Miles of F.B. Culley Generating Station



As shown, the Newburgh POTW is the only wastewater treatment facility (WWTF) located within a 10-mile radius. Evansville Eastside POTW is located just outside this radius. The Regional Water Resource Agency's closest plant, Max Rhoads WWTF (serving Owensboro and Daviess County, Kentucky) was also considered as its straight-line distance from the plant is approximately 12 miles. However, due to the road configuration and limited bridges available across the Ohio River, the actual travel distance to the plant is approximately 25 miles one way, and as such, only the Newburgh POTW and Evansville Eastside POTW were examined in detail.

As the closest POTW, a pipeline to convey the FGD wastewater stream to the Newburgh POTW was considered. The straight-line distance for such a pipeline would be approximately 2.2 miles. For transportation via pipeline, this alternative would require several key items to be completed rapidly to be successful:

- Selection of pipeline route would require the completion of any environmental studies and environmental permitting from regulatory agencies.
- Application for any required federal and/or state permitting required, and timely receipt of approval.
- Acquisition of easements for pipeline right of-way.
- Design of pipeline and any necessary pumping stations.
- Construction of pipeline and pumping stations.
- Final testing.

Given the length of pipeline required and the significant regulatory and design obstacles, construction of a pipeline to a POTW is not the fastest technically feasible alternative. This alternative would require longer than 36 months to complete the route evaluation, permitting, design, property access rights, and construction of such a pipeline.

This timeline would exceed that of Alternative 2 and would not represent the fastest technically feasible alternative. This option would also come with significant schedule risks in the event property access could not be obtained

Transportation of FGD wastewater flows via truck was also considered. The FGD wastewater flow accounts for 95,000 GPD that would need to be transported to an off-site facility for treatment. Assuming a truck capacity of 5,000 gallons, 19 truckloads would be needed daily to transfer FGD wastewater to the off-site WWTF. Although truck transport of this quantity of wastewater is feasible, the nearby Newburgh POTW facility cannot accept truck delivery of wastewater. Further, several of the facilities contacted place limitations on the total suspended solids (TSS) in the wastestreams they can accept. The city of Evansville limits raw wastestreams to 2,114 milligrams/Liter (mg/L), which is substantially lower than the wastestreams currently discharged to the East Ash Pond. Pretreatment to reduce the TSS is required before treatment can be considered by any of the POTWs contacted. In addition to limitations on TSS, POTWs are not equipped to treat the constituents in FGD wastewater.

Many, if not all, of their processes are incompatible with treatment of the CCR wastewater flows from F.B. Culley. The existing Newburgh POTW consists of an activated sludge system with eight (8) sequencing batch reactors followed by ultraviolet disinfection. The system is designed to remove TSS, biological oxygen demand (BOD), and pathogens prior to discharging to the Ohio River. Additional treatment steps would likely be required to remove dissolved metals to below applicable categorical and local standards.

The requirement to pretreat FGD flows removes any benefit of managing this wastestream off-site. In addition, this option would not address the Unit 2 bottom ash wastestream as significant solids removal (in settling tanks for similar facilities) would be required prior to transport of the material. Given the additional infrastructure required for off-site management and treatment of the FGD wastewater flows, completion of this project is not considered to be technically feasible prior to October 15, 2023 and does not represent the fastest technically feasible alternative.

5.1.3 On-Site Wastewater Treatment Facility Alternatives

The FGD wastewater stream must meet the effluent limitations as defined by the current NPDES permit for F.B. Culley. The F.B. Culley NPDES permit contains a reopening clause that allows the facility to request a compliance date that is no later than December 31, 2023 for the Unit 3 FGD wastestream if unit retirement or ZLD technology is pursued. In 2017, various options to comply with the NPDES permit were evaluated including ZLD and advanced wastewater treatment. A ZLD technology that would eliminate the FGD wastewater stream was selected. The selection of the ZLD technology was included in a filing to the IURC seeking approval for the capital expenditure. The Order granting approval was issued April 24, 2019. The ZLD technology selected is detailed in Alternative 8.

Alternative 5 – Temporary Wastewater Treatment Facility (WWTF)

A temporary WWTF to treat the FGD wastewater stream was also considered. To replace the operational functions of the East Ash Pond, the temporary WWTF requires a significant amount of storage capacity and the capability to remove and dewater the suspended solids in these waste streams. The WWTF consists of the following primary components:

- Equalization Storage Tanks - to receive and store the influent flows.
- Primary Dewatering Clarifier/Thickeners - to remove suspended solids from the liquid.
- Filter Feed Storage Tanks – to receive the clarifier/thickener underflow and store until fed to the secondary dewatering filter presses.
- Secondary Dewatering Filter Presses - to remove liquid from the solids so that they can be disposed in a landfill.
- Treated Water Storage Tanks - to store the water that is returned to the system or discharged.

Equalization tanks balance the flow to the downstream clarifiers and blend the wastestreams to reduce fluctuations in temperature and composition. The equalization tanks are sized for 24 hours of wastestream production to address upset conditions in the WWTF and influent peak flow events such as stormwater runoff. The 0.233 MGD of CCR flow requires 250,000 gallons of capacity in the equalization tanks. The system would have 2 tanks, each 30' in diameter and 30' in height with mixers to prevent the solids from settling.

From the equalization tanks, the untreated wastestreams will be transferred to one of two clarifier/thickeners. Clarifier/thickeners is a large quiescent circular tank that removes the suspended solids by settlement. For these streams, each clarifier is approximately 110' diameter by 15' high. The large clarifier/thickeners volume is required to provide the 10 days of residence time required for the wastewater treatment reagents added to remove the mercury from the FGD wastewater. A coagulant and polymer are also added to the feed stream to promote settling and produce a low suspended solids stream. A rotating rake assembly moves the settled solids to the center of the clarifier/thickeners where they are discharged to the filter feed storage tanks. The overflow from the clarifier/thickeners is collected in a sump and pumped to one of the treated water storage tanks. Any water discharged must meet the TSS requirements and mercury limitations of the NPDES permit.

The treated water tanks would store the water for re-use by the system. Return water pumps would send water back to the system for re-use for bottom ash transport, fly ash transport and FGD system make-up. The treated water tanks would be sized for 250,000 gallons of capacity in 2 tanks. Each tank would be approximately 30' in diameter by 30' height and an agitator would not be required.

The filter press is a batch operation. Because solids must be purged from the clarifier/thickeners on a continuous basis, filter feed storage tanks are required. Filter press performance is highly dependent on the characteristics of the solids. Fly ash and FGD solids are among the more difficult to dewater and a filter press cycle time of 3 to 8 hours is expected for this material. To accommodate batch operation, 150,000 gallons of filter feed storage capacity is required. Due to the higher solids content, 2 tanks of 75,000 gallons, approximately 24' x 24' each, would be installed.

The filter press units would be fed from the filter feed tank with high-pressure diaphragm pumps. The fill cycle for a filter press varies dependent on the characteristics of the material. Based on the throughput, 2 or more filter press units are required. Dewatered solids would drop from the filter press units to the roll away bin and be taken to a landfill. The filtrate would be collected and returned to the clarifier/thickeners. Solids that are disposed in the landfill must meet the requirements for free liquids.

The project scope for this WWTF includes field-erected tanks, engineered equipment, structural steel, buildings, piping, electrical, and controls. A significant amount of engineering design is required including:

- Major Engineered Equipment – The system included the following engineered equipment: pumps, agitators, clarifiers, filter presses, power distribution systems, and distributed control systems. The design and manufacturing duration for this equipment ranges from 6 – 12 months after receipt of order.

- Foundations – The WWTF has 6 tanks ranging in size from 75,000 to 250,000 gallons. Each tank will require deep foundations, typically 30' to 60' piles, a mat and containment walls. The 2 clarifier/thickeners, each 110' in diameter also require deep foundations. The filter press unit must be elevated to discharge to the bins these structural support members and enclosure will also require deep foundations.

- Field Erected Tanks – The tanks would all be knockdown field erected. Panel sections would be fabricated, then assembled in the field.

- Electrical and Controls - The new WWTF will require a new electrical service for the pumps, agitators, clarifiers, filter press, freeze protection, heating, ventilation and lighting. New instrumentation and controls are required to operate this system.

In addition to the WWTF, the existing wastestreams must be re-directed from the East Ash Pond to the new facility. New pipe runs are required, and the existing systems will require upgrade and modification to transport these wastestreams to the new WWTF.

The following table summarizes the fastest schedule for implementation of a WWTF to treat the wastestream flows to the East Ash Pond.

Table 3. Temporary Wastewater Treatment Facility Implementation Schedule

Activity	Estimated Duration
Conceptual Design and Investigations	3 months
Major Equipment Vendor Selection and Award	2 months
Detailed Design	12 months
Construction Contractor Selection and Award	2 months
Construction	18 months
Start-up and Commissioning	3 months
Initial Operation	2 months
Total	**42 months**

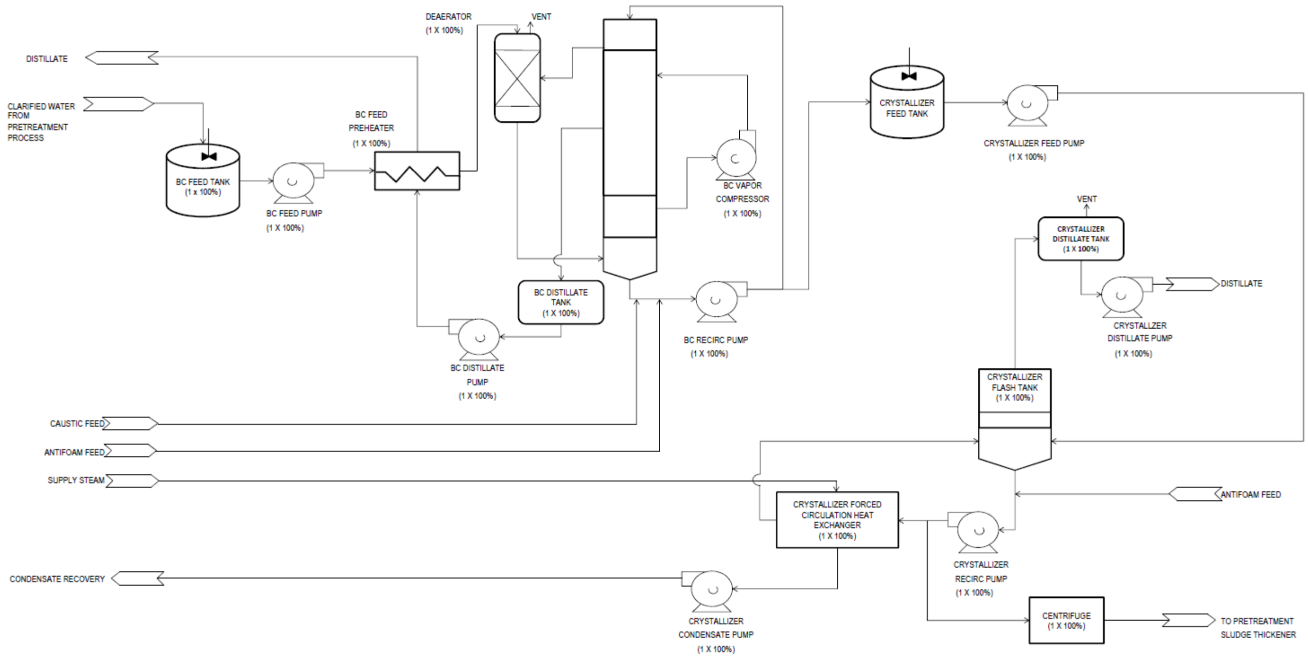
The fastest feasible duration to construct a WWTF is 42 months from December 1, 2020. The estimated completion for the system is June 1, 2024 and significantly exceeds the timeframe of the fastest technically feasible alternative.

Alternative 6 – Brine Concentrator

A brine concentrator / crystallizer is a ZLD technology. The system is a thermal process that concentrates dissolved species in a brine sludge that is then solidified in the crystallizer unit. Crystallized solids (salts) can then be disposed in a landfill. For an FGD wastewater application, pretreatment steps are required to ‘soften’ the wastewater prior to thermal treatment to reduce scaling and a reduction in throughput. The softened wastewater is then thermally treated in the brine concentrator or encapsulated with fly ash and lime. Evaporated water, now free of dissolved solids, is collected and returned to the plant as makeup water.

The materials of construction for the brine concentrator and crystallizer must be resistant to corrosion due to the high concentrations of chloride and elevated temperatures associated with the process. As a result, fabrication of the equipment has a long duration and requires over 12 months to procure. Brine concentrator and crystallizer for the FGD wastewater was not the selected option due to reliability issues in comparison with other ZLD options. Total project duration to design, procure, and install a brine concentrator is 36 to 42 months. A schematic of the brine concentration and crystallization steps was prepared by Black and Veatch and is presented as **Figure 9**. While potentially feasible, this option was not selected as the preferred option could be implemented in a shorter timeframe. In addition, this option is limited in that it would not address Unit 2 bottom ash flows.

Figure 9: Brine Concentrator / Crystallizer Schematic



Alternative 7 – Membrane Separation

Membrane separation is also a ZLD technology for treating FGD wastewater. This technology is typically used in conjunction with encapsulation to produce a waste product that can be landfilled. In a reverse osmosis system, a pump is used to convey a high-pressure stream of FGD wastewater across a polymeric membrane. The FGD wastewater salts are concentrated on one side of the membrane while a clean permeate (product stream) stream is discharged from the opposite side. The permeate can be returned to the FGD system as makeup water (ZLD) or discharged. The concentrated brine stream can be blended with fly ash and/or lime and landfilled. Membrane systems require pre-treatment of the wastewater to remove suspended solids and reduce scaling potential. Upstream pre-treatment typically includes clarification, sand filters, cartridge filters, anti-scalant additives, anti-microbial additives, and pH adjustment.

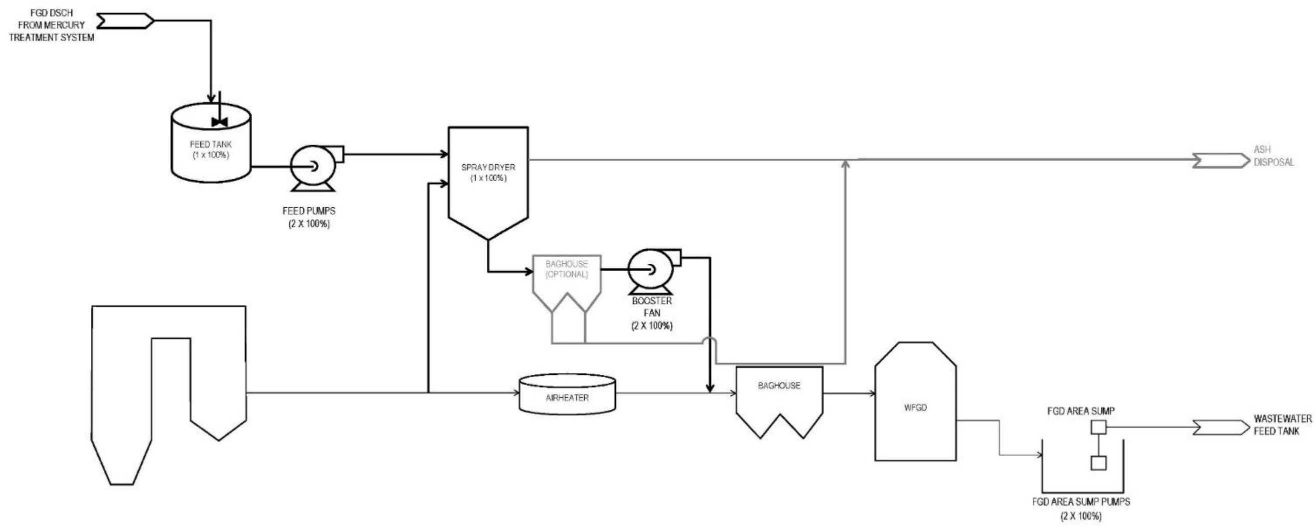
There is limited experience within the utility industry applying membrane separation for the treatment of FGD wastewater. This is an emerging technology and is not expected to be ready for commercial application for several more years. In consideration of the uncertainties regarding long term performance and reliability, and extended duration for project implementation, membrane technology is a technically infeasible alternative. In addition, this option is also limited in that it would not address Unit 2 bottom ash wastestream.

Alternative 8 – Wastewater Spray Dryer

A wastewater spray dryer evaporator (SDE) system uses a slip stream of hot flue gas to evaporate a wastewater upstream of a particulate collection device. Solids and salts in the wastewater are atomized and dried in the spray dryer vessel. The flue gas can either be returned to bulk flue gas stream where the solids are removed with the fly ash or routed to a separate particulate collector prior to being returned with the bulk flue gas. A preliminary process flow diagram of a wastewater spray dryer system is provided in **Figure 10**.

While waste spray dryer technology has only been recently applied to FGD wastewater, it is based on established technology in a similar application. An estimated duration of 33 months is required to design, procure and install a wastewater spray dryer system. While this alternative continues to be pursued for continued operation of Unit 3 beyond the NPDES compliance date of December 31, 2023, the timetable for completion of this option exceeds that of Alternative 2 and is not considered the fastest technically feasible alternative. It also has the limitation of not addressing Unit 2 bottom ash flows.

Figure 10: SDE Process Flow Diagram



5.1.4 Alternative Selected and Analysis of the Site and any Site-Specific Conditions that Led to the Alternative Selected (40 CFR § 257.103(f)(1)(iv)(A)(1)(i))

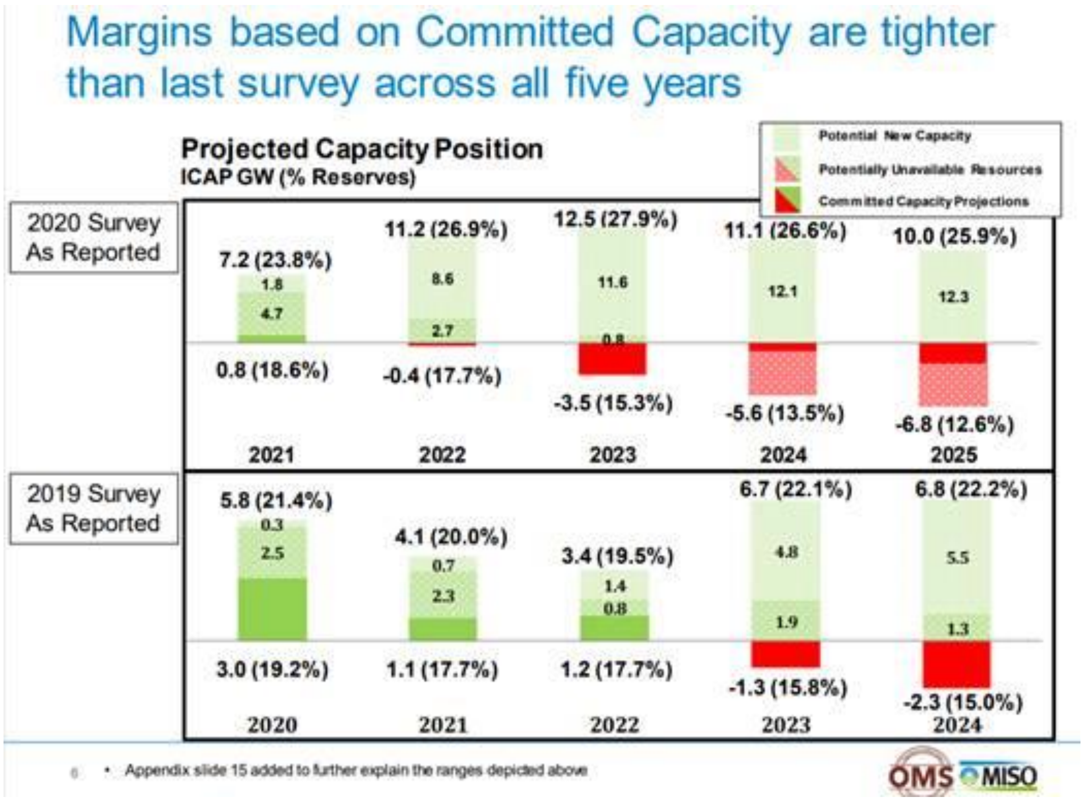
Alternative 2 (new lined CCR Pond) has been selected based on the following site-specific and other considerations:

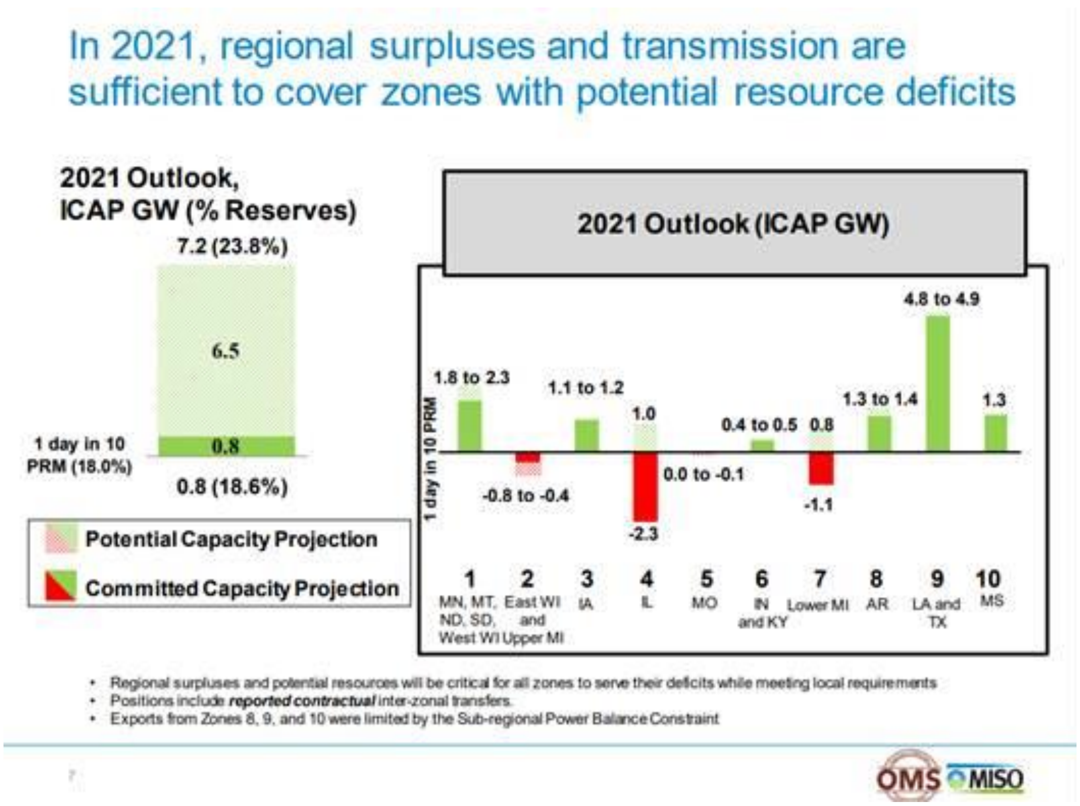
- Alternative 2 represents the “fastest technically feasible timeline” for addressing remaining flows to the East Ash Pond,
- The area selected for the new lined CCR Pond is well known (geotechnical characteristics, groundwater levels, etc.) and is ideal for construction of a new pond system,
- Alternative 2 involves reroute of flows, but does not involve significant mechanical or other treatment-related systems with longer lead times and startup/operational challenges, and
- Alternative 2 is well understood and defined, and has a high level of construction schedule certainty.

5.1.5 Adverse Impact on Plant Operation if the East Ash Pond Were No Longer Available (40 CFR § 257.103(f)(1)(iv)(A)(1)(ii))

Given the lack of current alternative capacity, continued operation of Units 2 and 3 at F.B. Culley is wholly dependent on the continued operation of the East Ash Pond until alternative capacity can be obtained for all flows managed by the East Ash Pond under Alternative 2 (March 1, 2023). If the CCR and non-CCR flows to the East Ash Pond were to cease on April 11, 2021, without alternative capacity available, Units 2 and 3 will not be able to continue operation.

F.B. Culley Units 2 and 3 have a combined capacity of 387 MW and currently comprise 27 percent of SIGECO’s generating units. F.B. Culley Units 2 and 3 are an essential part of the generation capacity within the fleet and the region. The results of the 2020 MISO Organization of MISO states survey projects a slight capacity surplus for zone 6 in 2021 and a potential shortfall in 2025. The survey shows that the MISO system in its entirety could experience a shortfall as early as 2022.





The source for the charts shown above:
https://cdn.misoenergy.org/20200708%20RASC%20Item%2004a%202021%20OMS-MISO%20Survey456786.pdf

5.1.6 Explanation and Justification for the Amount of Time being Requested and How it is the Fastest Technically Feasible Time to Complete the Development of Alternative Capacity

Based on this evaluation, the fastest technically feasible option for obtaining alternative capacity is a new lined CCR Pond in the vicinity of the new lined Contact Stormwater Pond (Alternative 2). This alternative supplements current plant activities to reduce flows to the East Ash Pond (i.e., dry bottom ash conversion of Unit 3 and management of non-CCR flows in the new lined Contact Stormwater Pond). With construction of a new lined CCR Pond, all flows to the East Ash Pond can cease on or before March 1, 2023. In addition, this option provides for significant flexibility in the event of operational and/or future generation changes. While ZLD technology consisting of a SDE system has been selected and continues to be pursued for addressing NPDES and Effluent Limitation Guideline (ELG) regulatory considerations relating to Unit 3 FGD flows, this project (if completed) would result in a cease flow date after Alternative 2 and is not considered the “fastest technically feasible timeline” for ceasing flows to the East Ash Pond. The selected alternative (Alternative 2) for management of non-CCR and future closure-related flows represents the fastest technically feasible time to obtain alternative capacity for these flows.

5.2 Detailed Schedule and Narrative Discussion (40 CFR § 257.103(f)(1)(iv)(A)(2) and (3))

The provisions of 40 CFR § 257.103(f)(1)(iv)(A)(2) and (3) require that a detailed schedule be provided illustrating 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 the following:

- How each phase and the steps within that phase interact with or are dependent on each other and the other phases (40 CFR §257.103(f)(1)(iv)(A)(2)(i)),
- Steps and phases that can be completed concurrently (40 CFR §257.103(f)(1)(iv)(A)(2)(ii)),
- Total time needed to obtain the alternative capacity and how long each phase and step within each phase will take (40 CFR §257.103(f)(1)(iv)(A)(2)(iii)), and
- At a minimum, the following phases: engineering and design, contractor selection, equipment fabrication and delivery, construction and start-up and implementation (40 CFR §257.103(f)(1)(iv)(A)(2)(iv)).

In addition, 40 CFR §257.103(f)(1)(iv)(A)(3) requires a narrative discussion of the schedule and visual timeline representation which must discuss all of 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 (40 CFR §257.103(f)(1)(iv)(A)(3)(i)),
- Why each phase and step shown on the chart must happen in the order it is occurring (40 CFR §257.103(f)(1)(iv)(A)(3)(ii)),
- The task that occur during each of the steps within the phase (40 CFR §257.103(f)(1)(iv)(A)(3)(iii)), and
- Anticipated worker schedules ((40 CFR §257.103(f)(1)(iv)(A)(3)(iv)).

These items are provided and discussed in the following sections.

5.2.1 Regulatory and Other Considerations Associated with Overall Project Schedule

The scenario at F.B. Culley involves a series of interrelated regulatory and technical milestones. In order to address the requirements of this section, two detailed schedule representations have been provided. The first, provided in **Appendix B**, provides a representation of the overall schedule for F.B. Culley, which includes sections for the regulatory process to select future generation technology, CCR-related activities, and alternative pond capacity development activities. This schedule is intended to represent the overall scenario at F.B. Culley and illustrates the interrelationships of the various activities.

5.2.2 Design and Installation Schedule

The cessation of CCR and non-CCR flows to the East Ash Pond requires alternative capacity to replace these functions. Based on current construction schedules, the East Ash Pond will be required to manage non-CCR flows until the new lined Contact Stormwater Pond is complete and operational (by end of 2020) and non-CCR flows can be re-routed (by July 1, 2021 under current IDEM OLQ commitments). Unit 3 Bottom Ash flow will be eliminated no later than December 31, 2020 (NPDES requirement). FGD wastewater and Unit 2 bottom ash streams will be redirected to a new lined CCR Pond (Alternative) which will be constructed adjacent to the new Contact Stormwater Pond. Based on the implementation schedules discussed within this document, this new lined CCR pond will be complete and operational on or before March 1, 2023.

Essentially, the approach selected to obtain alternative capacity has the following three subprojects:

- **Unit 3 Boiler Bottom Ash Handling System Wet to Dry Conversion – Submerged Chain Conveyor**

Unit 3 Bottom Ash flow will be eliminated from the East Ash Pond by the end of November, which is before the NPDES permit required date of December 31, 2020, when the new SCC system is completed and functional.

- **Closure of West Ash Pond / New Lined Contact Stormwater Pond and Re-Routing of Non-CCR Waste Piping**

Based on current construction schedules, the East Ash Pond will be required to manage non-CCR flows until the contact stormwater pond is complete and operational, which is on schedule to be completed by the end of 2020. At that time, physical construction work to re-route non-CCR flows from the East Ash Pond to the new contact stormwater pond can begin, with a scheduled completion date of no later than by July 1, 2021. Detailed design for re-routing these flows began in July of 2020 and is expected to last 6 months in duration. Following completion of design activities, a 3-month contractor bidding and selection period will occur, with an expected contract award date by end of February 2021. Construction is expected to take 4 months in duration, which includes 2 weeks for start-up and commissioning followed by initial operation of 2 weeks prior to cessation of flow for non-CCR streams to the East Ash Pond by July 1, 2021. A schedule for key milestone activities is found in **Table 4**.

Table 4: Milestone Activities for Re-routing Non-CCR Flows

MILESTONE ACTIVITY	DATE
Design Team Site Visit	6/24/2020
Receipt of 60% Design Documents	10/14/2020
Receipt of 90% Design Documents / Issue Bid Package	12/9/2020
Award Construction Project	2/28/2021
Project Completion/ Cease Flow of Non-CCR Streams to East Ash Pond	7/1/2021

- **New Lined CCR Pond and Re-Routing of CCR Piping**

The selected alternative (Alternative 2) will require 27 months for conceptual and preliminary design, permitting, detailed design, vendor and contractor selection, equipment fabrication, construction and start-up and commissioning. In consideration of the overall process leading to cessation of flows (both CCR and non-CCR) to the East Ash Pond, this effort is considered critical path. Below is a detailed discussion of the anticipated schedule for implementation.

The project schedule for the selected alternative can be broken down to the following segments:

a. Conceptual and Preliminary Design
b. Permitting
c. Detailed Design
d. Equipment Procurement and Manufacture
e. Construction Bid and Award
f. Construction
g. Construction Certification / Start-up and Commissioning
h. Initial Operation

5.2.2.1 Conceptual and Preliminary Design

Work on this phase for alternative capacity will initiate in December 2020 with project kick-off and the beginning-of-project definition and preliminary design. This phase will include various field investigations and infrastructure and information gathering to support the preliminary design and operating permit application. Groundwater monitoring wells will be installed to address CCR Rule requirements (as needed) and establish the groundwater water levels to provide a minimum elevation for the base of the future CCR Pond liner system. Groundwater monitoring data from existing wells will also be considered in order to provide a complete assessment in the fastest feasible timeframe. Key deliverables from this phase include:

a. Design Basis
b. Plant Water Balances and Process Flow Diagrams
c. Overall Site Plan
d. Install Groundwater Monitoring Wells
e. Preliminary Pond Design Drawings and Specifications
f. Permit Application Package
g. Permit Applications (i.e. IDEM OLQ Submittal and NPDES Major Modification)
h. Cost Estimate
i. Detailed Project Schedule

The new lined CCR Pond will be sized based on the expected flows. An ideal candidate location has been identified in the area to the north of the new lined Contact Stormwater Pond. A key objective of the preliminary design phase is to develop the permit package for submittal to IDEM OLQ. This task along with the installation of groundwater monitoring wells are on the critical path.

Other objectives of this phase include detailed information of the CCR streams that discharge to the East Ash Pond. This includes verification of the flowrates, composition, temperature, pressure and operating requirements. Activities to gather this information may include flow measurements, sampling and analysis, review of plant operating data and the collection of design information. Once all the streams have been defined and characterized, a conceptual design will be developed to redirect the flows to the new lined CCR pond. This may include the modification of existing plant facilities, re-grading to redirect stormwater and new facilities to transport the flows to the new lined CCR Pond. Four months are planned for the conceptual design phase.

The scope for the preliminary design phase will be refined based on the results of the conceptual design. Potential design issues and the information needed will be established. Development of the preliminary design will follow the conceptual design. This phase is expected to be completed in 4 months.

5.2.2.2 Permitting

A number of permitting requirements are associated with the selected alternative for alternative capacity. The two primary required permits are summarized below:

1. CCR Surface Impoundment Operations Permit from IDEM OLQ – Indiana is very involved in the surface impoundment operations approval and closure approval process as surface impoundments are regulated

by the state as land disposal units and Indiana has adopted reference to the Federal CCR Rule within their state regulations (329 IAC 10). While approval is not required for construction of a CCR surface impoundment, approval by IDEM OLQ is required for operation of a CCR surface impoundment. This process consists of submission of design materials, flows, and associated calculations and analyses. SIGECO representatives recently contacted IDEM to discuss the review time for this CCR surface impoundment operations approval, and IDEM indicated that 365 days (from submission) is the typical timeframe for approval. This review period has been factored into project schedules and will involve preparation of a permit-level design package for IDEM review and approval early in the design process (first four months), and detailed design will be continued during IDEM review of this package. During the review process, the permit-level design package will need to be supplemented with data demonstrating compliance with the aquifer separation criteria of 40 CFR 257.60.

- While the CCR Surface Impoundments Operations Permitting process is occurring, SIGECO will also be working with IDEM to obtain approval for the construction of the pond in this specific location, in accordance with requirement A2 of the “Approval of Closure/Post-Closure Plan F.B. Culley West Ash Pond” issued by IDEM, dated December 20, 2019. Requirement A2 states, “The owner or operator must request approval from IDEM before modifying the approved closure/post-closure requirements and procedures.”

2. NPDES Major Modification – In order to address the proposed CCR flow treatment changes, a Major Modification of F.B. Culley’s NPDES permit will be required. Based on recent IDEM experience and discussions with IDEM, 6 months is required from package submission to approval. Again, this has been factored into the schedule and this activity occurs in parallel with other activities (such as detailed design and OLQ review of the CCR surface impoundment application). It should be noted that there is schedule float associated with this permit approval process, and it can lag in schedule by approximately 6 months if needed without affecting the overall project timeline.

There will be a number of other approvals required such as permit coverage for Stormwater Associated with Construction Activities (Rule 5 in Indiana). However, these are typically shorter lead time permits and are not near the critical path.

Finally, it should be noted that the permitting timelines assume a Section 401/404 permit will not be required. This is a reasonable assumption given that new fill was just placed in the proposed CCR Pond area and it appears no stream crossings or tree clearing will be required for the construction activities of the CCR Pond or associated piping systems.

5.2.2.3 Detailed Design

The detailed design phase will commence following the conceptual and preliminary design and will occur in parallel to IDEM permit reviews. The key objective of the detailed design phase is to develop a design package and specifications for the equipment procurement and construction packages. Work from the conceptual and preliminary design will be used to develop drawings and specifications. Key deliverables from this phase include:

a) Final Pond Site Plan, Sections and Details Drawings
b) Final Pond Grading Plans and Calculations (geotechnical, stormwater management, pond capacity, etc.)
c) Liner and Earthwork Specifications
d) Piping and Instrument Diagrams (P&IDs)
e) General Arrangements (GA’s)
f) Pipe Routing and Lists
g) Electrical One Lines, Circuit Drawings, Cable Routing Drawings, Schedules
h) Control System Logic, Input Output Lists, Connection Diagrams
i) Construction and Equipment Specifications

Detailed design will be executed concurrently with on-going groundwater monitoring activities and permitting support. The pond design will not be finalized until all required design approvals have been received and permitting authorities have completed their reviews. Design tasks associated with the redirected flows from the East Pond include hydraulic calculations, pipe support design, electrical and control cable routing and termination diagrams, electrical load studies and control logic development. It may be necessary to proceed with the procurement of specific engineered equipment to achieve schedule milestones. This information may include electrical and controls circuits diagrams and equipment interface connections. A total of 10 months is planned for detailed engineering and design. During this phase, Issue for Bid (IFB) packages will be completed. Issue for Construction (IFC) packages will be developed following contractor award and completion of review/approval by the permitting authorities.

5.2.2.4 Equipment Procurement and Manufacture

Mechanical Engineered procurements are expected to include pumps or pump upgrades. A duration of 1 month is expected to receive vendor bids with 2 months to evaluate and award each package. Based on previously solicited vendor bids for similar equipment pumps are expected to have a 6-month lead time after receipt of order (ARO) for manufacturing and delivery, resulting in a total duration of 9 months for mechanical procurements.

Electrical procurements are expected to include transformers, motor control centers (MCC), power distribution centers (PDCs), and distributed control system components. As with the mechanical procurements, a duration of 1 month is expected to receive vendor bids and a 2-month period for evaluation and vendor award. The long lead items associated with electrical procurements have been identified as the PDCs with an expected lead time of 9 months ARO for manufacturing and delivery, resulting in a total duration of 12 months for mechanical procurements.

Mechanical and Electrical procurements occur in parallel for a total procurement cycle of 12 months. These activities follow completion of the mechanical detailed design and runs in parallel with completion of the electrical detailed design. The manufacturing and delivery of these components will occur in parallel with construction of the new pond. Other procurements are piping, structural steel, pond liner, valves and instrumentation. These items have been identified to have a short lead time and will be purchased by the construction contractor. They do not impact the overall project schedule and will occur in parallel with the mechanical and electrical procurements.

5.2.2.5 Contractor Bid, Selection and Award

In this phase, a Request for Proposal (RFP) will be issued to contractors to construct the system. The project scope may be bid and awarded in 2 separate packages:

- Package 1 - mechanical, structural, electrical and control scope that is not associated with the pond
- Package 2 - civil earthworks associated with the new CCR Pond

The decision to award the construction in 1 or 2 packages will be based on achieving the shortest duration for construction.

The bid, selection, and award phase is expected to take 3 months from issuance of the RFP. This includes 1.5 months for the bidders to prepare proposals and 1.5 months for evaluation and contract negotiations. Evaluation of the proposals includes a review of the means and methods of construction proposed by the bidders and any alternates that may improve the design or reduce the project schedule. The duration of the evaluation period is dependent on the quality of the proposals received, responsiveness of the bidders to questions, and complexity of the alternates considered. These activities occur concurrently with completion of detailed design and equipment fabrication and delivery.

5.2.2.6 Construction and Start-Up

The candidate location for the new lined CCR Pond is the CbR *Excavation Area* of the West Ash Pond closure (area currently complete). The CCR materials from the former West Ash Pond footprint have been completely removed and verified, and structural fill has been placed over the excavation grades to create a network of stormwater conveyance channels that manage clean (non-contact) stormwater flows from contributing drainage areas across the plant property. The new pond will meet the requirements for a composite liner system under the Federal CCR Rule (40 CFR § 257.72) as well as the location restrictions of 40 CFR § 257.60-64. The successful completion of groundwater monitoring and completion of review by the regulatory agencies is required before the pond design can be finalized.

The available area for the new lined CCR pond is 7 acres. Construction is planned to require 8 months including site prep and cleaning, cut and fill, and liner installation.

The project scope will include modifications to reroute various wastestreams to the new pond. The two CCR wastestreams are pumped by transfer systems. New lines will be routed to the pond using existing pipe racks and chases where available. The existing system treating the FGD wastewater prior to discharge to the East Ash Pond will be replaced or relocated to an area adjacent to the new lined CCR Pond. Tie-ins for the electrical supply and other utilities must be planned and coordinated with plant operations and it may be necessary to perform this work during an outage. An overall duration of 8 months is planned for construction of the new lined CCR Pond and rerouting the CCR lines from the East Ash Pond.

Following completion of construction, the system will undergo start-up and commissioning. This project phase will require 2 months and involves instrument loop checks, motor meggering, electrical system settings, overall system hydrostatic testing, mechanical operation of all rotating equipment and various other tasks to prepare the system for operation. Issues discovered during this period may require support from the equipment vendor to repair or replace damaged components. At the conclusion of this phase, a package with all checkout records will be produced.

Following the above and prior to operation, the pond construction must be certified to IDEM by a registered engineer. Certification requires record drawings of the final construction and various records verifying the installed pond meets the required standards. Two months is planned for assembly of this packet and IDEM review and release for operation.

A period of 1 month is allocated for initial operation, during which the process controls loops will be tuned and setpoints adjusted. A key objective of the run-in period is to verify the reliability of the system over a range of operating conditions. Issues that are identified during this phase may require support from the equipment vendor or modification of the system. At the completion of the initial operation period, all CCR flows to the East Ash Pond will cease and be redirected to the new pond.

5.2.2.7 Schedule Summary

Based on the schedule provided in **Appendix C**, conceptual design activities for the new lined CCR Pond and redirection of flows are currently underway. The path to alternative capacity will involve preliminary design, contractor selection, detailed design, procurement and construction. Based on this schedule, it is currently anticipated that flows to the East Ash Pond will cease on March 1, 2023. Throughout the design process, project management efforts will be made to identify schedule improvements.

5.2.2.8 Anticipated Worker Schedules (40 CFR 257.103(f)(1)((iv)(A)(3)(iv)

During construction of the new lined CCR Pond and infrastructure to redirect flows, the anticipated worker schedules will consist of 50-hour weeks. This will involve working 5 days per week, approximately 10 hours per day. If weather or other delays are encountered, the worker schedule may be adjusted (increased) to address this lost time and maintain project schedules.

5.3 Progress Toward Alternate Capacity (40 CFR 257.103(f)(1)(iv)(A)(4))

Part A (40 CFR 257.103(f)(1)(iv)(A)(4) requires a narrative discussion of the progress the Owner/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/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 development alternative capacity.

An Environmental Compliance review for continued coal-fired operation at F.B. Culley was performed in 2019 and a Final Report issued in February 2020. The review encompassed the modifications required to comply with the final CCR Rule and ELG Rule and the proposed revisions. Recommendations for modifications to the plant were made in the report and have been summarized in this Work Plan. Summary of projects in progress is as follows:

- Construction of the new lined Contact Stormwater Pond is underway and expected to be completed by December 31, 2020. This pond will serve non-CCR flows currently being sent to the East Ash Pond beginning on or before July 1, 2021 (following flow redirection).

- Re-route of contact stormwater flows from the East Ash Pond to the new Contact Stormwater Pond is underway and expected to be completed by July 1, 2021.

- Design of the Unit 3 dry bottom ash system has been completed (initiated early 2018) and installation of the unit is complete as of November, 2020. (prior to the December 31, 2020 deadline in accordance with NPDES permit requirements). This effort has eliminated this flow to the East Ash Pond.

- Efforts have been initiated for fatal flaw evaluation and conceptual design of a new CCR Rule compliant surface impoundment in the vicinity of the new lined Contact Stormwater Pond and redirection of subject flows to this pond. As discussed in this document, this pond will serve CCR-flows that are currently managed by the East Ash Pond (Unit 2 Bottom Ash, Unit 2/3 FGD Wastewater-related flows). Once complete on or before March 1, 2023, operation of this new CCR Pond will result in cessation of all flows to the East Ash Pond.

- Study work and planning for the FGD Wastewater system has been ongoing since 2017. The early study work and planning included efforts to evaluate the potential for reducing flow volumes and meeting the constituent requirements of the FGD wastewater in order to determine whether the design requirements for a spray dryer system could be achieved. The selection of the ZLD technology was included in a filing to the IURC seeking approval for the capital expenditure. The order granting this approval was issued April 24, 2019. Planning and preparation for design initiation has been occurring throughout 2020 culminating in Owner’s Engineer vendor selection in August 2020. Equipment specifications, vendor selection, and BOP design activities for the FGD Wastewater system began in September 2020. This effort is scheduled to be completed on July 1, 2023 (after initiation of the new CCR Pond operation). In the event this activity can be completed prior to operation of the new CCR Pond, this will result in early elimination of this flow to the East Ash Pond. However, due to the fact this project is not the fastest technically feasible timeline, ZLD technology is secondary to the new CCR Pond construction.

6 Compliance Certification and Additional Information (40 CFR § 257.103(f)(1)(iv)(B))

In accordance with *40 CFR § 257.103 (f)(1)(iv)(B),* the following information and attachments are submitted to demonstrate that the F.B. Culley Generating Station is in compliance with 40 CFR § 257 Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments (CCR Rule).

In accordance with Federal CCR Rule requirements, groundwater monitoring wells were installed to evaluate the groundwater quality in the vicinity of the East Ash Pond and the West Ash Pond. The analytical results and subsequent ASD efforts (**Appendix H**) resulted in the identification of one constituent, molybdenum, at an SSL exceeding the Appendix IV GWPS at the East Ash Pond and the identification of two constituents, lithium and molybdenum, at an SSL exceeding the Appendix IV GWPS at the West Ash Pond. In response, Haley & Aldrich prepared a Corrective Measures Assessment (**Appendix J**) for the East Ash Pond. The Corrective Measures Assessment for the East Ash Pond evaluated the risk related to the molybdenum exceedances and determined there are “no adverse effects on human health or ecological receptors…” from groundwater at the East Ash Pond. The Corrective Measures Assessment for the West Ash Pond was initiated and is currently in progress. Semiannual groundwater sampling has been implemented to continue to monitor and evaluate groundwater and will continue through the closure and post-closure processes at each unit. Activities toward remedy selection are ongoing for the East Ash Pond and will be pursued for the West Ash Pond following completion of the Corrective Measures Assessment.

With respect to groundwater considerations, it should further be noted that the alternative capacity being pursued at F.B. Culley as discussed throughout this demonstration will result in closure of the East Ash Pond sooner than originally anticipated. The West Ash Pond closure design resulted in the excavation of nearly all of the CCR material in potential contract with groundwater. A small quantity of CCR may be in contact with groundwater during periods of prolonged wet weather and/or high river levels.

Compliance data required by Part A associated with the East Ash Pond is referenced in the sections below and provided in Appendices to this report. Supplemental data and information related to the West Ash Pond is included in an addendum to this report (**West Ash Pond Supplemental Attachments).**

6.1. Certification of Compliance

The F.B. Culley Generating Station is in compliance with the requirements of the CCR Rule. SIGECO manages the company website for the F.B. Culley Generating Station and it is kept up to date and contains all the necessary documentation. **Appendix D** includes the required certification of compliance.

6.2. Visual Representation of Hydrogeologic Information

6.2.1. Groundwater Monitoring Well Locations

Figures detailing the location of the groundwater monitoring wells in relation to the East Ash Pond at F.B. Culley are attached (**Appendix E**). Figures detailing the location of the groundwater monitoring wells in relation to the West Ash Pond at F.B. Culley are included in the addendum (**West Ash Pond Supplemental Attachments**). The figures were prepared by Haley & Aldrich.

6.2.2. Well Construction Diagrams

Well construction diagrams and boring logs including stratigraphic cross-sections for the East Ash Pond are attached (**Appendix F**). Well construction diagrams and boring logs including stratigraphic cross-sections for the West Ash Pond are included in the addendum (**West Ash Pond Supplemental Attachments**). The well construction diagrams were prepared by Haley & Aldrich.

6.2.3. Groundwater Flow Direction

Figures detailing the groundwater elevation contours of November 2016 and June 2017 for the East Ash Pond to account for seasonal variations are attached (**Appendix G**). Figures illustrating the groundwater elevation contours of April 2017, January 2018, April to August 2018, and December 2018, for the West Ash Pond are included in the addendum (**West Ash Pond Supplemental Attachments**) The figures were prepared by Haley & Aldrich.

6.3. Groundwater Monitoring Analytical Results

Tables summarizing the constituent concentrations of each groundwater monitoring well sampled at the East Ash Pond between 2016 and 2020 are attached (**Appendix H**). The January 2020 Groundwater Monitoring Reports (prepared by Haley & Aldrich) including the ASD efforts are also included in **Appendix H**. Tables summarizing the constituent concentrations of each groundwater monitoring well sampled at the West Ash Pond between 2019 and 2020 are included in the addendum (**West Ash Pond Supplemental Attachments**). The tables were prepared by Haley & Aldrich.

6.4. Description of Site Hydrogeology

A description of the site hydrogeology at the F.B. Culley Generating Station is attached (**Appendix I**). The description was prepared by Haley & Aldrich.

6.5. Corrective Measures Assessment

The corrective measures assessment report for the East Ash Pond is attached (**Appendix J)**. The report was prepared by Haley & Aldrich. The corrective measures assessment report is located on F.B. Culley's company website. (https://www.vectren.com/assets/downloads/planning/ccr/Culley-East-Ash-Pond-Corrective-Measures-Assessment-Report.pdf)

Groundwater sampling at the East Ash Pond identified one Appendix IV constituent, molybdenum, in exceedance of GWPS, and the Corrective Measures Assessment was implemented in response to these results. The Corrective Measures Assessment evaluated the potential risk the constituent posed and potential corrective measures to prevent further releases. Groundwater flow was evaluated and found to be radial with an overall flow direction from the upland areas north of the Ash Pond to the South. As discussed in the Corrective Measures Assessment, "Groundwater downgradient of the East Ash Pond is not used as a source of drinking water and is not flowing toward any groundwater supply wells." The risk assessment also demonstrated "no adverse effects on human or ecological health from groundwater uses resulting from coal ash management practices at the F.B. Culley Generating Station East Ash Pond". Potential corrective measures to prevent further releases were identified and evaluated. These measures include Monitored Natural Attenuation, Hydraulic Containment, and In-Situ Treatment. These evaluations are further discussed and compared in the Corrective Measures Assessment.

The West Ash Pond is currently undergoing the corrective measures assessment. The Notification of Initiation of Corrective Measures Assessment is included in the addendum (**West Ash Pond Supplemental Attachments)** and is located on F.B. Culley's company website. (https://www.vectren.com/assets/downloads/planning/ccr/Culley-West-Notification-of-Initiation-of-Corrective-Measures-2020.pdf)).

6.6. Progress Reports

The progress reports on corrective action remedy dated March 2020 and September 2020 are attached (**Appendix K**). The reports were prepared by Haley & Aldrich and are also located on the company CCR compliance webpage for the F.B. Culley facility.

March 2020 Report (https://www.vectren.com/assets/downloads/planning/ccr/Culley-East-Ash-Pond-Semi-Annual-Selection-of-Remedy-Progress-Report_2020March.pdf)

September 2020 Report (https://www.vectren.com/assets/downloads/planning/ccr/Culley-East-Ash-Pond-Semi-Annual-Selection-of-Remedy-Progress-Report_2020September.pdf)

The West Ash Pond is currently undergoing the corrective measures assessment; therefore, progress reports for the West Ash Pond have not been prepared as of the date of this report.

6.7. Structural Stability Assessment

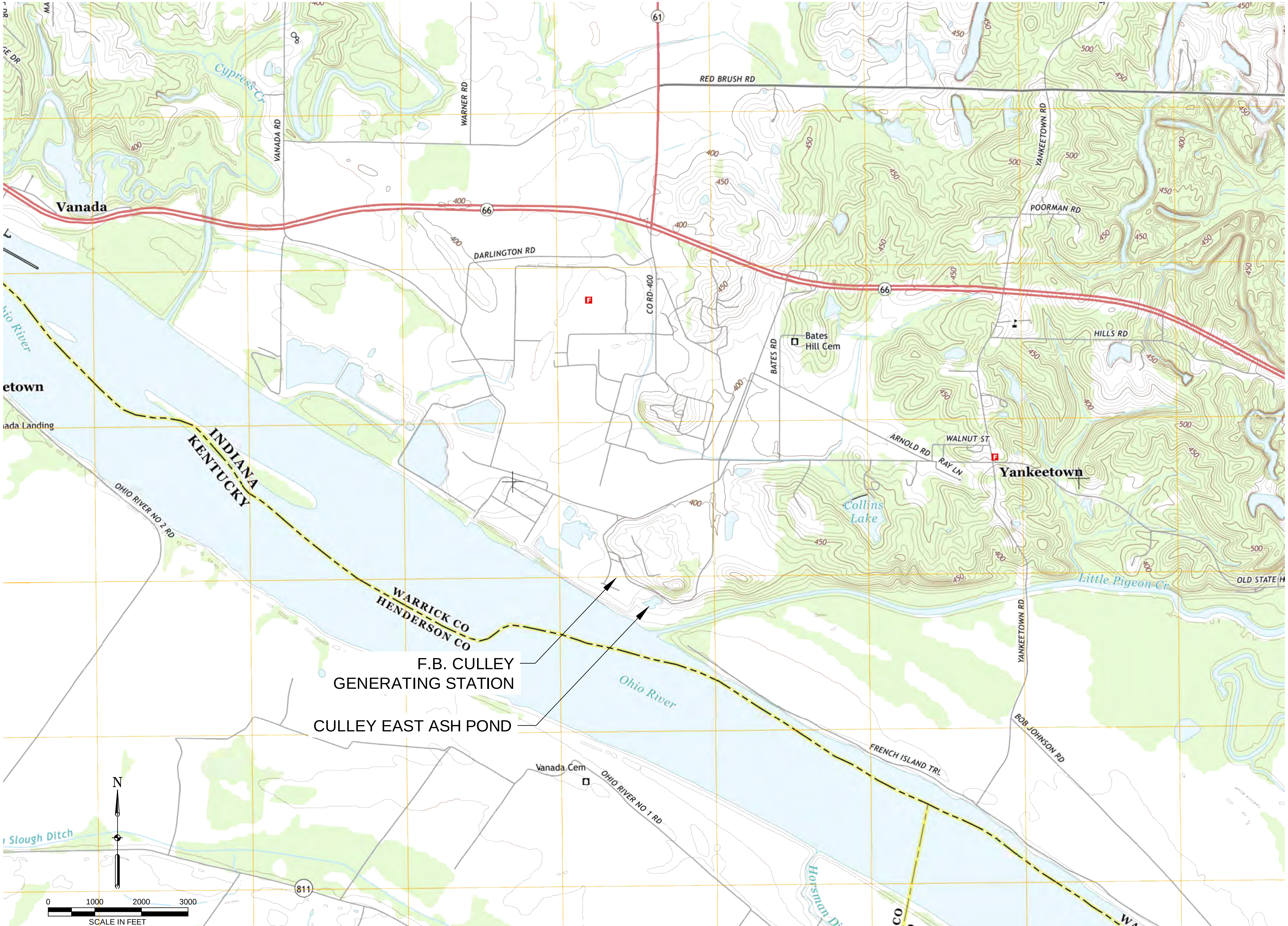
The structural stability assessment report for the East Ash Pond is attached (**Appendix L**). The report was prepared by AECOM. The report is also located on F.B. Culley's company website.
(https://www.vectren.com/assets/downloads/planning/ccr/Culley-East-Structural-Stability.pdf)

The structural stability assessment report for the West Ash Pond is not required as the unit was classified as "inactive" under the original 2015 CCR rule and was in the process of closure when the "Direct Final Rule" constituting a vacatur of 40 CFR §257.100 became effective.

6.8. Safety Factor Assessment

The factor of safety assessment report for the East Ash Pond is attached (**Appendix M**). The report was prepared by AECOM. The report is also located on F.B. Culley's company website.
(https://www.vectren.com/assets/downloads/planning/ccr/Culley-East-Safety-Factor-Assessment.pdfThe factor of safety assessment report for the West Ash Pond is not required as the unit was classified as "inactive" under the original 2015 CCR rule and was in the process of closure when the "Direct Final Rule" constituting a vacatur of 40 CFR §257.100 became effective.

Figures



AECOM DRAWING PATH: P:\Projects\Environmental\60442676_VectrenCCR\7.0_CAD_GIS\7.04_Plan_Sheets\CULLEY-LOCATION MAP.dwg

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F.B. CULLEY GENERATING STATION
NEWBURGH, IN

DEVELOPMENT OF ALTERNATIVE CAPACITY INFEASIBLE DEMOSTRATION

ISSUED FOR CERTIFICATION

ISSUED FOR BIDDING DATE BY

ISSUED FOR CONSTRUCTION DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
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△		
△		
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AECOM PROJECT NO:	60442676
DRAWN BY:	MJC
DESIGNED BY:	MJC
CHECKED BY:	TLE
DATE CREATED:	8/18/2016
PLOT DATE:	4/22/2016
SCALE:	AS SHOWN
ACAD VER:	2014

SHEET TITLE

LOCATION MAP

FIGURE 1

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1-800-227-1376 (phone)

F.B. CULLEY GENERATING STATION NEWBURGH, IN

DEVELOPMENT OF ALTERNATIVE CAPACITY INFEASIBLE DEMONSTRATION

ISSUED FOR CERTIFICATION

ISSUED FOR BIDDING - DATE BY

ISSUED FOR CONSTRUCTION DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
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△		
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AECOM PROJECT NO:	60442676
DRAWN BY:	JMW
DESIGNED BY:	JMW
CHECKED BY:	RJB
DATE CREATED:	12/19/2018
PLOT DATE:	12/19/2018
SCALE:	AS SHOWN
ACAD VER:	CIVIL 3D 2018

SHEET TITLE

SITE MAP

FIGURE 2

Appendices

Appendix A
IURC Order in Cause No. 45052

ORIGINAL

STATE OF INDIANA

INDIANA UTILITY REGULATORY COMMISSION

SNK

VERIFIED PETITION OF SOUTHERN INDIANA GAS AND ELECTRIC COMPANY d/b/a VECTREN ENERGY DELIVERY OF INDIANA, INC. ("VECTREN SOUTH") FOR (1) ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE CONSTRUCTION OF A COMBINED CYCLE GAS TURBINE GENERATION FACILITY ("CCGT"); (2) APPROVAL OF ASSOCIATED RATEMAKING AND ACCOUNTING TREATMENT; (3) ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR COMPLIANCE PROJECTS TO MEET FEDERALLY MANDATED REQUIREMENTS ("CULLEY 3 COMPLIANCE PROJECT"); (4) AUTHORITY TO TIMELY RECOVER 80% OF THE COSTS INCURRED DURING CONSTRUCTION AND OPERATION OF THE CULLEY 3 COMPLIANCE PROJECTS THROUGH VECTREN SOUTH'S ENVIRONMENTAL COST ADJUSTMENT MECHANISM; (5) AUTHORITY TO CREATE REGULATORY ASSETS TO RECORD (A) 20% OF THE REVENUE REQUIREMENT FOR COSTS, INCLUDING CAPITAL, OPERATING, MAINTENANCE, DEPRECIATION, TAX AND FINANCING COSTS ON THE CULLEY 3 COMPLIANCE PROJECT WITH CARRYING COSTS AND (B) POST-IN-SERVICE ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION, BOTH DEBT AND EQUITY, AND DEFERRED DEPRECIATION ASSOCIATED WITH THE CCGT AND CULLEY 3 COMPLIANCE PROJECT UNTIL SUCH COSTS ARE REFLECTED IN RETAIL ELECTRIC RATES; (6) ONGOING REVIEW OF THE CCGT; (7) AUTHORITY TO IMPLEMENT A PERIODIC RATE ADJUSTMENT MECHANISM FOR RECOVERY OF COSTS DEFERRED IN ACCORDANCE WITH THE ORDER IN CAUSE NO. 44446; AND (8) AUTHORITY TO ESTABLISH DEPRECIATION RATES FOR THE CCGT AND CULLEY 3 COMPLIANCE PROJECT ALL UNDER IND. CODE §§ 8-1-2-6.7, 8-1-2-23, 8-1-8.4-1 *ET SEQ*, 8-1-8.5-1 *ET SEQ.*, AND 8-1-8.8 - 1 *ET SEQ.*	)	CAUSE NO. 45052 APPROVED: APR 24 2019

ORDER OF THE COMMISSION

Presiding Officers:
David E. Ziegner, Commissioner
David E. Veleta, Senior Administrative Law Judge

On February 20, 2018, Southern Indiana Gas & Electric Company d/b/a Vectren Energy Delivery of Indiana, Inc. ("Vectren South") filed its verified petition in this Cause seeking, among other relief, certificates of public convenience and necessity for a new duct-fired F-class 2x1 combined cycle gas turbine ("CCGT") providing 700 MW of baseload and 150 MW of peaking capacity pursuant to Ind. Code ch. 8-1-8.5 and for certain environmental projects at its Culley Unit 3 generating station pursuant to Ind. Code ch. 8-1-8.4. Petitions to intervene were filed by the Vectren Industrial Group; Valley Watch, Inc., the Citizens Action Coalition of Indiana, Inc., and the Sierra Club ("Joint Intervenors"); the Indiana Coal Council, Inc. ("ICC"), Sunrise Coal, and Alliance Coal, LLC (the "Coal Parties"); SABIC Innovative Plastics Mt. Vernon, LLC; St. Joseph Energy Center, LLP; St. Joseph Phase II LLC; and Evansville Western Railway. All of these petitions to intervene were subsequently granted. A public field hearing was held in Evansville on July 11, 2018, at which time members of the public presented testimony. The Indiana Utility Regulatory Commission ("Commission") held an evidentiary hearing at 9:30 a.m. on October 9, 2018, in Room 222, PNC Center, 101 West Washington Street, Indianapolis, Indiana.

Based upon the applicable law and the evidence presented, the Commission finds:

1. **Notice and Jurisdiction.** Notice of the hearings in this Cause was given and published as required by law. Vectren South is a "public utility" as defined in Ind. Code § 8-1-2-1(a) and Ind. Code § 8-1-8.5-1, an "energy utility" as defined in Ind. Code § 8-1-8.4-3, and an "eligible business" as defined in Ind. Code § 8-1-8.8-6. Vectren South is subject to the jurisdiction of this Commission in the manner and to the extent provided by Indiana law. Pursuant to Ind. Code chs. 8-1-8.5 and 8-1-8.4, Vectren South may seek Commission approval of Certificates of Public Convenience and Necessity. Accordingly, the Commission has jurisdiction over Vectren South and the subject matter of this proceeding.

2. **Vectren South's Characteristics.** Vectren South is an operating public utility incorporated under the laws of the State of Indiana, with its principal office and place of business in the City of Evansville. Vectren South provides electric and gas utility service to the public in Indiana and is subject to the regulation by this Commission in the manner and to the extent provided by the laws of the State of Indiana. This proceeding pertains to Vectren South's electric utility business. Vectren South renders retail electric utility service to approximately 145,000 customers in seven counties in southwestern Indiana, and owns, operates, manages and controls electric generating, transmission and distribution plant, property and equipment and related facilities which are used and useful for the convenience of the public in the production, transmission, delivery and furnishing of electric energy, heat, light and power for residential, commercial, industrial and municipal uses. Vectren South furnishes such electric utility service to retail customers located in Vanderburgh, Posey, Gibson, Pike, Warrick, Dubois and Spencer Counties, with a major portion of such customers residing in and around the City of Evansville, Indiana. Vectren South owns and operates 1,248 megawatts ("MW") of total net generating capacity. This generation capacity is primarily derived from the following five coal-fired baseload units providing a total of approximately 1,000 MW: A.B. Brown 1 (245 MW), A.B. Brown 2 (245 MW), F.B. Culley 2 (90 MW), F.B. Culley 3 (270 MW) and Warrick Unit 4 (150 MW[1]). Vectren South procures 100% of its coal supply from mines located in Indiana.

[1] Represents Vectren South's ½ interest in Warrick Unit 4, a 300 MW unit.

Vectren South's operations are subject to federal, state and local rules promulgated and/or implemented by, among others, the federal Environmental Protection Agency ("EPA"), the Indiana Department of Environmental Management ("IDEM") and by the Environmental Rules Board of the State of Indiana. Such rules establish environmental compliance standards that govern emissions and discharges from Vectren South's electric generating units.

3. <u>Overview of the Evidence.</u>

A. <u>Condition of Current Fleet.</u>

i. Vectren South. The main drivers behind Vectren South's proposal are the age and operating characteristics of Vectren South's existing baseload capacity and the upcoming deadlines for significant capital investments to address environmental regulations. Mr. Wayne D. Games, Vice President of Power Supply at Vectren South, testified regarding the condition of Vectren South's current generation fleet and the challenges facing the fleet. He testified Vectren South's fleet consists of five coal-fired baseload units totaling 1,000 MW. Mr. Games further testified that growth of renewable energy sources and low natural gas prices have negatively affected MISO's dispatch of Vectren South's coal-fired units. Instead of running continuously, Vectren South's units are now cycled up and down throughout the day, or are shut down altogether, decreasing unit efficiency and increasing wear and tear on the units. Mr. Games testified that because the units were not designed to cycle in this manner, the units cannot effectively compete with gas units in particular, which have far better operating flexibility. Continued market reforms are exacerbating this issue and jeopardizing unit availability and reliability.

Mr. Games also explained that the individual units face additional operating challenges. In particular, the A.B. Brown Units rely on scrubbers that utilize a technology that has been abandoned by the industry because of its high variable costs and the vapor it emits which causes corrosion of the unit structure. The scrubbers are already past their expected 30 year design life and present a significant risk to reliability and maintenance costs. He explained that Culley Unit 2 is Vectren South's oldest and smallest unit and that it has the worst heat rate of any coal unit in the state. Finally, he explained the unique circumstances related to the joint operation of the Warrick Unit which creates uncertainty as to the duration of its operation.

Ms. Angila Retherford, Vice President of Environmental Affairs and Corporate Sustainability, testified regarding two new major federal regulatory initiatives – Effluent Limitations Guidelines ("ELG") and Coal Combustion Residuals ("CCR") - impacting Vectren South's coal-generating units. Absent substantial investment at all of Vectren South's coal plants, they must cease operations by December 31, 2023. Ms. Retherford described Vectren South's environmental compliance strategy for the A.B. Brown and Culley units and testified future compliance costs were modeled in Vectren South's 2016 Integrated Resource Plan ("IRP") under the business as usual scenario. Ms. Retherford testified these rules and other existing federal regulatory requirements will require Vectren South to make significant further investment at the A.B. Brown and Culley generating facilities to continue their operation.

ii. Non-Utility Parties.

(1) OUCC. OUCC witnesses Lauren M. Aguilar – Utility Analyst, Anthony A. Alvarez – Utility Analyst and Peter M. Boerger – Senior Utility Analyst testified regarding Vectren South's request for a CPCN to construct the CCGT. These OUCC witnesses testified Vectren South's decision to construct the CCGT is premature because Vectren South has not explored all practical alternatives to extend the life of the A.B. Brown units. OUCC Witness Aguilar ultimately recommended that the decision to build the CCGT be delayed until the end of the 2019 IRP process, in order to allow Vectren South the opportunity to evaluate additional alternatives. The OUCC offered no alternative resource proposal, but argued for a "blended approach" with the possible continued use of existing assets, and suggested that the necessary expenditures to continue use of these assets could be viewed as buying an "option on the future." The OUCC witnesses asserted that deferring any decision until the conclusion of the 2019 IRP process would still allow sufficient time to take action without affecting reliability.

(2) Coal Parties. The Coal Parties' witnesses generally testified that Vectren South should wait to transition its baseload generation from coal to natural gas because the environmental regulations driving the transition, the ELG and CCR rules, are in flux and not yet final. Specifically, the Coal Parties' witnesses testified that recent and anticipated EPA reconsiderations of the ELG and CCR regulations, as well as the potential stay or replacement of the Clean Power Plan ("CPP"), create the potential scenario where Vectren South could operate the A.B. Brown and Culley units beyond 2023 without the need to make material investments in compliance measures. Coal Parties witness Michael J. Nasi – Partner with the law firm of Jackson Walker L.L.P. – further testified that Vectren South's decision to retire its coal plants is premature. He recommended that the decision be delayed until the environmental regulations driving the decision are better understood. With respect to the A.B. Brown units, the Coal Parties suggested that Vectren should investigate an alternative scrubber technology marketed by a Chinese firm to replace the existing dual alkali scrubbers. This technology which uses ammonia creates material that can be sold as fertilizer with revenues used to offset variable operating costs of the scrubber.

iii. Vectren South Rebuttal. Ms. Retherford, who is also a licensed attorney, testified regarding the risks associated with continuing to operate Vectren South's coal-fired fleet and delaying the decision to construct the proposed CCGT. Ms. Retherford testified that recent legal developments related to the CCR rule have made it impossible for Vectren South to continue operating its coal-fired fleet beyond 2023 without significant capital investment. She testified that the current water discharge permits require, and the groundwater monitoring results at the A.B. Brown and Culley ash ponds confirm, that Vectren South must cease discharging coal ash by December 31, 2023, pursuant to the ELG and CCR rules. She also testified that *Utility Solid Waste Activities Group v. Environmental Protection Agency*, 901 F.3d 414 (D.C. Cir. 2018), 2018 U.S. App. LEXIS 23547, confirms that the CCR Rule is final, including the final compliance deadlines at issue in this proceeding. Ms. Retherford testified that pond retirement delay is not an option, and therefore Vectren South must either make investments to comply with the CCR rule or retire the plants before 2024.

In response to the Coal Parties' position that the current administration could alleviate environmental carbon regulations applicable to the coal units, Ms. Retherford testified that the Administration's proposed replacement for CPP does not alleviate the problems. On August 31, 2018, the EPA published its proposed Affordable Clean Energy ("ACE") rule in lieu of CPP. She explained that ACE would increase uncertainty and could actually increase the cost of compliance. For units with high heat rates – such as A.B. Brown – ACE would cause significant future compliance costs.

Vectren South also presented the testimony of Richard McMahon from Edison Electric Institute ("EEI") regarding the growing importance of Environmental, Sustainability and Governance ("ESG") reporting and metrics to the financial community, and the focus of all public electric utilities on being responsive to these topics and establishing explicit carbon reduction targets as part of their public disclosures. Mr. McMahon described the coordinated electric industry response to the demands for ESG reporting, and provided specific examples of lenders and large institutional investors who are putting pressure on companies to transition from dependence on coal units. He explained that Vectren South's 60% carbon emission reduction was in line with similar targets publicly disclosed by its electric utility peers. He also presented information regarding the industry transition from reliance on coal to use of gas as part of the ability to reduce carbon emissions.

As to the potential for alternative scrubbers, Vectren South witness Paul Farber – Principal of P. Farber & Associates, LLC – testified regarding the shortcomings of the technologies presented by Sunrise Coal witness Dombrowski and OUCC witness Aguilar and explained why, from an operational and financial perspective, it would not be prudent for Vectren South to adopt those technologies. With respect to the ammonia based scrubber technology presented by witness Dombrowski, Mr. Farber testified the technology has very limited deployment in the United States and would present a number of operational challenges if installed at baseload coal-fired units like A.B. Brown. These uncertainties and risks posed by adoption of this technology include its cost, its impact on operation of the units (including that it might cause Vectren South to be out of compliance with regulations for other constituents such as mercury and particulate matter absent further types of investments), the unknown ability to sell fertilizer output, and the complications associated with dealing with vendors with no domestic history. He discussed in depth the substantial operational burden and health and Homeland Security risk associated with handling the large amount of ammonia required by such a scrubber. Mr. Farber concluded that the Coal Parties had failed to provide any evidence that the capital costs of this scrubber technology would be any less than the scrubber modeled in Vectren South's 2017 IRP Update. In rebuttal testimony, Jon K. Luttrell, Senior Vice President, Utility Operations and President of Vectren Utility Holdings, Inc., also discussed the cyber security complications and risks posed by adoption of Chinese scrubber technology.

Mr. Farber also responded to OUCC witness Aguilar's criticism that Vectren South "only" evaluated wet limestone and her presentation of potential costs for other technologies. Mr. Farber testified that dry scrubbing is not an applicable technology at A.B. Brown for technical and economic reasons, and therefore it was logical for Vectren South to evaluate wet limestone technology at A.B. Brown. He also testified the cost estimates presented by Ms. Aguilar are not comparable cost estimates to replace the existing scrubbers at A.B. Brown Units 1 and 2.

Mr. Games testified on rebuttal that there simply is no time to delay a decision and await the outcome of another IRP. The Vectren South coal units must be retired or retrofitted by December 31, 2023. Given that there has been nothing to suggest more delay would change the overall economics that the F-class 2x1 CCGT is part of the lowest cost solution under every scenario, there is no reason to believe that modeling in the next IRP would change that result. Mr. Games provided an exhibit setting forth a timeline showing that a delay to allow the next IRP to proceed would leave Vectren South with essentially no baseload capacity for almost three years. During that entire period, Vectren

South customers would be completely exposed to the market for capacity and energy. Per the redirect examination of Justin M. Joiner, Director of Regulatory Policy and MISO Affairs for Vectren Utility Holdsings, Inc. ("VUHI"), this would be during the period when MISO is projecting its largest capacity shortfall for Zone 6 (Indiana). The Commission's Director's Report states "[a]n appropriate planning aspiration is to maintain flexibility while also waiting as long as reasonably possible to commit to a resource." Mr. Games testified on cross-examination that Vectren South has waited as long as reasonably possible.

B. <u>Modeling and Results</u>. Only two parties presented modeling evidence and results. Vectren South presented the modeling from the 2017 IRP Update and the 2016 IRP. Sunrise Coal Witness Philip Hayet presented alternative modeling whereby Vectren South's Preferred Portfolio was delayed by seven years in order to allow existing coal units to continue to operate beyond 2023. Other parties offered criticism of Vectren South's modeling but presented no alternative modeling.

i. <u>2016 IRP</u>. Vectren South's case was filed in the context of a proposed new rule to govern the IRP process. While our new rule was not effective during the 2016 IRPs, all participating electric utilities complied. This new process is significantly more transparent. It includes the participation of stakeholders, the convening of public meetings, and the submission of and response to comments. Mr. Matt Rice, Director – Research and Energy Technologies, testified regarding Vectren South's IRP process and the results of that process. Mr. Rice described Vectren's approach to its 2016 IRP process and testified Vectren South engaged several industry experts, including Burns & McDonnell and Pace Global, to conduct technical modeling. Mr. Rice testified Vectren South worked with these experts and IRP stakeholders to conduct scenario analysis to evaluate 15 portfolios, each representing a different mix of supply and demand side resources to meet customer load over a 20-year time horizon. He further testified Vectren South worked with Pace Global to conduct a risk analysis and evaluate the 15 portfolios using a balanced scorecard approach. From this analysis, Vectren South identified the "preferred portfolio" which consisted of replacing all existing coal fired generation other than Culley Unit 3 as well as gas peaking units Northeast 1 and 2 and Broadway 1 by 2024 with an F-class .05 Fired CCGT. Mr. Rice testified Vectren South incorporated stakeholder input throughout the process and described the steps Vectren South took to engage stakeholders both before and during the process. This engagement included having stakeholders develop two portfolios which were then modeled and included in the risk analysis.

Mr. Matthew Lind – Associate Project Manager, Burns & McDonnell – described the modeling Burns & McDonnell conducted in the 2016 IRP on behalf of Vectren South to evaluate its resource needs over the next 20 years. He testified the results of Burns & McDonnell's modeling identified a low-cost portfolio that ceased coal operations at Vectren South's coal fired facilities (A.B. Brown Units 1 and 2, F.B. Culley Units 2 and 3, and Warrick Unit 4) and replaced this capacity and energy with the combined cycle facility proposed here along with a simple cycle facility. Mr. Gary Vicinus – Managing Director for Utilities at Pace Global – described Pace Global's role in identifying and defining the objectives, metrics and risks in order to select the preferred portfolio among the many options. He testified Pace Global used a balanced scorecard approach to apply a risk analysis to a selection of portfolios ultimately to recommend a preferred portfolio. Mr. Vicinus further testified regarding revisions Pace Global made to its risk analysis and explained that, even with these revisions, the risk analysis indicated the preferred portfolio was the best approach.

Mr. Rice described the preferred portfolio and explained why it ranked the best on the balanced scorecard. He testified it performed the best because the portfolio is diversified as it contemplates keeping FB Culley 3 (a coal unit) and existing wind contracts, building a CCGT and introducing solar and continuing to offer energy efficiency. He further testified it is among the lower cost portfolios (within 4% of the predominantly gas lowest cost portfolio) and ultimately performed best overall when viewed across multiple measures on the balanced scorecard. Because the all-gas portfolio represented the lowest cost portfolio, it is the retention of Culley Unit 3 and the accelerated addition of the 50 MW solar project that increases the costs of the Preferred Portfolio over the lowest cost all-gas portfolio. Retention of coal and the addition of solar are essential to diversity.

ii. 2017 IRP Update. Mr. Lind testified Vectren South requested Burns & McDonnell to update the 2016 IRP modeling and the re-evaluated low-cost portfolio was consistent with the low-cost portfolio identified in the 2016 IRP. He explained that several modeling inputs were updated, including the capital cost for solar resources, variable production costs and revenue requirements for existing units, an assumed operation of Warrick Unit 4 through 2023, and updated cost assumptions for capacity, energy, natural gas, coal, and energy efficiency.

OUCC witness Peter Boerger testified regarding Vectren South's 2017 IRP Update economic modeling. Mr. Boerger testified that Vectren South's 2017 IRP Update did not adequately consider viable options for serving its customers—including making use of existing resources and adequately considering the addition of a smaller CCGT unit rather than the 2x1 unit being proposed. Mr. Boerger also testified Vectren South's modeling of the proposed CCGT understated its capital cost by $200 million, an error which disadvantaged other options in Vectren South's modeling. Mr. Boerger ultimately recommended Vectren South reevaluate its future needs and model additional alternatives.

CAC witness Tyler Comings – Senior Researcher at Applied Economics Clinic – testified on behalf of the Joint Intervenors. Mr. Comings criticized Vectren South's modeling, testifying it was too convoluted to yield a sufficiently transparent or credible result. He testified Vectren South used too many models in the selection of the preferred portfolio and that the use of many models created ample opportunity for flawed and/or inconsistent input assumptions and other settings that could create bias in favor of the preferred plan. Mr. Comings ultimately recommended Vectren South's petition be denied because, in his view, Vectren South did not provide sufficient justification for its choice to build the CCGT and continue the operation of Culley 3.

Indiana Coal Council witness Emily Medine – Principal in the consulting firm of Energy Venture Analysis, Inc. – also testified regarding Vectren South's modeling. Witness Medine testified Vectren South should have fully updated its 2016 IRP analysis, including its scenario analysis, in order to confirm its preferred resource portfolio. She further testified that such an update should include a broader analysis (including sensitivity analyses) of the relevant assumptions and factors as of a time as close to Vectren South filing its Petition as possible. Ms. Medine attributed the decision to build a CCGT to financial motivations and also opined that approval of the CCGT might be a condition to closing the Vectren South merger transaction.[2] Ms. Medine recommended that Vectren South's Petition be rejected because Vectren South has failed to show that proceeding with building the CCGT at this time is prudent, less risky, and a better decision for both customers and the environment.

[2] While this case was pending, it was announced publicly that Vectren South's holding company was the subject of an acquisition at the holding company level, which was the subject of Cause No. 45109.

Mr. Lind responded to Mr. Boerger's testimony about an alleged $200 million "error." He explained that approximately $67 million of the alleged error identified by Mr. Boerger was due to Mr. Boerger's mistaken assumption about whether modeled option costs are stated in 2017 dollars or nominal dollars in the year of incurrence. The remainder is due to Mr. Boerger's efforts to compare apples and oranges. As Mr. Lind explained, the modeling was done prior to the more refined cost estimates for the CCGT that were developed for this case. Rather than based on a design level accuracy of plus/minus 50%, the CCGT design has been refined to a plus/minus 10%. All of the other portfolios were still at plus/minus 50%. As Mr. Lind explained, to compare the other less refined portfolios to the more refined CCGT would require some additional risk factor for the other portfolios. But even if one includes the updated cost estimate, Mr. Lind testified that it doesn't change that the lowest cost portfolios still include the CCGT. Mr. Lind prepared additional modeling involving coal-to-gas conversion (which we will describe later) and which did include the more refined CCGT cost estimate. While this additional modeling used the more precise CCGT cost and therefore impacted every portfolio that included the CCGT by increasing the overall net present value ("NPV") by $54 million, the portfolios that included the CCGT were still the lowest cost portfolios compared to portfolios that did not include the CCGT. Regarding the use of the models, witnesses Lind and Vicinus confirmed that the process and modeling for Vectren South's IRP and risk analysis were consistent with the resource planning approach Pace and Burns & McDonnell have used for numerous other utilities.

(iii) Size of the Proposed CCGT. Joint Intervenors' witness Tyler Comings testified regarding the size of the proposed CCGT. Witness Comings testified that Vectren South has not provided a sufficient justification to build a CCGT of the size included in its proposal. Witness Comings also criticized Vectren South's Request for Proposals ("RFP") (which we will describe in greater detail later) which sought resources between 600 and 800 MW, because he believed Vectren South could have considered combinations of small resources that added up to 600 MW. He further testified that considering smaller options would limit the market risk exposure for ratepayers, as well as permit a combination of bids to make up a least cost alternative. Mr. Comings testified that in order to reduce ratepayers' risk, Vectren South should explore cost effective alternatives that do not require intensive capitalization, but still provide benefits to ratepayers.

OUCC witness Anthony Alvarez also testified regarding the size Vectren South is proposing for the CCGT. Mr. Alvarez testified that Vectren South currently has excess supply, and there is no resource shortfall or inadequacy that supports Vectren's proposed 850 MW CCGT. He also questioned the load forecast used in the IRP and testified Vectren South has excess supply after serving its peak load and therefore has excess capacity to offer into the market and serve new customers.

Industrial Group witness Michael Gorman also testified regarding the size of Vectren South's proposed CCGT. Mr. Gorman testified Vectren South's proposal to build an 850 MW CCGT will result in excess capacity and have a compound impact on Vectren South's cost of service because the plan increases the costs of new generation resources and results in unrecovered stranded costs from the retired resources. Mr. Gorman recommended the Commission implement mitigation measures to reduce the cost burden on customers related to stranded costs and the cost of the new CCGT. He also recommended the Commission modify the off-system sales margin treatment so that 100% of future wholesale revenues be provided to customers to offset the cost of the proposed resource plan.

Vectren South witness Carl Chapman testified on rebuttal regarding Vectren South's decision to construct an 850 MW CCGT. Mr. Chapman explained the CCGT is essentially two units -- a 700 MW baseload unit to replace 730 MWs of retiring coal unit capacity and 150 MWs of duct fired peaking capacity to replace older peaking units and provide available low cost capacity for growth and wholesale sales opportunity. The additional peaking capacity is provided by the decision to duct-fire the CCGT. The incremental cost of duct-firing the CCGT is $15 million, and that decision must be made at the time the CCGT is constructed (i.e., it cannot be added at a later time.) Mr. Chapman testified that if only the unfired 700 MW baseload CCGT is built, then by 2025, Vectren South has a projected surplus above MISO's Planning Reserve Margin ("PRM") (which fluctuates) of only 51 MW. He further testified that by 2030, the surplus is only 5 MWs and by 2031 Vectren South will fail to meet its PRM. He testified that by 2036, Vectren South will be short 39 MWs, and all of this assumes Vectren South will not add significant new load. Mr. Chapman testified that with its low capital cost, firing makes sense from a customer perspective. For an incremental cost of 2%, the firing provides a 21% increase in capacity. Nevertheless, if the Commission approves the baseload 700 MW CCGT without firing, Vectren South will proceed to construct the unfired CCGT to replace its baseload coal units. He stated that Vectren South would also consider investing the incremental $15 million to duct-fire the unit and be at risk to recoup its investment via retention of the wholesale revenue produced by that peaking capacity.

Mr. Chapman also testified regarding Industrial Group witness Gorman's recommendation that Vectren South pass off-system sales margins on to retail customers. Mr. Chapman testified that Vectren South has decided to commit to provide 100% of wholesale sales revenue from the CCGT (baseload and peaking) to customers. Mr. Chapman explained that once the CCGT is placed in rate base, the benefits from the wholesale revenue produced by the unit will go to reduce customer costs. Mr. Chapman testified that providing 100% of wholesale revenue to customers further improves the NPV of the CCGT, will provide a larger offset to customer costs in general, and adds even more support to the $15 million incremental investment to duct fire the unit.

C. **Coal Parties' Modeling.** Indiana Coal Council, Inc. witness Philip Hayet – Vice President of J. Kennedy and Associates, Inc. – testified regarding Vectren South's 2016 IRP modeling and the 2017 IRP Update. Mr. Hayet testified that Vectren South's modeling analyses were flawed due to errors, inconsistencies, and a lack of consideration of important factors. Mr. Hayet performed his own analysis and testified that using the same model with certain corrections, including a deferral of a decision to add a CCGT, produced a slightly lower cost result on a NPV basis. He predicated his modeling on the assumption that the A.B. Brown 2 scrubber will continue to operate reliably through 2030. He ultimately recommended that Vectren South defer its decision to construct the CCGT.

On rebuttal, Vectren South witness Matthew Lind testified regarding Indiana Coal Council witness Hayet's alternative modeling. Mr. Lind testified that when Mr. Hayet's modeling is corrected for obvious errors, it reaches the same preferred portfolio conclusion as Vectren South's modeling. Mr. Lind provided corrections to Mr. Hayet's modeling in the form of an updated Strategist model and spreadsheets documenting the corrections. Mr. Lind outlined each of the errors he identified in Mr. Hayet's modeling and the impact of the individual errors on his analysis. The first of several errors he identified was that Mr. Hayet failed to include cost escalation during the seven years of delay that he was urging and that correcting this error alone would change Mr. Hayet's overall conclusion that delay would be less costly. Mr. Lind also testified regarding the cumulative effect of addressing all of the errors. As part of this analysis, Mr. Lind testified that he included the increased cost of the CCGT to reflect the more recent cost estimates based on a plus or minus 10% confidence level. He testified that when correcting Mr. Hayet's modeling for all of these errors and inconsistencies, the NPV favors Vectren South's preferred portfolio, even under Mr. Hayet's no carbon regulation scenario. Witness Hayet corrected his testimony after Mr. Lind filed his rebuttal to add the escalation during the period of delay he was urging, and this correction changed his original conclusion that delay was less expensive. Mr. Hayet did not address the other modeling issues raised by Mr. Lind.

Mr. Games' rebuttal testimony also addressed witness Hayet's assumption that the A.B. Brown 2 unit and scrubber could be operated without added cost and reliability risk through 2030. Apart from the reliability issues created by the frequent cycling of the unit, he explained the structural damage resulting from the corrosive environment created by the unique characteristics of these scrubbers, and based on his direct experience with this equipment, Mr. Games concluded that he could not agree that it would be prudent to continue to operate the A.B. Brown 2 scrubber for another 12 years beyond 2018.

D. Renewables and All-Source RFP. Joint Intervenor witness Tyler Comings criticized the costs assumed in Vectren South's modeling for most renewable energy sources. Mr. Comings testified that Vectren South's forecast of the capital costs of future wind resources is higher than he would have recommended for the type of planning analysis and its forecast of the fixed O&M costs are lower. Mr. Comings recommended the use of the National Renewable Energy Laboratory's Annual Technology Baseline ("ATB") to develop the forecasts. With respect to future solar resources, Mr. Comings testified Vectren South's forecasts are too high for both the capital and fixed O&M costs. Mr. Comings recommended the reliance on the ATB to develop wind and solar price forecasts. For utility-scale PV, he testified that the ATB midpoint projection would be appropriate. As part of his discussion of renewable costs, he noted that Northern Indiana Public Service Company ("NIPSCO") had recently conducted an RFP and obtained solar and wind bids. Mr. Comings testified that Vectren South's overestimation of renewable costs compared to the ATB data biased the modeling results against renewable resources in favor of non-renewable resources, such as natural gas.

On rebuttal, Mr. Lind responded to Mr. Comings' testimony related to the cost of renewables included in Vectren South's modeling. With respect to wind resources, Mr. Lind noted that prior to revising his testimony, Mr. Comings' originally filed testimony included an inaccurate and inappropriate comparison of assumed capital cost for wind resources between Vectren South and ATB because Mr. Comings failed to account for the declining cost curve over time utilized by Vectren South. Mr. Lind testified that when Mr. Comings updated his testimony to reflect this decline, he recognized that Vectren South's wind costs are only "slightly higher" than what Mr. Comings recommends. Mr. Lind further testified that even with this correction, Mr. Comings' comparison to the ATB figures is incorrect because the ATB figure excludes a 2.1% construction finance factor and is thus understated. Mr. Lind testified that when the 2.1% construction finance factor is included, the ATB capital cost will exceed Vectren South's modeled capital cost for wind over more than half of the planning period. Mr. Lind pointed out that Vectren South assumed a higher capacity factor than the ATB survey and also assumed lower O&M costs compared to the ATB survey, and as a result, it is likely that the wind prices recommended by Mr. Comings are actually higher than those modeled by Vectren South.

With respect to Mr. Comings' criticisms of Vectren South's solar costs, Mr. Lind testified Mr. Comings again failed to account for the declining cost curve over time in the original version of his testimony. Mr. Lind further testified that while Mr. Comings did update his comparison to reflect the decline, he did not update it to include the 2.1% construction finance factor in the ATB comparison. Moreover, Mr. Lind explained that the national survey costs relied upon by Mr. Comings were presented on a direct current (DC) basis, whereas the 2017 IRP Update stated cost in terms of alternating current (AC), thus requiring that Comings' costs be converted to AC to allow for a valid comparison to be made. When correcting for these additional errors, Mr. Lind testified the solar costs used by Mr. Comings and Vectren South are nearly consistent over the last half of the study period and fairly similar from 2024 onward, which is the point at which capacity is needed.

Mr. Lind also testified regarding the impact of network upgrades and congestion costs on a portfolio that would rely more heavily on renewables. Mr. Lind testified that a portfolio which would rely heavily on renewables to supply power to Vectren South's customers is more likely to source some or all of these resources remote to Vectren South's service territory given the acreage required for such projects, the grid issues that can be encountered, and the enhanced production that can be obtained in certain locations (e.g., northern Indiana). Mr. Lind explained that when significant amounts of power are sourced from off-system resources, congestion costs to Vectren South's customers increase substantially. Because such costs were not part of the 2017 IRP Update assumptions, Mr. Lind concluded that any small differences between the solar costs presented by Mr. Comings and those modeled by Vectren South would be more than offset by the congestion costs associated with greater reliance on such resources. Finally, Mr. Lind noted that even assuming lower renewable costs could be achieved, such resources would likely displace Culley Unit 3's 270 MWs of capacity because that could be done incrementally to reduce the effects of network upgrades and congestion, whereas the CCGT would remain the optimal low cost choice to replace the remaining 730 MWs of retiring coal capacity in 2023. Further, wind and solar are intermittent sources of power; given that Culley Unit 3 would be Vectren South's only baseload capacity under its preferred portfolio, dispatchable baseload generation from a CCGT provides greater flexibility to respond to intermittent resources.

E. <u>Capacity Price Forecasts</u>. Mr. Comings testified regarding Vectren South's ability to purchase future needed capacity from the MISO market. Mr. Comings testified that Vectren South overestimated future capacity prices in MISO in its modeling, and in reality, the MISO market has had an oversupply of resources and tempered demand, leading to low capacity prices. He testified Vectren South's assumption of higher capacity prices is critical, because it makes the economics of building a new resource more attractive. He concluded that Vectren South was placing risk on its customers if the price of capacity is lower. To reach his conclusion, he relied on the MISO auction clearing results for Zone 6 (Indiana) for the past five years. Indiana Coal Council witness Hayet had a similar criticism of Vectren South's modeled capacity prices. He agreed that the cost of new entry ("CONE") served as the upper end of future capacity prices but that, also based on MISO historic auction clearing prices, it was inappropriate for future assumed capacity prices to approximate CONE. Instead, witness Hayet proposed to use 75% of CONE.

On rebuttal, Vectren South witness Joiner responded to Mr. Comings' testimony related to Vectren South's alleged overestimation of MISO capacity prices. Mr. Joiner testified he disagreed with Mr. Comings' contention that Vectren South should assume it will be able to purchase capacity and energy from the MISO market at low prices based upon recent market conditions. Mr. Joiner explained that the MISO market has been volatile in recent years and is experiencing shrinking capacity, and such factors have prompted MISO to evaluate changes to its market structure. Mr. Joiner testified that MISO's recent and pending market reform initiatives, including MISO's Resource Availability and Need ("RAN"), are aimed at increasing capacity and energy prices to incentivize new generation development and are thus leading to higher prices as capacity tightens. As such, Mr. Joiner testified that while MISO's historical capacity and energy prices are indicators of recent trends, contrary to Mr. Comings' MISO auction clearing price testimony, they are not good indicators of expected, long-term future pricing. Moreover, the reported potential for a capacity shortfall by 2024 shows the risk of increased market prices.

F. Refueling Options. OUCC witness Boerger recommended that Vectren model a smaller 440 MW CCGT option in conjunction with gas refueling of one or both A.B. Brown units in order to consider a lower capital cost alternative. This option, which replaces retired coal units with a smaller gas baseload unit, was consistent with his stated concern that implementation of large quantities of intermittent renewables could create grid difficulties and that the extension of the life of small coal units is not common in the industry.

Mr. Lind's rebuttal presented the results of additional modeling in response to the OUCC's interest in further analysis related to resource plan options including coal-to-gas conversion that would make use of the A.B. Brown unit boilers. Burns & McDonnell performed that modeling and analyzed four additional portfolios, each where the conversion of one or more units to natural gas was considered. Mr. Lind testified that this updated rebuttal modeling used the more refined cost estimates (at the plus/minus 10% confidence level) for the CCGT for comparison with the coal-to-gas conversion portfolios (which were stated at plus/minus 50% accuracy.) Mr. Lind described the results of the updated analysis and testified that when compared with the coal-to-gas conversion portfolios, the preferred portfolio still produces a lower NPV and projected customer cost. Witness Games explained that this is due in part to the high heat rates of refueled units which result in very poor dispatch rates and resulting reliance on the market for energy needs. He explained that such a portfolio would result in customers significantly depending on market purchases for energy. Witness Games testified the fuel cost per MWhr from a converted gas plant is roughly $20 more expensive than the cost from the proposed CCGT when gas price is $4.000/dkt. He showed the much higher heat rates and lower capacity factors at converted plants that were completed between 2013 through the first quarter of 2018. Mr. Games testified during the hearing that the problem of high heat rates means that the refueled units continue to cycle and ramp up and down when dispatched, leading to wear and tear and the risk of additional maintenance costs.

G. Docket Entry Question & Response. As a follow-up to the additional modeling performed by Vectren South on rebuttal of gas conversion options, we issued a Docket Entry requesting further iterations of gas conversion portfolios. These included refurbishment of Broadway Unit 2 coupled with delays of removal of Warrick Unit 4 and installation of either a simple cycle or combined cycle gas turbine. Vectren South's response included the more refined cost estimate of the CCGT at plus/minus 10%, excluded additional environmental compliance costs at Warrick Unit 4 that would allow for the delay, and were presented with and without the commitment by Vectren South on rebuttal to pass 100% of wholesale revenues to customers if the CCGT is approved. All of the additional modeling requested by our docket entry produced a higher NPV than the lowest cost refueling portfolio presented on rebuttal (to convert A.B. Brown and instill a simple cycle gas turbine). With the sharing of 100% of wholesale revenues, all of the additional modeling produced a higher NPV when compared to the preferred portfolio ranging from 3.5% to 7.0%. Given that the preferred portfolio was within 4% of the lowest cost 2016 IRP portfolio (CCGT, an additional simple cycle turbine, and delayed renewables), that means the gas conversion portfolios ranged anywhere from 8-12% higher than the lowest cost portfolio.

H. Estimated Cost of CCGT and RFP Process.

i. Vectren South. Mr. Games testified that, consistent with the 2016 IRP results, the 2017 IRP Update, and the Pace risk analysis, Vectren South is proposing to build a CCGT with 700 MW of baseload capacity and 150 MW of peaking capacity to replace retiring coal-fired capacity. Mr. Games testified Vectren South is proposing to build a unit with an output of approximately 850 MWs in order to hold some additional capacity to meet its obligations as a public utility, as well as to serve potential new customers and foster economic development. The 850 MW replaces 865 MW of retiring capacity (730 MW of baseload and 135 MW of peaking capacity, including Broadway Unit 2 in 2025). Mr. Games further testified the estimated cost of the CCGT is $781 million (+/-10%). The estimate includes owner's costs and allowance for funds used during construction ("AFUDC"). This figure was based on cost estimates developed by witness Diane M. Fischer, Central Regional Area Director and Associate Vice President with Black & Veatch. Those estimates were derived from a request for proposals for all equipment comprising the CCGT as well as construction. Mr. Games testified Vectren South is proposing to construct the new CCGT on its existing A.B. Brown generating site which will provide a conservative cost savings of $50 million resulting from reusing the existing site, facilities and equipment. He explained the critical timing of the in-service date of the CCGT which will be operational for the 2023/2024 MISO capacity year in order to retire the Culley 2 and A.B. Brown units and thereby avoid material capital investments otherwise required to operate those units beyond 2023. Similarly, the Warrick Unit 4 joint operating agreement will terminate at the end of 2023. To continue to operate Warrick would also require further investment to comply with environmental regulations.

Mr. Luttrell testified regarding the other replacement generation options Vectren South considered. He described the solicitation of competitive bids for either purchased power or ownership of all or a portion of a new CCGT unit. Mr. Luttrell explained Vectren South engaged Burns & McDonnell to manage the entire power supply RFP process, and testified this process allowed Vectren South to compare the best competitive offers for dispatchable baseload capacity to several self-build alternatives, including a partnership alternative. Mr. Luttrell testified that based on this economic and qualitative comparison, Vectren South made the decision to pursue building the duct-fired version of the proposed CCGT at the existing A.B. Brown site.

Mr. Lind testified in greater depth regarding Burns & McDonnell's role in developing and managing the RFP process to address Vectren South's power supply needs. He testified Vectren South received 11 unique proposals from six different developers. He further testified each of the conforming proposals was ranked and the top two proposals were compared with Vectren South's self-build proposals. Mr. Lind testified that based on NPV cost and qualitative risk factors, including a congestion analysis related to an off-system generation project developed by a third party, Vectren South determined that the self-build option was the best resource for reliable, long term service.

ii. OUCC. Witness Alvarez testified that, while Vectren South conducted an RFP, Vectren South did not competitively bid the actual CCGT it seeks to build in this case. OUCC witness Aguilar testified that Vectren South has not yet identified a manufacturer, chosen an exact type of CCGT, or issued any bids for the project.

iii. Coal Parties. ICC witness Medine criticized Vectren South's RFP process for a number of reasons, including the contention that Vectren South was involved in the process and the self-build project did not submit a bid as part of the RFP process. ICC witness Hayet stated a similar concern. Ms. Medine also disagreed with the position that self-build projects represent less risk than merchant projects. Ms. Medine further testified regarding the risks associated with self-builds, including cost over-runs. She testified that most if not all new Indiana plants have experienced cost over-runs that utilities look to customers to recover, and unless Vectren South is willing to guarantee costs, this is a risk that should be considered.

iv. Joint Intervenors. Witness Comings testified Vectren South did not facilitate a competitive bidding process, which limited resources and discouraged bidders from offering purchased power agreements ("PPAs"). He further testified the RFP should not have been limited to MISO Zone 6 and should have been similar to other investor-owned utility solicitations.

v. Vectren South Rebuttal. Mr. Luttrell responded to the Intervenors' criticisms of Vectren South's RFP process. With respect to Mr. Comings' criticisms that Vectren South did not facilitate a competitive bidding process, including limiting resources and discouraging bidders from offering PPAs, Mr. Luttrell testified Vectren South is retiring over 70% of its baseload capacity and the RFP was specifically designed to fill that deficiency with reliable cost-effective supply identified by the IRP. Mr. Luttrell further testified PPAs were not discouraged and all four of the responsive bidders offered a PPA. Mr. Luttrell also responded to Ms. Medine's criticisms that Vectren South was involved in many aspects of the solicitation and that Vectren South did not submit a bid as part of the RFP Process. Mr. Luttrell testified Vectren South used two separate teams—one focused on the RFP and evaluation and one focused on developing the cost estimate for the Vectren South-build CCGT—and each of these teams were separate and walled off from the other. He testified Vectren South's involvement in the RFP process was critical to help ensure the RFP would meet the needs its modeling indicated was necessary. He further testified he did not believe the RFP process was negatively impacted as a result of the self-build alternative being developed parallel to the evaluation of the RFP bids, and Ms. Medine acknowledges "there is no evidence that there was inappropriate information transfer." Mr. Luttrell explained that ultimately, an evaluation of congestion costs associated with the off-system resource proposal was the driver of selecting the CCGT project at A.B. Brown as the best option.

Mr. Luttrell also responded to Ms. Medine's position that a PPA does not pose a greater risk than having a regulated utility own the generation facility. Mr. Luttrell testified that Vectren South believes that an on-system project at an existing utility site subject to regulatory oversight and financed by a public utility, is less risky than relying on a developer. He further testified that when 70% of baseload capacity is at stake, a utility should consider all risks to project completion and to ongoing service in the long term. Mr. Luttrell provided a real-life, recent example of the risks associated with relying on a developer to construct a project. Further, Mr. Luttrell testified that a PPA does represent greater risk compared to a self-build option because the financing, construction, operation, and future financial stability of the seller is not in control of either the regulated public utility or the Commission. Mr. Lind also explained that while the cost estimate for the CCGT is stated at plus/minus 10%, the risk is actually higher (plus/minus 50%) for all portfolios that do not include the CCGT.

I. Construction of Gas Lateral to Serve CCGT.

i. Vectren South. Mr. Perry Pergola – Director, Gas Supply – testified regarding Vectren South's decision to secure the interstate pipeline services of Texas Gas Transmission ("TGT") to provide natural gas service to the proposed CCGT. He testified Vectren South selected TGT because it was the least cost pipeline option to serve the CCGT at the A.B. Brown location. Mr. Pergola further testified Vectren South will build and operate a new gas lateral to interconnect with TGT and serve the CCGT.

Mr. Steve Hoover – Director of Engineering – testified regarding the 23 mile gas lateral Vectren South will construct to connect the CCGT with TGT. He testified Vectren South will construct the pipeline itself because, by virtue of its experience building, operating and maintaining new or existing gas facilities in the Vectren South service area, Vectren South is uniquely qualified and positioned to construct the new pipeline. Mr. Hoover further testified the estimated cost to construct the gas pipeline is approximately $87 million. This is not included in the estimated cost of the CCGT as presented by witnesses Fischer and Games, as it is expected the costs of the gas pipeline will be reflected in the delivered cost of the gas.

ii. OUCC. OUCC witness Alvarez testified regarding Vectren South's proposal to build the gas lateral to serve the CCGT. He testified Vectren South did not include the costs necessary to build the gas lateral in the $781 million CCGT cost estimate and should have.

iii. Industrial Group. Industrial Group witness Gorman also testified regarding Vectren South's proposal to construct a gas lateral to serve the proposed CCGT. Mr. Gorman testified Vectren South's proposal to self-build the gas lateral is not consistent with protecting the public interest and is anti-competitive. He testified that Vectren South should have considered a third party or TGT to develop the gas lateral. Mr. Gorman testified that to the extent TGT can construct a gas lateral at a lower cost than the Vectren South self-build option, then this option should be adopted. Mr. Gorman further testified that Vectren South's proposal to recover the pipeline costs as part of the fuel costs for the CCGT is not reasonable because the fixed cost to build the gas lateral will not vary with energy generation or volume of gas delivered to the CCGT. He testified instead it would be appropriate to allocate the gas lateral cost as part of the CCGT fixed capital cost of the facility and allocate it on a capacity basis.

iv. Coal Parties. ICC witness Medine testified regarding Vectren South's proposal to construct the gas lateral. Ms. Medine characterized Vectren South's proposal as a proposal to build the lateral using an affiliate without competitive bidding. She also criticized Vectren South's decision to self-build the gas lateral instead of soliciting bids from third parties. Ms. Medine testified that Vectren South did not solicit bids for the lateral from third parties, and, therefore, it cannot represent that it was the lowest cost option for the construction of the lateral.

v. Vectren South Rebuttal. Vectren South witness Steve Hoover responded to criticisms raised by the Intervenors related to Vectren South's proposal to construct the gas lateral. Mr. Hoover testified that Ms. Medine's characterization of the proposal as an "affiliate transaction" has no bearing on the overall substance of the proposed transaction because there are many reasons why it is advantageous for Vectren South to construct the gas lateral. He reiterated that the Vectren South engineering, land services, and construction management teams have already successfully completed two similar projects to deliver gas to Duke Edwardsport and IPL Eagle Valley generating units. He testified it is therefore in the best interest of Vectren South's customers for it to enlist the experience and expertise of its gas utility in the pipeline construction and operations. Mr. Hoover also responded to criticisms raised by witnesses Gorman and Medine that the lateral project is anti-competitive and being conducted without competitive bidding. Mr. Hoover testified that Vectren South requested TGT to provide a cost estimate to construct the lateral early in the process, and TGT's cost estimate was 10-15% higher than Vectren South's estimate. He further testified that Vectren South will complete a competitive procurement process to select a contractor to construct the lateral. Mr. Hoover testified that during the course of bidding and the evaluation process, Vectren South will also incorporate cost protections and performance incentives to ensure both competitive and fair pricing.

Mr. Hoover also responded to Mr. Gorman's preference that the lateral be placed in Vectren South's rate base as opposed to the costs being recovered via the Fuel Adjustment Clause ("FAC"). Mr. Hoover testified that like IPL and Duke, Vectren South has chosen to have a qualified local distribution company ("LDC") own and operate its gas delivery pipeline. Therefore, the pipeline will not be an electric utility asset and the costs associated with it will be recovered through gas rates.

As to the allegation that Vectren South's owning the gas pipeline as a gas utility asset is anti-competitive, witness Pergola testified on cross-examination that nearly all of the pipeline (more than 22 of the 23 miles of length) is located in Kentucky and therefore presents no opportunity for bypass, because Vectren South does not possess the right to serve customers in Kentucky.

J. Warrick Unit 4.

i. Vectren South. Mr. Wayne Games testified regarding the uncertain future of Warrick Unit 4. Mr. Games explained that Vectren South and Alcoa co-own the unit pursuant to a Joint Operating Agreement ("JOA") whereby each has 50% ownership in the unit. Mr. Games testified that while Warrick Unit 4 will continue to operate in the near term, the long term outlook for the unit is uncertain. He testified the future of the unit is tied to the Alcoa industrial site, and at any time Alcoa could decide to close the smelter unit, which utilizes significant quantities of electricity produced by Warrick Unit 4, based on price volatility in the aluminum market. He testified that the decision to shut down the smelter unit would jeopardize the future of Warrick Unit 4 and this uncertainty makes it difficult to justify investment in the unit or to depend upon it in the long run.

Vectren South witness Carl Chapman also testified regarding the future of Warrick Unit 4. Mr. Chapman testified that Vectren South has agreed to retain its involvement in the unit through 2023 to support the re-opening of the Alcoa smelter. However, he testified beyond 2023 it does not makes sense to continue to invest in a unit that could be subject to shut down if Alcoa decides it has no continuing need for the capacity.

ii. OUCC. OUCC witness Aguilar testified regarding Warrick Unit 4. Ms. Aguilar testified she does not agree with Vectren South's assessments of the risk of continuing to operate Warrick Unit 4 under the JOA and she disagrees with Vectren South's "presentation of the agreement." She further testified that Vectren South could continue to operate Warrick Unit 4 beyond 2023 with environmental compliance updates.

iii. Vectren South Rebuttal. Mr. Games responded to OUCC witness Aguilar's contention that Vectren South could continue to operate Warrick Unit 4 beyond 2023. He testified that due to compliance requirements coming in Alcoa's next National Pollutant Discharge Elimination System ("NPDES") permit, it is anticipated that the unit will require significant capital investment to meet environmental standards in the future. He testified that these investments coupled with the uncertainty related to whether Alcoa will continue to operate Warrick Unit 4[3] under the JOA and performance issues at the unit, warn against continued reliance on Warrick Unit 4.

Mr. Chapman also testified regarding the continued operation of Warrick Unit 4. He testified that the partnership with Alcoa jointly to operate Warrick Unit 4 has become highly uncertain in terms of duration and no longer represents a viable long-term resource option. Mr. Chapman further testified that while Vectren South's IRP recommended retirement of Warrick Unit 4 well before 2023, Vectren South examined each of the coal units to determine whether such units should be retained. He testified that while Culley 3 and Warrick Unit 4 had better profiles in terms of environmental equipment as compared to Vectren South's other units, Culley 3 ultimately had a better operating history based on cost, availability and heat rate. Mr. Chapman reiterated that a strike against continued operation of Warrick Unit 4 is the uncertainty surrounding the longevity of the Alcoa partnership. He reiterated the continued operation of Warrick Unit 4 is dependent on the aluminum market, and if Alcoa's industrial operations cease at the site, the environmental requirements facing Warrick Unit 4 will become significantly more stringent. Mr. Chapman ultimately testified the bottom line is assuming Warrick Unit 4 can continue on post-2023 presents great risk.

As noted previously, in response to our Docket Entry question seeking additional modeling of a portfolio with delayed retirement of Warrick Unit 4, Vectren South indicated that an additional capital investment cost of as much as $50 million may be required to retain the unit if IDEM determines not to renew a variance in the unit's current NPDES permit that allows water discharge at a higher temperature. The new draft renewal NPDES permit allows IDEM to terminate this variance at any time, which will likely require the construction of a cooling tower. Coupled with both Alcoa's and Vectren South's ability to terminate the joint operating agreement, this even further increases the risk of reliance on Warrick Unit 4 beyond 2023.

K. Culley Unit 3. While making investments to preserve some coal-fired generation is not part of the lowest NPV under the 2016 IRP modeling, Vectren South proposes to make investments at Culley Unit 3, its most efficient plant, in order that it may continue to operate beyond 2023. This decision became part of the preferred portfolio as a result of the risk assessment in the 2016 IRP. Preserving Culley Unit 3 promotes greater diversity in fuel sources and it also lessens the impact on the local coal industry. Witness Retherford described the environmental controls that are needed as a result of CCR and ELG. The Culley 3 Compliance Projects consist of (1) conversion of the current wet bottom ash collection system to a dry handling bottom ash system; (2) installation of a spray dryer evaporator system; and (3) the closure of the Culley West ash pond and construction of a new lined process water and storm water retention pond in its place. This new retention pond will be constructed on the location of the existing ash pond due to space limitations. Witness Fischer developed the cost estimates for the former two and Ms. Retherford provided the cost estimate for the latter. Recovery of the associated costs through a rate adjustment mechanism under Ind. Code ch. 8-1-8.4 was opposed by OUCC witness Aguilar and Industrial Group witness Gorman.

[3] With proper notice, Alcoa can also terminate the JOA.

4. Pending Summary Judgment Motion and Motion to Dismiss under T.R. 41(B). On July 19, 2018, the Coal Parties, Joint Intervenors, Evansville Western Railway, the OUCC, and the Industrial Group filed a Motion for Summary Judgment asking the Commission to vacate the schedule, arguing that we cannot grant Vectren South's request for authority to construct facilities until we have completed a "final" statewide analysis pursuant to Ind. Code § 8-1-8.5-3(a). Alternatively, the Movants asked us to grant them an extension of time to file their pre-filed testimony until at least 45 days after we post a "final" statewide analysis. We took the matter under advisement. At the conclusion of Vectren South's case-in-chief, Alliance Coal made an oral motion to dismiss under T.R. 41(B) on the same grounds. The T.R. 41(B) motion was joined by the OUCC and all of the other Movants except the Industrial Group and Evansville Railway.

In construing a statute, we start with its plain language and "attempt[] to give words their plain and ordinary meanings." *Indiana Wholesale Wine & Liquor Co., Inc. v. State ex rel. Indiana Alcoholic Beverage Com'n*, 695 N.E.2d 99, 103 (Ind., 1998) (citations omitted). "[I]n seeking to give effect to the legislature's intent, [the court] read[s] an act's sections as a whole and strive[s] to give effect to all of the provisions so that no part is held meaningless if it can be reconciled with the rest of the statute." *Fort Wayne Patrolmen's Benev. Ass'n, Inc. v. City of Fort Wayne*, 903 N.E.2d 493, 497 (Ind. Ct. App., 2009) (citation omitted).

The Motion is based primarily on Section 3(a) of Ind. Code § 8-1-8.5, which provides that "[t]he Commission shall develop, publicize, and keep current an analysis of the long range needs for expansion of facilities for generation of electricity," and Section 3(c), which provides that "[t]he commission shall consider the analysis in acting upon any petition by any utility for consideration." The Movants interpret these provisions to mean that we cannot consider a certificate of public convenience and necessity ("CPCN") request absent a "final" statewide analysis. We disagree.

Neither provision requires or implies there must be a "final" or conclusive statewide analysis. Nor does any other provision in Chapter 8.5. Section 3 directs us to undertake an "analysis" that is subject to ongoing review and revision. An analysis that must remain "current" cannot possibly remain static or culminate in a finished product. We find that the analysis detailed in the draft and final versions of the Statewide Analysis meets the requirements of the statute.

To the extent the Movants argue that we cannot grant Vectren South's Petition until we complete our annual report on the analysis, their Motion also fails.

Section 3(h) requires us "[e]ach year" to "submit to the governor and to the appropriate committees of the general assembly a report of its analysis regarding the future requirements of electricity for Indiana or this region." Ind. Code § 8-1-8.5-3(h). Section 5(b)(2) provides that a certificate may be granted if the Commission finds the project (A) "will be consistent with the Commission's analysis (or such part of the analysis as may then be developed, if any)"; or (B) is "consistent with a utility's specific proposal submitted under Section 3(e)(1) of this chapter and approved under subsection (d)." Ind. Code § 8-1-8.5-5(b)(2)(A) and (B).

This unambiguous language reflects the Legislature's understanding that new generation needs may arise at a time while the analysis or even the annual report is being developed or under revision. The Legislature granted the Commission authority to issue a CPCN rather than hold the request in abeyance until the annual report is issued.

It must be presumed that "'the legislature intended the language used in the statute be applied logically and not to bring about an unjust or absurd result.'" *D.B. v. Review Bd. of Indiana Dept. of Workforce Development*, 2 N.E.3d 705, 710 (Ind. Ct. App., 2013) (quoting *Penny v. Review Bd. of Ind. Dep't of Workforce Dev.*, 852 N.E.2d 954, 960 (Ind. Ct. App., 2006), trans. denied). Reviewing bodies also avoid "interpreting a statute in such a manner as to render its provisions mere surplusage." *Id.* (citing *In re Adoption of D.C.*, 887 N.E.2d 950, 959 (Ind. Ct. App., 2008). The Legislature cannot have meant for the Commission to hold off assessing petitions until its analysis becomes "final" (which will never occur), or even until its annual report is submitted. Thus, the statute is clear that in considering a CPCN request, pursuant to Section 5(b)(2) we can rely on whatever current statewide analysis exists or simply determine whether the proposal is consistent with the utility's own plan and reports.

In sum, the Commission retains authority to review a project at any time. Ind. Code § 8-1-8.5-5.5 expressly allows us to "commence a review of any certificate granted under this chapter" when, "in the opinion of the commission, changes in the estimate of the probable future growth of the use of electricity" call for such review. Further, "[i]f the commission finds that completion of the facility under construction is no longer in the public interest, the commission may modify or revoke the certificate." Id.

For all of the foregoing reasons, and each of them, the Motions for Summary Judgment and for Dismissal under T.R. 41(B) are denied.

5. Commission Discussion and Findings.

A. Vectren South's Request for a CPCN for a CCGT. Vectren South requests a CPCN for a proposed CCGT (approximately 850 MW) to be constructed at the current site of the A.B. Brown power plant in Posey County. Under Chapter 8.5, a public utility may not begin the construction, purchase or lease of any steam, water, or other facility for the generation of electricity to be directly or indirectly used for the furnishing of public utility service without first obtaining from the Commission a certificate that public convenience and necessity requires, or will require, such construction, purchase or lease.

In considering a CPCN request, Chapter 8.5 requires the Commission to consider options other than the construction, purchase, or lease of an electric generating facility. *See* Ind. Code § 8-1-8.5-4.

Further, Ind. Code § 8-1-8.5-5 sets forth specific findings the Commission must make in order to approve and grant the requested CPCN. First, the Commission must make a finding, based on the evidence of the record, as to the best estimate of construction costs. Second, the Commission must find that either (a) construction will be consistent with the Commission's Statewide Analysis, if any, for the expansion of electric generation facilities, or (b) the proposed construction is consistent with a utility-specific proposal as to the future needs of consumers in the State of Indiana or in the petitioning public utility's service area [i.e., the utility's IRP]. Third, the Commission must find that public convenience and necessity require the facilities for which the CPCN is requested.[4]

[4] A fourth finding relating to coal-consuming facilities, pursuant to Ind. Code § 8-1-8.5-5(b)(4), does not apply to the proposed natural gas facilities.

"We have indicated in previous CPCN cases that 'least-cost planning' is an essential component of our [CPCN] law." *Joint Petition of PSI Energy, Inc. and CINCAP VII, LLC*, Cause No. 42145, at 4 (IURC Dec. 29, 2002), *quoting Southern Indiana Gas & Electric Co.*, Cause No. 38738, at 5 (IURC Oct. 25, 1989). "We have defined 'least-cost planning' as a 'planning approach' which will find the set of options most likely to provide utility services at the lowest cost once appropriate service and reliability levels are determined." *Id.* "However, we have emphasized that the [CPCN] statute does not require the utility to automatically select the least cost alternative. Nor does the statute require the utility to ignore its obligation to provide reliable service or to disregard its exercise of reasonable judgment as to how best to meet its obligation to serve." *Id.* As this Commission has previously ruled: "[i]f an Indiana utility reasonably considers and evaluates the statutorily required options for providing reliable, efficient, and economic service, then the utility should, in recognition that it bears the service obligations of IC 8-1-2-4, be given some discretion to exercise its reasonable judgment in selecting the option or options to implement which minimize the cost of providing such service." *PSI Energy, Inc.*, Cause No. 39175, at 14 (IURC May 13, 1992); *see also Joint Petition of PSI Energy, Inc. and CINCAP VII, LLC*, Cause No. 42145, at 4.

The pre-approval of long-lived power plant investment and the concurrent regulatory assurance of that investment's recovery is, at its base, the creation of fixed costs that customers will be required to pay several years into the future, perhaps as long as 30 years or more into the future. Accordingly, our consideration in this and other pre-approval requests, especially in periods of seemingly quickening technological change, must not ignore the risk that any such investment may become uneconomic over the long-term. We must acknowledge that the economic forces at work may come from other supply side options or even demand side opportunities. The supply side and demand side certificating statutes implicate this by recognizing that an optimal balance of energy resources should consider both aspects in meeting customer needs.[5] A complication in the optimizing effort is the often disparate time horizons of the supply and demand sides of the balance. The inability to adjust the long-lasting nature of the supply side of the equation in the event market conditions or demand side expectations change in a lesser time horizon introduces a risk that some measure of the supply side investment may become uneconomic within its lifetime.[6] Demand side efforts by customers as a result of the uncontroverted improving economics of customer-scale generation resources may further compound the challenge of the optimal balancing act. Reducing demand in the near term does not necessarily correspond with reduced assured supply side investment cost recovery.[7] Because unwinding assured cost recovery should an asset become uneconomic is not a commonly employed regulatory option, it is prudent to ensure during the pre-approval process that we understand and consider the risk that customers could sometime in the future be saddled with an uneconomic investment. Outcomes that reasonably minimize such potential risk and serve to foster utility and customer flexibility in an environment of rapid technological innovation on both the utility and customer side of the meter are, therefore, a lens through which we will review Vectren South's request.

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[5] Indiana Code §§ 8-1-8.5-4 and -10(c)(3).

[6] This effect can be see through the recovery of lost revenues a statutory component of utility DSM programs, which is in part a function of investment, of fixed cost, that is not being consumed at the expected rate.

[7] This timing inconsistency can reduce the value of demand side efforts because they are not avoiding long-lived fixed costs previously approved and included in rates. The full incremental impacts of demand side actions which occur after the approval of long-lived fixed costs are only affected over longer periods of time when future resources must be acquired and the timing and type of resource might change as a result of cumulative demand side activities.

i. Ind. Code §§ 8-1-8.5-4.

(1) Ind. Code § 8-1-8.5-4(1). In evaluating a utility application for approval to construct new generation, the Legislature has directed us to take into account the utility's "current and potential arrangements with other electric utilities for (A) the interchange of power; (B) the pooling of facilities; (C) the purchase of power; and (D) joint ownership of facilities."

As a member of MISO, Vectren South interchanges power on a daily basis, and Vectren South's modeling considered and factored this arrangement into its decision to seek a CPCN. In addition, early in its resource selection process Vectren South identified a potential partner for a joint generation project. Witness Luttrell explained that this partner was interested in owning a minority share of a larger CCGT, and agreed to study locating such a unit on Vectren South's system. As studies ensued, the partnership appeared to be a viable resource option. As a result, the parties studied this joint ownership opportunity throughout 2017, but ultimately in January 2018 the potential partner provided notice that it would not proceed with such a project. Both Vectren South and the Commission have considered the interchange of power and pooling of facilities.

When assessing a CPCN petition, the Commission also considers the potential purchase of power by Vectren South. On June 20, 2017, Vectren South issued a RFP for dispatchable resources located in MISO Zone 6. Vectren South explained that its RFP specified this location requirement in order to satisfy MISO's requirement that a load serving entity have at least 67% of its resources located within its zone. The RFP sought dispatchable resources based upon the 2016 IRP analysis, which recommended that Vectren South retire nearly all of its baseload coal-fired capacity by the end of 2023. As a result, the RFP was designed to solicit baseload capacity to replace the 730 MWs provided by the retiring coal units. In response, Vectren South received nine qualified bids offering both PPAs and offers to build a CCGT and sell that unit or a partial interest in that unit to Vectren South. Using the expertise of Burns & McDonnell ("BMC"), Vectren South evaluated both quantitative and qualitative aspects of the competing bids. Based on BMC's analysis of the levelized cost of energy ("LCOE") of the bids, Vectren South selected the bid with the most favorable LCOE to compare to a self-build option. BMC's analysis was that Vectren South's self-build option had a better net present value than this best bid, and also exposed Vectren South to less risk versus long-term reliance on a merchant developer. Vectren South's rebuttal testimony noted that the merchant developer in question had in fact, even prior to its bid submission, withdrawn its project from the MISO queue without informing Vectren South.

The Commission acknowledges Vectren South's issuance of an RFP but believes the RFP was unduly restrictive given the rapid changes in technology and costs being seen in the market, especially regarding renewable energy. The narrow RFP with its focus on a large baseload dispatchable resource limited the options Vectren South evaluated to those larger than 600 MW. As a result, Vectren South foreclosed consideration of combinations of smaller resources that might have offered greater resource diversity, flexibility and cost efficiencies than reliance on the acquisition of a single large natural-gas facility. As discussed further below, expansion of the RFP to consider a broader spectrum of resource options would have also gone a long way to improve the metrics to limit risks from exposure to changes in market conditions and technologies.

Based on Vectren South's unduly restrictive RFP the Commission cannot conclude that Vectren South thoroughly evaluated the purchase of power in connection with Vectren South's request.

(2). Ind. Code § 8-1-8.5-4(2).

(a) The Refurbishment of Existing Facilities. In acting upon a petition for the construction of an electric generation facility, we must consider other methods for providing reliable, efficient, and economical electric service, including the refurbishment of existing facilities. Ind. Code § 8-1-8.5-4(2). Ms. Aguilar summarized the following alternatives that Vectren South failed to fully analyze: (1) Retain Coal at Vectren South's existing plants and invest in refurbishments; (2) Retain the agreement with Alcoa for Warrick Unit 4; (3) Refuel the A.B. Brown unit(s) with gas; (4) A blended option, such as refueling one or more A.B. Brown units to gas and building a smaller CCGT; (5) Enter into a PPA with one of the bidders who responded to Vectren South's RFP; and (6) Retain its Broadway Avenue Unit 2. Pub. Ex 1, p. 8. Ms. Aguilar argued that Vectren South unfairly screened out these alternatives during the IRP process.

We agree with Ms. Aguilar and Dr. Boerger that Vectren South did not fully consider options to extend the life, or refurbish, existing units as required by Ind. Code § 8-1-8.5-4(1). *Id.* and Pub. Ex. 3, p. 6. This failure began during Vectren South's IRP process, when Vectren South screened out, without further study, viable refurbishment options. Pub. Ex. 1, p. 11. Vectren South's stated reason for shutting down the A.B. Brown units is premised on the need to replace the flue-gas desulfurization ("FGD") units at a cost of approximately $350 million. Pub. Ex. 3, p. 7. Dr. Boerger stated that with the exception of the current FGDs, the units operate quite well and are sized appropriately for a small utility like Vectren South. But as noted by Ms. Aguilar and Dr. Boerger, Vectren South's chosen FGD replacement technology was the most expensive and only technology reviewed. *Id.,* Pub. Ex. 3. Dr. Boerger pointed out that Vectren South did not consider lower-cost FGD replacement options, even though such options were available. He said that this decision made the continued use of the A.B. Brown units look less attractive in modeling than if those options had been included. A reasonable alternative would have been the refurbishment of these units through refueling. Pub. Ex. 3, p. 7. Refueling is viable, proven technology that could be accomplished at a fraction of the price of the CCGT – approximately $45 million for both A.B. Brown units.

Vectren South considered a smaller 440 MW CCGT option in its last IRP, but Vectren South did not include it as part of any refueling options. Pub. Ex. 3, p. 9. Further, when Vectren South issued its RFP, it did so for 600-800 MW of dispatchable power, precluding smaller units that might have combined with refurbishment of other Vectren South units. Tr. B-25 - B-26. Vectren South did not fully model the conversion of one of the A.B. Brown units in its rebuttal testimony. Tr. E-45 – E-46.

On cross-examination, Vectren South witness Mr. Swiz estimated that the value of the stranded assets at the A.B. Brown unit alone will equal $220 million and that the system-wide total will be $270 million. While Vectren South argues that the CCGT option is the lowest cost, we find for the many reasons stated throughout this Order, including Vectren South's failure to sufficiently consider the refurbishment and continued operation of its existing facilities, we are not able to verify this claim. Through the lens of minimizing risk and providing future flexibility the refurbishment option would seem to provide a potential bridge to the future, providing system capacity value that was not sufficiently evaluated. This conservative solution and risk avoidance strategy stands in stark contrast to proposed CCGT. Vectren South plans to submit a new IRP in 2019. We instruct Vectren South to closely consider our analysis in this Order and the Director's Report on the 2016 IRP of the flaws in their modeling for the 2016 IRP and the 2017 IRP Update and to present a more thorough analysis that fully evaluates all possible options for continuing to provide reliable, efficient, and economical electric service.

(b) Conservation and Load Management. The evidence demonstrates that Vectren South has evaluated the CCGT against other reasonable generation alternatives, and included demand side management and energy efficiency ("DSM/EE") levels consistent with the targets approved in Cause No. 44927. Vectren South's modeling concludes that, even when the cost of energy efficiency has been significantly lowered, the CCGT is still the least cost reliable resource alternative to meet Vectren South's customers' future energy resource needs.

The Joint Intervenors criticize the assumptions used by Vectren South to model the cost of DSM/EE, arguing that the assumptions used by Vectren South were too high resulting in a higher cost of DSM/EE. Ms. Harris stated in her rebuttal that for purposes of this proceeding, Vectren South opted only to update its growth factors in its revised cost analysis in order to show the impact lower DSM/EE costs would have on the energy resources selected in its IRP. Ms. Harris explained that limiting the updates to the growth factors preserved the integrity of Vectren South's 2016 IRP. Petitioner's Exhibit No. 8-R, p. 3. We find that while some of the cost assumptions used by Vectren South could have been updated, on the whole it does not render Vectren South's analysis of DSM/EE unreasonable.

(c) Cogeneration and Renewable Energy Sources. Vectren South's IRP modeling process considered the potential for cogeneration facilities to serve its customers and adjusted its load forecast to reflect the potential for cogeneration facilities. Petitioner's Exhibit No. 5, Attachment MAR-1, pp. 99-103. Consequently, the potential for customer-owned generation resources, including renewable generation, to reduce Vectren South's load was evaluated as part of the IRP process that concluded the CCGT was necessary as part of least-cost planning. Nonetheless, while Vectren South may have considered renewable energy in the IRP, there is a lack of evidence that Vectren South made a serious effort to determine the price and availability of renewables. In addition, the economics of customer-scale renewable and cogeneration facilities appears likely to continue to improve and we anticipate that additional well-developed efforts to understand their customers' interest would serve to provide clarity to the lens of risk avoidance by minimizing the potential for unexpected demand side efforts. Therefore, we would expect Vectren South to ensure an enhanced consideration of renewable energy and customer-generator opportunities in future IRPs.

(3) Ind. Code § 8-1-8.5-5. A certificate may be granted only if the Commission makes the followings findings:

(a) Best estimate of construction, purchase, or lease costs based on the evidence of record. The cost estimates for Vectren South's proposed CCGT were developed and presented by witness Diane Fischer. Black & Veatch developed a design basis and conceptual design and thereafter developed a cost estimate. Several conceptual designs were first developed. From that, ten plant alternatives for purposes of estimating costs were identified. This was later narrowed to seven alternatives for which detailed costs were developed. Competitive bids were obtained for the equipment and materials. Based upon Black & Veatch's experience as an engineering, procurement and construction ("EPC") contractor, Black & Veatch was able to estimate indirect costs, contingency, overhead, and profit for the EPC contractor. Bids were also received for construction. Ultimately, Ms. Fischer testified that the cost estimate for the proposed CCGT had been refined to +/- 10%. The total estimated project cost (excluding owner's costs) was $582,000,000. The owner's costs were then provided by witness Games, including insurance, contingency, study, and AFUDC. The total cost estimate was $781,000,000.

(b) Consistency of the CCGT with Vectren South's Utility-Specific IRP and the Statewide Analysis. Ind. Code § 8-1-8.5-5(b)(2)(A) directs the Commission to determine whether Vectren South's proposed construction of a new CCGT will be consistent with the Commission's 2018 Statewide Analysis. The final version of that report was issued after the parties' pre-filing deadline, but before the evidentiary hearing and was admitted into evidence as Pet. Admin. Not. Ex. 2. Included in that report is a synopsis of information taken from the most recent IRP projects of Indiana utilities, including Vectren South.

In Appendix 12 of the Statewide Analysis, the concept of Resource Diversity is explained:

> In an electric system, resource diversity may be characterized as utilizing multiple resource types to meet demand. A more diversified system is intuitively expected to have increased flexibility and adaptability to: 1) mitigate risk associated with equipment design issues or common modes of failure in similar resource types, 2) address fuel price volatility, and 3) reliably mitigate instabilities caused by weather and other unforeseen system shocks. In this way, resource diversity can be considered a system-wide tool to ensure a stable and reliable supply of electricity. Resource diversity itself, however, is not a measure of reliability. Relying too heavily on any one fuel type may create a fuel security or resilience issue because the level of resource mix diversity does not correlate directly with a resource portfolio's ability to provide sufficient generator reliability attributes.

Vectren South's proposal to concentrate its base load capacity from five different generating units located at three different sites down to just three generating units (one of them constituting 70% of Vectren South's baseload capacity) located at two sites appears to be contrary to the concept of resource diversity.

On page 5 of the 2018 Statewide Analysis it says:

> A key consideration in long-term resource planning is the need to retain maximum flexibility in utility resource decisions to minimize risks. An IRP developed by a utility should be regarded as illustrative and not a commitment for the utility to undertake.

In explaining the importance of sound long-range planning on page 56 of the 2018 Statewide Analysis, it says, "[t]he credibility of the analysis is critical to the efforts of Indiana utilities to maintain as many options as possible, which includes off ramps, to react quickly to changing circumstances and make appropriate changes in the resources." However, we find nothing in Vectren South's evidence convinces us that its proposal provides any off ramps that would allow Vectren South to react to changing circumstances and make appropriate changes in resources. To the contrary, Vectren South's proposal seems to close most off ramps for the foreseeable future.

The parties offered diametrically opposed views on the modeling offered to support the CPCN, with Vectren South pointing to its CCGT conclusion as consistent with its IRP. But that conclusion is but one part of the analysis. We have criticized utilities in the past for modeling infirmities and even penalized a utility for analysis we found lacking. In IPL's MATS case, we ordered a $10 million credit to customers to "send[] an appropriate message" to the utility. *Indianapolis Pwr. & Light Co*., Cause No. 44242, 2013 WL 4479081 *38, 307 P.U.R.4th 311, Order p. 36 (IURC Aug. 14, 2013). We found IPL's cost/benefit study "disappointing" and noted our own "responsibility to insure that the regulatory process involves the presentation of the best evidence possible, given the facts and circumstances of a particular case." *Id.* at 35.

At the outset, Mr. Games testified that Vectren South sent a request for information ("RFI") to original equipment manufacturers ("OEM") for CCGT pricing information before Vectren South's 2016 IRP. Tr. E-89 – E-91. Mr. Chapman stated that under any of the IRP models, the CCGT is the least expensive. Tr. A-27 - A-28.

Dr. Boerger testified that Vectren South did not consider other viable options such as refueling and smaller combinations of generation assets to meet its needs, Pub. Ex. 3, p. 1 – p. 2, which would be more prudent for a small utility like Vectren South. Pub. Ex. 3, p. 5. Vectren South excluded possible options such as maintaining Culley 2, Pub. Ex. 3, pp. 11-12, and did not allow the refueling of the A.B. Brown units to be included in any of its model runs. *Id.* Vectren South kept a smaller, 440 MW CCGT from being combined with a refueled A.B. Brown unit. Pub. Ex. 3, p. 13. Mr. Games admitted that Vectren "never [ran] a risk analysis of portfolios including a 1 X 1 CCGT instead of a 2 X 1[.]" Tr. E-50. Vectren South also did not allow for proposals of joint projects to be built at it's A.B. Brown site, which would eliminate the potential for congestion problems Vectren South identified as a problem in its RFP responses. Vectren South's Strategist model limited the amount of capacity purchases that a given portfolio could make. Tr. D-73. This had the effect of automatically screening out PPAs that could have been combined with other resources to meet Vectren South's capacity needs. The Director's Report on Vectren South's 2016 IRP noted that Vectren South failed to model a wide range of gas prices, making the "range of fuel price projections… unduly limited[,]" Tr. D-85, and Vectren South's re-run of gas costs did not model higher prices in a wide enough range. Tr. D-86. As noted by Mr. Alvarez, Vectren South's model retired the BAGS 2 unit in 2024 without evidence of any engineering reason to do so. Pub. Ex. 2, pp. 13-14.

Dr. Boerger also found that Vectren South modeled the cost of its proposed CCGT to be $200 million less than the cost of the project presented in the testimony of Vectren South witness Games. Pub. Ex. 3, p. 2. The consequence of excluding $200 million in Vectren South's NPV calculation had the effect of making the CCGT option look more favorable. Pub. Ex. 3, p. 14. Without adding the $200 million back into the model runs, Vectren South's analysis is skewed. Pub. Ex. 3, p. 18 – p. 19. Mr. Games admitted that his testimony about the estimates was confusing, stating "[w]e started off with 2017 dollars, and those were -- then overheads were added, anticipated profit with the EPC, contingency for EPC, and escalation was added to get to the 582 million." Tr. E-15 – E-16. Mr. Lind took issue with Dr. Boerger's analysis, but admitted that Vectren South did not include $130 million in owner's costs when it compared its self-built CCGT to other options offered in the RFP and otherwise. Tr. A-36 – A-38; Tr. D-7 – D-8. When questioned why BMC did not use the $781 million figure, Mr. Lind stated that the $630 million estimate used for modeling was a +/- 50% estimate; the $781 million had a more certain +/- 10% range of accuracy. Tr. A-35; Tr. C-61 - C-62, C-74. BMC's projected cost of $580 - $650 million was used to weigh the economics of potential projects. Tr. A-

36 – A-38. And Vectren South witness Mr. Vicinus ran his "low regulatory" model using the $630 million estimate. Tr. D-98.

In response to the OUCC's criticism of its modeling, Vectren South's rebuttal included a new model run that refueled one of the A.B. Brown units, and added 200 MW of solar. Tr. D-12 – D-13. Vectren South used this rebuttal modeling to try to reinforce its original request for a 850 MW CCGT. Both Mr. Lind and Mr. Games acknowledged, however, that the addition of 200 MW of solar was not the best choice to meet MISO's PRM, because MISO would only give Vectren 100 MW of credit for the 200 MW of solar. Tr. E-15. The revised model also did not take into account the fact that solar costs between $1,200 - $1,800 per MW, Tr. D-16 – D-17, and Vectren South did not model any storage to counter the inherent intermittency of solar resources. Tr. D-14.

While we find Vectren South's request is "consistent" with its 2016 IRP, the subsequent modeling for this case effectively screened out multiple less-expensive alternatives. Vectren South did not allow its models to choose refueling or smaller units in combination. While Vectren South's rebuttal modeling runs included refueling of the A.B. Brown units in various configurations, the rebuttal modeling was not used to make Vectren South's decision of what generation form to choose. Tr. D-14. We view the rebuttal modeling as an after-thought used to buttress Vectren South's initial request.

Vectren South had sufficient time to conduct its analysis in a way more open to smaller-scale options that would correct the modeling deficiencies that have been identified. It seems straight-forward to suggest that smaller-scale options, especially for a relatively small electric utility, serve to minimize the risk should a challenge arise at any one option. As noted above, minimizing supply side long-term investment risk in an environment of rapid technological innovation is an attractive characteristic in a utility resource proposal. Vectren South should use its scheduled 2019 IRP process to address problems in its modeling, incorporate more options for partnering with other entities and competitive inquiries into smaller-scale options that can be acted upon swiftly to meet the end-of-2023 date upon which additional capacity may be needed.

(c) Public Convenience and Necessity. Ind. Code § 8-1-8.5-5(b)(2) requires that we find that public convenience and necessity requires or will require the proposed CCGT. Such consideration of the public interest is not only a statutory requirement at the outset but would become a continuing obligation should the Commission grant a CPCN. Ind. Code § 8-1-8.5-5.5 provides that if, after granting a CPCN for construction of a new generator, "the commission finds that completion of the facility under construction is no longer in the public interest, the commission may modify or revoke the certificate."

"[P]ublic interest may be taken to encompass a wide range of considerations, from environmental, health, and safety concerns, to the financial concerns of employers, employees, and ratepayers." *General Motors Corp. v. Indianapolis Power & Light Co.*, 654 N.E.2d 752, 762 (Ind. Ct. App., 1995). In *General Motors*, the court approved the Commission's consideration of the impact on employment in the coal industry in its public interest determination. *Id.*

The parties dispute whether Vectren South accurately and adequately evaluated risk in its analysis of alternative portfolios and selection of the proposed CCGT. As noted earlier, under Ind. Code § 8-1-8.5-4, we are required to take into account other methods for providing reliable, efficient, and economical service, and we find utility risk analyses play an important role in comparing alternative portfolios.

Joint Intervenors argued that Vectren South's risk analysis is inadequate for multiple reasons. Joint Intervenors note that the risk analysis has not been updated since the 2016 IRP, despite Vectren South having updated inputs available for several inputs, including the estimated cost of its preferred build, and adequate time to re-run the model. Joint Intervenors complain that Vectren South ignored known material risks in a manner that biased results in favor of its preferred portfolio, including taking a one-sided view of capacity purchase and market purchase risks and failing to consider the potential for future methane regulations. Joint Intervenors further argue that Vectren South arbitrarily scored several metrics and designed others to conceal rather than measure obvious risks of the preferred portfolio.

We find merit in several of Joint Intervenor's critiques and are further concerned that Vectren South has not fully responded to critiques in the Final Director's Report on the 2016 IRPs. We agree that Vectren South had adequate time and opportunity to update its risk analysis modeling prior to this filing, and that it has sufficient time to do so now before moving forward. Vectren South updated inputs in its possession for multiple factors, including: solar capital costs; variable production costs and revenue requirement assumptions for existing units; forecasted cost for wholesale market capacity and energy; delivered fuel prices for gas and coal; and costs associated with new energy efficiency programs. Pet. Ex. 6 at 9-10. Vectren South also had a higher capital cost estimate for its preferred build. We know Vectren South had time to use these inputs to re-run the model because (a) it did just that with some of its Strategist modeling and (b) Mr. Vicinus testified that it would have taken just three months to re-run the risk analysis modeling. Tr. p. D-66. Mr. Vicinus opined that updated risk modeling would not change the result, but we are skeptical given the number and import of the updated inputs and the significance of the proposed portfolio changes. *See Indianapolis Pwr. & Light,* Cause No. 44339, 2014 WL 2091348, Order p. 27 (IURC May 14, 2014) ("[W]e believe that IPL could have reasonably updated the [model] given the extent of changes in data inputs and assumptions and provided a more robust analysis."). Before proposing a portfolio change of this magnitude, Vectren South should have taken the three months necessary to update its risk analysis modeling. Updated risk modeling may not be necessary in all cases, but it is warranted here given the size and cost of the proposed CCGT.

We are further concerned that Vectren South appears not to have accounted for material risks associated with its preferred portfolio. As we have previously stated, "it is appropriate that modeling take into consideration reasonable risks and unknowns." *Indianapolis Pwr. & Light Co.*, Cause No. 44794, 2017 WL 1632316, Order p. 28 (IURC Apr. 26, 2017). Joint Intervenors point out that Vectren South's risk analysis took a one-sided view of capacity purchase and market purchase risks. *See* JI Ex. 2 at 43; Vicinus Rebuttal. Vectren South offered no rebuttal explaining its one-sided view of market risk, which assumed surplus capacity and generation offers only benefits to ratepayers. JI Ex. 2 at 20-21. That view of market purchases is only true when market prices and/or load are high. JI Ex. 2 at 21. Further, Vectren South's Docket Entry response of October 5, 2018, presents portfolio results that suggest the material weight at which opportunity sales influences the analysis.[8] Heavy dependence on market revenues to support a regulated investment choice is a speculative influence that we find must be materially discounted to limit the risk of customers being saddled with

[8] The submitted table indicates that the advantage of the Preferred Portfolio in comparison to (1) BAU to Gas Conversion escalates from 1.3% to 3.5% when the opportunity sales sharing moves from 50% to 100%.

uneconomic options should such speculation unfold differently than forecasted. A metric biased in favor of portfolios with surplus generation is speculation we decline to embrace.

Vectren South's own witnesses and others acknowledged risks related to relying on gas generation, but Vectren South only considered carbon dioxide emission reductions when it evaluated environmental risk. We agree that was too narrow an approach to environmental risk and one that biased the analysis in favor of gas-fired generation.

The Commission appreciates the metrics developed and used by Vectren South in the 2016 IRP, but we agree with the Joint Intervenors that the use of these particular metrics also obscured critical characteristics of the preferred portfolio. One of Vectren South's IRP objectives was to develop a plan with flexibility to adapt to market conditions and technological change to minimize risks to shareholders and customers. Specific metrics to measure resource portfolio balance and flexibility included concentration on one technology, the number of technologies and having resources remote from Vectren South's load. A critical piece of information these metrics overlook is that the acquisition of an 850 MW resource must be evaluated relative to the load to be served. Vectren South's 2016 IRP Base peak load forecast is for the summer peak to increase from 1,109 MW in 2019 to 1,198 MW in 2036. The acquisition of an 850 MW generation facility represents approximately 77 percent of the 2019 peak load and just under 71 percent of the summer peak load for 2036. We are hard pressed to see how reliance on one facility for so much of the Vectren South system requirements is consistent with maintaining flexibility to respond to changing market conditions and technological change.

Therefore, we conclude that Vectren South's risk analysis does not adequately consider the relative risk of other methods for providing reliable, efficient, and economical electric service. The proposed large scale single resource investment for a utility of Vectren South's size does not present an outcome which reasonably minimizes the potential risk that customers could sometime in the future be saddled with an uneconomic investment or serve to foster utility and customer flexibility in an environment of rapid technological innovation. As a result, we find that Vectren South has not demonstrated through the evidence of record that the public convenience and necessity require the building of an 850 MW CCGT. Therefore, Vectren South's request for a CPCN to construct a 850 MW CCGT is denied.

B. <u>Vectren South's Request for a CPCN for Culley compliance projects and related relief</u>. Vectren South's preferred portfolio also includes the construction of various environmental projects that Vectren South contends are needed so that Culley Unit 3 can continue to operate beyond 2023. Vectren South's petition seeks relief for these projects under Ind. Code ch. 8-1-8.4 as "federally mandated" projects.

i. <u>Ind. Code ch. § 8-1-8.4 ("Chapter 8.4")</u>.

(1) <u>Federally Mandated Requirements (Ind. Code §§ 8-1-8.4-5 and 8-1-8.4-6(b)(1)(A) and 8-1-8.4-7(b)(3))</u>. Ind. Code § 8-1-8.4-5 defines a federally mandated requirement to include "a requirement that the commission determines is imposed on an energy utility by the federal government in connection with any of the following: (2) The federal Water Pollution Control Act (33 U.S.C. 1251 *et seq.*)" and also includes "(7) Any other law, order, or regulation administered or issued by the United States Environmental Protection Agency, the United States

Department of Transportation, the Federal Energy Regulatory Commission, or the United States Department of Energy."

The description of the Culley 3 Compliance Projects was set forth in the direct testimonies of Ms. Fischer and Ms. Retherford. The Culley 3 Compliance Projects consist of (1) conversion of the current wet bottom ash collection system to a dry handling bottom ash system; (2) installation of a spray dryer evaporator system; and (3) the closure of the Culley West ash pond and construction of a new lined process water and storm water retention pond in its place. This new retention pond will be constructed on the location of the existing ash pond due to space limitations. No party disputed that the dry handling bottom ash conversion or spray dryer evaporator system qualify as compliance projects to meet federally mandated requirements. The OUCC challenged whether the closure of the existing pond qualified for relief but did not contend that it was not federally mandated. For the reasons described below, we find that these projects all constitute compliance projects to meet federally mandated requirements as those terms are defined in Ind. Code §§ 8-1-8.4-2 and -5.

Vectren South witness Retherford testified that the dry handling bottom ash system is required to comply with the ELG Rule, which was promulgated under the federal Water Pollution Control Act. Petitioner's Exhibit No. 9, p. 11. The ELG rule prohibits further wet handling of fly and bottom ash. This system will enable ash from Culley Unit 3 to be disposed of in a landfill, hauled back to a surface mine in accordance with applicable surface mining regulation or recycled rather than being washed into the ash pond as part of a water discharge.

Ms. Retherford further explained that the spray dryer evaporator system was necessary to ensure compliance with ELG-imposed limits on FGD wastewater discharge. She noted that this system functions effectively as a ZLD system and enables Vectren South to utilize the alternative ELG-imposed compliance date of December 31, 2023, and to meet future more stringent ELG wastewater discharge limits.

Ms. Retherford testified that construction of a new, lined process and storm water retention pond is required to comply with the ELG Rule. As we have already noted, projects necessary to comply with the ELG Rule, promulgated pursuant to the federal Water Pollution Control Act (33 U.S.C. 1251 *et seq.*), constitute a federally mandated requirement. The only dispute, raised by OUCC witness Aguilar, pertains to Vectren South's plans to close the existing Culley West pond so that the new lined pond can be built at the site. Witness Retherford testified that there are two reasons the Culley West pond is closing: (1) the pond was taken out of service prior to the 2015 deadline and the CCR rule requires that it be closed by 2020; and (2) the current space limitations require that the new stormwater retention and process water pond be constructed on the current location. Thus, there is no dispute that costs associated with the construction of the new lined pond are incurred pursuant to a federally mandated requirement. The dispute is whether the costs to close the Culley West pond so that the new pond can be built on top of that location, also qualify as federally mandated costs.

The OUCC identifies three reasons closure costs for the Culley West pond should not be considered federally mandated costs. First, OUCC witness Aguilar contends that Vectren South has been collecting depreciation and asset retirement costs in base rates, which include the closure of ash ponds. Public's Exhibit No. 1, p. 28. However, Vectren South witness Retherford responded that finalization of the CCR rule on April 17, 2015 imposed more stringent requirements to close the ash pond. The CCR rule imposed an obligation to dewater, cap and/or remove ponded ash. Petitioner's Exhibit No. 9-R, pp. 24-25.

On rebuttal, Mr. Swiz stated Vectren South's existing depreciation rates include an estimated level of cost of removal that was designed well before the implementation of requirements to close the ponds in accordance with the environmental regulations described by Ms. Retherford. The assumed removal costs in the demolition study provided in Cause No. 43839 (Vectren South's most recent general rate case), estimated $1.1 million to close both of the Culley Ash Ponds based on cost of backfill, grading and seeding. By comparison, the estimate for closure of one ash pond in this proceeding is $19.969 million. Petitioner's Exhibit No. 13-R, pp. 6-7; Petitioner's Administrative Notice 1.

Consequently, we find that costs associated with CCR closure have not been included in Vectren South's depreciation rates, which were last updated prior to finalization of the CCR Rule.

Second, the OUCC contends that other utilities are not tracking pond closure costs as Federally-Mandated CCR Projects. Public's Exhibit No. 1, p. 28. Vectren South witness Swiz noted that no utility had proposed such recovery yet but that one utility specifically indicated that it would present closure related activities as recoverable under the Federal Mandate Statute. Petitioner's Exhibit No. 13-R, pp. 6-7. Mr. Swiz explained that Duke, IPL and NIPSCO did not ask for recovery of their pond closure costs in the proceedings Ms. Aguilar cited, and in fact the order in Cause No. 44765 specifically notes that Duke anticipates presenting closure related activities of existing surface impoundments and their associated costs in a future proceeding. Petitioner's Exhibit No. 13-R, p. 6, citing *Duke Energy Indiana*, Cause No. 44765, at *7 (IURC May 24, 2017). Each of the cases Ms. Aguilar cited were settled cases containing non-precedential language. Nevertheless, Mr. Swiz pointed out that the NIPSCO Order in Cause No. 44872, suggests that the OUCC agreed that closure costs can be recovered as federally mandated costs. Petitioner's Exhibit No. 13-R, p. 7.

Third, the OUCC contends that Vectren South should have presented alternative suitable locations to the West Pond for consideration. However, Ms. Retherford testified that the location was chosen because there was limited space at the Culley generating station. In other words, there was not an alternate location to explore. The statutory requirement to consider options does not require a utility to present alternatives that are not practical or feasible. Accordingly, we find the Culley 3 Compliance Projects are all federally mandated requirements and that Vectren South described them in its application.

(2) <u>Energy utilities seeking recovery of Federally Mandated Costs must establish that the costs are incurred in connection with a compliance project, including capital, operating, maintenance, depreciation, tax or financing costs and describe the costs to be recovered</u>. Ind. Code §§ 8-1-8.4-4 and -6(b)(1)(B). We have already found that the Culley 3 Compliance Projects constitute projects required by federally mandated requirements. Consequently, the costs associated with these projects constitute Federally Mandated Costs. These costs will consist of capital, operating, maintenance, depreciation, tax and financing costs. Vectren South identified the estimated costs to be recovered as Federally Mandated Costs. Costs associated with the dry handling bottom ash handling system and spray dryer evaporator system were identified by Vectren South witness Fischer. Petitioner's Exhibit No. 6, pp. 16-18, 26-28. Costs associated with the construction of a new lined process water and storm water retention pond were identified in Ms. Retherford's testimony. Petitioner's Exhibit No. 9, Attachment AMR-1. No party disputed the cost estimates for the Culley 3 Compliance Projects. Based on the evidence presented, we find that Vectren South has identified

federally mandated costs and reasonably described those costs. Those total costs are $95 million, and they are hereby approved. Petitioner's Exhibit No. 4, p. 26.

(3) Compliance with Federally Mandated Requirements (Ind. Code §§ 8-1-8.4-6(b)(1)(C)) and 8-1-8.4-7(b)(3)). No party disputed that the Culley 3 Compliance Projects will allow Vectren South to comply with ELG and CCR or that ELG and CCR are federally mandated. We previously addressed the OUCC's objections related to appropriateness of recovery. We have already found that the ELGs and CCR Rule are federally mandated requirements within the meaning of Ind. Code §§ 8-1-8.4-5 and 8-1-8.4-6(b)(1)(A) and 8-1-8.4-7(b)(3). Based on the evidence presented, we find that Vectren South's Culley 3 Compliance Projects, will allow the utility to comply with the ELGs and the CCR Rule. Therefore, we find that Vectren South has satisfied the requirements of Ind. Code § 8-1-8.4-6(b)(1)(C).

(4) Alternative Plans for Compliance (Ind. Code §§ 8-1-8.4-6(b)(1)(D) and 8-1-8.4-7(b)(3)). Ind. Code § 8-1-8.4-6(b)(1)(D) requires the Commission to examine "[a]lternative plan that demonstrate that the proposed compliance project is reasonable and necessary." Vectren South witness Diane Fischer testified about Black & Veatch's evaluation of the ELG Compliance Program for Culley to identify potential FGD discharge water treatment alternatives and ash transport water alternatives that could be implemented to comply with the ELGs. She sponsored two written reports setting forth Black & Veatch's analyses of the alternatives. Ms. Fischer testified that each of the potential discharge treatment technology alternatives assessed by Black & Veatch were screened for design concept feasibility, capital expense and operating expense.

With respect to FGD discharge water treatment, two main treatment alternatives were considered: (1) FGD treatment and discharge; and (2) zero liquid discharge ("ZLD"). Three technology types were evaluated within these two treatment alternatives: (1) for FGD treatment and discharge, physical/chemical pretreatment with biological treatment technology, (2) for ZLD, spray dryer evaporator technology, and (3) also for ZLD, brine concentrator/crystallizer technology. Ms. Fischer testified that multiple vendors providing such technologies were evaluated. A sensitivity analysis was then performed for each technology and vendor. Ms. Fischer's Discharge Treatment Report also included a cost assessment of all alternatives considered. Petitioner's Exhibit No. 10, p. 7. Ms. Fischer testified that Black & Veatch provided Vectren South with a final overall assessment of each technology and vendor offering based on Black & Veatch's analysis and the following attributes: (1) start-up/ramp up reliability; (2) technology readiness risk; (3) adaptability to sensitivity analysis scenarios; (4) operation and control risk; (5) heat rate impact risk; (6) number of operators; (7) capital and annual O&M costs; (8) susceptibility to future environmental regulations; (9) overall financial stability and credit rating. Black & Veatch ultimately recommended that Vectren move forward to a detailed engineering phase with Stochastic Differential Equation ("SDE") type technology if the maximum FGD wastewater flow rate of between 50 and 80 gpm is achieved through future testing and operations. Ms. Fischer explained the SDE solution ranks the highest among all technologies based on the attributes discussed above and the solution is economically viable and provides a zero discharge solution if the minimum FGD wastewater flow rate of between 50 and 80 gpm is achieved. The conceptual design evaluation indicated the SDE can be feasibly located and tied into the existing equipment at Culley. In addition, Ms. Fischer stated the ZLD solution provides certainty that any future change in EPA regulations would not apply at Culley since there would be no discharge of FGD wastewater.

With respect to ash transport, Ms. Fischer described Black & Veatch's analysis to identify alternative ash transport solutions that could be implemented at Culley to comply with ELG requirements, focused specifically on identifying options for removal and dewatering of bottom ash from the Culley Unit 3 boiler with truck transport and disposal of the dry material at an off-site location. Black & Veatch evaluated two categories of technologies: (1) dry conversion of the bottom ash system and (2) closed loop wet sluicing system. For dry conversion system, Black & Veatch evaluated a submerged chain conveyor under the existing bottom ash hopper. For the closed loop wet sluicing system, Black & Veatch evaluated both a dewatering bunker and a remote submerged chain conveyor. In comparing all technologies, Black & Veatch used the following quality attributes to select the preferred treatment: technical feasibility; total installed cost, O&M cost, estimated additional manpower ("FTE"), estimated footprint, major equipment, advantage, disadvantages and reliability. Ms. Fischer's testimony discussed in detail the advantages and disadvantage of each alternative. Black & Veatch prepared cost estimates for all technologies considered for addressing ash transport water. Black & Veatch ultimately recommended the submerged chain conveyor for Culley 3 compliance with ELG requirements, due to the complexity of design and comparatively higher installed cost of the other alternatives.

The only evidence offered in opposition as being an alternative plan was the OUCC's conclusory statement about possible alternative locations for the new lined pond. As we have previously found, the chosen site was selected because there are no alternative locations.

While the Commission gives significant weight to cost-effective planning and decision making when considering alternatives, the Federal Mandate Statute does not require that a utility demonstrate that the chosen compliance plan is the least cost option. Consistent with the Commission's finding in Indianapolis Power and Light's recent proceeding, Cause No. 44794 (IURC 4/26/2017), p. 30, 2017 Ind. PUC LEXIS 114, *92, (finding "it is important that the Petersburg Station is able to continue to operate on coal and protect customers from potential price volatility in the gas markets"), a reasonable alternative can be, and often is, a solution that includes risk balancing through a diversified portfolio.

Based on the evidence presented, we find that Vectren South considered alternative plans for compliance with the ELGs and the CCR Rule. The evidence shows that the Culley 3 Compliance Projects are reasonable and necessary.

(5) Useful Life of the Facility (Ind. Code §§ 8-1-8.4-6(b)(1)(E) and 8-1-8.4-7(b)(3)). Mr. Games testified that the investments in the Culley 3 Compliance Projects will allow for the continued operation of Vectren South's most efficient coal fired unit. Ms. Retherford described the environmental regulations requiring the Culley 3 Compliance Projects in order for Culley Unit 3 to continue operating. Ms. Retherford explained how closure of the Culley West pond will extend the useful life of Culley 3, because closure of the Culley West pond is necessary to provide a suitable location to construct a new pond that can continue to take non-CCR process water discharged from Culley Unit 3 and plant stormwater (i.e. surface water) which flows into the West Pond. Without this new lined process and stormwater pond, continued operation consistent with applicable regulations would be impossible after the Culley East pond commences closure.

No party disputes that issuance of a CPCN for the Culley 3 Compliance Projects will extend the useful life of Vectren South's Culley 3 unit or that Culley 3 would be required to retire in the near future if the Culley 3 Compliance Projects are not completed.

Based on the evidence presented, we find that Vectren South has satisfied the requirements of Ind. Code § 8-1-8.4-6(b)(1)(E).

(6) Conclusion. We find that the Culley 3 Compliance Projects will allow Vectren South to comply directly or indirectly with one or more federally mandated requirements and that public convenience and necessity will be served by the Culley 3 Compliance Projects.

ii. Accounting and Ratemaking Issues Associated with Culley Compliance Projects. Ind. Code § 8-1-8.4-7(c) states:

> If the commission approves under subsection (b) a proposed compliance project and the projected federally mandated costs associated with the proposed compliance project, the following apply:
> (1) Eighty percent (80%) of the approved federally mandated costs shall be recovered by the energy utility through a periodic retail rate adjustment mechanism that allows the timely recovery of the approved federally mandated costs. The Commission shall adjust the energy utility's authorized net operating income to reflect any approved earnings for purposes of IC 8-1-2-42(d)(3)and IC 8-1-2-42(g)(3).
> (2) Twenty percent (20%) of the approved federally mandated costs, including depreciation, allowance for funds used during construction, and post in service carrying costs, based on the overall cost of capital most recently approved by the commission, shall be deferred and recovered by the energy utility as part of the next general rate case filed by the energy utility with the commission.
> (3) Actual costs that exceed the projected federally mandated costs of the approved compliance project by more than twenty-five percent (25%) shall require specific justification by the energy utility and specific approval by the commission before being authorized in the next general rate case filed by the energy utility with the commission.

(1) Accounting and Ratemaking Treatment for ECA. Vectren South requests authority to implement a new annual rate adjustment mechanism ("ECA") pursuant to Ind. Code § 8-1-8.4-7 for the timely and periodic recovery of 80% of the federally mandated costs. Vectren South also requests approval of proposed changes to its electric service tariff relating to the proposed ECA mechanism, including the proposed Appendix E. Ind. Code §8-1-8.4-8 provides that an energy utility may, in a timely manner, recover 80% of all federally mandated costs through a periodic rate adjustment mechanism. Ind. Code §§ 8-1-8.4-4 and 8-1-8.4-7 provide that such costs include capital, AFUDC, O&M, depreciation, tax, and financing costs.

Vectren South witness Swiz described how the eligible costs associated with the Culley 3 Compliance Projects will be incorporated into the proposed ECA mechanism. He testified Vectren South will prepare in each annual filing a revenue requirement calculation accumulating all eligible costs incurred through December 31 of the previous calendar year. To provide for timely recovery, Mr. Swiz testified the proposed ECA will project an annualized level of expense related to the approved projects for the 12-month effective period. Mr. Swiz stated the annual revenue requirements will capture eligible new capital investments (both in service and Construction Work in Progress) related to the Culley 3 Compliance Projects, multiplied by the applicable rate of return, with depreciation, O&M and property tax expenses associated with the projects, and recovery of the regulatory assets recorded through interim deferral of depreciation expense, plan development expense, and PISCC, added to the resulting total. The revenue requirement for those projects will be the basis for the recovery of 80% of the eligible revenue requirement amounts in each annual ECA filing.

Mr. Swiz also described Vectren South's proposal to defer and subsequently recover depreciation expense as well as costs associated with development of the Culley 3 Compliance Projects through the ECA. The cumulative deferred balances of the regulatory assets recorded through interim deferral of such depreciation expenses would be amortized over the remaining life of the assets (20 years) and the amortization amount would be included in the ECA revenue requirements. Mr. Swiz stated the costs of development of the projects would be included for recovery within the ECA, with the balance amortized over a period of three years.

Vectren South proposes the pre-tax return on the new capital investment will be calculated by multiplying the pre-tax rate of return, based on the weighted average cost of capital ("WACC"), by total new capital investment related to the approved projects. Mr. Swiz testified Vectren South proposes to use a WACC in the ECA based upon the most recent approved WACC within Vectren South's TDSIC mechanism under Cause No. 44910, which is based on a return on equity ("ROE") of 10.4% as approved in Cause Nos. 43111 and 43839, Vectren South's two most recent base rate cases. Mr. Swiz stated the equity component of the rate used in the ECA revenue requirement calculation will be grossed up for recovery of income taxes, both state and federal, at then current rates.

Mr. Swiz testified that approved recoveries within each ECA filing will be calculated by taking the billing determinants by month multiplied by the applicable rates and charges for the ECA period. Any under recoveries resulting from instances in which ECA rates and charges are not in place for a full month will be recovered as an under-recovery variance in a subsequent ECA proceeding. Vectren South proposes to allocate ECA costs pursuant to the four-coincident peak allocation percentages for Vectren South utilized in its Cause No. 43406 RCRA15 and 43405 DSMA15 rate mechanisms.

With respect to the treatment of operating income, Mr. Swiz testified Vectren South will adjust its statutory earnings test under Ind. Code § 8-1-2-42(d)(3) to include the incremental earnings from approved ECA filings.

Mr. Swiz testified Vectren South proposes to file its ECA petitions and cases in chief annually, on May 1 of each year, with new ECA rates and charges becoming effective August 1 of each year. Each filing will be based on capital investments and expenses through the twelve months ended December of the prior calendar year. Variances will be reconciled in each ECA filing and recovered over the subsequent 12 month rate effective period. Vectren South seeks approval of its proposed Sheet No. 69, Appendix E, Environmental Cost Adjustment. Additional changes to Vectren South's rate schedules in its tariff are needed to reflect that the ECA will be applied monthly.

Industrial Group witness Gorman recommended that the ELG costs associated with the Culley 3 Compliance Projects be recovered within a base rate proceeding and not through the proposed ECA. He cited Vectren South's overall rate of return and stated Vectren South's costs have declined since the last base rate case. He also suggested that Vectren South should be permitted to recover a return on investment of no more than 9.8%.

Mr. Swiz explained on rebuttal that under the statutory test under Ind. Code § 8-1-2-42(d) and -42.3, performed in Vectren South's most recent FAC proceedings as of the time his rebuttal testimony was filed (Cause No. 38708 FAC 120), Vectren South's comprehensive earnings compared to authorized levels, including both changes in expenses and revenues, show that Vectren South is currently under-earning by approximately $6.5 million of net operating income and has been under-earning since February 2017. Mr. Swiz explained that depreciation and operating expense are driving much of these results, and Mr. Gorman does not capture those expenses in his calculation.

Eligibility for recovery through Ind. Code ch. 8-1-8.4 is not contingent on whether other costs have declined to offset the new federally mandated costs. Once we have made the required findings, 80% of the federally mandated costs "shall be recovered by the energy utility through a periodic retail rate adjustment mechanism." Ind. Code § 8-1-8.4-7(c)(1). In any event, we find that Mr. Swiz has adequately explained why Mr. Gorman's position is incorrect.

Mr. Swiz testified that pursuant to Ind. Code § 8-1-8.4-7, Vectren South seeks ratemaking treatment for 80% of the costs associated with the Culley 3 Compliance Projects through its proposed ECA mechanism. Specifically, Vectren South seeks timely recovery of all federally mandated costs associated with the Culley 3 Compliance Projects, including capital costs, AFUDC, post-in-service carrying cost charges ("PISCC"), O&M, depreciation expense, property tax expense, and other taxes, with 80% recovered through the ECA and the balance deferred for recovery in Vectren South's next rate case.

Vectren South proposes to implement construction work in progress ("CWIP") ratemaking treatment related to the recovery of financing costs incurred during construction of the Culley 3 Compliance Projects. In connection with CWIP ratemaking treatment, Vectren South will remove from the AFUDC-eligible balance the amount of investment included for recovery in the ECA, so that only the amount of the Culley 3 Compliance Projects investment not currently being recovered in the ECA would be eligible for AFUDC.

Mr. Swiz testified that Vectren South proposes to accrue post-in-service carrying charges on all eligible new capital investment from the date it is placed in service until the date it is included in rates. He explained the PISCC balances will be multiplied by the pre-tax rate of return within the ECA revenue requirement, at the WACC rate described herein. Unlike other utilities who have been granted such authority, Vectren South is not seeking to accrue and subsequently recover in the next base rate case PISCC on the 20% deferred balance discussed below.

OUCC witness Aguilar opposed Vectren South's request to recover pond closure costs for the Culley 3 Compliance Projects as part of the ECA because the OUCC's position is that Vectren South is already collecting pond closure costs within its depreciation rates. Ms. Aguilar also testified that neither Duke, IPL, nor NIPSCO are tracking pond closure costs. We have already addressed these positions and rejected them.

Based on the evidence presented, we find that the proposed ECA mechanism should allow for the timely and periodic recovery of 80% of Vectren South's approved federally mandated costs. We further find that Vectren South's request for approval to adjust its authorized net operating income to reflect an approved earnings associated with the Culley 3 Compliance Project for purposes of Ind. Code §§ 8-1-2-42(d)(3) and 8-1-2-42(g)(3) is consistent with Ind. Code § 8-1-8.4-7(c)(1).

Vectren South is authorized to defer (until captured within the ECA mechanism) and recover 80% of the approved federally mandated costs incurred in connection with the Culley 3 Compliance Projects through the approved ECA Mechanism pursuant to Ind. Code § 8-1-8.4-7, including capital, O&M, depreciation, taxes, financing, and carrying costs based on the current overall WACC and AFUDC. Vectren South is authorized to utilize CWIP ratemaking treatment for the Culley 3 Compliance Projects through the proposed ECA mechanism. Vectren South is authorized to defer post-in service costs of the Culley 3 Compliance Projects, including carrying costs based on the current overall WACC, depreciation, taxes and operating and maintenance expenses on an interim basis until such costs are recognized for ratemaking purposes through Vectren South's ECA mechanism or otherwise included for recovery in Vectren South's base rates in its next general rate case. Vectren South is authorized to defer and recover through the ECA mechanism 80% of its federally mandated costs, including but not limited to federally mandated costs incurred prior to and after approval of a final order in this proceeding to the extent that such costs are reasonable and consistent with the scope of the Culley 3 Compliance Projects described in Vectren South's evidence. Vectren South's proposed cost allocation factors are also approved.

(2) Accounting and Ratemaking Treatment for Deferred Costs. Indiana Code § 8-1-8.4-8 provides that 20% of the approved federally mandated costs, including depreciation, AFUDC, and PISCC, based on the overall cost of capital most recently approved by the Commission, shall be deferred and recovered by the energy utility as part of the next general rate case filed by the energy utility with the Commission. Vectren South proposes to defer as a regulatory asset 20% of all federally mandated costs incurred in connection with these projects.

Based on the evidence presented, the Commission finds Vectren South is authorized to defer 20% of the federally mandated costs incurred in connection with the Culley 3 Compliance Projects, and Vectren South may recover the deferred costs in its next general rate case as allowed by Ind. Code § 8-1-8.4-7(c)(2).

(3) Depreciation Treatment. Vectren South proposes to utilize a depreciation rate of 5%, representing a 20-year life on these investments. Mr. Swiz testified the proposed depreciation rate for the investments aligns with the estimated remaining life of Culley Unit 3.

No party opposed Vectren South's proposed depreciation rate for the investments required for the Culley 3 Compliance Projects.

Based on the evidence presented, we find that Vectren South's proposal to depreciate the individual projects included in the Culley 3 Compliance Projects based on a 5% depreciation rate is reasonable and is approved.

C. Recovery of Prior Pollution Control Investments. Our January 28, 2015 and June 22, 2016 Orders in Cause No. 44446 (the "44446 Orders") (1) granted Vectren South a CPCN for A.B. Brown Unit 1 and 2, Culley Unit 3 and Warrick Unit 3 clean coal technology projects and (2) authorized Vectren South to recover federally mandated costs associated with federally mandated requirements at A.B. Brown Units 1 and 2 (collectively the "MATS Projects"). Rather than recovering the costs of the MATS Projects through a tracking mechanism as authorized by Ind. Code § 8-1-8.4-7, Vectren South sought, and we granted, authority to defer these costs for recovery in a future proceeding. Vectren South now seeks to commence recovery of the MATS Projects' costs through the ECA pursuant to Ind. Code § 8-1-8.4-7.

Vectren South witness Swiz described the proposed recovery through the ECA in more detail. He indicated that Vectren South proposes recovery of the MATS Projects to begin on January 1, 2019 with the approval of ECA rates and charges recovering the specified revenue requirement. In accordance with applicable statutory requirements, Vectren South proposes to recover the 80% of eligible revenue requirements amounts for post-in-service carrying costs, incremental depreciation and property taxes and financing costs that Vectren South incurred to construct the MATS Projects and deferral of the remaining 20% of these costs for subsequent recovery in a base rate case. Vectren South will prepare an annual revenue requirement as part of the ECA to capture eligible capital investments in plant related to the MATS Projects, multiplied by the applicable rate of return, with depreciation, O&M, and property tax expenses associated with the MATS Projects added to the resulting total. To provide for timely recovery, Vectren South's proposed ECA will project an annualized level of expense related to these approved projects for the 12-month effective period.

Depreciation associated with the MATS Projects will be based on the currently approved depreciation rates applicable to the assets, as approved in Vectren South's last electric base rate case (Cause No. 43839). The pre-tax return on the new capital investment will be calculated by multiplying the pre-tax rate of return, based on the WACC, by total new capital investment related to the approved projects. Vectren South proposes to use a WACC in the ECA based upon the most recent approved WACC within Vectren South's TDSIC mechanism, Cause No. 44910. This WACC, approved by the Commission, represents an updated actual capital structure as of the cut-off date of each TDSIC filing, and includes the typical items captured in Vectren South's base rate case capital structure. This rate will be used in the ECA revenue requirement calculation, and the equity component will be grossed up for recovery of income taxes, both state and federal, at then current rates. O&M expense included for recovery in the ECA will reflect an annualized level of expense related to the MATS Projects. This O&M expense represents incremental chemical costs and other expenses associated only with the MATS Projects.

No party objected to Vectren South's proposal to commence recovery of the MATS Projects' costs, currently being deferred, through the ECA. We previously found the MATS Projects costs qualify as federally mandated costs in the 44446 Orders. While Vectren South proposed, and we approved of, deferral of these costs in lieu of the recovery through a periodic retail rate adjustment mechanism, Vectren South now seeks to recover the costs in accordance with Ind. Code § 8-1-8.4-7(c). We find that Vectren South shall be authorized to commence recovery of these MATS Projects' costs pursuant to Ind. Code § 8-1-8.4-7 through the ECA in accordance with the procedures outlined in Mr. Swiz's testimony.

6. <u>Confidentiality</u>. Vectren South filed motions for protection and nondisclosure of confidential and proprietary information on March 20, 2018, August 21, 2018, and September 10, 2018, respectively. In its motions, Vectren South states certain information redacted in the evidence is confidential, proprietary, competitively sensitive, and/or trade secrets. Docket entries were issued on March 29, August 27, and October 4, 2018 finding such information to be preliminarily confidential and protected from disclosure under Ind. Code §§ 8-1-2-29 and 5-14-3-4. The confidential information was subsequently submitted under seal. The Commission finds the information for which Vectren South seeks confidential treatment is confidential trade secret information pursuant to Ind. Code § 8-1-2-29 and Ind. Code ch. 5-14-3, is exempt from public access and disclosure by Indiana law, and shall continue to be held by the Commission as confidential and protected from public access and disclosure.

IT IS THEREFORE ORDERED BY THE INDIANA UTILITY REGULATORY COMMISSION that:

1. Vectren South's request for a certificate of public convenience and necessity under Ind. Code ch. 8-1- 8.5 to construct an 850 MW CCGT and all associated relief requested is denied.

2. Vectren South's request for a certificate of public convenience and necessity for the Culley 3 Compliance Projects pursuant to Ind. Code ch. 8-1-8.4 and all associated relief requested is approved.

3. Vectren South's proposed recovery of federally mandated costs approved in connection with Cause No. 44446 through the ECA is approved as described in this Order.

4. Vectren South's proposed ECA, and Vectren South's proposed Sheet No. 69, Appendix E of its tariff to implement such ECA is approved.

5. The Confidential Information submitted under seal in this Cause pursuant to Vectren South's requests for confidential treatment is determined to be confidential trade secret information as defined in Ind. Code § 24-2-3-2 and shall continue to be held as confidential and exempt from public access and disclosure under Ind. Code §§ 8-1-2-29 and 5-14-3-4.

6. This Order shall be effective on and after the date of its approval.

<u>HUSTON, KREVDA, OBER, AND ZIEGNER CONCUR; FREEMAN ABSENT</u>:

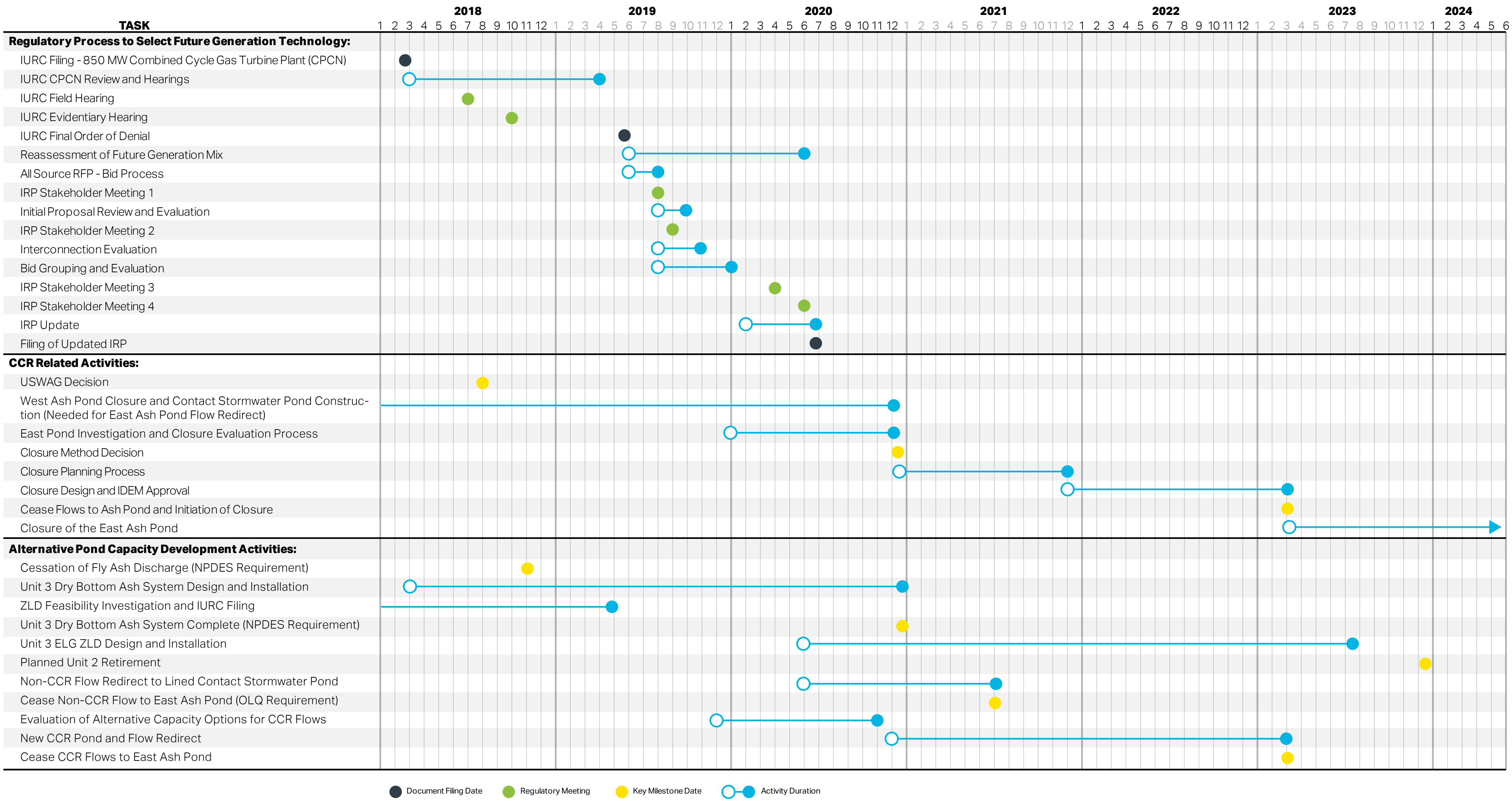
APPROVED: APR 24 2019

I hereby certify that the above is a true and correct copy of the Order as approved.

Mary M. Becerra

Mary M. Becerra
Secretary of the Commission

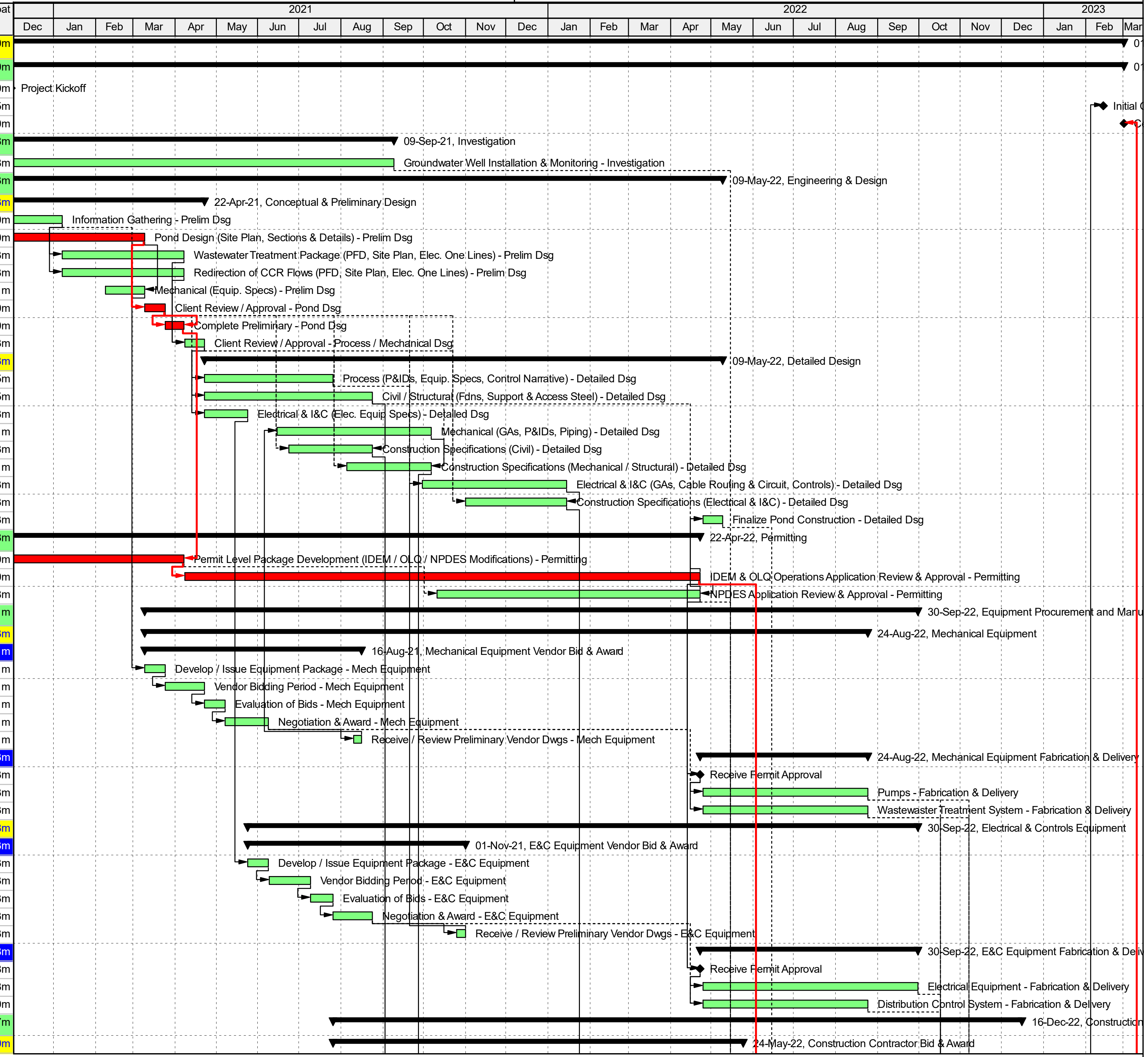
Appendix B
Schedule Activities and Milestone



TASK
2018
2019
2020
2021
2022
2023
2024
Regulatory Process to Select Future Generation Technology:
IURC Filing - 850 MW Combined Cycle Gas Turbine Plant (CPCN)
IURC CPCN Review and Hearings
IURC Field Hearing
IURC Evidentiary Hearing
IURC Final Order of Denial
Reassessment of Future Generation Mix
All Source RFP - Bid Process
IRP Stakeholder Meeting 1
Initial Proposal Review and Evaluation
IRP Stakeholder Meeting 2
Interconnection Evaluation
Bid Grouping and Evaluation
IRP Stakeholder Meeting 3
IRP Stakeholder Meeting 4
IRP Update
Filing of Updated IRP
CCR Related Activities:
USWAG Decision
West Ash Pond Closure and Contact Stormwater Pond Construction (Needed for East Ash Pond Flow Redirect)
East Pond Investigation and Closure Evaluation Process
Closure Method Decision
Closure Planning Process
Closure Design and IDEM Approval
Cease Flows to Ash Pond and Initiation of Closure
Closure of the East Ash Pond
Alternative Pond Capacity Development Activities:
Cessation of Fly Ash Discharge (NPDES Requirement)
Unit 3 Dry Bottom Ash System Design and Installation
ZLD Feasibility Investigation and IURC Filing
Unit 3 Dry Bottom Ash System Complete (NPDES Requirement)
Unit 3 ELG ZLD Design and Installation
Planned Unit 2 Retirement
Non-CCR Flow Redirect to Lined Contact Stormwater Pond
Cease Non-CCR Flow to East Ash Pond (OLQ Requirement)
Evaluation of Alternative Capacity Options for CCR Flows
New CCR Pond and Flow Redirect
Cease CCR Flows to East Ash Pond
Document Filing Date
Regulatory Meeting
Key Milestone Date
Activity Duration

Appendix C
Detailed Schedule for Development of Alternative Capacity

Activity ID	Activity Name	Duration	Start	Finish	Total Float
FBC New Lined CCR Pond_RevH		25.7m	01-Dec-20	01-Mar-23	0.0m
Milestones		25.7m	01-Dec-20	01-Mar-23	0.0m
A1350	Project Kickoff	0.0m	01-Dec-20*		0.0m
A1360	Initial Operation	0.0m	14-Feb-23		0.5m
A1750	Cease Flows to East Ash Pond	0.0m		01-Mar-23*	0.0m
Investigation		9.0m	01-Dec-20	09-Sep-21	8.8m
A1010	Groundwater Well Installation & Monitoring - Investigation	9.0m	01-Dec-20	09-Sep-21	8.8m
Engineering & Design		16.5m	01-Dec-20	09-May-22	2.3m
Conceptual & Preliminary Design		4.5m	01-Dec-20	22-Apr-21	3.3m
A1000	Information Gathering - Prelim Dsg	1.0m	01-Dec-20	07-Jan-21	2.0m
A1020	Pond Design (Site Plan, Sections & Details) - Prelim Dsg	3.0m	01-Dec-20	09-Mar-21	0.0m
A1040	Wastewater Treatment Package (PFD, Site Plan, Elec. One Lines) - Prelim	3.0m	07-Jan-21	07-Apr-21	3.3m
A1430	Redirection of CCR Flows (PFD, Site Plan, Elec. One Lines) - Prelim Dsg	3.0m	07-Jan-21	07-Apr-21	3.3m
A1540	Mechanical (Equip. Specs) - Prelim Dsg	1.0m	08-Feb-21	09-Mar-21	3.1m
A1450	Client Review / Approval - Pond Dsg	0.5m	09-Mar-21	24-Mar-21	0.0m
A1640	Complete Preliminary - Pond Dsg	0.5m	24-Mar-21	07-Apr-21	0.0m
A1740	Client Review / Approval - Process / Mechanical Dsg	0.5m	08-Apr-21	22-Apr-21	3.3m
Detailed Design		12.0m	22-Apr-21	09-May-22	2.3m
A1050	Process (P&IDs, Equip. Specs, Control Narrative) - Detailed Dsg	3.0m	22-Apr-21	26-Jul-21	6.5m
A1070	Civil / Structural (Fdns, Support & Access Steel) - Detailed Dsg	4.0m	22-Apr-21	24-Aug-21	4.5m
A1560	Electrical & I&C (Elec. Equip Specs) - Detailed Dsg	1.0m	22-Apr-21	24-May-21	3.3m
A1060	Mechanical (GAs, P&IDs, Piping) - Detailed Dsg	3.7m	15-Jun-21	06-Oct-21	3.1m
A1090	Construction Specifications (Civil) - Detailed Dsg	2.0m	23-Jun-21	24-Aug-21	6.3m
A1610	Construction Specifications (Mechanical / Structural) - Detailed Dsg	2.0m	05-Aug-21	06-Oct-21	3.1m
A1080	Electrical & I&C (GAs, Cable Routing & Circuit, Controls) - Detailed Dsg	3.0m	30-Sep-21	14-Jan-22	3.3m
A1440	Construction Specifications (Electrical & I&C) - Detailed Dsg	2.0m	01-Nov-21	14-Jan-22	3.3m
A1270	Finalize Pond Construction - Detailed Dsg	0.5m	25-Apr-22	09-May-22	2.3m
Permitting		16.0m	01-Dec-20	22-Apr-22	0.8m
A1030	Permit Level Package Development (IDEM / OLQ / NPDES Modifications)	4.0m	01-Dec-20	07-Apr-21	0.0m
A1100	IDEM & OLQ Operations Application Review & Approval - Permitting	12.0m	08-Apr-21	22-Apr-22	0.0m
A1110	NPDES Application Review & Approval - Permitting	6.0m	11-Oct-21	22-Apr-22	0.8m
Equipment Procurement and Manufacture		18.2m	09-Mar-21	30-Sep-22	1.1m
Mechanical Equipment		17.0m	09-Mar-21	24-Aug-22	2.3m
Mechanical Equipment Vendor Bid & Award		5.2m	09-Mar-21	16-Aug-21	3.1m
A1120	Develop / Issue Equipment Package - Mech Equipment	0.5m	09-Mar-21	24-Mar-21	3.1m
A1130	Vendor Bidding Period - Mech Equipment	1.0m	24-Mar-21	22-Apr-21	3.1m
A1140	Evaluation of Bids - Mech Equipment	0.5m	22-Apr-21	07-May-21	3.1m
A1150	Negotiation & Award - Mech Equipment	1.0m	07-May-21	08-Jun-21	3.1m
A1550	Receive / Review Preliminary Vendor Dwgs - Mech Equipment	0.2m	10-Aug-21	16-Aug-21	3.1m
Mechanical Equipment Fabrication & Delivery		4.0m	22-Apr-22	24-Aug-22	2.3m
A1290	Receive Permit Approval	0.0m		22-Apr-22	2.3m
A1160	Pumps - Fabrication & Delivery	4.0m	25-Apr-22	24-Aug-22	2.3m
A1170	Wastewaster Treatment System - Fabrication & Delivery	4.0m	25-Apr-22	24-Aug-22	2.3m
Electrical & Controls Equipment		15.7m	24-May-21	30-Sep-22	0.8m
E&C Equipment Vendor Bid & Award		5.2m	24-May-21	01-Nov-21	3.3m
A1490	Develop / Issue Equipment Package - E&C Equipment	0.5m	24-May-21	08-Jun-21	3.3m
A1500	Vendor Bidding Period - E&C Equipment	1.0m	09-Jun-21	09-Jul-21	3.3m
A1510	Evaluation of Bids - E&C Equipment	0.5m	09-Jul-21	26-Jul-21	3.3m
A1520	Negotiation & Award - E&C Equipment	1.0m	26-Jul-21	24-Aug-21	3.3m
A1530	Receive / Review Preliminary Vendor Dwgs - E&C Equipment	0.2m	25-Oct-21	01-Nov-21	3.3m
E&C Equipment Fabrication & Delivery		5.2m	22-Apr-22	30-Sep-22	0.8m
A1730	Receive Permit Approval	0.0m		22-Apr-22	0.8m
A1180	Electrical Equipment - Fabrication & Delivery	5.2m	25-Apr-22	30-Sep-22	0.8m
A1190	Distribution Control System - Fabrication & Delivery	4.0m	25-Apr-22	24-Aug-22	2.0m
Construction		16.0m	26-Jul-21	16-Dec-22	1.7m
Construction Contractor Bid & Award		9.5m	26-Jul-21	24-May-22	2.0m

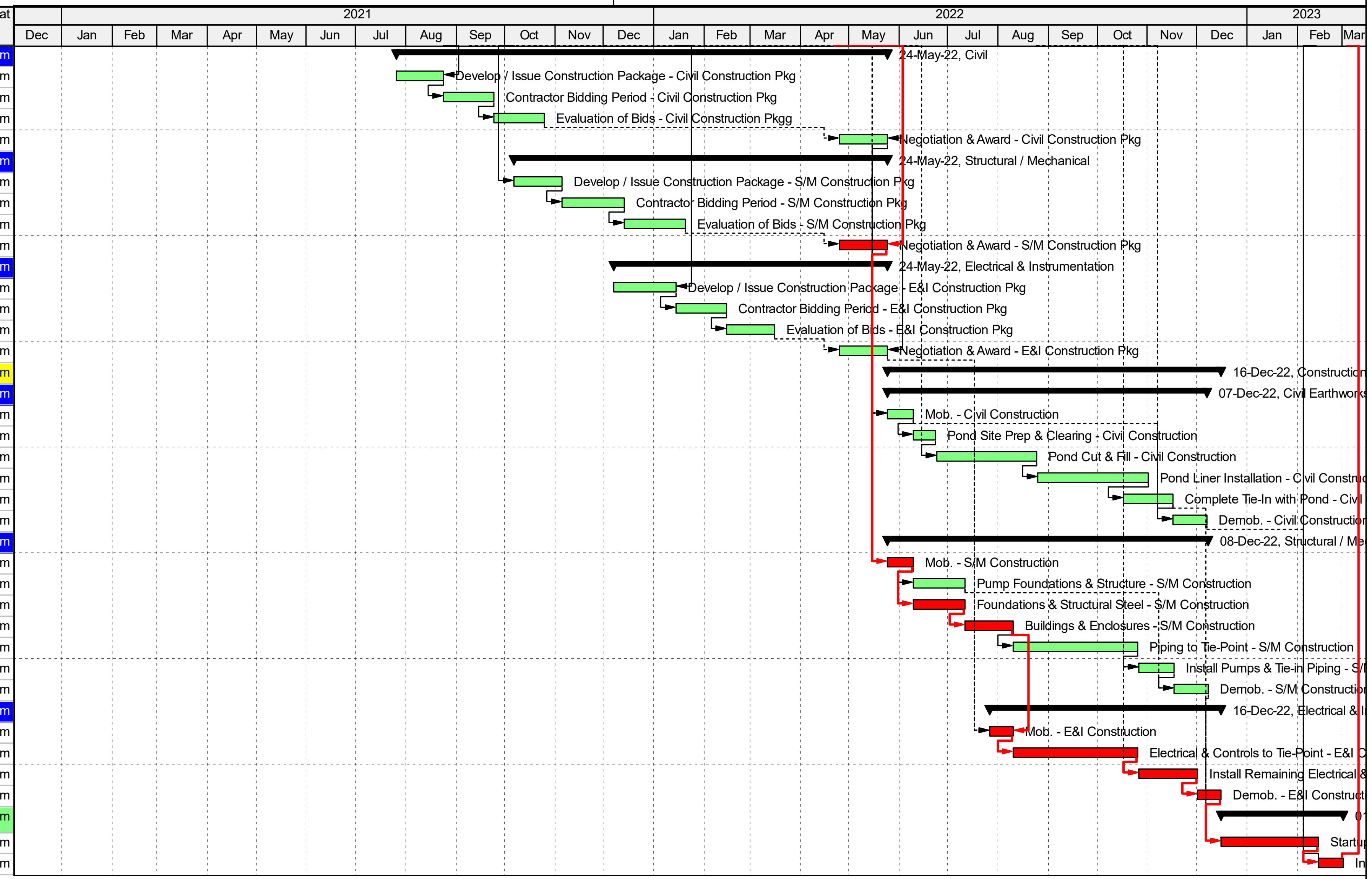


Legend: Actual Work | Critical Remaining Work | Summary | Remaining Work | Milestone

AECOM

FBC New Lined CCR Pond_RevH | RevH | Data Date: 30-Nov-20

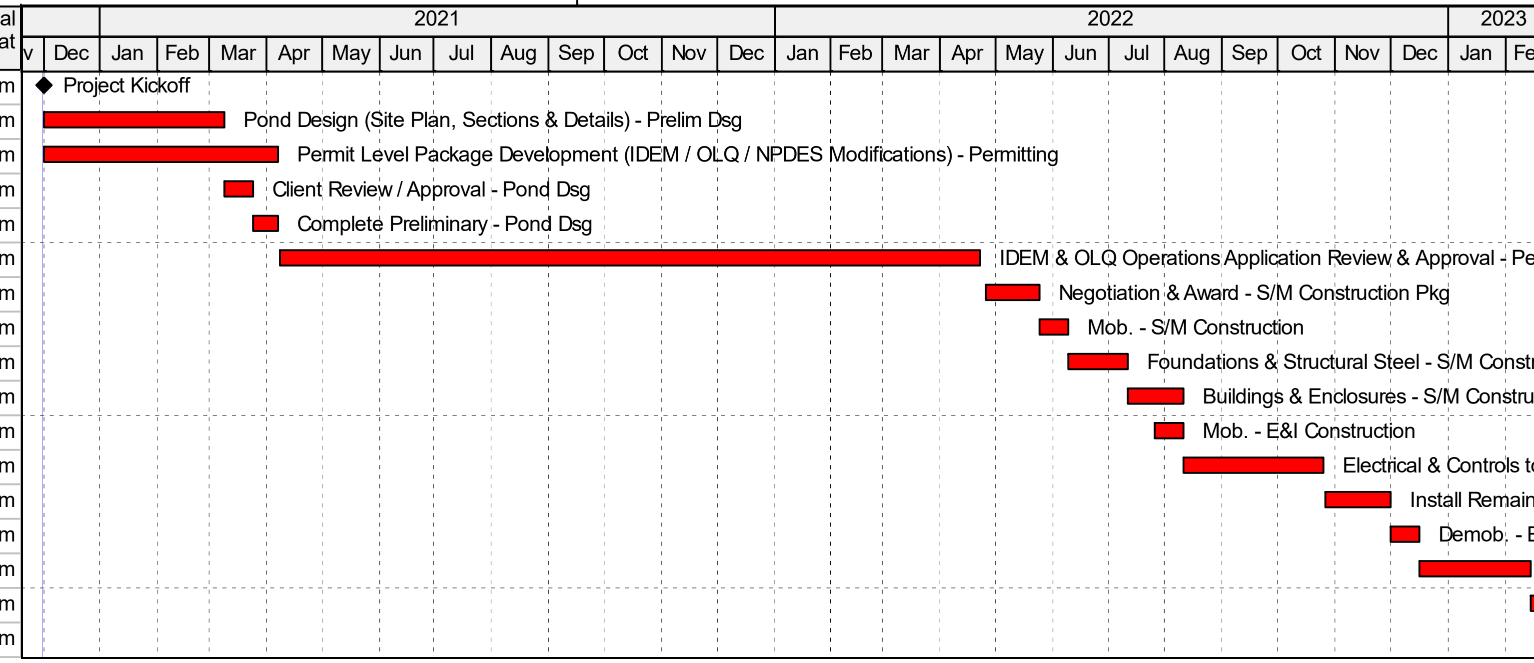
Activity ID	Activity Name	Duration	Start	Finish	Total Float
Civil		9.5m	26-Jul-21	24-May-22	0.8m
A1200	Develop / Issue Construction Package - Civil Construction Pkg	1.0m	26-Jul-21	24-Aug-21	6.3m
A1210	Contractor Bidding Period - Civil Construction Pkg	1.0m	24-Aug-21	24-Sep-21	6.3m
A1220	Evaluation of Bids - Civil Construction Pkgg	1.0m	24-Sep-21	25-Oct-21	6.3m
A1230	Negotiation & Award - Civil Construction Pkg	1.0m	25-Apr-22	24-May-22	0.8m
Structural / Mechanical		7.1m	06-Oct-21	24-May-22	0.0m
A1570	Develop / Issue Construction Package - S/M Construction Pkg	1.0m	06-Oct-21	05-Nov-21	3.1m
A1580	Contractor Bidding Period - S/M Construction Pkg	1.0m	05-Nov-21	13-Dec-21	3.1m
A1590	Evaluation of Bids - S/M Construction Pkg	1.0m	13-Dec-21	20-Jan-22	3.1m
A1600	Negotiation & Award - S/M Construction Pkg	1.0m	25-Apr-22	24-May-22	0.0m
Electrical & Instrumentation		5.3m	07-Dec-21	24-May-22	2.0m
A1390	Develop / Issue Construction Package - E&I Construction Pkg	1.0m	07-Dec-21	14-Jan-22	3.3m
A1400	Contractor Bidding Period - E&I Construction Pkg	1.0m	14-Jan-22	14-Feb-22	3.3m
A1410	Evaluation of Bids - E&I Construction Pkg	1.0m	14-Feb-22	16-Mar-22	3.3m
A1420	Negotiation & Award - E&I Construction Pkg	1.0m	25-Apr-22	24-May-22	2.0m
Construction		6.5m	24-May-22	16-Dec-22	1.7m
Civil Earthworks		6.2m	24-May-22	07-Dec-22	2.0m
A1240	Mob. - Civil Construction	0.5m	24-May-22	09-Jun-22	0.8m
A1250	Pond Site Prep & Clearing - Civil Construction	0.5m	09-Jun-22	23-Jun-22	0.8m
A1260	Pond Cut & Fill - Civil Construction	2.0m	24-Jun-22	24-Aug-22	0.8m
A1280	Pond Liner Installation - Civil Construction	2.2m	25-Aug-22	01-Nov-22	0.8m
A1630	Complete Tie-In with Pond - Civil Construction	1.0m	17-Oct-22	16-Nov-22	0.8m
A1470	Demob. - Civil Construction	0.5m	16-Nov-22	07-Dec-22	2.0m
Structural / Mechanical		6.3m	24-May-22	08-Dec-22	0.3m
A1620	Mob. - S/M Construction	0.5m	24-May-22	09-Jun-22	0.0m
A1650	Pump Foundations & Structure - S/M Construction	1.0m	09-Jun-22	11-Jul-22	3.8m
A1670	Foundations & Structural Steel - S/M Construction	1.0m	09-Jun-22	11-Jul-22	0.0m
A1680	Buildings & Enclosures - S/M Construction	1.0m	11-Jul-22	10-Aug-22	0.0m
A1690	Piping to Tie-Point - S/M Construction	2.5m	10-Aug-22	25-Oct-22	0.3m
A1700	Install Pumps & Tie-in Piping - S/M Construction	0.8m	26-Oct-22	17-Nov-22	0.3m
A1710	Demob. - S/M Construction	0.5m	17-Nov-22	08-Dec-22	0.3m
Electrical & Instrumentation		4.5m	26-Jul-22	16-Dec-22	0.0m
A1340	Mob. - E&I Construction	0.5m	26-Jul-22	10-Aug-22	0.0m
A1320	Electrical & Controls to Tie-Point - E&I Construction	2.5m	10-Aug-22	25-Oct-22	0.0m
A1480	Install Remaining Electrical & Controls - E&I Construction	1.0m	26-Oct-22	01-Dec-22	0.0m
A1460	Demob. - E&I Construction	0.5m	01-Dec-22	16-Dec-22	0.0m
Start-Up & Commissioning		2.2m	16-Dec-22	01-Mar-23	0.0m
A1370	Startup & Commissioning	1.7m	16-Dec-22	14-Feb-23	0.0m
A1380	Initial Operation	0.5m	14-Feb-23	01-Mar-23	0.0m



Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

AECOM

Activity ID	Activity Name	Orig. Dur.	Start	Finish	Total Float
A1350	Project Kickoff	0.0m	01-Dec-20*		0.0m
A1020	Pond Design (Site Plan, Sections & Details) - Prelim Dsg	3.0m	01-Dec-20	09-Mar-21	0.0m
A1030	Permit Level Package Development (IDEM / OLQ / NPDES Modifications) - Permitting	4.0m	01-Dec-20	07-Apr-21	0.0m
A1450	Client Review / Approval - Pond Dsg	0.5m	09-Mar-21	24-Mar-21	0.0m
A1640	Complete Preliminary - Pond Dsg	0.5m	24-Mar-21	07-Apr-21	0.0m
A1100	IDEM & OLQ Operations Application Review & Approval - Permitting	12.0m	08-Apr-21	22-Apr-22	0.0m
A1600	Negotiation & Award - S/M Construction Pkg	1.0m	25-Apr-22	24-May-22	0.0m
A1620	Mob. - S/M Construction	0.5m	24-May-22	09-Jun-22	0.0m
A1670	Foundations & Structural Steel - S/M Construction	1.0m	09-Jun-22	11-Jul-22	0.0m
A1680	Buildings & Enclosures - S/M Construction	1.0m	11-Jul-22	10-Aug-22	0.0m
A1340	Mob. - E&I Construction	0.5m	26-Jul-22	10-Aug-22	0.0m
A1320	Electrical & Controls to Tie-Point - E&I Construction	2.5m	10-Aug-22	25-Oct-22	0.0m
A1480	Install Remaining Electrical & Controls - E&I Construction	1.0m	26-Oct-22	01-Dec-22	0.0m
A1460	Demob. - E&I Construction	0.5m	01-Dec-22	16-Dec-22	0.0m
A1370	Startup & Commissioning	1.7m	16-Dec-22	14-Feb-23	0.0m
A1380	Initial Operation	0.5m	14-Feb-23	01-Mar-23	0.0m
A1750	Cease Flows to East Ash Pond	0.0m		01-Mar-23*	0.0m



Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

AECOM

Appendix D
Certification of Compliance

Certification of Compliance

In accordance with 40 CFR §257.103(f)(1)(iv)(B)(1), I, Angila Retherford, being a qualified representative of Southern Industrial Gas & Electric Company, do hereby certify, to the best of my knowledge, information, and belief, that the F.B. Culley Generating Station is in compliance with all of the requirements of 40 CFR 257 Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. F.B. Culley's CCR Compliance website is up-to-date and contains all the necessary documentation and notification postings.

Angila Retherford
Signed

Angila Retherford
Printed Name

VP, Environmental & Corp Resp
Title

11/23/20
Date

Appendix E
Groundwater Monitoring Well Location

LEGEND

CCR-AP-11 — MONITORING WELL

CCR-AP-6I — NATURE AND EXTENT MONITORING WELL

APPROXIMATE UNIT BOUNDARY

APPROXIMATE PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS ARE APPROXIMATE
2. CCR COAL COMBUSTION RESIDUALS
3. AERIAL IMAGERY SOURCE: ESRI

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

GROUNDWATER MONITORING WELL LOCATIONS

JANUARY 2020

FIGURE 1

GIS FILE PATH: \\haleyaldrich.com\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2020_01\129420_001_0001_MONITORING_WELL_LOCATIONS_CULLEY.mxd — USER: afeigl — LAST SAVED: 1/10/2020 2:01:30 PM

Appendix F
Well Construction Diagrams

TEST BORING REPORT

Boring No. CCR-AP-1R

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station	File No.	42796-001
Client	Southern Indiana Gas & Electric Company	Sheet No.	1 of 3
Contractor	Stearns Drilling	Start	15 December 2015
		Finish	08 March 2016
		Driller	J. Gryska
		H&A Rep.	J. Yonts

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	S	S	-	Rig Make & Model: Track
Inside Diameter (in.)	4.25	1 3/8	-	Bit Type: / Drill Mud: None
Hammer Weight (lb)	-	140	-	Casing: Auger
Hammer Fall (in.)	-	30	-	Hoist/Hammer: Winch Automatic Hammer / PID Make & Model:

Elevation 438.5 (est.)
Datum
Location
N 969,940
E 2,883,430

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	5 5 5 4	S1 16/24	0.0 2.0		438.0 0.5	--	Top soil with gravel parking lot base	-	-	-	-	-	-	-	-	-	-
						MH	Soft yellow-brown mottled tan elastic SILT, mps = 11 mm, no odor, moist -ALLUVIUM-	-	10	5	-	-	85	N	L	M	M
5	6 9 8 8	S2 18/24	4.0 6.0		434.5 4.0	ML	Medium stiff light brown SILT, mps = 3 mm, no odor, moist -ALLUVIUM-	-	-	-	-	10	90	R	L	N	L
10	2 4 6 5	S3 14/24	9.0 11.0		429.5 9.0	CL	Medium stiff yellow-brown lean CLAY, mps = 10 mm, no odor, moist -ALLUVIUM-	-	10	10	-	-	80	N	M	M	H
	4 6 50/4 -	S4 16/24	14.0 16.0			CL	Medium stiff light brown lean CLAY, mps = 5 mm, no odor, moist	-	-	-	-	10	90	N	M	M	H
15					423.5 15.0		Moderately hard slightly weathered light brown to yellow-brown to red fine-grained SANDSTONE, dry	-	-	-	-	-	-	-	-	-	-
	50/5 - - -	S5 5/5	18.0 21.0				Moderately hard moderately weathered yellow-brown to red fine-grained SANDSTONE, laminar bedding, dry	-	-	-	-	-	-	-	-	-	-
20							Medium hard, highly weathered, light brown SANDSTONE,	-	-	-	-	-	-	-	-	-	-

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/20/15	14:08				52.78

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 15.0
Rock Cored (ft) 50
Samples 13S

Boring No. CCR-AP-1R

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

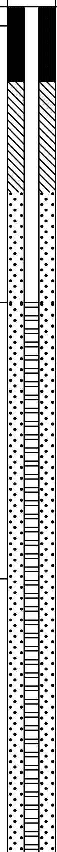
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20							extremely thin bedding, dry										
	50/2 - - -	S6 2/2	24.0 26.0		414.5 24.0		Medium hard highly weathered gray-brown SHALE, friable, dry	-	-	-	-	-	-	-	-	-	-
25																	
	50/5 - - -	S7 5/5	29.0 31.0				Similar as above	-	-	-	-	-	-	-	-	-	-
30							Similar as above	-	-	-	-	-	-	-	-	-	-
35	50/3 - - -	S8 3/3	35.0 37.0				Medium hard moderately weathered gray SHALE, friable, dry to moist	-	-	-	-	-	-	-	-	-	-
40	50/4 - - -	S9 4/4	40.0 42.0				Medium hard moderately weathered gray SHALE, friable, moist	-	-	-	-	-	-	-	-	-	-
45	50/3 - - -	S10 3/3	45.0 47.0				Similar as above	-	-	-	-	-	-	-	-	-	-

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-1R
File No. 42796-001
Sheet No. 3 of 3



Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50	- - -	S11 5/5	50.0 55.0		388.5 50.0		Gray SANDSTONE composed of medium to fine sand. No apparent fractures.	-	-	-	-	-	-	-	-	-	-
					385.1 53.4		Black organic rich layers, coal possible, breaks along laminae with mica and plants (fossil).	-	-	-	-	-	-	-	-	-	-
							Gray SILTSTONE with trace SHALE laminae.	-	-	-	-	-	-	-	-	-	-
55	- - -	S12 5/5	55.0 60.0				Similar to above except 55.2 ft to 55.4 ft black and gray turbidite layer.	-	-	-	-	-	-	-	-	-	-
							Gray SHALE with layers of siltstone, plant (fossil) stems and mica breaks.	-	-	-	-	-	-	-	-	-	-
							Gray SILTSTONE with lamiae of SHALE but mostly SHALE.	-	-	-	-	-	-	-	-	-	-
60	- - -	S13 5/5	60.0 65.0				Gray black SHALE with a few thin beds of gray (lighter) siltstone, pyrite rich SHALE layer from approximately 61.0 ft 61.3 ft.	-	-	-	-	-	-	-	-	-	-
							SHALE/SILTSTONE slight variation throughout except coarser silty layers.	-	-	-	-	-	-	-	-	-	-
65					373.5 65.0		BOTTOM OF EXPLORTION 65.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-2

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station	File No.	42796-001
Client	Southern Indiana Gas & Electric Company	Sheet No.	1 of 2
Contractor	Stearns Drilling	Start	16 December 2015
		Finish	16 December 2015
		Driller	J. Gryska
		H&A Rep.	E. Shirley

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	S	S	-	Rig Make & Model: Track
Inside Diameter (in.)	4.25	1 3/8	-	Bit Type: / Drill Mud: None
Hammer Weight (lb)	-	140	-	Casing: Auger
Hammer Fall (in.)	-	30	-	Hoist/Hammer: Winch Automatic Hammer / PID Make & Model:

Elevation 394.4 (est.)
Datum
Location N 969,118 E 2,884,169

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0							6-inch gravel base	-	-	-	-	-	-	-	-	-	-
	3 5 8 8	S1 21/24	0.0 2.0		393.9 0.5	ML	Medium stiff light brown SILT, mps = 1 mm, no odor, moist -FILL-	-	-	-	-	5	95	S	L	N	M
	3 5 6 6	S2 16/24	3.5 5.5			ML	Similar to S1 above	-	-	-	-	5	95	S	L	N	M
5																	
	0 2 3 4	S3 18/24	8.5 10.5			ML	Similar to S2 above except organic material observed and soft	-	-	-	-	5	95	S	L	N	M
10																	
	0 2 3 6	S4 21/24	13.5 15.5		380.4 14.0	CL	Soft light brown lean CLAY, mps = 3 mm, no odor, moist -FILL-	-	-	-	-	5	95	N	M	M	H
15																	
	1 3 3	S5 24/24	18.5 20.5			CL	Soft dark brown lean CLAY, no odor, moist, organic material observed and wood fibers approximately 19.5 feet	-	-	-	-	-	100	S	L	M	M
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/20/15	14:00				32.48

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 46.0
Rock Cored (ft) -
Samples 15S

Boring No. CCR-AP-2

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-2
File No. 42796-001
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	6															
						-FILL										
	2 3 6 7	S6 22/24	23.5 25.5		CL	Similar as above	-	-	-	-	-	100	S	L	M	M
25																
					CL	Similar as above except organic wood fibers observed	-	-	-	-	-	100	S	L	M	M
	1 3 4 6	S7 25/24	28.0 30.0													
30	2 3 4 4	S8 23/24	30.0 32.0		CL	Similar as above	-	-	-	-	-	100	S	L	M	M
	1 3 4 5	S9 23/24	32.0 34.0			Similar as above	-	-	-	-	-	100	S	L	M	M
35	0 3 4 4	S10 21/24	34.0 36.0	359.4 35.0	MH	Soft, brown, elastic SILT, no odor, moist	-	-	-	-	-	100	S	M	M	M
						-ALLUVIUM-										
	1 3 5 6	S11 23/24	36.0 38.0		MH	Similar as above	-	-	-	-	-	100	S	M	M	M
	0 2 3 4	S12 22/24	38.0 40.0		MH	Similar as above	-	-	-	-	-	100	S	M	M	M
40	1 2 3 4	S13 24/24	40.0 42.0		MH	Similar as above	-	-	-	-	-	100	S	M	M	M
				352.9 41.5	ML	Soft brown sandy SILT, mps = 1 mm, no odor, wet	-	-	-	-	30	70	R	L	N	L
	1 2 2 2	S14 24/24	42.0 44.0	352.4 42.0	MH	Soft brown elastic SILT, no odor, wet	-	-	-	-	-	100	S	M	M	M
						1-inch sandy SILT at 43.5 feet	-	-	-	-	30	70	S	M	M	M
45	0 1 2 2	S15 24/24	44.0 46.0		MH	Similar as above except more sand	-	-	-	-	40	60	S	M	M	M
				348.4 46.0		-BOTTOM OF EXPLORATION 46.0 FT-										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-2

HALEY ALDRICH — TEST BORING REPORT

Boring No. CCR-AP-3

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	Stearns Drilling

File No.	42796-001
Sheet No.	1 of 2
Start	15 December 2015
Finish	15 December 2015
Driller	J. Gryska
H&A Rep.	E. Shirley
Elevation	395.1 (est.)
Datum	
Location	N 969,008 E 2,883,542

	Casing	Sampler	Barrel
Type	S	S	-
Inside Diameter (in.)	4.25	1 3/8	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures
Rig Make & Model: Track
Bit Type:
Drill Mud: None
Casing: Auger
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	12 24 24 16	S1 24/24	0.0 2.0				Gravel and sand road base material	-	-	-	-	-	-	-	-	-	-
					394.1 1.0	ML	Stiff dark brown SILT, mps = 20 mm, no odor, moist. Grades brown at 1.75 feet -FILL-	5	5	10	-	-	80	S	L	L	L
	5 7 8 7	S2 17/24	4.0 6.0														
5					390.1 5.0	CL	Stiff dark brown lean CLAY, mps = 10 mm, no odor, moist, organic material observed -FILL-	-	5	5	-	-	90	N	M	M	H
	1 1 1 1	S3 16/24	9.0 11.0														
10					385.1 10.0	MH	Soft brown elastic SILT, mps = 5 mm, no odor, moist -FILL-	-	-	-	-	15	85	S	L	L	M
	1 1 2 4	S4 11/24	14.0 16.0														
15					380.1 15.0	CL	Soft brown lean CLAY, mps = 12 mm, no odor, moist -FILL-	-	5	-	-	-	95	N	M	M	H
	2 2	S5 19/24	19.0 21.0														
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/20/15	13:40				43.00

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 45.0
Rock Cored (ft) -
Samples 15S

Boring No. CCR-AP-3

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-3
File No. 42796-001
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	3 4					CL	Medium stiff brown lean CLAY, mps = 25 mm, no odor, moist	5	5	5	-	-	85	N	M	M	H
25	1 1 3 4	S6 18/24	24.0 26.0			CL	Soft dark brown lean CLAY, mps = 5 mm, no odor, moist	-	-	-	5	5	90	N	M	M	H
	0 0 1 3	S7 24/24	28.0 30.0			CL	Soft dark brown lean CLAY, mps = 3 mm, no odor, moist	-	-	-	-	5	95	N	M	M	H
30	0 2 3 5	S8 21/24	30.0 32.0			CL	Similar as above	-	-	-	-	5	95	N	M	M	H
	0 0 3 4	S9 24/24	32.0 34.0			CL	Similar as above	-	-	-	-	5	95	N	M	M	H
35	3 5 6 7	S10 20/24	34.0 36.0			CL	Similar as above except wood in shoe at 36 feet	-	-	-	-	5	95	N	M	M	H
	2 5 5 9	S11 22/24	36.0 38.0			CL	Similar as above	-	-	-	-	5	95	N	M	M	H
	3 5 6 6	S12 22/24	38.0 40.0		355.1 40.0	CL	Similar as above	-	-	-	-	5	95	N	M	M	H
40	2 3 4 5	S13 24/24	40.0 42.0			CL	Similar as above except organic material and interbedded 1- to 2-inch sand layers -ALLUVIUM-	-	-	-	-	5	95	N	M	M	H
	0 1 2 3	S14 24/24	42.0 44.0			CL	Similar as above	-	-	-	-	5	95	N	M	M	H
	0 0	S15 12/12	44.0 45.0		350.6 44.5	CL	Similar as above	-	-	-	-	5	95	N	M	M	H
					350.1 45.0	MH	Dark brown SILT, moist to wet at 44.5 feet	-	-	-	-	5	95	S	L	L	L
45	- -						-BOTTOM OF EXPLORATION 45 FT-										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-3

TEST BORING REPORT

Boring No. CCR-AP-4

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station	File No.	42796-001
Client	Southern Indiana Gas & Electric Company	Sheet No.	1 of 2
Contractor	Stearns Drilling	Start	16 December 2015
		Finish	16 December 2015
		Driller	J. Gryska
		H&A Rep.	E. Shirley
		Elevation	395.4 (est.)
		Datum	
		Location	N 969,642 E 2,883,282

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	S	S	-	Rig Make & Model: Track
Inside Diameter (in.)	4.25	1 3/8	-	Bit Type: Drill Mud: None
Hammer Weight (lb)	-	140	-	Casing: Auger
Hammer Fall (in.)	-	30	-	Hoist/Hammer: Winch Automatic Hammer PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	6 6 4 7	S1 19/24	0.0 2.0				Gravel base	-	-	-	-	-	-	-	-	-	-
					394.4 1.0	CL	Stiff brown lean CLAY, mps = 10 mm, no odor, moist -FILL-	5	-	-	-	-	95	N	M	M	H
5	4 6 10 12	S2 15/24	4.0 6.0		391.4 4.0	SW	Loose brown well-graded SAND, mps = 8 mm, no odor, moist -FILL-	-	5	25	35	30	5	-	-	-	-
10	1 2 1 2	S3 12/24	9.0 11.0			SW	Very loose brown well-graded SAND, mps = 9 mm, no odor, wet -FILL-	-	5	30	35	25	5	-	-	-	-
15	3 5 8 10	S4 10/24	14.0 16.0		381.4 14.0	MH	Medium stiff brown elastic SILT, no odor, moist -ALLUVIUM-	-	-	-	-	-	100	S	L	L	M
20	2 3	S5 15/24	19.0 21.0			MH	Soft, brown, elastic SILT, no odor, moist	-	-	-	-	-	100	S	L	L	M

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/20/15	13:33				7.11

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram: Riser Pipe, Screen, Filter Sand, Cuttings, Grout, Concrete, Bentonite Seal

Summary
- Overburden (ft) 35.5
- Rock Cored (ft) -
- Samples 10S

Boring No. CCR-AP-4

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	4 5																
	3 3 2 3	S6 19/24	24.0 26.0		371.4 24.0	CL	Soft dark brown lean CLAY, mps = 2 mm, no odor, moist -ALLUVIUM-	-	-	-	-	5	95	N	M	M	H
25																	
	1 2 4 3	S7 24/24	28.0 30.0			CL	Similar as above	-	-	-	-	-	-	-	-	-	-
30	0 3 2 3	S8 21/24	30.0 32.0			CL	Similar as above	-	-	-	-	-	-	-	-	-	-
							2-inch pocket of brown SILT at 31.5 feet	-	-	-	-	-	-	-	-	-	-
	1 2 4 7	S9 22/24	32.0 34.0			CL	Similar as above	-	-	-	-	-	-	-	-	-	-
						CL	Medium stiff gray mottled brown lean CLAY, mps = 12 mm, no odor, moist	-	5	5	5	-	85	N	M	M	H
35	2 4 50/1 -	S10 13/24	34.0 36.0		360.4 35.0		Highly weathered gray SHALE, friable	-	-	-	-	-	-	-	-	-	-
					359.9 35.5		-REFUSAL AT 35.5 FT-										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. CCR-AP-5

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	Stearns Drilling

File No.	42796-001
Sheet No.	1 of 2
Start	18 December 2015
Finish	18 December 2015
Driller	J. Gryska
H&A Rep.	E. Shirley
Elevation	394.8 (est.)
Datum	
Location	N 969,380 E 2,884,017

	Casing	Sampler	Barrel
Type	S	S	-
Inside Diameter (in.)	4.25	1 3/8	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures
Rig Make & Model: Track
Bit Type:
Drill Mud: None
Casing: Auger
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	5 5 7 9	S1 21/24	0.0 2.0		394.3 0.5		Gravel base	-	-	-	-	-	-	-	-	-	-
						CL	Medium stiff brown gravelly lean CLAY, mps = 33 mm, no odor, moist -FILL-	25	5	-	-	-	70	N	M	M	H
5	4 7 9 16	S2 24/24	4.0 6.0			CL	Medium stiff brown gravelly lean CLAY, mps = 25 mm, no odor, moist	25	15	-	-	-	65	N	M	M	H
10	2 4 3 2	S3 14/24	9.0 11.0			CL	Soft gray lean CLAY with weathered shale, mps = 40 mm, no odor, wet	40	-	-	-	-	60	N	M	M	H
					385.3 9.5		Moderately hard moderately weathered gray SHALE, friable, wet	-	-	-	-	-	-	-	-	-	-
15	4 2 3 3	S4 14/24	14.0 16.0				Medium hard highly weathered gray SHALE, friable, moist	-	-	-	-	-	-	-	-	-	-
20	8 19	S5 14/24	19.0 21.0				Medium hard highly weathered gray SHALE, friable, moist	-	-	-	-	-	-	-	-	-	-

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/20/15	14:04				9.92

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 9.5
Rock Cored (ft) 35.5
Samples 14S

Boring No. CCR-AP-5

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-5
File No. 42796-001

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	6 12																
25	5 6 7 9	S6 15/24	24.0 26.0				Medium hard highly weathered gray SHALE, friable, moist	-	-	-	-	-	-	-	-	-	-
					369.3 25.5		Moderately hard highly weathered brown SANDSTONE, friable, moist	-	-	-	-	-	-	-	-	-	-
	4 3 6 8	S7 20/24	28.0 30.0				Similar as above except moderately weathered at 28 feet	-	-	-	-	-	-	-	-	-	-
							Similar as above except highly weathered and brown to gray at 29 feet	-	-	-	-	-	-	-	-	-	-
30	2 4 4 4	S8 17/24	30.0 32.0														
	1 3 4 5	S9 16/24	32.0 34.0				Similar as above	-	-	-	-	-	-	-	-	-	-
35	3 2 2 2	S10 19/24	34.0 36.0				Similar as above	-	-	-	-	-	-	-	-	-	-
							Soft highly weathered brown SANDSTONE, wet	-	-	-	-	-	-	-	-	-	-
	2 3 4 19	S11 20/24	36.0 38.0				Medium hard highly weathered brown SANDSTONE, friable, moist	-	-	-	-	-	-	-	-	-	-
	36 13 6 6	S12 14/24	38.0 40.0				Similar as above	-	-	-	-	-	-	-	-	-	-
40	9 33 22 16	S13 21/24	40.0 42.0				Similar as above	-	-	-	-	-	-	-	-	-	-
	6 20 38 40	S14 14/24	42.0 44.0				Similar as above	-	-	-	-	-	-	-	-	-	-
					351.3 43.5		Soft, black COAL, friable, moist	-	-	-	-	-	-	-	-	-	-
					350.8 44.0		BOTTOM OF EXPLORTION 44.0 FT-										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-5

TEST BORING REPORT

Boring No. CCR-AP-6

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	Stearns Drilling

File No.	42796-001
Sheet No.	1 of 2
Start	08 March 2016
Finish	09 March 2016
Driller	J. Gryska
H&A Rep.	S. Lewis
Elevation	397.0 (est.)
Datum	
Location	N 969,122 E 2,883,285

	Casing	Sampler	Barrel
Type	-	S	-
Inside Diameter (in.)	-	1 3/8	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: CME 850 XR Air Track
Bit Type:
Drill Mud: None
Casing: Auger
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						ML	Brown/dark brown SILT -FILL-	-	-	-	-	-	-	-	-	-	-
	2 7 10 7	S1 18/24	3.5 5.5			ML	Very stiff bown SILT (ML), mps 19.0 mm, no odor, dry	-	5	-	-	10	85	-	-	-	-
5																	
	3 8 9 12	S2 20/24	8.5 10.5			ML	Very stiff olive brown SILT (ML), mps 2.0 mm, no odor, dry, wood fragments present	-	-	-	5	5	90	-	-	-	-
10																	
	2 3 3 4	S3 18/24	13.5 15.5		383.5 13.5	CL	Medium stiff olive gray lean CLAY with sand (CL), mps 2.0 mm, no odor, moist, rounded sand, black wood fragments present -FILL-	-	-	-	15	5	80	-	-	-	-
15																	
	1 1 3	S4 22/24	18.5 20.5			CL	Soft olive gray lean CLAY with sand (CL), mps 2.0 mm, no odor, wet, black wood fragments present, rounded sand	-	-	-	10	5	85	-	-	-	-
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	45.5
Rock Cored (ft)	-
Samples	15S

Boring No. CCR-AP-6

Field Tests:
Dilatancy: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	6																
25	2 2 4 4	S5 22/24	23.5 25.5			CL	Medium stiff olive gray lean CLAY with sand (CL), mps 2.0 mm, no odor, moist, black wood fragments present, rounded sand	-	-	-	10	5	85	-	-	-	-
30	4 5 6 6	S6 18/24	28.5 30.5		368.5 28.5	SW-SC	Medium dense olive gray well graded SAND with clay and gravel (SW-SC), mps 19.0 mm, no odor, wet	15	15	20	20	10	20	-	-	-	-
					367.5 29.5	SC	Medium dense olive gray clayey SAND (SC), no odor, wet, wood fragments present -ALLUVIUM-	-	-	-	10	60	30	-	-	-	-
35	3 4 7 8	S7 12/24	33.5 35.5				*Drove with 3.0 in. spoon due to no recovery.	-	-	-	-	-	-	-	-	-	-
					363.0 34.0	CL	Stiff olive gray lean CLAY with sand (CL), mps 2.0 mm, no odor, wet, wood fragments present -ALLUVIUM-	-	-	-	15	5	80	-	-	-	-
40	2 2 2 3	S8 24/24	38.5 40.5			CL	Soft gray lean CLAY (CL), no odor, wet, wood fragments present	-	-	-	5	5	90	-	-	-	-
45	1 3 2 3	S9 24/24	43.5 45.5			CL	Medium stiff gray sandy lean CLAY (CL), no odor, wet, wood fragments present	-	-	-		40	60	-	-	-	-
					351.5 45.5		BOTTOM OF EXPLORATION 45.5 FT										

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-7

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	Stearns Drilling

File No.	42796-001
Sheet No.	1 of 2
Start	09 March 2016
Finish	09 March 2016
Driller	J. Gryska
H&A Rep.	S. Lewis
Elevation	429.5 (est.)
Datum	
Location	N 970,775 E 2,883,090

	Casing	Sampler	Barrel
Type	-	S	-
Inside Diameter (in.)	-	1 3/8	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: CME 850 XR Air Track
Bit Type:
Drill Mud: None
Casing: Auger
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						ML	Brown SILT (ML), trace coarse gravel -FILL-	-	-	-	-	-	-	-	-	-	-
	1 1 2 3	S1 16/24	3.0 5.0			ML	Soft brown SILT with sand (ML), no odor, moist, mottle with gray and red colors	-	-	-	-	15	85	-	-	-	-
5																	
	2 2 2 7	S2 17/24	8.0 10.0		421.5 8.0	ML	Very stiff olive brown SILT (ML), mps 2.0 mm, no odor, dry, wood fragments present -ALLUVIUM-	-	-	-	-	15	85	-	-	-	-
10																	
	1 2 3 2	S3 19/24	13.0 15.0			ML	Medium stiff gray SILT with sand (CL), no odor, moist, wood fragments present	-	-	-	-	15	85	-	-	-	-
15																	
	1 2 3 3	S4 20/24	18.0 20.0			ML	Medium stiff gray SILT with sand (ML), no odor, wet	-	-	-	-	15	85	-	-	-	-
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	35.0
Rock Cored (ft)	-
Samples	5S

Boring No. CCR-AP-7

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																	
	1 1 2 1	S5 24/24	23.0 25.0			ML	Soft gray sandy SILT (ML), no odor, wet	-	-	-	-	30	70	-	-	-	-
25																	
	1 1 1 2	S6 24/24	28.0 30.0			CL	Soft gray lean CLAY (CL), no odor, wet, mottled with black colors, possibly organic matter	-	-	-	-	10	90	-	-	-	-
30																	
	1 2 3 3	S7 24/24	33.0 35.0			CL	Medium stiff gray lean CLAY (CL), no odor, wet	-	-	-	-	10	90	-	-	-	-
35					394.5 35.0												

BOTTOM OF EXPLORATION 35.5 FT

Notes:
Well set at 30.0 ft.
35.0 ft o 34.0 ft backfilled with bedtonite.
30.0 ft to 34.0 ft backfilled with sand.

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-07-1 HA-LIB09-REV.GLB HA-TB+CORE+WELL-07-1.GDT \\GRN\COMMON\42796 - VECTREN\FB CULLEY\GINT\F.B. CULLEY LOGS.GPJ Apr 20, 17

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-8

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	Stearns Drilling

File No.	42796-001
Sheet No.	1 of 2
Start	15 February 2017
Finish	15 February 2017
Driller	W. Bates
H&A Rep.	S.Lewis
Elevation	394.1 (est.)
Datum	
Location	N 969,046 E 2,883,847

	Casing	Sampler	Barrel
Type	S	S	--
Inside Diameter (in.)	4.25	1 3/8	--
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Track
Bit Type:
Drill Mud: None
Casing: Auger
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0																	
	6 7 9 10	S1 18	3.5 5.5			ML	Very stiff, brown, SILT(ML), MPS = 19 mm, no structure, no odor, dry	-	10	-	-	5	85	-	-	L	-
5					389.6 4.5	ML	-FILL- Very stiff, brown, SILT(ML), MPS = 4 mm, no structure, no odor, dry -FILL-	-	-	-	-	5	95	-	-	L	-
	3 2 3 4	S2 16	8.5 10.5		385.6 8.5	CL	Stiff, grayish brown, lean CLAY (CL), MPS = < 0.08 mm, no structure, no odor, dry, rootlets present	-	-	-	-	-	100	-	-	M-H	-
10																	
	3 2 3 4	S3 20	13.5 15.5		380.6 13.5	CL	Medium stiff, gray, lean CLAY (CL), MPS = < 0.08mm, no structure, no odor, moist	-	-	-	-	-	100	-	-	M-H	-
15																	
	3 3 4	S4 18	18.5 20.5		375.6 18.5	CL	Medium stiff, dark gray, lean CLAY (CL), MPS = < 0.08mm, no structure, no odor, moist, black wood fragments present	-	-	-	-	-	100	-	-	M-H	-
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
2/16/17	16:00				Dry

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	45.5
Rock Cored (ft)	-
Samples	9S

Boring No. CCR-AP-8

Field Tests:
Dilatancy: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	5																
25	2 2 3 4	S5 20	23.5 25.5		370.6 23.5	CL	Similar to S4, rootlets present	-	-	-	-	-	100	-	-	M-H	-
30	1 2 3 3	S6 23	28.5 30.5		365.6 28.5	CL	Similar to S4	-	-	-	-	-	100	-	-	M-H	-
35	2 2 3 5	S7 24	33.5 35.5		360.6 33.5	CL	Simlar to S4	-	-	-	-	-	100	-	-	M-H	-
					358.1 36.0	CL	Medium Stiff, dark gray, sandy lean CLAY (CL), MPS = 0.43 mm, interbedded, no odor, wet -ALLUVIUM-	-	-	-	-	30	70	-	-	M	-
					357.9 36.3	CL	Medium stiff, gray, lean CLAY (CL), MPS = < 0.08mm, no structure, no odor, moist, black wood fragments present -ALLUVIUM-	-	-	-	-	-	100	-	-	M-H	-
40	2 2 4 6	S8 24	38.5 40.5		355.6 38.5	CL	Similar to S7	-	-	-	-	-	100	-	-	M-H	-
45	1 2 4 4	S9 24	43.5 45.5														
					348.9 45.3	CL	Medium Stiff, gray, sandy lean CLAY (CL), MPS = 0.43, interbedded, no odor, wet	-	-	-	-	30	70	-	-	M	-
					348.6 45.5		END OF BORING AT 45.5 FT										

HALEY ALDRICH — TEST BORING REPORT

Boring No. CRR-AP-9

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station	File No.	42796-001
Client	Southern Indiana Gas & Electric Company	Sheet No.	1 of 3
Contractor	Stearns Drilling	Start	14 February 2017
		Finish	15 February 2017
		Driller	W.Bates
		H&A Rep.	S.Lewis

	Casing	Sampler	Barrel
Type	S	S	--
Inside Diameter (in.)	4.25	1 3/8	--
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures
Rig Make & Model: Track
Bit Type:
Drill Mud: None
Casing: Auger/Steel
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model:

Elevation 445.6 (est.)
Datum
Location
N 969,769
E 2,883,999

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0																	
	5 6 7 8	S1 17	3.5 5.5			ML	Stiff, brownish gray, SILT (ML), MPS = 0.08, laminated with interbedded layers of clay, no odor, dry	-	-	-	-	-	100	-	-	L-M	-
5							-ALLUVIUM-										
	4 7 9 11	S2 21	8.5 10.5		437.1 8.5	CL	Very stiff, grayish brown CLAY (CL), MPS = 0.08, laminated with interbedded layers of silt, no odor, dry, orange and black mottling	-	-	-	-	-	100	-	-	M	-
10																	
	5 8 20 50/2	S3 15	13.5 15.5		431.1 14.5		Gray, soft weathered SHALE, no structure, clayey, brown mottling, dry	-	-	-	-	-	-	-	-	-	-
15	- - - -	S4 53	15.1 20.1		430.5 15.1		Switched to rock coring at 15.5 ft Gray, LIMESTONE, no structure, fracture at 16.5 feet	-	-	-	-	-	-	-	-	-	-
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 14.5
Rock Cored (ft) 55.3
Samples 14S

Boring No. CRR-AP-9

Field Tests:
Dilatancy: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	- - - -	S5 60	19.8 24.8		425.6 20.0		Gray, weathered SHALE, no structure, organic fragments 20.5-21.0 feet	-	-	-	-	-	-	-	-	-	-
					421.1 24.5		Light gray, weathered SHALE, no structure	-	-	-	-	-	-	-	-	-	-
25	- - - -	S6 58	24.8 29.8		420.6 25.0		Gray, fine grained SANDSTONE	-	-	-	-	-	-	-	-	-	-
					416.6 29.0		Gray, fine grained SANDSTONE, interbedded layers of soft weathered SHALE	-	-	-	-	-	-	-	-	-	-
30	- - - -	S7 60	29.8 34.8														
					414.6 31.0		Gray, fine to medium grained SANDSTONE	-	-	-	-	-	-	-	-	-	-
					412.1 33.5		Gray, fine grained, SANDSTONE, interbedded layers of soft weathered SHALE	-	-	-	-	-	-	-	-	-	-
35	- - - -	S8 60	34.8 39.8		410.8 34.8		Gray, SHALE, very fine layering, interbedded layers of competent fine grainded SANDSTONE	-	-	-	-	-	-	-	-	-	-
40	- - - -	S9 22	39.8 44.8		405.8 39.8		Gray, fine grained, SANDSTONE, interbedded layers of soft weathered SHALE	-	-	-	-	-	-	-	-	-	-
45	- - - -	S10 60	44.8 49.8		400.8 44.8		Gray, SHALE, interbedded very fine layers of organics *brown/dark brown organic matter surfacing with drilling water, floats on water	-	-	-	-	-	-	-	-	-	-
					398.1 47.5		Dark gray, SHALE, thinly laminated	-	-	-	-	-	-	-	-	-	-

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. CRR-AP-9
File No. 42796-001
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50	- - - -	S11 60	49.8 54.8														
55	- - - -	S12 60	54.8 59.8		390.8 54.8		Dark gray, very fine grained, SANDSTONE, frequent very fine interbedded layers of organics,	-	-	-	-	-	-	-	-	-	-
60	- - - -	S13 60	59.8 64.8														
65	- - - -	S14 60	64.8 69.8														
					375.8 69.8 375.6 70.0		END OF BORING AT 69.8 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CRR-AP-9

H&A-TEST BORING-07-1 HA-LIB09-REV.GLB HA-TB+CORE+WELL-07-1.GDT \\GRN\COMMON\42796 - VECTREN\FB CULLEY\GINT\F.B. CULLEY LOGS.GPJ Apr 20, 17

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-10

Project	Nature and Extent, F. B. Culley Generating Station	File No.	129402-017
Client	Southern Indiana Gas & Electric Company	Sheet No.	1 of 2
Contractor	ATC	Start	January 10, 2019
		Finish	January 10, 2019
		Driller	J. Mitchner
		H&A Rep.	J. Yonts
		Elevation	402.4
		Datum	
		Location	Between CCR-AP-5 and 4, N of EAP

	Casing	Sampler	Barrel
Type	HSA	S	
Inside Diameter (in.)	4.25	1 3/8	
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures
- Rig Make & Model: Diedrich D-50 Turbo
- Bit Type: Cutting Head
- Drill Mud: None
- Casing: Spun
- Hoist/Hammer: Winch Automatic Hammer
- PID Make & Model: -

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							Gravel road base										
	4 4 4	S1 7	3.5 5.0	ML		398.4 4.0	Medium stiff, yellow-brown SILT with gravel (ML), mps 25 mm, stratified, no odor, moist	15	10	5	5	10	55				
5																	
	5 5 5 5	S2 13	8.5 10.5	ML		393.9 8.5	Stiff, brown SILT with sand (ML), mps 1.0 mm, stratified, no odor, moist				10	20	70				
				ML		393.4 9.0	Stiff, brown and red-brown SILT (ML), mps <0.075 mm, no structure, no odor, moist						100				
10				SM		392.6 9.8	Stiff, tan silty SAND (SM), mps 0.8 mm, no structure, no odor, dry					80	20				
				CL		392.2 10.2	Stiff, yellow-brown and dark brown CLAY (CL), mps <0.075 mm, stratified, no odor, moist Note: Rig chatter at ~13 ft.						100				
	50/3"	S3 1	13.5 15.5			388.9 13.5	Hard, slightly weathered, gray, fine-grained SANDSTONE										
15																	
	38 50/2"	S4 13	18.5 20.5			383.9 18.5	Hard, highly weathered, gray-brown and black, fine-grained SANDSTONE interbedded with soft, highly weathered, gray, fine-grained SILTSTONE. Bedding very thin and horizontal, primary joint set horizontal, very close, rough, planar, discolored, open.										
20	19 50/3"	S5 12	20.5 22.5			381.9 20.5	Soft, highly weathered, gray, fine-grained SHALE interbedded with hard, highly weathered, gray-brown and black, fine-grained SANDSTONE. Bedding very thin and horizontal, primary joint set horizontal, very close, rough, planar, discolored, open. Similar to above										
	49 50/4"	S6 10	22.5 24.5			379.4 23.0	Hard, highly weathered, gray-brown and black, fine-grained SANDSTONE interbedded with soft, highly weathered, gray, fine-										
25	50/4"	S7	24.5			377.9 24.5											

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
2/13/19	49.56				

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary
- Overburden (ft) 50.5
- Rock Cored (ft) -
- Samples 19S

Boring No. CCR-AP-10

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
25		4	26.5				grained SILTSTONE. Bedding very thin and horizontal, primary joint set horizontal, very close, rough, planar, discolored, open.										
	50/5"	S8 5	26.5 28.5			375.9 26.5	Soft, slightly weathered, gray and brown, fine-grained SHALE interbedded with medium hard, slightly weathered, brown, fine-grained SANDSTONE. Bedding very thin and horizontal, primary joint set horizontal, very close, rough, planar, discolored, open.										
	50/3"	S9 3	28.5 30.5				Medium hard, slightly weathered, gray, fine-grained SHALE. Bedding very thin and horizontal, primary joint set horizontal, very close, smooth, planar, fresh, closed.										
30	39 50/2"	S10 8	30.5 32.5				Similar to above with frequent organic material										
	50/5"	S11 5	32.5 34.5				Similar to above with no observed organic material										
35	50/2"	S12 2	34.5 36.5														
	26 50/2"	S13 8	36.5 38.5			365.9 36.5	Medium hard, slightly weathered, dark gray, fine-grained SHALE. Bedding very thin and horizontal, primary joint set horizontal, very close, smooth, planar, fresh, closed.										
	50/4"	S14 4	38.5 40.5														
40	50/3"	S15 3	40.5 42.5														
	50/4"	S16 4	42.5 44.5														
45	50/3"	S17 3	44.5 46.5														
	50/5"	S18 5	46.5 48.5														
	50/5"	S19 5	48.5 50.5														
50						351.9 50.5	BOTTOM OF EXPLORATION 50.5 FT										

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-11

Project	Nature and Extent, F. B. Culley Generating Station	File No.	129402-017
Client	Southern Indiana Gas & Electric Company	Sheet No.	1 of 2
Contractor	ATC	Start	January 11, 2019
		Finish	January 11, 2019
		Driller	J. Mitchner
		H&A Rep.	J. Yonts
		Elevation	385.1
		Datum	
		Location	See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S		Rig Make & Model: Diedrich D-50 Turbo
Inside Diameter (in.)	4.25	1 3/8		Bit Type: Cutting Head; Drill Mud: None
Hammer Weight (lb)	-	140	-	Casing: Spun
Hammer Fall (in.)	-	30	-	Hoist/Hammer: Winch Automatic Hammer; PID Make & Model: -

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0				CL-ML			Dark brown to black CLAY and SILT (CL-ML), mps < 0.075 mm, no structure, no odor, dry, coal ash										
	3 3 3 5	S1 20	3.5 5.5	CL		381.6 3.5	Medium stiff, dark brown and olive CLAY with gravel (CL), mps 50 mm, stratified, no odor, moist, frequent coal	5	10	5			80				
5				ML		379.8 5.3	Medium stiff, light gray to white SILT (ML), mps 1 mm, no structure, no odor, moist, frequent coal				5	5	90				
	2 4 9 2	S2 10	8.5 10.5	CL		376.6 8.5	Stiff, dark brown and olive CLAY with gravel (CL), mps 50 mm, stratified, no odor, moist, frequent coal and plant material	5	5	5		5	80				
10																	
	2 2 2 2	S3 11	13.5 15.5	CL		371.6 13.5	Soft, dark brown and black CLAY with gravel (CL), mps 30 mm, stratified, no odor, wet, frequent coal and limestone gravel, occasional black woody material	10	10	5	5	5	65				
15																	
	2 2 3 5	S4 12	18.5 20.5	CL		366.6 18.5	Medium stiff, brown and black CLAY with gravel (CL), mps 0.2 mm, stratified, no odor, wet					10	90				
20																	
	3 4 6	S5 14	23.5 25.5	CL		361.6 23.5	Stiff, red-brown and gray CLAY (CL), mps < 0.075 mm, no structure, no odor, wet						100				
25																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID: O - Open End Rod; T - Thin Wall Tube; U - Undisturbed Sample; S - Split Spoon Sample

Well Diagram: Riser Pipe; Screen; Filter Sand; Cuttings; Grout; Concrete; Bentonite Seal

Summary

Overburden (ft)	54.7
Rock Cored (ft)	-
Samples	13S

Boring No. CCR-AP-11

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-11
File No. 129402-017
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
25	8																
	4 6 10 11	S6 16	26.0 28.0	CL			Very stiff, red-brown CLAY (CL), mps 8 mm, no structure, no odor, wet		5	5	5	5	80				
	4 5 8 11	S7 24	28.0 30.0														
30	12 12 12 11	S8 24	30.0 32.0	CL			Very stiff, red-brown CLAY (CL), mps 8 mm, no structure, no odor, wet, frequent black woody material										
35	2 2 3 3	S9 24	34.0 36.0	ML		350.7 34.4	Medium stiff, brown and gray SILT with sand (ML), mps 1.0 mm, stratified, no odor, wet				10	20	70				
40	1 2 2 1	S10 20	39.0 41.0	SM		346.1 39.0	Soft, yellow-brown silty SAND (SM), mps 0.2 mm, no structure, no odor, wet, coarsening with depth					80	20				
45	2 1 1 2	S11 24	44.0 46.0	SM-CL		341.1 44.0	Soft, gray silty SAND (SM) interbedded with soft, gray CLAY (CL), mps 1.0 mm, no door, wet				20	60 5	20 95				
50	WOH 1 2 2	S12 24	49.0 51.0	SM-ML		336.1 49.0	Soft, gray silty SAND (SM) interbedded with soft, gray SILT (ML), mps 1.0 mm, no door, wet				10	70 10	20 90				
							Note: Rig chatter at ~53.0 ft bgs.										
	28 50/2"	S13 8	54.0 56.0			331.1 54.0 330.4 54.7	Medium hard, slightly weathered, gray, aphanitic SHALE. Bedding very thin and horizontal, primary joint set horizontal, very close, smooth, planar, fresh, closed.										
							BOTTOM OF EXPLORATION 54.7 FT BGS										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-11

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-5I

Project	Nature and Extent, F. B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	ATC

File No.	129402-017
Sheet No.	1 of 5
Start	January 7, 2019
Finish	January 9, 2019
Driller	J. Mitchner
H&A Rep.	J. Yonts
Elevation	395.0
Datum	
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	Steel
Inside Diameter (in.)	4.25	1 3/8	1 7/8
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Diedrich D-50 Turbo
Bit Type: Cutting Head
Drill Mud: None
Casing: Spun
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model: -

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							Refer to Soil Boring CCR-AP-5 for lithology from 0-40 ft.										
5																	
10																	
15																	
20																	
25																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
2/13/19	10.18				

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft) 49.1
Rock Cored (ft) 36.2
Samples 5S, 7C

Boring No. CCR-AP-5I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
25																	
30																	
35																	
40	5 1 3	S1 6	39.0 40.5				Medium, highly weathered, brown, medium-grained SANDSTONE, wet Note: Rig chatter/bounce at ~41 ft.										
	3 5 50/4"	S2 10	40.5 42.5														
	9 32 34 34	S3 10	42.5 44.5			351.5 43.5	Soft, highly weathered, black, fine-grained COAL, moist										
						351.0 44.0	Soft, highly weathered, gray, fine-grained SILTSTONE, moist										
45	10 14 17 22	S4 24	44.5 46.5			349.7 45.3	Soft, highly weathered, brown, tan, gray and yellow, aphanitic SHALE, moist Very soft, completely weathered, brown and tan, aphanitic SHALE, moist										
	9 50/1"	S5 7	46.5 48.5			348.3 46.7	Hard, highly weathered, gray, fine-grained LIMESTONE with brown CLAY, wet to moist Note: Rig chatter at ~47 ft.										
						345.9 49.1	Hard, fresh to slightly weathered, greenish gray to light gray, fine-grained LIMESTONE. No bedding, moderately dipping fractures, rough, tan discoloration, open, bioturbated										
50		C1 55	50.0 55.0			344.7 50.3	Soft, moderately weathered, gray and brown, fine-grained SHALE. Bedding extremely thin and horizontal, cleavage joints horizontal, extremely close, smooth, fresh, tight Medium hard, moderately weathered, gray, fine-grained SHALE. Bedding extremely thin and horizontal, cleavage joints horizontal, extremely close, smooth, discolored, tight. Thin occasional pyrite veins										
55	50/2"	S6 2	55.0 57.0				Similar to above except no pyrite, aphanitic and moist										
	50/3"	S7 3	57.0 59.0														
60	50/5"	S8 5	59.0 61.0			336.0 59.0	Soft, moderately weathered, tan and gray, fine-grained SHALE. Bedding extremely thin and horizontal, cleavage joints horizontal, extremely close, smooth, discolored, tight.										
	50/4"	S9 4	61.0 63.0			334.0 61.0	Medium hard, moderately weathered, gray, fine-grained SHALE. Bedding extremely thin and horizontal, cleavage joints horizontal,										

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
							extremely close, smooth, discolored, tight.										
	50/5"	S10 5	63.0 64.3														
65		C2 12	64.3 65.3				Medium hard, fresh, dark gray to gray, aphanitic SHALE. Bedding extremely thin and horizontal, cleavage joints horizontal, extremely close, smooth, fresh, tight										
		C3 50	65.3 70.3														
70		C4 60	70.3 75.3			324.7 70.3	Hard, fresh, dark gray to gray, aphanitic organic SHALE interbedded with gray, fine-grained SILTSTONE. Bedding extremely thin and horizontal, cleavage joints horizontal, extremely close to very close, smooth, fresh, tight. Trace plant fossils in SHALE 3 to 5 mm dissolution zone filled with pyrite										
75		C5 60	75.3 80.3			319.7 75.3	Similar to above except no visible fossils										
80		C6 60	80.3 85.3														
85						309.7 85.3	BOTTOM OF EXPLORATION 85.3 FT.										

TEST BORING REPORT

Boring No. CCR-AP-6I

Project	Nature and Extent, F. B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	ATC

File No.	129402-017
Sheet No.	1 of 3
Start	November 15, 2018
Finish	November 16, 2018
Driller	Z. Vaughen
H&A Rep.	S. Lewis
Elevation	397.2
Datum	
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	
Inside Diameter (in.)	4.25	1 3/8	
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Geoprobe 8040DT
Bit Type: Cutting Head
Drill Mud: None
Casing: Spun
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model: -

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							Refer to Test Boring CCR-AP-6 for lithology from 0-38 ft.										
5																	
10																	
15																	
20																	
25																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
2/13/19	20.09				

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	75.0
Rock Cored (ft)	-
Samples	8S

Boring No. CCR-AP-6I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
25																	
30																	
35																	
	3 1 2 4	S1 20	38.0 40.0	CL		359.2 38.0	Soft, gray CLAY (CL) with occasional small pockets of gray poorly-graded SAND (SP), mps 0.40 mm, laminated, no odor, moist						100				
40																	
	WOH WOH WOH WOH	S2 24	43.0 45.0	CL		354.2 43.0	Very soft, gray sandy CLAY (CL), mps 0.3 mm, no structure, no odor, wet, frequent black woody material					30	70				
45																	
	WOH 7 1 2	S3 24	48.0 50.0	CL		349.2 48.0	Very soft, brown-gray sandy CLAY (CL), mps 0.3 mm, no structure, no odor, wet, frequent mica, frequent black woody material					30	70				
50																	
	WOH 3 7 9	S4 24	53.0 55.0	CL			Stiff, brown-gray sandy CLAY (CL), mps 0.3 mm, stratified, no odor, wet, frequent mica, abundant black woody material					30	70				
				SM		343.0 54.2	Loose, brown-gray silty SAND with gravel (SM), mps 60 mm, no structure, no odor, wet, well rounded gravel and sand	15	15	15	20	15	20				
55																	
	3 6 8 8	S5 13	58.0 60.0	CL		339.2 58.0	Very soft, brown-gray sandy CLAY (CL), mps 0.3 mm, no structure, no odor, wet, frequent mica, frequent black woody material					30	70				
				CL		338.2 59.0	Stiff, brown-gray sandy CLAY (CL), mps 0.3 mm, stratified, no odor, wet, frequent mica, abundant black woody material					30	70				
60						337.2 60.0											

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
	8 9 12 13	S6 19	63.0 65.0	CL			Very stiff, gray and brown sandy CLAY (CL), mps 0.3 mm, stratified, no odor, wet					30	70				
65				SW-SM		333.2 64.0	Medium dense, brown well-graded SAND with silt and gravel (SW-SM), mps 35 mm, no structure, no odor, wet, well rounded gravel and sand	10	20	20	20	20	10				
	4 9 13 16	S7 12	68.0 70.0	SP		329.2 68.0	Medium dense, brown-gray poorly-graded SAND (SP), mps 25 mm, no structure, no odor, wet, well rounded gravel and sand	5	5	5	35	45	10				
70																	
75	8 11 15 26	S8 14	73.0 75.0			322.2 75.0	BOTTOM OF EXPLORATION 75.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-8I

Project	Nature and Extent, F. B. Culley Generating Station	File No.	129402-017
Client	Southern Indiana Gas & Electric Company	Sheet No.	1 of 3
Contractor	ATC	Start	November 14, 2018
		Finish	November 15, 2018
		Driller	Z. Vaughen
		H&A Rep.	S. Lewis
		Elevation	393.9
		Datum	
		Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	
Inside Diameter (in.)	4.25	1 3/8	
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Geoprobe 8040DT
Bit Type: Cutting Head
Drill Mud: None
Casing: Spun
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model: -

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							Refer to Test Boring CCR-AP-8 for lithology from 0-38 ft.										
5																	
10																	
15																	
20																	
25																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
2/13/19	16.79				

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft) 70.0
Rock Cored (ft) -
Samples 7S

Boring No. CCR-AP-8I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
25																	
30																	
35																	
	7 5 8 7	S1 12	38.0 40.0	CL		355.9 38.0	Stiff, gray lean CLAY (CL), mps < 0.075 mm, no structure, no odor, moist						100				
40																	
	3 4 5 7	S2 24	43.0 45.0	CL		350.9 43.0	Stiff, brown-gray lean CLAY (CL), mps < 0.075 mm, stratified, no odor, moist, frequent woody material						100				
45																	
	WOH WOH 3 3	S3 24	48.0 50.0	CL			Stiff, brown-gray lean CLAY (CL), mps < 0.075 mm, stratified, no odor, moist, abundant woody material						100				
50																	
	WOH WOH 3 3	S4 24	53.0 55.0	CL		339.9 54.0	Stiff, brown-gray lean CLAY (CL) with occasional gray poorly-graded SAND (SP) pockets, stratified, no odor, moist, abundant woody material						100				
55																	
							Note: Heaving sands at 58 ft. fill augers 5 ft.										
	2 WOH 1 WOH	S5 24	58.0 60.0	SP		335.9 58.0	Very loose, gray poorly-graded SAND (SP), mps 1.5 mm, no structure, no odor, wet				30	70					
				SW		334.4 59.5	Very loose, gray well-graded SAND with gravel (SW), mps 60 mm, no structure, no odor, wet	20	20	20	10	30					
60																	

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
	5 3 10 13	S6 11	63.0 65.0	SP		330.9 63.0	Medium dense, gray poorly-graded SAND (SP), mps 1.5 mm, no structure, no odor, wet, frequent coal fragments, subrounded sand				30	70					
65				SP		328.9 65.0	Medium dense, gray poorly-graded SAND (SM), mps 1.5 mm, no structure, no odor, wet, frequent coal fragments, occasional highly weathered gray shale, frequent black woody material starting at 69.5 ft, subrounded sand				30	70					
	1 1 9 12	S7 13	68.0 70.0														
70						323.9 70.0	BOTTOM OF EXPLORATION 70.0 FT										

TEST BORING REPORT

Boring No. HASB-1

Project	Nature and Extent, F. B. Culley Generating Station	File No.	129402-017
Client	Southern Indiana Gas & Electric Company	Sheet No.	1 of 2
Contractor	ATC	Start	November 16, 2018
		Finish	November 16, 2018
		Driller	Z. Vaughen
		H&A Rep.	S. Lewis

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S		Rig Make & Model: Geoprobe 8040DT
Inside Diameter (in.)	4.25	1 3/8		Bit Type: Cutting Head; Drill Mud: None
Hammer Weight (lb)	-	140	-	Casing: Spun
Hammer Fall (in.)	-	30	-	Hoist/Hammer: Winch Automatic Hammer; PID Make & Model: -

Elevation
Datum
Location See Plan

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0		S1 60	0.0 5.0	CL		Tanish-brown CLAY (CL), mps 10 mm, no odor, moist	5	5	5	5	5	75				
5		S2 60	5.0 10.0	CL		Similar to above, except wood fragments present										
10		S3 24	10.0 15.0													
15		S4 60	15.0 20.0	CL	15.0	Brown CLAY (CL), no odor, moist										
					17.0	Highly weathered, gray SHALE, extremely thin bedding										
20		S5 30	20.0 22.0			Refusal with macrocore, switch to augers										
	50/2"	S6 2	22.0 22.2			Highly weathered, gray SHALE with frequent highly weathered gray LIMESTONE fragments										
	50/2"	S7 2	24.0		24.0	Slightly weathered, gray LIMESTONE										
25																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 40.0
Rock Cored (ft) -
Samples 7S

Boring No. HASB-1

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
25			24.2			Note: No sample collected past 24.2 ft. Continued notes based on observations from auger cutting.										
30						Note: Rig chatter at 32 ft.										
						Gray LIMESTONE continues in auger cuttings										
35						Note: Rig chatter stop at 35 ft.										
						Black COAL and dark gray SHALE in auger cuttings when cutting head is at 40 ft.										
40					40.0	BOTTOM OF EXPLORATION 40.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

LEGEND

- CCR-AP-11 — MONITORING WELL
- CCR-AP-6I — NATURE AND EXTENT MONITORING WELL
- APPROXIMATE UNIT BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS ARE APPROXIMATE
2. CCR COAL COMBUSTION RESIDUALS
3. AERIAL IMAGERY SOURCE: ESRI

N

0 220 440
SCALE IN FEET

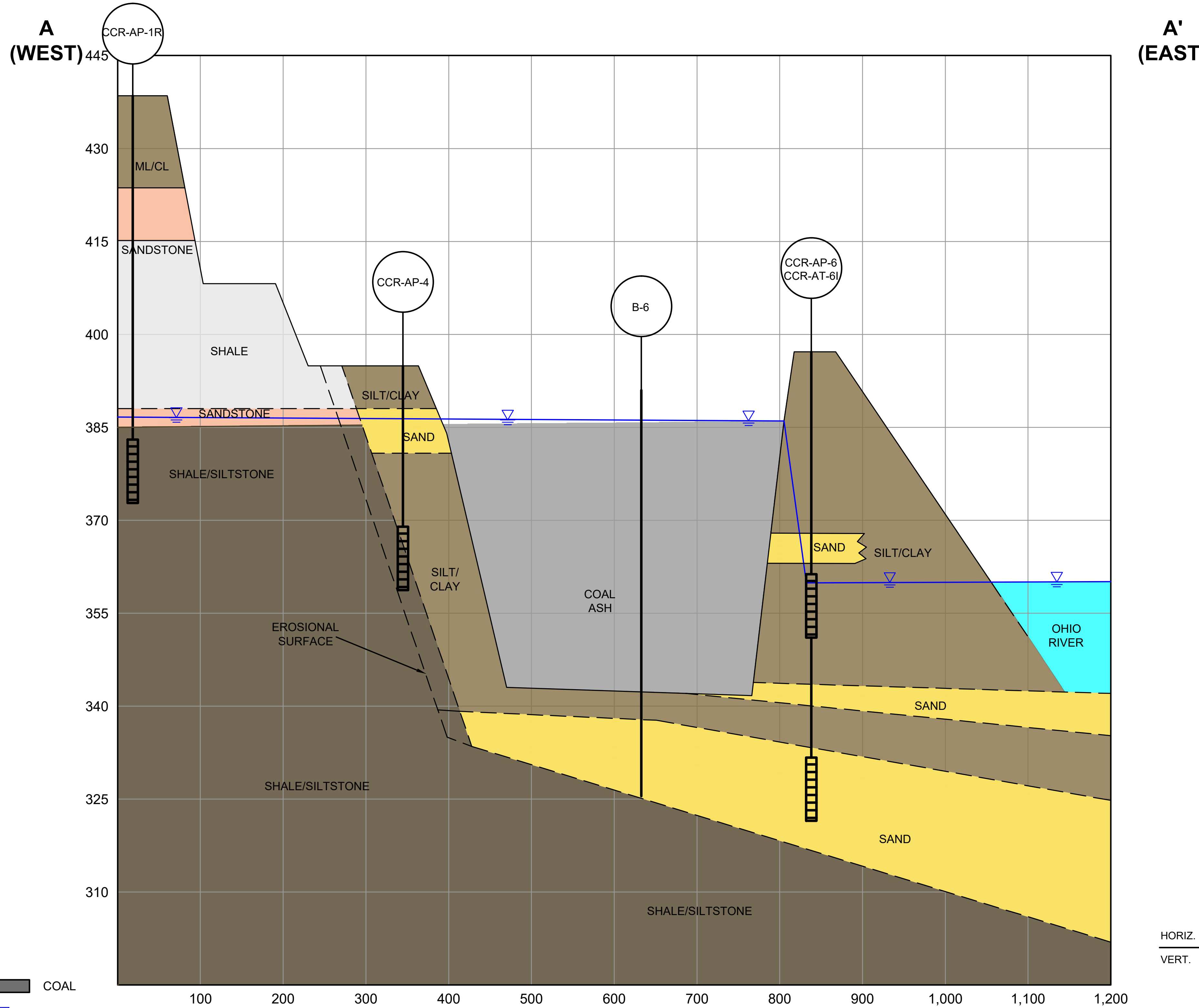
HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

CROSS-SECTION TRANSECT BASE MAP

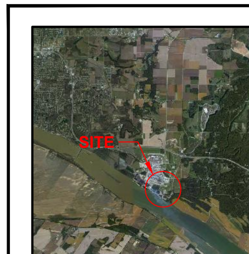
OCTOBER 2020

FIGURE 1



LEGEND

- COAL ASH
- LIMESTONE
- POORLY GRADED AND WELL GRADED SANDS
- SILT/CLAY
- SHALE
- SANDSTONE
- SHALE/SANDSTONE
- SCREEN LOCATION
- COAL
- GROUNDWATER LEVEL
- INTERPRETED SOIL/BEDROCK LEVELS
- BORING ID/LOCATION WITH GROUND SURFACE ELEVATION



PROJECT LOCATION

TOPO SOURCE: IMAGE DATED 2019 TAKEN ELECTRONICALLY FROM BING MAPS

PREPARED FOR:

SIGECO
F.B. CULLEY GENERATION STATION
EAST ASH POND

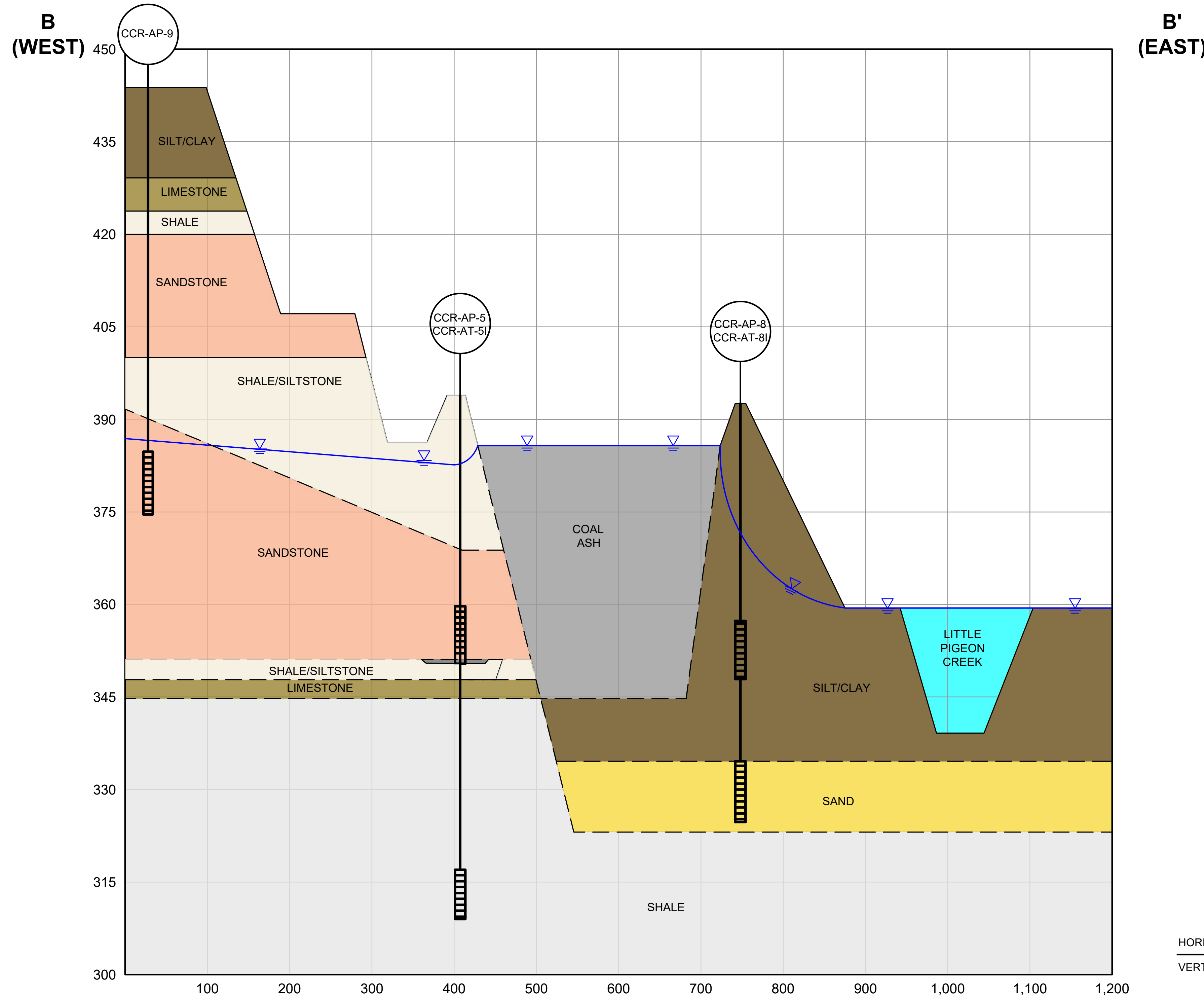
F.B. CULLEY GENERATION STATION
NEWBURGH, INDIANA

FIGURE 1A

EXISTING CONDITIONS
CROSS SECTION A-A'
EAST ASH POND

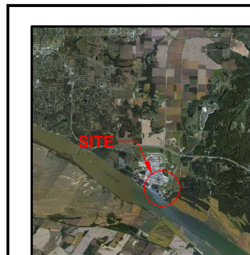
PROJECT: 129420	BY: OS/KC	REVISIONS:
DATE: OCT 2020	CHECKED: SL	

HALEY & ALDRICH



LEGEND

- COAL ASH
- LIMESTONE
- WELL GRADED AND POORLY GRADED SANDS
- SILT/CLAY
- SHALE
- SANDSTONE
- SHALE/SANDSTONE
- SCREEN LOCATION
- GROUNDWATER LEVEL
- INTERPRETED SOIL/BEDROCK LEVELS
- BORING ID/LOCATION WITH GROUND SURFACE ELEVATION



PROJECT LOCATION

TOPO SOURCE: IMAGE DATED 2019 TAKEN ELECTRONICALLY FROM BING MAPS

PREPARED FOR:

SIGECO
F.B. CULLEY GENERATION STATION
EAST ASH POND

F.B. CULLEY GENERATION STATION
NEWBURGH, INDIANA

FIGURE 1B

EXISTING CONDITIONS
CROSS SECTION B-B'
EAST ASH POND

PROJECT: 129420	BY: OS/KC	REVISIONS:
DATE: OCT 2020	CHECKED: SL	

HALEY & ALDRICH

Appendix G
Groundwater Flow Direction

UPGRADIENT MONITORING

DOWNGRADIENT MONITORING

POTENTIOMETRIC FLOW LINE, DASHED WHERE

GROUNDWATER FLOW

NOTES

1. AERIAL IMAGERY SOURCE: ESRI
2. LOCATIONS DERIVED FROM THREE I DESIGN DATA.
3. GROUNDWATER ELEVATIONS MEASURED 6 APRIL 2017

N

0 500

SCALE IN FEET

HALEY ALDRICH

VECTREN CORPORATION
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, INDIANA

SEASONAL HIGH WATER TABLE CONFIGURATION APRIL 6 2017

JANUARY 2018

FIGURE 2

GIS FILE PATH: \\haleyaldrich.com\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2017_12\42796_000_000MB_FB_CULLEY_GROUNDWATER_CONTOURS.mxd — USER: ajospe — LAST SAVED: 12/12/2017 5:26:45 PM

LEGEND

- UPGRADIENT MONITORING WELL
- DOWNGRADIENT MONITORING WELL
- MONITORING WELL NOT USED TO CONTOUR
- POTENTIOMETRIC FLOW LINE, DASHED WHERE INFERRED
- GROUNDWATER FLOW DIRECTION

NOTES

1. AERIAL IMAGERY SOURCE: ESRI
2. LOCATIONS DERIVED FROM THREE I DESIGN DATA.
3. GROUNDWATER ELEVATIONS MEASURED 28 OCTOBER 2016

N

0 500
SCALE IN FEET

HALEY ALDRICH

VECTREN CORPORATION
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, INDIANA

SEASONAL LOW WATER
TABLE CONFIGURATION
OCTOBER 28 2016

JANUARY 2018

FIGURE 2

GIS FILE PATH: \\haleyaldrich.com\share\bol_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2017_12\42796_000_000MB_FB_CULLEY_GROUNDWATER_CONTOURS.mxd — USER: ajespe — LAST SAVED: 12/12/2017 5:26:45 PM

Appendix H
Groundwater Monitoring Analytical Results

TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Downgradient								
Location Name	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2
Sample Name	CCR-AP-2-20160610	CCR-AP-2-20160812	CCR-AP-2-20161028	CCR-AP-2-20161207	CCR-AP-2-20170208	CCR-AP-2-20170406	CCR-AP-2-20170607	CCR-AP-2-20170928	CCR-AP-2-20171117
Sample Date	06/10/2016	08/12/2016	10/28/2016	12/07/2016	02/08/2017	04/06/2017	06/07/2017	09/28/2017	11/17/2017
Lab Sample ID	180-55667-2	180-57631-2	180-60350-2	180-61530-2	180-63329-2	180-65041-4	180-67233-2	180-70838-6	180-72640-2
Water Level (ft amsl)	360.81	360.09	359.74	360.29	361.42	365.93	360.28	359.91	360.97
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	23.78	**22.2**	**17.36**	**16.08**	**11.12**	**14**	**21.33**	**20.28**	**13.92**
Turbidity, Field (FNU)	-	-	-	-	-	-	-	-	-
Dissolved Oxygen, Field (mg/L)	2.34	**4.46**	**4.49**	**6.85**	**8.25**	**3.69**	**2.93**	**1.53**	**4.21**
Conductivity, Field (mS/cm)	2.05436	**2.149**	**2.05359**	**1.6746**	**0.78602**	**2.65509**	**1.99948**	**2.18197**	**2.18306**
ORP, Field (mv)	42.71	**40**	**-67.04**	**-73.8**	**17.3**	**10.57**	**59.36**	**141.67**	**143.3**
Turbidity, Field (NTU)	3729.19	**1083**	**375.23**	**6180**	**2286**	**2940**	**2131**	**3019**	**2084**
pH, Field (su)	6.56	**7.61**	**7.71**	**6.63**	**8.14**	**7.41**	**7.85**	**6.51**	**7.61**
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	15	**12**	**11**	**12**	**12**	**12**	**12**	**7.8**	**14**
Calcium, Total	200	**230**	**220 J-**	**240**	**260 J-**	**240 J+**	**240**	**220**	**260**
Chloride (mg/L)	72	**73**	**73 J+**	**75**	**83**	**89**	**81**	**110**	**120**
Fluoride (mg/L)	0.16 J+	**0.28**	**0.23**	**0.3 J+**	**0.26 J+**	**0.29**	**0.3 J**	**0.28**	**0.11**
Sulfate (mg/L)	530 J-	**730**	**540 J+**	**680**	**570**	**600**	**510**	**610**	**680 J-**
pH (lab) (su)	7.26 J	**7.4 J**	**6.7 J**	**6.8 J**	**7 J**	**6.8 J**	**6.8 J**	**6.9 J**	**7 J**
Total Dissolved Solids (TDS) (mg/L)	1700	**1700**	**1600**	**1600**	**1500**	**1600**	**1600**	**1700**	**1600**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.002	0.002 U	0.002 U	**0.00024 J**	0.002 U	0.002 U	0.002 U	**0.0017 J**	0.01 U
Arsenic, Total	0.0018	**0.0016**	**0.0044**	**0.003**	**0.0035**	**0.0018**	**0.0066**	**0.017**	**0.0066**
Barium, Total	0.055	**0.038**	**0.09**	**0.14**	**0.12**	**0.052**	**0.27**	**0.44**	**0.17**
Beryllium, Total	0.00014 J	**0.00015 J**	**0.00066 J**	**0.00056 J**	**0.00038 J**	**0.00032 J**	**0.00099 J**	**0.0027**	**0.0012 J**
Cadmium, Total	0.00055 J	**0.00023 J**	**0.00053 J**	**0.00048 J**	**0.00038 J**	**0.00011 J**	**0.00078 J**	**0.00073 J**	0.005 U
Chromium, Total	0.0035	**0.003**	**0.013**	**0.011**	**0.0084**	**0.0037**	**0.025**	**0.056**	**0.021**
Cobalt, Total	0.0073	**0.0096**	**0.016 J**	**0.012**	**0.014**	**0.011**	**0.021**	**0.038**	**0.018**
Lead, Total	0.0023	**0.0028**	**0.0096 J**	**0.006**	**0.0057**	**0.0026 J+**	**0.016**	**0.051**	**0.012**
Lithium, Total	0.05 U	0.05 U	**0.017 J**	0.05 U	**0.01 J**	0.05 U	**0.023 J**	**0.023 J**	0.25 U
Molybdenum, Total	0.0018 J	**0.00099 J**	**0.0014 J**	**0.0015 J**	**0.0017 J**	**0.00094 J**	**0.0024 J**	**0.0051**	**0.004 J**
Selenium, Total	0.00044 J	**0.00076 J**	**0.0013 J**	0.005 U	0.005 U	0.005 UJ	0.005 U	**0.0044 J**	0.025 U
Thallium, Total	0.000048 J	**0.000048 J**	**0.00014 J**	**0.00016 J**	**0.00017 J**	0.001 U	**0.00026 J**	**0.00068 J**	**0.00079 J**
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	0.222 J ± 0.145	**1.22 ± 0.355**	**0.731 ± 0.526**	**2.01 ± 1.16**	**0.672 ± 0.334**	**1.03 ± 0.385**	**0.894 ± 0.361**	**0.730 ± 0.327**	**0.266 ± 0.151**
Radium-226 & 228	0.764 U ± 0.590	**2.32 ± 1.08**	**1.38 J ± 0.750**	**2.72 J ± 1.61**	**1.68 ± 0.684**	**2.47 J ± 1.01**	**3.29 ± 1.13**	**1.91 J+ ± 1.11**	**0.850 J+ ± 0.522**
Radium-228	0.542 U ± 0.572	1.09 U ± 1.02	0.648 U ± 0.534	0.707 U ± 1.12	**1.00 ± 0.596**	**1.44 ± 0.934**	**2.40 ± 1.07**	1.18 U ± 1.06	0.585 U ± 0.500

ABBREVIATIONS AND NOTES:

CCR: Coal Combustion Residuals
CFR: Code of Federal Regulations
ft amsl: feet above mean sea level
MCL: Maximum Contaminant Level
mg/L: milligram per liter
mS/cm: milliSiemen per centimeter
mv: millivolt
NA: Not Applicable
NTU: Nephelometric Turbidity Units
pCi/L: picoCurie per liter
su: standard units
USEPA: United States Environmental Protection Agency

QUALIFIERS:

J: value is estimated
J+: value is estimated with a potentially high bias
J-: value is estimated with a potentially low bias
R: value is rejected
U: Not detected value is the laboratory reporting limit

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Downgradient								
Location Name	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3
Sample Name	CCR-AP-3-20160610	CCR-AP-3-20160815	CCR-AP-3-20161028	CCR-AP-3-20161207	CCR-AP-3-20170208	CCR-AP-3-20170406	CCR-AP-3-20170607	CCR-AP-3-20170928	CCR-AP-3-20171117
Sample Date	06/10/2016	08/15/2016	10/28/2016	12/07/2016	02/08/2017	04/06/2017	06/07/2017	09/28/2017	11/17/2017
Lab Sample ID	180-55667-3	180-57631-3	180-60350-3	180-61530-3	180-63329-3	180-65041-5	180-67233-3	180-70838-7	180-72640-3
Water Level (ft amsl)	363.31	362.21	361.83	361.92	364.22	364.05	363.8	362.09	362.36
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	**25.51**	**21.8**	**18.91**	**14.9**	**11.52**	**14.85**	**19.1**	**19.39**	**12.84**
Turbidity, Field (FNU)	-	-	-	-	-	-	-	-	-
Dissolved Oxygen, Field (mg/L)	**0.49**	**4.41**	**4.52**	**4.05**	**8.44**	**6.11**	**2.71**	**2.1**	**4.04**
Conductivity, Field (mS/cm)	**1.79964**	**1.827**	**1.81571**	**1.5418**	**1.84566**	**1.91137**	**1.71067**	**1.78845**	**1.79086**
ORP, Field (mv)	**-152.01**	**-92**	**-162.25**	**-200.5**	**-109.73**	**-34.59**	**-124.19**	**-133.73**	**-123.58**
Turbidity, Field (NTU)	**37.7**	**111.2**	**175.6**	**706.49**	**202.52**	**110.58**	**169.96**	**55.84**	**245.28**
pH, Field (su)	**6.83**	**6.8**	**7.68**	**7.12**	**7.63**	**7.39**	**6.96**	**6.99**	**7.08**
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	**0.18**	**0.15 J+**	**0.16**	**0.17 J+**	**0.18 J+**	**0.2**	0.27 U	**0.12**	0.19 U
Calcium, Total	**160**	**170**	**190 J-**	**190**	**190 J-**	**180 J+**	**200**	**180**	**190**
Chloride (mg/L)	**26**	**26**	**27 J+**	**26**	**23**	**25**	**25**	**25**	**25**
Fluoride (mg/L)	0.1 U	**0.93**	**0.31**	**0.5**	**0.39**	**0.57**	**0.55**	**0.45**	**0.14**
Sulfate (mg/L)	**1.3 J-**	R	**1.1 J+**	1 U	**0.67 J**	1 U	**0.56 J**	**0.48 J**	**0.82 J-**
pH (lab) (su)	**7.17 J**	**7.6 J**	**7 J**	**7.2 J**	**7.2 J**	**7.1 J**	**7.2 J**	**7.1 J**	**7.4 J**
Total Dissolved Solids (TDS) (mg/L)	**1000**	**1000**	**1000**	**970**	**1000**	**1000**	**1200**	**1000**	**970**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.002 U	0.002 U	0.002 U	**0.00031 J**	0.002 U	0.002 U	0.002 U	**0.00058 J**	0.002 U
Arsenic, Total	**0.058**	**0.072**	**0.071**	**0.068**	**0.086**	**0.08**	**0.077**	**0.066**	**0.067**
Barium, Total	**0.41**	**0.38**	**0.4**	**0.43**	**0.46**	**0.42**	**0.44**	**0.39**	**0.4**
Beryllium, Total	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Cadmium, Total	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Chromium, Total	**0.0021**	**0.0018 J**	**0.002**	**0.0023**	**0.002**	**0.0021**	0.002 U	0.002 U	**0.0021**
Cobalt, Total	**0.0094**	**0.008**	**0.0076 J**	**0.007**	**0.0072**	**0.0063**	**0.0062**	**0.0057**	**0.0056**
Lead, Total	**0.00041 J**	**0.00039 J**	0.001 UJ	**0.00066 J**	**0.00035 J**	**0.00048 J+**	0.001 U	**0.00098 J**	**0.00051 J**
Lithium, Total	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Molybdenum, Total	**0.011**	**0.014**	**0.014**	**0.014**	**0.013**	**0.011**	**0.012**	**0.01**	**0.011**
Selenium, Total	**0.0015 J**	**0.00062 J**	**0.0018 J**	**0.0019 J**	**0.002 J**	**0.0018 J-**	**0.0018 J**	**0.0016 J**	**0.0017 J**
Thallium, Total	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.0001 J**
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	**0.657 J ± 0.201**	**0.865 ± 0.232**	**1.15 ± 0.477**	**0.789 ± 0.398**	0.373 U ± 0.293	**0.450 ± 0.144**	**0.582 ± 0.158**	**0.411 ± 0.136**	**0.626 ± 0.162**
Radium-226 & 228	**1.75 ± 0.615**	**1.65 ± 0.627**	**1.97 ± 0.589**	**1.72 ± 0.623**	0.862 U ± 0.680	**1.09 ± 0.373**	**1.83 ± 0.456**	R	R
Radium-228	**1.10 ± 0.581**	0.784 U ± 0.583	**0.819 ± 0.347**	**0.932 ± 0.480**	0.489 U ± 0.614	**0.644 ± 0.344**	**1.25 ± 0.427**	R	R

ABBREVIATIONS AND NOTES:

CCR: Coal Combustion Residuals
CFR: Code of Federal Regulations
ft amsl: feet above mean sea level
MCL: Maximum Contaminant Level
mg/L: milligram per liter
mS/cm: milliSiemen per centimeter
mv: millivolt
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QUALIFIERS:

J: value is estimated
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TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Downgradient								
Location Name	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4
Sample Name	CCR-AP-4-20160610	CCR-AP-4-20160812	CCR-AP-4-20161028	CCR-AP-4-20161207	CCR-AP-4-20170208	CCR-AP-4-20170406	CCR-AP-4-20170608	CCR-AP-4-20170929	CCR-AP-4-20171117
Sample Date	06/10/2016	08/12/2016	10/28/2016	12/07/2016	02/08/2017	04/06/2017	06/08/2017	09/29/2017	11/17/2017
Lab Sample ID	180-55667-4	180-57631-4	180-60350-4	180-61530-4	180-63329-4	180-65041-6	180-67233-4	180-70838-8	180-72640-4
Water Level (ft amsl)	386.99	386.89	384.57	383.48	385.12	385.24	384.93	385.35	385.57
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	25.41	23.12	15.92	16.59	15.16	13.92	21.09	21.03	13.29
Turbidity, Field (FNU)	-	-	-	-	-	-	-	-	-
Dissolved Oxygen, Field (mg/L)	1.34	2.37	3.75	4.8	0.21	2.63	3.95	2.65	1.02
Conductivity, Field (mS/cm)	1.83585	1.971	1.86696	1.3787	1.8253	1.50947	1.75801	1.90655	1.89809
ORP, Field (mv)	-106.23	-129	-108.94	-115.5	-130.18	-16.37	-101.4	-166.25	-113.5
Turbidity, Field (NTU)	999.34	266.5	294.14	1.7824	242.85	1091	655.07	1016	419.08
pH, Field (su)	6.64	7.56	6.98	6.58	6.58	7.1	7.32	6.98	6.58
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	0.16	0.16 J+	0.18	0.16 J+	0.14 U	0.17	0.18 U	0.085	0.14 U
Calcium, Total	160	190	170 J-	160	180 J-	180 J+	190	170	180
Chloride (mg/L)	25	24	85 J+	70	49	48	46	41	40
Fluoride (mg/L)	0.29 J+	0.43	0.3	0.49	0.32 J+	0.36	0.46	0.35	0.35
Sulfate (mg/L)	20 J-	R	15 J+	3.9 J+	1 U	1 U	0.64 J	0.63 J	1.1 J-
pH (lab) (su)	6.95 J	7.3 J	6.7 J	7 J	6.9 J	6.7 J	6.7 J	6.8 J	7.1 J
Total Dissolved Solids (TDS) (mg/L)	1000	1000	890	880	900	960	1000	980	910
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.002 U	0.002 U	0.002 U	0.0004 J	0.002 U	0.002 U	0.002 U	0.00066 J	0.002 U
Arsenic, Total	0.036	0.065	0.05	0.045	0.086	0.086	0.086	0.081	0.083
Barium, Total	0.52	0.75	0.63	0.61	0.64	0.63	0.66	0.58	0.57
Beryllium, Total	0.00049 J	0.00033 J	0.00025 J	0.00046 J	0.00014 J	0.00015 J	0.00026 J	0.00017 J	0.00028 J
Cadmium, Total	0.00018 J	0.00018 J	0.001 U	0.00023 J	0.001 U	0.001 U	0.00014 J	0.00016 J	0.001 U
Chromium, Total	0.012	0.0081	0.0037	0.014	0.0026	0.0028	0.0066	0.0076	0.01
Cobalt, Total	0.0078	0.0071	0.0045 J	0.0086	0.0039	0.0045	0.0068	0.0055	0.0064
Lead, Total	0.0099	0.0063	0.0057 J	0.011	0.0018	0.0018 J+	0.0045	0.0048	0.0046
Lithium, Total	0.01 J	0.0096 J	0.014 J	0.0098 J	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Molybdenum, Total	0.0022 J	0.0025 J	0.0011 J	0.002 J	0.00093 J	0.00092 J	0.0014 J	0.0016 J	0.0022 J
Selenium, Total	0.0018 J	0.0016 J	0.0011 J	0.00098 J	0.005 U	0.005 UJ	0.005 U	0.005 U	0.005 U
Thallium, Total	0.000084 J	0.000061 J	0.00011 J	0.00015 J	0.000063 J	0.001 U	0.000061 J	0.001 U	0.00012 J
Mercury, Total	0.0002 U	0.0002 U	0.0004 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	1.07 J ± 0.261	1.53 ± 0.429	1.54 ± 0.683	2.11 ± 1.11	0.984 ± 0.383	0.789 ± 0.227	1.60 ± 0.408	1.26 ± 0.397	1.15 ± 0.266
Radium-226 & 228	1.49 ± 0.769	2.90 ± 1.49	2.40 ± 0.816	4.28 ± 1.74	2.01 ± 0.728	1.16 J ± 0.538	3.60 ± 0.914	R	R
Radium-228	0.417 U ± 0.723	1.37 U ± 1.43	0.864 ± 0.448	2.17 ± 1.34	1.03 ± 0.620	0.370 U ± 0.488	2.00 ± 0.818	R	R

ABBREVIATIONS AND NOTES:
CCR: Coal Combustion Residuals
CFR: Code of Federal Regulations
ft amsl: feet above mean sea level
MCL: Maximum Contaminant Level
mg/L: milligram per liter
mS/cm: milliSiemen per centimeter
mv: millivolt
NA: Not Applicable
NTU: Nephelometric Turbidity Units
pCi/L: picoCurie per liter
su: standard units
USEPA: United States Environmental Protection Agency

QUALIFIERS:
J: value is estimated
J+: value is estimated with a potentially high bias
J-: value is estimated with a potentially low bias
R: value is rejected
U: Not detected value is the laboratory reporting limit

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Downgradient								
Location Name	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5
Sample Name	CCR-AP-5-20160610	CCR-AP-5-20160812	CCR-AP-5-20161028	CCR-AP-5-20161207	CCR-AP-5-20170208	CCR-AP-5-20170407	CCR-AP-5-20170608	CCR-AP-5-20170928	CCR-AP-5-20171117
Sample Date	06/10/2016	08/12/2016	10/28/2016	12/07/2016	02/08/2017	04/07/2017	06/08/2017	09/28/2017	11/17/2017
Lab Sample ID	180-55667-5	180-57631-5	180-60350-5	180-61530-5	180-63329-5	180-65041-7	180-67233-5	180-70838-1	180-72640-5
Water Level (ft amsl)	383.83	382.15	377.81	378.14	383.3	383.12	382.28	380.86	382.01
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	**19.48**	**19.13**	**18.43**	**15.84**	**16.05**	**17.66**	**18.75**	**18.88**	**17**
Turbidity, Field (FNU)	-	-	-	-	-	-	-	**11.86**	-
Dissolved Oxygen, Field (mg/L)	**0.04**	**0.08**	**-0.02**	**0.25**	**0.07**	**0.05**	**0.08**	**0.08**	**0.09**
Conductivity, Field (mS/cm)	**4.89844**	**4.82**	**5.02113**	**3.9142**	**4.86306**	**4.22473**	**3.95584**	**4.19408**	**4.48884**
ORP, Field (mv)	**-82.1**	**-133**	**-247.07**	**-181.1**	**67.41**	**59.85**	**43.86**	**42.55**	**69.25**
Turbidity, Field (NTU)	**11.79**	**4.632**	**-3.91**	**2.44**	**0.62**	**-16.87**	**-1.13**	-	**1.94**
pH, Field (su)	**7**	**6.92**	**7.03**	**6.85**	**6.83**	**6.93**	**6.86**	**6.75**	**6.7**
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	**53**	**54**	**68**	**64**	**59**	**56**	**58**	**33**	**52**
Calcium, Total	**520**	**480**	**550 J-**	**570**	**580 J-**	**550 J+**	**510**	**470**	**510**
Chloride (mg/L)	**880**	**750**	**860 J+**	**860**	**780**	**880**	**560**	**640**	**770**
Fluoride (mg/L)	**0.58**	**0.99**	**1.1**	**1.3**	**0.98**	**0.96**	**1.1**	**0.76 J**	**1**
Sulfate (mg/L)	2.5 UJ	**1500**	**1600 J+**	**1700**	**1500**	**1900**	**1400**	**1400**	**1600 J-**
pH (lab) (su)	**7.09 J**	**7.4 J**	**7 J**	**7 J**	**7.2 J**	**7 J**	**7.1 J**	**7 J**	**7 J**
Total Dissolved Solids (TDS) (mg/L)	**4600**	**4400**	**4000**	**4200**	**4000**	**4200**	**4200**	**3300**	**3500**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.02 U	0.002 U	0.002 U	**0.000058 J**	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.01 U	**0.00059 J**	**0.00065 J**	**0.00073 J**	**0.0015**	**0.00039 J**	**0.00042 J**	**0.00084 J**	**0.00039 J**
Barium, Total	**0.032 J**	**0.03**	**0.034**	**0.036**	**0.046**	**0.034**	**0.036**	**0.041**	**0.038**
Beryllium, Total	0.01 U	0.001 U	0.001 U	**0.00096 J**	**0.00019 J**	**0.00058 J**	**0.00017 J**	**0.00047 J**	0.001 U
Cadmium, Total	0.01 U	**0.00016 J**	**0.00015 J**	0.001 U	**0.0012**	**0.0004 J**	**0.00037 J**	**0.00075 J**	**0.00035 J**
Chromium, Total	0.02 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cobalt, Total	**0.0069**	**0.0063**	**0.0065 J**	**0.0061**	**0.007**	**0.0063**	**0.0053**	**0.0041**	**0.0046**
Lead, Total	0.01 U	0.001 U	0.001 UJ	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium, Total	**0.14**	**0.13**	**0.15**	**0.13**	**0.15**	**0.15**	**0.11**	**0.099**	**0.12**
Molybdenum, Total	**0.38**	**0.37**	**0.41**	**0.39**	**0.39**	**0.33**	**0.3**	**0.21**	**0.24**
Selenium, Total	0.05 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 UJ	0.005 U	0.005 U	0.005 U
Thallium, Total	0.01 U	0.001 U	0.001 U	0.001 U	**0.000065 J**	0.001 U	0.001 U	**0.00016 J**	**0.00018 J**
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	**0.224 J ± 0.0858**	0.106 U ± 0.0753	0.449 U ± 0.338	0.0176 U ± 0.286	0.0782 U ± 0.217	**0.186 ± 0.0813**	**0.193 ± 0.0924**	**0.184 ± 0.0749**	**0.250 ± 0.0868**
Radium-226 & 228	**0.774 ± 0.313**	**0.629 ± 0.338**	**0.911 ± 0.486**	**0.732 J ± 0.524**	0.640 U ± 0.561	**0.396 J ± 0.241**	**1.21 ± 0.369**	R	**0.483 J+ ± 0.253**
Radium-228	**0.550 ± 0.300**	**0.523 ± 0.330**	0.462 U ± 0.350	**0.714 ± 0.438**	0.562 U ± 0.517	0.209 U ± 0.227	**1.01 ± 0.357**	R	0.234 U ± 0.238

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J: value is estimated
J+: value is estimated with a potentially high bias
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TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Downgradient								
Location Name	CCR-AP-6	CCR-AP-6	CCR-AP-6	CCR-AP-6	CCR-AP-6	CCR-AP-6	CCR-AP-6	CCR-AP-6	CCR-AP-6
Sample Name	CCR-AP-6-20160610	CCR-AP-6-20160812	CCR-AP-6-20161028	CCR-AP-6-20161207	CCR-AP-6-20170208	CCR-AP-6-20170406	CCR-AP-6-20170607	CCR-AP-6-20170929	CCR-AP-6-20171117
Sample Date	06/10/2016	08/12/2016	10/28/2016	12/07/2016	02/08/2017	04/06/2017	06/07/2017	09/29/2017	11/17/2017
Lab Sample ID	180-55667-6	180-57631-6	180-60350-6	180-61530-6	180-63329-6	180-65041-8	180-67233-6	180-70838-9	180-72640-6
Water Level (ft amsl)	357.44	357.42	357.81	357.84	357.16	357.22	357.77	358.13	358.29
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	**25.88**	**22.71**	**18.2**	**14.06**	**13.66**	**17.82**	**19.24**	**22.6**	**13.65**
Turbidity, Field (FNU)	-	-	-	-	-	-	-	-	-
Dissolved Oxygen, Field (mg/L)	**0.57**	**3.82**	**1.16**	**5.36**	**5.85**	**0.65**	**3.08**	**3.48**	**2**
Conductivity, Field (mS/cm)	**1.80952**	**1.894**	**1.45907**	**1.2681**	**1.79982**	**1.85853**	**1.69037**	**1.83685**	**1.78431**
ORP, Field (mv)	**-150.64**	**-113**	**-146.47**	**-215.4**	**-107.54**	**-104.62**	**-108.17**	**-241.24**	**-130.25**
Turbidity, Field (NTU)	**293.44**	**1073**	**1030**	**632.75**	**1329**	**397.33**	**1076**	**977.25**	**445.51**
pH, Field (su)	**6.88**	**7.56**	**7.28**	**7.31**	**7.19**	**7.17**	**7.35**	**7.44**	**7.07**
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	**1.1**	**0.83**	**0.74**	**0.79 J+**	**0.89 J+**	**2.2**	**1.3 J+**	**0.44**	**2.1 J+**
Calcium, Total	**180**	**190**	**190 J-**	**190**	**200 J-**	**210 J+**	**200**	**180**	**180**
Chloride (mg/L)	**40**	**39**	**38 J+**	**36**	**42**	**46**	**40**	**38**	**42**
Fluoride (mg/L)	**0.43**	**0.67**	**0.42**	**0.62**	**0.5**	**0.45**	**0.63**	**0.55**	**0.24**
Sulfate (mg/L)	**0.57 J-**	R	**0.98 J+**	1 U	**0.67 J**	**0.5 J**	**1.1**	**0.71 J**	**0.74 J-**
pH (lab) (su)	**7.35 J**	**7.8 J**	**7.2 J**	**7.3 J**	**7.4 J**	**7.2 J**	**7.3 J**	**7.3 J**	**7.6 J**
Total Dissolved Solids (TDS) (mg/L)	**1100**	**1100**	**1000**	**1000**	**1000**	**1100**	**1200**	**1100**	**1000**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.002 U	0.002 U	0.002 U	**0.00048 J**	**0.00047 J**	0.002 U	**0.00059 J**	**0.0014 J**	0.01 U
Arsenic, Total	**0.04**	**0.059**	**0.06**	**0.067**	**0.11**	**0.11**	**0.096**	**0.089**	**0.081**
Barium, Total	**0.51**	**0.58**	**0.55**	**0.62**	**0.61**	**0.64**	**0.6**	**0.55**	**0.49**
Beryllium, Total	0.001 U	**0.00026 J**	**0.00011 J**	**0.00036 J**	**0.00025 J**	**0.00024 J**	**0.00042 J**	**0.00039 J**	0.005 U
Cadmium, Total	0.001 U	**0.00016 J**	0.001 U	**0.00029 J**	**0.00027 J**	**0.00019 J**	**0.00024 J**	**0.00052 J**	**0.00039 J**
Chromium, Total	**0.0031**	**0.0092**	**0.005**	**0.015**	**0.011**	**0.0098**	**0.014**	**0.02**	**0.014**
Cobalt, Total	**0.0042**	**0.0095**	**0.0075 J**	**0.01**	**0.009**	**0.0069**	**0.011**	**0.012**	**0.0087**
Lead, Total	**0.0021**	**0.0071**	**0.0035 J**	**0.01**	**0.0079**	**0.0074 J+**	**0.0096**	**0.014**	**0.011**
Lithium, Total	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	**0.011 J**	0.05 U	0.25 U
Molybdenum, Total	**0.02**	**0.018**	**0.021**	**0.024**	**0.03**	**0.024**	**0.026**	**0.033**	**0.027**
Selenium, Total	**0.001 J**	**0.0014 J**	**0.0015 J**	**0.0014 J**	0.005 U	**0.0018 J-**	**0.0014 J**	**0.0023 J**	0.025 U
Thallium, Total	0.001 U	**0.000047 J**	0.001 U	**0.0001 J**	**0.000063 J**	0.001 U	**0.00009 J**	**0.00013 J**	0.005 U
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	**0.652 J ± 0.142**	**1.32 ± 0.278**	**1.38 ± 0.686**	-0.236 U ± 0.919	**0.929 ± 0.371**	**0.730 ± 0.221**	**2.33 ± 0.648**	**0.815 ± 0.227**	**0.695 ± 0.171**
Radium-226 & 228	**1.20 ± 0.325**	**2.13 ± 0.776**	**2.05 J ± 0.868**	1.58 U ± 1.80	**1.68 J ± 0.690**	**1.19 J ± 0.490**	**5.93 ± 1.60**	R	R
Radium-228	**0.543 ± 0.293**	0.811 U ± 0.725	0.663 U ± 0.532	1.58 U ± 1.55	0.755 U ± 0.581	0.455 U ± 0.438	**3.61 ± 1.47**	R	R

ABBREVIATIONS AND NOTES:

CCR: Coal Combustion Residuals
CFR: Code of Federal Regulations
ft amsl: feet above mean sea level
MCL: Maximum Contaminant Level
mg/L: milligram per liter
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J: value is estimated
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TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Downgradient								
Location Name	CCR-AP-8	CCR-AP-8	CCR-AP-8	CCR-AP-8	CCR-AP-8	CCR-AP-8	CCR-AP-8	CCR-AP-8	CCR-AP-8
Sample Name	CCR-AP8-20170309	CCR-AP-8-20170406	CCR-AP-8-20170426	CCR-AP-8-20170530	CCR-AP-8-20170607	CCR-AP-8-20170725	CCR-AP-8-20170815	CCR-AP-8-20170928	CCR-AP-8-20171117
Sample Date	03/09/2017	04/06/2017	04/26/2017	05/30/2017	06/07/2017	07/25/2017	08/15/2017	09/28/2017	11/17/2017
Lab Sample ID	180-64223-1	180-65041-1	180-65680-1	180-66910-1	180-67233-8	180-68557-1	180-69382-1	180-70838-10	180-72640-8
Water Level (ft amsl)	362.235	364.335	-	361.715	361.675	362.845	363.815	362.695	363.725
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	**19.68**	**14.06**	**23.49**	**24.86**	**20.32**	**24.02**	**27.23**	**19.71**	**14.18**
Turbidity, Field (FNU)	-	-	-	-	-	-	-	-	-
Dissolved Oxygen, Field (mg/L)	**3.19**	**2.37**	**3.52**	**0.3**	**2.73**	**2.33**	**0.89**	**2.22**	**2.99**
Conductivity, Field (mS/cm)	**2.39775**	**2.94999**	**2.50325**	**2.60564**	**2.35891**	**2.48464**	**2.48283**	**2.47995**	**2.47027**
ORP, Field (mv)	**-7.78**	**-90.85**	**-116.37**	**-115.14**	**-124.99**	**-66.59**	**-113.76**	**-159.16**	**-120.85**
Turbidity, Field (NTU)	**116.68**	**274.89**	**774.8**	**527.69**	**433.46**	**453.72**	**188.03**	**142.91**	**553**
pH, Field (su)	**6.14**	**7.09**	**6.95**	**6.86**	**7.26**	**7.9**	**6.43**	**6.78**	**6.92**
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	**0.037 J**	0.08 U	0.08 U	**0.034 J**	0.08 U	0.08 U	0.08 U	**0.025 J**	0.043 U
Calcium, Total	**300**	**320 J+**	**320**	**340**	**330**	**350**	**340**	**320**	**300**
Chloride (mg/L)	**21**	**19**	**18**	**17**	**13**	**17**	**16**	**17**	**16**
Fluoride (mg/L)	**0.13**	**0.35**	**0.28**	**0.24**	**0.21 J**	**0.24 J**	**0.26**	**0.34**	**0.4**
Sulfate (mg/L)	**37**	**16**	**1.6**	**6.2**	**4 J**	**3.8**	**5**	**2.3**	**1.9 J-**
pH (lab) (su)	**7.2 J**	**6.9 J**	**7 J**	**7.3 J**	**7 J**	**7 J**	**7.3 J**	**7 J**	**7 J**
Total Dissolved Solids (TDS) (mg/L)	**1400**	**1400**	**1400**	**1500**	**1500**	**1500**	**1400**	**1400**	**1300**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	**0.0018 J**	**0.00066 J**	**0.001 J**	**0.00082 J**	**0.0011 J**	0.002 U	**0.0014 J**	0.002 U	0.002 U
Arsenic, Total	**0.044**	**0.052**	**0.07**	**0.06**	**0.076**	**0.087**	**0.095**	**0.087**	**0.083**
Barium, Total	**0.57**	**0.59**	**0.59**	**0.58**	**0.6**	**0.67**	**0.64**	**0.56**	**0.53**
Beryllium, Total	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.0002 J**	**0.00039 J**	0.001 U	0.001 U
Cadmium, Total	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.00016 J**	0.001 U	0.001 U
Chromium, Total	**0.0012 J**	**0.0022**	**0.0019 J**	**0.0028**	R	**0.0041**	**0.012**	**0.0021 J+**	**0.0021**
Cobalt, Total	**0.015**	**0.012**	**0.011**	**0.011**	**0.011**	**0.012**	**0.017**	**0.0098**	**0.0082**
Lead, Total	**0.00058 J**	**0.0011 J+**	**0.00081 J**	**0.0022**	**0.001**	**0.0025**	**0.0076**	**0.0011**	**0.0011**
Lithium, Total	0.05 U	0.05 U	**0.014 J**	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Molybdenum, Total	**0.014**	**0.015**	**0.014**	**0.013**	**0.014**	**0.014**	**0.015**	**0.012**	**0.012**
Selenium, Total	0.005 U	**0.0017 J-**	**0.0015 J**	**0.0017 J**	**0.0017 J**	**0.0015 J**	**0.0022 J**	**0.002 J**	0.005 U
Thallium, Total	0.001 U	0.001 U	0.001 U	0.001 U	**0.000068 J**	**0.000058 J**	**0.00015 J**	0.001 U	**0.00029 J**
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	**0.893 ± 0.233**	**1.34 ± 0.310**	**0.883 ± 0.196**	**0.720 ± 0.162**	**0.721 J ± 0.211**	**0.704 ± 0.201**	**0.513 ± 0.143**	**0.529 ± 0.153**	**0.640 ± 0.164**
Radium-226 & 228	**1.96 J ± 1.04**	**2.01 ± 0.534**	**1.66 ± 0.421**	**1.18 ± 0.327**	**2.32 J ± 0.594**	**1.59 J ± 0.754**	**0.829 J ± 0.337**	R	R
Radium-228	1.07 U ± 1.02	**0.677 ± 0.435**	**0.778 ± 0.372**	**0.457 ± 0.284**	**1.60 J ± 0.556**	0.889 U ± 0.726	0.316 U ± 0.305	R	R

ABBREVIATIONS AND NOTES:

CCR: Coal Combustion Residuals
CFR: Code of Federal Regulations
ft amsl: feet above mean sea level
MCL: Maximum Contaminant Level
mg/L: milligram per liter
mS/cm: milliSiemen per centimeter
mv: millivolt
NA: Not Applicable
NTU: Nephelometric Turbidity Units
pCi/L: picoCurie per liter
su: standard units
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J: value is estimated
J+: value is estimated with a potentially high bias
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U: Not detected value is the laboratory reporting limit

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Upgradient								
Location Name	CCR-AP-1R	CCR-AP-1R	CCR-AP-1R	CCR-AP-1R	CCR-AP-1R	CCR-AP-1R	CCR-AP-1R	CCR-AP-1R	CCR-AP-1R
Sample Name	CCR-AP-1-20160610	CCR-AP-1-20160812	CCR-AP-1-20161028	CCR-AP-1-20161207	CCR-AP-1-20170208	CCR-AP-1-20170406	CCR-AP-1-20170607	CCR-AP-1-20170928	CCR-AP-1 -20171117
Sample Date	06/10/2016	08/12/2016	10/28/2016	12/07/2016	02/08/2017	04/06/2017	06/07/2017	09/28/2017	11/17/2017
Lab Sample ID	180-55667-1	180-57631-1	180-60350-1	180-61530-1	180-63329-1	180-65041-3	180-67233-1	180-70838-5	180-72640-1
Water Level (ft amsl)	388.98	388.07	387.44	386.93	388.04	388.09	388.06	388.5	387.6
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	21.31	25.58	20.76	8.43	10.31	14.42	19.36	18.61	13.03
Turbidity, Field (FNU)	-	-	-	-	-	-	-	-	-
Dissolved Oxygen, Field (mg/L)	1.28	0.13	0.6	11.68	8.29	3.13	3.2	1.01	8.88
Conductivity, Field (mS/cm)	1.12255	1.991	1.04547	1.0845	1.19011	1.55613	1.10803	1.20077	1.21515
ORP, Field (mv)	-148.68	-11.7	-171.8	-247.3	-60.52	15.79	90.06	-41.88	-14.37
Turbidity, Field (NTU)	1225	53.02	459.55	1053	1350	335.21	86.58	3.49	7.28
pH, Field (su)	7.38	7.87	7.85	8.12	8	8.01	8.33	7.46	7.72
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	0.51	0.54	0.65	0.68 J+	0.69 J+	0.62	0.72 J+	0.44	0.82 J+
Calcium, Total	53	51	50 J-	44	42 J-	55 J+	55	48	57
Chloride (mg/L)	19	18	19 J+	19	18	17	18	18	18
Fluoride (mg/L)	0.81	0.48	0.5	0.55	0.53	0.57	0.58	0.49	0.48
Sulfate (mg/L)	180 J-	180	110 J+	130	140	150	150	160	170 J-
pH (lab) (su)	7.74 J	8.1 J	7.6 J	7.7 J	7.5 J	7.8 J	7.7 J	7.7 J	7.9 J
Total Dissolved Solids (TDS) (mg/L)	740	760	740	710	750	730	840	770	770
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.002 U	0.002 U	0.002 U	0.00072 J	0.00077 J	0.00055 J	0.00053 J	0.0025	0.01 U
Arsenic, Total	0.0045	0.0067	0.0024	0.0036	0.0068	0.012	0.008	0.0055	0.0075
Barium, Total	0.077	0.12	0.05	0.081	0.11	0.16	0.11	0.086	0.15
Beryllium, Total	0.00053 J	0.00074 J	0.00011 J	0.00049 J	0.00058 J	0.0014	0.00073 J	0.00035 J	0.0013 J
Cadmium, Total	0.001 U	0.001 U	0.001 U	0.001 U	0.000081 J	0.00018 J	0.001 U	0.001 U	0.005 U
Chromium, Total	0.011	0.02	0.0019 J	0.0092	0.012	0.03	0.015	0.01	0.021
Cobalt, Total	0.0081	0.014	0.0015 J	0.005	0.0083	0.017	0.0088	0.0059	0.013
Lead, Total	0.0074	0.013	0.0011 J	0.0057	0.0083	0.02 J+	0.0093	0.0068	0.014
Lithium, Total	0.045 J	0.053	0.035 J	0.035 J	0.043 J	0.063	0.049 J	0.036 J	0.059 J
Molybdenum, Total	0.015	0.013	0.006	0.0047 J	0.0073	0.0067	0.0073	0.008	0.013 J
Selenium, Total	0.00071 J	0.0014 J	0.005 U	0.00045 J	0.005 U	0.0014 J-	0.005 U	0.005 U	0.025 U
Thallium, Total	0.000082 J	0.00012 J	0.001 U	0.000079 J	0.00033 J	0.001 U	0.00012 J	0.000088 J	0.0014 J
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	0.607 J ± 0.204	3.13 ± 0.594	0.353 U ± 0.558	1.75 U ± 1.31	2.99 ± 0.678	2.28 ± 0.580	1.74 ± 0.489	1.94 ± 0.553	3.33 ± 0.689
Radium-226 & 228	0.950 U ± 0.690	6.32 ± 1.51	0.862 U ± 0.753	2.09 U ± 1.98	6.56 ± 1.18	6.73 J ± 1.47	5.00 ± 1.19	6.46 ± 1.53	R
Radium-228	0.344 U ± 0.659	3.20 ± 1.39	0.509 U ± 0.505	0.340 U ± 1.48	3.58 ± 0.962	4.45 ± 1.35	3.25 ± 1.09	4.52 ± 1.43	R

ABBREVIATIONS AND NOTES:

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CFR: Code of Federal Regulations
ft amsl: feet above mean sea level
MCL: Maximum Contaminant Level
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QUALIFIERS:

J: value is estimated
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https://www.epa.gov/coalash/coal-ash-rule

TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Upgradient								
Location Name	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7
Sample Name	CCR-AP-7-20160610	CCR-AP-7-20160812	CCR-AP-7-20161028	CCR-AP-7-20161207	CCR-AP-7-20170208	CCR-AP-7-20170406	CCR-AP-7-20170607	CCR-AP-7-20170928	CCR-AP-7-20171117
Sample Date	06/10/2016	08/12/2016	10/28/2016	12/07/2016	02/08/2017	04/06/2017	06/07/2017	09/28/2017	11/17/2017
Lab Sample ID	180-55667-7	180-57631-7	180-60350-7	180-61530-7	180-63329-7	180-65041-9	180-67233-7	180-70838-3	180-72640-7
Water Level (ft amsl)	427.57	421.87	418.13	420.84	428.16	429.3	422.65	417.49	419.55
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	**20.27**	**19.2**	**22.01**	**15.31**	**13.89**	**16.15**	**16.62**	**17.93**	**14.47**
Turbidity, Field (FNU)	-	-	-	-	-	-	-	**11.09**	-
Dissolved Oxygen, Field (mg/L)	**0.21**	**0.15**	**0.69**	**0.23**	**-0.02**	**-0.02**	**0.09**	**0.13**	**0.21**
Conductivity, Field (mS/cm)	**0.96343**	**0.9769**	**0.90788**	**0.76817**	**1.00796**	**1.578**	**0.98246**	**0.97415**	**0.97231**
ORP, Field (mv)	**-105.35**	**-152**	**-141.57**	**-146.4**	**-80.23**	**-115.03**	**-143.84**	**-153.3**	**-103.98**
Turbidity, Field (NTU)	**27.02**	**18.9**	**207.68**	**370.05**	**385.27**	**519.28**	**193.1**	-	**3.04**
pH, Field (su)	**7.05**	**7.13**	**7.77**	**7.34**	**7.21**	**7.24**	**7.18**	**7.11**	**7.02**
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	**0.034 J+**	0.034 U	**0.02 J+**	0.071 U	0.034 U	0.08 U	0.15 U	**0.056 J**	0.091 U
Calcium, Total	**86**	**88**	**120 J-**	**99**	**150 J-**	**110 J+**	**100**	**94**	**96**
Chloride (mg/L)	**31**	**26**	**25 J+**	**26**	**25**	**27**	**28**	**29**	**31**
Fluoride (mg/L)	R	**0.24**	**0.25**	**0.37 J+**	**0.28 J+**	**0.29**	**0.34**	**0.19**	**0.25**
Sulfate (mg/L)	**93 J-**	**73**	**66 J+**	**96**	**110**	**110**	**100**	**82**	**77 J-**
pH (lab) (su)	**7.37 J**	**7.9 J**	**7.1 J**	**7.4 J**	**7.4 J**	**7.3 J**	**7.3 J**	**7.3 J**	**7.2 J**
Total Dissolved Solids (TDS) (mg/L)	**590**	**580**	**530**	**620**	**630**	**640**	**620**	**570**	**550**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.002 U	0.002 U	0.002 U	**0.00016 J**	**0.00062 J**	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	**0.0025**	**0.0048**	**0.0084**	**0.0083**	**0.018**	**0.008**	**0.0075**	**0.0058**	**0.0034**
Barium, Total	**0.1**	**0.12**	**0.16**	**0.14**	**0.19**	**0.15**	**0.15**	**0.12**	**0.11**
Beryllium, Total	0.001 U	0.001 U	**0.00017 J**	**0.00012 J**	**0.00075 J**	**0.00022 J**	**0.00015 J**	0.001 U	0.001 U
Cadmium, Total	0.001 U	0.001 U	0.001 U	0.001 U	**0.00032 J**	**0.00014 J**	0.001 U	0.001 U	0.001 U
Chromium, Total	**0.00048 J**	**0.00047 J**	**0.0026**	**0.0039**	**0.019**	**0.0048**	**0.0039 J+**	0.002 U	0.002 U
Cobalt, Total	**0.0012**	**0.0023**	**0.0053 J**	**0.0037**	**0.015**	**0.0054**	**0.0032**	**0.00054**	**0.0003 J**
Lead, Total	**0.00062 J**	**0.00099 J**	**0.0082 J**	**0.0036**	**0.02**	**0.0087 J+**	**0.0041**	0.001 U	0.001 U
Lithium, Total	**0.01 J**	**0.011 J**	**0.02 J**	**0.012 J**	**0.039 J**	**0.019 J**	**0.019 J**	**0.01 J**	**0.012 J**
Molybdenum, Total	**0.0082**	**0.0054**	**0.0044 J**	**0.0088**	**0.013**	**0.0058**	**0.0069**	**0.0036 J**	**0.0028 J**
Selenium, Total	**0.00035 J**	0.005 U	**0.00073 J**	0.005 U	0.005 U	0.005 UJ	0.005 U	0.005 U	0.005 U
Thallium, Total	0.001 U	0.001 U	**0.00008 J**	**0.000066 J**	**0.00061 J**	0.001 U	**0.000088 J**	0.001 U	0.001 U
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	**0.330 J ± 0.0973**	**0.390 ± 0.118**	**1.28 ± 0.664**	0.439 U ± 0.399	**0.744 ± 0.220**	**0.719 ± 0.182**	**0.398 ± 0.129**	**0.308 ± 0.0950**	**0.312 ± 0.0954**
Radium-226 & 228	**0.496 ± 0.284**	**1.02 J ± 0.363**	**1.72 J ± 0.792**	**0.997 ± 0.602**	**1.11 J ± 0.335**	**1.55 ± 0.464**	**1.29 ± 0.433**	R	R
Radium-228	0.166 U ± 0.267	**0.625 J ± 0.344**	0.434 U ± 0.433	0.558 U ± 0.451	0.365 U ± 0.252	**0.830 ± 0.427**	**0.895 ± 0.413**	R	R

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SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Upgradient								
Location Name	CCR-AP-9	CCR-AP-9	CCR-AP-9	CCR-AP-9	CCR-AP-9	CCR-AP-9	CCR-AP-9	CCR-AP-9	CCR-AP-9
Sample Name	CCR-AP9-20170309	CCR-AP-9-20170407	CCR-AP-9-20170426	CCR-AP-9-20170530	CCR-AP-9-20170608	CCR-AP-9-20170725	CCR-AP-9-20170815	CCR-AP-9-20170928	CCR-AP-9-20171117
Sample Date	03/09/2017	04/07/2017	04/26/2017	05/30/2017	06/08/2017	07/25/2017	08/15/2017	09/28/2017	11/17/2017
Lab Sample ID	180-64223-2	180-65041-2	180-65680-2	180-66910-2	180-67233-9	180-68557-2	180-69382-2	180-70838-4	180-72640-9
Water Level (ft amsl)	386.205	387.795	-	387.155	386.475	384.785	384.755	384.775	385.425
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	22.55	14.76	21.56	19.42	19.39	15.07	22.98	17.42	13.11
Turbidity, Field (FNU)	-	-	-	-	-	-	-	-	-
Dissolved Oxygen, Field (mg/L)	3.72	4.25	4.36	3.16	2.56	0.99	3.39	3.76	2.38
Conductivity, Field (mS/cm)	0.00137	1.2589	0.8002	0.97237	0.33375	0.00135	0.99112	1.00763	1.04212
ORP, Field (mv)	-33.4	-38	-4.1	72.93	15.83	107.35	66.57	-25.8	-38.27
Turbidity, Field (NTU)	2810	1444	2275	1494	1873	1663	2320	2008	1760
pH, Field (su)	7.61	8.25	7.38	6.09	9.11	7.78	7.73	7.44	7.31
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	0.2	0.23	0.26 J+	0.26	0.29 U	0.25	0.22	0.29	0.34 U
Calcium, Total	92	110 J+	110	120	120	130	130	110	130
Chloride (mg/L)	23	21	21	19	20	19	18	17	16
Fluoride (mg/L)	0.14	0.36	0.35	0.33	0.42	0.3	0.33	0.3	0.36
Sulfate (mg/L)	130	120	120	110	110	90	110	120	120 J-
pH (lab) (su)	7.5 J	7.4 J	7.5 J	7.7 J	7.6 J	7.4 J	7.5 J	7.5 J	7.4 J
Total Dissolved Solids (TDS) (mg/L)	550	610	590	600	600	650	600	620	620
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.0044	0.0014 J	0.0012 J	0.0011 J	0.0014 J	0.002 U	0.00078 J	0.002 U	0.0079 J+
Arsenic, Total	0.0031	0.006	0.008	0.01	0.0077	0.01	0.0087	0.0058	0.0088
Barium, Total	0.13	0.23	0.23	0.27	0.21	0.28	0.24	0.21	0.29
Beryllium, Total	0.00017 J	0.00053 J	0.00066 J	0.00092 J	0.00047 J	0.0011	0.00073 J	0.00017 J	0.00095 J
Cadmium, Total	0.000079 J	0.000095 J	0.00011 J	0.00015 J	0.00011 J	0.00022 J	0.00014 J	0.001 U	0.005 U
Chromium, Total	0.0042	0.0088	0.012	0.014	0.0088	0.02	0.013	0.0067	0.019
Cobalt, Total	0.0062	0.012	0.013	0.013	0.0096	0.014	0.016	0.0072	0.015
Lead, Total	0.0025	0.0073 J+	0.0069	0.012	0.0056	0.011	0.0098	0.0033	0.0098
Lithium, Total	0.03 J	0.033 J	0.04 J	0.04 J	0.034 J	0.048 J	0.036 J	0.029 J	0.05 J
Molybdenum, Total	0.011	0.0097	0.0071	0.0065	0.0059	0.0059	0.0027 J	0.0043 J	0.0069 J
Selenium, Total	0.0058	0.005 UJ	0.005 U	0.005 U	0.005 U	0.005 U	0.0014 J	0.005 U	0.025 U
Thallium, Total	0.001 U	0.001 U	0.000098 J	0.00018 J	0.0001 J	0.00016 J	0.00011 J	0.001 U	0.00062 J
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	R	1.62 ± 0.470	1.91 ± 0.393	0.614 ± 0.173	1.43 ± 0.332	0.962 ± 0.286	1.68 ± 0.304	2.05 ± 0.533	1.38 ± 0.300
Radium-226 & 228	0.934 UJ ± 0.938	3.23 J ± 1.10	4.02 ± 0.905	1.23 J ± 0.447	3.49 ± 0.747	1.61 ± 0.510	R	3.52 J+ ± 1.13	R
Radium-228	0.401 U ± 0.915	1.61 ± 0.989	2.11 ± 0.815	0.619 U ± 0.412	2.06 ± 0.670	0.644 ± 0.422	R	1.47 U ± 0.995	R

ABBREVIATIONS AND NOTES:

CCR: Coal Combustion Residuals
CFR: Code of Federal Regulations
ft amsl: feet above mean sea level
MCL: Maximum Contaminant Level
mg/L: milligram per liter
mS/cm: milliSiemen per centimeter
mv: millivolt
NA: Not Applicable
NTU: Nephelometric Turbidity Units
pCi/L: picoCurie per liter
su: standard units
USEPA: United States Environmental Protection Agency

QUALIFIERS:

J: value is estimated
J+: value is estimated with a potentially high bias
J-: value is estimated with a potentially low bias
R: value is rejected
U: Not detected value is the laboratory reporting limit

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

TABLE II
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EAST ASH POND - JUNE THROUGH AUGUST 2018
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA
FILE NO. 129420

Location Group	Action Level	Upgradient			
Location Name	Maximum	CCR-AP-1R	CCR-AP-1R	CCR-AP-7	CCR-AP-7
Sample Name	Contaminant	CCR-AP-1-20180611	CCR-AP-1-20180828	CCR-AP-7-20180611	CCR-AP-7-20180828
Sample Date	Level/Regional	06/11/2018	08/28/2018	06/11/2018	08/28/2018
Lab Sample ID	Screening Level	180-78672-1	180-81363-1	180-78672-7	180-81363-7
Detection Monitoring - EPA Appendix III Constituents (mg/L)					
Boron, Total	NA	-	**0.61 J**	-	0.08 U
Calcium, Total	NA	-	**47**	-	**100**
Chloride	NA	-	**11**	-	**27**
Fluoride	4	**0.47**	**0.47**	**0.31**	**0.31**
Sulfate (mg/L)	NA	-	**150**	-	**70**
Total Dissolved Solids (TDS)	NA	-	**820**	-	**580**
pH (lab) (SU)	NA	-	**7.8 J**	-	**7.5 J**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)					
Antimony, Total	0.006	0.02 U	0.02 U	0.002 U	0.002 U
Arsenic, Total	0.01	**0.029**	**0.023**	**0.0071**	**0.0064**
Barium, Total	2	**0.55**	**0.47**	**0.14**	**0.14**
Beryllium, Total	0.004	**0.0056 J**	**0.0033 J**	0.001 U	**0.000067 J**
Cadmium, Total	0.005	0.01 U	0.01 U	0.001 U	0.001 U
Chromium, Total	0.1	**0.12**	**0.13**	0.0014 U	**0.0061 J+**
Cobalt, Total	0.006	**0.047**	**0.036**	**0.00065**	**0.0014**
Fluoride	4	**0.47**	**0.47**	**0.31**	**0.31**
Lead, Total	0.015	**0.063**	**0.049**	**0.00041 J**	**0.0014**
Lithium, Total	0.04	**0.17**	**0.13**	**0.011**	**0.013**
Mercury, Total	0.002	0.0002 U	-	0.0002 U	-
Molybdenum, Total	0.1	**0.01 J**	**0.0077 J**	**0.0025 J**	**0.0026 J**
Selenium, Total	0.05	0.05 U	0.05 U	0.005 U	0.005 U
Thallium, Total	0.002	**0.001 J**	**0.00094 J**	0.001 U	0.001 U
Radiological (pCi/L)					
Radium-226	NA	**2.01 ± 0.674**	**2.42 ± 0.633**	**0.480 ± 0.216**	R
Radium-228	NA	**2.14 ± 0.626**	**2.65 ± 1.05**	0.0986 U ± 0.257	0.307 U ± 0.231
Radium-226 & 228	5	**4.15 ± 0.92**	**5.07 ± 1.23**	**0.579 J ± 0.336**	R

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TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
EAST ASH POND - JUNE THROUGH AUGUST 2018
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA
FILE NO. 129420

Location Group	Action Level	Downgradient						
Location Name	Maximum	CCR-AP-2	CCR-AP-2	CCR-AP-3	CCR-AP-3	CCR-AP-4	CCR-AP-4	CCR-AP-5
Sample Name	Contaminant	CCR-AP-2-20180611	CCR-AP-2-20180828	CCR-AP-3-20180611	CCR-AP-3-20180828	CCR-AP-4-20180611	CCR-AP-4-20180828	CCR-AP-5-20180611
Sample Date	Level/Regional	06/11/2018	08/28/2018	06/11/2018	08/28/2018	06/11/2018	08/28/2018	06/11/2018
Lab Sample ID	Screening Level	180-78672-2	180-81363-2	180-78672-3	180-81363-3	180-78672-4	180-81363-4	180-78672-5
Detection Monitoring - EPA Appendix III Constituents (mg/L)								
Boron, Total	NA	-	**9.6**	-	**0.14**	-	**0.1**	-
Calcium, Total	NA	-	**220**	-	**180**	-	**190**	-
Chloride	NA	-	**150**	-	**12**	-	**16**	-
Fluoride	4	**0.28**	**0.25**	**0.56**	**0.33**	**0.41**	**0.29**	**1.4**
Sulfate (mg/L)	NA	-	**510**	-	1 U	-	**2.6**	-
Total Dissolved Solids (TDS)	NA	-	**1500**	-	**1000**	-	**950**	-
pH (lab) (SU)	NA	-	**6.9 J**	-	**7.3 J**	-	**6.8 J**	-
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)								
Antimony, Total	0.006	0.002 U	0.02 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.01	**0.013**	**0.021**	**0.08**	**0.071**	**0.027**	**0.11**	R
Barium, Total	2	**0.27**	**0.52**	**0.47**	**0.43**	**0.45**	**0.78**	**0.068**
Beryllium, Total	0.004	**0.0021**	**0.002 J**	0.001 U	0.001 U	0.001 U	**0.00084 J**	0.001 U
Cadmium, Total	0.005	**0.00089 J**	0.01 U	0.001 U	0.001 U	0.001 U	**0.00048 J**	**0.00057 J**
Chromium, Total	0.1	**0.042**	**0.082**	**0.0041 J+**	**0.0041 J+**	R	**0.028**	0.0014 U
Cobalt, Total	0.006	**0.023**	**0.029**	**0.0052**	**0.0046**	**0.002**	**0.013**	**0.0028**
Fluoride	4	**0.28**	**0.25**	**0.56**	**0.33**	**0.41**	**0.29**	**1.4**
Lead, Total	0.015	**0.03**	**0.035**	**0.00092 J**	**0.00078 J**	**0.00052 J**	**0.021**	**0.000099 J**
Lithium, Total	0.04	**0.033**	**0.057**	0.005 U	0.005 U	**0.0029 J**	**0.019**	**0.11**
Mercury, Total	0.002	0.0002 U	-	0.0002 U	-	0.0002 U	-	0.0002 U
Molybdenum, Total	0.1	**0.003 J**	**0.0056 J**	**0.0099**	**0.0096**	**0.0012 J**	**0.0033 J**	**0.39**
Selenium, Total	0.05	**0.0026 J**	0.05 U	**0.0023 J**	**0.0021 J**	**0.0009 J**	**0.0016 J**	0.005 U
Thallium, Total	0.002	**0.00048 J**	**0.00099 J**	0.001 U	0.001 U	0.001 U	**0.00026 J**	0.001 U
Radiological (pCi/L)								
Radium-226	NA	**0.597 ± 0.32**	R	**0.475 ± 0.329**	R	**0.830 ± 0.366**	**2.47 ± 0.635**	**0.261 ± 0.167**
Radium-228	NA	0.294 U ± 0.337	**0.880 ± 0.51**	0.292 U ± 0.375	**0.946 ± 0.416**	0.458 U ± 0.313	1.06 U ± 0.934	0.213 U ± 0.216
Radium-226 & 228	5	**0.891 J ± 0.465**	R	**0.768 J ± 0.499**	**1.70 J+ ± 0.463**	**1.29 J ± 0.482**	**3.53 J ± 1.13**	**0.474 J ± 0.273**

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TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
EAST ASH POND - JUNE THROUGH AUGUST 2018
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA
FILE NO. 129420

Location Group	Action Level	Downgradient						
Location Name	Maximum	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-6	CCR-AP-6	CCR-AP-8	CCR-AP-8
Sample Name	Contaminant	IND DUPLICATE-201806	CCR-AP-5-20180828	BLIND DUP-20180828	CCR-AP-6-20180611	CCR-AP-6-20180828	CCR-AP-8-20180611	CCR-AP-8-20180828
Sample Date	Level/Regional	06/11/2018	08/28/2018	08/28/2018	06/11/2018	08/28/2018	06/11/2018	08/28/2018
Lab Sample ID	Screening Level	180-78672-10	180-81363-5	180-81363-10	180-78672-6	180-81363-6	180-78672-8	180-81363-8
Detection Monitoring - EPA Appendix III Constituents (mg/L)								
Boron, Total	NA	-	**41**	**42**	-	**0.51**	-	0.08 U
Calcium, Total	NA	-	**320**	**340**	-	**190**	-	**280**
Chloride	NA	-	**340**	**350**	-	**19**	-	**6**
Fluoride	4	**1.5**	**1.3**	**1.3**	**0.6**	**0.42**	**0.41**	**0.21**
Sulfate (mg/L)	NA	-	**1200**	**1200**	-	**1.1**	-	**1.3**
Total Dissolved Solids (TDS)	NA	-	**2700**	**2700**	-	**1000**	-	**1300**
pH (lab) (SU)	NA	-	**7.2 J**	**7.2 J**	-	**7.4 J**	-	**7 J**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)								
Antimony, Total	0.006	0.002 U	0.002 U	0.002 U	**0.0012 J**	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.01	R	0.001 U	**0.00082 J**	**0.12**	**0.1**	**0.11**	**0.096**
Barium, Total	2	**0.073**	**0.033**	**0.034**	**0.69**	**0.64**	**0.68**	**0.58**
Beryllium, Total	0.004	0.001 U	0.001 U	0.001 U	**0.00065 J**	**0.00046 J**	**0.00022 J**	**0.00016 J**
Cadmium, Total	0.005	**0.0006 J**	**0.00024 J**	**0.00027 J**	**0.00051 J**	**0.0005 J**	0.001 U	0.001 U
Chromium, Total	0.1	R	0.002 U	0.0033 U	**0.029**	**0.031**	**0.0069 J+**	**0.0068 J+**
Cobalt, Total	0.006	**0.0033**	**0.0028**	**0.0036**	**0.014**	**0.013**	**0.0086**	**0.0077**
Fluoride	4	**1.5**	**1.3**	**1.3**	**0.6**	**0.42**	**0.41**	**0.21**
Lead, Total	0.015	**0.000096 J**	0.001 U	0.001 U	**0.02**	**0.02**	**0.0033**	**0.0021**
Lithium, Total	0.04	**0.096**	**0.094**	**0.098**	**0.016**	**0.014**	**0.0057**	**0.0052**
Mercury, Total	0.002	0.0002 U	-	-	0.0002 U	-	0.0002 U	-
Molybdenum, Total	0.1	**0.42**	**0.37**	**0.38**	**0.033**	**0.031**	**0.013**	**0.012**
Selenium, Total	0.05	0.005 U	0.005 U	0.005 U	**0.0023 J**	**0.0019 J**	**0.0021 J**	**0.0018 J**
Thallium, Total	0.002	**0.000076 J**	0.001 U	0.001 U	**0.00022 J**	**0.0002 J**	**0.000083 J**	0.001 U
Radiological (pCi/L)								
Radium-226	NA	**0.231 ± 0.168**	R	R	**1.15 ± 0.384**	**1.71 J ± 0.551**	**0.544 ± 0.277**	R
Radium-228	NA	**0.605 ± 0.274**	0.252 U ± 0.311	0.130 U ± 0.253	**1.12 ± 0.415**	0.929 U ± 1.02	**0.502 ± 0.319**	0.367 U ± 0.309
Radium-226 & 228	5	**0.836 ± 0.321**	R	R	**2.27 ± 0.565**	**2.64 J ± 1.16**	**1.05 ± 0.422**	R

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TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
EAST ASH POND - MAY THROUGH OCTOBER 2019
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Action Level	Background					
Location Name		CCR-AP-7	CCR-AP-7	CCR-AP-1R	CCR-AP-1R	CCR-AP-9	CCR-AP-9
Sample Name	Maximum Contaminant Level	CCR-AP-7-20190528	CCR-AP-7-20191023	CCR-AP-1R-20190528	CCR-AP-1R-20191023	CCR-AP-9-20190528	CCR-AP-9-20191022
Sample Date		05/28/2019	10/23/2019	05/28/2019	10/23/2019	05/28/2019	10/22/2019
Lab Sample ID		180-90609-7	180-97809-16	180-90609-1	180-97809-1	180-90609-9	180-97809-11
Detection Monitoring - EPA Appendix III Constituents (mg/L)							
Boron, Total	NA	**0.28 J**	0.08 U	**0.72 J-**	**0.43**	**0.41 J**	**0.36 J**
Calcium, Total	NA	**100**	**110**	**67**	**70**	**130**	**130**
Chloride	NA	**28**	**27**	**17**	**16**	**12**	**9.7**
Fluoride	4	**0.27 J+**	**0.14**	**0.57 J+**	**0.34**	**0.33 J+**	**0.21**
Sulfate	NA	**82**	**65**	**190**	**180**	**100**	**120**
Total Dissolved Solids (TDS)	NA	**590**	**530**	**890**	**300**	**650**	**600**
pH (lab) (SU)	NA	**7.5 J**	**7.4 HF**	**7.8 J**	**7.8 HF**	**7.5 J**	**7.6 HF**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)							
Antimony, Total	0.006	0.002 U	0.002 U	**0.00057 J**	**0.0019 J**	**0.00061 J**	0.01 U
Arsenic, Total	0.01	**0.0037**	**0.0075**	**0.038**	**0.037**	**0.0078**	**0.013**
Barium, Total	2	**0.13**	**0.15**	**0.38**	**0.59**	**0.29**	**0.35**
Beryllium, Total	0.004	0.001 U	0.001 U	**0.005**	**0.0066**	**0.00066 J**	**0.0011 J**
Cadmium, Total	0.005	0.001 U	0.001 U	**0.00052 J**	**0.00087 J**	**0.00014 J**	0.005 U
Chromium, Total	0.1	0.002 U	**0.0018 J**	**0.11**	**0.16**	**0.016 J+**	**0.033**
Cobalt, Total	0.006	**0.00047 J**	**0.001**	**0.075**	**0.081**	**0.012**	**0.017**
Fluoride	4	**0.27 J+**	**0.14**	**0.57 J+**	**0.34**	**0.33 J+**	**0.21**
Lead, Total	0.015	0.001 U	**0.0014**	**0.076**	**0.094**	**0.01**	**0.017**
Lithium, Total	0.04	**0.011**	**0.02**	**0.16**	**0.23**	**0.041**	**0.072**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.002 J**	**0.0017 J**	**0.01**	**0.012 J**	**0.0038 J**	**0.0049 J**
Selenium, Total	0.05	0.005 U	0.005 U	0.005 U	**0.012 J**	0.005 U	**0.013 J**
Thallium, Total	0.002	0.001 U	0.001 U	**0.00074 J**	**0.0014 J**	**0.00016 J**	0.005 U
Radiological (pCi/L)							
Radium-226	NA	**0.423 ± 0.123**	**0.194 ± 0.097**	**0.564 ± 0.216**	**0.561 ± 0.237**	**1.02 ± 0.252**	**1.67 ± 0.375**
Radium-228	NA	0.112 U ± 0.31	**1.02 ± 0.324**	**1.91 ± 1.12**	**1.37 ± 0.665**	**1.30 ± 0.699**	**1.47 ± 0.625**
Radium-226 & 228	5	**0.535 J ± 0.334**	**1.21 ± 0.338**	**2.47 ± 1.14**	**1.93 ± 0.706**	**2.32 ± 0.743**	**3.13 ± 0.729**
Field Parameters							
Temperature (Deg C)	NA	**18.68**	**18.44**	**28.08**	**20.79**	**26.01**	**16.23**
Dissolved Oxygen, Field (mg/L)	NA	**0.03**	**0.18**	**4.51**	**2.01**	**3.75**	**7.72**
Conductivity, Field (mS/cm)	NA	**0.90624**	**0.97501**	**1.1438**	**1.273**	**0.91846**	**0.92719**
ORP, Field (mv)	NA	**-131.2**	**-111.5**	**79.4**	**-48.7**	**-32.9**	**-8.3**
Turbidity, Field (NTU)	NA	**1.97**	**21.59**	**3716**	**2013**	**2572**	**1547**
pH, Field (SU)	NA	**7.42**	**7.01**	**7.82**	**7.48**	**7.56**	**7.51**

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EAST ASH POND - MAY THROUGH OCTOBER 2019
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Action Level	Downgradient								
Location Name		CCR-AP-10	CCR-AP-11	CCR-AP-11	CCR-AP-2	CCR-AP-2	CCR-AP-3	CCR-AP-3	CCR-AP-4	CCR-AP-4
Sample Name	Maximum Contaminant Level	CCR-AP-10-20191024	CCR-AP-11-20190612	CCR-AP-11-20191023	CCR-AP-2-20190528	CCR-AP-2-20191022	CCR-AP-3-20190528	CCR-AP-3-20191022	CCR-AP-4-20190528	CCR-AP-4-20191022
Sample Date		10/24/2019	06/13/2019	10/23/2019	05/28/2019	10/22/2019	05/28/2019	10/22/2019	05/28/2019	10/22/2019
Lab Sample ID		180-97809-12	180-91361-4 1906573-5	180-97809-13	180-90609-2	180-97809-2	180-90609-3	180-97809-3	180-90609-4	180-97809-4
Detection Monitoring - EPA Appendix III Constituents (mg/L)										
Boron, Total	NA	**1.3**	**0.22 J+**	**0.21**	**6.8 J-**	**5.3**	**0.24 J**	**0.097**	**0.13 J**	0.4 U
Calcium, Total	NA	**82**	**110**	**94**	**190**	**220**	**190**	**190**	**180**	**180**
Chloride	NA	**22**	**20**	**15**	**160**	**120**	**25**	**23**	**30**	**26**
Fluoride	4	**0.49**	**0.32**	**0.3**	**0.4 J+**	**0.51**	**0.53 J+**	**0.39**	**0.37 J+**	**0.083 J**
Sulfate	NA	**4.5**	**310**	**330**	**490**	**310**	**0.5 J**	**0.91 J**	**2.8**	**4.8**
Total Dissolved Solids (TDS)	NA	**1000**	**870**	**680**	**1300**	**440**	**1000**	**990**	**940**	**910**
pH (lab) (SU)	NA	**7.5 HF**	**6.5 J**	**6.7 HF**	**7 J**	**6.8 HF**	**7.3 J**	**7.2 HF**	**6.8 J**	**6.8 HF**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)										
Antimony, Total	0.006	**0.00052 J**	0.002 U	0.002 U	**0.0011 J**	0.01 U	0.002 U	0.002 U	0.002 U	0.01 U
Arsenic, Total	0.01	**0.013**	**0.047**	**0.013**	**0.032**	**0.02**	**0.077**	**0.069**	**0.11**	**0.32**
Barium, Total	2	**0.17**	**0.34**	**0.12**	**0.26**	**0.28**	**0.44**	**0.48**	**0.66**	**1.3**
Beryllium, Total	0.004	0.001 U	**0.00017 J**	0.001 U	**0.0021**	**0.0019 J**	0.001 U	0.001 U	0.001 U	**0.0011 J**
Cadmium, Total	0.005	0.001 U	0.001 U	0.001 U	**0.0023**	**0.0016 J**	0.001 U	0.001 U	0.001 U	0.005 U
Chromium, Total	0.1	**0.0017 J**	0.0032 U	0.002 U	**0.052**	**0.054**	0.002 U	**0.0025**	0.0034 U	**0.026**
Cobalt, Total	0.006	**0.0007**	**0.025**	**0.0049**	**0.026**	**0.026**	**0.0054**	**0.0048**	**0.0031**	**0.012**
Fluoride	4	**0.49**	**0.32**	**0.3**	**0.4 J+**	**0.51**	**0.53 J+**	**0.39**	**0.37 J+**	**0.083 J**
Lead, Total	0.015	**0.00084 J**	0.001 U	**0.00023 J**	**0.038**	**0.026**	**0.00033 J**	**0.00083 J**	**0.0043**	**0.02**
Lithium, Total	0.04	**0.057**	**0.004 J**	**0.014**	**0.031**	**0.069**	0.005 U	**0.0078**	**0.0041 J**	**0.047**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	**0.00038**	**0.00019 J**	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.03**	**0.0011 J**	**0.0007 J**	**0.0078**	**0.0078 J**	**0.0099**	**0.0089**	**0.0011 J**	**0.0037 J**
Selenium, Total	0.05	**0.0053**	0.005 U	**0.0066**	**0.0065**	**0.026**	0.005 U	**0.0068**	0.005 U	**0.031**
Thallium, Total	0.002	0.001 U	0.001 U	0.001 U	**0.0009 J**	**0.00096 J**	0.001 U	0.001 U	0.001 U	0.005 U
Radiological (pCi/L)										
Radium-226	NA	**0.543 ± 0.147**	**0.56 ± 0.29**	0.0634 U ± 0.0737	**2.57 ± 0.584**	**0.560 ± 0.22**	**0.404 ± 0.159**	0.116 U ± 0.104	**0.846 ± 0.224**	**0.606 ± 0.226**
Radium-228	NA	**0.535 ± 0.307**	0.60 U ± 0.39	0.246 U ± 0.302	2.81 U ± 1.93	0.217 U ± 0.45	**1.83 ± 1.11**	0.477 U ± 0.354	**1.54 ± 0.735**	**1.18 ± 0.569**
Radium-226 & 228	5	**1.08 ± 0.34**	**1.16 J ± 0.486**	0.310 U ± 0.311	**5.38 J ± 2.02**	**0.778 ± 0.501**	**2.24 ± 1.12**	**0.593 ± 0.369**	**2.38 ± 0.768**	**1.78 ± 0.612**
Field Parameters										
Temperature (Deg C)	NA	**18.85**	**17.71**	**19.53**	**29.7**	**20.11**	**33.68**	**19.35**	**25.99**	**19.24**
Dissolved Oxygen, Field (mg/L)	NA	**3.73**	**0.03**	**0.25**	**8.31**	**4.89**	**2.14**	**1.09**	**1.55**	**1.14**
Conductivity, Field (mS/cm)	NA	**1.592**	**1.144**	**1.1326**	-	**1.1641**	**1.6096**	**1.6303**	**1.5681**	**1.7555**
ORP, Field (mv)	NA	**-96.5**	**-152.2**	**-104.1**	**122.8**	**43.7**	**-142.5**	**-7.4**	**-97.7**	**-63.9**
Turbidity, Field (NTU)	NA	**35.54**	**45.14**	**21.5**	**0.72**	**1088**	**183.72**	**0.27**	**63.06**	**486.26**
pH, Field (SU)	NA	**7.2**	**6.9**	**6.63**	**7.79**	**7.33**	**7.13**	**8.14**	**6.8**	**6.51**

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TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
EAST ASH POND - MAY THROUGH OCTOBER 2019
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Action Level	Downgradient							
Location Name		CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5I	CCR-AP-5I	CCR-AP-6	CCR-AP-6
Sample Name	Maximum	CCR-AP-5-20190528	BLIND DUPLICATE-20190528	CCR-AP-5-20191023	BLIND DUPLICATE-20191023	CCR-AP-5I-20190612	CCR-AP-5I-20191023	CCR-AP-6-20190528	CCR-AP-6-20191022
Sample Date	Contaminant Level	05/28/2019	05/28/2019	10/23/2019	10/23/2019	06/12/2019	10/23/2019	05/28/2019	10/22/2019
Lab Sample ID		180-90609-5	180-90609-10	180-97809-5	180-97809-14	180-91361-1 1906573-1	180-97809-6	180-90609-6	180-97809-7
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	NA	**35 J-**	**34 J-**	**16**	**8.8**	**14**	**2.5**	**0.85 J-**	**0.28**
Calcium, Total	NA	**260**	**270**	**220**	**220**	**250**	**120**	**190**	**200**
Chloride	NA	**160**	**170**	**59**	**61**	**240**	**80**	**39**	**37**
Fluoride	4	**1.2 J+**	**1.3 J+**	**1.3**	**1.3**	**0.31**	**0.25**	**0.67 J+**	**0.46**
Sulfate	NA	**860**	**930**	**670**	**680**	**700**	**390**	**7.5**	**3.9**
Total Dissolved Solids (TDS)	NA	**2100**	**2000**	**1500**	**1500**	**1700**	**980**	**1000**	**1000**
pH (lab) (SU)	NA	**7.3 J**	**7.3 J**	**7.5 HF**	**7.5 HF**	**7 J**	**7.4 HF**	**7.4 J**	**7.4 HF**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.006	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	**0.00039 J**	**0.00083 J**	0.002 U
Arsenic, Total	0.01	**0.0011**	**0.0013**	**0.00066 J**	**0.00079 J**	**0.00072 J**	**0.00062 J**	**0.11**	**0.092**
Barium, Total	2	**0.04**	**0.042**	**0.042**	**0.043**	**0.085**	**0.035**	**0.69**	**0.6**
Beryllium, Total	0.004	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.00069 J**	0.001 U
Cadmium, Total	0.005	**0.00051 J**	**0.00053 J**	**0.00016 J**	0.001 U	0.001 U	0.001 U	**0.0006 J**	**0.00018 J**
Chromium, Total	0.1	0.0027 U	0.0028 U	0.002 U	0.002 U	0.002 U	0.002 U	**0.028**	**0.0075**
Cobalt, Total	0.006	**0.0031**	**0.0031**	**0.0023**	**0.0022**	**0.00048 J**	**0.00047 J**	**0.018**	**0.006**
Fluoride	4	**1.2 J+**	**1.3 J+**	**1.3**	**1.3**	**0.31**	**0.25**	**0.67 J+**	**0.46**
Lead, Total	0.015	**0.0011**	**0.0017**	**0.00013 J**	0.001 U	**0.00023 J**	0.001 U	**0.024**	**0.0049**
Lithium, Total	0.04	**0.087**	**0.086**	**0.095**	**0.091**	**0.035**	**0.035**	**0.014**	**0.0098**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.38**	**0.38**	**0.53**	**0.52**	**0.0017 J**	**0.0072**	**0.028**	**0.023**
Selenium, Total	0.05	0.005 U	0.005 U	**0.007**	**0.0075**	0.005 U	**0.009**	0.005 U	**0.0053**
Thallium, Total	0.002	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.00018 J**	0.001 U
Radiological (pCi/L)									
Radium-226	NA	**0.107 ± 0.0722**	**0.146 ± 0.0812**	**0.103 ± 0.0685**	0.0299 U ± 0.0704	**0.85 ± 0.36**	0.0924 U ± 0.0773	**6.34 J- ± 1.43**	**0.567 ± 0.163**
Radium-228	NA	0.257 U ± 0.341	0.435 U ± 0.42	**0.497 ± 0.256**	**0.588 ± 0.301**	0.40 U ± 0.36	-0.0597 U ± 0.26	3.90 UJ ± 4.41	**0.675 ± 0.337**
Radium-226 & 228	5	0.364 UJ ± 0.349	0.581 UJ ± 0.428	**0.599 ± 0.265**	**0.617 ± 0.309**	**1.25 J ± 0.509**	0.0327 U ± 0.271	**10.2 J- ± 4.64**	**1.24 ± 0.374**
Field Parameters									
Temperature (Deg C)	NA	**20.61**	**20.61**	**18.55**	**18.55**	**17.93**	**20.04**	**35.64**	**19.94**
Dissolved Oxygen, Field (mg/L)	NA	**0.04**	**0.04**	**0.21**	**0.21**	**0.03**	**0.21**	**2.55**	**2.41**
Conductivity, Field (mS/cm)	NA	**2.1567**	**2.1567**	**1.1217**	**1.1217**	**2.4352**	**1.4368**	**1.4215**	**1.7371**
ORP, Field (mv)	NA	**35.3**	**35.3**	**76.8**	**76.8**	**205**	**-168.5**	**-229.3**	**-110.3**
Turbidity, Field (NTU)	NA	**87.1**	**87.1**	**1.44**	**1.44**	**72.85**	**2.39**	**390.25**	**92.38**
pH, Field (SU)	NA	**7.25**	**7.25**	**6.94**	**6.94**	**7.06**	**7.18**	**7.28**	**7.16**

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TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
EAST ASH POND - MAY THROUGH OCTOBER 2019
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Action Level	Downgradient					
Location Name		CCR-AP-6I	CCR-AP-6I	CCR-AP-8	CCR-AP-8	CCR-AP-8I	CCR-AP-8I
Sample Name	Maximum	CCR-AP-6I-20190612	CCR-AP-6I-20191024	CCR-AP-8-20190528	CCR-AP-8-20191022	CCR-AP-8I-20190612	CCR-AP-8I-20191024
Sample Date	Contaminant	06/12/2019	10/24/2019	05/28/2019	10/22/2019	06/12/2019	10/24/2019
	Level	180-91361-2				180-91361-3	
Lab Sample ID		1906573-3	180-97809-8	180-90609-8	180-97809-9	1906573-4	180-97809-10
Detection Monitoring - EPA Appendix III Constituents (mg/L)							
Boron, Total	NA	**12**	**12**	**0.12 J**	0.08 U	**18**	**8**
Calcium, Total	NA	**340**	**560**	**270**	**310**	**490**	**380**
Chloride	NA	**350**	**170**	**15**	**15**	**130**	**350**
Fluoride	4	**0.19 J+**	**0.13 J**	**0.51 J+**	**0.072 J**	**0.12 J+**	**0.24 J**
Sulfate	NA	**860**	**1400**	**0.99 J**	**2**	**1100**	**1000**
Total Dissolved Solids (TDS)	NA	**2300**	**2600**	**1200**	**1300**	**2200**	**2400**
pH (lab) (SU)	NA	**6.9 J**	**7.3 HF**	**6.9 J**	**7.1 HF**	**7.4 J**	**6.9 HF**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)							
Antimony, Total	0.006	0.002 U	0.002 U	**0.00046 J**	**0.00043 J**	0.002 U	0.002 U
Arsenic, Total	0.01	**0.0028**	**0.0049**	**0.1**	**0.09**	**0.0051**	**0.0022**
Barium, Total	2	**0.28**	**0.067**	**0.49**	**0.65**	**0.063**	**0.27**
Beryllium, Total	0.004	**0.00019 J**	0.001 U	0.001 U	0.001 U	**0.00018 J**	0.001 U
Cadmium, Total	0.005	0.001 U	**0.00022 J**	0.001 U	**0.00019 J**	**0.00022 J**	**0.00018 J**
Chromium, Total	0.1	0.0026 U	0.002 U	0.0034 U	**0.0067**	0.0033 U	0.002 U
Cobalt, Total	0.006	**0.00062 J+**	**0.0025**	**0.0044**	**0.0054**	**0.0031**	**0.00037 J**
Fluoride	4	**0.19 J+**	**0.13 J**	**0.51 J+**	**0.072 J**	**0.12 J+**	**0.24 J**
Lead, Total	0.015	0.001 U	**0.0011**	**0.0012**	**0.003**	0.001 U	**0.00046 J**
Lithium, Total	0.04	**0.33**	**0.056**	**0.0031 J**	**0.0093**	**0.047**	**0.41**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.34**	**0.83**	**0.0099**	**0.012**	**0.86**	**0.31**
Selenium, Total	0.05	0.005 U	**0.0041 J**	0.005 U	**0.007**	0.005 U	**0.0062**
Thallium, Total	0.002	0.001 U	0.001 U	0.001 U	0.001 U	**0.00013 J**	0.001 U
Radiological (pCi/L)							
Radium-226	NA	**1.31 ± 0.47**	0.0977 U ± 0.0836	**0.443 ± 0.148**	**0.295 ± 0.143**	**0.46 ± 0.24**	**1.14 ± 0.204**
Radium-228	NA	**1.76 ± 0.58**	0.282 U ± 0.258	0.0635 UJ ± 0.848	0.431 U ± 0.358	**0.88 ± 0.42**	**1.28 ± 0.323**
Radium-226 & 228	5	**3.07 ± 0.747**	0.380 U ± 0.271	0.506 UJ ± 0.861	**0.726 ± 0.386**	**1.34 ± 0.484**	**2.42 ± 0.382**
Field Parameters							
Temperature (Deg C)	NA	**20.34**	**19.12**	**29.13**	**22.28**	**18.71**	**18.19**
Dissolved Oxygen, Field (mg/L)	NA	**0.03**	**0.16**	**2.9**	**1.41**	**0.04**	**0.07**
Conductivity, Field (mS/cm)	NA	**2.6443**	**2.7861**	**1.409**	**2.2261**	**3.0502**	**3.1838**
ORP, Field (mv)	NA	**-182**	**-26.4**	**-98**	**-106.6**	**-231.7**	**-107.2**
Turbidity, Field (NTU)	NA	**35.69**	**43.2**	**40.92**	**112.99**	**25.06**	**12.85**
pH, Field (SU)	NA	**7.36**	**7.06**	**7.04**	**7.06**	**7.14**	**6.77**

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https://www.epa.gov/coalash/coal-ash-rule

www.haleyaldrich.com

ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT
EAST ASH POND
F.B. CULLEY GENERATING STATION
WARRICK COUNTY, INDIANA

by
Haley & Aldrich, Inc.
Greenville, South Carolina

for
Southern Indiana Gas and Electric Company
Evansville, Indiana

File No. 129420
January 2020

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1. 40 CFR § 257.90 Applicability

1.1 40 CFR § 257.90(a)

Except as provided for in § 257.100 for inactive CCR surface impoundments, all CCR landfills, CCR surface impoundments, and lateral expansions of CCR units are subject to the groundwater monitoring and corrective action requirements under § 257.90 through § 257.98.

The East Ash Pond (EAP) at F.B. Culley Generating Station (FBC) is subject to the groundwater monitoring and corrective action requirements described under Code of Federal Regulations Title 40 (40 CFR) § 257.90 through § 257.98 (Rule). This document addresses the requirement for the Owner/Operator to prepare an Annual Groundwater Monitoring and Corrective Action Report per § 257.90(e).

1.2 40 CFR § 257.90(e) - SUMMARY

Annual groundwater monitoring and corrective action report. For existing CCR landfills and existing CCR surface impoundments, no later than January 31, 2018, and annually thereafter, the owner or operator must prepare an annual groundwater monitoring and corrective action report. For new CCR landfills, new CCR surface impoundments, and all lateral expansions of CCR units, the owner or operator must prepare the initial annual groundwater monitoring and corrective action report no later than January 31 of the year following the calendar year a groundwater monitoring system has been established for such CCR unit as required by this subpart, and annually thereafter. For the preceding calendar year, the annual report must document the status of the groundwater monitoring and corrective action program for the CCR unit, summarize key actions completed, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year. For purposes of this section, the owner or operator has prepared the annual report when the report is placed in the facility's operating record as required by § 257.105(h)(1).

This Annual Groundwater Monitoring and Corrective Action Report documents the activities completed in 2019 for the EAP as required by the Rule. Groundwater sampling and analysis was conducted per the requirements described in § 257.93, and the status of the groundwater monitoring program described in § 257.95 is provided in this report.

1.2.1 Status of the Groundwater Monitoring Program

As provided in the notification on 15 January 2018 statistically significant increases (SSI) of Appendix III constituents were identified downgradient of the EAP. An evaluation of alternate sources was conducted; however, a successful alternate source demonstration (ASD) was not achieved at that time. As a result, an Assessment Monitoring program was initiated as required by § 257.94(e)(2). The notification was placed in the facility's operating record as required by 257.105(h)(5). Annual and semi-annual groundwater samples were collected as outlined in § 257.95(b) and 257.95(d)(1) and groundwater protection standards were established as required by § 257.95(d)(2). Statistical analysis was completed in January 2019 as described in § 257.93(h)(2) and statistically significant levels (SSL) of Appendix IV constituents (molybdenum and arsenic) were identified downgradient of the EAP. An alternate source evaluation was conducted and an ASD was prepared (Appendix A) to demonstrate that a source other than the EAP caused the SSLs for arsenic. A successful alternate source demonstration for molybdenum has not been achieved at this time. As a result, an assessment of corrective measures was initiated as required by § 257.96. A 60-day extension to complete the assessment of corrective measures was required and certified by a professional engineer as required by 257.96(a) resulting in completion of the Assessment of Corrective Measures in September 2019.

1.2.2 Key Actions Completed

The following key actions were completed in 2019:

- Completed a statistical analysis of assessment monitoring results to evaluate potential SSLs;
- Prepared 2018 Annual Report including:
  - The Annual Report was placed in the facility's operating record pursuant to § 257.105(h)(1);
  - Pursuant to § 257.106(h)(1), the notification was sent to the relevant State Director and/or Tribal authority within 30 days of the Annual Report being placed in the facility's operating record [§ 257.106(d)];
  - Pursuant to § 257.107(h)(1), the Annual Report was posted to the CCR Website within 30 days of the Annual Report being placed in the facility's operating record [§ 257.107(d)] and 257.107(h)(1)];
- Conducted and certified an ASD for arsenic (Appendix A);
- Evaluated the nature and extent of Appendix IV SSLs as required by § 257.95(g)(1);
- Collected and analyzed two rounds of groundwater samples in accordance with § 257.95
- Initiated and completed an assessment of corrective measures in accordance with § 257.96;
  - The 90-day deadline to complete the assessment of corrective measures was extended an additional 60-days in accordance with § 257.96(a). (Appendix B)
  - The assessment of corrective measures was placed in the facility's operating record in accordance with § 257.96(d).

1.2.3 Problems Encountered

Monitoring well (CCR-AP-10) was installed on the north side of the East Ash Pond to evaluate the nature and extent of arsenic and molybdenum in groundwater. The shale bedrock encountered at this location did not yield a sufficient amount of groundwater for sampling in June 2019. However, in October 2019 there was a sufficient amount of groundwater for sampling.

1.2.4 Actions to Resolve Problems

Monitoring well CCR-AP-10 will be evaluated during the first semiannual groundwater sampling event in 2020. If CCR-AP-10 does not yield enough groundwater, the monitoring well will be properly abandoned and deepened.

1.2.5 Project Key Activities for Upcoming Year

Key activities to be completed in 2020 include the following:

- Further refine the characterization of the nature and extent of molybdenum in groundwater downgradient of the EAP.
- Continue semiannual groundwater monitoring in accordance with § 257.95.

- Complete statistical analysis of the semiannual groundwater sampling results as required by § 257.93(h)(2).
- Hold a public meeting with interested and affected parties in accordance with § 257.96(e) to discuss the results of the corrective measures assessment at least 30 days prior to the selection of remedy.
- As soon as feasible following the public meeting select a remedy that, at a minimum, meets the standards outlined in § 257.97(b).
  - As part of the selected remedy SIGECO will develop a schedule for implementing and completing remedial activities as defined in § 257.97(d).
- Prepare semiannual and annual progress reports, as necessary, describing the progress in selecting and designing the remedy as outlined in § 257.97(a).

1.3 40 CFR § 257.90(e) - INFORMATION

At a minimum, the annual groundwater monitoring and corrective action report must contain the following information, to the extent available:

1.3.1 40 CFR § 257.90(e)(1)

A map, aerial image, or diagram showing the CCR unit and all background (or upgradient) and downgradient monitoring wells, to include the well identification numbers, that are part of the groundwater monitoring program for the CCR unit;

As required by § 257.90(e)(1), a map showing the location of the EAP and associated upgradient, downgradient and nature and extent monitoring wells is presented as Figure 1.

1.3.2 40 CFR § 257.90(e)(2)

Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a narrative description of why those actions were taken;

To characterize the horizontal and vertical nature and extent of SSLs at the EAP, three new monitoring wells were installed in the uppermost aquifer downgradient of the East Ash Pond. The new monitoring wells, identified as CCR-AP-5I, CCR-AP-10 and CCR-AP-11 as shown on Figure 1, were completed in the intermediate zone within the uppermost aquifer. Location and construction details are provided in Table I.

1.3.3 40 CFR § 257.90(e)(3)

In addition to all the monitoring data obtained under § 257.90 through § 257.98, a summary including the number of groundwater samples that were collected for analysis for each background and downgradient well, the dates the samples were collected, and whether the sample was required by the detection monitoring or assessment monitoring programs;

In accordance with § 257.95(b) and § 257.95(d)(1), two independent samples from each background and downgradient monitoring well were collected and analyzed. A summary table including the sample names, dates of sample collection, reason for sample collection (detection or assessment), and monitoring data obtained for the groundwater monitoring program for the EAP is presented in Table II of this report.

1.3.4 40 CFR § 257.90(e)(4)

A narrative discussion of any transition between monitoring programs (e.g., the date and circumstances for transitioning from detection monitoring to assessment monitoring in addition to identifying the constituent(s) detected at a statistically significant increase over background levels); and

As required by § 257.95(d) through § 257.95(g) a statistical analysis of the Appendix IV constituents was completed by 15 January 2019. This statistical analysis determined that statistically significant levels of molybdenum and arsenic were present downgradient of the EAP. An evaluation of alternate sources was initiated and completed in September 2019 as required by § 257.94(e)(2). A source causing the SSL of arsenic over background levels other than the CCR Unit was identified. However, a source causing the molybdenum SSL was not identified and as a result an assessment of corrective measures was completed for the EAP. The Assessment Monitoring program was established to meet the requirements of 40 CFR § 257.95. Semiannual sampling will continue in 2020.

1.3.5 40 CFR § 257.90(e)(5)

Other information required to be included in the annual report as specified in § 257.90 through § 257.98.

Other information including development of groundwater protection standards, recording groundwater monitoring results in the operating record, and an evaluation of alternate sources is discussed in preceding sections.

TABLES

TABLE I

GROUNDWATER MONITORING WELL LOCATION AND CONSTRUCTION DETAILS
F.B. CULLEY GENERATING STATION - EAST ASH POND
NEWBURGH, INDIANA

Well	CCR Unit	Date Installed	Easting	Northing	Top of Pad Elevation (ft msl)	Top of Riser Elevation (ft msl)	Surface Grout (ft bgs)	Bentonite (ft bgs)	Sand Pack (ft bgs)	Screen Zone (ft bgs)	Screen Length (ft)	Well Radius (in)	Status
CCR-AP-1R	Background	March 2016	2883429.69	969939.69	438.50	441.64	1.0-51.0	51.0-53.0	53.0-65.0	55.00 - 65.00	10	2	Active
CCR-AP-7	Background	March 2016	2883090.34	970774.64	429.50	434.11	1.0-16.0	16.0-18.0	18.0-30.0	20.00 - 30.00	10	2	Active
CCR-AP-9	Background	February 2017	2883998.96	969768.61	445.58	448.69	1.0-56.0	56.0-58.0	58.0-70.0	60.00 - 70.00	10	2	Active
CCR-AP-2	East Ash Pond	December 2015	2884168.67	969117.52	394.40	393.97	1.0-30.5	30.5-32.5	32.5-45.0	36.00 - 46.00	10	2	Active
CCR-AP-3	East Ash Pond	December 2015	2883542.09	969007.98	395.10	394.54	1.0-31.0	31.0-32.8	32.8-45.0	35.00 - 45.00	10	2	Active
CCR-AP-4	East Ash Pond	December 2015	2883281.93	969641.70	395.40	394.91	1.0-19.7	19.7-22.5	23.0-35.5	25.50 - 35.50	10	2	Active
CCR-AP-5	East Ash Pond	December 2015	2884016.66	969379.68	394.80	394.32	1.0-28.6	28.6-30.6	30.6-44.0	34.00 - 44.00	10	2	Active
CCR-AP-5I	East Ash Pond	Janaury 2019	2884022.40	969377.37	--	395.00	1.0-71.2	71.2-73.0	73.0-86.0	75.30 - 85.30	10	2	Available
CCR-AP-6	East Ash Pond	March 2016	2883285.03	969122.16	397.00	396.71	1.0-31.5	31.5-33.0	33.5-45.5	35.50 - 45.50	10	2	Active
CCR-AP-6I	East Ash Pond	November 2018	2883289.32	969119.72	--	397.20	1.0-60.7	60.7-62.7	62.7-64.7	34.70 - 74.70	10	2	Available
CCR-AP-8	East Ash Pond	February 2017	2883846.87	969046.03	394.15	393.83	1.0-31.5	31.5-33.0	33.5-45.5	35.50 - 45.50	10	2	Active
CCR-AP-8I	East Ash Pond	November 2018	2883853.25	969047.00	--	393.90	1.0-53.7	53.7-56.7	56.7-69.0	58.70 - 68.70	10	2	Available
CCR-AP-10	East Ash Pond	Janaury 2019	2883772.84	969536.11	--	402.40	1.0-36.5	36.5-38.0	38.0-50.5	40.20 - 50.20	10	2	Available
CCR-AP-11	East Ash Pond	Janaury 2019	2884485.51	969352.71	--	385.10	1.0-40.0	40.0-41.8	41.8-54.7	44.40 - 54.40	10	2	Available

NOTES:
bgs = below ground surface
--- = was not surveyed
ft = feet
in = inches
msl = mean sea level
Datum of Elevations in NAVD 88

TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
EAST ASH POND - MAY THROUGH OCTOBER 2019
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Action Level	Background					
Location Name		CCR-AP-7	CCR-AP-7	CCR-AP-1R	CCR-AP-1R	CCR-AP-9	CCR-AP-9
Sample Name	Maximum	CCR-AP-7-20190528	CCR-AP-7-20191023	CCR-AP-1R-20190528	CCR-AP-1R-20191023	CCR-AP-9-20190528	CCR-AP-9-20191022
Sample Date	Contaminant Level	05/28/2019	10/23/2019	05/28/2019	10/23/2019	05/28/2019	10/22/2019
Lab Sample ID		180-90609-7	180-97809-16	180-90609-1	180-97809-1	180-90609-9	180-97809-11
Detection Monitoring - EPA Appendix III Constituents (mg/L)							
Boron, Total	NA	**0.28 J**	0.08 U	**0.72 J-**	**0.43**	**0.41 J**	**0.36 J**
Calcium, Total	NA	**100**	**110**	**67**	**70**	**130**	**130**
Chloride	NA	**28**	**27**	**17**	**16**	**12**	**9.7**
Fluoride	4	**0.27 J+**	**0.14**	**0.57 J+**	**0.34**	**0.33 J+**	**0.21**
Sulfate	NA	**82**	**65**	**190**	**180**	**100**	**120**
Total Dissolved Solids (TDS)	NA	**590**	**530**	**890**	**300**	**650**	**600**
pH (lab) (SU)	NA	**7.5 J**	**7.4 HF**	**7.8 J**	**7.8 HF**	**7.5 J**	**7.6 HF**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)							
Antimony, Total	0.006	0.002 U	0.002 U	**0.00057 J**	**0.0019 J**	**0.00061 J**	0.01 U
Arsenic, Total	0.01	**0.0037**	**0.0075**	**0.038**	**0.037**	**0.0078**	**0.013**
Barium, Total	2	**0.13**	**0.15**	**0.38**	**0.59**	**0.29**	**0.35**
Beryllium, Total	0.004	0.001 U	0.001 U	**0.005**	**0.0066**	**0.00066 J**	**0.0011 J**
Cadmium, Total	0.005	0.001 U	0.001 U	**0.00052 J**	**0.00087 J**	**0.00014 J**	0.005 U
Chromium, Total	0.1	0.002 U	**0.0018 J**	**0.11**	**0.16**	**0.016 J+**	**0.033**
Cobalt, Total	0.006	**0.00047 J**	**0.001**	**0.075**	**0.081**	**0.012**	**0.017**
Fluoride	4	**0.27 J+**	**0.14**	**0.57 J+**	**0.34**	**0.33 J+**	**0.21**
Lead, Total	0.015	0.001 U	**0.0014**	**0.076**	**0.094**	**0.01**	**0.017**
Lithium, Total	0.04	**0.011**	**0.02**	**0.16**	**0.23**	**0.041**	**0.072**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.002 J**	**0.0017 J**	**0.01**	**0.012 J**	**0.0038 J**	**0.0049 J**
Selenium, Total	0.05	0.005 U	0.005 U	0.005 U	**0.012 J**	0.005 U	**0.013 J**
Thallium, Total	0.002	0.001 U	0.001 U	**0.00074 J**	**0.0014 J**	**0.00016 J**	0.005 U
Radiological (pCi/L)							
Radium-226	NA	**0.423 ± 0.123**	**0.194 ± 0.097**	**0.564 ± 0.216**	**0.561 ± 0.237**	**1.02 ± 0.252**	**1.67 ± 0.375**
Radium-228	NA	0.112 U ± 0.31	**1.02 ± 0.324**	**1.91 ± 1.12**	**1.37 ± 0.665**	**1.30 ± 0.699**	**1.47 ± 0.625**
Radium-226 & 228	5	**0.535 J ± 0.334**	**1.21 ± 0.338**	**2.47 ± 1.14**	**1.93 ± 0.706**	**2.32 ± 0.743**	**3.13 ± 0.729**
Field Parameters							
Temperature (Deg C)	NA	**18.68**	**18.44**	**28.08**	**20.79**	**26.01**	**16.23**
Dissolved Oxygen, Field (mg/L)	NA	**0.03**	**0.18**	**4.51**	**2.01**	**3.75**	**7.72**
Conductivity, Field (mS/cm)	NA	**0.90624**	**0.97501**	**1.1438**	**1.273**	**0.91846**	**0.92719**
ORP, Field (mv)	NA	**-131.2**	**-111.5**	**79.4**	**-48.7**	**-32.9**	**-8.3**
Turbidity, Field (NTU)	NA	**1.97**	**21.59**	**3716**	**2013**	**2572**	**1547**
pH, Field (SU)	NA	**7.42**	**7.01**	**7.82**	**7.48**	**7.56**	**7.51**

ABBREVIATIONS AND NOTES:

CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
pCi/L: picoCurie per liter.
SU: standard units.
USEPA: United States Environmental Protection Agency.
Results in **bold** are detected.

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
EAST ASH POND - MAY THROUGH OCTOBER 2019
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Action Level	Downgradient								
Location Name		CCR-AP-10	CCR-AP-11	CCR-AP-11	CCR-AP-2	CCR-AP-2	CCR-AP-3	CCR-AP-3	CCR-AP-4	CCR-AP-4
Sample Name	Maximum	CCR-AP-10-20191024	CCR-AP-11-20190612	CCR-AP-11-20191023	CCR-AP-2-20190528	CCR-AP-2-20191022	CCR-AP-3-20190528	CCR-AP-3-20191022	CCR-AP-4-20190528	CCR-AP-4-20191022
Sample Date	Contaminant Level	10/24/2019	06/13/2019	10/23/2019	05/28/2019	10/22/2019	05/28/2019	10/22/2019	05/28/2019	10/22/2019
Lab Sample ID		180-97809-12	180-91361-4 1906573-5	180-97809-13	180-90609-2	180-97809-2	180-90609-3	180-97809-3	180-90609-4	180-97809-4
Detection Monitoring - EPA Appendix III Constituents (mg/L)										
Boron, Total	NA	**1.3**	**0.22 J+**	**0.21**	**6.8 J-**	**5.3**	**0.24 J**	**0.097**	**0.13 J**	0.4 U
Calcium, Total	NA	**82**	**110**	**94**	**190**	**220**	**190**	**190**	**180**	**180**
Chloride	NA	**22**	**20**	**15**	**160**	**120**	**25**	**23**	**30**	**26**
Fluoride	4	**0.49**	**0.32**	**0.3**	**0.4 J+**	**0.51**	**0.53 J+**	**0.39**	**0.37 J+**	**0.083 J**
Sulfate	NA	**4.5**	**310**	**330**	**490**	**310**	**0.5 J**	**0.91 J**	**2.8**	**4.8**
Total Dissolved Solids (TDS)	NA	**1000**	**870**	**680**	**1300**	**440**	**1000**	**990**	**940**	**910**
pH (lab) (SU)	NA	**7.5 HF**	**6.5 J**	**6.7 HF**	**7 J**	**6.8 HF**	**7.3 J**	**7.2 HF**	**6.8 J**	**6.8 HF**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)										
Antimony, Total	0.006	**0.00052 J**	0.002 U	0.002 U	**0.0011 J**	0.01 U	0.002 U	0.002 U	0.002 U	0.01 U
Arsenic, Total	0.01	**0.013**	**0.047**	**0.013**	**0.032**	**0.02**	**0.077**	**0.069**	**0.11**	**0.32**
Barium, Total	2	**0.17**	**0.34**	**0.12**	**0.26**	**0.28**	**0.44**	**0.48**	**0.66**	**1.3**
Beryllium, Total	0.004	0.001 U	**0.00017 J**	0.001 U	**0.0021**	**0.0019 J**	0.001 U	0.001 U	0.001 U	**0.0011 J**
Cadmium, Total	0.005	0.001 U	0.001 U	0.001 U	**0.0023**	**0.0016 J**	0.001 U	0.001 U	0.001 U	0.005 U
Chromium, Total	0.1	**0.0017 J**	0.0032 U	0.002 U	**0.052**	**0.054**	0.002 U	**0.0025**	0.0034 U	**0.026**
Cobalt, Total	0.006	**0.0007**	**0.025**	**0.0049**	**0.026**	**0.026**	**0.0054**	**0.0048**	**0.0031**	**0.012**
Fluoride	4	**0.49**	**0.32**	**0.3**	**0.4 J+**	**0.51**	**0.53 J+**	**0.39**	**0.37 J+**	**0.083 J**
Lead, Total	0.015	**0.00084 J**	0.001 U	**0.00023 J**	**0.038**	**0.026**	**0.00033 J**	**0.00083 J**	**0.0043**	**0.02**
Lithium, Total	0.04	**0.057**	**0.004 J**	**0.014**	**0.031**	**0.069**	0.005 U	**0.0078**	**0.0041 J**	**0.047**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	**0.00038**	**0.00019 J**	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.03**	**0.0011 J**	**0.0007 J**	**0.0078**	**0.0078 J**	**0.0099**	**0.0089**	**0.0011 J**	**0.0037 J**
Selenium, Total	0.05	**0.0053**	0.005 U	**0.0066**	**0.0065**	**0.026**	0.005 U	**0.0068**	0.005 U	**0.031**
Thallium, Total	0.002	0.001 U	0.001 U	0.001 U	**0.0009 J**	**0.00096 J**	0.001 U	0.001 U	0.001 U	0.005 U
Radiological (pCi/L)										
Radium-226	NA	**0.543 ± 0.147**	**0.56 ± 0.29**	0.0634 U ± 0.0737	**2.57 ± 0.584**	**0.560 ± 0.22**	**0.404 ± 0.159**	0.116 U ± 0.104	**0.846 ± 0.224**	**0.606 ± 0.226**
Radium-228	NA	**0.535 ± 0.307**	0.60 U ± 0.39	0.246 U ± 0.302	2.81 U ± 1.93	0.217 U ± 0.45	**1.83 ± 1.11**	0.477 U ± 0.354	**1.54 ± 0.735**	**1.18 ± 0.569**
Radium-226 & 228	5	**1.08 ± 0.34**	**1.16 J ± 0.486**	0.310 U ± 0.311	**5.38 J ± 2.02**	**0.778 ± 0.501**	**2.24 ± 1.12**	**0.593 ± 0.369**	**2.38 ± 0.768**	**1.78 ± 0.612**
Field Parameters										
Temperature (Deg C)	NA	**18.85**	**17.71**	**19.53**	**29.7**	**20.11**	**33.68**	**19.35**	**25.99**	**19.24**
Dissolved Oxygen, Field (mg/L)	NA	**3.73**	**0.03**	**0.25**	**8.31**	**4.89**	**2.14**	**1.09**	**1.55**	**1.14**
Conductivity, Field (mS/cm)	NA	**1.592**	**1.144**	**1.1326**	-	**1.1641**	**1.6096**	**1.6303**	**1.5681**	**1.7555**
ORP, Field (mv)	NA	**-96.5**	**-152.2**	**-104.1**	**122.8**	**43.7**	**-142.5**	**-7.4**	**-97.7**	**-63.9**
Turbidity, Field (NTU)	NA	**35.54**	**45.14**	**21.5**	**0.72**	**1088**	**183.72**	**0.27**	**63.06**	**486.26**
pH, Field (SU)	NA	**7.2**	**6.9**	**6.63**	**7.79**	**7.33**	**7.13**	**8.14**	**6.8**	**6.51**

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mg/L: milligram per liter.
pCi/L: picoCurie per liter.
SU: standard units.
USEPA: United States Environmental Protection Agency.
Results in **bold** are detected.

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TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
EAST ASH POND - MAY THROUGH OCTOBER 2019
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Action Level	Downgradient							
Location Name		CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5I	CCR-AP-5I	CCR-AP-6	CCR-AP-6
Sample Name	Maximum	CCR-AP-5-20190528	BLIND DUPLICATE-20190528	CCR-AP-5-20191023	BLIND DUPLICATE-20191023	CCR-AP-5I-20190612	CCR-AP-5I-20191023	CCR-AP-6-20190528	CCR-AP-6-20191022
Sample Date	Contaminant Level	05/28/2019	05/28/2019	10/23/2019	10/23/2019	06/12/2019	10/23/2019	05/28/2019	10/22/2019
Lab Sample ID		180-90609-5	180-90609-10	180-97809-5	180-97809-14	180-91361-1 1906573-1	180-97809-6	180-90609-6	180-97809-7
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	NA	**35 J-**	**34 J-**	**16**	**8.8**	**14**	**2.5**	**0.85 J-**	**0.28**
Calcium, Total	NA	**260**	**270**	**220**	**220**	**250**	**120**	**190**	**200**
Chloride	NA	**160**	**170**	**59**	**61**	**240**	**80**	**39**	**37**
Fluoride	4	**1.2 J+**	**1.3 J+**	**1.3**	**1.3**	**0.31**	**0.25**	**0.67 J+**	**0.46**
Sulfate	NA	**860**	**930**	**670**	**680**	**700**	**390**	**7.5**	**3.9**
Total Dissolved Solids (TDS)	NA	**2100**	**2000**	**1500**	**1500**	**1700**	**980**	**1000**	**1000**
pH (lab) (SU)	NA	**7.3 J**	**7.3 J**	**7.5 HF**	**7.5 HF**	**7 J**	**7.4 HF**	**7.4 J**	**7.4 HF**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.006	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	**0.00039 J**	**0.00083 J**	0.002 U
Arsenic, Total	0.01	**0.0011**	**0.0013**	**0.00066 J**	**0.00079 J**	**0.00072 J**	**0.00062 J**	**0.11**	**0.092**
Barium, Total	2	**0.04**	**0.042**	**0.042**	**0.043**	**0.085**	**0.035**	**0.69**	**0.6**
Beryllium, Total	0.004	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.00069 J**	0.001 U
Cadmium, Total	0.005	**0.00051 J**	**0.00053 J**	**0.00016 J**	0.001 U	0.001 U	0.001 U	**0.0006 J**	**0.00018 J**
Chromium, Total	0.1	0.0027 U	0.0028 U	0.002 U	0.002 U	0.002 U	0.002 U	**0.028**	**0.0075**
Cobalt, Total	0.006	**0.0031**	**0.0031**	**0.0023**	**0.0022**	**0.00048 J**	**0.00047 J**	**0.018**	**0.006**
Fluoride	4	**1.2 J+**	**1.3 J+**	**1.3**	**1.3**	**0.31**	**0.25**	**0.67 J+**	**0.46**
Lead, Total	0.015	**0.0011**	**0.0017**	**0.00013 J**	0.001 U	**0.00023 J**	0.001 U	**0.024**	**0.0049**
Lithium, Total	0.04	**0.087**	**0.086**	**0.095**	**0.091**	**0.035**	**0.035**	**0.014**	**0.0098**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.38**	**0.38**	**0.53**	**0.52**	**0.0017 J**	**0.0072**	**0.028**	**0.023**
Selenium, Total	0.05	0.005 U	0.005 U	**0.007**	**0.0075**	0.005 U	**0.009**	0.005 U	**0.0053**
Thallium, Total	0.002	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.00018 J**	0.001 U
Radiological (pCi/L)									
Radium-226	NA	**0.107 ± 0.0722**	**0.146 ± 0.0812**	**0.103 ± 0.0685**	0.0299 U ± 0.0704	**0.85 ± 0.36**	0.0924 U ± 0.0773	**6.34 J- ± 1.43**	**0.567 ± 0.163**
Radium-228	NA	0.257 U ± 0.341	0.435 U ± 0.42	**0.497 ± 0.256**	**0.588 ± 0.301**	0.40 U ± 0.36	-0.0597 U ± 0.26	3.90 UJ ± 4.41	**0.675 ± 0.337**
Radium-226 & 228	5	0.364 UJ ± 0.349	0.581 UJ ± 0.428	**0.599 ± 0.265**	**0.617 ± 0.309**	**1.25 J ± 0.509**	0.0327 U ± 0.271	**10.2 J- ± 4.64**	**1.24 ± 0.374**
Field Parameters									
Temperature (Deg C)	NA	**20.61**	**20.61**	**18.55**	**18.55**	**17.93**	**20.04**	**35.64**	**19.94**
Dissolved Oxygen, Field (mg/L)	NA	**0.04**	**0.04**	**0.21**	**0.21**	**0.03**	**0.21**	**2.55**	**2.41**
Conductivity, Field (mS/cm)	NA	**2.1567**	**2.1567**	**1.1217**	**1.1217**	**2.4352**	**1.4368**	**1.4215**	**1.7371**
ORP, Field (mv)	NA	**35.3**	**35.3**	**76.8**	**76.8**	**205**	**-168.5**	**-229.3**	**-110.3**
Turbidity, Field (NTU)	NA	**87.1**	**87.1**	**1.44**	**1.44**	**72.85**	**2.39**	**390.25**	**92.38**
pH, Field (SU)	NA	**7.25**	**7.25**	**6.94**	**6.94**	**7.06**	**7.18**	**7.28**	**7.16**

ABBREVIATIONS AND NOTES:

CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
pCi/L: picoCurie per liter.
SU: standard units.
USEPA: United States Environmental Protection Agency.
Results in **bold** are detected.

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
EAST ASH POND - MAY THROUGH OCTOBER 2019
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Action Level	Downgradient					
Location Name		CCR-AP-6I	CCR-AP-6I	CCR-AP-8	CCR-AP-8	CCR-AP-8I	CCR-AP-8I
Sample Name	Maximum	CCR-AP-6I-20190612	CCR-AP-6I-20191024	CCR-AP-8-20190528	CCR-AP-8-20191022	CCR-AP-8I-20190612	CCR-AP-8I-20191024
Sample Date	Contaminant	06/12/2019	10/24/2019	05/28/2019	10/22/2019	06/12/2019	10/24/2019
	Level	180-91361-2				180-91361-3	
Lab Sample ID		1906573-3	180-97809-8	180-90609-8	180-97809-9	1906573-4	180-97809-10
Detection Monitoring - EPA Appendix III Constituents (mg/L)							
Boron, Total	NA	**12**	**12**	**0.12 J**	0.08 U	**18**	**8**
Calcium, Total	NA	**340**	**560**	**270**	**310**	**490**	**380**
Chloride	NA	**350**	**170**	**15**	**15**	**130**	**350**
Fluoride	4	**0.19 J+**	**0.13 J**	**0.51 J+**	**0.072 J**	**0.12 J+**	**0.24 J**
Sulfate	NA	**860**	**1400**	**0.99 J**	**2**	**1100**	**1000**
Total Dissolved Solids (TDS)	NA	**2300**	**2600**	**1200**	**1300**	**2200**	**2400**
pH (lab) (SU)	NA	**6.9 J**	**7.3 HF**	**6.9 J**	**7.1 HF**	**7.4 J**	**6.9 HF**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)							
Antimony, Total	0.006	0.002 U	0.002 U	**0.00046 J**	**0.00043 J**	0.002 U	0.002 U
Arsenic, Total	0.01	**0.0028**	**0.0049**	**0.1**	**0.09**	**0.0051**	**0.0022**
Barium, Total	2	**0.28**	**0.067**	**0.49**	**0.65**	**0.063**	**0.27**
Beryllium, Total	0.004	**0.00019 J**	0.001 U	0.001 U	0.001 U	**0.00018 J**	0.001 U
Cadmium, Total	0.005	0.001 U	**0.00022 J**	0.001 U	**0.00019 J**	**0.00022 J**	**0.00018 J**
Chromium, Total	0.1	0.0026 U	0.002 U	0.0034 U	**0.0067**	0.0033 U	0.002 U
Cobalt, Total	0.006	**0.00062 J+**	**0.0025**	**0.0044**	**0.0054**	**0.0031**	**0.00037 J**
Fluoride	4	**0.19 J+**	**0.13 J**	**0.51 J+**	**0.072 J**	**0.12 J+**	**0.24 J**
Lead, Total	0.015	0.001 U	**0.0011**	**0.0012**	**0.003**	0.001 U	**0.00046 J**
Lithium, Total	0.04	**0.33**	**0.056**	**0.0031 J**	**0.0093**	**0.047**	**0.41**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.34**	**0.83**	**0.0099**	**0.012**	**0.86**	**0.31**
Selenium, Total	0.05	0.005 U	**0.0041 J**	0.005 U	**0.007**	0.005 U	**0.0062**
Thallium, Total	0.002	0.001 U	0.001 U	0.001 U	0.001 U	**0.00013 J**	0.001 U
Radiological (pCi/L)							
Radium-226	NA	**1.31 ± 0.47**	0.0977 U ± 0.0836	**0.443 ± 0.148**	**0.295 ± 0.143**	**0.46 ± 0.24**	**1.14 ± 0.204**
Radium-228	NA	**1.76 ± 0.58**	0.282 U ± 0.258	0.0635 UJ ± 0.848	0.431 U ± 0.358	**0.88 ± 0.42**	**1.28 ± 0.323**
Radium-226 & 228	5	**3.07 ± 0.747**	0.380 U ± 0.271	0.506 UJ ± 0.861	**0.726 ± 0.386**	**1.34 ± 0.484**	**2.42 ± 0.382**
Field Parameters							
Temperature (Deg C)	NA	**20.34**	**19.12**	**29.13**	**22.28**	**18.71**	**18.19**
Dissolved Oxygen, Field (mg/L)	NA	**0.03**	**0.16**	**2.9**	**1.41**	**0.04**	**0.07**
Conductivity, Field (mS/cm)	NA	**2.6443**	**2.7861**	**1.409**	**2.2261**	**3.0502**	**3.1838**
ORP, Field (mv)	NA	**-182**	**-26.4**	**-98**	**-106.6**	**-231.7**	**-107.2**
Turbidity, Field (NTU)	NA	**35.69**	**43.2**	**40.92**	**112.99**	**25.06**	**12.85**
pH, Field (SU)	NA	**7.36**	**7.06**	**7.04**	**7.06**	**7.14**	**6.77**

ABBREVIATIONS AND NOTES:

CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
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- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257.
https://www.epa.gov/coalash/coal-ash-rule

FIGURES

LEGEND

CCR-AP-11 MONITORING WELL

CCR-AP-6I NATURE AND EXTENT MONITORING WELL

APPROXIMATE UNIT BOUNDARY

APPROXIMATE PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS ARE APPROXIMATE
2. CCR COAL COMBUSTION RESIDUALS
3. AERIAL IMAGERY SOURCE: ESRI

0 220 440

SCALE IN FEET

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

GROUNDWATER MONITORING
WELL LOCATIONS

JANUARY 2020

FIGURE 1

GIS FILE PATH: \\haleyaldrich.com\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2020_01\129420_001_0001_MONITORING_WELL_LOCATIONS_CULLEY.mxd — USER: afeigl — LAST SAVED: 1/10/2020 2:01:30 PM

APPENDIX A

Alternate Source Demonstration

www.haleyaldrich.com

REPORT ON

F.B. CULLEY GENERATING STATION
EAST ASH POND – ALTERNATE SOURCE DEMONSTRATION
NEWBURGH, INDIANA

by
Haley & Aldrich, Inc.
Cleveland, Ohio

for
Southern Indiana Gas and Electric Company
Evansville, Indiana

File No. 129420
September 2019

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List of Acronyms and Abbreviations

Abbreviation	**Definition**
As	Arsenic
ASD	Alternate Source Demonstration
CCR	Coal Combustion Residual
DOC	Dissolved Organic Carbon
EAP	East Ash Pond
Eh	Hydrogen Electrode
FBC	F.B. Culley Generating Station
Fe	Iron
GWPS	Groundwater Protection Standards
Haley & Aldrich	Haley & Aldrich, Inc.
ORP	Oxidation Reduction Potential
SIGECO	Southern Indiana Gas and Electric Company
Site	F.B. Culley Generating Station
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
USEPA	United States Environmental Protection Agency

1. Introduction

Haley & Aldrich, Inc. (Haley & Aldrich) prepared this Alternate Source Demonstration (ASD) for Southern Indiana Gas and Electric Company (SIGECO) for the East Ash Pond (EAP) at the F.B. Culley Generating Station (FBC or "Site"). SIGECO has been monitoring groundwater at the EAP to comply with the United States Environmental Protection Agency (USEPA) Coal Combustion Residual (CCR) Rule effective 19 October 2015 (Rule). This ASD documents that a source other than the CCR unit caused the statistically significant level (SSL) of arsenic identified at the EAP consistent with 257.95 (g)(3)(ii).

1.1 SITE DETAILS

The FBC was constructed in 1953 with design plans prepared by Commonwealth and Associates Inc. Plant development involved excavating a portion of the hillsides to the north and placing the material as fill to the south of the current facility and EAP. Little Pigeon Creek originally flowed east-to-west across the property. To facilitate construction of the generating station, Little Pigeon Creek was diverted, joining the Ohio River near the southeastern property boundary in the vicinity of the EAP. As a result, the soil conditions beneath the EAP are represented by depositional environments associated with the former Little Pigeon Creek rather than the Ohio River floodplain. SIGECO currently owns and operates the Site and supplies electric power to the industrial, commercial, and residential customers in its service territory. The Site utilizes two coal-fired units to generate power utilizing steam. CCR is currently managed on the Site in the 9.8-acre EAP (Figure 1).

The EAP was constructed in 1971 at the base of the upland area, located north of the floodplain, overlying Ohio River alluvial deposits. The eastern and southern banks are earthen dikes constructed during the development of the generating station and diversion of Little Pigeon Creek in 1953. Modifications to the East Ash Pond occurred from 1992 to 1993 by filling an approximately 14,000 square-foot area in the southwest corner to build a pad for new scrubber silos.

1.2 CCR RULE REQUIREMENTS

USEPA regulations regarding assessment monitoring programs for CCR landfills and surface impoundments provide owners and operators with the option to make an ASD when an Appendix IV constituent is identified at a SSL above the groundwater protection standard (GWPS) (40 CFR 257.95(g)(3)(ii)). According to the Rule, an owner or operator may:

- Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase (SSI) resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for conclusions and must be certified to be accurate by a qualified professional engineer.

An evaluation was completed to assess possible alternate sources to which the identified SSLs could be attributed to the EAP at FBC.

1.3 SITE GEOLOGY

The EAP at FBC is located within the Ohio River valley which contains naturally occurring alluvial (stream) and loess (windblown) deposits derived indirectly from continental ice sheets. These sediments were transported in meltwater heavily loaded with entrained sediments that accumulated on top of the Pennsylvanian age shale, limestone and sandstone bedrock. Westerly winds simultaneously deposited silty sediments in the upland areas adjacent to the stream valley. As a result, base levels of the valley floor increased in elevation and created natural levees and outwashes. These natural levees produced slackwater lakes which deposited thick sequences of silt and clay adjacent to the river channel. When the ice sheets retreated, the sediment load in the Ohio River diminished and lowered base levels. Consequently, the river incised the slackwater lake sediments, sculpted lacustrine terraces, and deposited sand and gravel stream alluvium.

Soil types described in boring logs from monitoring wells installed in the vicinity of the EAP, as well as boring logs generated from geotechnical explorations conducted by AECOM indicate that the uppermost aquifer is comprised of a layered sequence of unconsolidated deposits consisting primarily of clay and silt associated with the slackwater lakes. Abundant black wood fragments are present in the uppermost aquifer along the southern berm of the EAP associated with former Little Pigeon Creek. This unconsolidated overburden overlies Pennsylvanian age sandstone which overlies shale. During construction of the facility and EAP, the northern portion of the pond was incised into bedrock.

Bedrock around FBC belongs to the Carbondale Group. The Group consists of Pennsylvanian age sandstone, limestone, shale and coal. The Group ranges from 260 to 470 feet thick but on average is approximately 300 feet thick. The Carbondale Group includes laterally persistent limestone units and four of Indiana's commercially important coal seams. Laterally continuous shale beds are associated with the coal formations.

The uppermost aquifer on the northern side of the EAP in the vicinity of CCR-AP-5 is located within the Pennsylvanian sandstone, which contains a coal seam. A soil boring (HASB-1) completed during the ASD indicates the coal seam is laterally continuous in the vicinity of the EAP. In the upland area to the northeast of the EAP, the top of bedrock is represented by sandstone. In CCR-AP-1R and CCR-AP-9 the sandstone has interbedded very fine organic-rich layers containing mica and pyrite. The sandstone unit and the coal seam are not present along the Ohio River where the bedrock is more deeply eroded, and the top of bedrock is represented by gray shale.

1.4 HYDROGEOLOGY

In the vicinity of the EAP, the uppermost aquifer occurs within unconsolidated Ohio River and Little Pigeon Creek alluvial deposits consisting of silt and clay with discontinuous interbedded layers of sand. To the north of the EAP the uppermost aquifer occurs in the shale and sandstone bedrock units. Recharge to the surficial aquifer occurs through direct surface infiltration.

Piezometric data recorded from the monitoring wells installed on-site indicates that the configuration of the uppermost aquifer is primarily controlled by the Ohio River. Groundwater flow in the immediate vicinity of the EAP is radial with an overall flow direction from the upland areas north of the EAP to the south toward the Ohio River (**Figure 2**). Groundwater elevations vary seasonally but the groundwater flow patterns remain consistent.

1.5 SCOPE AND OBJECTIVE

The overall objective of this investigation is to determine if a naturally occurring source of arsenic exists within the vicinity of the EAP, as well as to characterize the naturally occurring geochemical conditions present within the uppermost aquifer system that are responsible for the mobilization of naturally occurring arsenic.

2. Alternate Source Demonstration for Arsenic

Arsenic geochemistry was evaluated in surface water, porewater, soil and groundwater; and all lines of evidence indicate that arsenic found in groundwater is associated with the reductive dissolution of naturally occurring arsenic and not arsenic related to the EAP. These mechanisms, and the lines of evidence that support them, are described below.

2.1 DATA COLLECTION ACTIVITIES

The ASD included the installation of five (5) temporary monitoring wells (PW-1, PW-1D, PW-2, PW-2D and HASB-1) at the EAP in August 2019 to supplement the sampling results that were obtained from the existing CCR monitoring well network installed at the EAP. In addition, samples of soil, groundwater, and porewater from the EAP were collected and analyzed in August 2017 and November 2018 to determine if conditions within and surrounding the EAP could be releasing naturally occurring arsenic into groundwater. Surface water samples were also collected at this time to establish baseline water quality conditions in the EAP.

Five temporary monitoring wells were also installed southeast of Little Pigeon Creek to further evaluate the naturally occurring geological conditions along the Ohio River floodplain that could contribute to the occurrence of arsenic in groundwater. However, due to an extended period of time where the Ohio River was at flood stage, the proposed sampling locations southeast of Little Pigeon Creek could not be accessed and the ASD could not be completed prior to the April 15, 2019 deadline to initiate an assessment of corrective measures. As previously stated, the depositional environment encountered and resulting geochemistry represented by the Ohio River deposits were different than the depositional environment of Little Pigeon Creek found beneath the EAP. Therefore, data generated from these locations were not representative of the conditions in the vicinity of the EAP and were not included in the ASD evaluation.

This comprehensive approach was used to provide a defensible basis for evaluating the potential for an alternate source for the elevated levels of arsenic in CCR groundwater compliance wells associated with the EAP. The ASD evaluation included:

- The collection and analysis of soil samples from soil borings co-located with monitoring wells CCR-AP-2, CCR-AP-3, CCR-AP-4, CCR-AP-6 and CCR-AP-8 to identify naturally occurring iron and arsenic-bearing mineralogy in the soil opposite the well screens where elevated levels of arsenic have been observed.

- Sampling and analysis of porewater from the EAP to assess whether arsenic was present at concentrations that represent a potential source of arsenic to groundwater beneath the pond.

- Collecting groundwater samples from four (4) monitoring wells (CCR-AP-2, CCR-AP-3, CCR-AP-6 and CCR-AP-8) to determine the geochemical conditions in the aquifer (e.g., to determine whether or not iron-reducing conditions are present that could serve as a mechanism for release of arsenic to groundwater).

- Analysis of surface water impounded in the EAP to determine the surface water baseline quality and the absence/presence of arsenic concentrations coincident with the groundwater sampling events.

- Measurement of groundwater and surface water elevations to determine groundwater flow directions and variation in water table elevation and potential influences in fluctuations of surface elevations of surrounding surface water boundaries (i.e. Ohio River).

Figure 1 shows the locations of the monitoring wells used in the ASD evaluation, as well as porewater, soil, and surface water sample locations. **Figure 2** shows the potentiometric surface map for the EAP.

Groundwater sampling depths and well information is summarized in **Table 1A** while soil boring information is provided in **Table 1B**. Analytical results for groundwater are summarized in **Table 2**, surface water in **Table 3,** and porewater in **Table 4**. Soil analytical results are summarized in **Table 5**.

2.2 RESULTS AND TECHNICAL DISCUSSION

An alternate source of arsenic has been identified for the EAP. This section presents the data, technical analysis, and geochemical lines of evidence to support the ASD for the EAP.

- Iron oxyhydroxides constitute the most common source of naturally occurring arsenic in groundwater. This is due to reductive dissolution that occurs following the reaction of naturally occurring iron oxyhydroxides with organic carbon which releases arsenic into solution. This mechanism occurs within the sandstone and clay units exposed to reducing conditions along the groundwater flow path. The oxidation of sulfide minerals such as pyrite sourced from naturally occurring coal seams and shale deposits is another major source of naturally occurring arsenic. This mechanism has been well documented at many locations where gray to black marine shales are observed in the subsurface [Korte (1991), Matisoff et. al. (1982), Welch and Stollenwerk (2002)].

- Arsenic exists in nature in the oxidation states +V (arsenate), +III (arsenite), 0 (arsenic) and -III (arsine). During the ASD study, arsenic was detected in surface water, porewater, and groundwater samples. The geochemistry and origin of arsenic in these samples are provided below.

  - Arsenic speciation results for surface water, porewater, and groundwater are provided in the depth profiles in **Figure 3A**. Arsenic detected in surface water and porewater samples are predominantly arsenate (As (V)), conversely groundwater samples are predominately arsenite (As (III)). These differences in speciation are due to a different source of arsenic in groundwater. Naturally occurring arsenic is mobilized in groundwater due to reaction with naturally elevated concentrations of organic carbon, evidenced by the significant increase in total organic carbon (TOC) and dissolved organic carbon (DOC) in **Figure 3B** between surface/porewater samples and shallow groundwater samples. Because the EAP is significantly elevated in total dissolved solids (TDS), this provides a good chemical indicator for surface water contributions and is therefore plotted alongside TOC/DOC concentrations in **Figure 3B** as a differentiator. Inconsistent with TOC/DOC concentrations, TDS concentrations decrease by almost an order of magnitude between surface water samples and groundwater samples.

- In most natural aqueous systems, arsenic exhibits anionic behavior. The speciation and mobilization of arsenic in groundwater is controlled by two variables, pH and oxidation reduction potential (ORP) according to the standard hydrogen electrode (Eh). A Site-specific Eh-pH diagram constructed using water quality from the 2018 groundwater monitoring event is shown in **Figure 4**. Groundwater samples from upgradient wells (CCR-AP-1R, CCR-AP-7, and CCR-AP-9) and downgradient wells (CCR-AP-2, CCR-AP-3, CCR-AP-4, CCR-AP-5, and CCR-AP-8) collected for two 2018 sampling events (June and August) are plotted to predict the geochemical state of arsenic. In general, the results are consistent with the speciation results described above. Under oxidizing conditions with neutral pH, arsenic is typically found in the solid phase bound to iron oxyhydroxides (**Figure 4**). Under reducing conditions typically found in upgradient and downgradient groundwater (Eh < 0 Volts), arsenic is typically found in its mobilized, arsenite (+III) state. These observations suggest that the reducing conditions necessary to mobilize arsenic are naturally occurring, because they are observed in both upgradient and downgradient wells. Combined with the elevated soil concentrations of arsenic collected at upgradient location HASB-1 (18 mg/Kg, highest soil concentration for any upgradient or downgradient location), these are strong lines of evidence that indicate the sources and the conditions necessary for mobilizing arsenic are naturally occurring. The reductive mobilization pathway responsible for the occurrence of arsenic in groundwater is shown on **Figure 4** (blue arrow), which shows that the solubility of arsenic in groundwater is entirely controlled by naturally occurring oxidation reduction conditions. This conclusion is strongly supported by the relationship shown in **Figure 5** between groundwater arsenic and DOC (A), TOC (B), and dissolved iron (Fe) (C) concentrations; which shows that all elevated arsenic concentrations correlate to elevated DOC, TOC, and Fe concentrations indicative of naturally reducing conditions.

- Because arsenic was detected in surface water and porewater within the pond, further analysis was warranted. Unlike groundwater where arsenic mobility is controlled by redox conditions, arsenic is controlled in the vadose zone by pH conditions. Arsenic was present in surface water and porewater as arsenate (+V) (**Figure 3**), because solubility was controlled by elevated pH conditions. Surface water samples and porewater samples exhibited pH measurements greater than ten standard units with measured Eh values greater than zero volts. Because arsenic acts as an oxyanion, it demonstrates amphoteric solubility, and some arsenic does mobilize under high pH conditions observed in the vadose zone. However, as porewater mixes with groundwater in the capillary fringe, the rapid decrease in pH to neutral conditions creates geochemical conditions that precipitate arsenic out of solution and decrease mobility.

- Appendix III parameters (boron, sulfate and TDS) which demonstrated an SSI during Detection Monitoring and triggered Assessment Monitoring of Appendix IV parameters were used as geochemical differentiators to support the naturally occurring arsenic assessment provided above. Boron, sulfate, and TDS demonstrated SSIs and can therefore provide a useful bivariate analysis with arsenic to differentiate between anthropogenic sources (EAP) and naturally occurring sources (reductive dissolution, pyrite oxidation). Arsenic sourced from the EAP should correlate to elevated boron, sulfate, and TDS concentrations. Conversely, naturally occurring arsenic should correlate with lower boron, sulfate, and TDS reflective of background conditions. **Figure 6** provides the bivariate analysis of boron (A), sulfate (B), and TDS (C) concentrations against arsenic concentrations in all EAP groundwater samples collected between 2016 and 2018. The arsenic maximum contaminant level of 0.01 mg/L is provided (red line) for context.

All samples with elevated concentrations of arsenic correlate to low concentrations of boron, sulfate, and TDS. Samples exhibiting elevated concentrations of boron, sulfate, and TDS correspond to significantly lower concentrations of arsenic.

3. ASD Conclusions and Discussion

Arsenic geochemistry was evaluated in surface water, porewater, soil and groundwater; and all lines of evidence indicate that arsenic found in groundwater is associated with the reductive dissolution of naturally occurring arsenic and not arsenic related to the EAP. These mechanisms, and the lines of evidence that support them are recapped below. The certification statement is provided in Appendix C.

3.1 GEOLOGIC LINES OF EVIDENCE

The goals of this ASD were to 1) identify if a naturally occurring alternate source of arsenic was present, and 2) determine if naturally occurring reducing agents could mobilize the naturally occurring arsenic in groundwater. A review of the site-specific geology records for on-Site boreholes was conducted, and indicate that naturally occurring arsenic, and naturally reducing conditions responsible for the mobilization of naturally occurring arsenic exist in the vicinity of the EAP. The result of this review demonstrates that an alternate source of arsenic is present and is the source of the SSL determined during the Assessment Monitoring program conducted at the Site.

Findings that support this conclusion are summarized below:

1. Moderately weathered yellow brown to red fine-grained sandstone present in most lithology logs indicates an abundance of iron oxides, and the presence of naturally occurring arsenic bound to these oxides.
2. Black organic layer below the sandstone, likely coal, is a naturally occurring source of pyrite and arsenic and is a naturally occurring geochemical reducing agent that can mobilize naturally occurring arsenic through reductive dissolution.
3. Shale present in lithology logs is a possible naturally occurring source of arsenic and organics. Dark gray to black shale is a known source of naturally occurring arsenic and organic carbon (Pratt et. al., 1992).
4. Wood fragments observed ubiquitously in various layers. Wood is a geochemical reducing agent.
5. Most shallow wells were completed in gray lean clay with wood fragments and other organics associated with Little Pigeon Creek deposits.

3.2 SOIL LINES OF EVIDENCE

Soil data supports geologic lines of evidence summarized above with the following additional lines of evidence:

1. High TOC concentrations in CCR-AP-6I, CCR-AP-8I at 68 to 70 feet (3600 to 6400 mg/Kg), and high concentrations of organic carbon in HASB-1 (20 percent organic carbon) (upgradient location) from 35 to 38 feet indicates the presence of a naturally-occurring reducing agent that would create groundwater geochemical conditions necessary for reductive dissolution of iron oxides and iron oxyhydroxides, and subsequently the mobilization of naturally occurring arsenic into groundwater.

2. Elevated arsenic concentrations in soil samples obtained at HASB-1.

3.3 SURFACE WATER LINES OF EVIDENCE

Surface water in the pond is characterized by low arsenic concentrations; high concentrations of TDS, sulfate, and boron; and low TOC and DOC concentrations. Because TDS, sulfate, and boron tend to remain in solution, they were used as a geochemical fingerprinting tool to differentiate between anthropogenic and naturally occurring sources. Groundwater samples with elevated TDS, sulfate, and boron exhibit low concentrations of arsenic. Conversely, groundwater samples with elevated arsenic concentrations exhibit low TDS, sulfate, and boron. This method of geochemical differentiation is a widely recognized method [Myers and Thrbjornsen (2010); Thorbjornsen and Myers (2007)] and demonstrates that an alternate source exists for arsenic.

3.4 POREWATER LINES OF EVIDENCE

1. Low TOC and DOC (source of organic carbon in aquifer is naturally occurring and not originating from the EAP or fill material)
2. Majority (78 to 100 percent) of arsenic is present in the form of arsenate (As V), and likely attenuated at Vadose Zone/ Groundwater interface within capillary fringe due to lower pH conditions.

3.5 GROUNDWATER LINES OF EVIDENCE

The results of the analysis of groundwater samples collected for this ASD were combined with the available groundwater dataset from the semi-annual assessment monitoring program to make the following conclusions:

1. Elevated DOC and TOC concentrations in groundwater is naturally occurring.
2. Elevated As correlates to elevated TOC; i.e. arsenic is observed in wells with high TOC concentrations.
3. Elevated As correlates to elevated DOC; i.e. arsenic is observed in wells with high DOC concentrations.
4. The bivariate relationship between the geochemical indicator parameters and arsenic is a good geochemical differentiator that demonstrates an alternative source. Boron, sulfate, and TDS concentrations were used as a geochemical forensic tool to differentiate between anthropogenic source (EAP) and an alternative naturally occurring source(s) (reductive dissolution, pyrite oxidation) for arsenic. These analytes are useful indicator parameters and were used to trace the contribution of surface water to groundwater. A review of the bivariate relationships between arsenic and these three indicator parameters clearly demonstrate that a naturally occurring alternative source of arsenic is present within the groundwater bearing zone.
5. Majority of arsenic is present in groundwater as arsenite (As (III)), and likely mobilized from reductive dissolution of a naturally occurring source. This is opposed to the majority of arsenic in the vadose zone and surface water samples is present as arsenate (As V).
6. Site specific Eh-pH diagrams generated for the EAP show reducing conditions and arsenic present in its mobilized form at most upgradient background locations.

4. References

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Tables

TABLE 1A
ASD BOREHOLE AND WELL SUMMARY TABLE
GROUNDWATER SAMPLING
F.B. CULLEY GENERATING STATION - EAST ASH POND
NEWBURGH, INDIANA

Location Name	Date of Completion	Top of Casing Elevation (ft msl)	Screen Zone (ft bgs)	Screen Zone Elevation (ft msl)	Depth to Water (ft btoc)*	Groundwater Elevation (ft msl)	Sample/Screen Zone Lithology
CCR-AP-1R	March 2016	441.64	55.00 - 65.00	386.64 - 376.64	54.20	387.44	Gray SHALE and SILTSTONE
CCR-AP-2	December 2015	393.97	36.00 - 46.00	357.97 - 347.97	34.02	359.95	Brown SILT
CCR-AP-3	December 2015	394.54	35.00 - 45.00	359.54 - 349.54	29.00	365.54	Brown CLAY
CCR-AP-4	December 2015	394.91	25.50 - 35.50	369.41 - 359.41	9.78	385.13	Brown CLAY
CCR-AP-5	December 2015	394.32	34.00 - 44.00	360.32 - 350.32	10.86	383.46	Brown SANDSTONE
CCR-AP-5I	Janaury 2019	395.00	75.30 - 85.30	319.70 - 309.70	11.59	383.41	Gray SILTSTONE
CCR-AP-6	March 2016	396.71	35.50 - 45.50	361.21 - 351.21	38.20	358.51	Gray CLAY
CCR-AP-6I	November 2018	397.20	64.70 - 74.70	332.50 - 322.50	38.80	358.40	Brown and Gray SAND
CCR-AP-7	March 2016	434.11	20.00 - 30.00	414.11 - 404.11	10.21	423.90	Gray SILT and CLAY
CCR-AP-8	February 2017	393.83	35.50 - 45.50	358.33 - 348.33	26.86	366.97	Gray CLAY
CCR-AP-8I	November 2018	393.90	58.70 - 68.70	335.20 - 325.20	35.06	358.84	Gray SAND
CCR-AP-9	February 2017	448.69	60.00 - 70.00	388.69 - 378.69	61.31	387.38	Gray SANDSTONE
CCR-AP-10	Janaury 2019	402.40	40.20 - 50.20	362.20 - 352.20	45.18	357.22	Gray SHALE
CCR-AP-11	Janaury 2019	385.10	44.40 - 54.40	340.70 - 330.70	15.36	369.74	Gray SAND interbedded with gray CLAY
PW-1	August 2017	--	10.00 - 15.00	-- - --	--	--	Black Coal ASH
PW-1	August 2017	--	30.00 - 35.00	-- - --	--	--	Black Coal ASH
PW-2	August 2017	--	10.00 - 15.00	-- - --	--	--	Black Coal ASH
PW-2	August 2017	--	30.00 - 35.00	-- - --	--	--	Black Coal ASH
HASB-01	November 2018	--	30.00 - 40.00	-- - --	--	--	Gray LIMESTONE and Black COAL

NOTES:
*Depth to water measurements taken 6/12/2019
bgs = below ground surface
ft = feet
in = inches
btoc = below top of casing
msl = mean sea level
Datum of Elevations in NAVD 88

TABLE 1B
ASD BOREHOLE AND WELL SUMMARY TABLE
SOIL SAMPLING
F.B. CULLEY GENERATING STATION - EAST ASH POND
NEWBURGH, INDIANA

Location Name	Date of Completion	Top of Casing Elevation (ft msl)	Sample Depth (ft bgs)	Sample Elevation (ft msl)	Sample/Screen Zone Lithology
CCR-AP-2	December 2015	393.97	40.00 - 41.00	353.97 - 352.97	Brown SILT
CCR-AP-3	December 2015	394.54	40.00 - 41.00	354.54 - 353.54	Brown CLAY
CCR-AP-4	December 2015	394.91	31.00 - 32.00	363.91 - 362.91	Brown CLAY
CCR-AP-6	March 2016	396.71	40.00 - 41.00	356.71 - 355.71	Gray CLAY
CCR-AP-6I	November 2018	397.20	68.00 - 70.00	329.20 - 327.20	Brown and Gray SAND
CCR-AP-8	February 2017	393.83	40.00 - 41.00	353.83 - 352.83	Gray CLAY
CCR-AP-8I	November 2018	393.90	68.00 - 70.00	325.90 - 323.90	Gray SAND
HASB-01	November 2018	--	35.00 - 38.00	-- - --	Gray LIMESTONE and Black COAL

NOTES:
bgs = below ground surface
ft = feet
in = inches
btoc = below top of casing
msl = mean sea level
Datum of Elevations in NAVD 88

TABLE 2
SUMMARY OF GROUNDWATER ANALYTICAL DATA
F.B. CULLEY GENERATING STATION - EAST ASH POND
NEWBURGH, INDIANA

Location Name	CCR-AP-2	CCR-AP-3	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5I	CCR-AP-6	CCR-AP-6I	CCR-AP-6I	CCR-AP-8	CCR-AP-8I	CCR-AP-8I	CCR-AP-11	HASB-1
Sample Name	CCR-AP-2-20181115	CCR-AP-3-20181116	CCR-AP-4-20181115	CCR-AP-5-20181115	CCR-AP-5-20181217	CCR-AP-5I-20190213	CCR-AP-6-20181117	CCR-AP-6I-20181117	CCR-AP-6I-20190212	CCR-AP-8-20181116	CCR-AP-8I-20181117	CCR-AP-8I-20190212	CCR-AP-11-20190213	HASB-1-20181117
Sample Date	11/15/2018	11/16/2018	11/15/2018	11/15/2018	12/17/2018	02/13/2019	11/17/2018	11/17/2018	02/12/2019	11/16/2018	11/17/2018	02/12/2019	02/13/2019	11/17/2018
Lab Sample ID	180-84236-1	180-84236-5	180-84236-3	180-84236-2	180-85009-1	180-86762-1	180-84236-6	180-84236-7	180-86638-1	180-84236-4	180-84236-8	180-86638-2	180-86762-2	180-84236-9
Inorganic Compounds (mg/L)														
Antimony, Dissolved	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	-	0.002 U	0.002 U	-	0.002 U	0.002 U	-	-	0.0021
Arsenic, Dissolved	0.00098 J	0.07	0.083	0.0017	0.001	-	0.11	0.0029	-	0.08	0.0033	-	-	0.0024
Arsenic (III)-, Dissolved	0.0031	0.005 F1	0.0052	0.0012 J	-	-	0.014	0.005	-	0.0067	0.0012 J	-	-	0.0026
Arsenic (V), Dissolved	0.0021	0.0012 JF1	0.00076 J	0.0017 J	-	-	0.0022	0.0019 J	-	0.00086 J	0.0014 J	-	-	0.0009 J
Barium, Dissolved	0.039 B	0.38	0.54	0.035	0.076	-	0.56	0.1	-	0.46	0.28	-	-	0.081
Beryllium, Dissolved	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	-	0.001 U	0.001 U	-	0.001 U	0.001 U	-	-	0.001 U
Cadmium, Dissolved	0.001 U	0.001 U	0.001 U	0.001 U	0.00092 J	-	0.001 U	0.00014 J	-	0.001 U	0.001 U	-	-	0.001 U
Chromium, Dissolved	0.0013 J	0.0022	0.0019 J	0.0016 J	0.00098 J	-	0.0015 J	0.0013 J	-	0.0016 J	0.0013 J	-	-	0.0014 J
Cobalt, Dissolved	0.0084	0.005	0.0013	0.000076 J	0.0007	-	0.0032	0.0012	-	0.0052	0.00088	-	-	0.00059
Iron, Dissolved	0.061	50	76	0.022 J	0.05 U	-	42	0.11	-	88	18	-	-	0.099
Lead, Dissolved	0.001 U	0.001 U	0.001 U	0.000098 J	0.001 U	-	0.001 U	0.001 U	-	0.001 U	0.001 U	-	-	0.001 U
Lithium, Dissolved	0.005 U	0.005 U	0.0039 J	0.0074	0.067	-	0.005 U	0.041	-	0.005 U	0.42	-	-	0.048
Mercury, Dissolved	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	-	0.0002 U	0.0002 U	-	0.0002 U	0.0002 U	-	-	0.0002 U
Selenium, Dissolved	0.005 U	0.0021 J	0.001 J	0.0017 J	0.005 U	-	0.0016 J	0.005 U	-	0.0019 J	0.005 U	-	-	0.005 U
Thallium, Dissolved	0.001 U	0.001 U	0.001 U	0.001 U	0.000069 J	-	0.001 U	0.001 U	-	0.001 U	0.001 U	-	-	0.001 U
Antimony, Total	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.00075 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.0023
Arsenic, Total	0.0012	0.076	0.088	0.0027	0.0014	0.0007 J	0.11	0.0037	0.0048	0.1	0.004	0.00099 J	0.0026	0.0061
Arsenic (III)-, Total	-	-	-	-	0.0012 JH	-	-	-	-	-	-	-	-	-
Arsenic (V), Total	-	-	-	-	0.00085 JH	-	-	-	-	-	-	-	-	-
Barium, Total	0.043 B	0.45	0.58	0.05	0.08	0.037	0.58	0.11	0.052	0.58	0.3	0.21	0.092	0.13
Beryllium, Total	0.001 U	0.001 U	0.00018 J	0.000081 J	0.001 U	0.001 U	0.000083 J	0.001 U	0.001 U	0.001 U	0.000078 J	0.001 U	0.001 U	0.00083 J
Boron, Total	-	-	-	-	-	3.7	-	-	16	-	-	9.7	0.58	-
Cadmium, Total	0.00015 J	0.001 U	0.001 U	0.00023 J	0.00077 J	0.001 U	0.001 U	0.00015 J	0.00019 J	0.001 U	0.001 U	0.00022 J	0.001 U	0.00025 J
Calcium, Total	-	-	-	-	-	120	-	-	510	-	-	390	130	-
Chromium, Total	0.0019 J	0.0029	0.0062	0.0041	0.00067 J	0.002 U	0.0048	0.002	0.002 U	0.0024	0.0029	0.002 U	0.002 U	0.018
Cobalt, Total	0.0084	0.0055	0.003	0.00052	0.00071	0.00064	0.0044	0.0017	0.0019	0.0059	0.0016	0.00014 J	0.0016	0.0052
Iron, Total	0.7	54	81	1.2	0.082	-	44	1.2	-	100	20	-	-	11
Lead, Total	0.00053 J	0.00018 J	0.0029	0.0016	0.00021 J	0.001 U	0.0022	0.00084 J	0.0003 J	0.0005 J	0.001	0.001 U	0.00018 J	0.0056
Lithium, Total	0.005 U	0.005 U	0.0062	0.0085	0.067	0.03	0.0035 J	0.043	0.055	0.005 U	0.44	0.37	0.0077	0.064
Manganese, Total	27	0.95	0.8	0.032	5.3	-	0.84	8.6	-	6.4	3.2	-	-	0.75
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	-	0.0002 U	0.0002 U	-	0.0002 U	0.0002 U	-	-	0.0002 U
Molybdenum, Total	0.00091 J	0.01	0.00076 J	0.0094	0.25	0.0054	0.027	0.63	0.75	0.0095	0.36	0.67	0.0049 J	0.038
Selenium, Total	0.005 U	0.0021 J	0.0011 J	0.0017 J	0.001 J	0.005 U	0.0016 J	0.005 U	0.005 U	0.0019 J	0.005 U	0.005 U	0.005 U	0.0014 J
Thallium, Total	0.001 U	0.001 U	0.001 U	0.000066 J	0.000073 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00024 J
Other														
Alkalinity, Total (as CaCO3) (mg/L)	590	1100	960	130	270	-	1000	130	-	1300	220	-	-	570
Dissolved Organic Carbon (DOC) (mg/L)	3.5	75	27	3.7	2.4	-	51	4.6	-	58	3.9	-	-	1.7
Total Dissolved Solids (TDS) (mg/L)	1500	990	880	310	1600	960	1000	1500	2300	1200	2200	2300	680	730
Total Organic Carbon (TOC) (mg/L)	3	49	26	3	2.5	-	68	2.9	-	41	3.4	-	-	1.4
pH (lab) (SU)	-	-	-	-	-	7.3 HF	-	-	7.5 HF	-	-	7 HF	7.1 HF	-
Chloride, Dissolved (mg/L)	-	-	-	-	160	-	-	-	-	-	-	-	-	-
Fluoride, Dissolved (mg/L)	0.35	0.44	0.41	1.5	1.1	-	0.59	0.14	-	0.34	0.27	-	-	0.47
Sulfate, Dissolved (mg/L)	-	-	-	-	670	-	-	-	-	-	-	-	-	-
Chloride (mg/L)	160	26	28	3	170	82	43	120	170	16	300	370	11	6.5
Fluoride (mg/L)	0.32	0.37	0.34	1.4	1.1	0.34	0.44	0.13	0.16 J	0.25	0.26	0.27	0.97	0.47
Sulfate (mg/L)	450	0.65 J	8.9	150	700	390	1.6	790	1300	1.1	1000	1100	360	110
Radiological (pCi/L)														
Radium-226	-	-	-	-	-	0.274 ± 0.188	-	-	0.203 ± 0.0906	-	-	1.25 ± 0.222	0.283 ± 0.171	-
Radium-228	-	-	-	-	-	0.189 U ± 0.213	-	-	0.460 ± 0.246	-	-	1.87 ± 0.412	0.0228 U ± 0.24	-
Radium-226 & 228	-	-	-	-	-	0.463 U ± 0.284	-	-	0.664 ± 0.262	-	-	3.12 ± 0.468	0.305 ± 0.295	-

ABBREVIATIONS AND NOTES:
mg/L: milligram per liter
NA: Not Applicable
pCi/L: picoCurie per liter

QUALIFIERS:
B: Compound was found in the blank and sample.
F1: MS and/or MSD Recovery is outside acceptance limits.
H: Sample was prepped or analyzed beyond the specified holding time
HF: Field parameter with a holding time of 15 minutes. Test
performed by laboratory at client's request.
J: value is estimated
U: Not detected value is the laboratory reporting limit

TABLE 3
SUMMARY OF SURFACE WATER ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION - EAST ASH POND
NEWBURGH, INDIANA

	Location Name	SW-A	SW-B	SW-C	SW-D
	Sample Name	SW-A-20170803	SW-B-20170803	SW-C-20170803	SW-D-20170803
	Sample Date	08/03/2017	08/03/2017	08/03/2017	08/03/2017
Inorganic Compounds (ug/L)	**Analytical Method**				
Arsenic, Dissolved	SW6020	**2.7**	**2.9**	**2.3**	**2.8**
Arsenic (III)-, Dissolved	E1632	**1.8 J**	**1.2 J**	**1.2 J**	2 U
Arsenic (V), Dissolved	E1632	**1.3 JF1**	**1.5 J**	**1 J**	**0.81 J**
Iron, Dissolved	SW6020	50 U	50 U	**44 J**	50 U
Manganese, Dissolved	SW6020	**5600**	**5900**	**34000**	**6100**
Molybdenum, Dissolved	SW6020	**35**	**35**	**81**	**38**
Arsenic, Total	SW6020	**3.5**	**3.2**	**3.4**	**4.1**
Iron, Total	SW6020	**470**	**290**	**2200**	**1700**
Manganese, Total	SW6020	**5600**	**6200**	**31000**	**6200**
Molybdenum, Total	SW6020	**33**	**35**	**78**	**37**
Other (mg/L)					
Chloride	SW9056A	**800**	**810**	**3500**	**810**
Sulfate	SW9056A	**1100**	**1200**	**5000**	**1200**
Total Dissolved Solids (TDS)	SM2540C	**3700**	**3500**	**17000**	**3500**
Total Organic Carbon (TOC)	SM5310C	**5.1**	**5.3**	**19**	**5.1**

Notes:
ug/L: microgram per liter.
mg/L: milligram per liter.

1. Results in bold are detected.
2. Qualifiers defined as follows:
   U: Not detected above the indicated reporting limit.
   F1: MS and/or MSD Recovery is outside acceptance limits.
   J: Estimated result

TABLE 4
SUMMARY OF POREWATER ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION - EAST ASH POND
NEWBURGH, INDIANA

	Location Group	SHALLOW		DEEP	
	Location Name	PW-1	PW-2	PW-1	PW-2
	Sample Name	PW-1-A-20170802	PW-2-A-20170802	PW-1-B-20170802	PW-2-B-20170803
	Sample Date	08/02/2017	08/02/2017	08/02/2017	08/03/2017
	Sample Depth (bgs)	10 - 15 (ft)	10 - 15 (ft)	30 - 35 (ft)	30 - 35 (ft)
Inorganic Compounds (ug/L)	**Analytical Method**				
Arsenic, Dissolved	SW6020	**8.8**	**7.1**	**220**	**280**
Arsenic (III)-, Dissolved	E1632	2 U	2 U	**8.8**	**31**
Arsenic (V), Dissolved	E1632	**4.1**	**1.7 J**	**120**	**110**
Iron, Dissolved	SW6020	50 U	**42000**	50 U	50 U
Manganese, Dissolved	SW6020	5 U	**7500**	**6.4**	**140**
Molybdenum, Dissolved	SW6020	**1900**	**310**	**9500**	**8900**
Arsenic, Total	SW6020	**36**	**87**	**230**	**260**
Iron, Total	SW6020	**5000**	**120000**	50 U	50 U
Manganese, Total	SW6020	**650**	**22000**	**6.3**	**140**
Molybdenum, Total	SW6020	**1900**	**81**	**9500**	**7600**
Other (mg/L)					
Chloride	SW9056A	**570**	**760**	**340**	**170**
Sulfate	SW9056A	**1100**	**3300**	**990**	**1600**
Total Dissolved Solids (TDS)	SM2540C	**3200**	**6400**	**2700**	**3300**
Total Organic Carbon (TOC)	SM5310C	**2**	**13**	**4.2**	**7.7**

Notes:
ug/L: microgram per liter.
mg/L: milligram per liter.

1. Results in bold are detected.
2. Qualifiers defined as follows:
   U: Not detected above the indicated reporting limit.
   J: Estimated result

TABLE 5
SUMMARY OF SOIL ANALYTICAL DATA
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Name	CCR-AP-2	CCR-AP-3	CCR-AP-4	CCR-AP-6	CCR-AP-8	CCR-AP-6I	CCR-AP-8I	HASB-1
Sample Name	CCR-AP-2 (40-41)	CCR-AP-3 (40-41)	CCR-AP-4 (31-32)	CCR-AP-6 (40-41)	CCR-AP-8 (40-41)	CCR-AP-6I (68-70)	CCR-AP-8I (68-70)	HASB-1 (35-38)
Sample Date	08/01/2017	08/01/2017	08/01/2017	08/01/2017	08/01/2017	11/16/2018	11/15/2018	11/16/2018
Sample Depth (bgs)	40 - 41 (ft)	40 - 41 (ft)	31 - 32 (ft)	40 - 41 (ft)	40 - 41 (ft)	68 - 70 (ft)	68 - 70 (ft)	35 - 38 (ft)
Inorganic Compounds (mg/kg)								
Antimony	-	-	-	-	-	0.24 U	0.24 U	0.96
Arsenic	7.7	12	8.2	8.4	8.5	3.3	3.3	18
Barium	-	-	-	-	-	18	8	32
Beryllium	-	-	-	-	-	0.14	0.13	0.93
Cadmium	-	-	-	-	-	0.06 J	0.04 J	3.5
Chromium	-	-	-	-	-	4.9	4.7	29
Cobalt	-	-	-	-	-	4	2.5	13
Iron	26000	22000	24000	25000	27000	-	-	-
Lead	-	-	-	-	-	2.8	2.6	23
Lithium	-	-	-	-	-	2.3	2	21
Mercury	-	-	-	-	-	0.037 U	0.039 U	0.064
Molybdenum	-	-	-	-	-	3.1	12	25
Selenium	-	-	-	-	-	0.59 U	0.089 J	9.8
Thallium	-	-	-	-	-	0.039 J	0.035 J	1.1
Other								
Total Organic Carbon (TOC) (mg/kg)						3600	6400	200000
SPLP Inorganics (ug/L)								
Antimony	-	-	-	-	-	2 U	2 U	5.3
Arsenic	0.32 J	2.8	2.2	3.0	1.7	6.1	3.7	1.9
Barium	-	-	-	-	-	19	24	9.1 J
Beryllium	-	-	-	-	-	0.26 J	0.15 J	1 U
Cadmium	-	-	-	-	-	1 U	1 U	1 U
Chromium	-	-	-	-	-	12 B	9.3 B	4.6 B
Cobalt	-	-	-	-	-	3.1	1.2	0.099 J
Iron	71 J	290	31 U	440	32 J	-	-	-
Lead	-	-	-	-	-	3.9	2.2	0.31 J
Lithium	-	-	-	-	-	5.1	4.8 J	8.8
Mercury	-	-	-	-	-	0.2 U^	0.2 U^	0.2 U^
Molybdenum	-	-	-	-	-	47	160	210
Selenium	-	-	-	-	-	5 U	5 U	37
Thallium	-	-	-	-	-	1 U	1 U	1 U
SPLP Other								
Alkalinity, Bicarbonate (as CaCO3) (mg/	-	-	-	-	-	10	28	62
Alkalinity, Carbonate (mg/L)	-	-	-	-	-	18	16	14
Alkalinity, Phenolphthalein (mg/L)	-	-	-	-	-	9	8	7
Ammonia (mg/L)	-	-	-	-	-	0.1 U	0.1 U	0.079 J
Chloride (mg/L)	-	-	-	-	-	6.3	7.3	6.8
Fluoride (mg/L)	-	-	-	-	-	0.35	0.51	0.86
Nitrate (as N) (mg/L)	-	-	-	-	-	0.034 J	0.034 J	0.031 J
Sulfate (mg/L)	-	-	-	-	-	8.9	5.7	30

ABBREVIATIONS AND NOTES:
bgs: below ground surface
ft: feet
mg/Kg: milligram per kilogram
mg/L: milligram per liter
ug/L: microgram per liter

QUALIFIERS:
^: Instrument related QC is outside acceptance limits.
B: Compound was found in the blank and sample.
J: value is estimated
U: Not detected value is the laboratory reporting limit

Figures

LEGEND

- CCR MONITORING WELL
- NATURE AND EXTENT MONITORING WELL
- POREWATER SAMPLE
- SOIL BORING/ GROUNDWATER SAMPLE
- SURFACE WATER SAMPLE
- APPROXIMATE WASTE BOUNDARY OF EASTERN ASH POND
- F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS ARE APPROXIMATE
2. AERIAL IMAGERY SOURCE: ESRI

HALEY ALDRICH

F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

SITE MAP

SEPTEMBER 2019

FIGURE 1

GIS FILE PATH: \\haleyaldrich\share\bol_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_11\129420_001_0001_SITE_MAP.mxd — USER: hwachholz — LAST SAVED: 11/27/2019 9:36:12 AM

GIS FILE PATH: \\haleyaldrich\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_11\129420_001_0002_POTENTIOMETRIC_SURFACE_MAP.mxd — USER: hwachholz — LAST SAVED: 11/27/2019 9:27:53 AM

LEGEND

- CCR MONITORING WELL
- GROUNDWATER ELEVATION CONTOURS, 1-FT INTERVAL
- INFERRED GROUNDWATER CONTOUR
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. ELEVATIONS ARE FEET ABOVE MEAN SEA LEVEL
3. WATER LEVEL MEASURED 6/12/2019
4. AERIAL IMAGERY SOURCE: GOOGLE 2018

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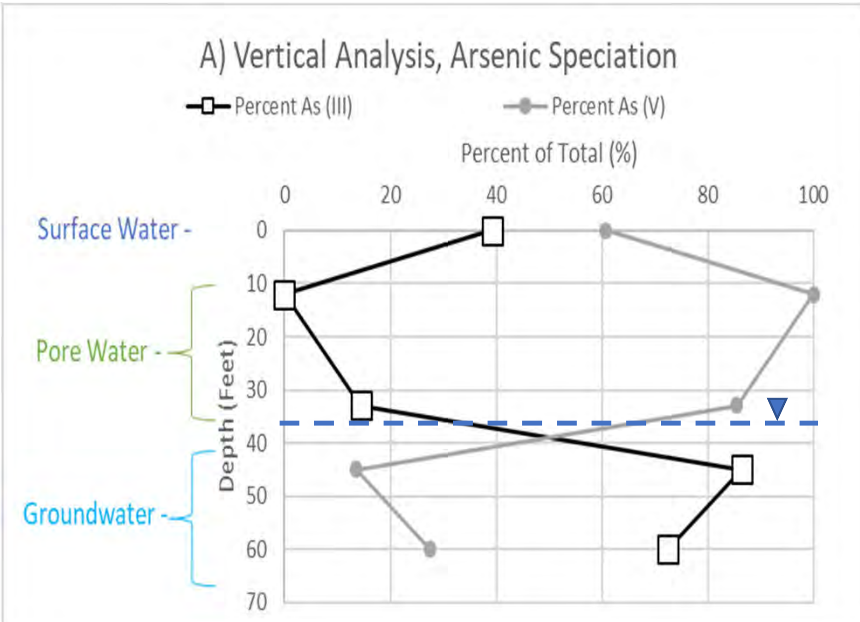
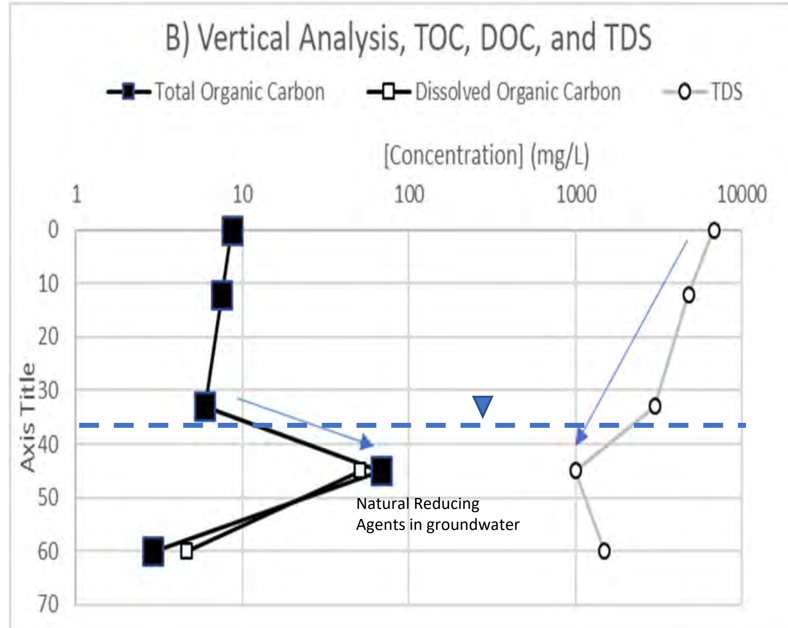
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

POTENTIOMETRIC SURFACE MAP

SEPTEMBER 2019

FIGURE 2





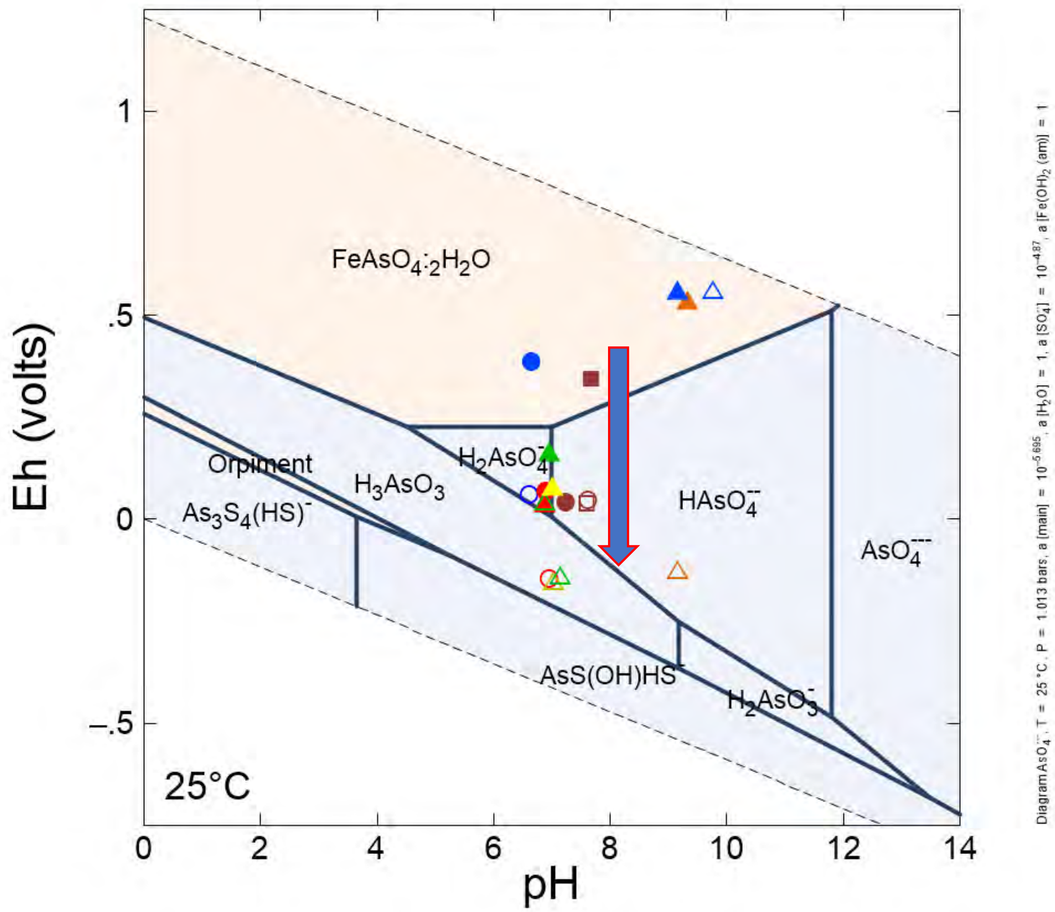
Notes:
1) Dataset Used: ASD Dataset

F.B. Culley Generating Station
East Ash Pond
Newburgh, Indiana

Vertical Analysis of
Arsenic And Differentiators

September 2019

FIGURE 3



LEGEND

(arrow)	Reductive dissolution pathway
(shaded box)	Solid-Phase

Upgradient Wells
- AP–1R (June)
- AP–1R (August)
- AP–7 (June)
- AP–7 (August)
- AP–9 (June)
- AP–9 (August)

Downgradient Wells
- AP–2 (June)
- AP–2 (August)
- AP–3 (June)
- AP–3 (August)
- AP–4 (June)
- AP–4 (August)
- AP–5 (June)
- AP–5 (August)
- AP–8 (June)
- AP–8 (August)
- AP–6 (June)
- AP–6 (August)

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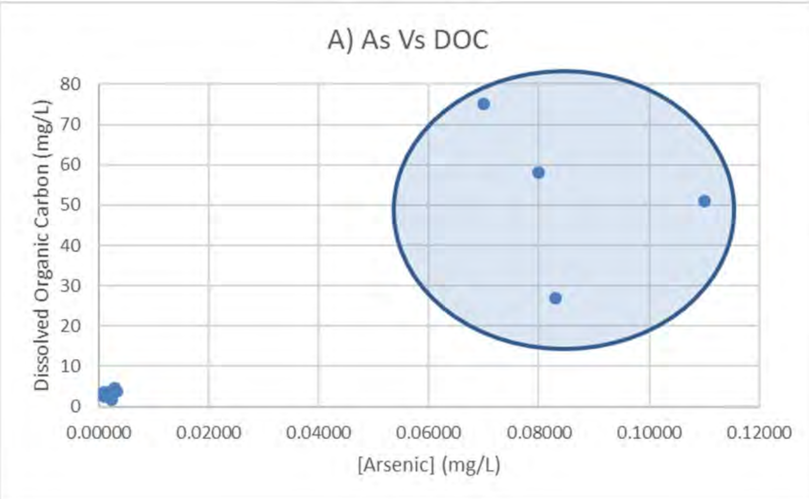
F.B. Culley Generating Station
East Ash Pond
Newburgh, Indiana

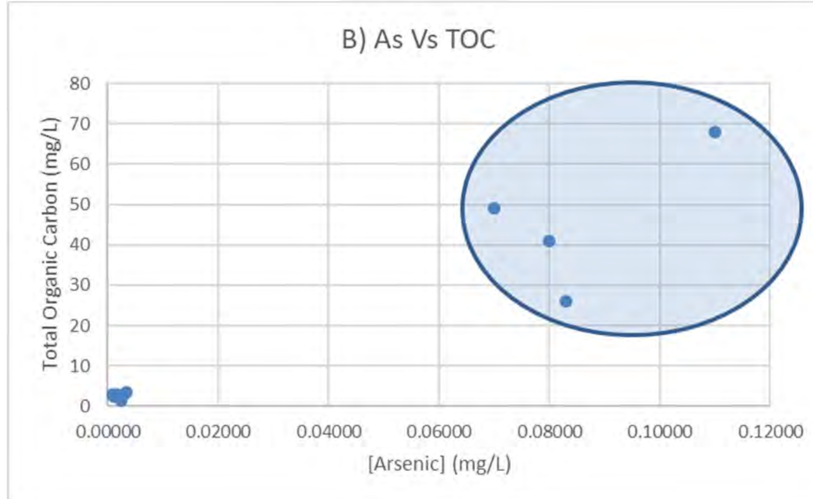
Eh-pH Stability Diagram of Arsenic

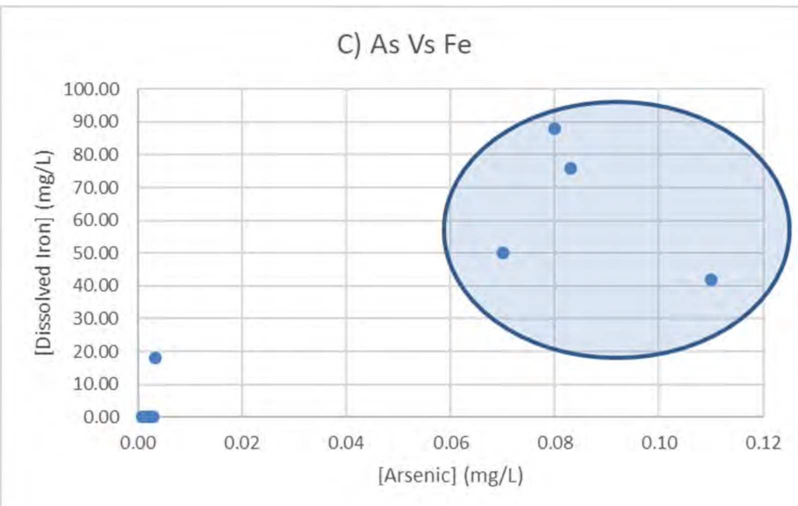
September 2019

FIGURE 4

Notes:
1) Field ORP measurements used as Standard Hydrogen Electrode (SHE).
2) Field pH measurements plotted for accuracy.
3) Assumptions: Solute activities = measured concentrations in mols/L
4) Modelled system Fe-As-S-O-H using Site-specific laboratory obtained data
5) Thermodynamic Database: Minteq.dat for GWB (Compiled by J.P. Gustafsson, 2005)
6) System in equilibrium with the amorphous $Fe(OH)_2$







Notes:
1) Dataset Used: ASD Dataset

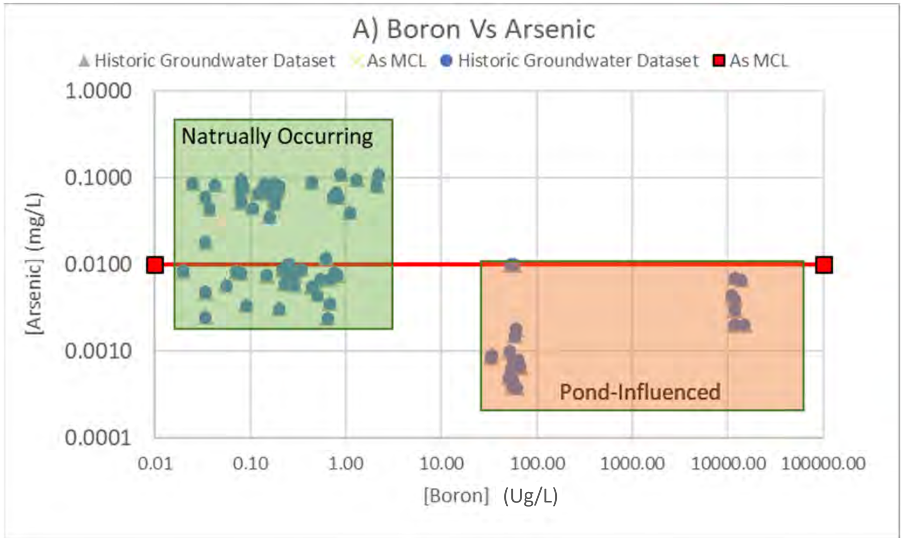
HALEY ALDRICH

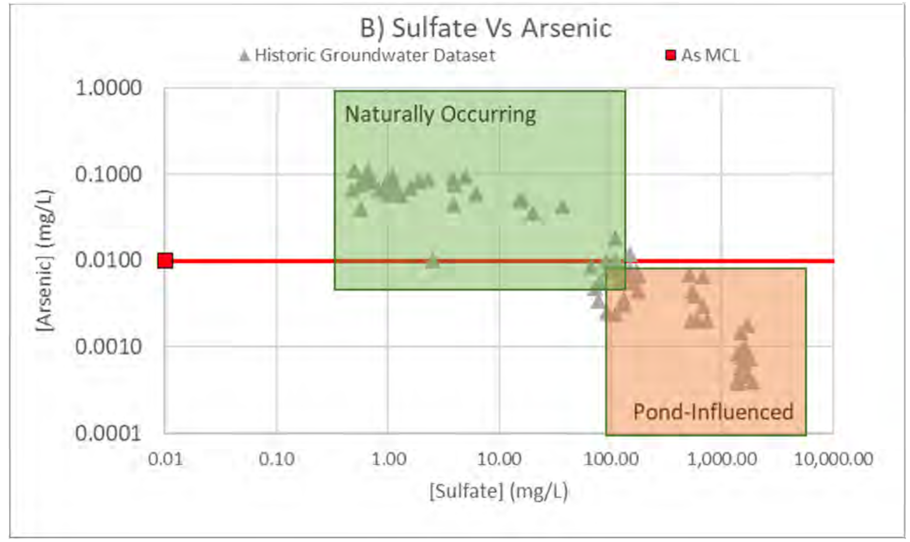
F.B. Culley Generating Station
East Ash Pond
Newburgh, Indiana

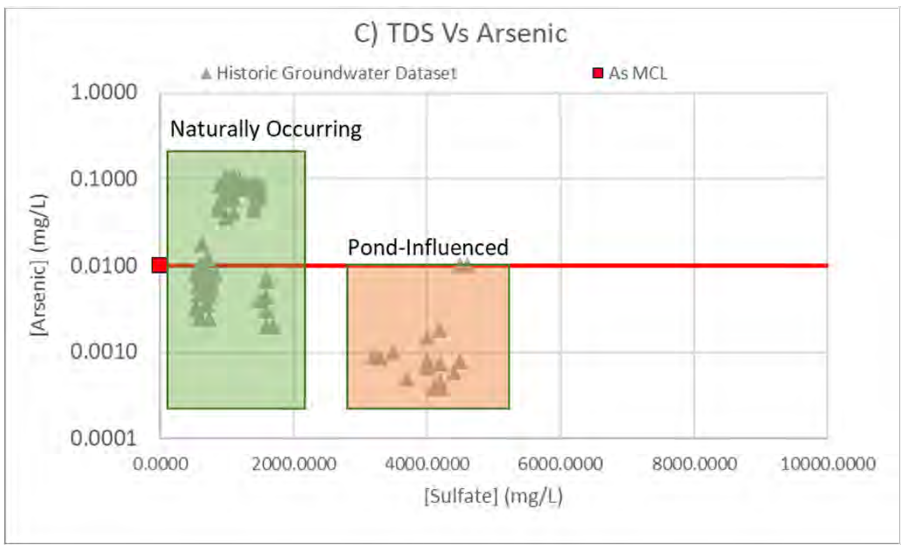
Bivariate Analysis: Arsenic Versus DOC (A), TOC (B), and Fe (C) in Groundwater

September 2019

FIGURE 5







Notes:

1) Dataset Used: All historic data available for CCR-AP-1, AP-7, AP-9, AP-2, AP-3, AP-4, AP-5, and AP-6

HALEY ALDRICH

F.B. Culley Generating Station
East Ash Pond
Newburgh, Indiana

Geochemical Differentiators for Arsenic

September 2019

FIGURE 6

APPENDIX A

Boring Logs

TEST BORING REPORT

Boring No. PW-1

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station	File No.	42796-001
Client	Southern Indiana Gas & Electric Company	Sheet No.	1 of 2
Contractor	Stearns Drilling	Start	02 August 2017
		Finish	02 August 2017
		Driller	Z.Vaughan
		H&A Rep.	S.Lewis
		Elevation	(est.)
		Datum	
		Location	See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	-	-	-	Rig Make & Model: Geoprobe 8040DT
Inside Diameter (in.)	-	-	-	Bit Type: Drill Mud: None
Hammer Weight (lb)	-	-	-	Casing: Steel
Hammer Fall (in.)	-	-	-	Hoist/Hammer: Winch Automatic Hammer PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0		S1 36"	0.0 3.0		ASH	-FILL- Loose, black and gray, coal ASH, MPS = 19mm, no structure, no odor, dry, interbedded layers of FGD sluge	5	5	15	30	35	10				
		S2 27"	3.0 8.0	3.0	FGD/ASH	Medium stiff, brownish tan and black, FGD SLUGE and coal ASH, MPS = 0.43 mm no structure, no odor, wet, clayey					30	70				
5																
				7.0	ASH	Medium stiff, black, coal ASH, MPS = 0.43 mm, no structure, no odor, wet					35	65				
		S3 60"	8.0 13.0													
10																
		S4 60"	13.0 18.0	13.0	ASH	Stiff, black, coal ASH, MPS = 0.43 mm, no structure, no odor, wet					45	55				
15																
				17.0	ASH	Medium stiff, black, coal ASH, MPS = 0.43 mm, no structure, no odor, wet, clayey					30	70				
		S5 60"	18.0 23.0	18.0	ASH	Stiff, black, coal ASH, MPS = 0.43 mm, thinly layered, no odor, wet					80	20				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	38
Rock Cored (ft)	-
Samples	8S

Boring No. PW-1

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. PW-1
File No. 42796-001

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																
		S6 60"	23.0 28.0	23.0	ASH	Stiff, black, coal ASH, MPS = 0.43 mm, no structure, no odor, wet					30	70				
25																
		S7 60"	28.0 33.0	28.0		NO RECOVERY										
30																
		S8 60"	33.0 38.0	33.0	ASH	Simliar to S6					30	70				
35																
				37.0	CL	-ALLUVIUM- Medium stiff, gray, CLAY (CL), MPS = clay, no structure, no odor, wet						100				
				38.0		END OF BORING AT 38 FT										

H&A-TEST BORING-07-1 HA-LIB09-REV.GLB HA-TB+CORE+WELL-07-1.GDT \\HALEYALDRICH.COM\SHARE\GRN_COMMON\42796 - VECTREN\FB CULLEY\GINT\F.B. CULLEY LOGS.GPJ Aug 8, 17

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-6I

Project	Nature and Extent, F. B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	ATC

File No.	129402-017
Sheet No.	1 of 3
Start	November 15, 2018
Finish	November 16, 2018
Driller	Z. Vaughen
H&A Rep.	S. Lewis
Elevation	397.2
Datum	
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	
Inside Diameter (in.)	4.25	1 3/8	
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

- Rig Make & Model: Geoprobe 8040DT
- Bit Type: Cutting Head
- Drill Mud: None
- Casing: Spun
- Hoist/Hammer: Winch Automatic Hammer
- PID Make & Model: -

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							Refer to Test Boring CCR-AP-6 for lithology from 0-38 ft.										
5																	
10																	
15																	
20																	
25																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
2/13/19	20.09				

Sample ID

- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	75.0
Rock Cored (ft)	-
Samples	8S

Boring No. CCR-AP-6I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 REV 132892_HA-LIB09.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT G:\129420 VECTREN\PROJECT DATA\FIELD DATA\04_GINT\FB CULLEY\EAST ASH POND\2019_0328_HAI_N&E FBCULLEY_D1.GPJ Jul 16, 19

TEST BORING REPORT

Boring No. CCR-AP-6

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station	File No.	42796-001
Client	Southern Indiana Gas & Electric Company	Sheet No.	1 of 2
Contractor	Stearns Drilling	Start	08 March 2016
		Finish	09 March 2016
		Driller	J. Gryska
		H&A Rep.	S. Lewis

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	-	S	-	Rig Make & Model: CME 850 XR Air Track
Inside Diameter (in.)	-	1 3/8	-	Bit Type: Drill Mud: None
Hammer Weight (lb)	-	140	-	Casing: Auger
Hammer Fall (in.)	-	30	-	Hoist/Hammer: Winch Automatic Hammer; PID Make & Model:

Elevation 397.0 (est.)
Datum
Location
N 969,122
E 2,883,285

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						ML	Brown/dark brown SILT -FILL-	-	-	-	-	-	-	-	-	-	-
	2 7 10 7	S1 18/24	3.5 5.5			ML	Very stiff bown SILT (ML), mps 19.0 mm, no odor, dry	-	5	-	-	10	85	-	-	-	-
5																	
	3 8 9 12	S2 20/24	8.5 10.5			ML	Very stiff olive brown SILT (ML), mps 2.0 mm, no odor, dry, wood fragments present	-	-	-	5	5	90	-	-	-	-
10																	
	2 3 3 4	S3 18/24	13.5 15.5		383.5 13.5	CL	Medium stiff olive gray lean CLAY with sand (CL), mps 2.0 mm, no odor, moist, rounded sand, black wood fragments present -FILL-	-	-	-	15	5	80	-	-	-	-
15																	
	1 1 3	S4 22/24	18.5 20.5			CL	Soft olive gray lean CLAY with sand (CL), mps 2.0 mm, no odor, wet, black wood fragments present, rounded sand	-	-	-	10	5	85	-	-	-	-
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 45.5
Rock Cored (ft) -
Samples 15S

Boring No. CCR-AP-6

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	6																
25	2 2 4 4	S5 22/24	23.5 25.5			CL	Medium stiff olive gray lean CLAY with sand (CL), mps 2.0 mm, no odor, moist, black wood fragments present, rounded sand	-	-	-	10	5	85	-	-	-	-
30	4 5 6 6	S6 18/24	28.5 30.5		368.5 28.5	SW-SC	Medium dense olive gray well graded SAND with clay and gravel (SW-SC), mps 19.0 mm, no odor, wet	15	15	20	20	10	20	-	-	-	-
					367.5 29.5	SC	Medium dense olive gray clayey SAND (SC), no odor, wet, wood fragments present	-	-	-	10	60	30	-	-	-	-
							-ALLUVIUM-										
							*Drove with 3.0 in. spoon due to no recovery.	-	-	-	-	-	-	-	-	-	-
35	3 4 7 8	S7 12/24	33.5 35.5		363.0 34.0	CL	Stiff olive gray lean CLAY with sand (CL), mps 2.0 mm, no odor, wet, wood fragments present	-	-	-	15	5	80	-	-	-	-
							-ALLUVIUM-										
40	2 2 2 3	S8 24/24	38.5 40.5			CL	Soft gray lean CLAY (CL), no odor, wet, wood fragments present	-	-	-	5	5	90	-	-	-	-
45	1 3 2 3	S9 24/24	43.5 45.5			CL	Medium stiff gray sandy lean CLAY (CL), no odor, wet, wood fragments present	-	-	-		40	60	-	-	-	-
					351.5 45.5		BOTTOM OF EXPLORATION 45.5 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-6I
File No. 129402-017
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
25																	
30																	
35																	
	3 1 2 4	S1 20	38.0 40.0	CL		359.2 38.0	Soft, gray CLAY (CL) with occasional small pockets of gray poorly-graded SAND (SP), mps 0.40 mm, laminated, no odor, moist						100				
40																	
	WOH WOH WOH WOH	S2 24	43.0 45.0	CL		354.2 43.0	Very soft, gray sandy CLAY (CL), mps 0.3 mm, no structure, no odor, wet, frequent black woody material					30	70				
45																	
	WOH 7 1 2	S3 24	48.0 50.0	CL		349.2 48.0	Very soft, brown-gray sandy CLAY (CL), mps 0.3 mm, no structure, no odor, wet, frequent mica, frequent black woody material					30	70				
50																	
	WOH 3 7 9	S4 24	53.0 55.0	CL			Stiff, brown-gray sandy CLAY (CL), mps 0.3 mm, stratified, no odor, wet, frequent mica, abundant black woody material					30	70				
				SM		343.0 54.2	Loose, brown-gray silty SAND with gravel (SM), mps 60 mm, no structure, no odor, wet, well rounded gravel and sand	15	15	15	20	15	20				
55																	
	3 6 8 8	S5 13	58.0 60.0	CL		339.2 58.0	Very soft, brown-gray sandy CLAY (CL), mps 0.3 mm, no structure, no odor, wet, frequent mica, frequent black woody material					30	70				
				CL		338.2 59.0	Stiff, brown-gray sandy CLAY (CL), mps 0.3 mm, stratified, no odor, wet, frequent mica, abundant black woody material					30	70				
60						337.2 60.0											

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-6I
File No. 129402-017
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
	8 9 12 13	S6 19	63.0 65.0	CL			Very stiff, gray and brown sandy CLAY (CL), mps 0.3 mm, stratified, no odor, wet					30	70				
65				SW-SM		333.2 64.0	Medium dense, brown well-graded SAND with silt and gravel (SW-SM), mps 35 mm, no structure, no odor, wet, well rounded gravel and sand	10	20	20	20	20	10				
	4 9 13 16	S7 12	68.0 70.0	SP		329.2 68.0	Medium dense, brown-gray poorly-graded SAND (SP), mps 25 mm, no structure, no odor, wet, well rounded gravel and sand	5	5	5	35	45	10				
70																	
75	8 11 15 26	S8 14	73.0 75.0			322.2 75.0	BOTTOM OF EXPLORATION 75.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-6I

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-8I

Project	Nature and Extent, F. B. Culley Generating Station	File No.	129402-017
Client	Southern Indiana Gas & Electric Company	Sheet No.	1 of 3
Contractor	ATC	Start	November 14, 2018
		Finish	November 15, 2018
		Driller	Z. Vaughen
		H&A Rep.	S. Lewis
		Elevation	393.9
		Datum	
		Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	
Inside Diameter (in.)	4.25	1 3/8	
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

- Rig Make & Model: Geoprobe 8040DT
- Bit Type: Cutting Head
- Drill Mud: None
- Casing: Spun
- Hoist/Hammer: Winch Automatic Hammer
- PID Make & Model: -

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							Refer to Test Boring CCR-AP-8 for lithology from 0-38 ft.										
5																	
10																	
15																	
20																	
25																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
2/13/19	16.79				

Sample ID

- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	70.0
Rock Cored (ft)	-
Samples	7S

Boring No. CCR-AP-8I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-8

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	Stearns Drilling

File No.	42796-001
Sheet No.	1 of 2
Start	15 February 2017
Finish	15 February 2017
Driller	W. Bates
H&A Rep.	S.Lewis
Elevation	394.1 (est.)
Datum	
Location	N 969,046 E 2,883,847

	Casing	Sampler	Barrel
Type	S	S	--
Inside Diameter (in.)	4.25	1 3/8	--
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Track
Bit Type:
Drill Mud: None
Casing: Auger
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0																	
	6 7 9 10	S1 18	3.5 5.5			ML	Very stiff, brown, SILT(ML), MPS = 19 mm, no structure, no odor, dry	-	10	-	-	5	85	-	-	L	-
							-FILL-										
5					389.6 4.5	ML	Very stiff, brown, SILT(ML), MPS = 4 mm, no structure, no odor, dry	-	-	-	-	5	95	-	-	L	-
							-FILL-										
	3 2 3 4	S2 16	8.5 10.5		385.6 8.5	CL	Stiff, grayish brown, lean CLAY (CL), MPS = < 0.08 mm, no structure, no odor, dry, rootlets present	-	-	-	-	-	100	-	-	M-H	-
10																	
	3 2 3 4	S3 20	13.5 15.5		380.6 13.5	CL	Medium stiff, gray, lean CLAY (CL), MPS = < 0.08mm, no structure, no odor, moist	-	-	-	-	-	100	-	-	M-H	-
15																	
	3 3 4	S4 18	18.5 20.5		375.6 18.5	CL	Medium stiff, dark gray, lean CLAY (CL), MPS = < 0.08mm, no structure, no odor, moist, black wood fragments present	-	-	-	-	-	100	-	-	M-H	-
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
2/16/17	16:00				Dry

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	45.5
Rock Cored (ft)	-
Samples	9S

Boring No. CCR-AP-8

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-8
File No. 42796-001
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	5															
25	2 2 3 4	S5 20	23.5 25.5	370.6 23.5	CL	Similar to S4, rootlets present	-	-	-	-	-	100	-	-	M-H	-
30	1 2 3 3	S6 23	28.5 30.5	365.6 28.5	CL	Similar to S4	-	-	-	-	-	100	-	-	M-H	-
35	2 2 3 5	S7 24	33.5 35.5	360.6 33.5	CL	Simlar to S4	-	-	-	-	-	100	-	-	M-H	-
				358.1 36.0	CL	Medium Stiff, dark gray, sandy lean CLAY (CL), MPS = 0.43 mm, interbedded, no odor, wet -ALLUVIUM-	-	-	-	-	30	70	-	-	M	-
				357.9 36.3	CL	Medium stiff, gray, lean CLAY (CL), MPS = < 0.08mm, no structure, no odor, moist, black wood fragments present -ALLUVIUM-	-	-	-	-	-	100	-	-	M-H	-
40	2 2 4 6	S8 24	38.5 40.5	355.6 38.5	CL	Similar to S7	-	-	-	-	-	100	-	-	M-H	-
45	1 2 4 4	S9 24	43.5 45.5													
				348.9 45.3	CL	Medium Stiff, gray, sandy lean CLAY (CL), MPS = 0.43, interbedded, no odor, wet	-	-	-	-	30	70	-	-	M	-
				348.6 45.5		END OF BORING AT 45.5 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-8

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-8I
File No. 129402-017
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
25																	
30																	
35																	
	7 5 8 7	S1 12	38.0 40.0	CL		355.9 38.0	Stiff, gray lean CLAY (CL), mps < 0.075 mm, no structure, no odor, moist						100				
40																	
	3 4 5 7	S2 24	43.0 45.0	CL		350.9 43.0	Stiff, brown-gray lean CLAY (CL), mps < 0.075 mm, stratified, no odor, moist, frequent woody material						100				
45																	
	WOH WOH 3 3	S3 24	48.0 50.0	CL			Stiff, brown-gray lean CLAY (CL), mps < 0.075 mm, stratified, no odor, moist, abundant woody material						100				
50																	
	WOH WOH 3 3	S4 24	53.0 55.0	CL		339.9 54.0	Stiff, brown-gray lean CLAY (CL) with occasional gray poorly-graded SAND (SP) pockets, stratified, no odor, moist, abundant woody material						100				
55																	
							Note: Heaving sands at 58 ft. fill augers 5 ft.										
	2 WOH 1 WOH	S5 24	58.0 60.0	SP		335.9 58.0	Very loose, gray poorly-graded SAND (SP), mps 1.5 mm, no structure, no odor, wet				30	70					
				SW		334.4 59.5	Very loose, gray well-graded SAND with gravel (SW), mps 60 mm, no structure, no odor, wet	20	20	20	10	30					
60																	

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-8I

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-8I
File No. 129402-017
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
	5 3 10 13	S6 11	63.0 65.0	SP		330.9 63.0	Medium dense, gray poorly-graded SAND (SP), mps 1.5 mm, no structure, no odor, wet, frequent coal fragments, subrounded sand				30	70					
65				SP		328.9 65.0	Medium dense, gray poorly-graded SAND (SM), mps 1.5 mm, no structure, no odor, wet, frequent coal fragments, occasional highly weathered gray shale, frequent black woody material starting at 69.5 ft, subrounded sand				30	70					
	1 1 9 12	S7 13	68.0 70.0														
70						323.9 70.0	BOTTOM OF EXPLORATION 70.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-8I

APPENDIX B

Laboratory Analytical Results

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Pittsburgh
301 Alpha Drive
RIDC Park
Pittsburgh, PA 15238
Tel: (412)963-7058

TestAmerica Job ID: 180-68950-1
Client Project/Site: Vectren Groundwater and Soil Sampling

For:
Haley & Aldrich, Inc.
400 Augusta Street
Suite 130
Greenville, South Carolina 29601

Attn: Sean Lewis

Authorized for release by:
8/21/2017 3:04:26 PM

Veronica Bortot, Senior Project Manager
(412)963-2435
veronica.bortot@testamericainc.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Case Narrative

Client: Haley & Aldrich, Inc. TestAmerica Job ID: 180-68950-1
Project/Site: Vectren Groundwater and Soil Sampling

Job ID: 180-68950-1

Laboratory: TestAmerica Pittsburgh

Narrative

Job Narrative
180-68950-1

Comments
No additional comments.

Receipt
The samples were received on 8/4/2017 9:45 AM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperatures of the 2 coolers at receipt time were 0.2º C and 1.4º C.

GC Semi VOA
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Metals
Method(s) 6010C: A deviation from the Standard Operating Procedure (SOP) occurred. Details are as follows: the laboratory control sample (LCS) for the associated samples was spiked at the ICP-MS level for arsenic (40ppb). The recovery in the LCS was acceptable, data for arsenic will be reported with this narrative.

Method(s) 6010C: The serial dilution performed for the following sample associated with prep batch 220230 was outside the control limits for iron: CCR-AP-8 (40-41) (180-68950-5)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

General Chemistry
Method(s) SM 2540C: Due to the matrix, the initial volume(s) used for the following samples deviated from the standard procedure: SW-A (180-68950-6), SW-B (180-68950-7), SW-C (180-68950-8), SW-D (180-68950-9), PW-2-B (180-68950-13) and (180-68950-A-9 DU). The reporting limits (RLs) have been adjusted proportionately.

Method(s) SM 2540C: Due to the matrix, the initial volume(s) used for the following samples deviated from the standard procedure: PW-1-A (180-68950-10), PW-1-B (180-68950-11) and PW-2-A (180-68950-12). The reporting limits (RLs) have been adjusted proportionately.

Method(s) SM 5310C: The matrix spike / matrix spike duplicate (MS/MSD) recoveries for analytical batch 180-219639 were outside control limits. Sample matrix interference is suspected because the associated laboratory control sample (LCS) recovery was within acceptance limits.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

ASTM Leaching
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Qualifiers

Metals

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
F1	MS and/or MSD Recovery is outside acceptance limits.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Accreditation/Certification Summary

Client: Haley & Aldrich, Inc.
TestAmerica Job ID: 180-68950-1
Project/Site: Vectren Groundwater and Soil Sampling

Laboratory: TestAmerica Pittsburgh

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
A2LA	A2LA		PA00164	07-31-18
Arkansas DEQ	State Program	6	88-0690	06-27-18
California	State Program	9	2891	03-31-18
Connecticut	State Program	1	PH-0688	09-30-18
Florida	NELAP	4	E871008	06-30-18
Illinois	NELAP	5	200005	06-30-18
Kansas	NELAP	7	E-10350	01-31-18
Louisiana	NELAP	6	04041	06-30-18
New Hampshire	NELAP	1	2030	04-04-18
New Jersey	NELAP	2	PA005	06-30-18
New York	NELAP	2	11182	03-31-18
North Carolina (WW/SW)	State Program	4	434	12-31-17
Pennsylvania	NELAP	3	02-00416	04-30-18
South Carolina	State Program	4	89014	04-30-18
Texas	NELAP	6	T104704528-15-2	03-31-18
US Fish & Wildlife	Federal		LE94312A-1	10-31-17
USDA	Federal		P330-16-00211	06-26-19
Utah	NELAP	8	PA001462015-4	05-31-18
Virginia	NELAP	3	460189	09-14-17
West Virginia DEP	State Program	3	142	01-31-18
Wisconsin	State Program	5	998027800	08-31-17

Laboratory: TestAmerica Denver

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
A2LA	DoD ELAP		2907.01	10-31-17
A2LA	ISO/IEC 17025		2907.01	10-31-17
Alabama	State Program	4	40730	09-30-12 *
Alaska (UST)	State Program	10	UST-30	04-05-18
Arizona	State Program	9	AZ0713	12-20-17
Arkansas DEQ	State Program	6	88-0687	06-01-18
California	State Program	9	2513	01-08-18
Connecticut	State Program	1	PH-0686	09-30-18
Florida	NELAP	4	E87667	06-30-18
Georgia	State Program	4	N/A	01-08-18
Illinois	NELAP	5	200017	04-30-18
Iowa	State Program	7	370	12-01-18
Kansas	NELAP	7	E-10166	04-30-18
Louisiana	NELAP	6	02096	06-30-18
Maine	State Program	1	CO0002	03-03-19
Minnesota	NELAP	5	8-999-405	12-31-17
Nevada	State Program	9	CO0026	07-31-18
New Hampshire	NELAP	1	205310	04-28-18
New Jersey	NELAP	2	CO004	06-30-18
New York	NELAP	2	11964	04-01-18
North Carolina (WW/SW)	State Program	4	358	12-31-17
North Dakota	State Program	8	R-034	01-09-18
Oklahoma	State Program	6	8614	08-31-17
Oregon	NELAP	10	4025	01-08-18

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Laboratory: TestAmerica Denver (Continued)

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
Pennsylvania	NELAP	3	68-00664	07-31-18
South Carolina	State Program	4	72002001	01-08-18
Texas	NELAP	6	T104704183-16-12	09-30-17
USDA	Federal		P330-16-00397	12-15-19
Utah	NELAP	8	CO00026	07-31-17 *
Virginia	NELAP	3	460232	06-14-18
Washington	State Program	10	C583	08-03-18
West Virginia DEP	State Program	3	354	11-30-17
Wisconsin	State Program	5	999615430	08-31-17
Wyoming (UST)	A2LA	8	2907.01	10-31-17

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Sample Summary

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
180-68950-1	CCR-AP-2 (40-41)	Solid	08/01/17 09:00	08/04/17 09:45
180-68950-2	CCR-AP-3 (40-41)	Solid	08/01/17 11:55	08/04/17 09:45
180-68950-3	CCR-AP-4 (31-32)	Solid	08/01/17 15:55	08/04/17 09:45
180-68950-4	CCR-AP-6 (40-41)	Solid	08/01/17 13:25	08/04/17 09:45
180-68950-5	CCR-AP-8 (40-41)	Solid	08/01/17 10:40	08/04/17 09:45
180-68950-6	SW-A	Water	08/03/17 10:35	08/04/17 09:45
180-68950-7	SW-B	Water	08/03/17 09:20	08/04/17 09:45
180-68950-8	SW-C	Water	08/03/17 09:45	08/04/17 09:45
180-68950-9	SW-D	Water	08/03/17 10:15	08/04/17 09:45
180-68950-10	PW-1-A	Water	08/02/17 10:45	08/04/17 09:45
180-68950-11	PW-1-B	Water	08/02/17 12:25	08/04/17 09:45
180-68950-12	PW-2-A	Water	08/02/17 14:20	08/04/17 09:45
180-68950-13	PW-2-B	Water	08/03/17 08:31	08/04/17 09:45

Method	Method Description	Protocol	Laboratory
9056A	Anions, Ion Chromatography	SW846	TAL PIT
6010C	Metals (ICP)	SW846	TAL PIT
6020A	Metals (ICP/MS)	SW846	TAL PIT
Se Speciation	Selenium Speciation	NONE	TAL DEN
2540G	SM 2540G	SM22	TAL PIT
9034	Sulfide, Acid soluble and Insoluble (Titrimetric)	SW846	TAL PIT
SM 2540C	Solids, Total Dissolved (TDS)	SM	TAL PIT
SM 5310C	TOC	SM	TAL PIT

Protocol References:

NONE = NONE

SM = "Standard Methods For The Examination Of Water And Wastewater",

SM22 = SM22

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL DEN = TestAmerica Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100

TAL PIT = TestAmerica Pittsburgh, 301 Alpha Drive, RIDC Park, Pittsburgh, PA 15238, TEL (412)963-7058

Client: Haley & Aldrich, Inc.
TestAmerica Job ID: 180-68950-1
Project/Site: Vectren Groundwater and Soil Sampling

Client Sample ID: CCR-AP-2 (40-41)

Lab Sample ID: 180-68950-1
Date Collected: 08/01/17 09:00
Matrix: Solid
Date Received: 08/04/17 09:45

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
ASTM Leach	Leach	D3987-85			100.30 g	2000 mL	219850	08/11/17 16:30	JPM	TAL PIT
ASTM Leach	Prep	3010A			50 mL	50 mL	220131	08/15/17 10:30	RJG	TAL PIT
ASTM Leach	Analysis	6010C		1			220293	08/16/17 07:46	RJG	TAL PIT
	Instrument ID: C									
ASTM Leach	Leach	D3987-85			100.30 g	2000 mL	219850	08/11/17 16:30	JPM	TAL PIT
ASTM Leach	Prep	3010A			50 mL	50 mL	220085	08/15/17 08:43	SES	TAL PIT
ASTM Leach	Analysis	6020A		1			220429	08/17/17 02:45	WTR	TAL PIT
	Instrument ID: A									
Total/NA	Analysis	2540G		1			219459	08/08/17 15:20	MTW	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-2 (40-41)

Lab Sample ID: 180-68950-1
Date Collected: 08/01/17 09:00
Matrix: Solid
Date Received: 08/04/17 09:45
Percent Solids: 78.3

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			1.04 g	100 mL	220230	08/14/17 01:45	RJG	TAL PIT
Total/NA	Analysis	6010C		1			220293	08/16/17 11:47	RJG	TAL PIT
	Instrument ID: C									
Total/NA	Prep	3050B			1.04 g	100 mL	220008	08/14/17 11:49	WCT	TAL PIT
Total/NA	Analysis	6020A		1			220304	08/16/17 00:56	PFK	TAL PIT
	Instrument ID: M									
Total/NA	Prep	9030B			5.03 mL	50 mL	219405	08/08/17 12:50	JJZ	TAL PIT
Total/NA	Analysis	9034		1			219439	08/08/17 15:11	JJZ	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-3 (40-41)

Lab Sample ID: 180-68950-2
Date Collected: 08/01/17 11:55
Matrix: Solid
Date Received: 08/04/17 09:45

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
ASTM Leach	Leach	D3987-85			100.42 g	2000 mL	219850	08/11/17 16:30	JPM	TAL PIT
ASTM Leach	Prep	3010A			50 mL	50 mL	220131	08/15/17 10:30	RJG	TAL PIT
ASTM Leach	Analysis	6010C		1			220293	08/16/17 07:51	RJG	TAL PIT
	Instrument ID: C									
ASTM Leach	Leach	D3987-85			100.42 g	2000 mL	219850	08/11/17 16:30	JPM	TAL PIT
ASTM Leach	Prep	3010A			50 mL	50 mL	220085	08/15/17 08:43	SES	TAL PIT
ASTM Leach	Analysis	6020A		1			220429	08/17/17 02:48	WTR	TAL PIT
	Instrument ID: A									
Total/NA	Analysis	2540G		1			219459	08/08/17 15:20	MTW	TAL PIT
	Instrument ID: NOEQUIP									

1 2 3 4 5 6 7 8 9 10 11 12 13

Client Sample ID: CCR-AP-3 (40-41) Lab Sample ID: 180-68950-2

Date Collected: 08/01/17 11:55 **Matrix: Solid**

Date Received: 08/04/17 09:45 **Percent Solids: 78.5**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			1.02 g	100 mL	220230	08/14/17 01:45	RJG	TAL PIT
Total/NA	Analysis	6010C		1			220293	08/16/17 11:53	RJG	TAL PIT
	Instrument ID: C									
Total/NA	Prep	3050B			1.02 g	100 mL	220008	08/14/17 11:49	WCT	TAL PIT
Total/NA	Analysis	6020A		1			220304	08/16/17 01:01	PFK	TAL PIT
	Instrument ID: M									
Total/NA	Prep	9030B			5.03 mL	50 mL	219405	08/08/17 12:50	JJZ	TAL PIT
Total/NA	Analysis	9034		1			219439	08/08/17 15:08	JJZ	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-4 (31-32) Lab Sample ID: 180-68950-3

Date Collected: 08/01/17 15:55 **Matrix: Solid**

Date Received: 08/04/17 09:45

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
ASTM Leach	Leach	D3987-85			100.29 g	2000 mL	219850	08/11/17 16:30	JPM	TAL PIT
ASTM Leach	Prep	3010A			50 mL	50 mL	220131	08/15/17 10:30	RJG	TAL PIT
ASTM Leach	Analysis	6010C		1			220293	08/16/17 07:56	RJG	TAL PIT
	Instrument ID: C									
ASTM Leach	Leach	D3987-85			100.29 g	2000 mL	219850	08/11/17 16:30	JPM	TAL PIT
ASTM Leach	Prep	3010A			50 mL	50 mL	220085	08/15/17 08:43	SES	TAL PIT
ASTM Leach	Analysis	6020A		1			220429	08/17/17 02:50	WTR	TAL PIT
	Instrument ID: A									
Total/NA	Analysis	2540G		1			219459	08/08/17 15:20	MTW	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-4 (31-32) Lab Sample ID: 180-68950-3

Date Collected: 08/01/17 15:55 **Matrix: Solid**

Date Received: 08/04/17 09:45 **Percent Solids: 78.3**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.99 g	100 mL	220230	08/14/17 01:45	RJG	TAL PIT
Total/NA	Analysis	6010C		1			220293	08/16/17 11:58	RJG	TAL PIT
	Instrument ID: C									
Total/NA	Prep	3050B			0.99 g	100 mL	220008	08/14/17 11:49	WCT	TAL PIT
Total/NA	Analysis	6020A		1			220304	08/16/17 01:05	PFK	TAL PIT
	Instrument ID: M									
Total/NA	Prep	9030B			5.02 mL	50 mL	219405	08/08/17 12:50	JJZ	TAL PIT
Total/NA	Analysis	9034		1			219439	08/08/17 15:05	JJZ	TAL PIT
	Instrument ID: NOEQUIP									

1 2 3 4 5 6 7 8 9 10 11 12 13

Client Sample ID: CCR-AP-6 (40-41) Lab Sample ID: 180-68950-4

Date Collected: 08/01/17 13:25 **Matrix: Solid**
Date Received: 08/04/17 09:45

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
ASTM Leach	Leach	D3987-85			100.33 g	2000 mL	219850	08/11/17 16:30	JPM	TAL PIT
ASTM Leach	Prep	3010A			50 mL	50 mL	220131	08/15/17 10:30	RJG	TAL PIT
ASTM Leach	Analysis	6010C		1			220293	08/16/17 08:02	RJG	TAL PIT
	Instrument ID: C									
ASTM Leach	Leach	D3987-85			100.33 g	2000 mL	219850	08/11/17 16:30	JPM	TAL PIT
ASTM Leach	Prep	3010A			50 mL	50 mL	220085	08/15/17 08:43	SES	TAL PIT
ASTM Leach	Analysis	6020A		1			220429	08/17/17 02:53	WTR	TAL PIT
	Instrument ID: A									
Total/NA	Analysis	2540G		1			219459	08/08/17 15:20	MTW	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-6 (40-41) Lab Sample ID: 180-68950-4

Date Collected: 08/01/17 13:25 **Matrix: Solid**
Date Received: 08/04/17 09:45 **Percent Solids: 76.6**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.99 g	100 mL	220230	08/14/17 01:45	RJG	TAL PIT
Total/NA	Analysis	6010C		1			220293	08/16/17 12:03	RJG	TAL PIT
	Instrument ID: C									
Total/NA	Prep	3050B			0.99 g	100 mL	220008	08/14/17 11:49	WCT	TAL PIT
Total/NA	Analysis	6020A		1			220304	08/16/17 01:10	PFK	TAL PIT
	Instrument ID: M									
Total/NA	Prep	9030B			5.03 mL	50 mL	219405	08/08/17 12:50	JJZ	TAL PIT
Total/NA	Analysis	9034		1			219439	08/08/17 15:02	JJZ	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-8 (40-41) Lab Sample ID: 180-68950-5

Date Collected: 08/01/17 10:40 **Matrix: Solid**
Date Received: 08/04/17 09:45

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
ASTM Leach	Leach	D3987-85			100.49 g	2000 mL	219850	08/11/17 16:30	JPM	TAL PIT
ASTM Leach	Prep	3010A			50 mL	50 mL	220131	08/15/17 10:30	RJG	TAL PIT
ASTM Leach	Analysis	6010C		1			220293	08/16/17 08:07	RJG	TAL PIT
	Instrument ID: C									
ASTM Leach	Leach	D3987-85			100.49 g	2000 mL	219850	08/11/17 16:30	JPM	TAL PIT
ASTM Leach	Prep	3010A			50 mL	50 mL	220085	08/15/17 08:43	SES	TAL PIT
ASTM Leach	Analysis	6020A		1			220429	08/17/17 03:01	WTR	TAL PIT
	Instrument ID: A									
Total/NA	Analysis	2540G		1			219459	08/08/17 15:20	MTW	TAL PIT
	Instrument ID: NOEQUIP									

Lab Chronicle

Client: Haley & Aldrich, Inc.
Project/Site: Vectren Groundwater and Soil Sampling

TestAmerica Job ID: 180-68950-1

Client Sample ID: CCR-AP-8 (40-41)
Date Collected: 08/01/17 10:40
Date Received: 08/04/17 09:45

Lab Sample ID: 180-68950-5
Matrix: Solid
Percent Solids: 78.2

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.97 g	100 mL	220230	08/14/17 01:45	RJG	TAL PIT
Total/NA	Analysis	6010C		1			220293	08/16/17 12:08	RJG	TAL PIT
	Instrument ID: C									
Total/NA	Prep	3050B			0.97 g	100 mL	220008	08/14/17 11:49	WCT	TAL PIT
Total/NA	Analysis	6020A		1			220304	08/16/17 01:15	PFK	TAL PIT
	Instrument ID: M									
Total/NA	Prep	9030B			5.01 mL	50 mL	219405	08/08/17 12:50	JJZ	TAL PIT
Total/NA	Analysis	9034		1			219439	08/08/17 14:59	JJZ	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: SW-A
Date Collected: 08/03/17 10:35
Date Received: 08/04/17 09:45

Lab Sample ID: 180-68950-6
Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	9056A		50			219430	08/08/17 18:51	CMR	TAL PIT
	Instrument ID: CHICS2000									
Dissolved	Prep	3005A			50 mL	50 mL	219388	08/08/17 08:28	SES	TAL PIT
Dissolved	Analysis	6020A		1			220148	08/15/17 01:23	WTR	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50 mL	50 mL	219388	08/08/17 08:28	SES	TAL PIT
Total Recoverable	Analysis	6020A		1			220148	08/15/17 01:21	WTR	TAL PIT
	Instrument ID: A									
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	384144	08/14/17 13:02	LMT	TAL DEN
	Instrument ID: MT_024_Se									
Total/NA	Analysis	SM 2540C		1	25 mL	100 mL	219438	08/08/17 13:31	KXW	TAL PIT
	Instrument ID: NOEQUIP									
Total/NA	Analysis	SM 5310C		1			219639	08/09/17 17:54	CLL	TAL PIT
	Instrument ID: TOC1030									

Client Sample ID: SW-B
Date Collected: 08/03/17 09:20
Date Received: 08/04/17 09:45

Lab Sample ID: 180-68950-7
Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	9056A		50			219430	08/08/17 19:23	CMR	TAL PIT
	Instrument ID: CHICS2000									
Dissolved	Prep	3005A			50 mL	50 mL	219388	08/08/17 08:28	SES	TAL PIT
Dissolved	Analysis	6020A		1			220148	08/15/17 01:28	WTR	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50 mL	50 mL	219388	08/08/17 08:28	SES	TAL PIT
Total Recoverable	Analysis	6020A		1			220148	08/15/17 01:26	WTR	TAL PIT
	Instrument ID: A									

Client Sample ID: SW-B — Lab Sample ID: 180-68950-7

Date Collected: 08/03/17 09:20 — **Matrix: Water**
Date Received: 08/04/17 09:45

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	384144	08/14/17 13:45	LMT	TAL DEN
	Instrument ID: MT_024_Se									
Total/NA	Analysis	SM 2540C		1	25 mL	100 mL	219438	08/08/17 13:31	KXW	TAL PIT
	Instrument ID: NOEQUIP									
Total/NA	Analysis	SM 5310C		1			219639	08/09/17 18:06	CLL	TAL PIT
	Instrument ID: TOC1030									

Client Sample ID: SW-C — Lab Sample ID: 180-68950-8

Date Collected: 08/03/17 09:45 — **Matrix: Water**
Date Received: 08/04/17 09:45

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	9056A		250			219430	08/08/17 23:05	CMR	TAL PIT
	Instrument ID: CHICS2000									
Dissolved	Prep	3005A			50 mL	50 mL	219388	08/08/17 08:28	SES	TAL PIT
Dissolved	Analysis	6020A		1			220148	08/15/17 01:33	WTR	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50 mL	50 mL	219388	08/08/17 08:28	SES	TAL PIT
Total Recoverable	Analysis	6020A		1			220148	08/15/17 01:31	WTR	TAL PIT
	Instrument ID: A									
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	384144	08/14/17 13:59	LMT	TAL DEN
	Instrument ID: MT_024_Se									
Total/NA	Analysis	SM 2540C		1	10 mL	100 mL	219438	08/08/17 13:31	KXW	TAL PIT
	Instrument ID: NOEQUIP									
Total/NA	Analysis	SM 5310C		1			220063	08/14/17 14:19	CLL	TAL PIT
	Instrument ID: TOC1030									

Client Sample ID: SW-D — Lab Sample ID: 180-68950-9

Date Collected: 08/03/17 10:15 — **Matrix: Water**
Date Received: 08/04/17 09:45

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	9056A		50			219430	08/08/17 19:55	CMR	TAL PIT
	Instrument ID: CHICS2000									
Dissolved	Prep	3005A			50 mL	50 mL	219388	08/08/17 08:28	SES	TAL PIT
Dissolved	Analysis	6020A		1			220148	08/15/17 01:44	WTR	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50 mL	50 mL	219388	08/08/17 08:28	SES	TAL PIT
Total Recoverable	Analysis	6020A		1			220148	08/15/17 01:36	WTR	TAL PIT
	Instrument ID: A									
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	384144	08/14/17 14:13	LMT	TAL DEN
	Instrument ID: MT_024_Se									

Client Sample ID: SW-D

Lab Sample ID: 180-68950-9
Date Collected: 08/03/17 10:15
Matrix: Water
Date Received: 08/04/17 09:45

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	SM 2540C		1	25 mL	100 mL	219438	08/08/17 13:31	KXW	TAL PIT
	Instrument ID: NOEQUIP									
Total/NA	Analysis	SM 5310C		1			219639	08/09/17 18:32	CLL	TAL PIT
	Instrument ID: TOC1030									

Client Sample ID: PW-1-A

Lab Sample ID: 180-68950-10
Date Collected: 08/02/17 10:45
Matrix: Water
Date Received: 08/04/17 09:45

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	9056A		50			219430	08/08/17 20:26	CMR	TAL PIT
	Instrument ID: CHICS2000									
Dissolved	Prep	3005A			50 mL	50 mL	219532	08/09/17 08:36	SES	TAL PIT
Dissolved	Analysis	6020A		1			219796	08/10/17 19:15	JIS	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50 mL	50 mL	219532	08/09/17 08:36	SES	TAL PIT
Total Recoverable	Analysis	6020A		1			219796	08/10/17 19:13	JIS	TAL PIT
	Instrument ID: A									
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	384144	08/14/17 14:27	LMT	TAL DEN
	Instrument ID: MT_024_Se									
Total/NA	Analysis	SM 2540C		1	25 mL	100 mL	219384	08/08/17 08:17	KXW	TAL PIT
	Instrument ID: NOEQUIP									
Total/NA	Analysis	SM 5310C		1			219639	08/09/17 18:44	CLL	TAL PIT
	Instrument ID: TOC1030									

Client Sample ID: PW-1-B

Lab Sample ID: 180-68950-11
Date Collected: 08/02/17 12:25
Matrix: Water
Date Received: 08/04/17 09:45

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	9056A		5			219430	08/08/17 21:14	CMR	TAL PIT
	Instrument ID: CHICS2000									
Total/NA	Analysis	9056A		50			219430	08/08/17 21:30	CMR	TAL PIT
	Instrument ID: CHICS2000									
Dissolved	Prep	3005A			50 mL	50 mL	219532	08/09/17 08:36	SES	TAL PIT
Dissolved	Analysis	6020A		1			219796	08/10/17 19:20	JIS	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50 mL	50 mL	219532	08/09/17 08:36	SES	TAL PIT
Total Recoverable	Analysis	6020A		1			219796	08/10/17 19:18	JIS	TAL PIT
	Instrument ID: A									
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	384144	08/14/17 15:24	LMT	TAL DEN
	Instrument ID: MT_024_Se									

Client Sample ID: PW-1-B
Lab Sample ID: 180-68950-11
Date Collected: 08/02/17 12:25
Matrix: Water
Date Received: 08/04/17 09:45

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	SM 2540C		1	50 mL	100 mL	219384	08/08/17 08:17	KXW	TAL PIT
	Instrument ID: NOEQUIP									
Total/NA	Analysis	SM 5310C		1			219639	08/09/17 18:56	CLL	TAL PIT
	Instrument ID: TOC1030									

Client Sample ID: PW-2-A
Lab Sample ID: 180-68950-12
Date Collected: 08/02/17 14:20
Matrix: Water
Date Received: 08/04/17 09:45

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	9056A		10			219430	08/08/17 22:18	CMR	TAL PIT
	Instrument ID: CHICS2000									
Total/NA	Analysis	9056A		100			219430	08/08/17 22:34	CMR	TAL PIT
	Instrument ID: CHICS2000									
Dissolved	Prep	3005A			50 mL	50 mL	219532	08/09/17 08:36	SES	TAL PIT
Dissolved	Analysis	6020A		1			219796	08/10/17 19:25	JIS	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50 mL	50 mL	219532	08/09/17 08:36	SES	TAL PIT
Total Recoverable	Analysis	6020A		1			219796	08/10/17 19:23	JIS	TAL PIT
	Instrument ID: A									
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	384144	08/14/17 15:38	LMT	TAL DEN
	Instrument ID: MT_024_Se									
Total/NA	Analysis	SM 2540C		1	25 mL	100 mL	219384	08/08/17 08:17	KXW	TAL PIT
	Instrument ID: NOEQUIP									
Total/NA	Analysis	SM 5310C		1			219639	08/09/17 19:09	CLL	TAL PIT
	Instrument ID: TOC1030									

Client Sample ID: PW-2-B
Lab Sample ID: 180-68950-13
Date Collected: 08/03/17 08:31
Matrix: Water
Date Received: 08/04/17 09:45

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	9056A		5			219430	08/08/17 21:46	CMR	TAL PIT
	Instrument ID: CHICS2000									
Total/NA	Analysis	9056A		50			219430	08/08/17 22:02	CMR	TAL PIT
	Instrument ID: CHICS2000									
Dissolved	Prep	3005A			50 mL	50 mL	219532	08/09/17 08:36	SES	TAL PIT
Dissolved	Analysis	6020A		1			219796	08/10/17 19:36	JIS	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50 mL	50 mL	219532	08/09/17 08:36	SES	TAL PIT
Total Recoverable	Analysis	6020A		1			219796	08/10/17 19:33	JIS	TAL PIT
	Instrument ID: A									

Client: Haley & Aldrich, Inc.
Project/Site: Vectren Groundwater and Soil Sampling

TestAmerica Job ID: 180-68950-1

Client Sample ID: PW-2-B
Date Collected: 08/03/17 08:31
Date Received: 08/04/17 09:45

Lab Sample ID: 180-68950-13
Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	384144	08/14/17 15:53	LMT	TAL DEN
	Instrument ID: MT_024_Se									
Total/NA	Analysis	SM 2540C		1	50 mL	100 mL	219438	08/08/17 13:31	KXW	TAL PIT
	Instrument ID: NOEQUIP									
Total/NA	Analysis	SM 5310C		1			219639	08/09/17 19:21	CLL	TAL PIT
	Instrument ID: TOC1030									

Laboratory References:

TAL DEN = TestAmerica Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100

TAL PIT = TestAmerica Pittsburgh, 301 Alpha Drive, RIDC Park, Pittsburgh, PA 15238, TEL (412)963-7058

Analyst References:

Lab: TAL DEN

Batch Type: Analysis

LMT = Lynn-Anne Trudell

Lab: TAL PIT

Batch Type: Leach

JPM = Jeremy Merriman

Batch Type: Prep

JJZ = Joseph Zubrow

RJG = Rob Good

SES = Samantha Strauser

WCT = William Tippins

Batch Type: Analysis

CLL = Cheryl Loheyde

CMR = Carl Reagle

JIS = John Shannon

JJZ = Joseph Zubrow

KXW = Kaitlyn White

MTW = Michael Wesoloski

PFK = Paul Kolarczyk

RJG = Rob Good

WTR = Bill Reinheimer

Client Sample Results

Client: Haley & Aldrich, Inc.
Project/Site: Vectren Groundwater and Soil Sampling

TestAmerica Job ID: 180-68950-1

Client Sample ID: CCR-AP-2 (40-41)

Lab Sample ID: 180-68950-1

Date Collected: 08/01/17 09:00
Date Received: 08/04/17 09:45
Matrix: Solid

Method: 6010C - Metals (ICP) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		10	4.1	ug/L		08/15/17 10:30	08/16/17 07:46	1
Iron	**71**	**J**	100	31	ug/L		08/15/17 10:30	08/16/17 07:46	1

Method: 6020A - Metals (ICP/MS) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.32**	**J**	1.0	0.22	ug/L		08/15/17 08:43	08/17/17 02:45	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**21.7**		0.1	0.1	%			08/08/17 15:20	1
Percent Solids	**78.3**		0.1	0.1	%			08/08/17 15:20	1

Client Sample ID: CCR-AP-2 (40-41)

Lab Sample ID: 180-68950-1

Date Collected: 08/01/17 09:00
Date Received: 08/04/17 09:45
Matrix: Solid
Percent Solids: 78.3

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	**26000**		12	6.8	mg/Kg	☼	08/14/17 01:45	08/16/17 11:47	1
Arsenic	**7.7**		1.2	0.54	mg/Kg	☼	08/14/17 01:45	08/16/17 11:47	1

Method: 6020A - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**7.8**		0.12	0.025	mg/Kg	☼	08/14/17 11:49	08/16/17 00:56	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfide	ND		38	13	mg/Kg	☼	08/08/17 12:50	08/08/17 15:11	1

Client Sample ID: CCR-AP-3 (40-41)

Lab Sample ID: 180-68950-2

Date Collected: 08/01/17 11:55
Date Received: 08/04/17 09:45
Matrix: Solid

Method: 6010C - Metals (ICP) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		10	4.1	ug/L		08/15/17 10:30	08/16/17 07:51	1
Iron	**290**		100	31	ug/L		08/15/17 10:30	08/16/17 07:51	1

Method: 6020A - Metals (ICP/MS) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**2.8**		1.0	0.22	ug/L		08/15/17 08:43	08/17/17 02:48	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**21.5**		0.1	0.1	%			08/08/17 15:20	1
Percent Solids	**78.5**		0.1	0.1	%			08/08/17 15:20	1

Client Sample ID: CCR-AP-3 (40-41)

Lab Sample ID: 180-68950-2
Date Collected: 08/01/17 11:55
Matrix: Solid
Date Received: 08/04/17 09:45
Percent Solids: 78.5

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	**22000**		12	6.9	mg/Kg	☼	08/14/17 01:45	08/16/17 11:53	1
Arsenic	**12**		1.2	0.55	mg/Kg	☼	08/14/17 01:45	08/16/17 11:53	1

Method: 6020A - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**12**		0.12	0.025	mg/Kg	☼	08/14/17 11:49	08/16/17 01:01	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfide	ND		38	13	mg/Kg	☼	08/08/17 12:50	08/08/17 15:08	1

Client Sample ID: CCR-AP-4 (31-32)

Lab Sample ID: 180-68950-3
Date Collected: 08/01/17 15:55
Matrix: Solid
Date Received: 08/04/17 09:45

Method: 6010C - Metals (ICP) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		10	4.1	ug/L		08/15/17 10:30	08/16/17 07:56	1
Iron	ND		100	31	ug/L		08/15/17 10:30	08/16/17 07:56	1

Method: 6020A - Metals (ICP/MS) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**2.2**		1.0	0.22	ug/L		08/15/17 08:43	08/17/17 02:50	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**21.7**		0.1	0.1	%			08/08/17 15:20	1
Percent Solids	**78.3**		0.1	0.1	%			08/08/17 15:20	1

Client Sample ID: CCR-AP-4 (31-32)

Lab Sample ID: 180-68950-3
Date Collected: 08/01/17 15:55
Matrix: Solid
Date Received: 08/04/17 09:45
Percent Solids: 78.3

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	**24000**		13	7.1	mg/Kg	☼	08/14/17 01:45	08/16/17 11:58	1
Arsenic	**8.2**		1.3	0.57	mg/Kg	☼	08/14/17 01:45	08/16/17 11:58	1

Method: 6020A - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**7.9**		0.13	0.026	mg/Kg	☼	08/14/17 11:49	08/16/17 01:05	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfide	ND		38	13	mg/Kg	☼	08/08/17 12:50	08/08/17 15:05	1

Client Sample Results

Client: Haley & Aldrich, Inc.
Project/Site: Vectren Groundwater and Soil Sampling

TestAmerica Job ID: 180-68950-1

Client Sample ID: CCR-AP-6 (40-41)

Lab Sample ID: 180-68950-4

Date Collected: 08/01/17 13:25
Date Received: 08/04/17 09:45

Matrix: Solid

Method: 6010C - Metals (ICP) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		10	4.1	ug/L		08/15/17 10:30	08/16/17 08:02	1
Iron	**440**		100	31	ug/L		08/15/17 10:30	08/16/17 08:02	1

Method: 6020A - Metals (ICP/MS) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**3.0**		1.0	0.22	ug/L		08/15/17 08:43	08/17/17 02:53	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**23.4**		0.1	0.1	%			08/08/17 15:20	1
Percent Solids	**76.6**		0.1	0.1	%			08/08/17 15:20	1

Client Sample ID: CCR-AP-6 (40-41)

Lab Sample ID: 180-68950-4

Date Collected: 08/01/17 13:25
Date Received: 08/04/17 09:45

Matrix: Solid
Percent Solids: 76.6

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	**25000**		13	7.3	mg/Kg	☼	08/14/17 01:45	08/16/17 12:03	1
Arsenic	**8.4**		1.3	0.58	mg/Kg	☼	08/14/17 01:45	08/16/17 12:03	1

Method: 6020A - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**8.7**		0.13	0.027	mg/Kg	☼	08/14/17 11:49	08/16/17 01:10	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfide	ND		39	13	mg/Kg	☼	08/08/17 12:50	08/08/17 15:02	1

Client Sample ID: CCR-AP-8 (40-41)

Lab Sample ID: 180-68950-5

Date Collected: 08/01/17 10:40
Date Received: 08/04/17 09:45

Matrix: Solid

Method: 6010C - Metals (ICP) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		10	4.1	ug/L		08/15/17 10:30	08/16/17 08:07	1
Iron	**32**	**J**	100	31	ug/L		08/15/17 10:30	08/16/17 08:07	1

Method: 6020A - Metals (ICP/MS) - ASTM Leach

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**1.7**		1.0	0.22	ug/L		08/15/17 08:43	08/17/17 03:01	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**21.8**		0.1	0.1	%			08/08/17 15:20	1
Percent Solids	**78.2**		0.1	0.1	%			08/08/17 15:20	1

Client Sample ID: CCR-AP-8 (40-41)

Lab Sample ID: 180-68950-5
Date Collected: 08/01/17 10:40
Matrix: Solid
Date Received: 08/04/17 09:45
Percent Solids: 78.2

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	**27000**		13	7.3	mg/Kg	☼	08/14/17 01:45	08/16/17 12:08	1
Arsenic	**8.5**		1.3	0.58	mg/Kg	☼	08/14/17 01:45	08/16/17 12:08	1

Method: 6020A - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**8.0**		0.13	0.027	mg/Kg	☼	08/14/17 11:49	08/16/17 01:15	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfide	ND		38	13	mg/Kg	☼	08/08/17 12:50	08/08/17 14:59	1

Client Sample ID: SW-A

Lab Sample ID: 180-68950-6
Date Collected: 08/03/17 10:35
Matrix: Water
Date Received: 08/04/17 09:45

Method: 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**800**		50	36	mg/L			08/08/17 18:51	50
Sulfate	**1100**		50	19	mg/L			08/08/17 18:51	50

Method: 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**3.5**		1.0	0.22	ug/L		08/08/17 08:28	08/15/17 01:21	1
Iron	**470**		50	20	ug/L		08/08/17 08:28	08/15/17 01:21	1
Manganese	**5600**		5.0	1.3	ug/L		08/08/17 08:28	08/15/17 01:21	1
Molybdenum	**33**		5.0	0.59	ug/L		08/08/17 08:28	08/15/17 01:21	1

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**2.7**		1.0	0.22	ug/L		08/08/17 08:28	08/15/17 01:23	1
Iron	ND		50	20	ug/L		08/08/17 08:28	08/15/17 01:23	1
Manganese	**5600**		5.0	1.3	ug/L		08/08/17 08:28	08/15/17 01:23	1
Molybdenum	**35**		5.0	0.59	ug/L		08/08/17 08:28	08/15/17 01:23	1

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	**1.8**	**J**	2.0	0.79	ug/L			08/14/17 13:02	1
Arsenic (V)	**1.3**	**J F1**	2.0	0.75	ug/L			08/14/17 13:02	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	**3700**		40	40	mg/L			08/08/17 13:31	1
Total Organic Carbon - Duplicates	**5.1**		1.0	0.51	mg/L			08/09/17 17:54	1

Client Sample ID: SW-B

Lab Sample ID: 180-68950-7
Date Collected: 08/03/17 09:20
Matrix: Water
Date Received: 08/04/17 09:45

Method: 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**810**		50	36	mg/L			08/08/17 19:23	50

Client: Haley & Aldrich, Inc.
Project/Site: Vectren Groundwater and Soil Sampling

TestAmerica Job ID: 180-68950-1

Client Sample ID: SW-B

Lab Sample ID: 180-68950-7
Date Collected: 08/03/17 09:20
Matrix: Water
Date Received: 08/04/17 09:45

Method: 9056A - Anions, Ion Chromatography (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	1200		50	19	mg/L			08/08/17 19:23	50

Method: 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	3.2		1.0	0.22	ug/L		08/08/17 08:28	08/15/17 01:26	1
Iron	290		50	20	ug/L		08/08/17 08:28	08/15/17 01:26	1
Manganese	6200		5.0	1.3	ug/L		08/08/17 08:28	08/15/17 01:26	1
Molybdenum	35		5.0	0.59	ug/L		08/08/17 08:28	08/15/17 01:26	1

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	2.9		1.0	0.22	ug/L		08/08/17 08:28	08/15/17 01:28	1
Iron	ND		50	20	ug/L		08/08/17 08:28	08/15/17 01:28	1
Manganese	5900		5.0	1.3	ug/L		08/08/17 08:28	08/15/17 01:28	1
Molybdenum	35		5.0	0.59	ug/L		08/08/17 08:28	08/15/17 01:28	1

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	1.2	J	2.0	0.79	ug/L			08/14/17 13:45	1
Arsenic (V)	1.5	J	2.0	0.75	ug/L			08/14/17 13:45	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	3500		40	40	mg/L			08/08/17 13:31	1
Total Organic Carbon - Duplicates	5.3		1.0	0.51	mg/L			08/09/17 18:06	1

Client Sample ID: SW-C

Lab Sample ID: 180-68950-8
Date Collected: 08/03/17 09:45
Matrix: Water
Date Received: 08/04/17 09:45

Method: 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	3500		250	180	mg/L			08/08/17 23:05	250
Sulfate	5000		250	95	mg/L			08/08/17 23:05	250

Method: 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	3.4		1.0	0.22	ug/L		08/08/17 08:28	08/15/17 01:31	1
Iron	2200		50	20	ug/L		08/08/17 08:28	08/15/17 01:31	1
Manganese	31000		5.0	1.3	ug/L		08/08/17 08:28	08/15/17 01:31	1
Molybdenum	78		5.0	0.59	ug/L		08/08/17 08:28	08/15/17 01:31	1

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	2.3		1.0	0.22	ug/L		08/08/17 08:28	08/15/17 01:33	1
Iron	44	J	50	20	ug/L		08/08/17 08:28	08/15/17 01:33	1
Manganese	34000		5.0	1.3	ug/L		08/08/17 08:28	08/15/17 01:33	1
Molybdenum	81		5.0	0.59	ug/L		08/08/17 08:28	08/15/17 01:33	1

Client Sample ID: SW-C

Lab Sample ID: 180-68950-8
Date Collected: 08/03/17 09:45
Matrix: Water
Date Received: 08/04/17 09:45

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	1.2	J	2.0	0.79	ug/L			08/14/17 13:59	1
Arsenic (V)	1.0	J	2.0	0.75	ug/L			08/14/17 13:59	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	17000		100	100	mg/L			08/08/17 13:31	1
Total Organic Carbon - Duplicates	19		1.0	0.51	mg/L			08/14/17 14:19	1

Client Sample ID: SW-D

Lab Sample ID: 180-68950-9
Date Collected: 08/03/17 10:15
Matrix: Water
Date Received: 08/04/17 09:45

Method: 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	810		50	36	mg/L			08/08/17 19:55	50
Sulfate	1200		50	19	mg/L			08/08/17 19:55	50

Method: 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	4.1		1.0	0.22	ug/L		08/08/17 08:28	08/15/17 01:36	1
Iron	1700		50	20	ug/L		08/08/17 08:28	08/15/17 01:36	1
Manganese	6200		5.0	1.3	ug/L		08/08/17 08:28	08/15/17 01:36	1
Molybdenum	37		5.0	0.59	ug/L		08/08/17 08:28	08/15/17 01:36	1

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	2.8		1.0	0.22	ug/L		08/08/17 08:28	08/15/17 01:44	1
Iron	ND		50	20	ug/L		08/08/17 08:28	08/15/17 01:44	1
Manganese	6100		5.0	1.3	ug/L		08/08/17 08:28	08/15/17 01:44	1
Molybdenum	38		5.0	0.59	ug/L		08/08/17 08:28	08/15/17 01:44	1

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	ND		2.0	0.79	ug/L			08/14/17 14:13	1
Arsenic (V)	0.81	J	2.0	0.75	ug/L			08/14/17 14:13	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	3500		40	40	mg/L			08/08/17 13:31	1
Total Organic Carbon - Duplicates	5.1		1.0	0.51	mg/L			08/09/17 18:32	1

Client Sample ID: PW-1-A

Lab Sample ID: 180-68950-10
Date Collected: 08/02/17 10:45
Matrix: Water
Date Received: 08/04/17 09:45

Method: 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	570		50	36	mg/L			08/08/17 20:26	50
Sulfate	1100		50	19	mg/L			08/08/17 20:26	50

Client Sample ID: PW-1-A

Lab Sample ID: 180-68950-10

Date Collected: 08/02/17 10:45

Date Received: 08/04/17 09:45

Matrix: Water

Method: 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**36**		1.0	0.22	ug/L		08/09/17 08:36	08/10/17 19:13	1
Iron	**5000**		50	20	ug/L		08/09/17 08:36	08/10/17 19:13	1
Manganese	**650**		5.0	1.3	ug/L		08/09/17 08:36	08/10/17 19:13	1
Molybdenum	**1900**		5.0	0.59	ug/L		08/09/17 08:36	08/10/17 19:13	1

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**8.8**		1.0	0.22	ug/L		08/09/17 08:36	08/10/17 19:15	1
Iron	ND		50	20	ug/L		08/09/17 08:36	08/10/17 19:15	1
Manganese	ND		5.0	1.3	ug/L		08/09/17 08:36	08/10/17 19:15	1
Molybdenum	**1900**		5.0	0.59	ug/L		08/09/17 08:36	08/10/17 19:15	1

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	ND		2.0	0.79	ug/L			08/14/17 14:27	1
Arsenic (V)	**4.1**		2.0	0.75	ug/L			08/14/17 14:27	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	**3200**		40	40	mg/L			08/08/17 08:17	1
Total Organic Carbon - Duplicates	**2.0**		1.0	0.51	mg/L			08/09/17 18:44	1

Client Sample ID: PW-1-B

Lab Sample ID: 180-68950-11

Date Collected: 08/02/17 12:25

Date Received: 08/04/17 09:45

Matrix: Water

Method: 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**340**		5.0	3.6	mg/L			08/08/17 21:14	5
Sulfate	**990**		50	19	mg/L			08/08/17 21:30	50

Method: 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**230**		1.0	0.22	ug/L		08/09/17 08:36	08/10/17 19:18	1
Iron	ND		50	20	ug/L		08/09/17 08:36	08/10/17 19:18	1
Manganese	**6.3**		5.0	1.3	ug/L		08/09/17 08:36	08/10/17 19:18	1
Molybdenum	**9500**		5.0	0.59	ug/L		08/09/17 08:36	08/10/17 19:18	1

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**220**		1.0	0.22	ug/L		08/09/17 08:36	08/10/17 19:20	1
Iron	ND		50	20	ug/L		08/09/17 08:36	08/10/17 19:20	1
Manganese	**6.4**		5.0	1.3	ug/L		08/09/17 08:36	08/10/17 19:20	1
Molybdenum	**9500**		5.0	0.59	ug/L		08/09/17 08:36	08/10/17 19:20	1

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	**8.8**		2.0	0.79	ug/L			08/14/17 15:24	1
Arsenic (V)	**120**		2.0	0.75	ug/L			08/14/17 15:24	1

Client Sample ID: PW-1-B

Lab Sample ID: 180-68950-11
Date Collected: 08/02/17 12:25
Matrix: Water
Date Received: 08/04/17 09:45

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	2700		20	20	mg/L			08/08/17 08:17	1
Total Organic Carbon - Duplicates	4.2		1.0	0.51	mg/L			08/09/17 18:56	1

Client Sample ID: PW-2-A

Lab Sample ID: 180-68950-12
Date Collected: 08/02/17 14:20
Matrix: Water
Date Received: 08/04/17 09:45

Method: 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	760		10	7.1	mg/L			08/08/17 22:18	10
Sulfate	3300		100	38	mg/L			08/08/17 22:34	100

Method: 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	87		1.0	0.22	ug/L		08/09/17 08:36	08/10/17 19:23	1
Iron	120000		50	20	ug/L		08/09/17 08:36	08/10/17 19:23	1
Manganese	22000		5.0	1.3	ug/L		08/09/17 08:36	08/10/17 19:23	1
Molybdenum	81		5.0	0.59	ug/L		08/09/17 08:36	08/10/17 19:23	1

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	7.1		1.0	0.22	ug/L		08/09/17 08:36	08/10/17 19:25	1
Iron	42000		50	20	ug/L		08/09/17 08:36	08/10/17 19:25	1
Manganese	7500		5.0	1.3	ug/L		08/09/17 08:36	08/10/17 19:25	1
Molybdenum	310		5.0	0.59	ug/L		08/09/17 08:36	08/10/17 19:25	1

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	ND		2.0	0.79	ug/L			08/14/17 15:38	1
Arsenic (V)	1.7	J	2.0	0.75	ug/L			08/14/17 15:38	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	6400		40	40	mg/L			08/08/17 08:17	1
Total Organic Carbon - Duplicates	13		1.0	0.51	mg/L			08/09/17 19:09	1

Client Sample ID: PW-2-B

Lab Sample ID: 180-68950-13
Date Collected: 08/03/17 08:31
Matrix: Water
Date Received: 08/04/17 09:45

Method: 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	170		5.0	3.6	mg/L			08/08/17 21:46	5
Sulfate	1600		50	19	mg/L			08/08/17 22:02	50

Method: 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	260		1.0	0.22	ug/L		08/09/17 08:36	08/10/17 19:33	1
Iron	ND		50	20	ug/L		08/09/17 08:36	08/10/17 19:33	1
Manganese	140		5.0	1.3	ug/L		08/09/17 08:36	08/10/17 19:33	1
Molybdenum	7600		5.0	0.59	ug/L		08/09/17 08:36	08/10/17 19:33	1

Client Sample ID: PW-2-B

Lab Sample ID: 180-68950-13

Date Collected: 08/03/17 08:31

Matrix: Water

Date Received: 08/04/17 09:45

Method: 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**280**		1.0	0.22	ug/L		08/09/17 08:36	08/10/17 19:36	1
Iron	ND		50	20	ug/L		08/09/17 08:36	08/10/17 19:36	1
Manganese	**140**		5.0	1.3	ug/L		08/09/17 08:36	08/10/17 19:36	1
Molybdenum	**8900**		5.0	0.59	ug/L		08/09/17 08:36	08/10/17 19:36	1

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	**31**		2.0	0.79	ug/L			08/14/17 15:53	1
Arsenic (V)	**110**		2.0	0.75	ug/L			08/14/17 15:53	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	**3300**		20	20	mg/L			08/08/17 13:31	1
Total Organic Carbon - Duplicates	**7.7**		1.0	0.51	mg/L			08/09/17 19:21	1

Method: 9056A - Anions, Ion Chromatography

Lab Sample ID: MB 180-219430/6
Matrix: Water
Analysis Batch: 219430

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	ND		1.0	0.71	mg/L			08/08/17 14:21	1
Sulfate	ND		1.0	0.38	mg/L			08/08/17 14:21	1

Lab Sample ID: LCS 180-219430/5
Matrix: Water
Analysis Batch: 219430

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Chloride	25.0	24.4		mg/L		98	80 - 120
Sulfate	25.0	21.5		mg/L		86	80 - 120

Method: 6010C - Metals (ICP)

Lab Sample ID: MB 180-220131/1-A
Matrix: Solid
Analysis Batch: 220293

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 220131

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		10	4.1	ug/L		08/15/17 10:30	08/16/17 07:26	1
Iron	ND		100	31	ug/L		08/15/17 10:30	08/16/17 07:26	1

Lab Sample ID: LCS 180-220131/2-A
Matrix: Solid
Analysis Batch: 220293

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 220131

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	500	507		ug/L		101	80 - 120
Iron	1000	1020		ug/L		102	80 - 120

Lab Sample ID: LCSD 180-220131/3-A
Matrix: Solid
Analysis Batch: 220293

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 220131

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Arsenic	500	523		ug/L		105	80 - 120	3	20
Iron	1000	1050		ug/L		105	80 - 120	3	20

Lab Sample ID: MB 180-220230/1-A
Matrix: Solid
Analysis Batch: 220293

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 220230

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		1.0	0.44	mg/Kg		08/14/17 01:45	08/16/17 11:37	1
Iron	ND		10	5.5	mg/Kg		08/14/17 01:45	08/16/17 11:37	1

Method: 6010C - Metals (ICP) (Continued)

Lab Sample ID: LCS 180-220230/2-A **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 220293 **Prep Batch: 220230**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	4.00	4.24		mg/Kg		106	80 - 120
Iron	100	111		mg/Kg		111	80 - 120

Lab Sample ID: LB 180-219850/1-C **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: ASTM Leach**
Analysis Batch: 220293 **Prep Batch: 220131**

Analyte	LB Result	LB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		10	4.1	ug/L		08/15/17 10:30	08/16/17 07:41	1
Iron	ND		100	31	ug/L		08/15/17 10:30	08/16/17 07:41	1

Method: 6020A - Metals (ICP/MS)

Lab Sample ID: MB 180-220008/1-A **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 220304 **Prep Batch: 220008**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		0.10	0.020	mg/Kg		08/14/17 11:49	08/15/17 23:52	1

Lab Sample ID: LCS 180-220008/2-A **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 220304 **Prep Batch: 220008**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	4.00	4.00		mg/Kg		100	80 - 120

Lab Sample ID: MB 180-220085/1-A **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 220429 **Prep Batch: 220085**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		1.0	0.22	ug/L		08/15/17 08:43	08/17/17 02:37	1

Lab Sample ID: LCS 180-220085/2-A **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 220429 **Prep Batch: 220085**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	40.0	37.7		ug/L		94	80 - 120

Lab Sample ID: LCSD 180-220085/3-A **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 220429 **Prep Batch: 220085**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Arsenic	40.0	37.2		ug/L		93	80 - 120	1	20

Method: 6020A - Metals (ICP/MS) (Continued)

Lab Sample ID: MB 180-219388/1-A | **Client Sample ID: Method Blank**
Matrix: Water | **Prep Type: Total Recoverable**
Analysis Batch: 220148 | **Prep Batch: 219388**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		1.0	0.22	ug/L		08/08/17 08:28	08/15/17 00:24	1
Iron	ND		50	20	ug/L		08/08/17 08:28	08/15/17 00:24	1
Manganese	ND		5.0	1.3	ug/L		08/08/17 08:28	08/15/17 00:24	1
Molybdenum	ND		5.0	0.59	ug/L		08/08/17 08:28	08/15/17 00:24	1

Lab Sample ID: LCS 180-219388/2-A | **Client Sample ID: Lab Control Sample**
Matrix: Water | **Prep Type: Total Recoverable**
Analysis Batch: 220148 | **Prep Batch: 219388**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	40.0	36.2		ug/L		90	80 - 120
Iron	1000	1050		ug/L		105	80 - 120
Manganese	500	507		ug/L		101	80 - 120
Molybdenum	1000	961		ug/L		96	80 - 120

Lab Sample ID: MB 180-219532/1-A | **Client Sample ID: Method Blank**
Matrix: Water | **Prep Type: Total Recoverable**
Analysis Batch: 219796 | **Prep Batch: 219532**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		1.0	0.22	ug/L		08/09/17 08:36	08/10/17 18:47	1
Iron	ND		50	20	ug/L		08/09/17 08:36	08/10/17 18:47	1
Manganese	ND		5.0	1.3	ug/L		08/09/17 08:36	08/10/17 18:47	1
Molybdenum	ND		5.0	0.59	ug/L		08/09/17 08:36	08/10/17 18:47	1

Lab Sample ID: LCS 180-219532/2-A | **Client Sample ID: Lab Control Sample**
Matrix: Water | **Prep Type: Total Recoverable**
Analysis Batch: 219796 | **Prep Batch: 219532**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	40.0	37.0		ug/L		93	80 - 120
Iron	1000	1080		ug/L		108	80 - 120
Manganese	500	528		ug/L		106	80 - 120
Molybdenum	1000	972		ug/L		97	80 - 120

Lab Sample ID: LB 180-219850/1-B | **Client Sample ID: Method Blank**
Matrix: Solid | **Prep Type: ASTM Leach**
Analysis Batch: 220429 | **Prep Batch: 220085**

Analyte	LB Result	LB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		1.0	0.22	ug/L		08/15/17 08:43	08/17/17 02:35	1

Method: Se Speciation - Selenium Speciation

Lab Sample ID: MB 280-384144/4
Matrix: Water
Analysis Batch: 384144

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	ND		2.0	0.79	ug/L			08/14/17 12:34	1
Arsenic (V)	ND		2.0	0.75	ug/L			08/14/17 12:34	1

Lab Sample ID: LCS 280-384144/5
Matrix: Water
Analysis Batch: 384144

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic (III)	50.0	40.9		ug/L		82	50 - 150
Arsenic (V)	50.0	27.0		ug/L		54	50 - 150

Lab Sample ID: 180-68950-6 MS
Matrix: Water
Analysis Batch: 384144

Client Sample ID: SW-A
Prep Type: Dissolved

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic (III)	1.8	J	50.0	42.3		ug/L		81	50 - 150
Arsenic (V)	1.3	J F1	50.0	22.9	F1	ug/L		43	50 - 150

Lab Sample ID: 180-68950-6 MSD
Matrix: Water
Analysis Batch: 384144

Client Sample ID: SW-A
Prep Type: Dissolved

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Arsenic (III)	1.8	J	50.0	41.1		ug/L		78	50 - 150	3	50
Arsenic (V)	1.3	J F1	50.0	23.2	F1	ug/L		44	50 - 150	1	50

Method: 2540G - SM 2540G

Lab Sample ID: 180-68950-1 DU
Matrix: Solid
Analysis Batch: 219459

Client Sample ID: CCR-AP-2 (40-41)
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Percent Moisture	21.7		21.9		%		1	20
Percent Solids	78.3		78.1		%		0.3	20

Method: 9034 - Sulfide, Acid soluble and Insoluble (Titrimetric)

Lab Sample ID: MB 180-219405/2-A
Matrix: Solid
Analysis Batch: 219439

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 219405

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfide	ND		30	10	mg/Kg		08/08/17 12:50	08/08/17 14:48	1

Method: 9034 - Sulfide, Acid soluble and Insoluble (Titrimetric) (Continued)

Lab Sample ID: LCS 180-219405/1-A **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 219439 **Prep Batch: 219405**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Sulfide	202	196		mg/Kg		97	85 - 115

Method: SM 2540C - Solids, Total Dissolved (TDS)

Lab Sample ID: MB 180-219384/2 **Client Sample ID: Method Blank**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 219384

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	ND		10	10	mg/L			08/08/17 08:17	1

Lab Sample ID: LCS 180-219384/1 **Client Sample ID: Lab Control Sample**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 219384

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Dissolved Solids	458	442		mg/L		97	80 - 120

Lab Sample ID: MB 180-219438/2 **Client Sample ID: Method Blank**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 219438

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	ND		10	10	mg/L			08/08/17 13:31	1

Lab Sample ID: LCS 180-219438/1 **Client Sample ID: Lab Control Sample**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 219438

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Dissolved Solids	458	462		mg/L		101	80 - 120

Lab Sample ID: 180-68950-9 DU **Client Sample ID: SW-D**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 219438

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Total Dissolved Solids	3500		3400		mg/L		4	10

Method: SM 5310C - TOC

Lab Sample ID: MB 180-219639/31 **Client Sample ID: Method Blank**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 219639

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon - Duplicates	ND		1.0	0.51	mg/L			08/09/17 15:48	1

Method: SM 5310C - TOC (Continued)

Lab Sample ID: LCS 180-219639/29 **Client Sample ID: Lab Control Sample**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 219639

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon - Duplicates	20.0	19.9		mg/L		100	85 - 115

Lab Sample ID: LCSD 180-219639/30 **Client Sample ID: Lab Control Sample Dup**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 219639

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Total Organic Carbon - Duplicates	20.0	20.0		mg/L		100	85 - 115	0	20

Lab Sample ID: MB 180-220063/6 **Client Sample ID: Method Blank**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 220063

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon - Duplicates	ND		1.0	0.51	mg/L			08/14/17 13:04	1

Lab Sample ID: LCS 180-220063/4 **Client Sample ID: Lab Control Sample**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 220063

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon - Duplicates	20.0	19.4		mg/L		97	85 - 115

Lab Sample ID: LCSD 180-220063/5 **Client Sample ID: Lab Control Sample Dup**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 220063

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Total Organic Carbon - Duplicates	20.0	19.6		mg/L		98	85 - 115	1	20

HPLC/IC

Analysis Batch: 219430

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-6	SW-A	Total/NA	Water	9056A	
180-68950-7	SW-B	Total/NA	Water	9056A	
180-68950-8	SW-C	Total/NA	Water	9056A	
180-68950-9	SW-D	Total/NA	Water	9056A	
180-68950-10	PW-1-A	Total/NA	Water	9056A	
180-68950-11	PW-1-B	Total/NA	Water	9056A	
180-68950-11	PW-1-B	Total/NA	Water	9056A	
180-68950-12	PW-2-A	Total/NA	Water	9056A	
180-68950-12	PW-2-A	Total/NA	Water	9056A	
180-68950-13	PW-2-B	Total/NA	Water	9056A	
180-68950-13	PW-2-B	Total/NA	Water	9056A	
MB 180-219430/6	Method Blank	Total/NA	Water	9056A	
LCS 180-219430/5	Lab Control Sample	Total/NA	Water	9056A	

Metals

Prep Batch: 219388

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-6	SW-A	Dissolved	Water	3005A	
180-68950-6	SW-A	Total Recoverable	Water	3005A	
180-68950-7	SW-B	Dissolved	Water	3005A	
180-68950-7	SW-B	Total Recoverable	Water	3005A	
180-68950-8	SW-C	Dissolved	Water	3005A	
180-68950-8	SW-C	Total Recoverable	Water	3005A	
180-68950-9	SW-D	Dissolved	Water	3005A	
180-68950-9	SW-D	Total Recoverable	Water	3005A	
MB 180-219388/1-A	Method Blank	Total Recoverable	Water	3005A	
LCS 180-219388/2-A	Lab Control Sample	Total Recoverable	Water	3005A	

Prep Batch: 219532

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-10	PW-1-A	Dissolved	Water	3005A	
180-68950-10	PW-1-A	Total Recoverable	Water	3005A	
180-68950-11	PW-1-B	Dissolved	Water	3005A	
180-68950-11	PW-1-B	Total Recoverable	Water	3005A	
180-68950-12	PW-2-A	Dissolved	Water	3005A	
180-68950-12	PW-2-A	Total Recoverable	Water	3005A	
180-68950-13	PW-2-B	Dissolved	Water	3005A	
180-68950-13	PW-2-B	Total Recoverable	Water	3005A	
MB 180-219532/1-A	Method Blank	Total Recoverable	Water	3005A	
LCS 180-219532/2-A	Lab Control Sample	Total Recoverable	Water	3005A	

Analysis Batch: 219796

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-10	PW-1-A	Dissolved	Water	6020A	219532
180-68950-10	PW-1-A	Total Recoverable	Water	6020A	219532
180-68950-11	PW-1-B	Dissolved	Water	6020A	219532
180-68950-11	PW-1-B	Total Recoverable	Water	6020A	219532
180-68950-12	PW-2-A	Dissolved	Water	6020A	219532
180-68950-12	PW-2-A	Total Recoverable	Water	6020A	219532

Metals (Continued)

Analysis Batch: 219796 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-13	PW-2-B	Dissolved	Water	6020A	219532
180-68950-13	PW-2-B	Total Recoverable	Water	6020A	219532
MB 180-219532/1-A	Method Blank	Total Recoverable	Water	6020A	219532
LCS 180-219532/2-A	Lab Control Sample	Total Recoverable	Water	6020A	219532

Leach Batch: 219850

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-1	CCR-AP-2 (40-41)	ASTM Leach	Solid	D3987-85	
180-68950-2	CCR-AP-3 (40-41)	ASTM Leach	Solid	D3987-85	
180-68950-3	CCR-AP-4 (31-32)	ASTM Leach	Solid	D3987-85	
180-68950-4	CCR-AP-6 (40-41)	ASTM Leach	Solid	D3987-85	
180-68950-5	CCR-AP-8 (40-41)	ASTM Leach	Solid	D3987-85	
LB 180-219850/1-B	Method Blank	ASTM Leach	Solid	D3987-85	
LB 180-219850/1-C	Method Blank	ASTM Leach	Solid	D3987-85	

Prep Batch: 220008

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-1	CCR-AP-2 (40-41)	Total/NA	Solid	3050B	
180-68950-2	CCR-AP-3 (40-41)	Total/NA	Solid	3050B	
180-68950-3	CCR-AP-4 (31-32)	Total/NA	Solid	3050B	
180-68950-4	CCR-AP-6 (40-41)	Total/NA	Solid	3050B	
180-68950-5	CCR-AP-8 (40-41)	Total/NA	Solid	3050B	
MB 180-220008/1-A	Method Blank	Total/NA	Solid	3050B	
LCS 180-220008/2-A	Lab Control Sample	Total/NA	Solid	3050B	

Prep Batch: 220085

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-1	CCR-AP-2 (40-41)	ASTM Leach	Solid	3010A	219850
180-68950-2	CCR-AP-3 (40-41)	ASTM Leach	Solid	3010A	219850
180-68950-3	CCR-AP-4 (31-32)	ASTM Leach	Solid	3010A	219850
180-68950-4	CCR-AP-6 (40-41)	ASTM Leach	Solid	3010A	219850
180-68950-5	CCR-AP-8 (40-41)	ASTM Leach	Solid	3010A	219850
LB 180-219850/1-B	Method Blank	ASTM Leach	Solid	3010A	219850
MB 180-220085/1-A	Method Blank	Total/NA	Solid	3010A	
LCS 180-220085/2-A	Lab Control Sample	Total/NA	Solid	3010A	
LCSD 180-220085/3-A	Lab Control Sample Dup	Total/NA	Solid	3010A	

Prep Batch: 220131

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-1	CCR-AP-2 (40-41)	ASTM Leach	Solid	3010A	219850
180-68950-2	CCR-AP-3 (40-41)	ASTM Leach	Solid	3010A	219850
180-68950-3	CCR-AP-4 (31-32)	ASTM Leach	Solid	3010A	219850
180-68950-4	CCR-AP-6 (40-41)	ASTM Leach	Solid	3010A	219850
180-68950-5	CCR-AP-8 (40-41)	ASTM Leach	Solid	3010A	219850
LB 180-219850/1-C	Method Blank	ASTM Leach	Solid	3010A	219850
MB 180-220131/1-A	Method Blank	Total/NA	Solid	3010A	
LCS 180-220131/2-A	Lab Control Sample	Total/NA	Solid	3010A	
LCSD 180-220131/3-A	Lab Control Sample Dup	Total/NA	Solid	3010A	

Metals (Continued)

Analysis Batch: 220148

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-6	SW-A	Dissolved	Water	6020A	219388
180-68950-6	SW-A	Total Recoverable	Water	6020A	219388
180-68950-7	SW-B	Dissolved	Water	6020A	219388
180-68950-7	SW-B	Total Recoverable	Water	6020A	219388
180-68950-8	SW-C	Dissolved	Water	6020A	219388
180-68950-8	SW-C	Total Recoverable	Water	6020A	219388
180-68950-9	SW-D	Dissolved	Water	6020A	219388
180-68950-9	SW-D	Total Recoverable	Water	6020A	219388
MB 180-219388/1-A	Method Blank	Total Recoverable	Water	6020A	219388
LCS 180-219388/2-A	Lab Control Sample	Total Recoverable	Water	6020A	219388

Prep Batch: 220230

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-1	CCR-AP-2 (40-41)	Total/NA	Solid	3050B	
180-68950-2	CCR-AP-3 (40-41)	Total/NA	Solid	3050B	
180-68950-3	CCR-AP-4 (31-32)	Total/NA	Solid	3050B	
180-68950-4	CCR-AP-6 (40-41)	Total/NA	Solid	3050B	
180-68950-5	CCR-AP-8 (40-41)	Total/NA	Solid	3050B	
MB 180-220230/1-A	Method Blank	Total/NA	Solid	3050B	
LCS 180-220230/2-A	Lab Control Sample	Total/NA	Solid	3050B	

Analysis Batch: 220293

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-1	CCR-AP-2 (40-41)	ASTM Leach	Solid	6010C	220131
180-68950-1	CCR-AP-2 (40-41)	Total/NA	Solid	6010C	220230
180-68950-2	CCR-AP-3 (40-41)	ASTM Leach	Solid	6010C	220131
180-68950-2	CCR-AP-3 (40-41)	Total/NA	Solid	6010C	220230
180-68950-3	CCR-AP-4 (31-32)	ASTM Leach	Solid	6010C	220131
180-68950-3	CCR-AP-4 (31-32)	Total/NA	Solid	6010C	220230
180-68950-4	CCR-AP-6 (40-41)	ASTM Leach	Solid	6010C	220131
180-68950-4	CCR-AP-6 (40-41)	Total/NA	Solid	6010C	220230
180-68950-5	CCR-AP-8 (40-41)	ASTM Leach	Solid	6010C	220131
180-68950-5	CCR-AP-8 (40-41)	Total/NA	Solid	6010C	220230
LB 180-219850/1-C	Method Blank	ASTM Leach	Solid	6010C	220131
MB 180-220131/1-A	Method Blank	Total/NA	Solid	6010C	220131
MB 180-220230/1-A	Method Blank	Total/NA	Solid	6010C	220230
LCS 180-220131/2-A	Lab Control Sample	Total/NA	Solid	6010C	220131
LCS 180-220230/2-A	Lab Control Sample	Total/NA	Solid	6010C	220230
LCSD 180-220131/3-A	Lab Control Sample Dup	Total/NA	Solid	6010C	220131

Analysis Batch: 220304

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-1	CCR-AP-2 (40-41)	Total/NA	Solid	6020A	220008
180-68950-2	CCR-AP-3 (40-41)	Total/NA	Solid	6020A	220008
180-68950-3	CCR-AP-4 (31-32)	Total/NA	Solid	6020A	220008
180-68950-4	CCR-AP-6 (40-41)	Total/NA	Solid	6020A	220008
180-68950-5	CCR-AP-8 (40-41)	Total/NA	Solid	6020A	220008
MB 180-220008/1-A	Method Blank	Total/NA	Solid	6020A	220008
LCS 180-220008/2-A	Lab Control Sample	Total/NA	Solid	6020A	220008

Metals (Continued)

Analysis Batch: 220429

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-1	CCR-AP-2 (40-41)	ASTM Leach	Solid	6020A	220085
180-68950-2	CCR-AP-3 (40-41)	ASTM Leach	Solid	6020A	220085
180-68950-3	CCR-AP-4 (31-32)	ASTM Leach	Solid	6020A	220085
180-68950-4	CCR-AP-6 (40-41)	ASTM Leach	Solid	6020A	220085
180-68950-5	CCR-AP-8 (40-41)	ASTM Leach	Solid	6020A	220085
LB 180-219850/1-B	Method Blank	ASTM Leach	Solid	6020A	220085
MB 180-220085/1-A	Method Blank	Total/NA	Solid	6020A	220085
LCS 180-220085/2-A	Lab Control Sample	Total/NA	Solid	6020A	220085
LCSD 180-220085/3-A	Lab Control Sample Dup	Total/NA	Solid	6020A	220085

Analysis Batch: 384144

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-6	SW-A	Dissolved	Water	Se Speciation	
180-68950-7	SW-B	Dissolved	Water	Se Speciation	
180-68950-8	SW-C	Dissolved	Water	Se Speciation	
180-68950-9	SW-D	Dissolved	Water	Se Speciation	
180-68950-10	PW-1-A	Dissolved	Water	Se Speciation	
180-68950-11	PW-1-B	Dissolved	Water	Se Speciation	
180-68950-12	PW-2-A	Dissolved	Water	Se Speciation	
180-68950-13	PW-2-B	Dissolved	Water	Se Speciation	
MB 280-384144/4	Method Blank	Total/NA	Water	Se Speciation	
LCS 280-384144/5	Lab Control Sample	Total/NA	Water	Se Speciation	
180-68950-6 MS	SW-A	Dissolved	Water	Se Speciation	
180-68950-6 MSD	SW-A	Dissolved	Water	Se Speciation	

General Chemistry

Analysis Batch: 219384

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-10	PW-1-A	Total/NA	Water	SM 2540C	
180-68950-11	PW-1-B	Total/NA	Water	SM 2540C	
180-68950-12	PW-2-A	Total/NA	Water	SM 2540C	
MB 180-219384/2	Method Blank	Total/NA	Water	SM 2540C	
LCS 180-219384/1	Lab Control Sample	Total/NA	Water	SM 2540C	

Prep Batch: 219405

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-1	CCR-AP-2 (40-41)	Total/NA	Solid	9030B	
180-68950-2	CCR-AP-3 (40-41)	Total/NA	Solid	9030B	
180-68950-3	CCR-AP-4 (31-32)	Total/NA	Solid	9030B	
180-68950-4	CCR-AP-6 (40-41)	Total/NA	Solid	9030B	
180-68950-5	CCR-AP-8 (40-41)	Total/NA	Solid	9030B	
MB 180-219405/2-A	Method Blank	Total/NA	Solid	9030B	
LCS 180-219405/1-A	Lab Control Sample	Total/NA	Solid	9030B	

Analysis Batch: 219438

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-6	SW-A	Total/NA	Water	SM 2540C	
180-68950-7	SW-B	Total/NA	Water	SM 2540C	
180-68950-8	SW-C	Total/NA	Water	SM 2540C	

General Chemistry (Continued)

Analysis Batch: 219438 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-9	SW-D	Total/NA	Water	SM 2540C	
180-68950-13	PW-2-B	Total/NA	Water	SM 2540C	
MB 180-219438/2	Method Blank	Total/NA	Water	SM 2540C	
LCS 180-219438/1	Lab Control Sample	Total/NA	Water	SM 2540C	
180-68950-9 DU	SW-D	Total/NA	Water	SM 2540C	

Analysis Batch: 219439

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-1	CCR-AP-2 (40-41)	Total/NA	Solid	9034	219405
180-68950-2	CCR-AP-3 (40-41)	Total/NA	Solid	9034	219405
180-68950-3	CCR-AP-4 (31-32)	Total/NA	Solid	9034	219405
180-68950-4	CCR-AP-6 (40-41)	Total/NA	Solid	9034	219405
180-68950-5	CCR-AP-8 (40-41)	Total/NA	Solid	9034	219405
MB 180-219405/2-A	Method Blank	Total/NA	Solid	9034	219405
LCS 180-219405/1-A	Lab Control Sample	Total/NA	Solid	9034	219405

Analysis Batch: 219459

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-1	CCR-AP-2 (40-41)	Total/NA	Solid	2540G	
180-68950-2	CCR-AP-3 (40-41)	Total/NA	Solid	2540G	
180-68950-3	CCR-AP-4 (31-32)	Total/NA	Solid	2540G	
180-68950-4	CCR-AP-6 (40-41)	Total/NA	Solid	2540G	
180-68950-5	CCR-AP-8 (40-41)	Total/NA	Solid	2540G	
180-68950-1 DU	CCR-AP-2 (40-41)	Total/NA	Solid	2540G	

Analysis Batch: 219639

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-6	SW-A	Total/NA	Water	SM 5310C	
180-68950-7	SW-B	Total/NA	Water	SM 5310C	
180-68950-9	SW-D	Total/NA	Water	SM 5310C	
180-68950-10	PW-1-A	Total/NA	Water	SM 5310C	
180-68950-11	PW-1-B	Total/NA	Water	SM 5310C	
180-68950-12	PW-2-A	Total/NA	Water	SM 5310C	
180-68950-13	PW-2-B	Total/NA	Water	SM 5310C	
MB 180-219639/31	Method Blank	Total/NA	Water	SM 5310C	
LCS 180-219639/29	Lab Control Sample	Total/NA	Water	SM 5310C	
LCSD 180-219639/30	Lab Control Sample Dup	Total/NA	Water	SM 5310C	

Analysis Batch: 220063

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-68950-8	SW-C	Total/NA	Water	SM 5310C	
MB 180-220063/6	Method Blank	Total/NA	Water	SM 5310C	
LCS 180-220063/4	Lab Control Sample	Total/NA	Water	SM 5310C	
LCSD 180-220063/5	Lab Control Sample Dup	Total/NA	Water	SM 5310C	

TestAmerica Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone (412) 963-7058 Fax (412) 963-2468

Chain of Custody Record

180-68950 Chain of Custody

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information	Sampler: Sean Lewis	Lab PM: Bortot, Veronica	COC No: 180-38481-8387.1
Client Contact: Sean Lewis	Phone: 864-395-0326	E-Mail: veronica.bortot@testamericainc.com	Page: Page 1 of 2
Company: Haley & Aldrich, Inc.			Job #:
Address: 400 Augusta Street Suite 130	Due Date Requested:		
City: Greenville	TAT Requested (days): Standard		
State, Zip: SC, 29601			
Phone:	PO #: 129420-005		
Email: slewis@haleyaldrich.com	WO #:		
Project Name: Vectren Groundwater and Soil Sampling	Project #: 18017692		
Site:	SSOW#:		

Analysis Requested

Preservation Codes:
A - HCL; B - NaOH; C - Zn Acetate; D - Nitric Acid; E - NaHSO4; F - MeOH; G - Amchlor; H - Ascorbic Acid; I - Ice; J - DI Water; K - EDTA; L - EDA
M - Hexane; N - None; O - AsNaO2; P - Na2O4S; Q - Na2SO3; R - Na2S2O3; S - H2SO4; T - TSP Dodecahydrate; U - Acetone; V - MCAA; W - pH 4-5; Z - other (specify)
Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	6010C, 6020A	9034_Calc, Moisture	5310C - TOC - Duplicate	6020A - As, Fe, Mn, Mo by ICP-MS	6020A - As, Fe, Mn, Mo Dissolved (field filtered	9056A_ORGFM_28D - Chloride and Sulfate	2540C_Calcd - Solids, Total Dissolved (TDS)	Se_SPEC - As (III) and As (V), Dissolved (field fi	Total Number of containers	Special Instructions/Note:
				Preservation Code:			N	N	S	D	D	N	N	N		
CCR-AP-2 (40-41)	8/1/17	0900	G	Solid	N	N	X	X							3	Soil Samples will
CCR-AP-3 (40-41)	8/1/17	1155	G	Solid	N	N	X	X								remain on hold,
CCR-AP-4 (31-32)	8/1/17	1555	G	Solid	N	N	X	X								pending groundwater
CCR-AP-6 (40-41)	8/1/17	1325	G	Solid	N	N	X	X								sample results
CCR-AP-8 (40-41)	8/1/17	1040	G	Solid	N	N	X	X								
SW-A	8/3/17	1035	G	Water	Y	N			X	X	X	X	X	X		• For PW-2A prepare
SW-B	8/3/17	0920	G	Water	Y	N			X	X	X	X	X	X		sample with 1.0 um
SW-C	8/3/17	0945	G	Water	Y	N			X	X	X	X	X	X		nominal pore size filter
SW-D	8/3/17	1015	G	Water	Y	N			X	X	X	X	X	X		disk for analysis of
PW-1-A	8/2/17	1045	G	Water	Y	N			X	X	X	X	X	X		Total metals by EPA
PW-1-B	8/2/17	1225	G	Water	Y	N			X	X	X	X	X	X		Method 6020A.

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☐ Disposal By Lab ☐ Archive For ______ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:		Method of Shipment:
Relinquished by: Sean Lewis	Date/Time: 8/3/17 1330	Company	Received by: [signature]	Date/Time: 8/4/17 0945 Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time: Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time: Company
Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:		Cooler Temperature(s) °C and Other Remarks:	

TestAmerica Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone (412) 963-7058 Fax (412) 963-2468

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information	Sampler:	Lab PM: Bortot, Veronica	Carrier Tracking No(s):	COC No: 180-38481-8387.2
Client Contact: Sean Lewis	Phone:	E-Mail: veronica.bortot@testamericainc.com		Page: Page 2 of 2
Company: Haley & Aldrich, Inc.				Job #:
Address: 400 Augusta Street Suite 130	Due Date Requested:			
City: Greenville	TAT Requested (days):			
State, Zip: SC, 29601				
Phone:	PO #: 129420-005			
Email: slewis@haleyaldrich.com	WO #:			
Project Name: Vectren Groundwater and Soil Sampling	Project #: 18017692			
Site:	SSOW#:			

Analysis Requested

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	6010C, 6020A	9034_Calc, Moisture	5310C - TOC - Duplicate	6020A - As, Fe, Mn, Mo by ICP-MS	6020A - As, Fe, Mn, Mo Dissolved (field filtered	9056A_ORGFM_28D - Chloride and Sulfate	2540C_Calcd - Solids, Total Dissolved (TDS)	Se_SPEC - As (III) and As (V), Dissolved (field fi	Total Number of containers	Special Instructions/Note:
				Preservation Code:			N	N	S	D	D	N	N	N		
PW-2-A	8/2/17	1420	G	Water	Y	N			X	X	X	X	X	X		
PW-2-B	8/3/17	0831	G	Water	Y	N			X	X	X	X	X	X		

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☐ Disposal By Lab ☐ Archive For ______ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:		Date:	Time:		Method of Shipment:
Relinquished by:	Date/Time:	Company	Received by: [signature]	Date/Time: 8/4/17 0945	Company: TA PIT
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No | Custody Seal No.: | Cooler Temperature(s) °C and Other Remarks:

UPS Next Day Air®
UPS Worldwide Express®
Shipping Document

…ee instructions on back. Visit UPS.com® or call 1-800-PICK-UPS® (800-742-5877) for addition… information and Tariff/Terms and Conditions.

TRACKING NUMBER 1Z 376 1R0 22 1000 046 5

1 SHIPMENT FROM
SHIPPER'S UPS ACCOUNT NO. 3 7 6 1 R 0
REFERENCE NUMBER 129420-005
NAME Sean Lewis TELEPHONE 864-214-8750
COMPANY HALEY & ALDRICH INC
STREET ADDRESS 400 AUGUSTA ST RM 130
CITY AND STATE GREENVILLE SC ZIP CODE 29601 3552

2 EXTREMELY URGENT DELIVERY TO
NAME Sample Receiving TELEPHONE (412) 963-7058
COMPANY Test America Pittsburgh

Uncorrected temp 1.4 °C
Thermometer ID 12
CF 0 Initials TB

PT-WI-SR-001 effective 7/26/13

UPS Next Day Air®
UPS Worldwide Express®
Shipping Document

See instructions on back. Visit UPS.com® or call 1-800-PICK-UPS® (800-742-5877) for additional information and Tariff/Terms and Conditions.

TRACKING NUMBER 1Z 376 1R0 22 1000 045 6

1 SHIPMENT FROM
SHIPPER'S UPS ACCOUNT NO. 3 7 6 1 R 0
REFERENCE NUMBER 129420-005
NAME Sean Lewis TELEPHONE 864-214-8750
COMPANY HALEY & ALDRICH INC
STREET ADDRESS 400 AUGUSTA ST RM 130
CITY AND STATE GREENVILLE SC ZIP CODE 29601 3552

2 EXTREMELY URGENT DELIVERY TO
NAME Sample receiving TELEPHONE (412) 963-7058
COMPANY Test America Pittsburgh DEPT./FLR. Residential

Uncorrected temp 0.2 °C
Thermometer ID 12
CF 0 Initials TS

PT-WI-SR-001 effective 7/26/13

3 WEIGHT LTR PAK

5 TYPE OF SERVICE
- [x] NEXT DAY AIR
- [ ] EXPRESS (INT'L)

FOR INTERNATIONAL SHIPMENTS $ CUSTOMS VALUE
- [ ] DOCUMENTS ONLY

6 OPTIONAL SERVICES
- [ ] SATURDAY PICKUP See instructions.
- [ ] SATURDAY DELIVERY See instructions.
- [ ] DECLARED VALUE FOR CARRIAGE For declared value over $100, see instructions. $ AMOUNT
- [ ] C.O.D. If C.O.D. enter amount to be collected and attach completed UPS C.O.D. tag to package. $ AMOUNT

7 ADDITIONAL HANDLING CHARGE
- [ ] An Additional Handling Charge applies for certain items. See instructions.

TOTAL CHARGES $

8 METHOD OF PAYMENT
- [ ] BILL SHIPPER'S ACCOUNT NUMBER In Section 1
- [ ] BILL RECEIVER
- [x] BILL THIRD PARTY (Domestic Only; Record Account No. In Section 9)
- [ ] CREDIT CARD American Express, Diner's Club, MasterCard, Visa
- CHEC…

9 RECEIVER'S/THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.
0 1 5 6 4 3

THIRD PARTY'S COMPANY NAME HALEY & ALDRICH,INC.
STREET ADDRESS 465 MEDFORD ST RM: 2200
CITY AND STATE …RLESTOWN MA ZIP CODE 02129

UPS to act as forwarding agent for export control and customs purposes. Shipper certifies that these commodities, … United States, were exported in accordance with the Export Administration Regulations. Diversion contrary to law …

…URE X Sean Lewis DATE OF … 8/…

…s are subject to the terms contained in the UPS Tariff/Terms and … Service, which are available at UPS.com and local UPS offices.

1202609 6/14 RRD

180-68950 Waybill

TestAmerica Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone (412) 963-7058 Fax (412) 963-2468

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Bortot, Veronica	Carrier Tracking No(s):	COC No: 180-295256.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: veronica.bortot@testamericainc.com	State of Origin: Indiana	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note):		Job #: 180-68950-1
Address: 4955 Yarrow Street,	Due Date Requested: 8/16/2017	**Analysis Requested**		**Preservation Codes:**
City: Arvada	TAT Requested (days):			
State, Zip: CO, 80002				
Phone: 303-736-0100(Tel) 303-431-7171(Fax)	PO #:			
Email:	WO #:			
Project Name: Vectren Groundwater and Soil Sampling	Project #: 18017692			
Site:	SSOW#:			

Preservation Codes:
A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA
M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - pH 4-5, Z - other (specify)
Other:

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	Se_SPEC/FIELD_FLTRD As (III) and As (V), Dissolved (field fi	Total Number of containers	Special Instructions/Note:
				Preservation Code:					
SW-A (180-68950-6)	8/3/17	10:35 Eastern		Water			X	1	
SW-B (180-68950-7)	8/3/17	09:20 Eastern		Water			X	1	
SW-C (180-68950-8)	8/3/17	09:45 Eastern		Water			X	1	
SW-D (180-68950-9)	8/3/17	10:15 Eastern		Water			X	1	
PW-1-A (180-68950-10)	8/2/17	10:45 Eastern		Water			X	1	
PW-1-B (180-68950-11)	8/2/17	12:25 Eastern		Water			X	1	
PW-2-A (180-68950-12)	8/2/17	14:20 Eastern		Water			X	1	
PW-2-B (180-68950-13)	8/3/17	08:31 Eastern		Water			X	1	

Note: Since laboratory accreditations are subject to change, TestAmerica Laboratories, Inc. places the ownership of method, analyte & accreditation compliance upon out subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to TestAmerica Laboratories, Inc. attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said complicance to TestAmerica Laboratories, Inc.

Possible Hazard Identification
Unconfirmed

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For ______ Months*

Deliverable Requested: I, II, III, IV, Other (specify) — Primary Deliverable Rank: 2
Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:		
Relinquished by: [signature]	Date/Time: 8-7-17 1700	Company: TA PIT	Received by: Reed [signature]	Date/Time: 8-8-17 0850	Company: TAD
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No | Custody Seal No.: | Cooler Temperature(s) °C and Other Remarks: 2.6 IR#7 +0.1 transfer RP 8-8-17

Login Sample Receipt Checklist

Client: Haley & Aldrich, Inc.

Job Number: 180-68950-1

Login Number: 68950
List Number: 1
Creator: Neri, Tom

List Source: TestAmerica Pittsburgh

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: Haley & Aldrich, Inc. Job Number: 180-68950-1

Login Number: 68950
List Number: 2
Creator: Pottruff, Reed W

List Source: TestAmerica Denver
List Creation: 08/08/17 12:48 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	N/A	Received project as a subcontract.
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Pittsburgh
301 Alpha Drive
RIDC Park
Pittsburgh, PA 15238
Tel: (412)963-7058

TestAmerica Job ID: 180-69382-2

Client Project/Site: CCR Groundwater Monitoring FB Culley

For:
Vectren Corporation
PO BOX 209
Evansville, Indiana 47702

Attn: Lisa Messinger

Authorized for release by:
9/18/2017 11:28:13 AM

Veronica Bortot, Senior Project Manager
(412)963-2435
veronica.bortot@testamericainc.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

1 2 3 4 5 6 7 8 9 10 11 12 13

Table of Contents

Job ID: 180-69382-2

Laboratory: TestAmerica Pittsburgh

Narrative

Job Narrative
180-69382-2

Comments
No additional comments.

Receipt
The samples were received on 8/16/2017 9:00 AM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 3.8º C.

RAD
Method(s) PrecSep_0: Radium 228 Prep Batch 160-323471
Insufficient sample volume was available to perform a sample duplicate (DU). A laboratory control sample/ laboratory control sample duplicate (LCS/LCSD) were prepared instead to demonstrate batch precision.
CCR-AP-8 (180-69382-1)

Method(s) PrecSep_0: Radium 228 Prep Batch 160-323471
The following sample was reduced due to limited volume.

CCR-AP-8 (180-69382-1)

Method(s) PrecSep_0: Radium 228 Prep Batch 160-323579
The following sample was reduced due to limited volume. The sample was also murky and gray in color due to heavy amounts of sediment.

CCR-AP-9 (180-69382-2)

Method(s) PrecSep-21: Radium 226 Prep Batch 160-323456
Insufficient sample volume was available to perform a sample duplicate (DU). A laboratory control sample/ laboratory control sample duplicate (LCS/LCSD) were prepared instead to demonstrate batch precision.
CCR-AP-8 (180-69382-1)

Method(s) PrecSep-21: Radium 226 Prep Batch 160-323456
the following sample was reduced due to limited volume.

CCR-AP-8 (180-69382-1)

Method(s) PrecSep-21: Radium 226 Prep Batch 160-323575
The following sample was reduced due to limited volume. The sample was also murky and gray in color due to heavy amounts of sediment.

CCR-AP-9 (180-69382-2)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Qualifiers

Rad

Qualifier	Qualifier Description
U	Result is less than the sample detection limit.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Accreditation/Certification Summary

Client: Vectren Corporation TestAmerica Job ID: 180-69382-2
Project/Site: CCR Groundwater Monitoring FB Culley

Laboratory: TestAmerica Pittsburgh

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
A2LA	A2LA		PA00164	07-31-18
Arkansas DEQ	State Program	6	88-0690	06-27-18
California	State Program	9	2891	03-31-18
Connecticut	State Program	1	PH-0688	09-30-18
Florida	NELAP	4	E871008	06-30-18
Illinois	NELAP	5	200005	06-30-18
Kansas	NELAP	7	E-10350	01-31-18
Louisiana	NELAP	6	04041	06-30-18
Nevada	State Program	9	PA00164	07-31-18
New Hampshire	NELAP	1	2030	04-04-18
New Jersey	NELAP	2	PA005	06-30-18
New York	NELAP	2	11182	03-31-18
North Carolina (WW/SW)	State Program	4	434	12-31-17
Pennsylvania	NELAP	3	02-00416	04-30-18
South Carolina	State Program	4	89014	04-30-18
Texas	NELAP	6	T104704528-15-2	03-31-18
US Fish & Wildlife	Federal		LE94312A-1	07-31-18
USDA	Federal		P330-16-00211	06-26-19
Utah	NELAP	8	PA001462015-4	05-31-18
Virginia	NELAP	3	460189	09-14-17 *
West Virginia DEP	State Program	3	142	01-31-18
Wisconsin	State Program	5	998027800	08-31-18

Laboratory: TestAmerica St. Louis

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
Alaska	State Program	10	MO00054	06-30-18
California	State Program	9	2886	03-31-18 *
Connecticut	State Program	1	PH-0241	03-31-19
Florida	NELAP	4	E87689	06-30-18
Illinois	NELAP	5	200023	11-30-17
Iowa	State Program	7	373	02-01-18
Kansas	NELAP	7	E-10236	10-31-17 *
Kentucky (DW)	State Program	4	90125	12-31-17
L-A-B	DoD ELAP		L2305	04-06-19
Louisiana	NELAP	6	04080	06-30-18
Louisiana (DW)	NELAP	6	LA170011	12-31-17
Maryland	State Program	3	310	09-30-18
Missouri	State Program	7	780	06-30-18
Nevada	State Program	9	MO000542017-1	07-31-18
New Jersey	NELAP	2	MO002	06-30-18
New York	NELAP	2	11616	03-31-18
North Dakota	State Program	8	R207	06-30-17 *
NRC	NRC		24-24817-01	12-31-22
Oklahoma	State Program	6	9997	08-31-18
Pennsylvania	NELAP	3	68-00540	02-21-18
South Carolina	State Program	4	85002001	06-30-17 *
Texas	NELAP	6	T104704193-17-11	07-31-18
US Fish & Wildlife	Federal		058448	08-31-18

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Laboratory: TestAmerica St. Louis (Continued)

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
USDA	Federal		P330-17-0028	02-02-20
Utah	NELAP	8	MO000542016-8	07-31-18
Virginia	NELAP	3	460230	06-14-18
Washington	State Program	10	C592	08-30-18
West Virginia DEP	State Program	3	381	08-31-18

Sample Summary

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
180-69382-1	CCR-AP-8	Water	08/15/17 12:00	08/16/17 09:00
180-69382-2	CCR-AP-9	Water	08/15/17 12:40	08/16/17 09:00

Method Summary

Method	Method Description	Protocol	Laboratory
9315	Radium-226 (GFPC)	SW846	TAL SL
9320	Radium-228 (GFPC)	SW846	TAL SL
Ra226_Ra228	Combined Radium-226 and Radium-228	TAL-STL	TAL SL

Protocol References:

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

TAL-STL = TestAmerica Laboratories, St. Louis, Facility Standard Operating Procedure.

Laboratory References:

TAL SL = TestAmerica St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Client Sample ID: CCR-AP-8

Lab Sample ID: 180-69382-1

Date Collected: 08/15/17 12:00

Matrix: Water

Date Received: 08/16/17 09:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	PrecSep-21			750.88 mL	1.0 g	323456	08/22/17 08:55	LDE	TAL SL
Total/NA	Analysis	9315		1	1.0 mL	1.0 mL	327005	09/13/17 06:16	RTM	TAL SL
	Instrument ID: GFPCPURPLE									
Total/NA	Prep	PrecSep_0			750.88 mL	1.0 g	323471	08/22/17 09:25	LDE	TAL SL
Total/NA	Analysis	9320		1			325012	08/30/17 13:52	RTM	TAL SL
	Instrument ID: GFPCPURPLE									
Total/NA	Analysis	Ra226_Ra228		1			327331	09/14/17 15:15	RTM	TAL SL
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-9

Lab Sample ID: 180-69382-2

Date Collected: 08/15/17 12:40

Matrix: Water

Date Received: 08/16/17 09:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	PrecSep-21			749.12 mL	1.0 g	323575	08/23/17 07:47	LDE	TAL SL
Total/NA	Analysis	9315		1			327140	09/14/17 09:24	RTM	TAL SL
	Instrument ID: GFPCORANGE									
Total/NA	Prep	PrecSep_0			749.12 mL	1.0 g	323579	08/23/17 08:07	LDE	TAL SL
Total/NA	Analysis	9320		1			325254	08/31/17 10:53	ALD	TAL SL
	Instrument ID: GFPCORANGE									
Total/NA	Analysis	Ra226_Ra228		1			327331	09/14/17 15:15	RTM	TAL SL
	Instrument ID: NOEQUIP									

Laboratory References:

TAL SL = TestAmerica St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Analyst References:

Lab: TAL SL

Batch Type: Prep

LDE = Larissa Ehlert

Batch Type: Analysis

ALD = Amanda Dick

RTM = Rachel Mueller

Client Sample ID: CCR-AP-8 Lab Sample ID: 180-69382-1

Date Collected: 08/15/17 12:00 **Matrix: Water**
Date Received: 08/16/17 09:00

Method: 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	**0.513**		0.135	0.143	1.00	0.103	pCi/L	08/22/17 08:55	09/13/17 06:16	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*101*		*40 - 110*	*08/22/17 08:55*	*09/13/17 06:16*	*1*

Method: 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.316	U	0.304	0.305	1.00	0.492	pCi/L	08/22/17 09:25	08/30/17 13:52	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*101*		*40 - 110*	*08/22/17 09:25*	*08/30/17 13:52*	*1*
Y Carrier	*89.0*		*40 - 110*	*08/22/17 09:25*	*08/30/17 13:52*	*1*

Method: Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	**0.829**		0.333	0.337	5.00	0.492	pCi/L		09/14/17 15:15	1

Client Sample ID: CCR-AP-9 Lab Sample ID: 180-69382-2

Date Collected: 08/15/17 12:40 **Matrix: Water**
Date Received: 08/16/17 09:00

Method: 9315 - Radium-226 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	**1.68**		0.264	0.304	1.00	0.104	pCi/L	08/23/17 07:47	09/14/17 09:24	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*83.5*		*40 - 110*	*08/23/17 07:47*	*09/14/17 09:24*	*1*

Method: 9320 - Radium-228 (GFPC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	**1.45**		0.463	0.482	1.00	0.631	pCi/L	08/23/17 08:07	08/31/17 10:53	1

Carrier	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*83.5*		*40 - 110*	*08/23/17 08:07*	*08/31/17 10:53*	*1*
Y Carrier	*88.2*		*40 - 110*	*08/23/17 08:07*	*08/31/17 10:53*	*1*

Client Sample Results

Client: Vectren Corporation
Project/Site: CCR Groundwater Monitoring FB Culley

TestAmerica Job ID: 180-69382-2

Client Sample ID: CCR-AP-9
Date Collected: 08/15/17 12:40
Date Received: 08/16/17 09:00

Lab Sample ID: 180-69382-2
Matrix: Water

Method: Ra226_Ra228 - Combined Radium-226 and Radium-228

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Combined Radium 226 + 228	3.13		0.533	0.570	5.00	0.631	pCi/L		09/14/17 15:15	1

Method: 9315 - Radium-226 (GFPC)

Lab Sample ID: MB 160-323456/1-A — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 327005 — **Prep Batch: 323456**

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.01009	U	0.0485	0.0485	1.00	0.0976	pCi/L	08/22/17 08:55	09/13/17 06:16	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*104*		*40 - 110*	*08/22/17 08:55*	*09/13/17 06:16*	*1*

Lab Sample ID: LCS 160-323456/2-A — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 327005 — **Prep Batch: 323456**

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits
Radium-226	12.8	11.59		1.20	1.00	0.0845	pCi/L	91	68 - 137

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*107*		*40 - 110*

Lab Sample ID: LCSD 160-323456/3-A — **Client Sample ID: Lab Control Sample Dup**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 327005 — **Prep Batch: 323456**

Analyte	Spike Added	LCSD Result	LCSD Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits	RER	RER Limit
Radium-226	12.8	12.31		1.26	1.00	0.0983	pCi/L	96	68 - 137	0.29	1

Carrier	*LCSD %Yield*	*LCSD Qualifier*	*Limits*
Ba Carrier	*104*		*40 - 110*

Lab Sample ID: MB 160-323575/1-A — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 327140 — **Prep Batch: 323575**

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.03629	U	0.0475	0.0476	1.00	0.0789	pCi/L	08/23/17 07:47	09/14/17 09:24	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*88.5*		*40 - 110*	*08/23/17 07:47*	*09/14/17 09:24*	*1*

Lab Sample ID: LCS 160-323575/2-A — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 327140 — **Prep Batch: 323575**

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits
Radium-226	9.60	10.38		1.08	1.00	0.0938	pCi/L	108	68 - 137

Method: 9315 - Radium-226 (GFPC) (Continued)

Lab Sample ID: LCS 160-323575/2-A | **Client Sample ID: Lab Control Sample**
Matrix: Water | **Prep Type: Total/NA**
Analysis Batch: 327140 | **Prep Batch: 323575**

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*91.7*		*40 - 110*

Method: 9320 - Radium-228 (GFPC)

Lab Sample ID: MB 160-323471/1-A | **Client Sample ID: Method Blank**
Matrix: Water | **Prep Type: Total/NA**
Analysis Batch: 325012 | **Prep Batch: 323471**

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.07831	U	0.252	0.252	1.00	0.439	pCi/L	08/22/17 09:25	08/30/17 13:52	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*104*		*40 - 110*	*08/22/17 09:25*	*08/30/17 13:52*	*1*
Y Carrier	*87.5*		*40 - 110*	*08/22/17 09:25*	*08/30/17 13:52*	*1*

Lab Sample ID: LCS 160-323471/2-A | **Client Sample ID: Lab Control Sample**
Matrix: Water | **Prep Type: Total/NA**
Analysis Batch: 325012 | **Prep Batch: 323471**

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits
Radium-228	17.3	17.89		1.90	1.00	0.451	pCi/L	103	56 - 140

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*107*		*40 - 110*
Y Carrier	*89.0*		*40 - 110*

Lab Sample ID: LCSD 160-323471/3-A | **Client Sample ID: Lab Control Sample Dup**
Matrix: Water | **Prep Type: Total/NA**
Analysis Batch: 325012 | **Prep Batch: 323471**

Analyte	Spike Added	LCSD Result	LCSD Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits	RER	RER Limit
Radium-228	17.3	18.70		2.00	1.00	0.460	pCi/L	108	56 - 140	0.21	1

Carrier	*LCSD %Yield*	*LCSD Qualifier*	*Limits*
Ba Carrier	*104*		*40 - 110*
Y Carrier	*83.7*		*40 - 110*

Lab Sample ID: MB 160-323579/1-A | **Client Sample ID: Method Blank**
Matrix: Water | **Prep Type: Total/NA**
Analysis Batch: 325254 | **Prep Batch: 323579**

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	0.6516		0.282	0.288	1.00	0.406	pCi/L	08/23/17 08:07	08/31/17 10:53	1

Carrier	*MB %Yield*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Ba Carrier	*88.5*		*40 - 110*	*08/23/17 08:07*	*08/31/17 10:53*	*1*
Y Carrier	*88.2*		*40 - 110*	*08/23/17 08:07*	*08/31/17 10:53*	*1*

Lab Sample ID: LCS 160-323579/2-A
Matrix: Water
Analysis Batch: 325254

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 323579

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits
Radium-228	13.0	13.50		1.46	1.00	0.336	pCi/L	104	56 - 140

Carrier	*LCS %Yield*	*LCS Qualifier*	*Limits*
Ba Carrier	*91.7*		*40 - 110*
Y Carrier	*91.2*		*40 - 110*

Rad

Prep Batch: 323456

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-69382-1	CCR-AP-8	Total/NA	Water	PrecSep-21	
MB 160-323456/1-A	Method Blank	Total/NA	Water	PrecSep-21	
LCS 160-323456/2-A	Lab Control Sample	Total/NA	Water	PrecSep-21	
LCSD 160-323456/3-A	Lab Control Sample Dup	Total/NA	Water	PrecSep-21	

Prep Batch: 323471

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-69382-1	CCR-AP-8	Total/NA	Water	PrecSep_0	
MB 160-323471/1-A	Method Blank	Total/NA	Water	PrecSep_0	
LCS 160-323471/2-A	Lab Control Sample	Total/NA	Water	PrecSep_0	
LCSD 160-323471/3-A	Lab Control Sample Dup	Total/NA	Water	PrecSep_0	

Prep Batch: 323575

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-69382-2	CCR-AP-9	Total/NA	Water	PrecSep-21	
MB 160-323575/1-A	Method Blank	Total/NA	Water	PrecSep-21	
LCS 160-323575/2-A	Lab Control Sample	Total/NA	Water	PrecSep-21	

Prep Batch: 323579

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-69382-2	CCR-AP-9	Total/NA	Water	PrecSep_0	
MB 160-323579/1-A	Method Blank	Total/NA	Water	PrecSep_0	
LCS 160-323579/2-A	Lab Control Sample	Total/NA	Water	PrecSep_0	

TestAmerica Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone (412) 963-7058 Fax (412) 963-2468

Chain of Custody Record

COLUMBUS
240507

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information

Client Contact: Lisa Messinger	Sampler: J. Winsett	Lab PM: Bortot, Veronica	Carrier Tracking No(s):
	Phone: (812) 228-9422	E-Mail: veronica.bortot@testamericainc.com	
Company: Vectren Corporation			
Address: PO BOX 209	Due Date Requested:		
City: Evansville	TAT Requested (days):		
State, Zip: IN, 47702			
Phone:	PO #: Purchase Order Requested		
Email: lmessinger@vectren.com	WO #:		
Project Name: CCR Groundwater Monitoring Fb Culley	Project #: 18016014		
Site: FB Culley	SSOW#:		

COC No: 180-39023-8128.1
Page: Page 1 of 1
Job #: ATC: 170600367

Analysis Requested

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9040C, 9056A_ORGFM_28D	6010C, 6020A, 7470A	2540C_Calcd - Local Method	9316_Ra226, 9320_Ra228	Total Number of containers	Special Instructions/Note:
			Preservation Code:				N	D	N	D		
CCR-AP-8	8/15/17	1200	G	Water			|	|	|	|		
CCR-AP-9	↓	1240	G	Water								

180-69382 Chain of Custody

COLUMBUS
240507

Preservation Codes:

A - HCL
B - NaOH
C - Zn Acetate
D - Nitric Acid
E - NaHSO4
F - MeOH
G - Amchlor
H - Ascorbic Acid
I - Ice
J - DI Water
K - EDTA
L - EDA
M - Hexane
N - None
O - AsNaO2
P - Na2O4S
Q - Na2SO3
R - Na2S2O3
S - H2SO4
T - TSP Dodecahydrate
U - Acetone
V - MCAA
W - pH 4-5
Z - other (specify)

Other:

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☒ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☐ Disposal By Lab ☐ Archive For ______ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by	Date/Time	Company	Received by	Date/Time	Company
Jacob Winsett	8/15/17 3:00 pm	ATC	Fed Ex	8/15/17	Fed Ex
			[signature]	8/16/17 0900	TA[signature]

Custody Seals Intact: Δ Yes Δ No
Custody Seal No.:
Cooler Temperature(s) °C and Other Remarks:

ORIGIN ID:EVVA (812) 477-1176
BRIAN KLEEMAN

6149 WEDEKING AVENUE
BUILDING D, SUITE 2
EVANSVILLE, IN 47715
UNITED STATES US

SHIP DATE: 15AUG17
ACTWGT: 40.00 LB
CAD: 106997842/INET3920
DIMS: 23x13x13 IN

BILL SENDER

TO **VERONICA BORTOT**
TESTAMERICA
301 ALPHA DRIVE

PITTSBURGH PA 15238
(412) 963-7058
INV:
DEPT:

180-69382 Waybill

549J1/577E/104C

FedEx Express

J172017062901uv

TRK# 0201 **7799 9809 7683**

WED - 16 AUG 3:00P
STANDARD OVERNIGHT

NA AGCA

15238
PA-US **PIT**

Uncorrected temp 3.8 °C
Thermometer ID 12
CF +/-0 Initials JW

PT-WI-SR-001 effective 7/26/13

After printing this label:
1. Use the 'Print' button on this page to print your label to your laser or inkjet printer.
2. Fold the printed page along the horizontal line.
3. Place label in shipping pouch and affix it to your shipment so that the barcode portion of the label can be read and scanned.

Warning: Use only the printed original label for shipping. Using a photocopy of this label for shipping purposes is fraudulent and could result in additional billing charges, along with the cancellation of your FedEx account number.
Use of this system constitutes your agreement to the service conditions in the current FedEx Service Guide, available on fedex.com.FedEx will not be responsible for any claim in excess of $100 per package, whether the result of loss, damage, delay, non-delivery,misdelivery,or misinformation, unless you declare a higher value, pay an additional charge, document your actual loss and file a timely claim.Limitations found in the current FedEx Service Guide apply. Your right to recover from FedEx for any loss, including intrinsic value of the package, loss of sales, income interest, profit, attorney's fees, costs, and other forms of damage whether direct, incidental,consequential, or special is limited to the greater of $100 or the authorized declared value. Recovery cannot exceed actual documented loss.Maximum for items of extraordinary value is $1,000, e.g. jewelry, precious metals, negotiable instruments and other items listed in our ServiceGuide. Written claims must be filed within strict time limits, see current FedEx Service Guide.

TestAmerica Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone (412) 963-7058 Fax (412) 963-2468

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Bortot, Veronica	Carrier Tracking No(s):	COC No: 180-296967.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: veronica.bortot@testamericainc.com	State of Origin: Indiana	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note):		Job #: 180-69382-2
Address: 13715 Rider Trail North,	Due Date Requested: 9/18/2017			
City: Earth City	TAT Requested (days):			
State, Zip: MO, 63045				
Phone: 314-298-8566(Tel) 314-298-8757(Fax)	PO #:			
Email:	WO #:			
Project Name: CCR Groundwater Monitoring FB Culley	Project #: 18016014			
Site:	SSOW#:			

Analysis Requested

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	Ra226Ra228_GFPC	9315_Ra226/PrecSep_21 Standard Target List	9320_Ra228/PrecSep_0 Standard Target List	Total Number of containers	Special Instructions/Note:
			Preservation Code:								
CCR-AP-8 (180-69382-1)	8/15/17	12:00 Eastern		Water			X	X	X	1	
CCR-AP-9 (180-69382-2)	8/15/17	12:40 Eastern		Water			X	X	X	1	

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Note: Since laboratory accreditations are subject to change, TestAmerica Laboratories, Inc. places the ownership of method, analyte & accreditation compliance upon out subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to TestAmerica Laboratories, Inc. attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said complicance to TestAmerica Laboratories, Inc.

Possible Hazard Identification
Unconfirmed

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ______ *Months*

Deliverable Requested: I, II, III, IV, Other (specify) — Primary Deliverable Rank: 2

Special Instructions/QC Requirements:

Empty Kit Relinquished by:		Date:		Time:		Method of Shipment:	
Relinquished by: [signature]	Date/Time: 8/17/17 1700	Company: [signature]		Received by: [signature]	Date/Time: 8·18·17 0850	Company: TASR	
Relinquished by:	Date/Time:	Company		Received by:	Date/Time:	Company	
Relinquished by:	Date/Time:	Company		Received by:	Date/Time:	Company	

Custody Seals Intact: Δ Yes Δ No | Custody Seal No.: | Cooler Temperature(s) °C and Other Remarks:

Login Sample Receipt Checklist

Client: Vectren Corporation

Job Number: 180-69382-2

Login Number: 69382
List Number: 1
Creator: Neri, Tom

List Source: TestAmerica Pittsburgh

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: Vectren Corporation | Job Number: 180-69382-2

Login Number: 69382
List Number: 2
Creator: Clarke, Jill C

List Source: TestAmerica St. Louis
List Creation: 08/18/17 11:38 AM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	N/A	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	18.0
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	False	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	Added nitric acid, lot # 929870, to Sample # 1. Corrected pH to < 2.
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Pittsburgh
301 Alpha Drive
RIDC Park
Pittsburgh, PA 15238
Tel: (412)963-7058

TestAmerica Job ID: 180-84236-1
Client Project/Site: Vectren ASD Sampling - FB Culley

For:
Haley & Aldrich, Inc.
400 Augusta Street
Suite 130
Greenville, South Carolina 29601

Attn: Sean Lewis

Authorized for release by:
1/31/2019 2:19:10 PM

Veronica Bortot, Senior Project Manager
(412)963-2435
veronica.bortot@testamericainc.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

PA Lab ID: 02-00416

Table of Contents

Job ID: 180-84236-1

Laboratory: TestAmerica Pittsburgh

Narrative

Job Narrative
180-84236-1

Comments
No additional comments.

Receipt
The samples were received on 11/21/2018 10:00 AM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperatures of the 4 coolers at receipt time were 2.7º C, 3.7º C, 4.9º C and 5.5º C.

Receipt Exceptions

One of the total TOC vials was received broken. CCR-AP-5 (180-84236-2).

GC Semi VOA
Method(s) Lloyd Kahn: Please note that the reporting limit for Lloyd Kahn TOC analysis is a nominal value and does not reflect adjustments in sample mass processed on an individual basis.

CCR-AP-8I (68-70) (180-84236-10), CCR-AP-6I (68-70) (180-84236-11), HASB-1 (35-38) (180-84236-12), (LCS 180-263935/28), (MB 180-263935/27), (240-104562-Q-2), (240-104562-B-2 DU), (240-104562-B-2 MS) and (240-104562-B-2 MSD)

Method(s) Lloyd Kahn: A deviation from the Standard Operating Procedure (SOP) occurred. Details are as follows: Due to an autosampler malfunction the CCV that normally starts the sequence was not injected. The passing LCS is analyzed before any samples so analyst believes this should suffice for a standard starting the sequence. The other CCVs in the sequence also pass proving the calibration curve still is effective.

Method(s) Lloyd Kahn: The matrix spike / matrix spike duplicate (MS/MSD) precision for analytical batch 180-264051 was outside control limits. Sample non-homogeneity is suspected. Analyst notes that the sample in the MSD jar had a different color and general appearance to the original and MS samples.

Method(s) Lloyd Kahn: Please note that the reporting limit for Lloyd Kahn TOC analysis is a nominal value and does not reflect adjustments in sample mass processed on an individual basis.

CCR-AP-8I (68-70) (180-84236-10), CCR-AP-6I (68-70) (180-84236-11), HASB-1 (35-38) (180-84236-12), (240-104562-P-2), (240-104562-B-2 DU), (240-104562-B-2 MS) and (240-104562-B-2 MSD)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Metals
Method(s) 6020A: The following sample was diluted to bring the concentration of manganese within the calibration range: CCR-AP-2 (180-84236-1). Elevated reporting limits (RLs) are provided.

Method(s) 7470A: Insufficient sample volume was available to perform a matrix spike/matrix spike duplicate (MS/MSD) associated with preparation batch 180-263760, 180-263760 and 180-263948.

Method(s) 7470A: The continuing calibration verification (CCV) associated with batch 180-264124 recovered above the upper control limit for Mercury. The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported.

Method(s) Se Speciation
No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

General Chemistry
Method(s) SM 5310C: The RPD between the duplicate analyses was >10%. The difference between the results was less than the reporting limit, therefore the results are reported with this NCM

Job ID: 180-84236-1 (Continued)

Laboratory: TestAmerica Pittsburgh (Continued)

HASB-1 (180-84236-9)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

TCLP

No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Qualifiers

HPLC/IC

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

Metals

Qualifier	Qualifier Description
B	Compound was found in the blank and sample.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
^	ICV,CCV,ICB,CCB, ISA, ISB, CRI, CRA, DLCK or MRL standard: Instrument related QC is outside acceptance limits.
F1	MS and/or MSD Recovery is outside acceptance limits.

General Chemistry

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

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Laboratory: TestAmerica Pittsburgh

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
Arkansas DEQ	State Program	6	88-0690	06-27-19
California	State Program	9	2891	04-30-19
Connecticut	State Program	1	PH-0688	09-30-20
Florida	NELAP	4	E871008	06-30-19
Illinois	NELAP	5	200005	06-30-19
Kansas	NELAP	7	E-10350	01-31-19 *
Louisiana	NELAP	6	04041	06-30-19
Nevada	State Program	9	PA00164	07-31-19
New Hampshire	NELAP	1	2030	04-04-19
New Jersey	NELAP	2	PA005	06-30-19
New York	NELAP	2	11182	03-31-19
North Carolina (WW/SW)	State Program	4	434	12-31-19
Oregon	NELAP	10	PA-2151	01-28-19 *
Pennsylvania	NELAP	3	02-00416	04-30-19
South Carolina	State Program	4	89014	04-30-19
Texas	NELAP	6	T104704528-15-2	03-31-19
US Fish & Wildlife	Federal		LE94312A-1	07-31-19
USDA	Federal		P330-16-00211	06-26-19
Utah	NELAP	8	PA001462015-4	05-31-19
Virginia	NELAP	3	460189	09-14-19
West Virginia DEP	State Program	3	142	01-31-20
Wisconsin	State Program	5	998027800	08-31-19

Laboratory: TestAmerica Denver

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
A2LA	DoD ELAP		2907.01	10-31-19
A2LA	ISO/IEC 17025		2907.01	10-31-19
Alabama	State Program	4	40730	09-30-12 *
Alaska (UST)	State Program	10	UST-30	02-28-19
Arizona	State Program	9	AZ0713	12-20-19
Arkansas DEQ	State Program	6	88-0687	06-01-19
California	State Program	9	2513	01-18-19 *
Connecticut	State Program	1	PH-0686	09-30-20
Florida	NELAP	4	E87667	06-30-19
Georgia	State Program	4	N/A	01-08-20
Illinois	NELAP	5	200017	04-30-19
Iowa	State Program	7	370	12-01-20
Kansas	NELAP	7	E-10166	04-30-19
Louisiana	NELAP	6	02096	06-30-19
Maine	State Program	1	CO0002	03-03-19
Minnesota	NELAP	5	8-999-405	12-31-19
Nevada	State Program	9	CO0026	07-31-19
New Hampshire	NELAP	1	205310	04-28-19
New Jersey	NELAP	2	CO004	06-30-19
New York	NELAP	2	11964	04-01-19
North Carolina (WW/SW)	State Program	4	358	12-31-19
North Dakota	State Program	8	R-034	01-08-19 *
Oklahoma	State Program	6	8614	08-31-19

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Laboratory: TestAmerica Denver (Continued)

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
Pennsylvania	NELAP	3	68-00664	07-31-19
South Carolina	State Program	4	72002001	01-08-19 *
Texas	NELAP	6	T104704183-18-15	09-30-19
US Fish & Wildlife	Federal			07-31-19
USDA	Federal			03-26-21
Utah	NELAP	8	CO00026	07-31-19
Virginia	NELAP	3	460232	06-14-19
Washington	State Program	10	C583	08-03-19
West Virginia DEP	State Program	3	354	01-31-19
Wisconsin	State Program	5	999615430	08-31-19 *
Wyoming (UST)	A2LA	8	2907.01	10-31-19

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Sample Summary

Client: Haley & Aldrich, Inc.
Project/Site: Vectren ASD Sampling - FB Culley

TestAmerica Job ID: 180-84236-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
180-84236-1	CCR-AP-2	Water	11/15/18 09:25	11/21/18 10:00
180-84236-2	CCR-AP-5	Water	11/15/18 11:46	11/21/18 10:00
180-84236-3	CCR-AP-4	Water	11/15/18 15:00	11/21/18 10:00
180-84236-4	CCR-AP-8	Water	11/16/18 09:02	11/21/18 10:00
180-84236-5	CCR-AP-3	Water	11/16/18 10:37	11/21/18 10:00
180-84236-6	CCR-AP-6	Water	11/17/18 10:01	11/21/18 10:00
180-84236-7	CCR-AP-6I	Water	11/17/18 14:27	11/21/18 10:00
180-84236-8	CCR-AP-8I	Water	11/17/18 15:47	11/21/18 10:00
180-84236-9	HASB-1	Water	11/17/18 16:36	11/21/18 10:00
180-84236-10	CCR-AP-8I (68-70)	Solid	11/15/18 09:10	11/21/18 10:00
180-84236-11	CCR-AP-6I (68-70)	Solid	11/16/18 09:25	11/21/18 10:00
180-84236-12	HASB-1 (35-38)	Solid	11/16/18 15:50	11/21/18 10:00

Method Summary

Client: Haley & Aldrich, Inc.
Project/Site: Vectren ASD Sampling - FB Culley

TestAmerica Job ID: 180-84236-1

Method	Method Description	Protocol	Laboratory
EPA 9056A	Anions, Ion Chromatography	SW846	TAL PIT
6020A	SPLP Metals	SW846	TAL PIT
7470A	SPLP Mercury	SW846	TAL PIT
EPA 6020A	Metals (ICP/MS)	SW846	TAL PIT
EPA 7470A	Mercury (CVAA)	SW846	TAL PIT
EPA 7471B	Mercury (CVAA)	SW846	TAL PIT
Se Speciation	Selenium Speciation	None	TAL DEN
2540G	SM 2540G	SM22	TAL PIT
EPA 350.1	Nitrogen, Ammonia	EPA	TAL PIT
EPA-Lloyd Kahn	Organic Carbon, Total (TOC)	EPA	TAL PIT
SM 2540C	Solids, Total Dissolved (TDS)	SM	TAL PIT
SM 5310C	Organic Carbon, Dissolved (DOC)	SM	TAL PIT
SM 5310C	Total Organic Carbon	SM	TAL PIT
SM2320 B	Alkalinity, Total	SM18	TAL PIT
1312	SPLP Extraction	SW846	TAL PIT
3005A	Preparation, Total Recoverable or Dissolved Metals	SW846	TAL PIT
3010A	Preparation, Total Metals	SW846	TAL PIT
3050B	Preparation, Metals	SW846	TAL PIT
7470A	Preparation, Mercury	SW846	TAL PIT
7471B	Preparation, Mercury	SW846	TAL PIT
Distill/Ammonia	Distillation, Ammonia	None	TAL PIT
EPA 1312	SPLP Extraction	SW846	TAL PIT

Protocol References:

EPA = US Environmental Protection Agency

None = None

SM = "Standard Methods For The Examination Of Water And Wastewater"

SM18 = "Standard Methods For The Examination Of Water And Wastewater", 18th Edition, 1992.

SM22 = Standard Methods For The Examination Of Water And Wastewater, 22nd Edition

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL DEN = TestAmerica Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100

TAL PIT = TestAmerica Pittsburgh, 301 Alpha Drive, RIDC Park, Pittsburgh, PA 15238, TEL (412)963-7058

Client Sample ID: CCR-AP-2 Lab Sample ID: 180-84236-1

Date Collected: 11/15/18 09:25 **Matrix: Water**
Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Analysis	EPA 9056A		1			264318	12/03/18 07:04	MJH	TAL PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		1			264317	12/03/18 07:39	MJH	TAL PIT
	Instrument ID: CHIC2100A									
Total/NA	Analysis	EPA 9056A		10			264317	12/03/18 07:55	MJH	TAL PIT
	Instrument ID: CHIC2100A									
Dissolved	Prep	3005A			50.0 mL	50.0 mL	263656	11/23/18 13:00	RSK	TAL PIT
Dissolved	Analysis	EPA 6020A		1			263680	11/24/18 11:57	RSK	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50.0 mL	50.0 mL	263656	11/23/18 13:00	RSK	TAL PIT
Total Recoverable	Analysis	EPA 6020A		10			263680	11/24/18 10:33	RSK	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50.0 mL	50.0 mL	263656	11/23/18 13:00	RSK	TAL PIT
Total Recoverable	Analysis	EPA 6020A		1			263680	11/24/18 11:50	RSK	TAL PIT
	Instrument ID: A									
Dissolved	Prep	7470A			50 mL	50 mL	263719	11/26/18 09:55	RJR	TAL PIT
Dissolved	Analysis	EPA 7470A		1			263824	11/27/18 07:47	RJR	TAL PIT
	Instrument ID: HGY									
Total/NA	Prep	7470A			50 mL	50 mL	263721	11/26/18 09:58	RJR	TAL PIT
Total/NA	Analysis	EPA 7470A		1			263824	11/27/18 08:18	RJR	TAL PIT
	Instrument ID: HGY									
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	439085	11/28/18 17:34	LMT	TAL DEN
	Instrument ID: MT_024_Se									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	263522	11/21/18 11:00	JAS	TAL PIT
	Instrument ID: NOEQUIP									
Dissolved	Analysis	SM 5310C		1			263820	11/27/18 07:45	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM 5310C		1			263767	11/26/18 12:53	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM2320 B		1	50 mL	50 mL	263870	11/28/18 05:15	CLL	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-5 Lab Sample ID: 180-84236-2

Date Collected: 11/15/18 11:46 **Matrix: Water**
Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Analysis	EPA 9056A		1			264318	12/03/18 08:24	MJH	TAL PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		1			264317	12/03/18 08:42	MJH	TAL PIT
	Instrument ID: CHIC2100A									
Dissolved	Prep	3005A			50.0 mL	50.0 mL	263658	11/23/18 13:30	RSK	TAL PIT

1 2 3 4 5 6 7 8 9 10 11 12 13

Client Sample ID: CCR-AP-5
Lab Sample ID: 180-84236-2
Date Collected: 11/15/18 11:46
Matrix: Water
Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Analysis	EPA 6020A		1			263793	11/24/18 13:44	RSK	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50.0 mL	50.0 mL	263658	11/23/18 13:30	RSK	TAL PIT
Total Recoverable	Analysis	EPA 6020A		1			263793	11/24/18 13:41	RSK	TAL PIT
	Instrument ID: A									
Dissolved	Prep	7470A			50 mL	50 mL	263719	11/26/18 09:55	RJR	TAL PIT
Dissolved	Analysis	EPA 7470A		1			263824	11/27/18 07:48	RJR	TAL PIT
	Instrument ID: HGY									
Total/NA	Prep	7470A			50 mL	50 mL	263721	11/26/18 09:58	RJR	TAL PIT
Total/NA	Analysis	EPA 7470A		1			263824	11/27/18 08:20	RJR	TAL PIT
	Instrument ID: HGY									
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	439085	11/28/18 17:47	LMT	TAL DEN
	Instrument ID: MT_024_Se									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	263522	11/21/18 11:00	JAS	TAL PIT
	Instrument ID: NOEQUIP									
Dissolved	Analysis	SM 5310C		1			263820	11/27/18 07:57	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM 5310C		1			263767	11/26/18 13:06	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM2320 B		1	50 mL	50 mL	263870	11/28/18 05:15	CLL	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-4
Lab Sample ID: 180-84236-3
Date Collected: 11/15/18 15:00
Matrix: Water
Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Analysis	EPA 9056A		1			264318	12/03/18 07:20	MJH	TAL PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		1			264317	12/03/18 08:10	MJH	TAL PIT
	Instrument ID: CHIC2100A									
Dissolved	Prep	3005A			50.0 mL	50.0 mL	263658	11/23/18 13:30	RSK	TAL PIT
Dissolved	Analysis	EPA 6020A		1			263793	11/24/18 13:50	RSK	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50.0 mL	50.0 mL	263658	11/23/18 13:30	RSK	TAL PIT
Total Recoverable	Analysis	EPA 6020A		1			263793	11/24/18 13:47	RSK	TAL PIT
	Instrument ID: A									
Dissolved	Prep	7470A			50 mL	50 mL	263719	11/26/18 09:55	RJR	TAL PIT
Dissolved	Analysis	EPA 7470A		1			263824	11/27/18 07:50	RJR	TAL PIT
	Instrument ID: HGY									
Total/NA	Prep	7470A			50 mL	50 mL	263721	11/26/18 09:58	RJR	TAL PIT
Total/NA	Analysis	EPA 7470A		1			263824	11/27/18 08:23	RJR	TAL PIT
	Instrument ID: HGY									

Client Sample ID: CCR-AP-4

Lab Sample ID: 180-84236-3

Date Collected: 11/15/18 15:00

Matrix: Water

Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	439085	11/28/18 18:00	LMT	TAL DEN
	Instrument ID: MT_024_Se									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	263522	11/21/18 11:00	JAS	TAL PIT
	Instrument ID: NOEQUIP									
Dissolved	Analysis	SM 5310C		1			263820	11/27/18 08:10	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM 5310C		1			263767	11/26/18 13:18	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM2320 B		1	50 mL	50 mL	263870	11/28/18 05:15	CLL	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-8

Lab Sample ID: 180-84236-4

Date Collected: 11/16/18 09:02

Matrix: Water

Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Analysis	EPA 9056A		1			264318	12/03/18 07:36	MJH	TAL PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		1			264317	12/03/18 08:26	MJH	TAL PIT
	Instrument ID: CHIC2100A									
Dissolved	Prep	3005A			50.0 mL	50.0 mL	263658	11/23/18 13:30	RSK	TAL PIT
Dissolved	Analysis	EPA 6020A		1			263793	11/24/18 13:57	RSK	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50.0 mL	50.0 mL	263658	11/23/18 13:30	RSK	TAL PIT
Total Recoverable	Analysis	EPA 6020A		1			263793	11/24/18 13:54	RSK	TAL PIT
	Instrument ID: A									
Dissolved	Prep	7470A			50 mL	50 mL	263719	11/26/18 09:55	RJR	TAL PIT
Dissolved	Analysis	EPA 7470A		1			263824	11/27/18 07:51	RJR	TAL PIT
	Instrument ID: HGY									
Total/NA	Prep	7470A			50 mL	50 mL	263721	11/26/18 09:58	RJR	TAL PIT
Total/NA	Analysis	EPA 7470A		1			263824	11/27/18 08:24	RJR	TAL PIT
	Instrument ID: HGY									
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	439085	11/28/18 18:14	LMT	TAL DEN
	Instrument ID: MT_024_Se									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	263522	11/21/18 11:00	JAS	TAL PIT
	Instrument ID: NOEQUIP									
Dissolved	Analysis	SM 5310C		1			263820	11/27/18 08:22	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM 5310C		1			263767	11/26/18 13:30	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM2320 B		1	50 mL	50 mL	263925	11/28/18 09:11	CLL	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-3 Lab Sample ID: 180-84236-5

Date Collected: 11/16/18 10:37 **Matrix: Water**
Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Analysis	EPA 9056A		1			264318	12/03/18 07:52	MJH	TAL PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		1			264317	12/03/18 10:15	MJH	TAL PIT
	Instrument ID: CHIC2100A									
Dissolved	Prep	3005A			50.0 mL	50.0 mL	263658	11/23/18 13:30	RSK	TAL PIT
Dissolved	Analysis	EPA 6020A		1			263793	11/24/18 14:04	RSK	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50.0 mL	50.0 mL	263658	11/23/18 13:30	RSK	TAL PIT
Total Recoverable	Analysis	EPA 6020A		1			263793	11/24/18 14:00	RSK	TAL PIT
	Instrument ID: A									
Dissolved	Prep	7470A			50 mL	50 mL	263719	11/26/18 09:55	RJR	TAL PIT
Dissolved	Analysis	EPA 7470A		1			263824	11/27/18 07:52	RJR	TAL PIT
	Instrument ID: HGY									
Total/NA	Prep	7470A			50 mL	50 mL	263721	11/26/18 09:58	RJR	TAL PIT
Total/NA	Analysis	EPA 7470A		1			263824	11/27/18 08:25	RJR	TAL PIT
	Instrument ID: HGY									
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	439085	11/28/18 18:27	LMT	TAL DEN
	Instrument ID: MT_024_Se									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	263522	11/21/18 11:00	JAS	TAL PIT
	Instrument ID: NOEQUIP									
Dissolved	Analysis	SM 5310C		1			263820	11/27/18 08:34	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM 5310C		1			263767	11/26/18 13:43	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM2320 B		1	50 mL	50 mL	263925	11/28/18 09:11	CLL	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-6 Lab Sample ID: 180-84236-6

Date Collected: 11/17/18 10:01 **Matrix: Water**
Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Analysis	EPA 9056A		1			264318	12/03/18 08:08	MJH	TAL PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		1			264317	12/03/18 10:31	MJH	TAL PIT
	Instrument ID: CHIC2100A									
Dissolved	Prep	3005A			50.0 mL	50.0 mL	263658	11/23/18 13:30	RSK	TAL PIT
Dissolved	Analysis	EPA 6020A		1			263793	11/24/18 14:17	RSK	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50.0 mL	50.0 mL	263658	11/23/18 13:30	RSK	TAL PIT
Total Recoverable	Analysis	EPA 6020A		1			263793	11/24/18 14:14	RSK	TAL PIT
	Instrument ID: A									
Dissolved	Prep	7470A			50 mL	50 mL	263719	11/26/18 09:55	RJR	TAL PIT

Client Sample ID: CCR-AP-6 Lab Sample ID: 180-84236-6

Date Collected: 11/17/18 10:01 **Matrix: Water**
Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Analysis	EPA 7470A		1			263824	11/27/18 07:55	RJR	TAL PIT
	Instrument ID: HGY									
Total/NA	Prep	7470A			50 mL	50 mL	263721	11/26/18 09:58	RJR	TAL PIT
Total/NA	Analysis	EPA 7470A		1			263824	11/27/18 08:26	RJR	TAL PIT
	Instrument ID: HGY									
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	439085	11/28/18 19:06	LMT	TAL DEN
	Instrument ID: MT_024_Se									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	263522	11/21/18 11:00	JAS	TAL PIT
	Instrument ID: NOEQUIP									
Dissolved	Analysis	SM 5310C		1			263820	11/27/18 09:12	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM 5310C		1			263767	11/26/18 13:55	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM2320 B		1	50 mL	50 mL	263925	11/28/18 09:11	CLL	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-6I Lab Sample ID: 180-84236-7

Date Collected: 11/17/18 14:27 **Matrix: Water**
Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Analysis	EPA 9056A		1			264318	12/03/18 09:51	MJH	TAL PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		1			264317	12/03/18 10:46	MJH	TAL PIT
	Instrument ID: CHIC2100A									
Total/NA	Analysis	EPA 9056A		10			264317	12/03/18 11:01	MJH	TAL PIT
	Instrument ID: CHIC2100A									
Dissolved	Prep	3005A			50.0 mL	50.0 mL	263658	11/23/18 13:30	RSK	TAL PIT
Dissolved	Analysis	EPA 6020A		1			263793	11/24/18 14:23	RSK	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50.0 mL	50.0 mL	263658	11/23/18 13:30	RSK	TAL PIT
Total Recoverable	Analysis	EPA 6020A		1			263793	11/24/18 14:20	RSK	TAL PIT
	Instrument ID: A									
Dissolved	Prep	7470A			50 mL	50 mL	263719	11/26/18 09:55	RJR	TAL PIT
Dissolved	Analysis	EPA 7470A		1			263824	11/27/18 07:56	RJR	TAL PIT
	Instrument ID: HGY									
Total/NA	Prep	7470A			50 mL	50 mL	263721	11/26/18 09:58	RJR	TAL PIT
Total/NA	Analysis	EPA 7470A		1			263824	11/27/18 08:27	RJR	TAL PIT
	Instrument ID: HGY									
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	439085	11/28/18 19:46	LMT	TAL DEN
	Instrument ID: MT_024_Se									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	263522	11/21/18 11:00	JAS	TAL PIT
	Instrument ID: NOEQUIP									

Client: Haley & Aldrich, Inc.
Project/Site: Vectren ASD Sampling - FB Culley

TestAmerica Job ID: 180-84236-1

Client Sample ID: CCR-AP-6I
Date Collected: 11/17/18 14:27
Date Received: 11/21/18 10:00

Lab Sample ID: 180-84236-7
Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Analysis	SM 5310C		1			263820	11/27/18 09:25	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM 5310C		1			263767	11/26/18 14:33	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM2320 B		1	50 mL	50 mL	263870	11/28/18 05:15	CLL	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-8I
Date Collected: 11/17/18 15:47
Date Received: 11/21/18 10:00

Lab Sample ID: 180-84236-8
Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Analysis	EPA 9056A		1			264318	12/03/18 10:07	MJH	TAL PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		1			264317	12/03/18 11:17	MJH	TAL PIT
	Instrument ID: CHIC2100A									
Total/NA	Analysis	EPA 9056A		10			264317	12/03/18 11:32	MJH	TAL PIT
	Instrument ID: CHIC2100A									
Dissolved	Prep	3005A			50.0 mL	50.0 mL	263658	11/23/18 13:30	RSK	TAL PIT
Dissolved	Analysis	EPA 6020A		1			263793	11/24/18 14:30	RSK	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50.0 mL	50.0 mL	263658	11/23/18 13:30	RSK	TAL PIT
Total Recoverable	Analysis	EPA 6020A		1			263793	11/24/18 14:27	RSK	TAL PIT
	Instrument ID: A									
Dissolved	Prep	7470A			50 mL	50 mL	263719	11/26/18 09:55	RJR	TAL PIT
Dissolved	Analysis	EPA 7470A		1			263824	11/27/18 07:57	RJR	TAL PIT
	Instrument ID: HGY									
Total/NA	Prep	7470A			50 mL	50 mL	263721	11/26/18 09:58	RJR	TAL PIT
Total/NA	Analysis	EPA 7470A		1			263824	11/27/18 08:29	RJR	TAL PIT
	Instrument ID: HGY									
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	439085	11/28/18 19:59	LMT	TAL DEN
	Instrument ID: MT_024_Se									
Total/NA	Analysis	SM 2540C		1	50 mL	100 mL	263522	11/21/18 11:00	JAS	TAL PIT
	Instrument ID: NOEQUIP									
Dissolved	Analysis	SM 5310C		1			263820	11/27/18 09:38	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM 5310C		1			263767	11/26/18 14:45	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM2320 B		1	50 mL	50 mL	263870	11/28/18 05:15	CLL	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: HASB-1 — Lab Sample ID: 180-84236-9

Date Collected: 11/17/18 16:36 — **Matrix: Water**
Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Analysis	EPA 9056A		1			264318	12/03/18 10:23	MJH	TAL PIT
	Instrument ID: CHICS2100B									
Total/NA	Analysis	EPA 9056A		1			264317	12/03/18 11:47	MJH	TAL PIT
	Instrument ID: CHIC2100A									
Dissolved	Prep	3005A			50.0 mL	50.0 mL	263658	11/23/18 13:30	RSK	TAL PIT
Dissolved	Analysis	EPA 6020A		1			263793	11/24/18 14:36	RSK	TAL PIT
	Instrument ID: A									
Total Recoverable	Prep	3005A			50.0 mL	50.0 mL	263658	11/23/18 13:30	RSK	TAL PIT
Total Recoverable	Analysis	EPA 6020A		1			263793	11/24/18 14:33	RSK	TAL PIT
	Instrument ID: A									
Dissolved	Prep	7470A			50 mL	50 mL	263719	11/26/18 09:55	RJR	TAL PIT
Dissolved	Analysis	EPA 7470A		1			263824	11/27/18 07:59	RJR	TAL PIT
	Instrument ID: HGY									
Total/NA	Prep	7470A			50 mL	50 mL	263721	11/26/18 09:58	RJR	TAL PIT
Total/NA	Analysis	EPA 7470A		1			263824	11/27/18 08:30	RJR	TAL PIT
	Instrument ID: HGY									
Dissolved	Analysis	Se Speciation		1	1 mL	1 mL	439085	11/28/18 20:13	LMT	TAL DEN
	Instrument ID: MT_024_Se									
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	263522	11/21/18 11:00	JAS	TAL PIT
	Instrument ID: NOEQUIP									
Dissolved	Analysis	SM 5310C		1			263820	11/27/18 09:51	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM 5310C		1			263767	11/26/18 14:57	CLL	TAL PIT
	Instrument ID: TOC1030									
Total/NA	Analysis	SM2320 B		1	50 mL	50 mL	263870	11/28/18 05:15	CLL	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-8I (68-70) — Lab Sample ID: 180-84236-10

Date Collected: 11/15/18 09:10 — **Matrix: Solid**
Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
SPLP	Leach	1312			25 g	500 mL	263846	11/27/18 12:25	TAH	TAL PIT
SPLP	Analysis	EPA 9056A		1			263887	11/28/18 11:24	MJH	TAL PIT
	Instrument ID: CHIC2100A									
SPLP East	Leach	EPA 1312			100 g	2000 mL	263760	11/26/18 14:25	TAH	TAL PIT
SPLP East	Prep	3010A			50 mL	50 mL	263844	11/27/18 12:10	NAM	TAL PIT
SPLP East	Analysis	6020A		1			264025	11/28/18 10:44	RSK	TAL PIT
	Instrument ID: A									
SPLP East	Leach	EPA 1312			100 g	2000 mL	263760	11/26/18 14:25	TAH	TAL PIT
SPLP East	Prep	7470A			50 mL	50 mL	263948	11/28/18 11:06	KA	TAL PIT
SPLP East	Analysis	7470A		1			264124	11/29/18 15:05	KA	TAL PIT
	Instrument ID: HGY									

Client Sample ID: CCR-AP-8I (68-70)
Lab Sample ID: 180-84236-10
Date Collected: 11/15/18 09:10
Matrix: Solid
Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	2540G		1			263619	11/23/18 08:06	AVS	TAL PIT
	Instrument ID: NOEQUIP									
SPLP East	Leach	EPA 1312			100 g	2000 mL	263760	11/26/18 14:25	TAH	TAL PIT
SPLP East	Prep	Distill/Ammonia			50 mL	50 mL	263861	11/27/18 13:31	TAM	TAL PIT
SPLP East	Analysis	EPA 350.1		1			264014	11/28/18 17:57	BSH	TAL PIT
	Instrument ID: ASTORIA1									
SPLP East	Leach	EPA 1312			100 g	2000 mL	263760	11/26/18 14:25	TAH	TAL PIT
SPLP East	Analysis	SM2320 B		1	50 mL	50 mL	263868	11/28/18 05:00	CLL	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-8I (68-70)
Lab Sample ID: 180-84236-10
Date Collected: 11/15/18 09:10
Matrix: Solid
Date Received: 11/21/18 10:00
Percent Solids: 85.2

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.99 g	100 mL	263578	11/21/18 14:04	NAM	TAL PIT
Total/NA	Analysis	EPA 6020A		1	1.0 mL	1.0 mL	264070	11/28/18 19:53	WTR	TAL PIT
	Instrument ID: M									
Total/NA	Prep	3050B			0.99 g	100 mL	263578	11/21/18 14:04	NAM	TAL PIT
Total/NA	Analysis	EPA 6020A		1			264192	11/28/18 19:53	WTR	TAL PIT
	Instrument ID: M									
Total/NA	Prep	7471B			0.59 g	100 mL	263884	11/27/18 17:18	KA	TAL PIT
Total/NA	Analysis	EPA 7471B		1			264013	11/28/18 14:51	KA	TAL PIT
	Instrument ID: HGZ									
Total/NA	Analysis	EPA-Lloyd Kahn		1			264051	11/28/18 15:03	JBF	TAL PIT
	Instrument ID: FLASHEA									

Client Sample ID: CCR-AP-6I (68-70)
Lab Sample ID: 180-84236-11
Date Collected: 11/16/18 09:25
Matrix: Solid
Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
SPLP	Leach	1312			25 g	500 mL	263846	11/27/18 12:25	TAH	TAL PIT
SPLP	Analysis	EPA 9056A		1			263887	11/28/18 11:39	MJH	TAL PIT
	Instrument ID: CHIC2100A									
SPLP East	Leach	EPA 1312			100 g	2000 mL	263760	11/26/18 14:25	TAH	TAL PIT
SPLP East	Prep	3010A			50 mL	50 mL	263844	11/27/18 12:10	NAM	TAL PIT
SPLP East	Analysis	6020A		1			264025	11/28/18 10:47	RSK	TAL PIT
	Instrument ID: A									
SPLP East	Leach	EPA 1312			100 g	2000 mL	263760	11/26/18 14:25	TAH	TAL PIT
SPLP East	Prep	7470A			50 mL	50 mL	263948	11/28/18 11:06	KA	TAL PIT
SPLP East	Analysis	7470A		1			264124	11/29/18 15:07	KA	TAL PIT
	Instrument ID: HGY									

Client Sample ID: CCR-AP-6I (68-70) Lab Sample ID: 180-84236-11

Date Collected: 11/16/18 09:25 **Matrix: Solid**
Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	2540G		1			263619	11/23/18 08:06	AVS	TAL PIT
	Instrument ID: NOEQUIP									
SPLP East	Leach	EPA 1312			100 g	2000 mL	263760	11/26/18 14:25	TAH	TAL PIT
SPLP East	Prep	Distill/Ammonia			50 mL	50 mL	263861	11/27/18 13:31	TAM	TAL PIT
SPLP East	Analysis	EPA 350.1		1			264014	11/28/18 17:59	BSH	TAL PIT
	Instrument ID: ASTORIA1									
SPLP East	Leach	EPA 1312			100 g	2000 mL	263760	11/26/18 14:25	TAH	TAL PIT
SPLP East	Analysis	SM2320 B		1	50 mL	50 mL	263868	11/28/18 05:00	CLL	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: CCR-AP-6I (68-70) Lab Sample ID: 180-84236-11

Date Collected: 11/16/18 09:25 **Matrix: Solid**
Date Received: 11/21/18 10:00 **Percent Solids: 88.2**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.96 g	100 mL	263578	11/21/18 14:04	NAM	TAL PIT
Total/NA	Analysis	EPA 6020A		1	1.0 mL	1.0 mL	264070	11/28/18 19:58	WTR	TAL PIT
	Instrument ID: M									
Total/NA	Prep	3050B			0.96 g	100 mL	263578	11/21/18 14:04	NAM	TAL PIT
Total/NA	Analysis	EPA 6020A		1			264192	11/28/18 19:58	WTR	TAL PIT
	Instrument ID: M									
Total/NA	Prep	7471B			0.60 g	100 mL	263885	11/27/18 17:20	KA	TAL PIT
Total/NA	Analysis	EPA 7471B		1			264013	11/28/18 15:07	KA	TAL PIT
	Instrument ID: HGZ									
Total/NA	Analysis	EPA-Lloyd Kahn		1			264051	11/28/18 15:13	JBF	TAL PIT
	Instrument ID: FLASHEA									

Client Sample ID: HASB-1 (35-38) Lab Sample ID: 180-84236-12

Date Collected: 11/16/18 15:50 **Matrix: Solid**
Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
SPLP	Leach	1312			25 g	500 mL	263846	11/27/18 12:25	TAH	TAL PIT
SPLP	Analysis	EPA 9056A		1			264016	11/29/18 06:58	MJH	TAL PIT
	Instrument ID: CHICS2100B									
SPLP East	Leach	EPA 1312			100 g	2000 mL	263760	11/26/18 14:26	TAH	TAL PIT
SPLP East	Prep	3010A			50 mL	50 mL	263844	11/27/18 12:10	NAM	TAL PIT
SPLP East	Analysis	6020A		1			264025	11/28/18 10:50	RSK	TAL PIT
	Instrument ID: A									
SPLP East	Leach	EPA 1312			100 g	2000 mL	263760	11/26/18 14:26	TAH	TAL PIT
SPLP East	Prep	7470A			50 mL	50 mL	263948	11/28/18 11:06	KA	TAL PIT
SPLP East	Analysis	7470A		1			264124	11/29/18 15:08	KA	TAL PIT
	Instrument ID: HGY									

Client Sample ID: HASB-1 (35-38)

Lab Sample ID: 180-84236-12

Date Collected: 11/16/18 15:50

Matrix: Solid

Date Received: 11/21/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	2540G		1			263619	11/23/18 08:06	AVS	TAL PIT
	Instrument ID: NOEQUIP									
SPLP East	Leach	EPA 1312			100 g	2000 mL	263760	11/26/18 14:26	TAH	TAL PIT
SPLP East	Prep	Distill/Ammonia			50 mL	50 mL	263861	11/27/18 13:31	TAM	TAL PIT
SPLP East	Analysis	EPA 350.1		1			264014	11/28/18 18:00	BSH	TAL PIT
	Instrument ID: ASTORIA1									
SPLP East	Leach	EPA 1312			100 g	2000 mL	263760	11/26/18 14:26	TAH	TAL PIT
SPLP East	Analysis	SM2320 B		1	50 mL	50 mL	263868	11/28/18 05:00	CLL	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: HASB-1 (35-38)

Lab Sample ID: 180-84236-12

Date Collected: 11/16/18 15:50

Matrix: Solid

Date Received: 11/21/18 10:00

Percent Solids: 91.3

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			1.01 g	100 mL	263578	11/21/18 14:04	NAM	TAL PIT
Total/NA	Analysis	EPA 6020A		1	1.0 mL	1.0 mL	264070	11/28/18 20:03	WTR	TAL PIT
	Instrument ID: M									
Total/NA	Prep	3050B			1.01 g	100 mL	263578	11/21/18 14:04	NAM	TAL PIT
Total/NA	Analysis	EPA 6020A		1			264192	11/28/18 20:03	WTR	TAL PIT
	Instrument ID: M									
Total/NA	Prep	7471B			0.59 g	100 mL	263885	11/27/18 17:20	KA	TAL PIT
Total/NA	Analysis	EPA 7471B		1			264013	11/28/18 15:08	KA	TAL PIT
	Instrument ID: HGZ									
Total/NA	Analysis	EPA-Lloyd Kahn		1			264051	11/28/18 15:24	JBF	TAL PIT
	Instrument ID: FLASHEA									

Laboratory References:

TAL DEN = TestAmerica Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100

TAL PIT = TestAmerica Pittsburgh, 301 Alpha Drive, RIDC Park, Pittsburgh, PA 15238, TEL (412)963-7058

Analyst References:

Lab: TAL DEN

Batch Type: Analysis

LMT = Lynn-Anne Trudell

Lab: TAL PIT

Batch Type: Leach

TAH = Todd Harteis

Batch Type: Prep

KA = Kayla Kalamasz

NAM = Nicole Marfisi

RJR = Ron Rosenbaum

RSK = Robert Kurtz

TAM = Tessa Mastalski

Batch Type: Analysis

AVS = Abbey Smith

BSH = Brandon Hough

CLL = Cheryl Loheyde

JAS = Joshua Schmidt

JBF = Joshua Fritsch

KA = Kayla Kalamasz

MJH = Matthew Hartman

RJR = Ron Rosenbaum

RSK = Robert Kurtz

WTR = Bill Reinheimer

Client Sample Results

Client: Haley & Aldrich, Inc.
Project/Site: Vectren ASD Sampling - FB Culley

TestAmerica Job ID: 180-84236-1

Client Sample ID: CCR-AP-2

Lab Sample ID: 180-84236-1

Date Collected: 11/15/18 09:25
Date Received: 11/21/18 10:00

Matrix: Water

Method: EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**160**		1.0	0.71	mg/L			12/03/18 07:39	1
Sulfate	**450**		10	3.8	mg/L			12/03/18 07:55	10
Fluoride	**0.32**		0.10	0.026	mg/L			12/03/18 07:39	1

Method: EPA 9056A - Anions, Ion Chromatography - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	**0.35**		0.10	0.026	mg/L			12/03/18 07:04	1

Method: EPA 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**1.2**		1.0	0.32	ug/L		11/23/18 13:00	11/24/18 11:50	1
Barium	**43**	**B**	10	0.37	ug/L		11/23/18 13:00	11/24/18 11:50	1
Beryllium	ND		1.0	0.057	ug/L		11/23/18 13:00	11/24/18 11:50	1
Cadmium	**0.15**	**J**	1.0	0.13	ug/L		11/23/18 13:00	11/24/18 11:50	1
Chromium	**1.9**	**J**	2.0	0.63	ug/L		11/23/18 13:00	11/24/18 11:50	1
Cobalt	**8.4**		0.50	0.075	ug/L		11/23/18 13:00	11/24/18 11:50	1
Iron	**700**		50	14	ug/L		11/23/18 13:00	11/24/18 11:50	1
Manganese	**27000**		50	14	ug/L		11/23/18 13:00	11/24/18 10:33	10
Molybdenum	**0.91**	**J**	5.0	0.47	ug/L		11/23/18 13:00	11/24/18 11:50	1
Lead	**0.53**	**J**	1.0	0.094	ug/L		11/23/18 13:00	11/24/18 11:50	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:00	11/24/18 11:50	1
Selenium	ND		5.0	0.81	ug/L		11/23/18 13:00	11/24/18 11:50	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:00	11/24/18 11:50	1
Lithium	ND		5.0	2.6	ug/L		11/23/18 13:00	11/24/18 11:50	1

Method: EPA 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**0.98**	**J**	1.0	0.32	ug/L		11/23/18 13:00	11/24/18 11:57	1
Barium	**39**	**B**	10	0.37	ug/L		11/23/18 13:00	11/24/18 11:57	1
Beryllium	ND		1.0	0.057	ug/L		11/23/18 13:00	11/24/18 11:57	1
Cadmium	ND		1.0	0.13	ug/L		11/23/18 13:00	11/24/18 11:57	1
Chromium	**1.3**	**J**	2.0	0.63	ug/L		11/23/18 13:00	11/24/18 11:57	1
Cobalt	**8.4**		0.50	0.075	ug/L		11/23/18 13:00	11/24/18 11:57	1
Iron	**61**		50	14	ug/L		11/23/18 13:00	11/24/18 11:57	1
Lead	ND		1.0	0.094	ug/L		11/23/18 13:00	11/24/18 11:57	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:00	11/24/18 11:57	1
Selenium	ND		5.0	0.81	ug/L		11/23/18 13:00	11/24/18 11:57	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:00	11/24/18 11:57	1
Lithium	ND		5.0	2.6	ug/L		11/23/18 13:00	11/24/18 11:57	1

Method: EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:58	11/27/18 08:18	1

Method: EPA 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:55	11/27/18 07:47	1

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	**3.1**		2.0	0.79	ug/L			11/28/18 17:34	1

Client Sample ID: CCR-AP-2

Lab Sample ID: 180-84236-1
Date Collected: 11/15/18 09:25
Matrix: Water
Date Received: 11/21/18 10:00

Method: Se Speciation - Selenium Speciation - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (V)	2.1		2.0	0.75	ug/L			11/28/18 17:34	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	1500		10	10	mg/L			11/21/18 11:00	1
Total Organic Carbon - Duplicates	3.0		1.0	0.51	mg/L			11/26/18 12:53	1
Total Alkalinity as CaCO3 to pH 4.!	590		5.0	5.0	mg/L			11/28/18 05:15	1

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	3.5		1.0	0.51	mg/L			11/27/18 07:45	1

Client Sample ID: CCR-AP-5

Lab Sample ID: 180-84236-2
Date Collected: 11/15/18 11:46
Matrix: Water
Date Received: 11/21/18 10:00

Method: EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	3.0		1.0	0.71	mg/L			12/03/18 08:42	1
Sulfate	150		1.0	0.38	mg/L			12/03/18 08:42	1
Fluoride	1.4		0.10	0.026	mg/L			12/03/18 08:42	1

Method: EPA 9056A - Anions, Ion Chromatography - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	1.5		0.10	0.026	mg/L			12/03/18 08:24	1

Method: EPA 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	2.7		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 13:41	1
Barium	50		10	0.37	ug/L		11/23/18 13:30	11/24/18 13:41	1
Beryllium	0.081	J	1.0	0.057	ug/L		11/23/18 13:30	11/24/18 13:41	1
Cadmium	0.23	J	1.0	0.13	ug/L		11/23/18 13:30	11/24/18 13:41	1
Chromium	4.1		2.0	0.63	ug/L		11/23/18 13:30	11/24/18 13:41	1
Cobalt	0.52		0.50	0.075	ug/L		11/23/18 13:30	11/24/18 13:41	1
Iron	1200		50	14	ug/L		11/23/18 13:30	11/24/18 13:41	1
Manganese	32		5.0	1.4	ug/L		11/23/18 13:30	11/24/18 13:41	1
Molybdenum	9.4		5.0	0.47	ug/L		11/23/18 13:30	11/24/18 13:41	1
Lead	1.6		1.0	0.094	ug/L		11/23/18 13:30	11/24/18 13:41	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 13:41	1
Selenium	1.7	J	5.0	0.81	ug/L		11/23/18 13:30	11/24/18 13:41	1
Thallium	0.066	J	1.0	0.063	ug/L		11/23/18 13:30	11/24/18 13:41	1
Lithium	8.5		5.0	2.6	ug/L		11/23/18 13:30	11/24/18 13:41	1

Method: EPA 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	1.7		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 13:44	1
Barium	35		10	0.37	ug/L		11/23/18 13:30	11/24/18 13:44	1
Beryllium	ND		1.0	0.057	ug/L		11/23/18 13:30	11/24/18 13:44	1
Cadmium	ND		1.0	0.13	ug/L		11/23/18 13:30	11/24/18 13:44	1
Chromium	1.6	J	2.0	0.63	ug/L		11/23/18 13:30	11/24/18 13:44	1

Client Sample ID: CCR-AP-5
Lab Sample ID: 180-84236-2

Date Collected: 11/15/18 11:46
Matrix: Water
Date Received: 11/21/18 10:00

Method: EPA 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cobalt	0.076	J	0.50	0.075	ug/L		11/23/18 13:30	11/24/18 13:44	1
Iron	22	J	50	14	ug/L		11/23/18 13:30	11/24/18 13:44	1
Lead	0.098	J	1.0	0.094	ug/L		11/23/18 13:30	11/24/18 13:44	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 13:44	1
Selenium	1.7	J	5.0	0.81	ug/L		11/23/18 13:30	11/24/18 13:44	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:30	11/24/18 13:44	1
Lithium	7.4		5.0	2.6	ug/L		11/23/18 13:30	11/24/18 13:44	1

Method: EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:58	11/27/18 08:20	1

Method: EPA 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:55	11/27/18 07:48	1

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	1.2	J	2.0	0.79	ug/L			11/28/18 17:47	1
Arsenic (V)	1.7	J	2.0	0.75	ug/L			11/28/18 17:47	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	310		10	10	mg/L			11/21/18 11:00	1
Total Organic Carbon - Duplicates	3.0		1.0	0.51	mg/L			11/26/18 13:06	1
Total Alkalinity as CaCO3 to pH 4.!	130		5.0	5.0	mg/L			11/28/18 05:15	1

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	3.7		1.0	0.51	mg/L			11/27/18 07:57	1

Client Sample ID: CCR-AP-4
Lab Sample ID: 180-84236-3

Date Collected: 11/15/18 15:00
Matrix: Water
Date Received: 11/21/18 10:00

Method: EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	28		1.0	0.71	mg/L			12/03/18 08:10	1
Sulfate	8.9		1.0	0.38	mg/L			12/03/18 08:10	1
Fluoride	0.34		0.10	0.026	mg/L			12/03/18 08:10	1

Method: EPA 9056A - Anions, Ion Chromatography - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	0.41		0.10	0.026	mg/L			12/03/18 07:20	1

Method: EPA 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	88		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 13:47	1
Barium	580		10	0.37	ug/L		11/23/18 13:30	11/24/18 13:47	1
Beryllium	0.18	J	1.0	0.057	ug/L		11/23/18 13:30	11/24/18 13:47	1

Client Sample ID: CCR-AP-4

Lab Sample ID: 180-84236-3
Date Collected: 11/15/18 15:00
Matrix: Water
Date Received: 11/21/18 10:00

Method: EPA 6020A - Metals (ICP/MS) - Total Recoverable (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cadmium	ND		1.0	0.13	ug/L		11/23/18 13:30	11/24/18 13:47	1
Chromium	**6.2**		2.0	0.63	ug/L		11/23/18 13:30	11/24/18 13:47	1
Cobalt	**3.0**		0.50	0.075	ug/L		11/23/18 13:30	11/24/18 13:47	1
Iron	**81000**		50	14	ug/L		11/23/18 13:30	11/24/18 13:47	1
Manganese	**800**		5.0	1.4	ug/L		11/23/18 13:30	11/24/18 13:47	1
Molybdenum	**0.76**	**J**	5.0	0.47	ug/L		11/23/18 13:30	11/24/18 13:47	1
Lead	**2.9**		1.0	0.094	ug/L		11/23/18 13:30	11/24/18 13:47	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 13:47	1
Selenium	**1.1**	**J**	5.0	0.81	ug/L		11/23/18 13:30	11/24/18 13:47	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:30	11/24/18 13:47	1
Lithium	**6.2**		5.0	2.6	ug/L		11/23/18 13:30	11/24/18 13:47	1

Method: EPA 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**83**		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 13:50	1
Barium	**540**		10	0.37	ug/L		11/23/18 13:30	11/24/18 13:50	1
Beryllium	ND		1.0	0.057	ug/L		11/23/18 13:30	11/24/18 13:50	1
Cadmium	ND		1.0	0.13	ug/L		11/23/18 13:30	11/24/18 13:50	1
Chromium	**1.9**	**J**	2.0	0.63	ug/L		11/23/18 13:30	11/24/18 13:50	1
Cobalt	**1.3**		0.50	0.075	ug/L		11/23/18 13:30	11/24/18 13:50	1
Iron	**76000**		50	14	ug/L		11/23/18 13:30	11/24/18 13:50	1
Lead	ND		1.0	0.094	ug/L		11/23/18 13:30	11/24/18 13:50	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 13:50	1
Selenium	**1.0**	**J**	5.0	0.81	ug/L		11/23/18 13:30	11/24/18 13:50	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:30	11/24/18 13:50	1
Lithium	**3.9**	**J**	5.0	2.6	ug/L		11/23/18 13:30	11/24/18 13:50	1

Method: EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:58	11/27/18 08:23	1

Method: EPA 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:55	11/27/18 07:50	1

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	**5.2**		2.0	0.79	ug/L			11/28/18 18:00	1
Arsenic (V)	**0.76**	**J**	2.0	0.75	ug/L			11/28/18 18:00	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	**880**		10	10	mg/L			11/21/18 11:00	1
Total Organic Carbon - Duplicates	**26**		1.0	0.51	mg/L			11/26/18 13:18	1
Total Alkalinity as CaCO3 to pH 4.!	**960**		5.0	5.0	mg/L			11/28/18 05:15	1

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	**27**		1.0	0.51	mg/L			11/27/18 08:10	1

Client Sample ID: CCR-AP-8 Lab Sample ID: 180-84236-4

Date Collected: 11/16/18 09:02 **Matrix: Water**
Date Received: 11/21/18 10:00

Method: EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	16		1.0	0.71	mg/L			12/03/18 08:26	1
Sulfate	1.1		1.0	0.38	mg/L			12/03/18 08:26	1
Fluoride	0.25		0.10	0.026	mg/L			12/03/18 08:26	1

Method: EPA 9056A - Anions, Ion Chromatography - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	0.34		0.10	0.026	mg/L			12/03/18 07:36	1

Method: EPA 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	100		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 13:54	1
Barium	580		10	0.37	ug/L		11/23/18 13:30	11/24/18 13:54	1
Beryllium	ND		1.0	0.057	ug/L		11/23/18 13:30	11/24/18 13:54	1
Cadmium	ND		1.0	0.13	ug/L		11/23/18 13:30	11/24/18 13:54	1
Chromium	2.4		2.0	0.63	ug/L		11/23/18 13:30	11/24/18 13:54	1
Cobalt	5.9		0.50	0.075	ug/L		11/23/18 13:30	11/24/18 13:54	1
Iron	100000		50	14	ug/L		11/23/18 13:30	11/24/18 13:54	1
Manganese	6400		5.0	1.4	ug/L		11/23/18 13:30	11/24/18 13:54	1
Molybdenum	9.5		5.0	0.47	ug/L		11/23/18 13:30	11/24/18 13:54	1
Lead	0.50	J	1.0	0.094	ug/L		11/23/18 13:30	11/24/18 13:54	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 13:54	1
Selenium	1.9	J	5.0	0.81	ug/L		11/23/18 13:30	11/24/18 13:54	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:30	11/24/18 13:54	1
Lithium	ND		5.0	2.6	ug/L		11/23/18 13:30	11/24/18 13:54	1

Method: EPA 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	80		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 13:57	1
Barium	460		10	0.37	ug/L		11/23/18 13:30	11/24/18 13:57	1
Beryllium	ND		1.0	0.057	ug/L		11/23/18 13:30	11/24/18 13:57	1
Cadmium	ND		1.0	0.13	ug/L		11/23/18 13:30	11/24/18 13:57	1
Chromium	1.6	J	2.0	0.63	ug/L		11/23/18 13:30	11/24/18 13:57	1
Cobalt	5.2		0.50	0.075	ug/L		11/23/18 13:30	11/24/18 13:57	1
Iron	88000		50	14	ug/L		11/23/18 13:30	11/24/18 13:57	1
Lead	ND		1.0	0.094	ug/L		11/23/18 13:30	11/24/18 13:57	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 13:57	1
Selenium	1.9	J	5.0	0.81	ug/L		11/23/18 13:30	11/24/18 13:57	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:30	11/24/18 13:57	1
Lithium	ND		5.0	2.6	ug/L		11/23/18 13:30	11/24/18 13:57	1

Method: EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:58	11/27/18 08:24	1

Method: EPA 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:55	11/27/18 07:51	1

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	6.7		2.0	0.79	ug/L			11/28/18 18:14	1

Client Sample ID: CCR-AP-8 — Lab Sample ID: 180-84236-4

Date Collected: 11/16/18 09:02 — **Matrix: Water**
Date Received: 11/21/18 10:00

Method: Se Speciation - Selenium Speciation - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (V)	0.86	J	2.0	0.75	ug/L			11/28/18 18:14	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	1200		10	10	mg/L			11/21/18 11:00	1
Total Organic Carbon - Duplicates	41		1.0	0.51	mg/L			11/26/18 13:30	1
Total Alkalinity as CaCO3 to pH 4.!	1300		5.0	5.0	mg/L			11/28/18 09:11	1

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	58		1.0	0.51	mg/L			11/27/18 08:22	1

Client Sample ID: CCR-AP-3 — Lab Sample ID: 180-84236-5

Date Collected: 11/16/18 10:37 — **Matrix: Water**
Date Received: 11/21/18 10:00

Method: EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	26		1.0	0.71	mg/L			12/03/18 10:15	1
Sulfate	0.65	J	1.0	0.38	mg/L			12/03/18 10:15	1
Fluoride	0.37		0.10	0.026	mg/L			12/03/18 10:15	1

Method: EPA 9056A - Anions, Ion Chromatography - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	0.44		0.10	0.026	mg/L			12/03/18 07:52	1

Method: EPA 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	76		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 14:00	1
Barium	450		10	0.37	ug/L		11/23/18 13:30	11/24/18 14:00	1
Beryllium	ND		1.0	0.057	ug/L		11/23/18 13:30	11/24/18 14:00	1
Cadmium	ND		1.0	0.13	ug/L		11/23/18 13:30	11/24/18 14:00	1
Chromium	2.9		2.0	0.63	ug/L		11/23/18 13:30	11/24/18 14:00	1
Cobalt	5.5		0.50	0.075	ug/L		11/23/18 13:30	11/24/18 14:00	1
Iron	54000		50	14	ug/L		11/23/18 13:30	11/24/18 14:00	1
Manganese	950		5.0	1.4	ug/L		11/23/18 13:30	11/24/18 14:00	1
Molybdenum	10		5.0	0.47	ug/L		11/23/18 13:30	11/24/18 14:00	1
Lead	0.18	J	1.0	0.094	ug/L		11/23/18 13:30	11/24/18 14:00	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 14:00	1
Selenium	2.1	J	5.0	0.81	ug/L		11/23/18 13:30	11/24/18 14:00	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:30	11/24/18 14:00	1
Lithium	ND		5.0	2.6	ug/L		11/23/18 13:30	11/24/18 14:00	1

Method: EPA 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	70		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 14:04	1
Barium	380		10	0.37	ug/L		11/23/18 13:30	11/24/18 14:04	1
Beryllium	ND		1.0	0.057	ug/L		11/23/18 13:30	11/24/18 14:04	1
Cadmium	ND		1.0	0.13	ug/L		11/23/18 13:30	11/24/18 14:04	1
Chromium	2.2		2.0	0.63	ug/L		11/23/18 13:30	11/24/18 14:04	1

Client Sample ID: CCR-AP-3 Lab Sample ID: 180-84236-5

Date Collected: 11/16/18 10:37 Matrix: Water
Date Received: 11/21/18 10:00

Method: EPA 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cobalt	5.0		0.50	0.075	ug/L		11/23/18 13:30	11/24/18 14:04	1
Iron	50000		50	14	ug/L		11/23/18 13:30	11/24/18 14:04	1
Lead	ND		1.0	0.094	ug/L		11/23/18 13:30	11/24/18 14:04	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 14:04	1
Selenium	2.1	J	5.0	0.81	ug/L		11/23/18 13:30	11/24/18 14:04	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:30	11/24/18 14:04	1
Lithium	ND		5.0	2.6	ug/L		11/23/18 13:30	11/24/18 14:04	1

Method: EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:58	11/27/18 08:25	1

Method: EPA 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:55	11/27/18 07:52	1

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	5.0	F1	2.0	0.79	ug/L			11/28/18 18:27	1
Arsenic (V)	1.2	J F1	2.0	0.75	ug/L			11/28/18 18:27	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	990		10	10	mg/L			11/21/18 11:00	1
Total Organic Carbon - Duplicates	49		1.0	0.51	mg/L			11/26/18 13:43	1
Total Alkalinity as CaCO3 to pH 4.!	1100		5.0	5.0	mg/L			11/28/18 09:11	1

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	75		1.0	0.51	mg/L			11/27/18 08:34	1

Client Sample ID: CCR-AP-6 Lab Sample ID: 180-84236-6

Date Collected: 11/17/18 10:01 Matrix: Water
Date Received: 11/21/18 10:00

Method: EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	43		1.0	0.71	mg/L			12/03/18 10:31	1
Sulfate	1.6		1.0	0.38	mg/L			12/03/18 10:31	1
Fluoride	0.44		0.10	0.026	mg/L			12/03/18 10:31	1

Method: EPA 9056A - Anions, Ion Chromatography - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	0.59		0.10	0.026	mg/L			12/03/18 08:08	1

Method: EPA 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	110		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 14:14	1
Barium	580		10	0.37	ug/L		11/23/18 13:30	11/24/18 14:14	1
Beryllium	0.083	J	1.0	0.057	ug/L		11/23/18 13:30	11/24/18 14:14	1

Client Sample ID: CCR-AP-6

Lab Sample ID: 180-84236-6
Date Collected: 11/17/18 10:01
Matrix: Water
Date Received: 11/21/18 10:00

Method: EPA 6020A - Metals (ICP/MS) - Total Recoverable (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cadmium	ND		1.0	0.13	ug/L		11/23/18 13:30	11/24/18 14:14	1
Chromium	**4.8**		2.0	0.63	ug/L		11/23/18 13:30	11/24/18 14:14	1
Cobalt	**4.4**		0.50	0.075	ug/L		11/23/18 13:30	11/24/18 14:14	1
Iron	**44000**		50	14	ug/L		11/23/18 13:30	11/24/18 14:14	1
Manganese	**840**		5.0	1.4	ug/L		11/23/18 13:30	11/24/18 14:14	1
Molybdenum	**27**		5.0	0.47	ug/L		11/23/18 13:30	11/24/18 14:14	1
Lead	**2.2**		1.0	0.094	ug/L		11/23/18 13:30	11/24/18 14:14	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 14:14	1
Selenium	**1.6**	**J**	5.0	0.81	ug/L		11/23/18 13:30	11/24/18 14:14	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:30	11/24/18 14:14	1
Lithium	**3.5**	**J**	5.0	2.6	ug/L		11/23/18 13:30	11/24/18 14:14	1

Method: EPA 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**110**		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 14:17	1
Barium	**560**		10	0.37	ug/L		11/23/18 13:30	11/24/18 14:17	1
Beryllium	ND		1.0	0.057	ug/L		11/23/18 13:30	11/24/18 14:17	1
Cadmium	ND		1.0	0.13	ug/L		11/23/18 13:30	11/24/18 14:17	1
Chromium	**1.5**	**J**	2.0	0.63	ug/L		11/23/18 13:30	11/24/18 14:17	1
Cobalt	**3.2**		0.50	0.075	ug/L		11/23/18 13:30	11/24/18 14:17	1
Iron	**42000**		50	14	ug/L		11/23/18 13:30	11/24/18 14:17	1
Lead	ND		1.0	0.094	ug/L		11/23/18 13:30	11/24/18 14:17	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 14:17	1
Selenium	**1.6**	**J**	5.0	0.81	ug/L		11/23/18 13:30	11/24/18 14:17	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:30	11/24/18 14:17	1
Lithium	ND		5.0	2.6	ug/L		11/23/18 13:30	11/24/18 14:17	1

Method: EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:58	11/27/18 08:26	1

Method: EPA 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:55	11/27/18 07:55	1

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	**14**		2.0	0.79	ug/L			11/28/18 19:06	1
Arsenic (V)	**2.2**		2.0	0.75	ug/L			11/28/18 19:06	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	**1000**		10	10	mg/L			11/21/18 11:00	1
Total Organic Carbon - Duplicates	**68**		1.0	0.51	mg/L			11/26/18 13:55	1
Total Alkalinity as CaCO3 to pH 4.!	**1000**		5.0	5.0	mg/L			11/28/18 09:11	1

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	**51**		1.0	0.51	mg/L			11/27/18 09:12	1

1 2 3 4 5 6 7 8 9 10 11 12 13

Client Sample ID: CCR-AP-6I

Lab Sample ID: 180-84236-7

Date Collected: 11/17/18 14:27
Matrix: Water
Date Received: 11/21/18 10:00

Method: EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**120**		1.0	0.71	mg/L			12/03/18 10:46	1
Sulfate	**790**		10	3.8	mg/L			12/03/18 11:01	10
Fluoride	**0.13**		0.10	0.026	mg/L			12/03/18 10:46	1

Method: EPA 9056A - Anions, Ion Chromatography - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	**0.14**		0.10	0.026	mg/L			12/03/18 09:51	1

Method: EPA 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**3.7**		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 14:20	1
Barium	**110**		10	0.37	ug/L		11/23/18 13:30	11/24/18 14:20	1
Beryllium	ND		1.0	0.057	ug/L		11/23/18 13:30	11/24/18 14:20	1
Cadmium	**0.15**	**J**	1.0	0.13	ug/L		11/23/18 13:30	11/24/18 14:20	1
Chromium	**2.0**		2.0	0.63	ug/L		11/23/18 13:30	11/24/18 14:20	1
Cobalt	**1.7**		0.50	0.075	ug/L		11/23/18 13:30	11/24/18 14:20	1
Iron	**1200**		50	14	ug/L		11/23/18 13:30	11/24/18 14:20	1
Manganese	**8600**		5.0	1.4	ug/L		11/23/18 13:30	11/24/18 14:20	1
Molybdenum	**630**		5.0	0.47	ug/L		11/23/18 13:30	11/24/18 14:20	1
Lead	**0.84**	**J**	1.0	0.094	ug/L		11/23/18 13:30	11/24/18 14:20	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 14:20	1
Selenium	ND		5.0	0.81	ug/L		11/23/18 13:30	11/24/18 14:20	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:30	11/24/18 14:20	1
Lithium	**43**		5.0	2.6	ug/L		11/23/18 13:30	11/24/18 14:20	1

Method: EPA 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**2.9**		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 14:23	1
Barium	**100**		10	0.37	ug/L		11/23/18 13:30	11/24/18 14:23	1
Beryllium	ND		1.0	0.057	ug/L		11/23/18 13:30	11/24/18 14:23	1
Cadmium	**0.14**	**J**	1.0	0.13	ug/L		11/23/18 13:30	11/24/18 14:23	1
Chromium	**1.3**	**J**	2.0	0.63	ug/L		11/23/18 13:30	11/24/18 14:23	1
Cobalt	**1.2**		0.50	0.075	ug/L		11/23/18 13:30	11/24/18 14:23	1
Iron	**110**		50	14	ug/L		11/23/18 13:30	11/24/18 14:23	1
Lead	ND		1.0	0.094	ug/L		11/23/18 13:30	11/24/18 14:23	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 14:23	1
Selenium	ND		5.0	0.81	ug/L		11/23/18 13:30	11/24/18 14:23	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:30	11/24/18 14:23	1
Lithium	**41**		5.0	2.6	ug/L		11/23/18 13:30	11/24/18 14:23	1

Method: EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:58	11/27/18 08:27	1

Method: EPA 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:55	11/27/18 07:56	1

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	**5.0**		2.0	0.79	ug/L			11/28/18 19:46	1

1 2 3 4 5 6 7 8 9 10 11 12 13

Client Sample ID: CCR-AP-6I

Lab Sample ID: 180-84236-7

Date Collected: 11/17/18 14:27
Date Received: 11/21/18 10:00

Matrix: Water

Method: Se Speciation - Selenium Speciation - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (V)	1.9	J	2.0	0.75	ug/L			11/28/18 19:46	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	1500		10	10	mg/L			11/21/18 11:00	1
Total Organic Carbon - Duplicates	2.9		1.0	0.51	mg/L			11/26/18 14:33	1
Total Alkalinity as CaCO3 to pH 4.!	130		5.0	5.0	mg/L			11/28/18 05:15	1

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	4.6		1.0	0.51	mg/L			11/27/18 09:25	1

Client Sample ID: CCR-AP-8I

Lab Sample ID: 180-84236-8

Date Collected: 11/17/18 15:47
Date Received: 11/21/18 10:00

Matrix: Water

Method: EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	300		10	7.1	mg/L			12/03/18 11:32	10
Sulfate	1000		10	3.8	mg/L			12/03/18 11:32	10
Fluoride	0.26		0.10	0.026	mg/L			12/03/18 11:17	1

Method: EPA 9056A - Anions, Ion Chromatography - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	0.27		0.10	0.026	mg/L			12/03/18 10:07	1

Method: EPA 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	4.0		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 14:27	1
Barium	300		10	0.37	ug/L		11/23/18 13:30	11/24/18 14:27	1
Beryllium	0.078	J	1.0	0.057	ug/L		11/23/18 13:30	11/24/18 14:27	1
Cadmium	ND		1.0	0.13	ug/L		11/23/18 13:30	11/24/18 14:27	1
Chromium	2.9		2.0	0.63	ug/L		11/23/18 13:30	11/24/18 14:27	1
Cobalt	1.6		0.50	0.075	ug/L		11/23/18 13:30	11/24/18 14:27	1
Iron	20000		50	14	ug/L		11/23/18 13:30	11/24/18 14:27	1
Manganese	3200		5.0	1.4	ug/L		11/23/18 13:30	11/24/18 14:27	1
Molybdenum	360		5.0	0.47	ug/L		11/23/18 13:30	11/24/18 14:27	1
Lead	1.0		1.0	0.094	ug/L		11/23/18 13:30	11/24/18 14:27	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 14:27	1
Selenium	ND		5.0	0.81	ug/L		11/23/18 13:30	11/24/18 14:27	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:30	11/24/18 14:27	1
Lithium	440		5.0	2.6	ug/L		11/23/18 13:30	11/24/18 14:27	1

Method: EPA 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	3.3		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 14:30	1
Barium	280		10	0.37	ug/L		11/23/18 13:30	11/24/18 14:30	1
Beryllium	ND		1.0	0.057	ug/L		11/23/18 13:30	11/24/18 14:30	1
Cadmium	ND		1.0	0.13	ug/L		11/23/18 13:30	11/24/18 14:30	1
Chromium	1.3	J	2.0	0.63	ug/L		11/23/18 13:30	11/24/18 14:30	1

1 2 3 4 5 6 7 8 9 10 11 12 13

Client Sample ID: CCR-AP-8I
Lab Sample ID: 180-84236-8
Date Collected: 11/17/18 15:47
Matrix: Water
Date Received: 11/21/18 10:00

Method: EPA 6020A - Metals (ICP/MS) - Dissolved (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cobalt	0.88		0.50	0.075	ug/L		11/23/18 13:30	11/24/18 14:30	1
Iron	18000		50	14	ug/L		11/23/18 13:30	11/24/18 14:30	1
Lead	ND		1.0	0.094	ug/L		11/23/18 13:30	11/24/18 14:30	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 14:30	1
Selenium	ND		5.0	0.81	ug/L		11/23/18 13:30	11/24/18 14:30	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:30	11/24/18 14:30	1
Lithium	420		5.0	2.6	ug/L		11/23/18 13:30	11/24/18 14:30	1

Method: EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:58	11/27/18 08:29	1

Method: EPA 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:55	11/27/18 07:57	1

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	1.2	J	2.0	0.79	ug/L			11/28/18 19:59	1
Arsenic (V)	1.4	J	2.0	0.75	ug/L			11/28/18 19:59	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	2200		20	20	mg/L			11/21/18 11:00	1
Total Organic Carbon - Duplicates	3.4		1.0	0.51	mg/L			11/26/18 14:45	1
Total Alkalinity as CaCO3 to pH 4.!	220		5.0	5.0	mg/L			11/28/18 05:15	1

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	3.9		1.0	0.51	mg/L			11/27/18 09:38	1

Client Sample ID: HASB-1
Lab Sample ID: 180-84236-9
Date Collected: 11/17/18 16:36
Matrix: Water
Date Received: 11/21/18 10:00

Method: EPA 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	6.5		1.0	0.71	mg/L			12/03/18 11:47	1
Sulfate	110		1.0	0.38	mg/L			12/03/18 11:47	1
Fluoride	0.47		0.10	0.026	mg/L			12/03/18 11:47	1

Method: EPA 9056A - Anions, Ion Chromatography - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	0.47		0.10	0.026	mg/L			12/03/18 10:23	1

Method: EPA 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	6.1		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 14:33	1
Barium	130		10	0.37	ug/L		11/23/18 13:30	11/24/18 14:33	1
Beryllium	0.83	J	1.0	0.057	ug/L		11/23/18 13:30	11/24/18 14:33	1

Client Sample Results

Client: Haley & Aldrich, Inc.
Project/Site: Vectren ASD Sampling - FB Culley

TestAmerica Job ID: 180-84236-1

Client Sample ID: HASB-1

Date Collected: 11/17/18 16:36
Date Received: 11/21/18 10:00

Lab Sample ID: 180-84236-9
Matrix: Water

Method: EPA 6020A - Metals (ICP/MS) - Total Recoverable (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cadmium	0.25	J	1.0	0.13	ug/L		11/23/18 13:30	11/24/18 14:33	1
Chromium	18		2.0	0.63	ug/L		11/23/18 13:30	11/24/18 14:33	1
Cobalt	5.2		0.50	0.075	ug/L		11/23/18 13:30	11/24/18 14:33	1
Iron	11000		50	14	ug/L		11/23/18 13:30	11/24/18 14:33	1
Manganese	750		5.0	1.4	ug/L		11/23/18 13:30	11/24/18 14:33	1
Molybdenum	38		5.0	0.47	ug/L		11/23/18 13:30	11/24/18 14:33	1
Lead	5.6		1.0	0.094	ug/L		11/23/18 13:30	11/24/18 14:33	1
Antimony	2.3		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 14:33	1
Selenium	1.4	J	5.0	0.81	ug/L		11/23/18 13:30	11/24/18 14:33	1
Thallium	0.24	J	1.0	0.063	ug/L		11/23/18 13:30	11/24/18 14:33	1
Lithium	64		5.0	2.6	ug/L		11/23/18 13:30	11/24/18 14:33	1

Method: EPA 6020A - Metals (ICP/MS) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	2.4		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 14:36	1
Barium	81		10	0.37	ug/L		11/23/18 13:30	11/24/18 14:36	1
Beryllium	ND		1.0	0.057	ug/L		11/23/18 13:30	11/24/18 14:36	1
Cadmium	ND		1.0	0.13	ug/L		11/23/18 13:30	11/24/18 14:36	1
Chromium	1.4	J	2.0	0.63	ug/L		11/23/18 13:30	11/24/18 14:36	1
Cobalt	0.59		0.50	0.075	ug/L		11/23/18 13:30	11/24/18 14:36	1
Iron	99		50	14	ug/L		11/23/18 13:30	11/24/18 14:36	1
Lead	ND		1.0	0.094	ug/L		11/23/18 13:30	11/24/18 14:36	1
Antimony	2.1		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 14:36	1
Selenium	ND		5.0	0.81	ug/L		11/23/18 13:30	11/24/18 14:36	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:30	11/24/18 14:36	1
Lithium	48		5.0	2.6	ug/L		11/23/18 13:30	11/24/18 14:36	1

Method: EPA 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:58	11/27/18 08:30	1

Method: EPA 7470A - Mercury (CVAA) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:55	11/27/18 07:59	1

Method: Se Speciation - Selenium Speciation - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	2.6		2.0	0.79	ug/L			11/28/18 20:13	1
Arsenic (V)	0.90	J	2.0	0.75	ug/L			11/28/18 20:13	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	730		10	10	mg/L			11/21/18 11:00	1
Total Organic Carbon - Duplicates	1.4		1.0	0.51	mg/L			11/26/18 14:57	1
Total Alkalinity as CaCO3 to pH 4.!	570		5.0	5.0	mg/L			11/28/18 05:15	1

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	1.7		1.0	0.51	mg/L			11/27/18 09:51	1

Client Sample ID: CCR-AP-8I (68-70)

Lab Sample ID: 180-84236-10

Date Collected: 11/15/18 09:10
Matrix: Solid
Date Received: 11/21/18 10:00

Method: EPA 9056A - Anions, Ion Chromatography - SPLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	7.3		1.0	0.71	mg/L			11/28/18 11:24	1
Fluoride	0.51		0.10	0.026	mg/L			11/28/18 11:24	1
Sulfate	5.7		1.0	0.38	mg/L			11/28/18 11:24	1
Nitrate as N	0.034	J	0.10	0.023	mg/L			11/28/18 11:24	1

Method: 6020A - SPLP Metals - SPLP East

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		2.0	1.1	ug/L		11/27/18 12:10	11/28/18 10:44	1
Arsenic	3.7		1.0	0.32	ug/L		11/27/18 12:10	11/28/18 10:44	1
Barium	24		10	0.37	ug/L		11/27/18 12:10	11/28/18 10:44	1
Beryllium	0.15	J	1.0	0.057	ug/L		11/27/18 12:10	11/28/18 10:44	1
Cadmium	ND		1.0	0.13	ug/L		11/27/18 12:10	11/28/18 10:44	1
Chromium	9.3	B	2.0	0.63	ug/L		11/27/18 12:10	11/28/18 10:44	1
Cobalt	1.2		0.50	0.075	ug/L		11/27/18 12:10	11/28/18 10:44	1
Lead	2.2		1.0	0.094	ug/L		11/27/18 12:10	11/28/18 10:44	1
Lithium	4.8	J	5.0	2.6	ug/L		11/27/18 12:10	11/28/18 10:44	1
Molybdenum	160		5.0	0.47	ug/L		11/27/18 12:10	11/28/18 10:44	1
Selenium	ND		5.0	0.81	ug/L		11/27/18 12:10	11/28/18 10:44	1
Thallium	ND		1.0	0.063	ug/L		11/27/18 12:10	11/28/18 10:44	1

Method: 7470A - SPLP Mercury - SPLP East

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND	^	0.20	0.065	ug/L		11/28/18 11:06	11/29/18 15:05	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	14.8		0.1	0.1	%			11/23/18 08:06	1
Percent Solids	85.2		0.1	0.1	%			11/23/18 08:06	1

General Chemistry - SPLP East

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Ammonia, distilled	ND		0.10	0.046	mg/L		11/27/18 13:31	11/28/18 17:57	1
Total Alkalinity as CaCO3 to pH 4.!	44		5.0	5.0	mg/L			11/28/18 05:00	1
Bicarbonate Alkalinity as CaCO3	28		5.0	5.0	mg/L			11/28/18 05:00	1
Carbonate Alkalinity as CaCO3	16		5.0	5.0	mg/L			11/28/18 05:00	1
Phenolphthalein Alkalinity	8.0		5.0	5.0	mg/L			11/28/18 05:00	1

Client Sample ID: CCR-AP-8I (68-70)

Lab Sample ID: 180-84236-10

Date Collected: 11/15/18 09:10
Matrix: Solid
Date Received: 11/21/18 10:00
Percent Solids: 85.2

Method: EPA 6020A - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.24	0.073	mg/Kg	☼	11/21/18 14:04	11/28/18 19:53	1
Arsenic	3.3		0.12	0.031	mg/Kg	☼	11/21/18 14:04	11/28/18 19:53	1
Barium	8.0		1.2	0.068	mg/Kg	☼	11/21/18 14:04	11/28/18 19:53	1
Beryllium	0.13		0.12	0.0089	mg/Kg	☼	11/21/18 14:04	11/28/18 19:53	1
Cadmium	0.040	J	0.12	0.020	mg/Kg	☼	11/21/18 14:04	11/28/18 19:53	1
Chromium	4.7		0.24	0.078	mg/Kg	☼	11/21/18 14:04	11/28/18 19:53	1
Cobalt	2.5		0.059	0.0098	mg/Kg	☼	11/21/18 14:04	11/28/18 19:53	1

1 2 3 4 5 6 7 8 9 10 11 12 13

Client Sample ID: CCR-AP-8I (68-70)

Lab Sample ID: 180-84236-10
Date Collected: 11/15/18 09:10
Matrix: Solid
Date Received: 11/21/18 10:00
Percent Solids: 85.2

Method: EPA 6020A - Metals (ICP/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	2.6		0.12	0.041	mg/Kg	☼	11/21/18 14:04	11/28/18 19:53	1
Lithium	2.0		0.59	0.33	mg/Kg	☼	11/21/18 14:04	11/28/18 19:53	1
Molybdenum	12		0.59	0.073	mg/Kg	☼	11/21/18 14:04	11/28/18 19:53	1
Selenium	0.089	J	0.59	0.071	mg/Kg	☼	11/21/18 14:04	11/28/18 19:53	1
Thallium	0.035	J	0.12	0.015	mg/Kg	☼	11/21/18 14:04	11/28/18 19:53	1

Method: EPA 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.039	0.017	mg/Kg	☼	11/27/18 17:18	11/28/18 14:51	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon - Duplicates	6400		1200	880	mg/Kg	☼		11/28/18 15:03	1

Client Sample ID: CCR-AP-6I (68-70)

Lab Sample ID: 180-84236-11
Date Collected: 11/16/18 09:25
Matrix: Solid
Date Received: 11/21/18 10:00

Method: EPA 9056A - Anions, Ion Chromatography - SPLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	6.3		1.0	0.71	mg/L			11/28/18 11:39	1
Fluoride	0.35		0.10	0.026	mg/L			11/28/18 11:39	1
Sulfate	8.9		1.0	0.38	mg/L			11/28/18 11:39	1
Nitrate as N	0.034	J	0.10	0.023	mg/L			11/28/18 11:39	1

Method: 6020A - SPLP Metals - SPLP East

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		2.0	1.1	ug/L		11/27/18 12:10	11/28/18 10:47	1
Arsenic	6.1		1.0	0.32	ug/L		11/27/18 12:10	11/28/18 10:47	1
Barium	19		10	0.37	ug/L		11/27/18 12:10	11/28/18 10:47	1
Beryllium	0.26	J	1.0	0.057	ug/L		11/27/18 12:10	11/28/18 10:47	1
Cadmium	ND		1.0	0.13	ug/L		11/27/18 12:10	11/28/18 10:47	1
Chromium	12	B	2.0	0.63	ug/L		11/27/18 12:10	11/28/18 10:47	1
Cobalt	3.1		0.50	0.075	ug/L		11/27/18 12:10	11/28/18 10:47	1
Lead	3.9		1.0	0.094	ug/L		11/27/18 12:10	11/28/18 10:47	1
Lithium	5.1		5.0	2.6	ug/L		11/27/18 12:10	11/28/18 10:47	1
Molybdenum	47		5.0	0.47	ug/L		11/27/18 12:10	11/28/18 10:47	1
Selenium	ND		5.0	0.81	ug/L		11/27/18 12:10	11/28/18 10:47	1
Thallium	ND		1.0	0.063	ug/L		11/27/18 12:10	11/28/18 10:47	1

Method: 7470A - SPLP Mercury - SPLP East

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND	^	0.20	0.065	ug/L		11/28/18 11:06	11/29/18 15:07	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	11.8		0.1	0.1	%			11/23/18 08:06	1
Percent Solids	88.2		0.1	0.1	%			11/23/18 08:06	1

Client Sample ID: CCR-AP-6I (68-70) Lab Sample ID: 180-84236-11

Date Collected: 11/16/18 09:25 Matrix: Solid
Date Received: 11/21/18 10:00

General Chemistry - SPLP East

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Ammonia, distilled	ND		0.10	0.046	mg/L		11/27/18 13:31	11/28/18 17:59	1
Total Alkalinity as CaCO3 to pH 4.!	**28**		5.0	5.0	mg/L			11/28/18 05:00	1
Bicarbonate Alkalinity as CaCO3	**10**		5.0	5.0	mg/L			11/28/18 05:00	1
Carbonate Alkalinity as CaCO3	**18**		5.0	5.0	mg/L			11/28/18 05:00	1
Phenolphthalein Alkalinity	**9.0**		5.0	5.0	mg/L			11/28/18 05:00	1

Client Sample ID: CCR-AP-6I (68-70) Lab Sample ID: 180-84236-11

Date Collected: 11/16/18 09:25 Matrix: Solid
Date Received: 11/21/18 10:00 Percent Solids: 88.2

Method: EPA 6020A - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.24	0.073	mg/Kg	☼	11/21/18 14:04	11/28/18 19:58	1
Arsenic	**3.3**		0.12	0.031	mg/Kg	☼	11/21/18 14:04	11/28/18 19:58	1
Barium	**18**		1.2	0.067	mg/Kg	☼	11/21/18 14:04	11/28/18 19:58	1
Beryllium	**0.14**		0.12	0.0089	mg/Kg	☼	11/21/18 14:04	11/28/18 19:58	1
Cadmium	**0.060**	**J**	0.12	0.020	mg/Kg	☼	11/21/18 14:04	11/28/18 19:58	1
Chromium	**4.9**		0.24	0.078	mg/Kg	☼	11/21/18 14:04	11/28/18 19:58	1
Cobalt	**4.0**		0.059	0.0098	mg/Kg	☼	11/21/18 14:04	11/28/18 19:58	1
Lead	**2.8**		0.12	0.041	mg/Kg	☼	11/21/18 14:04	11/28/18 19:58	1
Lithium	**2.3**		0.59	0.33	mg/Kg	☼	11/21/18 14:04	11/28/18 19:58	1
Molybdenum	**3.1**		0.59	0.073	mg/Kg	☼	11/21/18 14:04	11/28/18 19:58	1
Selenium	ND		0.59	0.071	mg/Kg	☼	11/21/18 14:04	11/28/18 19:58	1
Thallium	**0.039**	**J**	0.12	0.015	mg/Kg	☼	11/21/18 14:04	11/28/18 19:58	1

Method: EPA 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.037	0.016	mg/Kg	☼	11/27/18 17:20	11/28/18 15:07	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon - Duplicates	**3600**		1100	850	mg/Kg	☼		11/28/18 15:13	1

Client Sample ID: HASB-1 (35-38) Lab Sample ID: 180-84236-12

Date Collected: 11/16/18 15:50 Matrix: Solid
Date Received: 11/21/18 10:00

Method: EPA 9056A - Anions, Ion Chromatography - SPLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**6.8**		1.0	0.71	mg/L			11/29/18 06:58	1
Fluoride	**0.86**		0.10	0.026	mg/L			11/29/18 06:58	1
Sulfate	**30**		1.0	0.38	mg/L			11/29/18 06:58	1
Nitrate as N	**0.031**	**J**	0.10	0.023	mg/L			11/29/18 06:58	1

Method: 6020A - SPLP Metals - SPLP East

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	**5.3**		2.0	1.1	ug/L		11/27/18 12:10	11/28/18 10:50	1
Arsenic	**1.9**		1.0	0.32	ug/L		11/27/18 12:10	11/28/18 10:50	1
Barium	**9.1**	**J**	10	0.37	ug/L		11/27/18 12:10	11/28/18 10:50	1
Beryllium	ND		1.0	0.057	ug/L		11/27/18 12:10	11/28/18 10:50	1

Client Sample ID: HASB-1 (35-38)

Lab Sample ID: 180-84236-12
Date Collected: 11/16/18 15:50
Matrix: Solid
Date Received: 11/21/18 10:00

Method: 6020A - SPLP Metals - SPLP East (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cadmium	ND		1.0	0.13	ug/L		11/27/18 12:10	11/28/18 10:50	1
Chromium	**4.6**	**B**	2.0	0.63	ug/L		11/27/18 12:10	11/28/18 10:50	1
Cobalt	**0.099**	**J**	0.50	0.075	ug/L		11/27/18 12:10	11/28/18 10:50	1
Lead	**0.31**	**J**	1.0	0.094	ug/L		11/27/18 12:10	11/28/18 10:50	1
Lithium	**8.8**		5.0	2.6	ug/L		11/27/18 12:10	11/28/18 10:50	1
Molybdenum	**210**		5.0	0.47	ug/L		11/27/18 12:10	11/28/18 10:50	1
Selenium	**37**		5.0	0.81	ug/L		11/27/18 12:10	11/28/18 10:50	1
Thallium	ND		1.0	0.063	ug/L		11/27/18 12:10	11/28/18 10:50	1

Method: 7470A - SPLP Mercury - SPLP East

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND	^	0.20	0.065	ug/L		11/28/18 11:06	11/29/18 15:08	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**8.7**		0.1	0.1	%			11/23/18 08:06	1
Percent Solids	**91.3**		0.1	0.1	%			11/23/18 08:06	1

General Chemistry - SPLP East

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Ammonia, distilled	**0.079**	**J**	0.10	0.046	mg/L		11/27/18 13:31	11/28/18 18:00	1
Total Alkalinity as CaCO3 to pH 4.!	**76**		5.0	5.0	mg/L			11/28/18 05:00	1
Bicarbonate Alkalinity as CaCO3	**62**		5.0	5.0	mg/L			11/28/18 05:00	1
Carbonate Alkalinity as CaCO3	**14**		5.0	5.0	mg/L			11/28/18 05:00	1
Phenolphthalein Alkalinity	**7.0**		5.0	5.0	mg/L			11/28/18 05:00	1

Client Sample ID: HASB-1 (35-38)

Lab Sample ID: 180-84236-12
Date Collected: 11/16/18 15:50
Matrix: Solid
Date Received: 11/21/18 10:00
Percent Solids: 91.3

Method: EPA 6020A - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	**0.96**		0.22	0.067	mg/Kg	☼	11/21/18 14:04	11/28/18 20:03	1
Arsenic	**18**		0.11	0.028	mg/Kg	☼	11/21/18 14:04	11/28/18 20:03	1
Barium	**32**		1.1	0.062	mg/Kg	☼	11/21/18 14:04	11/28/18 20:03	1
Beryllium	**0.93**		0.11	0.0081	mg/Kg	☼	11/21/18 14:04	11/28/18 20:03	1
Cadmium	**3.5**		0.11	0.018	mg/Kg	☼	11/21/18 14:04	11/28/18 20:03	1
Chromium	**29**		0.22	0.072	mg/Kg	☼	11/21/18 14:04	11/28/18 20:03	1
Cobalt	**13**		0.054	0.0090	mg/Kg	☼	11/21/18 14:04	11/28/18 20:03	1
Lead	**23**		0.11	0.038	mg/Kg	☼	11/21/18 14:04	11/28/18 20:03	1
Lithium	**21**		0.54	0.30	mg/Kg	☼	11/21/18 14:04	11/28/18 20:03	1
Molybdenum	**25**		0.54	0.067	mg/Kg	☼	11/21/18 14:04	11/28/18 20:03	1
Selenium	**9.8**		0.54	0.065	mg/Kg	☼	11/21/18 14:04	11/28/18 20:03	1
Thallium	**1.1**		0.11	0.014	mg/Kg	☼	11/21/18 14:04	11/28/18 20:03	1

Method: EPA 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.064**		0.037	0.016	mg/Kg	☼	11/27/18 17:20	11/28/18 15:08	1

Client Sample ID: HASB-1 (35-38)
Lab Sample ID: 180-84236-12

Date Collected: 11/16/18 15:50
Matrix: Solid
Date Received: 11/21/18 10:00
Percent Solids: 91.3

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon - Duplicates	200000		1100	820	mg/Kg	☼		11/28/18 15:24	1

QC Sample Results

Client: Haley & Aldrich, Inc.
TestAmerica Job ID: 180-84236-1
Project/Site: Vectren ASD Sampling - FB Culley

Method: EPA 9056A - Anions, Ion Chromatography

Lab Sample ID: MB 180-263887/6
Client Sample ID: Method Blank
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 263887

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	ND		1.0	0.71	mg/L			11/28/18 05:40	1
Fluoride	ND		0.10	0.026	mg/L			11/28/18 05:40	1
Sulfate	ND		1.0	0.38	mg/L			11/28/18 05:40	1
Nitrate as N	ND		0.10	0.023	mg/L			11/28/18 05:40	1

Lab Sample ID: LCS 180-263887/5
Client Sample ID: Lab Control Sample
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 263887

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Chloride	25.0	25.0		mg/L		100	80 - 120
Fluoride	1.25	1.33		mg/L		106	80 - 120
Sulfate	25.0	24.8		mg/L		99	80 - 120
Nitrate as N	1.25	1.23		mg/L		98	80 - 120

Lab Sample ID: MB 180-264016/6
Client Sample ID: Method Blank
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 264016

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	ND		1.0	0.71	mg/L			11/29/18 05:55	1
Fluoride	ND		0.10	0.026	mg/L			11/29/18 05:55	1
Sulfate	ND		1.0	0.38	mg/L			11/29/18 05:55	1
Nitrate as N	ND		0.10	0.023	mg/L			11/29/18 05:55	1

Lab Sample ID: LCS 180-264016/5
Client Sample ID: Lab Control Sample
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 264016

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Chloride	25.0	25.8		mg/L		103	80 - 120
Fluoride	1.25	1.35		mg/L		108	80 - 120
Sulfate	25.0	25.7		mg/L		103	80 - 120
Nitrate as N	1.25	1.25		mg/L		100	80 - 120

Lab Sample ID: MB 180-264317/6
Client Sample ID: Method Blank
Matrix: Water
Prep Type: Total/NA
Analysis Batch: 264317

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	ND		1.0	0.71	mg/L			12/03/18 06:02	1
Sulfate	ND		1.0	0.38	mg/L			12/03/18 06:02	1
Fluoride	ND		0.10	0.026	mg/L			12/03/18 06:02	1

Method: EPA 9056A - Anions, Ion Chromatography (Continued)

Lab Sample ID: LCS 180-264317/5
Matrix: Water
Analysis Batch: 264317

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Chloride	25.0	25.1		mg/L		101	80 - 120
Sulfate	25.0	25.0		mg/L		100	80 - 120
Fluoride	1.25	1.34		mg/L		107	80 - 120

Lab Sample ID: MB 180-264318/6
Matrix: Water
Analysis Batch: 264318

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	ND		0.10	0.026	mg/L			12/03/18 06:15	1

Lab Sample ID: LCS 180-264318/5
Matrix: Water
Analysis Batch: 264318

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Fluoride	1.25	1.36		mg/L		109	80 - 120

Lab Sample ID: 180-84236-2 MS
Matrix: Water
Analysis Batch: 264318

Client Sample ID: CCR-AP-5
Prep Type: Dissolved

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Fluoride	1.5		1.25	2.78		mg/L		103	80 - 120

Lab Sample ID: 180-84236-2 MSD
Matrix: Water
Analysis Batch: 264318

Client Sample ID: CCR-AP-5
Prep Type: Dissolved

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Fluoride	1.5		1.25	2.76		mg/L		101	80 - 120	1	15

Lab Sample ID: LB 180-263846/1-A
Matrix: Solid
Analysis Batch: 263887

Client Sample ID: Method Blank
Prep Type: SPLP

Analyte	LB Result	LB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	ND		1.0	0.71	mg/L			11/28/18 11:09	1
Fluoride	ND		0.10	0.026	mg/L			11/28/18 11:09	1
Sulfate	ND		1.0	0.38	mg/L			11/28/18 11:09	1
Nitrate as N	ND		0.10	0.023	mg/L			11/28/18 11:09	1

Method: 6020A - SPLP Metals

Lab Sample ID: MB 180-263844/1-A **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 264025 **Prep Batch: 263844**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		1.0	0.32	ug/L		11/27/18 12:10	11/28/18 10:17	1
Barium	ND		10	0.37	ug/L		11/27/18 12:10	11/28/18 10:17	1
Beryllium	ND		1.0	0.057	ug/L		11/27/18 12:10	11/28/18 10:17	1
Cadmium	ND		1.0	0.13	ug/L		11/27/18 12:10	11/28/18 10:17	1
Chromium	0.998	J	2.0	0.63	ug/L		11/27/18 12:10	11/28/18 10:17	1
Cobalt	ND		0.50	0.075	ug/L		11/27/18 12:10	11/28/18 10:17	1
Lead	ND		1.0	0.094	ug/L		11/27/18 12:10	11/28/18 10:17	1
Molybdenum	ND		5.0	0.47	ug/L		11/27/18 12:10	11/28/18 10:17	1
Antimony	ND		2.0	1.1	ug/L		11/27/18 12:10	11/28/18 10:17	1
Selenium	ND		5.0	0.81	ug/L		11/27/18 12:10	11/28/18 10:17	1
Thallium	ND		1.0	0.063	ug/L		11/27/18 12:10	11/28/18 10:17	1
Lithium	ND		5.0	2.6	ug/L		11/27/18 12:10	11/28/18 10:17	1

Lab Sample ID: LCS 180-263844/2-A **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 264025 **Prep Batch: 263844**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	40.0	38.1		ug/L		95	80 - 120
Barium	2000	2140		ug/L		107	80 - 120
Beryllium	50.0	44.5		ug/L		89	80 - 120
Cadmium	50.0	55.8		ug/L		112	80 - 120
Chromium	200	211		ug/L		105	80 - 120
Cobalt	500	483		ug/L		97	80 - 120
Lead	20.0	22.0		ug/L		110	80 - 120
Molybdenum	1000	1080		ug/L		108	80 - 120
Antimony	500	550		ug/L		110	80 - 120
Selenium	10.0	9.46		ug/L		95	80 - 120
Thallium	50.0	56.4		ug/L		113	80 - 120
Lithium	50.0	45.5		ug/L		91	80 - 120

Lab Sample ID: LCSD 180-263844/3-A **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 264025 **Prep Batch: 263844**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Arsenic	40.0	37.8		ug/L		95	80 - 120	1	20
Barium	2000	2090		ug/L		105	80 - 120	2	20
Beryllium	50.0	46.5		ug/L		93	80 - 120	4	20
Cadmium	50.0	55.0		ug/L		110	80 - 120	1	20
Chromium	200	208		ug/L		104	80 - 120	1	20
Cobalt	500	487		ug/L		97	80 - 120	1	20
Lead	20.0	21.9		ug/L		109	80 - 120	0	20
Molybdenum	1000	1070		ug/L		107	80 - 120	1	20
Antimony	500	539		ug/L		108	80 - 120	2	20
Selenium	10.0	9.32		ug/L		93	80 - 120	2	20
Thallium	50.0	55.8		ug/L		112	80 - 120	1	20
Lithium	50.0	47.6		ug/L		95	80 - 120	4	20

Method: 6020A - SPLP Metals (Continued)

Lab Sample ID: LB 180-263760/1-C
Matrix: Solid
Analysis Batch: 264025

Client Sample ID: Method Blank
Prep Type: SPLP East
Prep Batch: 263844

Analyte	LB Result	LB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		1.0	0.32	ug/L		11/27/18 12:10	11/28/18 10:20	1
Barium	ND		10	0.37	ug/L		11/27/18 12:10	11/28/18 10:20	1
Beryllium	ND		1.0	0.057	ug/L		11/27/18 12:10	11/28/18 10:20	1
Cadmium	ND		1.0	0.13	ug/L		11/27/18 12:10	11/28/18 10:20	1
Chromium	ND		2.0	0.63	ug/L		11/27/18 12:10	11/28/18 10:20	1
Cobalt	ND		0.50	0.075	ug/L		11/27/18 12:10	11/28/18 10:20	1
Lead	ND		1.0	0.094	ug/L		11/27/18 12:10	11/28/18 10:20	1
Molybdenum	ND		5.0	0.47	ug/L		11/27/18 12:10	11/28/18 10:20	1
Antimony	ND		2.0	1.1	ug/L		11/27/18 12:10	11/28/18 10:20	1
Selenium	ND		5.0	0.81	ug/L		11/27/18 12:10	11/28/18 10:20	1
Thallium	ND		1.0	0.063	ug/L		11/27/18 12:10	11/28/18 10:20	1
Lithium	ND		5.0	2.6	ug/L		11/27/18 12:10	11/28/18 10:20	1

Method: 7470A - SPLP Mercury

Lab Sample ID: MB 180-263948/1-A
Matrix: Solid
Analysis Batch: 264124

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 263948

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/28/18 11:06	11/29/18 14:52	1

Lab Sample ID: LCS 180-263948/2-A
Matrix: Solid
Analysis Batch: 264124

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 263948

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	2.50	2.48		ug/L		99	80 - 120

Lab Sample ID: LCSD 180-263948/3-A
Matrix: Solid
Analysis Batch: 264124

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 263948

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Mercury	2.50	2.52		ug/L		101	80 - 120	2	20

Lab Sample ID: LB 180-263760/1-F
Matrix: Solid
Analysis Batch: 264124

Client Sample ID: Method Blank
Prep Type: SPLP East
Prep Batch: 263948

Analyte	LB Result	LB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/28/18 11:06	11/29/18 14:55	1

Method: EPA 6020A - Metals (ICP/MS)

Lab Sample ID: MB 180-263578/1-A
Matrix: Solid
Analysis Batch: 264070

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 263578

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		0.10	0.026	mg/Kg		11/21/18 14:04	11/28/18 18:54	1
Barium	ND		1.0	0.057	mg/Kg		11/21/18 14:04	11/28/18 18:54	1
Beryllium	ND		0.10	0.0075	mg/Kg		11/21/18 14:04	11/28/18 18:54	1
Cadmium	ND		0.10	0.017	mg/Kg		11/21/18 14:04	11/28/18 18:54	1
Chromium	ND		0.20	0.066	mg/Kg		11/21/18 14:04	11/28/18 18:54	1
Cobalt	ND		0.050	0.0083	mg/Kg		11/21/18 14:04	11/28/18 18:54	1
Lead	ND		0.10	0.035	mg/Kg		11/21/18 14:04	11/28/18 18:54	1
Molybdenum	ND		0.50	0.062	mg/Kg		11/21/18 14:04	11/28/18 18:54	1
Antimony	ND		0.20	0.062	mg/Kg		11/21/18 14:04	11/28/18 18:54	1
Selenium	ND		0.50	0.060	mg/Kg		11/21/18 14:04	11/28/18 18:54	1
Thallium	ND		0.10	0.013	mg/Kg		11/21/18 14:04	11/28/18 18:54	1
Lithium	ND		0.50	0.28	mg/Kg		11/21/18 14:04	11/28/18 18:54	1

Lab Sample ID: LCS 180-263578/2-A
Matrix: Solid
Analysis Batch: 264070

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 263578

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	4.00	3.90		mg/Kg		97	80 - 120
Barium	200	179		mg/Kg		90	80 - 120
Beryllium	5.00	4.58		mg/Kg		92	80 - 120
Cadmium	5.00	5.21		mg/Kg		104	80 - 120
Chromium	20.0	21.8		mg/Kg		109	80 - 120
Cobalt	50.0	52.9		mg/Kg		106	80 - 120
Lead	2.00	2.17		mg/Kg		109	80 - 120
Molybdenum	100	102		mg/Kg		102	80 - 120
Antimony	50.0	48.9		mg/Kg		98	80 - 120
Selenium	1.00	1.15		mg/Kg		115	80 - 120
Thallium	5.00	5.15		mg/Kg		103	80 - 120
Lithium	5.00	4.85		mg/Kg		97	80 - 120

Lab Sample ID: MB 180-263656/1-A
Matrix: Water
Analysis Batch: 263680

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 263656

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		1.0	0.32	ug/L		11/23/18 13:00	11/24/18 10:14	1
Barium	0.950	J	10	0.37	ug/L		11/23/18 13:00	11/24/18 10:14	1
Beryllium	ND		1.0	0.057	ug/L		11/23/18 13:00	11/24/18 10:14	1
Cadmium	ND		1.0	0.13	ug/L		11/23/18 13:00	11/24/18 10:14	1
Chromium	ND		2.0	0.63	ug/L		11/23/18 13:00	11/24/18 10:14	1
Cobalt	ND		0.50	0.075	ug/L		11/23/18 13:00	11/24/18 10:14	1
Iron	ND		50	14	ug/L		11/23/18 13:00	11/24/18 10:14	1
Manganese	ND		5.0	1.4	ug/L		11/23/18 13:00	11/24/18 10:14	1
Lead	ND		1.0	0.094	ug/L		11/23/18 13:00	11/24/18 10:14	1
Molybdenum	ND		5.0	0.47	ug/L		11/23/18 13:00	11/24/18 10:14	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:00	11/24/18 10:14	1
Selenium	ND		5.0	0.81	ug/L		11/23/18 13:00	11/24/18 10:14	1

Method: EPA 6020A - Metals (ICP/MS) (Continued)

Lab Sample ID: MB 180-263656/1-A
Matrix: Water
Analysis Batch: 263680

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 263656

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:00	11/24/18 10:14	1
Lithium	ND		5.0	2.6	ug/L		11/23/18 13:00	11/24/18 10:14	1

Lab Sample ID: LCS 180-263656/2-A
Matrix: Water
Analysis Batch: 263680

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 263656

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	40.0	39.6		ug/L		99	80 - 120
Barium	2000	2010		ug/L		100	80 - 120
Beryllium	50.0	51.1		ug/L		102	80 - 120
Cadmium	50.0	52.2		ug/L		104	80 - 120
Chromium	200	207		ug/L		103	80 - 120
Cobalt	500	479		ug/L		96	80 - 120
Iron	1000	1080		ug/L		108	80 - 120
Manganese	500	510		ug/L		102	80 - 120
Lead	20.0	20.6		ug/L		103	80 - 120
Molybdenum	1000	1040		ug/L		104	80 - 120
Antimony	500	506		ug/L		101	80 - 120
Selenium	10.0	9.99		ug/L		100	80 - 120
Thallium	50.0	51.0		ug/L		102	80 - 120
Lithium	50.0	47.5		ug/L		95	80 - 120

Lab Sample ID: MB 180-263658/1-A
Matrix: Water
Analysis Batch: 263793

Client Sample ID: Method Blank
Prep Type: Total Recoverable
Prep Batch: 263658

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		1.0	0.32	ug/L		11/23/18 13:30	11/24/18 13:34	1
Barium	ND		10	0.37	ug/L		11/23/18 13:30	11/24/18 13:34	1
Beryllium	ND		1.0	0.057	ug/L		11/23/18 13:30	11/24/18 13:34	1
Cadmium	ND		1.0	0.13	ug/L		11/23/18 13:30	11/24/18 13:34	1
Chromium	ND		2.0	0.63	ug/L		11/23/18 13:30	11/24/18 13:34	1
Cobalt	ND		0.50	0.075	ug/L		11/23/18 13:30	11/24/18 13:34	1
Iron	ND		50	14	ug/L		11/23/18 13:30	11/24/18 13:34	1
Manganese	ND		5.0	1.4	ug/L		11/23/18 13:30	11/24/18 13:34	1
Lead	ND		1.0	0.094	ug/L		11/23/18 13:30	11/24/18 13:34	1
Molybdenum	ND		5.0	0.47	ug/L		11/23/18 13:30	11/24/18 13:34	1
Antimony	ND		2.0	1.1	ug/L		11/23/18 13:30	11/24/18 13:34	1
Selenium	ND		5.0	0.81	ug/L		11/23/18 13:30	11/24/18 13:34	1
Thallium	ND		1.0	0.063	ug/L		11/23/18 13:30	11/24/18 13:34	1
Lithium	ND		5.0	2.6	ug/L		11/23/18 13:30	11/24/18 13:34	1

Lab Sample ID: LCS 180-263658/2-A
Matrix: Water
Analysis Batch: 263793

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 263658

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	40.0	37.6		ug/L		94	80 - 120

Method: EPA 6020A - Metals (ICP/MS) (Continued)

Lab Sample ID: LCS 180-263658/2-A
Matrix: Water
Analysis Batch: 263793

Client Sample ID: Lab Control Sample
Prep Type: Total Recoverable
Prep Batch: 263658

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Barium	2000	1940		ug/L		97	80 - 120
Beryllium	50.0	50.7		ug/L		101	80 - 120
Cadmium	50.0	50.1		ug/L		100	80 - 120
Chromium	200	198		ug/L		99	80 - 120
Cobalt	500	469		ug/L		94	80 - 120
Iron	1000	1010		ug/L		101	80 - 120
Manganese	500	483		ug/L		97	80 - 120
Lead	20.0	19.7		ug/L		99	80 - 120
Molybdenum	1000	995		ug/L		100	80 - 120
Antimony	500	483		ug/L		97	80 - 120
Selenium	10.0	9.32		ug/L		93	80 - 120
Thallium	50.0	48.3		ug/L		97	80 - 120
Lithium	50.0	48.8		ug/L		98	80 - 120

Method: EPA 7470A - Mercury (CVAA)

Lab Sample ID: MB 180-263719/1-A
Matrix: Water
Analysis Batch: 263824

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 263719

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.123	J	0.20	0.065	ug/L		11/26/18 09:55	11/27/18 07:28	1

Lab Sample ID: LCS 180-263719/2-A
Matrix: Water
Analysis Batch: 263824

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 263719

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	2.50	2.61		ug/L		104	80 - 120

Lab Sample ID: MB 180-263721/1-A
Matrix: Water
Analysis Batch: 263824

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 263721

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.20	0.065	ug/L		11/26/18 09:58	11/27/18 08:00	1

Lab Sample ID: LCS 180-263721/2-A
Matrix: Water
Analysis Batch: 263824

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 263721

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	2.50	2.51		ug/L		101	80 - 120

Client: Haley & Aldrich, Inc.
Project/Site: Vectren ASD Sampling - FB Culley

TestAmerica Job ID: 180-84236-1

Method: EPA 7471B - Mercury (CVAA)

Lab Sample ID: MB 180-263884/1-A
Matrix: Solid
Analysis Batch: 264013

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 263884

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.033	0.014	mg/Kg		11/27/18 17:18	11/28/18 14:26	1

Lab Sample ID: LCS 180-263884/2-A
Matrix: Solid
Analysis Batch: 264013

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 263884

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	0.417	0.434		mg/Kg		104	80 - 120

Lab Sample ID: MB 180-263885/1-A
Matrix: Solid
Analysis Batch: 264013

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 263885

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.033	0.014	mg/Kg		11/27/18 17:20	11/28/18 14:54	1

Lab Sample ID: LCS 180-263885/2-A
Matrix: Solid
Analysis Batch: 264013

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 263885

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	0.417	0.430		mg/Kg		103	80 - 120

Method: Se Speciation - Selenium Speciation

Lab Sample ID: MB 280-439085/4
Matrix: Water
Analysis Batch: 439085

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic (III)	ND		2.0	0.79	ug/L			11/28/18 17:08	1
Arsenic (V)	ND		2.0	0.75	ug/L			11/28/18 17:08	1

Lab Sample ID: LCS 280-439085/5
Matrix: Water
Analysis Batch: 439085

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic (III)	50.0	70.5		ug/L		141	50 - 150
Arsenic (V)	50.0	34.0		ug/L		68	50 - 150

Lab Sample ID: 180-84236-5 MS
Matrix: Water
Analysis Batch: 439085

Client Sample ID: CCR-AP-3
Prep Type: Dissolved

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic (III)	5.0	F1	50.0	88.0	F1	ug/L		166	50 - 150
Arsenic (V)	1.2	J F1	50.0	16.2	F1	ug/L		30	50 - 150

Method: Se Speciation - Selenium Speciation (Continued)

Lab Sample ID: 180-84236-5 MSD
Matrix: Water
Analysis Batch: 439085
Client Sample ID: CCR-AP-3
Prep Type: Dissolved

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Arsenic (III)	5.0	F1	50.0	89.4	F1	ug/L		169	50 - 150	2	50
Arsenic (V)	1.2	J F1	50.0	14.2	F1	ug/L		26	50 - 150	13	50

Method: EPA 350.1 - Nitrogen, Ammonia

Lab Sample ID: MB 180-263861/6-A
Matrix: Solid
Analysis Batch: 264014
Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 263861

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Ammonia, distilled	ND		0.10	0.046	mg/L		11/27/18 13:31	11/28/18 17:40	1

Lab Sample ID: LCS 180-263861/7-A
Matrix: Solid
Analysis Batch: 264014
Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 263861

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Ammonia, distilled	2.00	1.95		mg/L		98	90 - 110

Lab Sample ID: LB 180-263760/1-D
Matrix: Solid
Analysis Batch: 264014
Client Sample ID: Method Blank
Prep Type: SPLP East
Prep Batch: 263861

Analyte	LB Result	LB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Ammonia, distilled	ND		0.10	0.046	mg/L		11/27/18 13:31	11/28/18 17:52	1

Method: EPA-Lloyd Kahn - Organic Carbon, Total (TOC)

Lab Sample ID: MB 180-264051/3
Matrix: Solid
Analysis Batch: 264051
Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon - Duplicates	ND		1000	750	mg/Kg			11/28/18 13:52	1

Lab Sample ID: LCS 180-264051/4
Matrix: Solid
Analysis Batch: 264051
Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon - Duplicates	37800	31700		mg/Kg		84	75 - 125

QC Sample Results

Client: Haley & Aldrich, Inc.
Project/Site: Vectren ASD Sampling - FB Culley

TestAmerica Job ID: 180-84236-1

Method: SM 2540C - Solids, Total Dissolved (TDS)

Lab Sample ID: MB 180-263522/2
Matrix: Water
Analysis Batch: 263522

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	ND		10	10	mg/L			11/21/18 11:00	1

Lab Sample ID: LCS 180-263522/1
Matrix: Water
Analysis Batch: 263522

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Dissolved Solids	729	698		mg/L		96	80 - 120

Lab Sample ID: 180-84236-1 DU
Matrix: Water
Analysis Batch: 263522

Client Sample ID: CCR-AP-2
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Total Dissolved Solids	1500		1510		mg/L		1	10

Method: SM 5310C - Total Organic Carbon

Lab Sample ID: MB 180-263767/6
Matrix: Water
Analysis Batch: 263767

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon - Duplicates	ND		1.0	0.51	mg/L			11/26/18 12:41	1

Lab Sample ID: LCS 180-263767/4
Matrix: Water
Analysis Batch: 263767

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon - Duplicates	20.0	18.9		mg/L		94	85 - 115

Lab Sample ID: LCSD 180-263767/5
Matrix: Water
Analysis Batch: 263767

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Total Organic Carbon - Duplicates	20.0	18.8		mg/L		94	85 - 115	0	20

Method: SM 5310C - Organic Carbon, Dissolved (DOC)

Lab Sample ID: MB 180-263820/6
Matrix: Water
Analysis Batch: 263820

Client Sample ID: Method Blank
Prep Type: Dissolved

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	ND		1.0	0.51	mg/L			11/27/18 07:32	1

Client: Haley & Aldrich, Inc. TestAmerica Job ID: 180-84236-1
Project/Site: Vectren ASD Sampling - FB Culley

Method: SM 5310C - Organic Carbon, Dissolved (DOC) (Continued)

Lab Sample ID: LCS 180-263820/4 **Client Sample ID: Lab Control Sample**
Matrix: Water **Prep Type: Dissolved**
Analysis Batch: 263820

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Dissolved Organic Carbon - Duplicate	20.0	19.5		mg/L		98	85 - 115

Lab Sample ID: LCSD 180-263820/5 **Client Sample ID: Lab Control Sample Dup**
Matrix: Water **Prep Type: Dissolved**
Analysis Batch: 263820

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Dissolved Organic Carbon - Duplicate	20.0	19.5		mg/L		98	85 - 115	0	20

Method: SM2320 B - Alkalinity, Total

Lab Sample ID: MB 180-263868/3 **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 263868

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Alkalinity as CaCO3 to pH 4.5	ND		5.0	5.0	mg/L			11/28/18 05:00	1
Bicarbonate Alkalinity as CaCO3	ND		5.0	5.0	mg/L			11/28/18 05:00	1
Carbonate Alkalinity as CaCO3	ND		5.0	5.0	mg/L			11/28/18 05:00	1
Phenolphthalein Alkalinity	ND		5.0	5.0	mg/L			11/28/18 05:00	1

Lab Sample ID: LCS 180-263868/1 **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 263868

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Alkalinity as CaCO3 to pH 4.5	250	258		mg/L		103	90 - 110

Lab Sample ID: LCSD 180-263868/2 **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 263868

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Total Alkalinity as CaCO3 to pH 4.5	250	260		mg/L		104	90 - 110	1	20

Lab Sample ID: MB 180-263870/2 **Client Sample ID: Method Blank**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 263870

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Alkalinity as CaCO3 to pH 4.5	ND		5.0	5.0	mg/L			11/28/18 05:15	1

Method: SM2320 B - Alkalinity, Total (Continued)

Lab Sample ID: LCS 180-263870/1 **Client Sample ID: Lab Control Sample**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 263870

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Alkalinity as CaCO3 to pH 4.5	250	260		mg/L		104	90 - 110

Lab Sample ID: MB 180-263925/2 **Client Sample ID: Method Blank**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 263925

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Alkalinity as CaCO3 to pH 4.5	ND		5.0	5.0	mg/L			11/28/18 09:11	1

Lab Sample ID: LCS 180-263925/1 **Client Sample ID: Lab Control Sample**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 263925

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Alkalinity as CaCO3 to pH 4.5	1000	1080		mg/L		108	90 - 110

Lab Sample ID: 180-84236-4 DU **Client Sample ID: CCR-AP-8**
Matrix: Water **Prep Type: Total/NA**
Analysis Batch: 263925

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Total Alkalinity as CaCO3 to pH 4.5	1300		1310		mg/L		0.7	20

Lab Sample ID: LB 180-263760/1-A **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: SPLP East**
Analysis Batch: 263868

Analyte	LB Result	LB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Alkalinity as CaCO3 to pH 4.5	ND		5.0	5.0	mg/L			11/28/18 05:00	1
Bicarbonate Alkalinity as CaCO3	ND		5.0	5.0	mg/L			11/28/18 05:00	1
Carbonate Alkalinity as CaCO3	ND		5.0	5.0	mg/L			11/28/18 05:00	1
Phenolphthalein Alkalinity	ND		5.0	5.0	mg/L			11/28/18 05:00	1

HPLC/IC

Leach Batch: 263846

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	SPLP	Solid	1312	
180-84236-11	CCR-AP-6I (68-70)	SPLP	Solid	1312	
180-84236-12	HASB-1 (35-38)	SPLP	Solid	1312	
LB 180-263846/1-A	Method Blank	SPLP	Solid	1312	

Analysis Batch: 263887

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	SPLP	Solid	EPA 9056A	263846
180-84236-11	CCR-AP-6I (68-70)	SPLP	Solid	EPA 9056A	263846
LB 180-263846/1-A	Method Blank	SPLP	Solid	EPA 9056A	263846
MB 180-263887/6	Method Blank	Total/NA	Solid	EPA 9056A	
LCS 180-263887/5	Lab Control Sample	Total/NA	Solid	EPA 9056A	

Analysis Batch: 264016

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-12	HASB-1 (35-38)	SPLP	Solid	EPA 9056A	263846
MB 180-264016/6	Method Blank	Total/NA	Solid	EPA 9056A	
LCS 180-264016/5	Lab Control Sample	Total/NA	Solid	EPA 9056A	

Analysis Batch: 264317

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-1	CCR-AP-2	Total/NA	Water	EPA 9056A	
180-84236-1	CCR-AP-2	Total/NA	Water	EPA 9056A	
180-84236-2	CCR-AP-5	Total/NA	Water	EPA 9056A	
180-84236-3	CCR-AP-4	Total/NA	Water	EPA 9056A	
180-84236-4	CCR-AP-8	Total/NA	Water	EPA 9056A	
180-84236-5	CCR-AP-3	Total/NA	Water	EPA 9056A	
180-84236-6	CCR-AP-6	Total/NA	Water	EPA 9056A	
180-84236-7	CCR-AP-6I	Total/NA	Water	EPA 9056A	
180-84236-7	CCR-AP-6I	Total/NA	Water	EPA 9056A	
180-84236-8	CCR-AP-8I	Total/NA	Water	EPA 9056A	
180-84236-8	CCR-AP-8I	Total/NA	Water	EPA 9056A	
180-84236-9	HASB-1	Total/NA	Water	EPA 9056A	
MB 180-264317/6	Method Blank	Total/NA	Water	EPA 9056A	
LCS 180-264317/5	Lab Control Sample	Total/NA	Water	EPA 9056A	

Analysis Batch: 264318

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-1	CCR-AP-2	Dissolved	Water	EPA 9056A	
180-84236-2	CCR-AP-5	Dissolved	Water	EPA 9056A	
180-84236-3	CCR-AP-4	Dissolved	Water	EPA 9056A	
180-84236-4	CCR-AP-8	Dissolved	Water	EPA 9056A	
180-84236-5	CCR-AP-3	Dissolved	Water	EPA 9056A	
180-84236-6	CCR-AP-6	Dissolved	Water	EPA 9056A	
180-84236-7	CCR-AP-6I	Dissolved	Water	EPA 9056A	
180-84236-8	CCR-AP-8I	Dissolved	Water	EPA 9056A	
180-84236-9	HASB-1	Dissolved	Water	EPA 9056A	
MB 180-264318/6	Method Blank	Total/NA	Water	EPA 9056A	
LCS 180-264318/5	Lab Control Sample	Total/NA	Water	EPA 9056A	
180-84236-2 MS	CCR-AP-5	Dissolved	Water	EPA 9056A	
180-84236-2 MSD	CCR-AP-5	Dissolved	Water	EPA 9056A	

QC Association Summary

Client: Haley & Aldrich, Inc. TestAmerica Job ID: 180-84236-1
Project/Site: Vectren ASD Sampling - FB Culley

Metals

Prep Batch: 263578

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	Total/NA	Solid	3050B	
180-84236-11	CCR-AP-6I (68-70)	Total/NA	Solid	3050B	
180-84236-12	HASB-1 (35-38)	Total/NA	Solid	3050B	
MB 180-263578/1-A	Method Blank	Total/NA	Solid	3050B	
LCS 180-263578/2-A	Lab Control Sample	Total/NA	Solid	3050B	

Prep Batch: 263656

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-1	CCR-AP-2	Dissolved	Water	3005A	
180-84236-1	CCR-AP-2	Total Recoverable	Water	3005A	
MB 180-263656/1-A	Method Blank	Total Recoverable	Water	3005A	
LCS 180-263656/2-A	Lab Control Sample	Total Recoverable	Water	3005A	

Prep Batch: 263658

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-2	CCR-AP-5	Dissolved	Water	3005A	
180-84236-2	CCR-AP-5	Total Recoverable	Water	3005A	
180-84236-3	CCR-AP-4	Dissolved	Water	3005A	
180-84236-3	CCR-AP-4	Total Recoverable	Water	3005A	
180-84236-4	CCR-AP-8	Dissolved	Water	3005A	
180-84236-4	CCR-AP-8	Total Recoverable	Water	3005A	
180-84236-5	CCR-AP-3	Dissolved	Water	3005A	
180-84236-5	CCR-AP-3	Total Recoverable	Water	3005A	
180-84236-6	CCR-AP-6	Dissolved	Water	3005A	
180-84236-6	CCR-AP-6	Total Recoverable	Water	3005A	
180-84236-7	CCR-AP-6I	Dissolved	Water	3005A	
180-84236-7	CCR-AP-6I	Total Recoverable	Water	3005A	
180-84236-8	CCR-AP-8I	Dissolved	Water	3005A	
180-84236-8	CCR-AP-8I	Total Recoverable	Water	3005A	
180-84236-9	HASB-1	Dissolved	Water	3005A	
180-84236-9	HASB-1	Total Recoverable	Water	3005A	
MB 180-263658/1-A	Method Blank	Total Recoverable	Water	3005A	
LCS 180-263658/2-A	Lab Control Sample	Total Recoverable	Water	3005A	

Analysis Batch: 263680

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-1	CCR-AP-2	Dissolved	Water	EPA 6020A	263656
180-84236-1	CCR-AP-2	Total Recoverable	Water	EPA 6020A	263656
180-84236-1	CCR-AP-2	Total Recoverable	Water	EPA 6020A	263656
MB 180-263656/1-A	Method Blank	Total Recoverable	Water	EPA 6020A	263656
LCS 180-263656/2-A	Lab Control Sample	Total Recoverable	Water	EPA 6020A	263656

Prep Batch: 263719

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-1	CCR-AP-2	Dissolved	Water	7470A	
180-84236-2	CCR-AP-5	Dissolved	Water	7470A	
180-84236-3	CCR-AP-4	Dissolved	Water	7470A	
180-84236-4	CCR-AP-8	Dissolved	Water	7470A	
180-84236-5	CCR-AP-3	Dissolved	Water	7470A	
180-84236-6	CCR-AP-6	Dissolved	Water	7470A	
180-84236-7	CCR-AP-6I	Dissolved	Water	7470A	

Metals (Continued)

Prep Batch: 263719 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-8	CCR-AP-8I	Dissolved	Water	7470A	
180-84236-9	HASB-1	Dissolved	Water	7470A	
MB 180-263719/1-A	Method Blank	Total/NA	Water	7470A	
LCS 180-263719/2-A	Lab Control Sample	Total/NA	Water	7470A	

Prep Batch: 263721

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-1	CCR-AP-2	Total/NA	Water	7470A	
180-84236-2	CCR-AP-5	Total/NA	Water	7470A	
180-84236-3	CCR-AP-4	Total/NA	Water	7470A	
180-84236-4	CCR-AP-8	Total/NA	Water	7470A	
180-84236-5	CCR-AP-3	Total/NA	Water	7470A	
180-84236-6	CCR-AP-6	Total/NA	Water	7470A	
180-84236-7	CCR-AP-6I	Total/NA	Water	7470A	
180-84236-8	CCR-AP-8I	Total/NA	Water	7470A	
180-84236-9	HASB-1	Total/NA	Water	7470A	
MB 180-263721/1-A	Method Blank	Total/NA	Water	7470A	
LCS 180-263721/2-A	Lab Control Sample	Total/NA	Water	7470A	

Leach Batch: 263760

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	SPLP East	Solid	EPA 1312	
180-84236-11	CCR-AP-6I (68-70)	SPLP East	Solid	EPA 1312	
180-84236-12	HASB-1 (35-38)	SPLP East	Solid	EPA 1312	
LB 180-263760/1-C	Method Blank	SPLP East	Solid	EPA 1312	
LB 180-263760/1-F	Method Blank	SPLP East	Solid	EPA 1312	

Analysis Batch: 263793

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-2	CCR-AP-5	Dissolved	Water	EPA 6020A	263658
180-84236-2	CCR-AP-5	Total Recoverable	Water	EPA 6020A	263658
180-84236-3	CCR-AP-4	Dissolved	Water	EPA 6020A	263658
180-84236-3	CCR-AP-4	Total Recoverable	Water	EPA 6020A	263658
180-84236-4	CCR-AP-8	Dissolved	Water	EPA 6020A	263658
180-84236-4	CCR-AP-8	Total Recoverable	Water	EPA 6020A	263658
180-84236-5	CCR-AP-3	Dissolved	Water	EPA 6020A	263658
180-84236-5	CCR-AP-3	Total Recoverable	Water	EPA 6020A	263658
180-84236-6	CCR-AP-6	Dissolved	Water	EPA 6020A	263658
180-84236-6	CCR-AP-6	Total Recoverable	Water	EPA 6020A	263658
180-84236-7	CCR-AP-6I	Dissolved	Water	EPA 6020A	263658
180-84236-7	CCR-AP-6I	Total Recoverable	Water	EPA 6020A	263658
180-84236-8	CCR-AP-8I	Dissolved	Water	EPA 6020A	263658
180-84236-8	CCR-AP-8I	Total Recoverable	Water	EPA 6020A	263658
180-84236-9	HASB-1	Dissolved	Water	EPA 6020A	263658
180-84236-9	HASB-1	Total Recoverable	Water	EPA 6020A	263658
MB 180-263658/1-A	Method Blank	Total Recoverable	Water	EPA 6020A	263658
LCS 180-263658/2-A	Lab Control Sample	Total Recoverable	Water	EPA 6020A	263658

Analysis Batch: 263824

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-1	CCR-AP-2	Dissolved	Water	EPA 7470A	263719

QC Association Summary

Client: Haley & Aldrich, Inc.
Project/Site: Vectren ASD Sampling - FB Culley

TestAmerica Job ID: 180-84236-1

Metals (Continued)

Analysis Batch: 263824 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-1	CCR-AP-2	Total/NA	Water	EPA 7470A	263721
180-84236-2	CCR-AP-5	Dissolved	Water	EPA 7470A	263719
180-84236-2	CCR-AP-5	Total/NA	Water	EPA 7470A	263721
180-84236-3	CCR-AP-4	Dissolved	Water	EPA 7470A	263719
180-84236-3	CCR-AP-4	Total/NA	Water	EPA 7470A	263721
180-84236-4	CCR-AP-8	Dissolved	Water	EPA 7470A	263719
180-84236-4	CCR-AP-8	Total/NA	Water	EPA 7470A	263721
180-84236-5	CCR-AP-3	Dissolved	Water	EPA 7470A	263719
180-84236-5	CCR-AP-3	Total/NA	Water	EPA 7470A	263721
180-84236-6	CCR-AP-6	Dissolved	Water	EPA 7470A	263719
180-84236-6	CCR-AP-6	Total/NA	Water	EPA 7470A	263721
180-84236-7	CCR-AP-6I	Dissolved	Water	EPA 7470A	263719
180-84236-7	CCR-AP-6I	Total/NA	Water	EPA 7470A	263721
180-84236-8	CCR-AP-8I	Dissolved	Water	EPA 7470A	263719
180-84236-8	CCR-AP-8I	Total/NA	Water	EPA 7470A	263721
180-84236-9	HASB-1	Dissolved	Water	EPA 7470A	263719
180-84236-9	HASB-1	Total/NA	Water	EPA 7470A	263721
MB 180-263719/1-A	Method Blank	Total/NA	Water	EPA 7470A	263719
MB 180-263721/1-A	Method Blank	Total/NA	Water	EPA 7470A	263721
LCS 180-263719/2-A	Lab Control Sample	Total/NA	Water	EPA 7470A	263719
LCS 180-263721/2-A	Lab Control Sample	Total/NA	Water	EPA 7470A	263721

Prep Batch: 263844

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	SPLP East	Solid	3010A	263760
180-84236-11	CCR-AP-6I (68-70)	SPLP East	Solid	3010A	263760
180-84236-12	HASB-1 (35-38)	SPLP East	Solid	3010A	263760
LB 180-263760/1-C	Method Blank	SPLP East	Solid	3010A	263760
MB 180-263844/1-A	Method Blank	Total/NA	Solid	3010A	
LCS 180-263844/2-A	Lab Control Sample	Total/NA	Solid	3010A	
LCSD 180-263844/3-A	Lab Control Sample Dup	Total/NA	Solid	3010A	

Prep Batch: 263884

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	Total/NA	Solid	7471B	
MB 180-263884/1-A	Method Blank	Total/NA	Solid	7471B	
LCS 180-263884/2-A	Lab Control Sample	Total/NA	Solid	7471B	

Prep Batch: 263885

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-11	CCR-AP-6I (68-70)	Total/NA	Solid	7471B	
180-84236-12	HASB-1 (35-38)	Total/NA	Solid	7471B	
MB 180-263885/1-A	Method Blank	Total/NA	Solid	7471B	
LCS 180-263885/2-A	Lab Control Sample	Total/NA	Solid	7471B	

Prep Batch: 263948

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	SPLP East	Solid	7470A	263760
180-84236-11	CCR-AP-6I (68-70)	SPLP East	Solid	7470A	263760
180-84236-12	HASB-1 (35-38)	SPLP East	Solid	7470A	263760
LB 180-263760/1-F	Method Blank	SPLP East	Solid	7470A	263760

Metals (Continued)

Prep Batch: 263948 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 180-263948/1-A	Method Blank	Total/NA	Solid	7470A	
LCS 180-263948/2-A	Lab Control Sample	Total/NA	Solid	7470A	
LCSD 180-263948/3-A	Lab Control Sample Dup	Total/NA	Solid	7470A	

Analysis Batch: 264013

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	Total/NA	Solid	EPA 7471B	263884
180-84236-11	CCR-AP-6I (68-70)	Total/NA	Solid	EPA 7471B	263885
180-84236-12	HASB-1 (35-38)	Total/NA	Solid	EPA 7471B	263885
MB 180-263884/1-A	Method Blank	Total/NA	Solid	EPA 7471B	263884
MB 180-263885/1-A	Method Blank	Total/NA	Solid	EPA 7471B	263885
LCS 180-263884/2-A	Lab Control Sample	Total/NA	Solid	EPA 7471B	263884
LCS 180-263885/2-A	Lab Control Sample	Total/NA	Solid	EPA 7471B	263885

Analysis Batch: 264025

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	SPLP East	Solid	6020A	263844
180-84236-11	CCR-AP-6I (68-70)	SPLP East	Solid	6020A	263844
180-84236-12	HASB-1 (35-38)	SPLP East	Solid	6020A	263844
LB 180-263760/1-C	Method Blank	SPLP East	Solid	6020A	263844
MB 180-263844/1-A	Method Blank	Total/NA	Solid	6020A	263844
LCS 180-263844/2-A	Lab Control Sample	Total/NA	Solid	6020A	263844
LCSD 180-263844/3-A	Lab Control Sample Dup	Total/NA	Solid	6020A	263844

Analysis Batch: 264070

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	Total/NA	Solid	EPA 6020A	263578
180-84236-11	CCR-AP-6I (68-70)	Total/NA	Solid	EPA 6020A	263578
180-84236-12	HASB-1 (35-38)	Total/NA	Solid	EPA 6020A	263578
MB 180-263578/1-A	Method Blank	Total/NA	Solid	EPA 6020A	263578
LCS 180-263578/2-A	Lab Control Sample	Total/NA	Solid	EPA 6020A	263578

Analysis Batch: 264124

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	SPLP East	Solid	7470A	263948
180-84236-11	CCR-AP-6I (68-70)	SPLP East	Solid	7470A	263948
180-84236-12	HASB-1 (35-38)	SPLP East	Solid	7470A	263948
LB 180-263760/1-F	Method Blank	SPLP East	Solid	7470A	263948
MB 180-263948/1-A	Method Blank	Total/NA	Solid	7470A	263948
LCS 180-263948/2-A	Lab Control Sample	Total/NA	Solid	7470A	263948
LCSD 180-263948/3-A	Lab Control Sample Dup	Total/NA	Solid	7470A	263948

Analysis Batch: 264192

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	Total/NA	Solid	EPA 6020A	263578
180-84236-11	CCR-AP-6I (68-70)	Total/NA	Solid	EPA 6020A	263578
180-84236-12	HASB-1 (35-38)	Total/NA	Solid	EPA 6020A	263578
MB 180-263578/1-A	Method Blank	Total/NA	Solid	EPA 6020A	263578
LCS 180-263578/2-A	Lab Control Sample	Total/NA	Solid	EPA 6020A	263578

Metals (Continued)

Analysis Batch: 439085

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-1	CCR-AP-2	Dissolved	Water	Se Speciation	
180-84236-2	CCR-AP-5	Dissolved	Water	Se Speciation	
180-84236-3	CCR-AP-4	Dissolved	Water	Se Speciation	
180-84236-4	CCR-AP-8	Dissolved	Water	Se Speciation	
180-84236-5	CCR-AP-3	Dissolved	Water	Se Speciation	
180-84236-6	CCR-AP-6	Dissolved	Water	Se Speciation	
180-84236-7	CCR-AP-6I	Dissolved	Water	Se Speciation	
180-84236-8	CCR-AP-8I	Dissolved	Water	Se Speciation	
180-84236-9	HASB-1	Dissolved	Water	Se Speciation	
MB 280-439085/4	Method Blank	Total/NA	Water	Se Speciation	
LCS 280-439085/5	Lab Control Sample	Total/NA	Water	Se Speciation	
180-84236-5 MS	CCR-AP-3	Dissolved	Water	Se Speciation	
180-84236-5 MSD	CCR-AP-3	Dissolved	Water	Se Speciation	

General Chemistry

Analysis Batch: 263522

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-1	CCR-AP-2	Total/NA	Water	SM 2540C	
180-84236-2	CCR-AP-5	Total/NA	Water	SM 2540C	
180-84236-3	CCR-AP-4	Total/NA	Water	SM 2540C	
180-84236-4	CCR-AP-8	Total/NA	Water	SM 2540C	
180-84236-5	CCR-AP-3	Total/NA	Water	SM 2540C	
180-84236-6	CCR-AP-6	Total/NA	Water	SM 2540C	
180-84236-7	CCR-AP-6I	Total/NA	Water	SM 2540C	
180-84236-8	CCR-AP-8I	Total/NA	Water	SM 2540C	
180-84236-9	HASB-1	Total/NA	Water	SM 2540C	
MB 180-263522/2	Method Blank	Total/NA	Water	SM 2540C	
LCS 180-263522/1	Lab Control Sample	Total/NA	Water	SM 2540C	
180-84236-1 DU	CCR-AP-2	Total/NA	Water	SM 2540C	

Analysis Batch: 263619

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	Total/NA	Solid	2540G	
180-84236-11	CCR-AP-6I (68-70)	Total/NA	Solid	2540G	
180-84236-12	HASB-1 (35-38)	Total/NA	Solid	2540G	

Leach Batch: 263760

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	SPLP East	Solid	EPA 1312	
180-84236-11	CCR-AP-6I (68-70)	SPLP East	Solid	EPA 1312	
180-84236-12	HASB-1 (35-38)	SPLP East	Solid	EPA 1312	
LB 180-263760/1-A	Method Blank	SPLP East	Solid	EPA 1312	
LB 180-263760/1-D	Method Blank	SPLP East	Solid	EPA 1312	

Analysis Batch: 263767

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-1	CCR-AP-2	Total/NA	Water	SM 5310C	
180-84236-2	CCR-AP-5	Total/NA	Water	SM 5310C	
180-84236-3	CCR-AP-4	Total/NA	Water	SM 5310C	

QC Association Summary

Client: Haley & Aldrich, Inc.
Project/Site: Vectren ASD Sampling - FB Culley

TestAmerica Job ID: 180-84236-1

General Chemistry (Continued)

Analysis Batch: 263767 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-4	CCR-AP-8	Total/NA	Water	SM 5310C	
180-84236-5	CCR-AP-3	Total/NA	Water	SM 5310C	
180-84236-6	CCR-AP-6	Total/NA	Water	SM 5310C	
180-84236-7	CCR-AP-6I	Total/NA	Water	SM 5310C	
180-84236-8	CCR-AP-8I	Total/NA	Water	SM 5310C	
180-84236-9	HASB-1	Total/NA	Water	SM 5310C	
MB 180-263767/6	Method Blank	Total/NA	Water	SM 5310C	
LCS 180-263767/4	Lab Control Sample	Total/NA	Water	SM 5310C	
LCSD 180-263767/5	Lab Control Sample Dup	Total/NA	Water	SM 5310C	

Analysis Batch: 263820

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-1	CCR-AP-2	Dissolved	Water	SM 5310C	
180-84236-2	CCR-AP-5	Dissolved	Water	SM 5310C	
180-84236-3	CCR-AP-4	Dissolved	Water	SM 5310C	
180-84236-4	CCR-AP-8	Dissolved	Water	SM 5310C	
180-84236-5	CCR-AP-3	Dissolved	Water	SM 5310C	
180-84236-6	CCR-AP-6	Dissolved	Water	SM 5310C	
180-84236-7	CCR-AP-6I	Dissolved	Water	SM 5310C	
180-84236-8	CCR-AP-8I	Dissolved	Water	SM 5310C	
180-84236-9	HASB-1	Dissolved	Water	SM 5310C	
MB 180-263820/6	Method Blank	Dissolved	Water	SM 5310C	
LCS 180-263820/4	Lab Control Sample	Dissolved	Water	SM 5310C	
LCSD 180-263820/5	Lab Control Sample Dup	Dissolved	Water	SM 5310C	

Prep Batch: 263861

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	SPLP East	Solid	Distill/Ammonia	263760
180-84236-11	CCR-AP-6I (68-70)	SPLP East	Solid	Distill/Ammonia	263760
180-84236-12	HASB-1 (35-38)	SPLP East	Solid	Distill/Ammonia	263760
LB 180-263760/1-D	Method Blank	SPLP East	Solid	Distill/Ammonia	263760
MB 180-263861/6-A	Method Blank	Total/NA	Solid	Distill/Ammonia	
LCS 180-263861/7-A	Lab Control Sample	Total/NA	Solid	Distill/Ammonia	

Analysis Batch: 263868

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	SPLP East	Solid	SM2320 B	263760
180-84236-11	CCR-AP-6I (68-70)	SPLP East	Solid	SM2320 B	263760
180-84236-12	HASB-1 (35-38)	SPLP East	Solid	SM2320 B	263760
LB 180-263760/1-A	Method Blank	SPLP East	Solid	SM2320 B	263760
MB 180-263868/3	Method Blank	Total/NA	Solid	SM2320 B	
LCS 180-263868/1	Lab Control Sample	Total/NA	Solid	SM2320 B	
LCSD 180-263868/2	Lab Control Sample Dup	Total/NA	Solid	SM2320 B	

Analysis Batch: 263870

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-1	CCR-AP-2	Total/NA	Water	SM2320 B	
180-84236-2	CCR-AP-5	Total/NA	Water	SM2320 B	
180-84236-3	CCR-AP-4	Total/NA	Water	SM2320 B	
180-84236-7	CCR-AP-6I	Total/NA	Water	SM2320 B	
180-84236-8	CCR-AP-8I	Total/NA	Water	SM2320 B	

QC Association Summary

Client: Haley & Aldrich, Inc.
Project/Site: Vectren ASD Sampling - FB Culley

TestAmerica Job ID: 180-84236-1

General Chemistry (Continued)

Analysis Batch: 263870 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-9	HASB-1	Total/NA	Water	SM2320 B	
MB 180-263870/2	Method Blank	Total/NA	Water	SM2320 B	
LCS 180-263870/1	Lab Control Sample	Total/NA	Water	SM2320 B	

Analysis Batch: 263925

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-4	CCR-AP-8	Total/NA	Water	SM2320 B	
180-84236-5	CCR-AP-3	Total/NA	Water	SM2320 B	
180-84236-6	CCR-AP-6	Total/NA	Water	SM2320 B	
MB 180-263925/2	Method Blank	Total/NA	Water	SM2320 B	
LCS 180-263925/1	Lab Control Sample	Total/NA	Water	SM2320 B	
180-84236-4 DU	CCR-AP-8	Total/NA	Water	SM2320 B	

Analysis Batch: 264014

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	SPLP East	Solid	EPA 350.1	263861
180-84236-11	CCR-AP-6I (68-70)	SPLP East	Solid	EPA 350.1	263861
180-84236-12	HASB-1 (35-38)	SPLP East	Solid	EPA 350.1	263861
LB 180-263760/1-D	Method Blank	SPLP East	Solid	EPA 350.1	263861
MB 180-263861/6-A	Method Blank	Total/NA	Solid	EPA 350.1	263861
LCS 180-263861/7-A	Lab Control Sample	Total/NA	Solid	EPA 350.1	263861

Analysis Batch: 264051

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-84236-10	CCR-AP-8I (68-70)	Total/NA	Solid	EPA-Lloyd Kahn	
180-84236-11	CCR-AP-6I (68-70)	Total/NA	Solid	EPA-Lloyd Kahn	
180-84236-12	HASB-1 (35-38)	Total/NA	Solid	EPA-Lloyd Kahn	
MB 180-264051/3	Method Blank	Total/NA	Solid	EPA-Lloyd Kahn	
LCS 180-264051/4	Lab Control Sample	Total/NA	Solid	EPA-Lloyd Kahn	

Chain of Custody Record

273727

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING
TestAmerica Laboratories, Inc.
TAL-8210 (0713)

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

Client Contact	Project Manager: C. Horch	Site Contact: S. Lewis	Date: 11/19/18	COC No:
Company Name: Haley Aldrich	Tel/Fax:	Lab Contact: Veronica Bortot	Carrier: UPS	1 of 1 COCs
Address: 400 Augusta St, Suite 130	Analysis Turnaround Time			Sampler:
City/State/Zip: Greenville, SC 29601	☐ CALENDAR DAYS ☐ WORKING DAYS			For Lab Use Only:
Phone: 864-395-0324	TAT if different from Below ____			Walk-in Client:
Fax:	☒ 2 weeks			Lab Sampling:
Project Name: Vectren ASD	☐ 1 week			
Site:	☐ 2 days			Job / SDG No.:
P O # 129420-001	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)	Cl, SO4, F, Alkalinity	Dissolved F	App IV, Fe, Mn	Dissolved App III + Fe	Dissolved TOC	Total TOC	As speciation	TDS	App IV total	App IV dissolved SPLP	TOC	Cl, SO4, Nitrate via SPLP	Ammonia, sulfide SPLP	Alkalinity SPLP	Sample Specific Notes:
CCR-AP-2	11/15/18	925	G	GW	10	Y	N	X	X	X	X	X	X	X	X							–
CCR-AP-5	11/15/18	1146	G	GW	10	Y	N	X	X	X	X	X	X	X	X							
CCR-AP-4	11/15/18	1500	G	GW	10	Y	N	X	X	X	X	X	X	X	X							
CCR-AP-8	11/16/18	902	G	GW	10	Y	N	X	X	X	X	X	X	X	X							
CCR-AP-3	11/16/18	1037	G	GW	10	Y	N	X	X	X	X	X	X	X	X							
CCR-AP-6	11/17/18	1001	G	GW	10	Y	N	X	X	X	X	X	X	X	X							
CCR-AP-6I	11/17/18	1427	G	GW	10	Y	N	X	X	X	X	X	X	X	X							
CCR-AP-8I	11/17/18	1547	G	GW	10	Y	N	X	X	X	X	X	X	X	X							
HASB-1	11/17/18	1636	G	GW	10	Y	N	X	X	X	X	X	X	X	X							
CCR-AP-8I (68-70)	11/15/18	910	G	S	4	N	N									X	X	X	X	X	X	
CCR-AP-6I (68-70)	11/16/18	925	G	S	4	N	N									X	X	X	X	X	X	
HASB-1 (35-38)	11/16/18	1550	G	S	4	N	N									X	X	X	X	X	X	
Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other								1	1	4	4	3	3	1	1	1	1	1	1	1	1	

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ Return to Client ☐ Disposal by Lab ☐ Archive for ______ Months

Special Instructions/QC Requirements & Comments:

Custody Seals Intact: ☐ Yes ☐ No	Custody Seal No.:	Cooler Temp. (°C): Obs'd: ____ Corr'd: ____	Therm ID No.:

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
[signature]	Haley and Aldrich	11/19/18 0910	[signature]	TA Pitt	11/21/18 900
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

180-84236 Chain of Custody

UPS Worldwide Express®

Shipping Docume

Uncorrected temp 3.2 / 3.7C

Thermometer ID 10

CF +0.2 Initials MD

PT-WI-SR-001 effective 7/26/13

1

1

EXPORT

J451 750 890 0

EXPORT

J451 750 890 0

TELEPHONE

UPS Next Day Air®

1

DELIVERY

J451 750 890 0

J451 750 890 0

TRACKING NUMBER

DATE OF SHIPMENT

/ /

Service, Louisville, KY

180-84236 Waybill

1 2 3 4 5 6 7 8 9 10 11 12 13

UPS Next Day Air®
UPS Worldwide Express®

Shipping Document

LTR	PAK	WEIGHT	DIMENSIONAL	LARGE

Uncorrected temp 5.3 / 5.5 °C
Thermometer ID D
CF +0.2 Initials ND
PT-WI-SR-001 effective 7/26/13

SHIPMENT FROM
UPS ACCOUNT NO. 376124
REFERENCE NUMBER 125420-001
Sean Lewis TELEPHONE 864-393-0326
Daley and Aldrich, Inc
400 Augusta St, Rm 130
Greenville SC 29601

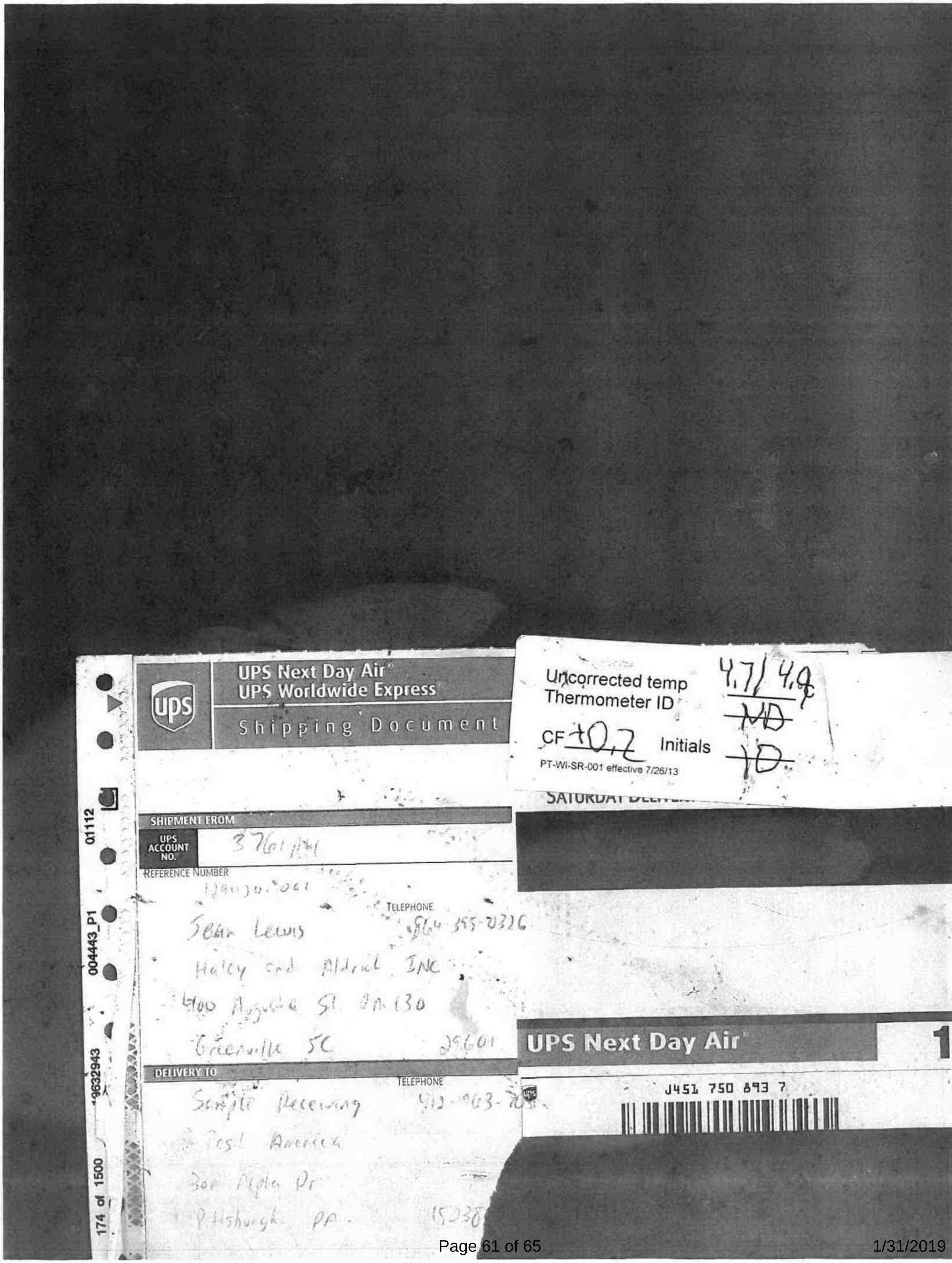
J451 750 891 9

DELIVERY TO
Sample Receiving TELEPHONE 412-963-7058
Test America
Alpha Dr
Pgh PA 15238

UPS Next Day Air® 1

J451 750 891 9
J451 750 891 9
TRACKING NUMBER
DELIVERY
DATE OF SHIPMENT / /

United Parcel Service, Louisville, KY



UPS Next Day Air®
UPS Worldwide Express®
Shipping Document

Uncorrected temp 4.7/4.9
Thermometer ID ~~MD~~
CF +0.2 Initials ~~JD~~
PT-WI-SR-001 effective 7/26/13

SATURDAY DELIVERY

SHIPMENT FROM
UPS ACCOUNT NO. 376124
REFERENCE NUMBER 1190)0.001
TELEPHONE 864 395-0326
Sean Lewis
Haley and Aldrich, INC
400 Augusta St. Rm 130
Greenville SC 29601

DELIVERY TO
TELEPHONE 412-963-70…
Sample Receiving
Test America
301 Alpha Dr
Pittsburgh PA 15238

[redacted]

UPS Next Day Air® 1
J451 750 893 7

01112 004443_P1 49632943 174 of 1500

Uncorrected temp 2.5/2.7°C
Thermometer ID TO
CF +0.2 Initials ND
PT-WI-SR-001 effective 7/26/13

UPS Worldwide Express Shipping Document

SATURDAY DELIVERY ☐

J451 750 892 8

J451 750 892 8

EXPORT

EXPORT

SHIPMENT FROM

UPS ACCOUNT NO. 376184

REFERENCE NUMBER 189420-C01

TELEPHONE 864-395-0

Sam Lewis

Haley and Aldrich, Inc

400 Augusta ST Rm 136

Greenville SC 29601

UPS Next Day Air®

1

DELIVERY TO

Sample Receiving

TELEPHONE 412-963-70

Test America

301 Alpha Dr

Pittsburgh PA 15238

Residential ☐

J451 750 892 8

TRACKING NUMBER

DATE OF SHIPMENT 11/7/18

010191120 1/10 S United Parcel Service, Louisville, KY

TestAmerica Pittsburgh

301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone (412) 963-7058 Fax (412) 963-2468

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Bortot, Veronica	Carrier Tracking No(s):	COC No: 180-348338.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: veronica.bortot@testamericainc.com	State of Origin: Indiana	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note):		Job #: 180-84236-1
Address: 4955 Yarrow Street,	Due Date Requested: 12/4/2018	Analysis Requested		Preservation Codes:
City: Arvada	TAT Requested (days):			
State, Zip: CO, 80002				
Phone: 303-736-0100(Tel) 303-431-7171(Fax)	PO #:			
Email:	WO #:			
Project Name: Vectren ASD Sampling - FB Culley	Project #: 18019698			
Site:	SSOW#:			Other:

Preservation Codes:
A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA
M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - pH 4-5, Z - other (specify)

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	Se_SPEC/FIELD_FLTRD As (III) and As (V), Dissolved (field fi	Total Number of containers	Special Instructions/Note:
			Preservation Code:						
CCR-AP-2 (180-84236-1)	11/15/18	09:25 Eastern		Water			X	1	
CCR-AP-5 (180-84236-2)	11/15/18	11:46 Eastern		Water			X	1	
CCR-AP-4 (180-84236-3)	11/15/18	15:00 Eastern		Water			X	1	
CCR-AP-8 (180-84236-4)	11/16/18	09:02 Eastern		Water			X	1	
CCR-AP-3 (180-84236-5)	11/16/18	10:37 Eastern		Water			X	1	
CCR-AP-6 (180-84236-6)	11/17/18	10:01 Eastern		Water			X	1	
CCR-AP-6I (180-84236-7)	11/17/18	14:27 Eastern		Water			X	1	
CCR-AP-8I (180-84236-8)	11/17/18	15:47 Eastern		Water			X	1	
HASB-1 (180-84236-9)	11/17/18	16:36 Eastern		Water			X	1	

Note: Since laboratory accreditations are subject to change, TestAmerica Laboratories, Inc. places the ownership of method, analyte & accreditation compliance upon out subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to TestAmerica Laboratories, Inc. attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said complicance to TestAmerica Laboratories, Inc.

Possible Hazard Identification

Unconfirmed

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ______ *Months*

Deliverable Requested: I, II, III, IV, Other (specify) | Primary Deliverable Rank: 2 | Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:		
Relinquished by: [signature]	Date/Time: 11/26/18 1700	Company: TA Pitt	Received by: [signature]	Date/Time: 11/27/18 0945	Company: TADEN
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:		Cooler Temperature(s) °C and Other Remarks: -0.4 / 1.0		

Ver: 09/20/2016

Login Sample Receipt Checklist

Client: Haley & Aldrich, Inc.

Job Number: 180-84236-1

Login Number: 84236
List Number: 1
Creator: Say, Thomas C

List Source: TestAmerica Pittsburgh

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: Haley & Aldrich, Inc. | Job Number: 180-84236-1

Login Number: 84236
List Number: 2
Creator: Diffendall, Jessica L

List Source: TestAmerica Denver
List Creation: 11/27/18 01:35 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	N/A	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

APPENDIX C

Certification Statement

HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Cleveland, OH 44121
216.739.0555

13 September 2019
File No. 129420-014

SUBJECT: F.B. Culley Generating Station Arsenic Alternate Source Demonstration for the East Ash Pond, Southern Indiana Gas and Electric Company (SIGECO)

Pursuant to 40 CFR §257.95(g)(3)(ii), Haley & Aldrich, Inc. conducted an alternate source evaluation to demonstrate that a source other than the East Ash Pond caused a statistically significant level above the groundwater protection standard (GWPS) during assessment monitoring for this unit. I certify that this report and all attachments were prepared by me or under my direct supervision. I am a professional engineer who is registered in the State of Indiana.

This certification and the underlying data support the conclusion that a source other than the CCR unit East Ash Pond is the cause of the statistically significant levels of arsenic identified above the GWPS during assessment monitoring of this Unit. The source of the elevated levels of arsenic found in the CCR groundwater compliance wells is the reductive dissolution of naturally occurring arsenic in soil and not arsenic related to the East Ash Pond.

The information contained in this evaluation is, to the best of my knowledge, true, accurate and complete.

HALEY & ALDRICH, INC.

Signed:______________________________
Certifying Engineer

Print Name: Steven F. Putrich, P.E.
Date: 13 September 2019
Indiana License No.: PE11200566
Title: Vice President
Company: Haley & Aldrich, Inc.

STEVEN F. PUTRICH REGISTERED NO. PE11200566 STATE OF INDIANA PROFESSIONAL ENGINEER

APPENDIX B

60 Day CMA Extension Demonstration

HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Cleveland, OH 44131
216.739.0555

MEMORANDUM

July 2019
Project No. 129420-017

SUBJECT: **Demonstration for 60-Day Extension – Corrective Measures Assessment (CMA)**
Southern Indiana Gas and Electric Company (SIGECO)
East Ash Pond
F. B. Culley Generating Station (FBC); Warrick County, Indiana

Pursuant to 40 CFR §257.96(a) (CCR Rule Assessment of Corrective Measures), I certify that SIGECO has demonstrated the need for additional time beyond the period of 90 days to complete the assessment of corrective measures due to site-specific conditions and the evaluation of remedial treatment alternatives in support of an informed CMA process.

In the case of the assessment of corrective measures for the FBC East Ash Pond, the site has complex hydrogeology. Receipt of analytical data by certified analytical laboratories has also been delayed due to overwhelming numbers of CCR samples submitted for analysis. SIGECO is also in the process of reviewing possible groundwater remedies and is having ongoing discussions with third-party experts regarding potential closure strategies, including beneficial reuse as well as implementation of critical steps in the groundwater treatment and remedy assessment process. Based on these site-specific conditions and related groundwater treatment alternatives evaluations in support of the CMA by SIGECO, the CCR Rule allows for a 60-day extension to complete the CMA process.

This certification as submitted, is to the best of my knowledge, accurate and complete.

Signed:______________________________

Certifying Engineer

Print Name:	Steven F. Putrich, P.E.
Indiana License No.:	PE11200566
Title:	CCR Practice Lead, Senior Consulting Engineer
Company:	Haley & Aldrich, Inc.

Professional Engineer's Seal

STEVEN F. PUTRICH
REGISTERED
7-12-19
No. PE11200566
STATE OF
INDIANA
PROFESSIONAL ENGINEER

HALEY & ALDRICH, INC.
400 Augusta Street
Suite 130
Greenville, SC 29601
864.214.8750

24 September 2020
File No. 129420

TO: Southern Indiana Gas and Electric Company

FROM: Haley & Aldrich, Inc.
[Steven F. Putrich, P.E., Project Principal
Mark Miesfeldt, Lead Hydrogeologist]

SUBJECT: May 2020 Sampling Results and Assessment Monitoring Statistical Analysis Summary Pursuant to 40 CFR § 257.96(b)
F.B. Culley Generating Station – East Ash Pond – Newburgh, Indiana

Southern Indiana Gas and Electric Company (SIGECO) is implementing the 17 April 2015 United States Environmental Protection Agency Federal Coal Combustion Residuals (CCR) Rule (40 CFR § 257 and 261) for the F.B. Culley Generating Station, in Warrick County near the communities of Yankeetown and Newburgh, Indiana. Detection monitoring events occurred in 2016 and 2017. The results of the sampling events were compared to background using appropriate statistical methods to determine if Appendix III constituents were present at concentrations above background. The result of the statistical analysis identified statistically significant increases of Appendix III constituents downgradient of the East Ash Pond (EAP) thereby triggering Assessment Monitoring and respective notification of the same.

During the Assessment Monitoring phase, groundwater samples were collected from the CCR monitoring well network. Samples were collected in June, and August 2018 and subsequently analyzed for the Appendix III and Appendix IV constituents as required by 40 CFR § 257.95(b) and 40 CFR § 257.95(d)(1). Concurrent with the second assessment sampling round, and as required by 40 CFR § 257.95(h), groundwater protection standards (GWPS) were established for the detected Appendix IV constituents. The assessment monitoring sampling results were compared to the GWPS to determine if statistically significant levels (SSL) of Appendix IV constituents were present downgradient of the EAP. The results of this evaluation indicated that arsenic and molybdenum were present in groundwater at SSLs above the GWPS thereby requiring notification as established by 40 CFR § 105(h)(8) and triggering an assessment of corrective measures.

As a result of this determination, and in accordance with 40 CFR § 257.95(g)(3), a field investigation was initiated to determine whether a source other than the EAP caused the arsenic and molybdenum contamination. Soil and groundwater sampling results confirmed that arsenic was naturally occurring in the fine grained, organic rich, alluvial soil and documented the geochemical conditions required to mobilize arsenic through the process of reductive dissolution. The sampling and analysis for the molybdenum alternate source evaluation was conducted to evaluate the potential for the naturally occurring coal seam, identified in the boring for CCR-AP-5, to be an alternate source for molybdenum. The molybdenum evaluation concluded that the naturally occurring coal was a contributing source of molybdenum but the CCR material in the EAP was the primary source.

As required by 40 CFR § 257.95(b) and 40 CFR § 257.95(d)(1), semiannual groundwater sampling and analysis continued for the EAP in 2020. The first round of semiannual groundwater sampling was conducted in May 2020. Analytical results for the May 2020 semiannual sampling event are summarized in Table 1. For the EAP a statistical analysis of the May 2020 analytical results was finalized within 90-days of completion of sampling and analysis as required by 40 CFR § 257.93(g). Downgradient wells were compared to each constituents' respective GWPS. The assessment monitoring statistical analysis summary is provided in Table 2.

If the detected constituent was greater than the associated GWPS for that Unit, pursuant to 40 CFR § 257.93 (f)(5), the confidence interval method was used to evaluate if that Appendix IV constituent was present at an SSL. Intrawell statistical analysis was used for arsenic as a result of the alternate source demonstration. Based on the comparisons outlined above, the results of the statistical analyses conducted for those detected Appendix IV constituents confirm that molybdenum remains as the only constituent present at SSLs above GWPSs downgradient of the EAP. This information is being provided for SIGECO's records. Since no new constituents were identified at SSLs above the GWPS, further notifications associated with the statistical analysis of the May 2020 sampling results are not required at this time.

Attachments:
Table 1 - Summary of Analytical Results – May 2020
Table 2 - Assessment Monitoring Statistical Analysis Summary – May 2020

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TABLE I
SUMMARY OF ANALYTICAL RESULTS - MAY 2020
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, IN

Location Group	Action Level	Background		
Location Name	Maximum Contaminant Level	CCR-AP-1R	CCR-AP-7	CCR-AP-9
Sample Name		CCR-AP-1-20200519	CCR-AP-7-20200518	CCR-AP-9-20200519
Sample Date		05/19/2020	05/18/2020	05/19/2020
Lab Sample ID		180-106111-1	180-106111-9	180-106111-12
Detection Monitoring - EPA Appendix III Constituents (mg/L)				
Boron, Total	NA	**0.74**	**0.12**	**0.55 J+**
Calcium, Total	NA	**64**	**130**	**120**
Chloride	NA	**17**	**28**	**9.7**
Fluoride	4	**0.52**	**0.29**	**0.37**
pH (lab) (SU)	NA	**7.8 J**	**7.5 J**	**7.5 J**
Sulfate	NA	**180**	**76**	**120**
Total Dissolved Solids (TDS)	NA	**980**	**650**	**650**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)				
Antimony, Total	0.006	**0.002 J**	**0.00083 J**	**0.00069 J**
Arsenic, Total	0.01	**0.025**	**0.015**	**0.0055**
Barium, Total	2	**0.3**	**0.19**	**0.19**
Beryllium, Total	0.004	**0.0043 J**	**0.00027 J**	**0.00058 J**
Cadmium, Total	0.005	0.005 U	0.001 U	0.001 U
Chromium, Total	0.1	**0.084**	**0.0062**	**0.011**
Cobalt, Total	0.006	**0.048**	**0.0049**	**0.008**
Fluoride	4	**0.52**	**0.29**	**0.37**
Lead, Total	0.015	**0.05**	**0.006**	**0.0066 J+**
Lithium, Total	0.04	**0.13**	**0.018**	**0.037**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.0096 J**	**0.002 J**	**0.0028 J**
Selenium, Total	0.05	**0.025**	**0.0028 J**	**0.0037 J**
Thallium, Total	0.002	0.005 U	0.001 U	0.001 U
Radiological (pCi/L)				
Radium-226	NA	**1.47 ± 0.35**	0.0602 U ± 0.147	**1.22 ± 0.411**
Radium-228	NA	1.34 U ± 0.599	0.242 U ± 0.611	0.795 U ± 0.684
Radium-226 & 228	5	**2.81 J+ ± 0.694**	0.302 U ± 0.628	**2.01 J ± 0.798**
Field Parameters				
Temperature (Deg C)	NA	**16.41**	**16.96**	**18.23**
Dissolved Oxygen, Field (mg/L)	NA	**1.37**	**0.05**	**4.09**
Conductivity, Field (mS/cm)	NA	**1.3261**	**1.004**	**1.0932**
ORP, Field (mv)	NA	**-33.7**	**-129.6**	**-8.2**
Turbidity, Field (NTU)	NA	**1938**	**23.16**	**815.5**
pH, Field (SU)	NA	**7.61**	**7.29**	**7.76**

ABBREVIATIONS AND NOTES:
CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
pCi/L: picoCurie per liter.
su: standard units.
USEPA: United States Environmenta.l Protection Agency
J: Value is estimated
J-: Value is estimated, biased low
J+: Value is estimated, biased high
R: Rejected during validation
U: Not detected, value is the laboratory reporting limit

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

TABLE I
SUMMARY OF ANALYTICAL RESULTS - MAY 2020
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, IN

Location Group	Action Level	Downgradient										
Location Name	Maximum Contaminant Level	CCR-AP-2	CCR-AP-3	CCR-AP-4	CCR-AP-5	CCR-AP-5	CCR-AP-5I	CCR-AP-6	CCR-AP-6I	CCR-AP-8	CCR-AP-8I	CCR-AP-11
Sample Name		CCR-AP-2-20200520	CCR-AP-3-20200520	CCR-AP-4-20200520	CCR-AP-5-20200519	BLIND DUPLICATE-20200519	CCR-AP-5I-20200519	CCR-AP-6-20200520	CCR-AP-6I-20200519	CCR-AP-8-20200520	CCR-AP-8I-20200519	CCR-AP-11-20200520
Sample Date		05/20/2020	05/20/2020	05/20/2020	05/19/2020	05/19/2020	05/19/2020	05/20/2020	05/19/2020	05/20/2020	05/19/2020	05/20/2020
Lab Sample ID		180-106111-2	180-106111-3	180-106111-4	180-106111-5	180-106111-14	180-106111-6	180-106111-7	180-106111-8	180-106111-10	180-106111-11	180-106111-13
Detection Monitoring - EPA Appendix III Constituents (mg/L)												
Boron, Total	NA	**12**	**0.24**	**0.1**	**14**	**13**	**13**	**0.67**	**19**	0.1 U	**12**	**0.21 J+**
Calcium, Total	NA	**260**	**180**	**130**	**170**	**170**	**230**	**200**	**510**	**260**	**380**	**110**
Chloride	NA	**230**	**24**	**16**	**73**	**76**	**250**	**40**	**160**	**16**	**390**	**23**
Fluoride	4	**0.35**	**0.36**	**0.64**	**1.4**	**1.5**	**0.35**	**0.44**	**0.086 J**	**0.3**	0.25 U	**0.34**
pH (lab) (SU)	NA	**6.9 J**	**7.4 J**	**6.8 J**	**7.5 J**	**7.5 J**	**7.1 J**	**7.5 J**	**7.4 J**	**7.3 J**	**7 J**	**6.7 J**
Sulfate	NA	**400**	**2.2 J+**	**6**	**440**	**430**	**670**	**7.9**	**1500**	**2.4 J+**	**960**	**430**
Total Dissolved Solids (TDS)	NA	**1400**	**950**	**660**	**1100**	**1100**	**1900**	**950**	**2300**	**1100**	**2200**	**840**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)												
Antimony, Total	0.006	**0.0021 J**	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	**0.00049 J**	0.002 U	**0.0004 J**	0.002 U	0.002 U
Arsenic, Total	0.01	**0.019**	**0.083**	**0.15**	**0.00073 J**	**0.00071 J**	**0.00097 J**	**0.11**	**0.0038**	**0.11**	**0.0023**	**0.048**
Barium, Total	2	**0.24**	**0.42**	**0.57**	**0.059**	**0.058**	**0.09**	**0.63**	**0.036**	**0.53**	**0.24**	**0.29**
Beryllium, Total	0.004	**0.002 J**	0.001 U	0.001 U	0.001 U	0.001 U	**0.0002 J**	**0.00019 J**	0.001 U	**0.00025 J**	0.001 U	0.001 U
Cadmium, Total	0.005	0.005 U	0.001 U	0.001 U	0.001 U	**0.00027 J**	0.001 U	0.001 U	0.001 U	**0.00028 J**	0.001 U	0.001 U
Chromium, Total	0.1	**0.051**	**0.0029**	0.002 U	0.002 U	0.002 U	**0.0038**	**0.0075**	0.002 U	**0.0029**	0.002 U	0.002 U
Cobalt, Total	0.006	**0.031**	**0.0051**	**0.0014**	**0.00036 J**	**0.00034 J**	**0.0022**	**0.0052**	**0.0018**	**0.0064**	**0.00014 J**	**0.03**
Fluoride	4	**0.35**	**0.36**	**0.64**	**1.4**	**1.5**	**0.35**	**0.44**	**0.086 J**	**0.3**	0.25 U	**0.34**
Lead, Total	0.015	**0.043**	**0.0014 J+**	**0.0015 J+**	0.001 U	0.001 U	**0.0026 J+**	**0.0046**	**0.0018 J+**	**0.0017 J+**	0.001 U	0.001 U
Lithium, Total	0.04	**0.036**	0.005 U	**0.0046 J**	**0.05**	**0.049**	**0.043**	**0.0042 J**	**0.05**	0.005 U	**0.37**	0.005 U
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.0057 J**	**0.01**	0.005 U	**0.21**	**0.21**	**0.0017 J**	**0.024**	**0.77**	**0.013**	**0.28**	**0.00063 J**
Selenium, Total	0.05	**0.016 J**	**0.0019 J**	**0.0018 J**	**0.0018 J**	**0.002 J**	**0.0028 J**	**0.0021 J**	0.005 U	**0.0032 J**	0.005 U	0.005 U
Thallium, Total	0.002	0.005 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Radiological (pCi/L)												
Radium-226	NA	**0.355 ± 0.211**	**0.770 ± 0.257**	**1.03 ± 0.328**	0.113 U ± 0.137	**0.194 ± 0.139**	**0.944 ± 0.369**	**0.345 ± 0.189**	0.212 U ± 0.209	**0.572 ± 0.231**	**0.887 ± 0.272**	**0.255 ± 0.151**
Radium-228	NA	0.581 U ± 0.555	0.252 U ± 0.408	0.395 U ± 0.63	0.254 U ± 0.54	0.0410 U ± 0.409	0.256 U ± 0.689	**0.988 ± 0.571**	0.565 U ± 0.809	0.519 U ± 0.449	**1.76 ± 0.583**	0.412 U ± 0.342
Radium-226 & 228	5	**0.936 J ± 0.594**	**1.02 J ± 0.482**	**1.43 J ± 0.71**	0.367 U ± 0.557	0.235 UJ ± 0.432	**1.20 J ± 0.782**	**1.33 ± 0.601**	0.776 U ± 0.836	**1.09 J ± 0.505**	**2.64 ± 0.643**	**0.666 J ± 0.374**
Field Parameters												
Temperature (Deg C)	NA	**18.22**	**16.83**	**16.4**	**16.63**	**16.63**	**16.95**	**17.38**	**18.13**	**17.64**	**17.11**	**15.86**
Dissolved Oxygen, Field (mg/L)	NA	**4.79**	**3.85**	**2.83**	**0.16**	**0.16**	**0.28**	**3.26**	**0.21**	**2.29**	**0.27**	**0.27**
Conductivity, Field (mS/cm)	NA	**1.9069**	**1.1803**	**1.3146**	**1.292**	**1.292**	**2.48**	**1.6714**	**2.8202**	**2.0354**	**3.1519**	**1.2642**
ORP, Field (mv)	NA	**-12.4**	**-132.1**	**-69.8**	**43.4**	**43.4**	**-57.9**	**-94.7**	**-37.2**	**-104.4**	**-118.5**	**-110.3**
Turbidity, Field (NTU)	NA	**801.01**	**0.04**	**220.36**	**0.47**	**0.47**	**119.76**	**61.95**	**0.58**	**48.03**	**0.73**	**12.56**
pH, Field (SU)	NA	**6.71**	**7.28**	**6.76**	**7.25**	**7.25**	**6.99**	**7.51**	**7.25**	**6.97**	**6.95**	**6.8**

ABBREVIATIONS AND NOTES:

CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
pCi/L: picoCurie per liter.
su: standard units.
USEPA: United States Environmenta.l Protection Agency
J: Value is estimated
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U: Not detected, value is the laboratory reporting limit

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

Table II

F.B. Culley EAP Generating Station

Assessment Monitoring Statistical Analysis Summary - May 2020

Prepared: September 18, 2020

										MCL Comparison							Inter-well Analysis				Intra-well Analysis			GWPS		
Location Id	Frequency of Detection	Percent Non-Detects	Maximum Detect	Variance	Standard Deviation	Coefficient of Variance	CCR MCL/RSL	Report Result Unit	Detection Exceedances (Y/N)	Number of Detection Exceedances	Number of Non-Detection Exceedances	Outlier Presence	Outlier Removed	Trend	Distribution Group	Distribution Well*	May 2020 Concentration (mg/L)	Detect?	Upper Tolerance Limit (mg/L)	SSI (Exceedance above Background at Individual Well)	Upper Prediction Limits (mg/L)		SSI (Exceedance above Background at Individual Well)	Groundwater Protection Standard (Higher of MCL/RSL or Upper Tolerance Limit) mg/L	Exceedance above GWPS at Individual Well	SSL
CCR Appendix-IV: Antimony, Total (mg/L)																										
CCR-AP-1R	8/14	43%	0.0025	0.00004777	0.006912	1.476	0.006	mg/L	N	0	3	N	N	Stable		Non-parametric										
CCR-AP-7	3/16	81%	0.00083	3.636E-07	0.000603	0.3494	0.006	mg/L	N	0	0	Y	N	Stable	Non-parametric	Non-parametric			0.02					0.020		
CCR-AP-9	10/14	29%	0.0079	0.00002967	0.005447	1.395	0.006	mg/L	Y	1	2	Y	N	Stable		Non-parametric										
CCR-AP-2	5/14	64%	0.0021	0.00002975	0.005454	1.291	0.006	mg/L	N	0	3	Y	N	Stable		Non-parametric	0.0021	Y		N					N	No
CCR-AP-3	2/14	86%	0.00058	3.217E-07	0.0005672	0.319	0.006	mg/L	N	0	0	Y	N	Stable		Non-parametric	0.002	N		N					N	No
CCR-AP-4	2/14	86%	0.00066	0.000005117	0.002262	0.958	0.006	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.002	N		N					N	No
CCR-AP-5	1/14	93%	0.000058	0.0000238	0.004878	1.55	0.006	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.002	N		N					N	No
CCR-AP-6	7/14	50%	0.0014	0.00000579	0.002406	1.227	0.006	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.00049	Y		N					N	No
CCR-AP-8	9/14	36%	0.0018	4.424E-07	0.0006651	0.5153	0.006	mg/L	N	0	0	N	N	Stable		Normal	0.0004	Y		N					N	No
CCR Appendix-IV: Arsenic, Total (mg/L)																										
CCR-AP-1R	14/14	0%	0.038	0.0001625	0.01275	0.8539	0.01	mg/L	Y	6	0	N	N	Increase		Log-transformed										
CCR-AP-7	16/16	0%	0.018	0.00001846	0.004297	0.6127	0.01	mg/L	Y	2	0	N	N	Stable	Non-parametric	Log-transformed			0.038					0.038		
CCR-AP-9	14/14	0%	0.032	0.00004701	0.006856	0.7084	0.01	mg/L	Y	2	0	Y	N	Stable		Log-transformed										
CCR-AP-2	14/14	0%	0.032	0.0000912	0.00955	0.8837	0.01	mg/L	Y	6	0	N	N	Increase		Normal	0.019	Y		N	0.046	46	N		N	No
CCR-AP-3	14/14	0%	0.086	0.00005834	0.007638	0.1043	0.01	mg/L	Y	14	0	N	N	Stable		Normal	0.083	Y		Y	0.102	102.019	N		N	No
CCR-AP-4	14/14	0%	0.32	0.005247	0.07244	0.7596	0.01	mg/L	Y	14	0	Y	N	Increase		Normal	0.15	Y		Y	0.177	177.053	N		N	No
CCR-AP-5	12/14	14%	0.0015	0.000006175	0.002485	1.731	0.01	mg/L	N	0	0	Y	N	Stable		Non-parametric	0.00073	Y		N	0.010	10	N		N	No
CCR-AP-6	14/14	0%	0.12	0.0005841	0.02417	0.272	0.01	mg/L	Y	14	0	N	N	Increase		Normal	0.11	Y		Y	0.184	184.064	N		N	No
CCR-AP-8	14/14	0%	0.11	0.0004131	0.02032	0.2453	0.01	mg/L	Y	14	0	N	N	Increase		Normal	0.11	Y		Y	0.157	157.336	N		N	No
CCR Appendix-IV: Barium, Total (mg/L)																										
CCR-AP-1R	14/14	0%	0.59	0.03599	0.1897	0.8213	2	mg/L	N	0	0	N	N	Increase		Log-transformed										
CCR-AP-7	16/16	0%	0.19	0.0006917	0.0263	0.1895	2	mg/L	N	0	0	N	N	Stable	Non-parametric	Normal			0.720					2.000		
CCR-AP-9	14/14	0%	0.72	0.01902	0.1379	0.4876	2	mg/L	N	0	0	Y	N	Increase		Log-transformed										
CCR-AP-2	14/14	0%	0.52	0.02093	0.1447	0.6877	2	mg/L	N	0	0	N	N	Increase		Normal	0.24	Y		N					N	No
CCR-AP-3	14/14	0%	0.48	0.0008863	0.02977	0.06981	2	mg/L	N	0	0	N	N	Stable		Normal	0.42	Y		N					N	No
CCR-AP-4	14/14	0%	1.3	0.04017	0.2004	0.3001	2	mg/L	N	0	0	N	N	Stable		Normal	0.57	Y		N					N	No
CCR-AP-5	14/14	0%	0.068	0.0001155	0.01075	0.2644	2	mg/L	N	0	0	Y	N	Stable		Log-transformed	0.059	Y		N					N	No
CCR-AP-6	14/14	0%	0.69	0.003569	0.05974	0.09957	2	mg/L	N	0	0	N	N	Stable		Normal	0.63	Y		N					N	No
CCR-AP-8	14/14	0%	0.68	0.003031	0.05505	0.09331	2	mg/L	N	0	0	N	N	Stable		Normal	0.53	Y		N					N	No
CCR Appendix-IV: Beryllium, Total (mg/L)																										
CCR-AP-1R	14/14	0%	0.0066	0.000005096	0.002257	1.018	0.004	mg/L	Y	4	0	Y	N	Increase		Non-parametric										
CCR-AP-7	7/16	56%	0.00075	0.000000169	0.0004111	0.6121	0.004	mg/L	N	0	0	N	N	Stable	Non-parametric	Normal			0.007					0.007		
CCR-AP-9	14/14	0%	0.0041	9.189E-07	0.0009586	1.021	0.004	mg/L	Y	1	0	Y	N	Increase		Non-parametric										
CCR-AP-2	14/14	0%	0.0027	7.728E-07	0.0008791	0.7156	0.004	mg/L	N	0	0	N	N	Increase		Normal	0.002	Y		N					N	No
CCR-AP-3	0/14	100%		0	0	0	0.004	mg/L	N	0	0	NA	NA	NA	NA	NA	0.001	N		N					N	No
CCR-AP-4	11/14	21%	0.0011	1.361E-07	0.000369	0.6915	0.004	mg/L	N	0	0	N	N	Stable		Normal	0.001	N		N					N	No
CCR-AP-5	5/14	64%	0.00096	0.000006147	0.002479	1.704	0.004	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.001	N		N					N	No
CCR-AP-6	11/14	21%	0.00069	0.000001548	0.001244	1.581	0.004	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.00019	Y		N					N	No
CCR-AP-8	5/14	64%	0.00039	1.437E-07	0.0003791	0.5193	0.004	mg/L	N	0	0	N	N	Stable		Non-parametric	0.00025	Y		N					N	No
CCR Appendix-IV: Cadmium, Total (mg/L)																										
CCR-AP-1R	4/14	71%	0.00087	0.00001199	0.003462	1.287	0.005	mg/L	N	0	2	N	N	Stable		Non-parametric										
CCR-AP-7	2/16	88%	0.00032	7.025E-08	0.0002651	0.2933	0.005	mg/L	N	0	0	Y	N	Stable	Non-parametric	Non-parametric			0.010					0.010		
CCR-AP-9	9/14	36%	0.00022	0.000008745	0.002957	1.783	0.005	mg/L	N	0	1	Y	N	Stable		Non-parametric										
CCR-AP-2	11/14	21%	0.0023	0.000007882	0.002807	1.375	0.005	mg/L	N	0	1	Y	N	Increase		Non-parametric	0.005	N		N					N	No
CCR-AP-3	0/14	100%		0	0	0	0.005	mg/L	N	0	0	N	N	NA		NA	0.001	N		N					N	No
CCR-AP-4	6/14	57%	0.00048	0.00000151	0.001229	1.287	0.005	mg/L	N	0	0	N	N	Stable		Non-parametric	0.001	N		N					N	No
CCR-AP-5	11/14	21%	0.0012	0.000006526	0.002555	2.121	0.005	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.001	N		N					N	No
CCR-AP-6	11/14	21%	0.0006	9.613E-08	0.00031	0.6337	0.005	mg/L	N	0	0	N	N	Stable		Normal	0.001	N		N					N	No
CCR-AP-8	3/14	79%	0.00028	1.138E-07	0.0003373	0.406	0.005	mg/L	N	0	0	N	N	Stable		Non-parametric	0.00028	Y		N					N	No
CCR Appendix-IV: Chromium, Total (mg/L)																										
CCR-AP-1R	14/14	0%	0.16	0.003076	0.05546	1.058	0.1	mg/L	Y	4	0	N	N	Increase		Log-transformed										
CCR-AP-7	11/16	31%	0.019	0.00001956	0.004422	1.171	0.1	mg/L	N	0	0	N	N	Stable	Non-parametric	Log-transformed			0.160					0.160		
CCR-AP-9	14/14	0%	0.15	0.001365	0.03695	1.515	0.1	mg/L	Y	1	0	N	N	Increase		Log-transformed										
CCR-AP-2	14/14	0%	0.082	0.0006437	0.02537	0.8346	0.1	mg/L	N	0	0	N	N	Increase		Normal	0.051	Y		N					N	No
CCR-AP-3	11/14	21%	0.0041	5.745E-07	0.000758	0.3121	0.1	mg/L	N	0	0	N	N	Stable		Normal	0.0029	Y		N					N	No
CCR-AP-4	12/14	14%	0.028	0.00007141	0.008451	0.9178	0.1	mg/L	N	0	0	N	N	Stable		Normal	0.002	N		N					N	No
CCR-AP-5	0/14	100%		0.00002319	0.004815	1.462	0.1	mg/L	N	0	0	Y	N	NA		NA	0.002	N		N					N	No
CCR-AP-6	14/14	0%	0.031	0.00008279	0.009099	0.6241	0.1	mg/L	N	0	0	N	N	Increase		Normal	0.0075	Y		N					N	No
CCR-AP-8	13/14	7%	0.012	0.000008983	0.002997	0.7336	0.1	mg/L	N	0	0	N	N	Stable		Normal	0.0029	Y		N					N	No

Table 2
F.B. Culley EAP Generating Station
Assessment Monitoring Statistical Analysis Summary - May 2020
Prepared: September 18, 2020

CCR Appendix-IV: Cobalt, Total (mg/L)																										
CCR-AP-1R	14/14	0%	0.081	0.0007091	0.02663	1.011	0.006	mg/L	Y	11	0	N	N	Increase		Log-transformed										
CCR-AP-7	16/16	0%	0.015	0.00001371	0.003702	1.267	0.006	mg/L	Y	1	0	N	N	Stable	Non-parametric	Log-transformed			0.081					0.081		
CCR-AP-9	14/14	0%	0.047	0.00009792	0.009895	0.6824	0.006	mg/L	Y	14	0	N	N	Stable		Log-transformed										
CCR-AP-2	14/14	0%	0.038	0.00008294	0.009107	0.4523	0.006	mg/L	Y	14	0	N	N	Increase		Normal	0.031	Y		N					N	No
CCR-AP-3	14/14	0%	0.0094	0.000001919	0.001385	0.2201	0.006	mg/L	Y	7	0	N	N	Decrease		Normal	0.0051	Y		N					N	No
CCR-AP-4	14/14	0%	0.013	0.00001164	0.003411	0.5514	0.006	mg/L	Y	7	0	N	N	Stable		Normal	0.0014	Y		N					N	No
CCR-AP-5	14/14	0%	0.007	0.000004264	0.002065	0.4485	0.006	mg/L	Y	6	0	N	N	Decrease		Normal	0.00036	Y		N					N	No
CCR-AP-6	14/14	0%	0.018	0.00001413	0.003759	0.3898	0.006	mg/L	Y	12	0	N	N	Increase		Normal	0.0052	Y		N					N	No
CCR-AP-8	14/14	0%	0.017	0.00001238	0.003519	0.3532	0.006	mg/L	Y	12	0	N	N	Decrease		Normal	0.0064	Y		N					N	No
CCR Appendix-III: Fluoride (mg/L)																										
CCR-AP-1R	14/14	0%	3.24	0.04004	0.4004	0.7612	4	mg/L	N	0	0	Y	N	Stable		Non-parametric										
CCR-AP-7	16/16	0%	1.48	0.018424	0.27148	1.044	4	mg/L	N	0	0	N	N	Stable	Normal	Normal			0.612					4.000		
CCR-AP-9	14/14	0%	1.68	0.019268	0.27764	0.862	4	mg/L	N	0	0	Y	N	Stable		Non-parametric										
CCR-AP-2	14/14	0%	2.04	0.03548	0.37672	1.3184	4	mg/L	N	0	0	N	N	Stable		Non-parametric	0.35	Y		N					N	No
CCR-AP-3	13/14	7%	3.72	0.16032	0.8008	1.8348	4	mg/L	N	0	0	N	N	Stable		Normal	0.36	Y		N					N	No
CCR-AP-4	13/14	7%	2.56	0.05764	0.4804	1.3028	4	mg/L	N	0	0	N	N	Stable		Normal	0.64	Y		Y					N	No
CCR-AP-5	14/14	0%	5.6	0.22284	0.944	0.86	4	mg/L	N	0	0	N	N	Stable		Normal	1.4	Y		Y					N	No
CCR-AP-6	14/14	0%	2.68	0.05744	0.4792	0.9452	4	mg/L	N	0	0	N	N	Stable		Normal	0.44	Y		N					N	No
CCR-AP-8	13/14	7%	2.04	0.04776	0.4372	1.5372	4	mg/L	N	0	0	N	N	Stable		Normal	0.3	Y		N					N	No
CCR Appendix-IV: Lead, Total (mg/L)																										
CCR-AP-1R	14/14	0%	0.094	0.0009293	0.03048	1.022	0.015	mg/L	Y	6	0	N	N	Increase		Log-transformed										
CCR-AP-7	12/16	25%	0.02	0.0000259	0.005089	1.337	0.015	mg/L	Y	1	0	N	N	Stable	Non-parametric	Log-transformed			0.094					0.094		
CCR-AP-9	14/14	0%	0.041	0.00008857	0.009411	0.8567	0.015	mg/L	Y	2	0	N	N	Increase		Log-transformed										
CCR-AP-2	14/14	0%	0.051	0.0002827	0.01681	0.8407	0.015	mg/L	Y	7	0	N	N	Increase		Normal	0.043	Y		N					N	No
CCR-AP-3	11/14	21%	0.0014	1.082E-07	0.000329	0.4511	0.015	mg/L	N	0	0	N	N	Stable		Normal	0.0014	Y		N					N	No
CCR-AP-4	14/14	0%	0.021	0.0000417	0.006457	0.9251	0.015	mg/L	Y	2	0	N	N	Stable		Normal	0.0015	Y		N					N	No
CCR-AP-5	2/14	86%	0.0011	0.000005925	0.002434	1.535	0.015	mg/L	N	0	0	Y	N	Stable		Non-parametric	0.001	N		N					N	No
CCR-AP-6	14/14	0%	0.024	0.00004538	0.006736	0.6455	0.015	mg/L	Y	3	0	N	N	Increase		Normal	0.0046	Y		N					N	No
CCR-AP-8	14/14	0%	0.0076	0.000003217	0.001794	0.8573	0.015	mg/L	N	0	0	N	N	Stable		Log-transformed	0.0017	Y		N					N	No
CCR Appendix-IV: Lithium, Total (mg/L)																										
CCR-AP-1R	14/14	0%	0.23	0.004	0.06325	0.7153	0.04	mg/L	Y	11	0	N	N	Increase		Log-transformed										
CCR-AP-7	16/16	0%	0.039	0.00005505	0.00742	0.4826	0.04	mg/L	N	0	0	Y	N	Stable	Non-parametric	Non-parametric			0.230					0.230		
CCR-AP-9	14/14	0%	0.12	0.0005614	0.02369	0.5041	0.04	mg/L	Y	6	0	Y	N	Increase		Non-parametric										
CCR-AP-2	9/14	36%	0.069	0.003479	0.05899	1.103	0.04	mg/L	Y	2	5	Y	N	Stable		Log-transformed	0.036	Y		N					N	No
CCR-AP-3	0/14	100%		0.0004888	0.02211	0.6478	0.04	mg/L	N	0	9	Y	N	NA		NA	0.005	N		N					N	No
CCR-AP-4	9/14	36%	0.047	0.0004438	0.02107	0.7949	0.04	mg/L	Y	1	5	N	N	Stable		Normal	0.0046	Y		N					N	No
CCR-AP-5	14/14	0%	0.15	0.0008407	0.02899	0.2513	0.04	mg/L	Y	14	0	N	N	Decrease		Normal	0.05	Y		N					N	No
CCR-AP-6	6/14	57%	0.016	0.003763	0.06134	1.284	0.04	mg/L	N	0	8	N	N	Stable		Non-parametric	0.0042	Y		N					N	No
CCR-AP-8	4/14	71%	0.014	0.0004925	0.02219	0.7025	0.04	mg/L	N	0	8	N	N	Stable		Non-parametric	0.005	N		N					N	No
CCR Appendix-IV: Mercury, Total (mg/L)																										
CCR-AP-1R	0/13	100%		0	0	0	0.002	mg/L	N	0	0	NA	NA	NA		NA										
CCR-AP-7	0/13	100%		0	0	0	0.002	mg/L	N	0	0	NA	NA	NA	Non-parametric	NA			0.0002					0.002		
CCR-AP-9	0/13	100%		0	0	0	0.002	mg/L	N	0	0	NA	NA	NA		NA										
CCR-AP-2	2/13	85%	0.00038	2.523E-09	0.00005023	0.2357	0.002	mg/L	N	0	0	NA	NA	NA		NA	0.0002	N		N					N	No
CCR-AP-3	0/13	100%		0	0	0	0.002	mg/L	N	0	0	NA	NA	NA		NA	0.0002	N		N					N	No
CCR-AP-4	0/13	100%		3.077E-09	0.00005547	0.2575	0.002	mg/L	N	0	0	NA	NA	NA		NA	0.0002	N		N					N	No
CCR-AP-5	0/13	100%		0	0	0	0.002	mg/L	N	0	0	NA	NA	NA		NA	0.0002	N		N					N	No
CCR-AP-6	0/13	100%		0	0	0	0.002	mg/L	N	0	0	NA	NA	NA		NA	0.0002	N		N					N	No
CCR-AP-8	0/13	100%		0	0	0	0.002	mg/L	N	0	0	NA	NA	NA		NA	0.0002	N		N					N	No
CCR Appendix-IV: Molybdenum, Total (mg/L)																										
CCR-AP-1R	14/14	0%	0.015	0.000009176	0.003029	0.3255	0.1	mg/L	N	0	0	N	N	Stable		Normal										
CCR-AP-7	16/16	0%	0.013	0.00001086	0.003296	0.7264	0.1	mg/L	N	0	0	N	N	Decrease	Normal	Normal			0.013					0.100		
CCR-AP-9	14/14	0%	0.012	0.000008244	0.002871	0.4552	0.1	mg/L	N	0	0	N	N	Stable		Normal										
CCR-AP-2	14/14	0%	0.0078	0.000005989	0.002447	0.6889	0.1	mg/L	N	0	0	N	N	Increase		Normal	0.0057	Y		N					N	No
CCR-AP-3	14/14	0%	0.014	0.00000319	0.001786	0.158	0.1	mg/L	N	0	0	N	N	Decrease		Normal	0.01	Y		N					N	No
CCR-AP-4	13/14	7%	0.0037	0.000001454	0.001206	0.5792	0.1	mg/L	N	0	0	N	N	Decrease		Normal	0.005	N		N					N	No
CCR-AP-5	14/14	0%	0.53	0.007508	0.08665	0.2476	0.1	mg/L	Y	14	0	N	N	Stable		Non-parametric	0.21	Y		Y					Y	Yes
CCR-AP-6	14/14	0%	0.033	0.00002229	0.004721	0.1826	0.1	mg/L	N	0	0	N	N	Increase		Normal	0.024	Y		Y					N	No
CCR-AP-8	14/14	0%	0.015	0.000001966	0.001402	0.1073	0.1	mg/L	N	0	0	N	N	Decrease		Normal	0.013	Y		Y					N	No
CCR Appendix-IV: Radium-226 & 228 (mg/L)																										
CCR-AP-1R	11/14	21%	6.73	4.596	2.144	0.5137	1	mg/L	Y	11	2	N	N	Stable		Normal										
CCR-AP-7	14/15	7%	1.72	1.25	1.118	0.9242	1	mg/L	Y	6	1	N	N	Stable	Log-transformed	Normal			6.730					6.730		
CCR-AP-9	13/14	7%	4.02	1.141	1.068	0.3818	1	mg/L	Y	13	1	N	N	Stable		Normal										
CCR-AP-2	13/14	7%	5.38	1.595	1.263	0.6439	1	mg/L	Y	9	0	N	N	Stable		Normal	0.936	Y		N					N	No
CCR-AP-3	13/14	7%	2.24	0.2384	0.4882	0.3401	1	mg/L	Y	11	1	N	N	Stable		Normal	1.02	Y		N					N	No
CCR-AP-4	14/14	0%	4.28	0.9471	0.9732	0.4023	1	mg/L	Y	14	0	N	N	Stable		Normal	1.43	Y		N					N	No
CCR-AP-5	11/14	21%	1.21	2.467	1.571	1.185	1	mg/L	Y	1	2	Y	N	Stable		Non-parametric	5	N		N					N	No
CCR-AP-6	13/14	7%	10.2	6.045	2.459	0.9032	1	mg/L	Y	13	1	Y	N	Increase		Non-parametric	1.33	Y		N					N	No
CCR-AP-8	13/14	7%	2.32	1.146	1.07	0.6271	1	mg/L	Y	11	1	N	N	Stable		Normal	1.09	Y		N					N	No

Table 2

F.B. Culley EAP Generating Station

Assessment Monitoring Statistical Analysis Summary - May 2020

Prepared: September 18, 2020

CCR Appendix-IV: Selenium, Total (mg/L)																										
CCR-AP-1R	5/14	64%	0.025	0.0003102	0.01761	1.209	0.05	mg/L	N	0	2	N	N	Increase	Non-parametric	Non-parametric			0.050					0.050		
CCR-AP-7	3/14	79%	0.0028	0.000002759	0.001661	0.3949	0.05	mg/L	N	0	0	Y	N	Stable		Non-parametric										
CCR-AP-9	5/14	64%	0.0099	0.00005825	0.007632	0.9995	0.05	mg/L	N	0	0	N	N	Stable		Non-parametric										
CCR-AP-2	8/14	43%	0.026	0.0001966	0.01402	1.283	0.05	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.016	Y		N					N	No
CCR-AP-3	13/14	7%	0.0068	0.00000254	0.001594	0.6799	0.05	mg/L	N	0	0	N	N	Stable		Normal	0.0019	Y		N					N	No
CCR-AP-4	8/14	43%	0.031	0.00005906	0.007685	1.52	0.05	mg/L	N	0	0	N	N	Stable		Normal	0.0018	Y		N					N	No
CCR-AP-5	2/14	86%	0.007	0.0001463	0.0121	1.488	0.05	mg/L	N	0	1	N	N	NA		NA	0.0018	Y		N					N	No
CCR-AP-6	11/14	21%	0.0053	0.00003836	0.006194	1.511	0.05	mg/L	N	0	0	N	N	Increase		Non-parametric	0.0021	Y		N					N	No
CCR-AP-8	11/14	21%	0.007	0.00000319	0.001786	0.604	0.05	mg/L	N	0	0	N	N	Stable		Normal	0.0032	Y		N					N	No
CCR Appendix-IV: Thallium, Total (mg/L)																										
CCR-AP-1R	11/14	21%	0.0014	0.000001606	0.001267	1.334	0.002	mg/L	N	0	1	N	N	Stable	Non-parametric	Normal			0.005					0.005		
CCR-AP-7	4/16	75%	0.00061	1.387E-07	0.0003724	0.4639	0.002	mg/L	N	0	0	N	N	Stable		Non-parametric										
CCR-AP-9	9/14	36%	0.00098	0.000001605	0.001267	1.527	0.002	mg/L	N	0	1	N	N	Stable		Normal										
CCR-AP-2	12/14	14%	0.00099	0.000001578	0.001256	1.513	0.002	mg/L	N	0	1	N	N	Increase		Normal	0.005	N		N					N	No
CCR-AP-3	1/14	93%	0.0001	5.786E-08	0.0002405	0.2571	0.002	mg/L	N	0	0	N	N	Stable		Non-parametric	0.001	N		N					N	No
CCR-AP-4	8/14	43%	0.00026	0.000001664	0.00129	1.656	0.002	mg/L	N	0	1	N	N	Stable		Non-parametric	0.001	N		N					N	No
CCR-AP-5	3/14	79%	0.00018	0.000006179	0.002486	1.705	0.002	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.001	N		N					N	No
CCR-AP-6	8/14	43%	0.00022	0.000001652	0.001285	1.631	0.002	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.001	N		N					N	No
CCR-AP-8	5/14	64%	0.00029	1.901E-07	0.000436	0.6326	0.002	mg/L	N	0	0	N	N	Stable		Non-parametric	0.001	N		N					N	No

Appendix I
Description of Site Hydrogeology

2. Site Geology and Hydrogeology

2.1 SITE GEOLOGY

The Ohio River valley contains alluvial (river) and loess (windblown) deposits derived indirectly from continental ice sheets. The unconsolidated alluvial materials were transported down the Ohio River Valley in meltwater heavily loaded with entrained coarse-grained sediments deposited on top of the Pennsylvanian age shale, limestone and sandstone bedrock. Westerly winds simultaneously deposited fine-grained silty sediments. As a result, base levels of the valley floor increased in elevation and created natural levees and outwashes. These natural levees produced slackwater lakes which deposited thick sequences of silt and clay. When the ice sheets retreated, the sediment load in the Ohio River diminished and lowered base levels. Consequently, the river incised the slackwater lake sediments, sculpted lacustrine terraces, and deposited silty and clayey stream alluvium.

Soil borings drilled at the Site indicate that in the vicinity of the Ash Pond the uppermost geologic unit is comprised of alluvial deposits consisting of primarily silts and clays. In the upland areas to the north, the alluvial deposits are absent but instead consist of discontinuous layers of sand and consolidated shale.

The Site is located in the vicinity of the Wabash Valley and New Madrid seismic zones. The largest earthquake recorded (magnitude 5.2) proximal to the Site occurred in April 18, 2008 approximately 50 miles northwest of the facility.

2.2 SITE HYDROGEOLOGY

Hydrogeologic units are defined based on their ability to transmit groundwater or serve as confining units between zones of groundwater. In the vicinity of the Ash Pond, the uppermost aquifer occurs within unconsolidated Ohio River alluvial deposits consisting of silt and clay with discontinuous interbedded layers of sand. To the north of the Ash Pond the uppermost aquifer occurs in the shale and sandstone bedrock units. Recharge to the surficial aquifer occurs through direct surface infiltration.

Piezometric data recorded from the monitoring wells installed on-site shows that the configuration of the uppermost aquifer is primarily controlled by surface topography with some influence from the underlying weathered bedrock. Groundwater flow in the immediate vicinity of the Ash Pond is radial with an overall flow direction from the upland areas north of the Ash Pond to the south toward the Ohio River. Groundwater elevations vary seasonally but the groundwater flow patterns remain consistent.

Groundwater flow velocity in the uppermost aquifer beneath the Ash Pond was estimated using site-specific hydraulic conductivity, measured hydraulic gradients, and an assumed effective porosity of 25 percent. Hydraulic conductivity varied from 1.3E-3 cm/sec adjacent to the northern boundary of the Ash Pond to 5.5E-5 cm/sec in the upland area north of the Ash Pond. The hydraulic gradient north of the Ash Pond is 0.06 feet/foot. South of the Ash Pond the hydraulic gradient steepens to 0.1 feet/foot down to the Ohio River. Using the site-specific hydraulic conductivity and hydraulic gradients, and assuming an effective porosity of 25 percent the groundwater flow north of the Ash Pond is estimated to be 325 feet/year. To the south of the Ash Pond groundwater flow is estimated to be 25 feet/year.

Appendix J
Corrective Measures Assessment

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REPORT ON

CORRECTIVE MEASURES ASSESSMENT
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

by
Haley & Aldrich, Inc.
Cleveland, Ohio

for
Southern Indiana Gas and Electric Company
Evansville, Indiana

File No. 129420-020
September 2019

Overview

Southern Indiana Gas and Electric Company (SIGECO) retained Haley & Aldrich, Inc. (Haley & Aldrich) to prepare this Corrective Measures Assessment (CMA) for the Coal Combustion Residual (CCR) management unit, referred to as the East Ash Pond (EAP), located at F.B. Culley Generating Station (FBC) in Newburgh, Indiana. FBC is a coal-fired power plant located on the Ohio River in Warrick County, Indiana. The CMA was completed in accordance with requirements stated in the U.S. Environmental Protection Agency's (USEPA) rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities*. 80 Fed. Reg. 21302 (Apr. 17, 2015) (promulgating 40 CFR §257.61); 83 Fed. Reg. 36435 (July 30, 2018) (amending 40 CFR §257.61) (CCR Rule).

SIGECO implemented groundwater monitoring under the CCR Rule through a phased approach to allow for a graduated response and evaluation of steps to address groundwater quality. Assessment monitoring completed in 2018 evaluated the presence and concentration of Appendix IV constituents in groundwater specified in the CCR Rule. Of the 23 CCR parameters evaluated, only one Appendix IV constituent, molybdenum, exceeds the Groundwater Protection Standards (GWPS) established for the EAP.

In performing this CMA, Haley & Aldrich considered the following: presence and distribution of molybdenum, EAP configuration, hydrogeologic setting, and the results of the risk evaluation. Within the EAP, CCR is managed in an impoundment at depths that range from zero (0) feet to approximately 60 feet. The alluvial aquifer beneath the EAP is approximately 80 feet in thickness. Although flow within the alluvial aquifer is directly controlled by the river stages of the Ohio River, groundwater flow is generally from the upland area north of the EAP toward the Ohio River.

To provide a comprehensive CMA, the evaluation described herein included surface impoundment closure options and groundwater remediation alternatives that were combined to constitute comprehensive groundwater remedies, including:

- Alternative 1: Monitored Natural Attenuation (MNA) with In-Situ Solidification (ISS) and Closure in Place (CIP);
- Alternative 2: Hydraulic Containment using pumping with no treatment of the extracted groundwater prior to discharge (hereafter referred to as “Hydraulic Containment with No Treatment”), ISS and CIP;
- Alternative 3: Hydraulic Containment using pumping with treatment of the extracted groundwater prior to discharge (hereafter referred to as “Hydraulic Containment with Treatment”), ISS and CIP;
- Alternative 4: In-Situ Groundwater Treatment, ISS and CIP;
- Alternative 5: MNA with Closure by Removal (CBR);
- Alternative 6: Hydraulic Containment with No Treatment and CBR;
- Alternative 7: Hydraulic Containment with Treatment and CBR; and
- Alternative 8: In-Situ Groundwater Treatment and CBR.

These eight alternatives were developed to meet the threshold criteria provided in the CCR rule at § 257.97 as discussed in **Section 4**, which are:

- Be protective of human health and the environment;

- Attain the groundwater protection standard as specified pursuant to §257.95(h);
- 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;
- 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;
- Comply with standards for management of wastes as specified in §257.98(d).

The alternatives were then compared to three of the four balancing criteria stated in the CCR Rule at §257.97. The four balancing criteria consider:

1. The long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful;
2. The effectiveness of the remedy in controlling the source to reduce further releases;
3. The ease or difficulty of implementing a potential remedy; and
4. The degree to which community concerns are addressed by a potential remedy.

Balancing criteria four, which considers community concerns, will be evaluated following a public information session to be conducted at least 30 days prior to remedy selection by SIGECO.

The following observations are made regarding closure scenarios and groundwater remedial alternatives for the EAP and are described more fully in this report:

- **Cap Integrity and Hydrogeologic Conditions:** All CIP alternatives assumed the installation of a cap and cover system that meets or exceeds the performance criteria set forth in the CCR Rule and is referred to in this CMA as a "low permeability cap." Vertical infiltration via precipitation would be virtually eliminated following installation of the geomembrane cover system. Ash in contact with groundwater would be addressed via remedies that would control, minimize or eliminate the post-closure infiltration of liquids[1].

- **No Risk:** Risk assessment evaluations confirm that the EAP, even prior to closure, presents no **unacceptable risk** to human health or the environment. In fact, concentration levels of molybdenum would need to be **more than 1,000 times higher** than currently measured levels in groundwater before an adverse impact to human health or the environment to a receptor in the Ohio River (the only affected receptor) would occur. Therefore, because no adverse risk currently exists, implementation of any of the remedies considered herein will not result in a meaningful reduction in risk to groundwater-related exposures.

- **Excavation Timeframe:** Because the EAP is relatively small (approximately 378,000 cubic yards), the timeframes associated with excavation and off-site disposal of CCR material are comparable to the timeframes anticipated for capping with ISS. As a result, the logistical challenges – including excavation, transportation, and disposal, and the short-term risks to the community are not significantly different for the CIP and CBR remedy components.

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[1] For purposes of this document, the representative remedy that would achieve this requirement is in-situ solidification (ISS). We note that subsurface barrier walls are also appropriate under this remedy and could be used interchangably to describe this remedy component.

In accordance with §257.98, SIGECO will implement a groundwater monitoring program to document the effectiveness of the selected remedial alternative. Corrective measures are considered complete when monitoring reflects groundwater downgradient of the EAP does not exceed Appendix IV GWPS for three consecutive years.

USEPA is in the process of modifying certain CCR Rule requirements and, depending upon the nature of such changes, assessments made herein could be modified or supplemented to reflect such future regulatory revisions. See *Federal Register (March 15, 2018; 83 FR 11584*).

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List of Acronyms and Abbreviations

Abbreviation	**Definition**
ASD	Alternate Source Demonstration
CBR	Closure by Removal
CCR	Coal Combustion Residual
CIP	Closure in Place
COC	Constituent of Concern
CMA	Corrective Measures Assessment
CSM	Conceptual Site Model
EAP	East Ash Pond CCR Management Unit
FBC	F.B. Culley Generating Station
GMP	Groundwater Monitoring Plan
GWPS	Groundwater Protection Standards
Haley & Aldrich	Haley & Aldrich, Inc.
ISS	In-Situ Solidification
MNA	Monitorned Natural Attenuation
msl	Mean Sea Level
N&E	Nature and Extent
SIGECO	Southern Indiana Gas and Electric Company
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
USEPA	United States Environmental Protection Agency

1. Introduction

Haley & Aldrich, Inc. (Haley & Aldrich) was retained by Southern Indiana Gas and Electric Company (SIGECO) to prepare this Corrective Measures Assessment (CMA) for the Coal Combustion Residual (CCR) management unit (East Ash Pond [EAP]) located at the F.B. Culley Generating Station (FBC), herein referred to as the "Site", in Warrick County, Indiana. SIGECO has conducted detailed geologic and hydrogeologic investigations under the U.S. Environmental Protection Agency (USEPA) rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities*. 80 Fed. Reg. 21302 (Apr. 17, 2015) (promulgating 40 CFR §257.61); 83 Fed. Reg. 36435 (July 30, 2018) (amending 40 CFR §257.61) (CCR Rule). These investigations were, in part, related to the groundwater monitoring and corrective action requirements in the CCR Rule.

This CMA includes a summary of the groundwater monitoring results for Appendix IV constituents, a summary of the evaluation of the Appendix III constituents for statistically significant increases (SSI) compared to background, and a comparison of the Appendix IV constituents detected in assessment monitoring to the Groundwater Protection Standards (GWPS). These evaluations identified statistically significant levels (SSL) of molybdenum in groundwater downgradient of the EAP. This report evaluates potential corrective measures to remediate groundwater for the exceedance of the GWPS.

1.1 FACILITY DESCRIPTION/BACKGROUND

The Site is located adjacent the northern bank of the Ohio River west of the confluence of the Ohio River and Little Pigeon Creek approximately three miles east of the town of Newburgh. The Site varies in ground surface elevations from 359 to 430-feet above mean sea level (msl). The higher elevations are to the north of the Site, north of the Ohio River floodplain. In general, surface topography across the site slopes to the south towards the Ohio River **(Figure 1-1)**. Surface water runoff occurs via sheet flow to low lying areas which eventually lead to the Ohio River and Little Pigeon Creek.

The Site began operations in 1953. FBC is an active energy production facility that generates electricity through the combustion of Illinois Basin coal. The coal combustion residuals are products of the combustion process and include bottom ash, fly ash, and flue gas desulfurization sludge. CCR is currently managed through beneficial re-use and on the Site in a 10-acre impoundment known as the EAP. Site features are shown on **Figure 1-2**. Approximately 378,000 cubic yards of CCR material is currently stored in the EAP. SIGECO owns the land and operates the station for supplying electric power to industrial, commercial, and residential customers in its service territory.

1.2 GROUNDWATER MONITORING

Groundwater monitoring under the CCR Rule occurs through a phased approach to allow for a graduated response (i.e., baseline, detection, and assessment monitoring as applicable) and evaluation of steps to address groundwater quality. Haley and Aldrich prepared a *Groundwater Monitoring Plan* (GMP) as required by the CCR Rule. The GMP presents the design of the groundwater monitoring system, groundwater sampling and analysis procedures, and groundwater statistical analysis methods.

Monitoring wells were installed in December 2015, March 2016 and February 2017. The monitoring well network includes three background wells (CCR-AP-1R, CCR-AP-7 and CCR-AP-9) and seven downgradient monitoring wells (CCR-AP-2, CCR-AP-3, CCR-AP-4, CCR-AP-5, CCR-AP-6, CCR-AP-8) located around the perimeter of the EAP. Monitoring well locations are shown in **Figure 1-3**.

Detection monitoring events occurred in 2016 and 2017. The results of the sampling events were then compared to background using statistical methods to determine if Appendix III constituents are present at concentrations above background, called SSIs downgradient of the EAP. The result of the statistical analysis identified SSIs were calculated thereby triggering Assessment Monitoring and respective notification of the same.

During the Assessment Monitoring phase, CCR groundwater samples were collected from the CCR monitoring well network in June, and August 2018 and subsequently analyzed for the Appendix III and Appendix IV constituents as required by 40 CFR §257.95(b) and 40 CFR §257.95(d)(1). Appendix IV analytical results are summarized in Table I. Concurrent with the second assessment sampling round, and as required by 40 CFR §257.95(h), GWPS were established for the detected Appendix IV constituents. The assessment monitoring sampling results were compared to the GWPS to determine if SSLs of Appendix IV constituents were present downgradient of the EAP. The results of this evaluation indicated that arsenic and molybdenum were present in groundwater at statistically significant levels above the GWPS. Appendix IV analytical results are summarized in **Table IA**.

As a result of this determination and in accordance with 40 CFR §257.95(g)(3) a field investigation was initiated to demonstrate that a source other than the EAP caused the arsenic and molybdenum contamination. However, due to an extended period of time where the Ohio River was at flood stage, the proposed sampling locations associated with the alternate source demonstration (ASD) for arsenic could not be accessed and the ASD could not be completed prior to the April 15, 2019 deadline to initiate an assessment of corrective measures. The sampling and analysis conducted to evaluate the potential for the naturally occurring coal seam, identified in the boring for CCR-AP-5, to be an alternate source for molybdenum was completed. The molybdenum ASD showed that the naturally occurring coal was a contributing source of molybdenum but the CCR material in the EAP was the primary source. Consequently, both molybdenum and arsenic were carried forward into the assessment of corrective measures while SIGECO continued to pursue the alternate source demonstration for arsenic. Field work for the arsenic ASD was completed on June 12, 2019 and the analytical results were received on July 23, 2019. Soil and groundwater sampling results confirmed that arsenic was naturally occurring in the fine grained, organic rich, alluvial soil and documented the geochemical conditions required to mobilize arsenic through the process of reductive dissolution. As a result, it was determined that the alternate source for arsenic in downgradient groundwater wells from the EAP is the naturally occurring fine-grained alluvium soils, and therefore the corrective measures assessment that follows is focused solely on molybdenum.

1.3 CORRECTIVE MEASURES ASSESSMENT PROCESS

The CMA process involves development of groundwater remediation technologies that will result in meeting the following threshold criteria: protection of human health and the environment, attainment of GWPS, source control, constituent removal, and compliance with standards for waste management. Once these technologies are demonstrated to meet these criteria, they are then compared to one another with respect to the following balancing criteria: long- and short-term effectiveness, source control, and ease or difficulty of implementation. Input from the community on such proposed measures will occur as part of a public meeting to be conducted at least 30 days prior to remedy selection by SIGECO.

1.4 RISK REDUCTION AND REMEDY

The CCR Rule (§257.97(b)(1) - Selection of Remedy) requires that remedies must be protective of human health and the environment. Further, §257.97(c) of the CCR Rule requires that in selecting a remedy, the owner or operator of the CCR unit must consider specific evaluation factors, including the risk reduction achieved by each of the proposed corrective measures. Each of the following evaluation factors listed here from §257.97 and discussed in **Section 4** are those that are directly related to human health and environmental risk:

- (c)(1)(i) Magnitude of reduction of existing risks;
- (c)(1)(ii) Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy;
- (c)(1)(iv) Short-term risks that might be posed to the community or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminant;
- (c)(1)(vi) Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment;

The following are additional factors related to risk that are considered when developing the schedule for implementing and completing remedial activities once a remedy is selected (§257.97(d)):

- (d)(4) Potential risks to human health and the environment from exposure to contamination prior to completion of the remedy[2];
- (d)(5)(i) Current and future uses of the aquifer;
- (d)(5)(ii) Proximity and withdrawal rate of users; and
- (d)(5)(iv) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to CCR constituents.

[2] Factors (d)(4) and (d)(5) are not part of the CMA evaluation process as described in §257.97(d)(4), §257.97(d)(5)(i)(ii)(iv); rather they are factors the owner or operator must consider as part of the schedule for remedy implementation.

2. Groundwater Conceptual Site Model

The Site geology and hydrogeology was initially described in the *Groundwater Monitoring Plan* prepared by Haley & Aldrich in October 2017. The Conceptual Site Model (CSM) presented in this section of the CMA has been updated to reflect information gathered to comply with the CCR Rule.

2.1 SITE SETTING

The Site is located on the northern bank of the Ohio River, at the confluence of the Ohio River and Little Pigeon Creek, approximately three miles east of the town of Newburgh. The Site varies in elevation with ground surface elevations varying from 430 to 359-feet above msl. Higher elevations are north of the Ash Pond with surface topography sloping to the west and south towards the Ohio River. Surface water runoff occurs via sheet flow into low lying areas towards the Ohio River and Little Pigeon Creek.

2.2 GEOLOGY AND HYDROGEOLOGY

The EAP is located within the Ohio River valley which contains naturally occurring alluvial (stream) and loess (windblown) deposits derived indirectly from continental ice sheets. These sediments were transported in meltwater heavily loaded with entrained sediments that accumulated on top of the Pennsylvanian age shale, limestone and sandstone bedrock. Westerly winds simultaneously deposited silty sediments in the upland areas adjacent to the stream valley. As a result, base levels of the valley floor increased in elevation and created natural levees and terraces. These natural levees produced slackwater lakes which deposited thick sequences of silt and clay adjacent to the river channel. When the ice sheets retreated, the sediment load in the Ohio River diminished and lowered base levels. Consequently, the river incised the slackwater lake sediments, sculpted fluvial terraces, and deposited sand and gravel stream alluvium.

Soil types described in boring logs from monitoring wells installed around the EAP, as well as boring logs generated from geotechnical explorations conducted by AECOM through the EAP indicate that the uppermost aquifer is comprised of a layered sequence of unconsolidated deposits consisting primarily of silts and clay associated with the slackwater lakes overlying sand and gravel alluvium. This unconsolidated overburden overlies Pennsylvanian age shale.

Bedrock around FBC belongs to the Carbondale Group. The Group consists of Pennsylvanian age sandstone, limestone, shale and coal. The Group ranges from 260 to 470 feet thick but on average is approximately 300 feet thick. The Carbondale Group includes laterally persistent limestone units and four of Indiana's commercially important coal seams. Laterally continuous shale beds are associated with the coal formations. Bedrock beneath the EAP dips to the south and south west toward the Ohio River. In the upland area to the northeast of the EAP, the top of bedrock is represented by sandstone. The sandstone unit is not present along the Ohio River where the bedrock is more deeply eroded, and the top of bedrock is represented by gray shale.

The Site is located in the vicinity of the Wabash Valley and New Madrid seismic zones. The largest earthquake recorded (magnitude 5.2) proximal to the Site occurred in April 18, 2008 approximately fifty miles northwest of the facility.
Hydrogeologic units are defined based on their ability to transmit groundwater or serve as confining units between zones of groundwater. In the vicinity of the EAP, the uppermost aquifer occurs within

unconsolidated Ohio River alluvial deposits consisting of silt and clay with discontinuous interbedded layers of sand. To the north of the Ash Pond the uppermost aquifer occurs in the shale and sandstone bedrock units. Recharge to the surficial aquifer occurs through direct surface infiltration.

Piezometric data recorded from the monitoring wells installed on-site shows that the configuration of the uppermost aquifer is primarily controlled by surface topography with some influence from the underlying weathered bedrock. Groundwater flow in the immediate vicinity of the Ash Pond is radial with an overall flow direction from the upland areas north of the Ash Pond to the south toward the Ohio River and Little Pigeon Creek. Groundwater elevations vary seasonally but the groundwater flow patterns remain consistent.

Groundwater flow velocity in the uppermost aquifer beneath the EAP was estimated using site-specific hydraulic conductivity, measured hydraulic gradients, and an assumed effective porosity of 25 percent. Hydraulic conductivity varied from 1.3E-3 cm/sec adjacent to the northern boundary of the Ash Pond to 5.5E-5 cm/sec in the upland area north of the Ash Pond. The hydraulic gradient north of the Ash Pond is 0.06 feet/foot. South of the Ash Pond the hydraulic gradient steepens to 0.1 feet/foot down to the Ohio River. Using the site-specific hydraulic conductivity and hydraulic gradients, and assuming an effective porosity of 25 percent the groundwater flow north of the Ash Pond is estimated to be 325 feet/year. To the south of the Ash Pond groundwater flow is estimated to be 25 feet/year.

2.3 GROUNDWATER PROTECTION STANDARDS

Haley and Aldrich completed a statistical evaluation of groundwater samples using the methods and procedures outlined in the Groundwater Monitoring Plan's *Statistical Analysis Plan* (Haley and Aldrich 2017) to develop site-specific GWPS for each Appendix IV constituent.

Groundwater results were compared to the site-specific GWPS. Exceedances above the GWPS are limited to three monitoring wells (CCR-AP-5, CCR-AP-6I, and CCR-AP-8I) for molybdenum only. Monitoring well locations with SSLs above the GWPS are illustrated on **Figure 2-1**.

2.4 NATURE AND EXTENT OF GROUNDWATER IMPACTS

As outlined in Section 1.2 of this CMA, a successful ASD for arsenic was determined and therefore the corrective measures assessment is focused solely on molybdenum. However, because of the compressed schedule in the Rule and concern over the availability of drillers, SIGECO decided to initiate an evaluation of the nature and extent of molybdenum and arsenic prior to determining the presence of an SSL and prior to the conclusion of the alternate source demonstration, which is the reasoning for installing new monitoring wells along the south side of the EAP. Prior to the successful ASD for arsenic, molybdenum was limited to the shallow aquifer at monitoring well CCR-AP-5 and arsenic was limited to the shallow wells installed in the fine-grained soil south and west of the EAP. Haley & Aldrich initiated an investigation to define the horizontal and vertical nature and extent (N&E) of Appendix IV SSLs as required by the CCR Rule in November 2018 by installing five new monitoring wells (CCR-AP-10, CCR-AP-11, CCR-AP-5I, CCR-AP-6I, and CCR-AP-8I). Monitoring wells CCR-AP-10 and CCR-AP-11 were installed to horizontally delineate molybdenum detected in samples collected from CCR-AP-5 and CCR-AP-5I was installed to vertically delineate molybdenum. Monitoring wells CCR-AP-6I and CCR-AP-8I were installed to vertically delineate arsenic detected along the south side of the EAP. The location of the new monitoring wells is shown on **Figure 1-3**.

Groundwater sampling results from the monitoring wells installed to horizontally and vertically delineate molybdenum detected in samples collected from CCR-AP-5 showed that the extent of molybdenum was limited to the vicinity of CCR-AP-5. Molybdenum was not detected in these newly installed wells at concentrations above GWPSs. However, molybdenum was identified at concentrations above GWPS in groundwater samples collected from the wells installed along the southern berm of the EAP to vertically delineate arsenic . Horizontally, the molybdenum plume is delineated by the Ohio River and vertically the molybdenum plume is defined by the top of the shale bedrock recognizing that the shale bedrock will impede the vertical movement of groundwater. Additional refinement of the groundwater conditions may be considered in the future to support design and construction of groundwater remedies, as necessary. Appendix IV analytical results for the nature and extent monitoring wells are summarized in **Table 1B**.

3. Risk Assessment and Exposure Evaluation

A "Groundwater Risk Evaluation" report has been prepared by Haley & Aldrich, as a companion to this CMA document, and is presented in Appendix A. The purpose of the risk evaluation report is to provide the information needed to interpret and meaningfully understand the groundwater monitoring data collected and published for the FBC EAP under the CCR Rule. In addition, SIGECO has voluntarily taken the additional step of evaluating potential groundwater-to-surface water transport and exposure pathways in the risk evaluation.

The risk evaluation report was completed by developing a CSM to identify the potential for human or ecological exposure to constituents that may have been released to the environment. The CSM was used to resolve questions such as: Is there a source? Are constituents released from the source? Are environmental media (soil, groundwater, surface water, sediments and air) affected by the constituent release? Do constituents travel within and between media? Is there a point where a receptor (human or ecological) could contact the constituents in the medium? If the answers to these questions are 'Yes', then the risk evaluation resolves the question "Are the constituent concentrations high enough to potentially have a toxic effect?" by comparing constituent concentrations in groundwater to risk-based screening levels.

Screening levels are constituent concentrations in groundwater (and other media) that are considered to be protective of specific human exposures and ecological exposures. The USEPA and other regulatory agencies, including the Indiana Department of Environmental Management, develop screening levels to provide a conservative estimate of the concentration to which a receptor (human or ecological) can be exposed without experiencing adverse health effects. Due to the conservative methods used to derive risk-based screening levels, it is understood with reasonable certainty that concentrations below screening levels will not result in adverse health effects, and that no further evaluation is necessary. Concentrations above conservative risk-based screening levels do not necessarily indicate that a potential risk exists but indicate that further evaluation may be warranted.

The results of the risk evaluation indicate that:

- Groundwater downgradient of the EAP is not used as a source of drinking water and is not flowing toward any groundwater supply wells. Therefore, despite one constituent in groundwater being detected at statistically significant levels above GWPS, the constituent does not pose any health risks associated with drinking water uses or exposures.

- If constituents in groundwater downgradient of the EAP were assumed to flow into the Ohio River, the concentrations in groundwater would need to be orders of magnitude higher than they are to be a potential concern to people who use the Ohio River as a source of drinking water and for recreational purposes, and for ecological receptors that live in or use the Ohio River.

Consequently, the risk evaluation demonstrates that there are no adverse impacts on human health or ecological receptors from groundwater uses resulting from coal ash management practices at the F.B Culley Generating Station East Ash Pond.

4. Corrective Measures Alternatives

4.1 CORRECTIVE MEASURES ASSESSMENT GOALS

The overall goal of this CMA is to identify and evaluate the appropriateness of potential corrective measures to prevent further releases of Appendix IV constituents to groundwater above their GWPS, to remediate releases of Appendix IV constituents detected during groundwater monitoring above their GWPS that have already occurred, and to restore groundwater in the affected area to conditions where Appendix IV constituents are present at concentrations below the GWPS. The corrective measures evaluation that is discussed below and subsequent sections provides an analysis of the effectiveness of eight potential corrective measures in meeting the requirements and objectives of remedies as described under §257.97 (also shown graphically on **Figure 4-1**). Additional remedial alternatives were considered but were determined to not be viable for remediating groundwater at this site. By meeting these requirements. this assessment also meets the requirements promulgated in §257.96 which include an evaluation of:

- The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to residual contamination;
- The time required to complete the remedy; and
- The institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy.

The criteria listed above are included in the balancing criteria considered during the corrective measures evaluation, described in **Section 5**.

4.2 GROUNDWATER FATE AND TRANSPORT MODELING

Groundwater at the Site was modeled utilizing Groundwater Vista Version 7 for flow and solute transport. The model was constructed, calibrated, and subsequent simulations run to evaluate remedy alternatives for Appendix IV constituents above the GWPS. Site-specific parameters (i.e. groundwater elevations and hydraulic conductivity) were utilized for model preparation. MODFLOW 2005, a finite difference three-dimensional solver, was utilized for groundwater flow estimation. Modeled groundwater elevations were compared to observed values from the on-site well network (February 2019) to achieve a calibration of less than 10 percent scaled root mean squared of measured water levels. Once groundwater flow was calibrated in the model, solute transport was completed using MT3DMS, a three-dimensional solute transport modeling program. Parameters affecting transport such as advection, diffusion, dispersion, and adsorption are utilized within the MT3DMS package to estimate solute transport within the model domain.

The calibrated flow models were used to simulate the different remediation alternatives and the effects they have on groundwater quality through time. These simulations are incorporated into the discussion on remediation alternatives provided below.

4.3 CORRECTIVE MEASURES ALTERNATIVES

Corrective measures are considered complete when groundwater impacted by the EAP does not exceed the Appendix IV GWPS for three consecutive years of groundwater monitoring. In accordance with §257.97, the groundwater corrective measures being considered must meet, at a minimum, the following threshold criteria:

1. Be protective of human health and the environment;
2. Attain the GWPS;
3. Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of COCs to the environment;
4. Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, considering factors such as avoiding inappropriate disturbance of sensitive ecosystems; and
5. Comply with standards (regulations) for waste management.

Each of the corrective measures assembled in this CMA meet the requirements of the threshold criteria listed above.

The corrective measures alternatives presented below contemplate both closure in place (CIP) (Alternatives 1 through 4) and closure by removal (CBR) (Alternatives 5 through 8) of the EAP. Both closure methods are expressly authorized under the CCR Rule.

4.3.1 Alternative 1 – Monitored Natural Attenuation (MNA) with In-Situ Solidification (ISS) and Closure in Place

The EAP would be closed in place with a cap system that will reduce infiltration of surface water to groundwater thereby isolating source material. This cap selection would meet or exceed the performance criteria set forth in the CCR Rule. Over time, depletion of COCs in CCR would allow the concentration of COCs in downgradient groundwater to decline and overall groundwater concentrations of COCs to attenuate. CCR material below the water table would be isolated using targeted in-situ soil solidification (ISS). In-situ soil solidification is a technique that uses mixing of the CCR with amendments to solidify the material in place. Amendments typically include Portland Cement and the solidification is completed in-situ using large diameter augers. CCR located beneath the water table would be isolated by ISS, followed by capping of the surface impoundment. Groundwater impacts would be addressed through the processes of natural attenuation. This alternative would isolate the source (through solidification and installation of a low-permeability cap) and over time, allow the concentrations of COCs in downgradient groundwater to decline and overall groundwater concentrations of COCs to attenuate (MNA).

Closure-in-place (CIP) with MNA can be completed safely, in compliance with applicable federal and state regulations, and be protective of public health and the environment. In general, CIP consists of installing a cap/cover designed to significantly reduce infiltration from surface water or rainwater, resist erosion, contain CCR materials, and prevent exposures to CCR. CIP at the EAP will require mounding of the remaining CCRs within the pond, or importation of borrow soil, in order to create a surface with adequate slope to construct a cap and prevent the mounding and ponding of stormwater. This could require extensive excavation and transferring of the material within the pond. Excavation and construction safety during closure is a concern due to heavy equipment (e.g., bulldozers, excavators, front end loaders, and off-road trucks) and dump truck operation within the active FBC site. Additionally, the stormwater runoff will need to be managed, requiring additional time to design and potentially construct a stormwater runoff pond. As previously stated, CCR material below the water table would be isolated using targeted ISS. At the EAP, CIP construction activities are roughly anticipated to take approximately 12 to 18 months.

MNA is a viable remedial technology recognized by both state and federal regulators that is applicable to inorganic compounds in groundwater. The USEPA defines MNA as "the reliance on natural attenuation processes to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods". The 'natural attenuation processes' that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes may include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants (USEPA, 2015). When combined with a low-permeability cap and targeted ISS to address the source by limiting the infiltration of precipitation into and through the CCR, MNA can reduce concentrations of molybdenum in groundwater at the boundary of the EAP.

Following the installation of the cap system, SIGECO would implement post-closure care activities. Post-closure care includes cap system maintenance and long-term groundwater monitoring until such time that groundwater conditions return to below GWPS.

4.3.2 Alternative 2 – Hydraulic Containment with No Treatment, ISS and CIP

Using this alternative, the EAP would be closed in-place as described in Section 4.3.1 to reduce infiltration of surface water to groundwater and isolate the CCR material below the water table. Molybdenum in groundwater would be addressed with hydraulic containment through groundwater pumping to hydraulically control the migration of those constituents downgradient. Pumping would be undertaken in the alluvial aquifer and the pumping well effluent is assumed to be discharged directly to surface water under existing or future discharge permits. Under this alternative no treatment would be used prior to discharge. Verification that the effluent could be discharged under current permits or application for and approval of a new permit would be required.

Implementation of a large-scale hydraulic containment system will require a detailed and lengthy design effort. Pilot testing, such as pumping tests and additional groundwater modeling will be needed to verify the hydraulic capture zone.

The pumping well effluent would be discharged directly to a receiving water body (i.e. the Ohio River) in accordance with a National Pollutant Discharge Elimination System (NPDES) Permit. No treatment would be used prior to discharge. The construction of water discharge piping from the EAP to the receiving water body will require engineering design, permitting, and site construction. For the effluent to be discharged to a receiving water body, the existing FBC NPDES Permit may need to be modified or a new permit issued. Either option would likely require effluent testing or modeling to support a permit application. The anticipated timeline for permitting and construction of this option is one year.

Following the installation of the groundwater pumping well network, SIGECO would implement post-closure care activities that includes operation and maintenance of the hydraulic containment system, long-term groundwater sampling to monitor hydraulic control system performance, and cap and cover system maintenance.

4.3.3 Alternative 3 – Hydraulic Containment with Treatment, ISS and CIP

The EAP would be closed in-place as described in Section 4.3.1 to reduce infiltration of surface water to groundwater. Molybdenum detected at the boundary of the unit at concentrations above the GWPS would be addressed with hydraulic containment through groundwater pumping to hydraulically control the migration of those constituents downgradient. Pumping would be limited to the uppermost aquifer. Pumping well effluent would be treated ex-situ, likely with an ion exchange or a reverse osmosis (RO) treatment system. Both systems would have ongoing operation and maintenance and would generate a secondary waste stream – including regeneration/replacement of the ion exchange media or accumulation of reject water from the RO system.

The design and construction of an ion exchange or RO system would require additional development of a treatment system enclosure, equipment and space that adds complexity to this alternative. As noted in the previous option, implementation of a large-scale hydraulic containment system would require a detailed and lengthy design effort. Pilot testing, such as pumping tests and additional groundwater modeling, will be needed to verify the hydraulic capture zone. The timeline for engineering , procurement, permit modification and construction of this option is estimated to be 1 to 2 years.

Following the installation of the low-permeability cap, groundwater pumping well network, and ex-situ treatment system, SIGECO would implement post-closure care activities that includes operation and maintenance of the hydraulic containment system, long-term groundwater sampling to monitor hydraulic containment system performance, and cover system maintenance. Over time, concentrations of molybdenum would decrease to less than the GWPS and operation of the hydraulic containment system would cease.

4.3.4 Alternative 4 – In-Situ Treatment, ISS and CIP

The EAP would be closed in-place as described in Section 4.3.1 to reduce infiltration of surface water to groundwater. Molybdenum would be addressed through in-situ addition of groundwater treatment amendments downgradient of the EAP with the objective of accelerating the time required to achieve the GWPS within the treatment zone. Approvals and permitting would be required for the construction and installation of the treatment system and injection/application of amendments to the subsurface.

Implementation of an in-situ treatment system will require a detailed lengthy design effort with additional bench scale testing to verify groundwater treatment. The bench scale testing will evaluate the efficacy of treating molybdenum in-situ, while factoring in potential changes in groundwater geochemistry which may adversely affect the stability of other CCR-related constituents.

Following the installation of the in-situ treatment system, SIGECO would implement post-closure care activities that include periodic amendment injections or periodic replenishment of the treatment reagents within the treatment zone or reactive barrier, long-term groundwater sampling to monitor treatment system performance, and cover system maintenance. Over time concentrations of molybdenum would decrease to values less than the GWPS and in-situ treatment would cease.

4.3.5 Alternative 5 – MNA with Closure by Removal

This alternative evaluates the removal of CCR from the EAP at FBC followed by natural attenuation of molybdenum in groundwater. Because the EAP is relatively small (approximately 378,000 cubic yards), excavation and off-site disposal is expected to take less than 2-years to complete. As with Alternative 1, concentrations of molybdenum in downgradient groundwater would decline via natural attenuation processes.

Due to the relatively small size of the EAP, potential community impacts, safety concerns, and construction challenges associated with the CBR alternative are not anticipated to be significantly different than CIP with ISS. Technical and logistical challenges of implementing an ash removal project have already been addressed by SIGECO through their ongoing closure activities associated with the West Ash Pond. Removal activities require dewatering and temporary staging/stockpiling of material for drying prior to transportation, which may affect productivity and extend the timeframe to complete removal. During periods of rain and inclement weather, the removal schedule will be negatively impacted. Excavation and construction safety during the removal duration is another concern due to heavy equipment (e.g., bulldozers, excavators, front end loaders, and off-road trucks) and dump truck operation within the active FBC site.

Groundwater would be addressed through MNA. MNA is a viable remedial technology recognized by both state and federal regulators that is applicable to inorganic compounds in groundwater. The USEPA defines MNA as "the reliance on natural attenuation processes to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods". The 'natural attenuation processes' that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants" (USEPA, 2015). MNA can reduce concentrations of molybdenum in groundwater at the boundary of the EAP. Long-term, SIGECO would implement post-closure care activities that includes groundwater sampling.

4.3.6 Alternative 6 – Hydraulic Containment with No Treatment and CBR

Similar to Alternative 5, the EAP would be closed by removal; however, under this alternative molybdenum in groundwater would be addressed with hydraulic containment through groundwater pumping to hydraulically control the migration of those constituents downgradient. Pumping would be undertaken in the alluvial aquifer. Under this alternative the pumping well effluent would be discharged directly to surface water under existing or future discharge permits. No treatment would be used prior to discharge. Verification that the effluent could be discharged under current permits or application for and approval of a new permit would be required.

Implementation of a large-scale hydraulic containment system would require a detailed and lengthy design effort. Pilot testing, such as pumping tests and additional groundwater modeling will be needed to verify the hydraulic capture zone.

The pumping well effluent would be discharged directly to a receiving water body (i.e. the Ohio River) in accordance with a National Pollutant Discharge Elimination System (NPDES) Permit. No treatment

would be used prior to discharge. The construction of a transport system from the EAP to the receiving water body would require engineering design, permitting, and site construction. For the effluent to be discharged to a receiving water body, the existing FBC NPDES Permit may need to be modified or a new permit issued. Either option will require effluent testing or modeling to support a permit application. The anticipated timeline for permitting and construction of this option is one year.
Following the installation of the groundwater pumping well network, SIGECO would implement post-closure care activities that includes operation and maintenance of the hydraulic containment system, long-term groundwater sampling to monitor hydraulic control system performance, and cap and cover system maintenance.

4.3.7 Alternative 7 – Hydraulic Containment with Treatment and CBR

Similar to Alternative 5, the EAP would be closed by removal; however, under this alternative molybdenum detected at the boundary of the unit at concentrations above the GWPS would be addressed with hydraulic containment through groundwater pumping to hydraulically control the migration of those constituents downgradient. Pumping would be limited to the uppermost aquifer. Pumping well effluent would be treated ex-situ, likely with an ion exchange or a reverse osmosis (RO) treatment system. Both systems would have ongoing operation and maintenance and would generate a secondary waste stream – including regeneration/replacement of the ion exchange media or accumulation of reject water from the RO system.

The design and construction of an ion exchange or RO system would require additional development of a treatment system enclosure, equipment and space that adds complexity to this alternative. As noted in the previous option, implementation of a large-scale hydraulic containment system would require a detailed and lengthy design effort. Pilot testing, such as pumping tests and additional groundwater modeling, will be needed to verify the hydraulic capture zone.

Following the installation of the low-permeability cap, groundwater pumping well network, and ex-situ treatment system, SIGECO would implement post-closure care activities that includes operation and maintenance of the hydraulic containment system, long-term groundwater sampling to monitor hydraulic containment system performance, and cover system maintenance

4.3.8 Alternative 8 – In-Situ Treatment and CBR

Similar to Alternative 5, the EAP would be closed by removal; however, under this alternative molybdenum would be addressed through in-situ addition of groundwater treatment amendments downgradient of the EAP with the objective of accelerating the time required to achieve the GWPS within the treatment zone. Approvals and permitting would be required for the construction and installation of the treatment system and injection/application of amendments to the subsurface.

Implementation of an in-situ treatment system will require a detailed lengthy design effort with additional bench scale testing to verify groundwater treatment. The bench scale testing will evaluate the efficacy of treating molybdenum in-situ, while factoring in potential changes in groundwater geochemistry which may adversely affect the stability of other CCR-related constituents.

Following the installation of the in-situ treatment system, SIGECO would implement post-closure care activities that include periodic amendment injections or periodic replenishment of the treatment reagents within the treatment zone or reactive barrier, long-term groundwater sampling to monitor treatment system performance, and cover system maintenance.

5. Comparison of Corrective Measures Alternatives

The purpose of this section is to evaluate, compare, and rank the eight corrective measures alternatives using the balancing criteria described in §257.97.

5.1 EVALUATION CRITERIA

In accordance with §257.97, remedial alternatives that satisfy the threshold criteria are then compared to four balancing (evaluation) criteria. The balancing criteria allow a comparative analysis for each corrective measure, thereby providing the basis for final corrective measure selection. The four balancing criteria include the following:

1. The long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful;
2. The effectiveness of the remedy in controlling the source to reduce further releases;
3. The ease or difficulty of implementing a potential remedy; and
4. The degree to which community concerns are addressed by a potential remedy.

Public input and feedback will be considered following a public information session to be conducted at least 30 days prior to remedy selection by SIGECO.

5.2 COMPARISON OF ALTERNATIVES

This section compares the alternatives to each other based on evaluation of the balancing criteria listed above. Each of the balancing criteria consists of several sub criteria listed in the Rule which have been considered in this assessment. The goal of this analysis is to identify the alternative that is technologically feasible, relevant and readily implementable, provides adequate protection to human health and the environment, and minimizes impacts to the community.

A color-coded graphic which is part of a comprehensive visual comparison tool (see **Table 2**) is presented within each subsection below. These graphics provide a visual snapshot of the favorability of each alternative compared to the other alternatives, where green represents "most favorable", yellow represents "less favorable", and red represents "least favorable".

5.2.1 Balancing Criterion 1 - The Long- and Short-Term Effectiveness and Protectiveness of the Potential Remedy, along with the Degree of Certainty that the Remedy Will Prove Successful

This balancing criterion takes into consideration the following sub criteria relative to the long-term and short-term effectiveness of the remedy, along with the anticipated success of the remedy.

5.2.1.1 Magnitude of reduction of existing risks

As indicated by the N&E evaluation and the most recent groundwater sampling results, and the risk evaluation presented in Section 3, no unacceptable risk to human health and the environment exists with respect to the FBC EAP. Therefore, none of the remedial alternatives are necessary to reduce risks because no such unacceptable risk to molybdenum currently exists. However, other types of impacts may be posed by the various remedial alternatives considered herein. Alternatives 5 through 8 which all include closure by removal are considered the most favorable options because the source is completely removed from the environment. Alternatives 1 through 4 are considered less favorable because the source is left in place. Alternatives 3 and 7, which incorporate hydraulic containment and ex--situ treatment have the highest potential remediation risk due to the installation of pumping wells, construction of treatment systems, long-term operation and maintenance, and the generation of secondary waste streams.

	Alternative 1 MNA with ISS and CIP	**Alternative 2** HC with No Treatment, ISS and CIP	**Alternative 3** HC with Treatment, ISS and CIP	**Alternative 4** In-Situ Treatment, ISS and CIP
Category 1 - Subcriteria i) Magnitude of reduction of risks				

	Alternative 5 MNA with CBR	**Alternative 6** HC with No Treatment and CBR	**Alternative 7** HC with Treatment and CBR	**Alternative 8** In-Situ Treatment and CBR
Category 1 - Subcriteria i) Magnitude of reduction of risks				

5.2.1.2 *Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy*

All alternatives have equal magnitude of residual risks in terms of likelihood of further releases due to CCR remaining because full implementation of all of the remedies will result in meeting the GWPS (as a proxy for risk).

	Alternative 1 MNA with ISS and CIP	**Alternative 2** HC with No Treatment, ISS and CIP	**Alternative 3** HC with Treatment, ISS and CIP	**Alternative 4** In-Situ Treatment, ISS and CIP
Category 1 - Subcriteria ii) Magnitude of residual risk in terms of likelihood of further release				

	Alternative 5 MNA with CBR	**Alternative 6** HC with No Treatment and CBR	**Alternative 7** HC with Treatment and CBR	**Alternative 8** In-Situ Treatment and CBR
Category 1 - Subcriteria ii) Magnitude of residual risk in terms of likelihood of further release				

5.2.1.3 *The type and degree of long-term management required, including monitoring, operation, and maintenance*

Alternative 5 (CBR with MNA) is the most favorable alternative with respect to this criterion because it requires the least amount of long-term management and involves no mechanical systems as part of the remedy. Alternative 1 (CIP with capping and MNA) is slightly less favorable because it requires maintenance of a cap and cover system. The remaining alternatives, which all include hydraulic containment or in-situ treatment require long-term O&M, and those alternatives that contain ex-situ treatment (Alternatives 3 and 7) are the least favorable due to the O&M of groundwater treatment systems and the generation of secondary waste streams.

	Alternative 1 MNA with ISS and CIP	Alternative 2 HC with No Treatment, ISS and CIP	Alternative 3 HC with Treatment, ISS and CIP	Alternative 4 In-Situ Treatment, ISS and CIP
Category 1 - Subcriteria iii) Type and degree of long-term management required				

	Alternative 5 MNA with CBR	Alternative 6 HC with No Treatment and CBR	Alternative 7 HC with Treatment and CBR	Alternative 8 In-Situ Treatment and CBR
Category 1 - Subcriteria iii) Type and degree of long-term management required				

5.2.1.4 Short-term risks that might be posed to the community or the environment during implementation of such a remedy

Community impacts include general impacts to the community due to increased truck traffic on public roads during construction and operation of the remedies, along with generation of secondary waste streams with transportation and off-site disposal of waste streams. Because the volume of material that would need to be imported to cap and cover the EAP is not significantly different than the volume of CCR material in the EAP that would be excavated and disposed off-site the short-term risks associated with CIP and CBR are considered to be similar with little difference in truck traffic for all options.

	Alternative 1 MNA with ISS and CIP	Alternative 2 HC with No Treatment, ISS and CIP	Alternative 3 HC with Treatment, ISS and CIP	Alternative 4 In-Situ Treatment, ISS and CIP
Category 1 - Subcriteria iv) Short term risk to community or environment during implementation				

	Alternative 5 MNA with CBR	Alternative 6 HC with No Treatment and CBR	Alternative 7 HC with Treatment and CBR	Alternative 8 In-Situ Treatment and CBR
Category 1 - Subcriteria iv) Short term risk to community or environment during implementation				

5.2.1.5 Time until full protection is achieved

As previously stated, there is currently no unacceptable exposure to groundwater impacted by molybdenum associated with the EAP; therefore, protection is already achieved. The timeframes to achieve GWPS were evaluated using a predictive model as described above. Based upon predictive modeling, Alternatives 2, 3, 4, 6, 7 and 8, which include a groundwater pumping or in-situ remediation component are predicted to achieve the GWPS in the shortest amount of time. Closure by removal with MNA (Alternative 5) and closure in place (Alternative 1) with MNA are predicted to take slightly more time to achieve GWPS due to the longer period of time required for MNA to reduce molybdenum concentrations and are therefore less favorable.

	Alternative 1 MNA with ISS and CIP	Alternative 2 HC with No Treatment, ISS and CIP	Alternative 3 HC with Treatment, ISS and CIP	Alternative 4 In-Situ Treatment, ISS and CIP
Category 1 - Subcriteria v) Time until full protection is achieved				

	Alternative 5 MNA with CBR	Alternative 6 HC with No Treatment and CBR	Alternative 7 HC with Treatment and CBR	Alternative 8 In-Situ Treatment and CBR
Category 1 - Subcriteria v) Time until full protection is achieved				

5.2.1.6 Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment

Because the extent of groundwater impacted by the EAP is limited to the alluvial aquifer, Alternative 1 (CIP with MNA) has the lowest potential for exposure to human and environmental receptors and is considered most favorable with respect to this criteria. Alternative 4 which relies on in-situ treatment is slightly less favorable because it involves the construction of reactive barriers or injection systems however exposures to remaining wastes during construction are still quite low. Alternatives 5 through 8, which include excavation, transportation, and disposal of CCR material with off-site disposal have a potential risk for exposure to humans and environmental receptors due to construction and transportation. Alternative 7 that include hydraulic containment with ex-situ treatment also has a potential risk associated with the generation and management of secondary waste streams and is considered least favorable.

	Alternative 1 MNA with ISS and CIP	Alternative 2 HC with No Treatment, ISS and CIP	Alternative 3 HC with Treatment, ISS and CIP	Alternative 4 In-Situ Treatment, ISS and CIP
Category 1 - Subcriteria vi) Potential for exposure of humans and environmental receptors to remaining wastes				

	Alternative 5 MNA with CBR	Alternative 6 HC with No Treatment and CBR	Alternative 7 HC with Treatment and CBR	Alternative 8 In-Situ Treatment and CBR
Category 1 - Subcriteria vi) Potential for exposure of humans and environmental receptors to remaining wastes				

5.2.1.7 Long-term reliability of the engineering and institutional controls

Alternative 5 (CBR with MNA) is expected to have high long-term reliability and is considered most favorable with respect to this criteria. Alternative 1 (CIP with MNA) is considered slightly less reliable due to the long-term maintenance of the cap and cover system, however, is still quite reliable. Hydraulic containment (Alternatives 2, 3, 6 and 7) are considered reliable, proven technologies and would have high long-term reliability, but require field pilot studies and bench scale testing and rely on mechanical systems (groundwater pumping and/or treatment systems) to operate and maintain.

Alternatives 4 and 8 are considered least favorable with respect to this criteria because the treatment technology is unproven.

	Alternative 1 MNA with ISS and CIP	**Alternative 2** HC with No Treatment, ISS and CIP	**Alternative 3** HC with Treatment, ISS and CIP	**Alternative 4** In-Situ Treatment, ISS and CIP
Category 1 - Subcriteria vii) Long-term reliability of engineering and institutional controls				

	Alternative 5 MNA with CBR	**Alternative 6** HC with No Treatment and CBR	**Alternative 7** HC with Treatment and CBR	**Alternative 8** In-Situ Treatment and CBR
Category 1 - Subcriteria vii) Long-term reliability of engineering and institutional controls				

5.2.1.8 Potential need for replacement of the remedy

Alternative 5, which incorporates closure by removal with MNA is considered the remedy with the lowest likelihood of requiring replacement because source removal is permanent and natural processes will remedy groundwater. Alternative 1, which includes closure in-place with MNA is considered slightly less favorable since it relies on ISS and the cap and cover system to reduce infiltration and control the source and natural processes to reduce the concentrations of molybdenum in groundwater. Should monitoring results indicate that the selected remedial alternative is not effective at reducing the concentration of molybdenum over time, alternate and/or additional active remedial methods for groundwater may be considered in the future. From the perspective of needing to replace the remedy, the alternatives that rely on operating systems (Alternatives 2, 3, 4, 6, 7, and 8) are considered more likely to require replacement, with alternatives 4 and 8 being the most likely to be replaced due to the unproven nature of the in-situ treatment technology.

	Alternative 1 MNA with ISS and CIP	**Alternative 2** HC with No Treatment, ISS and CIP	**Alternative 3** HC with Treatment, ISS and CIP	**Alternative 4** In-Situ Treatment, ISS and CIP
Category 1 - Subcriteria viii) Potential need for replacement of the remedy				

	Alternative 5 MNA with CBR	**Alternative 6** HC with No Treatment and CBR	**Alternative 7** HC with Treatment and CBR	**Alternative 8** In-Situ Treatment and CBR
Category 1 - Subcriteria viii) Potential need for replacement of the remedy				

5.2.1.9 Long- and short-term effectiveness and protectiveness criterion summary

The following graphic provides a summary of the long- and short-term effectiveness and protectiveness of the potential remedy, along with the degree of certainty that the remedy will prove successful.

	Alternative 1 MNA with ISS and CIP	**Alternative 2** HC with No Treatment, ISS and CIP	**Alternative 3** HC with Treatment, ISS and CIP	**Alternative 4** In-Situ Treatment, ISS and CIP
CATEGORY 1 Long- and Short Term Effectiveness, Protectiveness, and Certainty of Success				

	Alternative 5 MNA with CBR	**Alternative 6** HC with No Treatment and CBR	**Alternative 7** HC with Treatment and CBR	**Alternative 8** In-Situ Treatment and CBR
CATEGORY 1 Long- and Short Term Effectiveness, Protectiveness, and Certainty of Success				

5.2.2 Balancing Criterion 2 - The Effectiveness of the Remedy in Controlling the Source to Reduce Further Releases

This balancing criterion takes into consideration the ability of the remedy to control a future release, and the degree of complexity of treatment technologies that would be required.

5.2.2.1 The extent to which containment practices will reduce further releases

Although Alternatives 5 through 8 do not include containment as part of the remedy, they are considered highly effective at reducing further releases because they all include source removal.

Alternatives 1 through 4 are considered less favorable in this sub-category because source material remains in place. Despite this ranking, the containment practices in Alternatives 1 through 4 are proven and are known to successfully contain releases.

	Alternative 1 MNA with ISS and CIP	**Alternative 2** HC with No Treatment, ISS and CIP	**Alternative 3** HC with Treatment, ISS and CIP	**Alternative 4** In-Situ Treatment, ISS and CIP
Category 2 - Subcriteria i) Extent to which containment practices will reduce further releases				

	Alternative 5 MNA with CBR	**Alternative 6** HC with No Treatment and CBR	**Alternative 7** HC with Treatment and CBR	**Alternative 8** In-Situ Treatment and CBR
Category 2 - Subcriteria i) Extent to which containment practices will reduce further releases				

5.2.2.2 The extent to which treatment technologies may be used

In-situ groundwater treatment technologies have been identified that could successfully treat molybdenum in groundwater, but these in-situ treatment technologies are not proven and would require extensive treatability testing and field scale pilot testing and as a result are considered least favorable with respect to this comparative analysis. With respect to Alternatives 1 and 5, no groundwater treatment technologies, other than natural attenuation will be used. Alternatives 2 and 6 will rely on one technology (hydraulic containment) to address groundwater with the effluent being directly discharge elsewhere on the property. For Alternatives 3 and 7, which include hydraulic containment with ex-situ treatment, two technologies, hydraulic containment and ex-situ treatment, will be utilized. The operation of an ex-situ treatment system will create a secondary waste stream, such as concentrated reject water (from RO) requiring off-site disposal, or depleted resin (from ion exchange), requiring regeneration or off-site disposal.

	Alternative 1 MNA with ISS and CIP	**Alternative 2** HC with No Treatment, ISS and CIP	**Alternative 3** HC with Treatment, ISS and CIP	**Alternative 4** In-Situ Treatment, ISS and CIP
Category 2 - Subcriteria ii) Extent to which treatment technologies may be used				

	Alternative 5 MNA with CBR	**Alternative 6** HC with No Treatment and CBR	**Alternative 7** HC with Treatment and CBR	**Alternative 8** In-Situ Treatment and CBR
Category 2 - Subcriteria ii) Extent to which treatment technologies may be used				

5.2.2.3 Effectiveness of the remedy in controlling the source to reduce further releases summary

The graphic below provides a summary of the effectiveness of the remedial alternatives to control the source to reduce further releases.

	Alternative 1 MNA with ISS and CIP	**Alternative 2** HC with No Treatment, ISS and CIP	**Alternative 3** HC with Treatment, ISS and CIP	**Alternative 4** In-Situ Treatment, ISS and CIP
CATEGORY 2 Effectiveness in controlling the source to reduce further releases				

	Alternative 5 MNA with CBR	**Alternative 6** HC with No Treatment and CBR	**Alternative 7** HC with Treatment and CBR	**Alternative 8** In-Situ Treatment and CBR
CATEGORY 2 Effectiveness in controlling the source to reduce further releases				

5.2.3 Balancing Criterion 3 - The Ease or Difficulty of Implementing a Potential Remedy

This balancing criterion takes into consideration the following technical and logistical challenges required to implement a remedy:

1. Degree of difficulty associated with constructing the technology;
2. Expected operational reliability of the technologies;
3. Need to coordinate with and obtain necessary approvals and permits from other agencies;
4. Availability of necessary equipment and specialists; and
5. Available capacity and location of needed treatment, storage, and disposal services.

5.2.3.1 *Degree of difficulty associated with constructing the technology*

For Alternatives 1 and 5 (CIP and CBR with MNA), the concept is already proven and can be implemented in a reasonable timeframe (less than two years). Alternative 1 is considered slightly less favorable due to the need for targeted ISS to address CCR material below the water table. Alternatives 4 and 8, which rely on in-situ treatment that will require extensive treatability testing and field scale pilot testing are slightly more difficult to construct than Alternatives 1 and 5.

Alternatives 2, 3, 6, and 7, which all incorporate hydraulic containment, will be more difficult to construct and will require additional treatability testing, field scale pilot studies, and permitting, with Alternatives 3 and 7 being the most difficult due to the O&M of ex-situ treatment systems.

	Alternative 1 MNA with ISS and CIP	**Alternative 2** HC with No Treatment, ISS and CIP	**Alternative 3** HC with Treatment, ISS and CIP	**Alternative 4** In-Situ Treatment, ISS and CIP
Category 3 - Subcriteria i) Degree of difficulty associated with constructing the technology				

	Alternative 5 MNA with CBR	**Alternative 6** HC with No Treatment and CBR	**Alternative 7** HC with Treatment and CBR	**Alternative 8** In-Situ Treatment and CBR
Category 3 - Subcriteria i) Degree of difficulty associated with constructing the technology				

5.2.3.2 *Expected operational reliability of the technologies*

Alternative 5 (CBR with MNA) is considered the most favorable from an operational perspective because removal of the source followed by MNA has a proven track record and only requires long-term monitoring following implementation. Alternative 1 (CIP with MNA) is considered slightly less favorable because it relies on construction and long-term maintenance of the cap and cover system to control the source. While Alternatives 2, 3, 6, and 7, which include hydraulic containment, are also expected to be reliable, these alternatives will utilize additional groundwater treatment technologies which will require treatability studies and operations and maintenance and therefore are considered the less favorable when compared to the other alternatives. The in-situ treatment alternatives (Alternatives 4 and 8) are considered least favorable with respect to this criteria due to the less-proven nature of this technology.

	Alternative 1 MNA with ISS and CIP	**Alternative 2** HC with No Treatment, ISS and CIP	**Alternative 3** HC with Treatment, ISS and CIP	**Alternative 4** In-Situ Treatment, ISS and CIP
Category 3 - Subcriteria ii) Expected operational reliability of the technologies				

	Alternative 5 MNA with CBR	**Alternative 6** HC with No Treatment and CBR	**Alternative 7** HC with Treatment and CBR	**Alternative 8** In-Situ Treatment and CBR
Category 3 - Subcriteria ii) Expected operational reliability of the technologies				

5.2.3.3 *Need to coordinate with and obtain necessary approvals and permits from other agencies*

Alternative 5 (CBR with MNA) is the most favorable since the implementation of the remedy is straightforward, generally consistent with other construction at the facility (that has been successfully permitted) and only includes MNA. The remaining alternatives will require additional permitting and approvals for treatability testing, field scale pilot testing, groundwater discharge, groundwater treatment, and/or disposal of secondary waste streams. Alternatives 1 through 4, which all include CIP with ISS, are considered the least favorable due to CCR materials remaining beneath the water table, which may require more extensive approvals and permitting.

	Alternative 1 MNA with ISS and CIP	**Alternative 2** HC with No Treatment, ISS and CIP	**Alternative 3** HC with Treatment, ISS and CIP	**Alternative 4** In-Situ Treatment, ISS and CIP
Category 3 - Subcriteria iii) Need to coordinate with and obtain necessary approvals and permits from other agencies				

	Alternative 5 MNA with CBR	**Alternative 6** HC with No Treatment and CBR	**Alternative 7** HC with Treatment and CBR	**Alternative 8** In-Situ Treatment and CBR
Category 3 - Subcriteria iii) Need to coordinate with and obtain necessary approvals and permits from other agencies				

5.2.3.4 *Availability of necessary equipment and specialists*

Alternative 5 (CBR with MNA) is the most favorable since specialty equipment and specialists will not be required to implement the MNA remedy and the size of the construction project is relatively small. Alternatives 1 through 4 require some specialized equipment to undertake ISS. Alternatives 2 and 6 will require equipment for drilling, recovery well installation, and construction of groundwater conveyance systems and are less favorable than Alternatives 1 and 5 but equipment required should not present a great challenge. Alternatives 3 and 7 which include an ex-situ treatment component are less favorable since they will require construction, operation, and maintenance of ex-situ treatment systems. Alternatives 4 and 8, which incorporate in-situ groundwater treatment, will require extensive treatability testing, field scale pilot testing, and specialty laboratory and contractor support and are therefore considered least favorable.

	Alternative 1 MNA with ISS and CIP	**Alternative 2** HC with No Treatment, ISS and CIP	**Alternative 3** HC with Treatment, ISS and CIP	**Alternative 4** In-Situ Treatment, ISS and CIP
Category 3 - Subcriteria iv) Availability of necessary equipment and specialists				

	Alternative 5 MNA with CBR	**Alternative 6** HC with No Treatment and CBR	**Alternative 7** HC with Treatment and CBR	**Alternative 8** In-Situ Treatment and CBR
Category 3 - Subcriteria iv) Availability of necessary equipment and specialists				

5.2.3.5 Available capacity and location of needed treatment, storage, and disposal services

Alternatives 5 through 8, which include closure by removal, require adequate capacity, storage, and disposal service for off-site receiving facilities. The relatively small size of the EAP should not adversely impact closure by removal with respect to this criteria.

Except for Alternatives 3 and 7, which include hydraulic containment with ex-situ treatment the remaining alternatives would not generate a waste stream and therefore would not require treatment, storage, or disposal services. For Alternatives 3 and 7, the ex-situ treatment system may generate a concentrated waste stream which would require off-site transportation and disposal that the other alternatives would not require and are therefore considered the least favorable.

	Alternative 1 MNA with ISS and CIP	**Alternative 2** HC with No Treatment, ISS and CIP	**Alternative 3** HC with Treatment, ISS and CIP	**Alternative 4** In-Situ Treatment, ISS and CIP
Category 3 - Subcriteria v) Available capacity and location of needed treatment, storage, and disposal services				

	Alternative 5 MNA with CBR	**Alternative 6** HC with No Treatment and CBR	**Alternative 7** HC with Treatment and CBR	**Alternative 8** In-Situ Treatment and CBR
Category 3 - Subcriteria v) Available capacity and location of needed treatment, storage, and disposal services				

5.2.3.6 Ease or difficulty of implementation summary

The graphic below provides a summary of the ease or difficulty that will be needed to implement each alternative. Alternative 1 (CIP with capping and MNA) and Alternative 4 (CBR with MNA) are considered the most favorable, while the remaining alternatives that include a hydraulic containment component or in-situ treatment are considered less favorable.

	Alternative 1 MNA with ISS and CIP	**Alternative 2** HC with No Treatment, ISS and CIP	**Alternative 3** HC with Treatment, ISS and CIP	**Alternative 4** In-Situ Treatment, ISS and CIP
CATEGORY 3 Ease of implementation				

	Alternative 5 MNA with CBR	**Alternative 6** HC with No Treatment and CBR	**Alternative 7** HC with Treatment and CBR	**Alternative 8** In-Situ Treatment and CBR
CATEGORY 3 Ease of implementation				

6. Summary

This Corrective Measures Assessment has evaluated the following alternatives:

- Alternative 1: MNA with ISS and CIP;
- Alternative 2: Hydraulic Containment with No Treatment, ISS and CIP;
- Alternative 3: Hydraulic Containment with Treatment, ISS and CIP;
- Alternative 4: In-Situ Groundwater Treatment, ISS and CIP;
- Alternative 5: MNA with CBR;
- Alternative 6: Hydraulic Containment with No Treatment and CBR;
- Alternative 7: Hydraulic Containment with Treatment and CBR; and
- Alternative 8: In-Situ Treatment Groundwater Treatment and CBR.

In accordance with §257.97, each of these alternatives has been confirmed to meet the following threshold criteria:

- Be protective of human health and the environment;
- Attain the GWPS;
- Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of COCs to the environment;
- Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, considering factors such as avoiding inappropriate disturbance of sensitive ecosystems; and
- Comply with standards (regulations) for waste management.

In addition, in accordance with §257.96, each of the alternatives has been evaluated in the context of the following balancing criteria:

- The long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful;
- The effectiveness of the remedy in controlling the source to reduce further releases;
- The ease or difficulty of implementing a potential remedy; and
- The degree to which community concerns are addressed by a potential remedy.

This Corrective Measures Assessment, and the input received during the public comment period, will be used to identify and select a final corrective measure for implementation at the EAP.

References

1. USEPA. 2015a. Final Rule: Disposal of Coal Combustion Residuals (CCRs) for Electric Utilities. 80 FR 21301-21501. U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.govinfo.gov/content/pkg/FR-2015-04-17/pdf/2015-00257.pdf

2. USEPA. 2015b. Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites.

3. USEPA. 2018a. USEPA Regional Screening Levels. November 2018, values for tapwater. U.S. Environmental Protection Agency. Available at: https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables

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TABLES

TABLE 1A
ASSESSMENT MONITORING GROUNDWATER ANALYTICAL RESULTS - APPENDIX IV CONSTITUENTS
CORRECTIVE MEASURES ASSESSMENT
F.B. CULLEY GENERATING STATION - EAST ASH POND

Location Name	Groundwater	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-3	CCR-AP-3	CCR-AP-3
Sample Name	Protection	CCR-AP-2-20160610	CCR-AP-2-20160812	CCR-AP-2-20161028	CCR-AP-2-20161207	CCR-AP-2-20170208	CCR-AP-2-20170406	CCR-AP-2-20170607	CCR-AP-2-20170928	CCR-AP-2-20171117	CCR-AP-2-20180611	CCR-AP-2-20180828	CCR-AP-2-20181115	CCR-AP-2-20190528	CCR-AP-3-20160610	CCR-AP-3-20160815	CCR-AP-3-20161028
Sample Date	Standard	06/10/2016	08/12/2016	10/28/2016	12/07/2016	02/08/2017	04/06/2017	06/07/2017	09/28/2017	11/17/2017	06/11/2018	08/28/2018	11/15/2018	05/28/2019	06/10/2016	08/15/2016	10/28/2016
Appendix IV Constituents (mg/L)																	
Antimony, Total	0.006	**0.002**	0.002 U	0.002 U	**0.00024 J**	0.002 U	0.002 U	0.002 U	**0.0017 J**	0.01 U	0.002 U	0.02 U	0.002 U	**0.0011 J**	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.01	**0.0018**	**0.0016**	**0.0044**	**0.003**	**0.0035**	**0.0018**	**0.0066**	**0.017**	**0.0066**	**0.013**	**0.021**	**0.0012**	**0.032**	**0.058**	**0.072**	**0.071**
Barium, Total	2	**0.055**	**0.038**	**0.09**	**0.14**	**0.12**	**0.052**	**0.27**	**0.44**	**0.17**	**0.27**	**0.52**	**0.043 B**	**0.26**	**0.41**	**0.38**	**0.4**
Beryllium, Total	0.004	**0.00014 J**	**0.00015 J**	**0.00066 J**	**0.00056 J**	**0.00038 J**	**0.00032 J**	**0.00099 J**	**0.0027**	**0.0012 J**	**0.0021**	**0.002 J**	0.001 U	**0.0021**	0.001 U	0.001 U	0.001 U
Cadmium, Total	0.005	**0.00055 J**	**0.00023 J**	**0.00053 J**	**0.00048 J**	**0.00038 J**	**0.00011 J**	**0.00078 J**	**0.00073 J**	0.005 U	**0.00089 J**	0.01 U	**0.00015 J**	**0.0023**	0.001 U	0.001 U	0.001 U
Chromium, Total	0.1	**0.0035**	**0.003**	**0.013**	**0.011**	**0.0084**	**0.0037**	**0.025**	**0.056**	**0.021**	**0.042**	**0.082**	**0.0019 J**	**0.052**	**0.0021**	**0.0018 J**	**0.002**
Cobalt, Total	0.006	**0.0073**	**0.0096**	**0.016 J**	**0.012**	**0.014**	**0.011**	**0.021**	**0.038**	**0.018**	**0.023**	**0.029**	**0.0084**	**0.026**	**0.0094**	**0.008**	**0.0076 J**
Fluoride	4	**0.16 J+**	**0.28**	**0.23**	**0.3 J+**	**0.26 J+**	**0.29**	**0.3 J**	**0.28**	**0.11**	**0.28**	**0.25**	**0.32**	**0.4 J+**	0.1 U	**0.93**	**0.31**
Lead, Total	0.015	**0.0023**	**0.0028**	**0.0096 J**	**0.006**	**0.0057**	**0.0026 J+**	**0.016**	**0.051**	**0.012**	**0.03**	**0.035**	**0.00053 J**	**0.038**	**0.00041 J**	**0.00039 J**	0.001 UJ
Lithium, Total	0.04	0.05 U	0.05 U	**0.017 J**	0.05 U	**0.01 J**	0.05 U	**0.023 J**	**0.023 J**	0.25 U	**0.033**	**0.057**	0.005 U	**0.031**	0.05 U	0.05 U	0.05 U
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	-	0.0002 U	**0.00038**	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.0018 J**	**0.00099 J**	**0.0014 J**	**0.0015 J**	**0.0017 J**	**0.00094 J**	**0.0024 J**	**0.0051**	**0.004 J**	**0.003 J**	**0.0056 J**	**0.00091 J**	**0.0078**	**0.011**	**0.014**	**0.014**
Selenium, Total	0.05	**0.00044 J**	**0.00076 J**	**0.0013 J**	0.005 U	0.005 U	0.005 UJ	0.005 U	**0.0044 J**	0.025 U	**0.0026 J**	0.05 U	0.005 U	**0.0065**	**0.0015 J**	**0.00062 J**	**0.0018 J**
Thallium, Total	0.002	**0.000048 J**	**0.000048 J**	**0.00014 J**	**0.00016 J**	**0.00017 J**	0.001 U	**0.00026 J**	**0.00068 J**	**0.00079 J**	**0.00048 J**	**0.00099 J**	0.001 U	**0.0009 J**	0.001 U	0.001 U	0.001 U
Radiological (pCi/L)																	
Radium-226	NA	**0.222 J ± 0.145**	**1.22 ± 0.355**	**0.731 ± 0.526**	**2.01 ± 1.16**	**0.672 ± 0.334**	**1.03 ± 0.385**	**0.894 ± 0.361**	**0.730 ± 0.327**	**0.266 ± 0.151**	**0.597 ± 0.32**	R	-	**2.57 ± 0.584**	**0.657 J ± 0.201**	**0.865 ± 0.232**	**1.15 ± 0.477**
Radium-228	NA	0.542 U ± 0.572	1.09 U ± 1.02	0.648 U ± 0.534	0.707 U ± 1.12	**1.00 ± 0.596**	**1.44 ± 0.934**	**2.40 ± 1.07**	1.18 U ± 1.06	0.585 U ± 0.5	0.294 U ± 0.337	**0.880 ± 0.51**	-	2.81 U ± 1.93	**1.10 ± 0.581**	0.784 U ± 0.583	**0.819 ± 0.347**
Radium-226 & 228	5	0.764 U ± 0.59	**2.32 ± 1.08**	**1.38 J ± 0.75**	**2.72 J ± 1.61**	**1.68 ± 0.684**	**2.47 J ± 1.01**	**3.29 ± 1.13**	**1.91 J+ ± 1.11**	**0.850 J+ ± 0.522**	**0.891 J ± 0.465**	R	-	**5.38 J ± 2.02**	**1.75 ± 0.615**	**1.65 ± 0.627**	**1.97 ± 0.589**

ABBREVIATIONS AND NOTES:

Statistically significant level (SSL) concentration.
CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
pCi/L: picoCurie per liter.
su: standard units.
USEPA: United States Environmenta.l Protection Agency
J: Value is estimated
J-: Value is estimated, biased low
J+: Value is estimated, biased high
R: Rejected during validation
U: Not detected, value is the laboratory reporting limit

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

TABLE 1A
ASSESSMENT MONITORING GROUNDWATER ANALYTICAL RESULTS - APPENDIX IV CONSTITUENTS
CORRECTIVE MEASURES ASSESSMENT
F.B. CULLEY GENERATING STATION - EAST ASH POND

Location Name	Groundwater	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3R	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4
Sample Name	Protection	CCR-AP-3-20161207	CCR-AP-3-20170208	CCR-AP-3-20170406	CCR-AP-3-20170607	CCR-AP-3-20170928	CCR-AP-3-20171117	CCR-AP-3-20180611	CCR-AP-3-20180828	CCR-AP-3-20181116	CCR-AP-3R-20190528	CCR-AP-4-20160610	CCR-AP-4-20160812	CCR-AP-4-20161028	CCR-AP-4-20161207	CCR-AP-4-20170208	CCR-AP-4-20170406
Sample Date	Standard	12/07/2016	02/08/2017	04/06/2017	06/07/2017	09/28/2017	11/17/2017	06/11/2018	08/28/2018	11/16/2018	05/28/2019	06/10/2016	08/12/2016	10/28/2016	12/07/2016	02/08/2017	04/06/2017
Appendix IV Constituents (mg/L)																	
Antimony, Total	0.006	**0.00031 J**	0.002 U	0.002 U	0.002 U	**0.00058 J**	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	**0.0004 J**	0.002 U	0.002 U
Arsenic, Total	0.01	**0.068**	**0.086**	**0.08**	**0.077**	**0.066**	**0.067**	**0.08**	**0.071**	**0.076**	**0.077**	**0.036**	**0.065**	**0.05**	**0.045**	**0.086**	**0.086**
Barium, Total	2	**0.43**	**0.46**	**0.42**	**0.44**	**0.39**	**0.4**	**0.47**	**0.43**	**0.45**	**0.44**	**0.52**	**0.75**	**0.63**	**0.61**	**0.64**	**0.63**
Beryllium, Total	0.004	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.00049 J**	**0.00033 J**	**0.00025 J**	**0.00046 J**	**0.00014 J**	**0.00015 J**
Cadmium, Total	0.005	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.00018 J**	**0.00018 J**	0.001 U	**0.00023 J**	0.001 U	0.001 U
Chromium, Total	0.1	**0.0023**	**0.002**	**0.0021**	0.002 U	0.002 U	**0.0021**	**0.0041 J+**	**0.0041 J+**	**0.0029**	0.002 U	**0.012**	**0.0081**	**0.0037**	**0.014**	**0.0026**	**0.0028**
Cobalt, Total	0.006	**0.007**	**0.0072**	**0.0063**	**0.0062**	**0.0057**	**0.0056**	**0.0052**	**0.0046**	**0.0055**	**0.0054**	**0.0078**	**0.0071**	**0.0045 J**	**0.0086**	**0.0039**	**0.0045**
Fluoride	4	**0.5**	**0.39**	**0.57**	**0.55**	**0.45**	**0.14**	**0.56**	**0.33**	**0.37**	**0.53 J+**	**0.29 J+**	**0.43**	**0.3**	**0.49**	**0.32 J+**	**0.36**
Lead, Total	0.015	**0.00066 J**	**0.00035 J**	**0.00048 J+**	0.001 U	**0.00098 J**	**0.00051 J**	**0.00092 J**	**0.00078 J**	**0.00018 J**	**0.00033 J**	**0.0099**	**0.0063**	**0.0057 J**	**0.011**	**0.0018**	**0.0018 J+**
Lithium, Total	0.04	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.005 U	0.005 U	0.005 U	0.005 U	**0.01 J**	**0.0096 J**	**0.014 J**	**0.0098 J**	0.05 U	0.05 U
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	-	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0004 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.014**	**0.013**	**0.011**	**0.012**	**0.01**	**0.011**	**0.0099**	**0.0096**	**0.01**	**0.0099**	**0.0022 J**	**0.0025 J**	**0.0011 J**	**0.002 J**	**0.00093 J**	**0.00092 J**
Selenium, Total	0.05	**0.0019 J**	**0.002 J**	**0.0018 J-**	**0.0018 J**	**0.0016 J**	**0.0017 J**	**0.0023 J**	**0.0021 J**	**0.0021 J**	0.005 U	**0.0018 J**	**0.0016 J**	**0.0011 J**	**0.00098 J**	0.005 U	0.005 UJ
Thallium, Total	0.002	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.0001 J**	0.001 U	0.001 U	0.001 U	0.001 U	**0.000084 J**	**0.000061 J**	**0.00011 J**	**0.00015 J**	**0.000063 J**	0.001 U
Radiological (pCi/L)																	
Radium-226	NA	**0.789 ± 0.398**	0.373 U ± 0.293	**0.450 ± 0.144**	**0.582 ± 0.158**	**0.411 ± 0.136**	**0.626 ± 0.162**	**0.475 ± 0.329**	R	-	**0.404 ± 0.159**	**1.07 J ± 0.261**	**1.53 ± 0.429**	**1.54 ± 0.683**	**2.11 ± 1.11**	**0.984 ± 0.383**	**0.789 ± 0.227**
Radium-228	NA	**0.932 ± 0.48**	0.489 U ± 0.614	**0.644 ± 0.344**	**1.25 ± 0.427**	R	R	0.292 U ± 0.375	**0.946 ± 0.416**	-	**1.83 ± 1.11**	0.417 U ± 0.723	1.37 U ± 1.43	**0.864 ± 0.448**	**2.17 ± 1.34**	**1.03 ± 0.62**	0.370 U ± 0.488
Radium-226 & 228	5	**1.72 ± 0.623**	0.862 U ± 0.68	**1.09 ± 0.373**	**1.83 ± 0.456**	R	R	**0.768 J ± 0.499**	**1.70 J+ ± 0.463**	-	**2.24 ± 1.12**	**1.49 ± 0.769**	**2.90 ± 1.49**	**2.40 ± 0.816**	**4.28 ± 1.74**	**2.01 ± 0.728**	**1.16 J ± 0.538**

ABBREVIATIONS AND NOTES:

Statistically significant level (SSL) concentration.
CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
pCi/L: picoCurie per liter.
su: standard units.
USEPA: United States Environmenta.l Protection Agency
J: Value is estimated
J-: Value is estimated, biased low
J+: Value is estimated, biased high
R: Rejected during validation
U: Not detected, value is the laboratory reporting limit

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

TABLE 1A
ASSESSMENT MONITORING GROUNDWATER ANALYTICAL RESULTS - APPENDIX IV CONSTITUENTS
CORRECTIVE MEASURES ASSESSMENT
F.B. CULLEY GENERATING STATION - EAST ASH POND

Location Name	Groundwater	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4R
Sample Name	Protection	CCR-AP-4-20170608	CCR-AP-4-20170929	CCR-AP-4-20171117	CCR-AP-4-20180611	CCR-AP-4-20180828	CCR-AP-4-20181115	CCR-AP-4R-20190528
Sample Date	Standard	06/08/2017	09/29/2017	11/17/2017	06/11/2018	08/28/2018	11/15/2018	05/28/2019
Appendix IV Constituents (mg/L)								
Antimony, Total	0.006	0.002 U	**0.00066 J**	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.01	**0.086**	**0.081**	**0.083**	**0.027**	**0.11**	**0.088**	**0.11**
Barium, Total	2	**0.66**	**0.58**	**0.57**	**0.45**	**0.78**	**0.58**	**0.66**
Beryllium, Total	0.004	**0.00026 J**	**0.00017 J**	**0.00028 J**	0.001 U	**0.00084 J**	**0.00018 J**	0.001 U
Cadmium, Total	0.005	**0.00014 J**	**0.00016 J**	0.001 U	0.001 U	**0.00048 J**	0.001 U	0.001 U
Chromium, Total	0.1	**0.0066**	**0.0076**	**0.01**	R	**0.028**	**0.0062**	0.0034 U
Cobalt, Total	0.006	**0.0068**	**0.0055**	**0.0064**	**0.002**	**0.013**	**0.003**	**0.0031**
Fluoride	4	**0.46**	**0.35**	**0.35**	**0.41**	**0.29**	**0.34**	**0.37 J+**
Lead, Total	0.015	**0.0045**	**0.0048**	**0.0046**	**0.00052 J**	**0.021**	**0.0029**	**0.0043**
Lithium, Total	0.04	0.05 U	0.05 U	0.05 U	**0.0029 J**	**0.019**	**0.0062**	**0.0041 J**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	-	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.0014 J**	**0.0016 J**	**0.0022 J**	**0.0012 J**	**0.0033 J**	**0.00076 J**	**0.0011 J**
Selenium, Total	0.05	0.005 U	0.005 U	0.005 U	**0.0009 J**	**0.0016 J**	**0.0011 J**	0.005 U
Thallium, Total	0.002	**0.000061 J**	0.001 U	**0.00012 J**	0.001 U	**0.00026 J**	0.001 U	0.001 U
Radiological (pCi/L)								
Radium-226	NA	**1.60 ± 0.408**	**1.26 ± 0.397**	**1.15 ± 0.266**	**0.830 ± 0.366**	**2.47 ± 0.635**	-	**0.846 ± 0.224**
Radium-228	NA	**2.00 ± 0.818**	R	R	0.458 U ± 0.313	1.06 U ± 0.934	-	**1.54 ± 0.735**
Radium-226 & 228	5	**3.60 ± 0.914**	R	R	**1.29 J ± 0.482**	**3.53 J ± 1.13**	-	**2.38 ± 0.768**

Location Name	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5
Sample Name	CCR-AP-5-20160610	BLIND DUPLICATE-20160610	CCR-AP-5-20160812	DUP-20160812	CCR-AP-5-20161028	DUP-20161028	CCR-AP-5-20161207	DUP-20161207	CCR-AP-5-20170208
Sample Date	06/10/2016	06/10/2016	08/12/2016	08/12/2016	10/28/2016	10/28/2016	12/07/2016	12/07/2016	02/08/2017
Appendix IV Constituents (mg/L)									
Antimony, Total	0.02 U	0.02 U	0.002 U	0.002 U	0.002 U	0.002 U	**0.000058 J**	0.002 U	0.002 U
Arsenic, Total	0.01 U	0.01 U	**0.00059 J**	**0.00078 J**	**0.00065 J**	**0.0008 J**	**0.00073 J**	**0.00073 J**	**0.0015**
Barium, Total	**0.032 J**	**0.039 J**	**0.03**	**0.03**	**0.034**	**0.034**	**0.036**	**0.036**	**0.046**
Beryllium, Total	0.01 U	0.01 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.00096 J**	**0.00077 J**	**0.00019 J**
Cadmium, Total	0.01 U	0.01 U	**0.00016 J**	**0.00019 J**	**0.00015 J**	**0.00016 J**	0.001 U	**0.00016 J**	**0.0012**
Chromium, Total	0.02 U	0.02 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cobalt, Total	**0.0069**	**0.0081**	**0.0063**	**0.0061**	**0.0065 J**	**0.0066 J**	**0.0061**	**0.0058**	**0.007**
Fluoride	**0.58**	**0.5**	**0.99**	**0.92**	**1.1**	**1.1**	**1.3**	**1.3**	**0.98**
Lead, Total	0.01 U	0.01 U	0.001 U	0.001 U	0.001 UJ	0.001 UJ	0.001 U	0.001 U	0.001 U
Lithium, Total	**0.14**	**0.14**	**0.13**	**0.13**	**0.15**	**0.15**	**0.13**	**0.13**	**0.15**
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	**0.38**	**0.45**	**0.37**	**0.37**	**0.41**	**0.42**	**0.39**	**0.38**	**0.39**
Selenium, Total	0.05 U	0.05 U	0.005 U	0.005 U	0.005 U	**0.0007 J**	0.005 U	0.005 U	0.005 U
Thallium, Total	0.01 U	0.01 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.000065 J**
Radiological (pCi/L)									
Radium-226	**0.224 J ± 0.0858**	**0.176 J ± 0.0741**	0.106 U ± 0.0753	**0.230 ± 0.0858**	0.449 U ± 0.338	0.398 U ± 0.331	0.0176 U ± 0.286	**0.683 ± 0.42**	0.0782 U ± 0.217
Radium-228	**0.550 ± 0.3**	**0.634 ± 0.33**	**0.523 ± 0.33**	**0.748 J ± 0.388**	0.462 U ± 0.35	**0.557 ± 0.349**	**0.714 ± 0.438**	0.618 U ± 0.487	0.562 U ± 0.517
Radium-226 & 228	**0.774 ± 0.313**	**0.810 ± 0.338**	**0.629 ± 0.338**	**0.978 J ± 0.397**	**0.911 ± 0.486**	**0.955 J ± 0.481**	**0.732 J ± 0.524**	**1.30 J ± 0.643**	0.640 U ± 0.561

ABBREVIATIONS AND NOTES:

Statistically significant level (SSL) concentration.
CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
pCi/L: picoCurie per liter.
su: standard units.
USEPA: United States Environmenta.l Protection Agency
J: Value is estimated
J-: Value is estimated, biased low
J+: Value is estimated, biased high
R: Rejected during validation
U: Not detected, value is the laboratory reporting limit

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

TABLE 1A
ASSESSMENT MONITORING GROUNDWATER ANALYTICAL RESULTS - APPENDIX IV CONSTITUENTS
CORRECTIVE MEASURES ASSESSMENT
F.B. CULLEY GENERATING STATION - EAST ASH POND

Location Name Sample Name Sample Date	Groundwater Protection Standard	CCR-AP-5 DUP-20170208 02/08/2017	CCR-AP-5 CCR-AP-5-20170407 04/07/2017	CCR-AP-5 DUP-20170407 04/07/2017	CCR-AP-5 CCR-AP-5-20170608 06/08/2017	CCR-AP-5 DUP1-20170608 06/08/2017	CCR-AP-5 CCR-AP-5-20170928 09/28/2017	CCR-AP-5 DUP1-20170928 09/28/2017	CCR-AP-5 CCR-AP-5-20171117 11/17/2017	CCR-AP-5 DUP-20171117 11/17/2017	CCR-AP-5 CCR-AP-5-20180611 06/11/2018	CCR-AP-5 BLIND DUPLICATE-20180611 06/11/2018	CCR-AP-5 CCR-AP-5-20180828 08/28/2018	CCR-AP-5 BLIND DUP-20180828 08/28/2018	CCR-AP-5 CCR-AP-5-20181115 11/15/2018	CCR-AP-5 CCR-AP-5-20181217 12/17/2018	CCR-AP-5 CCR-AP-5-20190528 05/28/2019
Appendix IV Constituents (mg/L)																	
Antimony, Total	0.006	0.002 U	0.002 U	**0.00082 J**	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.01	**0.0018**	**0.00039 J**	**0.00047 J**	**0.00042 J**	**0.00038 J**	**0.00084 J**	**0.0009 J**	**0.00039 J**	**0.0005 J**	R	R	0.001 U	**0.00082 J**	**0.0027**	**0.0014**	**0.0011**
Barium, Total	2	**0.048**	**0.034**	**0.035**	**0.036**	**0.035**	**0.041**	**0.041**	**0.038**	**0.04**	**0.068**	**0.073**	**0.033**	**0.034**	**0.05**	**0.08**	**0.04**
Beryllium, Total	0.004	**0.00014 J**	**0.00058 J**	**0.00068 J**	**0.00017 J**	**0.00017 J**	**0.00047 J**	**0.00046 J**	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.000081 J**	0.001 U	0.001 U
Cadmium, Total	0.005	**0.001**	**0.0004 J**	**0.00042 J**	**0.00037 J**	**0.00044 J**	**0.00075 J**	**0.00081 J**	**0.00035 J**	**0.00036 J**	**0.00057 J**	**0.0006 J**	**0.00024 J**	**0.00027 J**	**0.00023 J**	**0.00077 J**	**0.00051 J**
Chromium, Total	0.1	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.0014 U	R	0.002 U	0.0033 U	**0.0041**	**0.00067 J**	0.0027 U
Cobalt, Total	0.006	**0.0066**	**0.0063**	**0.0064**	**0.0053**	**0.0054**	**0.0041**	**0.0047**	**0.0046**	**0.0049**	**0.0028**	**0.0033**	**0.0028**	**0.0036**	**0.00052**	**0.00071**	**0.0031**
Fluoride	4	**1.2**	**0.96**	**1**	**1.1**	**1.1**	**0.76 J**	**0.49 J**	**1**	**0.9**	**1.4**	**1.5**	**1.3**	**1.3**	**1.4**	**1.1**	**1.2 J+**
Lead, Total	0.015	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.000099 J**	**0.000096 J**	0.001 U	0.001 U	**0.0016**	**0.00021 J**	**0.0011**
Lithium, Total	0.04	**0.15**	**0.15**	**0.14**	**0.11**	**0.11**	**0.099**	**0.099**	**0.12**	**0.12**	**0.11**	**0.096**	**0.094**	**0.098**	**0.0085**	**0.067**	**0.087**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	-	-	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.39**	**0.33**	**0.33**	**0.3**	**0.3**	**0.21**	**0.22**	**0.24**	**0.25**	**0.39**	**0.42**	**0.37**	**0.38**	**0.0094**	**0.25**	**0.38**
Selenium, Total	0.05	0.005 U	0.005 UJ	0.005 UJ	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	**0.0017 J**	**0.001 J**	0.005 U
Thallium, Total	0.002	**0.000056 J**	0.001 U	0.001 U	0.001 U	**0.000056 J**	**0.00016 J**	**0.00017 J**	**0.00018 J**	**0.00023 J**	0.001 U	**0.000076 J**	0.001 U	0.001 U	**0.000066 J**	**0.000073 J**	0.001 U
Radiological (pCi/L)																	
Radium-226	NA	-0.0195 U ± 0.206	**0.186 ± 0.0813**	**0.123 ± 0.0744**	**0.193 ± 0.0924**	**0.143 ± 0.0878**	**0.184 ± 0.0749**	**0.150 ± 0.0692**	**0.250 ± 0.0868**	**0.294 ± 0.0941**	**0.261 ± 0.167**	**0.231 ± 0.168**	R	R	-	-	**0.107 ± 0.0722**
Radium-228	NA	0.452 U ± 0.496	0.209 U ± 0.227	0.0557 U ± 0.211	**1.01 ± 0.357**	**0.578 ± 0.317**	R	-0.0776 UJ ± 0.182	0.234 U ± 0.238	R	0.213 U ± 0.216	**0.605 ± 0.274**	0.252 U ± 0.311	0.130 U ± 0.253	-	-	0.257 U ± 0.341
Radium-226 & 228	5	0.452 U ± 0.537	**0.396 J ± 0.241**	0.179 UJ ± 0.224	**1.21 ± 0.369**	**0.721 ± 0.329**	R	0.15 UJ ± 0.195	**0.483 J+ ± 0.253**	R	**0.474 J ± 0.273**	**0.836 ± 0.321**	R	R	-	-	0.364 UJ ± 0.349

ABBREVIATIONS AND NOTES:

Statistically significant level (SSL) concentration.
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mg/L: milligram per liter.
pCi/L: picoCurie per liter.
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J-: Value is estimated, biased low
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TABLE 1A
ASSESSMENT MONITORING GROUNDWATER ANALYTICAL RESULTS - APPENDIX IV CONSTITUENTS
CORRECTIVE MEASURES ASSESSMENT
F.B. CULLEY GENERATING STATION - EAST ASH POND

Location Name Sample Name Sample Date	Groundwater Protection Standard	CCR-AP-5 BLIND DUPLICATE-20190528 05/28/2019	CCR-AP-6 CCR-AP-6-20160610 06/10/2016	CCR-AP-6 CCR-AP-6-20160812 08/12/2016	CCR-AP-6 CCR-AP-6-20161028 10/28/2016	CCR-AP-6 CCR-AP-6-20161207 12/07/2016	CCR-AP-6 CCR-AP-6-20170208 02/08/2017	CCR-AP-6 CCR-AP-6-20170406 04/06/2017	CCR-AP-6 CCR-AP-6-20170607 06/07/2017	CCR-AP-6 CCR-AP-6-20170929 09/29/2017	CCR-AP-6 CCR-AP-6-20171117 11/17/2017	CCR-AP-6 CCR-AP-6-20180611 06/11/2018	CCR-AP-6 CCR-AP-6-20180828 08/28/2018	CCR-AP-6 CCR-AP-6-20181117 11/17/2018	CCR-AP-6 CCR-AP-6-20190528 05/28/2019	CCR-AP-8 CCR-AP8-20170309 03/09/2017
Appendix IV Constituents (mg/L)																	
Antimony, Total	0.006	0.002 U	0.002 U	0.002 U	0.002 U	**0.00048 J**	**0.00047 J**	0.002 U	**0.00059 J**	**0.0014 J**	0.01 U	**0.0012 J**	0.002 U	0.002 U	**0.00083 J**	**0.0018 J**
Arsenic, Total	0.01	**0.0013**	**0.04**	**0.059**	**0.06**	**0.067**	**0.11**	**0.11**	**0.096**	**0.089**	**0.081**	**0.12**	**0.1**	**0.11**	**0.11**	**0.044**
Barium, Total	2	**0.042**	**0.51**	**0.58**	**0.55**	**0.62**	**0.61**	**0.64**	**0.6**	**0.55**	**0.49**	**0.69**	**0.64**	**0.58**	**0.69**	**0.57**
Beryllium, Total	0.004	0.001 U	0.001 U	**0.00026 J**	**0.00011 J**	**0.00036 J**	**0.00025 J**	**0.00024 J**	**0.00042 J**	**0.00039 J**	0.005 U	**0.00065 J**	**0.00046 J**	**0.000083 J**	**0.00069 J**	0.001 U
Cadmium, Total	0.005	**0.00053 J**	0.001 U	**0.00016 J**	0.001 U	**0.00029 J**	**0.00027 J**	**0.00019 J**	**0.00024 J**	**0.00052 J**	**0.00039 J**	**0.00051 J**	**0.0005 J**	0.001 U	**0.0006 J**	0.001 U
Chromium, Total	0.1	0.0028 U	**0.0031**	**0.0092**	**0.005**	**0.015**	**0.011**	**0.0098**	**0.014**	**0.02**	**0.014**	**0.029**	**0.031**	**0.0048**	**0.028**	**0.0012 J**
Cobalt, Total	0.006	**0.0031**	**0.0042**	**0.0095**	**0.0075 J**	**0.01**	**0.009**	**0.0069**	**0.011**	**0.012**	**0.0087**	**0.014**	**0.013**	**0.0044**	**0.018**	**0.015**
Fluoride	4	**1.3 J+**	**0.43**	**0.67**	**0.42**	**0.62**	**0.5**	**0.45**	**0.63**	**0.55**	**0.24**	**0.6**	**0.42**	**0.44**	**0.67 J+**	**0.13**
Lead, Total	0.015	**0.0017**	**0.0021**	**0.0071**	**0.0035 J**	**0.01**	**0.0079**	**0.0074 J+**	**0.0096**	**0.014**	**0.011**	**0.02**	**0.02**	**0.0022**	**0.024**	**0.00058 J**
Lithium, Total	0.04	**0.086**	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	**0.011 J**	0.05 U	0.25 U	**0.016**	**0.014**	**0.0035 J**	**0.014**	0.05 U
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	-	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.38**	**0.02**	**0.018**	**0.021**	**0.024**	**0.03**	**0.024**	**0.026**	**0.033**	**0.027**	**0.033**	**0.031**	**0.027**	**0.028**	**0.014**
Selenium, Total	0.05	0.005 U	**0.001 J**	**0.0014 J**	**0.0015 J**	**0.0014 J**	0.005 U	**0.0018 J-**	**0.0014 J**	**0.0023 J**	0.025 U	**0.0023 J**	**0.0019 J**	**0.0016 J**	0.005 U	0.005 U
Thallium, Total	0.002	0.001 U	0.001 U	**0.000047 J**	0.001 U	**0.0001 J**	**0.000063 J**	0.001 U	**0.00009 J**	**0.00013 J**	0.005 U	**0.00022 J**	**0.0002 J**	0.001 U	**0.00018 J**	0.001 U
Radiological (pCi/L)																	
Radium-226	NA	**0.146 ± 0.0812**	**0.652 J ± 0.142**	**1.32 ± 0.278**	**1.38 ± 0.686**	-0.236 U ± 0.919	**0.929 ± 0.371**	**0.730 ± 0.221**	**2.33 ± 0.648**	**0.815 ± 0.227**	**0.695 ± 0.171**	**1.15 ± 0.384**	**1.71 J ± 0.551**	-	**6.34 J- ± 1.43**	**0.893 ± 0.233**
Radium-228	NA	0.435 U ± 0.42	**0.543 ± 0.293**	0.811 U ± 0.725	0.663 U ± 0.532	1.58 U ± 1.55	0.755 U ± 0.581	0.455 U ± 0.438	**3.61 ± 1.47**	R	R	**1.12 ± 0.415**	0.929 U ± 1.02	-	3.90 UJ ± 4.41	1.07 U ± 1.02
Radium-226 & 228	5	0.581 UJ ± 0.428	**1.20 ± 0.325**	**2.13 ± 0.776**	**2.05 J ± 0.868**	1.58 U ± 1.8	**1.68 J ± 0.69**	**1.19 J ± 0.49**	**5.93 ± 1.6**	R	R	**2.27 ± 0.565**	**2.64 J ± 1.16**	-	**10.2 J- ± 4.64**	**1.96 J ± 1.04**

ABBREVIATIONS AND NOTES:

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mg/L: milligram per liter.
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J: Value is estimated
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TABLE 1A
ASSESSMENT MONITORING GROUNDWATER ANALYTICAL RESULTS - APPENDIX IV CONSTITUENTS
CORRECTIVE MEASURES ASSESSMENT
F.B. CULLEY GENERATING STATION - EAST ASH POND

Location Name Sample Name Sample Date	Groundwater Protection Standard	CCR-AP-8 CCR-AP-8-20170406 04/06/2017	CCR-AP-8 CCR-AP-8-20170426 04/26/2017	CCR-AP-8 CCR-AP-8-20170530 05/30/2017	CCR-AP-8 CCR-AP-8-20170607 06/07/2017	CCR-AP-8 CCR-AP-8-20170725 07/25/2017	CCR-AP-8 CCR-AP-8-20170815 08/15/2017	CCR-AP-8 CCR-AP-8-20170928 09/28/2017	CCR-AP-8 CCR-AP-8-20171117 11/17/2017	CCR-AP-8 CCR-AP-8-20180611 06/11/2018	CCR-AP-8 CCR-AP-8-20180828 08/28/2018	CCR-AP-8 CCR-AP-8-20181116 11/16/2018	CCR-AP-8 CCR-AP-8-20190528 05/28/2019
Appendix IV Constituents (mg/L)													
Antimony, Total	0.006	**0.00066 J**	**0.001 J**	**0.00082 J**	**0.0011 J**	0.002 U	**0.0014 J**	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	**0.00046 J**
Arsenic, Total	0.01	**0.052**	**0.07**	**0.06**	**0.076**	**0.087**	**0.095**	**0.087**	**0.083**	**0.11**	**0.096**	**0.1**	**0.1**
Barium, Total	2	**0.59**	**0.59**	**0.58**	**0.6**	**0.67**	**0.64**	**0.56**	**0.53**	**0.68**	**0.58**	**0.58**	**0.49**
Beryllium, Total	0.004	0.001 U	0.001 U	0.001 U	0.001 U	**0.0002 J**	**0.00039 J**	0.001 U	0.001 U	**0.00022 J**	**0.00016 J**	0.001 U	0.001 U
Cadmium, Total	0.005	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.00016 J**	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Chromium, Total	0.1	**0.0022**	**0.0019 J**	**0.0028**	R	**0.0041**	**0.012**	**0.0021 J+**	**0.0021**	**0.0069 J+**	**0.0068 J+**	**0.0024**	0.0034 U
Cobalt, Total	0.006	**0.012**	**0.011**	**0.011**	**0.011**	**0.012**	**0.017**	**0.0098**	**0.0082**	**0.0086**	**0.0077**	**0.0059**	**0.0044**
Fluoride	4	**0.35**	**0.28**	**0.24**	**0.21 J**	**0.24 J**	**0.26**	**0.34**	**0.4**	**0.41**	**0.21**	**0.25**	**0.51 J+**
Lead, Total	0.015	**0.0011 J+**	**0.00081 J**	**0.0022**	**0.001**	**0.0025**	**0.0076**	**0.0011**	**0.0011**	**0.0033**	**0.0021**	**0.0005 J**	**0.0012**
Lithium, Total	0.04	0.05 U	**0.014 J**	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	**0.0057**	**0.0052**	0.005 U	**0.0031 J**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	-	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.015**	**0.014**	**0.013**	**0.014**	**0.014**	**0.015**	**0.012**	**0.012**	**0.013**	**0.012**	**0.0095**	**0.0099**
Selenium, Total	0.05	**0.0017 J-**	**0.0015 J**	**0.0017 J**	**0.0017 J**	**0.0015 J**	**0.0022 J**	**0.002 J**	0.005 U	**0.0021 J**	**0.0018 J**	**0.0019 J**	0.005 U
Thallium, Total	0.002	0.001 U	0.001 U	0.001 U	**0.000068 J**	**0.000058 J**	**0.00015 J**	0.001 U	**0.00029 J**	**0.000083 J**	0.001 U	0.001 U	0.001 U
Radiological (pCi/L)													
Radium-226	NA	**1.34 ± 0.31**	**0.883 ± 0.196**	**0.720 ± 0.162**	**0.721 J ± 0.211**	**0.704 ± 0.201**	**0.513 ± 0.143**	**0.529 ± 0.153**	**0.640 ± 0.164**	**0.544 ± 0.277**	R	-	**0.443 ± 0.148**
Radium-228	NA	**0.677 ± 0.435**	**0.778 ± 0.372**	**0.457 ± 0.284**	**1.60 J ± 0.556**	0.889 U ± 0.726	0.316 U ± 0.305	R	R	**0.502 ± 0.319**	0.367 U ± 0.309	-	0.0635 UJ ± 0.848
Radium-226 & 228	5	**2.01 ± 0.534**	**1.66 ± 0.421**	**1.18 ± 0.327**	**2.32 J ± 0.594**	**1.59 J ± 0.754**	**0.829 J ± 0.337**	R	R	**1.05 ± 0.422**	R	-	0.506 UJ ± 0.861

ABBREVIATIONS AND NOTES:

Statistically significant level (SSL) concentration.
CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
pCi/L: picoCurie per liter.
su: standard units.
USEPA: United States Environmenta.l Protection Agency
J: Value is estimated
J-: Value is estimated, biased low
J+: Value is estimated, biased high
R: Rejected during validation
U: Not detected, value is the laboratory reporting limit

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

TABLE 1B
NATURE AND EXTENT GROUNDWATER ANALYTICAL RESULTS - APPENDIX IV CONSTITUENTS
CORRECTIVE MEASURES ASSESSMENT
F.B. CULLEY GENERATING STATION - EAST ASH POND

Location Name	Groundwater	CCR-AP-5I	CCR-AP-5I	CCR-AP-6I	CCR-AP-6I	CCR-AP-6I	CCR-AP-8I	CCR-AP-8I	CCR-AP-8I	CCR-AP-11	CCR-AP-11
Sample Name	Protection	CCR-AP-5I-20190213	CCR-AP-5I-20190612	CCR-AP-6I-20181117	CCR-AP-6I-20190212	CCR-AP-6I-20190612	CCR-AP-8I-20181117	CCR-AP-8I-20190212	CCR-AP-8I-20190612	CCR-AP-11-20190213	CCR-AP-11-20190612
Sample Date	Standard	02/13/2019	06/12/2019	11/17/2018	02/12/2019	06/12/2019	11/17/2018	02/12/2019	06/12/2019	02/13/2019	06/13/2019
Appendix IV Constituents (mg/L)											
Antimony, Total	0.006	**0.00075 J**	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.01	**0.0007 J**	**0.00072 J**	**0.0037**	**0.0048**	**0.0028**	**0.004**	**0.00099 J**	**0.0051**	**0.0026**	**0.047**
Barium, Total	2	**0.037**	**0.085**	**0.11**	**0.052**	**0.28**	**0.3**	**0.21**	**0.063**	**0.092**	**0.34**
Beryllium, Total	0.004	0.001 U	0.001 U	0.001 U	0.001 U	**0.00019 J**	**0.000078 J**	0.001 U	**0.00018 J**	0.001 U	**0.00017 J**
Cadmium, Total	0.005	0.001 U	0.001 U	**0.00015 J**	**0.00019 J**	0.001 U	0.001 U	**0.00022 J**	**0.00022 J**	0.001 U	0.001 U
Chromium, Total	0.1	0.002 U	0.002 U	**0.002**	0.002 U	0.0026 U	**0.0029**	0.002 U	0.0033 U	0.002 U	0.0032 U
Cobalt, Total	0.006	**0.00064**	**0.00048 J**	**0.0017**	**0.0019**	**0.00062 J+**	**0.0016**	**0.00014 J**	**0.0031**	**0.0016**	**0.025**
Fluoride	4	**0.34**	**0.31**	**0.13**	**0.16 J**	**0.19 J+**	**0.26**	**0.27**	**0.12 J+**	**0.97**	**0.32**
Lead, Total	0.015	0.001 U	**0.00023 J**	**0.00084 J**	**0.0003 J**	0.001 U	**0.001**	0.001 U	0.001 U	**0.00018 J**	0.001 U
Lithium, Total	0.04	**0.03**	**0.035**	**0.043**	**0.055**	**0.33**	**0.44**	**0.37**	**0.047**	**0.0077**	**0.004 J**
Mercury, Total	0.002	-	0.0002 U	0.0002 U	-	0.0002 U	0.0002 U	-	0.0002 U	-	0.0002 U
Molybdenum, Total	0.1	**0.0054**	**0.0017 J**	**0.63**	**0.75**	**0.34**	**0.36**	**0.67**	**0.86**	**0.0049 J**	**0.0011 J**
Selenium, Total	0.05	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Thallium, Total	0.002	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.00013 J**	0.001 U	0.001 U
Radiological (pCi/L)											
Radium-226	NA	**0.274 ± 0.188**	**0.85 ± 0.36**	-	**0.203 ± 0.0906**	**1.31 ± 0.47**	-	**1.25 ± 0.222**	**0.46 ± 0.24**	**0.283 ± 0.171**	**0.56 ± 0.29**
Radium-228	NA	0.189 U ± 0.213	0.40 U ± 0.36	-	**0.460 ± 0.246**	**1.76 ± 0.58**	-	**1.87 ± 0.412**	**0.88 ± 0.42**	0.0228 U ± 0.24	0.60 U ± 0.39
Radium-226 & 228	5	**0.463 ± 0.284**	**1.25 J ± 0.509**	-	**0.664 ± 0.262**	**3.07 ± 0.747**	-	**3.12 ± 0.468**	**1.34 ± 0.484**	0.305 U ± 0.295	**1.16 J ± 0.486**

ABBREVIATIONS AND NOTES:

Statistically significant level (SSL) concentration.
CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
pCi/L: picoCurie per liter.
su: standard units.
USEPA: United States Environmenta.l Protection Agency
J: Value is estimated
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J+: Value is estimated, biased high
R: Rejected during validation
U: Not detected, value is the laboratory reporting limit

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

TABLE 2

SUMMARY OF CORRECTIVE MEASURES

CORRECTIVE MEASURES ASSESSMENT

F.B. CULLEY GENERATING STATION - EAST ASH POND

Alternative Number	Remedial Alternative Description	THRESHOLD CRITERIA: Be protective of human health and the environment	THRESHOLD CRITERIA: Attain the groundwater protective standard	THRESHOLD CRITERIA: Control the source of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents into the environment	THRESHOLD CRITERIA: 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	THRESHOLD CRITERIA: Management of waste to comply with all applicable RCRA requirements	BALANCING CRITERIA: CATEGORY 1 Long- and Short-Term Effectiveness, Protectiveness, and Certainty of Success that the remedy will prove successful	Sub-Category 1: 1 *Magnitude of reduction of existing risks*	Sub-Category 1: 2 *Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy*	Sub-Category 1: 3 *Type and degree of long-term management required including monitoring, operation and maintenance*	Sub-Category 1: 4 *Short-term risk to community or environment during implementation of remedy*	Sub-Category 1: 5 *Time until full protection is achieved*	Sub-Category 1: 6 *Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment*	Sub-Category 1: 7 *Long-term reliability of engineering and institutional controls*	Sub-Category 1: 8 *Potential need for replacement of the remedy*	CATEGORY 2 Effectiveness in controlling the source to reduce further releases	Sub-Cat. 2: 1 *Extent to which containment practices will reduce further releases*	Sub-Cat. 2: 2 *Extent to which treatment technologies may be used*	CATEGORY 3 The ease or difficulty of implementation	Sub-Category 3: 1 *Degree of difficulty associated with constructing the technology*	Sub-Category 3: 2 *Expected operational reliability of the technologies*	Sub-Category 3: 3 *Need to coordinate with and obtain necessary approvals and permits from other agencies*	Sub-Category 3: 4 *Availability of necessary equipment and specialists*	Sub-Category 3: 5 *Available capacity and location of needed treatment, storage, and disposal services*
1	Monitored Natural Attenuation (MNA) with In-Situ Solidification (ISS) and Closure in Place (CIP)	✓	✓	✓	✓	✓																		
2	Hydraulic Containment with No Treatment, ISS and CIP	✓	✓	✓	✓	✓																		
3	Hydraulic Containment with Treatment, ISS and CIP	✓	✓	✓	✓	✓																		
4	In-Situ Treatment, ISS and CIP	✓	✓	✓	✓	✓																		

TABLE 2

SUMMARY OF CORRECTIVE MEASURES

CORRECTIVE MEASURES ASSESSMENT

F.B. CULLEY GENERATING STATION - EAST ASH POND

Alternative Number	Remedial Alternative Description	THRESHOLD CRITERIA					BALANCING CRITERIA																		
								Sub-Category 1									Sub-Cat. 2			Sub-Category 3				
								1	2	3	4	5	6	7	8		1	2		1	2	3	4	5
		Be protective of human health and the environment	Attain the groundwater protective standard	Control the source of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents into the environment	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	Management of waste to comply with all applicable RCRA requirements	CATEGORY 1 Long- and Short-Term Effectiveness, Protectiveness, and Certainty of Success that the remedy will prove successful	*Magnitude of reduction of existing risks*	*Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy*	*Type and degree of long-term management required including monitoring, operation and maintenance*	*Short-term risk to community or environment during implementation of remedy*	*Time until full protection is achieved*	*Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment*	*Long-term reliability of engineering and institutional controls*	*Potential need for replacement of the remedy*	CATEGORY 2 Effectiveness in controlling the source to reduce further releases	*Extent to which containment practices will reduce further releases*	*Extent to which treatment technologies may be used*	CATEGORY 3 The ease or difficulty of implementation	*Degree of difficulty associated with constructing the technology*	*Expected operational reliability of the technologies*	*Need to coordinate with and obtain necessary approvals and permits from other agencies*	*Availability of necessary equipment and specialists*	*Available capacity and location of needed treatment, storage, and disposal services*
5	MNA with Closure by Removal (CBR)	✓	✓	✓	✓	✓	Green	Green	Green	Green	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
6	Hydraulic Containment with No Treatment and CBR	✓	✓	✓	✓	✓	Yellow	Green	Green	Yellow	Yellow	Green	Yellow	Yellow	Yellow	Yellow	Green	Yellow	Yellow	Red	Yellow	Yellow	Yellow	Green
7	Hydraulic Containment with Treatment and CBR	✓	✓	✓	✓	✓	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Yellow	Yellow	Green	Yellow	Yellow	Red	Yellow	Yellow	Yellow	Yellow
8	In-Situ Treatment and CBR	✓	✓	✓	✓	✓	Red	Green	Green	Yellow	Yellow	Green	Yellow	Red	Red	Red	Green	Red	Red	Yellow	Red	Red	Red	Green

COLOR LEGEND

- Green: **Most favorable when compared to other alternatives**
- Yellow: **Less favorable when compared to other alternatives**
- Red: **Least favorable when compared to other alternatives**

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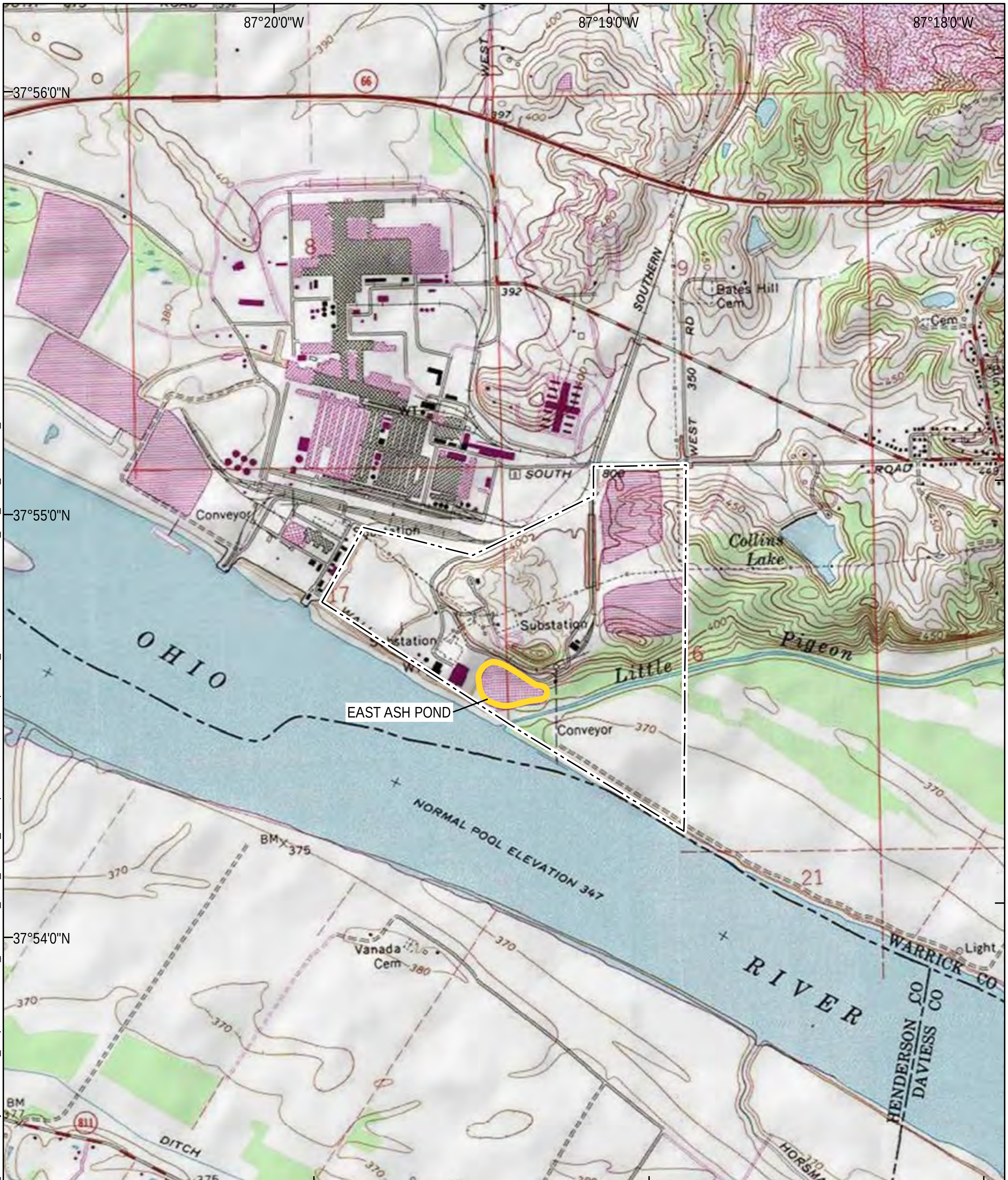
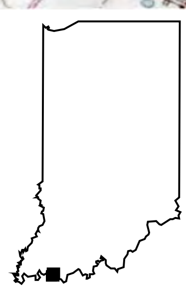
FIGURES





MAP SOURCE: ESRI
SITE COORDINATES: 36°30'28"N, 89°33'37"W

HALEY ALDRICH

CORRECTIVE MEASURE ASSESSMENT
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

SITE LOCATION MAP

APPROXIMATE SCALE: 1 IN = 2000 FT
SEPTEMBER 2019

FIGURE 1-1

GIS FILE PATH: \\haleyaldrich.com\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_08\F.B. CULLEY\129420_001_0000_PROJECT_LOCUS.mxd — USER: hwachholz — LAST SAVED: 8/28/2019 10:06:45 AM

LEGEND

- EAST ASH POND BOUNDARY
- WEST ASH POND BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS ARE APPROXIMATE
2. CCR COAL COMBUSTION RESIDUALS
3. AERIAL IMAGERY SOURCE: ESRI

0 350 700
SCALE IN FEET

HALEY ALDRICH

CORRECTIVE MEASURES ASSESSMENT
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

SITE FEATURES MAP

SEPTEMBER 2019

FIGURE 1-2

GIS FILE PATH: \\haleyaldrich.com\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_08\F.B. CULLEY\129420_001_0001-2_SITE_FEATURES_MAP.mxd — USER: hwachholz — LAST SAVED: 8/23/2019 12:14:28 PM

LEGEND

CCR-AP-11 MONITORING WELL

CCR-AP-6I NATURE AND EXTENT MONITORING WELL

APPROXIMATE UNIT BOUNDARY

APPROXIMATE PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS ARE APPROXIMATE
2. CCR COAL COMBUSTION RESIDUALS
3. AERIAL IMAGERY SOURCE: ESRI

0 220 440

SCALE IN FEET

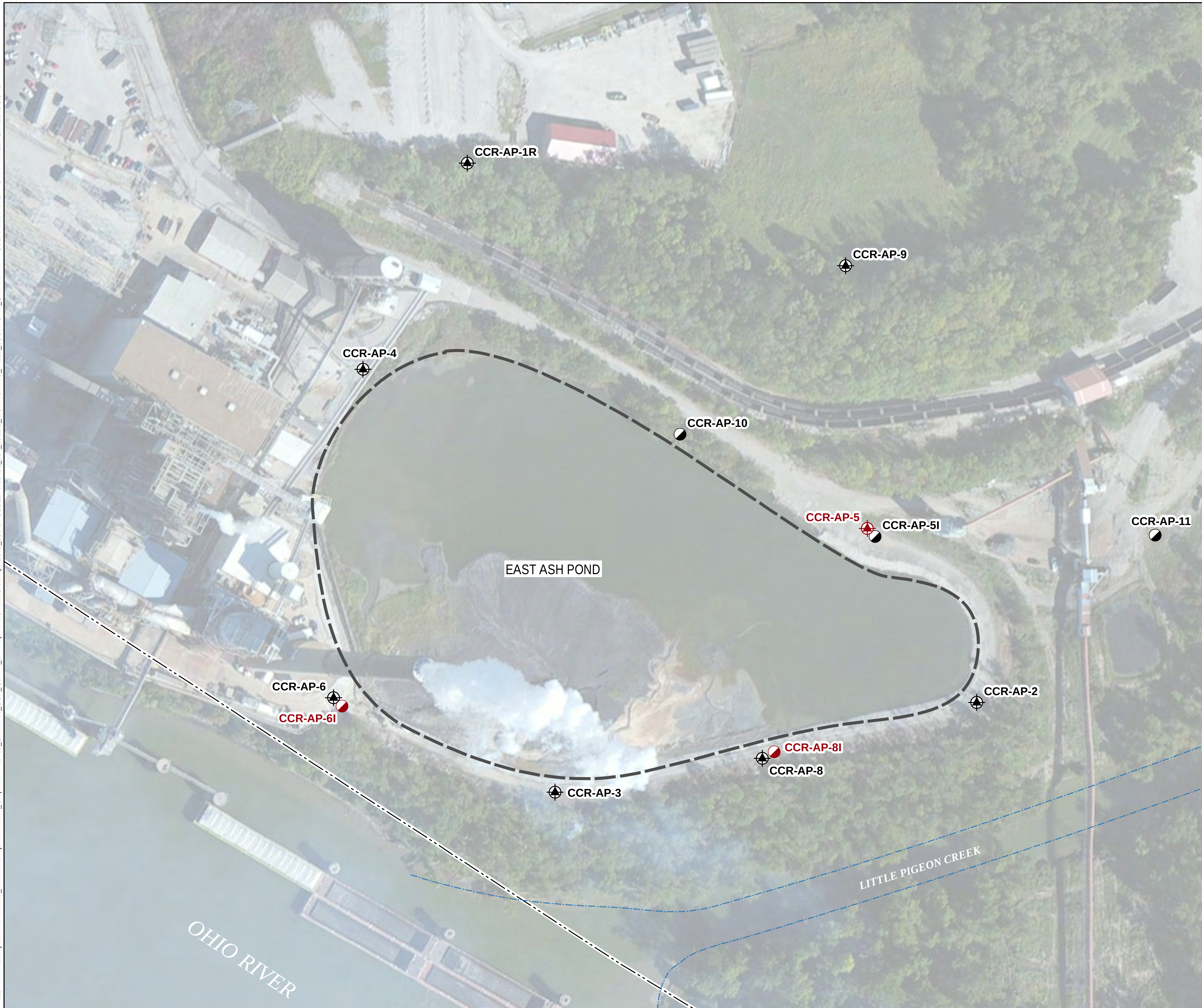
HALEY ALDRICH

CORRECTIVE MEASURES ASSESSMENT
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

GROUNDWATER MONITORING WELL LOCATIONS

SEPTEMBER 2019

FIGURE 1-3



LEGEND

- CCR-AP-11 — MONITORING WELL WITH NO CONSTITUENTS ABOVE GWPS
- CCR-AP-5I — NATURE AND EXTENT MONITORING WELL
- CCR-AP-5 — MONITORING WELL WITH MOLYBDENUM CONCENTRATION ABOVE THE GWPS
- APPROXIMATE UNIT BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS ARE APPROXIMATE
2. CCR COAL COMBUSTION RESIDUALS
3. GWPS = GROUNDWATER PROTECTION STANDARDS
4. REFER TO TABLE I FOR GROUNDWATER ANALYTICAL RESULTS.
5. AERIAL IMAGERY SOURCE: ESRI

0 150 300
SCALE IN FEET

HALEY ALDRICH

CORRECTIVE MEASURES ASSESSMENT
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

MONITORING WELL LOCATIONS WITH STATISTICALLY SIGNIFICANT LEVELS ABOVE GWPS

SEPTEMBER 2019

FIGURE 2-1

GIS FILE PATH: \\haleyaldrich\share\bos_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_08\F.B. CULLEY\129420_001_0002-2_MONITORING_WELL_LOCATIONS_GWPS.mxd — USER: hwachholz — LAST SAVED: 9/11/2019 3:34:21 PM

FIGURE 4-1
REMEDIAL ALTERNATIVE ROADMAP
CORRECTIVE MEASURES ASSESSMENT
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION - EAST ASH POND
NEWBURGH, INDIANA

Alternative Number	Remedial Alternative Description	Ash Pond Closure Method	Interim Measure Options for Groundwater	Post-Closure Options for Groundwater
1	**Monitored Natural Attenuation (MNA) with In-Situ Solidification (ISS) and Closure in Place (CIP)**	**Closure in Place with ISS (or equivalent - e.g., Fully Encapsulated Slurry Wall) and Cap**	**MNA**	**MNA** Post-closure groundwater monitoring to confirm reduction of CCR constituents following completion of ISS and capping
2	**Hydraulic Containment with No Treatment, ISS and CIP**		**Hydraulic Containment with No Treatment*** Mitigate off-site migration of groundwater with CCR constituents above GWPS using extraction wells, direct discharge of effluent	
3	**Hydraulic Containment with Treatment, ISS and CIP**		**Hydraulic Containment with Ex-Situ Treatment** Mitigate off-site migration of groundwater with CCR constituents above Groundwater Protection Standards (GWPS) using extraction wells, ex-situ treatment of effluent prior to discharge	
4	**In-Situ Treatment, ISS and CIP**		**In-Situ Treatment** Subsurface treatment to reduce CCR constituents in groundwater	
5	**MNA with Closure by Removal (CBR)**	**Closure by Removal**	**MNA**	**MNA** Post-closure groundwater monitoring to confirm reduction of CCR constituents following removal
6	**Hydraulic Containment with No Treatment and CBR**		**Hydraulic Containment with No Treatment** Mitigate off-site migration of groundwater with CCR constituents above GWPS using extraction wells, direct discharge of effluent	
7	**Hydraulic Containment with Treatment and CBR**		**Hydraulic Containment with Ex-Situ Treatment** Mitigate off-site migration of groundwater with CCR constituents above GWPS using extraction wells, ex-situ treatment of effluent prior to discharge	
8	**In-Situ Treatment and CBR**		**In-Situ Treatment** Subsurface treatment to reduce CCR constituents in groundwater	

* To be determined based on ELG/NPDES permit updates

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APPENDIX A

Groundwater Risk Evaluation

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REPORT ON

GROUNDWATER RISK EVALUATION
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

by
Haley & Aldrich, Inc.
Cleveland, Ohio

for
Southern Indiana Gas and Electric Company
Evansville, Indiana

File No. 129420-020
September 2019

Table of Contents

List of Tables

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List of Acronyms

AAC	Acute Aquatic Criterion
ASD	Alternate Source Demonstration
AWQC	Ambient Water Quality Criteria
CAC	Chronic Aquatic Criterion
CCR	Coal Combustion Residual
CMA	Corrective Measures Assessment
CSM	Conceptual Site Model
CWA	Clean Water Act
EAP	East Ash Pond
FBC	F.B. Culley Generating Station
GWPS	Groundwater Protection Standards
IDEM	Indiana Department of Environmental Management
IWPCD	Indiana Water Pollution Control Division
MCL	Maximum Contaminant Level
mg/L	Milligram per Liter
NRWQC	National Recommended Water Quality Criteria
ORSANCO	Ohio River Valley Water Sanitation Commission
RSL	Regional Screening Level
SIGECO	Southern Indiana Gas and Electric Company
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
ug/L	Microgram per Liter
USEPA	United States Environmental Protection Agency

1. Introduction

The F.B. Culley Generating Station (FBC) is a coal-fired power plant (the Site) located on the Ohio River in Warrick County, Indiana. The facility is located adjacent to the northern bank of the Ohio River and Little Pigeon Creek approximately three miles east of the town of Newburgh, Indiana. The facility has been in operation since 1953, and coal combustion residuals (CCR) are currently managed on the Site in a 10-acre impoundment known as the East Ash Pond (EAP), commissioned around 1971. Southern Indiana Gas and Electric Company (SIGECO) currently owns the land and operates the station for supplying electric power to industrial, commercial, and residential customers in its service territory. **Figure 1** shows the location of the facility, and the location of the EAP.

The U.S. Environmental Protection Agency (USEPA) issued a final rule for "Disposal of Coal Combustion Residuals from Electric Utilities" in 2015 (the CCR Rule) (USEPA, 2015). One of the requirements in the CCR Rule is that utilities monitor groundwater at coal ash management facilities, and that the data be reported publicly. SIGECO is complying with the CCR Rule, and has posted the required information on their publicly-available website: *https://www.vectren.com/reporting/ccr*.

This "Groundwater Risk Evaluation" report has been prepared by Haley & Aldrich, Inc. (Haley & Aldrich), and is a companion document to the "Corrective Measures Assessment (CMA) for the F.B. Culley Generating Station – East Ash Pond, Newburgh, Indiana." The purpose of this risk evaluation report is to provide the information needed to interpret and meaningfully understand the groundwater monitoring data collected and published for the FBC under the CCR Rule.

Beyond the specific monitoring requirements of the CCR Rule, SIGECO has also voluntarily taken the additional step to evaluate potential groundwater-to-surface water transport and exposure pathways through the development of risk-based groundwater screening levels that are protective of surface water in the Ohio River and Little Pigeon Creek. Details about the evaluation are provided below.

2. Approach

The analysis presented in this report was conducted by evaluating the environmental setting of the FBC, including its location and where ash management has occurred at the facility. Information on where groundwater is located at the facility, the rate(s) of groundwater flow, the direction(s) of groundwater flow, and where waterbodies may intercept groundwater flow are reviewed and summarized here.

A conceptual model was developed based on this physical setting information, and the model was used to identify what human populations could contact groundwater and/or surface water in the area of the facility. This information was also used to identify where ecological populations could come into contact with surface water.

Human health risk assessment is a process used to estimate the chance that contact with constituents in the environment may result in harm to people. Generally, there are four components to the process (USEPA, 1989): (1) Hazard Identification/Data Evaluation, (2) Toxicity Assessment, (3) Exposure Assessment, and (4) Risk Characterization.

The USEPA and other regulatory agencies, including the Indiana Department of Environmental Management (IDEM), develop "screening levels" of constituent concentrations in groundwater (and other media) that are considered to be protective of specific human exposures. In developing screening levels, USEPA uses a specific target risk level (component 4) combined with an assumed exposure scenario (component 3) and toxicity information from USEPA (component 2) to derive an estimate of a concentration of a constituent in an environmental medium, for example groundwater, (component 1) that is protective of a person in that exposure scenario (for example, drinking water). Similarly, ecological screening levels for surface water are developed by USEPA and IDEM to be protective of the wide range of potential aquatic ecological resources, or receptors.

Risk-based screening levels are designed to provide a conservative estimate of the concentration to which a receptor (human or ecological) can be exposed without experiencing adverse health effects. Due to the conservative methods used to derive risk-based screening levels, it can be assumed with reasonable certainty that concentrations below screening levels will not result in adverse health effects, and that no further evaluation is necessary. Concentrations above conservative risk-based screening levels do not necessarily indicate that a potential risk exists but indicate that further evaluation may be warranted.

Human health risk-based and ecological risk-based screening levels drawn from USEPA and IDEM sources are used to determine if the concentration levels of constituents in groundwater could pose a risk to human health or the environment that warrants further evaluation.

2.1 CONCEPTUAL SITE MODEL

A conceptual site model (CSM) is used to evaluate the potential for human or ecological exposure to constituents that may have been released to the environment. Some of the questions posed during the CSM evaluation include:

> What is the source? How can constituents be released from the source? What environmental media may be affected by constituent release? How and where do constituents travel within a medium? Is there a point where a receptor (human or ecological) could contact the constituents in the medium? Are the constituent concentrations high enough to potentially exert a toxic effect?

For the evaluation of the ash management operations at the FBC, the coal ash stored in the EAP is the potential source. Constituents present in the coal ash can be dissolved into infiltrating water (either from precipitation or from groundwater intrusion) that flows to groundwater, and those constituents may then be present in shallow groundwater. Constituents could move with groundwater as it flows, usually in a downgradient/downhill direction.

The constituents derived from the coal ash could then be introduced to adjacent surface water bodies; here, that could be the Ohio River and/or Little Pigeon Creek. **Figure 1** shows the facility location and layout, identifies direction of groundwater flow, and identifies the adjacent surface water bodies. Thus, the environmental media of interest for this evaluation are:

- Groundwater on the facility;
- Ohio River surface water; and
- Little Pigeon Creek surface water.

Groundwater flow in the immediate vicinity of the EAP is radial with an overall flow direction from the upland areas north of the EAP to the south toward the Ohio River, as shown in **Figure 1**. Groundwater elevations vary seasonally but the direction of groundwater flow patterns remain consistent.

There are no on-site users of shallow groundwater adjacent to the EAP. There are approximately 28 private wells recorded within a half-mile radius of the facility, and all are located either west or upgradient of the facility (see **Figure 2**), meaning that groundwater does not flow from the EAP toward those wells. One well (number 233831 on **Figure 2)**, owned by Yankeetown Dock Corp., is located to the east of the EAP. This well is on the opposite side of Little Pigeon Creek from the Site and is not downgradient to the EAP.

There are three water wells on facility property that are used to supply water to the FBC. These wells are located upgradient and west of the EAP (see **Figure 2**).

Thus, there are no downgradient users of the groundwater. Consequently, there are no complete drinking water exposure pathways to groundwater downgradient of the EAP.

The Ohio River is a supply source for drinking water and the nearest public water supply intake is located approximately 18.4 miles downstream near the City of Evansville, Indiana. Little Pigeon Creek flows into the Ohio River, except during periods of low precipitation, when the creek is dry. The creek is not used as a source of drinking water.

The Ohio River can be used for human recreation – wading, swimming, boating, fishing. Little Pigeon Creek can also be used recreationally, though its small size and periodic drying would limit its recreational use mostly to wading.

Both the creek and the river serve as habitat for aquatic species – fish, amphibians, etc.

A depiction of the conceptual site model is shown in **Figure 3**.

Figure 1 shows the groundwater sample locations. Based on this conceptual site model and the facility setting, samples collected from groundwater monitoring wells have been included in the evaluation. The samples have been analyzed for constituents that are commonly associated with CCR, as discussed below. However, it is recognized by the USEPA that all of these constituents can also be naturally occurring and can be found in rocks, soils, water and sediments; thus, it is necessary is to understand what the naturally occurring background levels are for these constituents. The CCR Rule requires sampling and analysis of upgradient and/or background groundwater just for this reason. The sampling is detailed in the next section.

To answer the question, "Are the constituent concentrations high enough to potentially exert a toxic effect?" health risk-based screening levels from USEPA and IDEM sources are used for comparison to the data, as described in Section 5.

3. Sample Collection and Analysis

3.1 GROUNDWATER SAMPLES

The CCR Rule requires that groundwater monitoring occur at one (1) upgradient location and three (3) downgradient locations. For the EAP evaluation, nine (9) groundwater monitoring wells were installed to evaluate shallow alluvial groundwater: six (6) monitoring wells were installed around the perimeter of the EAP to assess groundwater conditions at the ash management area, and three (3) monitoring wells were installed just north of the facility to assess background groundwater conditions. **Figure 1** shows the locations of the monitoring wells. Each well is identified by a unique name. CCR-AP-2 through CCR-AP-6 and CCR-AP-8 are located around the perimeter of the EAP, and CCR-AP-1R, CCR-AP-7, and CCR-AP-9 are the three background wells that are used to identify upgradient/background conditions in groundwater. Each groundwater monitoring well was sampled eleven (11) times[1].

3.2 SAMPLE ANALYSIS

The CCR Rule identifies the constituents that are included for groundwater testing; these are:

Appendix III	Appendix IV	
Boron	Antimony	Lead
Calcium	Arsenic	Lithium
Chloride	Barium	Mercury
pH	Beryllium	Molybdenum
Sulfate	Cadmium	Selenium
TDS	Chromium	Thallium
Fluoride	Cobalt	Radium 226/228
	Fluoride	

The CCR Rule requires eight (8) rounds of groundwater sampling and analysis be conducted for all wells to provide a baseline for current conditions. At this facility, nine rounds of groundwater samples were collected through November 2017, and were analyzed for all constituents. Assessment Monitoring samples in June and August 2018 were analyzed for constituents in the last two columns above (these are the Appendix IV constituents under the CCR Rule – the remaining are referred to as Appendix III constituents). The CCR Rule requires statistical methods be used to determine whether a statistically significant increase (SSI) above background exists for the first column (Appendix III) constituents, a condition that triggers conducting Assessment Monitoring. Based on the SSI results from the groundwater monitoring, assessment monitoring has been conducted. Section 1.3 of the "Corrective Measures Assessment (CMA)" report provides more detail on the objectives of the rounds of groundwater sampling. Appendix III and IV analytical results for the baseline and Assessment Monitoring events are summarized in **Table 1**.

[1] The CCR Rule requires eight (8) rounds of sampling events to establish baseline conditions in each well. Under the CCR Rule, further rounds are defined as "Detection" sampling.

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4. Risk-Based Screening Levels

A comprehensive set of risk-based screening levels have been compiled for this evaluation for the three types of potential exposures identified in the conceptual site model discussion above:

- Human health drinking water consumption;
- Human health recreational use of surface water; and
- Aquatic ecological receptors for surface water.

It is important to note that the CCR Rule requires that the downgradient monitoring wells be located at the edge of the ash management area. Moreover, the CCR Rule limits the evaluation of groundwater monitoring data from ash management areas to groundwater protection standards (GWPS), which are Federal primary drinking water standards, also known as Maximum Contaminant Levels or MCLs (USEPA, 2018a) that are enforceable for municipal drinking water supplies, whether or not that groundwater is used as a source of drinking water, or to Regional Screening Levels (RSLs) for those constituents that do not have an established MCL, or finally to a comparison with site-specific background. GWPS used to evaluate potential drinking water exposures for CCR monitoring wells are shown on **Table 1**.

To augment this evaluation, **Table 2** provides the risk-based human health drinking water and recreational screening levels for surface water available from the IDEM and USEPA sources. **Table 3** provides site-specific risk-based screening levels (RBSLs) derived for recreational exposure to surface water. **Table 4** provides the ecological surface water screening levels from IDEM and USEPA sources.

4.1 GROUNDWATER PROTECTION STANDARDS

The GWPS is defined in the CCR Rule at §257.95 Assessment monitoring program:

> (h) The owner or operator of the CCR unit must establish a groundwater protection standard for each constituent in appendix IV to this part detected in the groundwater. The groundwater protection standard shall be:
>
> > (1) For constituents for which a maximum contaminant level (MCL) has been established under §§141.62 and 141.66 of this title, the MCL for that constituent;
> > (2) For constituents for which an MCL has not been established, the background concentration for the constituent established from wells in accordance with § 257.91; or
> > (3) For constituents for which the background level is higher than the MCL identified under paragraph (h)(1) of this section, the background concentration.

USEPA published Amendments to the National Minimum Criteria Finalized in 2018 (Phase One, Part One) in the Federal Register on July 30, 2018 (USEPA, 2018b). This included revising the groundwater protection standard for constituents that do not have an established drinking water standard (or MCL) at §257.95 Assessment monitoring program (h) (2):

- Cobalt – 6 ug/L (micrograms per liter)
- Lead – 15 ug/L
- Lithium – 40 ug/L
- Molybdenum – 100 ug/l

GWPS used to evaluate potential drinking water exposures for CCR monitoring wells are shown on **Table 1**.

4.2 SCREENING LEVELS FOR THE PROTECTION OF SURFACE WATER

The GWPS are specific to the evaluation of groundwater at the CCR Rule monitoring wells. Based on the CSM presented in **Section 2.1** and **Figure 3**, this section outlines the risk-based human health and ecological surface water screening levels that are protective of surface water in the Ohio River.

Human health screening levels for surface water are identified for the following exposure settings: 1) use of surface water as a drinking water source, 2) the consumption of fish from a surface water body, and 3) recreational uses of surface water.

4.2.1 Drinking Water Screening Levels

The human health screening levels for drinking water are from IDEM and USEPA sources and address the drinking water exposure pathway. The IDEM criteria for drinking water class groundwater are the same as the Federal primary drinking water standards, also known as Maximum Contaminant Levels or MCLs. USEPA risk-based Regional Screening Levels (RSLs) (USEPA, 2019a) for tapwater (drinking water, or untreated groundwater used as potable water) have also been included for constituents which do not have promulgated IDEM/MCL criteria. The tapwater RSLs are based on USEPA default assumptions for residential exposure to tapwater. These sources, in the order in which they are to be used, are:

- USEPA Office of Water, Health Advisory Program. 2018 Edition of the Drinking Water Standards and Health Advisories. (USEPA, 2018a)
- USEPA. Regional Screening Levels (RSLs), May 2019. Values for tapwater. (USEPA, 2019a)
- Indiana Administrative Code Title 327 - Water Pollution Control Division. 327 IAC 2-11-6(a)(1). Health protective goals for select inorganic contaminants in untreated groundwater used as drinking water. (IWPCD, 2019a)

Screening levels for human health drinking water are provided in **Table 2**.

4.2.2 Published Recreational Screening Levels

Published human health screening levels for surface water are generally derived to be protective of the use of surface water as a drinking water source and the consumption of fish from a surface water body. The drinking water screening levels are also protective of, but highly conservative for, recreational uses of a surface water body (such as swimming or boating) because drinking water exposure is of a higher magnitude and frequency. The drinking water screening levels used to evaluate surface water, as discussed above, are protective for other recreational uses of the river such as swimming, wading, and boating. Note that this evaluation of other uses of surface water are above and beyond the requirements of the CCR Rule.

The human health screening levels for surface water are from federal and state sources. Values that address use of surface water as drinking water are the values for drinking water provided in **Table 2**. Values that address the fish consumption pathway are the federal and state values for surface water.

Where the surface water body is not within the Great Lakes System, is on the Ohio River, and is a source of public drinking water, these screening level sources, in the order in which they are to be used, are:

- Ohio River Valley Water Sanitation Commission (ORSANCO) Pollution Control Standards for Discharges to the Ohio River. 2019 Revision. Chapter 3 Water Quality Criteria - Human Health. Human health protection criteria are protective of drinking water, recreational, and fish consumption uses. (ORSANCO, 2019)
- USEPA Ambient Water Quality Criteria (AWQC) for Human Health Consumption of Organisms. (USEPA, 2019b)
- Indiana Administrative Code Title 327 - Water Pollution Control Division. Active Projects. Proposed revisions to Indiana's Aquatic Life and Human Health Ambient Water Quality Criteria for metals. Revisions are proposed to reflect updates to National Recommended Water Quality Criteria (NRWQC) at Section 304(a) of the Clean Water Act (CWA). The proposed revisions are to 327 IAC 2-1-6 Minimum Surface Water Quality Standards for metals in Indiana waters not within the Great Lakes System, for consumption of organisms. (IN.gov, 2019; 2017)
- Indiana Administrative Code Title 327 - Water Pollution Control Division. Article 2. Water Quality Standards. Rule 1. Water Quality Standards Applicable to All State Waters Except Waters Within the Great Lakes System. 327 IAC 2-1-6 Minimum Surface Water Quality Standards (current/ promulgated surface water quality standards), for consumption or organisms. (IWPCD, 2019b)

If values from the above surface water sources are not published for a given constituent, then the selected drinking water screening level from Section 4.2.1 is used.

4.2.3 Calculated Recreational Risk-Based Screening Levels

Site-specific RBSLs are essentially refined screening levels to account for receptor population characteristics and exposure pathways. As such, the site-specific RBSLs are more realistic than screening levels and, therefore, are useful for evaluating whether constituents may have the potential to pose health risks in excess of risk thresholds. For example, whereas surface water that is used as a recreational water body for swimming could be evaluated using drinking water standards which assume that people are drinking and bathing in the water daily, site-specific RBSLs for surface water will reflect incidental ingestion and dermal contact at an exposure rate and magnitude commensurate with swimming activities.

Potential exposures to constituents in surface water could, in general, occur through ingestion and dermal contact. However, the specific nature of the potential exposures is dependent on the type of water body. Specifically:

- Incidental ingestion and dermal contact with shallow surface water (e.g., less than two feet in depth) can only occur via wading because the water is not deep enough to permit swimming. Wading exposures could potentially occur in Little Pigeon Creek.

- Incidental ingestion and dermal contact with deeper surface water (e.g., more than three feet in depth) could occur via swimming. Exposures during swimming could be potentially complete in the Ohio River; the water in Little Pigeon Creek is not deep enough to allow for swimming.

- Dermal contact with surface water could occur during boating or fishing activities in the Ohio River. Since these types of activities are not associated with intense exposures to water (such as is the case with swimming), incidental ingestion of surface water would be insignificant.

RBSLs derived for recreational exposures to surface water for a recreational swimmer, wader, and boater are presented in **Table 3**. The RBSLs were calculated using USEPA-derived exposure factors and equations, as well as site-specific inputs where appropriate using the USEPA RSL calculator (USEPA, 2019c). The RBSL presented is the lower of the noncancer RBSL at a target noncancer hazard index of 1 and the RBSL calculated for a target cancer-based risk of 10^{-4}. The RSL calculator output, including the exposure parameters used, is provided in **Attachment A**.

4.2.4 Ecological Screening Levels

Ecological screening levels for surface water are published to provide a conservative estimate of the concentration to which an ecological receptor can be exposed without experiencing adverse effects. Due to the conservative methods used to derive published reference screening levels, it can be assumed with reasonable certainty that concentrations at or below screening levels will not result in any adverse effects to survival, growth and/or reproduction. Concentrations above published ecological screening levels for surface water, however, do not necessarily indicate that a potential ecological risk exists, but rather that further evaluation may be warranted.

Table 4 presents the published ecological risk-based screening levels for surface water. Some of the screening levels are based on the hardness of the water, a default hardness value of 100 mg/L has been used, in accordance with USEPA and IDEM guidance. Note that this ecological evaluation of surface water is above and beyond the requirements of the CCR Rule.

Water quality criteria are concentrations calculated from controlled laboratory tests on freshwater or marine organisms that are protective of the most sensitive organism (often zooplankton such as daphnids) for the most sensitive life stage (typically reproduction). The following criteria are used to evaluate the levels of metals in off-site surface water, in the order in which they were used:

- Ohio River Valley Water Sanitation Commission (ORSANCO) Pollution Control Standards for Discharges to the Ohio River. 2019 Revision. Chapter 3 Water Quality Criteria - Aquatic life. Aquatic Life criteria are protective of maintaining fish and other aquatic life. (ORSANCO, 2019).
- USEPA AWQC Freshwater Chronic and Acute. (USEPA, 2019d)
- Planned Revisions to Metals Criteria for the Protection of Aquatic Life and Human Health. IDEM Aquatic Life Criterion Applicable to All State Waters Except Waters of the State Within the Great Lakes System; acute aquatic criterion (AAC) and chronic aquatic criterion (CAC). (IN.gov, 2019; 2017).
- Current (promulgated) IDEM Aquatic Life Criterion Applicable to All State Waters Except Waters of the State Within the Great Lakes System; AAC and CAC. Indiana Administrative Code Title 327 Water Pollution Control Division. (IWPCD, 2019b)
- USEPA Region 5 Resource Conservation and Recovery Act (RCRA) Ecological Screening Levels, Archive Document. (USEPA, 2003)

4.2.5 Selected Screening Levels

Table 5 presents the selected human health and ecological screening levels (from **Tables 1 through 4**) and identifies the lowest selected screening level for surface water for the human health drinking water, human health recreational, and ecological potential exposure scenarios.

5. Results

The level of analysis and comparison to risk-based screening levels presented below is above and beyond the requirements of the CCR Rule. The analysis of the groundwater results required by the CCR Rule is presented in the 2019 "Annual Groundwater Monitoring and Corrective Action Report" for FBC East Ash Pond [*https://www.vectren.com/assets/downloads/planning/ccr/Culley%20East%20Ash%20Pond%20Annual%20Ground%20Water%20Report%202019.pdf*]. This report serves to supplement that report by providing the risk-based analysis of groundwater, so that the groundwater results can be understood in their broader environmental context.

5.1 SHALLOW ALLUVIAL AQUIFER GROUNDWATER – CCR RULE EVALUATION

SIGECO has filed reports and notification required by the federal CCR Rule on its website, as noted above, and additional reports will be prepared and posted on SIGECO's website per the CCR Rule. The statistical analysis of the data has indicated an SSI for samples collected from monitoring wells CCR-AP-3, CCR-AP-4, CCR-AP-5, CCR-AP- 6, and CCR-AP-8 (see **Figure 1**) that monitor the shallow alluvial aquifer. Analytes exhibiting an SSI are a subset of the parameters identified in Section 4: arsenic and molybdenum. The Appendix III statistical analysis results, followed by an unsuccessful Alternate Source Demonstration, moved the groundwater sampling into the Assessment Monitoring phase.

Groundwater data from eleven rounds of sampling of the shallow alluvial aquifer groundwater were compared to the site-specific GWPS required by the CCR Rule. **Figure 1** shows that the monitoring wells are all located at the edge of the EAP and, therefore, provide worst-case groundwater results. Based on the assessment monitoring results, concentrations of only two (2) constituents, arsenic and molybdenum, of the 15 Appendix IV constituents analyzed in the downgradient wells are statistically above the GWPS. These measured concentrations are then referred to as Statistically Significant Levels (SSLs). Therefore, the Assessment of Corrective Measures phase of the CCR Rule is triggered for these Appendix IV constituents. An arsenic alternative source demonstration (ASD) determined that the alternate source for arsenic in downgradient groundwater wells from the EAP is the naturally occurring fine-grained alluvium soils and, therefore, the corrective measures assessment is focused solely on molybdenum.

Table 1 compares the results of all CCR monitoring well sampling rounds to the GWPS. The vast majority of the results indicate concentration levels below the site-specific GWPS. A limited number of parameters are above the GWPS for some, but not all, sampling events.

The striking aspect of the analysis shown in **Table 1** is how few CCR monitoring well results are above a conservative GWPS based on MCLs, health-based GWPS, or background levels, given that the wells are located immediately adjacent to the base of the ash management area, and the facility has been in operation for over 60 years. Out of the 912 groundwater analyses conducted, only 128 results are above the GWPS (see **Table 1**). Put another way, approximately 86% of the groundwater results for the

CCR Rule monitoring wells located at the edge of the EAP (CCR-AP-2 through CCR-AP-6 and CCR-AP-8) are below the GWPS. Even for the very few results that may be above screening values for some of the sampling events, including the SSI results identified under the CCR Rule, there is no complete drinking water exposure pathway to groundwater. Without the complete drinking water exposure pathway, the risk is negated.

The SSI and SSL values reflect a statistical evaluation that mathematically compares the results of the various rounds of samples to background water quality and GWPS as required under the CCR Rule. However, such values without further evaluation do not establish that there is an actual adverse impact to human health or the environment. The CSM process and screening analysis described in this report provide the relevant context for such groundwater monitoring results and whether the EAP poses a true risk to human health and the environment. As explained in the remaining sections of this report, based upon the application of risk assessment principles uniformly adopted by USEPA, no such risk exists.

6. Derivation of Risk-Based Screening Levels for Groundwater

FBC is located on the Ohio River – a major river system with a massive and rapid river flow. This section illustrates how the groundwater – which is a fraction of the volume and flow rate of the river – may interact with the Ohio River under an assumed set of criteria and conditions (see **Attachment B**). Such an exercise in assumptions can help put in context whether a theoretical risk to river water and its uses exists. Because of the intermittent dry nature of the creek, a DAF for Little Pigeon Creek was not calculated.

Impacts to groundwater do not mean that surface waters are impaired. The degree of interface between groundwater and surface waters is variable and complex and dependent upon a variety of factors including gradient and flow rate. It is possible, however, to determine the maximum concentration level that would need to be present on-site in groundwater and still be protective of the surface water environment, assuming gradient and flow rates are such that groundwater flows into the surface water. Groundwater and surface waters flow at very different rates and volumes. The Ohio River is a large river system in North America and as depicted on **Table 6** and **Attachment B**, and as groundwater flows into the river, it is diluted by more than 18,000 times.

It is possible to calculate a protective screening level for groundwater based upon the amount of dilution that occurs under the above assumption. This calculated risk-based screening level for groundwater can be used to determine whether an on-site groundwater concentration level is protective of the river. Stated differently, at what concentration level does groundwater entering the river system pose a human health or ecological risk?

Table 6 is summarized below and shows the application of the dilution factor to calculate risk-based groundwater screening levels that are protective for surface water, for Appendix III and Appendix IV constituents with risk-based screening levels available. For each constituent, the selected human health drinking water and recreational screening levels, as well as the ecological screening levels (from **Table 5**) are presented. The lowest of the three screening levels is then identified for surface water. The dilution factor is then applied to this lowest screening level for surface water to result in the groundwater screening level that is protective for human and ecological uses of surface water, as shown in the table below.

This evaluation is not limited to only those constituents for which SSIs or SSLs have been identified. The constituents listed in **Table 6** are those for which there is one or more detected groundwater result with available risk-based screening levels.

The groundwater risk-based screening levels are calculated in units of milligrams of constituent per liter of water (mg/L). One mg/L is equivalent to one part per million.

The table identifies the maximum groundwater concentration of each constituent detected in the EAP monitoring wells. The comparison between the target levels and the maximum concentrations indicates that there is a wide margin of safety between the two values. This margin is shown in the last column of the table. To illustrate, concentration levels of arsenic and molybdenum would need to be more than 1,500 and more than 4,000 times higher, respectively, than currently measured levels before an adverse impact in the river could occur.

CALCULATING RISK-BASED SCREENING LEVELS FOR GROUNDWATER (see Table 6)

Dilution Attenuation Factor for Ohio River		**18,000**			
Constituents	**Lowest of the Human Health and Ecological Screening Levels (mg/L)**	**Target Groundwater Screening Level - Ohio River (mg/L)***	**Maximum Groundwater Concentration (mg/L)**		**Ratio Between Target Groundwater Screening Level and the Maximum Groundwater Concentration**
Detection Monitoring - EPA Appendix III Constituents					
Boron	4	72,000	68	CCR-AP-5	>1,000
Fluoride	1	18,000	1.4	CCR-AP-5	>12,000
Assessment Monitoring - EPA Appendix IV Constituents					
Antimony	0.0056	101	0.002	CCR-AP-2	>50,000
Arsenic	0.000175	180	0.12	CCR-AP-6	>1,500
Barium	0.22	3,960	0.78	CCR-AP-4	>5,000
Beryllium	0.000068	21	0.0027	CCR-AP-2	>7,500
Cadmium	0.00025	4	0.0012	CCR-AP-5	>3,500
Chromium (Total)	0.074	1,334	0.082	CCR-AP-2	>16,000
Cobalt	0.006	108	0.038	CCR-AP-2	>2,500
Lead	0.0025	45	0.051	CCR-AP-2	>800
Lithium	0.04	720	0.15	CCR-AP-5	>4,500
Mercury	0.000012	0.2	0.2 U		NA
Molybdenum	0.1	1,800	0.41	CCR-AP-5	>4,000
Selenium	0.0031	56	0.0044	CCR-AP-2	>12,00
Thallium	0.00024	4	0.00099	CCP-AP-2	>4,000
Radiological Constituent		**(pCi/L)**	**(pCi/L)**		**(pCi/L)**
Radium	4	72,000	5.93 ± 1.6	CCP-AP-6	>9,500

*** Where the Groundwater Risk-Based Screening Level = Screening Level x Dilution Factor.**

This means that not only do the present concentrations of constituents in groundwater at the EAP not pose a risk to human health or the environment, but even much higher concentrations in groundwater would not be harmful.

7. Summary

This comprehensive evaluation demonstrates that there are no adverse impacts on human health or ecological receptors from constituents present in groundwater resulting from coal ash management practices at the East Ash Pond at the F.B Culley Generating Station.

8. References

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TABLES

TABLE 1
COMPARISON OF EAST ASH POND GROUNDWATER MONITORING RESULTS TO SITE GROUNDWATER PROTECTION STANDARDS –
JUNE 2016 THROUGH AUGUST 2018 SAMPLING EVENTS
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Monitoring Well ID		Date Sampled	pH (lab)	Chloride	Fluoride	Sulfate	Total Dissolved Solids	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chromium Total	Cobalt Total	Lead Total	Lithium Total	Mercury Total	Molybdenum Total	Selenium Total	Thallium Total	Radium-226	Radium-228	Radium-226 & 228
			SU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	pCi/L
Site GWPS (a)			NA	NA	4	NA	NA	0.006	0.01	2	0.004	NA	0.005	NA	0.1	0.006	0.015	0.04	0.002	0.1	0.05	0.002	NA	NA	NA
Upgradient	CCR-AP-1	06/10/2016	7.74 J	19	0.81	180 J-	740	0.002 U	0.0045	0.077	0.00053 J	0.51	0.001 U	53	0.011	**0.0081**	0.0074	**0.045 J**	0.0002 U	0.015	0.00071 J	0.000082 J	0.607 J ± 0.204	0.344 U ± 0.659	0.950 U ± 0.69
		08/12/2016	8.1 J	18	0.48	180	760	0.002 U	0.0067	0.12	0.00074 J	0.54	0.001 U	51	0.02	**0.014**	0.013	**0.053**	0.0002 U	0.013	0.0014 J	0.00012 J	3.13 ± 0.594	3.20 ± 1.39	6.32 ± 1.51
		10/28/2016	7.6 J	19 J+	0.5	110 J+	740	0.002 U	0.0024	0.05	0.00011 J	0.65	0.001 U	50 J-	0.0019 J	0.0015 J	0.0011 J	0.035 J	0.0002 U	0.006	0.005 U	0.001 U	0.353 U ± 0.558	0.509 U ± 0.505	0.862 U ± 0.753
		12/07/2016	7.7 J	19	0.55	130	710	0.00072 J	0.0036	0.081	0.00049 J	0.68 J+	0.001 U	44	0.0092	0.005	0.0057	0.035 J	0.0002 U	0.0047 J	0.00045 J	0.000079 J	1.75 U ± 1.31	0.340 U ± 1.48	2.09 U ± 1.98
		02/08/2017	7.5 J	18	0.53	140	750	0.00077 J	0.0068	0.11	0.00058 J	0.69 J+	0.000081 J	42 J-	0.012	**0.0083**	0.0083	**0.043 J**	0.0002 U	0.0073	0.005 U	0.00033 J	2.99 ± 0.678	3.58 ± 0.962	6.56 ± 1.18
		04/06/2017	7.8 J	17	0.57	150	730	0.00055 J	**0.012**	0.16	0.0014	0.62	0.00018 J	55 J+	0.03	**0.017**	**0.02 J+**	**0.063**	0.0002 U	0.0067	0.0014 J-	0.001 U	2.28 ± 0.58	4.45 ± 1.35	6.73 J ± 1.47
		06/07/2017	7.7 J	18	0.58	150	840	0.00053 J	0.008	0.11	0.00073 J	0.72 J+	0.001 U	55	0.015	**0.0088**	0.0093	**0.049 J**	0.0002 U	0.0073	0.005 U	0.00012 J	1.74 ± 0.489	3.25 ± 1.09	5.00 ± 1.19
		09/28/2017	7.7 J	18	0.49	160	770	0.0025	0.0055	0.086	0.00035 J	0.44	0.001 U	48	0.01	0.0059	0.0068	0.036 J	0.0002 U	0.008	0.005 U	0.000088 J	1.94 ± 0.553	4.52 ± 1.43	6.46 ± 1.53
		11/17/2017	7.9 J	18	0.48	170 J-	770	0.01 U	0.0075	0.15	0.0013 J	0.82 J+	0.005 U	57	0.021	**0.013**	0.014	**0.059 J**	0.0002 U	0.013 J	0.025 U	0.0014 J	3.33 ± 0.689	R	R
		06/11/2018	-	-	0.47	-	-	0.02 U	**0.029**	0.55	**0.0056 J**	-	0.01 U	-	**0.12**	**0.047**	**0.063**	**0.17**	0.0002 U	0.01 J	0.05 U	0.001 J	2.01 ± 0.674	2.14 ± 0.626	4.15 ± 0.92
		08/28/2018	7.8 J	11	0.47	150	820	0.02 U	**0.023**	0.47	0.0033 J	0.61 J	0.01 U	47	**0.13**	**0.036**	**0.049**	**0.13**	-	0.0077 J	0.05 U	0.00094 J	2.42 ± 0.633	2.65 ± 1.05	5.07 ± 1.23
	CCR-AP-7	06/10/2016	7.37 J	31	R	93 J-	590	0.002 U	0.0025	0.1	0.001 U	0.034 J+	0.001 U	86	0.00048 J	0.0012	0.00062 J	0.01 J	0.0002 U	0.0082	0.00035 J	0.001 U	0.330 J ± 0.0973	0.166 U ± 0.267	0.496 ± 0.284
		08/12/2016	7.9 J	26	0.24	73	580	0.002 U	0.0048	0.12	0.001 U	0.034 U	0.001 U	88	0.00047 J	0.0023	0.00099 J	0.011 J	0.0002 U	0.0054	0.005 U	0.001 U	0.390 ± 0.118	0.625 J ± 0.344	1.02 J ± 0.363
		10/28/2016	7.1 J	25 J+	0.25	66 J+	530	0.002 U	0.0084	0.16	0.00017 J	0.02 J+	0.001 U	120 J-	0.0026	0.0053 J	0.0082 J	0.02 J	0.0002 U	0.0044 J	0.00073 J	0.00008 J	1.28 ± 0.664	0.434 U ± 0.433	1.72 J ± 0.792
		12/07/2016	7.4 J	26	0.37 J+	96	620	0.00016 J	0.0083	0.14	0.00012 J	0.071 U	0.001 U	99	0.0039	0.0037	0.0036	0.012 J	0.0002 U	0.0088	0.005 U	0.000066 J	0.439 U ± 0.399	0.558 U ± 0.451	0.997 ± 0.602
		02/08/2017	7.4 J	25	0.28 J+	110	630	0.00062 J	**0.018**	0.19	0.00075 J	0.034 U	0.00032 J	150 J-	0.019	**0.015**	**0.02**	0.039 J	0.0002 U	0.013	0.005 U	0.00061 J	0.744 ± 0.22	0.365 U ± 0.252	1.11 J ± 0.335
		04/06/2017	7.3 J	27	0.29	110	640	0.002 U	0.008	0.15	0.00022 J	0.08 U	0.00014 J	110 J+	0.0048	0.0054	0.0087 J+	0.019 J	0.0002 U	0.0058	0.005 UJ	0.001 U	0.719 ± 0.182	0.830 ± 0.427	1.55 ± 0.464
		06/07/2017	7.3 J	28	0.34	100	620	0.002 U	0.0075	0.15	0.00015 J	0.15 U	0.001 U	100	0.0039 J+	0.0032	0.0041	0.019 J	0.0002 U	0.0069	0.005 U	0.000088 J	0.398 ± 0.129	0.895 ± 0.413	1.29 ± 0.433
		09/28/2017	7.3 J	29	0.19	82	570	0.002 U	0.0058	0.12	0.001 U	0.056 J	0.001 U	94	0.002 U	0.00054	0.001 U	0.01 J	0.0002 U	0.0036 J	0.005 U	0.001 U	0.308 ± 0.095	R	R
		11/17/2017	7.2 J	31	0.25	77 J-	550	0.002 U	0.0034	0.11	0.001 U	0.091 U	0.001 U	96	0.002 U	0.0003 J	0.001 U	0.012 J	0.0002 U	0.0028 J	0.005 U	0.001 U	0.312 ± 0.0954	R	R
		06/11/2018	-	-	0.31	-	-	0.002 U	0.0071	0.14	0.001 U	-	0.001 U	-	0.0014 U	0.00065	0.00041 J	0.011	0.0002 U	0.0025 J	0.005 U	0.001 U	0.480 ± 0.216	0.0986 U ± 0.257	0.579 J ± 0.336
		08/28/2018	7.5 J	27	0.31	70	580	0.002 U	0.0064	0.14	0.000067 J	0.08 U	0.001 U	100	0.0061 J+	0.0014	0.0014	0.013	-	0.0026 J	0.005 U	0.001 U	R	0.307 U ± 0.231	R
	CCR-AP-9	03/09/2017	7.5 J	23	0.14	130	550	0.0044	0.0031	0.13	0.00017 J	0.2	0.000079 J	92	0.0042	**0.0062**	0.0025	0.03 J	0.0002 U	0.011	0.0058	0.001 U	R	0.401 U ± 0.915	0.934 UJ ± 0.938
		04/07/2017	7.4 J	21	0.36	120	610	0.0014 J	0.006	0.23	0.00053 J	0.23	0.000095 J	110 J+	0.0088	**0.012**	0.0073 J+	0.033 J	0.0002 U	0.0097	0.005 UJ	0.001 U	1.62 ± 0.47	1.61 ± 0.989	3.23 J ± 1.1
		04/26/2017	7.5 J	21	0.35	120	590	0.0012 J	0.008	0.23	0.00066 J	0.26 J+	0.00011 J	110	0.012	**0.013**	0.0069	0.04 J	0.0002 U	0.0071	0.005 U	0.000098 J	1.91 ± 0.393	2.11 ± 0.815	4.02 ± 0.905
		05/30/2017	7.7 J	19	0.33	110	600	0.0011 J	0.01	0.27	0.00092 J	0.26	0.00015 J	120	0.014	**0.013**	0.012	0.04 J	0.0002 U	0.0065	0.005 U	0.00018 J	0.614 ± 0.173	0.619 U ± 0.412	1.23 J ± 0.447
		06/08/2017	7.6 J	20	0.42	110	600	0.0014 J	0.0077	0.21	0.00047 J	0.29 U	0.00011 J	120	0.0088	**0.0096**	0.0056	0.034 J	0.0002 U	0.0059	0.005 U	0.0001 J	1.43 ± 0.332	2.06 ± 0.67	3.49 ± 0.747
		07/25/2017	7.4 J	19	0.3	90	650	0.002 U	0.01	0.28	0.0011	0.25	0.00022 J	130	0.02	**0.014**	0.011	**0.048 J**	0.0002 U	0.0059	0.005 U	0.00016 J	0.962 ± 0.286	0.644 ± 0.422	1.61 ± 0.51
		08/15/2017	7.5 J	18	0.33	110	600	0.00078 J	0.0087	0.24	0.00073 J	0.22	0.00014 J	130	0.013	**0.016**	0.0098	0.036 J	0.0002 U	0.0027 J	0.0014 J	0.00011 J	1.68 ± 0.304	R	R
		09/28/2017	7.5 J	17	0.3	120	620	0.002 U	0.0058	0.21	0.00017 J	0.29	0.001 U	110	0.0067	**0.0072**	0.0033	0.029 J	0.0002 U	0.0043 J	0.005 U	0.001 U	2.05 ± 0.533	1.47 U ± 0.995	3.52 J+ ± 1.13
		11/17/2017	7.4 J	16	0.36	120 J-	620	**0.0079 J+**	0.0088	0.29	0.00095 J	0.34 U	0.005 U	130	0.019	**0.015**	0.0098	**0.05 J**	0.0002 U	0.0069 J	0.025 U	0.00062 J	1.38 ± 0.3	R	R
		06/11/2018	-	-	0.37	-	-	0.0012 J	0.0091	0.32	0.001	-	0.00017 J	-	0.025	**0.013**	0.011	**0.048**	0.0002 U	0.0048 J	0.0011 J	0.00021 J	1.18 ± 0.397	0.108 U ± 0.374	1.29 J ± 0.545
		08/28/2018	7.2 J	9.3	0.34	99	650	0.02 U	**0.032**	0.72	**0.0041 J**	0.34 J	0.01 U	190	**0.15**	**0.047**	**0.041**	**0.12**	-	0.012 J	0.0099 J	0.00098 J	1.35 J ± 0.32	1.25 ± 0.619	2.60 J ± 0.697
Downgradient	CCR-AP-2	06/10/2016	7.26 J	72	0.16 J+	530 J-	1700	0.002	0.0018	0.055	0.00014 J	15	0.00055 J	200	0.0035	**0.0073**	0.0023	0.05 U	0.0002 U	0.0018 J	0.00044 J	0.000048 J	0.222 J ± 0.145	0.542 U ± 0.572	0.764 U ± 0.59
		08/12/2016	7.4 J	73	0.28	730	1700	0.002 U	0.0016	0.038	0.00015 J	12	0.00023 J	230	0.003	**0.0096**	0.0028	0.05 U	0.0002 U	0.00099 J	0.00076 J	0.000048 J	1.22 ± 0.355	1.09 U ± 1.02	2.32 ± 1.08
		10/28/2016	6.7 J	73 J+	0.23	540 J+	1600	0.002 U	0.0044	0.09	0.00066 J	11	0.00053 J	220 J-	0.013	**0.016 J**	0.0096 J	0.017 J	0.0002 U	0.0014 J	0.0013 J	0.00014 J	0.731 ± 0.526	0.648 U ± 0.534	1.38 J ± 0.75
		12/07/2016	6.8 J	75	0.3 J+	680	1600	0.00024 J	0.003	0.14	0.00056 J	12	0.00048 J	240	0.011	**0.012**	0.006	0.05 U	0.0002 U	0.0015 J	0.005 U	0.00016 J	2.01 ± 1.16	0.707 U ± 1.12	2.72 J ± 1.61
		02/08/2017	7 J	83	0.26 J+	570	1500	0.002 U	0.0035	0.12	0.00038 J	12	0.00038 J	260 J-	0.0084	**0.014**	0.0057	0.01 J	0.0002 U	0.0017 J	0.005 U	0.00017 J	0.672 ± 0.334	1.00 ± 0.596	1.68 ± 0.684
		04/06/2017	6.8 J	89	0.29	600	1600	0.002 U	0.0018	0.052	0.00032 J	12	0.00011 J	240 J+	0.0037	**0.011**	0.0026 J+	0.05 U	0.0002 U	0.00094 J	0.005 UJ	0.001 U	1.03 ± 0.385	1.44 ± 0.934	2.47 J ± 1.01
		06/07/2017	6.8 J	81	0.3 J	510	1600	0.002 U	0.0066	0.27	0.00099 J	12	0.00078 J	240	0.025	**0.021**	**0.016**	0.023 J	0.0002 U	0.0024 J	0.005 U	0.00026 J	0.894 ± 0.361	2.40 ± 1.07	3.29 ± 1.13
		09/28/2017	6.9 J	110	0.28	610	1700	0.0017 J	**0.017**	0.44	0.0027	7.8	0.00073 J	220	0.056	**0.038**	**0.051**	0.023 J	0.0002 U	0.0051	0.0044 J	0.00068 J	0.730 ± 0.327	1.18 U ± 1.06	1.91 J+ ± 1.11
		11/17/2017	7 J	120	0.11	680 J-	1600	0.01 U	0.0066	0.17	0.0012 J	14	0.005 U	260	0.021	**0.018**	0.012	0.25 U	0.0002 U	0.004 J	0.025 U	0.00079 J	0.266 ± 0.151	0.585 U ± 0.5	0.850 J+ ± 0.522
		06/11/2018	-	-	0.28	-	-	0.002 U	**0.013**	0.27	0.0021	-	0.00089 J	-	0.042	**0.023**	**0.03**	0.033	0.0002 U	0.003 J	0.0026 J	0.00048 J	0.597 ± 0.32	0.294 U ± 0.337	0.891 J ± 0.465
		08/28/2018	6.9 J	150	0.25	510	1500	0.02 U	**0.021**	0.52	0.002 J	9.6	0.01 U	220	0.082	**0.029**	**0.035**	**0.057**	-	0.0056 J	0.05 U	0.00099 J	R	0.880 ± 0.51	R
	CCR-AP-3	06/10/2016	7.17 J	26	0.1 U	1.3 J-	1000	0.002 U	**0.058**	0.41	0.001 U	0.18	0.001 U	160	0.0021	**0.0094**	0.00041 J	0.05 U	0.0002 U	0.011	0.0015 J	0.001 U	0.657 J ± 0.201	1.10 ± 0.581	1.75 ± 0.615
		08/15/2016	7.6 J	26	0.93	R	1000	0.002 U	**0.072**	0.38	0.001 U	0.15 J+	0.001 U	170	0.0018 J	**0.008**	0.00039 J	0.05 U	0.0002 U	0.014	0.00062 J	0.001 U	0.865 ± 0.232	0.784 U ± 0.583	1.65 ± 0.627
		10/28/2016	7 J	27 J+	0.31	1.1 J+	1000	0.002 U	**0.071**	0.4	0.001 U	0.16	0.001 U	190 J-	0.002	**0.0076 J**	0.001 UJ	0.05 U	0.0002 U	0.014	0.0018 J	0.001 U	1.15 ± 0.477	0.819 ± 0.347	1.97 ± 0.589
		12/07/2016	7.2 J	26	0.5	1 U	970	0.00031 J	**0.068**	0.43	0.001 U	0.17 J+	0.001 U	190	0.0023	**0.007**	0.00066 J	0.05 U	0.0002 U	0.014	0.0019 J	0.001 U	0.789 ± 0.398	0.932 ± 0.48	1.72 ± 0.623
		02/08/2017	7.2 J	23	0.39	0.67 J	1000	0.002 U	**0.086**	0.46	0.001 U	0.18 J+	0.001 U	190 J-	0.002	**0.0072**	0.00035 J	0.05 U	0.0002 U	0.013	0.002 J	0.001 U	0.373 U ± 0.293	0.489 U ± 0.614	0.862 U ± 0.68
		04/06/2017	7.1 J	25	0.57	1 U	1000	0.002 U	**0.08**	0.42	0.001 U	0.2	0.001 U	180 J+	0.0021	**0.0063**	0.00048 J+	0.05 U	0.0002 U	0.011	0.0018 J-	0.001 U	0.450 ± 0.144	0.644 ± 0.344	1.09 ± 0.373
		06/07/2017	7.2 J	25	0.55	0.56 J	1200	0.002 U	**0.077**	0.44	0.001 U	0.27 U	0.001 U	200	0.002 U	**0.0062**	0.001 U	0.05 U	0.0002 U	0.012	0.0018 J	0.001 U	0.582 ± 0.158	1.25 ± 0.427	1.83 ± 0.456
		09/28/2017	7.1 J	25	0.45	0.48 J	1000	0.00058 J	**0.066**	0.39	0.001 U	0.12	0.001 U	180	0.002 U	0.0057	0.00098 J	0.05 U	0.0002 U	0.01	0.0016 J	0.001 U	0.411 ± 0.136	R	R
		11/17/2017	7.4 J	25	0.14	0.82 J-	970	0.002 U	**0.067**	0.4	0.001 U	0.19 U	0.001 U	190	0.0021	0.0056	0.00051 J	0.05 U	0.0002 U	0.011	0.0017 J	0.0001 J	0.626 ± 0.162	R	R
		06/11/2018	-	-	0.56	-	-	0.002 U	**0.08**	0.47	0.001 U	-	0.001 U	-	0.0041 J+	0.0052	0.00092 J	0.005 U	0.0002 U	0.0099	0.0023 J	0.001 U	0.475 ± 0.329	0.292 U ± 0.375	0.768 J ± 0.499
		08/28/2018	7.3 J	12	0.33	1 U	1000	0.002 U	**0.071**	0.43	0.001 U	0.14	0.001 U	180	0.0041 J+	0.0046	0.00078 J	0.005 U	-	0.0096	0.0021 J	0.001 U	R	0.946 U ± 0.416	1.70 J+ ± 0.463
	CCR-AP-4	06/10/2016	6.95 J	25	0.29 J+	20 J-	1000	0.002 U	**0.036**	0.52	0.00049 J	0.16	0.00018 J	160	0.012	**0.0078**	0.0099	0.01 J	0.0002 U	0.0022 J	0.0018 J	0.000084 J	1.07 J ± 0.261	0.417 U ± 0.723	1.49 ± 0.769
		08/12/2016	7.3 J	24	0.43	R	1000	0.002 U	**0.065**	0.75	0.00033 J	0.16 J+	0.00018 J	190	0.0081	**0.0071**	0.0063	0.0096 J	0.0002 U	0.0025 J	0.0016 J	0.000061 J	1.53 ± 0.429	1.37 U ± 1.43	2.90 ± 1.49
		10/28/2016	6.7 J	85 J+	0.3	15 J+	890	0.002 U	**0.05**	0.63	0.00025 J	0.18	0.001 U	170 J-	0.0037	0.0045 J	0.0057 J	0.014 J	0.0004 U	0.0011 J	0.0011 J	0.00011 J	1.54 ± 0.683	0.864 ± 0.448	2.40 ± 0.816
		12/07/2016	7 J	70	0.49	3.9 J+	880	0.0004 J	**0.045**	0.61	0.00046 J	0.16 J+	0.00023 J	160	0.014	**0.0086**	0.011	0.0098 J	0.0002 U	0.002 J	0.00098 J	0.00015 J	2.11 ± 1.11	2.17 ± 1.34	4.28 ± 1.74
		02/08/2017	6.9 J	49	0.32 J+	1 U	900	0.002 U	**0.086**	0.64	0.00014 J	0.14 U	0.001 U	180 J-	0.0026	0.0039	0.0018	0.05 U	0.0002 U	0.00093 J	0.005 U	0.000063 J	0.984 ± 0.383	1.03 ± 0.62	2.01 ± 0.728
		04/06/2017	6.7 J	48	0.36	1 U	960	0.002 U	**0.086**	0.63	0.00015 J	0.17	0.001 U	180 J+	0.0028	0.0045	0.0018 J+	0.05 U	0.0002 U	0.00092 J	0.005 UJ	0.001 U	0.789 ± 0.227	0.370 U ± 0.488	1.16 J ± 0.538
		06/08/2017	6.7 J	46	0.46	0.64 J	1000	0.002 U	**0.086**	0.66	0.00026 J	0.18 U	0.00014 J	190	0.0066	**0.0068**	0.0045	0.05 U	0.0002 U	0.0014 J	0.005 U	0.000061 J	1.60 ± 0.408	2.00 ± 0.818	3.60 ± 0.914
		09/29/2017	6.8 J	41	0.35	0.63 J	980	0.00066 J	**0.081**	0.58	0.00017 J	0.085	0.00016 J	170	0.0076	0.0055	0.0048	0.05 U	0.0002 U	0.0016 J	0.005 U	0.001 U	1.26 ± 0.397	R	R
		11/17/2017	7.1 J	40	0.35	1.1 J-	910	0.002 U	**0.083**	0.57	0.00028 J	0.14 U	0.001 U	180	0.01	**0.0064**	0.0046	0.05 U	0.0002 U	0.0022 J	0.005 U	0.00012 J	1.15 ± 0.266	R	R
		06/11/2018	-	-	0.41	-	-	0.002 U	**0.027**	0.45	0.001 U	-	0.001 U	-	R	0.002	0.00052 J	0.0029 J	0.0002 U	0.0012 J	0.0009 J	0.001 U	0.830 ± 0.366	0.458 U ± 0.313	1.29 J ± 0.482
		08/28/2018	6.8 J	16	0.29	2.6	950	0.002 U	**0.11**	0.78	0.00084 J	0.1	0.00048 J	190	0.028	**0.013**	**0.021**	0.019	-	0.0033 J	0.0016 J	0.00026 J	2.47 ± 0.635	1.06 U ± 0.934	3.53 J ± 1.13

TABLE 1
COMPARISON OF EAST ASH POND GROUNDWATER MONITORING RESULTS TO SITE GROUNDWATER PROTECTION STANDARDS –
JUNE 2016 THROUGH AUGUST 2018 SAMPLING EVENTS
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Monitoring Well ID		Date Sampled	pH (lab)	Chloride	Fluoride	Sulfate	Total Dissolved Solids	Antimony Total	Arsenic Total	Barium Total	Beryllium Total	Boron Total	Cadmium Total	Calcium Total	Chromium Total	Cobalt Total	Lead Total	Lithium Total	Mercury Total	Molybdenum Total	Selenium Total	Thallium Total	Radium-226	Radium-228	Radium-226 & 228
			SU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	pCi/L	pCi/L
Site GWPS (a)			NA	NA	4	NA	NA	0.006	0.01	2	0.004	NA	0.005	NA	0.1	0.006	0.015	0.04	0.002	0.1	0.05	0.002	NA	NA	NA
Downgradient	CCR-AP-5	06/10/2016	7.09 J	880	0.58	2.5 UJ	4600	0.02 U	0.01 U	0.032 J	0.01 U	53	0.01 U	520	0.02 U	**0.0069**	0.01 U	**0.14**	0.0002 U	**0.38**	0.05 U	0.01 U	0.224 J ± 0.0858	0.550 ± 0.3	0.774 ± 0.313
		08/12/2016	7.4 J	750	0.99	1500	4400	0.002 U	0.00059 J	0.03	0.001 U	54	0.00016 J	480	0.002 U	**0.0063**	0.001 U	**0.13**	0.0002 U	**0.37**	0.005 U	0.001 U	0.106 U ± 0.0753	0.523 ± 0.33	0.629 ± 0.338
		10/28/2016	7 J	860 J+	1.1	1600 J+	4000	0.002 U	0.00065 J	0.034	0.001 U	68	0.00015 J	550 J-	0.002 U	**0.0065 J**	0.001 UJ	**0.15**	0.0002 U	**0.41**	0.005 U	0.001 U	0.449 U ± 0.338	0.462 U ± 0.35	0.911 ± 0.486
		12/07/2016	7 J	860	1.3	1700	4200	0.000058 J	0.00073 J	0.036	0.00096 J	64	0.001 U	570	0.002 U	**0.0061**	0.001 U	**0.13**	0.0002 U	**0.39**	0.005 U	0.001 U	0.0176 U ± 0.286	0.714 ± 0.438	0.732 J ± 0.524
		02/08/2017	7.2 J	780	0.98	1500	4000	0.002 U	0.0015	0.046	0.00019 J	59	0.0012	580 J-	0.002 U	**0.007**	0.001 U	**0.15**	0.0002 U	**0.39**	0.005 U	0.000065 J	0.0782 U ± 0.217	0.562 U ± 0.517	0.640 U ± 0.561
		04/07/2017	7 J	880	0.96	1900	4200	0.002 U	0.00039 J	0.034	0.00058 J	56	0.0004 J	550 J+	0.002 U	**0.0063**	0.001 U	**0.15**	0.0002 U	**0.33**	0.005 UJ	0.001 U	0.186 ± 0.0813	0.209 U ± 0.227	0.396 J ± 0.241
		06/08/2017	7.1 J	560	1.1	1400	4200	0.002 U	0.00042 J	0.036	0.00017 J	58	0.00037 J	510	0.002 U	0.0053	0.001 U	**0.11**	0.0002 U	**0.3**	0.005 U	0.001 U	0.193 ± 0.0924	1.01 ± 0.357	1.21 ± 0.369
		09/28/2017	7 J	640	0.76 J	1400	3300	0.002 U	0.00084 J	0.041	0.00047 J	33	0.00075 J	470	0.002 U	0.0041	0.001 U	**0.099**	0.0002 U	**0.21**	0.005 U	0.00016 J	0.184 ± 0.0749	R	R
		11/17/2017	7 J	770	1	1600 J-	3500	0.002 U	0.00039 J	0.038	0.001 U	52	0.00035 J	510	0.002 U	0.0046	0.001 U	**0.12**	0.0002 U	**0.24**	0.005 U	0.00018 J	0.250 ± 0.0868	0.234 U ± 0.238	0.483 J+ ± 0.253
		06/11/2018	-	-	1.4	-	-	0.002 U	R	0.068	0.001 U	-	0.00057 J	-	0.0014 U	0.0028	0.000099 J	**0.11**	0.0002 U	**0.39**	0.005 U	0.001 U	0.261 ± 0.167	0.213 U ± 0.216	0.474 J ± 0.273
		08/28/2018	7.2 J	340	1.3	1200	2700	0.002 U	0.001 U	0.033	0.001 U	41	0.00024 J	320	0.002 U	0.0028	0.001 U	**0.094**	-	**0.37**	0.005 U	0.001 U	R	0.252 U ± 0.311	R
	CCR-AP-6	06/10/2016	7.35 J	40	0.43	0.57 J-	1100	0.002 U	**0.04**	0.51	0.001 U	1.1	0.001 U	180	0.0031	0.0042	0.0021	0.05 U	0.0002 U	0.02	0.001 J	0.001 U	0.652 J ± 0.142	0.543 ± 0.293	1.20 ± 0.325
		08/12/2016	7.8 J	39	0.67	R	1100	0.002 U	**0.059**	0.58	0.00026 J	0.83	0.00016 J	190	0.0092	**0.0095**	0.0071	0.05 U	0.0002 U	0.018	0.0014 J	0.000047 J	1.32 ± 0.278	0.811 U ± 0.725	2.13 ± 0.776
		10/28/2016	7.2 J	38 J+	0.42	0.98 J+	1000	0.002 U	**0.06**	0.55	0.00011 J	0.74	0.001 U	190 J-	0.005	**0.0075 J**	0.0035 J	0.05 U	0.0002 U	0.021	0.0015 J	0.001 U	1.38 ± 0.686	0.663 U ± 0.532	2.05 J ± 0.868
		12/07/2016	7.3 J	36	0.62	1 U	1000	0.00048 J	**0.067**	0.62	0.00036 J	0.79 J+	0.00029 J	190	0.015	**0.01**	0.01	0.05 U	0.0002 U	0.024	0.0014 J	0.0001 J	-0.236 U ± 0.919	1.58 U ± 1.55	1.58 U ± 1.8
		02/08/2017	7.4 J	42	0.5	0.67 J	1000	0.00047 J	**0.11**	0.61	0.00025 J	0.89 J+	0.00027 J	200 J-	0.011	**0.009**	0.0079	0.05 U	0.0002 U	0.03	0.005 U	0.000063 J	0.929 ± 0.371	0.755 U ± 0.581	1.68 J ± 0.69
		04/06/2017	7.2 J	46	0.45	0.5 J	1100	0.002 U	**0.11**	0.64	0.00024 J	2.2	0.00019 J	210 J+	0.0098	**0.0069**	0.0074 J+	0.05 U	0.0002 U	0.024	0.0018 J-	0.001 U	0.730 ± 0.221	0.455 U ± 0.438	1.19 J ± 0.49
		06/07/2017	7.3 J	40	0.63	1.1	1200	0.00059 J	**0.096**	0.6	0.00042 J	1.3 J+	0.00024 J	200	0.014	**0.011**	0.0096	0.011 J	0.0002 U	0.026	0.0014 J	0.00009 J	2.33 ± 0.648	3.61 ± 1.47	5.93 ± 1.6
		09/29/2017	7.3 J	38	0.55	0.71 J	1100	0.0014 J	**0.089**	0.55	0.00039 J	0.44	0.00052 J	180	0.02	**0.012**	0.014	0.05 U	0.0002 U	0.033	0.0023 J	0.00013 J	0.815 ± 0.227	R	R
		11/17/2017	7.6 J	42	0.24	0.74 J-	1000	0.01 U	**0.081**	0.49	0.005 U	2.1 J+	0.00039 J	180	0.014	**0.0087**	0.011	0.25 U	0.0002 U	0.027	0.025 U	0.005 U	0.695 ± 0.171	R	R
		06/11/2018	-	-	0.6	-	-	0.0012 J	**0.12**	0.69	0.00065 J	-	0.00051 J	-	0.029	**0.014**	**0.02**	0.016	0.0002 U	0.033	0.0023 J	0.00022 J	1.15 ± 0.384	1.12 ± 0.415	2.27 ± 0.565
		08/28/2018	7.4 J	19	0.42	1.1	1000	0.002 U	**0.1**	0.64	0.00046 J	0.51	0.0005 J	190	0.031	**0.013**	**0.02**	0.014	-	0.031	0.0019 J	0.0002 J	1.71 J ± 0.551	0.929 U ± 1.02	2.64 J ± 1.16
	CCR-AP-8	03/09/2017	7.2 J	21	0.13	37	1400	0.0018 J	**0.044**	0.57	0.001 U	0.037 J	0.001 U	300	0.0012 J	**0.015**	0.00058 J	0.05 U	0.0002 U	0.014	0.005 U	0.001 U	0.893 ± 0.233	1.07 U ± 1.02	1.96 J ± 1.04
		04/06/2017	6.9 J	19	0.35	16	1400	0.00066 J	**0.052**	0.59	0.001 U	0.08 U	0.001 U	320 J+	0.0022	**0.012**	0.0011 J+	0.05 U	0.0002 U	0.015	0.0017 J-	0.001 U	1.34 ± 0.31	0.677 ± 0.435	2.01 ± 0.534
		04/26/2017	7 J	18	0.28	1.6	1400	0.001 J	**0.07**	0.59	0.001 U	0.08 U	0.001 U	320	0.0019 J	**0.011**	0.00081 J	0.014 J	0.0002 U	0.014	0.0015 J	0.001 U	0.883 ± 0.196	0.778 ± 0.372	1.66 ± 0.421
		05/30/2017	7.3 J	17	0.24	6.2	1500	0.00082 J	**0.06**	0.58	0.001 U	0.034 J	0.001 U	340	0.0028	**0.011**	0.0022	0.05 U	0.0002 U	0.013	0.0017 J	0.001 U	0.720 ± 0.162	0.457 ± 0.284	1.18 ± 0.327
		06/07/2017	7 J	13	0.21 J	4 J	1500	0.0011 J	**0.076**	0.6	0.001 U	0.08 U	0.001 U	330	R	**0.011**	0.001	0.05 U	0.0002 U	0.014	0.0017 J	0.000068 J	0.721 J ± 0.211	1.60 J ± 0.556	2.32 J ± 0.594
		07/25/2017	7 J	17	0.24 J	3.8	1500	0.002 U	**0.087**	0.67	0.0002 J	0.08 U	0.001 U	350	0.0041	**0.012**	0.0025	0.05 U	0.0002 U	0.014	0.0015 J	0.000058 J	0.704 ± 0.201	0.889 U ± 0.726	1.59 J ± 0.754
		08/15/2017	7.3 J	16	0.26	5	1400	0.0014 J	**0.095**	0.64	0.00039 J	0.08 U	0.00016 J	340	0.012	**0.017**	0.0076	0.05 U	0.0002 U	0.015	0.0022 J	0.00015 J	0.513 ± 0.143	0.316 U ± 0.305	0.829 J ± 0.337
		09/28/2017	7 J	17	0.34	2.3	1400	0.002 U	**0.087**	0.56	0.001 U	0.025 J	0.001 U	320	0.0021 J+	**0.0098**	0.0011	0.05 U	0.0002 U	0.012	0.002 J	0.001 U	0.529 ± 0.153	R	R
		11/17/2017	7 J	16	0.4	1.9 J-	1300	0.002 U	**0.083**	0.53	0.001 U	0.043 U	0.001 U	300	0.0021	**0.0082**	0.0011	0.05 U	0.0002 U	0.012	0.005 U	0.00029 J	0.640 ± 0.164	R	R
		06/11/2018	-	-	0.41	-	-	0.002 U	**0.11**	0.68	0.00022 J	-	0.001 U	-	0.0069 J+	**0.0086**	0.0033	0.0057	0.0002 U	0.013	0.0021 J	0.000083 J	0.544 ± 0.277	0.502 ± 0.319	1.05 ± 0.422
		08/28/2018	7 J	6	0.21	1.3	1300	0.002 U	**0.096**	0.58	0.00016 J	0.08 U	0.001 U	280	0.0068 J+	**0.0077**	0.0021	0.0052	-	0.012	0.0018 J	0.001 U	R	0.367 U ± 0.309	R

Notes:
Blank cells - Constituent not included in this analysis.
GW - Groundwater.
GWPS - Groundwater Protection Standard.

mg/L - milligrams per liter.
NA - Not Available.
pCi/L - picoCurie per liter.
su - Standard Units

Qualifiers:
J: Value is estimated
J-: Value is estimated, biased low
J+: Value is estimated, biased high
R: Rejected during validation
U: Not detected, value is the laboratory reporting limit

(a) - Site GWPS provided in the 2018 Transmittal of Groundwater Protection Standards - F.B. Culley Station – East Ash Pond (Haley & Aldrich, 2018).

[green shading] Detected Concentration > Groundwater Protection Standard.

TABLE 2
HUMAN HEALTH PUBLISHED SCREENING LEVELS FOR SURFACE WATER
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

		Human Health Published Screening Level - Drinking Water			Human Health Published Screening Level - Surface Water				Selected Published Human Health Screening Levels for Surface Water	
Constituent	CAS RN	USEPA MCL (a) (mg/L)	USEPA RSL Tap Water (b) (mg/L)	IDEM Criteria for Drinking Water Class Groundwater (c) (mg/L)	ORSANCO Human Health Water Quality Standards (d) (mg/L)	USEPA NRWQC Consumption of Organism Only (e) (mg/L)	IDEM CCC HLSC Consumption of Organism Only (proposed) (f)(g) (mg/L)	IDEM CCC HLSC Consumption of Organism Only (current) (h) (mg/L)	Selected Screening Level - Drinking Water (i) (mg/L)	Selected Screening Level - Surface Water Consumption of Organism Only (j) (mg/L)
Detection Monitoring - USEPA Appendix III Constituents (r)										
Boron	7440-42-8	NA	4	NA	NA	NA	NA	NA	4	NA
Fluoride	16984-48-8	4	0.8	4	1	NA	NA	NA	4	1
Assessment Monitoring - USEPA Appendix IV Constituents										
Antimony	7440-36-0	0.006	0.0078	0.006	0.0056	0.64	0.64	45	0.006	0.0056
Arsenic	7440-38-2	0.01	0.000052	0.01	0.01	0.0014 (m, n)	NP	0.000175 (l)	0.01	0.01
Barium	7440-39-3	2	3.8	2	1	NA	NA	NA	2	1
Beryllium	7440-41-7	0.004	0.025	0.004	NA	NA	NP	0.00117	0.004	0.00117
Cadmium	7440-43-9	0.005	0.0092	0.005	NA	NA	NP	NA	0.005	NA
Chromium (Total)	7440-47-3	0.1	22 (k)	0.1	NA (k)	NA (k)	NP (k)	3433 (k)	0.1	3433
Cobalt	7440-48-4	NA	0.006	NA	NA	NA	NA	NA	0.006	NA
Lead	7439-92-1	0.015 (o)	0.015 (o)	0.015 (o)	NA	NA	NP	NA	0.015	NA
Lithium	7439-93-2	NA	0.04	NA	NA	NA	NA	NA	0.04	NA
Mercury	7439-97-6	0.002 (p)	0.0057 (q)	0.002 (p)	0.000012	NA	0.00015	0.00015	0.002	0.000012
Molybdenum	7439-98-7	NA	0.1	NA	NA	NA	NA	NA	0.1	NA
Selenium	7782-49-2	0.05	0.1	0.05	0.17	4.2	4.2	NA	0.05	0.17
Thallium	7440-28-0	0.002	0.0002	0.002	0.00024	0.00047	0.048	0.048	0.002	0.00024
Radiological (pCi/L)										
Radium-226 & 228	7440-14-4	5	NA	5	4	NA	NA	NA	5	4

Notes:

CAS RN - Chemical Abstracts Service Registry Number.
CCC HLSC - Continuous Criterion Concentration. Human Life-Cycle Safe Concentration.
IDEM - Indiana Department of Environmental Management.
MCL - Maximum Contaminant Level.
mg/L - milligrams/liter.
NA - Not Available.
NP - (NRWQC) Not Proposed. Criteria to be deleted.
NRWQC - National Recommended Water Quality Criteria.
ORSANCO - Ohio River Valley Water Sanitation Commission.
pCi/L - picoCuries/liter.
RSL - Regional Screening Level.
USEPA - United States Environmental Protection Agency.

(a) - USEPA, 2018. 2018 Edition of the Drinking Water Standards and Health Advisories. March.
https://www.epa.gov/dwstandardsregulations/2018-drinking-water-standards-and-advisory-tables
(b) - USEPA, 2019. Regional Screening Levels (May 2019). Values for Tap Water, Hazard Index = 1.0. TR = 1E-06.
https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables

TABLE 2
HUMAN HEALTH PUBLISHED SCREENING LEVELS FOR SURFACE WATER
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

(c) - IDEM Water Quality Standards. Title 327 of the Indiana Administrative Code (IAC). Article 2. Water Quality Standards. Rule 11. Ground Water Quality Standards.
Part 327 IAC 2-11-6. Criteria for Drinking Water Class Ground Water.
http://www.in.gov/legislative/iac/T03270/A00020.PDF?

(d) - Ohio River Valley Water Sanitation Commission (ORSANCO) Pollution Control Standards for Discharges to the Ohio River. 2019 Revision.
Chapter 3 Water Quality Criteria - Human Health. Human health protection criteria are protective of drinking water, recreational, and fish consumption uses
http://www.orsanco.org/wp-content/uploads/2019/06/Final-Standards-Doc-2019-Revision.pdf

(e) - USEPA National Recommended Water Quality Criteria - Human Health Criteria Table.
USEPA NRWQC - Human Health Criterion for the Consumption of Organism Only apply to total concentrations.
https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table

(f) - IDEM (IN.gov). Water Quality in Indiana. Water Quality Standards.
http://www.in.gov/idem/cleanwater/2329.htm

(g) - IDEM (IN.gov). Water Quality in Indiana. Water Quality Standards. Active Projects - Planned Revisions to Metals Criteria for the Protection of Aquatic Life and Human Health.
Second Notice of Tables of Rulemaking. IDEM is providing notice of its intent to revise Indiana's Aquatic Life and Human Health Ambient Water Quality Criteria (WQC) for metals (total recoverable).
Proposed revisions reflect updates to USEPA NRWQC at Section 304(a) of the Clean Water Act.
https://www.in.gov/idem/cleanwater/files/wqs_rulemaking_tables_second_notice.pdf

(h) - IDEM Water Quality Standards. Title 327 of the IAC. Article 2. Water Quality Standards. Rule 1. Water Quality Standards Applicable to All State Waters Except Waters of the State Within the Great Lakes
Part 327 IAC 2-1-6 Minimum Surface Water Quality Standards. Table 6-1. Surface Water Quality Standards for metals apply to total recoverable concentrations.
For carcinogenic substances, criteria are to protect human health from unacceptable cancer risk of greater than one (1) additional occurrence of cancer per one hundred thousand (100,000) populatic
http://www.in.gov/legislative/iac/T03270/A00020.PDF?

(i) - The hierarchy for selection among the Human Health Published Screening Levels for Drinking Water is:
1) USEPA MCL
2) USEPA RSL - Tap Water
3) IDEM Criteria for Drinking Water Class Groundwater

(j) - The hierarchy for selection among the Human Health Published Screening Values for Surface Water - Consumption of Organism Only is:
1) ORSANCO Human Health Water Quality Standards
2) USEPA NRWQC - Consumption of Organism Only.
3) IDEM CCC HLSC - Consumption of Organism Only (proposed).
4) IDEM CCC HLSC - Consumption of Organism Only (current).

(k) - Value for chromium (III).
(l) - Value for inorganic arsenic as arsenite, As(III). Value derived from nonthreshold cancer risk
(m) - Value for inorganic arsenic only.
(n) - This criterion adjusted to a carcinogenicity of 1E-05 risk.
(o) - Lead Action Level. This is a drinking water treatment action level applicable to regulated Community and Non-Transient Non-Community public water systems.
http://www.in.gov/idem/files/factsheet_owq_pws_lead_copper.pdf
https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=60001N8P.txt
(p) - Value for inorganic mercury.
(q) - Value for mercuric chloride.
(r) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.

TABLE 3
HUMAN HEALTH CALCULATED RISK BASED SCREENING LEVELS FOR SURFACE WATER
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Constituent	CAS RN	Human Health Calculated RBSL - Recreational Use of Surface Water (c): Current/Future Off-Site Recreational Swimmer Age-Adjusted (Ages 1 - 26) (a) (mg/L)		Current/Future Off-Site Recreational Wader Age-Adjusted (Ages 1 - 26) (a) (mg/L)		Current/Future Off-Site Recreational Boater (Adult) (a) (mg/L)		Selected Human Health Calculated RBSL - Recreational Use of Surface Water (b) (mg/L)
Detection Monitoring - USEPA Appendix III Constituents (d)								
Boron	7440-42-8	114		120		11,200		114
Fluoride	16984-48-8	23.9		23.9		2,240		23.9
Assessment Monitoring - USEPA Appendix IV Constituents								
Antimony	7440-36-0	0.171		0.218		3.36		0.171
Arsenic	7440-38-2	0.236	(e, f)	0.389	(e, g)	16.8	(e, h)	0.236
Barium	7440-39-3	63.7		97.1		784		63.7
Beryllium	7440-41-7	0.121		0.345		0.784		0.121
Cadmium	7440-43-9	0.134		0.225		1.4		0.134
Chromium (Total)	7440-47-3	155	(i)	386	(i)	1090	(i)	155
Cobalt	7440-48-4	0.178		0.181		42		0.178
Lead	7439-92-1	0.015	(j)	0.015	(j)	0.015	(j)	0.015
Lithium	7439-93-2	1.14		1.2		112		1.14
Mercury	7439-97-6	0.0956	(k)	0.146	(k)	1.18	(k)	0.0956
Molybdenum	7439-98-7	2.86		2.99		280		2.86
Selenium	7782-49-2	2.86		2.99		280		2.86
Thallium	7440-28-0	0.00572		0.00598		0.56		0.00572
Radiological (pCi/L)								
Radium-226 & 228	7440-14-4	NA		NA		NA		NA

Notes:
CAS RN - Chemical Abstracts Service Registry Number.
NA - Not Available.
pCi/L - picoCuries/liter.
mg/L - micrograms/liter.
RBSL - Risk-Based Screening Level.
USEPA - United States Environmental Protection Agency.

(a) - Documentation for the receptor-specific Human Health Calculated Screening Level for Recreational Use of Surface Water is provided in Attachment B.
(b) - The selected human health RBSL for recreational use of surface water is the minimum value from amongst the Current/Future Off-Site Recreational Swimmer, Current/Future Off-Site Recreational Wader, and Current/Future Off-Site Recreational Boater RBSLs.
(c) - Some calculated values may be above solubility limits.
(d) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.
(e) - Arsenic RBSLs are based on the lower of the values based on a hazard index of 1 and an excess lifetime cancer risk of 1E-05.
Note that of the constituents evaluated, arsenic is the only constituent with an RSL based on potential carcinogenic effects.
(f) - RBSL based on cancer endpoint at 1E-4 (noncancer-based RBSL is 0.647 mg/L).
(g) - RBSL based on cancer endpoint at 1E-4 (noncancer-based RBSL is 3 mg/L).
(h) - RBSL based on noncancer endpoint (cancer-based RBSL at 1E-4 is 26.1 mg/L).
(i) - Value for chromium (III) used.
(j) - USEPA lead action level of 0.015 mg/L for lead in drinking water (USEPA, 2018) is used as the RBSL.
(k) - Value for mercuric chloride used.

TABLE 4
ECOLOGICAL SCREENING LEVELS FOR SURFACE WATER
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

		Ecological Published Screening Levels - Surface Water																					
		ORSANCO Aquatic Life Criteria CMC - Freshwater (acute) (a) (mg/L)		ORSANCO Aquatic Life Criteria CCC - Freshwater (chronic) (a) (mg/L)		USEPA NRWQC Aquatic Life Criteria CMC - Freshwater (acute) (b) (mg/L)		USEPA NRWQC Aquatic Life Criteria CCC - Freshwater (chronic) (b) (mg/L)		USEPA Region 5 Ecological Screening Values (freshwater - chronic) (c) (mg/L)		IDEM AAC Aquatic Life Criterion (acute) (proposed) (d)(e) (mg/L)		IDEM CAC Aquatic Life Criterion (chronic) (proposed) (d)(e) (mg/L)		IDEM AAC Aquatic Life Criterion (acute) (current) (f) (mg/L)		IDEM CAC Aquatic Life Criterion (chronic) (current) (f) (mg/L)		Selected Ecological Screening Level (acute) (g) (mg/L)		Selected Ecological Screening Level (chronic) (g) (mg/L)	
Constituent	**CAS RN**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**
Detection Monitoring - USEPA Appendix III Constituents (m)																							
Boron	7440-42-8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoride	16984-48-8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Assessment Monitoring - USEPA Appendix IV Constituents																							
Antimony	7440-36-0	NA	NA	NA	NA	NA	NA	NA	NA	0.08	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.08	NA
Arsenic	7440-38-2	0.34 (i)	0.34 (i)	0.15 (i)	0.15 (i)	0.34 (i)	0.34 (i)	0.15 (i)	0.15 (i)	0.148	NA	0.34	0.34 (j)	0.15	0.15 (j)	0.36	0.36 (j)	0.19	0.19 (j)	0.34	0.34	0.15	0.15
Barium	7440-39-3	NA	NA	NA	NA	NA	NA	NA	NA	0.22 (h)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.22	NA
Beryllium	7440-41-7	NA	NA	NA	NA	NA	NA	NA	NA	0.0036	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0036	NA
Cadmium	7440-43-9	0.0021 (k)	0.0020 (k)	0.00027 (k)	0.00025 (k)	0.0019 (k)	0.0018 (k)	0.00079 (k)	0.00072 (k)	0.00015 (h)	NA	0.0019 (k)	0.0018 (k)	0.00079 (k)	0.00072 (k)	0.0039 (k)	0.0037 (k)	0.0011 (k)	0.0010 (k)	0.0021	0.0020	0.00027	0.00025
Chromium (Total)	7440-47-3	1.8 (n)	0.57 (n)	0.086 (n)	0.074 (n)	1.8 (n)	0.57 (n)	0.086 (n)	0.074 (n)	0.042 h, n	NA	1.8 (n)	0.57 (n)	0.086 (n)	0.074 (n)	1.7 (n)	0.55 (n)	0.21 (n)	0.18 (n)	1.8	0.57	0.086	0.074
Cobalt	7440-48-4	NA	NA	NA	NA	NA	NA	NA	NA	0.024	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.024	NA
Lead	7439-92-1	0.082 (k)	0.065 (k)	0.0032 (k)	0.0025 (k)	0.082 (k)	0.065 (k)	0.0032 (k)	0.0025 (k)	0.00117 (h)	NA	0.12 (k)	0.10 (k)	0.010 (k)	0.0079 (k)	0.082 (k)	0.065 (k)	0.0032 (k)	0.0025 (k)	0.082	0.065	0.0032	0.0025
Lithium	7439-93-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	7439-97-6	0.0017 (l)	0.0014 (l)	0.00091 (l)	0.00077 (l)	0.0016 (l)	0.0014 (l)	0.00091 (l)	0.00077 (l)	0.0000013	NA	0.0024	NA	0.000012	NA	0.0024	NA	0.000012	NA	0.0017	0.0014	0.00091	0.00077
Molybdenum	7439-98-7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	7782-49-2	NA	NA	0.005	NA	NA	NA	NA	0.0031 (o)	0.005	NA	NA	NA	NA	0.0031 (o)	0.13	NA	0.035	NA	0.13	NA	0.005	0.0031
Thallium	7440-28-0	NA	NA	NA	NA	NA	NA	NA	NA	0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.01	NA
Radiological (pCi/L)																							
Radium-226 & 22	7440-14-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
AAC - Acute Aquatic Criterion
CAC - Chronic Aquatic Criterion
CAS RN - Chemical Abstracts Service Registry Number.
CCC - Continuous Criterion Concentration
CMC - Criterion Maximum Concentration
IDEM - Indiana Department of Environmental Management
mg/L - micrograms/liter.
NA - Not Available
NRWQC - National Recommended Water Quality Criteria
ORSANCO - Ohio River Valley Water Sanitation Commission
pCi/L - picoCuries/liter.
USEPA - United States Environmental Protection Agency

TABLE 4
ECOLOGICAL SCREENING LEVELS FOR SURFACE WATER
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Notes:

(a) - Ohio River Valley Water Sanitation Commission (ORSANCO) Pollution Control Standards for Discharges to the Ohio River. 2019 Revision.
Chapter 3 Water Quality Criteria - Aquatic life. Aquatic Life criteria are protective of maintaining fish and other aquatic life.
http://www.orsanco.org/wp-content/uploads/2019/06/Final-Standards-Doc-2019-Revision.pdf

(b) - USEPA Water Quality Criteria. Current Water Quality Criteria Tables. National Recommended Water Quality Criteria - Aquatic Life Criteria Table.
http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm

(c) - USEPA Archive Document. USEPA Region 5 Resource Conservation and Recovery Act (RCRA) - Ecological Screening Values. August 22, 2003.
https://archive.epa.gov/region5/waste/cars/web/pdf/ecological-screening-levels-200308.pdf

(d) - IDEM (IN.gov). Water Quality in Indiana. Water Quality Standards. Active Projects - Planned Revisions to Metals Criteria for the Protection of Aquatic Life and Human Health.
Second Notice of Tables of Rulemaking. IDEM is providing notice of its intent to revise Indiana's Aquatic Life and Human Health Ambient Water Quality Criteria (WQC) for metals (total recoverable).
Aquatic Life Criteria Tables 1, 2, and 4. The screening levels for hardness-dependent metals are calculated for a default hardness value of 100 mg/L CaCO3.
Proposed revisions reflect updates to USEPA NRWQC at Section 304(a) of the Clean Water Act.
https://www.in.gov/idem/cleanwater/files/wqs_rulemaking_tables_second_notice.pdf

(e) - IDEM (IN.gov). Water Quality in Indiana. Water Quality Standards.
http://www.in.gov/idem/cleanwater/2329.htm

(f) - IDEM Water Quality Standards. Title 327 of the IAC. Article 2. Water Quality Standards. Rule 1. Water Quality Standards Applicable to All State Waters Except Waters of the State Within the Great Lakes System.
Part 327 IAC 2-1-6 Minimum Surface Water Quality Standards. Tables 6-1, 6-2, and 6-3. Surface Water Quality Standards for metals apply to total recoverable concentrations.
The screening levels for hardness-based metals are calculated for a default hardness value of 100 mg/L $CaCO_3$.
http://www.in.gov/legislative/iac/T03270/A00020.PDF?

(g) - The hierarchy for the selection of ecological screening levels is:
1) ORSANCO Aquatic Life Criterion.
2) USEPA NRWQC. Aquatic Life Criteria - Freshwater.
3) USEPA Region 5. Freshwater Screening Values.
4) IDEM Aquatic Life Criterion (proposed).
5) IDEM Aquatic Life Criterion (current).

(h) - USEPA Region 5, RCRA Ecological Screening Levels (archive 2003-08-22) for hardness-dependent metal, freshwater - chronic criteria. Value displayed corresponds to a soft water total hardness of 50 mg/L as $CaCO_3$.

(i) - Value for inorganic arsenic only.

(j) - Value for inorganic arsenic as arsenite, As(III).

(k) - Criterion expressed as a function of total hardness (mg/L). Value displayed is the site-specific total hardness of 100 mg/L.

(l) - Aquatic Life Criterion for metallic mercury (CAS RN 7439-97-6) and/or methylmercury (CAS RN 22967-92-6).

(m) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.

(n) - Value for chromium (III).

(o) - USEPA Office of Water. Final Criterion: Aquatic Life Ambient Water Quality Criterion for Selenium - Freshwater. 30 June 2016.
Freshwater value for chronic (30 day) water column concentration (mg/L) of dissolved selenium in lotic (flowing) surface water. The criterion is based on fish ovary concentrations, and in lieu of that, the water column values are used.
https://www.epa.gov/sites/production/files/2016-07/documents/aquatic_life_awqc_for_selenium_-_freshwater_2016.pdf

TABLE 5
SELECTED SURFACE WATER SCREENING LEVELS
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Constituent	CAS RN	HH DW SL (a) (mg/L)	HH REC SL - Consumption of Organism Only (b) (mg/L)	HH Recreational Calculated RBSL (c) (mg/L)	ECO SL - Total (acute) (d) (mg/L)	ECO SL - Dissolved (acute) (d) (mg/L)	ECO SL - Total (chronic) (d) (mg/L)	ECO SL - Dissolved (chronic) (d) (mg/L)
Detection Monitoring - USEPA Appendix III Constituents (e)								
Boron	7440-42-8	4	NA	114	NA	NA	NA	NA
Fluoride	16984-48-8	4	1	23.9	NA	NA	NA	NA
Assessment Monitoring - USEPA Appendix IV Constituents								
Antimony	7440-36-0	0.006	0.0056	0.171	NA	NA	0.08	NA
Arsenic	7440-38-2	0.01	0.01	0.236	0.34	0.34	0.15	0.15
Barium	7440-39-3	2	1	63.7	NA	NA	0.22	NA
Beryllium	7440-41-7	0.004	0.00117	0.121	NA	NA	0.0036	NA
Cadmium	7440-43-9	0.005	NA	0.134	0.0021	0.0020	0.00027	0.00025
Chromium (Total)	7440-47-3	0.1	3433	155	1.8	0.57	0.086	0.074
Cobalt	7440-48-4	0.006	NA	0.178	NA	NA	0.024	NA
Lead	7439-92-1	0.015	NA	0.015	0.082	0.065	0.0032	0.0025
Lithium	7439-93-2	0.04	NA	1.14	NA	NA	NA	NA
Mercury	7439-97-6	0.002	0.000012	0.0956	0.0017	0.0014	0.00091	0.00077
Molybdenum	7439-98-7	0.1	NA	2.86	NA	NA	NA	NA
Selenium	7782-49-2	0.05	0.17	2.86	0.13	NA	0.005	0.0031
Thallium	7440-28-0	0.002	0.00024	0.00572	NA	NA	0.01	NA
Radiological (pCi/L)								
Radium-226 & 228	7440-14-4	5	4	NA	NA	NA	NA	NA

Notes:

CAS RN - Chemical Abstracts Service Registry Number.
ECO SL - Ecological Screening Level.
HH DW SL - Human Health Drinking Water Screening Level.
HH REC SL - Human Health Recreational Use Screening Level.
mg/L - milligram per liter.
NA - Not Available.
RBSL - Risk-Based Screening Level.

(a) - Drinking Water Screening Levels selected in Table 2 using the following hierarchy:
1) USEPA MCL
2) USEPA RSL - Tap Water
3) IDEM Criteria for Drinking Water Class Groundwater

(b) - Human Health Published Screening Values for Surface Water - Consumption of Organism Only selected in Table 2 using the following hierarchy:
1) ORSANCO Human Health Water Quality Standards
2) USEPA NRWQC - Consumption of Organism Only.
3) IDEM CCC HLSC - Consumption of Organism Only (proposed).
4) IDEM CCC HLSC - Consumption of Organism Only (current).

(c) - The Human Health Calculated Screening Levels are presented in Table 3.
The minimum calculated value for the Off-Site Recreational Boater, Wader, and Swimmer was selected.

(d) - Ecological Screening Levels selected in Table 4 using the following hierarchy:
1) ORSANCO Aquatic Life Criterion.
2) USEPA NRWQC. Aquatic Life Criteria - Freshwater.
3) USEPA Region 5. Freshwater Screening Values.
4) IDEM Aquatic Life Criterion (proposed).
5) IDEM Aquatic Life Criterion (current).

(e) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.

TABLE 6
DERIVATION OF RISK-BASED TARGET SCREENING LEVELS FOR GROUNDWATER
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

										Dilution Attenuation Factor - Ohio River (e)	18,000			
Constituent	CAS RN	HH DW SL (a) (mg/L)	HH REC SL - Consumption of Organism Only (b) (mg/L)	HH Recreational Calculated RBSL (c) (mg/L)	ECO SL - Total (acute) (d) (mg/L)	ECO SL - Dissolved (acute) (d) (mg/L)	ECO SL - Total (chronic) (d) (mg/L)	ECO SL - Dissolved (chronic) (d) (mg/L)	Lowest of the Human Health and Ecological Screening Levels (mg/L)	Target Groundwater Screening Level - Ohio River (f) (mg/L)	Maximum Groundwater Concentration (mg/L)		Ratio Between Target Groundwater Screening Level and the Maximum Groundwater Concentration
Detection Monitoring - USEPA Appendix III Constituents (g)													
Boron	7440-42-8	4	NA	114	NA	NA	NA	NA	4	72,000	68	CCR-AP-5	>1,000
Fluoride	16984-48-8	4	1	23.9	NA	NA	NA	NA	1	18,000	1.4	CCR-AP-5	>12,000
Assessment Monitoring - USEPA Appendix IV Constituents													
Antimony	7440-36-0	0.006	0.0056	0.171	NA	NA	0.08	NA	0.0056	101	0.002	CCR-AP-2	>50,000
Arsenic	7440-38-2	0.01	0.01	0.236	0.34	0.34	0.15	0.15	0.01	180	0.12	CCR-AP-6	>1,500
Barium	7440-39-3	2	1	63.7	NA	NA	0.22	NA	0.22	3,960	0.78	CCR-AP-4	>5,000
Beryllium	7440-41-7	0.004	0.00117	0.121	NA	NA	0.0036	NA	0.00117	21	0.0027	CCR-AP-2	>7,500
Cadmium	7440-43-9	0.005	NA	0.134	0.0021	0.0020	0.00027	0.00025	0.00025	4	0.0012	CCR-AP-5	>3,500
Chromium (Total)	7440-47-3	0.1	3433	155	1.8	0.57	0.086	0.074	0.074	1,334	0.082	CCR-AP-2	>16,000
Cobalt	7440-48-4	0.006	NA	0.178	NA	NA	0.024	NA	0.006	108	0.038	CCR-AP-2	>2,500
Lead	7439-92-1	0.015	NA	0.015	0.082	0.065	0.0032	0.0025	0.0025	45	0.051	CCR-AP-2	>800
Lithium	7439-93-2	0.04	NA	1.14	NA	NA	NA	NA	0.04	720	0.15	CCR-AP-5	>4,500
Mercury	7439-97-6	0.002	0.000012	0.0956	0.0017	0.0014	0.00091	0.00077	0.000012	0.2	0.2 U		NA
Molybdenum	7439-98-7	0.1	NA	2.86	NA	NA	NA	NA	0.1	1,800	0.41	CCR-AP-5	>4,000
Selenium	7782-49-2	0.05	0.17	2.86	0.13	NA	0.005	0.0031	0.0031	56	0.0044	CCR-AP-2	>12,000
Thallium	7440-28-0	0.002	0.00024	0.00572	NA	NA	0.01	NA	0.00024	4	0.00099	CCP-AP-2	>4,000
Radiological (pCi/L)													
Radium-226 & 228	7440-14-4	5	4	NA	NA	NA	NA	NA	4	72,000	5.93 ± 1.6	CCP-AP-6	>9,500

Notes:

CAS RN - Chemical Abstracts Service Registry Num
ECO SL - Ecological Screening Level.
HH DW SL - Human Health Drinking Water Screeni
HH REC SL - Human Health Recreational Use Screening Level.
mg/L - milligram per liter.
NA - Not Available.
RBSL - Risk-Based Screening Level.

TABLE 6
DERIVATION OF RISK-BASED TARGET SCREENING LEVELS FOR GROUNDWATER
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

(a) - Drinking Water Screening Levels selected in Table 2 using the following hierarchy:
  1) USEPA MCL
  2) USEPA RSL - Tap Water
  3) IDEM Criteria for Drinking Water Class Groundwater

(b) - Human Health Published Screening Values for Surface Water - Consumption of Organism Only selected in Table 2 using the following hierarchy:
  1) ORSANCO Human Health Water Quality Standards
  2) USEPA NRWQC - Consumption of Organism Only.
  3) IDEM CCC HLSC - Consumption of Organism Only (proposed).
  4) IDEM CCC HLSC - Consumption of Organism Only (current).

(c) - The Human Health Calculated Screening Levels are presented in Table 3.
The minimum calculated value for the Off-Site Recreational Boater, Wader, and Swimmer was selected.

(d) - Ecological Screening Levels selected in Table 4 using the following hierarchy:
  1) ORSANCO Aquatic Life Criterion.
  2) USEPA NRWQC. Aquatic Life Criteria - Freshwater.
  3) USEPA Region 5. Freshwater Screening Values.
  4) IDEM Aquatic Life Criterion (proposed).
  5) IDEM Aquatic Life Criterion (current).

(e) - Estimated value, see DAF calculation documents for derivation.

(f) - The Target Groundwater Screening Level = Minimum SL x Dilution Factor.

(g) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.

FIGURES

GIS FILE PATH: \\haleyaldrich.com\share\bol_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2017_12\42796_000_000MB_FB_CULLEY_GROUNDWATER_CONTOURS.mxd — USER: ajospe — LAST SAVED: 12/12/2017 5:26:45 PM

LEGEND

- UPGRADIENT MONITORING WELL
- DOWNGRADIENT MONITORING WELL
- POTENTIOMETRIC FLOW LINE, DASHED WHERE

NOTES

1. AERIAL IMAGERY SOURCE: ESRI
2. LOCATIONS DERIVED FROM THREE I DESIGN DATA.
3. GROUNDWATER ELEVATIONS MEASURED 6 APRIL 2017

HALEY ALDRICH

VECTREN CORPORATION
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, INDIANA

SITE FEATURES

JANUARY 2018

FIGURE 1

FIGURE 2
PRIVATE WELL LOCATIONS WITHIN A HALF-MILE RADIUS OF FACILITY BOUNDARY SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION, NEWBURGH, IN

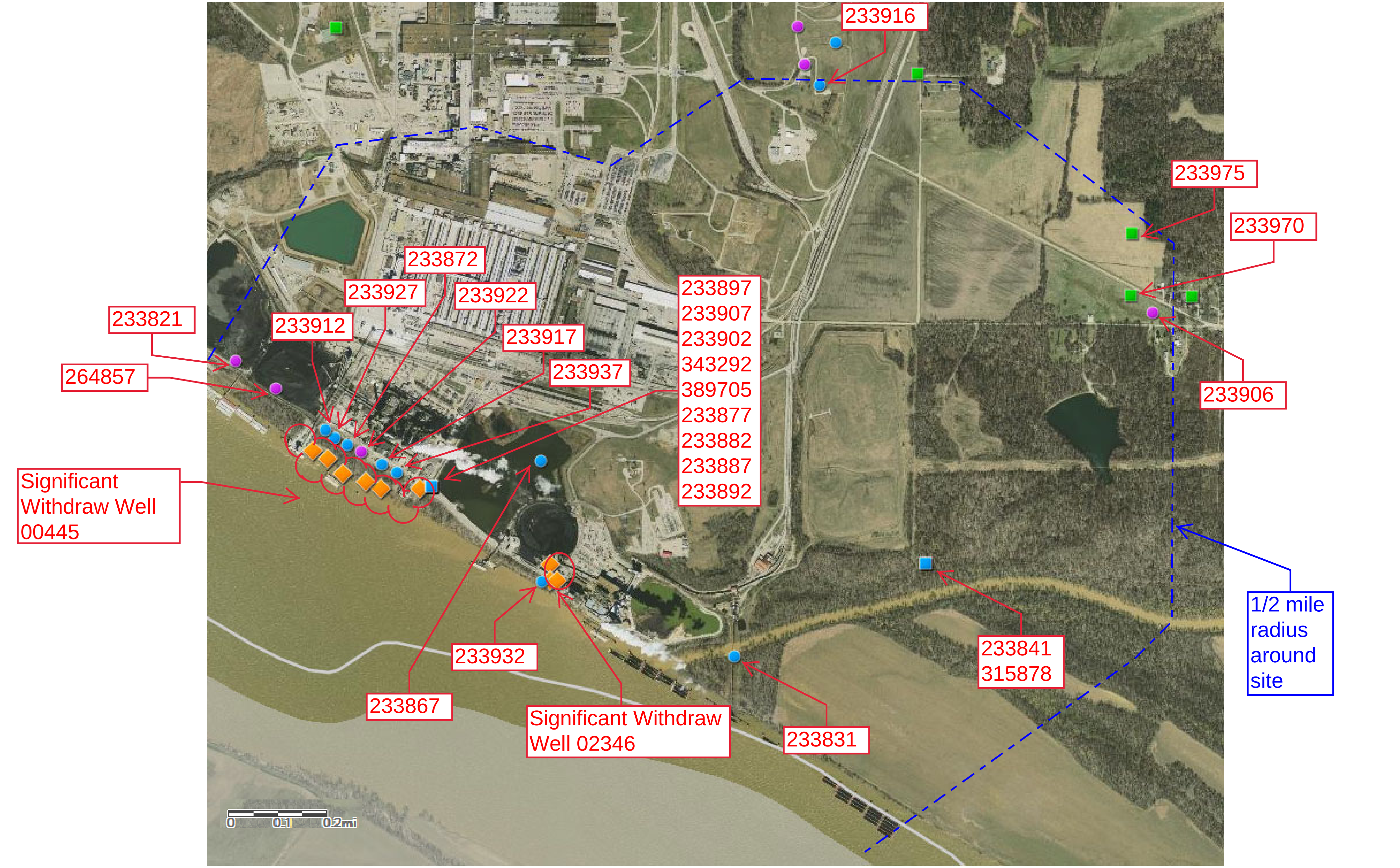
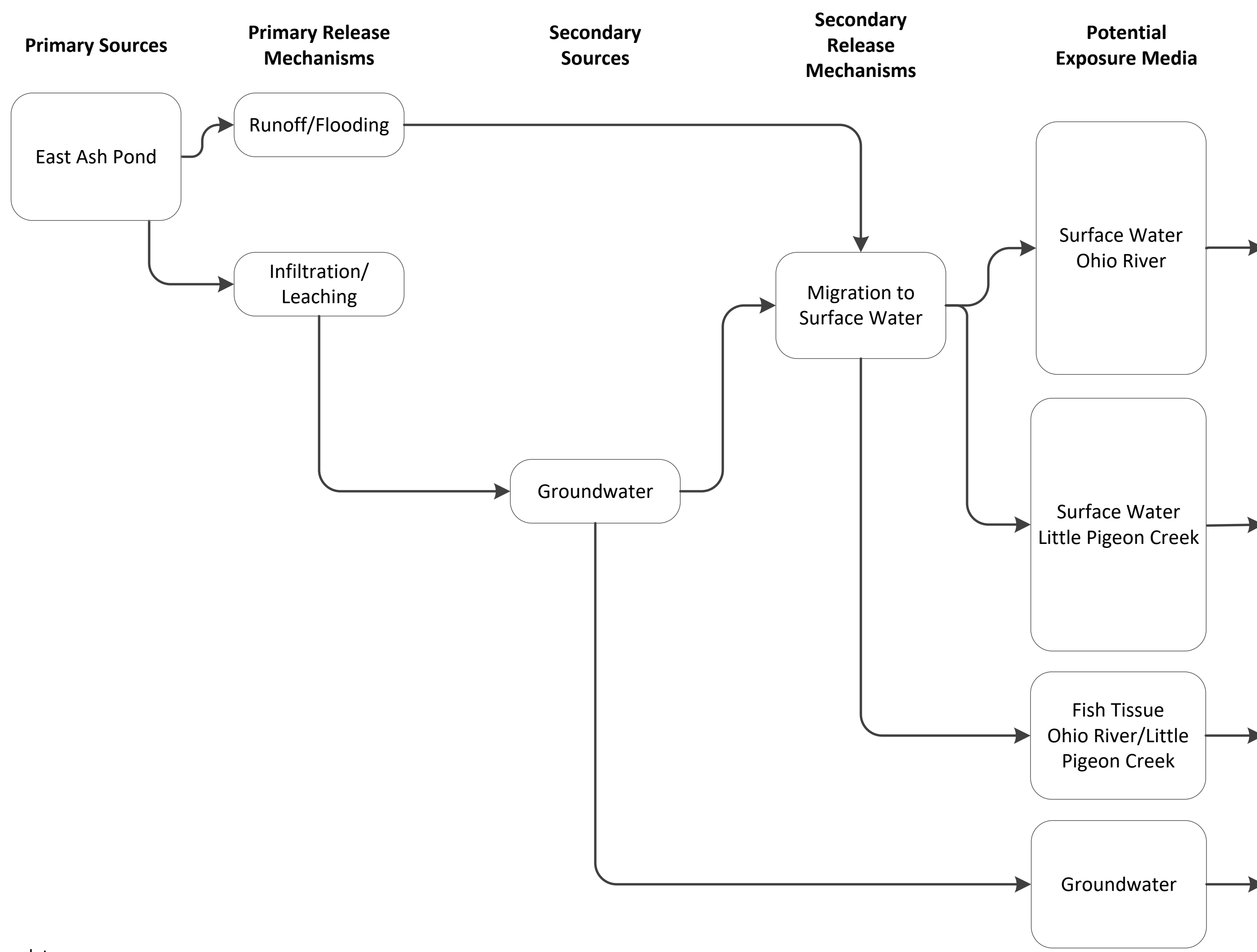


FIGURE 3
CONCEPTUAL SITE MODEL
SOUTHERN INDIANA GAS & ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION, NEWBURGH, IN



	Potential Human Health Receptors					Potential Ecological Receptors
Potential Exposure Route	**Current/Future Off-Site Resident Adult/Child**	**Current/Future Off-Site Recreational Swimmer**	**Current/Future Off-Site Recreational Wader**	**Current/Future Off-Site Recreational Boater**	**Current/Future Off-Site Recreational Fisher**	**Aquatic Receptors**
Drinking Water Use	⊙ (a)	○	○	○	○	NA
Incidental Ingestion	○	⊙	⊙	⊙	⊙	NA
Dermal Contact	○	⊙	⊙	⊙	⊙	NA
Aquatic Exposure	NA	NA	NA	NA	NA	⊙
Drinking Water Use	○ (b)	○	○	○	○	NA
Incidental Ingestion	○	○ (c)	⊙	○ (c)	○ (c)	NA
Dermal Contact	○	○ (c)	⊙	○ (c)	○ (c)	NA
Aquatic Exposure	NA	NA	NA	NA	NA	⊙
Ingestion	○	○	○	○	⊙	NA
Aquatic Exposure	NA	NA	NA	NA	NA	⊙
Drinking Water Use	○ (d)	○	○	○	○	NA
Aquatic Exposure	NA	NA	NA	NA	NA	○ (e)

Notes:

- ● Pathway potentially complete
- ⊙ Pathway potentially complete – pathway evaluated in this risk assessment; results indicate no risk to human health or the environment.
- ○ Pathway evaluated and found incomplete; results indicate no risk to human health or the environment.

(a) The Ohio River is used as a source of drinking water; the nearest downstream drinking water intake is 18.4 miles downstream at the City of Evansville, Indiana.
(b) Little Pigeon Creek is not used as a source of drinking water.
(c) The size of Little Pigeon Creek precludes swimming, fishing and boating activities.
(d) The shallow alluvial aquifer in the vicinity of the East Ash Pond is not used for drinking water purposes.
(e) Ecological Receptors are not exposed to groundwater.

NA – Not Applicable.

HALEY ALDRICH

ATTACHMENT A

Calculated Recreational Risk-Based Screening Levels

TABLE A-1
HUMAN HEALTH EXPOSURE PARAMETERS FOR DERIVATION OF RISK BASED SCREENING LEVELS (RBSLs) - RECREATIONAL SURFACE WATER

Exposure Parameter		Units	Current/Future Off-Site Recreational Swimmer								Current/Future Off-Site Recreational Wader								Current/Future Off-Site Recreational Boater	
			Child (Age <6)		Adolescent (6-<16 years)		Adult		Child, Adolescent and Adult (Ages 1 - 26)		Child (Age <6)		Adolescent (6-<16 years)		Adult		Child, Adolescent and Adult (Ages 1 - 26)		Adult	
Standard Parameters																				
Body Weight	BW	kg	15	USEPA, 2011 [1]	44	USEPA, 2011 [1]	80	USEPA, 2014a	NA		15	USEPA, 2011 [1]	44	USEPA, 2011 [1]	80	USEPA, 2014a	NA		80	USEPA, 2014a
Exposure Duration	ED	years	6	Ages <6	10	Ages 6 - <16	10	Balance of 26-yr exposure	26		6	Ages <6	10	Ages 6 - <16	10	Balance of 26-yr exposure	26		10	Balance of 26-yr exposure
Non–carcinogenic Averaging Time	Atnc	days	2190	ED expressed in days	3650	ED expressed in days	3650	ED expressed in days	9490	ED expressed in days	2190	ED expressed in days	3650	ED expressed in days	3650	ED expressed in days	9490	ED expressed in days	3650	ED expressed in days
Carcinogenic Averaging Time	Atc	days	25550	70 year lifetime	25550	70 year lifetime	25550	70 year lifetime	25550	70 year lifetime	25550	70 year lifetime	25550	70 year lifetime	25550	70 year lifetime	25550	70 year lifetime	25550	70 year lifetime
Incidental Ingestion of Surface Water																				
Exposure Frequency	EF	days/year	45	USEPA, 2014b	45	USEPA, 2014b	45	USEPA, 2014b	45	USEPA, 2014b	45	USEPA, 2014b	45	USEPA, 2014b	45	USEPA, 2014b	45	USEPA, 2014b	NA	
Water Ingestion Rate	IR	L/day	0.10	USEPA, 2014b [2]	0.10	USEPA, 2014b [2]	0.10	USEPA, 2014b [2]	NA		0.10	USEPA, 2014b [2]	0.02	USEPA, 2014b [2]	0.02	USEPA, 2014b [2]	NA		NA	
Fraction Ingested	FI	unitless	1.0	Assumption	1.0	Assumption	1.0	Assumption	1.0	Assumption	1.0	Assumption	1.0	Assumption	1.0	Assumption	1.0	Assumption	NA	
Age-Adjusted Water Ingestion Factor	IFWadj	L/kg	NA		NA		NA		3.39		NA		NA		NA		2.12		NA	
Age-Adjusted Water Ingestion Factor-Mutagenic	IFWM	L/kg	NA		NA		NA		13.23		NA		NA		NA		10.33		NA	
Dermal Exposure with Surface Water																				
Exposure Frequency	EF	days/year	45	USEPA, 2014b	45	USEPA, 2014b	45	USEPA, 2014b	45	USEPA, 2014b	45	USEPA, 2014b	45	USEPA, 2014b	45	USEPA, 2014b	45	USEPA, 2014b	45	USEPA, 2014b
Exposed Skin Surface Area	SA	cm^2	6365	USEPA, 2014a	13350	USEPA, 2011 [3]	19652	USEPA, 2014a	NA		1770	USEPA, 2011 [4]	3820	USEPA, 2011 [4]	5790	USEPA, 2011 [4]	NA		5790	USEPA, 2011 [4]
Exposure Time	t-event	hr/event	2	Site-specific [5]	2	Site-specific [5]	2	Site-specific [5]	2	Site-specific [5]	2	Site-specific [5]	2	Site-specific [5]	2	Site-specific [5]	2	Site-specific	2	Site-specific [5]
Events per Day	EV	event/day	1.0	Site-specific [5]	1.0	Site-specific [5]	1.0	Site-specific [5]	1.0	Site-specific [5]	1.0	Site-specific [5]	1.0	Site-specific [5]	1.0	Site-specific [5]	1.0	Site-specific	1	Site-specific [5]
Age-Adjusted Dermal Contact Factor	DFWadj	events-cm^2/kg	NA		NA		NA		361647		NA		NA		NA		103497		NA	
Age-Adjusted Dermal Contact Factor-Mutagenic	DFWM	events-cm^2/kg	NA		NA		NA		1131185		NA		NA		NA		319693		NA	

NOTES AND ABBREVIATIONS

USEPA, 2002 - Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OWSWER 9355.4-24
USEPA, 2011 - Exposure Factors Handbook. USEPA/600/R-10/030. October, 2011.
USEPA, 2014a - Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER 9200.1-120. February 6, 201.
USEPA, 2014b - Region 4 Human Health Risk Assessment Supplemental Guidance. January 2014. Draft Final.
[1] - Table 8-1 of USEPA (2011).
[2] - Ingestion rate of 50 ml/hour of surface water is used for exposures to water during swimming. Intake rates for exposure to surface water during wading are 50 ml/hour for children 1-6, and 10 ml/hour for adolescents and adults.
The water ingestion rate in liters/day is calculated as follows: ingestion (ml/hr) x exposure time (hr/event)/1000 (ml/L).
[3] - Based on weighted average of mean values for 6-<16 years.
[4] - Based on surface area of hands, forearms, lower legs, and feet.
[5] - Assumes 2 hours per event and that on days when recreation in water occurs, all daily exposure to water is derived from locations at the Site.

Values based on a time-weighted average of child, adolescent, and adult exposure values are calculated as follows:
Water
IFWadj = (child ED [0-2] x child EF [0-2] x child IR [0-2] / child BW [0-2]) + (child ED [2-6] x child EF [2-6] x child IR [2-6] / child BW [2-6]) + (older child ED [6-16] x older child EF [6-16] x older child IR [6-16] / older child BW [6-16]) + (adult ED x adult EF x adult IR / adult BW)
DFWadj = (child EF [0-2] x child ED [0-2] x child SA [0-2] x child EV [0-2] / child BW [0-2]) + (child EF [2-6] x child ED [2-6] x child SA [2-6] x child EV [2-6] / child BW [2-6]) + (older child EF [6-16] x older child ED [6-16] x older child SA [6-16] x older child EV [6-16] / older child BW [6-16]) + (adult EF x adult ED x adult SA x adult EV / adult BW)
Water - mutagenic
IFWM = (child ED [0-2] x child EF [0-2] x child IR [0-2] x ADAF [0-2] / child BW [0-2]) + (child ED [2-6] x child EF [2-6] x child IR [2-6] x ADAF [2-6] / child BW [2-6]) + (older child ED [6-16] x child EF [6-16] x older child IR [6-16] x ADAF [6-16] / older child BW [6-16]) + (adult ED x adult EF x adult IR x adult ADAF / adult BW)
DFWM = (child EF [0-2] x child ED [0-2] x child SA [0-2] x child EV [0-2] x ADAF [0-2] / child BW [0-2]) + (child EF [2-6] x child ED [2-6] x child SA [2-6] x child EV [2-6] x ADAF [2-6] / child BW [2-6]) + (older child EF [6-16] x older child ED [6-16] x older child SA [6-16] x older child EV [6-16] x ADAF [6-16] / older child BW [6-16]) + (adult EF x adult ED x adult SA x adult EV x adult ADAF / adult BW)

USEPA guidance for early life exposure to carcinogens (USEPA, 2005) requires that risks for potentially carcinogenic constituents that are presumed to act by a mutagenic mode of action be calculated differently than for constituents that do not act via a mutagenic mode of action.
Therefore, the age-dependent adjustment factors (ADAF) will be applied for calculations involving children under the age of 16. The ADAFs are as follows:

Age 0 to 2 years (2 year interval from birth until 2nd birthday) – ADAF = 10
Ages 2 to 16 years (14 year interval from 2nd birthday to 16th birthday) – ADAF = 3
Ages 16 and up (after 16th birthday) – no adjustment - ADAF = 1

The exposure parameters for children ages <6 are applied to children 0 - 2 and 2- 6.

Current/Future Off-Site Recreational Boater

Site-specific

Recreator Equation Inputs for Surface Water

* Inputted values different from Recreator defaults are highlighted.

Variable	Recreator Surface Water Default Value	Form-input Value
BW_{0-2} (body weight) kg	15	0
BW_{2-6} (body weight) kg	15	0
BW_{6-16} (body weight) kg	80	0
BW_{16-30} (body weight) kg	80	80
BW_{a} (body weight - adult) kg	80	80
BW_{rec-a} (body weight - adult) kg	80	80
$DFW_{rec-adj}$ (age-adjusted dermal factor) cm^2-event/kg	0	32568.75
$DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	0	32568.75
ED_{rec} (exposure duration - recreator) years	26	10
ED_{0-2} (exposure duration) years	2	0
ED_{2-6} (exposure duration) years	4	0
ED_{6-16} (exposure duration) years	10	0
ED_{16-30} (exposure duration) years	10	10
ED_{rec-a} (exposure duration - adult) years	20	10
EF_{rec-w} (exposure frequency) days/year	0	45
EF_{0-2} (exposure frequency) days/year	0	0
EF_{2-6} (exposure frequency) days/year	0	0
EF_{6-16} (exposure frequency) days/year	0	0
EF_{16-30} (exposure frequency) days/year	0	45
EF_{rec-a} (adult exposure frequency) days/year	0	45
ET_{0-2} (exposure time) hours/event	0	0
ET_{2-6} (exposure time) hours/event	0	0
ET_{6-16} (exposure time) hours/event	0	0
ET_{16-30} (exposure time) hours/event	0	2
ET_{rec-a} (adult exposure time) hours/event	0	2
EV_{0-2} (events) events/day	0	0
EV_{2-6} (events) events/day	0	0
EV_{6-16} (events) events/day	0	0
EV_{16-30} (events) events/day	0	1
EV_{rec-a} (adult) events/day	0	1
THQ (target hazard quotient) unitless	0.1	1
$IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg	0	0
$IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg	0	0
IRW_{0-2} (water intake rate) L/hour	0.12	0
IRW_{2-6} (water intake rate) L/hour	0.12	0
IRW_{6-16} (water intake rate) L/hour	0.071	0
IRW_{16-30} (water intake rate) L/hour	0.071	0
IRW_{rec} (water intake rate - adult) L/day	0.071	0
IRW_{rec-a} (water intake rate - adult) L/hr	0.071	0
LT (lifetime - recreator) years	70	70
SA_{0-2} (skin surface area) cm^2	6365	0
SA_{2-6} (skin surface area) cm^2	6365	0
SA_{6-16} (skin surface area) cm^2	19652	0
SA_{16-30} (skin surface area) cm^2	19652	5790
SA_{rec} (skin surface area - adult) cm^2	19652	5790
SA_{rec-a} (skin surface area - adult) cm^2	19652	5790
Apparent thickness of stratum corneum (cm)	0.001	0.001
TR (target risk) unitless	0.000001	0.0001

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Site-specific

Recreator Regional Screening Levels (RSL) for Surface Water

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	SF_o(mg/kg-day)$^{-1}$	SF_o Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	RAGSe GIABS (unitless)	K_p (cm/hr)	MW	FA (unitless)	In EPD?	$DA_{event(ca)}$	$DA_{event(nc child)}$	$DA_{event(nc adult)}$	Ingestion SL TR=1E-05 (ug/L)	Dermal SL TR=1E-05 (ug/L)	Carcinogenic SL TR=1E-05 (ug/L)	Ingestion SL (Child) THQ=1 (ug/L)	Dermal SL (Child) THQ=1 (ug/L)	Noncarcinogenic SL (Child) THQ=1 (ug/L)	Ingestion SL (Adult) THQ=1 (ug/L)	Dermal SL (Adult) THQ=1 (ug/L)	Noncarcinogenic SL (Adult) THQ=1 (ug/L)	Screening Level (ug/L)
Antimony (metallic)	7440-36-0	No	No	Inorganics	-		0.0004	I	-		0.1500	0.0010	121.7600	1.0000	Yes	-	-	0.0067	-	-	-	-	-	-	-	3360.0000	3360.0000	3.36E+03nc
Arsenic, Inorganic	7440-38-2	No	No	Inorganics	1.5000	I	0.0003	I	0.0000	C	1.0000	0.0010	74.9220	1.0000	Yes	0.0005	-	0.0336	-	26100.0000	26100.0000	-	-	-	-	16800.0000	16800.0000	1.68E+04nc
Barium	7440-39-3	No	No	Inorganics	-		0.2000	I	0.0005	H	0.0700	0.0010	137.3300	1.0000	Yes	-	-	1.5690	-	-	-	-	-	-	-	784000.0000	784000.0000	7.84E+05nc
Beryllium and compounds	7440-41-7	No	No	Inorganics	-		0.0020	I	0.0000	I	0.0070	0.0010	9.0100	1.0000	Yes	-	-	0.0016	-	-	-	-	-	-	-	784.0000	784.0000	7.84E+02nc
Boron And Borates Only	7440-42-8	No	No	Inorganics	-		0.2000	I	0.0200	H	1.0000	0.0010	13.8400	1.0000	Yes	-	-	22.4141	-	-	-	-	-	-	-	11200000.0000	11200000.0000	1.12E+07nc
Cadmium (Water)	7440-43-9	No	No	Inorganics	-		0.0005	I	0.0000	A	0.0500	0.0010	112.4000	1.0000	Yes	-	-	0.0028	-	-	-	-	-	-	-	1400.0000	1400.0000	1.40E+03nc
Chromium(III), Insoluble Salts	16065-83-1	No	No	Inorganics	-		1.5000	I	-		0.0130	0.0010	52.0000	1.0000	Yes	-	-	2.1854	-	-	-	-	-	-	-	1090000.0000	1090000.0000	1.09E+06nc
Cobalt	7440-48-4	No	No	Inorganics	-		0.0003	P	0.0000	P	1.0000	0.0004	58.9300	1.0000	Yes	-	-	0.0336	-	-	-	-	-	-	-	42000.0000	42000.0000	4.20E+04nc
Fluoride	16984-48-8	No	No	Inorganics	-		0.0400	C	0.0130	C	1.0000	0.0010	38.0000	1.0000	Yes	-	-	4.4828	-	-	-	-	-	-	-	2240000.0000	2240000.0000	2.24E+06nc
Lithium	7439-93-2	No	No	Inorganics	-		0.0020	P	-		1.0000	0.0010	6.9400	1.0000	Yes	-	-	0.2241	-	-	-	-	-	-	-	112000.0000	112000.0000	1.12E+05nc
Mercuric Chloride	7487-94-7	No	No	Inorganics	-		0.0003	I	0.0003	S	0.0700	0.0010	271.5000	1.0000	Yes	-	-	0.0024	-	-	-	-	-	-	-	1180.0000	1180.0000	1.18E+03nc
Molybdenum	7439-98-7	No	No	Inorganics	-		0.0050	I	-		1.0000	0.0010	95.9400	1.0000	Yes	-	-	0.5604	-	-	-	-	-	-	-	280000.0000	280000.0000	2.80E+05nc
Selenium	7782-49-2	No	No	Inorganics	-		0.0050	I	0.0200	C	1.0000	0.0010	78.9600	1.0000	Yes	-	-	0.5604	-	-	-	-	-	-	-	280000.0000	280000.0000	2.80E+05nc
Thallium (Soluble Salts)	7440-28-0	No	No	Inorganics	-		0.0000	X	-		1.0000	0.0010	204.3800	1.0000	Yes	-	-	0.0011	-	-	-	-	-	-	-	560.0000	560.0000	5.60E+02nc

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Current/Future Off-Site Recreational Swimmer

Site-specific

Recreator Equation Inputs for Surface Water

*** Inputted values different from Recreator defaults are highlighted.**

Variable	Recreator Surface Water Default Value	Form-input Value
BW_{0-2} (body weight) kg	15	15
BW_{2-6} (body weight) kg	15	15
BW_{6-16} (body weight) kg	80	44
BW_{16-30} (body weight) kg	80	80
BW_{a} (body weight - adult) kg	80	62
BW_{rec-a} (body weight - adult) kg	80	62
$DFW_{rec-adj}$ (age-adjusted dermal factor) cm^2-event/kg	0	354100.645
$DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	0	1131184.77
ED_{rec} (exposure duration - recreator) years	26	26
ED_{0-2} (exposure duration) years	2	2
ED_{2-6} (exposure duration) years	4	4
ED_{6-16} (exposure duration) years	10	10
ED_{16-30} (exposure duration) years	10	10
ED_{rec-a} (exposure duration - adult) years	20	20
EF_{rec-w} (exposure frequency) days/year	0	45
EF_{0-2} (exposure frequency) days/year	0	45
EF_{2-6} (exposure frequency) days/year	0	45
EF_{6-16} (exposure frequency) days/year	0	45
EF_{16-30} (exposure frequency) days/year	0	45
EF_{rec-a} (adult exposure frequency) days/year	0	45
ET_{0-2} (exposure time) hours/event	0	2
ET_{2-6} (exposure time) hours/event	0	2
ET_{6-16} (exposure time) hours/event	0	2
ET_{16-30} (exposure time) hours/event	0	2
ET_{rec-a} (adult exposure time) hours/event	0	2
EV_{0-2} (events) events/day	0	1
EV_{2-6} (events) events/day	0	1
EV_{6-16} (events) events/day	0	1
EV_{16-30} (events) events/day	0	1
EV_{rec-a} (adult) events/day	0	1
THQ (target hazard quotient) unitless	0.1	1
$IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg	0	6.503
$IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg	0	26.461
IRW_{0-2} (water intake rate) L/hour	0.12	0.1
IRW_{2-6} (water intake rate) L/hour	0.12	0.1
IRW_{6-16} (water intake rate) L/hour	0.071	0.1
IRW_{16-30} (water intake rate) L/hour	0.071	0.1
IRW_{rec} (water intake rate - adult) L/day	0.071	0.1
IRW_{rec-a} (water intake rate - adult) L/hr	0.071	0.1
LT (lifetime - recreator) years	70	70
SA_{0-2} (skin surface area) cm^2	6365	6365
SA_{2-6} (skin surface area) cm^2	6365	6365
SA_{6-16} (skin surface area) cm^2	19652	13350
SA_{16-30} (skin surface area) cm^2	19652	19652
SA_{rec} (skin surface area - adult) cm^2	19652	16501
SA_{rec-a} (skin surface area - adult) cm^2	19652	16501
Apparent thickness of stratum corneum (cm)	0.001	0.001
TR (target risk) unitless	0.000001	0.0001

Output generated 15AUG2019:13:20:13

Site-specific

Recreator Regional Screening Levels (RSL) for Surface Water

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	SF_o(mg/kg-day)$^{-1}$	SF_o Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	RAGSe GIABS (unitless)	K_p (cm/hr)	MW	FA (unitless)	In EPD?	$DA_{event(ca)}$	$DA_{event(nc\ child)}$	$DA_{event(nc\ adult)}$	Ingestion SL TR=1E-05 (ug/L)	Dermal SL TR=1E-05 (ug/L)	Carcinogenic SL TR=1E-05 (ug/L)	Ingestion SL (Child) THQ=1 (ug/L)	Dermal SL (Child) THQ=1 (ug/L)	Noncarcinogenic SL (Child) THQ=1 (ug/L)	Ingestion SL (Adult) THQ=1 (ug/L)	Dermal SL (Adult) THQ=1 (ug/L)	Noncarcinogenic SL (Adult) THQ=1 (ug/L)	Screening Level (ug/L)
Antimony (metallic)	7440-36-0	No	No	Inorganics	-		0.0004	I	-		0.1500	0.0010	121.7600	1.0000	Yes	-	0.0011	0.0018	-	-	-	243.0000	573.0000	171.0000	1010.0000	914.0000	479.0000	1.71E+02nc
Arsenic, Inorganic	7440-38-2	No	No	Inorganics	1.5000	I	0.0003	I	0.0000	C	1.0000	0.0010	74.9220	1.0000	Yes	0.0000	0.0057	0.0091	262.0000	2410.0000	236.0000	183.0000	2870.0000	172.0000	754.0000	4570.0000	647.0000	2.36E+02ca**
Barium	7440-39-3	No	No	Inorganics	-		0.2000	I	0.0005	H	0.0700	0.0010	137.3300	1.0000	Yes	-	0.2676	0.4267	-	-	-	122000.0000	134000.0000	63700.0000	503000.0000	213000.0000	150000.0000	6.37E+04nc
Beryllium and compounds	7440-41-7	No	No	Inorganics	-		0.0020	I	0.0000	I	0.0070	0.0010	9.0100	1.0000	Yes	-	0.0003	0.0004	-	-	-	1220.0000	134.0000	121.0000	5030.0000	213.0000	205.0000	1.21E+02nc
Boron And Borates Only	7440-42-8	No	No	Inorganics	-		0.2000	I	0.0200	H	1.0000	0.0010	13.8400	1.0000	Yes	-	3.8230	6.0953	-	-	-	122000.0000	1910000.0000	114000.0000	503000.0000	3050000.0000	432000.0000	1.14E+05nc
Cadmium (Water)	7440-43-9	No	No	Inorganics	-		0.0005	I	0.0000	A	0.0500	0.0010	112.4000	1.0000	Yes	-	0.0005	0.0008	-	-	-	304.0000	239.0000	134.0000	1260.0000	381.0000	292.0000	1.34E+02nc
Chromium(III), Insoluble Salts	16065-83-1	No	No	Inorganics	-		1.5000	I	-		0.0130	0.0010	52.0000	1.0000	Yes	-	0.3727	0.5943	-	-	-	913000.0000	186000.0000	155000.0000	3770000.0000	297000.0000	275000.0000	1.55E+05nc
Cobalt	7440-48-4	No	No	Inorganics	-		0.0003	P	0.0000	P	1.0000	0.0004	58.9300	1.0000	Yes	-	0.0057	0.0091	-	-	-	183.0000	7170.0000	178.0000	754.0000	11400.0000	708.0000	1.78E+02nc
Fluoride	16984-48-8	No	No	Inorganics	-		0.0400	C	0.0130	C	1.0000	0.0010	38.0000	1.0000	Yes	-	0.7646	1.2191	-	-	-	24300.0000	382000.0000	22900.0000	101000.0000	610000.0000	86300.0000	2.29E+04nc
Lithium	7439-93-2	No	No	Inorganics	-		0.0020	P	-		1.0000	0.0010	6.9400	1.0000	Yes	-	0.0382	0.0610	-	-	-	1220.0000	19100.0000	1140.0000	5030.0000	30500.0000	4320.0000	1.14E+03nc
Mercuric Chloride	7487-94-7	No	No	Inorganics	-		0.0003	I	0.0003	S	0.0700	0.0010	271.5000	1.0000	Yes	-	0.0004	0.0006	-	-	-	183.0000	201.0000	95.6000	754.0000	320.0000	225.0000	9.56E+01nc
Molybdenum	7439-98-7	No	No	Inorganics	-		0.0050	I	-		1.0000	0.0010	95.9400	1.0000	Yes	-	0.0956	0.1524	-	-	-	3040.0000	47800.0000	2860.0000	12600.0000	76200.0000	10800.0000	2.86E+03nc
Selenium	7782-49-2	No	No	Inorganics	-		0.0050	I	0.0200	C	1.0000	0.0010	78.9600	1.0000	Yes	-	0.0956	0.1524	-	-	-	3040.0000	47800.0000	2860.0000	12600.0000	76200.0000	10800.0000	2.86E+03nc
Thallium (Soluble Salts)	7440-28-0	No	No	Inorganics	-		0.0000	X	-		1.0000	0.0010	204.3800	1.0000	Yes	-	0.0002	0.0003	-	-	-	6.0800	95.6000	5.7200	25.1000	152.0000	21.6000	5.72E+00nc

Output generated 15AUG2019:13:20:13

Current/Future Off-Site Recreational Wader

Site-specific

Recreator Equation Inputs for Surface Water

* Inputted values different from Recreator defaults are highlighted.

Variable	Recreator Surface Water Default Value	Form-input Value
BW_{0-2} (body weight) kg	15	15
BW_{2-6} (body weight) kg	15	15
BW_{6-16} (body weight) kg	80	44
BW_{16-30} (body weight) kg	80	80
BW_{a} (body weight - adult) kg	80	62
BW_{rec-a} (body weight - adult) kg	80	62
$DFW_{rec-adj}$ (age-adjusted dermal factor) cm^2-event/kg	0	101610
$DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	0	319693.295
ED_{rec} (exposure duration - recreator) years	26	26
ED_{0-2} (exposure duration) years	2	2
ED_{2-6} (exposure duration) years	4	4
ED_{6-16} (exposure duration) years	10	10
ED_{16-30} (exposure duration) years	10	10
ED_{rec-a} (exposure duration - adult) years	20	20
EF_{rec-w} (exposure frequency) days/year	0	45
EF_{0-2} (exposure frequency) days/year	0	45
EF_{2-6} (exposure frequency) days/year	0	45
EF_{6-16} (exposure frequency) days/year	0	45
EF_{16-30} (exposure frequency) days/year	0	45
EF_{rec-a} (adult exposure frequency) days/year	0	45
ET_{0-2} (exposure time) hours/event	0	2
ET_{2-6} (exposure time) hours/event	0	2
ET_{6-16} (exposure time) hours/event	0	2
ET_{16-30} (exposure time) hours/event	0	2
ET_{rec-a} (adult exposure time) hours/event	0	2
EV_{0-2} (events) events/day	0	1
EV_{2-6} (events) events/day	0	1
EV_{6-16} (events) events/day	0	1
EV_{16-30} (events) events/day	0	1
EV_{rec-a} (adult) events/day	0	1
THQ (target hazard quotient) unitless	0.1	1
$IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg	0	4.181
$IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg	0	20.652
IRW_{0-2} (water intake rate) L/hour	0.12	0.1
IRW_{2-6} (water intake rate) L/hour	0.12	0.1
IRW_{6-16} (water intake rate) L/hour	0.071	0.02
IRW_{16-30} (water intake rate) L/hour	0.071	0.02
IRW_{rec} (water intake rate - adult) L/day	0.071	0.02
IRW_{rec-a} (water intake rate - adult) L/hr	0.071	0.02
LT (lifetime - recreator) years	70	70
SA_{0-2} (skin surface area) cm^2	6365	1770
SA_{2-6} (skin surface area) cm^2	6365	1770
SA_{6-16} (skin surface area) cm^2	19652	3820
SA_{16-30} (skin surface area) cm^2	19652	5790
SA_{rec} (skin surface area - adult) cm^2	19652	4805
SA_{rec-a} (skin surface area - adult) cm^2	19652	4805
Apparent thickness of stratum corneum (cm)	0.001	0.001
TR (target risk) unitless	0.000001	0.0001

Output generated 15AUG2019:13:22:00

Site-specific

Recreator Regional Screening Levels (RSL) for Surface Water

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	SF_o(mg/kg-day)$^{-1}$	SF_o Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	RAGSe GIABS (unitless)	K_p (cm/hr)	MW	FA (unitless)	In EPD?	$DA_{event(ca)}$	$DA_{event(nc\ child)}$	$DA_{event(nc\ adult)}$
Antimony (metallic)	7440-36-0	No	No	Inorganics	-		0.0004	I	-		0.1500	0.0010	121.7600	1.0000	Yes	-	0.0041	0.0063
Arsenic, Inorganic	7440-38-2	No	No	Inorganics	1.5000	I	0.0003	I	0.0000	C	1.0000	0.0010	74.9220	1.0000	Yes	0.0002	0.0206	0.0314
Barium	7440-39-3	No	No	Inorganics	-		0.2000	I	0.0005	H	0.0700	0.0010	137.3300	1.0000	Yes	-	0.9623	1.4652
Beryllium and compounds	7440-41-7	No	No	Inorganics	-		0.0020	I	0.0000	I	0.0070	0.0010	9.0100	1.0000	Yes	-	0.0010	0.0015
Boron And Borates Only	7440-42-8	No	No	Inorganics	-		0.2000	I	0.0200	H	1.0000	0.0010	13.8400	1.0000	Yes	-	13.7476	20.9319
Cadmium (Water)	7440-43-9	No	No	Inorganics	-		0.0005	I	0.0000	A	0.0500	0.0010	112.4000	1.0000	Yes	-	0.0017	0.0026
Chromium(III), Insoluble Salt	16065-83-1	No	No	Inorganics	-		1.5000	I	-		0.0130	0.0010	52.0000	1.0000	Yes	-	1.3404	2.0409
Cobalt	7440-48-4	No	No	Inorganics	-		0.0003	P	0.0000	P	1.0000	0.0004	58.9300	1.0000	Yes	-	0.0206	0.0314
Fluoride	16984-48-8	No	No	Inorganics	-		0.0400	C	0.0130	C	1.0000	0.0010	38.0000	1.0000	Yes	-	2.7495	4.1864
Lithium	7439-93-2	No	No	Inorganics	-		0.0020	P	-		1.0000	0.0010	6.9400	1.0000	Yes	-	0.1375	0.2093
Mercuric Chloride	7487-94-7	No	No	Inorganics	-		0.0003	I	0.0003	S	0.0700	0.0010	271.5000	1.0000	Yes	-	0.0014	0.0022
Molybdenum	7439-98-7	No	No	Inorganics	-		0.0050	I	-		1.0000	0.0010	95.9400	1.0000	Yes	-	0.3437	0.5233
Selenium	7782-49-2	No	No	Inorganics	-		0.0050	I	0.0200	C	1.0000	0.0010	78.9600	1.0000	Yes	-	0.3437	0.5233
Thallium (Soluble Salts)	7440-28-0	No	No	Inorganics	-		0.0000	X	-		1.0000	0.0010	204.3800	1.0000	Yes	-	0.0007	0.0010

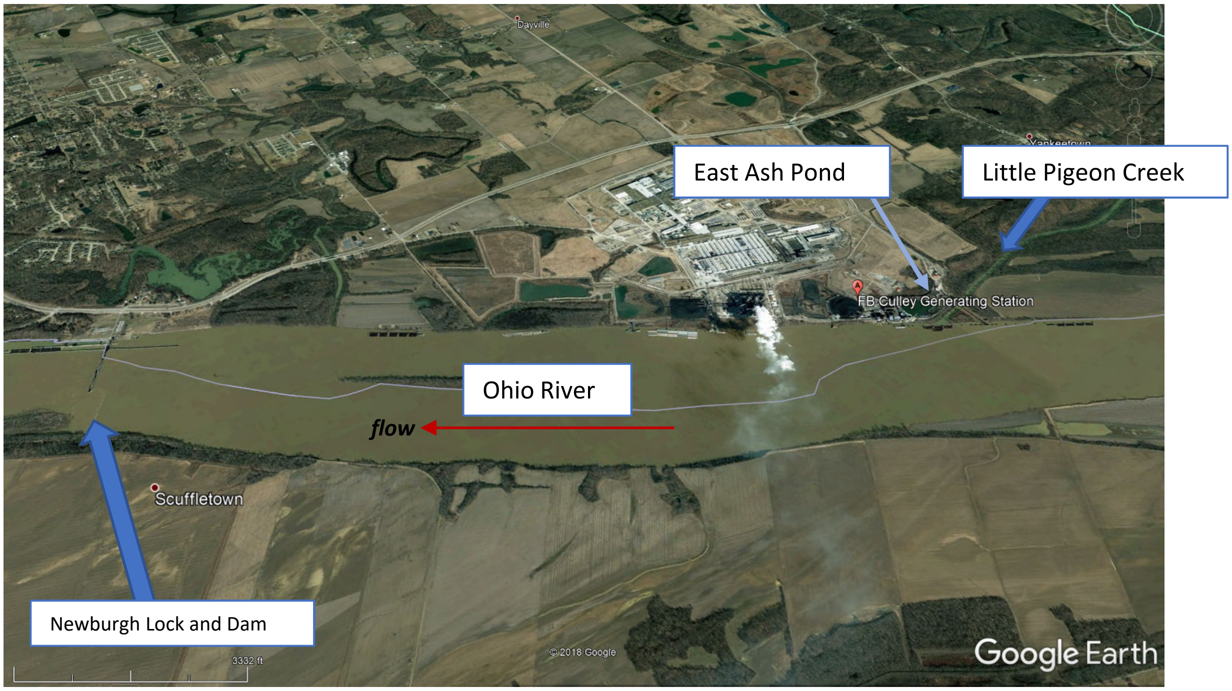
Chemical	Ingestion SL TR=1E-05 (ug/L)	Dermal SL TR=1E-05 (ug/L)	Carcinogenic SL TR=1E-05 (ug/L)	Ingestion SL (Child) THQ=1 (ug/L)	Dermal SL (Child) THQ=1 (ug/L)	Noncarcinogenic SL (Child) THQ=1 (ug/L)	Ingestion SL (Adult) THQ=1 (ug/L)	Dermal SL (Adult) THQ=1 (ug/L)	Noncarcinogenic SL (Adult) THQ=1 (ug/L)	Screening Level (ug/L)
Antimony (metallic)	-	-	-	243.0000	2060.0000	218.0000	5030.0000	3140.0000	1930.0000	2.18E+02nc
Arsenic, Inorganic	407.0000	8380.0000	389.0000	183.0000	10300.0000	179.0000	3770.0000	15700.0000	3040.0000	3.89E+02ca*
Barium	-	-	-	122000.0000	481000.0000	97100.0000	2510000.0000	733000.0000	567000.0000	9.71E+04nc
Beryllium and compounds	-	-	-	1220.0000	481.0000	345.0000	25100.0000	733.0000	712.0000	3.45E+02nc
Boron And Borates Only	-	-	-	122000.0000	6870000.0000	120000.0000	2510000.0000	10500000.0000	2030000.0000	1.20E+05nc
Cadmium (Water)	-	-	-	304.0000	859.0000	225.0000	6290.0000	1310.0000	1080.0000	2.25E+02nc
Chromium(III), Insoluble Salt	-	-	-	913000.0000	670000.0000	386000.0000	18900000.0000	1020000.0000	968000.0000	3.86E+05nc
Cobalt	-	-	-	183.0000	25800.0000	181.0000	3770.0000	39200.0000	3440.0000	1.81E+02nc
Fluoride	-	-	-	24300.0000	1370000.0000	23900.0000	503000.0000	2090000.0000	405000.0000	2.39E+04nc
Lithium	-	-	-	1220.0000	68700.0000	1200.0000	25100.0000	105000.0000	20300.0000	1.20E+03nc
Mercuric Chloride	-	-	-	183.0000	722.0000	146.0000	3770.0000	1100.0000	851.0000	1.46E+02nc
Molybdenum	-	-	-	3040.0000	172000.0000	2990.0000	62900.0000	262000.0000	50700.0000	2.99E+03nc
Selenium	-	-	-	3040.0000	172000.0000	2990.0000	62900.0000	262000.0000	50700.0000	2.99E+03nc
Thallium (Soluble Salts)	-	-	-	6.0800	344.0000	5.9800	126.0000	523.0000	101.0000	5.98E+00nc

Output generated 15AUG2019:13:22:00

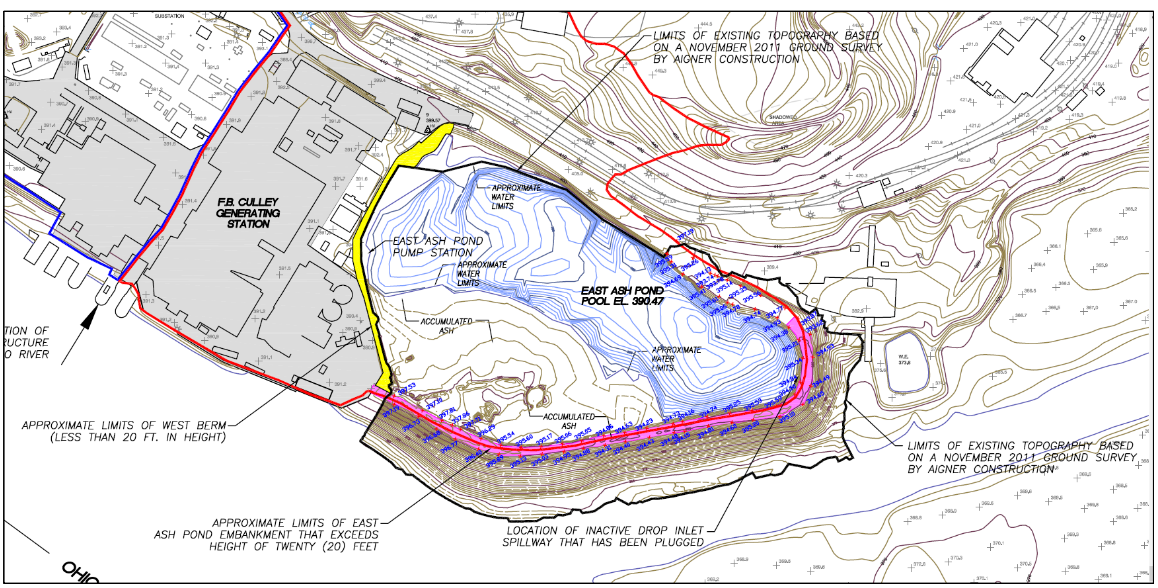
ATTACHMENT B

East Ash Pond Dilution Attenuation Factor Calculations

HALEY ALDRICH	CALCULATIONS	File No.	129420-017
Client	Vectren	Sheet	1 of 5
Project	F.B. Culley Generation Station East Ash Pond	Date	26 July 2019
Subject	Dilution-Attenuation Factor Calculation	Computed By	J.P. Brandenburg
		Checked By	Jacob Chu



Google Earth Perspective View, Facing North

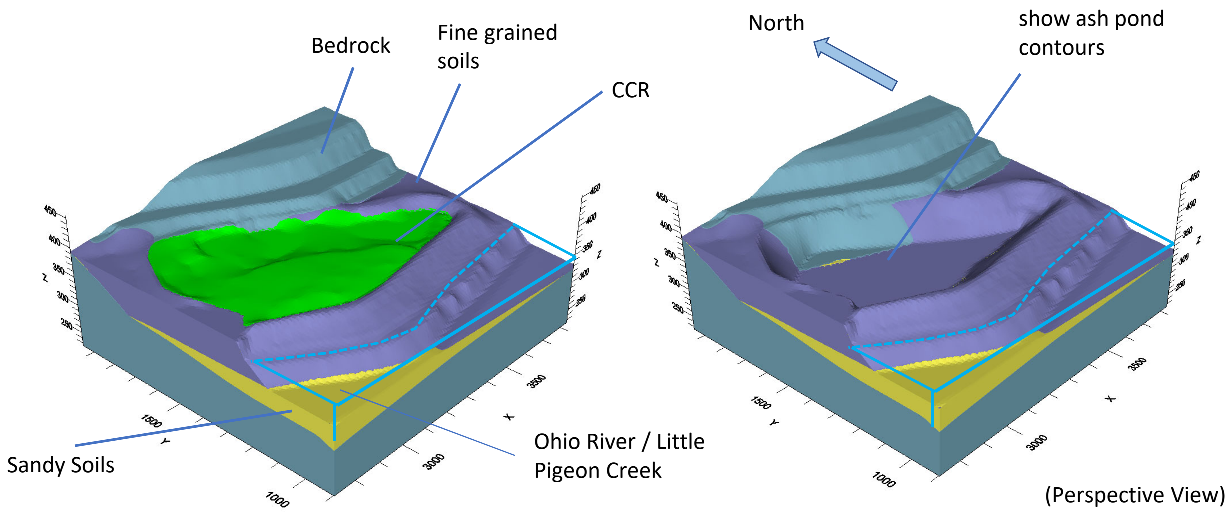


From ATC Group Services, East Ash Pond Visual Site Inspection Report, 2015

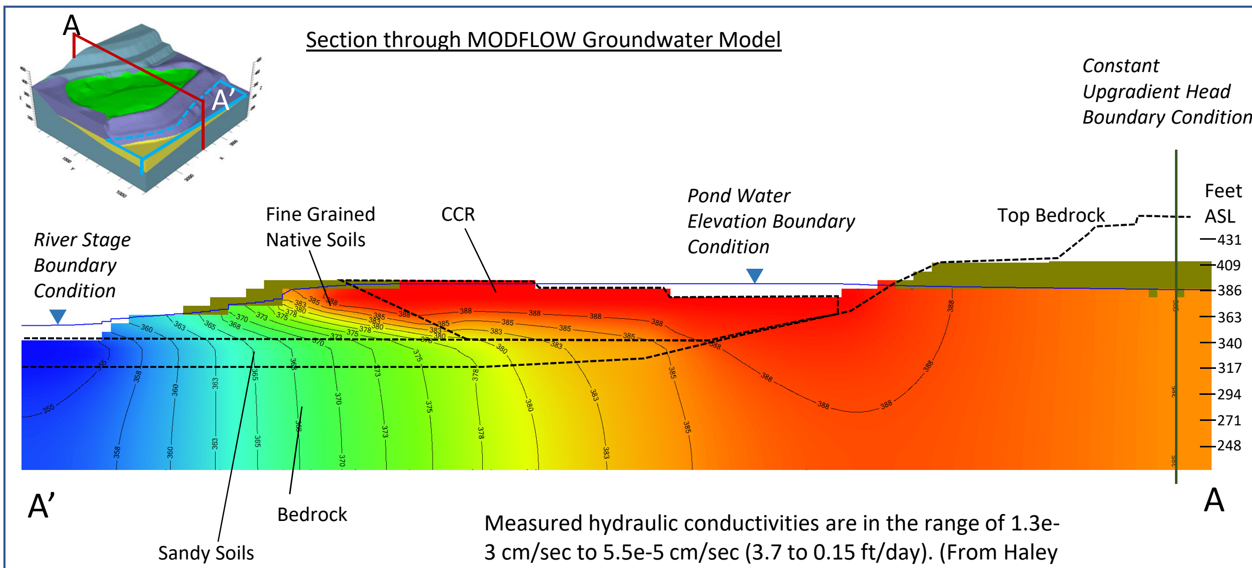
A 3D Conceptual Model was constructed for the East Ash Pond using subsurface cross sections interpreted from boring logs by Haley & Aldrich, and surveyed elevations from the 2015 East Pond Ash Inspection by ATC Group Services. Four basic subsurface units were identified: bedrock, fine grained soils, sandy soils, and coal-combustion residuals (CCR, or “ash”).

The 3D Conceptual Model was then used to construct a MODFLOW-2005 Groundwater Model. Properties assigned to each of the four units were mapped to a regular (undeformed) 8-foot grid. Three boundary conditions are assigned: a river boundary condition representing the Ohio River and Little Pigeon Creek, a constant head boundary condition representing water ponded in the East Ash Pond, and a constant upgradient head. A water balance budget zone is assigned to the grid layer beneath the CCR.

East Ash Pond: 3D Conceptual Model



Section through MODFLOW Groundwater Model

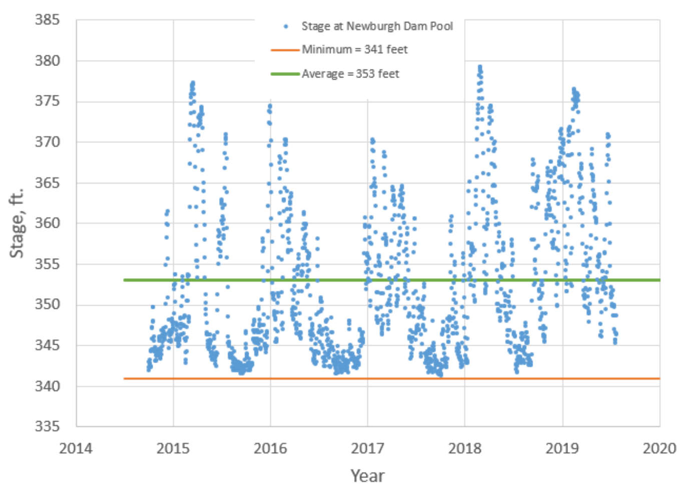


Measured hydraulic conductivities are in the range of 1.3e-3 cm/sec to 5.5e-5 cm/sec (3.7 to 0.15 ft/day). (From Haley & Aldrich “Report on Groundwater Monitoring Program,” 2017, October)

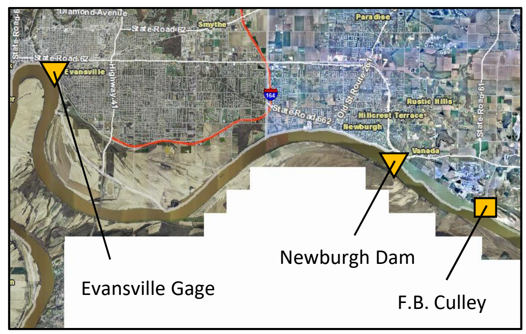
HALEY ALDRICH	**CALCULATIONS**	File No.	129420-017
		Sheet	3 of 5
Client	Vectren	Date	26 July 2019
Project	F.B. Culley Generation Station East Ash Pond	Computed By	J.P. Brandenburg
Subject	Dilution-Attenuation Factor Calculation	Checked By	Jacob Chu

Based on gaging data, water surface elevation (stage) of the Newburgh Dam Pool ranges from 341 to 379 feet above the NGVD29 vertical datum. The average stage is 353 feet.

Discontinuous discharge data is available at the Evansville Gage (USGS 03322000; below the Newburgh Dam) from 1940-1996. Although minimum instantaneous flow was approximately 100,000 cfs after the dam was completed in 1975, flow durations will depend on operation of the Dam and Locks and are not presently known. The pre-1975 minimum of approximately 10,000 cfs is used as a most conservative assumption of low flow conditions on the Ohio River. This may be improved to less conservative values if information can be obtained from the Army Corps of Engineers hydrologic model or dam release data.

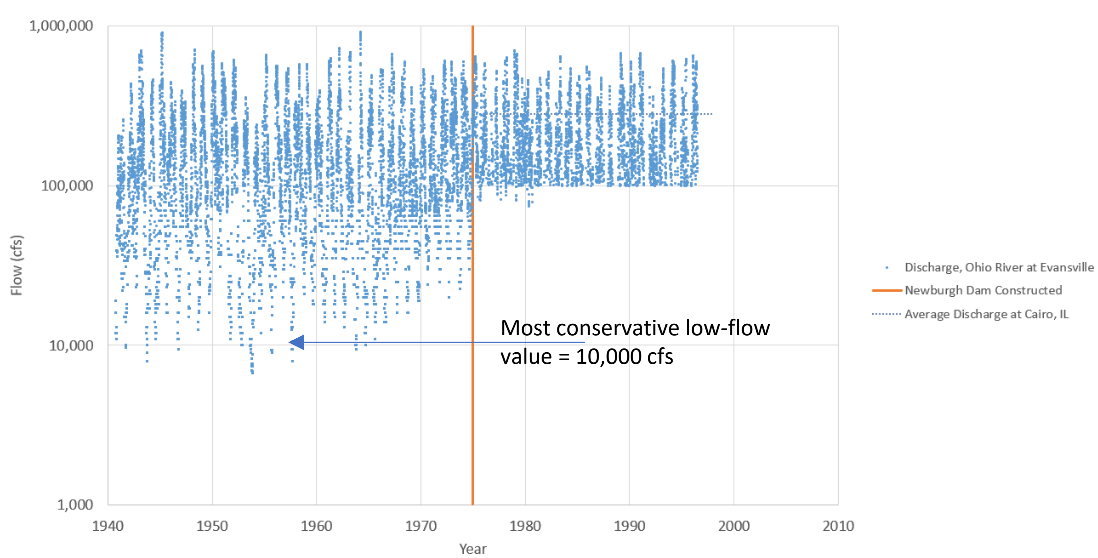


https://waterdata.usgs.gov/nwis/inventory/?site_no=03304300



https://maps.indiana.edu/previewMaps/Hydrology/Monitoring_Streamflow_Gauges.html

Datum = 329.18 feet NGVD29

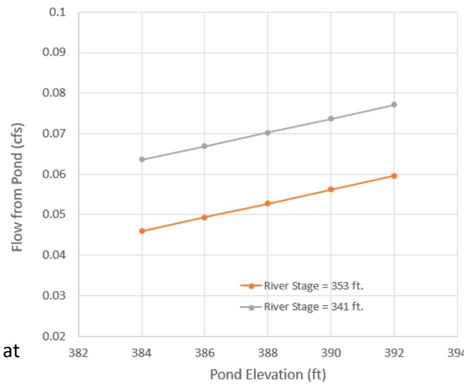


https://waterdata.usgs.gov/nwis/inventory/?site_no=03322000

Scenario 1

•Typical measured values for site hydraulic conductivities (K), most conservative value for discharge of Ohio River

Unit	Horizontal K (ft/day)	Vertical K (ft/day)
CCR	0.1	0.1
Fine grained soils	0.15	0.015
Sandy soils	3	0.3
Bedrock	0.1	0.1



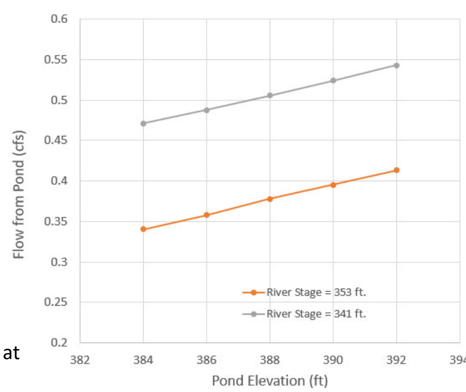
$$DAF = \frac{Q_R}{Q_G}$$ Where: $Q_R =$ Discharge of Ohio River at East Ash Pond, at Low-Flow conditions. $Q_G =$ Model Discharge from East Ash Pond to Ohio River

Pond Elevation (feet)	River Stage (feet)	Qg (cfs)	Qr (cfs)	DAF
384	353	0.046	10,000	**210,000**
392	353	0.060	10,000	**160,000**
384	341	0.064	10,000	**150,000**
392	341	0.077	10,000	**130,000**

Scenario 2

•Conservative (very high) values for site hydraulic conductivities (K), most conservative value for discharge of Ohio River

Unit	Horizontal K (ft/day)	Vertical K (ft/day)
CCR	1	1
Fine grained soils	10	1
Sandy soils	10	1
Bedrock	0.1	0.1



$$DAF = \frac{Q_R}{Q_G}$$ Where: $Q_R =$ Discharge of Ohio River at East Ash Pond, at Low-Flow conditions. $Q_G =$ Model Discharge from East Ash Pond to Ohio River

Pond Elevation (feet)	River Stage (feet)	Qg (cfs)	Qr (cfs)	DAF
384	353	0.34	10,000	**29,000**
392	353	0.41	10,000	**24,000**
384	341	0.47	10,000	**21,000**
392	341	0.54	10,000	**18,000**

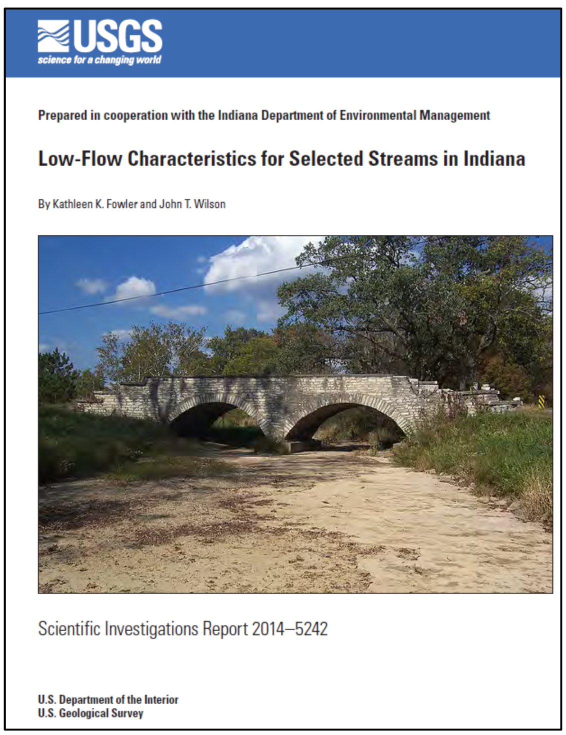
HALEY ALDRICH CALCULATIONS

Client	Vectren	File No.	129420-017
Project	F.B. Culley Generation Station East Ash Pond	Sheet	5 of 5
Subject	Dilution-Attenuation Factor Calculation	Date	26 July 2019
		Computed By	J.P. Brandenburg
		Checked By	Jacob Chu

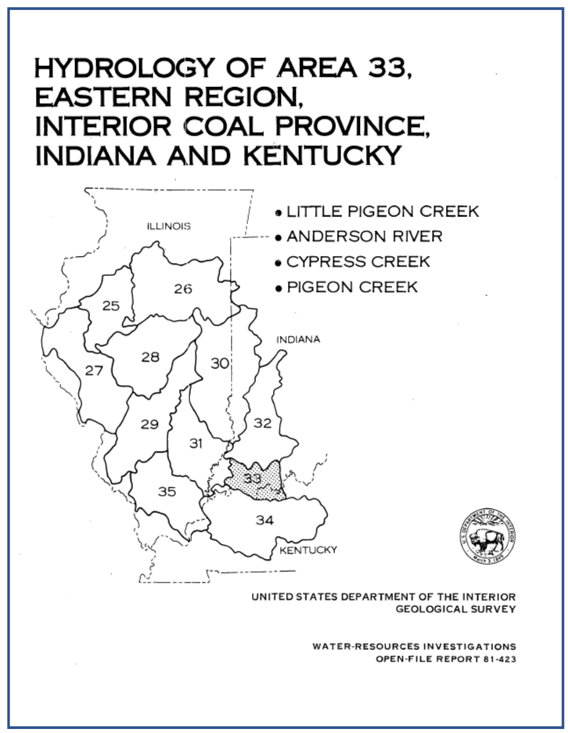
The confluence of Little Pigeon Creek and the Ohio River is adjacent to the east side of the East Ash Pond. The lowest reach of the Creek runs parallel to the Ohio River.

As reported by the USGS, higher reaches of the Creek have weak aquifer support and are dry during periods of low precipitation (7Q10 flow is zero). Flow in the terminal reach of the Creek is controlled by fluctuations of the Newburgh Dam pool.

Relevant Publications:



https://pubs.usgs.gov/sir/2014/5242/



https://pubs.usgs.gov/of/1981/0423/report.pdf

www.haleyaldrich.com

REPORT ON
GROUNDWATER FLOW MODELING
ADDENDUM TO CORRECTIVE MEASURES ASSESSMENT
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

by
Haley & Aldrich, Inc.
Cleveland, Ohio

for
Southern Indiana Gas and Electric Company
Evansville, Indiana

File No. 129420-020
September 2019
Issued as CMA Addendum
November 24, 2020

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1. Groundwater Flow Modeling

A groundwater flow and solute transport model was constructed to evaluate and compare potential corrective measures in support of the Corrective Measures Assessment (CMA) for the F.B. Culley Generating Station (Site) in Newburgh, Indiana. Molybdenum is the only Appendix IV constituent that exceeds the Groundwater Protection Standard (GWPS) at the Site. Therefore, molybdenum was used for the solute transport portion of the model. The following text describes the model construction, calibration and subsequent simulations of remedy alternatives for molybdenum above the GWPS.

The numerical model MODFLOW-2005 (Harbaugh, 2005) was selected for the modeling effort and is a three-dimensional, finite difference groundwater flow model capable of simulating the groundwater conditions under various scenarios including pumping and changes to infiltration over time. Models were built using available information and for the purpose of aiding decision making in the CMA process. The level of accuracy is directly dependent on the data available to construct the model and should not be construed by the user as a definitive predictor of the future. Instead the CMA alternatives model simulations should be viewed relative to one another to enable the user to determine (when appropriate) favorable, less favorable and least favorable CMA alternatives.

1.1 MODEL DOMAIN

The model domain was established to encompass the Site and surrounding areas that represented model boundaries including the nearby Ohio River located south of the ash pond and landfill.

MODFLOW uses a rectangular grid within the domain and allows for establishing irregular groundwater flow boundary conditions that represent actual and Site-specific features in the study area. The setup is facilitated by assigning boundary types and values to specific grid cells. **Figure 1** depicts the model domain boundary overlain on an aerial photograph of the Site.

Figure 2 depicts the model domain with the grid spacing selected for the model. The three-dimensional finite difference groundwater flow model domain covers a length of 15,000 feet (ft) in the x-direction (west to east), 15,000 ft in the y-direction (north to south), and approximately 160 ft in the z-direction (vertical). The model consists of 191 rows, 216 columns, and 30 layers for a total of 1,237,680 cells covering an approximate area of 378 acres. In MODFLOW, the groundwater-flow system is subdivided laterally and vertically into rectilinear blocks called cells. The hydraulic properties of the material in each cell are assigned and assumed to be uniform within each cell. The row and column dimension of each cell is variable based on proximity to the Site. This variability was created to allow for finer resolution within the vicinity of the primary flow pathway for the Site.

A Digital Elevation Model was obtained from the United States Geological Survey (USGS) website to create the surface of the model for the Site. Lithologic descriptions contained in the boring logs generated during various phases of geo-environmental investigations as well as cross-sections were used to develop formation geometry and hydraulic properties. The Site was divided into two vertical lithologic units to represent geologic conditions underlying the Site and to account for vertical heterogeneities within the model. A summary of each geologic unit is as follows:

- Unconsolidated Ohio River alluvial deposits consisting of silt and clay with discontinuous interbedded layers of sand (Haley & Aldrich, Inc., 2017).

- Shale and sandstone bedrock units underlie the unconsolidated alluvial soil deposits.

Elevations used in the model were determined from digital elevation models for the area. The topography of the ground surface is mimicked in the subsequent lower layers; however, the elevation has been reduced by the layer thickness. Layer thicknesses were determined through the review of the above-mentioned Site geology.

Figure 3 depicts the two-dimensional views of the model layer elevations. The surfaces shown in **Figure 3** represent the model top (i.e., land surface), the flat model bottom, and all the lithologic interfaces between.

1.2 BOUNDARY CONDITIONS

Boundary conditions define the locations and manner in which water enters and exits the active model domain. The conceptual model for the groundwater system that forms the basis for the model boundaries are as follows:

1. The Ohio River is used to estimate southern boundary elevations and is the major groundwater discharge feature.
2. A specified head boundary condition is used to control groundwater flow across the western side of the model.
3. A specified head boundary condition is used to simulate recharge along the topographic high north of East Ash Pond.

The specified boundaries of the model coincide with predicted natural hydrologic boundaries. To recreate observed groundwater flow, two types of model boundaries were used: specified head boundaries, and the Modflow River Package. The locations of these boundary conditions in the model are illustrated in **Figure 3** and **Figure 4**.

1.2.1 Specified Head Boundaries

The MODFLOW Time Variant Specified Head Package (Harbaugh, 2005) also known as the Constant Head Package, was used to simulate boundaries presented in **Figure 4**. The package is used to fix the head values in selected grid cells regardless of the conditions in the surrounding grid cells. The cell with the assigned constant head acts either as a source of water entering or a sink of water leaving the system. Three separate constant head boundaries are used in the model. All constant head boundaries are referenced to datum NAVD 88 and are active in Layer 10 through 30. Constant head boundary one (1) is set to 390 ft. Constant head boundary two (2) is set to 390 ft to the eastern extent and decreases to 370.10 ft at the western extent. Constant head boundary three (3) is to 370.10 ft at the northern extent and decreases to 353.06 ft at the southern extent. These values were estimated based on topography, the depths to water in wells at the Site, the pattern of groundwater flow, elevations of nearby water bodies, and through calibration of the groundwater flow model as described in **Section 1.3** below.

1.2.2 River Boundaries

River boundaries in Modflow are a special form of the head-dependent boundary condition. In a head-dependent boundary, the model computes the difference in head between the boundary and the model cell to calculate the amount of water flowing into or out of the model through the boundary. **Figure 5** represents the river boundary condition representing the Ohio River near the Site. The head assigned to this boundary was 353.00 ft based on the nearby Ohio River USGS gage at Newburgh, Indiana at a time recent to when groundwater elevations used in model calibration were taken at the site.

1.2.3 Recharge Boundaries

Recharge in the model is simulated using constant head boundary one (1) along the topographic high north of East Ash Pond.

1.3 HYDRAULIC MODEL PROPERTIES

Hydraulic properties were initially assigned consistent with observations presented in the 2017 Groundwater Monitoring Program Report (Haley & Aldrich, Inc., 2017). Values were assigned for horizontal hydraulic conductivity and vertical hydraulic conductivity. These parameters were iteratively varied during model calibration to achieve the best fit to observed hydraulic patterns including head elevations, hydraulic gradients, and flow directions.

For calibration, uniform hydraulic properties were applied within discrete model layers. Results of the initial calibration indicated that hydraulic conductivities in the range of those values associated with material described in boring logs were representative with regard to groundwater flow observed at the Site. The hydraulic conductivity values used in the model are presented below for the four hydrogeologic units underlying at the Site:

- Bedrock – 1.0 x 10-1 ft per day (ft/day) or 3.5 x 10-5 centimeters per second (cm/s)
- Fine soils – 1.5 x 10-1 ft/day or 5.3 x 10-5 cm/s
- Sandy soils – 3.7 ft/day or 1.3 x 10-3 cm/s
- Ash pond – 1.5 x 10-1 ft/day or 5.3 x 10-5 cm/s

1.3.1 Calibrated Horizontal and Vertical Hydraulic Conductivity

The calibrated horizontal (K_X and K_Y) and vertical (K_Z) hydraulic conductivity values in Model Layer 1 through Layer 30 were distributed uniformly across the model domain. Vertical hydraulic conductivity values were estimated at 1/10th of the horizontal hydraulic conductivity values. This ration between horizontal and vertical conductivities was selected to represent resultant hydraulic conductivity when stratification typical of alluvial sediments is evident.

1.3.2 Porosity, Storage, and Yield

Effective porosity values are needed for particle tracking and solute transport simulations. The effective porosity values were conservatively estimated based on the soil type through the examination of boring logs. For areas that are generally alluvial silty clay, a porosity of 0.25, specific storage of 0.01 ft^{-1} and specific yield of 0.01 were utilized.

1.4 METHODS OF EVALUATING MODEL CALIBRATION QUALITY

Model calibration is the process of refining the model representation of the hydrogeologic framework, hydraulic properties, and boundary conditions to minimize the difference between the simulated heads and fluxes to the measured data. Construction of a complex model with more parameters than the data support may reduce the residuals (difference between measured and simulated values) but does not ensure a more accurate model. Therefore, calibrated model parameters also need to be checked for their validity. Throughout the calibration process, no adjustments were made that conflicted with the general understanding of the groundwater system and previously documented information.

The iterative calibration process of "trial and error" was used for model calibration. It involves making changes to the input values, running MODFLOW, and assessing the impact of the changes. Beside the trial and error approach, a model independent parameter optimization software tool – PEST was used to adjust selected input values to further improve model calibration (Doherty, 2016).

The quality of model fit can be assessed from many statistical and graphical methods. One method is based on the difference between simulated and observed heads and flows, or residuals. The overall magnitude of the residuals is considered, but the distribution of those residuals, both statistically and spatially, can be equally important. The magnitude of residuals can initially point to gross errors in the model, the data (measured quantity), or how the measured quantity is simulated (Hill, 2000). A useful graphical analysis is a simple scatter plot of all simulated values as a function of all observed values.

For the flow calibration, the statistics of the mean error (ME), mean absolute error (MAE), and the root mean square (RMS) error were used to assess the calibration quality. They are defined as follows:

$$ME = \frac{\sum_{i=1}^{n}(O_i - C_i)}{n}$$

$$MAE = \frac{\sum_{i=1}^{n}|O_i - C_i|}{n}$$

$$RMS = \frac{\sum_{i=1}^{n}(O_i - C_i)^2}{n}$$

Where:
Oi = Observed head at observation point i
Ci = Calculated head at observation point i
n = Number of observation points

The mean error is the average of the differences between the observed and calculated heads (or residuals) and can indicate the overall comparison between computed and observed data. Negative and positive residuals can cancel each other out, resulting in a mean error close to zero even when the calibration is not good. The sign of the mean error is an indication of the overall comparison of the model to the data (e.g. a positive mean error indicates the model is generally computing heads that are too high).

The mean absolute error is the average of the absolute values of the residuals. The absolute value prevents positive and negative residuals from canceling each other, providing a clearer picture of the magnitude of errors across the model, without an indication of the direction (high or low) of the errors. The RMS error is the square root of the average of the squares of the residuals. The RMS adds additional weight to points where the residual is greatest. If the residuals at all points are very similar, the RMS will be close to the mean absolute error. Alternatively, a few points with high errors can add significantly to the RMS for an otherwise well calibrated model. For all three of these criteria the optimal value is zero.

The numerical goals for the groundwater flow model calibration are to (1) minimize the ME and MAE errors and (2) achieve the ratio of the RMS error of the head residuals to the range of observed heads (i.e., normalized RMS error) to be at least less than 10 percent (%) (Anderson, M.P., Woessner, WW., 1992).

Groundwater flow field calibration for the Site has been conducted to provide a reasonable representation of the groundwater flow field in the vicinity of the Site, which forms the basis of assessing molybdenum migration potential through the fate and transport process. To accomplish this objective, a MODFLOW numerical model was developed to simulate observed groundwater conditions at the Site through calibrating a representative steady-state flow field. The decision of using a steady-state flow field for the flow model calibration was made through an evaluation of the available groundwater elevation data for the Site. Most importantly is that historical flow patterns have been relatively consistent at the Site; therefore, a steady-state flow model was deemed reasonable to represent average flow conditions.

The evaluation of collected groundwater elevation data resulted in the selection of multiple dates which are considered representative for the Site as the observed heads for the flow model calibration for representing Site conditions (**Table 1**).

Based on the outcome of this quality of model fit evaluation, it is concluded that the numerical calibration goals have been achieved for the Site. The mean error in head was 7.22 ft or 10.0 percent (%) of the head observation range, 72.14 ft. The absolute residual is +6.20 ft. The RMS error for the calibrated model was +0.56 ft and the normalized RMS error was 10.0 percent (%). Presented below is the scatter plot of the observed versus simulated heads, which generally fall along the theoretical slope of 1 to 1. **Table 1** provides the observed heads at the Site for multiple dates, as discussed above, used to generate the plot below. The quality of the flow model calibration meets the calibration goals as described herein. Observed versus computed target values is shown in **Figure 6.**

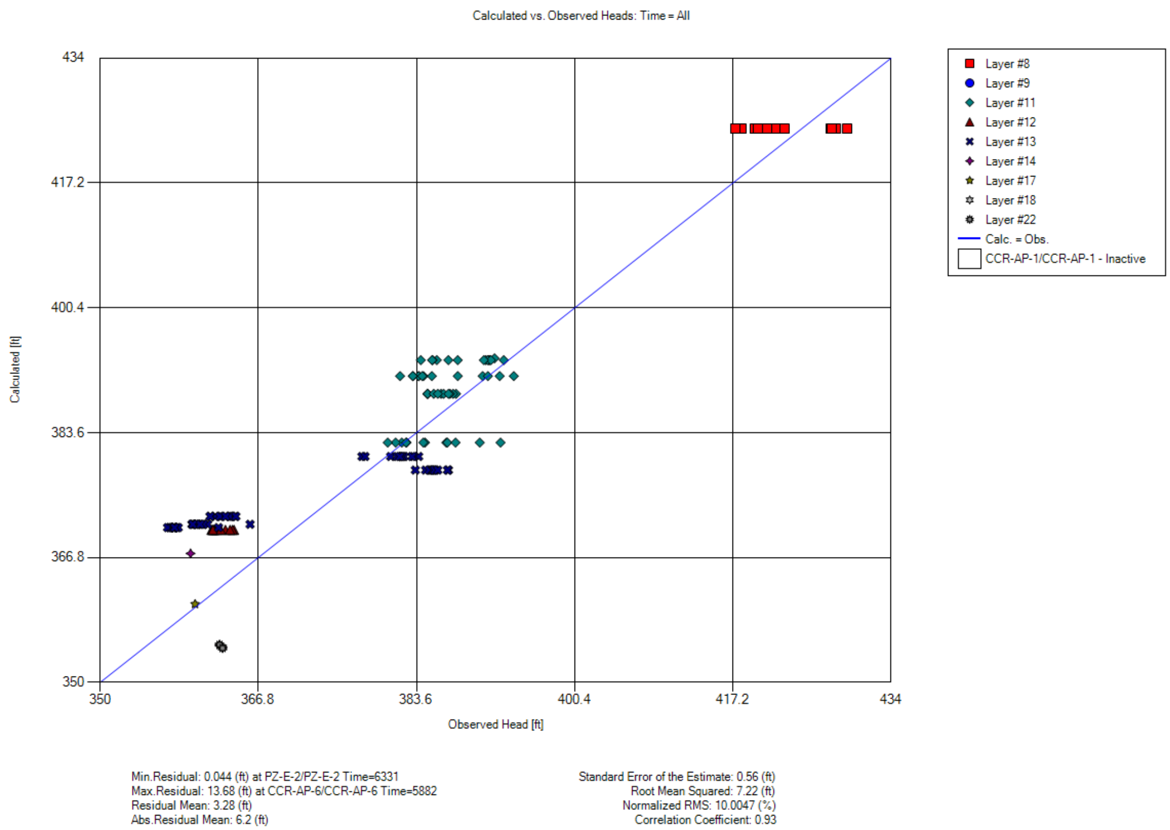

Figure 6: Calibration scatter plot. Values represent steady-state targets.

Furthermore, the calibration assessment has met the acceptable calibration goals, and therefore, the groundwater flow model is considered to be usable for the development of the molybdenum fate and transport models described in **Section 2.**

2. Fate and Transport Modeling

Contaminant fate and transport modeling was conducted utilizing the three-dimensional, numerical model MT3DMS (Version 5 of MT3D) (Zheng, C. and Wang, P.P., 1999). MT3DMS simulates advection, dispersion, adsorption and decay of dissolved constituents in groundwater using a modular structure similar to MODFLOW to permit simulation of transport components independently or jointly. MT3D interfaces directly with MODFLOW for the head solution and supports all the hydrologic and discretization features of MODFLOW. The MT3D code has a comprehensive set of solution options, including the method of characteristics, the modified method of characteristics, a hybrid of these two methods, and the standard finite-difference method. MT3D was originally released in 1990 as a public domain code from the United States Environmental Protection Agency and has been widely used and accepted by federal and state regulatory agencies.

For this modeling effort, the MT3DMS model utilized the flow regime from the steady-state, calibrated Site groundwater flow model presented in **Section 1** to simulate transport of molybdenum. The steady state model was transformed into a transient model so various CMA options could be evaluated with respect to time. The strength and locations of the potential molybdenum sources specified in the transport models were based on surface water concentrations from the Site.

The following describe the adsorption effects on solute transport based on the geochemical properties and published empirical data, as well as the choice of the linear adsorption coefficient for each contaminant used for transport modeling.

2.1 TRANSPORT MODELING APPROACH

The solute transport portion of the modeling effort focused mainly on the future flow pathway for molybdenum at the Site. As such, the initial concentration including the current plume extent and the estimated leachable mass near the ash pond were utilized in place as a constant source. The location and initial concentrations for molybdenum within the model (layers 1 and 2) is presented in **Figure 7**.

The calibrated flow model was allowed to run for 1000 years following implementation of the groundwater remedy. Calibration of the concentrations through time was not performed on the predictive model as the starting conditions were the current conditions at the Site and thus represent a conservative estimate of transport through the Site.

2.2 KEY PARAMETERS FOR TRANSPORT MODELING

The following sections describe the key input parameters of the transport model, and how they were derived. Note that these parameters were selected for the purpose of comparative evaluation of relative benefits of various corrective measures. The parameters and conditions used for the modeling are selected based on the data available to date. Therefore, simulated remedial timeframes using the parameters described in this section should not be construed as absolute predictions of remedial time frames for various corrective measures.

2.2.1 Effective Porosity

The effective porosities used in the model were presented in previous **Section 1.3.2**.

2.2.2 Dispersivity

Dispersion incorporates the effects of fluid mixing that result from heterogeneities within the groundwater system and molecular diffusion, which is the random movement of ions or molecules. If the molecules of water and dissolved constituents traveled at the average seepage velocity, there would be an abrupt interface and dispersion would be negligible. However, in natural systems water molecules and dissolved contaminants do not all travel at the same rate; some travel faster and some slower. Dispersion in the model accounts for the spreading of the dissolved plume. Diffusion is time dependent and is significant at low velocities. In general, dispersion acts to decrease the contaminant concentration on the leading edge of the plume, while increasing the size and rate of transport of the dissolved plume. Longitudinal dispersion occurs in the direction of advective groundwater flow, while transverse dispersion occurs perpendicular to groundwater flow.

The groundwater modeling generally accepted longitudinal dispersity value (α_L) estimate is 1 to 100. The horizontal transverse dispersivity (α_T) can be estimated as approximately one-tenth of the α_L, and vertical transverse (α_v) dispersivity can be estimated as one-hundredth of the α_L. The values utilized for dispersivity values are as follows:

- α_L – 100 ft,
- α_T – 10 ft, and
- α_V – 1 ft

2.2.3 First-Order Degradation Rate Constant – Lambda (λ)

Another input parameter for the fate and transport model is the first order degradation rate constant (λ) for molybdenum. This rate constant only takes into account precipitation of molybdenum during transport due to an in-situ treatment remedy, as it leaves the source. This rate constant does not factor in effects of advection, sorption or dispersivity (dispersion). The field-scale degradation rate constant usually can be expressed as a first order decay constant or as a reaction half-life. A reaction half-life of 0.1 day was specified for the scenario that includes an in-situ remedy. The magnitude of the half-life is based on results of a reported field pilot test that used a redox manipulation approach to remove molybdenum from groundwater through precipitation. Note that this redox manipulation approach can also promote arsenic precipitation.

2.2.4 Retardation Effects

Chemical retardation occurs when a solute (contaminant) reacts with the porous media and its rate of movement is retarded relative the advective groundwater velocity. Retardation can occur by a variety of processes including adsorption and mass transfer in porous media. The effects of retardation are often related to site-specific adsorption isotherms. For this modeling purpose, a liner adsorption isotherm is used to account for the effects of transport retardation that may occur for Site-related contaminants. The effects of retardation on contaminant mobility is usually expressed in terms of a retardation factor (R), which is the ratio of the groundwater velocity to contaminant transport velocity (Bedient, P.B., Rifai, H.S. and Newell, C.J., 1994). When a linear adsorption isotherm is used to characterize contaminant mobility, the linear adsorption coefficient (K_d) can be linked to the retardation factor with the mathematical relationship below:

$$R = \frac{v_{gw}}{v_c} = 1 + \frac{\rho_b}{n} \times K_d$$

Where:

R = Retardation factor
v_{gw} = Groundwater velocity
v_c = Contaminant transport
ρ_b = Aquifer solid bulk density
n = Effective transport porosity of the medium
K_d = Linear adsorption coefficient

The following describe the adsorption effects of molybdenum and arsenic based on their geochemical properties and the published empirical data, as well as the choice of the linear adsorption coefficient for each contaminant used for transport modeling.

2.2.5 Adsorption of Molybdenum on Aquifer Solids

Molybdenum (atomic number 42) is a transition metal in Group VI of the periodic classification of the elements. The affinity for molybdenum to adsorb to the geologic matrix can be affected by factors such as pH, redox conditions, mineral contents of aquifer solids, organic matter abundance, and the presence of organic ligands in the groundwater system.

The aqueous speciation of molybdenum and potential formation of molybdenum-related minerals under a spectrum of the electro-potential (Eh) and pH conditions are shown below (**Figure 8**). Based on Site groundwater monitoring results, the predominant pH values are within the neutral pH range (between 6.5 and 7.5) except at the locations of AP-2 and AP-3. The values of oxidation-reduction potential (Eh) vary widely among locations and sampling events. The main molybdenum species in groundwater is expected to be molybdenum species of a valence state of +6. No molybdenum associated precipitation is expected under the current geochemical conditions.

2.2.5.1 Empirical data on adsorption

The adsorption of molybdenum has been studied on a variety of minerals, sediments, soils, and crushed rock materials. The extent of adsorption is greatly influenced by pH; generally, the degree of adsorption decreases with an increase in pH (Sheppard, S., Long, J., Sanipelli, B. and Sohlenius, G., 2009). Metal oxides (iron, manganese, and aluminum oxides) in aquifer solids are shown to play a major role in molybdenum adsorption; the K_d values reported by Goldberg et al. (1996) for oxide minerals range from 10 to 10^3 liter per kilogram (L/Kg) (Goldberg, S., Forster, H.S. and Godfrey, C.L., 1996). Adsorption on a weight basis of iron oxide minerals increased in the order: hematite< goethite < amorphous Fe oxide < poorly crystalline goethite; adsorption on a weight basis for clay minerals increases in the order: well crystallized kaolinite < poorly crystallized kaolinite < illite < montmorillonite.

2.2.5.2 K_d value used for molybdenum transport modeling

Based on the total iron concentrations found at the Site, a total iron concentration of 24,000 mg/Kg is considered representative. Site aquifer solids likely possess a wide range of redox states and are

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predominately coarse-grained material. The geometric mean of the published Kd values for iron oxide minerals for more weathered iron oxides (e.g., hematite and goethite) are approximately 100 L/Kg at pH = 7. Assuming that only 10,000 mg/Kg of iron oxide minerals in aquifer solids is available for adsorption, a nominal K_d value of 1 L/Kg for bulk aquifer solids is estimated (= 10,000 mg/Kg x 10^{-6} Kg/mg x 100 L/Kg). This value is considered a representative, yet conservative value for evaluation of molybdenum transport in the saturated zone.

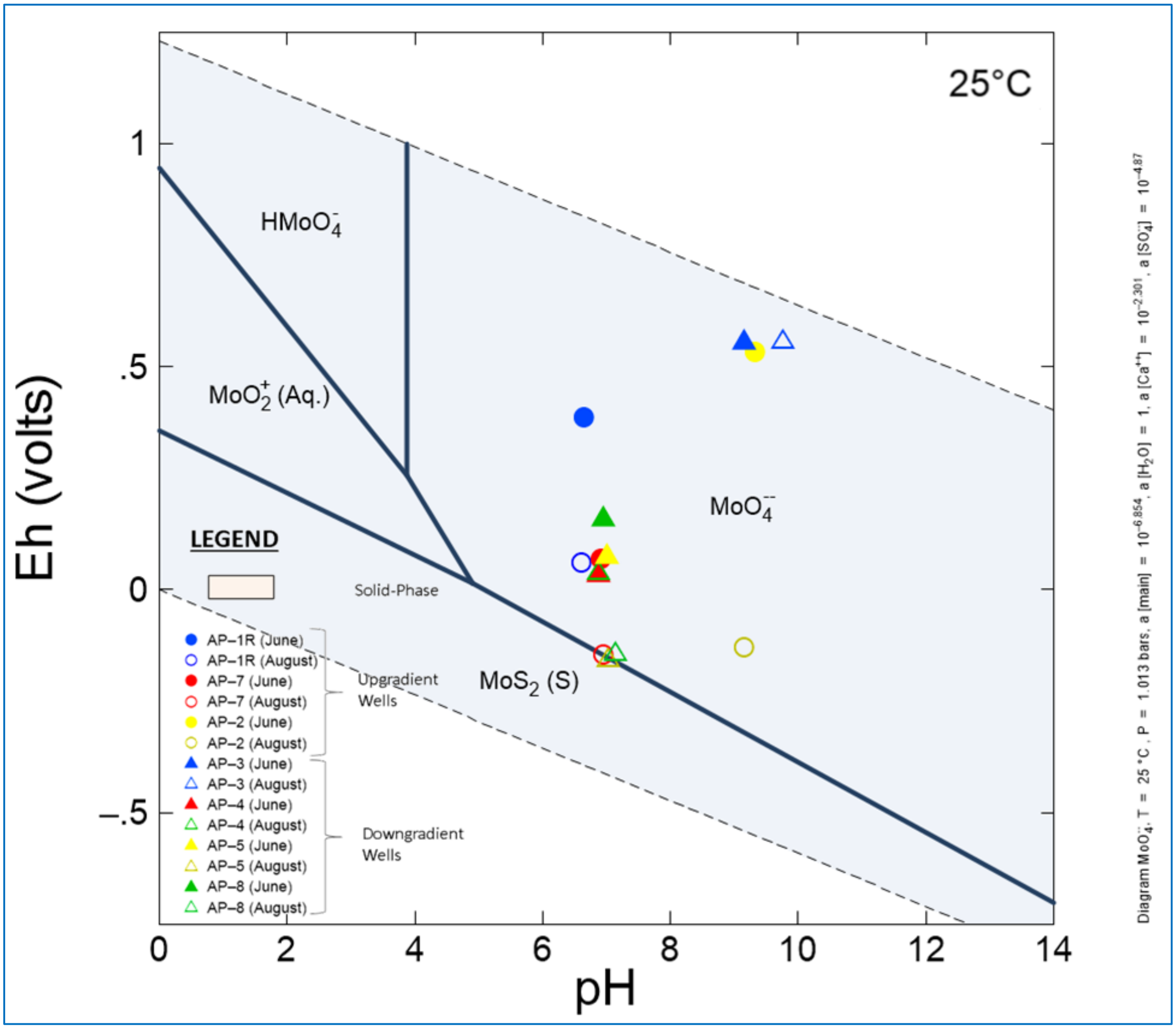

Figure 8: Molybdenum Eh-pH Diagram for a molybdenum-sulfur-oxygen-hydrogen system; groundwater monitoring data collected in June and August 2018 used; field ORP measurements converted to the Standard Hydrogen Electrode (SHE); field pH measurements plotted; assumptions: solute activities = measured concentrations in mols/L; analytical concentrations results for AP-2R used to generate stability diagram. Thermodynamic database used: thermo.com.V8.R6+, fully modified with molybdenum solubility data from Vlek and Lindsay (1977).

2.2.6 Source Initial Concentration Data

To conservatively predict the transport of molybdenum and preserve the mass transported through the Site, the source area was defined utilizing initial concentration and constant sources in the form of recharge. The current extent of the groundwater plume for molybdenum was generated based on groundwater concentrations in the monitoring well network.

Three discrete areas with concentrations of molybdenum above the GWPS are present at the Site within the vicinity of the ash pond. Initial concentrations were created near the following wells at concentrations observed from groundwater sampling events conducted on 28 May 2019 (CCR-AP-5) and 12 June 2019 (CCR-AP-6I and CCR-AP-8I).

- CCR-AP-5 – 0.38 milligram per liter (mg/L)
- CCR-AP-6I – 0.34 mg/L
- CCR-AP-8I – 0.86 mg/L

2.3 TRANSPORT MODEL RESULTS - MOLYBDENUM

Model results for Molybdenum concentrations for each CMA option is shown in **Figure 9**. A detailed discussion of each option is presented in the CMA report (Haley & Aldrich, Inc., 2019).

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TABLES

Table 1
Groundwater Elevations
F.B Culley Generating Station
Newburgh, Indiana

Well Location	Easting Feet	Northing Feet	Date Collected	Depth To Water Feet	Groundwater Elevation Feet (NAVD88)
CCR-AP-1	2883429.69	969939.69	6/2/2016	52.66	388.98
			8/12/2016	53.57	388.07
			10/28/2016	54.20	387.44
			12/7/2016	54.71	386.93
			2/8/2017	53.60	388.04
			4/6/2017	53.55	388.09
			6/7/2017	53.58	388.06
			9/28/2017	53.14	388.50
			11/17/2017	54.04	387.60
			6/11/2018	52.20	389.44
			8/28/2018	54.04	387.60
CCR-AP-2	2884168.67	969117.52	6/2/2016	33.16	360.81
			8/12/2016	33.88	360.09
			10/28/2016	34.23	359.74
			12/7/2016	33.68	360.29
			2/8/2017	32.55	361.42
			4/6/2017	28.04	365.93
			6/7/2017	33.69	360.28
			9/28/2017	34.06	359.91
			11/17/2017	33.00	360.97
			6/11/2018	33.35	360.62
			8/28/2018	34.13	359.84
CCR-AP-3	2883542.09	969007.98	6/2/2016	31.23	363.31
			8/12/2016	32.33	362.21
			10/28/2016	32.71	361.83
			12/7/2016	32.62	361.92
			2/8/2017	30.32	364.22
			4/6/2017	30.49	364.05
			6/7/2017	30.74	363.80
			9/28/2017	32.45	362.09
			11/17/2017	32.18	362.36
			6/11/2018	32.55	361.99
			8/28/2018	31.73	362.81

Table 1
Groundwater Elevations
F.B Culley Generating Station
Newburgh, Indiana

Well Location	Easting Feet	Northing Feet	Date Collected	Depth To Water Feet	Groundwater Elevation Feet (NAVD88)
CCR-AP-4	2883281.93	969641.70	6/2/2016	7.92	386.99
			8/12/2016	8.02	386.89
			10/28/2016	10.34	384.57
			12/7/2016	11.43	383.48
			2/8/2017	9.79	385.12
			4/6/2017	9.67	385.24
			6/7/2017	9.98	384.93
			9/28/2017	9.56	385.35
			11/17/2017	9.34	385.57
			6/11/2018	9.39	385.52
			8/28/2018	9.05	385.86
CCR-AP-5	2884016.66	969379.68	6/2/2016	10.49	383.83
			8/12/2016	12.17	382.15
			10/28/2016	16.51	377.81
			12/7/2016	16.18	378.14
			2/8/2017	11.02	383.30
			4/7/2017	11.20	383.12
			6/7/2017	12.04	382.28
			9/28/2017	13.46	380.86
			11/17/2017	12.31	382.01
			6/11/2018	12.78	381.54
			8/28/2018	12.50	381.82
CCR-AP-6	2883285.03	969122.16	6/2/2016	39.27	357.44
			8/12/2016	39.29	357.42
			10/28/2016	38.90	357.81
			12/7/2016	38.87	357.84
			2/8/2017	39.55	357.16
			4/6/2017	34.14	362.57
			6/7/2017	38.94	357.77
			9/28/2017	38.58	358.13
			11/17/2017	38.42	358.29
			6/11/2018	38.80	357.91
			8/28/2018	38.80	357.91

Table 1
Groundwater Elevations
F.B Culley Generating Station
Newburgh, Indiana

Well Location	Easting Feet	Northing Feet	Date Collected	Depth To Water Feet	Groundwater Elevation Feet (NAVD88)
CCR-AP-7	2883090.34	970774.64	6/2/2016	6.54	427.57
			8/12/2016	12.24	421.87
			10/28/2016	15.98	418.13
			12/7/2016	13.27	420.84
			2/8/2017	5.95	428.16
			4/7/2017	4.81	429.30
			6/7/2017	11.46	422.65
			9/28/2017	16.62	417.49
			11/17/2017	14.56	419.55
			6/11/2018	6.45	427.66
			8/28/2018	14.20	419.91
CCR-AP-8	2883846.87	969046.03	3/8/2017	31.59	362.24
			4/6/2017	29.49	364.34
			4/26/2017	29.83	364.00
			5/30/2017	32.11	361.72
			6/7/2017	32.15	361.68
			7/25/2017	30.98	362.85
			8/15/2017	30.01	363.82
			9/28/2017	31.13	362.70
			11/17/2017	30.10	363.73
			6/11/2018	30.49	363.34
			8/28/2018	29.42	364.41
CCR-AP-9	2883998.96	969768.61	3/8/2017	62.48	386.21
			4/7/2017	60.89	387.80
			4/26/2017	61.20	387.49
			5/30/2017	61.53	387.16
			6/7/2017	62.21	386.48
			7/25/2017	63.90	384.79
			8/15/2017	63.93	384.76
			9/28/2017	63.91	384.78
			11/17/2017	63.26	385.43
			6/11/2018	61.69	387.00
			8/28/2018	62.82	385.87

Table 1
Groundwater Elevations
F.B Culley Generating Station
Newburgh, Indiana

Well Location	Easting Feet	Northing Feet	Date Collected	Depth To Water Feet	Groundwater Elevation Feet (NAVD88)
PZ-E-1	2882753.00	971139.68	7/17/2017	20.50	385.76
			7/27/2017	20.95	385.31
			8/15/2017	21.00	385.26
			8/27/2017	22.20	384.06
			1/23/2018	14.97	391.29
			4/2/2018	13.40	392.86
			5/3/2018	14.90	391.36
			5/23/2018	15.30	390.96
			6/14/2018	15.08	391.18
			7/5/2018	14.76	391.50
			7/25/2018	18.28	387.98
			8/16/2018	19.27	386.99
			12/4/2018	15.51	390.75
PZ-E-2	2882682.29	971069.08	7/17/2017	20.10	384.33
			7/27/2017	20.60	383.83
			8/15/2017	20.60	383.83
			8/27/2017	21.20	383.23
			1/23/2018	13.81	390.62
			4/2/2018	10.50	393.93
			5/3/2018	13.25	391.18
			5/23/2018	16.44	387.99
			6/14/2018	22.57	381.86
			7/5/2018	12.00	392.43
			7/25/2018	19.20	385.23
			8/16/2018	21.22	383.21
			12/4/2018	20.22	384.21

Table 1
Groundwater Elevations
F.B Culley Generating Station
Newburgh, Indiana

Well Location	Easting Feet	Northing Feet	Date Collected	Depth To Water Feet	Groundwater Elevation Feet (NAVD88)
PZ-E-3	2882537.49	970928.88	7/17/2017	22.00	382.54
			7/27/2017	22.50	382.04
			8/15/2017	23.15	381.39
			8/27/2017	24.00	380.54
			1/23/2018	20.04	384.50
			4/2/2018	14.22	390.32
			5/3/2018	12.02	392.52
			5/23/2018	17.77	386.77
			6/14/2018	17.66	386.88
			7/5/2018	16.80	387.74
			7/25/2018	20.21	384.33
			8/16/2018	22.05	382.49
WAP-2R	2881511.71	971395.70	4/1/2017	35.69	359.60
WAP-3	2881262.53	971000.02	4/1/2017	33.02	360.08
WAP-4	2881333.33	970405.14	4/1/2017	34.40	362.68
WAP-4I	2881329.18	970408.95	4/1/2017	34.55	362.68
WAP-4D	2881325.08	970412.71	4/1/2017	34.35	362.68
WAP-5	2881521.35	970235.87	4/1/2017	33.41	363.00
WAP-5I	2881524.71	970232.61	4/1/2017	33.35	363.00
WAP-5D	2881528.71	970229.88	4/1/2017	33.35	363.00
WAP-1	2882824.18	971214.17	4/1/2017	11.50	391.89

FIGURES

LEGEND

- MONITORING WELL LOCATION
- MODEL DOMAIN
- EAST ASH POND
- WEST ASH POND

NOTES

1. ALL LOCATIONS ARE APPROXIMATE
2. AERIAL IMAGERY SOURCE: ESRI

N

0 500 1,000
SCALE IN FEET

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CORRECTIVE MEASURE ASSESSMENT
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

SITE PLAN WITH MODEL DOMAIN

SEPTEMBER 2019

FIGURE 1

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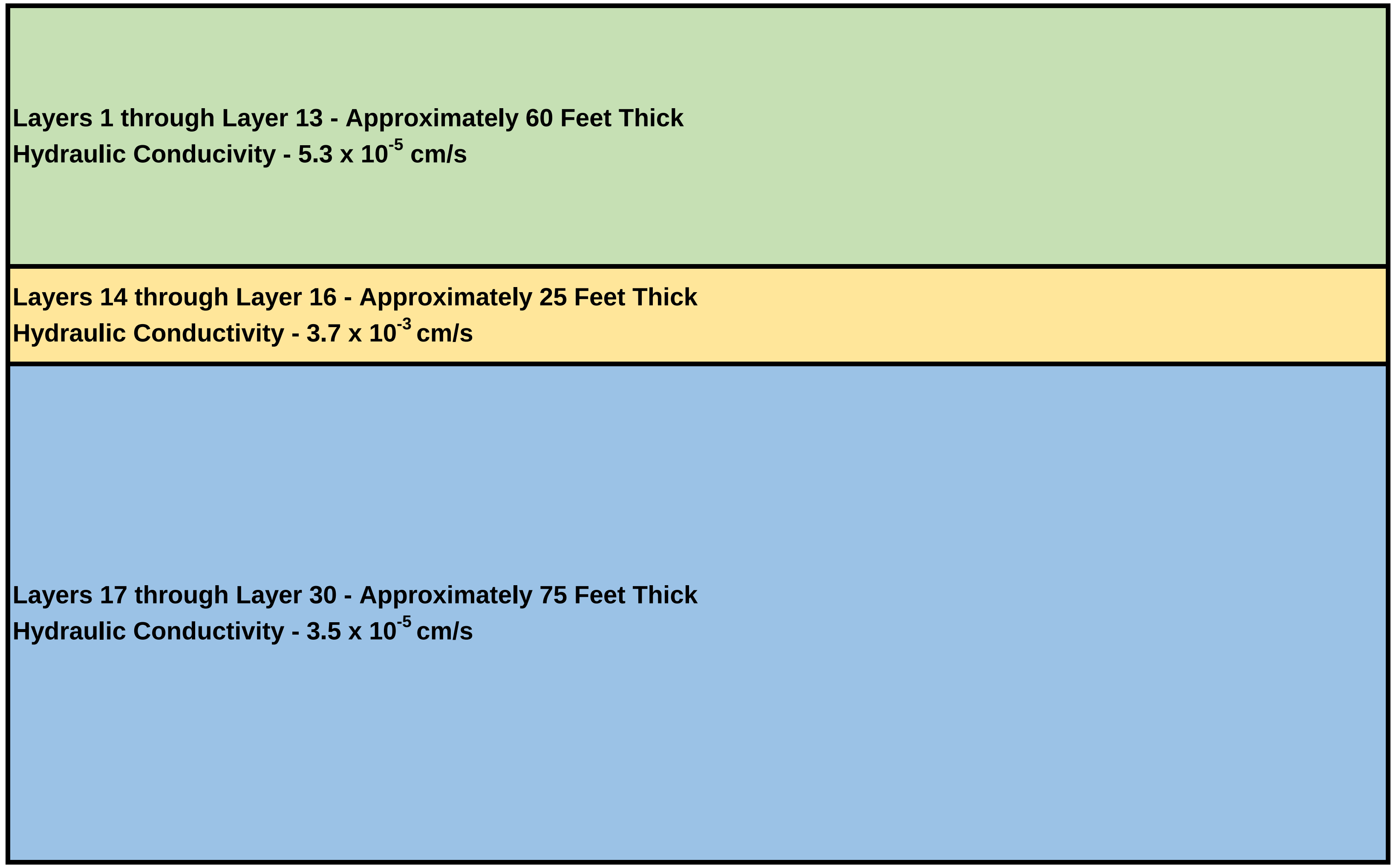
CORRECTIVE MEASURE ASSESSMENT
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

SITE PLAN WITH MODEL GRID

SEPTEMBER 2019

FIGURE 2

GIS FILE PATH: \\haleyaldrich.com\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_09\133274_000_00MB_CULLEY_GW_MODEL.mxd — USER: hwachholz — LAST SAVED: 1/22/2020 1:20:02 PM



NOTES:

1. Layer Thicknesses Approximate Due To Variability In Model
2. Layers 1 Through 13 Represent Fine Soils ;
Layers 14 Through 16 Represent Sandy Soils ;
Layers 17 Through 30 Represent Bedrock

HALEY ALDRICH

VECTREN CORPORATION
F.B CULLEY GENERATING STATION
WARRICK COUNTY, IN

MODEL LAYERS 1 THROUGH 30 WITH HYDRAULIC CONDUCTIVITIES AND LAYER THICKNESSES

SEPTEMBER 2019

FIGURE 3

LEGEND

- MONITORING WELL LOCATION
- MODEL DOMAIN
- EAST ASH POND
- WEST ASH POND

CONSTANT HEAD BOUNDARY

- CONSTANT HEAD BOUNDARY ONE (1) - REACH #10
- CONSTANT HEAD BOUNDARY ONE (2) - REACH #11
- CONSTANT HEAD BOUNDARY ONE (3) - REACH #12

NOTES

1. ALL LOCATIONS ARE APPROXIMATE
2. AERIAL IMAGERY SOURCE: ESRI

0 500 1,000
SCALE IN FEET

HALEY ALDRICH

CORRECTIVE MEASURE ASSESSMENT
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

SITE PLAN WITH CONSTANT HEAD BOUNDARY LAYERS 10 THROUGH 30

SEPTEMBER 2019

FIGURE 4

GIS FILE PATH: \\haleyaldrich.com\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_09\133274_000_00MB_CULLEY_GW_MODEL.mxd — USER: hwachholz — LAST SAVED: 1/22/2020 1:20:02 PM

LEGEND

- MONITORING WELL LOCATION
- MODEL DOMAIN
- RIVER
- EAST ASH POND
- WEST ASH POND

NOTES

1. ALL LOCATIONS ARE APPROXIMATE
2. AERIAL IMAGERY SOURCE: ESRI

0 500 1,000
SCALE IN FEET

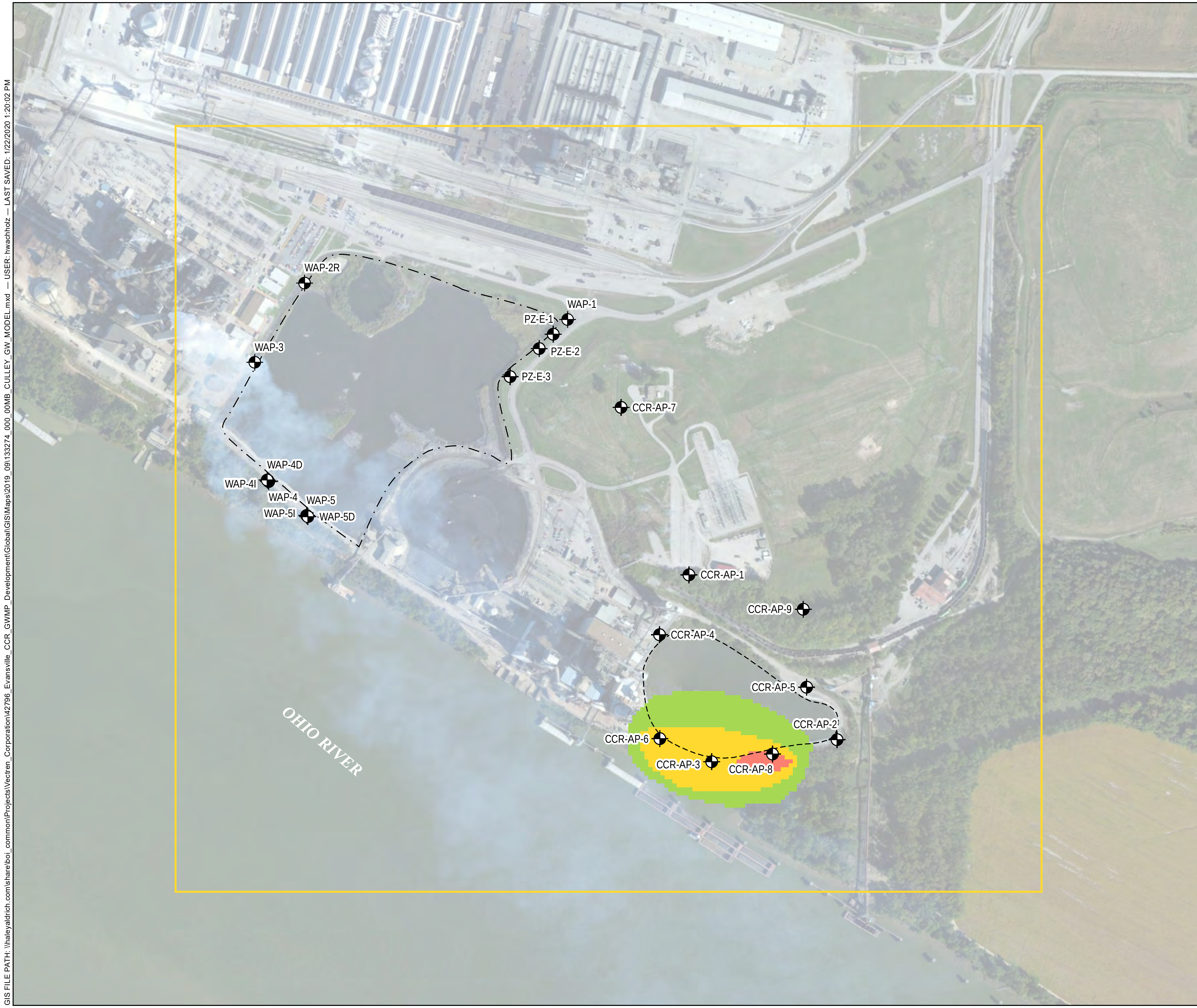
HALEY ALDRICH

CORRECTIVE MEASURE ASSESSMENT
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

SITE PLAN WITH RIVER BOUNDARY CONDITION FOR LAYER 14 AND 15

SEPTEMBER 2019

FIGURE 5



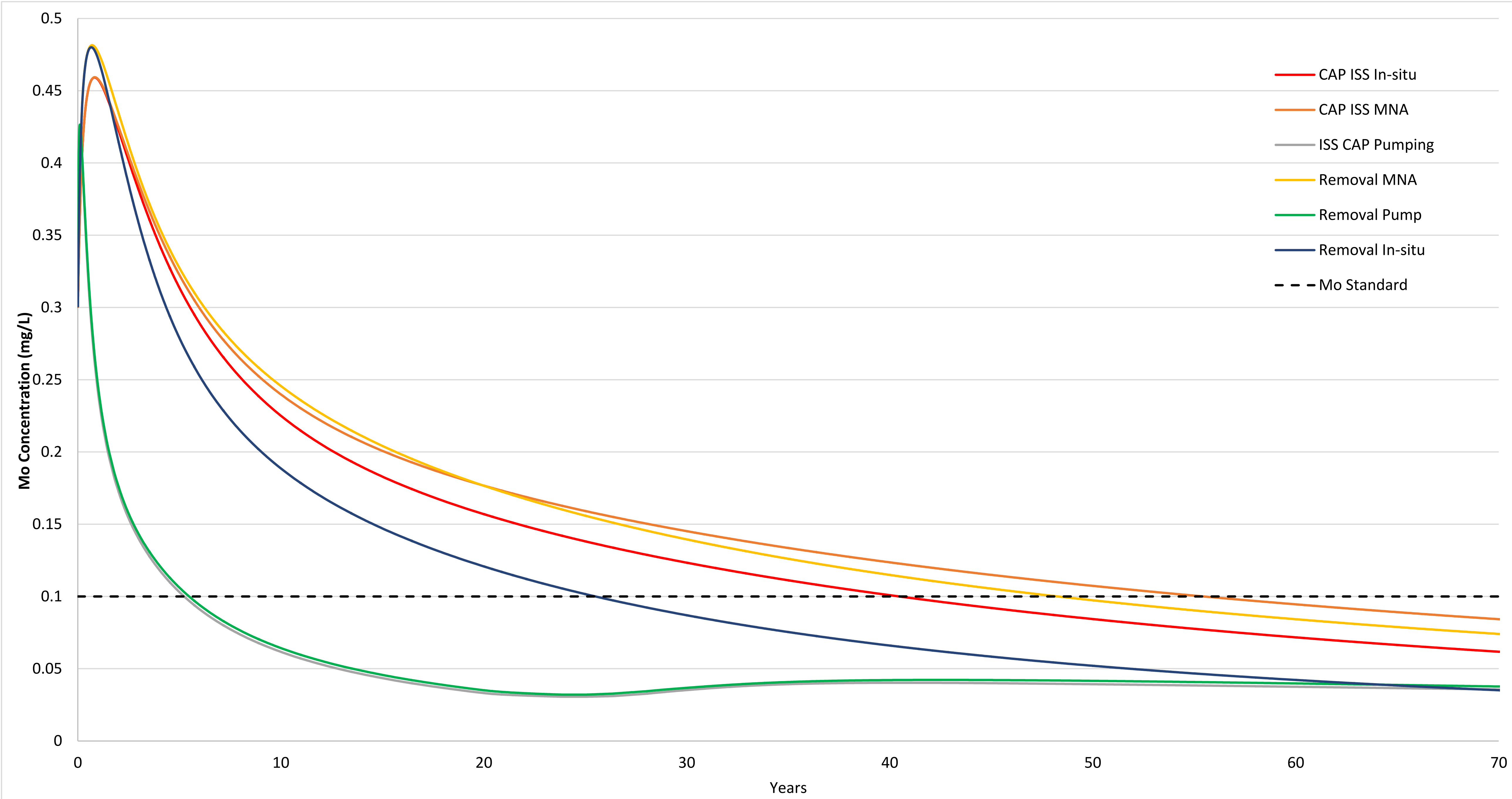
HALEY ALDRICH

CORRECTIVE MEASURE ASSESSMENT
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

INITIAL MOLYBDENUM CONCENTRATION FOR LAYERS 14 AND 15

SEPTEMBER 2019

FIGURE 7



NOTES:

1. Modeled Monitoring Well Located Approximately 200 Feet Downgradient from Pond Toward The River.

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

MODELED MOLYBDENUM CONCENTRATIONS FOR CMA OPTIONS OVER TIME

SEPTEMBER 2019

FIGURE 9

Appendix K
Progress Reports

HALEY & ALDRICH, INC.
400 Augusta Street
Suite 130
Greenville, SC 29601
864.214.8750

13 March 2020
File No. 129420

TO: Southern Indiana Gas and Electric Company

FROM: Haley & Aldrich, Inc.

SUBJECT: Semi-Annual Remedy Selection Progress Report Pursuant to 40 CFR §257.97(a)
F.B. Culley Generating Station - East Ash Pond

The Southern Indiana Gas and Electric Company (SIGECO) initiated corrective measures for the East Ash Pond at the F.B. Culley Generating Station (FBC) on 15 April 2019 in response to a statistically significant level (SSL) of an Appendix IV constituent exceeding Groundwater Protection Standards. Pursuant to 40 CFR §257.96(a), a demonstration of need for a 60-day extension for the assessment of corrective measures was completed on 12 July 2019. The Corrective Measures Assessment (CMA) Report was completed and placed in the facility operating record on 13 September 2019.

Following completion of the CMA, SIGECO must, as soon as feasible, select a remedy that meets the standards listed in 40 CFR §257.97(b). Pursuant to §257.97(a), the owner or operator of a Coal Combustion Residual (CCR) management unit that has completed a CMA for groundwater shall prepare a semi-annual report describing the progress in selecting and designing the remedy. This report constitutes the first semi-annual remedy selection progress report and is comprised of activities during the period of 13 September 2019 through 13 March 2020. A summary of the progress in selecting a remedy is provided below.

SUMMARY OF ACTIONS COMPLETED

The following actions have been completed during this reporting period:

- Discussions between Haley & Aldrich and SIGECO representatives to further evaluate the details and feasibility of potential corrective measures identified by the completed CMA.
- Efforts to determine the nature and extent (N&E) of the Appendix IV SSLs continued pursuant to § 257.95(g). Groundwater samples were collected from the N&E monitoring wells in November 2019. The analytical results will be used to supplement and enhance the evaluation of the extent of groundwater impacts and assessment of corrective measures. Groundwater characterization of the N&E monitoring wells is ongoing.
- Refined the remediation cost estimates and timelines associated with closure alternatives and potential corrective measures included in the CMA.
- Reviewed regulatory programs potentially related to closure alternatives and potential corrective measures, as well as existing environmental permits.
- Initiated an evaluation of the potential for beneficial use of CCR contained in the EAP.

PLANNED ACTIVITIES

Anticipated activities for the upcoming six months include the following:

- Conduct semiannual groundwater sampling in May consistent with 257.95(b) and (d)(1).
- Continue to evaluate the potential for beneficial use of CCR contained in the EAP.
- Continue to evaluate engineering aspects of closure alternatives and connectivity to potential corrective measures.

HALEY & ALDRICH, INC.
400 Augusta Street
Suite 130
Greenville, SC 29601
864.214.8750

22 September 2020
File No. 129420

TO: Southern Indiana Gas and Electric Company

FROM: Haley & Aldrich, Inc.

SUBJECT: Semi-Annual Remedy Selection Progress Report Pursuant to 40 CFR §257.97(a)
F.B. Culley Generating Station - East Ash Pond

The Southern Indiana Gas and Electric Company (SIGECO) initiated corrective measures for the East Ash Pond at the F.B. Culley Generating Station (FBC) on 15 April 2019 in response to a statistically significant level (SSL) of an Appendix IV constituent exceeding Groundwater Protection Standards. Pursuant to 40 CFR §257.96(a), a demonstration of need for a 60-day extension for the assessment of corrective measures was completed on 12 July 2019. The Corrective Measures Assessment (CMA) Report was completed and placed in the facility operating record on 13 September 2019.

Following completion of the CMA, SIGECO must, as soon as feasible, select a remedy that meets the standards listed in 40 CFR §257.97(b). Pursuant to §257.97(a), the owner or operator of a Coal Combustion Residual (CCR) management unit that has completed a CMA for groundwater shall prepare a semi-annual report describing the progress in selecting and designing the remedy. This report constitutes the second semi-annual remedy selection progress report and documents activities completed during the period of 13 March 2020 through 13 September 2020. A summary of the progress in selecting a remedy is provided below.

SUMMARY OF ACTIONS COMPLETED

The following actions have been completed during this reporting period:

- Discussions between Haley & Aldrich and SIGECO representatives to further evaluate the details and feasibility of potential corrective measures identified by the completed CMA.
- Efforts to corroborate the nature and extent (N&E) of the Appendix IV SSLs continued pursuant to § 257.95(g). Groundwater samples were collected from the N&E monitoring wells in May 2020. The analytical results will be used to supplement and enhance the evaluation of the extent of groundwater impacts and assessment of corrective measures. Groundwater characterization of the N&E monitoring wells is ongoing.
- Refined the remediation cost estimates and timelines associated with closure alternatives and potential corrective measures included in the CMA.
- Reviewed regulatory programs potentially related to closure alternatives and potential corrective measures, as well as existing environmental permits.
- Continued the evaluation of the potential for beneficial use of CCR contained in the EAP.

- Met with consultant to identify and review considerations/technical implications and potential benefits of reducing the contaminants leaching from the CCR unit prior to unit closure;
- Began preparations for public meeting;

PLANNED ACTIVITIES

Anticipated activities for the upcoming six months include the following:

- Conduct semiannual groundwater sampling in November consistent with 257.95(b) and (d)(1).
- Continue evaluation of the potential for beneficial use of CCR contained in the EAP.
- Complete evaluation of engineering aspects of closure alternatives and connectivity to potential corrective measures.
- Hold public meeting and begin to evaluate community input provided at meeting as part of the selection of remedy process.

Appendix L
Structural Stability Assessment

AECOM

Submitted to
Southern Indiana
Gas & Electric Company
dba Vectren Power
Supply, Inc., (SIGECO)
One Vectren Square
Evansville, IN 47708

Submitted by
AECOM
9400 Amberglen Boulevard
Austin, Texas 78729

October 13, 2016

CCR Certification:

Initial Structural Stability Assessment

§257.73 (d)

for the

East Ash Pond

at the

F. B. Culley Generating Station

Revision 0

Table of Contents

Tables

Appendices

Executive Summary

This Coal Combustion Residuals (CCR) Initial Structural Stability Assessment (Structural Stability Assessment) for the East Ash Pond at the Southern Indiana Gas & Electric Company dba Vectren Power Supply, Inc., F.B. Culley Generating Station has been prepared in accordance with the requirements specified in the USEPA CCR Rule under 40 Code of Federal Regulations §257.73 (d)(1). These regulations require that the specified documentation, assessments and plans for an existing CCR surface impoundment be prepared by October 17, 2016.

This Structural Stability Assessment for the East Ash Pond meets the regulatory requirements as summarized in **Table ES-1**.

Table ES-1 – Certification Summary				
Report Section	**CCR Rule Reference**	**Requirement Summary**	**Requirement Met?**	**Comments**
2.1	§257.73 (d)(1)(i)	*Foundations and Abutments*	Yes	The CCR Unit has stable foundations
2.2	§257.73 (d)(1)(ii)	*Slope Protections*	Yes	The CCR Unit has sufficient slope protection
2.3	§257.73 (d)(1)(iii)	*Dike Compaction*	Yes	The CCR Unit has appropriate dike Compaction
2.4	§257.73 (d)(1)(iv)	*Vegetated Slopes*	Yes	The CCR Unit has vegetated slopes or other forms of protection
2.5	§257.73 (d)(1)(v)	*Spillways*	Yes	The CCR Unit spillways are sufficient for the 1000 year event
2.6	§257.73 (d)(1)(vi)	*Stability and Structural Integrity of Hydraulic Structures*	Yes	Hydraulic structures passing through the base of the unit are free from noticeable defects which may negatively affect the operation of the unit
2.7	§257.73 (d)(1)(vii)	*Downstream Slope Inundation / Stability*	Yes	The CCR Unit maintains structural stability during low pool or sudden drawdown of adjacent water body

The Culley East Ash Pond is currently an active surface impoundment. All structural stability assessment requirements were evaluated and the surface impoundment was found to meet all requirements as required within each individual structural stability assessment in §257.73 (d)(1).

1 Introduction

1.1 Purpose of this Report

The purpose of the Initial Structural Stability Assessment (Structural Stability Assessment) presented in this report is to document that the requirements specified in 40 Code of Federal Regulations (CFR) §257.73 (d) have been met to support the certification required under each of the applicable regulatory provisions for the F. B. Culley Generating Station (Culley) East Ash Pond. The East Ash Pond is an existing coal combustion residual (CCR) surface impoundment as defined by 40 CFR §257.53. The CCR Rule requires that the Structural Stability Assessment for an existing CCR surface impoundment be prepared by October 17, 2016.

The following table summarizes the documentation required within the CCR Rule and the sections that specifically respond to those requirements of this assessment.

Table 1-1 – CCR Rule Cross Reference Table

Report Section	Title	CCR Rule Reference
2.1	Foundations and Abutments	§257.73 (d)(1)(i)
2.2	Slope Protection	§257.73 (d)(1)(ii)
2.3	Dike Compaction	§257.73 (d)(1)(iii)
2.4	Vegetated Slopes	§257.73 (d)(1)(iv)
2.5	Spillways	§257.73 (d)(1)(v)
2.6	Stability and Structural Integrity of Hydraulic Structures	§257.73 (d)(1)(vi)
2.7	Downstream Slope Inundation / Stability	§257.73 (d)(1)(vii)

1.2 Brief Description of Impoundment

The Culley station is located in Warrick County, Indiana, southeast of Newburgh, Indiana, and is owned and operated by Southern Indiana Gas and Electric Company, dba Vectren Power Supply Inc. (SIGECO). The Culley station is located along the north bank of the Ohio River and the west bank of the Little Pigeon Creek along the southeast portion of the site. Culley has two CCR surface impoundments, identified as the West Ash Pond and the East Ash Pond. Only the East Ash Pond is actively receiving CCR materials. The East Ash Pond is located directly east of the station and is approximately 10 acres in size.

The East Ash Pond was commissioned in or around 1971. Earthen embankments were constructed along the south and east sides of the impoundment. Structural fill used for the original construction of the Culley station in the 1950's borders the impoundment to the west side, and west end of the north side. The east embankment intersects a natural hillside on the east end of the north side of the impoundment. The embankment is approximately 1,200 feet long, 30 feet high, and has 2.4 to 1 (horizontal to vertical) exterior side slopes covered with grassy vegetation. Interior side slopes varied from 2.5 to 1 (horizontal to vertical) to 2 to 1 (horizontal to vertical) for the upper and lower portion of the embankment, respectively. The embankment crest elevation varies from 392.67 feet[1] to 396.42 feet and has a crest width of approximately 15 feet. The surface area of the impoundment is approximately 9.8 acres. Within the pond, there are several small pools that are being utilized for treatment and separation of CCR material within the pond as part of an ongoing construction project. The ponding water has a surface area of approximately 2.56 acres and has normal operating level of 387 feet.

A site Location Map showing the area surrounding the station is included as **Figure 1** of **Appendix A**. **Figure 2** in **Appendix A** presents the Culley Site Map.

[1] Unless otherwise noted, all elevations in this report are in the NAVD88 datum.

2 Structural Stability Assessment Description

Regulatory Citation: 40 CFR §257.73 (d)(1);

- *The owner or operator of the CCR unit must conduct initial and periodic structural stability assessments and document whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein. The assessment must, at a minimum, document whether the CCR unit has been designed, constructed, operated, and maintained with [the standards in (d)(1)(i)-(vii)]:*

The Structural Stability Analysis for the East Ash Pond is described in this section. Information about operational and maintenance procedures was provided by Culley plant personnel. The Culley station follows an established maintenance program that quickly identifies and resolves issues of concern.

2.1 Foundations and Abutments

Regulatory Citation: 40 CFR §257.73 (d)(1);

- *(i) Stable foundations and abutments;*

Background and Assessment

The stability of the foundations was evaluated using soil data from field investigations and reviewing design drawings, operational and maintenance procedures, and conditions observed in the field by AECOM. Additionally, slope stability analyses were performed to evaluate slip surfaces passing through the foundations.

The foundation soils consist of medium stiff to very stiff clay and loose to medium sandy soils. Medium stiff to stiff clay soils indicate stable foundations. While the sands may be susceptible to liquefaction as a result of strong earthquake shaking, liquefaction analysis concluded that a liquefaction of a continuous layer is not anticipated. Furthermore, the slope stability analyses exceed the criteria listed in §257.73 (e)(1) for slip surfaces passing through the foundation (including the post-liquefaction loading condition). Therefore, the foundation soils are considered to be stable under all loading conditions. The slope stability analyses are discussed in the *CCR Certification Report: Initial Safety Factor Assessment for the East Ash Pond at the F.B. Culley Generating Station* (October 2016). A review of operational and maintenance procedures as well as current and past performance of the dikes has determined appropriate processes are in place for continued operational performance.

Conclusion and Recommendation

Based on the conditions observed by AECOM, the East Ash Pond was designed and constructed with stable foundations. Operational and maintenance procedures are in place to address any issues related to the stability of foundations.

Therefore, the East Ash Pond meets the requirements in §257.73 (d)(1)(i).

2.2 Slope Protection

Regulatory Citation: 40 CFR §257.73 (d)(1);

- *(ii) Adequate slope protection to protect against surface erosion, wave action and adverse effects of sudden drawdown;*

Background and Assessment

The adequacy of slope protection was evaluated by reviewing design drawings, operational and maintenance procedures, and conditions observed in the field by AECOM.

The exterior slopes of the embankment are covered with a combination of grass vegetation, concrete rubble, some rip-rap, and scrub brush. The toe of the embankment includes sparse trees that help to stabilize the embankment against erosion. The interior slopes of the embankment are covered with rip-rap which has an approximate median diameter of 15-inches. No evidence of significant areas of erosion or wave action was observed during AECOM's site visit on February 23, 2016. See **Appendix B** for further details from AECOM's site visit.

Conclusion and Recommendation

Based on this evaluation, adequate slope protection was designed and constructed at the East Ash Pond. The slopes show no evidence of significant areas of erosion or wave action. Operational and maintenance procedures to repair the vegetation and rip-rap (exterior slopes) and rip-rap (interior slopes) as needed are appropriate to protect against surface erosion or wave action. See **Section 2.7** of this report for further information on sudden drawdown.

Therefore, the East Ash Pond meets the requirements in §257.73 (d)(1)(ii).

2.3 Dike Compaction

Regulatory Citation: 40 CFR §257.73 (d)(1)

- *(iii) Dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit;*

Background and Assessment

The density of the dike materials was evaluated using soil data from field investigations and reviewing design drawings, operational and maintenance procedures, and conditions observed in the field by AECOM. Additionally, slope stability analyses were performed to evaluate slip surfaces passing through the dike over the range of expected loading conditions as defined within §257.73 (e)(1).

Based on the evaluation, the dike consists of medium to very stiff material, which is indicative of mechanically compacted dikes. Slope stability analyses exceed the criteria listed in §257.73 (e)(1) for slip surfaces passing through the dike. The slope stability analyses and results are discussed in the *CCR Certification: Safety Factor Assessment Report for the East Ash Pond at the F. B. Culley Generating Station* (October 2016).

Conclusion and Recommendation

Based on the conditions observed by AECOM, the East Ash Pond was designed and constructed with sufficient dike compaction.

Therefore, the East Ash Pond meets the requirements in §257.73 (d)(1)(iii).

2.4 Vegetated Slopes

Regulatory Citation: 40 CFR §257.73 (d)(1)

- *(iv) Vegetated slopes of dikes and surrounding areas, except for slopes which have an alternate form or forms of slope protection;*[2]

Background and Assessment

The adequacy of slope vegetation and protection was evaluated by reviewing design drawings, operational and maintenance procedures, and conditions observed in the field by AECOM.

The exterior slopes of the embankments are covered with grass vegetation, concrete rubble, rip-rap, and scrub brush. The toe of the embankment includes sparse trees that stabilize the embankment against erosion. No evidence of significant areas of erosion was observed during AECOM's site visit on February 23, 2016. See **Appendix B** for further details from AECOM's site visit.

Conclusion and Recommendation

Based on this evaluation, the vegetation and/or slope protection on the exterior slopes of the embankments is adequate as no substantial erosion areas were observed. Therefore, the original design and construction of the East Ash Pond included adequate vegetation or slope protection of the dikes and surrounding areas. Adequate operational and maintenance procedures are in place to regularly manage vegetation growth, including mowing and seeding any bare areas, and to address erosional issues as they occur, as evidenced by the conditions observed by AECOM.

Therefore, the East Ash Pond meets the requirements in §257.73 (d)(1)(iv).

2.5 Spillways

Regulatory Citation: 40 CFR §257.73 (d)(1)

- *(v) single spillway or a combination of spillways configured as specified in [paragraph (A) and (B)]:*
  - *(A) All spillways must be either:*
    - *(1) of non-erodible construction and designed to carry sustained flows; or*
    - *(2) earth- or grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected.*

[2] As modified by court order issued June 14, 2016, Utility Solid Waste Activities Group v. EPA, D.C. Cir. No. 15-1219 (order granting remand and vacatur of specific regulatory provisions).

- *(B) The combined capacity of all spillways must adequately manage flow during and following the peak discharge from a:*
  - *(1) Probable maximum flood (PMF) for a high hazard potential CCR surface impoundment; or*
  - *(2) 1000-year flood for a significant hazard potential CCR surface impoundment; or*
  - *(3) 100-year flood for a low hazard potential CCR surface impoundment.*

Background and Assessment

The current primary discharge method at the Culley station consists of two portable, diesel-powered pumps located in the main pool in the west side of the East Ash Pond. This was evaluated using operational and maintenance procedures, and conditions observed in the field by AECOM. The permanent discharge method, although not currently in use, consists of a pump station and was evaluated using design drawings, operational and maintenance procedures, and conditions observed ni the field by AECOM.

The two portable, diesel-powered pumps are currently the only method to discharge from the East Ash Pond. A riser spillway was present in the southeast portion of the East Ash Pond which had discharged to the Little Pigeon Creek but was previously plugged with concrete and abandoned. The two portable, diesel-powered pumps have a capacity of 2,000 gpm and connect to the existing 10-inch high density polyethylene (HDPE) pipe from the East Ash Pond Pump Station that connects to an 84-inch reinforced concrete pipe which ultimately empties into an underground 12-foot wide by 11-foot high pre-cast concrete discharge tunnel.

The East Pump Station, which is currently not in use, consists of a 12 foot concrete weir that collects runoff and two, 5,400 gpm submersible pumps, which operate at 2,180 gpm each, connected to the existing 10 inch HDPE pipe that connects to the 84-inch reinforced concrete pipe as described above. The condition of the pump station was observed in the field by AECOM February 23, 2016. See Site Visit Report in **Appendix B** for additional details. The concrete weir and the discharge piping of the pump station are non-erodible material, while the cast-in-place reinforced concrete tunnel is designed to prevent erosion.

Additionally, hydrologic and hydraulic analyses were completed to evaluate the capacity of the discharge method relative to inflow estimated for the 1,000-year flood event for the significant hazard potential of the East Ash Pond. The ability of the design to carry sustained flows, as well as the capacity, was evaluated using hydrologic and hydraulic analysis performed per §257.82(a). The hydrologic and hydraulic analyses are discussed in the *CCR Certification: Initial Inflow Design Flood Control System Plan for the East Ash Pond at the F.B. Culley Generating Station* (October 13, 2016).

Conclusion and Recommendation

The current and permanent primary discharge method, the pump station structure, weir structure, discharge piping of the pump station, and cast-in-place reinforced concrete discharge tunnel are constructed of non-erodible materials.

The analysis found that the discharge method can adequately manage flow during peak discharge resulting from the 1,000-year storm event without overtopping of the embankments. The peak water surcharge elevation is 391.01 feet during the IDF, and the minimum crest elevation of the East Ash Pond dike is 392.67 feet, resulting in 1.66 feet of freeboard. This also indicates that the design is adequate to carry sustained flows. Operational and maintenance procedures are in place to remove debris or other obstructions, if observed after normal inspections. As a result, these procedures are appropriate for maintaining sufficient discharge rate.

Therefore, the East Ash Pond meets the requirements in §257.73 (d)(1)(v).

2.6 Stability and Structural Integrity of Hydraulic Structures

Regulatory Citation: 40 CFR §257.73 (d)(1)

- *(vi) Hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure*

Background and Assessment

Based on an evaluation of design drawings, operational and maintenance procedures, and conditions observed in the field by AECOM on February 23, 2016, no active hydraulic structures are present that underlie the base or pass through the dike of the East Ash Pond. A riser spillway was present in the southeast portion of the East Ash Pond which had discharged to the Little Pigeon Creek but was previously plugged with concrete and abandoned. There was no seepage observed on the outer slope of the embankment in the area opposite the previous spillway. See the Site Visit report in **Appendix B** for additional information from AECOM's site visit.

Conclusion and Recommendation

The only penetration through the East Ash Pond embankment has previously been plugged and abandoned and is no longer active. There is no evidence of seepage from this structure or along the exterior of the structure. Therefore, the East Ash Pond meets the requirements in §257.73 (d)(1)(vi).

2.7 Downstream Slope Inundation / Stability

Regulatory Citation: 40 CFR §257.73 (d)(1)

- *(vii) For CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body.*

Background and Assessment

The structural stability of the downstream slopes of the East Ash Pond was evaluated by comparing the location of the East Ash Pond relative to adjacent water bodies using published United States Geological Survey (USGS) topographic maps, aerial imagery, and conditions observed in the field by AECOM.

Based on this evaluation, the Ohio River can inundate the downstream slopes of the East Ash Pond. The 100 year flood of the Ohio River has an elevation of approximately 384 feet, while the toe of the East Ash Pond embankment has an elevation of approximately 364 feet. Therefore the Ohio River can inundate the embankment by roughly 20 feet. A sudden drawdown slope stability analysis was performed at the worst case cross-section adjacent to the downstream water body, and considered a drawdown of the flood pool in the downstream water body from a flood elevation to normal pool condition. The resulting factor of safety was found to satisfy the criteria listed in United States Army Corps of Engineers Engineer Manual 1110-2-1902 for drawdown. See AECOM's *CCR Certification: Slope Stability Analysis for the East Ash Pond at the F.B. Culley Generating Station* (October 13, 2016) for the full analysis.

Conclusion and Recommendation

The East Ash Pond embankment is stable in the event of sudden drawdown from the adjacent Ohio River. Therefore, the East Ash Pond meets the requirements in §257.73 (d)(1)(vii).

3 Certification

This Certification Statement documents that the East Ash Pond at the F. B. Culley Generating Station meets the Initial Structural Stability Assessment requirements specified in 40 CFR §257.73 (d). The East Ash Pond is an existing CCR surface impoundment as defined by 40 CFR §257.53. The CCR Rule requires that the Initial Structural Stability Assessment for an existing CCR surface impoundment be prepared by October 17, 2016.

CCR Unit: Southern Indiana Gas & Electric Company; F. B. Culley Generating Station; East Ash Pond

I, Jeremy Thomas, being a Registered Professional Engineer in good standing in the State of Indiana, do hereby certify, to the best of my knowledge, information, and belief that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above referenced CCR Unit, that the Initial Structural Stability Assessment dated October 13, 2016 meets the requirements of 40 CFR § 257.73 (d).

Jeremy Thomas

Printed Name

10-13-16

Date

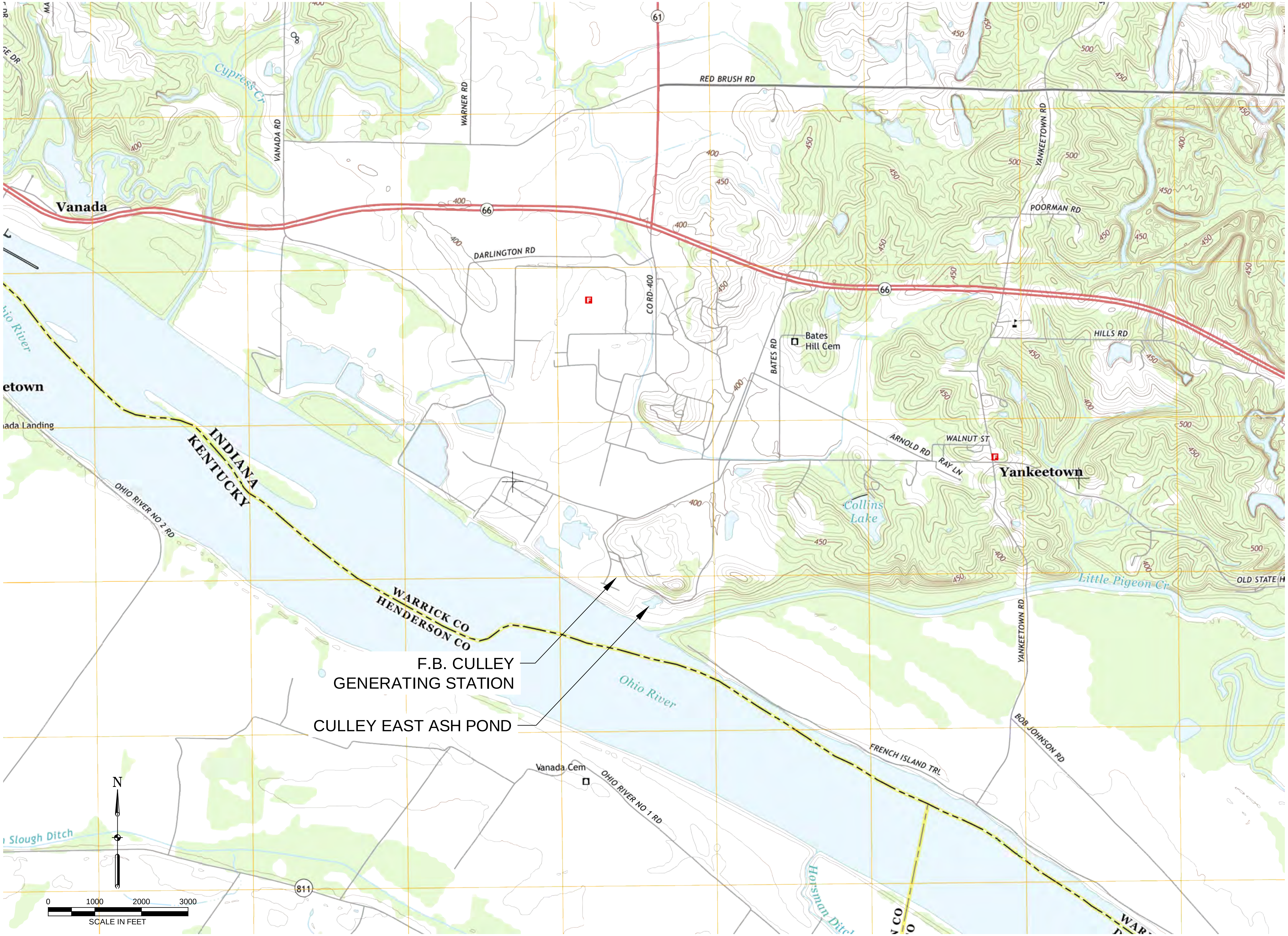
4 Limitations

Background information, design basis, and other data which AECOM has used in preparation of this report have been furnished to AECOM by SIGECO. AECOM has relied on this information as furnished, and is not responsible for the accuracy of this information. Our recommendations are based on available information from previous and current investigations. These recommendations may be updated as future investigations are performed.

The conclusions presented in this report are intended only for the purpose, site location, and project indicated. The recommendations presented in this report should not be used for other projects or purposes. Conclusions or recommendations made from these data by others are their responsibility. The conclusions and recommendations are based on AECOM's understanding of current plant operations, maintenance, stormwater handling, and ash handling procedures at the station, as provided by SIGECO. Changes in any of these operations or procedures may invalidate the findings in this report until AECOM has had the opportunity to review the findings, and revise the report if necessary.

This development of the Initial Structural Stability Assessment was performed in accordance with the standard of care commonly used as state-of-practice in our profession. Specifically, our services have been performed in accordance with accepted principles and practices of the engineering profession. The conclusions presented in this report are professional opinions based on the indicated project criteria and data available at the time this report was prepared. Our services were provided in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation is intended.

Appendix A
Figures



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AECOM DRAWING PATH: P:\Projects\Environmental\60442676_VectrenCCR\7.0_CAD_GIS\7.04_Plan_Sheets\CULLEY-LOCATION MAP.dwg

AECOM
9400 Amberglen Boulevard
Austin, TX 78729-1100
512-454-4797 (phone)
512-454-8807 (fax)

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY dba VECTREN POWER SUPPLY, INC.

One Vectren Square
Evansville, IN 47708
1-800-227-1376 (phone)

F.B. CULLEY GENERATING STATION
NEWBURGH, IN

CCR CERTIFICATION
EAST ASH POND

ISSUED FOR CERTIFICATION

ISSUED FOR BIDDING — DATE — BY

ISSUED FOR CONSTRUCTION — DATE — BY

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

AECOM PROJECT NO:	60442676
DRAWN BY:	MJC
DESIGNED BY:	MJC
CHECKED BY:	TLE
DATE CREATED:	8/18/2016
PLOT DATE:	4/22/2016
SCALE:	AS SHOWN
ACAD VER:	2014

SHEET TITLE

LOCATION MAP

FIGURE 1

CARUSO, MICHAEL 10/7/2016 3:13 PM

AECOM DRAWING PATH: P:\Projects\Environmental\60442676_VectrenCCR\7.0_CAD_GIS\7.04_Plan_Sheets\CULLEY-SITE MAP.dwg

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F.B. CULLEY
GENERATING STATION
NEWBURGH, IN

CCR CERTIFICATION
EAST ASH POND

ISSUED FOR CERTIFICATION

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PLOT DATE:	4/22/2016
SCALE:	AS SHOWN
ACAD VER:	2014

SHEET TITLE

SITE MAP

FIGURE 2

Appendix B
AECOM Site Visit Report

STATION SITE VISIT SUMMARY

AECOM

Station: F.B. Culley Generating Station
Station Location: Indiana
Site Visit Date: 02/23/2016
Prepared by: Teresa L. Entwistle, PE (AECOM)
Checked by: John Davis, PE (AECOM)
ITR by: Vik Gautam, PE (AECOM)
Distribution to: File

Background:

AECOM engineering and program management team visited the F.B. Culley Generating Station (Culley) and were accompanied by Vectren personnel. AECOM personnel inspected the East Ash Pond at the Culley station to assess the unit in regards to the CCR Rule and to better understand the operating methods of the surface impoundment for the analysis required under the CCR Rule. Engineering design personnel that toured the facility included Teresa Entwistle, John Davis, Vik Gautam, and John Priebe. AECOM program management personnel included Tommy Bell, Milton Owen, Ty Cloud and Steven Kosler. Vectren personnel present included Lisa Messinger, Chris Leslie, and John Minnette.

Summary of Observation/Comments on Site Visit:

AECOM performed a visual inspection of the East Ash Pond and the areas surrounding the East Ash Pond. Inspections were conducted from the top of the unit along an access road and from the base of the impoundment via an access road between the unit and the Ohio River. The surface impoundment is a partially incised unit that includes an access road surrounding the entire unit. The north side is cut into a hill and the south and east sides were created by the construction of the southern and eastern berms. The surface impoundment is bounded on the west by the generating station.

Drainage into the surface impoundment is from floor and surface drains within the generating station pumped into the surface impoundment, rainfall falling directly onto the surface impoundment and from runoff from an area immediately north of the access road. Discharge from the unit is via an active pumping station that pumps to a stormwater system under the generating station prior to discharge via a permitted NPDES outfall to the Ohio River. Per Vectren personnel, the unit previously included an auxiliary overflow located in the western portion of the surface impoundment, and this structure has been plugged and abandoned. No seepage was observed on the exterior of the berm at the previous location of this penetration.

No downstream structures were observed between the unit and the Ohio River.

The surface impoundment is north of the Ohio River which is located south of the toe of the unit's southern embankment. Slope protection included gravel and concrete pieces, scrub grass and established trees along the most southern portion of the embankment at the toe. Upon inspection of the exterior of the southern and eastern berms, no seepage was observed, minimal sloughing was observed and minor surficial erosion was present. Vectren personnel were verbally advised of these issues and were advised to correct them.

Photo No. 1	Date: 02/23/2016	
Location: F.B. Culley Generating Station		
Description: Standing at west end of southern berm, looking east. Picture shows slope protection of southern berm. Photographer: Entwistle		
Photo No. 2	Date: 02/23/2016	
Location: F.B. Culley Generating Station		
Description: Standing midway along southern berm, looking downslope. Picture shows minor surficial erosion to be addressed by Vectren. Photographer: Entwistle		

Photo No. 3	Date: 02/23/2016	
Location: F.B. Culley Generating Station		
Description: Standing midway along southern berm, looking east. Picture shows slope protection. Photographer: Entwistle		
Photo No. 4	Date: 02/23/2016	
Location: F.B. Culley Generating Station		
Description: Standing midway along southern berm, looking back over surface impoundment. Picture shows stability of northern berm into surface impoundment. Photographer: Entwistle		

<table>
<tr><td>Photo No. 5</td><td>Date: 02/23/2016</td><td rowspan="3"></td></tr>
<tr><td colspan="2">Location: F.B. Culley Generating Station</td></tr>
<tr><td colspan="2">Description:
Standing along the base of the west side of the impoundment, looking south.

Picture shows adequate slope protection and no evidence of seepage.

Photographer: Entwistle</td></tr>
<tr><td>Photo No. 6</td><td>Date: 02/23/2016</td><td rowspan="3"></td></tr>
<tr><td colspan="2">Location: F.B. Culley Generating Station</td></tr>
<tr><td colspan="2">Description:
Standing along the base of the south side of the impoundment, looking east.

Picture shows adequate slope protection and no evidence of seepage or sloughing.

Photographer: Entwistle</td></tr>
</table>

Photo No. 7	Date: 02/23/2016	
Location: F.B. Culley Generating Station		
Description: Standing on the southeast corner of the berm looking at plugged and abandoned auxiliary spillway. Photographer: Entwistle		
Photo No. 8	Date: 11/04/2015	
Location: F.B. Culley Generating Station		
Description: Pumping station for discharge into and out of surface impoundment. . Photographer: Entwistle		

About AECOM

AECOM (NYSE: ACM) is a global provider of professional technical and management support services to a broad range of markets, including transportation, facilities, environmental, energy, water and government. With approximately 45,000 employees around the world, AECOM is a leader in all of the key markets that it serves. AECOM provides a blend of global reach, local knowledge, innovation, and collaborative technical excellence in delivering solutions that enhance and sustain the world's built, natural, and social environments. A Fortune 500 company, AECOM serves clients in more than 100 countries and has annual revenue in excess of $6 billion..

9400 Amberglen Boulevard
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Appendix M
Safety Factor Assessment

Submitted to:
Southern Indiana
Gas & Electric Company
dba Vectren Power
Supply, Inc. (SIGECO)
One Vectren Square
Evansville, IN 47708

Submitted by
AECOM
9400 Amberglen Boulevard
Austin, Texas 78729

October 13, 2016

CCR Certification:
Safety Factor Assessment
§257.73 (e)

for the

East Ash Pond

at the

F.B. Culley Power Station

Revision 0

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Executive Summary

This Coal Combustion Residuals (CCR) Safety Factor Assessment for the East Ash Pond at the Southern Indiana Gas & Electric Company, dba Vectren Power Supply, Inc., F.B. Culley Generating Station has been prepared in accordance with the requirements specified in the USEPA CCR Rule under 40 Code of Federal Regulations §257.73 (e)(1). These regulations require that the specified documentation, assessments and plans for an existing CCR surface impoundment be prepared by October 17, 2016.

The East Ash Pond meets the regulatory requirements for the safety factor assessment analysis, as summarized in **Table ES-1**.

Table ES-1 – Certification Summary

Report Section	CCR Rule Reference	Requirement Summary	Requirement Met?	Comments
Safety Factor Assessment				
6.1	§257.73 (e)(1)(i)	*Maximum storage pool safety factor must be at least 1.50*	Yes	Safety factors were calculated to be 1.87 and higher.
6.1	§257.73 (e)(1)(ii)	*Maximum surcharge pool safety factor must be at least 1.40*	Yes	Safety factors were calculated to be 1.68 and higher.
6.2	§257.73 (e)(1)(iii)	*Seismic safety factor must be at least 1.00*	Yes	Safety factors were calculated to be 1.02 and higher.
6.2	§257.73 (e)(1)(iv)	*Liquefaction safety factor must be at least 1.20*	Yes	Safety factors were calculated to be 1.70 and higher.

1 Introduction

1.1 Purpose of this Report

The purpose of the Safety Factor Assessment is to document that the requirements specified in 40 Code of Federal Regulations (CFR) §257.73 (e) have been met to support the certification required under each of the applicable regulatory provisions for the F.B. Culley Generating Station (Culley) East Ash Pond. The East Ash Pond is an existing CCR surface impoundment as defined by 40 CFR §257.53. The CCR Rule requires that the Safety Factor Assessment for an existing CCR surface impoundment be prepared by October 17, 2016.

Table 1-1 – CCR Rule Cross Reference Table

Report Section	Title	CCR Rule Reference
6.1	Factor of Safety: Maximum Storage Pool Loading	§257.73 (e)(1)(i)
6.1	Factor of Safety: Maximum Surcharge Pool Loading	§257.73 (e)(1)(ii)
6.2	Factor of Safety: Seismic	§257.73 (e)(1)(iii)
6.2	Factor of Safety: Post-Liquefaction	§257.73 (e)(1)(iv)

The purpose of the geotechnical investigation and analyses is to evaluate the design, performance, and condition of the impoundment and associated structures using available design drawings, construction records, inspection reports, previous engineering investigations, reports and analyses, Station operating records, and other pertinent documents. This information combined with subsurface investigations, laboratory testing, and engineering analyses was used to evaluate the design and operation of the surface impoundment using current regulatory and engineering practice, and to identify potential geotechnical deficiencies that may require additional investigation, repair or remediation. The regulatory criteria and current engineering practice related to the design of coal combustion residual's (CCR) ash impoundments were used as guidance during development of geotechnical analysis and stability evaluations.

The AECOM geotechnical field evaluation was conducted between November 9 and November 13, 2015 and between March 25 and March 30, 2016. The field program consisted of conventional hollow stem auger (HSA) borings, Standard Penetration Testing (SPT), and Cone Penetration testing (CPT). Laboratory testing was conducted on the materials obtained through various sampling techniques to assist in characterization of the subsurface conditions.

Stability analyses were performed by AECOM to evaluate the potential for slope instabilities, in accordance with the EPA regulation 40 CFR 257.73(d) and (e). The potential for slope instability is dependent on factors such as slope geometry, groundwater/phreatic surface conditions, and shear strengths of the embankment and foundation soils. A summary of the geotechnical field program, laboratory testing program and stability evaluations are presented in the following sections.

1.2 Brief Description of Impoundment

The Culley station is located in Warrick County, Indiana, southeast of Newburgh, Indiana, and is owned and operated by Southern Indiana Gas and Electric Company, dba Vectren Power Supply Inc. (SIGECO). The Culley station is located along the north bank of the Ohio River and the north bank of the Little Pigeon Creek along the southeast portion of the site. Culley has two CCR surface impoundments, identified as the West Ash Pond and the East Ash Pond. The East Ash Pond is located directly east of the station and is approximately 10 acres in size.

The East Ash Pond was commissioned in or around 1971. Earthen embankments were constructed along the south and east sides of the impoundment. Structural fill used for the original construction of the Culley station in the 1950's borders the impoundment to the west side, and west end of the north side. The east embankment intersects a natural hillside on the east end of the north side of the impoundment. The embankment is approximately 1,200 feet long, 30 feet high, and has 2.4 to 1 (horizontal to vertical) exterior side slopes covered with grassy vegetation. Interior side slopes varied from 2.5 to 1 (horizontal to vertical) to 2 to 1 (horizontal to vertical) for the upper and lower portion of the embankment, respectively. The embankment crest elevation varies from 392.67 feet[1] to 396.42 feet and has a crest width of approximately 15 feet. The surface area of the impoundment is approximately 9.8 acres. Within the pond, there are several small pools that are being utilized for treatment and separation of CCR material within the pond as part of an ongoing construction project. The ponding water has a surface area of approximately 2.56 acres and has normal operating level of 387 feet.

A site Location Map showing the area surrounding the station is included as **Figure 1** of **Appendix A**. **Figure 2** in **Appendix A** presents the Culley Site Map.

[1] Unless otherwise noted, all elevations in this report are in the NAVD88 datum.

2 Summary of Field Investigations

Sub-surface exploration programs were performed at the East Ash Pond dam in 2015, and included 9 soil borings, and program of 5, cone-penetration test (CPT) soundings, with seismic wave velocity measurements and pore pressure dissipation testing. Boring depths ranged from 62 to 94 ft, and CPT depths ranged from 32 to 96 ft below existing grades. Boring and CPT locations are depicted in **Figure 3 (Appendix A).** Boring and CPT exploration location data (ID, easting, northing, and ground surface elevation) are summarized in **Table 2-1**. Boring logs are provided in **Appendix B** and CPT data/plots are provided in **Appendix C.**

All borings were drilled by Cardno ATC (Cardno), of Indianapolis, Indiana, who was subcontracted directly to SIGECO. Two borings were drilled in early 2015. Seven additional borings were drilled in the scope of this assessment. AECOM borings B-1 to B-3 were drilled on the embankment in order to determine embankment material characteristics and B16-1 to B16-4 were drilled in the ash pond in order to characterize ash material. A total of 5 cone-penetration test (CPT) soundings with shear wave velocity measurement and pore pressure dissipation testing were conducted; 2 of them in early 2015 and 3 of them in the scope of this study.

CPT soundings were performed by Cardno ATC, with full-time oversight by an AECOM geotechnical engineer. The soundings were performed by Cardno using a GeoProbe 8040DT rig equipped to advance CPT tooling and instrumentation with real-time data collection. The SCPTu soundings were completed in accordance with ASTM D5778 and provided nearly continuous digital logging of tip and sleeve resistance and generated pore pressure with depth. Shear wave measurements were taken during soundings at two-meter intervals in order to provide a shear wave velocity profile for the subsurface materials to support seismic site response analyses. Pore pressure dissipation tests were conducted at selected locations in each sounding.

Representative soil samples were collected from each of the borings for classification and/or testing. The soil samples were obtained using split spoon samplers and in accordance with the Standard Penetration Test (SPT) methodology (ASTM D 1586). Undisturbed samples of fine-grained soils (silts and clays) were obtained using 3-inch outside diameter steel (Shelby) tubes, either conventionally pushed in accordance with ASTM D1587 or by utilizing a piston sampler in accordance with ASTM D6519 (in very soft soils). All of the soil samples selected for laboratory testing were delivered to the Terracon Laboratory in Vernon Hills, Illinois.

Table 2-1 – Boring and CPT Exploration Location Data			
Exploration ID	Easting (ft NAD83)	Northing (ft NAD83)	Elevation (ft NAVD88)
Borings			
AECOM-B1	2883408.9	969048.4	396.7
AECOM-B2	2884074.5	969096.5	395.1
AECOM-B3	2883759.4	969044.2	394.2
AECOM-B16-1	2883425.8	969314.4	391.0
AECOM-B16-2	2883550.3	969371.9	390.0
AECOM-B16-3	2883664.3	969297.0	390.0
AECOM-B16-4	2883708.8	969146.2	391.0
CARDNO-B-101	2883686.0	969020.0	394.5
CARDNO-B-102	2883360.0	969085.0	397.1
CPT Soundings			
AECOM-C1	2883760.1	969036.4	394.2
AECOM-C2	2883911.5	969062.9	393.9
AECOM-C2A	2883911.5	969062.9	393.9

3 Summary of Site-Specific Subsurface Conditions

3.1 Site Stratigraphy

3.1.1 Regional Geologic Setting

The Culley station is located on a terrace that is above the Ohio River normal pool elevation. Based upon site reconnaissance observations, it appears that fill has been placed to reach the plant floor elevation of approximately El 391.

The site is located on the west flank of the Cincinnati-Kankakee Arch, in the Boonville Hills physiographic subdivision of the Southern Hills and Lowlands Region of Indiana. Bedrock at this site is mapped as the Pennsylvanian Carbondale group, which consists mostly of shale and sandstone with thin beds of limestone, clay and coal. The nearest mapped fault is about 12 miles east of the site in Spencer County, Indiana. Ground shaking from earthquakes would likely result from fault movements within either the New Madrid Seismic Zone, which is located in southeastern Missouri, or the Wabash Valley Fault System in southwestern Indiana.

The unconsolidated materials that overlay bedrock are rather complex. Units mapped as alluvium and outwash (primarily sand and gravel) are present near the Ohio River, with loess (wind-blown) and lacustrine (lake-bed) deposits mapped away from the river. The bluffs on the north and east portions of the Culley station are mapped as loess and the materials in the western portion, which is a low, flat plain, are mapped as lacustrine deposits from flooding of the Ohio River during the late Pleistocene, when the Ohio River served as a major glacial meltwater sluiceway. Silt and clay, reaching thicknesses exceeding 100 feet to the west of the area investigated, were deposited in water that ponded in the tributaries to the Ohio River, while sand and gravel were deposited in the main channel.

3.1.2 Site-Specific Stratigraphy

Five materials were encountered during the geotechnical investigation at the East Ash Pond:

1) Impounded Ash Materials: The impounded ash materials consisted mainly of fly ash, with occasional thin layers of bottom ash and sludge. The ash varied from gray to brown to black and was generally very loose. Borings B16-1 to B16-4 were drilled in the East Ash Pond.
2) Embankment Fill: Fill was encountered below the surficial gravel material is all borings with the exception of those in the ash pond (B16-1 through B16-2). Reddish brown to gray silty to sandy clay (CL) with consistency of very stiff to hard and traces of gravel, wood, and coal ash was encountered to depths ranging between 5.5 to 10 feet. Underlying the very stiff to hard silty to sandy clay, a layer of brown to gray silty clay (CL) with consistency ranging from medium soft to stiff and little to trace sand and coal ash was encountered to depth ranging between 28 to 33 feet below ground surface. The soft to stiff clay was underlain by native soils in all borings except B-102. In boring B-102, a layer of fill consisting of brown silty sand (SM) with loose relative density was encountered from 29 to 31.5 feet below ground surface.
3) Native Fine-Grained Deposits: Underlying the fill material, gray to brown silty clay (CL) with medium to very stiff consistency was encountered at depths ranging between 28 to 33 feet in all borings except B-102. The medium to very stiff gray silty clay was encountered to a depth of 58 feet in boring B-101 and to the termination depth of 60 feet in borings ATC B-1 and ATC B-2. In boring ATC B-2, a layer of very

loose gray silt (ML) was encountered within the medium to stiff gray silty clay from 48 to 53 feet deep. Below the fill material in boring B-102, gray to brown clay (CL) with stiff to very stiff consistency was encountered from 31.5 to 43 feet below ground surface. Underlying the gray to brown clay in boring B-102, brown silty clay (CL) with stiff consistency was encountered from 43 to 48 feet of depth. From 48 to 53 feet below ground surface, the brown silty clay transitioned into reddish brown sandy clay (CL).

4) Native Granular Deposits: In borings B-101 and B-102, granular deposits were encountered at depths of 53 and 58 feet, respectively. In boring B-101, gray silty sand (SC-SM) with sandy clay seams and loose relative density was encountered from 46.5 to 58 feet of depth. From 64.5 to 69 feet of depth, a layer of medium consistency sandy clay (CL) was encountered within the sand layer. Below the sandy clay, medium dense gray sand (SP) with loose to medium relative density was encountered from 53 to 73 feet below ground surface. Underlying the reddish brown sand, medium dense gray sand (SP-SM) with gravel and trace silt was encountered from 73 to 80 feet depth. SPT-N values range between 8 and 32 with an average of 23.

5) Bedrock: Below the native sand layers in borings B-101 and B-102, gray weathered shale was encountered at depths of 72 to 79.5 feet below ground surface, respectively. Boring B-101 was terminated at a depth of 80 feet. Boring B-102 was advanced an additional 1.7 feet into weathered shale. Based on the boring termination depths, competent bedrock was encountered at depths ranging between 73.7 and 80 feet (+321 to +317 feet NAVD88). **Table 3.1** summarizes the depth/elevation of the top of rock as encountered in the borings.

Logs of the borings and CPT soundings are included in **Appendix B** and **C**, respectively, and laboratory test results are included in **Appendix D**.

Table 3-1 – Summary of Bedrock Depth and Elevation

Boring No.	Depth at Top of Rock (ft bgs)	Elevation at Top of Rock (ft NAVD88)	Rock Type
AECOM-B1	84.0	312.7	Shale
AECOM-B2	67.0	328.1	Shale
CARDNO-B101	73.7	320.8	Shale
CARDNO-B102	80.0	317.1	Shale
AECOM B16-1	64.5	326.5	Shale
AECOM B16-2	67.0	323.0	Shale
AECOM B16-3	64.0	326.0	Shale
AECOM B16-4	64.5	326.5	Shale

3.2 Groundwater Conditions

The presence of groundwater was noted in split spoon samples while drilling in borings AECOM B-1 and B-2 and noted on Cardno borings B-101 and B-102. Groundwater borings are listed in Table 3-2.

Table 3-2 – Water Level Data					
Boring No.	Northing (ft NAD83)	Easting (ft NAD83)	Ground Surface Elevation (ft NAVD88)	Depth (feet)	Water Surface Elevation (feet)
AECOM-B1	969048.4	2883408.9	396.7	27.5	369.2
AECOM-B2	969096.5	2884074.5	395.1	47.0	347.1
CARDNO-B101	969020.0	2883686.0	394.5	58.0	336.5
CARDNO-B102	969085.0	2883360.0	397.1	28.5	363.6

4 Summary of Laboratory Testing

4.1 Summary of Laboratory Testing Scope

The laboratory testing program performed for the East Ash Pond was intended to obtain information on index properties and shear strength properties of the subsurface material at the site. The laboratory testing program for characterization of the materials at the East Ash Pond are summarized in **Table 4-1**.

Table 4-1 – Summary of Laboratory Testing Program for the East Ash Pond

ASTM Designation	Test Type	Number of Tests				
		Total	Ash	Embankment	Native Fine-grained Soils	Native Granular Soils
D2216	Moisture Content	97	12	33	44	8
D2937	Dry Unit Weight	8	3	1	4	0
D4318	Atterberg Limits	31	0	11	20	0
T311, D1140, D422	Gradation/Hydrometer	37	8	5	16	8
D854	Specific Gravity	9	8	0	1	0
D5084	Hydraulic Conductivity	8	0	3	5	0
D2435	One Dimensional Consolidation	4	3	0	1	0
D4767	Consolidated Undrained Triaxial (CIU)	10	0	4	6	0
D3080	Direct Shear (DSS)	4	1	0	3	0

4.2 Summary of Laboratory Testing Results

A summary of laboratory test results for the impounded ash, embankment fill, native fine grained soils, and native granular soils at the East Ash Pond are presented in **Tables 4-2, 4-3, 4-4**, and **4-5**, respectively. See **Appendix D** for a complete list of laboratory test data and results and **Appendix B** for boring logs.

4.2.1 Impounded Ash

Table 4-2 summarizes the results of the laboratory testing performed within the Impounded Ash.

Table 4-2 – Summary of Lab Test Results: Impounded Ash		
LAB TEST	**Range**	**Average**
Index/General Properties:		
Moisture Content (%)	36.2-91.5	58.8
Particle Size Analysis (%)		
Percent Fines (passing No. 200 Sieve)	46.3-98.2	87.7
Strength Properties:	**Friction Angle ϕ (degrees)**	**Cohesion c (psf)**
Drained (Effective) Strength	26.4	197

4.2.2 Embankment

Table 4-3 summarizes the results of static laboratory testing performed within the Embankment Soils.

Table 4-3 – Summary of Lab Test Results: Embankment Soils		
LAB TEST	**Range**	**Average**
Index/General Properties:		
Moisture Content (%)	3.5 – 28.4	21.2
Atterberg Limits (%)		
Liquid Limit	26 – 47	35
Plastic Limit	17 – 21	19.3
Plasticity Index	6 – 26	15.7
Particle Size Analysis (%)		
Percent Fines (passing No. 200 Sieve)	12.8 – 65.1	75.2
Strength Properties:	Friction Angle ϕ (degrees)	Cohesion c (psf)
Drained (Effective) Strength	30	500
Peak Undrained (Total) Strength	18.4	575

4.2.3 Native Fine-Grained Soils

Table 4-4 summarizes the results of static laboratory testing performed within the native fine-grained soils.

Table 4-4 – Summary of Lab Test Results: Native Fine Grained Soils		
LAB TEST	**Range**	**Average**
Index/General Properties:		
Moisture Content (%)	17.8-39.7	27.9
*Atterberg Limits (%)**		
Liquid Limit	22-53	37
Plastic Limit	17-39	22
Plasticity Index	2-32	15
Particle Size Analysis (%)		
Percent Fines (passing No. 200 Sieve)	22.2-97.5	76.5
Strength Properties:	Friction Angle ϕ (degrees)	Cohesion c (psf)
Drained (Effective) Strength	27.4	318
Peak Undrained (Total) Strength	15.4	339

4.2.4 Native Granular Soils

Table 4-5 summarizes the results of static laboratory testing performed within the native granular soils.

Table 4-5 – Summary of Lab Test Results: Native Granular Soils		
LAB TEST	**Range**	**Average**
Index/General Properties:		
Moisture Content (%)	7.8-36.3	14.6
Particle Size Analysis (%)		
Percent Fines (passing No. 200 Sieve)	2.5-8.7	6.0

5 Slope Stability Analyses

Slope stability analyses were performed for varying loading conditions at a selected cross-section, as described in the following sub-sections. Analysis section development, soil material properties, and seismic analyses related to the slope stability analysis are also discussed in the following sub-sections.

5.1 Cross-Sections for Analysis

Based upon the subsurface exploration, laboratory testing, and requirements listed in part 257.73 (e) of the EPA CCR Rule, two critical cross-sections (worst cases) were selected to perform a slope stability analyses. Several surveying campaigns took place in order to determine the geometry of the East Pond Embankment during investigation campaigns in 2011, April 2015 and November 2015. The downstream slope of the embankment ranges between 2.4H/1V at the western part of the embankment to 2.7H/1V at the eastern part of the embankment. The most critical cross-sections are determined to be at the western (cross section AECOM B1) and eastern (cross section AECOM B2) sections of the East Ash pond Embankment. Cross section AECOM B-1 is near boreholes B-102 and AECOM B-1 and cross section AECOM B2 is near boreholes B-101 and AECOM B-2. Sections of the existing slopes are shown in **Appendix A, Figure 3**. The subsurface profile utilized in the slope stability analyses is presented in **Appendix F**.

5.2 Stability Analysis Conditions Considered

Consistent with the criteria provided in §257.73(e), the stability of the East Ash Pond was evaluated for the following five load cases.

5.2.1 Static, Steady-State, Normal Pool Condition

This case models the embankment under static, long-term conditions, at normal water level within the impoundment. The CCR Rule requires a maximum storage pool factor of safety greater than or equal to 1.50.

5.2.2 Static, Maximum Surcharge Pool Condition

This case models the conditions under short-term surcharge pool conditions, with the water level in the pond corresponding to the anticipated level during the design flood condition (which is a 1,000 year recurrence interval flood event for this site). This condition requires a minimum Factor of Safety greater than or equal to 1.40.

5.2.3 Seismic Slope Stability Analysis

These analyses incorporate a horizontal seismic coefficient k_h selected to be representative of expected loading during the design earthquake event (i.e., a “pseudostatic” analysis). The design earthquake event is one with a 2% probability of exceedance in 50 years (approximately 2,500 year recurrence interval), as required by the CCR Rule. The analyses utilized peak undrained strength parameters for soils that are not considered to be rapidly draining materials (including the dam embankment and buttress soils, silty clay foundation stratum, and silt foundation stratum). The phreatic surface and pore water pressures corresponding to the steady state pool from the static analyses were utilized. This condition requires a minimum Factor of Safety greater than or equal to 1.00.

5.2.4 Post-Liquefaction Condition

These analyses were performed at each stability cross section where liquefaction triggering analysis indicates potential liquefaction of granular, non-plastic materials or cyclic softening of fine-grained soils. The purpose of the post-liquefaction stability analysis is to assess stability conditions immediately following a seismic event. No horizontal seismic coefficient is included in these analyses, but selection of strength parameters for the analyses takes into account the potential for softening/ weakening of the soils as a result of pore pressures generated in sand-like materials, or cyclic softening in clay-like materials due to the earthquake shaking. The CCR Rule requires a minimum Factor of Safety greater than or equal to 1.20 for the post-liquefaction slope stability analysis.

5.2.5 Sudden Drawdown Conditions

This case models the potential for embankment failure due to rapid drawdown during a flood event on the downstream side of the slope. In this case, the Ohio River was assumed to remain at a flood elevation of 387.0 ft for duration of approximately 3 months, a time long enough to completely saturate the embankment. It was then assumed that the river would return to a normal elevation of 365.0 ft in less than three months. The criteria of this condition are not listed in USEPA CCR 257.72(3), however, guidance is provided in USACE EM 1110-2-1902. A minimum acceptable Factor of Safety of 1.30 was used for the review of this case.

5.3 Material Properties

Material properties for slope stability analyses were developed using both laboratory testing data (index and strength testing) and strength correlations from field data. The material characterization is described in **Appendix E**.

Unit weights for the materials were evaluated using laboratory test results from relatively undisturbed samples. Embankment fill above the phreatic surface was assigned unit weights and shear strengths consistent with saturated embankment fill.

To estimate the shear strength properties of the soils encountered, consolidated undrained (CU) triaxial tests and direct shear (DS) tests were performed on select samples of clay materials. Strength characteristics of granular soils are determined based on SPT blow counts. For cohesive materials, failure envelopes defined by cohesion and angle of internal friction were developed by plotting the failure points on a Modified Mohr-Coulomb plot (a p-q and p'-q plot), as described in Appendix D of the United States Corps of Engineers Engineer Manual EM-1110-2-1902 "Slope Stability." Laboratory CU tests performed on the embankment fill and native clay material from both AECOM and Cardno investigations are incorporated into these plots. Drained and undrained strength parameters for embankment material and native soil are presented in **Appendix E** and summarized in **Table 5-1**.

Liquefaction potential calculations and all strength tests were evaluated in order to determine whether peak or reduced strength parameters were to be assigned for soil layers in the post-earthquake analysis. **Appendix I** includes a detailed discussion of liquefaction potential of soils encountered at the site. A 2D dynamic site response analysis was performed to determine the cyclic stress acting on the embankment and native soils. Liquefaction analysis utilized cyclic stress ratio based on cyclic stresses obtained from this site response analysis rather than conservative empirical approach.

For clay soils where liquefaction or softening is not anticipated, the peak undrained strength parameters were utilized directly in the analysis. For the native clay, reduced undrained shear strength was utilized in the modeling. Specifically, the modeled strength was reduced to 90% of the peak strength for the post-earthquake condition. The sand zone on top of the rock is free-draining material and post-earthquake strength is based on peak drained strength. For impounded ash, peak strength properties were used for analysis with the exception of the pseudo-static and post-liquefaction conditions. For the pseudo-static condition, the shear strength was reduced to 80% of peak strength. For the post-liquefaction condition, a Su/p' ratio was used in the model. The post-earthquake strength parameters are shown in **Table 5-1.**

Soil strengths for sudden drawdown analyses were developed using the Duncan et al. (1990) approach. This approach uses both drained and undrained (R-envelope) soil strengths to evaluate sudden drawdown slope stability. A modified total strength envelope that is developed based on the lower of these Mohr strength envelopes is utilized in the third stage of the calculation for undrained materials. This resulting total strength envelope is computed automatically by the software at the end of the second stage of the calculation based on effective confining stress and principal stress ratio acting on the base of the each slice of the slip surface. Effective confining stress and effective principal stress ratio are computed at the first stage of the calculation.

The material properties developed for use in slope stability analyses are listed in **Table 5-1**.

Table 5-1 – Material Properties for Slope Stability Analyses

Material	Natural Unit Weight (pcf)	Saturated Unit Weight (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters		Post Liquefaction Shear Strength Parameters	
			c' (psf)	Φ' (°)	c (psf)	Φ (°)	c (psf)	Φ (°)
Embankment Fill	125	130	335	31.0	736	20.0	736	20.0
Native Clay	120	125	150	30.0	750	12.0	675	10.8
Native Sand	125	130	-	34.0	-	34.0	-	34.0
Impounded Ash	90	105	-	26.0/20.8[(a)]	100	12.0	-	0.12[(b)]

(a) friction angle for impounded ash during pseudo-static condition at 80% of peak
(b) tau/sigma ratio

5.4 Methodology of Analyses

Limit equilibrium stability analysis was completed using the two-dimensional Slope/W (v. 8.15.1.11236 by GeoStudio) computer program. Factors of safety were calculated using Spencer's method and using circular search routines to determine the critical failure surface for each analysis section and load case. Shallow, infinite-slope type failure surfaces were neglected as they correspond to sloughing failure which can be addressed as part of regular maintenance. Critical surfaces with respect to dam safety were considered to be those which intersected the dam crest at or upstream of the centerline, which are considered to have the potential to create an immediate threat to dam safety. Pore pressures were assigned as hydrostatic pressure under the piezometric line.

A brief summary of the analyses is presented in the following sections. A more detailed discussion is provided in **Appendix F.**

5.4.1 Static Analysis Conditions

5.4.1.1 Pool Elevations

The static analysis conditions include the steady-state normal pool and maximum surcharge pool loading conditions. Static stability was evaluated for steady-state conditions using a maximum normal pool elevation of 387 ft, and a maximum pool surcharge elevation of 392.67 ft. The latter elevation corresponds to a conservative estimate based on the crest elevation of embankment. The water level in the pond during the IDF event is 391.1 ft as identified in AECOM's *CCR Certification: Initial Inflow Design Flood Control System Plan* (October 2016).

5.4.1.2 Phreatic Surface

The phreatic surface used in the steady-state normal pool condition was established using the water levels in the measured in the boreholes. The water elevations were drawn into the stability models with an interpolation between the pool elevation and toe of the embankment at Ohio River elevation. Field observations and measurements indicated no evidence for seepage at the downstream surface of the embankment. Therefore the exit point of the phreatic surface is chosen where the surface of the embankment crosses the river elevation. AECOM reviewed the water elevations and cross-checked the interpolated phreatic surface with finite element seepage analysis using GeoStudio's SEEP/W software. Phreatic surfaces calculated in SEEP/W were in reasonable agreement with the interpolations from the available field measurements.

For the maximum surcharge pool condition analysis, the pool level in the pond was raised to elevation 392.67 ft. The interpolation described above was adjusted accordingly to the raised water level. Therefore, the phreatic surface used for this loading condition corresponds to steady-state seepage for the raised pool level. This is a conservative representation, as the maximum storage pool water level is likely to be a short-term event and steady state seepage conditions through the dam are unlikely to develop.

5.4.1.3 Shear Strength Parameters

For the steady-state normal pool condition, drained (effective stress) shear strength parameters were used for all materials. Due to rapid loading nature of maximum surcharge condition, undrained shear strength parameters for cohesive and drained shear strength parameters materials for granular materials were used in the maximum surcharge pool conditions. However this loading condition is also analyzed with drained parameters for all materials. Conservative values are presented in the report.

5.4.2 Earthquake Analysis Conditions

A site specific seismic hazard assessment (PSHA) was performed to identify the earthquake loads in the vicinity of the site, and dynamic response analysis was performed to determine the appropriate seismic loads and material properties for the earthquake stability analysis load cases. Liquefaction triggering analyses were completed to assess the potential for liquefaction or cyclic softening of the materials and determine the appropriate material properties for use in post-liquefaction slope stability analysis.

5.4.2.1 Probabilistic Seismic Hazard Analysis

Given the relatively close proximity of the Culley Station to the Brown Station, it was determined that the PSHA analysis performed at Brown could conservatively be used for Culley. The PSHA was completed for the Brown station to develop 2,500-year earthquake ground motions for use in liquefaction and dynamic response analyses of the facility. The PSHA results were used to compute a 2,500-yr return period Uniform Hazard Spectrum (UHS) for both hard rock (Class A rock, with shear wave velocity greater than 9,200 ft/s) and firm rock (Class B rock, with shear wave velocity between 2,500 and 9,200 ft/s). Parameters were developed including magnitude, distance, style of faulting, response spectra, and Arias Intensity. All seismically capable fault systems in the project region were considered, including the Illinois Basin Extended Basin Zone, New Madrid Seismic Zone which lies to the west and the Wabash Valley Seismic Zone.

Table 5-2 summarizes the UHS computed from the PSHA for the top of firm rock at the site, and **Table 5-3** summarizes modal magnitude and source distance which represent the highest contributor to the hazard for the design return period.

Table 5-2 – Uniform Hazard Response Spectrum For Firm Rock

Period	Spectral Acceleration (g)
0.01	0.53
0.02	0.96
0.03	1.16
0.04	1.21
0.10	1.02
0.20	0.68
0.40	0.40
1.0	0.14
2.0	0.07
3.0	0.041
4.0	0.028

Table 5-3 – Modal Earthquake Magnitude and Source Distance		
Period	**Modal Magnitude (M*)**	**Modal Source Distance (D*)**
PGA	5.1	12.5 km
0.4 (bimodal)	7.1 7.6	12.5 km 238 km
1.0	7.6	238 km

Four sets of time histories were developed for each design spectrum. The time histories represent the site-specific ground motions associated with the controlling near-field or far-field earthquake event, and consider the magnitude, distance, and Arias Intensity. The site-specific acceleration time histories were then used in two-dimensional dynamic response analysis (see section below) to estimate site-specific seismic loads for liquefaction triggering and seismic (pseudo-static) stability analysis.

Details of the PSHA are included in **Appendix G**.

5.4.2.2 Dynamic Response Analysis

The dynamic response of the ash pond embankment was evaluated by using the most recent version of the finite element program QUAD4M (Hudson et al. 1994). This is a modified version of the program QUAD4, originally developed by Idriss, et al. (1973). The dynamic response analysis was useful for more precisely estimating the amplification / attenuation characteristics of the dam structure and local foundation soils to estimate the cyclic stress ratios (CSR) induced by the earthquake loading. Input to the dynamic response analyses includes the acceleration time histories developed as part of the PSHA for the A.B. Brown Station (**Appendix H**). Since the A.B. Brown site is closer to the New Madrid Fault, the ground motions estimated for this site are conservative.

The QUAD4M program uses a two-dimensional, dynamic finite-element formulation that utilizes equivalent-linear, strain-dependent modulus and damping properties. The program performs a time-domain analysis that allows variable damping throughout the model, and uses an iterative process to approximate the nonlinear behavior of soil. Shear moduli and damping ratios are estimated initially for each element in the model, and the system is analyzed using those properties. After each iteration, values of the effective shear strain are computed and the modulus and damping values are updated to correspond to the computed strain level for each element. The analysis iterations are repeated until compatibility between moduli, damping, and strain levels is achieved in all elements.

The analysis was performed at for the cross-section that is defined in **Section 5.1**. Details of the dynamic response analysis are included in **Appendix H.**

5.4.2.3 Seismic Coefficient

In the pseudo-static method, a seismic force in the middle of the slip surface is estimated and applied in the horizontal direction. The analysis is performed based on static limit equilibrium method counting this additional horizontal force by utilizing a slope analysis procedure. Horizontal force due to earthquake is calculated based on peak ground acceleration (PGA) estimated for the site. The PGA at the top of rock is 0.26g and at the ground surface is 0.34g (assuming site class D) as per USGS web site http://earthquake.usgs.gov/designmaps/us/application.php **(Appendix F)**. PGA at crest of 0.60g was obtained per Idriss (2008). A pseudo-static coefficient (kh) of 0.2 was calculated for a full-height of the global failure surface per Makdisi-Seed (1978) procedure. For pseudo-static analyses, the peak undrained shear strength of clay soils were established on the basis of the p-q plots given in **Appendix E**. These values correspond to the results of CU testing and include both total friction angle and total cohesion.

5.4.2.4 Liquefaction Triggering Analysis

Liquefaction triggering analysis was used to evaluate the potential for liquefaction of the foundation silt and sand deposits under the 2,500-year event. Liquefaction triggering evaluations were performed using an empirical SPTbased procedure.

The SPT based liquefaction triggering analyses were performed using the procedure proposed by Idriss and Boulanger (2008, 2014). The procedure considers a stress-based approach to evaluate the potential for liquefaction triggering, and compares calculated earthquake-induced cyclic stress ratios (CSRs) with the estimated cyclic resistance ratios (CRRs) of the soil to establish the factor of safety against liquefaction triggering. CSRs used as input to this analysis were based on the results of the site-specific dynamic response analyses. Within the method, CRRs are a function of the soil's fines content (FC), relative density and effective stress, and penetration resistance (SPT). The CRR is also dependent on the duration of shaking, and is adjusted to the site-specific design earthquake using a Magnitude Scaling Factor (MSF). Fines content, density, and other material parameters used as input to the analysis were based on the laboratory test data obtained as part of this project. The magnitude of the design earthquake was input as M 7.1, based on the modal results from the site-specific PSHA.

In both procedures, the ratio of CRR to CSR is the triggering factor of safety. For calculated triggering factors of safety less than 1.20, the material was considered to be potentially liquefiable.

Details of the liquefaction triggering analysis are provided in **Appendix I.**

5.4.2.5 Pool Elevations and Phreatic Surface

Pool elevation in the pond and the phreatic surface for both the seismic and post-liquefaction loading conditions were the same as utilized in the steady-state normal pool loading condition.

5.4.2.6 Shear Strength Parameters

Under the pseudo-static loading condition, embankment and native clay soils at the site are not expected to rapidly drain as a result of seismic shaking. Therefore, peak undrained strength parameters (as summarized in **Table 5-1**) were utilized in the slope stability analyses of the seismic loading condition. As this condition incorporates a horizontal seismic coefficient, liquefied strengths are not pertinent to the analysis and were not utilized.

For post-earthquake loading condition, liquefaction potential calculations and all strength tests were evaluated in order to determine whether peak or reduced strength parameters were to be assigned for soil layers. **Appendix I** includes a detailed discussion of liquefaction potential of soils encountered at the site. A 2D dynamic site response analysis was performed to determine the cyclic stress acting on the embankment and native soils. Liquefaction analysis utilized cyclic stress ratio based on cyclic stresses obtained from this site response analysis rather than conservative empirical approach. For clay soils where liquefaction or softening is not anticipated, the peak undrained strength parameters were utilized directly in the analysis in post-earthquake condition. However, for the entire native clay, reduced undrained shear strength was utilized in the modeling. Specifically, the modeled strength was reduced to 90% of the peak strength for the post-earthquake condition. The sand zone on top of the rock is free-draining material and post-earthquake strength is based on peak drained strength.

For impounded ash, peak strength properties were used for analysis for static loading conditions. For the pseudo-static condition, the shear strength was reduced to 80% of peak strength. For the post-liquefaction condition, an Su/p’ ratio was used in the model. The post-earthquake strength parameters are shown in **Table 5-1**.

6 Results

Regulatory Citation: 40 CFR §257.73 (e); Periodic safety factor assessments. (1) The owner or operator must conduct an initial and periodic safety factor assessments for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minim safety factors specified in paragraphs (e)(1)(i) through (iv) of this section for the critical cross-section of the embankment..

6.1 Results of Static Stability Analyses

Regulatory Citation: 40 CFR §257.73 (e)(1);

- *(i) The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.*
- *(ii) The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.*

The results of the limit equilibrium slope stability analyses for the static load cases are summarized in **Table 6-1**: The Slope/W output figures showing the critical slip surfaces and details of the analyses are included in **Appendix F**.

Table 6-1 – Summary of Minimum Slope Stability Factors of Safety for Static Load Cases

Load Case	Criteria	Cross-Section AECOM B1	Cross-Section AECOM B2
Steady State (Normal Pool)	FS ≥ 1.50	1.87	1.92
Surcharge Pool (Flood Pool)	FS ≥ 1.40	1.68	1.77

The calculated factors of are greater than the minimum values required in §257.73 (e)(i) and (ii), thereby satisfying the regulatory requirement.

6.2 Results of Earthquake Stability Analyses

Regulatory Citation: 40 CFR §257.73 (e)(1);

- *(iii) The calculated seismic factor of safety must equal or exceed 1.00.*
- *(iv) For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.*

6.2.1 Liquefaction Triggering Analysis

Based on the liquefaction triggering analysis, the factor of safety against liquefaction for the overwhelming majority of sample intervals evaluated are above 1.0, and well above in most cases, indicating that the potential for liquefaction of the sand deposit is very low.

Results from the analysis indicate that a very thin zone of sand (less than 5 feet thick) at the top of the sand deposit at some locations has a lower factor of safety. Based on the inconsistency of this layer encountered in the borings, the thin zone of sand has a low potential of inducing slope failure due to liquefaction. The zone is located immediately at the interface of the native clay and native sand interface. As all of the borings performed for the project were located at the crest of the dam (other locations were not accessible to a drill rig, given the proximity of the dam to the surrounding water bodies), the lateral extent of such zones cannot be determined. However, it is anticipated that these zones will be of limited extent and discontinuous, as the dam is located in an alluvial setting, and alluvial deposition typically yields some heterogeneity in soils. It is considered highly unlikely that localized liquefaction of thin pockets or zones within the sand deposit will endanger stability of the dam. Based on the results of the liquefaction potential evaluation, large-scale liquefaction of the sand deposit is not anticipated during the design earthquake.

6.2.2 Slope Stability Analysis

The results of the slope stability analyses for the seismic load cases are summarized in **Table 6-2**. The Slope/W output figures showing the critical slip surfaces and details of the analyses are included in **Appendix F.**

Table 6-2 – Summary of Minimum Slope Stability Factors of Safety for Earthquake Load Cases

Load Case	Criteria	Cross-Section AECOM B1	Cross-Section AECOM B2
Seismic (Pseudostatic)	FS ≥ 1.00	1.06	1.02
Post-liquefaction	FS ≥ 1.20	1.70	1.78

The calculated factors of safety are greater than the minimum values required in §257.73 (e)(iii) and (iv), satisfying the regulatory requirement.

6.3 Results of Sudden Drawdown Stability Analyses

The result of the slope stability analysis for the sudden drawdown load case is summarized in **Table 6-3.** The Slope/W output figures showing the critical slip surfaces and details of the analyses are included in **Appendix F**.

Table 6-3 – Summary of Minimum Slope Stability Factor of Safety from Sudden Drawdown Load Case

Load Case	Criteria	Cross-Section AECOM B1	Cross-Section AECOM B2
Sudden Drawdown	FS ≥ 1.30	1.68	1.81

6.4 Critical Cross-Sections

CCR Rule §257.73 (e) requires identification of a critical cross-section to represent the impoundment. As presented herein, two cross-sections of the East Ash Pond have been evaluated, to provide a thorough evaluation of the stratigraphic and topographic conditions across the structure. As such, the resulting factors of safety for each loading condition considered vary between cross-sections and certain sections are critical. Herein, the critical cross-section for any given load case has been interpreted as that section which has the lowest factor of safety for that particular load case. Table 6-3 below summarizes the critical cross-section and corresponding factor of safety for each load case. The factors of safety presented in this table correspond to the values being certified in this document.

Table 6-4 – Summary of Critical Cross-Section and Factors of Safety For Stability Analysis Loading Conditions

Load Case	Critical Cross-Section	Minimum Factor of Safety
Steady State (Normal Pool)	**AECOM B1**	1.87
Max Surcharge Pool (Flood Pool)	**AECOM B1**	1.68
Seismic (Pseudostatic)	**AECOM B2**	1.02
Post-Liquefaction	**AECOM B1**	1.70
Sudden Drawdown	**AECOM B1**	1.68

7 Conclusions

The calculated factors of safety from the limit equilibrium slope stability analysis satisfy the CCR Rule §257.73 (e) requirements for all the load cases analyzed at the critical analysis section for the embankment that comprises the perimeter of the impoundment. Load cases analyzed for this study included static (steady-state) normal pool, maximum flood surcharge pool, seismic (pseudo-static), and static post-liquefaction.

8 Certification

This Certification Statement documents that the East Ash Pond at the F. B. Culley Generating Station meets the Safety Factor Assessment requirements specified in 40 CFR §257.73 (e). The East Ash Pond is an existing CCR surface impoundment as defined by 40 CFR §257.53. The CCR Rule requires that the Safety Factor Assessment for an existing CCR surface impoundment be prepared by October 17, 2016.

CCR Unit: Southern Indiana Gas & Electric Company; F. B. Culley Generating Station; East Ash Pond

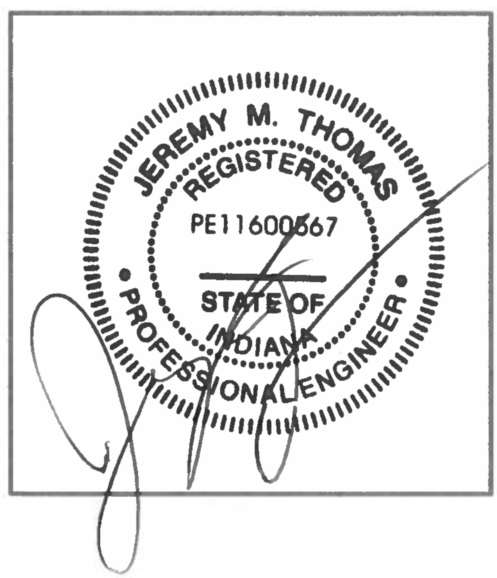
I, Jeremy Thomas, being a Registered Professional Engineer in good standing in the State of Indiana, do hereby certify, to the best of my knowledge, information, and belief that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above referenced CCR Unit, that the Safety Factor Assessment dated October 13, 2016 meets the requirements of 40 CFR §257.73 (e).

JEREMY THOMAS

Printed Name

10-13-16

Date



9 Limitations

Background information, design basis, and other data have been furnished to AECOM by SIGECO. AECOM has used this data in preparing this report. AECOM has relied on this information as furnished, and is not responsible for the accuracy of this information. Our recommendations are based on available information from previous and current investigations. These recommendations may be updated as future investigations are performed.

Borings have been spaced as closely as economically feasible, but variations in soil properties between borings, that may become evident at a later date, are possible. The conclusions developed in this report are based on the assumption that the subsurface soil, rock, and groundwater conditions do not deviate appreciably from those encountered in the site-specific exploratory borings. If any variations or undesirable conditions are encountered in any future exploration, we should be notified so that additional analyses can be made, if necessary.

The conclusions presented in this report are intended only for the purpose, site location, and project indicated. The recommendations presented in this report should not be used for other projects or purposes. Conclusions or recommendations made from these data by others are their responsibility. The conclusions and recommendations are based on AECOM's understanding of current plant operations, maintenance, stormwater handling, and ash handling procedures at the station, as provided by Client. Changes in any of these operations or procedures may invalidate the findings in this report until AECOM has had the opportunity to review the findings, and revise the report if necessary.

This geotechnical investigation was performed in accordance with the standard of care commonly used as state-of-practice in our profession. Specifically, our services have been performed in accordance with accepted principles and practices of the geological and geotechnical engineering profession. The conclusions presented in this report are professional opinions based on the indicated project criteria and data available at the time this report was prepared. Our services were provided in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation is intended.

10 References

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Appendix A
Figures

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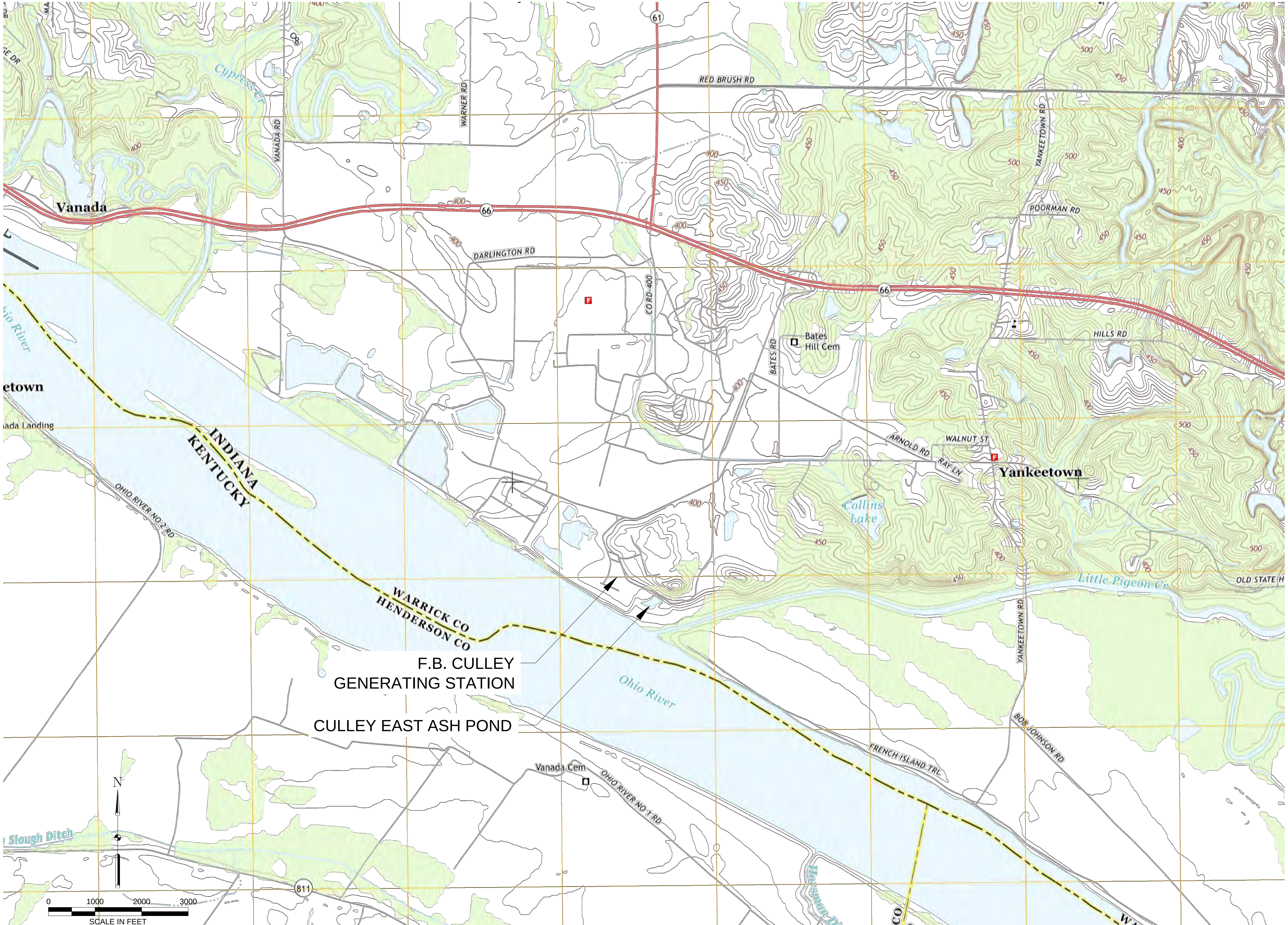

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F.B. CULLEY
GENERATING STATION
NEWBURGH, IN

INITIAL INFLOW DESIGN
FLOOD CONTROL
SYSTEMS PLAN
EAST ASH POND

PRELIMINARY

ISSUED FOR BIDDING — DATE BY

ISSUED FOR CONSTRUCTION — DATE BY

REVISIONS

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AECOM PROJECT NO:	60442676
DRAWN BY:	MJC
DESIGNED BY:	MJC
CHECKED BY:	TLE
DATE CREATED:	8/18/2016
PLOT DATE:	4/22/2016
SCALE:	AS SHOWN
ACAD VER:	2014

SHEET TITLE

LOCATION MAP

FIGURE 1

SHEET 1 OF 3

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AECOM DRAWING PATH: P:\Projects\Environmental\60442676_VectrenCCR\7.0_CAD_GIS\7.04_Plan_Sheets\CULLEY-SITE MAP.dwg

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INITIAL INFLOW DESIGN FLOOD CONTROL SYSTEMS PLAN
EAST ASH POND

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NO.	DESCRIPTION	DATE
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AECOM PROJECT NO:	60442676
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DESIGNED BY:	MJC
CHECKED BY:	TLE
DATE CREATED:	8/18/2016
PLOT DATE:	4/22/2016
SCALE:	AS SHOWN
ACAD VER:	2014

SHEET TITLE

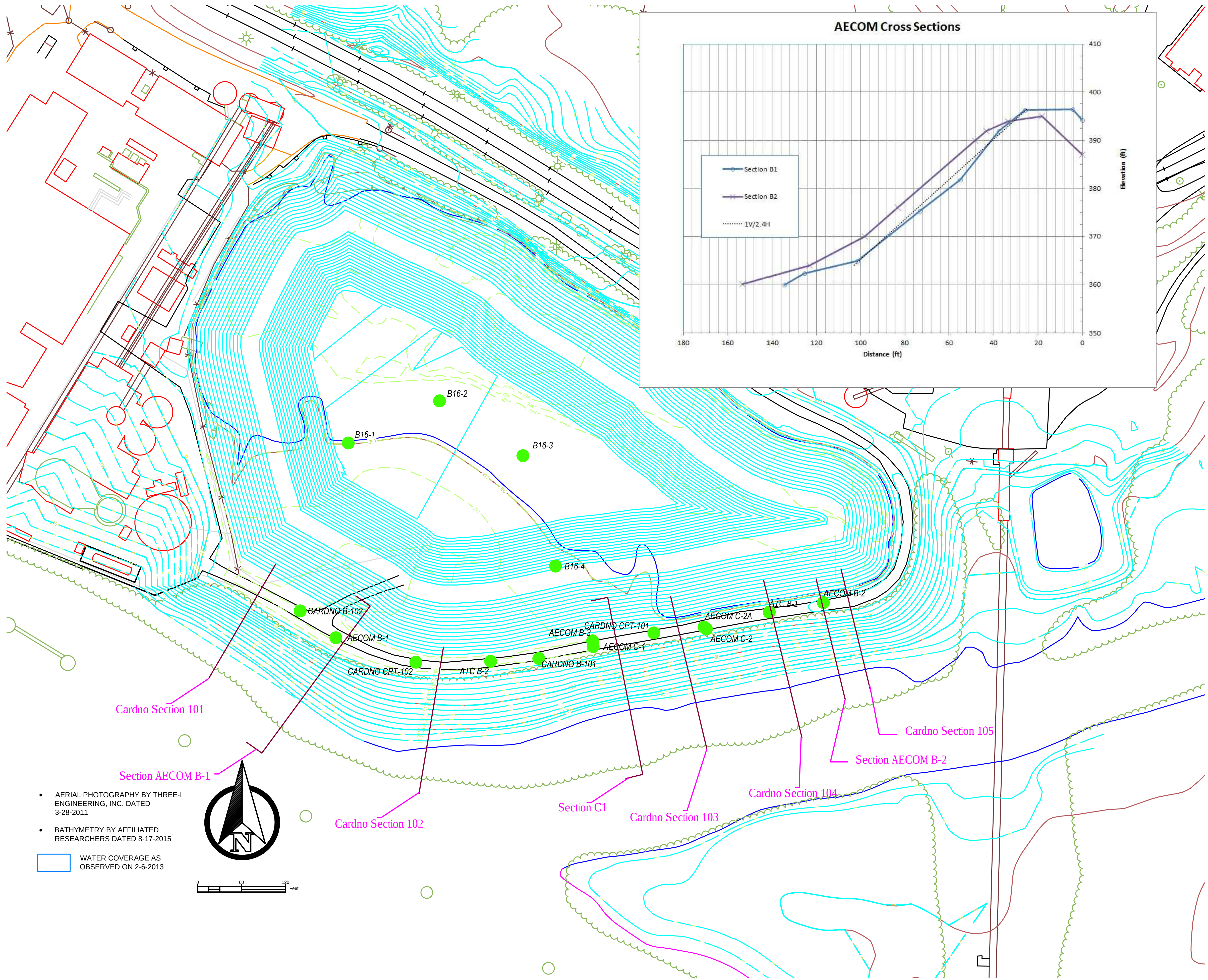
SITE MAP

FIGURE 2

SHEET 2 OF 3

Project Management Initials:___ Designer:___ Checked:___ Approved:___ ARCH D 24" x 36"

Last saved by: GAMBLINA(2016-10-07) Last Plotted: 2016-10-07
Filename: L:\USERS\GEOTECH\PROJECTS\60442676 VECTREN CCR STUDY\FB CULLEY\EAST POND\CERTIFICATION\REVISED\FINALREPORT\CROSSSECTION\CULLEY-ASH-POND.DWG



- AERIAL PHOTOGRAPHY BY THREE-I ENGINEERING, INC. DATED 3-28-2011
- BATHYMETRY BY AFFILIATED RESEARCHERS DATED 8-17-2015

WATER COVERAGE AS OBSERVED ON 2-6-2013

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AECOM

PROJECT

Vectren CCR
East Ash Pond
Embankment Stability
Analysis

Vectren F.B. Culley Generating Station
P.O. Box 209
Evansville, IN 40772

CLIENT

Vectren Corporation

P.O. Box 209
Evansville, IN 40772

CONSULTANT

AECOM
1350 Deming Way
Middleton, WI 53562
(608)836-9800 T
(608)836-9767 F
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PROJECT NUMBER

60442676

FIGURE TITLE

FB CULLEY EAST POND
CURRENT POND GRADES

FIGURE NUMBER

3

Appendix B
Boring Logs

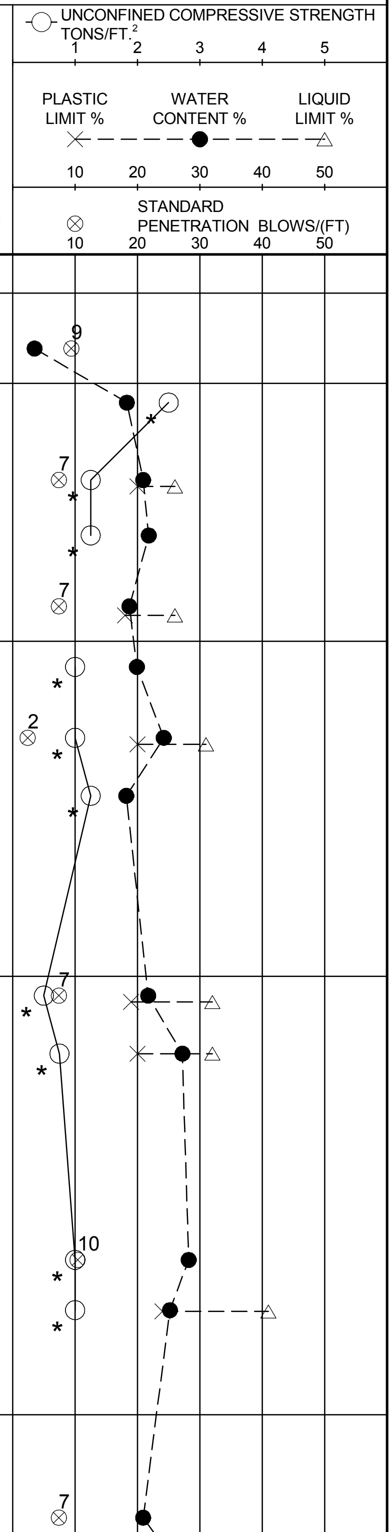
OWNER: **Vectren**	LOG OF BORING NUMBER: **AECOM-B1**
PROJECT NAME: **FB Culley East Ash Pond Dam Assesment**	ARCHITECT-ENGINEER: **AECOM**

AECOM

SITE LOCATION

SURFACE ELEVATION +396.7

DEPTH(FT)	SAMPLE NO.	SAMPLE TYPE	STRATUM DEPTH	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
		HSA	1.5	FILL: Fine to coarse sand and gravel - gray - dry to moist (SP-GP)	
5.0	1	SS	5.0	FILL: Silty clay - trace sand and coal - brown - stiff (CL)	
	2	ST		FILL: Silty clay - trace coal, sand, and gravel - brown to gray - stiff (CL-ML)	
		HSA			
10.0	3	SS			
	4	ST			106
		HSA			
15.0	5	SS	15.0		
	6	ST		FILL: Silty clay - brown to gray - stiff (CL)	106
		HSA			
20.0	7	SS			
	8	ST			105
25.0		HSA	28.0		
30.0	9	SS		SILTY CLAY - gray to grayish brown - medium to stiff (CL)	
	10	ST			96
35.0		HSA			
40.0	11	SS		Trace organics in sample 11	
	12	ST			97
45.0		HSA	45.0	SANDY SILT - brown brown - wet - loose (ML)	
50.0	13	SS	50.0		



. . . continued

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

AECOM JOB NO. 60442676 | SHEET NO. 1 OF 2

OWNER: Vectren	LOG OF BORING NUMBER: **AECOM-B1**
PROJECT NAME: **FB Culley East Ash Pond Dam Assesment**	ARCHITECT-ENGINEER: **AECOM**

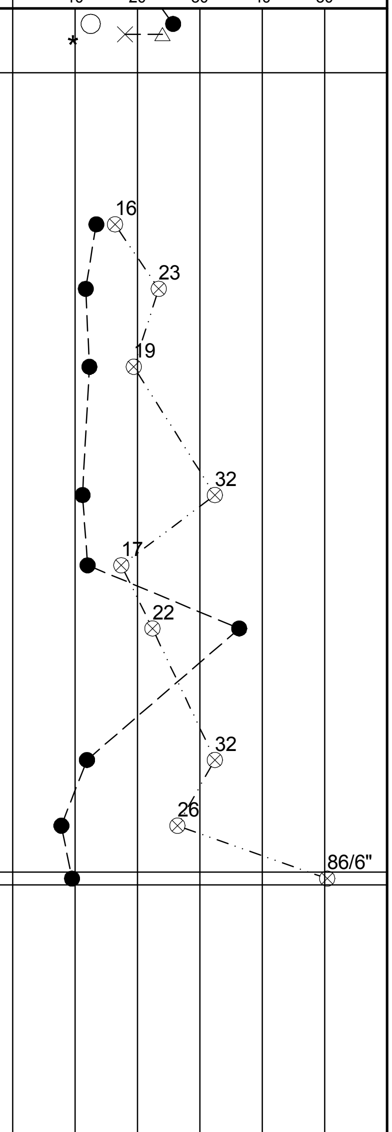
SITE LOCATION

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1, 2, 3, 4, 5)
PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10, 20, 30, 40, 50)
STANDARD PENETRATION BLOWS/(FT) (10, 20, 30, 40, 50)

SURFACE ELEVATION +396.7 (Continued)

DEPTH(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
	14	ST	SILTY CLAY - dark brown - stiff (CL-ML)	97
52.5	15	ST	SAND - some to little gravel - trace silt - yellowish brown to brown - wet - medium dense to dense (SP-SM)	
55.0		HSA		
	17	SS		
60.0		HSA		
	18	SS		
		HSA		
65.0	19	SS		
		HSA		
70.0	20	SS		
		HSA		
	21	SS		
		HSA		
75.0	22	SS		
80.0	23	SS		
		HSA		
	24	SS		
83.5		HSA	SILTY CLAY - gray (CL)	
84.0	25	SS	SHALE - dark gray - very weak to weak field strength - laminated - moderately decomposed - intensely to moderately fractured - infilling of fractures with cohesive sediment - fair to good rock quality	
85.0	RUN 1	DB		
90.0	RUN 2	DB		
94.0			End of Boring	

Run #	Depth (ft.)	Recovery (%)	RQD (%)	Frac Freq.
1	84.0-85.0	91.7	71.7	2.6/ft
2	85.0-89.0	100	85.8	1.8/ft



End of Boring
Boring advanced to 84.0 feet with hollow-stem auger
Boring advanced from 84.0 to 94.0 feet with NQ-sized diamond bit and core barrel
Standard Penetration Test performed with automatic hammer

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

NORTHING 969048.4	BORING STARTED 11/9/15	AECOM OFFICE Middleton, Wisconsin	
EASTING 2883408.9	BORING COMPLETED 11/10/15	ENTERED BY MLB	SHEET NO. 2 OF 2
WL 27.5 WD	RIG/FOREMAN /ZV (Cardno ATC)	APP'D BY BH	AECOM JOB NO. 60442676

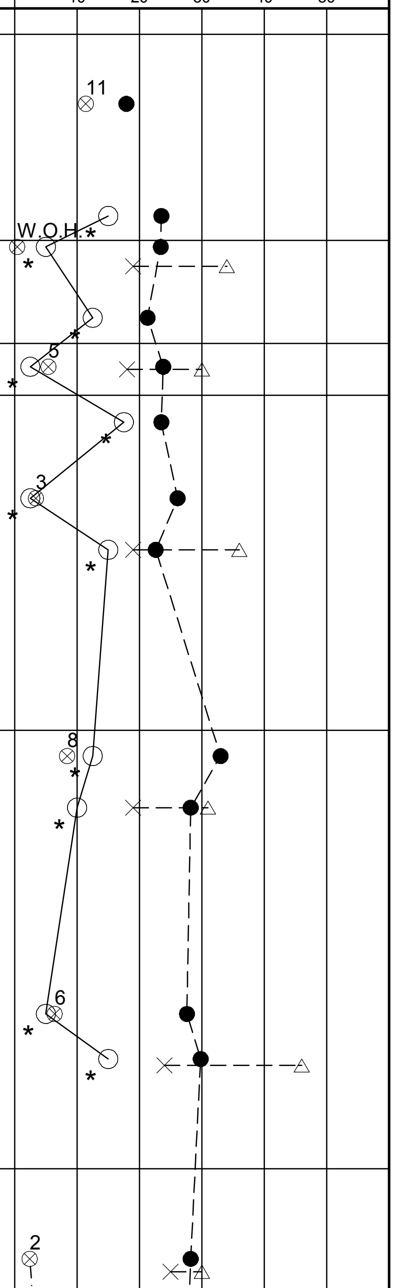
AECOM	OWNER **Vectren**	LOG OF BORING NUMBER **AECOM-B2**
	PROJECT NAME **FB Culley East Ash Pond Dam Assesment**	ARCHITECT-ENGINEER **AECOM**

SITE LOCATION

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2} (1, 2, 3, 4, 5)
PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10, 20, 30, 40, 50)
STANDARD PENETRATION BLOWS/(FT) (10, 20, 30, 40, 50)

SURFACE ELEVATION +395.1

DEPTH(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
		HSA	1.0 FILL: Fine to coarse sand and gravel - trace silt - gray - dry (SP-GP)	
			FILL: Silty clay - trace coal - yellowish brown to gray - medium (CL)	
	1	SS		
5.0	2	ST		
	3	ST	9.0	
10.0	4	SS	FILL: Clay - trace fine gravel, coal, and organics - gray - very soft (CL)	
	5	ST	13.0	104
	6	SS	FILL: Silty clay - trace coal - brown to gray - soft (CL)	
15.0			15.0	
	7	ST	FILL: Silty clay - trace coal and organics - grayish brown to brownish gray - very soft to sitff (CL)	
		HSA		
20.0	8	SS		
	9	ST		
25.0		HSA	28.0	
	10	SS	SILTY CLAY - some sand - gray to brown - stiff to medium (CL)	
30.0	11	ST		94
35.0		HSA		
	12	SS		
40.0	13	ST		93
		HSA	45.0	
45.0			SANDY SILT - some clay - brown - wet - very loose (ML)	
	14	SS		
50.0				



. . . continued

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

AECOM JOB NO. 60442676 | SHEET NO. 1 OF 2

AECOM_LOG_WSAMPLENOTES 60442676_VECTREN_BORING_LOGS.GPJ DATATEMPLATE_CURRENT.GDT 2/9/16

AECOM	OWNER: **Vectren**	LOG OF BORING NUMBER: **AECOM-B2**
	PROJECT NAME: **FB Culley East Ash Pond Dam Assesment**	ARCHITECT-ENGINEER: **AECOM**

SITE LOCATION

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2} (1 2 3 4 5)
PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)
STANDARD PENETRATION BLOWS/(FT) (10 20 30 40 50)

SURFACE ELEVATION +395.1 (Continued)

DEPTH(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}	SPT
50.5		HSA	SILTY CLAY - trace sand and gravel - brown to gray - soft to medium (CL-ML)		
	15	SS			3
		HSA			
55.0	16	ST		77	
55.5		HSA	SILTY CLAY - trace sand and fine gravel - brown to gray - soft to stiff (CL)		
	17	SS			2
		HSA			
60.0	18	ST		90	
60.5		HSA	SANDY SILT - little clay - gray - wet - loose (ML)		
	19	SS			4
63.0		HSA	SILTY CLAY - brown - medium (CL)		
65.0	20	ST		107	
66.0		HSA			
67.0	21	SS	SANDY CLAY - dark gray (CL)		50/4"
		HSA	Weathered bedrock		
68.8	RUN 1	DB	SHALE - dark gray - very weak to weak field strength - laminated - moderately decomposed - intensely to moderately fractured - infilling of fractures with cohesive sediment		
70.0					
75.0	RUN 2	DB			
80.0					
81.0					

End of Boring
Boring advanced to 68.8 feet with hollow-stem auger
Boring advanced from 68.8 to 81.0 feet with NQ-sized diamond bit and core barrel
Standard Penetration Test performed with automatic hammer
Boring backfilled with bentonite grout

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

NORTHING 969096.5	BORING STARTED 11/11/15	AECOM OFFICE **Middleton, Wisconsin**	
EASTING 2884074.5	BORING COMPLETED 11/12/15	ENTERED BY MLB	SHEET NO. 2 OF 2
WL 48.0 WD	RIG/FOREMAN /ZV (Cardno ATC)	APP'D BY BH	AECOM JOB NO. 60442676

AECOM	OWNER **Vectren**	LOG OF BORING NUMBER **AECOM-B3**
	PROJECT NAME **FB Culley East Ash Pond Dam Assesment**	ARCHITECT-ENGINEER **AECOM**

SITE LOCATION

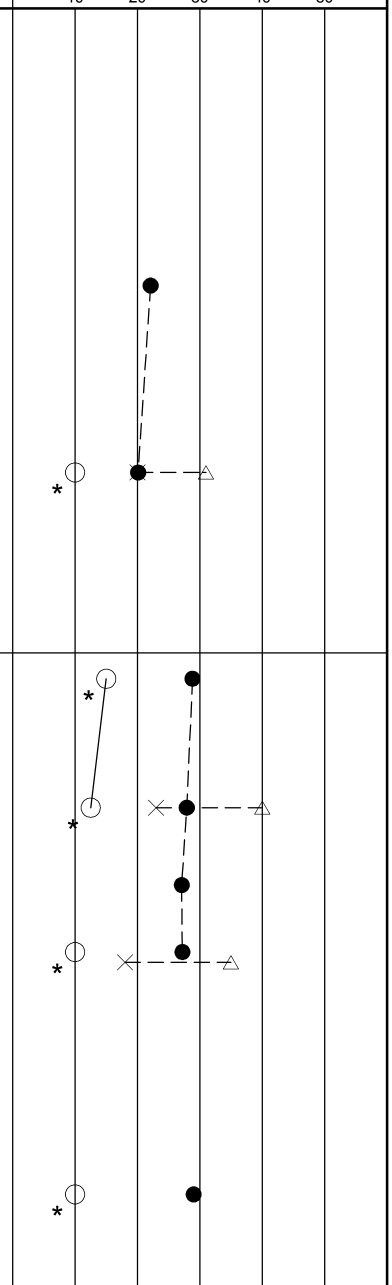
UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2} 1 2 3 4 5

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % 10 20 30 40 50

STANDARD PENETRATION BLOWS/(FT) 10 20 30 40 50

SURFACE ELEVATION +394.2

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
			HSA	FILL: Silty clay - olive brown to dark gray - stiff (CL)	
5.0		1	ST		
			HSA		
10.0		2	ST		106
			HSA		
15.0		3	ST		97
20.0			HSA		
		4	ST		
			HSA		
25.0		5	ST	25.0 SILTY CLAY - trace sand - brownish gray to brown - stiff (CL)	93
			HSA		
30.0		6	ST		95
			HSA		
		7	ST		94
35.0			HSA		
		8	ST		
			HSA		
40.0		9	ST		
			HSA		
45.0		10	ST		95
50.0					



. . . continued

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

AECOM JOB NO. 60442676 SHEET NO. 1 OF 2

AECOM_LOG_WSAMPLENOTES 60442676_VECTREN_BORING_LOGS.GPJ DATATEMPLATE_CURRENT.GDT 2/9/16

OWNER	LOG OF BORING NUMBER
Vectren	**AECOM-B3**
PROJECT NAME	ARCHITECT-ENGINEER
FB Culley East Ash Pond Dam Assesment	**AECOM**

SITE LOCATION

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2} 1 2 3 4 5

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % 10 20 30 40 50

STANDARD PENETRATION BLOWS/(FT) 10 20 30 40 50

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL SURFACE ELEVATION +394.2 (Continued)	UNIT DRY WT. LBS./FT.^{3}
			HSA			SILTY CLAY - trace sand - brownish gray to brown - stiff (CL)	
55.0		11	ST				
			HSA				
60.0		12	ST				
62.0						62.0	
						End of Boring Boring advanced to 62 feet with hollow-stem auger Boring bacfilled with bentonite grout	

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

NORTHING **969044.2**	BORING STARTED **11/13/15**	AECOM OFFICE **Middleton, Wisconsin**	
EASTING **2883759.4**	BORING COMPLETED **11/13/15**	ENTERED BY **MLB**	SHEET NO. **2** OF **2**
WL	RIG/FOREMAN **/ZV (Cardno ATC)**	APP'D BY **BH**	AECOM JOB NO. **60442676**

AECOM	OWNER **Vectren**	LOG OF BORING NUMBER **B16-1**	
	PROJECT NAME **F.B. West Ash Pond Closure**	ARCHITECT-ENGINEER **AECOM**	
SITE LOCATION			UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2} 1 2 3 4 5

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL SURFACE ELEVATION +391.0	UNIT DRY WT. LBS./FT.^{3}	PLASTIC LIMIT % / WATER CONTENT % / LIQUID LIMIT % (10 20 30 40 50); STANDARD PENETRATION BLOWS/(FT) (10 20 30 40 50)
						BOTTOM ASH - black - loose - moist		
5.0						6.0		
		1	SS			FLY ASH - some bottom ash - gray - very loose - moist		W.O.H.
10.0		2	ST					
		3	SS					1
15.0		4	SS			15.0		1/36"
						SLUDGE - brown - very soft - wet		
		5	ST			19.0		W.O.H
20.0		6	SS			FLY ASH - trace to some clay - gray - very loose to medium dense - wet		
		7	SS					5
25.0		8	SS					1/36"
		9	SS					4
30.0		10	ST					
		11	SS					3
35.0								
		12	SS					W.O.R.
40.0		13	ST					
		14	SS					16
45.0						45.5		
						CLAY - some silt - brown - soft - wet (CL)		
		15	SS			47.0		4 * *
						FLY ASH - some clay - gray - loose - wet		
						49.0		
50.0								

. . . continued

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

AECOM JOB NO. 60442676.9050 SHEET NO. 1 OF 2

AECOM	OWNER: **Vectren**	LOG OF BORING NUMBER: **B16-1**
	PROJECT NAME: **F.B. West Ash Pond Closure**	ARCHITECT-ENGINEER: **AECOM**

SITE LOCATION

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2}: 1 2 3 4 5

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %: 10 20 30 40 50

STANDARD PENETRATION BLOWS/(FT): 10 20 30 40 50

SURFACE ELEVATION +391.0 (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}	STANDARD PENETRATION BLOWS/(FT)
		16	ST			CLAY - zones of silt and fly ash - gray - medium stiff - wet (CL)		
52.5								
		17	SS			fine SAND - trace gravel - gray and black - medium dense - wet (SP)		25
55.0		18	SS					22
57.0								
		19	SS			coarse to fine SAND - some gravel - trace silt - gray - medium dense - wet (SP)		22
60.0								
		20	SS					50/4"
64.5								
65.0						SHALE - gray		
						End of Boring Boring backfilled with cement/bentonite grout from 65.0 ft to ground surface		

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

NORTHING **969314.4**	BORING STARTED **3/30/16**	AECOM OFFICE **Middleton, Wisconsin**
EASTING **2883425.8**	BORING COMPLETED **3/30/16**	ENTERED BY / SHEET NO. **2** OF **2**
WL **7.0 WD**	RIG/FOREMAN **Mobile D-50 ATV/ATC**	APP'D BY / AECOM JOB NO. **60442676.9050**

AECOM_LOG_WSAMPLENOTES VECTREN-CULLEY_LOGS.GPJ DATATEMPLATE_CURRENT.GDT 8/8/16

AECOM	OWNER: **Vectren**	LOG OF BORING NUMBER: **B16-2**
	PROJECT NAME: **F.B. West Ash Pond Closure**	ARCHITECT-ENGINEER: **AECOM**

SITE LOCATION

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1, 2, 3, 4, 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10, 20, 30, 40, 50)

STANDARD PENETRATION BLOWS/(FT) (10, 20, 30, 40, 50)

SURFACE ELEVATION +390.0

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³	SPT BLOWS/(FT)
0.0–6.0				BOTTOM ASH - black - moist - loose		
6.0–13.5		1	SS	BOTTOM ASH - layers of fly ash - black - moist - very loose		2
		2	SS			W.O.H
		3	SS			W.O.H
13.5–21.0		4	ST	FLY ASH - with bottom ash - dark gray - wet - very loose		
		5	ST			
		6	SS			W.O.H
21.0–25.0		7	ST	BOTTOM ASH - dark gray - wet - loose		
25.0–47.5		8	SS	FLY ASH - some silt - some clay - gray - wet - loose to very loose		9
		9	SS			1
		10	ST			
		11	SS			3
		12	SS			1
		13	ST			
		14	SS			1
		15	SS			1
47.5–				CLAY - with silt - gray - wet - soft (CL)		

Depth marks: 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0

. . . continued

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

OWNER	LOG OF BORING NUMBER
Vectren	**B16-2**
PROJECT NAME	ARCHITECT-ENGINEER
F.B. West Ash Pond Closure	**AECOM**

SITE LOCATION

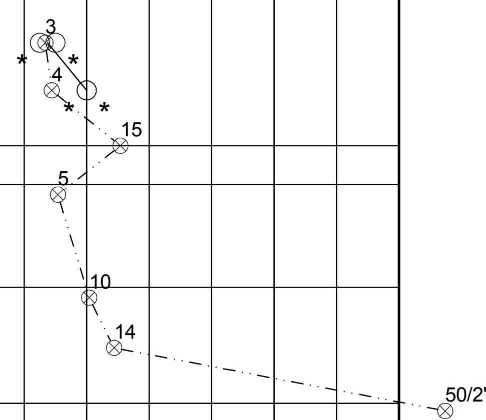
UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2}: 1 2 3 4 5

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %: 10 20 30 40 50

STANDARD PENETRATION BLOWS/(FT): 10 20 30 40 50

SURFACE ELEVATION +390.0 (Continued)

DEPTH(FT)	SAMPLE NO.	SAMPLE TYPE	STRATUM DEPTH	DESCRIPTION OF MATERIAL
	16	ST		CLAY - with silt - gray - wet - soft (CL)
	17	SS		
55.0	18	SS		1" layer of coarse to fine sand
	19	SS	57.0	
				coarse to fine SAND - with gravel - gray - wet - medium dense (SP)
	20	SS	58.5	SILT - with clay and fine sand - gray - wet - loose (ML)
60.0				
			62.5	
	21	SS		coarse to fine SAND - with gravel - gray - wet - medium dense - (SP)
65.0	22	SS		thin layers clay with silt
			67.0	
67.7	23	SS	67.7	SHALE - gray
				End of Boring Boring backfilled with cement/bentonite grout from 67.7 feet to ground surface



* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

NORTHING 969371.9	BORING STARTED 3/29/16	AECOM OFFICE **Middleton, Wisconsin**
EASTING 2883550.5	BORING COMPLETED 3/29/16	ENTERED BY — SHEET NO. 2 OF 2
WL 6.0 WD	RIG/FOREMAN Mobile D-50 ATV/ATC	APP'D BY — AECOM JOB NO. 60442676.9050

AECOM_LOG_WSAMPLENOTES VECTREN-CULLEY_LOGS.GPJ DATATEMPLATE_CURRENT.GDT 8/8/16

AECOM

OWNER	LOG OF BORING NUMBER
Vectren	**B16-3**
PROJECT NAME	ARCHITECT-ENGINEER
F.B. West Ash Pond Closure	**AECOM**

SITE LOCATION

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2}: 1 2 3 4 5

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %: 10 20 30 40 50

STANDARD PENETRATION BLOWS/(FT): 10 20 30 40 50

SURFACE ELEVATION +390.0

DEPTH(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	STANDARD PENETRATION BLOWS/(FT)
			BOTTOM ASH - black - moist - loose	
5.0			5.0	
			6.0 SLUDGE - brown - wet - very loose	W.O.R.
	1	SS	FLY ASH - gray - wet - very loose	W.O.R.
	2	SS		
10.0				
	3	ST		
	4	SS		W.O.H.
15.0	5	ST		
	6	SS		2
20.0				
	7	ST		2
25.0	8	SS	2' Layer of Bottom Ash	W.O.H.
	9	SS		
30.0	10	ST		W.O.H.
	11	SS		W.O.H.
35.0	12	SS	6" Layer of CLAY - some silt - wet - soft	W.O.H.
	13	SS	39.5 1' Layer of sludge and ash	4
40.0	14	SS	SILT - brown - wet - loose (ML)	
	15	ST	No Recovery Sample 15	
	16	ST	45.0 No Recovery Sample 16	
45.0	17	SS	FLY ASH - some clay - gray - wet - very loose	W.O.H.
	18	SS		W.O.H.
50.0				

. . . continued

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

AECOM JOB NO. **60442676.9050** SHEET NO. **1** OF **2**

AECOM

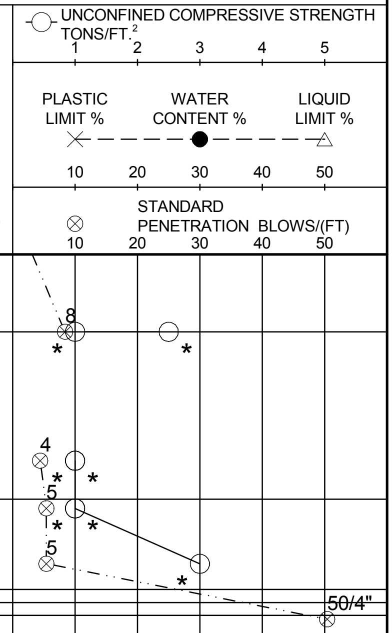
OWNER	LOG OF BORING NUMBER
Vectren	**B16-3**
PROJECT NAME	ARCHITECT-ENGINEER
F.B. West Ash Pond Closure	**AECOM**

SITE LOCATION

SURFACE ELEVATION +390.0 (Continued)

DEPTH(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL
			FLY ASH - some clay - gray - wet - very loose
	19	SS	53.0
55.0	20	ST	CLAY - with silt - brown to gray - moist - medium stiff (CL)
	21	SS	59.5
60.0	22	SS	CLAY - with silt - silt zones - silt seams - gray - wet - soft (CL)
	23	SS	63.0
			63.5 SILT - with fine sand - some clay - brown - wet - loose (ML)
64.8	24	SS	64.0 coarse to fine SAND - some gravel - gray - wet - loose (SP)
			64.8 SHALE - gray

End of Boring
Boring backfilled with cement/bentonite grout from 64.8 feet to ground surface



UNIT DRY WT. LBS./FT.^{3}

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

NORTHING 969297	BORING STARTED 3/28/16	AECOM OFFICE	Middleton, Wisconsin
EASTING 2883664.3	BORING COMPLETED 3/28/16	ENTERED BY	SHEET NO. 2 OF 2
WL 5.0 WD	RIG/FOREMAN Mobile D-50 ATV/ATC	APP'D BY	AECOM JOB NO. 60442676.9050

AECOM

OWNER: **Vectren**

LOG OF BORING NUMBER: **B16-4**

PROJECT NAME: **F.B. West Ash Pond Closure**

ARCHITECT-ENGINEER: **AECOM**

SITE LOCATION

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2}: 1 2 3 4 5

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %: 10 20 30 40 50

STANDARD PENETRATION BLOWS/(FT): 10 20 30 40 50

SURFACE ELEVATION +391.0

DEPTH(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	STANDARD PENETRATION BLOWS/(FT)
0.0–2.0			BOTTOM ASH - black - loose - moist	
2.0–5.5			SLUDGE - brown and gray - very loose - wet	
5.0	1	SS		4
5.5–40.5			FLY ASH - gray - very loose - wet	
	2	SS		W.O.R
10.0	3	ST		
	4	SS		W.O.R
15.0	5	ST	No Recovery Sample ST-5	
	6	ST		
20.0	7	SS		W.O.R
	8	SS		W.O.H
25.0	9	ST		
	10	SS		W.O.R
30.0	11	ST		
	12	SS		W.O.H
35.0				
	13	SS		W.O.H
40.0	14	SS		W.O.H
40.5–41.0			CLAY - some silt - brown - very soft - wet	
41.0–47.0			SILT - trace clay - zones of fly ash - loose - wet	
	15	ST		
45.0	16	SS		W.O.H
47.0	17	SS	CLAY - some silt - brown - soft - wet	5
50.0	18	SS		6

. . . continued

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

AECOM JOB NO. **60442676.9050** SHEET NO. **1** OF **2**

AECOM	OWNER **Vectren**	LOG OF BORING NUMBER **B16-4**
	PROJECT NAME **F.B. West Ash Pond Closure**	ARCHITECT-ENGINEER **AECOM**

SITE LOCATION

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2} 1 2 3 4 5

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % 10 20 30 40 50

STANDARD PENETRATION BLOWS/(FT) 10 20 30 40 50

SURFACE ELEVATION +391.0 (Continued)

DEPTH(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}	SPT BLOWS/(FT)
			CLAY - some silt - brown - soft - wet		
	19	SS			6
55.0	20	SS			7
	21	SS			8
58.5			fine SAND - gray - loose - wet		
60.0					
63.5	22	SS	coarse to fine SAND - some gravel - gray - dense - wet		49
64.5 / 65.0			SHALE - gray		
67.8	23	SS			50/4"

End of Boring
Boring backfilled with cement/bentonite grout from 67.8 ft to the ground surface

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

NORTHING 969146.2	BORING STARTED 3/25/16	AECOM OFFICE	Middleton, Wisconsin
EASTING 2883708.8	BORING COMPLETED 3/25/16	ENTERED BY	SHEET NO. 2 OF 2
WL 2.0 WD	RIG/FOREMAN Mobile D-50 ATV/ATC	APP'D BY	AECOM JOB NO. 60442676.9050

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CLIENT	CDF Ā&E'&E; G&F	BORING #	0)+,+
PROJECT NAME	A<HĀ&FJĀ I$;?Ā D;&EĀ<<$<<! $F;	JOB #	+*,4 8,,+,*
PROJECT LOCATION	>'0' Ā L#$?Ā FE ;GMĀ; ;G&F	NORTHING	QRQ.-..
	%$NOLEMHĀFJGF	EASTING	-77BR7R

DRILLING and SAMPLING INFORMATION

Date Started	.979+6	Hammer Wt.	+., lbs.
Date Completed	.979+6	Hammer Drop	B, in.
Drill Foreman	: 'Ā ; $<	Spoon Sampler OD	-', in.
Inspector	= 'Ā&?$	Rock Core Dia.	)) in.
Boring Method	@ÀA	Shelby Tube OD	B', in.

TEST DATA

SOIL CLASSIFICATION / SURFACE ELEVATION 394.5	Stratum Elevation	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Crushed limestone	394.0	0.5								Ground surface elevation surveyed by Three I Design.
Brown, moist, sandy clay with black coal ash (EMBANKMENT FILL)	391.5	3.0		1	SS		14-26-21			
Gray, moist, silty clay with wood and roots (EMBANKMENT FILL)	388.0	6.5	5	2	SS		4-10-49	14.1		
Reddish gray, moist, sandy clay (EMBANKMENT FILL)	386.5	8.0		3	SS		1-2-1	15.3		Borehole backfilled with cement/bentonite grout by tremie.
Gray, moist, silty clay with little sand (EMBANKMENT FILL)	374.0	20.5	10	4	SS		1-1-2	22.6		
				5	ST					
			15	6	SS		2-4-4	21.7	2.0	
				7	ST					À ! "#$Ā%&'ĀĀ( )* Atterberg limits: LL=38, PL=17, PI=21 Passing No. 200 sieve = 83.9%
			20	8	SS		2-3-2	26.3	1.0	
Gray, moist, silty clay with trace sand and coal ash	361.5	33.0		9	SS		5-4-5	22.0	2.5	
			25	10	ST			26.6		À ! "#$Ā%&'ĀĀ( )+, Atterberg limits: LL=47, PL=21, PI=26 Dry Density = 94.6 pcf Passing No. 200 sieve = 95.1%
				11	SS		2-2-3	28.4	0.75	
			30	12	ST					À ! "#$Ā%&'ĀĀ( )+- Atterberg limits: LL=47, PL=21, PI=26
				13	SS		4-5-7	26.7	2.0	
Gray, moist, soft to stiff, SILTY CLAY (CL) with sandy clay seams			35	14	SS		2-3-3	32.5	1.0	À ! "#$Ā%&'ĀĀ)+. Atterberg limits: LL=44, PL=20, PI=24 Passing No. 200 sieve = 97.5%
				15	SS		4-5-5	29.5	1.0	
				16	SS		0-2-2	29.0	0.75	

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools 67', ft.
At Completion)) ft.
After)) hours)) ft.
Cave Depth)) ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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CLIENT CDEFĀ8&E'&E; G&F
PROJECT NAME A<HĀ&FJĀ I$;?Ā D;&EĀ<<$<<! $F;
PROJECT LOCATION >'0' Ā8 L#$?Ā4 FE ;GMĀ; ;G&F
%$NOLEMHĀFJGF

BORING # 0)+,+
JOB # +*,4 8 ,,+,*
NORTHING QRQ.-..
EASTING -77BR7R

DRILLING and SAMPLING INFORMATION

Date Started	.979+6	Hammer Wt.	+., lbs.
Date Completed	.979+6	Hammer Drop	B, in.
Drill Foreman	: 'Ā ; $<	Spoon Sampler OD	-', in.
Inspector	= 'Ā&?$	Rock Core Dia.	)) in.
Boring Method	@ĀA	Shelby Tube OD	B', in.

TEST DATA

SOIL CLASSIFICATION (continued)	Stratum Elevation	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Gray, moist, soft to stiff, SILTY CLAY (CL) with sandy clay seams				17	SS		3-3-4	29.3	0.75	
			45	18	SS		2-3-4	28.7	1.5	
				19	SS		5-6-6	28.5	2.0	
			50	20	SS		3-4-4	25.2	1.25	À ! "#$Ā%&'ĀÀ)-, Atterberg limits: LL=39, PL=19, PI=20 Passing No. 200 sieve = 90.4%
				21	SS		5-5-6	25.4	0.75	
			55	22	SS		1-1-2	27.7		
				23	SS	●	3-4-5	28.8	0.75	
	336.5	58.0								
Gray, wet, loose, SILTY fine SAND (SC-SM) with sandy clay seams				24	SS		2-1-5			À ! "#$Ā%&'ĀÀ)-. Atterberg limits: LL=22, PL=17, PI=5 Passing No. 200 sieve = 31.4%
	334.0	60.5	60							
Gray, wet, loose, SILTY fine to medium SAND (SM)				25	SS		3-4-5			À ! "#$Ā%&'ĀÀ)-6 Atterberg limits: LL=NP, PL=NP, PI=NP Passing No. 200 sieve = 22.2%
	330.0	64.5		26	SS		3-2-3	27.4	0.75	
Gray, very moist, medium stiff, SANDY CLAY (CL)			65	27	SS		4-3-5	28.5	1.25	
	325.5	69.0								
Gray, wet, medium dense to very dense, fine to coarse SAND (SP) with some gravel			70	28	SS		8-11-13			
	322.5	72.0		29	SS		18-21-50/0.1'			
Gray, weathered SHALE	320.8	73.7		30	SS		50/0.2'			
Bottom of Test Boring at 73.7 ft										

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools 67', ft.
▽ At Completion)) ft.
▼ After)) hours)) ft.
Cave Depth)) ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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CLIENT	CDEFĀ&E'&E; @F	BORING #	0)+,-
PROJECT NAME	A<HĀ&FJĀ I$;?Ā D;&EĀ<<$<<! $F;	JOB #	+*,4 8 ,,+,*
PROJECT LOCATION	>'0' Ā L#$?Ā FE ;GMĀ; ;@F	NORTHING	QRQ.76
	%$NOLEMHĀFJGF	EASTING	-77BBR,

DRILLING and SAMPLING INFORMATION

Date Started	.9Q96	Hammer Wt.	+., lbs.
Date Completed	.9Q96	Hammer Drop	B, in.
Drill Foreman	: 'Ā ; $<	Spoon Sampler OD	-' , in.
Inspector	= 'Ā&?$	Rock Core Dia.	)) in.
Boring Method	@ÀA	Shelby Tube OD	B' in.

TEST DATA

SOIL CLASSIFICATION

SURFACE ELEVATION 397.1

Soil Description	Stratum Elevation	Stratum Depth, ft	Sample No.	Sample Type	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Crushed limestone	395.6	1.5						Ground surface elevation surveyed by Three I Design.
Reddish brown, slightly moist, silty clay with trace sand, gravel and coal ash (EMBANKMENT FILL)			1	SS	18-21-24			
			2	SS	9-11-10			
			3	SS	4-5-6	19.5	2.0	Borehole backfilled with cement/bentonite grout by tremie.
	387.1	10.0	4	ST				
Brown, slightly moist, silty clay with coal ash and trace to little sand (EMBANKMENT FILL)			5	SS	5-6-5	16.2		
			6	SS	2-2-3	22.2	1.0	
			7	SS	4-4-3	27.7	0.25	À ! "#$Ā%&'ÀÀ)* Atterberg limits: LL=39, PL=19, PI=20 Passing No. 200 sieve = 89.4%
			8	SS	0-0-0	20.0		
			9	SS	11-10-9			
			10	ST				
	371.6	25.5						
Brown, moist, silty clay with sandy clay seams (EMBANKMENT FILL)			11	SS	3-3-4	20.3	2.0	
	368.1	29.0						
Brown, wet, fine to coarse sand with little silt (EMBANKMENT FILL)			12	SS	3-4-3			À ! "#$Ā%&'ÀÀ)+- Passing No. 200 sieve = 12.8%
	365.6	31.5						
Gray and brown, moist to very moist, medium stiff to very stiff, CLAY (CH) with little sand			13	SS	3-3-3	17.8		
			14	SS	3-5-8	21.1	3.0	À ! "#$Ā%&'ÀÀ)+. Atterberg limits: LL=53, PL=21, PI=32 Passing No. 200 sieve = 88.8%
			15	SS	4-5-7	19.1		
			16	SS	5-7-10	29.1	2.5	

Depth Scale, ft: 5, 10, 15, 20, 25, 30, 35

Sample Type
- SS - Driven Split Spoon
- ST - Pressed Shelby Tube
- CA - Continuous Flight Auger
- RC - Rock Core
- CU - Cuttings
- CT - Continuous Tube

Depth to Groundwater
- Noted on Drilling Tools -7' 6 ft.
- At Completion)) ft.
- After)) hours)) ft.
- Cave Depth)) ft.

Boring Method
- HSA - Hollow Stem Augers
- CFA - Continuous Flight Augers
- CA - Casing Advancer
- MD - Mud Drilling
- HA - Hand Auger

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CLIENT	C$DĘ$FĀ8&E'&E; Œ&F	BORING #	0)+,-
PROJECT NAME	A<HĀ&FJĀÀ K$;?Ā D;&ĘÀ<<$<<! $F;	JOB #	+*,4 8,,+,*
PROJECT LOCATION	>'0' Ā8 L#$?Ā4 FE ;ŒMĀ; ;Œ&F	NORTHING	QRQ.7(6
	%$NOLEMHĀFJGF	EASTING	-77BBR,

DRILLING and SAMPLING INFORMATION

Date Started	.9Q96	Hammer Wt.	+., lbs.
Date Completed	.9Q96	Hammer Drop	B, in.
Drill Foreman	: 'Ā0 ; $<	Spoon Sampler OD	-', in.
Inspector	= 'Ā&?$	Rock Core Dia.	)) in.
Boring Method	@ÀA	Shelby Tube OD	B', in.

TEST DATA

SOIL CLASSIFICATION (continued)	Stratum Elevation	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Gray and brown, moist to very moist, medium stiff to very stiff, CLAY (CH) with little sand	354.1	43.0		17	SS			12-11-10	39.1	1.5	
Brown, moist, soft, SILTY CLAY (CL) with little sand			45	18	SS			2-2-2	24.8	1.0	À ! "#$Ā%&'ÀÀ)+7 Atterberg limits: LL=45, PL=21, PI=24 Passing No. 200 sieve = 86.4%
	349.1	48.0		19	SS			4-6-7			
Reddish brown, very moist, very soft to soft, SANDY CLAY (CL) with shale fragments			50	20	SS			0-1-1	30.5		
	344.1	53.0		21	SS			6-2-3	29.8		
Reddish brown, wet, loose, fine SAND (SP) with interbedded sand and gravel seams			55	22	SS			3-4-4			À ! "#$Ā%&'ÀÀ)-- Atterberg limits: LL=NP, PL=NP, PI=NP Passing No. 200 sieve = 2.5%
	339.1	58.0		23	SS			6-4-5			
Reddish brown, wet, medium dense, SAND (SP) with interbedded sand and gravel seams			60	24	SS			4-11-12			
				25	SS			10-12-14			À ! "#$Ā%&'ÀÀ)-6 Atterberg limits: LL=NP, PL=NP, PI=NP Passing No. 200 sieve = 5.7%
			65	26	SS			10-13-16			
				27	SS			10-10-12			
			70	28	SS			12-14-16			
	324.1	73.0		29	SS			5-9-14			
Gray, wet, medium dense, SAND (SP-SM) with gravel and trace silt			75	30	SS			7-18-19			À ! "#$Ā%&'ÀÀ)B Atterberg limits: LL=NP, PL=NP, PI=NP Passing No. 200 sieve = 8.7%
				31	SS			11-12-14			
	317.6	79.5		32	SS			3-5-9			

DRAFT

Sample Type

SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater

Noted on Drilling Tools -7' 6 ft.
At Completion)) ft.
After)) hours)) ft.
Cave Depth)) ft.

Boring Method

HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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CLIENT C$D;E$FĀ8&E'&E; G&F

PROJECT NAME A<HĀ&FJĀ I$;?Ā D;&EĀ<<$<<! $F;

PROJECT LOCATION >'0' Ā8 L#$?Ā4 FE ;GMĀ; ;G&F

%$NOLEMHĀFJGF

BORING # 0)+,-

JOB # +*,4 8 ,,+,*

NORTHING QRQ.7(6

EASTING -77BBR,

DRILLING and SAMPLING INFORMATION

Date Started	.9Q96	Hammer Wt.	+., lbs.
Date Completed	.9Q96	Hammer Drop	B, in.
Drill Foreman	: 'Ā0 ; $<	Spoon Sampler OD	-' , in.
Inspector	= 'Ā>&?$	Rock Core Dia.	)) in.
Boring Method	@ÀA	Shelby Tube OD	B', in.

TEST DATA

SOIL CLASSIFICATION (continued)	Stratum Elevation	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Black, weathered SHALE	317.1	80.0									
Bottom of Test Boring at 80.0 ft											

Sample Type

SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater

Noted on Drilling Tools	-7' 6	ft.
At Completion	))	ft.
After)) hours	))	ft.
Cave Depth	))	ft.

Boring Method

HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

ATC ASSOCIATES INC.
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TEST BORING LOG

CLIENT: **Vectren Utility Holdings, Inc.**
BORING #: **B-1**
PROJECT NAME: **Embankment Stability - East Ash Pond**
JOB #: **86.33159.0070**
PROJECT LOCATION: **F.B. Culley Generating Station**
Yankeetown, Indiana

DRILLING and SAMPLING INFORMATION

Date Started	**4/18/11**	Hammer Wt.	**140** lbs.
Date Completed	**4/18/11**	Hammer Drop	**30** in.
Drill Foreman	**W. Bates**	Spoon Sampler OD	**2.0** in.
Inspector	**D. Warder**	Rock Core Dia.	**--** in.
Boring Method	**HSA**	Shelby Tube OD	**--** in.

TEST DATA

SOIL CLASSIFICATION
SURFACE ELEVATION 394

Soil Classification	Stratum Elevation	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Crushed stone	393.3	0.7							Ground surface elevation estimated from topographic map
Brown, slightly moist, sandy silty clay with trace gravel (EMBANKMENT FILL)				1	SS	11-10-8	15.5	4.5+	
				2	SS	12-6-5	17.0	3.0	Borehole backfilled with bentonite
	388.5	5.5	5						
Gray, moist, silty clay with trace sand (EMBANKMENT FILL)				3	SS	3-2-2	29.8	0.5	
				4	SS	2-2-3	24.3		
			10						
				5	SS	1-2-2	17.3	2.5	
				6	SS	2-1-2	28.4	0.25	
			15						
				7	SS	2-2-3	23.7	0.75	
				8	SS	2-4-5	25.2	0.75	
			20						
				9	SS	3-3-4	25.0	1.5	
				10	SS	4-3-5	25.8	2.0	
			25						
				11	SS	3-4-4	28.9	1.0	
	366.0	28.0							
Gray to brown, slightly moist to moist, stiff to soft SILTY CLAY (CL)				12	SS	3-5-7	28.9	2.5	
			30						
				13	SS	2-3-4	27.3	3.0	
				14	SS	3-3-4	29.4	2.0	
			35						
				15	SS	2-3-3	26.3	1.5	
				16	SS	3-4-5	28.9	1.75	

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools **None** ft.
At Completion -- ft.
After -- hours -- ft.
Cave Depth -- ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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Fax (317) 849-4278

TEST BORING LOG

CLIENT: **Vectren Utility Holdings, Inc.**
PROJECT NAME: **Embankment Stability - East Ash Pond**
PROJECT LOCATION: **F.B. Culley Generating Station**
Yankeetown, Indiana

BORING #: **B-1**
JOB #: **86.33159.0070**

DRILLING and SAMPLING INFORMATION

Date Started	4/18/11	Hammer Wt.	140 lbs.
Date Completed	4/18/11	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	D. Warder	Rock Core Dia.	-- in.
Boring Method	HSA	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION (continued)	Stratum Elevation	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Gray to brown, slightly moist to moist, stiff to soft SILTY CLAY (CL)				17	SS			3-2-3	28.4	1.5	
				18	SS			2-3-3	31.6	1.0	
			45								
				19	SS			2-2-3	30.4	1.25	
			50	20	SS			3-4-3	30.0	1.25	
				21	SS			2-3-3	29.9	1.0	
			55	22	SS			3-2-4	30.5	1.25	
				23	SS			3-3-5	29.2	1.0	
	334.0	60.0	60	24	SS			3-4-4	29.6	0.75	
Bottom of Test Boring at 60.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools: **None** ft.
At Completion: -- ft.
After -- hours: -- ft.
Cave Depth: -- ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

ATC ASSOCIATES INC.
7988 Centerpoint Drive, Suite 100
Indianapolis, IN 46256
(317) 849-4990
Fax (317) 849-4278

TEST BORING LOG

CLIENT: **Vectren Utility Holdings, Inc.**
PROJECT NAME: **Embankment Stability - East Ash Pond**
PROJECT LOCATION: **F.B. Culley Generating Station**
Yankeetown, Indiana

BORING #: **B-2**
JOB #: **86.33159.0070**

DRILLING and SAMPLING INFORMATION

Date Started	**4/18/11**	Hammer Wt.	**140** lbs.
Date Completed	**4/18/11**	Hammer Drop	**30** in.
Drill Foreman	**W. Bates**	Spoon Sampler OD	**2.0** in.
Inspector	**D. Warder**	Rock Core Dia.	**--** in.
Boring Method	**HSA**	Shelby Tube OD	**3.0** in.

TEST DATA

SOIL CLASSIFICATION
SURFACE ELEVATION 394

Soil Classification	Stratum Elevation	Stratum Depth, ft	Sample No.	Sample Type	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Crushed stone	393.3	0.7						Ground surface elevation estimated from topographic map
Gray to brown, slightly moist, sandy silty clay with trace gravel (EMBANKMENT FILL)			1	SS	9-12-15	14.5		
	388.5	5.5	2	SS	8-7-5	18.8	4.0	Borehole backfilled with bentonite
Brown to gray, moist, silty clay with trace sand (EMBANKMENT FILL)			ST-1	ST				
			3	SS	2-2-2	22.2	0.75	One inch diameter PVC pipe piezometer installed to a depth of 20 ft in an offset boring
			4	SS	2-3-3	23.4	1.0	Screen located between depths of 10 and 20 ft
			ST-2	ST		20.9	1.7	
			5	SS	1-2-2	23.4	0.75	
			ST-3	ST		19.5	1.2	
			6	SS	2-2-2	24.0	0.5	
			7	SS	2-3-3	28.6	1.0	
			8	SS	2-2-3	27.1	1.0	
			9	SS	3-2-3	29.5	0.75	
Gray, moist, stiff to soft SILTY CLAY (CL) -decayed wood fragments in Sample No. 10	363.5	30.5	10	SS	3-4-5	30.3	0.75	
			11	SS	4-6-7	24.1	3.0	
			12	SS	4-4-5	23.4		
			13	SS	4-4-4	24.9		

Depth Scale, ft: 5, 10, 15, 20, 25, 30, 35

Groundwater: (none shown)

DRAFT

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools **None** ft.
At Completion **--** ft.
After **--** hours **--** ft.
Cave Depth **--** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

ATC Associates Inc.
7988 Centerpoint Drive, Suite 100
Indianapolis, IN 46256
(317) 849-4990
Fax (317) 849-4278

TEST BORING LOG

CLIENT: **Vectren Utility Holdings, Inc.**
PROJECT NAME: **Embankment Stability - East Ash Pond**
PROJECT LOCATION: **F.B. Culley Generating Station**
Yankeetown, Indiana
BORING #: **B-2**
JOB #: **86.33159.0070**

DRILLING and SAMPLING INFORMATION

Date Started	4/18/11	Hammer Wt.	140 lbs.
Date Completed	4/18/11	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	D. Warder	Rock Core Dia.	-- in.
Boring Method	HSA	Shelby Tube OD	3.0 in.

TEST DATA

SOIL CLASSIFICATION (continued)	Stratum Elevation	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Gray, moist, stiff to soft SILTY CLAY (CL)				ST-4	ST				37.5	1.0	
				14	SS			4-2-3	39.7		
			45								
				ST-5	ST				36.3	0.6	
	346.0	48.0									
Gray, wet to very moist, very soft SILT (ML) with trace clay				15	SS			1-1-1	43.3		
			50								
				16	SS			2-1-2	32.8		
	341.0	53.0									
Gray, moist, soft to medium stiff SILTY CLAY (CL)				17	SS			2-2-2	42.4	0.5	
			55								
				18	SS			2-3-3	40.3	1.0	
				19	SS			3-4-3	49.6	1.0	
	334.0	60.0	60								
Bottom of Test Boring at 60.0 ft											

DRAFT

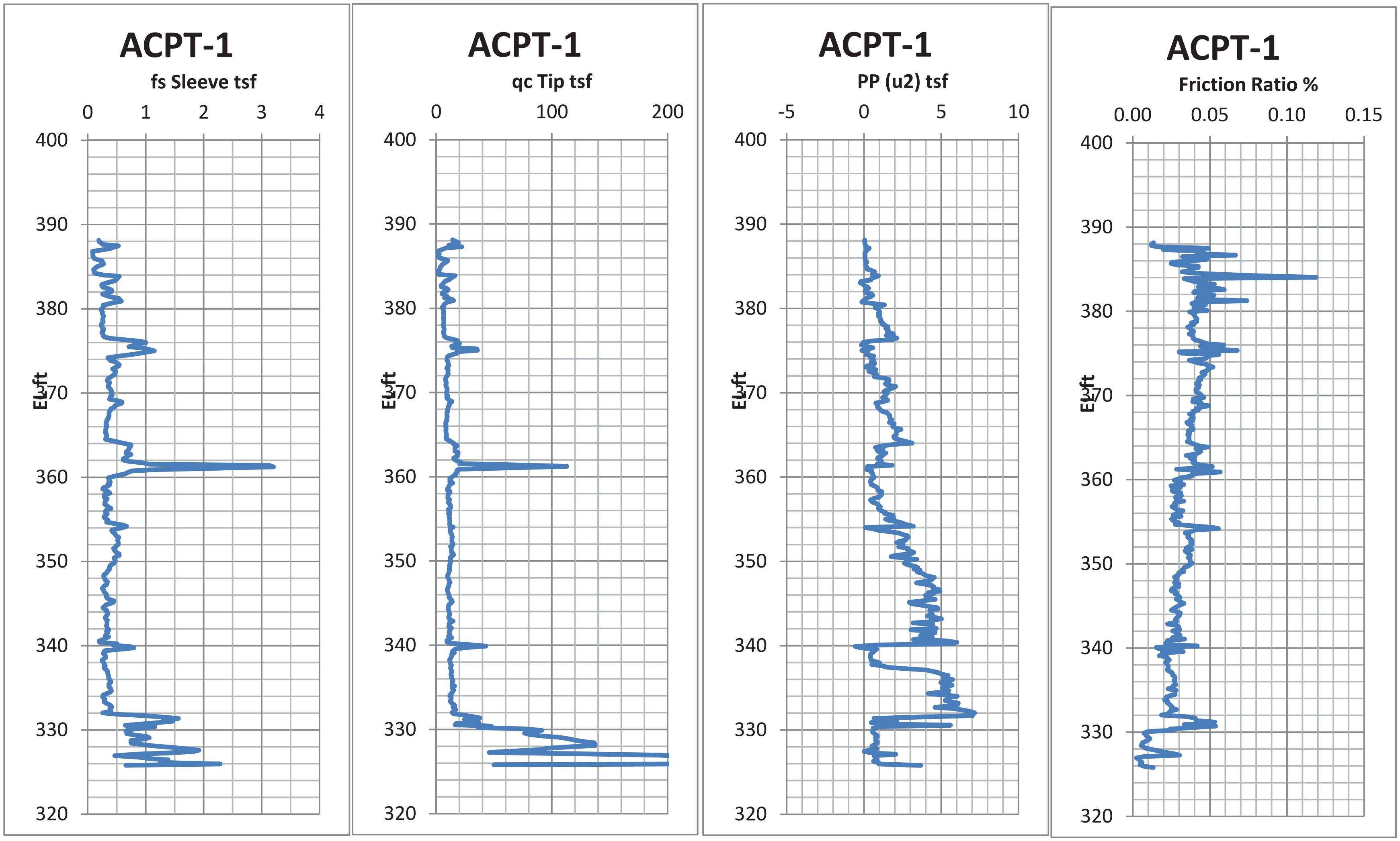
Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools: None ft.
At Completion: -- ft.
After -- hours: -- ft.
Cave Depth: -- ft.

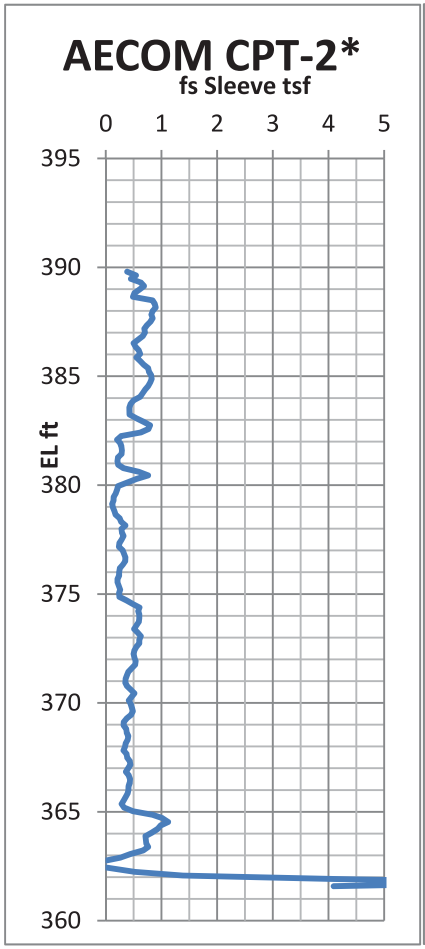
Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

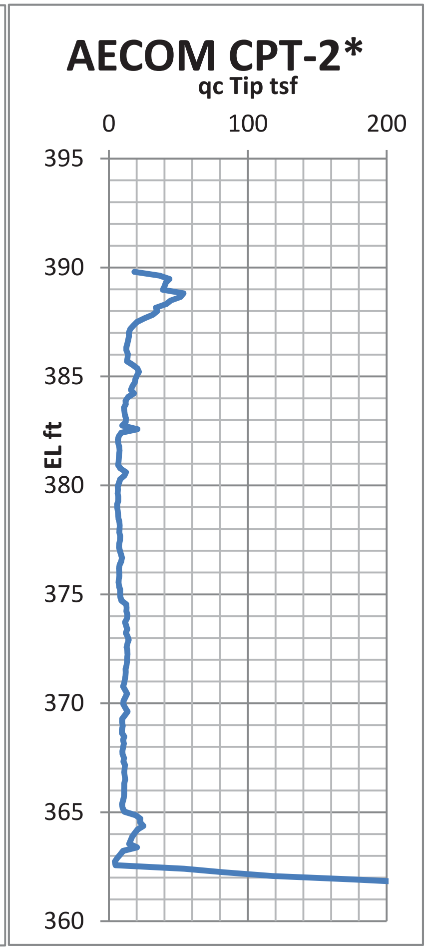
Appendix C
CPT Data

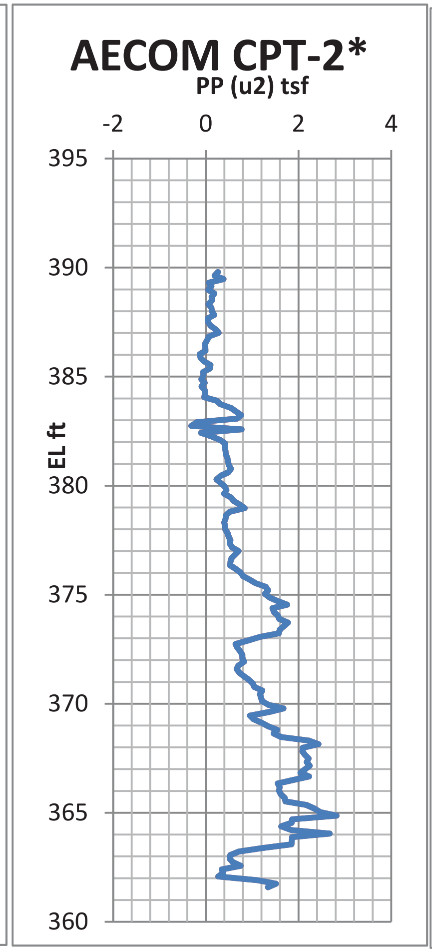
CPT Results   for AECOM CPT-1

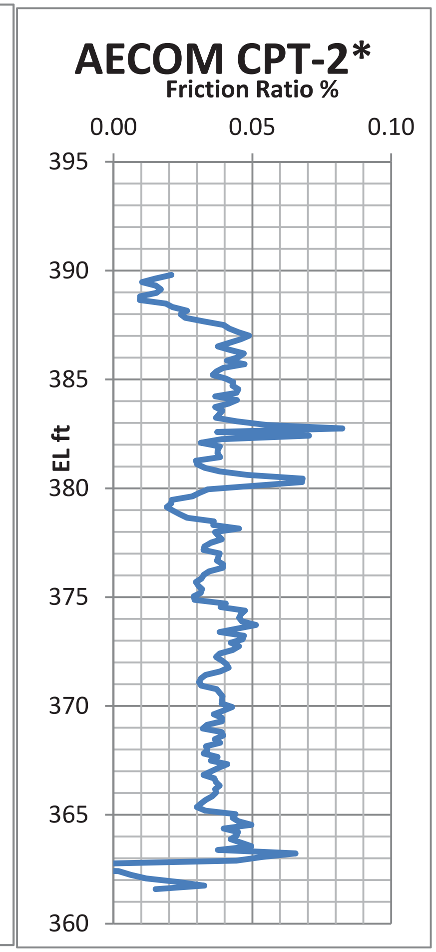


CPT Results for AECOM CPT-2

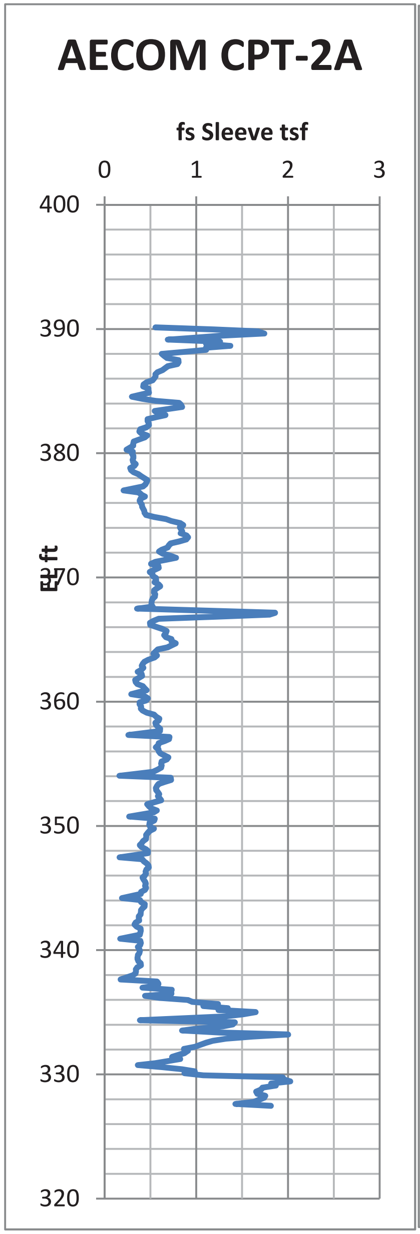


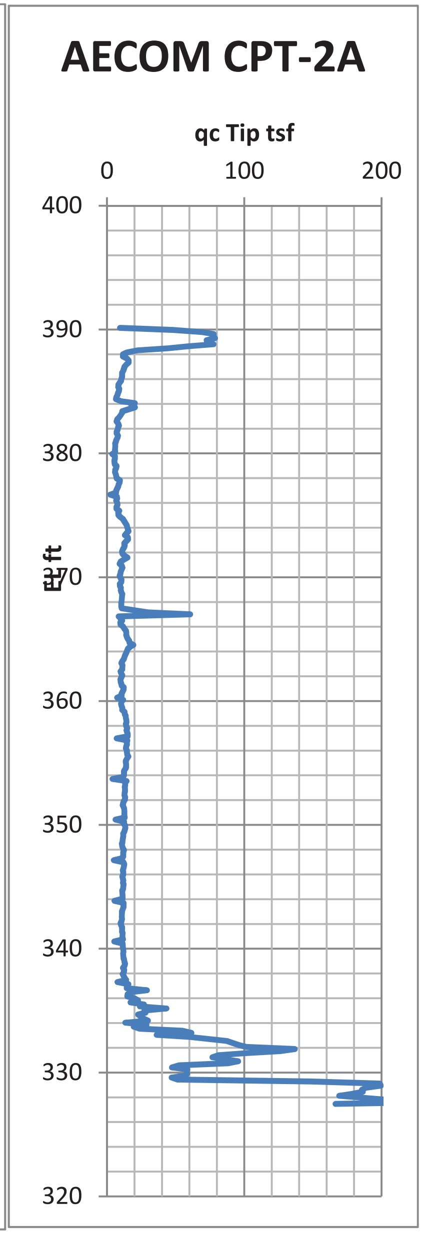


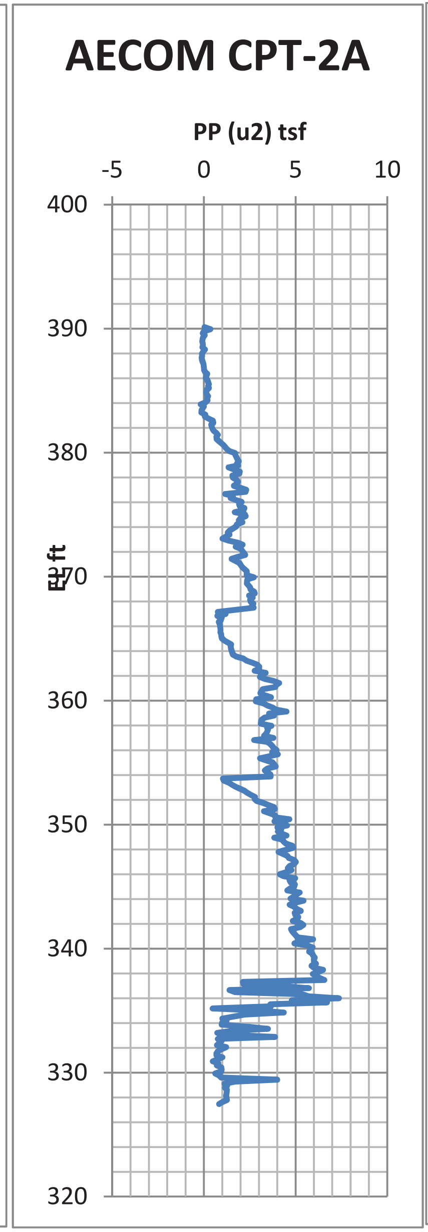


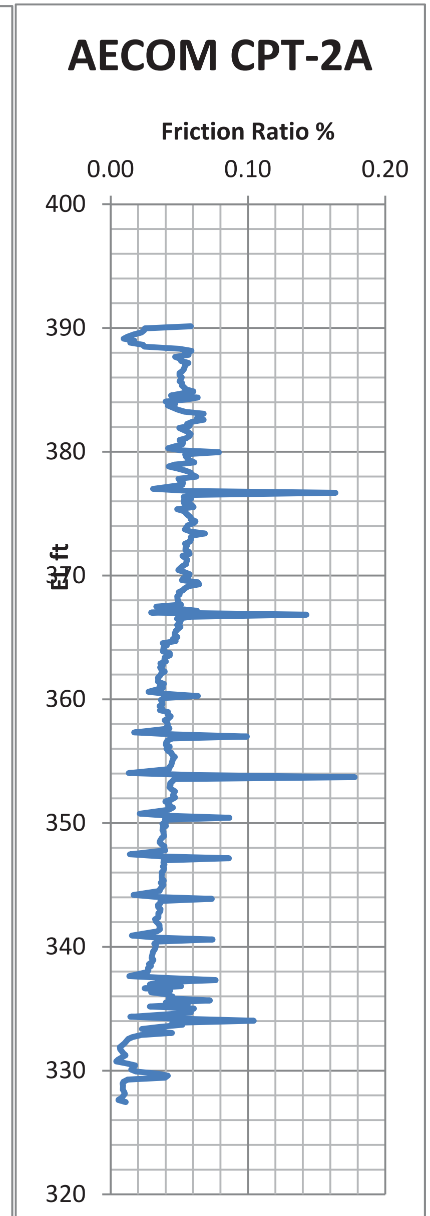


CPT Results for AECOM CPT-2A





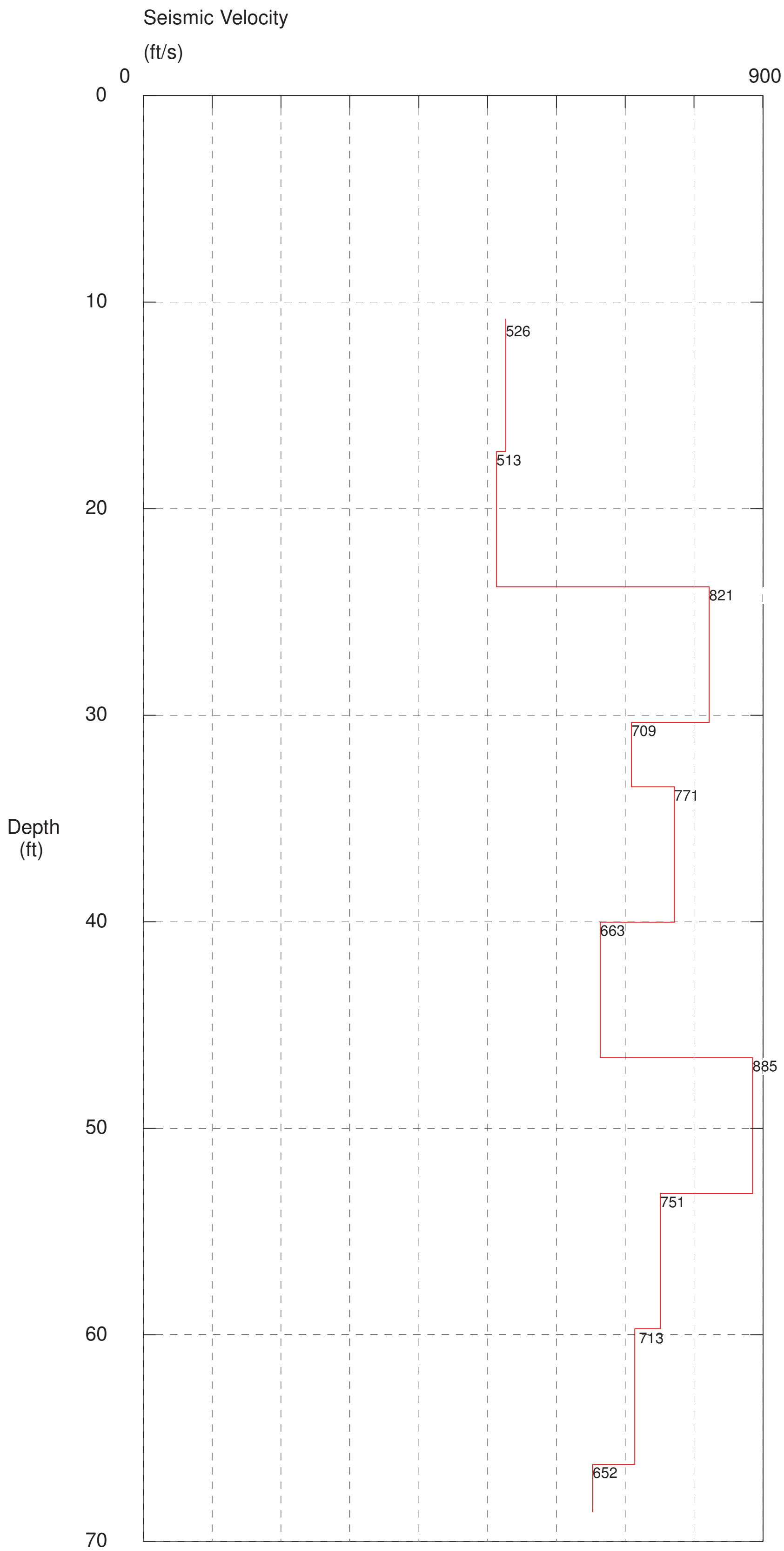




CPT-AECOM-1

Operator: ATC
Sounding: Elev: 394
Cone Used: DDG1181

CPT Date/Time: 11/13/2015 9:09:53 AM
Location: FB Culley - East Ash Pond
Job Number: 170GC00107

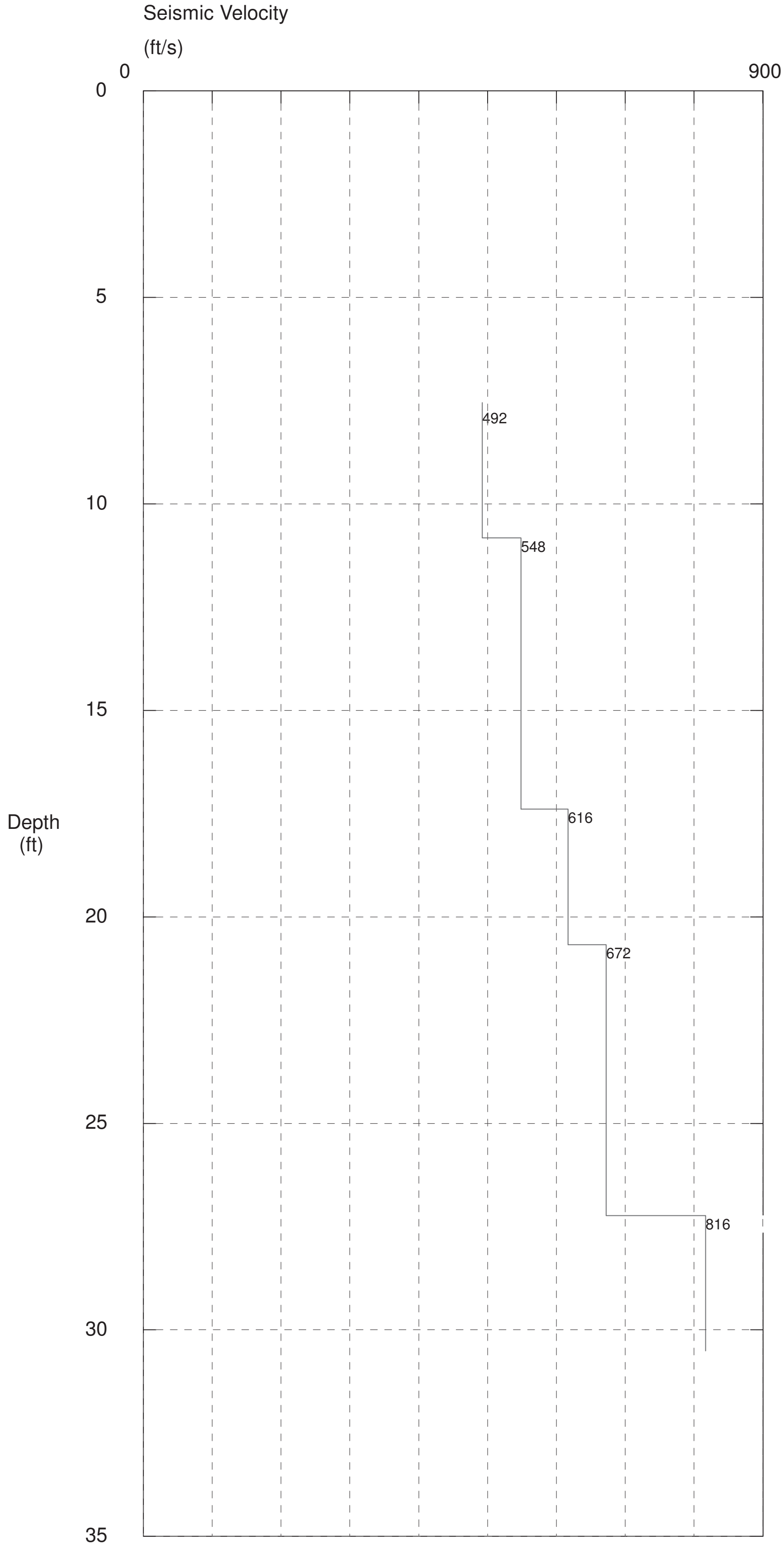


Maximum Depth = 68.57 feet

CPT-AECOM-2

Operator: ATC
Sounding: Elev: 394
Cone Used: DDG1181

CPT Date/Time: 11/12/2015 3:36:04 PM
Location: FB Culley - East Ash Pond
Job Number: 170GC00107

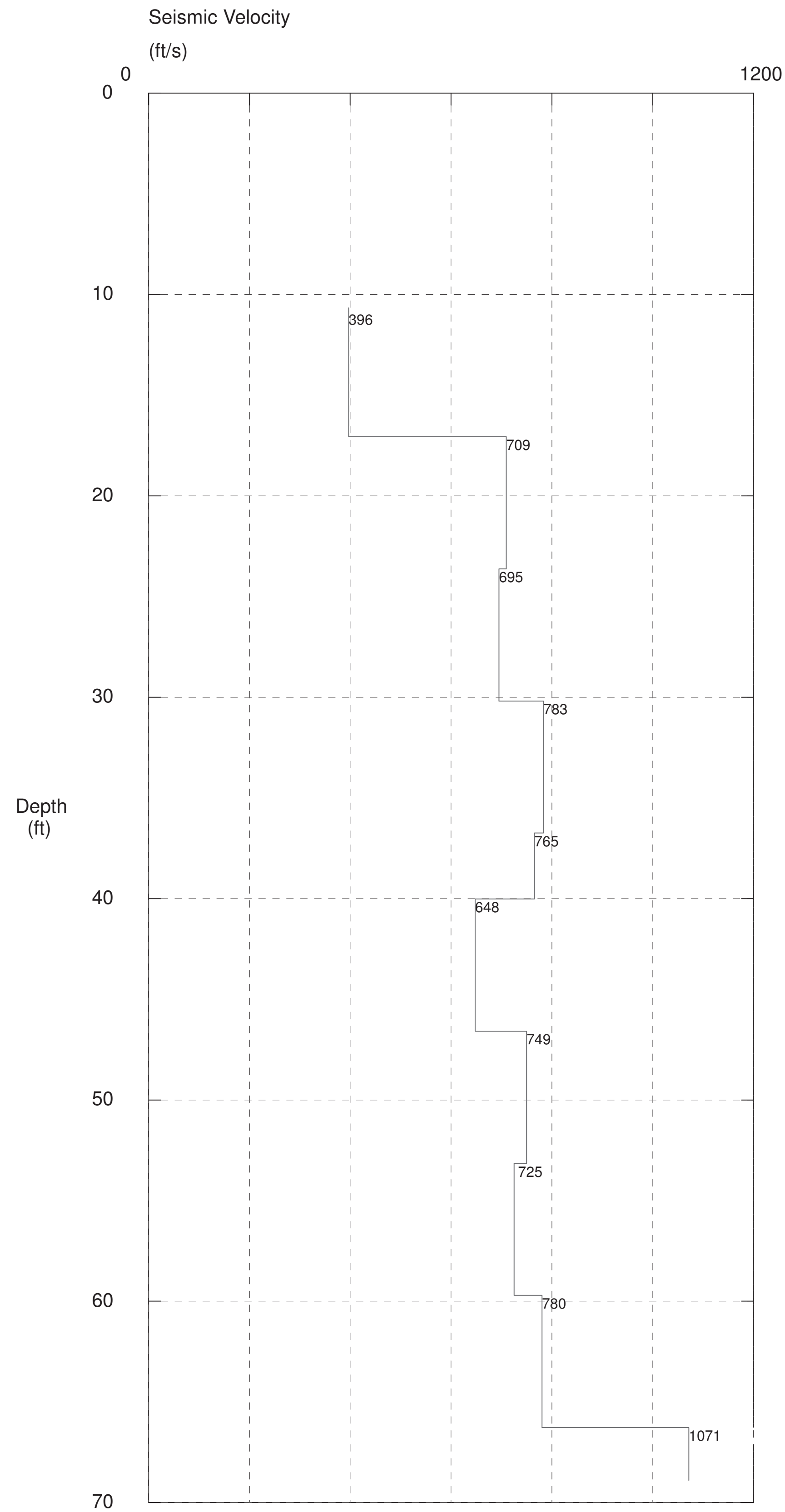


Maximum Depth = 32.48 feet

CPT-AECOM-2A

Operator: ATC
Sounding: Elev: 394
Cone Used: DDG1181

CPT Date/Time: 11/12/2015 5:34:32 PM
Location: FB Culley - East Ash Pond
Job Number: 170GC00107

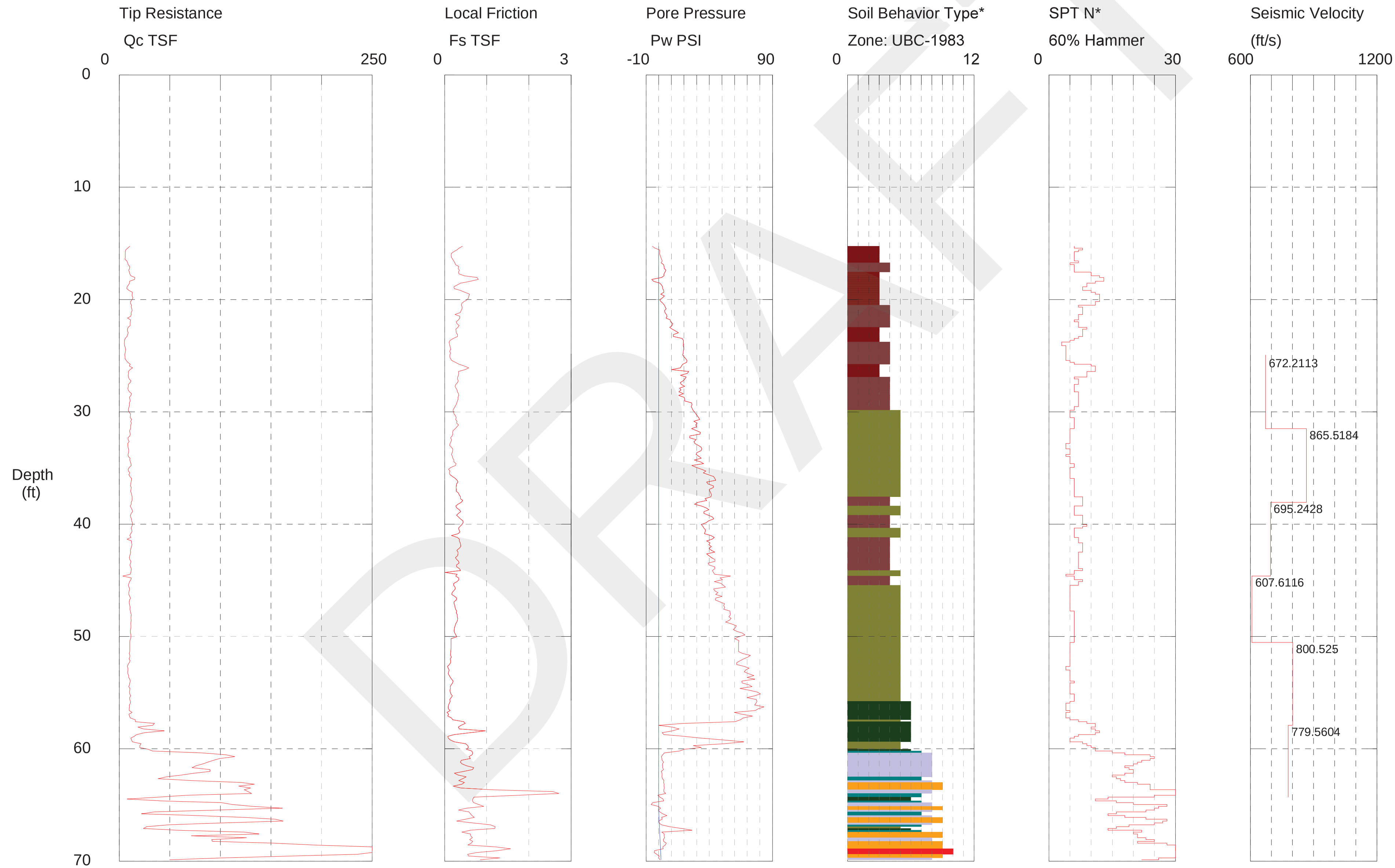


Maximum Depth = 68.90 feet

CPT-101

Operator: Cardno - ZV
Sounding: Elev: 393.7
Cone Used: DDG1181

CPT Date/Time: 4/14/2015
Location: North=969055, East=2883843
Job Number: 170GC00107



Maximum Depth = 71.36 feet

Depth Increment = 0.164 feet

1 sensitive fine grained	4 silty clay to clay	7 silty sand to sandy silt	10 gravelly sand to sand
2 organic material	5 clayey silt to silty clay	8 sand to silty sand	11 very stiff fine grained (*)
3 clay	6 sandy silt to clayey silt	9 sand	12 sand to clayey sand (*)

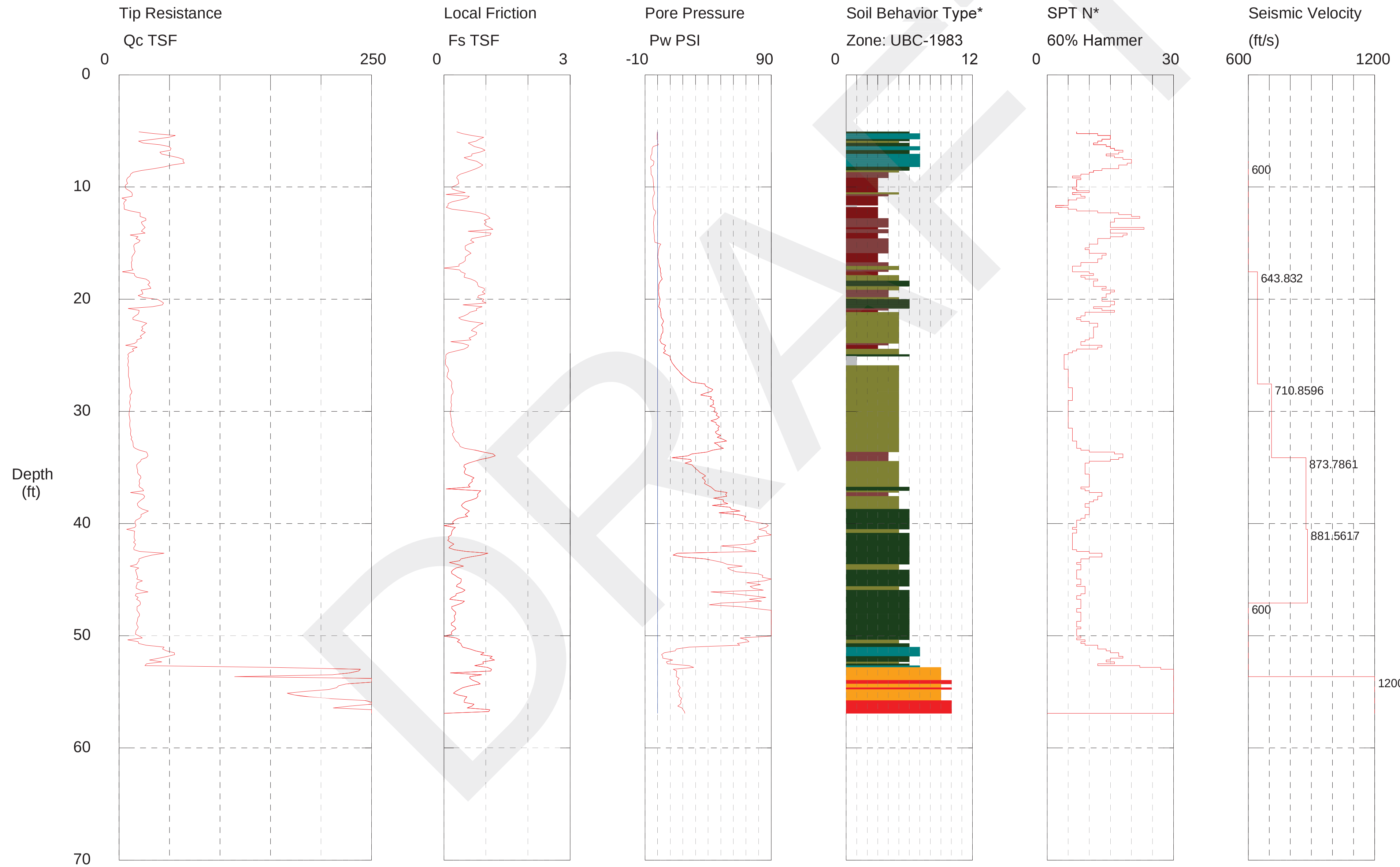
FB Culley - East Ash Pond

*Soil behavior type and SPT based on data from UBC-1983

CPT-102

Operator: Cardno - ZV
Sounding: Elev: 395.1
Cone Used: DDG1181

CPT Date/Time: 4/14/2015
Location: North=969015, East=2883518
Job Number: 170GC00107



Maximum Depth = 56.92 feet

Depth Increment = 0.164 feet

1 sensitive fine grained	4 silty clay to clay	7 silty sand to sandy silt	10 gravelly sand to sand
2 organic material	5 clayey silt to silty clay	8 sand to silty sand	11 very stiff fine grained (*)
3 clay	6 sandy silt to clayey silt	9 sand	12 sand to clayey sand (*)

FB Culley - East Ash Pond

*Soil behavior type and SPT based on data from UBC-1983

Appendix D
Laboratory Testing Data

LABORATORY TESTING SUMMARY

Terracon

PROJECT NAME: VECTREN F.B. CULLEY EAST POND

PROJECT NUMBER: AW165009

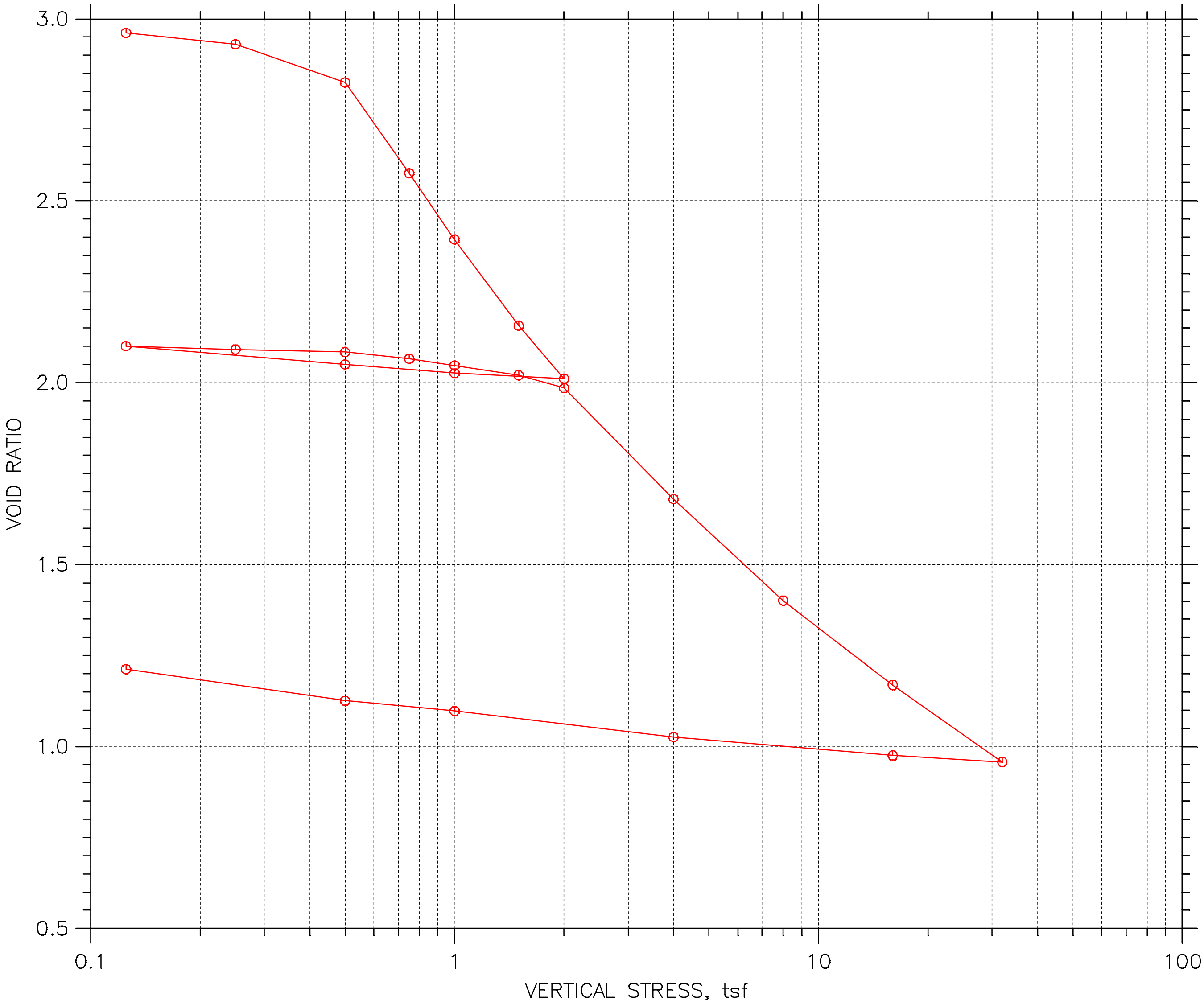
CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	% Gravel	% Sand	% Silt	% Clay	LL	PL	PI	Specific Gravity	Dry Density (pcf)	Consolidation P_c (tsf)	C_c	C_{cr}	CIU Triaxial Testing Φ' (deg)	C' (tsf)	Φ (deg)	C (tsf)	Direct Shear Φ (deg)	C (tsf)	Unconfined Qu (tsf)
B16-1	ST-1	8.0'-10.0'	GRAY AND DARK GRAY FLY ASH WITH SAND		45.8																			
B16-1	ST-2	17.0'-19.0'	LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH			0.0	2.4	57.4	40.2				2.655	41.4	0.59	1.390	0.081					26.4	0.0984	
B16-1	ST-3	29.0'-31.0'	DARK BROWN, GRAY AND BLACK FLY ASH WITH SILT AND SAND		59.4								2.667											
B16-1	ST-4	39.0'-41.0'	BROWNISH GRAY FLY ASH WITH SILT AND CLAY										2.678	60.5	2.00	0.392	0.014							
B16-1	ST-5	49.0'-51.0'	GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH.	CL		0.0	16.4	52.8	30.8	35	20	15		86.0	2.70	0.321	0.031							1.0
B16-2	ST-1	N/A	NO RECOVERY																					
B16-2	ST-2	16.0'-18.0'	DARK GRAY AND BLACK FLY ASH WITH BROWN CLAY LAYERS NOTED		78.1	0.0	20.7	50.2	29.1															
B16-2	ST-3	22.0'-24.0'	GRAY, DARK GRAY AND BLACK BOTTOM ASH WITH CINDERS AND GRAVEL		36.2	5.0	48.7	34.4	11.9															
B16-2	ST-4	29.0'-31.0'	DARK BROWNISH GRAY FLY ASH WITH CLAY			0.6	9.3	75.4	14.7				2.640	74.7	6.00	0.259	0.010							
B16-2	ST-5	39.0'-41.0'	VERY DARK BROWNISH GRAY FLY ASH		43.3																			
B16-2	ST-6	49.0'-51.0'	GRAY LEAN CLAY WITH SAND	CL		0.0	8.4	58.7	32.9	37	21	16		99.7								29.1	0.0508	0.6
B16-3	ST-1	11.0'-13.0'	BROWNISH GRAY CLAY AND FLYASH MIX - 3' SAND LAYER NOTED		91.4	0.0	5.5	81.0	13.5				2.717											
B16-3	ST-2	15.0'-17.0'	VERY DARK BROWNISH GRAY VARVED FLY ASH WITH CLAY - 3" SAND LAYER NOTED		69.1																			
B16-3	ST-3	21.0'-23.0'	VERY DARK GRAY TO BLACK FLY ASH WITH CLAY - 2" SAND LAYER AT TOP		42.0	0.0	1.8	82.9	15.3				2.612											
B16-3	ST-7	54.0'-56.0'	GRAY TO OLIVE GRAY LEAN CLAY WITH SAND SILT POCKETS NOTED	CL						43	21	22		91.5				30.7	0.132	16.5	0.243			0.6
B16-4	ST-1	9.0'-11.0'	BROWNISH GRAY CLAY AND DARK GRAY FLY ASH MIX		91.5	0.0	2.4	89.0	8.6				2.721											
B16-4	ST-2	N/A	NO RECOVERY																					
B16-4	ST-3	17.0'-19.0'	VERY DARK GRAY FLY ASH TRACE CLAY		54.4	0.0	2.3	88.6	9.1				2.576											
B16-4	ST-4	24.0'-26.0'	VERY DARK BROWNISH GRAY SLIGHTLY VARVED FLY ASH		48.3																			
B16-4	ST-5	30.0'-32.0'	VERY DARK GRAY AND BROWNISH GRAY FLY ASH MIX		45.8																			
B16-4	ST-6	42.0'-44.0'	DARK BROWNISH GRAY SILT ML FLY ASH NOTED	ML		0.0	6.9	64.4	28.7	47	33	14	2.704	54..0								26.5	0.0119	

Terracon

One-Dimensional Consolidation Test – ASTM D 2435

ONE DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS
USING INCREMENTAL LOADING
ASTM D2435

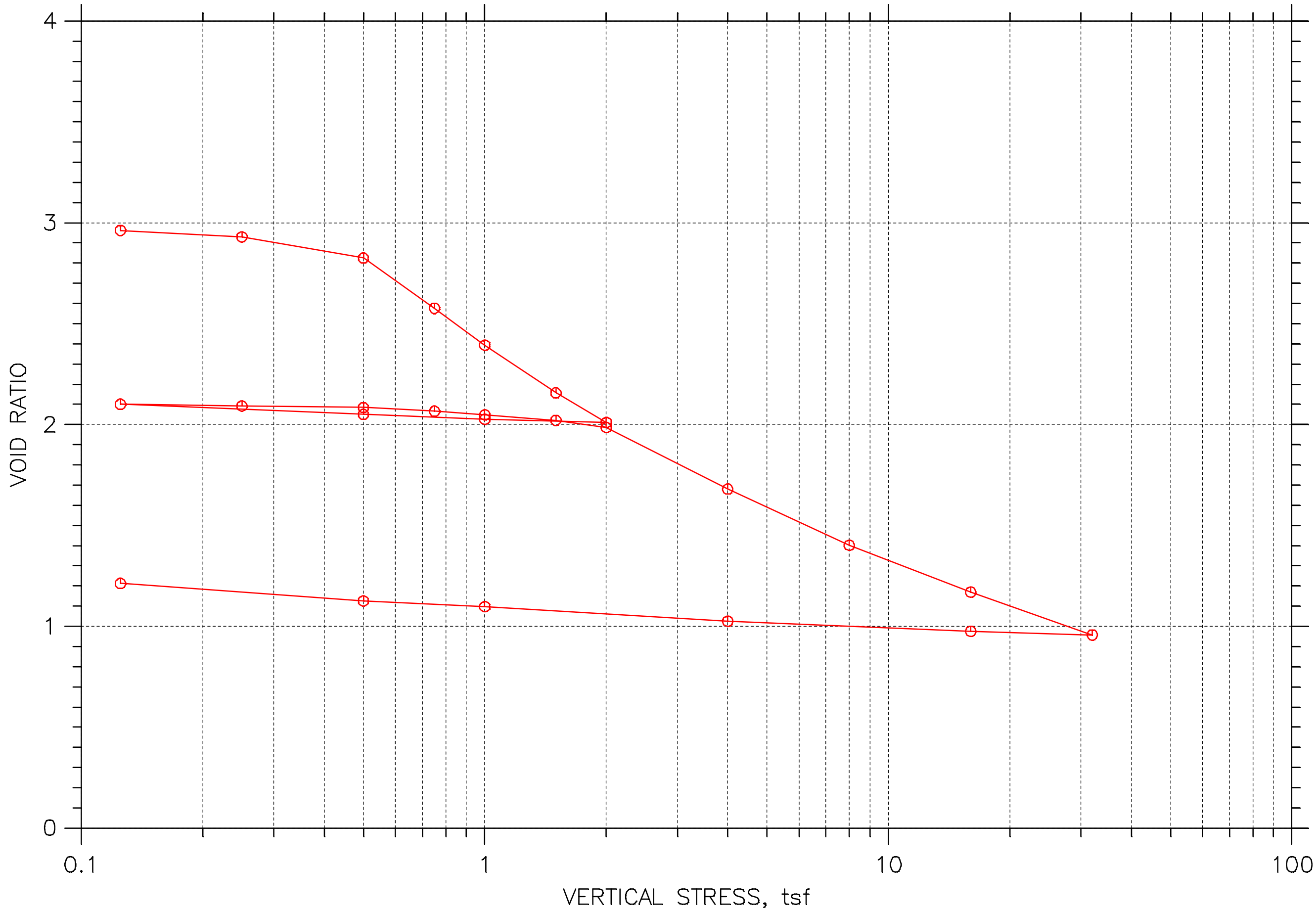


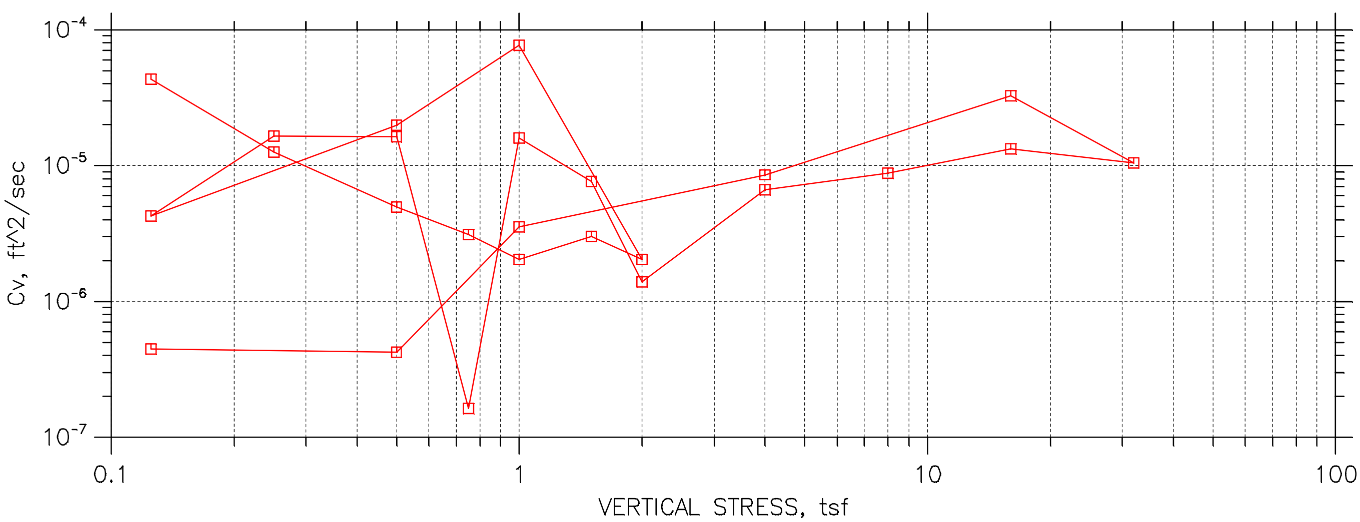
					Before Test	After Test
Overburden Pressure: 0.369 tsf				Water Content, %	113.76	47.98
Preconsolidation Pressure: 0.59 tsf				Dry Unit Weight, pcf	41.42	74.92
				Saturation, %	100.62	105.08
Diameter: 2.509 in		Height: 0.7488 in		Void Ratio	3.00	1.21
LL: ---	PL: ---	PI: ---	GS: 2.65			

Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
Boring No.: B-16-01	Tested By: HP	Checked By: BCM
Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

Terracon
Consulting Engineers & Scientists

ONE DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS
USING INCREMENTAL LOADING
ASTM D2435





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

Mon, 25-APR-2016 16:17:47

CONSOLIDATION TEST DATA

Project: VECTREN CULLEY E POND
Boring No.: B-16-01
Sample No.: ST2
Test No.: ST2CON

Location: NEWBURGH, IN
Tested By: HP
Test Date: 04/11/2106
Sample Type: 3.0" ST

Project No.: AW165009
Checked By: BCM
Depth: 17.0'-19.0'
Elevation: -----------

Soil Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH
Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435

Measured Specific Gravity: 2.65
Initial Void Ratio: 3.00
Final Void Ratio: 1.22

Liquid Limit: ---
Plastic Limit: ---
Plasticity Index: ---

Initial Height: 0.75 in
Specimen Diameter: 2.51 in

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	X16	RING	RING	X-19
Wt. Container + Wet Soil, gm	156.11	160.37	133.9	99.36
Wt. Container + Dry Soil, gm	96.74	114.59	114.59	81.52
Wt. Container, gm	44.47	74.35	74.35	44.34
Wt. Dry Soil, gm	52.27	40.241	40.241	37.18
Water Content, %	113.58	113.76	47.98	47.98
Void Ratio	---	3.00	1.22	---
Degree of Saturation, %	---	100.62	104.67	---
Dry Unit Weight, pcf	---	41.419	74.759	---

CONSOLIDATION TEST DATA

Project: VECTREN CULLEY E POND
Boring No.: B-16-01
Sample No.: ST2
Test No.: ST2CON

Location: NEWBURGH, IN
Tested By: HP
Test Date: 04/11/2106
Sample Type: 3.0" ST

Project No.: AW165009
Checked By: BCM
Depth: 17.0'-19.0'
Elevation: -----------

Soil Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH
Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435

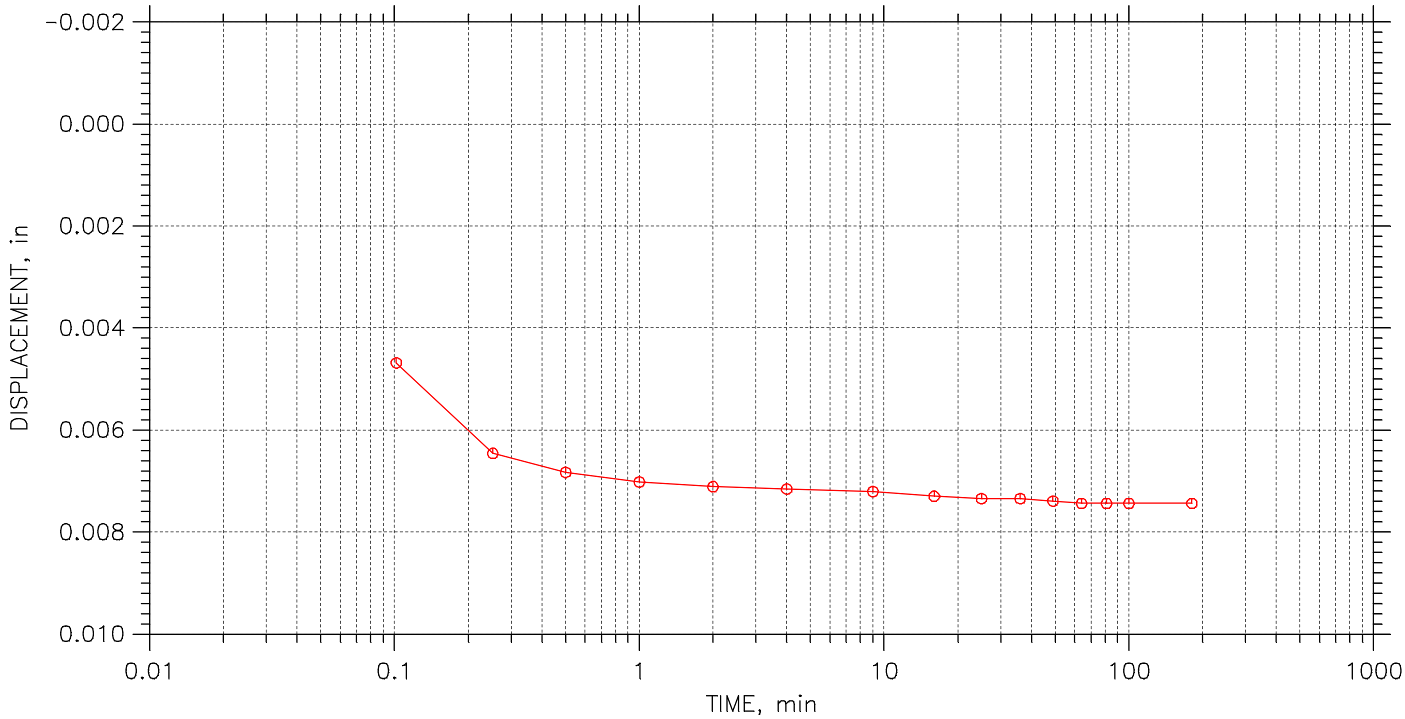
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	T50 Fitting Sq.Rt. min	T50 Fitting Log min	Coefficient of Consolidation Sq.Rt. ft^2/sec	Coefficient of Consolidation Log ft^2/sec	Coefficient of Consolidation Ave. ft^2/sec
1	0.125	0.00744	2.962	0.99	0.1	0.0	4.33e-005	0.00e+000	4.33e-005
2	0.25	0.01341	2.930	1.79	0.2	0.0	1.29e-005	0.00e+000	1.29e-005
3	0.5	0.03305	2.825	4.41	1.0	0.3	3.13e-006	1.16e-005	4.93e-006
4	0.75	0.07965	2.576	10.64	1.0	0.8	2.86e-006	3.43e-006	3.12e-006
5	1	0.1138	2.393	15.20	1.4	1.0	1.70e-006	2.55e-006	2.04e-006
6	1.5	0.1581	2.157	21.12	1.0	0.5	2.20e-006	4.71e-006	3.00e-006
7	2	0.1854	2.011	24.76	1.4	0.5	1.36e-006	4.10e-006	2.04e-006
8	1	0.1826	2.026	24.38	0.0	0.0	7.67e-005	0.00e+000	7.67e-005
9	0.5	0.1781	2.050	23.78	0.1	0.0	1.99e-005	0.00e+000	1.99e-005
10	0.125	0.1687	2.100	22.53	0.7	0.2	2.66e-006	1.04e-005	4.24e-006
11	0.25	0.1703	2.092	22.75	0.1	0.0	1.64e-005	0.00e+000	1.64e-005
12	0.5	0.1722	2.082	22.99	0.1	0.0	1.63e-005	4.82e-002	3.26e-005
13	0.75	0.1751	2.066	23.39	11.6	0.0	1.63e-007	0.00e+000	1.63e-007
14	1	0.1786	2.047	23.85	0.1	0.0	1.60e-005	0.00e+000	1.60e-005
15	1.5	0.1836	2.020	24.52	0.2	0.0	7.60e-006	0.00e+000	7.60e-006
16	2	0.1902	1.985	25.40	3.9	0.0	4.63e-007	0.00e+000	4.63e-007
17	4	0.2474	1.680	33.04	0.4	0.1	4.47e-006	1.27e-005	6.62e-006
18	8	0.2995	1.401	39.99	0.2	0.1	6.93e-006	1.20e-005	8.80e-006
19	16	0.3429	1.169	45.79	0.1	0.0	1.33e-005	0.00e+000	1.33e-005
20	32	0.3825	0.958	51.08	0.1	0.0	1.05e-005	0.00e+000	1.05e-005
21	16	0.3789	0.977	50.60	0.0	0.0	3.26e-005	0.00e+000	3.26e-005
22	4	0.3698	1.026	49.38	0.1	0.0	8.58e-006	0.00e+000	8.58e-006
23	1	0.3564	1.097	47.59	0.2	0.0	3.54e-006	0.00e+000	3.54e-006
24	0.5	0.351	1.126	46.88	2.1	0.0	4.24e-007	0.00e+000	4.24e-007
25	0.125	0.334	1.217	44.60	3.3	1.8	2.90e-007	5.33e-007	3.76e-007

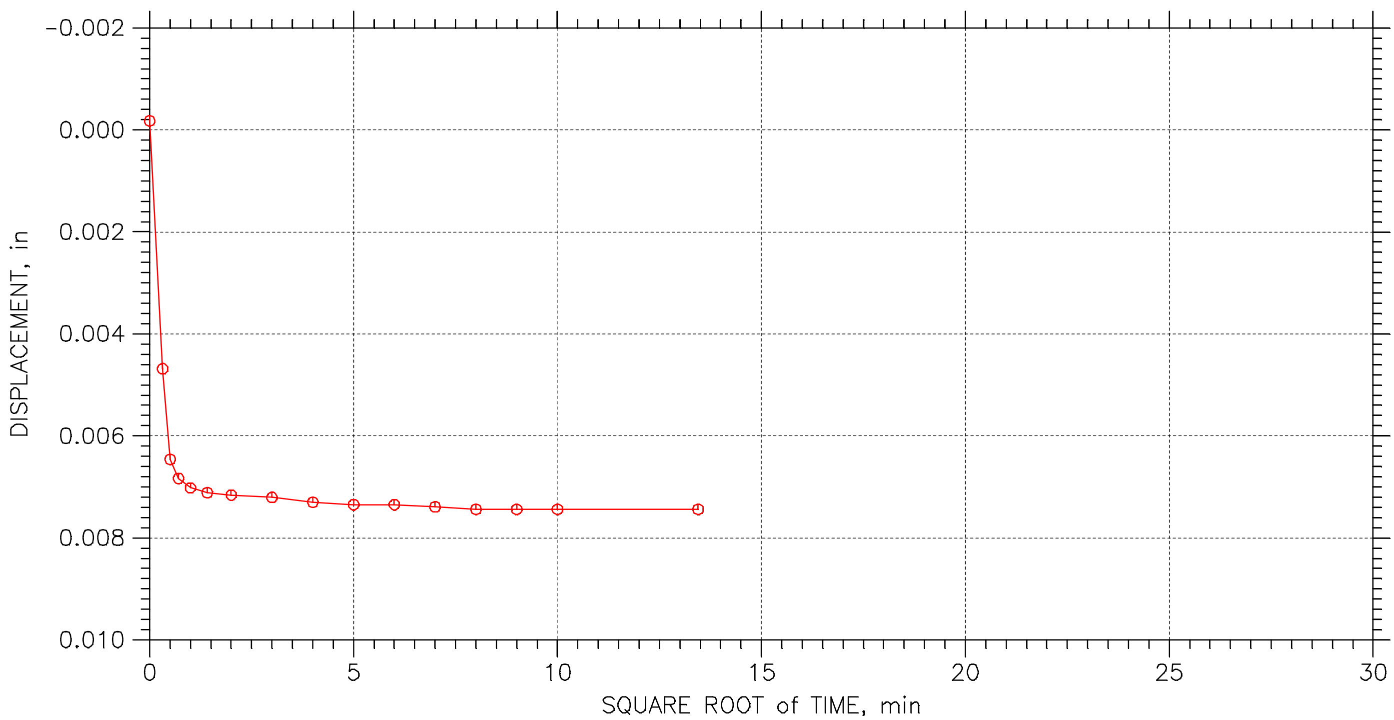
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 1 of 25

Stress: 0.125 tsf





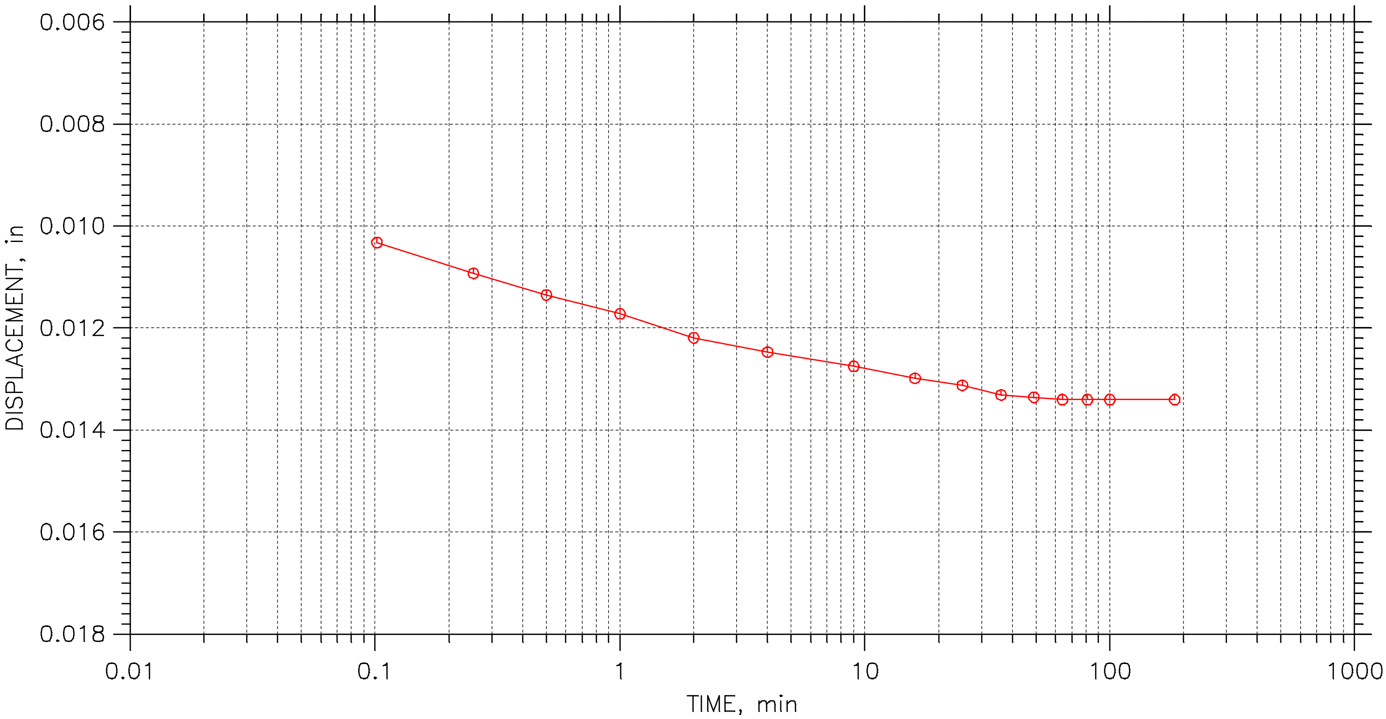
Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

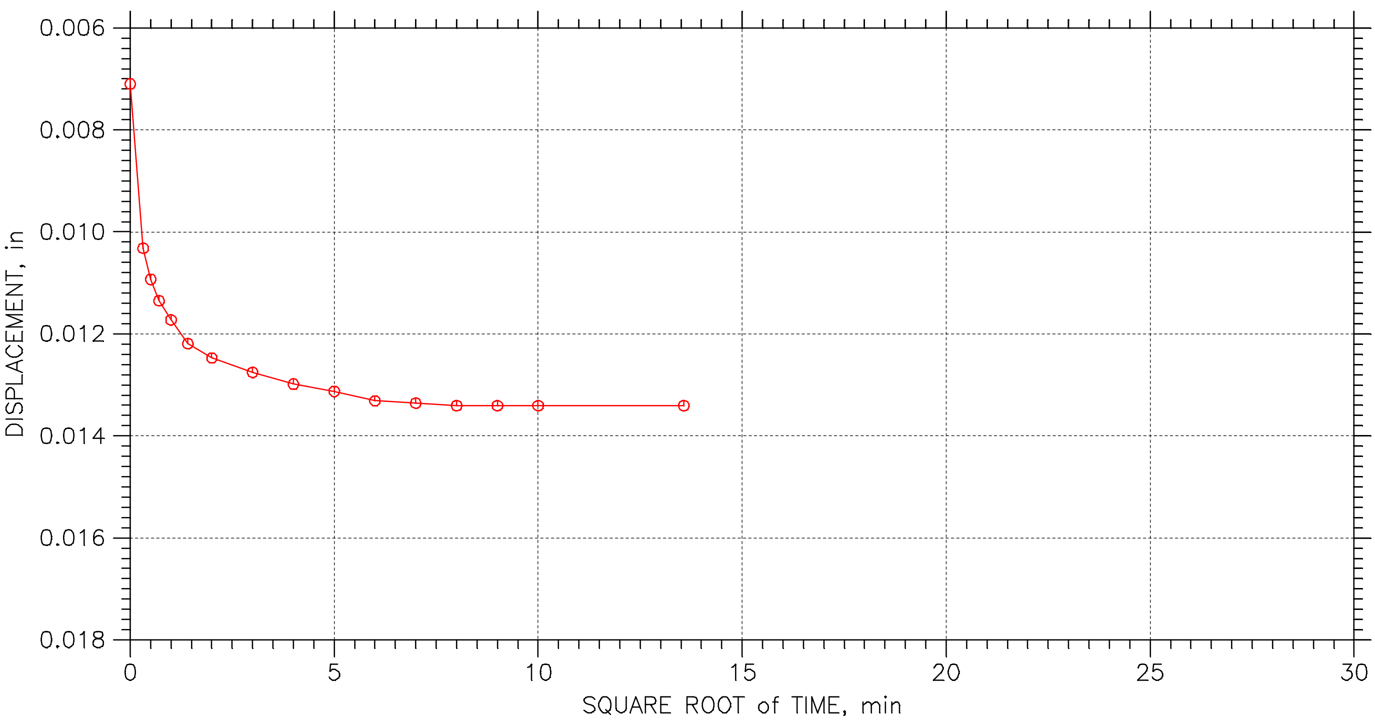
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 2 of 25

Stress: 0.25 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

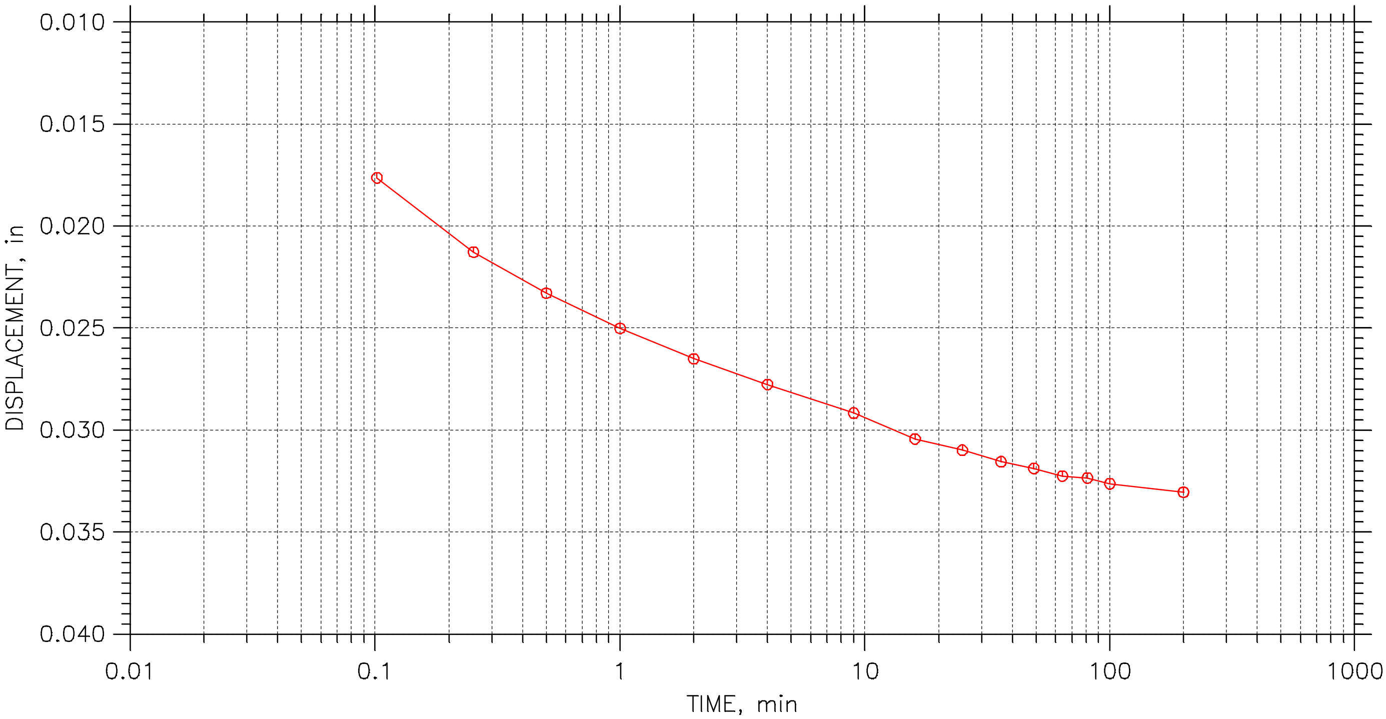
Mon, 25-APR-2016 16:42:22

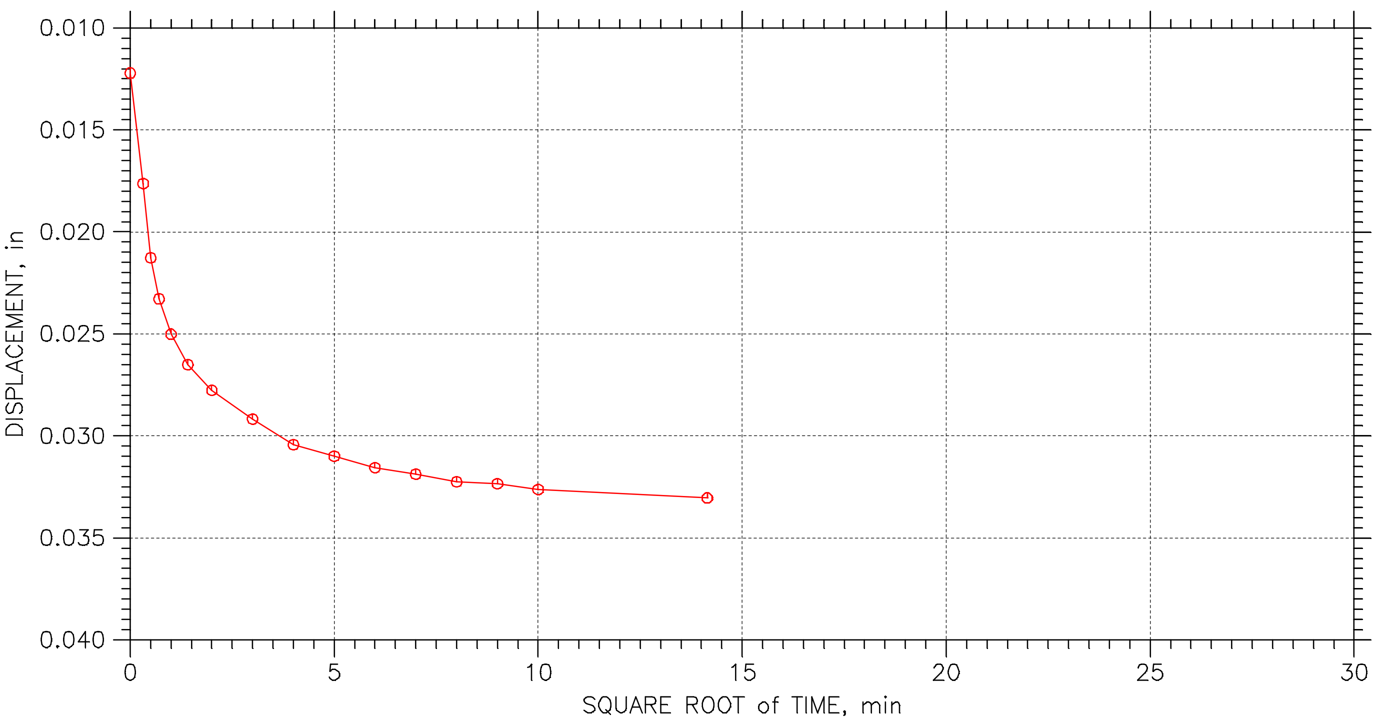
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 3 of 25

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

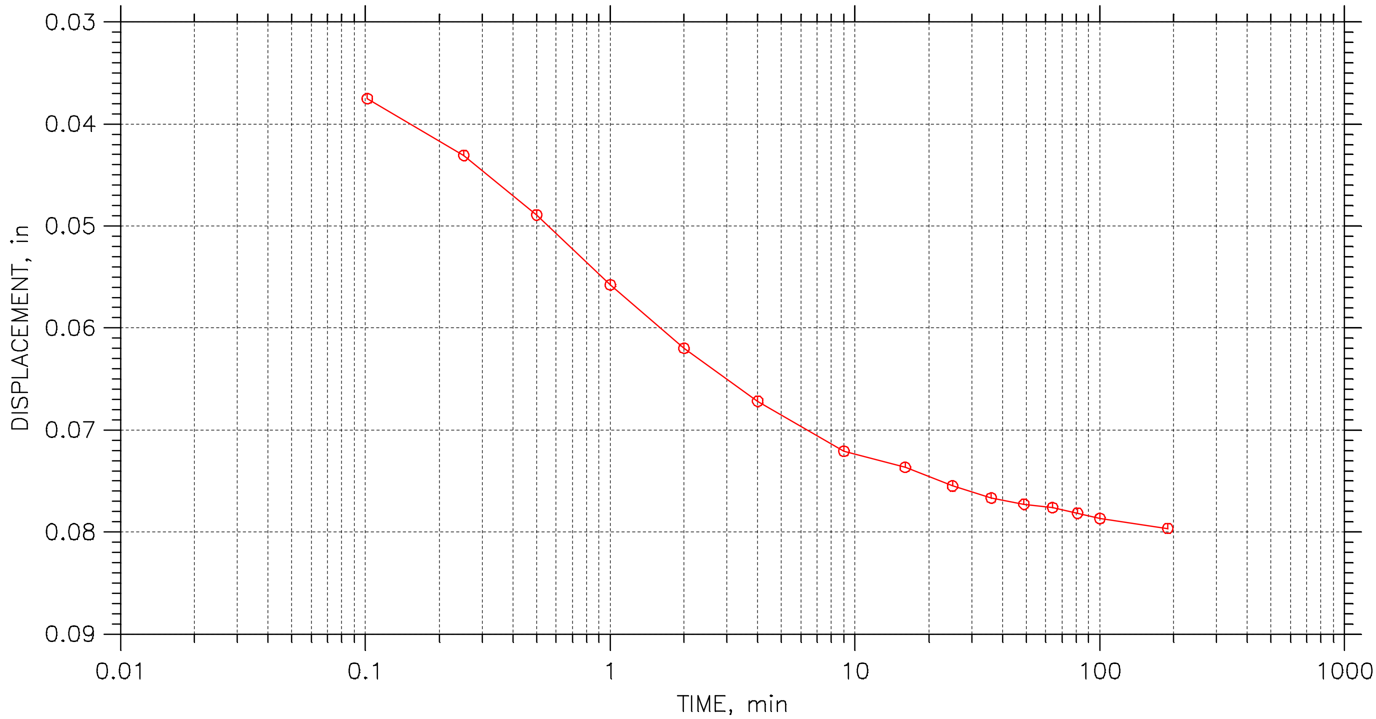
Mon, 25-APR-2016 16:42:23

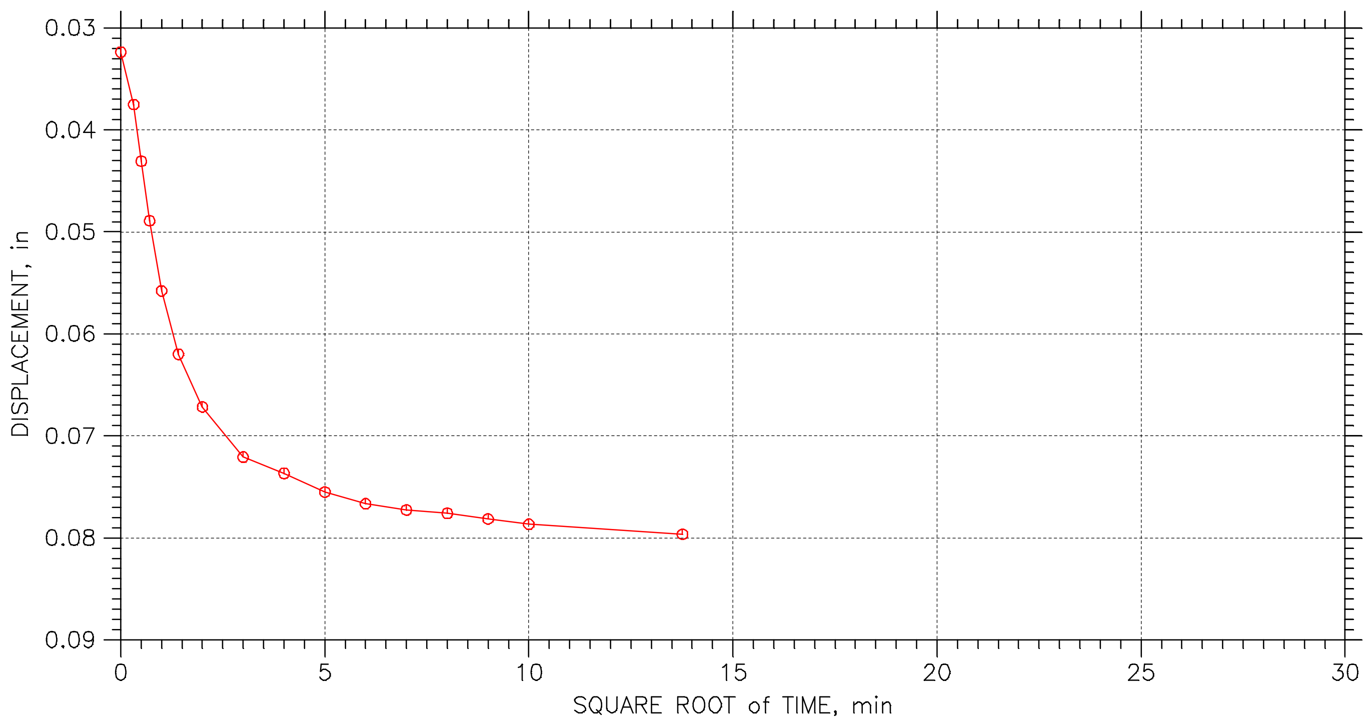
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 4 of 25

Stress: 0.75 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

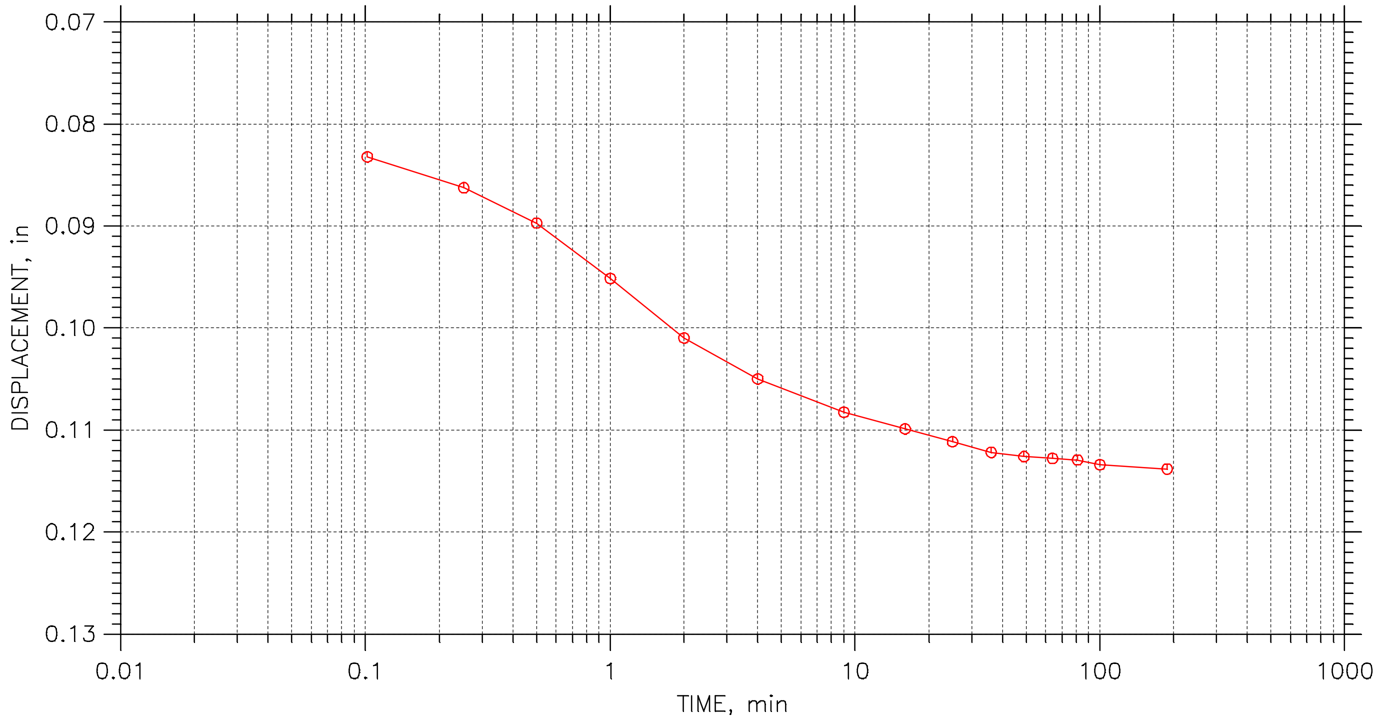
Mon, 25-APR-2016 16:42:25

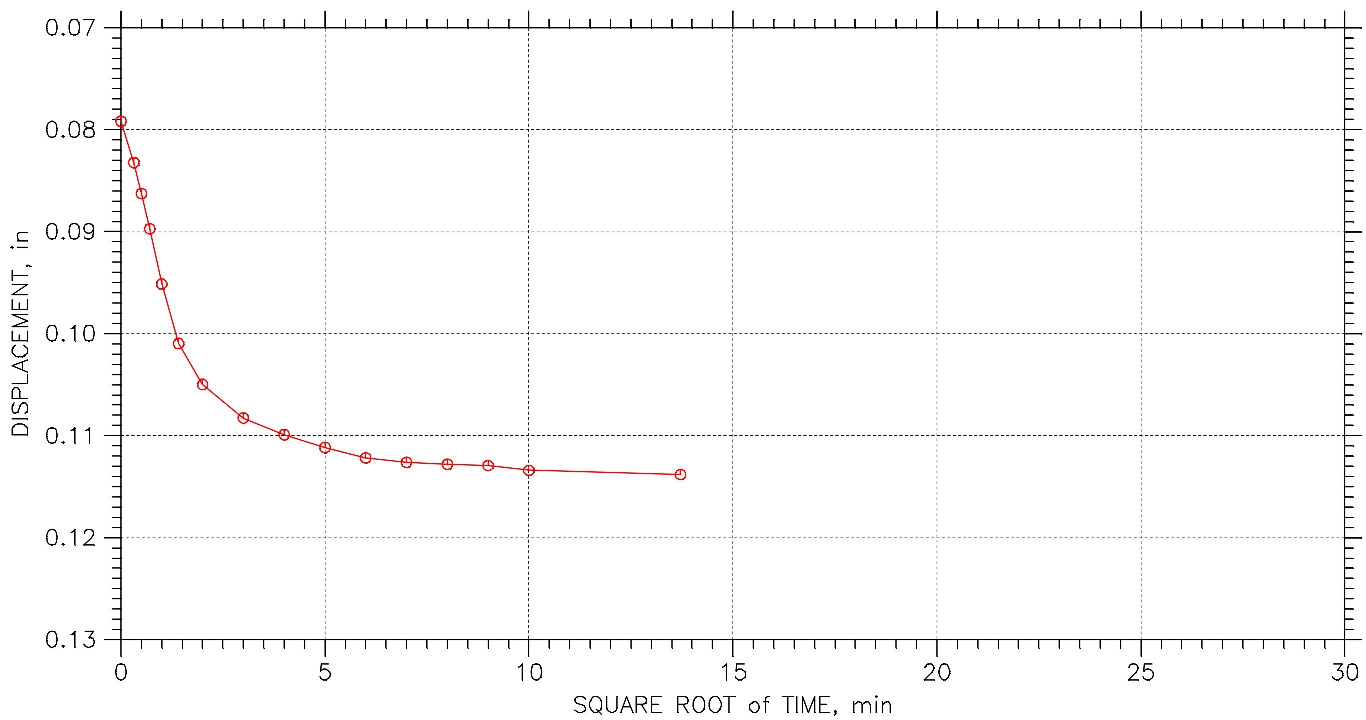
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 5 of 25

Stress: 1. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

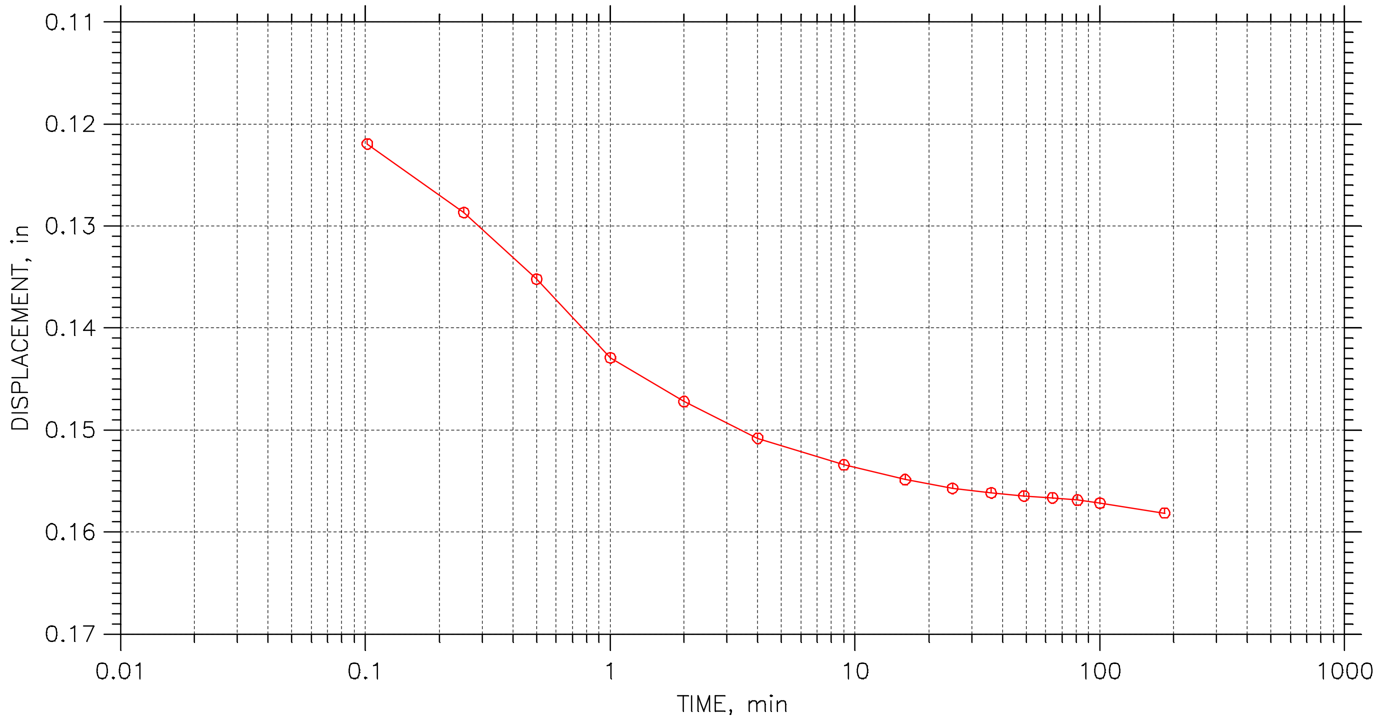
Mon, 25-APR-2016 16:42:26

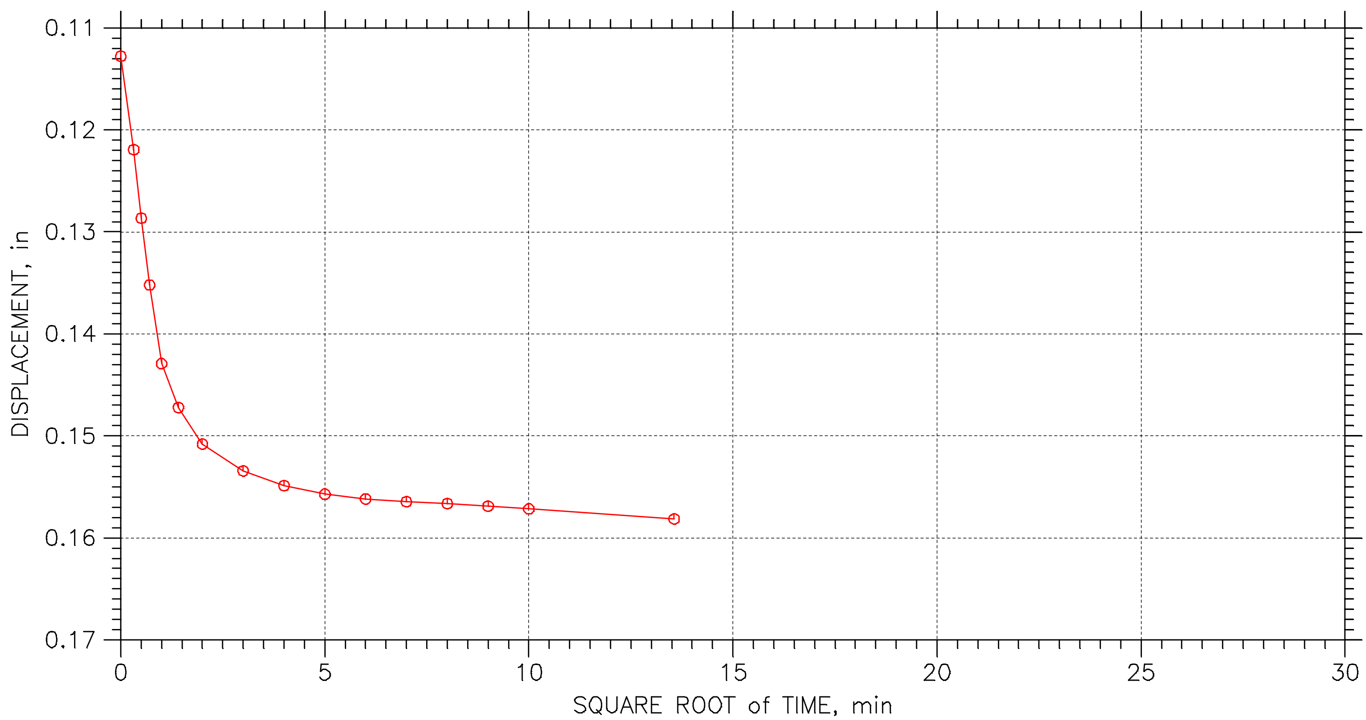
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 6 of 25

Stress: 1.5 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

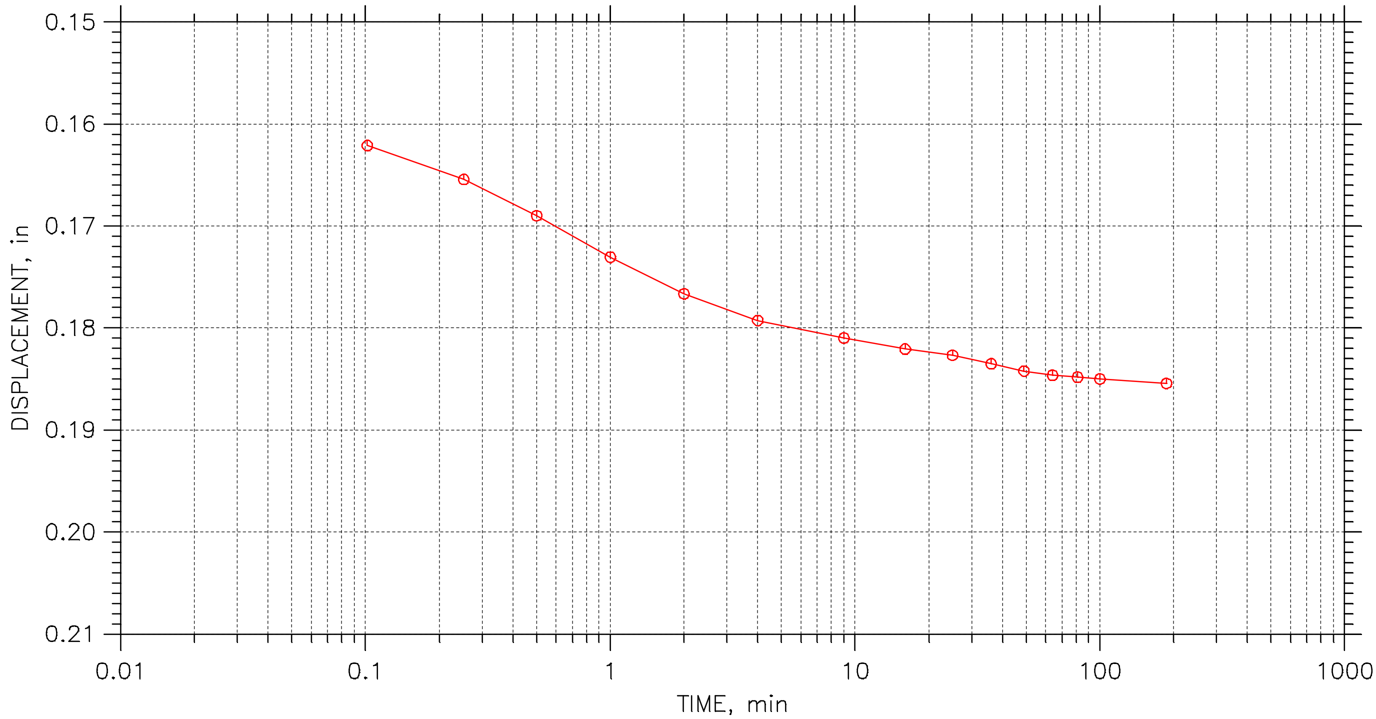
Mon, 25-APR-2016 16:42:28

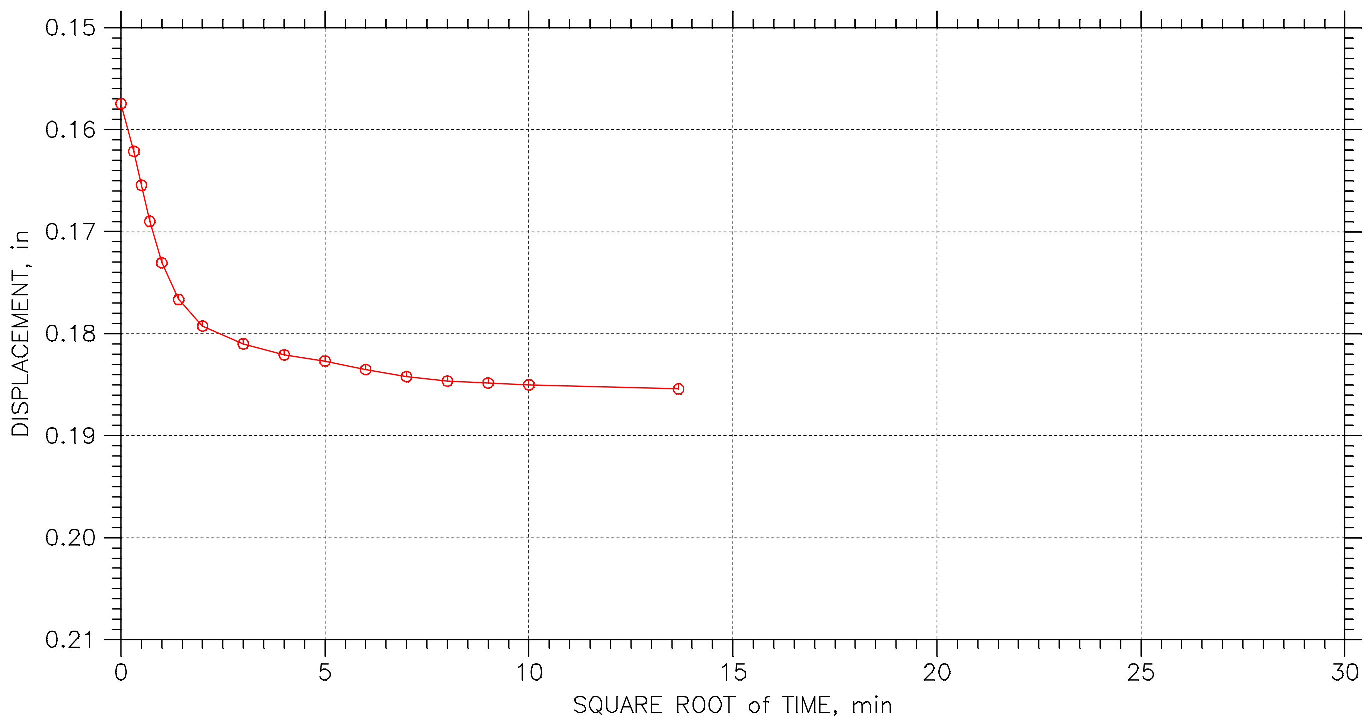
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 7 of 25

Stress: 2. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

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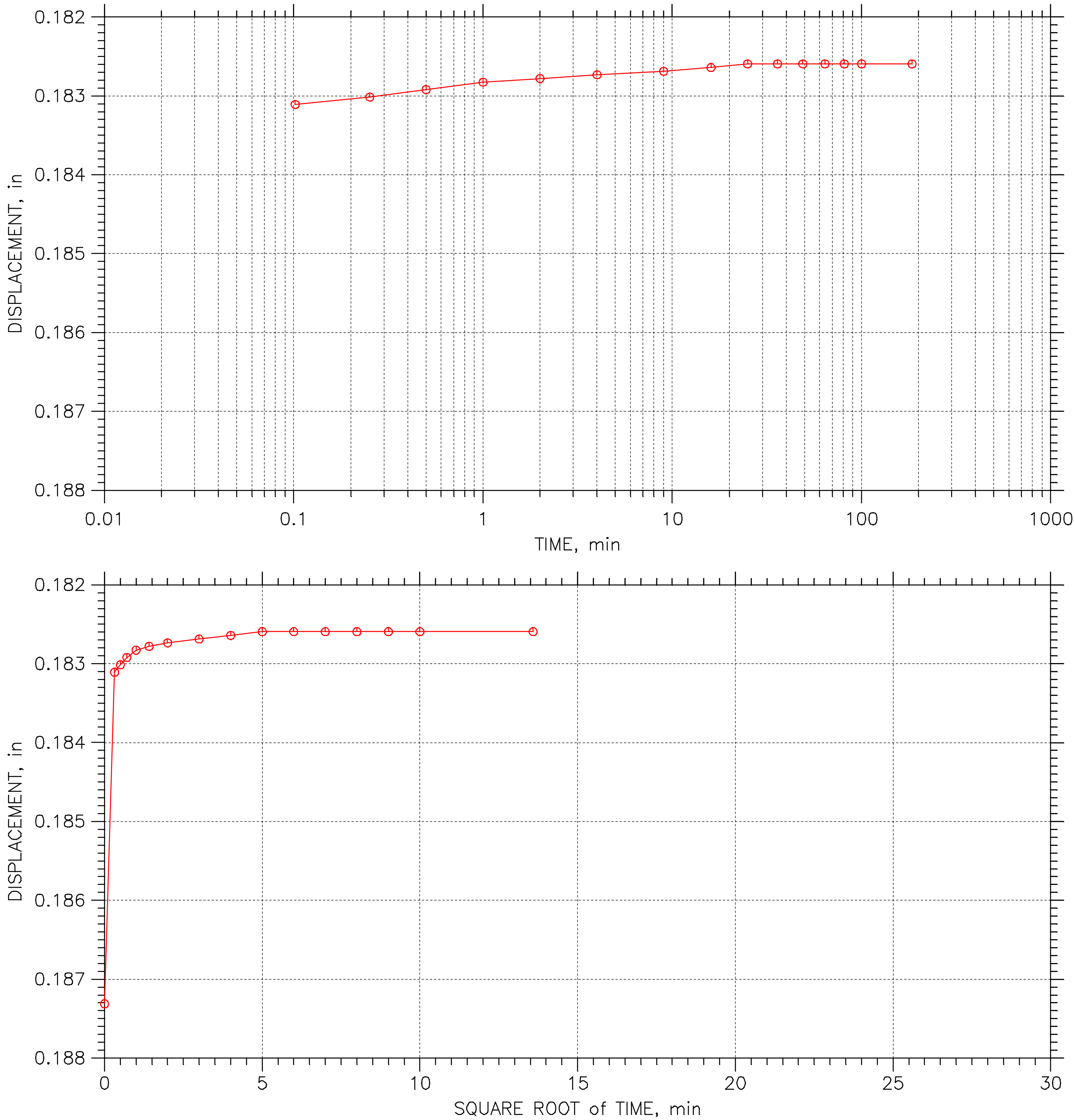
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 8 of 25

Stress: 1. tsf



Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

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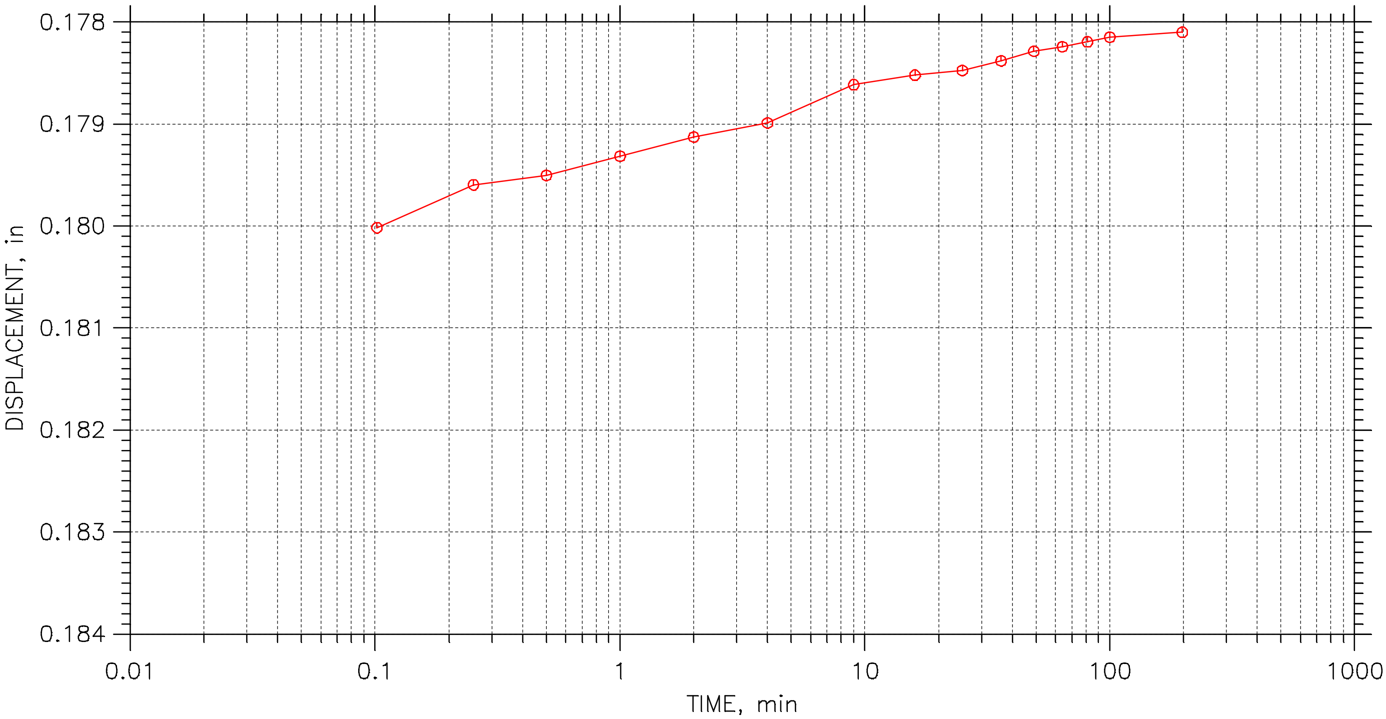
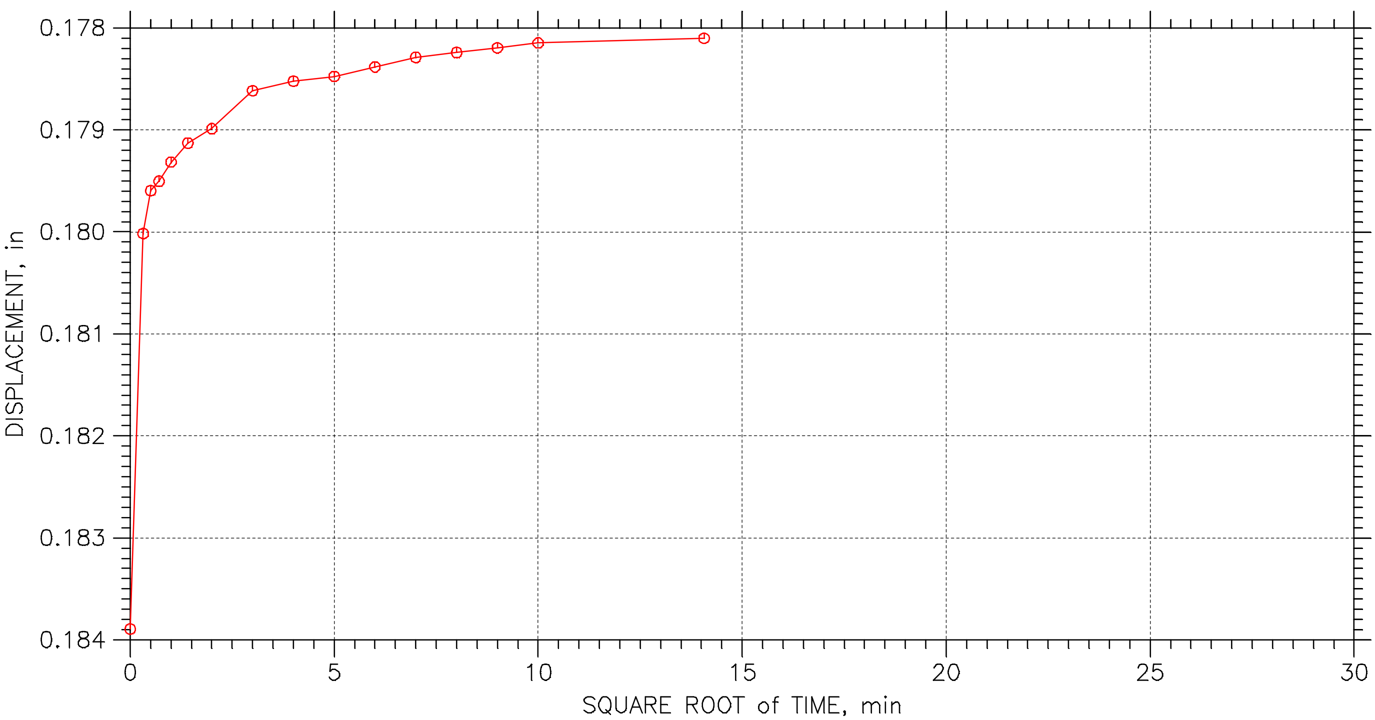
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 9 of 25

Stress: 0.5 tsf





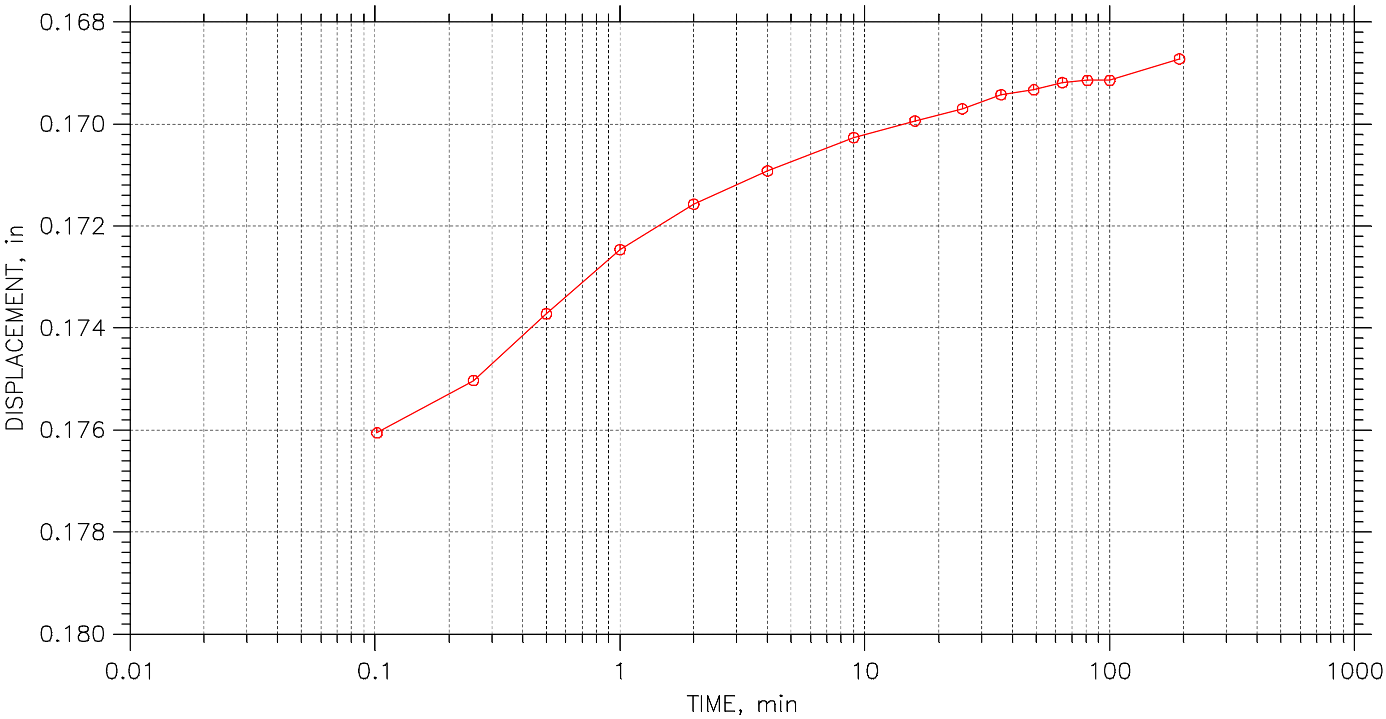
Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

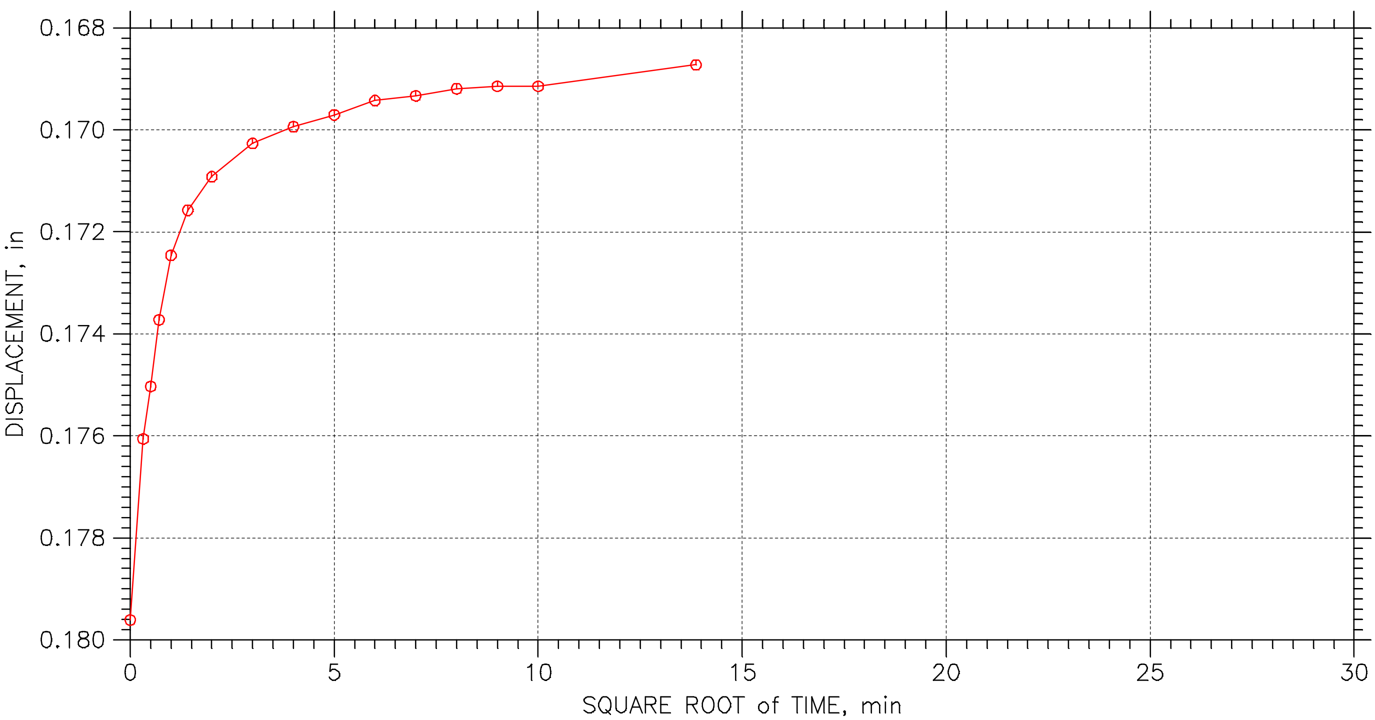
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 10 of 25

Stress: 0.125 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

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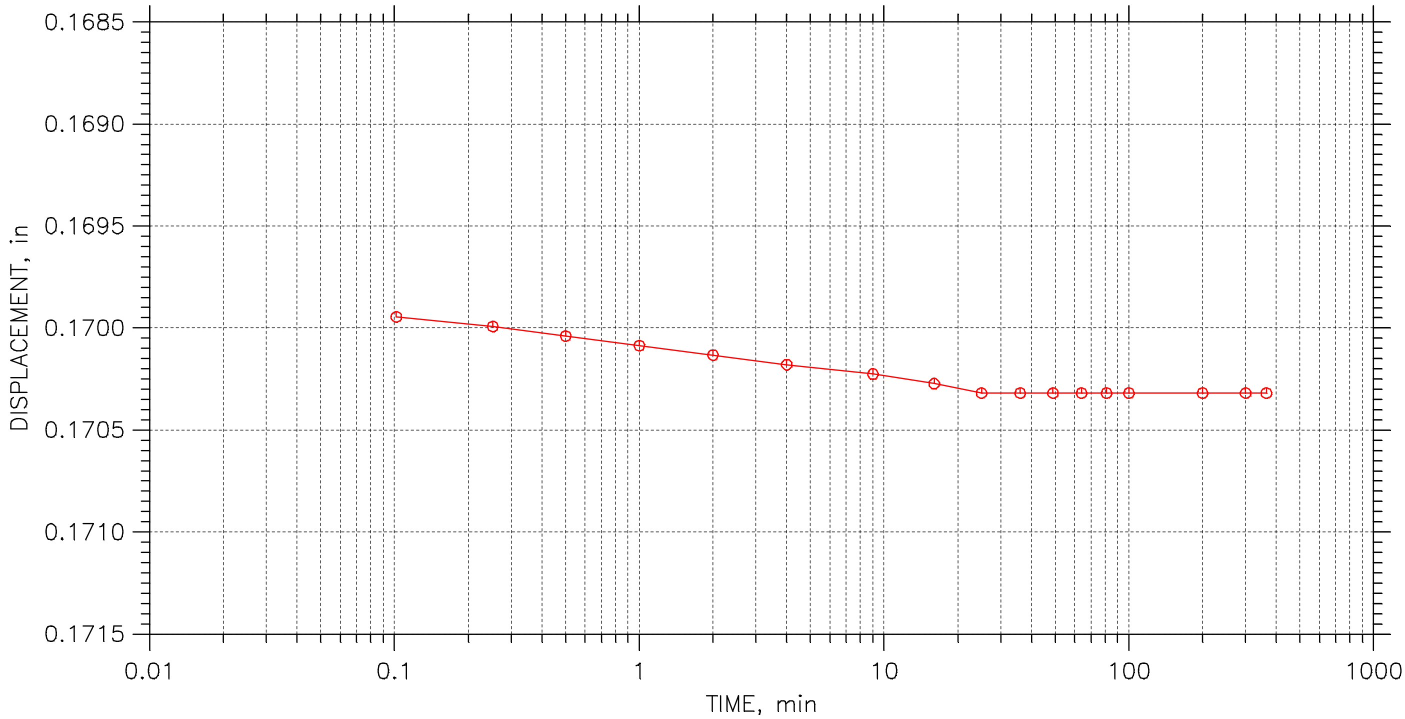
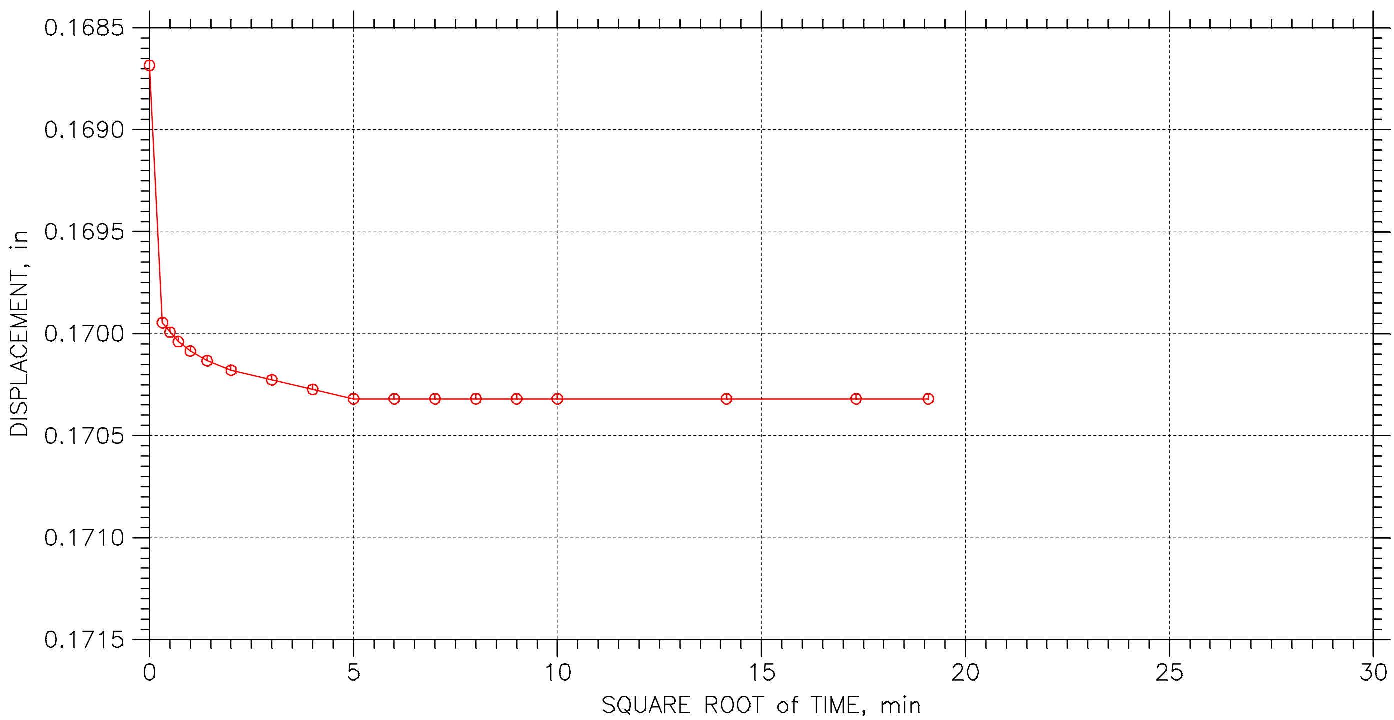
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 11 of 25

Stress: 0.25 tsf





Terracon Consulting Engineers & Scientists			
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	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

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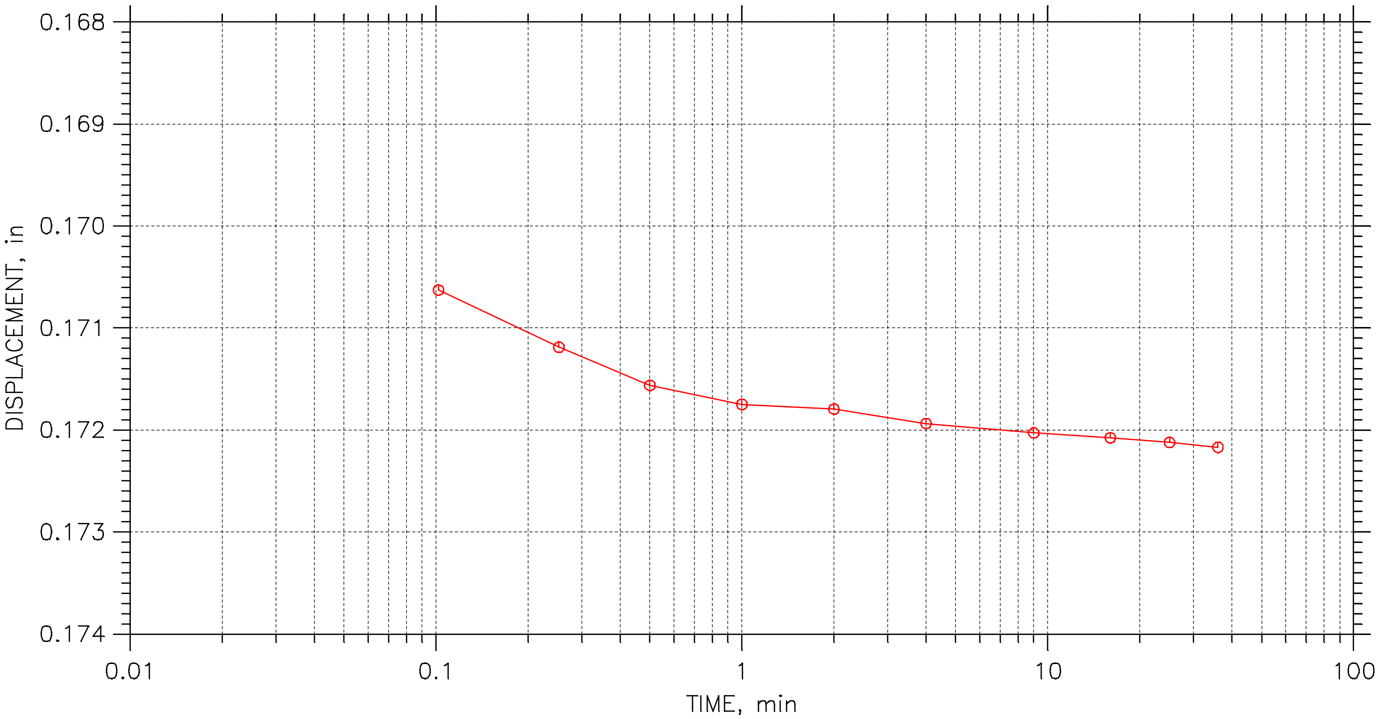
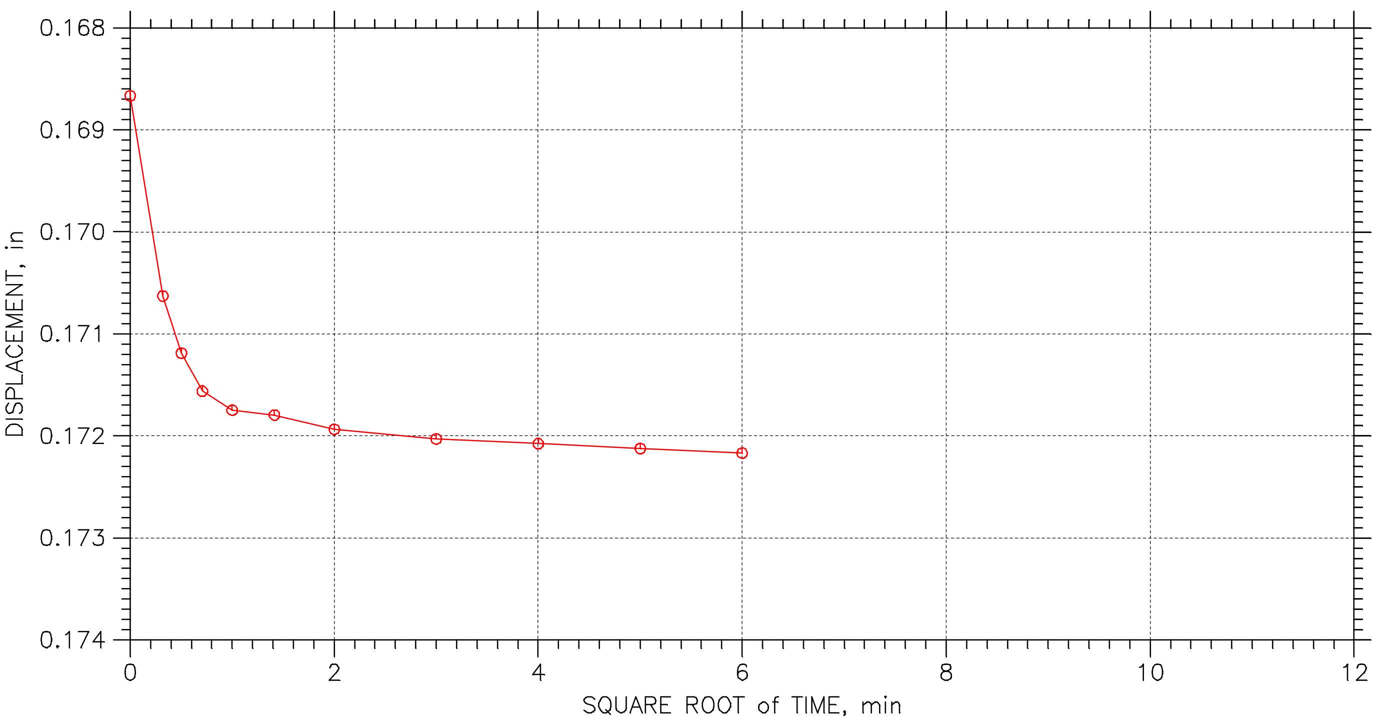
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 12 of 25

Stress: 0.5 tsf





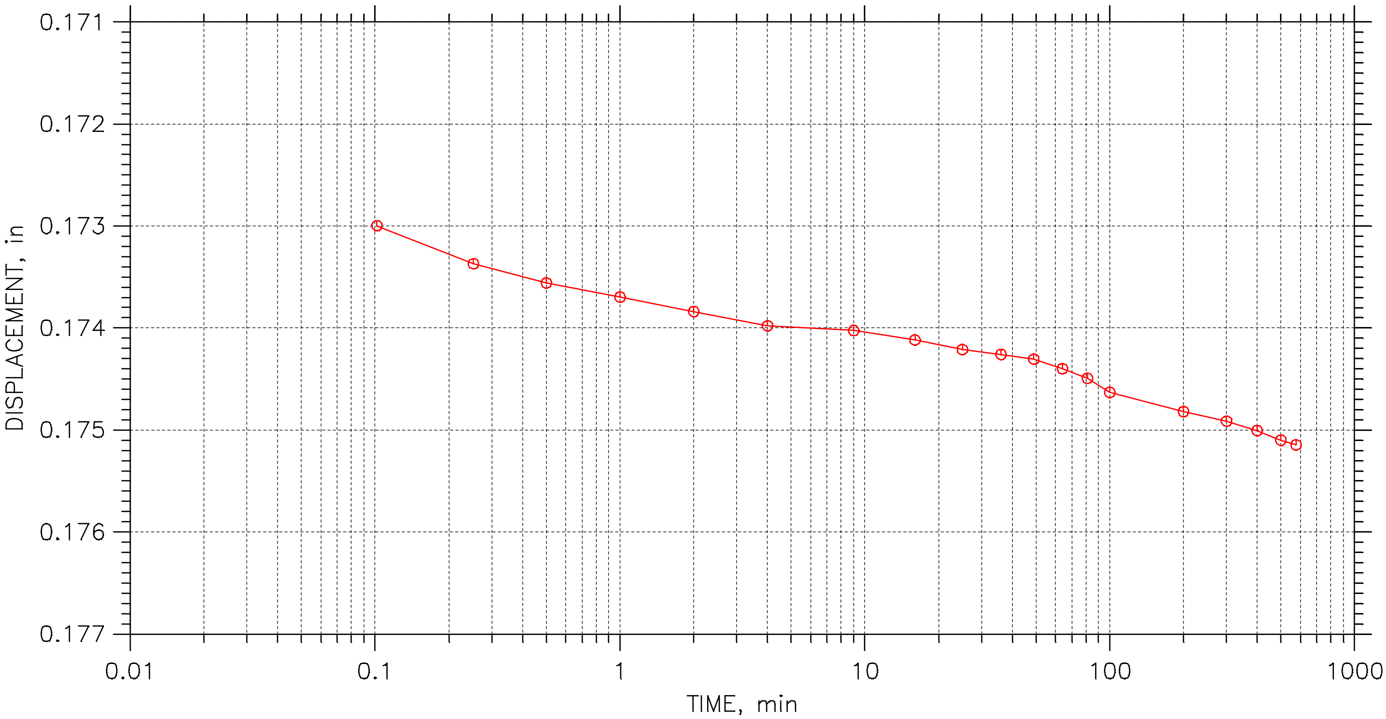
Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

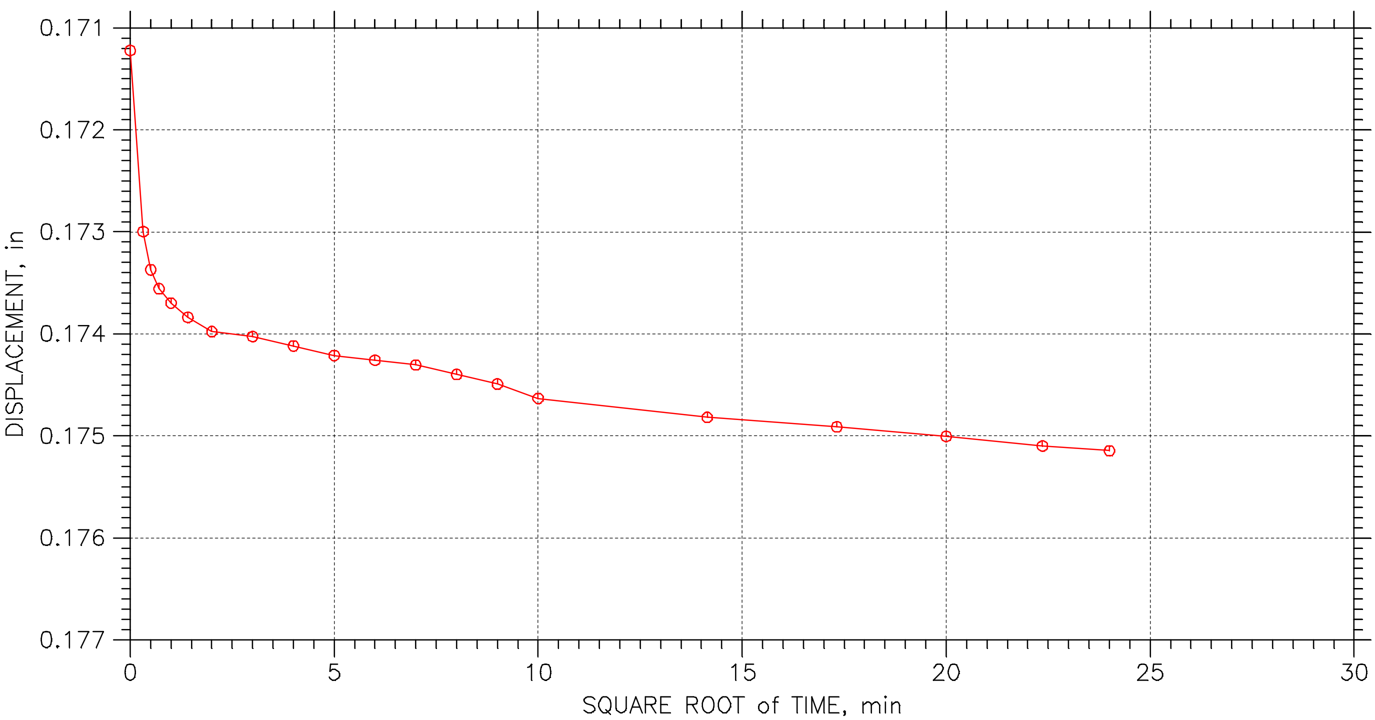
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 13 of 25

Stress: 0.75 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

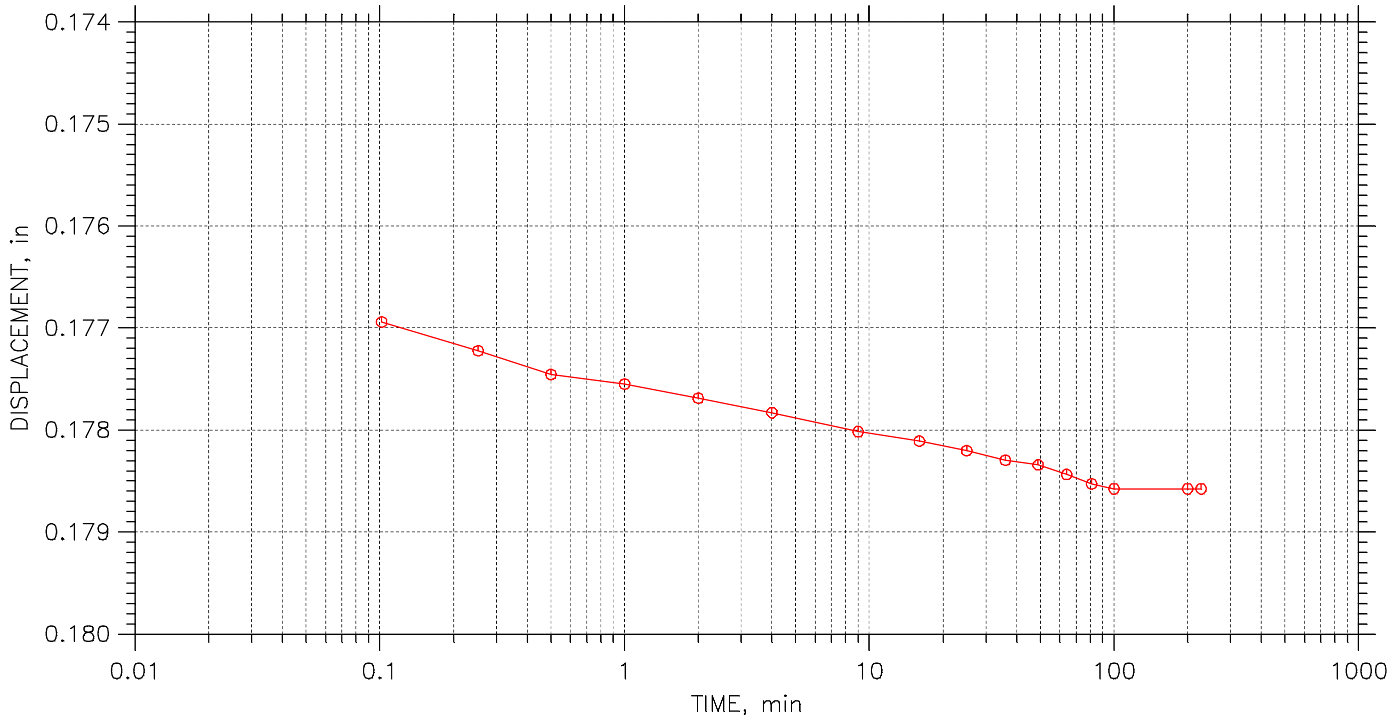
Mon, 25-APR-2016 16:42:38

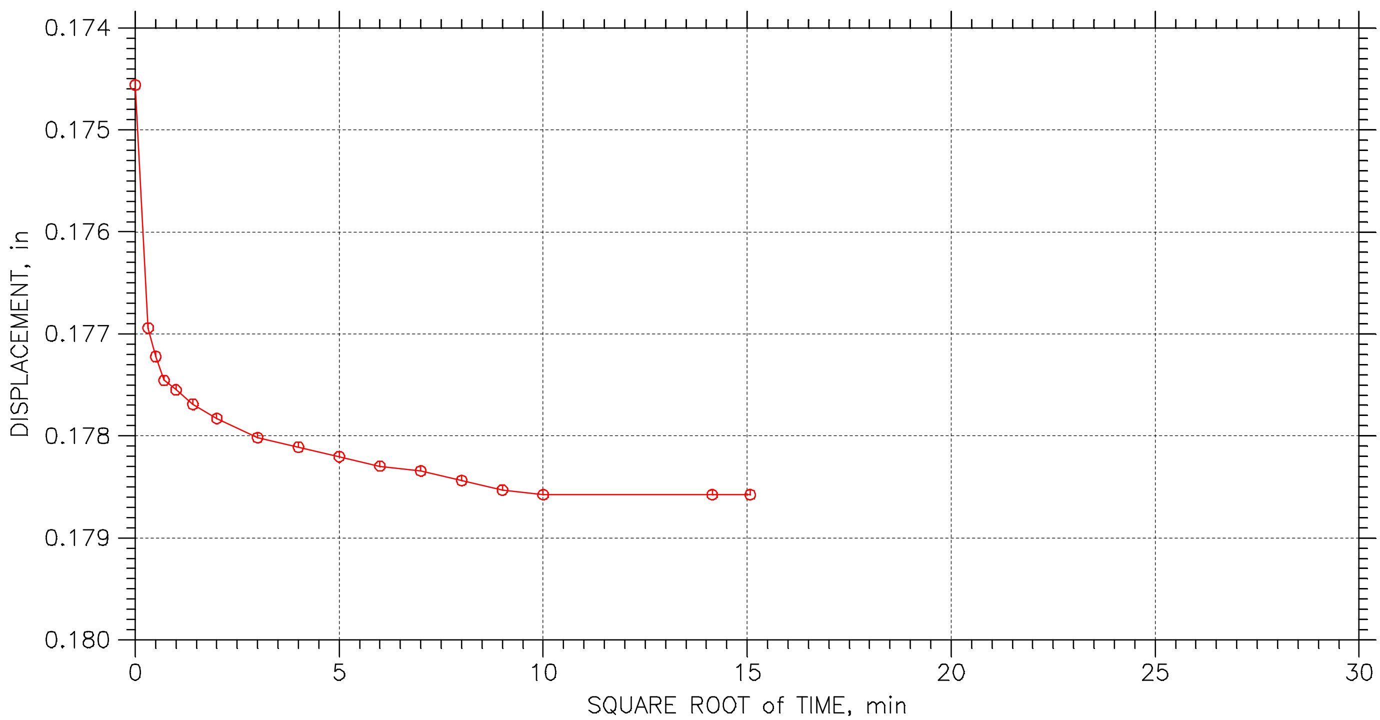
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 14 of 25

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

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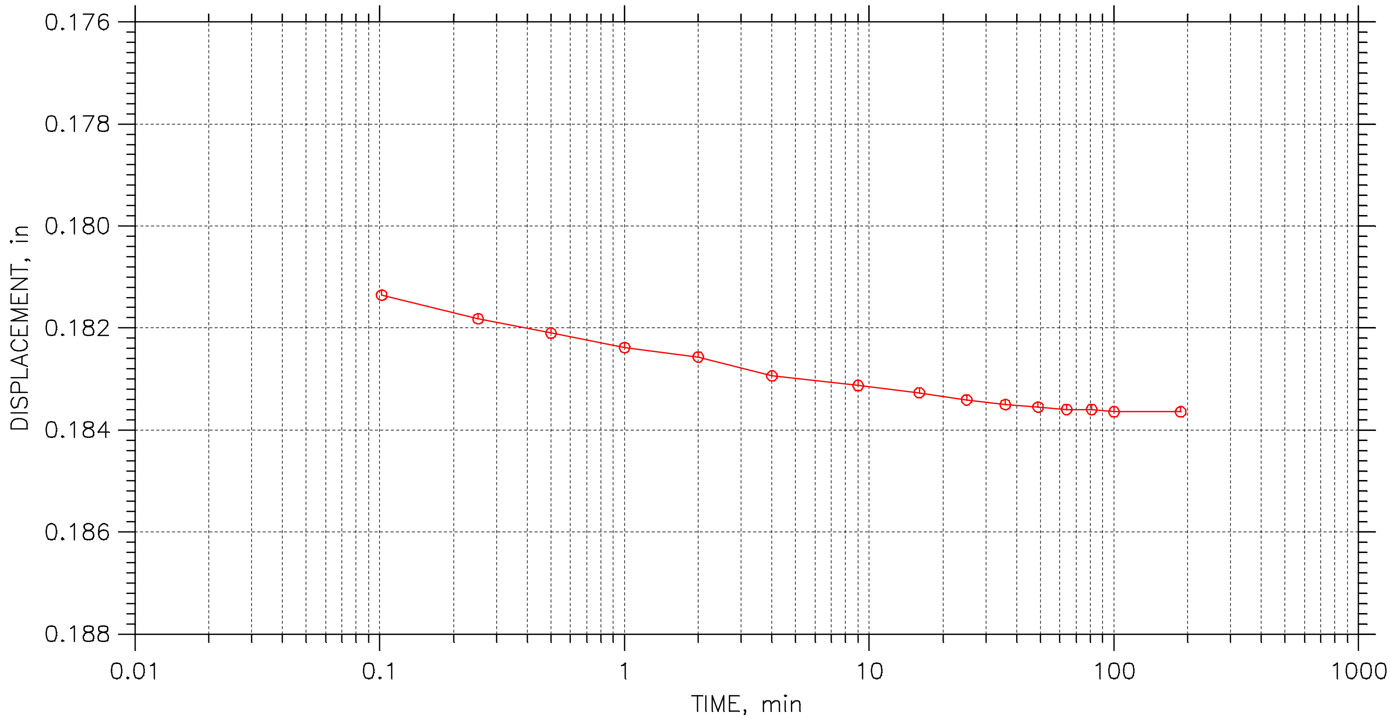
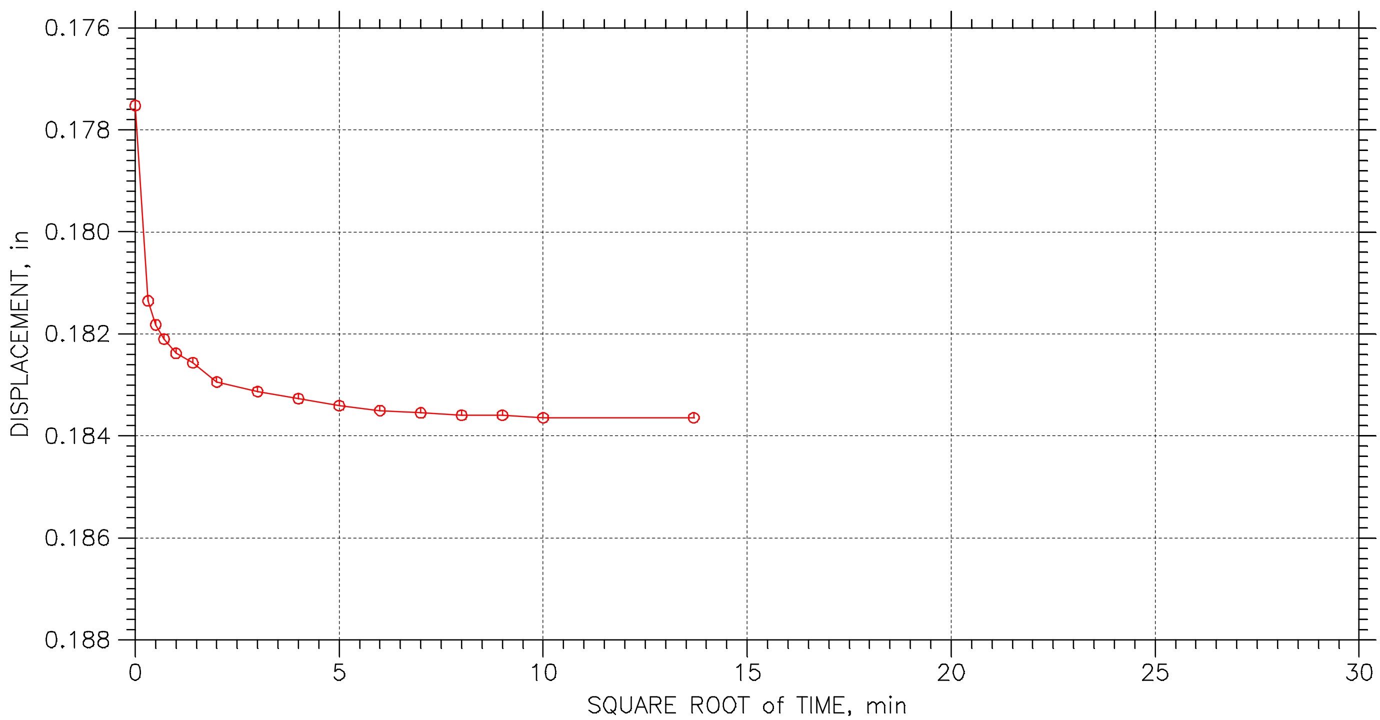
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 15 of 25

Stress: 1.5 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

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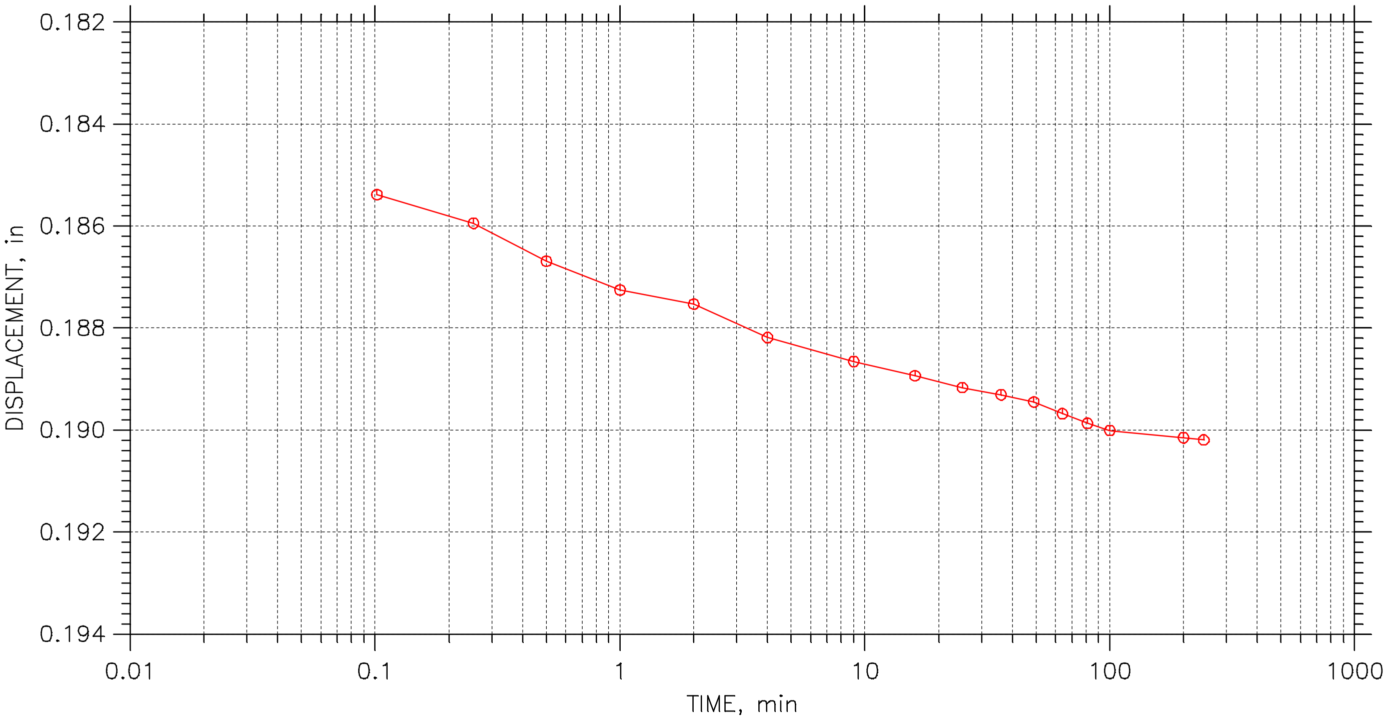
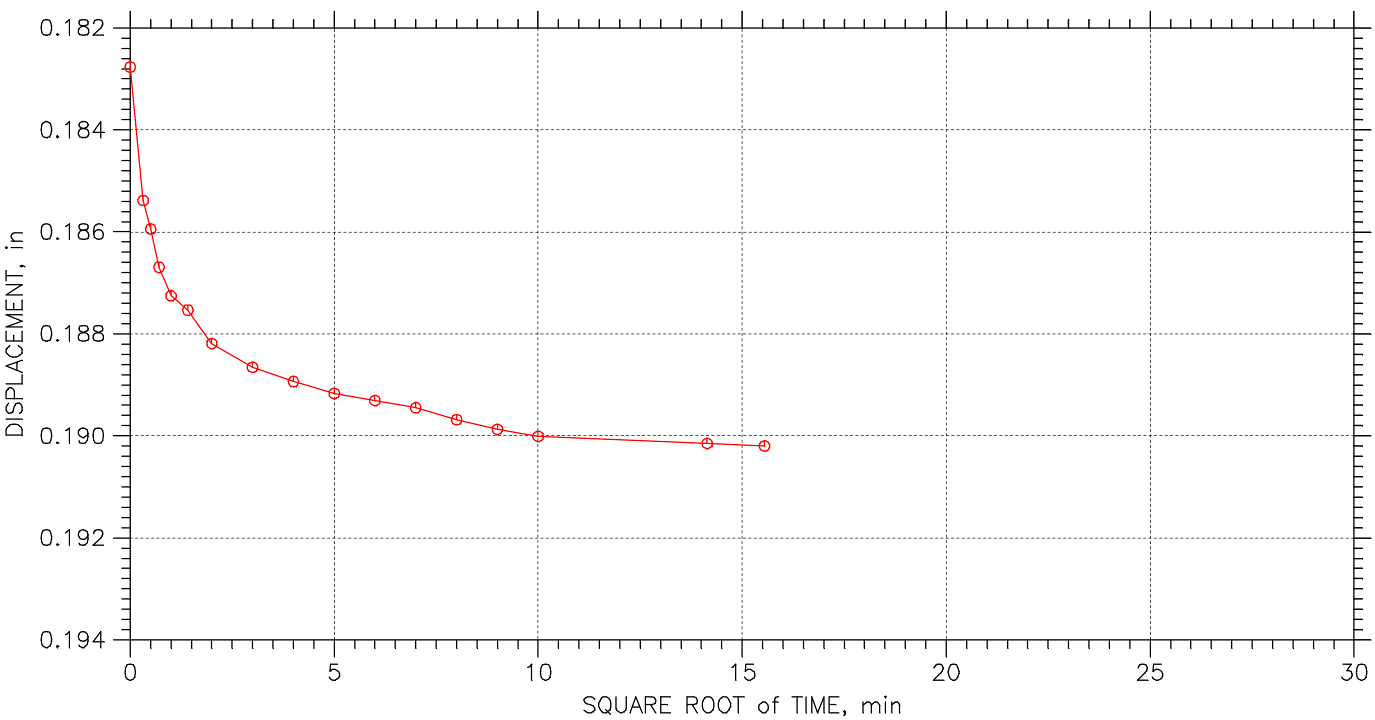
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 16 of 25

Stress: 2. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

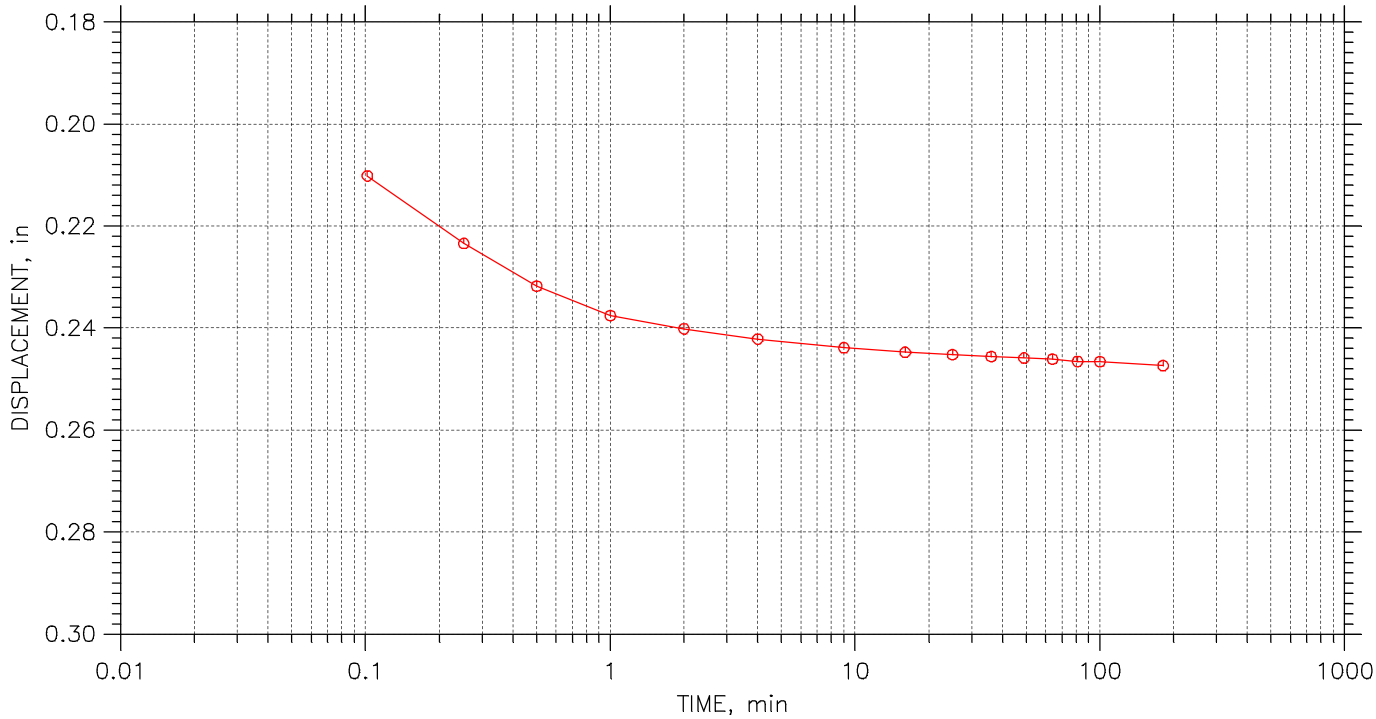
Mon, 25-APR-2016 16:42:42

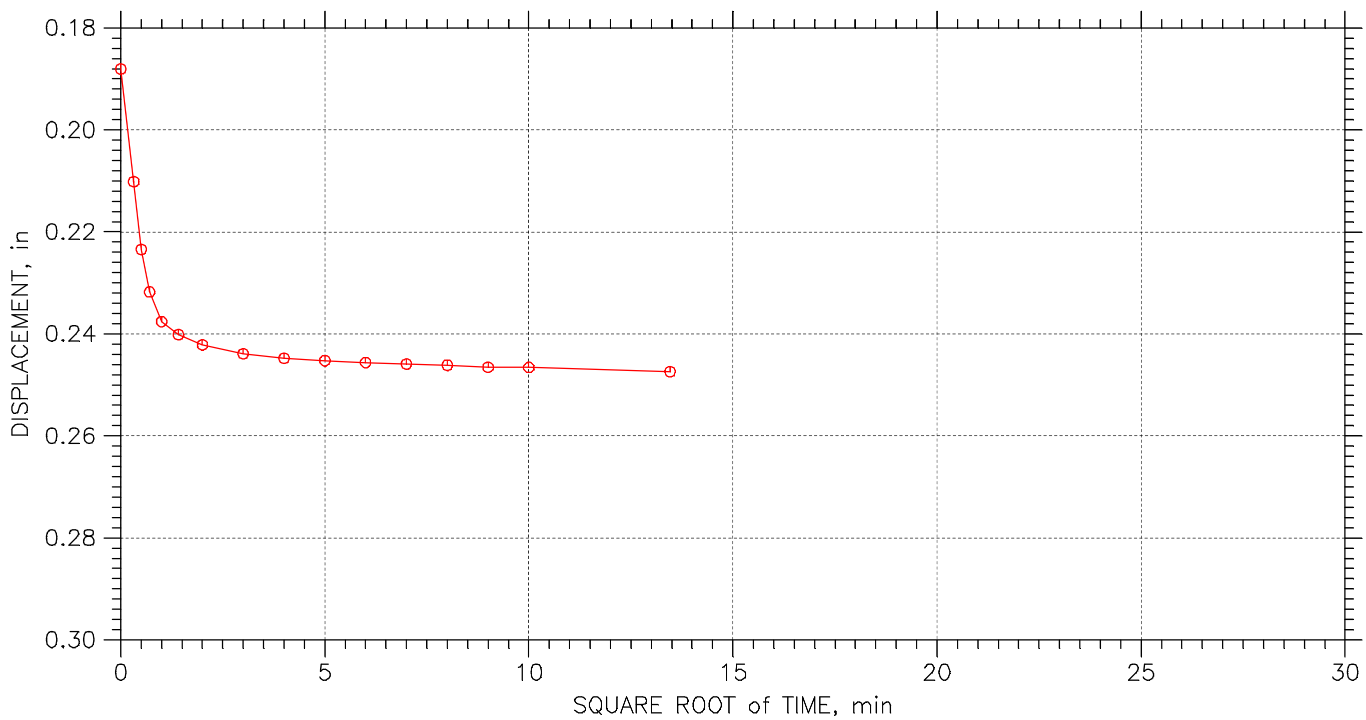
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 17 of 25

Stress: 4. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

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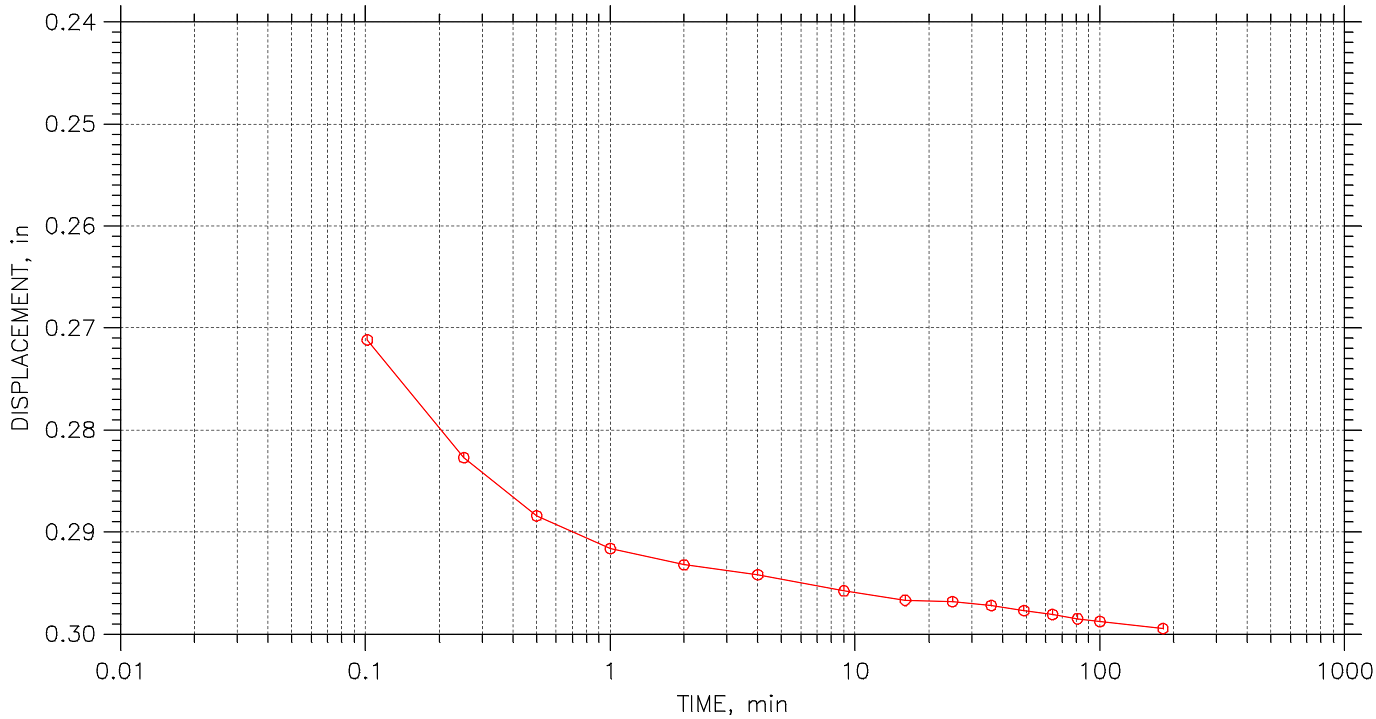
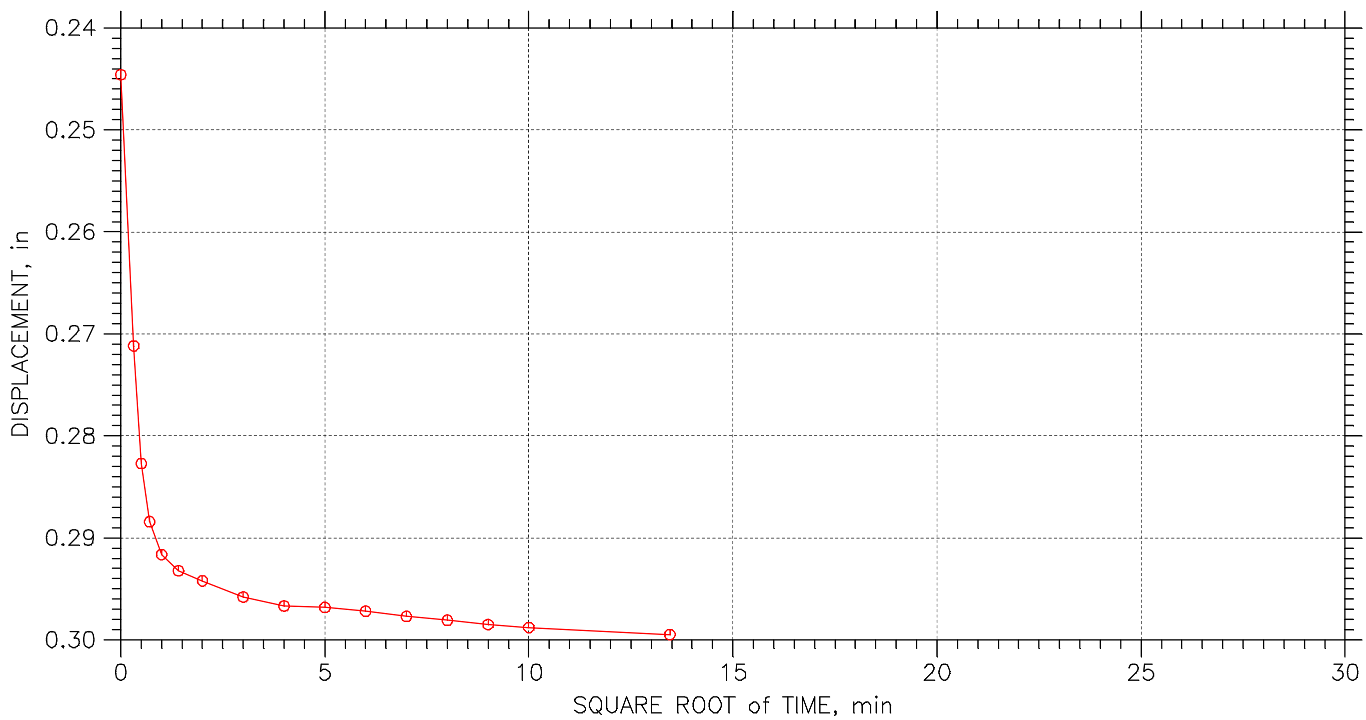
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 18 of 25

Stress: 8. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

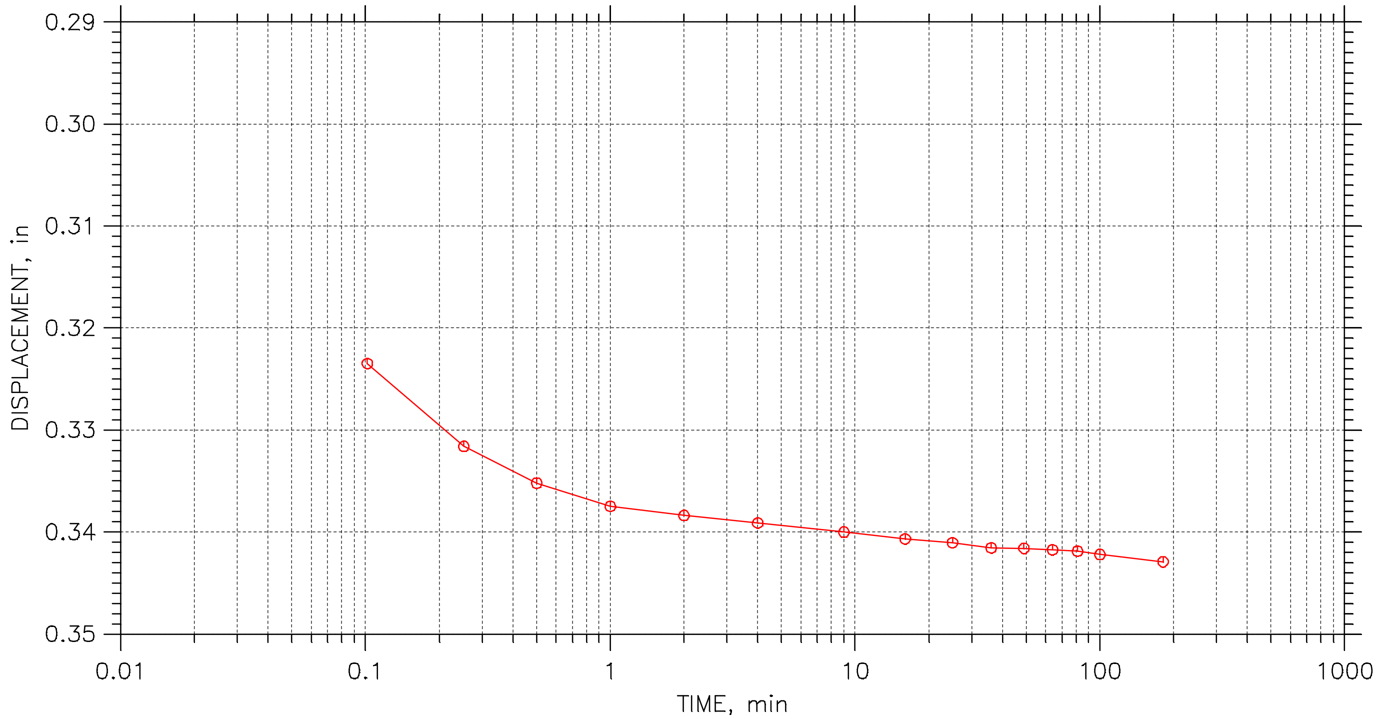
Mon, 25-APR-2016 16:42:45

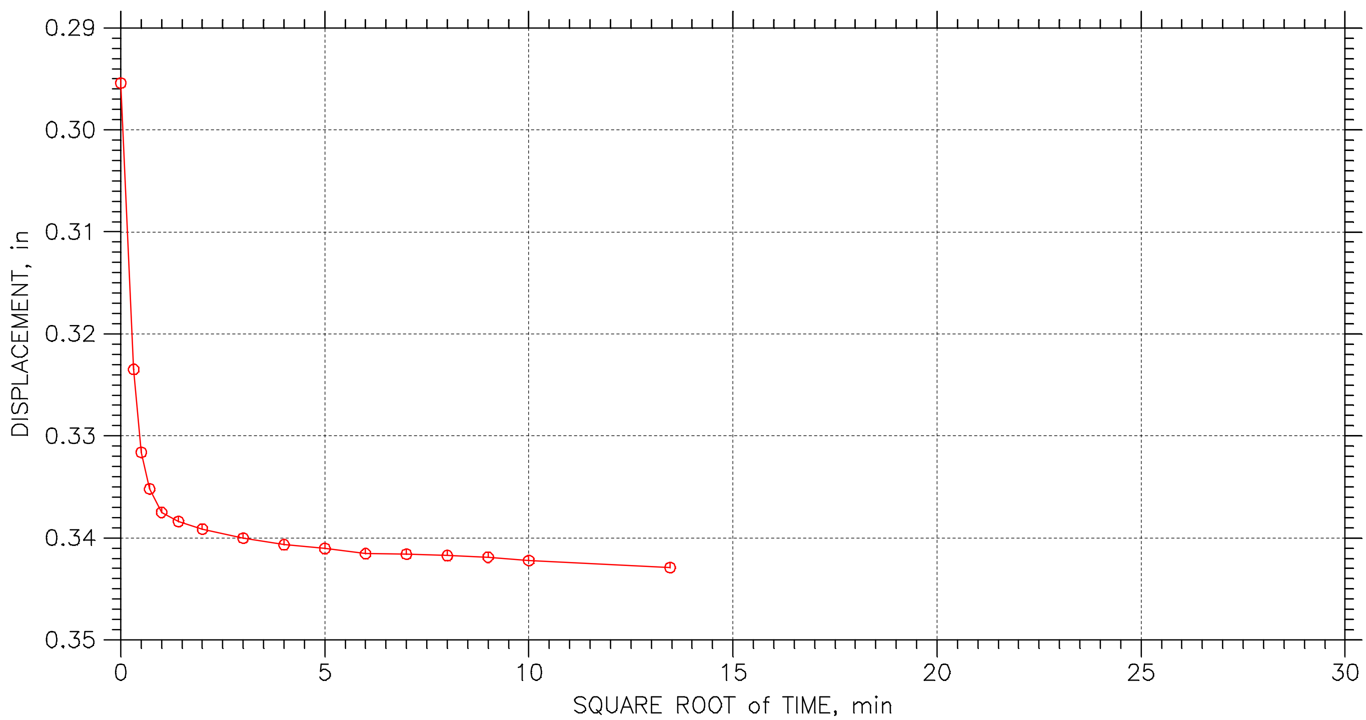
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 19 of 25

Stress: 16. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

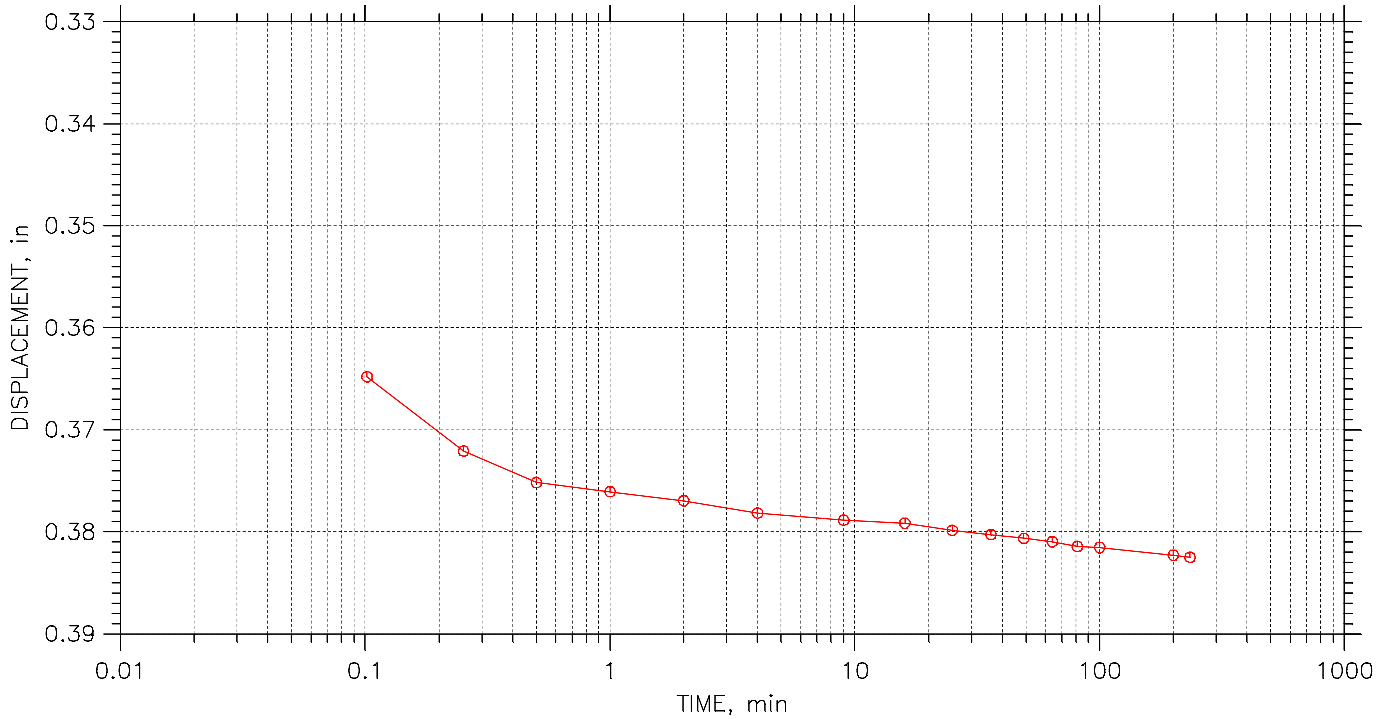
Mon, 25-APR-2016 16:42:46

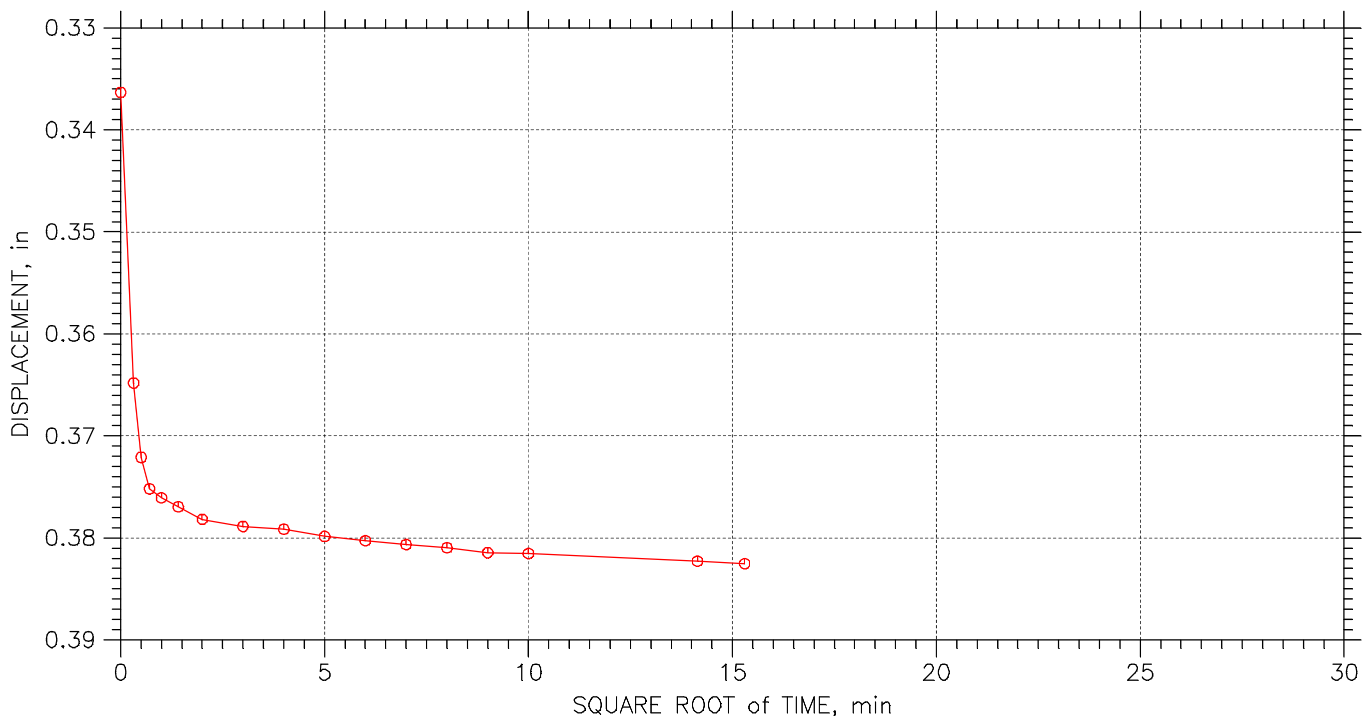
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 20 of 25

Stress: 32. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

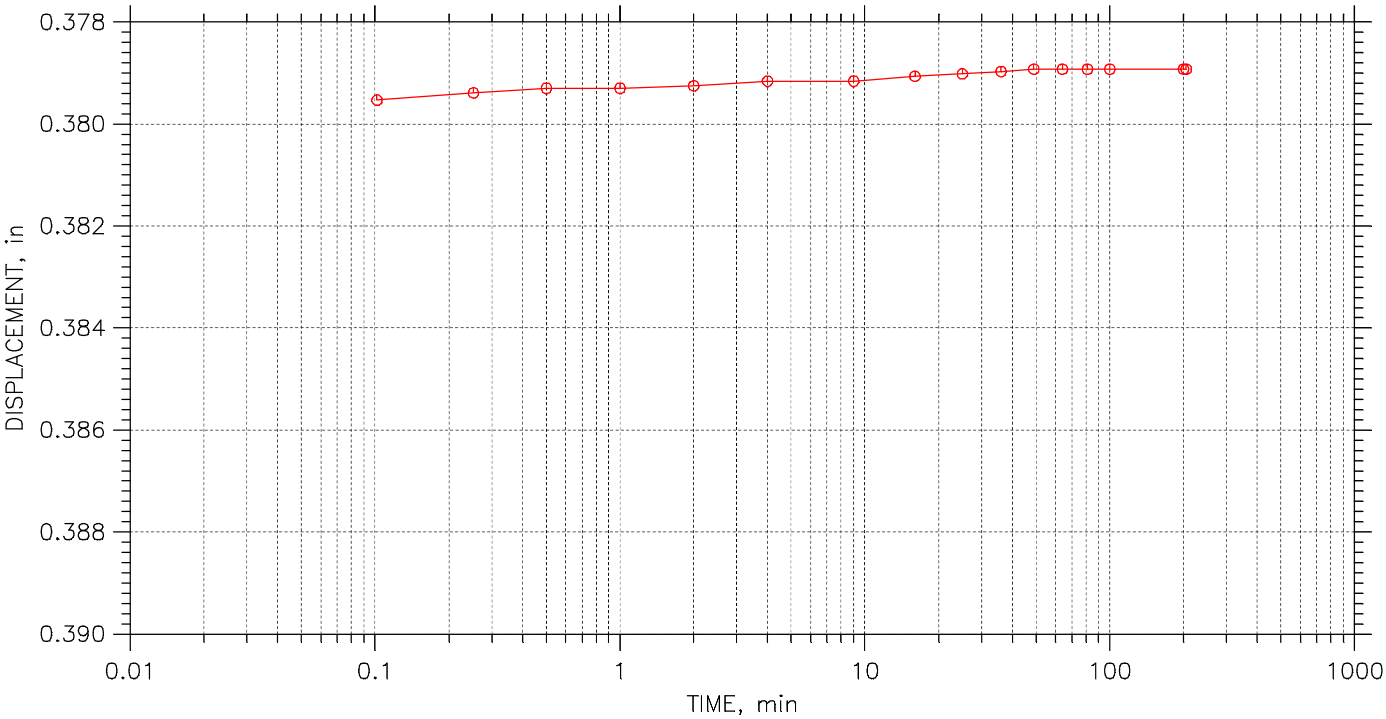
Mon, 25-APR-2016 16:42:48

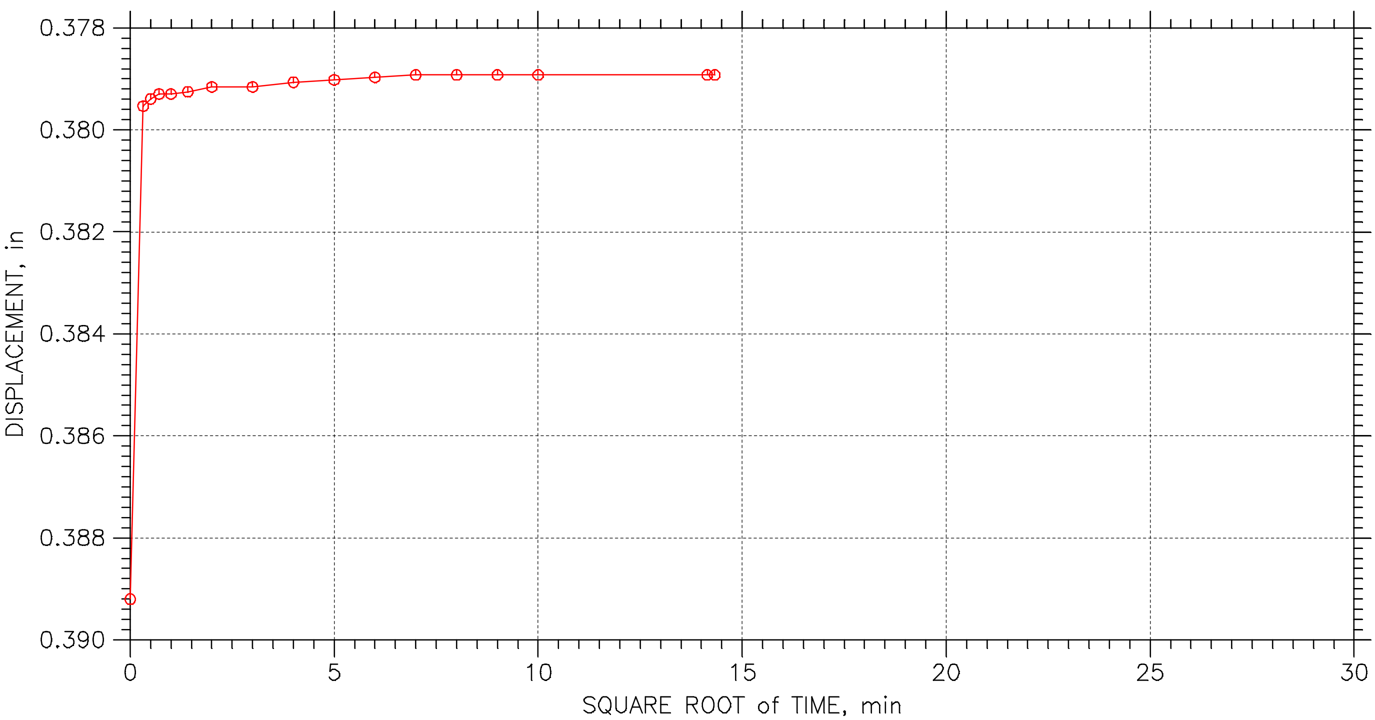
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 21 of 25

Stress: 16. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

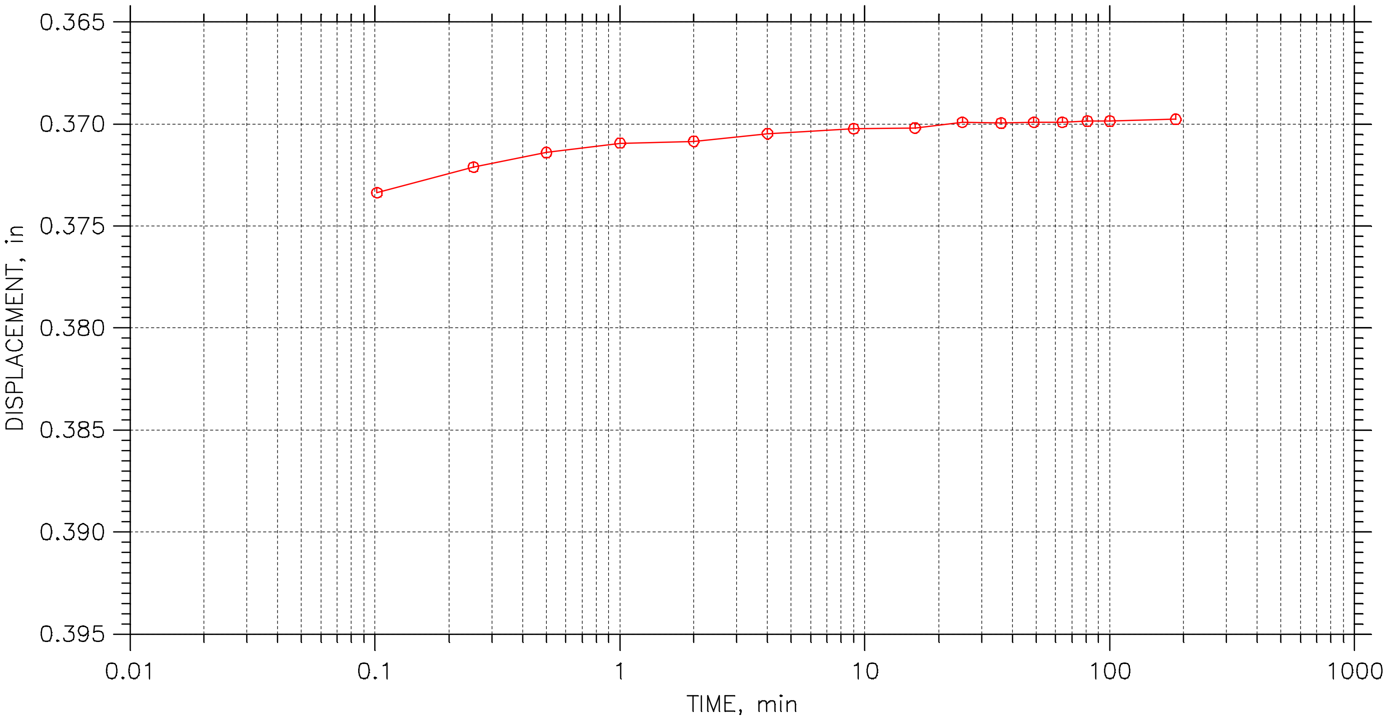
Mon, 25-APR-2016 16:42:49

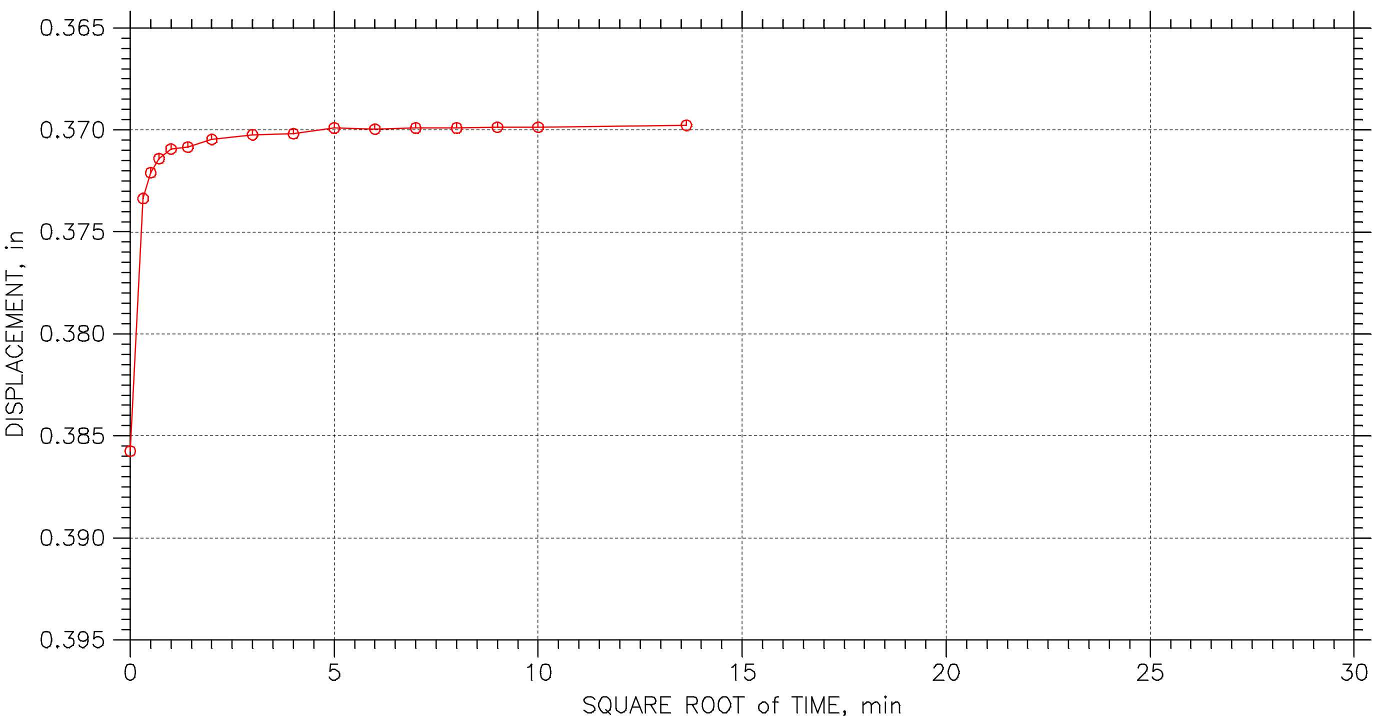
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 22 of 25

Stress: 4. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

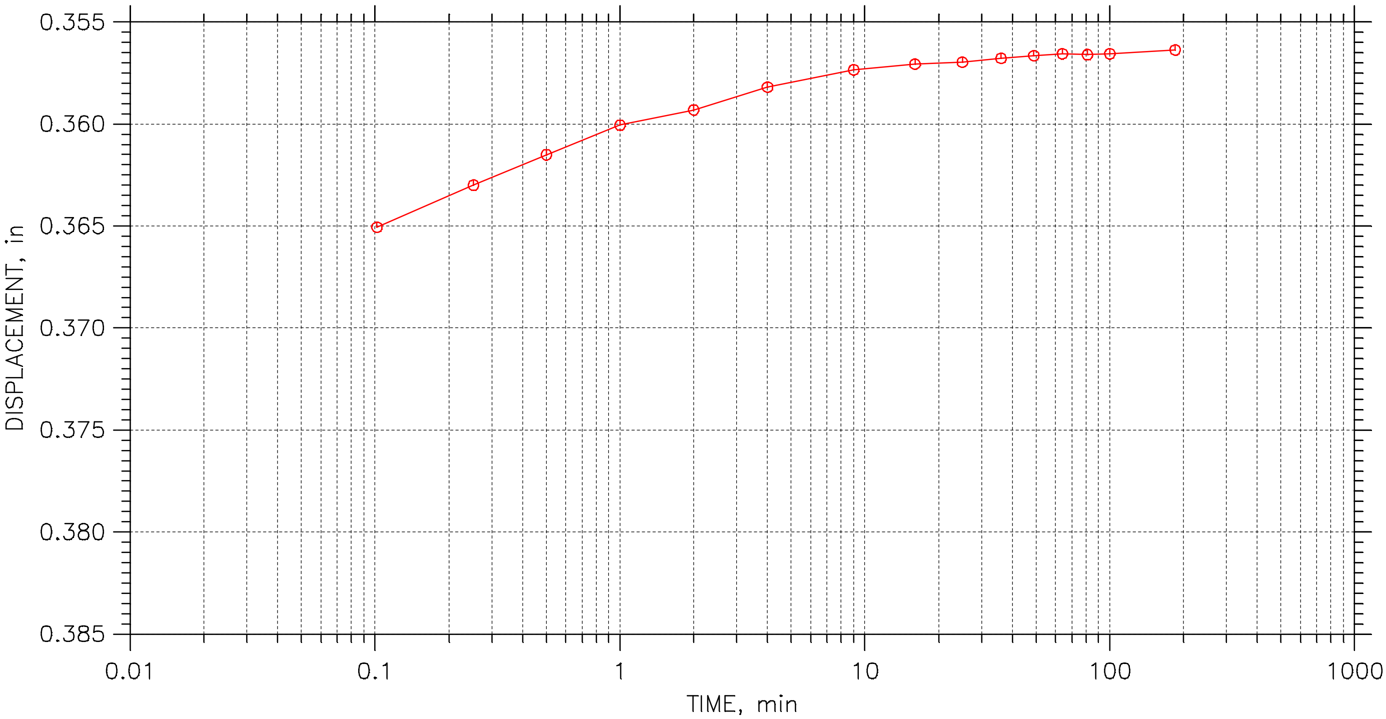
Mon, 25-APR-2016 16:42:51

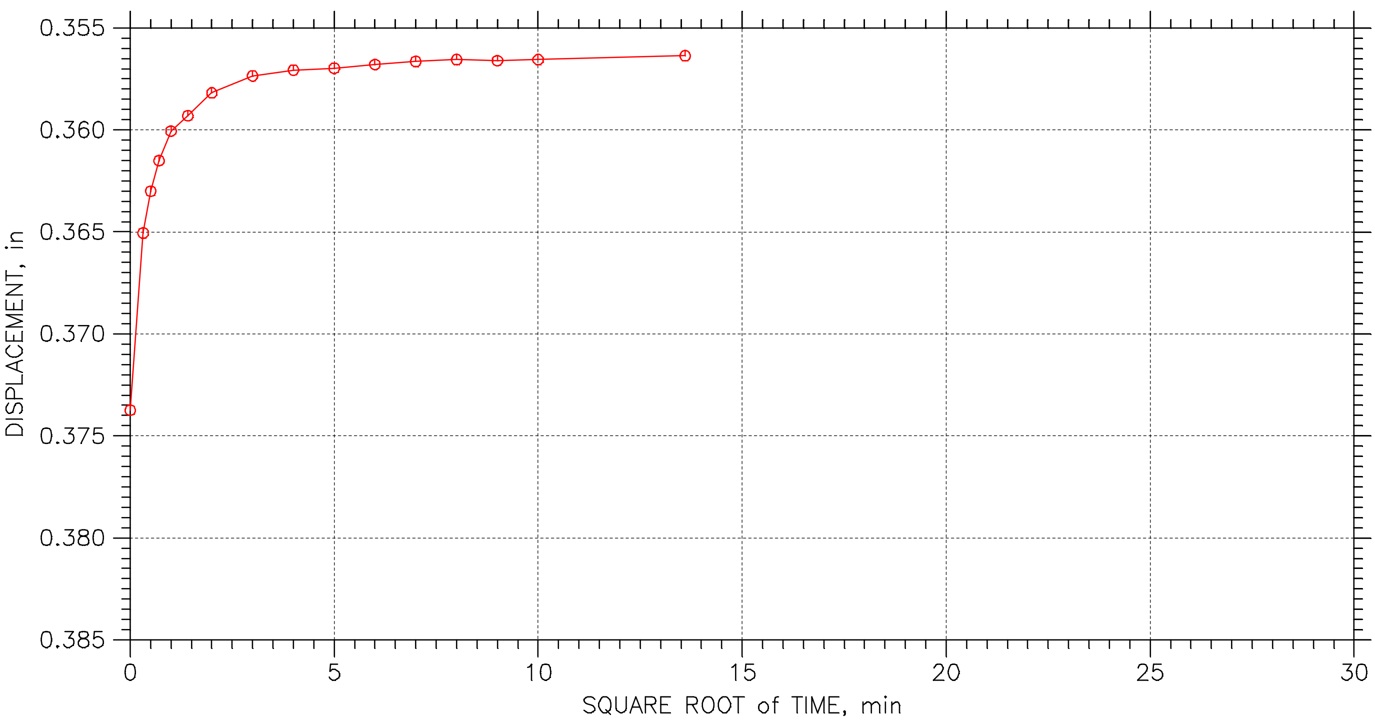
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 23 of 25

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

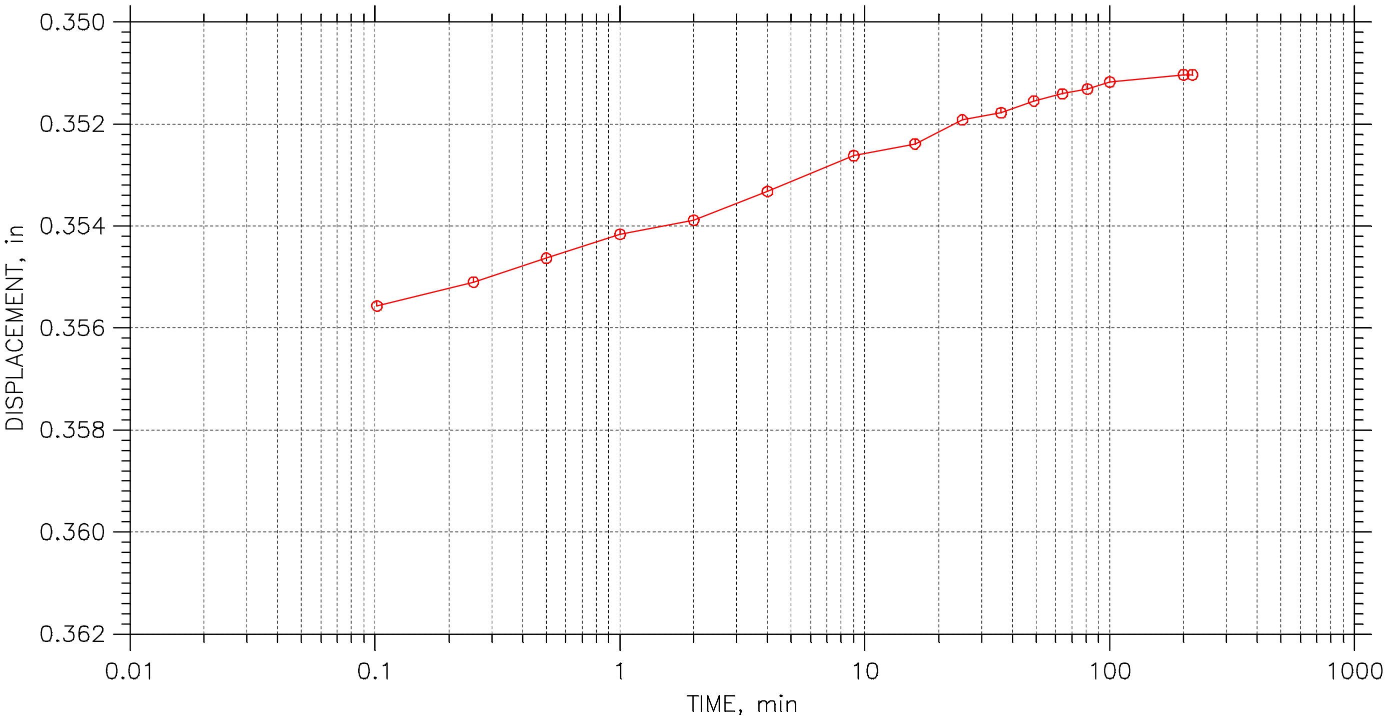
Mon, 25-APR-2016 16:42:52

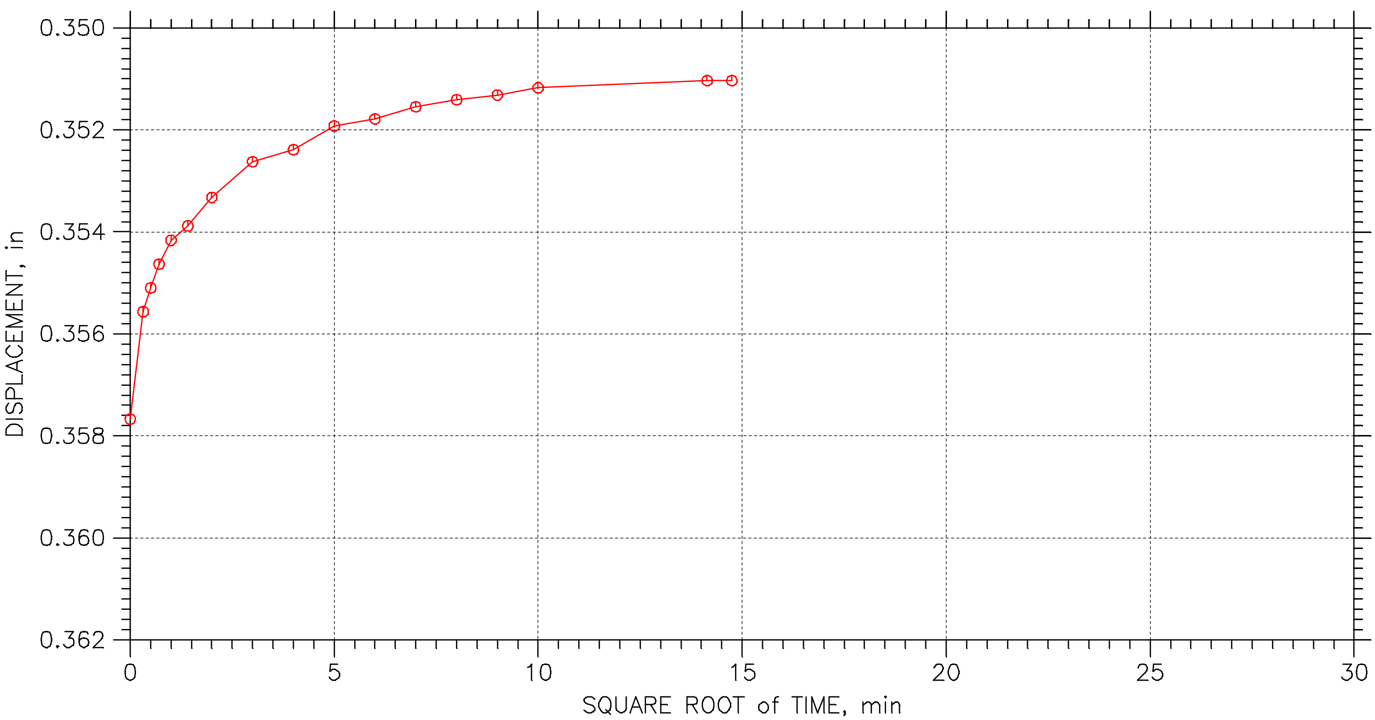
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 24 of 25

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

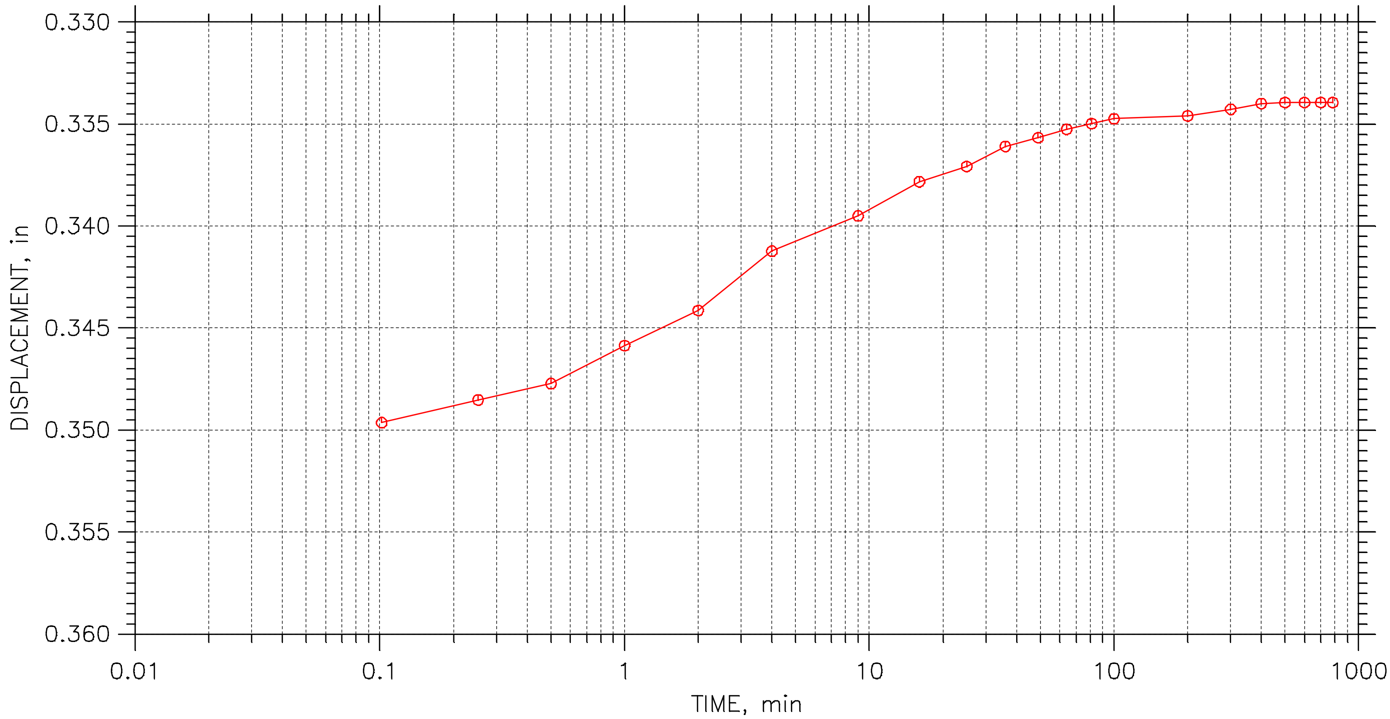
Mon, 25-APR-2016 16:42:54

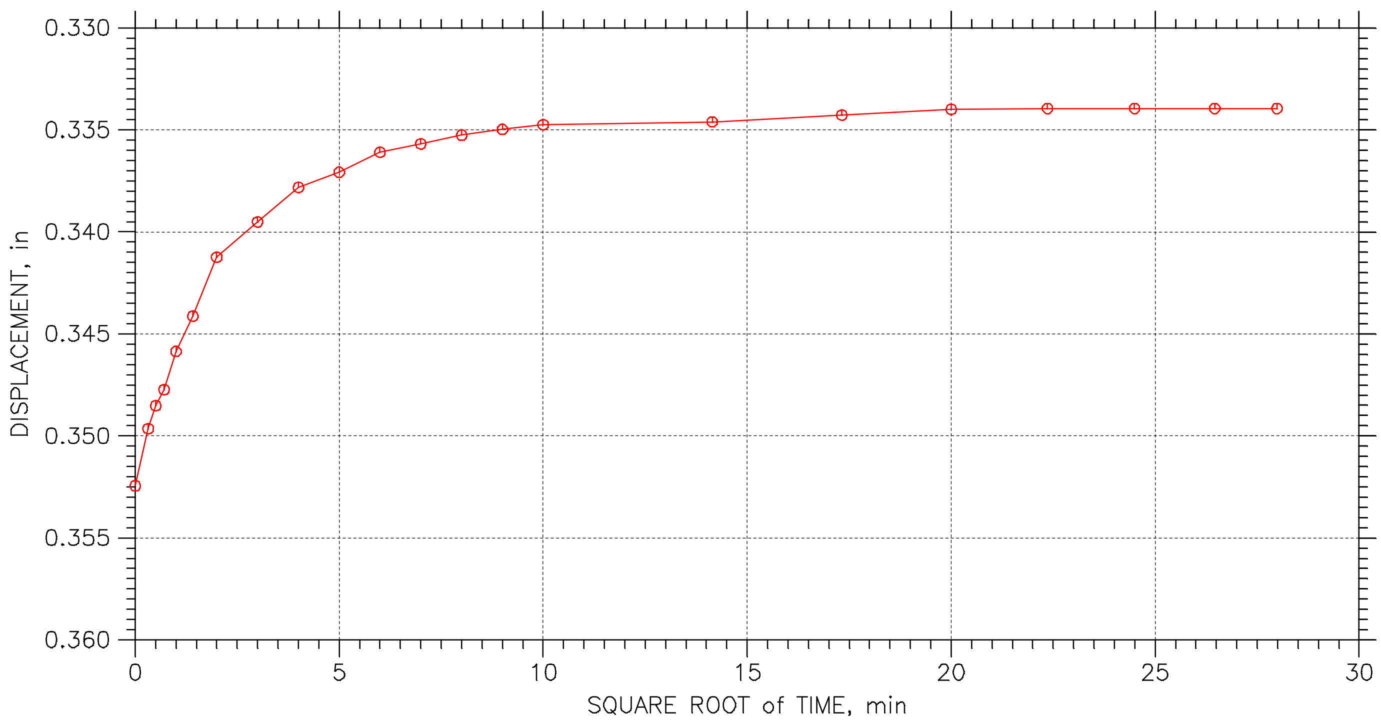
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 25 of 25

Stress: 0.125 tsf

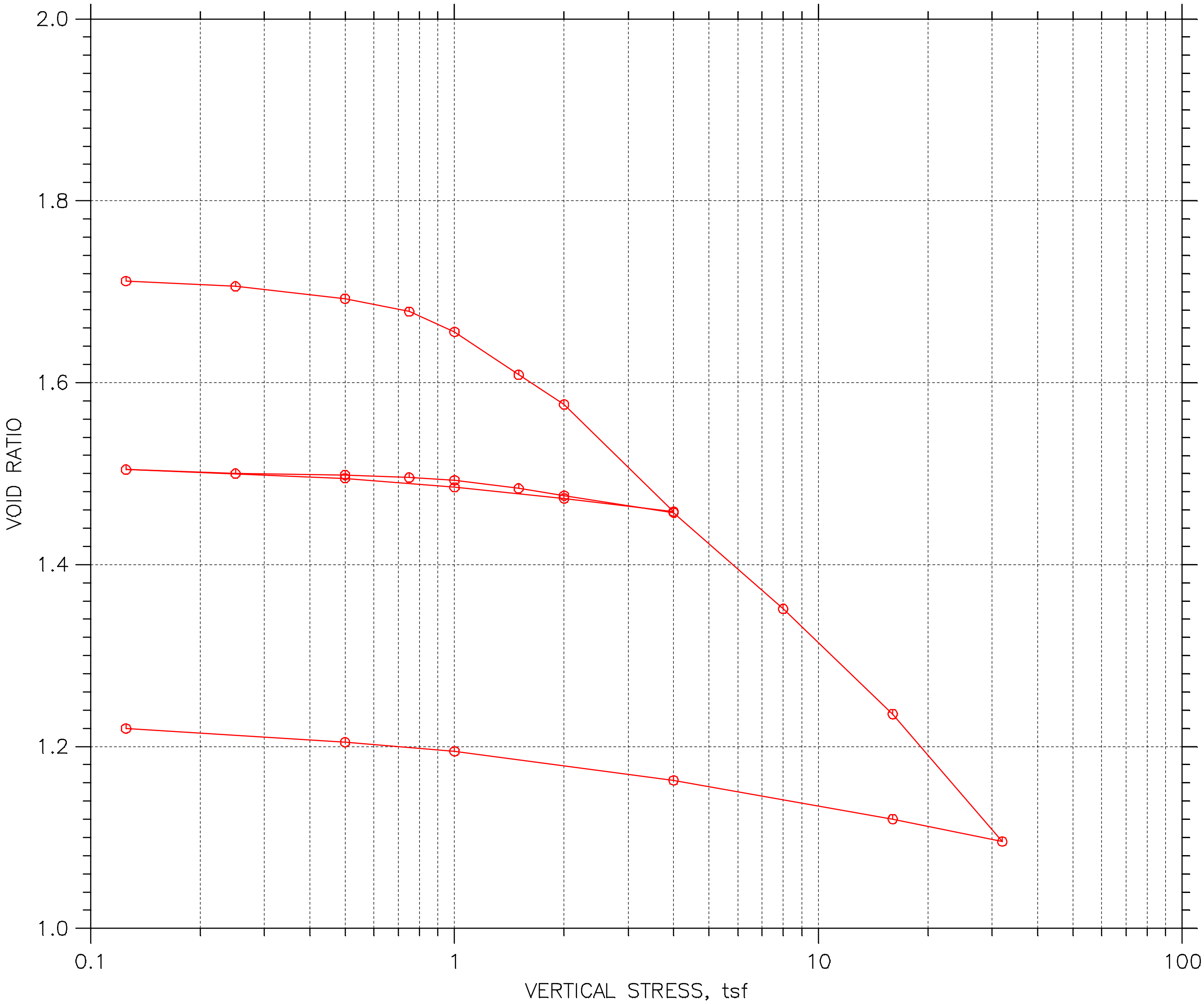




Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0" ST	Elevation: -----------
	Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH		
	Remarks: Pc = 0.59 tsf Cc = 1.39 Ccr = 0.081 TEST PERFORMED AS PER ASTM D2435		

Mon, 25-APR-2016 16:42:55

ONE DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS
USING INCREMENTAL LOADING
ASTM D2435

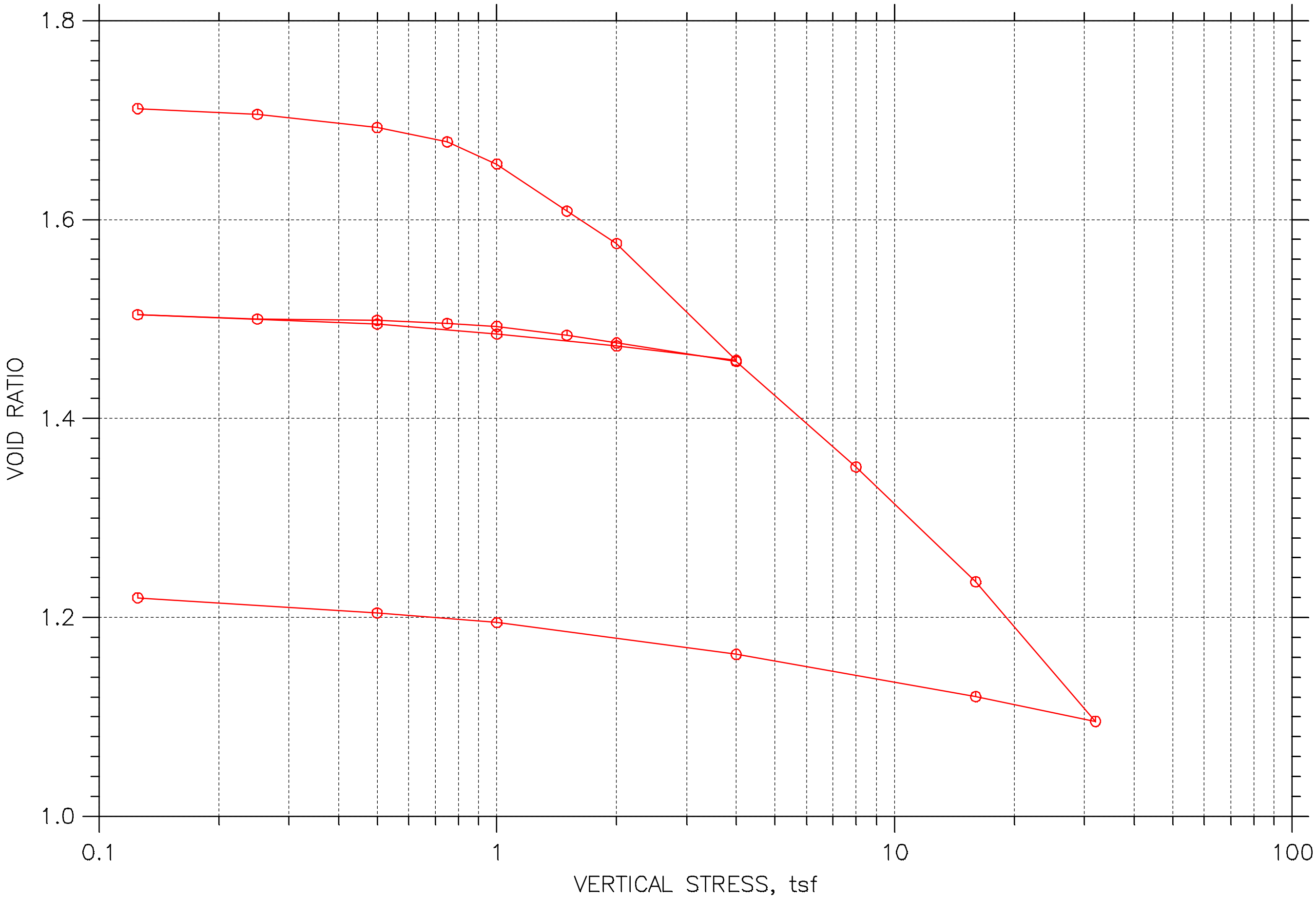


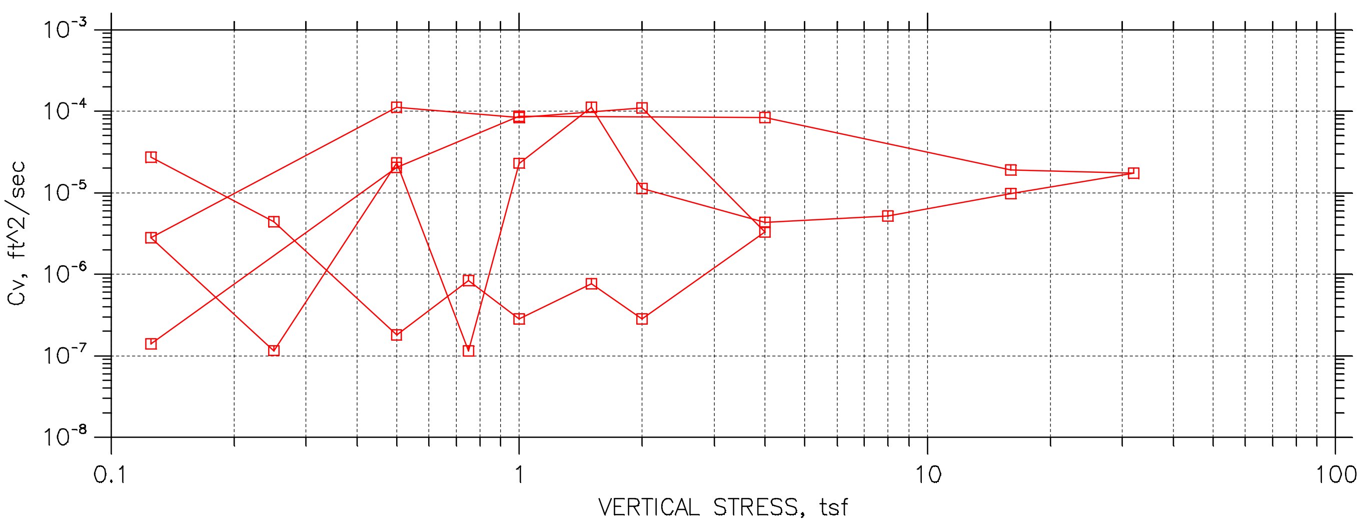
					Before Test	After Test
Overburden Pressure: 1.2 tsf				Water Content, %	64.64	45.93
Preconsolidation Pressure: 2 tsf				Dry Unit Weight, pcf	60.55	74.25
				Saturation, %	99.10	99.42
Diameter: 2.508 in		Height: 0.748 in		Void Ratio	1.72	1.22
LL: ---	PL: ---	PI: ---	GS: 2.64			

Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

Tue, 26-APR-2016 10:09:52

ONE DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS
USING INCREMENTAL LOADING
ASTM D2435





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

Tue, 26-APR-2016 10:09:30

CONSOLIDATION TEST DATA

Project: VECTREN CULLEY E POND
Location: NEWBURGH, IN
Project No.: AW165009
Boring No.: B-16-01
Tested By: HP
Checked By: BCM
Sample No.: ST4
Test Date: 04/15/2106
Depth: 39.0'-41.0'
Test No.: ST4CON
Sample Type: 3.0" ST
Elevation: -----------

Soil Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY
Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435

Measured Specific Gravity: 2.64
Liquid Limit: ---
Initial Height: 0.75 in
Initial Void Ratio: 1.72
Plastic Limit: ---
Specimen Diameter: 2.51 in
Final Void Ratio: 1.22
Plasticity Index: ---

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	X-16	RING	RING	X-14
Wt. Container + Wet Soil, gm	169.08	172.25	161.26	130.46
Wt. Container + Dry Soil, gm	123.85	134.28	134.28	103.63
Wt. Container, gm	44.67	75.53	75.53	45.22
Wt. Dry Soil, gm	79.18	58.746	58.746	58.41
Water Content, %	57.12	64.64	45.93	45.93
Void Ratio	---	1.72	1.22	---
Degree of Saturation, %	---	99.10	99.42	---
Dry Unit Weight, pcf	---	60.548	74.249	---

CONSOLIDATION TEST DATA

Terracon
Consulting Engineers & Scientists

Project: VECTREN CULLEY E POND
Location: NEWBURGH, IN
Project No.: AW165009
Boring No.: B-16-01
Tested By: HP
Checked By: BCM
Sample No.: ST4
Test Date: 04/15/2106
Depth: 39.0'-41.0'
Test No.: ST4CON
Sample Type: 3.0" ST
Elevation: -----------

Soil Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY
Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435

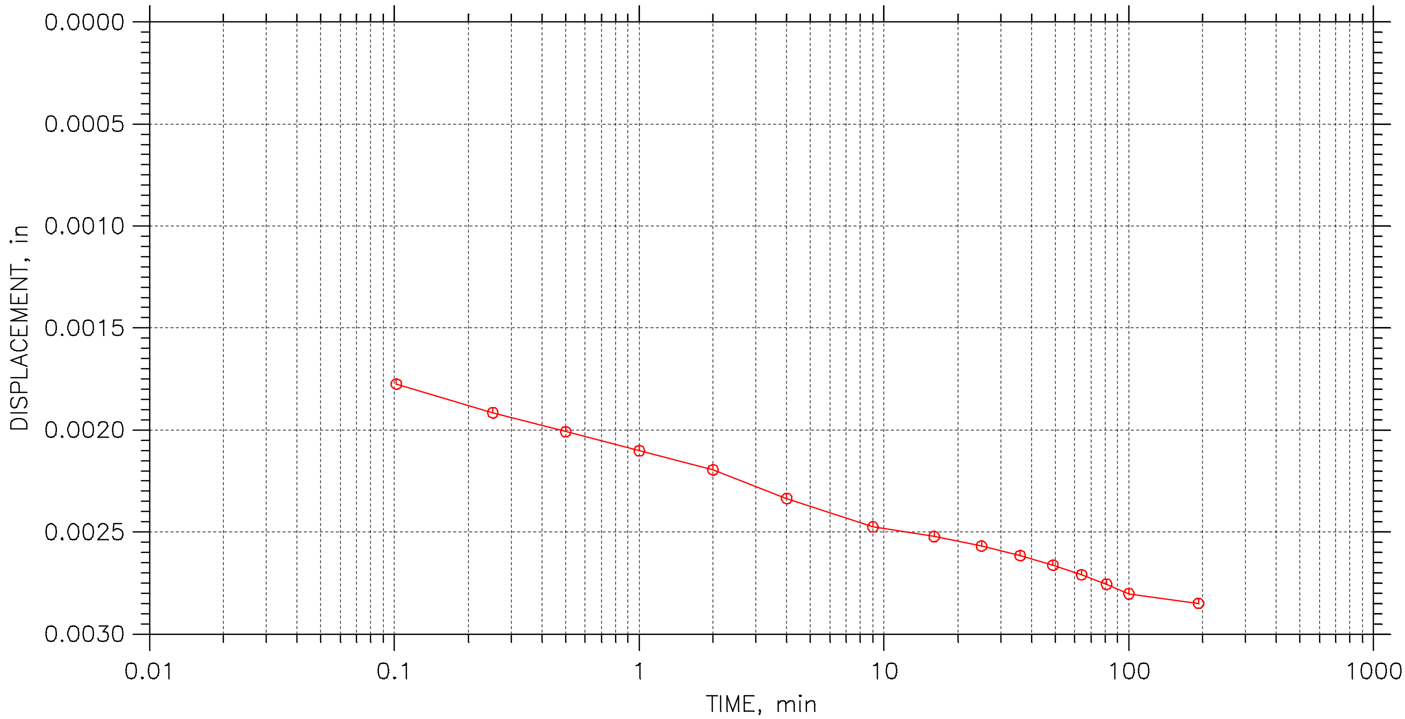
	Applied	Final	Void	Strain	T50 Fitting		Coefficient of Consolidation		
	Stress tsf	Displacement in	Ratio	at End %	Sq.Rt. min	Log min	Sq.Rt. ft^2/sec	Log ft^2/sec	Ave. ft^2/sec
1	0.125	0.002849	1.712	0.38	0.1	0.0	2.73e-005	0.00e+000	2.73e-005
2	0.25	0.004438	1.706	0.59	0.7	0.0	4.43e-006	0.00e+000	4.43e-006
3	0.5	0.008128	1.692	1.09	17.3	0.0	1.81e-007	0.00e+000	1.81e-007
4	0.75	0.01205	1.678	1.61	3.7	0.0	8.32e-007	0.00e+000	8.32e-007
5	1	0.01817	1.656	2.43	10.9	0.0	2.82e-007	0.00e+000	2.82e-007
6	1.5	0.03116	1.609	4.17	3.9	0.0	7.70e-007	0.00e+000	7.70e-007
7	2	0.04013	1.576	5.36	10.3	0.0	2.81e-007	0.00e+000	2.81e-007
8	4	0.07245	1.458	9.69	0.8	0.0	3.30e-006	0.00e+000	3.30e-006
9	2	0.06848	1.473	9.15	0.0	0.0	1.10e-004	0.00e+000	1.10e-004
10	1	0.06516	1.485	8.71	0.0	0.0	8.35e-005	0.00e+000	8.35e-005
11	0.5	0.06241	1.495	8.34	0.0	0.0	1.13e-004	0.00e+000	1.13e-004
12	0.125	0.05979	1.504	7.99	1.0	0.0	2.78e-006	0.00e+000	2.78e-006
13	0.25	0.06101	1.500	8.16	23.3	0.0	1.16e-007	0.00e+000	1.16e-007
14	0.5	0.06138	1.499	8.21	0.1	0.0	2.31e-005	0.00e+000	2.31e-005
15	0.75	0.06222	1.496	8.32	23.3	0.0	1.15e-007	0.00e+000	1.15e-007
16	1	0.06301	1.493	8.42	0.1	0.0	2.30e-005	0.00e+000	2.30e-005
17	1.5	0.06549	1.484	8.75	0.0	0.0	1.12e-004	0.00e+000	1.12e-004
18	2	0.06764	1.476	9.04	0.2	0.0	1.13e-005	0.00e+000	1.13e-005
19	4	0.07278	1.457	9.73	0.6	0.0	4.30e-006	0.00e+000	4.30e-006
20	8	0.1019	1.351	13.62	0.5	0.0	5.21e-006	0.00e+000	5.21e-006
21	16	0.1336	1.236	17.87	0.2	0.0	9.71e-006	0.00e+000	9.71e-006
22	32	0.1722	1.095	23.02	0.1	0.0	1.73e-005	0.00e+000	1.73e-005
23	16	0.1654	1.120	22.11	0.1	0.0	1.89e-005	0.00e+000	1.89e-005
24	4	0.1537	1.163	20.54	0.0	0.0	8.32e-005	0.00e+000	8.32e-005
25	1	0.1449	1.195	19.37	0.0	0.0	8.61e-005	0.00e+000	8.61e-005
26	0.5	0.1422	1.205	19.01	0.1	0.0	2.06e-005	0.00e+000	2.06e-005
27	0.125	0.138	1.220	18.45	15.1	0.0	1.40e-007	0.00e+000	1.40e-007

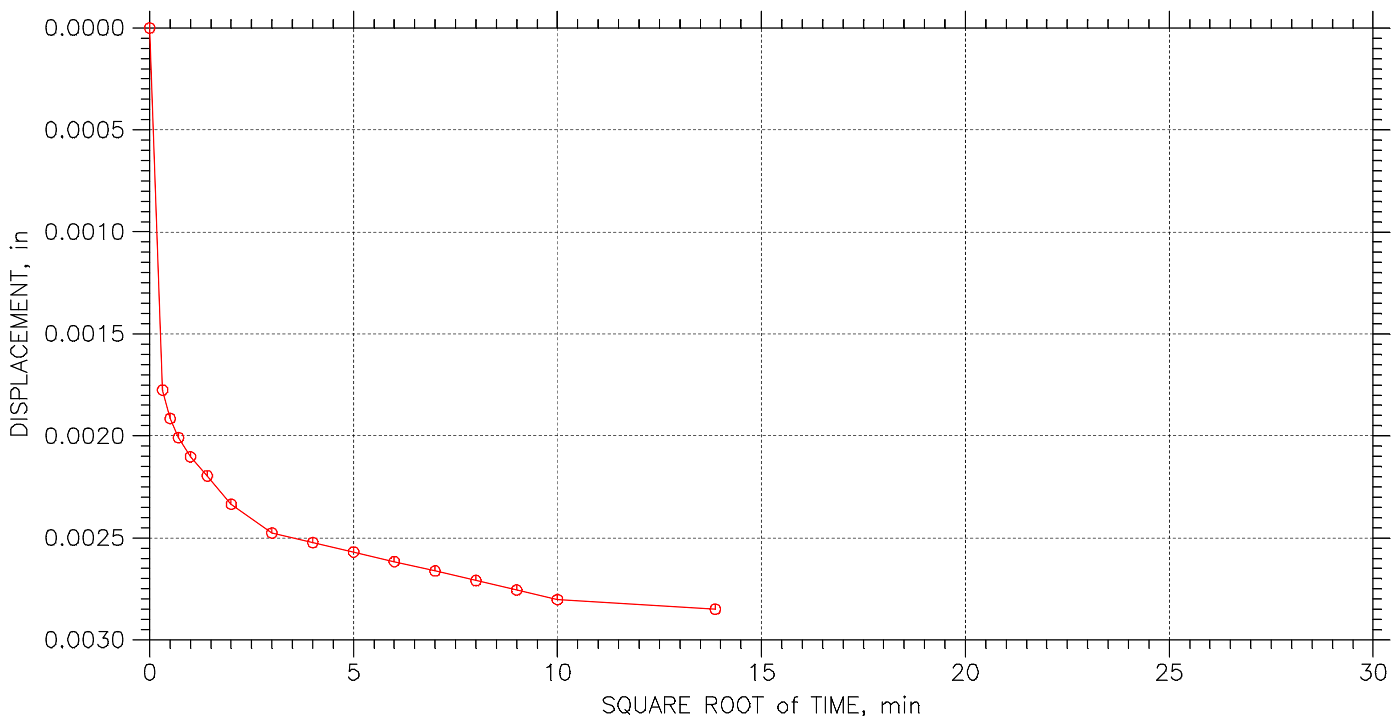
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 1 of 27

Stress: 0.125 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

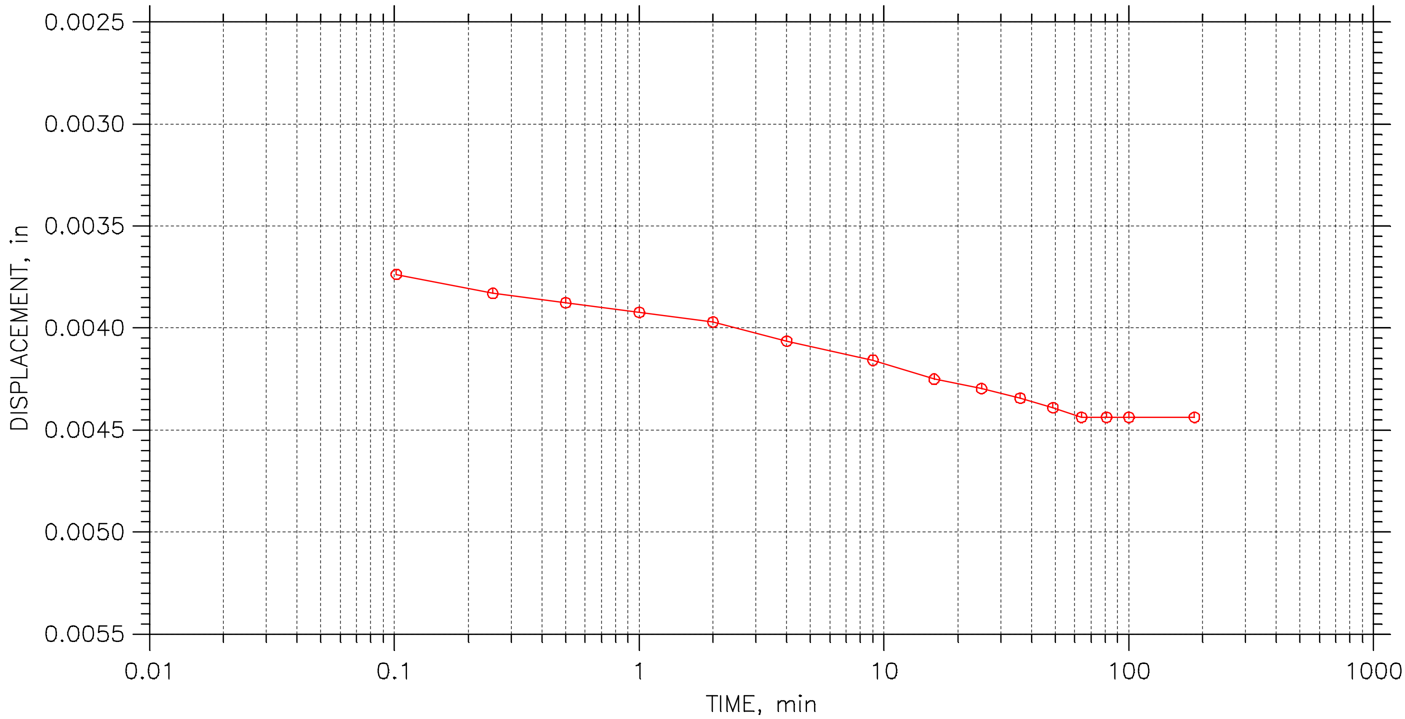
Tue, 26-APR-2016 10:11:36

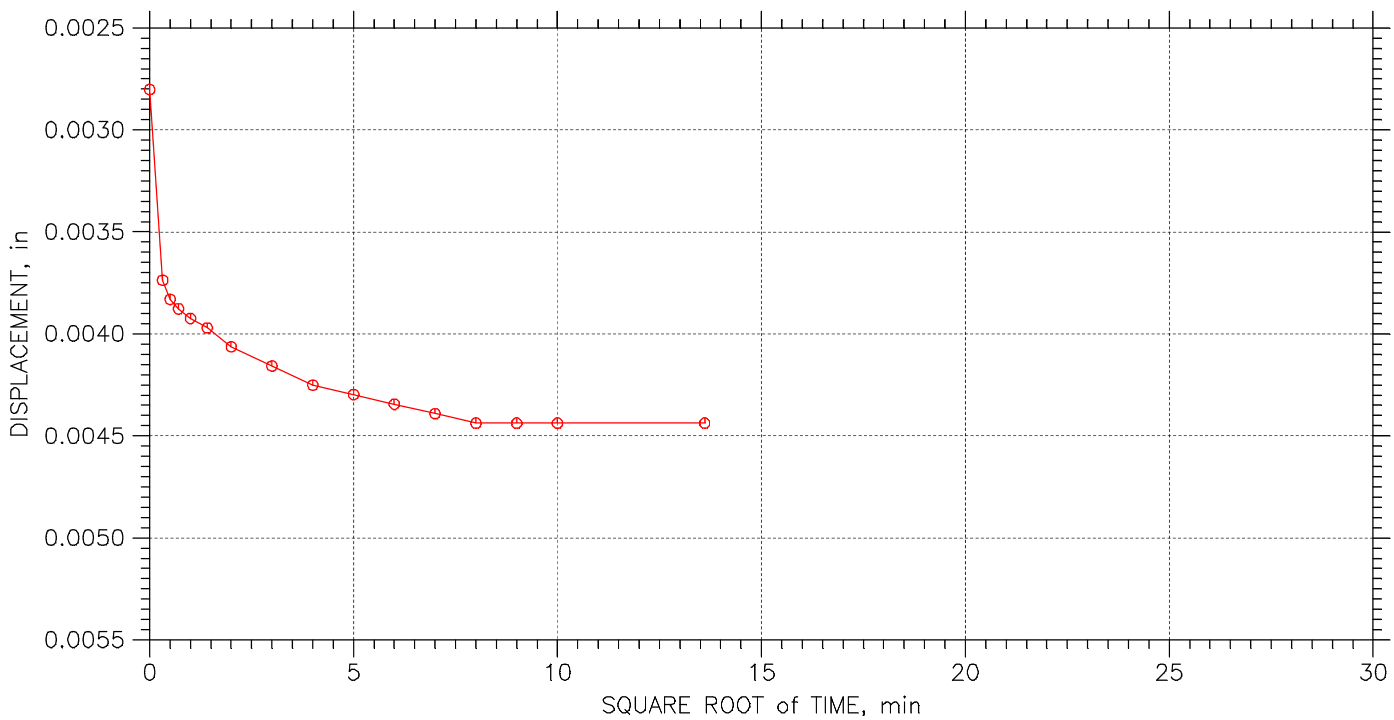
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 2 of 27

Stress: 0.25 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

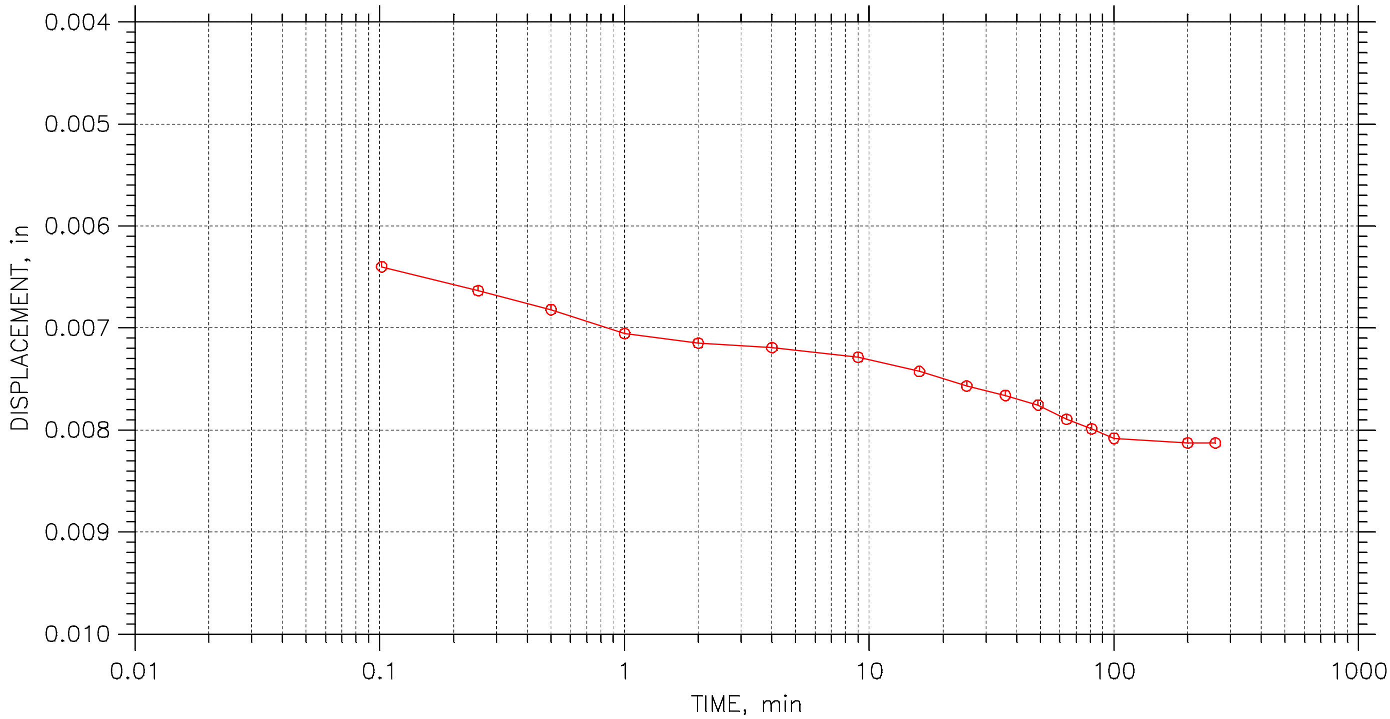
Tue, 26-APR-2016 10:11:38

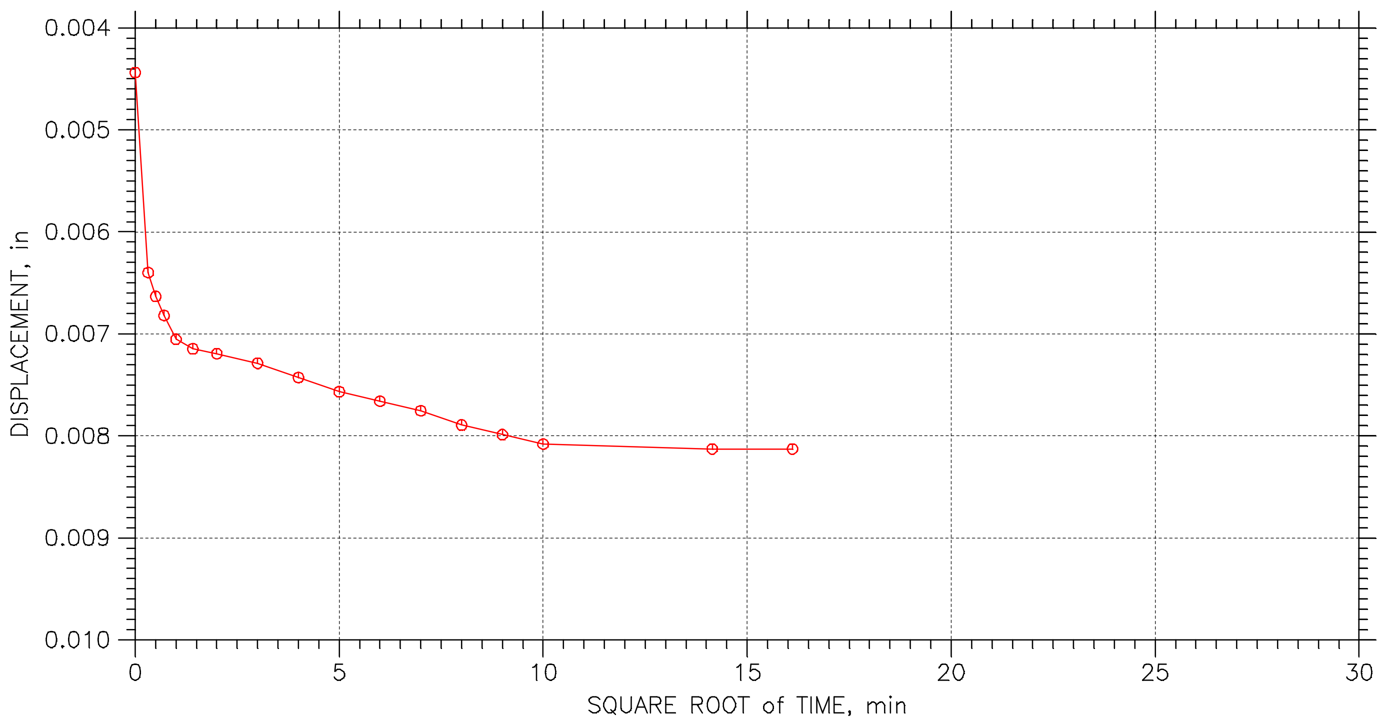
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 3 of 27

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

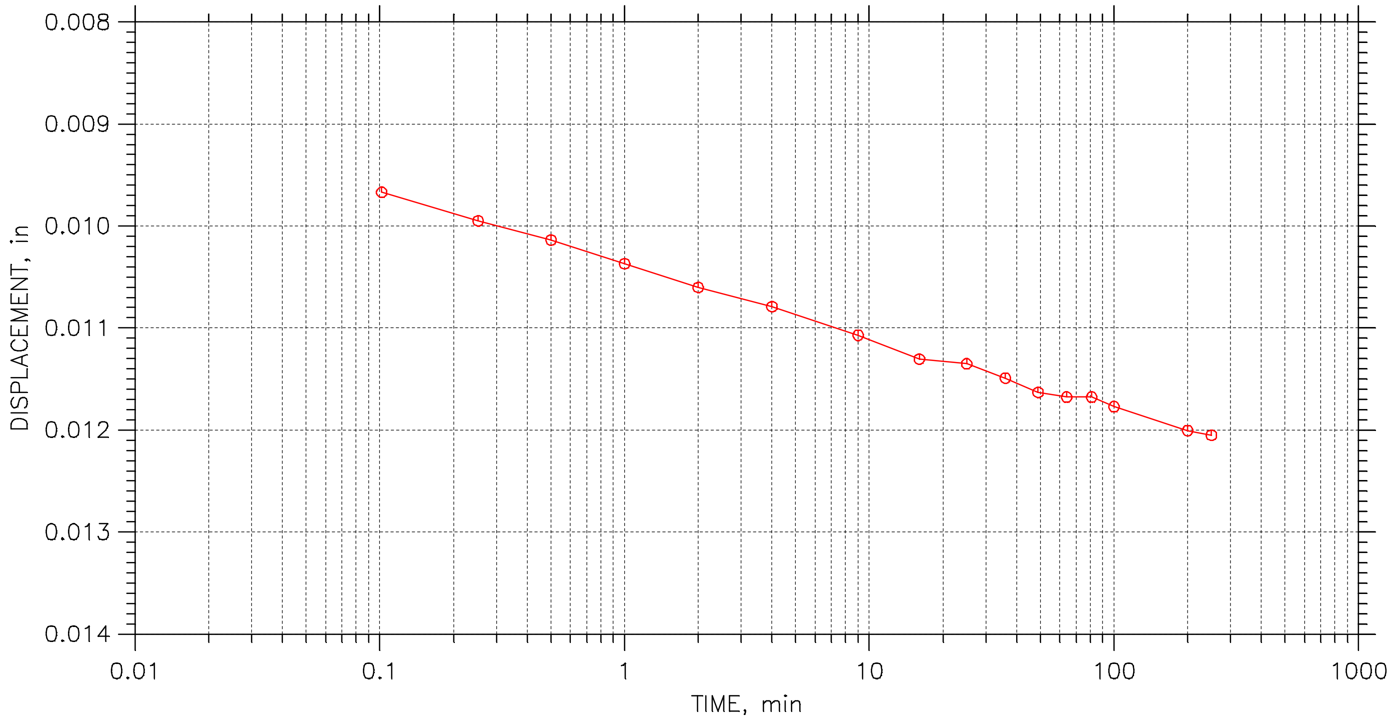
Tue, 26-APR-2016 10:11:39

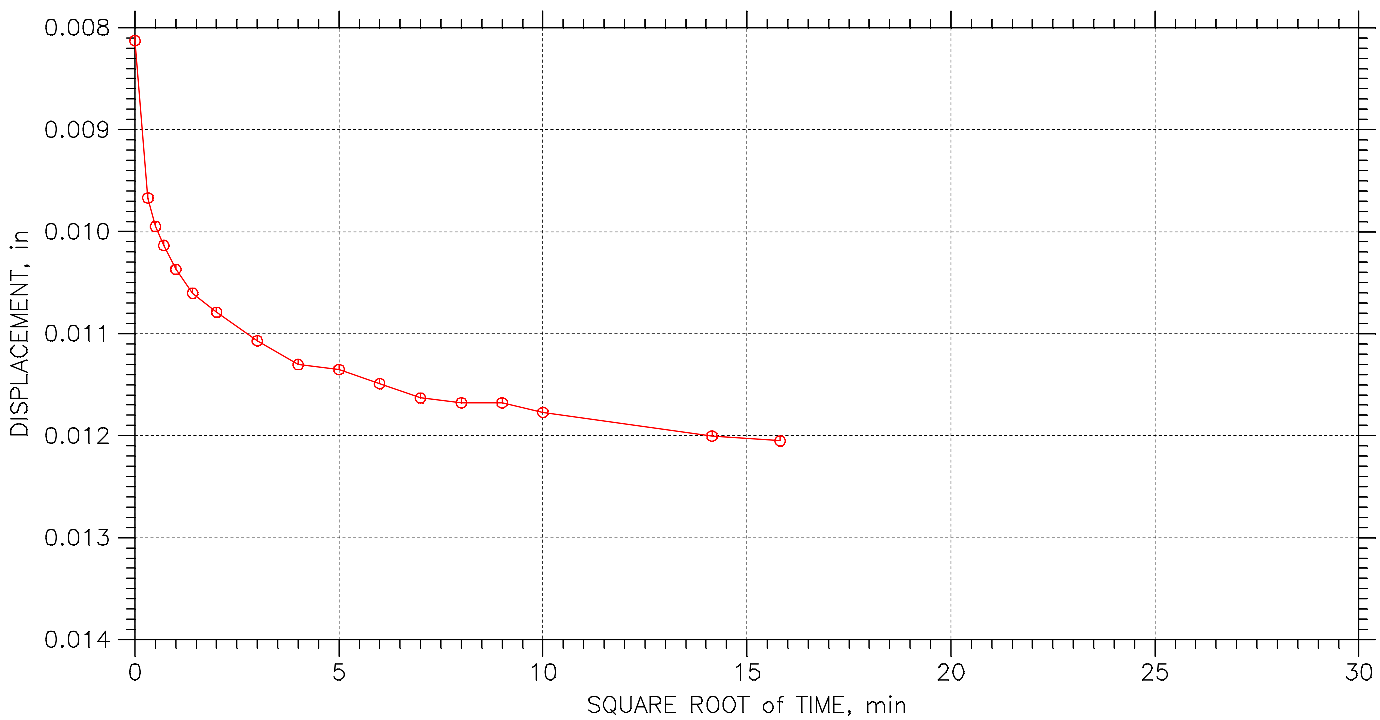
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 4 of 27

Stress: 0.75 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

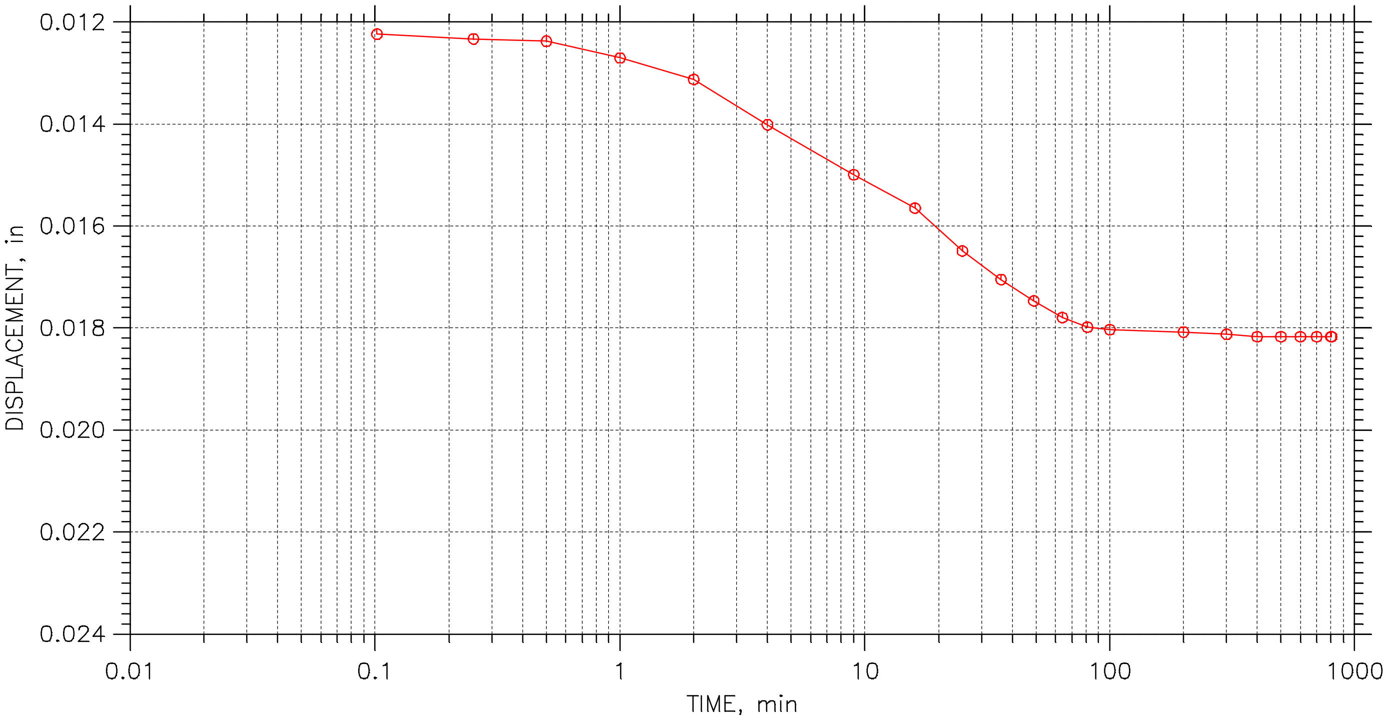
Tue, 26-APR-2016 10:11:41

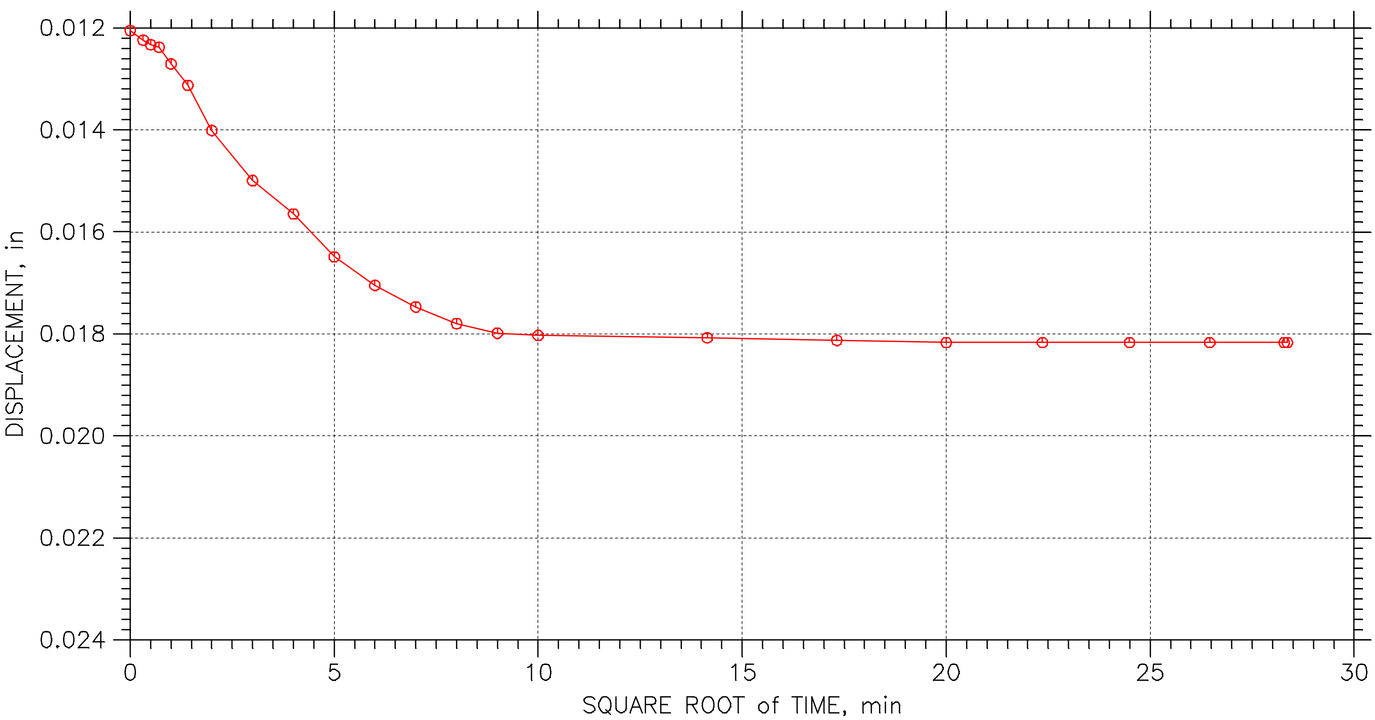
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 5 of 27

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

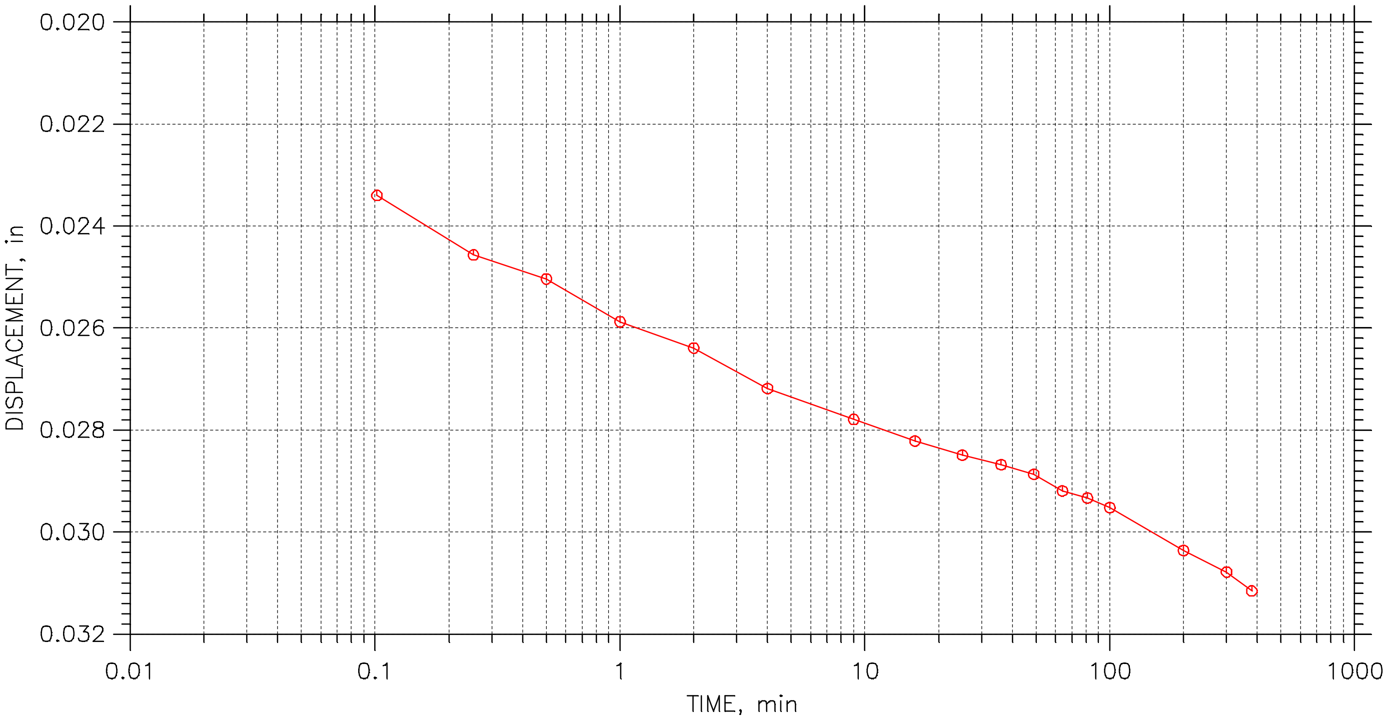
Tue, 26-APR-2016 10:11:42

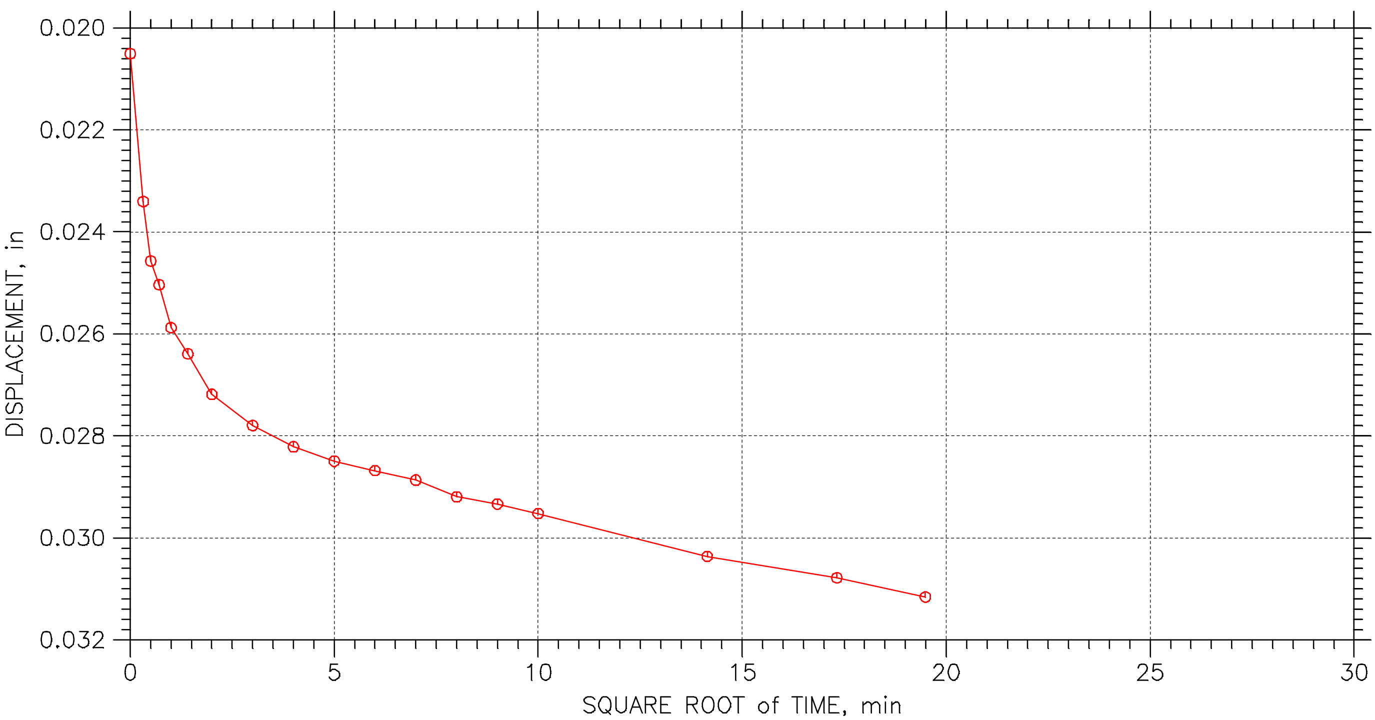
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 6 of 27

Stress: 1.5 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

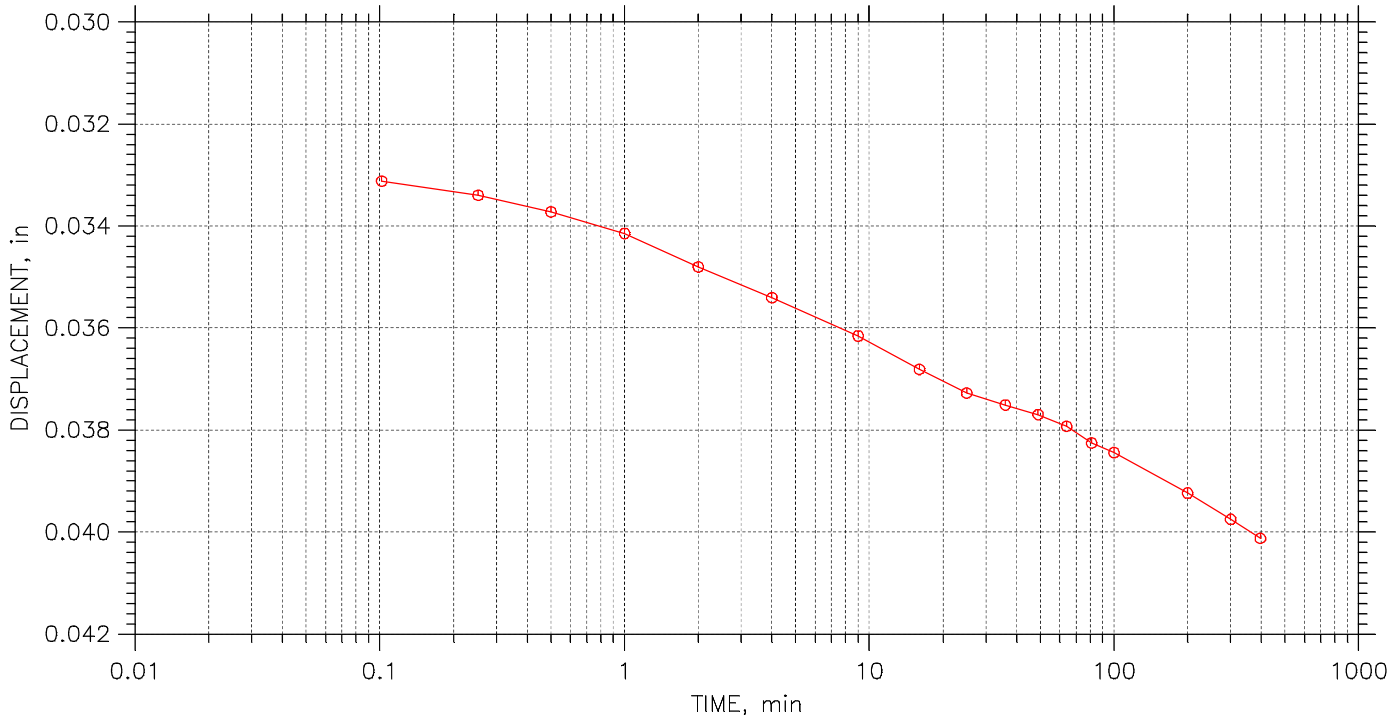
Tue, 26-APR-2016 10:11:44

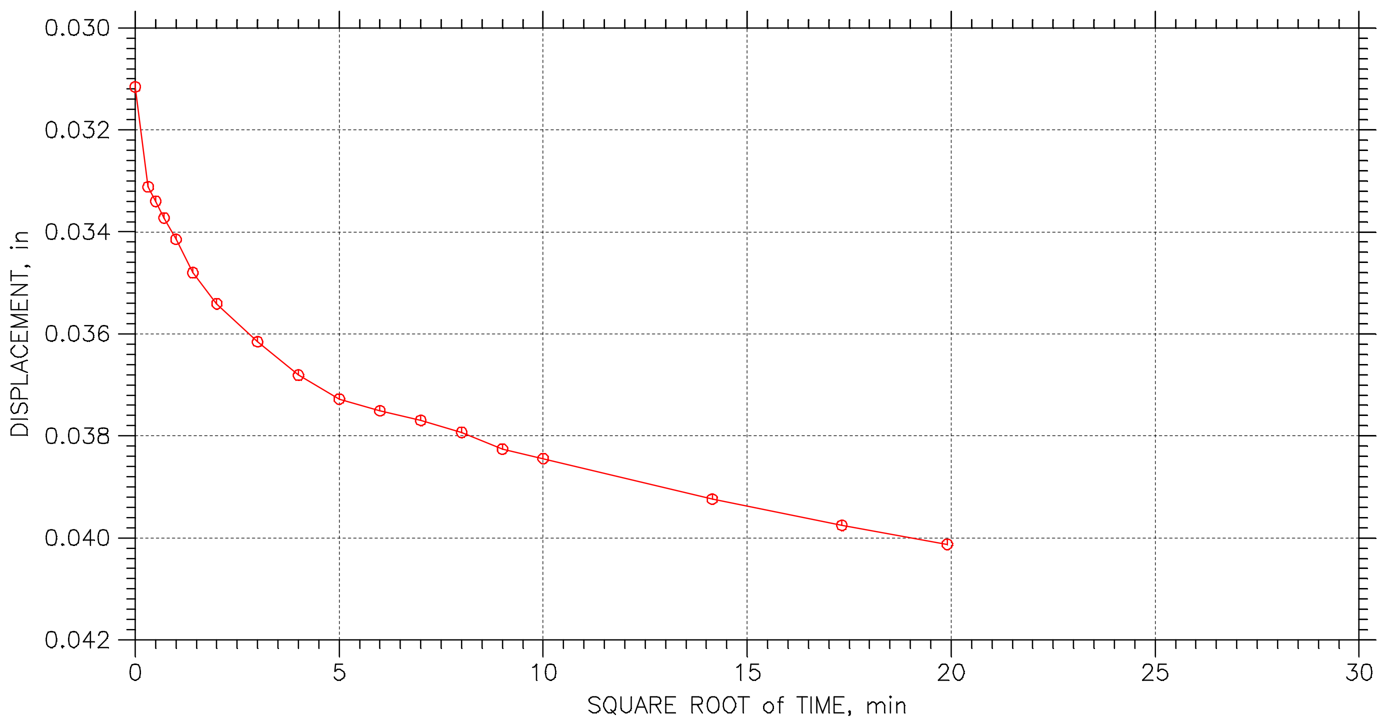
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 7 of 27

Stress: 2. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

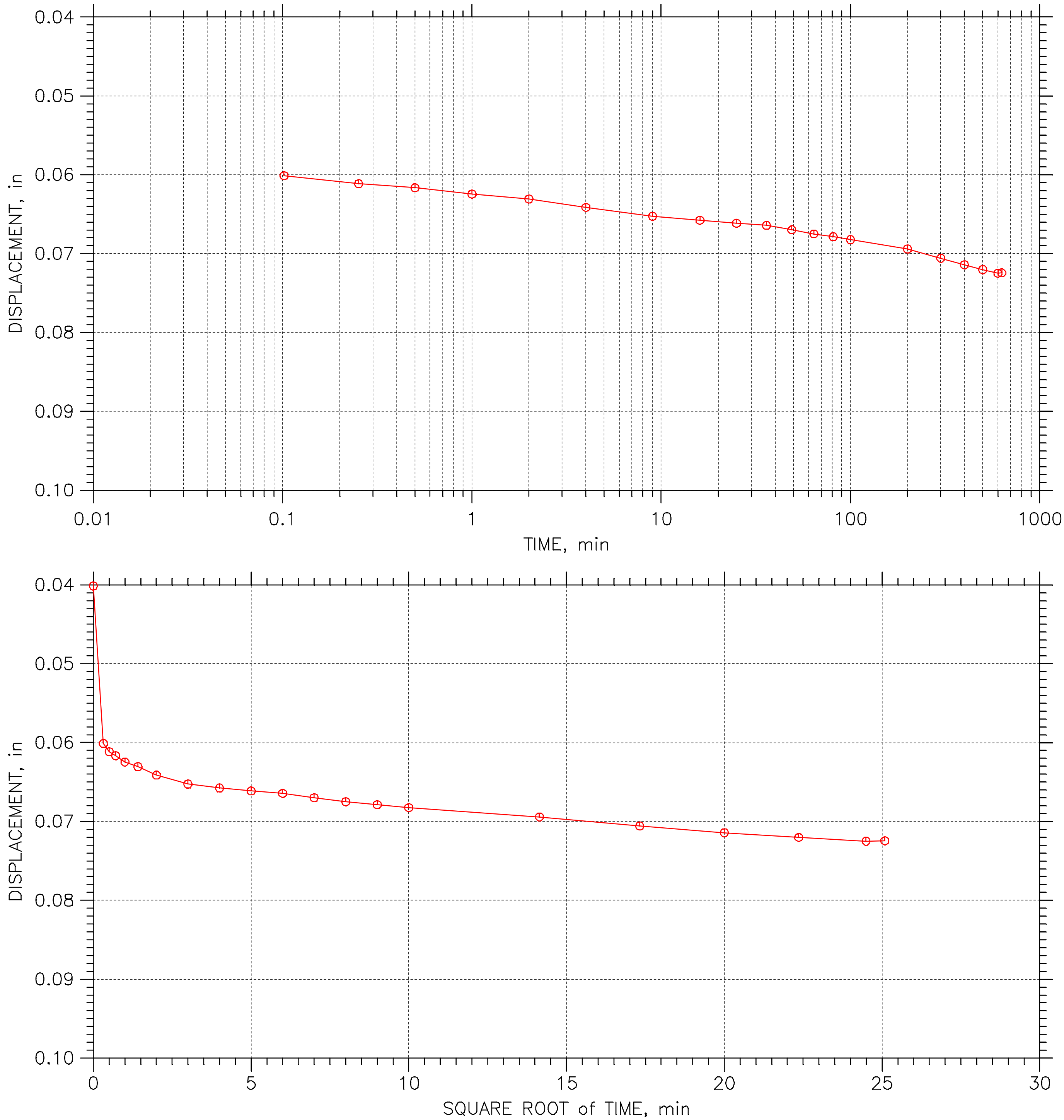
Tue, 26-APR-2016 10:11:45

CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 8 of 27

Stress: 4. tsf



Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

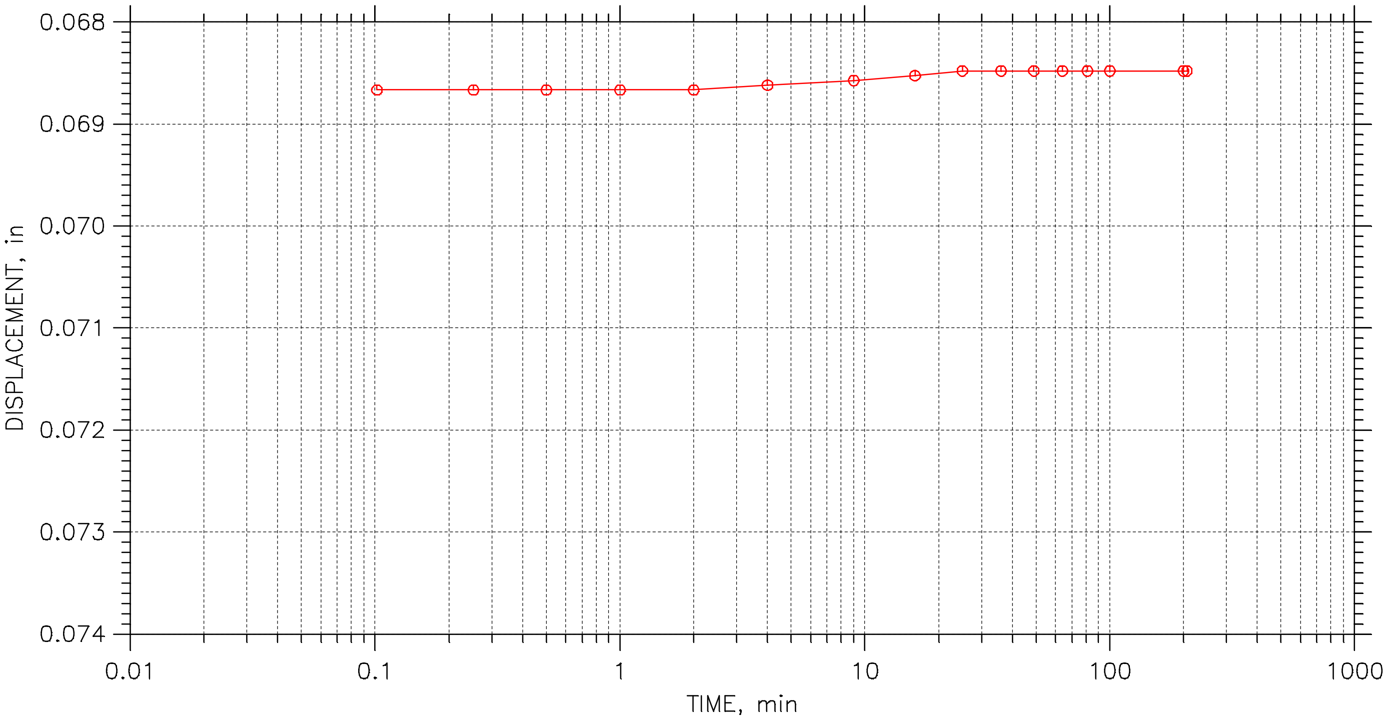
Tue, 26-APR-2016 10:11:47

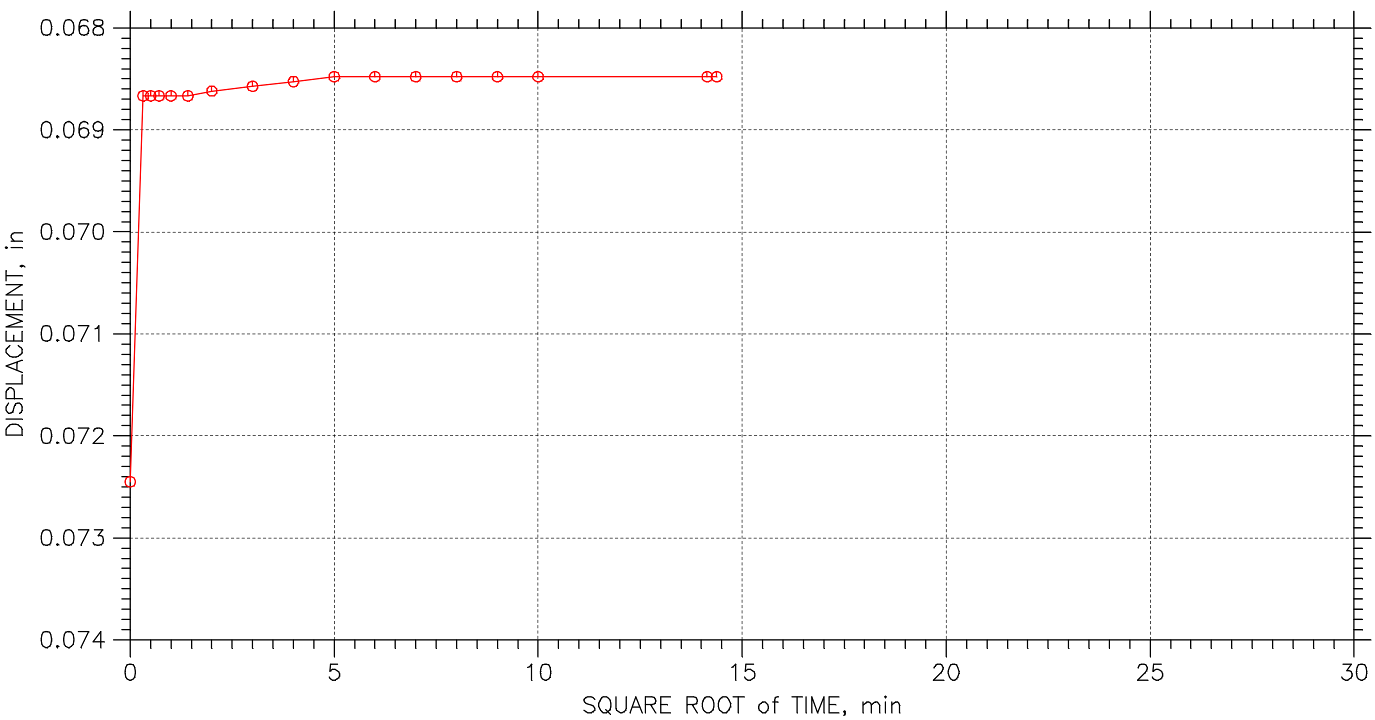
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 9 of 27

Stress: 2. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

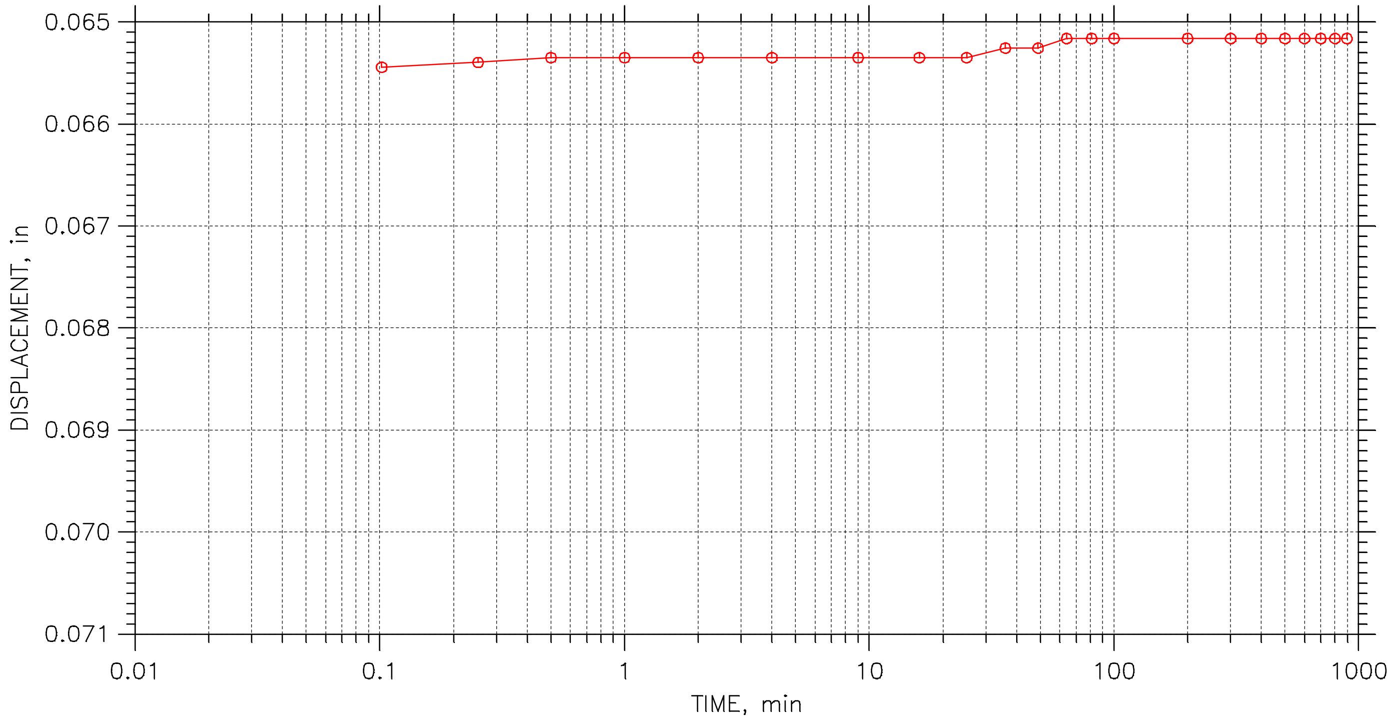
Tue, 26-APR-2016 10:11:48

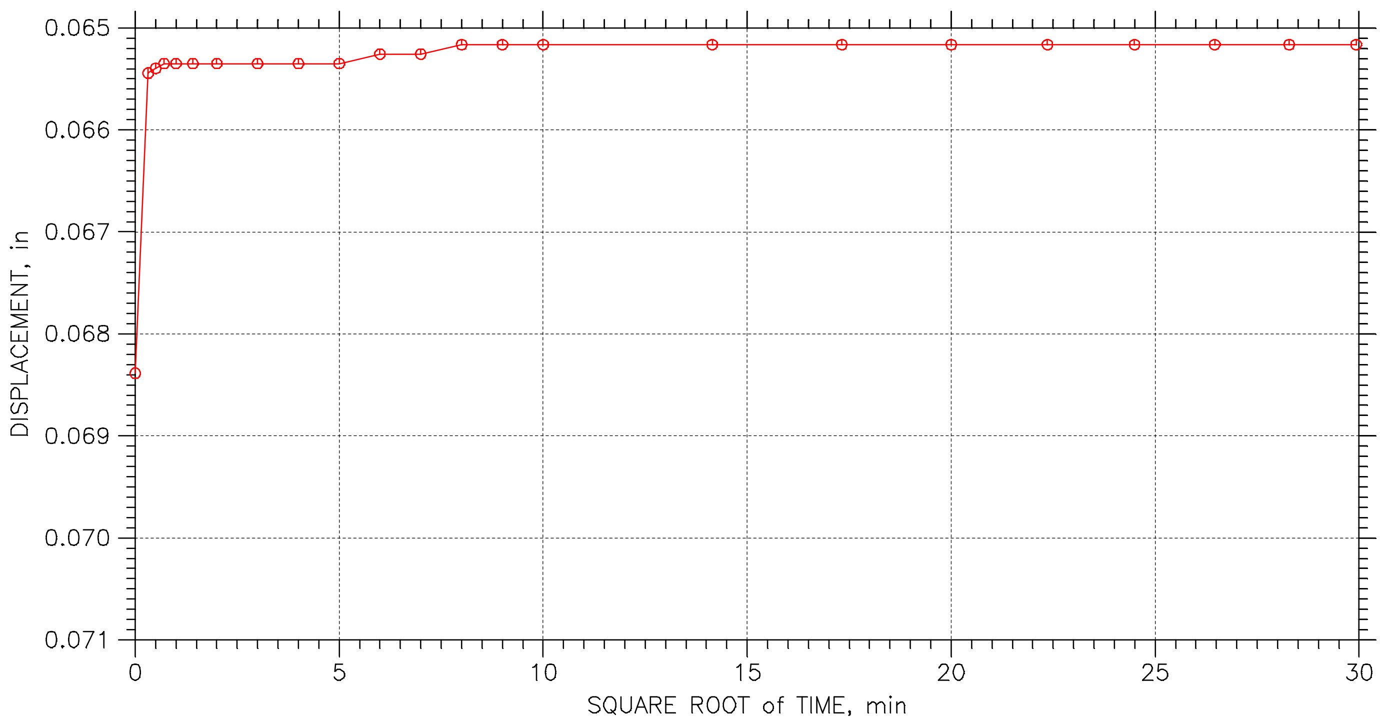
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 10 of 27

Stress: 1. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

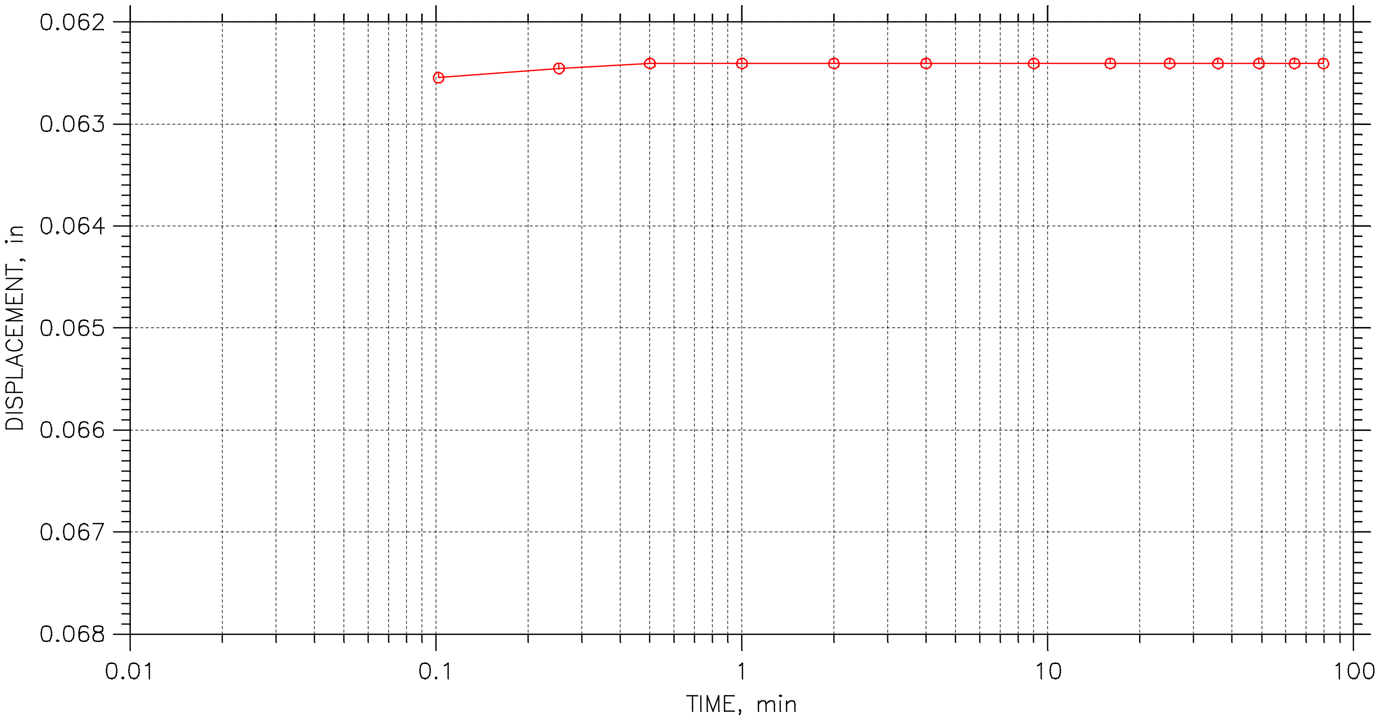
Tue, 26-APR-2016 10:11:49

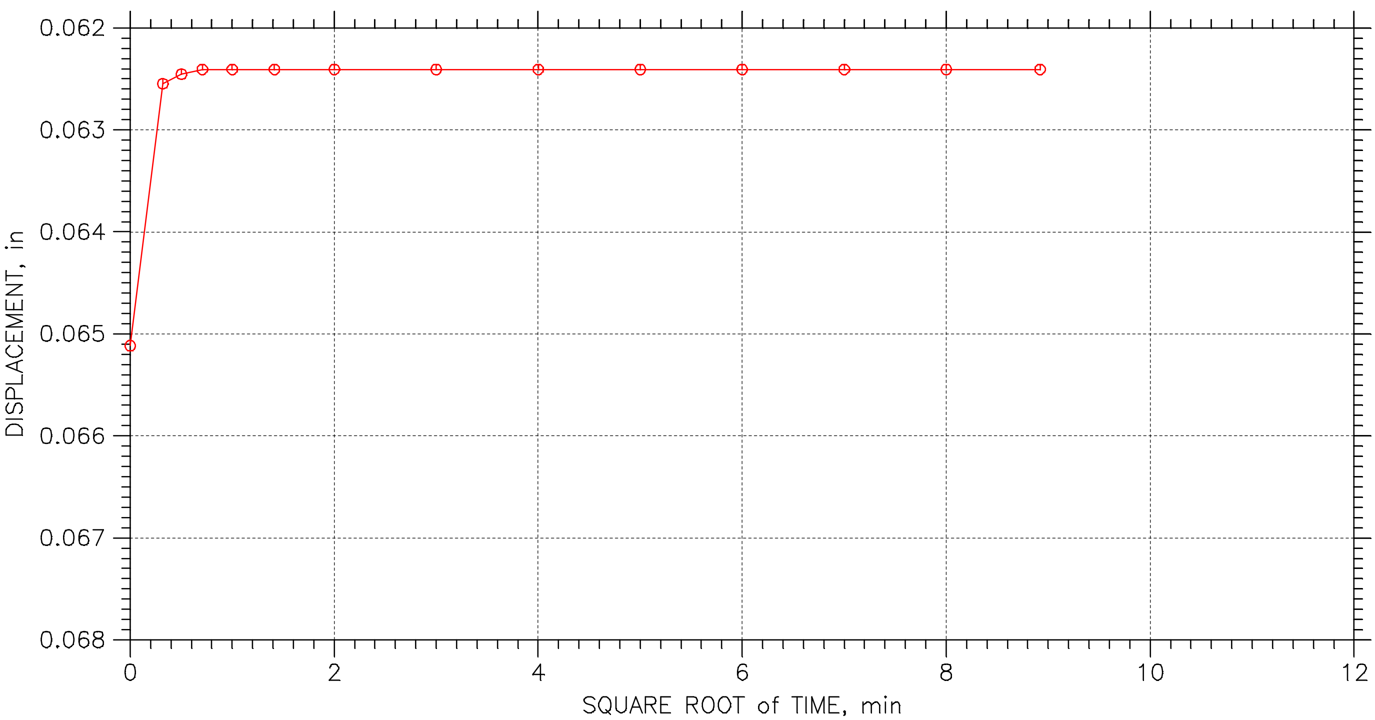
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 11 of 27

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

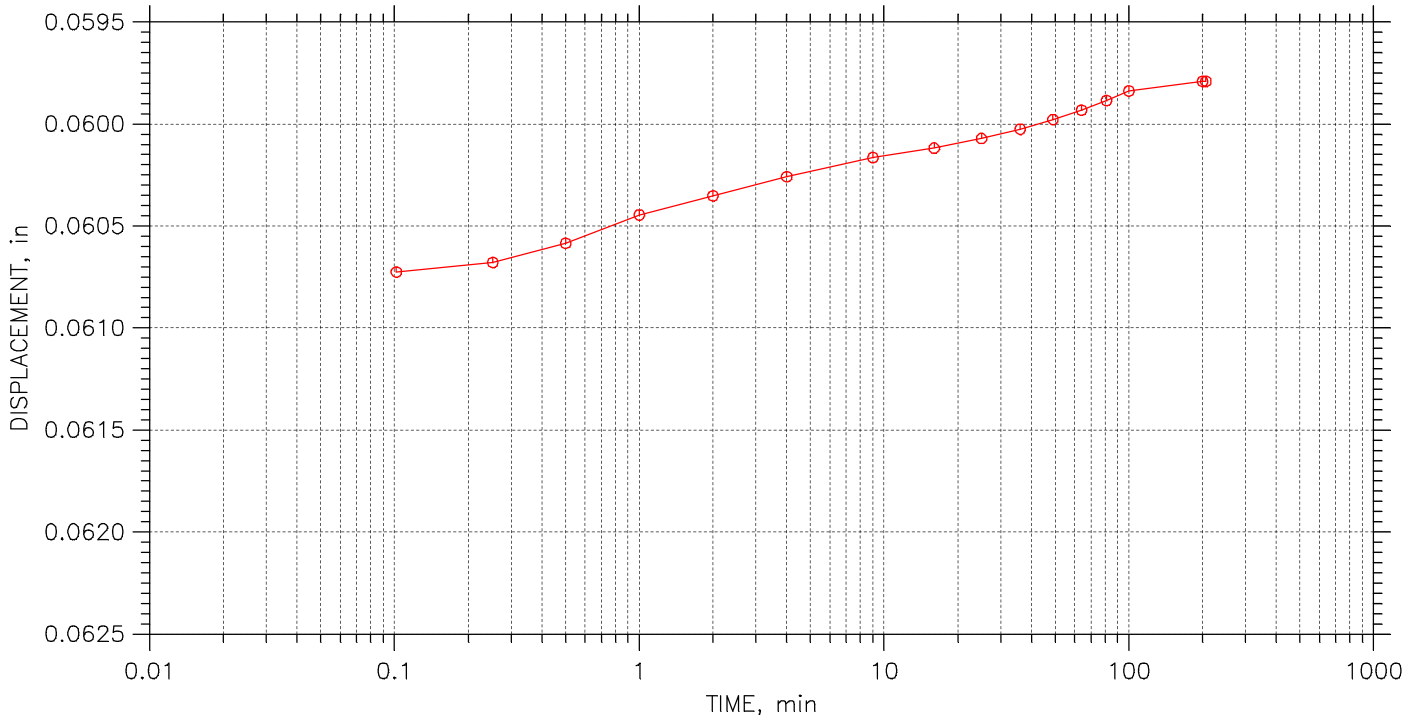
Tue, 26-APR-2016 10:11:51

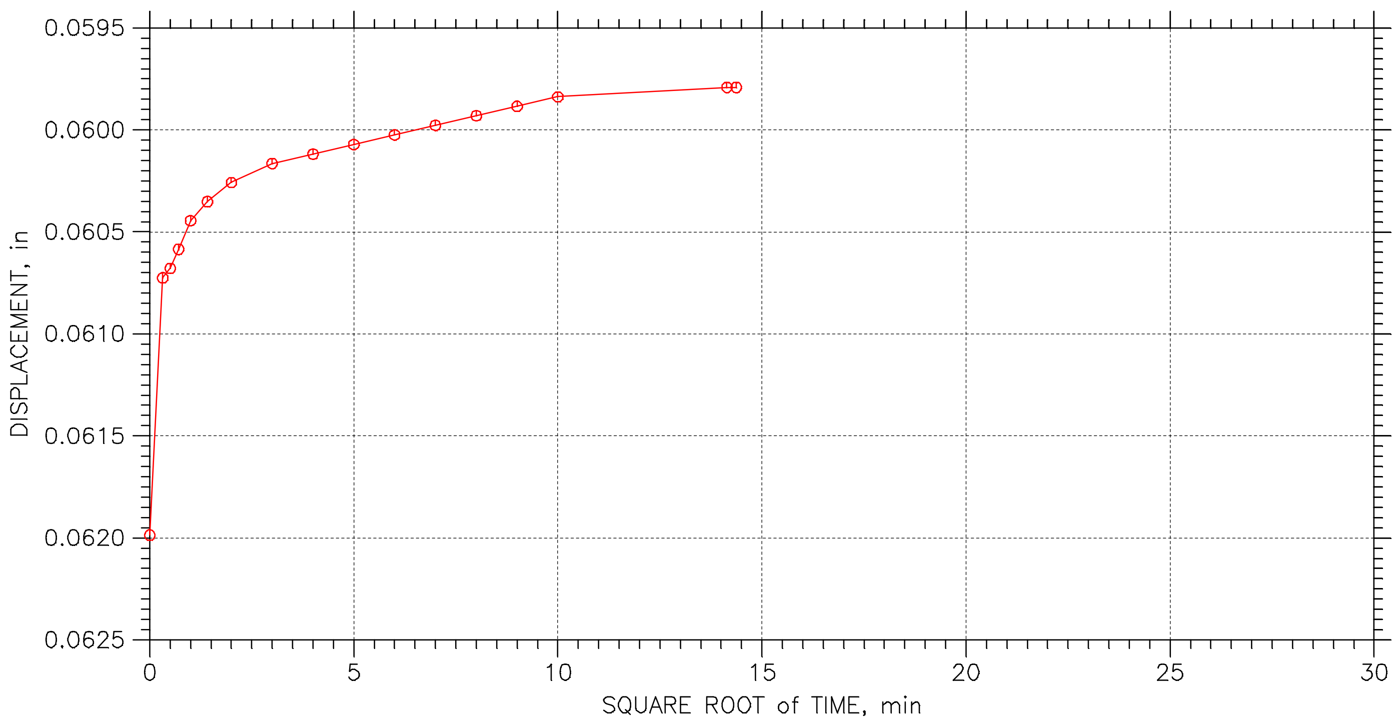
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 12 of 27

Stress: 0.125 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

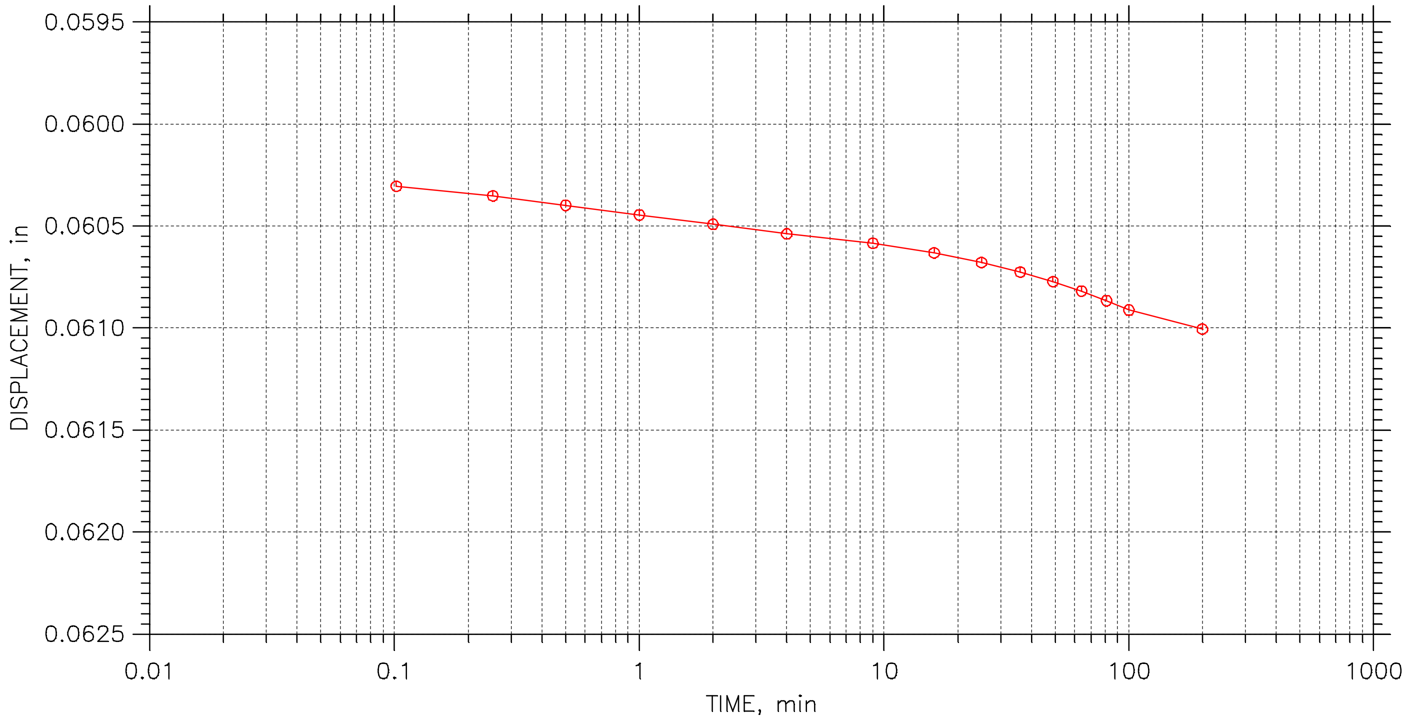
Tue, 26-APR-2016 10:11:52

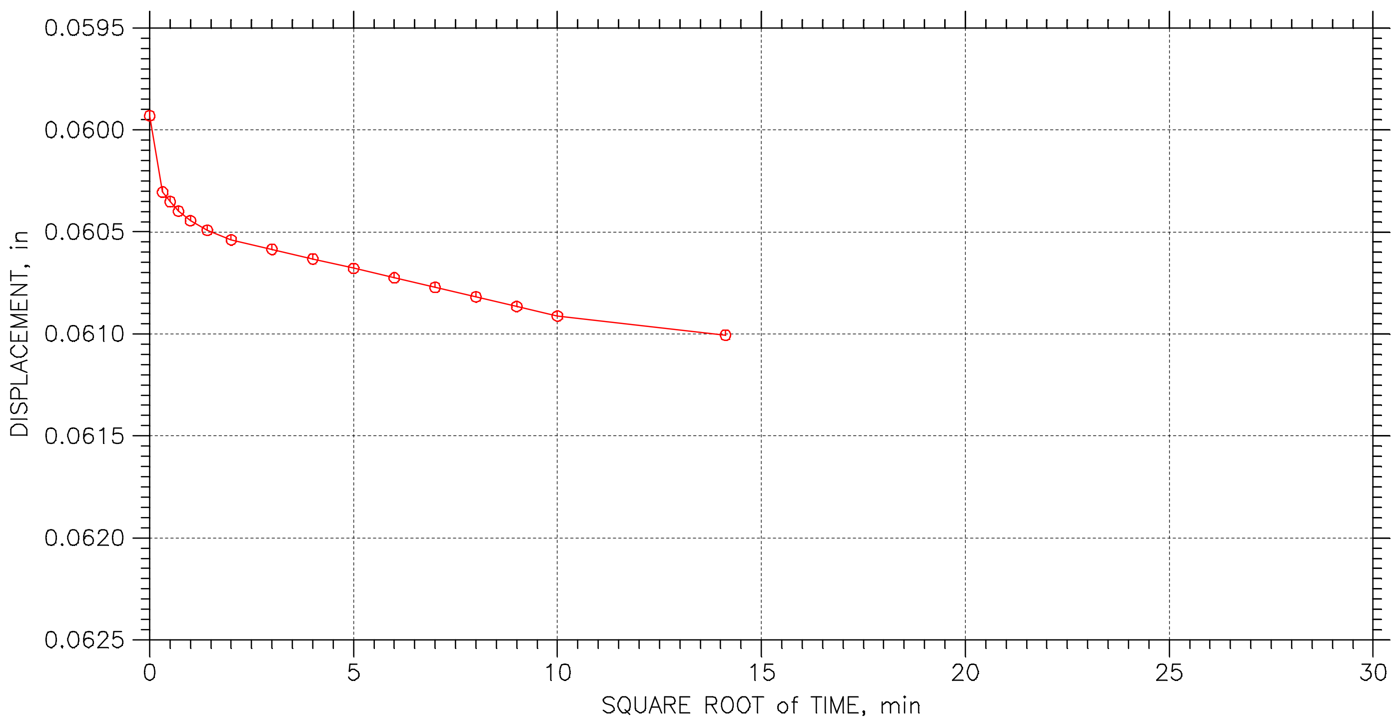
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 13 of 27

Stress: 0.25 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

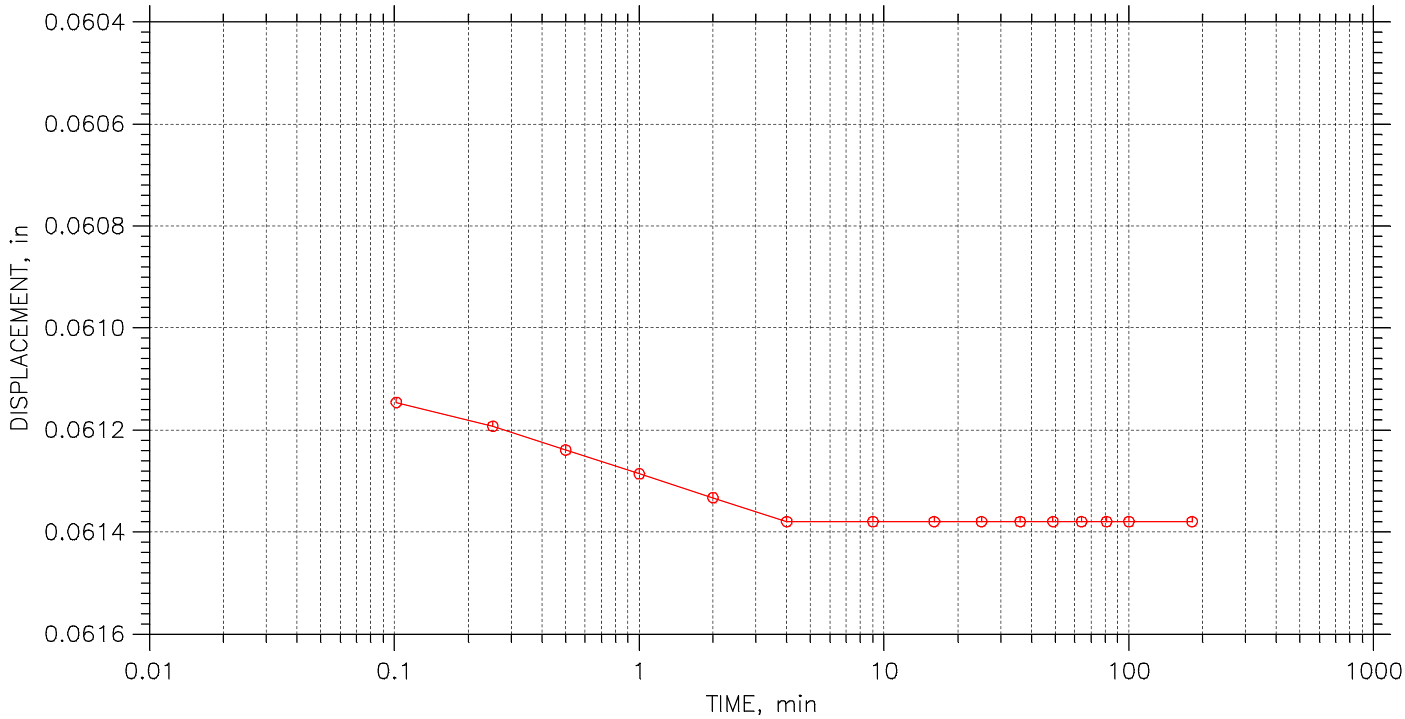
Tue, 26-APR-2016 10:11:54

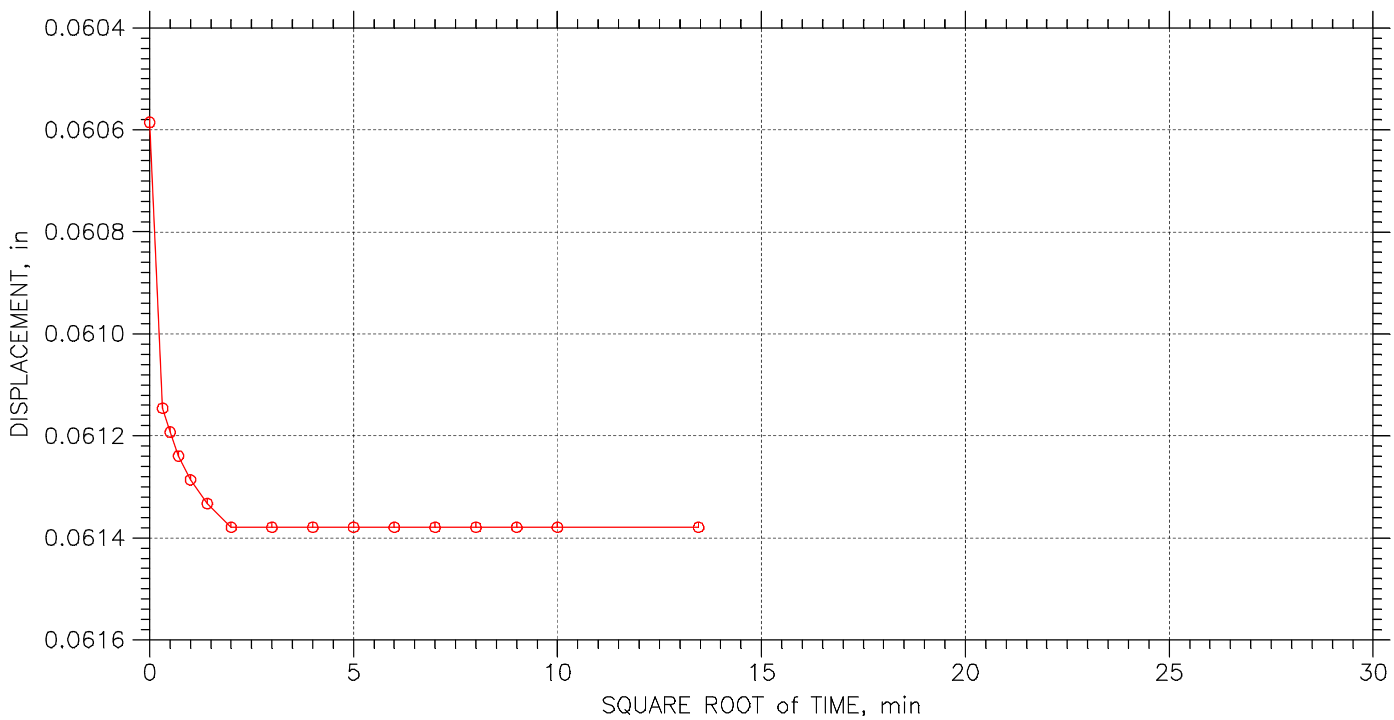
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 14 of 27

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

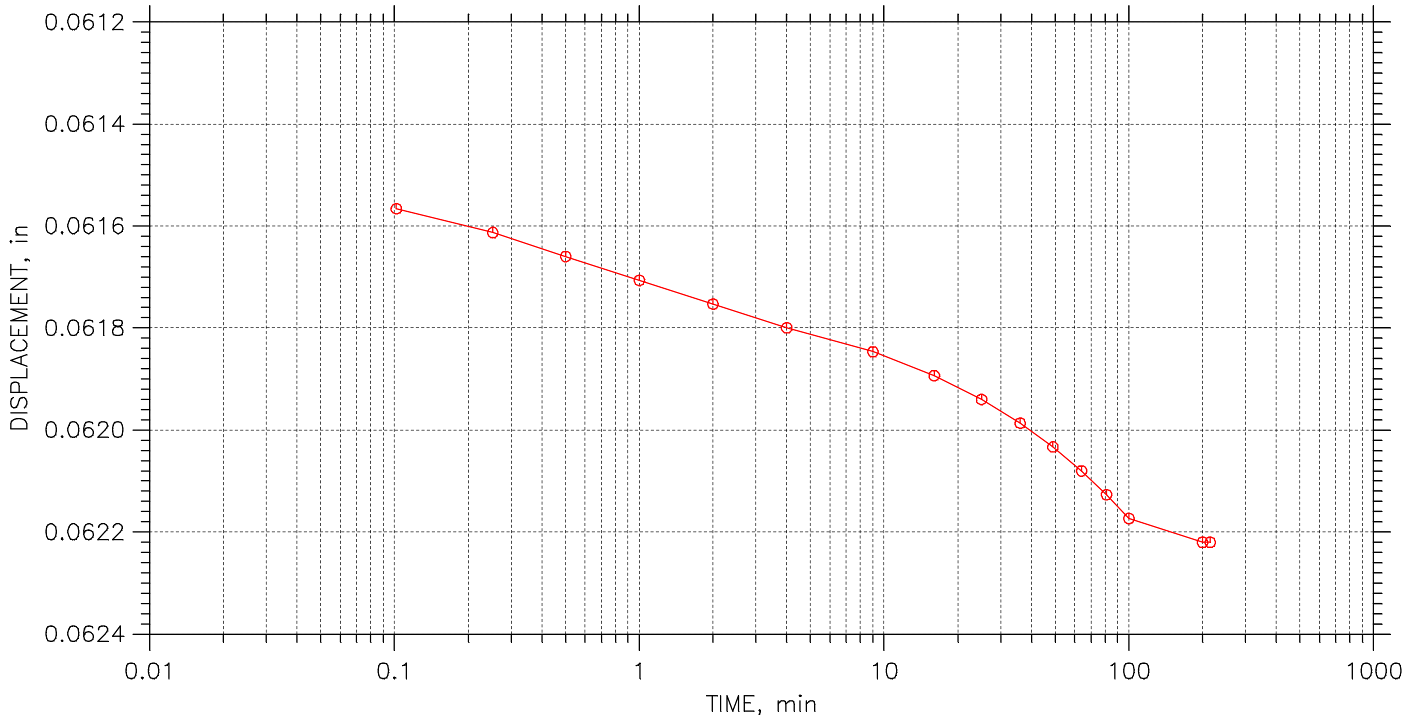
Tue, 26-APR-2016 10:11:55

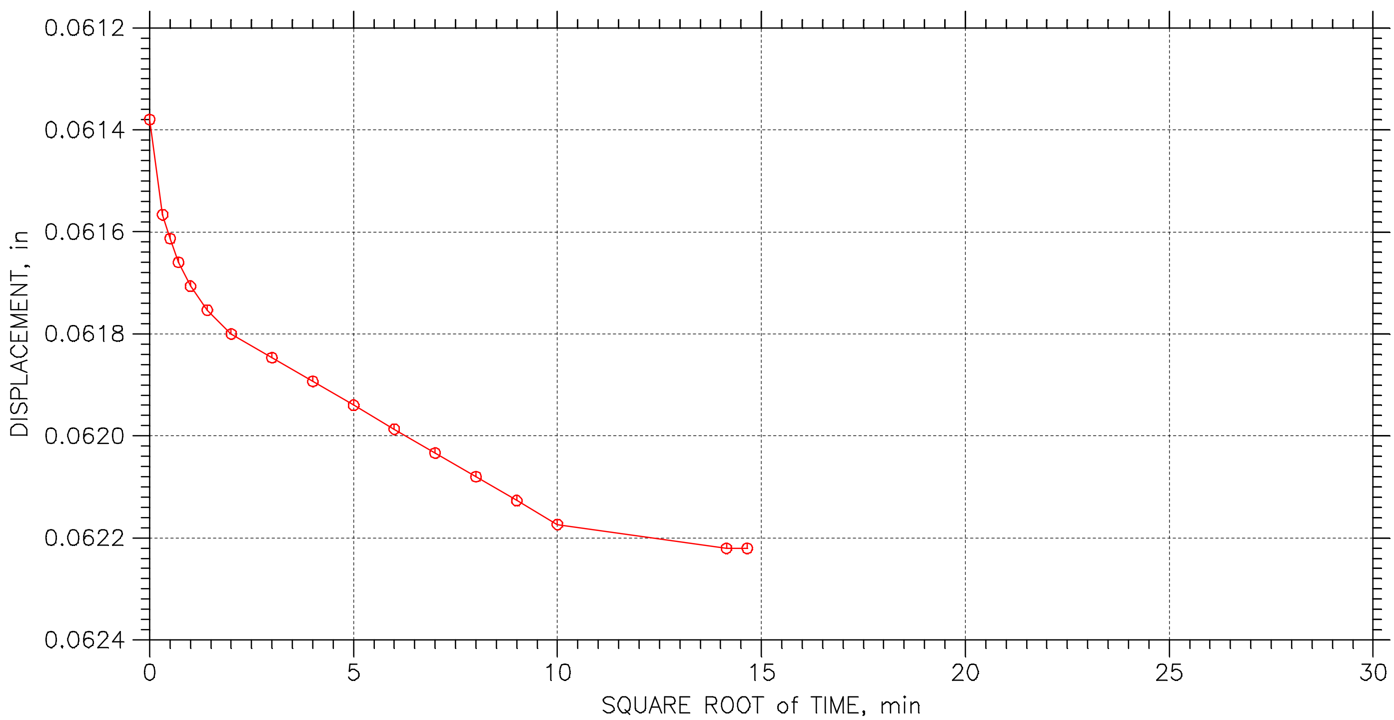
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 15 of 27

Stress: 0.75 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

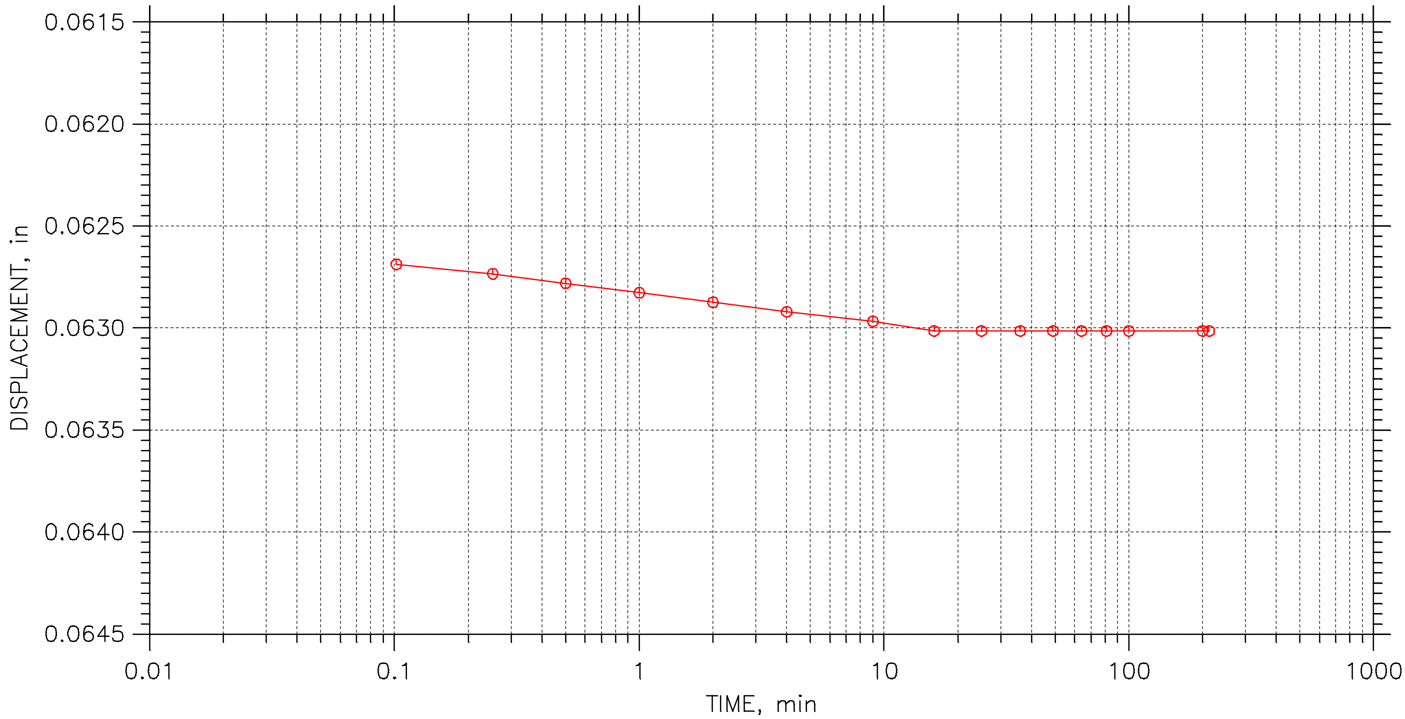
Tue, 26-APR-2016 10:11:57

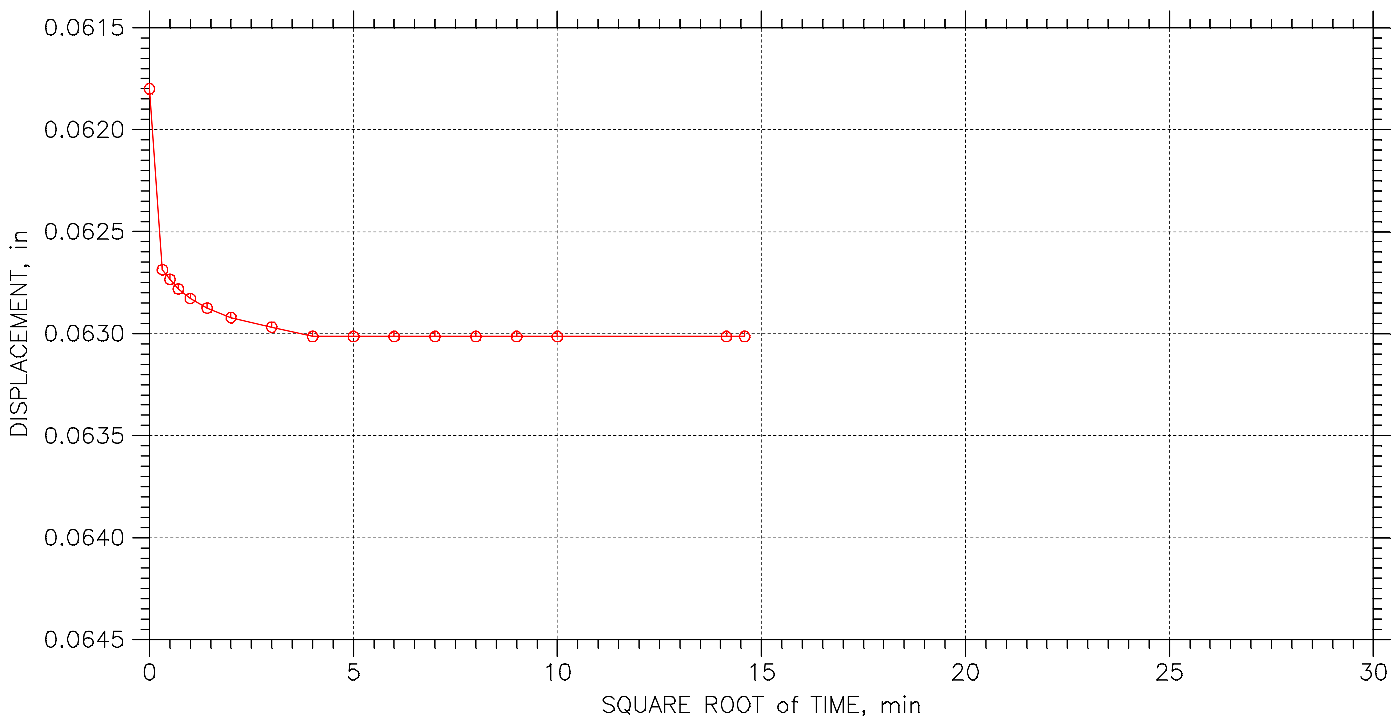
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 16 of 27

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

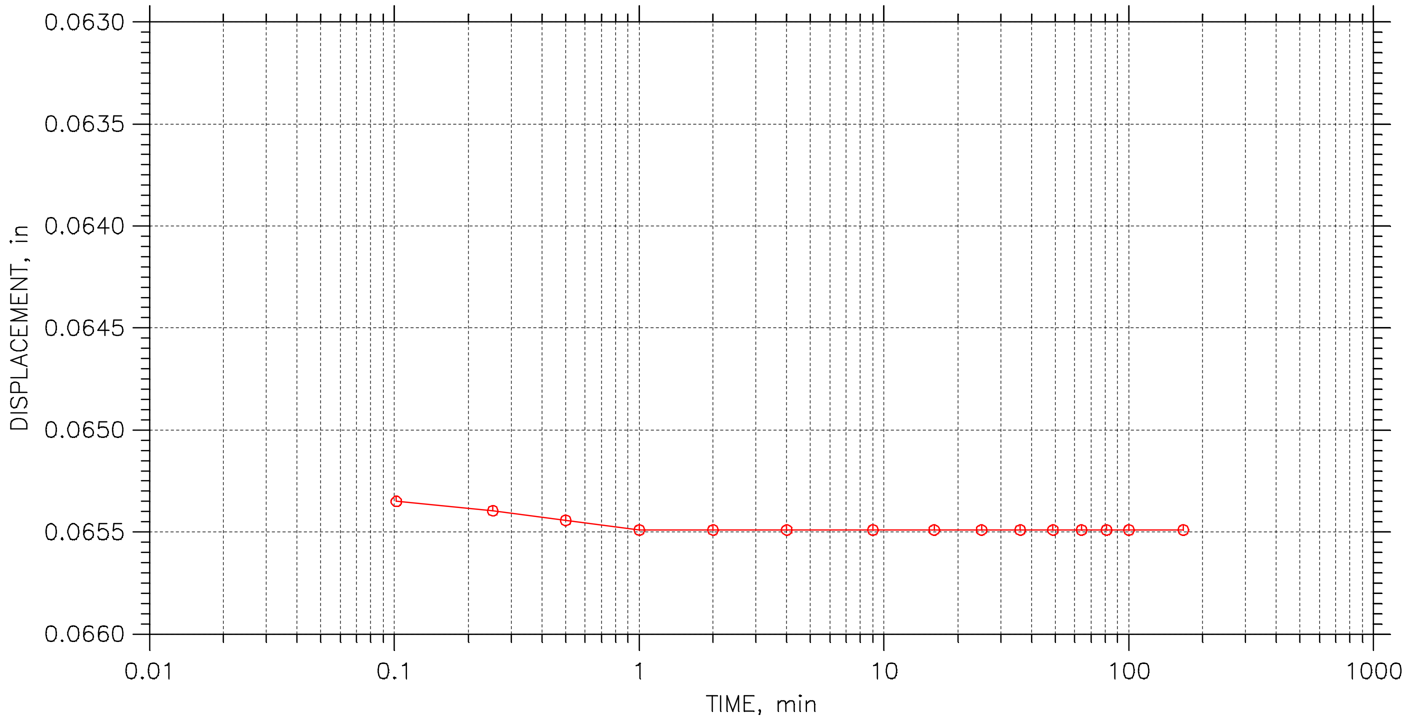
Tue, 26-APR-2016 10:11:58

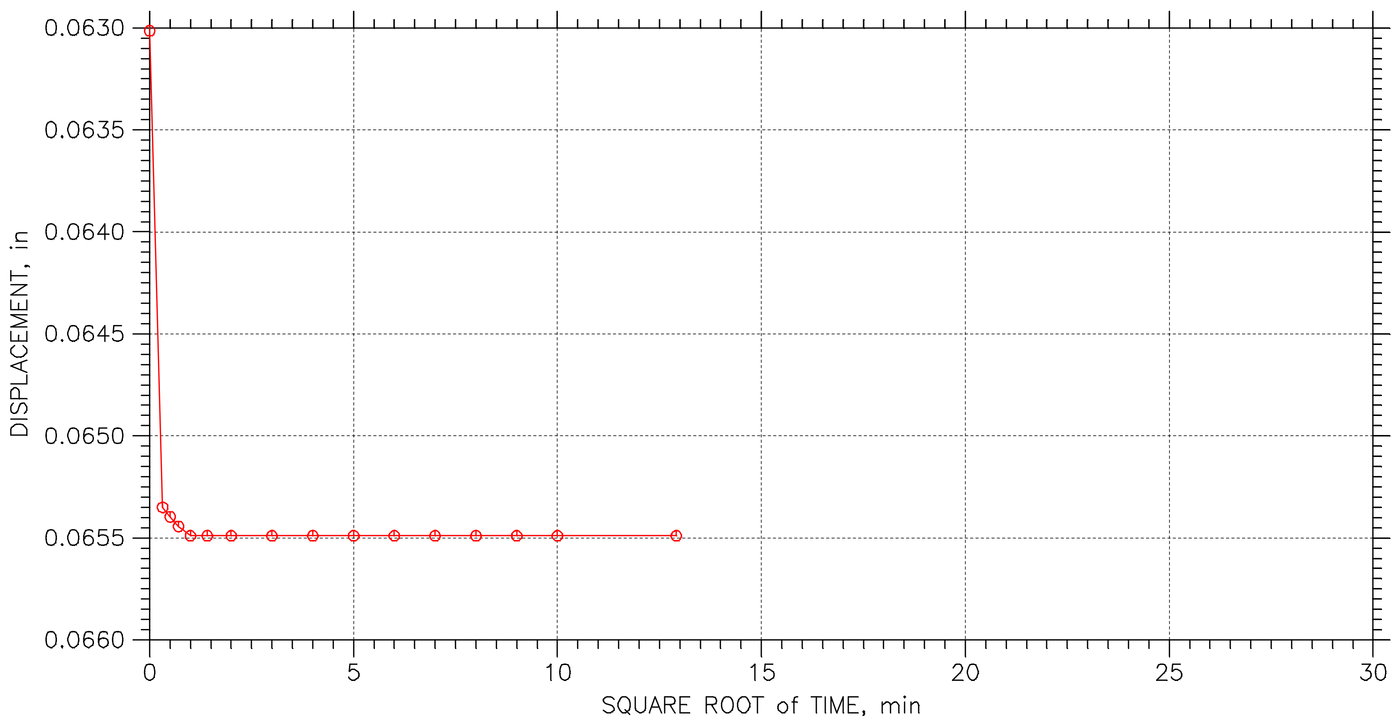
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 17 of 27

Stress: 1.5 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

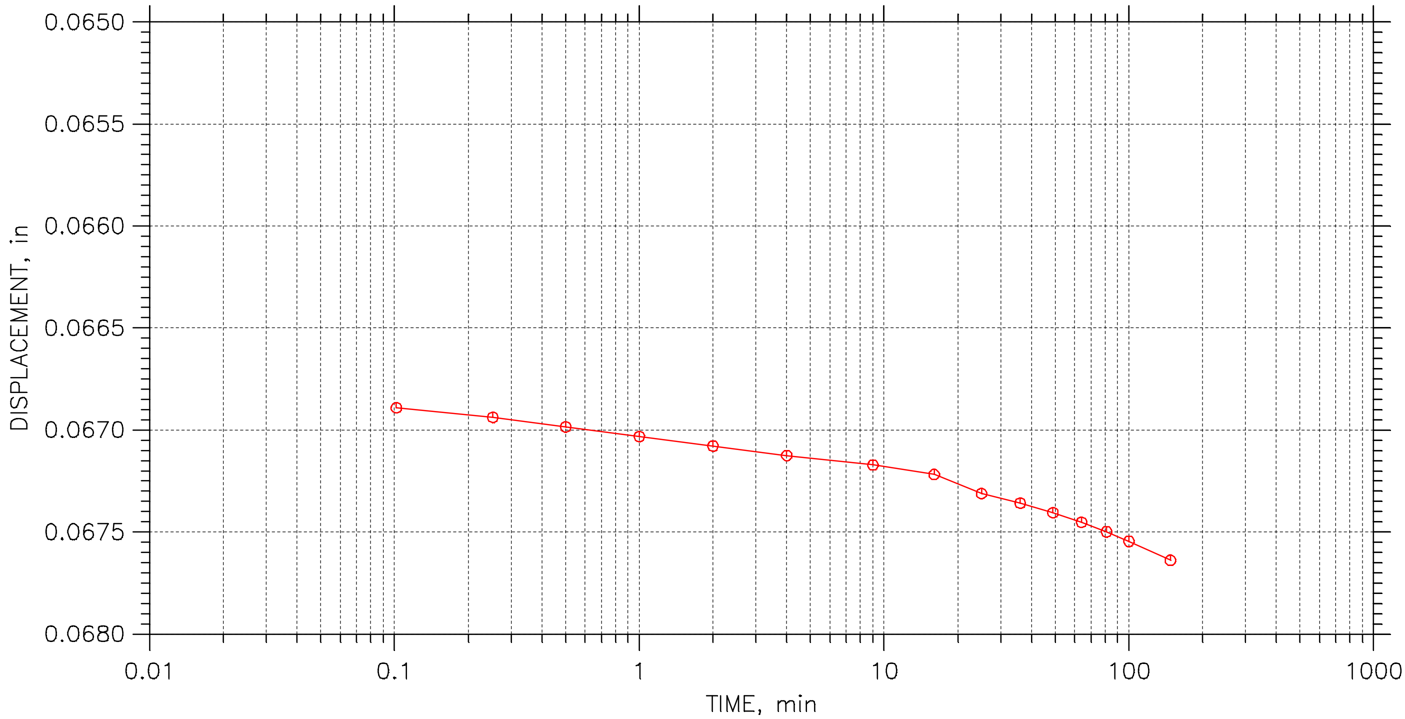
Tue, 26-APR-2016 10:12:00

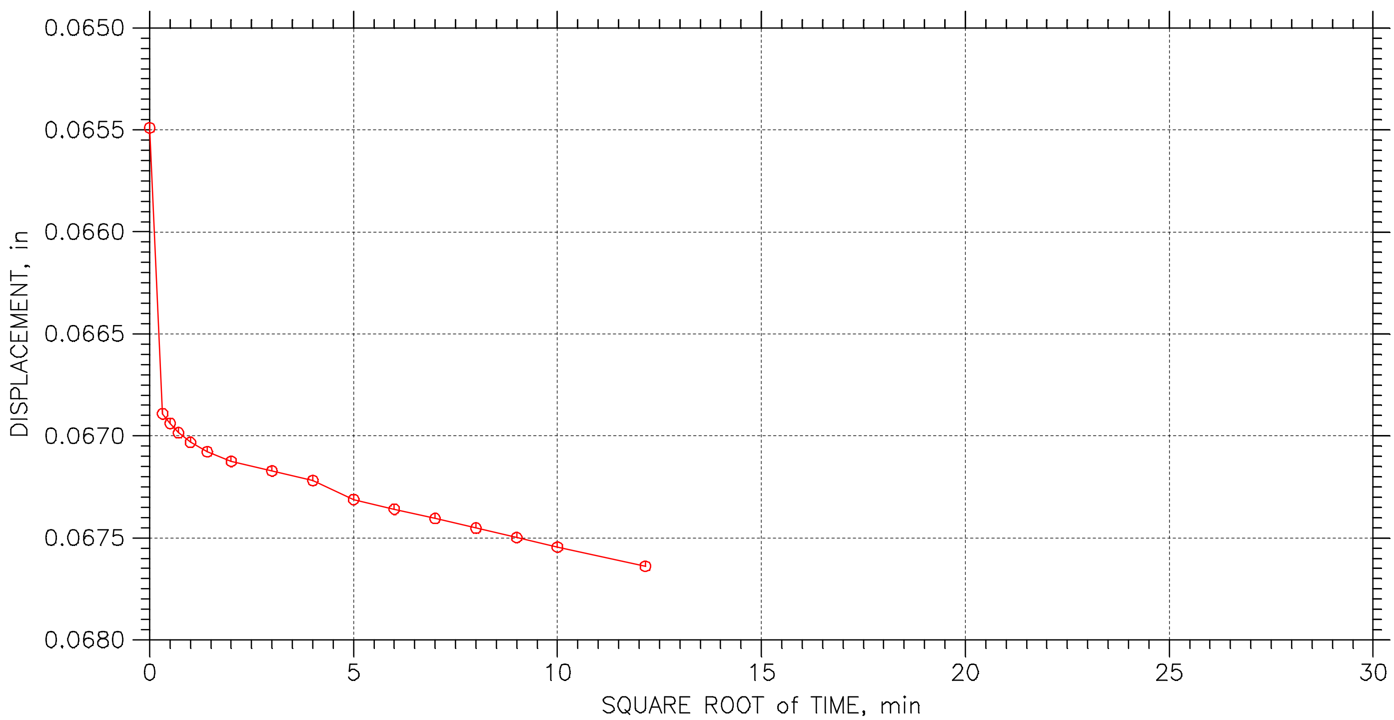
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 18 of 27

Stress: 2. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

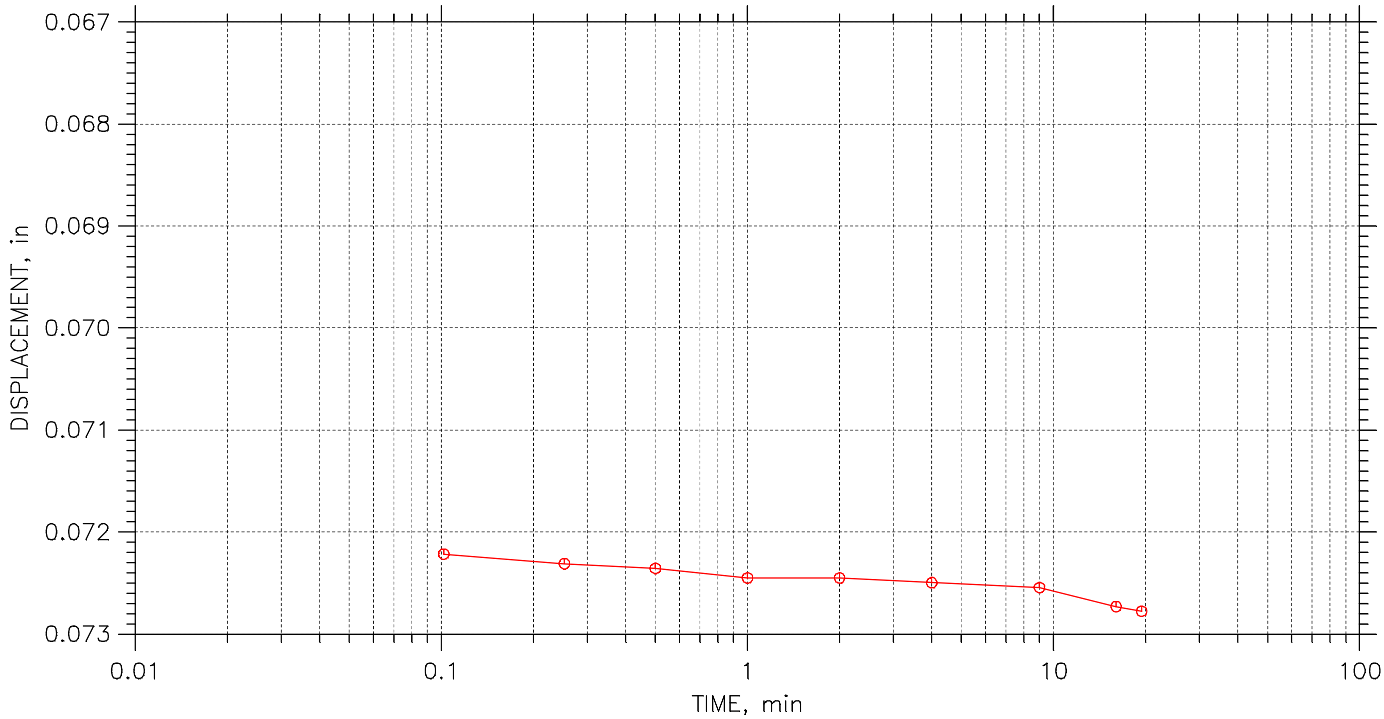
Tue, 26-APR-2016 10:12:01

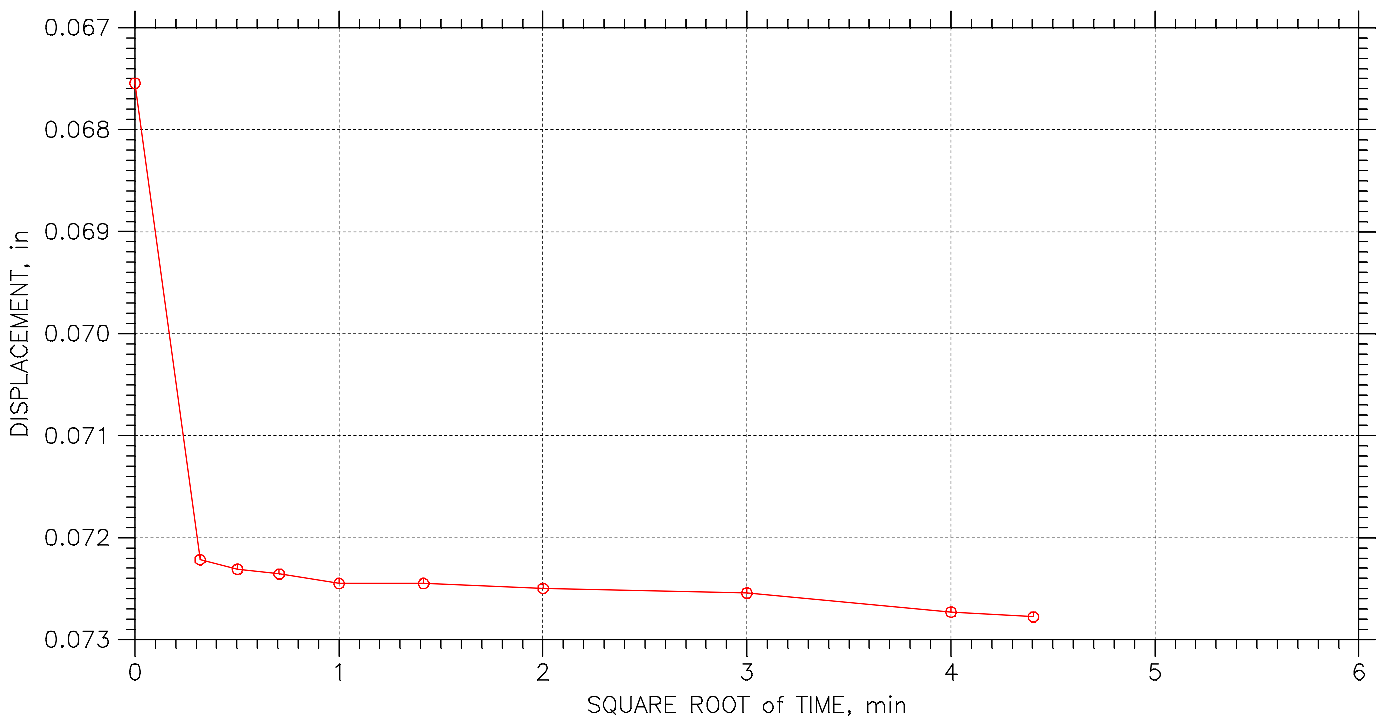
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 19 of 27

Stress: 4. tsf





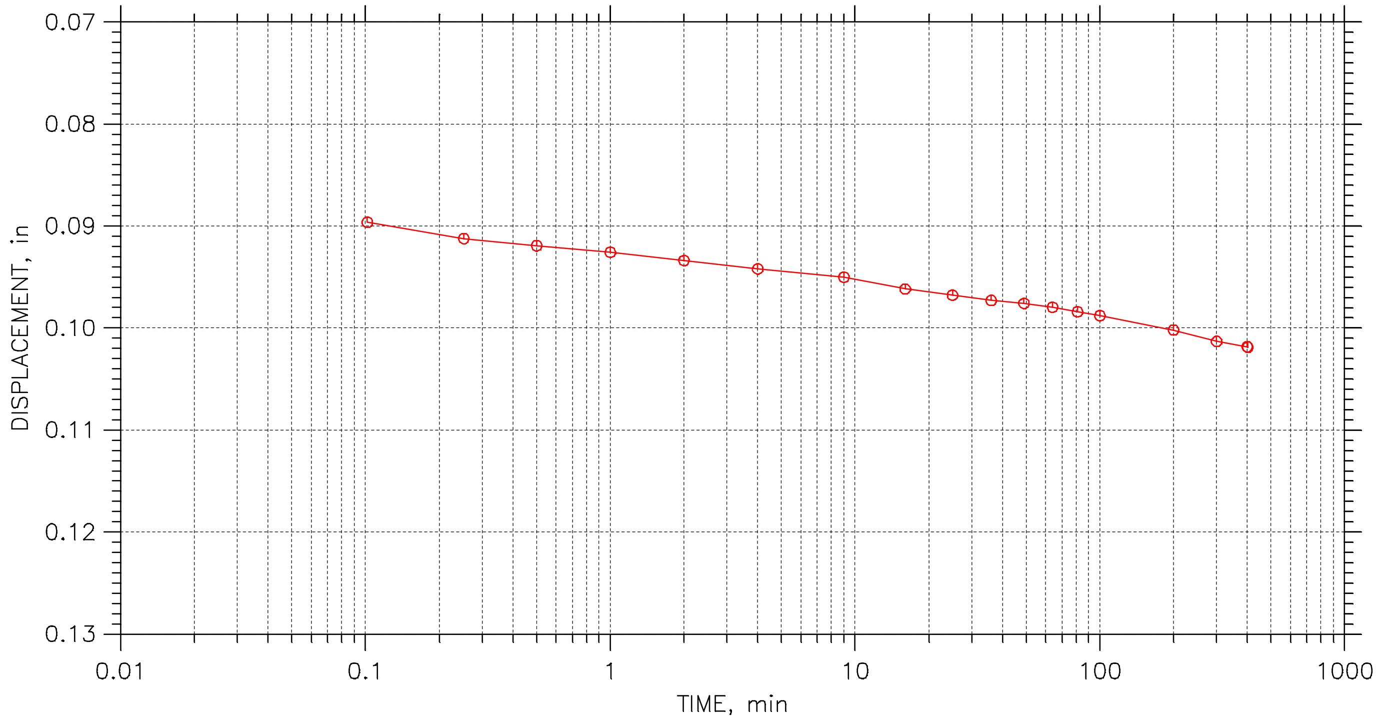
Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

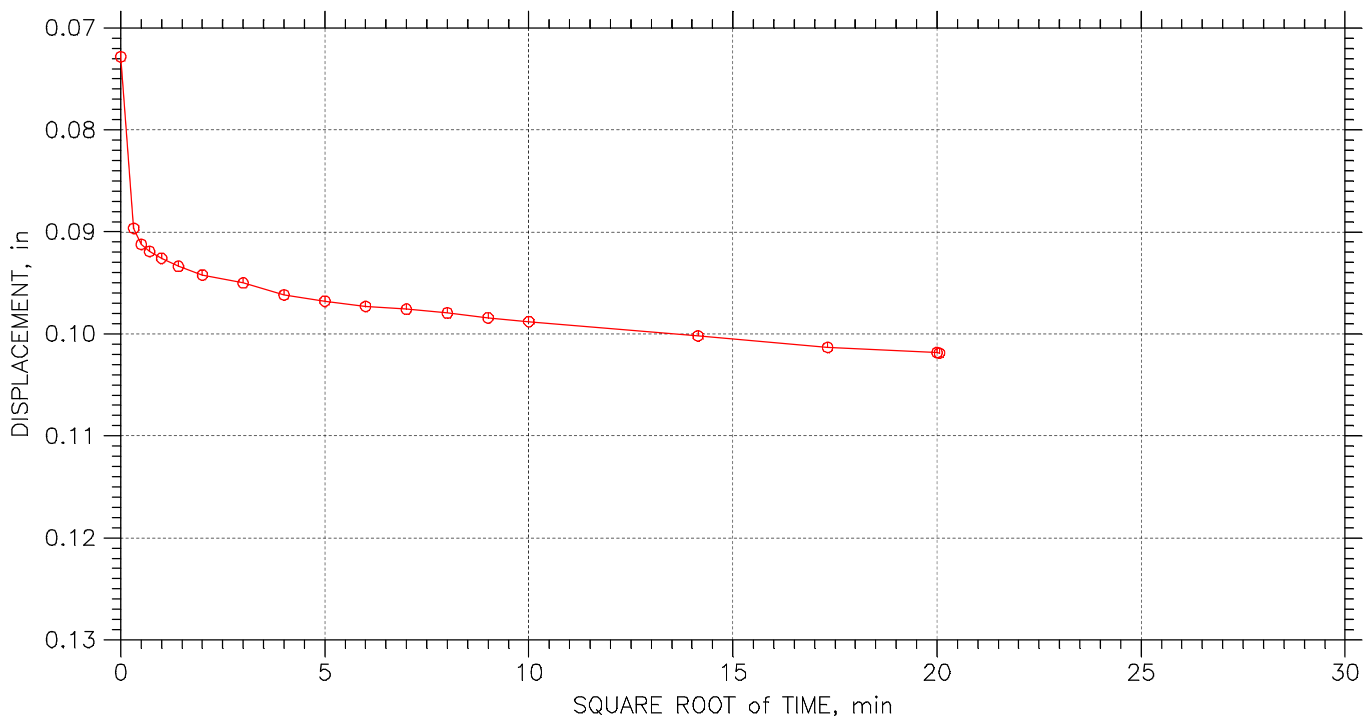
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 20 of 27

Stress: 8. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

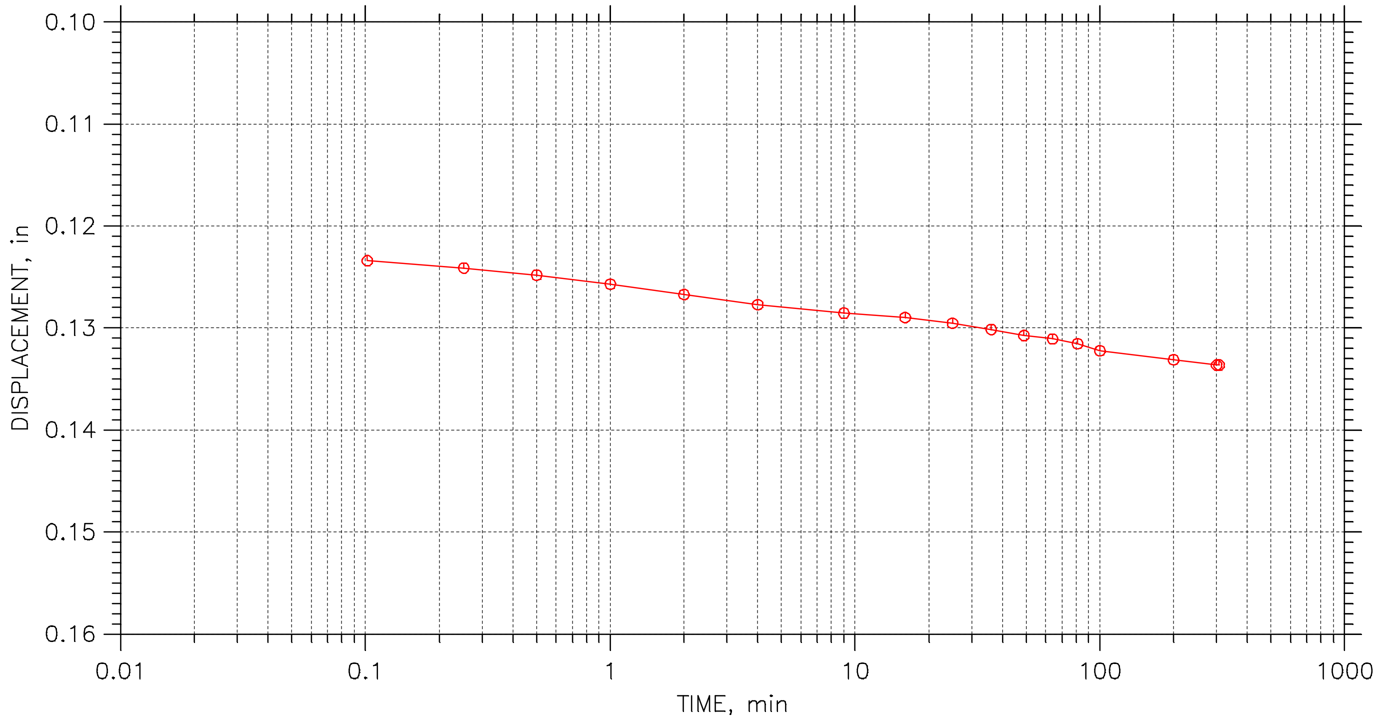
Tue, 26-APR-2016 10:12:04

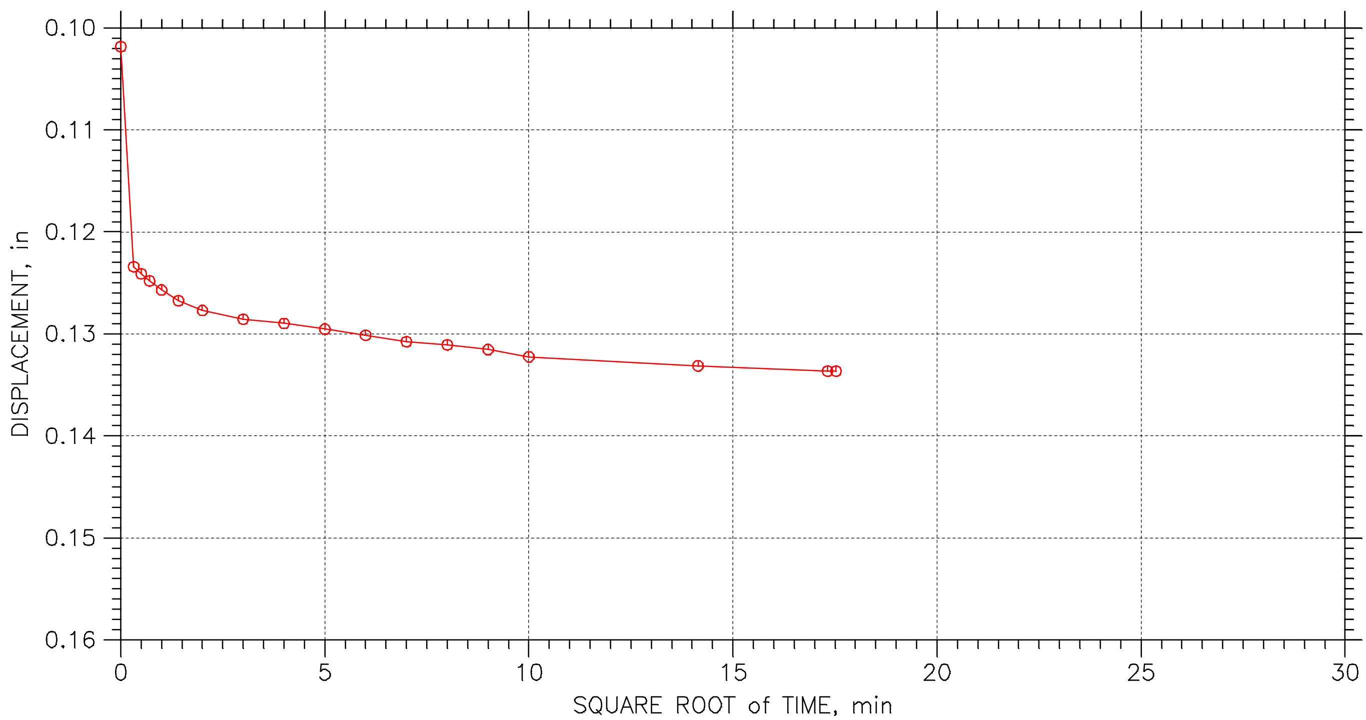
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 21 of 27

Stress: 16. tsf





	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

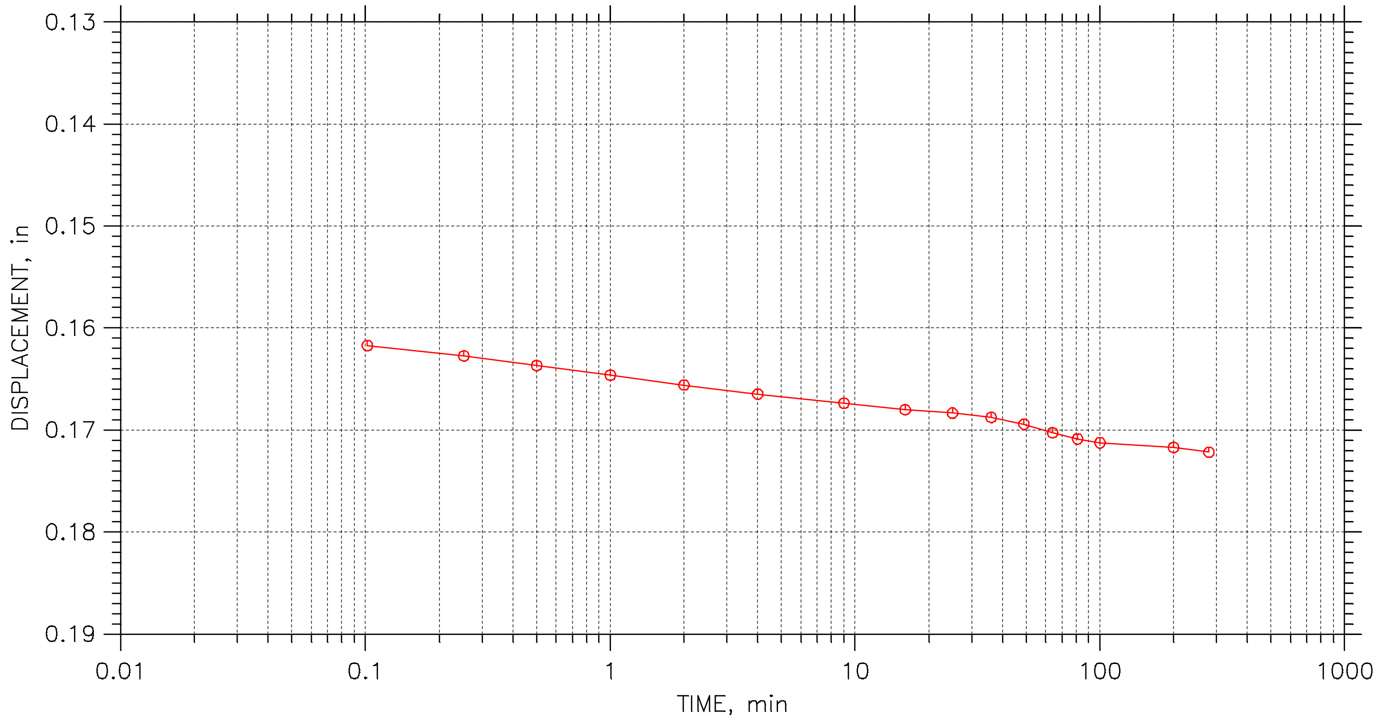
Tue, 26-APR-2016 10:12:06

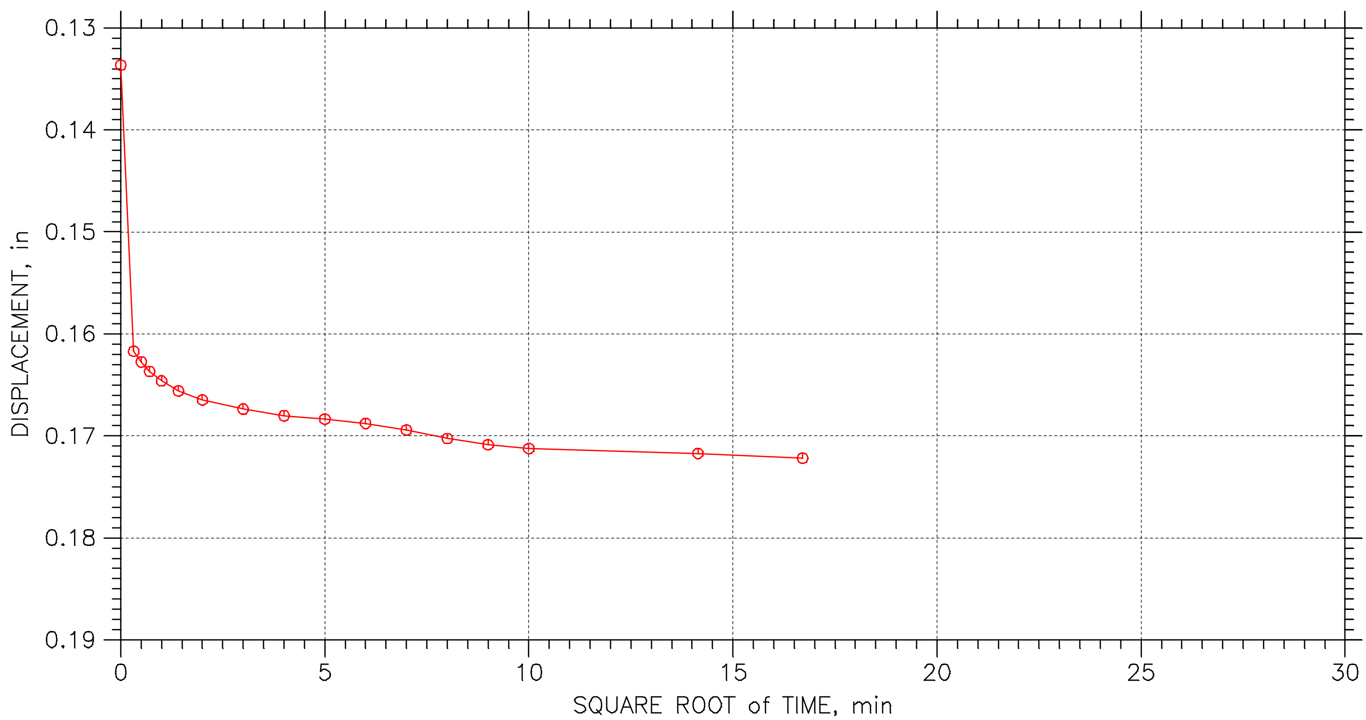
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 22 of 27

Stress: 32. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

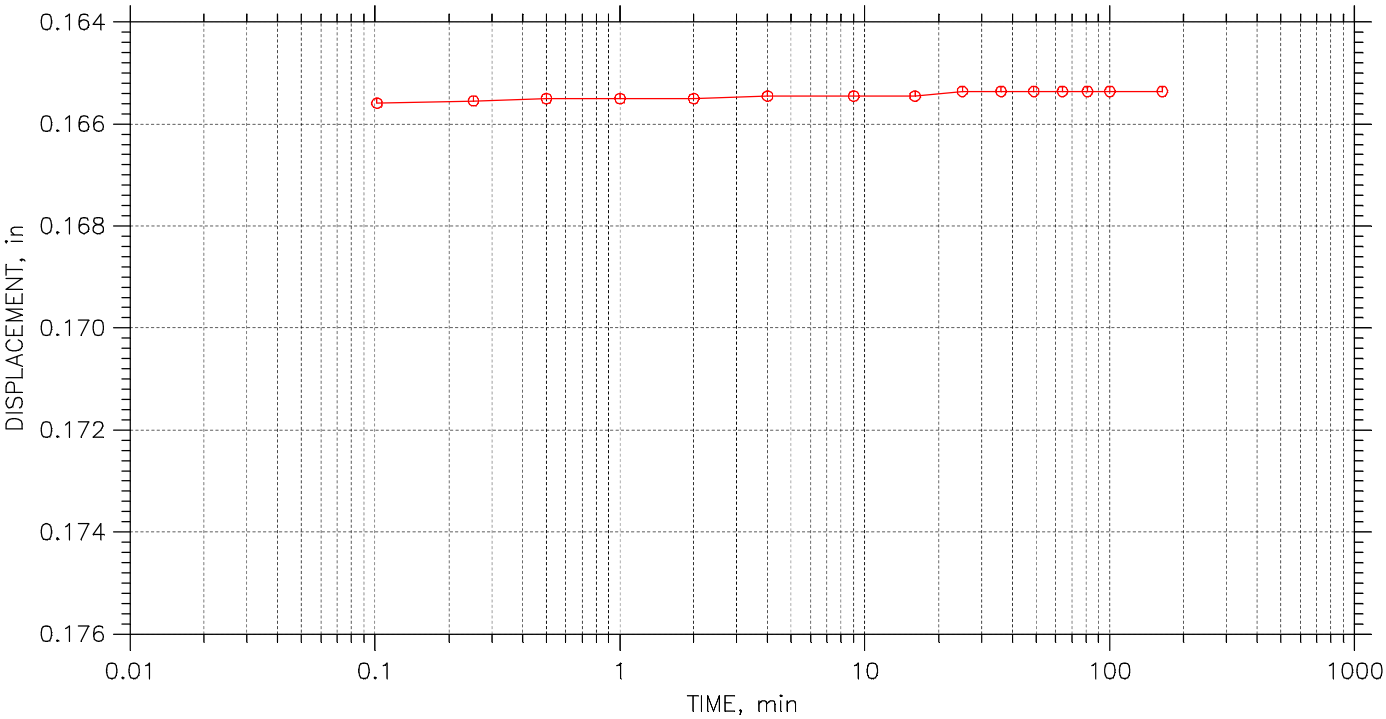
Tue, 26-APR-2016 10:12:07

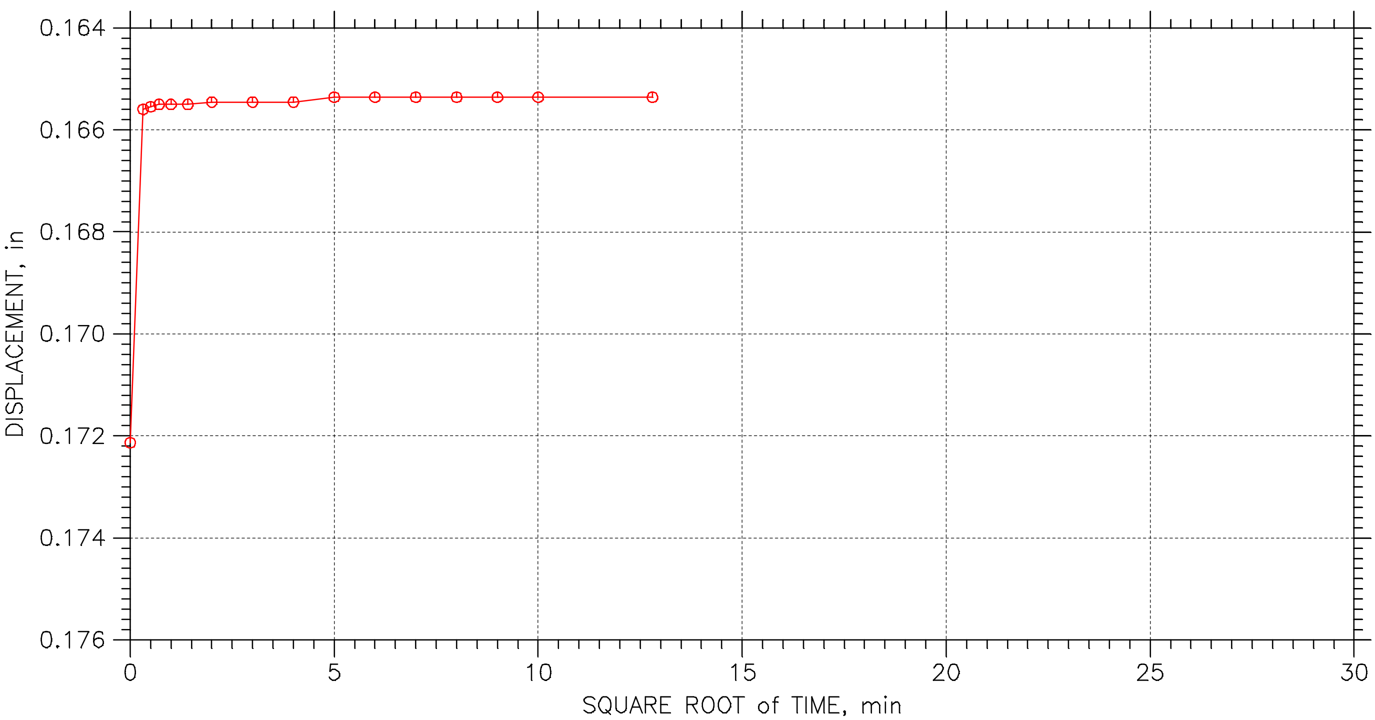
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 23 of 27

Stress: 16. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

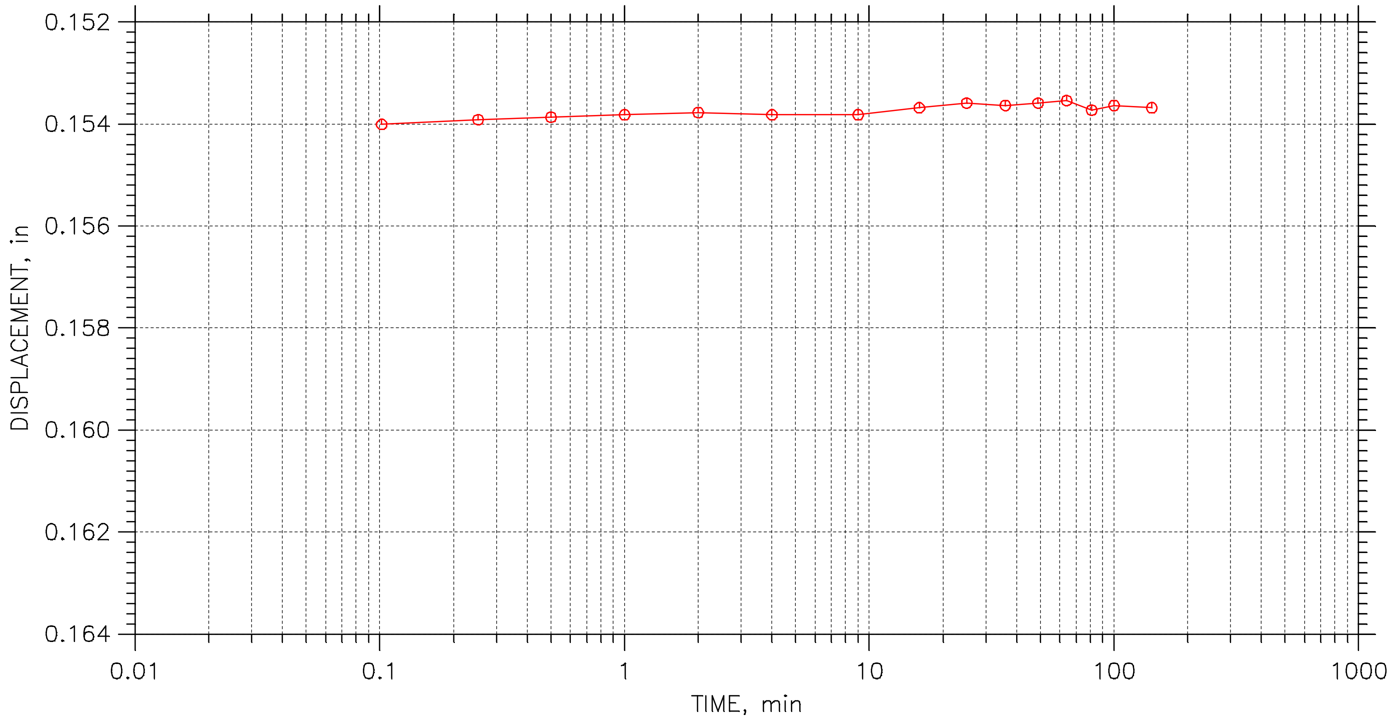
Tue, 26-APR-2016 10:12:08

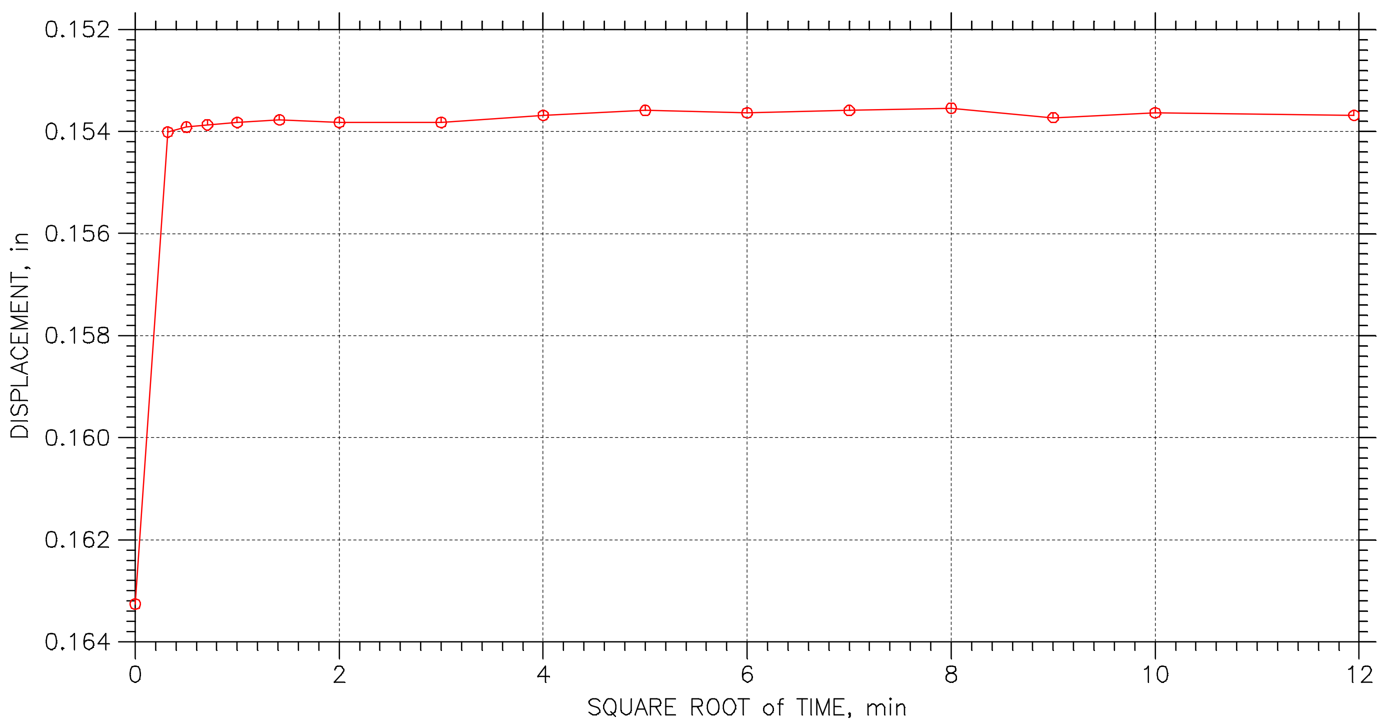
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 24 of 27

Stress: 4. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

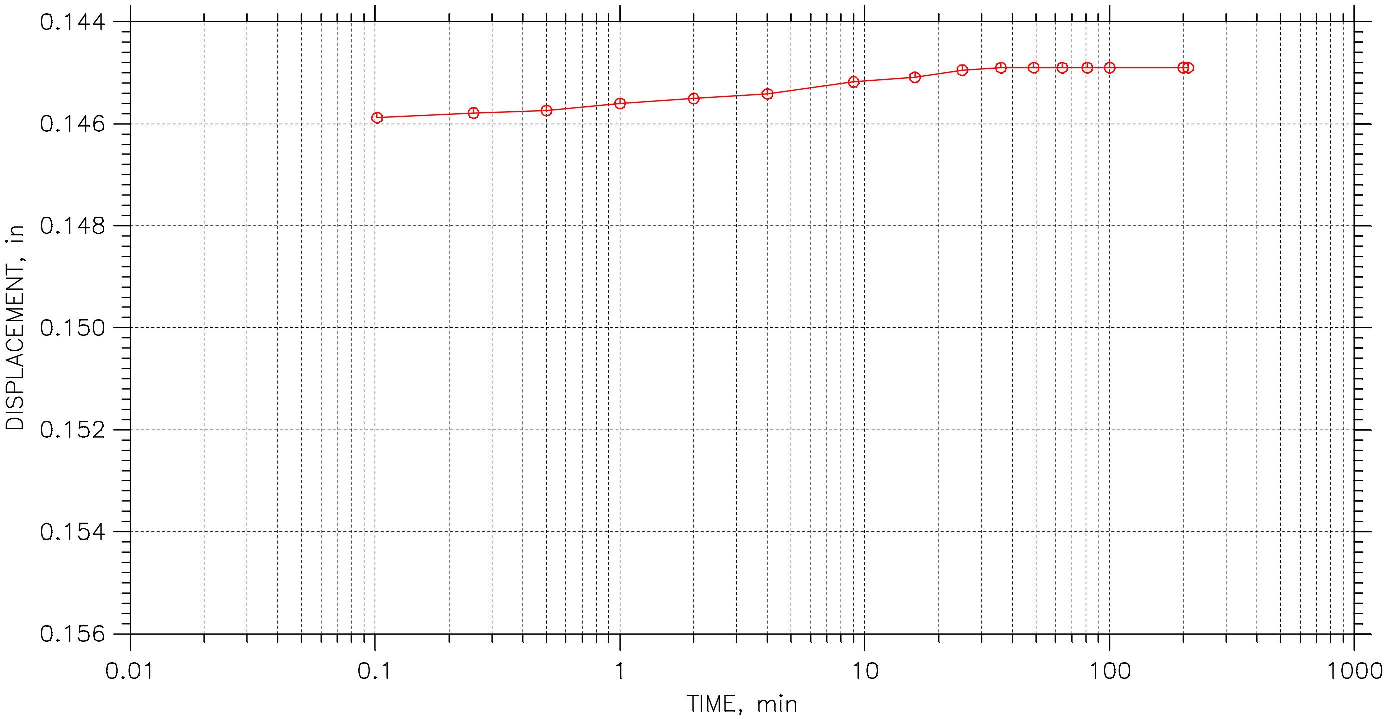
Tue, 26-APR-2016 10:12:10

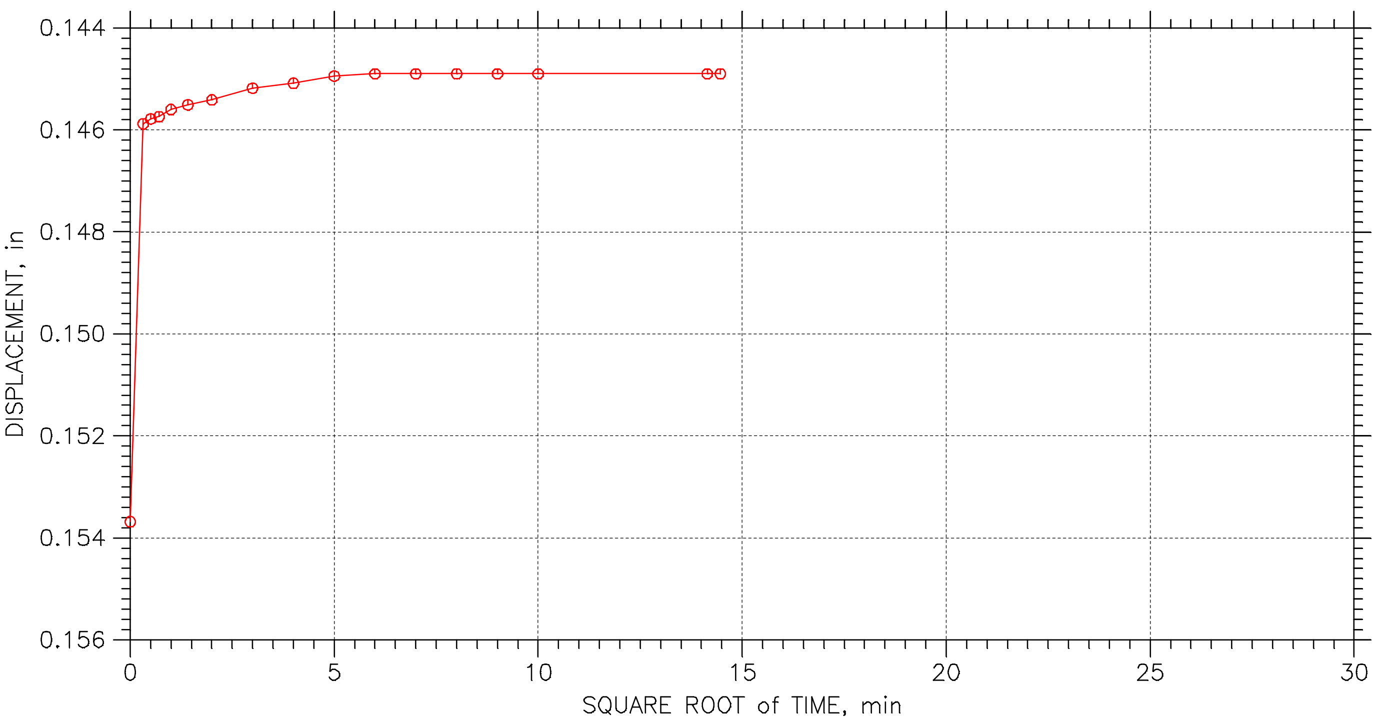
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 25 of 27

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

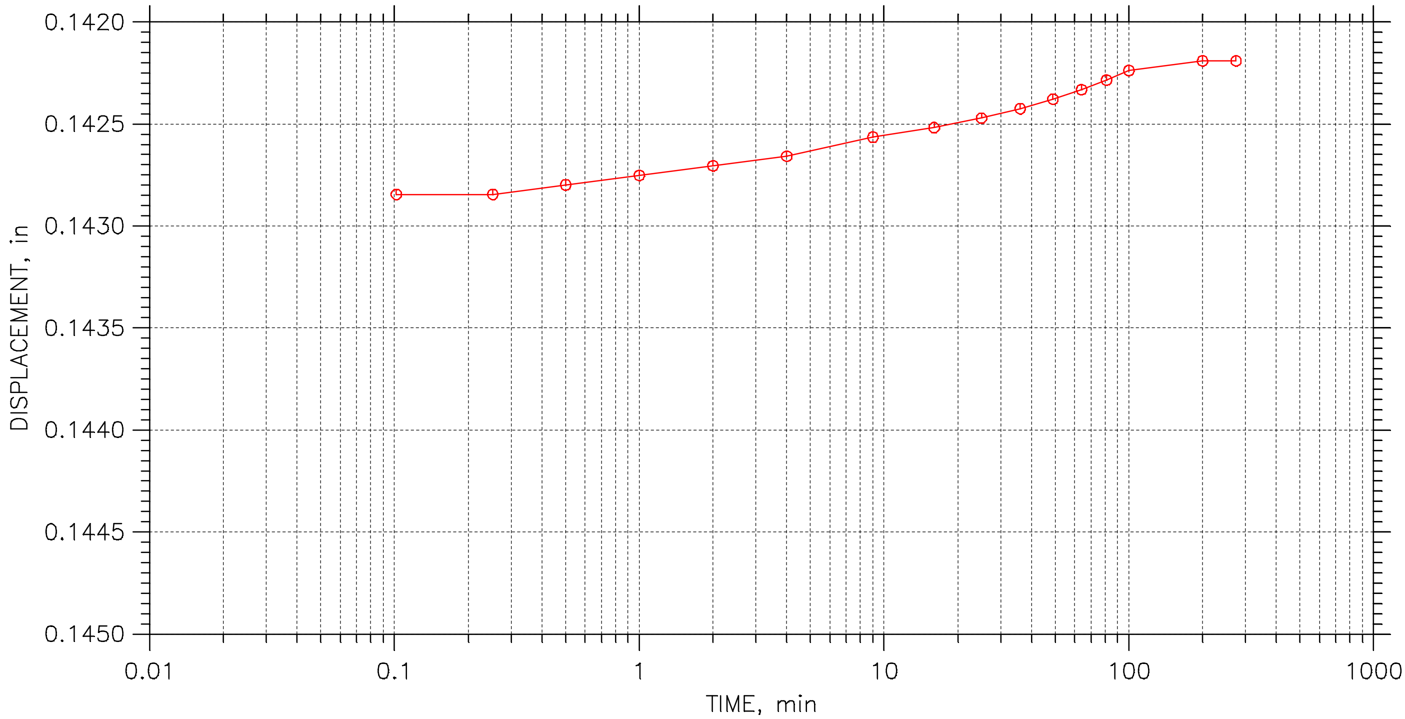
Tue, 26-APR-2016 10:12:11

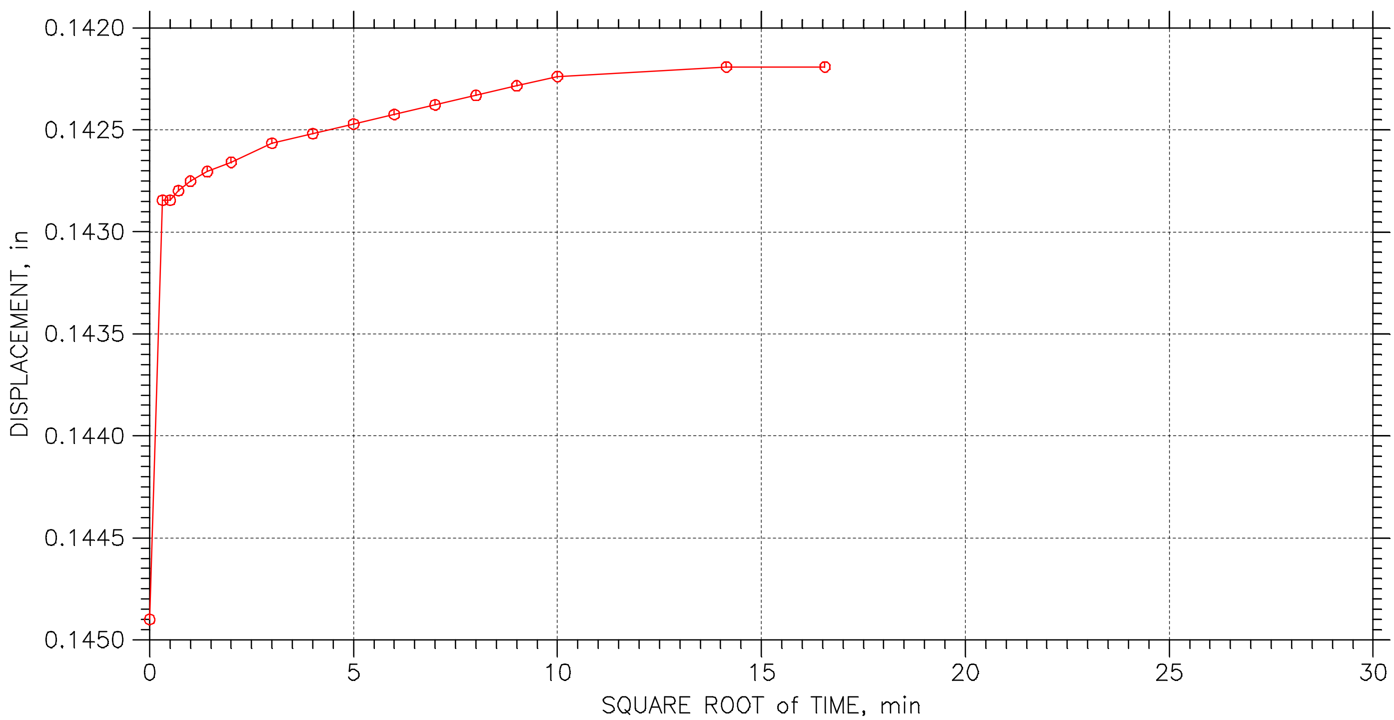
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 26 of 27

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

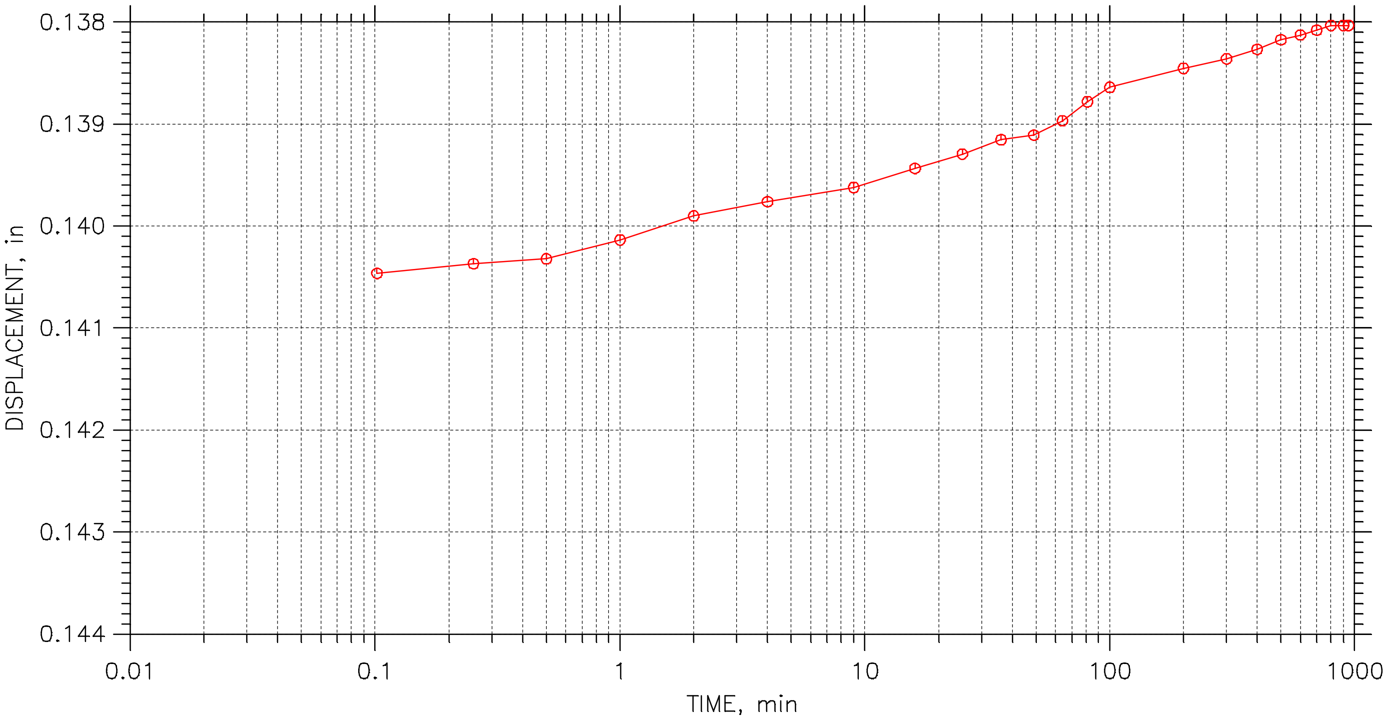
Tue, 26-APR-2016 10:12:13

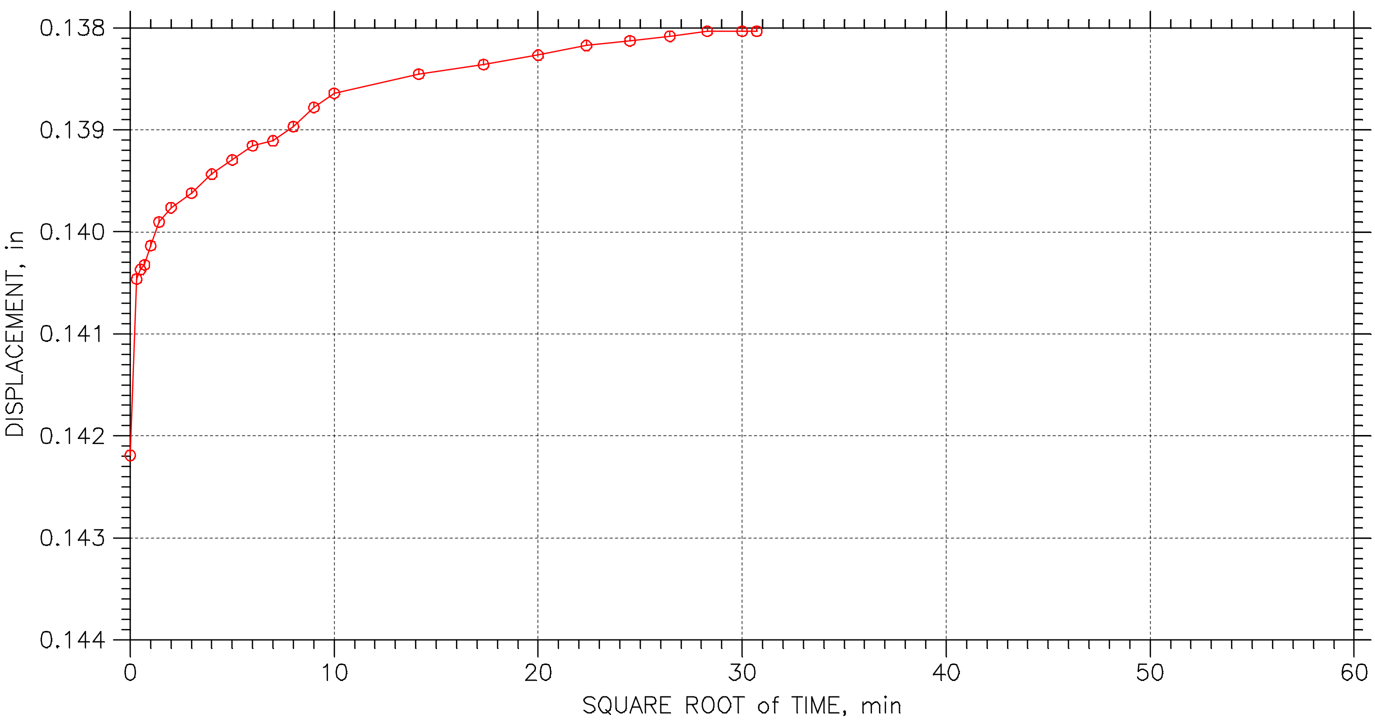
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 27 of 27

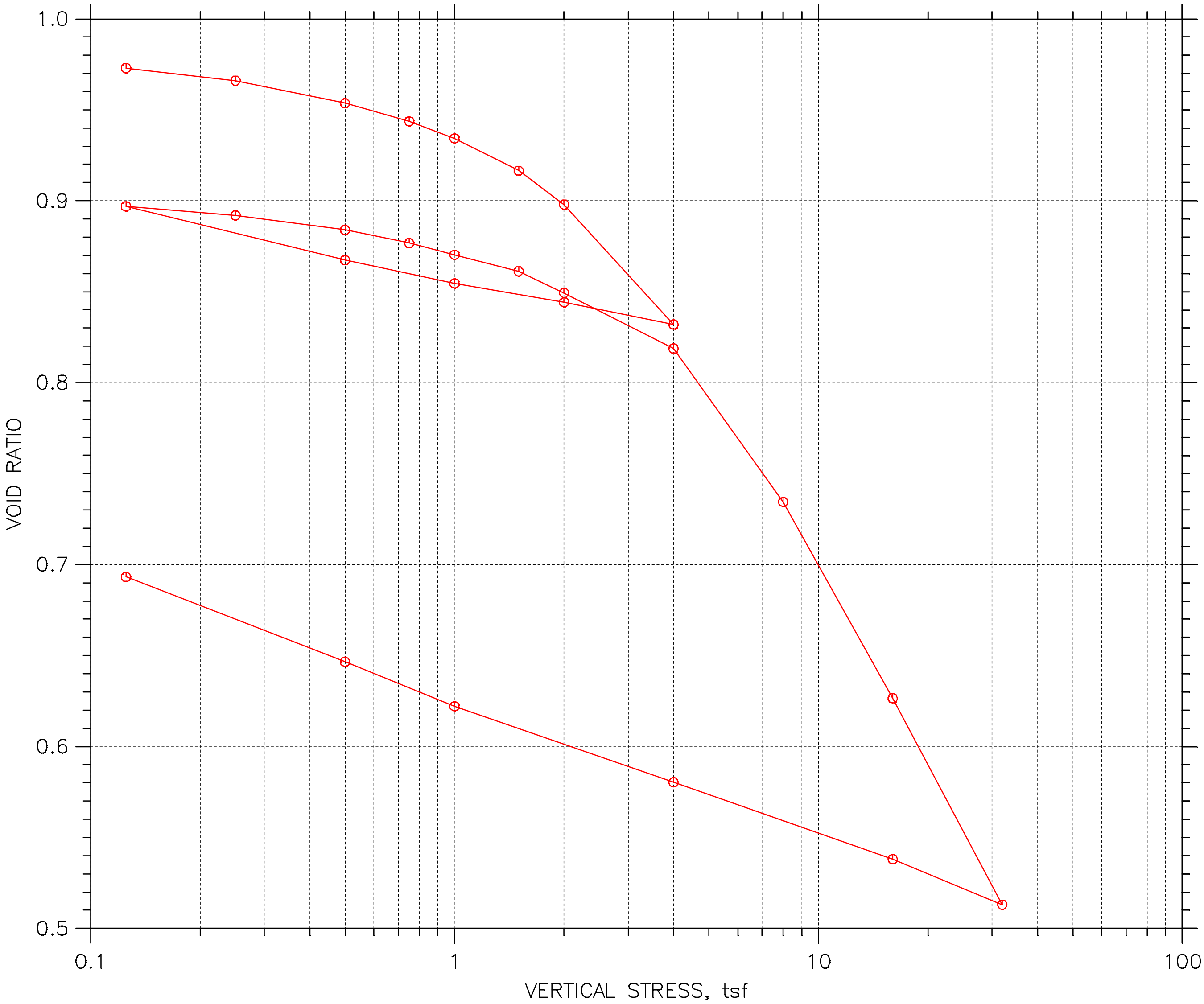
Stress: 0.125 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY		
	Remarks: Pc = 2.0 tsf Cc = 0.392 Ccr = 0.014 TEST PERFORMED AS PER ASTM D2435		

ONE DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS
USING INCREMENTAL LOADING
ASTM D2435

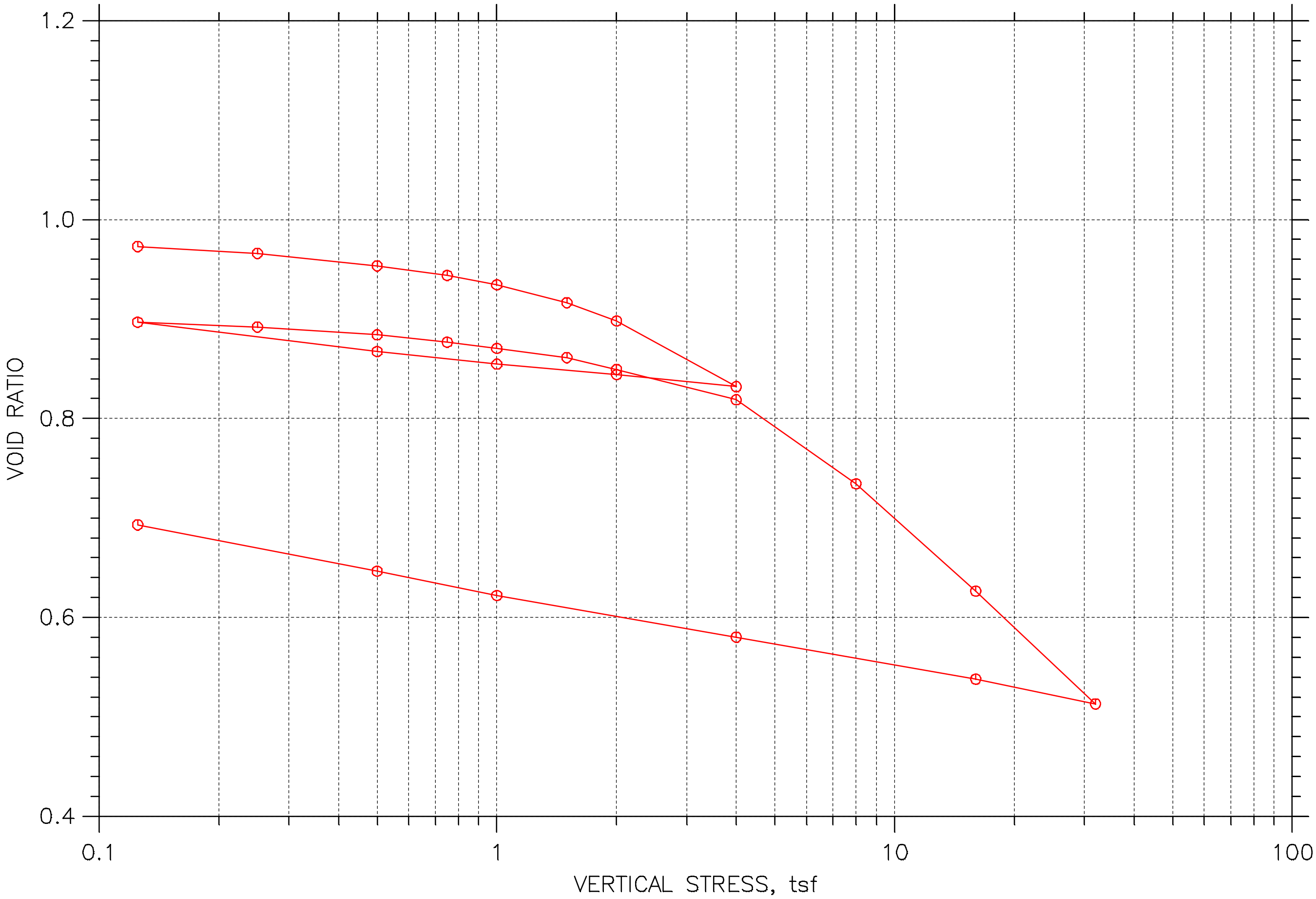


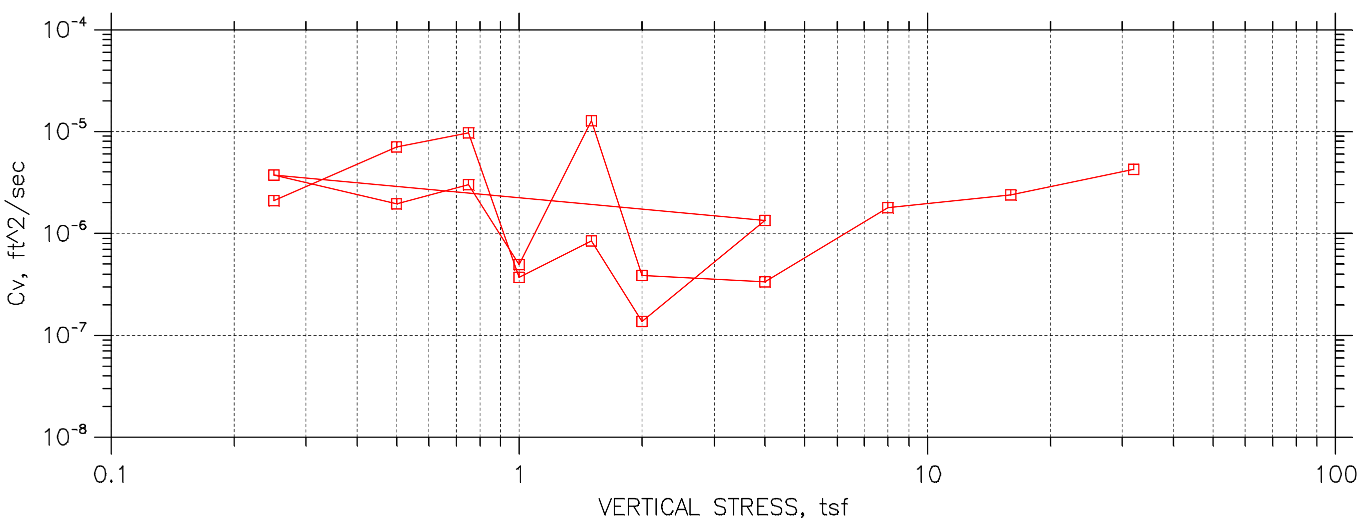
				Before Test	After Test
Overburden Pressure: 2.2 tsf					
			Water Content, %	33.45	25.14
Preconsolidation Pressure: 2.7 tsf			Dry Unit Weight, pcf	86.04	100.3
			Saturation, %	93.45	98.65
Diameter: 2.504 in	Height: 0.7476 in		Void Ratio	0.97	0.69
LL: 35	PL: 20	PI: 15	GS: 2.72		

Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

Tue, 26-APR-2016 10:21:34

ONE DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS
USING INCREMENTAL LOADING
ASTM D2435





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

Tue, 26-APR-2016 10:19:13

CONSOLIDATION TEST DATA

Terracon Consulting Engineers & Scientists

Project: VECTREN CULLEY E POND
Location: NEWBURGH, IN
Project No.: AW165009
Boring No.: B16-1ST5
Tested By: BCM
Checked By: WPQ
Sample No.: ST-5
Test Date: 04/14/16
Depth: 49.0'-51.0'
Test No.: B161ST5CON
Sample Type: 3.0" ST
Elevation: ----

Soil Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL
Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435

Estimated Specific Gravity: 2.72
Liquid Limit: 35
Initial Height: 0.75 in
Initial Void Ratio: 0.97
Plastic Limit: 20
Specimen Diameter: 2.50 in
Final Void Ratio: 0.69
Plasticity Index: 15

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	X7	RING	RING	X-9
Wt. Container + Wet Soil, gm	188.06	190.88	183.97	147.75
Wt. Container + Dry Soil, gm	153.22	163.06	163.06	126.95
Wt. Container, gm	44.54	79.89	79.89	44.22
Wt. Dry Soil, gm	108.68	83.17	83.17	82.73
Water Content, %	32.06	33.45	25.14	25.14
Void Ratio	---	0.97	0.69	---
Degree of Saturation, %	---	93.45	98.65	---
Dry Unit Weight, pcf	---	86.035	100.29	---

CONSOLIDATION TEST DATA

Terracon
Consulting Engineers & Scientists

Project: VECTREN CULLEY E POND
Location: NEWBURGH, IN
Project No.: AW165009
Boring No.: B16-1ST5
Tested By: BCM
Checked By: WPQ
Sample No.: ST-5
Test Date: 04/14/16
Depth: 49.0'-51.0'
Test No.: B161ST5CON
Sample Type: 3.0" ST
Elevation: ----

Soil Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL
Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435

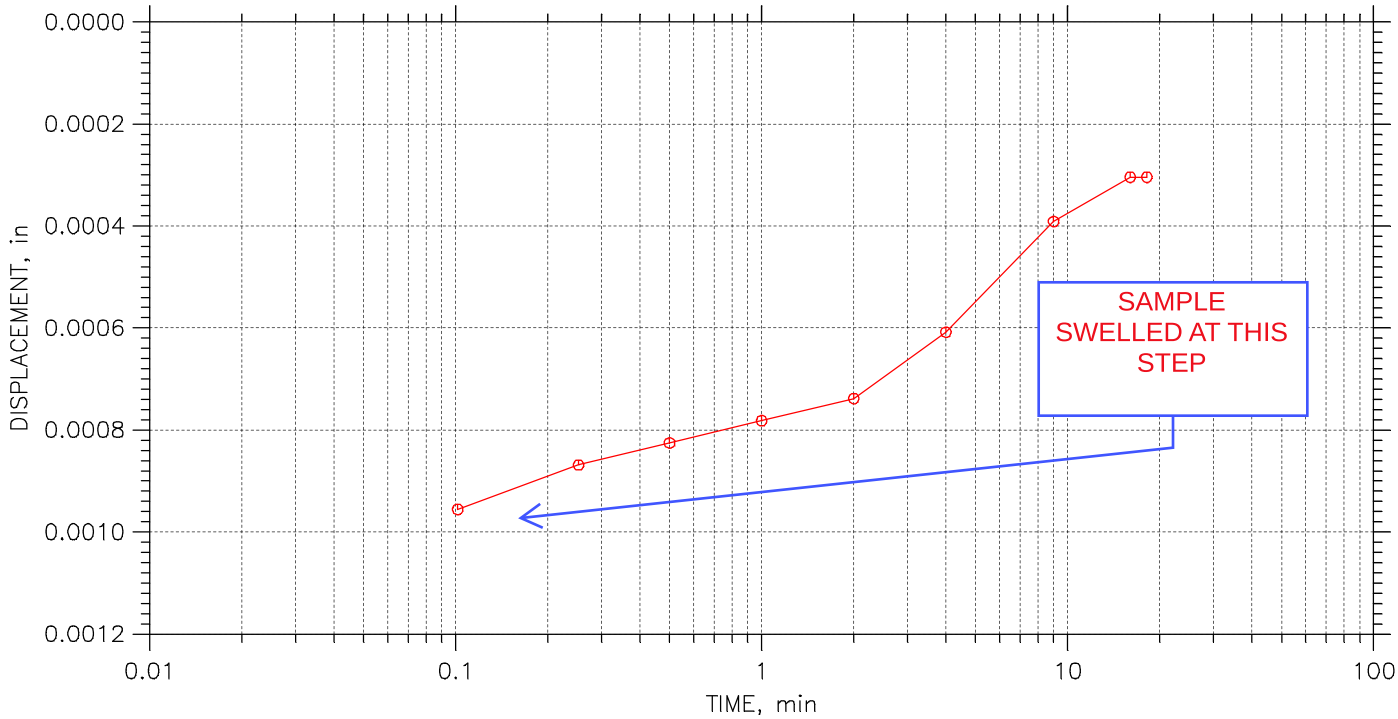
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	T50 Fitting Sq.Rt. min	T50 Fitting Log min	Coefficient of Consolidation Sq.Rt. ft^2/sec	Coefficient of Consolidation Log ft^2/sec	Coefficient of Consolidation Ave. ft^2/sec
1	0.125	0.0002606	0.973	0.03	0.0	0.0	0.00e+000	0.00e+000	0.00e+000
2	0.25	0.002867	0.966	0.38	1.5	0.0	2.09e-006	0.00e+000	2.09e-006
3	0.5	0.007601	0.954	1.02	0.4	0.0	7.06e-006	0.00e+000	7.06e-006
4	0.75	0.01134	0.944	1.52	0.5	0.2	6.49e-006	1.94e-005	9.73e-006
5	1	0.0149	0.934	1.99	14.6	2.1	2.11e-007	1.48e-006	3.69e-007
6	1.5	0.02163	0.917	2.89	3.6	0.0	8.44e-007	0.00e+000	8.44e-007
7	2	0.02867	0.898	3.83	21.7	0.0	1.37e-007	0.00e+000	1.37e-007
8	4	0.05369	0.832	7.18	3.9	0.4	7.32e-007	7.77e-006	1.34e-006
9	2	0.04904	0.844	6.56	0.5	0.0	6.03e-006	0.00e+000	6.03e-006
10	1	0.04513	0.855	6.04	1.5	0.0	1.82e-006	0.00e+000	1.82e-006
11	0.5	0.04026	0.867	5.39	2.4	0.0	1.16e-006	0.00e+000	1.16e-006
12	0.125	0.02906	0.897	3.89	3.8	0.0	7.55e-007	0.00e+000	7.55e-007
13	0.25	0.03093	0.892	4.14	0.8	0.0	3.73e-006	0.00e+000	3.73e-006
14	0.5	0.03397	0.884	4.54	1.5	0.0	1.96e-006	0.00e+000	1.96e-006
15	0.75	0.0367	0.877	4.91	1.0	0.0	2.99e-006	0.00e+000	2.99e-006
16	1	0.03914	0.870	5.23	5.8	0.0	4.93e-007	0.00e+000	4.93e-007
17	1.5	0.04257	0.861	5.69	0.2	0.0	1.27e-005	0.00e+000	1.27e-005
18	2	0.04708	0.849	6.30	7.3	0.0	3.87e-007	0.00e+000	3.87e-007
19	4	0.05868	0.819	7.85	8.2	0.0	3.37e-007	0.00e+000	3.37e-007
20	8	0.09061	0.734	12.12	2.1	0.8	1.23e-006	3.30e-006	1.79e-006
21	16	0.1315	0.626	17.59	1.4	0.6	1.68e-006	4.06e-006	2.38e-006
22	32	0.1745	0.513	23.34	0.5	0.0	4.24e-006	0.00e+000	4.24e-006
23	16	0.165	0.538	22.07	0.0	0.0	8.03e-005	0.00e+000	8.03e-005
24	4	0.149	0.580	19.93	0.1	0.0	2.13e-005	0.00e+000	2.13e-005
25	1	0.1332	0.622	17.81	2.1	0.0	1.00e-006	0.00e+000	1.00e-006
26	0.5	0.1239	0.647	16.57	29.6	0.0	7.39e-008	0.00e+000	7.39e-008
27	0.125	0.1062	0.693	14.21	43.3	29.9	5.27e-008	7.63e-008	6.24e-008

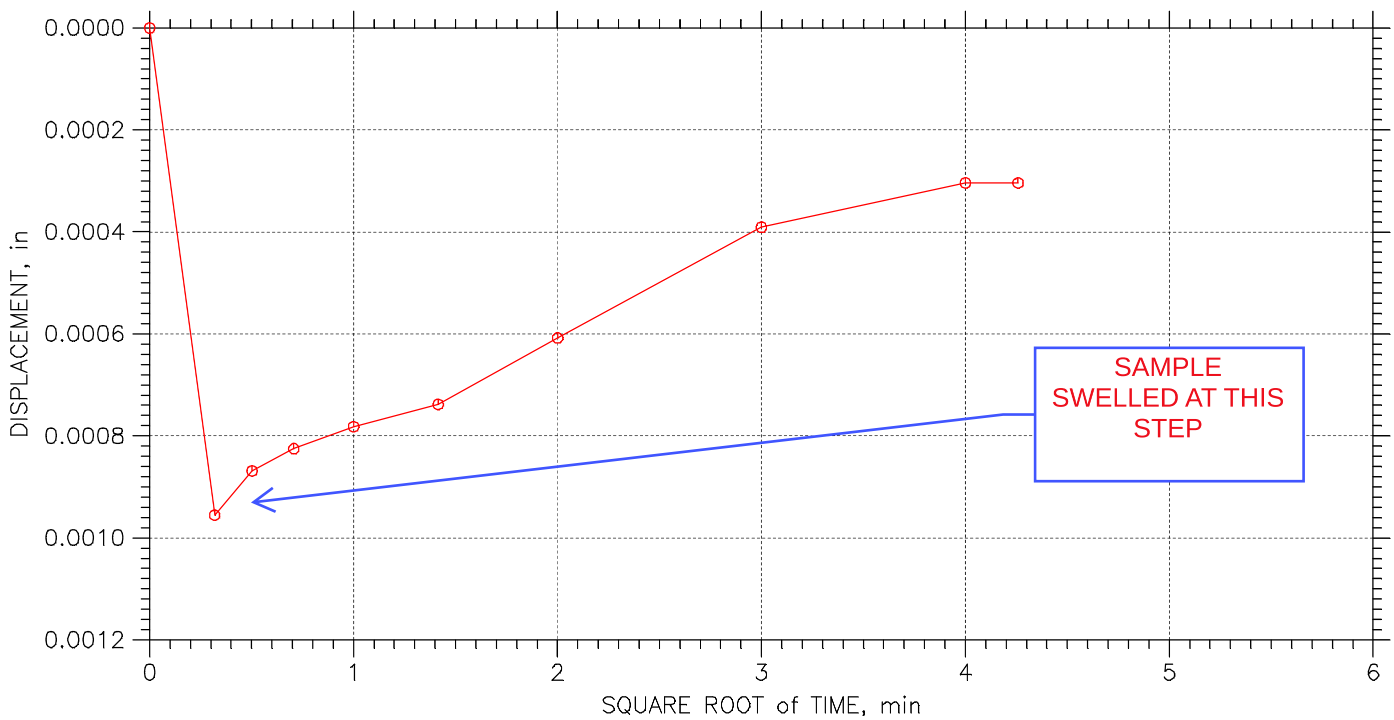
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 1 of 27

Stress: 0.125 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

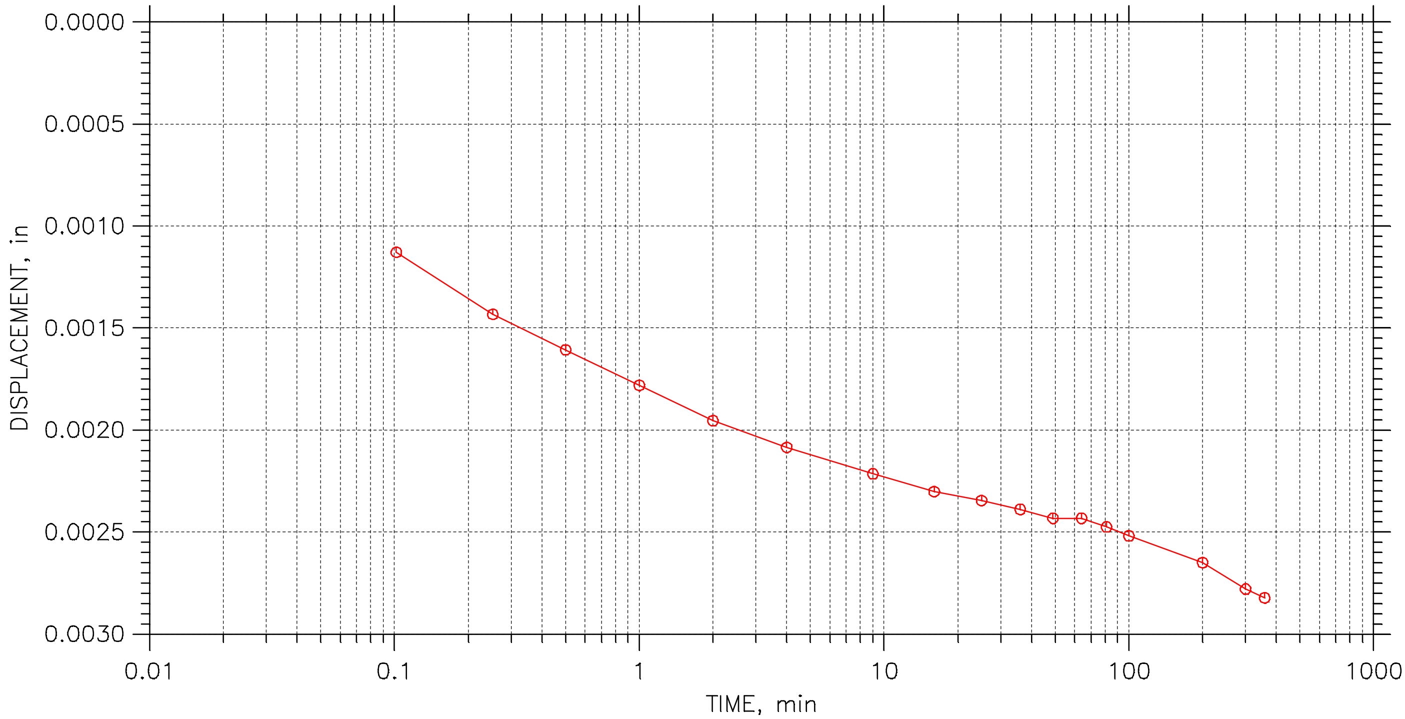
Tue, 26-APR-2016 10:51:59

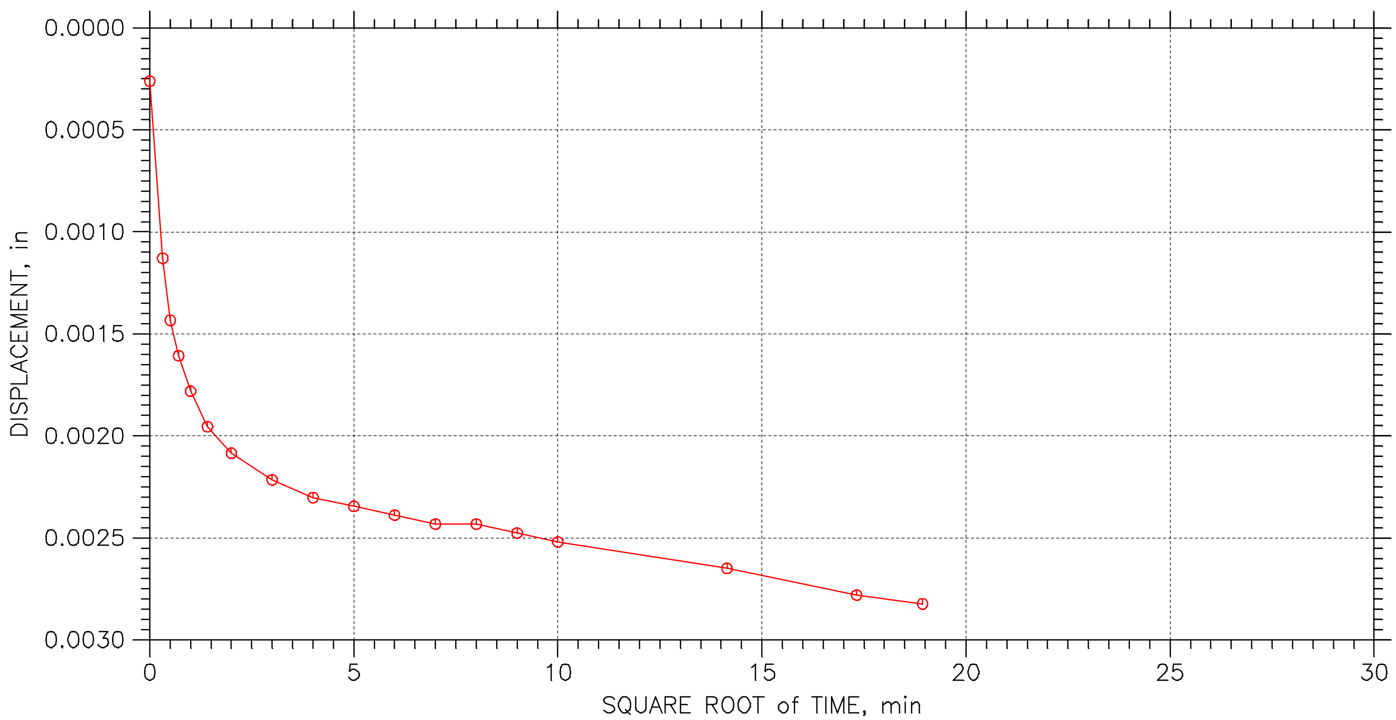
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 2 of 27

Stress: 0.25 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

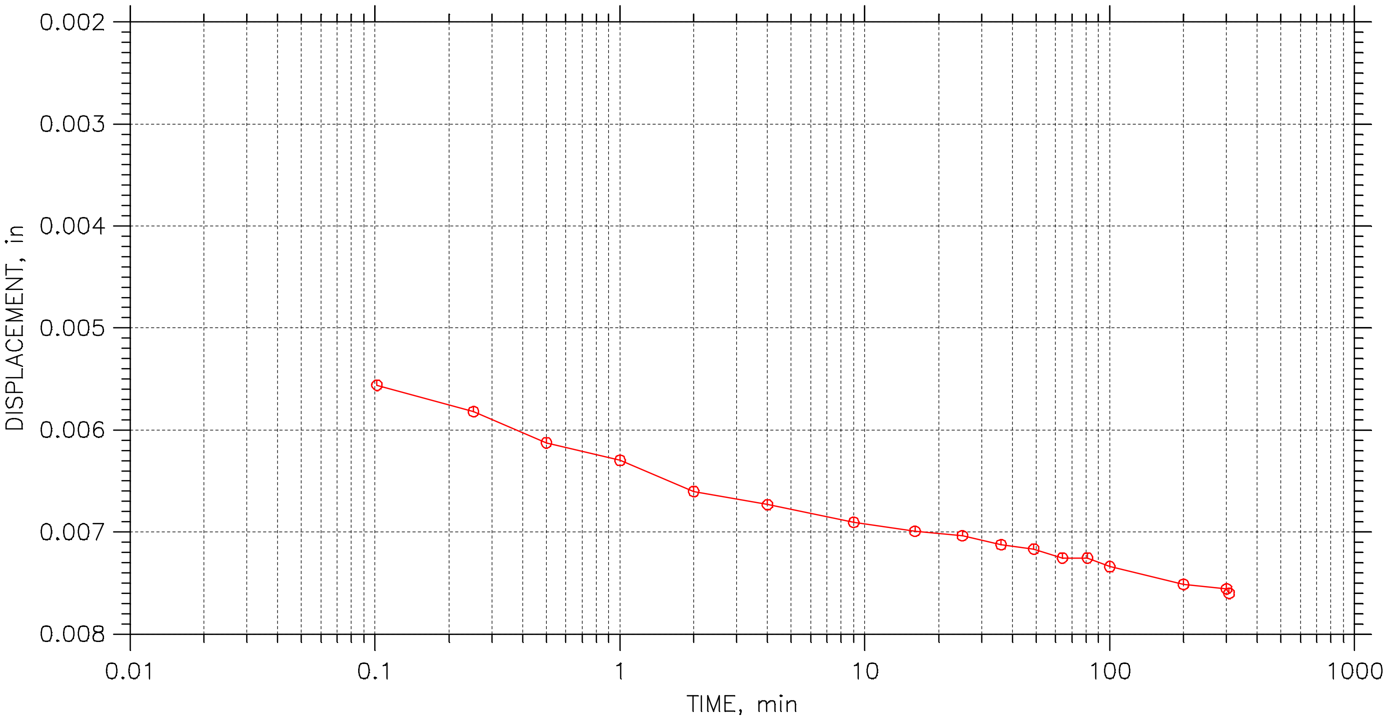
Tue, 26-APR-2016 10:52:01

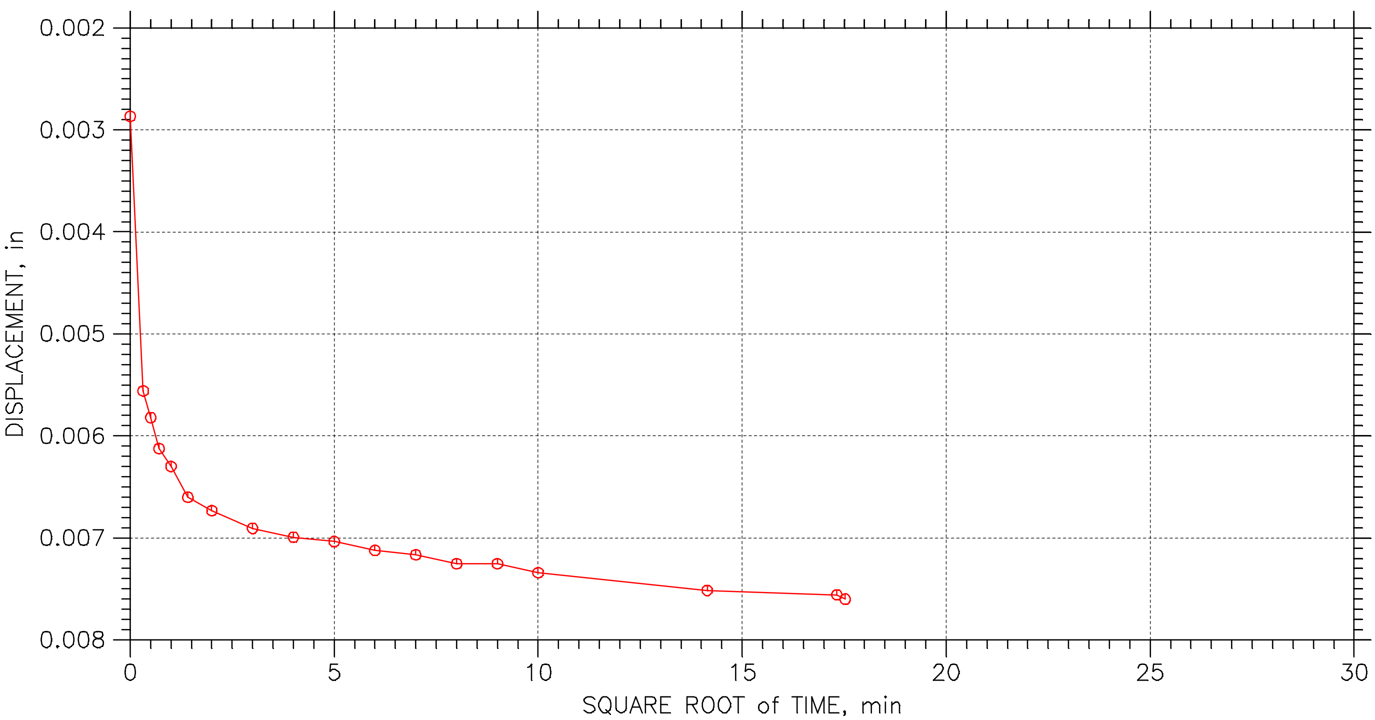
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 3 of 27

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0" ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

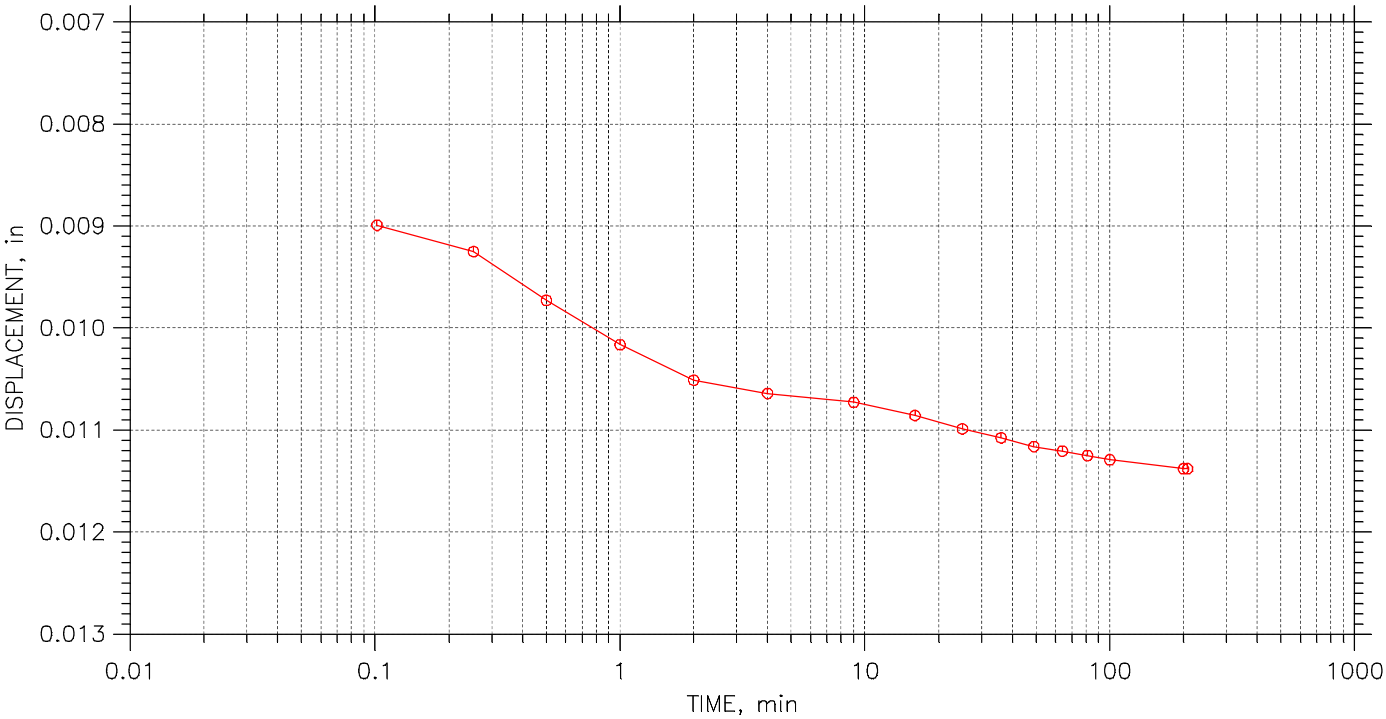
Tue, 26-APR-2016 10:52:02

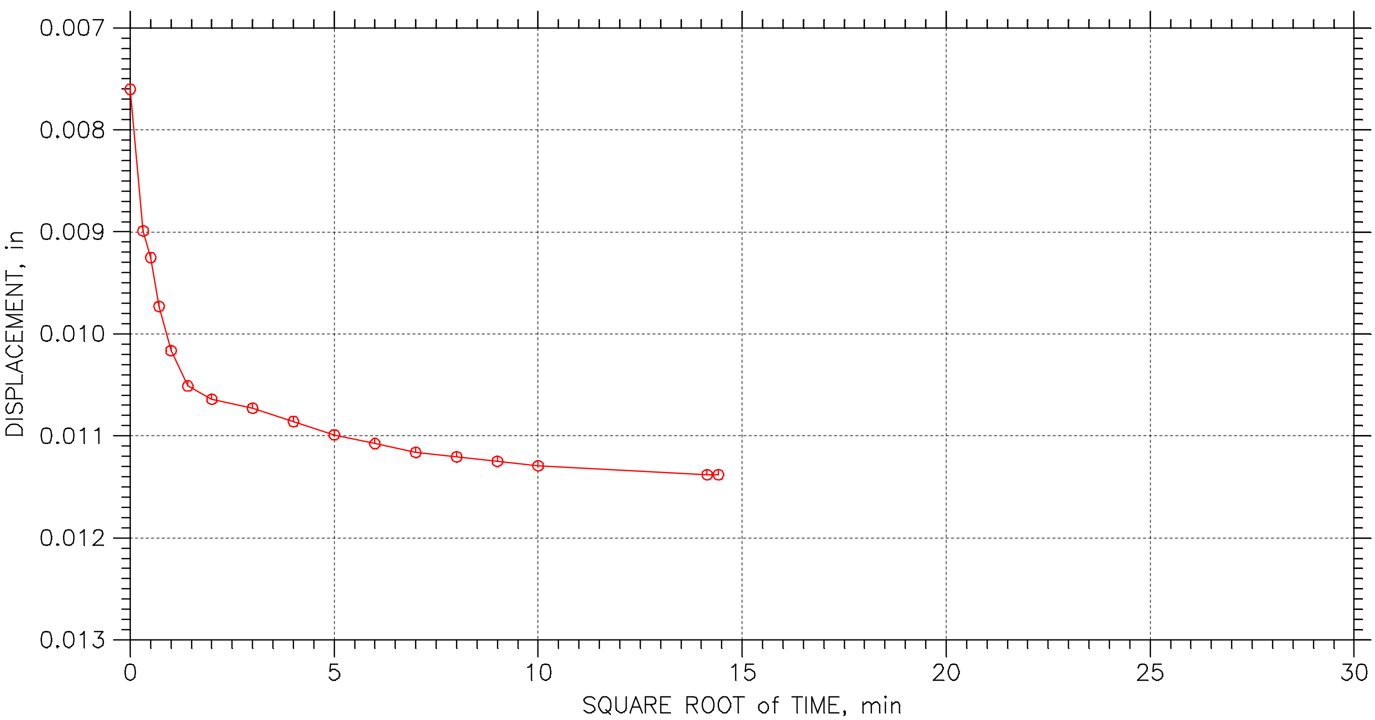
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 4 of 27

Stress: 0.75 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0" ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

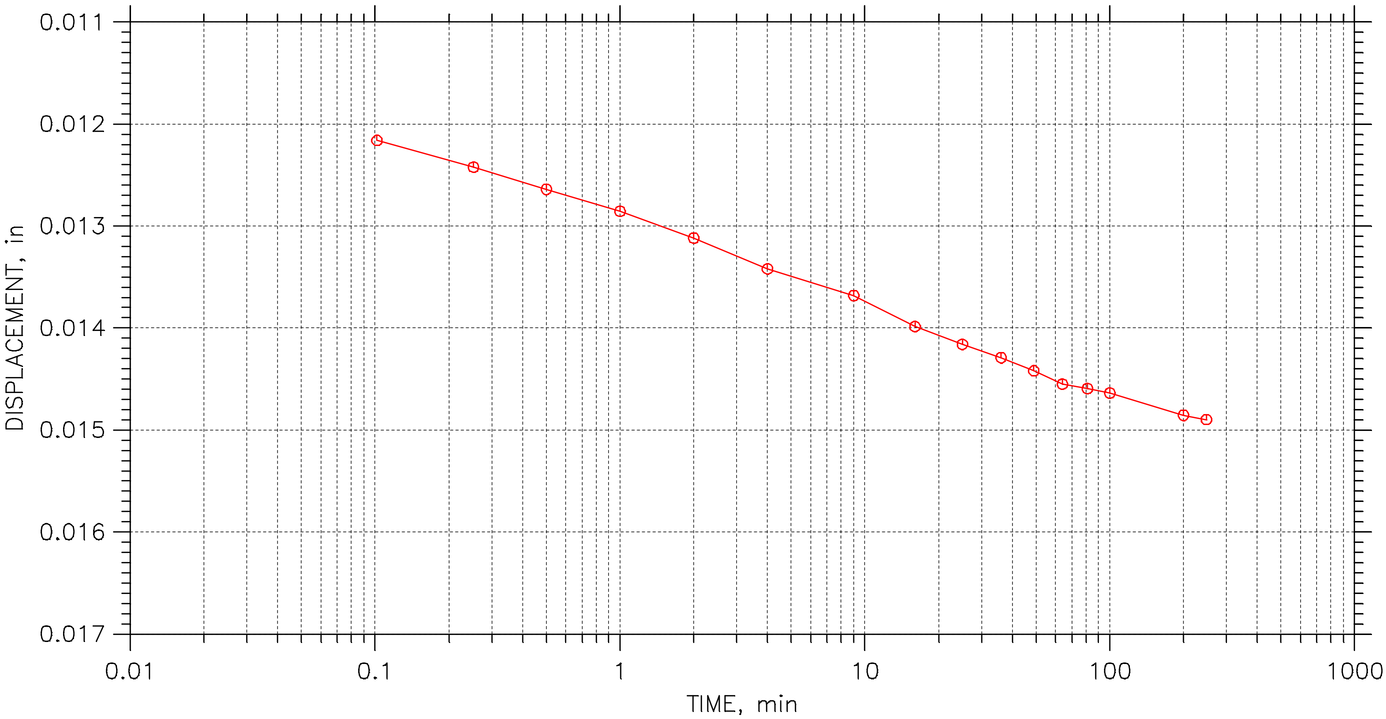
Tue, 26-APR-2016 10:52:04

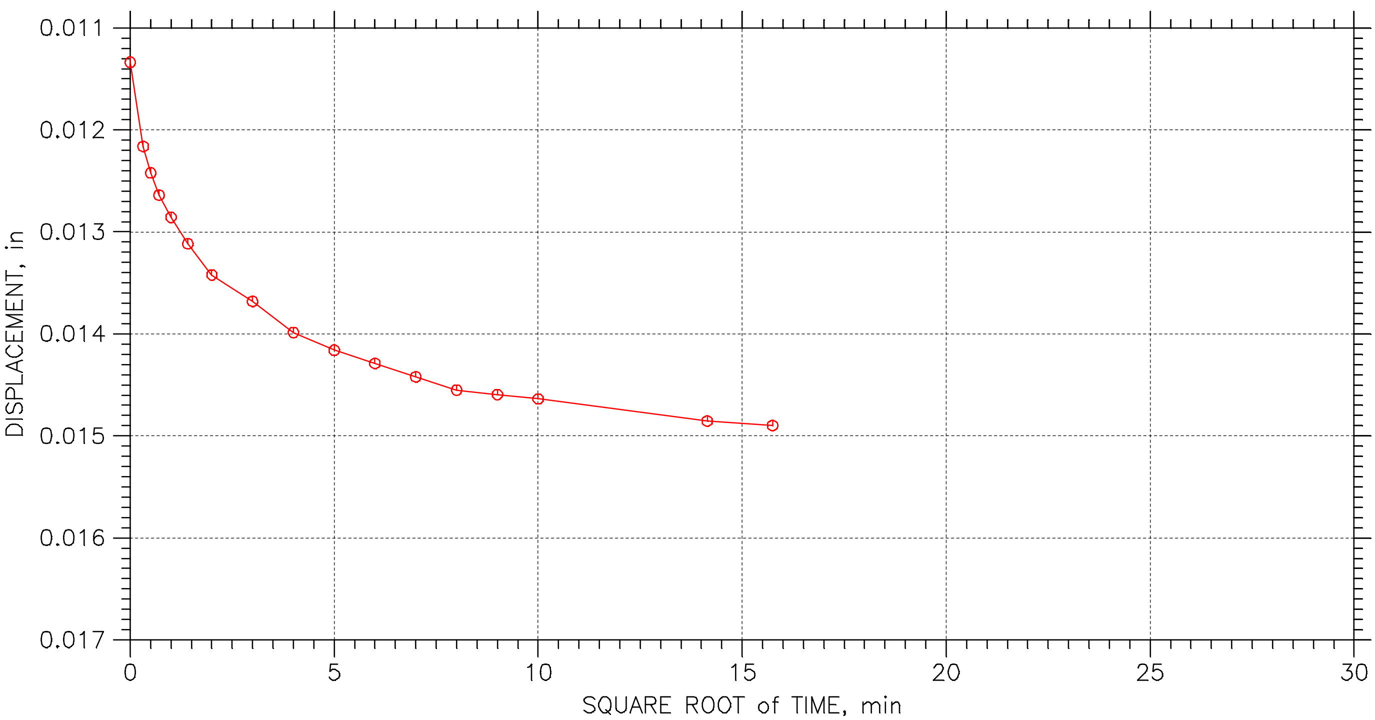
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 5 of 27

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

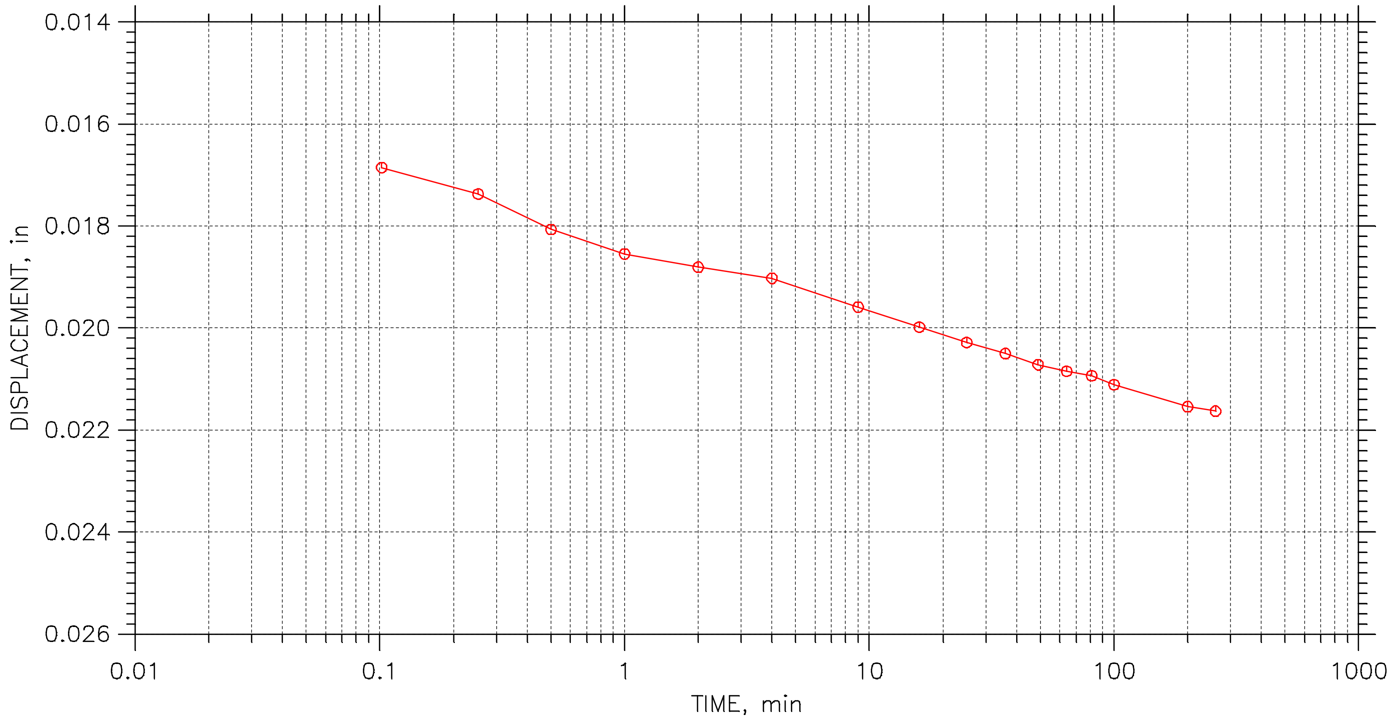
Tue, 26-APR-2016 10:52:05

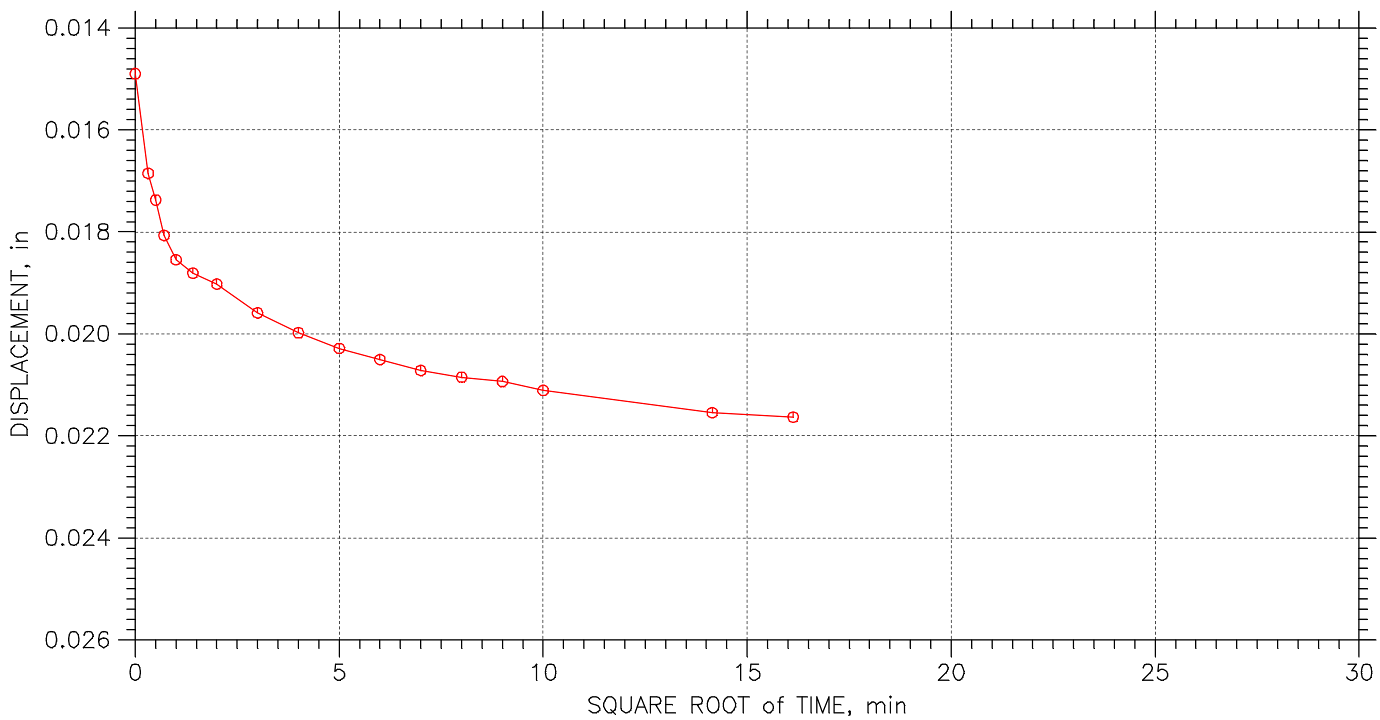
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 6 of 27

Stress: 1.5 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

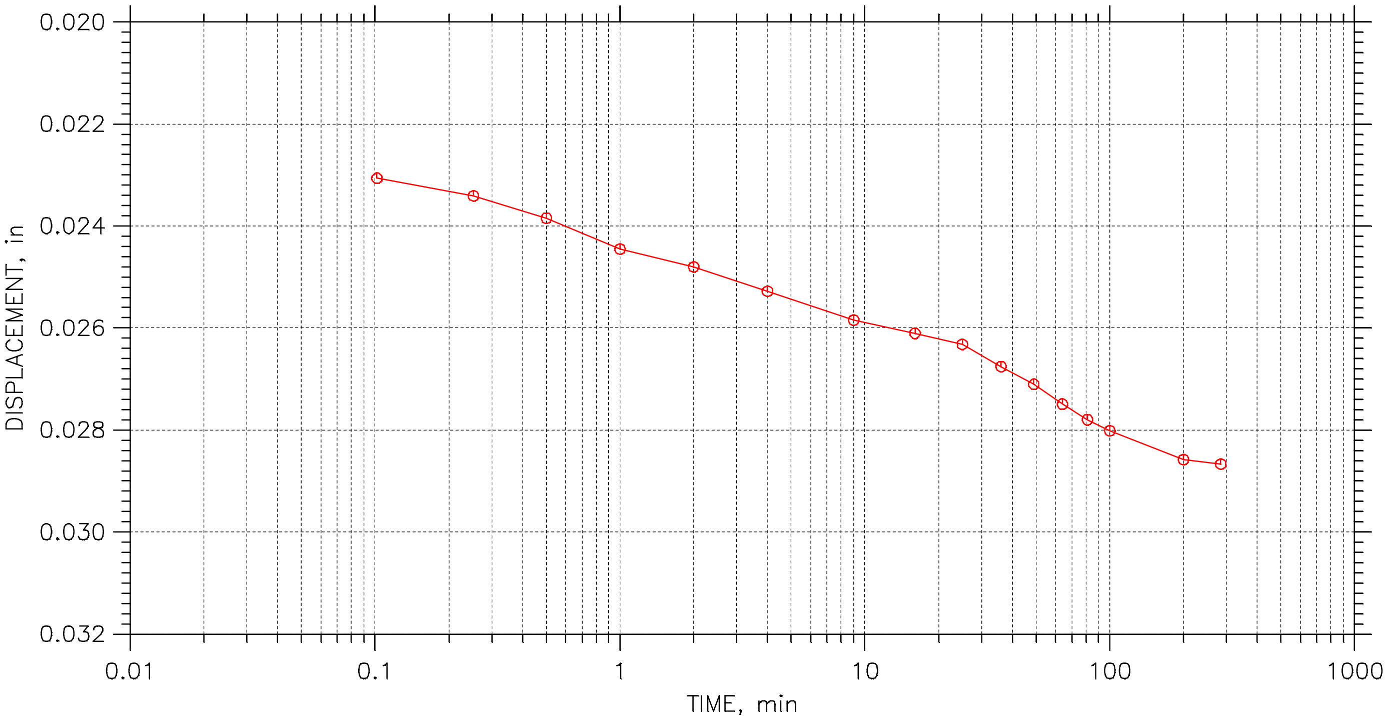
Tue, 26-APR-2016 10:52:07

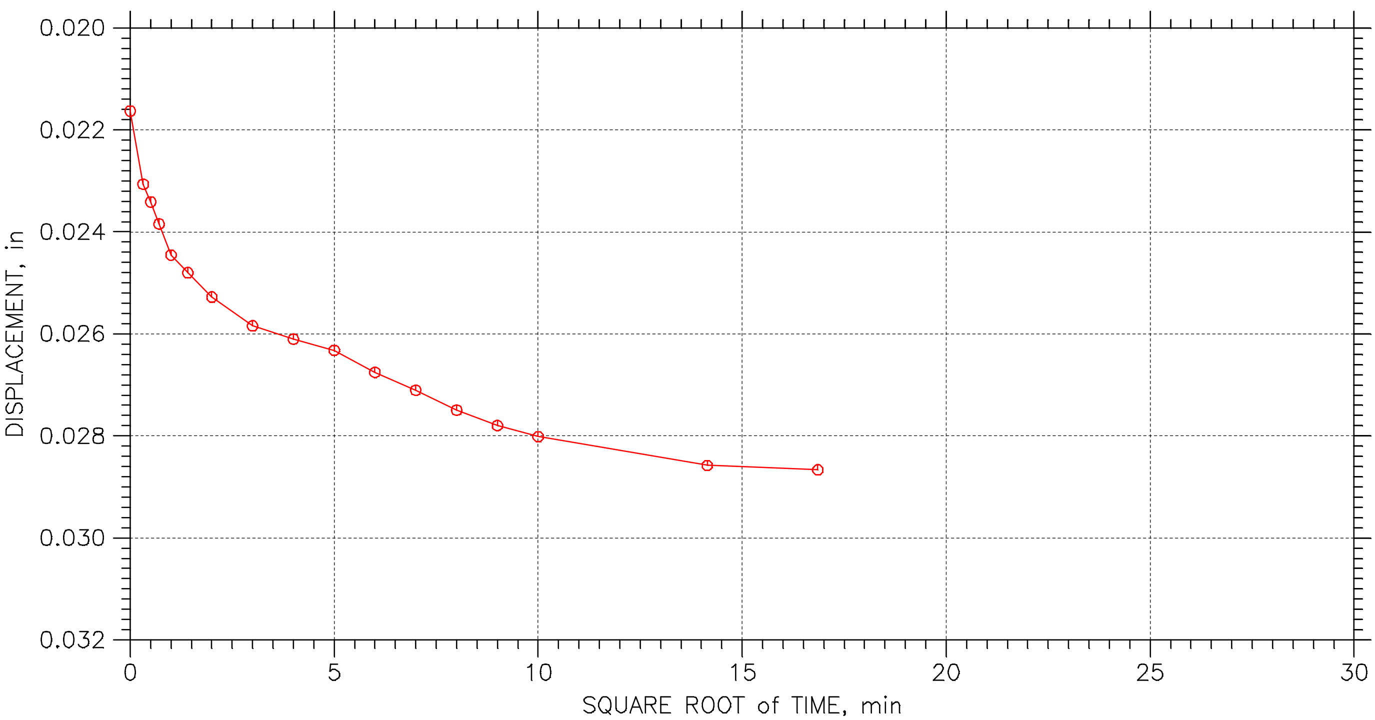
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 7 of 27

Stress: 2. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0" ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

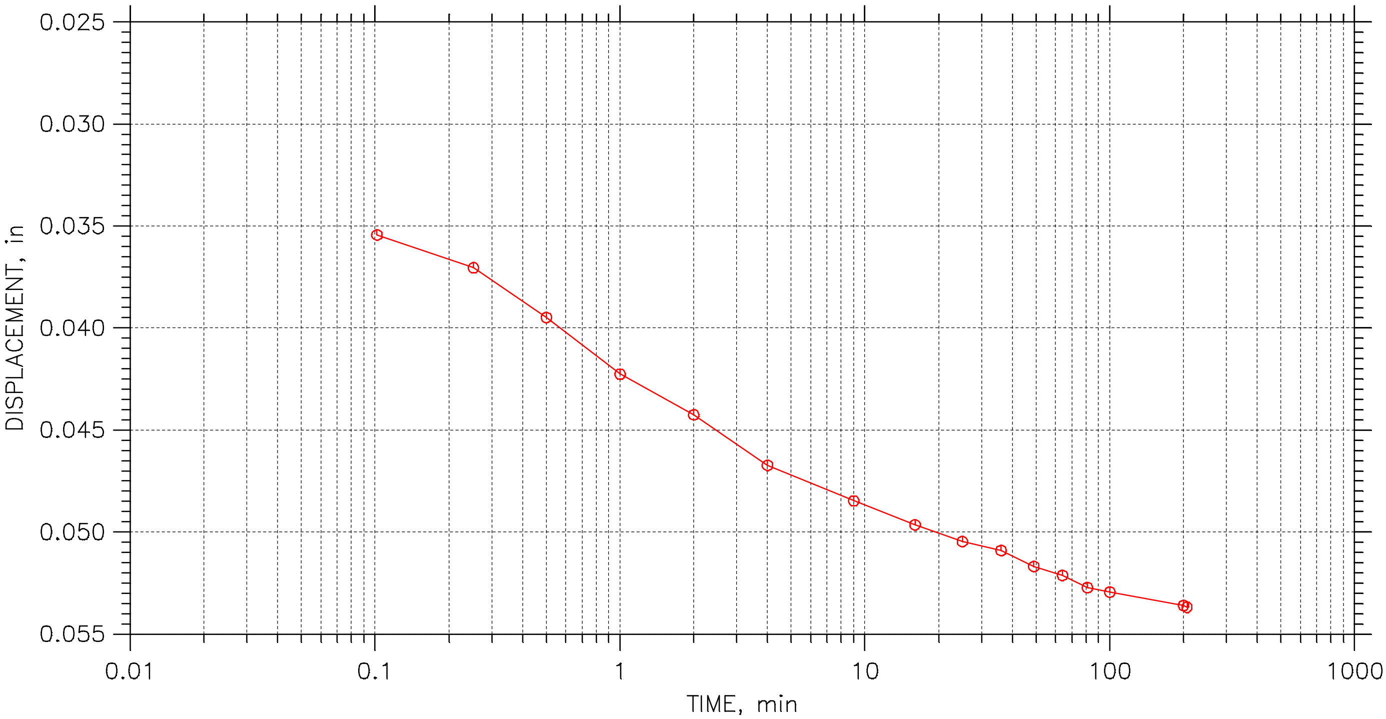
Tue, 26-APR-2016 10:52:08

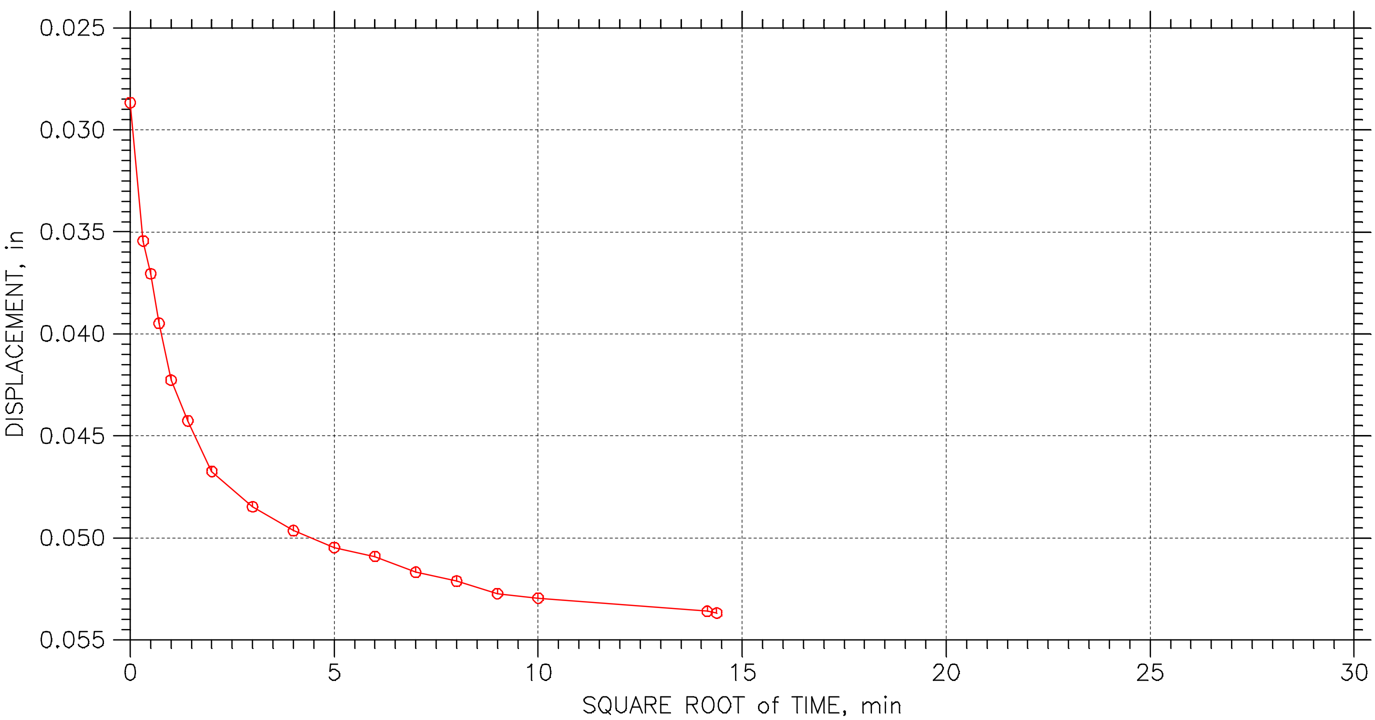
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 8 of 27

Stress: 4. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

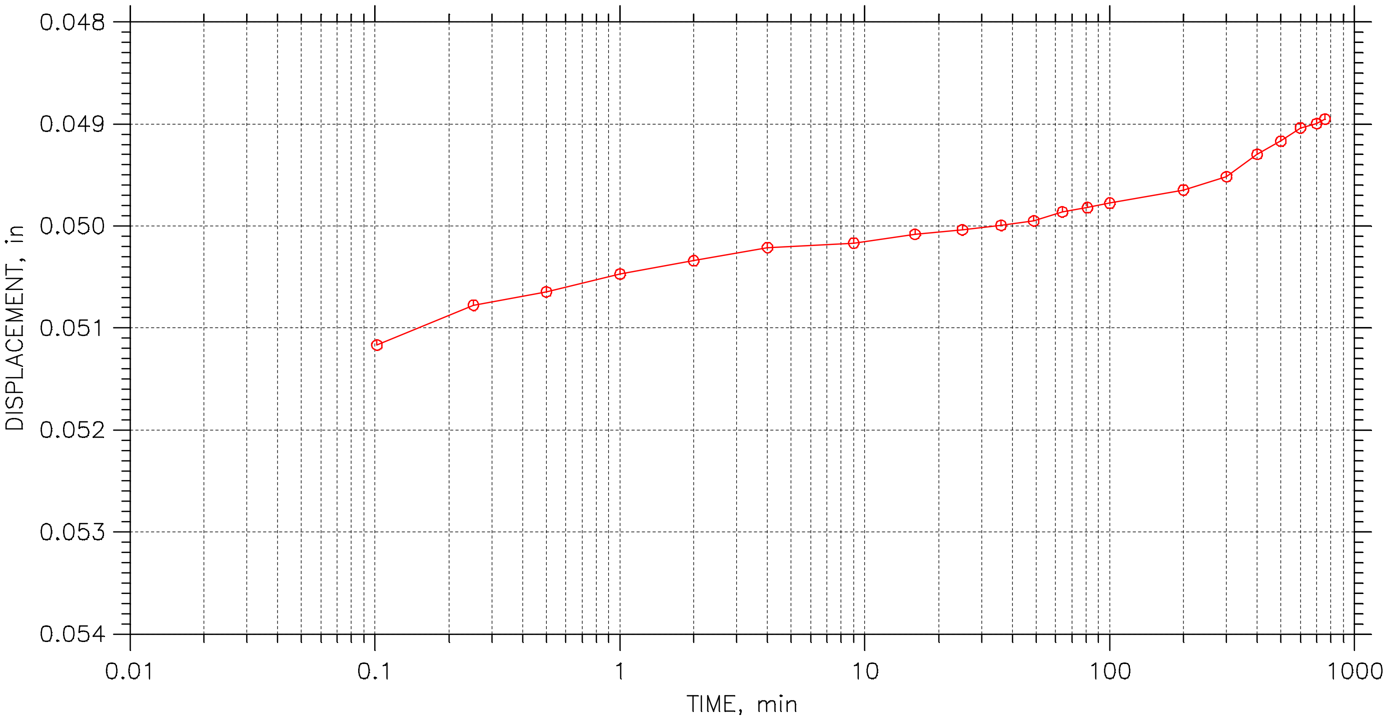
Tue, 26-APR-2016 10:52:09

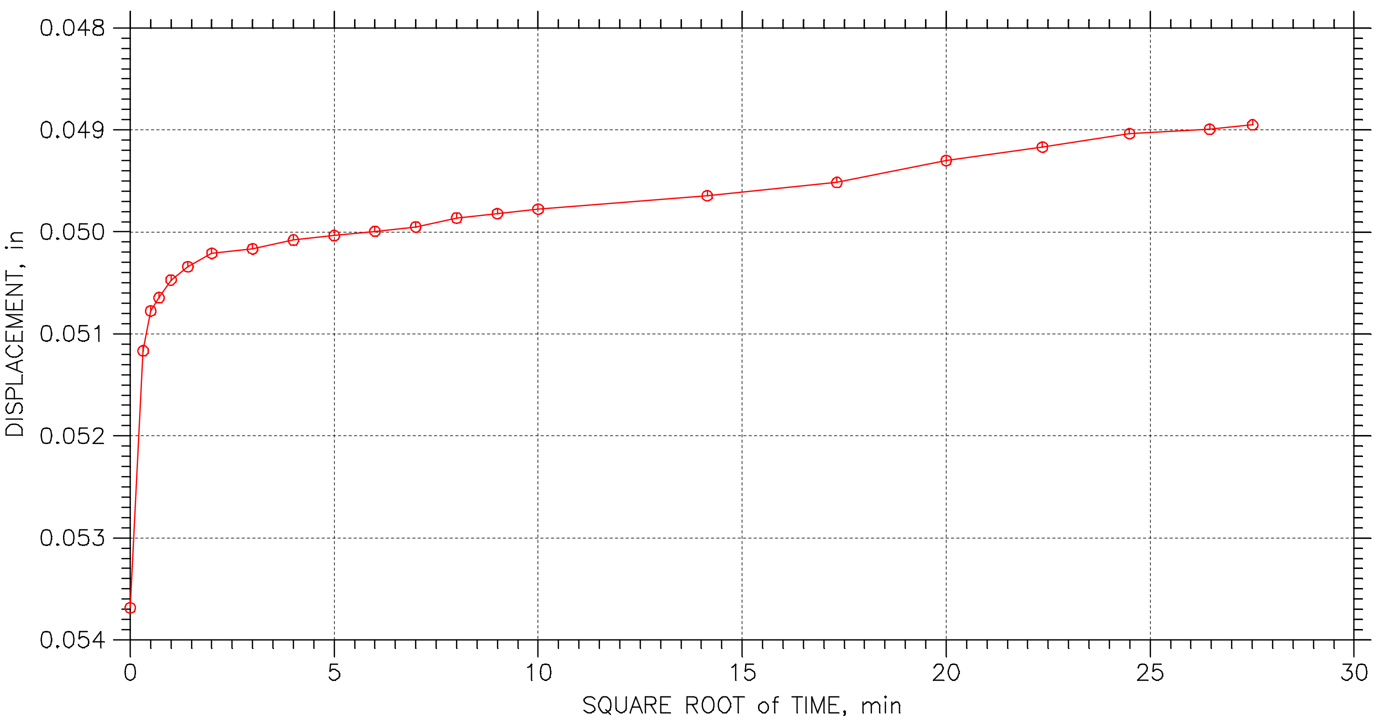
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 9 of 27

Stress: 2. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

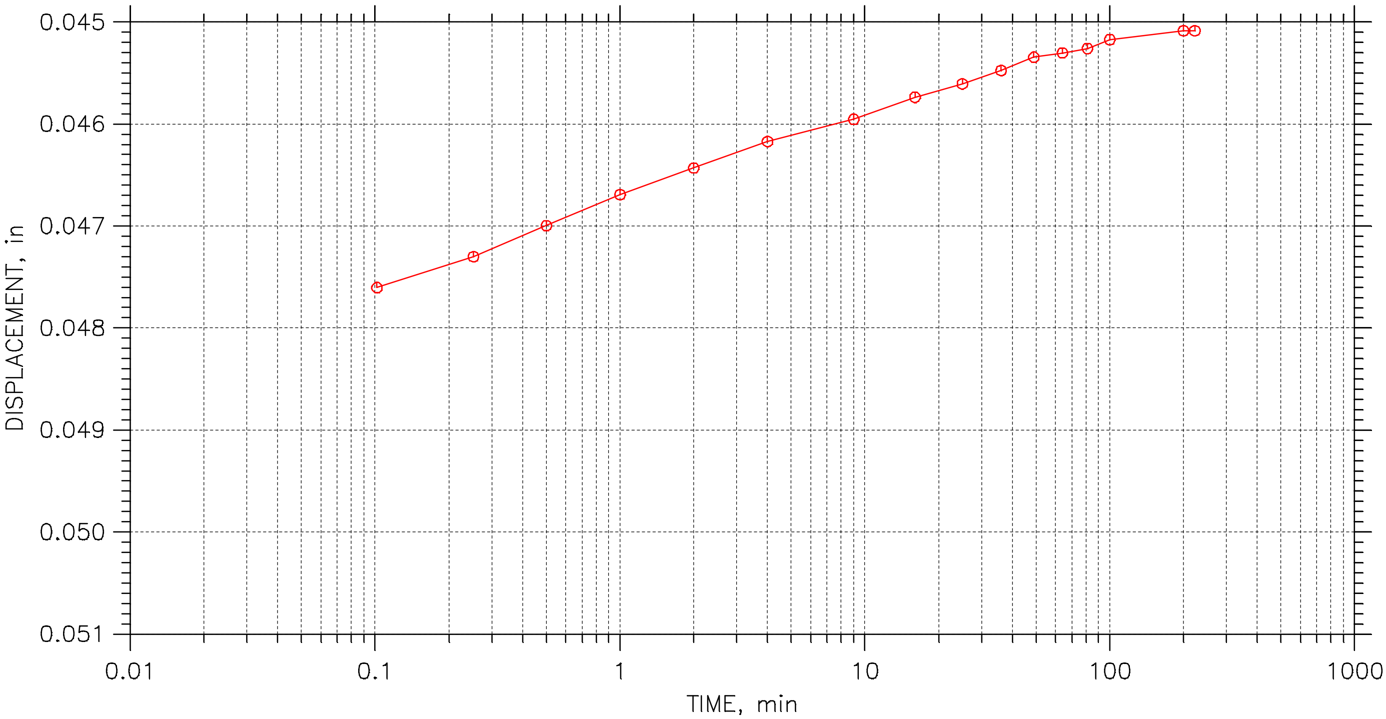
Tue, 26-APR-2016 10:52:11

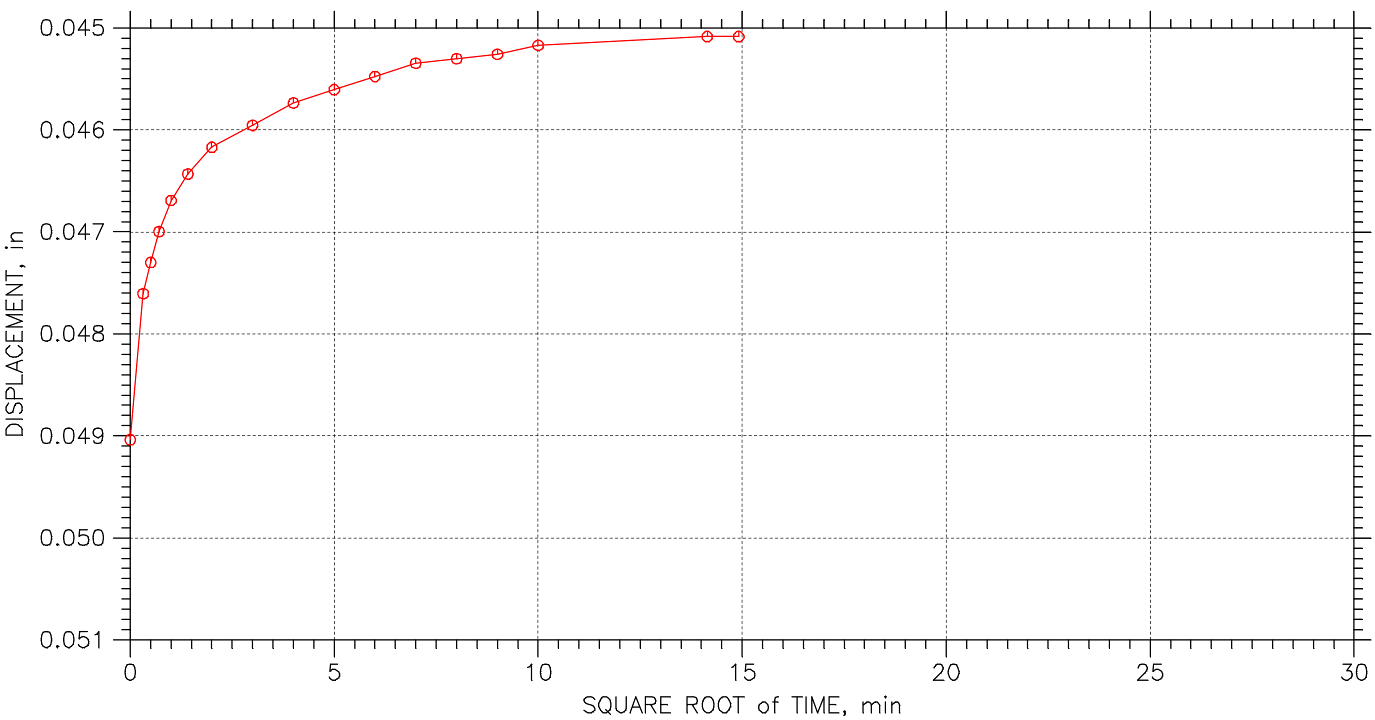
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 10 of 27

Stress: 1. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0" ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

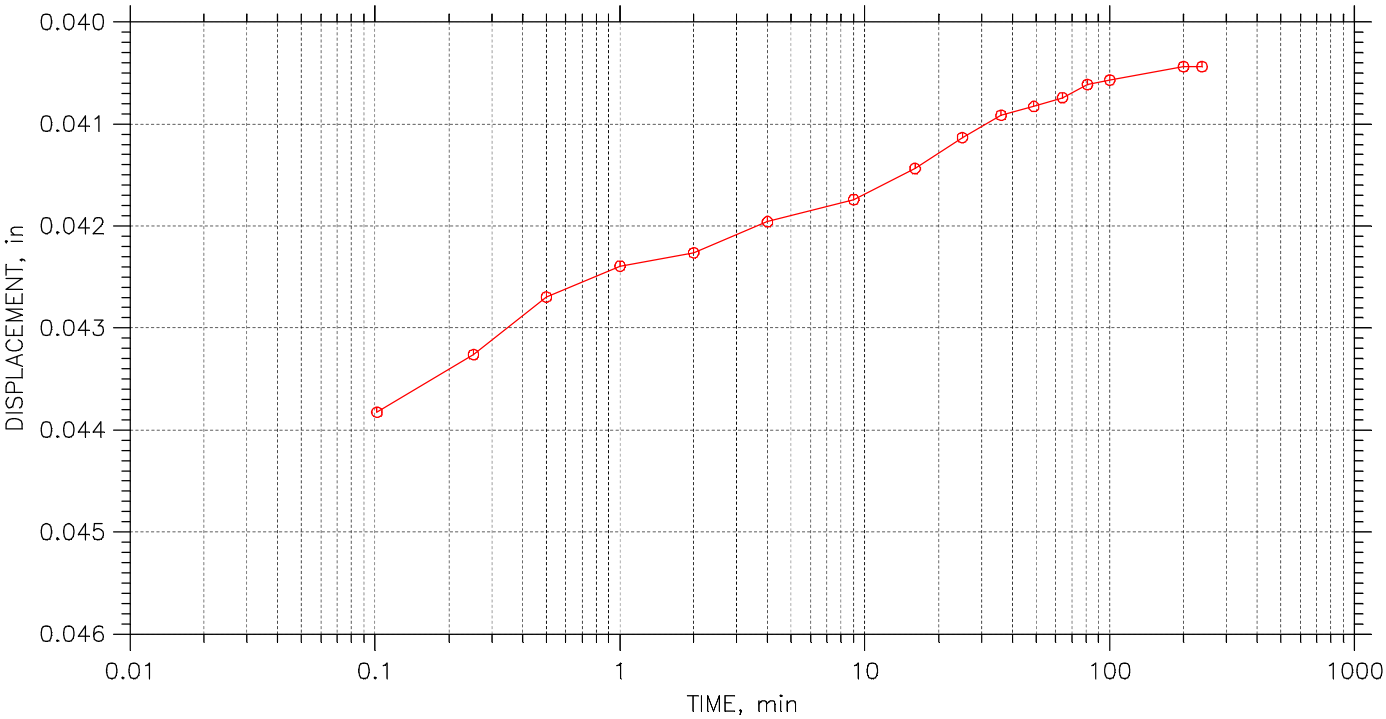
Tue, 26-APR-2016 10:52:12

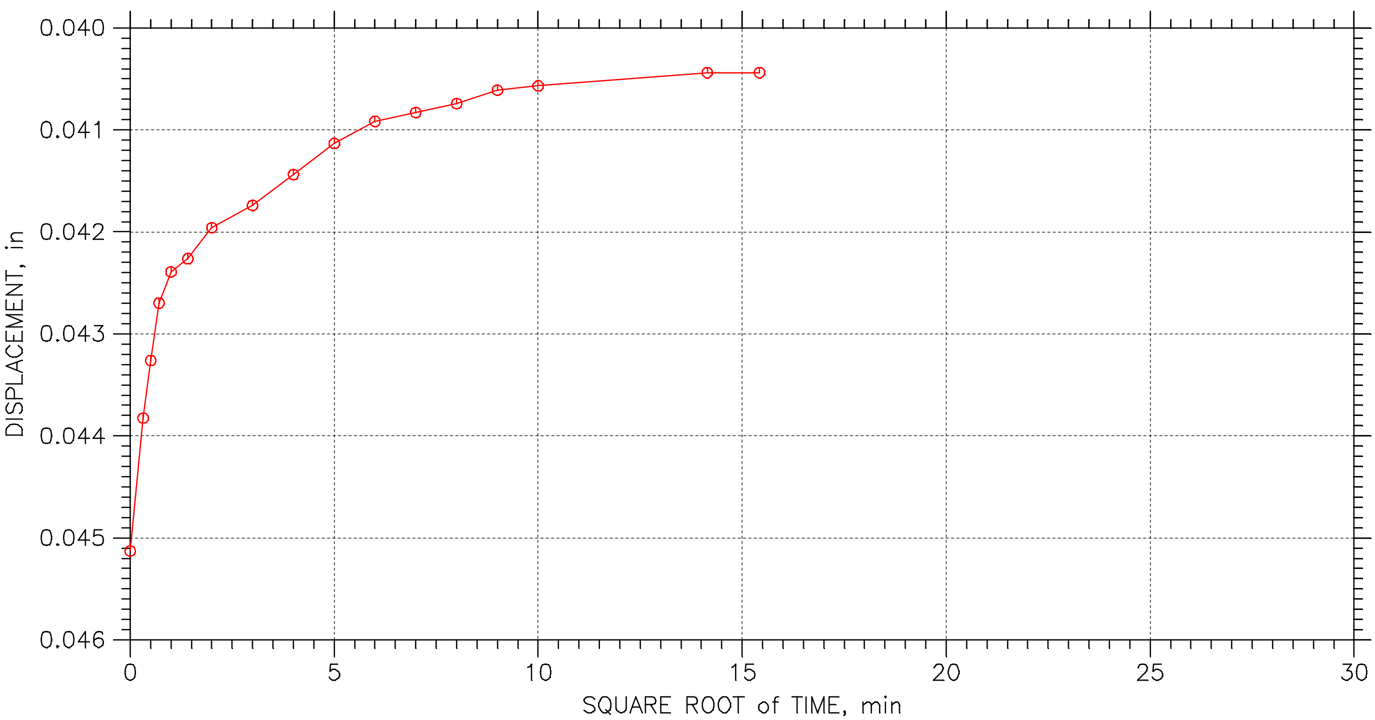
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 11 of 27

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

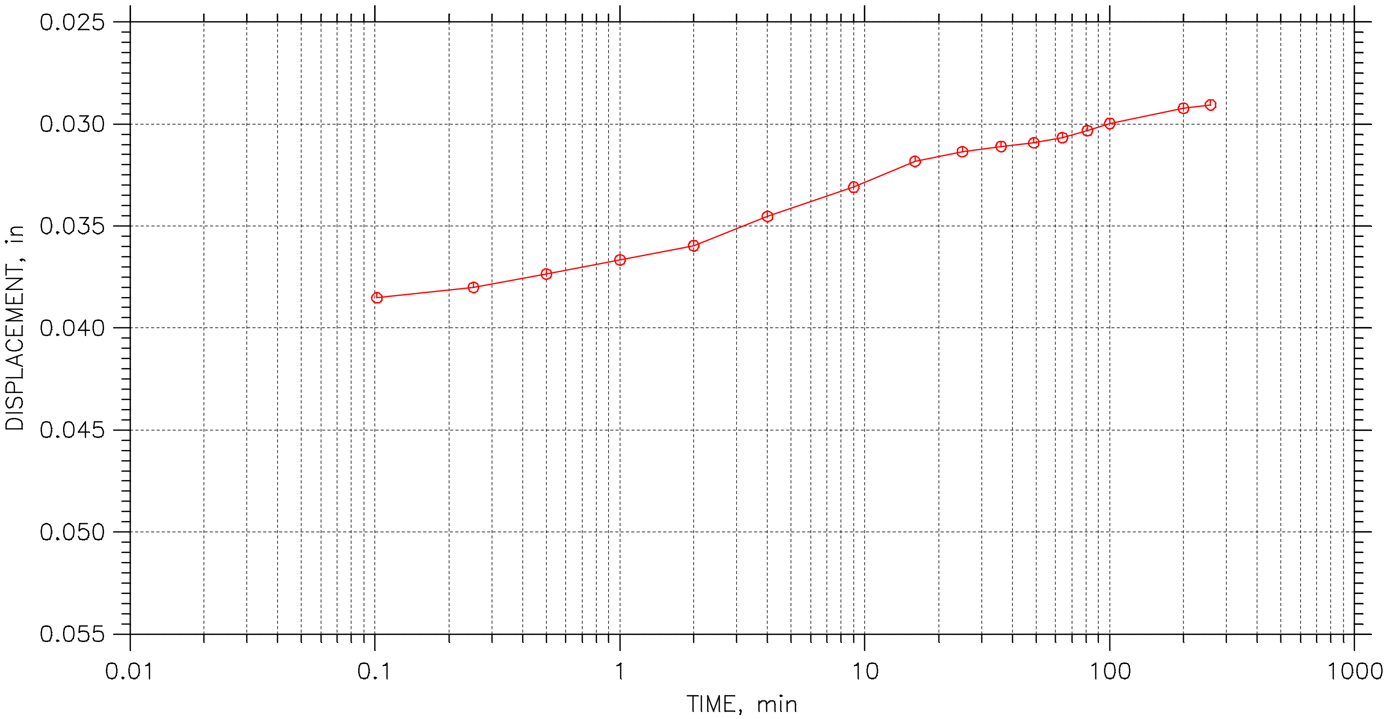
Tue, 26-APR-2016 10:52:14

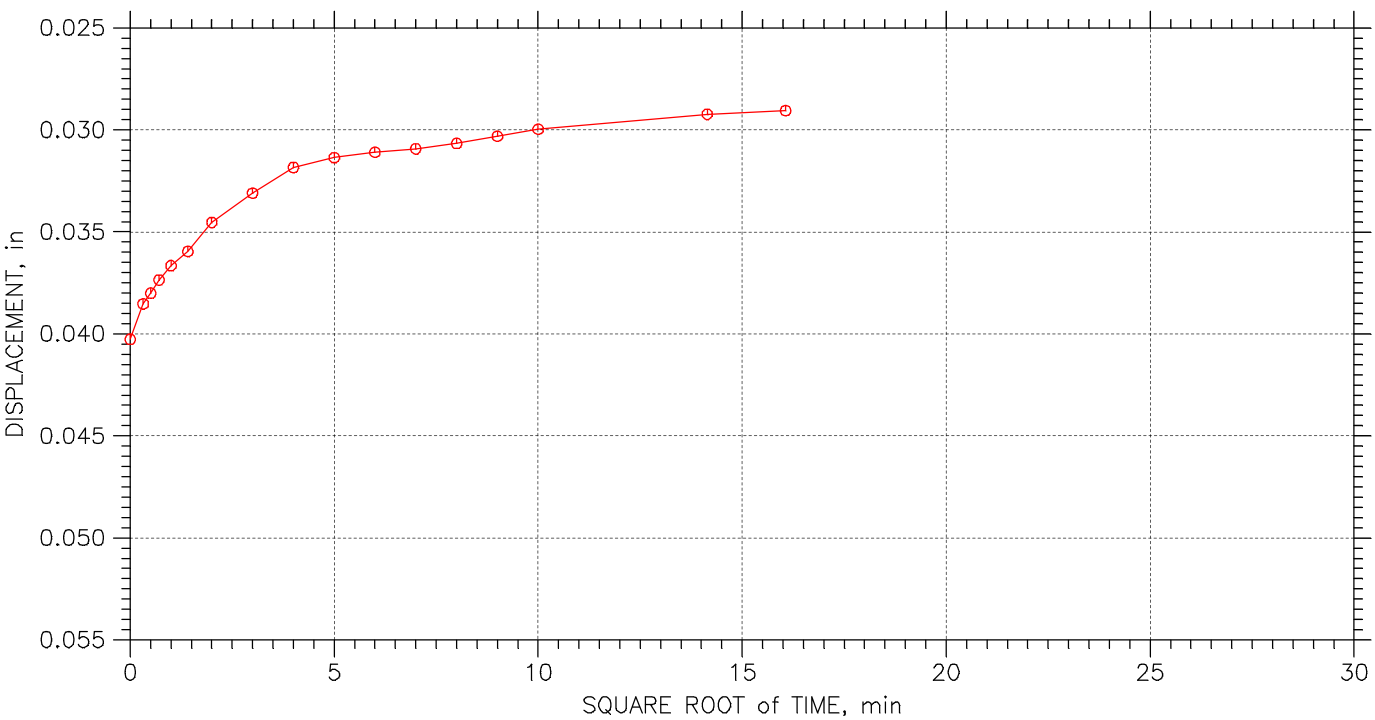
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 12 of 27

Stress: 0.125 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0" ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

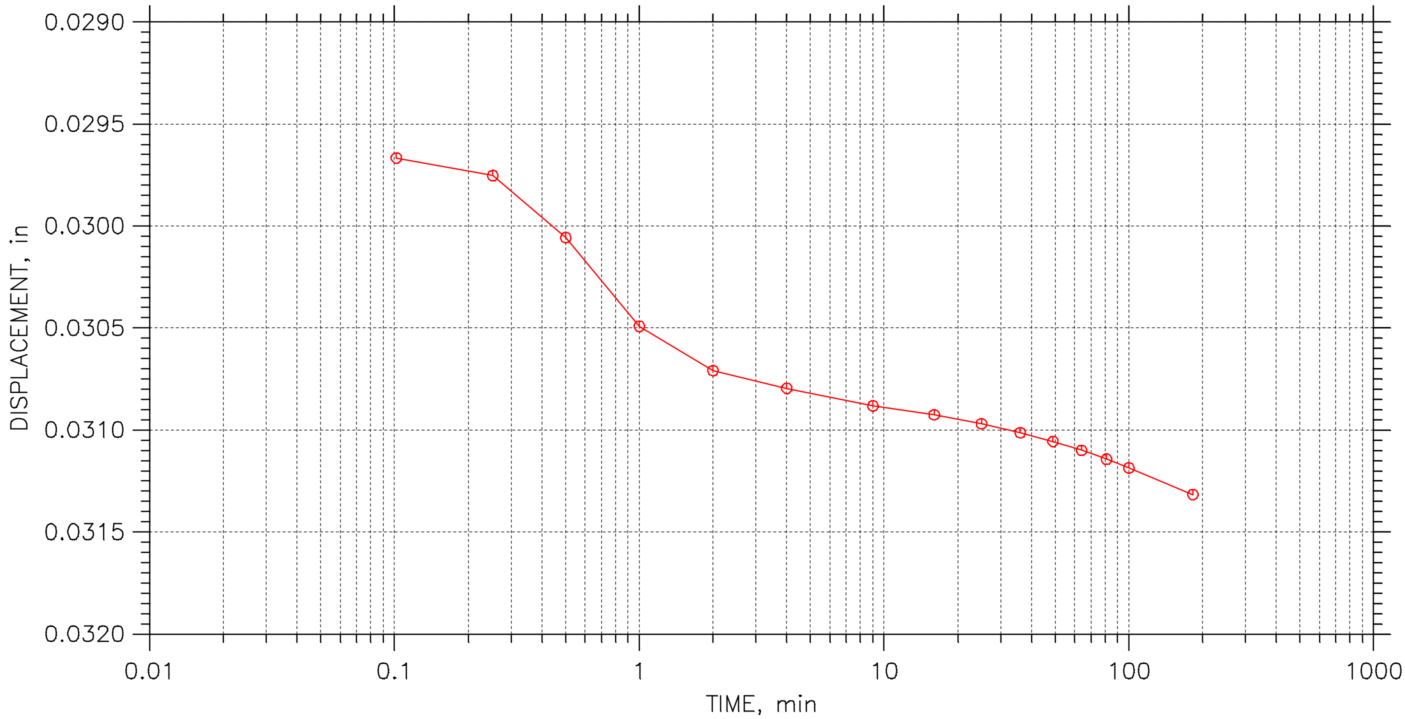
Tue, 26-APR-2016 10:52:15

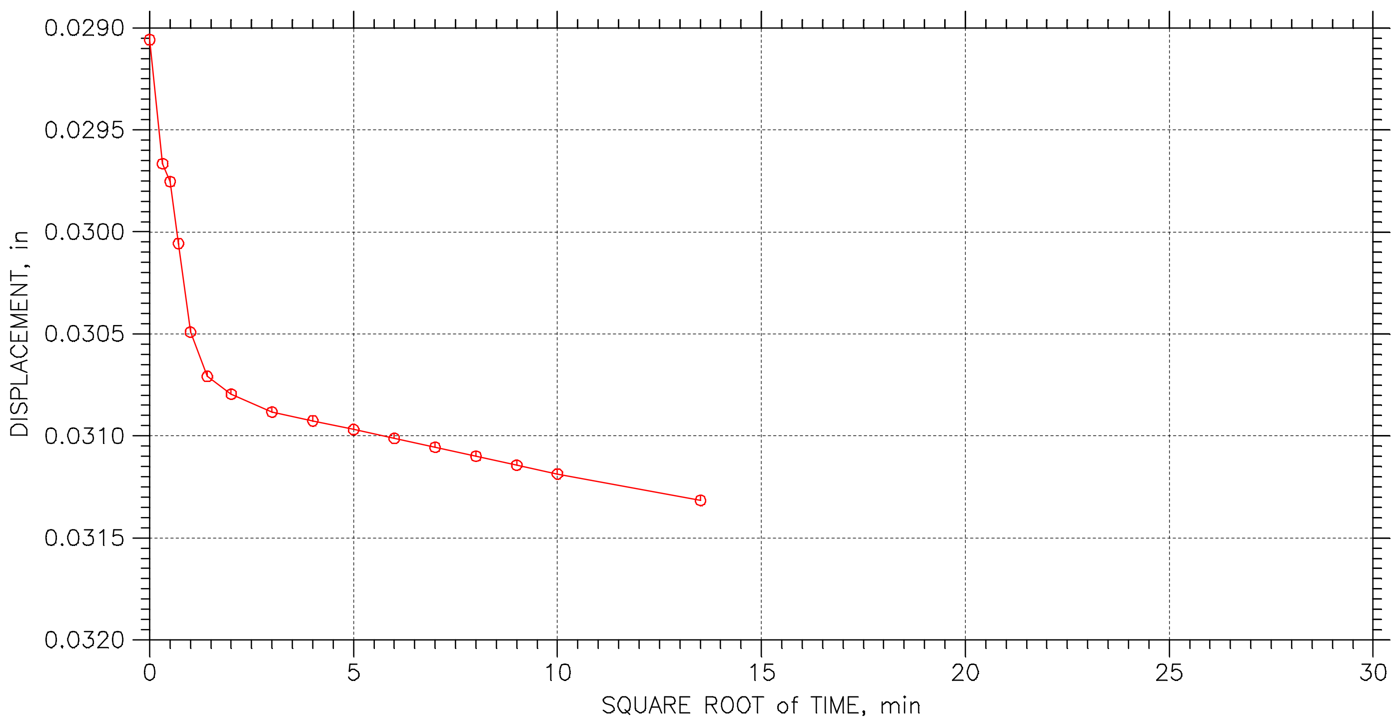
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 13 of 27

Stress: 0.25 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

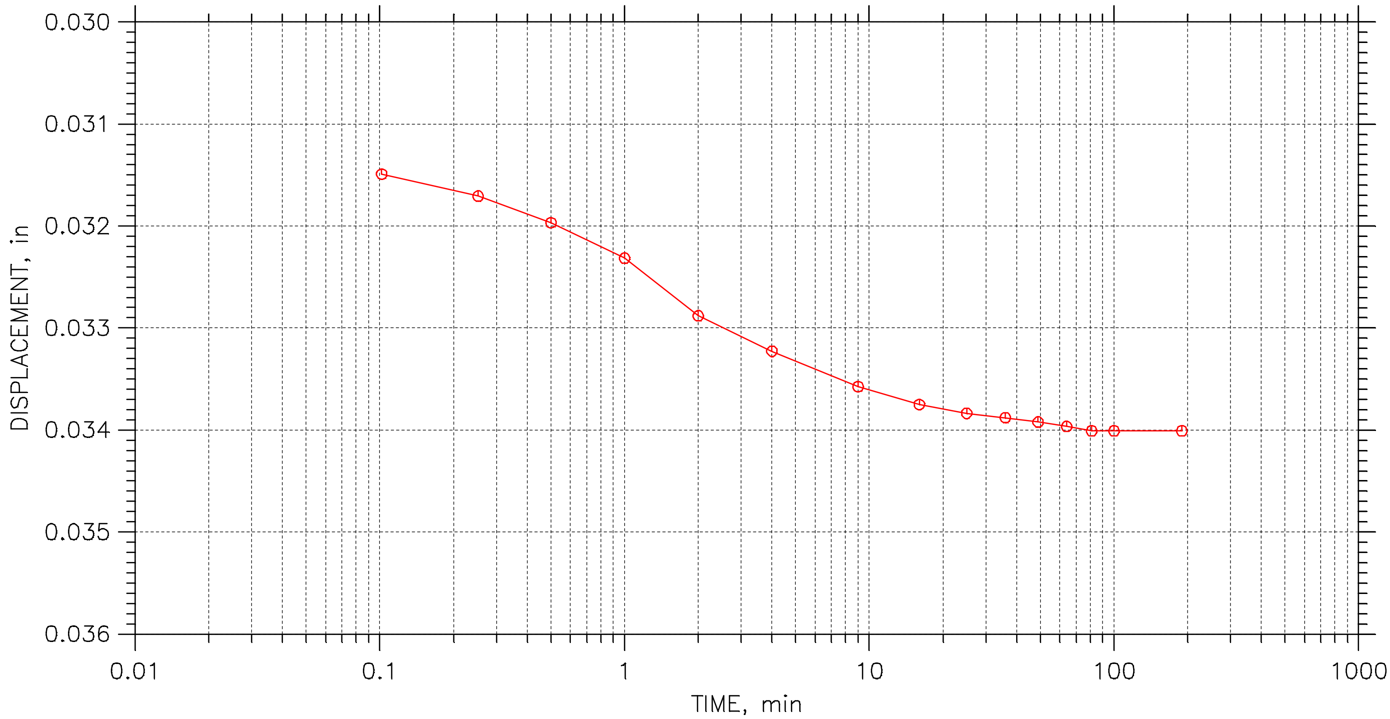
Tue, 26-APR-2016 10:52:17

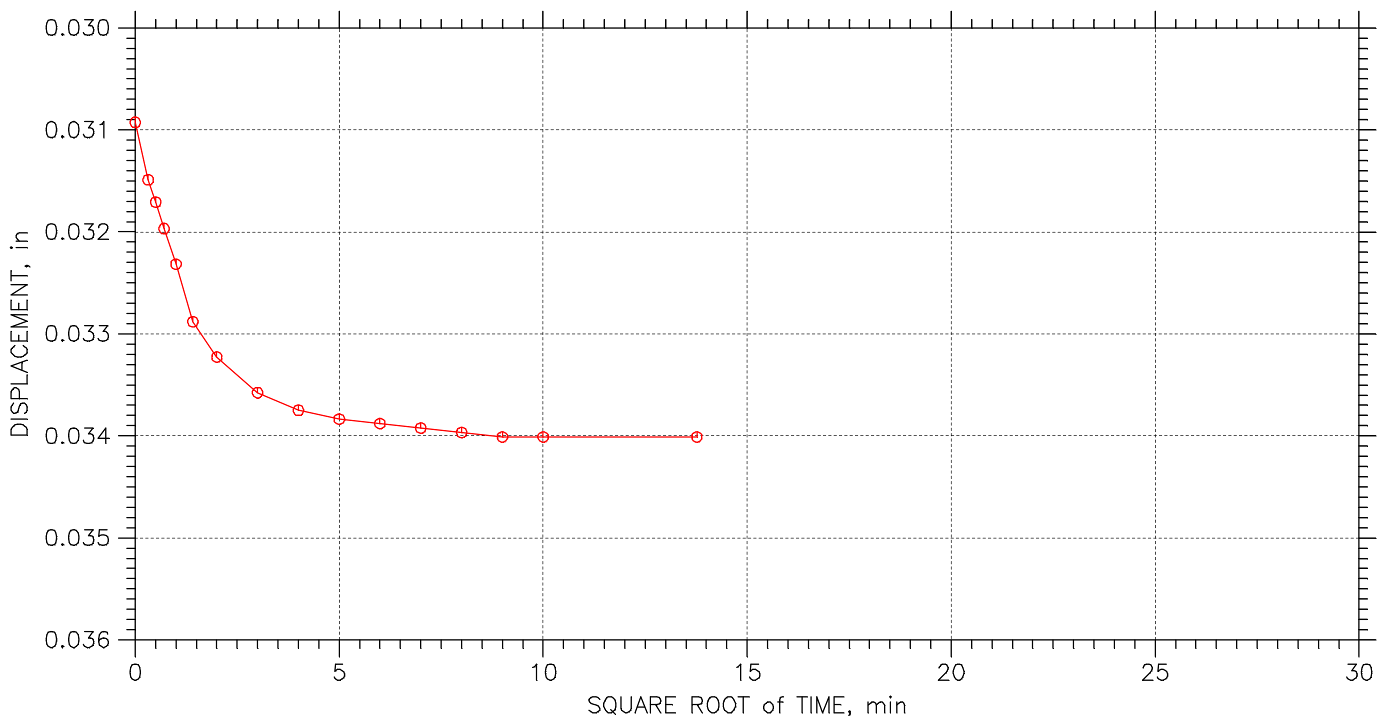
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 14 of 27

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

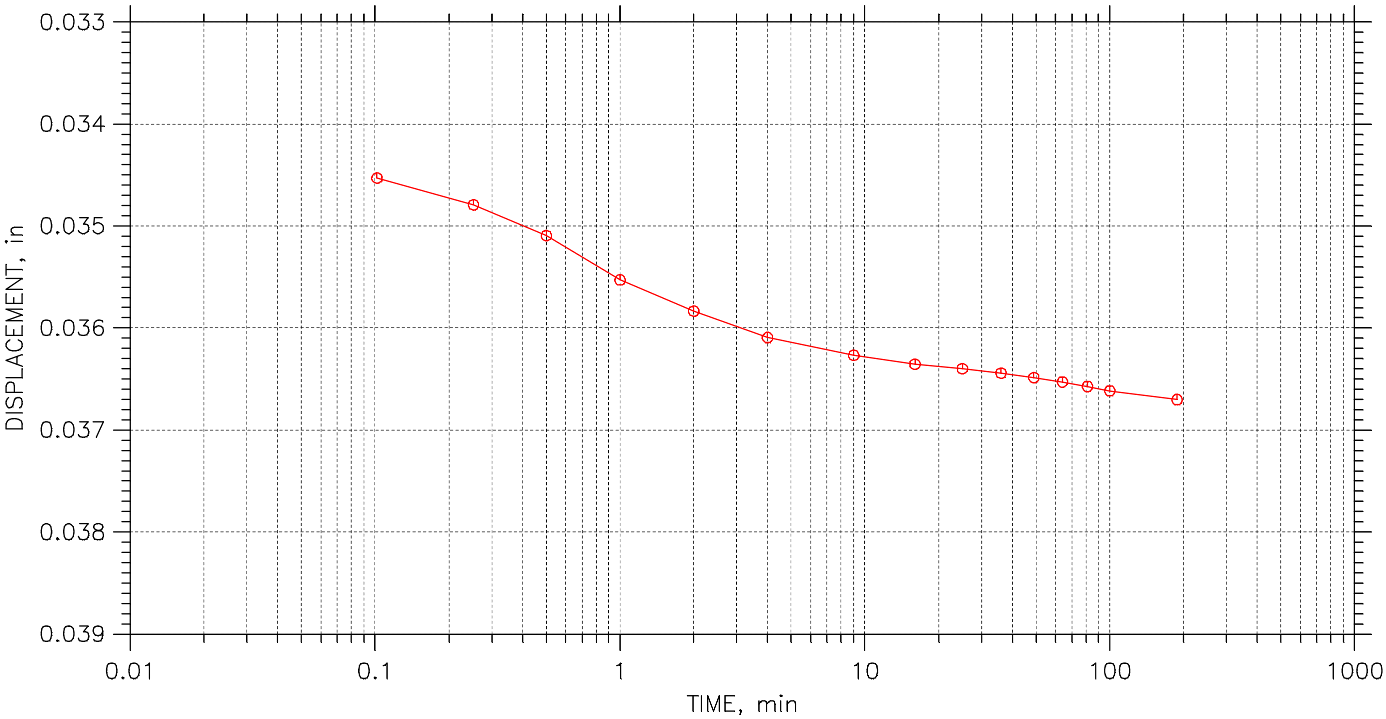
Tue, 26-APR-2016 10:52:18

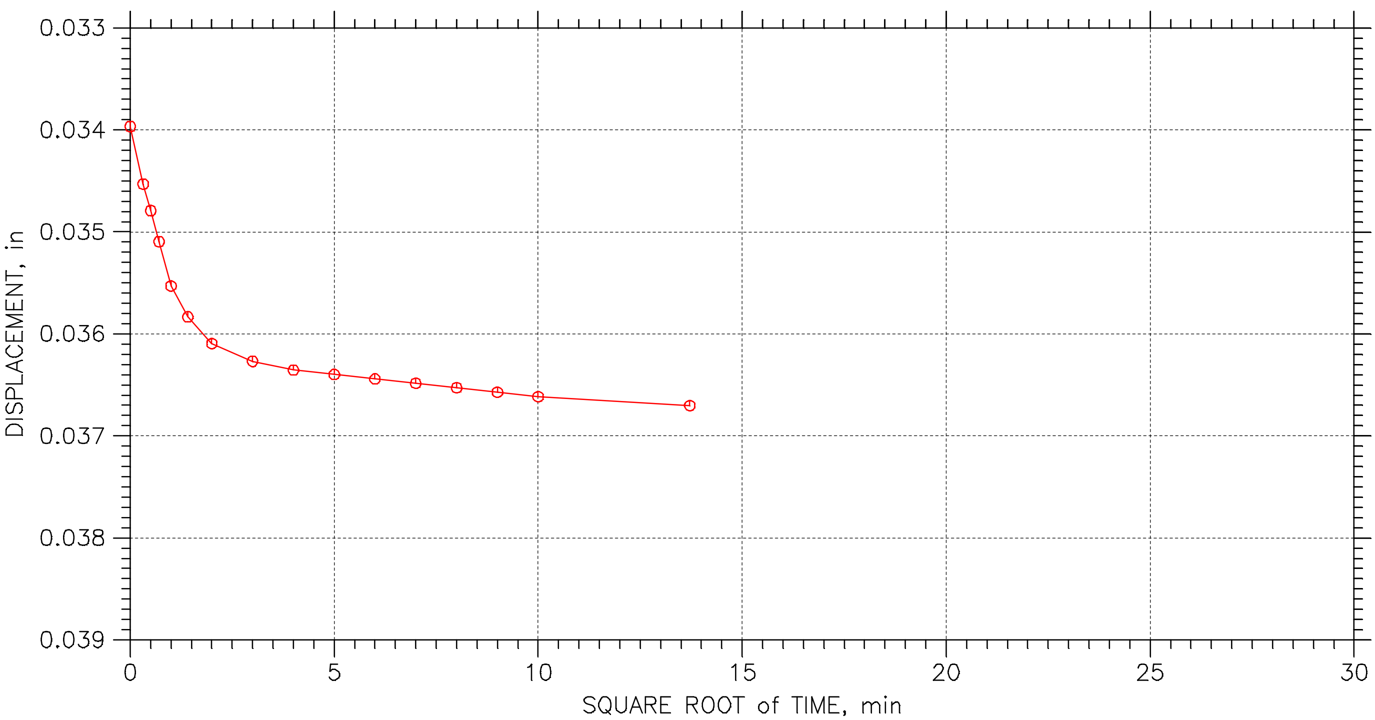
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 15 of 27

Stress: 0.75 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

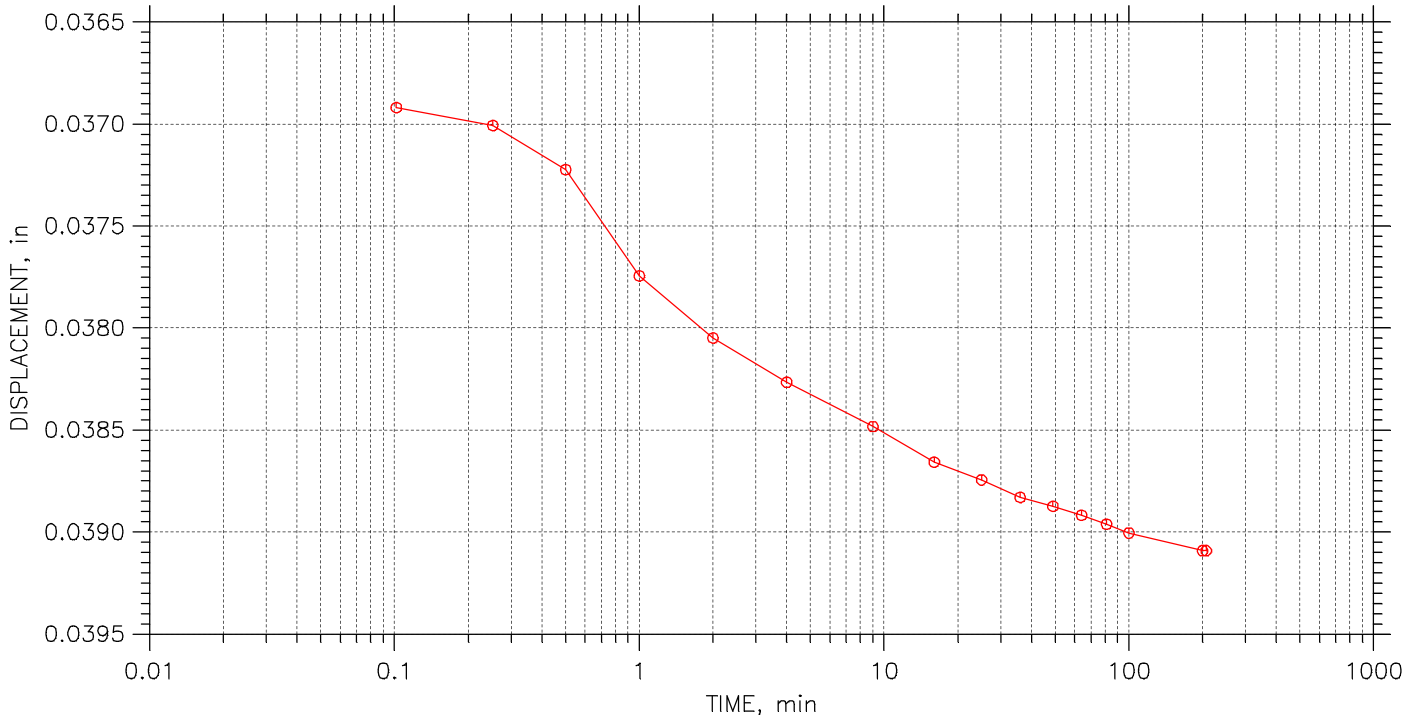
Tue, 26-APR-2016 10:52:20

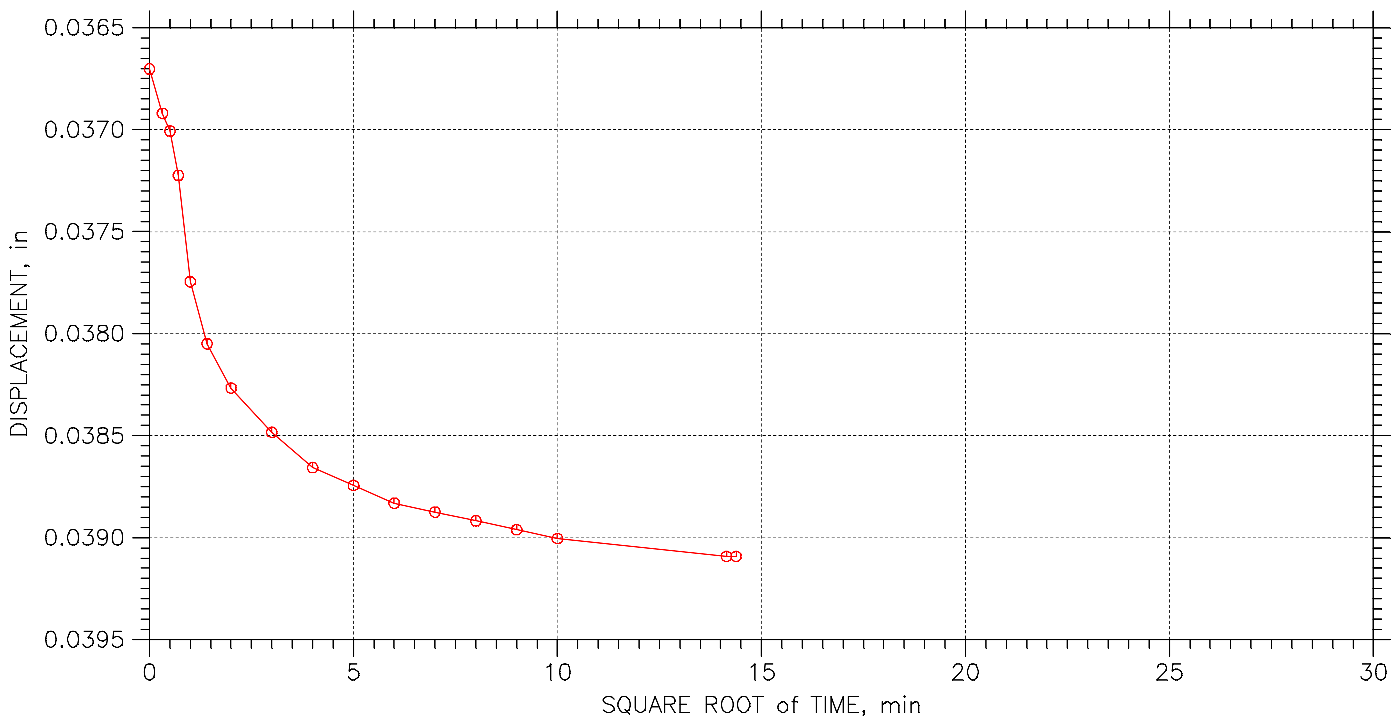
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 16 of 27

Stress: 1. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

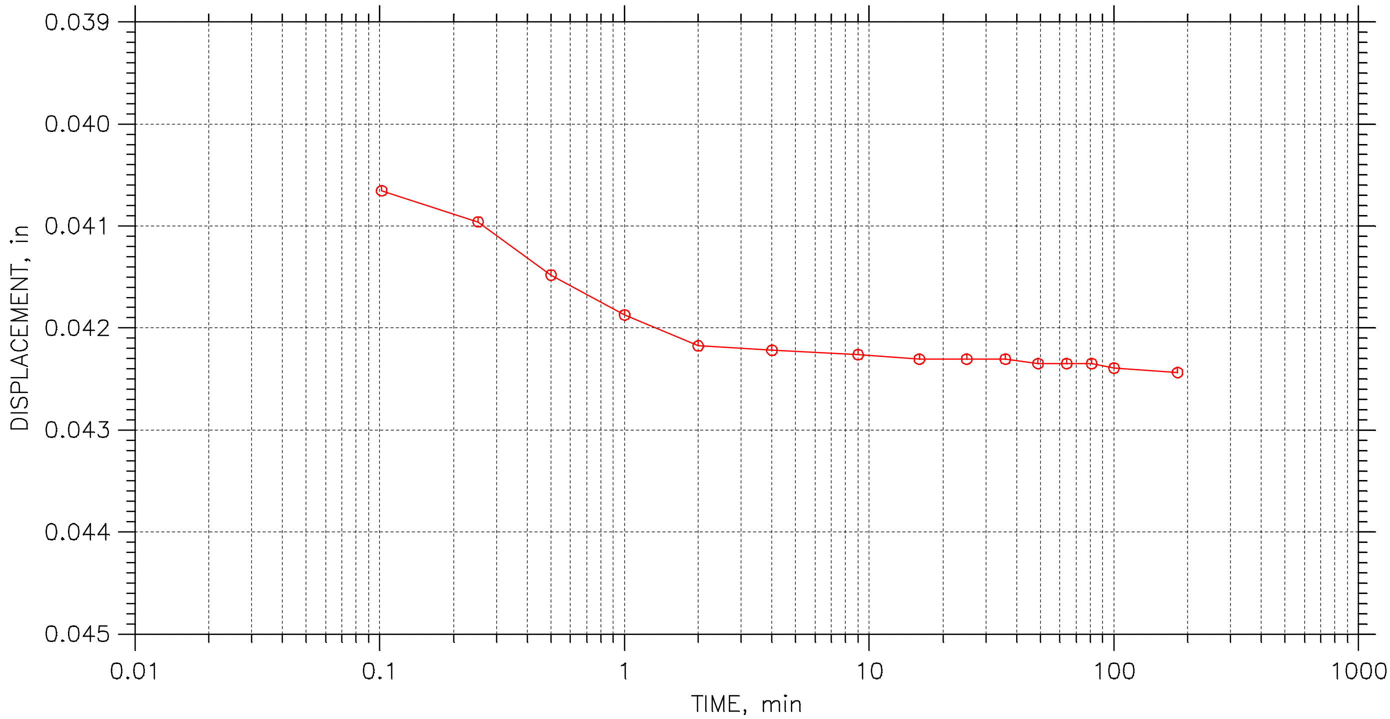
Tue, 26-APR-2016 10:52:21

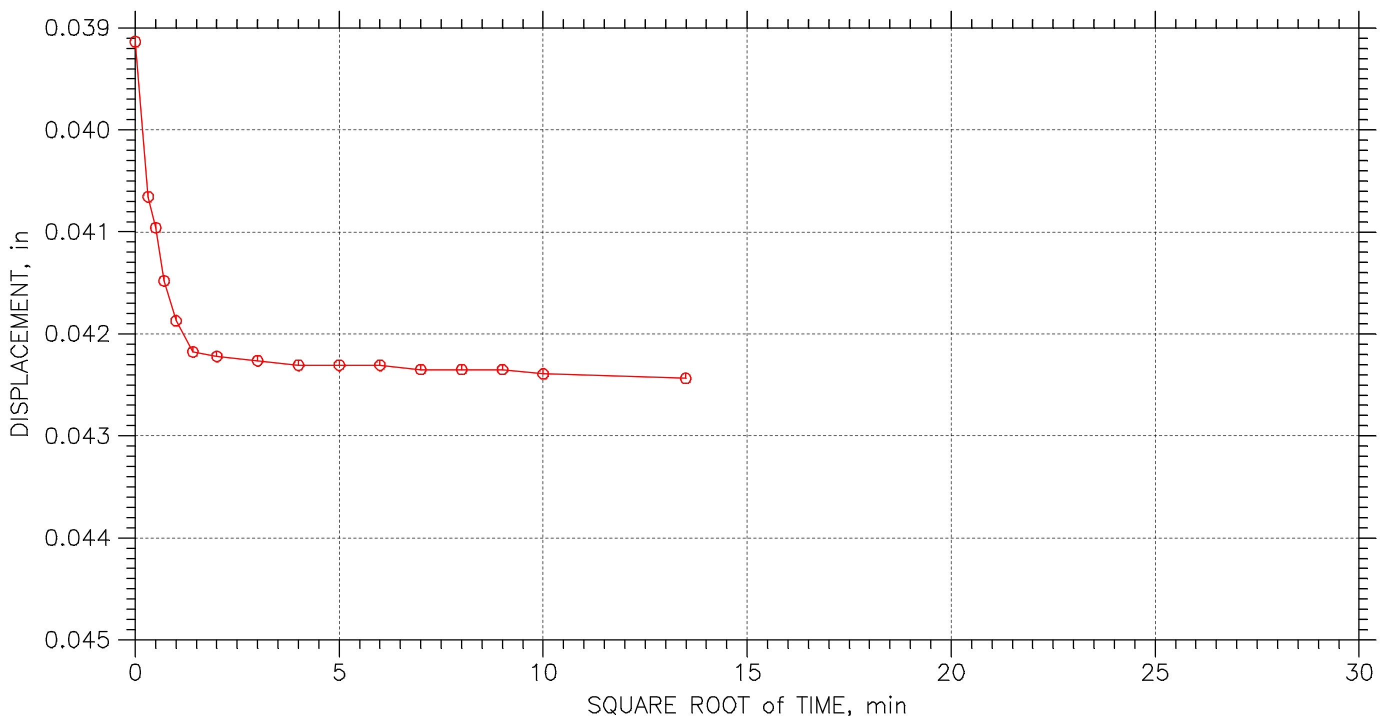
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 17 of 27

Stress: 1.5 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

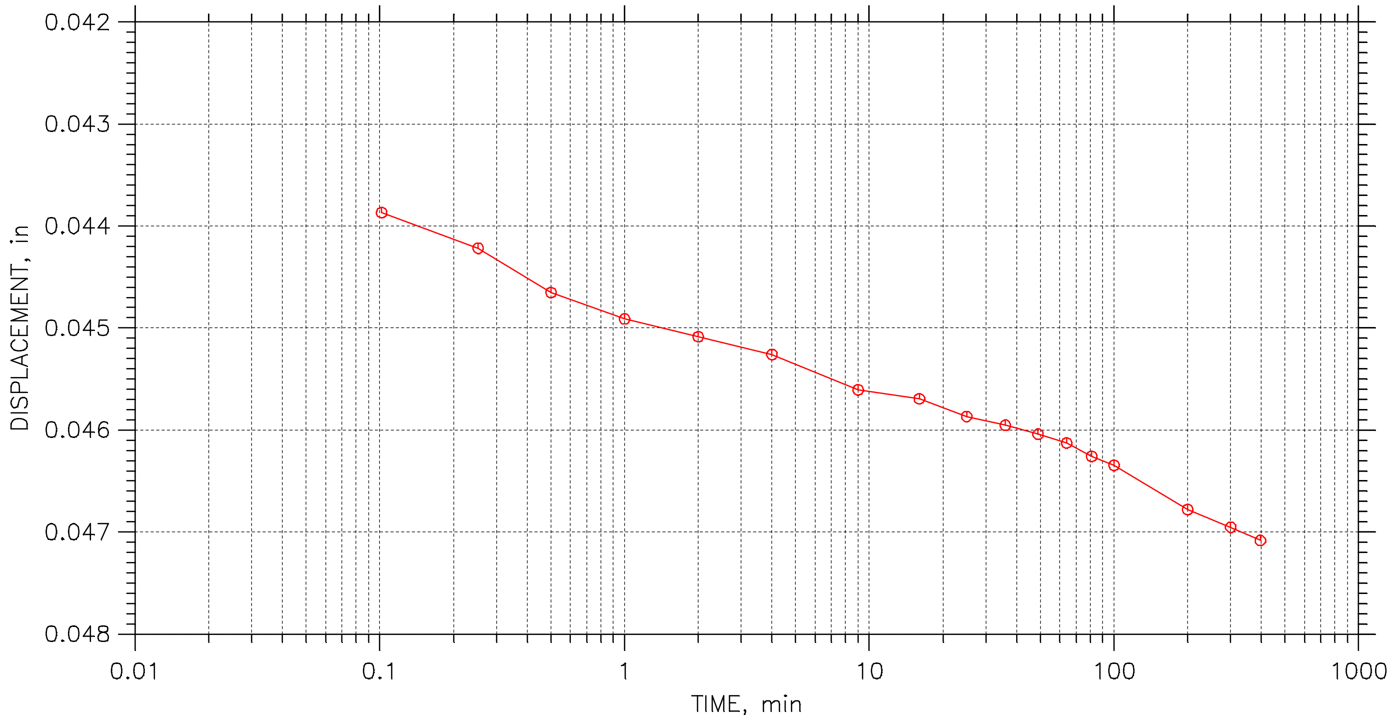
Tue, 26-APR-2016 10:52:23

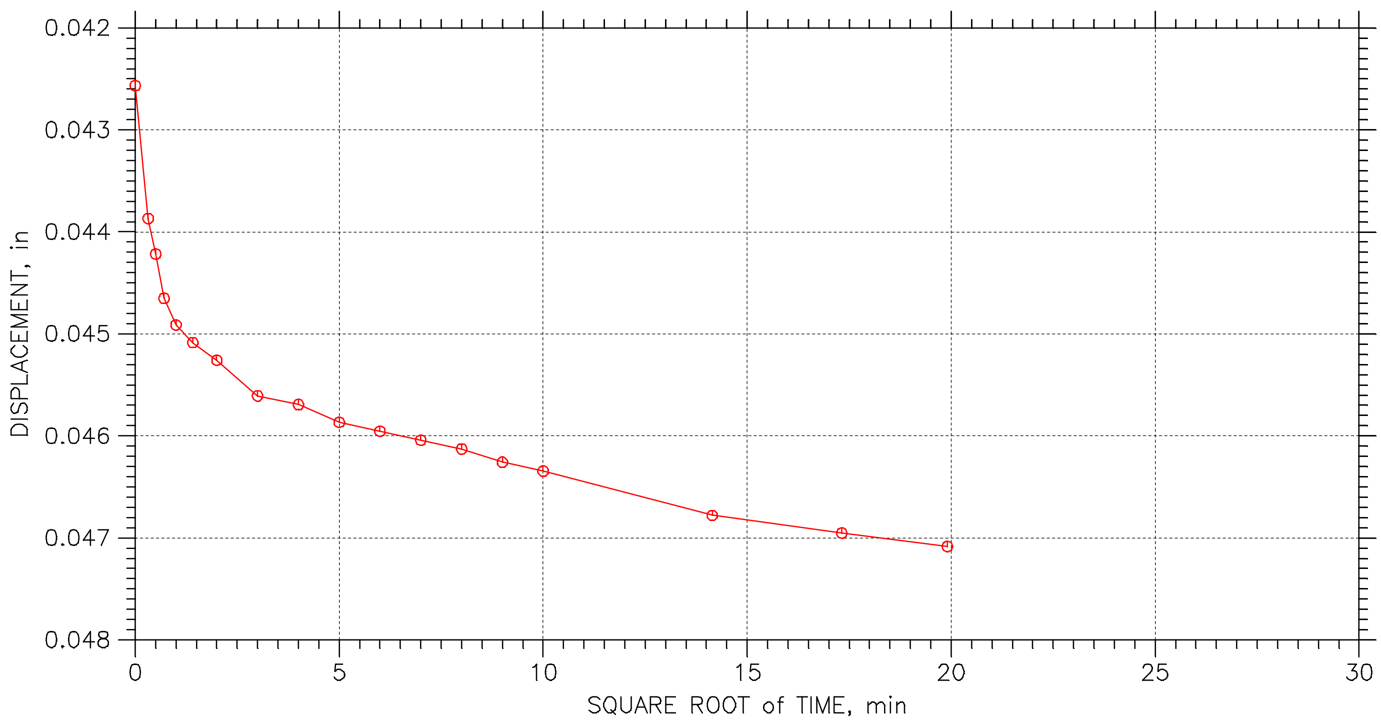
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 18 of 27

Stress: 2. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

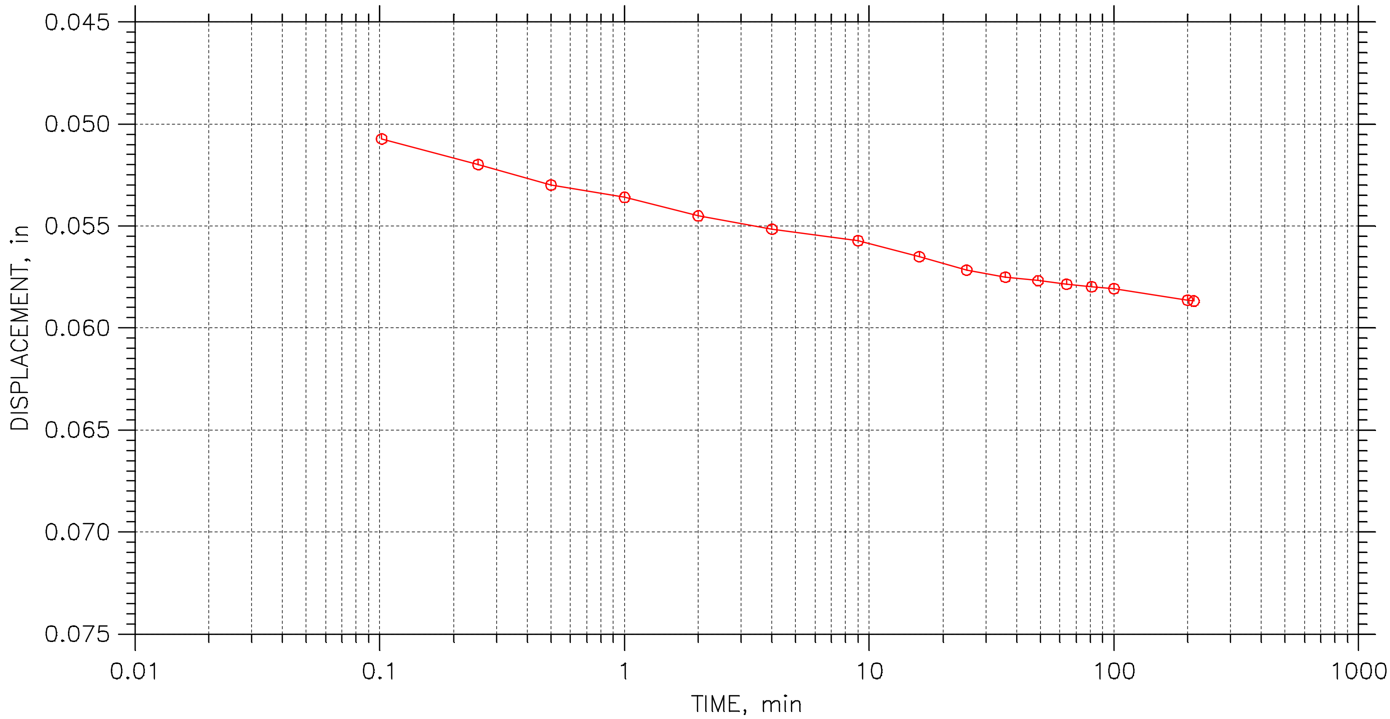
Tue, 26-APR-2016 10:52:24

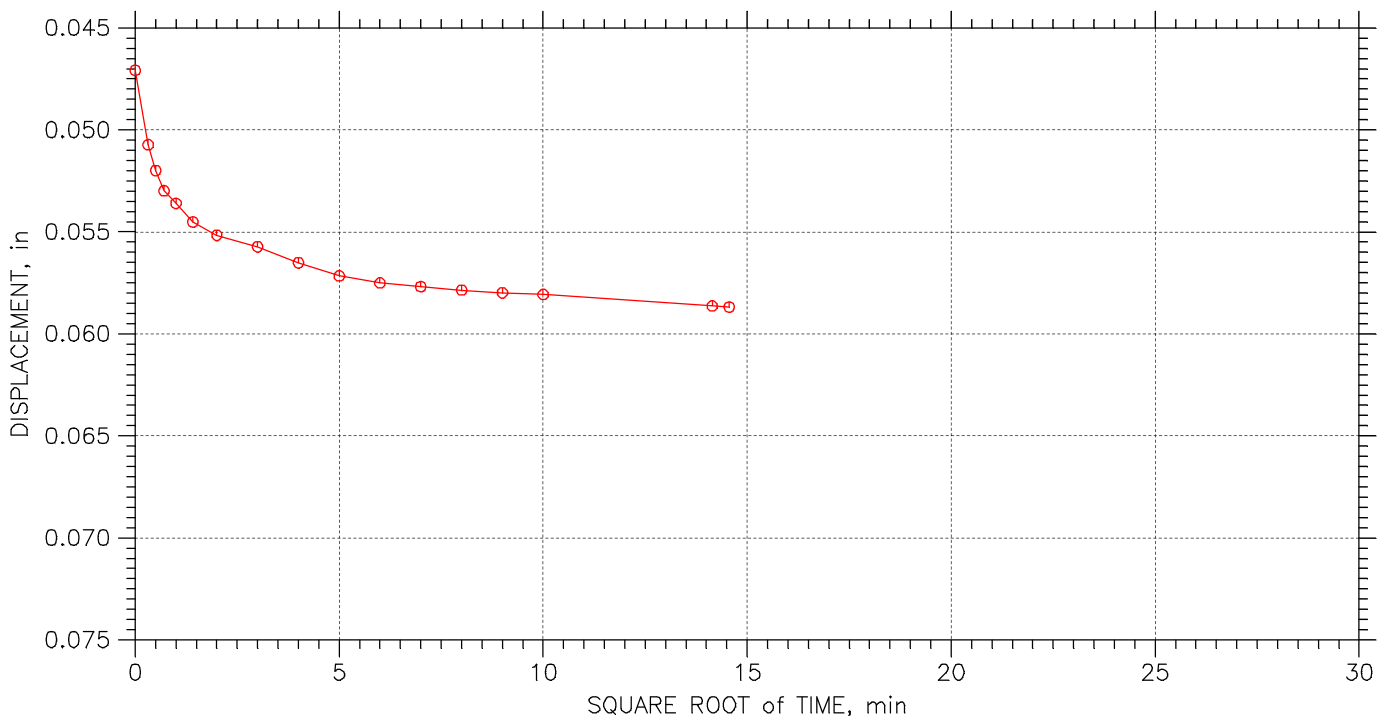
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 19 of 27

Stress: 4. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

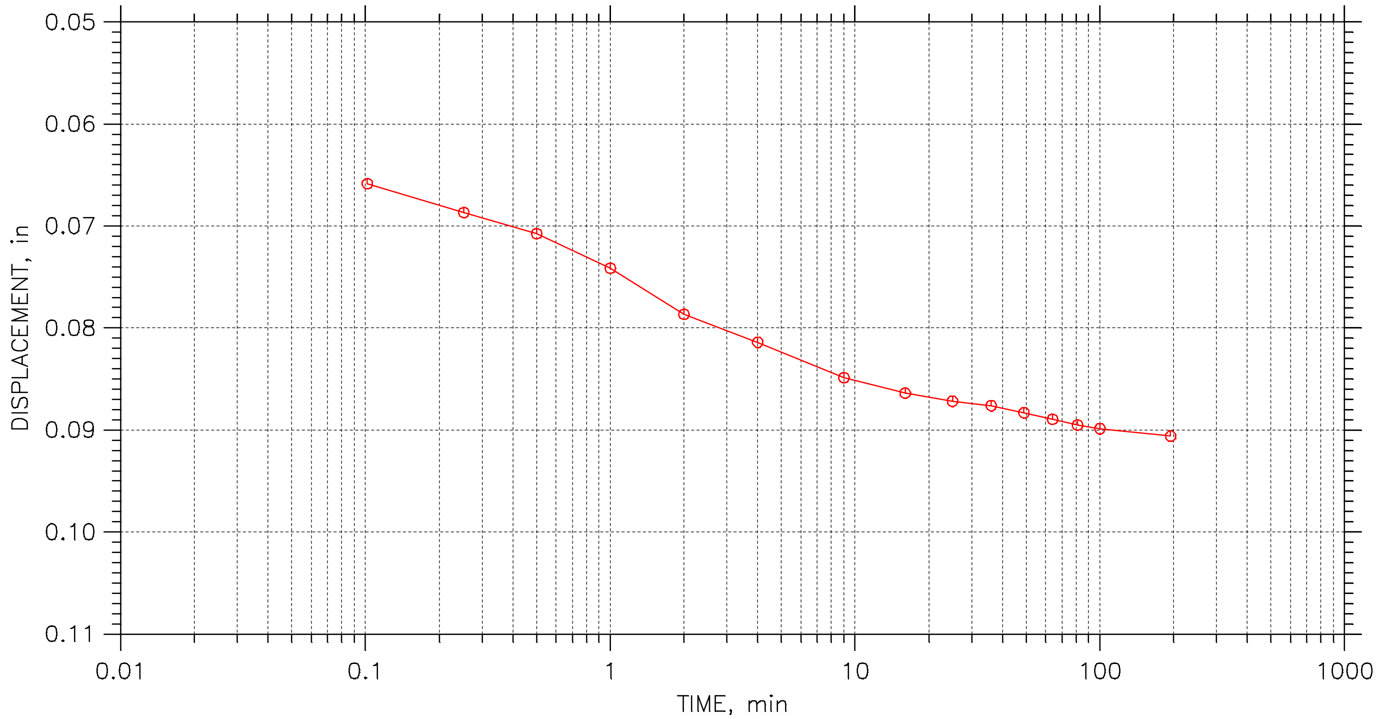
Tue, 26-APR-2016 10:52:25

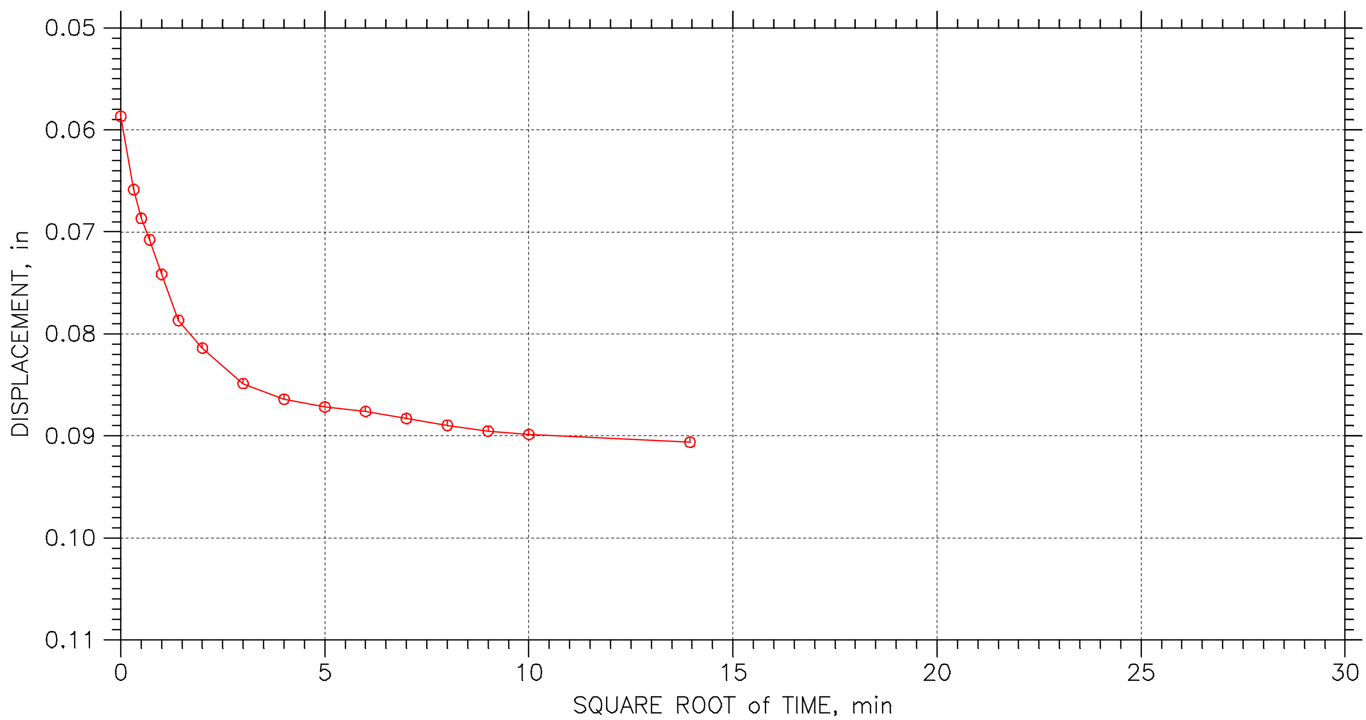
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 20 of 27

Stress: 8. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

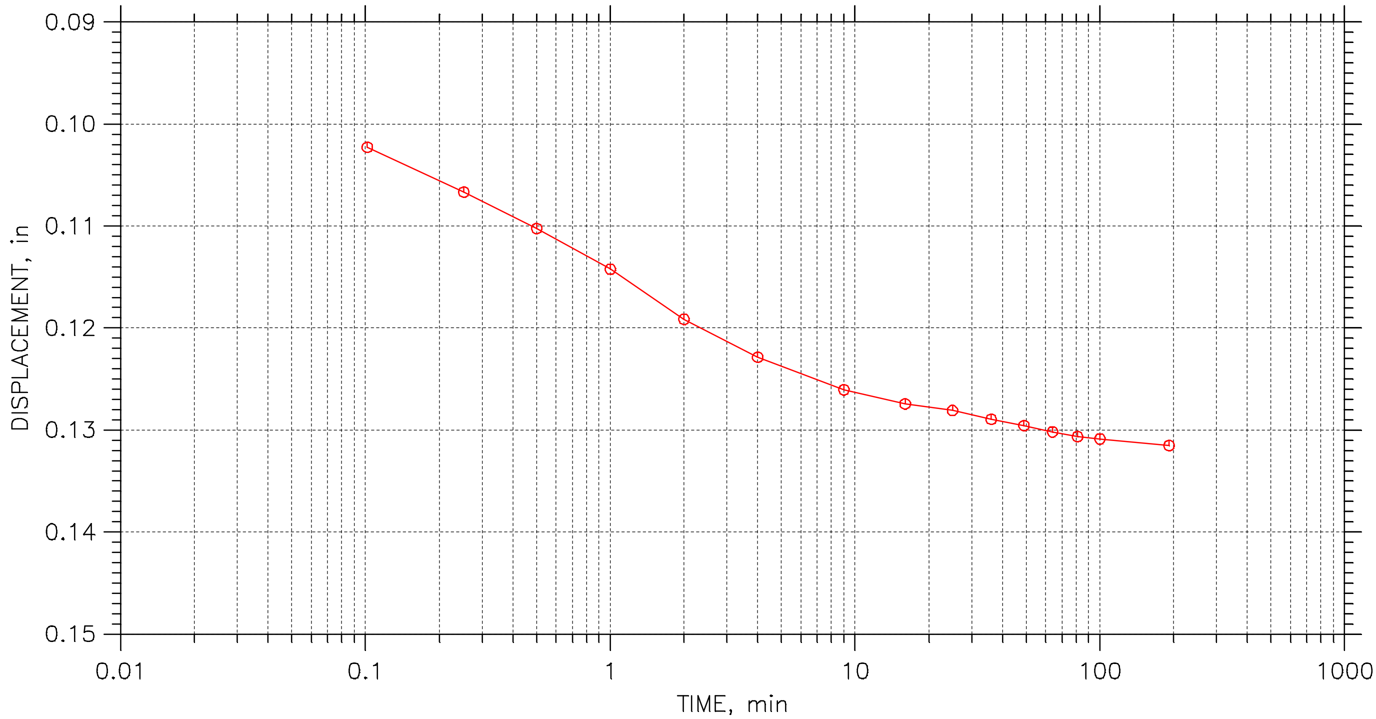
Tue, 26-APR-2016 10:52:27

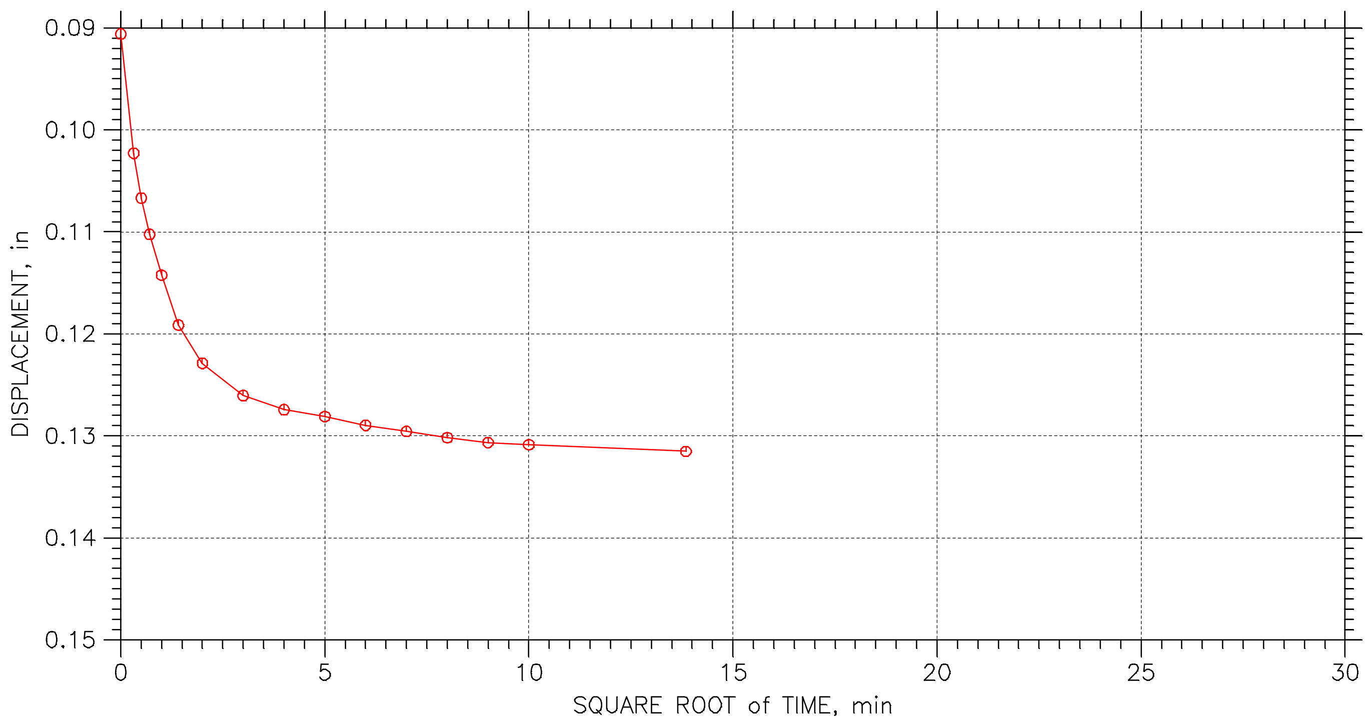
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 21 of 27

Stress: 16. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

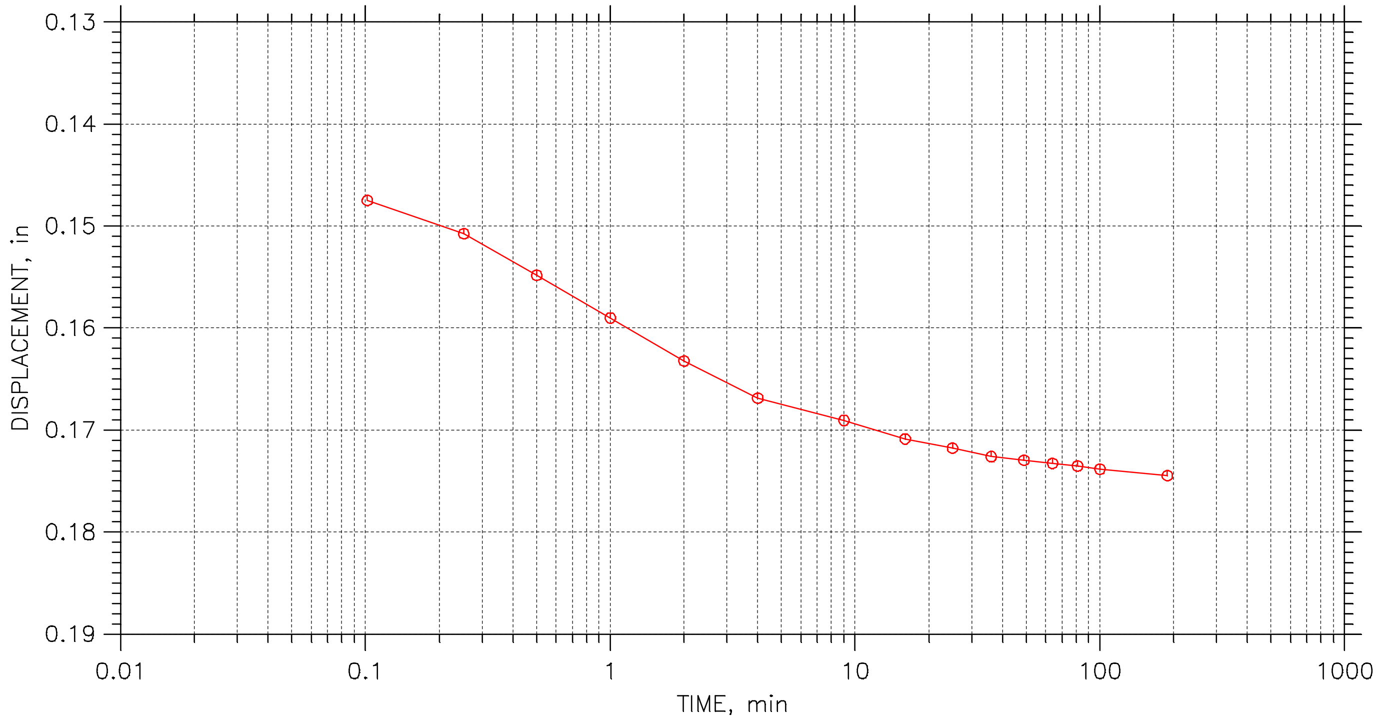
Tue, 26-APR-2016 10:52:28

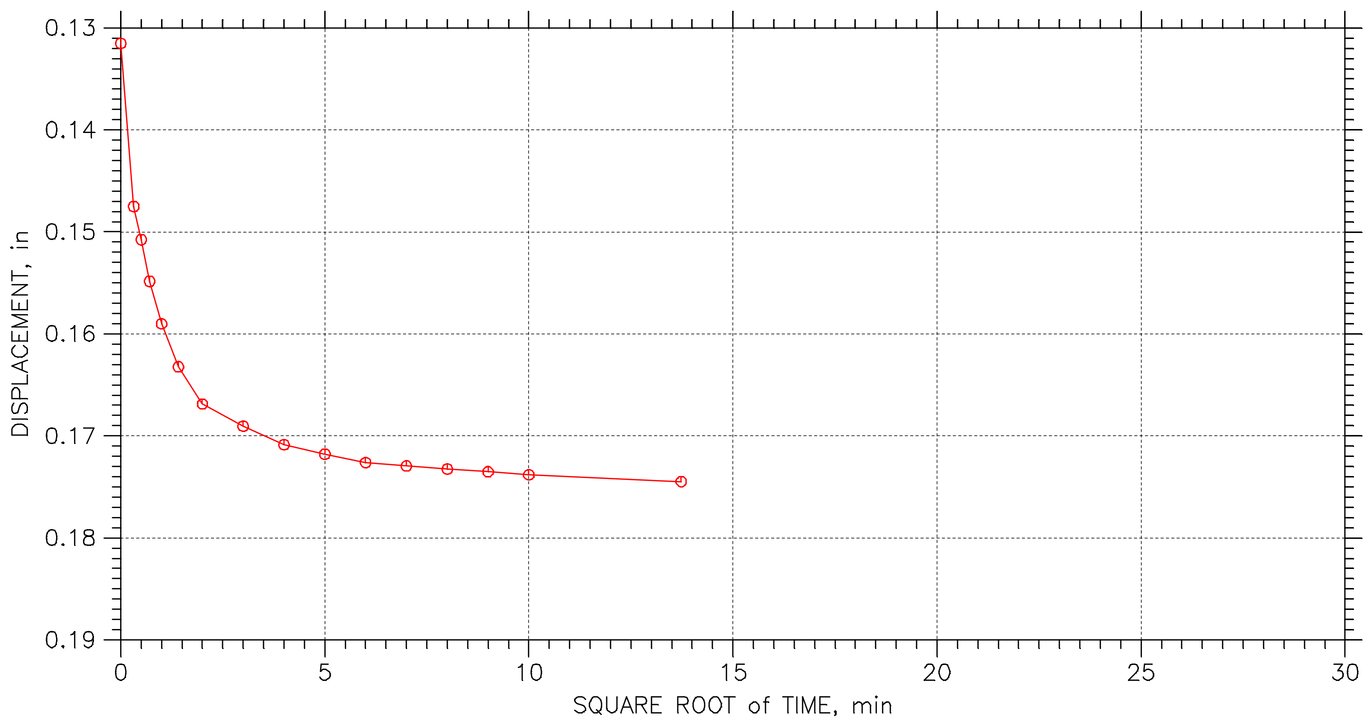
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 22 of 27

Stress: 32. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

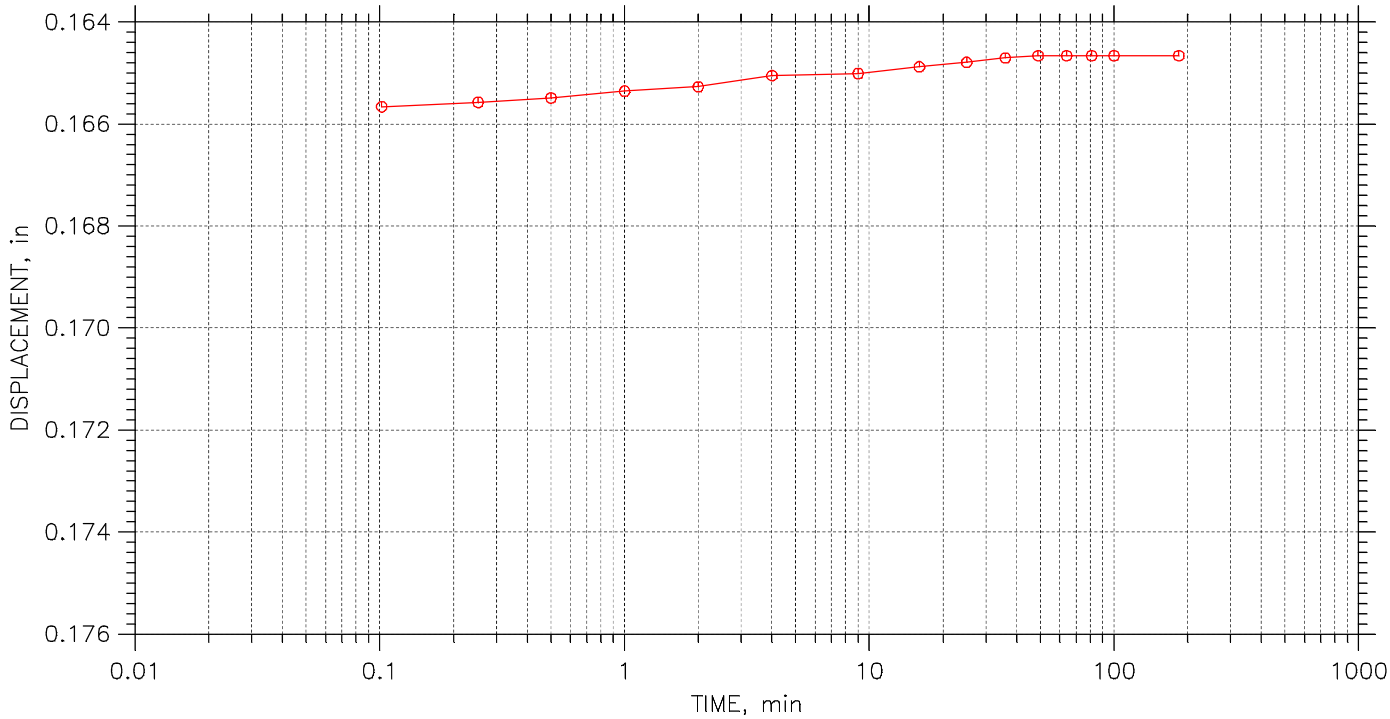
Tue, 26-APR-2016 10:52:30

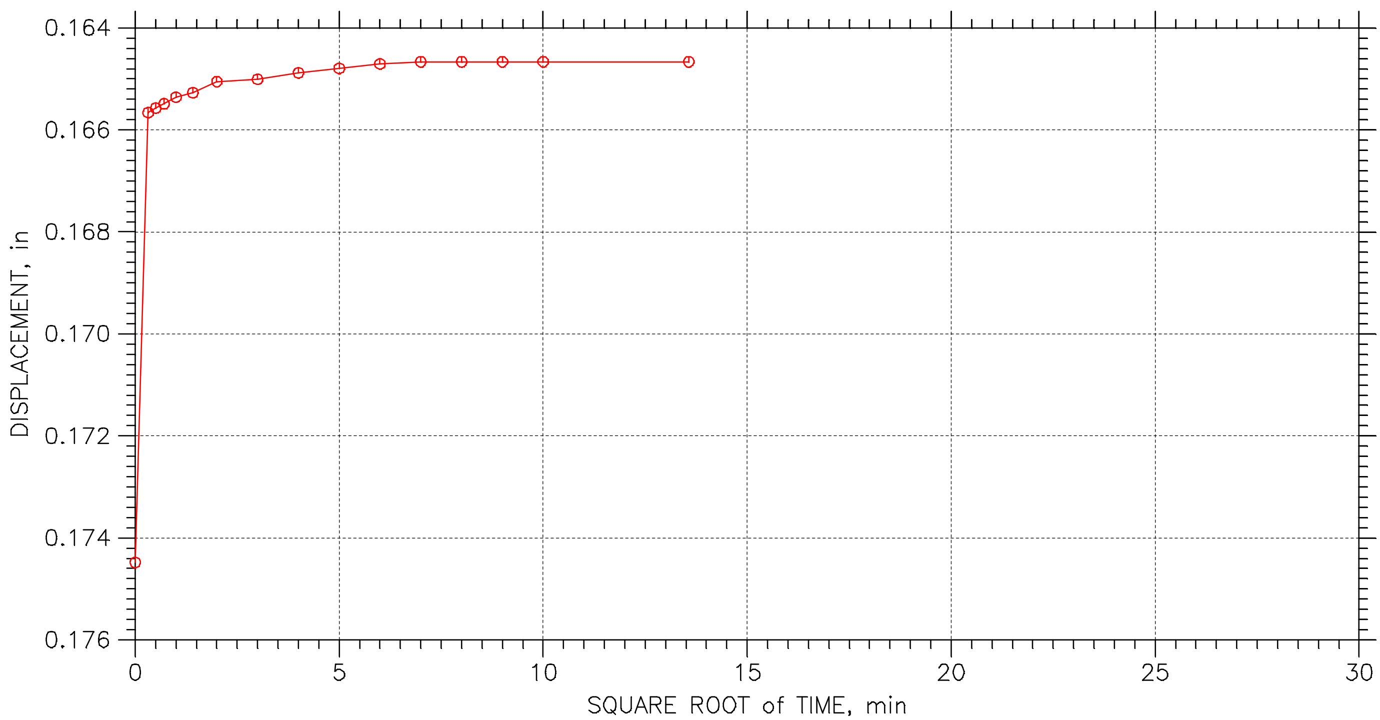
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 23 of 27

Stress: 16. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

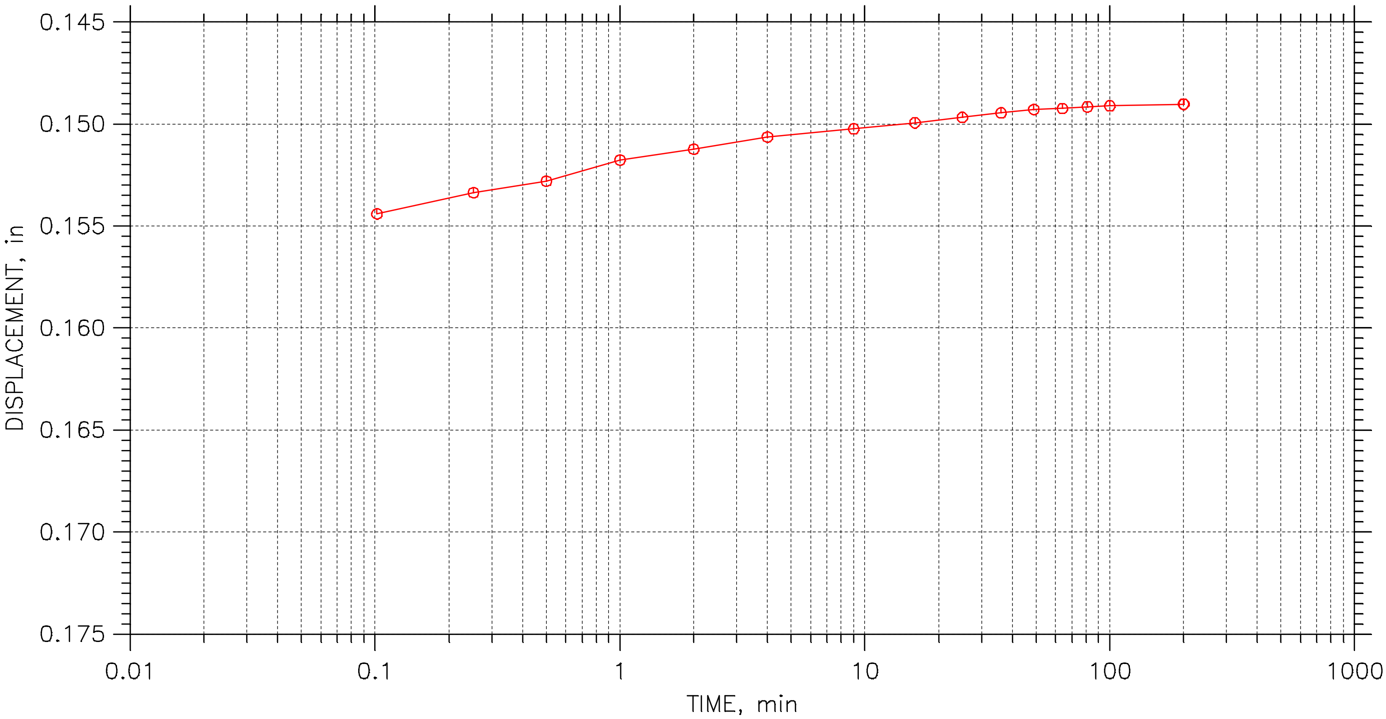
Tue, 26-APR-2016 10:52:31

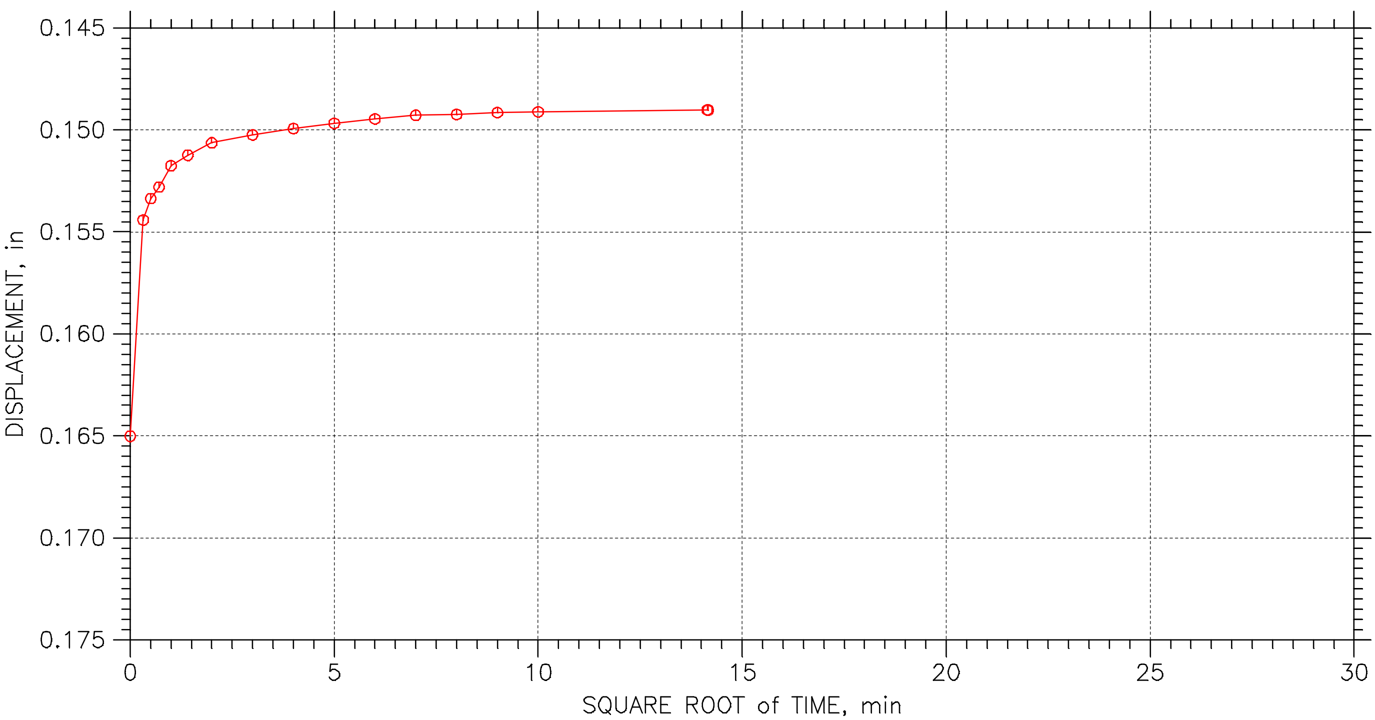
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 24 of 27

Stress: 4. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

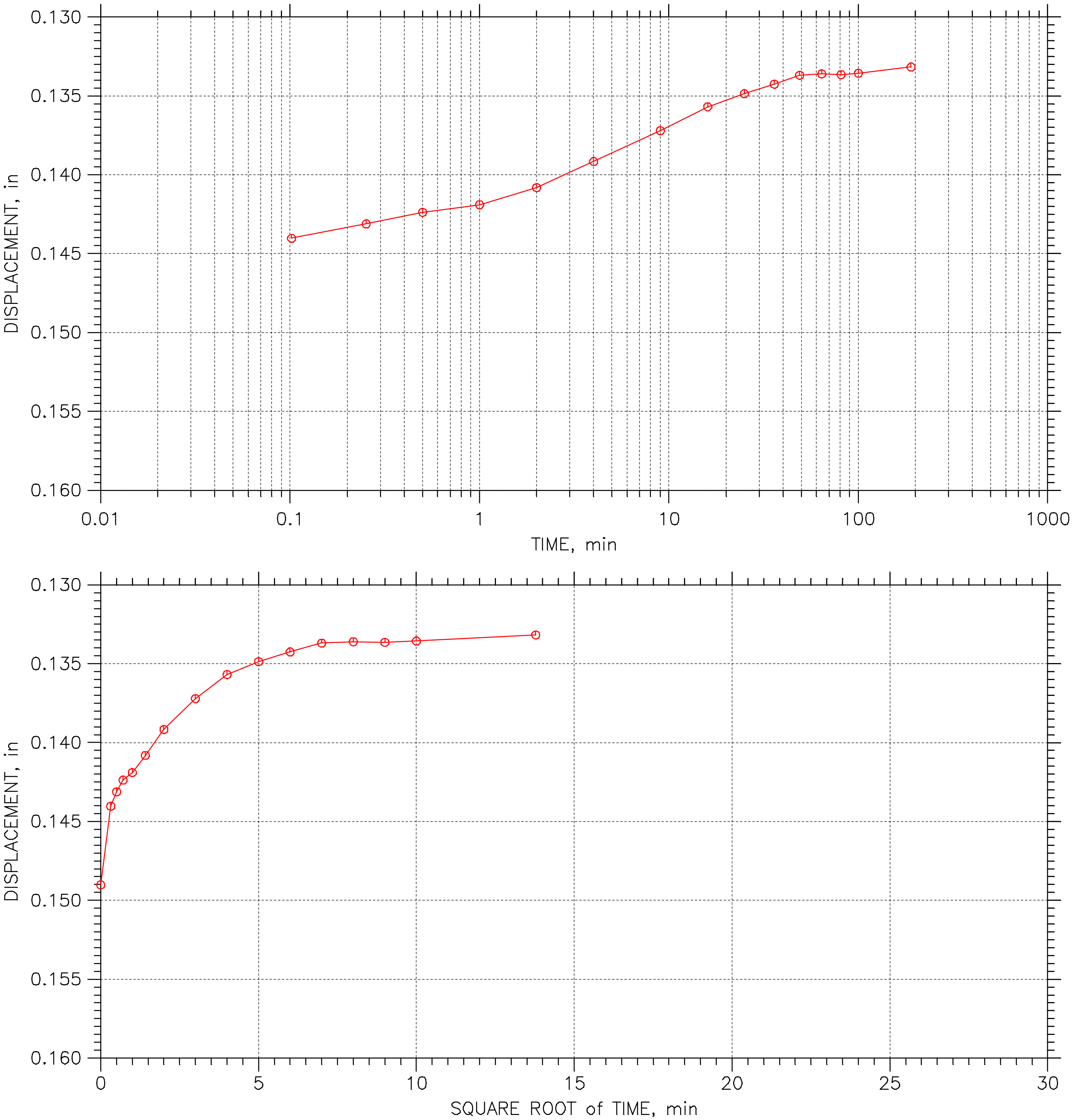
Tue, 26-APR-2016 10:52:32

CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 25 of 27

Stress: 1. tsf



Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

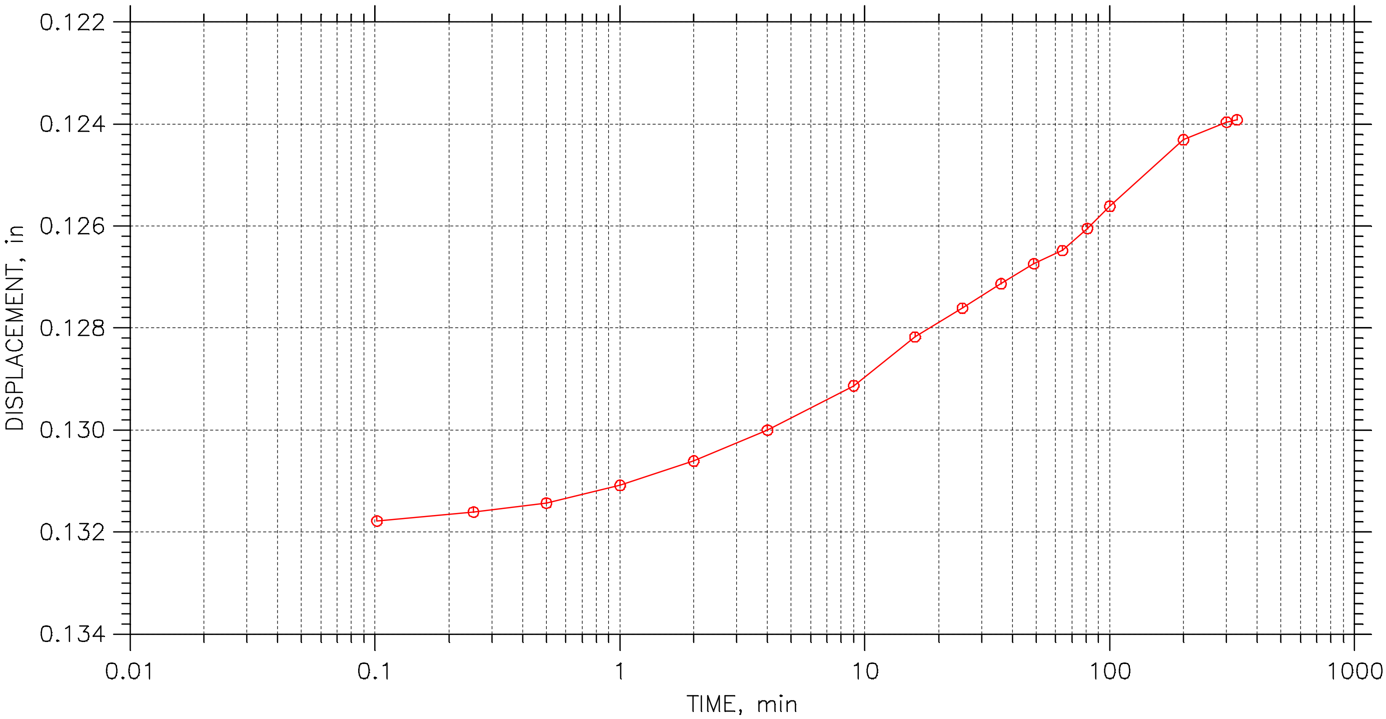
Tue, 26-APR-2016 10:52:34

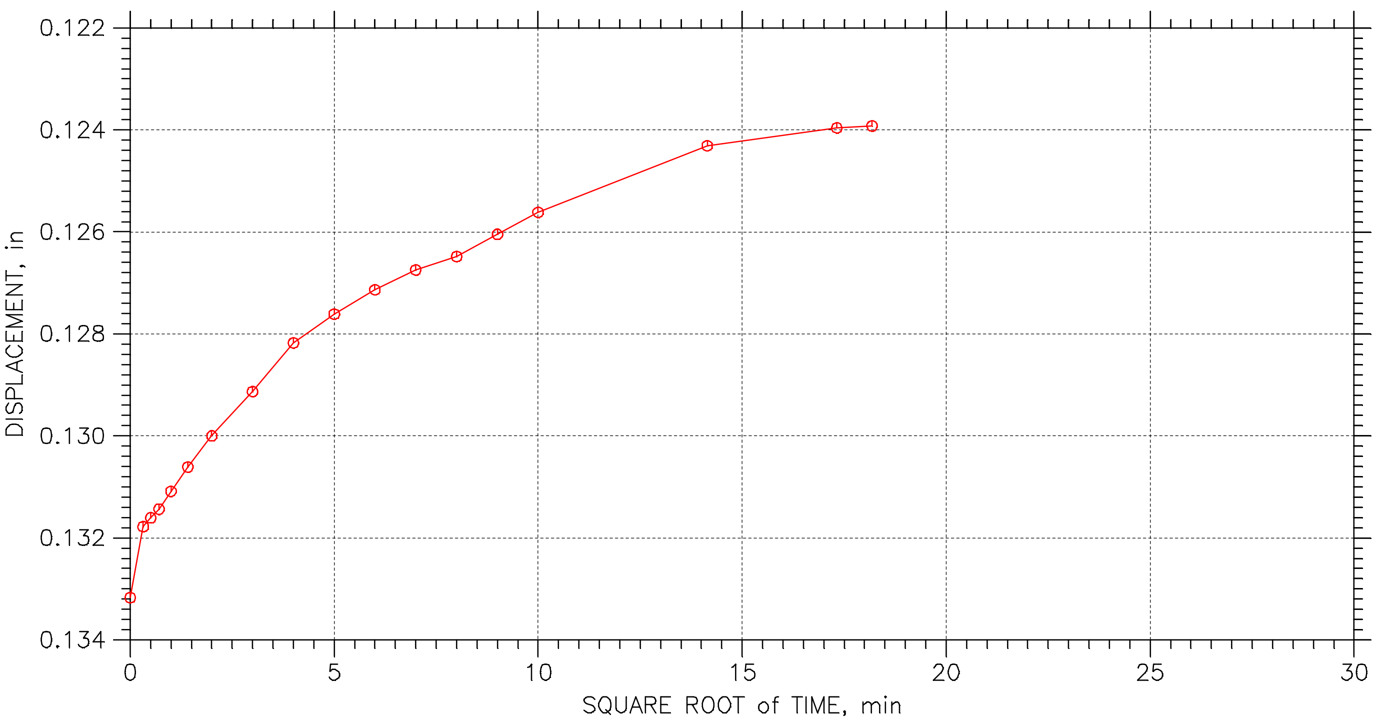
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 26 of 27

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0" ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

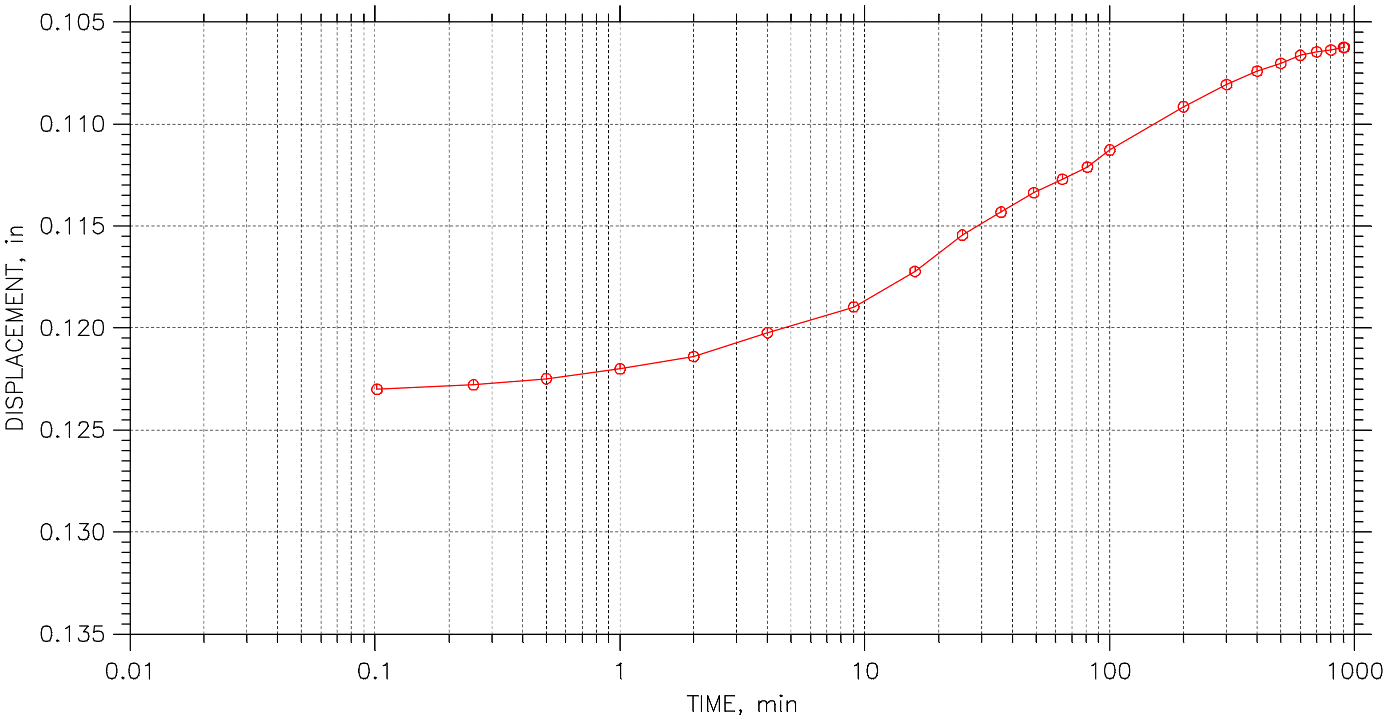
Tue, 26-APR-2016 10:52:35

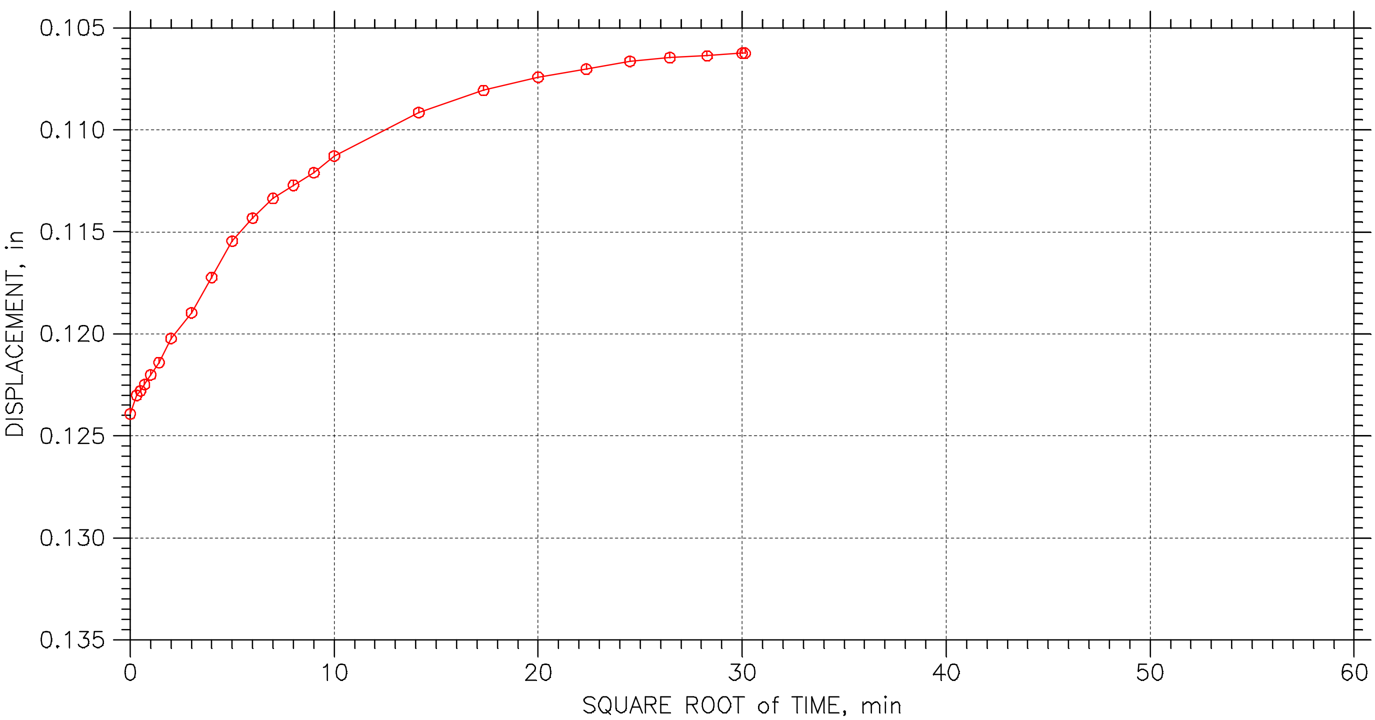
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 27 of 27

Stress: 0.125 tsf

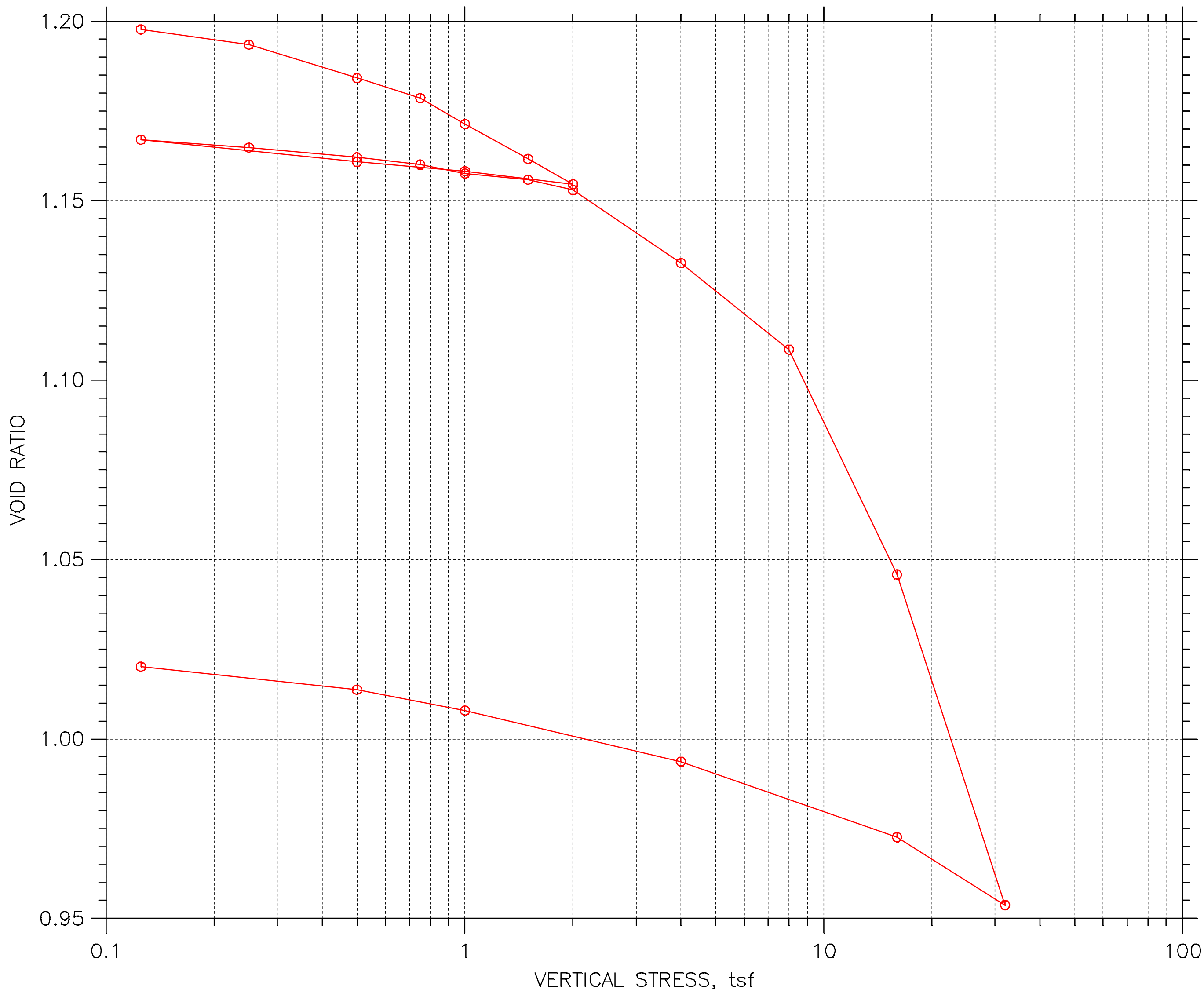




Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH CL		
	Remarks: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435		

Tue, 26-APR-2016 10:52:37

ONE DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS
USING INCREMENTAL LOADING
ASTM D2435



					Before Test	After Test
Overburden Pressure: 1.1 tsf				Water Content, %	45.09	39.22
Preconsolidation Pressure: 6 tsf				Dry Unit Weight, pcf	74.71	81.58
				Saturation, %	98.71	101.49
Diameter: 2.502 in		Height: 1.001 in		Void Ratio	1.21	1.02
LL: ---	PL: ---	PI: ---	GS: 2.64			

Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

Terracon
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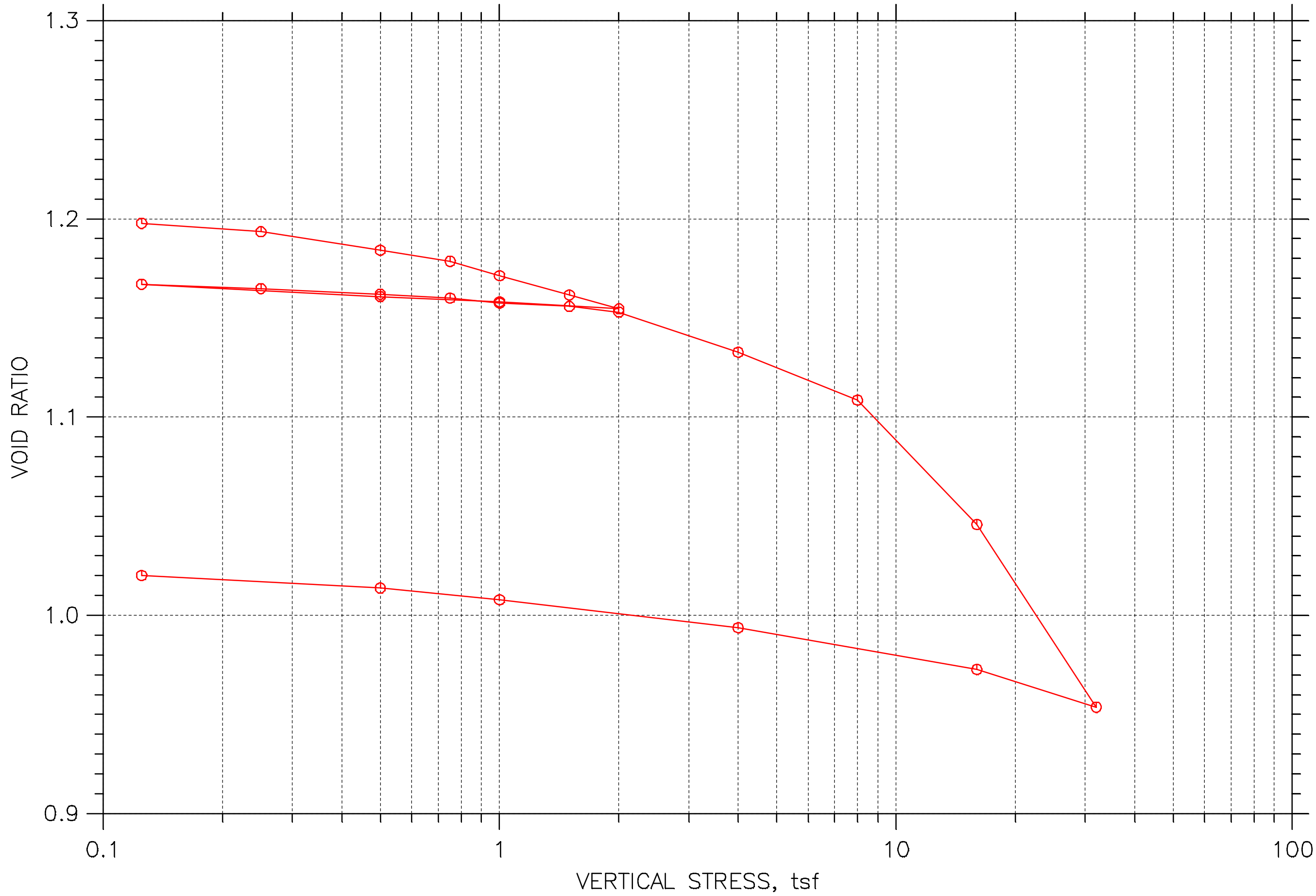
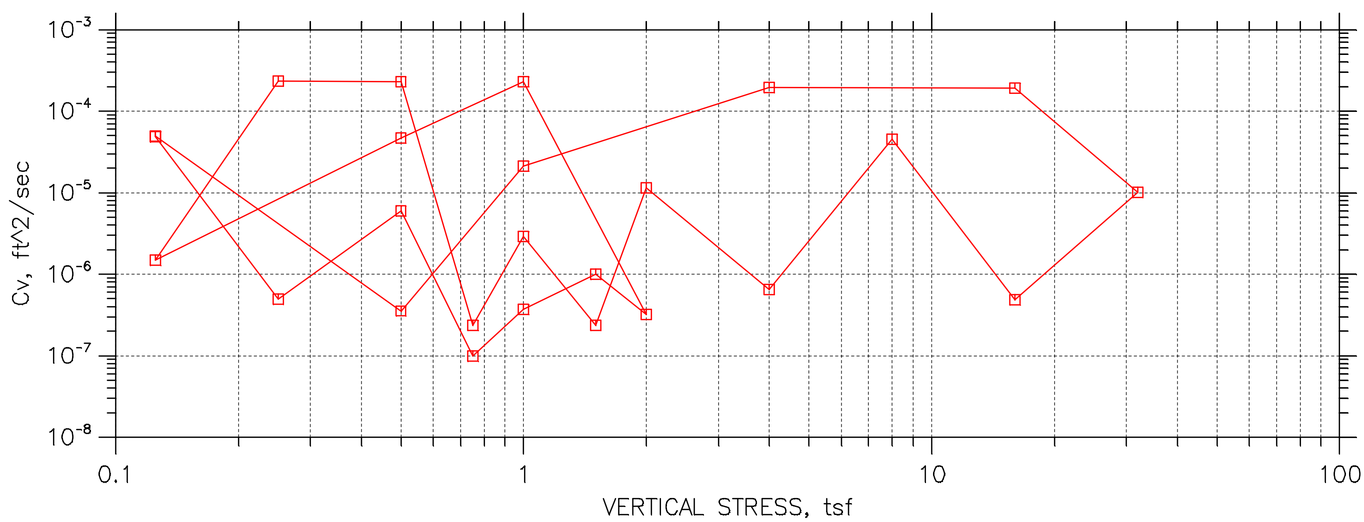
Tue, 26-APR-2016 13:53:03

ONE DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS
USING INCREMENTAL LOADING
ASTM D2435





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

Tue, 26-APR-2016 13:50:25

Terracon Consulting Engineers & Scientists

CONSOLIDATION TEST DATA

Project: VECTREN CULLEY E POND
Location: NEWBURGH, IN
Project No.: AW165009
Boring No.: B16-2 ST-4
Tested By: BCM
Checked By: BCM
Sample No.: ST4
Test Date: 4/22/16
Depth: 29.0'-31.0'
Test No.: B162ST4CON
Sample Type: 3.0" ST
Elevation: ----

Soil Description: DARK BROWNISH GRAY FLY ASH WITH CLAY
Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435

Measured Specific Gravity: 2.64
Liquid Limit: ---
Initial Height: 1.00 in
Initial Void Ratio: 1.21
Plastic Limit: ---
Specimen Diameter: 2.50 in
Final Void Ratio: 1.02
Plasticity Index: ---

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	X-6	RING	RING	X-5
Wt. Container + Wet Soil, gm	201.73	251.52	245.85	176.7
Wt. Container + Dry Soil, gm	144.76	208.01	208.01	139.38
Wt. Container, gm	43.55	111.52	111.52	44.22
Wt. Dry Soil, gm	101.21	96.489	96.489	95.16
Water Content, %	56.29	45.09	39.22	39.22
Void Ratio	---	1.21	1.02	---
Degree of Saturation, %	---	98.71	101.49	---
Dry Unit Weight, pcf	---	74.707	81.583	---

CONSOLIDATION TEST DATA

Project: VECTREN CULLEY E POND
Boring No.: B16-2 ST-4
Sample No.: ST4
Test No.: B162ST4CON

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 4/22/16
Sample Type: 3.0" ST

Project No.: AW165009
Checked By: BCM
Depth: 29.0'-31.0'
Elevation: ----

Soil Description: DARK BROWNISH GRAY FLY ASH WITH CLAY
Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435

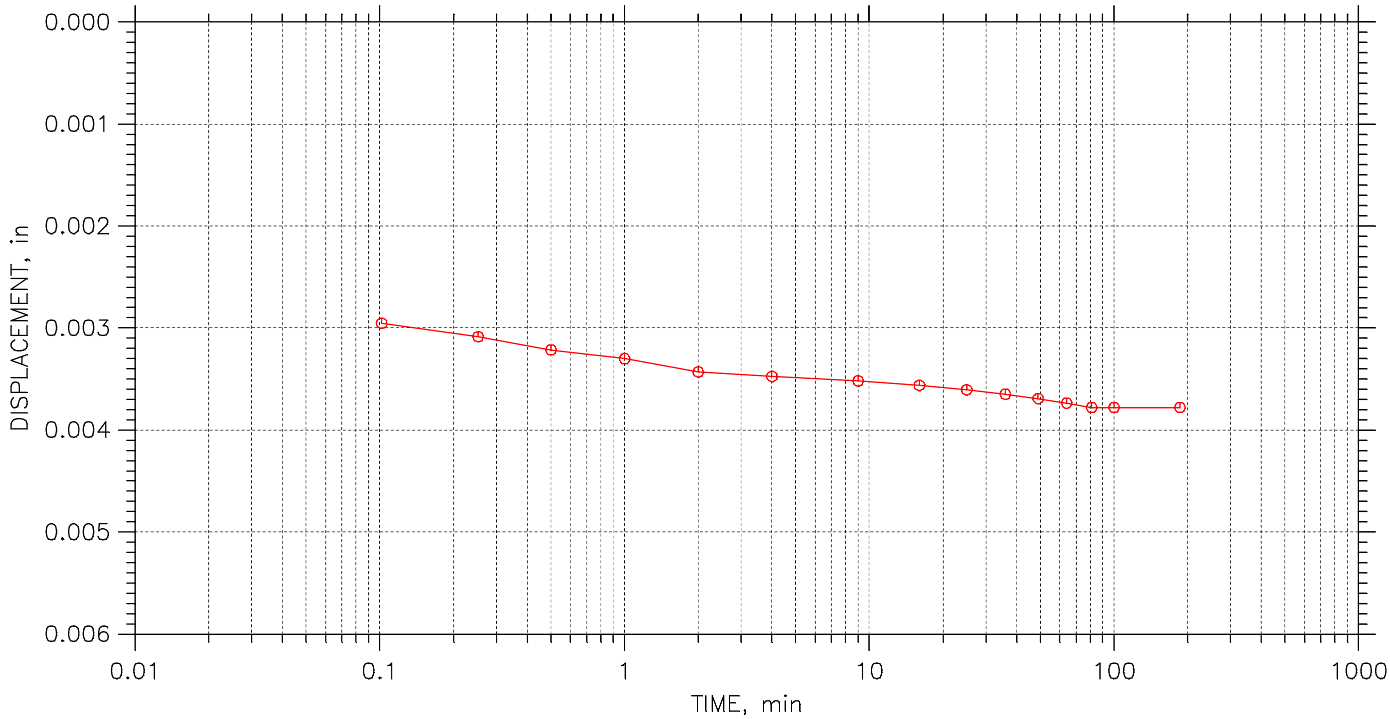
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	T50 Fitting Sq.Rt. min	T50 Fitting Log min	Coefficient of Consolidation Sq.Rt. ft^2/sec	Coefficient of Consolidation Log ft^2/sec	Coefficient of Consolidation Ave. ft^2/sec
1	0.125	0.003779	1.198	0.38	0.1	0.0	4.88e-005	0.00e+000	4.88e-005
2	0.25	0.005733	1.193	0.57	11.4	0.0	4.95e-007	0.00e+000	4.95e-007
3	0.5	0.009947	1.184	0.99	0.9	0.0	6.03e-006	0.00e+000	6.03e-006
4	0.75	0.01247	1.179	1.25	56.2	0.0	9.94e-008	0.00e+000	9.94e-008
5	1	0.01577	1.171	1.58	14.9	0.0	3.72e-007	0.00e+000	3.72e-007
6	1.5	0.02015	1.162	2.01	5.5	0.0	1.00e-006	0.00e+000	1.00e-006
7	2	0.02337	1.155	2.33	17.1	0.0	3.21e-007	0.00e+000	3.21e-007
8	1	0.02172	1.158	2.17	0.0	0.0	2.30e-004	0.00e+000	2.30e-004
9	0.5	0.02054	1.161	2.05	0.1	0.0	4.69e-005	0.00e+000	4.69e-005
10	0.125	0.01772	1.167	1.77	3.7	0.0	1.49e-006	0.00e+000	1.49e-006
11	0.25	0.01872	1.165	1.87	0.0	0.0	2.32e-004	0.00e+000	2.32e-004
12	0.5	0.01998	1.162	2.00	0.0	0.0	2.31e-004	0.00e+000	2.31e-004
13	0.75	0.02089	1.160	2.09	23.3	0.0	2.35e-007	0.00e+000	2.35e-007
14	1	0.02202	1.158	2.20	1.9	0.0	2.89e-006	0.00e+000	2.89e-006
15	1.5	0.0228	1.156	2.28	23.3	0.0	2.34e-007	0.00e+000	2.34e-007
16	2	0.02411	1.153	2.41	0.5	0.0	1.14e-005	0.00e+000	1.14e-005
17	4	0.03331	1.133	3.33	8.3	0.0	6.53e-007	0.00e+000	6.53e-007
18	8	0.04426	1.109	4.42	0.1	0.0	4.53e-005	0.00e+000	4.53e-005
19	16	0.07271	1.046	7.27	10.5	0.0	4.85e-007	0.00e+000	4.85e-007
20	32	0.1145	0.954	11.44	0.5	0.0	1.01e-005	0.00e+000	1.01e-005
21	16	0.1059	0.973	10.58	0.0	0.0	1.91e-004	0.00e+000	1.91e-004
22	4	0.09634	0.994	9.63	0.0	0.0	1.94e-004	0.00e+000	1.94e-004
23	1	0.08991	1.008	8.98	0.2	0.0	2.11e-005	0.00e+000	2.11e-005
24	0.5	0.08726	1.014	8.72	13.4	0.0	3.54e-007	0.00e+000	3.54e-007
25	0.125	0.08435	1.020	8.43	0.1	0.0	4.95e-005	0.00e+000	4.95e-005

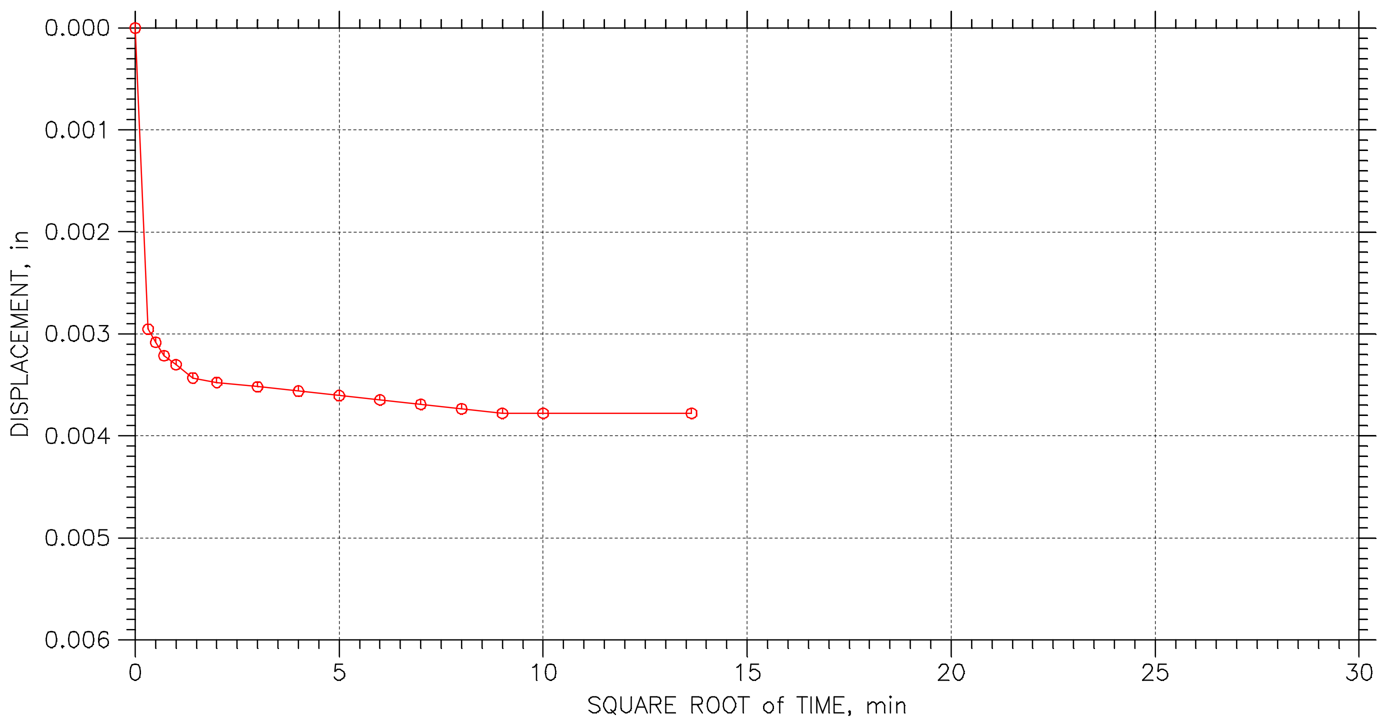
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 1 of 25

Stress: 0.125 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

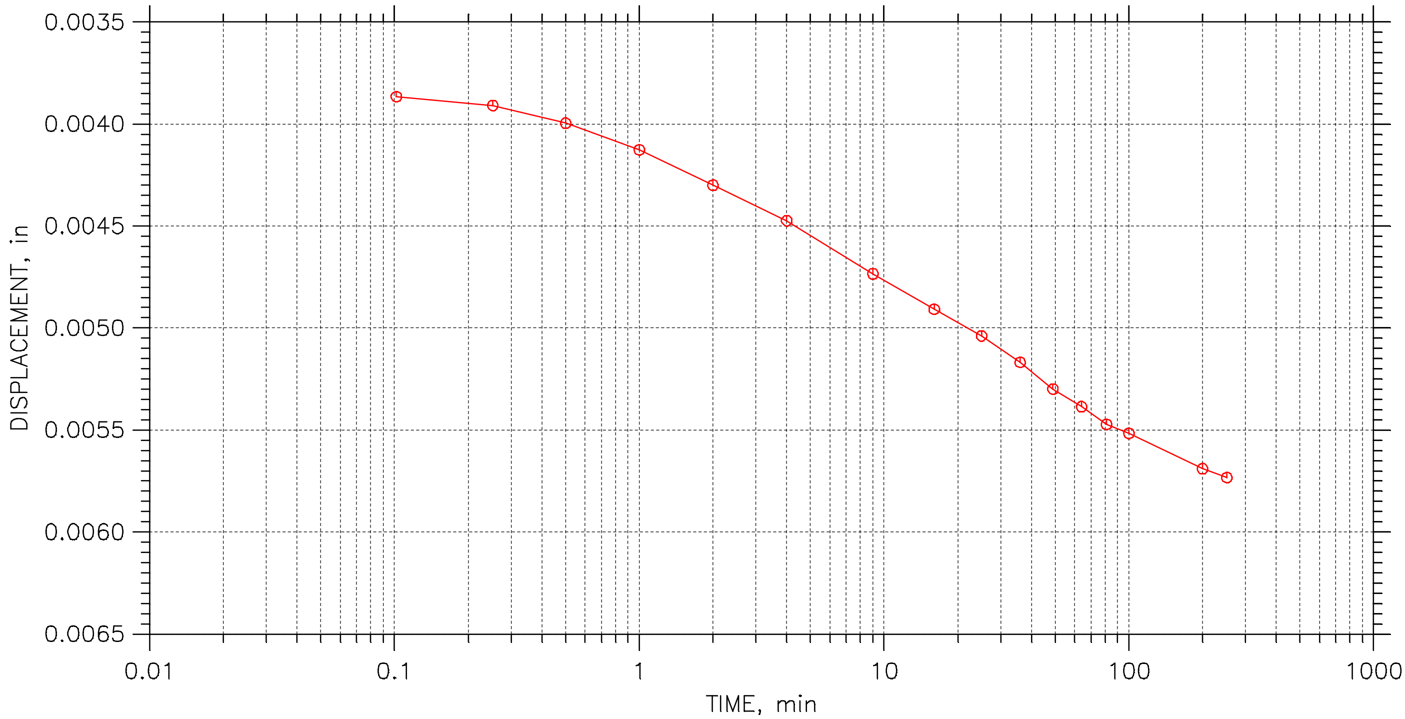
Tue, 26-APR-2016 13:53:51

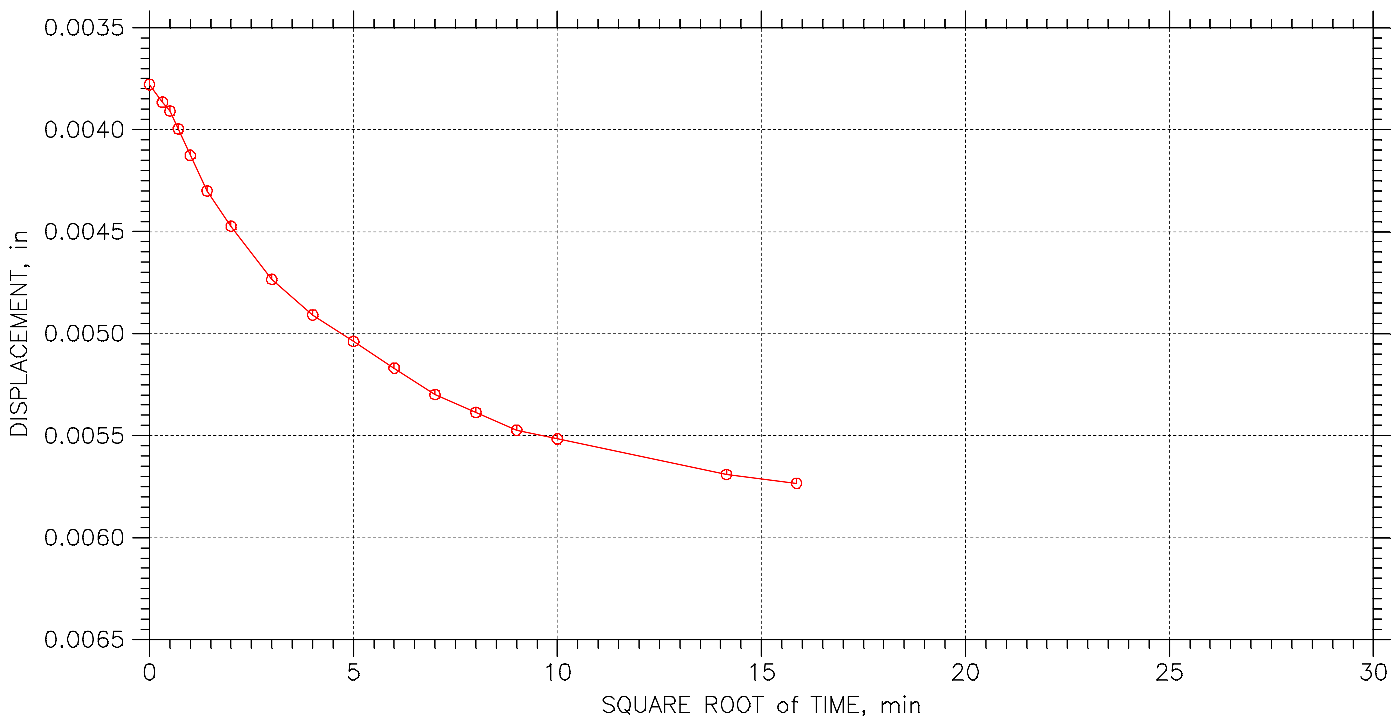
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 2 of 25

Stress: 0.25 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

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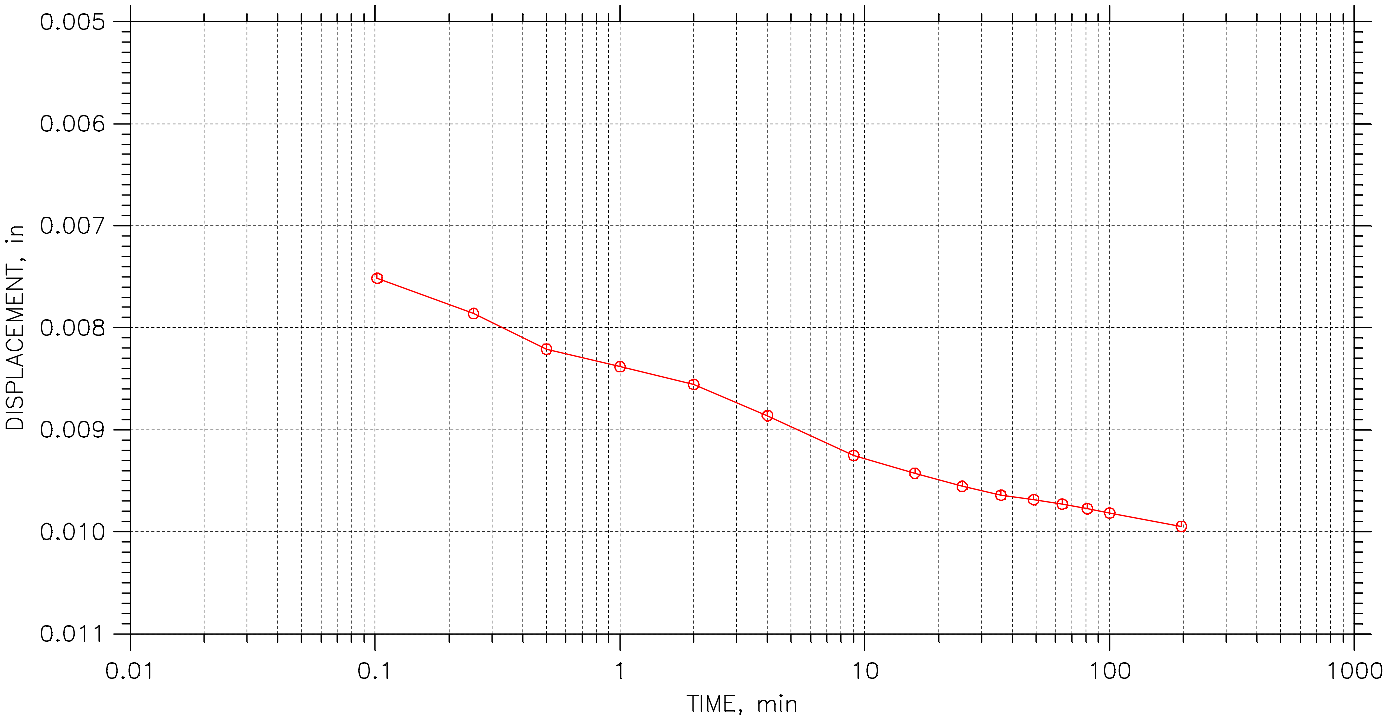
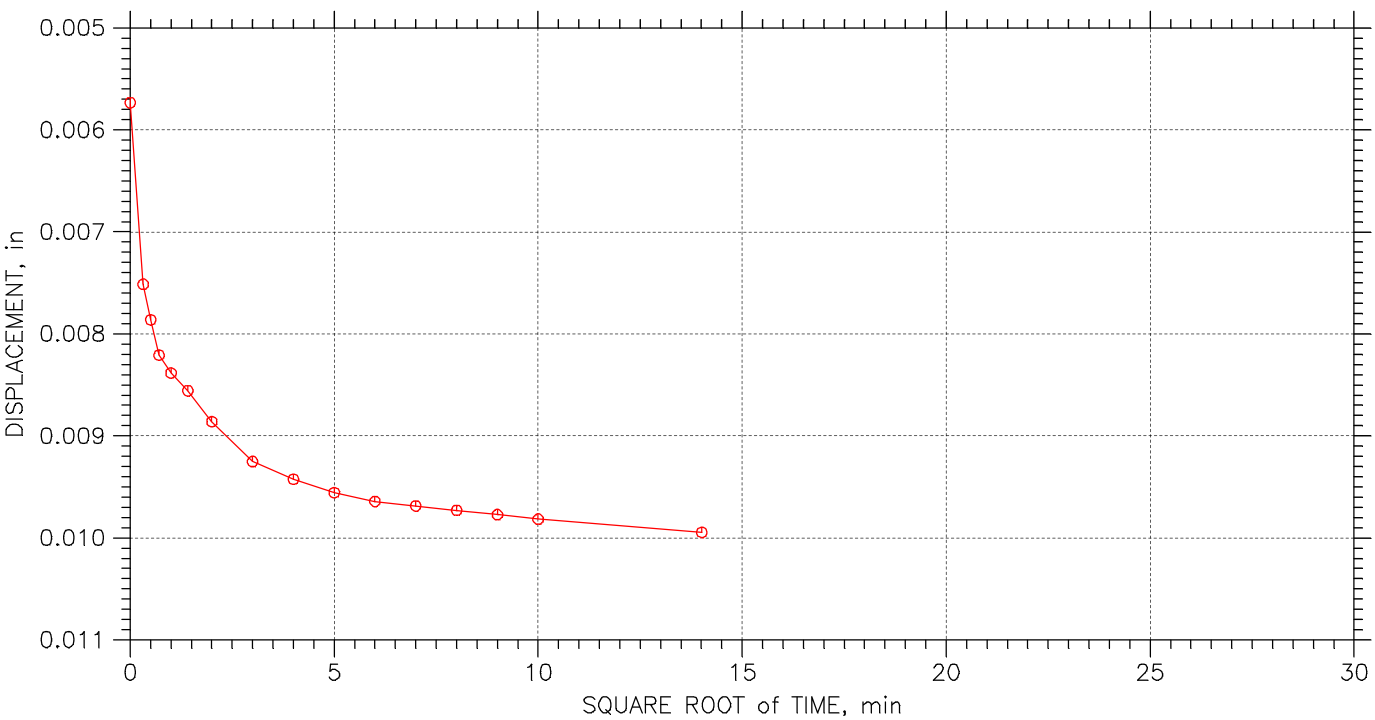
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 3 of 25

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0" ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

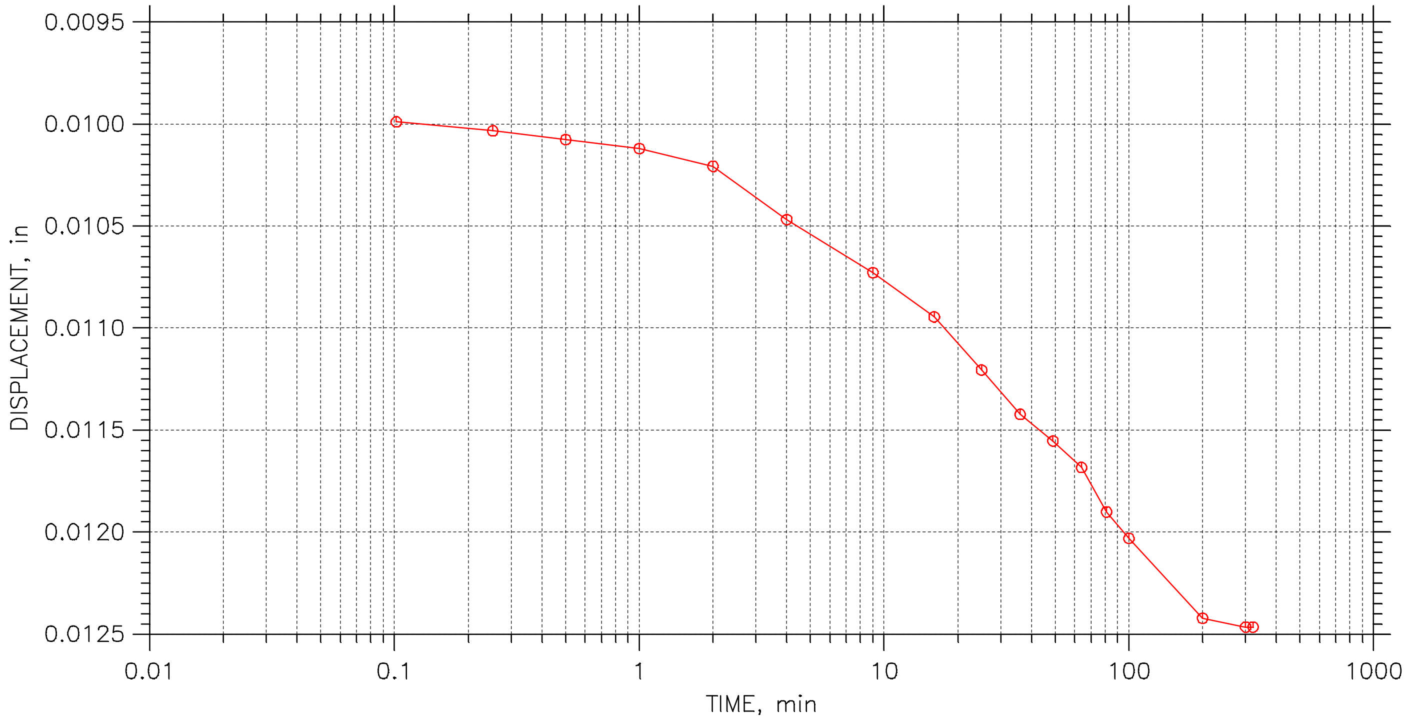
Tue, 26-APR-2016 13:53:54

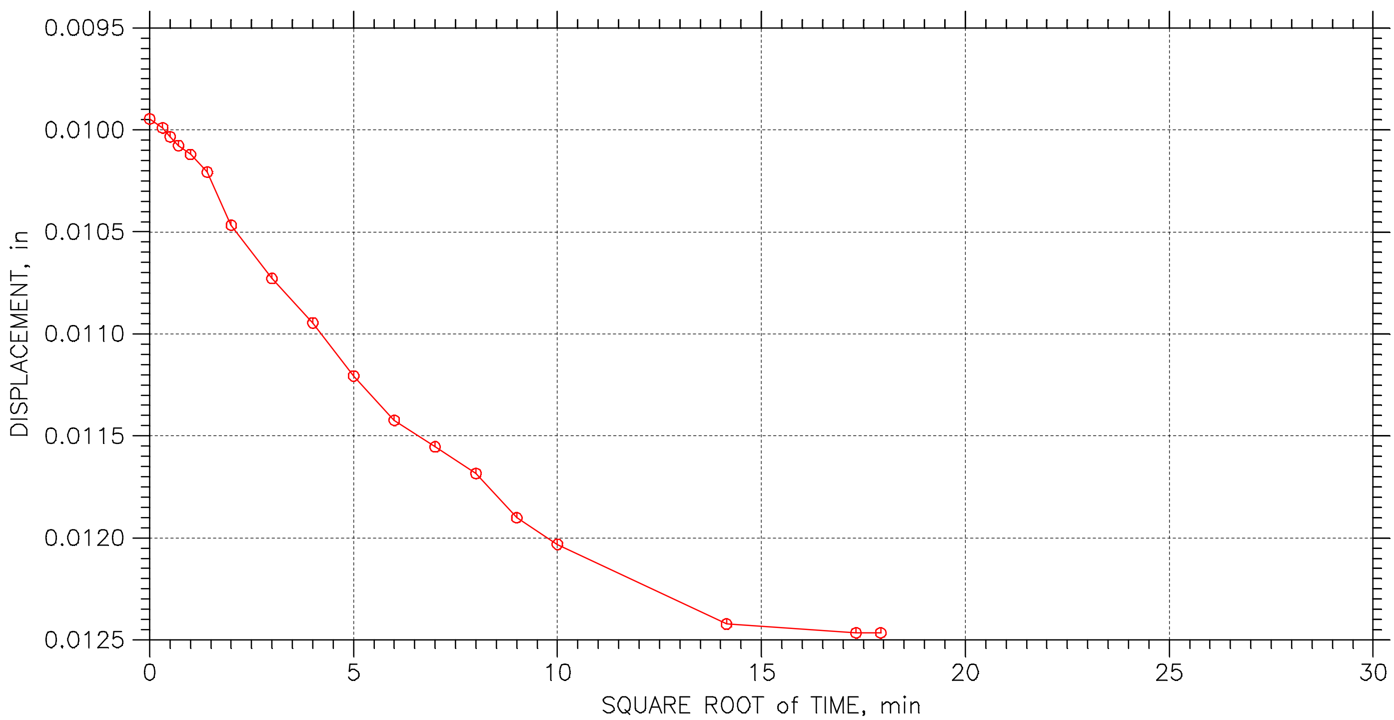
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 4 of 25

Stress: 0.75 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

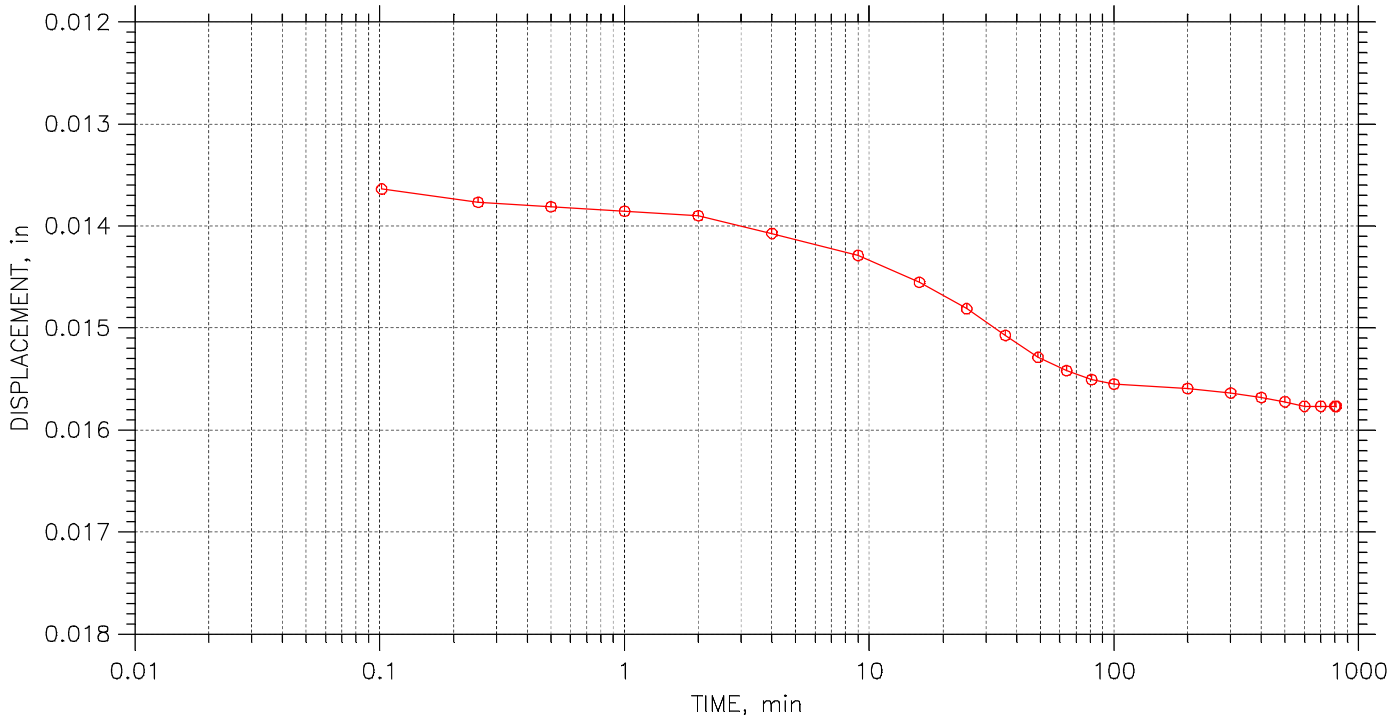
Tue, 26-APR-2016 13:53:56

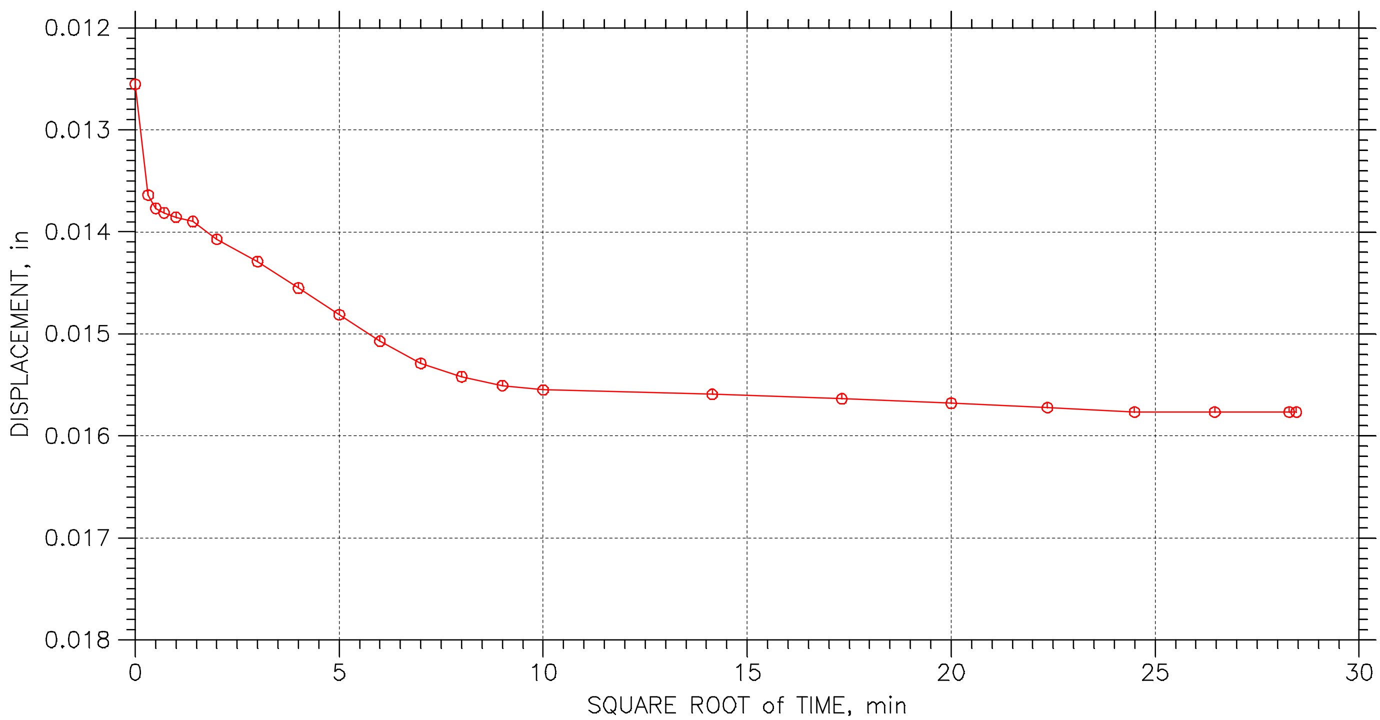
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 5 of 25

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

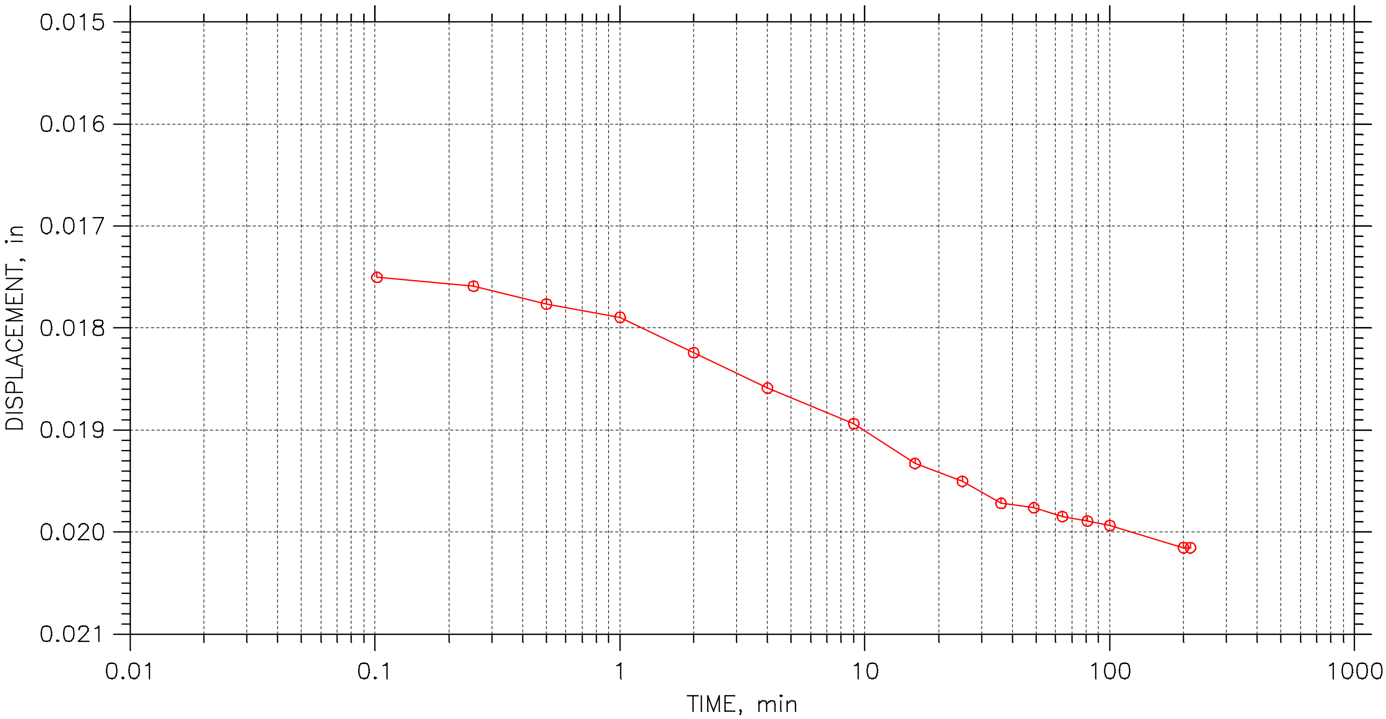
Tue, 26-APR-2016 13:53:57

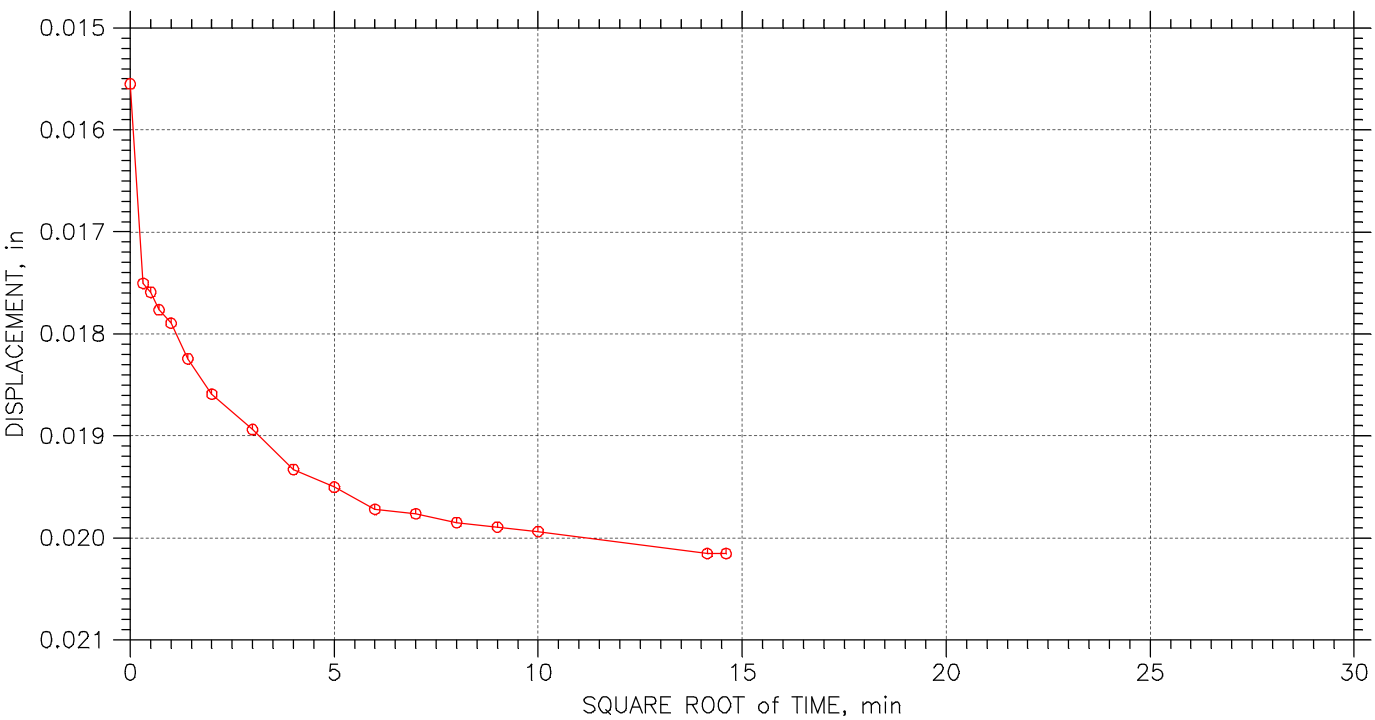
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 6 of 25

Stress: 1.5 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

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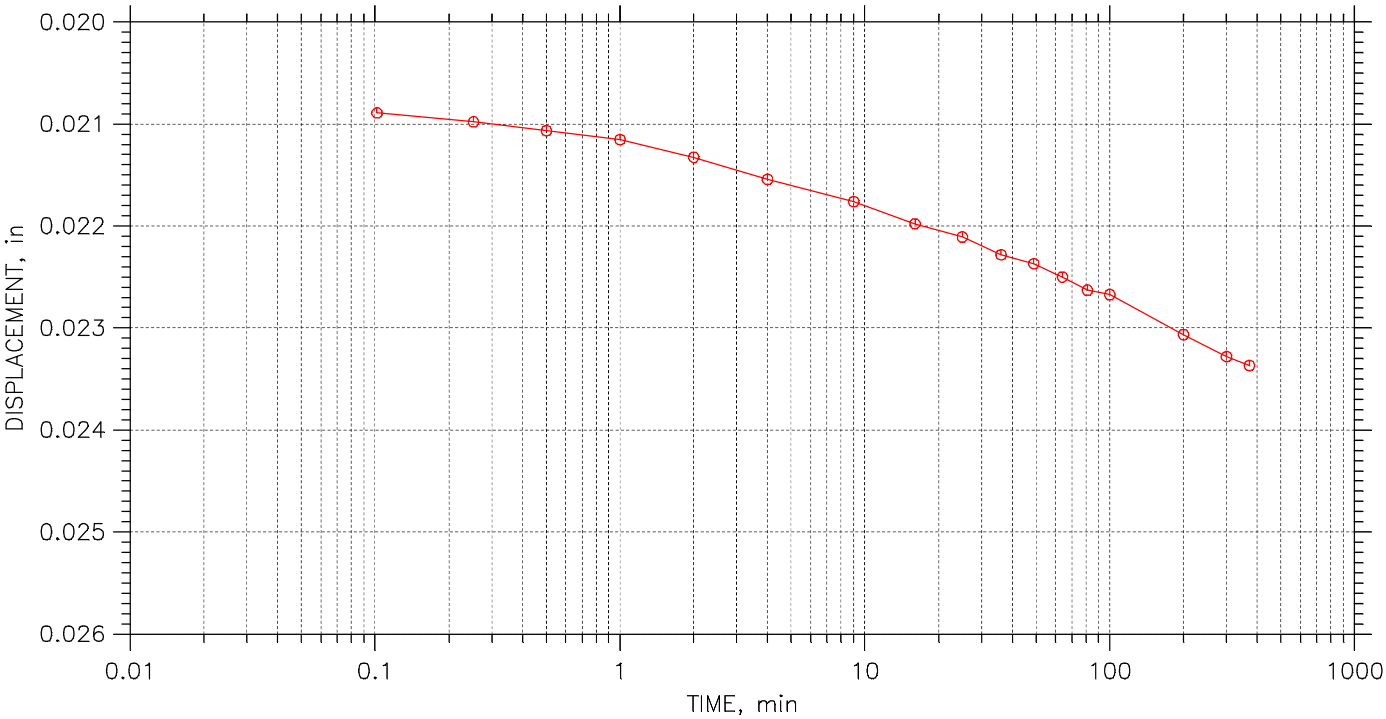
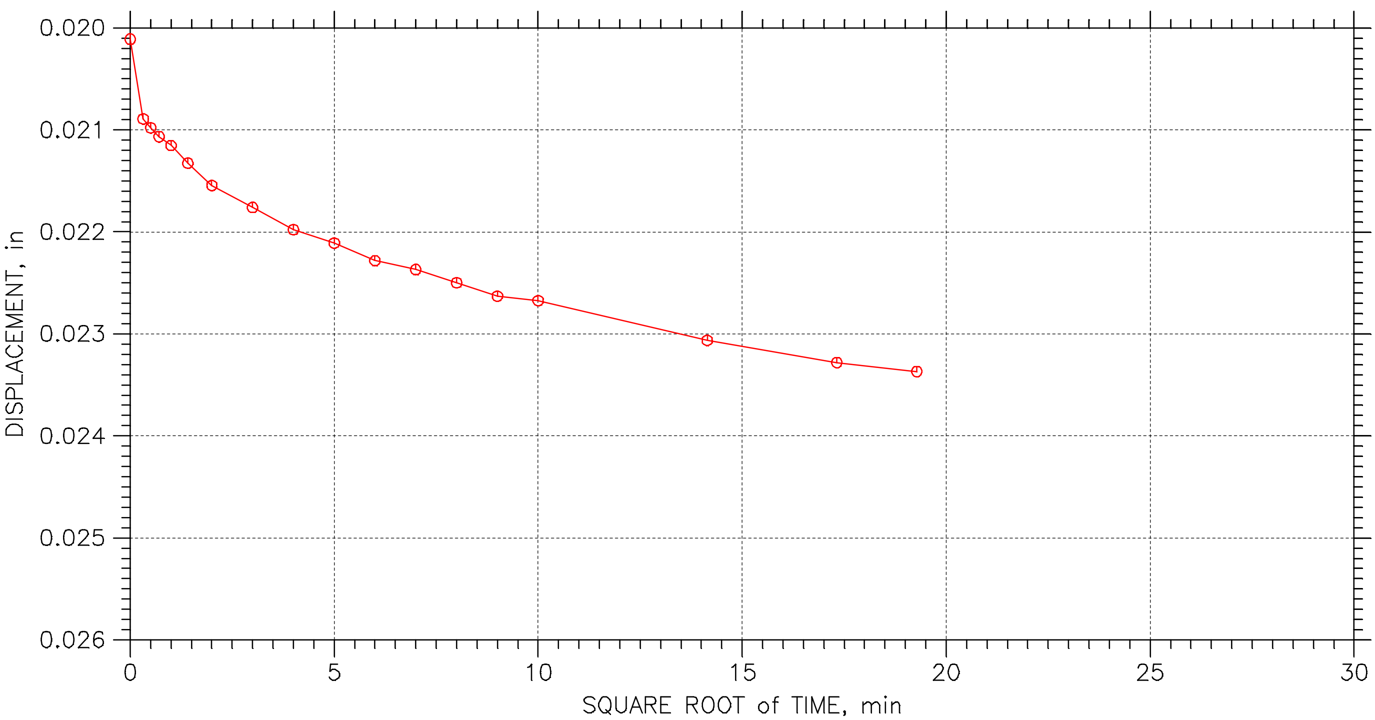
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 7 of 25

Stress: 2. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

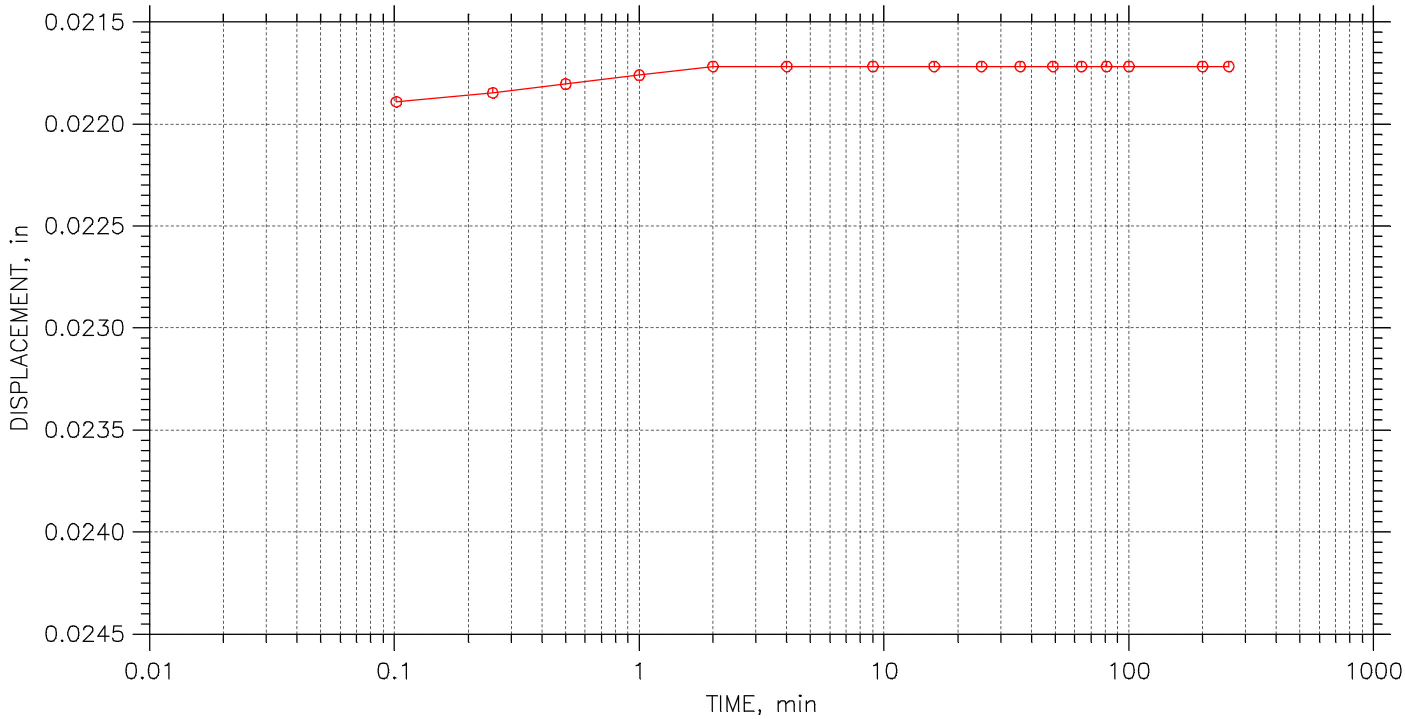
Tue, 26-APR-2016 13:54:00

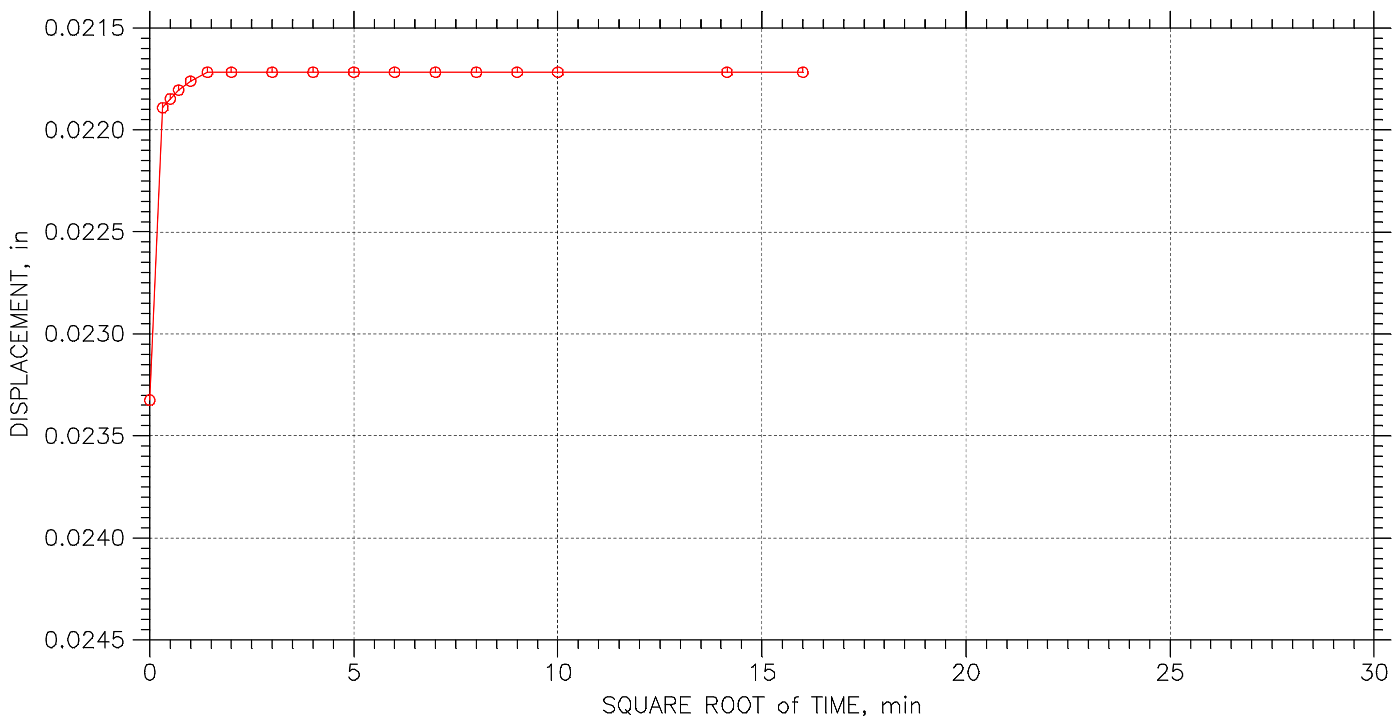
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 8 of 25

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

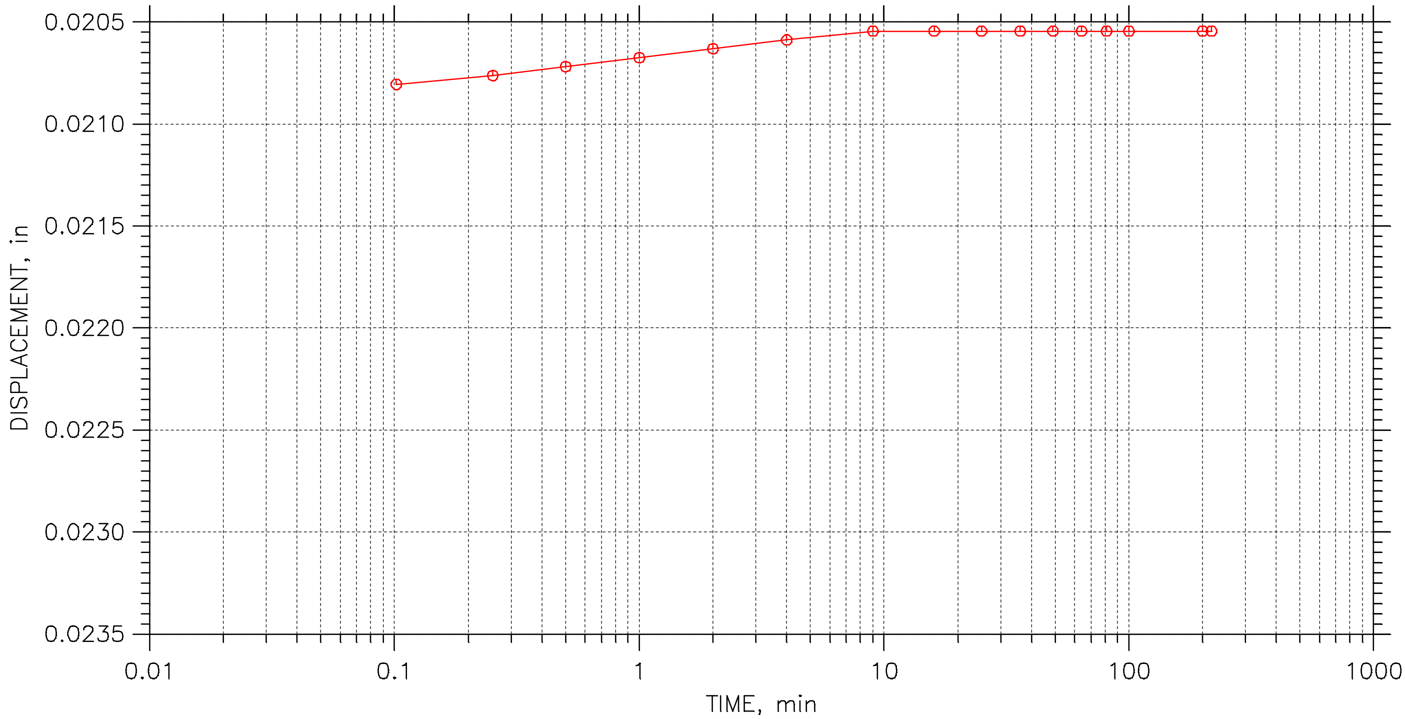
Tue, 26-APR-2016 13:54:02

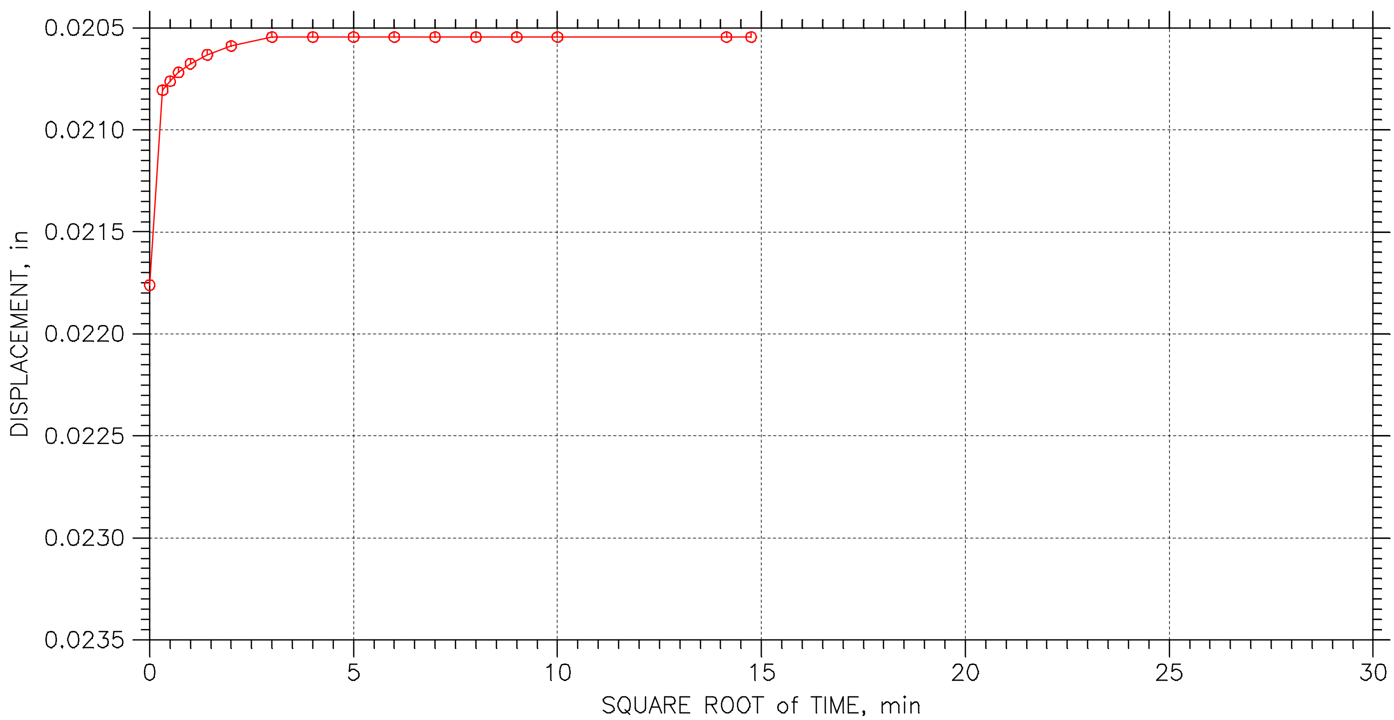
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 9 of 25

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

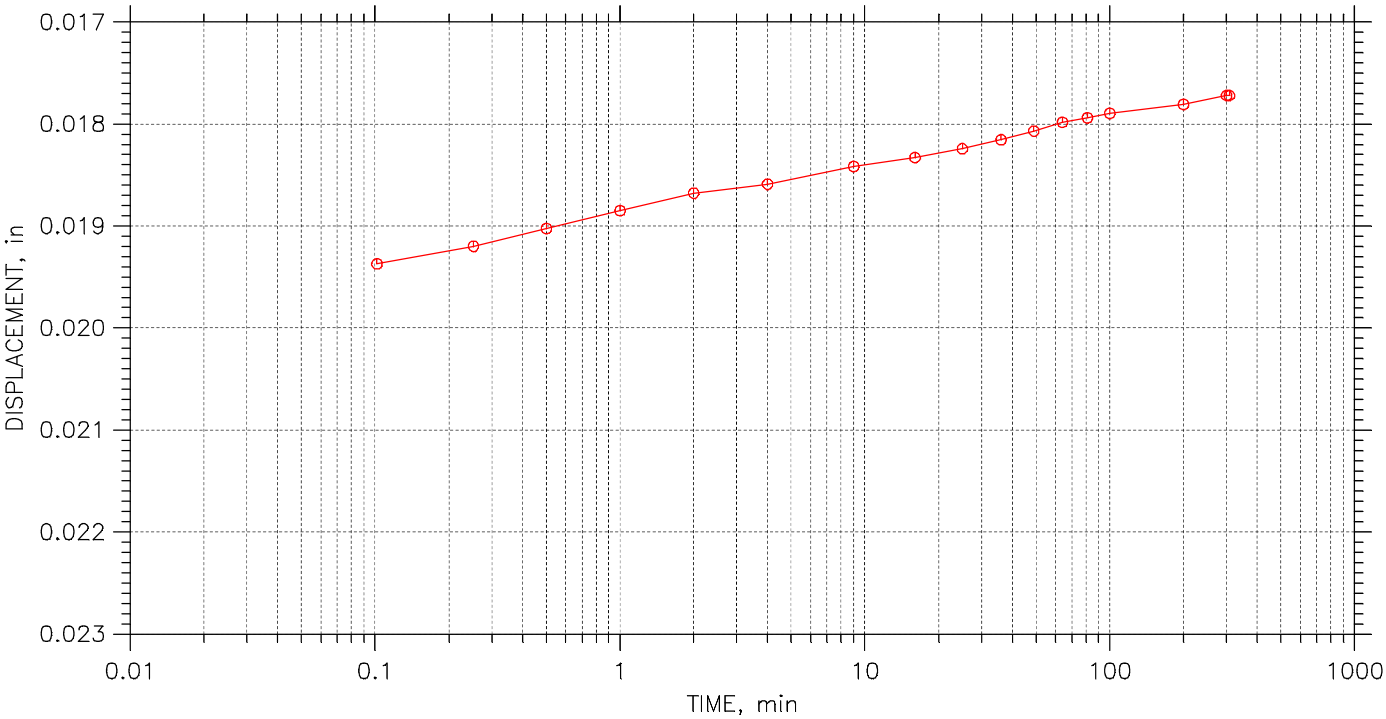
Tue, 26-APR-2016 13:54:03

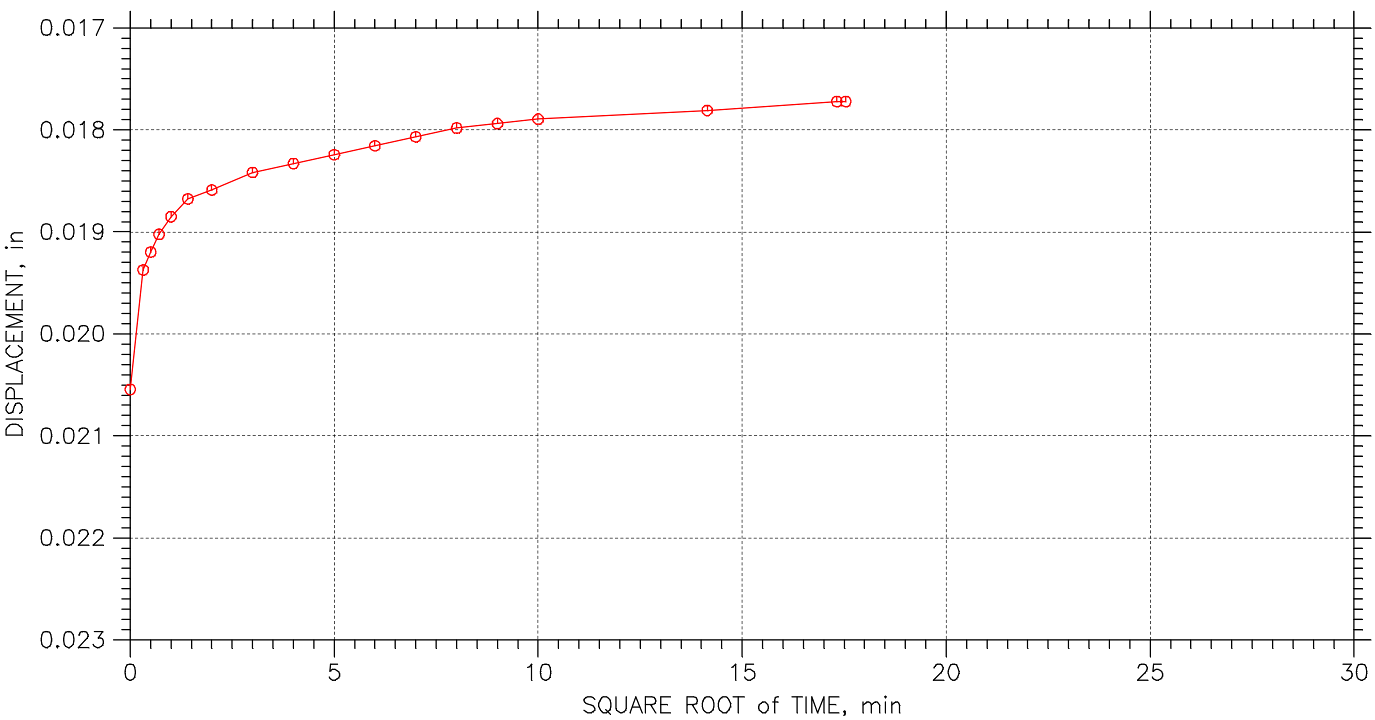
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 10 of 25

Stress: 0.125 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

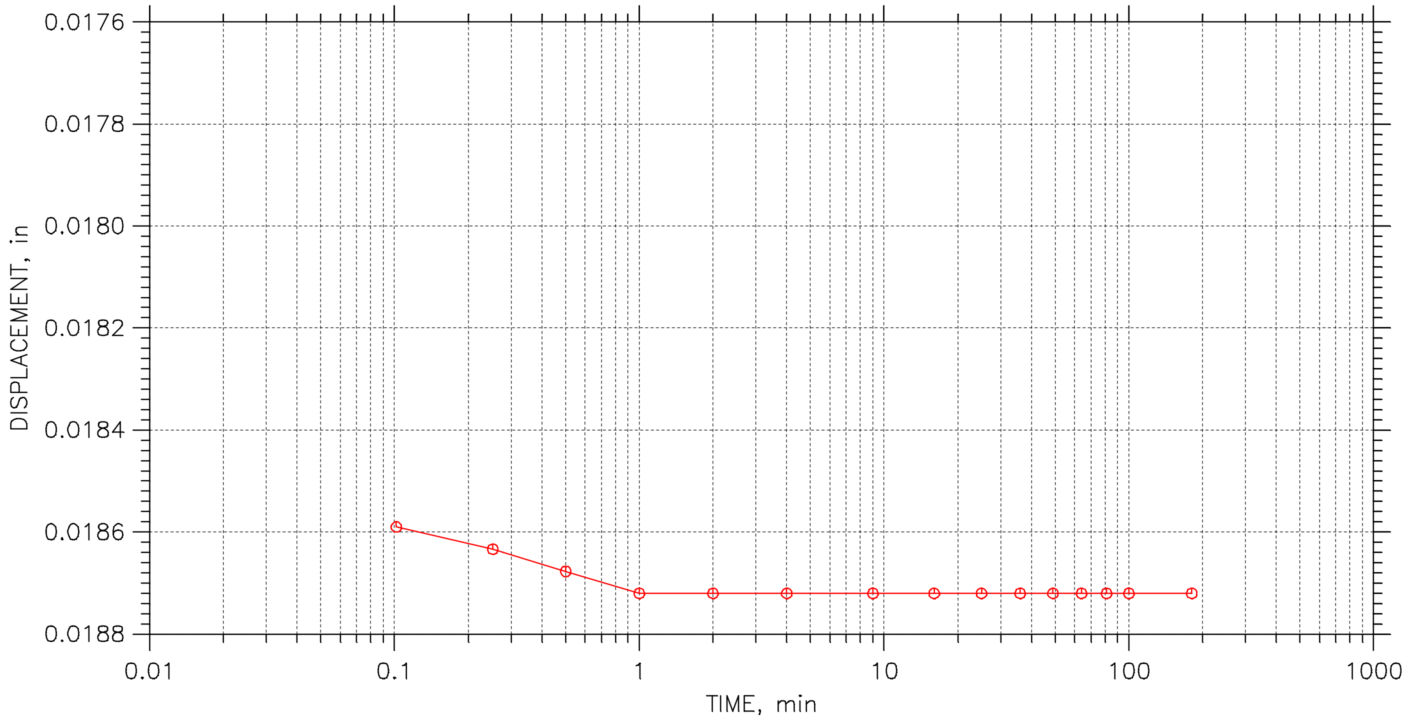
Tue, 26-APR-2016 13:54:05

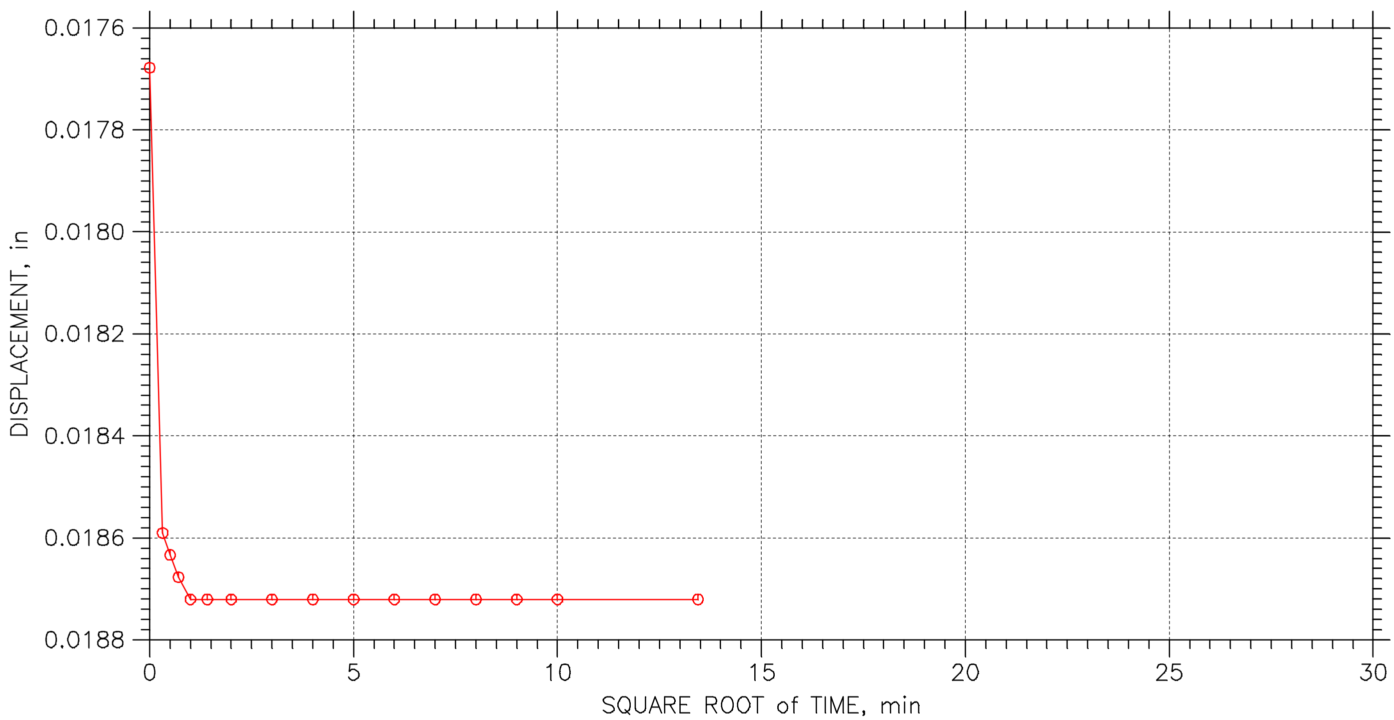
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 11 of 25

Stress: 0.25 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

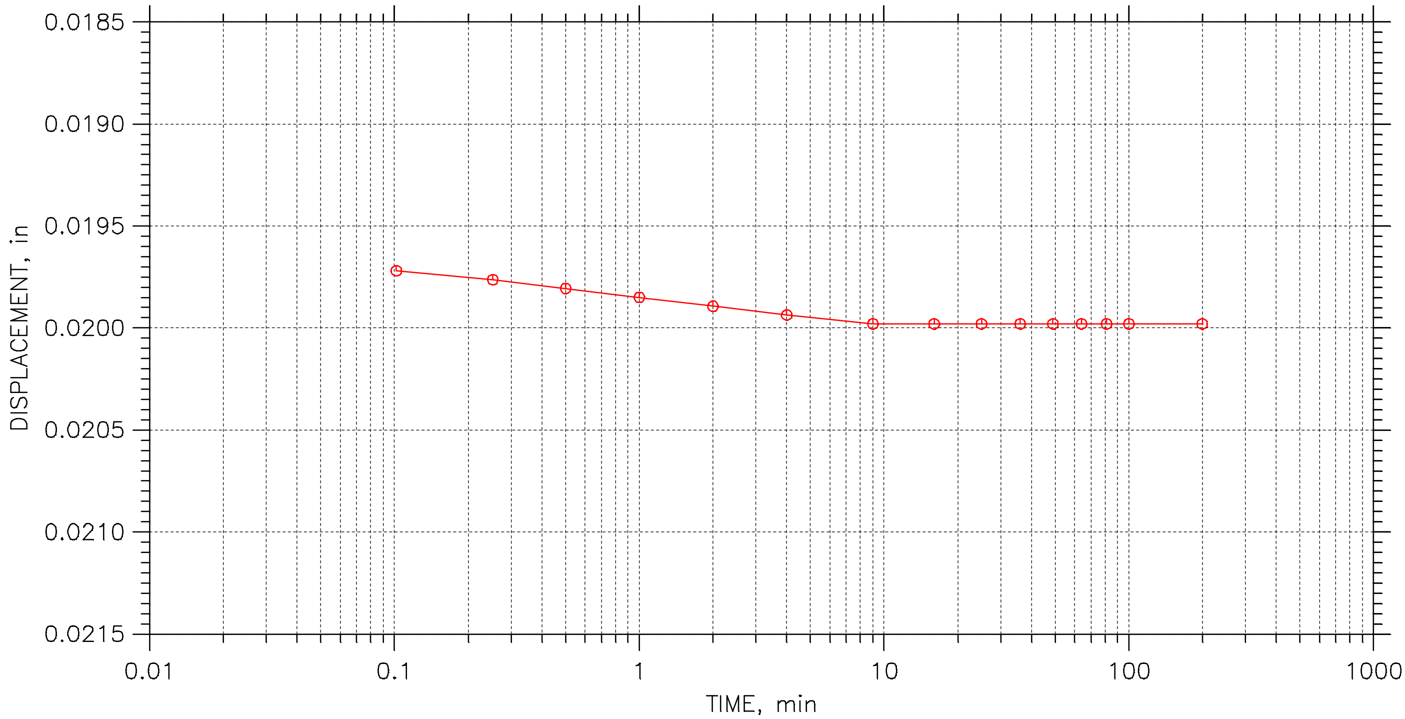
Tue, 26-APR-2016 13:54:06

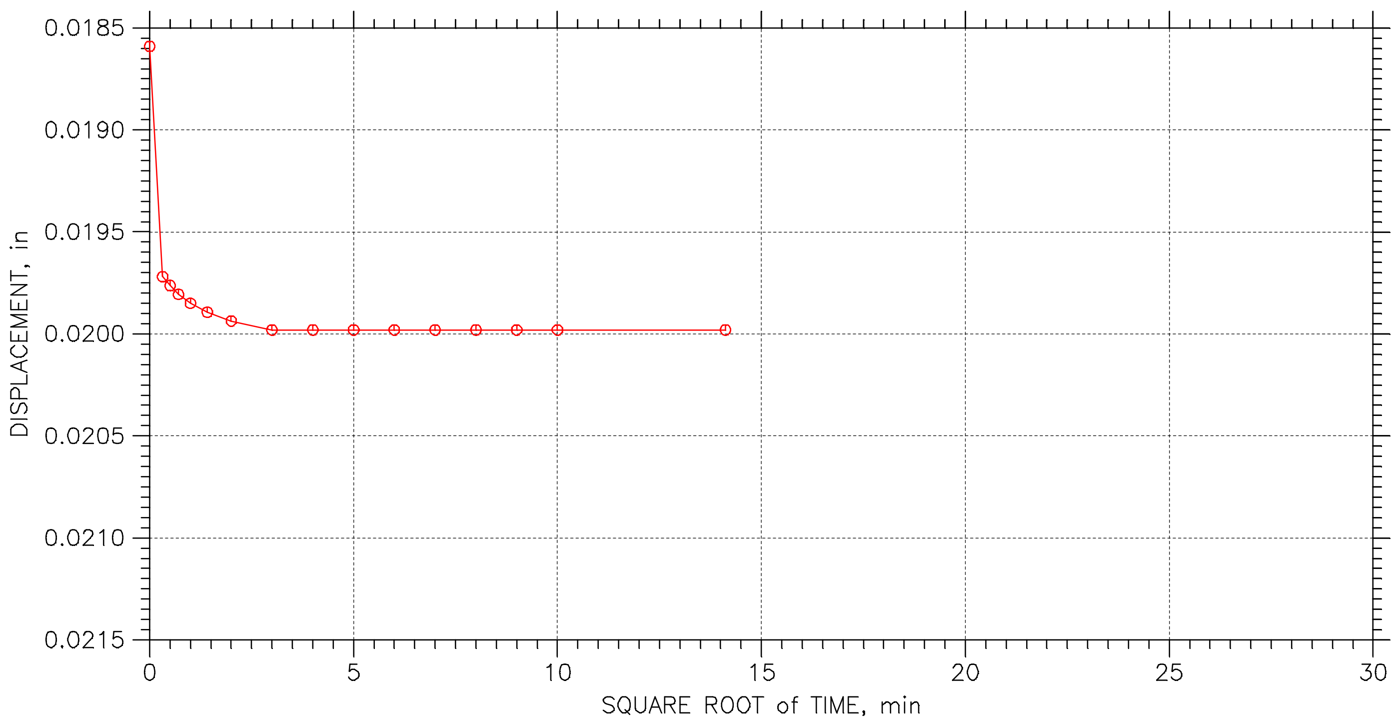
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 12 of 25

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

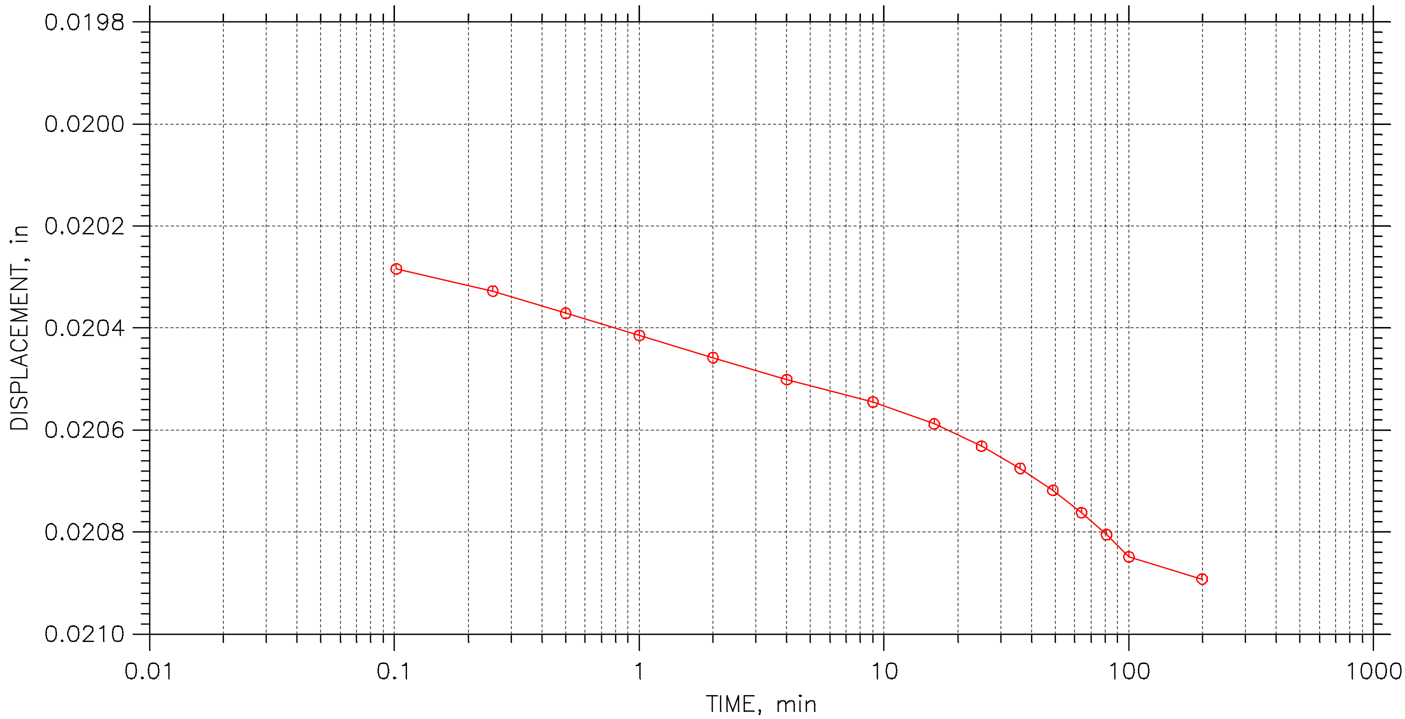
Tue, 26-APR-2016 13:54:07

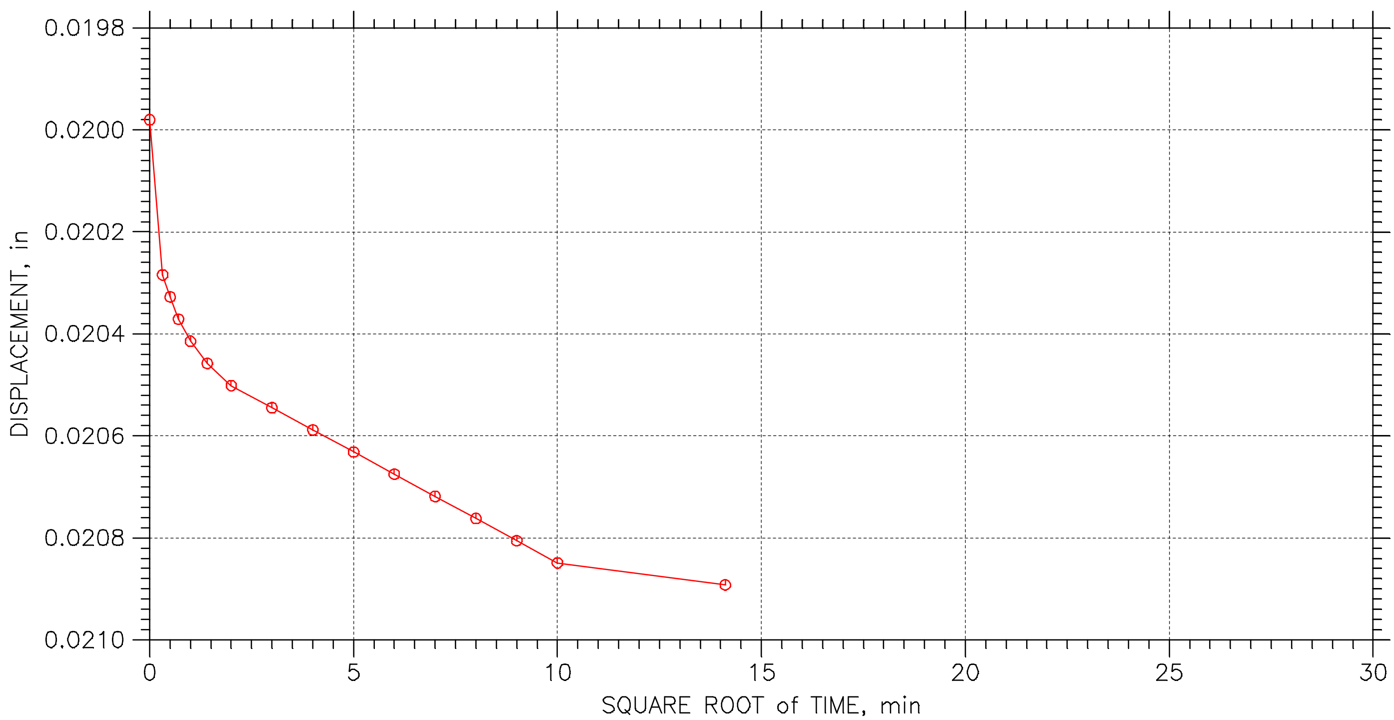
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 13 of 25

Stress: 0.75 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

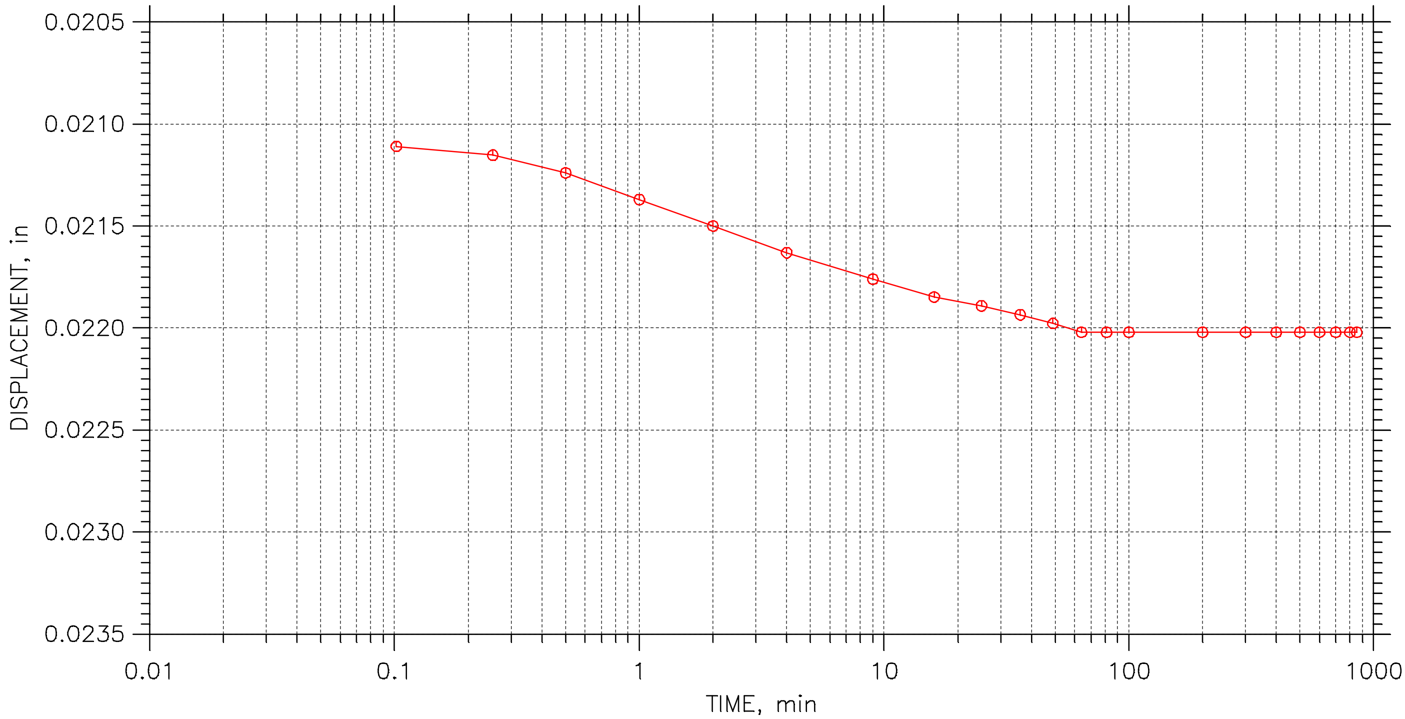
Tue, 26-APR-2016 13:54:09

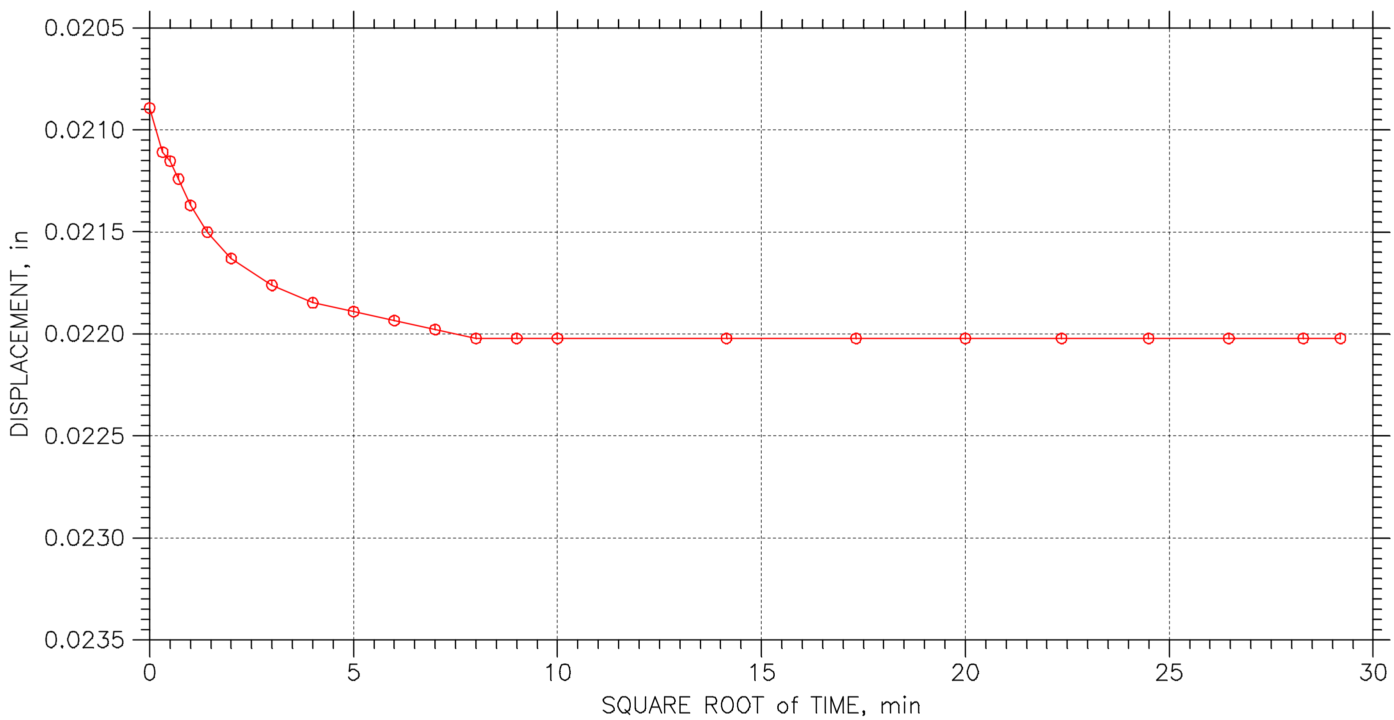
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 14 of 25

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0" ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

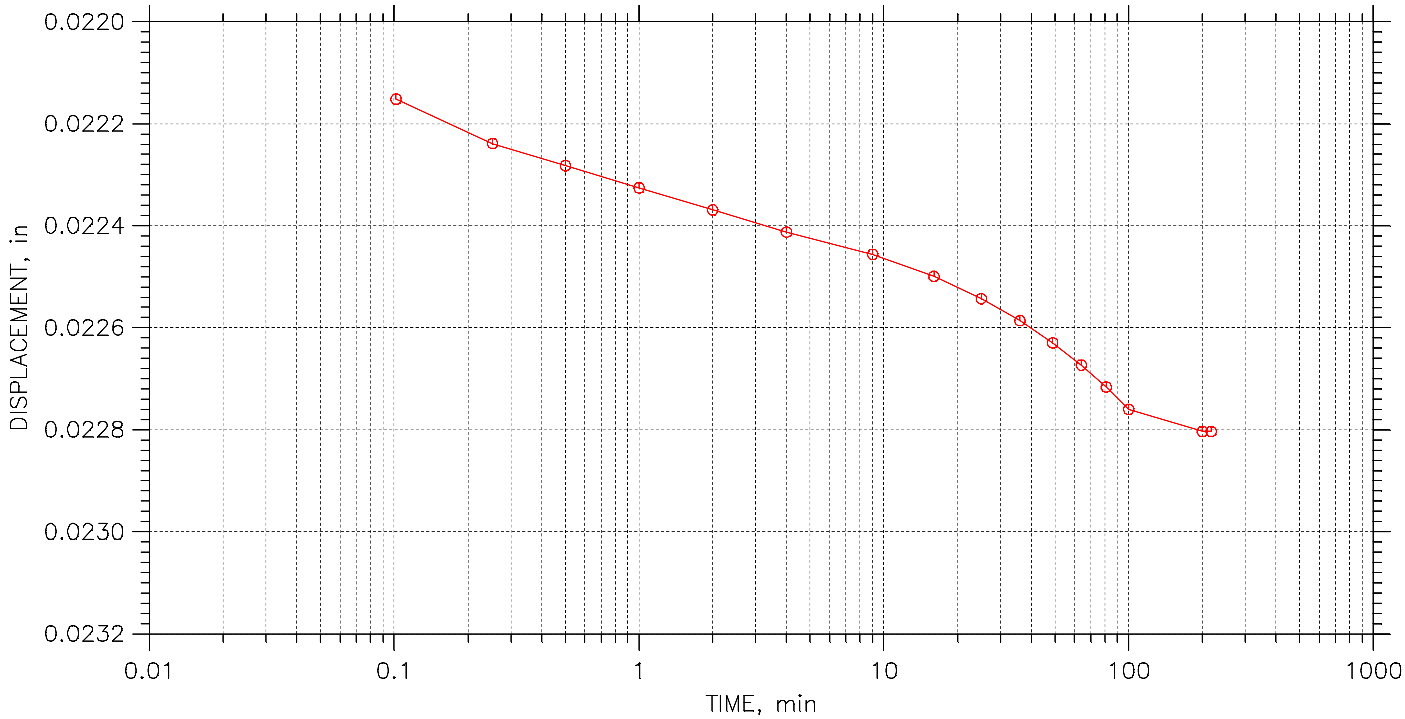
Tue, 26-APR-2016 13:54:10

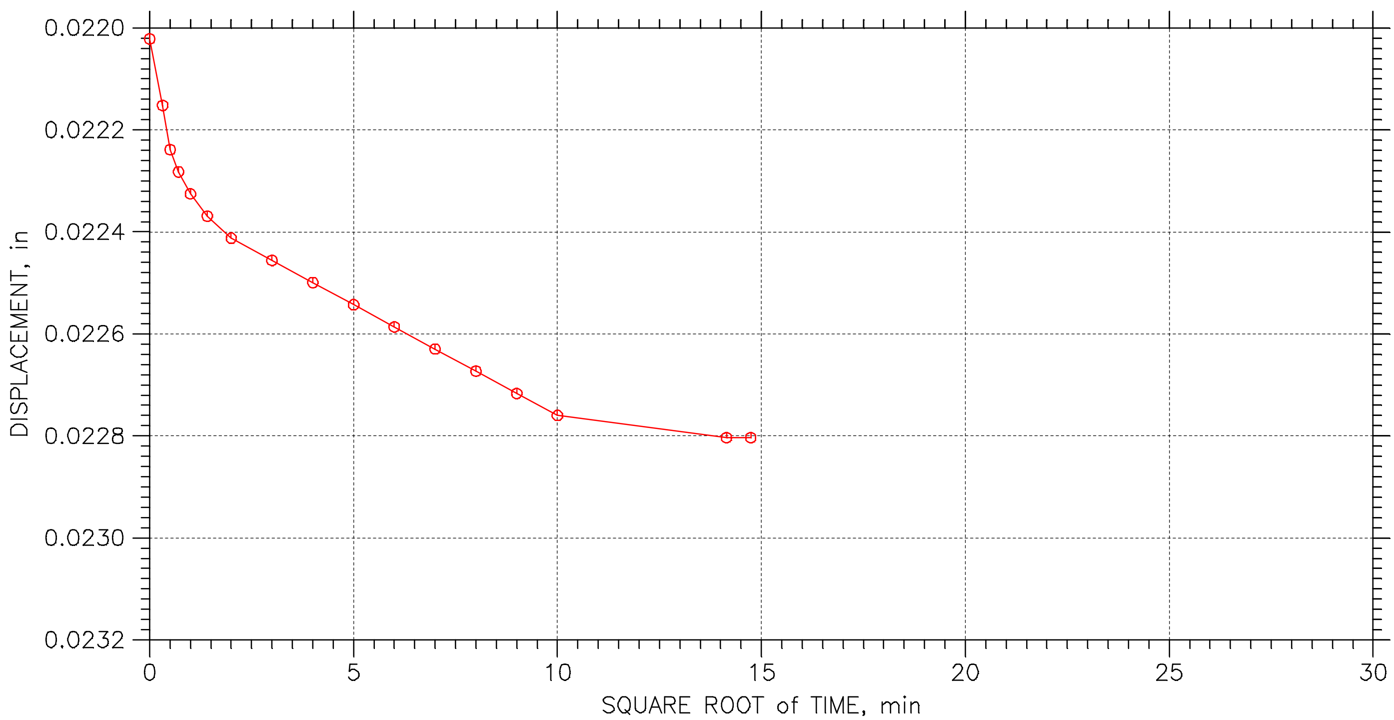
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 15 of 25

Stress: 1.5 tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

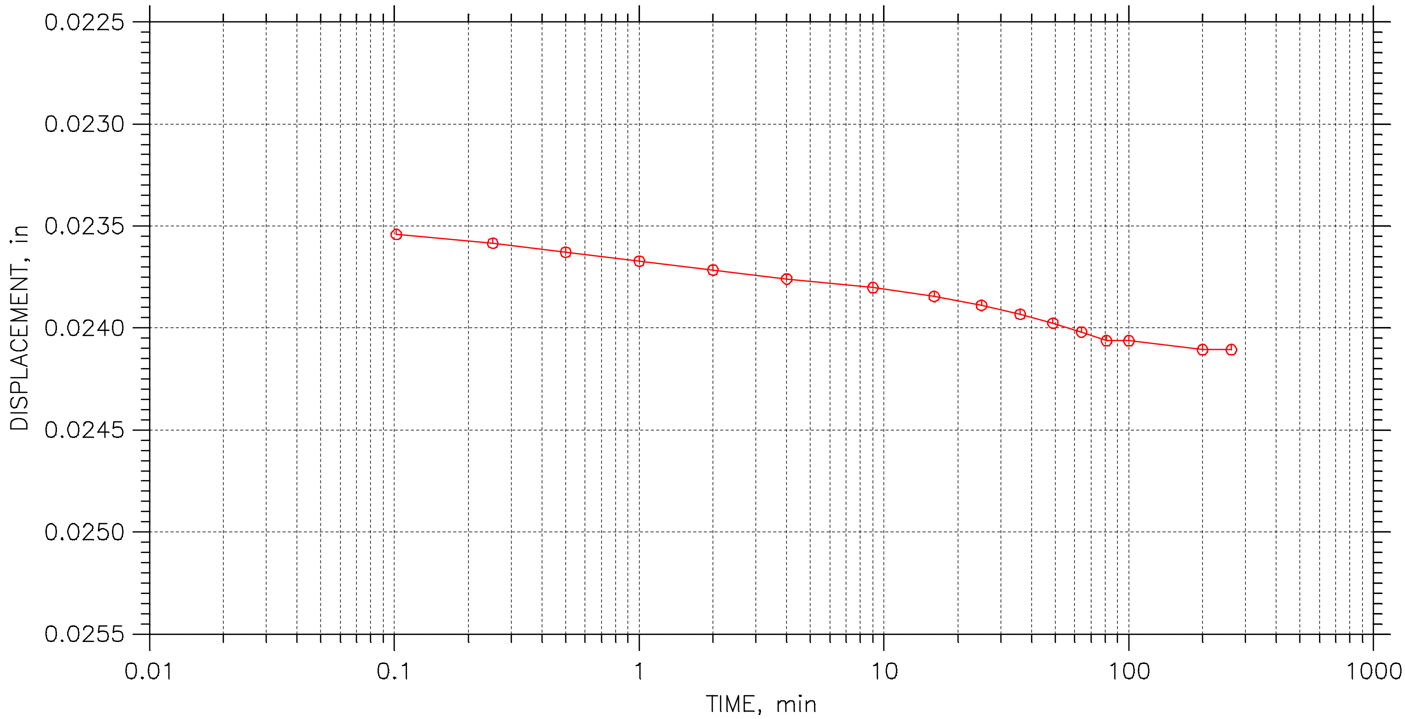
Tue, 26-APR-2016 13:54:12

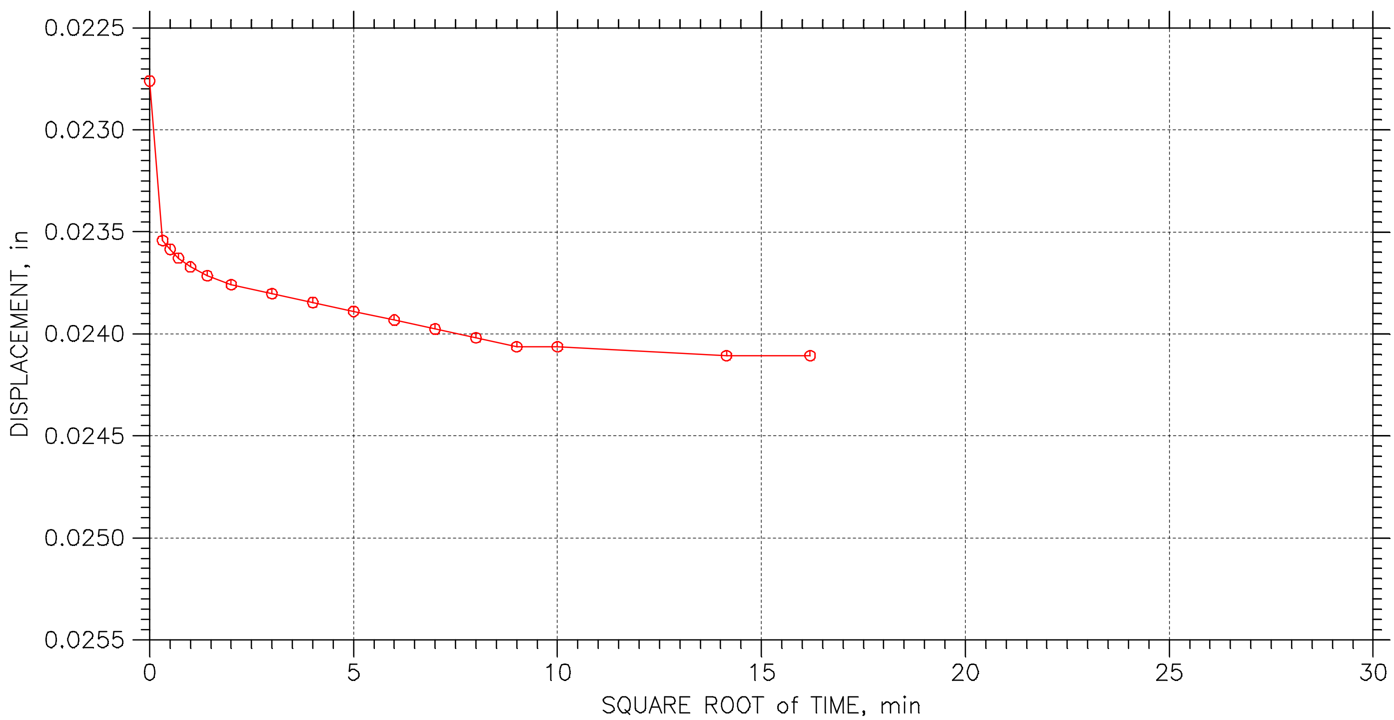
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 16 of 25

Stress: 2. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

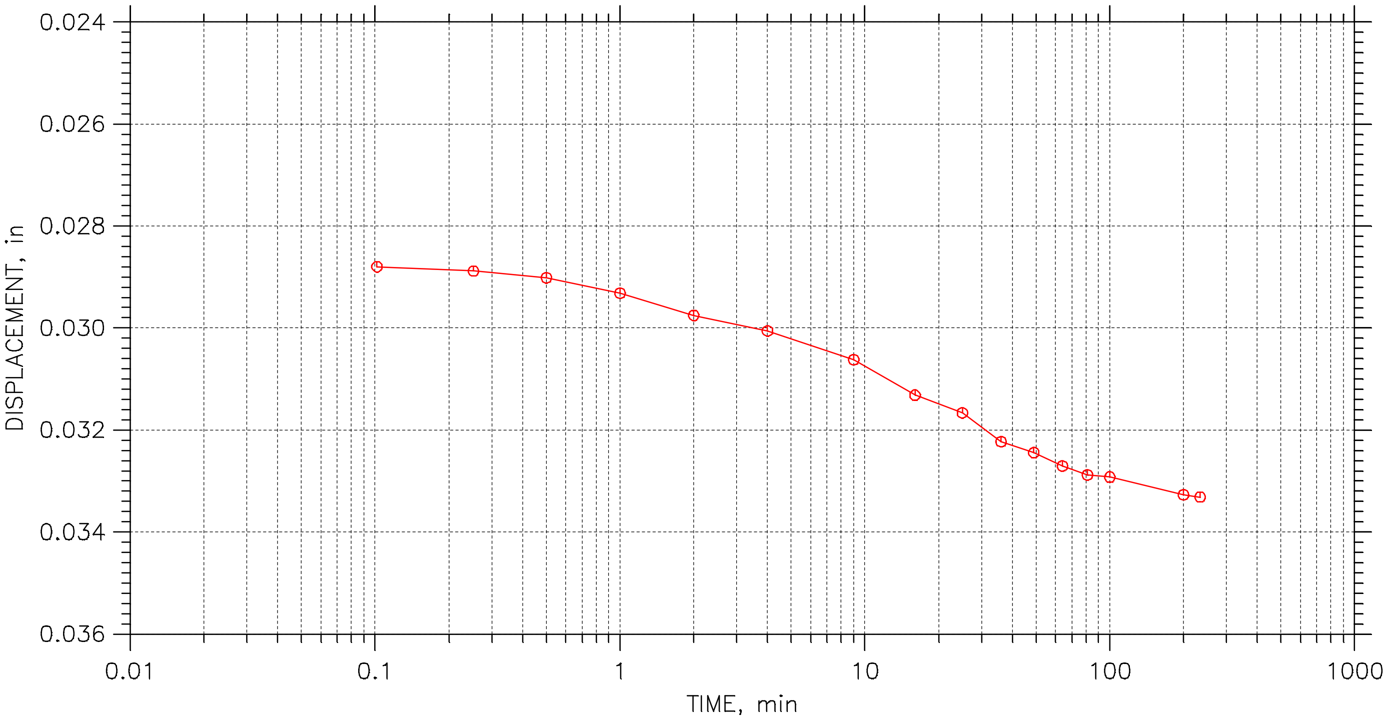
Tue, 26-APR-2016 13:54:13

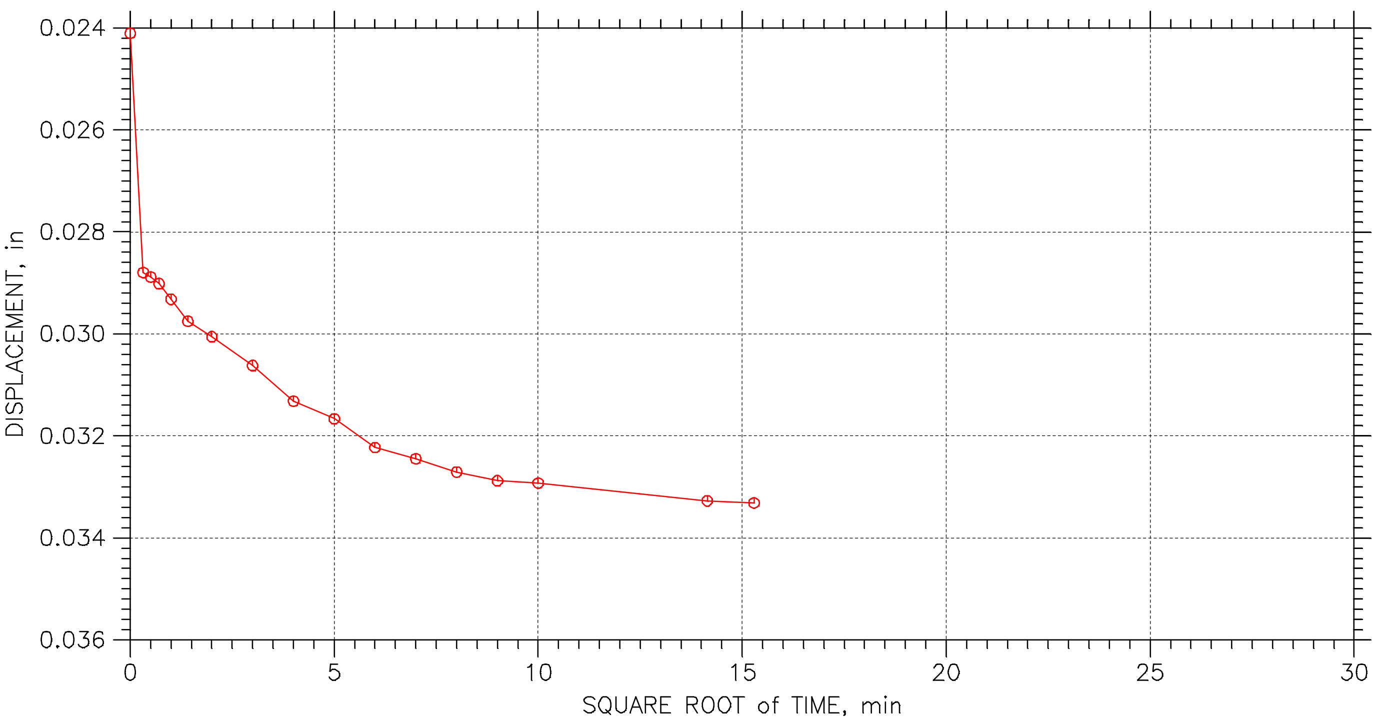
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 17 of 25

Stress: 4. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

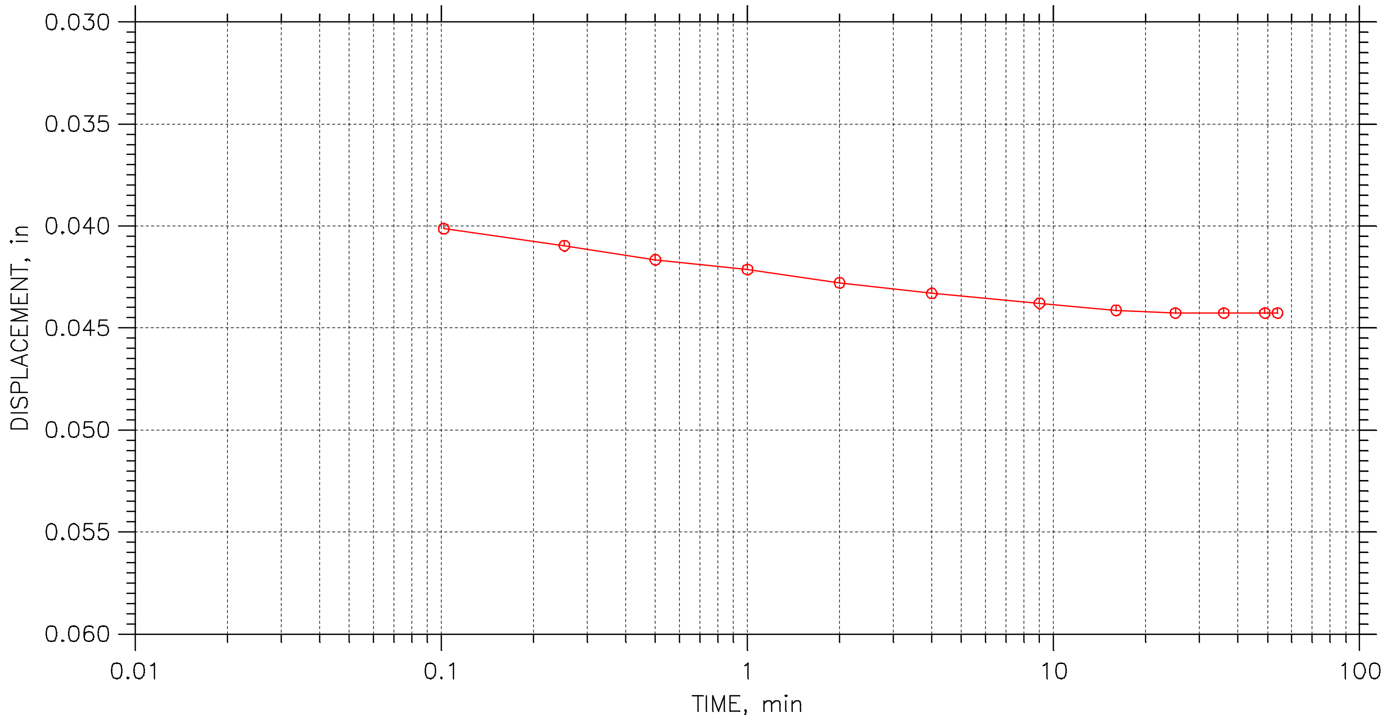
Tue, 26-APR-2016 13:54:15

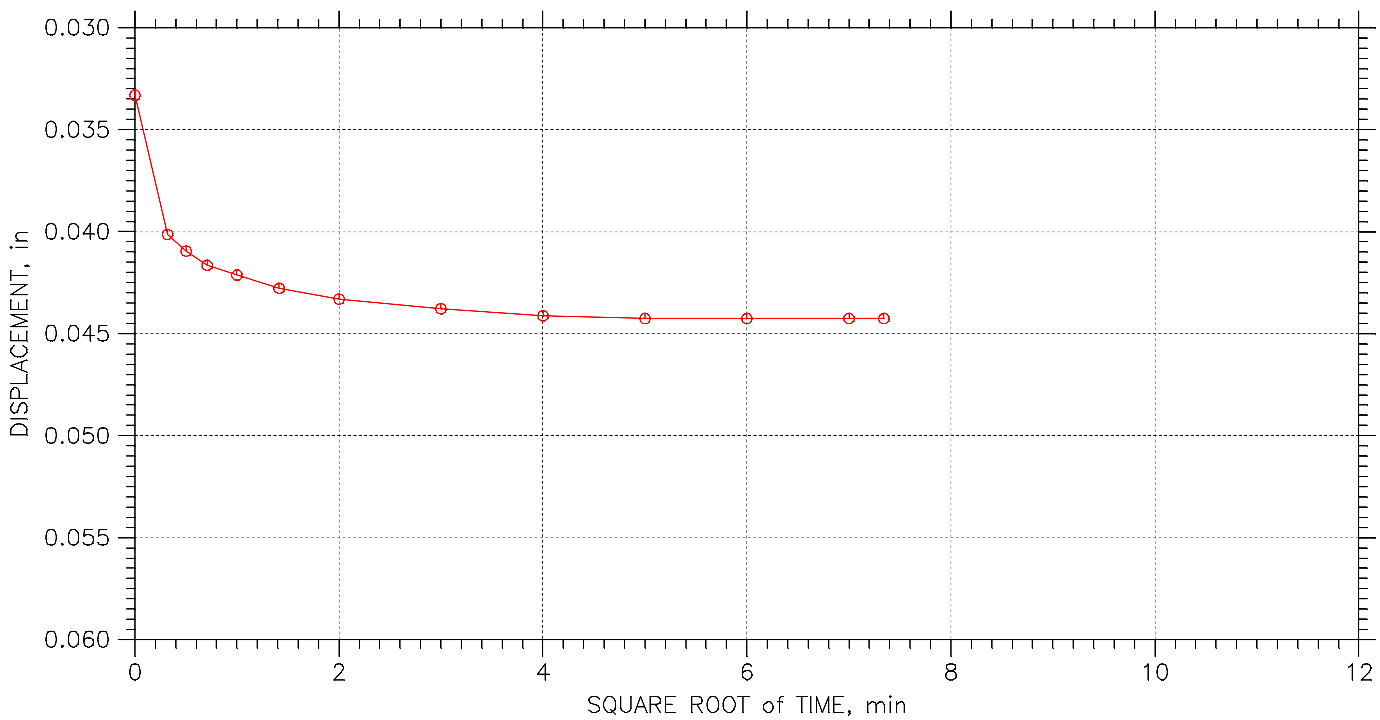
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 18 of 25

Stress: 8. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

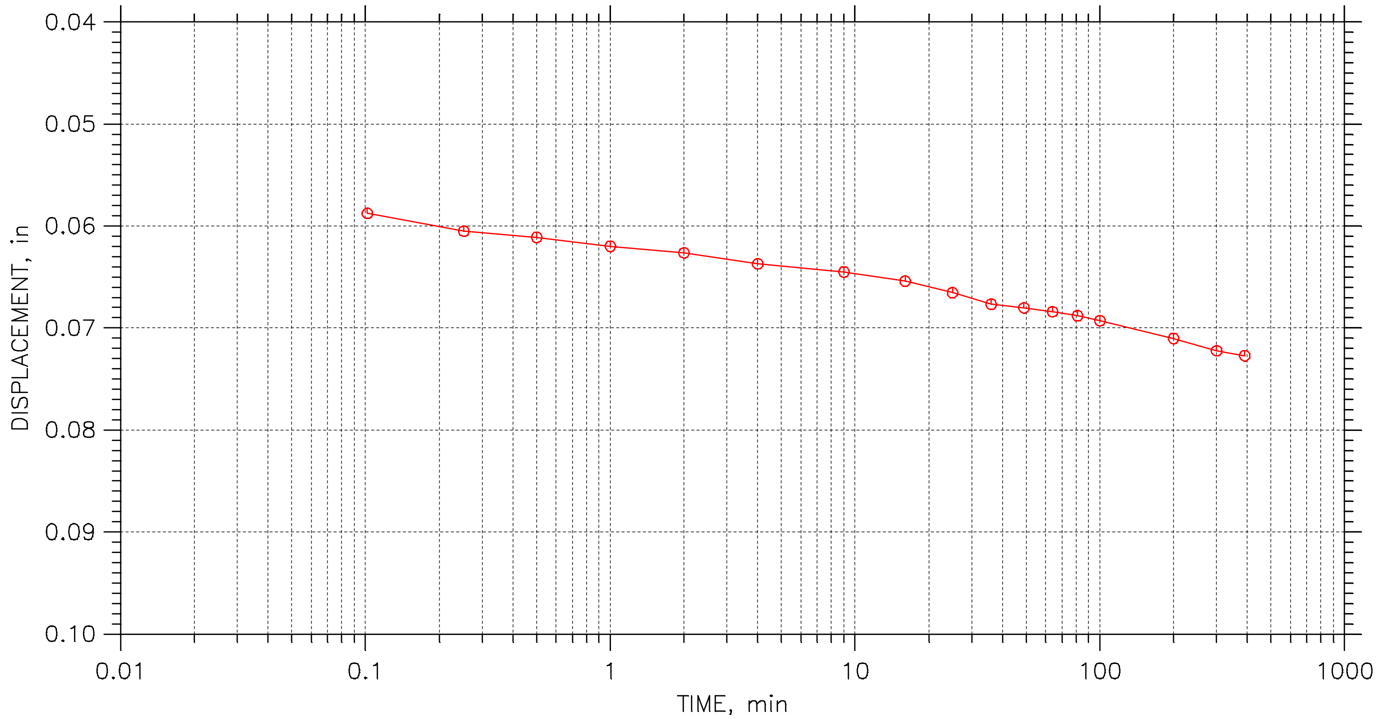
Tue, 26-APR-2016 13:54:16

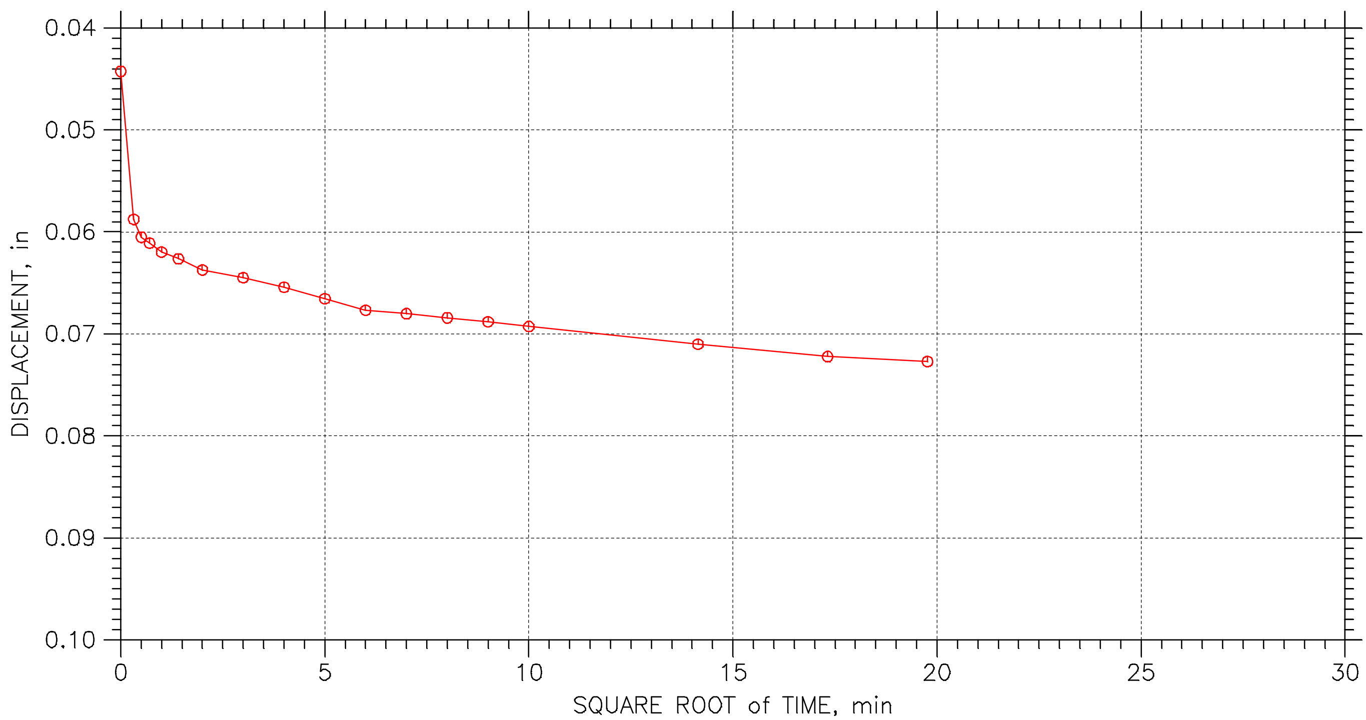
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 19 of 25

Stress: 16. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

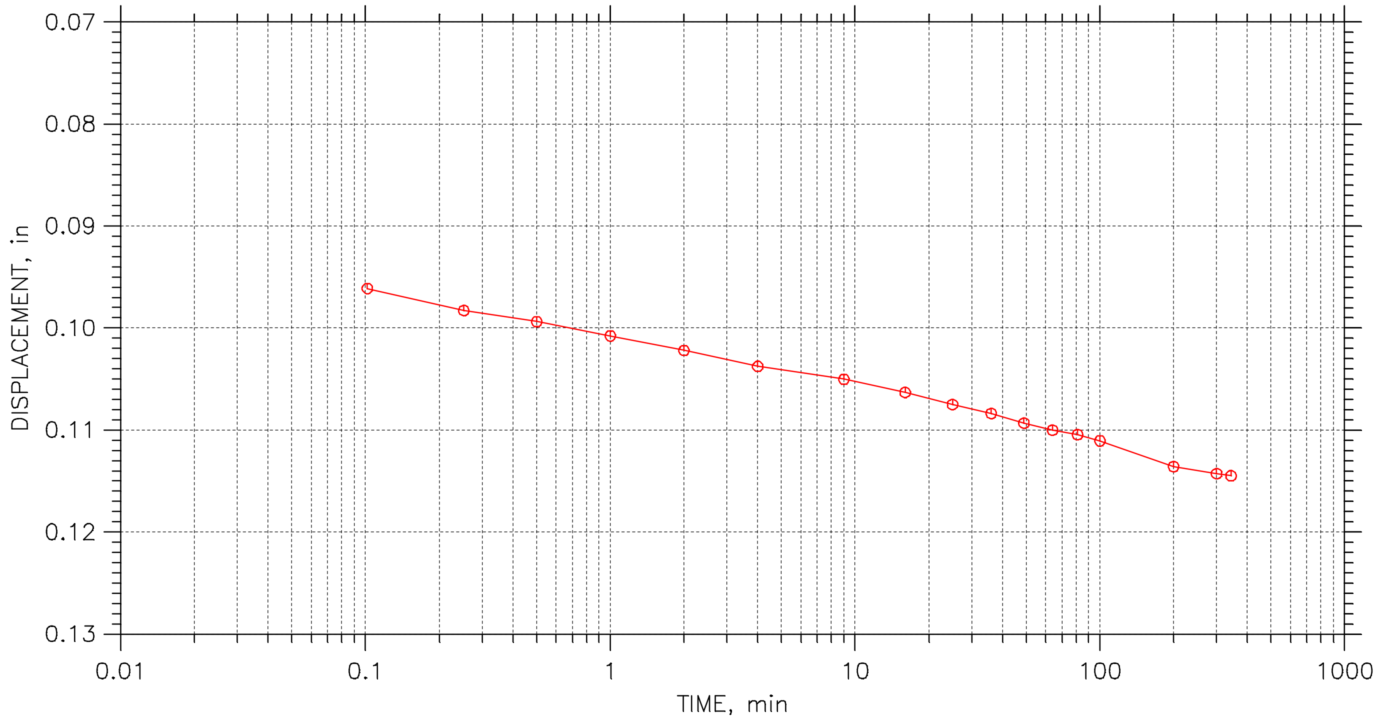
Tue, 26-APR-2016 13:54:18

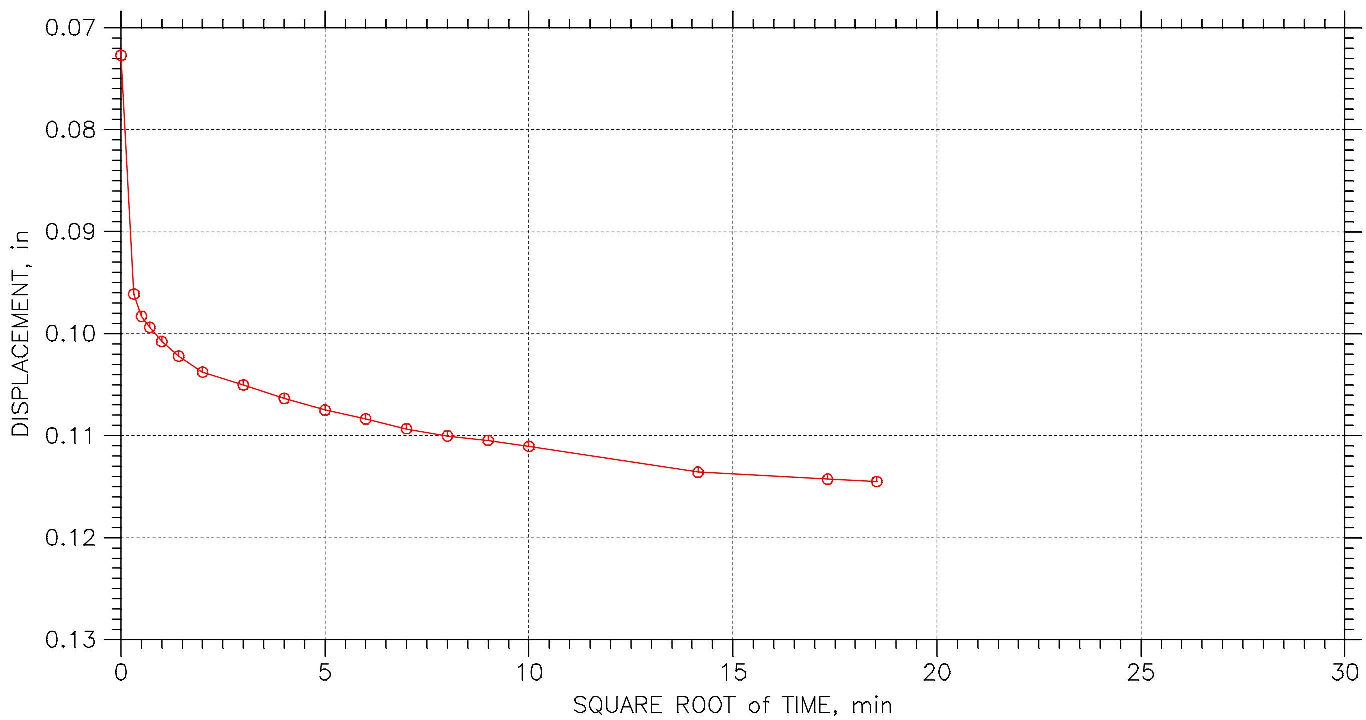
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 20 of 25

Stress: 32. tsf





Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

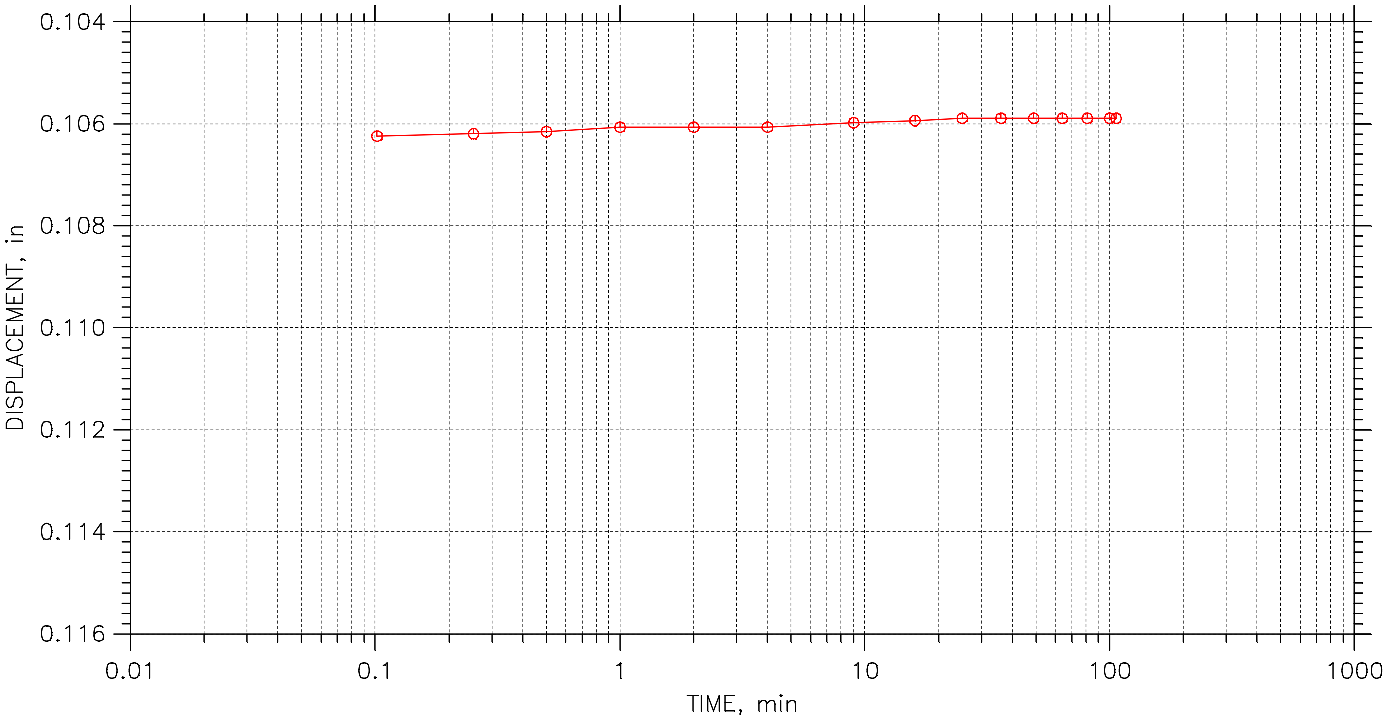
Tue, 26-APR-2016 13:54:19

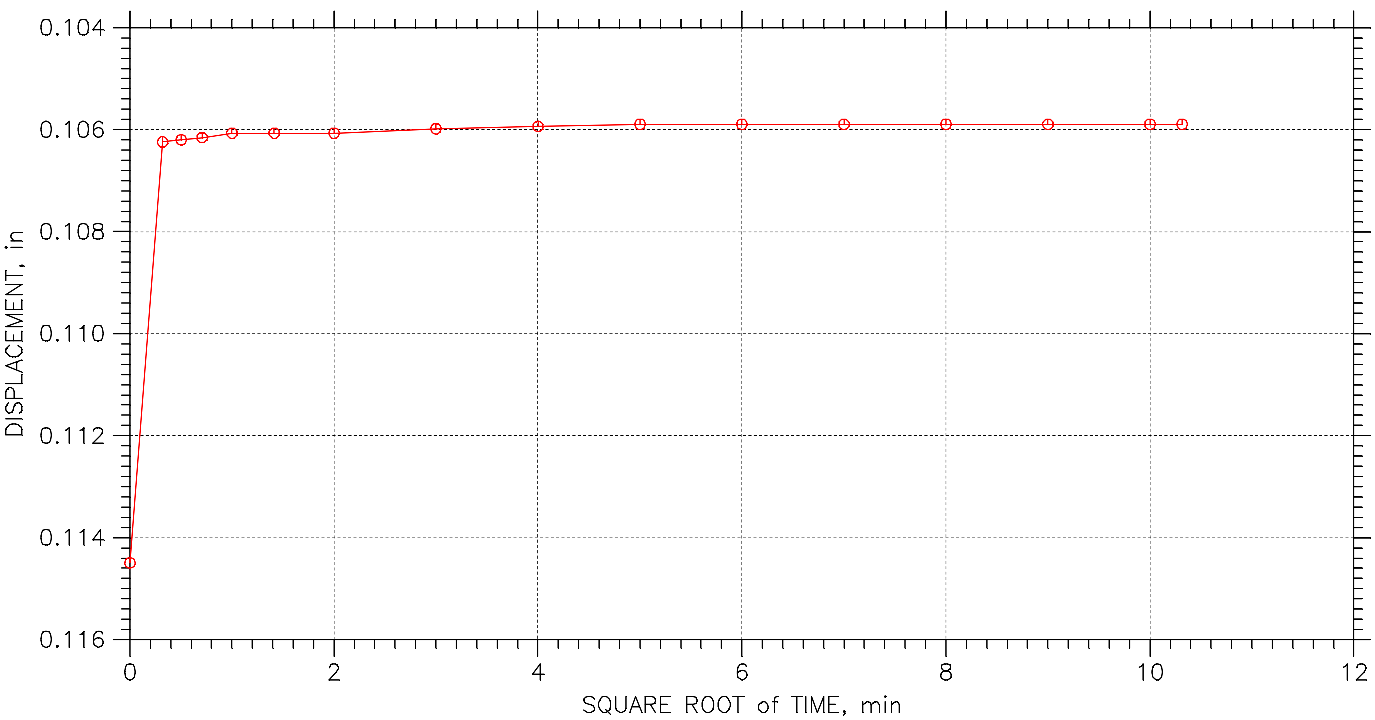
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 21 of 25

Stress: 16. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

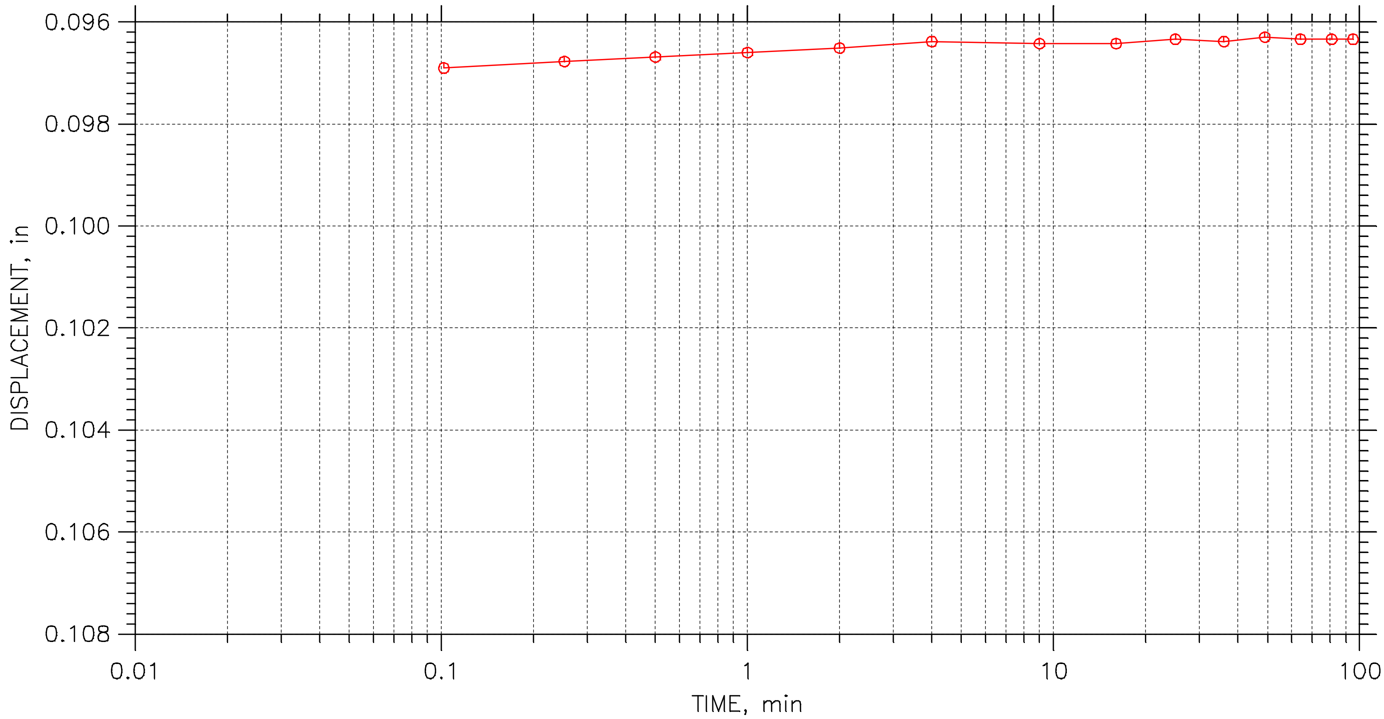
Tue, 26-APR-2016 13:54:21

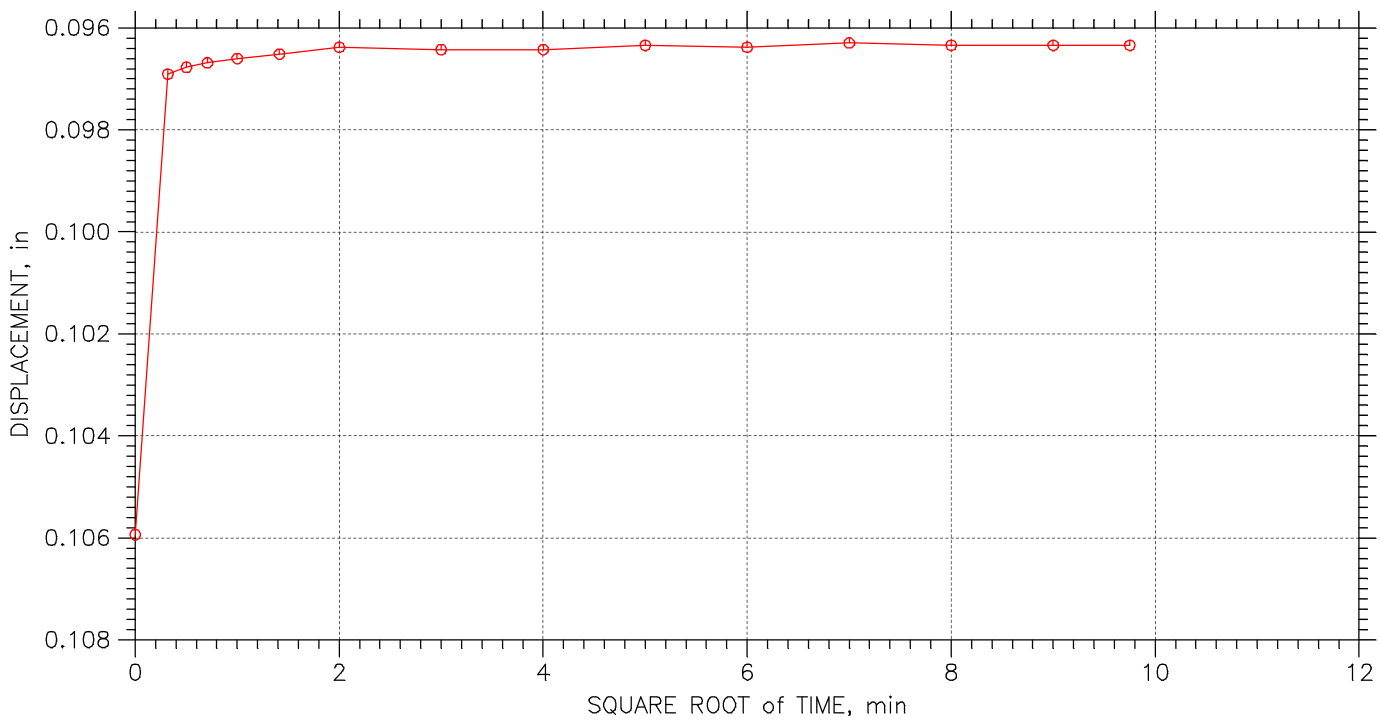
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 22 of 25

Stress: 4. tsf





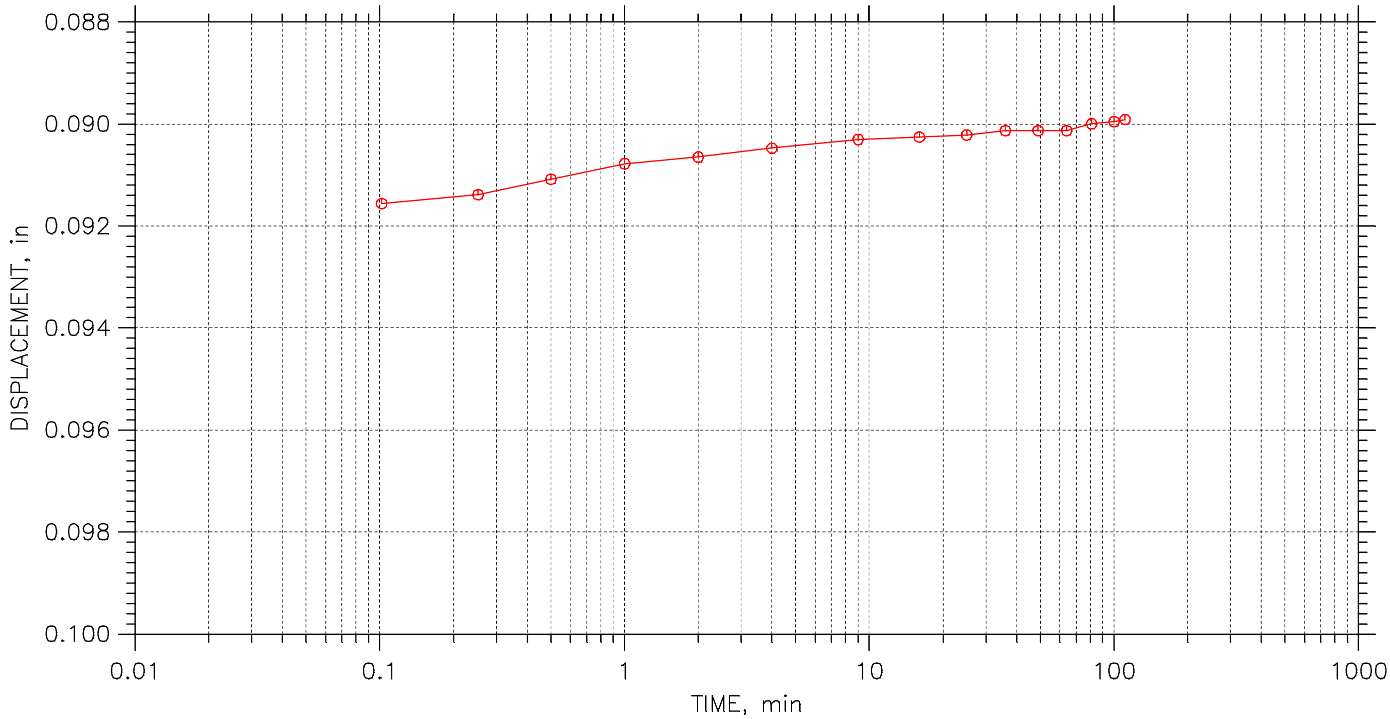
Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

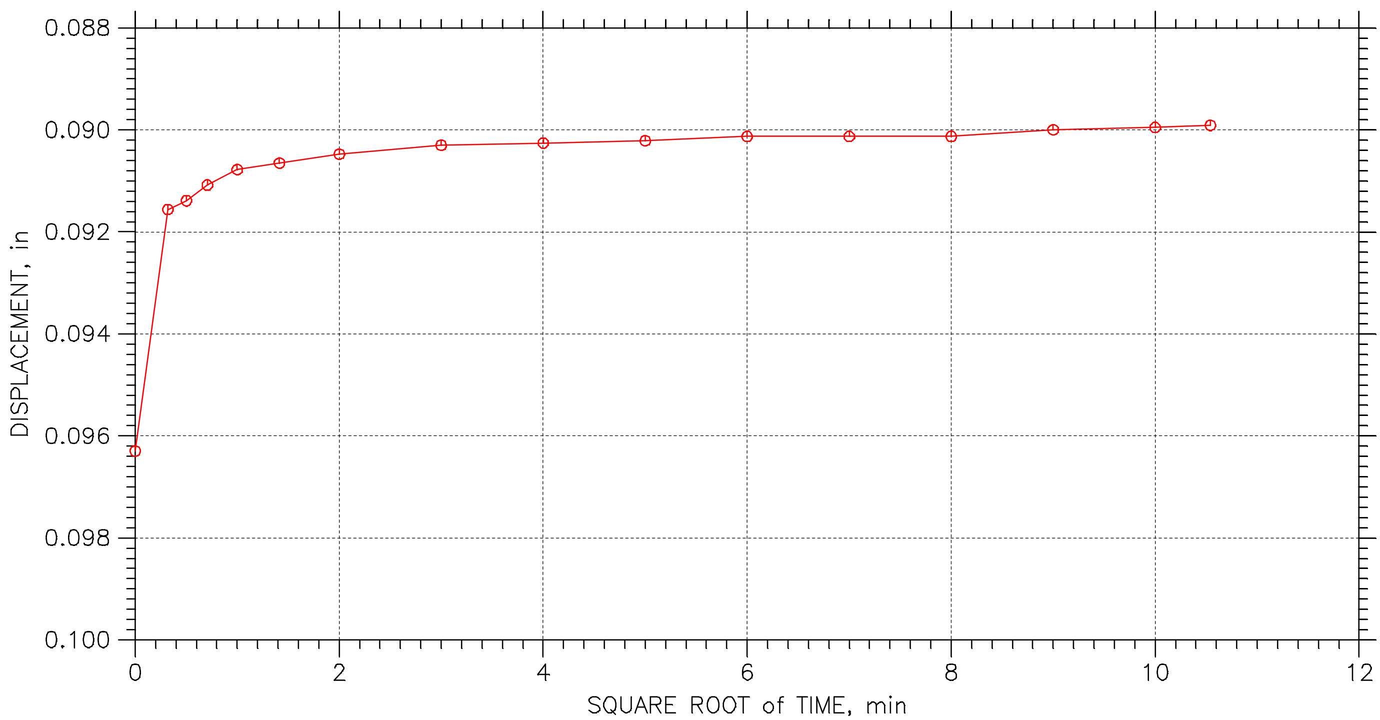
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 23 of 25

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

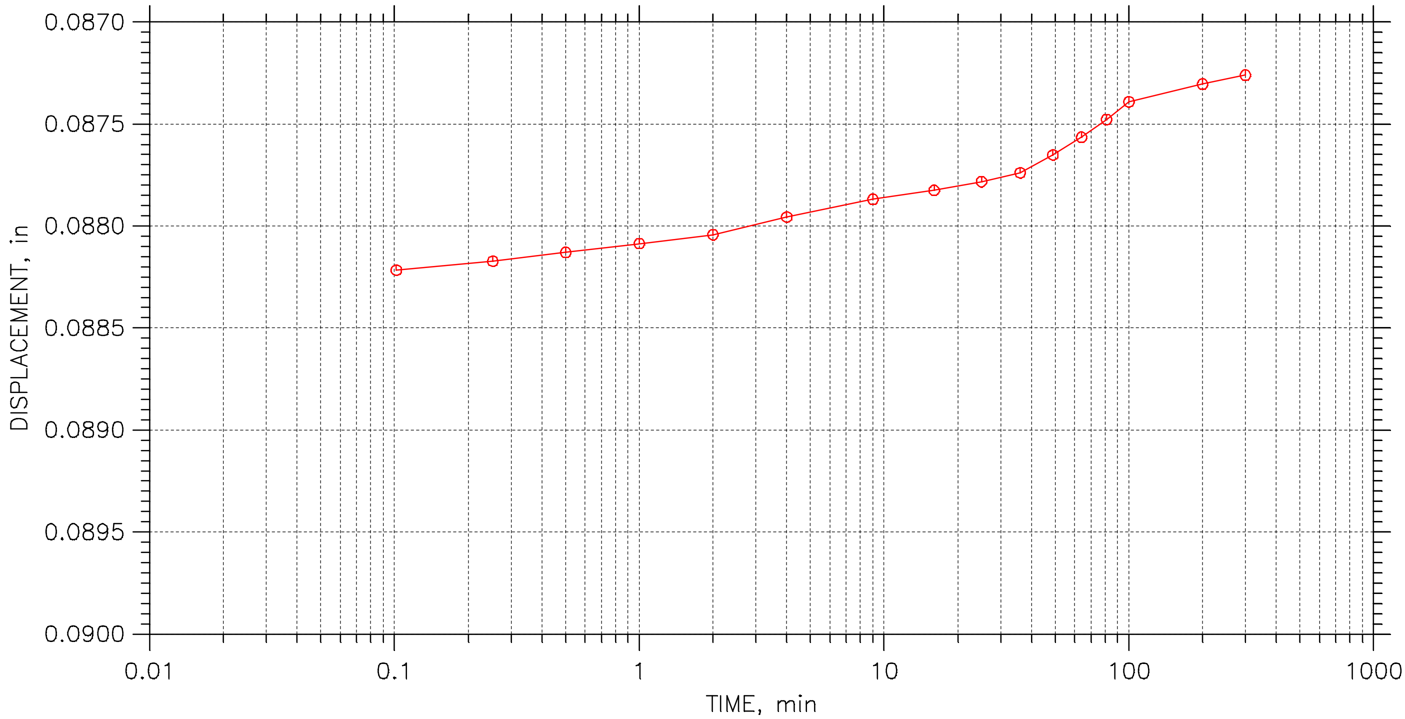
Tue, 26-APR-2016 13:54:23

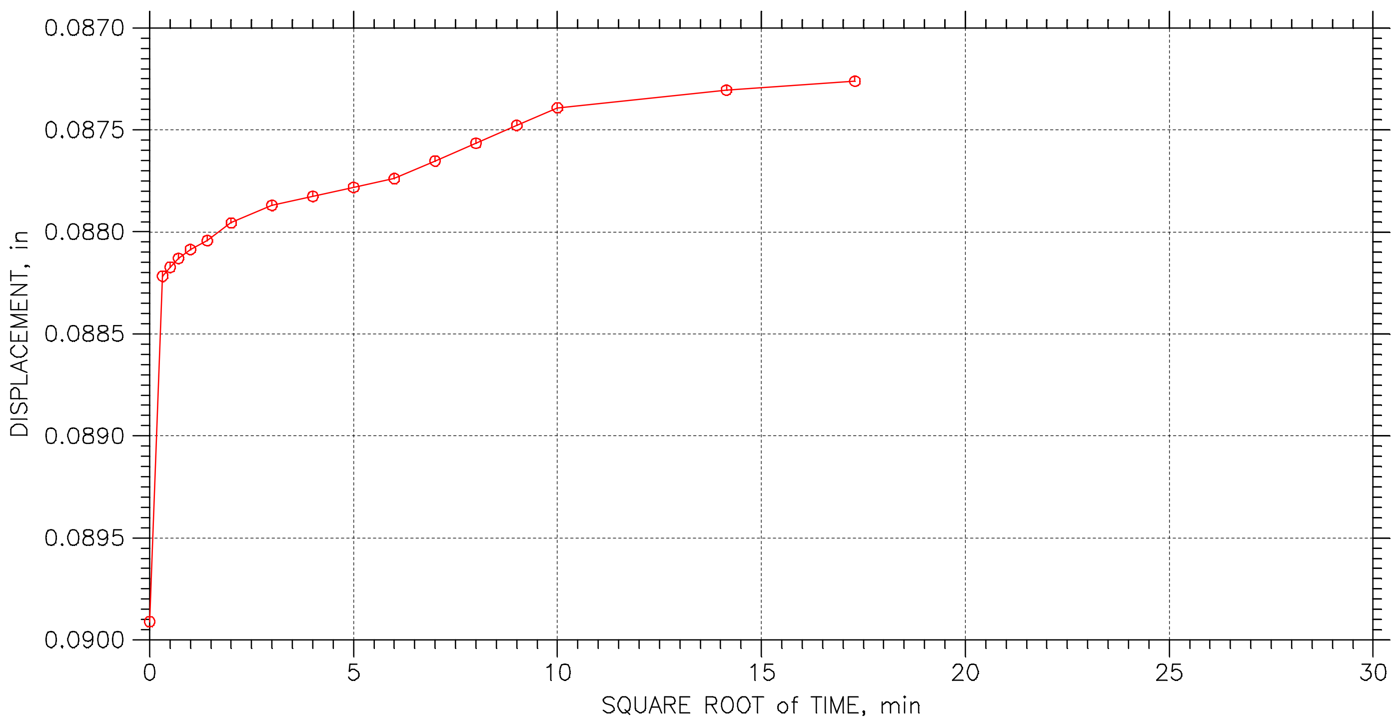
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 24 of 25

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

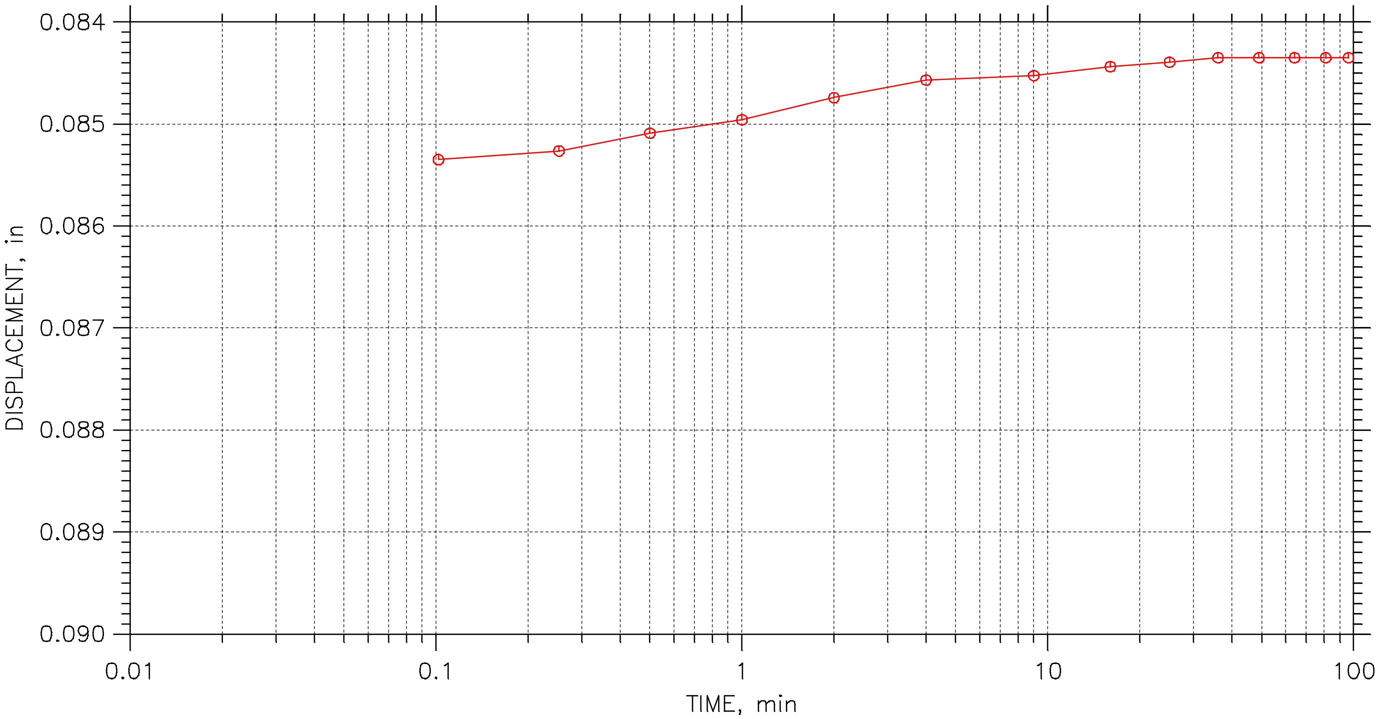
Tue, 26-APR-2016 13:54:25

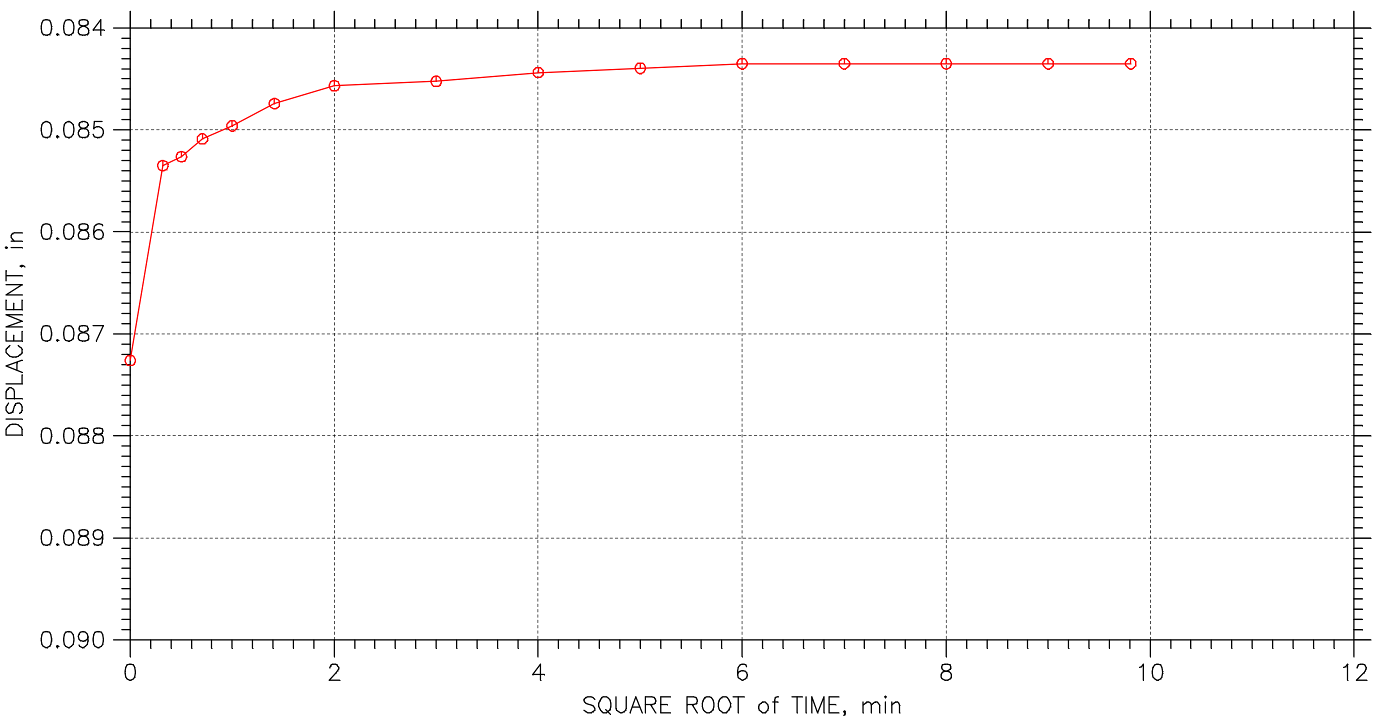
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 25 of 25

Stress: 0.125 tsf





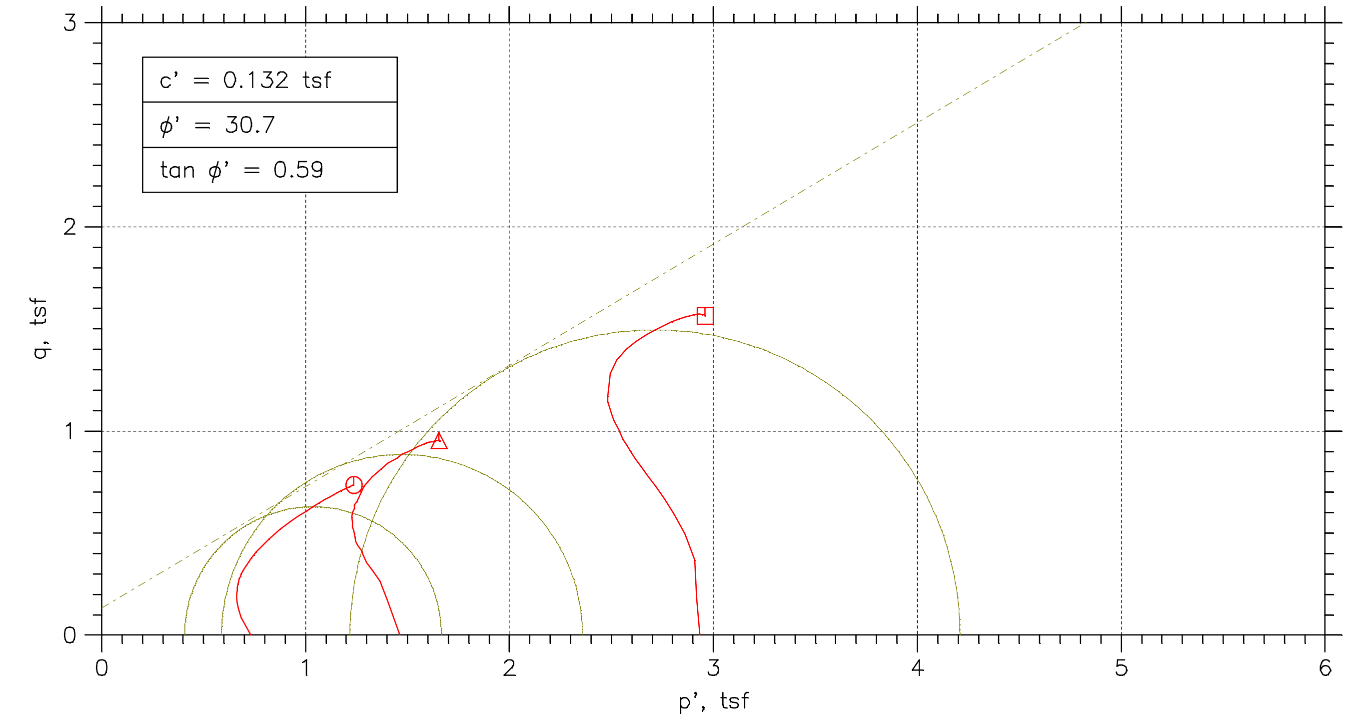
Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

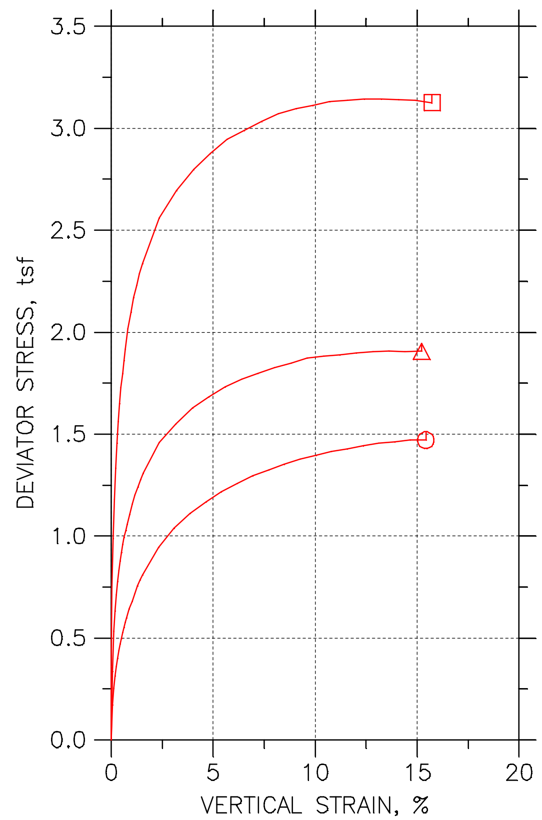
Tue, 26-APR-2016 13:54:26

Consolidated Undrained Triaxial Compression Test – ASTM D 4767

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

Terracon
Consulting Engineers & Scientists





	Symbol	○	△	□	
	Test No.	10.2 PSI	20.4 PSI	40.8 PSI	
Initial	Diameter, in	2.837	2.8539	2.8602	
Initial	Height, in	6.065	6.1339	5.9839	
Initial	Water Content, %	31.42	29.63	27.39	
Initial	Dry Density, pcf	91.54	93.63	96.51	
Initial	Saturation, %	99.97	99.05	98.09	
Initial	Void Ratio	0.85487	0.81349	0.75941	
Before Shear	Water Content, %	30.29	28.03	24.16	
Before Shear	Dry Density, pcf	93.11	96.35	102.5	
Before Shear	Saturation, %	100.00	100.00	100.00	
Before Shear	Void Ratio	0.82377	0.76245	0.65721	
Before Shear	Back Press., tsf	5.0439	5.0463	5.0455	
	Minor Prin. Stress, tsf	0.73047	1.4625	2.9321	
	Max. Dev. Stress, tsf	1.4706	1.9084	3.1442	
	Time to Failure, min	1200	1020	900	
	Strain Rate, %/min	0.02	0.02	0.02	
	B-Value	0.96	0.99	0.95	
	Estimated Specific Gravity	2.72	2.72	2.72	
	Liquid Limit	43	43	43	
	Plastic Limit	21	21	21	
	Plasticity Index	22	22	22	
	Failure Sketch				

Project: VECTREN CULLEY EAST POND

Location: NEWBURGH, IN

Project No.: AW165009

Boring No.: B16-3 ST-7

Sample Type: 3.0'' ST

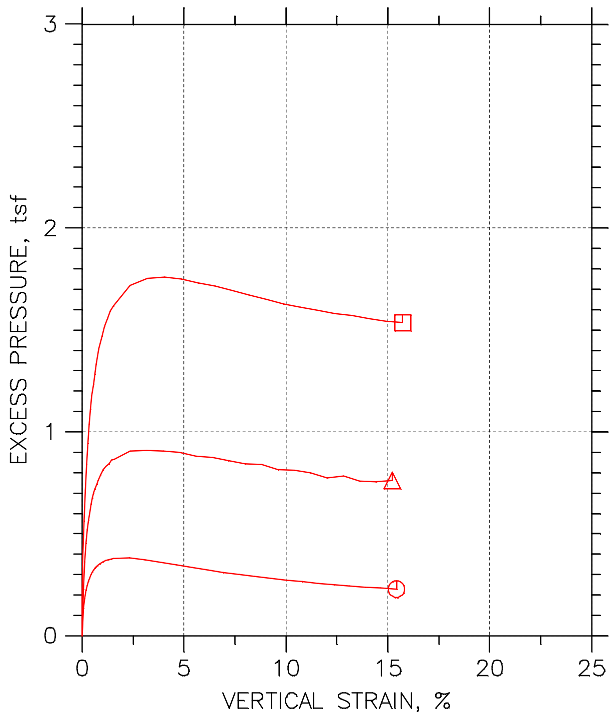
Description: GRAY TO OLIVE GRAY LEAN CLAY WITH SAND CL SILT POCKETS NOTED

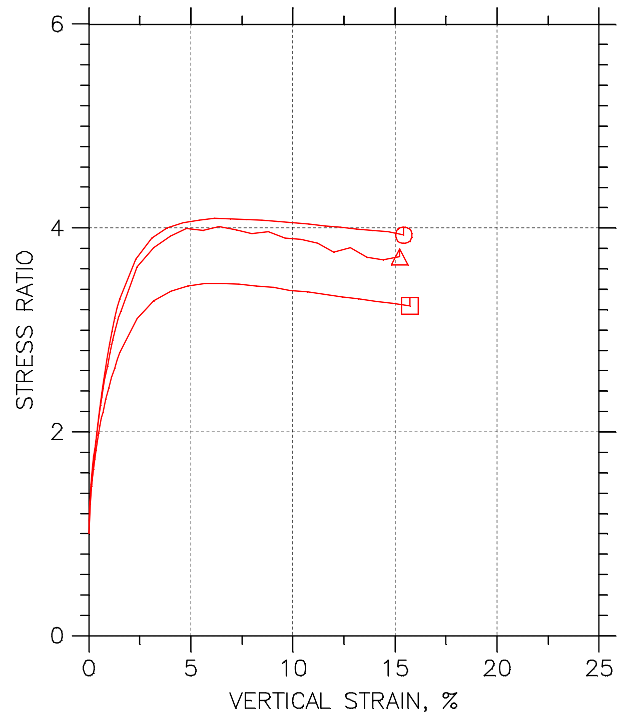
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

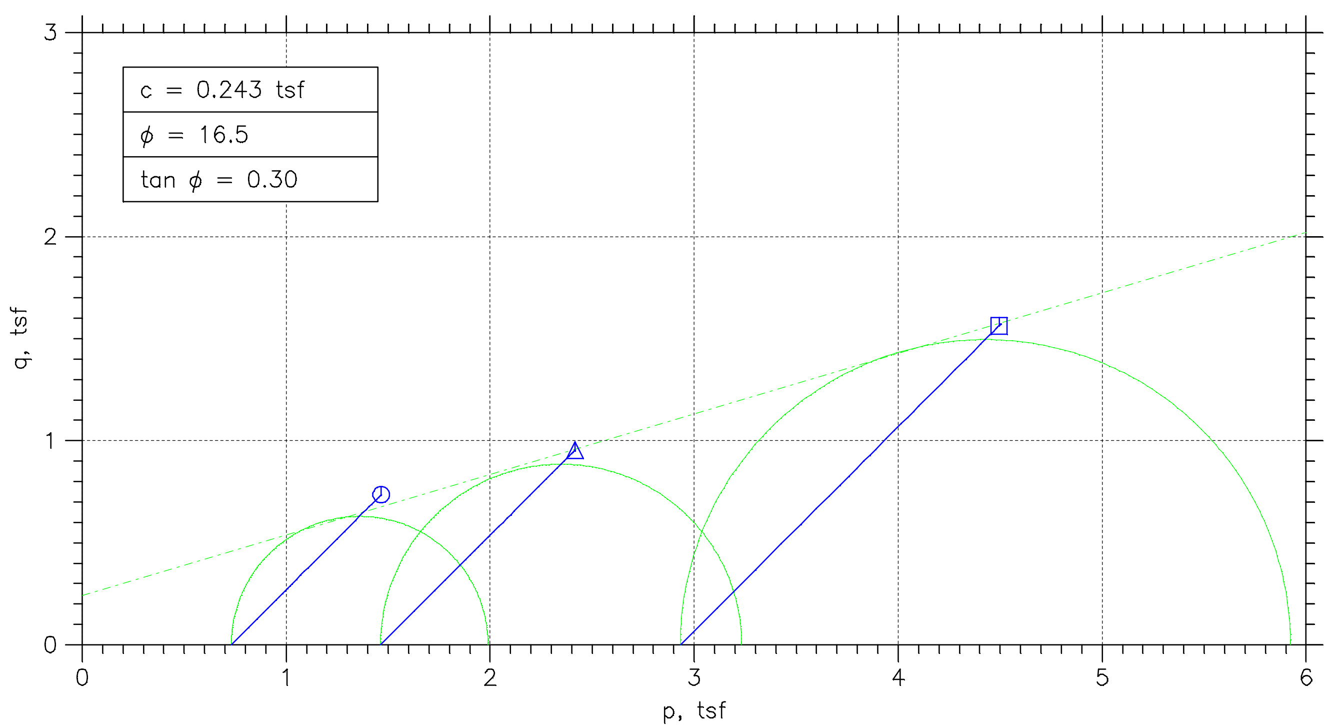
Tue, 26-APR-2016 14:28:03

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

Terracon
Consulting Engineers & Scientists







Project: VECTREN CULLEY EAST POND	Location: NEWBURGH, IN	Project No.: AW165009
Boring No.: B16-3 ST-7	Tested By: BCM	Checked By: WPQ
Sample No.: ST-7	Test Date: 4/21/16	Depth: 54.0'-56.0'
Test No.: B16-3 ST-7	Sample Type: 3.0" ST	Elevation: -----
Description: GRAY TO OLIVE GRAY LEAN CLAY WITH SAND CL SILT POCKETS NOTED		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767		

Tue, 26-APR-2016 14:29:21

TRIAXIAL TEST

Project: VECTREN CULLEY EAST POND
Boring No.: B16-3 ST-7
Sample No.: ST-7
Test No.: 10.2 PSI

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 4/21/16
Sample Type: 3.0" ST

Project No.: AW165009
Checked By: WPQ
Depth: 54.0'-56.0'
Elevation: -----

Soil Description: GRAY TO OLIVE GRAY LEAN CLAY WITH SAND CL SILT POCKETS NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

Specimen Height: 6.06 in
Specimen Area: 6.32 in^2
Specimen Volume: 38.34 in^3

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

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 43

Plastic Limit: 21

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.3214	0	0	5.0439	5.7744	5.7744
2	5.0044	0.061135	6.3252	15.127	0.1722	5.1766	5.7744	5.9466
3	10.001	0.12511	6.3293	22.228	0.25286	5.229	5.7744	6.0273
4	15.003	0.18767	6.3333	27.476	0.31237	5.2651	5.7744	6.0868
5	20.004	0.25165	6.3373	31.644	0.35952	5.2918	5.7744	6.1339
6	25.002	0.31563	6.3414	35.349	0.40135	5.3128	5.7744	6.1758
7	30.004	0.37961	6.3455	38.59	0.43787	5.3291	5.7744	6.2123
8	35.001	0.44501	6.3496	41.369	0.46909	5.3442	5.7744	6.2435
9	40.004	0.50899	6.3537	44.147	0.50028	5.3558	5.7744	6.2747
10	45	0.57296	6.3578	46.463	0.52618	5.3663	5.7744	6.3006
11	50.002	0.63836	6.362	48.778	0.55204	5.3745	5.7744	6.3264
12	55.003	0.70234	6.3661	50.939	0.57612	5.382	5.7744	6.3505
13	60.004	0.7649	6.3701	52.946	0.59844	5.3884	5.7744	6.3728
14	70	0.8957	6.3785	56.959	0.64295	5.3989	5.7744	6.4174
15	80.003	1.0237	6.3867	60.51	0.68215	5.407	5.7744	6.4565
16	90.002	1.1502	6.3949	63.906	0.71951	5.4129	5.7744	6.4939
17	100	1.2796	6.4033	67.147	0.75502	5.4175	5.7744	6.5294
18	110	1.4075	6.4116	69.926	0.78524	5.421	5.7744	6.5596
19	120	1.5341	6.4199	72.241	0.8102	5.4228	5.7744	6.5846
20	180	2.3103	6.4709	84.745	0.94294	5.4245	5.7744	6.7173
21	240	3.0895	6.5229	94.006	1.0376	5.4164	5.7744	6.812
22	300	3.8558	6.5749	101.42	1.1106	5.4047	5.7744	6.885
23	360	4.6306	6.6283	107.44	1.167	5.3919	5.7744	6.9414
24	420	5.4055	6.6826	112.84	1.2158	5.3791	5.7744	6.9902
25	480	6.169	6.737	117.78	1.2587	5.3675	5.7744	7.0331
26	540	6.9495	6.7935	122.25	1.2957	5.3553	5.7744	7.0701
27	600	7.7229	6.8504	125.96	1.3239	5.3448	5.7744	7.0983
28	660	8.4878	6.9077	129.82	1.3531	5.3349	5.7744	7.1275
29	720	9.2669	6.967	133.21	1.3767	5.325	5.7744	7.1511
30	780	10.036	7.0266	136.15	1.3951	5.3168	5.7744	7.1695
31	840	10.79	7.0859	139.23	1.4148	5.3093	5.7744	7.1892
32	900	11.573	7.1487	141.7	1.4272	5.3017	5.7744	7.2016
33	960	12.358	7.2127	144.48	1.4423	5.2953	5.7744	7.2167
34	1020	13.117	7.2757	146.95	1.4542	5.2883	5.7744	7.2286
35	1080	13.895	7.3414	148.96	1.4609	5.2831	5.7744	7.2353
36	1140	14.667	7.4079	151.27	1.4703	5.2779	5.7744	7.2447
37	1200	15.426	7.4744	152.66	1.4706	5.2726	5.7744	7.245

TRIAXIAL TEST

Project: VECTREN CULLEY EAST POND
Boring No.: B16-3 ST-7
Sample No.: ST-7
Test No.: 10.2 PSI

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 4/21/16
Sample Type: 3.0" ST

Project No.: AW165009
Checked By: WPQ
Depth: 54.0'-56.0'
Elevation: -----

Terracon Consulting Engineers & Scientists

Soil Description: GRAY TO OLIVE GRAY LEAN CLAY WITH SAND CL SILT POCKETS NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

Specimen Height: 6.06 in
Specimen Area: 6.32 in^2
Specimen Volume: 38.34 in^3

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

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 43

Plastic Limit: 21

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	5.7744	5.7744	0	0.000	0.73047	0.73047	1.000	0.73047	0
2	0.06	5.9466	5.7744	0.13267	0.770	0.76999	0.59779	1.288	0.68389	0.086098
3	0.13	6.0273	5.7744	0.18505	0.732	0.79828	0.54542	1.464	0.67185	0.12643
4	0.19	6.0868	5.7744	0.22112	0.708	0.82171	0.50934	1.613	0.66553	0.15618
5	0.25	6.1339	5.7744	0.24789	0.690	0.84209	0.48258	1.745	0.66234	0.17976
6	0.32	6.1758	5.7744	0.26884	0.670	0.86298	0.46163	1.869	0.6623	0.20068
7	0.38	6.2123	5.7744	0.28513	0.651	0.88321	0.44534	1.983	0.66427	0.21894
8	0.45	6.2435	5.7744	0.30026	0.640	0.8993	0.43021	2.090	0.66475	0.23455
9	0.51	6.2747	5.7744	0.3119	0.623	0.91885	0.41857	2.195	0.66871	0.25014
10	0.57	6.3006	5.7744	0.32237	0.613	0.93427	0.40809	2.289	0.67118	0.26309
11	0.64	6.3264	5.7744	0.33052	0.599	0.95198	0.39995	2.380	0.67596	0.27602
12	0.70	6.3505	5.7744	0.33809	0.587	0.9685	0.39238	2.468	0.68044	0.28806
13	0.76	6.3728	5.7744	0.34449	0.576	0.98442	0.38598	2.550	0.6852	0.29922
14	0.90	6.4174	5.7744	0.35496	0.552	1.0185	0.37551	2.712	0.69698	0.32148
15	1.02	6.4565	5.7744	0.36311	0.532	1.0495	0.36736	2.857	0.70843	0.34107
16	1.15	6.4939	5.7744	0.36893	0.513	1.0811	0.36154	2.990	0.7213	0.35976
17	1.28	6.5294	5.7744	0.37358	0.495	1.1119	0.35689	3.116	0.73439	0.37751
18	1.41	6.5596	5.7744	0.37707	0.480	1.1386	0.35339	3.222	0.74602	0.39262
19	1.53	6.5846	5.7744	0.37882	0.468	1.1619	0.35165	3.304	0.75675	0.4051
20	2.31	6.7173	5.7744	0.38056	0.404	1.2928	0.3499	3.695	0.82137	0.47147
21	3.09	6.812	5.7744	0.37242	0.359	1.3957	0.35805	3.898	0.87687	0.51882
22	3.86	6.885	5.7744	0.36078	0.325	1.4803	0.36969	4.004	0.92498	0.55529
23	4.63	6.9414	5.7744	0.34798	0.298	1.5495	0.38249	4.051	0.966	0.58351
24	5.41	6.9902	5.7744	0.33518	0.276	1.611	0.39529	4.076	1.0032	0.60788
25	6.17	7.0331	5.7744	0.32354	0.257	1.6657	0.40693	4.093	1.0363	0.62936
26	6.95	7.0701	5.7744	0.31132	0.240	1.7149	0.41915	4.091	1.067	0.64785
27	7.72	7.0983	5.7744	0.30084	0.227	1.7535	0.42962	4.081	1.0916	0.66193
28	8.49	7.1275	5.7744	0.29095	0.215	1.7926	0.43952	4.079	1.1161	0.67656
29	9.27	7.1511	5.7744	0.28106	0.204	1.8261	0.44941	4.063	1.1378	0.68835
30	10.04	7.1695	5.7744	0.27291	0.196	1.8526	0.45756	4.049	1.1551	0.69754
31	10.79	7.1892	5.7744	0.26535	0.188	1.8799	0.46512	4.042	1.1725	0.70738
32	11.57	7.2016	5.7744	0.25778	0.181	1.8999	0.47268	4.019	1.1863	0.71361
33	12.36	7.2167	5.7744	0.25138	0.174	1.9214	0.47909	4.010	1.2002	0.72114
34	13.12	7.2286	5.7744	0.2444	0.168	1.9403	0.48607	3.992	1.2132	0.72711
35	13.89	7.2353	5.7744	0.23916	0.164	1.9522	0.49131	3.973	1.2218	0.73045
36	14.67	7.2447	5.7744	0.23392	0.159	1.9668	0.49654	3.961	1.2317	0.73515
37	15.43	7.245	5.7744	0.22869	0.156	1.9724	0.50178	3.931	1.2371	0.7353

TRIAXIAL TEST

Project: VECTREN CULLEY EAST POND
Boring No.: B16-3 ST-7
Sample No.: ST-7
Test No.: 20.4 PSI

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 4/21/16
Sample Type: 3.0" ST

Project No.: AW165009
Checked By: WPQ
Depth: 54.0'-56.0'
Elevation: ----

Soil Description: GRAY TO OLIVE GRAY LEAN CLAY WITH SAND CL SILT POCKETS NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.13 in
Specimen Area: 6.40 in^2
Specimen Volume: 39.24 in^3

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

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 43

Plastic Limit: 21

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.397	0	0	5.0463	6.5088	6.5088
2	5.0034	0.051477	6.4003	29.758	0.33476	5.2737	6.5088	6.8436
3	10.004	0.11387	6.4043	47.364	0.53249	5.4108	6.5088	7.0413
4	15	0.17939	6.4085	56.539	0.63522	5.4988	6.5088	7.144
5	20.001	0.24647	6.4128	63.483	0.71275	5.5647	6.5088	7.2216
6	25.002	0.31198	6.4171	69.31	0.77767	5.6131	6.5088	7.2865
7	30.004	0.3775	6.4213	74.146	0.83138	5.6511	6.5088	7.3402
8	35.001	0.44302	6.4255	78.362	0.87807	5.6919	6.5088	7.3869
9	40.004	0.51165	6.4299	82.205	0.9205	5.7239	6.5088	7.4293
10	45.004	0.57873	6.4343	85.801	0.96012	5.7479	6.5088	7.4689
11	50.001	0.64425	6.4385	89.025	0.99554	5.7659	6.5088	7.5043
12	55.001	0.71288	6.443	92.001	1.0281	5.7881	6.5088	7.5369
13	60.001	0.77684	6.4471	94.604	1.0565	5.8085	6.5088	7.5653
14	70.003	0.91255	6.4559	99.44	1.109	5.8348	6.5088	7.6178
15	80.003	1.0467	6.4647	104.03	1.1586	5.8598	6.5088	7.6674
16	90.003	1.1777	6.4733	108	1.2012	5.8779	6.5088	7.71
17	100	1.3072	6.4818	111.71	1.2409	5.8902	6.5088	7.7497
18	110	1.4414	6.4906	115.06	1.2764	5.9082	6.5088	7.7852
19	120	1.5724	6.4992	118.16	1.309	5.9106	6.5088	7.8178
20	180	2.3648	6.552	132.79	1.4593	5.9514	6.5088	7.9681
21	240	3.1775	6.607	142.34	1.5512	5.9561	6.5088	8.06
22	300	3.984	6.6625	150.52	1.6267	5.9514	6.5088	8.1355
23	360	4.7811	6.7182	156.97	1.6823	5.9473	6.5088	8.1911
24	420	5.5876	6.7756	163.05	1.7326	5.9263	6.5088	8.2414
25	480	6.3957	6.8341	168.01	1.77	5.9211	6.5088	8.2788
26	540	7.1912	6.8927	172.22	1.799	5.9059	6.5088	8.3078
27	600	7.9961	6.953	176.44	1.8271	5.889	6.5088	8.3359
28	660	8.8026	7.0145	180.16	1.8492	5.8849	6.5088	8.358
29	720	9.5997	7.0763	184.13	1.8734	5.8627	6.5088	8.3822
30	780	10.408	7.1402	186.6	1.8817	5.8569	6.5088	8.3905
31	840	11.211	7.2048	189.08	1.8896	5.8464	6.5088	8.3984
32	900	12.01	7.2702	191.69	1.8984	5.8213	6.5088	8.4072
33	960	12.821	7.3378	194.17	1.9052	5.8295	6.5088	8.414
34	1020	13.615	7.4053	196.28	1.9084	5.805	6.5088	8.4172
35	1080	14.412	7.4742	197.64	1.9039	5.8003	6.5088	8.4127
36	1140	15.222	7.5456	199.75	1.906	5.8073	6.5088	8.4148

TRIAXIAL TEST

Project: VECTREN CULLEY EAST POND
Boring No.: B16-3 ST-7
Sample No.: ST-7
Test No.: 20.4 PSI

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 4/21/16
Sample Type: 3.0" ST

Project No.: AW165009
Checked By: WPQ
Depth: 54.0'-56.0'
Elevation: ----

Terracon
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Soil Description: GRAY TO OLIVE GRAY LEAN CLAY WITH SAND CL SILT POCKETS NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.13 in
Specimen Area: 6.40 in^2
Specimen Volume: 39.24 in^3

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

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 43

Plastic Limit: 21

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	6.5088	6.5088	0	0.000	1.4625	1.4625	1.000	1.4625	0
2	0.05	6.8436	6.5088	0.22744	0.679	1.5698	1.2351	1.271	1.4024	0.16738
3	0.11	7.0413	6.5088	0.36449	0.685	1.6305	1.098	1.485	1.3643	0.26624
4	0.18	7.144	6.5088	0.45255	0.712	1.6452	1.01	1.629	1.3276	0.31761
5	0.25	7.2216	6.5088	0.51845	0.727	1.6568	0.94406	1.755	1.3004	0.35638
6	0.31	7.2865	6.5088	0.56685	0.729	1.6733	0.89566	1.868	1.2845	0.38883
7	0.38	7.3402	6.5088	0.60476	0.727	1.6891	0.85775	1.969	1.2734	0.41569
8	0.44	7.3869	6.5088	0.64558	0.735	1.695	0.81693	2.075	1.256	0.43904
9	0.51	7.4293	6.5088	0.67766	0.736	1.7054	0.78485	2.173	1.2451	0.46025
10	0.58	7.4689	6.5088	0.70157	0.731	1.7211	0.76094	2.262	1.241	0.48006
11	0.64	7.5043	6.5088	0.71965	0.723	1.7384	0.74286	2.340	1.2406	0.49777
12	0.71	7.5369	6.5088	0.74181	0.722	1.7488	0.7207	2.427	1.2348	0.51405
13	0.78	7.5653	6.5088	0.76222	0.721	1.7568	0.70029	2.509	1.2285	0.52826
14	0.91	7.6178	6.5088	0.78846	0.711	1.7831	0.67405	2.645	1.2285	0.5545
15	1.05	7.6674	6.5088	0.81354	0.702	1.8076	0.64897	2.785	1.2283	0.5793
16	1.18	7.71	6.5088	0.83162	0.692	1.8321	0.63089	2.904	1.2315	0.6006
17	1.31	7.7497	6.5088	0.84387	0.680	1.8596	0.61864	3.006	1.2391	0.62047
18	1.44	7.7852	6.5088	0.86195	0.675	1.877	0.60057	3.125	1.2388	0.63819
19	1.57	7.8178	6.5088	0.86428	0.660	1.9073	0.59823	3.188	1.2527	0.65452
20	2.36	7.9681	6.5088	0.9051	0.620	2.0167	0.55741	3.618	1.287	0.72964
21	3.18	8.06	6.5088	0.90977	0.587	2.1039	0.55274	3.806	1.3283	0.77558
22	3.98	8.1355	6.5088	0.9051	0.556	2.1841	0.55741	3.918	1.3708	0.81334
23	4.78	8.1911	6.5088	0.90102	0.536	2.2438	0.56149	3.996	1.4026	0.84114
24	5.59	8.2414	6.5088	0.88002	0.508	2.3151	0.58249	3.974	1.4488	0.86629
25	6.40	8.2788	6.5088	0.87478	0.494	2.3577	0.58774	4.012	1.4727	0.885
26	7.19	8.3078	6.5088	0.85961	0.478	2.4019	0.6029	3.984	1.5024	0.8995
27	8.00	8.3359	6.5088	0.8427	0.461	2.4469	0.61981	3.948	1.5333	0.91353
28	8.80	8.358	6.5088	0.83862	0.453	2.4731	0.62389	3.964	1.5485	0.92461
29	9.60	8.3822	6.5088	0.81646	0.436	2.5195	0.64605	3.900	1.5828	0.93671
30	10.41	8.3905	6.5088	0.81063	0.431	2.5336	0.65189	3.887	1.5927	0.94084
31	11.21	8.3984	6.5088	0.80013	0.423	2.552	0.66238	3.853	1.6072	0.9448
32	12.01	8.4072	6.5088	0.77505	0.408	2.5858	0.68746	3.761	1.6367	0.94919
33	12.82	8.414	6.5088	0.78322	0.411	2.5845	0.67929	3.805	1.6319	0.95261
34	13.61	8.4172	6.5088	0.75872	0.398	2.6121	0.70379	3.712	1.658	0.95418
35	14.41	8.4127	6.5088	0.75406	0.396	2.6123	0.70845	3.687	1.6604	0.95194
36	15.22	8.4148	6.5088	0.76105	0.399	2.6074	0.70146	3.717	1.6545	0.953

TRIAXIAL TEST

Project: VECTREN CULLEY EAST POND
Location: NEWBURGH, IN
Project No.: AW165009
Boring No.: B16-3 ST-7
Tested By: BCM
Checked By: WPQ
Sample No.: ST-7
Test Date: 4/21/16
Depth: 54.0'-56.0'
Test No.: 40.8 PSI
Sample Type: 3.0" ST
Elevation: ----

Soil Description: GRAY TO OLIVE GRAY LEAN CLAY WITH SAND CL SILT POCKETS NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.98 in
Specimen Area: 6.43 in^2
Specimen Volume: 38.45 in^3
Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb
Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 43
Plastic Limit: 21
Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.4253	0	0	5.0455	7.9776	7.9776
2	5.0044	0.012213	6.4261	32.163	0.36036	5.2406	7.9776	8.338
3	10.001	0.048853	6.4284	65.799	0.73696	5.4369	7.9776	8.7146
4	15.002	0.099232	6.4317	88.313	0.98863	5.6093	7.9776	8.9662
5	20.003	0.15724	6.4354	105.47	1.18	5.759	7.9776	9.1576
6	25.004	0.21984	6.4395	119.27	1.3336	5.8842	7.9776	9.3112
7	30.001	0.28548	6.4437	130.39	1.457	5.9896	7.9776	9.4346
8	35.004	0.35266	6.448	140.04	1.5637	6.0816	7.9776	9.5413
9	40.002	0.41983	6.4524	147.95	1.6509	6.1597	7.9776	9.6285
10	45.004	0.487	6.4567	154.92	1.7275	6.2249	7.9776	9.7051
11	50	0.55417	6.4611	161.35	1.798	6.282	7.9776	9.7756
12	55.002	0.62287	6.4656	166.98	1.8594	6.3321	7.9776	9.837
13	60.003	0.69157	6.47	172.2	1.9163	6.3775	7.9776	9.8939
14	70.001	0.8305	6.4791	181.58	2.0179	6.452	7.9776	9.9955
15	80.002	0.97095	6.4883	189.22	2.0998	6.5132	7.9776	10.077
16	90.002	1.1099	6.4974	195.79	2.1696	6.5621	7.9776	10.147
17	100	1.2534	6.5069	201.55	2.2302	6.6029	7.9776	10.208
18	110	1.3938	6.5161	206.91	2.2863	6.6384	7.9776	10.264
19	120	1.5343	6.5254	211.87	2.3377	6.6646	7.9776	10.315
20	180	2.3602	6.5806	233.98	2.5601	6.7648	7.9776	10.538
21	240	3.1907	6.6371	248.46	2.6953	6.7986	7.9776	10.673
22	300	4.0349	6.6955	260.25	2.7986	6.8032	7.9776	10.776
23	360	4.8578	6.7534	269.76	2.876	6.7951	7.9776	10.854
24	420	5.6929	6.8132	278.88	2.9471	6.7764	7.9776	10.925
25	480	6.5402	6.8749	285.58	2.9908	6.7596	7.9776	10.968
26	540	7.3676	6.9363	292.28	3.0339	6.7374	7.9776	11.011
27	600	8.2057	6.9997	298.44	3.0698	6.7159	7.9776	11.047
28	660	9.0576	7.0652	303.94	3.0973	6.6961	7.9776	11.075
29	720	9.8759	7.1294	308.09	3.1114	6.6739	7.9776	11.089
30	780	10.711	7.1961	312.78	3.1295	6.6588	7.9776	11.107
31	840	11.563	7.2654	316.67	3.1382	6.6419	7.9776	11.116
32	900	12.393	7.3343	320.28	3.1442	6.6262	7.9776	11.122
33	960	13.228	7.4048	323.23	3.1429	6.6151	7.9776	11.121
34	1020	14.074	7.4777	326.05	3.1394	6.6011	7.9776	11.117
35	1080	14.892	7.5496	329	3.1376	6.5895	7.9776	11.115
36	1140	15.735	7.6251	331.01	3.1255	6.5808	7.9776	11.103

TRIAXIAL TEST

Project: VECTREN CULLEY EAST POND
Boring No.: B16-3 ST-7
Sample No.: ST-7
Test No.: 40.8 PSI

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 4/21/16
Sample Type: 3.0" ST

Project No.: AW165009
Checked By: WPQ
Depth: 54.0'-56.0'
Elevation: ----

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Soil Description: GRAY TO OLIVE GRAY LEAN CLAY WITH SAND CL SILT POCKETS NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.98 in
Specimen Area: 6.43 in^2
Specimen Volume: 38.45 in^3

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

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 43

Plastic Limit: 21

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	7.9776	7.9776	0	0.000	2.9321	2.9321	1.000	2.9321	0
2	0.01	8.338	7.9776	0.19511	0.541	3.0974	2.737	1.132	2.9172	0.18018
3	0.05	8.7146	7.9776	0.39139	0.531	3.2777	2.5407	1.290	2.9092	0.36848
4	0.10	8.9662	7.9776	0.56378	0.570	3.3569	2.3683	1.417	2.8626	0.49431
5	0.16	9.1576	7.9776	0.71346	0.605	3.3986	2.2186	1.532	2.8086	0.58998
6	0.22	9.3112	7.9776	0.83868	0.629	3.427	2.0934	1.637	2.7602	0.66678
7	0.29	9.4346	7.9776	0.9441	0.648	3.445	1.988	1.733	2.7165	0.72848
8	0.35	9.5413	7.9776	1.0361	0.663	3.4597	1.896	1.825	2.6778	0.78186
9	0.42	9.6285	7.9776	1.1142	0.675	3.4688	1.8179	1.908	2.6434	0.82545
10	0.49	9.7051	7.9776	1.1794	0.683	3.4802	1.7527	1.986	2.6164	0.86374
11	0.55	9.7756	7.9776	1.2365	0.688	3.4936	1.6956	2.060	2.5946	0.899
12	0.62	9.837	7.9776	1.2866	0.692	3.505	1.6455	2.130	2.5753	0.92972
13	0.69	9.8939	7.9776	1.332	0.695	3.5164	1.6001	2.198	2.5583	0.95816
14	0.83	9.9955	7.9776	1.4065	0.697	3.5434	1.5256	2.323	2.5345	1.0089
15	0.97	10.077	7.9776	1.4677	0.699	3.5642	1.4644	2.434	2.5143	1.0499
16	1.11	10.147	7.9776	1.5166	0.699	3.5851	1.4155	2.533	2.5003	1.0848
17	1.25	10.208	7.9776	1.5574	0.698	3.6049	1.3747	2.622	2.4898	1.1151
18	1.39	10.264	7.9776	1.5929	0.697	3.6255	1.3392	2.707	2.4823	1.1431
19	1.53	10.315	7.9776	1.6191	0.693	3.6507	1.313	2.780	2.4818	1.1689
20	2.36	10.538	7.9776	1.7193	0.672	3.7729	1.2128	3.111	2.4928	1.28
21	3.19	10.673	7.9776	1.7531	0.650	3.8743	1.179	3.286	2.5267	1.3476
22	4.03	10.776	7.9776	1.7577	0.628	3.973	1.1744	3.383	2.5737	1.3993
23	4.86	10.854	7.9776	1.7496	0.608	4.0586	1.1825	3.432	2.6205	1.438
24	5.69	10.925	7.9776	1.7309	0.587	4.1482	1.2012	3.454	2.6747	1.4735
25	6.54	10.968	7.9776	1.7141	0.573	4.2088	1.218	3.455	2.7134	1.4954
26	7.37	11.011	7.9776	1.6919	0.558	4.274	1.2402	3.446	2.7571	1.5169
27	8.21	11.047	7.9776	1.6704	0.544	4.3315	1.2617	3.433	2.7966	1.5349
28	9.06	11.075	7.9776	1.6506	0.533	4.3789	1.2815	3.417	2.8302	1.5487
29	9.88	11.089	7.9776	1.6284	0.523	4.4151	1.3037	3.387	2.8594	1.5557
30	10.71	11.107	7.9776	1.6133	0.516	4.4483	1.3188	3.373	2.8836	1.5648
31	11.56	11.116	7.9776	1.5964	0.509	4.4739	1.3357	3.349	2.9048	1.5691
32	12.39	11.122	7.9776	1.5807	0.503	4.4956	1.3514	3.327	2.9235	1.5721
33	13.23	11.121	7.9776	1.5696	0.499	4.5054	1.3625	3.307	2.9339	1.5715
34	14.07	11.117	7.9776	1.5556	0.496	4.5158	1.3765	3.281	2.9461	1.5697
35	14.89	11.115	7.9776	1.544	0.492	4.5257	1.3881	3.260	2.9569	1.5688
36	15.74	11.103	7.9776	1.5353	0.491	4.5224	1.3968	3.238	2.9596	1.5628

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Direct Shear of Soils Under Consolidated Drained Conditions – ASTM D 3080

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

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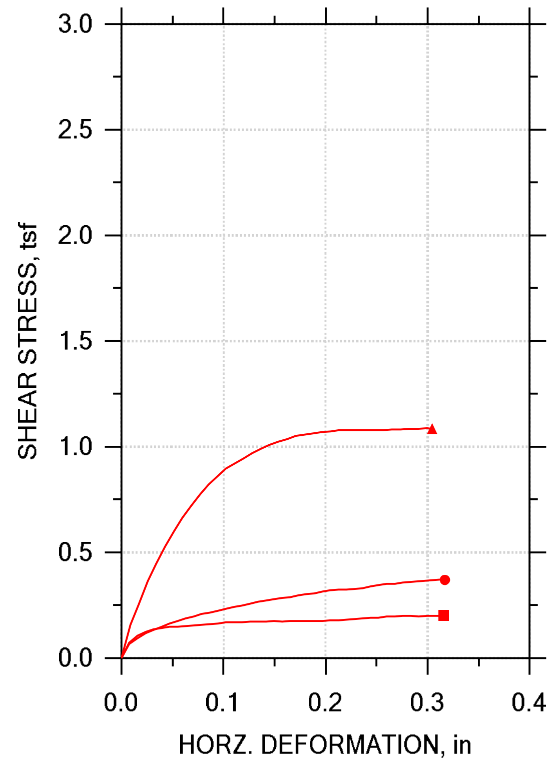

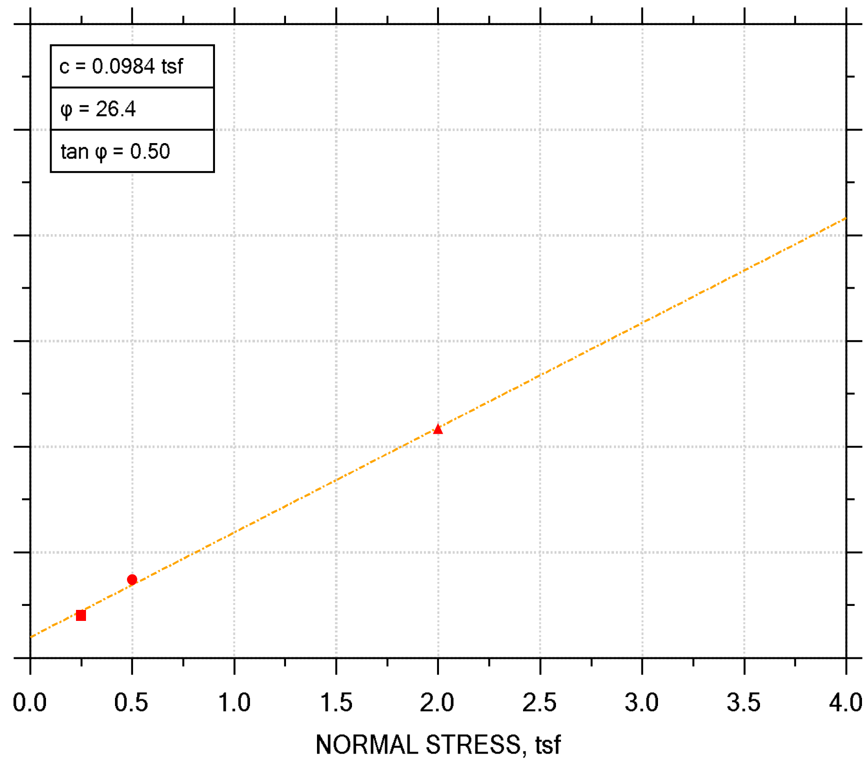

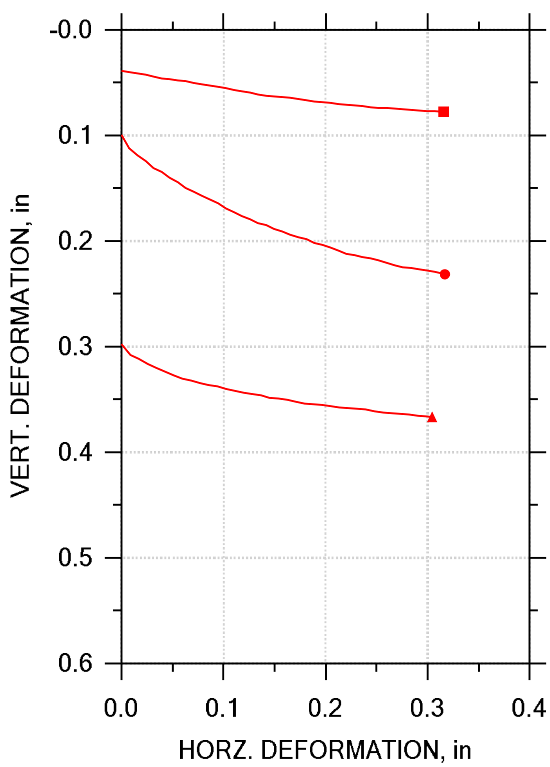

Symbol		■	●	▲	
Test No.		500 PSF	1000 PSF	4000 PSF	
Sample No.		ST-2	ST-2	ST-2	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.5142	2.5142	2.5142	
	Area, in²	4.9646	4.9646	4.9646	
	Height, in	0.99409	0.99921	0.9748	
	Water Content, %	112.48	113.96	113.13	
	Dry Density, pcf	40.54	40.43	41.47	
	Saturation, %	96.70	97.61	100.23	
	Void Ratio	3.0881	3.0996	2.9968	
Consol. Height, in		0.95539	0.89998	0.67744	
Consol. Void Ratio		2.9289	2.6925	1.7776	
Final	Water Content, %	103.70	80.34	55.16	
	Dry Density, pcf	43.98	52.62	66.45	
	Saturation, %	99.43	99.21	98.01	
	Void Ratio	2.769	2.15	1.4943	
Normal Stress, tsf		0.24969	0.49937	1.9998	
Max. Shear Stress, tsf		0.20069	0.37122	1.0866	
Ult. Shear Stress, tsf		0.20069	0.3701	1.0862	
Time to Failure, min		1895.4	1868.1	1657	
Disp. Rate, in/min		0.0001746	0.0001746	0.0001746	
Measured Specific Gravity		2.65	2.65	2.65	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	
Plasticity Index		---	---	---	

Project: VECTREN CULLEY EAST POND

Location: NEWBURGH,IN

Project No.: AW165009

Boring No.: B16-1 ST-2

Sample Type: 3'' ST

Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH

Remarks: TEST PERFORMED AS PER ASTM D3080.

DIRECT SHEAR TEST DATA

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Project: VECTREN CULLEY EAST POND
Boring No.: B16-1 ST-2
Sample No.: ST-2
Test No.: 500 PSF

Location: NEWBURGH,IN
Tested By: HP
Test Date: 04/11/16
Sample Type: 3'' ST

Project No.: AW165009
Checked By: BCM
Depth: 17.0'-19.0'
Elevation: ----

Soil Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH
Remarks: TEST PERFORMED AS PER ASTM D3080.

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	0.250	0.03871	0.000	0.0000	0.0000
2	66.32	0.250	0.03990	0.0730	0.007876	0.007876
3	113.74	0.250	0.04123	0.106	0.01575	0.01575
4	162.69	0.250	0.04249	0.125	0.02363	0.02363
5	208.88	0.250	0.04400	0.137	0.03150	0.03150
6	252.81	0.250	0.04602	0.143	0.03938	0.03938
7	301.40	0.250	0.04684	0.148	0.04725	0.04725
8	349.30	0.250	0.04791	0.149	0.05513	0.05513
9	396.30	0.250	0.04879	0.152	0.06301	0.06301
10	439.13	0.250	0.05031	0.156	0.07088	0.07088
11	487.22	0.250	0.05182	0.159	0.07876	0.07876
12	533.80	0.250	0.05283	0.162	0.08663	0.08663
13	579.03	0.250	0.05421	0.165	0.09451	0.09451
14	623.03	0.249	0.05535	0.168	0.1024	0.1024
15	673.08	0.250	0.05680	0.170	0.1103	0.1103
16	722.54	0.250	0.05819	0.171	0.1181	0.1181
17	765.29	0.250	0.05932	0.172	0.1260	0.1260
18	813.27	0.249	0.06128	0.173	0.1339	0.1339
19	859.02	0.250	0.06260	0.174	0.1418	0.1418
20	910.77	0.250	0.06279	0.174	0.1496	0.1496
21	959.24	0.250	0.06342	0.174	0.1575	0.1575
22	1001.92	0.250	0.06455	0.174	0.1654	0.1654
23	1053.04	0.250	0.06575	0.175	0.1733	0.1733
24	1100.11	0.250	0.06689	0.175	0.1811	0.1811
25	1146.44	0.250	0.06783	0.176	0.1890	0.1890
26	1195.46	0.250	0.06859	0.177	0.1969	0.1969
27	1239.80	0.249	0.06934	0.178	0.2048	0.2048
28	1287.73	0.250	0.07004	0.179	0.2126	0.2126
29	1334.58	0.250	0.07086	0.181	0.2205	0.2205
30	1383.06	0.250	0.07149	0.184	0.2284	0.2284
31	1427.06	0.250	0.07218	0.188	0.2362	0.2362
32	1475.83	0.250	0.07306	0.190	0.2441	0.2441
33	1519.38	0.250	0.07376	0.192	0.2520	0.2520
34	1566.12	0.250	0.07420	0.195	0.2599	0.2599
35	1616.21	0.250	0.07464	0.197	0.2677	0.2677
36	1662.20	0.250	0.07502	0.199	0.2756	0.2756
37	1706.23	0.250	0.07577	0.200	0.2835	0.2835
38	1752.33	0.250	0.07666	0.197	0.2914	0.2914
39	1797.00	0.250	0.07697	0.200	0.2992	0.2992
40	1844.22	0.250	0.07729	0.200	0.3071	0.3071
41	1893.10	0.250	0.07760	0.200	0.3150	0.3150
42	1895.44	0.250	0.07760	0.201	0.3156	0.3156

DIRECT SHEAR TEST DATA

Project: VECTREN CULLEY EAST POND
Location: NEWBURGH,IN
Project No.: AW165009
Boring No.: B16-1 ST-2
Tested By: HP
Checked By: BCM
Sample No.: ST-2
Test Date: 04/14/16
Depth: 17.0'-19.0'
Test No.: 1000 PSF
Sample Type: 3'' ST
Elevation: ----

Soil Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH
Remarks: TEST PERFORMED AS PER ASTM D3080.

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	0.495	0.09924	0.000	0.0000	0.0000
2	53.59	0.499	0.1121	0.0652	0.007876	0.007876
3	104.96	0.499	0.1189	0.0953	0.01575	0.01575
4	150.89	0.499	0.1240	0.117	0.02363	0.02363
5	194.90	0.499	0.1308	0.134	0.03150	0.03150
6	241.24	0.499	0.1347	0.149	0.03938	0.03938
7	289.68	0.499	0.1398	0.164	0.04725	0.04725
8	337.35	0.499	0.1442	0.174	0.05513	0.05513
9	382.26	0.499	0.1494	0.189	0.06301	0.06301
10	427.80	0.499	0.1534	0.198	0.07088	0.07088
11	478.05	0.499	0.1570	0.208	0.07876	0.07876
12	519.12	0.499	0.1608	0.216	0.08663	0.08663
13	569.86	0.499	0.1645	0.224	0.09451	0.09451
14	613.72	0.499	0.1691	0.232	0.1024	0.1024
15	662.08	0.499	0.1728	0.241	0.1103	0.1103
16	707.10	0.499	0.1762	0.248	0.1181	0.1181
17	753.62	0.499	0.1791	0.256	0.1260	0.1260
18	799.93	0.499	0.1829	0.265	0.1339	0.1339
19	846.66	0.499	0.1851	0.273	0.1418	0.1418
20	891.67	0.499	0.1882	0.278	0.1496	0.1496
21	937.52	0.499	0.1910	0.284	0.1575	0.1575
22	989.40	0.499	0.1939	0.289	0.1654	0.1654
23	1035.28	0.499	0.1966	0.296	0.1733	0.1733
24	1077.75	0.499	0.1984	0.302	0.1811	0.1811
25	1128.27	0.499	0.2017	0.306	0.1890	0.1890
26	1174.49	0.499	0.2036	0.315	0.1969	0.1969
27	1218.88	0.499	0.2058	0.321	0.2048	0.2048
28	1269.48	0.499	0.2088	0.324	0.2126	0.2126
29	1313.13	0.499	0.2121	0.325	0.2205	0.2205
30	1365.58	0.499	0.2136	0.328	0.2284	0.2284
31	1411.02	0.499	0.2152	0.331	0.2362	0.2362
32	1453.57	0.499	0.2166	0.339	0.2441	0.2441
33	1503.71	0.499	0.2184	0.346	0.2520	0.2520
34	1553.55	0.499	0.2205	0.351	0.2599	0.2599
35	1592.77	0.499	0.2229	0.351	0.2677	0.2677
36	1643.47	0.499	0.2248	0.358	0.2756	0.2756
37	1686.94	0.499	0.2256	0.359	0.2835	0.2835
38	1734.05	0.499	0.2268	0.363	0.2914	0.2914
39	1774.84	0.499	0.2280	0.367	0.2992	0.2992
40	1825.33	0.499	0.2293	0.371	0.3071	0.3071
41	1868.14	0.499	0.2310	0.371	0.3150	0.3150
42	1879.60	0.499	0.2314	0.370	0.3167	0.3167

DIRECT SHEAR TEST DATA

Project: VECTREN CULLEY EAST POND
Boring No.: B16-1 ST-2
Sample No.: ST-2
Test No.: 4000 PSF

Location: NEWBURGH,IN
Tested By: HP
Test Date: 04/13/16
Sample Type: 3'' ST

Project No.: AW165009
Checked By: BCM
Depth: 17.0'-19.0'
Elevation: ----

Soil Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH
Remarks: TEST PERFORMED AS PER ASTM D3080.

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	2.00	0.2974	0.000	0.0000	0.0000
2	64.92	2.00	0.3077	0.157	0.008548	0.008548
3	110.39	2.00	0.3114	0.253	0.01710	0.01710
4	164.14	2.00	0.3163	0.363	0.02564	0.02564
5	208.91	2.00	0.3202	0.446	0.03419	0.03419
6	257.27	2.00	0.3239	0.527	0.04274	0.04274
7	305.11	2.00	0.3273	0.600	0.05129	0.05129
8	350.37	2.00	0.3302	0.664	0.05983	0.05983
9	394.42	2.00	0.3323	0.721	0.06838	0.06838
10	440.90	2.00	0.3344	0.774	0.07693	0.07693
11	490.25	2.00	0.3363	0.822	0.08548	0.08548
12	536.76	2.00	0.3379	0.861	0.09403	0.09403
13	586.72	2.00	0.3402	0.897	0.1026	0.1026
14	630.06	2.00	0.3421	0.922	0.1111	0.1111
15	676.07	2.00	0.3434	0.946	0.1197	0.1197
16	722.73	2.00	0.3450	0.971	0.1282	0.1282
17	771.05	2.00	0.3463	0.990	0.1368	0.1368
18	817.52	2.00	0.3482	1.01	0.1453	0.1453
19	862.22	2.00	0.3493	1.02	0.1539	0.1539
20	906.75	2.00	0.3504	1.04	0.1624	0.1624
21	954.20	2.00	0.3523	1.05	0.1710	0.1710
22	1002.51	2.00	0.3538	1.06	0.1795	0.1795
23	1046.18	2.00	0.3545	1.06	0.1881	0.1881
24	1094.00	2.00	0.3551	1.07	0.1966	0.1966
25	1137.56	2.00	0.3562	1.07	0.2051	0.2051
26	1185.16	2.00	0.3575	1.08	0.2137	0.2137
27	1233.45	2.00	0.3584	1.08	0.2222	0.2222
28	1280.26	2.00	0.3591	1.08	0.2307	0.2307
29	1324.62	2.00	0.3595	1.08	0.2393	0.2393
30	1372.06	2.00	0.3614	1.08	0.2478	0.2478
31	1417.68	2.00	0.3624	1.08	0.2564	0.2564
32	1465.26	2.00	0.3629	1.08	0.2649	0.2649
33	1515.89	2.00	0.3634	1.08	0.2735	0.2735
34	1564.74	2.00	0.3642	1.08	0.2820	0.2820
35	1608.16	2.00	0.3654	1.08	0.2906	0.2906
36	1656.99	2.00	0.3661	1.09	0.2991	0.2991
37	1692.78	2.00	0.3665	1.09	0.3045	0.3045

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

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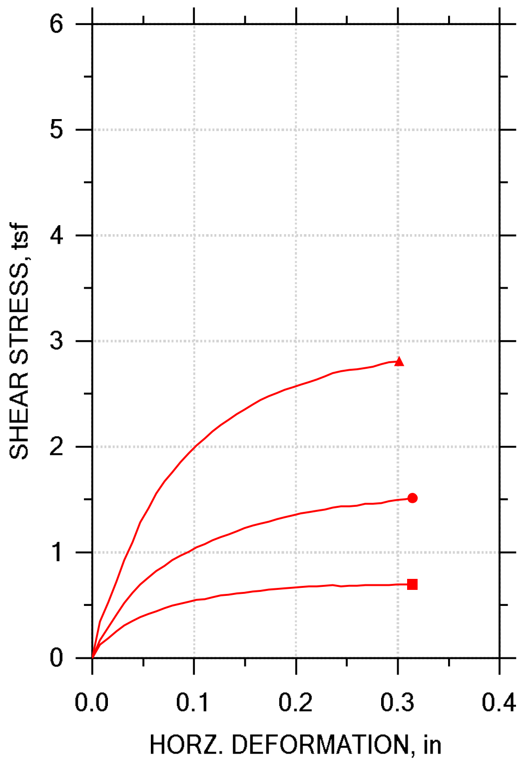
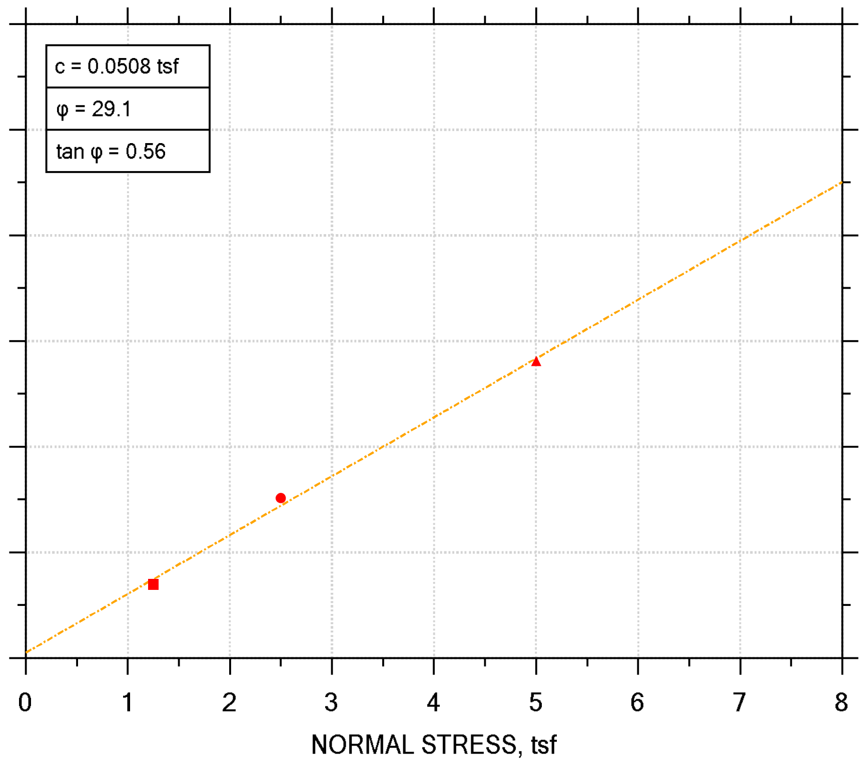
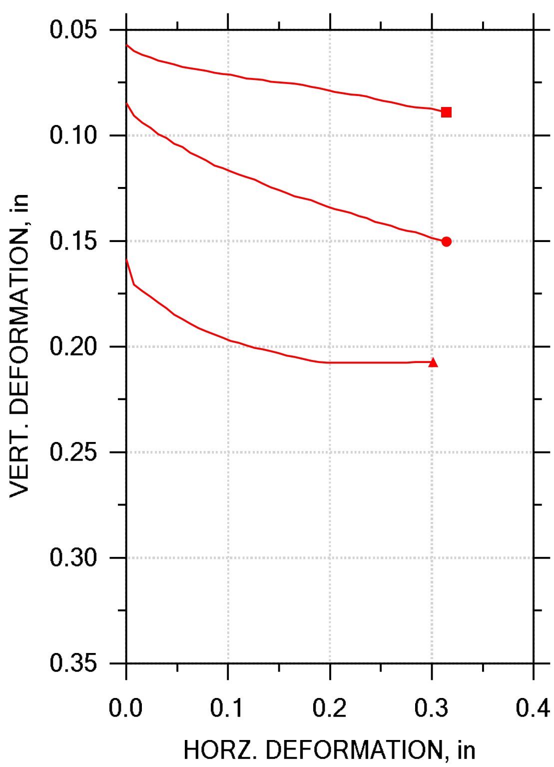






Symbol		■	●	▲	
Test No.		2500 PSF	5000 PSF	10000 PSF	
Sample No.		ST6	ST6	ST6	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.5071	2.5071	2.5071	
	Area, in²	4.9366	4.9366	4.9366	
	Height, in	0.99528	0.99921	1.0008	
	Water Content, %	25.04	25.12	26.01	
	Dry Density, pcf	99.74	98.78	98.45	
	Saturation, %	96.96	95.02	97.61	
	Void Ratio	0.70239	0.71898	0.72483	
Consol. Height, in		0.93824	0.91466	0.84229	
Consol. Void Ratio		0.60484	0.57353	0.45167	
Final	Water Content, %	19.93	16.47	13.22	
	Dry Density, pcf	109.5	116.3	124.2	
	Saturation, %	98.54	97.28	97.84	
	Void Ratio	0.5501	0.46051	0.36753	
Normal Stress, tsf		1.2498	2.4996	4.9997	
Max. Shear Stress, tsf		0.6994	1.5138	2.8113	
Ult. Shear Stress, tsf		0.6994	1.5138	2.8113	
Time to Failure, min		1850.7	1846.9	1799.1	
Disp. Rate, in/min		0.0001741	0.0001741	0.0001741	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		37	37	37	
Plastic Limit		21	21	21	
Plasticity Index		16	16	16	

Project: VECTREN CULLEY EAST POND	
Location: NEWBURGH, IN	
Project No.: AW165009	
Boring No.: B16-2 ST6	
Sample Type: TRIMMED	

Description: GRAY LEAN CLAY WITH SAND,ORGANIC POCKETS NOTED. Qp = 3.0 tsf

Remarks: TEST PERFORMED AS PER ASTM D3080.

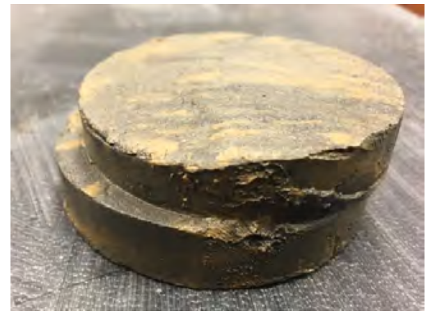
DIRECT SHEAR TEST DATA

Project: VECTREN CULLEY EAST POND
Location: NEWBURGH, IN
Project No.: AW165009
Boring No.: B16-2 ST6
Tested By: HP
Checked By: BCM
Sample No.: ST6
Test Date: BCM
Depth: 49.0'-51.0'
Test No.: 2500 PSF
Sample Type: TRIMMED
Elevation: .....

Soil Description: GRAY LEAN CLAY WITH SAND,ORGANIC POCKETS NOTED.
Remarks: TEST PERFORMED AS PER ASTM D3080.

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	1.25	0.05703	0.000	0.0000	0.0000
2	67.50	1.25	0.05986	0.127	0.007902	0.007902
3	114.14	1.25	0.06175	0.190	0.01577	0.01577
4	161.89	1.25	0.06299	0.255	0.02364	0.02364
5	209.42	1.25	0.06451	0.307	0.03150	0.03150
6	255.74	1.25	0.06553	0.350	0.03940	0.03940
7	302.53	1.25	0.06647	0.388	0.04727	0.04727
8	345.21	1.25	0.06771	0.417	0.05514	0.05514
9	392.37	1.25	0.06818	0.444	0.06300	0.06300
10	438.02	1.25	0.06870	0.471	0.07087	0.07087
11	486.71	1.25	0.06944	0.497	0.07877	0.07877
12	529.99	1.25	0.07022	0.516	0.08664	0.08664
13	577.11	1.25	0.07097	0.535	0.09451	0.09451
14	622.66	1.25	0.07133	0.550	0.1024	0.1024
15	671.74	1.25	0.07205	0.560	0.1102	0.1102
16	717.46	1.25	0.07293	0.576	0.1181	0.1181
17	761.45	1.25	0.07342	0.592	0.1260	0.1260
18	806.30	1.25	0.07373	0.602	0.1339	0.1339
19	852.89	1.25	0.07447	0.612	0.1417	0.1417
20	895.97	1.25	0.07475	0.620	0.1496	0.1496
21	944.71	1.25	0.07522	0.630	0.1575	0.1575
22	985.25	1.25	0.07555	0.638	0.1654	0.1654
23	1031.05	1.25	0.07607	0.646	0.1732	0.1732
24	1080.08	1.25	0.07695	0.656	0.1811	0.1811
25	1125.10	1.25	0.07771	0.663	0.1890	0.1890
26	1169.53	1.25	0.07857	0.668	0.1969	0.1969
27	1212.50	1.25	0.07935	0.671	0.2047	0.2047
28	1259.02	1.25	0.08001	0.676	0.2126	0.2126
29	1305.60	1.25	0.08053	0.681	0.2205	0.2205
30	1350.92	1.25	0.08082	0.686	0.2283	0.2283
31	1394.36	1.25	0.08149	0.692	0.2362	0.2362
32	1440.40	1.25	0.08275	0.680	0.2441	0.2441
33	1486.66	1.25	0.08365	0.685	0.2520	0.2520
34	1533.85	1.25	0.08437	0.687	0.2598	0.2598
35	1577.51	1.25	0.08502	0.692	0.2678	0.2678
36	1622.53	1.25	0.08597	0.693	0.2756	0.2756
37	1671.95	1.25	0.08660	0.692	0.2835	0.2835
38	1714.96	1.25	0.08713	0.692	0.2914	0.2914
39	1761.33	1.25	0.08727	0.694	0.2992	0.2992
40	1805.56	1.25	0.08815	0.697	0.3071	0.3071
41	1850.66	1.25	0.08903	0.699	0.3142	0.3142



DIRECT SHEAR TEST DATA

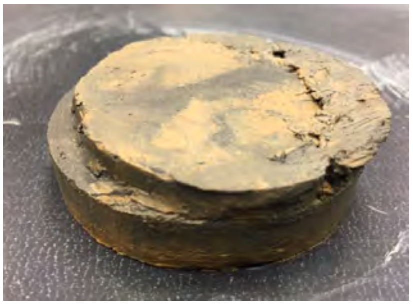
Project: VECTREN CULLEY EAST POND
Boring No.: B16-2 ST6
Sample No.: ST6
Test No.: 5000 PSF

Location: NEWBURGH, IN
Tested By: HP
Test Date: BCM
Sample Type: TRIMMED

Project No.: AW165009
Checked By: BCM
Depth: 49.0'-51.0'
Elevation: .....

Soil Description: GRAY LEAN CLAY WITH SAND CL ORGANIC POCKETS NOTED.
Remarks: TEST PERFORMED AS PER ASTM D3080.

Step: 1 of 1



	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	2.50	0.08455	0.000	0.0000	0.0000
2	57.11	2.50	0.09069	0.168	0.007902	0.007902
3	104.68	2.50	0.09406	0.288	0.01577	0.01577
4	152.44	2.50	0.09642	0.410	0.02364	0.02364
5	198.93	2.50	0.09930	0.523	0.03154	0.03154
6	245.89	2.50	0.1012	0.619	0.03940	0.03940
7	292.55	2.50	0.1038	0.698	0.04727	0.04727
8	335.77	2.50	0.1055	0.761	0.05517	0.05517
9	384.30	2.50	0.1081	0.823	0.06300	0.06300
10	428.50	2.50	0.1100	0.874	0.07087	0.07087
11	480.17	2.50	0.1119	0.924	0.07877	0.07877
12	528.20	2.50	0.1142	0.970	0.08664	0.08664
13	564.55	2.50	0.1154	1.00	0.09451	0.09451
14	615.16	2.50	0.1171	1.05	0.1024	0.1024
15	659.46	2.50	0.1185	1.08	0.1102	0.1102
16	710.08	2.50	0.1198	1.12	0.1181	0.1181
17	754.20	2.50	0.1210	1.14	0.1260	0.1260
18	799.29	2.50	0.1228	1.17	0.1339	0.1339
19	847.26	2.50	0.1246	1.20	0.1417	0.1417
20	891.89	2.50	0.1259	1.23	0.1496	0.1496
21	936.11	2.50	0.1272	1.25	0.1575	0.1575
22	981.12	2.50	0.1287	1.27	0.1654	0.1654
23	1028.35	2.50	0.1296	1.29	0.1732	0.1732
24	1074.19	2.50	0.1308	1.31	0.1811	0.1811
25	1120.70	2.50	0.1322	1.33	0.1890	0.1890
26	1165.21	2.50	0.1336	1.35	0.1969	0.1969
27	1212.47	2.50	0.1348	1.37	0.2047	0.2047
28	1258.09	2.50	0.1357	1.38	0.2126	0.2126
29	1303.12	2.50	0.1365	1.39	0.2205	0.2205
30	1346.94	2.50	0.1383	1.41	0.2283	0.2283
31	1391.43	2.50	0.1392	1.42	0.2362	0.2362
32	1436.16	2.50	0.1408	1.44	0.2441	0.2441
33	1482.34	2.50	0.1420	1.44	0.2520	0.2520
34	1526.69	2.50	0.1429	1.44	0.2598	0.2598
35	1573.49	2.50	0.1443	1.46	0.2678	0.2678
36	1622.31	2.50	0.1451	1.46	0.2756	0.2756
37	1665.15	2.50	0.1458	1.47	0.2835	0.2835
38	1708.38	2.50	0.1470	1.48	0.2914	0.2914
39	1757.23	2.50	0.1484	1.49	0.2992	0.2992
40	1806.18	2.50	0.1495	1.51	0.3071	0.3071
41	1846.87	2.50	0.1502	1.51	0.3143	0.3143

DIRECT SHEAR TEST DATA

Project: VECTREN CULLEY EAST POND
Location: NEWBURGH, IN
Project No.: AW165009
Boring No.: B16-2 ST6
Tested By: BCM
Checked By: BCM
Sample No.: ST6
Test Date: WPQ
Depth: 49.0'-51.0'
Test No.: 10000 PSF
Sample Type: TRIMMED
Elevation: .....

Soil Description: GRAY LEAN CLAY WITH SAND CL ORGANIC POCKETS NOTED.
Remarks: TEST PERFORMED AS PER ASTM D3080.

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	5.00	0.1585	0.000	0.0000	0.0000
2	77.36	5.00	0.1707	0.346	0.007902	0.007902
3	123.66	5.00	0.1737	0.527	0.01577	0.01577
4	174.27	5.00	0.1764	0.730	0.02364	0.02364
5	220.78	5.00	0.1790	0.925	0.03150	0.03150
6	264.89	5.00	0.1819	1.10	0.03940	0.03940
7	317.18	5.00	0.1849	1.28	0.04727	0.04727
8	359.11	5.00	0.1869	1.42	0.05514	0.05514
9	410.69	5.00	0.1891	1.56	0.06300	0.06300
10	459.18	5.00	0.1913	1.67	0.07087	0.07087
11	496.22	5.00	0.1928	1.76	0.07877	0.07877
12	545.87	5.00	0.1942	1.86	0.08664	0.08664
13	591.11	5.00	0.1958	1.94	0.09451	0.09451
14	638.72	5.00	0.1972	2.01	0.1024	0.1024
15	683.46	5.00	0.1982	2.08	0.1102	0.1102
16	730.08	5.00	0.1995	2.14	0.1181	0.1181
17	780.14	5.00	0.2005	2.21	0.1260	0.1260
18	824.18	5.00	0.2013	2.26	0.1339	0.1339
19	869.17	5.00	0.2022	2.31	0.1417	0.1417
20	915.45	5.00	0.2032	2.35	0.1496	0.1496
21	963.42	5.00	0.2041	2.40	0.1575	0.1575
22	1010.46	5.00	0.2050	2.44	0.1654	0.1654
23	1055.78	5.00	0.2058	2.48	0.1732	0.1732
24	1102.20	5.00	0.2066	2.51	0.1811	0.1811
25	1150.51	5.00	0.2072	2.54	0.1890	0.1890
26	1196.33	5.00	0.2075	2.57	0.1969	0.1969
27	1241.12	5.00	0.2076	2.59	0.2047	0.2047
28	1281.75	5.00	0.2077	2.61	0.2126	0.2126
29	1329.38	5.00	0.2077	2.63	0.2205	0.2205
30	1377.26	5.00	0.2077	2.67	0.2283	0.2283
31	1424.12	5.00	0.2076	2.70	0.2362	0.2362
32	1465.80	5.00	0.2076	2.71	0.2441	0.2441
33	1513.42	5.00	0.2076	2.73	0.2520	0.2520
34	1556.89	5.00	0.2076	2.73	0.2598	0.2598
35	1602.91	5.00	0.2076	2.75	0.2678	0.2678
36	1645.89	5.00	0.2075	2.76	0.2756	0.2756
37	1693.31	5.00	0.2074	2.78	0.2835	0.2835
38	1742.12	5.00	0.2074	2.80	0.2914	0.2914
39	1786.95	5.00	0.2073	2.81	0.2992	0.2992
40	1799.06	5.00	0.2073	2.81	0.3015	0.3015

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

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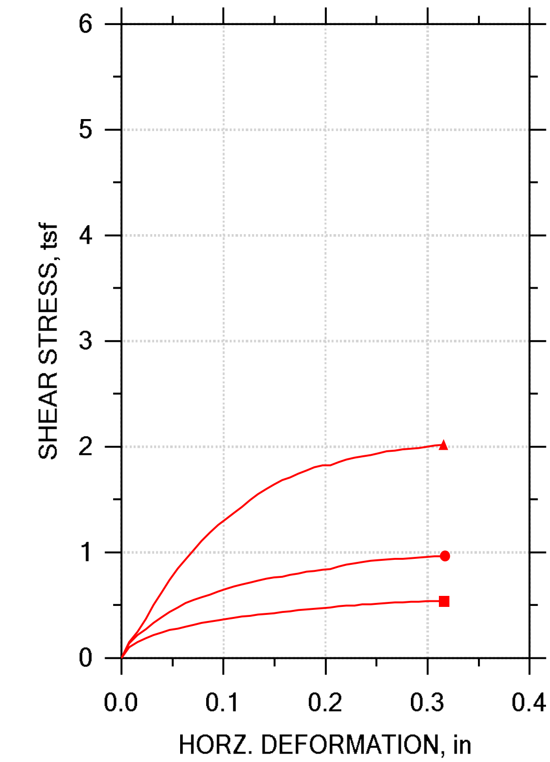

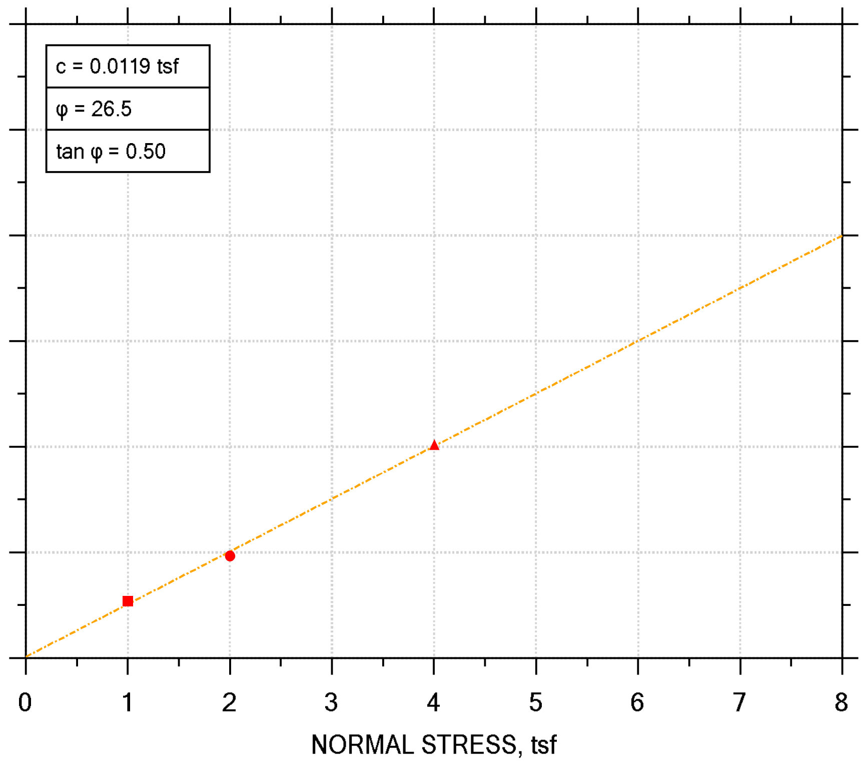

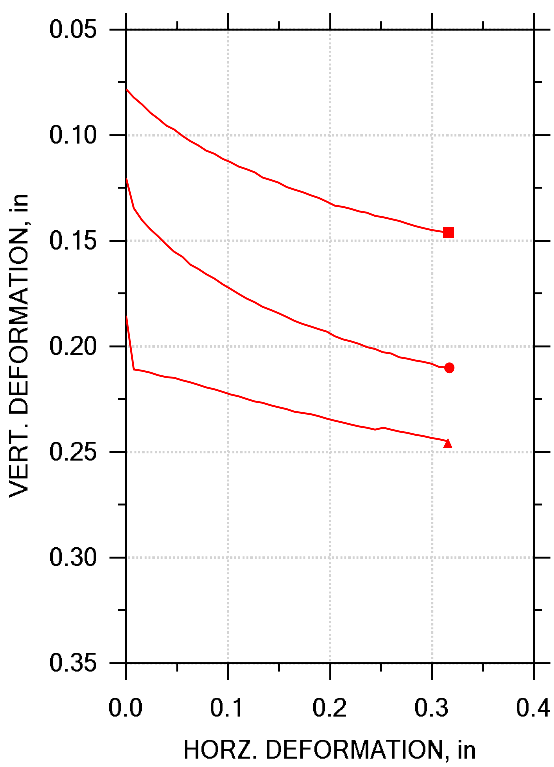

	Symbol	■	●	▲	
	Test No.	2000 PSF	4000 PSF	8000 PSF	
	Sample No.	ST6	ST6	ST-6	
	Shape	Circular	Circular	Circular	
Initial	Dimension, in	2.5031	2.5031	2.5031	
Initial	Area, in²	4.9211	4.9211	4.9211	
Initial	Height, in	0.99528	0.99528	0.99646	
Initial	Water Content, %	73.24	73.61	73.45	
Initial	Dry Density, pcf	54.02	54.91	55.05	
Initial	Saturation, %	93.75	96.56	96.71	
Initial	Void Ratio	2.0858	2.0354	2.0277	
	Consol. Height, in	0.91711	0.87506	0.81104	
	Consol. Void Ratio	1.8435	1.6688	1.4643	
Final	Water Content, %	60.21	51.70	48.37	
Final	Dry Density, pcf	63.31	69.61	73.08	
Final	Saturation, %	98.46	98.98	100.83	
Final	Void Ratio	1.6328	1.3946	1.2809	
	Normal Stress, tsf	0.99964	1.9993	4.0021	
	Max. Shear Stress, tsf	0.5387	0.96541	2.0207	
	Ult. Shear Stress, tsf	0.53658	0.96541	2.0204	
	Time to Failure, min	1835.6	1874.5	1870.6	
	Disp. Rate, in/min	0.00017383	0.00017383	0.00017383	
	Estimated Specific Gravity	2.67	2.67	2.67	
	Liquid Limit	47	47	47	
	Plastic Limit	33	33	33	
	Plasticity Index	14	14	14	

Project: VECTREN CULLEY EAST POND

Location: NEWBURGH,IN

Project No.: AW165009

Boring No.: B16-4 ST6

Sample Type: 3'' ST

Description: DARK BROWNISH GRAY SILT ML FLY ASH NOTED Qp = 0.25 tsf

Remarks: TEST PERFORMED AS PER ASTM D3080.

DIRECT SHEAR TEST DATA

Project: VECTREN CULLEY EAST POND
Location: NEWBURGH,IN
Project No.: AW165009
Boring No.: B16-4 ST6
Tested By: HP
Checked By: BCM
Sample No.: ST6
Test Date: 04/18/16
Depth: 42.0'-44.0'
Test No.: 2000 PSF
Sample Type: 3'' ST
Elevation: ----

Soil Description: DARK BROWNISH GRAY SILT ML FLY ASH NOTED
Remarks: TEST PERFORMED AS PER ASTM D3080.

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	0.999	0.07817	0.000	0.0000	0.0000
2	56.02	1.00	0.08208	0.104	0.007876	0.007876
3	105.01	1.00	0.08561	0.153	0.01575	0.01575
4	150.50	1.00	0.08933	0.189	0.02363	0.02363
5	198.94	0.999	0.09217	0.217	0.03150	0.03150
6	245.39	1.00	0.09532	0.241	0.03938	0.03938
7	290.86	1.00	0.09727	0.263	0.04725	0.04725
8	334.20	1.00	0.1004	0.282	0.05513	0.05513
9	381.91	1.00	0.1027	0.298	0.06301	0.06301
10	428.26	0.999	0.1049	0.316	0.07088	0.07088
11	477.83	1.00	0.1073	0.332	0.07876	0.07876
12	526.75	0.999	0.1087	0.345	0.08663	0.08663
13	573.06	1.00	0.1111	0.358	0.09451	0.09451
14	624.23	1.00	0.1126	0.371	0.1024	0.1024
15	666.94	0.999	0.1149	0.380	0.1103	0.1103
16	713.61	1.00	0.1159	0.391	0.1181	0.1181
17	762.26	0.999	0.1176	0.399	0.1260	0.1260
18	810.36	1.00	0.1202	0.410	0.1339	0.1339
19	856.46	1.00	0.1212	0.418	0.1418	0.1418
20	902.06	1.00	0.1224	0.426	0.1496	0.1496
21	949.48	0.999	0.1246	0.435	0.1575	0.1575
22	994.56	1.00	0.1257	0.442	0.1654	0.1654
23	1042.55	0.999	0.1270	0.452	0.1733	0.1733
24	1088.66	1.00	0.1284	0.460	0.1811	0.1811
25	1136.30	1.00	0.1297	0.468	0.1890	0.1890
26	1178.85	0.999	0.1316	0.475	0.1969	0.1969
27	1225.94	1.00	0.1333	0.482	0.2048	0.2048
28	1275.19	0.999	0.1340	0.490	0.2126	0.2126
29	1322.85	1.00	0.1348	0.495	0.2205	0.2205
30	1369.18	1.00	0.1360	0.499	0.2284	0.2284
31	1417.68	0.999	0.1368	0.506	0.2362	0.2362
32	1465.82	1.00	0.1382	0.511	0.2441	0.2441
33	1510.26	1.00	0.1389	0.516	0.2520	0.2520
34	1558.73	1.00	0.1398	0.519	0.2599	0.2599
35	1601.53	1.00	0.1407	0.524	0.2677	0.2677
36	1651.25	1.00	0.1419	0.527	0.2756	0.2756
37	1697.95	1.00	0.1431	0.531	0.2835	0.2835
38	1743.29	1.00	0.1440	0.534	0.2914	0.2914
39	1790.09	0.999	0.1447	0.537	0.2992	0.2992
40	1835.55	1.00	0.1456	0.539	0.3071	0.3071
41	1880.03	1.00	0.1461	0.536	0.3150	0.3150
42	1888.17	1.00	0.1461	0.537	0.3163	0.3163

DIRECT SHEAR TEST DATA

Project: VECTREN CULLEY EAST POND
Location: NEWBURGH,IN
Project No.: AW165009
Boring No.: B16-4 ST6
Tested By: HP
Checked By: BCM
Sample No.: ST6
Test Date: 04/20/16
Depth: 42.0'-44.0'
Test No.: 4000 PSF
Sample Type: 3'' ST
Elevation: ----

Soil Description: DARK BROWNISH GRAY SILT ML FLY ASH NOTED
Remarks: TEST PERFORMED AS PER ASTM D3080.

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	1.99	0.1202	0.000	0.0000	0.0000
2	53.62	2.00	0.1345	0.138	0.007876	0.007876
3	102.80	2.00	0.1403	0.217	0.01575	0.01575
4	148.18	2.00	0.1444	0.273	0.02363	0.02363
5	195.81	2.00	0.1480	0.332	0.03150	0.03150
6	243.23	2.00	0.1517	0.389	0.03938	0.03938
7	290.29	2.00	0.1551	0.437	0.04725	0.04725
8	338.51	2.00	0.1577	0.481	0.05513	0.05513
9	386.27	2.00	0.1612	0.520	0.06301	0.06301
10	429.58	2.00	0.1633	0.549	0.07088	0.07088
11	476.04	2.00	0.1657	0.576	0.07876	0.07876
12	521.12	2.00	0.1679	0.603	0.08663	0.08663
13	571.73	2.00	0.1707	0.631	0.09451	0.09451
14	618.32	2.00	0.1729	0.653	0.1024	0.1024
15	661.97	2.00	0.1751	0.676	0.1103	0.1103
16	706.60	2.00	0.1773	0.697	0.1181	0.1181
17	753.78	2.00	0.1790	0.717	0.1260	0.1260
18	801.89	2.00	0.1811	0.735	0.1339	0.1339
19	845.04	2.00	0.1826	0.750	0.1418	0.1418
20	892.79	2.00	0.1843	0.762	0.1496	0.1496
21	936.65	2.00	0.1860	0.772	0.1575	0.1575
22	983.37	2.00	0.1880	0.786	0.1654	0.1654
23	1029.62	2.00	0.1893	0.799	0.1733	0.1733
24	1078.09	2.00	0.1906	0.815	0.1811	0.1811
25	1120.81	2.00	0.1919	0.827	0.1890	0.1890
26	1168.68	2.00	0.1930	0.837	0.1969	0.1969
27	1210.08	2.00	0.1952	0.844	0.2048	0.2048
28	1251.45	2.00	0.1966	0.864	0.2126	0.2126
29	1303.71	2.00	0.1974	0.883	0.2205	0.2205
30	1351.20	2.00	0.1989	0.898	0.2284	0.2284
31	1394.76	2.00	0.2002	0.910	0.2362	0.2362
32	1445.63	2.00	0.2011	0.920	0.2441	0.2441
33	1495.01	2.00	0.2026	0.928	0.2520	0.2520
34	1536.89	2.00	0.2032	0.934	0.2599	0.2599
35	1589.91	2.00	0.2052	0.937	0.2677	0.2677
36	1632.68	2.00	0.2059	0.942	0.2756	0.2756
37	1678.77	2.00	0.2067	0.946	0.2835	0.2835
38	1722.31	2.00	0.2073	0.951	0.2914	0.2914
39	1772.39	2.00	0.2082	0.959	0.2992	0.2992
40	1819.85	2.00	0.2098	0.963	0.3071	0.3071
41	1862.73	2.00	0.2100	0.965	0.3150	0.3150
42	1874.52	2.00	0.2101	0.965	0.3170	0.3170

DIRECT SHEAR TEST DATA

Project: VECTREN F.B. CULLEY
Boring No.: B16-4 ST-6
Sample No.: ST-6
Test No.: 8000 PSF

Location: NEWBURGH, IN
Tested By: HP
Test Date: BCM
Sample Type: TRIMMED

Project No.: AW165009
Checked By: BCM
Depth: 42.0'-44.0'
Elevation: .....

Soil Description: DARK BROWNISH GRAY SILT ML FLY ASH NOTED
Remarks: TEST PERFORMED AS PER ASTM 3080.

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	4.00	0.1854	0.000	0.0000	0.0000
2	67.12	4.00	0.2108	0.153	0.007902	0.007902
3	118.91	4.00	0.2116	0.251	0.01577	0.01577
4	166.38	4.00	0.2125	0.371	0.02364	0.02364
5	213.58	4.00	0.2135	0.501	0.03150	0.03150
6	260.14	4.00	0.2144	0.622	0.03940	0.03940
7	310.60	4.00	0.2148	0.742	0.04727	0.04727
8	357.05	4.00	0.2160	0.846	0.05514	0.05514
9	401.17	4.00	0.2171	0.936	0.06300	0.06300
10	450.23	4.00	0.2183	1.03	0.07087	0.07087
11	496.15	4.00	0.2194	1.11	0.07877	0.07877
12	542.78	4.00	0.2204	1.19	0.08664	0.08664
13	590.95	4.00	0.2216	1.26	0.09451	0.09451
14	630.33	4.00	0.2227	1.32	0.1024	0.1024
15	679.09	4.00	0.2238	1.38	0.1102	0.1102
16	723.16	4.00	0.2250	1.43	0.1181	0.1181
17	773.82	4.00	0.2260	1.50	0.1260	0.1260
18	819.35	4.00	0.2268	1.55	0.1339	0.1339
19	865.22	4.00	0.2279	1.60	0.1417	0.1417
20	912.67	4.00	0.2287	1.64	0.1496	0.1496
21	959.20	4.00	0.2297	1.68	0.1575	0.1575
22	1001.98	4.00	0.2309	1.71	0.1654	0.1654
23	1049.56	4.00	0.2314	1.74	0.1732	0.1732
24	1094.37	4.00	0.2322	1.78	0.1811	0.1811
25	1144.06	4.00	0.2332	1.81	0.1890	0.1890
26	1187.15	4.00	0.2342	1.82	0.1969	0.1969
27	1233.12	4.00	0.2351	1.82	0.2047	0.2047
28	1280.48	4.00	0.2361	1.85	0.2126	0.2126
29	1325.12	4.00	0.2369	1.88	0.2205	0.2205
30	1369.51	4.00	0.2378	1.90	0.2283	0.2283
31	1411.51	4.00	0.2386	1.91	0.2362	0.2362
32	1457.99	4.00	0.2394	1.92	0.2441	0.2441
33	1506.31	4.00	0.2385	1.94	0.2520	0.2520
34	1553.00	4.00	0.2394	1.95	0.2598	0.2598
35	1594.21	4.00	0.2403	1.97	0.2678	0.2678
36	1640.15	4.00	0.2410	1.98	0.2757	0.2757
37	1686.07	4.00	0.2417	1.98	0.2835	0.2835
38	1730.08	4.00	0.2426	1.99	0.2914	0.2914
39	1772.47	4.00	0.2434	2.00	0.2992	0.2992
40	1821.21	4.00	0.2440	2.01	0.3071	0.3071
41	1870.59	4.00	0.2449	2.02	0.3150	0.3150
42	1871.56	4.00	0.2458	2.02	0.3154	0.3154

Unconfined Compression Test – ASTM D 2166

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOILS ASTM D2166

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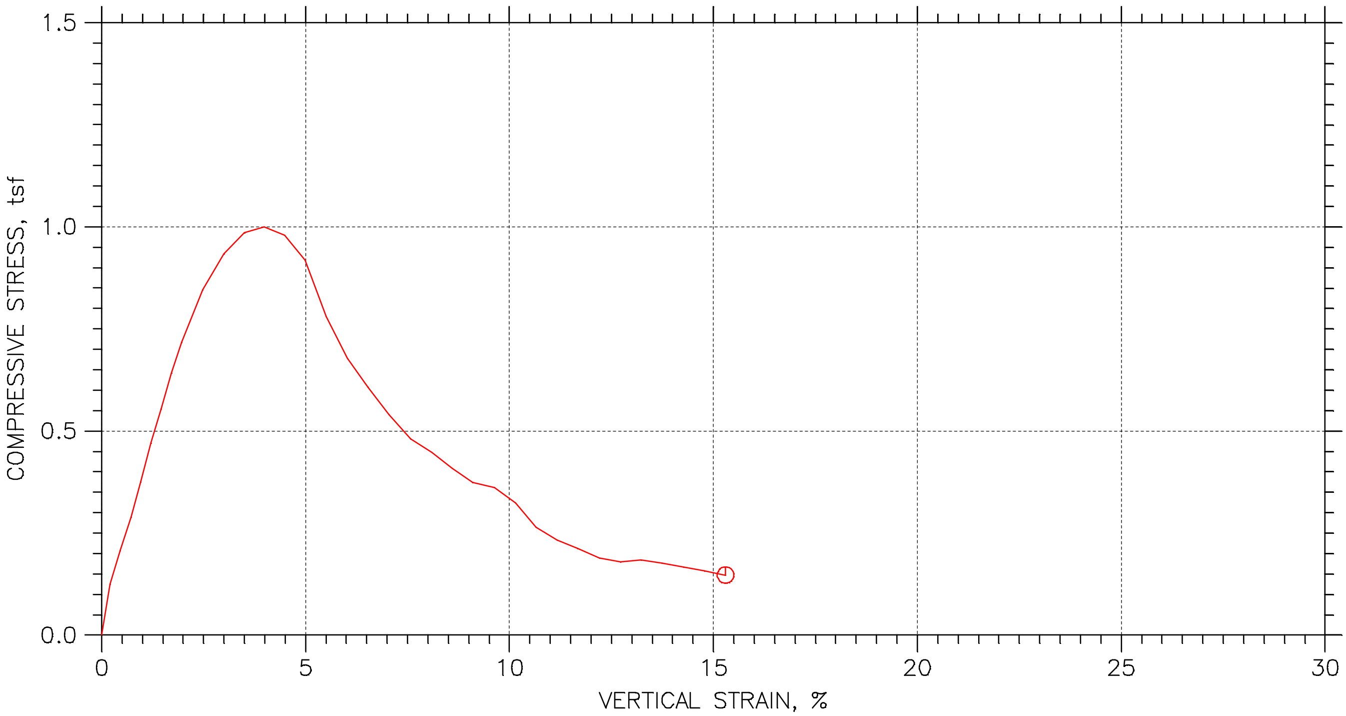

Symbol		⦶			
Test No.		B161ST5QU			
Initial	Diameter, in	2.8528			
	Height, in	6.0685			
	Water Content, %	32.96			
	Dry Density, pcf	88.45			
	Saturation, %	97.46			
	Void Ratio	0.91972			
Unconfined Compressive Strength, tsf		1.0001			
Undrained Shear Strength, tsf		0.50003			
Time to Failure, min		4.0021			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.72			
Liquid Limit		35			
Plastic Limit		20			
Plasticity Index		15			
Failure Sketch					

Project: VECTREN CULLEY EAST POND
Location: NEWBURGH, IN
Project No.: AW165009
Boring No.: B16-1 ST-5
Sample Type: 3" ST
Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH. CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

UNCONFINED COMPRESSION TEST

Project: VECTREN CULLEY EAST POND
Boring No.: B16-1 ST-5
Sample No.: ST-5
Test No.: B161ST5QU

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 4/21/16
Sample Type: 3" ST

Project No.: AW165009
Checked By: WPQ
Depth: 49.0'-51.0'
Elevation: -----

Soil Description: GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH. CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.07 in
Specimen Area: 6.39 in^2
Specimen Volume: 38.79 in^3

Liquid Limit: 35
Plastic Limit: 20
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.3917	0	0
2	0.2523	0.012789	0.21075	11.123	6.4052	0.12503	0.062515
3	0.50022	0.028137	0.46365	18.493	6.4215	0.20735	0.10368
4	0.75257	0.043575	0.71805	25.864	6.438	0.28925	0.14463
5	1.0005	0.058466	0.96343	33.637	6.4539	0.37525	0.18763
6	1.2528	0.073813	1.2163	42.347	6.4704	0.47122	0.23561
7	1.5008	0.088795	1.4632	49.986	6.4867	0.55483	0.27741
8	1.7531	0.10414	1.7161	58.027	6.5033	0.64242	0.32121
9	2.001	0.1194	1.9675	64.995	6.52	0.71773	0.35887
10	2.5013	0.15046	2.4793	77.056	6.5542	0.84648	0.42324
11	3.0015	0.18143	2.9896	85.499	6.5887	0.93431	0.46715
12	3.5018	0.21194	3.4924	90.725	6.623	0.98628	0.49314
13	4.0021	0.24199	3.9877	92.467	6.6572	1.0001	0.50003
14	4.5023	0.27232	4.4875	90.993	6.692	0.979	0.4895
15	5.0026	0.3032	4.9963	85.767	6.7279	0.91785	0.45893
16	5.5029	0.33444	5.5111	73.304	6.7645	0.78023	0.39011
17	6.0031	0.36514	6.0169	64.057	6.8009	0.67816	0.33908
18	6.5031	0.39638	6.5317	57.758	6.8384	0.60813	0.30406
19	7.0034	0.42762	7.0466	51.594	6.8763	0.54023	0.27011
20	7.5037	0.4595	7.5719	46.234	6.9154	0.48137	0.24068
21	8.0039	0.49084	8.0883	43.285	6.9542	0.44815	0.22408
22	8.5042	0.52162	8.5956	39.667	6.9928	0.40842	0.20421
23	9	0.5525	9.1044	36.585	7.032	0.37459	0.1873
24	9.5003	0.5842	9.6267	35.513	7.0726	0.36152	0.18076
25	10	0.61572	10.146	32.028	7.1135	0.32418	0.16209
26	10.5	0.64668	10.656	26.266	7.1541	0.26435	0.13217
27	11	0.67738	11.162	23.318	7.1948	0.23335	0.11667
28	11.501	0.70853	11.676	21.308	7.2367	0.212	0.106
29	12.001	0.74041	12.201	19.029	7.28	0.1882	0.094102
30	12.501	0.77202	12.722	18.225	7.3234	0.17918	0.089592
31	13.001	0.8029	13.231	18.761	7.3663	0.18338	0.091689
32	13.502	0.83387	13.741	18.091	7.4099	0.17579	0.087894
33	14.002	0.86538	14.26	17.287	7.4548	0.16696	0.083482
34	14.502	0.89717	14.784	16.349	7.5006	0.15694	0.07847
35	15.002	0.92832	15.297	15.411	7.5461	0.14704	0.073522

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOILS ASTM D2166

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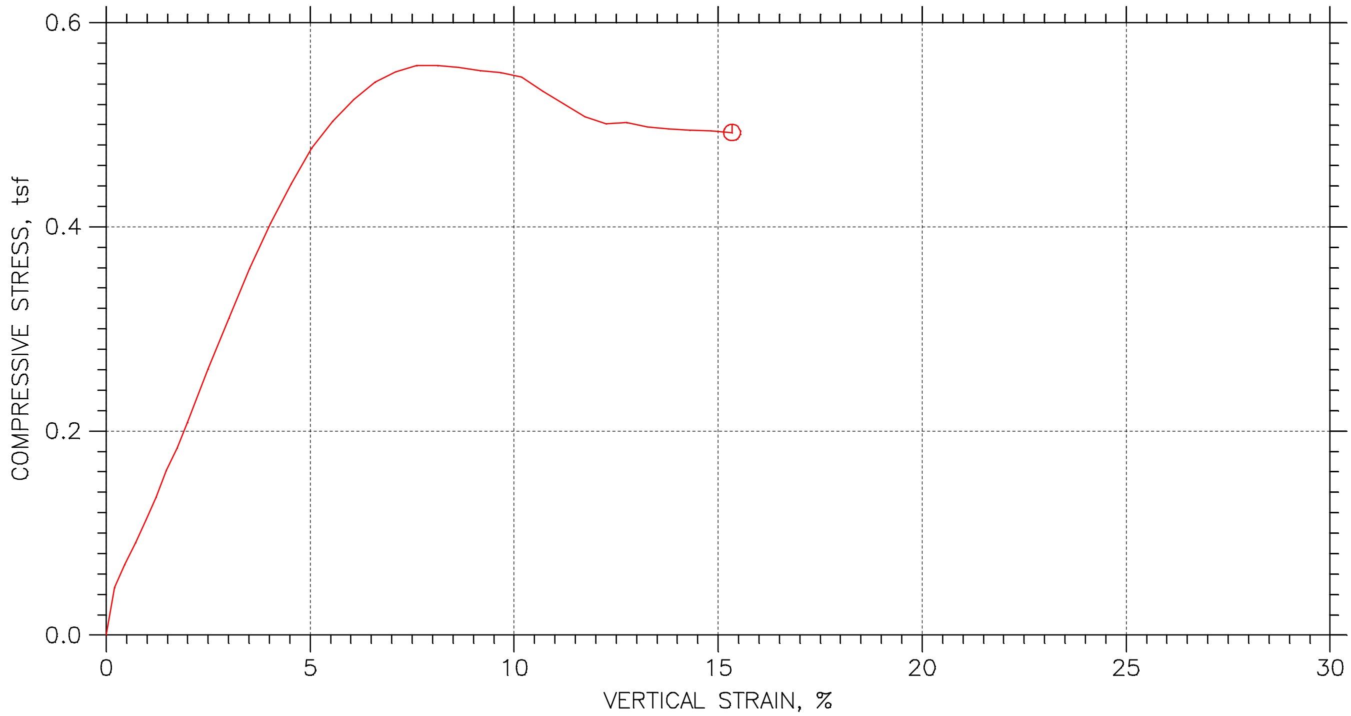

Symbol					
Test No.		B162ST6QU			
Initial	Diameter, in	2.8445			
	Height, in	6.0701			
	Water Content, %	25.88			
	Dry Density, pcf	98.18			
	Saturation, %	96.47			
	Void Ratio	0.72957			
Unconfined Compressive Strength, tsf		0.55834			
Undrained Shear Strength, tsf		0.27917			
Time to Failure, min		7.5028			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.72			
Liquid Limit		37			
Plastic Limit		21			
Plasticity Index		16			
Failure Sketch					

Project: VECTREN CULLEY EAST POND
Location: NEWBURGH, IN
Project No.: AW165009
Boring No.: B16-2 ST-6
Sample Type: 3" ST
Description: GRAY LEAN CLAY WITH SAND CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

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UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOILS ASTM D2166

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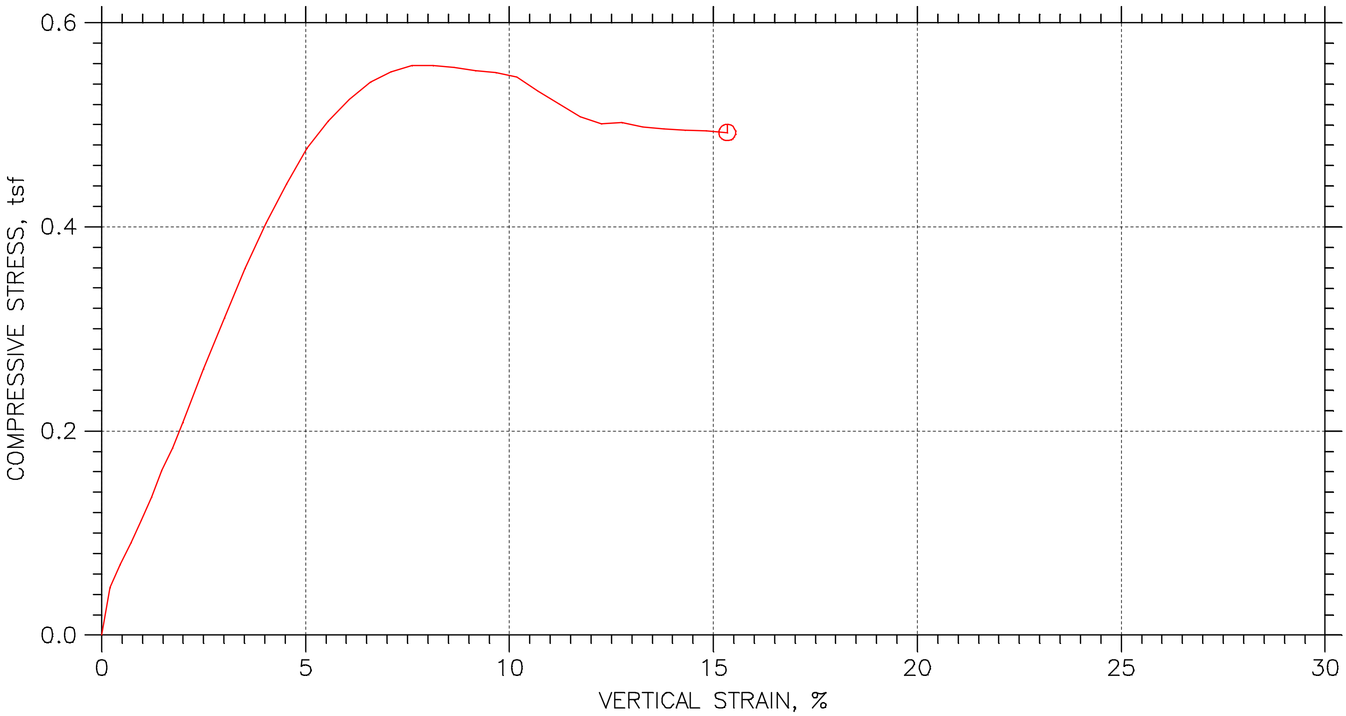

Symbol		①			
Test No.		B162ST6QU			
Initial	Diameter, in	2.8445			
	Height, in	6.0701			
	Water Content, %	25.88			
	Dry Density, pcf	98.18			
	Saturation, %	96.47			
	Void Ratio	0.72957			
Unconfined Compressive Strength, tsf		0.55834			
Undrained Shear Strength, tsf		0.27917			
Time to Failure, min		7.5028			
Strain Rate, %/min		1			
Estimated Specific Gravity		2.72			
Liquid Limit		37			
Plastic Limit		21			
Plasticity Index		16			
Failure Sketch					

Project: VECTREN CULLEY EAST POND
Location: NEWBURGH, IN
Project No.: AW165009
Boring No.: B16-2 ST-6
Sample Type: 3" ST
Description: GRAY LEAN CLAY WITH SAND CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Tue, 26-APR-2016 15:15:36

UNCONFINED COMPRESSION TEST

Project: VECTREN CULLEY EAST POND
Boring No.: B16-2 ST-6
Sample No.: ST-6
Test No.: B162ST6QU

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 1/21/16
Sample Type: 3" ST

Project No.: AW165009
Checked By: WPQ
Depth: 49.0'-51.0'
Elevation: -----

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Soil Description: GRAY LEAN CLAY WITH SAND CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.07 in
Specimen Area: 6.35 in^2
Specimen Volume: 38.57 in^3

Liquid Limit: 37
Plastic Limit: 21
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.3547	0	0
2	0.25218	0.012789	0.21069	4.1543	6.3682	0.04697	0.023485
3	0.5001	0.028045	0.46202	6.1645	6.3842	0.069522	0.034761
4	0.75245	0.043666	0.71937	8.0406	6.4008	0.090446	0.045223
5	1.0004	0.058922	0.9707	10.051	6.417	0.11277	0.056386
6	1.2527	0.074544	1.2281	12.061	6.4338	0.13497	0.067487
7	1.5006	0.089891	1.4809	14.473	6.4503	0.16155	0.080777
8	1.7527	0.10551	1.7382	16.483	6.4672	0.18351	0.091756
9	2.0006	0.12077	1.9896	18.761	6.4837	0.20834	0.10417
10	2.5006	0.15165	2.4982	23.586	6.5176	0.26055	0.13028
11	3.0006	0.18252	3.0069	28.276	6.5518	0.31074	0.15537
12	3.5006	0.21349	3.5171	32.833	6.5864	0.35891	0.17946
13	4.0009	0.24446	4.0273	37.121	6.6214	0.40365	0.20182
14	4.5012	0.27534	4.536	40.873	6.6567	0.44209	0.22105
15	5.0014	0.30612	5.0431	44.357	6.6922	0.47723	0.23861
16	5.5017	0.33718	5.5548	47.038	6.7285	0.50334	0.25167
17	6.002	0.36842	6.0695	49.316	6.7654	0.52484	0.26242
18	6.5022	0.39985	6.5872	51.192	6.8029	0.5418	0.2709
19	7.0025	0.43082	7.0974	52.398	6.8402	0.55154	0.27577
20	7.5028	0.4617	7.6061	53.336	6.8779	0.55834	0.27917
21	8.003	0.49285	8.1193	53.604	6.9163	0.55803	0.27901
22	8.5033	0.52427	8.637	53.738	6.9555	0.55627	0.27814
23	9.0036	0.55579	9.1562	53.738	6.9952	0.55311	0.27656
24	9.5038	0.58685	9.6679	53.872	7.0349	0.55137	0.27568
25	10.004	0.61782	10.178	53.738	7.0748	0.54689	0.27344
26	10.504	0.64942	10.699	52.666	7.1161	0.53287	0.26644
27	11	0.68076	11.215	51.728	7.1575	0.52036	0.26018
28	11.5	0.71218	11.733	50.79	7.1994	0.50794	0.25397
29	12	0.74343	12.247	50.388	7.2417	0.50098	0.25049
30	12.5	0.77458	12.761	50.79	7.2843	0.50202	0.25101
31	13.001	0.806	13.278	50.656	7.3277	0.49773	0.24886
32	13.501	0.83725	13.793	50.79	7.3715	0.49608	0.24804
33	14.001	0.86849	14.308	50.924	7.4158	0.49442	0.24721
34	14.501	0.89973	14.822	51.192	7.4606	0.49404	0.24702
35	15.002	0.93106	15.339	51.326	7.5061	0.49233	0.24617

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOILS ASTM D2166

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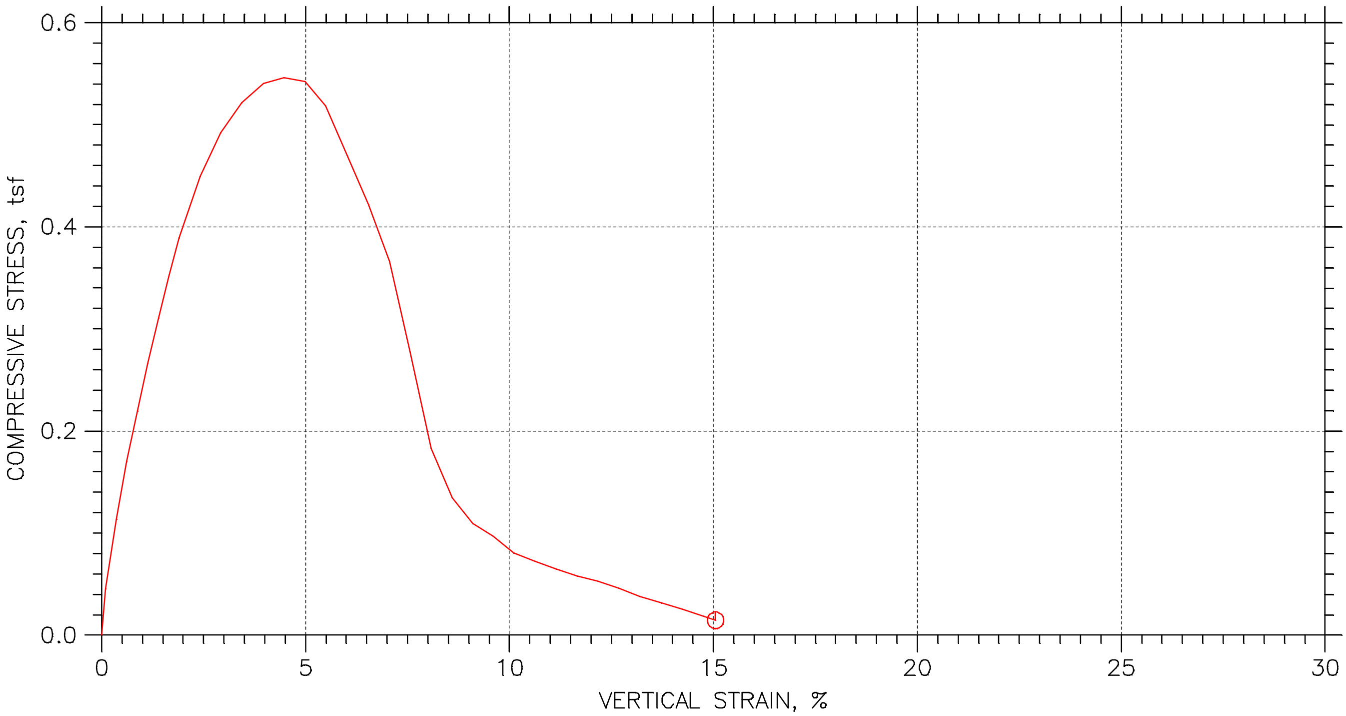

Symbol		⦶			
Test No.		B163ST7QU			
Initial	Diameter, in	2.8569			
	Height, in	6.1102			
	Water Content, %	31.77			
	Dry Density, pcf	90.82			
	Saturation, %	99.37			
	Void Ratio	0.86963			
Unconfined Compressive Strength, tsf		0.54602			
Undrained Shear Strength, tsf		0.27301			
Time to Failure, min		4.5041			
Strain Rate, %/min		1.52			
Estimated Specific Gravity		2.72			
Liquid Limit		43			
Plastic Limit		21			
Plasticity Index		22			
Failure Sketch					

Project: VECTREN CULLEY EAST POND	
Location: NEWBURGH, IN	
Project No.: AW165009	
Boring No.: B16-3 ST-7	
Sample Type: 3" ST	
Description: GRAY TO OLIVE GRAY LEAN CLAY WITH SAND CL SILT POCKETS NOTED	
Remarks: TEST PERFORMED AS PER ASTM D2166.	

UNCONFINED COMPRESSION TEST

Project: VECTREN CULLEY EAST POND
Boring No.: B16-3 ST-7
Sample No.: ST-7
Test No.: B163ST7QU

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 4/21/16
Sample Type: 3" ST

Project No.: AW165009
Checked By: WPQ
Depth: 54.0'-56.0'
Elevation: -----

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Soil Description: GRAY TO OLIVE GRAY LEAN CLAY WITH SAND CL SILT POCKETS NOTED
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 6.11 in
Specimen Area: 6.41 in^2
Specimen Volume: 39.17 in^3

Liquid Limit: 43
Plastic Limit: 21
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.4105	0	0
2	0.25413	0.0058116	0.095112	4.0633	6.4166	0.045594	0.022797
3	0.50413	0.022047	0.36082	10.192	6.4337	0.11406	0.057029
4	0.75413	0.037821	0.61898	15.243	6.4504	0.17014	0.085072
5	1.0041	0.053503	0.87563	19.733	6.4671	0.21969	0.10985
6	1.2541	0.06937	1.1353	23.953	6.4841	0.26598	0.13299
7	1.5041	0.085144	1.3935	28.061	6.501	0.31078	0.15539
8	1.7541	0.10092	1.6516	31.833	6.5181	0.35163	0.17582
9	2.0041	0.11651	1.9068	35.312	6.5351	0.38905	0.19453
10	2.5041	0.14741	2.4125	40.992	6.5689	0.4493	0.22465
11	3.0041	0.17859	2.9228	45.145	6.6035	0.49223	0.24612
12	3.5041	0.21042	3.4437	48.108	6.6391	0.52173	0.26086
13	4.0041	0.24224	3.9645	50.084	6.6751	0.54022	0.27011
14	4.5041	0.27351	4.4763	50.892	6.7109	0.54602	0.27301
15	5.0041	0.30442	4.9821	50.847	6.7466	0.54265	0.27132
16	5.5041	0.33578	5.4954	48.827	6.7832	0.51827	0.25913
17	6.0041	0.36788	6.0207	44.472	6.8211	0.46942	0.23471
18	6.5041	0.39961	6.5401	40.161	6.859	0.42158	0.21079
19	7.0041	0.43098	7.0534	35.043	6.8969	0.36583	0.18291
20	7.5041	0.46243	7.5682	26.759	6.9353	0.27781	0.1389
21	8.0041	0.49371	8.08	17.735	6.9739	0.1831	0.091548
22	8.5041	0.52516	8.5948	13.088	7.0132	0.13436	0.067182
23	9.0041	0.55607	9.1005	10.708	7.0522	0.10933	0.054663
24	9.5041	0.5866	9.6003	9.5184	7.0912	0.096644	0.048322
25	10.004	0.61722	10.101	7.9694	7.1308	0.080468	0.040234
26	10.504	0.64868	10.616	7.2062	7.1718	0.072345	0.036172
27	11.004	0.6806	11.139	6.5102	7.214	0.064976	0.032488
28	11.504	0.71215	11.655	5.8592	7.2562	0.058139	0.029069
29	12.004	0.74314	12.162	5.3878	7.2981	0.053154	0.026577
30	12.504	0.77432	12.673	4.6694	7.3407	0.045799	0.0229
31	13.004	0.80624	13.195	3.8837	7.3849	0.037865	0.018932
32	13.504	0.83843	13.722	3.2327	7.43	0.031326	0.015663
33	14.004	0.87026	14.243	2.6265	7.4751	0.025299	0.012649
34	14.504	0.90171	14.757	1.9531	7.5203	0.018699	0.0093495
35	14.792	0.91961	15.05	1.5265	7.5462	0.014565	0.0072825

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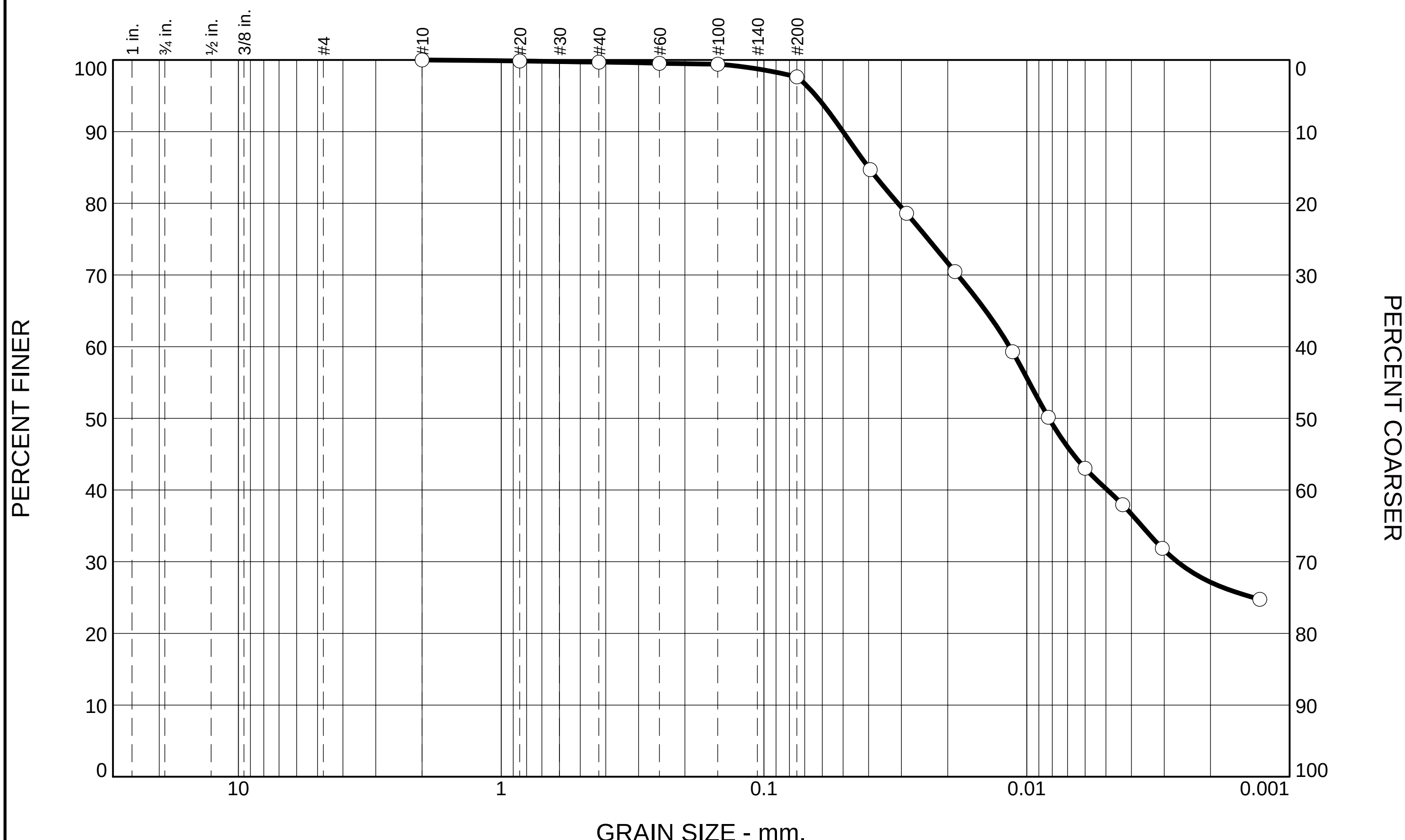
Particle Size Analysis – ASTM D 422

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.3	2.1	57.4	40.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.9		
#40	99.7		
#60	99.5		
#100	99.4		
#200	97.6		

* (no specification provided)

LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.0500 D_{85}= 0.0400 D_{60}= 0.0116
D_{50}= 0.0082 D_{30}= 0.0027 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

ORGANIC POCKETS NOTED
F.M.=0.01

Source of Sample: B16-1 **Depth:** 17.0'-19.0'
Sample Number: ST-2

Date: 4/19/16

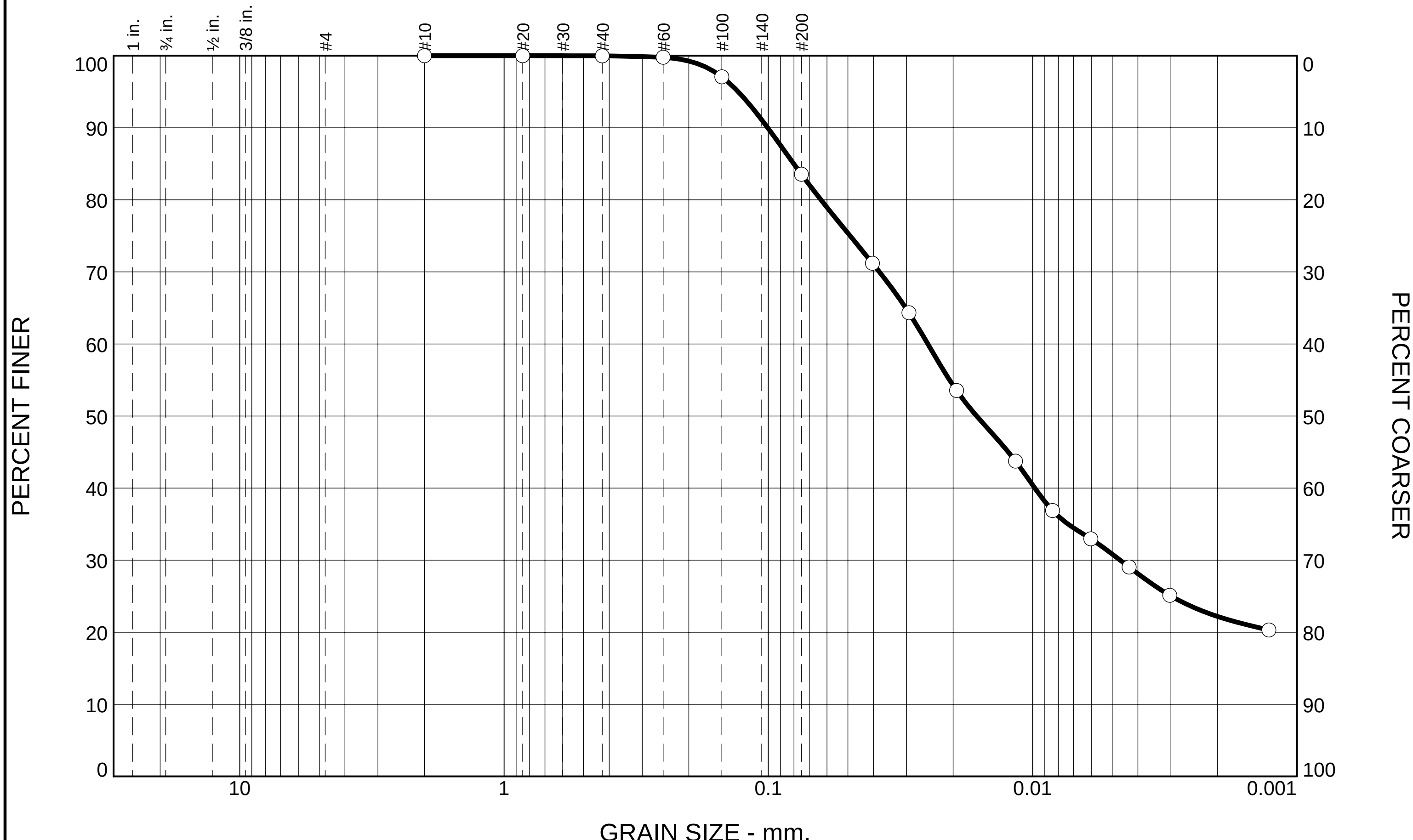
Terracon

Client: AECOM
Project: VECTREN F.B. CULLEY EAST POND

Project No: AW165009 **Figure**

Tested By: SH **Checked By:** BCM

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	16.4	52.8	30.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	100.0		
#60	99.8		
#100	97.1		
#200	83.6		

* (no specification provided)

GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH.

Atterberg Limits

PL= 20 LL= 35 PI= 15

Coefficients

D_{90}= 0.1005 D_{85}= 0.0801 D_{60}= 0.0249
D_{50}= 0.0163 D_{30}= 0.0047 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(12)

Remarks

F.M.=0.03

Source of Sample: B16-1 **Depth:** 49.0'-51.0'
Sample Number: ST-5

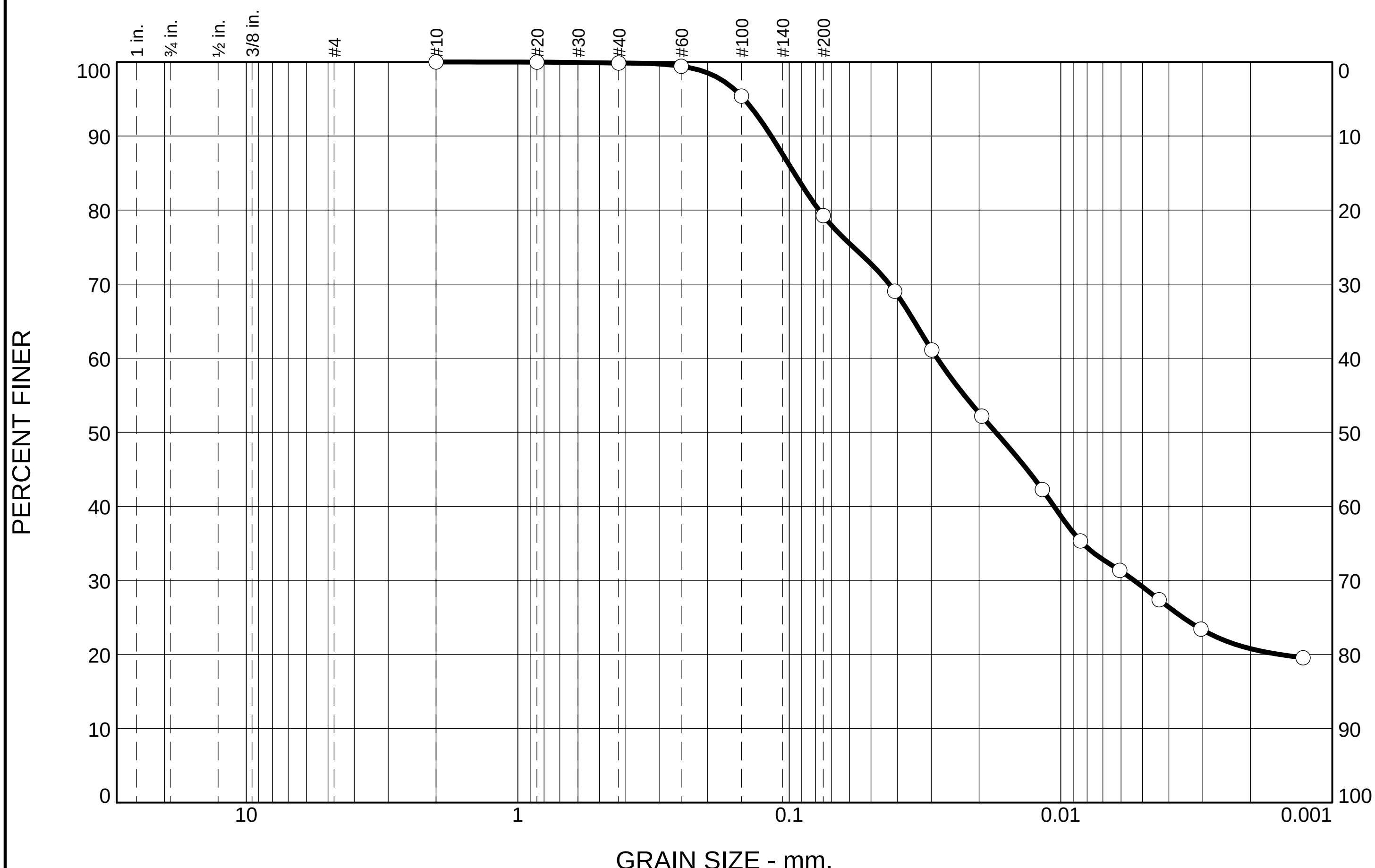
Date: 4/19/16

Terracon

Client: AECOM
Project: VECTREN F.B. CULLEY EAST POND
Project No: AW165009 **Figure**

Tested By: SH **Checked By:** BCM

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	20.6	50.2	29.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	99.9		
#60	99.4		
#100	95.4		
#200	79.3		

* (no specification provided)

DARK GRAY AND BLACK FLY ASH WITH BROWN CLAY LAYERS NOTED

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.1166 D_{85}= 0.0959 D_{60}= 0.0285
D_{50}= 0.0174 D_{30}= 0.0054 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

F.M.=0.05

Source of Sample: B16-2 **Depth:** 16.0'-18.0'
Sample Number: ST-2

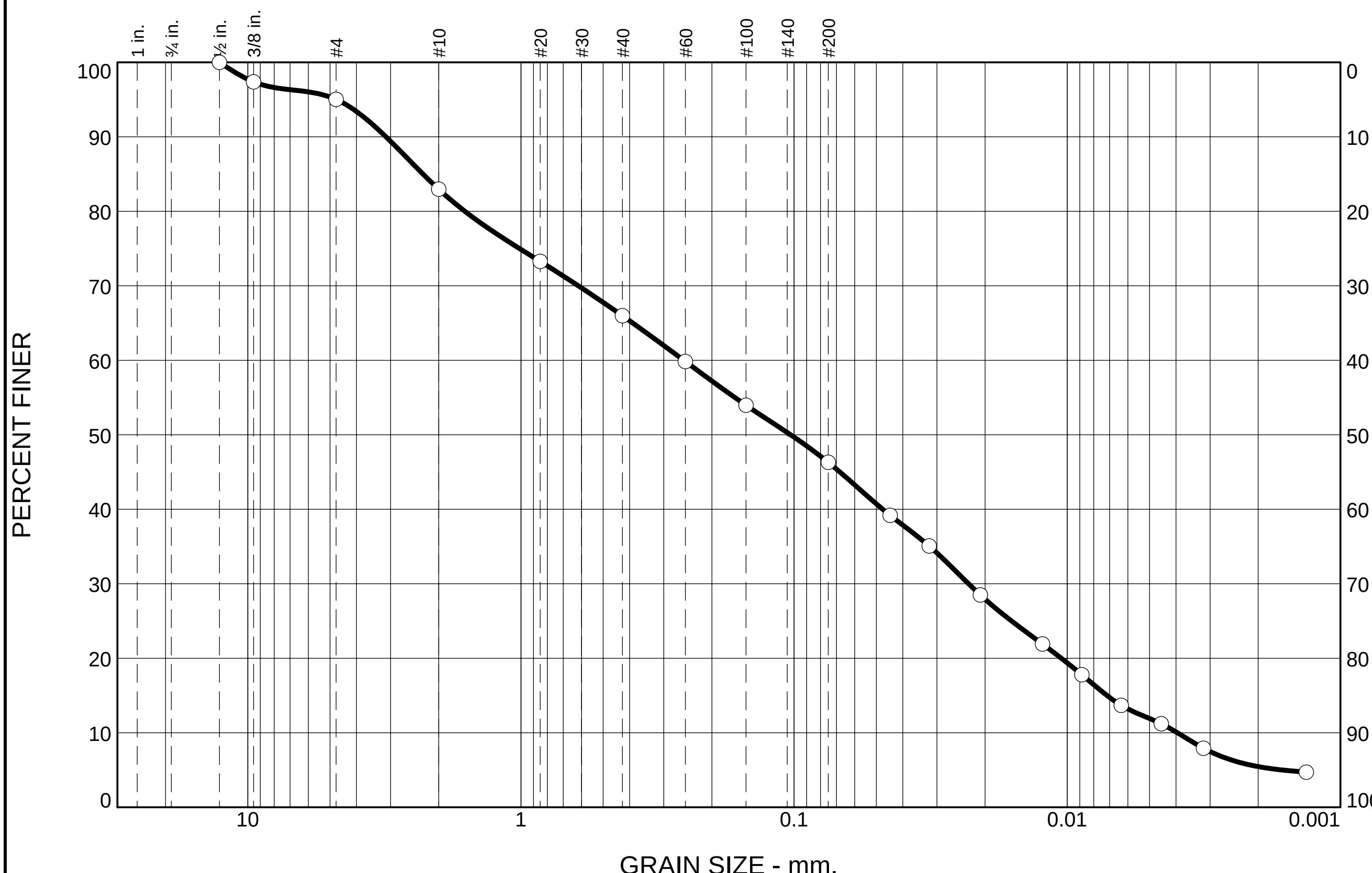
Date: 4/19/16

Terracon

Client: AECOM
Project: VECTREN F.B. CULLEY EAST POND
Project No: AW165009 **Figure**

Tested By: SH **Checked By:** BCM

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	5.0	12.0	17.0	19.7	34.4	11.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100.0		
3/8"	97.4		
#4	95.0		
#10	83.0		
#20	73.3		
#40	66.0		
#60	59.8		
#100	54.0		
#200	46.3		

* (no specification provided)

GRAY, DARK GRAY AND BLACK BOTTOM ASH WITH CINDERS AND GRAVEL

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 3.1190 D_{85}= 2.2832 D_{60}= 0.2535
D_{50}= 0.1030 D_{30}= 0.0230 D_{15}= 0.0072
D_{10}= 0.0040 C_u= 64.13 C_c= 0.53

Classification

USCS= AASHTO=

Remarks

F.M.=1.60

Source of Sample: B16-2 **Depth:** 22.0'-24.0'
Sample Number: ST-3

Date: 4/19/16

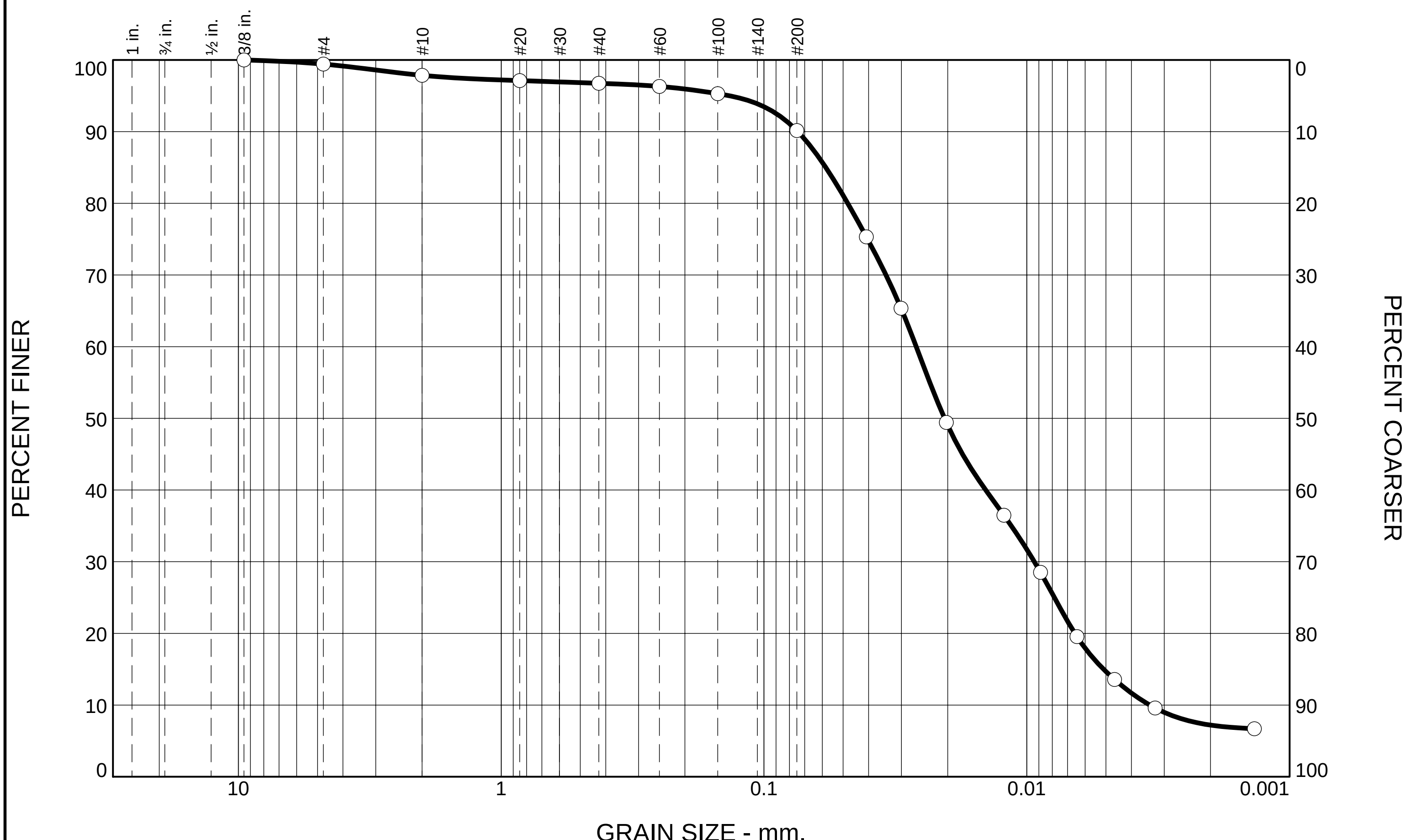
Terracon

Client: AECOM
Project: VECTREN F.B. CULLEY EAST POND

Project No: AW165009 **Figure**

Tested By: SH **Checked By:** BCM

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.6	1.5	1.2	6.6	75.4	14.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
#4	99.4		
#10	97.9		
#20	97.1		
#40	96.7		
#60	96.3		
#100	95.3		
#200	90.1		

* (no specification provided)

DARK BROWNISH GRAY FLY ASH WITH CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.0743 D_{85}= 0.0582 D_{60}= 0.0264
D_{50}= 0.0206 D_{30}= 0.0094 D_{15}= 0.0051
D_{10}= 0.0034 C_u= 7.74 C_c= 0.98

Classification

USCS= AASHTO=

Remarks

F.M.=0.16

Source of Sample: B16-2 **Depth:** 29.0'-31.0'
Sample Number: ST-4

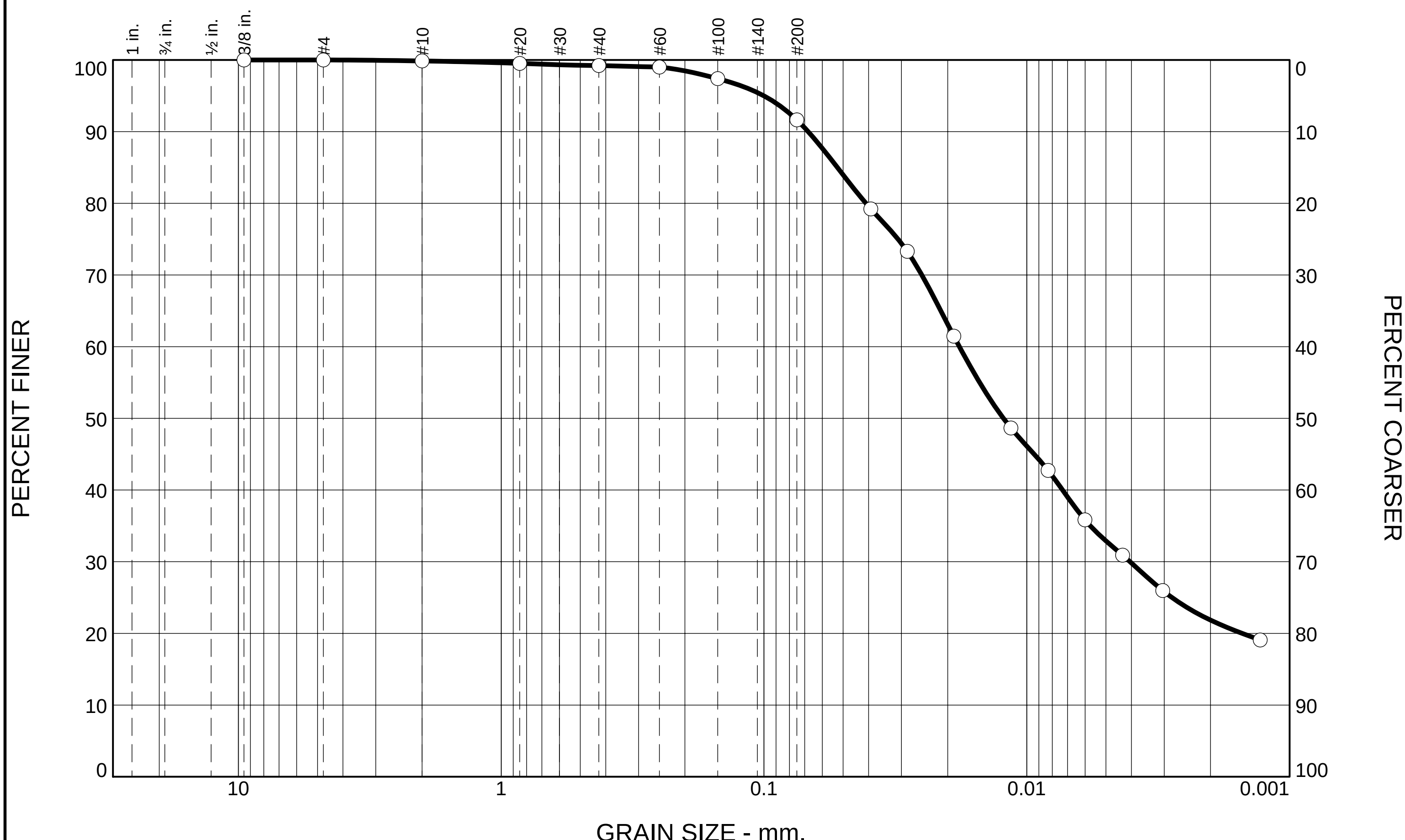
Date: 4/19/16

Terracon

Client: AECOM
Project: VECTREN F.B. CULLEY EAST POND
Project No: AW165009 **Figure**

Tested By: SH **Checked By:** BCM

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.7	7.6	58.7	32.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
#4	100.0		
#10	99.9		
#20	99.5		
#40	99.2		
#60	99.0		
#100	97.4		
#200	91.6		

* (no specification provided)

GRAY LEAN CLAY WITH SAND

Atterberg Limits

PL= 21 LL= 37 PI= 16

Coefficients

D_{90}= 0.0679 D_{85}= 0.0526 D_{60}= 0.0181
D_{50}= 0.0123 D_{30}= 0.0041 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(15)

Remarks

ORGANIC POCKETS NOTED
F.M.=0.05

Source of Sample: B16-2 **Depth:** 49.0'-51.0'
Sample Number: ST-6

Date: 4/26/16

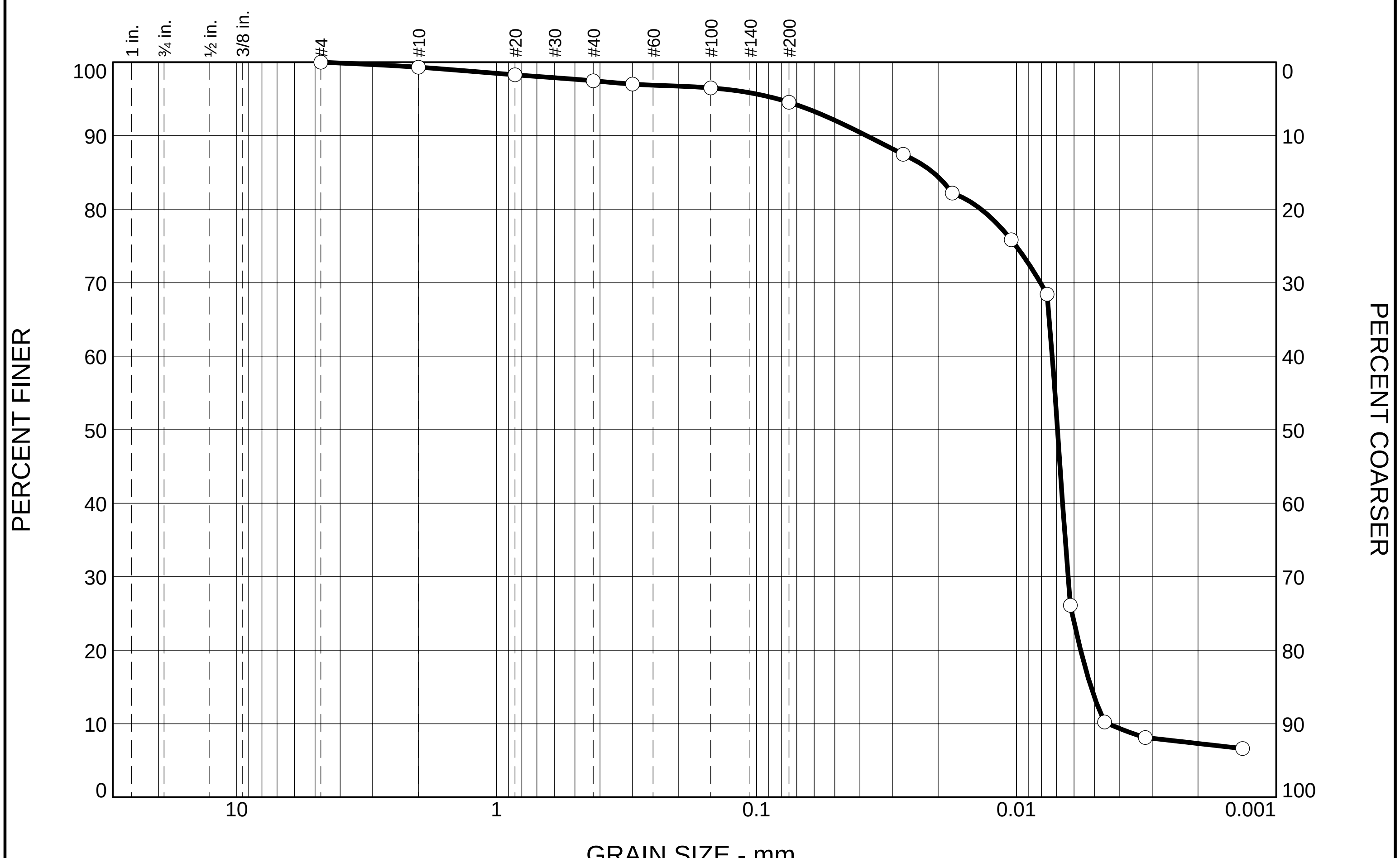
Terracon

Client: AECOM
Project: VECTREN F.B. CULLEY EAST POND

Project No: AW165009 **Figure**

Tested By: SH **Checked By:** BCM

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.7	1.8	3.0	81.0	13.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.3		
#20	98.3		
#40	97.5		
#50	97.0		
#100	96.5		
#200	94.5		

* (no specification provided)

BROWNISH GRAY CLAY AND FLYASH MIX - 3' SAND LAYER NOTED

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.0377 D_{85}= 0.0209 D_{60}= 0.0073
D_{50}= 0.0069 D_{30}= 0.0063 D_{15}= 0.0052
D_{10}= 0.0044 C_u= 1.64 C_c= 1.25

Classification

USCS= AASHTO=

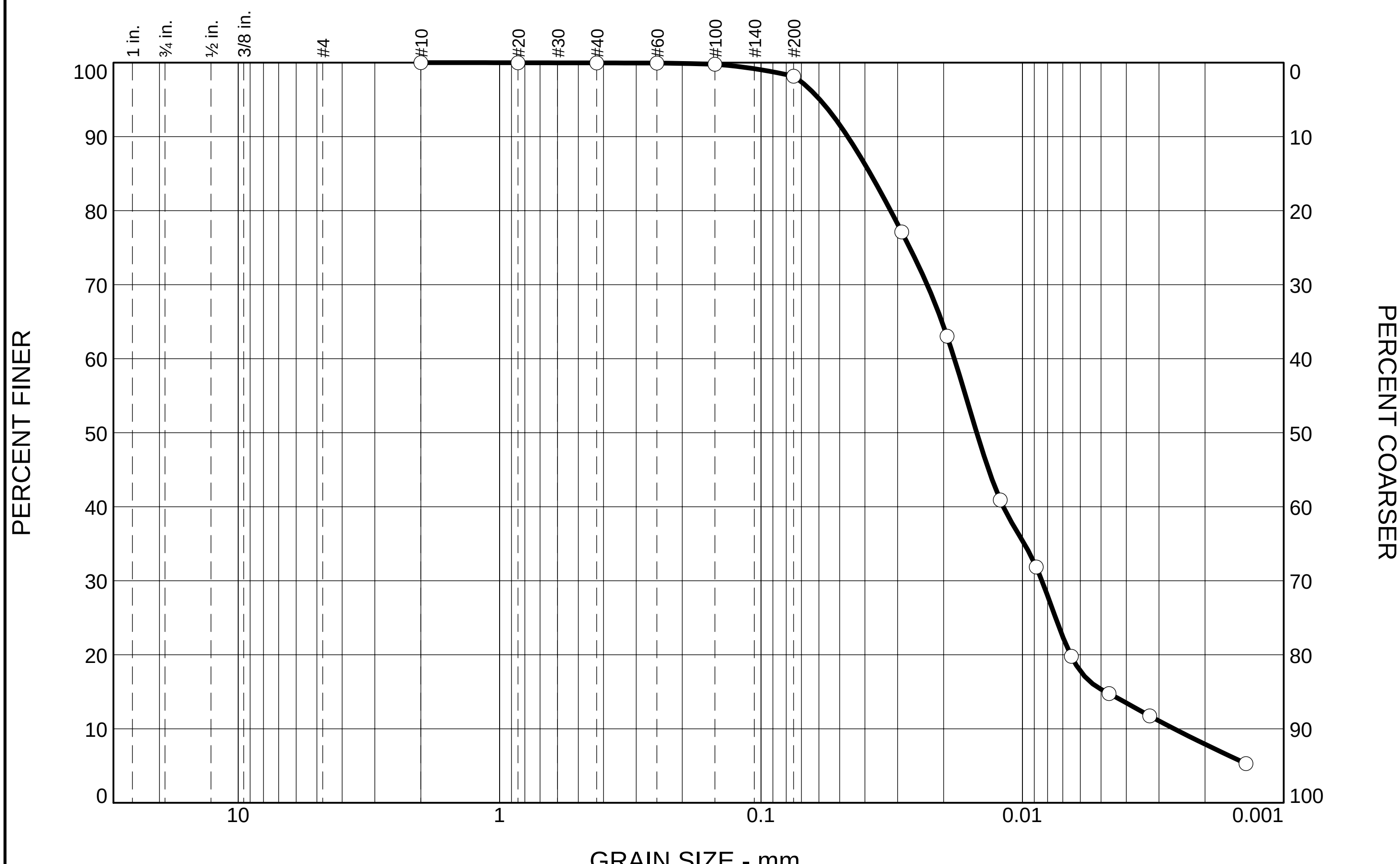
Remarks

F.M.=0.10

Source of Sample: B16-3 **Depth:** 11.0'-13.0'
Sample Number: ST-1 **Date:** 4/22/16

Client: AECOM
Project: VECTREN F.B. CULLEY EAST POND
Project No: AW165009 **Figure**

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.8	82.9	15.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	100.0		
#60	99.9		
#100	99.8		
#200	98.2		

* (no specification provided)

VERY DARK GRAY TO BLACK FLY ASH WITH CLAY - 2" SAND LAYER AT TOP

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.0466 D_{85}= 0.0382 D_{60}= 0.0182
D_{50}= 0.0149 D_{30}= 0.0084 D_{15}= 0.0048
D_{10}= 0.0026 C_u= 6.93 C_c= 1.48

Classification

USCS= AASHTO=

Remarks

F.M.=0.00

Source of Sample: B16-3 **Depth:** 21.0'-23.0'
Sample Number: ST-3

Date: 4/22/16

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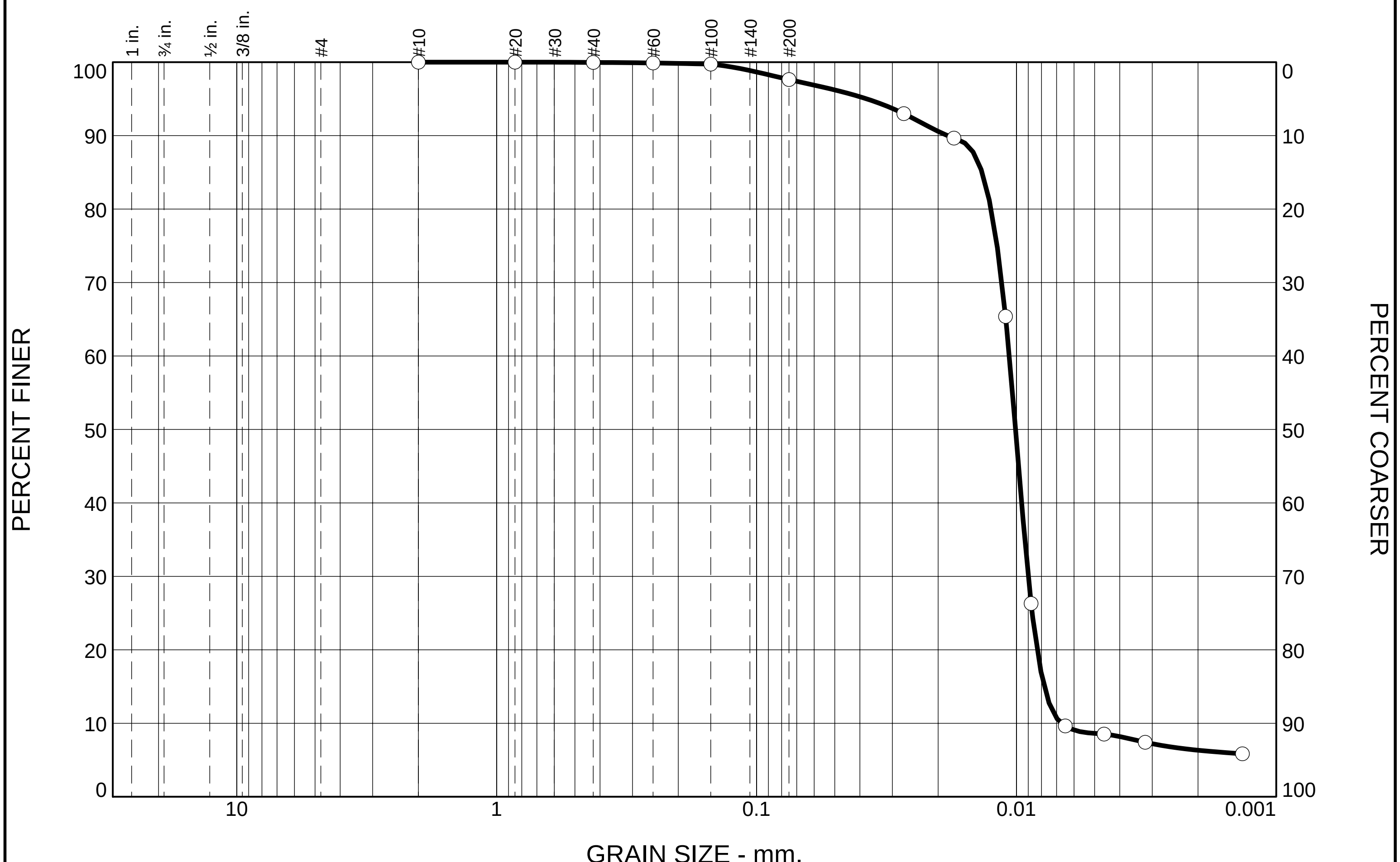
Client: AECOM
Project: VECTREN F.B. CULLEY EAST POND

Project No: AW165009 **Figure**

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	2.4	89.0	8.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	100.0		
#60	99.9		
#100	99.7		
#200	97.6		

* (no specification provided)

BROWNISH GRAY CLAY AND DARK GRAY FLY ASH MIX

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.0184 D_{85}= 0.0136 D_{60}= 0.0107
D_{50}= 0.0101 D_{30}= 0.0090 D_{15}= 0.0078
D_{10}= 0.0067 C_u= 1.59 C_c= 1.13

Classification

USCS= AASHTO=

Remarks

F.M.=0.00

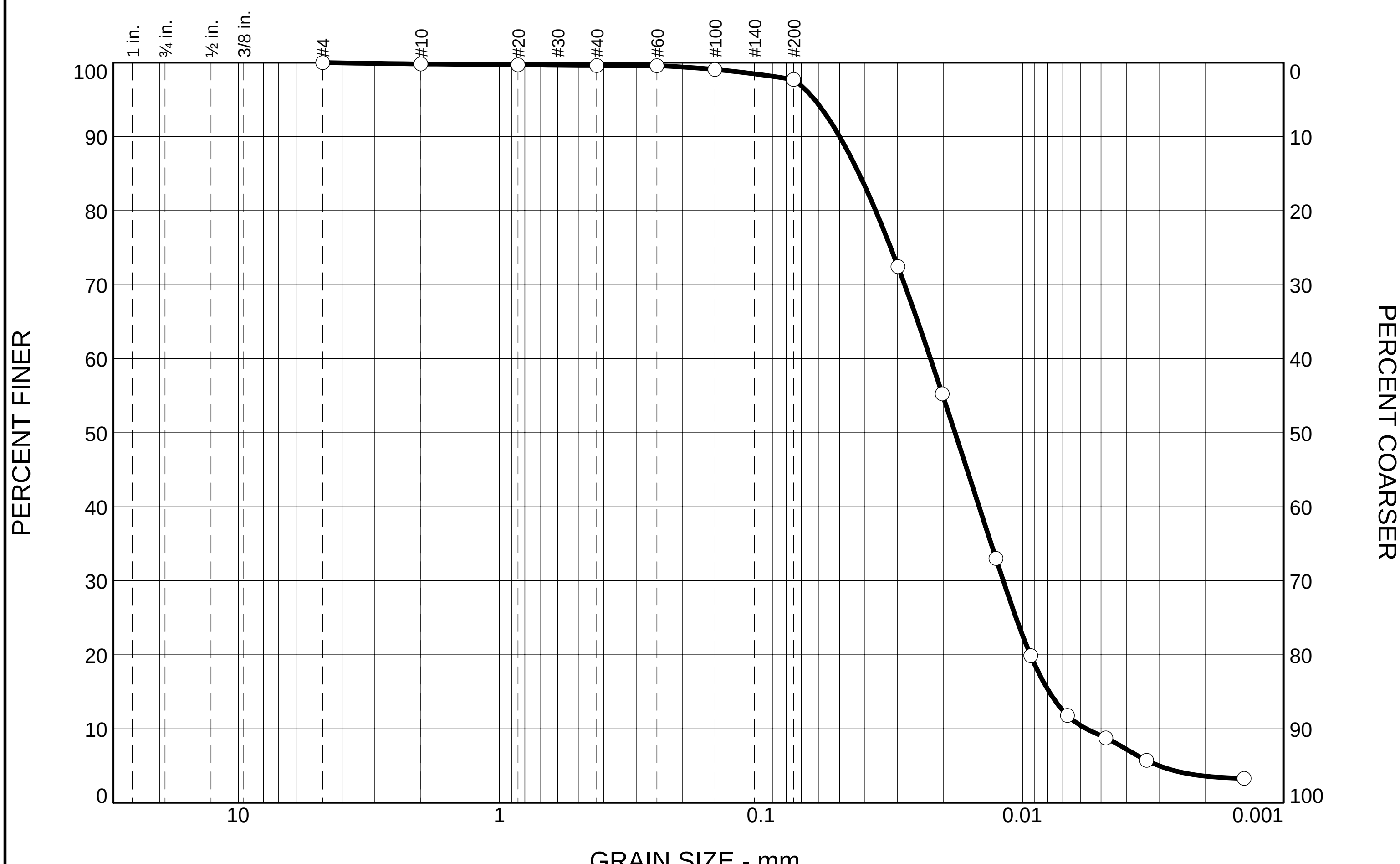
Source of Sample: B16-4 **Depth:** 9.0'-11.0'
Sample Number: ST-1

Date: 4/22/16

Client: AECOM
Project: VECTREN F.B. CULLEY EAST POND

Project No: AW165009 **Figure**

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.2	1.9	88.6	9.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.8		
#20	99.7		
#40	99.6		
#60	99.6		
#100	99.1		
#200	97.7		

* (no specification provided)

VERY DARK GRAY FLY ASH TRACE CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.0500 D_{85}= 0.0421 D_{60}= 0.0225
D_{50}= 0.0181 D_{30}= 0.0118 D_{15}= 0.0079
D_{10}= 0.0057 C_u= 3.94 C_c= 1.09

Classification

USCS= AASHTO=

Remarks

F.M.=0.02

Source of Sample: B16-4 **Depth:** 17.0'-19.0'
Sample Number: ST-3

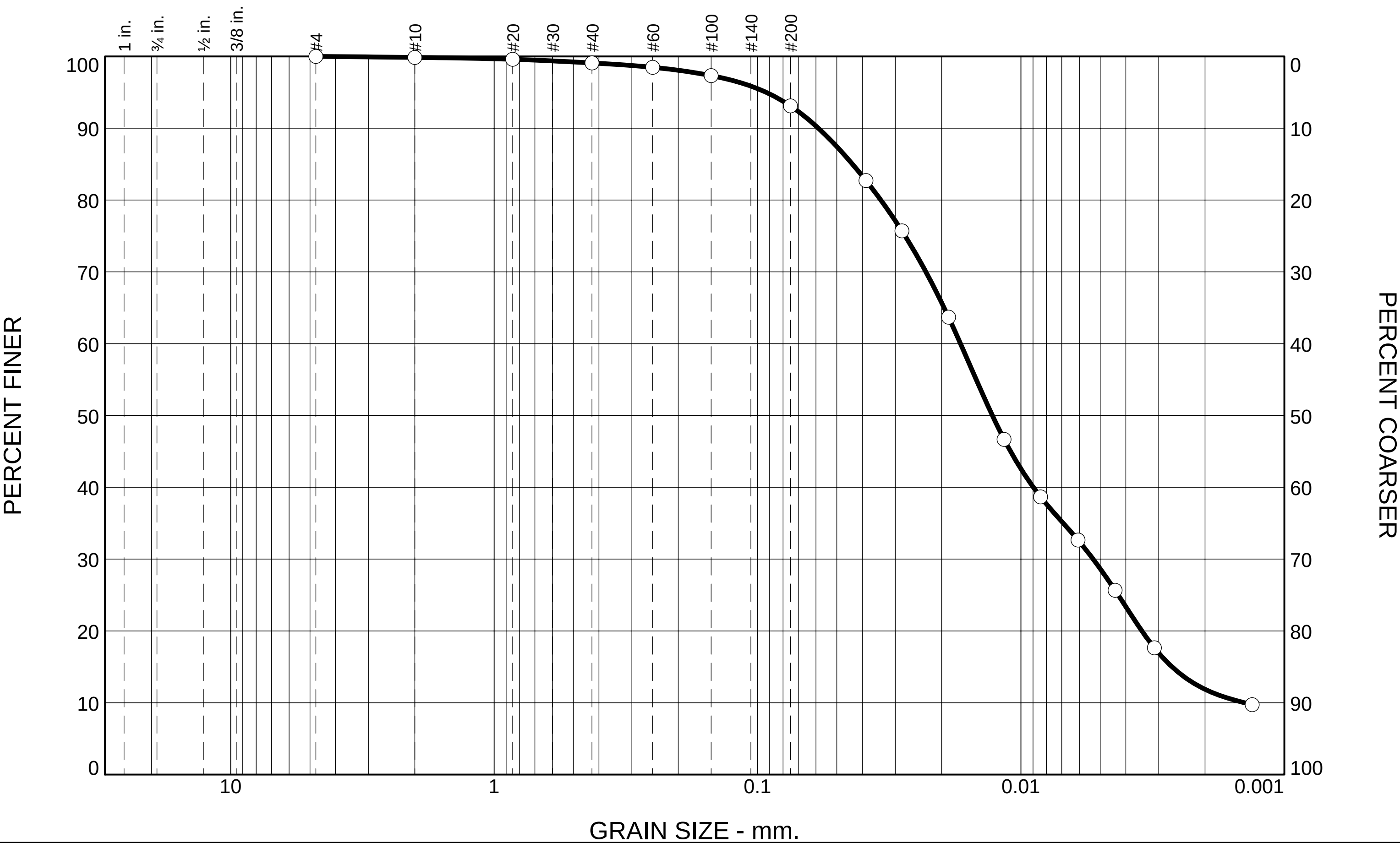
Date: 4/22/16

Terracon

Client: AECOM
Project: VECTREN F.B. CULLEY EAST POND

Project No: AW165009 **Figure**

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.8	6.0	64.4	28.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.6		
#40	99.1		
#60	98.5		
#100	97.3		
#200	93.1		

* (no specification provided)

DARK BROWNISH GRAY SILT ML FLY ASH NOTED

Atterberg Limits

PL= 33 LL= 47 PI= 14

Coefficients

D_{90}= 0.0587 D_{85}= 0.0436 D_{60}= 0.0170
D_{50}= 0.0128 D_{30}= 0.0053 D_{15}= 0.0027
D_{10}= 0.0014 C_u= 11.97 C_c= 1.18

Classification

USCS= ML AASHTO= A-7-5(17)

Remarks

F.M.=0.05

Source of Sample: B16-4 **Depth:** 42.0'-44.0'
Sample Number: ST-6

Date: 4/19/16

Terracon

Client: AECOM
Project: VECTREN F.B. CULLEY EAST POND

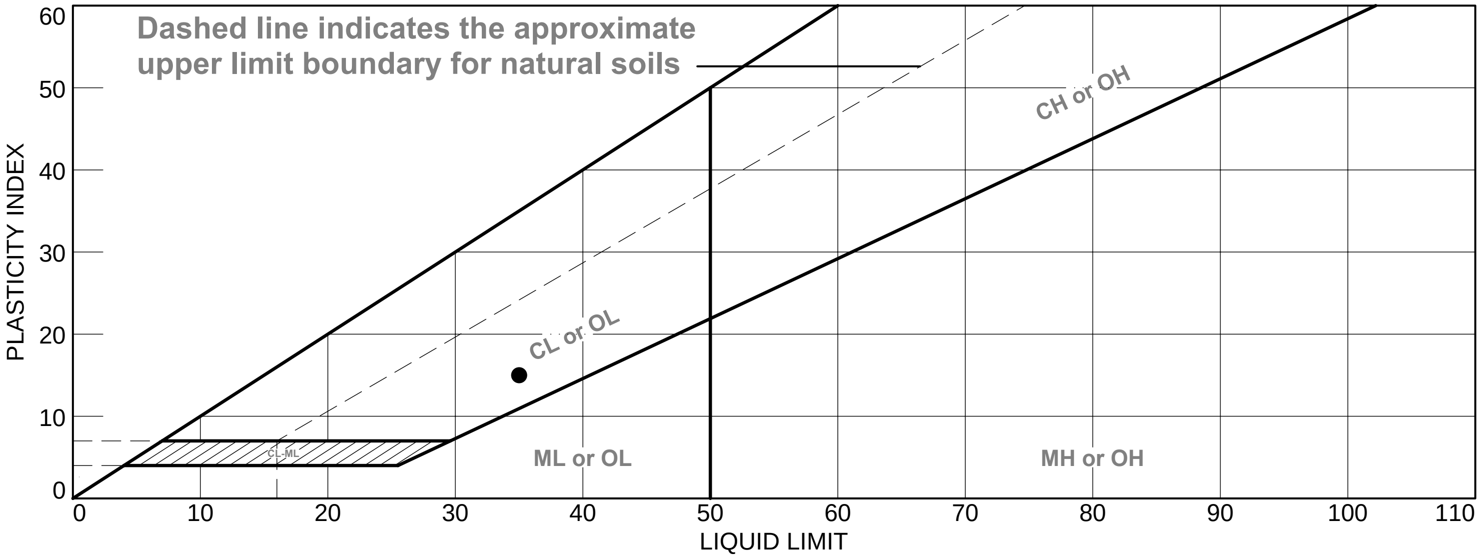
Project No: AW165009 **Figure**

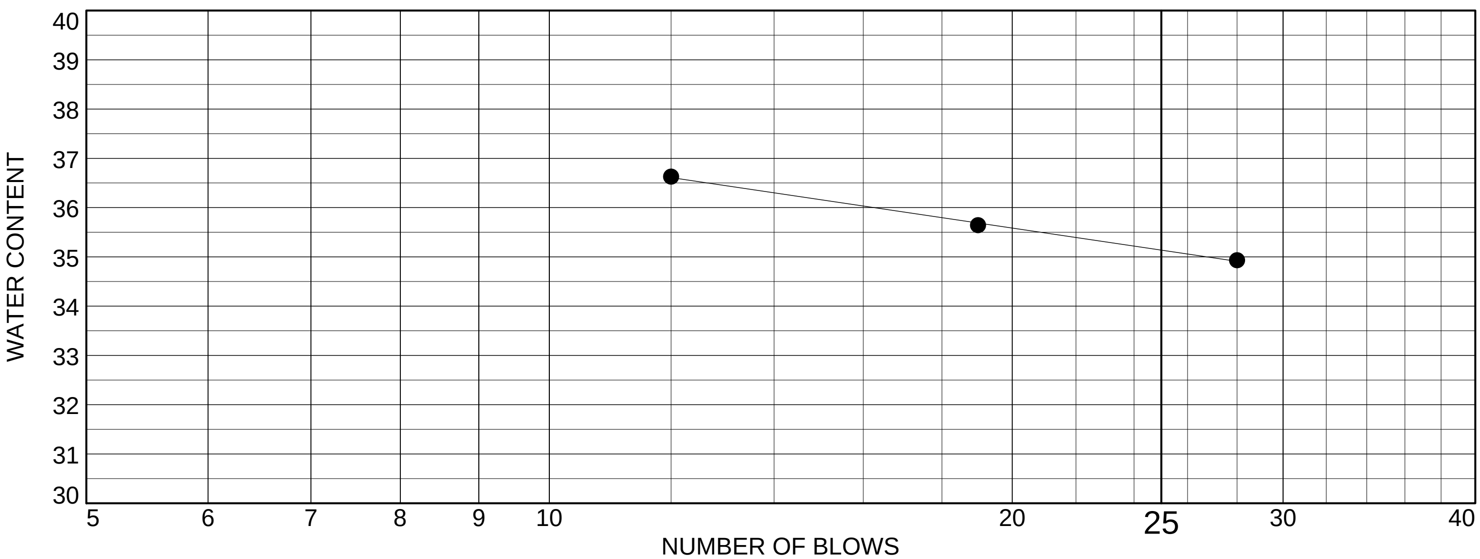
Tested By: SH **Checked By:** BCM

Terracon

Liquid and Plastic Limits of Soils – ASTM D 4318

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY TO DARK GRAY LEAN CLAY WITH SAND AND FLY ASH.	35	20	15	100.0	83.6	CL

Project No. AW165009 **Client:** AECOM

Project: VECTREN F.B. CULLEY EAST POND

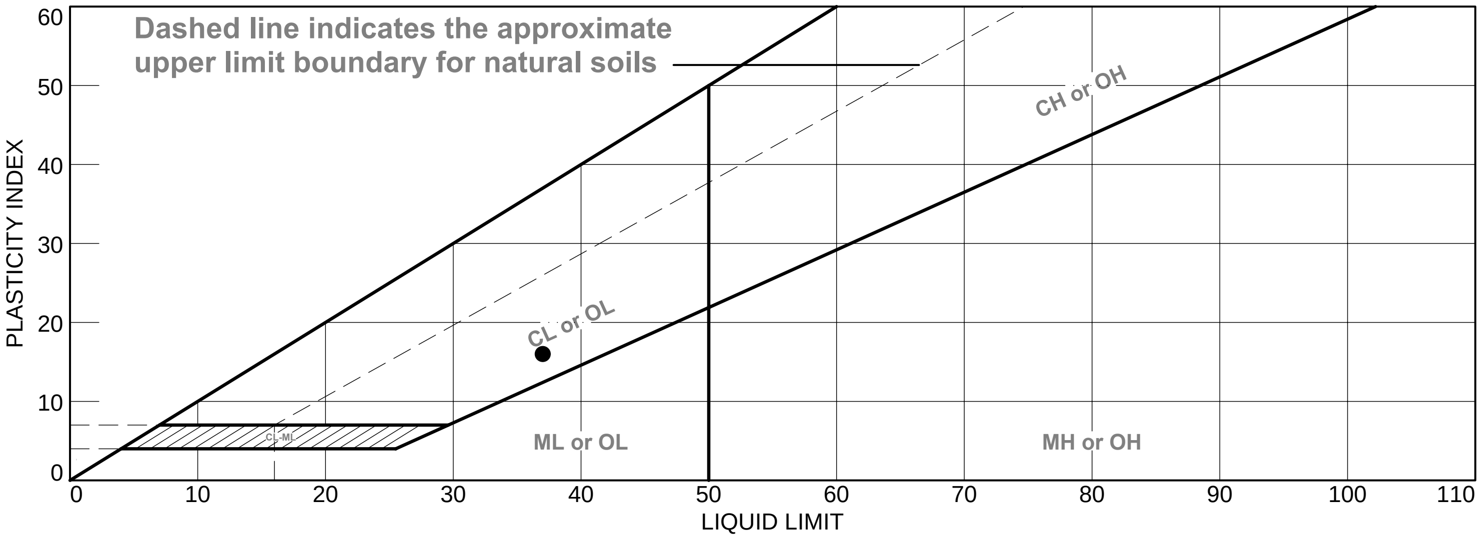
● **Source of Sample:** B16-1 **Depth:** 49.0'-51.0' **Sample Number:** ST-5

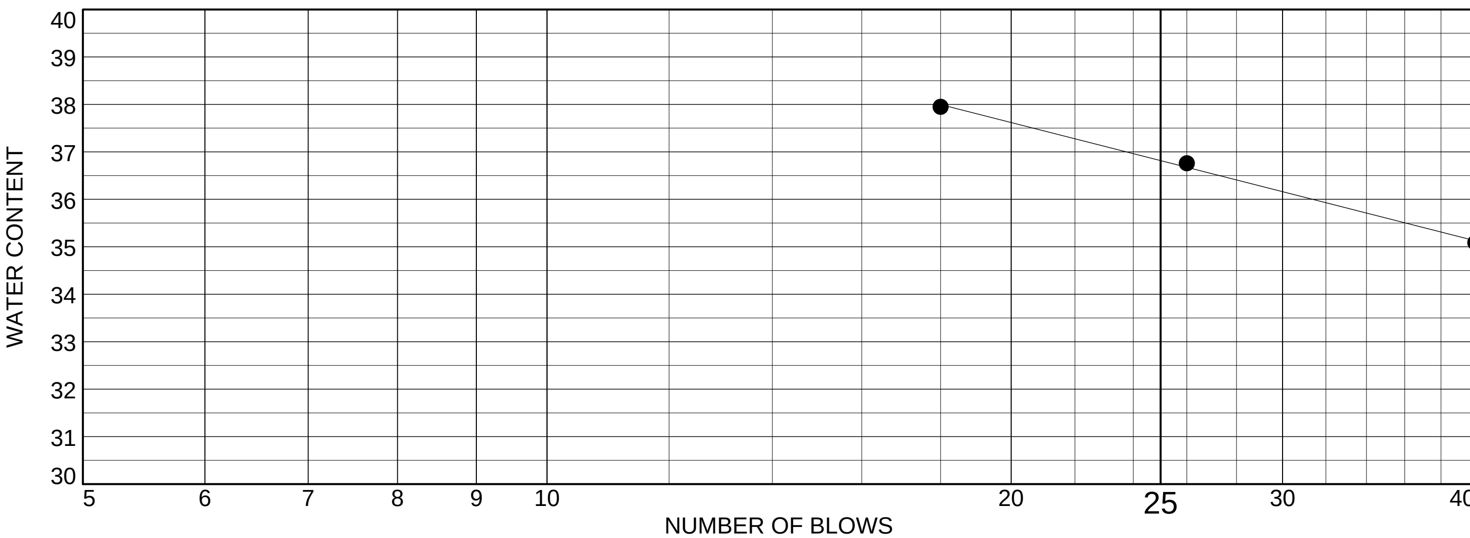
Remarks:

Terracon

Figure

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY LEAN CLAY WITH SAND	37	21	16	99.2	91.6	CL

Project No. AW165009 **Client:** AECOM

Project: VECTREN F.B. CULLEY EAST POND

● **Source of Sample:** B16-2 **Depth:** 49.0'-51.0' **Sample Number:** ST-6

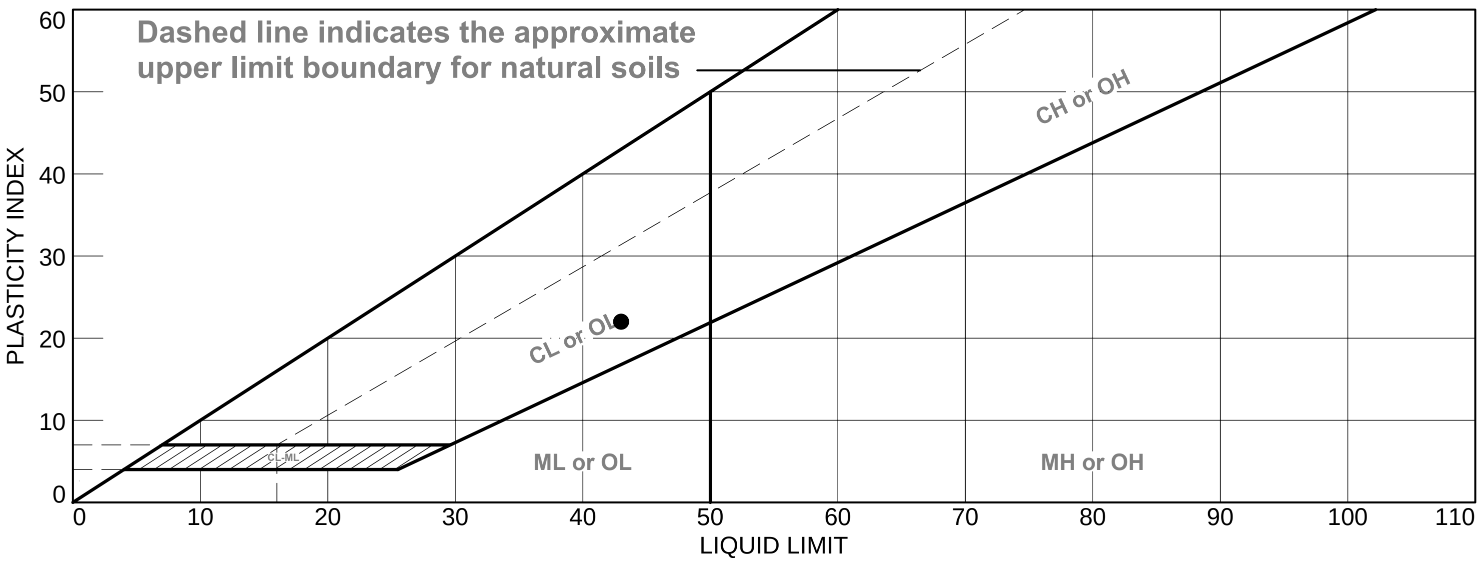
Remarks:

Terracon

Figure

Tested By: SJH **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY TO OLIVE GRAY LEAN CLAY WITH SAND SILT POCKETS NOTED	43	21	22			CL

Project No. AW165009 **Client:** AECOM

Project: VECTREN F.B. CULLEY EAST POND

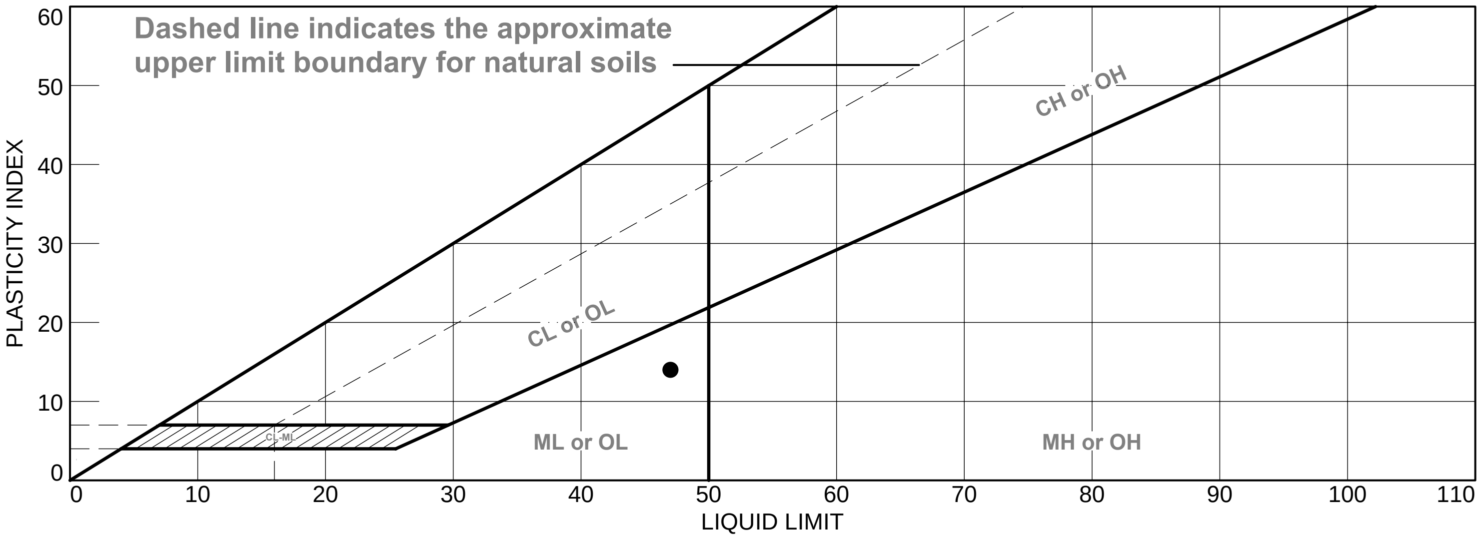
● **Source of Sample:** B16-3 **Depth:** 54.0'-56.0' **Sample Number:** ST-7

Remarks:

Terracon

Figure

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK BROWNISH GRAY SILT ML FLY ASH NOTED	47	33	14	99.1	93.1	ML

Project No. AW165009 **Client:** AECOM

Project: VECTREN F.B. CULLEY EAST POND

● **Source of Sample:** B16-4 **Depth:** 42.0'-44.0' **Sample Number:** ST-6

Remarks:

Terracon

Figure

Tested By: SH **Checked By:** BCM

Terracon

Specific Gravity of Soils – ASTM D 854

SPECIFIC GRAVITY OF SOIL SOLIDS
ASTM D-854

Project Number: AW165009
Project Name: VECTREN CULLEY EAST POND
Test Date: 4/20/2016

Results Summary

Boring Number	Sample Number	Depth (ft)		Specific Gravity (Gs)
B16-1	ST-2	17.0'-19.0'		2.655
B16-1	ST-3	29..0'-31.0'		2.667
B16-1	ST-4	39.0'-41.0'		2.678
B16-2	ST-4	29.0'-31.0'		2.640
B16-3	ST-1	11.0'-13.0'		2.717
B16-3	ST-3	21.0'-23.0'		2.612
B16-4	ST-1	9.0'-11.0'		2.721
B16-4	ST-3	17.0'-19.0'		2.576
B16-4	ST-6	42.0'-46.0'		2.704

Tested By: BCM

Checked By: WPQ

Terracon

LABORATORY TESTING SUMMARY

PROJECT NAME: VECTREN - FB CULLEY PROJECT NUMBER: MR155242 CLIENT: AECOM

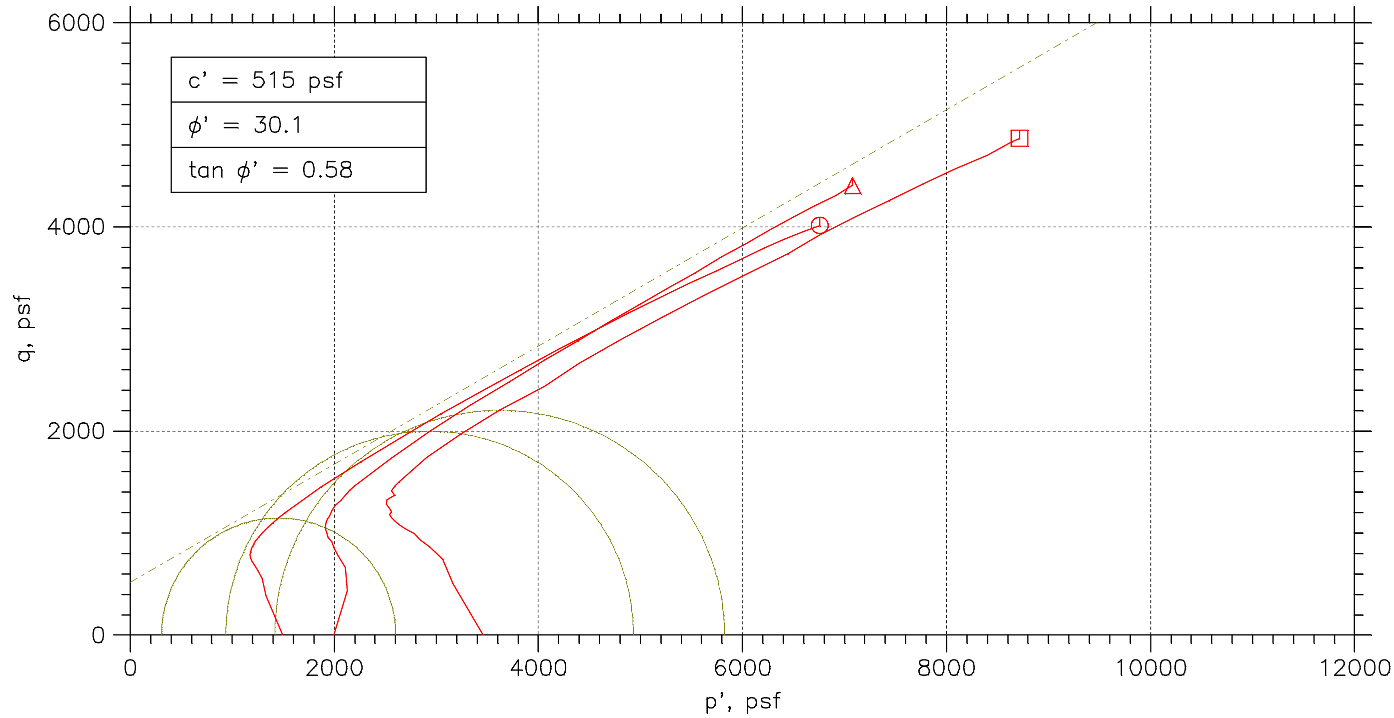
Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI
B-1	S-1	3.0'-5.0'	BROWN SILTY CLAY	CL	3.5									
B-1	S-2	5.0'-7.0'	BROWN TO GRAYISH BROWN LEAN CLAY WITH SILT AND SAND SEAMS AND POCKETS	CL	18.3	2.50								
B-1	S-3	8.0'-10.0'	BROWN SILTY CLAY	CL-ML	20.9	1.25						26	20	6
B-1	S-4	10.0'-12.0'	BROWN AND GRAY LEAN CLAY	CL	21.8	1.25	0.0	5.3	54.6	40.1	94.7			
B-1	S-5	13.0'-15.0'	BROWN AND GRAY LEAN CLAY WITH SILT	CL	18.7							26	18	8
B-1	S-6	15.0'-17.0'	GRAY AND TAN LEAN CLAY	CL	19.9	1.00								
B-1	S-7	18.0'-20.0'	BROWN AND GRAY LEAN CLAY	CL	24.2	1.00						31	20	11
B-1	S-8	20.0'-22.0'	DARK BROWN LEAN CLAY	CL	18.2	1.25								
B-1	S-9	28.0'-30.0'	BROWN AND GRAY LEAN CLAY	CL	21.7	0.50						32	19	13
B-1	S-10	30.0'-32.0'	DARK GRAY LEAN CLAY - SAND POCKETS NOTED	CL	27.2	0.75	1.0	14.0	50.5	34.5	85.0	32	20	12
B-1	S-11	38.0'-40.0'	GRAYISH BROWN LEAN CLAY	CL	28.2	1.00								
B-1	S-12	40.0'-42.0'	DARK BROWN LEAN CLAY	CL	25.2	1.00						41	24	17
B-1	S-13	48.0'-50.0'	GRAYISH BROWN SANDY SILT	ML	20.9		0.0	37.4			62.6			
B-1	S-14	50.0'-52.0'	DARK BROWN SANDY LEAN CLAY	CL-ML	25.7	1.25						24	18	6
B-1	S-17	58.0'-59.5'	BROWN SAND WITH GRAVEL	SP	13.4	0.50	24.5	71.4			4.1			
B-1	S-18	60.5'-62.0'	BROWN GRAVELLY SAND	SP	11.7	0.25	28.5	66.4			5.1			
B-1	S-19	63.5'-65.0'	BROWN GRAVELLY SAND	SP-SM	12.3		33.3	60.9			5.8			
B-1	S-20	68.5'-70.0'	BROWN AND GRAYISH BROWN GRAVELLY SAND	SP	11.2									
B-1	S-21	71.0'-72.5'	GRAY SILTY SAND WITH GRAVEL	SM	12.0		33.1	59.3			7.6			
B-1	S-22	73.5'-75.0'	GRAY SAND	SP	36.3									
B-1	S-23	78.5'-80.0'	GRAY AND BROWN GRAVELLY SAND	SP-SM	11.9		17.2	74.5			8.3			
B-1	S-24	81.0'-82.5'	GRAY SAND WITH GRAVEL	SP	7.8									
B-1	S-25	83.5'-84.0'	BROWN AND GRAY LEAN CLAY WITH SAND	CL	9.5									

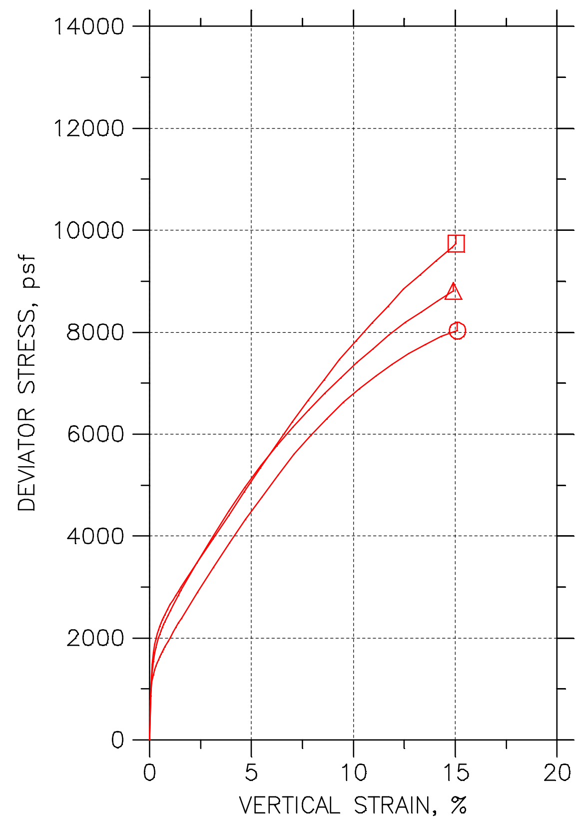
LABORATORY TESTING SUMMARY

PROJECT NAME: VECTREN - FB CULLEY   PROJECT NUMBER: MR155242   CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI
B-2	S-1	3.0'-5.0'	BROWN AND GRAYISH BROWN SILTY CLAY	CL	17.9									
B-2	S-3	7.0'-9.0'	BROWNIST GRAY LEAN CLAY WITH SILT AND SAND SEAMS	CL	23.5	1.50								
B-2	S-4	9.0'-11.0'	BROWN AND GRAY LEAN CLAY - ORGANIC ODOR NOTED	CL	23.4	0.50						34	19	15
B-2	S-5	11.0'-13.0'	OLIVE BROWN LEAN CLAY	CL	22.2	1.25								
B-2	S-6	13.0'-15.0'	BROWN AND GRAY SILTY CLAY	CL	23.8	0.25						30	18	12
B-2	S-7	15.0-17.0'	GRAYISH BROWN TO GRAY LEAN CLAY	CL	23.5	1.75								
B-2	S-8	18.0'-20.0'	BROWN AND GRAYISH BROWN LEAN CLAY	CL	26.1	0.25								
B-2	S-9	20.0'-22.0'	BROWNISH GRAY LEAN CLAY	CL	22.6	1.50						36	19	17
B-2	S-10	28.0'-30.0'	GRAY LEAN CLAY	CL	33.0	1.25								
B-2	S-11	30.0'-32.0'	OLIVE BROWN LEAN CLAY	CL	28.2	1.00						31	19	12
B-2	S-12	38.0'-40.0'	BROWN AND GRAY SANDY CLAY	CL	27.6	0.50	0.0	20.1	26.5	53.4	79.9			
B-2	S-13	40.0'-42.0'	BROWN LEAN CLAY	CL	29.8	1.50						46	24	22
B-2	S-14	48.0'-50.0'	BROWN SANDY SILT	ML	28.2	<0.25	0.0	26.7	52.7	20.6	73.3	30	25	5
B-2	S-15	51.0'-52.5'	BROWN LEAN CLAY	CL	27.8	0.50								
B-2	S-16	53.0'-55.0'	VERY DARK GRAY LEAN CLAY WITH SAND	CL-ML	39.7	0.75						24	20	4
B-2	S-17	56.0'-57.5'	BROWN AND GRAY LEAN CLAY	CL	28.4	0.25	1.8	8.7			89.5			
B-2	S-18	58.0'-60.0'	DARK GRAY FAT CLAY - SAND POCKETS NOTED	CH	30.2	1.25								
B-2	S-19	61.0'-62.5'	GRAY SANDY SILT	ML	38.5	<0.25	0.4	41.1	42.9	15.6	58.5	41	39	2
B-2	S-20	63.0'-65.0'	BROWN LEAN CLAY	CL	24.7	0.50								
B-2	S-21	66.0'-67.0'	GRAY SANDY CLAY	CL	19.2									
B-3	S-2	10.0'-12.0'	OLIVE BROWN LEAN CLAY	CL	22.1									
B-3	S-3	17.0'-19.0'	BROWN LEAN CLAY	CL	20.1	1.00						31	20	11
B-3	S-5	25.0'-27.0'	OLIVE BROWN FAT CLAY	CH	28.8	1.50								
B-3	S-6	30.0'-32.0'	BROWNISH GRAY LEAN CLAY	CL	27.9	1.25						40	23	17
B-3	S-7	33.0'-35.0'	OLIVE BROWN LEAN CLAY	CL	27.1									
B-3	S-8	36.0'-38.0'	BROWNISH GRAY LEAN CLAY	CL	27.2	1.0	0.0	10.5	20.5	69.0	89.5	35	18	17
B-3	S-10	43.0'-45.0'	OLIVE BROWN LEAN CLAY	CL	29.0	1.00								

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767





	Symbol	○	△	□	
	Test No.	1500 PSF	2000 PSF	3500 PSF	
Initial	Diameter, in	2.8303	2.852	2.8768	
Initial	Height, in	6.2287	6.0469	6.2197	
Initial	Water Content, %	21.78	21.61	20.34	
Initial	Dry Density, pcf	105.8	106.4	106.2	
Initial	Saturation, %	97.88	98.54	92.49	
Initial	Void Ratio	0.6051	0.5964	0.59825	
Before Shear	Water Content, %	21.87	20.82	19.81	
Before Shear	Dry Density, pcf	106.5	108.4	110.3	
Before Shear	Saturation, %	100.00	100.00	100.00	
Before Shear	Void Ratio	0.59486	0.5664	0.53891	
Before Shear	Back Press., psf	10082	10083	10122	
	Minor Prin. Stress, psf	1495.7	1998.4	3457.5	
	Max. Dev. Stress, psf	8029.2	8809.6	9736	
	Time to Failure, min	1140	1140	1156.1	
	Strain Rate, %/min	0.02	0.02	0.02	
	B-Value	0.96	0.95	0.99	
	Estimated Specific Gravity	2.72	2.72	2.72	
	Liquid Limit	---	---	---	
	Plastic Limit	---	---	---	
	Plasticity Index	---	---	---	

Failure Sketch

Project: VECTREN F.B. CULLEY

Location: NEWBURGH, IN

Project No.: MR155242

Boring No.: B-1 S-4

Sample Type: 3.0'' ST

Description: BROWN AND GRAY LEAN CLAY CL

Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

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CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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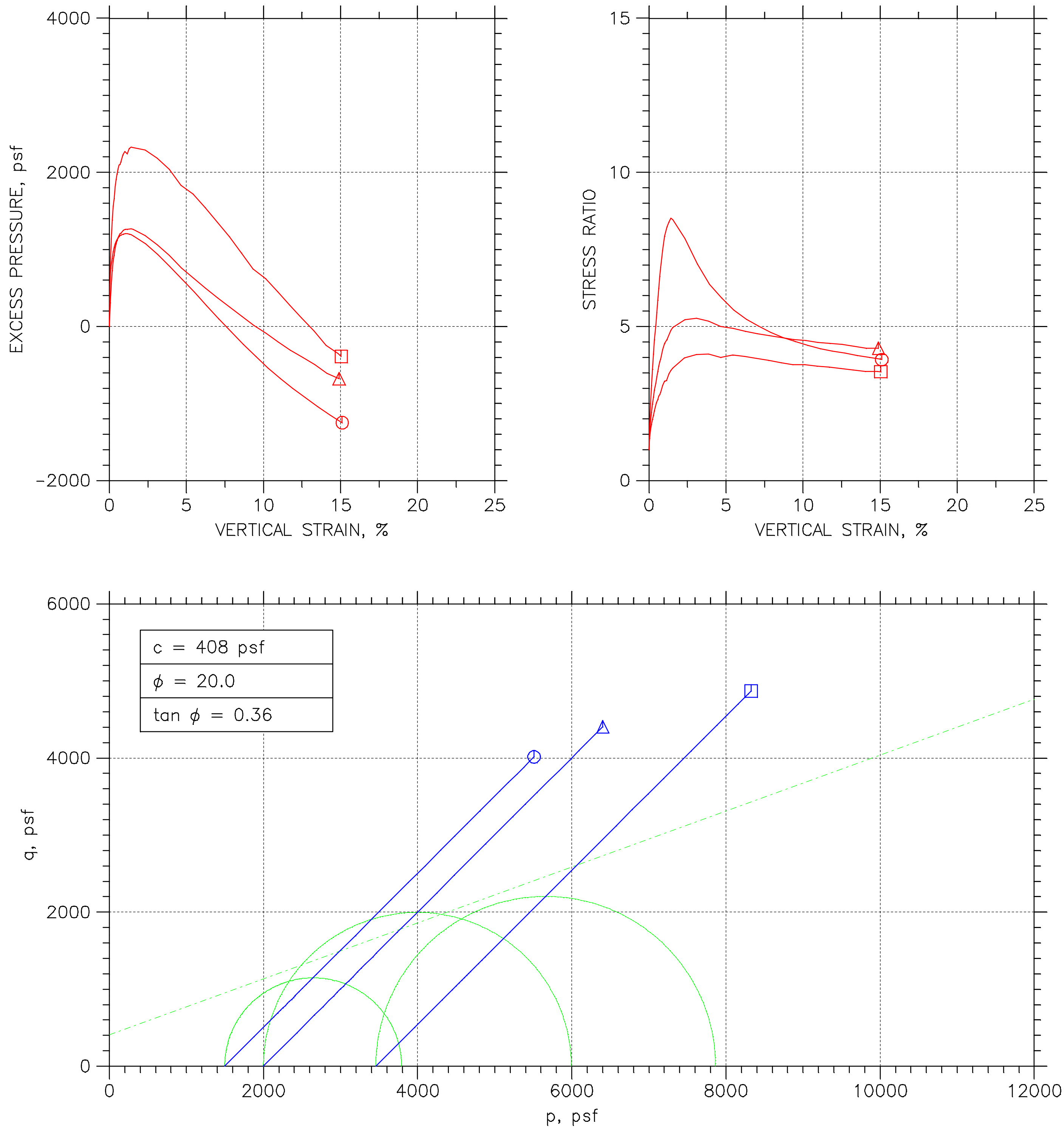

Project: VECTREN F.B. CULLEY	Location: NEWBURGH, IN	Project No.: MR155242
Boring No.: B-1 S-4	Tested By: BCM	Checked By: WPQ
Sample No.: S-4	Test Date: 11/28/15	Depth: 10.0'-12.0'
Test No.: B-1 S-4	Sample Type: 3.0" ST	Elevation: ----
Description: BROWN AND GRAY LEAN CLAY CL		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.		

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TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-1 S-4
Sample No.: S-4
Test No.: 1500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

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Soil Description: BROWN AND GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.23 in
Specimen Area: 6.29 in^2
Specimen Volume: 39.19 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.2916	0	0	10082	11578	11578
2	5.0001	0.048095	6.2946	33.457	765.38	10630	11578	12343
3	10	0.11076	6.2986	48.587	1110.8	10839	11578	12688
4	15	0.17635	6.3027	55.828	1275.5	10968	11578	12853
5	20	0.24048	6.3067	60.372	1378.5	11052	11578	12956
6	25	0.30606	6.3109	63.718	1453.9	11110	11578	13031
7	30	0.3731	6.3151	66.514	1516.7	11153	11578	13094
8	35	0.43869	6.3193	69.061	1573.7	11188	11578	13151
9	40	0.50427	6.3235	71.458	1627.3	11213	11578	13205
10	45	0.57131	6.3277	73.955	1683	11231	11578	13261
11	50	0.6369	6.3319	76.401	1737.5	11246	11578	13315
12	55	0.70248	6.3361	78.649	1787.4	11260	11578	13365
13	60	0.76806	6.3403	80.746	1833.9	11268	11578	13411
14	70	0.89923	6.3487	84.94	1926.6	11280	11578	13504
15	80	1.0289	6.357	89.285	2022.5	11286	11578	13600
16	90	1.1616	6.3655	93.529	2115.8	11285	11578	13693
17	100	1.2942	6.3741	97.624	2205.5	11279	11578	13783
18	110	1.4254	6.3826	101.72	2294.9	11272	11578	13873
19	120	1.558	6.3911	105.86	2385.2	11258	11578	13963
20	180	2.3494	6.4429	129.73	2899.5	11154	11578	14477
21	240	3.1393	6.4955	153	3392	11015	11578	14970
22	300	3.9263	6.5487	175.82	3866.2	10858	11578	15444
23	360	4.7162	6.603	198.54	4329.9	10697	11578	15908
24	420	5.5149	6.6588	220.57	4769.8	10526	11578	16347
25	480	6.3092	6.7153	242.44	5198.8	10352	11578	16776
26	540	7.1006	6.7725	263.56	5604	10181	11578	17182
27	600	7.9022	6.8314	283.23	5970.3	10013	11578	17548
28	660	8.7023	6.8913	301.41	6298.3	9848.1	11578	17876
29	720	9.4995	6.952	319.74	6622.9	9692.3	11578	18200
30	780	10.297	7.0138	335.57	6889.6	9543.4	11578	18467
31	840	11.106	7.0776	350.65	7134.3	9403.8	11578	18712
32	900	11.906	7.1419	365.13	7362	9277	11578	18940
33	960	12.707	7.2074	379.56	7583.4	9157.2	11578	19161
34	1020	13.51	7.2744	391.99	7759.7	9043.2	11578	19337
35	1080	14.308	7.342	403.63	7916.4	8935	11578	19494
36	1140	15.103	7.4109	413.22	8029.2	8833.8	11578	19607

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-1 S-4
Sample No.: S-4
Test No.: 1500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

Terracon Consulting Engineers & Scientists

Soil Description: BROWN AND GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.23 in
Specimen Area: 6.29 in^2
Specimen Volume: 39.19 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	11578	11578	0	0.000	1495.7	1495.7	1.000	1495.7	0
2	0.05	12343	11578	547.89	0.716	1713.1	947.76	1.808	1330.5	382.69
3	0.11	12688	11578	757.28	0.682	1849.2	738.37	2.504	1293.8	555.41
4	0.18	12853	11578	886.4	0.695	1884.8	609.25	3.094	1247	637.76
5	0.24	12956	11578	970.16	0.704	1904	525.5	3.623	1214.7	689.23
6	0.31	13031	11578	1028.3	0.707	1921.2	467.33	4.111	1194.3	726.95
7	0.37	13094	11578	1071.4	0.706	1941	424.29	4.575	1182.6	758.34
8	0.44	13151	11578	1106.3	0.703	1963.1	389.4	5.041	1176.3	786.86
9	0.50	13205	11578	1130.7	0.695	1992.2	364.97	5.459	1178.6	813.63
10	0.57	13261	11578	1149.3	0.683	2029.3	346.36	5.859	1187.8	841.49
11	0.64	13315	11578	1164.4	0.670	2068.8	331.23	6.246	1200	868.76
12	0.70	13365	11578	1178.4	0.659	2104.7	317.27	6.634	1211	893.72
13	0.77	13411	11578	1186.5	0.647	2143	309.13	6.932	1226.1	916.95
14	0.90	13504	11578	1198.2	0.622	2224.1	297.5	7.476	1260.8	963.31
15	1.03	13600	11578	1204	0.595	2314.2	291.68	7.934	1302.9	1011.3
16	1.16	13693	11578	1202.8	0.568	2408.7	292.85	8.225	1350.8	1057.9
17	1.29	13783	11578	1197	0.543	2504.1	298.66	8.385	1401.4	1102.7
18	1.43	13873	11578	1190	0.519	2600.6	305.64	8.509	1453.1	1147.5
19	1.56	13963	11578	1176.1	0.493	2704.8	319.6	8.463	1512.2	1192.6
20	2.35	14477	11578	1072.5	0.370	3322.7	423.13	7.853	1872.9	1449.8
21	3.14	14970	11578	932.93	0.275	3954.7	562.72	7.028	2258.7	1696
22	3.93	15444	11578	775.89	0.201	4586	719.76	6.371	2652.9	1933.1
23	4.72	15908	11578	615.36	0.142	5210.2	880.29	5.919	3045.2	2165
24	5.51	16347	11578	444.36	0.093	5821.1	1051.3	5.537	3436.2	2384.9
25	6.31	16776	11578	269.88	0.052	6424.5	1225.8	5.241	3825.2	2599.4
26	7.10	17182	11578	98.877	0.018	7000.7	1396.8	5.012	4198.8	2802
27	7.90	17548	11578	-68.632	-0.011	7534.6	1564.3	4.817	4549.5	2985.2
28	8.70	17876	11578	-233.81	-0.037	8027.8	1729.5	4.642	4878.6	3149.1
29	9.50	18200	11578	-389.69	-0.059	8508.2	1885.3	4.513	5196.8	3311.4
30	10.30	18467	11578	-538.59	-0.078	8923.8	2034.2	4.387	5479	3444.8
31	11.11	18712	11578	-678.18	-0.095	9308.1	2173.8	4.282	5741	3567.1
32	11.91	18940	11578	-804.97	-0.109	9662.7	2300.6	4.200	5981.6	3681
33	12.71	19161	11578	-924.79	-0.122	10004	2420.4	4.133	6212.1	3791.7
34	13.51	19337	11578	-1038.8	-0.134	10294	2534.4	4.062	6414.3	3879.9
35	14.31	19494	11578	-1147	-0.145	10559	2642.6	3.996	6600.8	3958.2
36	15.10	19607	11578	-1248.2	-0.155	10773	2743.8	3.926	6758.4	4014.6

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-1 S-4
Sample No.: S-4
Test No.: 2000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN AND GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.05 in
Specimen Area: 6.39 in^2
Specimen Volume: 38.63 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.3882	0	0	10083	12082	12082
2	5.0006	0.054621	6.3917	38.658	870.94	10391	12082	12953
3	10.001	0.11379	6.3955	58.917	1326.6	10638	12082	13408
4	15.001	0.18055	6.3998	68.746	1546.8	10813	12082	13628
5	20.001	0.24276	6.4038	75.878	1706.3	10939	12082	13788
6	25.001	0.308	6.4079	81.153	1823.7	11014	12082	13905
7	30.001	0.37324	6.4121	85.408	1918	11099	12082	14000
8	35.001	0.43849	6.4163	89.304	2004.2	11159	12082	14086
9	40.001	0.50525	6.4207	92.541	2075.5	11203	12082	14157
10	45.001	0.57049	6.4249	95.777	2146.6	11238	12082	14228
11	50.001	0.63725	6.4292	98.774	2212.3	11265	12082	14294
12	55.001	0.70249	6.4334	101.53	2272.6	11286	12082	14354
13	60.001	0.76773	6.4376	103.93	2324.7	11295	12082	14406
14	70.001	0.8967	6.446	109.38	2443.5	11329	12082	14525
15	80.001	1.0287	6.4546	114.06	2544.6	11343	12082	14626
16	90.001	1.1592	6.4631	118.67	2644	11342	12082	14726
17	110	1.4186	6.4801	127.9	2842.2	11349	12082	14924
18	120	1.5491	6.4887	132.1	2931.6	11343	12082	15013
19	180	2.3275	6.5404	157.69	3471.9	11260	12082	15553
20	240	3.0982	6.5925	182.86	3994.3	11145	12082	16076
21	300	3.8766	6.6458	207.5	4496	11005	12082	16578
22	360	4.6701	6.7012	230.69	4957.3	10844	12082	17039
23	420	5.4591	6.7571	252.57	5382.5	10713	12082	17464
24	480	6.248	6.814	273.01	5769.5	10579	12082	17851
25	540	7.034	6.8716	292.55	6130.6	10456	12082	18212
26	600	7.8199	6.9301	311.43	6471	10336	12082	18553
27	660	8.6043	6.9896	329.95	6797.5	10214	12082	18879
28	720	9.3918	7.0504	347.57	7098.9	10098	12082	19180
29	780	10.175	7.1118	365.61	7402.8	9992.3	12082	19484
30	840	10.959	7.1745	382.21	7671.4	9881.5	12082	19753
31	900	11.747	7.2385	399.41	7945.7	9778.8	12082	20027
32	960	12.537	7.3039	415.47	8191.3	9682	12082	20273
33	1020	13.325	7.3703	429.68	8395	9585.2	12082	20477
34	1080	14.11	7.4377	444.6	8607.9	9472.1	12082	20689
35	1140	14.896	7.5064	459.23	8809.6	9406.8	12082	20891

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-1 S-4
Sample No.: S-4
Test No.: 2000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

Soil Description: BROWN AND GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.05 in
Specimen Area: 6.39 in^2
Specimen Volume: 38.63 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	12082	12082	0	0.000	1998.4	1998.4	1.000	1998.4	0
2	0.05	12953	12082	307.92	0.354	2561.4	1690.4	1.515	2125.9	435.47
3	0.11	13408	12082	555.19	0.419	2769.7	1443.2	1.919	2106.4	663.28
4	0.18	13628	12082	730.15	0.472	2815.1	1268.2	2.220	2041.6	773.42
5	0.24	13788	12082	856.11	0.502	2848.5	1142.2	2.494	1995.4	853.13
6	0.31	13905	12082	930.76	0.510	2891.3	1067.6	2.708	1979.4	911.84
7	0.37	14000	12082	1015.9	0.530	2900.5	982.45	2.952	1941.5	959.02
8	0.44	14086	12082	1075.4	0.537	2927.2	922.96	3.172	1925.1	1002.1
9	0.51	14157	12082	1119.7	0.539	2954.1	878.64	3.362	1916.4	1037.7
10	0.57	14228	12082	1154.7	0.538	2990.3	843.65	3.544	1917	1073.3
11	0.64	14294	12082	1181.5	0.534	3029.1	816.82	3.708	1923	1106.2
12	0.70	14354	12082	1202.5	0.529	3068.4	795.83	3.856	1932.1	1136.3
13	0.77	14406	12082	1211.9	0.521	3111.2	786.5	3.956	1948.9	1162.4
14	0.90	14525	12082	1245.7	0.510	3196.2	752.67	4.246	1974.4	1221.8
15	1.03	14626	12082	1259.7	0.495	3283.3	738.68	4.445	2011	1272.3
16	1.16	14726	12082	1258.5	0.476	3383.9	739.84	4.574	2061.9	1322
17	1.42	14924	12082	1265.5	0.445	3575.1	732.84	4.878	2154	1421.1
18	1.55	15013	12082	1259.7	0.430	3670.2	738.68	4.969	2204.5	1465.8
19	2.33	15553	12082	1176.9	0.339	4293.3	821.49	5.226	2557.4	1735.9
20	3.10	16076	12082	1061.4	0.266	4931.3	936.96	5.263	2934.1	1997.2
21	3.88	16578	12082	921.43	0.205	5572.9	1076.9	5.175	3324.9	2248
22	4.67	17039	12082	760.47	0.153	6195.2	1237.9	5.005	3716.5	2478.6
23	5.46	17464	12082	629.84	0.117	6751	1368.5	4.933	4059.8	2691.2
24	6.25	17851	12082	495.71	0.086	7272.1	1502.6	4.840	4387.4	2884.7
25	7.03	18212	12082	373.24	0.061	7755.7	1625.1	4.772	4690.4	3065.3
26	7.82	18553	12082	253.1	0.039	8216.3	1745.3	4.708	4980.8	3235.5
27	8.60	18879	12082	130.63	0.019	8665.2	1867.7	4.639	5266.5	3398.8
28	9.39	19180	12082	15.163	0.002	9082.1	1983.2	4.580	5532.6	3549.4
29	10.17	19484	12082	-90.977	-0.012	9492.1	2089.3	4.543	5790.7	3701.4
30	10.96	19753	12082	-201.78	-0.026	9871.5	2200.1	4.487	6035.8	3835.7
31	11.75	20027	12082	-304.42	-0.038	10249	2302.8	4.451	6275.6	3972.9
32	12.54	20273	12082	-401.23	-0.049	10591	2399.6	4.414	6495.2	4095.6
33	13.32	20477	12082	-498.04	-0.059	10891	2496.4	4.363	6693.9	4197.5
34	14.11	20689	12082	-611.18	-0.071	11217	2609.5	4.299	6913.5	4303.9
35	14.90	20891	12082	-676.49	-0.077	11484	2674.8	4.294	7079.7	4404.8

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-1 S-4
Sample No.: S-4
Test No.: 3500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

Terracon
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Soil Description: BROWN AND GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.22 in
Specimen Area: 6.50 in^2
Specimen Volume: 40.43 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.4998	0	0	10122	13579	13579
2	5.0002	0.055088	6.5034	45.436	1006.1	10920	13579	14585
3	10	0.11597	6.5074	67.036	1483.4	11256	13579	15063
4	15	0.17976	6.5115	77.932	1723.5	11505	13579	15303
5	20	0.24355	6.5157	84.986	1878.2	11683	13579	15457
6	25	0.30588	6.5198	89.997	1987.7	11784	13579	15567
7	30	0.37112	6.524	94.57	2087.4	11932	13579	15667
8	35	0.43345	6.5281	98.121	2164.4	12029	13579	15744
9	40	0.49869	6.5324	101.48	2237	12104	13579	15816
10	45	0.56392	6.5367	104.4	2299.8	12166	13579	15879
11	50	0.62916	6.541	107.17	2359.3	12218	13579	15939
12	55	0.6944	6.5453	109.65	2412.4	12225	13579	15992
13	60	0.75963	6.5496	112.13	2465.3	12263	13579	16045
14	70	0.8901	6.5582	116.8	2564.6	12350	13579	16144
15	80	1.0206	6.5668	121.18	2657.3	12390	13579	16236
16	90	1.1525	6.5756	125.27	2743.2	12359	13579	16322
17	100	1.2844	6.5844	129.45	2831.1	12433	13579	16410
18	110	1.4134	6.593	133.44	2914.5	12447	13579	16494
19	120	1.5439	6.6017	137.48	2998.7	12446	13579	16578
20	180	2.3195	6.6542	160.73	3478.3	12412	13579	17057
21	240	3.1038	6.708	183.84	3946.4	12305	13579	17526
22	300	3.8851	6.7625	206.94	4406.6	12162	13579	17986
23	360	4.6564	6.8172	230.44	4867.6	11954	13579	18447
24	420	5.4392	6.8737	254.42	5330	11843	13579	18909
25	480	6.2264	6.9314	278.55	5787	11663	13579	19366
26	540	6.9918	6.9884	302.44	6231.9	11478	13579	19811
27	600	7.7775	7.048	325.84	6657.3	11288	13579	20237
28	660	8.5632	7.1085	348.85	7066.7	11076	13579	20646
29	720	9.3345	7.169	371.91	7470.3	10871	13579	21049
30	780	10.122	7.2318	393.46	7834.6	10743	13579	21414
31	840	10.912	7.2959	414.62	8183.3	10571	13579	21763
32	900	11.689	7.3601	435.15	8513.6	10400	13579	22093
33	960	12.472	7.4259	455.97	8841.9	10233	13579	22421
34	1020	13.262	7.4936	474.75	9122.9	10062	13579	22702
35	1080	14.043	7.5617	493.62	9400.2	9875.5	13579	22979
36	1140	14.83	7.6316	512.25	9665.7	9771	13579	23245
37	1156.1	15.042	7.6506	517.26	9736	9732.6	13579	23315

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-1 S-4
Sample No.: S-4
Test No.: 3500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN AND GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.22 in
Specimen Area: 6.50 in^2
Specimen Volume: 40.43 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---
Plastic Limit: ---
Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	13579	13579	0	0.000	3457.5	3457.5	1.000	3457.5	0
2	0.06	14585	13579	797.89	0.793	3665.7	2659.6	1.378	3162.6	503.03
3	0.12	15063	13579	1134.7	0.765	3806.2	2322.8	1.639	3064.5	741.71
4	0.18	15303	13579	1383.2	0.803	3797.7	2074.3	1.831	2936	861.73
5	0.24	15457	13579	1560.9	0.831	3774.8	1896.6	1.990	2835.7	939.12
6	0.31	15567	13579	1662	0.836	3783.3	1795.5	2.107	2789.4	993.87
7	0.37	15667	13579	1810.6	0.867	3734.2	1646.9	2.267	2690.5	1043.7
8	0.43	15744	13579	1907	0.881	3714.9	1550.5	2.396	2632.7	1082.2
9	0.50	15816	13579	1982.5	0.886	3711.9	1475	2.517	2593.5	1118.5
10	0.56	15879	13579	2044.1	0.889	3713.2	1413.4	2.627	2563.3	1149.9
11	0.63	15939	13579	2096.3	0.889	3720.5	1361.1	2.733	2540.8	1179.7
12	0.69	15992	13579	2103.3	0.872	3766.6	1354.2	2.781	2560.4	1206.2
13	0.76	16045	13579	2141.6	0.869	3781.2	1315.9	2.874	2548.5	1232.7
14	0.89	16144	13579	2228.7	0.869	3793.4	1228.7	3.087	2511.1	1282.3
15	1.02	16236	13579	2268.2	0.854	3846.5	1189.3	3.234	2517.9	1328.6
16	1.15	16322	13579	2236.9	0.815	3963.8	1220.6	3.247	2592.2	1371.6
17	1.28	16410	13579	2311.2	0.816	3977.3	1146.3	3.470	2561.8	1415.5
18	1.41	16494	13579	2325.1	0.798	4046.8	1132.3	3.574	2589.6	1457.2
19	1.54	16578	13579	2324	0.775	4132.2	1133.5	3.645	2632.9	1499.3
20	2.32	17057	13579	2290.3	0.658	4645.5	1167.2	3.980	2906.3	1739.1
21	3.10	17526	13579	2183.5	0.553	5220.4	1274	4.098	3247.2	1973.2
22	3.89	17986	13579	2040.6	0.463	5823.5	1416.9	4.110	3620.2	2203.3
23	4.66	18447	13579	1832.7	0.377	6492.4	1624.8	3.996	4058.6	2433.8
24	5.44	18909	13579	1721.2	0.323	7066.3	1736.3	4.070	4401.3	2665
25	6.23	19366	13579	1541.2	0.266	7703.3	1916.3	4.020	4809.8	2893.5
26	6.99	19811	13579	1356.5	0.218	8332.9	2101	3.966	5216.9	3115.9
27	7.78	20237	13579	1166.1	0.175	8948.8	2291.4	3.905	5620.1	3328.7
28	8.56	20646	13579	954.68	0.135	9569.5	2502.8	3.824	6036.2	3533.4
29	9.33	21049	13579	749.11	0.100	10179	2708.4	3.758	6443.5	3735.1
30	10.12	21414	13579	621.36	0.079	10671	2836.1	3.762	6753.4	3917.3
31	10.91	21763	13579	449.47	0.055	11191	3008	3.721	7099.7	4091.7
32	11.69	22093	13579	278.74	0.033	11692	3178.8	3.678	7435.6	4256.8
33	12.47	22421	13579	111.5	0.013	12188	3346	3.643	7767	4421
34	13.26	22702	13579	-59.232	-0.006	12640	3516.7	3.594	8078.2	4561.5
35	14.04	22979	13579	-246.22	-0.026	13104	3703.7	3.538	8403.8	4700.1
36	14.83	23245	13579	-350.75	-0.036	13474	3808.2	3.538	8641.1	4832.8
37	15.04	23315	13579	-389.07	-0.040	13583	3846.6	3.531	8714.5	4868

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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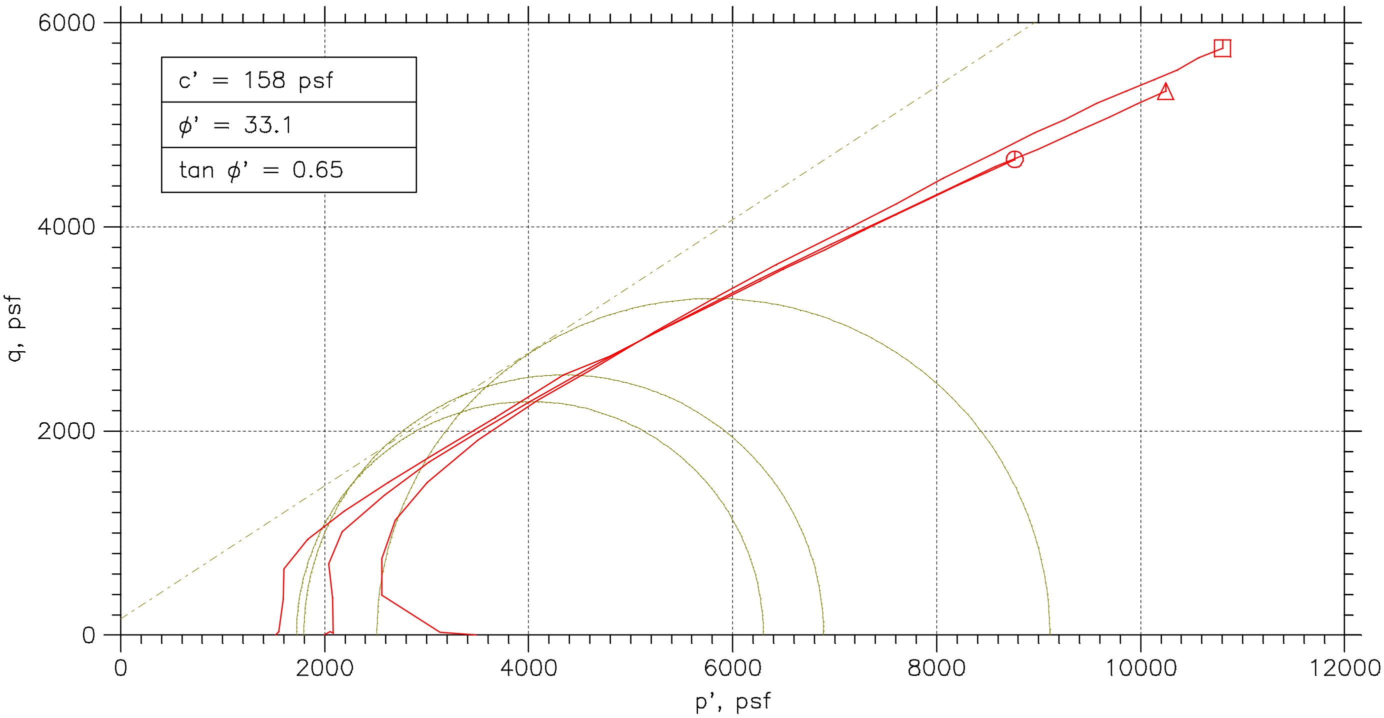

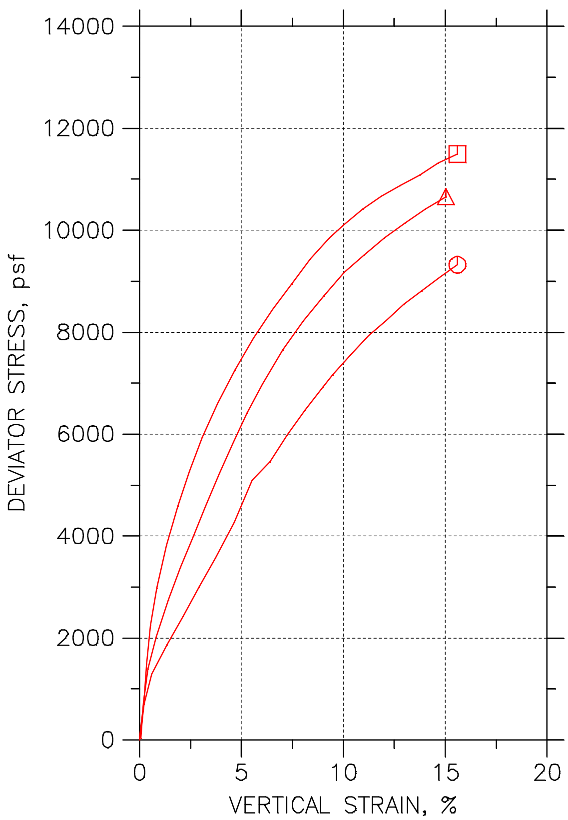

Symbol		⦶	△	⊡	
Test No.		1500 PSF	2000 PSF	3500 PSF	
Initial	Diameter, in	2.875	2.85	2.85	
	Height, in	6.29	6.05	5.91	
	Water Content, %	19.95	19.36	20.57	
	Dry Density, pcf	105.9	108.6	108.6	
	Saturation, %	90.05	93.49	99.35	
	Void Ratio	0.60273	0.56326	0.56314	
Before Shear	Water Content, %	20.95	18.99	16.65	
	Dry Density, pcf	108.2	112.	116.9	
	Saturation, %	100.00	100.00	100.00	
	Void Ratio	0.56992	0.51656	0.453	
	Back Press., psf	8640	8640	8640	
Minor Prin. Stress, psf		1516.3	1997.3	3484.8	
Max. Dev. Stress, psf		9321.8	10658	11497	
Time to Failure, min		300	480	420	
Strain Rate, %/min		0.02	0.02	0.02	
B-Value		0.97	0.98	0.96	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	
Plasticity Index		---	---	---	
Failure Sketch					

Project: VECTREN F.B. CULLEY

Location: NEWBURGH, IN

Project No.: MR155242

Boring No.: B-1 S-6

Sample Type: 3.0'' ST

Description: BROWN AND GRAY LEAN CLAY CL

Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Fri, 04-DEC-2015 14:09:50

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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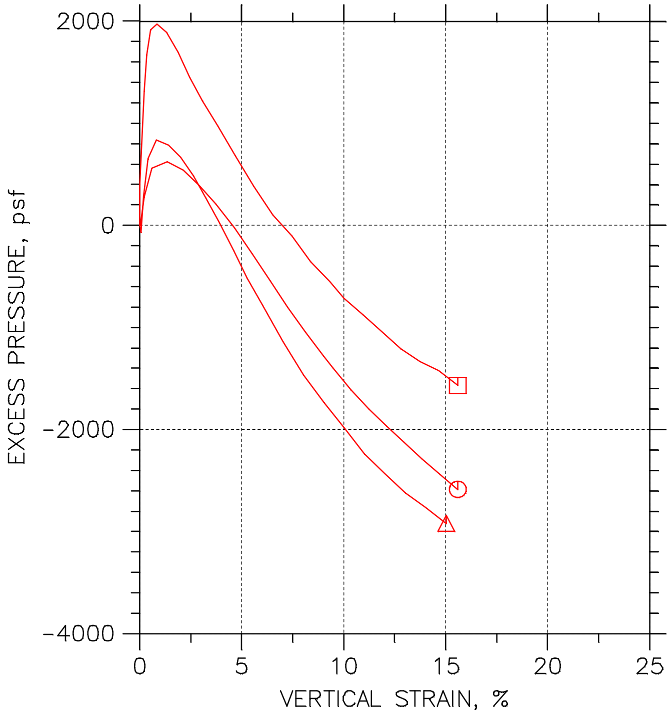

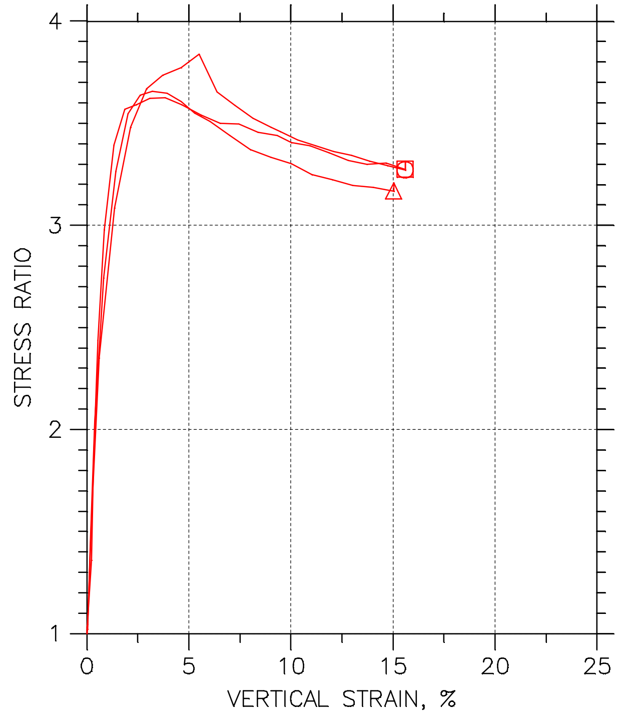

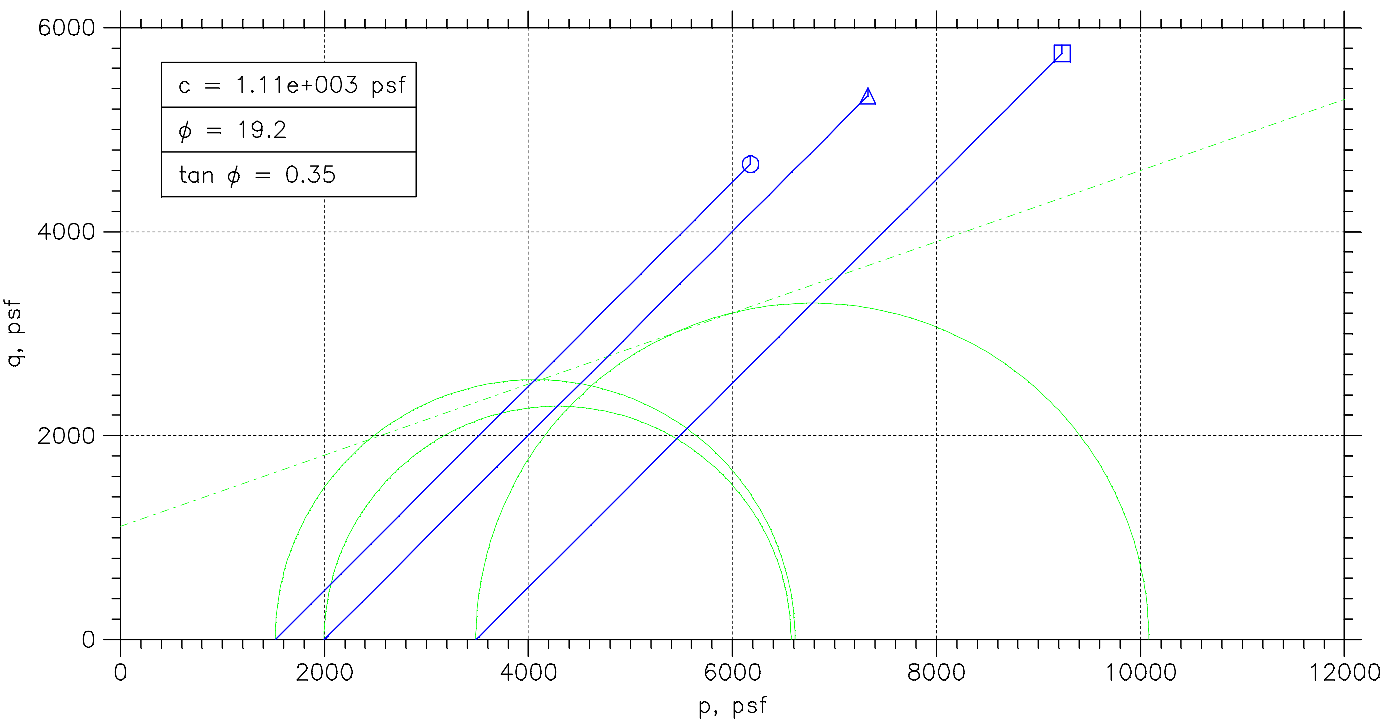

Project: VECTREN F.B. CULLEY	Location: NEWBURGH, IN	Project No.: MR155242
Boring No.: B-1 S-6	Tested By: BCM	Checked By: WPQ
Sample No.: S-6	Test Date: 11/28/15	Depth: 15.0'-17.0'
Test No.: B-1 S-6	Sample Type: 3.0" ST	Elevation: ----
Description: BROWN AND GRAY LEAN CLAY CL		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.		

Fri, 04-DEC-2015 14:12:27

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-1 S-6
Sample No.: S-6
Test No.: 1500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 15.0'-17.0'
Elevation: ----

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Consulting Engineers & Scientists

Soil Description: BROWN AND GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.29 in
Specimen Area: 6.49 in^2
Specimen Volume: 40.83 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.4918	0	0	8640	10156	10156
2	5.0001	0.042925	6.4946	3.1	68.734	8640.6	10156	10225
3	10	0.22258	6.5063	32	708.24	8915.9	10156	10865
4	15	0.59459	6.5306	58.6	1292.1	9200.9	10156	11448
5	20	1.3593	6.5813	85.4	1868.6	9260.6	10156	12025
6	25	2.1463	6.6342	111.7	2424.5	9178.4	10156	12581
7	30	2.9332	6.688	139.1	2995	9033.6	10156	13151
8	35	3.7218	6.7428	167.2	3570.8	8850.8	10156	13727
9	40	4.6391	6.8076	201.6	4264.4	8618	10156	14421
10	45	5.5135	6.8706	243.2	5097.2	8361.4	10156	15254
11	50	6.3879	6.9348	263.1	5463.2	8096.5	10156	15620
12	55	7.2623	7.0002	291.2	5990.2	7840.7	10156	16147
13	60	8.1383	7.0669	317.5	6469.6	7594.1	10156	16626
14	70	9.0127	7.1349	343.5	6932.7	7362.4	10156	17089
15	80	9.4754	7.1713	356.8	7164.5	7243.2	10156	17321
16	90	10.35	7.2413	379.8	7552.7	7031.1	10156	17709
17	100	11.224	7.3126	402.8	7932	6838.6	10156	18088
18	110	12.099	7.3853	422.2	8232.1	6671.8	10156	18388
19	120	12.973	7.4595	442.5	8542.1	6511.7	10156	18698
20	180	13.847	7.5352	460.9	8807.9	6353	10156	18964
21	240	14.722	7.6125	479.4	9068.5	6201.6	10156	19225
22	300	15.596	7.6914	497.9	9321.8	6052.6	10156	19478

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-1 S-6
Sample No.: S-6
Test No.: 1500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 15.0'-17.0'
Elevation: ----

Soil Description: BROWN AND GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.29 in
Specimen Area: 6.49 in^2
Specimen Volume: 40.83 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	10156	10156	0	0.000	1516.3	1516.3	1.000	1516.3	0
2	0.04	10225	10156	0.576	0.008	1584.5	1515.7	1.045	1550.1	34.367
3	0.22	10865	10156	275.9	0.390	1948.7	1240.4	1.571	1594.5	354.12
4	0.59	11448	10156	560.88	0.434	2247.6	955.44	2.352	1601.5	646.06
5	1.36	12025	10156	620.64	0.332	2764.3	895.68	3.086	1830	934.29
6	2.15	12581	10156	538.42	0.222	3402.4	977.9	3.479	2190.2	1212.3
7	2.93	13151	10156	393.55	0.131	4117.8	1122.8	3.668	2620.3	1497.5
8	3.72	13727	10156	210.82	0.059	4876.3	1305.5	3.735	3090.9	1785.4
9	4.64	14421	10156	-22.032	-0.005	5802.8	1538.4	3.772	3670.6	2132.2
10	5.51	15254	10156	-278.64	-0.055	6892.1	1795	3.840	4343.6	2548.6
11	6.39	15620	10156	-543.46	-0.099	7523	2059.8	3.652	4791.4	2731.6
12	7.26	16147	10156	-799.34	-0.133	8305.9	2315.7	3.587	5310.8	2995.1
13	8.14	16626	10156	-1045.9	-0.162	9031.8	2562.2	3.525	5797	3234.8
14	9.01	17089	10156	-1277.6	-0.184	9726.6	2793.9	3.481	6260.3	3466.4
15	9.48	17321	10156	-1396.8	-0.195	10078	2913.1	3.459	6495.4	3582.3
16	10.35	17709	10156	-1608.9	-0.213	10678	3125.2	3.417	6901.6	3776.4
17	11.22	18088	10156	-1801.4	-0.227	11250	3317.8	3.391	7283.7	3966
18	12.10	18388	10156	-1968.2	-0.239	11717	3484.5	3.362	7600.6	4116.1
19	12.97	18698	10156	-2128.3	-0.249	12187	3644.6	3.344	7915.7	4271
20	13.85	18964	10156	-2287	-0.260	12611	3803.3	3.316	8207.3	4403.9
21	14.72	19225	10156	-2438.4	-0.269	13023	3954.7	3.293	8488.9	4534.2
22	15.60	19478	10156	-2587.4	-0.278	13426	4103.7	3.272	8764.6	4660.9

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-1 S-6
Sample No.: S-6
Test No.: 2000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 15.0'-17.0'
Elevation: ----

Terracon
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Soil Description: BROWN AND GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.05 in
Specimen Area: 6.38 in^2
Specimen Volume: 38.60 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.3794	0	0	8640	10637	10637
2	5.0006	0.025455	6.381	2.97	67.024	8616.8	10637	10704
3	10.001	0.049091	6.3825	1.8	40.611	8573.2	10637	10678
4	15.001	0.17455	6.3906	32.49	732.11	8926.6	10637	11369
5	20.001	0.4	6.405	62.1	1396.2	9293.5	10637	12033
6	25.001	0.82545	6.4325	90.36	2022.8	9477.9	10637	12660
7	30.001	1.4255	6.4716	123.3	2743.5	9425.8	10637	13381
8	35.001	2.0255	6.5113	153.18	3387.6	9307.3	10637	14025
9	40.001	2.6255	6.5514	181.44	3988.1	9125.3	10637	14625
10	45.001	3.2255	6.592	209.52	4576.9	8914	10637	15214
11	50.001	3.9255	6.64	241.56	5238.6	8657.9	10637	15876
12	55.001	4.6255	6.6888	271.8	5851.5	8391	10637	16489
13	60.001	5.2764	6.7347	299.88	6411.9	8123.9	10637	17049
14	70.001	6.0255	6.7884	328.95	6977.9	7856.5	10637	17615
15	80.001	7.0255	6.8614	364.95	7659.1	7500.1	10637	18296
16	90.001	8.0255	6.936	395.91	8219.5	7172.5	10637	18857
17	110	9.0255	7.0123	424.35	8714.2	6903.2	10637	19351
18	120	10.027	7.0904	451.8	9175.7	6651.1	10637	19813
19	180	11.027	7.1701	473.94	9518.4	6402.5	10637	20156
20	240	12.027	7.2516	496.35	9856.4	6204.5	10637	20494
21	300	13.027	7.3349	516.42	10138	6020.9	10637	20776
22	360	14.027	7.4203	536.49	10411	5876.1	10637	21049
23	420	15.027	7.5076	555.57	10656	5720	10637	21293
24	480	15.029	7.5077	555.66	10658	5722.1	10637	21295

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-1 S-6
Sample No.: S-6
Test No.: 2000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 15.0'-17.0'
Elevation: ----

Terracon Consulting Engineers & Scientists

Soil Description: BROWN AND GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.05 in
Specimen Area: 6.38 in^2
Specimen Volume: 38.60 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	10637	10637	0	0.000	1997.3	1997.3	1.000	1997.3	0
2	0.03	10704	10637	-23.184	-0.346	2087.5	2020.5	1.033	2054	33.512
3	0.05	10678	10637	-66.816	-1.645	2104.7	2064.1	1.020	2084.4	20.305
4	0.17	11369	10637	286.56	0.391	2442.8	1710.7	1.428	2076.8	366.05
5	0.40	12033	10637	653.47	0.468	2740	1343.8	2.039	2041.9	698.08
6	0.83	12660	10637	837.94	0.414	3182.2	1159.3	2.745	2170.8	1011.4
7	1.43	13381	10637	785.81	0.286	3955	1211.5	3.265	2583.2	1371.8
8	2.03	14025	10637	667.3	0.197	4717.6	1330	3.547	3023.8	1693.8
9	2.63	14625	10637	485.28	0.122	5500.1	1512	3.638	3506	1994
10	3.23	15214	10637	274.03	0.060	6300.1	1723.2	3.656	4011.7	2288.4
11	3.93	15876	10637	17.856	0.003	7218	1979.4	3.647	4598.7	2619.3
12	4.63	16489	10637	-248.98	-0.043	8097.7	2246.3	3.605	5172	2925.7
13	5.28	17049	10637	-516.1	-0.080	8925.3	2513.4	3.551	5719.3	3206
14	6.03	17615	10637	-783.5	-0.112	9758.7	2780.8	3.509	6269.7	3488.9
15	7.03	18296	10637	-1139.9	-0.149	10796	3137.2	3.441	6966.8	3829.6
16	8.03	18857	10637	-1467.5	-0.179	11684	3464.8	3.372	7574.5	4109.8
17	9.03	19351	10637	-1736.8	-0.199	12448	3734.1	3.334	8091.2	4357.1
18	10.03	19813	10637	-1988.9	-0.217	13162	3986.2	3.302	8574.1	4587.9
19	11.03	20156	10637	-2237.5	-0.235	13753	4234.8	3.248	8993.9	4759.2
20	12.03	20494	10637	-2435.5	-0.247	14289	4432.8	3.224	9361	4928.2
21	13.03	20776	10637	-2619.1	-0.258	14755	4616.4	3.196	9685.5	5069.2
22	14.03	21049	10637	-2763.9	-0.265	15173	4761.2	3.187	9966.9	5205.7
23	15.03	21293	10637	-2920	-0.274	15573	4917.3	3.167	10245	5328.1
24	15.03	21295	10637	-2917.9	-0.274	15573	4915.2	3.168	10244	5328.8

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-1 S-6
Sample No.: S-6
Test No.: 3500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 15.0'-17.0'
Elevation: ----

Terracon Consulting Engineers & Scientists

Soil Description: BROWN AND GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.91 in
Specimen Area: 6.38 in^2
Specimen Volume: 37.70 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.3794	0	0	8640	12125	12125
2	5.0002	0.015228	6.3804	2.5	56.423	9023.6	12125	12181
3	10	0.22504	6.3938	34.6	779.26	9952.3	12125	12904
4	15	0.3401	6.4012	66.5	1496	10313	12125	13621
5	20	0.54992	6.4147	100.2	2249.3	10558	12125	14374
6	25	0.85279	6.4343	133.6	2990	10614	12125	15115
7	30	1.3181	6.4646	171.2	3813.5	10531	12125	15938
8	35	1.8765	6.5014	207.5	4595.9	10336	12125	16721
9	40	2.4349	6.5386	239.2	5267.9	10092	12125	17393
10	45	3.0863	6.5826	271.5	5939.3	9858.8	12125	18064
11	50	3.8308	6.6335	303.9	6597	9612.7	12125	18722
12	55	4.6701	6.6919	337.1	7253.9	9323.7	12125	19379
13	60	5.6007	6.7579	369.6	7875.6	9024.5	12125	20000
14	70	6.5313	6.8252	400.4	8447.8	8743.1	12125	20573
15	80	7.4619	6.8938	428.6	8952.7	8536.9	12125	21078
16	90	8.3926	6.9638	456.6	9441.7	8282.3	12125	21566
17	100	9.3232	7.0353	481.1	9847.2	8089.6	12125	21972
18	110	10.007	7.0888	497.1	10098	7926.6	12125	22223
19	120	10.937	7.1628	518.4	10422	7764.5	12125	22547
20	180	11.868	7.2385	536	10663	7599.6	12125	22788
21	240	12.799	7.3157	552.8	10881	7430.4	12125	23006
22	300	13.729	7.3946	568.8	11077	7305	12125	23201
23	360	14.66	7.4753	587.3	11313	7216.6	12125	23438
24	420	15.591	7.5577	603.4	11497	7070.3	12125	23622

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-1 S-6
Sample No.: S-6
Test No.: 3500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 15.0'-17.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN AND GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.91 in
Specimen Area: 6.38 in^2
Specimen Volume: 37.70 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	12125	12125	0	0.000	3484.8	3484.8	1.000	3484.8	0
2	0.02	12181	12125	383.62	6.799	3157.6	3101.2	1.018	3129.4	28.212
3	0.23	12904	12125	1312.3	1.684	2951.8	2172.5	1.359	2562.2	389.63
4	0.34	13621	12125	1673	1.118	3307.8	1811.8	1.826	2559.8	747.99
5	0.55	14374	12125	1918.2	0.853	3815.9	1566.6	2.436	2691.2	1124.7
6	0.85	15115	12125	1973.5	0.660	4501.3	1511.3	2.978	3006.3	1495
7	1.32	15938	12125	1891	0.496	5407.3	1593.8	3.393	3500.5	1906.8
8	1.88	16721	12125	1696.3	0.369	6384.4	1788.5	3.570	4086.4	2298
9	2.43	17393	12125	1452.4	0.276	7300.3	2032.4	3.592	4666.4	2634
10	3.09	18064	12125	1218.8	0.205	8205.3	2266	3.621	5235.7	2969.7
11	3.83	18722	12125	972.72	0.147	9109.1	2512.1	3.626	5810.6	3298.5
12	4.67	19379	12125	683.71	0.094	10055	2801.1	3.590	6428	3626.9
13	5.60	20000	12125	384.48	0.049	10976	3100.3	3.540	7038.1	3937.8
14	6.53	20573	12125	103.1	0.012	11829	3381.7	3.498	7605.6	4223.9
15	7.46	21078	12125	-103.1	-0.012	12541	3587.9	3.495	8064.3	4476.4
16	8.39	21566	12125	-357.7	-0.038	13284	3842.5	3.457	8563.3	4720.8
17	9.32	21972	12125	-550.37	-0.056	13882	4035.2	3.440	8958.8	4923.6
18	10.01	22223	12125	-713.38	-0.071	14296	4198.2	3.405	9247.2	5049
19	10.94	22547	12125	-875.52	-0.084	14782	4360.3	3.390	9571.2	5210.9
20	11.87	22788	12125	-1040.4	-0.098	15188	4525.2	3.356	9856.7	5331.5
21	12.80	23006	12125	-1209.6	-0.111	15576	4694.4	3.318	10135	5440.6
22	13.73	23201	12125	-1335	-0.121	15896	4819.8	3.298	10358	5538.3
23	14.66	23438	12125	-1423.4	-0.126	16222	4908.2	3.305	10565	5656.7
24	15.59	23622	12125	-1569.7	-0.137	16551	5054.5	3.275	10803	5748.4

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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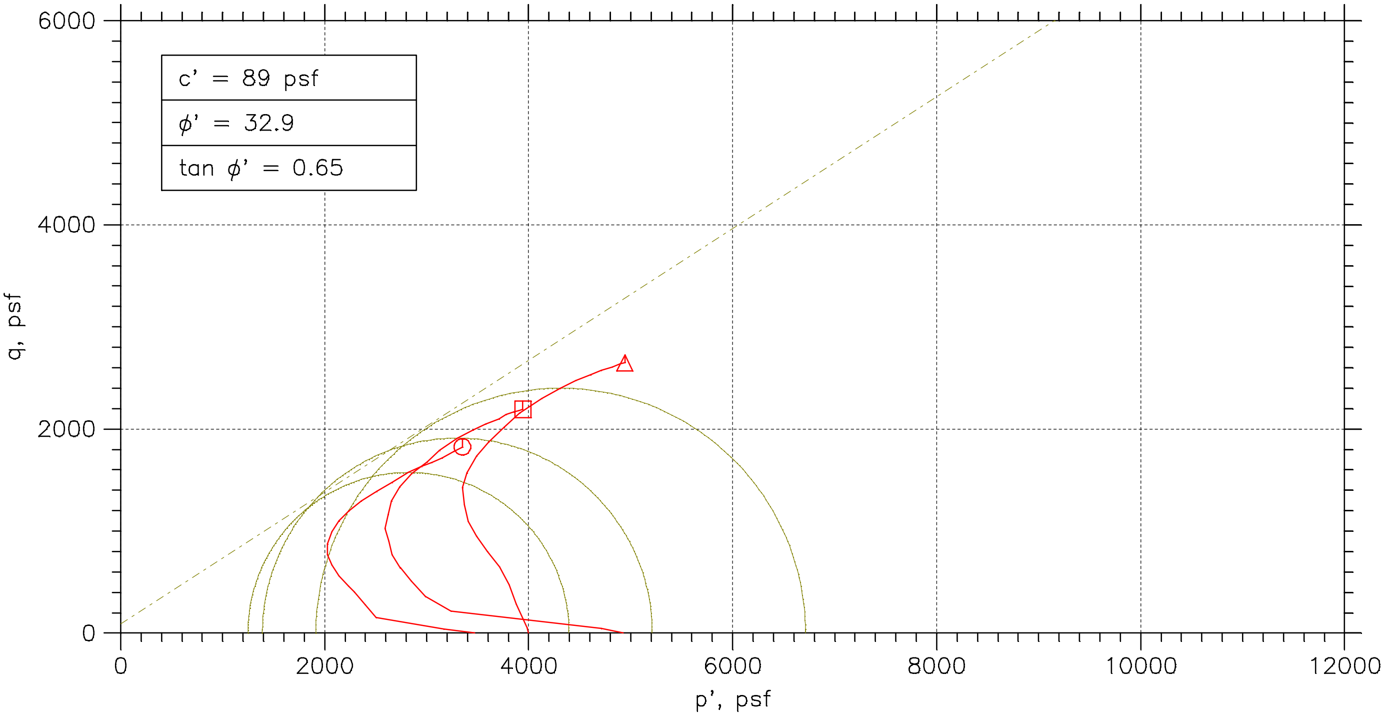

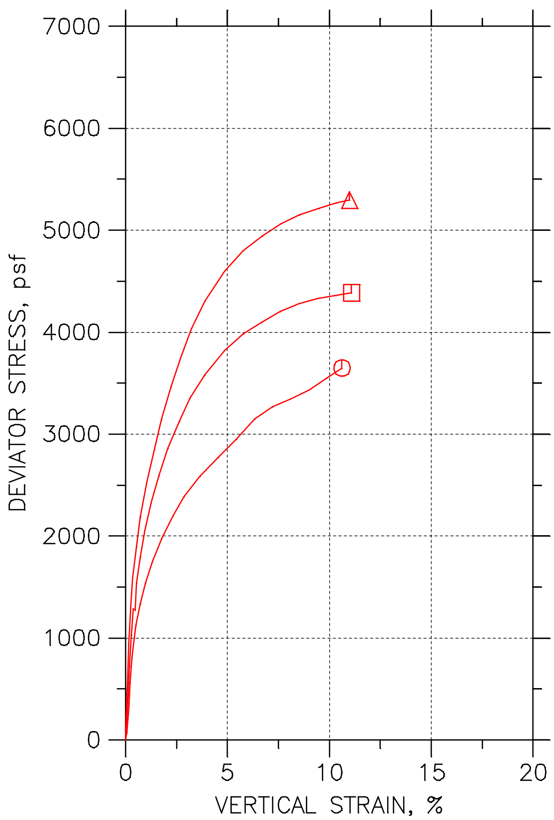

	Symbol	○	△	□	
	Test No.	3500 PSF	4000 PSF	5000 PSF	
Initial	Diameter, in	2.85	2.86	2.847	
	Height, in	6.17	5.965	6.03	
	Water Content, %	25.17	26.36	25.89	
	Dry Density, pcf	97.13	97.45	97.78	
	Saturation, %	91.49	96.56	95.59	
	Void Ratio	0.74825	0.74256	0.73664	
Before Shear	Water Content, %	26.37	25.34	24.28	
	Dry Density, pcf	98.87	100.5	102.3	
	Saturation, %	100.00	100.00	100.00	
	Void Ratio	0.71737	0.6893	0.66045	
	Back Press., psf	8640	8640	8640	
Minor Prin. Stress, psf		3473.3	3998.9	4926.2	
Max. Dev. Stress, psf		3647.9	5295.1	4386.4	
Time to Failure, min		300	420	420	
Strain Rate, %/min		0.001	0.001	0.001	
B-Value		0.95	0.99	0.96	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		41	41	41	
Plastic Limit		24	24	24	
Plasticity Index		17	17	17	
Failure Sketch					

Project: VECTREN F.B. CULLEY	
Location: NEWBURGH, IN	
Project No.: MR155242	
Boring No.: B-1 S-12	
Sample Type: 3.0'' ST	
Description: DARK BROWN LEAN CLAY CL	
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.	

Fri, 04-DEC-2015 13:42:16

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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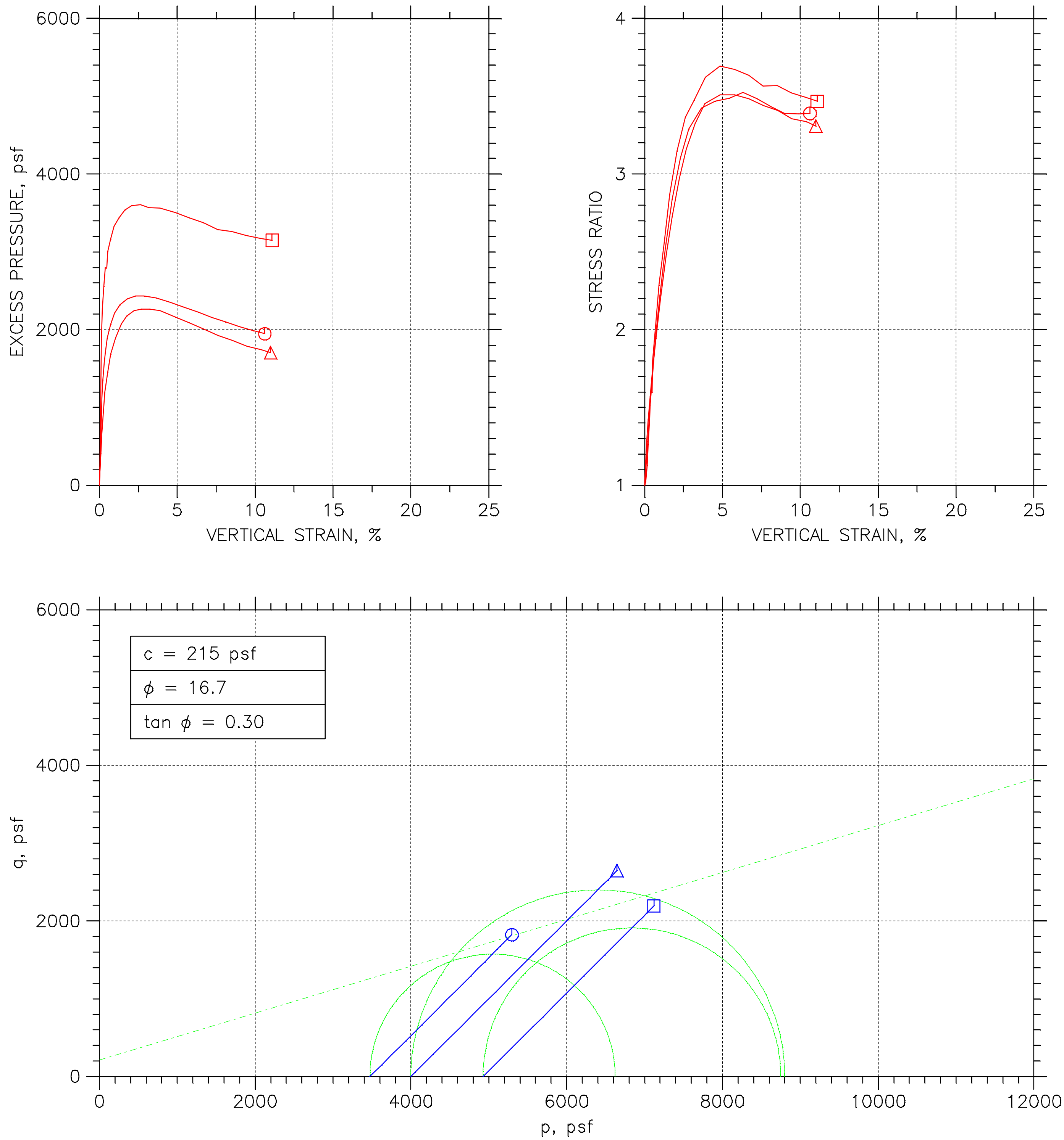

Project: VECTREN F.B. CULLEY	Location: NEWBURGH, IN	Project No.: MR155242
Boring No.: B-1 S-12	Tested By: BCM	Checked By: WPQ
Sample No.: S-12	Test Date: 11/28/15	Depth: 40.0'-42.0'
Test No.: B-1 S-12	Sample Type: 3.0" ST	Elevation: ----
Description: DARK BROWN LEAN CLAY CL		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.		

Fri, 04-DEC-2015 13:53:28

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-1 S-12
Sample No.: S-12
Test No.: 3500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 40.0'-42.0'
Elevation: ----

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Soil Description: DARK BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.17 in
Specimen Area: 6.38 in^2
Specimen Volume: 39.36 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 41

Plastic Limit: 24

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.3794	0	0	8640	12113	12113
2	5.0001	0.061588	6.3833	3.3	74.444	8984.2	12113	12188
3	10	0.15559	6.3893	13.4	302	9763.3	12113	12415
4	15	0.22204	6.3936	24.9	560.81	9996.2	12113	12674
5	20	0.3128	6.3994	35.9	807.82	10224	12113	12921
6	25	0.37277	6.4033	40.8	917.53	10336	12113	13031
7	30	0.50729	6.4119	50	1122.9	10532	12113	13236
8	35	0.70827	6.4249	59.5	1333.6	10709	12113	13447
9	40	0.97569	6.4423	68.7	1535.6	10855	12113	13649
10	45	1.3323	6.4655	78.6	1750.6	10962	12113	13864
11	50	1.778	6.4949	89.4	1982.1	11034	12113	14095
12	55	2.3128	6.5304	99.6	2196.2	11070	12113	14310
13	60	2.8476	6.5664	108.8	2386	11072	12113	14499
14	70	3.6499	6.6211	118.9	2585.9	11046	12113	14699
15	80	4.5413	6.6829	128.7	2773.2	10990	12113	14886
16	90	5.4327	6.7459	138.2	2950.1	10927	12113	15063
17	100	6.3241	6.8101	148.9	3148.5	10866	12113	15262
18	110	7.2156	6.8755	156.2	3271.4	10797	12113	15385
19	120	8.107	6.9422	161.3	3345.8	10738	12113	15459
20	180	8.9984	7.0102	167.1	3432.5	10677	12113	15546
21	240	9.8898	7.0795	174.6	3551.4	10626	12113	15665
22	300	10.616	7.1371	180.8	3647.9	10587	12113	15761

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY | Location: NEWBURGH, IN | Project No.: MR155242
Boring No.: B-1 S-12 | Tested By: BCM | Checked By: WPQ
Sample No.: S-12 | Test Date: 11/28/15 | Depth: 40.0'-42.0'
Test No.: 3500 PSF | Sample Type: 3.0" ST | Elevation: ----

Terracon Consulting Engineers & Scientists

Soil Description: DARK BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.17 in | Piston Area: 0.00 in^2 | Filter Strip Correction: 0.00 psf
Specimen Area: 6.38 in^2 | Piston Friction: 0.00 lb | Membrane Correction: 0.00 lb/in
Specimen Volume: 39.36 in^3 | Piston Weight: 0.00 lb | Correction Type: Uniform

Liquid Limit: 41 | Plastic Limit: 24 | Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	12113	12113	0	0.000	3473.3	3473.3	1.000	3473.3	0
2	0.06	12188	12113	344.16	4.623	3203.6	3129.1	1.024	3166.3	37.222
3	0.16	12415	12113	1123.3	3.720	2651.9	2349.9	1.129	2500.9	151
4	0.22	12674	12113	1356.2	2.418	2677.9	2117.1	1.265	2397.5	280.41
5	0.31	12921	12113	1584.1	1.961	2697	1889.1	1.428	2293	403.91
6	0.37	13031	12113	1696.5	1.849	2694.3	1776.8	1.516	2235.6	458.77
7	0.51	13236	12113	1892.4	1.685	2703.7	1580.8	1.710	2142.3	561.45
8	0.71	13447	12113	2069.4	1.552	2737.4	1403.9	1.950	2070.6	666.78
9	0.98	13649	12113	2215	1.442	2793.9	1258.3	2.220	2026.1	767.81
10	1.33	13864	12113	2322.4	1.327	2901.4	1150.8	2.521	2026.1	875.29
11	1.78	14095	12113	2394.3	1.208	3061.1	1079	2.837	2070.1	991.06
12	2.31	14310	12113	2430.3	1.107	3239.2	1043	3.106	2141.1	1098.1
13	2.85	14499	12113	2431.6	1.019	3427.7	1041.7	3.290	2234.7	1193
14	3.65	14699	12113	2406.1	0.930	3653.1	1067.2	3.423	2360.1	1293
15	4.54	14886	12113	2349.9	0.847	3896.5	1123.3	3.469	2509.9	1386.6
16	5.43	15063	12113	2287.2	0.775	4136.2	1186.1	3.487	2661.2	1475
17	6.32	15262	12113	2226.2	0.707	4395.6	1247	3.525	2821.3	1574.3
18	7.22	15385	12113	2156.8	0.659	4587.9	1316.4	3.485	2952.2	1635.7
19	8.11	15459	12113	2098.1	0.627	4721	1375.2	3.433	3048.1	1672.9
20	9.00	15546	12113	2037.5	0.594	4868.3	1435.8	3.391	3152.1	1716.2
21	9.89	15665	12113	1986	0.559	5038.6	1487.2	3.388	3262.9	1775.7
22	10.62	15761	12113	1946.9	0.534	5174.3	1526.4	3.390	3350.3	1823.9

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-1 S-12
Sample No.: S-12
Test No.: 4000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 40.0'-42.0'
Elevation: ----

Soil Description: DARK BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.96 in
Specimen Area: 6.42 in^2
Specimen Volume: 38.32 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 41

Plastic Limit: 24

Measured Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.4242	0	0	8640	12639	12639
2	5.0006	0.013412	6.4251	4.9	109.82	8709.4	12639	12749
3	10.001	0.083822	6.4296	25.6	573.35	9046.8	12639	13212
4	15.001	0.15256	6.4341	42.5	951.19	9307.9	12639	13590
5	20.001	0.24476	6.44	58	1296.9	9571.2	12639	13936
6	25.001	0.36044	6.4475	71.4	1594.7	9837.9	12639	14234
7	30.001	0.52137	6.4579	85	1895.3	10095	12639	14534
8	35.001	0.72925	6.4714	98.4	2189.6	10329	12639	14828
9	40.001	1.0293	6.4911	113.6	2520.1	10532	12639	15159
10	45.001	1.3982	6.5153	129	2851.1	10715	12639	15490
11	50.001	1.767	6.5398	142.8	3144.3	10815	12639	15783
12	55.001	2.228	6.5706	158.1	3464.9	10884	12639	16104
13	60.001	2.689	6.6018	171.7	3745.2	10906	12639	16384
14	70.001	3.2422	6.6395	186.1	4036.2	10901	12639	16675
15	80.001	3.8877	6.6841	199.8	4304.4	10884	12639	16943
16	90.001	4.8567	6.7522	215.6	4598	10806	12639	17237
17	110	5.7787	6.8182	227.3	4800.5	10726	12639	17439
18	120	6.7008	6.8856	236.4	4943.9	10648	12639	17583
19	180	7.6228	6.9544	244.4	5060.7	10564	12639	17700
20	240	8.5448	7.0245	251.2	5149.5	10502	12639	17788
21	300	9.4669	7.096	257	5215.3	10426	12639	17854
22	360	10.389	7.169	262.5	5272.7	10384	12639	17912
23	420	10.991	7.2175	265.4	5295.1	10345	12639	17934

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-1 S-12
Sample No.: S-12
Test No.: 4000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 40.0'-42.0'
Elevation: ----

Terracon Consulting Engineers & Scientists

Soil Description: DARK BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.96 in
Specimen Area: 6.42 in^2
Specimen Volume: 38.32 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 41

Plastic Limit: 24

Measured Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	12639	12639	0	0.000	3998.9	3998.9	1.000	3998.9	0
2	0.01	12749	12639	69.408	0.632	4039.3	3929.5	1.028	3984.4	54.91
3	0.08	13212	12639	406.8	0.710	4165.4	3592.1	1.160	3878.8	286.67
4	0.15	13590	12639	667.87	0.702	4282.2	3331	1.286	3806.6	475.59
5	0.24	13936	12639	931.25	0.718	4364.5	3067.6	1.423	3716.1	648.45
6	0.36	14234	12639	1197.9	0.751	4395.6	2800.9	1.569	3598.3	797.33
7	0.52	14534	12639	1455	0.768	4439.3	2543.9	1.745	3491.6	947.67
8	0.73	14828	12639	1688.8	0.771	4499.6	2310	1.948	3404.8	1094.8
9	1.03	15159	12639	1891.6	0.751	4627.4	2107.3	2.196	3367.4	1260.1
10	1.40	15490	12639	2074.8	0.728	4775.2	1924.1	2.482	3349.7	1425.6
11	1.77	15783	12639	2174.7	0.692	4968.5	1824.2	2.724	3396.4	1572.2
12	2.23	16104	12639	2243.8	0.648	5219.9	1755.1	2.974	3487.5	1732.4
13	2.69	16384	12639	2266	0.605	5478.1	1732.9	3.161	3605.5	1872.6
14	3.24	16675	12639	2261.2	0.560	5773.8	1737.6	3.323	3755.7	2018.1
15	3.89	16943	12639	2243.5	0.521	6059.8	1755.4	3.452	3907.6	2152.2
16	4.86	17237	12639	2165.9	0.471	6431	1833	3.508	4132	2299
17	5.78	17439	12639	2085.6	0.434	6713.9	1913.3	3.509	4313.6	2400.3
18	6.70	17583	12639	2007.5	0.406	6935.2	1991.4	3.483	4463.3	2471.9
19	7.62	17700	12639	1924.4	0.380	7135.1	2074.5	3.439	4604.8	2530.3
20	8.54	17788	12639	1861.6	0.362	7286.8	2137.2	3.409	4712	2574.8
21	9.47	17854	12639	1786	0.342	7428.2	2212.8	3.357	4820.5	2607.7
22	10.39	17912	12639	1743.7	0.331	7527.9	2255.2	3.338	4891.5	2636.3
23	10.99	17934	12639	1704.5	0.322	7589.5	2294.4	3.308	4941.9	2647.6

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Location: NEWBURGH, IN
Project No.: MR155242
Boring No.: B-2 S-12
Tested By: BCM
Checked By: WPQ
Sample No.: S-12
Test Date: 11/28/15
Depth: 40.0'-42.0'
Test No.: 5000 PSF
Sample Type: 3.0" ST
Elevation: ----

Soil Description: DARK BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.03 in
Piston Area: 0.00 in^2
Filter Strip Correction: 0.00 psf
Specimen Area: 6.37 in^2
Piston Friction: 0.00 lb
Membrane Correction: 0.00 lb/in
Specimen Volume: 38.39 in^3
Piston Weight: 0.00 lb
Correction Type: Uniform

Liquid Limit: 41
Plastic Limit: 24
Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.366	0	0	8640	13566	13566
2	5.0002	0.048093	6.369	4.2	94.959	8872.1	13566	13661
3	10	0.12106	6.3737	19.2	433.78	10515	13566	14000
4	15	0.19071	6.3781	32	722.47	10910	13566	14289
5	20	0.28192	6.384	45.5	1026.3	11199	13566	14593
6	25	0.38972	6.3909	57.1	1286.6	11435	13566	14853
7	30	0.47264	6.3962	56.6	1274.3	11431	13566	14840
8	35	0.5257	6.3996	68.3	1536.8	11643	13566	15103
9	40	0.70813	6.4114	79.9	1794.6	11807	13566	15361
10	45	0.93698	6.4262	91.6	2052.6	11971	13566	15619
11	50	1.2554	6.4469	104.1	2325.2	12080	13566	15891
12	55	1.6202	6.4708	116.4	2590.3	12179	13566	16157
13	60	2.0763	6.501	129.3	2864.1	12232	13566	16430
14	70	2.6235	6.5375	141.9	3125.6	12245	13566	16692
15	80	3.1725	6.5745	153.4	3359.9	12209	13566	16926
16	90	3.9022	6.6245	164.7	3580.2	12200	13566	17146
17	100	4.859	6.6911	177.6	3822.2	12148	13566	17388
18	110	5.7711	6.7559	187	3985.9	12074	13566	17552
19	120	6.6833	6.8219	194.1	4097.2	12012	13566	17663
20	180	7.5954	6.8892	201	4201.3	11929	13566	17768
21	240	8.5075	6.9579	206.9	4282	11898	13566	17848
22	300	9.4196	7.028	211.4	4331.5	11849	13566	17898
23	360	10.332	7.0995	215.1	4362.9	11815	13566	17929
24	420	11.09	7.16	218.1	4386.4	11788	13566	17953

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Location: NEWBURGH, IN
Project No.: MR155242

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Consulting Engineers & Scientists

Boring No.: B-2 S-12
Tested By: BCM
Checked By: WPQ
Sample No.: S-12
Test Date: 11/28/15
Depth: 40.0'-42.0'
Test No.: 5000 PSF
Sample Type: 3.0" ST
Elevation: ----

Soil Description: DARK BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.03 in
Piston Area: 0.00 in^2
Filter Strip Correction: 0.00 psf
Specimen Area: 6.37 in^2
Piston Friction: 0.00 lb
Membrane Correction: 0.00 lb/in
Specimen Volume: 38.39 in^3
Piston Weight: 0.00 lb
Correction Type: Uniform

Liquid Limit: 41
Plastic Limit: 24
Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	13566	13566	0	0.000	4926.2	4926.2	1.000	4926.2	0
2	0.05	13661	13566	232.13	2.444	4789.1	4694.1	1.020	4741.6	47.48
3	0.12	14000	13566	1875.2	4.323	3484.9	3051.1	1.142	3268	216.89
4	0.19	14289	13566	2269.9	3.142	3378.8	2656.4	1.272	3017.6	361.23
5	0.28	14593	13566	2558.6	2.493	3394	2367.6	1.433	2880.8	513.16
6	0.39	14853	13566	2795.5	2.173	3417.4	2130.8	1.604	2774.1	643.29
7	0.47	14840	13566	2791.3	2.191	3409.2	2134.9	1.597	2772.1	637.13
8	0.53	15103	13566	3003.1	1.954	3460	1923.1	1.799	2691.5	768.42
9	0.71	15361	13566	3167.1	1.765	3553.7	1759.1	2.020	2656.4	897.28
10	0.94	15619	13566	3331.2	1.623	3647.7	1595.1	2.287	2621.4	1026.3
11	1.26	15891	13566	3439.7	1.479	3811.7	1486.5	2.564	2649.1	1162.6
12	1.62	16157	13566	3539.4	1.366	3977.2	1386.9	2.868	2682	1295.2
13	2.08	16430	13566	3592.1	1.254	4198.2	1334.2	3.147	2766.2	1432
14	2.62	16692	13566	3604.8	1.153	4447.1	1321.5	3.365	2884.3	1562.8
15	3.17	16926	13566	3568.8	1.062	4717.4	1357.5	3.475	3037.4	1679.9
16	3.90	17146	13566	3560.3	0.994	4946.2	1366	3.621	3156.1	1790.1
17	4.86	17388	13566	3508.3	0.918	5240.1	1418	3.696	3329	1911.1
18	5.77	17552	13566	3434.4	0.862	5477.7	1491.8	3.672	3484.8	1992.9
19	6.68	17663	13566	3371.6	0.823	5651.8	1554.6	3.635	3603.2	2048.6
20	7.60	17768	13566	3289.4	0.783	5838.2	1636.8	3.567	3737.5	2100.7
21	8.51	17848	13566	3258.3	0.761	5949.9	1668	3.567	3808.9	2141
22	9.42	17898	13566	3208.6	0.741	6049.1	1717.6	3.522	3883.4	2165.7
23	10.33	17929	13566	3175.5	0.728	6113.7	1750.8	3.492	3932.2	2181.5
24	11.09	17953	13566	3148.3	0.718	6164.3	1778	3.467	3971.2	2193.2

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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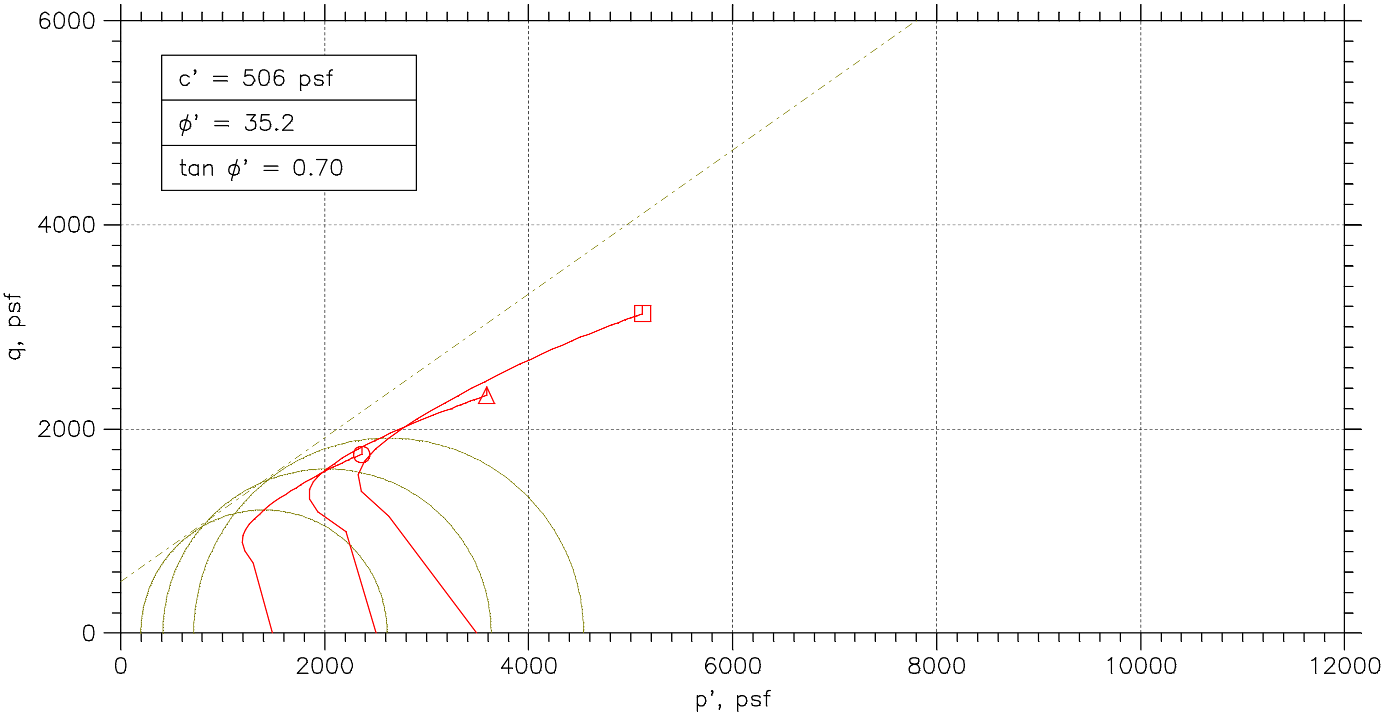

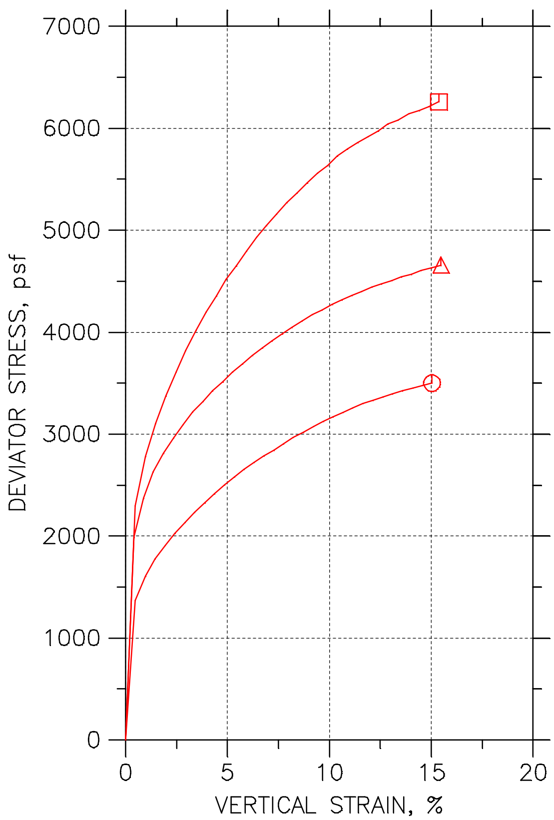

Symbol		○	△	□	
Test No.		1500 PSF	2500 PSF	3500 PSF	
Initial	Diameter, in	2.8665	2.8689	2.8622	
	Height, in	6.0205	6.3382	6.2492	
	Water Content, %	21.71	21.71	20.57	
	Dry Density, pcf	103.7	103.2	104.8	
	Saturation, %	92.69	91.46	90.30	
	Void Ratio	0.63715	0.64577	0.61978	
Before Shear	Water Content, %	22.20	22.10	18.96	
	Dry Density, pcf	105.9	106.1	112.	
	Saturation, %	100.00	100.00	100.00	
	Void Ratio	0.60374	0.60116	0.51583	
	Back Press., psf	10089	10081	10092	
Minor Prin. Stress, psf		1488.6	2504.7	3487	
Max. Dev. Stress, psf		3500.1	4657.3	6259.7	
Time to Failure, min		155	160	155	
Strain Rate, %/min		0.13	0.13	0.13	
B-Value		0.96	0.99	0.95	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	
Plasticity Index		---	---	---	

Failure Sketch

Project: VECTREN F.B. CULLEY	
Location: NEWBURGH, IN	
Project No.: MR155242	
Boring No.: B-2 S-5	
Sample Type: 3.0" ST	

Description: DARK GRAY LEAN CLAY CL SAND POCKETS NOTED

Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

Tue, 01-DEC-2015 15:33:10

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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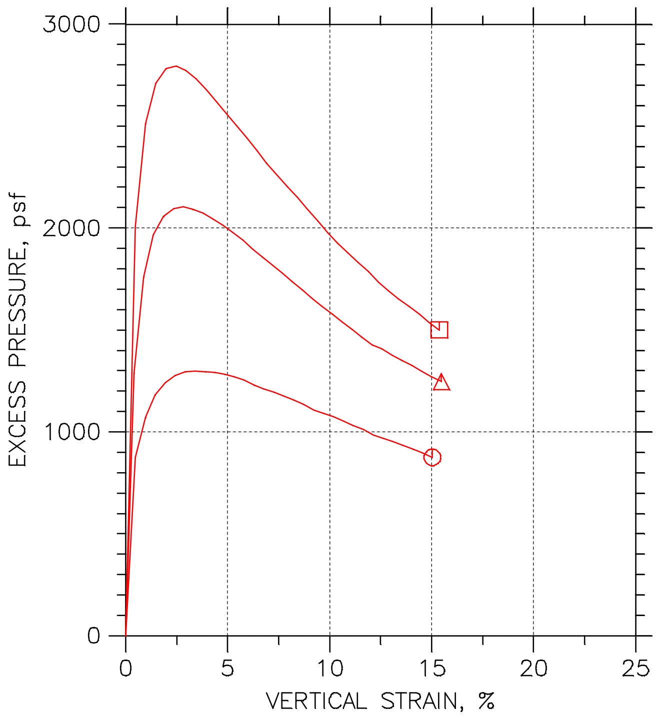
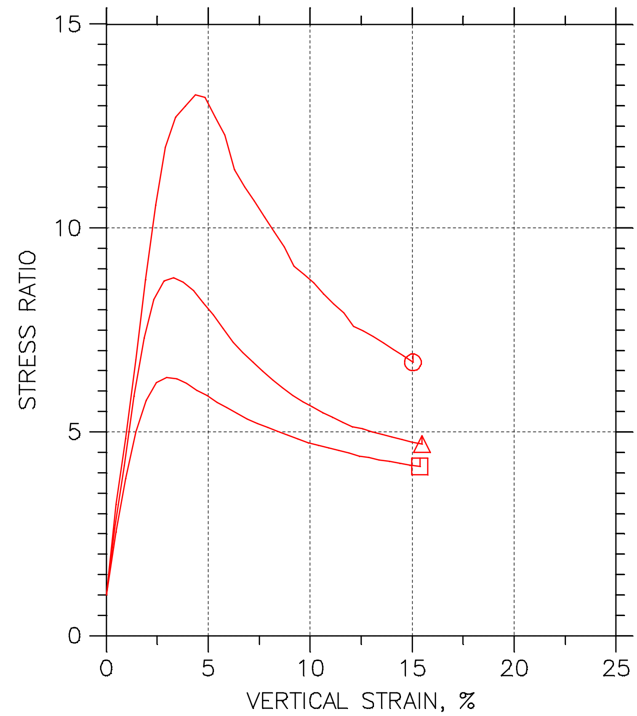
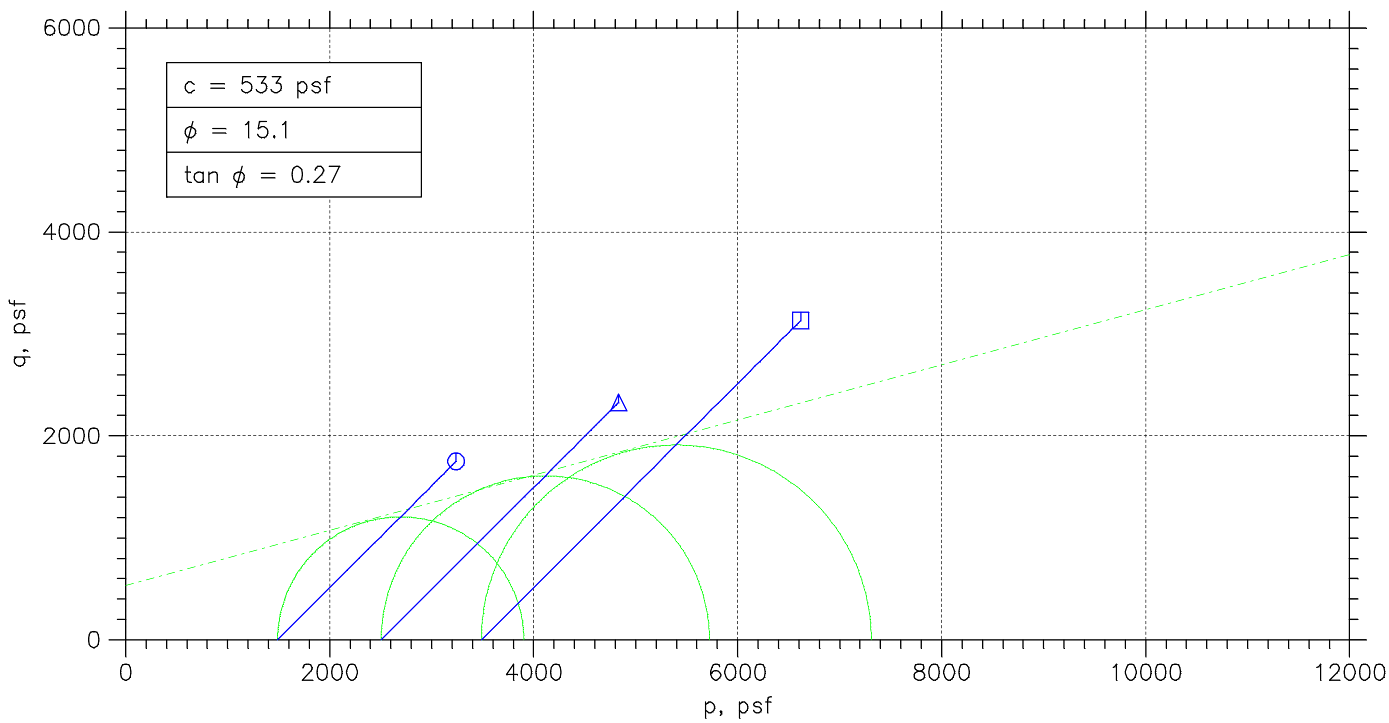
Consulting Engineers & Scientists







Project: VECTREN F.B. CULLEY	Location: NEWBURGH, IN	Project No.: MR155242
Boring No.: B-2 S-5	Tested By: BCM	Checked By: WPQ
Sample No.: S-5	Test Date: 11/30/15	Depth: 11.0'-13.0'
Test No.: B-2 S-5	Sample Type: 3.0" ST	Elevation: -----
Description: DARK GRAY LEAN CLAY CL SAND POCKETS NOTED		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767		

Tue, 01-DEC-2015 15:34:07

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Location: NEWBURGH, IN
Project No.: MR155242
Boring No.: B-2 S-5
Tested By: BCM
Checked By: WPQ
Sample No.: S-5
Test Date: 11/30/15
Depth: 11.0'-13.0'
Test No.: 1500 PSF
Sample Type: 3.0" ST
Elevation: -----

Terracon Consulting Engineers & Scientists

Soil Description: DARK GRAY LEAN CLAY CL SAND POCKETS NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

Specimen Height: 6.02 in
Specimen Area: 6.45 in^2
Specimen Volume: 38.85 in^3
Piston Area: 0.00 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.00 lb
Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---
Plastic Limit: ---
Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.4536	0	0	10089	11578	11578
2	5.0001	0.4798	6.4848	61.697	1370	10963	11578	12948
3	10	0.96391	6.5164	72.664	1605.7	11160	11578	13183
4	15	1.448	6.5485	80.757	1775.8	11270	11578	13353
5	20	1.9335	6.5809	87.149	1907	11331	11578	13485
6	25	2.4248	6.614	93.073	2026.4	11366	11578	13604
7	30	2.9118	6.6472	98.527	2134.4	11383	11578	13712
8	35	3.3944	6.6804	103.75	2236.3	11387	11578	13814
9	40	3.8785	6.714	108.61	2329.5	11383	11578	13907
10	45	4.3669	6.7483	113.13	2414	11381	11578	13992
11	50	4.8539	6.7829	117.82	2501.4	11373	11578	14079
12	55	5.3351	6.8174	122.04	2577.9	11358	11578	14155
13	60	5.8164	6.8522	126.21	2652.3	11342	11578	14230
14	65	6.3005	6.8876	130.14	2720.8	11317	11578	14298
15	70	6.7874	6.9236	133.89	2784.7	11299	11578	14362
16	75	7.2758	6.96	137.53	2845.4	11283	11578	14423
17	80	7.7556	6.9962	141.1	2904.3	11264	11578	14482
18	85.004	8.2369	7.0329	144.92	2967.2	11245	11578	14545
19	90.004	8.7224	7.0703	148.32	3020.8	11224	11578	14598
20	95.004	9.2165	7.1088	151.9	3076.9	11196	11578	14654
21	100	9.7021	7.147	155.12	3125.4	11180	11578	14703
22	105	10.182	7.1852	158.23	3171.1	11163	11578	14749
23	110	10.662	7.2238	161.22	3213.8	11142	11578	14791
24	115	11.147	7.2633	164.21	3255.6	11121	11578	14833
25	120	11.641	7.3039	167.26	3297.6	11100	11578	14875
26	125	12.128	7.3444	169.78	3328.9	11072	11578	14907
27	130	12.61	7.3848	172.54	3364.4	11058	11578	14942
28	135	13.094	7.426	175.18	3397	11041	11578	14975
29	140	13.589	7.4686	177.82	3428.5	11024	11578	15006
30	145	14.079	7.5111	179.87	3448.4	11005	11578	15026
31	150	14.557	7.5532	182.45	3478.4	10984	11578	15056
32	155	15.034	7.5956	184.62	3500.1	10964	11578	15078

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-5
Sample No.: S-5
Test No.: 1500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/30/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 11.0'-13.0'
Elevation: -----

Terracon Consulting Engineers & Scientists

Soil Description: DARK GRAY LEAN CLAY CL SAND POCKETS NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

Specimen Height: 6.02 in
Specimen Area: 6.45 in^2
Specimen Volume: 38.85 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	11578	11578	0	0.000	1488.6	1488.6	1.000	1488.6	0
2	0.48	12948	11578	874.02	0.638	1984.6	614.55	3.229	1299.6	685.02
3	0.96	13183	11578	1070.7	0.667	2023.6	417.87	4.843	1220.7	802.86
4	1.45	13353	11578	1181.3	0.665	2083.1	307.31	6.779	1195.2	887.92
5	1.93	13485	11578	1241.8	0.651	2153.8	246.79	8.727	1200.3	953.48
6	2.42	13604	11578	1276.7	0.630	2238.3	211.88	10.564	1225.1	1013.2
7	2.91	13712	11578	1294.2	0.606	2328.8	194.42	11.978	1261.6	1067.2
8	3.39	13814	11578	1297.6	0.580	2427.2	190.93	12.713	1309.1	1118.2
9	3.88	13907	11578	1294.2	0.556	2523.9	194.42	12.982	1359.2	1164.8
10	4.37	13992	11578	1291.8	0.535	2610.8	196.75	13.270	1403.8	1207
11	4.85	14079	11578	1283.7	0.513	2706.2	204.89	13.208	1455.6	1250.7
12	5.34	14155	11578	1268.5	0.492	2797.9	220.02	12.716	1509	1288.9
13	5.82	14230	11578	1253.4	0.473	2887.4	235.15	12.279	1561.3	1326.1
14	6.30	14298	11578	1227.8	0.451	2981.6	260.76	11.434	1621.2	1360.4
15	6.79	14362	11578	1210.4	0.435	3062.9	278.21	11.009	1670.6	1392.4
16	7.28	14423	11578	1194.1	0.420	3139.9	294.51	10.661	1717.2	1422.7
17	7.76	14482	11578	1175.4	0.405	3217.4	313.13	10.275	1765.3	1452.1
18	8.24	14545	11578	1155.7	0.389	3300.1	332.91	9.913	1816.5	1483.6
19	8.72	14598	11578	1134.7	0.376	3374.6	353.86	9.537	1864.2	1510.4
20	9.22	14654	11578	1106.8	0.360	3458.7	381.79	9.059	1920.2	1538.4
21	9.70	14703	11578	1090.5	0.349	3523.5	398.09	8.851	1960.8	1562.7
22	10.18	14749	11578	1074.2	0.339	3585.5	414.38	8.653	1999.9	1585.5
23	10.66	14791	11578	1053.2	0.328	3649.1	435.33	8.382	2042.2	1606.9
24	11.15	14833	11578	1032.3	0.317	3711.9	456.28	8.135	2084.1	1627.8
25	11.64	14875	11578	1011.3	0.307	3774.9	477.22	7.910	2126	1648.8
26	12.13	14907	11578	983.42	0.295	3834.1	505.16	7.590	2169.6	1664.5
27	12.61	14942	11578	969.45	0.288	3883.5	519.12	7.481	2201.3	1682.2
28	13.09	14975	11578	951.99	0.280	3933.5	536.58	7.331	2235.1	1698.5
29	13.59	15006	11578	934.54	0.273	3982.5	554.04	7.188	2268.3	1714.2
30	14.08	15026	11578	915.91	0.266	4021	572.66	7.022	2296.9	1724.2
31	14.56	15056	11578	894.97	0.257	4072	593.6	6.860	2332.8	1739.2
32	15.03	15078	11578	875.18	0.250	4113.5	613.39	6.706	2363.4	1750.1

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-5
Sample No.: S-5
Test No.: 2500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/27/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 11.0'-13.0'
Elevation: ----

Soil Description: DARK GRAY LEAN CLAY CL SAND POCKETS NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.34 in
Specimen Area: 6.46 in^2
Specimen Volume: 40.97 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.4643	0	0	10081	12586	12586
2	5.0041	0.41213	6.491	89.758	1991.2	11371	12586	14577
3	10.004	0.88313	6.5219	107.54	2374.3	11841	12586	14960
4	15.004	1.3662	6.5538	119.57	2627.2	12047	12586	15213
5	20.004	1.8553	6.5865	128.57	2811	12140	12586	15397
6	25.004	2.3399	6.6192	136.24	2964	12177	12586	15550
7	30	2.826	6.6523	142.86	3092.4	12184	12586	15678
8	35	3.3076	6.6854	149.38	3217.6	12172	12586	15803
9	40	3.7922	6.7191	154.94	3320.6	12152	12586	15906
10	45	4.2783	6.7532	160.59	3424.3	12127	12586	16010
11	50	4.7614	6.7875	165.69	3515.2	12095	12586	16101
12	55	5.2444	6.8221	170.83	3606	12060	12586	16192
13	60	5.7275	6.857	175.8	3691.8	12022	12586	16277
14	65	6.2166	6.8928	180.48	3770.5	11977	12586	16356
15	70	6.7088	6.9291	185.17	3848.1	11939	12586	16434
16	75	7.1994	6.9658	189.39	3915.2	11899	12586	16501
17	80	7.684	7.0023	193.89	3987.3	11860	12586	16573
18	85.004	8.1671	7.0392	197.94	4049.2	11818	12586	16635
19	90.004	8.6562	7.0769	201.98	4109.9	11777	12586	16695
20	95.004	9.1483	7.1152	206.02	4169.5	11735	12586	16755
21	100	9.639	7.1538	209.56	4218.2	11696	12586	16804
22	105	10.124	7.1924	213.46	4273.8	11659	12586	16859
23	110	10.607	7.2313	216.77	4316.7	11619	12586	16902
24	115	11.097	7.2712	220.35	4363.9	11583	12586	16950
25	120	11.591	7.3118	223.48	4401.2	11545	12586	16987
26	125	12.074	7.352	226.74	4441	11509	12586	17027
27	130	12.556	7.3924	229.68	4474	11489	12586	17060
28	135	13.04	7.4336	232.66	4507	11458	12586	17093
29	140	13.531	7.4758	235.88	4543.5	11432	12586	17129
30	145	14.02	7.5183	238.64	4570.6	11406	12586	17156
31	150	14.503	7.5608	241.71	4603.6	11378	12586	17189
32	155	14.988	7.6039	244.56	4631.4	11350	12586	17217
33	160	15.48	7.6482	247.36	4657.3	11328	12586	17243

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-5
Sample No.: S-5
Test No.: 2500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/27/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 11.0'-13.0'
Elevation: ----

Terracon Consulting Engineers & Scientists

Soil Description: DARK GRAY LEAN CLAY CL SAND POCKETS NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.34 in
Specimen Area: 6.46 in^2
Specimen Volume: 40.97 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	12586	12586	0	0.000	2504.7	2504.7	1.000	2504.7	0
2	0.41	14577	12586	1290	0.648	3205.9	1214.7	2.639	2210.3	995.62
3	0.88	14960	12586	1760	0.741	3119	744.64	4.189	1931.8	1187.2
4	1.37	15213	12586	1966.5	0.749	3165.4	538.19	5.882	1851.8	1313.6
5	1.86	15397	12586	2058.6	0.732	3257.1	446.05	7.302	1851.5	1405.5
6	2.34	15550	12586	2096	0.707	3372.7	408.72	8.252	1890.7	1482
7	2.83	15678	12586	2103	0.680	3494.2	401.72	8.698	1947.9	1546.2
8	3.31	15803	12586	2091.3	0.650	3631	413.39	8.784	2022.2	1608.8
9	3.79	15906	12586	2071.5	0.624	3753.8	433.22	8.665	2093.5	1660.3
10	4.28	16010	12586	2045.8	0.597	3883.2	458.88	8.462	2171	1712.2
11	4.76	16101	12586	2014.3	0.573	4005.6	490.37	8.169	2248	1757.6
12	5.24	16192	12586	1979.3	0.549	4131.3	525.36	7.864	2328.3	1803
13	5.73	16277	12586	1940.8	0.526	4255.6	563.85	7.547	2409.7	1845.9
14	6.22	16356	12586	1896.5	0.503	4378.7	608.17	7.200	2493.4	1885.3
15	6.71	16434	12586	1858	0.483	4494.8	646.66	6.951	2570.7	1924
16	7.20	16501	12586	1818.4	0.464	4601.5	686.32	6.705	2643.9	1957.6
17	7.68	16573	12586	1778.7	0.446	4713.3	725.97	6.492	2719.6	1993.7
18	8.17	16635	12586	1736.7	0.429	4817.1	767.96	6.273	2792.6	2024.6
19	8.66	16695	12586	1695.9	0.413	4918.7	808.79	6.082	2863.7	2054.9
20	9.15	16755	12586	1653.9	0.397	5020.3	850.78	5.901	2935.5	2084.8
21	9.64	16804	12586	1615.4	0.383	5107.5	889.27	5.743	2998.4	2109.1
22	10.12	16859	12586	1578.1	0.369	5200.4	926.59	5.612	3063.5	2136.9
23	10.61	16902	12586	1538.4	0.356	5282.9	966.25	5.467	3124.6	2158.3
24	11.10	16950	12586	1502.3	0.344	5366.3	1002.4	5.353	3184.4	2182
25	11.59	16987	12586	1463.8	0.333	5442.1	1040.9	5.228	3241.5	2200.6
26	12.07	17027	12586	1427.6	0.321	5518.1	1077.1	5.123	3297.6	2220.5
27	12.56	17060	12586	1407.8	0.315	5570.9	1096.9	5.079	3333.9	2237
28	13.04	17093	12586	1377.5	0.306	5634.2	1127.2	4.998	3380.7	2253.5
29	13.53	17129	12586	1350.7	0.297	5697.6	1154	4.937	3425.8	2271.8
30	14.02	17156	12586	1325	0.290	5750.3	1179.7	4.874	3465	2285.3
31	14.50	17189	12586	1297	0.282	5811.2	1207.7	4.812	3509.5	2301.8
32	14.99	17217	12586	1269	0.274	5867.1	1235.7	4.748	3551.4	2315.7
33	15.48	17243	12586	1246.8	0.268	5915.2	1257.8	4.703	3586.5	2328.7

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-5
Sample No.: S-5
Test No.: 3500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/27/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 11.0'-13.0'
Elevation: ----

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Consulting Engineers & Scientists

Soil Description: DARK GRAY LEAN CLAY CL SAND POCKETS NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.25 in
Specimen Area: 6.43 in^2
Specimen Volume: 40.21 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.4342	0	0	10092	13579	13579
2	5.0038	0.4824	6.4653	103.03	2294.8	12099	13579	15874
3	10.004	0.96919	6.4971	125.35	2778.2	12606	13579	16357
4	15.004	1.4633	6.5297	140.89	3107.1	12803	13579	16686
5	20.004	1.9662	6.5632	153.75	3373.5	12873	13579	16953
6	25.004	2.469	6.597	165.34	3609.1	12885	13579	17188
7	30.004	2.9617	6.6305	175.98	3821.9	12863	13579	17401
8	35.004	3.4499	6.6641	185.71	4012.8	12823	13579	17592
9	40.004	3.944	6.6983	195.11	4194.5	12771	13579	17774
10	45.004	4.4439	6.7334	203.66	4355.4	12712	13579	17935
11	50.004	4.9366	6.7683	212.2	4514.8	12656	13579	18094
12	55.004	5.4263	6.8033	219.61	4648.3	12595	13579	18227
13	60.004	5.9189	6.8389	227.7	4794.4	12536	13579	18374
14	65.004	6.4189	6.8755	235.38	4929.8	12472	13579	18509
15	70.004	6.9174	6.9123	242.15	5044.6	12411	13579	18624
16	75.004	7.4173	6.9496	248.92	5157.9	12353	13579	18737
17	80.004	7.907	6.9866	255.7	5270.1	12297	13579	18849
18	85.003	8.3982	7.024	261.7	5365	12242	13579	18944
19	90.003	8.901	7.0628	267.92	5462.5	12185	13579	19042
20	95.003	9.4098	7.1025	274.15	5558.3	12126	13579	19137
21	100	9.9024	7.1413	279.47	5635.3	12069	13579	19214
22	105	10.391	7.1802	285.56	5726.9	12018	13579	19306
23	110	10.888	7.2203	290.69	5797.5	11971	13579	19377
24	115	11.392	7.2614	295.37	5857.5	11923	13579	19437
25	120	11.899	7.3032	300.15	5918.1	11879	13579	19497
26	125	12.392	7.3442	304.69	5974.1	11827	13579	19553
27	130	12.876	7.385	309.74	6039.5	11786	13579	19619
28	135	13.374	7.4275	313.69	6081.6	11744	13579	19661
29	140	13.886	7.4717	318.64	6141.2	11708	13579	19720
30	145	14.39	7.5157	322.28	6174.9	11668	13579	19754
31	150	14.881	7.559	326.19	6213.9	11630	13579	19793
32	155	15.374	7.603	330.51	6259.7	11592	13579	19839

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY | Location: NEWBURGH, IN | Project No.: MR155242
Boring No.: B-2 S-5 | Tested By: BCM | Checked By: WPQ
Sample No.: S-5 | Test Date: 11/27/15 | Depth: 11.0'-13.0'
Test No.: 3500 PSF | Sample Type: 3.0" ST | Elevation: ----

Soil Description: DARK GRAY LEAN CLAY CL SAND POCKETS NOTED
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.25 in | Piston Area: 0.00 in^2 | Filter Strip Correction: 0.00 psf
Specimen Area: 6.43 in^2 | Piston Friction: 0.00 lb | Membrane Correction: 0.00 lb/in
Specimen Volume: 40.21 in^3 | Piston Weight: 0.00 lb | Correction Type: Uniform

Liquid Limit: --- | Plastic Limit: --- | Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	13579	13579	0	0.000	3487	3487	1.000	3487	0
2	0.48	15874	13579	2007	0.875	3774.8	1480	2.551	2627.4	1147.4
3	0.97	16357	13579	2513.7	0.905	3751.5	973.32	3.854	2362.4	1389.1
4	1.46	16686	13579	2710.6	0.872	3883.6	776.46	5.002	2330	1553.6
5	1.97	16953	13579	2780.5	0.824	4080	706.57	5.774	2393.3	1686.7
6	2.47	17188	13579	2793.3	0.774	4302.9	693.76	6.202	2498.3	1804.6
7	2.96	17401	13579	2771.2	0.725	4537.8	715.89	6.339	2626.8	1910.9
8	3.45	17592	13579	2730.4	0.680	4769.5	756.66	6.303	2763.1	2006.4
9	3.94	17774	13579	2679.1	0.639	5002.4	807.91	6.192	2905.2	2097.3
10	4.44	17935	13579	2619.7	0.601	5222.7	867.32	6.022	3045	2177.7
11	4.94	18094	13579	2563.8	0.568	5438	923.23	5.890	3180.6	2257.4
12	5.43	18227	13579	2503.2	0.539	5632.1	983.8	5.725	3308	2324.1
13	5.92	18374	13579	2443.8	0.510	5837.6	1043.2	5.596	3440.4	2397.2
14	6.42	18509	13579	2379.8	0.483	6037.1	1107.3	5.452	3572.2	2464.9
15	6.92	18624	13579	2319.2	0.460	6212.5	1167.8	5.320	3690.2	2522.3
16	7.42	18737	13579	2261	0.438	6383.9	1226.1	5.207	3805	2578.9
17	7.91	18849	13579	2205	0.418	6552.2	1282	5.111	3917.1	2635.1
18	8.40	18944	13579	2150.3	0.401	6701.8	1336.8	5.013	4019.3	2682.5
19	8.90	19042	13579	2093.2	0.383	6856.4	1393.8	4.919	4125.1	2731.3
20	9.41	19137	13579	2033.8	0.366	7011.5	1453.2	4.825	4232.4	2779.1
21	9.90	19214	13579	1976.7	0.351	7145.6	1510.3	4.731	4327.9	2817.6
22	10.39	19306	13579	1925.5	0.336	7288.4	1561.6	4.667	4425	2863.4
23	10.89	19377	13579	1878.9	0.324	7405.7	1608.2	4.605	4506.9	2898.8
24	11.39	19437	13579	1831.1	0.313	7513.5	1655.9	4.537	4584.7	2928.8
25	11.90	19497	13579	1786.9	0.302	7618.3	1700.2	4.481	4659.2	2959.1
26	12.39	19553	13579	1734.4	0.290	7726.7	1752.6	4.409	4739.7	2987.1
27	12.88	19619	13579	1693.7	0.280	7832.9	1793.4	4.368	4813.1	3019.8
28	13.37	19661	13579	1651.7	0.272	7916.9	1835.3	4.314	4876.1	3040.8
29	13.89	19720	13579	1615.6	0.263	8012.6	1871.4	4.282	4942	3070.6
30	14.39	19754	13579	1576	0.255	8085.9	1911	4.231	4998.4	3087.4
31	14.88	19793	13579	1537.6	0.247	8163.4	1949.5	4.188	5056.6	3106.9
32	15.37	19839	13579	1500.3	0.240	8246.4	1986.7	4.151	5116.6	3129.9

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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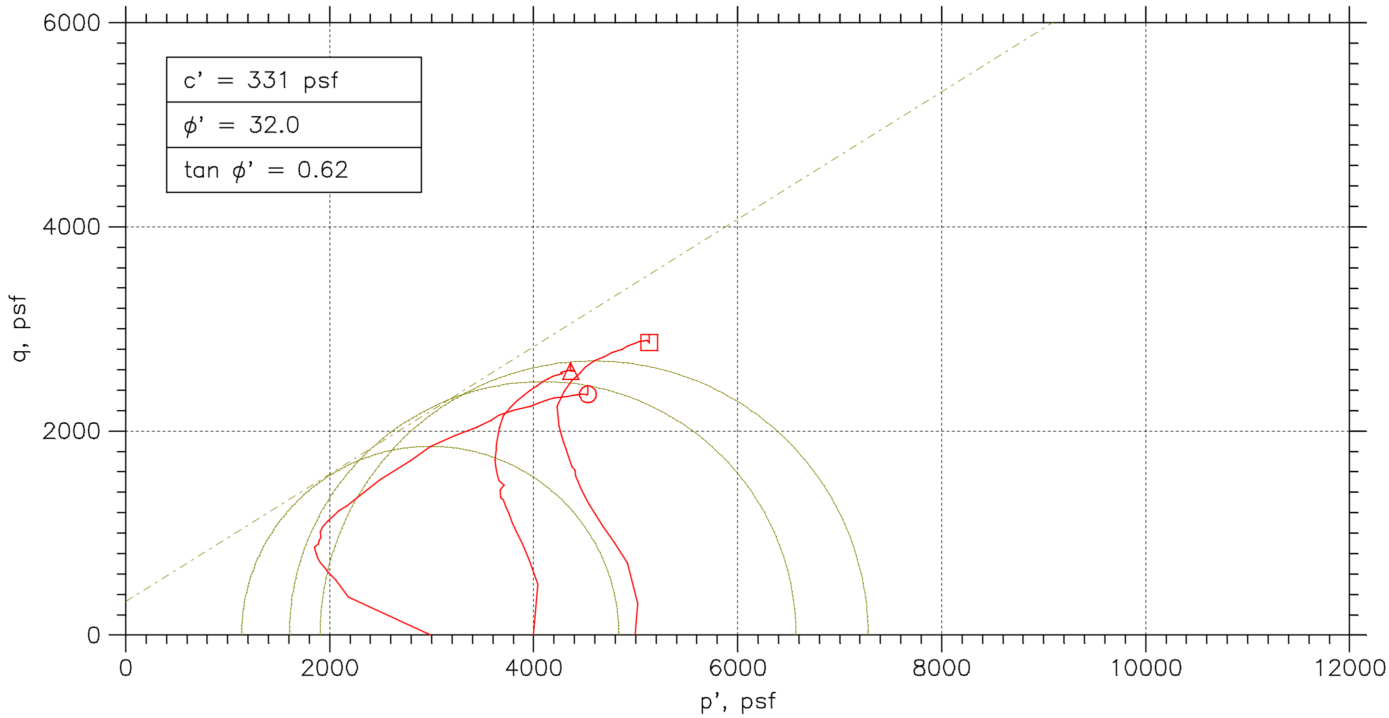

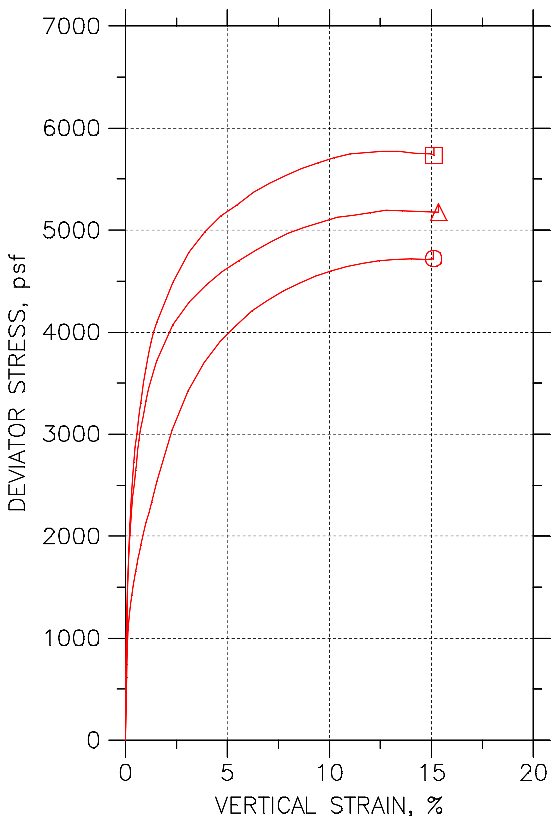

	Symbol	○	△	□	
	Test No.	3000 PSF	4000 PSF	5000 PSF	
Initial	Diameter, in	2.8504	2.8492	2.8551	
	Height, in	6.2839	6.1752	6.276	
	Water Content, %	28.75	28.28	28.90	
	Dry Density, pcf	93.95	91.68	93.39	
	Saturation, %	96.85	90.28	96.07	
	Void Ratio	0.80747	0.85213	0.8182	
Before Shear	Water Content, %	28.61	29.57	27.10	
	Dry Density, pcf	95.49	94.12	97.76	
	Saturation, %	100.00	100.00	100.00	
	Void Ratio	0.77831	0.80418	0.73703	
	Back Press., psf	10086	10088	10082	
	Minor Prin. Stress, psf	2989.5	3995.3	4994.9	
	Max. Dev. Stress, psf	4720.3	5193.6	5774.9	
	Time to Failure, min	1166.8	960	960	
	Strain Rate, %/min	0.02	0.02	0.02	
	B-Value	0.97	0.97	0.96	
	Estimated Specific Gravity	2.72	2.72	2.72	
	Liquid Limit	31	31	31	
	Plastic Limit	19	19	19	
	Plasticity Index	12	12	12	

Failure Sketch

Project: VECTREN F.B. CULLEY

Location: NEWBURGH, IN

Project No.: MR155242

Boring No.: B-2 S-11

Sample Type: 3.0'' ST

Description: OLIVE BROWN LEAN CLAY CL

Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Tue, 01-DEC-2015 15:18:20

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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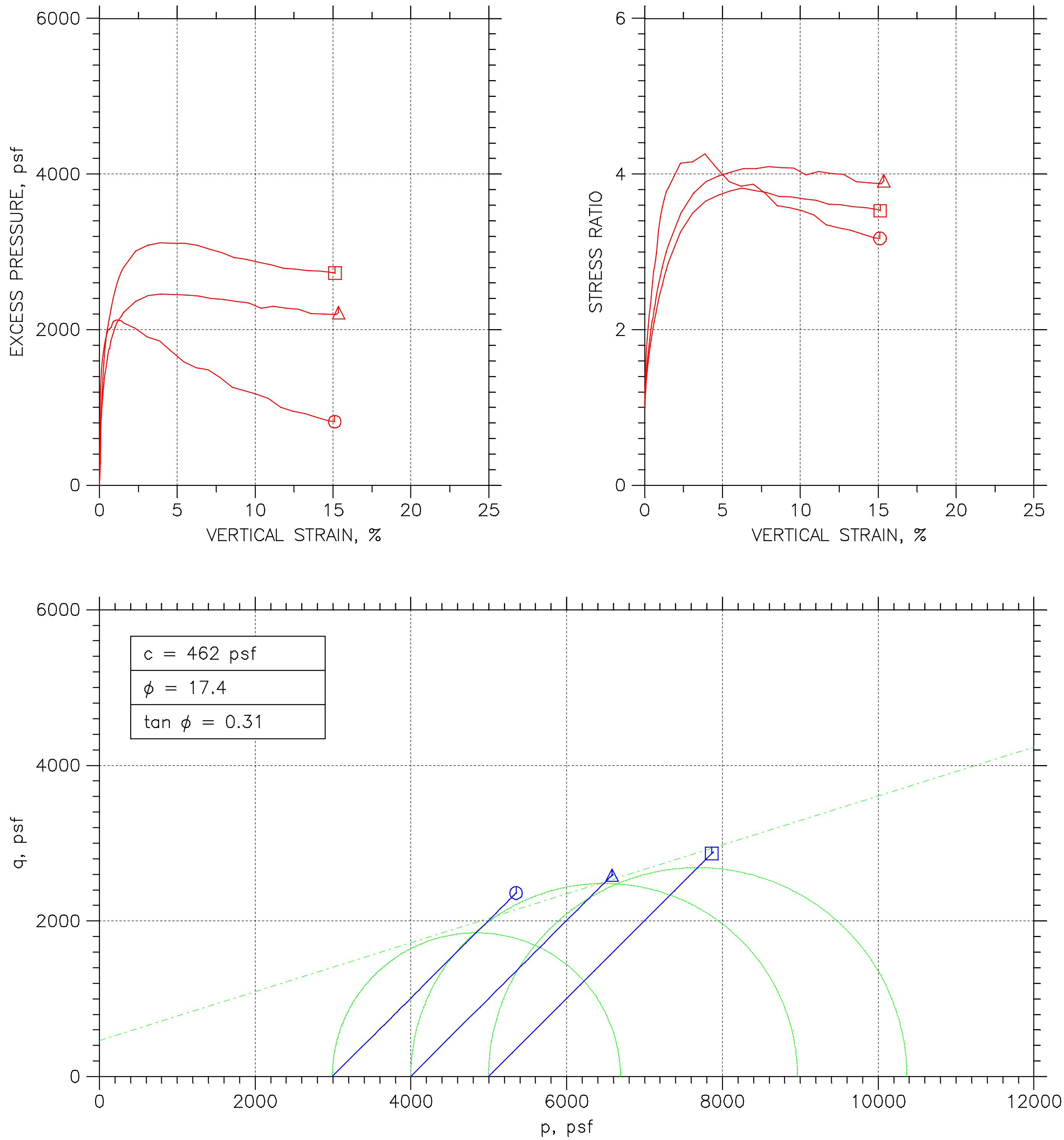

Project: VECTREN F.B. CULLEY	Location: NEWBURGH, IN	Project No.: MR155242
Boring No.: B-2 S-11	Tested By: BCM	Checked By: WPQ
Sample No.: S-11	Test Date: 11/30/15	Depth: 30.0'-32.0'
Test No.: B-2 S-11	Sample Type: 3.0" ST	Elevation: ----
Description: OLIVE BROWN LEAN CLAY CL		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.		

Tue, 01-DEC-2015 15:16:00

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-11
Sample No.: S-11
Test No.: 3000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/30/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 30.0'-32.0'
Elevation: ----

Soil Description: OLIVE BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.28 in
Specimen Area: 6.38 in^2
Specimen Volume: 657.09 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 31

Plastic Limit: 19

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.3812	0	0	10086	13075	13075
2	5.004	0.050221	6.3844	33.177	748.32	11266	13075	13824
3	10.004	0.11479	6.3885	48.015	1082.3	11561	13075	14157
4	15.004	0.17936	6.3926	54.339	1224	11697	13075	14299
5	20.004	0.24393	6.3968	59.252	1333.8	11796	13075	14409
6	25.004	0.30993	6.401	63.241	1422.7	11878	13075	14498
7	30.004	0.37594	6.4052	67.133	1509.3	11946	13075	14584
8	35.004	0.43907	6.4093	70.733	1589.2	12002	13075	14664
9	40.004	0.50508	6.4136	73.846	1658	12050	13075	14733
10	45.004	0.57108	6.4178	77.008	1727.9	12090	13075	14803
11	50.004	0.63708	6.4221	79.927	1792.2	12083	13075	14867
12	55.004	0.70022	6.4262	82.408	1846.6	12103	13075	14922
13	60.004	0.76622	6.4304	85.375	1911.9	12116	13075	14987
14	70.004	0.89536	6.4388	90.581	2025.8	12183	13075	15101
15	80	1.0188	6.4468	95.397	2130.8	12205	13075	15206
16	90	1.1479	6.4553	100.21	2235.5	12209	13075	15311
17	100	1.2742	6.4635	104.74	2333.4	12205	13075	15409
18	110	1.399	6.4717	109.36	2433.3	12199	13075	15509
19	120	1.5281	6.4802	113.98	2532.8	12176	13075	15608
20	180	2.3073	6.5319	138.11	3044.7	12105	13075	16120
21	240	3.0893	6.5846	156.55	3423.6	11992	13075	16499
22	300	3.8641	6.6376	170.51	3699.1	11939	13075	16774
23	360	4.6476	6.6922	181.65	3908.6	11801	13075	16984
24	420	5.4267	6.7473	190.65	4068.8	11672	13075	17144
25	480	6.2058	6.8034	198.77	4207.2	11596	13075	17282
26	540	6.9821	6.8601	205.44	4312.3	11571	13075	17387
27	600	7.7584	6.9179	211.71	4406.9	11471	13075	17482
28	660	8.5303	6.9763	217.16	4482.5	11347	13075	17558
29	720	9.3109	7.0363	222.32	4549.8	11303	13075	17625
30	780	10.086	7.0969	226.65	4598.8	11258	13075	17674
31	840	10.865	7.159	230.78	4642.1	11198	13075	17717
32	900	11.644	7.2221	234.33	4672.3	11086	13075	17748
33	960	12.417	7.2859	237.88	4701.6	11040	13075	17777
34	1020	13.198	7.3514	240.41	4709.2	11009	13075	17784
35	1080	13.981	7.4183	243.14	4719.6	10957	13075	17795
36	1140	14.759	7.486	245.08	4714.4	10914	13075	17790
37	1166.8	15.108	7.5168	246.4	4720.3	10903	13075	17795

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-11
Sample No.: S-11
Test No.: 3000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/30/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 30.0'-32.0'
Elevation: ----

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Soil Description: OLIVE BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.28 in
Specimen Area: 6.38 in^2
Specimen Volume: 657.09 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 31

Plastic Limit: 19

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	13075	13075	0	0.000	2989.5	2989.5	1.000	2989.5	0
2	0.05	13824	13075	1180	1.577	2557.8	1809.5	1.414	2183.7	374.16
3	0.11	14157	13075	1475	1.363	2596.8	1514.5	1.715	2055.6	541.14
4	0.18	14299	13075	1610.9	1.316	2602.7	1378.6	1.888	1990.6	612.02
5	0.24	14409	13075	1710.8	1.283	2612.6	1278.7	2.043	1945.7	666.92
6	0.31	14498	13075	1792.1	1.260	2620.1	1197.4	2.188	1908.8	711.35
7	0.38	14584	13075	1860.6	1.233	2638.2	1128.9	2.337	1883.5	754.63
8	0.44	14664	13075	1916.3	1.206	2662.3	1073.2	2.481	1867.8	794.59
9	0.51	14733	13075	1963.9	1.185	2683.6	1025.6	2.617	1854.6	829.01
10	0.57	14803	13075	2004.6	1.160	2712.8	984.9	2.754	1848.8	863.94
11	0.64	14867	13075	1997.6	1.115	2784	991.87	2.807	1888	896.09
12	0.70	14922	13075	2017.4	1.092	2818.8	972.13	2.900	1895.4	923.32
13	0.77	14987	13075	2030.1	1.062	2871.2	959.35	2.993	1915.3	955.93
14	0.90	15101	13075	2097.5	1.035	2917.8	891.99	3.271	1904.9	1012.9
15	1.02	15206	13075	2119.6	0.995	3000.8	869.92	3.449	1935.3	1065.4
16	1.15	15311	13075	2123.1	0.950	3101.9	866.44	3.580	1984.2	1117.7
17	1.27	15409	13075	2119.6	0.908	3203.3	869.92	3.682	2036.6	1166.7
18	1.40	15509	13075	2113.8	0.869	3309	875.73	3.779	2092.4	1216.7
19	1.53	15608	13075	2090.5	0.825	3431.8	898.96	3.817	2165.4	1266.4
20	2.31	16120	13075	2019.7	0.663	4014.5	969.8	4.140	2492.2	1522.4
21	3.09	16499	13075	1905.9	0.557	4507.2	1083.6	4.159	2795.4	1711.8
22	3.86	16774	13075	1853.6	0.501	4835	1135.9	4.257	2985.4	1849.5
23	4.65	16984	13075	1715.4	0.439	5182.7	1274.1	4.068	3228.4	1954.3
24	5.43	17144	13075	1586.5	0.390	5471.8	1403	3.900	3437.4	2034.4
25	6.21	17282	13075	1509.8	0.359	5686.9	1479.7	3.843	3583.3	2103.6
26	6.98	17387	13075	1485.4	0.344	5816.3	1504.1	3.867	3660.2	2156.1
27	7.76	17482	13075	1385.6	0.314	6010.9	1603.9	3.748	3807.4	2203.5
28	8.53	17558	13075	1261.3	0.281	6210.7	1728.2	3.594	3969.5	2241.3
29	9.31	17625	13075	1217.2	0.268	6322.1	1772.3	3.567	4047.2	2274.9
30	10.09	17674	13075	1171.9	0.255	6416.4	1817.6	3.530	4117	2299.4
31	10.86	17717	13075	1112.6	0.240	6518.9	1876.9	3.473	4197.9	2321
32	11.64	17748	13075	999.98	0.214	6661.8	1989.5	3.348	4325.7	2336.2
33	12.42	17777	13075	954.68	0.203	6736.4	2034.8	3.311	4385.6	2350.8
34	13.20	17784	13075	923.32	0.196	6775.4	2066.2	3.279	4420.8	2354.6
35	13.98	17795	13075	871.06	0.185	6838.1	2118.4	3.228	4478.3	2359.8
36	14.76	17790	13075	828.09	0.176	6875.8	2161.4	3.181	4518.6	2357.2
37	15.11	17795	13075	817.63	0.173	6892.1	2171.9	3.173	4532	2360.1

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-11
Sample No.: S-11
Test No.: 4000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 30.0'-32.0'
Elevation: ----

Soil Description: OLIVE BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.18 in
Specimen Area: 6.38 in^2
Specimen Volume: 645.20 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 31

Plastic Limit: 19

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.3759	0	0	10088	14083	14083
2	5.0041	0.041836	6.3785	44.292	999.93	10542	14083	15083
3	10.004	0.099166	6.3822	65.929	1487.5	10871	14083	15571
4	15.004	0.16424	6.3864	79.055	1782.5	11086	14083	15866
5	20.004	0.22777	6.3904	89.364	2013.7	11254	14083	16097
6	25.004	0.2944	6.3947	97.935	2205.4	11394	14083	16289
7	30.004	0.36103	6.399	105.55	2375.2	11512	14083	16458
8	35.004	0.42765	6.4033	111.96	2517.8	11615	14083	16601
9	40	0.49273	6.4074	117.83	2648.2	11703	14083	16731
10	45	0.54387	6.4107	119.75	2689.9	11752	14083	16773
11	50	0.60894	6.4149	126.7	2844.2	11832	14083	16927
12	55	0.67402	6.4191	131.02	2939.1	11847	14083	17022
13	60	0.7391	6.4233	135.15	3029.9	11939	14083	17113
14	70	0.87235	6.432	142.23	3184.2	12036	14083	17267
15	80	1.0056	6.4406	148.64	3323.3	12116	14083	17407
16	90	1.1373	6.4492	154.21	3443.3	12182	14083	17527
17	110	1.4054	6.4668	163.32	3636.9	12266	14083	17720
18	120	1.5386	6.4755	167.34	3721.3	12308	14083	17804
19	180	2.3335	6.5282	184.72	4074.6	12454	14083	18158
20	240	3.1423	6.5827	196.35	4295.2	12527	14083	18378
21	300	3.9465	6.6378	205.7	4462.4	12545	14083	18546
22	360	4.7507	6.6939	213.49	4592.7	12540	14083	18676
23	420	5.5564	6.751	220.44	4702.1	12530	14083	18785
24	480	6.3559	6.8086	226.92	4799.2	12520	14083	18882
25	540	7.1555	6.8673	233.21	4890.2	12491	14083	18973
26	600	7.9612	6.9274	238.96	4967.4	12479	14083	19051
27	660	8.77	6.9888	243.88	5025	12452	14083	19108
28	720	9.568	7.0505	248.67	5078.9	12433	14083	19162
29	780	10.374	7.1138	253.29	5127.1	12367	14083	19210
30	840	11.178	7.1782	256.4	5143.6	12388	14083	19227
31	900	11.974	7.2432	259.94	5167.8	12366	14083	19251
32	960	12.782	7.3102	263.66	5193.6	12349	14083	19277
33	1020	13.586	7.3783	265.75	5186.7	12295	14083	19270
34	1080	14.39	7.4476	267.97	5181.3	12289	14083	19264
35	1140	15.193	7.5181	270.31	5177.5	12283	14083	19261
36	1152.2	15.357	7.5326	270.73	5175.5	12308	14083	19259

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY | Location: NEWBURGH, IN | Project No.: MR155242
Boring No.: B-2 S-11 | Tested By: BCM | Checked By: WPQ
Sample No.: S-11 | Test Date: 11/28/15 | Depth: 30.0'-32.0'
Test No.: 4000 PSF | Sample Type: 3.0" ST | Elevation: ----

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Soil Description: OLIVE BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.18 in | Piston Area: 0.00 in^2 | Filter Strip Correction: 0.00 psf
Specimen Area: 6.38 in^2 | Piston Friction: 0.00 lb | Membrane Correction: 0.00 lb/in
Specimen Volume: 645.20 cc | Piston Weight: 0.00 lb | Correction Type: Uniform

Liquid Limit: 31 | Plastic Limit: 19 | Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	14083	14083	0	0.000	3995.3	3995.3	1.000	3995.3	0
2	0.04	15083	14083	453.72	0.454	4541.5	3541.6	1.282	4041.5	499.97
3	0.10	15571	14083	782.63	0.526	4700.2	3212.7	1.463	3956.4	743.77
4	0.16	15866	14083	998.41	0.560	4779.4	2996.9	1.595	3888.1	891.27
5	0.23	16097	14083	1166.4	0.579	4842.6	2828.9	1.712	3835.8	1006.9
6	0.29	16289	14083	1306.3	0.592	4894.3	2689	1.820	3791.6	1102.7
7	0.36	16458	14083	1424.1	0.600	4946.3	2571.2	1.924	3758.7	1187.6
8	0.43	16601	14083	1526.8	0.606	4986.3	2468.5	2.020	3727.4	1258.9
9	0.49	16731	14083	1615.4	0.610	5028	2379.9	2.113	3704	1324.1
10	0.54	16773	14083	1664.4	0.619	5020.8	2330.9	2.154	3675.8	1344.9
11	0.61	16927	14083	1743.7	0.613	5095.8	2251.6	2.263	3673.7	1422.1
12	0.67	17022	14083	1758.9	0.598	5175.5	2236.4	2.314	3706	1469.6
13	0.74	17113	14083	1851	0.611	5174.2	2144.3	2.413	3659.2	1515
14	0.87	17267	14083	1947.8	0.612	5231.7	2047.5	2.555	3639.6	1592.1
15	1.01	17407	14083	2028.3	0.610	5290.3	1967	2.690	3628.6	1661.7
16	1.14	17527	14083	2093.6	0.608	5345	1901.7	2.811	3623.3	1721.7
17	1.41	17720	14083	2177.6	0.599	5454.5	1817.7	3.001	3636.1	1818.4
18	1.54	17804	14083	2219.6	0.596	5496.9	1775.7	3.096	3636.3	1860.6
19	2.33	18158	14083	2366.6	0.581	5703.3	1628.7	3.502	3666	2037.3
20	3.14	18378	14083	2438.9	0.568	5851.6	1556.4	3.760	3704	2147.6
21	3.95	18546	14083	2457.5	0.551	6000.1	1537.8	3.902	3768.9	2231.2
22	4.75	18676	14083	2451.7	0.534	6136.2	1543.6	3.975	3839.9	2296.3
23	5.56	18785	14083	2442.4	0.519	6255	1552.9	4.028	3904	2351.1
24	6.36	18882	14083	2431.9	0.507	6362.6	1563.4	4.070	3963	2399.6
25	7.16	18973	14083	2402.7	0.491	6482.8	1592.6	4.071	4037.7	2445.1
26	7.96	19051	14083	2391.1	0.481	6571.6	1604.2	4.096	4087.9	2483.7
27	8.77	19108	14083	2364.2	0.470	6656	1631.1	4.081	4143.5	2512.5
28	9.57	19162	14083	2345.6	0.462	6728.7	1649.7	4.079	4189.2	2539.5
29	10.37	19210	14083	2279.1	0.445	6843.3	1716.2	3.987	4279.8	2563.6
30	11.18	19227	14083	2300.1	0.447	6838.8	1695.2	4.034	4267	2571.8
31	11.97	19251	14083	2277.9	0.441	6885.2	1717.4	4.009	4301.3	2583.9
32	12.78	19277	14083	2261.6	0.435	6927.3	1733.7	3.996	4330.5	2596.8
33	13.59	19270	14083	2206.8	0.425	6975.2	1788.5	3.900	4381.9	2593.3
34	14.39	19264	14083	2200.9	0.425	6975.6	1794.4	3.888	4385	2590.6
35	15.19	19261	14083	2195.1	0.424	6977.7	1800.2	3.876	4388.9	2588.7
36	15.36	19259	14083	2219.6	0.429	6951.2	1775.7	3.915	4363.4	2587.7

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-11
Sample No.: S-11
Test No.: 5000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/30/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 30.0'-32.0'
Elevation: ----

Soil Description: OLIVE BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.28 in
Specimen Area: 6.40 in^2
Specimen Volume: 658.45 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 31

Plastic Limit: 19

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.4023	0	0	10082	15077	15077
2	5.0039	0.053519	6.4058	27.421	616.41	10368	15077	15693
3	10.004	0.11138	6.4095	62.729	1409.3	10861	15077	16486
4	15.004	0.17213	6.4134	81.521	1830.4	11206	15077	16907
5	20.004	0.23288	6.4173	94.755	2126.2	11456	15077	17203
6	25.004	0.29797	6.4215	105.39	2363.5	11654	15077	17440
7	30.004	0.36017	6.4255	114.29	2561.3	11812	15077	17638
8	35.004	0.42381	6.4296	121.7	2725.6	11942	15077	17802
9	40.004	0.48746	6.4337	128.47	2875.5	12053	15077	17952
10	45.004	0.5511	6.4378	134.35	3005.1	12143	15077	18082
11	50.004	0.61474	6.4419	139.7	3122.7	12226	15077	18200
12	55.004	0.67839	6.4461	144.51	3228.3	12285	15077	18305
13	60.004	0.74348	6.4503	148.22	3308.9	12357	15077	18386
14	70.004	0.87221	6.4587	156.95	3499.4	12482	15077	18576
15	80.004	1.0009	6.4671	163.73	3645.7	12582	15077	18723
16	90.004	1.1311	6.4756	170.08	3782.2	12676	15077	18859
17	100	1.2599	6.484	175.8	3904.2	12754	15077	18981
18	110	1.3915	6.4927	180.46	4002.3	12819	15077	19079
19	120	1.5246	6.5014	184.85	4094.3	12878	15077	19171
20	180	2.3187	6.5543	204.17	4485.7	13090	15077	19563
21	240	3.0983	6.607	219.26	4778.7	13167	15077	19856
22	300	3.8895	6.6614	230.59	4984.6	13197	15077	20061
23	360	4.6894	6.7173	239.69	5138.3	13192	15077	20215
24	420	5.4734	6.773	246.68	5244.6	13191	15077	20321
25	480	6.2689	6.8305	254.83	5372.3	13170	15077	20449
26	540	7.0659	6.8891	261.03	5456.1	13119	15077	20533
27	600	7.8398	6.947	267.06	5535.8	13074	15077	20613
28	660	8.6353	7.0074	272.62	5602.2	13011	15077	20679
29	720	9.4396	7.0697	277.81	5658.5	12984	15077	20735
30	780	10.222	7.1313	282.89	5712.3	12947	15077	20789
31	840	11.016	7.1949	287.23	5748.6	12916	15077	20825
32	900	11.812	7.2598	290.35	5759.2	12871	15077	20836
33	960	12.591	7.3246	293.74	5774.9	12859	15077	20852
34	1020	13.39	7.3921	296.23	5770.6	12842	15077	20847
35	1080	14.188	7.4609	298.19	5755.2	12835	15077	20832
36	1140	14.975	7.53	300.41	5744.9	12817	15077	20822
37	1151.2	15.123	7.543	300.3	5732.9	12810	15077	20810

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-11
Sample No.: S-11
Test No.: 5000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/30/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 30.0'-32.0'
Elevation: ----

Soil Description: OLIVE BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.28 in
Specimen Area: 6.40 in^2
Specimen Volume: 658.45 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

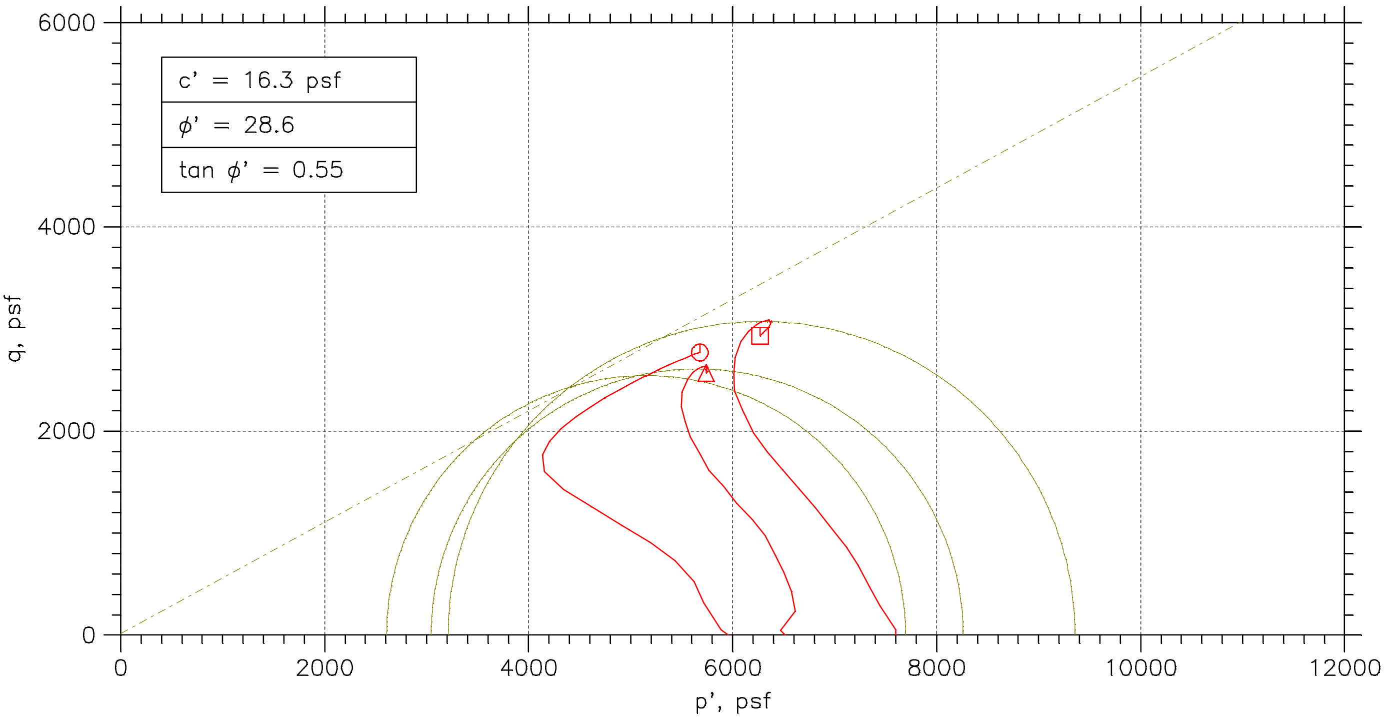
Liquid Limit: 31

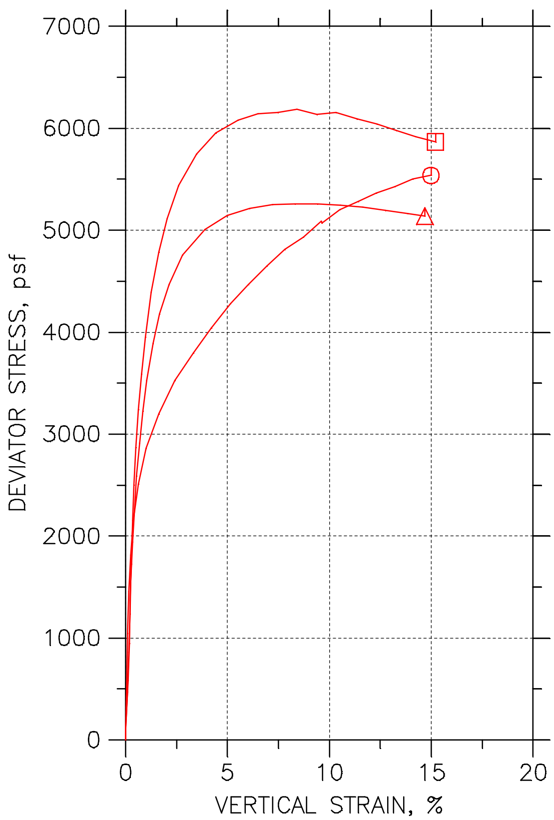
Plastic Limit: 19

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	15077	15077	0	0.000	4994.9	4994.9	1.000	4994.9	0
2	0.05	15693	15077	286.16	0.464	5325.1	4708.7	1.131	5016.9	308.2
3	0.11	16486	15077	779.38	0.553	5624.8	4215.5	1.334	4920.1	704.66
4	0.17	16907	15077	1123.7	0.614	5701.5	3871.1	1.473	4786.3	915.2
5	0.23	17203	15077	1373.8	0.646	5747.3	3621	1.587	4684.2	1063.1
6	0.30	17440	15077	1571.6	0.665	5786.7	3423.3	1.690	4605	1181.7
7	0.36	17638	15077	1729.8	0.675	5826.4	3265.1	1.784	4545.7	1280.6
8	0.42	17802	15077	1860	0.682	5860.4	3134.8	1.869	4497.6	1362.8
9	0.49	17952	15077	1970.6	0.685	5899.8	3024.3	1.951	4462.1	1437.8
10	0.55	18082	15077	2061.3	0.686	5938.7	2933.6	2.024	4436.1	1502.6
11	0.61	18200	15077	2143.9	0.687	5973.7	2851	2.095	4412.3	1561.4
12	0.68	18305	15077	2203.2	0.682	6020	2791.6	2.156	4405.8	1614.2
13	0.74	18386	15077	2275.3	0.688	6028.5	2719.5	2.217	4374	1654.5
14	0.87	18576	15077	2399.8	0.686	6094.4	2595.1	2.348	4344.8	1749.7
15	1.00	18723	15077	2499.8	0.686	6140.7	2495	2.461	4317.9	1822.9
16	1.13	18859	15077	2594.1	0.686	6183	2400.8	2.575	4291.9	1891.1
17	1.26	18981	15077	2672	0.684	6227.1	2322.9	2.681	4275	1952.1
18	1.39	19079	15077	2737.1	0.684	6260	2257.7	2.773	4258.9	2001.2
19	1.52	19171	15077	2796.5	0.683	6292.6	2198.4	2.862	4245.5	2047.1
20	2.32	19563	15077	3008.2	0.671	6472.4	1986.7	3.258	4229.5	2242.9
21	3.10	19856	15077	3085	0.646	6688.6	1909.9	3.502	4299.3	2389.4
22	3.89	20061	15077	3115.2	0.625	6864.3	1879.7	3.652	4372	2492.3
23	4.69	20215	15077	3110.5	0.605	7022.6	1884.3	3.727	4453.5	2569.2
24	5.47	20321	15077	3109.4	0.593	7130.1	1885.5	3.782	4507.8	2622.3
25	6.27	20449	15077	3088.4	0.575	7278.7	1906.4	3.818	4592.6	2686.2
26	7.07	20533	15077	3037.3	0.557	7413.7	1957.6	3.787	4685.6	2728
27	7.84	20613	15077	2991.9	0.540	7538.7	2003	3.764	4770.8	2767.9
28	8.64	20679	15077	2929.1	0.523	7668	2065.8	3.712	4866.9	2801.1
29	9.44	20735	15077	2902.3	0.513	7751.1	2092.5	3.704	4921.8	2829.3
30	10.22	20789	15077	2865.1	0.502	7842	2129.8	3.682	4985.9	2856.1
31	11.02	20825	15077	2833.7	0.493	7909.8	2161.2	3.660	5035.5	2874.3
32	11.81	20836	15077	2789.5	0.484	7964.5	2205.4	3.611	5084.9	2879.6
33	12.59	20852	15077	2776.7	0.481	7993	2218.2	3.603	5105.6	2887.4
34	13.39	20847	15077	2760.4	0.478	8005	2234.4	3.583	5119.7	2885.3
35	14.19	20832	15077	2753.4	0.478	7996.6	2241.4	3.568	5119	2877.6
36	14.98	20822	15077	2734.8	0.476	8005	2260	3.542	5132.5	2872.5
37	15.12	20810	15077	2727.8	0.476	7999.9	2267	3.529	5133.5	2866.5

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767





	Symbol	○	△	□	
	Test No.	5500 PSF	6500 PSF	7500 PSF	
Initial	Diameter, in	2.845	2.86	2.86	
Initial	Height, in	6.165	5.965	5.73	
Initial	Water Content, %	19.24	25.59	25.75	
Initial	Dry Density, pcf	106.8	98.04	96.38	
Initial	Saturation, %	88.79	95.10	91.95	
Initial	Void Ratio	0.58926	0.73193	0.76188	
Before Shear	Water Content, %	22.14	25.71	25.84	
Before Shear	Dry Density, pcf	106.	99.92	99.72	
Before Shear	Saturation, %	100.00	100.00	100.00	
Before Shear	Void Ratio	0.60226	0.69944	0.70282	
Before Shear	Back Press., psf	8208	8640	8640	
	Minor Prin. Stress, psf	5954.4	6513.1	7600.3	
	Max. Dev. Stress, psf	5538.5	5259.3	6183.9	
	Time to Failure, min	566.67	240	300	
	Strain Rate, %/min	0.001	0.001	0.001	
	B-Value	0.99	0.99	0.97	
	Estimated Specific Gravity	2.72	2.72	2.72	
	Liquid Limit	---	---	---	
	Plastic Limit	---	---	---	
	Plasticity Index	---	---	---	
	Failure Sketch				

Project: VECTREN F.B. CULLEY
Location: NEWBURGH, IN
Project No.: MR155242
Boring No.: B-2 S-20
Sample Type: 3.0'' ST
Description: BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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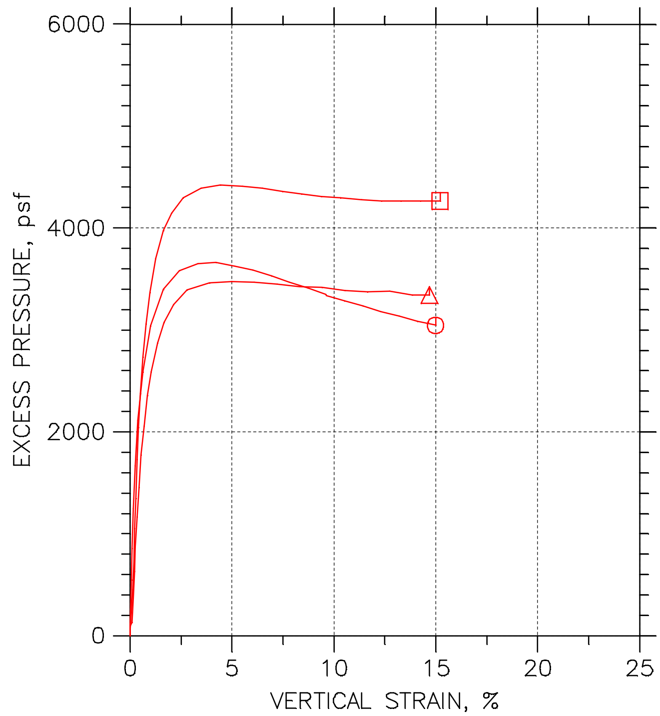

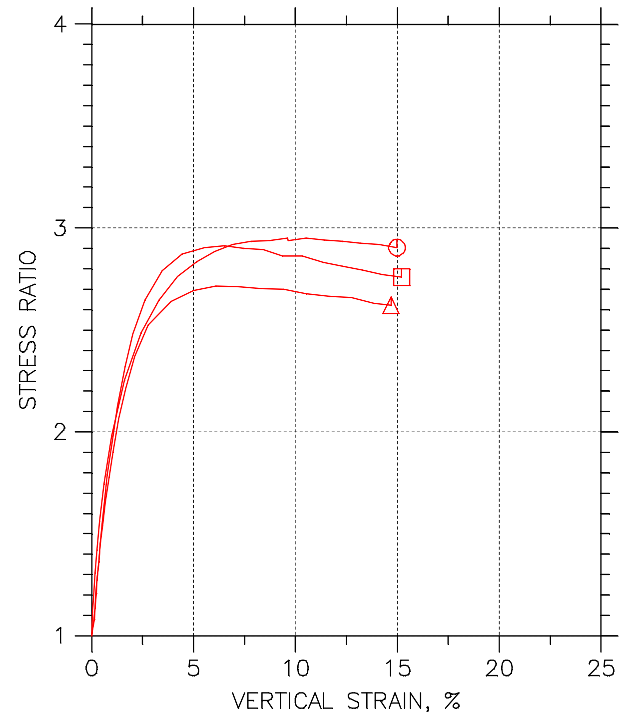

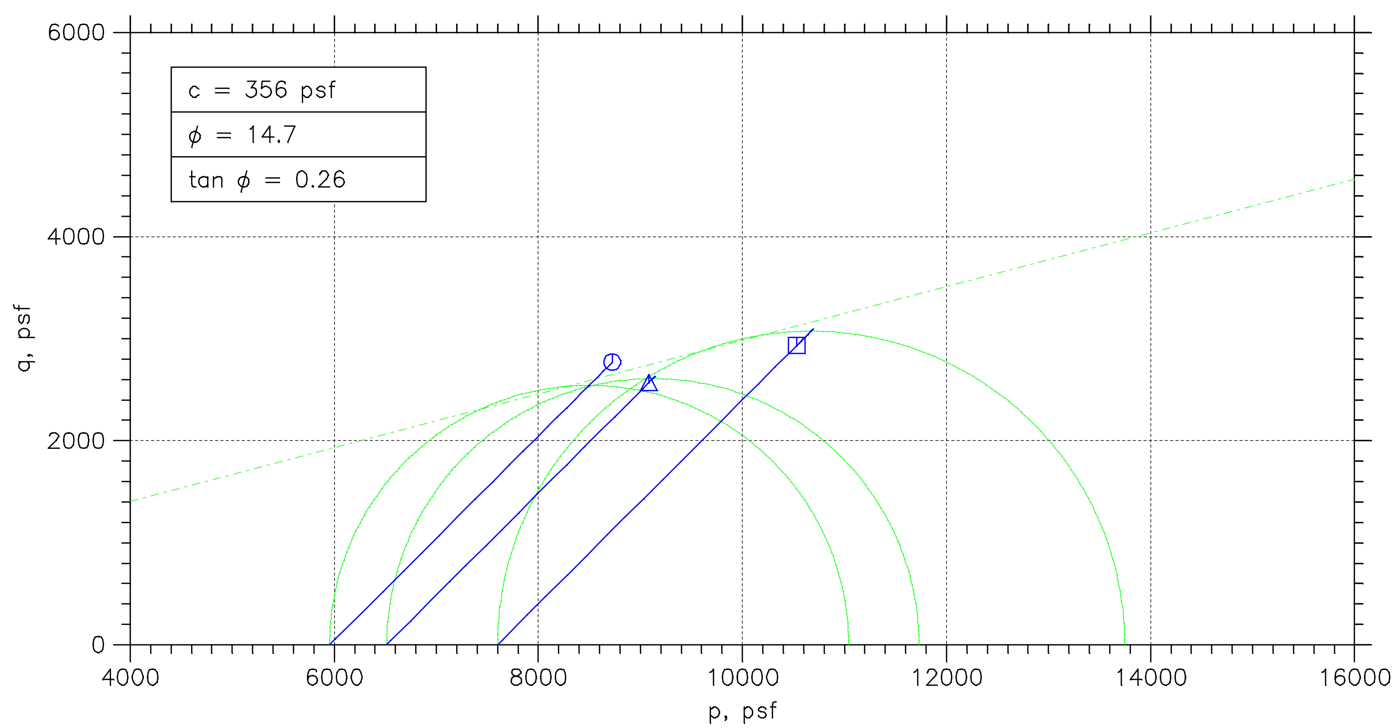

Project: VECTREN F.B. CULLEY	Location: NEWBURGH, IN	Project No.: MR155242
Boring No.: B-2 S-20	Tested By: BCM	Checked By: WPQ
Sample No.: S-20	Test Date: 11/28/15	Depth: 63.0'-65.0'
Test No.: B-2 S-20	Sample Type: 3.0" ST	Elevation: ----
Description: BROWN LEAN CLAY CL		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.		

Fri, 04-DEC-2015 14:04:28

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-20
Sample No.: S-20
Test No.: 5500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 63.0'-65.0'
Elevation: ----

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Soil Description: BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.17 in
Specimen Area: 6.36 in^2
Specimen Volume: 39.19 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.357	0	0	8208	14162	14162
2	5.0001	0.012976	6.3579	4.8	108.72	8328.2	14162	14271
3	10	0.058394	6.3607	27.9	631.62	8759.3	14162	14794
4	15	0.10219	6.3635	46.2	1045.5	9063.8	14162	15208
5	20	0.16869	6.3678	64.5	1458.6	9457	14162	15621
6	25	0.25791	6.3735	80.2	1812	9874	14162	15974
7	30	0.39254	6.3821	95.3	2150.3	10323	14162	16313
8	35	0.61638	6.3965	111.5	2510.1	10796	14162	16673
9	40	0.99432	6.4209	127.5	2859.4	11251	14162	17022
10	45	1.6204	6.4617	143.7	3202.4	11607	14162	17365
11	50	2.4234	6.5149	159.5	3525.5	11791	14162	17688
12	55	3.3155	6.575	173.4	3797.6	11857	14162	17960
13	60	4.2076	6.6363	186.3	4042.5	11868	14162	18205
14	70	5.1452	6.7019	199.1	4278	11832	14162	18440
15	80	6.0373	6.7655	209.8	4465.5	11794	14162	18628
16	90	6.9294	6.8303	220.4	4646.6	11740	14162	18809
17	100	7.8216	6.8964	230.4	4810.8	11675	14162	18973
18	110	8.7137	6.9638	238.5	4931.8	11619	14162	19094
19	120	9.6058	7.0326	248.4	5086.3	11555	14162	19249
20	180	9.6302	7.0345	247.7	5070.6	11547	14162	19233
21	240	10.524	7.1047	256.6	5200.8	11495	14162	19363
22	300	11.416	7.1763	263.4	5285.4	11442	14162	19448
23	366.67	12.308	7.2493	270.1	5365.3	11390	14162	19528
24	433.33	13.2	7.3238	276	5426.7	11342	14162	19589
25	500	14.092	7.3999	282.7	5501.3	11295	14162	19664
26	566.67	14.985	7.4775	287.6	5538.5	11254	14162	19701

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-20
Sample No.: S-20
Test No.: 5500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 63.0'-65.0'
Elevation: ----

Terracon Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.17 in
Specimen Area: 6.36 in^2
Specimen Volume: 39.19 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	14162	14162	0	0.000	5954.4	5954.4	1.000	5954.4	0
2	0.01	14271	14162	120.25	1.106	5942.9	5834.2	1.019	5888.5	54.358
3	0.06	14794	14162	551.3	0.873	6034.7	5403.1	1.117	5718.9	315.81
4	0.10	15208	14162	855.82	0.819	6144	5098.6	1.205	5621.3	522.73
5	0.17	15621	14162	1249	0.856	6164	4705.4	1.310	5434.7	729.3
6	0.26	15974	14162	1666	0.919	6100.5	4288.4	1.423	5194.5	906.01
7	0.39	16313	14162	2115.2	0.984	5989.5	3839.2	1.560	4914.3	1075.1
8	0.62	16673	14162	2588.4	1.031	5876.1	3366	1.746	4621.1	1255.1
9	0.99	17022	14162	3042.6	1.064	5771.3	2911.8	1.982	4341.5	1429.7
10	1.62	17365	14162	3398.9	1.061	5757.8	2555.5	2.253	4156.6	1601.2
11	2.42	17688	14162	3582.8	1.016	5897.1	2371.6	2.487	4134.3	1762.7
12	3.32	17960	14162	3649.1	0.961	6102.9	2305.3	2.647	4204.1	1898.8
13	4.21	18205	14162	3660.2	0.905	6336.7	2294.2	2.762	4315.4	2021.3
14	5.15	18440	14162	3624.2	0.847	6608.1	2330.2	2.836	4469.1	2139
15	6.04	18628	14162	3585.7	0.803	6834.2	2368.7	2.885	4601.5	2232.7
16	6.93	18809	14162	3532	0.760	7068.9	2422.4	2.918	4745.6	2323.3
17	7.82	18973	14162	3467.3	0.721	7297.9	2487.1	2.934	4892.5	2405.4
18	8.71	19094	14162	3411.2	0.692	7474.9	2543.2	2.939	5009	2465.9
19	9.61	19249	14162	3347.1	0.658	7693.6	2607.3	2.951	5150.5	2543.1
20	9.63	19233	14162	3339.3	0.659	7685.7	2615.1	2.939	5150.4	2535.3
21	10.52	19363	14162	3286.8	0.632	7868.5	2667.6	2.950	5268.1	2600.4
22	11.42	19448	14162	3233.5	0.612	8006.3	2720.9	2.943	5363.6	2642.7
23	12.31	19528	14162	3182.4	0.593	8137.3	2772	2.936	5454.7	2682.6
24	13.20	19589	14162	3134.2	0.578	8246.9	2820.2	2.924	5533.5	2713.3
25	14.09	19664	14162	3086.9	0.561	8368.8	2867.5	2.918	5618.2	2750.6
26	14.98	19701	14162	3045.6	0.550	8447.4	2908.8	2.904	5678.1	2769.3

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-20
Sample No.: S-20
Test No.: 6500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 63.0'-65.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.96 in
Specimen Area: 6.42 in^2
Specimen Volume: 38.32 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.4242	0	0	8640	15153	15153
2	5.0001	0.016094	6.4253	3.92	87.853	8729.7	15153	15241
3	10	0.10059	6.4307	20.88	467.56	8770.9	15153	15621
4	15	0.1549	6.4342	38.48	861.2	9010.2	15153	16014
5	20	0.21123	6.4378	55.36	1238.3	9269.7	15153	16391
6	25	0.26555	6.4413	69.6	1555.9	9511.5	15153	16709
7	30	0.35004	6.4468	87.2	1947.8	9806.7	15153	17101
8	35	0.43252	6.4521	101.36	2262.2	10091	15153	17415
9	40	0.54317	6.4593	116.16	2589.6	10413	15153	17743
10	45	0.68198	6.4684	130.72	2910.1	10699	15153	18063
11	50	0.84694	6.4791	145.12	3225.3	10996	15153	18378
12	55	1.0401	6.4918	159.04	3527.8	11231	15153	18681
13	60	1.3459	6.5119	175.84	3888.4	11510	15153	19042
14	70	1.6778	6.5339	189.6	4178.6	11711	15153	19332
15	80	2.1204	6.5634	203.76	4470.5	11890	15153	19624
16	90	2.7842	6.6082	218.32	4757.4	12031	15153	19911
17	100	3.8907	6.6843	232.48	5008.3	12100	15153	20161
18	110	4.9972	6.7622	241.6	5144.9	12113	15153	20298
19	120	6.1036	6.8418	247.84	5216.3	12110	15153	20369
20	180	7.2101	6.9234	252.48	5251.3	12087	15153	20404
21	240	8.3185	7.0071	255.92	5259.3	12063	15153	20412
22	300	9.425	7.0927	258.96	5257.5	12059	15153	20411
23	366.67	10.531	7.1804	261.6	5246.2	12024	15153	20399
24	433.33	11.638	7.2704	263.92	5227.3	12016	15153	20380
25	500	12.744	7.3626	265.76	5197.9	12019	15153	20351
26	566.67	13.851	7.4571	267.44	5164.4	11983	15153	20317
27	633.33	14.682	7.5297	268.64	5137.5	11983	15153	20291

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-20
Sample No.: S-20
Test No.: 6500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 63.0'-65.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.96 in
Specimen Area: 6.42 in^2
Specimen Volume: 38.32 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	15153	15153	0	0.000	6513.1	6513.1	1.000	6513.1	0
2	0.02	15241	15153	89.712	1.021	6511.3	6423.4	1.014	6467.3	43.927
3	0.10	15621	15153	130.9	0.280	6849.8	6382.2	1.073	6616	233.78
4	0.15	16014	15153	370.22	0.430	7004.1	6142.9	1.140	6573.5	430.6
5	0.21	16391	15153	629.71	0.509	7121.7	5883.4	1.210	6502.5	619.14
6	0.27	16709	15153	871.49	0.560	7197.6	5641.6	1.276	6419.6	777.97
7	0.35	17101	15153	1166.7	0.599	7294.2	5346.4	1.364	6320.3	973.88
8	0.43	17415	15153	1451.4	0.642	7323.9	5061.7	1.447	6192.8	1131.1
9	0.54	17743	15153	1773.1	0.685	7329.6	4740	1.546	6034.8	1294.8
10	0.68	18063	15153	2059.3	0.708	7363.9	4453.8	1.653	5908.8	1455.1
11	0.85	18378	15153	2356.1	0.731	7382.3	4157	1.776	5769.7	1612.7
12	1.04	18681	15153	2591.4	0.735	7449.5	3921.7	1.900	5685.6	1763.9
13	1.35	19042	15153	2870.4	0.738	7531.2	3642.8	2.067	5587	1944.2
14	1.68	19332	15153	3070.5	0.735	7621.2	3442.6	2.214	5531.9	2089.3
15	2.12	19624	15153	3249.9	0.727	7733.6	3263.2	2.370	5498.4	2235.2
16	2.78	19911	15153	3390.6	0.713	7879.9	3122.5	2.524	5501.2	2378.7
17	3.89	20161	15153	3460.2	0.691	8061.3	3052.9	2.640	5557.1	2504.2
18	5.00	20298	15153	3473.3	0.675	8184.7	3039.8	2.692	5612.3	2572.4
19	6.10	20369	15153	3469.5	0.665	8259.9	3043.6	2.714	5651.7	2608.1
20	7.21	20404	15153	3446.8	0.656	8317.7	3066.3	2.713	5692	2625.7
21	8.32	20412	15153	3423.5	0.651	8348.9	3089.7	2.702	5719.3	2629.6
22	9.42	20411	15153	3419	0.650	8351.7	3094.1	2.699	5722.9	2628.8
23	10.53	20399	15153	3383.9	0.645	8375.5	3129.3	2.677	5752.4	2623.1
24	11.64	20380	15153	3375.5	0.646	8364.9	3137.6	2.666	5751.3	2613.7
25	12.74	20351	15153	3379	0.650	8332	3134.2	2.658	5733.1	2598.9
26	13.85	20317	15153	3343.2	0.647	8334.3	3169.9	2.629	5752.1	2582.2
27	14.68	20291	15153	3343	0.651	8307.7	3170.2	2.621	5738.9	2568.8

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-20
Sample No.: S-20
Test No.: 7500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 63.0'-65.0'
Elevation: ----

Terracon Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.73 in
Specimen Area: 6.42 in^2
Specimen Volume: 36.81 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.4242	0	0	8640	16240	16240
2	5.0001	0.013962	6.4251	4.41	98.837	8688.8	16240	16339
3	10	0.13438	6.4329	26.1	584.25	9089	16240	16825
4	15	0.1815	6.4359	42.39	948.45	9372.8	16240	17189
5	20	0.23037	6.4391	61.11	1366.6	9694.4	16240	17607
6	25	0.27749	6.4421	77.13	1724.1	9988.1	16240	17964
7	30	0.35079	6.4469	96.39	2153	10369	16240	18393
8	35	0.42234	6.4515	112.23	2505	10687	16240	18745
9	40	0.51832	6.4577	128.52	2865.9	11019	16240	19106
10	45	0.63874	6.4655	145.53	3241.2	11375	16240	19482
11	50	0.78185	6.4749	161.46	3590.8	11701	16240	19831
12	55	0.97382	6.4874	178.11	3953.5	12011	16240	20194
13	60	1.2618	6.5063	198.45	4392.1	12339	16240	20632
14	70	1.6457	6.5317	217.17	4787.8	12614	16240	21028
15	80	2.0314	6.5575	232.83	5112.9	12783	16240	21353
16	90	2.6073	6.5962	249.3	5442.4	12935	16240	21683
17	100	3.4712	6.6553	265.59	5746.6	13032	16240	21987
18	110	4.4311	6.7221	277.92	5953.6	13063	16240	22194
19	120	5.5358	6.8007	287.1	6079.1	13047	16240	22319
20	180	6.4956	6.8705	293.22	6145.6	13029	16240	22386
21	240	7.4555	6.9418	296.82	6157.2	13001	16240	22398
22	300	8.4154	7.0145	301.23	6183.9	12976	16240	22424
23	366.67	9.3752	7.0888	302.13	6137.4	12948	16240	22378
24	433.33	10.335	7.1647	306.27	6155.6	12935	16240	22396
25	500	11.366	7.2481	306.54	6090.1	12916	16240	22330
26	566.67	12.326	7.3275	307.35	6040.1	12907	16240	22280
27	633.33	13.286	7.4086	307.71	5981	12905	16240	22221
28	700	14.246	7.4915	307.8	5916.5	12903	16240	22157
29	766.67	15.206	7.5763	308.61	5865.6	12905	16240	22106

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-20
Sample No.: S-20
Test No.: 7500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 63.0'-65.0'
Elevation: ----

Soil Description: BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.73 in
Specimen Area: 6.42 in^2
Specimen Volume: 36.81 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	16240	16240	0	0.000	7600.3	7600.3	1.000	7600.3	0
2	0.01	16339	16240	48.816	0.494	7650.3	7551.5	1.013	7600.9	49.418
3	0.13	16825	16240	448.99	0.768	7735.6	7151.3	1.082	7443.5	292.12
4	0.18	17189	16240	732.82	0.773	7816	6867.5	1.138	7341.7	474.23
5	0.23	17607	16240	1054.4	0.772	7912.6	6546	1.209	7229.3	683.32
6	0.28	17964	16240	1348.1	0.782	7976.3	6252.2	1.276	7114.2	862.04
7	0.35	18393	16240	1729.2	0.803	8024.2	5871.2	1.367	6947.7	1076.5
8	0.42	18745	16240	2047	0.817	8058.4	5553.4	1.451	6805.9	1252.5
9	0.52	19106	16240	2379.3	0.830	8086.9	5221	1.549	6653.9	1432.9
10	0.64	19482	16240	2734.7	0.844	8106.8	4865.6	1.666	6486.2	1620.6
11	0.78	19831	16240	3061.2	0.852	8130	4539.2	1.791	6334.6	1795.4
12	0.97	20194	16240	3370.9	0.853	8182.9	4229.4	1.935	6206.2	1976.7
13	1.26	20632	16240	3698.6	0.842	8293.8	3901.7	2.126	6097.8	2196.1
14	1.65	21028	16240	3973.5	0.830	8414.6	3626.8	2.320	6020.7	2393.9
15	2.03	21353	16240	4143.3	0.810	8569.9	3457	2.479	6013.5	2556.4
16	2.61	21683	16240	4295.1	0.789	8747.6	3305.2	2.647	6026.4	2721.2
17	3.47	21987	16240	4392.4	0.764	8954.5	3207.9	2.791	6081.2	2873.3
18	4.43	22194	16240	4422.5	0.743	9131.4	3177.8	2.873	6154.6	2976.8
19	5.54	22319	16240	4407.4	0.725	9272	3192.9	2.904	6232.5	3039.6
20	6.50	22386	16240	4389.4	0.714	9356.5	3210.9	2.914	6283.7	3072.8
21	7.46	22398	16240	4360.8	0.708	9396.8	3239.6	2.901	6318.2	3078.6
22	8.42	22424	16240	4336	0.701	9448.2	3264.3	2.894	6356.3	3091.9
23	9.38	22378	16240	4308	0.702	9429.6	3292.3	2.864	6361	3068.7
24	10.34	22396	16240	4294.8	0.698	9461.1	3305.5	2.862	6383.3	3077.8
25	11.37	22330	16240	4275.8	0.702	9414.6	3324.5	2.832	6369.6	3045.1
26	12.33	22280	16240	4267	0.706	9373.4	3333.3	2.812	6353.4	3020
27	13.29	22221	16240	4265.4	0.713	9315.8	3334.9	2.793	6325.4	2990.5
28	14.25	22157	16240	4263.3	0.721	9253.5	3337.1	2.773	6295.3	2958.2
29	15.21	22106	16240	4264.7	0.727	9201.3	3335.6	2.758	6268.4	2932.8

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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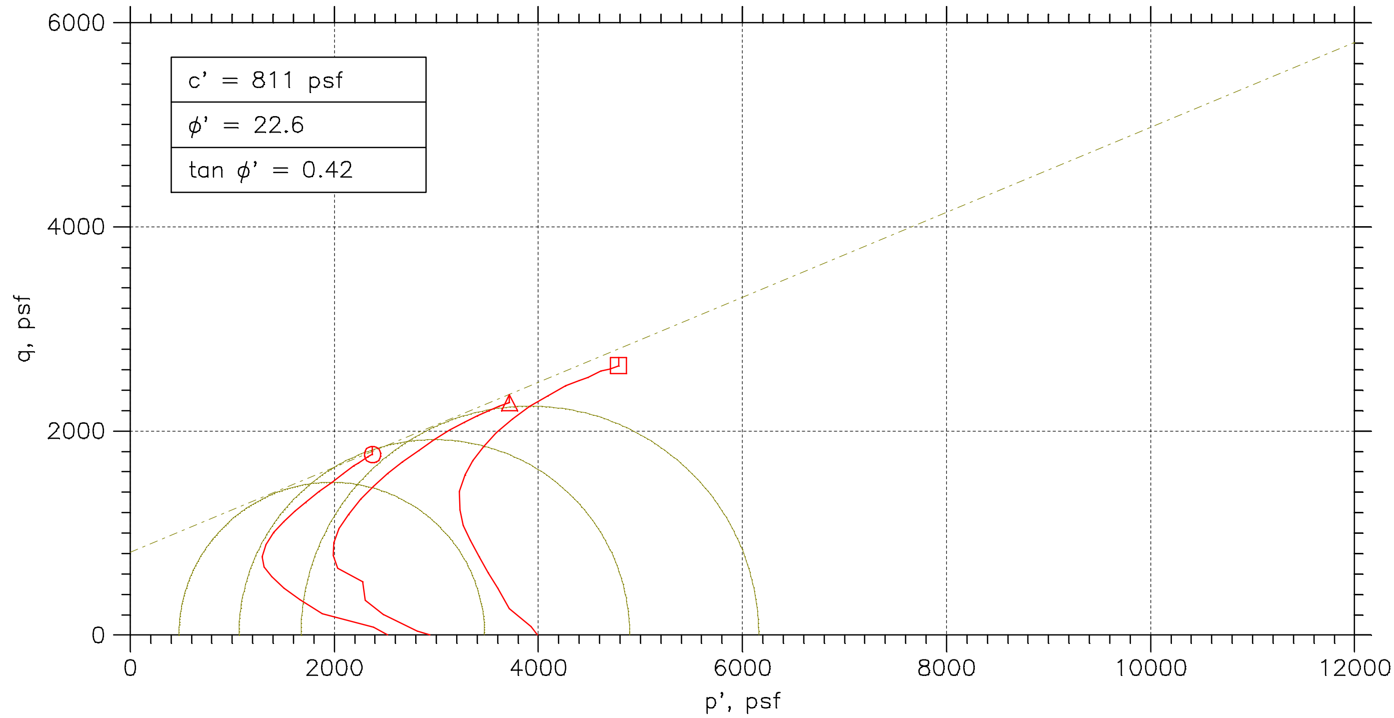
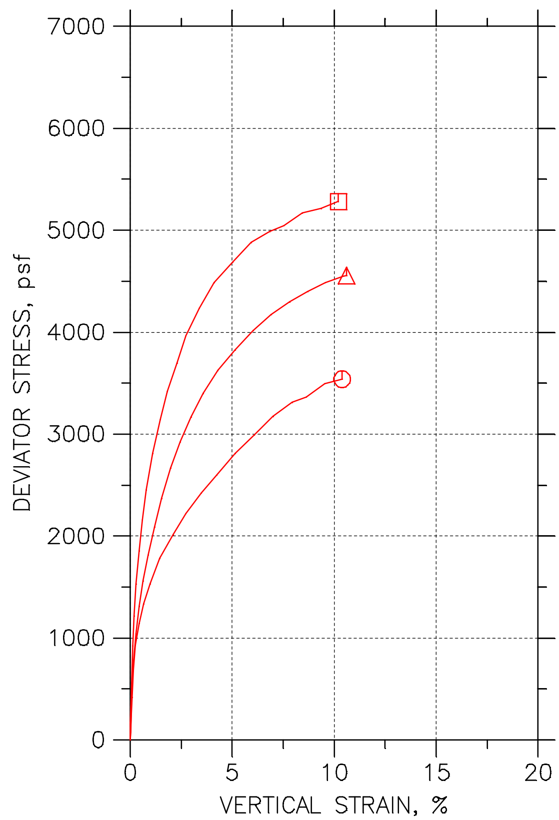




	Symbol	○	△	□	
	Test No.	2500 PSF	3000 PSF	4000 PSF	
Initial	Diameter, in	2.98	2.82	2.81	
Initial	Height, in	5.94	6.2	6.05	
Initial	Water Content, %	20.06	24.67	24.10	
Initial	Dry Density, pcf	96.93	98.89	99.82	
Initial	Saturation, %	72.56	93.55	93.52	
Initial	Void Ratio	0.7519	0.71718	0.70103	
Before Shear	Water Content, %	23.57	26.62	24.94	
Before Shear	Dry Density, pcf	103.5	98.48	101.2	
Before Shear	Saturation, %	100.00	100.00	100.00	
Before Shear	Void Ratio	0.6411	0.72416	0.6784	
Before Shear	Back Press., psf	7776	8467.2	8640	
	Minor Prin. Stress, psf	2524.3	2936.2	3988.8	
	Max. Dev. Stress, psf	3538.3	4556.7	5280	
	Time to Failure, min	180	440	373.33	
	Strain Rate, %/min	0.02	0.02	0.02	
	B-Value	0.98	0.97	0.97	
	Estimated Specific Gravity	2.72	2.72	2.72	
	Liquid Limit	31	31	31	
	Plastic Limit	20	20	20	
	Plasticity Index	11	11	11	
	Failure Sketch				

Project: VECTREN F.B. CULLEY

Location: NEWBURGH, IN

Project No.: MR155242

Boring No.: B-3 S-3

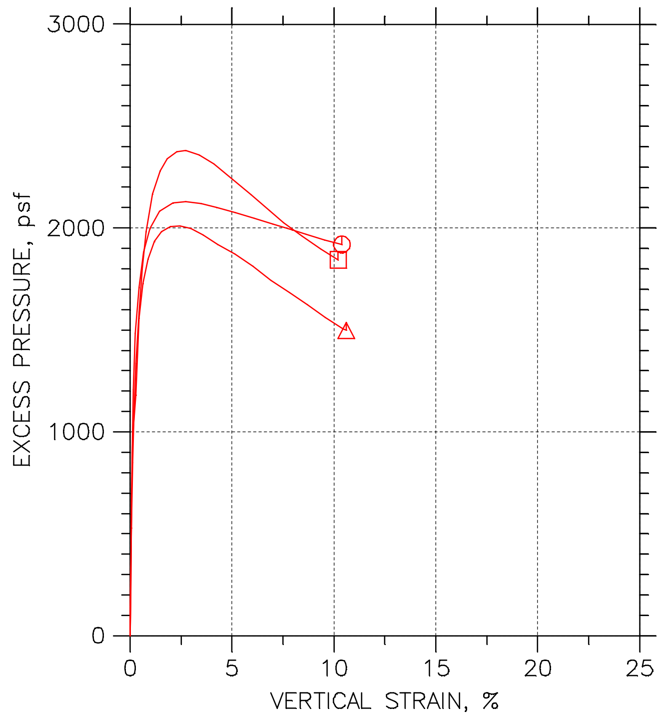
Sample Type: 3.0'' ST

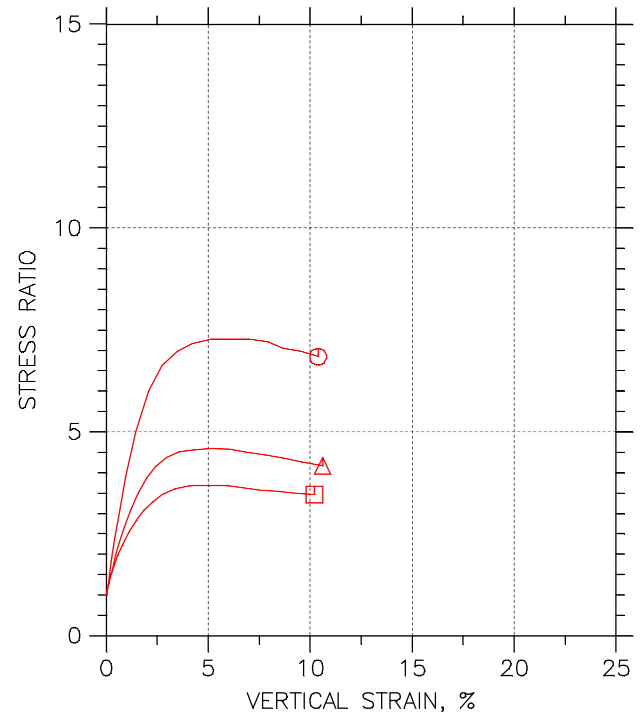
Description: BROWN LEAN CLAY CL

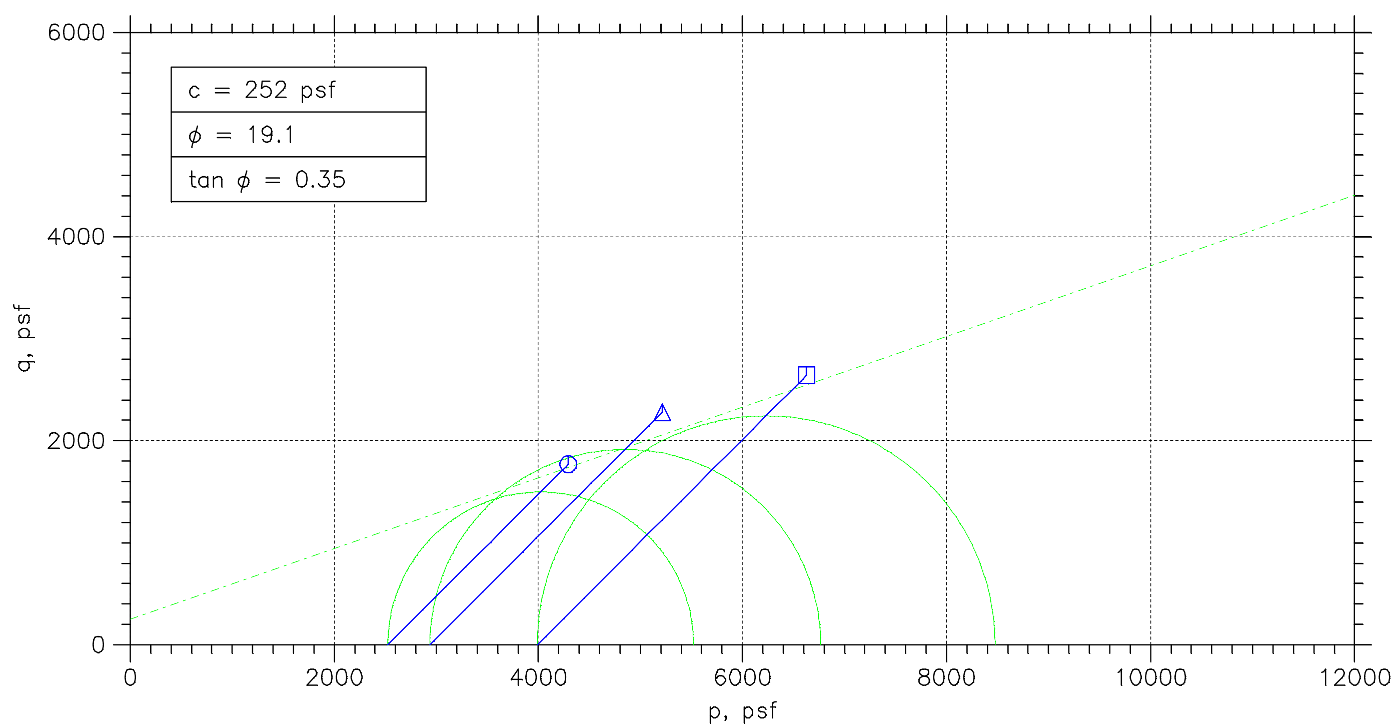
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Fri, 04-DEC-2015 14:36:04

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767







Project: VECTREN F.B. CULLEY	Location: NEWBURGH, IN	Project No.: MR155242
Boring No.: B-3 S-3	Tested By: BCM	Checked By: WPQ
Sample No.: S-3	Test Date: 11/28/15	Depth: 17.0'-19.0'
Test No.: B-3 S-3	Sample Type: 3.0" ST	Elevation: ----
Description: BROWN LEAN CLAY CL		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.		

Fri, 04-DEC-2015 14:37:41

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-3
Sample No.: S-3
Test No.: 2500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 17.0'-19.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.94 in
Specimen Area: 6.97 in^2
Specimen Volume: 678.91 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 31

Plastic Limit: 20

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.9746	0	0	7776	10300	10300
2	5.0001	0.045455	6.9778	7.25	149.62	7991.1	10300	10450
3	10	0.092593	6.9811	20.5	422.86	8629.8	10300	10723
4	15	0.16162	6.9859	33.5	690.53	8982.7	10300	10991
5	20	0.26768	6.9934	45	926.59	9258.8	10300	11227
6	25	0.42929	7.0047	55.5	1140.9	9486.2	10300	11441
7	30	0.66162	7.0211	65.25	1338.3	9656.6	10300	11639
8	35	0.96128	7.0423	75	1533.6	9772.2	10300	11834
9	40	1.4478	7.0771	87.5	1780.4	9857.8	10300	12081
10	45	2.096	7.124	99.5	2011.2	9898.2	10300	12312
11	50	2.7441	7.1714	110.75	2223.8	9905.6	10300	12524
12	55	3.4865	7.2266	121.5	2421.1	9895.3	10300	12721
13	60	4.2273	7.2825	131.5	2600.2	9878.5	10300	12901
14	70	5.1532	7.3536	143.5	2810.1	9851.9	10300	13110
15	80	6.0791	7.4261	154.5	2995.9	9823.2	10300	13296
16	90	7.0051	7.5	165.25	3172.8	9794.1	10300	13473
17	100	7.931	7.5755	174.25	3312.3	9767.2	10300	13613
18	110	8.6263	7.6331	178.25	3362.7	9745.3	10300	13663
19	120	9.5522	7.7112	187	3492	9716	10300	13792
20	180	10.391	7.7834	191.25	3538.3	9695.1	10300	13839

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-3
Sample No.: S-3
Test No.: 2500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 17.0'-19.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.94 in
Specimen Area: 6.97 in^2
Specimen Volume: 678.91 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 31

Plastic Limit: 20

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	10300	10300	0	0.000	2524.3	2524.3	1.000	2524.3	0
2	0.05	10450	10300	215.14	1.438	2458.8	2309.2	1.065	2384	74.808
3	0.09	10723	10300	853.8	2.019	2093.4	1670.5	1.253	1881.9	211.43
4	0.16	10991	10300	1206.7	1.748	2008.1	1317.6	1.524	1662.9	345.26
5	0.27	11227	10300	1482.8	1.600	1968.2	1041.6	1.890	1504.9	463.3
6	0.43	11441	10300	1710.2	1.499	1955.1	814.12	2.401	1384.6	570.47
7	0.66	11639	10300	1880.6	1.405	1981.9	643.69	3.079	1312.8	669.13
8	0.96	11834	10300	1996.2	1.302	2061.7	528.09	3.904	1294.9	766.79
9	1.45	12081	10300	2081.8	1.169	2222.9	442.56	5.023	1332.7	890.19
10	2.10	12312	10300	2122.2	1.055	2413.4	402.12	6.002	1407.7	1005.6
11	2.74	12524	10300	2129.6	0.958	2618.6	394.73	6.634	1506.6	1111.9
12	3.49	12721	10300	2119.3	0.875	2826	404.97	6.978	1615.5	1210.5
13	4.23	12901	10300	2102.5	0.809	3022	421.82	7.164	1721.9	1300.1
14	5.15	13110	10300	2075.9	0.739	3258.4	448.39	7.267	1853.4	1405
15	6.08	13296	10300	2047.2	0.683	3473.1	477.16	7.279	1975.1	1498
16	7.01	13473	10300	2018.1	0.636	3679	506.19	7.268	2092.6	1586.4
17	7.93	13613	10300	1991.2	0.601	3845.4	533.15	7.213	2189.3	1656.1
18	8.63	13663	10300	1969.3	0.586	3917.8	555.05	7.058	2236.4	1681.4
19	9.55	13792	10300	1940	0.556	4076.4	584.34	6.976	2330.4	1746
20	10.39	13839	10300	1919.1	0.542	4143.5	605.2	6.846	2374.4	1769.2

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-3
Sample No.: S-3
Test No.: 3000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 17.0'-19.0'
Elevation: ----

Soil Description: BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.20 in
Specimen Area: 6.25 in^2
Specimen Volume: 634.57 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 31

Plastic Limit: 20

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.2458	0	0	8467.2	11403	11403
2	5.0001	0.032258	6.2478	3.52	81.129	8632.2	11403	11484
3	10	0.075806	6.2505	17.38	400.4	9122.7	11403	11804
4	15	0.14194	6.2547	29.81	686.31	9441.9	11403	12090
5	25	0.28387	6.2636	45.43	1044.4	9650.1	11403	12448
6	30	0.43871	6.2733	57.09	1310.5	10024	11403	12714
7	35	0.63871	6.2859	68.2	1562.3	10195	11403	12966
8	40	0.88226	6.3014	79.42	1814.9	10313	11403	13218
9	45	1.1935	6.3212	91.74	2089.9	10401	11403	13493
10	50	1.5484	6.344	104.39	2369.5	10449	11403	13773
11	55	1.9919	6.3727	118.03	2667	10475	11403	14070
12	60	2.4355	6.4017	129.91	2922.2	10477	11403	14326
13	70	2.9677	6.4368	141.68	3169.6	10463	11403	14573
14	80	3.5887	6.4783	152.9	3398.7	10435	11403	14802
15	90	4.2984	6.5263	164.23	3623.6	10387	11403	15027
16	100	5.1419	6.5844	175.12	3829.9	10338	11403	15233
17	110	6.029	6.6465	185.35	4015.7	10281	11403	15419
18	120	6.9161	6.7099	194.37	4171.4	10211	11403	15575
19	180	7.8032	6.7744	202.18	4297.6	10150	11403	15701
20	240	8.6903	6.8402	209	4399.8	10091	11403	15803
21	306.67	9.5774	6.9073	215.05	4483.2	10028	11403	15887
22	373.33	10.465	6.9758	220.33	4548.2	9972.7	11403	15952
23	440	10.61	6.9871	221.1	4556.7	9964.9	11403	15960

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-3
Sample No.: S-3
Test No.: 3000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 17.0'-19.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.20 in
Specimen Area: 6.25 in^2
Specimen Volume: 634.57 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 31

Plastic Limit: 20

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	11403	11403	0	0.000	2936.2	2936.2	1.000	2936.2	0
2	0.03	11484	11403	164.97	2.033	2852.3	2771.2	1.029	2811.8	40.565
3	0.08	11804	11403	655.5	1.637	2681.1	2280.7	1.176	2480.9	200.2
4	0.14	12090	11403	974.72	1.420	2647.8	1961.4	1.350	2304.6	343.15
5	0.28	12448	11403	1182.9	1.133	2797.7	1753.3	1.596	2275.5	522.22
6	0.44	12714	11403	1557.3	1.188	2689.4	1378.9	1.950	2034.1	655.23
7	0.64	12966	11403	1727.9	1.106	2770.6	1208.3	2.293	1989.5	781.17
8	0.88	13218	11403	1846.1	1.017	2904.9	1090	2.665	1997.5	907.46
9	1.19	13493	11403	1934.2	0.926	3091.8	1002	3.086	2046.9	1044.9
10	1.55	13773	11403	1981.6	0.836	3324	954.55	3.482	2139.3	1184.7
11	1.99	14070	11403	2007.4	0.753	3595.8	928.73	3.872	2262.2	1333.5
12	2.44	14326	11403	2009.8	0.688	3848.5	926.33	4.155	2387.4	1461.1
13	2.97	14573	11403	1996.1	0.630	4109.6	940.02	4.372	2524.8	1584.8
14	3.59	14802	11403	1967.4	0.579	4367.5	968.81	4.508	2668.1	1699.3
15	4.30	15027	11403	1920.1	0.530	4639.7	1016.1	4.566	2827.9	1811.8
16	5.14	15233	11403	1870.8	0.488	4895.2	1065.3	4.595	2980.3	1914.9
17	6.03	15419	11403	1813.5	0.452	5138.3	1122.6	4.577	3130.5	2007.8
18	6.92	15575	11403	1743.8	0.418	5363.7	1192.3	4.498	3278	2085.7
19	7.80	15701	11403	1683.1	0.392	5550.6	1253	4.430	3401.8	2148.8
20	8.69	15803	11403	1623.7	0.369	5712.3	1312.4	4.352	3512.4	2199.9
21	9.58	15887	11403	1560.5	0.348	5858.9	1375.7	4.259	3617.3	2241.6
22	10.46	15952	11403	1505.5	0.331	5978.9	1430.7	4.179	3704.8	2274.1
23	10.61	15960	11403	1497.7	0.329	5995.2	1438.5	4.168	3716.8	2278.4

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-3
Sample No.: S-3
Test No.: 4000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 17.0'-19.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.05 in
Specimen Area: 6.20 in^2
Specimen Volume: 614.84 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 31

Plastic Limit: 20

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.2016	0	0	8640	12629	12629
2	5.0001	0.014876	6.2025	7.2	167.16	8783.1	12629	12796
3	10	0.059504	6.2053	22.176	514.62	9170.6	12629	13143
4	15	0.12727	6.2095	39.744	921.68	9489.6	12629	13550
5	20	0.19669	6.2138	52.608	1219.1	9728.2	12629	13848
6	25	0.29091	6.2197	66.24	1533.6	9975.5	12629	14162
7	30	0.42645	6.2281	80.352	1857.8	10227	12629	14487
8	35	0.58678	6.2382	93.408	2156.2	10441	12629	14785
9	40	0.79008	6.251	106.37	2450.3	10622	12629	15079
10	45	1.1091	6.2711	122.4	2810.6	10806	12629	15439
11	50	1.4727	6.2943	137.28	3140.7	10919	12629	15769
12	55	1.8364	6.3176	150.05	3420.1	10981	12629	16049
13	60	2.2909	6.347	162.82	3694	11015	12629	16323
14	70	2.7455	6.3767	175.58	3965.1	11020	12629	16594
15	80	3.3818	6.4186	188.74	4234.2	11000	12629	16863
16	90	4.1107	6.4674	201.5	4486.6	10956	12629	17115
17	100	5.0198	6.5293	212.64	4689.6	10879	12629	17318
18	110	5.9289	6.5924	223.58	4883.8	10805	12629	17513
19	120	6.838	6.6568	230.59	4988.2	10724	12629	17617
20	180	7.519	6.7058	235.01	5046.6	10665	12629	17675
21	240	8.4298	6.7725	243.17	5170.4	10600	12629	17799
22	306.67	9.3388	6.8404	247.68	5214	10538	12629	17843
23	373.33	10.21	6.9068	253.25	5280	10483	12629	17909

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-3
Sample No.: S-3
Test No.: 4000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 17.0'-19.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.05 in
Specimen Area: 6.20 in^2
Specimen Volume: 614.84 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 31

Plastic Limit: 20

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	12629	12629	0	0.000	3988.8	3988.8	1.000	3988.8	0
2	0.01	12796	12629	143.14	0.856	4012.8	3845.7	1.043	3929.2	83.579
3	0.06	13143	12629	530.64	1.031	3972.8	3458.2	1.149	3715.5	257.31
4	0.13	13550	12629	849.6	0.922	4060.9	3139.2	1.294	3600	460.84
5	0.20	13848	12629	1088.2	0.893	4119.7	2900.6	1.420	3510.2	609.57
6	0.29	14162	12629	1335.5	0.871	4187	2653.3	1.578	3420.1	766.81
7	0.43	14487	12629	1587	0.854	4259.6	2401.8	1.774	3330.7	928.9
8	0.59	14785	12629	1801.4	0.835	4343.6	2187.4	1.986	3265.5	1078.1
9	0.79	15079	12629	1982	0.809	4457.1	2006.8	2.221	3232	1225.2
10	1.11	15439	12629	2166.2	0.771	4633.2	1822.6	2.542	3227.9	1405.3
11	1.47	15769	12629	2278.7	0.726	4850.8	1710.1	2.837	3280.5	1570.3
12	1.84	16049	12629	2341	0.684	5067.9	1647.8	3.076	3357.8	1710.1
13	2.29	16323	12629	2374.7	0.643	5308.1	1614.1	3.289	3461.1	1847
14	2.75	16594	12629	2379.6	0.600	5574.3	1609.2	3.464	3591.8	1982.6
15	3.38	16863	12629	2359.7	0.557	5863.3	1629.1	3.599	3746.2	2117.1
16	4.11	17115	12629	2316	0.516	6159.4	1672.8	3.682	3916.1	2243.3
17	5.02	17318	12629	2239.5	0.478	6438.9	1749.3	3.681	4094.1	2344.8
18	5.93	17513	12629	2164.6	0.443	6708	1824.2	3.677	4266.1	2441.9
19	6.84	17617	12629	2084.4	0.418	6892.6	1904.4	3.619	4398.5	2494.1
20	7.52	17675	12629	2025.4	0.401	7010	1963.4	3.570	4486.7	2523.3
21	8.43	17799	12629	1960	0.379	7199.2	2028.8	3.548	4614	2585.2
22	9.34	17843	12629	1897.6	0.364	7305.2	2091.2	3.493	4698.2	2607
23	10.21	17909	12629	1843.5	0.349	7425.3	2145.3	3.461	4785.3	2640

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

Terracon
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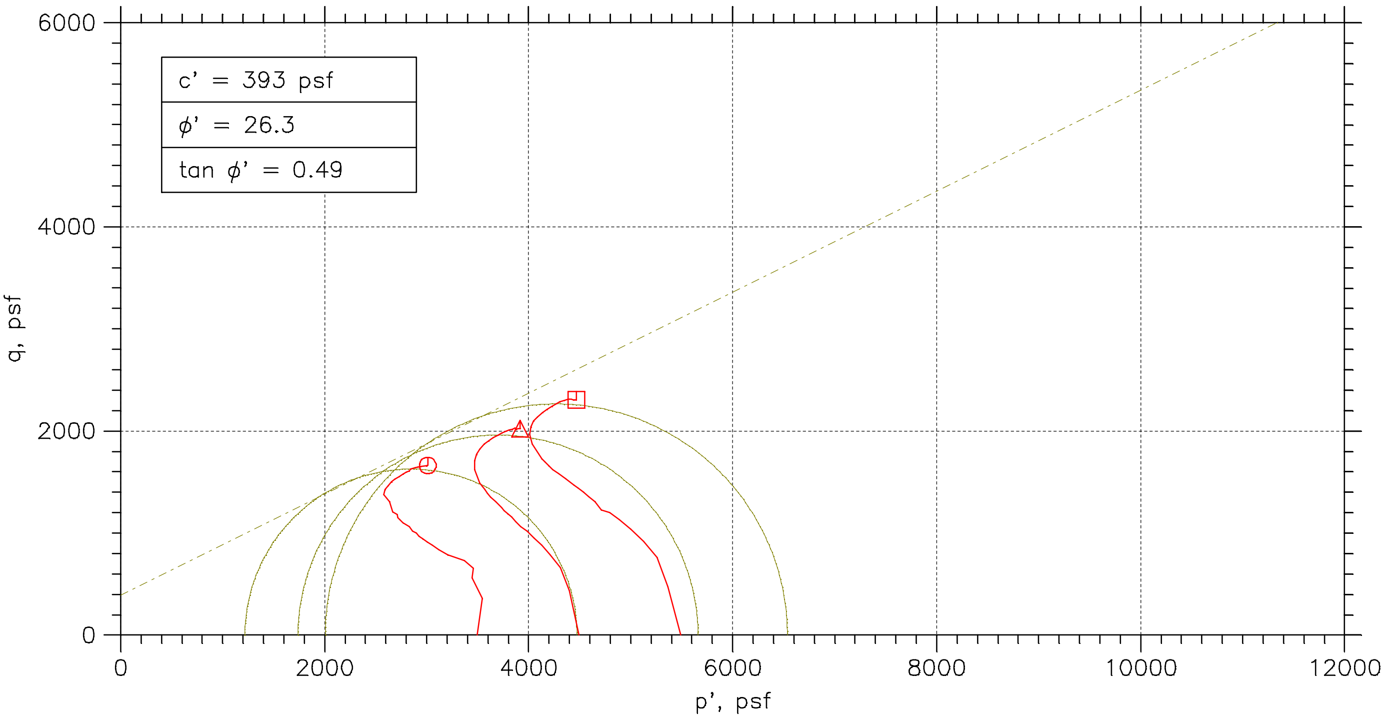

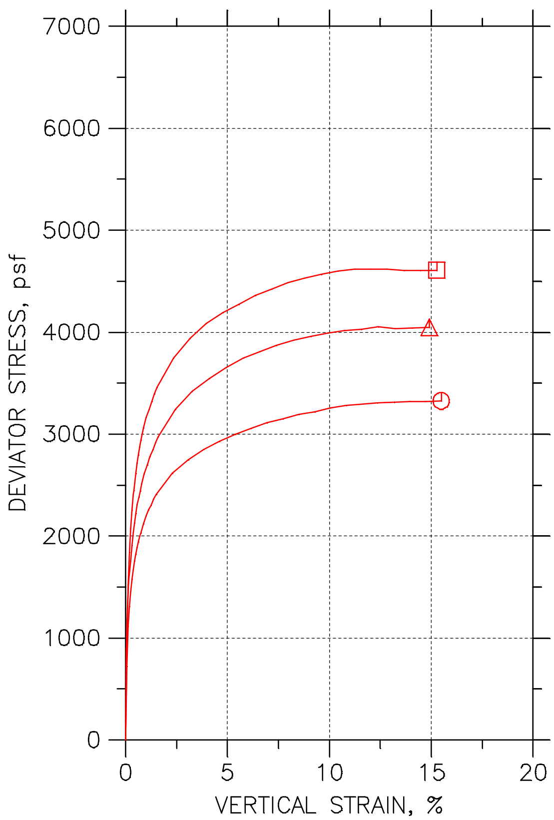

	Symbol	○	△	□	
	Test No.	3500 PSF	4500 PSF	5500 PSF	
Initial	Diameter, in	2.8295	2.8488	2.8394	
	Height, in	6.0327	6.0244	6.1685	
	Water Content, %	27.88	28.09	28.11	
	Dry Density, pcf	95.62	92.9	94.59	
	Saturation, %	97.74	92.29	96.13	
	Void Ratio	0.77581	0.82784	0.79521	
Before Shear	Water Content, %	25.77	26.95	25.15	
	Dry Density, pcf	99.83	97.97	100.8	
	Saturation, %	100.00	100.00	100.00	
	Void Ratio	0.70098	0.73315	0.68414	
	Back Press., psf	10086	10081	10089	
	Minor Prin. Stress, psf	3493.7	4492.3	5491.7	
	Max. Dev. Stress, psf	3326.1	4052.2	4620.3	
	Time to Failure, min	1200	900	840	
	Strain Rate, %/min	0.02	0.02	0.02	
	B-Value	0.95	0.96	0.98	
	Estimated Specific Gravity	2.72	2.72	2.72	
	Liquid Limit	40	40	40	
	Plastic Limit	23	23	23	
	Plasticity Index	17	17	17	
	Failure Sketch				

Project: VECTREN F.B. CULLEY	
Location: NEWBURGH, IN	
Project No.: MR155242	
Boring No.: B-3 S-6	
Sample Type: 3.0'' ST	
Description: BROWNISH GRAY LEAN CLAY CL	
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767	

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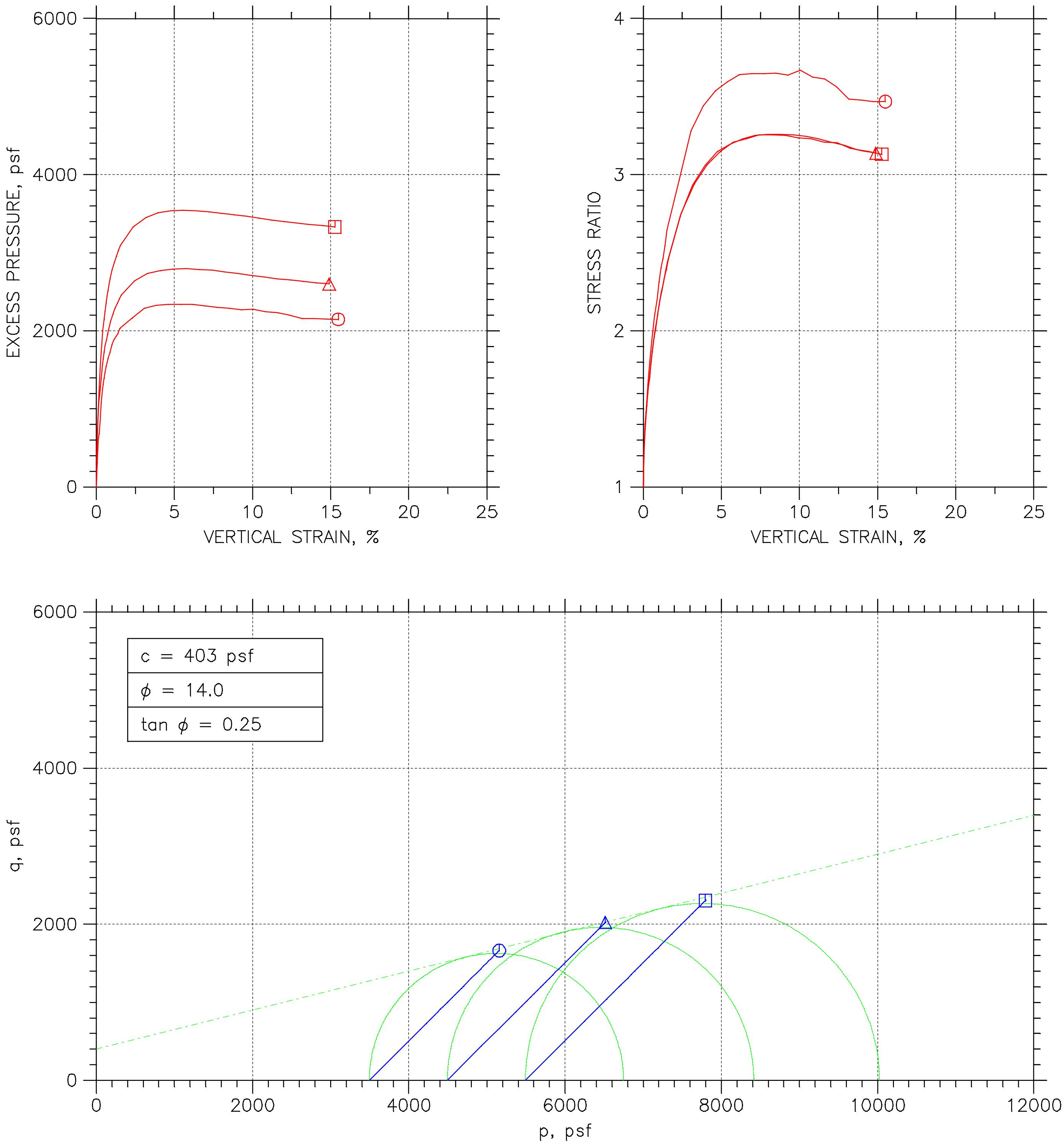
CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

Terracon Consulting Engineers & Scientists



Project: VECTREN F.B. CULLEY	Location: NEWBURGH, IN	Project No.: MR155242
Boring No.: B-3 S-6	Tested By: BCM	Checked By: WPQ
Sample No.: S-6	Test Date: 11/29/15	Depth: 30.0'-32.0'
Test No.: B-3 S-6	Sample Type: 3.0" ST	Elevation: -----
Description: BROWNISH GRAY LEAN CLAY CL		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767		

Mon, 30-NOV-2015 15:14:06

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-6
Sample No.: S-6
Test No.: 3500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/29/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 30.0'-32.0'
Elevation: -----

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Soil Description: BROWNISH GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

Specimen Height: 6.03 in
Specimen Area: 6.29 in^2
Specimen Volume: 37.93 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.2881	0	0	10086	13579	13579
2	5.0041	0.057174	6.2917	31.496	720.87	10396	13579	14300
3	10.004	0.11864	6.2955	48.934	1119.3	10692	13579	14698
4	15.004	0.18153	6.2995	57.287	1309.5	10773	13579	14889
5	20.004	0.24585	6.3036	63.723	1455.7	10939	13579	15035
6	25.004	0.30731	6.3075	68.927	1573.6	11161	13579	15153
7	30	0.36877	6.3113	73.172	1669.5	11292	13579	15249
8	35	0.43309	6.3154	77.006	1755.8	11399	13579	15335
9	40	0.49456	6.3193	80.156	1826.5	11486	13579	15406
10	45	0.55745	6.3233	82.849	1886.7	11559	13579	15466
11	50	0.62177	6.3274	85.36	1942.6	11625	13579	15522
12	55	0.68466	6.3314	87.688	1994.3	11680	13579	15574
13	60	0.74898	6.3355	89.559	2035.6	11732	13579	15615
14	70	0.87762	6.3437	93.531	2123.1	11810	13579	15702
15	80	1.0048	6.3519	96.909	2197	11909	13579	15776
16	90	1.1335	6.3602	99.739	2258.2	11971	13579	15837
17	100	1.2578	6.3682	101.75	2300.8	12009	13579	15880
18	110	1.3893	6.3767	104.67	2363.7	12049	13579	15943
19	120	1.518	6.385	106.77	2407.9	12118	13579	15987
20	180	2.2984	6.436	116.95	2616.6	12249	13579	16196
21	240	3.066	6.487	123.75	2747	12374	13579	16326
22	300	3.8421	6.5393	129.41	2849.7	12411	13579	16429
23	360	4.6211	6.5927	134.25	2932.3	12424	13579	16511
24	420	5.3858	6.646	138.4	2998.8	12422	13579	16578
25	480	6.1648	6.7012	142.24	3056.5	12421	13579	16636
26	540	6.9467	6.7575	145.93	3109.8	12404	13579	16689
27	600	7.7171	6.8139	149.17	3152.5	12389	13579	16732
28	660	8.4989	6.8721	152.42	3193.7	12375	13579	16773
29	720	9.2737	6.9308	155.06	3221.7	12357	13579	16801
30	780	10.038	6.9897	157.94	3253.8	12361	13579	16833
31	840	10.823	7.0512	160.54	3278.6	12331	13579	16858
32	900	11.608	7.1138	162.78	3295	12318	13579	16874
33	960	12.377	7.1763	164.83	3307.5	12289	13579	16887
34	1020	13.166	7.2415	166.7	3315	12244	13579	16894
35	1080	13.943	7.3069	168.39	3318.6	12240	13579	16898
36	1140	14.707	7.3723	169.81	3316.8	12236	13579	16896
37	1200	15.49	7.4406	171.86	3326.1	12232	13579	16905

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-6
Sample No.: S-6
Test No.: 3500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/29/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 30.0'-32.0'
Elevation: -----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWNISH GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

Specimen Height: 6.03 in
Specimen Area: 6.29 in^2
Specimen Volume: 37.93 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 40

Plastic Limit: 23

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	13579	13579	0	0.000	3493.7	3493.7	1.000	3493.7	0
2	0.06	14300	13579	310.74	0.431	3903.8	3182.9	1.226	3543.4	360.44
3	0.12	14698	13579	606.34	0.542	4006.6	2887.3	1.388	3447	559.64
4	0.18	14889	13579	687.81	0.525	4115.4	2805.9	1.467	3460.6	654.76
5	0.25	15035	13579	853.07	0.586	4096.3	2640.6	1.551	3368.4	727.85
6	0.31	15153	13579	1075.4	0.683	3991.9	2418.3	1.651	3205.1	786.81
7	0.37	15249	13579	1206.9	0.723	3956.3	2286.8	1.730	3121.5	834.75
8	0.43	15335	13579	1313.9	0.748	3935.6	2179.7	1.806	3057.7	877.92
9	0.49	15406	13579	1400.1	0.767	3920.1	2093.6	1.872	3006.9	913.27
10	0.56	15466	13579	1473.4	0.781	3907	2020.3	1.934	2963.6	943.36
11	0.62	15522	13579	1539.7	0.793	3896.6	1953.9	1.994	2925.3	971.31
12	0.68	15574	13579	1594.4	0.799	3893.6	1899.2	2.050	2896.4	997.17
13	0.75	15615	13579	1646.8	0.809	3882.5	1846.9	2.102	2864.7	1017.8
14	0.88	15702	13579	1724.8	0.812	3892	1768.9	2.200	2830.5	1061.6
15	1.00	15776	13579	1823.7	0.830	3866.9	1670	2.316	2768.5	1098.5
16	1.13	15837	13579	1885.4	0.835	3866.5	1608.3	2.404	2737.4	1129.1
17	1.26	15880	13579	1923.8	0.836	3870.6	1569.9	2.466	2720.3	1150.4
18	1.39	15943	13579	1963.3	0.831	3894	1530.3	2.545	2712.2	1181.8
19	1.52	15987	13579	2032	0.844	3869.6	1461.7	2.647	2665.6	1204
20	2.30	16196	13579	2163.5	0.827	3946.8	1330.1	2.967	2638.4	1308.3
21	3.07	16326	13579	2288	0.833	3952.6	1205.6	3.279	2579.1	1373.5
22	3.84	16429	13579	2325.3	0.816	4018.1	1168.4	3.439	2593.2	1424.8
23	4.62	16511	13579	2338.1	0.797	4087.8	1155.6	3.537	2621.7	1466.1
24	5.39	16578	13579	2336.9	0.779	4155.5	1156.7	3.592	2656.1	1499.4
25	6.16	16636	13579	2335.8	0.764	4214.4	1157.9	3.640	2686.1	1528.2
26	6.95	16689	13579	2318.3	0.745	4285.2	1175.4	3.646	2730.3	1554.9
27	7.72	16732	13579	2303.2	0.731	4343	1190.5	3.648	2766.8	1576.3
28	8.50	16773	13579	2289.2	0.717	4398.2	1204.5	3.652	2801.3	1596.9
29	9.27	16801	13579	2271.7	0.705	4443.6	1221.9	3.637	2832.8	1610.9
30	10.04	16833	13579	2275.2	0.699	4472.2	1218.4	3.670	2845.3	1626.9
31	10.82	16858	13579	2245	0.685	4527.2	1248.7	3.626	2888	1639.3
32	11.61	16874	13579	2232.2	0.677	4556.5	1261.5	3.612	2909	1647.5
33	12.38	16887	13579	2203.1	0.666	4598.1	1290.6	3.563	2944.3	1653.8
34	13.17	16894	13579	2158.9	0.651	4649.8	1334.8	3.483	2992.3	1657.5
35	13.94	16898	13579	2154.2	0.649	4658	1339.5	3.478	2998.7	1659.3
36	14.71	16896	13579	2150.7	0.648	4659.7	1343	3.470	3001.3	1658.4
37	15.49	16905	13579	2146.1	0.645	4673.7	1347.6	3.468	3010.6	1663

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-6
Sample No.: S-6
Test No.: 4500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/29/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 30.0'-32.0'
Elevation: ----

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Soil Description: BROWNISH GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.02 in
Specimen Area: 6.37 in^2
Specimen Volume: 38.40 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.3741	0	0	10081	14573	14573
2	5.004	0.043975	6.3769	38.655	872.89	10609	14573	15446
3	10.004	0.10615	6.3809	58.795	1326.9	10925	14573	15900
4	15.004	0.17287	6.3851	69.967	1577.9	11150	14573	16151
5	20.004	0.23959	6.3894	78.044	1758.9	11325	14573	16332
6	25.004	0.30631	6.3937	84.6	1905.4	11475	14573	16478
7	30.004	0.37606	6.3982	90.265	2031.5	11605	14573	16604
8	35.004	0.4443	6.4026	94.671	2129.2	11714	14573	16702
9	40.004	0.51253	6.4069	98.867	2222.1	11810	14573	16795
10	45.004	0.58077	6.4113	102.91	2311.3	11896	14573	16884
11	50.004	0.64901	6.4157	106.1	2381.5	11970	14573	16954
12	55.004	0.71876	6.4203	108.94	2443.3	12037	14573	17016
13	60.004	0.787	6.4247	111.87	2507.5	12096	14573	17080
14	70.004	0.92499	6.4336	116.75	2613.2	12202	14573	17186
15	80.004	1.0645	6.4427	120.79	2699.8	12293	14573	17273
16	90	1.2025	6.4517	124.57	2780.3	12369	14573	17353
17	100	1.339	6.4606	127.87	2850.1	12430	14573	17423
18	110	1.4769	6.4697	130.97	2915	12486	14573	17488
19	120	1.6165	6.4788	133.75	2972.6	12537	14573	17545
20	180	2.4444	6.5338	147.07	3241.2	12724	14573	17814
21	240	3.2754	6.59	156.4	3417.6	12813	14573	17990
22	300	4.1048	6.647	163.54	3542.9	12855	14573	18116
23	360	4.9282	6.7045	169.88	3648.7	12874	14573	18222
24	420	5.7607	6.7637	175.81	3743	12878	14573	18316
25	480	6.5932	6.824	180.42	3807.3	12866	14573	18380
26	540	7.4166	6.8847	185.04	3870.3	12856	14573	18443
27	600	8.2521	6.9474	189.18	3921.2	12834	14573	18494
28	660	9.0846	7.011	192.65	3956.8	12817	14573	18530
29	720	9.9095	7.0752	196.11	3991.3	12789	14573	18564
30	780	10.745	7.1415	199.1	4014.6	12771	14573	18587
31	840	11.576	7.2086	201.67	4028.5	12748	14573	18601
32	900	12.401	7.2765	204.76	4052.2	12734	14573	18625
33	960	13.236	7.3465	205.97	4037.2	12712	14573	18610
34	1020	14.07	7.4178	208.12	4040.1	12694	14573	18613
35	1080	14.898	7.49	210.43	4045.6	12680	14573	18618

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Location: NEWBURGH, IN
Project No.: MR155242
Boring No.: B-3 S-6
Tested By: BCM
Checked By: WPQ
Sample No.: S-6
Test Date: 11/29/15
Depth: 30.0'-32.0'
Test No.: 4500 PSF
Sample Type: 3.0" ST
Elevation: ----

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Soil Description: BROWNISH GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.02 in
Piston Area: 0.00 in^2
Filter Strip Correction: 0.00 psf
Specimen Area: 6.37 in^2
Piston Friction: 0.00 lb
Membrane Correction: 0.00 lb/in
Specimen Volume: 38.40 in^3
Piston Weight: 0.00 lb
Correction Type: Uniform

Liquid Limit: 40
Plastic Limit: 23
Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	14573	14573	0	0.000	4492.3	4492.3	1.000	4492.3	0
2	0.04	15446	14573	528.84	0.606	4836.3	3963.5	1.220	4399.9	436.44
3	0.11	15900	14573	844.51	0.636	4974.6	3647.8	1.364	4311.2	663.43
4	0.17	16151	14573	1069.3	0.678	5000.9	3423	1.461	4211.9	788.96
5	0.24	16332	14573	1244	0.707	5007.1	3248.2	1.541	4127.7	879.45
6	0.31	16478	14573	1394.3	0.732	5003.4	3098	1.615	4050.7	952.69
7	0.38	16604	14573	1524.8	0.751	4999.1	2967.5	1.685	3983.3	1015.8
8	0.44	16702	14573	1633.1	0.767	4988.4	2859.2	1.745	3923.8	1064.6
9	0.51	16795	14573	1729.8	0.778	4984.6	2762.5	1.804	3873.5	1111
10	0.58	16884	14573	1816	0.786	4987.6	2676.3	1.864	3831.9	1155.6
11	0.65	16954	14573	1889.4	0.793	4984.4	2602.9	1.915	3793.7	1190.7
12	0.72	17016	14573	1956.9	0.801	4978.7	2535.4	1.964	3757	1221.7
13	0.79	17080	14573	2015.2	0.804	4984.6	2477.1	2.012	3730.9	1253.7
14	0.92	17186	14573	2121.2	0.812	4984.3	2371.1	2.102	3677.7	1306.6
15	1.06	17273	14573	2212	0.819	4980	2280.3	2.184	3630.1	1349.9
16	1.20	17353	14573	2288.9	0.823	4983.7	2203.4	2.262	3593.5	1390.1
17	1.34	17423	14573	2349.5	0.824	4992.9	2142.8	2.330	3567.9	1425.1
18	1.48	17488	14573	2405.4	0.825	5001.9	2086.9	2.397	3544.4	1457.5
19	1.62	17545	14573	2456.6	0.826	5008.3	2035.6	2.460	3522	1486.3
20	2.44	17814	14573	2643	0.815	5090.5	1849.3	2.753	3469.9	1620.6
21	3.28	17990	14573	2732.7	0.800	5177.2	1759.6	2.942	3468.4	1708.8
22	4.10	18116	14573	2774.6	0.783	5260.5	1717.6	3.063	3489.1	1771.4
23	4.93	18222	14573	2793.3	0.766	5347.8	1699	3.148	3523.4	1824.4
24	5.76	18316	14573	2797.9	0.748	5437.3	1694.3	3.209	3565.8	1871.5
25	6.59	18380	14573	2785.1	0.732	5514.5	1707.2	3.230	3610.8	1903.7
26	7.42	18443	14573	2775.8	0.717	5586.8	1716.5	3.255	3651.6	1935.1
27	8.25	18494	14573	2753.7	0.702	5659.9	1738.6	3.255	3699.2	1960.6
28	9.08	18530	14573	2736.2	0.692	5712.8	1756.1	3.253	3734.5	1978.4
29	9.91	18564	14573	2708.2	0.679	5775.4	1784	3.237	3779.7	1995.7
30	10.75	18587	14573	2690.8	0.670	5816.1	1801.5	3.228	3808.8	2007.3
31	11.58	18601	14573	2667.5	0.662	5853.3	1824.8	3.208	3839.1	2014.3
32	12.40	18625	14573	2653.5	0.655	5891	1838.8	3.204	3864.9	2026.1
33	13.24	18610	14573	2631.4	0.652	5898.1	1860.9	3.169	3879.5	2018.6
34	14.07	18613	14573	2613.9	0.647	5918.5	1878.4	3.151	3898.5	2020.1
35	14.90	18618	14573	2599.9	0.643	5937.9	1892.4	3.138	3915.2	2022.8

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-6
Sample No.: S-6
Test No.: 5500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/29/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 30.0'-32.0'
Elevation: ----

Terracon Consulting Engineers & Scientists

Soil Description: BROWNISH GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.17 in
Specimen Area: 6.33 in^2
Specimen Volume: 39.06 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.3319	0	0	10089	15581	15581
2	5.0041	0.049637	6.335	41.819	950.58	10693	15581	16531
3	10.004	0.11323	6.3391	66.964	1521.2	11080	15581	17102
4	15.004	0.17528	6.343	81.044	1839.9	11377	15581	17421
5	20.004	0.24198	6.3473	91.579	2077.6	11621	15581	17658
6	25.004	0.30558	6.3513	99.625	2258.7	11820	15581	17840
7	30.004	0.37383	6.3557	106.24	2407.1	11989	15581	17988
8	35.004	0.42502	6.3589	108.04	2446.6	12092	15581	18027
9	40	0.48861	6.363	115.61	2616.4	12238	15581	18197
10	45	0.55221	6.3671	120.01	2714.1	12348	15581	18295
11	50	0.61891	6.3713	123.92	2800.8	12446	15581	18382
12	55	0.68561	6.3756	127.31	2875.4	12535	15581	18456
13	60	0.75076	6.3798	130.43	2944	12612	15581	18525
14	70	0.88416	6.3884	135.89	3063	12753	15581	18644
15	80	1.0145	6.3968	140.44	3161.4	12869	15581	18742
16	90	1.151	6.4056	144.41	3246.3	12965	15581	18827
17	100	1.2859	6.4144	147.9	3320.3	13045	15581	18901
18	110	1.4193	6.4231	151.4	3394.2	13119	15581	18975
19	120	1.5527	6.4318	154.52	3459.5	13182	15581	19040
20	180	2.3547	6.4846	168.71	3746.4	13420	15581	19327
21	240	3.1582	6.5384	178.82	3938.2	13542	15581	19519
22	300	3.9616	6.5931	186.92	4082.4	13600	15581	19663
23	360	4.7651	6.6487	193.48	4190.4	13629	15581	19771
24	420	5.5702	6.7054	199.04	4274.4	13633	15581	19855
25	480	6.369	6.7626	204.65	4357.7	13627	15581	19939
26	540	7.1725	6.8211	209.68	4426.5	13616	15581	20007
27	600	7.9853	6.8814	214.28	4484.1	13595	15581	20065
28	660	8.795	6.9425	218.41	4530.3	13575	15581	20111
29	720	9.6001	7.0043	222.12	4566.5	13557	15581	20147
30	780	10.416	7.0681	225.66	4597.5	13532	15581	20178
31	840	11.221	7.1322	228.84	4620.3	13508	15581	20201
32	900	12.031	7.1979	230.8	4617.4	13490	15581	20198
33	960	12.845	7.2651	232.97	4617.6	13470	15581	20198
34	1020	13.65	7.3328	234.56	4606.2	13449	15581	20187
35	1080	14.458	7.4021	236.83	4607.3	13437	15581	20188
36	1140	15.266	7.4727	239.11	4607.7	13418	15581	20188

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-6
Sample No.: S-6
Test No.: 5500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 11/29/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 30.0'-32.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWNISH GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.17 in
Specimen Area: 6.33 in^2
Specimen Volume: 39.06 in^3

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 40

Plastic Limit: 23

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	15581	15581	0	0.000	5491.7	5491.7	1.000	5491.7	0
2	0.05	16531	15581	604.18	0.636	5838.1	4887.5	1.194	5362.8	475.29
3	0.11	17102	15581	991.41	0.652	6021.5	4500.3	1.338	5260.9	760.58
4	0.18	17421	15581	1287.7	0.700	6043.9	4204.1	1.438	5124	919.94
5	0.24	17658	15581	1531.4	0.737	6037.9	3960.3	1.525	4999.1	1038.8
6	0.31	17840	15581	1730.9	0.766	6019.6	3760.8	1.601	4890.2	1129.4
7	0.37	17988	15581	1900	0.789	5998.8	3591.7	1.670	4795.3	1203.6
8	0.43	18027	15581	2002.7	0.819	5935.7	3489.1	1.701	4712.4	1223.3
9	0.49	18197	15581	2148.4	0.821	5959.7	3343.3	1.783	4651.5	1308.2
10	0.55	18295	15581	2259.3	0.832	5946.5	3232.5	1.840	4589.5	1357
11	0.62	18382	15581	2357.2	0.842	5935.3	3134.5	1.894	4534.9	1400.4
12	0.69	18456	15581	2445.9	0.851	5921.3	3045.8	1.944	4483.6	1437.7
13	0.75	18525	15581	2522.9	0.857	5912.9	2968.9	1.992	4440.9	1472
14	0.88	18644	15581	2664	0.870	5890.7	2827.7	2.083	4359.2	1531.5
15	1.01	18742	15581	2779.5	0.879	5873.7	2712.3	2.166	4293	1580.7
16	1.15	18827	15581	2876.3	0.886	5861.8	2615.5	2.241	4238.6	1623.2
17	1.29	18901	15581	2955.6	0.890	5856.5	2536.1	2.309	4196.3	1660.2
18	1.42	18975	15581	3030.2	0.893	5855.7	2461.5	2.379	4158.6	1697.1
19	1.55	19040	15581	3093.2	0.894	5858	2398.5	2.442	4128.3	1729.8
20	2.35	19327	15581	3331.1	0.889	5906.9	2160.6	2.734	4033.8	1873.2
21	3.16	19519	15581	3452.4	0.877	5977.5	2039.3	2.931	4008.4	1969.1
22	3.96	19663	15581	3510.8	0.860	6063.4	1981	3.061	4022.2	2041.2
23	4.77	19771	15581	3539.9	0.845	6142.2	1951.8	3.147	4047	2095.2
24	5.57	19855	15581	3543.4	0.829	6222.7	1948.3	3.194	4085.5	2137.2
25	6.37	19939	15581	3537.6	0.812	6311.8	1954.1	3.230	4133	2178.9
26	7.17	20007	15581	3527.1	0.797	6391.1	1964.6	3.253	4177.9	2213.2
27	7.99	20065	15581	3506.1	0.782	6469.7	1985.6	3.258	4227.7	2242
28	8.80	20111	15581	3486.3	0.770	6535.7	2005.4	3.259	4270.6	2265.1
29	9.60	20147	15581	3467.6	0.759	6590.6	2024.1	3.256	4307.3	2283.2
30	10.42	20178	15581	3443.1	0.749	6646.1	2048.6	3.244	4347.4	2298.8
31	11.22	20201	15581	3418.6	0.740	6693.4	2073.1	3.229	4383.3	2310.2
32	12.03	20198	15581	3401.1	0.737	6708	2090.6	3.209	4399.3	2308.7
33	12.85	20198	15581	3381.3	0.732	6728.1	2110.4	3.188	4419.2	2308.8
34	13.65	20187	15581	3360.3	0.730	6737.6	2131.4	3.161	4434.5	2303.1
35	14.46	20188	15581	3347.5	0.727	6751.6	2144.2	3.149	4447.9	2303.7
36	15.27	20188	15581	3328.8	0.722	6770.6	2162.9	3.130	4466.7	2303.8

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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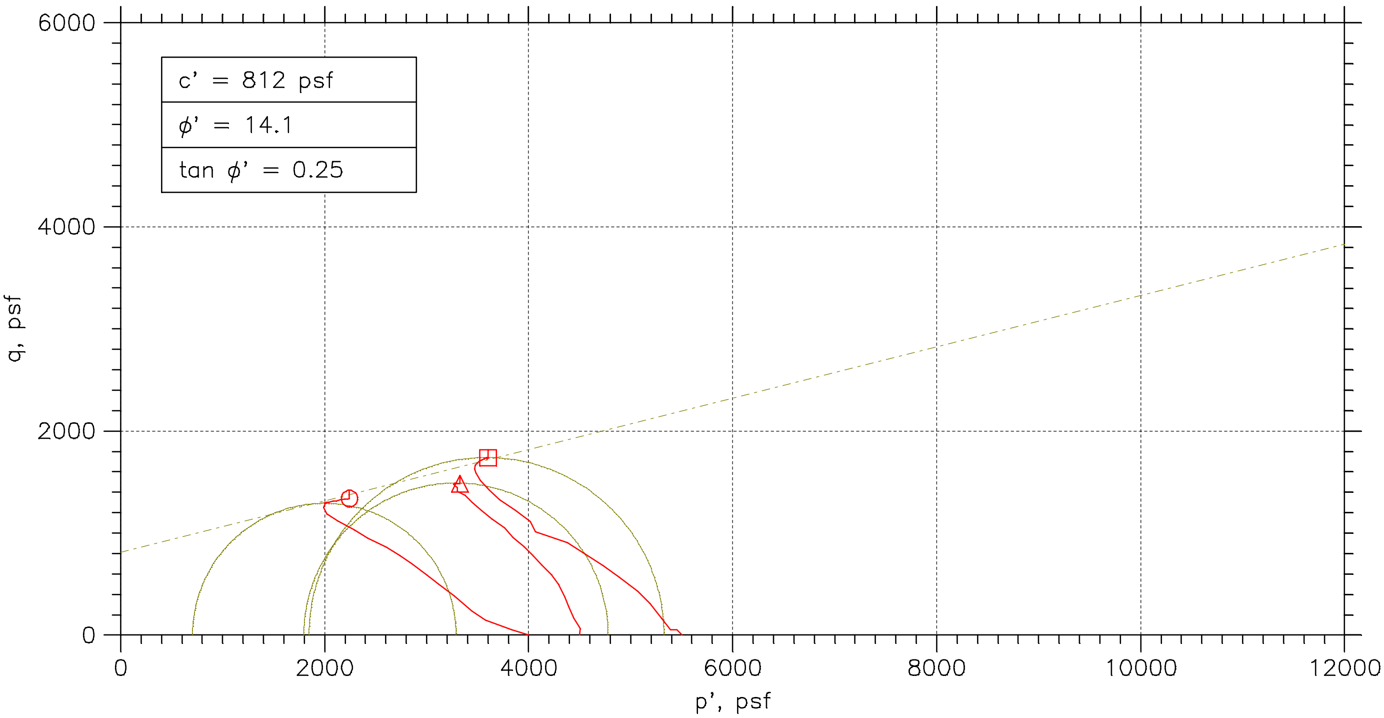

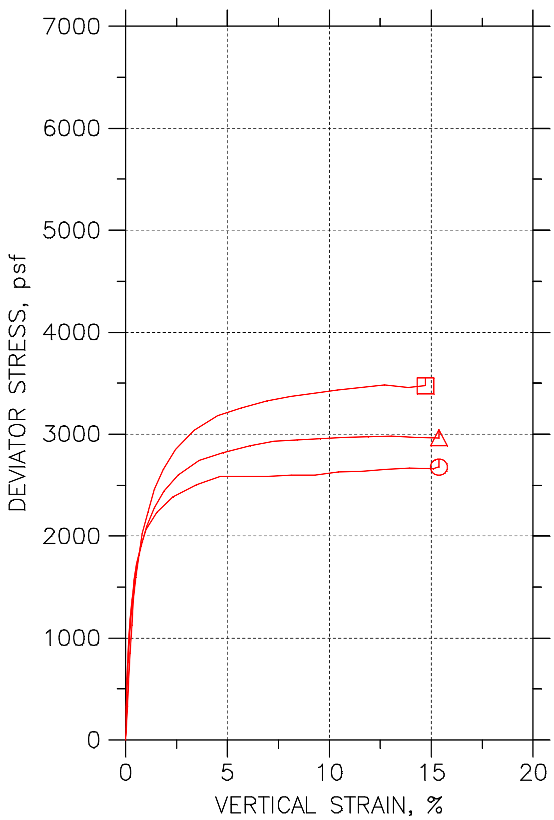

Symbol		○	△	□	
Test No.		4000 PSF	4500 PSF	5500 PSF	
Initial	Diameter, in	2.86	2.86	2.823	
	Height, in	6.17	6.17	6.203	
	Water Content, %	27.72	29.02	29.02	
	Dry Density, pcf	94.67	93.72	95.	
	Saturation, %	95.02	97.23	100.23	
	Void Ratio	0.79364	0.81181	0.78746	
Before Shear	Water Content, %	23.57	23.57	23.57	
	Dry Density, pcf	103.5	103.5	103.5	
	Saturation, %	100.00	100.00	100.00	
	Void Ratio	0.6411	0.6411	0.6411	
	Back Press., psf	8467.2	8640	8640	
Minor Prin. Stress, psf		4000	4499.5	5500	
Max. Dev. Stress, psf		2676.4	2983	3480.3	
Time to Failure, min		240	220	220	
Strain Rate, %/min		0.001	0.001	0.001	
B-Value		0.97	0.98	0.95	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	
Plasticity Index		---	---	---	
Failure Sketch					

NOTE:5500 PSF SAMPLE FAILED DURING TEST

Project: VECTREN F.B. CULLEY	
Location: NEWBURGH, IN	
Project No.: MR155242	
Boring No.: B-3 S-10	
Sample Type: 3.0'' ST	
Description: OLIVE BROWN LEAN CLAY CL	
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.	

Fri, 04-DEC-2015 15:11:07

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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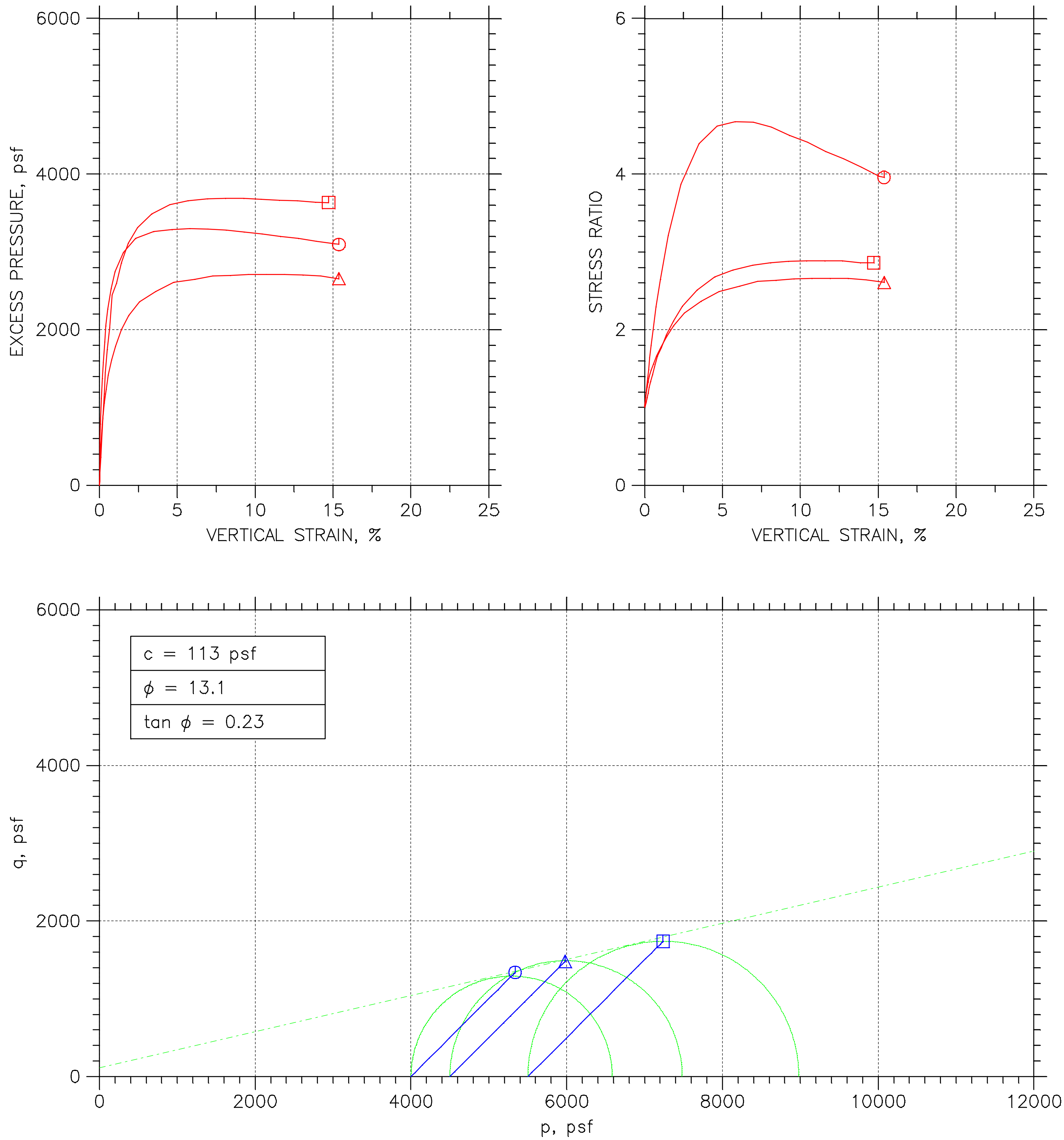

Project: VECTREN F.B. CULLEY	Location: NEWBURGH, IN	Project No.: MR155242
Boring No.: B-3 S-10	Tested By: BCM	Checked By: WPQ
Sample No.: S-10	Test Date: 12/3/15	Depth: 45.0'-47.5'
Test No.: B-3 S-10	Sample Type: 3.0" ST	Elevation: ----
Description: OLIVE BROWN LEAN CLAY CL		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.		

Fri, 04-DEC-2015 15:12:07

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-10
Sample No.: S-10
Test No.: 4000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 12/3/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 45.0'-47.5'
Elevation: ----

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Soil Description: OLIVE BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.17 in
Specimen Area: 6.42 in^2
Specimen Volume: 649.54 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.4242	0	0	8467.2	12467	12467
2	5.0001	0.018963	6.4255	4.7	105.33	8683.5	12467	12573
3	10	0.046353	6.4272	13.2	295.74	9035.6	12467	12763
4	15	0.075851	6.4291	21.1	472.6	9256.5	12467	12940
5	20	0.13485	6.4329	34.3	767.8	9581.6	12467	13235
6	25	0.19173	6.4366	44.3	991.08	9841.8	12467	13458
7	30	0.25073	6.4404	52.5	1173.8	10049	12467	13641
8	35	0.33712	6.446	62.3	1391.8	10310	12467	13859
9	40	0.4235	6.4516	70	1562.4	10515	12467	14030
10	45	0.53938	6.4591	77.5	1727.8	10730	12467	14195
11	50	0.74165	6.4722	85.5	1902.3	10997	12467	14369
12	55	1.0029	6.4893	93.1	2065.9	11212	12467	14533
13	60	1.5254	6.5238	101.3	2236	11457	12467	14703
14	70	2.3366	6.5779	108.8	2381.8	11638	12467	14849
15	80	3.4955	6.6569	115.8	2504.9	11728	12467	14972
16	90	4.6543	6.7378	120.9	2583.9	11752	12467	15051
17	100	5.8131	6.8207	122.4	2584.1	11763	12467	15051
18	110	6.9741	6.9059	124	2585.6	11762	12467	15053
19	120	8.1329	6.993	126.2	2598.7	11747	12467	15066
20	180	9.2917	7.0823	127.8	2598.5	11725	12467	15066
21	190	10.451	7.174	130.9	2627.5	11696	12467	15095
22	200	11.609	7.268	132.9	2633.1	11668	12467	15100
23	210	12.768	7.3646	135.6	2651.4	11638	12467	15119
24	220	13.927	7.4637	138.1	2664.4	11605	12467	15132
25	230	15.086	7.5656	139.7	2659	11571	12467	15126
26	240	15.377	7.5916	141.1	2676.4	11562	12467	15144

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-10
Sample No.: S-10
Test No.: 4000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 12/3/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 45.0'-47.5'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: OLIVE BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.17 in
Specimen Area: 6.42 in^2
Specimen Volume: 649.54 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	12467	12467	0	0.000	4000	4000	1.000	4000	0
2	0.02	12573	12467	216.34	2.054	3889	3783.7	1.028	3836.3	52.665
3	0.05	12763	12467	568.43	1.922	3727.3	3431.6	1.086	3579.4	147.87
4	0.08	12940	12467	789.28	1.670	3683.3	3210.7	1.147	3447	236.3
5	0.13	13235	12467	1114.4	1.451	3653.4	2885.6	1.266	3269.5	383.9
6	0.19	13458	12467	1374.6	1.387	3616.4	2625.4	1.378	3120.9	495.54
7	0.25	13641	12467	1582.2	1.348	3591.6	2417.8	1.486	3004.7	586.92
8	0.34	13859	12467	1843	1.324	3548.7	2157	1.645	2852.8	695.88
9	0.42	14030	12467	2048.2	1.311	3514.2	1951.8	1.801	2733	781.21
10	0.54	14195	12467	2262.6	1.310	3465.2	1737.4	1.994	2601.3	863.9
11	0.74	14369	12467	2529.7	1.330	3372.6	1470.3	2.294	2421.4	951.14
12	1.00	14533	12467	2744.4	1.328	3321.6	1255.6	2.645	2288.6	1033
13	1.53	14703	12467	2990.1	1.337	3246	1009.9	3.214	2128	1118
14	2.34	14849	12467	3170.5	1.331	3211.2	829.46	3.871	2020.3	1190.9
15	3.50	14972	12467	3260.6	1.302	3244.4	739.42	4.388	1991.9	1252.5
16	4.65	15051	12467	3285.1	1.271	3298.7	714.87	4.614	2006.8	1291.9
17	5.81	15051	12467	3296.3	1.276	3287.8	703.72	4.672	1995.8	1292.1
18	6.97	15053	12467	3295.3	1.274	3290.3	704.71	4.669	1997.5	1292.8
19	8.13	15066	12467	3279.5	1.262	3319.2	720.51	4.607	2019.9	1299.4
20	9.29	15066	12467	3257.5	1.254	3341	742.53	4.499	2041.8	1299.2
21	10.45	15095	12467	3228.7	1.229	3398.8	771.32	4.407	2085.1	1313.8
22	11.61	15100	12467	3200.5	1.215	3432.7	799.54	4.293	2116.1	1316.6
23	12.77	15119	12467	3170.7	1.196	3480.7	829.32	4.197	2155	1325.7
24	13.93	15132	12467	3137.5	1.178	3526.9	862.48	4.089	2194.7	1332.2
25	15.09	15126	12467	3103.9	1.167	3555.1	896.07	3.967	2225.6	1329.5
26	15.38	15144	12467	3094.9	1.156	3581.5	905.1	3.957	2243.3	1338.2

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-10
Sample No.: S-10
Test No.: 4500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 12/3/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 45.0'-47.5'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: OLIVE BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.17 in
Specimen Area: 6.42 in^2
Specimen Volume: 649.54 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.4242	0	0	8640	13140	13140
2	5.0001	0.018963	6.4255	5.832	130.7	8696.3	13140	13270
3	10	0.04846	6.4274	14.544	325.85	8860.2	13140	13465
4	15	0.077958	6.4293	24.984	559.58	9023.9	13140	13699
5	20	0.10746	6.4312	33.192	743.2	9158.8	13140	13883
6	25	0.16434	6.4348	44.784	1002.2	9348.5	13140	14142
7	30	0.22334	6.4386	53.064	1186.8	9512.4	13140	14326
8	35	0.30972	6.4442	61.632	1377.2	9696.1	13140	14517
9	40	0.42561	6.4517	69.84	1558.8	9876.1	13140	14698
10	45	0.57099	6.4611	77.832	1734.6	10056	13140	14874
11	50	0.77326	6.4743	86.184	1916.9	10249	13140	15056
12	55	1.0345	6.4914	94.464	2095.5	10425	13140	15235
13	60	1.4117	6.5162	103.1	2278.5	10640	13140	15418
14	70	1.8752	6.547	110.88	2438.8	10819	13140	15578
15	80	2.5705	6.5937	119.09	2600.8	10997	13140	15740
16	90	3.6135	6.6651	126.94	2742.5	11132	13140	15882
17	100	4.7723	6.7462	132.05	2818.6	11248	13140	15958
18	110	6.106	6.842	137.16	2886.7	11284	13140	16026
19	120	7.2648	6.9275	140.9	2928.9	11330	13140	16068
20	180	8.4237	7.0152	143.5	2945.5	11336	13140	16085
21	190	9.5825	7.1051	145.87	2956.4	11352	13140	16096
22	200	10.741	7.1973	148.25	2966.1	11351	13140	16106
23	210	11.9	7.292	150.62	2974.5	11348	13140	16114
24	220	13.061	7.3894	153.07	2983	11344	13140	16122
25	230	14.22	7.4892	154.37	2968.1	11329	13140	16108
26	240	15.379	7.5918	156.24	2963.5	11294	13140	16103

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-10
Sample No.: S-10
Test No.: 4500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 12/3/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 45.0'-47.5'
Elevation: ----

Terracon Consulting Engineers & Scientists

Soil Description: OLIVE BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.17 in
Specimen Area: 6.42 in^2
Specimen Volume: 649.54 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---
Plastic Limit: ---
Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	13140	13140	0	0.000	4499.5	4499.5	1.000	4499.5	0
2	0.02	13270	13140	56.304	0.431	4573.9	4443.2	1.029	4508.5	65.35
3	0.05	13465	13140	220.18	0.676	4605.2	4279.3	1.076	4442.2	162.92
4	0.08	13699	13140	383.9	0.686	4675.2	4115.6	1.136	4395.4	279.79
5	0.11	13883	13140	518.83	0.698	4723.9	3980.7	1.187	4352.3	371.6
6	0.16	14142	13140	708.48	0.707	4793.2	3791	1.264	4292.1	501.09
7	0.22	14326	13140	872.35	0.735	4813.9	3627.1	1.327	4220.5	593.39
8	0.31	14517	13140	1056.1	0.767	4820.6	3443.4	1.400	4132	688.6
9	0.43	14698	13140	1236.1	0.793	4822.2	3263.4	1.478	4042.8	779.4
10	0.57	14874	13140	1416.1	0.816	4818.1	3083.4	1.563	3950.7	867.32
11	0.77	15056	13140	1609.1	0.839	4807.3	2890.4	1.663	3848.9	958.44
12	1.03	15235	13140	1784.7	0.852	4810.3	2714.8	1.772	3762.5	1047.8
13	1.41	15418	13140	2000	0.878	4777.9	2499.5	1.912	3638.7	1139.2
14	1.88	15578	13140	2179	0.893	4759.3	2320.5	2.051	3539.9	1219.4
15	2.57	15740	13140	2357.1	0.906	4743.1	2142.4	2.214	3442.7	1300.4
16	3.61	15882	13140	2491.6	0.909	4750.3	2007.9	2.366	3379.1	1371.2
17	4.77	15958	13140	2608.1	0.925	4710	1891.4	2.490	3300.7	1409.3
18	6.11	16026	13140	2644.4	0.916	4741.8	1855.1	2.556	3298.4	1443.4
19	7.26	16068	13140	2689.6	0.918	4738.8	1809.9	2.618	3274.3	1464.5
20	8.42	16085	13140	2695.7	0.915	4749.4	1803.8	2.633	3276.6	1472.8
21	9.58	16096	13140	2711.7	0.917	4744.2	1787.8	2.654	3266	1478.2
22	10.74	16106	13140	2710.9	0.914	4754.6	1788.6	2.658	3271.6	1483
23	11.90	16114	13140	2708.4	0.911	4765.6	1791.1	2.661	3278.4	1487.2
24	13.06	16122	13140	2704.2	0.907	4778.3	1795.3	2.662	3286.8	1491.5
25	14.22	16108	13140	2689.1	0.906	4778.6	1810.4	2.639	3294.5	1484.1
26	15.38	16103	13140	2654.5	0.896	4808.6	1845	2.606	3326.8	1481.8

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-10
Sample No.: S-10
Test No.: 5500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 12/3/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 45.0'-47.5'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: OLIVE BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.20 in
Specimen Area: 6.26 in^2
Specimen Volume: 636.23 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

Plastic Limit: ---

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psf	Pore Pressure psf	Horizontal Stress psf	Vertical Stress psf
1	0	0	6.2591	0	0	8640	14140	14140
2	5.0001	0.018862	6.2603	4.8	110.41	8739.9	14140	14250
3	10	0.046107	6.262	4.32	99.342	8800.8	14140	14239
4	15	0.10479	6.2657	14.4	330.95	9002.9	14140	14471
5	20	0.16137	6.2692	26.8	615.58	9258.8	14140	14756
6	25	0.22005	6.2729	37.28	855.8	9496.7	14140	14996
7	30	0.30598	6.2783	49.28	1130.3	9817.1	14140	15270
8	35	0.39191	6.2837	59.6	1365.8	10090	14140	15506
9	40	0.50717	6.291	69.52	1591.3	10380	14140	15731
10	45	0.65178	6.3002	79.28	1812.1	10666	14140	15952
11	50	0.82573	6.3112	88.72	2024.3	11084	14140	16164
12	55	1.0856	6.3278	98.08	2232	11238	14140	16372
13	60	1.4021	6.3481	108.32	2457.1	11502	14140	16597
14	70	1.8631	6.3779	117.6	2655.2	11753	14140	16795
15	80	2.4395	6.4156	126.8	2846.1	11951	14140	16986
16	90	3.3616	6.4768	136.48	3034.4	12129	14140	17174
17	100	4.5143	6.555	144.72	3179.2	12244	14140	17319
18	110	5.669	6.6353	150.08	3257.1	12296	14140	17397
19	120	6.937	6.7257	155.28	3324.6	12324	14140	17465
20	180	8.0896	6.81	159.28	3368	12329	14140	17508
21	190	9.2423	6.8965	162.96	3402.6	12329	14140	17543
22	200	10.395	6.9852	166.64	3435.3	12317	14140	17575
23	210	11.548	7.0762	169.84	3456.2	12305	14140	17596
24	220	12.7	7.1697	173.28	3480.3	12294	14140	17620
25	230	13.853	7.2656	174.48	3458.1	12279	14140	17598
26	240	14.719	7.3393	177.04	3473.6	12273	14140	17614

TRIAXIAL TEST

Project: VECTREN F.B. CULLEY
Boring No.: B-3 S-10
Sample No.: S-10
Test No.: 5500 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 12/3/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 45.0'-47.5'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: OLIVE BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.20 in
Specimen Area: 6.26 in^2
Specimen Volume: 636.23 cc

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

Filter Strip Correction: 0.00 psf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: ---

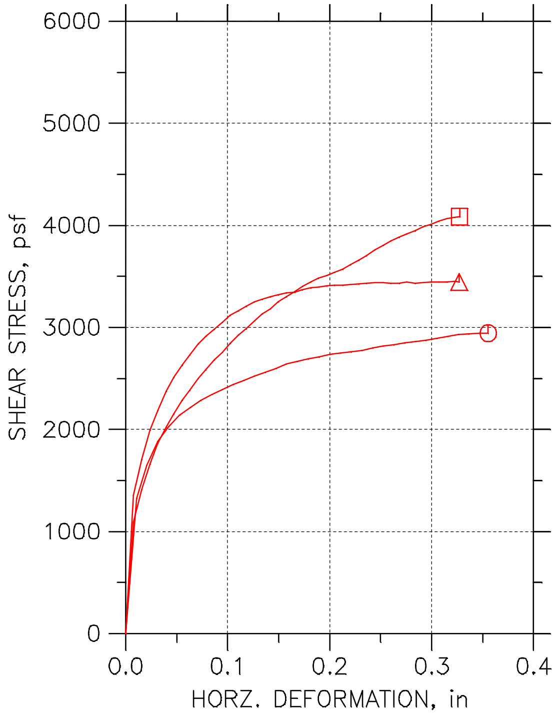
Plastic Limit: ---

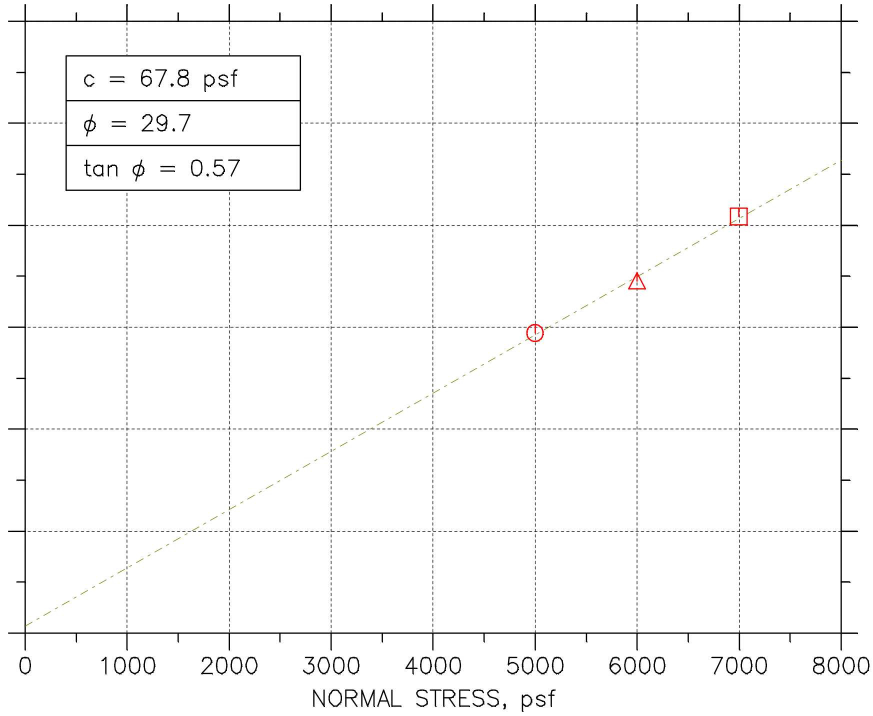
Estimated Specific Gravity: 2.72

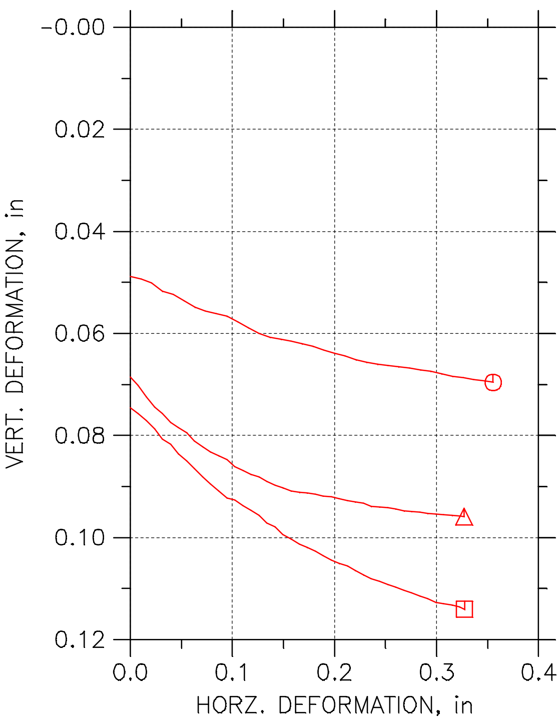
	Vertical Strain %	Total Vertical Stress psf	Total Horizontal Stress psf	Excess Pore Pressure psf	A Parameter	Effective Vertical Stress psf	Effective Horizontal Stress psf	Stress Ratio	Effective p psf	q psf
1	0.00	14140	14140	0	0.000	5500	5500	1.000	5500	0
2	0.02	14250	14140	99.936	0.905	5510.5	5400.1	1.020	5455.3	55.205
3	0.05	14239	14140	160.85	1.619	5438.5	5339.2	1.019	5388.8	49.671
4	0.10	14471	14140	362.88	1.096	5468.1	5137.1	1.064	5302.6	165.47
5	0.16	14756	14140	618.77	1.005	5496.8	4881.2	1.126	5189	307.79
6	0.22	14996	14140	856.66	1.001	5499.1	4643.3	1.184	5071.2	427.9
7	0.31	15270	14140	1177.1	1.041	5453.2	4322.9	1.261	4888.1	565.15
8	0.39	15506	14140	1449.9	1.062	5415.9	4050.1	1.337	4733	682.91
9	0.51	15731	14140	1739.7	1.093	5351.6	3760.3	1.423	4556	795.65
10	0.65	15952	14140	2025.5	1.118	5286.6	3474.5	1.522	4380.5	906.03
11	0.83	16164	14140	2443.5	1.207	5080.7	3056.5	1.662	4068.6	1012.1
12	1.09	16372	14140	2598.5	1.164	5133.5	2901.5	1.769	4017.5	1116
13	1.40	16597	14140	2861.9	1.165	5095.3	2638.1	1.931	3866.7	1228.6
14	1.86	16795	14140	3112.8	1.172	5042.3	2387.2	2.112	3714.7	1327.6
15	2.44	16986	14140	3310.6	1.163	5035.5	2189.4	2.300	3612.5	1423
16	3.36	17174	14140	3488.7	1.150	5045.7	2011.3	2.509	3528.5	1517.2
17	4.51	17319	14140	3604.3	1.134	5074.9	1895.7	2.677	3485.3	1589.6
18	5.67	17397	14140	3656.4	1.123	5100.6	1843.6	2.767	3472.1	1628.5
19	6.94	17465	14140	3684	1.108	5140.7	1816	2.831	3478.4	1662.3
20	8.09	17508	14140	3688.8	1.095	5179.2	1811.2	2.860	3495.2	1684
21	9.24	17543	14140	3688.8	1.084	5213.8	1811.2	2.879	3512.5	1701.3
22	10.39	17575	14140	3676.8	1.070	5258.5	1823.2	2.884	3540.9	1717.6
23	11.55	17596	14140	3665.4	1.061	5290.8	1834.6	2.884	3562.7	1728.1
24	12.70	17620	14140	3653.9	1.050	5326.4	1846.1	2.885	3586.3	1740.1
25	13.85	17598	14140	3638.6	1.052	5319.5	1861.4	2.858	3590.5	1729
26	14.72	17614	14140	3633.3	1.046	5340.3	1866.7	2.861	3603.5	1736.8

DIRECT SHEAR TEST REPORT

Terracon







Symbol		○	△	□	
Test No.		5000 PSF	6000 PSF	7000 PSF	
Sample No.		S-18	S-18	S-18	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.5079	2.5083	2.5075	
	Area, mm^2	3186.9	3187.9	3185.9	
	Height, in	1.0091	1.0087	1.0079	
	Water Content, %	30.19	32.74	30.06	
	Dry Density, pcf	90.988	87.646	89.006	
	Saturation, %	94.80	95.00	90.08	
	Void Ratio	0.86622	0.93738	0.90777	
Consol. Height, in		0.96026	0.94023	0.9333	
Consol. Void Ratio		0.77598	0.80594	0.76661	
Final	Water Content, %	28.76	30.81	33.67	
	Dry Density, pcf	97.729	96.852	100.36	
	Saturation, %	106.08	111.27	132.35	
	Void Ratio	0.7375	0.75322	0.69191	
Normal Stress, psf		4998.3	5997.1	6995.4	
Max. Shear Stress, psf		2943.4	3453.7	4084.3	
Ult. Shear Stress, psf		2943.4	3444.3	4084.3	
Time to Failure, min		67.392	78.162	78.908	
Disp. Rate, in/min		0.0041772	0.0041772	0.0041772	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	
Plasticity Index		---	---	---	

Project: VECTREN F.B. CULLEY	
Location: **NEWBURGH, IN**	
Project No.: MR155242	
Boring No.: B-2 S-18	
Sample Type: 3.0'' ST	
Description: DARK GRAY FAT CLAY CH SAND POCKETS NOTED	
Remarks: TEST PERFORMED AS PER ASTM D3080. SPECIMEN REMOLDED TO 108.3 PCF @ 11.0% WC	

Mon, 30-NOV-2015 14:54:01

DIRECT SHEAR TEST DATA

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-18
Sample No.: S-18
Test No.: 5000 PSF

Location:
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 58.0'-60.0'
Elevation: ----

Soil Description: DARK GRAY FAT CLAY CH SAND POCKETS NOTED
Remarks: TEST PERFORMED AS PER ASTM D3080. SPECIMEN REMOLDED TO 108.3 PCF @ 11.0% WC

	Elapsed Time min	Vertical Stress psf	Vertical Displacement mm	Horizontal Stress psf	Horizontal Displacement mm
1	0.00	5000	1.239	0	0
2	5.58	4997	1.254	1326	0.2672
3	7.47	4995	1.273	1653	0.5345
4	9.48	4998	1.313	1884	0.8017
5	11.37	4997	1.329	2028	1.069
6	13.36	5000	1.363	2140	1.336
7	15.15	4997	1.395	2213	1.603
8	17.07	4998	1.414	2284	1.871
9	18.97	4997	1.425	2340	2.138
10	20.73	4995	1.44	2394	2.405
11	22.57	4998	1.468	2442	2.672
12	24.52	4995	1.496	2481	2.94
13	26.45	4997	1.523	2524	3.207
14	28.34	4997	1.542	2559	3.474
15	30.25	4998	1.553	2599	3.741
16	32.21	4998	1.563	2639	4.009
17	34.04	4997	1.576	2669	4.279
18	35.89	4997	1.587	2693	4.543
19	37.75	4997	1.606	2712	4.81
20	39.73	4998	1.624	2735	5.078
21	41.54	4998	1.635	2749	5.345
22	43.38	4997	1.656	2762	5.612
23	45.31	4998	1.668	2776	5.879
24	47.25	4998	1.676	2797	6.147
25	49.04	4998	1.684	2816	6.414
26	51.06	4998	1.689	2830	6.681
27	52.97	4998	1.696	2846	6.948
28	54.72	4998	1.705	2860	7.214
29	56.53	4998	1.713	2877	7.481
30	58.55	4997	1.726	2895	7.749
31	60.30	4998	1.739	2910	8.016
32	62.29	4997	1.745	2929	8.283
33	64.09	4997	1.753	2938	8.55
34	65.93	4998	1.761	2942	8.817
35	67.39	4998	1.768	2943	9.026

DIRECT SHEAR TEST DATA

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-18
Sample No.: S-18
Test No.: 6000 PSF

Location:
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 58.0'-60.0'
Elevation: ----

Terracon

Soil Description: DARK GRAY FAT CLAY CH SAND POCKETS NOTED
Remarks: TEST PERFORMED AS PER ASTM D3080. SPECIMEN REMOLDED TO 108.3 PCF @ 11.0% WC

	Elapsed Time min	Vertical Stress psf	Vertical Displacement mm	Horizontal Stress psf	Horizontal Displacement mm
1	0.00	5997	1.74	0	0
2	2.68	5992	1.781	1356	0.2
3	4.55	5989	1.841	1705	0.4001
4	6.72	5995	1.889	1997	0.6001
5	8.40	5991	1.922	2185	0.8002
6	10.42	5992	1.967	2370	1
7	12.27	5995	1.994	2510	1.2
8	14.17	5995	2.017	2633	1.4
9	15.99	5995	2.059	2731	1.6
10	17.92	5995	2.088	2836	1.8
11	19.75	5997	2.115	2914	2
12	21.56	5995	2.134	2980	2.2
13	23.50	5995	2.152	3052	2.401
14	25.58	5995	2.187	3119	2.601
15	27.28	5995	2.207	3160	2.801
16	29.32	5995	2.225	3207	3.001
17	31.22	5997	2.239	3250	3.201
18	33.04	5995	2.261	3274	3.401
19	34.98	5997	2.279	3299	3.601
20	36.65	5997	2.291	3321	3.801
21	38.73	5997	2.309	3341	4.001
22	40.54	5997	2.315	3343	4.201
23	42.36	5997	2.318	3369	4.401
24	44.35	5997	2.325	3388	4.601
25	46.21	5997	2.334	3397	4.801
26	48.18	5997	2.338	3408	5.001
27	49.87	5997	2.345	3413	5.201
28	51.81	5997	2.356	3411	5.4
29	53.65	5997	2.361	3422	5.6
30	55.69	5997	2.37	3427	5.8
31	57.43	5997	2.385	3432	6
32	59.25	5997	2.387	3436	6.2
33	61.14	5997	2.392	3436	6.4
34	63.16	5999	2.397	3435	6.6
35	65.00	5997	2.406	3432	6.8
36	66.84	5999	2.41	3447	7
37	68.75	5997	2.414	3433	7.2
38	70.63	5999	2.419	3441	7.4
39	72.40	5997	2.424	3444	7.601
40	74.53	5997	2.426	3446	7.801
41	76.28	5997	2.428	3447	8.001
42	78.16	5997	2.432	3454	8.201
43	79.03	5999	2.435	3444	8.302

DIRECT SHEAR TEST DATA

Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-18
Sample No.: S-18
Test No.: 7000 PSF

Location:
Tested By: BCM
Test Date: 11/28/15
Sample Type: 3.0" ST

Project No.: MR155242
Checked By: WPQ
Depth: 58.0'-60.0'
Elevation: ----

Terracon

Soil Description: DARK GRAY FAT CLAY CH SAND POCKETS NOTED
Remarks: TEST PERFORMED AS PER ASTM D3080. SPECIMEN REMOLDED TO 108.3 PCF @ 11.0% WC

	Elapsed Time min	Vertical Stress psf	Vertical Displacement mm	Horizontal Stress psf	Horizontal Displacement mm
1	0.00	6997	1.894	0	0
2	2.28	6994	1.923	1090	0.2
3	4.10	6992	1.957	1411	0.4001
4	6.07	6992	2	1664	0.6001
5	7.89	6991	2.05	1866	0.8002
6	9.69	6997	2.077	2018	1
7	11.73	6995	2.123	2155	1.2
8	13.79	6995	2.158	2282	1.4
9	15.54	6992	2.195	2382	1.6
10	17.57	6992	2.237	2495	1.8
11	19.42	6994	2.272	2586	2
12	21.32	6992	2.307	2677	2.2
13	23.24	6995	2.343	2754	2.401
14	25.12	6992	2.354	2842	2.601
15	27.05	6992	2.383	2922	2.801
16	28.81	6995	2.405	2990	3.001
17	30.71	6994	2.431	3062	3.201
18	32.67	6992	2.467	3130	3.401
19	34.53	6992	2.488	3184	3.602
20	36.44	6997	2.524	3249	3.801
21	38.25	6994	2.548	3298	4.001
22	40.11	6997	2.572	3350	4.201
23	42.00	6995	2.589	3400	4.401
24	43.99	6997	2.608	3446	4.601
25	45.80	6994	2.631	3481	4.801
26	47.59	6994	2.652	3511	5.001
27	49.47	6995	2.668	3540	5.201
28	51.46	6997	2.682	3571	5.4
29	53.37	6995	2.704	3616	5.6
30	55.18	6997	2.725	3659	5.8
31	57.10	6994	2.745	3703	6
32	58.95	6995	2.757	3756	6.2
33	60.83	6995	2.773	3801	6.4
34	62.90	6997	2.788	3847	6.6
35	64.70	6995	2.804	3884	6.8
36	66.56	6997	2.817	3916	7
37	68.30	6997	2.831	3949	7.2
38	70.36	6997	2.844	3984	7.4
39	72.10	6995	2.863	4010	7.601
40	73.99	6997	2.869	4041	7.801
41	76.01	6997	2.874	4064	8.001
42	77.76	6995	2.885	4077	8.201
43	78.91	6995	2.897	4084	8.315

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

Terracon Consulting Engineers & Scientists

Laboratory Services Group 750 Corporate Woods Parkway Vernon Hills, Illinois 60061 Phone:(224) 352-7000 Fax:(224) 352-7024

TERRACON PROJECT NO.:	**MR155242**	**11/30/2015**
PROJECT NAME:	**VECTREN FB CULLEY**	
CLIENT:	**AECOM**	
LOCATION :	**NEWBURGH, IN**	

SUMMARY OF TEST RESULTS

BORING NO.	B-1
SAMPLE NO.	S-4
DEPTH:	10.0'-12.0'
CLASSIFICATION	BROWN AND GRAY LEAN CLAY CL

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	106.3	108.8
WATER CONTENT (%)	21.6	20.6
DIAMETER (cm)	7.128	7.073
LENGTH (cm)	8.139	8.076

SAMPLE PHOTO

HYDRAULIC GRADIENT (MAXIMUM)	28.86
PERCENT SATURATION	100.3
HYDRAULIC CONDUCTIVITY k (cm/sec)	5.30E-08

(Percent saturation calculation is based on final measurements and an estimated specific gravity.)

Deaired water was used as the liquid permeant.

Terracon
Consulting Engineers & Scientists

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

Laboratory Services Group 750 Corporate Woods Parkway Vernon Hills, Illinois 60061 Phone:(224) 352-7000 Fax:(224) 352-7024

TERRACON PROJECT NO.:	**MR155242**	**11/30/2015**
PROJECT NAME:	**VECTREN FB CULLEY**	
CLIENT:	**AECOM**	
LOCATION :	**NEWBURGH, IN**	

SUMMARY OF TEST RESULTS

BORING NO.	B-1
SAMPLE NO.	S-8
DEPTH:	20.0'-22.0'
CLASSIFICATION	DARK BROWN LEAN CLAY CL

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	104.8	108.6
WATER CONTENT (%)	18.2	20.4
DIAMETER (cm)	7.281	7.207
LENGTH (cm)	7.573	7.463

SAMPLE PHOTO

HYDRAULIC GRADIENT (MAXIMUM)	26.38
PERCENT SATURATION	99.1
HYDRAULIC CONDUCTIVITY k (cm/sec)	1.35E-07

(Percent saturation calculation is based on final measurements and an estimated specific gravity.)

Deaired water was used as the liquid permeant.

Terracon
Consulting Engineers & Scientists

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

Laboratory Services Group 750 Corporate Woods Parkway Vernon Hills, Illinois 60061 Phone:(224) 352-7000 Fax:(224) 352-7024

TERRACON PROJECT NO.:	**MR155242**	**11/30/2015**
PROJECT NAME:	**VECTREN FB CULLEY**	
CLIENT:	**AECOM**	
LOCATION :	**NEWBURGH, IN**	

SUMMARY OF TEST RESULTS

BORING NO.	B-1
SAMPLE NO.	S-14
DEPTH:	50.0'-52.0'
CLASSIFICATION	DARK BROWN SANDY LEAN CLAY CL

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	96.8	98.8
WATER CONTENT (%)	25.7	26.3
DIAMETER (cm)	7.323	7.272
LENGTH (cm)	7.571	7.516
HYDRAULIC GRADIENT (MAXIMUM)	26.38	
PERCENT SATURATION	100.1	
HYDRAULIC CONDUCTIVITY k (cm/sec)	**4.26E-07**	

SAMPLE PHOTO

(Percent saturation calculation is based on final measurements and an estimated specific gravity.)

Deaired water was used as the liquid permeant.

Terracon
Consulting Engineers & Scientists

Laboratory Services Group 750 Corporate Woods Parkway Vernon Hills, Illinois 60061 Phone:(224) 352-7000 Fax:(224) 352-7024

TERRACON PROJECT NO.:	**MR155242**	**11/30/2015**
PROJECT NAME:	**VECTREN FB CULLEY**	
CLIENT:	**AECOM**	
LOCATION :	**NEWBURGH, IN**	

SUMMARY OF TEST RESULTS

BORING NO.	B-2
SAMPLE NO.	S-13
DEPTH:	40.0'-42.0'
CLASSIFICATION	BROWN LEAN CLAY CL

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	92.6	93.7
WATER CONTENT (%)	29.8	29.6
DIAMETER (cm)	7.277	7.248
LENGTH (cm)	7.773	7.745

SAMPLE PHOTO

HYDRAULIC GRADIENT (MAXIMUM)	28.41
PERCENT SATURATION	99.6
HYDRAULIC CONDUCTIVITY k (cm/sec)	3.64E-08

(Percent saturation calculation is based on final measurements and an estimated specific gravity.)

Deaired water was used as the liquid permeant.

Laboratory Services Group 750 Corporate Woods Parkway Vernon Hills, Illinois 60061 Phone:(224) 352-7000 Fax:(224) 352-7024

TERRACON PROJECT NO.:	**MR155242**	**11/30/2015**
PROJECT NAME:	**VECTREN FB CULLEY**	
CLIENT:	**AECOM**	
LOCATION :	**NEWBURGH, IN**	

SUMMARY OF TEST RESULTS

BORING NO.	B-2
SAMPLE NO.	S-16
DEPTH:	53.0'-55.0'
CLASSIFICATION	VERY DARK GRAY LEAN CLAY WITH SAND CL

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	76.8	76.6
WATER CONTENT (%)	39.7	44.4
DIAMETER (cm)	7.302	7.304
LENGTH (cm)	5.584	5.596

SAMPLE PHOTO

HYDRAULIC GRADIENT (MAXIMUM)	29.48
PERCENT SATURATION	99.6
HYDRAULIC CONDUCTIVITY k (cm/sec)	9.00E-08

(Percent saturation calculation is based on final measurements and an estimated specific gravity.)

Deaired water was used as the liquid permeant.

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

Laboratory Services Group 750 Corporate Woods Parkway Vernon Hills, Illinois 60061 Phone:(224) 352-7000 Fax:(224) 352-7024

TERRACON PROJECT NO.:	**MR155242**	**11/30/2015**
PROJECT NAME:	**VECTREN FB CULLEY**	
CLIENT:	**AECOM**	
LOCATION :	**NEWBURGH, IN**	

SUMMARY OF TEST RESULTS

BORING NO.	B-3
SAMPLE NO.	S-2
DEPTH:	10.0'-12.0'
CLASSIFICATION	OLIVE BROWN LEAN CLAY CL

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	105.5	110.9
WATER CONTENT (%)	22.1	19.1
DIAMETER (cm)	7.265	7.204
LENGTH (cm)	7.545	7.299
HYDRAULIC GRADIENT (MAXIMUM)	26.47	
PERCENT SATURATION	98.5	
HYDRAULIC CONDUCTIVITY k (cm/sec)	9.28E-08	

SAMPLE PHOTO

(Percent saturation calculation is based on final measurements and an estimated specific gravity.)

Deaired water was used as the liquid permeant.

Terracon Consulting Engineers & Scientists

Laboratory Services Group 750 Corporate Woods Parkway Vernon Hills, Illinois 60061 Phone:(224) 352-7000 Fax:(224) 352-7024

TERRACON PROJECT NO.:	**MR155242**	**11/30/2015**
PROJECT NAME:	**VECTREN FB CULLEY**	
CLIENT:	**AECOM**	
LOCATION :	**NEWBURGH, IN**	

SUMMARY OF TEST RESULTS

BORING NO.	B-3
SAMPLE NO.	S-5
DEPTH:	25.0'-27.0'
CLASSIFICATION	OLIVE BROWN FAT CLAY CH

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	93.4	97.4
WATER CONTENT (%)	28.8	27.0
DIAMETER (cm)	7.230	7.102
LENGTH (cm)	7.757	7.705

SAMPLE PHOTO

HYDRAULIC GRADIENT (MAXIMUM)	25.75
PERCENT SATURATION	99.3
HYDRAULIC CONDUCTIVITY k (cm/sec)	9.18E-08

(Percent saturation calculation is based on final measurements and an estimated specific gravity.)

Deaired water was used as the liquid permeant.

Terracon
Consulting Engineers & Scientists

HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C
RISING TAILWATER LEVEL

Laboratory Services Group 750 Corporate Woods Parkway Vernon Hills, Illinois 60061 Phone: (224) 352-7000 Fax: (224) 352-7024

TERRACON PROJECT NO.:	**MR155242**	**11/30/2015**
PROJECT NAME:	**VECTREN FB CULLEY**	
CLIENT:	**AECOM**	
LOCATION :	**NEWBURGH, IN**	

SUMMARY OF TEST RESULTS

BORING NO.	B-3
SAMPLE NO.	S-7
DEPTH:	33.0'-35.0'
CLASSIFICATION	OLIVE BROWN LEAN CLAY CL

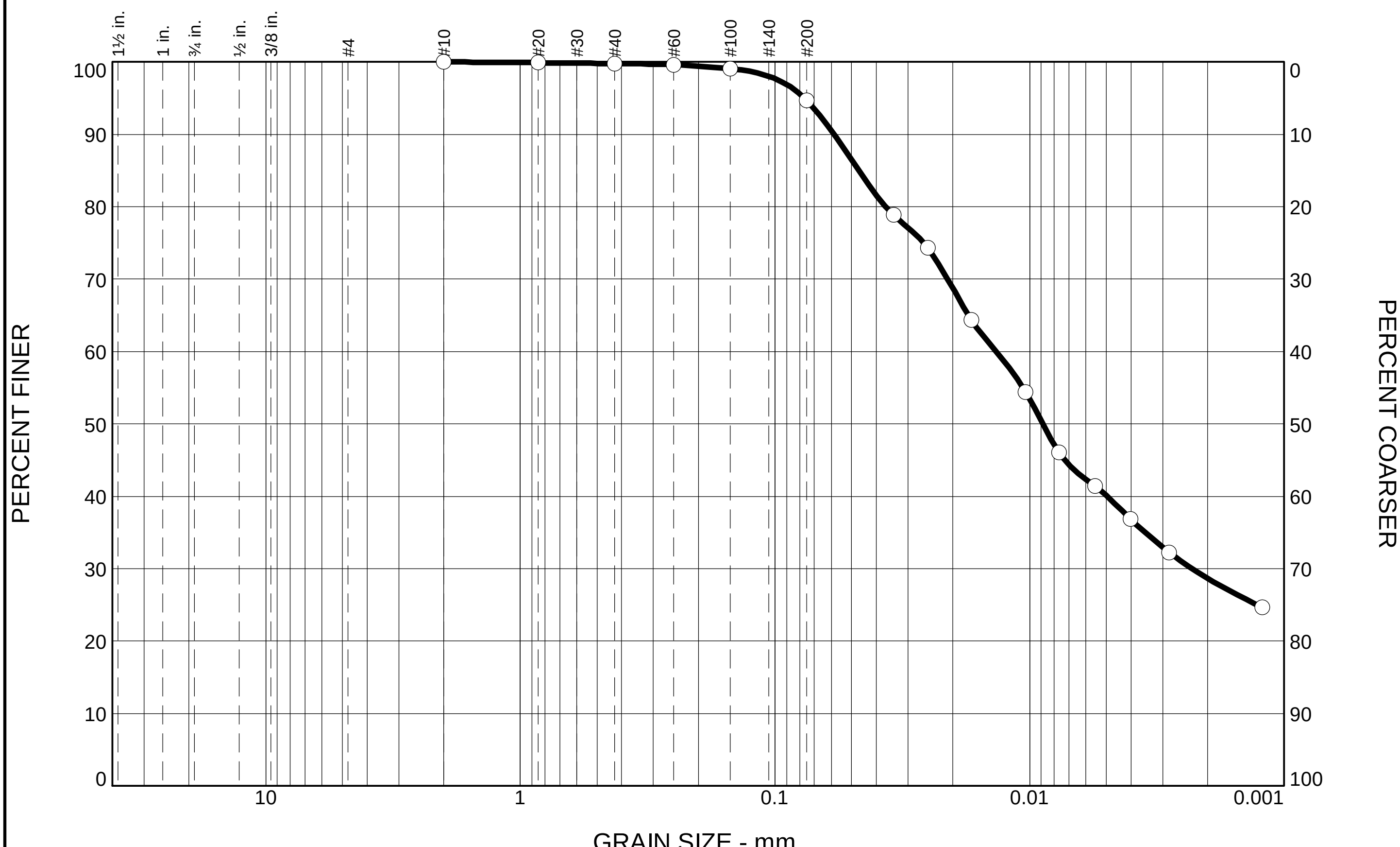
	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	94.3	97.4
WATER CONTENT (%)	27.1	27.1
DIAMETER (cm)	7.206	7.146
LENGTH (cm)	7.894	7.771
HYDRAULIC GRADIENT (MAXIMUM)	29.76	
PERCENT SATURATION	99.6	
HYDRAULIC CONDUCTIVITY k (cm/sec)	1.30E-07	

SAMPLE PHOTO

(Percent saturation calculation is based on final measurements and an estimated specific gravity.)

Deaired water was used as the liquid permeant.

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	5.1	54.6	40.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.9		
#40	99.8		
#60	99.6		
#100	99.1		
#200	94.7		

* (no specification provided)

BROWN AND GRAY LEAN CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.0586 D_{85}= 0.0468 D_{60}= 0.0136
D_{50}= 0.0089 D_{30}= 0.0023 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

F.M.=0.01

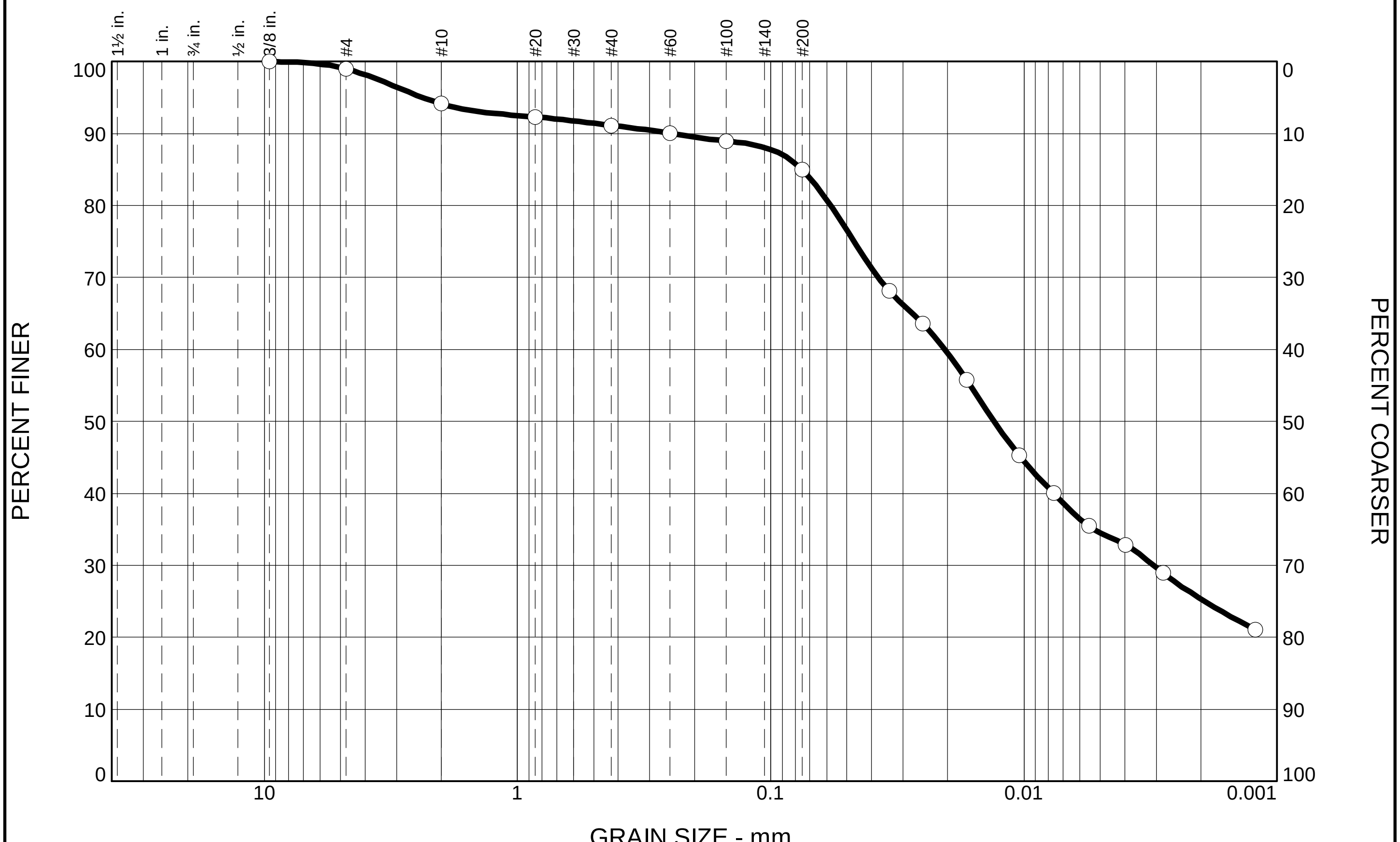
Source of Sample: B-1 **Depth:** 10.0'-12.0'
Sample Number: S-4 **Date:** 11-24-15

Terracon

Client: VECTREN
Project: F.B. CULLEY POWER PLANT
Project No: MR155242 **Figure**

Tested By: HP **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.0	4.9	3.0	6.1	50.5	34.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.0		
#10	94.1		
#20	92.3		
#40	91.1		
#60	90.1		
#100	88.9		
#200	85.0		

* (no specification provided)

DARK GRAY LEAN CLAY - SAND POCKETS NOTED

Atterberg Limits

PL= 20 LL= 32 PI= 12

Coefficients

D_{90}= 0.2434 D_{85}= 0.0752 D_{60}= 0.0205
D_{50}= 0.0131 D_{30}= 0.0031 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(9)

Remarks

F.M.=0.42

Source of Sample: B-1 **Depth:** 30.0'-32.0'
Sample Number: S-10

Date: 11-24-15

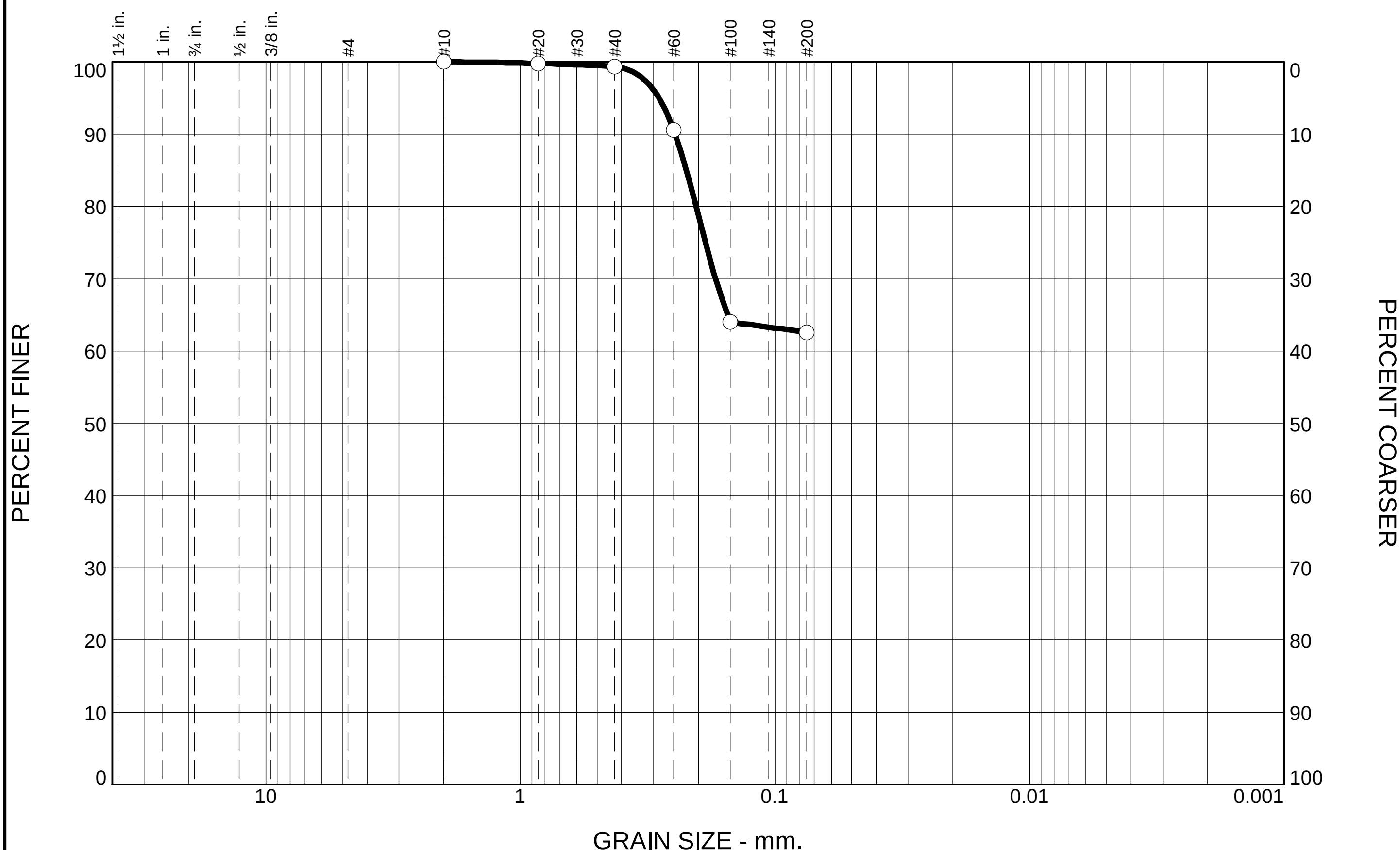
Terracon

Client: VECTREN
Project: F.B. CULLEY POWER PLANT

Project No: MR155242 **Figure**

Tested By: HP **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.6	36.8	62.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.8		
#40	99.4		
#60	90.6		
#100	64.0		
#200	62.6		

* (no specification provided)

GRAYISH BROWN SANDY SILT

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2466 D_{85}= 0.2227 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO=

Remarks

F.M.=0.40

Source of Sample: B-1 **Depth:** 48.0'-50.0'
Sample Number: S-13

Date: 11-24-15

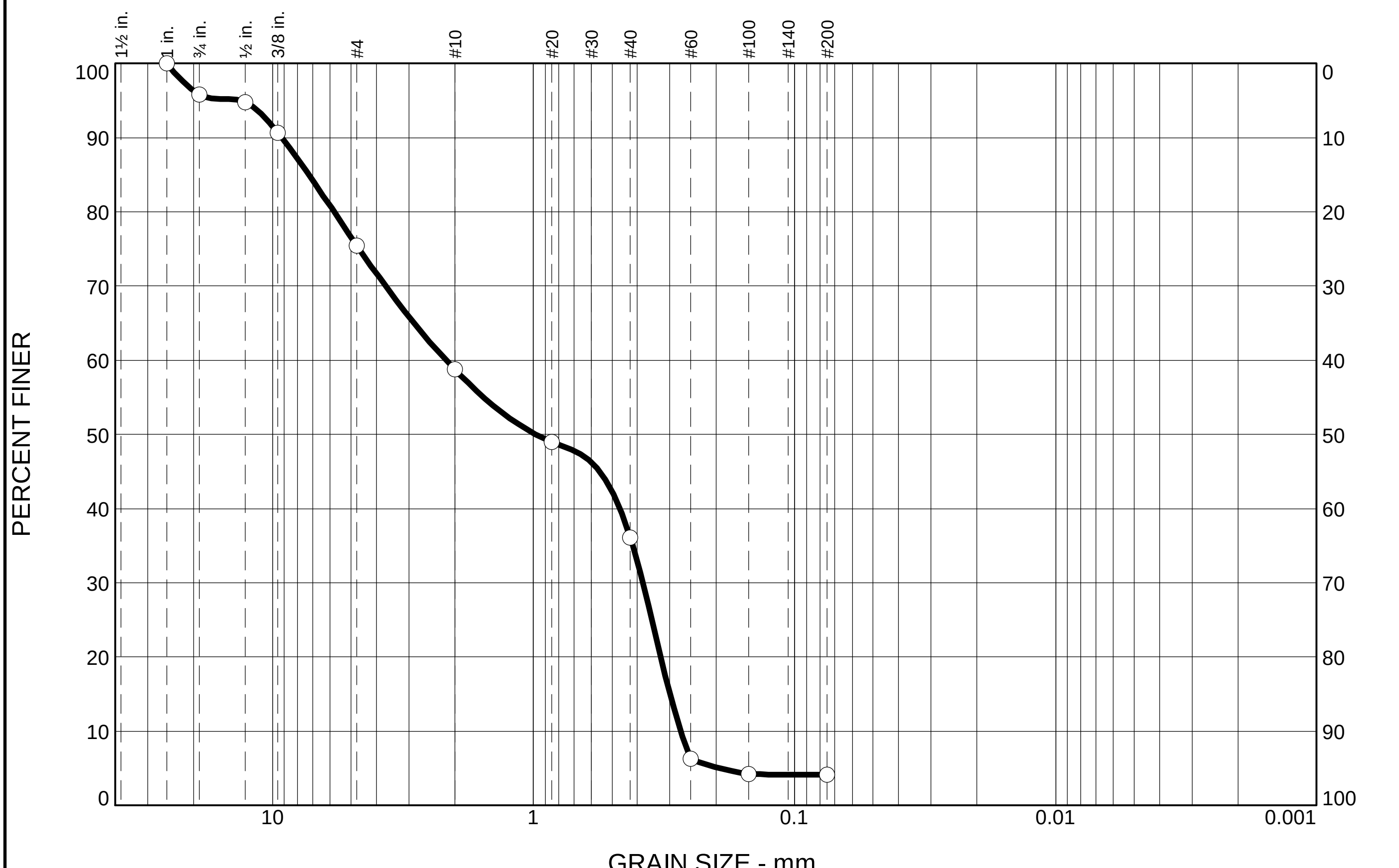
Terracon

Client: VECTREN
Project: F.B. CULLEY POWER PLANT

Project No: MR155242 **Figure**

Tested By: DT **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.2	20.3	16.8	22.6	32.0	4.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.75	95.8		
.5	94.8		
.375	90.7		
#4	75.5		
#10	58.7		
#20	49.0		
#40	36.1		
#60	6.3		
#100	4.2		
#200	4.1		

* (no specification provided)

BROWN SAND WITH GRAVEL

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 9.2015 D_{85}= 7.2444 D_{60}= 2.1606
D_{50}= 0.9818 D_{30}= 0.3806 D_{15}= 0.2996
D_{10}= 0.2733 C_u= 7.91 C_c= 0.25

Classification

USCS= SP AASHTO=

Remarks

F.M.=3.59

Source of Sample: B-1 **Depth:** 58.0'-59.5'
Sample Number: S-17

Date: 11-24-15

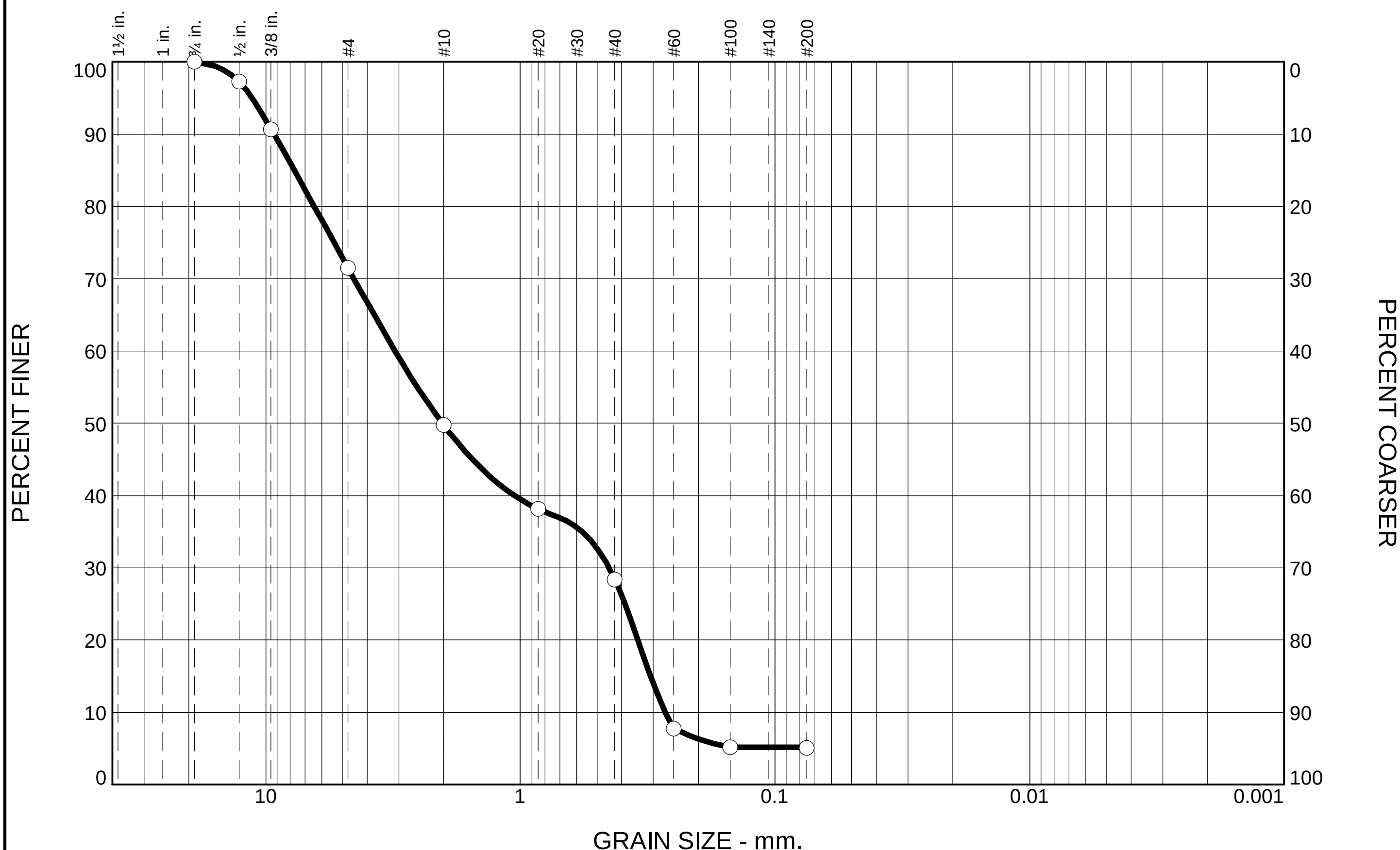
Terracon

Client: VECTREN
Project: F.B. CULLEY POWER PLANT

Project No: MR155242 **Figure**

Tested By: DT **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	28.5	21.7	21.4	23.3	5.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	97.2		
.375	90.7		
#4	71.5		
#10	49.8		
#20	38.1		
#40	28.4		
#60	7.7		
#100	5.2		
#200	5.1		

* (no specification provided)

BROWN GRAVELLY SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 9.2807 D_{85}= 7.7138 D_{60}= 3.1043
D_{50}= 2.0244 D_{30}= 0.4474 D_{15}= 0.3077
D_{10}= 0.2701 C_u= 11.49 C_c= 0.24

Classification

USCS= SP AASHTO=

Remarks

F.M.=3.89

Source of Sample: B-1 **Depth:** 60.5'-62.0'
Sample Number: S-18

Date: 11-24-15

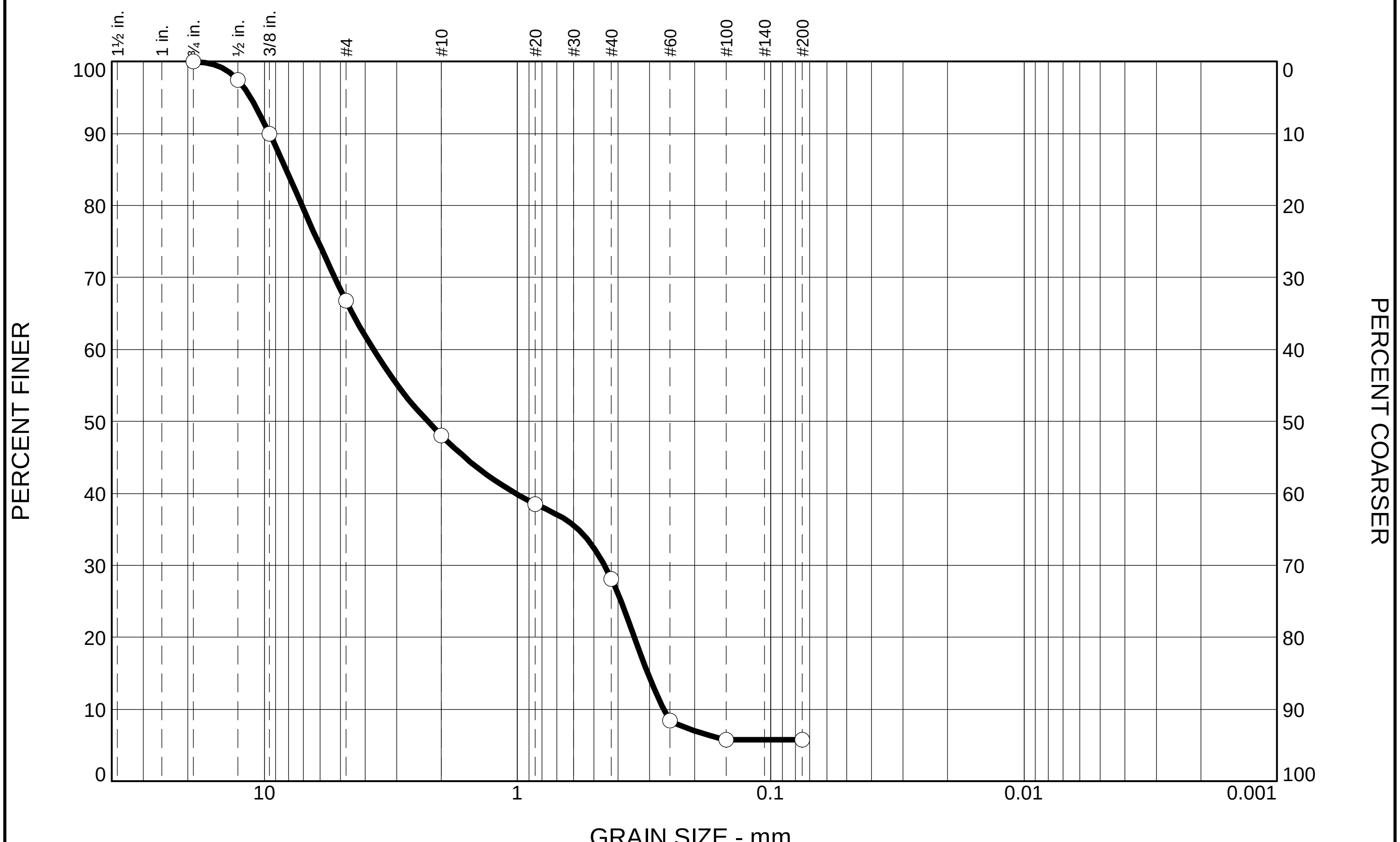
Terracon

Client: VECTREN
Project: F.B. CULLEY POWER PLANT

Project No: MR155242 **Figure**

Tested By: DT **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	33.3	18.7	19.9	22.3	5.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	97.4		
.375	90.0		
#4	66.7		
#10	48.0		
#20	38.5		
#40	28.1		
#60	8.4		
#100	5.8		
#200	5.8		

* (no specification provided)

BROWN GRAVELLY SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 9.5370 D_{85}= 8.1915 D_{60}= 3.7089
D_{50}= 2.2623 D_{30}= 0.4518 D_{15}= 0.3052
D_{10}= 0.2651 C_u= 13.99 C_c= 0.21

Classification

USCS= SP-SM AASHTO=

Remarks

F.M.=3.96

Source of Sample: B-1 **Depth:** 63.5'-65.0'
Sample Number: S-19

Date: 11-24-15

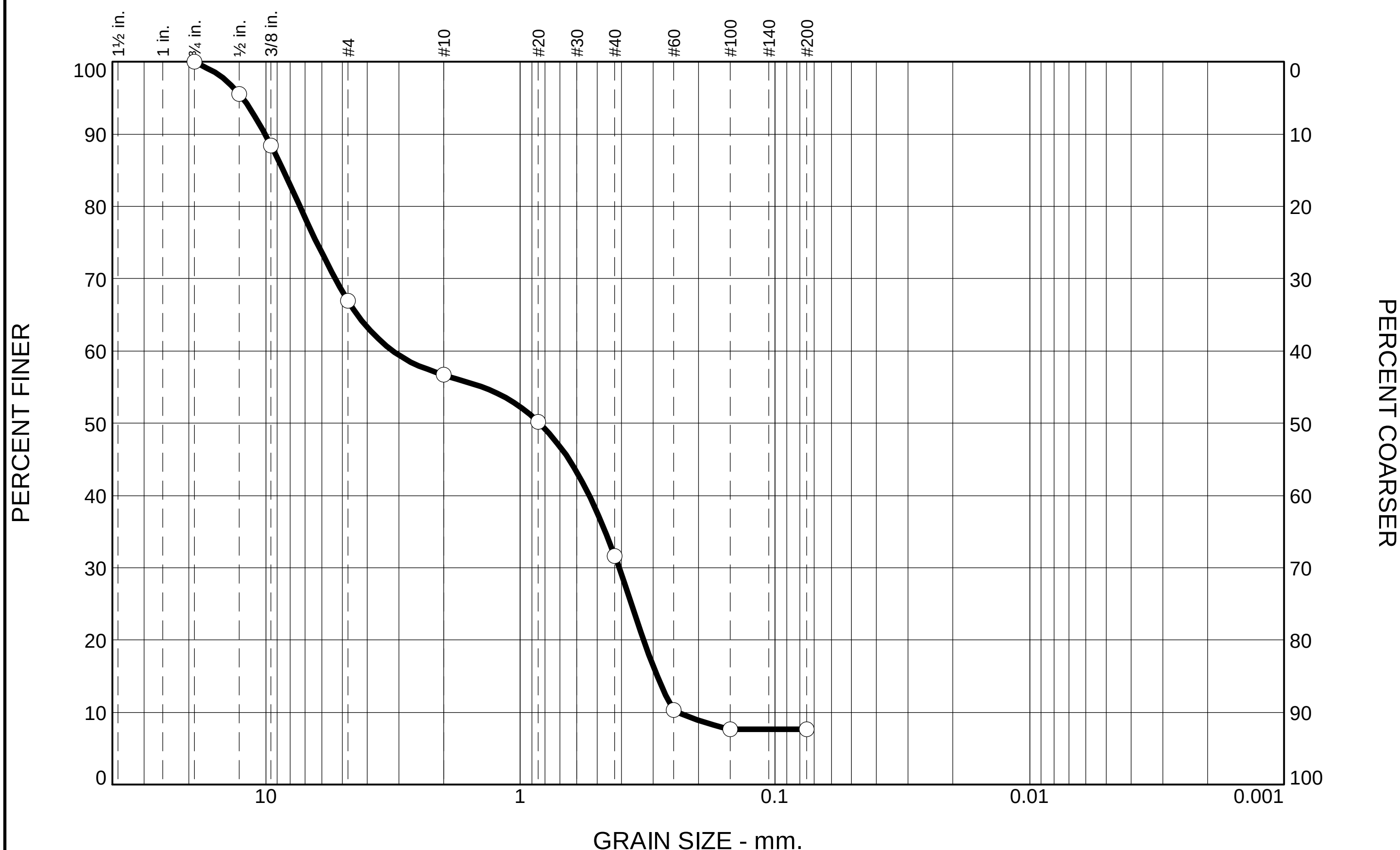
Terracon

Client: VECTREN
Project: F.B. CULLEY POWER PLANT

Project No: MR155242 **Figure**

Tested By: DT **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	33.1	10.2	25.1	24.0	7.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	95.6		
.375	88.4		
#4	66.9		
#10	56.7		
#20	50.2		
#40	31.6		
#60	10.3		
#100	7.7		
#200	7.6		

* (no specification provided)

GRAY SILTY SAND WITH GRAVEL

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 10.0654 D_{85}= 8.5417 D_{60}= 3.1683
D_{50}= 0.8384 D_{30}= 0.4090 D_{15}= 0.2901
D_{10}= 0.2392 C_u= 13.25 C_c= 0.22

Classification

USCS= SM AASHTO=

Remarks

F.M.=3.66

Source of Sample: B-1 **Depth:** 71.0'-72.5'
Sample Number: S-21

Date: 11-18-15

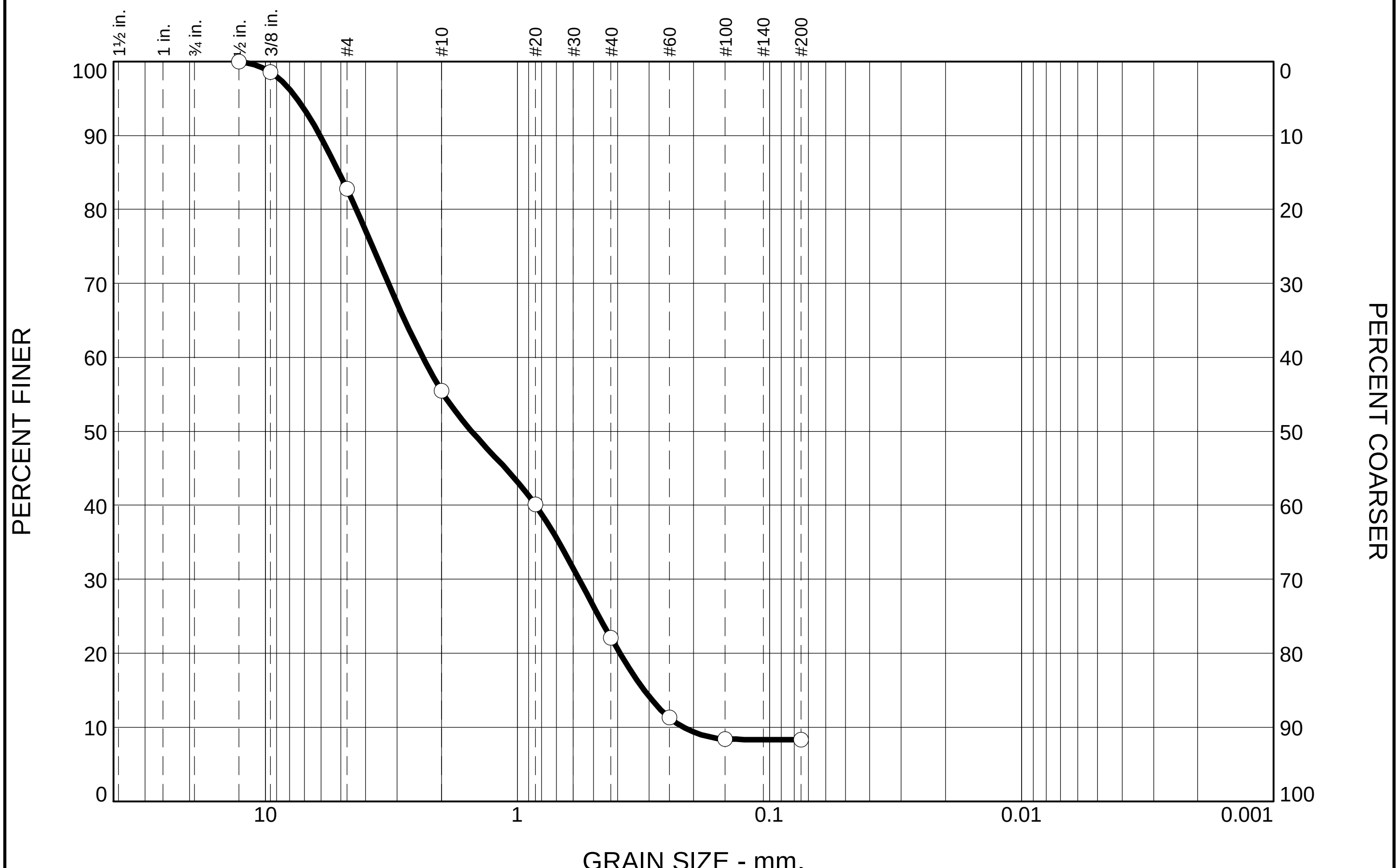
Terracon

Client: VECTREN
Project: F.B. CULLEY POWER PLANT

Project No: MR155242 **Figure**

Tested By: DT **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	17.2	27.3	33.4	13.8	8.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5	100.0		
.375	98.6		
#4	82.8		
#10	55.5		
#20	40.1		
#40	22.1		
#60	11.3		
#100	8.4		
#200	8.3		

* (no specification provided)

GRAY AND BROWN GRAVELLY SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 6.0598 D_{85}= 5.0935 D_{60}= 2.3709
D_{50}= 1.5207 D_{30}= 0.5689 D_{15}= 0.3133
D_{10}= 0.2200 C_u= 10.78 C_c= 0.62

Classification

USCS= SP-SM AASHTO=

Remarks

F.M.=3.59

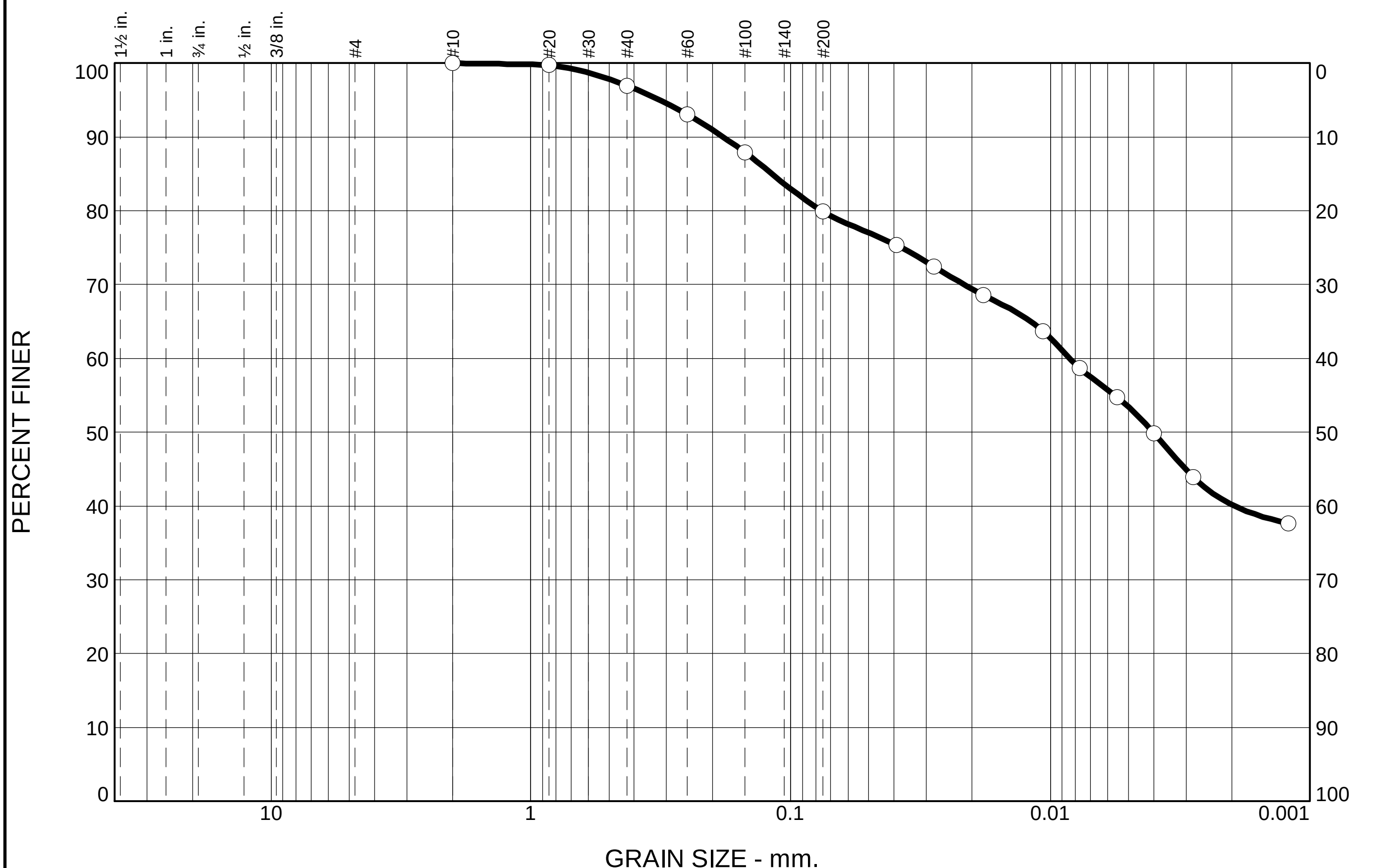
Source of Sample: B-1 **Depth:** 78.5'-80.0'
Sample Number: S-23 **Date:**

Terracon

Client: VECTREN
Project: F.B. CULLEY POWER PLANT

Project No: MR155242 **Figure**

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	3.1	17.0	26.5	53.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.8		
#40	96.9		
#60	93.0		
#100	87.9		
#200	79.9		

* (no specification provided)

BROWN AND GRAY SANDY CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.1812 D_{85}= 0.1178 D_{60}= 0.0084
D_{50}= 0.0040 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

F.M.=0.19

Source of Sample: B-2 **Depth:** 38.0'-40.0'
Sample Number: S-12

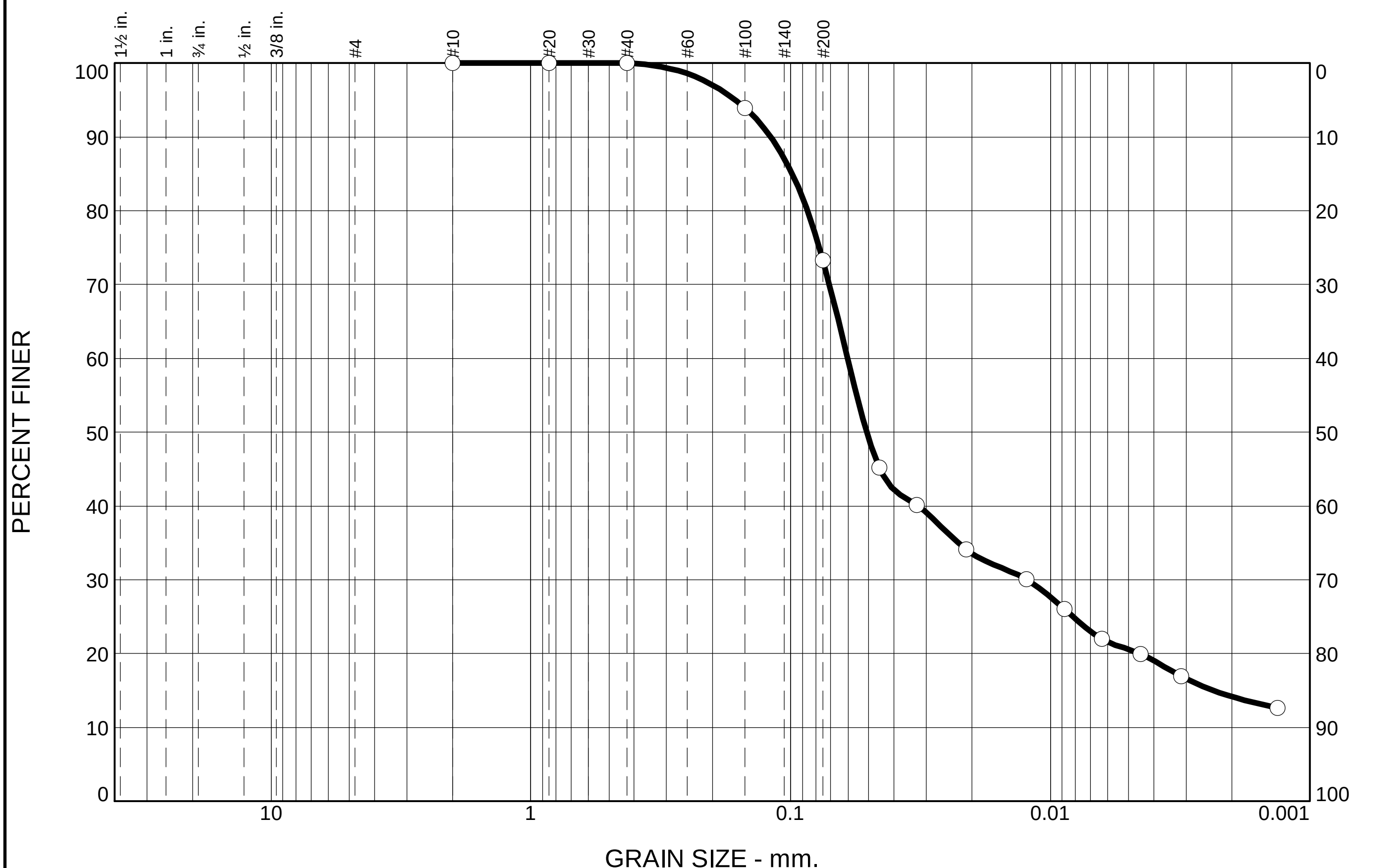
Date: 12/1/15

Terracon

Client: VECTREN
Project: F.B. CULLEY POWER PLANT
Project No: MR155242 **Figure**

Tested By: BCM **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	26.7	52.7	20.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	100.0		
#100	93.9		
#200	73.3		

* (no specification provided)

BROWN SANDY SILT

Atterberg Limits

PL= 25 LL= 30 PI= 5

Coefficients

D_{90}= 0.1190 D_{85}= 0.0985 D_{60}= 0.0604
D_{50}= 0.0509 D_{30}= 0.0123 D_{15}= 0.0024
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(3)

Remarks

F.M.=0.07

Source of Sample: B-2 **Depth:** 48.0'-50.0'
Sample Number: S-14

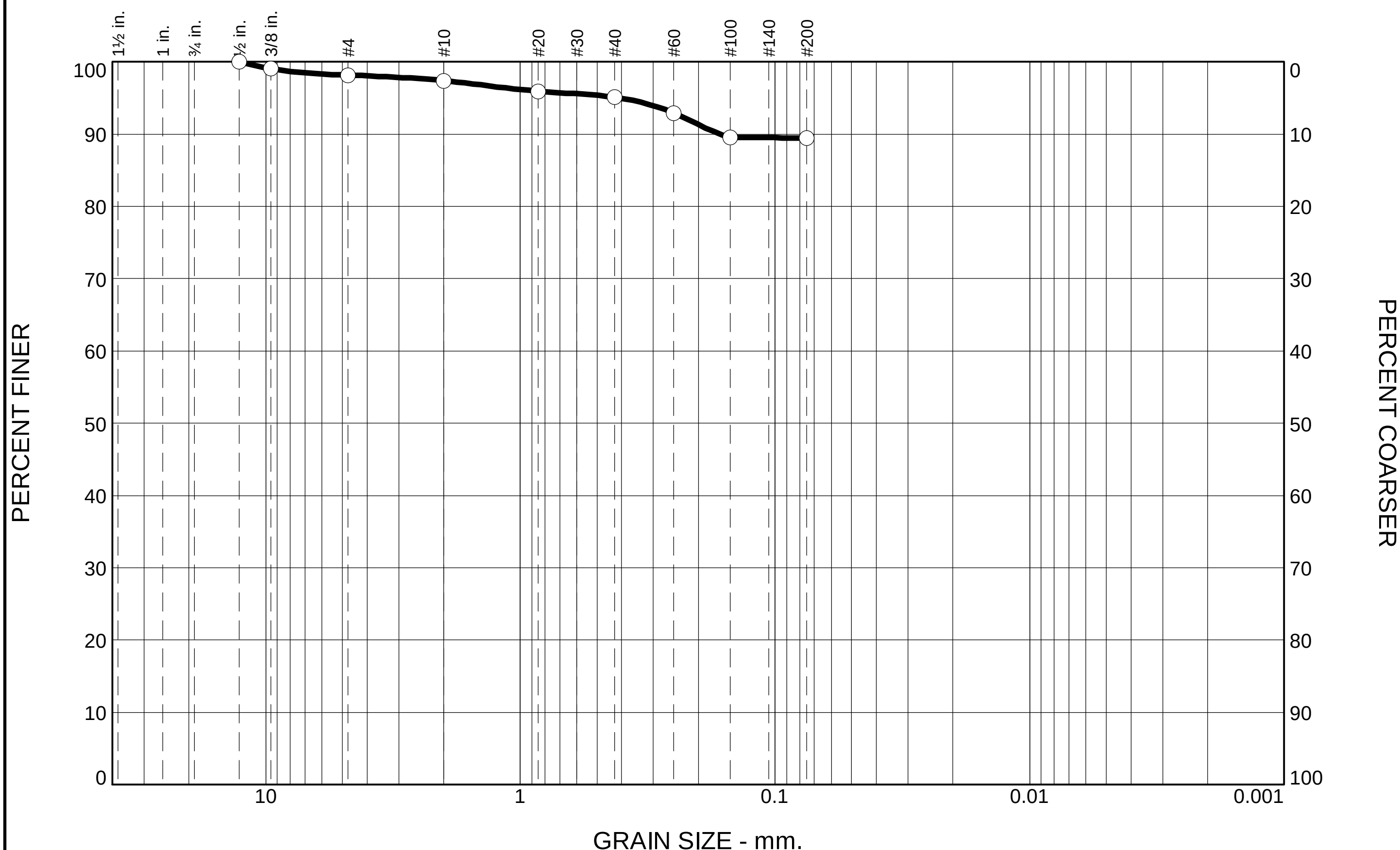
Date: 12/1/15

Terracon

Client: VECTREN
Project: F.B. CULLEY POWER PLANT
Project No: MR155242 **Figure**

Tested By: DT **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.8	0.8	2.3	5.6	89.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5	100.0		
.375	99.0		
#4	98.2		
#10	97.4		
#20	95.9		
#40	95.1		
#60	92.9		
#100	89.5		
#200	89.5		

* (no specification provided)

BROWN AND GRAY LEAN CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.1640 D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

F.M.=0.30

Source of Sample: B-2 **Depth:** 56.0'-57.5'
Sample Number: S-17

Date: 11-24-15

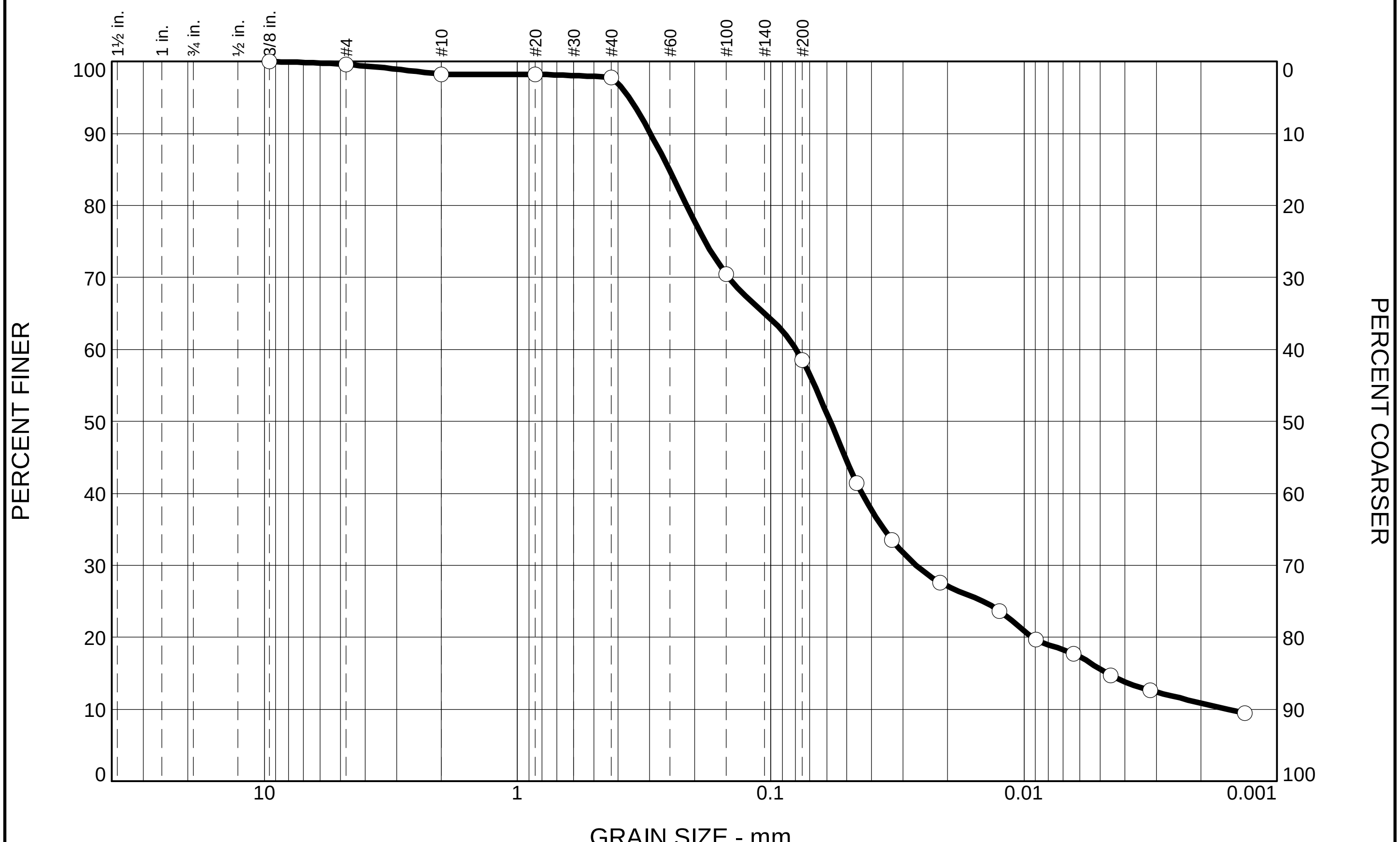
Terracon

Client: VECTREN
Project: F.B. CULLEY POWER PLANT

Project No: MR155242 **Figure**

Tested By: DT **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.4	1.4	0.4	39.3	42.9	15.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.6		
#10	98.2		
#20	98.2		
#40	97.8		
#100	70.4		
#200	58.5		

* (no specification provided)

GRAY SANDY SILT

Atterberg Limits

PL= 39 LL= 41 PI= 2

Coefficients

D_{90}= 0.2979 D_{85}= 0.2522 D_{60}= 0.0794
D_{50}= 0.0582 D_{30}= 0.0267 D_{15}= 0.0047
D_{10}= 0.0016 C_u= 50.51 C_c= 5.69

Classification

USCS= ML AASHTO= A-5(1)

Remarks

F.M.=0.45

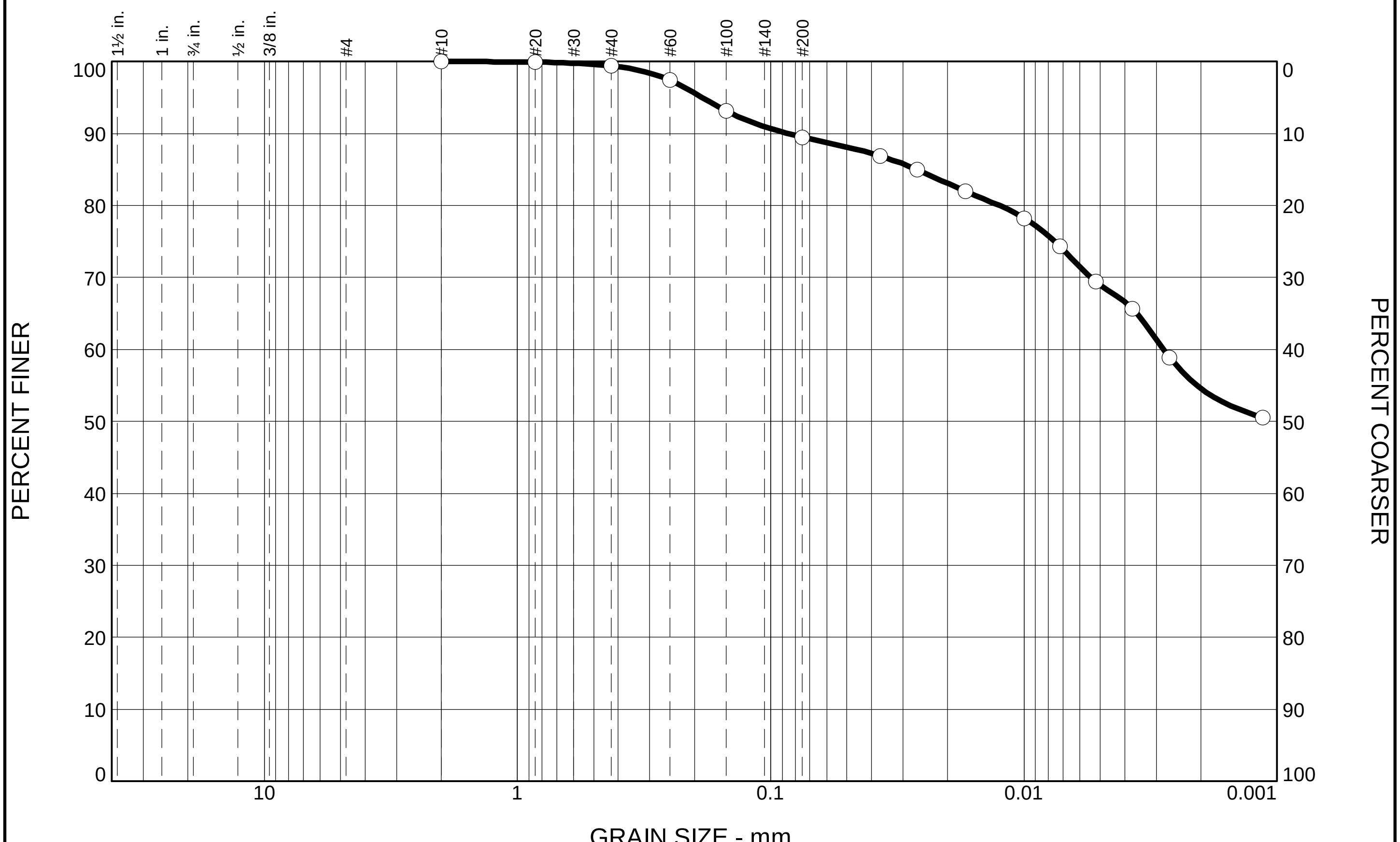
Source of Sample: B-2 **Depth:** 61.0'-62.5'
Sample Number: S-19 **Date:**

Terracon

Client: VECTREN
Project: F.B. CULLEY POWER PLANT
Project No: MR155242 **Figure**

Tested By: DT **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.6	9.9	20.5	69.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.9		
#40	99.4		
#60	97.4		
#100	93.2		
#200	89.5		

* (no specification provided)

BROWNISH GRAY LEAN CLAY

Atterberg Limits

PL= 18 LL= 35 PI= 17

Coefficients

D_{90}= 0.0860 D_{85}= 0.0265 D_{60}= 0.0028
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(15)

Remarks

SHALE STRATA NOTED
F.M.=0.09

Source of Sample: B-3 **Depth:** 36.0'-38.0'
Sample Number: S-8

Date: 12/1/15

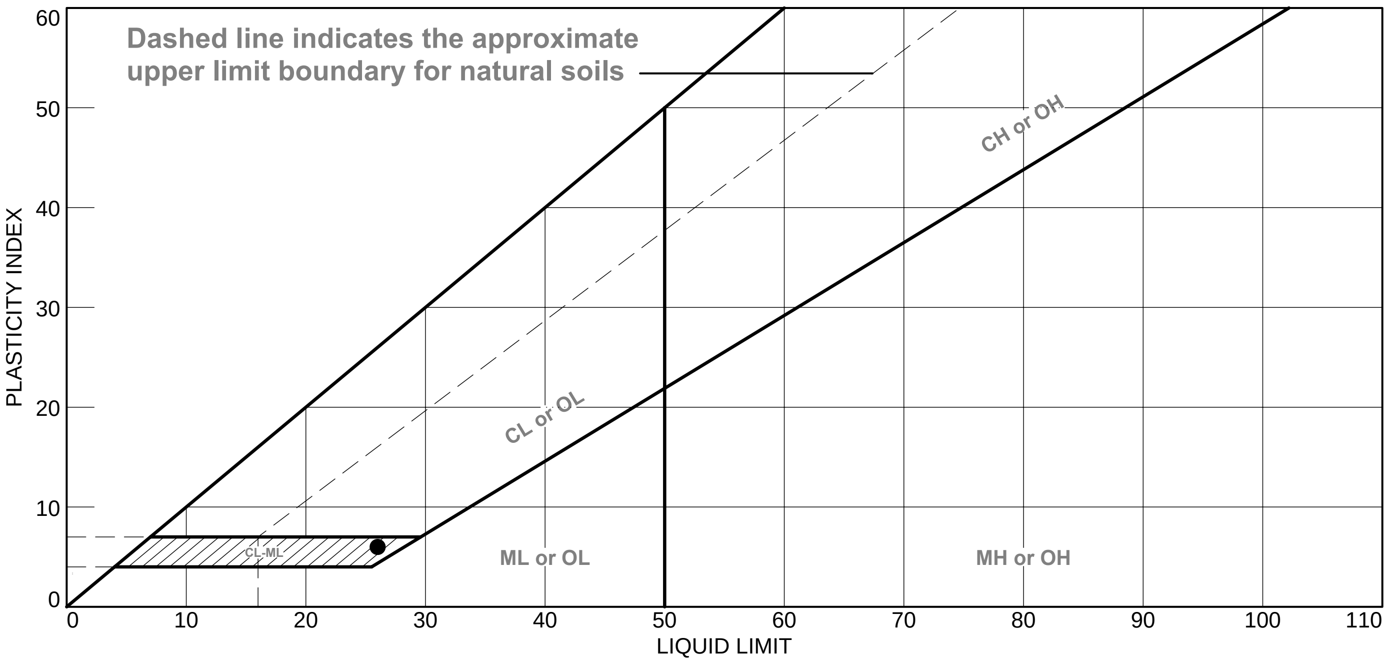
Terracon

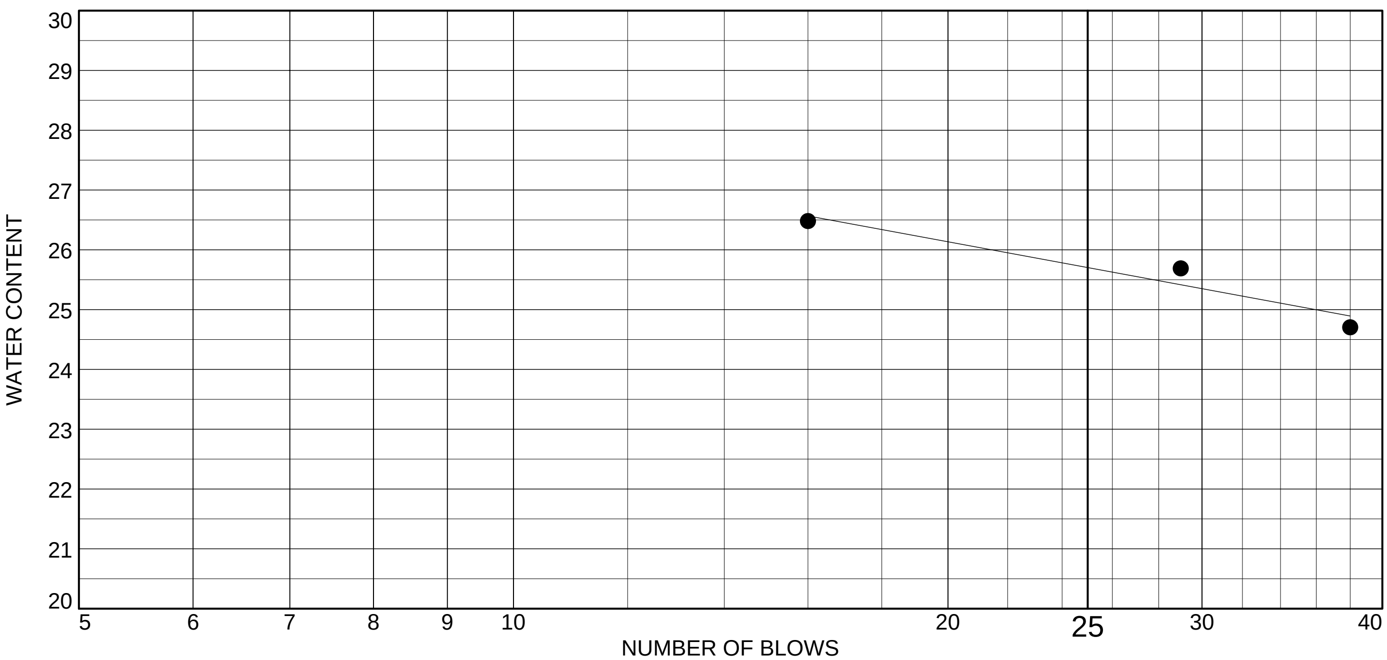
Client: VECTREN
Project: F.B. CULLEY POWER PLANT

Project No: MR155242 **Figure**

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN SILTY CLAY	26	20	6			CL-ML

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

Source of Sample: B-1 **Depth:** 8.0'-10.0'

Sample Number: S-3

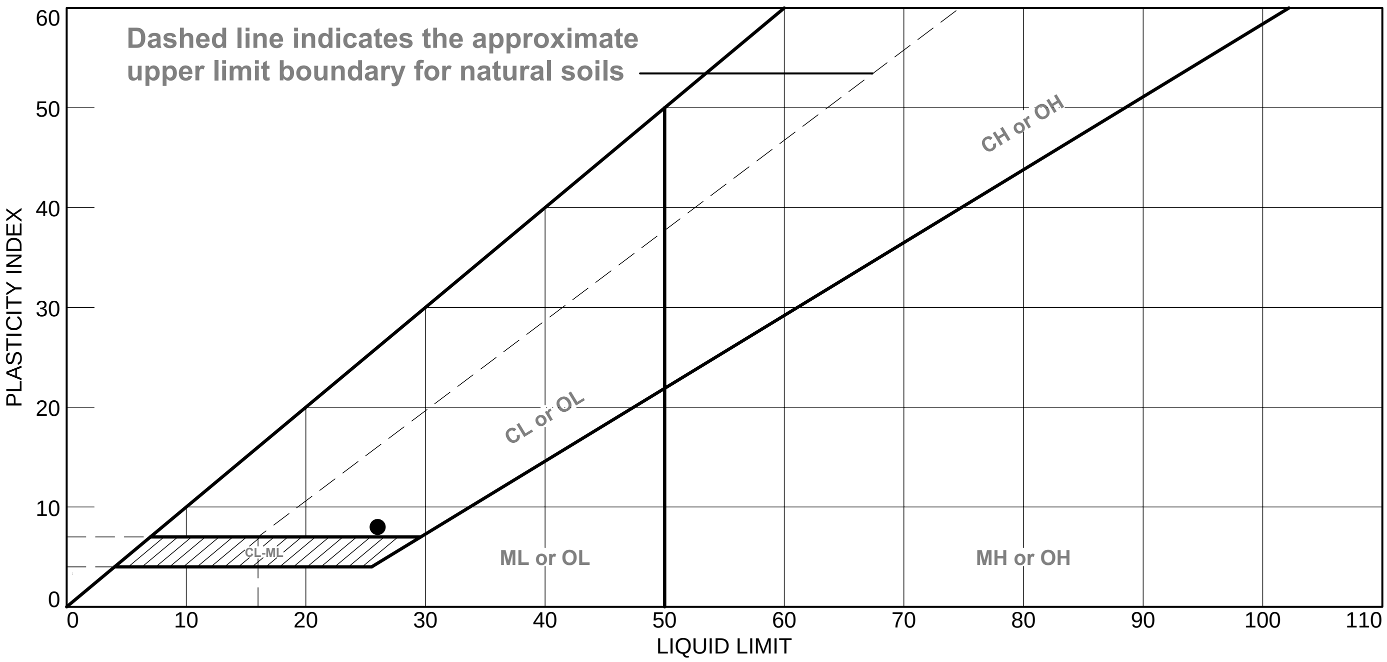
Terracon

Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN AND GRAY LEAN CLAY WITH SILT	26	18	8			CL

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

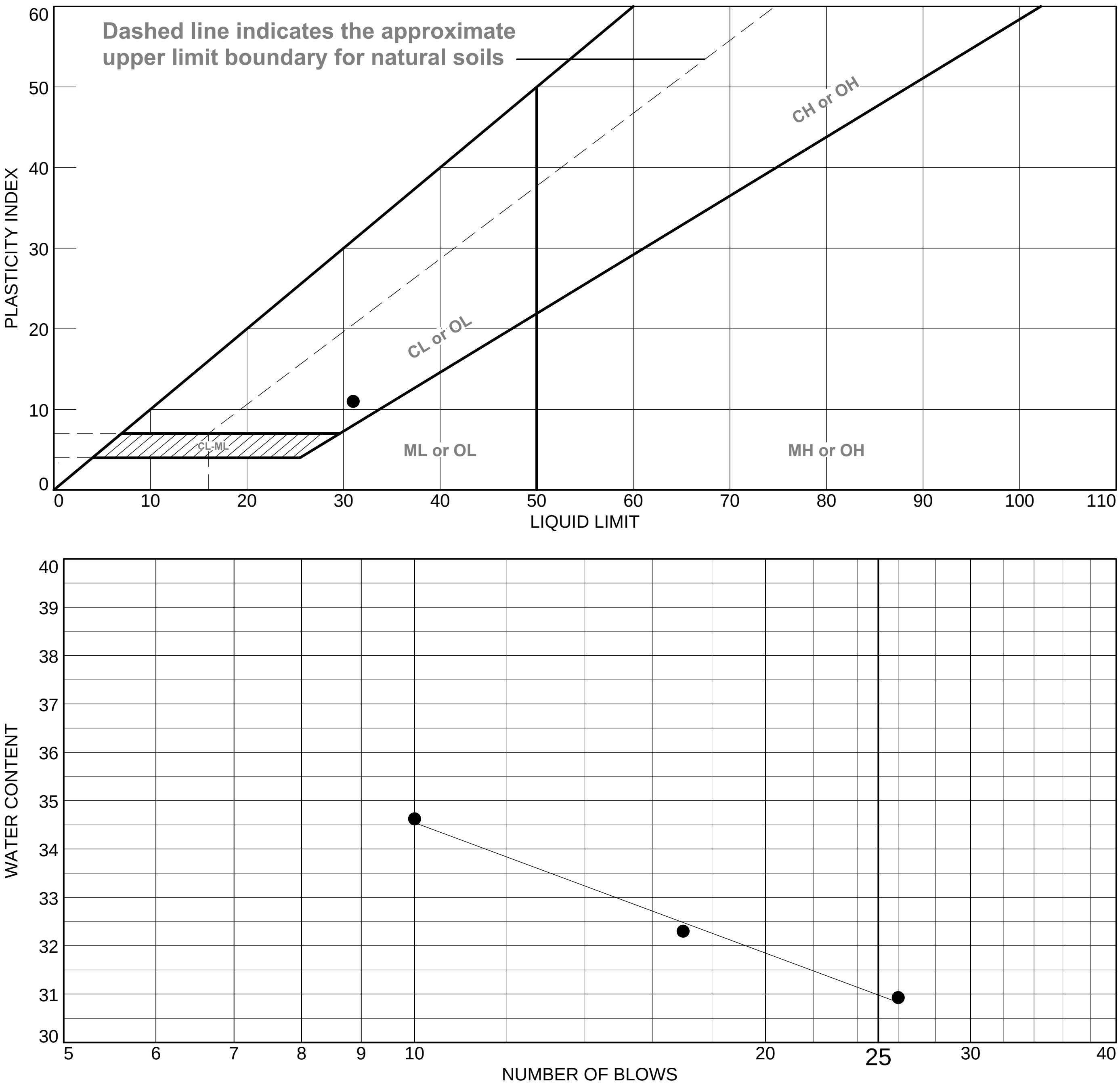
Source of Sample: B-1 **Depth:** 13.0'-15.0'
Sample Number: S-5

Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN AND GRAY LEAN CLAY	31	20	11			CL

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

Source of Sample: B-1 **Depth:** 18.0'-20.0'
Sample Number: S-7

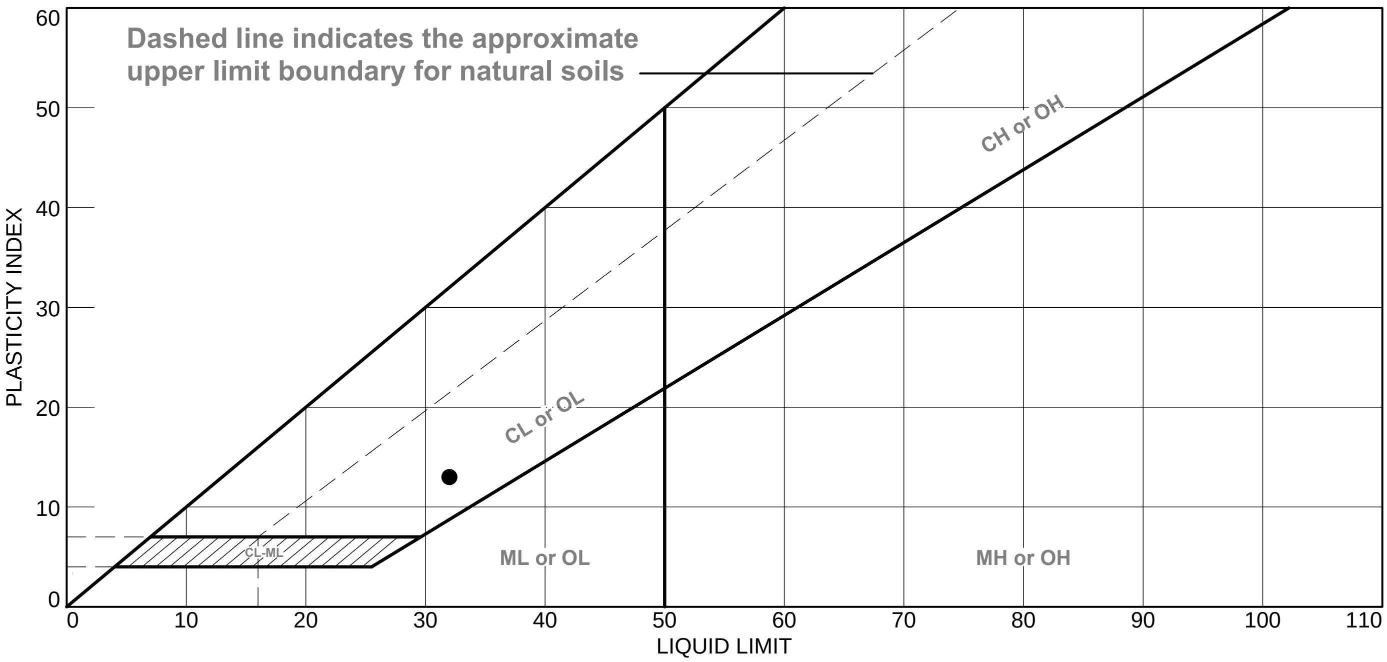
Terracon

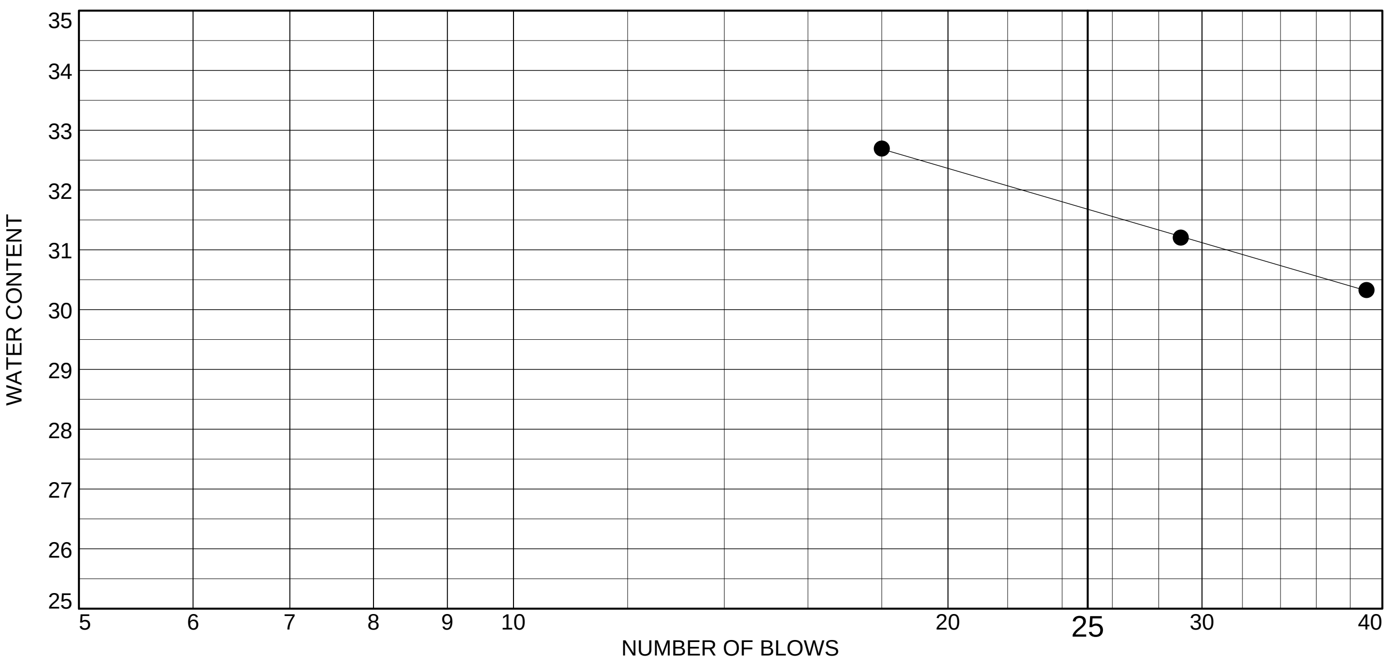
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN AND GRAY LEAN CLAY	32	19	13			CL

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

Source of Sample: B-1 **Depth:** 28.0'-30.0'

Sample Number: S-9

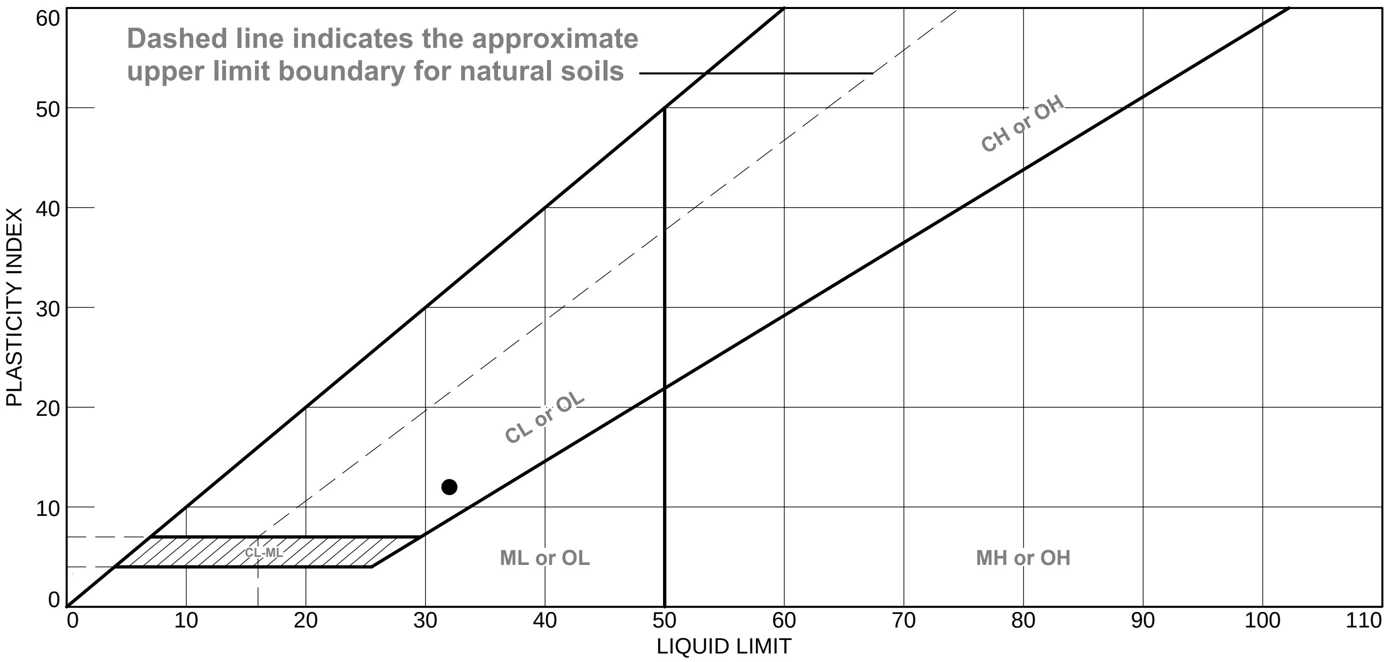
Terracon

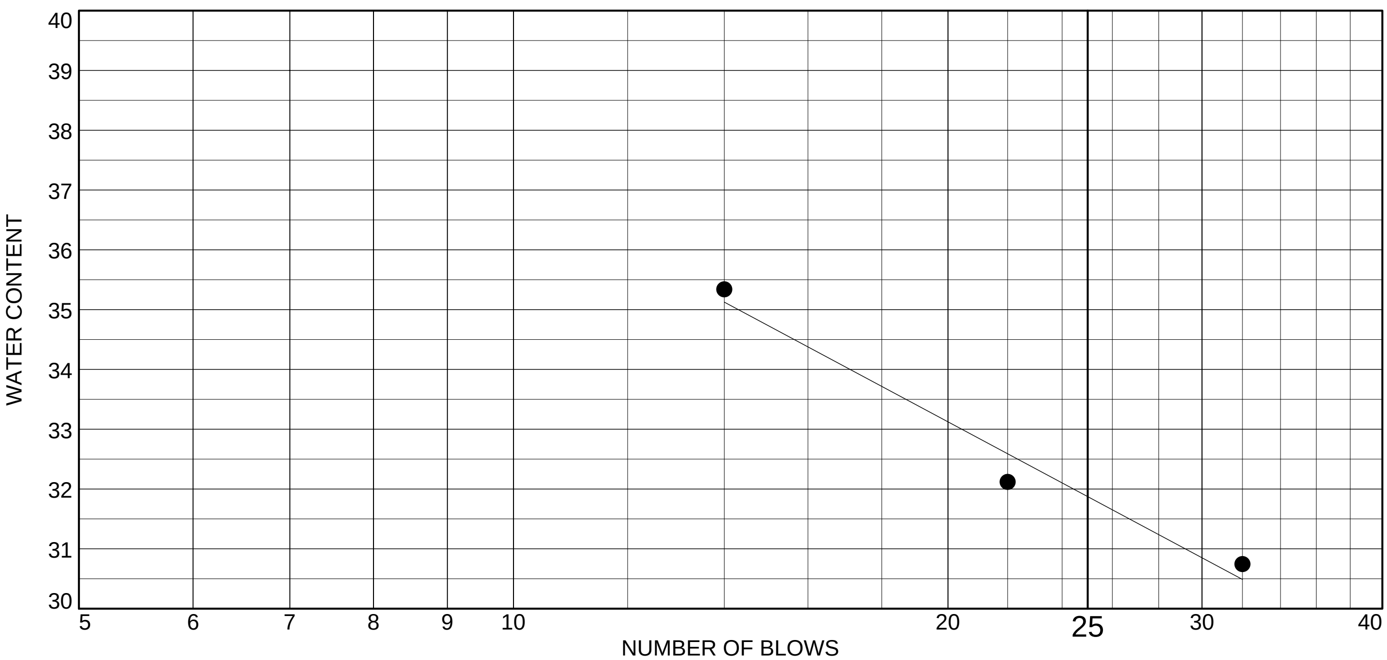
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK GRAY LEAN CLAY - SAND POCKETS NOTED	32	20	12	91.1	85.0	CL

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

Source of Sample: B-1 **Depth:** 30.0'-32.0'
Sample Number: S-10

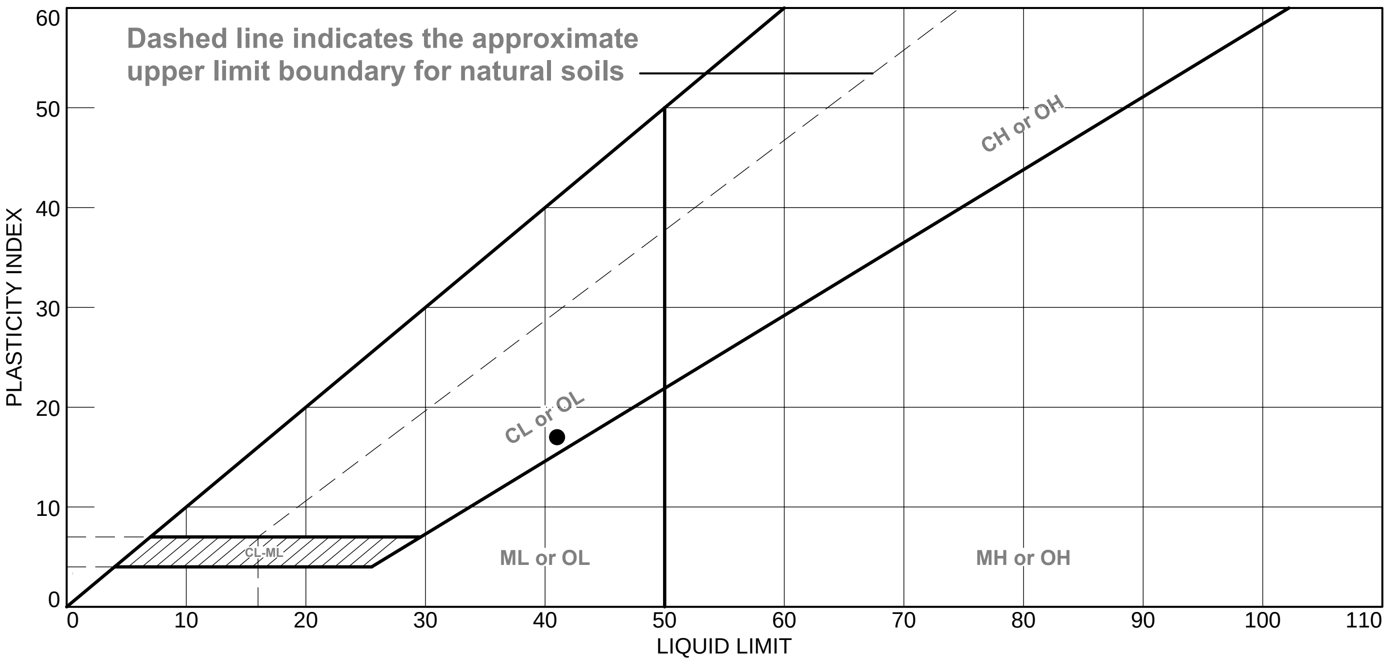
Remarks:

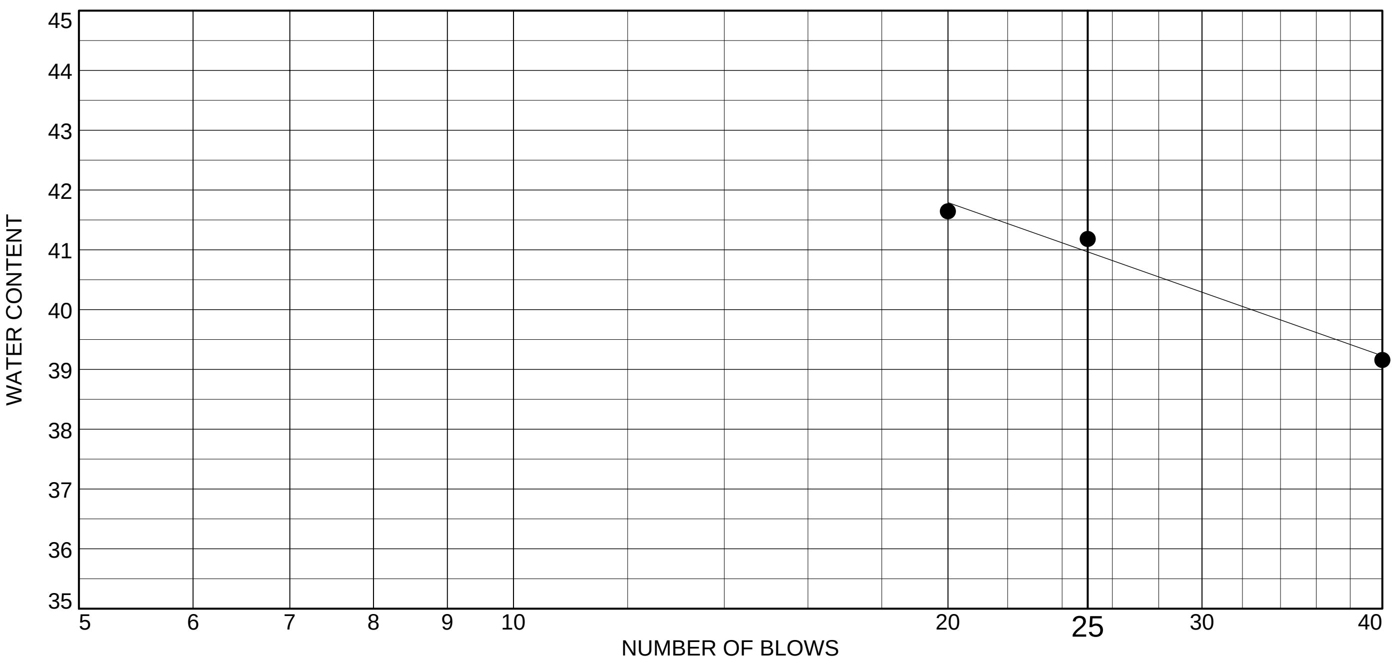
Terracon

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK BROWN LEAN CLAY	41	24	17			CL

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

Source of Sample: B-1 **Depth:** 40.0'-42.0'
Sample Number: S-12

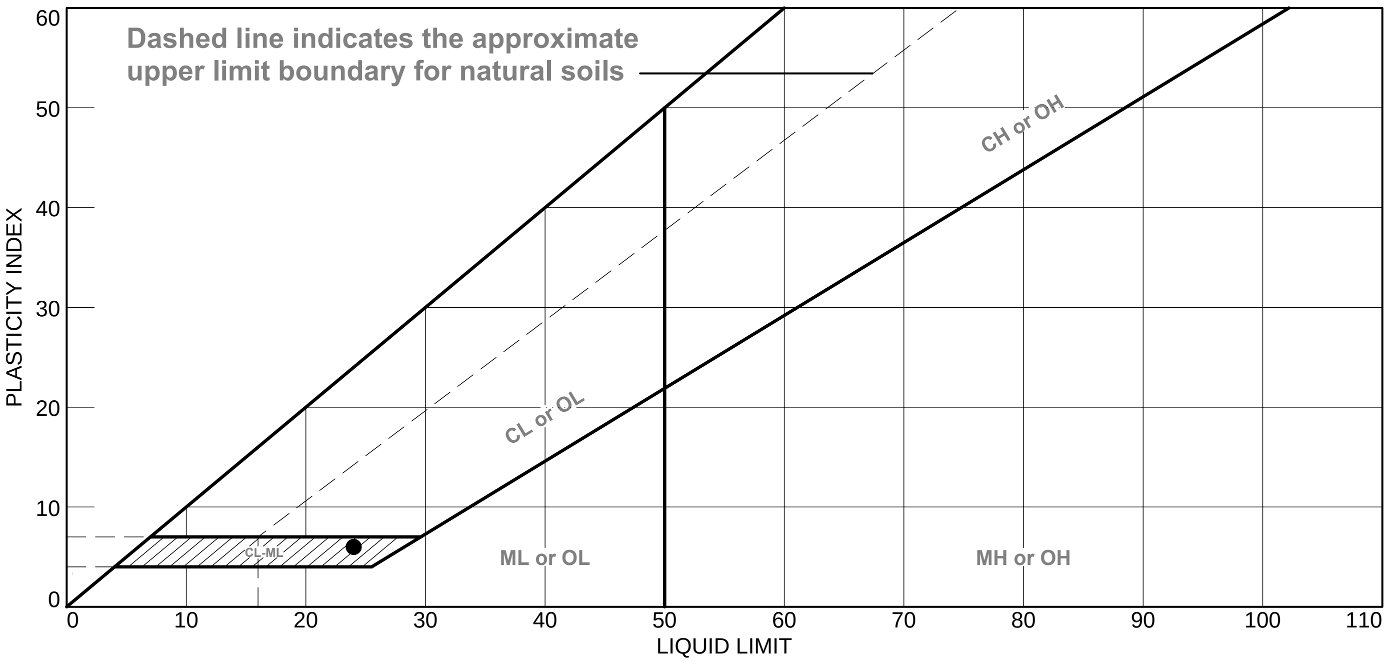
Remarks:

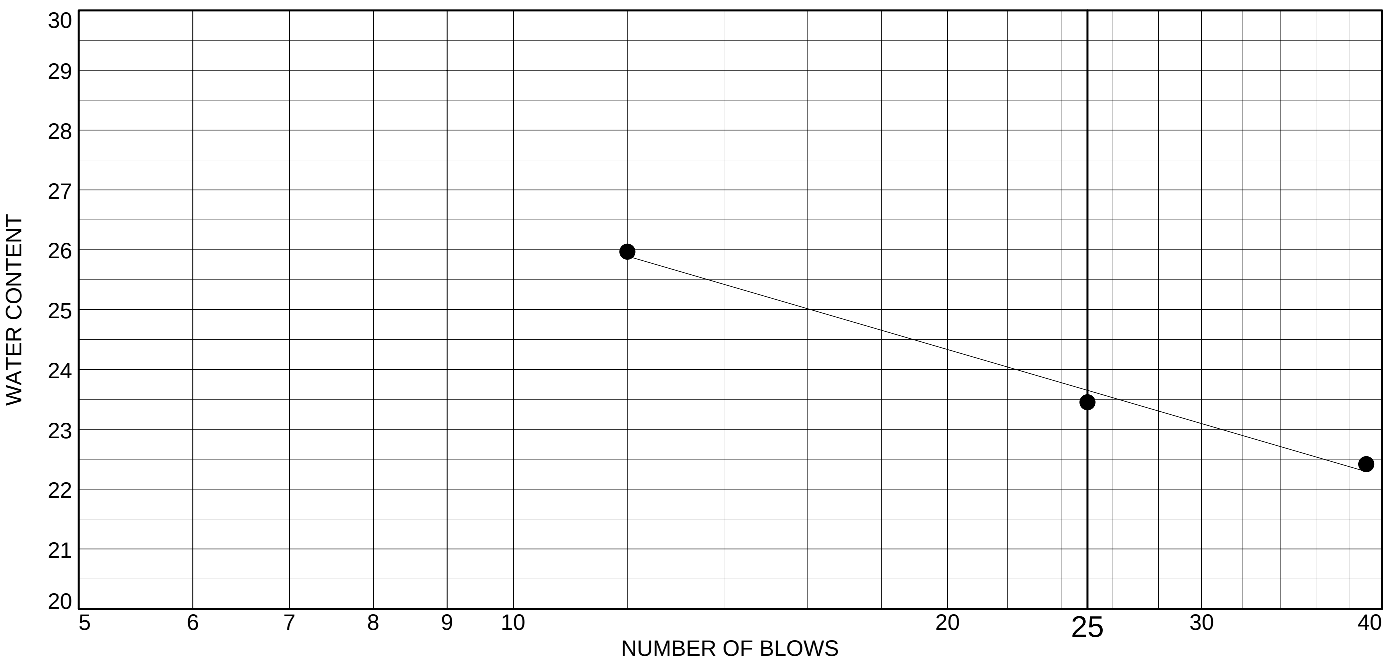
Terracon

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK BROWN SANDY LEAN CLAY	24	18	6			CL-ML

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

Source of Sample: B-1 **Depth:** 50.0'-52.0'
Sample Number: S-14

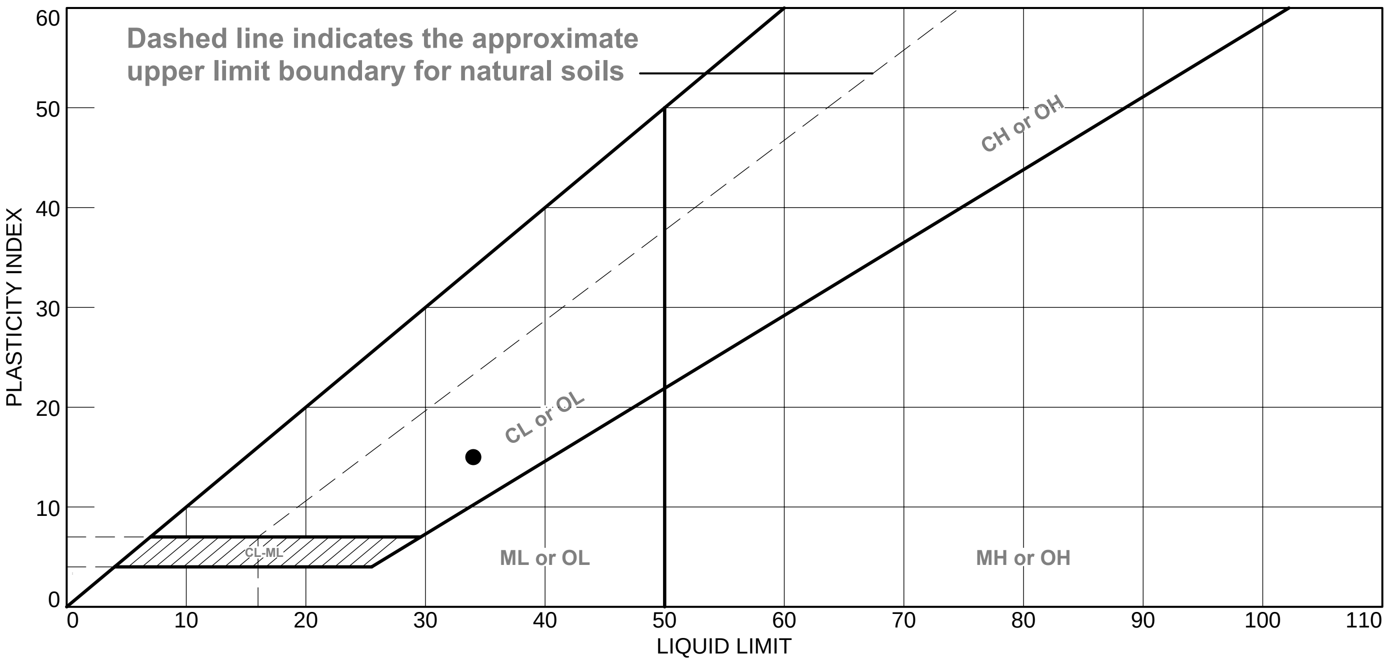
Terracon

Remarks:

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN AND GRAY LEAN CLAY - ORGANIC ODOR NOTED	34	19	15			CL

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

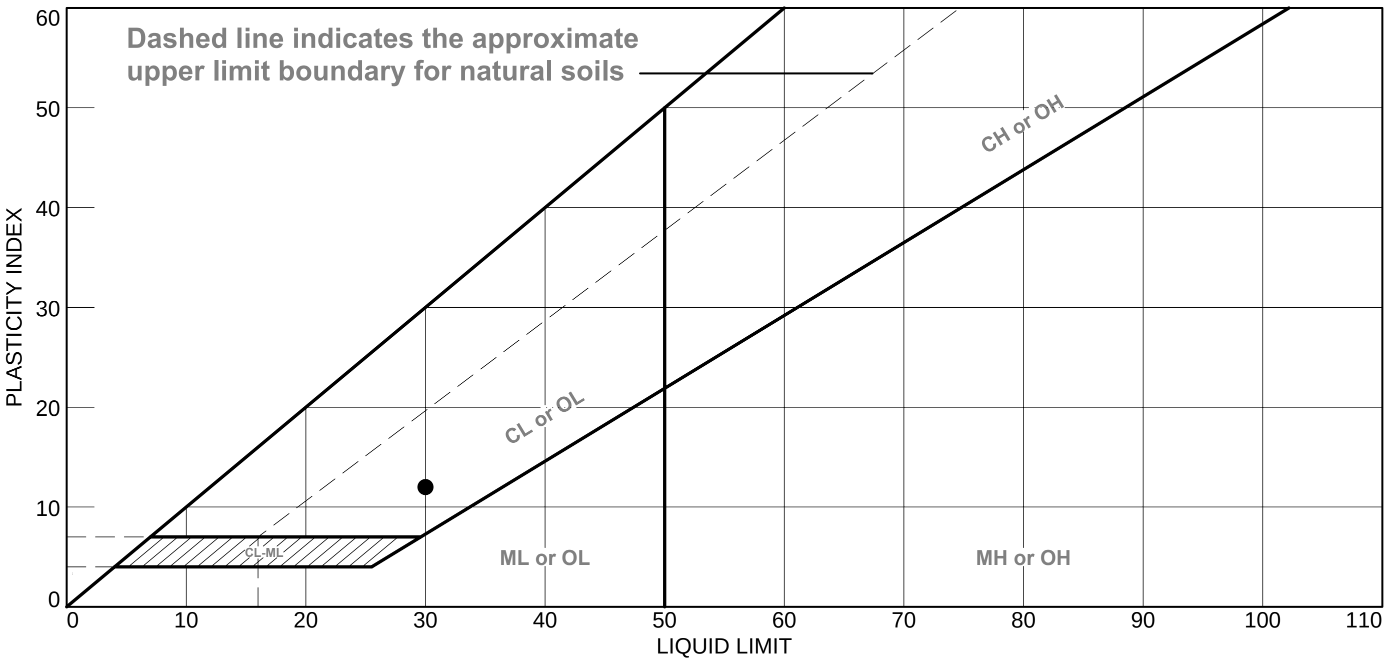
Source of Sample: B-2 **Depth:** 9.0'-11.0'
Sample Number: S-4

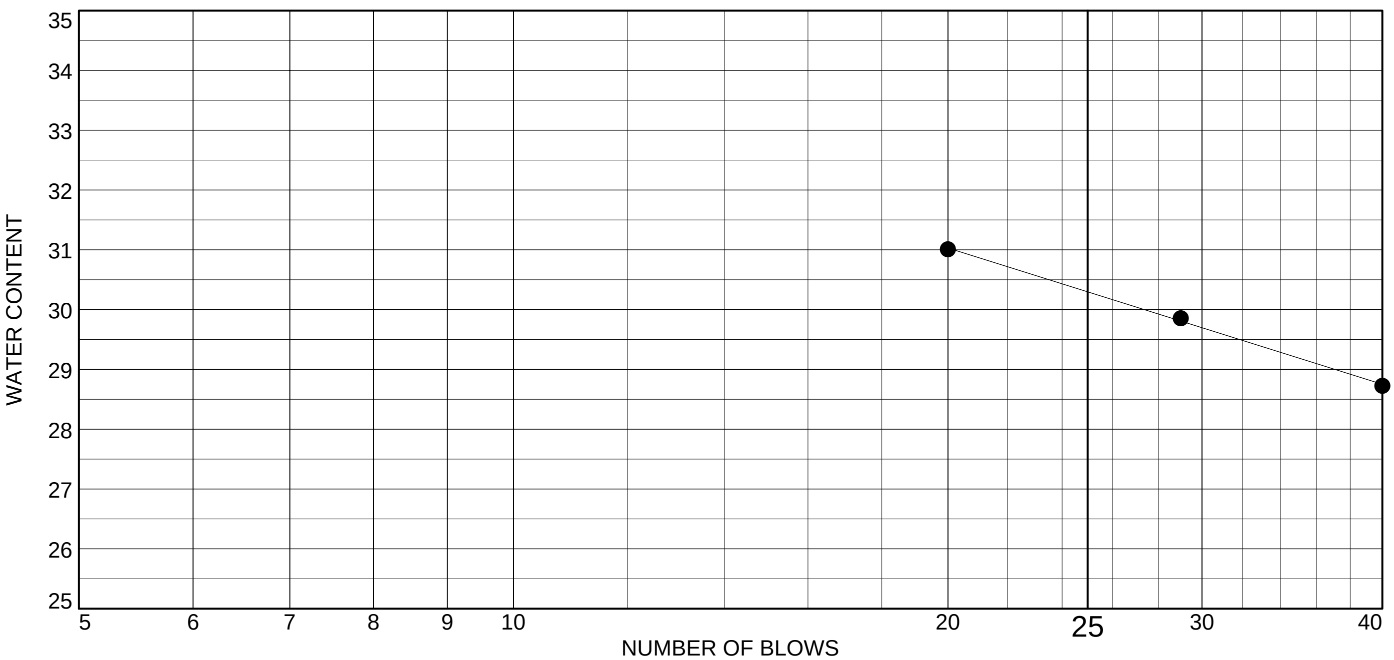
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN AND GRAY SILTY CLAY	30	18	12			CL

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

Source of Sample: B-2 **Depth:** 13.0'-15.0'
Sample Number: S-6

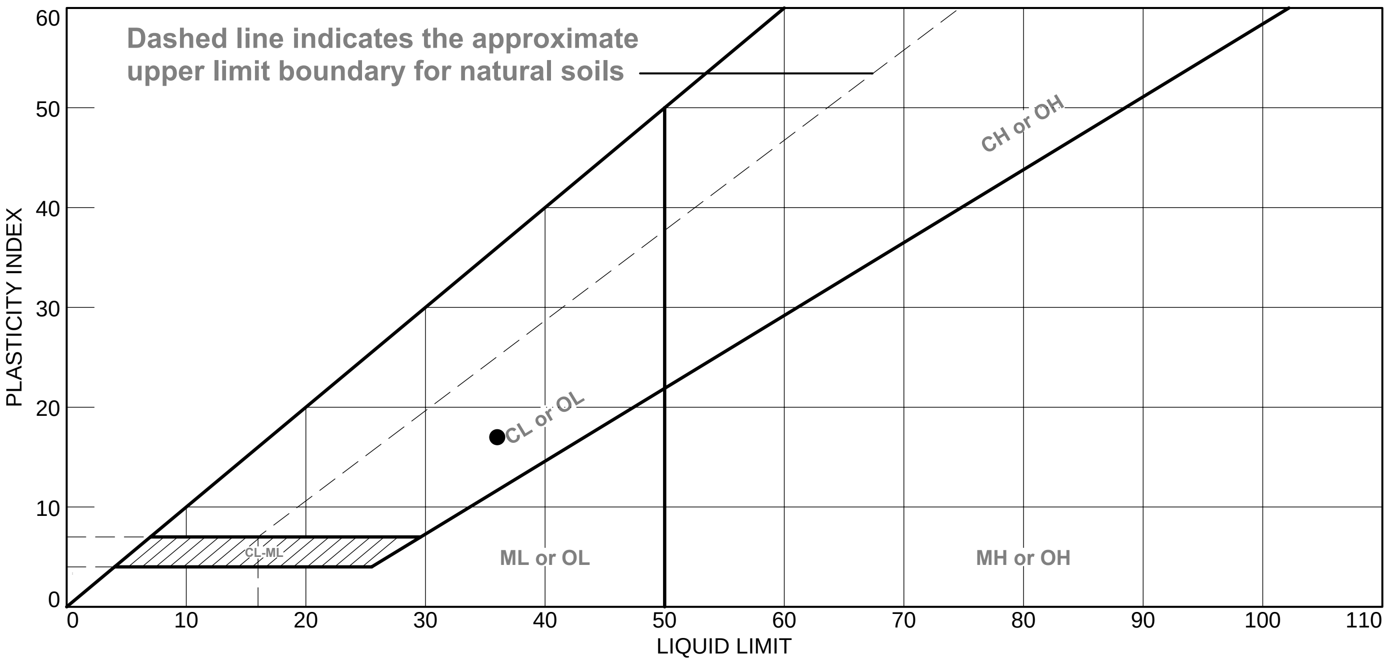
Terracon

Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWNISH GRAY LEAN CLAY	36	19	17			CL

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

Source of Sample: B-2 **Depth:** 20.0'-22.0'
Sample Number: S-9

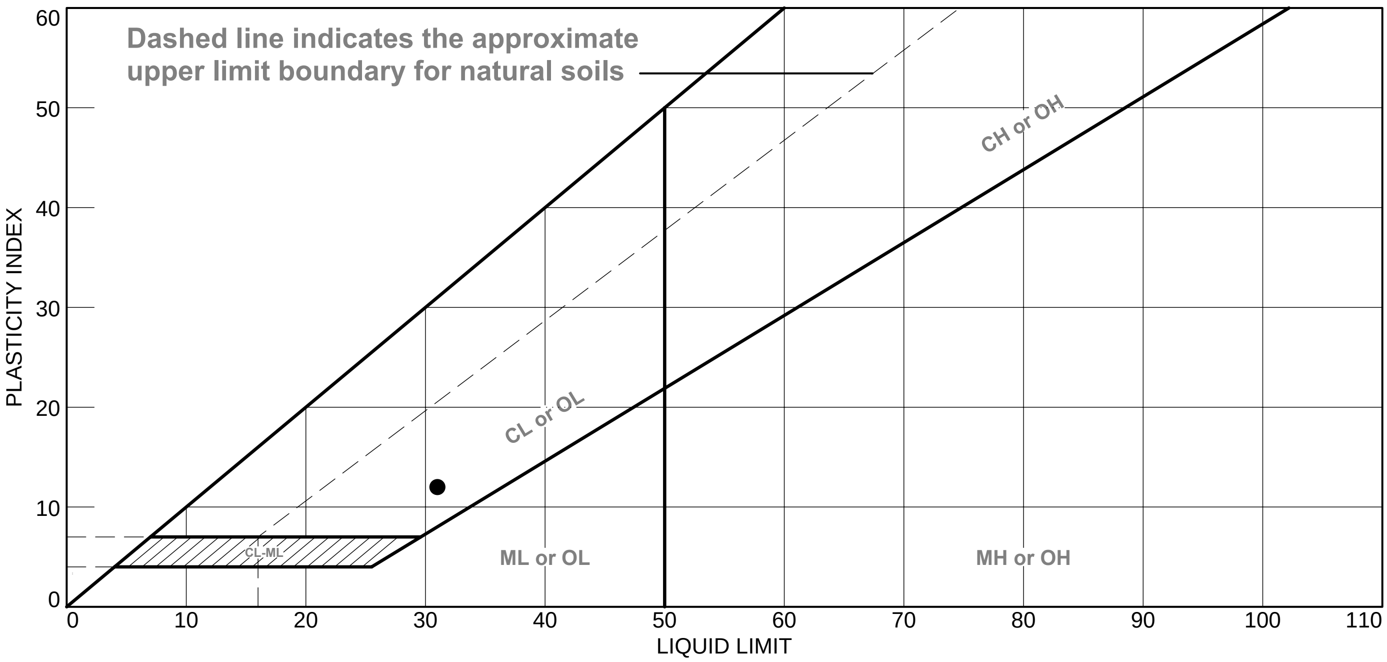
Terracon

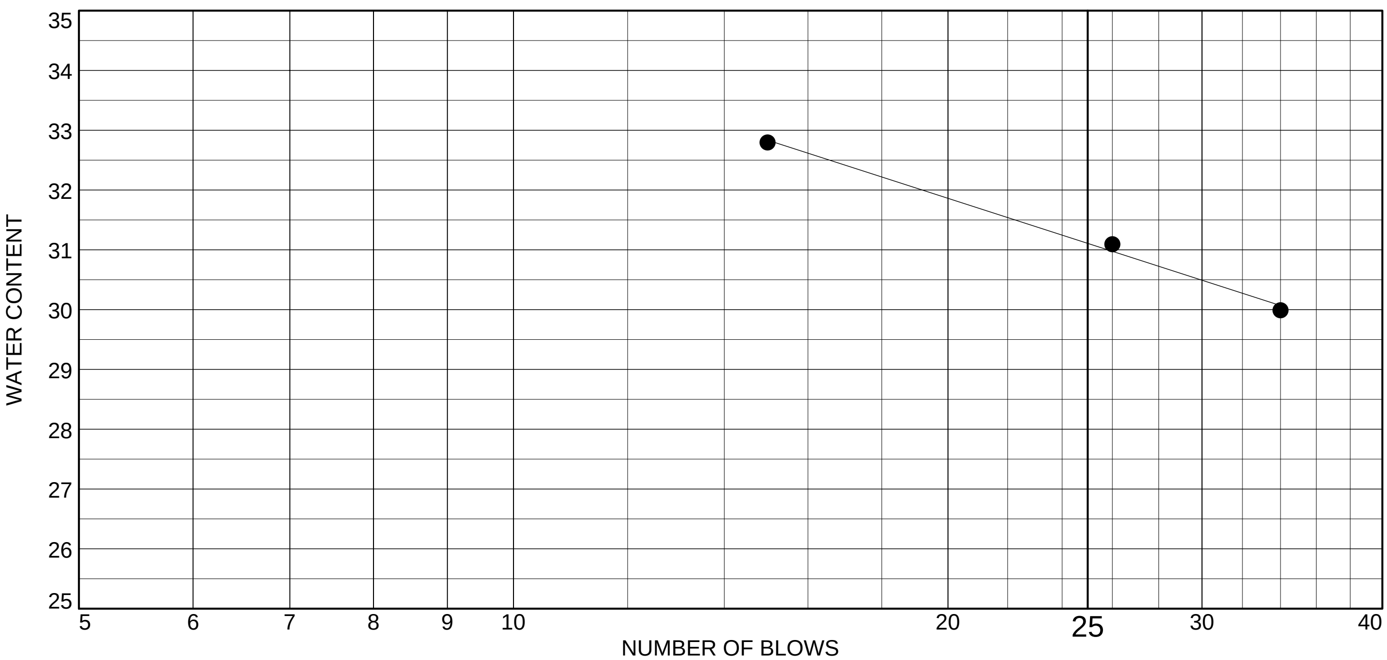
Remarks:

Figure

Tested By: SJH **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	OLIVE BROWN LEAN CLAY	31	19	12			CL

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

Source of Sample: B-2 **Depth:** 30.0'-32.0'
Sample Number: S-11

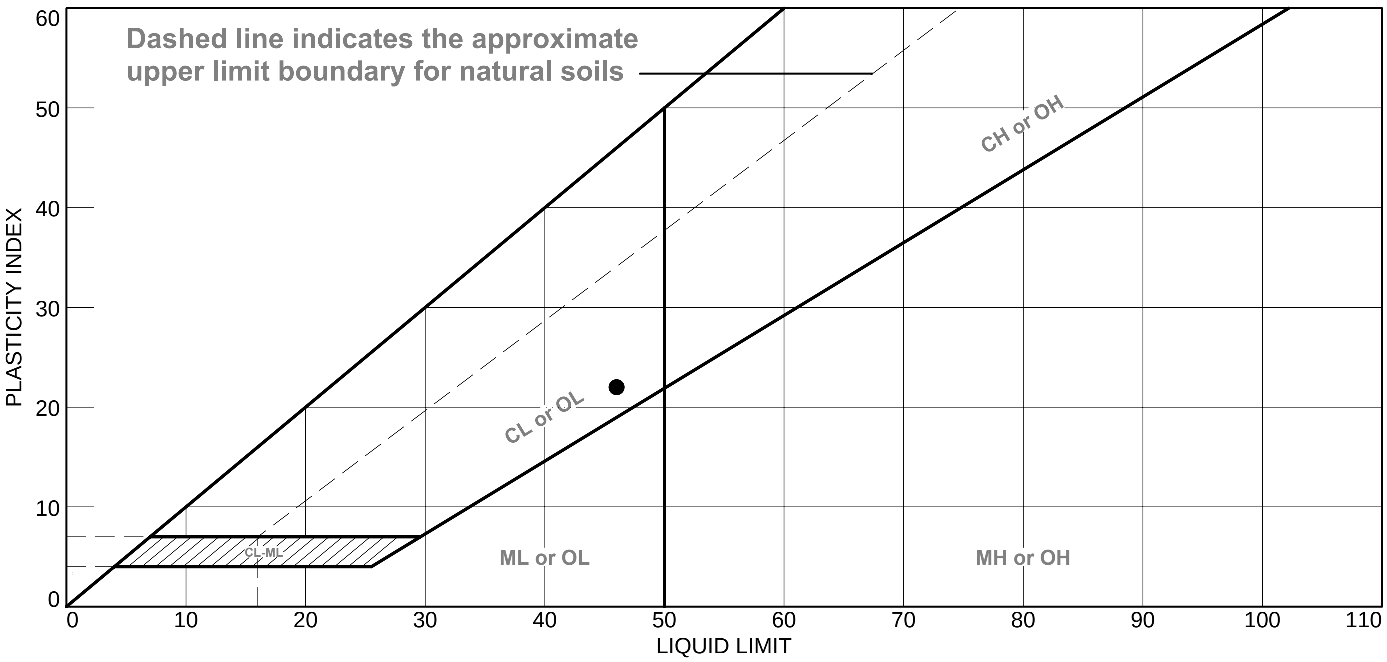
Terracon

Remarks:

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN LEAN CLAY	46	24	22			CL

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

Source of Sample: B-2 **Depth:** 40.0'-42.0'
Sample Number: S-13

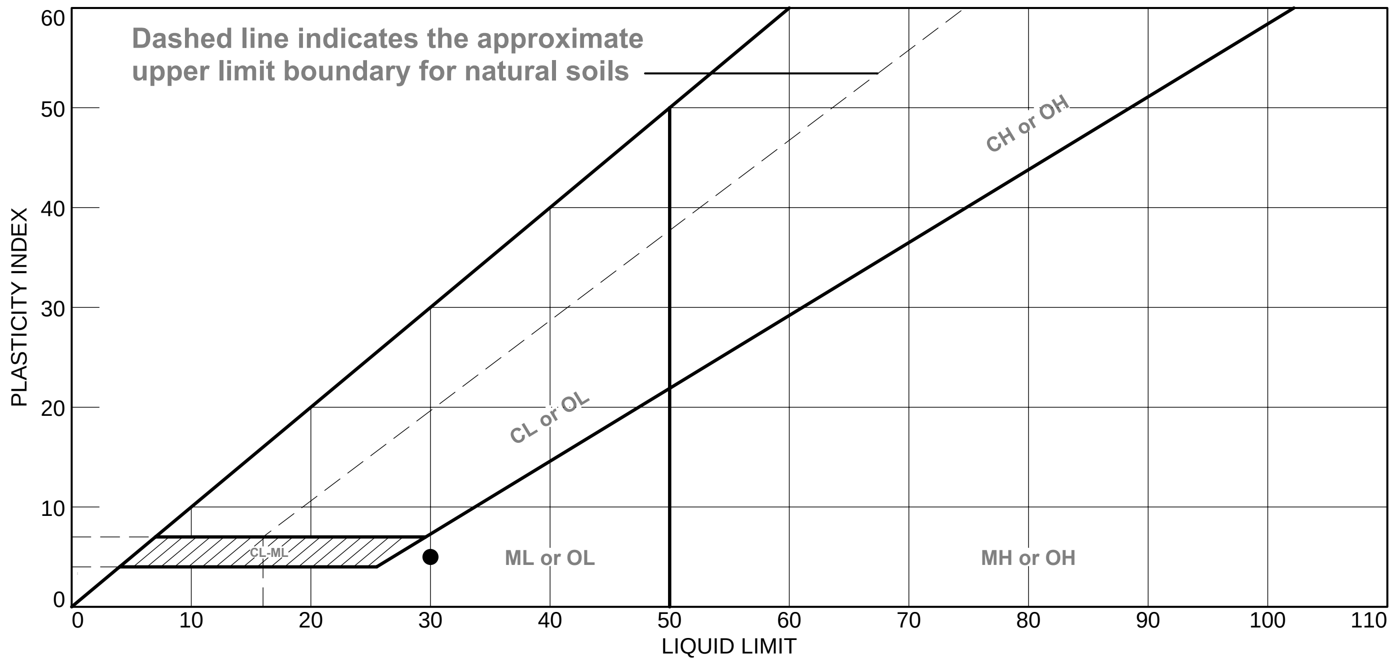
Terracon

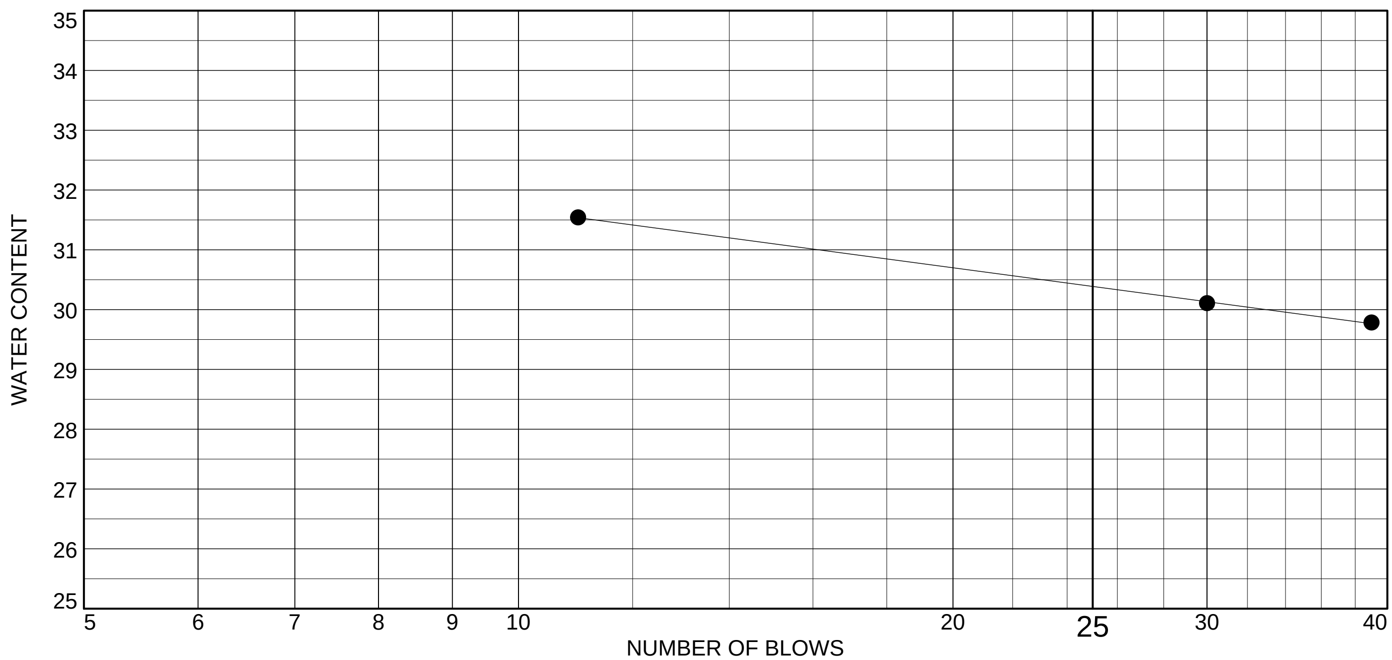
Remarks:

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN SANDY SILT	30	25	5	100.0	73.3	ML

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

Source of Sample: B-2 **Depth:** 48.0'-50.0'
Sample Number: S-14

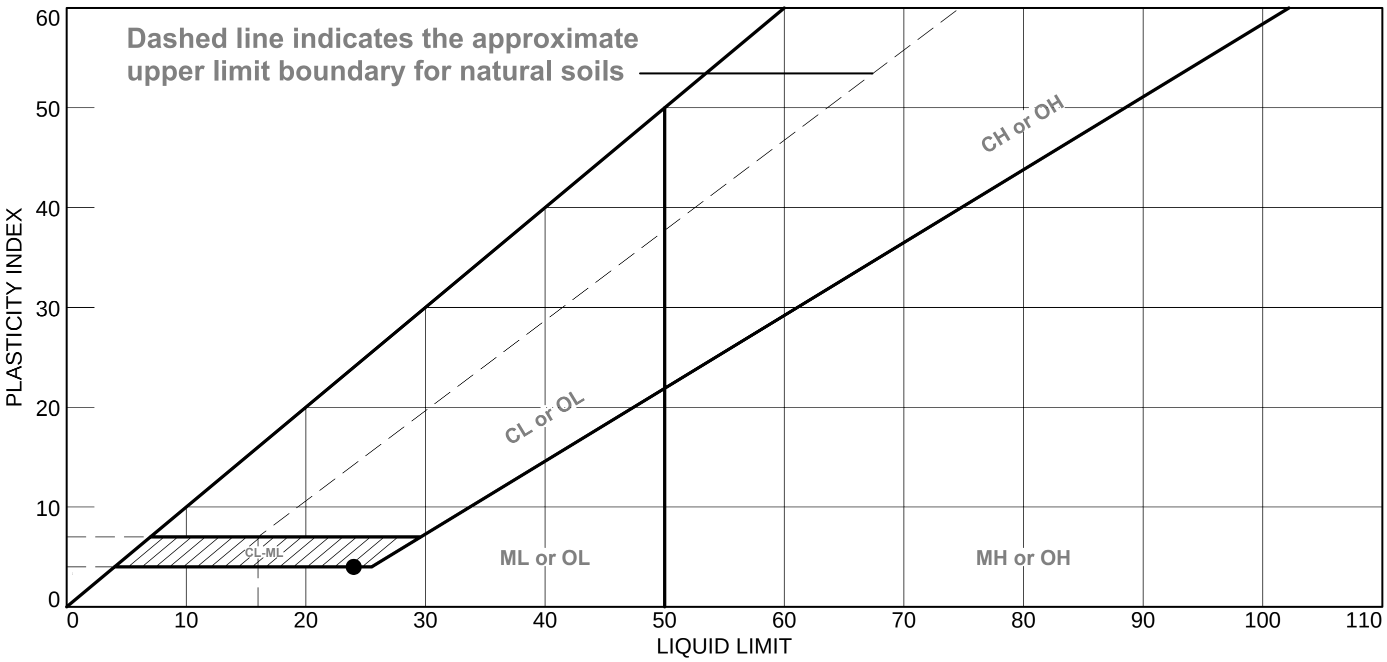
Remarks:
● CLAY POCKETS NOTED

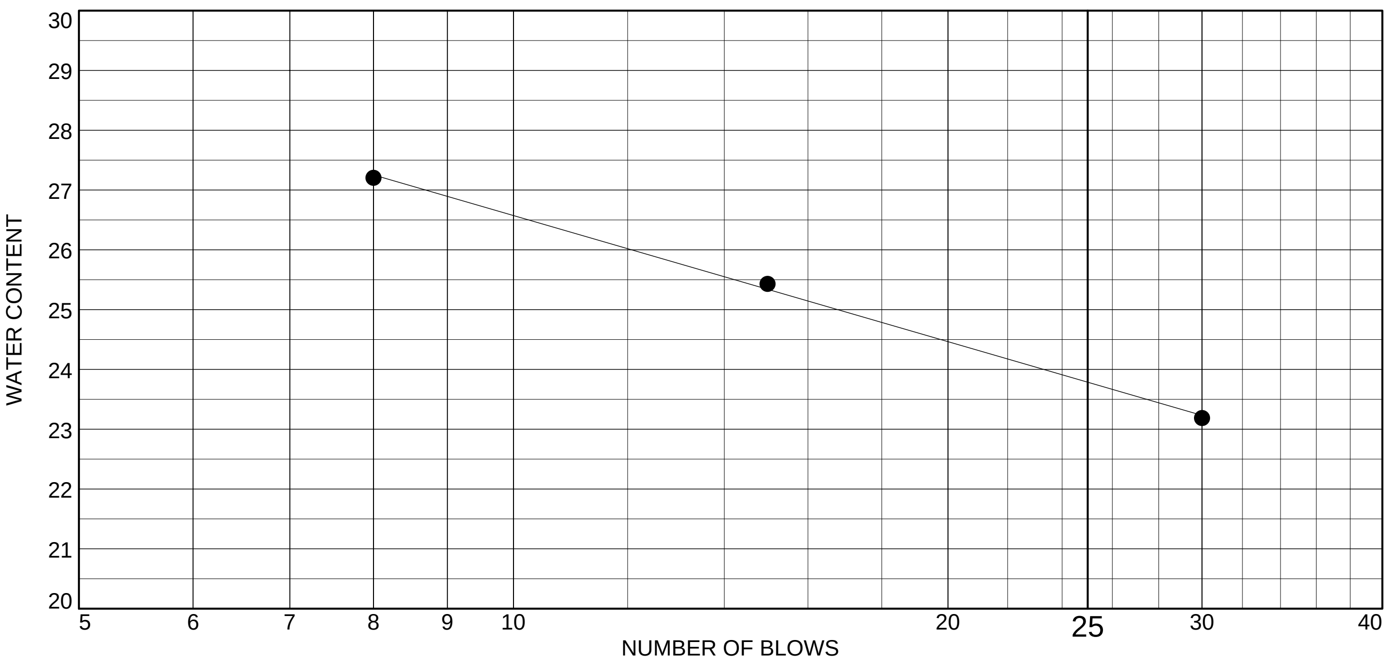
Terracon

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	VERY DARK GRAY LEAN CLAY WITH SAND	24	20	4			CL-ML

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

Source of Sample: B-2 **Depth:** 53.0'-55.0'
Sample Number: S-16

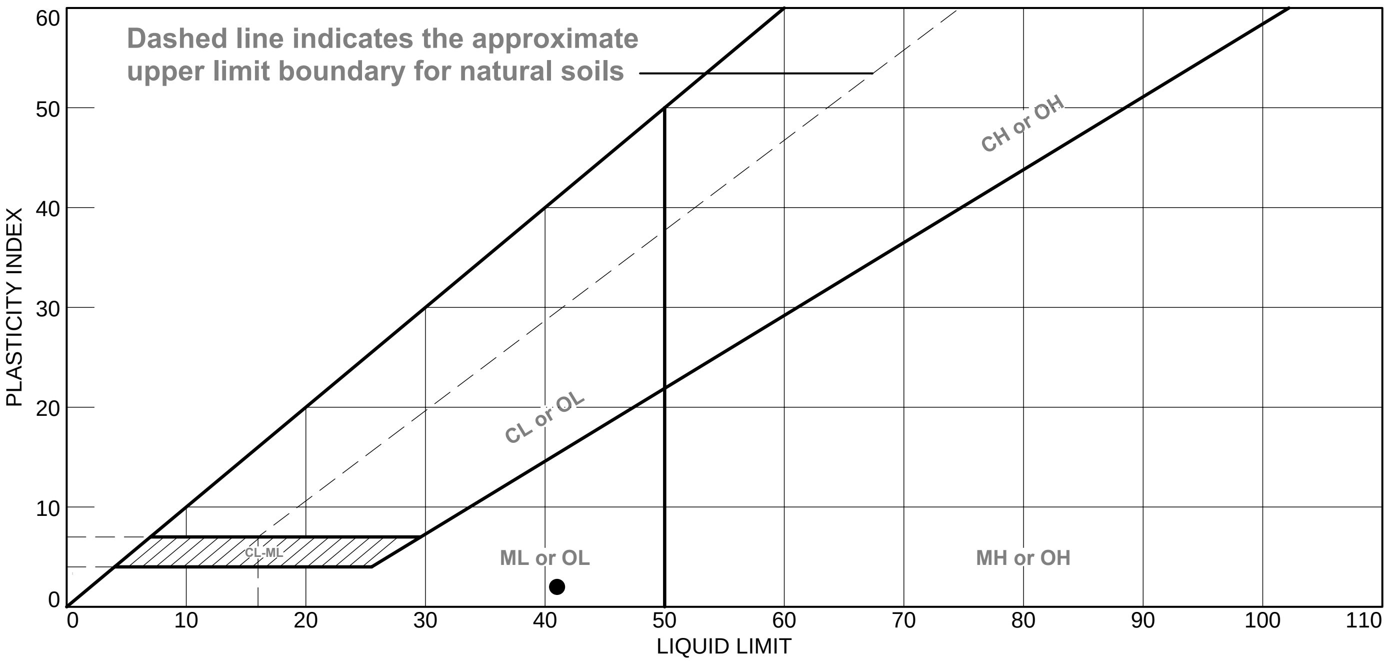
Terracon

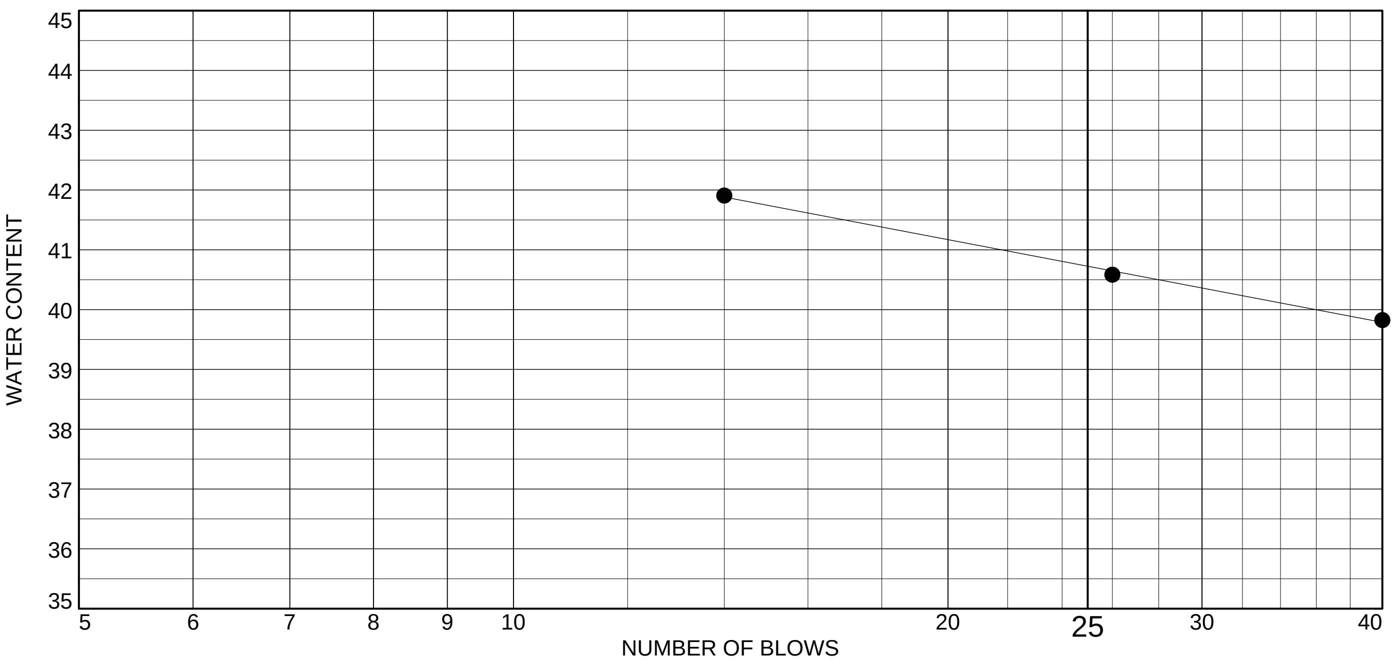
Remarks:

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	GRAY SANDY SILT	41	39	2	97.8	58.5	ML

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

Source of Sample: B-2 **Depth:** 61.0'-62.5'
Sample Number: S-19

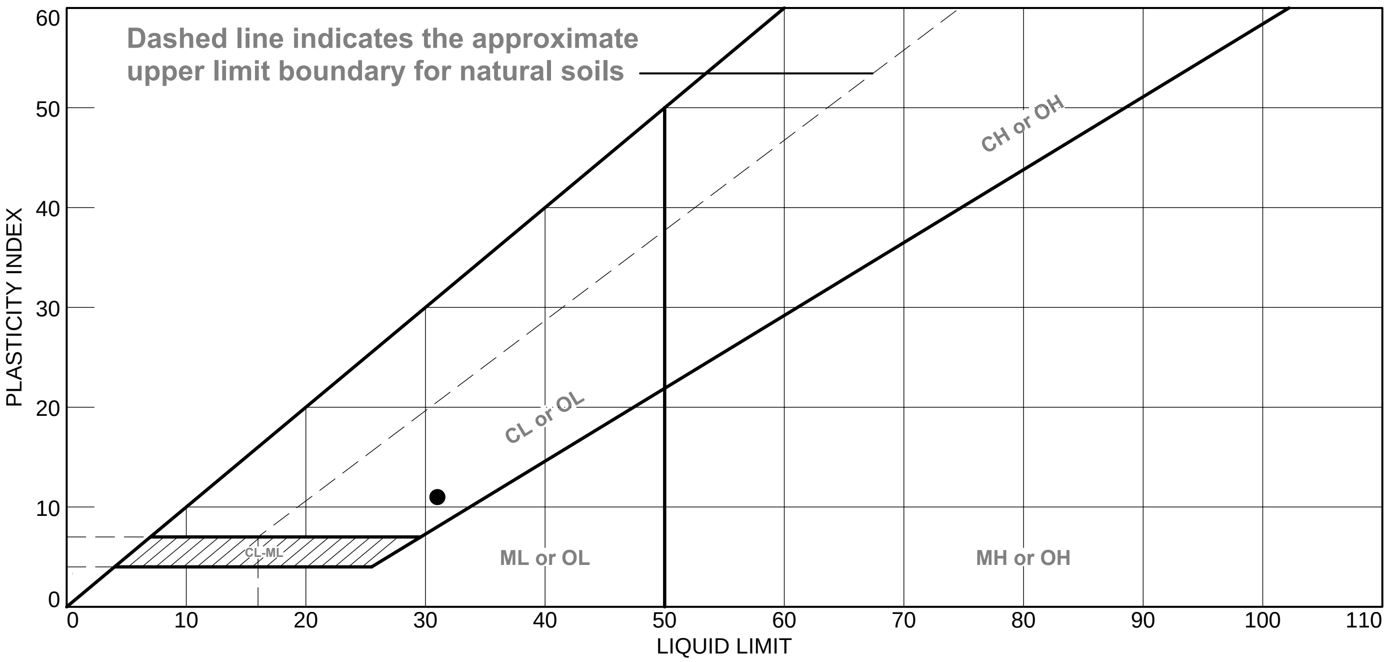
Terracon

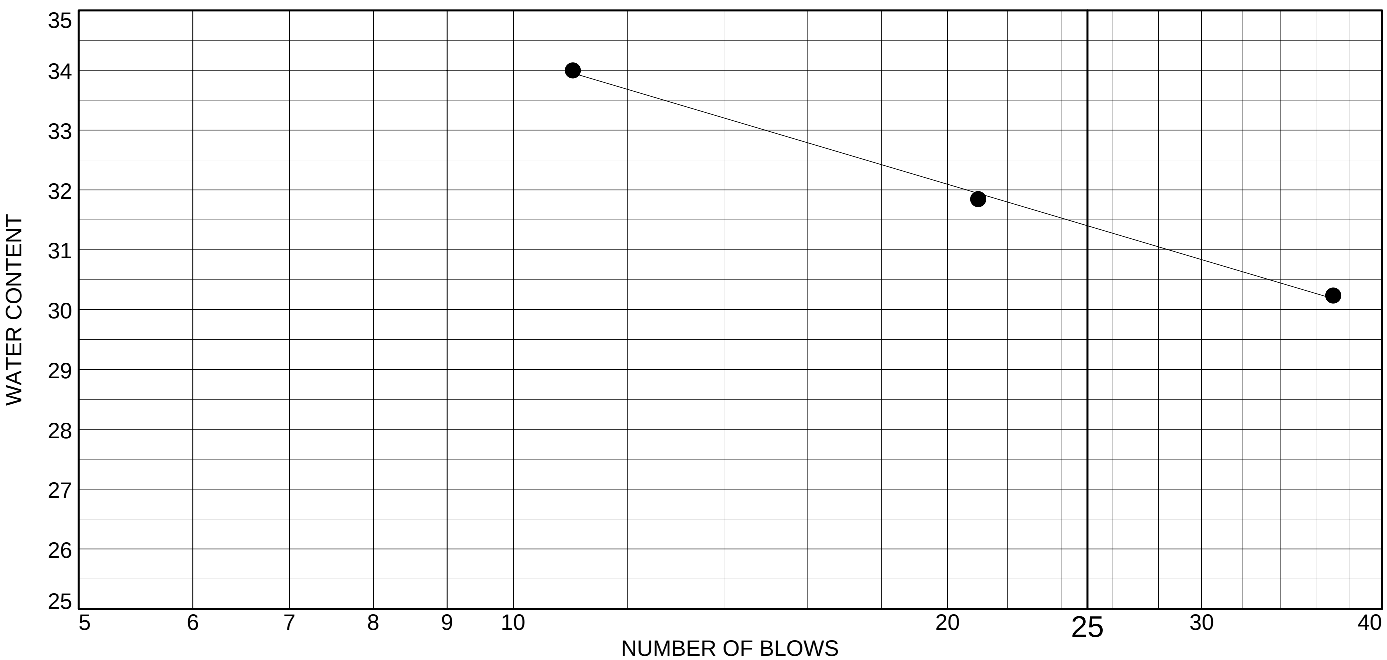
Remarks:

Figure

Tested By: DT **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN LEAN CLAY	31	20	11			CL

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

Source of Sample: B-3 **Depth:** 17.0'-19.0'
Sample Number: S-3

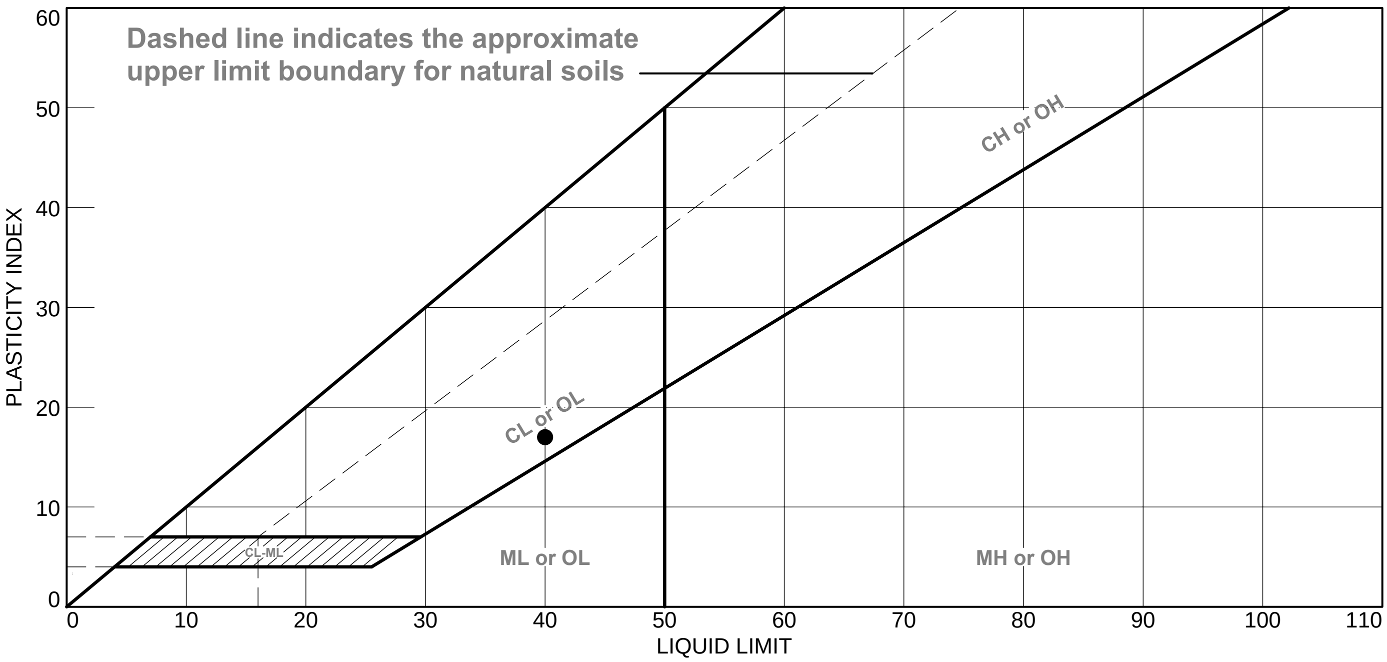
Terracon

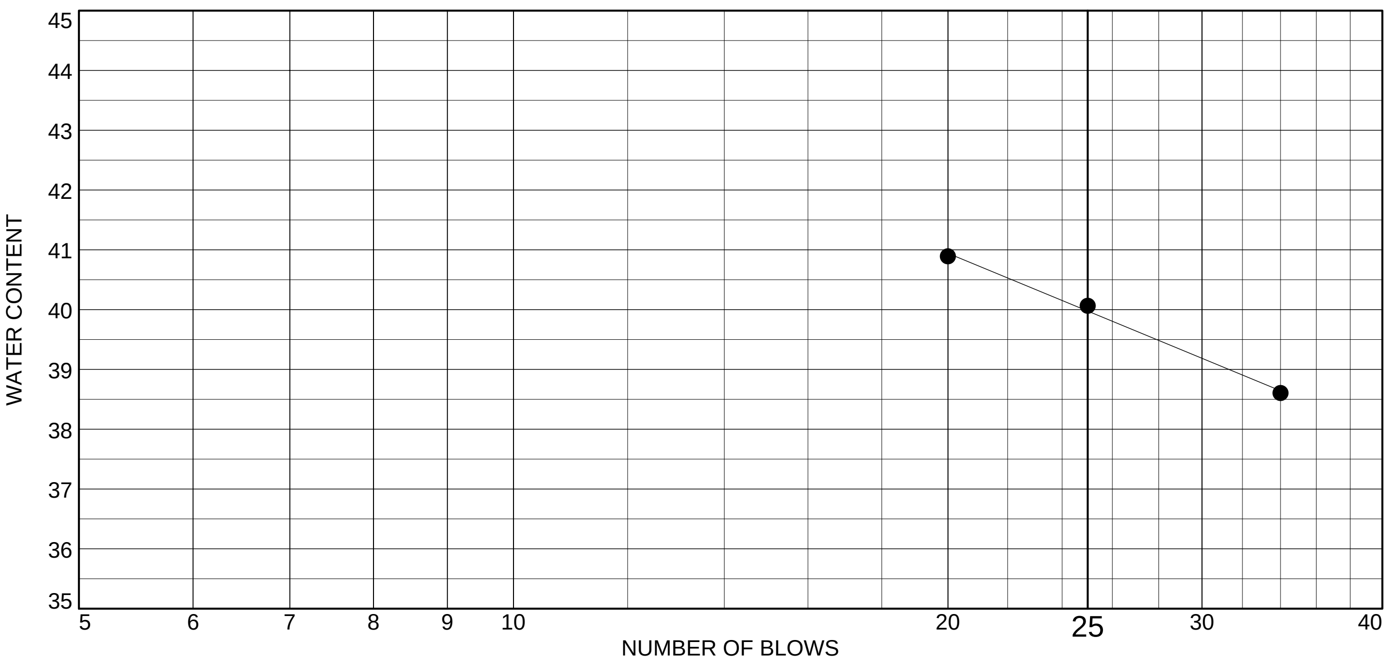
Remarks:

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWNISH GRAY LEAN CLAY	40	23	17			CL

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

Source of Sample: B-3 **Depth:** 30.0'-32.0'
Sample Number: S-6

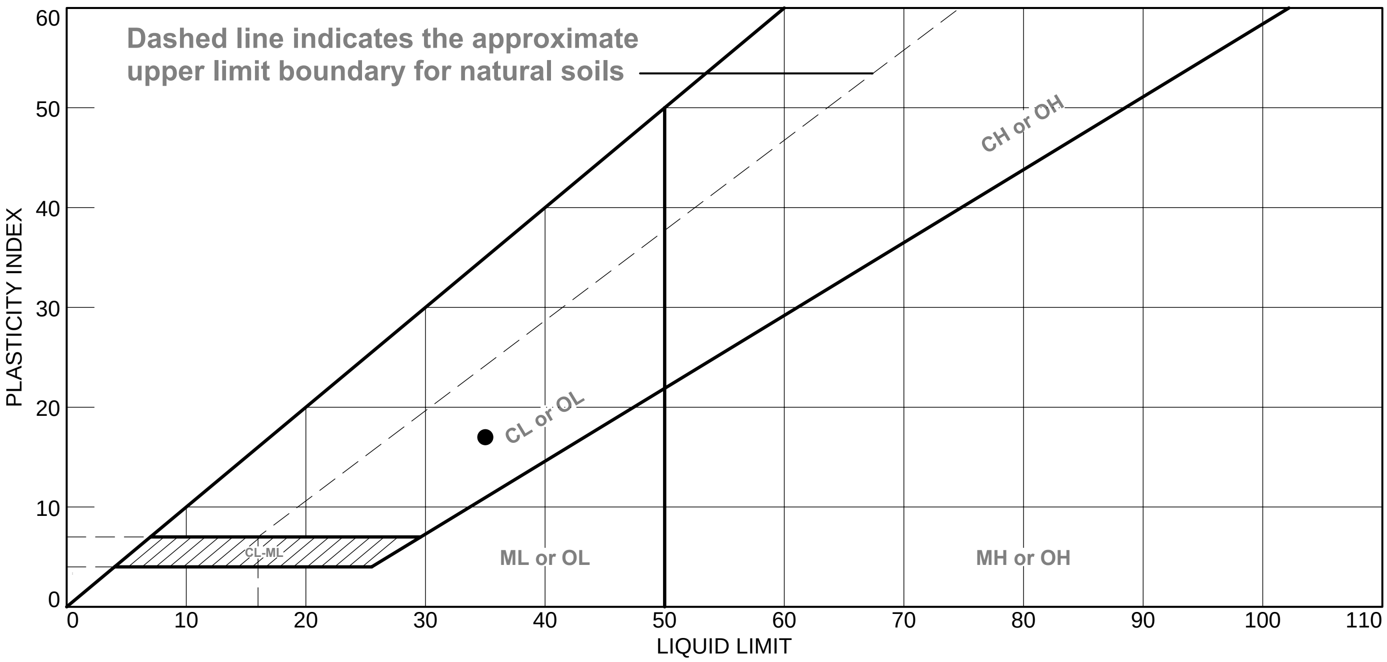
Terracon

Remarks:

Figure

Tested By: HP **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWNISH GRAY LEAN CLAY	35	18	17	99.4	89.5	CL

Project No. MR155242 **Client:** VECTREN

Project: F.B. CULLEY POWER PLANT

Source of Sample: B-3 **Depth:** 36.0'-38.0'
Sample Number: S-8

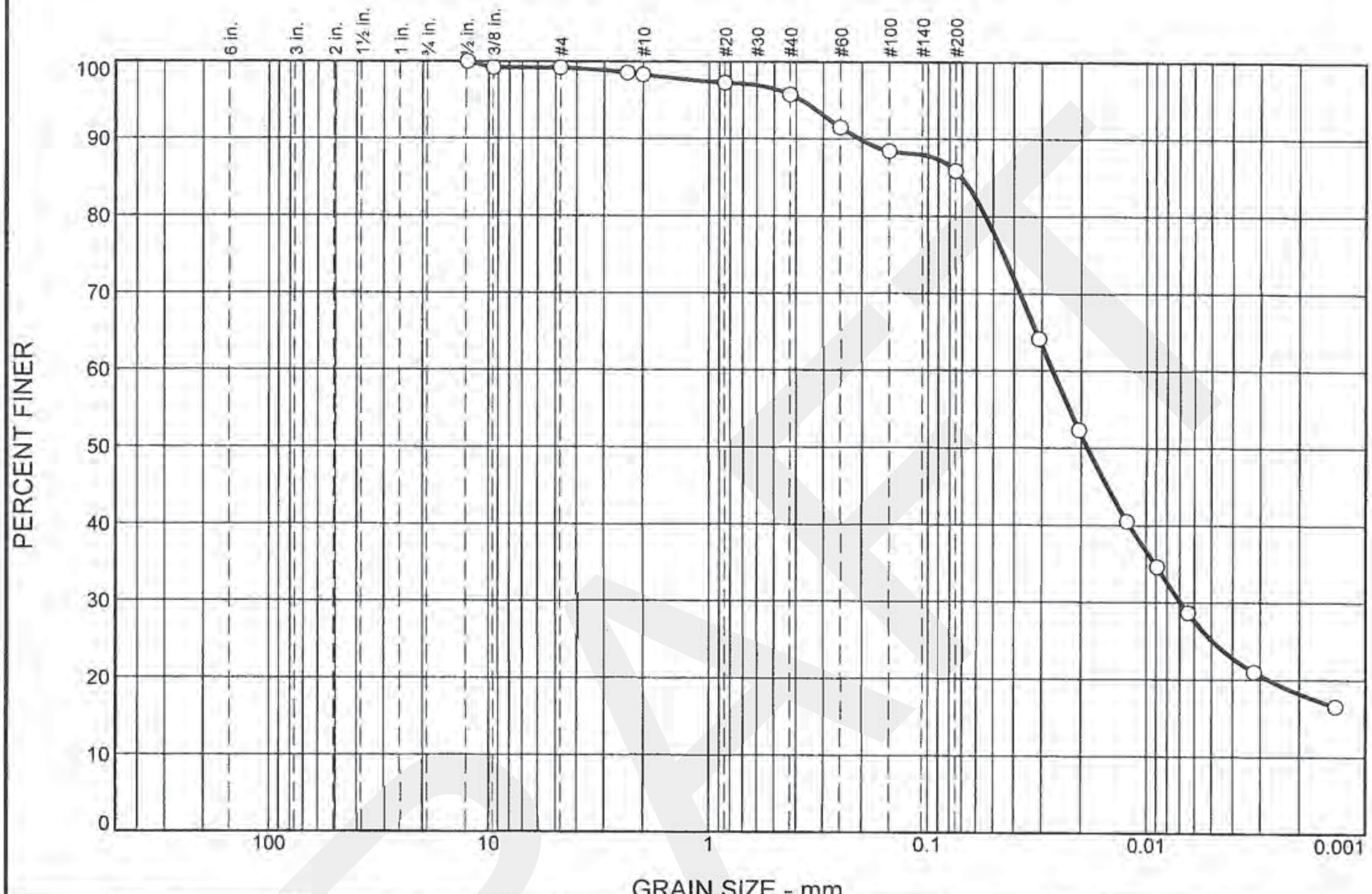
Terracon

Remarks:

Figure

Tested By: SJH **Checked By:** WPQ

Particle Size Distribution Report



% +3"	% Gravel	% Sand	% Silt	% Clay
0.0	0.8	13.3	60.7	25.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100.0		
3/8"	99.2		
#4	99.2		
#8	98.5		
#10	98.3		
#20	97.3		
#40	95.8		
#60	91.5		
#100	88.4		
#200	85.9		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2057 D_{85}= 0.0701 D_{60}= 0.0268
D_{50}= 0.0187 D_{30}= 0.0069 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

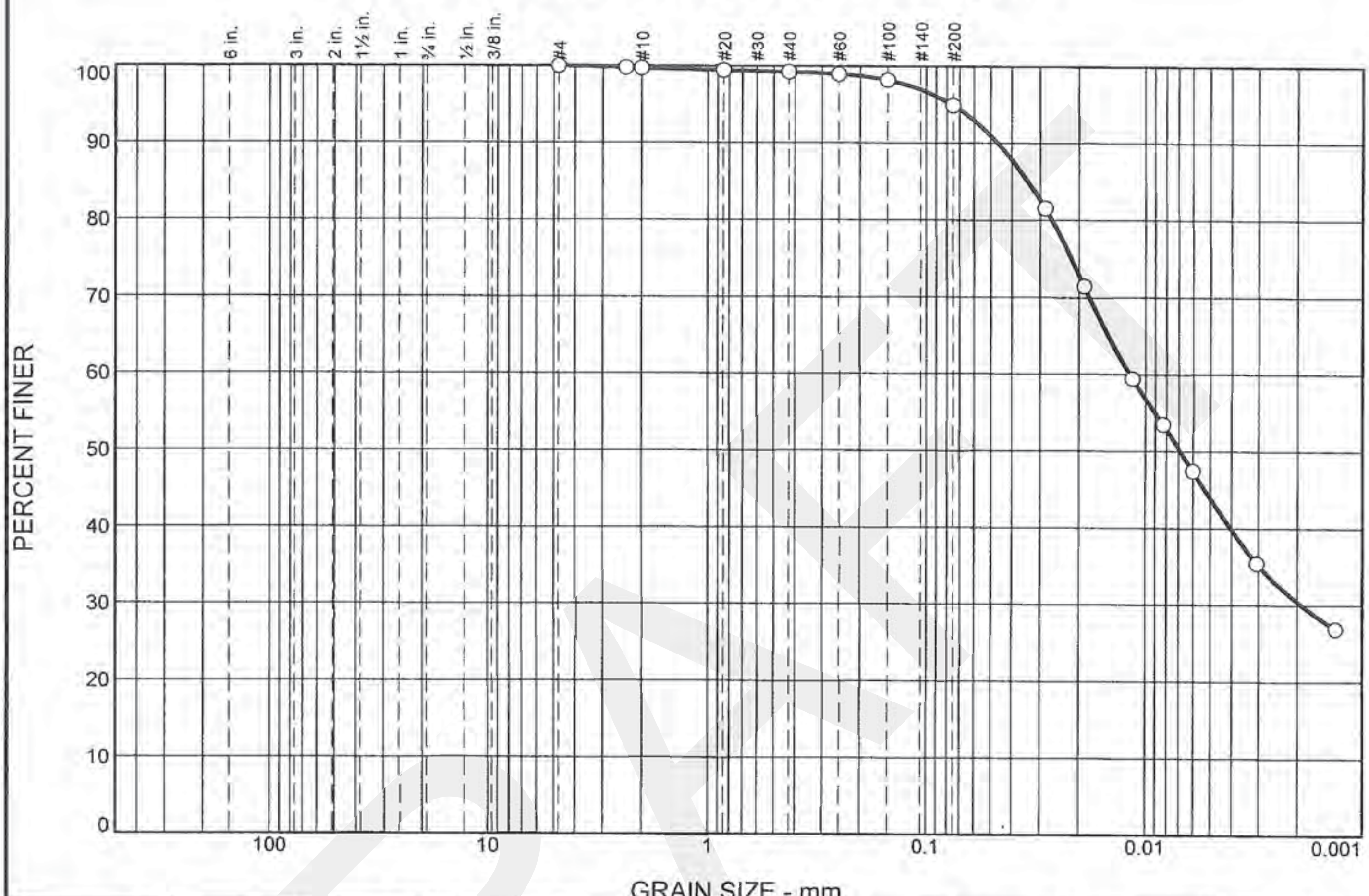
Remarks

Source of Sample: 7030 **Depth:** 11.0'-13.0'
Sample Number: B-101

Date:

Cardno ATC, INC.	**Client:** Vectren
	Project: Culley Stability Assessment
Indianapolis, Indiana	**Project No:** 170GC00107 **Figure**

Particle Size Distribution Report



% +3"	% Gravel	% Sand	% Silt	% Clay
0.0	0.0	5.1	51.0	43.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.8		
#10	99.7		
#20	99.4		
#40	99.2		
#60	99.0		
#100	98.2		
#200	94.9		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.0462 D_{85}= 0.0337 D_{60}= 0.0118
D_{50}= 0.0069 D_{30}= 0.0019 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Source of Sample: 7030 **Depth:** 28.0'-30.0'
Sample Number: B-101

Date:

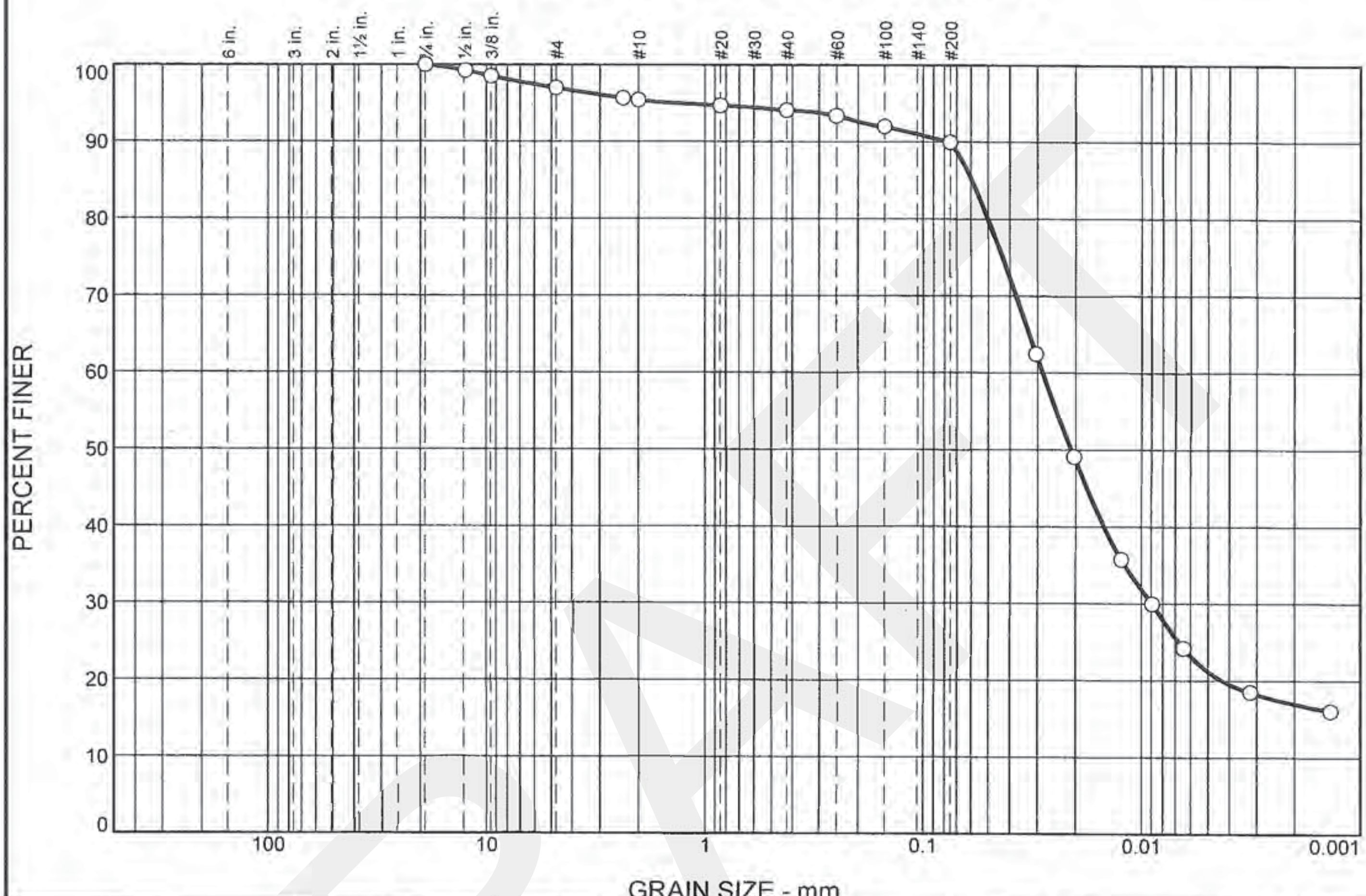
Cardno ATC, INC.

Indianapolis, Indiana

Client: Vectren
Project: Culley Stability Assessment

Project No: 170GC00107 **Figure**

Particle Size Distribution Report



% +3"	% Gravel	% Sand	% Silt	% Clay
0.0	3.0	7.1	68.7	21.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	99.2		
3/8"	98.5		
#4	97.0		
#8	95.7		
#10	95.4		
#20	94.7		
#40	94.1		
#60	93.4		
#100	92.0		
#200	89.9		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.0762 D_{85}= 0.0592 D_{60}= 0.0284
D_{50}= 0.0209 D_{30}= 0.0089 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Source of Sample: 7030 **Depth:** 8.5'-10.5'
Sample Number: B-102

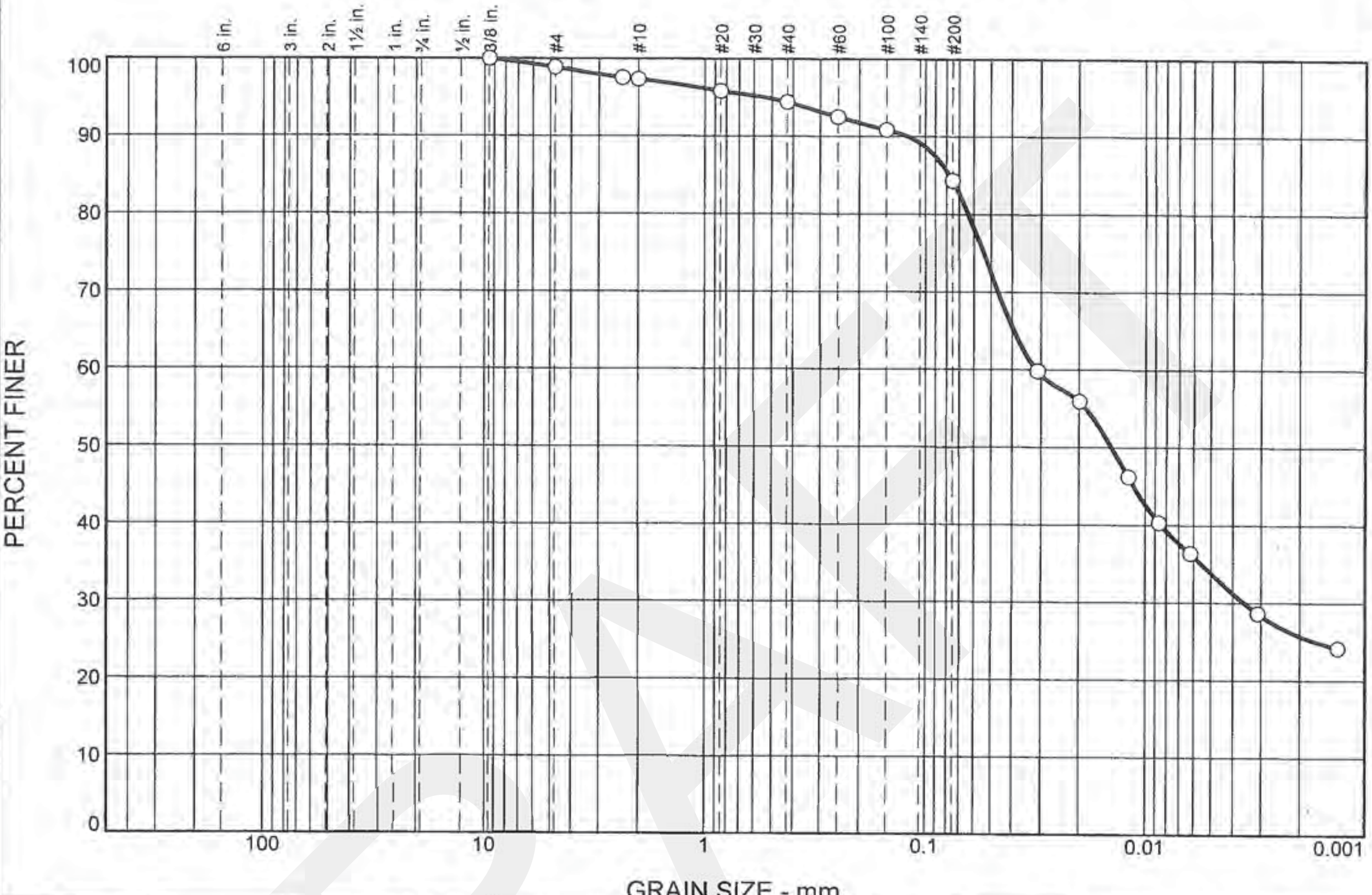
Date:

Cardno ATC, INC.

Indianapolis, Indiana

Client: Vectren
Project: Culley Stability Assessment
Project No: 170GC00107 **Figure**

Particle Size Distribution Report



% +3"	% Gravel	% Sand	% Silt	% Clay
0.0	1.1	14.6	50.4	33.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
#4	98.9		
#8	97.6		
#10	97.3		
#20	95.8		
#40	94.4		
#60	92.5		
#100	90.9		
#200	84.3		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.1196 D_{85}= 0.0774 D_{60}= 0.0314
D_{50}= 0.0142 D_{30}= 0.0036 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

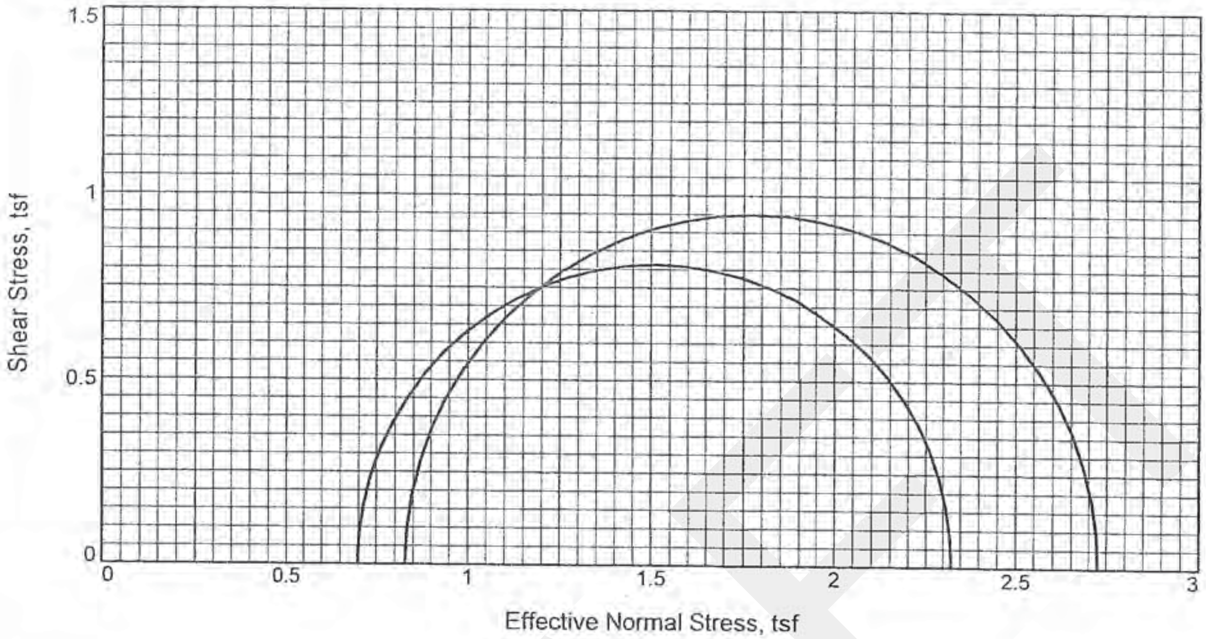
Source of Sample: 7030 **Depth:** 23.5'-25.5'
Sample Number: B-102

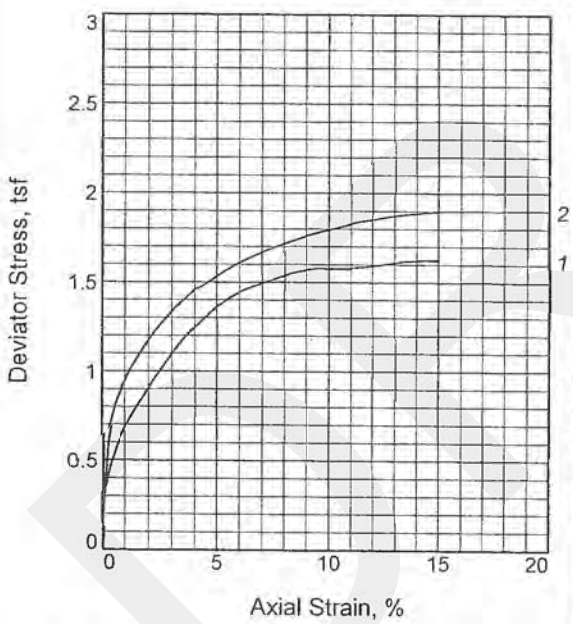
Date:

Cardno ATC, INC.

Indianapolis, Indiana

Client: Vectren
Project: Culley Stability Assessment
Project No: 170GC00107 **Figure**





Sample No.		1	2
Initial	Water Content, %	21.9	24.3
	Dry Density, pcf	99.6	99.5
	Saturation, %	88.1	97.1
	Void Ratio	0.6603	0.6623
	Diameter, in.	2.88	2.88
	Height, in.	5.81	5.63
At Test	Water Content, %	23.3	23.3
	Dry Density, pcf	102.3	102.3
	Saturation, %	100.0	100.0
	Void Ratio	0.6168	0.6165
	Diameter, in.	2.86	2.85
	Height, in.	5.76	5.57
Strain rate, %/min.		0.06	0.06
Back Pressure, psi		60.00	45.00
Cell Pressure, psi		69.00	59.00
Fail. Stress, tsf		1.63	1.90
Total Pore Pr., tsf		4.27	3.42
Ult. Stress, tsf			
Total Pore Pr., tsf			
$\bar{\sigma}_1$ Failure, tsf		2.32	2.73
$\bar{\sigma}_3$ Failure, tsf		0.70	0.83

Type of Test:
CU with Pore Pressures

Sample Type: Shelby tube

Description:

Assumed Specific Gravity= 2.65

Remarks:

Figure CU7030B

Client: Vectren

Project: Culley Safety Factor Assesment

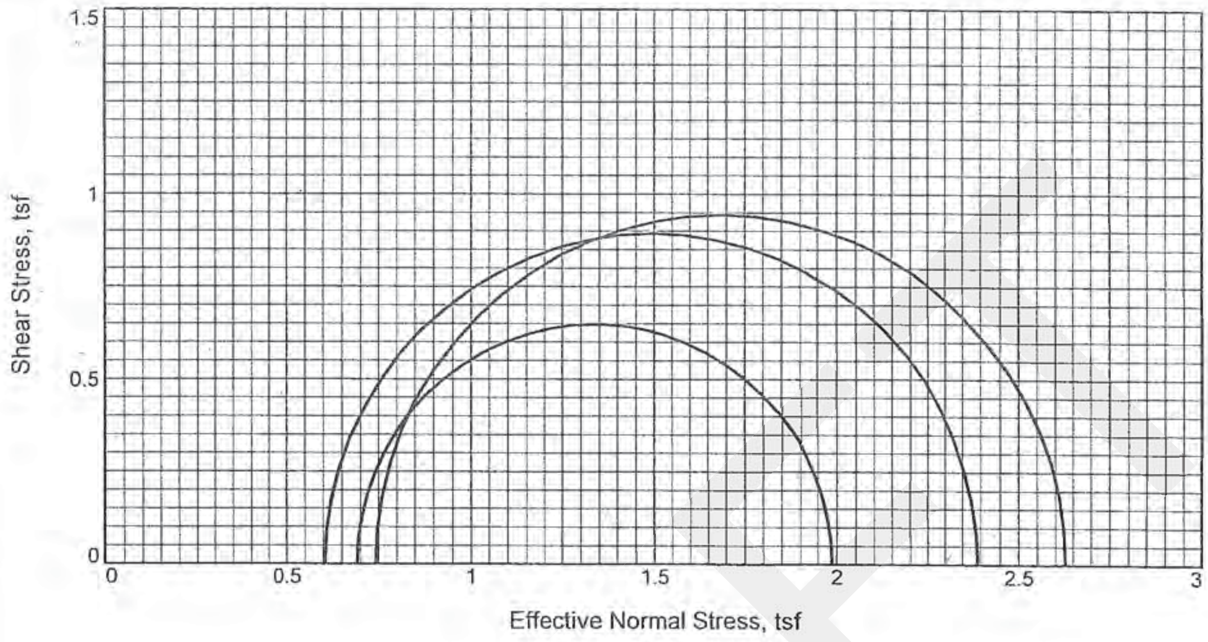
Source of Sample: 7030 **Depth:** 16-18'

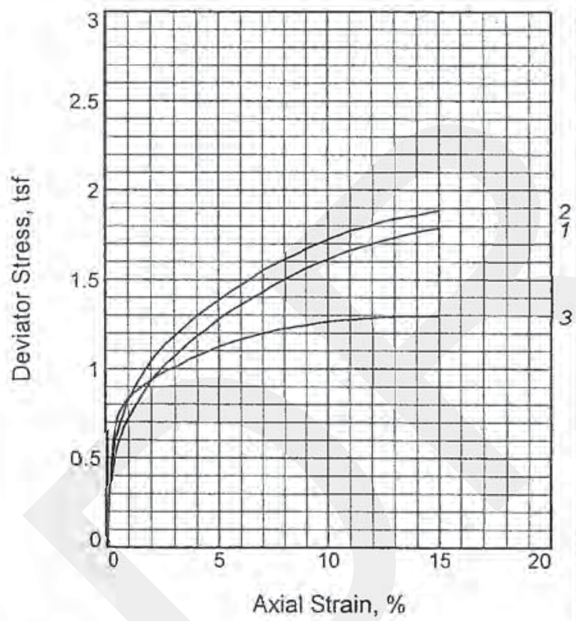
Sample Number: B-101

Proj. No.: 170GC00107 **Date Sampled:**

TRIAXIAL SHEAR TEST REPORT
Cardno ATC, INC.
Indianapolis, Indiana

Tested By: MDr





Sample No.		1	2	3
Initial	Water Content, %	25.2	25.7	26.9
	Dry Density, pcf	99.2	98.4	95.7
	Saturation, %	99.9	100.0	97.8
	Void Ratio	0.6669	0.6810	0.7290
	Diameter, in.	2.88	2.88	2.87
	Height, in.	5.75	5.71	5.65
At Test	Water Content, %	24.8	24.7	24.6
	Dry Density, pcf	99.8	100.0	100.2
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.6582	0.6546	0.6517
	Diameter, in.	2.88	2.87	2.82
	Height, in.	5.74	5.68	5.56
Strain rate, %/min.		0.06	0.06	0.06
Back Pressure, psi		65.00	60.00	45.00
Cell Pressure, psi		72.00	72.00	62.00
Fail. Stress, tsf		1.79	1.89	1.30
Total Pore Pr., tsf		4.58	4.44	3.77
Ult. Stress, tsf				
Total Pore Pr., tsf				
$\bar{\sigma}_1$ Failure, tsf		2.39	2.63	1.99
$\bar{\sigma}_3$ Failure, tsf		0.60	0.74	0.69

Type of Test:
CU with Pore Pressures
Sample Type: Shelby tube
Description:

Assumed Specific Gravity= 2.65
Remarks:

Figure CU7030D

Client: Vectren

Project: Culley Safety Factor Assesment

Source of Sample: 7030 **Depth:** 28-30'
Sample Number: B-101
Proj. No.: 170GC00107 **Date Sampled:**

TRIAXIAL SHEAR TEST REPORT
Cardno ATC, INC.
Indianapolis, Indiana

Tested By: MDr

Appendix E
Material Characterization Calculations

1. **Objective**

This calculation package summarizes the material characteristics of the subsurface strata encountered during AECOM's geotechnical investigation of the East Ash Pond at Vectren's FB Culley Power Station in West Franklin, Indiana. Selection of material properties for slope stability analyses are also developed and summarized within this package.

2. **Subsurface Conditions**

A subsurface exploration was performed at the East Ash Pond between September 1 and October 21, 2015. The subsurface exploration included the following; eight soil borings and a program of three cone penetrometer test (CPT) soundings. A full set of AECOM's boring logs, including soil descriptions, types of sampling, and choice laboratory test results, is provided in **Appendix B** of the report. The geotechnical exploration locations are shown on **Figure 3 – Vectren East Ash Pond Boring Locations** in **Appendix A** of the report.

Based on the results of the investigation, five main stratigraphic materials were identified at the site. These are listed below and briefly summarized:

Embankment Fill: Fill was encountered below the surficial gravel material is all borings with the exception of those in the ash pond (B16-1 through B16-2). Reddish brown to gray silty to sandy clay (CL) with consistency of very stiff to hard and traces of gravel, wood, and coal ash was encountered to depths ranging between 5.5 to 10 feet. Underlying the very stiff to hard silty to sandy clay, a layer of brown to gray silty clay (CL) with consistency ranging from medium to soft to stiff and little to trce sand and coal ash was encountered to depth ranging between 28 to 33 feet below ground surface. The soft to stiff clay was underlain by native soils in all borings except B-102. In boring B-102, a layer of fill consisting of brown silty sand (SM) with loose relative density was encountered from 29 to 31.5 feet below ground surface.

Impounded Ash Materials: The impounded ash materials consisted mainly of fly ash, with occasional thin layers of bottom ash and sludge. The ash varied from gray to brown to black and was generally very loose. Borings B16-1 to B16-4 were drilled in the East Ash Pond.

Native Fine-grained Deposits: Underlying the fill material, gray to brown silty clay (CL) with medium to very stiff consistency was encountered at depths ranging between 28 to 33 feet in all borings except B-102. The medium to very stiff gray silty lay was encountered to a depth of 58 feet in boring B-101 and to the termination depth of 60 feet in borings ATC B-1 and ATC B-2. In boring ATC B-2, a layer of very loose gray silt (ML) was encountered within the medium to stiff gray silty clay from 48 to 53 feet deep. Below the fill material in boring B-102, gray to brown clay (CL) with stiff to very stiff consistency was encountered from 31.5 to 43 feet below ground surface. Underlying the gray to brown clay in boring B-102, brown silty clay (CL) with stiff consistency was encountered from 43 to 48 feet of depth. From 48 to 53 feet below ground surface, the brown silty clay transitioned into reddish brown sandy clay (CL).

Native Granular Deposits: In borings B-101 and B-102, granular deposits were encountered at depths of 53 and 58 feet, respectively. In boring B-101, gray silty sand (SC-SM) with sandy clay seams and loose relative density was encountered from 46.5 to 58 feet of depth. From 64.5 to 69 feet of depth, a layer of medium consistency sandy clay (CL) was encountered within the sand layer. Below the sandy clay, medium dense gray sand (SP) with loose to medium relative density was encountered from 53 to 73 feet below ground surface. Underlying the reddish brown sand, medium dense gray sand (SP-SM) with gravel and trace silty was encountered from 73 to 80 feet depth. SPT-N values range between 8 and 32 with an average of 23.

Bedrock: Below the native sand layers in borings B-101 and B-102, gray weathered shale was encountered at depths of 72 to 79.5 feet below ground surface, respectively. Boring B-101 was terminated at 80 feet depth. Boring B-102 was advanced an additional 1.7 feet into weathered shale. Based on the boring termination depths, competent bedrock was encountered at depths ranging between 73.7 and 80 feet (+321 to +317 feet NAVD88).

3. **Laboratory Testing Program**

Representative samples were collected at regular intervals from the borings and were utilized for laboratory testing. The laboratory tests were assigned to characterize the site materials including index (moisture content, unit weight, Atterberg limits, specific gravity, and particle size analysis), permeability and consolidation tests. Strength testing included isotropically consolidated-undrained triaxial tests with pore pressure measurements (CIU), Unconfined Compression (UC) tests, and direct shear tests (DS) on the native clay materials, embankment materials, and ash materials.

Table E-1: Laboratory Testing Program for East Ash Pond

ASTM Designation	Test Type	Number of Tests				
		Total	Ash	Embankment	Native Fine-grained Soils	Native Granular Soils
D2216	Moisture Content	97	12	33	44	8
D2937	Dry Unit Weight	8	3	1	4	0
D4318	Atterberg Limits	31	0	11	20	0
T311, D1140, D422	Gradation/Hydrometer	37	8	5	16	8
D854	Specific Gravity	9	8	0	1	0
D5084	Hydraulic Conductivity	8	0	3	5	0
D2435	Consolidation	4	3	0	1	0
D4767	Consolidated Undrained Triaxial (CIU)	10	0	4	6	0
D6528	Direct Simple Shear (DSS)	4	1	0	3	0

Compete results of the laboratory tests are included in **Appendix D** of the report.

4. **Material Properties**

To estimate the shear strength properties of the soils encountered, consolidated undrained triaxial tests and direct shear tests were performed on select samples of clay materials. Strength characteristics of granular soils are determined based on SPT blow counts. For cohesive materials, failure envelopes defined by cohesion and angle of internal friction were developed by plotting the failure points on a Modified Mohr-Coulomb plot (a p-q and p'-q plot), as described in Appendix D of the United States Corps of Engineers Engineer Manual EM-1110-2-1902 "Slope Stability." Laboratory CU tests performed on the embankment fill and native clay material from both AECOM and Cardno investigations are incorporated into these plots. Drained and undrained strength parameters for embankment material and native soil are presented in **Table E-2**.

Liquefaction potential calculations and all strength tests were evaluated in order to determine whether peak of reduced strength parameters to be assigned for soil layers in the post-earthquake analysis. **Appendix I** includes a detailed discussion of liquefaction potential of soils encountered at the site. A 2D dynamic site response analysis was performed to determine the cyclic stress acting on the embankment and native soils. Liquefaction analysis utilized cyclic stress ratio based on cyclic stresses obtained from this site response analysis rather than conservative empirical approach.

For clay soils where liquefaction or softening is not anticipated, the peak undrained strength parameters were utilized directly in the analysis. This includes the clayey embankment soils, and the uppermost portions of the fine-grained alluvium, that are observed to have a stiff to very stiff consistency and are located above the groundwater table. Lower portion of the native clay just above the sand zone may experience some limited loss of strength due to its relatively softer stiffness. However, for entire native clay, reduced undrained shear strength was utilized in the modeling. Specifically, the modeled strength was reduced to 90% of the peak strength for the post-earthquake condition. The sand zone on top of the rock is free-draining materials and post-earthquake strength is based on peak drained strength. The post-earthquake strength parameters are shown in **Table E-2**.

Soil strengths for drawdown analyses were developed using the Duncan et al. (1990) approach. This approach uses both drained and undrained (R-envelope) soil strengths to evaluate sudden drawdown slope stability. A modified total strength envelope that is developed based on the lower of those Mohr strength envelops is utilized in the third stage of the calculation for undrained materials. This resulting total strength envelop is computed automatically by the software at the end of the second stage of the calculation based on effective confining stress and principal stress ratio acting on the base of the each slice of the slip surface. Effective confining stress and effective principal stress ratio are computed at the first stage of the calculation.

5. Material Properties for Analysis

The table below summarizes the material parameters used in the stability analysis, based on the analysis and strength selection procedures and considerations presented in the preceding sections.

Table E-2: Summary of Material Parameters used in Stability Analysis

Material	Natural Unit Weight (pcf)	Saturated Unit Weight (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters		Post Liquefaction Shear Strength Parameters	
			c' (psf)	Φ' (°)	c (psf)	Φ (°)	c (psf)	Φ (°)
Embankment Fill	125	130	335	31.0	736	20.0	736	20.0
Native Clay	120	125	150	30.0	750	12.0	675	10.8
Native Sand	125	130	-	34.0	-	34.0	-	34.0
Ash	90	105	-	26.0/20.8[(a)]	100	12.0	-	0.08[(b)]

(a) Friction angle for impounded ash during pseudo-static condition at 80% of peak
(b) Tau/sigma ratio

6. References

Duncan, J.M., Wright, S.G. and Wong, K.S., (1990). " Slope Stability during Rapid Drawdown" H. Bolton Seed Memorial Symposium Proceedings, May 1990. Vol 2. Pp 253-272.

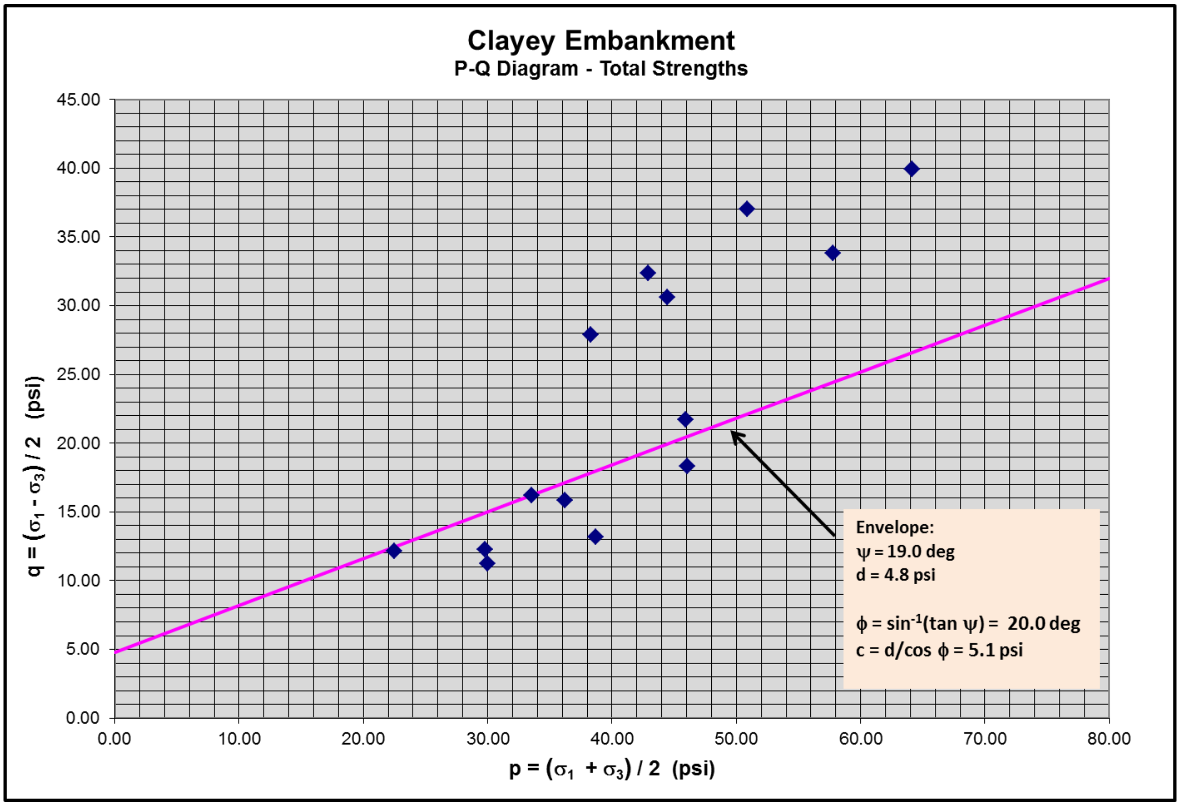
Idriss, I. M., and Boulanger, R. W. (2008). Soil Liquefaction During Earthquakes. Earthquake Engineering Research Institute, Oakland, California, USA.

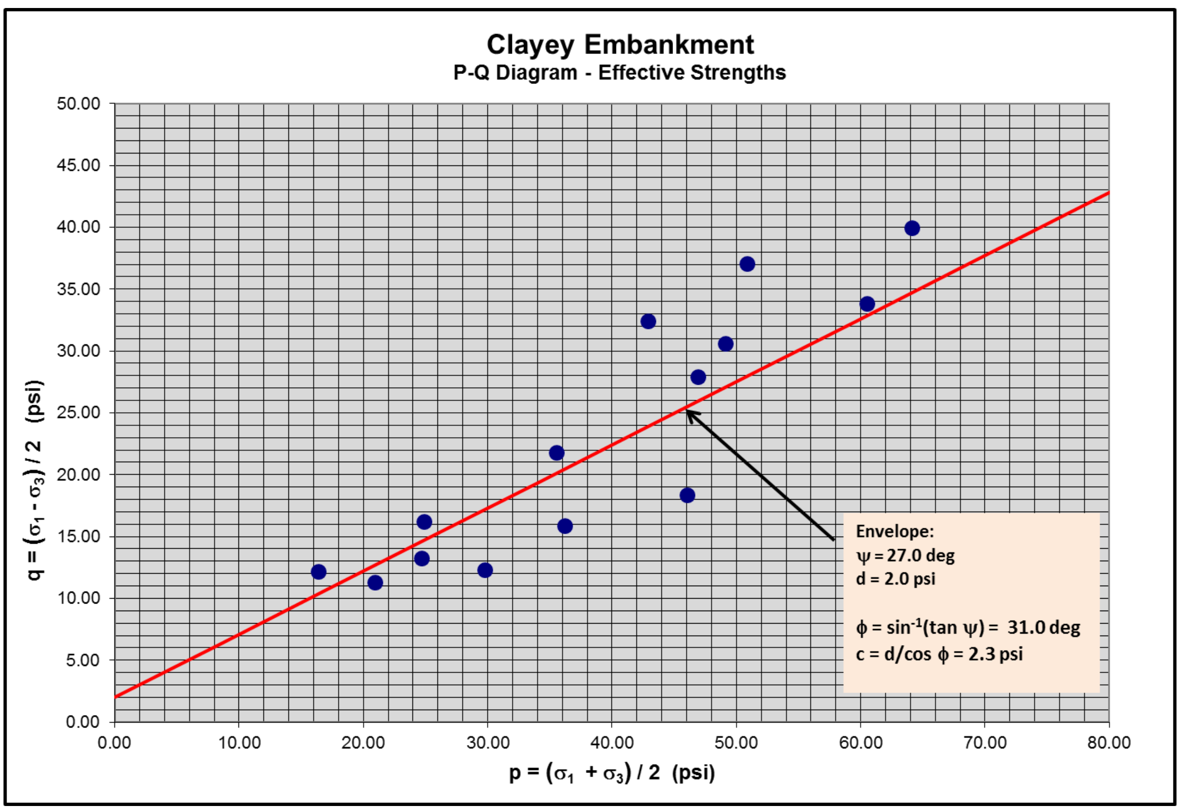
U.S. Army Corps of Engineers [USACE]. (2003). Engineer Manual, EM-1110-2-1902, Slope Stability.

7. Attachments

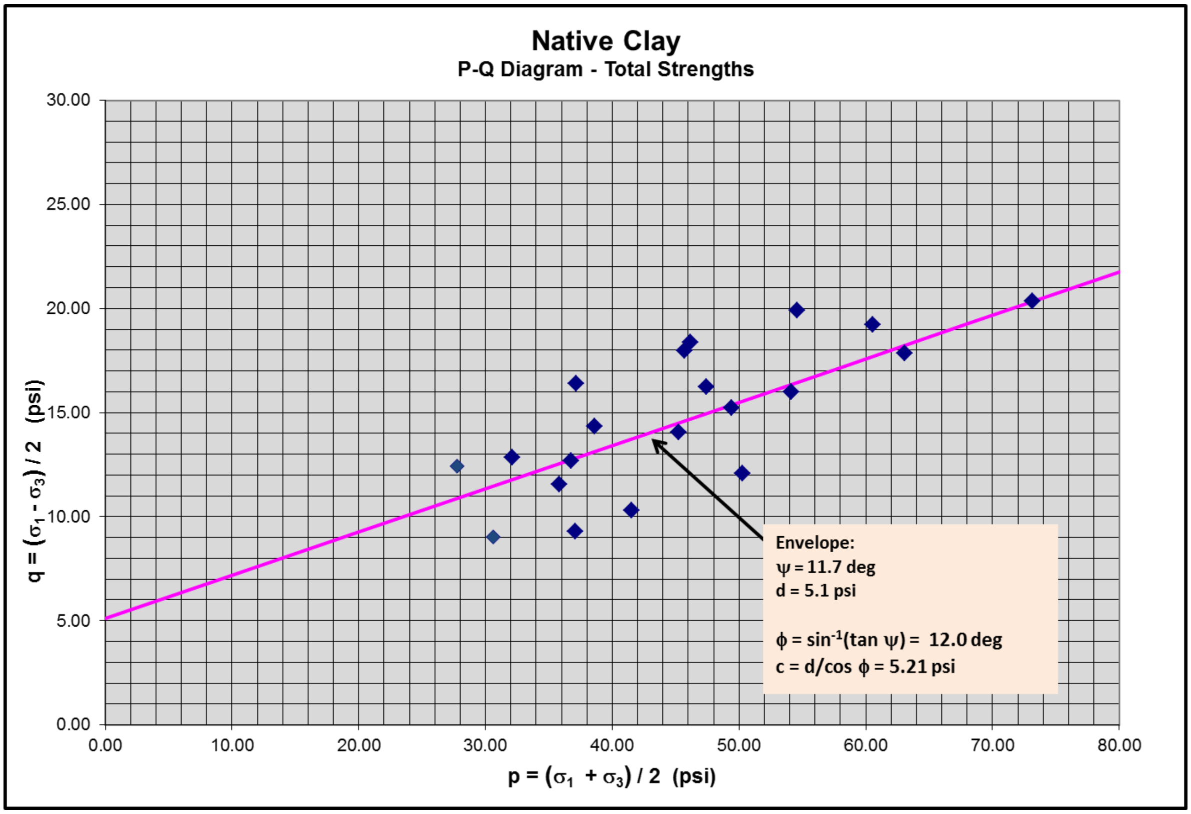
E.1 Material Characterization Plot – Embankment Fill
E.2 Material Characterization Plot – Native Clay

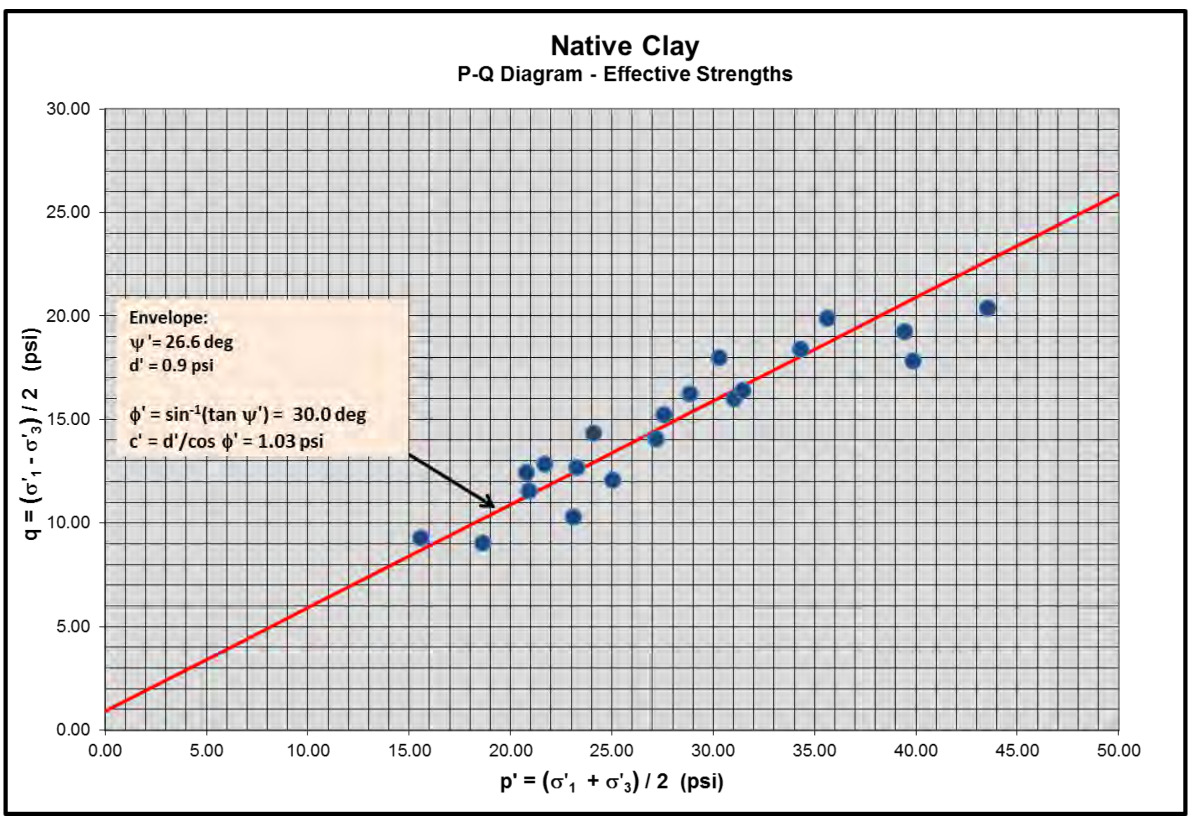
E.1 – Material Characterization Plots – Clayey Embankment





E.2 – Material Characterization Plots – Native Clay





Appendix F
Slope Stability Analysis Calculations

1. Objective & Introduction

This calculation package summarizes the limit equilibrium slope stability analyses for both the static and seismic loading conditions performed in support of the East Ash Pond CCR Unit Geotechnical Report for Vectren's F.B. Culley Plant. Figures, calculations and computer program outputs are provided as attachments and are referenced herein. Slope stability analyses have been completed for five cross-sections within the East Ash Pond to evaluate the stability of the embankment under loading conditions listed in the Programmatic Document.

The objective for the slope stability analysis is to determine factors of safety (FS) at critical cross section locations across the Hennepin East Ash Pond dike complex for the following loading cases:

- Static, Steady-State, Normal Pool Conditions
- Static, Maximum Pool Surcharge Conditions
- Seismic Slope Stability Analysis
- Post-Liquefaction Condition
- Sudden Drawdown Condition

The factors of safety determined from each of these loading conditions will be utilized to determine if the requirements outlined by the USEPA CCR Rule criteria are met or if additional measures will be needed for stability purposes. The methodology used to perform the slope stability analysis and the results of the analyses are summarized in the subsequent sections listed below.

2. Development of Cross-Sections for Analysis

A total of two cross-sections (AECOM B1 and AECOM B2) were utilized to evaluate the perimeter embankment stability at the East Ash Pond. These sections were chosen as the critical cross sections (worst case) for the perimeter embankment at the East Ash Pond.

The section geometry for the analysis cross-section AECOM B-1 was determined based on the survey performed by Three i Design on November 10, 2015. The survey is spatially referenced to the Indiana NAD 1983 State Plane West. The surveyed cross-section was conservatively modeled by a 1(V)/2.4(H) single slope. Elevations are in feet and referenced with respect to the North American Vertical Datum 1988 (NAVD 88). Cross section geometry for AECOM B-2 was developed from topographic data for the site.

3. Subsurface Conditions

Subsurface materials and extents (stratigraphy) at the cross section were developed by utilizing nearby subsurface explorations (CPTs and borings) from AECOM's exploration activities and historic geotechnical explorations. The subsurface strata generally encountered across the exploration locations can be generalized into three typical layers. These layers are listed below and are further described in **Appendix E** – Material Characterization.

- Embankment Fill
- Native Fine-grained Soils (Clay – CL)
- Native Granular Soils (Sand – SP)

Material interfaces inferred from the subsurface explorations nearest to the cross-sections were transposed onto the profile and a reasonable interpretation of the subsurface stratigraphy between the exploration locations was developed. For cross section AECOM B-1, borings AECOM B-1 and Cardno B-102 were utilized for development of the stratigraphy. For cross section AECOM B-2, boring AECOM B-2 was utilized for stratigraphy development.

Groundwater surfaces were modeled as a piezometric line in SLOPE/W. Groundwater was noted during split spoon sampling operations for AECOM borings B1 and B2 as well as CARDNO borings B101 and B102. Elevations and configuration of the piezometric lines were established based on the groundwater water levels recorded from the boring operations. The normal pool (proposed design) elevation of impounded ash in the East Ash Pond is 387.0 ft.

4. Analysis Methodology

Analyses were performed using Spencer's Method which is a limit equilibrium slope stability analysis procedure. The computer program SLOPE/W 2012 by Geo-Slope International was utilized. The program analyzes a large number of potential slip surface geometries and identifies the geometry that results in a critical (i.e. lowest) factor of safety (FS). Additional information on the program is available at http://www.geo-slope.com/. Circular shaped failure surfaces were analyzed for the each of the loading cases considered.

The critical sections were analyzed for the following cases:

- **Static, Steady-State, Normal Pool Condition:** This case models the conditions under static, long-term conditions, under the normal storage water level within the impoundment. Drained (effective stress) shear strength parameters were used for all materials, and phreatic conditions were estimated based on available data as described above. A target **Factor of Safety of 1.50** is needed for this loading condition. The Impounded Ash level of the East Ash Pond is El. 395.0 ft for cross section AECOM B-1 and El. 387.0 ft for AECOM B-2. The operating water level of the East Ash Pond for AECOM B-1 and AECOM B-2 is El. 387.0 ft. The phreatic surface was modeled as following a gradual slope through the embankment from the pool elevation of 387.0 ft to the surface of the Ohio River at approximately 365.0 ft.

- **Static, Maximum Surcharge Pool Condition:** This case models the conditions under short-term surcharge pool conditions. Undrained (total stress) shear strength parameters were used for fine-grained materials, due to the short-term nature of the surcharge pool duration. The Impounded Ash level of the East Ash Pond is El. 395.0 ft for cross section AECOM B-1 and El. 387.0 ft for AECOM B-2. The maximum surcharge water level of the East Ash Pond is El. 392.67 ft for cross section AECOM B-1 and El. 392.67 ft. for AECOM B-2. Although the temporary surcharge load was not of a sufficient duration to significantly alter the phreatic surface (i.e. saturation line within the embankment), the phreatic surface was interpolated with a linear line between maximum surcharge pool elevation and downstream toe of the slope by following a conservative approach. Target **Factor of Safety of 1.40**.

- **Seismic Stability Condition:** This analysis incorporates a horizontal seismic coefficient kh selected to be representative of expected loading during the design earthquake event (i.e., a "pseudostatic" analysis). The analyses utilized peak undrained strength parameters in soils that are not consider to be rapidly draining materials, and peak drained strengths in soils considered to freely drain. The Impounded Ash level of the East Ash Pond is El. 395.0 ft for cross section AECOM B-1 and El. 387.0 ft for AECOM B-2. The operating water level of the East Ash Pond for AECOM B-1 and AECOM B-2 is El. 387.0 ft. The phreatic surface and pore water pressures corresponding to the Steady State Normal Storage Pool case from the static analyses were utilized. Seismic loading was included in this analysis using a pseudostatic coefficient (kh). A **Factor of Safety of 1.00** is required for this loading condition.

The seismic parameter calculations were based on USGS detailed design method obtained from USGS website http://earthquake.usgs.gov/designmaps/us/application.php. For the F.B Culley Power Station, the calculated PGA for a 2,500-year event was 0.26g for top of hard rock. To determine the free-field, ground surface horizontal acceleration, the site was classified according to the site classes defined in IBC (2003) and amplified using the site amplification factors found in NEHRP (2009). The site class was determined based on the weighted average of the shear wave velocity of the foundation soils (600 ≤ vs ≤ 1,200 ft/s) and found to be Site Class D. This corresponds to a NEHRP amplification factor of 1.6, resulting in a ground surface acceleration of 0.34g. The Peak Transverse Acceleration at the dike crest was estimated using the ground surface acceleration and the procedure proposed by Idriss (2008), resulting in a crest acceleration of 0.60g.

The pseudostatic coefficient was calculated based on the simplified procedure developed by Makdisi and Seed (1978). Specifically, the pseudostatic coefficient was taken as the parameter kmax, which represents the peak average acceleration along the failure surface. As shown in Figure 1 below (excerpted from the above reference), the ratio kmax/umax (where umax is the peak acceleration at the crest of the embankment) for a full height failure surface (y/H = 1.0) is 0.34. From the procedure noted above, the anticipated maximum peak crest acceleration is approximately 0.60g. Therefore, the pseudostatic coefficient kh was estimated as kh= 0.34*0.60g = 0.20 g for these analyses.

For the impounded ash, the shear strength of the material was reduced to 80% of peak strength. These parameters are included in Table F-1.

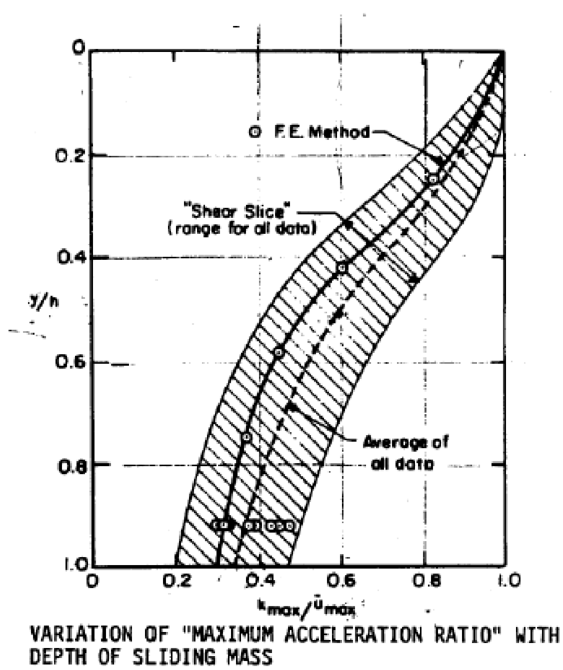


Figure 1: Determination of Maximum Average Acceleration Along Failure Surface

• **Post-Liquefaction Condition:** This analysis was performed at cross section B1 where liquefaction triggering analysis indicates potential liquefaction of granular, non-plastic materials. The purpose of the post-liquefaction stability analysis is to assess stability conditions immediately following a seismic event. No horizontal seismic coefficient is included in these analyses, but selection of strength parameters for the analyses takes into account the potential for softening/ weakening of the soils as a result of pore pressures generated in sand-like materials due to the earthquake shaking. The Impounded Ash level of the East Ash Pond is El. 395.0 ft for cross section AECOM B-1 and El. 387.0 ft for AECOM B-2. The operating water level of the East Ash Pond for AECOM B-1 and AECOM B-2 is El. 387.0 ft. A target **Factor of Safety of 1.20** is needed for this loading condition.

Liquefaction potential calculations and all strength tests were evaluated in order to determine whether peak of reduced strength parameters to be assigned for soil layers in the post-earthquake analysis. 2D dynamic response analysis calculation AECOM (2016) includes a detailed discussion of liquefaction potential of soils encountered at the site. A 2D dynamic site response analysis was performed to determine the cyclic stresses acting on the embankment and native soils. Liquefaction analysis was performed based on cyclic stress ratio based on cyclic stresses obtained from this 2D site response analysis rather than conservative empirical approach.

For clay soils where liquefaction or softening is not anticipated, the peak undrained strength parameters were utilized directly in the analysis. This includes the clayey embankment soils, and the uppermost portions of the fine-grained alluvium, that are observed to have a stiff to very stiff consistency and are located above the groundwater table. For the entire native clay, reduced undrained shear strength was utilized in the modeling. Specifically, the modeled strength was reduced to 90% of the peak strength for the post-earthquake condition. The sand zone on top of the rock is free-draining materials and post-earthquake strength is based on peak drained strength. The post-earthquake strength parameters are shown in Table F-1.

• **Sudden Drawdown Condition:** This case models the potential for embankment failure due to rapid drawdown during a flood event on the downstream side of the slope. In this case, the Ohio River was assumed to remain at a flood elevation of 387.0 ft for duration of approximately 3 months, a time long enough to completely saturate the embankment. It was then assumed that the river would return to a normal elevation of 365.0 ft in less than three months. The criteria of this condition are not listed in USEPA CCR 257.72(3), however, guidance is provided in USACE EM 1110-2-1902. The Impounded Ash level of the East Ash Pond is El. 395.0 ft for cross section AECOM B-1 and El. 387.0 ft for AECOM B-2. The operating water level of the East Ash Pond for AECOM B-1 and AECOM B-2 is El. 387.0 ft. A target **Factor of Safety of 1.30** is needed for this loading condition

5. Material Properties for Analysis

Material properties for slope stability analyses were developed using both laboratory testing data (index and strength testing) and strength correlations from CPT and SPT data. Details of the material characterization and strength parameter selection for each stratum are provided in **Appendix E**. The properties used in the stability analysis are summarized in the Table F-1 below:

Table F-1: Summary of Material Parameters used in Stability Analysis

Material	Unit Weight Above WT (pcf)	Unit Weight Below WT (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters		Post Liquefaction Shear Strength Parameters	
			c' (psf)	Φ' (°)	c (psf)	Φ (°)	c (psf)	Φ (°)
Embankment Fill	125	130	335	31.0	736	20.0	736	20
Native Clay	120	125	150	30.0	750	12.0	675	10.8
Native Sand	125	130	-	34.0	-	34.0	-	34.0
Ash	90	105	-	26.0/20.8[a]	100	12.0	-	0.12 [b]

(a) friction angle for impounded ash during pseudo-static condition at 80% of peak
(b) tau/sigma ratio

6. Results

Table F-2 summarizes the results of the stability analyses for each section, and output figures from the SLOPE/W models are provided at the back of this document.

Table F-2: Summary of Minimum Slope Stability Factors

Cross Section	Factor of Safety				
	Drained		Undrained		
	Steady State (Normal Pool)	Surcharge Pool (Flood)	Seismic (Pseudostatic)	Post-Liquefaction	Sudden Drawdown
CCR Rule Criteria	*FS ≥ 1.50*	*FS ≥ 1.40*	*FS ≥ 1.00*	*FS ≥ 1.20*	*FS ≥ 1.30*[1]
AECOM B-1	1.87	1.68	1.06	1.70	1.68
AECOM B-2	1.92	1.77	1.02	1.78	1.81

(1) from USACE EM 1110-2-1902

7. Conclusions

Load cases analyzed for this study included static (steady-state) normal pool, maximum flood surcharge pool, seismic (pseudostatic), static post-liquefaction and rapid drawdown. The calculated factors of safety from the limit equilibrium slope stability analysis satisfy the USEPA CCR Rule § 257.73(e) requirements for all the load cases analyzed at the critical analysis section (B1) for the perimeter of the impoundment.

8. References

AECOM (2016): 2D Dynamic Site Response Analysis Calculation for Vectren FB Culley East Pond Embankment Calculation.

GEO-SLOPE International Ltd. (2015). "GeoStudio 2012 (SLOPE/W and SEEP/W)." Calgary, Alberta, Canada.

Idriss, I. M., and Boulanger, R. W. (2008). Soil Liquefaction During Earthquakes. Earthquake Engineering Research Institute, Oakland, California, USA.

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Three i Design (November 2015). Survey data.

Makdisi, F.I. and Seed, B. H., August, 1977. "A Simplified Procedure for Estimating Earthquake-Induced Deformations in Dams and Embankments", Earthquake Engineering Research Center Report No. UCB/EERC-77/19, University of California, Berkeley, CA.

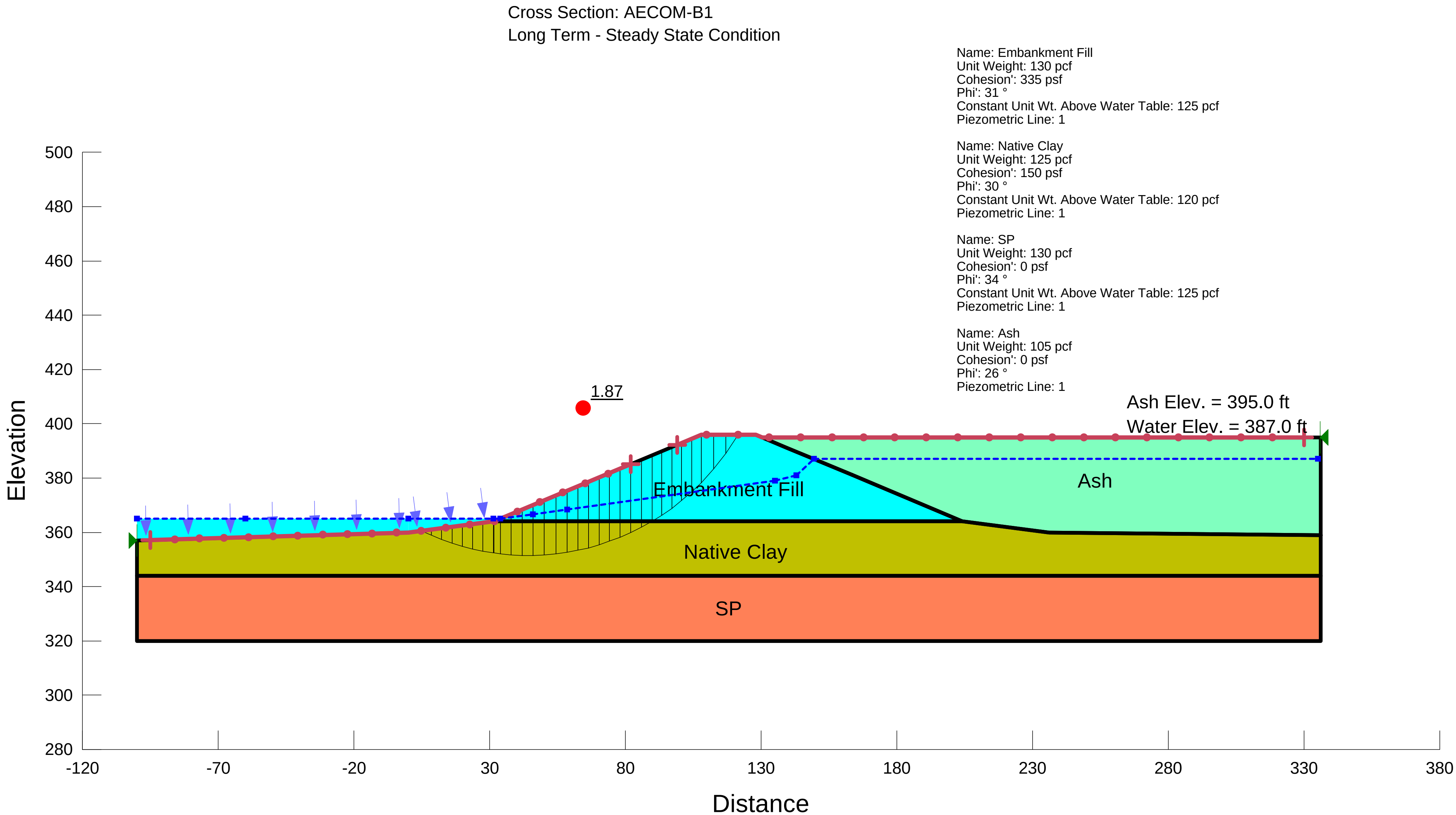
NEHRP (National Earthquake Hazards Reduction Program), (2009) Recommended Seismic Provisions for New and Other Structures, (FEMA P-750), 2009 Edition.

U.S. Environmental Protection Agency [USEPA]. (2015). Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. 40 CFR §257. Federal Register 80, Subpart D, April 17, 2015.

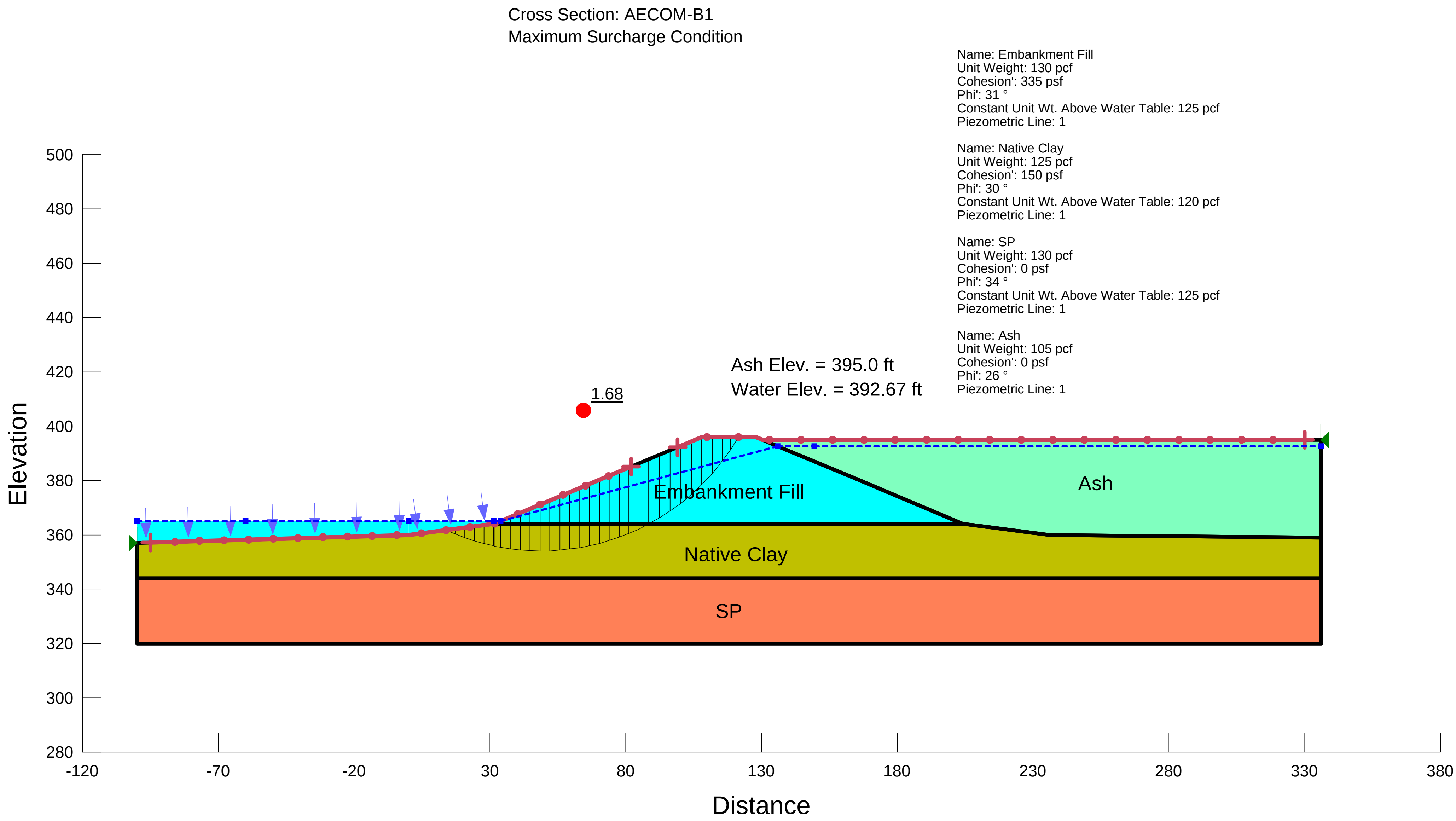
U.S. Army Corps of Engineers [USACE]. (2003). Engineer Manual, EM-1110-2-1902, Slope Stability.

9. Attachments

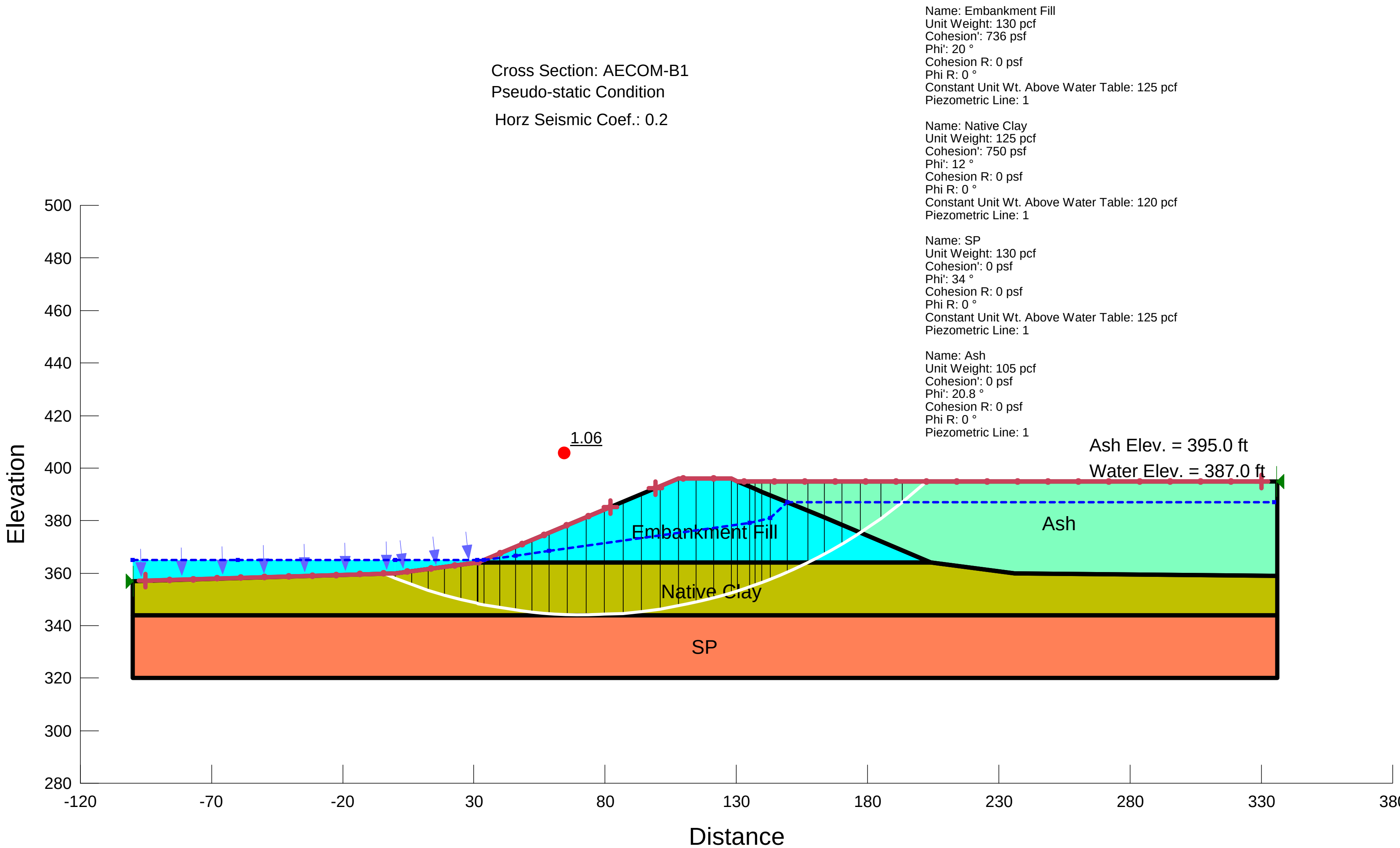
F.1 Slope Stability Analysis Output Data
F.2 Seismic Parameter Calculations



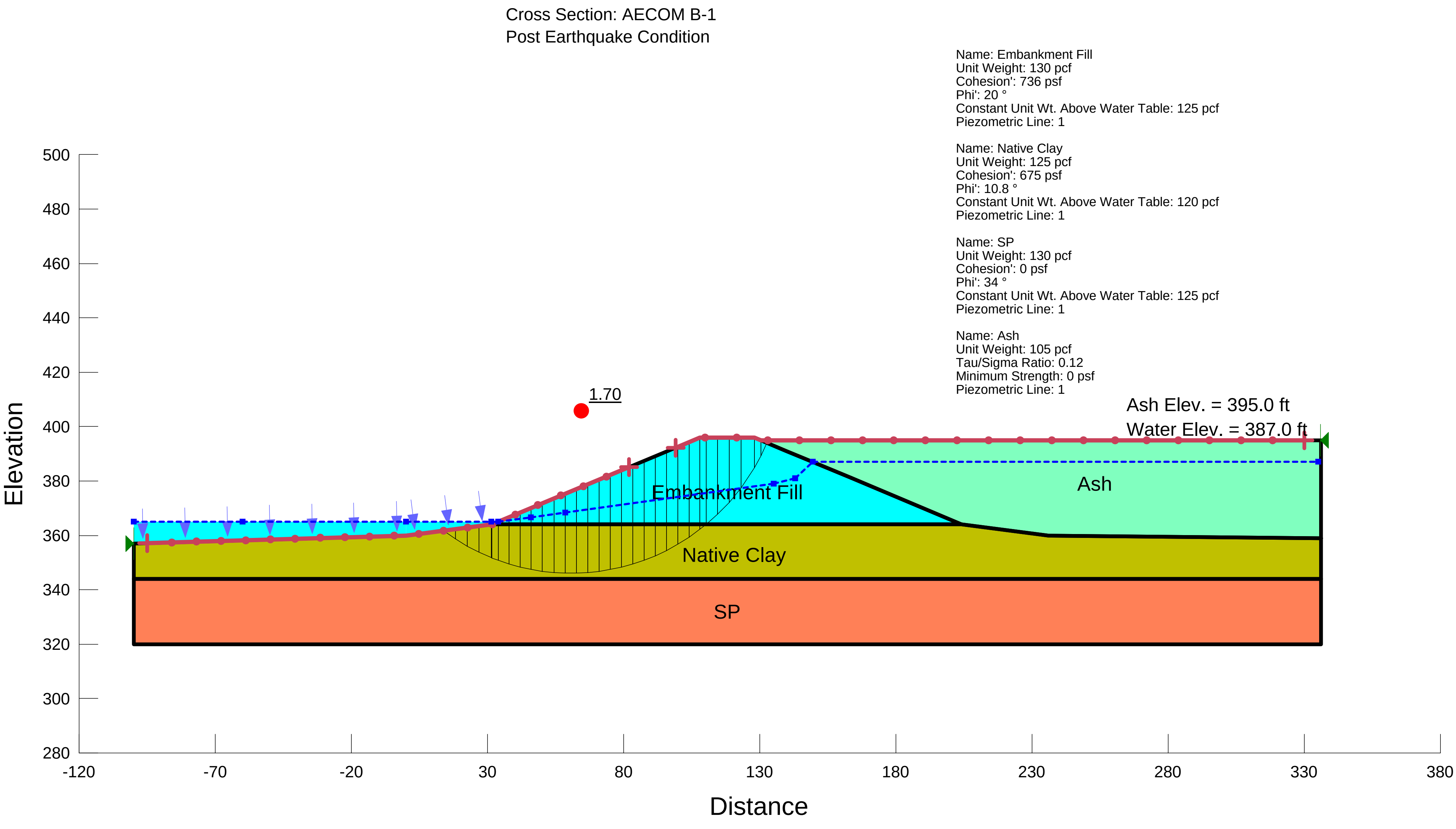
Cross Section: AECOM-B1
Long Term - Steady State Condition
Name: Embankment Fill
Unit Weight: 130 pcf
Cohesion': 335 psf
Phi': 31 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1
Name: Native Clay
Unit Weight: 125 pcf
Cohesion': 150 psf
Phi': 30 °
Constant Unit Wt. Above Water Table: 120 pcf
Piezometric Line: 1
Name: SP
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 34 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1
Name: Ash
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 26 °
Piezometric Line: 1
1.87
Ash Elev. = 395.0 ft
Water Elev. = 387.0 ft
Embankment Fill
Ash
Native Clay
SP
Elevation
500
480
460
440
420
400
380
360
340
320
300
280
-120
-70
-20
30
80
130
180
230
280
330
380
Distance



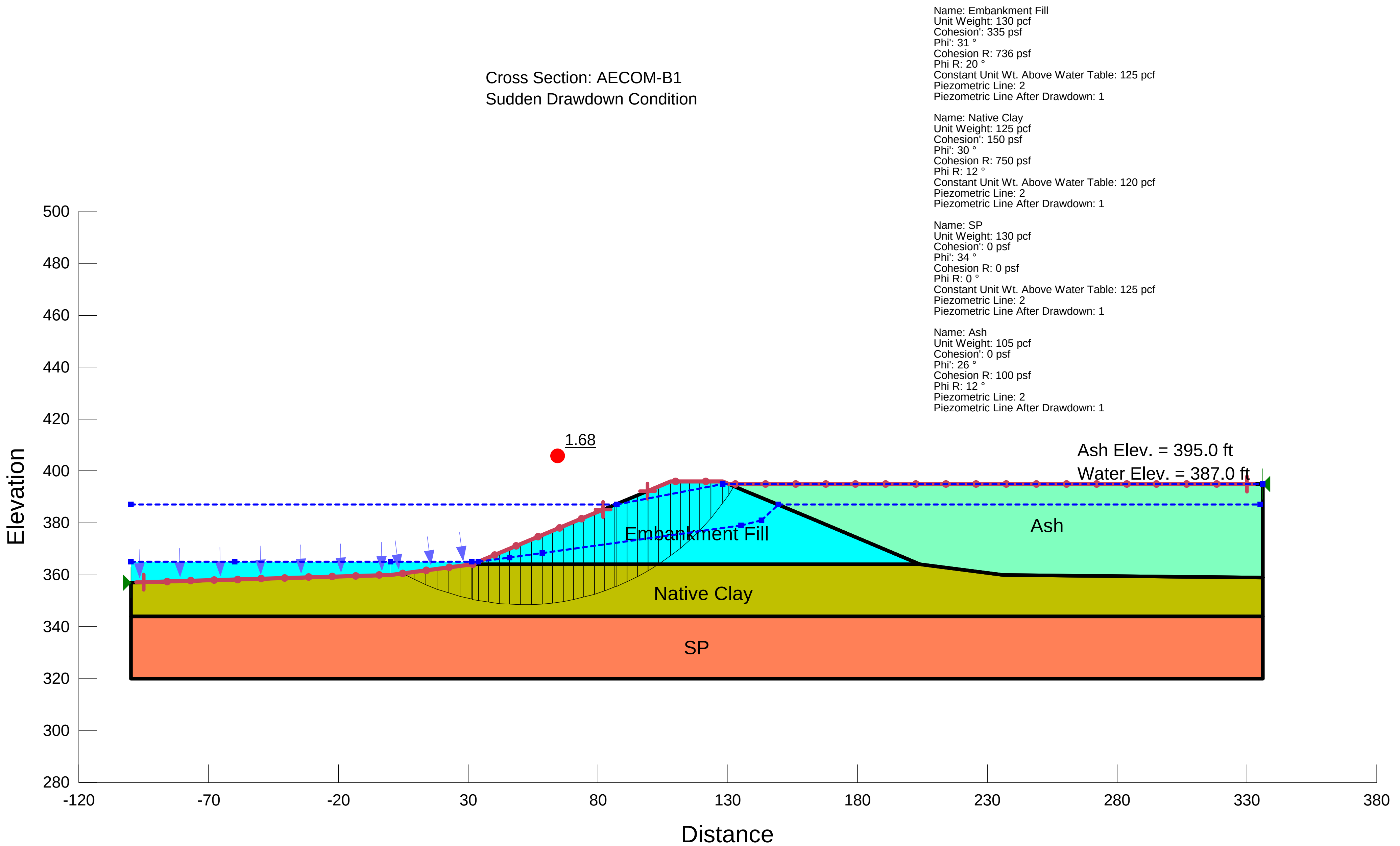
Cross Section: AECOM-B1
Maximum Surcharge Condition
Name: Embankment Fill
Unit Weight: 130 pcf
Cohesion': 335 psf
Phi': 31 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1
Name: Native Clay
Unit Weight: 125 pcf
Cohesion': 150 psf
Phi': 30 °
Constant Unit Wt. Above Water Table: 120 pcf
Piezometric Line: 1
Name: SP
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 34 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1
Name: Ash
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 26 °
Piezometric Line: 1
Ash Elev. = 395.0 ft
Water Elev. = 392.67 ft
1.68
Embankment Fill
Ash
Native Clay
SP
Elevation
500
480
460
440
420
400
380
360
340
320
300
280
-120
-70
-20
30
80
130
180
230
280
330
380
Distance



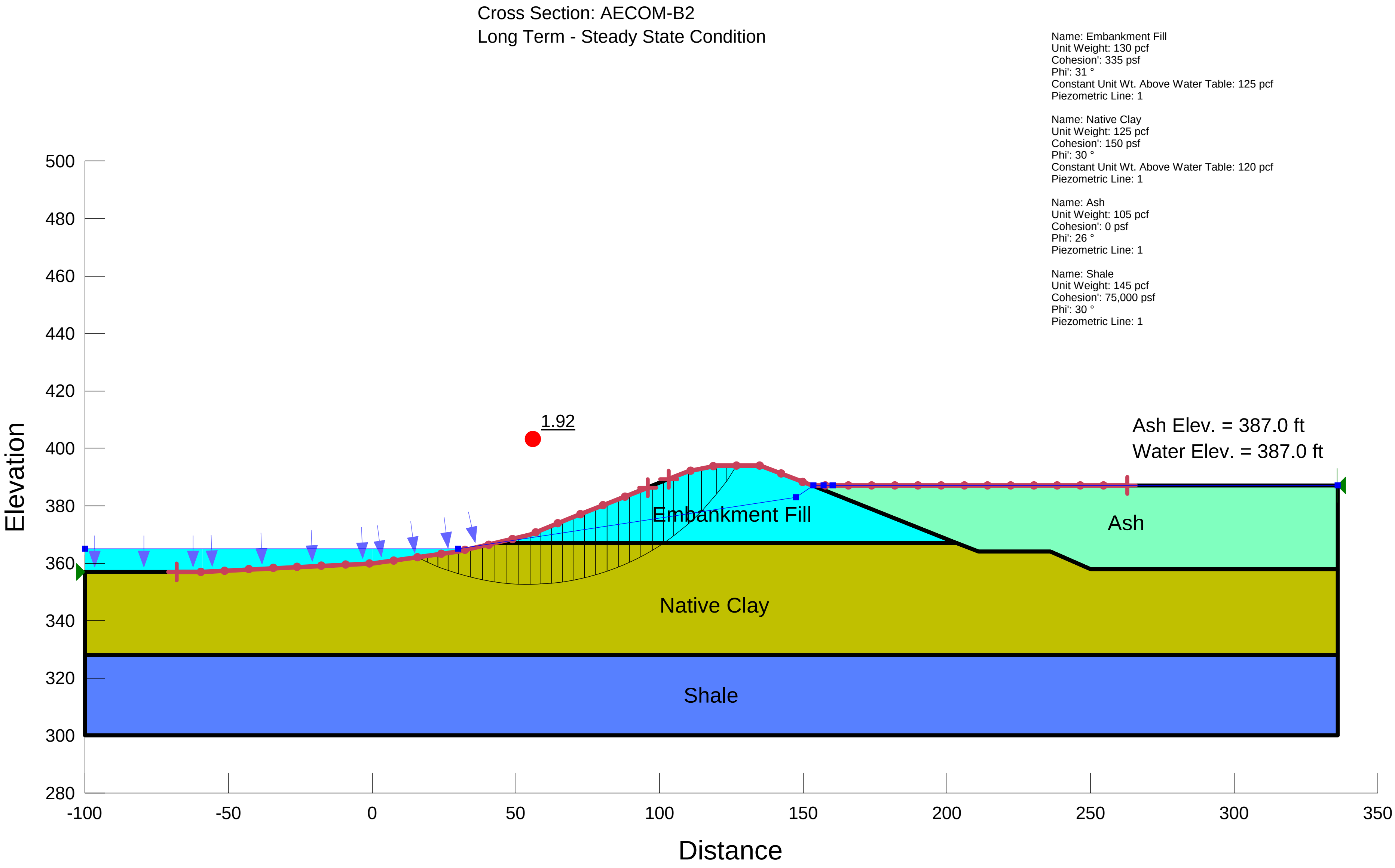
Cross Section: AECOM-B1
Pseudo-static Condition
Horz Seismic Coef.: 0.2
Name: Embankment Fill
Unit Weight: 130 pcf
Cohesion': 736 psf
Phi': 20 °
Cohesion R: 0 psf
Phi R: 0 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1
Name: Native Clay
Unit Weight: 125 pcf
Cohesion': 750 psf
Phi': 12 °
Cohesion R: 0 psf
Phi R: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Piezometric Line: 1
Name: SP
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 34 °
Cohesion R: 0 psf
Phi R: 0 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1
Name: Ash
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 20.8 °
Cohesion R: 0 psf
Phi R: 0 °
Piezometric Line: 1
1.06
Ash Elev. = 395.0 ft
Water Elev. = 387.0 ft
Embankment Fill
Ash
Native Clay
SP
Elevation
500
480
460
440
420
400
380
360
340
320
300
280
-120
-70
-20
30
80
130
180
230
280
330
380
Distance

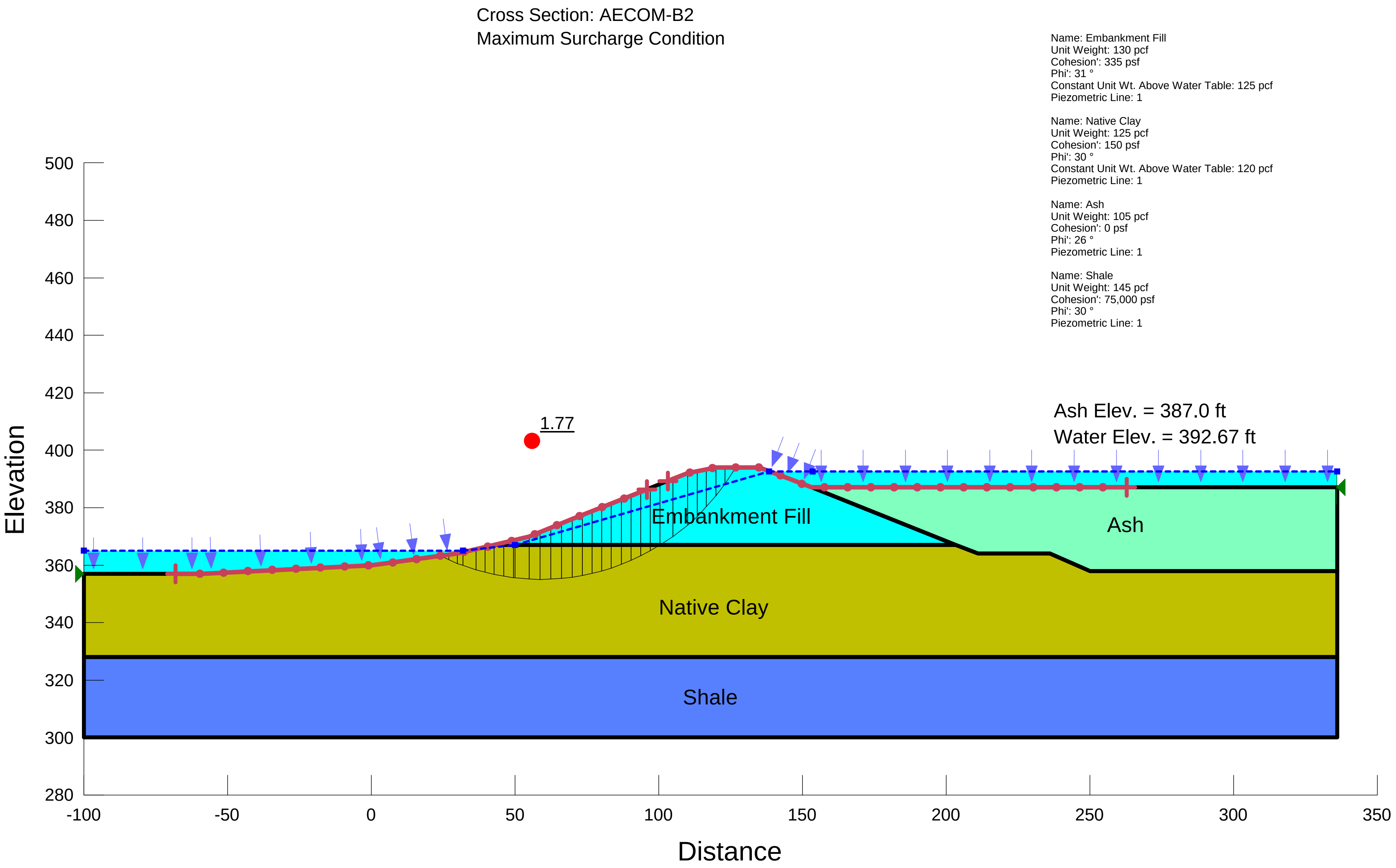


Cross Section: AECOM B-1
Post Earthquake Condition
Name: Embankment Fill
Unit Weight: 130 pcf
Cohesion': 736 psf
Phi': 20 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1
Name: Native Clay
Unit Weight: 125 pcf
Cohesion': 675 psf
Phi': 10.8 °
Constant Unit Wt. Above Water Table: 120 pcf
Piezometric Line: 1
Name: SP
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 34 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1
Name: Ash
Unit Weight: 105 pcf
Tau/Sigma Ratio: 0.12
Minimum Strength: 0 psf
Piezometric Line: 1
1.70
Ash Elev. = 395.0 ft
Water Elev. = 387.0 ft
Embankment Fill
Ash
Native Clay
SP
Elevation
500
480
460
440
420
400
380
360
340
320
300
280
-120
-70
-20
30
80
130
180
230
280
330
380
Distance

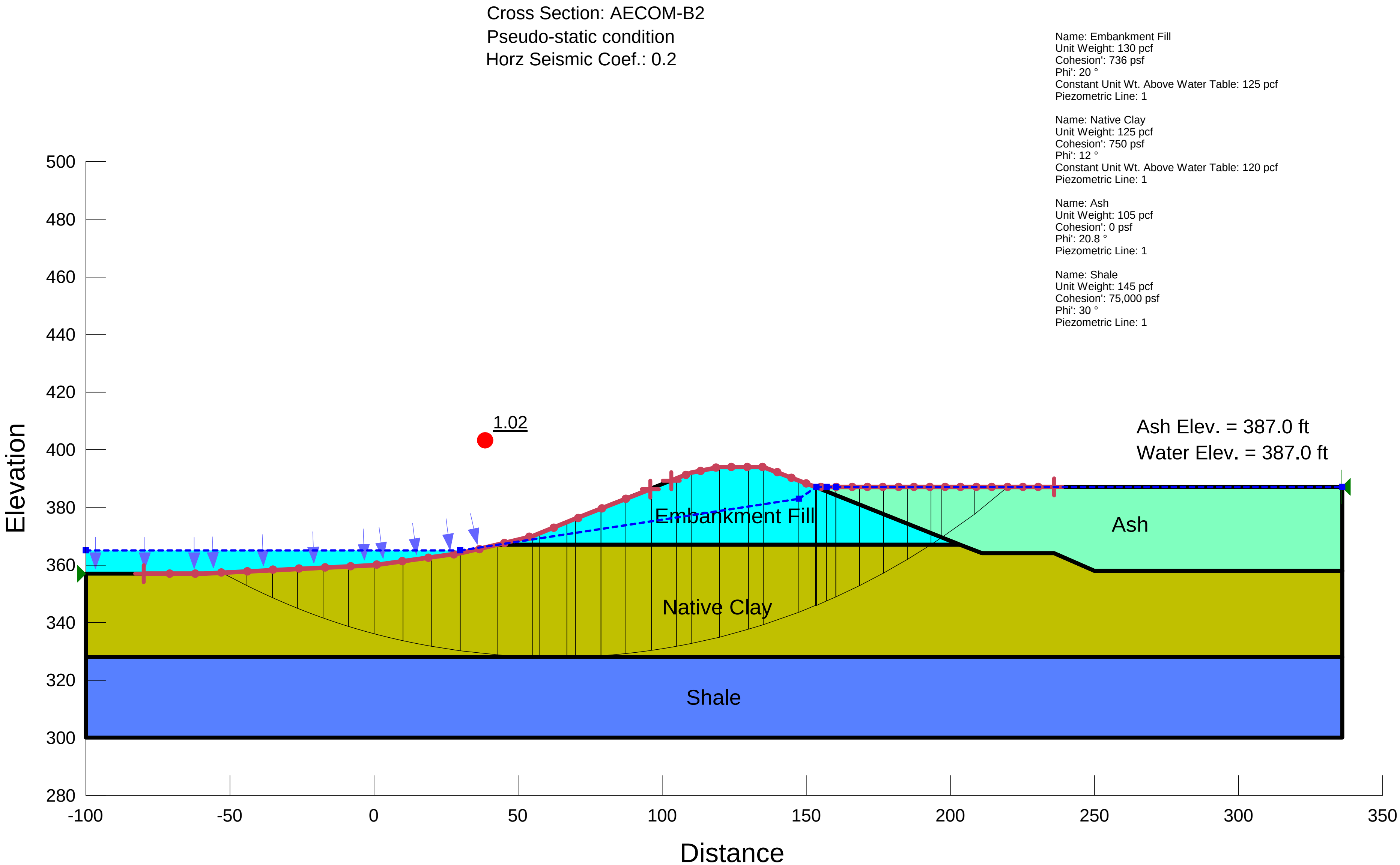


Cross Section: AECOM-B1
Sudden Drawdown Condition
Name: Embankment Fill
Unit Weight: 130 pcf
Cohesion': 335 psf
Phi': 31 °
Cohesion R: 736 psf
Phi R: 20 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 2
Piezometric Line After Drawdown: 1
Name: Native Clay
Unit Weight: 125 pcf
Cohesion': 150 psf
Phi': 30 °
Cohesion R: 750 psf
Phi R: 12 °
Constant Unit Wt. Above Water Table: 120 pcf
Piezometric Line: 2
Piezometric Line After Drawdown: 1
Name: SP
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 34 °
Cohesion R: 0 psf
Phi R: 0 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 2
Piezometric Line After Drawdown: 1
Name: Ash
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 26 °
Cohesion R: 100 psf
Phi R: 12 °
Piezometric Line: 2
Piezometric Line After Drawdown: 1
1.68
Ash Elev. = 395.0 ft
Water Elev. = 387.0 ft
Embankment Fill
Ash
Native Clay
SP
Elevation
500
480
460
440
420
400
380
360
340
320
300
280
-120
-70
-20
30
80
130
180
230
280
330
380
Distance

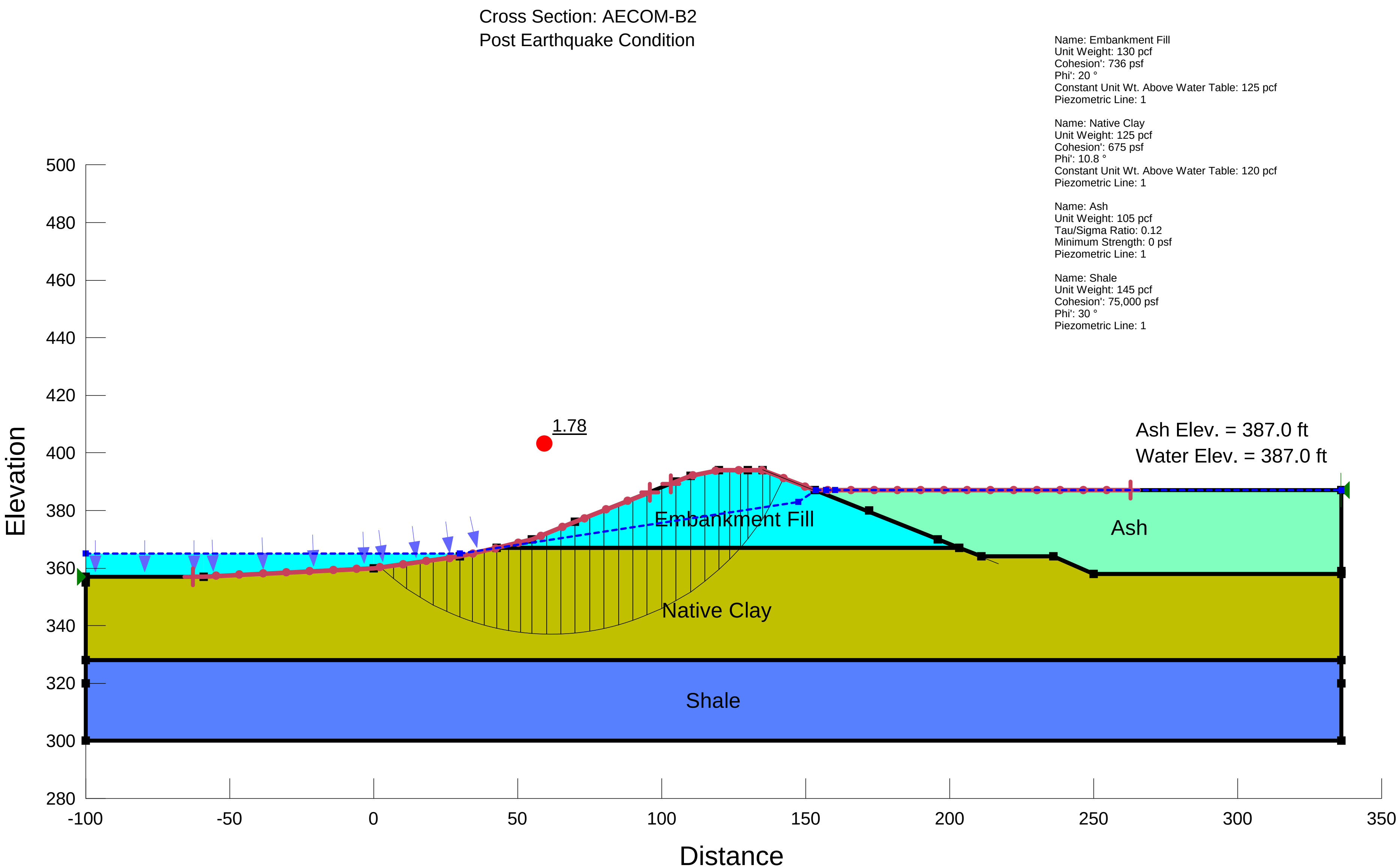

Cross Section: AECOM-B2
Long Term - Steady State Condition
Name: Embankment Fill
Unit Weight: 130 pcf
Cohesion': 335 psf
Phi': 31 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1
Name: Native Clay
Unit Weight: 125 pcf
Cohesion': 150 psf
Phi': 30 °
Constant Unit Wt. Above Water Table: 120 pcf
Piezometric Line: 1
Name: Ash
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 26 °
Piezometric Line: 1
Name: Shale
Unit Weight: 145 pcf
Cohesion': 75,000 psf
Phi': 30 °
Piezometric Line: 1
1.92
Ash Elev. = 387.0 ft
Water Elev. = 387.0 ft
Embankment Fill
Ash
Native Clay
Shale
Elevation
500
480
460
440
420
400
380
360
340
320
300
280
-100
-50
0
50
100
150
200
250
300
350
Distance



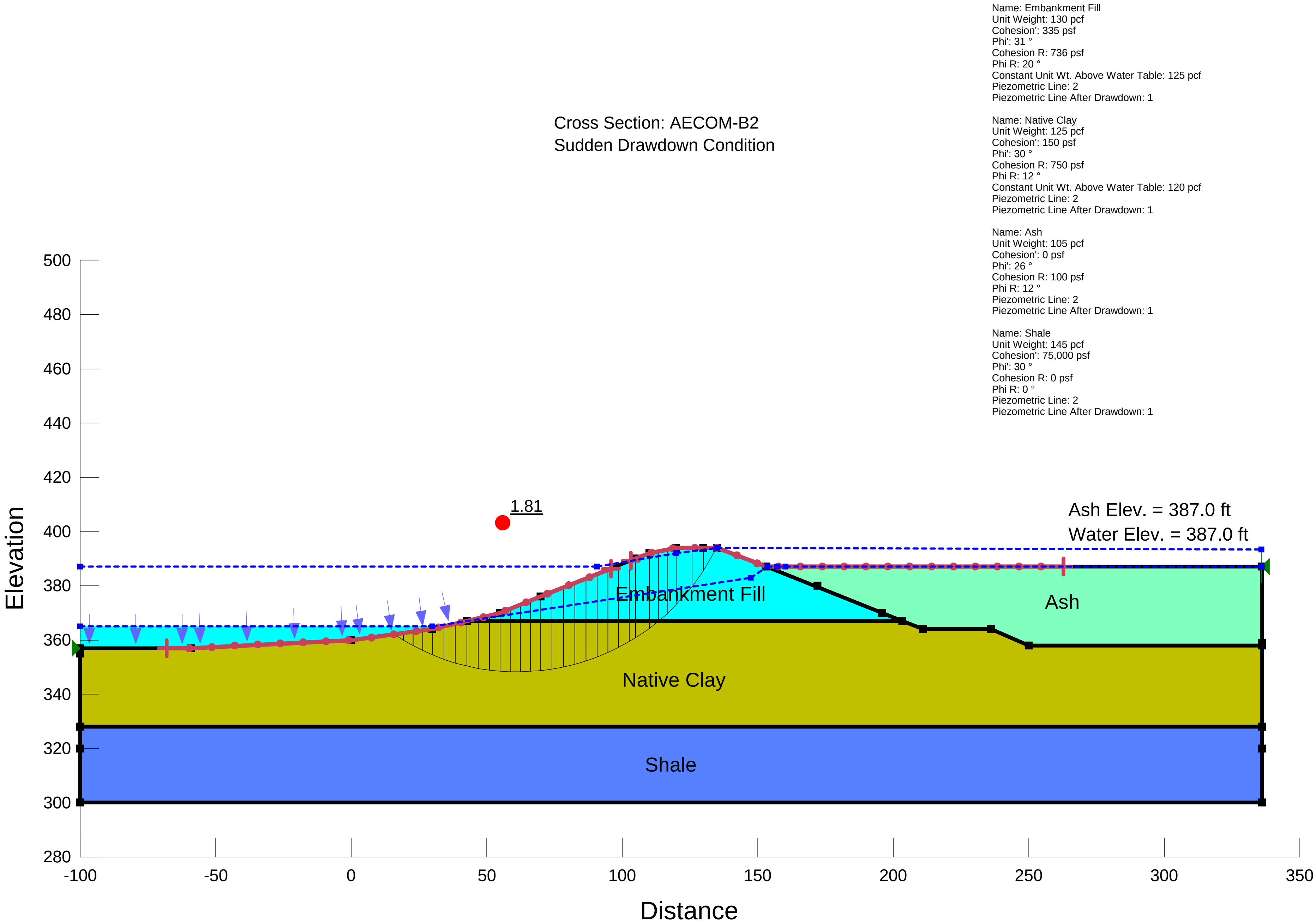
Cross Section: AECOM-B2
Maximum Surcharge Condition
Name: Embankment Fill
Unit Weight: 130 pcf
Cohesion': 335 psf
Phi': 31 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1
Name: Native Clay
Unit Weight: 125 pcf
Cohesion': 150 psf
Phi': 30 °
Constant Unit Wt. Above Water Table: 120 pcf
Piezometric Line: 1
Name: Ash
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 26 °
Piezometric Line: 1
Name: Shale
Unit Weight: 145 pcf
Cohesion': 75,000 psf
Phi': 30 °
Piezometric Line: 1
1.77
Ash Elev. = 387.0 ft
Water Elev. = 392.67 ft
Embankment Fill
Ash
Native Clay
Shale
Elevation
Distance
500
480
460
440
420
400
380
360
340
320
300
280
-100
-50
0
50
100
150
200
250
300
350



Cross Section: AECOM-B2
Pseudo-static condition
Horz Seismic Coef.: 0.2
Name: Embankment Fill
Unit Weight: 130 pcf
Cohesion': 736 psf
Phi': 20 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1
Name: Native Clay
Unit Weight: 125 pcf
Cohesion': 750 psf
Phi': 12 °
Constant Unit Wt. Above Water Table: 120 pcf
Piezometric Line: 1
Name: Ash
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 20.8 °
Piezometric Line: 1
Name: Shale
Unit Weight: 145 pcf
Cohesion': 75,000 psf
Phi': 30 °
Piezometric Line: 1
1.02
Ash Elev. = 387.0 ft
Water Elev. = 387.0 ft
Embankment Fill
Ash
Native Clay
Shale
Elevation
500
480
460
440
420
400
380
360
340
320
300
280
-100
-50
0
50
100
150
200
250
300
350
Distance



Cross Section: AECOM-B2
Post Earthquake Condition
Name: Embankment Fill
Unit Weight: 130 pcf
Cohesion': 736 psf
Phi': 20 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1
Name: Native Clay
Unit Weight: 125 pcf
Cohesion': 675 psf
Phi': 10.8 °
Constant Unit Wt. Above Water Table: 120 pcf
Piezometric Line: 1
Name: Ash
Unit Weight: 105 pcf
Tau/Sigma Ratio: 0.12
Minimum Strength: 0 psf
Piezometric Line: 1
Name: Shale
Unit Weight: 145 pcf
Cohesion': 75,000 psf
Phi': 30 °
Piezometric Line: 1
1.78
Ash Elev. = 387.0 ft
Water Elev. = 387.0 ft
Embankment Fill
Ash
Native Clay
Shale
Elevation
500
480
460
440
420
400
380
360
340
320
300
280
-100
-50
0
50
100
150
200
250
300
350
Distance



Name: Embankment Fill
Unit Weight: 130 pcf
Cohesion': 335 psf
Phi': 31 °
Cohesion R: 736 psf
Phi R: 20 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 2
Piezometric Line After Drawdown: 1
Name: Native Clay
Unit Weight: 125 pcf
Cohesion': 150 psf
Phi': 30 °
Cohesion R: 750 psf
Phi R: 12 °
Constant Unit Wt. Above Water Table: 120 pcf
Piezometric Line: 2
Piezometric Line After Drawdown: 1
Name: Ash
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 26 °
Cohesion R: 100 psf
Phi R: 12 °
Piezometric Line: 2
Piezometric Line After Drawdown: 1
Name: Shale
Unit Weight: 145 pcf
Cohesion': 75,000 psf
Phi': 30 °
Cohesion R: 0 psf
Phi R: 0 °
Piezometric Line: 2
Piezometric Line After Drawdown: 1
Cross Section: AECOM-B2
Sudden Drawdown Condition
1.81
Ash Elev. = 387.0 ft
Water Elev. = 387.0 ft
Embankment Fill
Ash
Native Clay
Shale
Elevation
Distance
500
480
460
440
420
400
380
360
340
320
300
280
-100
-50
0
50
100
150
200
250
300
350

Design Maps Detailed Report

2009 NEHRP Recommended Seismic Provisions (37.91°N, 87.325°W)

Site Class D – "Stiff Soil", Risk Category IV (e.g. essential facilities)

Section 11.4.1 — Mapped Acceleration Parameters and Risk Coefficients

Note: Ground motion values contoured on Figures 22-1, 2, 5, & 6 below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_{SUH} and S_{SD}) and 1.3 (to obtain S_{1UH} and S_{1D}). Maps in the Proposed 2015 NEHRP Provisions are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 11.4.3.

Figure 22–1: Uniform–Hazard (2% in 50–Year) Ground Motions of 0.2-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

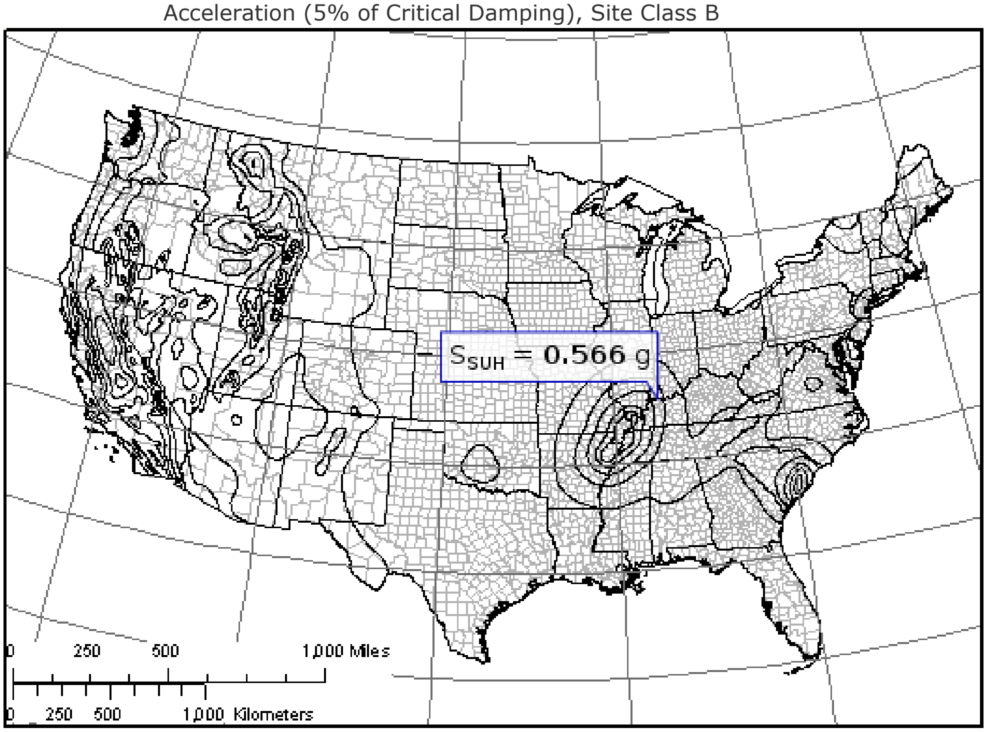
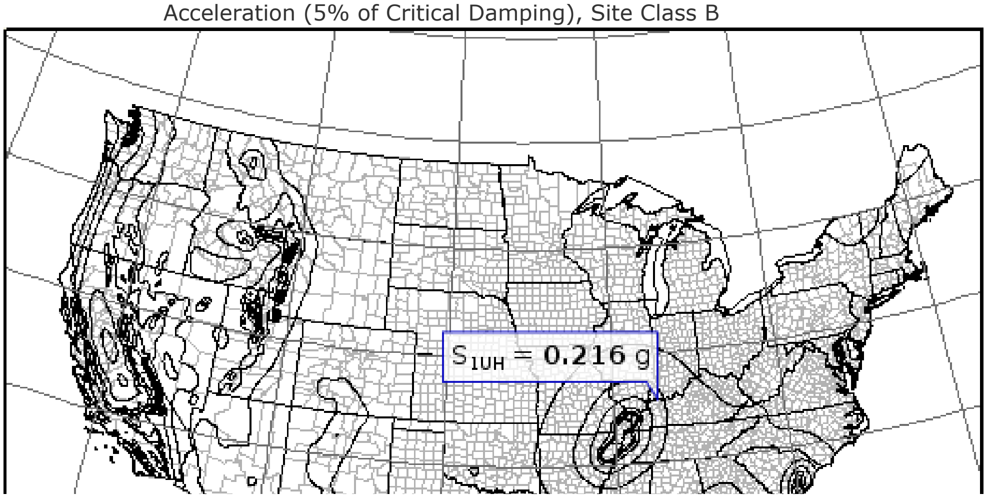


Figure 22–2: Uniform–Hazard (2% in 50–Year) Ground Motions of 1.0-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B



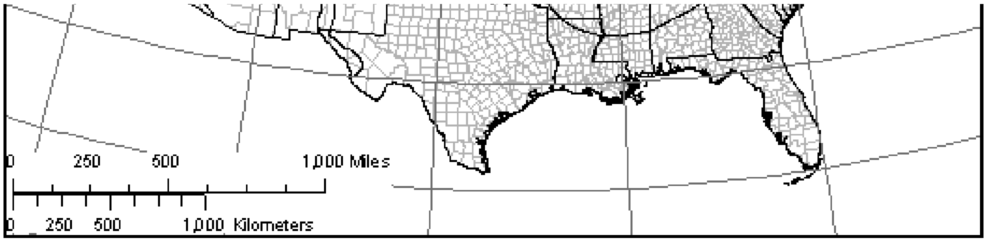

0 250 500 1,000 Miles
0 250 500 1,000 Kilometers

Figure 22–3: Risk Coefficient at 0.2-Second Spectral Response Period

CRS = 0.879

Figure 22–4: Risk Coefficient at 1.0-Second Spectral Response Period

CR1 = 0.847

Figure 22–5: Deterministic Ground Motions of 0.2-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

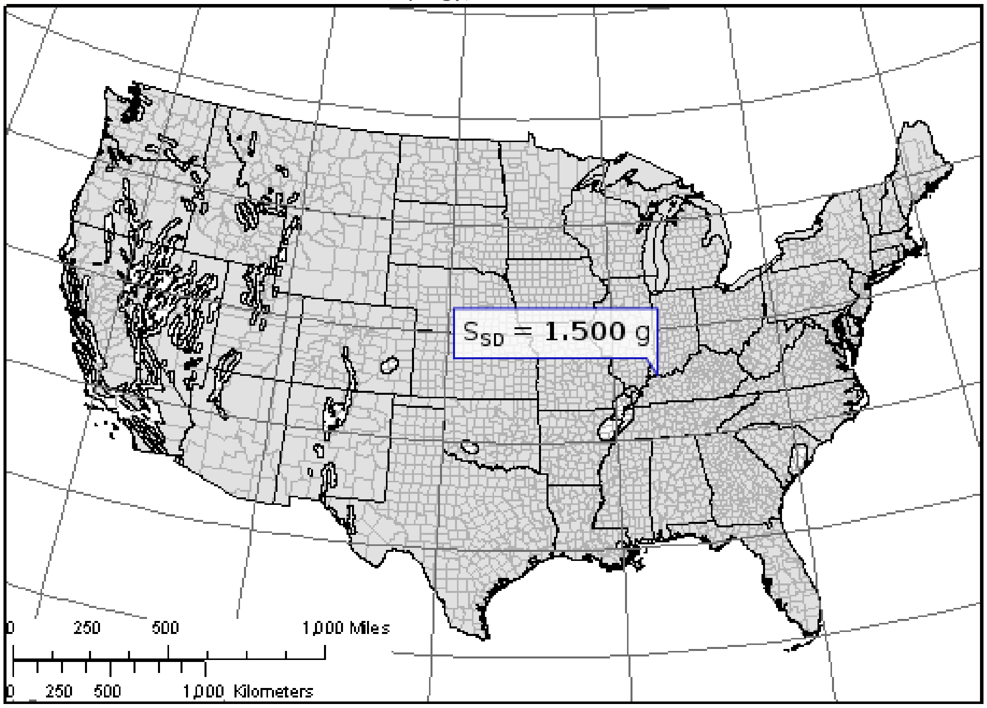
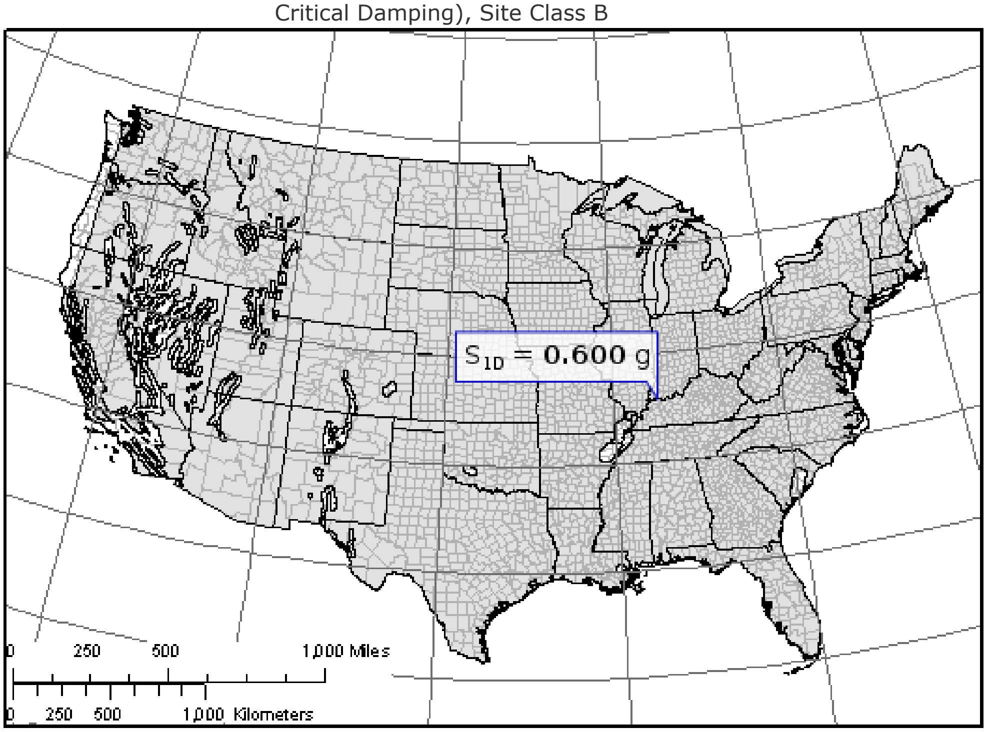


Figure 22–6: Deterministic Ground Motions of 1.0-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B



Section 11.4.2 — Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Chapter 20.

Table 20.3–1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index *PI* > 20, • Moisture content *w* ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 11.4.3 — Site Coefficients, Risk Coefficients, and Risk–Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters

Equation (11.4–1): $C_{RS}S_{SUH}$ = 0.879 x 0.566 = 0.498 g

Equation (11.4–2): S_{SD} = 1.500 g

S_S ≡ "Lesser of values from Equations (11.4–1) and (11.4–2)" = 0.498 g

Equation (11.4–3): $C_{R1}S_{1UH}$ = 0.847 x 0.216 = 0.183 g

Equation (11.4–4): S_{1D} = 0.600 g

S_1 ≡ "Lesser of values from Equations (11.4–3) and (11.4–4)" = 0.183 g

Table 11.4–1: Site Coefficient F_a

Site Class	Spectral Response Acceleration Parameter at Short Period				
	$S_S \le 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \ge 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 0.498 g, F_a = 1.402

Table 11.4–2: Site Coefficient F_v

Site Class	Spectral Response Acceleration Parameter at 1–Second Period				
	$S_1 \le 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \ge 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.183 g, F_v = 2.067

Equation (11.4–5):	$S_{MS} = F_aS_S = 1.402 \times 0.498 = 0.698$ g
Equation (11.4–6):	$S_{M1} = F_vS_1 = 2.067 \times 0.183 = 0.379$ g

Section 11.4.4 — Design Spectral Acceleration Parameters

Equation (11.4–7):	$S_{DS} = ⅔\ S_{MS} = ⅔ \times 0.698 = 0.465$ g
Equation (11.4–8):	$S_{D1} = ⅔\ S_{M1} = ⅔ \times 0.379 = 0.252$ g

Section 11.4.5 — Design Response Spectrum

Figure 22–7: Long–period Transition Period, T_L (s)

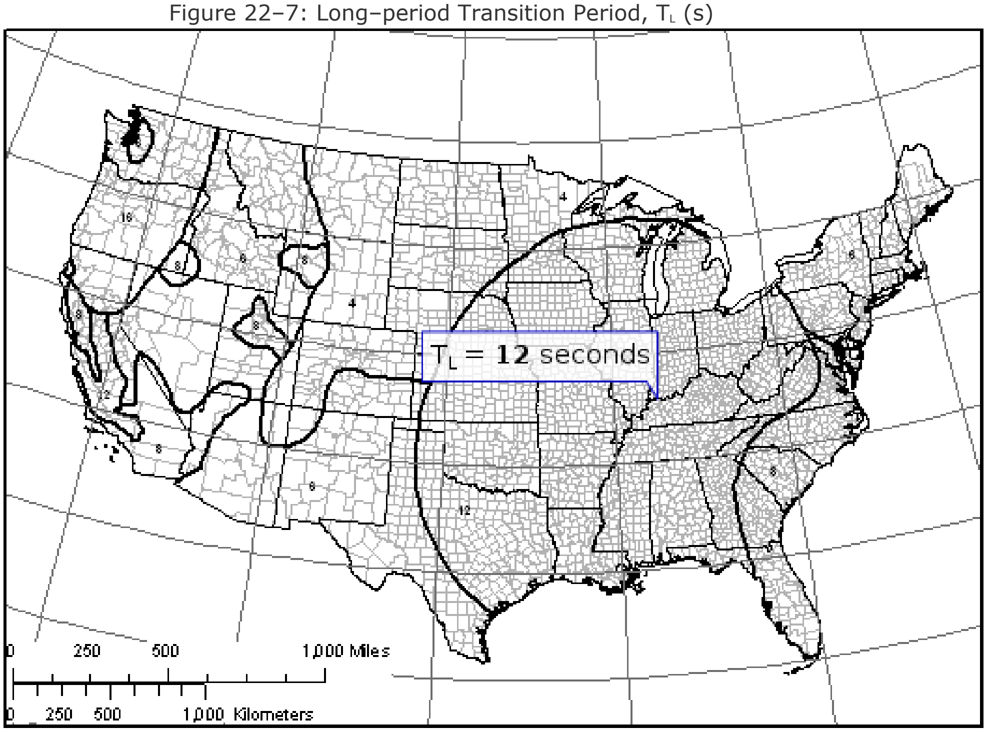
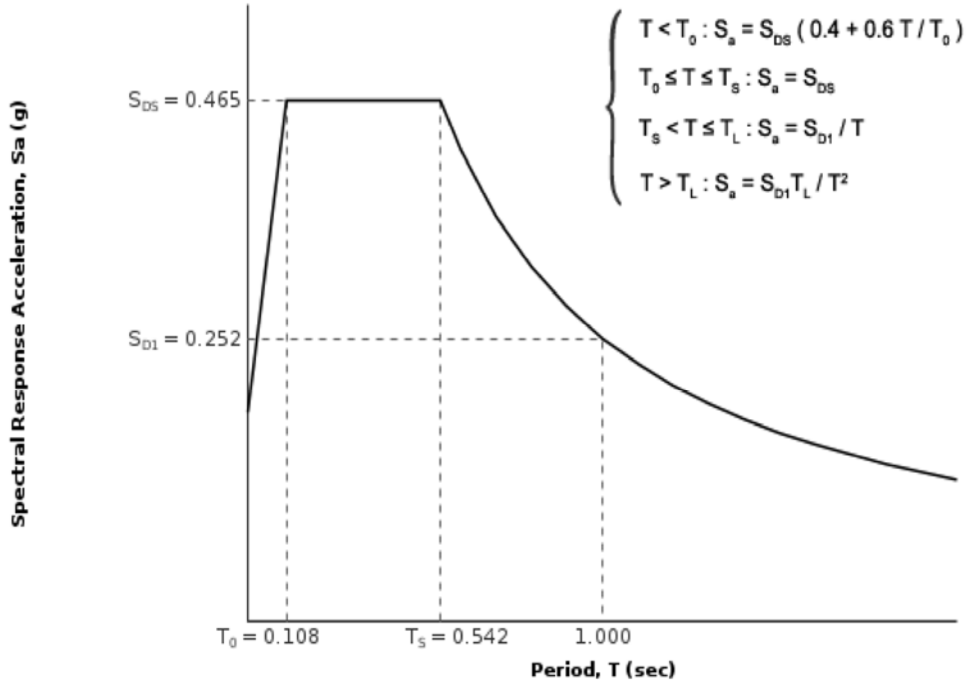
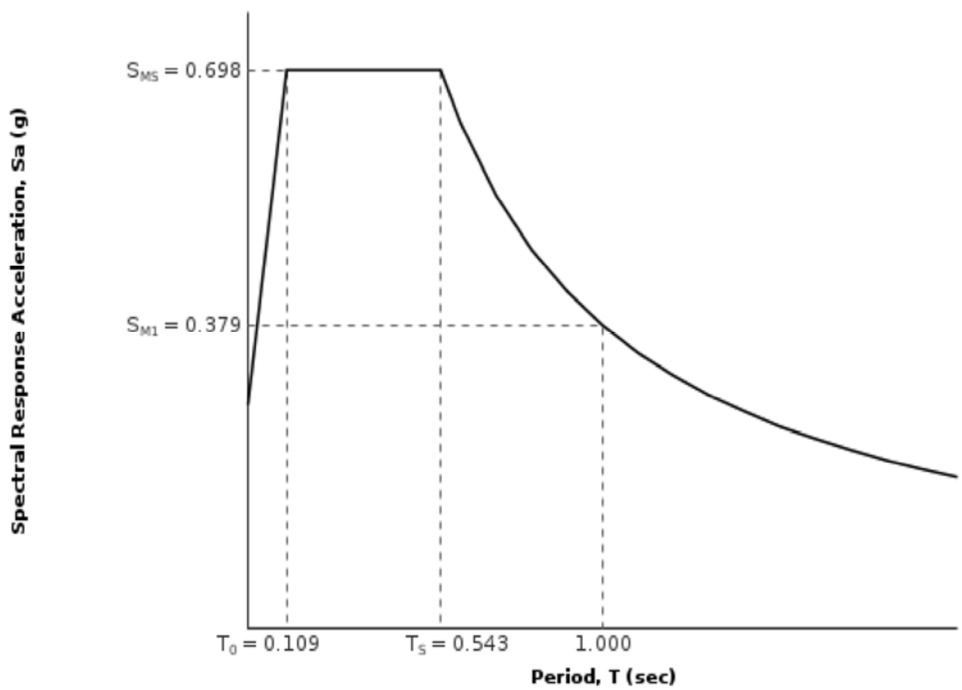


Figure 11.4–1: Design Response Spectrum



Section 11.4.6 — MCE_R Response Spectrum

The MCE_R response spectrum is determined by multiplying the design response spectrum above by 1.5.



Section 11.8.3 — Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

Table 11.8–1: Site Coefficient F_{PGA}

Site Class	Mapped MCE Geometric Mean Peak Ground Acceleration, PGA				
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA ≥ 0.50
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = D and PGA = 0.264 g, F_{PGA} = 1.272

Mapped PGA PGA = 0.264 g

Equation (11.8–1): $PGA_M = F_{PGA}PGA = 1.272 \times 0.264 = 0.336$ g

Appendix G
Probabilistic Seismic Hazard Analysis Report

Site-Specific Probabilistic Seismic Hazard Analysis and Development of Time Histories for A.B. Brown Generating Station in Southwestern Indiana

Prepared for

Vectren Corporation

14 December 2015

Prepared by

AECOM

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At the request of Vectren Corporation, a site-specific probabilistic seismic hazard analysis (PSHA) has been performed for A.B. Brown Generating Station in southwestern Indiana (Figure 1) for a hard rock site condition. The hard rock hazard results and period-dependent amplification factors were used to compute a 2,500-yr return period Uniform Hazard Spectrum (UHS) for a firm rock site condition characterized by a time-averaged shear-wave velocity in the top 30 m (V_S30) of 760 m/sec (NEHRP B/C boundary). Horizontal acceleration time histories were developed consistent with the firm rock 2,500-yr return period UHS. The firm rock acceleration time histories will be used in liquefaction and deformation analysis of the Lower Ash Pond Dam at the A.B. Brown Generating Station. This report presents the results of the site-specific PSHA and the development of the horizontal acceleration time histories

A.B. Brown Generating Station is located in the Midcontinent region of the U.S. away from active plate boundaries in a region that has exhibited a moderate level of historical seismicity (Figure 1). There have been seven known earthquakes larger than moment magnitude (**M**) 5.0 within 200 km of the site. However, the region is capable of experiencing strong ground motions from moderate to large earthquakes (**M** > 6) particularly from the Wabash Seismic Zone and the New Madrid Seismic Zone to the southwest of the site (Figure 1).

1.1 PURPOSE

As stated in the Statement of Work, the following is the scope of work and deliverables.

Develop mean hazard curves based on performing a PSHA for the site utilizing the 2012 EPRI/DOE/NRC Central and Eastern U.S. (CEUS) Seismic Source Characterization (CEUS-SSC) model and the EPRI (2013) ground motion prediction models. Compute the Uniform Hazard Spectra (UHS) corresponding to horizontal motion in hard rock (shear-wave velocity [V_S] 9,200 ft/sec [2,804 m/sec]) outcrop conditions for an annual frequency of exceedance of 1 in 2,500 at 5% damping. Develop three sets of horizontal acceleration time histories consistent with the 2,500-year hard rock UHS.

Current ground motion prediction models for the CEUS are only available for hard rock conditions, hence the PSHA must be performed for hard rock conditions. However, the depth to hard rock at A.B. Brown Generating Station is estimated to be more than 60 m (200 ft). In order to limit the size of the model used in deformation analyses, acceleration time histories consistent with a 2,500-year UHS for a firm rock site condition (V_S of 760 m/sec) were developed using amplification factors to convert the hard rock UHS to a firm rock site condition.

The PSHA methodology used in this study allows for the explicit inclusion of the range of possible interpretations in components of the model, including seismic source characterization and ground motion estimation. Uncertainties in models and parameters are incorporated into the PSHA through the use of logic trees. This report describes the seismic source model, the ground motion prediction models used in the PSHA, the hard rock hazard results and the development of a 2,500-yr UHS for firm rock and associated time histories.

1.2 ACKNOWLEDGMENTS

The seismic hazard analysis of A.B. Brown Generating Station was performed by Melanie Walling, Mark Dober, Patricia Thomas, and Ivan Wong of the Seismic Hazards Group of

AECOM. Our appreciation to Rajendram Arulnathan for project management support and Melinda Lee for her assistance in the preparation of this report.

The PSHA approach used in this study is based on the model developed principally by Cornell (1968). The occurrence of earthquakes on a fault is assumed to be a Poisson process. The Poisson model is widely used and is a reasonable assumption in regions where data are sufficient to provide only an estimate of average recurrence rate (Cornell, 1968). The occurrence of ground motions at the site in excess of a specified level is also a Poisson process, if (1) the occurrence of earthquakes is a Poisson process, and (2) the probability that any one event will result in ground motions at the site in excess of a specified level is independent of the occurrence of other events.

The probability that a ground motion parameter "*Z*" exceeds a specified value "*z*" in a time period "t" is given by:

$$p(Z > z) = 1 - e^{-\nu(z) \cdot t} \qquad (2\text{-}1)$$

where $\nu(z)$ is the annual mean number (or rate) of events in which Z exceeds z. It should be noted that the assumption of a Poisson process for the number of events is not critical. This is because the mean number of events in time t, $\nu(z) \bullet t$, can be shown to be a close upper bound on the probability $p(Z > z)$ for small probabilities (less than 0.10) that generally are of interest for engineering applications. The annual mean number of events is obtained by summing the contributions from all sources, that is:

$$\nu(z) = \sum_{n} \nu_n(z) \qquad (2\text{-}2)$$

where $\nu_n(z)$ is the annual mean number (or rate) of events on source n for which Z exceeds z at the site. The parameter $\nu_n(z)$ is given by the expression:

$$\nu_n(z) = \sum_{i}\sum_{j} ß_n(m_i) \bullet p(R{=}r_j|m_i) \bullet p(Z{>}z|m_i,r_j) \qquad (2\text{-}3)$$

where:

$ß_n(m_i)$ = annual mean rate of recurrence of earthquakes of magnitude increment m_i on source n;

$p(R{=}r_j|m_i)$ = probability that given the occurrence of an earthquake of magnitude m_i on source n, r_j is the closest distance increment from the rupture surface to the site;

$p(Z > z|m_i,r_j)$ = probability that given an earthquake of magnitude m_i at a distance of r_j, the ground motion exceeds the specified level z.

The calculations were made using the computer program HAZ38CEUS. The basic program (HAZ38) has been validated in the Pacific Earthquake Engineering Research (PEER) Center-sponsored "Validation of PSHA Computer Programs" Project (Thomas *et al.*, 2010). Modifications were made to HAZ38 to incorporate the CEUS-SSC model and the resulting revision, HAZ38CEUS, was validated by comparing hazard results with the test case results contained in EPRI/DOE/NRC (2012).

The following is a general overview of PSHA methodology used by AECOM. For this study, we have adopted the EPRI/DOE/NRC (2012) seismic source model, which required modifications to our general approach. For a detailed description, see EPRI/DOE/NRC (2012). A sample logic tree is shown on Figure 2. Logic trees such as shown on Figure 3 are used in the EPRI/DOE/NRC (2012) model.

2.1 SEISMIC SOURCE CHARACTERIZATION

Three types of earthquake sources are characterized in the CEUS-SSC model: (1) known fault sources; (2) seismotectonic zones; and (3) Mmax zones. Fault sources are modeled as three-dimensional fault surfaces and details of their behavior are incorporated into the source characterization. The inventory of fault sources in the CEUS is small and undoubtedly incomplete. Given this shortcoming, the historical seismicity is used as a proxy to address the hazard from those buried or unknown faults. The spatial density of the historical seismicity was assumed to be stationary; in this model the recurrence rates per area for each small area were smoothed using a Gaussian filter. The resulting seismotectonic and Mmax zones are areal source zones in which earthquakes are modeled as point sources.

The geometric source parameters for faults include fault location, segmentation model, dip, and thickness of the seismogenic zone (Figure 2). The recurrence parameters include recurrence model, recurrence rate (slip rate or average recurrence interval for the maximum event), slope of the recurrence curve (*b*-value), and maximum magnitude. Clearly, the geometry and recurrence are not totally independent. For example, if a fault is modeled with several small segments instead of large segments, the maximum magnitude is lower, and a given slip rate requires many more small earthquakes to accommodate a cumulative seismic moment. For areal source zones, only the area, seismogenic thickness, maximum magnitude, and recurrence parameters (based on the historical earthquake record) need to be defined.

Uncertainties in the CEUS-SSC source parameters are modeled using logic trees. In this procedure, values of the source parameters are represented by the branches of logic trees with weights that define the distribution of values. Sample logic trees are shown on Figures 2 and 3. In general, three or five values for each parameter were weighted and used in the analysis. Note that the weights associated with the percentiles are not equivalent to probabilities for these values, but rather are weights assigned to define the distribution.

2.1.1 Source Geometry

In the PSHA, it is assumed that earthquakes of a certain magnitude may occur randomly along the length of a given fault or segment. The distance from an earthquake to the site is dependent on the source geometry, the size and shape of the rupture on the fault plane, and the likelihood of the earthquake occurring at different points along the fault length. The distance to the fault is defined to be consistent with the specific ground motion prediction model used to calculate the ground motions. The distance, therefore, is dependent on both the dip and depth of the fault plane, and a separate distance function is calculated for each geometry and each ground motion prediction model. The size and shape of the rupture on the fault plane are dependent on the magnitude of the earthquake, with larger events rupturing longer and wider portions of the fault plane. For a given magnitude, the associated rupture surface is uniformly distributed along the fault length and width. Ruptures are constrained to occur entirely on the defined fault plane.

The rupture dimensions can be modeled using magnitude-rupture area and rupture width relationships.

2.1.2 Fault Recurrence

The recurrence relationships for faults are generally modeled using the exponentially truncated Gutenberg-Richter, characteristic earthquake, and the maximum moment (magnitude) recurrence models (Figure 2). These models are weighted to represent judgment on their applicability to the sources. For the areal source zones, only a truncated exponential recurrence relationship is assumed appropriate.

The general approach of Molnar (1979) and Anderson (1979) is often used to arrive at the recurrence for the exponentially truncated model. The number of events exceeding a given magnitude, *N(m)*, for the truncated exponential relationship is

$$N(m) = \alpha(m^o)\frac{10^{-b(m-m^o)} - 10^{-b(m^u-m^o)}}{1 - 10^{-b(m^u-m^o)}} \tag{2-4}$$

where $\alpha(m^o)$ is the annual frequency of occurrence of earthquake greater than the minimum magnitude, m^o; b is the Gutenberg-Richter parameter defining the slope of the recurrence curve; and m^u is the upper-bound magnitude event that can occur on the source. A m^o of **M** 5.0 was used for the hazard calculations; this value is also used by the USGS in the National Hazard Maps (Frankel *et al*., 1996; Petersen *et al*., 2008).

A popular model often used in PSHA is where faults rupture with a "characteristic" magnitude on specific segments; this model is described by Aki (1983) and Schwartz and Coppersmith (1984). For the characteristic model, the numerical model of Youngs and Coppersmith (1985) is often used. In the characteristic model, the number of events exceeding a given magnitude is the sum of the characteristic events and the non-characteristic events. The characteristic events are distributed uniformly over a ± 0.25 magnitude unit around the characteristic magnitude and the remainder of the moment rate is distributed exponentially up to the characteristic range using the above equation (Youngs and Coppersmith, 1985).

The maximum moment model can be regarded as an extreme version of the characteristic model. The model proposed by Wesnousky (1986) is often used when there is no exponential portion of the recurrence curve, i.e., no events can occur between the minimum magnitude of **M** 5.0 and the distribution about the maximum magnitude.

The recurrence rates for the fault sources are defined by either the slip rate or the average return time for the maximum or characteristic event and the recurrence *b*-value. The slip rate is used to calculate the moment rate on the fault using the following equation defining the seismic moment:

$$M_o = \mu\, A\, D \tag{2-5}$$

where M_o is the seismic moment, μ is the shear modulus, A is the area of the rupture plane, and D is the slip on the plane. Dividing both sides of the equation by time results in the moment rate as a function of slip rate:

$$\dot{M}_o = \mu A S \quad (2\text{-}6)$$

where $\dot{M}_o$ is the moment rate and S is the slip rate. M_o has been related to moment magnitude, **M**, by Hanks and Kanamori (1979):

$$\mathbf{M} = 2/3 \log M_o - 10.7 \quad (2\text{-}7)$$

Using this relationship and the relative frequency of different magnitude events from the recurrence model, the slip rate can be used to estimate the absolute frequency of different magnitude events.

The average return time for the characteristic or maximum magnitude event defines the high magnitude (low likelihood) end of the recurrence curve. When combined with the relative frequency of different magnitude events from the recurrence model, the recurrence curve is established.

2.2 GROUND MOTION PREDICTION

To characterize the ground motions at a specified site as a result of the seismic sources considered in the PSHA, we used ground motion prediction models for spectral accelerations (Figure 2; Section 4.2). Ground motion prediction models have at a minimum the variables of magnitude, distance, and site condition (e.g., rock, soil).

The uncertainty in ground motion models was included in the PSHA by using the log-normal distribution about the median values as defined by the standard deviation associated with each model. This distribution was truncated at five standard deviations above the median value predicted by the each model. We have tested our approach using the five sigma truncation against the test cases contained in EPRI/DOE/NRC (2012) where sigma was untruncated. The differences are insignificant.

In this section, we describe the seismotectonic and geologic setting and historical seismicity of the site region.

3.1 SEISMOTECTONIC SETTING

A.B. Brown Generating Station is located in southwestern Indiana, within the Wabash Valley Seismic Zone and about 140 km northeast of the New Madrid Seismic Zone (NMSZ) (Figure 4). Although the site is located within the continental interior and far from active plate boundaries, the preexisting structures formed in earlier tectonic settings are still capable of generating seismicity that can pose a hazard to the region. This seismicity has included several large historical earthquakes in the area (**M** > 7), e.g., the 1811 and 1812 New Madrid earthquakes (Figure 1).

The Wabash Valley Seismic Zone is a region of southwestern Indiana and southeastern Illinois that contains the Wabash Valley fault system (WVFS; see below). Numerous Holocene paleoliquefaction features have been mapped along river valleys within the Wabash Valley Seismic Zone and other regions of southern Indiana and Illinois and have been interpreted as having been caused by paleoearthquakes (e.g., Obermeier *et al.*, 1993). Munson *et al*. (1997) reported that at least eight paleoearthquakes had occurred in the area in the past 20,000 years. However, the faults of the WVFS have been mapped as pre-Quaternary, and no fault has been identified as the causative structure for the liquefaction nor been explicitly correlated with historic or paleoseismicity.

The CEUS is part of a broad mid-plate compressive stress province that also includes most of Canada (Zoback and Zoback, 1991). Over this large region, the stress field is oriented with a relatively uniform east-northeast direction of maximum horizontal compression. This compression direction corresponds well to the direction of absolute plate motion of the North American Plate, which suggests that a far-field tectonic source such as ridge-push or basal drag at the Mid-Atlantic Ridge may be the primary source of stress in the mid-plate region (Zoback and Zoback, 1991).

3.2 HISTORICAL SEISMICITY

The following is a discussion of the historical seismicity and significant earthquakes in the region surrounding A.B. Brown Generating Station.

3.2.1 Catalog

A historical seismicity catalog was derived mainly from the Central and Eastern United States Seismic Source Characterization (CEUS-SSC) catalog (EPRI/NRC/DOE, 2012). This catalog includes data primarily from the catalog compiled by the U.S. Geological Survey (USGS) for the National Seismic Hazard Mapping Project (Mueller *et al*., 1997; Petersen *et al*., 2008) and from the Geological Survey of Canada (GSC) catalog for seismic hazard analyses (Adams and Halchuk, 2003). The main source for the USGS catalog was the NCEER-91 catalog (Seeber and Ambruster, 1991) which updated the original EPRI-SOG (EPRI 1988) catalog. The catalog was then updated using the National Earthquake Information Center's (NEIC) Preliminary Determination of Epicenters (PDE) and data from the National Earthquake Database (NEDB) of Canada. Researchers reviewed original catalogs and special earthquake studies to verify and if needed update original entries, and regional catalogs were incorporated into the continental scale catalogs described above (see EPRI/NRC/DOE, 2012 for details of special study references and list of regional catalogs used). The CEUS-SSC catalog spans the time period of 1568 to 2008. We updated this catalog with more recent data (through 6 March 2013) from the Advanced National Seismic System (ANSS) and NEIC PDE catalogs (Figure 1).

All of the events in the USGS catalog used to compile the CEUS-SSC catalog have body-wave (m_b) magnitude values, which were converted to **M** using the equations of Atkinson and Boore (1995):

$$\mathbf{M} = -0.39 + 0.98Mn \text{ for magnitudes} \leq 5.5$$

$$\mathbf{M} = 2.715 - 0.277Mn + 0.127(Mn^2) \text{ for magnitudes} > 5.5$$

and Johnston (1996):

$$\mathbf{M} = 1.14 + 0.24\, m_b + 0.0933\, m_b^2$$

Mn (Nuttli magnitude) was considered to be equivalent to m_b. All events in the PDE catalog that we used to update the CEUS-SSC catalog were Mn or M_D. We converted the PDE Mn magnitudes to **M** using the average of Atkinson and Boore (1995) and Johnston (1996). For the M_D values, we used the same conversion used in the CEUS-SSC catalog to convert them to **M** values for the Mid-Continent U.S. east of 100º W (EPRI/DOE/NRC, 2012).

$$\mathbf{M} = 0.869 + 0.762\, M_D$$

3.2.2 Significant Earthquakes

The most significant earthquakes to have occurred in the CEUS are the 1811-1812 **M** 7 to 8 New Madrid earthquake sequence and the 1886 **M** 6.8 Charleston, South Carolina, earthquake (Figure 1). The New Madrid earthquake sequence occurred over the winter of 1811-1812 in southeastern Missouri/northeastern Arkansas. This sequence, which was felt as far away as the East Coast (Figure 5), consisted of three principal events on 16 December 1811, 23 January 1812, and 7 February 1812 (referred to as NM1, NM2, and NM3, respectively in Hough *et al*., 2000) (Figure 6). Because the epicentral region was sparsely populated at the time of the events, little structural damage occurred, and the maximum Modified Mercalli (MM) intensity is IX (NM1) as reinterpreted by Hough *et al.* (2000). The A.B. Brown Generating Station site probably underwent strong ground shaking of MM VII to VIII in the 16 December 1811 mainshock (Figure 5). The NMSZ is currently the most seismically active area in the CEUS (Figure 1).

The most damaging earthquake to have occurred in the southeast U.S. is the 31 August 1886 **M** 6.8 Charleston, South Carolina earthquake. Sixty people were killed and many buildings in the old city of Charleston were damaged or destroyed and estimated property damage was on the order of $23 million (Stover and Coffman, 1993). Liquefaction was extensive with cratering, sand ejecta and fissuring over an area of 1,300 km^2. No surface-faulting was observed. The maximum intensity reported was MM X within an elliptical area trending northeasterly between Charleston and Jedburg (Stover and Coffman, 1993) (Figure 7). The earthquake affected an area of over 5 million km^2 and the site may have been subjected to moderate ground shaking of MM IV even though it is located 880 km northwest of the epicenter (Figure 7).

The Wabash Valley has historically been seismically active with several earthquakes of **M** 4.5 and larger (Figure 1). Hence, the site has been strongly shaken numerous times after the 1811-1812 and 1886 earthquakes. An event on 27 September 1891 occurred near Mt. Vernon, Illinois, which caused chimney damage in the epicentral area (Stover and Coffman, 1993). The size of the earthquake was estimated to be a body-wave magnitude (m_b) 5.8 and the event was felt widely in several states (Figure 8). Shaking at the site could have been as strong as MM V.

On 31 October 1895, an earthquake of estimated surface wave magnitude (M_S) 6.7 struck the northern end of the NMSZ (Figure 9). This is the largest earthquake to have occurred in the central Mississippi Valley since 1811-1812 (Stover and Coffman, 1993). The event caused extensive damage in the town of Charleston, Missouri. Sand blows due to liquefaction were also reported in the epicentral area (Stover and Coffman, 1993). In the area of the site, the ground shaking was probably at a MM VII level (Figure 9).

On 9 November 1968, a m_b 5.5 earthquake struck southern Illinois and neighboring states with a maximum reported MM VII (Figure 10). Damage consisted of damaged chimneys, broken windows, cracked or fallen plaster, cracked foundations, and scattered instances of collapsed parapets (Stover and Coffman, 1993). The site was probably subjected to MM VI to VII ground shaking from this event. Another notable earthquake was the 18 April 2008 **M** 5.4 Southern Illinois earthquake south of the site (Figure 1).

On 27 July 1980, a **M** 5.1 earthquake struck the area near Sharpsburg, Kentucky. This event, the strongest in the history of Kentucky, occurred approximately 340 km east of the site and caused over $1 million in property damage (Stover and Coffman, 1993). The site was probably subjected to intensities of MM II to III (Figure 11).

The 23 August 2011 **M** 5.8 Mineral, Virginia, earthquake occurred within the Central Virginia Seismic Zone and is the largest reported event in this zone. The previous largest event in this zone was an event of estimated **M** 4.8 in 1875. The 2011 earthquake occurred at a shallow depth of 6 km but it was felt throughout the eastern U.S. from central Georgia to central Maine and as far west as Detroit, Michigan and Chicago, Illinois (Figure 12). It may possibly have been lightly felt at the site more than 875 km away, based on the USGS Did You Feel It (DYFI) map (Figure 12).

The following discusses the two major inputs into the PSHA: the seismic source model and the ground motion prediction models.

4.1 SEISMIC SOURCE MODEL

Seismic source characterization is concerned with three fundamental elements: (1) the location, geometry, and characteristics of significant sources of future earthquakes; (2) the maximum size of these earthquakes; and (3) the rate at which different size earthquakes occur. Two types of seismic sources were considered in this PSHA: discrete fault or fault zone sources and regional seismic source zones.

The seismic source characterization presented here is adopted from the comprehensive seismic source characterization of the CEUS, developed for nuclear facilities by EPRI/DOE/NRC (2012). Two zonation models, account for earthquakes associated with buried or generally unknown faults (background), were characterized and included in the PSHA; these models include multiple zones, many having alternative geometries (Figures 13 and 14). In addition, the source parameters for several fault sources or RLMEs (repeated large magnitude earthquakes) were characterized for input into the PSHA (Figure 13).

A major challenge in understanding the earthquake potential in the CEUS has been associating the observed seismicity with specific geologic structures. Few active faults are known east of the Rocky Mountains. Thus the traditional approach in addressing the seismic hazard in the CEUS has been to rely on the historical earthquake record in conjunction with seismic source zones that separate regions of different seismotectonic characteristics and hence possibly different earthquake potential. Each seismic source zone is defined and characterized according to geologic, tectonic, and seismicity data. The zones comprise regions having a common geologic history that distinguishes them from neighboring areas. They may have a similar structure (e.g., faults or fractures of similar age, type, orientation), a similar pattern of seismicity, and/or a homogeneous stress regime. The EPRI/DOE/NRC (2012) model retains this methodology by dividing the CEUS into numerous “seismotectonic zones”, defined by differences in various seismic source assessment criteria such as style of faulting, earthquake recurrence, maximum magnitude, seismogenic thickness, etc. The model includes an alternative approach to dividing the CEUS into source zones, which is based solely on the expected maximum magnitude in the zone. This alternative zonation approach divides the study area into “Mmax zones” (Figure 14). The seismotectonic zone approach receives slightly higher weight, 0.6, than the Mmax zone approach, 0.4.

Figures 13 and 14 show the locations of the seismotectonic and Mmax zones, respectively. There are three Mmax zones and 12 seismotectonic zones in the EPRI/DOE/NRC model. The Mmax zones and some seismotectonic zones have one or more alternate geometries. Table 1 summarizes the source zone parameters used in the analysis. (Not all seismic source zones are shown on Figure 13.) A.B. Brown Generating Station lies in the Illinois Basin Extended Basin Zone (IBEB) zone and near the boundary of the Wabash Valley RLME zone (Figure 13).

Table 1
Seismic Source Zones Incorporated Into Analysis

Source Zone	Symbol	Mmax (M)[1]	Seismogenic Depth[2] (km)	Area (km^2)
Seismotectonic Zones				
Atlantic Highly Extended Crust	AHEX	6.0 6.7 7.2 7.7 8.1	8 (0.5) 15 (0.5)	177683
Extended Continental Crust–Atlantic Margin Zone	ECC-AM	6.0 6.7 7.2 7.7 8.1	13 (0.4) 17 (0.4) 22 (0.2)	881480
Extended Continental Crust–Gulf Coast	ECC-GC	6.0 6.7 7.2 7.7 8.1	13 (0.4) 17 (0.4) 22 (0.2)	1239288
Gulf Highly Extended Crust	GHEX	6.0 6.7 7.2 7.7 8.1	8 (0.5) 15 (0.5)	509090
Great Meteor Hotspot Zone	GMH	6.0 6.7 7.2 7.7 8.1	25 (0.5) 30 (0.5)	32250
Illinois Basin Extended Basin Zone	IBEB	6.5 6.9 7.4 7.8 8.1	13 (0.4) 17 (0.4) 22 (0.2)	114526
Midcontinent Craton Zone (all alternatives)	MidC	5.6 6.1 6.6 7.2 8.0	13 (0.4) 17 (0.4) 22 (0.2)	4258598 4246625 4025001 4013028
Northern Appalachian Zone	NAP	6.1 6.7 7.2 7.7 8.1	13 (0.4) 17 (0.4) 22 (0.2)	378331
Oklahoma Aulacogen Zone	OKA	5.8 6.4 6.9 7.4 8.0	15 (0.5) 20 (0.5)	53583

Source Zone	Symbol	Mmax (M)[1]	Seismogenic Depth[2] (km)	Area (km^2)
Paleozoic Extended Crust (Narrow and Wide alternatives)	PEZ	5.9 6.4 6.8 7.2 7.9	13 (0.4) 17 (0.4) 22 (0.2)	365395 598992
Reelfoot Rift Zone	RR	6.2 6.7 7.2 7.7 8.1	13 (0.4) 15 (0.4) 17 (0.2)	69479
Reelfoot Rift with Rough Creek Graben Zone	RR and RR_RCG	6.1 6.6 7.1 7.6 8.1	13 (0.4) 15 (0.4) 17 (0.2)	81452
St. Lawrence Rift Zone	SLR	6.2 6.8 7.3 7.7 8.1	25 (0.5) 30 (0.5)	329322
Mmax Zones				
Mesozoic and Younger Extended Crust - Narrow	MESE-N	6.4 6.8 7.2 7.7 8.1	13 (0.4) 17 (0.4) 22 (0.2)	3616923
Mesozoic and Younger Extended Crust - Wide	MESE-W	6.5 6.9 7.3 7.7 8.1	13 (0.4) 17 (0.4) 22 (0.2)	4342413
Non-Mesozoic and Younger Extended Crust - Narrow	NMESE-N	6.4 6.8 7.1 7.5 8.0	13 (0.4) 17 (0.4) 22 (0.2)	4792101
Non-Mesozoic and Younger Extended Crust - Wide	NMESE-W	5.7 6.1 6.6 7.2 7.9	13 (0.4) 17 (0.4) 22 (0.2)	4066611
Study Region	Study Region	6.5 6.9 7.2 7.7 8.1	13 (0.4) 17 (0.4) 22 (0.2)	8409024

Notes:

[1] Weights for all magnitude distributions are 0.101/0.244/0.310/0.244/0.101, a discrete five-point approximation to an arbitrary continuous distribution (EPRI/DOE/NRC, 2012).

[2] Weights for depth in parentheses

The EPRI/DOE/NRC (2012) model includes sources defined based on RLMEs rather than only fault sources. Many of the RLMEs correlate with identified geologic faults, but some are defined solely by geographically clustered paleoliquefaction events that suggest a localized source even if the responsible fault has not been identified and characterized. The site is adjacent to the Wabash Valley RLME zone and the New Madrid fault system (NMFS) lies approximately 200 km to the south of the site (Figures 6 and 13). Although quite distant from the site, we include the Charleston source and the NMFS and its associated elements (Figures 6 and 13) in the PSHA because their maximum earthquakes and relatively high activity rates often dominate the hazard in the CEUS, particularly at long-period ground motions. The Reelfoot Rift-Eastern Rift Margin (ERM) fault, the Reelfoot Rift-Marianna fault, and the Reelfoot-Commerce fault zone, to the southwest were also included in the PSHA (Figure 6). Tables 2 and 3 summarize the RLME (fault) source parameters used in the analysis.

4.1.1 Seismotectonic Zones

This section describes the seismotectonic characteristics of the most significant seismotectonic zones to the site, the basis for delineating the zone and for defining the model values for style of faulting, geometry, seismogenic depth, and Mmax. Recurrence for the zones is discussed in Section 4.1.3.

Illinois Basin Extended Basement Zone (IBEB)

The site lies within the IBEB zone, which encompasses southwestern Indiana and southeastern Illinois (Figure 13). Southern Indiana and southern Illinois are characterized by several moderate-sized paleoearthquakes and by higher rates of seismicity than adjacent craton regions (Figure 4). Several characteristics combine to support the delineation of IBEB as a separate seismotectonic zone. The southern part of the Illinois basin is one of the most structurally complex areas of the Midcontinent (McBride *et al*., 2002), with a crust distinct from that of the neighboring craton. Numerous moderately dipping reflectors interpreted to be faults are present in the basement. Moderate-sized historical earthquakes that appear to be spatially associated with Precambrian basement faults and with Paleozoic faults suggest continued reactivation of older basement features as well as younger Paleozoic structures (McBride *et al*., 2002). Stresses induced by Mesozoic rifting possibly extend into the southern Illinois basin causing the reactivation of deep structures (Braile *et al*., 1984). The IBEB source zone is defined to characterize sources of moderate- to large-magnitude earthquakes (excluding those attributed to the Wabash Valley RLME source) that may occur on deep structures in the Precambrian basement and as Paleozoic faults that extend into the overlying Paleozoic sedimentary rocks (EPRI/DOE/NRC 2012).

Fault dips are generalized based on sense of slip, with strike-slip ruptures assigned steep dips between 70° and 90° and reverse ruptures assigned moderate dips between 40° and 70°. Seismogenic thickness ranges from 13 to 22 km, the default values for the entire study area (EPRI/NRC/DOE, 2012). The seismogenic thickness is based on reported depths of seismicity within the IBEB. The deepest well-constrained earthquake hypocenters in the deep part of the Illinois basin, are located at depths of 20 to 22 km (McBride *et al*., 2002; Yang *et al*., 2009). However, the average depth throughout the IBEB zone based on other historical earthquakes may be less (EPRI/DOE/NRC, 2012).

The largest earthquakes in the IBEB zone include an August 1891 **M** 5.5 event, a September 1891 **M** 5.0 event in eastern Nebraska, and a 2008 **M** 5.3 event. Four prehistoric earthquakes inferred from the paleoliquefaction studies have estimated magnitudes (**M** 6.2 to 6.3) that are larger than the historical earthquakes (EPRI/DOE/NRC, 2012). Maximum magnitudes modeled in the IBEB range from **M** 6.5 to 8.1, with a value of **M** 7.4 being preferred.

Midcontinent-Craton Zone (MidC)

The MidC zone occupies most of the CEUS study area, dominating the central United States and encompassing most of the Great Plains area (Figure 13). The MidC zone includes those regions of the continent that have not occupied the Phanerozoic continental margin, specifically Precambrian basement rocks of the Canadian shield and the platform (EPRI/DOE/NRC, 2012). The craton was formed by Paleoproterozoic accretion and now forms a cold, strong crustal core to the continent. Two orthogonal sets of structures, northeast-striking ductile shear zones and northwest-striking brittle-ductile faults dominate the Precambrian basement structure (Sims *et al*., 2005). Numerous geophysical anomalies have been observed within the MidC zone and may represent zones of crustal weakness that could localize future seismicity. Seismicity in the MidC zone is spatially variable and includes a few concentrations of activity that constitute seismic zones within the greater seismotectonic zone, such as the Anna seismic zone and Northeast Ohio seismic zone in Ohio, and the Nehama Ridge seismic zone in Kansas.

The fundamental distinguishing characteristic of the MidC zone is that it contains crust that has not experienced Mesozoic or younger extension, and generally not Paleozoic extension either. The characterization of the seismotectonic zone includes four alternative geometries, based on the inclusion or exclusion of smaller Mid-Continent regions. These smaller zones include a northeast-trending band of crust along the Appalachian Mountains that is included either within the PEZ or within the MidC zone, and the Rough Creek Graben, which is included either in the Reelfoot Ridge zone (RR) or in the MidC zone (Figure 13).

The largest earthquakes in the MidC zone include a 1909 **M** 5.7 event in eastern Montana, an 1877 **M** 5.5 event in eastern Nebraska, and a 1964 **M** 4.8 earthquake in eastern Ontario. Maximum magnitudes have a broader distribution in the MidC than most other seismotectonic zones, ranging from **M** 5.6 to 8.0, with a value of **M** 6.6 being preferred.

Few data exist to characterize independently the deep Precambrian structures within the intracratonic MidC region on which future earthquakes might be preferentially located. Thus the characterization of the MidC region is equivalent to what EPRI/DOE/NRC (2012) calls the "default" seismotectonic characteristics, representative of the entire study region. Thus both strike-slip and reverse mechanisms are included, with a 2/3 weight on strike-slip, reflecting the occurrence of both mechanisms in focal mechanism data, the state of stress, and the orientation of existing geologic structures in the region. Strikes include northwest, north-south, northeast and east-west orientations, determined based on focal mechanism data, tectonic stress, and structural grain within the study area. The dips are generalized based on sense of slip, with strike-slip ruptures assigned steep dips between 60° and 90° and reverse ruptures assigned moderate dips between 30° and 60°. Seismogenic thickness ranges from 13 to 22 km.

4.1.2 Mmax Zones

The Mmax zones are based on the observation that within the global catalogue of earthquakes within stable continental regions, there is little to distinguish any of them in a statistically significant way except that larger earthquakes seem to occur more commonly within those parts of the stable continental regions that have undergone extension, especially Mesozoic or younger extension (Johnston *et al*., 1994). Consequently, the zonation model is based on using global analogues to characterize the maximum magnitudes, with regions divided into extended and cratonic categories, each with a different distribution of maximum magnitudes. We adopt the zone boundaries and maximum magnitude distribution of EPRI/DOE/NRC (2012). The maximum magnitude distributions are used for the background seismicity.

The EPRI/DOE/NRC statistical analysis of the global database of earthquakes in stable continental regions (SCR) showed that the distinction between Mesozoic extended crust and non-extended crust noted by Johnston *et al*. (1994), while present, is only marginally significant. Therefore, within the Mmax zonation approach, two models are included: 1) the CEUS is divided into two Mmax zones, each with its own Mmax distribution, based on the presence or absence of Mesozoic-extended crust, and 2) the CEUS can be described by a single Mmax zone with a single Mmax distribution. The former model has slightly higher weight because of the marginally significant difference observed in the statistical analyses.

Mesozoic and Younger Extended Crust (MESE)

The Mesozoic extended zone (MESE) includes areas that underwent Paleozoic and Mesozoic or younger extension and includes the Atlantic and Gulf coastal regions as well as the failed rifts in the central U.S. (including the Reelfoot Rift and southern Oklahoma aulocogen) (Figure 14).

Non-Mesozoic and Younger Extended Crust (NMESE)

The Non-Mesozoic and Younger extended crust (NMESE) includes that part of the CEUS stable continental region that has not undergone Mesozoic or younger extension. This includes primarily interior cratonic regions and overlaps significantly with the MidC seismotectonic zone.

The boundaries between the extended and non-extended Mmax zones have two alternatives, reflecting uncertainty in the geographic extent of extended crust (Figure 14). The MESE-N (N = “narrow”) includes regions that have definitively experienced Mesozoic extension as inferred based on the presence of certain distinguishing characteristics. These may include: Mesozoic grabens and rift basin, Mesozoic and younger plutons, Mesozoic and younger uplift and unroofing associated with normal faulting (EPRI/DOE/NRC, 2012). Generally, regions that meet most of these criteria are considered to be extended and are assigned to the MESE-N zone. Regions with less compelling evidence, such as localized Mesozoic and younger reactivation of older structures or the presence of structures favorably oriented for reactivation, are less certainly extended and are assigned to the MESE-W (W = “wide”) zone. The NMESE-N and NMESE-W zones include the rest of the CEUS region outside the MESE-N and MESE-W zones, respectively. The narrow boundary, dividing definitively extended crust from the rest of the craton receives most of the weight (0.8) due to the lack of clear evidence for extension in the MESE-W zone.

The narrow and wide geometry for each zone has its own maximum magnitude distribution for this region, based on the largest historical earthquake known in each zone. These appear in Table 1 (Table 6.3.2-1 in EPRI/DOE/NRC, 2012).

Study Region

The single-zone alternative of the Mmax zone model includes the Study Region (StudyR) source zone (Figure 14), which encompasses the entire study area, which is represented by a single Mmax distribution. The distributions for seismogenic depth and Mmax for this zone appear in Table 1.

4.1.3 Recurrence for Seismic Zonation

The CEUS-SSC model is based on the spatial stationarity of seismicity, which is defined from small- to moderate-magnitude earthquakes that have occurred during a relatively short historical and instrumental record (EPRI/DOE/NRC, 2012).

For the seismotectonic and Mmax source zones, the seismicity rates are determined from the historical seismicity catalog. All dependent earthquakes were removed from the catalog, and earthquakes associated with the RLME sources were also removed to avoid double-counting. The cell size for all seismotectonic source zones except MidC was 0.25 degrees; the cell size for MidC was set to 0.5 degrees. The spatial smoothing operation, a penalized-likelihood function, is based on calculations of earthquake recurrence within each cell. Both *a*- and *b*- values are allowed to vary, but the degree of variation has been optimized such that *b*-values vary little across the study region, and the *a*-values are neither too smooth or spikey. Also, the recurrence calculations consider weighting of magnitudes in the recurrence rate calculations, with moderate events assigned more weight than smaller events.

Five alternative cases were considered for weights, which affect the degree of smoothing, for various magnitude bins; Cases A, B, C, D, and E (EPRI/DOE/NRC, 2012). Case C was dropped as it is very similar to Case B, and Case D was considered too extreme. Thus for each source zone three magnitude weighted cases were used: A, B, and E, with weights of 0.3, 0.3, and 0.4, respectively.

Furthermore, more than point estimates of the recurrence parameters are needed as modern PSHA requires an assessment of the epistemic uncertainty associated with these estimates, including correlations between the recurrence parameters of cells in the same geographical region, which may jointly affect the hazard at one site. The approach used to generate alternative maps of the recurrence parameters uses a technique known as Markov Chain Monte Carlo (MCMC) (EPRI/DOE/NRC, 2012).

This resulted in eight alternative maps representing the uncertainty in recurrence parameters that result from the limited duration of the catalog. If the smoothing parameters are treated as uncertain and estimated objectively from the data, the eight alternative maps also include the uncertainty about the appropriate values of the smoothing parameters. The eight realizations are equally weighted. For computational efficiency, the mean of the eight realizations was utilized in these calculations.

4.1.4 RLME

The following describes the Wabash Valley and NMFS RLMEs, which are the most significant RLMEs to the site.

Wabash Valley Fault Zone

The north-northeast-trending WVFS consists of numerous high-angle oblique-slip faults that comprise a broad 80-km-long zone located within the limits of the Grayville graben (Figure 6). The Wabash Valley RLME as configured in the CEUS-SSC model is significantly longer than the WVFS proper and extends north to include the Vincennes, Indiana area (Figures 6 and 13). The Grayville graben formed during Iapetan rifting (Hildenbrand and Ravat, 1997; EPRI/DOE/NRC, 2012). Direct evidence for neotectonic activity, including exposures of Quaternary displacement, was documented along the WVFS by Woolery (2005). He interpreted offset of a reflector, identified as a late Quaternary (ca 37,000 years old) sand, revealed in high-resolution seismic reflection profiles as due to displacement across the Hovey Lake fault at the south end of the WVFS. More recent work by Counts *et al*. (2009) and Van Arsdale *et al*. (2009) has identified Holocene deformation across the Uniontown scarp, part of the Hovey Lake fault. Van Arsdale *et al*. (2009) excavated a trench exposing 3500-year-old Ohio River alluvium that had been folded in a monocline with a 3-m amplitude, and also observed fractures within a younger unit that indicate possible activity within the last 295 years. For the most part, activity of the WVFS is indicated by historical seismicity and the aforementioned paleoliquefaction features. The historic seismicity includes five slightly damaging earthquakes of mb 5.0 to 5.8 during 200 years of historical time (Figure 1).

The maximum magnitude estimates adopted from the EPRI/DOE/NRC (2012) CEUS source characterization of the Wabash Valley source are based on analysis of paleoliquefaction features in the vicinity of the lower Wabash Valley of southern Illinois and Indiana. The magnitude of the largest paleoearthquake in the lower Wabash Valley (the Vincennes-Bridgeport earthquake), which occurred 6,011 ± 200 yr BP, was estimated to be ≥ **M** 7.5 using the magnitude-bound method (Obermeier, 1998). Use of a more recently developed magnitude-bound curve for the CEUS gives a lower estimate of **M** 7.1 to 7.3 (Olsen *et al*. (2005). The lower-bound relationship developed by Castilla and Audermard (2007) from a worldwide database gives a range of **M** 7.0 to 7.3. Estimates based on asuite of geotechnical analyses (cyclic stress and energy stress methods) range from **M** 7.5 to 7.8 (summarized in Obermeier *et al*., 1993). The next largest earthquake, the Skelton paleoearthquake, occurred 12,000 ± 1,000 yr BP (Obermeier, 1998). Lower and upperbound magnitude range from **M** 6.3 to 7.3 based on estimates by Munson *et al*. 1997, Olsen *et al*., 2005 and Castilla and Audemard (2007). The magnitude distribution of the EPRI/DOE/NRC (2012) CEUS source model (Table 2) incorporates the range of estimated sizes of the Vincennes-Bridgeport and Skelton paleoearthquakes as representative of both the aleatory variability in the size of individual Wabash Valley RLMEs and the epistemic uncertainty in the approaches and data used to estimate the magnitudes of prehistoric earthquakes.

The recurrence rates for the Wabash Valley RLME (Table 2) are based on the estimated ages for the Vincennes-Bridgeport and Skeleton paleoearthquakes using a Poisson model (EPRI/DOE/NRC, 2012).

Table 2
RLME Sources Incorporated Into Analysis

Fault	Geometry	Style of Faulting[1]	Mmax (M)	Dip (deg)	Seismogenic Thickness (km)	Recurrence Data[2]	Recurrence Interval (yr)[3]
Reelfoot Rift - Eastern Rift Margin Fault (ERM)							
ERM-N	ERM-N (1.0)	SS	6.7 (0.3) 6.9 (0.3) 7.1 (0.3) 7.4 (0.1)	90	13 (0.3) 15 (0.5) 17 (0.2)	1 event in 12-35 kyr (0.9)	3448 6667 12500 25000 71429
						2 events in 12-35 kyr (0.1)	2564 4545 7692 13889 31250
ERM-S	ERM-SCC (0.6)	SS	6.7 (0.15) 6.9 (0.2) 7.1 (0.2) 7.3 (0.2) 7.5 (0.2) 7.7 (0.05)	90	same as above	2 events in 17.7-21.7 kyr (0.333)	2857 4762 7143 12500 27778
						3 events in 17.7-21.7 kyr (0.334)	2326 3571 5263 8333 16129
						4 events in 17.7-21.7 kyr (0.333)	2000 2941 4167 6250 11111
	ERM-SRP (0.4)	same as above	same as above	same as above	same as above	same as above	same as above
Reelfoot Rift-Marianna In cluster (0.5) [Out of cluster (0.5) - default to background]	Marianna NW-strike (0.5)	SS	6.7 (0.15) 6.9 (0.2) 7.1 (0.2) 7.3 (0.2) 7.5 (0.2) 7.7 (0.05)	90	13 (0.3) 15 (0.5) 17 (0.2)	3 events in 9.6-10.2 kyr	1449 2381 3704 6250 13889
						4 events in 9.6-10.2 kyr	1190 1818 2703 4167 8333
	Marianna NE-strike (0.5)	same as above	same as above	same as above	same as above	same as above	same as above

Fault	Geometry	Style of Faulting[1]	Mmax (M)	Dip (deg)	Seismogenic Thickness (km)	Recurrence Data[2]	Recurrence Interval (yr)[3]
Reelfoot Rift - Commerce Fault Zone	Commerce fault (1.0)	SS	6.7 (0.15) 6.9 (0.35) 7.1 (0.35) 7.3 (0.1) 7.7 (0.05)	90	13 (0.3) 15 (0.5) 17 (0.2)	2 events in 18.9-23.6 kyr	4000 7143 12500 25000 71429
						3 events in 18.9-23.6 kyr	3030 5000 7692 13158 29412
Wabash Valley	Wabash Valley zone (1.0)	SS	6.75 (0.05) 7 (0.25) 7.25 (0.35) 7.5 (0.35)	90		2 events in 11-13 kyr	2273 4000 7143 13889 41667
Charleston	Local (0.5)	SS	6.7 (0.1) 6.9 (0.25) 7.1 (0.3) 7.3 (0.25) 7.5 (0.1)	90	13 (0.4) 17 (0.4) 22 (0.2)	2,000-yr record (0.8) 4 events in 2 kyr (1.0)	213 323 476 769 1471
						5,500-yr record (0.2) 4 events in 5.5 kyr (0.2)	213 323 476 769 1471
						5 events in 5.5 kyr (0.3)	370 526 769 1136 2000
						5 events in 5.5 kyr (0.2)	526 769 1086 1562 2941
						6 events in 5.5 kyr (0.3)	455 667 909 1282 2174
	Narrow (0.3)	SS	same as above	90	same as above	same as above	same as above
	Regional (0.2)	SS	same as above	90	same as above	same as above	same as above
New Madrid Fault System (NMFS)	see Table 3						

Note: Values in parentheses are weights. All faults are modeled with the Characteristic recurrence model

1 SS Strike-slip

2 "Recurrence Data" describes datasets used to calculate recurrence intervals.

3 Weights for all distributions are: 0.101/0.244/0.310/0.244/0.101.

New Madrid Fault System (NMFS) RLME

The NMSZ is the most likely site of the 1811-1812 New Madrid earthquake sequence, which includes three of the largest earthquakes to have occurred within the North American plate in historical times (Johnston and Shedlock, 1992) (Figure 6). The pattern of seismicity and surface uplift is generally interpreted as delineating a left-stepping, right-lateral, strike-slip fault system (Cox *et al*., 2001; Johnston and Schweig, 1996). Johnston and Schweig (1996) developed faulting models for the 1811-1812 sequence based on geological, geophysical, seismological, and historical data. They concur with the commonly held assumption that the current seismicity is illuminating the most active faults; i.e., those that ruptured in 1811–1812 and also prior to 1811.

Schweig and Ellis (1994) and Johnston and Schweig (1996) provide summaries of the seismological, geodetic, and paleoseismologic data that have been used to assess the repeat times of large-magnitude events in the New Madrid region. In addition, Wheeler and Perkins (2000) provide additional information from the 2002 USGS National Hazard Maps for the CEUS. Correlation of dated liquefaction features suggest that widespread liquefaction occurred within the zone in A.D. 1811-1812, 1450, 900, 300 as well as about 2350 B.C. (Tuttle *et al*., 2005). Liquefaction deposits can constrain the ages of prehistoric events but not the causative faults. However, several of the prehistoric liquefaction deposits are composite, indicating they were formed in multiple episodes within a short period and thus may have occurred in a rapid sequence of large earthquakes similar to the 1811-1812 sequence.

The occurrence of two large events in A.D. ~900 and 2500-1400 B.C. is supported by recent studies of Mississippi River channel morphology that suggest that the Mississippi River changed its course in response to a sudden localized change in base level at those times (Holbrook *et al*., 2006). That change in base level is attributed to uplift of the downstream side of the channel across the Reelfoot reverse fault (described below).

These paleoseismic results indicate a recurrence interval of about 500 years for large earthquakes or earthquake sequences in the NMSZ over the past 2,000 years. The absence of paleoseismic evidence for earthquakes between 300 A.D. and 2200-2350 B.C. has been cited as indicative of temporal clustering of earthquakes in the NMSZ, with large earthquakes or earthquake sequences happening every few hundred years over a period of time followed by a long hiatus in activity (Holbrook *et al*., 2006). However, at this point it remains uncertain if the lack of events documented between A.D. 300 and 2200 B.C. in New Madrid is due to clustering or an incomplete paleoseismic record.

The possibly clustered behavior in the NMSZ, coupled with the discovery of paleoliquefaction features in the Reelfoot Rift (RR) southwest of the New Madrid zone (indicative of large earthquakes between about 5,000 and 7,000 years ago but not during the New Madrid cycles), has led to the suggestion that the locus of earthquake activity moves around the RR, on time scales of 5 to 15 kyr. In this model, the New Madrid region is the current, or most recent, locus of activity, but other areas have been so in the past, and the locus may shift again.

In the seismic source model, the elevated seismicity in the NMSZ is included in the RR seismotectonic zone, whereas large historical and paleoseismic events that likely occurred on the structures that ruptured in 1811-1812 are modeled as part of the NMFS RLME, in keeping with the EPRI/DOE/NRC (2012) model. The source zone accommodates the hazard from background seismicity; the NMFS contributes an additional hazard (Tables 1 and 2). In the seismic source model, the NMFS comprises three distinct fault zones, located within the NMSZ source zone (Figure 6). The three NMFS faults, defined after the models of Van Arsdale (2000) and Johnston and Schwieg (1996), include: 1) the southern section (NMS), comprising the Blytheville arch (BA), extending into the Blytheville fault zone (BFZ) and Bootheel lineament (BL) area, 2) the central section, comprising the Reelfoot reverse fault (RFT), and 3) the northern section, comprising the New Madrid North fault and the Northwestern Seismicity Arm (NMN) (Figure 6; Table 3). Each of these sections ruptured to produce the 1811 and 1812 earthquakes.

The faults of the NMFS are defined primarily based on concentrations of seismicity as geomorphic expression of faulting is poor; only the Reelfoot reverse fault is well expressed as a definitively tectonic feature. Several different geologic faults have been postulated as the source of the events but there remains considerable uncertainty in defining the causative faults. The southern and northern sections of the fault system are northeast-striking features that are probably ancient faults related to rifting that have been reactivated in the modern stress regime as primarily right-lateral strike-slip faults. Focal mechanisms from these areas are consistent with predominantly dextral motion. The Reelfoot reverse fault strikes northwest and dips southwest; earthquakes associated with it have a variety of focal mechanisms. The fault has been described as a cross-structure in a compressional left step between right-lateral strike-slip faults.

Van Arsdale (2000) reports that the first of the 1811 and 1812 earthquakes, the NM1 event in December 1811, occurred on the southern section (NMS), which extends about 110 km (69 mi) from northeastern Arkansas to the southeastern bootheel of Missouri (EOI, 2008). The rupture occurred along the Blytheville arch, a 10 to 15-km wide northeast-trending Paleozoic upwarp that lies along the axis of the RR, and extended northeast of the arch proper. Van Arsdale (2000) considers that the event may have resulted from rupture of the 65-km long, steeply dipping to vertical, dextral-oblique Cottonwood Grove-Ridgely fault. Johnston and Schweig (1996) assign the northern extension of the rupture to the Blytheville fault, a 55-km long structure that continues on trend with the Blytheville arch and lies about 4 km east of the Cottonwood Grove fault. However, they suggest the Blytheville fault and the Cottonwood Grove fault may be essentially the same structure.

In contrast, Schweig and Ellis (1994) and Johnston and Schweig (1996) have proposed that the 1811 rupture did not follow the northeastern trend of seismicity along the Blytheville and/or Cottonwood Grove fault but rather branched onto the more northerly trending Bootheel lineament to the west of the Cottonwood Grove fault (Figure 6). This structure extends 135 km south-southwest from the western edge of the Reelfoot fault, crossing the Blytheville Arch. It was originally defined only as a lineament based on a linear alignment of *en echelon* fissures and sandblows, but has since been identified as a fault based on observations of Holocene surface faulting (Guccione *et al*., 2005). Unlike the Cottonwood Grove-Ridgely fault, the Bootheel lineament is not associated with a significant amount of seismicity, yet it is considered a candidate for the source of the December 1811 main event because of the numerous liquefaction features that occurred along it (Schweig and Marple, 1991).

Johnston and Schweig (1996) propose two alternative rupture scenarios for the December earthquake: 1) the Blytheville Arch region ruptured along with its extension to the northeast, the Blytheville fault (NMS: BA-BFZ) and 2) the Blytheville Arch ruptured, but the rupture branched onto the Bootheel lineament and ruptured the northernmost 70 km of that structure (NMS: BA-BL) (Figure 6). In each scenario, the structure that did not rupture in the main event was the source of one of more of the large aftershocks, which have been proposed as smaller mainshocks (Johnston and Schweig, 1996). In other words, the Bootheel lineament and Blytheville fault sustained the aftershocks in the first and second scenarios, respectively.

The second mainshock of the New Madrid 1811-1812 sequence was the NM2 earthquake, in January 1812, on the northern margin of the fault system (NMN; Figure 6). The source of this event is also uncertain. The region is delineated by a line of seismicity, the Northwestern Seismicity Arm. Concentrated seismicity extends about 40 km (25 mi), with more sparse seismicity extending another 20 km to near the Illinois border. This seismicity has been postulated to be correlated with the New Madrid North fault (sometimes the East Prairie fault), which has been seen in the subsurface, geomorphically, and in trench exposures (Baldwin *et al*., 2005; Johnston and Schweig, 1996). That fault is at least 30 km long; the seismicity extends beyond the known fault. Wheeler (1997) postulated that the structure continued still farther north to merge with the Rough Creek graben in western Kentucky; he considered this extent, about 100 km , to be the maximum extent of RR faults. There is little in the sparse distribution of seismicity and lack of significant Quaternary faulting in the northern extent to support that assertion, and based on surface and subsurface expression as well as focal mechanisms, this fault is likely a steeply dipping dextral fault (DTEE, 2011).

The last of the three 1811-1812 mainshocks, NM3, occurred in February 1812, on the central section, the Reelfoot reverse fault, the proposed cross-structure in a compressional step-over between the dextral southern and northern sections of the system (Figure 6). The Reelfoot fault is a south-dipping blind reverse fault that has a dip that varies laterally and down dip. The dip can be as steep as 45°-75° in the upper few kilometers and as shallow as 25°-30° at depth (Mueller and Pujol 2001; Csontos and Van Arsdale, 2008). This fault is well-expressed geomorphically with a pronounced scarp, but its extent is also uncertain because seismicity extends beyond the scarp in both directions, beyond the strike-slip faults of the postulated stepover. Johnston and Schweig (1996) define three distinct fault segments: 1) the central Reelfoot fault, defined by its mapped surface extent of about 32 km (Van Arsdale *et al*., 1995); 2) the Reelfoot South seismicity trend, extending 35 km east of the Reelfoot fault; and 3) the New Madrid West seismicity trend, extending about 40 km west of the Reelfoot fault. Their proposed rupture scenarios include rupture of the Reelfoot fault with one or the other of the flanking seismicity trends in the NM3 mainshock.

Table 3
New Madrid Fault System RLME Source Model

Cluster?	wt	Localizing Structures	Southern Fault Geometry	wt	Northern Fault Geometry	wt	Central Fault Geometry	wt	Thickness (km)	wt	Mmax	wt	Recurrence method	wt	Recurrence Data	wt	Earthquake Recurrence Model	wt	Repeat Time Coefficient of Variation	wt	Rate (yrs)	wt
All In	0.9	NMS NMN RFT	BA-BL	0.6	NMN-S	0.7	RFT-S	0.7	13	0.4	NMS, RFT, NMN 7.9, 7.8, 7.6	0.167	Intervals	1.0	1811-1812, 1450, and 900 AD	1.0	Poisson	0.75	NA		167	0.101
																					270	0.244
																					417	0.310
																					714	0.244
																					1613	0.101
											7.8, 7.7, 7.5	0.167	same as above				Renewal	0.25	0.3	0.2	286	0.101
											7.6, 7.8, 7.5	0.25									909	0.244
											7.2, 7.4, 7.2	0.085									3125	0.310
											6.9, 7.3, 7.0	0.25									15625	0.244
											6.7, 7.1, 6.8	0.085									212766	0.101
									15	0.4	same as above								0.5	0.5	208	0.101
									17	0.2											455	0.244
							RFT-L	0.3	same as above												1124	0.310
					NMN-L	0.3	same as above														3846	0.244
																					32258	0.101
			BA-BFZ	0.4	same as above														0.7	0.3	227	0.101
																					455	0.244
																					1000	0.310
																					2941	0.244
																					21277	0.101
All out except RFT	0.05	RFT	NA		NA		RFT-S	0.7	13	0.4	7.8	0.167	Intervals	1.0	2000 BC and 1000 AD	1.0	Poisson	1.0	NA		769	0.101
																					1389	0.244
																					2381	0.310
																					4545	0.244
																					12500	0.101
											7.7	0.167	same as above									
											7.8	0.25										
											7.4	0.085										
											7.3	0.25										
											7.1	0.085										
									15	0.4	same as above											
									17	0.2												
							RFT-L	0.3	same as above													
All Out	0.05	None	Revert to background																			

The third event may have served to accommodate the strain produced by the previous two bounding events (Van Arsdale, 2000). Van Arsdale (2000) also suggests that this sequence of multiple, temporally-clustered events may not be unusual for the NMFS. He cites evidence from subsurface analyses that suggests that these three faults may have identical displacement histories since the Late Cretaceous. Thus, he suggests that the paleoseismic history for the Reelfoot reverse fault can serve as a proxy for the other two faults. Trench exposures of the Reelfoot fault indicate that deformation occurs primarily as folding rather than faulting at the surface and that the structure has experienced at least three earthquakes in the past 2400 years at times consistent with those determined from regional paleoliquefaction studies (Kelson *et al*., 1996). This interpretation is supported by paleoliquefaction studies, which indicate that large magnitude earthquakes on the faults of the New Madrid system have occurred in clusters like those of 1811-1812 (e.g., Tuttle *et al*., 2002; 2005).

There is significant uncertainty regarding the exact identification and geometry of the faults that ruptured in the 1811-1812 and earlier earthquakes, and some models of rupture (e.g., EPRI/DOE/NRC, 2012; STNOC 2011; USNRC, 2006) include weighted alternative geometries for each of the three faults. We adopt the characterization of EPRI/DOE/NRC (2012; Table 3). We include two alternative geometries for the northern extent of the southern section, the Blytheville fault zone (NMS: BA-BL), weighted 0.4, and the Bootheel Lineament (NMS: BA-BFZ), weighted 0.6. For the central and northern sections, we include two alternatives: short and long (RFT-S, RFT-L, NMN-S, MNM-L). The short central section (RFT-S) includes only that part of the Reelfoot reverse fault that is defined by the Reelfoot scarp and extends from the Blytheville fault to the New Madrid North fault; the long alternative (RFT-L) extends both east and west, based on continued seismicity. The short alternative for the New Madrid north fault (NMN-S) is the fault as defined by Johnston and Schweig (1996); the long alternative (NMN-L) extends the source along northward continuations of seismicity identified by Wheeler (1997). Because the causative faults are not well understood, the dips are not well constrained. The northern and southern sections of the system are modeled as vertical. The Reelfoot fault is modeled with a 40-degree southwest dip.

The EPRI/DOE/NRC (2012) characterization also addresses the apparent clustering of activity along the NMFS faults using the approach of Toro and Silva (2001). The rate of earthquakes and geomorphic expression of faulting on the Reelfoot fault in the late Holocene suggests that the system is or has recently been in a cluster. However, geodetic data gathered over the last decade or so suggest that little or no interseismic deformation is occurring across the NMSZ, which some researchers have interpreted as evidence that the system is shutting down and entering an inter-cluster period of quiescence (e.g., Calais *et al*., 2005; Calais and Stein, 2009). The EPRI/DOE/NRC model strongly favors the interpretation that the system is currently in a cluster (0.9), based on the recent history of activity and the unlikelihood that we have just happened upon the exact moment the system is shutting down. However, they, and we, give some weight to two alternative models: 1) only the Reelfoot faultis currently in a cluster, and the other faults are quiescent (0.05), and 2) the entire system is out of a cluster (0.05) (Table 3). In the former case, the Reelfoot faultis active, but at a lower rate than the in-cluster case; in the latter case, no faults are active and the system defaults to the RR background zone characterization.

Several recent hazard analyses have developed source characterizations for the NMFS. The USGS National Seismic Hazard Maps (Petersen *et al*., 2008) compiled recent data to develop a model with lower weighted mean magnitudes for the faults than in previous models, and with a recurrence model reflecting possibly clustered timing of events. Their magnitudes range from **M** 7.3 to 8.0 for the southern and central sections, with a preferred magnitude of **M** 7.7 and weighted mean of **M** 7.6, and from **M** 7.1 to 7.8 for the northern section, with a preferred value of **M** 7.5 and weighted mean of **M** 7.4. Models developed for the Site Safety Analysis for Exelon Generation Company in Illinois (USNRC, 2006) include a lower magnitude distribution, with **M** 7.2 to 7.9 (weighted mean **M** 7.5), **M** 7.4 to 7.8 (weighted mean of **M** 7.6), and **M** 7.0 to 7.6 (weighted mean of **M** 7.3) for the southern, central, and northern faults, respectively. EPRI/DOE/NRC (2012) include distributions for the NMS, Reelfoot reverse fault, and NMN sections of the NMFS of **M** 6.7 to 7.9, **M** 7.1 to 7.8, and **M** 6.8 to 7.6, respectively. In our model, we adopt the EPRI/DOE/NRC distribution of maximum magnitudes. The preferred values and weighted means are similar to those developed in the nuclear studies described above.

4.2 EPRI GROUND MOTION PREDICTION MODELS

Several factors control the level and character of earthquake ground shaking. These factors are in general: (1) rupture dimensions, geometry, and orientation of the causative fault; (2) distance from the causative fault; (3) magnitude of the earthquake; (4) the rate of attenuation of the seismic waves along the propagation path from the source to site; and (5) site factors, including the effects of near-surface geology, particularly from soils and unconsolidated sediments. Other factors, which vary in their significance depending on specific conditions, include slip distribution along the fault, rupture process, footwall/hanging-wall effects, and the effects of crustal structure such as basin effects.

Several parameters may be used to characterize earthquake ground motions. The common parameters include: peak ground acceleration, velocity, and displacement; response spectral accelerations or velocities, duration, and time histories in acceleration, velocity, or displacement. In this analysis, we have estimated peak horizontal ground acceleration (PGA) and horizontal spectral accelerations (SA) at 0.04, 0.1, 0.2, 0.4, 1.0, and 2.0 sec.

Crustal ground motion prediction models for tectonically active regions like the western U.S. are empirical in nature and derived from strong motion data from such areas as California, Taiwan, Japan, and Italy. In contrast, few useable strong motion records exist for earthquakes in the Central and Eastern North America (CENA). Thus ground motion prediction models for the CENA have been developed, in large part, using seismological-based numerical models. During the past decade, ground motion models for the CENA have been derived using three different approaches: the stochastic method, the Green's function method, and the complex/empirical source method.

Recent efforts have been made to update the ground motion models for the CENA. One project is called the Next Generation of Attenuation (NGA) – East sponsored by Pacific Earthquake Engineering Research (PEER) Center. The objective of the project is to develop a new suite of ground motion prediction model for the CENA. The median ground motion models were just released but no standard deviations for the models were specified. There are 20 new NGA-East models and we expect it will be several months before the models become vetted.

In a second project, EPRI (2013) updated the 2004/2006 EPRI models in the near-term so that preliminary Ground Motion Response Spectra (GMRS) could be developed for existing nuclear power plant sites as required by the NRC's Recommendation 2.1 pending completion of the NGA East Project. The models were used in this study. The EPRI Ground-Motion Model (GMM) Review Project (EPRI, 2013), an enhanced SSHAC Level 2 assessment process, established a methodology to evaluate the existing 2004 EPRI GMM and determine if it should be updated. After reviewing the current literature and conducting interviews and convening a workshop with ground-motion experts and seismologists it was decided to update the 2004 GMM because (1) seven of the 13 developers of the 2004 EPRI GMM recommended that their models be replaced; (2) three new models have been developed for the CENA by ground-motion experts; (3) 80% of the earthquake records in a new ground-motion database provided by the NGA-East Project are from earthquakes that occurred after the development of the 2004 EPRI GMM; (4) comparisons to the updated CENA database indicate the 2004 EPRI GMM overpredicts ground motions at some magnitude-distance and structural frequency ranges that are important to nuclear power plant PSHA; and (5) the models used to develop the aleatory portion of the 2006 EPRI GMM have been superseded.

The 2013 EPRI GMM retains the structure of the 2004 EPRI GMM, grouping the candidate individual models into four clusters according to their seismological characteristics, weighting the models within each cluster according to their consistency with the data, representing each cluster by three fitted relationships (5^{th} percentile, median, and 95^{th} percentile), and assessing cluster weights based on consistency with observed data and seismological attributes of the models within each cluster. The GMM Review Project identified new candidate models for the updated GMM clusters, models and weights, as shown in Table 4 and a summary of the overall elements of the model are listed in Table 5.

For reference, the ground motion prediction models used by the USGS to develop the 2014 National Seismic Hazard Maps include Toro *et al.* (1997), Frankel *et al.* (1996), Silva *et al.* (2002), Atkinson and Boore (2006), Atkinson (2008), Campbell (2003), Tavakoli and Pezeshk (2005), Pezeshk *et al.* (2011), and Somerville *et al*. (2001). The versions of Atkinson and Boore (2006) and Atkinson (2008) in the EPRI study have been updated with Atkinson and Boore (2011). All the ground motion prediction models are for hard rock characterized by a V_S30 of 2,800 m/sec.

Comparisons indicate that the 2013 GMM is somewhat lower than 2004 EPRI GMM when the two models are taken as a whole, but these differences are moderate, given the broad uncertainty range spanned by both GMMs. The greater differences occur at low frequencies. For PGA the bulk of the curves are consistent between the two GMMs. In addition, there is a substantial overlap in the 10 to 200 km range indicating that the updated GMM does not represent a radical departure from the 2004 EPRI GMM. The observed differences are the result of possessing and using substantially more data and having acquired additional insights from other regions over a period of nearly 10 years.

The 2006 EPRI model for aleatory uncertainty (sigma) was based on preliminary NGA-West 1 models for sigma from active tectonic regions, adjusted to account for differences in properties of the earth's crust between active (western North America [WNA]) and stable tectonic regions (i.e., CENA) (EPRI, 2006). The EPRI GMM Review Project updated the model to incorporate the nearly final NGA-West 2 aleatory models, with the same adjustments for differences between WNA and CENA. The updated sigma model is frequency and magnitude dependent, with inter-event and intra-event components. There is additional aleatory variability for distances of R_{JB} <

20 km. The updated aleatory variability model has higher values of total sigma than the 2006 EPRI model for **M** 5 earthquakes, and lower values for **M** 6 and 7 earthquakes for motions at 2.5 Hz and higher. At 1 Hz, the values of sigma are comparable in the two models and at 0.5 Hz, the updated GMM has slightly higher sigma than the 2006 EPRI model.

Table 4

EPRI (2013) GMM Clusters and Models

Cluster	Model Types and Cluster Weights (repeated large-magnitude earthquake sources/area earthquake sources)	Models
1	Single-corner Brune source (0.15/0.185)	Silva *et al*. (2002) – SC-CS-Sat[1] Silva *et al*. (2002) – SC-VS[1] Toro *et al*. (1997) Frankel et al. (1996)
2	Complex/Empirical Source ~R^{-1} geometrical spreading (0.31/0.383)	Silva *et al*. (2002) – DC-Sat Atkinson (2008) with 2011 modifications (A08′)
3	Complex/Empirical Source ~$R^{-1.3}$ geometrical spreading (0.35/0.432)	Atkinson-Boore (2006) with 2011 modifications (AB06′) Pezeshk *et al*. (2011)
4	Finite-source /Green's function (0.19/0)	Somerville *et al*. (2001); slightly different models for rifted and nonrifted (not used for distributed seismicity sources with large contribution from **M** < 6)

SC = single-corner; DC = double-corner; CS = constant stress; VS = variable stress; Sat = saturation.
[1] Treated as one model for calculation of weights.

Table 5

Elements of the CENA Ground Motion Models

Feature	Attribute
Ground Motion Measure	Peak ground acceleration Spectral acceleration at frequencies of 0.5, 1, 2.5, 5, 10, 25 Hz
Site Conditions	Hard rock (V_S 2.8 km/sec, 9200 ft/sec)
Regions	Midcontinent (includes east coast) Gulf Coast
Ground Motion Model Types	Four types included: • Single-corner Brune source • Complex/empirical source ~R^{-1} geometrical spreading • Complex/empirical source ~$R^{-1.3}$ geometrical spreading • Finite-source/Green's function
Aleatory Variability	Magnitude and frequency dependent Includes additional variability for distances of R_{JB} < 20 km

The hard rock PSHA results are presented below including comparisons with the National Seismic Hazard Maps.

5.1 PSHA RESULTS

The results of the PSHA are presented in terms of ground motion for hard rock site conditions as a function of annual frequency of exceedance (AFE). AFE is the reciprocal of the average return period. Figure 15 shows the mean, median (50th percentile), 5th, 15th, 85th, and 95th percentile hazard curves for PGA. These fractiles indicate the range of epistemic uncertainties about the mean hazard. The uncertainties are very large due to both the large uncertainties in the ground motion prediction models and the source parameters of the controlling seismic source. The 0.4 sec and 1.0 sec horizontal spectral acceleration (SA) hazard are shown in Figures 16 and 17. The 2,500 year return period mean PGA for hard rock is 0.35 g (Table 6).

The contributions of the various seismic sources to the mean PGA hazard are shown on Figure 18. The major contributors to the hazard at the site for a return period of 2,500 years are the IBEB zone and the Wabash Valley RLME. The distributed seismicity contributes just over 70 percent of the PGA hazard at 2,500-year return period with the Wabash Valley and New Madrid RLMEs contributing approximately 15 percent each (Figure 19). At longer periods (0.4 and 1.0 sec SA), the New Madrid RLME relative contribution increases to up to 75 percent of the hazard at 2,500 years (Figures 20 through 23).

By deaggregating the PGA, 0.4 and 1.0 sec SA hazard by magnitude, distance and epsilon bins, we can illustrate the contributions by events at a return period of 2,500 years (Figures 24 through 26). Epsilon is the difference between the logarithm of the ground motion amplitude and the mean logarithm of ground motion (for that M and R) measured in units of the standard deviation (σ) of the logarithm of the ground motion. As shown on Figure 24, a majority of the PGA hazard at the site is coming from nearby distributed seismicity of **M** 5.0 to 6.0 within 25 km and the Wabash Valley RLME (**M** 7.0 to 7.75 within 25 km). The 0.4 sec SA hazard is bimodal with significant contributions from nearby events from both distributed seismicity (**M** 5.0 to 6.0 within 25 km) and the Wabash Valley RLME (**M** 7.0 to 7.75 within 25 km) and from more distant events from the NMFS RLME (**M** 7.0 to 8.25 at 150 to 250 km) (Figure 25). At 1.0 sec SA, the hazard is dominated by the NMFS RLME (Figure 26).

The deaggregation shown in Figures 24 through 26 also provides the modal magnitude M*, modal distance D*, and modal epsilon ε*, which represent the largest contributor to the hazard at the defined return period. The M* and D* for the 2,500-year return period for PGA, 0.4 and 1.0 sec horizontal SA are listed in Table 7. Because the 0.4 sec hazard is bimodal (Figure 25), Table 7 lists the modes for both peaks.

A horizontal UHS on hard rock computed for the 2,500-year return period is shown on Figure 27. A UHS shows the hazard across all periods for the same annual exceedance probability or return period. The SA hazard has been calculated at 0.01 (PGA), 0.04, 0.1, 0.2, 0.4, 1.0 and 2.0 sec. These are the spectral periods specified in the EPRI (2013) ground motion models.

To obtain a smooth spectrum at very short and longer periods, interpolation and extrapolation were required. For periods between PGA and 0.04 sec, linear or log-linear interpolation of the ground motions defined at those frequencies is not ideal. More recent ground motion models indicate that the UHS in the CEUS peak in this period range. The spectral accelerations in this range were determined using the shape predicted by recent ground motion models for the modal magnitude and distances controlling the UHS at 0.04 sec. The median acceleration response spectra were computed for the controlling M and D using the Silva *et al*. (2002) and Pezeshk *et al*. (2011) ground motion models. Each of these spectra were then scaled to their respective 0.04 sec SA to compute scale factors (ratios of 0.02 sec SA to 0.04 sec SA and 0.03 sec SA to 0.04 sec SA). The scale factors from the two ground motion models were then weighted equally. The weighted mean scale factors were then applied to the 0.04 sec value from the UHS to obtain the 0.02 and 0.03 sec SA values.

Similarly, the 3.0, 4.0, 5.0 7.5, and 10.0 sec SA values were computed by using the long-period spectral shape predicted by available CEUS ground motion models that are defined at these long periods. The Silva *et al*. (2002) and Pezeshk *et al.* (2011) ground motion models were equally weighted. Scale factors were computed relative to the 2.0 sec SA using the controlling M and D for the 2.0 sec hazard.

Given the large depth to hard rock at the site, ground motions consistent with firm rock (V_S of 760 m/sec) were requested for input into finite element deformation analyses. The hard rock UHS was adjusted to firm rock using the generic amplification factors developed by David Boore (Frankel *et al.*, 1996). These factors are used in the development of the National Seismic Hazard Maps (NSHMs) by the USGS. They are not site-specific and therefore are highly uncertain, but are probably adequate in lieu of performing a site response analysis. Figure 28 shows the firm rock 2,500-year UHS. The mean firm rock PGA is 0.53 g (Table 8).

5.2 COMPARISON WITH USGS NATIONAL HAZARD MAPS

In 1996, the USGS released a “landmark” set of NSHMs for earthquake ground shaking, which was a significant improvement from previous maps they had developed (Frankel *et al.*, 1996). These maps were the result of the most comprehensive analyses of seismic sources and ground motion prediction ever undertaken on a national scale. The maps are the basis for the NEHRP Maximum Considered Earthquake (MCE_R) maps, which are used in the International Building Code. The maps are for NEHRP site class B/C (firm rock) (V_S30 760 m/sec).

For a 2,500-year return period, the 2014 NSHMs indicate firm rock (site class B/C) PGA, 0.2 sec SA and 1.0 sec SA values of 0.33, 0.57, and 0.17 g, respectively (USGS website). The site-specific firm rock values of 0.53, 0.68, and 0.14 g for PGA, 0.2 and 1.0 sec SA. The site-specific values are higher at short periods and slightly lower at long periods. These differences are likely due to the differences in the seismic source model and/or the ground motion prediction models. Note that the EPRI (2013) ground motion models were not available at the time the 2014 USGS NSHMs began development. As noted in the documentation of these maps, the EPRI (2013) suite of ground motion models and weights produce higher short-period and lower long-period ground motions than the suite of models implemented in the 2014 USGS NSHM (Petersen *et al*., 2014). Also the 2014 NSHMs simplified the EPRI/DOE/NRC (2012) CEUS-SSC model for use in their PSHA and weighted this model in addition to the previous USGS model for Wabash Valley and New Madrid RLMEs.

Table 6

2,500-Year Return Period UHS for Hard Rock

Period (sec)	SA (g)
0.01	0.35
0.04	0.73
0.10	0.58
0.20	0.39
0.40	0.24
1.00	0.10
2.00	0.058

Table 7

Modal M* and D* at 2,500-year Return Period

	M*	D*
PGA	5.1	12.5 km
0.4 Sec SA (bimodal)	7.1 7.6	12.5 km 238 km
1.0 Sec SA	7.6	238 km

Table 8

2,500-Year Return Period UHS for Firm Rock (V_S of 760 m/sec)

Period (sec)	SA (g)
0.01	0.53
0.02	0.96
0.03	1.16
0.04	1.21
0.10	1.02
0.20	0.68
0.40	0.40
1.0	0.14
2.0	0.070
3.0	0.041
4.0	0.028
5.0	0.021

Four sets of two-component time histories were spectrally-matched to the firm rock 2,500-year UHS. At short periods, the 2,500-year hazard is from large events from the Wabash Valley RLME (**M** 7.0 to 7.75) and from moderate events (**M** 5.0 to 6.0) return period both within 25 km (Figure 24). At longer periods (0.4 and 1.0 sec), the hazard is bimodal with contribution from large events from the Wabash Valley RLME (**M** 7.0 to 7.75 within 25 km) and from large events of the New Madrid RLME (**M** 7.25 to 8.25 at 150 to 250 km) (Figures 25 and 26). Hence, two sets of seed time histories were selected consistent with a **M** 7.0 to 7.5 event within 25 km and two sets of seed time histories consistent with a larger, distant event (Table 9).

Because the response spectrum of a time history has peaks and valleys that deviate from the design response spectrum (target spectrum), it is necessary to modify the motion to improve its response spectrum compatibility. The procedure proposed by Lilhanand and Tseng (1988), as modified by Al Atik and Abrahamson (2010) and contained in the computer code RSPMatch09 (Fouad and Rathje, 2012), was used to develop the acceleration time histories through spectral matching to the target (seed) spectrum. This time-domain procedure has been shown to be superior to previous frequency-domain approaches because the adjustments to the time history are only done at the time at which the spectral response occurs resulting in only localized perturbations on both the time history and the spectra (Lilhanand and Tseng, 1988).

To match the design (target) spectrum, seed time histories should be from events of similar magnitude and distance (for duration) and most importantly, spectral shape as the earthquake dominating the spectrum. Figure 29 shows the spectra from the seed time histories scaled to the target spectrum at PGA. The spectral shapes of the seed time histories peak at about 0.1 sec typical of earthquakes in tectonically active regions compared to the 0.4 sec peak in the 2,500-Year UHS. The lack of strong motion records in stable continental interiors such as CEUS necessitates use of records from active regions.

The seed acceleration time history series are shown on Figures 30 to 33. The spectral matches and resulting time histories are shown on Figures 34 to 49. Arias intensities and durations of the spectrally-matched time histories are provided in Table 10. There are currently no predictive models available for the CEUS for Arias intensity or 5-95% duration.

Table 9
Seed Time Histories

Record Sequence Number	Year	Earthquake Name	Station Name	Earthquake Magnitude (M)	ClstD (km)	V_S30 (m/sec)	Comp	PGA(g)	PGV (cm/sec)	PGD (cm)	5-95% AI (m/sec)	5-95% Dur (sec)
1404	1999	Chi-Chi, Taiwan	PNG	7.6	110	466	E	0.03	1.5	0.47	0.027	31.99
							N	0.03	2.3	0.66	0.030	28.10
2112	2002	Denali, Alaska	TAPS Pump Station #8	7.9	105	425	049°	0.07	10.0	7.13	0.245	75.93
							319°	0.09	14.6	11.12	0.337	73.40
5804	2008	Iwate	Yamauchi Tsuchibuchi Yokote	6.9	28	562	E	0.26	10.5	7.76	0.648	9.18
							N	0.29	17.1	6.97	0.874	9.94
6928	2010	Darfield, NZ	LPCC	7.0	26	650	080°	0.24	17.7	3.82	0.613	12.91
							170°	0.36	30.3	21.27	0.618	11.37

ClstD Closest distance
Comp Component
PGV Peak horizontal ground velocity
PGD Peak horizontal ground displacement
AI Arias intensity
Dur Duration

Table 10
Spectrally-Matched Time Histories

Record Sequence Number	Year	Earthquake Name	Station Name	Earthquake Magnitude (M)	ClstD (km)	V_S30 (m/sec)	Comp	PGA(g)	PGV (cm/sec)	PGD (cm)	5-95% AI (m/sec)	5-95% Dur (sec)
1404	1999	Chi-Chi, Taiwan	PNG	7.6	110	466	E	0.54	13.9	3.3	4.69	35.3
							N	0.54	12.5	3.6	3.82	31.7
2112	2002	Denali, Alaska	TAPS Pump Station #8	7.9	105	425	049°	0.55	13.4	6.1	2.76	39.4
							319°	0.52	15.5	8.2	4.16	41.4
5804	2008	Iwate	Yamauchi Tsuchibuchi Yokote	6.9	28	562	E	0.55	19.0	9.7	1.79	10.2
							N	0.54	13.9	5.5	1.70	12.3
6928	2010	Darfield, NZ	LPCC	7.0	26	650	080°	0.53	18.8	9.8	1.80	17.1
							170°	0.53	20.4	8.3	1.07	12.6

ClstD Closest distance
Comp Component
PGV Peak horizontal ground velocity
PGD Peak horizontal ground displacement
AI Arias intensity
Dur Duration

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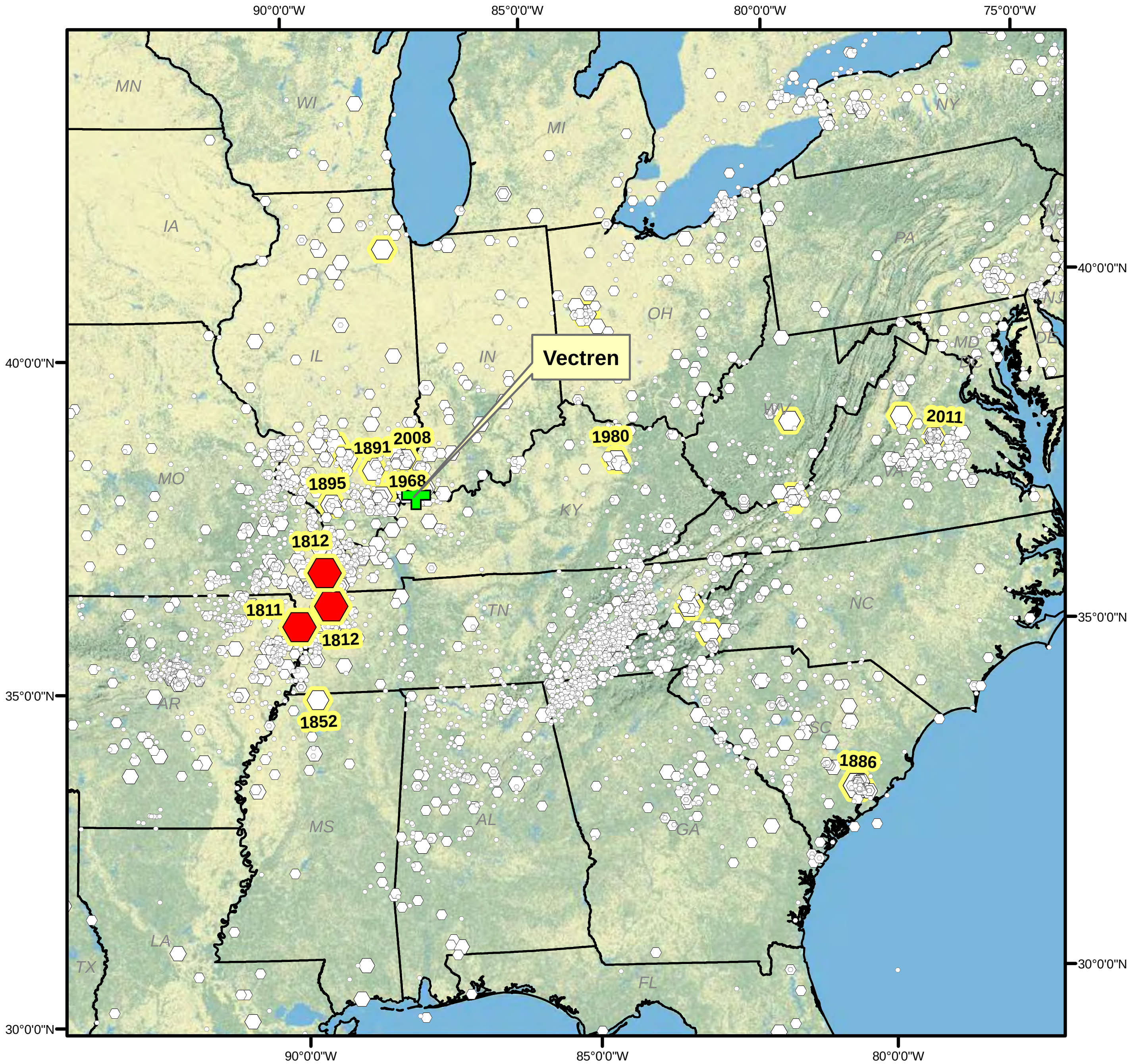


Magnitude Mw

- <= 3.0
- 3.0 - 4.0
- 4.1 - 5.0
- 5.1 - 6.0
- 6.1 - 7.0
- > 7.0

Data Sources: 1699 to 2008 from EPRI/DOE/NRC (2012)
2009 to May 2013 from NEIC

0 55 110 220 330 440 Kilometers

0 40 80 160 240 320 Miles

N

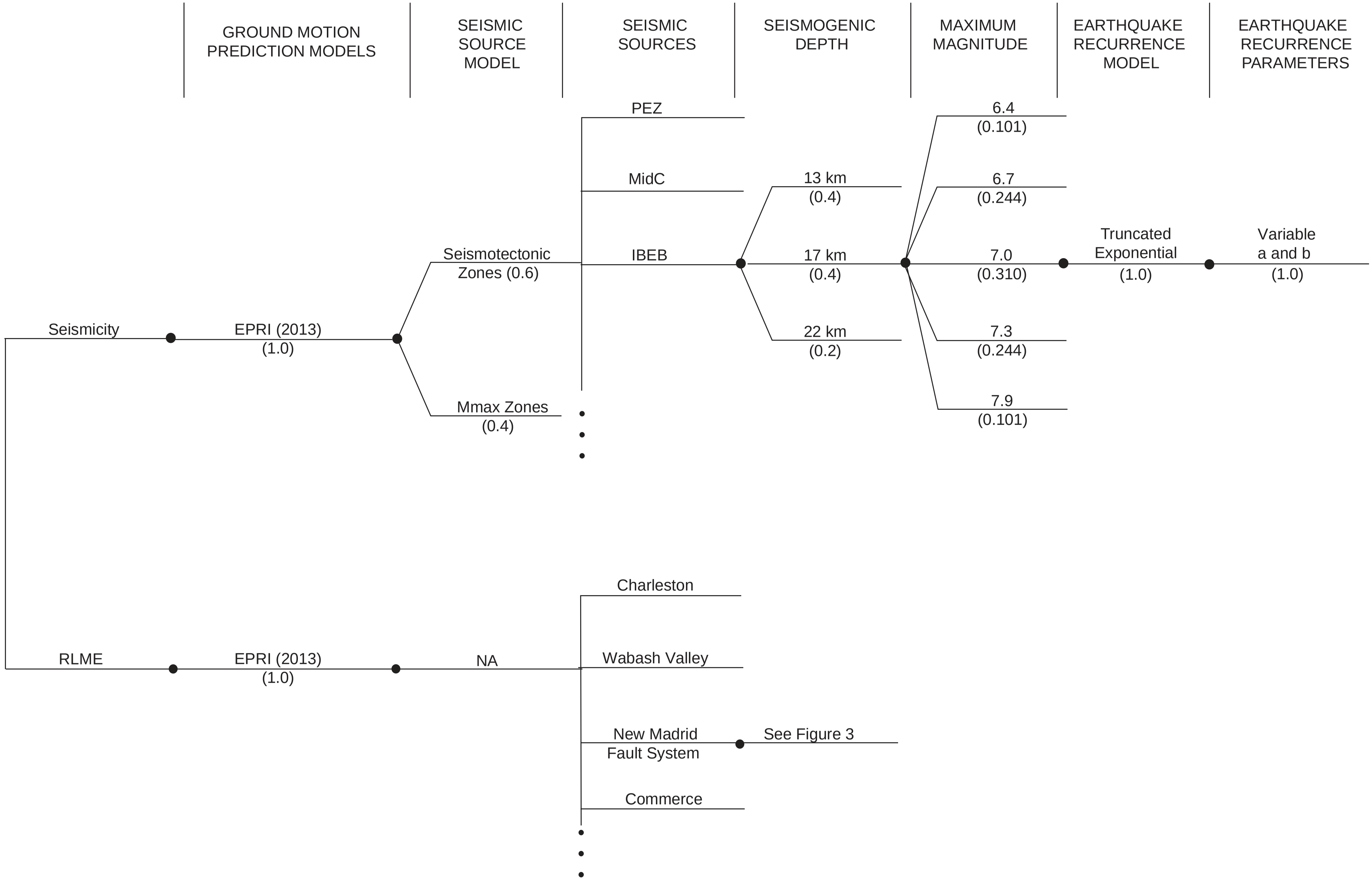
AECOM

Project No. 60442676

A.B. Brown Generating Station
Vectren Corporation

HISTORICAL SEISMICITY OF CENTRAL AND EASTERN UNITED STATES (1699 - 2013)

Figure 1

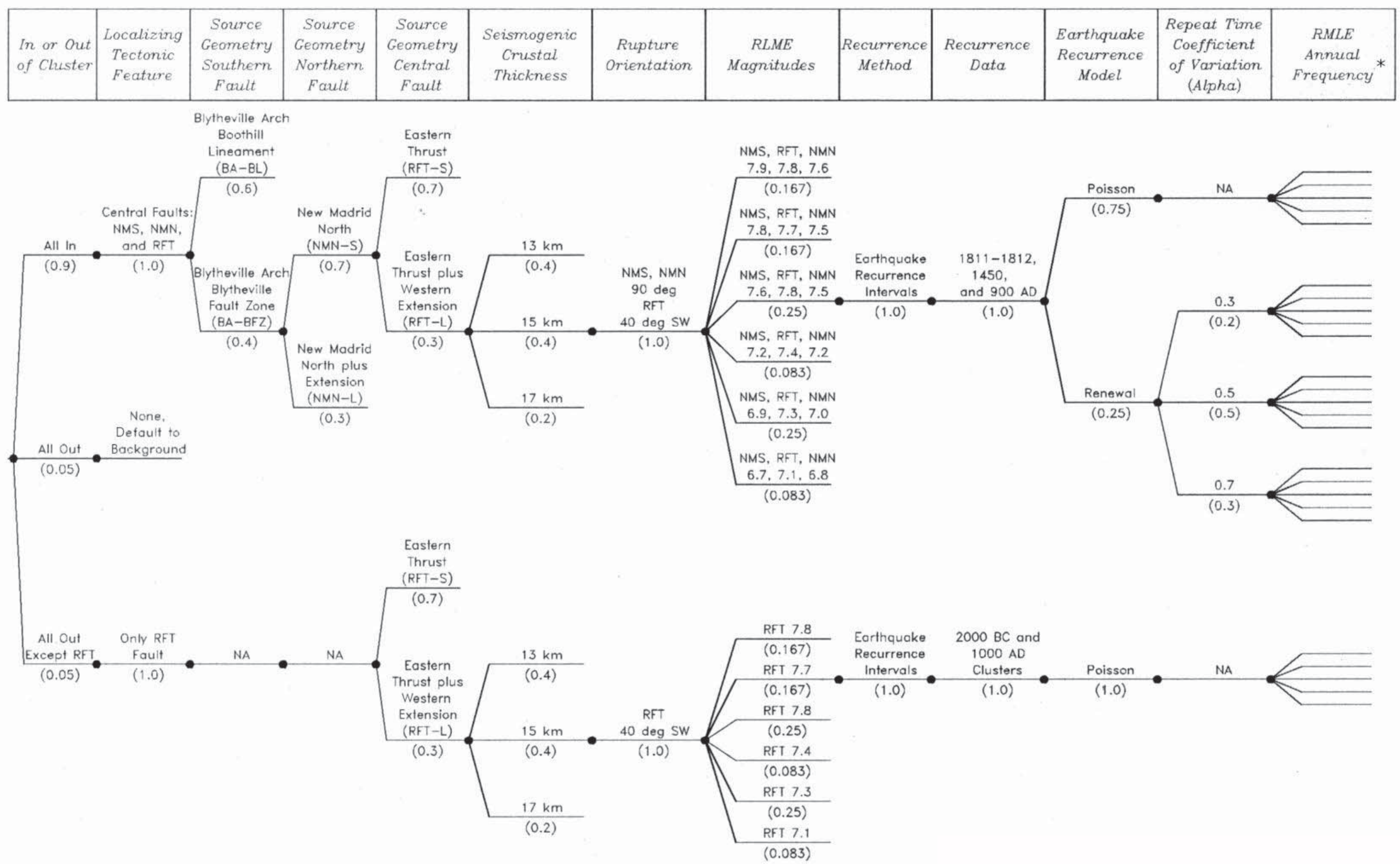


Project No. 60442676

A.B. Brown
Generating Station
Vectren Corporation

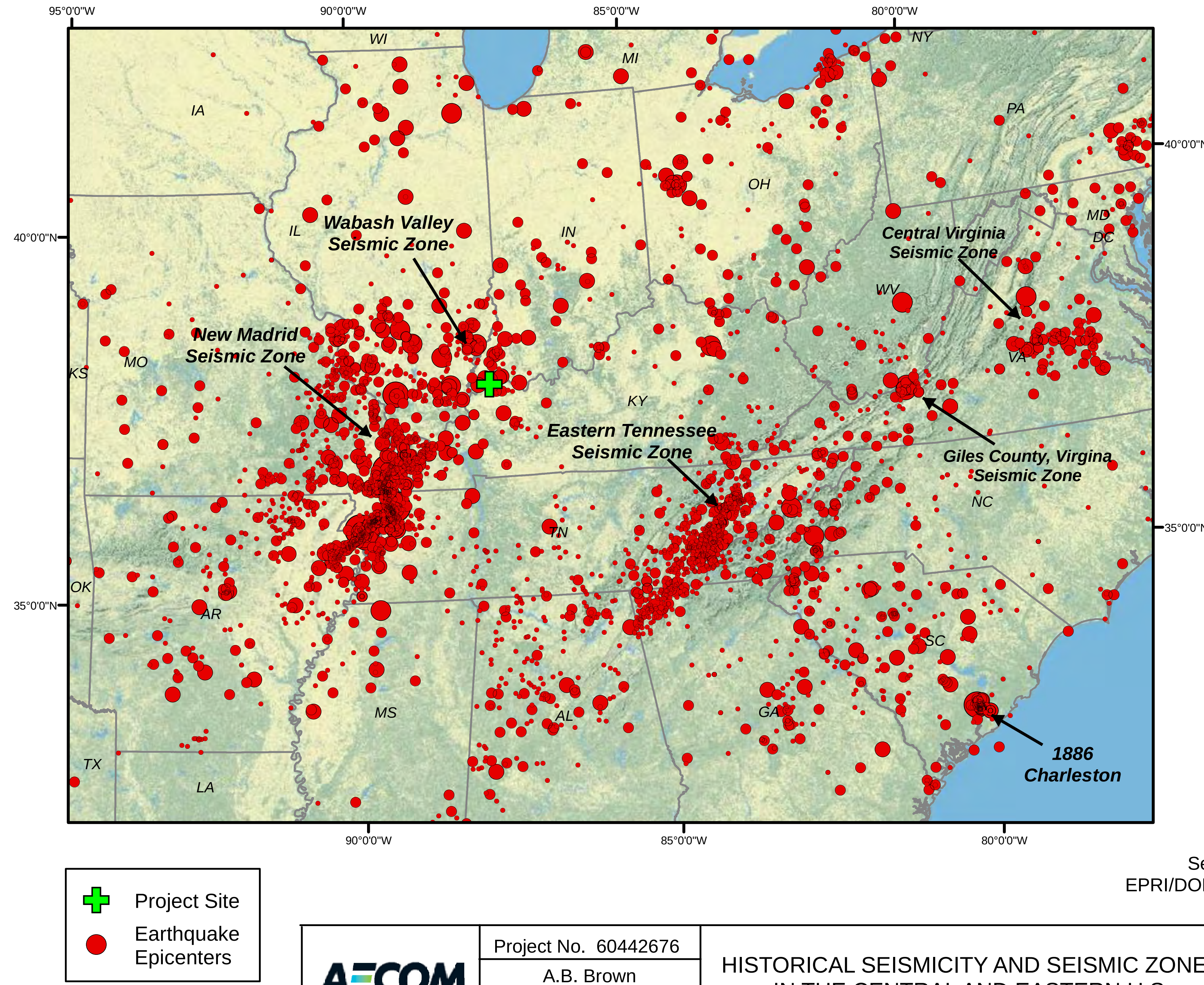
EXAMPLE SEISMIC HAZARD
MODEL LOGIC TREE

Figure 2



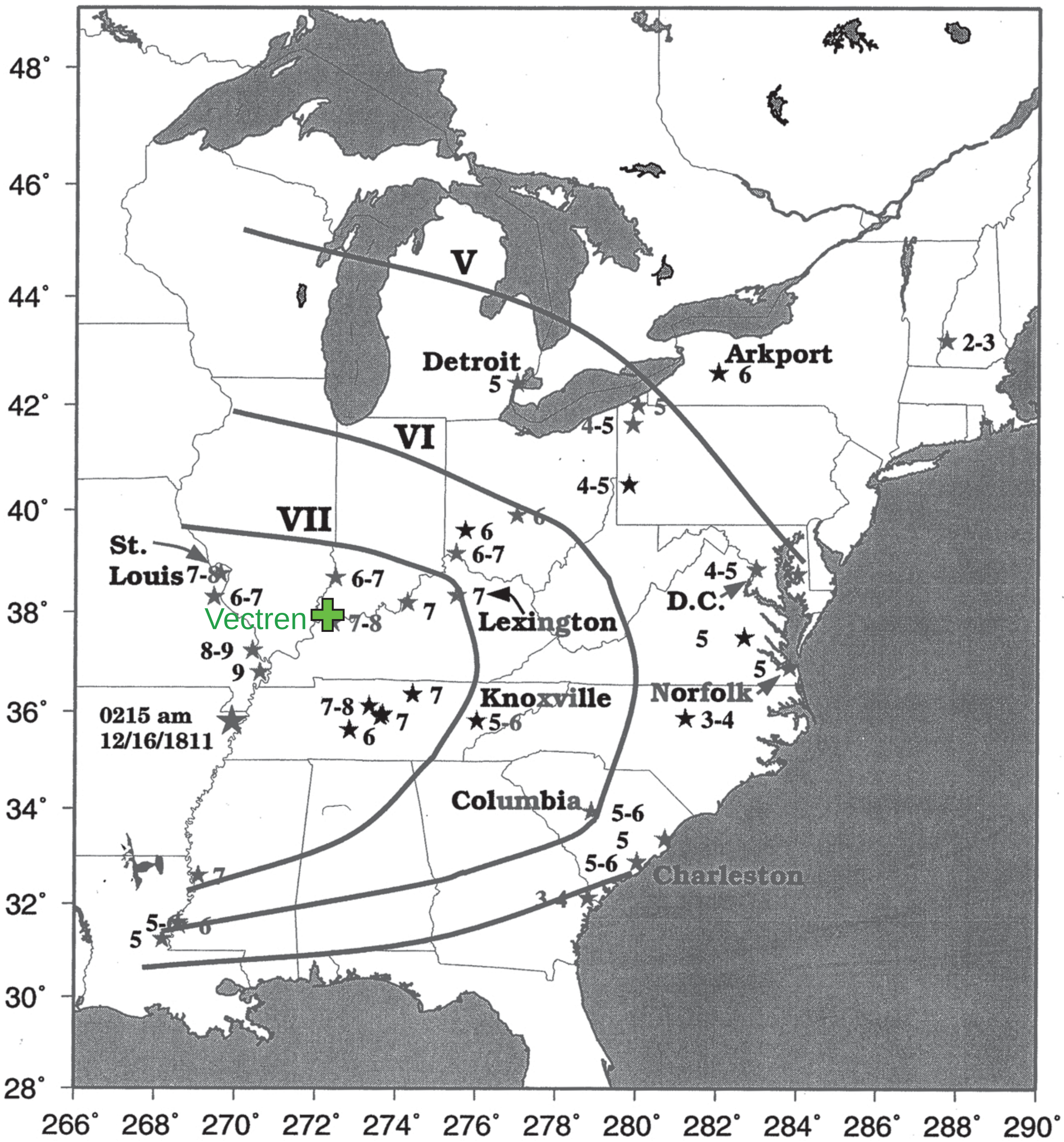
* See EPRI/DOE/NRC (2012)

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	NEW MADRID RLME LOGIC TREE	Figure 3



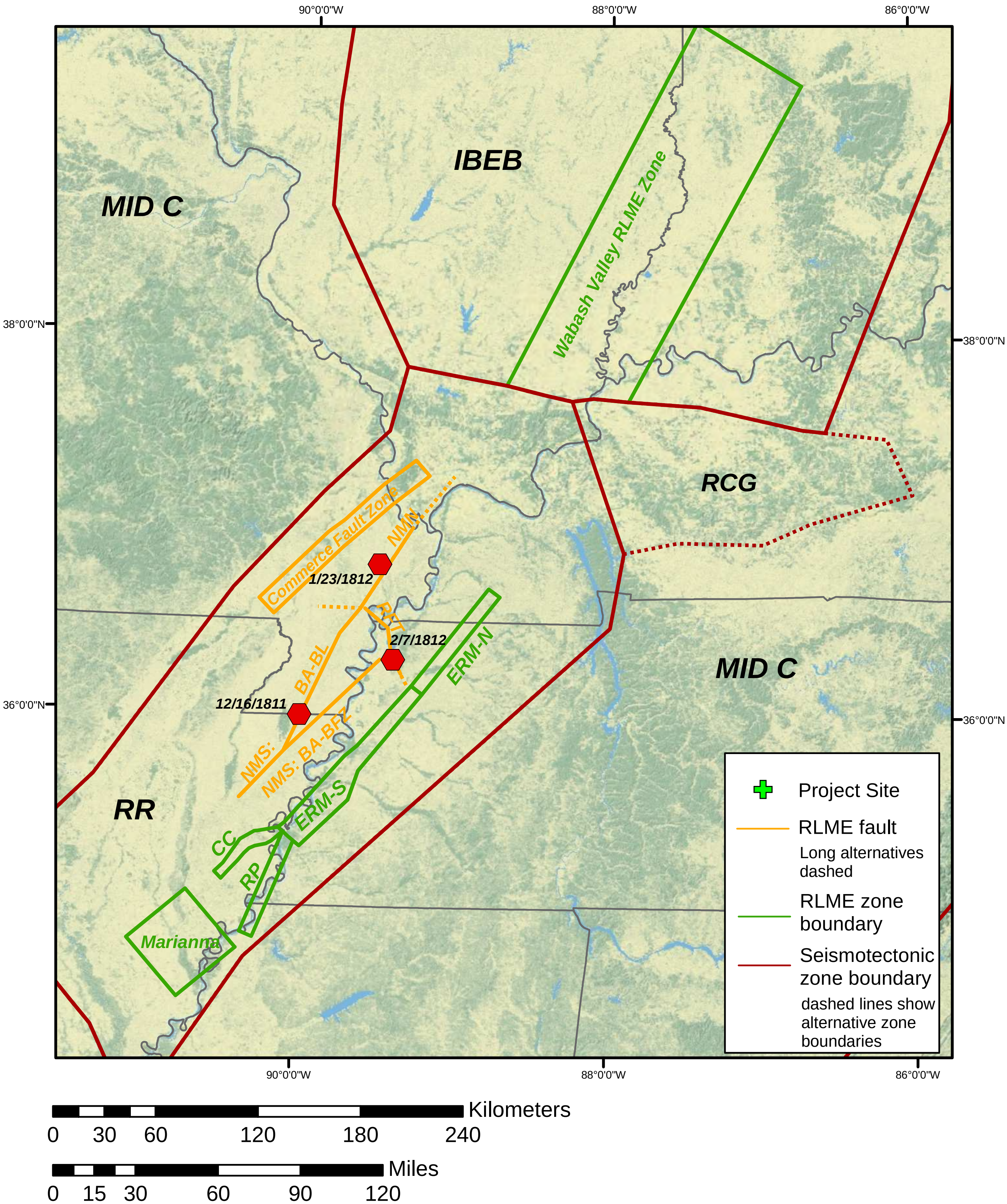
Seismicity from:
EPRI/DOE/NRC (2012)

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	HISTORICAL SEISMICITY AND SEISMIC ZONES IN THE CENTRAL AND EASTERN U.S.	Figure 4

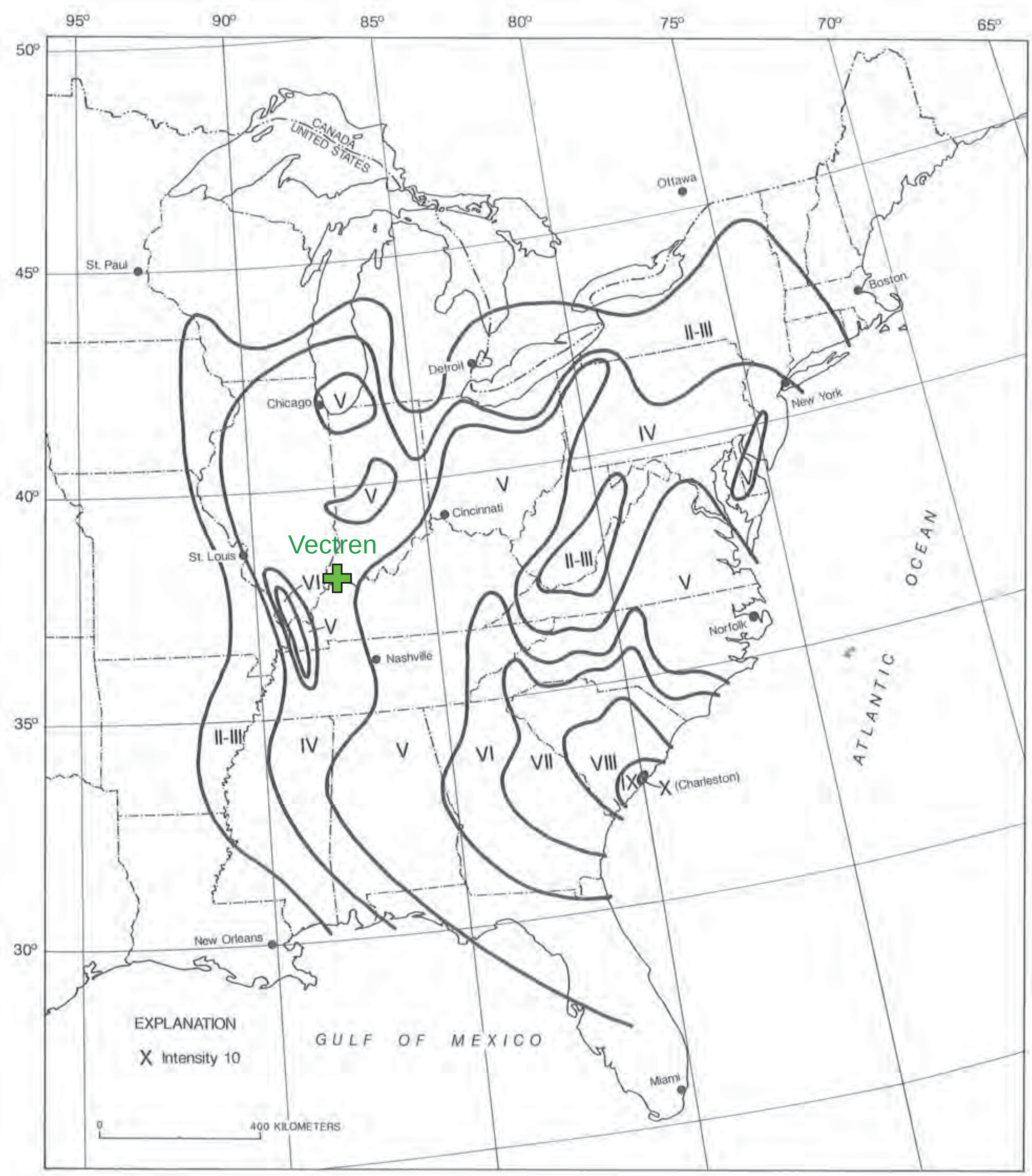


Source: Hough *et al*. (2000)

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	ISOSEISMAL MAP OF THE 16 DECEMBER 1811 **M** 7.2-7.3 NEW MADRID EARTHQUAKE	Figure 5

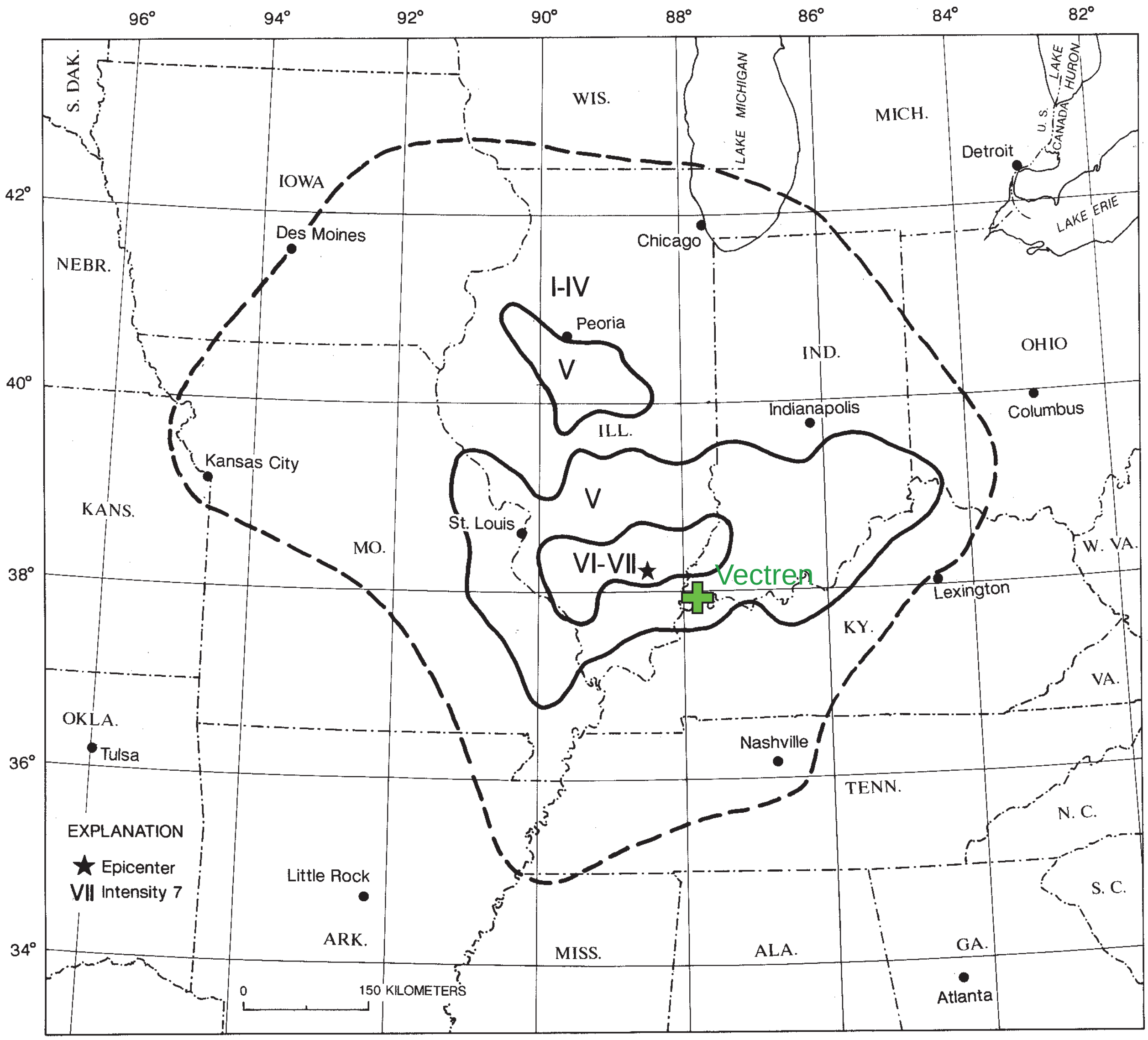


AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	NEW MADRID FAULT SYSTEM, 1811-1812 NMFS EARTHQUAKES, AND NEIGHBORING RLMEs	Figure 6



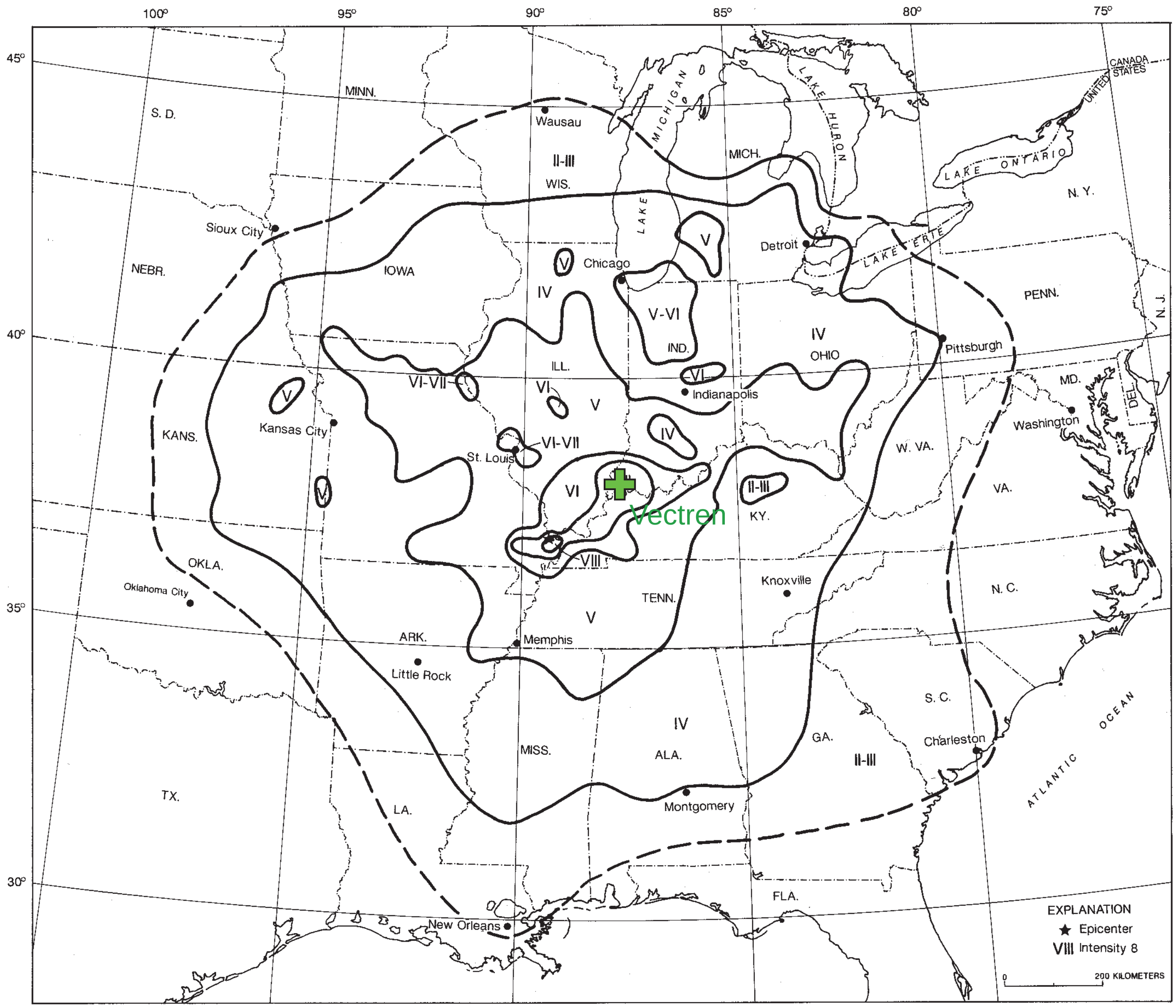
Source: Stover and Coffman (1993)

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	ISOSEISMAL MAP FOR THE 1 SEPTEMBER 1886 **M**~7 CHARLESTON EARTHQUAKE	Figure 7



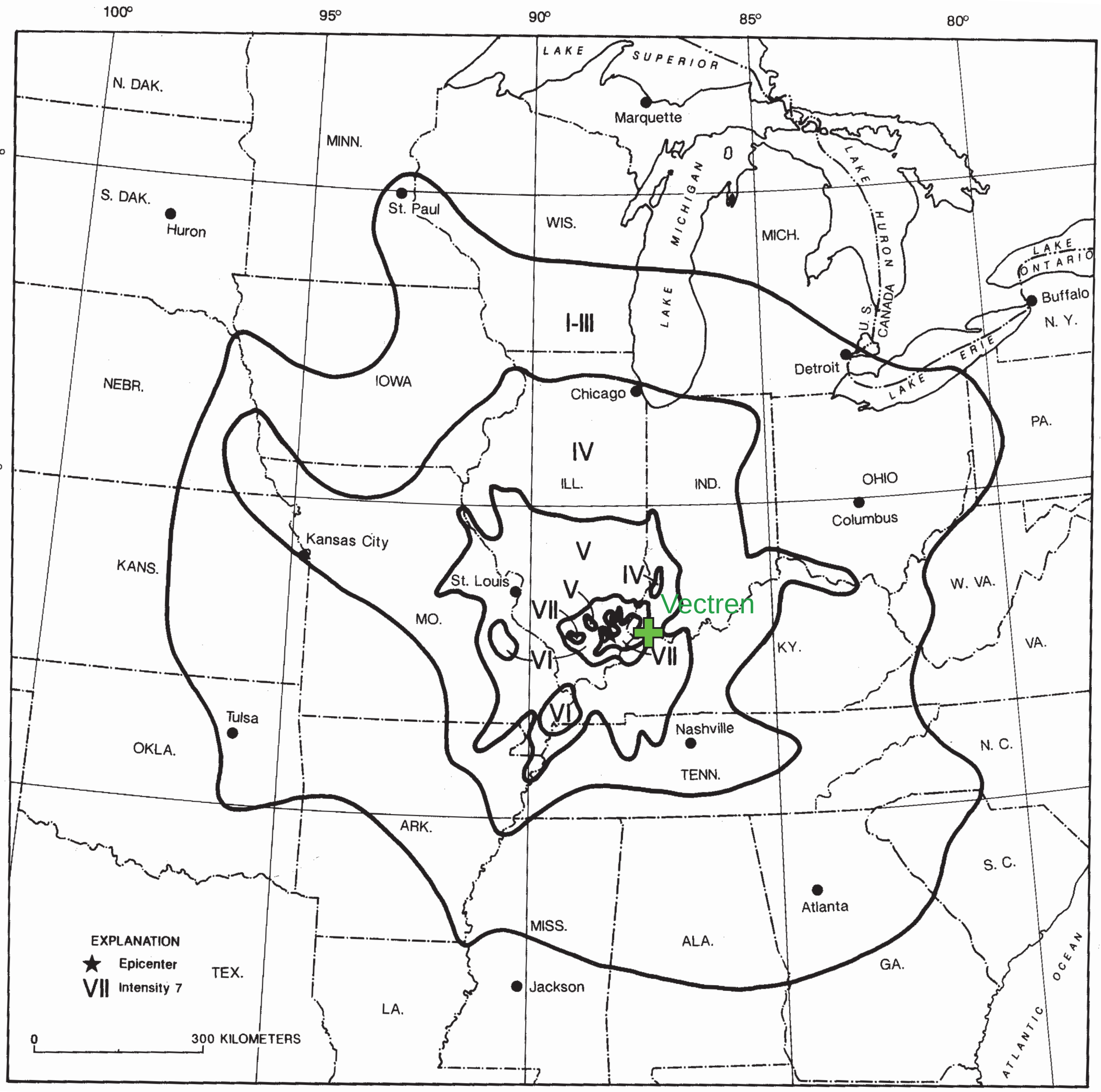
Source: Stover and Coffman (1993)

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	ISOSEISMAL MAP OF THE 27 SEPTEMBER 1891 m_b 5.8 SOUTHERN ILLINOIS EARTHQUAKE	Figure 8



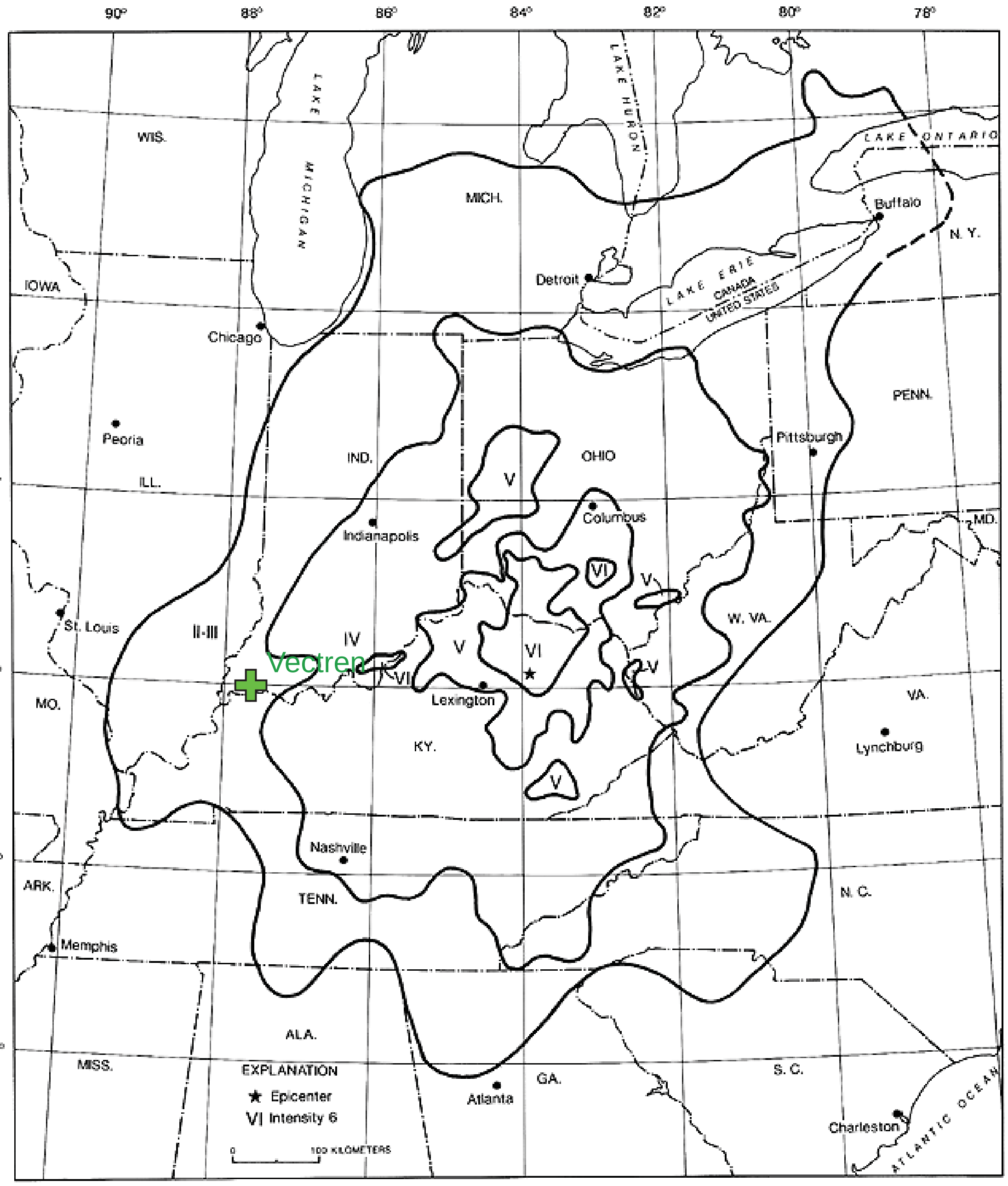
Source: Stover and Coffman (1993)

AECOM	Project No. 60442676	ISOSEISMAL MAP OF THE 31 OCTOBER 1895 M_S 6.7 CHARLESTON, MISSOURI EARTHQUAKE	Figure 9
	A.B. Brown Generating Station Vectren Corporation		



Source: Stover and Coffman (1993)

AECOM	Project No. 60442676	ISOSEISMAL MAP OF THE 9 NOVEMBER 1968 m_b 5.5 SOUTHERN ILLINOIS EARTHQUAKE	Figure 10
	A.B. Brown Generating Station Vectren Corporation		



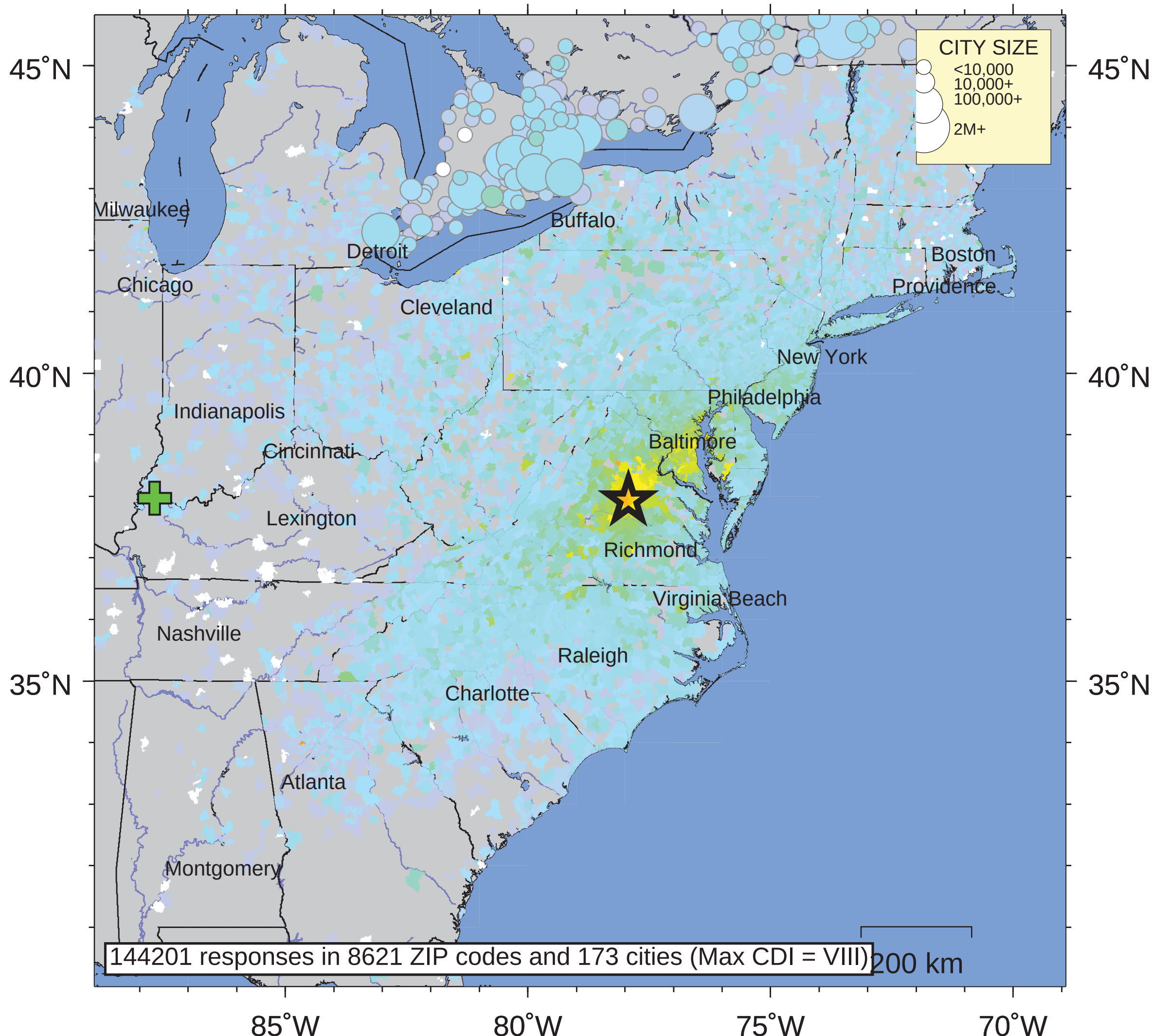
Source: Stover and Coffman (1993)

AECOM	Project No. 60442676	ISOSEISMAL MAP FOR THE 27 JULY 1980 M 5.1 SHARPSBURG, KENTUCKY EARTHQUAKE	Figure 11
	A.B. Brown Generating Station Vectren Corporation		

USGS Community Internet Intensity Map

VIRGINIA

Aug 23 2011 01:51:04 PM local 37.936N 77.933W M5.8 Depth: 6 km ID:se082311a

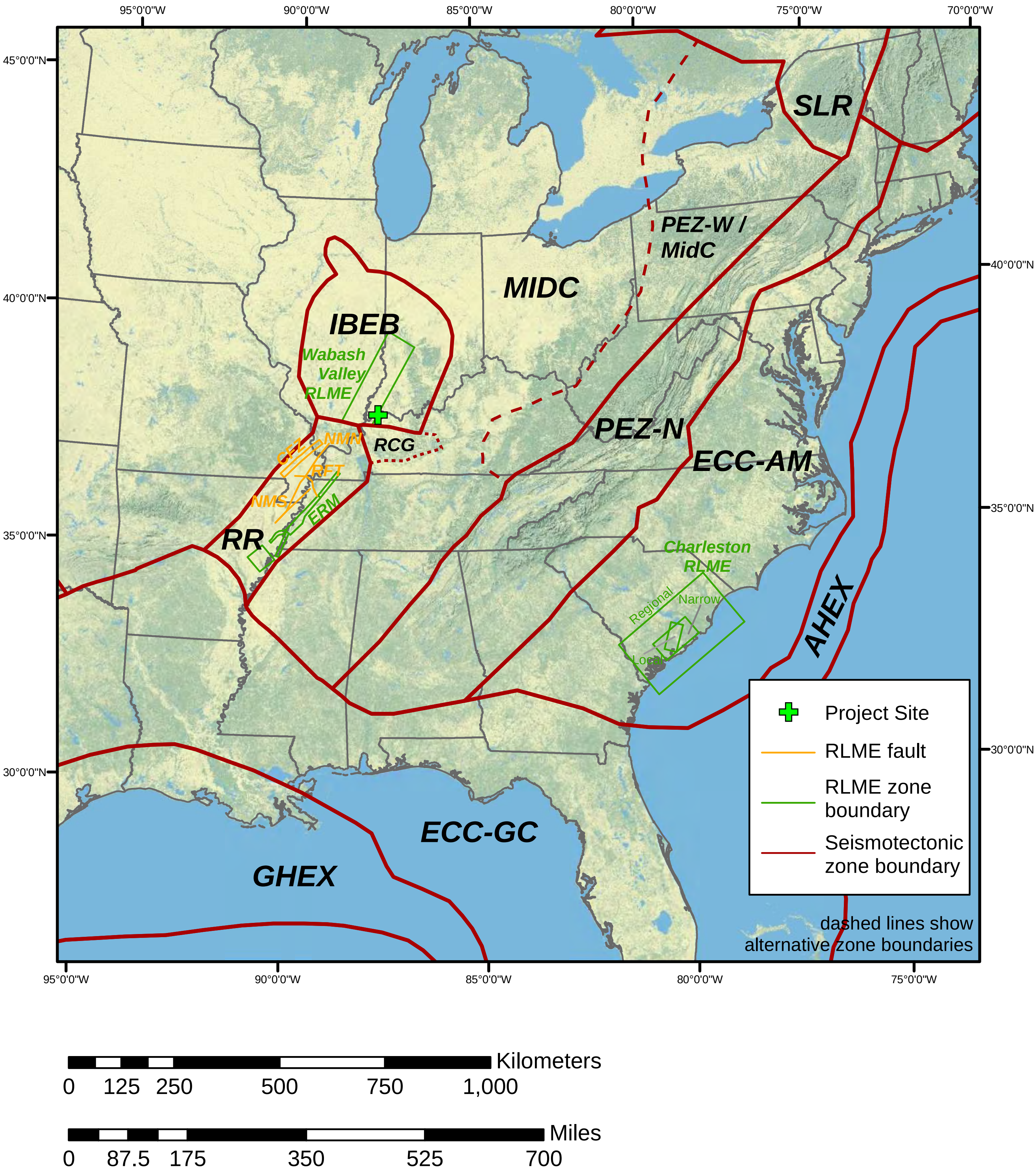


INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy

Processed: Wed Jan 28 00:56:30 2015

Source: http://earthquake.usgs.gov/earthquakes/dyfi/events/se/082311a/us/index.html

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	DYFI MAP FOR THE 23 AUGUST 2011 **M**5.8 MINERAL, VIRGINA EARTHQUAKE	Figure 12



AECOM

Project No. 60442676

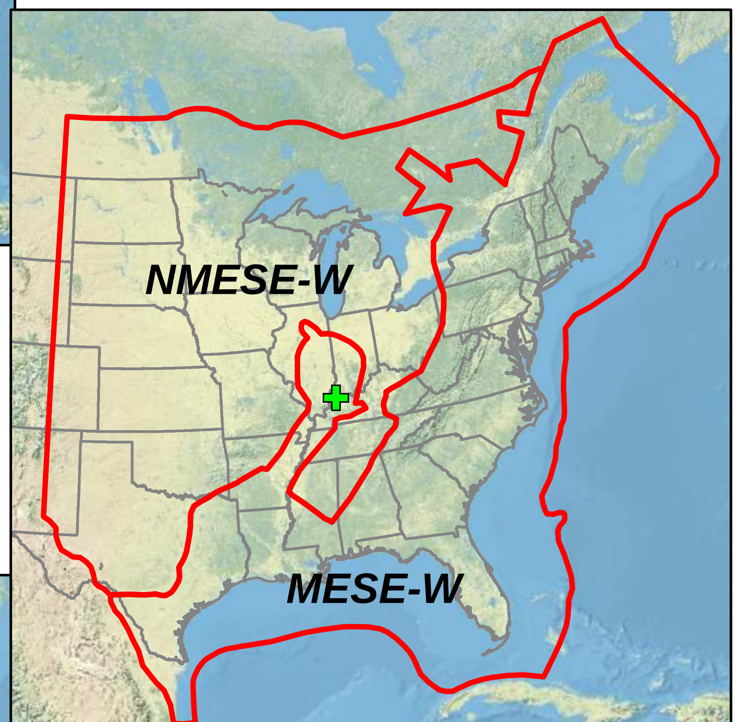
A.B. Brown Generating Station
Vectren Corporation

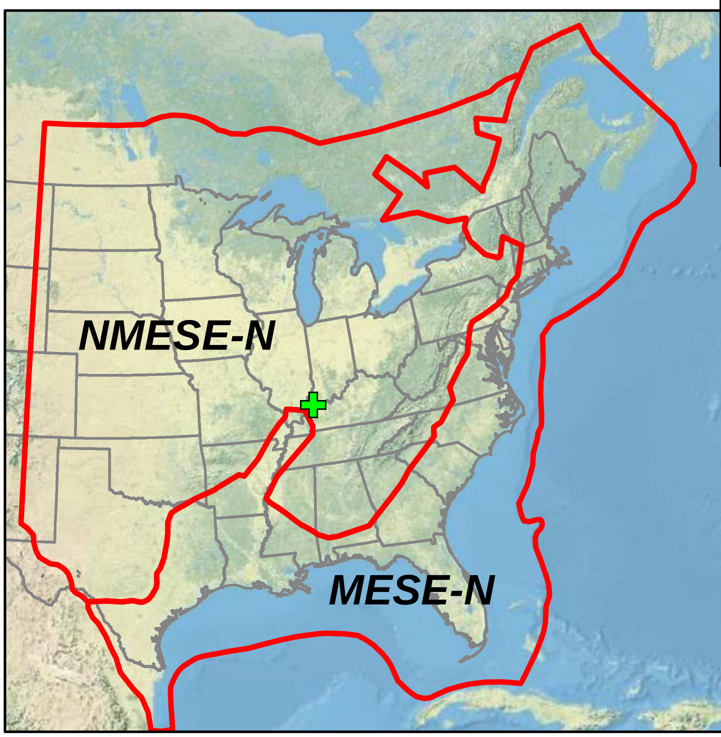
SEISMOTECTONIC ZONES AND RLMES

Figure 13

1-Zone Model

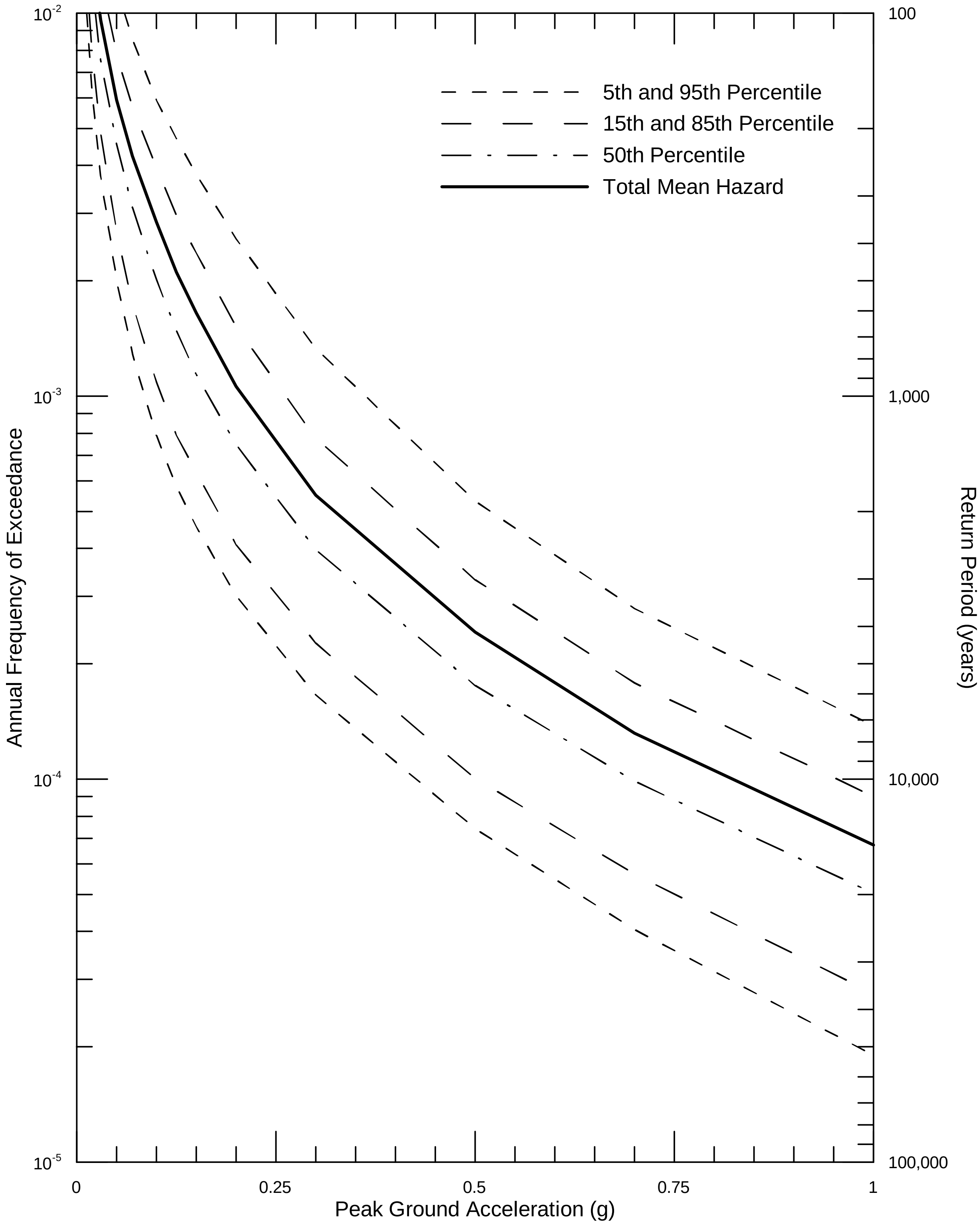
2-Zone Model Wide



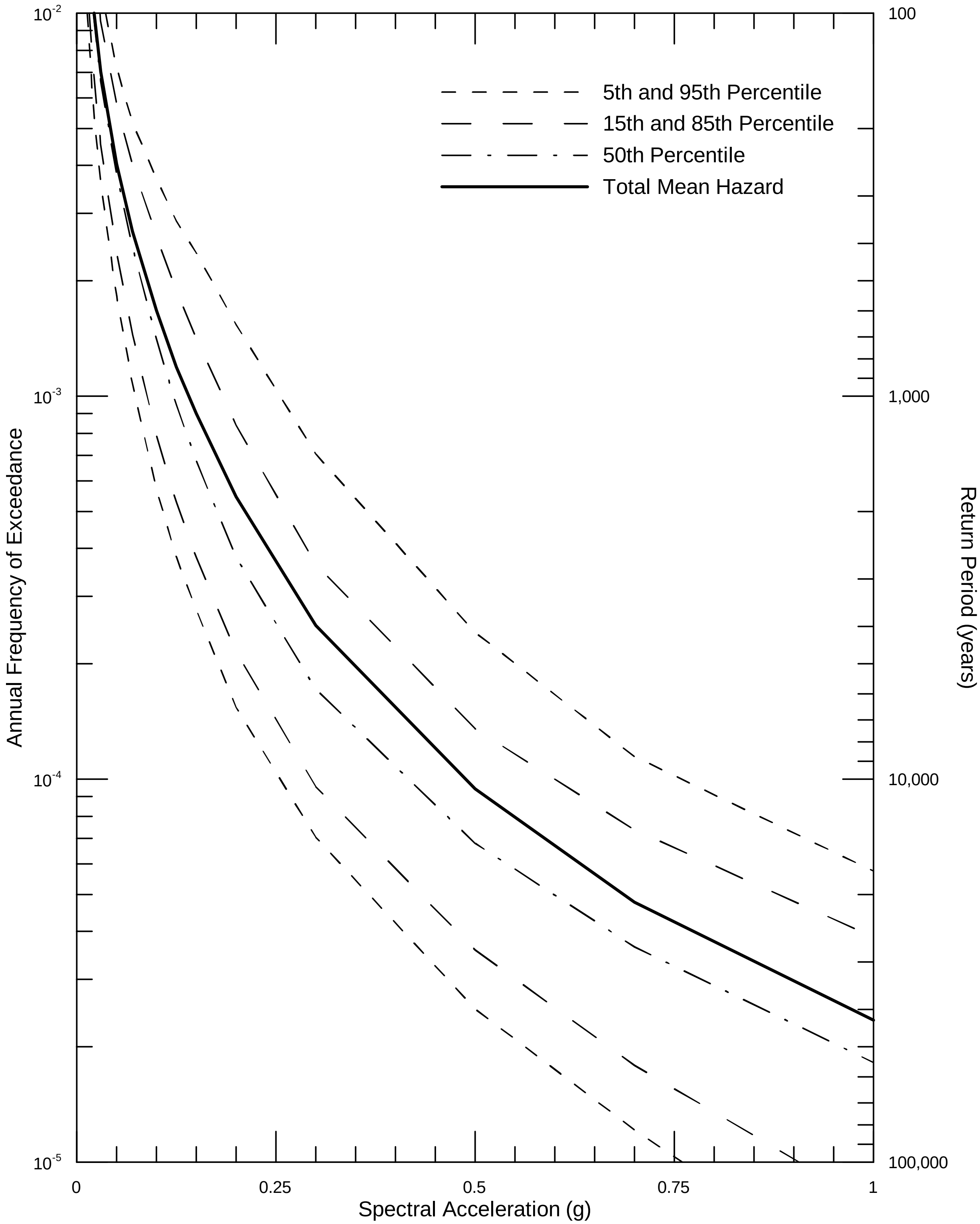


2-Zone Model Narrow

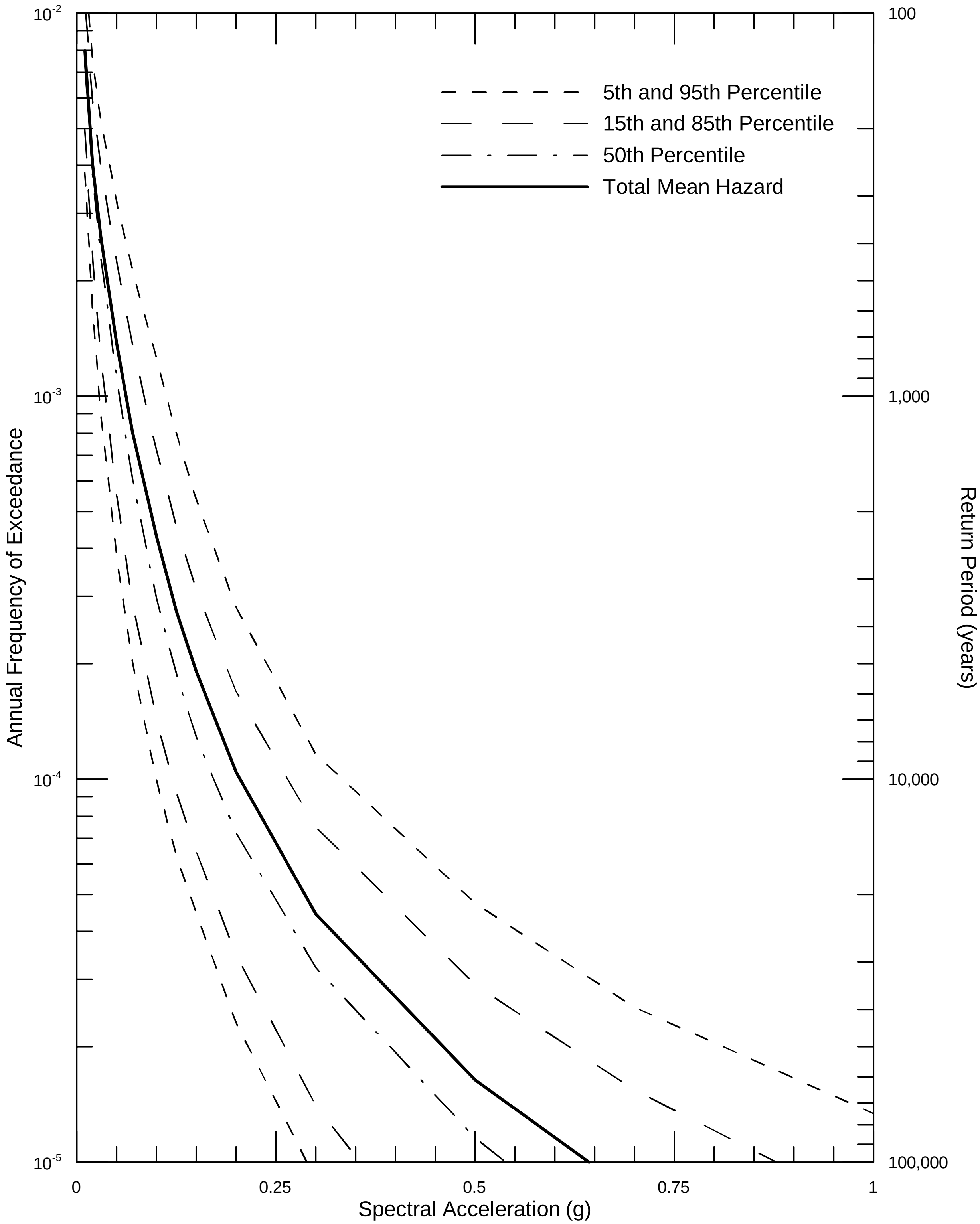
AECOM	Project No. 60442676	Mmax ZONES	Figure
	A.B. Brown Generating Station Vectren Corporation		14



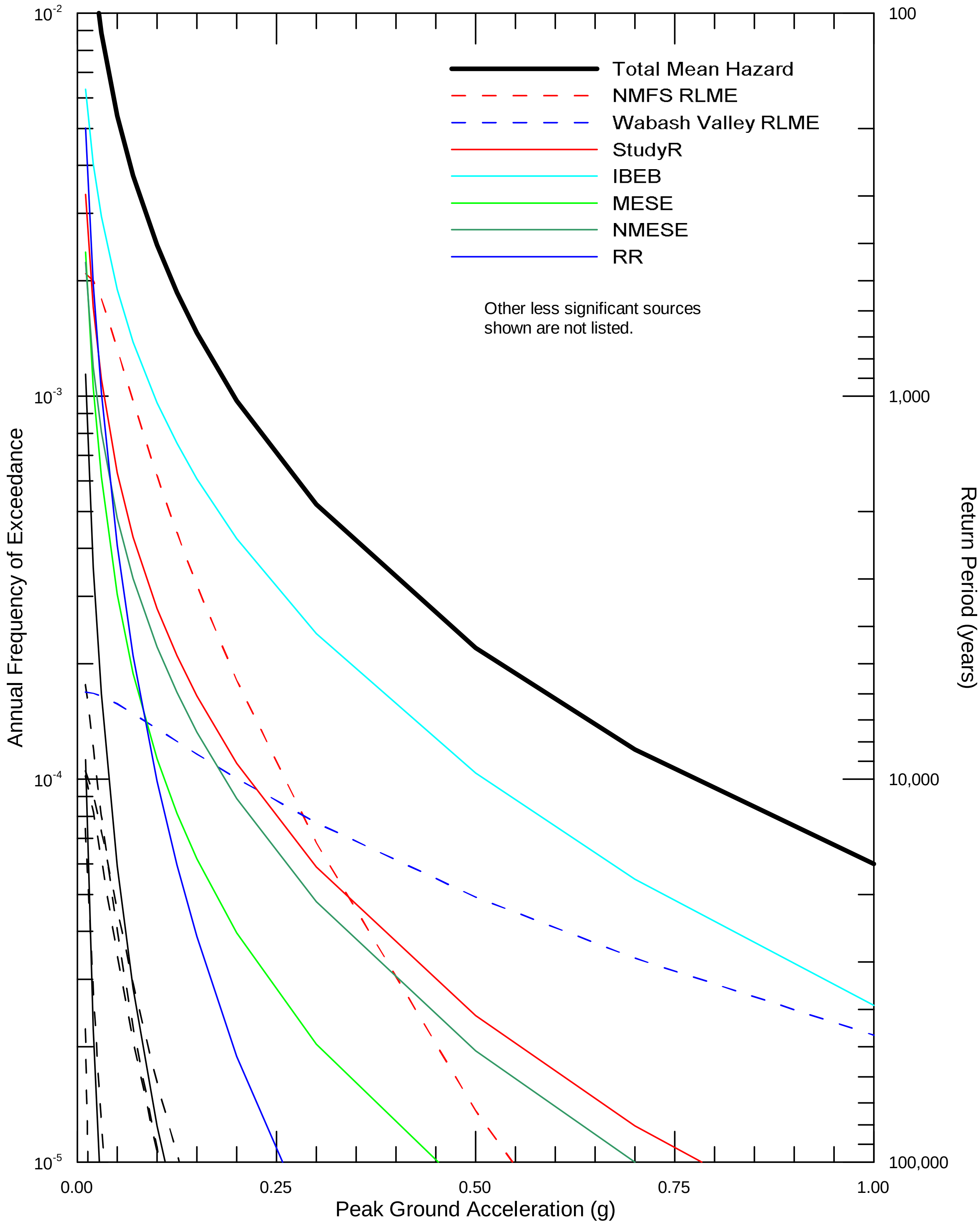
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	SEISMIC HAZARD CURVES FOR PEAK HORIZONTAL ACCELERATION ON HARD ROCK	Figure 15



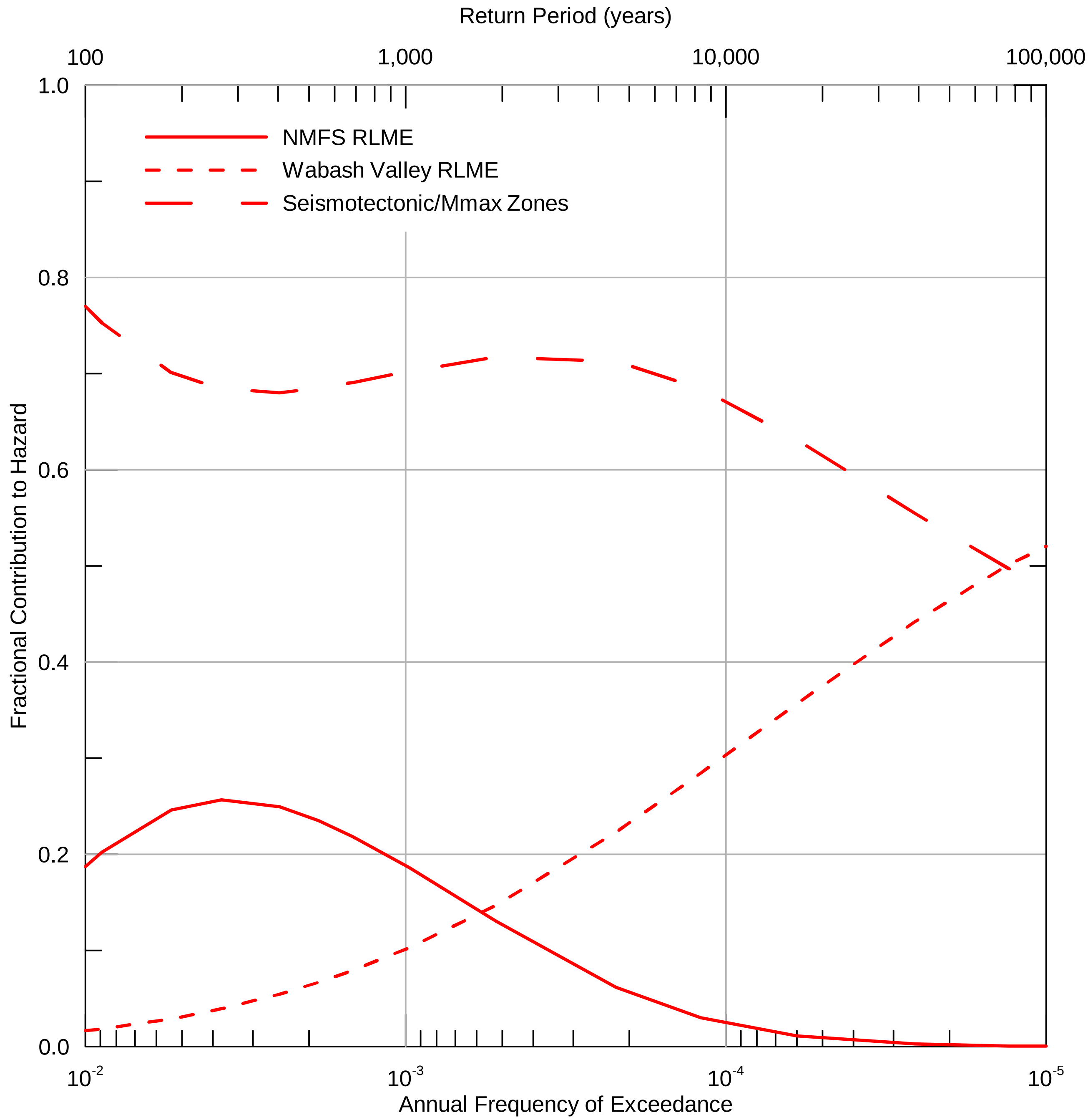
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	SEISMIC HAZARD CURVES FOR 0.4 SEC HORIZONTAL SPECTRAL ACCELERATION ON HARD ROCK	Figure 16



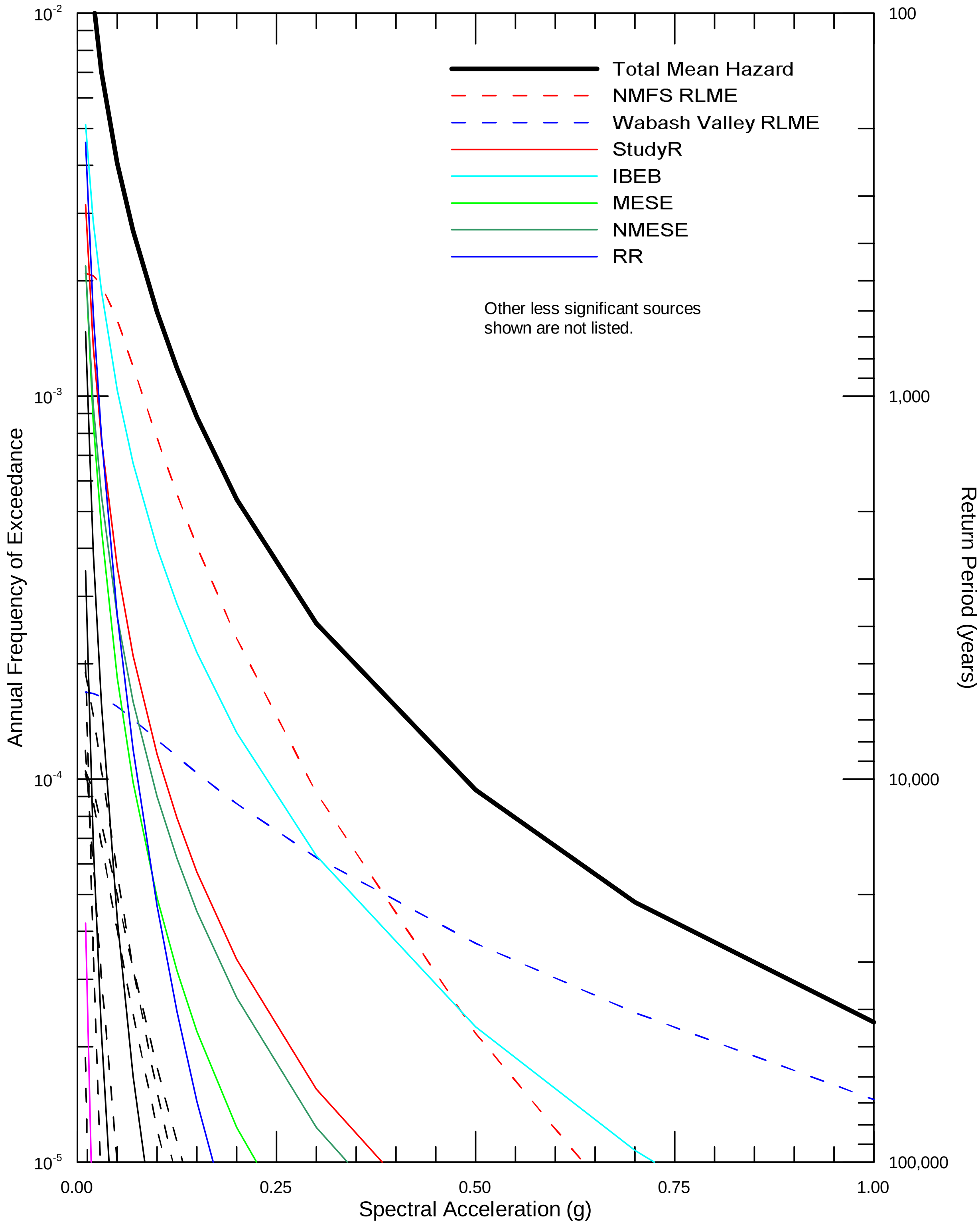
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	SEISMIC HAZARD CURVES FOR 1.0 SEC HORIZONTAL SPECTRAL ACCELERATION ON HARD ROCK	Figure 17



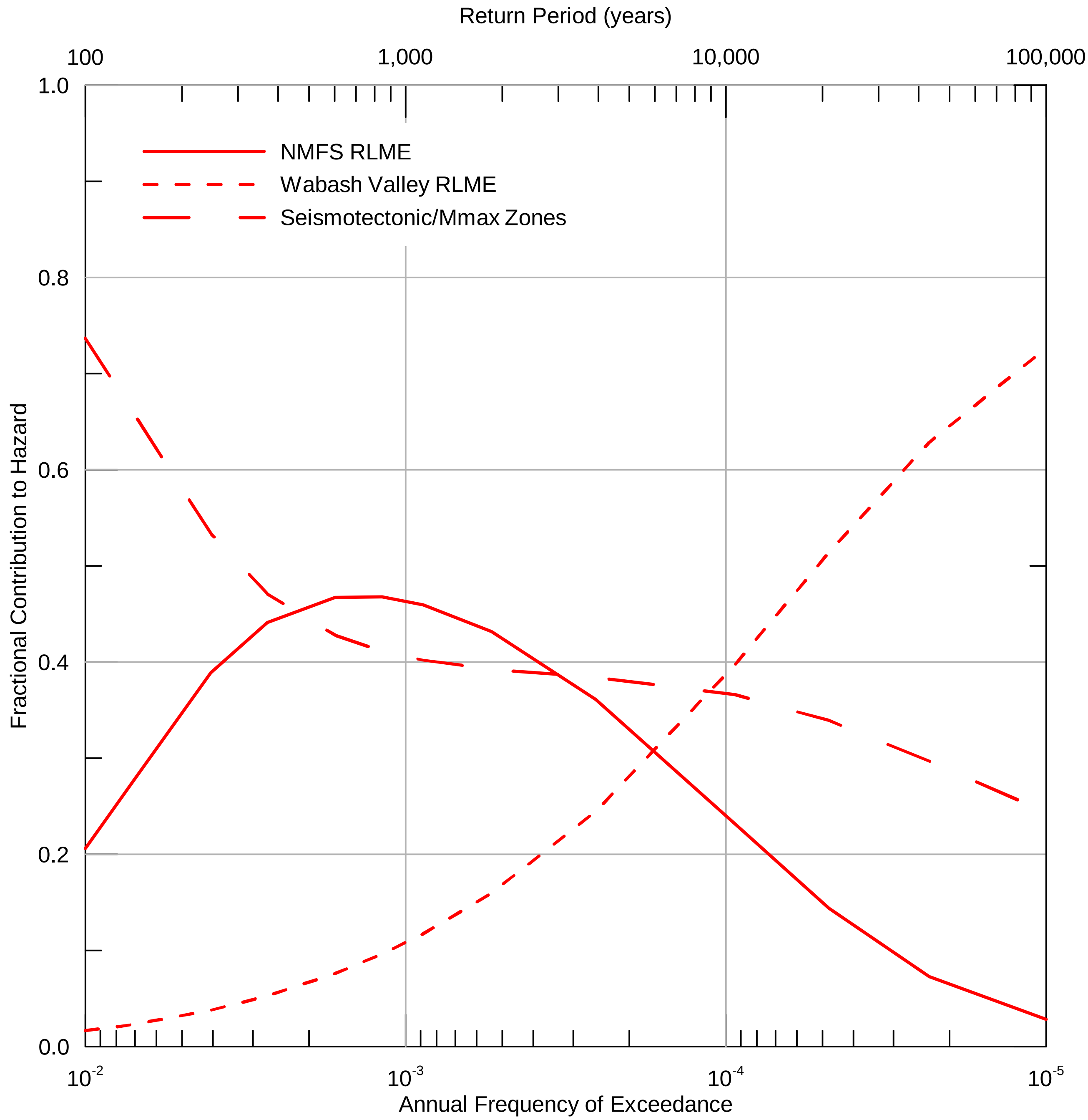
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	SEISMIC SOURCE CONTRIBUTIONS TO MEAN PEAK HORIZONTAL ACCELERATION HAZARD ON HARD ROCK	Figure 18



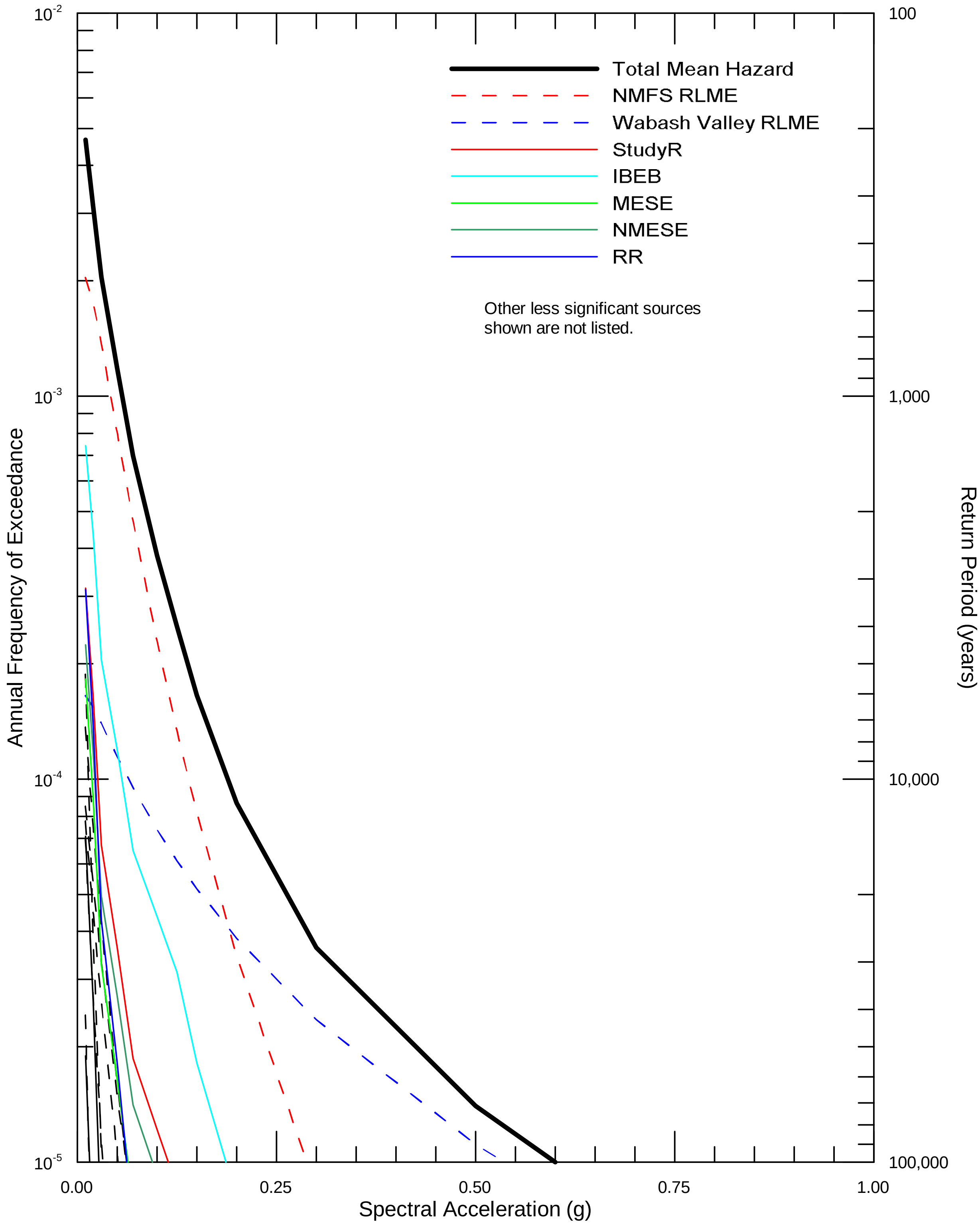
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	SEISMIC SOURCE FRACTIONAL CONTRIBUTION TO MEAN PEAK HORIZONTAL ACCELERATION HAZARD ON HARD ROCK	Figure 19



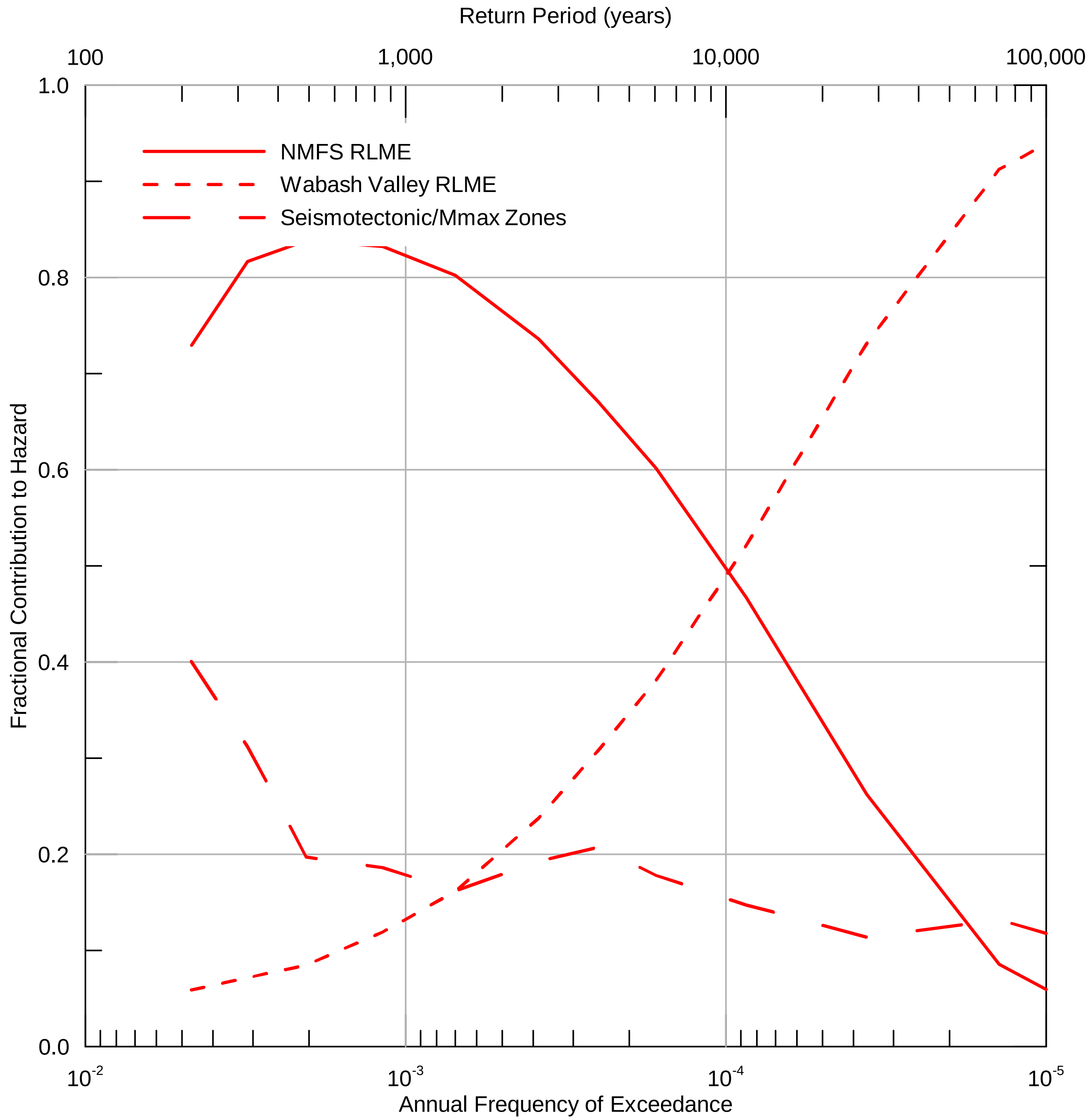
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	SEISMIC SOURCE CONTRIBUTIONS TO MEAN 0.4 SEC HORIZONTAL SPECTRAL ACCELERATION HAZARD ON HARD ROCK	Figure 20



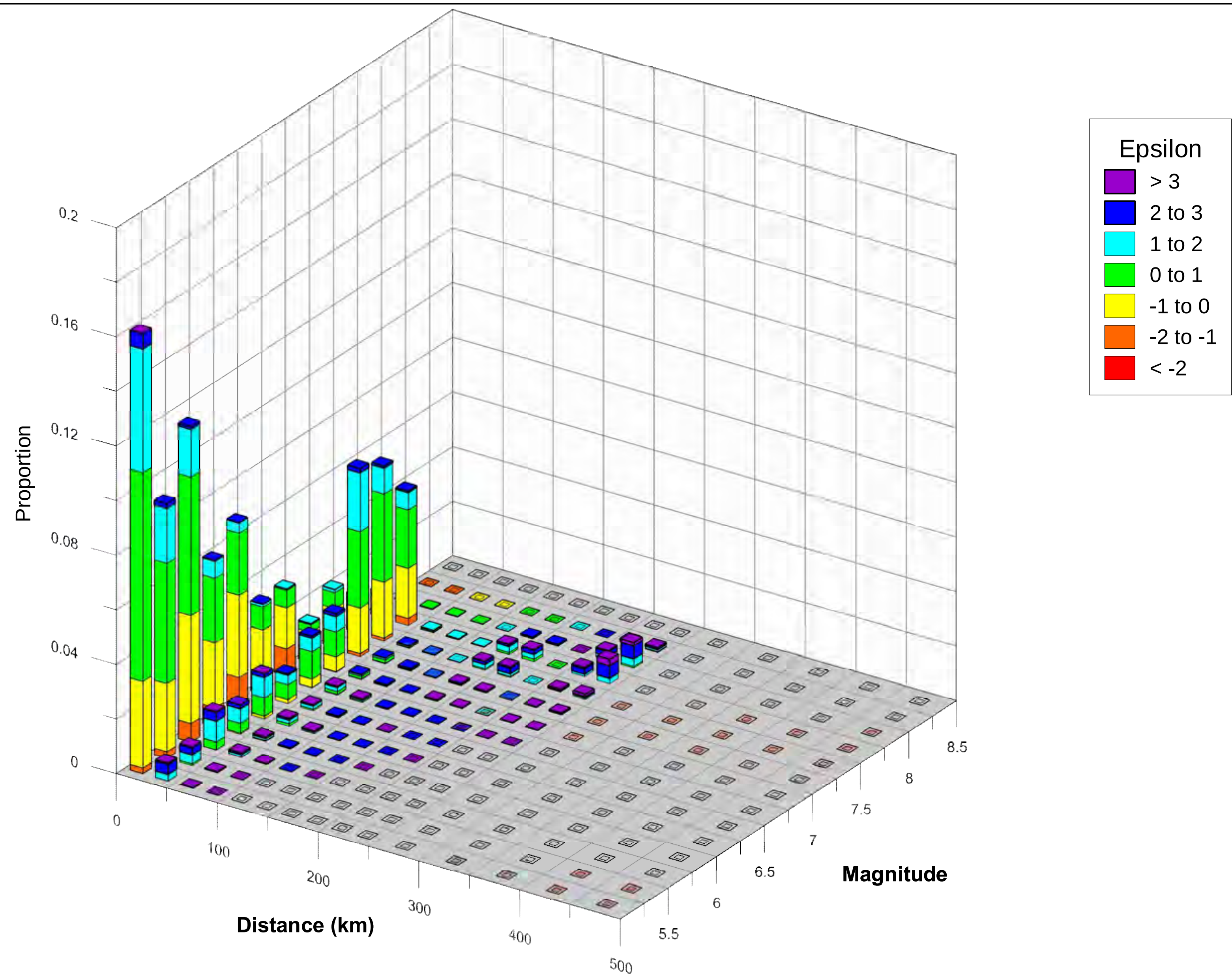
AECOM	Project No.60442676 A.B. Brown Generating Station Vectren Corporation	SEISMIC SOURCE FRACTIONAL CONTRIBUTION TO MEAN 0.4 SEC HORIZONTAL SPECTRAL ACCELERATION HAZARD ON HARD ROCK	Figure 21



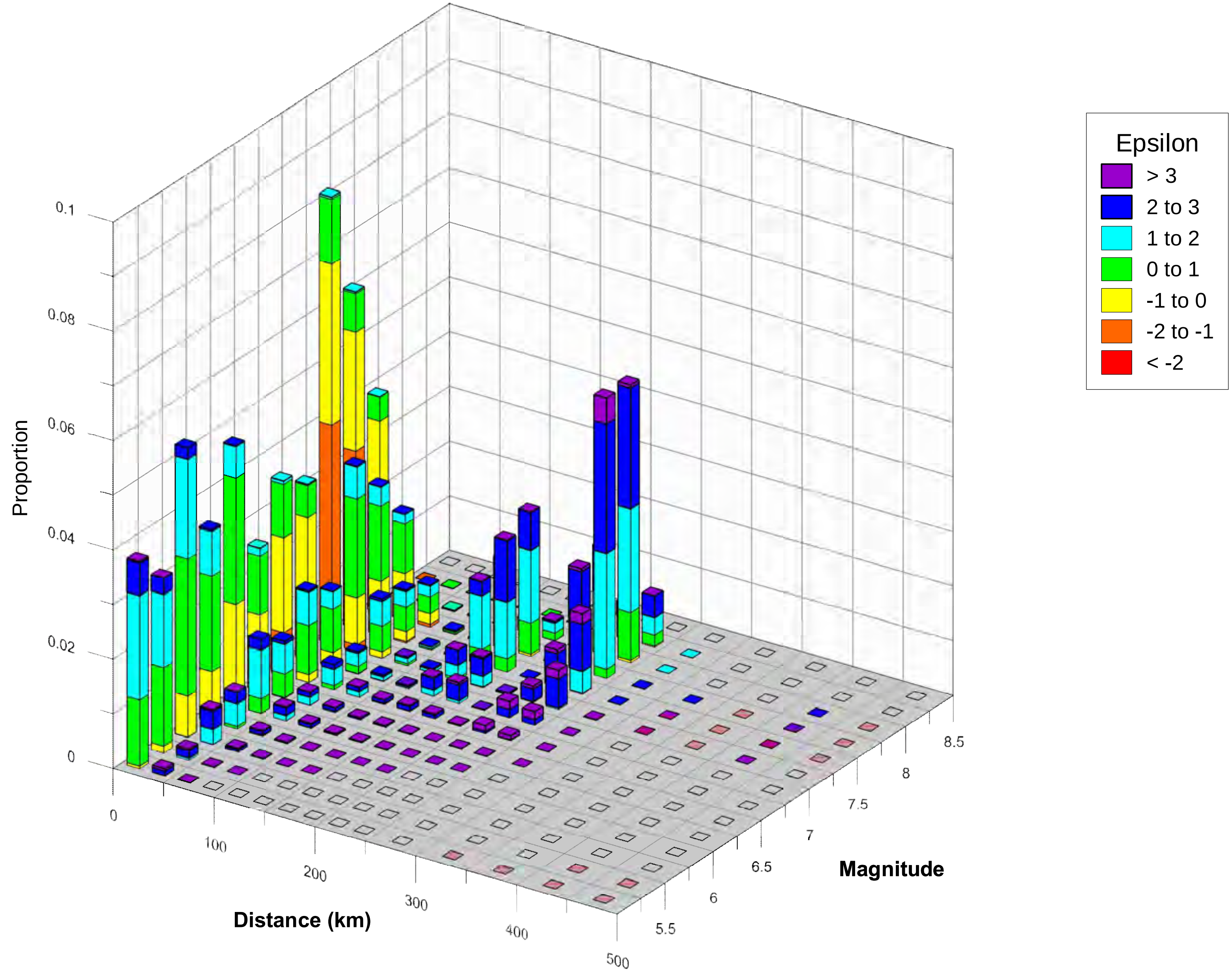
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	SEISMIC SOURCE CONTRIBUTIONS TO MEAN 1.0 SEC HORIZONTAL SPECTRAL ACCELERATION HAZARD ON HARD ROCK	Figure 22



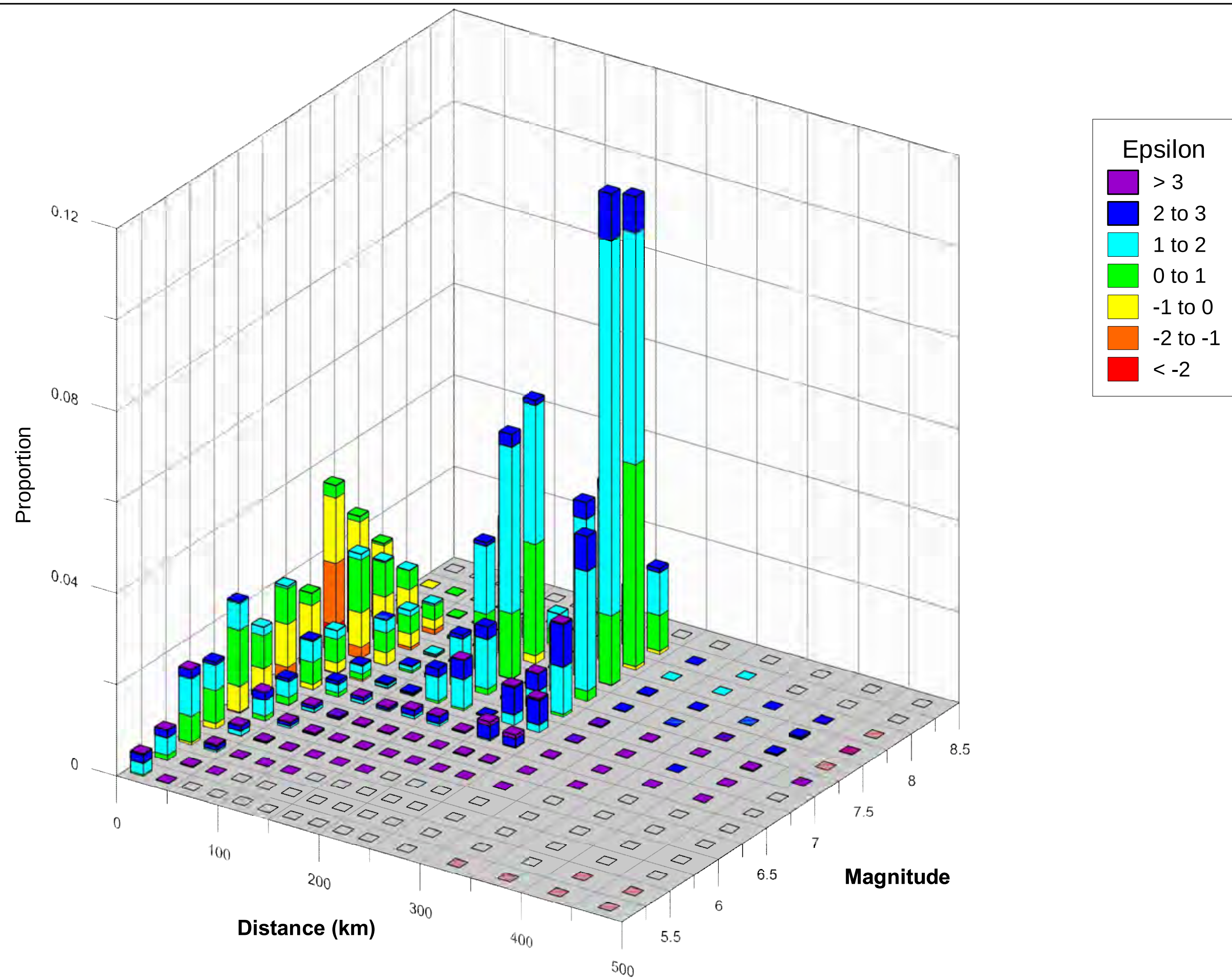
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	SEISMIC SOURCE FRACTIONAL CONTRIBUTION TO MEAN 1.0 SEC HORIZONTAL SPECTRAL ACCELERATION HAZARD ON HARD ROCK	Figure 23



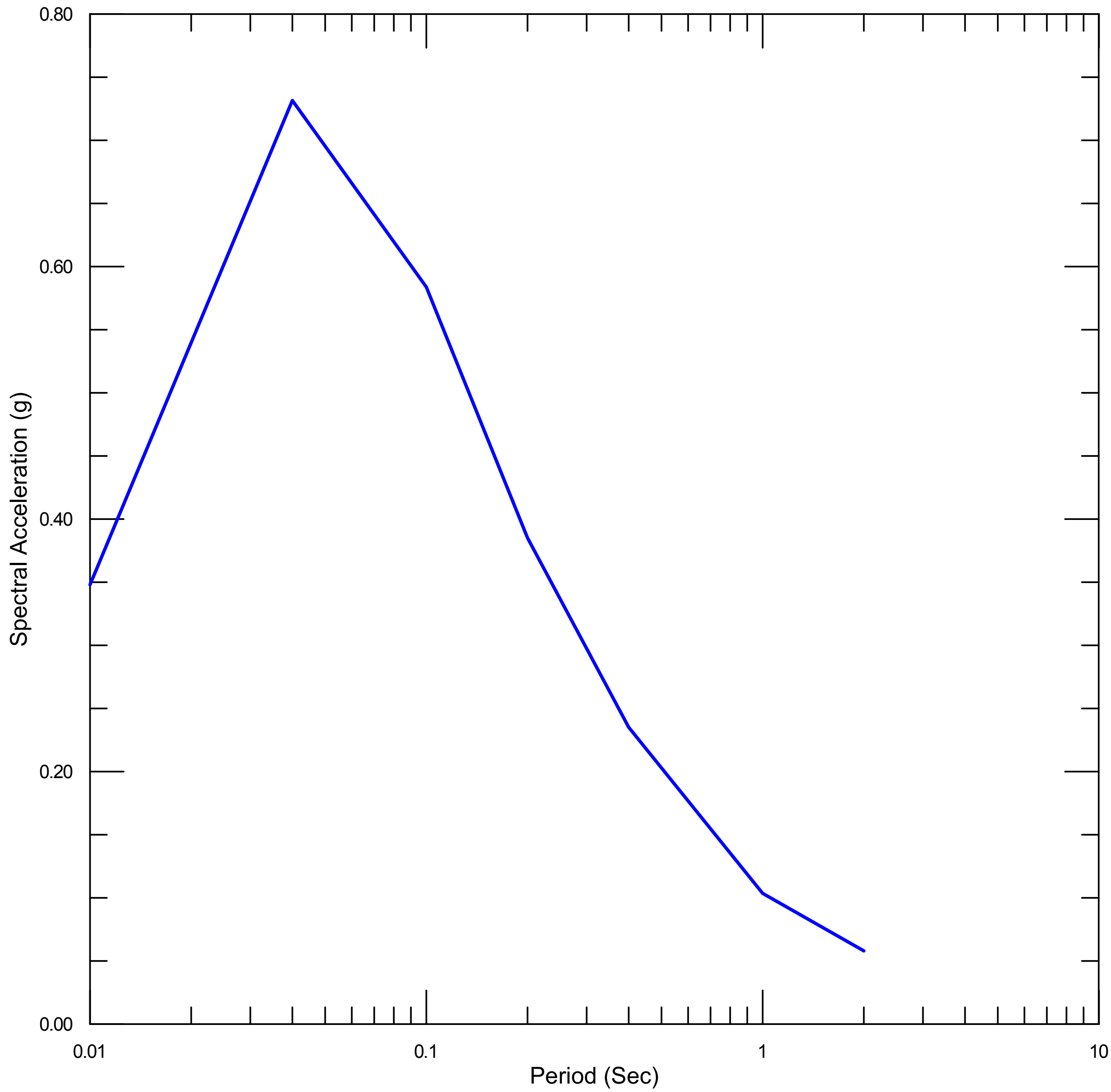
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	MAGNITUDE, DISTANCE AND EPSILON CONTRIBUTIONS TO THE MEAN PEAK HORIZONTAL ACCELERATIONHAZARD AT 2,500-YEAR RETURN PERIOD ON HARD ROCK	Figure 24



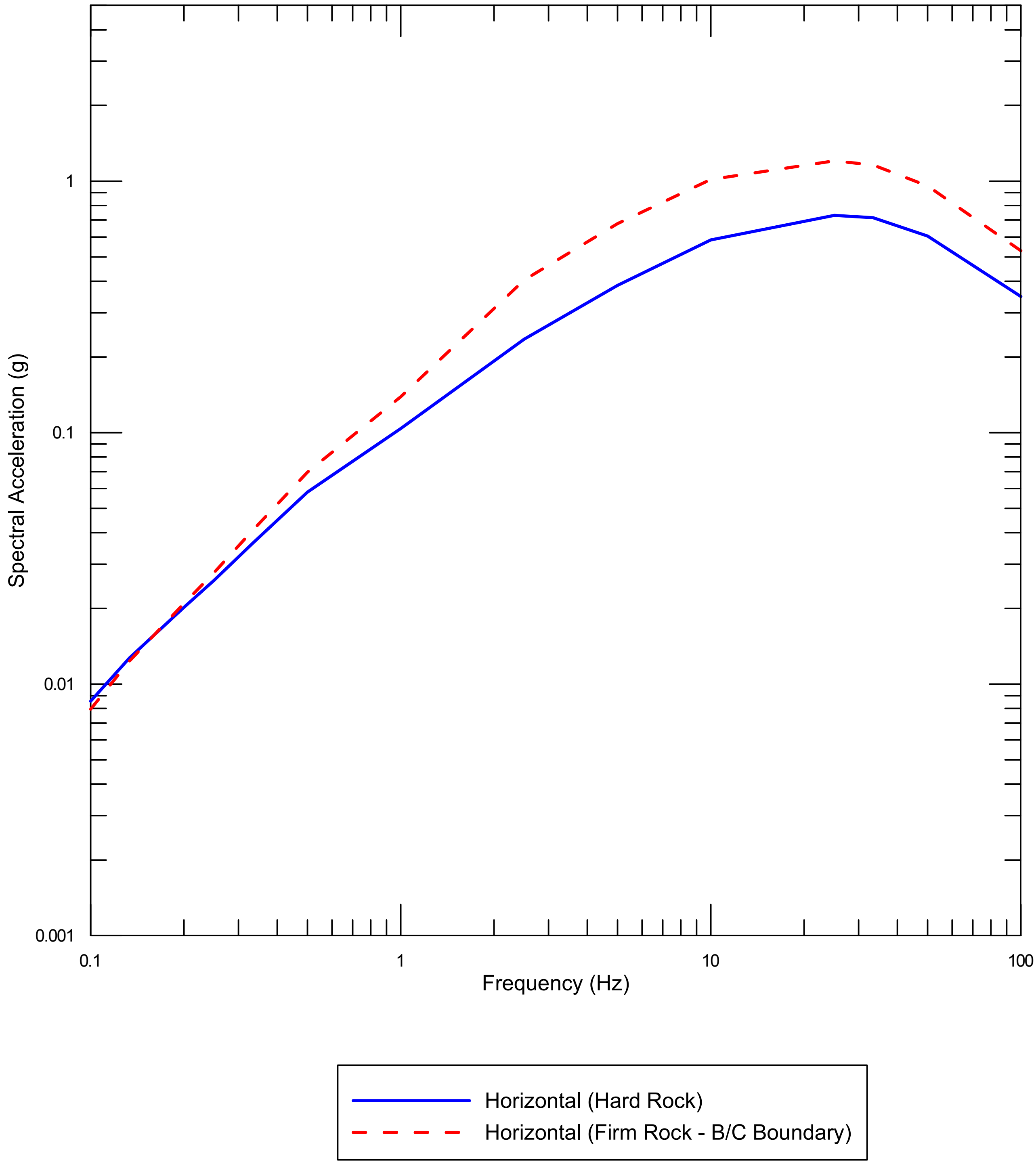
AECOM	Project No.60442676 A.B. Brown Generating Station Vectren Corporation	MAGNITUDE,DISTANCE AND EPSILON CONTRIBUTIONS TO THE MEAN 0.4 SEC HORIZONTAL SPECTRALACCELERATION HAZARD AT 2,500-YEAR RETURN PERIOD ON HARD ROCK	Figure 25



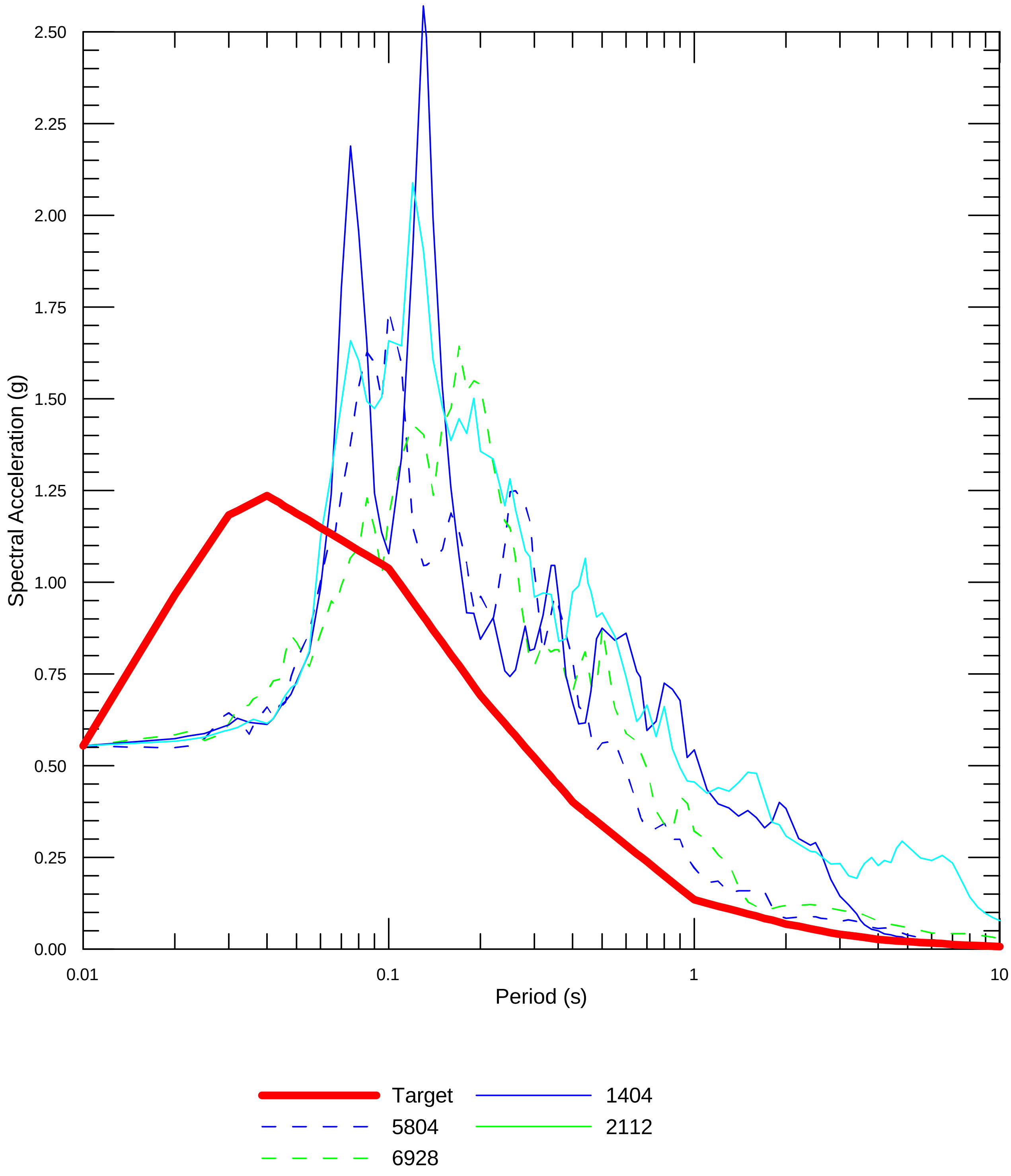
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	MAGNITUDE,DISTANCE AND EPSILON CONTRIBUTIONS TO THE MEAN 1.0 SEC HORIZONTAL SPECTRALACCELERATION HAZARD AT 2,500-YEAR RETURN PERIOD ON HARD ROCK	Figure 26



AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	HORIZONTAL 5%-DAMPED MEAN UHS AT 2,500-YEAR RETURN PERIOD ON HARD ROCK	Figure 27



AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	COMPARISON OF HORIZONTAL 5%-DAMPED MEAN UHS AT 2,500-YEAR RETURN PERIOD ON HARD AND FIRM ROCK	Figure 28

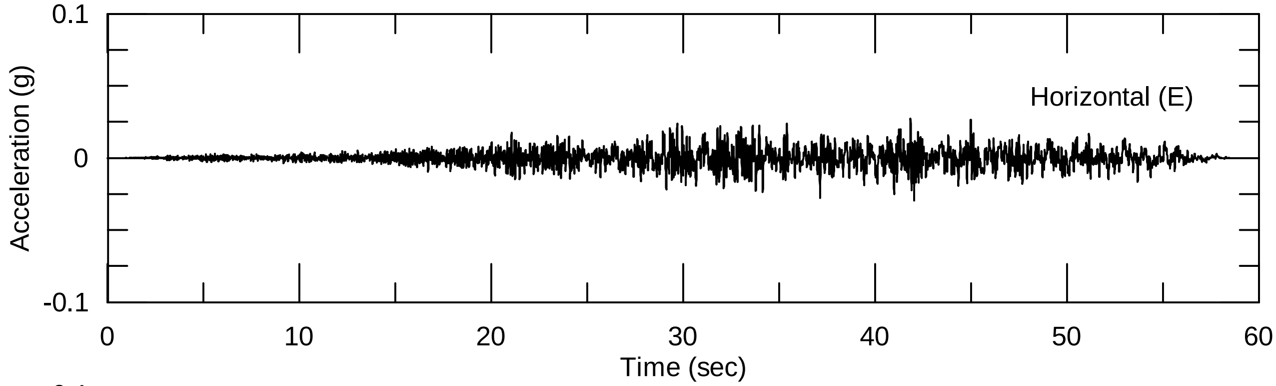


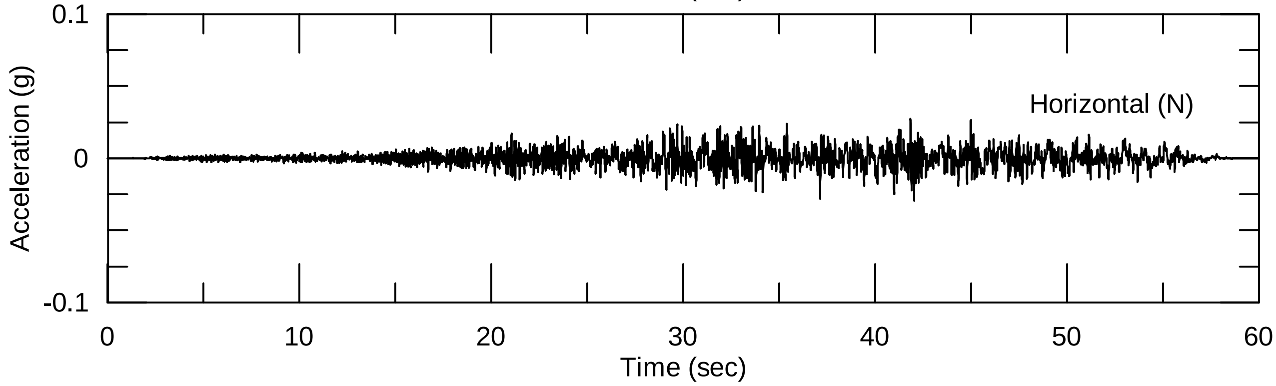
Project No.60442676

A.B. Brown
Generating Station
Vectren Corporation

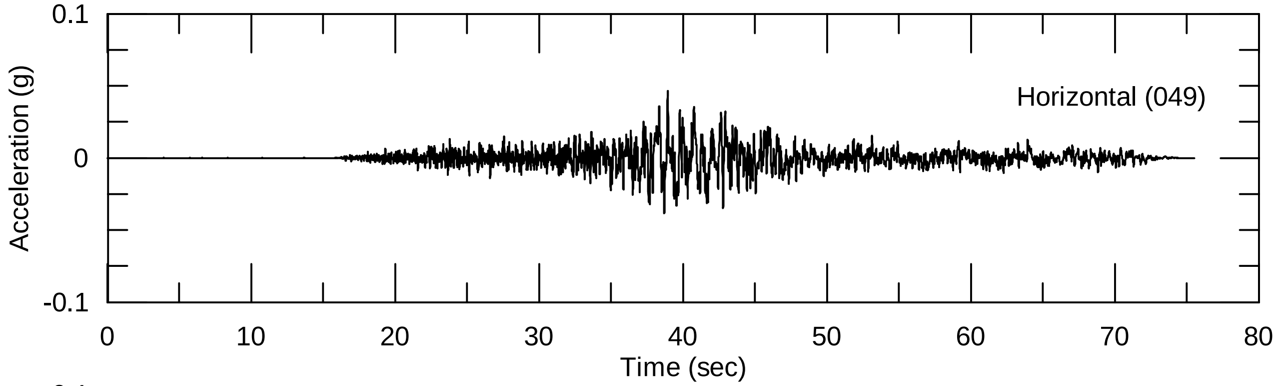
HORIZONTAL TARGET AND SELECTED
SEED RESPONSE SPECTRA

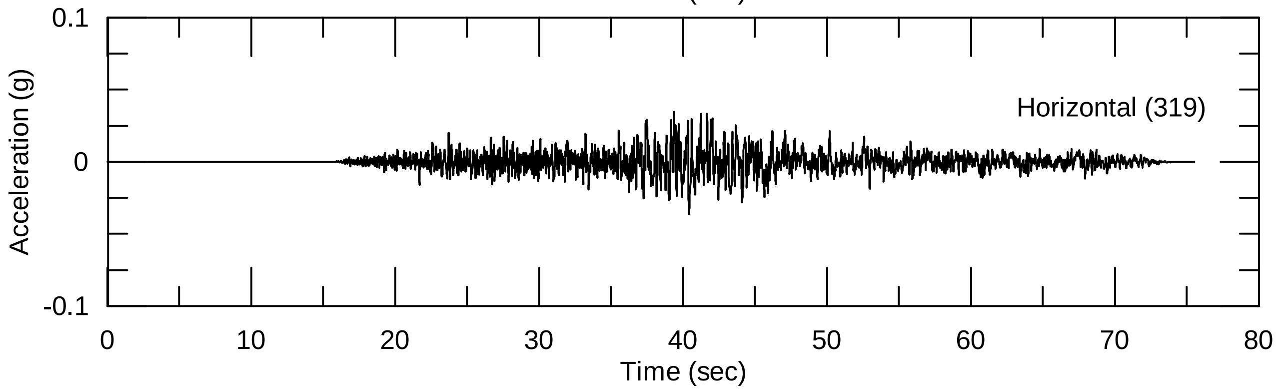
Figure
29



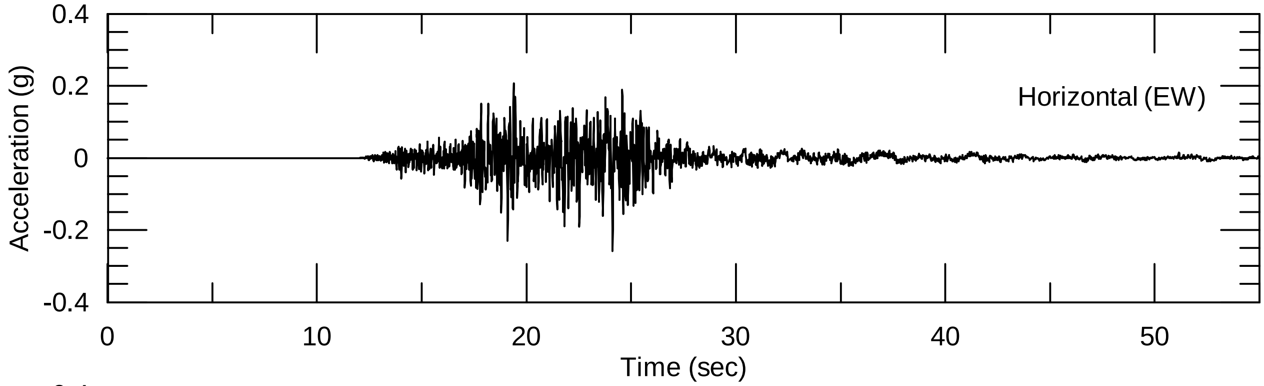


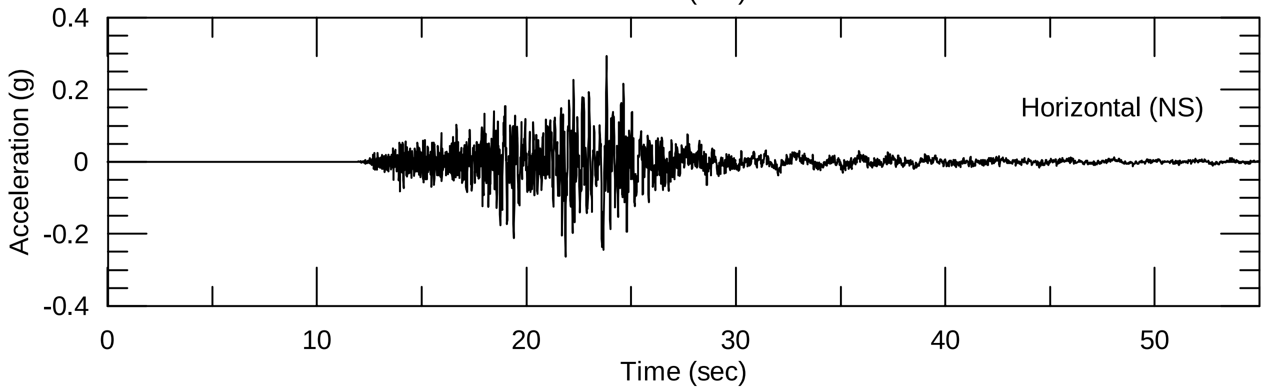
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	SEED TIME HISTORIES RSN1404 - 1999 CHI CHI PNG	Figure 30



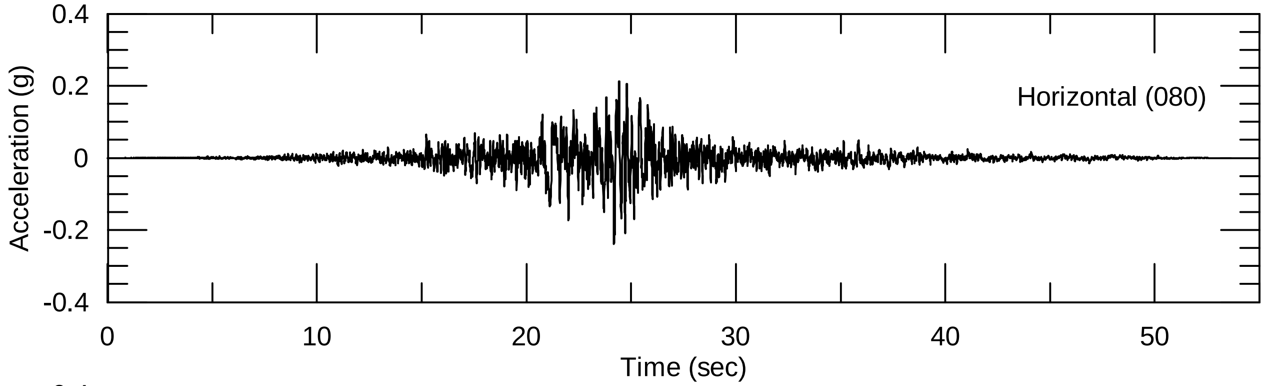


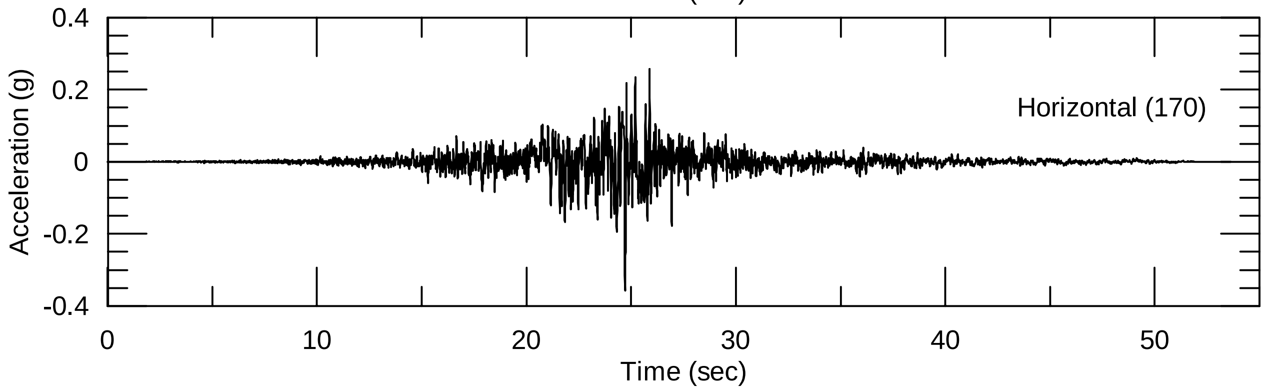
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	SEED TIME HISTORIES RSN2112 - 2002 DENALI TAPS PUMP STATION #8	Figure 31



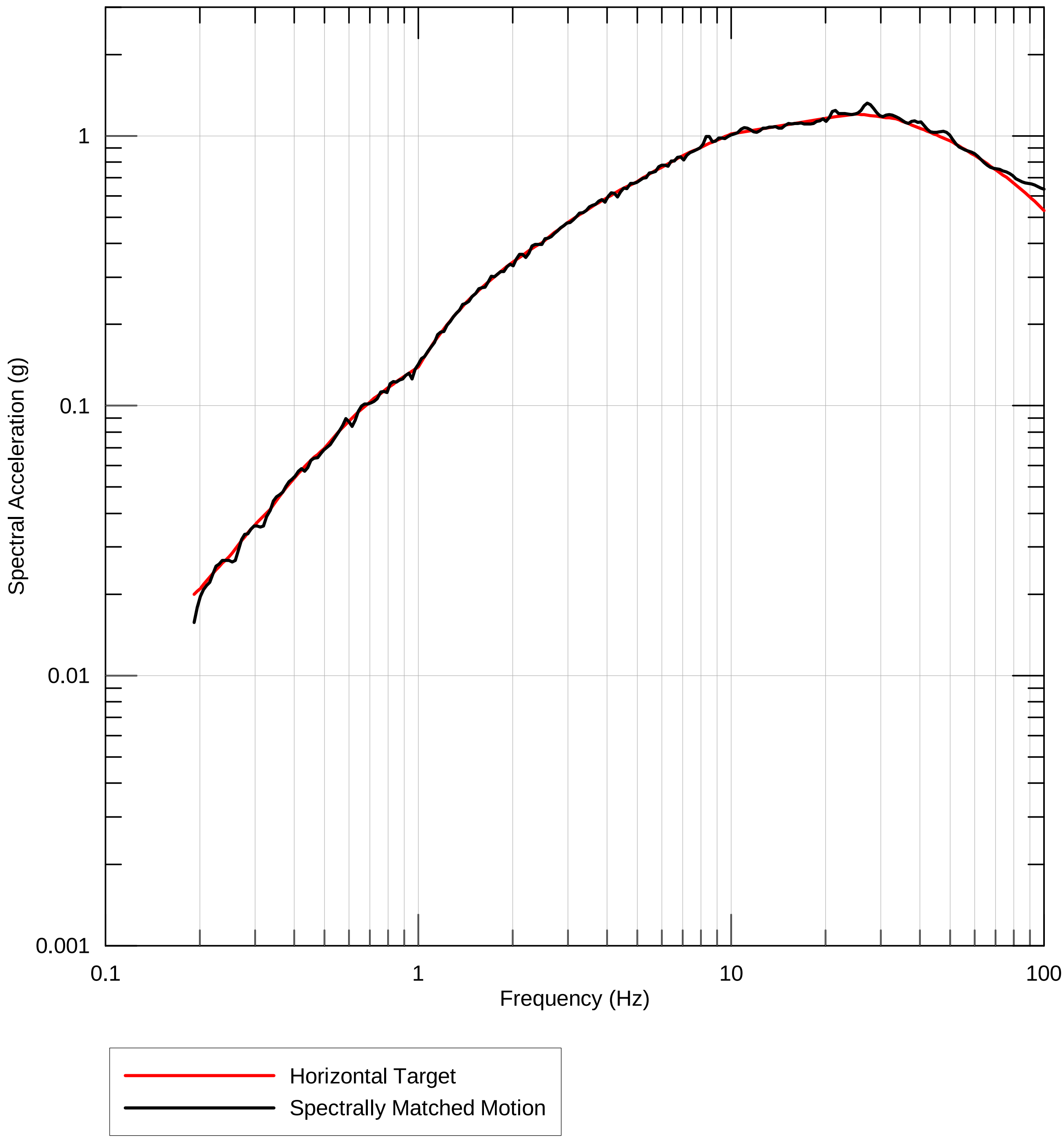


AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	SEED TIME HISTORIES RSN5804 - IWATE 55446	Figure 32



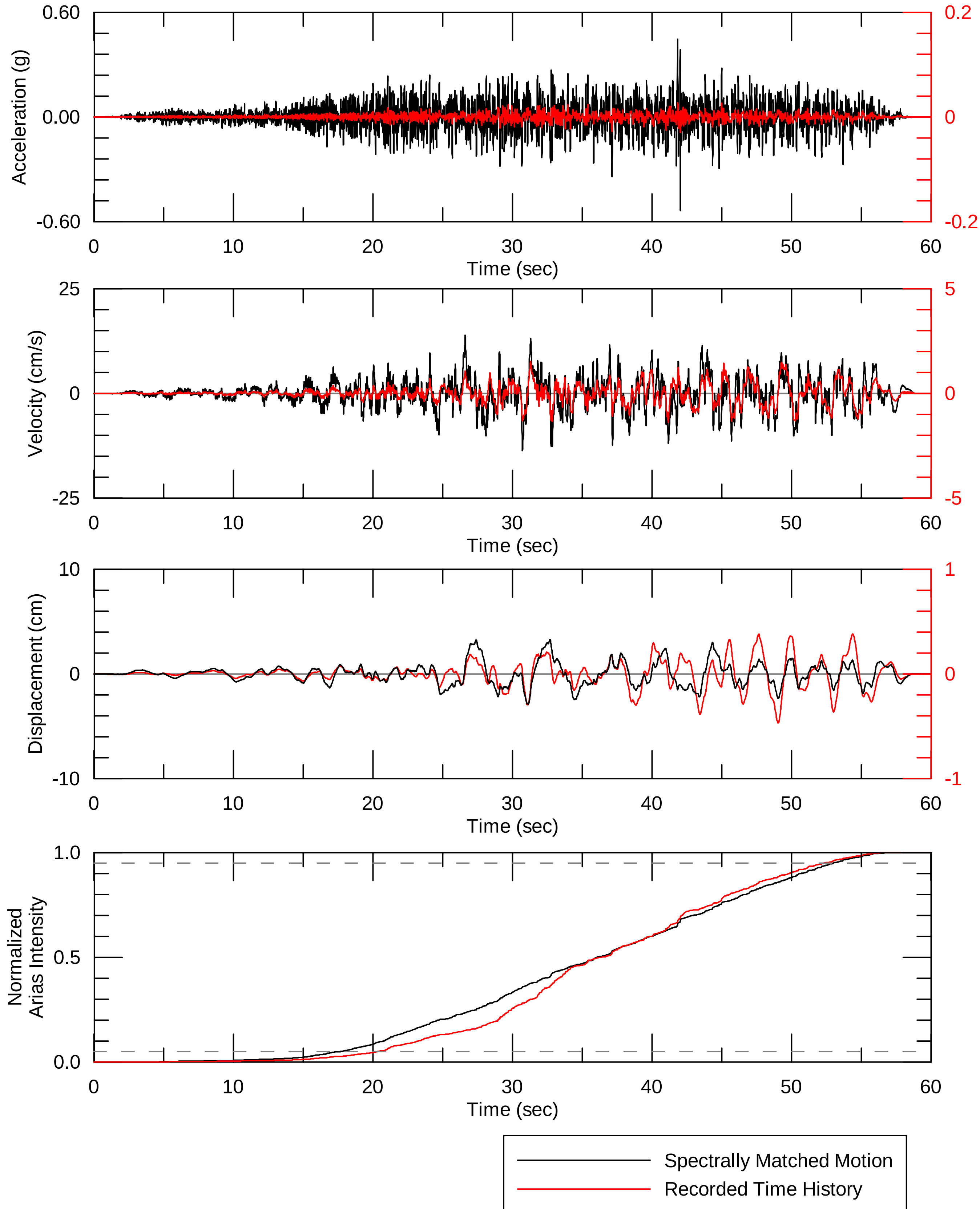


AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	SEED TIME HISTORIES RSN6928 - DARFIELD LPCC	Figure 33



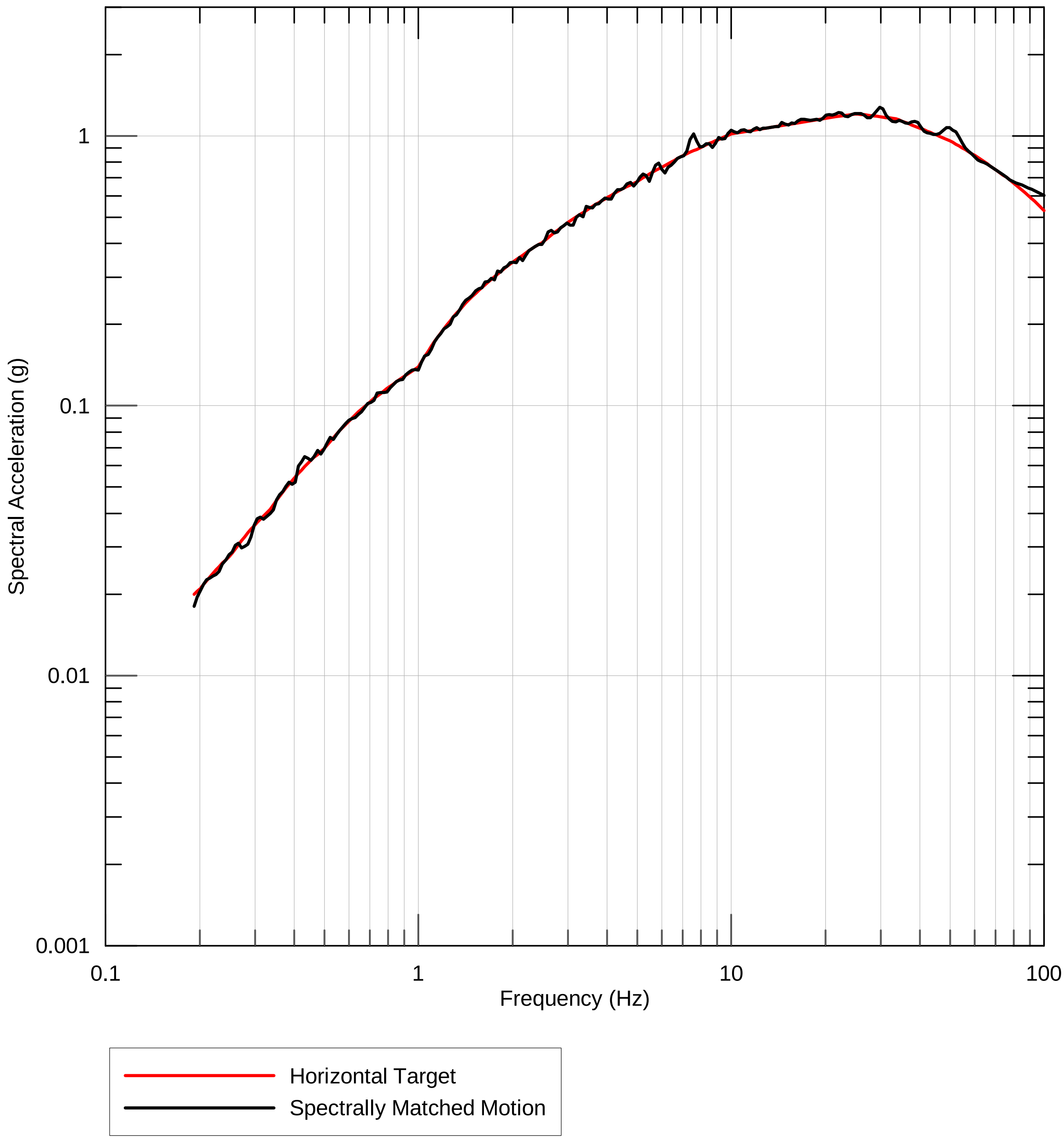
SEED: PEER RSN1404

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	RESPONSE SPECTRUM FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 1999 CHI CHI - PNG (E) SEED	Figure 34



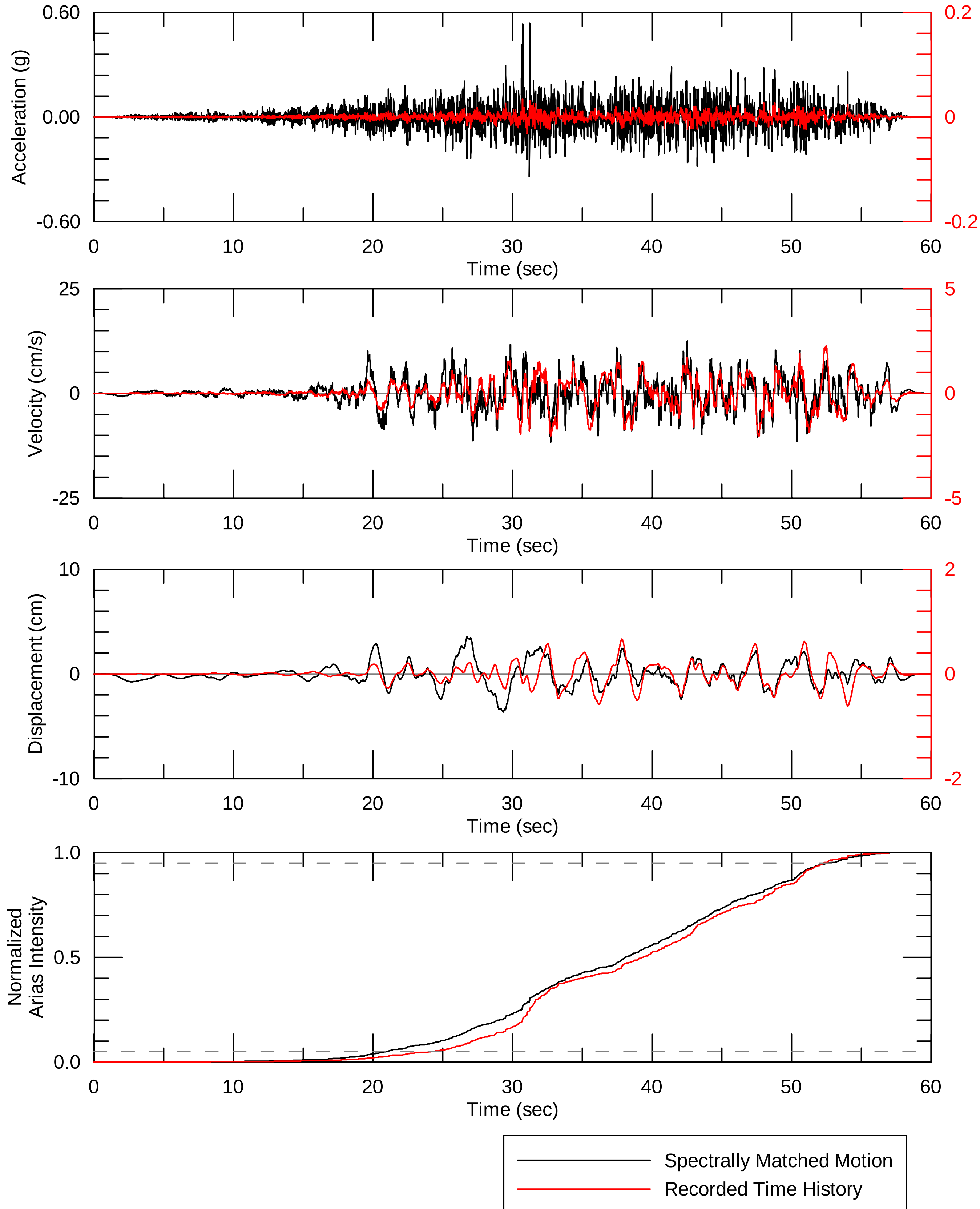
SEED: PEER RSN1404

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 1999 CHI CHI - PNG (E) SEED	Figure 35



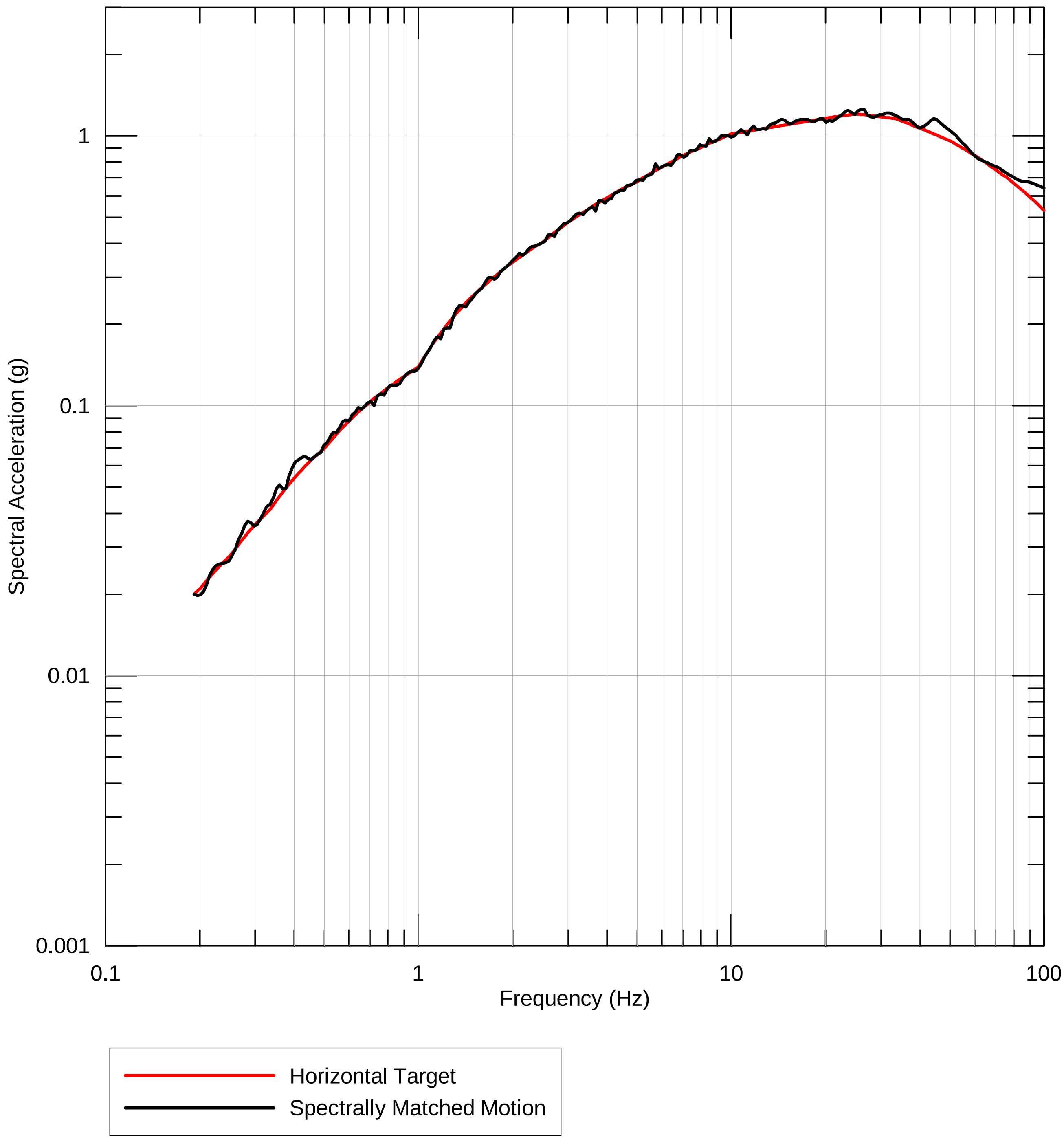
SEED: PEER RSN1404

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	RESPONSE SPECTRUM FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 1999 CHI CHI - PNG (N) SEED	Figure 36



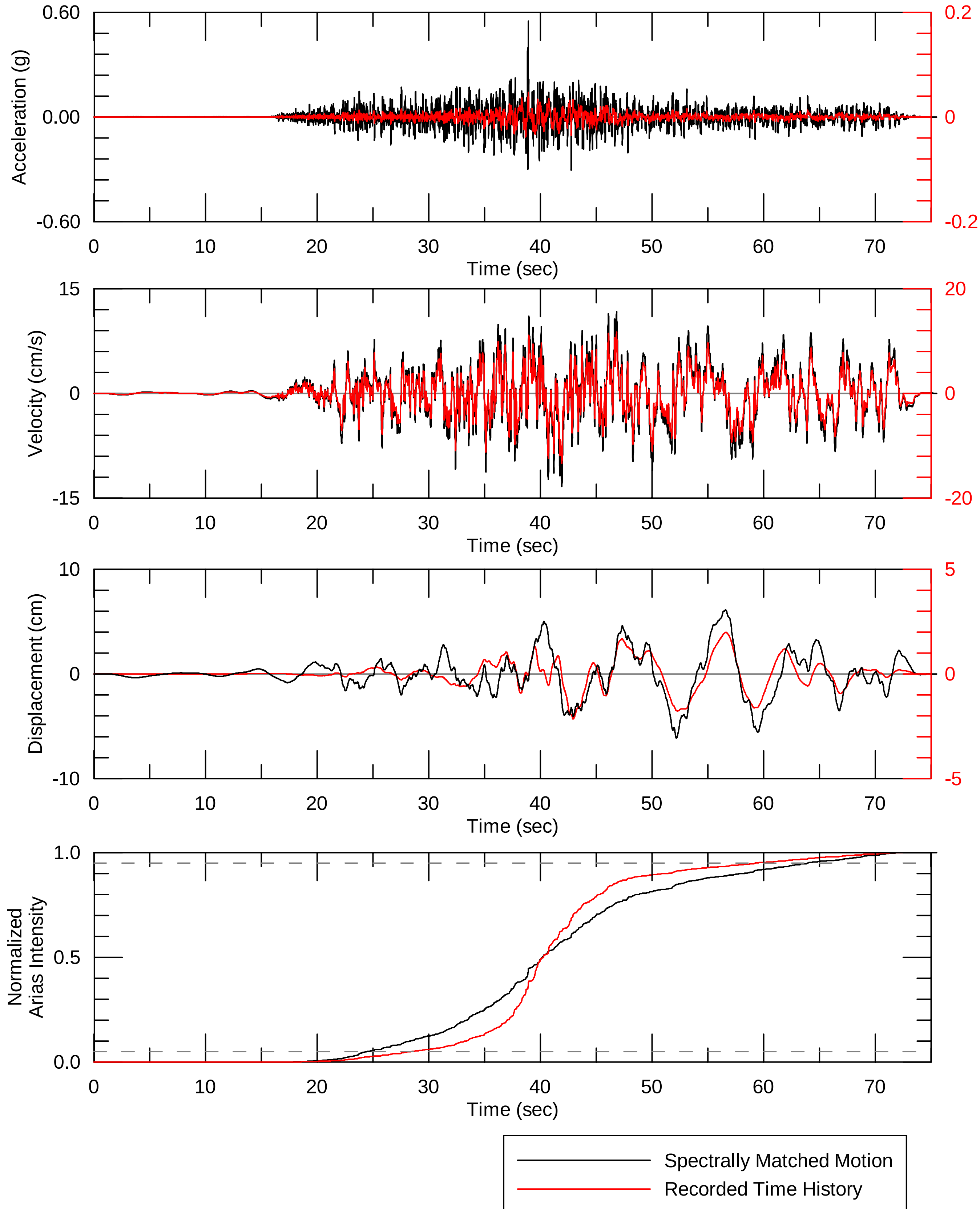
SEED: PEER RSN1404

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 1999 CHI CHI - PNG (N) SEED	Figure 37



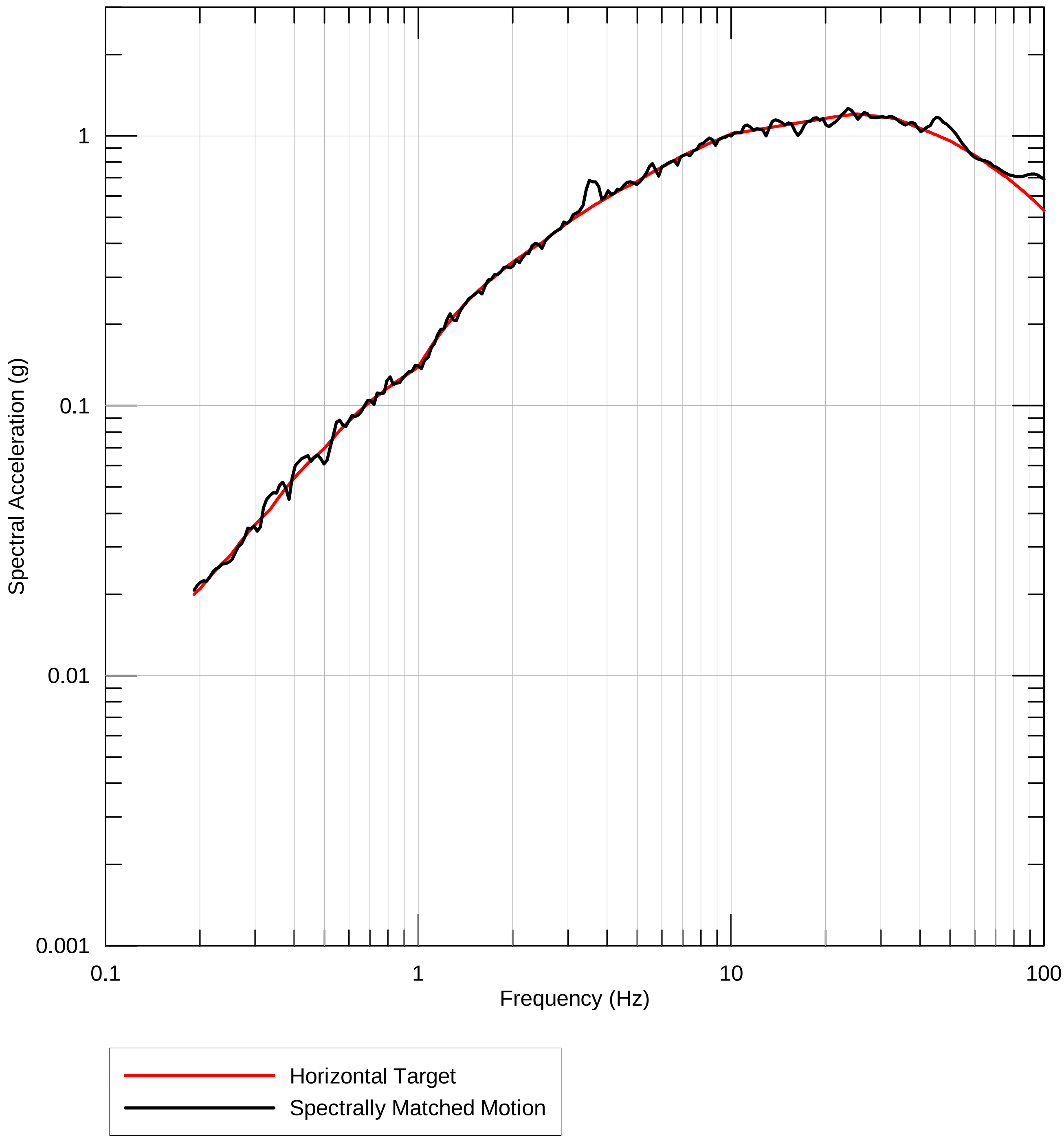
SEED: PEER RSN2112

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	RESPONSE SPECTRUM FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2002 DENALI - TAPS PUMP STATION #8 (049) SEED	Figure 38



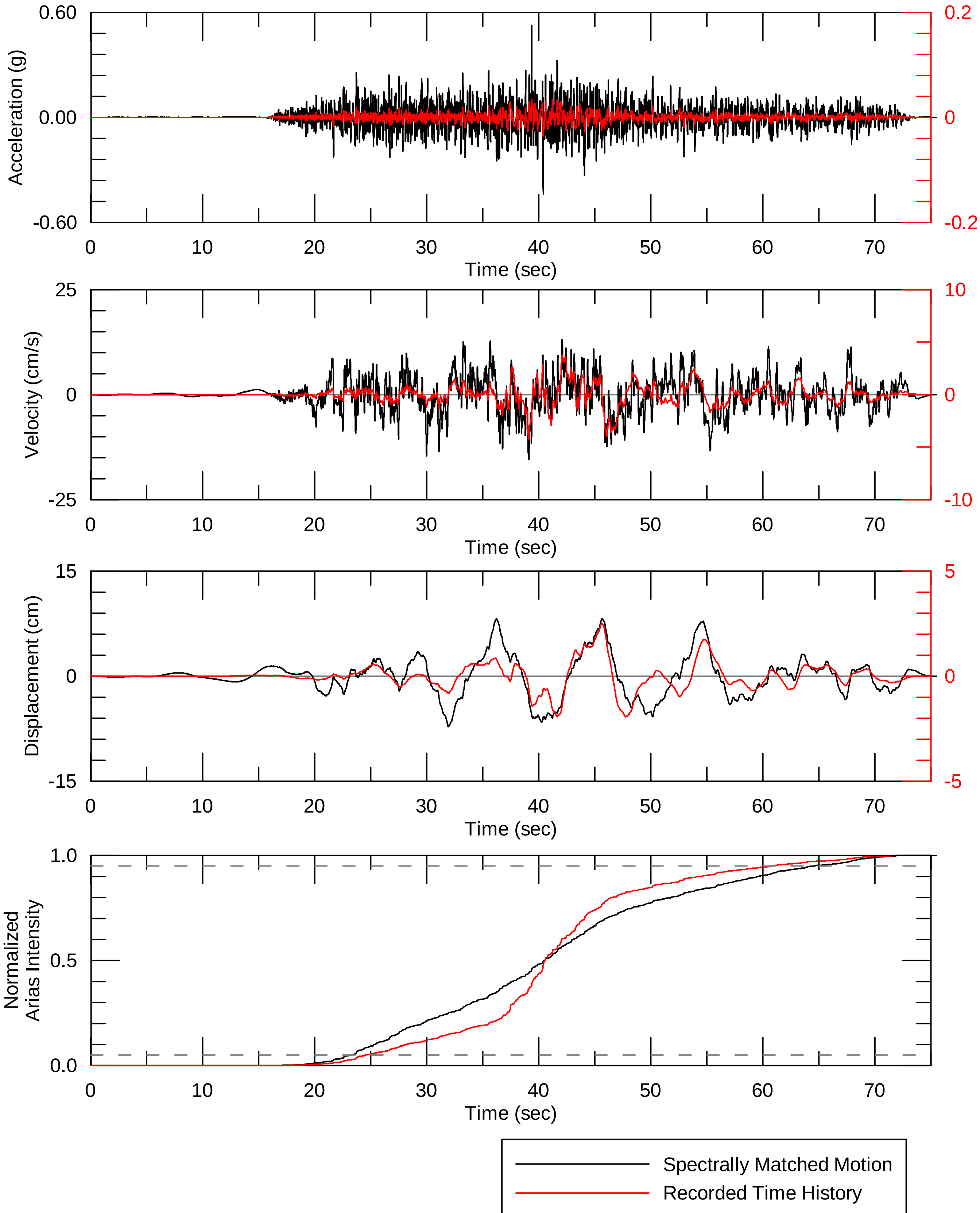
SEED: PEER RSN2112

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2002 DENALI - TAPS PUMP STATION #8 (049) SEED	Figure 39



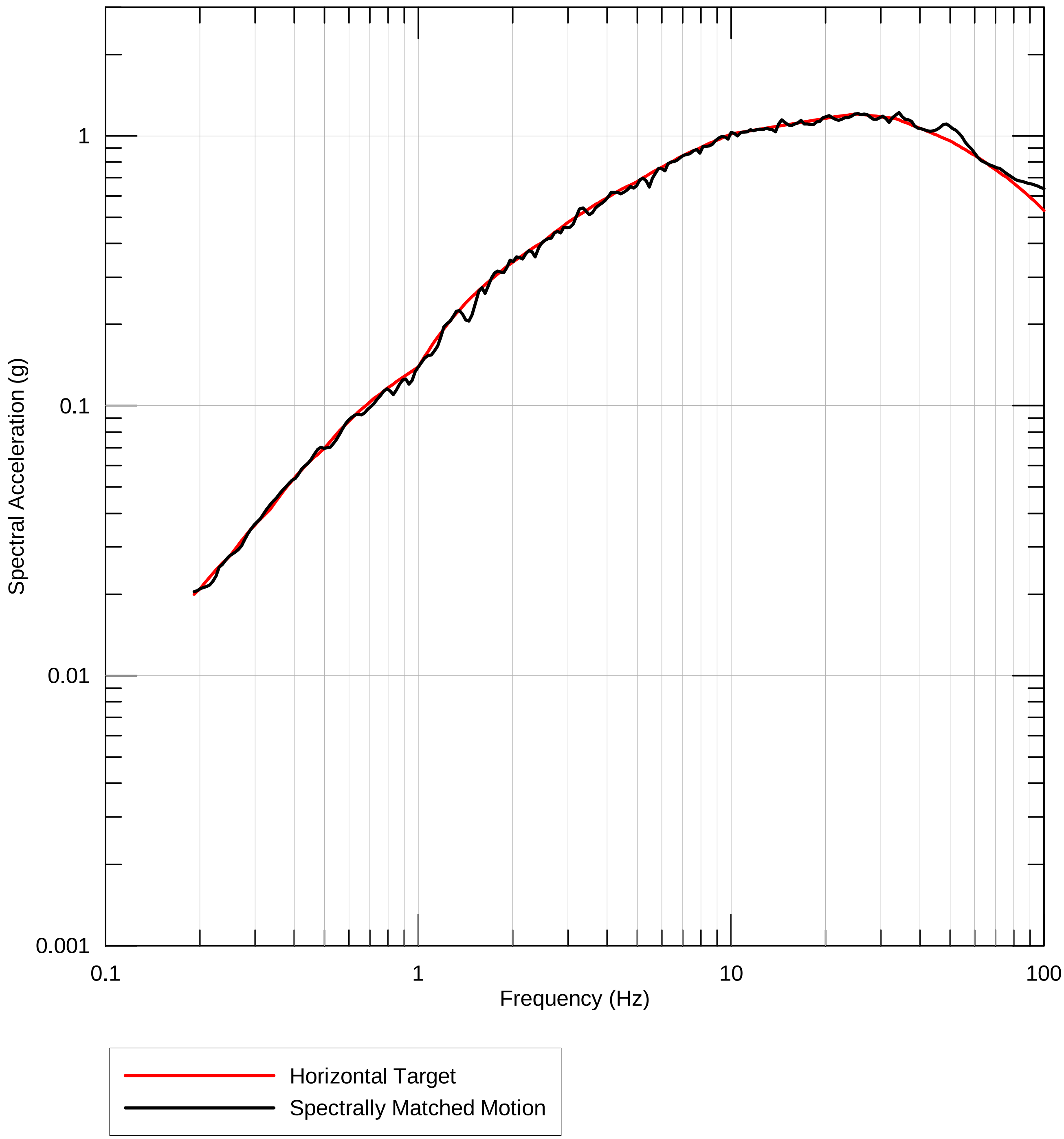
SEED: PEER RSN2112

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	RESPONSE SPECTRUM FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2002 DENALI - TAPS PUMP STATION #8 (319) SEED	Figure 40



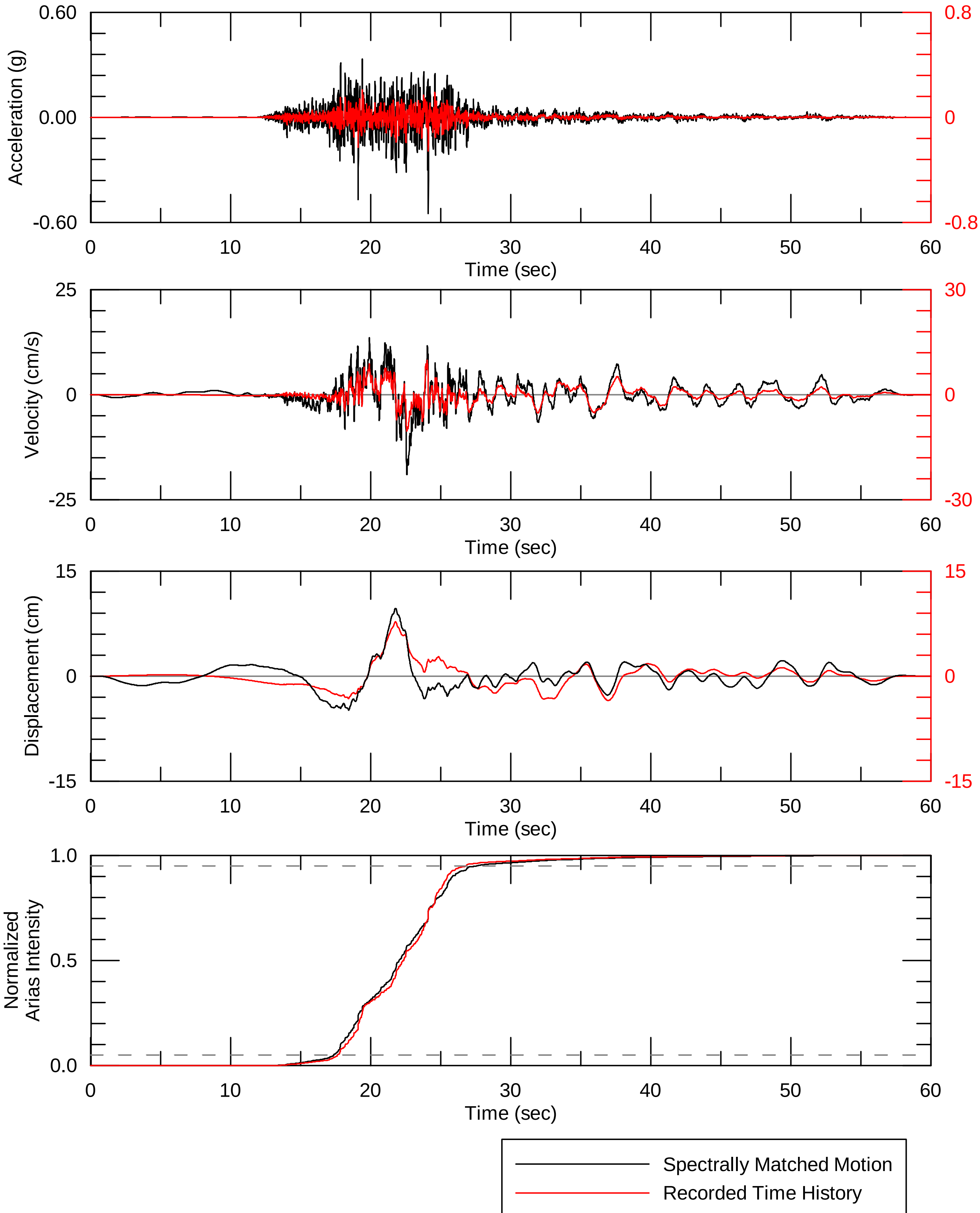
SEED: PEER RSN2112

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2002 DENALI - TAPS PUMP STATION #8 (319) SEED	Figure 41



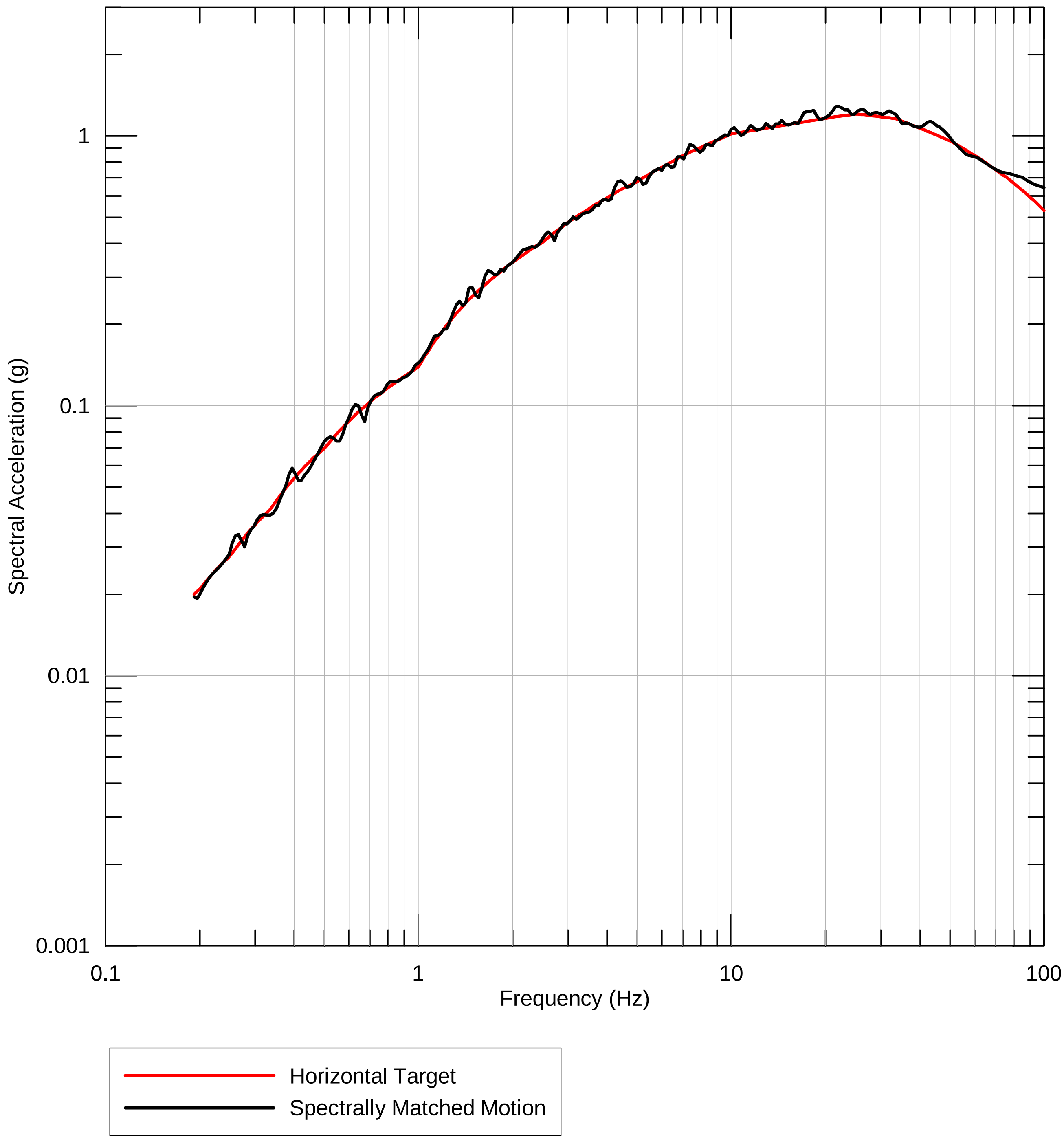
SEED: PEER RSN5804

AECOM	Project No.60442676 A.B. Brown Generating Station Vectren Corporation	RESPONSE SPECTRUM FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2008 IWATE - YAMAUCHI TSUCHIBUCHI YOKOTE (EW) SEED	Figure 42



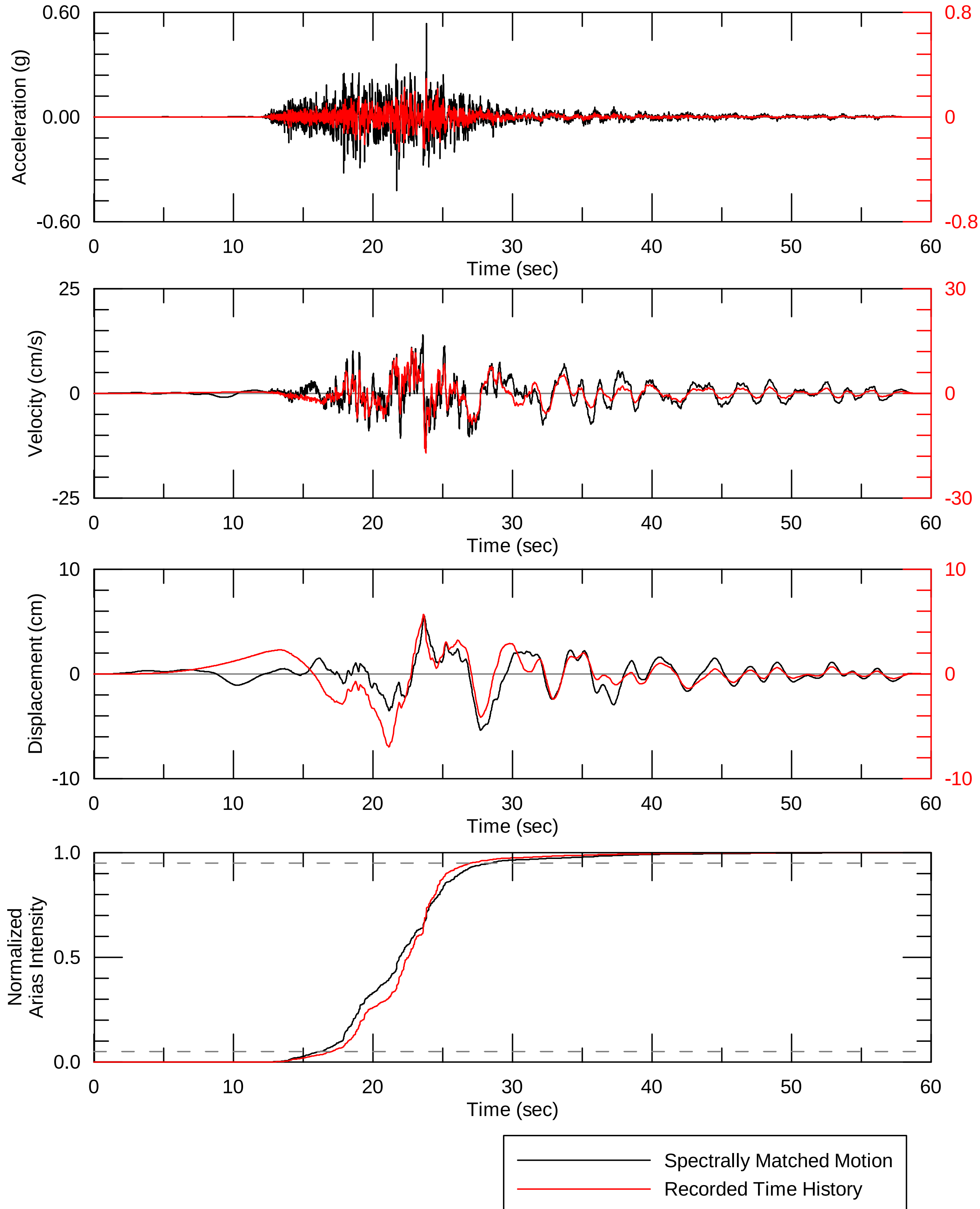
SEED: PEER RSN5804

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2008 IWATE - YAMAUCHI TSUCHIBUCHI YOKOTE (EW) SEED	Figure 43



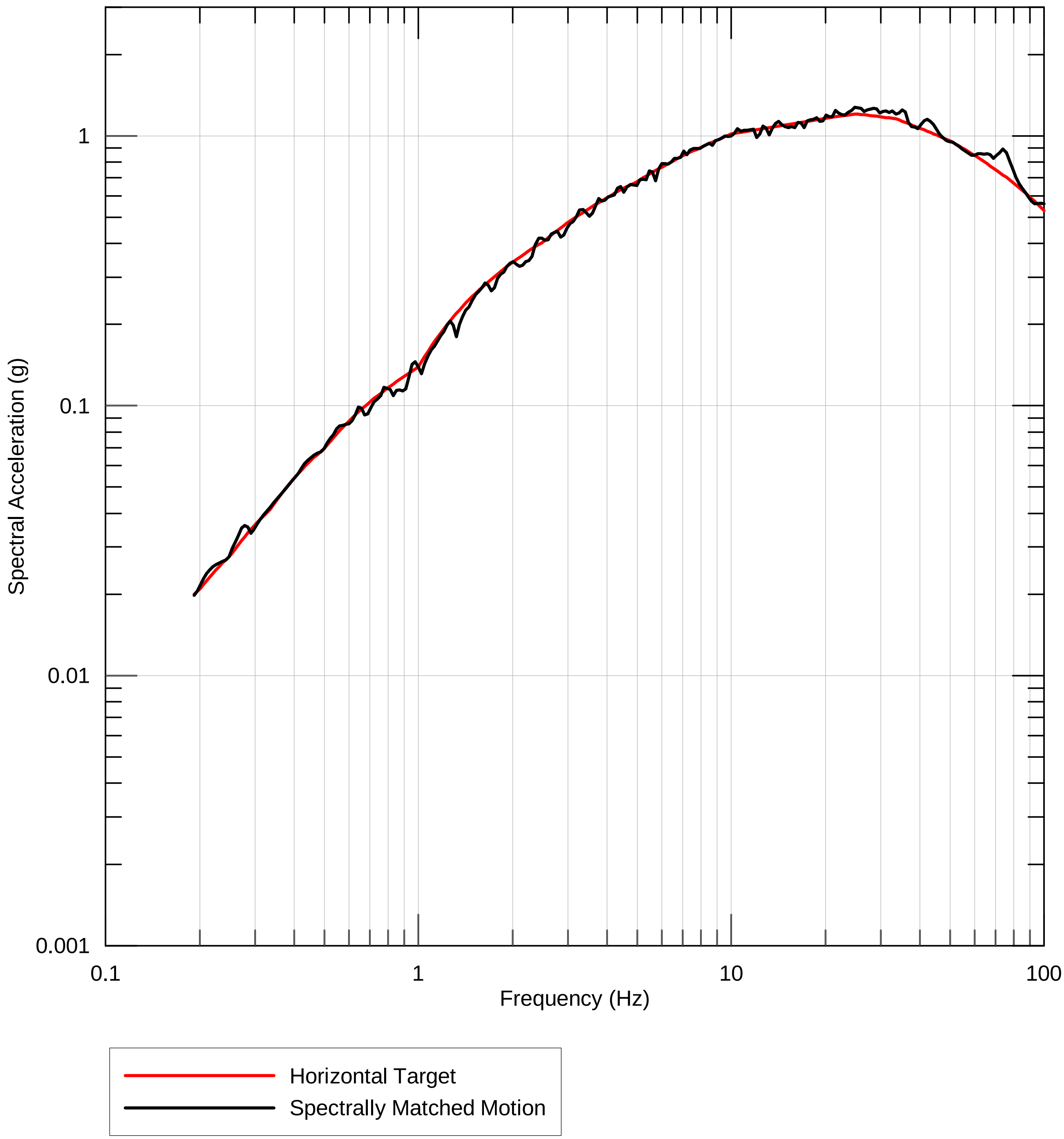
SEED: PEER RSN5804

AECOM	Project No.60442676 A.B. Brown Generating Station Vectren Corporation	RESPONSE SPECTRUM FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2008 IWATE - YAMAUCHI TSUCHIBUCHI YOKOTE (NS) SEED	Figure 44



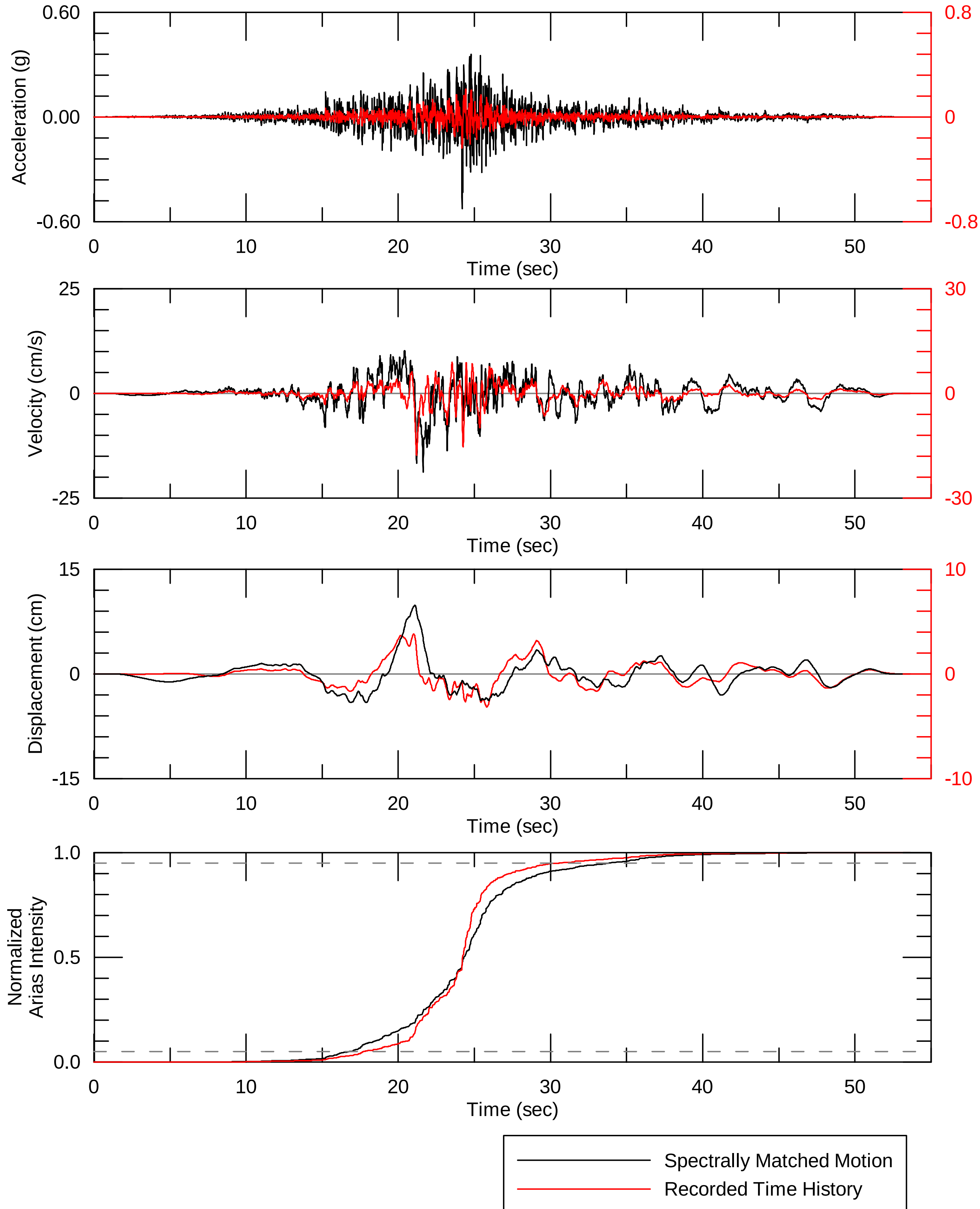
SEED: PEER RSN5804

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2008 IWATE - YAMAUCHI TSUCHIBUCHI YOKOTE (NS) SEED	Figure 45



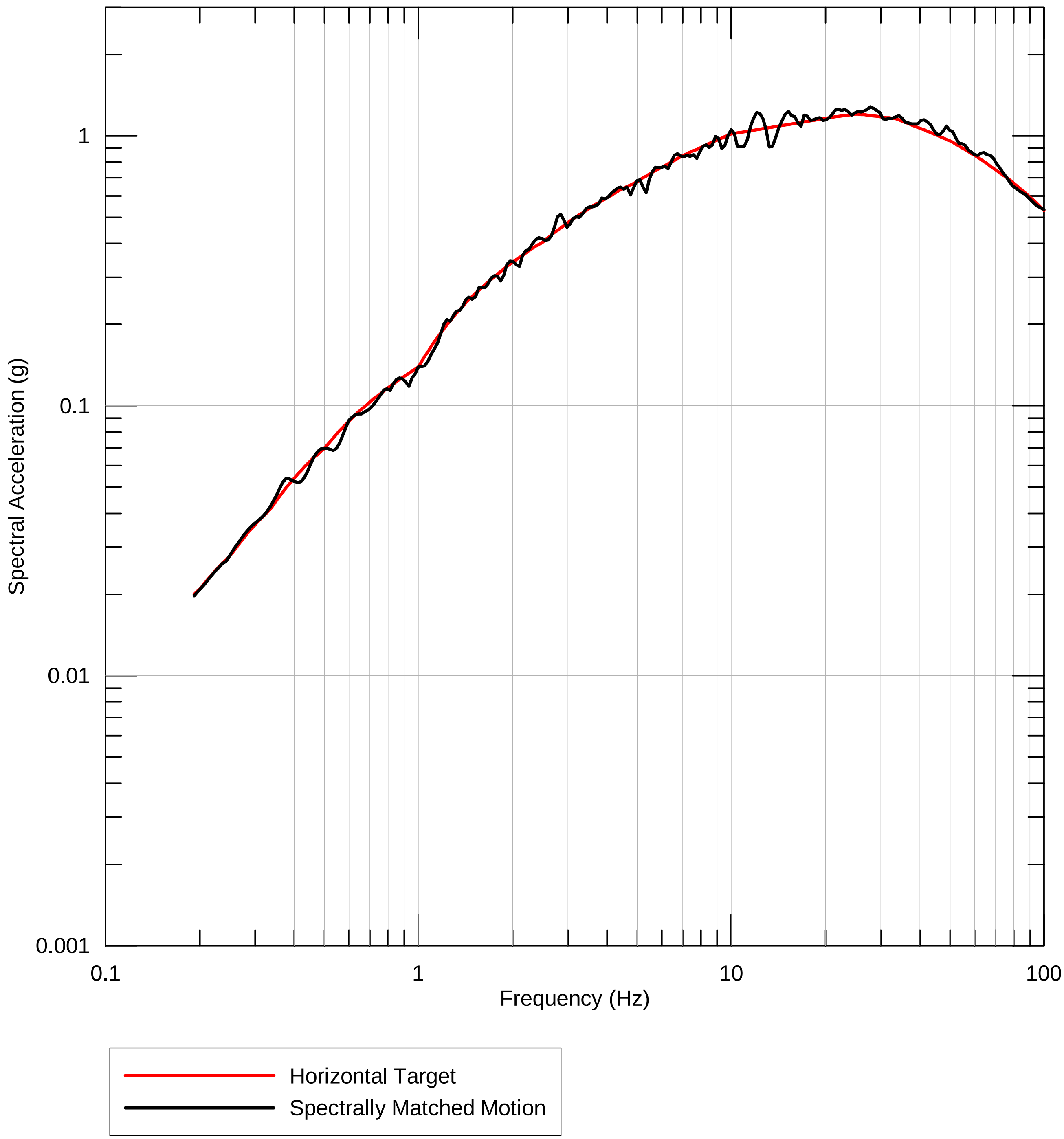
SEED: PEER RSN6928

AECOM	Project No.60442676 A.B. Brown Generating Station Vectren Corporation	RESPONSE SPECTRUM FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2010 DARFIELD - LPCC (080) SEED	Figure 46



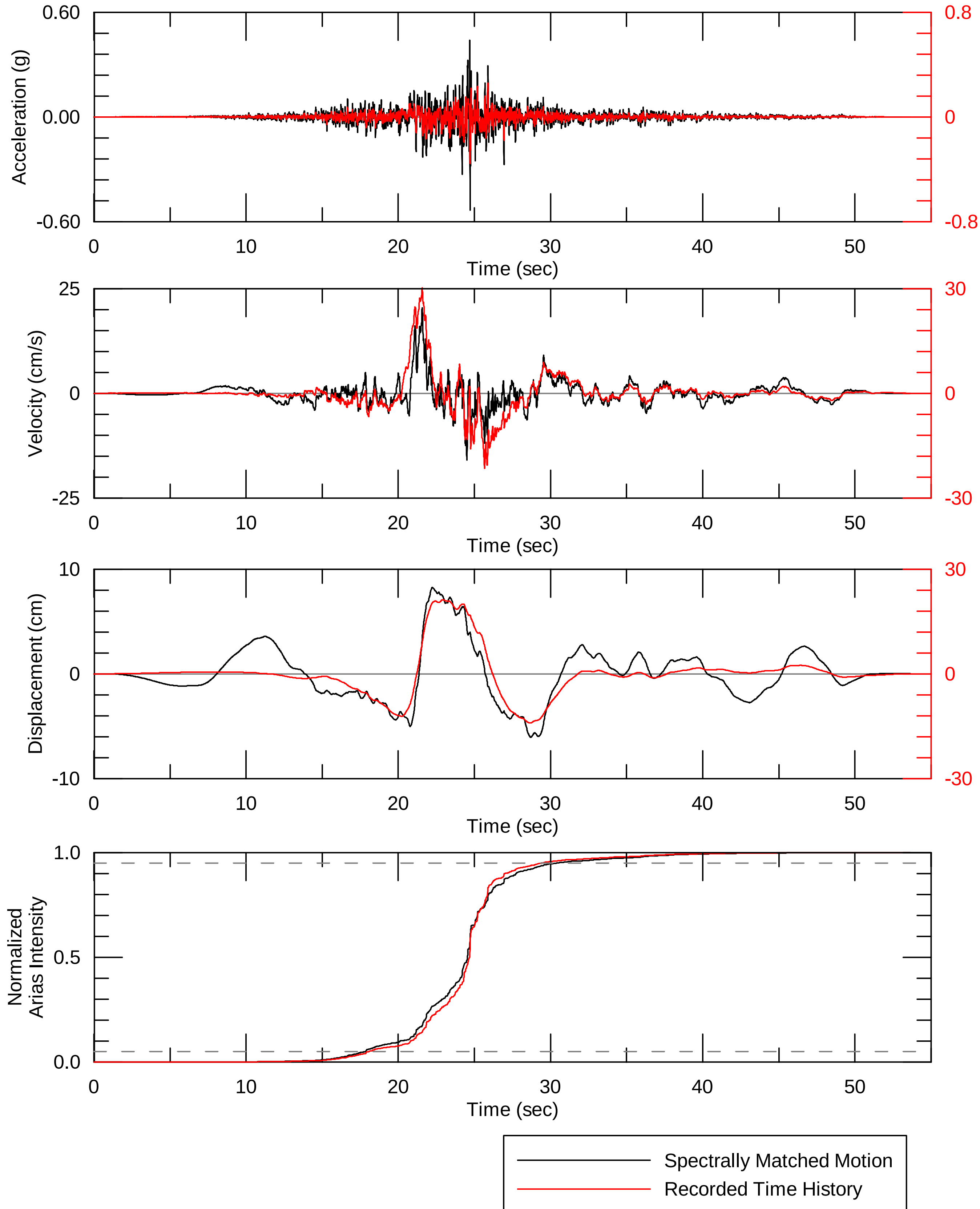
SEED: PEER RSN6928

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2010 DARFIELD - LPCC (080) SEED	Figure 47



SEED: PEER RSN6928

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	RESPONSE SPECTRUM FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2010 DARFIELD - LPCC (170) SEED	Figure 48



SEED: PEER RSN6928

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2010 DARFIELD - LPCC (170) SEED	Figure 49

About AECOM

AECOM is built to deliver a better world. We design, build, finance and operate infrastructure assets for governments, businesses and organizations in more than 150 countries. As a fully integrated firm, we connect knowledge and experience across our global network of experts to help clients solve their most complex challenges. From high-performance buildings and infrastructure, to resilient communities and environments, to stable and secure nations, our work is transformative, differentiated and vital. A Fortune 500 firm, AECOM companies had revenue of approximately US$18 billion during the 12 months ended September 30, 2015. See how we deliver what others can only imagine at aecom.com and @AECOM.

Appendix H
Dynamic Response Analysis Calculations

A. Objective

Perform a dynamic response analysis for the East Ash Pond. Use QUAD-4M finite element program to provide precise estimation of amplification/attenuation characteristics of the embankment structure at the site. Use the following embankment cross section for analysis:

- Cross-Section B1

Use acceleration time histories from Probabilistic Seismic Hazard Analysis (PSHA) report for the A.B. Brown Station by AECOM (2015). See **Appendix G** for the complete report.

B. Procedure

The QUAD-4M program uses a two-dimensional, dynamic finite-element formulation that utilizes equivalent-linear, strain-dependent modulus and damping properties. The program performs a time-domain analysis that allows variable damping throughout the model, and uses an iterative process to approximate the nonlinear behavior of soil. Shear moduli and damping ratios are estimated initially for each element in the model, and the system is analyzed using those properties. After each iteration, values of the effective shear strain are computed and the modulus and damping values are updated to correspond to the computed strain level for each element. The analysis iterations are repeated until compatibility between moduli, damping, and strain levels is achieved in all elements.

ASSUMPTIONS:

- All materials are homogeneous and isotropic.

a. Dynamic Material Properties

Dynamic response analysis of the model required characterization of the shear modulus (G), Poisson's ratio (v), and damping characteristics of embankment and foundation materials. To consider the variation in dynamic shear modulus with strain, the shear modulus is commonly represented in terms of its value at small strains (G_{max}) and the variation in the ratio (G/G_{max}) with shear strain, which is referred to as a modulus reduction relationship. Likewise, the variation in hysteretic damping with strain is represented by a damping relationship. For the clay embankment and clay foundation soils, the shear modulus reduction and damping relationships by Vucetic and Dobry (1991) were selected based on the index characteristics of the materials and experience. The average modulus-reduction and lower-bound damping relationships for sands by Seed and Idriss (1970) were selected to represent the sand foundation layer.

An estimate of the shear wave velocity of each soil stratum of the cross-section subsurface profile was developed using the average seismic shear wave velocity measurements obtained during the CPT testing program. The shear wave velocities were used to evaluate the dynamic shear modulus at small strains of the embankment and foundation materials, and the corresponding values of Poisson's ratio. The shear modulus at small strains was obtained from the measured shear wave velocity through the expression:

$$G_{max} = \rho V_s^2$$

where: Vs is the shear wave velocity and ρ is the mass density of the material. The shear wave velocities utilized in the analysis are given in Table H-1

Table H-1: Shear wave velocities of layers

Layer	Unit Weight (pcf)	Shear Wave Velocity (fps)
Embankment Clay	130	700
Native Clay	125	750
Native Sand	125	850

C. Results

The QUAD4M model incorporates a large number of finite elements making up the meshing for the whole cross-section. Seismically induced shear stresses are calculated for each element, and 2-dimensional plots of shear stress contours within the cross-section are generated. These plots are provided for each of the four time histories analyzed in the attachments. The peak cyclic shear stresses (in ksf) estimated for each time history is shown on the figures presented in the attachments.

The shear stresses vary both vertically and horizontally within the cross-section. As a broad interpretation of the results, the shear stresses and corresponding CSRs calculated for elements within the foundation sand layer were tallied, and ranges and averages were determined.

The CSR at any location was calculated as follows:

$$CSR = 0.65 * \tau_{cyc}/\sigma_{vc}'$$

where: τ_{cyc} = cyclic shear stress

σ_{vc}' = effective vertical stress

A summary of these values is provided in Table H-2 below:

Table H-2: Shear Stresses and Cyclic Stress Ratios (CSR) In Sand Deposit from each Time History (From QUAD4M Analysis)

Time History	Range of Shear Stresses in Sand (ksf)	Average CSR in Sand	Range of CSRs in Sand

1	1.2-1.4	0.15	0.150-0.180
2	1.1-1.3	0.14	0.144-0.136
3	1.2-1.3	0.14	0.134-0.162
4	1.2-1.3	0.14	0.129-0.159

The varying Liquefaction screening analyses utilize the CSR within the layer of interest as part of the formulation of the method. The QUAD-4M results were utilized to establish the variation of CSR as a function of depth within the silt deposit for these analyses. Specifically, the element CSR results at the location of the centerline of the bench were taken from the QUAD4M results, as shown in attachments. The average CSR (among all time histories analyzed) at the top, center, and bottom of the sand layer at this location are summarized in Table H-3.

Table H-3: Average Shear Stresses and Cyclic Stress Ratios (CSR) In Sand Zone (From QUAD4M Analysis)

Location	Average CSR
Top of Sand Deposit	0.154
Center of Sand Deposit	0.146
Bottom of Sand Deposit	0.145

Complete output from the QUAD-4M dynamic response analysis is presented as an attachment at the end of this calculation.

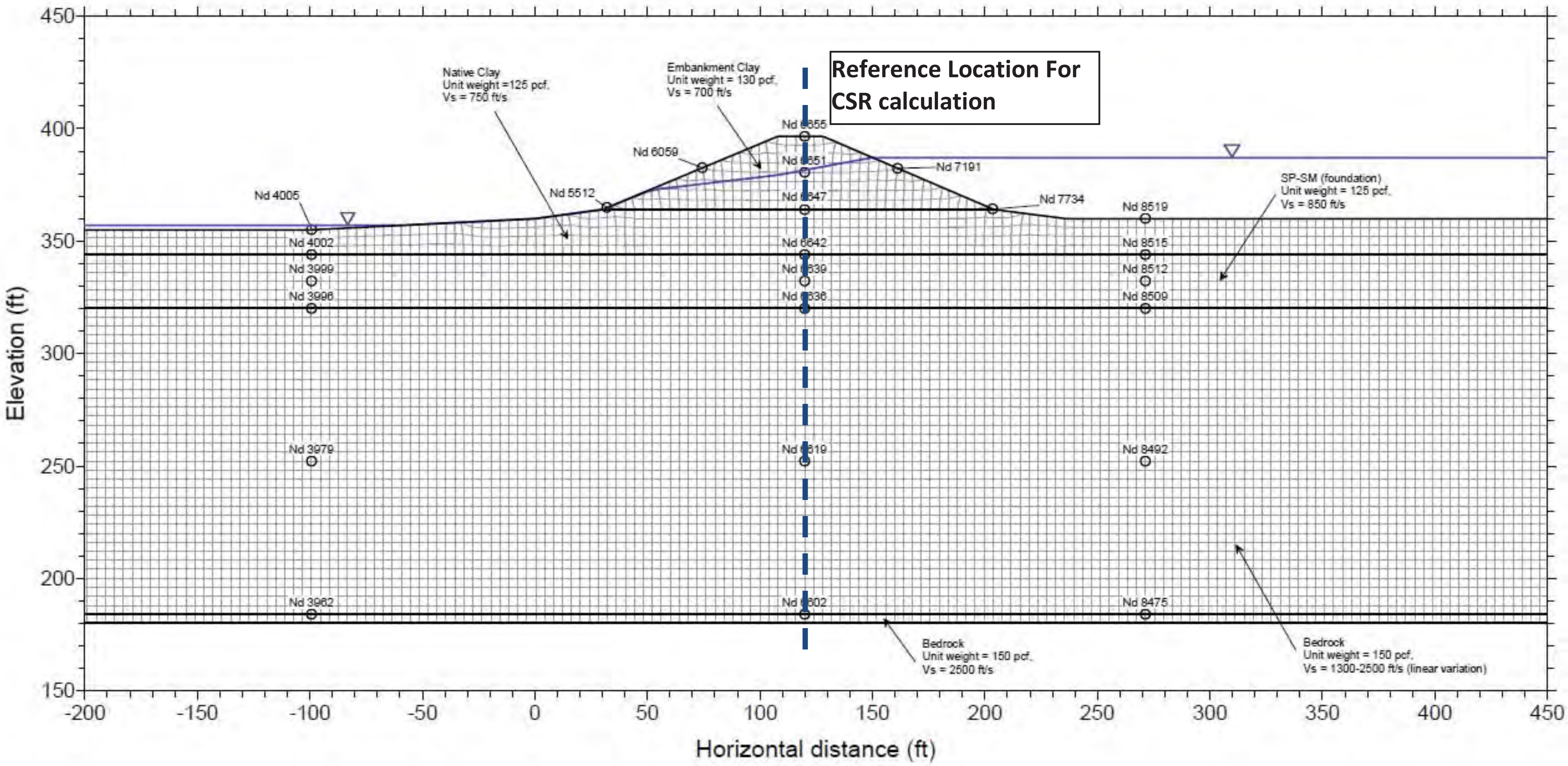
D. Attachments

H.1 QUAD-4M Dynamic Response Analysis Output

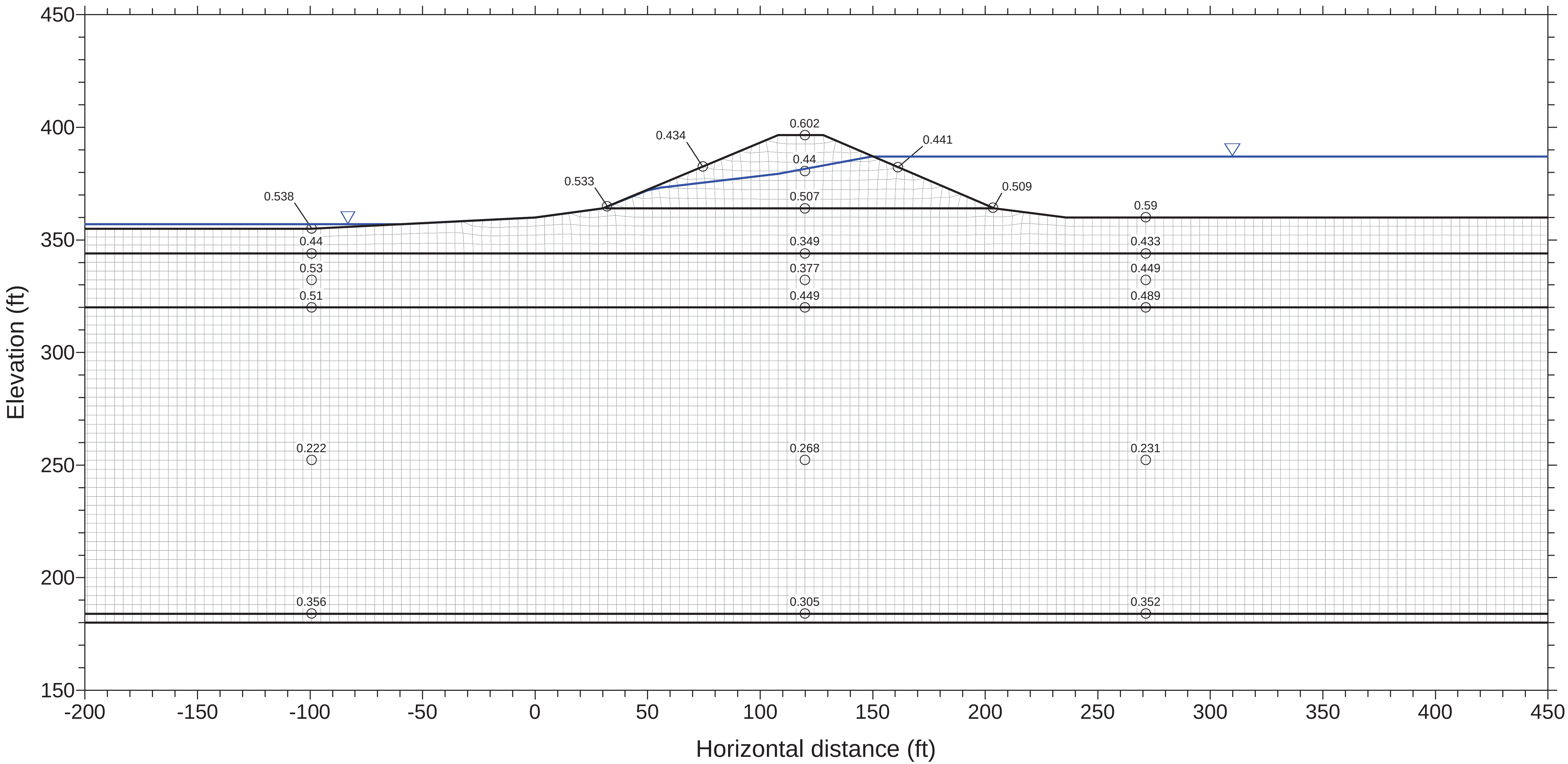
References

Idriss, I.M., Lysmer, J., Hwang, R., and Seed, H.B., 1973, QUAD4: A computer program for evaluating the seismic response of soil structures by variable damping finite-element procedures: Earthquake Engineering Research Institute, University of California, Berkeley, Report 73-16.

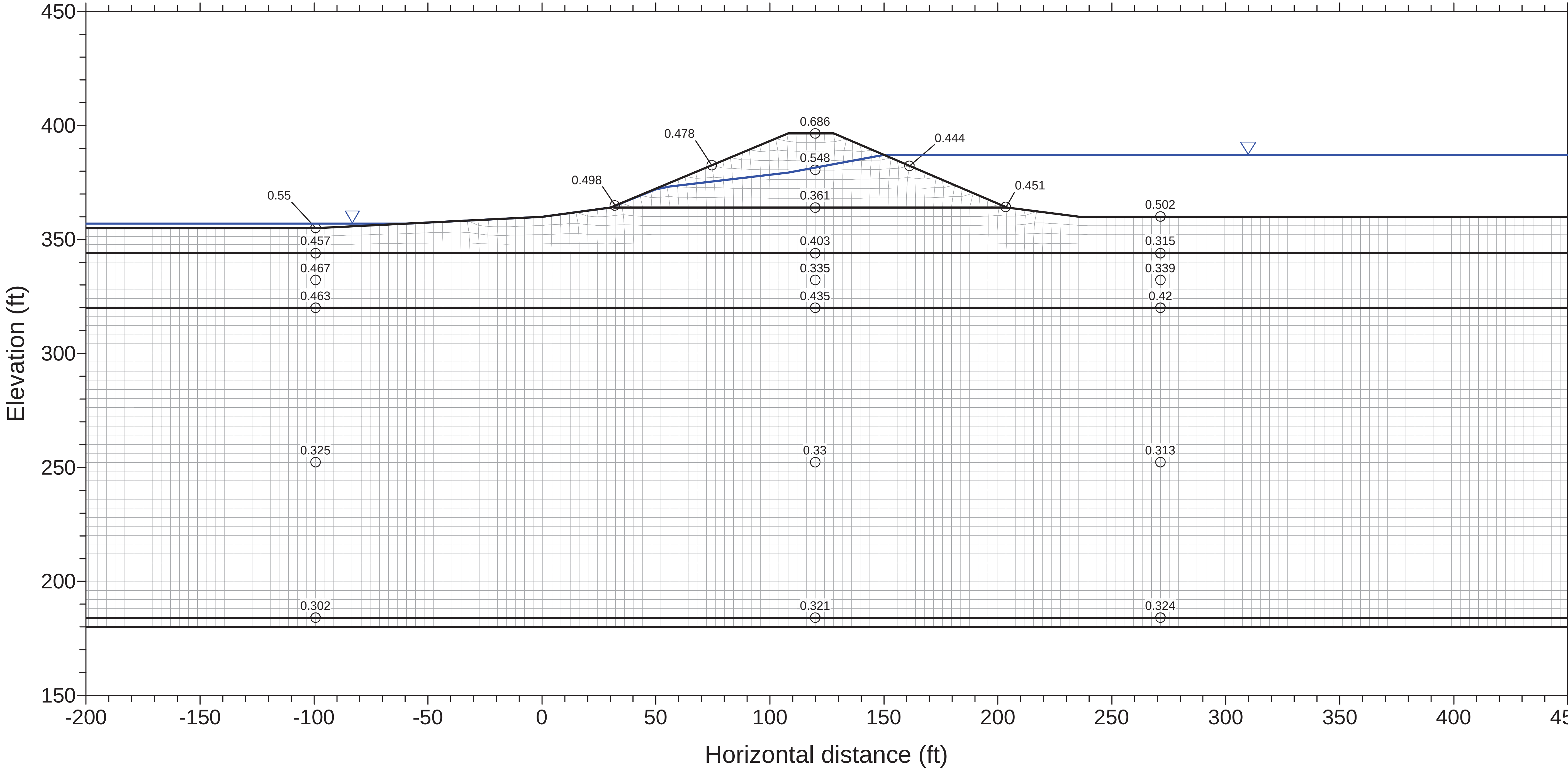
Vucetic, M. and Dobry, R. (1991). "Effect of Soil Plasticity on Cyclic Response". Journal of Geotechnical Engineering (ASCE). Vol. 117, No. 1, pp. 89-117.



Reference Location For CSR calculation
Native Clay
Unit weight =125 pcf,
Vs = 750 ft/s
Embankment Clay
Unit weight = 130 pcf,
Vs = 700 ft/s
SP-SM (foundation)
Unit weight = 125 pcf,
Vs = 850 ft/s
Bedrock
Unit weight = 150 pcf,
Vs = 2500 ft/s
Bedrock
Unit weight = 150 pcf,
Vs = 1300-2500 ft/s (linear variation)
Nd 4005
Nd 4002
Nd 3999
Nd 3996
Nd 3979
Nd 3962
Nd 5512
Nd 6059
Nd 7191
Nd 7734
Nd 6642
Nd 8519
Nd 8515
Nd 8512
Nd 8509
Nd 8492
Nd 8475
Elevation (ft)
Horizontal distance (ft)
450
400
350
300
250
200
150
-200
-150
-100
-50
0
50
100
150
200
250
300
350
400
450



Project No. 60442676	Vectren FB Culley CCR Study	FB Culley East Ash Pond Dam Section QUAD4 Output - Nodal Acceleration (g) Base Motion: TH1	Figure 2-1
	AECOM		



Project No. 60442676	Vectren FB Culley CCR Study	FB Culley East Ash Pond Dam Section QUAD4 Output - Nodal Acceleration (g) Base Motion: TH2	Figure 2-2
	AECOM		

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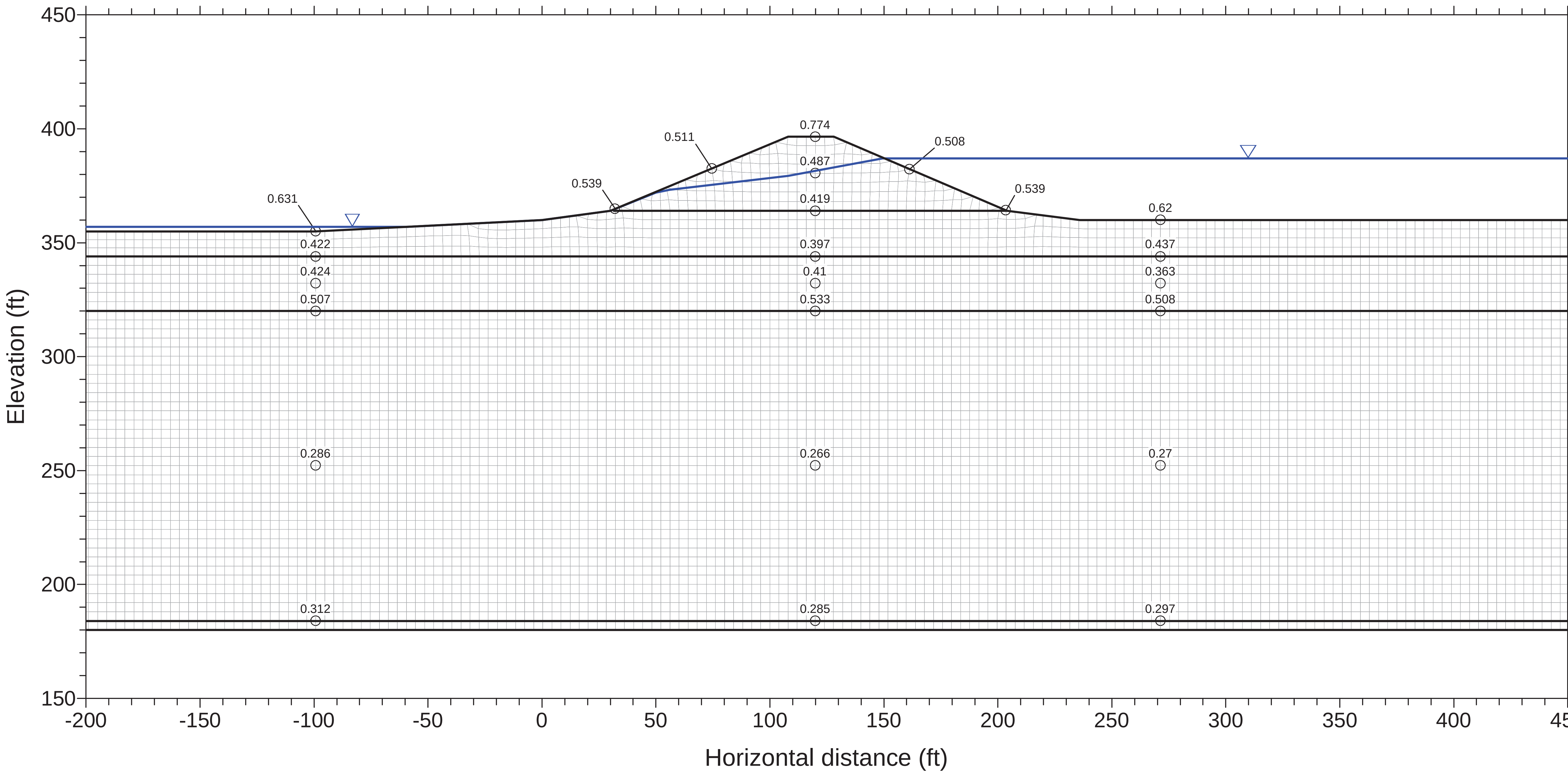

Project No. 60442676	Vectren FB Culley CCR Study	FB Culley East Ash Pond Dam Section QUAD4 Output - Nodal Acceleration (g) Base Motion: TH3	Figure 2-3
	AECOM		

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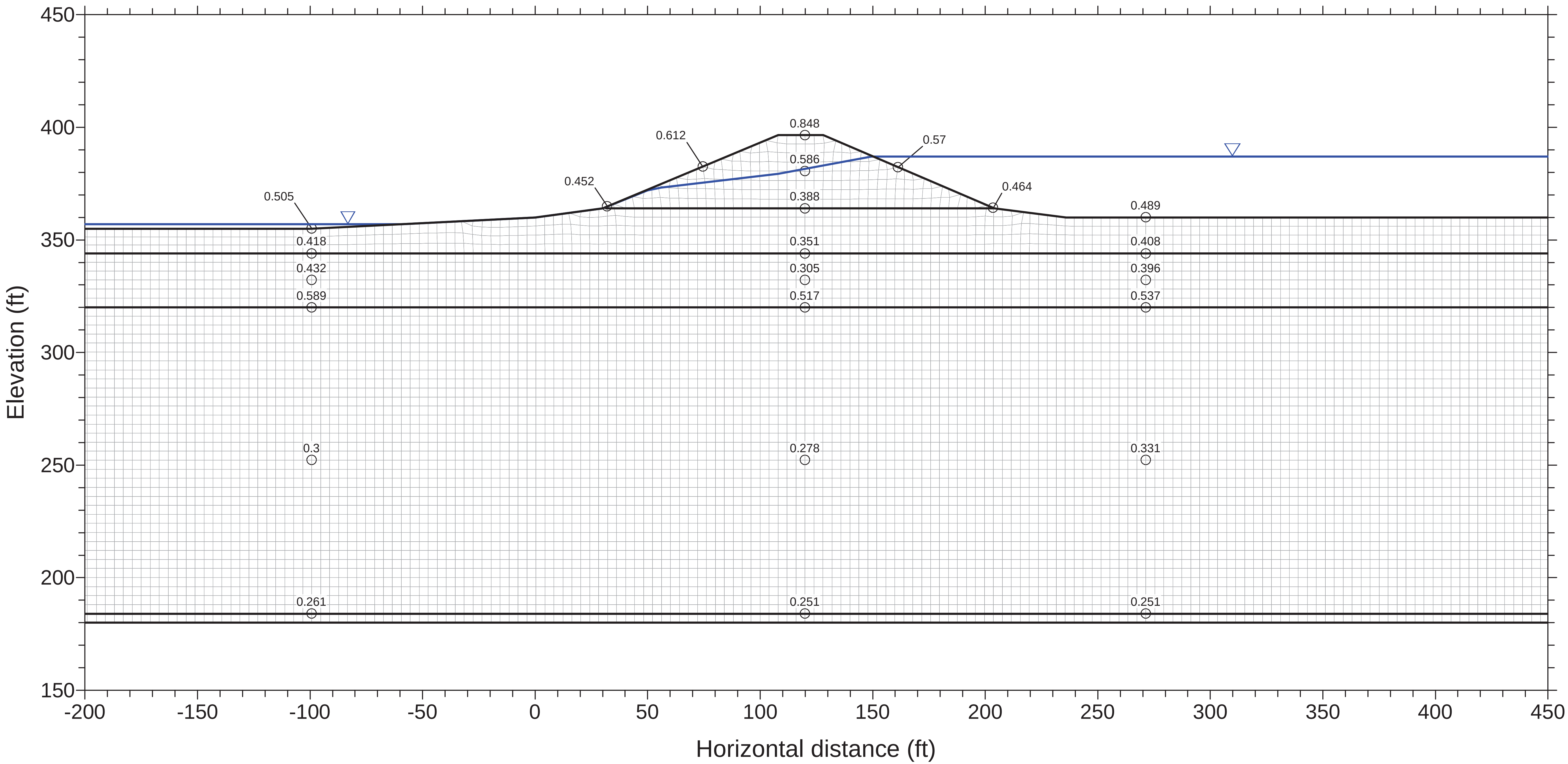

Project No. 60442676	Vectren FB Culley CCR Study	FB Culley East Ash Pond Dam Section QUAD4 Output - Nodal Acceleration (g) Base Motion: TH4	Figure 2-4
	AECOM		

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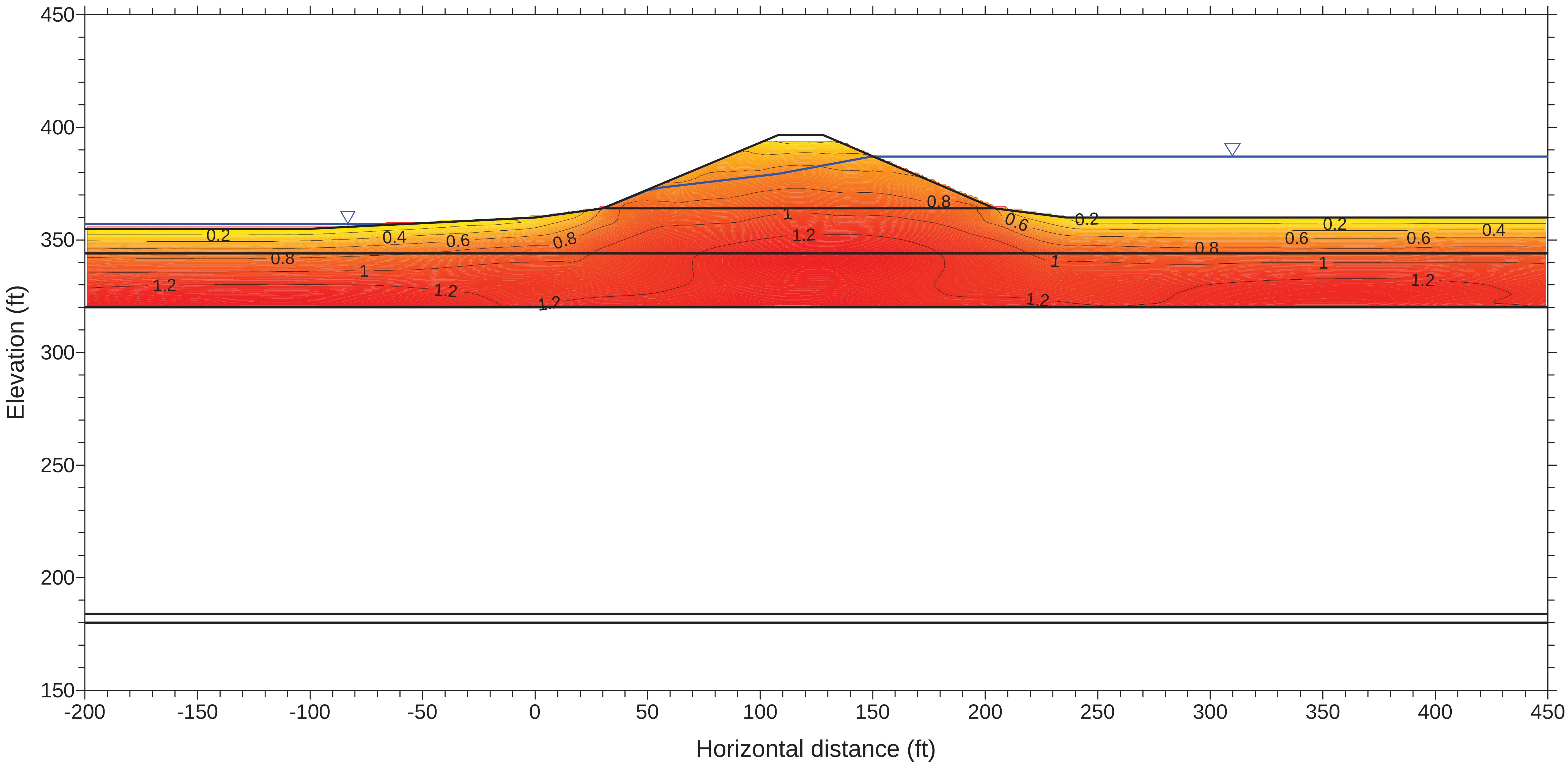

Project No. 60442676	Vectren FB Culley CCR Study	FB Culley East Ash Pond Dam Section QUAD4 Output - Peak Shear Stress (ksf) Base Motion: TH1	Figure 3-1
	AECOM		

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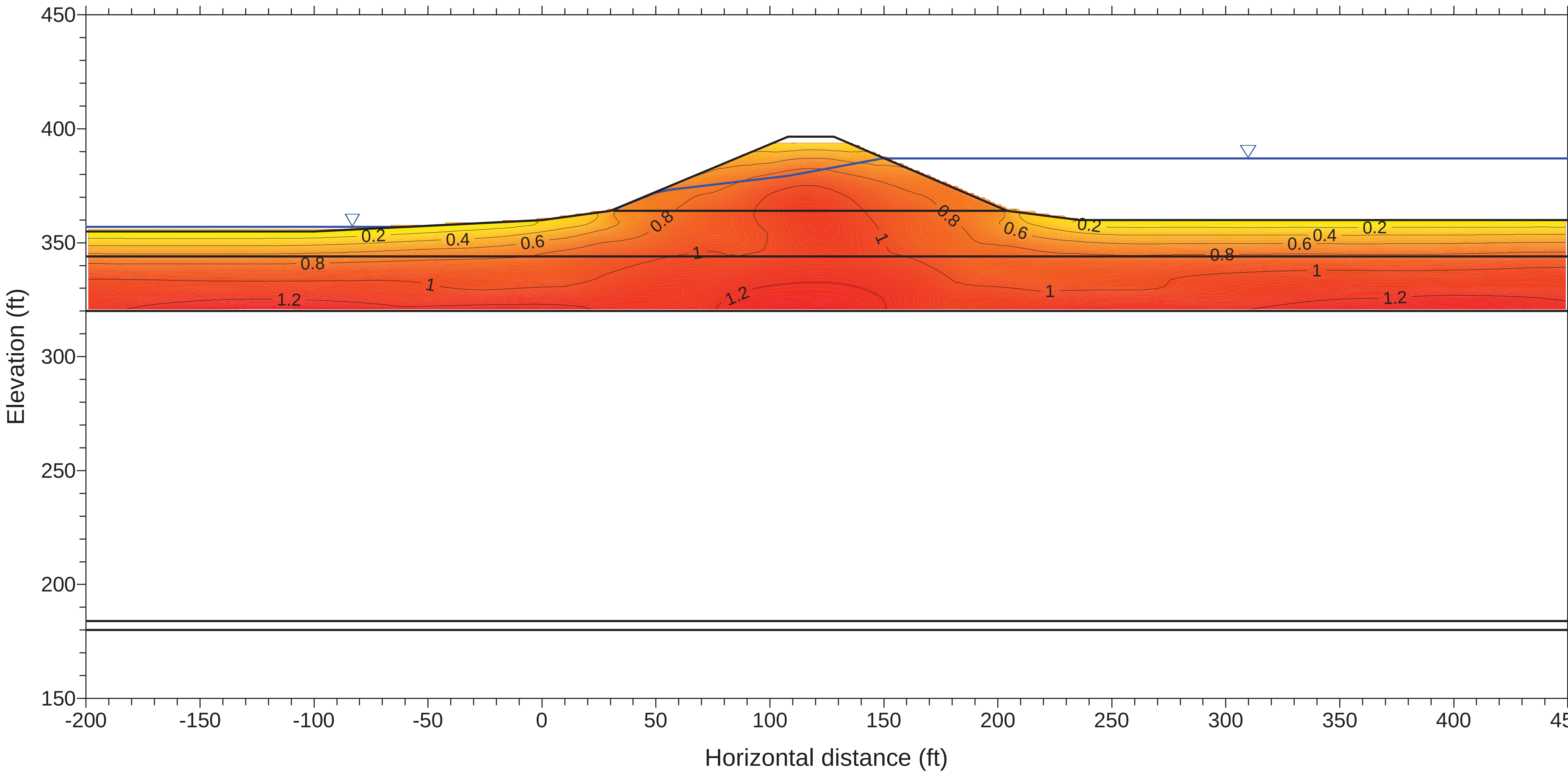

Project No. 60442676	Vectren FB Culley CCR Study	FB Culley East Ash Pond Dam Section QUAD4 Output - Peak Shear Stress (ksf) Base Motion: TH2	Figure 3-2
	AECOM		

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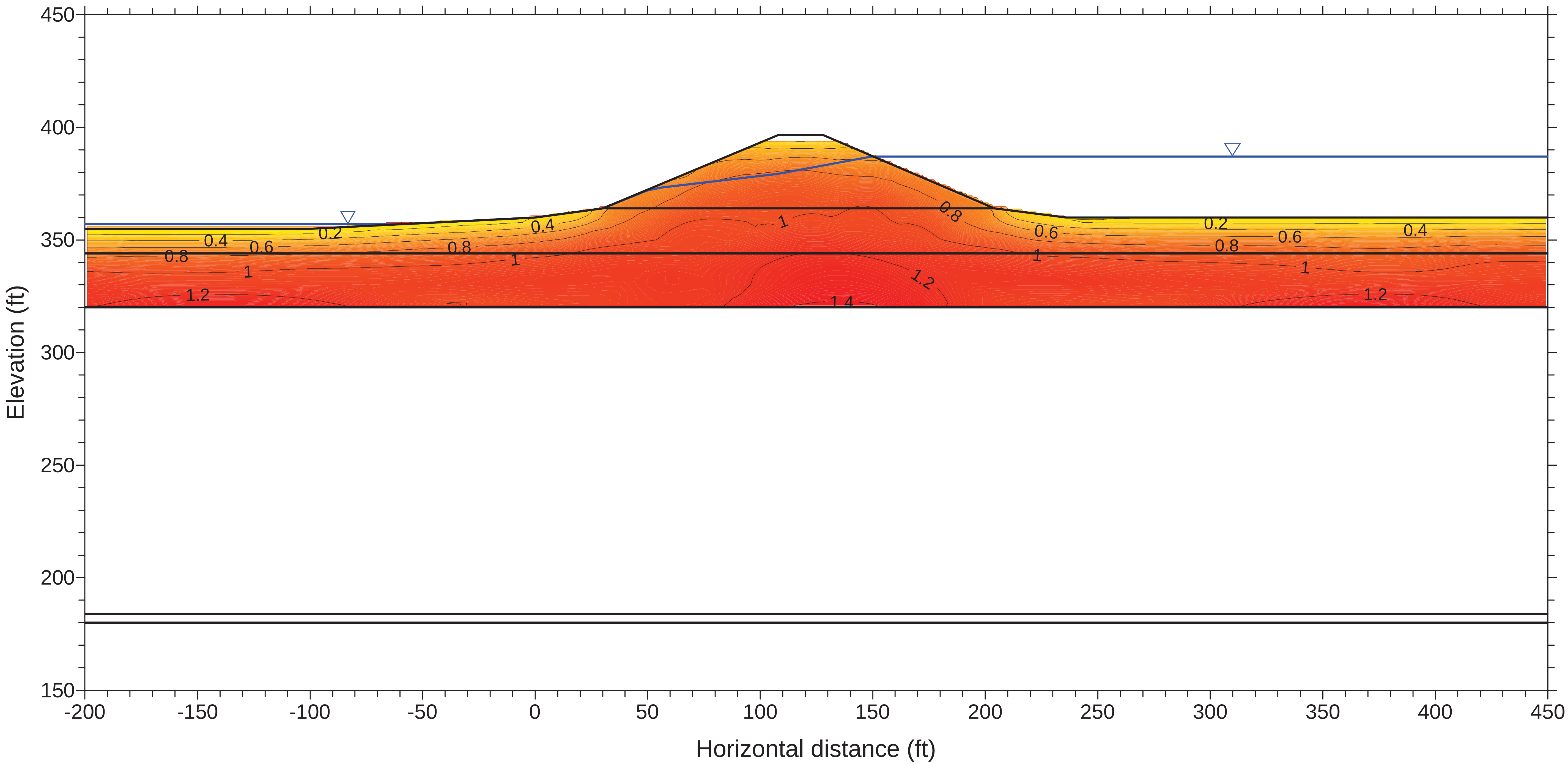

Project No. 60442676	Vectren FB Culley CCR Study	FB Culley East Ash Pond Dam Section QUAD4 Output - Peak Shear Stress (ksf) Base Motion: TH3	Figure 3-3
	AECOM		

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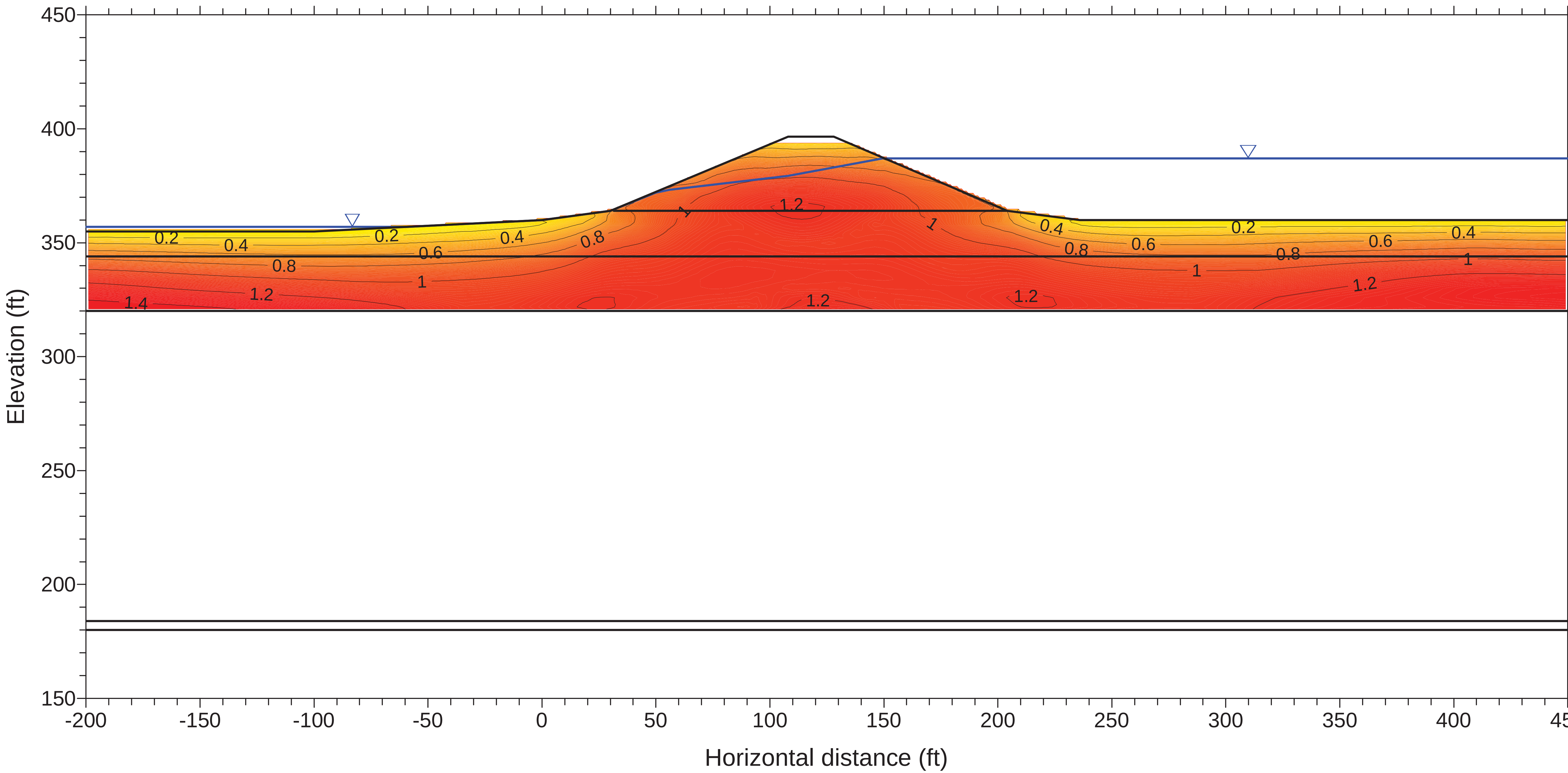

Project No. 60442676	Vectren FB Culley CCR Study	FB Culley East Ash Pond Dam Section QUAD4 Output - Peak Shear Stress (ksf) Base Motion: TH4	Figure 3-4
	AECOM		

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Appendix I
Liquefaction Analysis Calculations

A. Objective

Perform a liquefaction analysis for the East Ash Pond. For SPT borings, analyze saturated granular layers. Use the following geotechnical explorations performed by AECOM and others:

- Borings: AECOM B1 and B2, CARDNO B101 and B102, and ATC B1 and B2

Use earthquake magnitude obtained from USGS deaggregation, use PGA_{BC} obtained from the USGS deaggregation, amplified for Site Class D to obtain the PGA at the ground surface (See seismic parameter calculations within Slope Stability Calculations (**Appendix F**) for deaggregation and estimation of the PGA at the ground surface.

B. Procedure

- Obtain estimated ground motions, including modified peak ground acceleration for the respective site class, and earthquake moment magnitude. (As noted above, see seismic parameter calculations within Slope Stability Calculations (**Appendix F**) for deaggregation and estimation of the PGA at the ground surface.)
- Compute liquefaction potential based on Cyclic Stress Ratio (CSR) and Cyclic Resistance Ratio (CRR).

ASSUMPTIONS:

- All materials are homogeneous and isotropic.

a. Development of Cyclic Stress Ratio using QUAD-4M

The QUAD4M finite element program (Hudson et al. 1994) was used to precisely estimate the amplification/attenuation characteristics of the dam structure and local soils to the design rock motions and to estimate the earthquake-induced stresses within the embankment and foundation. Input to the dynamic response analyses includes the acceleration time histories developed as part of the Probabalistic Seismic Hazard Analysis (PSHA) for the A.B. Brown Station (AECOM, 2015), **Appendix G**. Since the AB Brown site is closer to the New Madrid Fault, the ground motions estimated for this site is expected to be conservative. Earthquake-induced shear stresses computed using QUAD-4M were used directly in SPT-based liquefaction triggering analysis.

Dynamic response analysis of the model required characterization of the shear modulus (G), Poisson's ratio (v), and damping characteristics of embankment and foundation materials. To consider the variation in dynamic shear modulus with strain, the shear modulus is commonly represented in terms of its value at small strains (G_{MAX}) and the variation in the ratio (G/G_{MAX}) with shear strain, which is referred to as a modulus reduction relationship. Likewise, the variation in hysteretic damping with strain is represented by a damping relationship. For the clay embankment and clay foundation soils, the shear modulus reduction and damping relationships by Vucetic and Dobry (1991) were selected based on the index characteristics of the materials and experience. The average modulus-reduction and lower-bound damping relationships for sands by Seed and Idriss (1970) were selected to represent the sand foundation layer.

An estimate of the shear wave velocity of each soil stratum of the cross-section subsurface profile was developed using the average seismic shear wave velocity measurements obtained during the CPT tests conducted at the East Ash Pond. The shear wave velocities were used to evaluate the dynamic shear modulus at small strains of the embankment and foundation materials, and the corresponding values of Poisson's ratio. The shear modulus at small strains was obtained from the measured shear wave velocity through the expression:

$$G_{MAX} = \rho V_s^2$$

where: Vs is the shear wave velocity and ρ is the mass density of the material. The shear wave velocities utilized in the analysis are given in Table I-1.

Table I-1: Shear wave velocities of layers

Layer	Unit Weight (pcf)	Shear Wave Velocity (fps)
Embankment Clay	130	700
Native Clay	125	750
Native Sand	125	850

The QUAD4M model incorporates a large number of finite elements making up the meshing for the whole cross-section. Seismically induced shear stresses are calculated for each element, and 2-dimensional plots of shear stress contours within the cross-section are generated. These plots are provided for each of the four time histories analyzed in **Appendix H**. The peak cyclic shear stresses (in ksf) estimated for each time history is shown on the figures presented in **Appendix H**, Figures 5.1 to 5.5.

The shear stresses vary both vertically and horizontally within the cross-section. As a broad interpretation of the results, the shear stresses and corresponding CSRs calculated for elements within the foundation sand layer were tallied, and ranges and averages were determined.

The CSR at any location was calculated as follows:

$$CSR = 0.65 * \tau_{cyc}/\sigma_{vc}'$$

where: τ_{cyc} = cyclic shear stress

σ_{vc}' = effective vertical stress

A summary of these values is provided in Table I-2 below:

Table I-2: Shear Stresses and Cyclic Stress Ratios (CSR) In Sand Deposit from each Time History (From QUAD4M Analysis)

Time History	Range of Shear Stresses in Sand (ksf)	Average CSR in Sand	Range of CSRs in Sand
1	1.2-1.4	0.15	0.150-0.180
2	1.1-1.3	0.14	0.144-0.136
3	1.2-1.3	0.14	0.134-0.162
4	1.2-1.3	0.14	0.129-0.159

The varying Liquefaction screening analyses utilize the CSR within the layer of interest as part of the formulation of the method. The QUAD-4M results were utilized to establish the variation of CSR as a function of depth within the silt deposit for these analyses. Specifically, the element CSR results at the location of the centerline of the bench were taken from the QUAD4M results, as shown in Attachment The average CSR (among all time histories analyzed) at the top, center, and bottom of the sand layer at this location are summarized in Table I-3.

Table I-3: Average Shear Stresses and Cyclic Stress Ratios (CSR) In Sand Zone (From QUAD4M Analysis)

Location	Average CSR
Top of Sand Deposit	0.154
Center of Sand Deposit	0.146
Bottom of Sand Deposit	0.145

b. SPT-based Liquefaction Analyses

SPT results from soil borings performed along the crest of the embankment of the East Ash Pond at the F.B Culley Plant by AECOM and historial borings by others (CARDNO and ATC), were used for the liquefaction analysis. Due to this, lateral extents of native clay and sand deposits were not determined during the investigation.

The liquefaction procedure is based on the revised methodology by Youd et al. (2001) updated by Idriss and Boulanger (2008, 2014). Penetration resistance (SPT-N values), fines content (FC), relative density, and effective stress values were used as the basis for calculations of factor of safety against liquefaction. Earthquake Magnitude Scaling Factor (MSF) and duration of shaking were also considered during analysis. Cyclic resistance ratios (CRR) and cyclic stress ratios (CSR) were calculated in liquefaction spreadsheets prepared by AECOM. The ratio of these two values results in the calculated factors of safety at depths identified in the borings:

$$FS_{liq} = \frac{CRR}{CSR}$$

Factors of safety values less than 1.0 are an indication of potential liquefaction during seismic events.

Embankment clay fill and native clay layers at elevations above 350 ft were considered as non-liquefiable based on soil classification and plasticity index. Native clays between 340 and 350 ft NAVD88 were potentially susceptible to liquefaction. Base on Boulanger and Idriss (2004), the high fine and clay content, high liquid limit, and high strength of the samples provide adequate data to eliminate liquefaction potential of this layer.

C. Results

Complete output from the liquefaction analysis spreadsheets is provided in the attachment to this document. Based on the analysis, the factor of safety against liquefaction for the overwhelming majority of sample intervals evaluated are above 1.0, and well above in most cases, indicating that the potential for liquefaction of the sand deposit is very low.

From the analysis, a very thin zone of sand (less than 5 feet thick) at the top of the sand deposit at some locations have lower factors of safety and indicate some liquefaction potential. The zone is located immediately at the interface of the native clay and native sand interface. As all of the borings performed for the project were located at the crest of the dam (other locations were not accessible to a drill rig, given the proximity of the dam to the surrounding water bodies), the lateral extent of such zones cannot be determined. However, it is anticipated that these zones will be of limited extent and discontinuous, as the dam is located in an alluvial setting, and alluvial deposition typically yields some heterogeneity in soils. It is considered highly unlikely that localized liquefaction of thin pockets or zones within the sand deposit will endanger stability of the dam.

Based on the results of the liquefaction potential evaluation, large-scale liquefaction of the sand deposit is not anticipated during the design earthquake. As such, it is concluded that use of peak drained strengths in the post-earthquake stability analysis is appropriate.

D. Attachments

SPT Liquefaction Analyses

Method: Idriss and Boulanger (2008), *Soil Liquefaction during Earthquakes* , EERI MNO-12

Input Parameters:

Title: Vectren Dam Assesment	Peak ground acceleration, pga (g):	0.6			Calculated Volumetric Settlement:	0.00 ft
Project: East Ash Pond	Earthquake Magnitude (M):	7.1			Calculated LDI:	0.0 ft
Project No.: 60442676	Water Table Depth at the time of drilling	27	ft	8.23 m		
	Water Table Depth at the time of earthquake	27	ft	8.23 m		
Date: 4/18/2015	Avg Unit Weight above GWT	120	pcf	18.8504957 kN/m^3		
Boring No. B-2 (ATC)	Avg Unit Weight below GWT	120	pcf	18.8504957 kN/m^3		
Units American feet, pounds, pcf	Borehole Diameter	0.6	ft	183 mm		
	Correction for Sampler Liner (N/Y)	N	ft			
	Rod stickup above ground at start of drive	7	ft	2.1336 m		
	Boring Total Depth	60	ft	18.288 m		
	Ground Surface Elevation	394	ft	120.0912 m		

Bold values for N and Fines were directly mesured.

Data No.	Depth	Elevation	Measured N Previously corrected for gravel content (*)	Soil Type (USCS)	Flag: "Unsaturated", "Clay", "85% Sat"	Fines Content (%)	Energy Ratio (%)	N_{60}	$(N_1)_{60}$	$(N_1)_{60\text{-}cs}$ for liquefaction triggering	$(N_1)_{60\text{-}cs}$ for residual strength	CRR	Stress reduction coeff, r_d	MSF	CSR	Factor of Safety	Layer Thickness ΔH_i	ΔLDI_i	Vertical Reconsol. Strain, ε_v	Layer Settlement ΔS_i
	ft	ft															ft	ft		ft
1	2.5	391.5	27	FILL-CL	Clay	80	80	31.1	na	na	na	#N/A	1.00			2.00	1.25	0.00	0.000	0.000
2	5	389	12	FILL-CL	Clay	80	80	14.7	na	na	na	#N/A	1.00			2.00	2.50	0.00	0.000	0.000
3	10	384	4	FILL-CL	Clay	80	80	5.2	na	na	na	#N/A	0.98			2.00	3.75	0.00	0.000	0.000
4	12.5	381.5	6	FILL-CL	Clay	80	80	7.8	na	na	na	#N/A	0.97			2.00	3.75	0.00	0.000	0.000
5	17.5	376.5	4	FILL-CL	Clay	80	80	5.8	na	na	na	#N/A	0.96			2.00	3.75	0.00	0.000	0.000
6	22.5	371.5	4	FILL-CL	Clay	80	80	5.8	na	na	na	#N/A	0.93			2.00	5.00	0.00	0.000	0.000
7	25	369	6	FILL-CL	Clay	80	80	8.7	na	na	na	#N/A	0.92			2.00	3.75	0.00	0.000	0.000
8	27.5	366.5	5	FILL-CL	Clay	80	80	7.7	na	na	na	#N/A	0.90			2.00	2.50	0.00	0.000	0.000
9	30	364	5	FILL-CL	Clay	80	80	7.7	na	na	na	#N/A	0.89			2.00	2.50	0.00	0.000	0.000
10	32.5	361.5	9	CL	Clay	80	80	13.8	na	na	na	#N/A	0.88			2.00	2.50	0.00	0.000	0.000
11	35	359	13	CL	Clay	80	80	19.9	na	na	na	#N/A	0.86			2.00	2.50	0.00	0.000	0.000
12	37.5	356.5	9	CL	Clay	80	80	13.8	na	na	na	#N/A	0.85			2.00	2.50	0.00	0.000	0.000
13	40	354	8	CL	Clay	80	80	12.3	na	na	na	#N/A	0.84			2.00	2.50	0.00	0.000	0.000
14	45	349	5	CL	Clay	80	80	7.7	na	na	na	#N/A	0.82			2.00	3.75	0.00	0.000	0.000
15	50	344	2	ML	Clay	50	80	3.1	na	na	na	#N/A	0.79		0.154	2.00	5.00	0.00	0.000	0.000
16	52.5	341.5	3	CL	Clay	80	80	4.6	na	na	na	#N/A	0.77			2.00	3.75	0.00	0.000	0.000
17	55	339	4	CL	Clay	80	80	6.1	na	na	na	#N/A	0.76			2.00	2.50	0.00	0.000	0.000
18	57.5	336.5	6	CL	Clay	80	80	9.2	na	na	na	#N/A	0.74			2.00	2.50	0.00	0.000	0.000
19	60	334	7	CL	Clay	80	80	10.7	na	na	na	#N/A	0.73			2.00	2.50	0.00	0.000	0.000

Method: Idriss and Boulanger (2008), *Soil Liquefaction during Earthquakes* , EERI MNO-12

Title: Vectren Dam Assesment
Project: East Ash Pond
Project No.: 60442676

Date: 4/8/2015
Boring No. B-101 (Cardno)
Units American feet, pounds, pcf

Input Parameters:

Parameter	Value	Unit	Converted
Peak ground acceleration, pga (g):	0.6		
Earthquake Magnitude (M):	7.1		
Water Table Depth at the time of drilling	58	ft	17.68 m
Water Table Depth at the time of earthquake	58	ft	17.68 m
Avg Unit Weight above GWT	120	pcf	18.8504957 kN/m^3
Avg Unit Weight below GWT	120	pcf	18.8504957 kN/m^3
Borehole Diameter	0.6	ft	183 mm
Correction for Sampler Liner (N/Y)	N	ft	
Rod stickup above ground at start of drive	7	ft	2.1336 m
Boring Total Depth	74	ft	22.5552 m
Ground Surface Elevation	394.5	ft	120.2436 m

Calculated Volumetric Settlement: 0.29 ft
Calculated LDI: 3.5 ft

Bold values for N and Fines were directly mesured.

Data No.	Depth	Elevation	Measured N Previously corrected for gravel content (*)	Soil Type (USCS)	Flag: "Unsaturated", "Clay", "85% Sat"	Fines Content (%)	Energy Ratio (%)	N_{60}	$(N_1)_{60}$	$(N_1)_{60\text{-cs}}$ for liquefaction triggering	$(N_1)_{60\text{-cs}}$ for residual strength	CRR	Stress reduction coeff, r_d	MSF	CSR	Factor of Safety	Layer Thickness ΔH_i	ΔLDI_i	Vertical Reconsol. Strain, ε_v	Layer Settlement ΔS_i
	ft	ft															ft	ft		ft
1	2.5	392	**47**	FILL-CL	Clay	65	80	54.1	na	na	na	#N/A	1.00			2.00	1.25	0.00	0.000	0.000
2	5	389.5	**59**	FILL-CL	Clay	65	80	72.4	na	na	na	#N/A	1.00			2.00	2.50	0.00	0.000	0.000
3	7.5	387	**3**	FILL-CL	Clay	65	80	3.9	na	na	na	#N/A	0.99			2.00	2.50	0.00	0.000	0.000
4	10	384.5	**3**	FILL-CL	Clay	84	80	3.9	na	na	na	#N/A	0.98			2.00	2.50	0.00	0.000	0.000
5	15	379.5	**8**	FILL-CL	Clay	84	80	10.4	na	na	na	#N/A	0.97			2.00	3.75	0.00	0.000	0.000
6	20	374.5	**5**	FILL-CL	Clay	84	80	7.3	na	na	na	#N/A	0.94			2.00	5.00	0.00	0.000	0.000
7	22.5	372	**9**	FILL-CL	Clay	95	80	13.1	na	na	na	#N/A	0.93			2.00	3.75	0.00	0.000	0.000
8	27.5	367	**5**	FILL-CL	Clay	95	80	7.3	na	na	na	#N/A	0.91			2.00	3.75	0.00	0.000	0.000
9	32.5	362	**12**	FILL-CL	Clay	95	80	18.4	na	na	na	#N/A	0.88			2.00	5.00	0.00	0.000	0.000
10	35	359.5	**6**	CL	Clay	**98**	80	9.2	na	na	na	#N/A	0.86			2.00	3.75	0.00	0.000	0.000
11	37.5	357	**10**	CL	Clay	98	80	15.3	na	na	na	#N/A	0.85			2.00	2.50	0.00	0.000	0.000
12	40	354.5	**4**	CL	Clay	98	80	6.1	na	na	na	#N/A	0.84			2.00	2.50	0.00	0.000	0.000
13	42.5	352	**7**	CL	Clay	98	80	10.7	na	na	na	#N/A	0.82			2.00	2.50	0.00	0.000	0.000
14	45	349.5	**7**	CL	Clay	98	80	10.7	na	na	na	#N/A	0.81			2.00	2.50	0.00	0.000	0.000
15	47.5	347	**12**	CL	Clay	90	80	18.4	na	na	na	#N/A	0.80			2.00	2.50	0.00	0.000	0.000
16	50	344.5	**8**	CL	Clay	**90**	80	12.3	na	na	na	#N/A	0.78			2.00	2.50	0.00	0.000	0.000
17	52.5	342	**11**	CL	Clay	90	80	16.9	na	na	na	#N/A	0.77			2.00	2.50	0.00	0.000	0.000
18	55	339.5	**3**	CL	Clay	90	80	4.6	na	na	na	#N/A	0.76			2.00	2.50	0.00	0.000	0.000
19	57.5	337	**9**	CL	Clay	90	80	13.8	na	na	na	#N/A	0.74			2.00	2.50	0.00	0.000	0.000
20	60	334.5	**6**	SC-SM		**31**	80	9.2	4.8	10.2	7	0.109	0.73	1.03	0.154	0.71	2.50	1.15	0.037	0.092
21	62.5	332	**9**	SM		**22**	80	13.8	7.3	12.1	8	0.121	0.72	1.03	0.154	0.79	2.50	0.94	0.033	0.083
22	65	329.5	**5**	SM		22	80	7.7	3.8	8.6	5	0.099	0.71	1.02	0.154	0.64	2.50	1.38	0.041	0.102
23	67.5	327	**8**	CL	Clay	80	80	12.3	na	na	na	#N/A	0.70		0.154	2.00	2.50	0.00	0.000	0.000
24	70	324.5	**24**	SP		5	80	36.8	21.2	21.2	21	0.196	0.69	1.08	0.154	1.27	2.50	0.04	0.005	0.012
25	72	322.5	**42**	SP		5	80	64.4	45.5	45.5	46	1.442	0.68	1.17	0.154	2.00	2.25	0.00	0.000	0.000

Method: Idriss and Boulanger (2008), *Soil Liquefaction during Earthquakes*, EERI MNO-12

Title: Vectren Dam Assesment
Project: East Ash Pond
Project No.: 60442676
Date: 4/9/2015
Boring No. B-102 (Cardno)
Units American feet, pounds, pcf

Input Parameters:

Parameter	Value	Unit	Converted
Peak ground acceleration, pga (g):	0.6		
Earthquake Magnitude (M):	7.1		
Water Table Depth at the time of drilling	28.5	ft	8.69 m
Water Table Depth at the time of earthquake	27	ft	8.23 m
Avg Unit Weight above GWT	120	pcf	18.8504957 kN/m^3
Avg Unit Weight below GWT	120	pcf	18.8504957 kN/m^3
Borehole Diameter	0.6	ft	183 mm
Correction for Sampler Liner (N/Y)	N	ft	
Rod stickup above ground at start of drive	7	ft	2.1336 m
Boring Total Depth	80	ft	24.384 m
Ground Surface Elevation	397.1	ft	121.03608 m

Calculated Volumetric Settlement: 0.44 ft
Calculated LDI: 5.5 ft

Bold values for N and Fines were directly mesured.

Data No.	Depth	Elevation	Measured N Previously corrected for gravel content (*)	Soil Type (USCS)	Flag: "Unsaturated", "Clay", "85% Sat"	Fines Content (%)	Energy Ratio (%)	N_{60}	$(N_1)_{60}$	$(N_1)_{60-cs}$ for liquefaction triggering	$(N_1)_{60-cs}$ for residual strength	CRR	Stress reduction coeff, r_d	MSF	CSR	Factor of Safety	Layer Thickness ΔH_i	ΔLDI_i	Vertical Reconsol. Strain, ε_v	Layer Settlement ΔS_i
	ft	ft															ft	ft		ft
1	2.5	394.6	**45**	FILL-CL	Clay	65	80	51.8	na	na	na	#N/A	1.00			2.00	1.25	0.00	0.000	0.000
2	5	392.1	**21**	FILL-CL	Clay	65	80	25.8	na	na	na	#N/A	1.00			2.00	2.50	0.00	0.000	0.000
3	7.5	389.6	**11**	FILL-CL	Clay	65	80	14.3	na	na	na	#N/A	0.99			2.00	2.50	0.00	0.000	0.000
4	12.5	384.6	**11**	FILL-CL	Clay	65	80	14.3	na	na	na	#N/A	0.98			2.00	3.75	0.00	0.000	0.000
5	15	382.1	**5**	FILL-CL	Clay	65	80	7.3	na	na	na	#N/A	0.96			2.00	3.75	0.00	0.000	0.000
6	17.5	379.6	**7**	FILL-CL	Clay	**89**	80	10.2	na	na	na	#N/A	0.95			2.00	2.50	0.00	0.000	0.000
7	20	377.1	**0**	FILL-CL	Clay	89	80	0.0	na	na	na	#N/A	0.94			2.00	2.50	0.00	0.000	0.000
8	22.5	374.6	**19**	FILL-CL	Clay	89	80	27.7	na	na	na	#N/A	0.93			2.00	2.50	0.00	0.000	0.000
9	27.5	369.6	**7**	FILL-CL	Clay	89	80	10.2	na	na	na	#N/A	0.91			2.00	3.75	0.00	0.000	0.000
10	30	367.1	**7**	SP		**13**	80	10.7	8.3	10.8	9	0.121	0.89	1.03	0.359	0.34	3.75	1.63	0.036	0.134
11	32.5	364.6	**6**	CH	Clay	89	80	9.2	na	na	na	#N/A	0.88			2.00	2.50	0.00	0.000	0.000
12	35	362.1	**13**	CL	Clay	**89**	80	19.9	na	na	na	#N/A	0.86			2.00	2.50	0.00	0.000	0.000
13	37.5	359.6	**12**	CL	Clay	89	80	18.4	na	na	na	#N/A	0.85			2.00	2.50	0.00	0.000	0.000
14	40	357.1	**17**	CL	Clay	89	80	26.1	na	na	na	#N/A	0.84			2.00	2.50	0.00	0.000	0.000
15	42.5	354.6	**21**	CL	Clay	89	80	32.2	na	na	na	#N/A	0.82			2.00	2.50	0.00	0.000	0.000
16	45	352.1	**4**	CL	Clay	**86**	80	6.1	na	na	na	#N/A	0.81			2.00	2.50	0.00	0.000	0.000
17	47.5	349.6	**13**	CL	Clay	86	80	19.9	na	na	na	#N/A	0.80			2.00	2.50	0.00	0.000	0.000
18	50	347.1	**2**	CL	Clay	86	80	3.1	na	na	na	#N/A	0.78			2.00	2.50	0.00	0.000	0.000
19	52.5	344.6	**5**	CL	Clay	86	80	7.7	na	na	na	#N/A	0.77		QUAD4	2.00	2.50	0.00	0.000	0.000
20	55	342.1	**8**	SP		**3**	80	12.3	7.6	7.6	8	0.097	0.76	1.02	0.154	0.63	2.50	1.55	0.043	0.109
21	57.5	339.6	**9**	SP		3	80	13.8	8.5	8.5	8	0.102	0.74	1.02	0.154	0.66	2.50	1.40	0.041	0.102
22	60	337.1	**23**	SP		6	80	35.3	24.6	24.6	25	0.265	0.73	1.10	0.154	1.72	2.50	0.01	0.001	0.003
23	62.5	334.6	**26**	SP		**6**	80	39.9	28.2	28.2	28	0.365	0.72	1.12	0.154	2.00	2.50	0.00	0.000	0.000
24	65	332.1	**29**	SP		6	80	44.5	31.9	31.9	32	0.580	0.71	1.16	0.154	2.00	2.50	0.00	0.000	0.000
25	67.5	329.6	**22**	SP		6	80	33.7	22.4	22.4	22	0.222	0.70	1.08	0.154	1.44	2.50	0.03	0.003	0.007
26	70	327.1	**30**	SP		6	80	46.0	32.5	32.6	33	0.631	0.69	1.16	0.154	2.00	2.50	0.00	0.000	0.000
27	72.5	324.6	**23**	SP		6	80	35.3	23.0	23.1	23	0.230	0.67	1.09	0.154	1.50	2.50	0.03	0.003	0.006
28	75	322.1	**37**	SP-SM		**9**	80	56.7	42.2	42.9	42	1.612	0.66	1.17	0.154	2.00	2.50	0.00	0.000	0.000
29	77.5	319.6	**26**	SP-SM		9	80	39.9	26.4	27.1	26	0.316	0.65	1.12	0.154	2.00	2.50	0.00	0.000	0.000
30	80	317.1	**14**	SP-SM		9	80	21.5	12.3	13.0	12	0.129	0.64	1.04	0.154	0.84	2.50	0.85	0.032	0.079

Method: Idriss and Boulanger (2008), *Soil Liquefaction during Earthquakes*, EERI MNO-12

Title: Vectren Dam Assesment
Project: East Ash Pond
Project No.: 60442676
Date: 11/10/2015
Boring No. B-1 (AECOM)
Units American feet, pounds, pcf

Input Parameters:

Parameter	Value	Unit	Metric
Peak ground acceleration, pga (g):	0.6		
Earthquake Magnitude (M):	7.1		
Water Table Depth at the time of drilling	27.5	ft	8.38 m
Water Table Depth at the time of earthquake	27.5	ft	8.38 m
Avg Unit Weight above GWT	120	pcf	18.8504957 kN/m^3
Avg Unit Weight below GWT	120	pcf	18.8504957 kN/m^3
Borehole Diameter	0.5	ft	152 mm
Correction for Sampler Liner (N/Y)	N	ft	
Rod stickup above ground at start of drive	7	ft	2.1336 m
Bedrock @ 84 Boring Total Depth	94	ft	28.6512 m
Ground Surface Elevation	397	ft	121.0056 m

Calculated Volumetric Settlement: 0.37 ft
Calculated LDI: 1.0 ft

Bold values for N and Fines were directly mesured.

Data No.	Depth	Elevation	Measured N Previously corrected for gravel content (*)	Soil Type (USCS)	Flag: "Unsaturated", "Clay", "85% Sat"	Fines Content (%)	Energy Ratio (%)	N_{60}	$(N_1)_{60}$	$(N_1)_{60-cs}$ for liquefaction triggering	$(N_1)_{60-cs}$ for residual strength	K_σ for sand	CRR for M = 7.5 & σ_{vo}' = 1 atm	CRR	Stress reduction coeff, r_d	MSF	CSR	Factor of Safety	Layer Thickness ΔH_i	ΔLDI_i	Vertical Reconsol. Strain, ε_v	Layer Settlement ΔS_i
	ft	ft																	ft	ft		ft
1	5	392	**9**	FILL-CL	Clay	95	80	10.4	na	na	na	1.10	na	#N/A	1.00			2.00	2.50	0.00	0.000	0.000
2	10	387	**7**	FILL-CL-ML	Clay	95	80	9.1	na	na	na	1.10	na	#N/A	0.98			2.00	5.00	0.00	0.000	0.000
3	15	382	**7**	FILL-CL-ML	Clay	95	80	9.1	na	na	na	1.10	na	#N/A	0.95			2.00	5.00	0.00	0.000	0.000
4	20	377	**2**	FILL-CL	Clay	95	80	2.9	na	na	na	1.00	na	#N/A	0.93			2.00	5.00	0.00	0.000	0.000
5	30	367	**7**	CL	Clay	85	80	10.2	na	na	na	0.90	na	#N/A	0.88			2.00	7.50	0.00	0.000	0.000
6	40	357	**10**	CL	Clay	85	80	15.3	na	na	na	0.83	na	#N/A	0.82			2.00	10.00	0.00	0.000	0.000
7	50	347	**7**	ML		**63**	80	10.7	7.5	13.1	11	0.93	0.141	0.143	0.75	1.10	0.154	0.93	10.00	0.64	0.025	0.251
8	59.5	337.5	**16**	SP-SM		**4**	80	24.5	16.5	16.5	17	0.90	0.170	0.174	0.69	1.14	0.154	1.13	9.75	0.21	0.007	0.070
9	62	335	**23**	SP-SM		**5**	80	35.3	24.5	24.5	24	0.86	0.278	0.300	0.66	1.26	0.154	1.95	6.00	0.00	0.000	0.001
10	65	332	**19**	SP-SM		**6**	80	29.1	19.2	19.2	19	0.88	0.197	0.203	0.64	1.17	0.154	1.32	2.75	0.04	0.004	0.011
11	70	327	**32**	SP-SM		6	80	49.1	35.7	35.7	36	0.73	1.300	1.383	0.62	1.45	0.154	2.00	4.00	0.00	0.000	0.000
12	72.5	324.5	**17**	SP-SM		**8**	80	26.1	16.2	16.5	16	0.88	0.169	0.170	0.60	1.14	0.154	1.10	3.75	0.09	0.008	0.030
13	75	322	**22**	SP-SM		8	80	33.7	21.7	22.1	22	0.85	0.235	0.243	0.59	1.22	0.154	1.58	2.50	0.02	0.002	0.005
14	80	317	**32**	SP-SM		**8**	80	49.1	34.3	34.7	34	0.72	1.046	1.097	0.57	1.45	0.154	2.00	3.75	0.00	0.000	0.000
15	82.5	314.5	**26**	SP-SM		8	80	39.9	25.8	26.2	26	0.81	0.322	0.337	0.56	1.29	0.154	2.00	3.75	0.00	0.000	0.000
16	84	313	50	CL	Clay	85	80	76.7	na	na	na	0.67	na	#N/A	0.55		0.154	2.00	2.00	0.00	0.000	0.000

Method: Idriss and Boulanger (2008), *Soil Liquefaction during Earthquakes*, EERI MNO-12

Title: Vectren Dam Assesment
Project: East Ash Pond
Project No.: 60442676
Date: 11/12/2015
Boring No. B-2 (AECOM)
Units American feet, pounds, pcf

Input Parameters:

Parameter	Value	Unit	Metric value
Peak ground acceleration, pga (g):	0.6		
Earthquake Magnitude (M):	6.5		
Water Table Depth at the time of drilling	48	ft	14.63 m
Water Table Depth at the time of earthquake	27.5	ft	8.38 m
Avg Unit Weight above GWT	120	pcf	18.8504957 kN/m^3
Avg Unit Weight below GWT	120	pcf	18.8504957 kN/m^3
Borehole Diameter	0.5	ft	152 mm
Correction for Sampler Liner (N/Y)	N	ft	
Rod stickup above ground at start of drive	7	ft	2.1336 m
Bedrock @ 68 Boring Total Depth	81	ft	24.6888 m
UNKNOWN Ground Surface Elevation	395	ft	120.396 m

Calculated Volumetric Settlement: 0.64 ft
Calculated LDI: 9.1 ft

Bold values for N and Fines were directly mesured.

Data No.	Depth		Elevation	Measured N Previously corrected for gravel content (*)	Soil Type (USCS)	Flag: "Unsaturated", "Clay", "85% Sat"	Fines Content (%)	Energy Ratio (%)	N_{60}	$(N_1)_{60}$	$(N_1)_{60-cs}$ for liquefaction triggering	$(N_1)_{60-cs}$ for residual strength	CRR	Stress reduction coeff, r_d	MSF	CSR	Factor of Safety	Layer Thickness ΔH_i	ΔLDI_i	Vertical Reconsol. Strain, ε_v	Layer Settlement ΔS_i
	ft		ft															ft	ft		ft
1	5		390	**11**	FILL-CL	Clay	70	80	12.7	na	na	na	#N/A	1.00			2.00	2.50	0.00	0.000	0.000
2	11		384	**0**	FILL-CL	Clay	70	80	0.0	na	na	na	#N/A	0.98			2.00	5.50	0.00	0.000	0.000
3	15		380	**5**	FILL-CL	Clay	70	80	7.3	na	na	na	#N/A	0.95			2.00	5.00	0.00	0.000	0.000
4	20		375	**3**	FILL-CL	Clay	70	80	4.4	na	na	na	#N/A	0.93			2.00	4.50	0.00	0.000	0.000
5	30		365	**8**	CL	Clay	80	80	11.7	na	na	na	#N/A	0.88			2.00	7.50	0.00	0.000	0.000
6	40		355	**6**	CL	Clay	**80**	80	9.2	na	na	na	#N/A	0.82			2.00	10.00	0.00	0.000	0.000
7	50		345	**2**	ML		**73**	80	3.1	1.8	7.4	6	0.098	0.75	1.05	0.367	0.27	10.00	6.38	0.044	0.441
8	52.5		342.5	**3**	CL-ML	Clay	90	80	4.6	na	na	na	#N/A	0.71			2.00	6.25	0.00	0.000	0.000
9	57.5		337.5	**2**	CL	Clay	90	80	3.1	na	na	na	#N/A	0.69			2.00	3.75	0.00	0.000	0.000
10	62.5		332.5	**4**	ML		**59**	80	6.1	3.3	8.9	7	0.106	0.66	1.06	0.358	0.30	5.00	2.67	0.040	0.200
11	67		328	50	CL	Clay	90	80	76.7	na	na	na	#N/A	0.63			2.00	4.75	0.00	0.000	0.000

Method: Idriss and Boulanger (2008), *Soil Liquefaction during Earthquakes* , EERI MNO-12

Title: Vectren Dam Assesment
Project: East Ash Pond
Project No.: 60442676
Date: 4/18/2011
Boring No. B-1 (ATC)
Units American feet, pounds, pcf

Input Parameters:

Parameter	Value	Unit	Metric	Unit
Peak ground acceleration, pga (g):	0.6			
Earthquake Magnitude (M):	7.1			
Water Table Depth at the time of drilling	27	ft	8.23	m
Water Table Depth at the time of earthquake	27	ft	8.23	m
Avg Unit Weight above GWT	120	pcf	18.8504957	kN/m^3
Avg Unit Weight below GWT	120	pcf	18.8504957	kN/m^3
Borehole Diameter	0.6	ft	183	mm
Correction for Sampler Liner (N/Y)	N	ft		
Rod stickup above ground at start of drive	7	ft	2.1336	m
Boring Total Depth	60	ft	18.288	m
Ground Surface Elevation	394	ft	120.0912	m

Calculated Volumetric Settlement: 0.00 ft
Calculated LDI: 0.0 ft

Bold values for N and Fines were directly mesured.

Data No.	Depth	Elevation	Measured N Previously corrected for gravel content (*)	Soil Type (USCS)	Flag: "Unsaturated", "Clay", "85% Sat"	Fines Content (%)	Energy Ratio (%)	N_{60}	$(N_1)_{60}$	$(N_1)_{60-cs}$ for liquefaction triggering	$(N_1)_{60-cs}$ for residual strength	CRR	Stress reduction coeff, r_d	MSF	CSR	Factor of Safety	Layer Thickness ΔH_i	ΔLDI_i	Vertical Reconsol. Strain, ε_v	Layer Settlement ΔS_i
	ft	ft															ft	ft		ft
1	2.5	391.5	**18**	FILL-CL	Clay	80	80	20.7	na	na	na	#N/A	1.00			2.00	1.25	0.00	0.000	0.000
2	5	389	**11**	FILL-CL	Clay	80	80	13.5	na	na	na	#N/A	1.00			2.00	2.50	0.00	0.000	0.000
3	7.5	386.5	**4**	FILL-CL	Clay	80	80	5.2	na	na	na	#N/A	0.99			2.00	2.50	0.00	0.000	0.000
4	10	384	**5**	FILL-CL	Clay	80	80	6.5	na	na	na	#N/A	0.98			2.00	2.50	0.00	0.000	0.000
5	12.5	381.5	**4**	FILL-CL	Clay	80	80	5.2	na	na	na	#N/A	0.97			2.00	2.50	0.00	0.000	0.000
6	15	379	**3**	FILL-CL	Clay	80	80	4.4	na	na	na	#N/A	0.96			2.00	2.50	0.00	0.000	0.000
7	17.5	376.5	**5**	FILL-CL	Clay	80	80	7.3	na	na	na	#N/A	0.95			2.00	2.50	0.00	0.000	0.000
8	20	374	**9**	FILL-CL	Clay	80	80	13.1	na	na	na	#N/A	0.94			2.00	2.50	0.00	0.000	0.000
9	22.5	371.5	**7**	FILL-CL	Clay	80	80	10.2	na	na	na	#N/A	0.93			2.00	2.50	0.00	0.000	0.000
10	25	369	**8**	FILL-CL	Clay	80	80	11.7	na	na	na	#N/A	0.92			2.00	2.50	0.00	0.000	0.000
11	27.5	366.5	**8**	FILL-CL	Clay	80	80	12.3	na	na	na	#N/A	0.90			2.00	2.50	0.00	0.000	0.000
12	30	364	**12**	CL	Clay	80	80	18.4	na	na	na	#N/A	0.89			2.00	2.50	0.00	0.000	0.000
13	32.5	361.5	**7**	CL	Clay	80	80	10.7	na	na	na	#N/A	0.88			2.00	2.50	0.00	0.000	0.000
14	35	359	**7**	CL	Clay	80	80	10.7	na	na	na	#N/A	0.86			2.00	2.50	0.00	0.000	0.000
15	37.5	356.5	**6**	CL	Clay	80	80	9.2	na	na	na	#N/A	0.85			2.00	2.50	0.00	0.000	0.000
16	40	354	**9**	CL	Clay	80	80	13.8	na	na	na	#N/A	0.84			2.00	2.50	0.00	0.000	0.000
17	42.5	351.5	**5**	CL	Clay	80	80	7.7	na	na	na	#N/A	0.82			2.00	2.50	0.00	0.000	0.000
18	45	349	**6**	CL	Clay	80	80	9.2	na	na	na	#N/A	0.81			2.00	2.50	0.00	0.000	0.000
19	47.5	346.5	**5**	CL	Clay	80	80	7.7	na	na	na	#N/A	0.80			2.00	2.50	0.00	0.000	0.000
20	50	344	**7**	CL	Clay	80	80	10.7	na	na	na	#N/A	0.78			2.00	2.50	0.00	0.000	0.000
21	52.5	341.5	**6**	CL	Clay	80	80	9.2	na	na	na	#N/A	0.77			2.00	2.50	0.00	0.000	0.000
22	55	339	**6**	CL	Clay	80	80	9.2	na	na	na	#N/A	0.76			2.00	2.50	0.00	0.000	0.000
23	57.5	336.5	**8**	CL	Clay	80	80	12.3	na	na	na	#N/A	0.74			2.00	2.50	0.00	0.000	0.000
24	60	334	**8**	CL	Clay	80	80	12.3	na	na	na	#N/A	0.73			2.00	2.50	0.00	0.000	0.000

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Submitted to
Southern Indiana
Gas & Electric Company
(SIGECO)
One Vectren Square
Evansville, IN 47708

Submitted by
AECOM
525 Vine Street, Suite 1800
Cincinnati, Ohio 45202

November 24, 2020

Addendum to the Request for Site-Specific Alternative Deadline to Initiate Closure of CCR Surface Impoundment

West Ash Pond Supplemental Attachments for the F.B. Culley Generating Station

Appendices

Appendix A
Groundwater Monitoring Program

www.haleyaldrich.com

REPORT ON

GROUNDWATER MONITORING PROGRAM
F.B CULLEY GENERATING STATION - WEST ASH POND
WARRICK COUNTY, INDIANA

by
Haley & Aldrich, Inc.
Greenville, South Carolina

for
Southern Indiana Gas and Electric Company
Evansville, Indiana

File No. 129420-006
April 2019

Haley & Aldrich, Inc.
400 Augusta Street
Suite 130
Greenville, SC 29601
864.214.8750

19 April 2019
File No. 129420-006

Southern Indiana Gas and Electric Company Corporation
P.O. Box 209
Evansville, Indiana 47702-0202

Attention: Ms. Angela Casbon-Scheller

Subject: Groundwater Monitoring Program Plan
F.B. Culley Generating Station – West Ash Pond
Warrick County, Indiana

Dear Ms. Casbon-Scheller:

Haley & Aldrich, Inc. (Haley & Aldrich) is pleased to submit this Groundwater Monitoring Program plan for the F.B. Culley Generating Station West Ash Pond. This Groundwater Monitoring Program has been updated as part of the West Ash Pond closure application and to comply with the United States Environmental Protection Agency (USEPA) Coal Combustion Residual (CCR) Rule dated 17 April 2015 (Rule) and is based on our review of the existing data on geology and hydrogeology and considering technical comments received from IDEM on 17 December 2018..

The CCR Rule was written to be "self-implementing" because the USEPA was not authorized under federal law to enforce the program. This changed in 2016 with Congress' passage of the Water Infrastructure Improvements for the Nation (WIIN) Act of 2016, which authorizes the U.S. EPA or a state to implement a permit program to enforce the CCR Rule. Indiana Department of Environmental Management (IDEM) is currently working to develop and gain approval of a CCR permit program.

Prior to the CCR Rule, IDEM regulated CCR landfills and surface impoundments in accordance with the Solid Waste Land Disposal Facility rules under 329 IAC 10. IDEM is currently updating these regulations to meet the requirements of the CCR Rule and has adopted an emergency rule incorporating the CCR Rule requirements for CCR surface impoundments into 329 IAC 10. As such, this Groundwater Monitoring Program plan specifically addresses the requirements of the CCR Rule, which has been incorporated into 329 IAC 10.

Sincerely,
HALEY & ALDRICH, INC.

Mark Miesfeldt
Hydrogeologist

Shaun Becker
Project Manager

Enclosures

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HALEY & ALDRICH, INC.
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SIGNATURE PAGE FOR

REPORT ON

GROUNDWATER MONITORING PROGRAM PLAN
F.B. CULLEY GENERATING STATION – WEST ASH POND
WARRICK COUNTY, INDIANA

PREPARED FOR

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY CORPORATION
EVANSVILLE, INDIANA

PREPARED BY:

Shaun Becker
Project Manager
Haley & Aldrich, Inc.

REVIEWED AND APPROVED BY:

Mark Miesfeldt
Hydrogeologist
Haley & Aldrich, Inc.

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1. Introduction

Haley & Aldrich, Inc. (Haley & Aldrich) was retained by Southern Indiana Gas and Electric Company (SIGECO) to perform technical services associated with development of a Groundwater Monitoring Program (GMP) for the West Ash Pond (WAP) that complies with the April 17, 2015 Coal Combustion Residuals (CCR) Rule (Rule) published by the U.S. Environmental Protection Agency (USEPA). Haley & Aldrich has prepared this GMP on behalf of SIGECO for the WAP at the F.B. Culley Generating Station (FBC) which is located in Warrick County near the communities of Yankeetown and Newburgh, Indiana. According to the CCR Rule, the first step in groundwater monitoring at existing CCR units is to implement a Detection Monitoring program, which requires construction of an adequate groundwater monitoring network established in the uppermost aquifer from which a minimum of eight rounds of representative hydrological and groundwater quality data must be obtained. The WAP was inactive when the CCR Rule was promulgated and was scheduled to be closed by October 18, 2018, therefore it was not considered to be subject to the compliance and schedule requirements in the April 17, 2015 CCR Rule. However, due to subsequent CCR Rule changes related to a partial vacatur ordered by the DC Circuit Court on June 14, 2016, the WAP must now meet the same requirements on a modified schedule. The CCR Rule changes extended the deadlines to comply with the groundwater monitoring requirements with the initial eight-rounds of groundwater sampling to be completed by April 17, 2019.

This GMP was prepared in general accordance with the USEPA "Sampling and Analysis Plan Guidance and Template" (USEPA, 2000), to establish a groundwater monitoring program at the Site that complies with the groundwater monitoring requirements of the CCR Rule for existing CCR units. The groundwater monitoring requirements of the CCR Rule are provided in Appendix A of this document, as outlined in 40 CFR §257.90 through §257.98. Appendix A also includes the accompanying list of constituents in Appendices III and IV for the analysis of groundwater, along with the extension of compliance deadlines for certain inactive surface impoundments in response to partial vacatur.

There are three groundwater monitoring components referenced in the CCR Rule that together describe the groundwater monitoring activities being undertaken. One component is the GMP which provides a summary of relevant background information and Site geology and hydrogeology along with a detailed description of the groundwater monitoring network and sampling program. The second component is the Groundwater Sampling and Analysis Plan (GWSAP) which is based on the CCR Rule specifications in §257. 93 and describes the sampling and chemical analysis procedures and processes that are followed to obtain representative and technically defensible groundwater monitoring results. The third component describes the methods for the statistical analysis of the collected groundwater quality data as required by the CCR Rule to determine whether a Statistically Significance Increase (SSI) of Appendix III constituents in the downgradient wells, compared to upgradient/background well(s), has occurred. The statistical methodology will be selected after the initial sampling rounds are completed and will be based on the CCR Rule-specified statistical methods in §257.93 paragraphs (f)(1) through (f)(5).

1.1 SITE SETTING

The location of FBC is shown on Figure 1. The WAP at FBC is located adjacent the northern bank of the Ohio River approximately three miles east of the town of Newburgh. Topography surrounding the WAP varies in elevation with ground surface elevations varying from 430 to 359-feet above mean sea level (msl). Higher ground surface elevations are northeast of the WAP with surface topography generally sloping to the west and south towards the Ohio River. As shown on Figure 2, the WAP is situated outside of the 100-year floodplain established by the Federal Emergency Management Agency (FEMA). Surface water runoff across the site occurs via sheet flow into low lying areas flowing towards the Ohio River and Little Pigeon Creek.

1.2 SITE BACKGROUND

FBC is an active energy production facility that generates electricity through the combustion of coal. The coal combustion residuals (CCR) are products of the combustion process and include bottom ash, fly ash, and flue gas desulfurization (FGD) sludge. CCR is currently managed on the Site in a 10-acre impoundment known as the East Ash Pond. Because the WAP was inactive when the CCR Rule was promulgated and was scheduled to be closed by October 18, 2018, it was not considered to be subject to the compliance and schedule requirements in the Rule. However, due to subsequent CCR Rule changes related to a partial vacatur ordered by the DC Circuit Court on June 14, 2016 the WAP must meet the requirements of the CCR Rule. The CCR Rule changes extend the deadlines to comply with the groundwater monitoring requirements. With respect to the WAP, nine rounds of groundwater sampling were completed by April 17, 2019. A Site Index Map showing the location of the WAP with soil boring and monitoring well locations used in the development of this GWMP is provided as **Figure 3**. In addition, a search of the Warrick County Health Department records, the Town of Newburgh Sewer/Utility Department records, the Indiana Department of Natural Resources water well database, and the Environmental Data Resources, Inc. (EDR) report was conducted to identify drinking water wells within ½ mile of the WAP. The results of the search indicated that seven production wells are present within the search radius. One of the production wells is located at FBC and the remaining six production wells are located at the Warrick Power Plant west of the WAP. The production well at FBC is used for grey water at the facility. The production wells at the Warrick Power Plant are permitted for potable purposes but it is our understanding that, like FBC, bottled water is supplied for drinking water purposes.

The Site was constructed in 1953 by excavating part of the hills located just north of the plant and diverting a portion of Little Pigeon Creek that previously flowed east-to-west across the plant area. The WAP was commissioned in the mid-1960s with an earthen berm constructed along the southern and western boundaries. It was used to store the various residuals from plant operations, plant storm water, and direct precipitation. In 1999, fly ash generated on the Site was stored in a silo and shipped to an offsite cement kiln. The WAP also received fly ash from a neighboring industrial site until 2007 when the CCR input was stopped. Some process residuals contained in the WAP were removed in 2008.

1.3 PREVIOUS INVESTIGATIONS

Haley & Aldrich reviewed numerous historical geotechnical boring logs and transects created prior to construction of the generating station. In addition, supplemental engineering design information collected for developing closure plans and provided by AECOM has been incorporated into this updated GWMP. These subsurface explorations were relied upon by Haley & Aldrich in the development of the groundwater monitoring program.

2. Site Geology and Hydrogeology

2.1 WAP SITE GEOLOGY

The WAP at FBC is located within the Ohio River valley which contains naturally occurring alluvial (stream) and loess (windblown) deposits derived indirectly from continental ice sheets. These sediments were transported in meltwater heavily loaded with entrained sediments that accumulated on top of the Pennsylvanian age shale, limestone and sandstone bedrock. Westerly winds simultaneously deposited silty sediments in the upland areas adjacent to the stream valley. As a result, base levels of the valley floor increased in elevation and created natural levees and outwashes. These natural levees produced slackwater lakes which deposited thick sequences of silt and clay adjacent to the river channel. When the ice sheets retreated, the sediment load in the Ohio River diminished and lowered base levels. Consequently, the river incised the slackwater lake sediments, sculpted lacustrine terraces, and deposited sand and gravel stream alluvium.

Soil types described in boring logs from monitoring wells installed around the WAP, as well as boring logs generated from geotechnical explorations conducted by AECOM through the WAP indicate that the uppermost aquifer is comprised of a layered sequence of unconsolidated deposits consisting primarily of sand with silty sand and clay associated with the slackwater lakes. This unconsolidated overburden overlies Pennsylvanian age sandstone which overlies shale.

As shown on the geologic cross sections A-A’, B-B’, C-C’, and D-D’, presented in Figures 4A through 4D, the WAP was constructed on unconsolidated silty clay and clay deposited adjacent to the Ohio River. The top of these fine-grained deposits represents the original land surface prior to constructing the WAP. These slackwater lake deposits are laterally continuous and competent beneath the WAP with thickness varying from 2.5 feet beneath the former Little Pigeon Creek bed to more than 30- feet north of the old creek bed. The competency of the fine-grained deposits was confirmed by AECOM. Hydraulic conductivity testing of undisturbed shelby tube samples showed that the average hydraulic conductivity of the material is 1X10-7 cm/sec, as presented in Appendix C. This low permeability material likely impedes the upward and downward movement of groundwater and may serve as a semi-confining layer. The former Little Pigeon Creek, which generally paralleled the Ohio River and flowed from east to west, bisected the WAP area until the creek was diverted prior to construction of the WAP.

The location of the former little Pigeon Creek is shown on historical topographic maps and was delineated by AECOM in 2017 by advancing a series of north-south oriented transects across the former creek bed. The original land surface, prior to constructing the WAP, is defined by the top of the native silty clay and clay deposits and the bottom of ash, as presented in Figure 5. Little Pigeon Creek cuts approximately 20-feet into the fine-grained silty clay and clay deposits but within the footprint of the WAP does not breach the clay layer. Beneath the silty clay and clay are sand and gravel alluvial sediments. This wedge of clastic sediments coarsens downward, thickens to the south toward the Ohio River, and directly overlies bedrock. As shown on the north-south oriented cross sections, the alluvial sand units located beneath the WAP thin and pinch out against the upland area along the northern boundary of the WAP.

Bedrock around FBC belongs to the Carbondale Group. The Group consists of Pennsylvanian age sandstone, limestone, shale and coal. The Group ranges from 260 to 470 feet thick but on average is approximately 300 feet thick. The Carbondale Group includes laterally persistent limestone units and four of Indiana's commercially important coal seams. Laterally continuous shale beds are associated with the coal formations. As shown on the geologic cross sections and the contour map showing the top of bedrock, presented in Figure 6, bedrock beneath the WAP dips to the south and south west toward the Ohio River and the Warrick Power Plant. In the upland area to the northeast of the WAP, the top of bedrock is represented by sandstone. The sandstone unit is not present along the Ohio River where the bedrock is more deeply eroded, and the top of bedrock is represented by gray shale.

The Site is located in the vicinity of the Wabash Valley and New Madrid seismic zones. The largest earthquake recorded (magnitude 5.2) proximal to the Site occurred in April 18, 2008 approximately fifty miles northwest of the facility.

2.2 WAP SITE HYDROGEOLOGY

The following groundwater flow characteristics in the vicinity of the WAP are developed based on information collected during the initial hydrogeological characterization completed in 2016 and supplemented with additional water level gauging and subsurface explorations conducted in 2017 and 2018. During the initial characterization, nine monitoring wells were installed around the WAP. Five of the wells were installed in the upper portion of the shallow aquifer; the remaining four wells include two deep wells screened at the top of bedrock installed to the south between the WAP and the Ohio River and two intermediate wells screened approximately mid-way between the shallow and deep wells. The locations of the CCR groundwater monitoring network wells are shown on Figure 7.

The depth to groundwater has been measured in the five monitoring wells constructed in the uppermost aquifer and an additional 10 piezometers located along the northern and eastern boundaries of the WAP. In addition, water levels have routinely been measured in the intermediate and deep wells installed along the southern berm. Water table elevations obtained from the shallow wells have been used to construct water table configuration maps while the potentiometric data obtained from the intermediate and deep wells have been used to calculate vertical groundwater gradients. A summary of the water level gauging and the groundwater elevations is provided in Table 1. Water table configuration maps for the 10 most recent rounds of gauging are provided as figures 8A through 8I. These maps have been used to interpret groundwater flow directions and to compare the elevation of groundwater to the elevation of the bottom of ash and the top of bedrock (Figure 6) to evaluate the potential for groundwater to be in contact with ash and to assess the extent to which the bedrock surface controls groundwater flow.

Water table mapping consistently shows that the direction of groundwater flow in the vicinity of the WAP is to the southwest toward the Ohio River with a component of flow to the west. While the water levels vary in response to the Ohio River stages the interpreted groundwater flow directions do not change. As shown on Figure 9, an overlay of the water table configuration map for the August 2018 round of gauging (Figure 8H) and the top of bedrock map (Figure 6) shows a strong correlation between the two surfaces suggesting that groundwater flow in the north and eastern portion of the WAP is partially controlled by the bedrock surface with a steep hydraulic gradient (0.05 feet per foot) being maintained across the fine-grained lake deposits. Under base flow conditions, groundwater elevations in the western and southern berms are below the elevation of the Ohio River. This condition is currently being evaluated. Post closure groundwater flow conditions are expected to be different than current conditions. As a result, changes in groundwater flow conditions will continue to be evaluated during the closure process and modifications to the groundwater monitoring network, as necessary and appropriate, will be implemented following closure to address compliance with post closure, long term monitoring requirements. As the water table falls below the fine-grained deposits into the sand and gravel the hydraulic conductivity of the material increases and the hydraulic gradient flattens to 0.001 feet per foot.

A summary of estimated hydraulic conductivities is provided in Table 2. In general, hydraulic conductivity values are consistent with the expected values for the materials that the wells are screened across. For example, the hydraulic conductivity in well WAP-1, screened in the fine-grained silty clay and clay was estimated to be 1.6x10-6 cm/sec. Higher hydraulic conductivities were measured at WAP-2R, WAP-5I and WAP-5D, which are screened across sand and gravel deposits, range from 7.7x10-3 cm/sec in well WAP-2R to 2.3x10-1 cm/sec in WAP-5D, as presented in Appendix C.

Vertical groundwater gradients are summarized on Table 3. In general, the vertical groundwater flow potential is negative, or downward, between the shallow and intermediate wells and between the intermediate and deep wells. While the magnitude of the gradient lessens during high river stages, the flow potential remains negative. The magnitude of the vertical gradient is greater in well cluster WAP-4 located along the western side of the south berm. Vertical migration of groundwater from the surficial aquifer to the bedrock aquifer is unknown at this time but will be evaluated in the future under an evaluation of the nature and extent of contamination, if necessary.

2.3 POTENTIAL FOR ASH TO BE IN CONTACT WITH GROUNDWATER

To evaluate the potential for groundwater to be in contact with ash, the elevation of the water table was compared to the elevation of the bottom of ash across the area where ash is being closed-in-place. Under baseflow conditions, which represents a majority of the time based on river gauging for the past two years, groundwater is not in contact with ash. To evaluate the potential for ash to be in contact with groundwater under flood conditions, which represents a small portion of the time based on the past two years of river gauging, the highest water level readings recorded to date were evaluated. The comparison of the high-water table to the bottom of ash would represent a potential “worst case” condition based on the information gathered to date and is shown on Figure 10. As shown on the cross sections, none of the area where ash is being consolidated is in contact with groundwater except for a narrow band along the northern boundary of the WAP where removal is not feasible due to the location of the transmission towers.

3. Groundwater Monitoring Program

Haley & Aldrich developed the groundwater monitoring program outlined below after reviewing and evaluating the existing hydrogeologic and groundwater quality data provided by SIGECO, the hydrogeological characterization results outlined above, and considering the performance standards provided in the CCR Rule §257.91. The groundwater monitoring program includes a sufficient number of wells installed at locations and depths to obtain representative groundwater samples from the uppermost aquifer. Groundwater sampling locations have been established to accurately represent background groundwater quality, not affected by potential releases from the CCR management unit as well as the quality of groundwater passing the waste boundary downgradient of the CCR management unit.

3.1 GROUNDWATER MONITORING NETWORK FOR THE WEST ASH POND

The WAP at FBC is located to the west of the main facility. The former Little Pigeon Creek previously flowed across the unit from east to west but was diverted to the Ohio River east of the facility during construction. Groundwater flow in the uppermost aquifer generally follows surface topography. Vertical migration of groundwater from the surficial aquifer to the bedrock aquifer is unknown at this time but will be evaluated in the future under an evaluation of the nature and extent of contamination, if necessary. Groundwater flow in the immediate vicinity of the WAP is to the southwest with a component of flow to the west as shown in Figures 8A through 8I. Therefore, Haley & Aldrich concludes that the four downgradient monitoring wells (WAP-2R, WAP-3, WAP-4 and WAP-5), located at the boundary of the unit, and screened in the uppermost aquifer, adequately monitor the potential release and migration of ash constituents from the pond, should that occur. The location of these four downgradient groundwater monitoring wells is shown on Figure 3 and Figure 7. Well placement was determined based on interpretations of site-specific hydrogeology including groundwater flow directions and rates of groundwater movement. The groundwater monitoring well network for the WAP complies with the CCR Rule by monitoring the uppermost aquifer at the boundary of the CCR unit. Based on the groundwater flow pattern in the area of the WAP, the upgradient (unaffected by the CCR unit) background monitoring wells are identified as WAP-1 and CCR-AP-7 as shown in Figure 3 and Figure 7**,** which are also installed in the uppermost aquifer. Therefore, the complete groundwater network for the CCR Rule groundwater sampling for the WAP consists of four downgradient wells and two upgradient/background wells. Groundwater flow conditions are anticipated to change following closure of the WAP. As a result, the number and location of groundwater monitoring wells surrounding the WAP will continue to be evaluated and modifications to the network will be made based on the conditions encountered at that time. The depth to groundwater in the intermediate and deep wells installed along the south berm and the piezometers located along the northern and eastern boundary of the WAP will continue to be gauged during groundwater sampling events. A summary of the monitoring network for the WAP along with well construction details is provided in Table 4.

3.2 MONITORING WELL CONSTRUCTION AND DOCUMENTATION

As described above, the groundwater monitoring program includes four downgradient monitoring wells located around the WAP (WAP-2R, WAP-3, WAP-4 and WAP-5), and two upgradient/background wells, one of which is located at the northeast boundary of the Ash Pond (WAP-1) and one located approximately 500 feet east-southeast of WAP-1 in an upland area of the site (CCR-AP-7). Boring logs and well construction diagrams for these wells are included in Appendix B.

The monitoring wells were constructed with 2-inch Inside Diameter (ID) Schedule 40 PVC casing; a 10-

foot long, 0.01-inch machine slotted PVC screen; and a locking, steel, 5-foot long protective casing or a steel, 8-inch flush mount manway cover. When possible, the well screen was placed so that the encountered water table was approximately five feet above the top of the well screen. In preparation for closure, dewatering that began after the installation of the well network initially reduced the pond elevation to approximately 365 feet above mean sea level. Since that time the water levels in the pond have been reduced further such that the potentiometric surface(s) provided in this revised GWMP reflect baseline flow conditions unaffected by the ash pond. Updating the site conceptual model to reflect current conditions initially revealed that the dewatering of the WAP reduced the water level in monitoring well WAP-2 to less than two feet from the bottom of the well. This water level was not sufficient to provide reliable groundwater samples. As such, Haley & Aldrich replaced this well with a new well screened 15-feet below the original WAP-2 well screen. The new well, WAP-2R, was installed at the same location as the original WAP-2 installation using hollow stem augers and constructed using 2-inch PVC casing with 10-foot, 0.01-inch machine slotted well screen.

At each monitoring well, the top of the PVC well casing was surveyed by a registered Indiana surveyor to within 0.01 foot, and the ground surface was surveyed to 0.01 foot. The surveyed top of the well casing, identified on each well, was used for measuring and recording water levels. Each sample location was surveyed to North American Datum of 1988 (NAD88). A summary of the survey results for the monitoring wells, with horizontal and vertical coordinates, is added to Table 4. During closure of the West Ash Pond, which began late summer 2018, the elevation of the berm will be lowered. Monitoring well nests WAP-4/4I/4D and WAP-5/5I/5D, which are installed through the berm, will be protected during this construction activity and resurveyed following installation of new surface completions.

All downhole drilling equipment was decontaminated prior to use at each well location. Well casing and screens were new and protected by factory packaging. Wells were installed according to the procedures described below.

Wells were installed using conventional hollow-stem auger drilling methods. Soil sampling was performed while advancing the borehole using standard split-spoon sampling on five-foot centers to provide samples for soil descriptions and to estimate the depth to groundwater. After the borehole was advanced approximately 15 feet below the water table, well casing and screen was placed through the augers to the bottom of the borehole. Filter sand was added by gravity to approximately 2 feet above the top of the well screen as the augers were withdrawn from the borehole. The filter pack was surged as the sand was emplaced to promote proper packing and to minimize the potential for settlement of the filter pack following placement of the bentonite seal. Approximately 2 feet of hydrated bentonite pellets was added by gravity above the sand pack to seal the well screen against surface water infiltration. A neat cement grout was emplaced by tremie pipe into the remaining annular space. The depth of the filter sand, bentonite seal, and annular space seal was carefully measured to 0.1 feet prior to the installation of the next layer. Steel protective casings or manholes were installed with a 2-foot by 2-foot square concrete pad sloping away from the casing at monitoring well. A weep hole was drilled at the base of the protective casing just above the concrete pad to evacuate rainwater that may have entered the casing. In addition, steel bollards were installed around the monitoring wells to protect them from being damaged. To protect wells installed in high traffic areas, WAP-1 and WAP-3 were completed below grade in vaults.

The groundwater monitoring wells were developed after construction by surging and purging each well with a pump. The pump was decontaminated before being used at each well. For wells that could not be purged dry, development was considered complete when a minimum of ten well volumes of groundwater was removed, and purged groundwater is visibly free of sediment. For wells that purged dry, a minimum of four well volumes of groundwater were removed.

4. Groundwater Sampling Program

This section includes an explanation of activities required to comply with the Detection Monitoring requirements outlined in the CCR Rule only. Assessment Monitoring will only be implemented if one or more of the constituents listed in Appendix III of the Rule is detected at a SSI over background levels in a downgradient well located at the waste boundary of the CCR unit at the conclusion of the detection monitoring data collection, as specified in §257.93. Initiation of Corrective Measures in accordance with §257.96 will commence within 90 days of finding that constituents listed in Appendix IV have been detected at statistically significant levels exceeding the groundwater protection standard defined under §257.95(h) during Assessment Monitoring.

4.1 DETECTION MONITORING

The first step in carrying out the groundwater monitoring program at a CCR unit, as required by §257.94 in the CCR Rule, is Detection Monitoring. An initial Detection Monitoring program is required to collect and analyze a minimum of eight independent samples from background and downgradient wells for the constituents listed in Appendix III and IV. Nine rounds of baseline groundwater sampling were completed by April 17, 2019. Procedures for sampling and chemical analysis methods will be provided in a separate GWSAP following approval of the WAP closure application. Similarly, methods for statistical analysis of the groundwater quality data will also be presented in a separate Statistical Data Analysis Plan (SDAP) for the WAP at FBC. The groundwater monitoring network consists of four downgradient monitoring wells located around the WAP (WAP-2R, WAP-3, WAP-4 and WAP-5), and two upgradient/background well at the northeast boundary of the WAP and north west hill top (WAP-1 and CCR-AP-7), as presented in Figure 7.

4.1.1 Sampling Schedule and Frequency

Ten independent samples from each upgradient/background and downgradient monitoring well were collected by April 17, 2019.

A schedule for collection of the detection monitoring samples is not established within the Rule. SIGECO began sampling in March 2018 with ten sampling rounds being completed by April 17, 2019.

4.1.2 Chemical Analysis

Groundwater samples collected for chemical analysis will be analyzed for constituents listed in Appendix III and Appendix IV of the CCR Rule, as required by the appropriate CCR Groundwater Monitoring Program.

The Appendix III and Appendix IV constituents consist of the following:

Appendix III Constituents	Appendix IV Constituents	
Boron	Antimony	Lead
Calcium	Arsenic	Lithium
Chloride	Barium	Mercury
Fluoride	Beryllium	Molybdenum
pH	Cadmium	Selenium
Sulfate	Chromium	Thallium
Total Dissolved Solids	Cobalt	Radium 226 and 228 combined
	Fluoride	

4.1.3 Sampling and Analysis Plan

The GWSAP will identify the site-specific activities and methodologies for groundwater sampling for the groundwater monitoring program as defined in §257.93 of the Rule. The GWSAP will describe field data collection, sample collection, sample preservation and shipment, interpretation, laboratory analytical methods, and reporting for groundwater sampling at the WAP. The administrative procedures and frequency for collection of groundwater elevation measurements, flow direction, and gradient will also be provided in the GWSAP.

Laboratory results from the ten initial Detection Monitoring events for the WAP will be statistically analyzed for each of the Appendix III constituents using one of the statistical methods specified in paragraphs (f)(1) through (5) of §257.93 of the CCR Rule. The statistical methods used for the evaluation of groundwater monitoring data will be described in the SDAP. The SDAP will identify the appropriate statistical analyses to be applied to the groundwater quality data based on the sample population distribution as defined in §257.93 of the CCR Rule, and guidance provided by USEPA in the RCRA Statistical Analysis of Groundwater Monitoring Data Unified Guidance Document (USEPA, 2009).

4.1.4 Trigger for Assessment Monitoring

Assessment Monitoring is triggered for the CCR unit when statistical analysis of the groundwater quality data collected under the Detection Monitoring program for constituents in Appendix III indicates that an SSI over background levels for one or more of the Appendix III constituents has been detected at any downgradient well during Detection Monitoring at the waste boundary.

However, one may demonstrate that a source other than the CCR unit caused the SSI over the background levels for a constituent. In this case a written demonstration report, certified by a qualified professional engineer verifying the accuracy of the information, must be completed within 90-days of the determination of an SSI. Successful demonstration of the alternative source of impact allows the CCR unit to continue with Detection Monitoring.

4.2 ASSESSMENT MONITORING

Pursuant to 40 CFR § 257.95(a), Assessment Monitoring is conducted whenever an SSI over background levels has been detected for one or more of the constituents listed in Appendix III of the CCR Rule. Within 90 days of triggering assessment monitoring, and annually thereafter, groundwater samples will be analyzed for the constituents listed in Appendix IV of the CCR Rule. Within 90 days of obtaining the results from the initial assessment monitoring samples, semi-annual sampling will begin for all wells installed pursuant 40 CFR § 257.91; these samples will be analyzed for constituents listed in Appendices III and IV of the CCR Rule. Field methods and procedures detailed in the GWSAP will be followed for the collection of the assessment monitoring groundwater samples.

If within 90 days of finding that any constituents listed in Appendix IV of the CCR Rule have been detected at a SSL over the Groundwater Protection Standard (GWPS), which is defined as the Maximum Concentration Limit (MCL) or Risk Reduction Standards (RSL), SIGECO must initiate an assessment of Corrective Measures to prevent further releases and define the nature and extent of the release.

4.3 GROUNDWATER ELEVATION MEASUREMENT

The depth to groundwater will be measured in each well, including the intermediate and deep wells installed in the south berm and the piezometers installed along the northern and eastern boundaries of the WAP, each time groundwater samples are collected. Groundwater measurements from monitoring wells surrounding the WAP will be recorded within a period short enough to avoid temporal variations in groundwater conditions. The measured groundwater levels will be converted to groundwater elevations for subsequent interpretation of groundwater flow direction and rate.

4.3.1 Procedures for Groundwater Elevation Measurement

The water level in each well will be measured using an electric water level indicator. Water level measurements will be made from a surveyed fixed reference point marked on the well. The fixed reference point will be located on the top of the well casing or on the top of the water level access point into the well, depending on the completion of the well at the surface. If a surveyed mark is not present, the reference point is typically established and marked on the north side of the well casing. More details for groundwater measurement procedures are provided in the GWSAP.

4.3.2 Frequency

The depth to groundwater, in wells which monitor the WAP, will be measured within a period short enough to avoid temporal variations in groundwater conditions which could preclude accurate determination of groundwater flow rate and direction.

4.4 GROUNDWATER FLOW DIRECTION AND GRADIENT

The groundwater elevations will be used to construct a water table configuration map to interpret the direction of groundwater flow and calculate the horizontal and vertical hydraulic gradients each time groundwater is sampled.

4.4.1 Procedures for Calculation

Groundwater flow direction and gradient will be calculated using one of several computer programs such as Surfer, AutoCAD, or equivalent. Groundwater flow direction and gradient can also be calculated without the use of a computer program by the following steps:

- Determine the groundwater surface elevation by subtracting the water level measurement (depth to water) from the surveyed measuring point elevation at each well.
- Determine the difference in groundwater surface elevation between each of the wells by subtracting the groundwater elevation of a well with a higher elevation from the groundwater

elevation of a well with a lower elevation. The elevation differences are divided up into equal increments. Repeat this step between multiple wells. Groundwater elevation contours can be drawn at corresponding elevation increments between wells.

- Determine groundwater flow direction by drawing a line perpendicular to the groundwater contour lines from higher elevations to lower elevations.

- Determine the hydraulic gradient by dividing the groundwater elevation change in the direction of flow by the horizontal difference between measurement points.

4.4.2 Frequency

The gradient and direction of groundwater flow within each CCR unit will be calculated upon completion of each groundwater sampling event.

5. Reporting

5.1 DATA MANAGEMENT

A project database that incorporates hydrogeologic and groundwater quality data will be established to allow efficient management of chemical and physical data collected in the field and received from the laboratories. Laboratories conducting groundwater analyses for this program have been supplied with specific formats for electronic data deliverables to ensure compatibility with the project database requirements. Qualified personnel will be assigned to conduct quality assurance/quality control (QA/QC) reviews for each dataset generated. The database will be integrated with a geographical information system to allow for presentation of spatial information and data, such as site features, ownership boundaries, and sample locations. Each sample location will be surveyed to North American Datum of 1988 (NAD88).

5.2 ANNUAL REPORTING

Per the CCR Rule, SIGECO, or a designated representative, will prepare an annual groundwater monitoring report for the WAP. For the WAP, the first annual report will be completed by 1 August 2019 and annually thereafter. The annual groundwater monitoring report summarizes key actions completed, for the previous year; describes any problems that may have been encountered, and the corresponding actions to resolve the problems. At a minimum, the annual groundwater monitoring report should include the following:

- A detailed site map showing the CCR units, including all background and downgradient monitoring wells;
- Identification of any monitoring wells installed or decommissioned during the preceding year;
- A summary of all groundwater monitoring activities, including number of samples collected, specific analysis for each groundwater sample, field procedures followed during sample collection activities, and dates of sampling events;
- Discussion of any transition between monitoring programs, including dates of transition, cause for transition, identification of constituents detected at an SSI over background levels; and
- Any other pertinent information regarding the groundwater monitoring system or groundwater monitoring program.

The annual groundwater monitoring report will comply with recordkeeping requirements specified in §257.105 and Section 6 of this Groundwater Monitoring Program Plan.

6. Documentation

6.1 RECORDKEEPING

Per the CCR Rule, SIGECO, or a designated representative, will maintain adequate information in a written operating record at the subject facility, as described in §257.105. The operating record will be retained for at least five years following the date of each occurrence, measurement, sampling event, maintenance activity, corrective action, or report for the WAP. The operating record may be maintained in a variety of methods, such as saved on a computer, computer storage devices, or equivalent system that ensure that adequate information is kept for the required timeframe. Documentation will be submitted to the state director when such documentation is not available on SIGECO's maintained website, as described in Section 6.3, below. The following information pertinent to the groundwater monitoring network and the groundwater monitoring program will be placed in the operating record:

- The annual groundwater monitoring report, as required by §257.90(e);
- Documentation of the design, installation, development, and decommissioning of any monitoring well, piezometer, and other measurement or sampling device as required under §257.91(e)(1);
- The groundwater monitoring system certification, as required under §257.91(f);
- Selection of the statistical method certification (SDAP), as required under §257.93(f)(6);
- A certified alternate source demonstration in accordance with §257.94 (e)(2) or §257.95(g)(3)(ii), as required by §257.90(e);
- Notification of establishing an Assessment Monitoring program (within 30 days of triggering), as required under §257.94(e)(3);
- Results of Appendix III and IV constituent concentrations, as required under §257.95(d)(1);
- Notification of returning to Detection Monitoring (within 30 days), as required under §257.95(e);
- Notification of detection of one or more Appendix IV constituents at statistically significant levels above the groundwater protection standard (within 30 days), as required by §257.95(g). Note - Appendix III constituents are not assessed above the groundwater protection standards but are assessed against the upgradient/background concentrations;
- Notification of initiating the assessment of Corrective Measures (within 30 days), as required under §257.95(g)(5);
- Completed assessment of Corrective Measures, as required under §257.96(d);
- Documents prepared by owner/operator recording the public meeting for Corrective Measures assessment, as required under §257.96(e);
- The semi-annual report documenting the progress in selecting and designing the remedy and the selection of remedy report, as required under §257.97(a); and
- Notification of completing the remedy (within 30 days), as required under §257.98(e).

6.2 NOTIFICATION

Notifications will be provided to the relevant State Director before the close of business on the day the notification is required to be completed, as specified under §257.106. The State must be notified when information is added or placed in the operating recorded and on SIGECO's publicly accessible internet site. Notification will be made to the relevant authority of any design or operating criteria modifications or actions specified under §257.106(f) and §257.106(g) of the Rule. Notification of the availability of the annual groundwater monitoring report is specified under §257.105(h)(1).

6.3 POSTING INFORMATION TO THE INTERNET

A publicly accessible Internet website (CCR website) will be maintained, titled "CCR Rule Compliance Data and Information," and will contain the information specified under §257.107 of the Rule. One CCR website will be kept for FBC Generating Station. All information will be made available to the public within 30 days of placing the information in the operating record and for at least five years following the date on which the information was first posted to the CCR website. Notification information provided to the relevant State Director will be posted on the CCR website as specified under §257.106.

References

1. United States Environmental Protection Agency (USEPA), 2000. Sampling and Analysis Plan Guidance and Template, R9QA/002.1. April 2000.

2. United States Environmental Protection Agency (USEPA), 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance, EPA 530/R-09-007. March 2009.

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TABLES

FIGURES

APPENDIX A

40 CFR §257.90 through §257.98, *revised 2016 August 5* 40 CFR §257, and Appendices III - IV

APPENDIX B

Boring Logs and Construction Diagrams

APPENDIX C

Hydraulic Conductivity Results

TABLES

TABLE 1
SUMMARY OF GROUNDWATER ELEVATION MEASUREMENTS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Well Identifier	Date of Measurement	Reference Point Elevation (feet above MSL)	Depth to Water (feet)	Static Water Level Elevation (feet above MSL)	Notes
CCR-AP-7	6/2/2016	434.11	6.54	427.57	
CCR-AP-7	8/12/2016	434.11	12.24	421.87	
CCR-AP-7	10/28/2016	434.11	15.98	418.13	
CCR-AP-7	12/7/2016	434.11	13.27	420.84	
CCR-AP-7	2/8/2017	434.11	5.95	428.16	
CCR-AP-7	4/7/2017	434.11	4.81	429.3	
CCR-AP-7	6/7/2017	434.11	11.46	422.65	
CCR-AP-7	9/28/2017	434.11	16.62	417.49	
CCR-AP-7	11/17/2017	434.11	14.56	419.55	
CCR-AP-7	6/11/2018	434.11	6.45	427.66	
CCR-AP-7	8/28/2018	434.11	14.2	419.91	
WAP-1	2/10/2016	403.39	10.6	392.79	
WAP-1	2/14/2017	403.39	10.59	392.8	
WAP-1	3/21/2017	403.39	11.32	392.07	
WAP-1	4/11/2017	403.39	11.5	391.89	
WAP-1	6/5/2017	403.39	12.8	390.59	
WAP-1	6/20/2017	403.39	14.3	389.09	
WAP-1	7/3/2017	403.39	14.8	388.59	
WAP-1	7/17/2017	403.39	15.5	387.89	
WAP-1	7/27/2017	403.39	16.3	387.09	
WAP-1	8/15/2017	403.39	16.2	387.19	
WAP-1	8/27/2017	403.39	17.7	385.69	
WAP-1	1/23/2018	403.39	13.22	390.17	
WAP-1	3/15/2018	403.39	10.51	392.88	
WAP-1	4/2/2018	403.39	9.4	393.99	
WAP-1	5/3/2018	403.39	11.55	391.84	
WAP-1	5/23/2018	403.39	11.57	391.82	
WAP-1	6/14/2018	403.39	11.2	392.19	
WAP-1	7/5/2018	403.39	11.35	392.04	
WAP-1	7/25/2018	403.39	15.57	387.82	
WAP-1	8/16/2018	403.39	15.22	388.17	
WAP-1	12/4/2018	403.39	11.42	391.97	
WAP-2	2/8/2016	394.22	33.81	360.41	
WAP-2	2/10/2016	394.22	34.55	359.67	
WAP-2	2/14/2017	394.22	37.63	356.59	
WAP-2	3/21/2017	394.22	34.73	359.49	
WAP-2	4/11/2017	394.22	34.59	359.63	
WAP-2	6/5/2017	394.22	35.1	359.12	
WAP-2	6/20/2017	394.22	37.2	357.02	
WAP-2	7/3/2017	394.22	39.8	354.42	
WAP-2	7/17/2017	394.22	40	354.22	
WAP-2	7/27/2017	394.22	39.9	354.32	
WAP-2	8/15/2017	394.22	40.3	353.92	
WAP-2	8/27/2017	394.22	40.1	354.12	
WAP-2	1/22/2018	394.22	39.52	354.7	
WAP-2R	3/15/2018	395.29	38.28	357.01	
WAP-2R	4/2/2018	395.29	32.81	362.48	
WAP-2R	5/3/2018	395.29	40.5	354.79	
WAP-2R	5/23/2018	395.29	40.83	354.46	
WAP-2R	6/14/2018	395.29	41.06	354.23	
WAP-2R	7/5/2018	395.29	41.89	353.4	
WAP-2R	7/25/2018	395.29	41.8	353.49	
WAP-2R	8/16/2018	395.29	42.15	353.14	
WAP-2R	12/4/2018	395.29	35.7	359.59	

TABLE 1
SUMMARY OF GROUNDWATER ELEVATION MEASUREMENTS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Well Identifier	Date of Measurement	Reference Point Elevation (feet above MSL)	Depth to Water (feet)	Static Water Level Elevation (feet above MSL)	Notes
WAP-3	2/8/2016	393.1	34.3	358.8	
WAP-3	2/10/2016	393.1	34.15	358.95	
WAP-3	2/14/2017	393.1	37.9	355.2	
WAP-3	3/21/2017	393.1	38.7	354.4	
WAP-3	4/11/2017	393.1	33.02	360.08	
WAP-3	6/5/2017	393.1	38.2	354.9	
WAP-3	6/20/2017	393.1	39.35	353.75	
WAP-3	7/3/2017	393.1	39.85	353.25	
WAP-3	7/17/2017	393.1	39.7	353.4	
WAP-3	7/27/2017	393.1	38.9	354.2	
WAP-3	8/15/2017	393.1	39.7	353.4	
WAP-3	8/27/2017	393.1	39.6	353.5	
WAP-3	1/23/2018	393.1	41.1	352	
WAP-3	3/15/2018	393.1	38.47	354.63	
WAP-3	4/2/2018	393.1	30.78	362.32	
WAP-3	5/3/2018	393.1	40.75	352.35	
WAP-3	5/23/2018	393.1	40.52	352.58	
WAP-3	6/14/2018	393.1	38.74	354.36	
WAP-3	7/5/2018	393.1	41	352.1	
WAP-3	7/25/2018	393.1	40.85	352.25	
WAP-3	8/16/2018	393.1	40.99	352.11	
WAP-3	12/4/2018	393.1	33.75	359.35	
WAP-4D	2/8/2016	397.03	34.41	362.62	
WAP-4D	2/14/2017	397.03	43.3	353.73	
WAP-4D	3/21/2017	397.03	44.05	352.98	
WAP-4D	4/11/2017	397.03	34.79	362.24	
WAP-4D	6/5/2017	397.03	41.2	355.83	
WAP-4D	6/20/2017	397.03	41.75	355.28	
WAP-4D	7/3/2017	397.03	44.9	352.13	
WAP-4D	7/17/2017	397.03	44.3	352.73	
WAP-4D	7/27/2017	397.03	40.8	356.23	
WAP-4D	8/15/2017	397.03	44.3	352.73	
WAP-4D	8/27/2017	397.03	43.9	353.13	
WAP-4D	1/23/2018	397.03	46.31	350.72	
WAP-4D	3/14/2018	397.03	44.54	352.49	
WAP-4D	4/9/2018	397.03	24.2	372.83	
WAP-4D	5/3/2018	397.03	46.3	350.73	
WAP-4D	5/23/2018	397.03	45.02	352.01	
WAP-4D	6/14/2018	397.03	42.11	354.92	
WAP-4D	7/5/2018	397.03	43.4	353.63	
WAP-4D	7/25/2018	397.03	45.2	351.83	
WAP-4D	8/16/2018	397.03	45.6	351.43	
WAP-4D	12/4/2018	397.03	37.27	359.76	

TABLE 1
SUMMARY OF GROUNDWATER ELEVATION MEASUREMENTS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Well Identifier	Date of Measurement	Reference Point Elevation (feet above MSL)	Depth to Water (feet)	Static Water Level Elevation (feet above MSL)	Notes
WAP-4I	2/8/2016	397.23	32.74	364.49	
WAP-4I	2/14/2017	397.23	41.5	355.73	
WAP-4I	3/21/2017	397.23	42.55	354.68	
WAP-4I	4/11/2017	397.23	34.99	362.24	
WAP-4I	6/5/2017	397.23	40.7	356.53	
WAP-4I	6/20/2017	397.23	41.15	356.08	
WAP-4I	7/3/2017	397.23	42.9	354.33	
WAP-4I	7/17/2017	397.23	42.55	354.68	
WAP-4I	7/27/2017	397.23	40.8	356.43	
WAP-4I	8/15/2017	397.23	42.5	354.73	
WAP-4I	8/27/2017	397.23	42.1	355.13	
WAP-4I	1/23/2018	397.23	44	353.23	
WAP-4I	3/14/2018	397.23	41	356.23	
WAP-4I	4/9/2018	397.23	24.08	373.15	
WAP-4I	5/3/2018	397.23	44.1	353.13	
WAP-4I	5/23/2018	397.23	42.86	354.37	
WAP-4I	6/14/2018	397.23	41.4	355.83	
WAP-4I	7/5/2018	397.23	45.5	351.73	
WAP-4I	7/25/2018	397.23	43.1	354.13	
WAP-4I	8/16/2018	397.23	43.45	353.78	
WAP-4I	12/4/2018	397.23	35.45	361.78	
WAP-4S	2/8/2016	397.08	32.3	364.78	
WAP-4S	2/14/2017	397.08	41.18	355.9	
WAP-4S	3/21/2017	397.08	41.72	355.36	
WAP-4S	4/11/2017	397.08	35.4	361.68	
WAP-4S	6/5/2017	397.08	40.45	356.63	
WAP-4S	6/20/2017	397.08	40.9	356.18	
WAP-4S	7/3/2017	397.08	42.25	354.83	
WAP-4S	7/17/2017	397.08	42.3	354.78	
WAP-4S	7/27/2017	397.08	40.9	356.18	
WAP-4S	8/15/2017	397.08	42.3	354.78	
WAP-4S	8/27/2017	397.08	41.9	355.18	
WAP-4S	1/23/2018	397.08	43.54	353.54	
WAP-4S	3/14/2018	397.08	40.68	356.4	
WAP-4S	4/2/2018	397.08	30.95	366.13	
WAP-4S	5/3/2018	397.08	43.79	353.29	
WAP-4S	5/23/2018	397.08	42.55	354.53	
WAP-4S	6/14/2018	397.08	40.94	356.14	
WAP-4S	7/5/2018	397.08	43.12	353.96	
WAP-4S	7/25/2018	397.08	42.85	354.23	
WAP-4S	8/16/2018	397.08	43.25	353.83	
WAP-4S	12/4/2018	397.08	35.28	361.8	

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SUMMARY OF GROUNDWATER ELEVATION MEASUREMENTS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Well Identifier	Date of Measurement	Reference Point Elevation (feet above MSL)	Depth to Water (feet)	Static Water Level Elevation (feet above MSL)	Notes
WAP-5D	2/8/2016	396.35	35.4	360.95	
WAP-5D	2/14/2017	396.35	39.79	356.56	
WAP-5D	3/21/2017	396.35	39.86	356.49	
WAP-5D	4/11/2017	396.35	33.41	362.94	
WAP-5D	6/5/2017	396.35	39.3	357.05	
WAP-5D	6/20/2017	396.35	39.7	356.65	
WAP-5D	7/3/2017	396.35	40.9	355.45	
WAP-5D	7/17/2017	396.35	40.5	355.85	
WAP-5D	7/27/2017	396.35	39.7	356.65	
WAP-5D	8/15/2017	396.35	40.85	355.5	
WAP-5D	8/27/2017	396.35	40.55	355.8	
WAP-5D	1/23/2018	396.35	41.92	354.43	
WAP-5D	3/13/2018	396.35	36.81	359.54	
WAP-5D	4/9/2018	396.35	24.05	372.3	
WAP-5D	5/3/2018	396.35	42.15	354.2	
WAP-5D	5/23/2018	396.35	40.27	356.08	
WAP-5D	6/14/2018	396.35	40.63	355.72	
WAP-5D	7/5/2018	396.35	41.54	354.81	
WAP-5D	7/25/2018	396.35	41.46	354.89	
WAP-5D	8/16/2018	396.35	41.7	354.65	
WAP-5D	12/4/2018	396.35	31.75	364.6	
WAP-5I	2/8/2016	396.35	31.5	364.85	
WAP-5I	2/14/2017	396.35	39.38	356.97	
WAP-5I	3/21/2017	396.35	39.82	356.53	
WAP-5I	4/11/2017	396.35	33.38	362.97	
WAP-5I	6/5/2017	396.35	36.25	360.1	
WAP-5I	6/20/2017	396.35	39.6	356.75	
WAP-5I	7/3/2017	396.35	40.5	355.85	
WAP-5I	7/17/2017	396.35	40.45	355.9	
WAP-5I	7/27/2017	396.35	39.6	356.75	
WAP-5I	8/15/2017	396.35	40.45	355.9	
WAP-5I	8/27/2017	396.35	40.2	356.15	
WAP-5I	1/23/2018	396.35	41.42	354.93	
WAP-5I	3/13/2018	396.35	36.03	360.32	
WAP-5I	4/9/2018	396.35	23.5	372.85	
WAP-5I	5/3/2018	396.35	41.6	354.75	
WAP-5I	5/23/2018	396.35	39.86	356.49	
WAP-5I	6/14/2018	396.35	40.2	356.15	
WAP-5I	7/5/2018	396.35	41.05	355.3	
WAP-5I	7/25/2018	396.35	41	355.35	
WAP-5I	8/16/2018	396.35	41.2	355.15	
WAP-5I	12/4/2018	396.35	31.4	364.95	

TABLE 1

SUMMARY OF GROUNDWATER ELEVATION MEASUREMENTS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Well Identifier	Date of Measurement	Reference Point Elevation (feet above MSL)	Depth to Water (feet)	Static Water Level Elevation (feet above MSL)	Notes
WAP-5S	2/8/2016	396.41	30.31	366.1	
WAP-5S	2/14/2017	396.41	39.25	357.16	
WAP-5S	3/21/2017	396.41	39.89	356.52	
WAP-5S	4/11/2017	396.41	33.41	363	
WAP-5S	6/5/2017	396.41	39.15	357.26	
WAP-5S	6/20/2017	396.41	39.8	356.61	
WAP-5S	7/3/2017	396.41	40.3	356.11	
WAP-5S	7/17/2017	396.41	40.4	356.01	
WAP-5S	7/27/2017	396.41	39.9	356.51	
WAP-5S	8/15/2017	396.41	40.5	355.91	
WAP-5S	8/27/2017	396.41	40.25	356.16	
WAP-5S	1/23/2018	396.41	41.23	355.18	
WAP-5S	3/13/2018	396.41	35.14	361.27	
WAP-5S	4/2/2018	396.41	28.2	368.21	
WAP-5S	5/3/2018	396.41	41.44	354.97	
WAP-5S	5/23/2018	396.41	39.95	356.46	
WAP-5S	6/14/2018	396.41	40.15	356.26	
WAP-5S	7/5/2018	396.41	41.04	355.37	
WAP-5S	7/25/2018	396.41	40.95	355.46	
WAP-5S	8/16/2018	396.41	41.25	355.16	
WAP-5S	12/4/2018	396.41	31.97	364.44	
PZ-E-1	7/17/2017	406.26	20.5	385.76	
PZ-E-1	7/27/2017	406.26	20.95	385.31	
PZ-E-1	8/15/2017	406.26	21	385.26	
PZ-E-1	8/27/2017	406.26	22.2	384.06	
PZ-E-1	1/23/2018	406.26	14.97	391.29	
PZ-E-1	4/2/2018	406.26	13.4	392.86	
PZ-E-1	5/3/2018	406.26	14.9	391.36	
PZ-E-1	5/23/2018	406.26	15.3	390.96	
PZ-E-1	6/14/2018	406.26	15.08	391.18	
PZ-E-1	7/5/2018	406.26	14.76	391.5	
PZ-E-1	7/25/2018	406.26	18.28	387.98	
PZ-E-1	8/16/2018	406.26	19.27	386.99	
PZ-E-1	12/4/2018	406.26	15.51	390.75	
PZ-E-2	7/17/2017	404.43	20.1	384.33	
PZ-E-2	7/27/2017	404.43	20.6	383.83	
PZ-E-2	8/15/2017	404.43	20.6	383.83	
PZ-E-2	8/27/2017	404.43	21.2	383.23	
PZ-E-2	1/23/2018	404.43	13.81	390.62	
PZ-E-2	4/2/2018	404.43	10.5	393.93	
PZ-E-2	5/3/2018	404.43	13.25	391.18	
PZ-E-2	5/23/2018	404.43	16.44	387.99	
PZ-E-2	6/14/2018	404.43	22.57	381.86	
PZ-E-2	7/5/2018	404.43	12	392.43	
PZ-E-2	7/25/2018	404.43	19.2	385.23	
PZ-E-2	8/16/2018	404.43	21.22	383.21	
PZ-E-2	12/4/2018	404.43	20.22	384.21	

TABLE 1
SUMMARY OF GROUNDWATER ELEVATION MEASUREMENTS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Well Identifier	Date of Measurement	Reference Point Elevation (feet above MSL)	Depth to Water (feet)	Static Water Level Elevation (feet above MSL)	Notes
PZ-E-3	7/17/2017	404.54	22	382.54	
PZ-E-3	7/27/2017	404.54	22.5	382.04	
PZ-E-3	8/15/2017	404.54	23.15	381.39	
PZ-E-3	8/27/2017	404.54	24	380.54	
PZ-E-3	1/23/2018	404.54	20.04	384.5	
PZ-E-3	4/2/2018	404.54	14.22	390.32	
PZ-E-3	5/3/2018	404.54	12.02	392.52	
PZ-E-3	5/23/2018	404.54	17.77	386.77	
PZ-E-3	6/14/2018	404.54	17.66	386.88	
PZ-E-3	7/5/2018	404.54	16.8	387.74	
PZ-E-3	7/25/2018	404.54	20.21	384.33	
PZ-E-3	8/16/2018	404.54	22.05	382.49	
PZ-E-3	12/4/2018	404.54			
PZ-E-4	7/17/2017	404.263	24.1	380.16	
PZ-E-4	7/27/2017	404.263	24.2	380.06	
PZ-E-4	8/15/2017	404.263	24.1	380.16	
PZ-E-4	8/27/2017	404.263	24.1	380.16	
PZ-E-4	1/23/2018	404.26	Dry		Dry
PZ-E-4	4/2/2018	404.26	18.83	385.43	
PZ-E-4	5/3/2018	404.26	22.57	381.69	
PZ-E-4	5/23/2018	404.26	23.16	381.1	
PZ-E-4	6/14/2018	404.26	22.13	382.13	
PZ-E-4	7/5/2018	404.26	22.5	381.76	
PZ-E-4	7/25/2018	404.26	24.05	380.21	
PZ-E-4	8/16/2018	404.26	Dry		Dry
PZ-E-4	12/4/2018	404.26	17.52	386.74	
PZ-E-5	7/17/2017	401.75	20.15	381.6	
PZ-E-5	7/27/2017	401.75	20.7	381.05	
PZ-E-5	8/15/2017	401.75	29.65	372.1	
PZ-E-5	8/27/2017	401.75	30.4	371.35	
PZ-E-5	1/23/2018	401.75	28.99	372.76	
PZ-E-5	4/2/2018	401.75	24.2	377.55	
PZ-E-5	5/3/2018	401.75	27.55	374.2	
PZ-E-5	5/23/2018	401.75	27.96	373.79	
PZ-E-5	6/14/2018	401.75	27.7	374.05	
PZ-E-5	7/5/2018	401.75	27	374.75	
PZ-E-5	7/25/2018	401.75	Dry		Dry
PZ-E-5	8/16/2018	401.75	26.89	374.86	
PZ-E-5	12/4/2018	401.75	31.7	370.05	
PZ-N-1	7/17/2017	407.42	22.4	385.02	
PZ-N-1	7/27/2017	407.42	22.8	384.62	
PZ-N-1	8/15/2017	407.42	22.6	384.82	
PZ-N-1	8/27/2017	407.42	23.8	383.62	
PZ-N-1	1/23/2018	407.42	15.73	391.69	
PZ-N-1	4/2/2018	407.42	17.32	390.1	
PZ-N-1	5/3/2018	407.42	15.36	392.06	
PZ-N-1	5/23/2018	407.42	15.49	391.93	
PZ-N-1	6/14/2018	407.42	14.81	392.61	
PZ-N-1	7/5/2018	407.42	14.86	392.56	
PZ-N-1	7/25/2018	407.42	19.21	388.21	
PZ-N-1	8/16/2018	407.42	18.74	388.68	
PZ-N-1	12/4/2018	407.42	15.16	392.26	

TABLE 1
SUMMARY OF GROUNDWATER ELEVATION MEASUREMENTS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Well Identifier	Date of Measurement	Reference Point Elevation (feet above MSL)	Depth to Water (feet)	Static Water Level Elevation (feet above MSL)	Notes
PZ-N-2	7/17/2017	406.36	21.4	384.96	
PZ-N-2	7/27/2017	406.36	21.35	385.01	
PZ-N-2	8/15/2017	406.36	22.1	384.26	
PZ-N-2	8/27/2017	406.36	22.4	383.96	
PZ-N-2	1/23/2018	406.36	17.46	388.9	
PZ-N-2	4/2/2018	406.36	14.16	392.2	
PZ-N-2	5/3/2018	406.36	15.25	391.11	
PZ-N-2	5/23/2018	406.36	15.18	391.18	
PZ-N-2	6/14/2018	406.36	14.8	391.56	
PZ-N-2	7/5/2018	406.36	17.2	389.16	
PZ-N-2	7/25/2018	406.36	19.05	387.31	
PZ-N-2	8/16/2018	406.36	18.72	387.64	
PZ-N-2	12/4/2018	406.36	15.26	391.1	
PZ-N-3	7/17/2017	405.2	20.3	384.9	
PZ-N-3	7/27/2017	405.2	20.8	384.4	
PZ-N-3	8/15/2017	405.2	21.8	383.4	
PZ-N-3	8/27/2017	405.2	22.5	382.7	
PZ-N-3	1/23/2018	405.2	19.82	385.38	
PZ-N-3	4/2/2018	405.2	11.88	393.32	
PZ-N-3	5/3/2018	405.2	17.28	387.92	
PZ-N-3	5/23/2018	405.2	17.38	387.82	
PZ-N-3	6/14/2018	405.2	17.35	387.85	
PZ-N-3	7/5/2018	405.2	16.76	388.44	
PZ-N-3	7/25/2018	405.2	20.3	384.9	
PZ-N-3	8/16/2018	405.2	21.3	383.9	
PZ-N-3	12/4/2018	405.2	18.64	386.56	
PZ-N-4	7/17/2017	398.31	18.4	379.91	
PZ-N-4	7/27/2017	398.31	18.6	379.71	
PZ-N-4	8/15/2017	398.31	18.8	379.51	
PZ-N-4	8/27/2017	398.31	19	379.31	
PZ-N-4	1/23/2018	398.31	18.21	380.1	
PZ-N-4	4/2/2018	398.31	13.03	385.28	
PZ-N-4	5/3/2018	398.31	18.15	380.16	
PZ-N-4	5/23/2018	398.31	18.27	380.04	
PZ-N-4	6/14/2018	398.31	18.01	380.3	
PZ-N-4	7/5/2018	398.31	17.91	380.4	
PZ-N-4	7/25/2018	398.31	20.91	377.4	
PZ-N-4	8/16/2018	398.31	20.2	378.11	
PZ-N-4	12/4/2018	398.31	17.52	380.79	
PZ-N-5	1/23/2018	393.9	13.08	380.82	
PZ-N-5	4/2/2018	393.9	11.44	382.46	
PZ-N-5	5/3/2018	393.9	12.59	381.31	
PZ-N-5	5/23/2018	393.9	12.74	381.16	
PZ-N-5	6/14/2018	393.9	22.47	371.43	
PZ-N-5	7/5/2018	393.9	21.22	372.68	
PZ-N-5	7/25/2018	393.9	21.5	372.4	
PZ-N-5	8/16/2018	393.9	17.56	376.34	
PZ-N-5	12/4/2018	393.9	11.82	382.08	

NOTES:
MSL: mean sea level

TABLE 2
SUMMARY OF HYDRAULIC CONDUCTIVITY ESTIMATES
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Well ID	Hydraulic Conductivity cm/sec
WAP-1	1.6E-06
WAP-2R	7.7E-03
WAP-5I	1.1E-01
WAP-5D	2.3E-01

TABLE 3
SUMMARY OF VERTICAL GRADIENTS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Well Identifier	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)
	2/8/2016	2/14/2017	3/21/2017	4/11/2017	6/5/2017	6/20/2017	7/3/2017	7/17/2017	7/27/2017	8/15/2017	8/27/2017
WAP-4D	362.62	354.27	352.98	362.24	355.83	355.28	352.13	352.73	356.23	352.73	353.13
WAP-4I	364.49	356.01	354.68	362.24	356.53	356.08	354.33	354.68	356.43	354.73	355.13
WAP-4S	364.78	356.08	355.36	361.68	356.63	356.18	354.83	354.78	356.18	354.78	355.18
WAP-5D	360.95	356.64	356.49	362.94	357.05	356.65	355.45	355.85	356.65	355.50	355.80
WAP-5I	364.85	356.96	356.53	362.97	360.10	356.75	355.85	355.90	356.75	355.90	356.15
WAP-5S	366.10	356.44	356.52	363.00	357.26	356.61	356.11	356.01	356.51	355.91	356.16

Well Pair	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)
WAP-4S WAP-4I	-0.0097	-0.0023	-0.0227	0.0187	-0.0033	-0.0033	-0.0167	-0.0033	0.0083	-0.0017	-0.0017
WAP-4I WAP-4D	-0.0456	-0.0424	-0.0415	0.0000	-0.0171	-0.0195	-0.0537	-0.0476	-0.0049	-0.0488	-0.0488
WAP-5S WAP-5I	-0.0357	0.0149	0.0003	-0.0009	0.0811	0.0040	-0.0074	-0.0031	0.0069	-0.0003	-0.0003
WAP-5I WAP-5D	-0.1026	-0.0084	-0.0011	-0.0008	-0.0803	-0.0026	-0.0105	-0.0013	-0.0026	-0.0105	-0.0092

Negative gradient indicates downward groundwater flow potential
* The estimated vertical gradient was calculated at the mid-point of the screen
* Results were checked using the EPA's vertical gradient calculator
0.0024 = Positive Vertical Gradient

TABLE 3
SUMMARY OF VERTICAL GRADIENTS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Well Identifier	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)	Static Water Level Elevation (ft.)
	1/23/2018	5/3/2018	5/23/2018	6/14/2018	7/5/2018	7/25/2018	8/16/2018	12/4/2018
WAP-4D	350.72	350.73	352.01	354.92	353.63	351.83	351.43	359.76
WAP-4I	353.23	353.13	354.37	355.83	351.73	354.13	353.78	361.78
WAP-4S	353.54	353.29	354.53	356.14	353.96	354.23	353.83	361.80
WAP-5D	354.43	354.20	356.08	355.72	354.81	354.89	354.65	364.60
WAP-5I	354.93	354.75	356.49	356.15	355.30	355.35	355.15	364.95
WAP-5S	355.18	354.97	356.46	356.26	355.37	355.46	355.16	364.44

Well Pair	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)	Estimated Vertical Gradient (ft./ft.)
WAP-4S WAP-4I	-0.0103	-0.0053	-0.0053	-0.0103	-0.0743	-0.0033	-0.0017	-0.0007
WAP-4I WAP-4D	-0.0612	-0.0585	-0.0576	-0.0222	0.0463	-0.0561	-0.0573	-0.0493
WAP-5S WAP-5I	-0.0071	-0.0063	0.0009	-0.0031	-0.0020	-0.0031	-0.0003	0.0146
WAP-5I WAP-5D	-0.0132	-0.0145	-0.0108	-0.0113	-0.0129	-0.0121	-0.0132	-0.0092

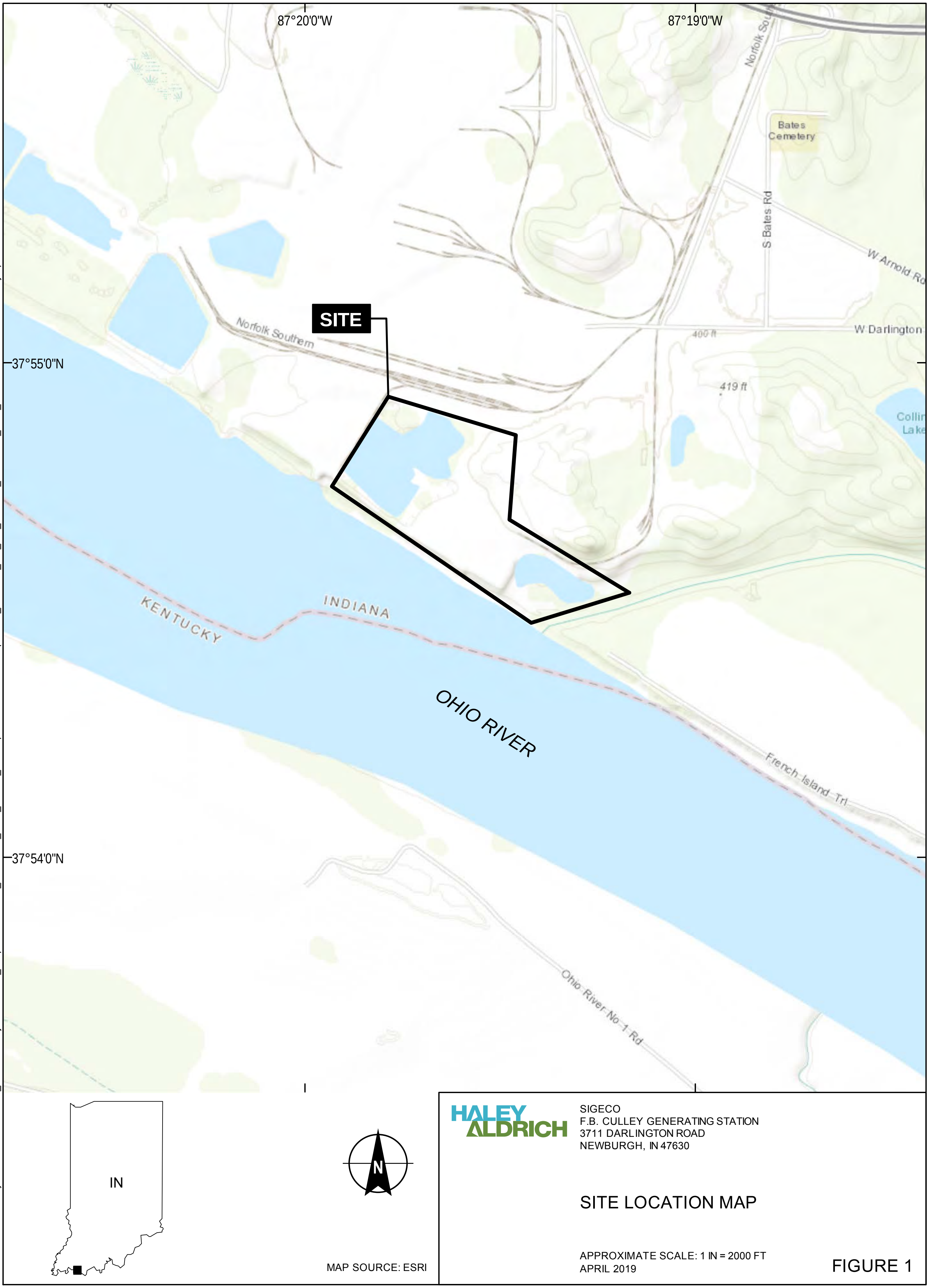
Negative gradient indicates downward groundwater flow potential
* The estimated vertical gradient was calculated at the mid-point of the screen
* Results were checked using the EPA's vertical gradient calculator
0.0024 = Positive Vertical Gradient

TABLE 4
GROUNDWATER MONITORING WELL LOCATION AND CONSTRUCTION DETAILS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

	Easting	Northing	Top of Pad Elevation (ft msl)	Top of Casing Elevation (ft msl)	Surface Grout (ft bgs)	Bentonite (ft bgs)	Sand Pack (ft bgs)	Screen Zone (ft bgs)	Screen Length (ft)	Well Radius (in)
Existing Wells										
WAP-1	2882824.18	971214.17	403.77	403.39	0 - 22	22 - 24	24 - 36	26 - 36	10	2
WAP-2R	2881511.71	971395.70	391.80	395.29	0 - 42	42 - 44	44 - 56	46 - 56	10	2
WAP-3	2881262.53	971000.02	393.59	393.10	0 - 59	59 - 61	61 - 73	63 - 73	10	2
WAP-4	2881333.33	970405.14	395.32	397.08	0 - 41	41 - 43	43 - 55	45 - 55	10	2
WAP-4I*	2881329.18	970408.95	395.26	397.23	0 - 71	71- 73	73 - 85	75 - 85	10	2
WAP-4D*	2881325.08	970412.71	395.31	397.03	0 - 112	112 - 114	114 - 126	116 - 126	10	2
WAP-5	2881521.35	970235.87	394.40	396.41	0 - 36	36 - 38	38 - 50	40 - 50	10	2
WAP-5I*	2881524.71	970232.61	394.43	396.35	0 - 71	71 - 73	73 - 85	75 - 85	10	2
WAP-5D*	2881528.71	970229.88	394.36	396.35	0 - 109	109 - 111	111 - 123	113 - 123	10	2
CCR-AP-7	2883090.34	970774.64	429.50	434.11	1.0-16	16.0-18	18.0-30	20.0-30	10	2
Piezometers										
PZ-N-1	2882733.21	971287.20	404.25	407.42	-	-	-	22 - 32	10	1
PZ-N-2	2882639.38	971316.70	403.26	406.36	-	-	-	22 - 32	10	1
PZ-N-3	2882446.57	971372.55	402.30	405.20	-	-	-	27 - 37	10	1
PZ-N-4	2882251.74	971421.58	394.78	398.31	-	-	-	16 - 26	10	1
PZ-N-5	2881915.47	971473.07	389.72	393.90	-	-	-	20 - 30	10	1
PZ-E-1	2882753.00	971139.68	403.40	406.26	-	-	-	22 - 32	10	1
PZ-E-2	2882682.29	971069.08	402.17	404.43	-	-	-	22.5 - 32.5	10	1
PZ-E-3	2882537.49	970928.88	401.60	404.54	-	-	-	27 - 37	10	1
PZ-E-4	2882506.93	970749.09	399.93	404.26	-	-	-	15 - 25	10	1
PZ-E-5	2882237.46	970565.84	399.03	401.75	-	-	-	32 - 42	10	1

NOTES:
bgs = below ground surface
ft = feet
in = inches
msl = mean sea level
*Wells will be sampled for IDEM closure requirements during the first event. Subsequently, monitoring wells will be only used to gauge water levels.

FIGURES



GIS FILE PATH: \\haleyaldrich.com\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2016_05\42796_000_001_CULLEY_PROJECT_SITE_LOCATION.mxd — USER: ajospe — LAST SAVED: 3/7/2019 2:32:43 PM

MAP SOURCE: ESRI

HALEY ALDRICH

SIGECO
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, IN 47630

SITE LOCATION MAP

APPROXIMATE SCALE: 1 IN = 2000 FT
APRIL 2019

FIGURE 1

LEGEND

- CCR BOUNDARY
- F.B. CULLEY PROJECT BOUNDARY

FLOOD HAZARD ZONES

- 1% ANNUAL CHANCE FLOOD HAZARD
- REGULATORY FLOODWAY
- SPECIAL FLOODWAY
- AREA OF UNDETERMINED FLOOD HAZARD
- 0.2% ANNUAL CHANCE FLOOD HAZARD
- FUTURE CONDITIONS 1% ANNUAL CHANCE FLOOD HAZARD
- AREA WITH REDUCED RISK DUE TO LEVEE

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. FEMA FLOOD MAP SOURCE: FEDERAL EMERGENCY MANAGEMENT AGENCY
3. AERIAL IMAGERY SOURCE: ESRI

0 200 400
APPROXIMATE SCALE IN FEET

HALEY ALDRICH

SIGECO
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, INDIANA 47630

FEMA FLOOD HAZARD AREAS

APRIL 2019

FIGURE 2

GIS FILE PATH: \\haleyaldrich.com\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_02\129420_001_0001_FEMA.mxd — USER: ajospe — LAST SAVED: 3/7/2019 2:36:38 PM

LEGEND

- BORING
- MONITORING WELL
- PIEZOMETER
- STAFF GAUGE
- SUMP
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: GOOGLE 2018

HALEY ALDRICH

SIGECO
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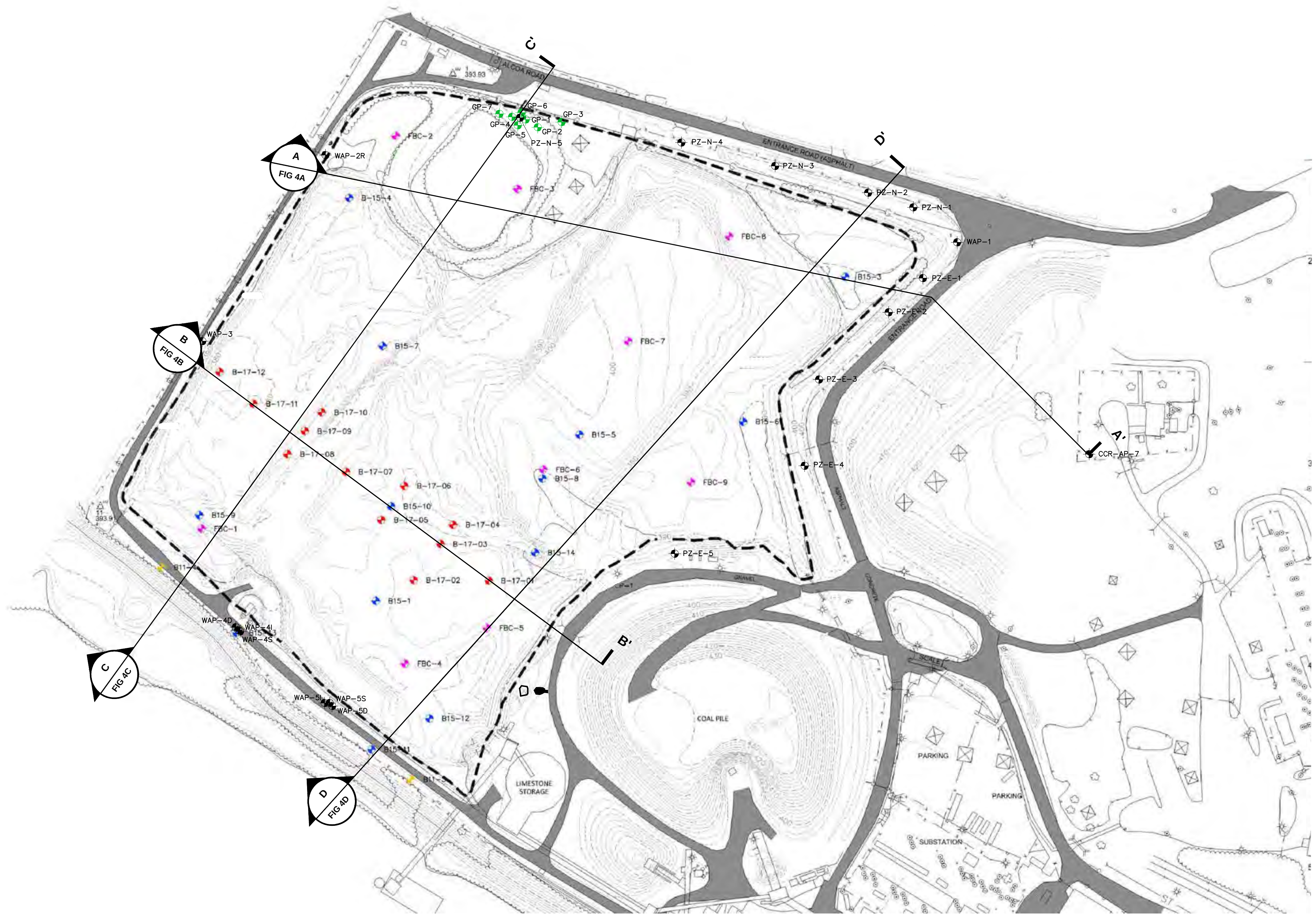
3711 DARLINGTON ROAD
NEWBURGH, IN 47630

SITE INDEX MAP

APRIL 2019

FIGURE 3

GIS FILE PATH: \\haleyaldrich.com\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_04\129420_001_00MB_CULLEY_WAP_GWE_CONTOURS.mxd — USER: ajospe — LAST SAVED: 4/18/2019 12:37:23 PM



LEGEND

- LIMIT OF WASTE
- CROSS-SECTION ID AND FIGURE NUMBER (A, FIG 4-3)
- MONITORING WELLS
- 2011 ATC SOIL BORINGS
- 2015 CARDNO ATC SOIL BORINGS
- 2015 AECOM BORINGS
- 2017 AECOM BORINGS
- 2019 AECOM BORINGS

NOTES:

1. EXISTING GRADE AND WATER SURFACE ELEVATIONS BASED ON "HYBRID CLOSURE OF WEST ASH POND - 90% DESIGN DRAWINGS (REV. C)" BY AECOM DATED OCTOBER 17, 2017.

N

0 250 500

SCALE IN FEET

PROJECT LOCATION

AERIAL SOURCE: IMAGE DATED 2019 TAKEN ELECTRONICALLY FROM BING MAPS

PREPARED FOR:

SIGECO

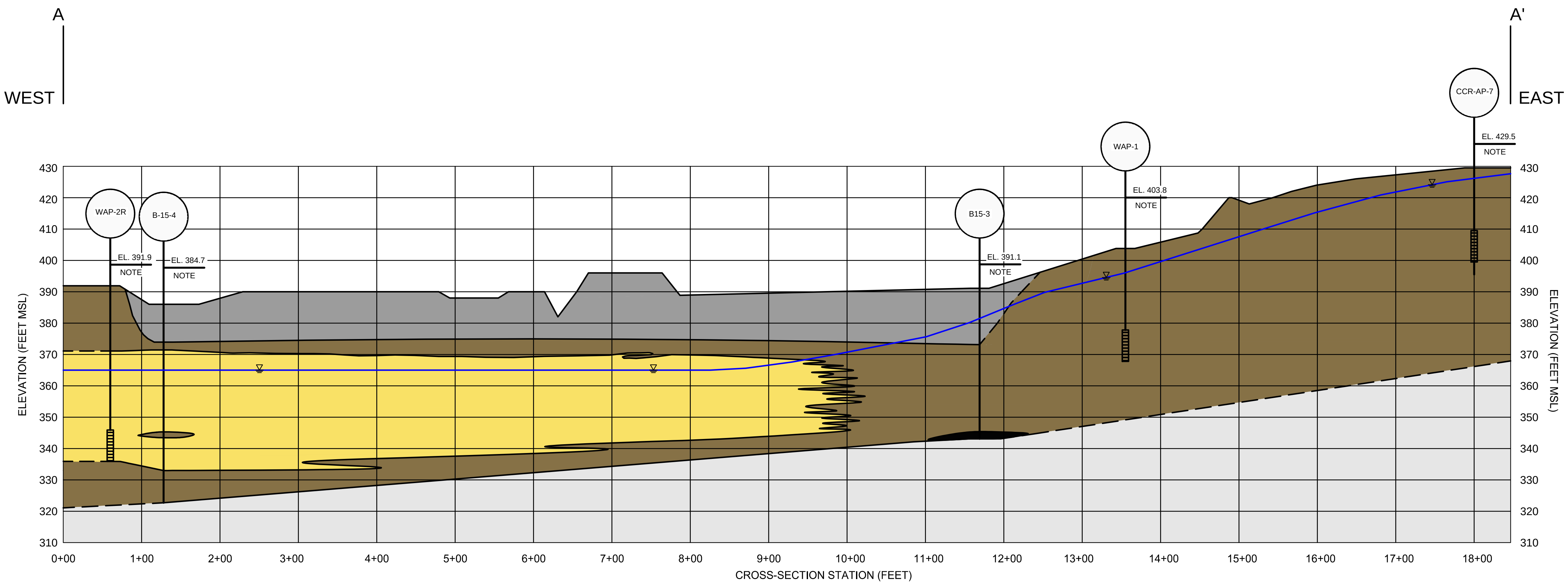
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, IN 47630

FIGURE 4

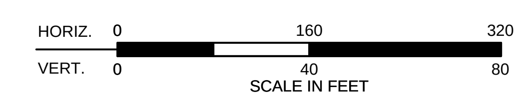
CROSS SECTION MAP WEST ASH POND

PROJECT: 129420	BY: GW/RY	REVISIONS:
DATE: APR 2019	CHECKED: SB	

HALEY & ALDRICH



F.B. CULLEY GENERATION STATION WEST ASH POND - CROSS SECTION A-A'



LEGEND

- ASH
- FILL
- SAND/CLAYEY SANDS
- SILT/CLAY
- SHALE
- SCREEN LOCATION
- GRAVEL
- COAL
- NO LITHOLOGY
- GROUNDWATER LEVEL
- LITHOLOGIC CONTACT, DASHED WHERE INFERRED
- BORING ID/LOCATION WITH GROUND SURFACE ELEVATION

NOTES:

1. EXISTING GRADE AND WATER SURFACE ELEVATIONS ARE BASED ON "HYBRID CLOSURE OF WEST ASH POND - 90% DESIGN DRAWINGS (REV. C)" BY AECOM DATED OCTOBER 17, 2017.
2. ASH POND LIMITS OF CCR ARE APPROXIMATE AND BASED ON "HYBRID CLOSURE OF WEST ASH POND - 90% DESIGN DRAWINGS (REV. C)" BY AECOM DATED OCTOBER 17, 2017.
3. GROUNDWATER ELEVATIONS ARE BASED ON "PREDICTED GROUNDWATER FLOW INTERPRETATION - APRIL 2018" BY HALEY & ALDRICH DATED APRIL 2019.

PROJECT LOCATION

AERIAL SOURCE: IMAGE DATED 2019 TAKEN ELECTRONICALLY FROM BING MAPS

PREPARED FOR:

SIGECO

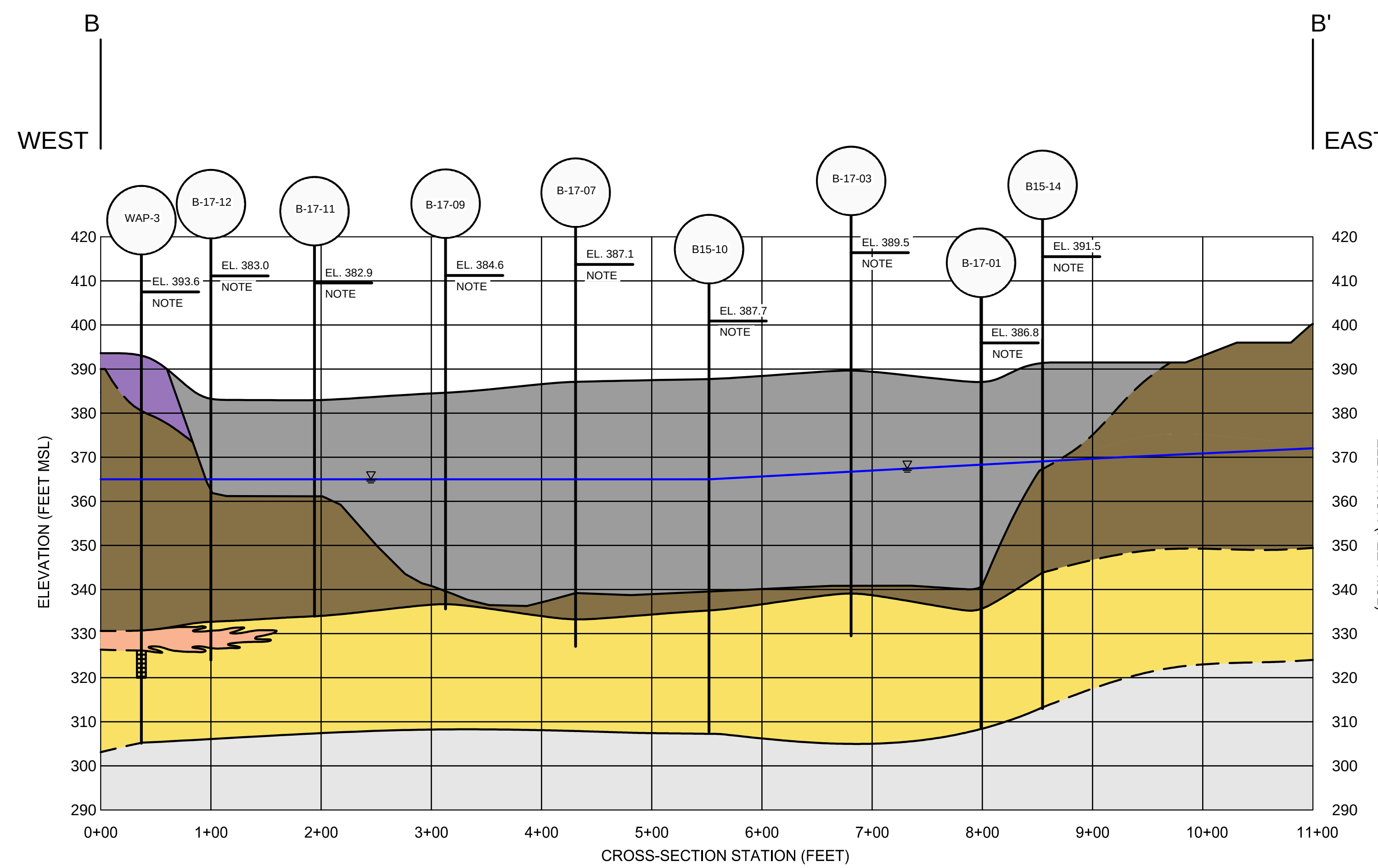
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, IN 47630

FIGURE 4A

EXISTING CONDITIONS CROSS SECTION A-A' WEST ASH POND

PROJECT: 129420	BY: GW/RY	REVISIONS:
DATE: APR 2019	CHECKED: SB	

HALEY & ALDRICH



F.B. CULLEY GENERATION STATION WEST ASH POND - CROSS SECTION B-B'

HORIZ. 0 160 320

VERT. 0 40 80

SCALE IN FEET

LEGEND

- ASH
- FILL
- SAND/CLAYEY SANDS
- SILT/CLAY
- SHALE
- SCREEN LOCATION
- GRAVEL
- COAL
- NO LITHOLOGY
- GROUNDWATER LEVEL
- LITHOLOGIC CONTACT, DASHED WHERE INFERRED
- BORING ID/LOCATION WITH GROUND SURFACE ELEVATION

NOTES:

1. EXISTING GRADE AND WATER SURFACE ELEVATIONS ARE BASED ON "HYBRID CLOSURE OF WEST ASH POND - 90% DESIGN DRAWINGS (REV. C)" BY AECOM DATED OCTOBER 17, 2017.
2. ASH POND LIMITS OF CCR ARE APPROXIMATE AND BASED ON "HYBRID CLOSURE OF WEST ASH POND - 90% DESIGN DRAWINGS (REV. C)" BY AECOM DATED OCTOBER 17, 2017.
3. GROUNDWATER ELEVATIONS ARE BASED ON "PREDICTED GROUNDWATER FLOW INTERPRETATION - APRIL 2018" BY HALEY & ALDRICH DATED APRIL 2019.

PROJECT LOCATION

AERIAL SOURCE: IMAGE DATED 2019 TAKEN ELECTRONICALLY FROM BING MAPS

PREPARED FOR:

SIGECO

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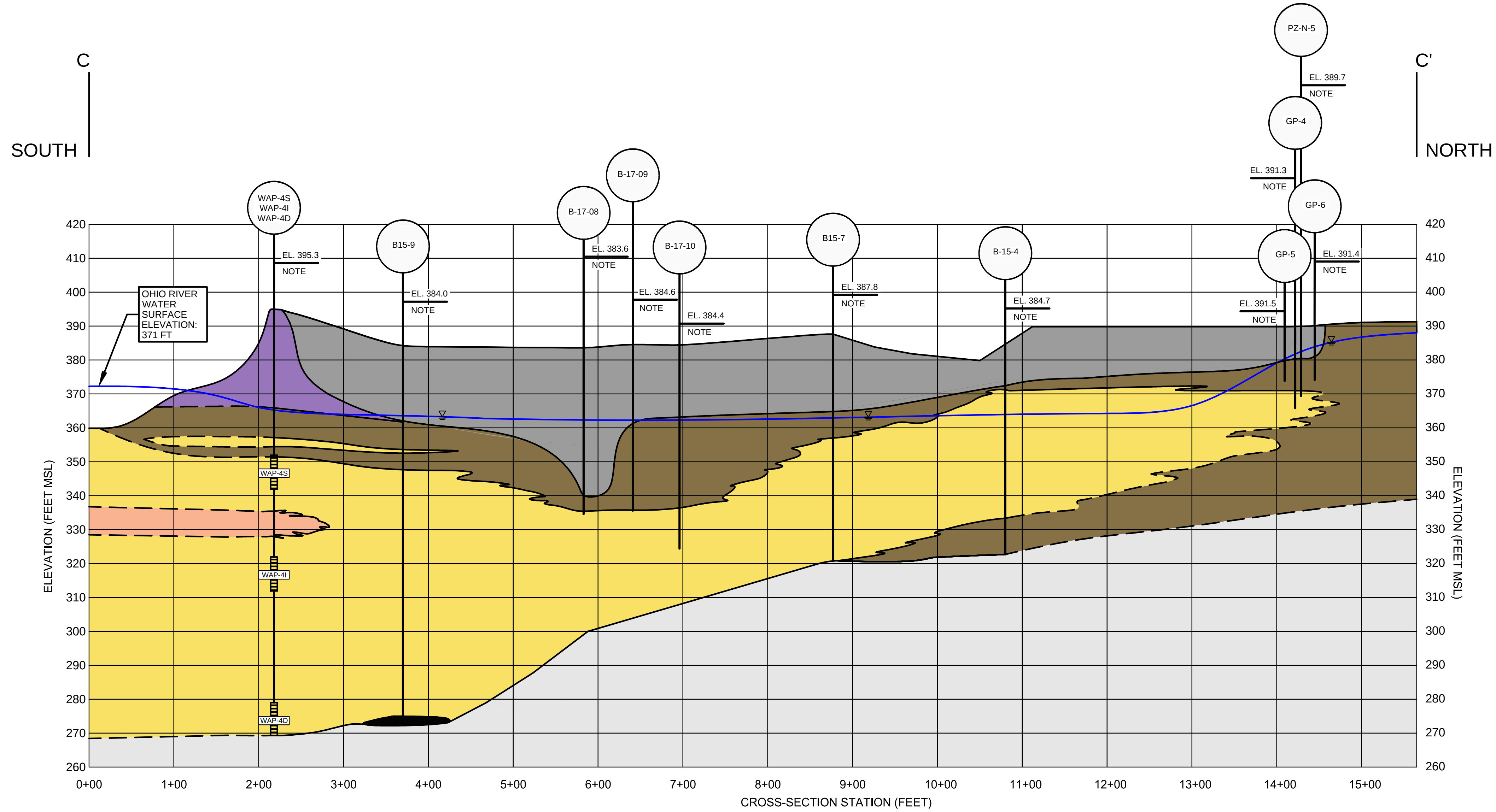
NEWBURGH, IN 47630

FIGURE 4B

EXISTING CONDITIONS CROSS SECTION B-B' WEST ASH POND

PROJECT: 129420	BY: GW/RY	REVISIONS:
DATE: APR 2019	CHECKED: SB	

HALEY & ALDRICH



F.B. CULLEY GENERATION STATION WEST ASH POND - CROSS SECTION C-C'

HORIZ.	0	160	320
VERT.	0	40	80

SCALE IN FEET

LEGEND

- ASH
- FILL
- SAND/CLAYEY SANDS
- SILT/CLAY
- SHALE
- SCREEN LOCATION
- GRAVEL
- COAL
- NO LITHOLOGY
- GROUNDWATER LEVEL
- LITHOLOGIC CONTACT, DASHED WHERE INFERRED
- BORING ID/LOCATION WITH GROUND SURFACE ELEVATION

NOTES:

1. EXISTING GRADE AND WATER SURFACE ELEVATIONS ARE BASED ON "HYBRID CLOSURE OF WEST ASH POND - 90% DESIGN DRAWINGS (REV. C)" BY AECOM DATED OCTOBER 17, 2017.
2. ASH POND LIMITS OF CCR ARE APPROXIMATE AND BASED ON "HYBRID CLOSURE OF WEST ASH POND - 90% DESIGN DRAWINGS (REV. C)" BY AECOM DATED OCTOBER 17, 2017.
3. GROUNDWATER ELEVATIONS ARE BASED ON "PREDICTED GROUNDWATER FLOW INTERPRETATION - APRIL 2018" BY HALEY & ALDRICH DATED APRIL 2019.

PROJECT LOCATION

AERIAL SOURCE: IMAGE DATED 2019 TAKEN ELECTRONICALLY FROM BING MAPS

PREPARED FOR:
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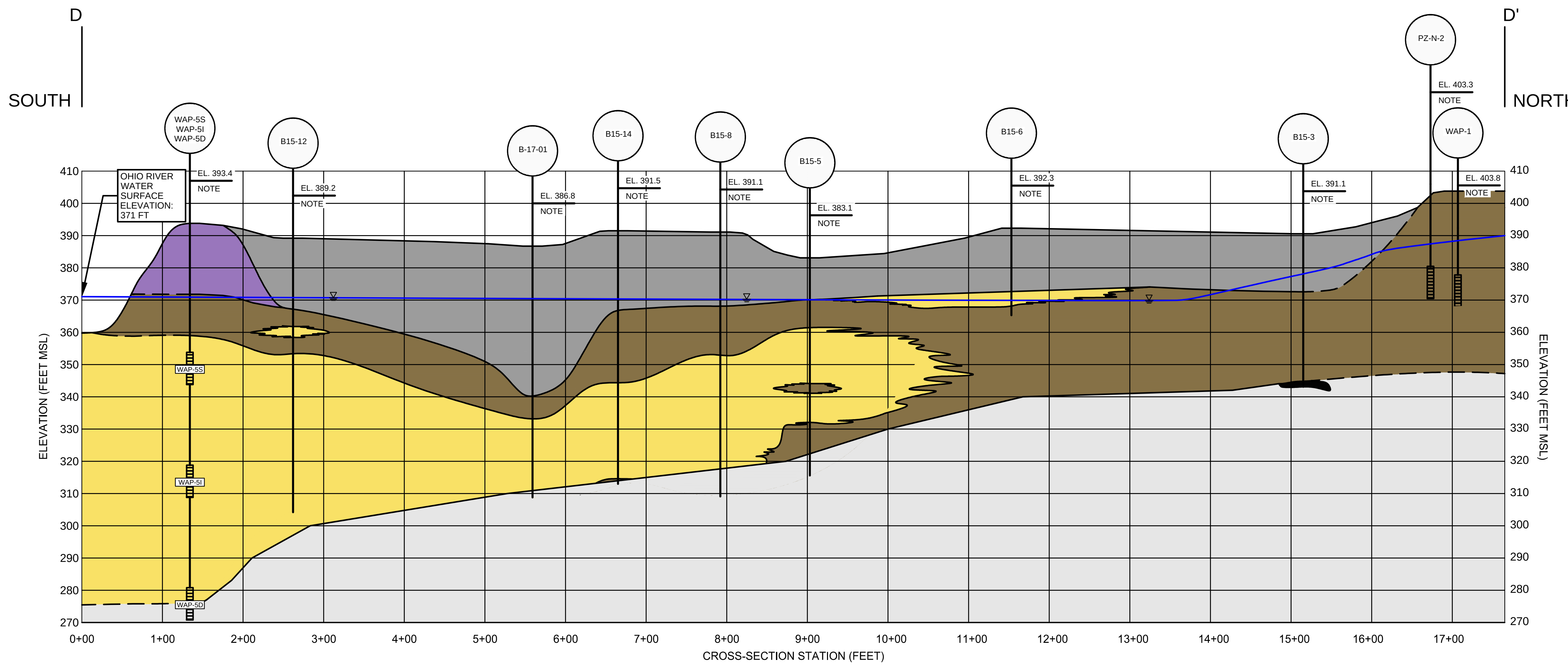
NEWBURGH, IN 47630

FIGURE 4C

EXISTING CONDITIONS CROSS SECTION C-C' WEST ASH POND

PROJECT: 129420	BY: GW/RY	REVISIONS:
DATE: APR 2019	CHECKED: SB	

HALEY & ALDRICH



F.B. CULLEY GENERATION STATION WEST ASH POND - CROSS SECTION D-D'

HORIZ.	0	160	320
VERT.	0	40	80

SCALE IN FEET

LEGEND

- ASH
- FILL
- SAND/CLAYEY SANDS
- SILT/CLAY
- SHALE
- SCREEN LOCATION
- GRAVEL
- COAL
- NO LITHOLOGY
- GROUNDWATER LEVEL
- LITHOLOGIC CONTACT, DASHED WHERE INFERRED
- BORING ID/LOCATION WITH GROUND SURFACE ELEVATION

NOTES:

1. EXISTING GRADE AND WATER SURFACE ELEVATIONS ARE BASED ON "HYBRID CLOSURE OF WEST ASH POND - 90% DESIGN DRAWINGS (REV. C)" BY AECOM DATED OCTOBER 17, 2017.
2. ASH POND LIMITS OF CCR ARE APPROXIMATE AND BASED ON "HYBRID CLOSURE OF WEST ASH POND - 90% DESIGN DRAWINGS (REV. C)" BY AECOM DATED OCTOBER 17, 2017.
3. GROUNDWATER ELEVATIONS ARE BASED ON "PREDICTED GROUNDWATER FLOW INTERPRETATION - APRIL 2018" BY HALEY & ALDRICH DATED APRIL 2019.

PROJECT LOCATION
AERIAL SOURCE: IMAGE DATED 2019 TAKEN ELECTRONICALLY FROM BING MAPS

PREPARED FOR:
SIGECO

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NEWBURGH, IN 47630

FIGURE 4D

EXISTING CONDITIONS CROSS SECTION D-D' WEST ASH POND

PROJECT: 129420	BY: GW/RY	REVISIONS:
DATE: APR 2019	CHECKED: SB	

HALEY & ALDRICH

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LEGEND

- 2015 AECOM BORING WITH DESIGNATION AND BOTTOM OF ASH ELEVATION
- 2017 AECOM BORING WITH DESIGNATION AND BOTTOM OF ASH ELEVATION
- MONITORING WELL OR BORING WITH DESIGNATION AND BOTTOM OF ASH ELEVATION
- BOTTOM OF ASH ELEVATION CONTOUR, IN FEET
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: GOOGLE 2018

0 200 400

APPROXIMATE SCALE IN FEET

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NEWBURGH, IN 47630

BOTTOM OF ASH CONTOURS

APRIL 2019

FIGURE 5

LEGEND

- MONITORING WELL WITH DESIGNATION AND TOP OF BEDROCK ELEVATION
- 2015 AECOM BORING WITH DESIGNATION AND TOP OF BEDROCK ELEVATION
- TOP OF BEDROCK CONTOUR, IN FEET
- INFERRED TOP OF BEDROCK CONTOUR
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. CCR-AP-7 WAS INSTALLED TO MONITOR THE BACKGROUND WATER QUALITY FOR THE EAST ASH POND AT FBC; AS A RESULT THE MONITORING WELL WAS NOT GAUGED DURING THE GROUNDWATER SAMPLING EVENT AT THE WAP.
3. AERIAL IMAGERY SOURCE: GOOGLE 2018

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NEWBURGH, IN 47630

TOP OF BEDROCK CONTOURS

APRIL 2019

FIGURE 6

GIS FILE PATH: \\haleyaldrich.com\share\bol_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_04\129420_001_00MB_CULLEY_WAP_GWE_CONTOURS.mxd — USER: ajospe — LAST SAVED: 4/18/2019 12:37:23 PM

LEGEND

- CCR COMPLIANCE MONITORING WELL
- MONITORING WELL
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: GOOGLE 2018

N

0 200 400

APPROXIMATE SCALE IN FEET

HALEY ALDRICH

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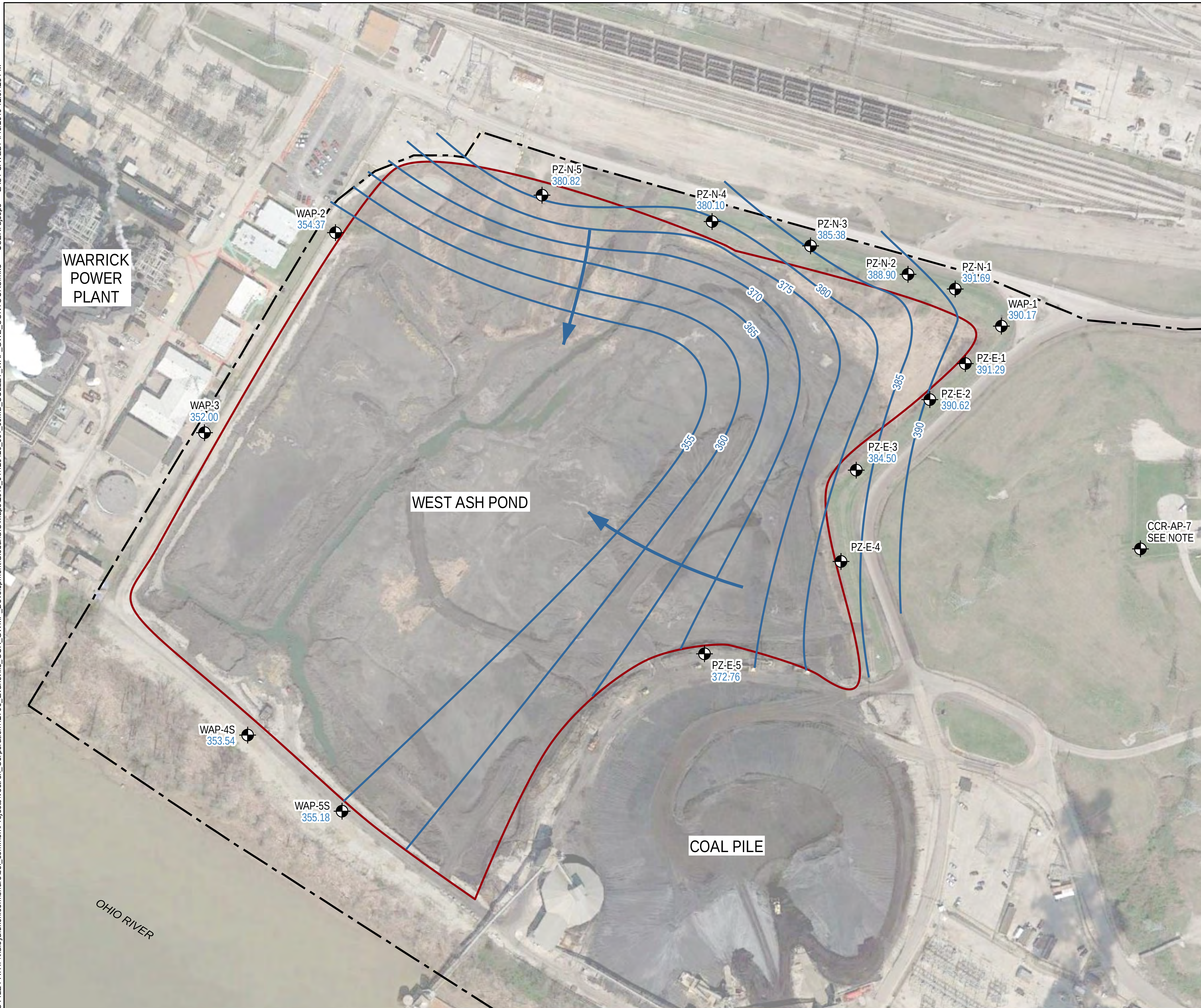
GROUNDWATER MONITORING WELL LOCATIONS FOR COMPLIANCE WITH FEDERAL CCR RULE

APRIL 2019

FIGURE 7

GIS FILE PATH: \\haleyaldrich.com\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_04\129420_001_00MB_CULLEY_WAP_GWE_CONTOURS.mxd — USER: ajospe — LAST SAVED: 4/18/2019 12:37:23 PM



LEGEND

- MONITORING WELL WITH DESIGNATION AND GROUNDWATER ELEVATION
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL
- APPROXIMATE DIRECTION OF GROUNDWATER FLOW
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. WATER LEVELS MEASURED ON 23 JANUARY 2018.
3. CCR-AP-7 WAS INSTALLED TO MONITOR THE BACKGROUND WATER QUALITY FOR THE EAST ASH POND AT FBC; AS A RESULT THE MONITORING WELL WAS NOT GAUGED DURING THE GROUNDWATER SAMPLING EVENT AT THE WAP.
4. AERIAL IMAGERY SOURCE: GOOGLE 2018

N

0 200 400
APPROXIMATE SCALE IN FEET

HALEY ALDRICH

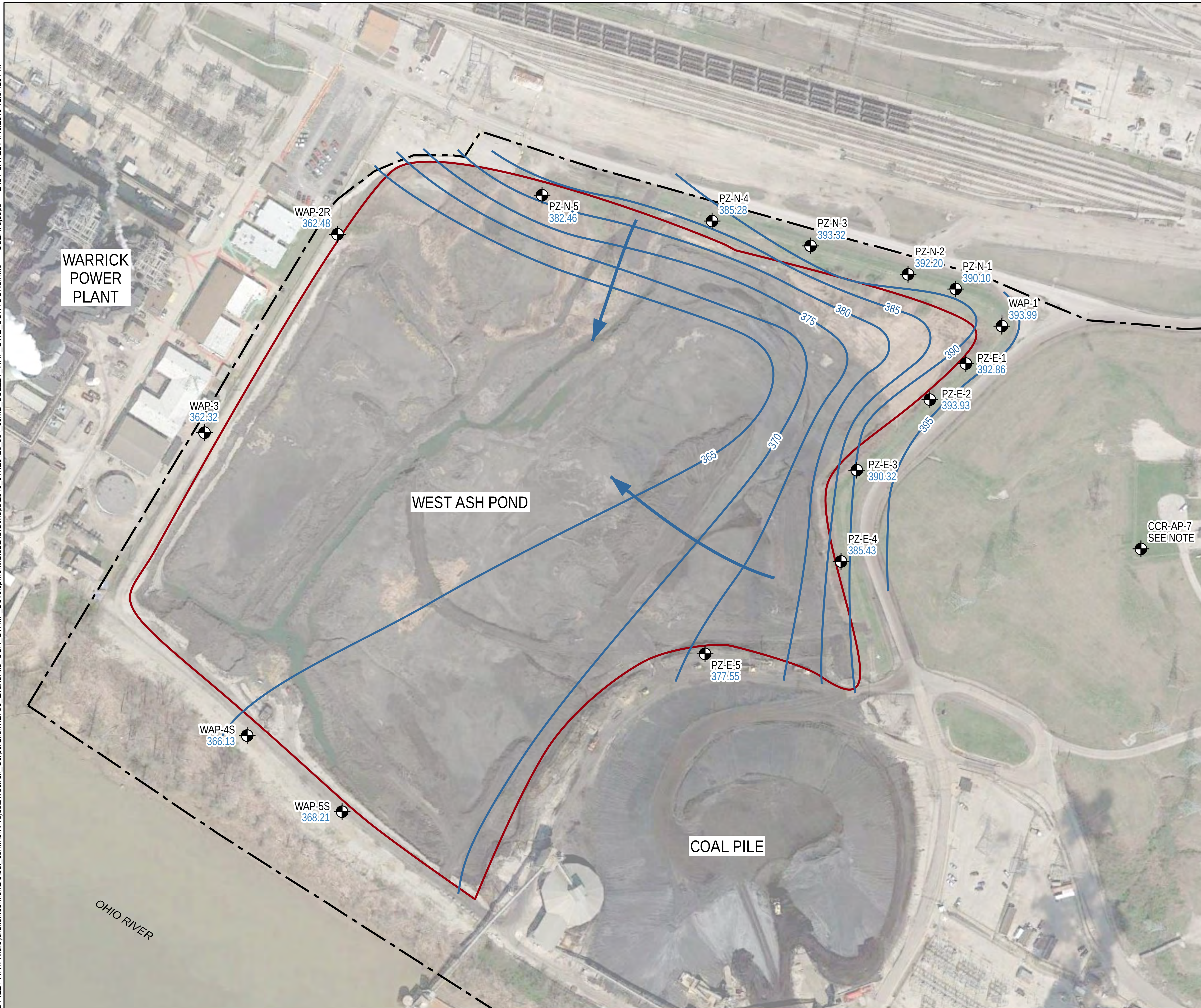
SIGECO
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, IN 47630

WATER TABLE CONFIGURATION MAP
23 JANUARY 2018

APRIL 2019

FIGURE 8A

GIS FILE PATH: \\haleyaldrich.com\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_04\129420_001_00MB_CULLEY_WAP_GWE_CONTOURS.mxd — USER: ajospe — LAST SAVED: 4/18/2019 12:37:23 PM



LEGEND

- MONITORING WELL WITH DESIGNATION AND GROUNDWATER ELEVATION
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL
- APPROXIMATE DIRECTION OF GROUNDWATER FLOW
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. WATER LEVELS MEASURED ON 2 APRIL 2018.
3. CCR-AP-7 WAS INSTALLED TO MONITOR THE BACKGROUND WATER QUALITY FOR THE EAST ASH POND AT FBC; AS A RESULT THE MONITORING WELL WAS NOT GAUGED DURING THE GROUNDWATER SAMPLING EVENT AT THE WAP.
4. AERIAL IMAGERY SOURCE: GOOGLE 2018

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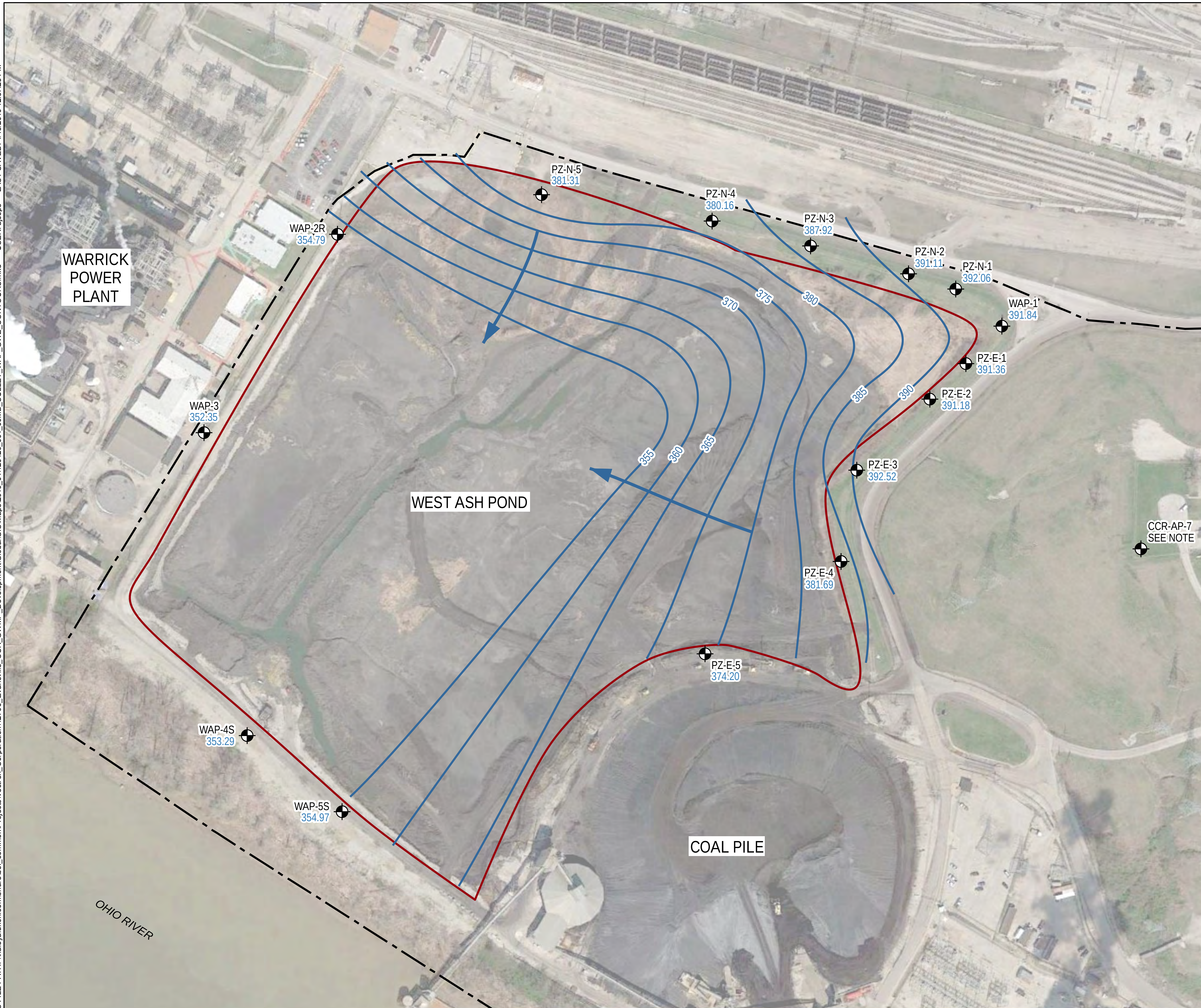
NEWBURGH, IN 47630

WATER TABLE CONFIGURATION MAP
2 APRIL 2018

APRIL 2019

FIGURE 8B

GIS FILE PATH: \\haleyaldrich.com\share\bol_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_04\129420_001_00MB_CULLEY_WAP_GWE_CONTOURS.mxd — USER: ajospe — LAST SAVED: 4/18/2019 12:37:23 PM



LEGEND

- MONITORING WELL WITH DESIGNATION AND GROUNDWATER ELEVATION
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL
- APPROXIMATE DIRECTION OF GROUNDWATER FLOW
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. WATER LEVELS MEASURED ON 3 MAY 2018.
3. CCR-AP-7 WAS INSTALLED TO MONITOR THE BACKGROUND WATER QUALITY FOR THE EAST ASH POND AT FBC; AS A RESULT THE MONITORING WELL WAS NOT GAUGED DURING THE GROUNDWATER SAMPLING EVENT AT THE WAP.
4. AERIAL IMAGERY SOURCE: GOOGLE 2018

0 200 400
APPROXIMATE SCALE IN FEET

HALEY ALDRICH

SIGECO
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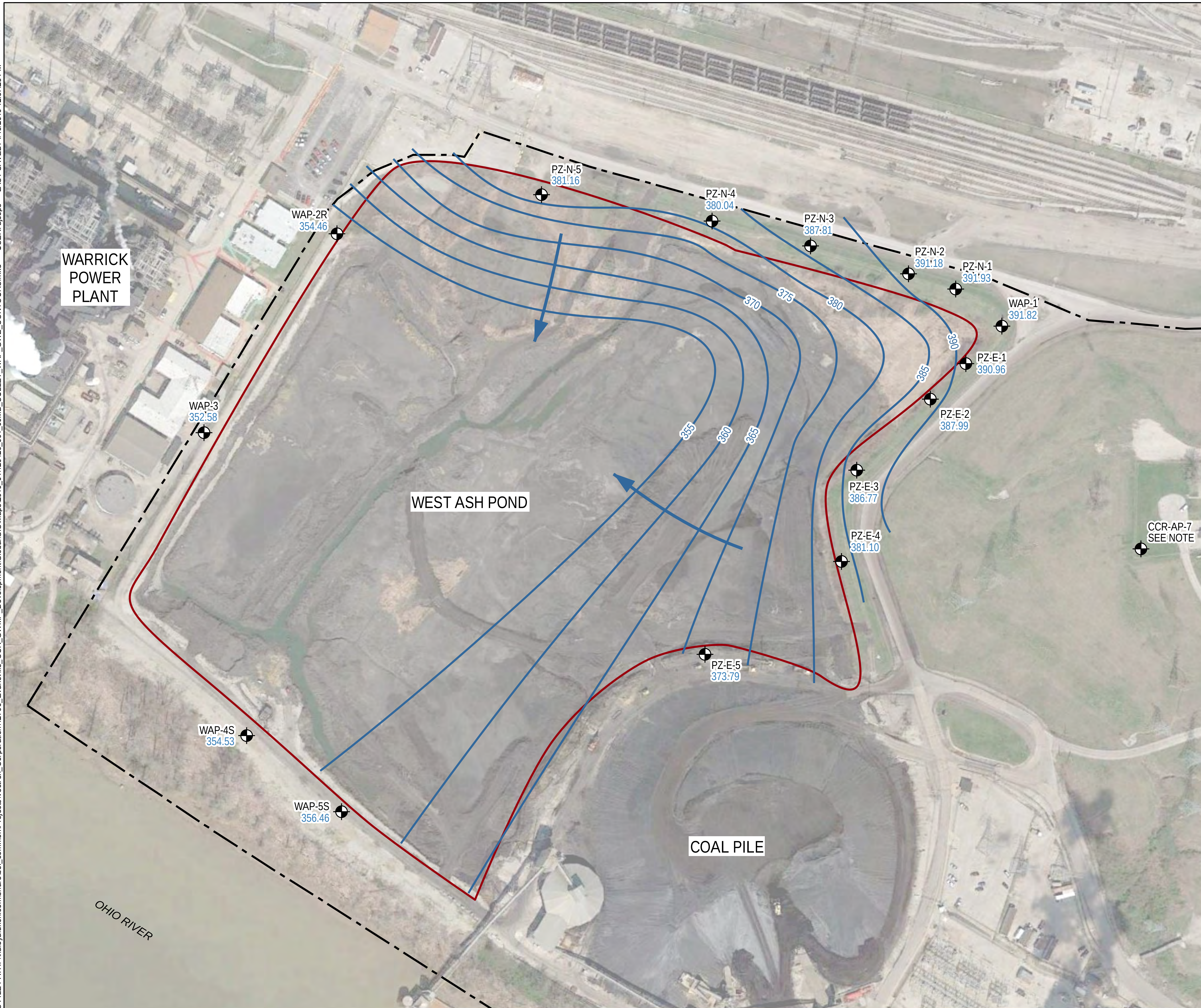
NEWBURGH, IN 47630

WATER TABLE CONFIGURATION MAP
3 MAY 2018

APRIL 2019

FIGURE 8C

GIS FILE PATH: \\haleyaldrich.com\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_04\129420_001_00MB_CULLEY_WAP_GWE_CONTOURS.mxd — USER: ajospe — LAST SAVED: 4/18/2019 12:37:23 PM



LEGEND

MONITORING WELL WITH DESIGNATION AND GROUNDWATER ELEVATION

GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL

APPROXIMATE DIRECTION OF GROUNDWATER FLOW

APPROXIMATE CCR BOUNDARY

APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. WATER LEVELS MEASURED ON 23 MAY 2018.
3. CCR-AP-7 WAS INSTALLED TO MONITOR THE BACKGROUND WATER QUALITY FOR THE EAST ASH POND AT FBC; AS A RESULT THE MONITORING WELL WAS NOT GAUGED DURING THE GROUNDWATER SAMPLING EVENT AT THE WAP.
4. AERIAL IMAGERY SOURCE: GOOGLE 2018

N

0 200 400
APPROXIMATE SCALE IN FEET

HALEY ALDRICH

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NEWBURGH, IN 47630

WATER TABLE CONFIGURATION MAP
23 MAY 2018

APRIL 2019

FIGURE 8D

GIS FILE PATH: \\haleyaldrich.com\share\bol_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_04\129420_001_00MB_CULLEY_WAP_GWE_CONTOURS.mxd — USER: ajospe — LAST SAVED: 4/18/2019 12:37:23 PM

LEGEND

- MONITORING WELL WITH DESIGNATION AND GROUNDWATER ELEVATION
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL
- APPROXIMATE DIRECTION OF GROUNDWATER FLOW
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. WATER LEVELS MEASURED ON 14 JUNE 2018.
3. CCR-AP-7 WAS INSTALLED TO MONITOR THE BACKGROUND WATER QUALITY FOR THE EAST ASH POND AT FBC; AS A RESULT THE MONITORING WELL WAS NOT GAUGED DURING THE GROUNDWATER SAMPLING EVENT AT THE WAP.
4. AERIAL IMAGERY SOURCE: GOOGLE 2018

N

0 200 400
APPROXIMATE SCALE IN FEET

HALEY ALDRICH

SIGECO
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, IN 47630

WATER TABLE CONFIGURATION MAP
14 JUNE 2018

APRIL 2019

FIGURE 8E

LEGEND

- MONITORING WELL WITH DESIGNATION AND GROUNDWATER ELEVATION
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL
- APPROXIMATE DIRECTION OF GROUNDWATER FLOW
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. WATER LEVELS MEASURED ON 5 JULY 2018.
3. CCR-AP-7 WAS INSTALLED TO MONITOR THE BACKGROUND WATER QUALITY FOR THE EAST ASH POND AT FBC; AS A RESULT THE MONITORING WELL WAS NOT GAUGED DURING THE GROUNDWATER SAMPLING EVENT AT THE WAP.
4. AERIAL IMAGERY SOURCE: GOOGLE 2018

N

0 200 400
APPROXIMATE SCALE IN FEET

HALEY ALDRICH

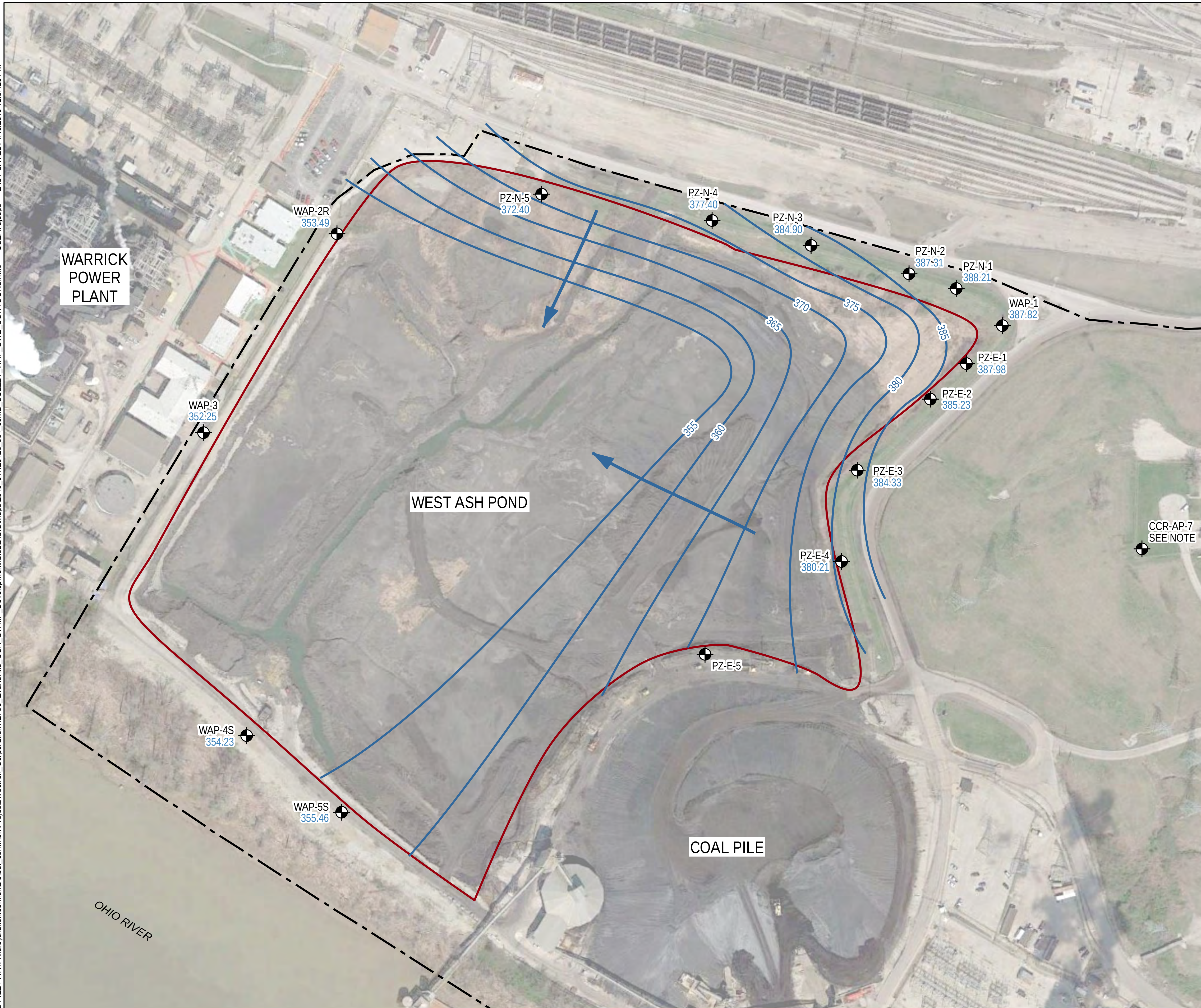
SIGECO
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, IN 47630

WATER TABLE CONFIGURATION MAP
5 JULY 2018

APRIL 2019

FIGURE 8F

GIS FILE PATH: \\haleyaldrich.com\share\bos_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_04\129420_001_00MB_CULLEY_WAP_GWE_CONTOURS.mxd — USER: ajospe — LAST SAVED: 4/18/2019 12:37:23 PM



LEGEND

- MONITORING WELL WITH DESIGNATION AND GROUNDWATER ELEVATION
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL
- APPROXIMATE DIRECTION OF GROUNDWATER FLOW
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. WATER LEVELS MEASURED ON 25 JULY 2018.
3. CCR-AP-7 WAS INSTALLED TO MONITOR THE BACKGROUND WATER QUALITY FOR THE EAST ASH POND AT FBC; AS A RESULT THE MONITORING WELL WAS NOT GAUGED DURING THE GROUNDWATER SAMPLING EVENT AT THE WAP.
4. AERIAL IMAGERY SOURCE: GOOGLE 2018

0 200 400
APPROXIMATE SCALE IN FEET

HALEY ALDRICH

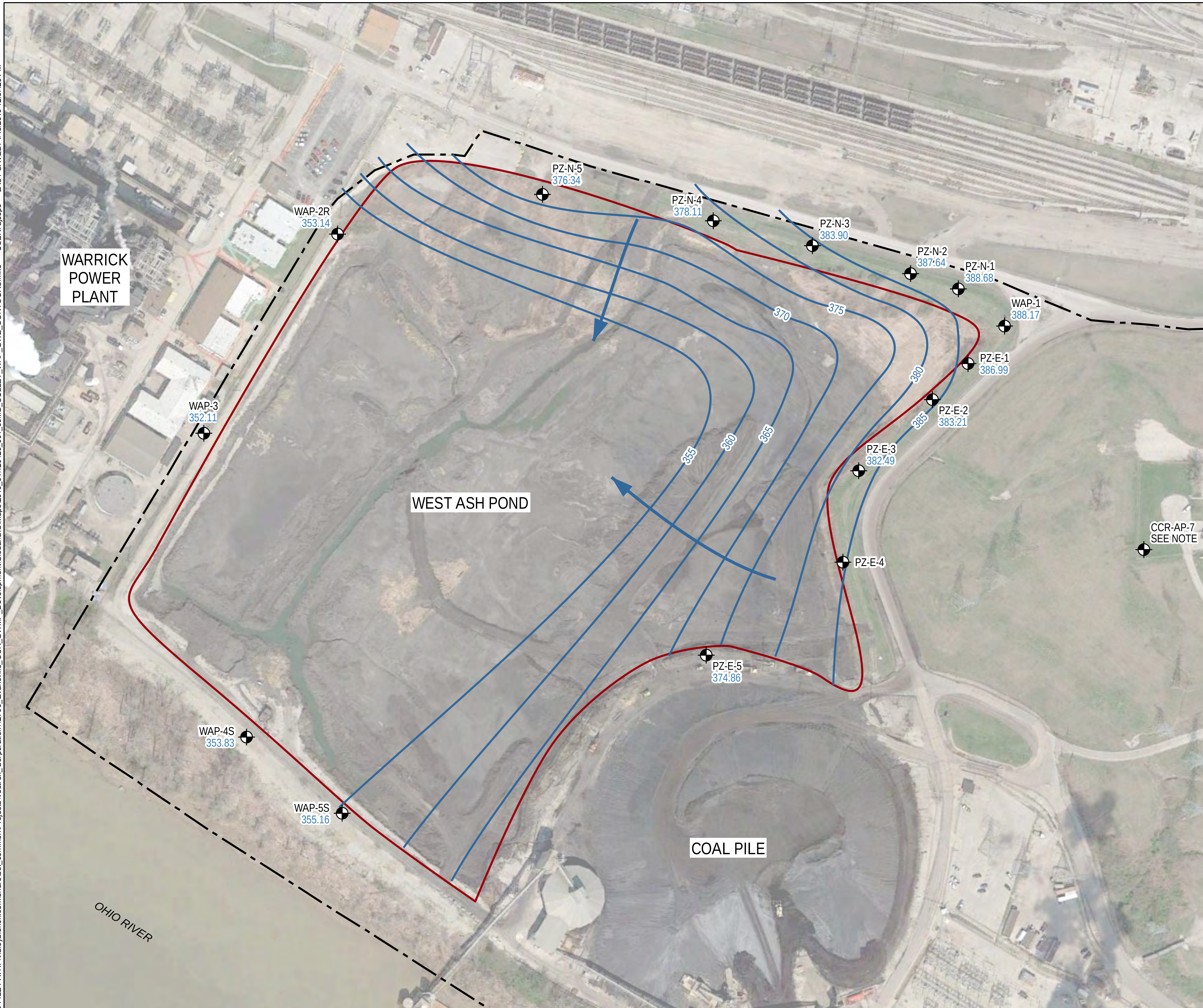
SIGECO
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, IN 47630

WATER TABLE CONFIGURATION MAP
25 JULY 2018

APRIL 2019

FIGURE 8G

GIS FILE PATH: \\haleyaldrich.com\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_04\129420_001_00MB_CULLEY_WAP_GWE_CONTOURS.mxd — USER: ajospe — LAST SAVED: 4/18/2019 12:37:23 PM



LEGEND

- MONITORING WELL WITH DESIGNATION AND GROUNDWATER ELEVATION
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL
- APPROXIMATE DIRECTION OF GROUNDWATER FLOW
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. WATER LEVELS MEASURED ON 16 AUGUST 2018.
3. CCR-AP-7 WAS INSTALLED TO MONITOR THE BACKGROUND WATER QUALITY FOR THE EAST ASH POND AT FBC; AS A RESULT THE MONITORING WELL WAS NOT GAUGED DURING THE GROUNDWATER SAMPLING EVENT AT THE WAP.
4. AERIAL IMAGERY SOURCE: GOOGLE 2018

N

0 200 400
APPROXIMATE SCALE IN FEET

HALEY ALDRICH

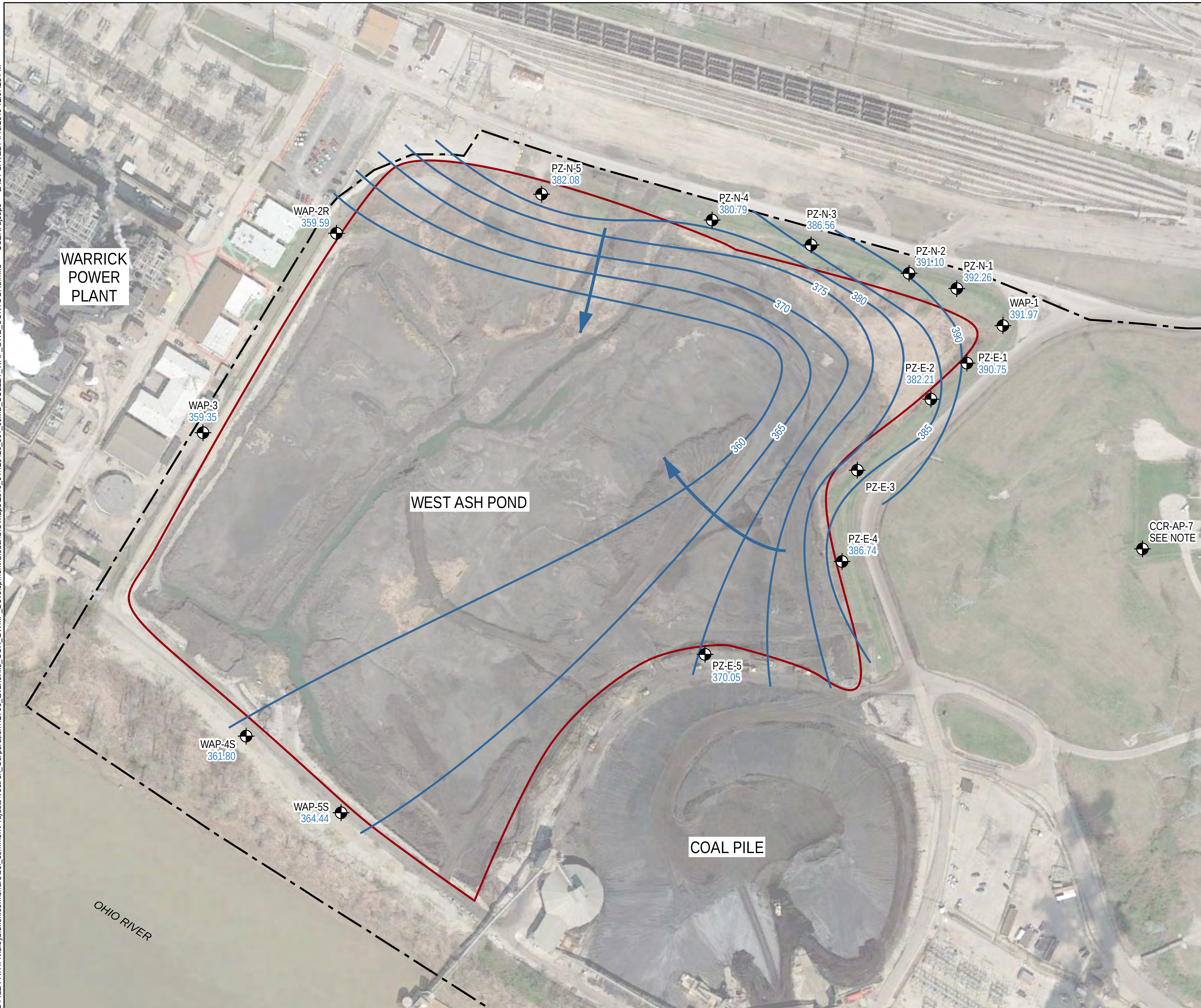
SIGECO
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, IN 47630

WATER TABLE CONFIGURATION MAP
16 AUGUST 2018

APRIL 2019

FIGURE 8H

GIS FILE PATH: \\haleyaldrich.com\share\bol_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_04\129420_001_00MB_CULLEY_WAP_GWE_CONTOURS.mxd — USER: ajospe — LAST SAVED: 4/18/2019 12:37:23 PM



GIS FILE PATH: \\haleyaldrich.com\share\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_04\129420_001_00MB_CULLEY_WAP_GWE_CONTOURS.mxd — USER: ajospe — LAST SAVED: 4/18/2019 12:37:23 PM

LEGEND

- MONITORING WELL WITH DESIGNATION AND GROUNDWATER ELEVATION
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL
- APPROXIMATE DIRECTION OF GROUNDWATER FLOW
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. WATER LEVELS MEASURED ON 4 DECEMBER 2018.
3. CCR-AP-7 WAS INSTALLED TO MONITOR THE BACKGROUND WATER QUALITY FOR THE EAST ASH POND AT FBC; AS A RESULT THE MONITORING WELL WAS NOT GAUGED DURING THE GROUNDWATER SAMPLING EVENT AT THE WAP.
4. AERIAL IMAGERY SOURCE: GOOGLE 2018

N

0 200 400
APPROXIMATE SCALE IN FEET

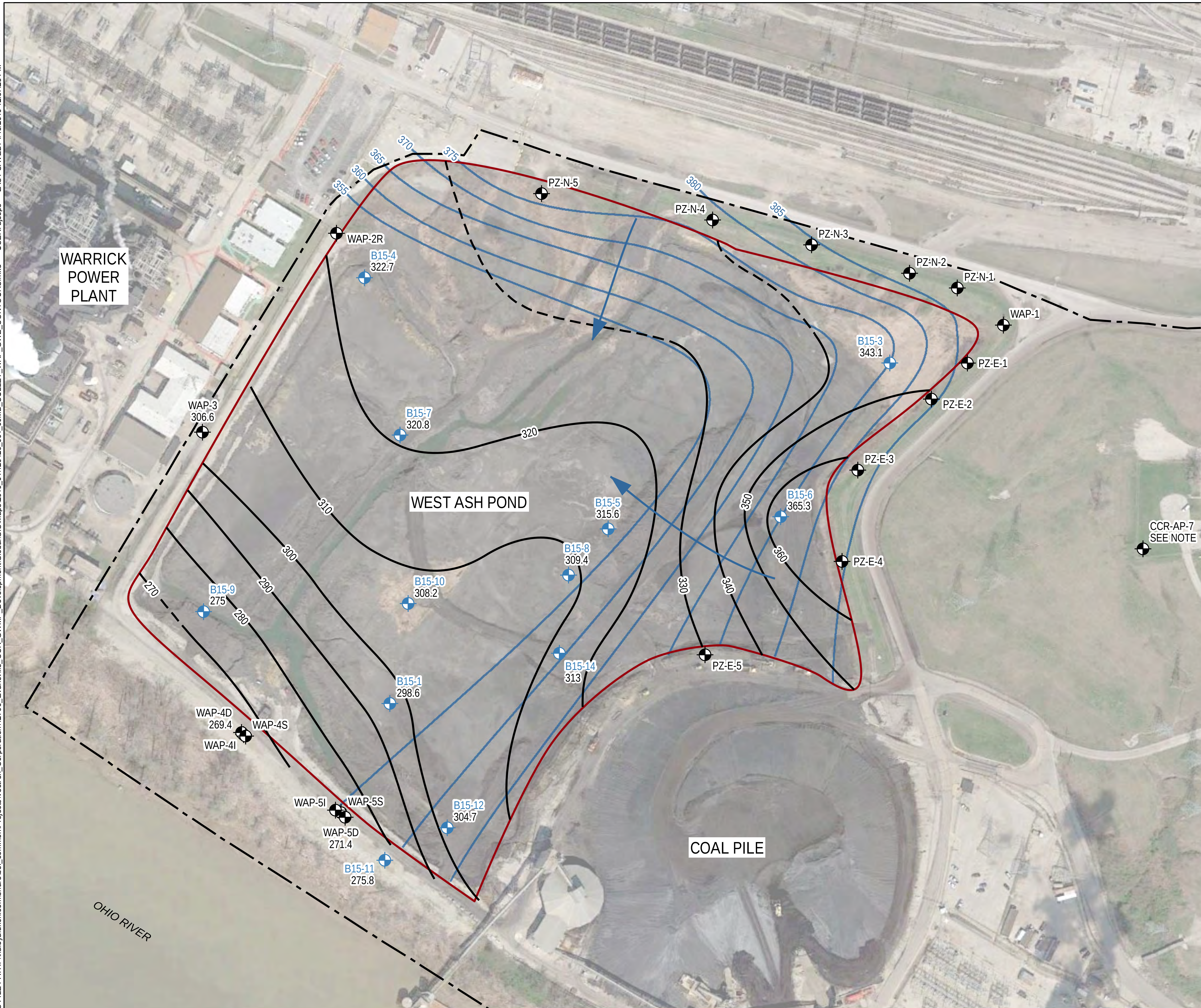
HALEY ALDRICH

SIGECO
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, IN 47630

WATER TABLE CONFIGURATION MAP
4 DECEMBER 2018

APRIL 2019

FIGURE 8I



LEGEND

- MONITORING WELL WITH DESIGNATION AND TOP OF BEDROCK ELEVATION
- 2015 AECOM BORING WITH DESIGNATION AND TOP OF BEDROCK ELEVATION
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL
- APPROXIMATE DIRECTION OF GROUNDWATER FLOW
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. GROUNDWATER CONTOUR MAP IS FROM 16 AUGUST 2018
3. CCR-AP-7 WAS INSTALLED TO MONITOR THE BACKGROUND WATER QUALITY FOR THE EAST ASH POND AT FBC; AS A RESULT THE MONITORING WELL WAS NOT GAUGED DURING THE GROUNDWATER SAMPLING EVENT AT THE WAP.
4. AERIAL IMAGERY SOURCE: GOOGLE 2018

N

0 200 400
APPROXIMATE SCALE IN FEET

HALEY ALDRICH

SIGECO
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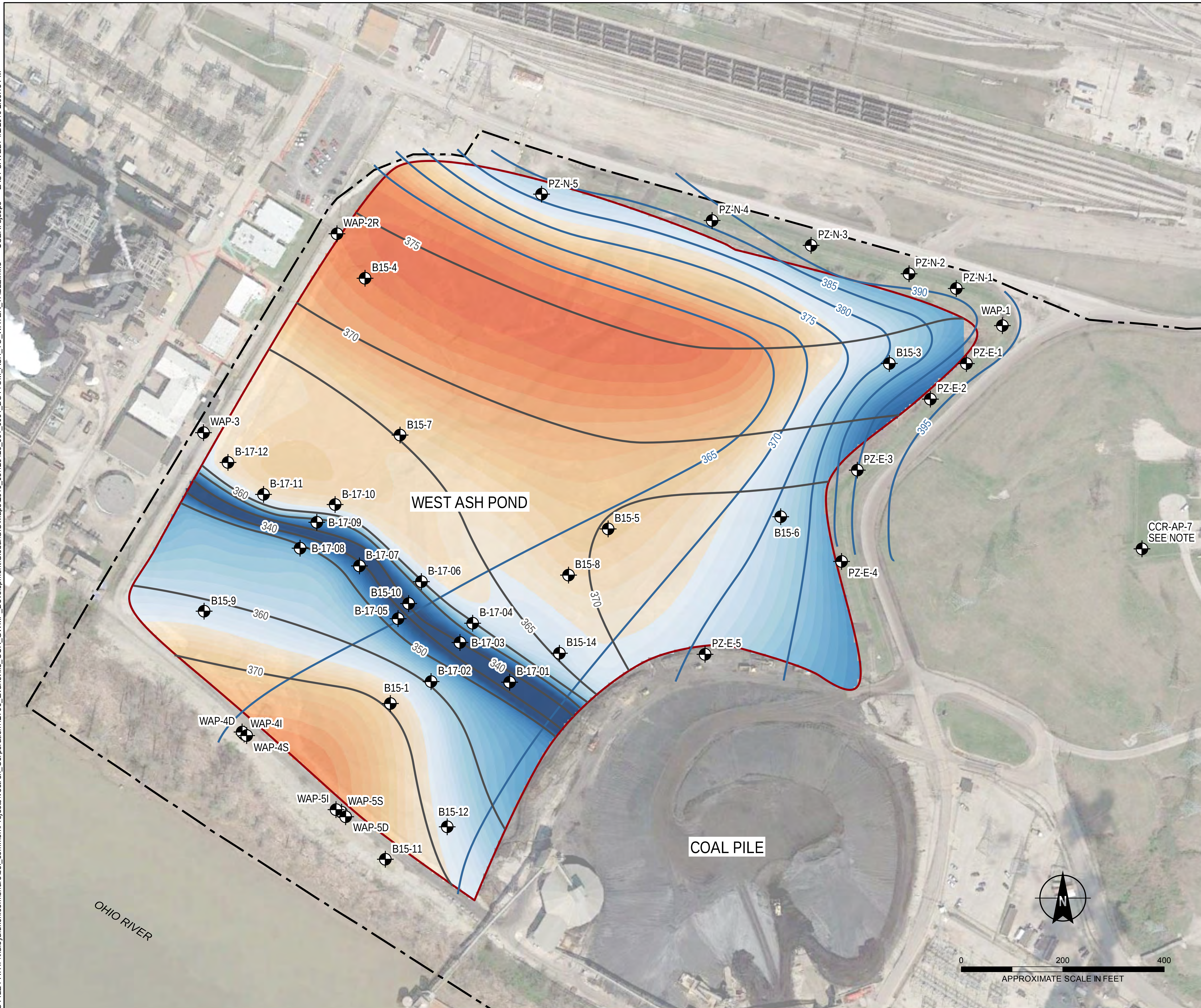
3711 DARLINGTON ROAD
NEWBURGH, IN 47630

COMPARISON OF TOP OF BEDROCK TO WATER TABLE - AUGUST 2018

APRIL 2019

FIGURE 9

GIS FILE PATH: \\haleyaldrich.com\share\bol_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2019_03\129420_001_0001_BOTTOM_ASH_TO_WATER_TABLE.mxd — USER: ajospe — LAST SAVED: 4/2/2019 2:06:15 PM



LEGEND

MONITORING WELL

BOTTOM OF ASH ELEVATION CONTOUR, IN FEET

GROUNDWATER ELEVATION CONTOUR FROM APRIL 2018, 5-FT INTERVAL

APPROXIMATE CCR BOUNDARY

APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

HEIGHT OF WATER TABLE ABOVE BOTTOM OF ASH, IN FEET

< -23	-12 - -11	0 - 1	12 - 13
-23 - -22	-11 - -10	1 - 2	13 - 14
-22 - -21	-10 - -9	2 - 3	14 - 15
-21 - -20	-9 - -8	3 - 4	15 - 16
-20 - -19	-8 - -7	4 - 5	16 - 17
-19 - -18	-7 - -6	5 - 6	17 - 18
-18 - -17	-6 - -5	6 - 7	18 - 19
-17 - -16	-5 - -4	7 - 8	19 - 20
-16 - -15	-4 - -3	8 - 9	20 - 21
-15 - -14	-3 - -2	9 - 10	21 - 22
-14 - -13	-2 - -1	10 - 11	22 - 23
-13 - -12	-1 - 0	11 - 12	23 - 24
			> 24

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. WATER LEVELS MEASURED 3 APRIL 2018.
3. AERIAL IMAGERY SOURCE: ESRI

HALEY ALDRICH

SIGECO
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, IN 47630

COMPARISON OF HIGH WATER TABLE (WORST CASE) TO BOTTOM OF ASH - APRIL 2018

APRIL 2019

Figure 10

APPENDIX A

40 CFR §257.90 through §257.98, *revised 2016 August 5* 40 CFR §257, and Appendices III - IV

following the date of initial receipt of CCR in the CCR unit.

(4) *Frequency of inspections.* (i) Except as provided for in paragraph (b)(4)(ii) of this section, the owner or operator of the CCR unit must conduct the inspection required by paragraphs (b)(1) and (2) of this section on an annual basis. The date of completing the initial inspection report is the basis for establishing the deadline to complete the first subsequent inspection. Any required inspection may be conducted prior to the required deadline provided the owner or operator places the completed inspection report into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing subsequent inspection reports is based on the date of completing the previous inspection report. For purposes of this section, the owner or operator has completed an inspection when the inspection report has been placed in the facility's operating record as required by § 257.105(g)(6).

(ii) In any calendar year in which both the periodic inspection by a qualified professional engineer and the quinquennial (occurring every five years) structural stability assessment by a qualified professional engineer required by §§ 257.73(d) and 257.74(d) are required to be completed, the annual inspection is not required, provided the structural stability assessment is completed during the calendar year. If the annual inspection is not conducted in a year as provided by this paragraph (b)(4)(ii), the deadline for completing the next annual inspection is one year from the date of completing the quinquennial structural stability assessment.

(5) If a deficiency or release is identified during an inspection, the owner or operator must remedy the deficiency or release as soon as feasible and prepare documentation detailing the corrective measures taken.

(c) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(g), the notification requirements specified in § 257.106(g), and the internet requirements specified in § 257.107(g).

§ 257.84 Inspection requirements for CCR landfills.

(a) *Inspections by a qualified person.* (1) All CCR landfills and any lateral expansion of a CCR landfill must be examined by a qualified person as follows:

(i) At intervals not exceeding seven days, inspect for any appearances of actual or potential structural weakness and other conditions which are disrupting or have the potential to disrupt the operation or safety of the CCR unit; and

(ii) The results of the inspection by a qualified person must be recorded in the facility's operating record as required by § 257.105(g)(8).

(2) *Timeframes for inspections by a qualified person*—(i) *Existing CCR landfills.* The owner or operator of the CCR unit must initiate the inspections required under paragraph (a) of this section no later than October 19, 2015.

(ii) *New CCR landfills and any lateral expansion of a CCR landfill.* The owner or operator of the CCR unit must initiate the inspections required under paragraph (a) of this section upon initial receipt of CCR by the CCR unit.

(b) *Annual inspections by a qualified professional engineer.* (1) Existing and new CCR landfills and any lateral expansion of a CCR landfill must be inspected on a periodic basis by a qualified professional engineer to ensure that the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering standards. The inspection must, at a minimum, include:

(i) A review of available information regarding the status and condition of the CCR unit, including, but not limited to, files available in the operating record (*e.g.*, the results of inspections by a qualified person, and results of previous annual inspections); and

(ii) A visual inspection of the CCR unit to identify signs of distress or malfunction of the CCR unit.

(2) *Inspection report.* The qualified professional engineer must prepare a report following each inspection that addresses the following:

(i) Any changes in geometry of the structure since the previous annual inspection;

(ii) The approximate volume of CCR contained in the unit at the time of the inspection;

(iii) Any appearances of an actual or potential structural weakness of the CCR unit, in addition to any existing conditions that are disrupting or have the potential to disrupt the operation and safety of the CCR unit; and

(iv) Any other change(s) which may have affected the stability or operation of the CCR unit since the previous annual inspection.

(3) *Timeframes for conducting the initial inspection*—(i) *Existing CCR landfills.* The owner or operator of the CCR unit must complete the initial inspection required by paragraphs (b)(1) and (2) of this section no later than January 18, 2016.

(ii) *New CCR landfills and any lateral expansion of a CCR landfill.* The owner or operator of the CCR unit must complete the initial annual inspection required by paragraphs (b)(1) and (2) of this section no later than 14 months following the date of initial receipt of CCR in the CCR unit.

(4) *Frequency of inspections.* The owner or operator of the CCR unit must conduct the inspection required by paragraphs (b)(1) and (2) of this section on an annual basis. The date of completing the initial inspection report is the basis for establishing the deadline to complete the first subsequent inspection. Any required inspection may be conducted prior to the required deadline provided the owner or operator places the completed inspection report into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing subsequent inspection reports is based on the date of completing the previous inspection report. For purposes of this section, the owner or operator has completed an inspection when the inspection report has been placed in the facility's operating record as required by § 257.105(g)(9).

(5) If a deficiency or release is identified during an inspection, the owner or operator must remedy the deficiency or release as soon as feasible and prepare documentation detailing the corrective measures taken.

(c) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(g), the notification requirements specified in § 257.106(g), and the internet requirements specified in § 257.107(g).

Groundwater Monitoring and Corrective Action

§ 257.90 Applicability.

(a) Except as provided for in § 257.100 for inactive CCR surface impoundments, all CCR landfills, CCR surface impoundments, and lateral expansions of CCR units are subject to the groundwater monitoring and corrective action requirements under §§ 257.90 through 257.98.

(b) *Initial timeframes*—(1) *Existing CCR landfills and existing CCR surface impoundments.* No later than October 17, 2017, the owner or operator of the CCR unit must be in compliance with the following groundwater monitoring requirements:

(i) Install the groundwater monitoring system as required by § 257.91;

(ii) Develop the groundwater sampling and analysis program to include selection of the statistical procedures to be used for evaluating groundwater monitoring data as required by § 257.93;

(iii) Initiate the detection monitoring program to include obtaining a minimum of eight independent samples for each background and downgradient well as required by § 257.94(b); and

(iv) Begin evaluating the groundwater monitoring data for statistically significant increases over background levels for the constituents listed in appendix III of this part as required by § 257.94.

(2) *New CCR landfills, new CCR surface impoundments, and all lateral expansions of CCR units.* Prior to initial receipt of CCR by the CCR unit, the owner or operator must be in compliance with the groundwater monitoring requirements specified in paragraph (b)(1)(i) and (ii) of this section. In addition, the owner or operator of the CCR unit must initiate the detection monitoring program to include obtaining a minimum of eight independent samples for each background well as required by § 257.94(b).

(c) Once a groundwater monitoring system and groundwater monitoring program has been established at the CCR unit as required by this subpart, the owner or operator must conduct groundwater monitoring and, if necessary, corrective action throughout the active life and post-closure care period of the CCR unit.

(d) In the event of a release from a CCR unit, the owner or operator must immediately take all necessary measures to control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of contaminants into the environment. The owner or operator of the CCR unit must comply with all applicable requirements in §§ 257.96, 257.97, and 257.98.

(e) *Annual groundwater monitoring and corrective action report.* For existing CCR landfills and existing CCR surface impoundments, no later than January 31, 2018, and annually thereafter, the owner or operator must prepare an annual groundwater monitoring and corrective action report. For new CCR landfills, new CCR surface impoundments, and all lateral expansions of CCR units, the owner or operator must prepare the initial annual groundwater monitoring and corrective action report no later than January 31 of the year following the calendar year a groundwater monitoring system has been established for such CCR unit as required by this subpart, and annually thereafter. For the preceding calendar year, the annual report must document the status of the groundwater monitoring and corrective action program for the CCR unit, summarize key actions completed, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year. For purposes of this section, the owner or operator has prepared the annual report when the report is placed in the facility's operating record as required by § 257.105(h)(1). At a minimum, the annual groundwater monitoring and corrective action report must contain the following information, to the extent available:

(1) A map, aerial image, or diagram showing the CCR unit and all background (or upgradient) and downgradient monitoring wells, to include the well identification numbers, that are part of the groundwater monitoring program for the CCR unit;

(2) Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a narrative description of why those actions were taken;

(3) In addition to all the monitoring data obtained under §§ 257.90 through 257.98, a summary including the number of groundwater samples that were collected for analysis for each background and downgradient well, the dates the samples were collected, and whether the sample was required by the detection monitoring or assessment monitoring programs;

(4) A narrative discussion of any transition between monitoring programs (*e.g.*, the date and circumstances for transitioning from detection monitoring to assessment monitoring in addition to identifying the constituent(s) detected at a statistically significant increase over background levels); and

(5) Other information required to be included in the annual report as specified in §§ 257.90 through 257.98.

(f) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(h), the notification requirements specified in § 257.106(h), and the internet requirements specified in § 257.107(h).

§ 257.91 Groundwater monitoring systems.

(a) *Performance standard.* The owner or operator of a CCR unit must install a groundwater monitoring system that consists of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that:

(1) Accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit. A determination of background quality may include sampling of wells that are not hydraulically upgradient of the CCR management area where:

(i) Hydrogeologic conditions do not allow the owner or operator of the CCR unit to determine what wells are hydraulically upgradient; or

(ii) Sampling at other wells will provide an indication of background groundwater quality that is as representative or more representative than that provided by the upgradient wells; 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.

(b) The number, spacing, and depths of monitoring systems shall be determined based upon site-specific technical information that must include thorough characterization of:

(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, materials comprising 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.

(c) The groundwater monitoring system must include the minimum number of monitoring wells necessary to meet the performance standards specified in paragraph (a) of this section, based on the site-specific information specified in paragraph (b) of this section. The groundwater monitoring system must contain:

(1) A minimum of one upgradient and three downgradient monitoring wells; and

(2) 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.

(d) The owner or operator of multiple CCR units may install a multiunit groundwater monitoring system instead of separate groundwater monitoring systems for each CCR unit.

(1) The multiunit groundwater monitoring system must be equally as capable of detecting monitored constituents at the waste boundary of

the CCR unit as the individual groundwater monitoring system specified in paragraphs (a) through (c) of this section for each CCR unit based on the following factors:

(i) Number, spacing, and orientation of each CCR unit;

(ii) Hydrogeologic setting;

(iii) Site history; and

(iv) Engineering design of the CCR unit.

(2) If the owner or operator elects to install a multiunit groundwater monitoring system, and if the multiunit system includes at least one existing unlined CCR surface impoundment as determined by § 257.71(a), and if at any time after October 19, 2015 the owner or operator determines in any sampling event that the concentrations of one or more constituents listed in appendix IV to this part are detected at statistically significant levels above the groundwater protection standard established under § 257.95(h) for the multiunit system, then all unlined CCR surface impoundments comprising the multiunit groundwater monitoring system are subject to the closure requirements under § 257.101(a) to retrofit or close.

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

(1) The owner or operator of the CCR unit must document and include in the operating record the design, installation, development, and decommissioning of any monitoring wells, piezometers and other measurement, sampling, and analytical devices. The qualified professional engineer must be given access to this documentation when completing the groundwater monitoring system certification required under paragraph (f) of this section.

(2) The monitoring wells, piezometers, and other measurement, sampling, and analytical devices must be operated and maintained so that they perform to the design specifications throughout the life of the monitoring program.

(f) The owner or operator must obtain a certification from a qualified professional engineer stating that the groundwater monitoring system has been designed and constructed to meet the requirements of this section. If the groundwater monitoring system includes the minimum number of monitoring wells specified in paragraph (c)(1) of this section, the certification must document the basis supporting this determination.

(g) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(h), the notification requirements specified in § 257.106(h), and the internet requirements specified in § 257.107(h).

§ 257.92 [Reserved]

§ 257.93 Groundwater sampling and analysis requirements.

(a) The groundwater monitoring program must include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide an accurate representation of groundwater quality at the background and downgradient wells required by § 257.91. The owner or operator of the CCR unit must develop a sampling and analysis program that includes procedures and techniques for:

(1) Sample collection;

(2) Sample preservation and shipment;

(3) Analytical procedures;

(4) Chain of custody control; and

(5) Quality assurance and quality control.

(b) The groundwater monitoring program must include sampling and analytical methods that are appropriate for groundwater sampling and that accurately measure hazardous constituents and other monitoring parameters in groundwater samples. For purposes of §§ 257.90 through 257.98, the term *constituent* refers to both hazardous constituents and other monitoring parameters listed in either appendix III or IV of this part.

(c) Groundwater elevations must be measured in each well immediately prior to purging, each time groundwater is sampled. The owner or operator of the CCR unit must determine the rate and direction of groundwater flow each time groundwater is sampled. Groundwater elevations in wells which monitor the same CCR management area must be measured within a period of time short enough to avoid temporal variations in groundwater flow which could preclude accurate determination of groundwater flow rate and direction.

(d) The owner or operator of the CCR unit must establish background groundwater quality in a hydraulically upgradient or background well(s) for each of the constituents required in the particular groundwater monitoring program that applies to the CCR unit as determined under § 257.94(a) or § 257.95(a). Background groundwater quality may be established at wells that are not located hydraulically upgradient from the CCR unit if it meets the requirements of § 257.91(a)(1).

(e) The number of samples collected when conducting detection monitoring and assessment monitoring (for both downgradient and background wells) must be consistent with the statistical procedures chosen under paragraph (f) of this section and the performance standards under paragraph (g) of this section. The sampling procedures shall be those specified under § 257.94(b) through (d) for detection monitoring, § 257.95(b) through (d) for assessment monitoring, and § 257.96(b) for corrective action.

(f) The owner or operator of the CCR unit must select one of the statistical methods specified in paragraphs (f)(1) through (5) of this section to be used in evaluating groundwater monitoring data for each specified constituent. The statistical test chosen shall be conducted separately for each constituent in each monitoring well.

(1) A parametric analysis of variance followed by multiple comparison procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's mean and the background mean levels for each constituent.

(2) An analysis of variance based on ranks followed by multiple comparison procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's median and the background median levels for each constituent.

(3) A tolerance or prediction interval procedure, in which an interval for each constituent is established from the distribution of the background data and the level of each constituent in each compliance well is compared to the upper tolerance or prediction limit.

(4) A control chart approach that gives control limits for each constituent.

(5) Another statistical test method that meets the performance standards of paragraph (g) of this section.

(6) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area. The certification must include a narrative description of the statistical method selected to evaluate the groundwater monitoring data.

(g) Any statistical method chosen under paragraph (f) of this section shall comply with the following performance standards, as appropriate, based on the statistical test method used:

(1) The statistical method used to evaluate groundwater monitoring data shall be appropriate for the distribution of constituents. Normal distributions of data values shall use parametric methods. Non-normal distributions shall use non-parametric methods. If the distribution of the constituents is shown by the owner or operator of the CCR unit to be inappropriate for a normal theory test, then the data must be transformed or a distribution-free (non-parametric) theory test must be used. If the distributions for the constituents differ, more than one statistical method may be needed.

(2) If an individual well comparison procedure is used to compare an individual compliance well constituent concentration with background constituent concentrations or a groundwater protection standard, the test shall be done at a Type I error level no less than 0.01 for each testing period. If a multiple comparison procedure is used, the Type I experiment wise error rate for each testing period shall be no less than 0.05; however, the Type I error of no less than 0.01 for individual well comparisons must be maintained. This performance standard does not apply to tolerance intervals, prediction intervals, or control charts.

(3) If a control chart approach is used to evaluate groundwater monitoring data, the specific type of control chart and its associated parameter values shall be such that this approach is at least as effective as any other approach in this section for evaluating groundwater data. The parameter values shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern.

(4) If a tolerance interval or a predictional interval is used to evaluate groundwater monitoring data, the levels of confidence and, for tolerance intervals, the percentage of the population that the interval must contain, shall be such that this approach is at least as effective as any other approach in this section for evaluating groundwater data. These parameters shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern.

(5) The statistical method must account for data below the limit of detection with one or more statistical procedures that shall at least as effective as any other approach in this section for evaluating groundwater data. Any practical quantitation limit that is used in the statistical method shall be the lowest concentration level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions that are available to the facility.

(6) If necessary, the statistical method must include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.

(h) The owner or operator of the CCR unit must determine whether or not there is a statistically significant increase over background values for each constituent required in the particular groundwater monitoring program that applies to the CCR unit, as determined under § 257.94(a) or § 257.95(a).

(1) In determining whether a statistically significant increase has occurred, the owner or operator must compare the groundwater quality of each constituent at each monitoring well designated pursuant to § 257.91(a)(2) or (d)(1) to the background value of that constituent, according to the statistical procedures and performance standards specified under paragraphs (f) and (g) of this section.

(2) Within 90 days after completing sampling and analysis, the owner or operator must determine whether there has been a statistically significant increase over background for any constituent at each monitoring well.

(i) The owner or operator must measure "total recoverable metals" concentrations in measuring groundwater quality. Measurement of total recoverable metals captures both the particulate fraction and dissolved fraction of metals in natural waters. Groundwater samples shall not be field-filtered prior to analysis.

(j) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(h), the notification requirements specified in § 257.106(h), and the Internet requirements specified in § 257.107(h).

§ 257.94 Detection monitoring program.

(a) The owner or operator of a CCR unit must conduct detection monitoring at all groundwater monitoring wells consistent with this section. At a minimum, a detection monitoring program must include groundwater monitoring for all constituents listed in appendix III to this part.

(b) Except as provided in paragraph (d) of this section, the monitoring frequency for the constituents listed in appendix III to this part shall be at least semiannual during the active life of the CCR unit and the post-closure period. For existing CCR landfills and existing CCR surface impoundments, a minimum of eight independent samples from each background and downgradient well must be collected and analyzed for the constituents listed in appendix III and IV to this part no later than October 17, 2017. For new CCR landfills, new CCR surface impoundments, and all lateral expansions of CCR units, a minimum of eight independent samples for each background well must be collected and analyzed for the constituents listed in appendices III and IV to this part during the first six months of sampling.

(c) The number of samples collected and analyzed for each background well and downgradient well during subsequent semiannual sampling events must be consistent with § 257.93(e), and must account for any unique characteristics of the site, but must be at least one sample from each background and downgradient well.

(d) The owner or operator of a CCR unit may demonstrate the need for an alternative monitoring frequency for repeated sampling and analysis for constituents listed in appendix III to this part during the active life and the post-closure care period based on the availability of groundwater. If there is not adequate groundwater flow to sample wells semiannually, the alternative frequency shall be no less than annual. The need to vary monitoring frequency must be evaluated on a site-specific basis. The demonstration must be supported by, at a minimum, the information specified in paragraphs (d)(1) and (2) of this section.

(1) Information documenting that the need for less frequent sampling. The alternative frequency must be based on consideration of the following factors:

(i) Lithology of the aquifer and unsaturated zone;

(ii) Hydraulic conductivity of the aquifer and unsaturated zone; and

(iii) Groundwater flow rates.

(2) Information documenting that the alternative frequency will be no less effective in ensuring that any leakage from the CCR unit will be discovered within a timeframe that will not materially delay establishment of an assessment monitoring program.

(3) The owner or operator must obtain a certification from a qualified

professional engineer stating that the demonstration for an alternative groundwater sampling and analysis frequency meets the requirements of this section. The owner or operator must include the demonstration providing the basis for the alternative monitoring frequency and the certification by a qualified professional engineer in the annual groundwater monitoring and corrective action report required by § 257.90(e).

(e) If the owner or operator of the CCR unit determines, pursuant to § 257.93(h) that there is a statistically significant increase over background levels for one or more of the constituents listed in appendix III to this part at any monitoring well at the waste boundary specified under § 257.91(a)(2), the owner or operator must:

(1) Except as provided for in paragraph (e)(2) of this section, within 90 days of detecting a statistically significant increase over background levels for any constituent, establish an assessment monitoring program meeting the requirements of § 257.95.

(2) The owner or operator may demonstrate that a source other than the CCR unit caused the statistically significant increase over background levels for a constituent or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The owner or operator must complete the written demonstration within 90 days of detecting a statistically significant increase over background levels to include obtaining a certification from a qualified professional engineer verifying the accuracy of the information in the report. If a successful demonstration is completed within the 90-day period, the owner or operator of the CCR unit may continue with a detection monitoring program under this section. If a successful demonstration is not completed within the 90-day period, the owner or operator of the CCR unit must initiate an assessment monitoring program as required under § 257.95. The owner or operator must also include the demonstration in the annual groundwater monitoring and corrective action report required by § 257.90(e), in addition to the certification by a qualified professional engineer.

(3) The owner or operator of a CCR unit must prepare a notification stating that an assessment monitoring program has been established. The owner or operator has completed the notification when the notification is placed in the facility's operating record as required by § 257.105(h)(5).

(f) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(h), the notification requirements specified in § 257.106(h), and the Internet requirements specified in § 257.107(h).

§ 257.95 Assessment monitoring program.

(a) Assessment monitoring is required whenever a statistically significant increase over background levels has been detected for one or more of the constituents listed in appendix III to this part.

(b) Within 90 days of triggering an assessment monitoring program, and annually thereafter, the owner or operator of the CCR unit must sample and analyze the groundwater for all constituents listed in appendix IV to this part. The number of samples collected and analyzed for each well during each sampling event must be consistent with § 257.93(e), and must account for any unique characteristics of the site, but must be at least one sample from each well.

(c) The owner or operator of a CCR unit may demonstrate the need for an alternative monitoring frequency for repeated sampling and analysis for constituents listed in appendix IV to this part during the active life and the post-closure care period based on the availability of groundwater. If there is not adequate groundwater flow to sample wells semiannually, the alternative frequency shall be no less than annual. The need to vary monitoring frequency must be evaluated on a site-specific basis. The demonstration must be supported by, at a minimum, the information specified in paragraphs (c)(1) and (2) of this section.

(1) Information documenting that the need for less frequent sampling. The alternative frequency must be based on consideration of the following factors:

(i) Lithology of the aquifer and unsaturated zone;

(ii) Hydraulic conductivity of the aquifer and unsaturated zone; and

(iii) Groundwater flow rates.

(2) Information documenting that the alternative frequency will be no less effective in ensuring that any leakage from the CCR unit will be discovered within a timeframe that will not materially delay the initiation of any necessary remediation measures.

(3) The owner or operator must obtain a certification from a qualified professional engineer stating that the demonstration for an alternative groundwater sampling and analysis frequency meets the requirements of this section. The owner or operator must include the demonstration providing the basis for the alternative monitoring frequency and the certification by a qualified professional engineer in the annual groundwater monitoring and corrective action report required by § 257.90(e).

(d) After obtaining the results from the initial and subsequent sampling events required in paragraph (b) of this section, the owner or operator must:

(1) Within 90 days of obtaining the results, and on at least a semiannual basis thereafter, resample all wells that were installed pursuant to the requirements of § 257.91, conduct analyses for all parameters in appendix III to this part and for those constituents in appendix IV to this part that are detected in response to paragraph (b) of this section, and record their concentrations in the facility operating record. The number of samples collected and analyzed for each background well and downgradient well during subsequent semiannual sampling events must be consistent with § 257.93(e), and must account for any unique characteristics of the site, but must be at least one sample from each background and downgradient well;

(2) Establish groundwater protection standards for all constituents detected pursuant to paragraph (b) or (d) of this section. The groundwater protection standards must be established in accordance with paragraph (h) of this section; and

(3) Include the recorded concentrations required by paragraph (d)(1) of this section, identify the background concentrations established under § 257.94(b), and identify the groundwater protection standards established under paragraph (d)(2) of this section in the annual groundwater monitoring and corrective action report required by § 257.90(e).

(e) If the concentrations of all constituents listed in appendices III and IV to this part are shown to be at or below background values, using the statistical procedures in § 257.93(g), for two consecutive sampling events, the owner or operator may return to detection monitoring of the CCR unit. The owner or operator must prepare a notification stating that detection monitoring is resuming for the CCR unit. The owner or operator has completed the notification when the notification is placed in the facility's operating record as required by § 257.105(h)(7).

(f) If the concentrations of any constituent in appendices III and IV to this part are above background values, but all concentrations are below the groundwater protection standard established under paragraph (h) of this section, using the statistical procedures in § 257.93(g), the owner or operator must continue assessment monitoring in accordance with this section.

(g) If one or more constituents in appendix IV to this part are detected at statistically significant levels above the groundwater protection standard established under paragraph (h) of this section in any sampling event, the owner or operator must prepare a notification identifying the constituents in appendix IV to this part that have exceeded the groundwater protection standard. The owner or operator has completed the notification when the notification is placed in the facility's operating record as required by § 257.105(h)(8). The owner or operator of the CCR unit also must:

(1) Characterize the nature and extent of the release and any relevant site conditions that may affect the remedy ultimately selected. The characterization must be sufficient to support a complete and accurate assessment of the corrective measures necessary to effectively clean up all releases from the CCR unit pursuant to § 257.96. Characterization of the release includes the following minimum measures:

(i) Install additional monitoring wells necessary to define the contaminant plume(s);

(ii) Collect data on the nature and estimated quantity of material released including specific information on the constituents listed in appendix IV of this part and the levels at which they are present in the material released;

(iii) Install at least one additional monitoring well at the facility boundary in the direction of contaminant migration and sample this well in accordance with paragraph (d)(1) of this section; and

(iv) Sample all wells in accordance with paragraph (d)(1) of this section to characterize the nature and extent of the release.

(2) Notify all persons who own the land or reside on the land that directly overlies any part of the plume of contamination if contaminants have migrated off-site if indicated by sampling of wells in accordance with paragraph (g)(1) of this section. The owner or operator has completed the notifications when they are placed in the facility's operating record as required by § 257.105(h)(8).

(3) Within 90 days of finding that any of the constituents listed in appendix IV to this part have been detected at a statistically significant level exceeding the groundwater protection standards the owner or operator must either:

(i) Initiate an assessment of corrective measures as required by § 257.96; or

(ii) Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section, and may return to detection monitoring if the constituents in appendices III and IV to this part are at or below background as specified in paragraph (e) of this section. The owner or operator must also include the demonstration in the annual groundwater monitoring and corrective action report required by § 257.90(e), in addition to the certification by a qualified professional engineer.

(4) If a successful demonstration has not been made at the end of the 90 day period provided by paragraph (g)(3)(ii) of this section, the owner or operator of the CCR unit must initiate the assessment of corrective measures requirements under § 257.96.

(5) If an assessment of corrective measures is required under § 257.96 by either paragraph (g)(3)(i) or (g)(4) of this section, and if the CCR unit is an existing unlined CCR surface impoundment as determined by § 257.71(a), then the CCR unit is subject to the closure requirements under § 257.101(a) to retrofit or close. In addition, the owner or operator must prepare a notification stating that an assessment of corrective measures has been initiated.

(h) The owner or operator of the CCR unit must establish a groundwater protection standard for each constituent in appendix IV to this part detected in the groundwater. The groundwater protection standard shall be:

(1) For constituents for which a maximum contaminant level (MCL) has been established under §§ 141.62 and 141.66 of this title, the MCL for that constituent;

(2) For constituents for which an MCL has not been established, the background concentration for the constituent established from wells in accordance with § 257.91; or

(3) For constituents for which the background level is higher than the MCL identified under paragraph (h)(1) of this section, the background concentration.

(i) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(h), the notification requirements specified in § 257.106(h), and the Internet requirements specified in § 257.107(h).

§ 257.96 Assessment of corrective measures.

(a) Within 90 days of finding that any constituent listed in appendix IV to this part has been detected at a statistically significant level exceeding the groundwater protection standard defined under § 257.95(h), or immediately upon detection of a release from a CCR unit, the owner or operator must initiate an assessment of corrective measures to prevent further releases, to remediate any releases and to restore affected area to original conditions. The assessment of corrective measures must be completed within 90 days, unless the owner or operator demonstrates the need for additional time to complete the assessment of corrective measures due to site-specific conditions or circumstances. The owner or operator must obtain a certification from a qualified professional engineer attesting that the demonstration is accurate. The 90-day deadline to complete the assessment of corrective measures may be extended for no longer than 60 days. The owner or operator must also include the demonstration in the annual groundwater monitoring and corrective action report required by § 257.90(e), in addition to the certification by a qualified professional engineer.

(b) The owner or operator of the CCR unit must continue to monitor groundwater in accordance with the assessment monitoring program as specified in § 257.95.

(c) 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).

(d) The owner or operator must place the completed assessment of corrective measures in the facility's operating record. The assessment has been completed when it is placed in the facility's operating record as required by § 257.105(h)(10).

(e) The owner or operator must discuss the results of the corrective measures assessment at least 30 days prior to the selection of remedy, in a public meeting with interested and affected parties.

(f) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(h), the notification requirements specified in § 257.106(h), and the Internet requirements specified in § 257.107(h).

§ 257.97 Selection of remedy.

(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).

(b) Remedies 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).

(c) In selecting a remedy that meets the standards of paragraph (b) of this section, the owner or operator of the CCR unit shall consider the following evaluation factors:

(1) The long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful based on consideration of the following:

(i) Magnitude of reduction of existing risks;

(ii) Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy;

(iii) The type and degree of long-term management required, including monitoring, operation, and maintenance;

(iv) Short-term risks that might be posed to the community or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminant;

(v) Time until full protection is achieved;

(vi) Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment;

(vii) Long-term reliability of the engineering and institutional controls; and

(viii) Potential need for replacement of the remedy.

(2) The effectiveness of the remedy in controlling the source to reduce further releases based on consideration of the following factors:

(i) The extent to which containment practices will reduce further releases; and

(ii) The extent to which treatment technologies may be used.

(3) The ease or difficulty of implementing a potential remedy(s) based on consideration of the following types of factors:

(i) Degree of difficulty associated with constructing the technology;

(ii) Expected operational reliability of the technologies;

(iii) Need to coordinate with and obtain necessary approvals and permits from other agencies;

(iv) Availability of necessary equipment and specialists; and

(v) Available capacity and location of needed treatment, storage, and disposal services.

(4) The degree to which community concerns are addressed by a potential remedy(s).

(d) The owner or operator must specify as part of the selected remedy a schedule(s) for implementing and completing remedial activities. Such a schedule must require the completion of remedial activities within a reasonable period of time taking into consideration the factors set forth in paragraphs (d)(1) through (6) of this section. The owner or operator of the CCR unit must consider the following factors in determining the schedule of remedial activities:

(1) Extent and nature of contamination, as determined by the characterization required under § 257.95(g);

(2) Reasonable probabilities of remedial technologies in achieving compliance with the groundwater protection standards established under § 257.95(h) and other objectives of the remedy;

(3) Availability of treatment or disposal capacity for CCR managed during implementation of the remedy;

(4) Potential risks to human health and the environment from exposure to contamination prior to completion of the remedy;

(5) Resource value of the aquifer including:

(i) Current and future uses;

(ii) Proximity and withdrawal rate of users;

(iii) Groundwater quantity and quality;

(iv) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to CCR constituents;

(v) The hydrogeologic characteristic of the facility and surrounding land; and

(vi) The availability of alternative water supplies; and

(6) Other relevant factors.

(e) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(h), the notification requirements specified in § 257.106(h), and the Internet requirements specified in § 257.107(h).

§ 257.98 Implementation of the corrective action program.

(a) Within 90 days of selecting a remedy under § 257.97, the owner or operator must initiate remedial activities. Based on the schedule established under § 257.97(d) for implementation and completion of remedial activities the owner or operator must:

(1) Establish and implement a corrective action groundwater monitoring program that:

(i) At a minimum, meets the requirements of an assessment monitoring program under § 257.95;

(ii) Documents the effectiveness of the corrective action remedy; and

(iii) Demonstrates compliance with the groundwater protection standard pursuant to paragraph (c) of this section.

(2) Implement the corrective action remedy selected under § 257.97; and

(3) Take any interim measures necessary to reduce the contaminants leaching from the CCR unit, and/or potential exposures to human or ecological receptors. Interim measures must, to the greatest extent feasible, be consistent with the objectives of and contribute to the performance of any remedy that may be required pursuant to § 257.97. The following factors must be considered by an owner or operator in determining whether interim measures are necessary:

(i) Time required to develop and implement a final remedy;

(ii) Actual or potential exposure of nearby populations or environmental receptors to any of the constituents listed in appendix IV of this part;

(iii) Actual or potential contamination of drinking water supplies or sensitive ecosystems;

(iv) Further degradation of the groundwater that may occur if remedial action is not initiated expeditiously;

(v) Weather conditions that may cause any of the constituents listed in appendix IV to this part to migrate or be released;

(vi) Potential for exposure to any of the constituents listed in appendix IV to this part as a result of an accident or failure of a container or handling system; and

(vii) Other situations that may pose threats to human health and the environment.

(b) If an owner or operator of the CCR unit, determines, at any time, that compliance with the requirements of § 257.97(b) is not being achieved through the remedy selected, the owner or operator must implement other methods or techniques that could feasibly achieve compliance with the requirements.

(c) Remedies selected pursuant to § 257.97 shall be considered complete when:

(1) The owner or operator of the CCR unit demonstrates compliance with the groundwater protection standards established under § 257.95(h) has been achieved at all points within the plume of contamination that lie beyond the groundwater monitoring well system established under § 257.91.

(2) Compliance with the groundwater protection standards established under § 257.95(h) has been achieved by demonstrating that concentrations of constituents listed in appendix IV to this part have not exceeded the groundwater protection standard(s) for a period of three consecutive years using the statistical procedures and performance standards in § 257.93(f) and (g).

(3) All actions required to complete the remedy have been satisfied.

(d) All CCR that are managed pursuant to a remedy required under § 257.97, or an interim measure required under paragraph (a)(3) of this section, shall be managed in a manner that complies with all applicable RCRA requirements.

(e) Upon completion of the remedy, the owner or operator must prepare a notification stating that the remedy has been completed. The owner or operator must obtain a certification from a qualified professional engineer attesting that the remedy has been completed in compliance with the requirements of paragraph (c) of this section. The report has been completed when it is placed in the operating record as required by § 257.105(h)(13).

(f) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(h), the notification requirements specified in § 257.106(h), and the internet requirements specified in § 257.107(h).

Closure and Post-Closure Care

§ 257.100 Inactive CCR surface impoundments.

(a) Except as provided by paragraph (b) of this section, inactive CCR surface impoundments are subject to all of the requirements of this subpart applicable to existing CCR surface impoundments.

(b) An owner or operator of an inactive CCR surface impoundment that completes closure of such CCR unit, and meets all of the requirements of either paragraphs (b)(1) through (4) of this section or paragraph (b)(5) of this section no later than April 17, 2018, is exempt from all other requirements of this subpart.

(1) *Closure by leaving CCR in place.* If the owner or operator of the inactive CCR surface impoundment elects to close the CCR surface impoundment by leaving CCR in place, the owner or operator must ensure that, at a minimum, the CCR unit is closed in a manner that will:

(i) Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;

(ii) Preclude the probability of future impoundment of water, sediment, or slurry;

(iii) Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system; and

(iv) Minimize the need for further maintenance of the CCR unit.

(2) The owner or operator of the inactive CCR surface impoundment must meet the requirements of paragraphs (b)(2)(i) and (ii) of this section prior to installing the final cover system required under paragraph (b)(3) of this section.

(i) Free liquids must be eliminated by removing liquid wastes or solidifying the remaining wastes and waste residues.

(ii) Remaining wastes must be stabilized sufficient to support the final cover system.

(3) The owner or operator must install a final cover system that is designed to minimize infiltration and erosion, and at a minimum, meets the requirements of paragraph (b)(3)(i) of this section, or the requirements of an alternative final cover system specified in paragraph (b)(3)(ii) of this section.

(i) The final cover system must be designed and constructed to meet the criteria specified in paragraphs (b)(3)(i)(A) through (D) of this section.

(A) The permeability of the final cover system must be less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1×10^{-5} centimeters/second, whichever is less.

(B) The infiltration of liquids through the CCR unit must be minimized by the use of an infiltration layer that contains a minimum of 18 inches of earthen material.

(C) The erosion of the final cover system must be minimized by the use of an erosion layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth.

(D) The disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence.

(ii) The owner or operator may select an alternative final cover system design, provided the alternative final cover system is designed and constructed to meet the criteria in paragraphs (b)(3)(ii)(A) through (C) of this section.

(A) The design of the final cover system must include an infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in paragraphs (b)(3)(i)(A) and (B) of this section.

(B) The design of the final cover system must include an erosion layer that provides equivalent protection from wind or water erosion as the erosion layer specified in paragraph (b)(3)(i)(C) of this section.

deficiency or release specified under § 257.105(f)(11).

(11) The initial and periodic safety factor assessments specified under § 257.105(f)(12).

(12) The design and construction plans, and any revisions of them, specified under § 257.105(f)(13).

(g) *Operating criteria.* The owner or operator of a CCR unit subject to this subpart must place the following information on the owner or operator's CCR Web site:

(1) The CCR fugitive dust control plan, or any subsequent amendment of the plan, specified under § 257.105(g)(1) except that only the most recent plan must be maintained on the CCR Web site irrespective of the time requirement specified in paragraph (c) of this section.

(2) The annual CCR fugitive dust control report specified under § 257.105(g)(2).

(3) The initial and periodic run-on and run-off control system plans specified under § 257.105(g)(3).

(4) The initial and periodic inflow design flood control system plans specified under § 257.105(g)(4).

(5) The periodic inspection reports specified under § 257.105(g)(6).

(6) The documentation detailing the corrective measures taken to remedy the deficiency or release specified under § 257.105(g)(7).

(7) The periodic inspection reports specified under § 257.105(g)(9).

(h) *Groundwater monitoring and corrective action.* The owner or operator of a CCR unit subject to this subpart must place the following information on the owner or operator's CCR Web site:

(1) The annual groundwater monitoring and corrective action report specified under § 257.105(h)(1).

(2) The groundwater monitoring system certification specified under § 257.105(h)(3).

(3) The selection of a statistical method certification specified under § 257.105(h)(4).

(4) The notification that an assessment monitoring programs has been established specified under § 257.105(h)(5).

(5) The notification that the CCR unit is returning to a detection monitoring program specified under § 257.105(h)(7).

(6) The notification that one or more constituents in appendix IV to this part have been detected at statistically significant levels above the groundwater protection standard and the notifications to land owners specified under § 257.105(h)(8).

(7) The notification that an assessment of corrective measures has been initiated specified under § 257.105(h)(9).

(8) The assessment of corrective measures specified under § 257.105(h)(10).

(9) The semiannual reports describing the progress in selecting and designing remedy and the selection of remedy report specified under § 257.105(h)(12), except that the selection of the remedy report must be maintained until the remedy has been completed.

(10) The notification that the remedy has been completed specified under § 257.105(h)(13).

(i) *Closure and post-closure care.* The owner or operator of a CCR unit subject to this subpart must place the following information on the owner or operator's CCR Web site:

(1) The notification of intent to initiate closure of the CCR unit specified under § 257.105(i)(1).

(2) The annual progress reports of closure implementation specified under § 257.105(i)(2).

(3) The notification of closure completion specified under § 257.105(i)(3).

(4) The written closure plan, and any amendment of the plan, specified under § 257.105(i)(4).

(5) The demonstration(s) for a time extension for initiating closure specified under § 257.105(i)(5).

(6) The demonstration(s) for a time extension for completing closure specified under § 257.105(i)(6).

(7) The notification of intent to close a CCR unit specified under § 257.105(i)(7).

(8) The notification of completion of closure of a CCR unit specified under § 257.105(i)(8).

(9) The notification recording a notation on the deed as required by § 257.105(i)(9).

(10) The notification of intent to comply with the alternative closure requirements as required by § 257.105(i)(10).

(11) The annual progress reports under the alternative closure requirements as required by § 257.105(i)(11).

(12) The written post-closure plan, and any amendment of the plan, specified under § 257.105(i)(12).

(13) The notification of completion of post-closure care specified under § 257.105(i)(13).

(j) *Retrofit criteria.* The owner or operator of a CCR unit subject to this subpart must place the following information on the owner or operator's CCR Web site:

(1) The written retrofit plan, and any amendment of the plan, specified under § 257.105(j)(1).

(2) The notification of intent to comply with the alternative retrofit requirements as required by § 257.105(j)(2).

(3) The annual progress reports under the alternative retrofit requirements as required by § 257.105(j)(3).

(4) The demonstration(s) for a time extension for completing retrofit activities specified under § 257.105(j)(4).

(5) The notification of intent to retrofit a CCR unit specified under § 257.105(j)(5).

(6) The notification of completion of retrofit activities specified under § 257.105(j)(6).

■ 5. Amend part 257 by adding "Appendix III to Part 257" and "Appendix IV to Part 257" to read as follows:

Appendix III to Part 257—Constituents for Detection Monitoring

Common name [1]
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids (TDS)

[1] Common names are those widely used in government regulations, scientific publications, and commerce; synonyms exist for many chemicals.

Appendix IV to Part 257—Constituents for Assessment Monitoring

Common name [1]
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 combined

[1] Common names are those widely used in government regulations, scientific publications, and commerce; synonyms exist for many chemicals.

PART 261—IDENTIFICATION AND LISTING OF HAZARDOUS WASTE

■ 6. The authority citation for part 261 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6921, 6922, 6924(y) and 6938.

■ 7. Section 261.4 is amended by revising paragraph (b)(4) to read as follows:

small entities that question or complain about this rule or any policy or action of the Coast Guard.

C. Collection of Information

This rule will not call for a new collection of information under the Paperwork Reduction Act of 1995 (44 U.S.C. 3501–3520).

D. Federalism and Indian Tribal Governments

A rule has implications for federalism under Executive Order 13132, Federalism, if it has a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. We have analyzed this rule under that Order and have determined that it is consistent with the fundamental federalism principles and preemption requirements described in Executive Order 13132.

Also, this rule does not have tribal implications under Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, because it does not have a substantial direct effect on one or more Indian tribes, on the relationship between the Federal Government and Indian tribes, or on the distribution of power and responsibilities between the Federal Government and Indian tribes. If you believe this rule has implications for federalism or Indian tribes, please contact the person listed in the **FOR FURTHER INFORMATION CONTACT** section.

E. Unfunded Mandates Reform Act

The Unfunded Mandates Reform Act of 1995 (2 U.S.C. 1531–1538) requires Federal agencies to assess the effects of their discretionary regulatory actions. In particular, the Act addresses actions that may result in the expenditure by a State, local, or tribal government, in the aggregate, or by the private sector of $100,000,000 (adjusted for inflation) or more in any one year. Though this rule will not result in such an expenditure, we do discuss the effects of this rule elsewhere in this preamble.

F. Environment

We have analyzed this rule under Department of Homeland Security Management Directive 023–01 and Commandant Instruction M16475.lD, which guide the Coast Guard in complying with the National Environmental Policy Act of 1969 (42 U.S.C. 4321–4370f), and have determined that this action is one of a category of actions that do not individually or cumulatively have a significant effect on the human environment. This rule involves a safety zone lasting approximately 6 hours annually that will prohibit entry within a specific section of the Columbia River in the vicinity of Hood River, OR. It is categorically excluded from further review under paragraph 34(g) of Figure 2–1 of the Commandant Instruction. An environmental analysis checklist supporting this determination and a Categorical Exclusion Determination are available in the docket where indicated under **ADDRESSES**. We seek any comments or information that may lead to the discovery of a significant environmental impact from this rule.

G. Protest Activities

The Coast Guard respects the First Amendment rights of protesters. Protesters are asked to contact the person listed in the **FOR FURTHER INFORMATION CONTACT** section to coordinate protest activities so that your message can be received without jeopardizing the safety or security of people, places or vessels.

List of Subjects in 33 CFR Part 165

Harbors, Marine safety, Navigation (water), Reporting and recordkeeping requirements, Security measures, Waterways.

For the reasons discussed in the preamble, the Coast Guard amends 33 CFR part 165 as follows:

PART 165—REGULATED NAVIGATION AREAS AND LIMITED ACCESS AREAS

■ 1. The authority citation for part 165 continues to read as follows:

Authority: 33 U.S.C. 1231; 50 U.S.C. 191; 33 CFR 1.05–1, 6.04–1, 6.04–6, 160.5; Department of Homeland Security Delegation No. 0170.1.

■ 2. Add, under the undesignated center heading Thirteenth Coast Guard District, § 165.1342 to read as follows:

§ 165.1342 Annual Roy Webster Cross-Channel Swim, Columbia River, Hood River, OR.

(a) *Regulated area.* The following regulated area is a safety zone. The safety zone will encompass all waters of the Columbia River between River Mile 169 and River Mile 170.

(b) *Definitions.* As used in this section—

Designated representative means Coast Guard Patrol Commanders, including Coast Guard coxswains, petty officers, and other officers operating Coast Guard vessels, and Federal, state, and local officers designated by or assisting the Captain of the Port Sector Columbia River in the enforcement of the regulated area.

Non-participant person means a person not registered as a swimmer in the Roy Webster Cross-Channel Swim held on the Columbia River in the vicinity of Hood River, OR, each Labor Day.

(c) *Regulations.* In accordance with the general regulations in 33 CFR part 165, subpart C, non-participant persons and vessels are prohibited from entering, transiting through, anchoring in, or remaining within the regulated area unless authorized by Captain of the Port, Sector Columbia River or a designated representative.

(1) Non-participant persons and vessels may request authorization to enter, transit through, anchor in, or remain within the regulated area by contacting the Captain of the Port Sector, Columbia River or a designated representative via VHF radio on channel 16. If authorization is granted by the Captain of the Port, Sector Columbia River or a designated representative, all persons and vessels receiving such authorization must comply with the instructions of the Captain of the Port Sector, Columbia River or a designated representative.

(2) The Coast Guard will provide notice of the safety zone by Local Notice to Mariners, Broadcast Notice to Mariners and on-scene designated representatives.

(d) *Enforcement period.* This safety zone will be enforced on Labor Day of each year, between the hours of 6 a.m. and Noon.

Dated: July 29, 2016.

W.R. Timmons,

Captain, U.S. Coast Guard, Captain of the Port, Sector Columbia River.

[FR Doc. 2016–18589 Filed 8–4–16; 8:45 am]

BILLING CODE 9110–04–P

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 257

[EPA–HQ–OLEM–2016–0274; FRL–9949–44–OLEM]

Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; Extension of Compliance Deadlines for Certain Inactive Surface Impoundments; Response to Partial Vacatur

AGENCY: Environmental Protection Agency (EPA).

ACTION: Direct final rule.

SUMMARY: The Environmental Protection Agency (EPA or the Agency) is taking

direct final action to extend for certain inactive coal combustion residuals (CCR) surface impoundments the compliance deadlines established by the regulations for the disposal of CCR under subtitle D of the Resource Conservation and Recovery Act (RCRA). These revisions are taken in response to a partial vacatur ordered by the United States Court of Appeals for the District of Columbia Circuit (D.C. Circuit) on June 14, 2016.

DATES: This rule is effective on October 4, 2016 without further notice, unless EPA receives adverse comment by August 22, 2016. If EPA receives adverse comment, we will publish a timely withdrawal notice in the **Federal Register** informing the public that the rule will not take effect.

ADDRESSES: Submit your comments, identified by Docket ID No. EPA–HQ–OLEM–2016–0274, at *http://www.regulations.gov*. Follow the online instructions for submitting comments. Once submitted, comments cannot be edited or removed from *Regulations.gov*. The EPA may publish any comment received to its public docket. Do not submit electronically any information you consider to be Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Multimedia submissions (audio, video, etc.) must be accompanied by a written comment. The written comment is considered the official comment and should include discussion of all points you wish to make. The EPA will generally not consider comments or comment contents located outside of the primary submission (*i.e.,* on the Web, cloud, or other file sharing system). For additional submission methods, the full EPA public comment policy, information about CBI or multimedia submissions, and general guidance on making effective comments, please visit *http://www.epa.gov/dockets/commenting-epa-dockets*.

FOR FURTHER INFORMATION CONTACT: For information concerning this direct final rule, contact Steve Souders, Office of Resource Conservation and Recovery, Environmental Protection Agency, 5304P, Washington, DC 20460; telephone number: (703) 308–8431; email address: *souders.steve@epa.gov*. For more information on this rulemaking please visit *https://www.epa.gov/coalash*.

SUPPLEMENTARY INFORMATION:

I. General Information

A. Does this action apply to me?

This direct final rule applies only to those owners or operators of inactive CCR surface impoundments that meet all three of the following conditions: (1) Complied with the requirement at 40 CFR 257.105(i)(1) by placing in their facility's written operating record a notification of intent to initiate closure of the CCR unit as required by 40 CFR 257.100(c)(1), no later than December 17, 2015; (2) complied with the requirement at 40 CFR 257.106(i)(1) by providing notification to the relevant State Director and/or appropriate Tribal authority by January 19, 2016, of the intent to initiate closure of the CCR unit; and (3) complied with the requirement at 40 CFR 257.107(i)(1) by placing the notification of intent to initiate closure of the CCR unit on the owner or operator's publicly accessible CCR Web site no later than January 19, 2016.

If you have any questions regarding the applicability of this action to a particular entity, consult the person listed in the preceding **FOR FURTHER INFORMATION CONTACT** section.

B. Why is EPA issuing a direct final rule?

EPA is publishing this rule without a prior proposed rule because we view this as a noncontroversial action and anticipate no adverse comment. This direct final rule merely extends the deadlines for the owners and operators of those inactive CCR surface impoundments that had taken advantage of the ''early closure'' provisions of 40 CFR 257.100, who became newly subject to the rule's requirements for existing CCR surface impoundments on June 14, 2016 when the United States Court of Appeals for the District of Columbia Circuit (D.C. Circuit) ordered the vacatur of those provisions. This rule provides time for these owners and operators to bring their units into compliance with the rule's substantive requirements, but does not otherwise amend the rule or otherwise impose new requirements on those units. However, in the ''Proposed Rules'' section of this **Federal Register**, we are publishing a separate document that will serve as the proposed rule to provide new compliance deadlines if adverse comments are received on this direct final rule. We will not institute a second comment period on this action. Any parties interested in commenting must do so at this time.

If EPA receives adverse comment, we will publish a timely withdrawal in the **Federal Register** informing the public that this direct final rule will not take effect. We would address all public comments in any subsequent final rule based on the proposed rule.

II. Statutory Authority

These regulations are established under the authority of sections 1006(b), 1008(a), 2002(a), 4004, and 4005(a) of the Solid Waste Disposal Act of 1970, as amended by the Resource Conservation and Recovery Act of 1976 (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA), 42 U.S.C. 6906(b), 6907(a), 6912(a), 6944, and 6945(a).

III. Background

On April 17, 2015 EPA finalized national regulations to regulate the disposal of coal combustion residuals (CCR) as solid waste under subtitle D of the Resource Conservation and Recovery Act (RCRA) titled, ''Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities,'' (80 FR 21302) (''CCR rule''). The CCR rule established national minimum criteria for existing and new CCR landfills and existing and new CCR surface impoundments and all lateral expansions consisting of location restrictions, design and operating criteria, groundwater monitoring and corrective action, closure requirements and post-closure care, and recordkeeping, notification and internet posting requirements. The rule also required any existing unlined CCR surface impoundment that is contaminating groundwater above a regulated constituent's groundwater protection standard to stop receiving CCR and either retrofit or close, except in limited circumstances. It also established requirements for inactive CCR surface impoundments, *i.e.,* those units that did not receive CCR after October 15, 2015 but still contain water and CCR. Under the rule as promulgated, inactive CCR surface impoundments must comply with the same requirements as existing CCR surface impoundments, unless the owner or operator of the facility closes the units no later than April 17, 2018. See 80 FR 21408–21409, April 17, 2015; 40 CFR 257.100(b). If an inactive CCR surface impoundment had completely closed by this date, no other requirements applied to that unit (*i.e.,* the ''early closure'' provisions). The effect of these ''early closure'' provisions was that no groundwater monitoring or other post-closure care requirements (such as the requirement to take corrective action for any releases) would apply to these units.

On June 14, 2016 the United States Court of Appeals for the D.C. Circuit ordered the vacatur of these ''early closure'' provisions in 40 CFR 257.100. The effect of the vacatur is that all inactive CCR surface impoundments must now comply with all of the requirements applicable to existing CCR surface impoundments.

IV. What action is EPA taking in this rule?

As a consequence of the order issued by the United States Court of Appeals for the D.C. Circuit on June 14, 2016, EPA is removing certain provisions of the CCR rule at 40 CFR 257.100(b), (c), and (d) related to the ''early closure'' of inactive CCR surface impoundments by April 17, 2018.

As a result of this order, owners and operators of inactive CCR surface impoundments that had relied on these ''early closure'' provisions must now comply with all of the requirements for existing CCR surface impoundments. These technical requirements are found in the following sections of the CCR rule: Location criteria; design and operating requirements, air criteria, inspection requirements, groundwater monitoring and corrective action; closure and post-closure care; and recordkeeping, notification and publicly accessible internet site requirements. Each of these requirements contained associated compliance deadlines, which must also be met. But the owners and operators of these units would have substantially less time than EPA had originally determined was needed to come into compliance; indeed some of these deadlines have already passed, prior to the issuance of the court's order. In the absence of an extension, these units would, through no fault of their own, become ''open dumps'' under the statute.

Accordingly, EPA is extending the compliance deadlines associated with these newly applicable regulatory requirements to allow the owners or operators of these units adequate time to come into compliance. The Agency is extending each of these compliance deadlines by 547 days, which is the amount of time between the signature date of the final rule and the last business day of the week during which the order from the court granting the motion to vacate 40 CFR 257.100 (b), (c), and (d) was signed. Thus, the 547 days represents the amount of time between December 19, 2014, and June 17, 2016.[1] In essence, this represents the amount of time that would have been available to these facilities had 40 CFR 257.100 not been included in the final rule; *i.e.,* this rule provides the same amount of time EPA granted to existing CCR surface impoundments in the final rule.

EPA defines the units subject to this extension rule as exclusively those units whose owners and operators of inactive CCR surface impoundments have complied with the following three requirements: (1) The requirement at 40 CFR 257.105(i)(1), by placing in their facility's written operating record a notification of intent to initiate closure of the CCR unit as required by 40 CFR 257.100(c)(1), by no later than December 17, 2015; (2) the requirement at 40 CFR 257.106(i)(1), by providing notification to the relevant State Director and/or appropriate Tribal authority no later than January 19, 2016, of the intent to initiate closure of the CCR unit; and (3) the requirement of 40 CFR 257.107(i)(1) by placing the notification of intent to initiate closure of the CCR unit on the owner or operator's publicly accessible CCR Web site, by no later than January 19, 2016.[2] EPA is not revising the regulation to require additional notification or postings from facilities to document that they have a unit(s) subject to the longer compliance deadlines in this extension rule. As noted previously, facilities were required to generate and post documents demonstrating their intent to take advantage of the ''early closure'' provisions by December 2015 and January 2016, pursuant to provisions that were not affected by the court order. Continued maintenance of these documents would be sufficient to establish that a particular unit is eligible for the extended compliance deadlines in this rule.

A brief discussion of the requirements with which these inactive CCR surface impoundments must comply is presented below for the ease of the reader. However, EPA is not soliciting comment on any of these requirements, including the original deadlines associated with these requirements, and is not otherwise reopening any aspect of the final CCR rule. EPA will not consider any comment on any topic other than the extension of the deadlines for the newly subject inactive CCR surface impoundments to be part of the record for this rule, and will not respond to such comments.

A. Location Criteria—Deadline To Complete the Demonstrations for Compliance With the Location Restrictions

To ensure that CCR surface impoundments are appropriately sited, the CCR rule established location restrictions, including restrictions relating to placement of CCR above the uppermost aquifer, in wetlands, within fault areas, in seismic impact zones, and in unstable areas. See 40 CFR 257.60 through 257.64. As discussed in the CCR rule, all of these location restrictions require the owner or operator of a CCR surface impoundment to demonstrate that they meet the specific criteria, as well as providing a deadline by when the demonstrations much be completed. In addition, the CCR rule requires existing CCR surface impoundments that cannot make the required demonstrations to close the unit. However, owners or operators of certain inactive CCR surface impoundments—those owners or operators that elected to comply with the now-vacated ''early closure'' provisions under 40 CFR 257.100(b)—were exempt from the location restrictions finalized in the CCR rule. With the vacatur of the exemption, these inactive CCR surface impoundments become subject to the location restrictions. This direct final rule provides owners or operators of eligible inactive CCR surface impoundments until April 16, 2020 to comply with the requirements for location restrictions; otherwise, the CCR unit must be closed. See also 80 FR 21359 –21368, April 17, 2015.

B. Design Criteria—Deadline To Document Whether the CCR Surface Impoundment Is Lined or Unlined

Owners or operators of inactive CCR surface impoundments subject to the provisions of the new 40 CFR 257.100(e)(3)(i) must by April 17, 2018 comply with the requirements at 40 CFR 257.71(a) and (b) and document, certified by a qualified professional engineer, whether their inactive CCR surface impoundment is constructed with any one of the three liner types: (1) A liner consisting of a minimum of two feet of compacted soil with a hydraulic

[1] The EPA selected June 17, 2016 (the end of the week the vacatur order was signed by the court) instead of June 14, 2016 (the actual date the court signed the order) to limit any potential confusion. Had EPA extended the compliance period based on the June 14 date, any facility that completed closure of their inactive surface impoundment by the original deadline in the vacated provisions would have been subject to certain rule requirements for one day. EPA concluded that no environmental or health protection would be achieved by requiring facilities to comply with requirements that are relevant only to active or inactive impoundments (because they determine whether the unit must close), when the unit would complete closure a single day later.

[2] Inactive CCR surface impoundments that are not affected by this rule: *i.e.,* inactive CCR surface impoundments without a notice of intent to close dated between April 17, 2015 and December 17, 2015, and placed in the facility's operating record and on the facility's publicly accessible internet site by January 19, 2016, remain subject to all of the requirements for existing CCR surface impoundments under 40 CFR part 257, subpart D (see § 257.100(a)), including the original timeframes in 40 CFR 257, subpart C, and are not subject to the new compliance timeframes discussed in this direct final rule.

conductivity of no more than 1 × 10–7 cm/sec; (2) a composite liner that meets the requirements of 40 CFR 257.70(b); or (3) an alternative liner that meets the requirements of 40 CFR 257.70(c). See also 80 FR 21370–21371, April 17, 2015.

C. Design Criteria—Deadline To Install Permanent Markers

Except for incised CCR surface impoundments as defined in 40 CFR 257.53, owners or operators of inactive CCR surface impoundments subject to the provisions of the new 40 CFR 257.100(e)(3)(ii) are subject to 40 CFR 257.73(a)(1) that requires the placement of a permanent identification marker, at least six feet high on or immediately adjacent to the CCR unit with the name associated with the CCR unit and the name of the owner or operator. The placement of the permanent marker must be completed by the owner or operator of the inactive CCR surface impoundment no later than June 16, 2017.

D. Design Criteria—Deadline To Complete the Initial Hazard Potential Classification and Prepare an Emergency Action Plan

Except for incised CCR surface impoundments as defined in 40 CFR 257.53, owners or operators of inactive CCR surface impoundments subject to the provisions of the new 40 CFR 257.100(e)(3)(v) must complete the initial periodic hazard potential classification assessment as required by 40 CFR 257.73 (a)(2) no later than April 17, 2018. Section 257.73(a)(3) requires any CCR surface impoundment that is determined by the owner or operator, through the certification by a qualified professional engineer, to be either a high hazard potential or a significant hazard potential CCR surface impoundment to prepare and maintain a written Emergency Action Plan (EAP). An EAP is a document that identifies potential emergency conditions at a CCR surface impoundment and specifies actions to be followed to minimize loss of life and property damage. In order to prepare an EAP, the owner or operator must accurately and comprehensively identify potential failure modes and at risk developments. Inactive surface impoundments that have been identified as having either a high hazard potential or a significant hazardous potential are subject to the provisions of the new 40 CFR 257.100(e)(3)(iii) and must prepare and maintain an EAP as required by 40 CFR 257.73 no later than October 16, 2018. See also 80 FR 21377–21379, April 17, 2015.

E. Design Criteria—Deadline To Document the CCR Surface Impoundments History of Construction

CCR surface impoundments that either have: (1) A height of five feet or more and a storage volume of 20 acre feet or more; or (2) have a height of 20 feet or more are required to document the design and construction of the CCR surface impoundment as required in 40 CFR 257.73(b) and (c). Owners or operators of inactive CCR surface impoundments that meet this size threshold and are subject to the provisions of the new 40 CFR 257.100(e)(3)(iv) must document the construction history of the CCR unit no later than April 17, 2018. See also 80 FR 21379–21380, April 17, 2015.

F. Design Criteria—Deadline To Complete the Initial Structural Stability Assessment and Initial Safety Factor Assessment

CCR surface impoundments meeting the size threshold discussed in section IV.E of this preamble, are also subject to two different types of technical assessments: (1) A structural stability assessment; and (2) a safety factor assessment. Owners or operators of inactive CCR surface impoundments subject to the provisions of the new 40 CFR 257.100(e)(3)(v) are required to conduct an initial assessment addressing both structural stability and safety factors by April 17, 2018. These requirements can be found at 40 CFR 257.73(b), (d), (e), and (f). See also 80 FR 21380–21386, April 17, 2015.

G. Operating Criteria—Deadline To Prepare a Fugitive Dust Control Plan

The owner or operator of a CCR unit is required under 40 CFR 257.80(b) to adopt measures that will effectively minimize CCR from becoming airborne at the facility, including CCR fugitive dust originating from CCR units, roads, and other CCR management and material handling activities. To meet this requirement, the owner or operator of the CCR unit must prepare and operate in accordance with a fugitive dust control plan. Owners or operators of inactive CCR surface impoundments subject to the provisions of the new 40 CFR 257.100(e)(4)(i) must complete this plan no later than April 18, 2017. See also 80 FR 21386–21388, April 17, 2015.

H. Operating Criteria—Deadline To Prepare an Initial Inflow Design Flood Control System Plan

Owners or operators of all CCR surface impoundments are required to design, construct, operate, and maintain hydraulic and hydrologic capacity to adequately manage flow both into and from a CCR surface impoundment during and after the peak discharge resulting from the inflow design flood, which is based on the Hazard Potential Classification of the CCR surface impoundment (40 CFR 257.82(a)). The rule requires the preparation of an initial inflow design flood control system plan (40 CFR 257.82(c)). Owners and operators of inactive CCR surface impoundments subject to the provisions of the new 40 CFR 257.100(e)(4)(ii) must complete the inflow design flood control system plan by April 17, 2018. See also 80 FR 21390–21392, April 17, 2015.

I. Operating Criteria—Deadline To Initiate Weekly Inspection of the CCR Surface Impoundment and Monthly Monitoring of the CCR Unit's Instrumentation

Under 40 CFR 257.83(a) all CCR surface impoundments must be examined by a qualified person at least once every seven days for any appearance of actual or potential structural weakness or other conditions that are disrupting or that have the potential to disrupt the operation or safety of the CCR unit. The results of the inspection by a qualified person must be recorded in the facility's operating record. Weekly inspections are intended to detect, as early as practicable, signs of distress in a CCR surface impoundment that may result in larger more severe conditions. Inspections are also designed to identify potential issues with hydraulic structures that may affect the structural safety of the unit and impact its hydraulic and hydrologic capacity. 40 CFR 257.83(a) also requires the monitoring of all instrumentation supporting the operation of the CCR unit to be conducted by a qualified person no less than once per month. Owners and operators of inactive CCR surface impoundments subject to the provisions of the new 40 CFR 257.100(e)(4)(iii) must initiate the inspection requirements set forth in 40 CFR 257.83(a) no later than April 18, 2017. See also 80 FR 21394–21395, April 17, 2015.

J. Operating Criteria—Deadline To Complete the Initial Annual Inspection of the CCR Surface Impoundment

Any CCR surface impoundment exceeding the size threshold discussed in section IV.E of this preamble, is required to conduct annual inspections of the CCR unit throughout its operating life (40 CFR 257.83(b)). These inspections are focused primarily on the structural stability of the unit and must ensure that the operation and maintenance of the unit is in accordance with recognized and generally accepted good engineering standards. Each inspection must be conducted and certified by a qualified professional engineer. Owners and operators of inactive CCR surface impoundments subject to the provisions of the new 40 CFR 257.100(e)(4)(iv) must conduct this initial annual inspection by July 19, 2017. See also 80 FR 21395, April 17, 2015.

K. Groundwater Monitoring and Corrective Action—Deadline To Install the Groundwater Monitoring System and Begin Monitoring

Owners and operators of inactive CCR surface impoundments subject to the provisions of the new 40 CFR 257.100(e)(5)(i) are required to comply with the provisions of 40 CFR 257.90(b) no later than April 17, 2019. These provisions require the installation of a groundwater monitoring system as required by 40 CFR 257.91 and the development of a groundwater sampling and analysis program. This program is to include selection of the statistical procedures to be used for evaluating groundwater monitoring data as required by 40 CFR 257.93. It also includes the initiation of the detection monitoring program and includes obtaining a minimum of eight independent samples for each background and downgradient wells as required by 40 CFR 257.94(b) and to begin evaluating the groundwater monitoring data for a statistically significant increase over background levels for the constituents listed in appendix III as required by 40 CFR 257.94. See also 80 FR at 21396–21407, April 17, 2015.

L. Groundwater Monitoring and Corrective Action—Deadline To Prepare an Initial Groundwater Monitoring and Corrective Action Report

Owners and operators of inactive CCR surface impoundments subject to the provisions of the new 40 CFR 257.100(e)(5)(ii) are required to comply with the provisions of 40 CFR 257.90(e) no later than August 1, 2019 (and annually thereafter) that require the preparation of an annual groundwater monitoring and corrective action report. The report must contain specific information identified in the regulations including but not limited to maps, aerial images or diagrams showing the CCR unit and all upgradient (background) and downgradient wells, identification of any monitoring wells installed or decommissioned in the previous year; monitoring data collected under 40 CFR 257.90–257.98 and a narrative discussion of any transition between monitoring programs (*i.e.,* detection and assessment monitoring).

M. Detection Monitoring Program—Deadline for Collection and Analyses of Eight Independent Samples

Consistent with the groundwater monitoring requirements previously discussed in section IV.K of this preamble, no later than April 17, 2019, owners or operators of inactive CCR surface impoundments subject to the provisions of the new 40 CFR 257.100(e)(5)(i) must collect a minimum of eight independent samples from each background and down gradient well and analyze for constituents listed in appendix III and IV of this part as required under 40 CFR 257.94(b).

N. Closure and Post-Closure Care—Deadline To Prepare a Written Closure Plan

The closure plan describes the steps necessary to close a CCR unit at any point during the active life of the unit based on recognized and generally accepted good engineering practices. Owners and operators of inactive CCR surface impoundments subject to the provisions of the new 40 CFR 257.100(e)(6)(i) are required to comply with the requirements of 40 CFR 257.102, including 40 CFR 257.102(b) requiring the preparation of a written closure plan no later than April 17, 2018. A written closure plan includes information that sets out how the closure of the unit will be conducted. It includes information such as a narrative description of the closure process, whether the closure of the CCR unit will be accomplished by leaving CCR in place or through clean closure. If the CCR is left in place, the closure plan must provide a description of the final cover system and how the final cover system will achieve the regulatory performance standards. The written closure plan must also provide a schedule for completing all activities necessary to satisfy the closure criteria of the rule. See also 80 FR 21410–21425, April 17, 2015.

O. Closure and Post-Closure Care—Deadline To Prepare a Written Post-Closure Care Plan

40 CFR 257.104(d) requires that an owner or operator of a CCR unit prepare a written post-closure plan. The content of the plan includes among other things, a description of the monitoring and maintenance activities required for the unit and the frequency that these activities will be performed. Owners and operators of inactive CCR surface impoundments subject to the provisions of the new 40 CFR 257.100(e)(6)(ii) are required to comply with the requirements of 40 CFR 257.104, including 40 CFR 257.104(d) requiring the preparation of a written post-closure plan no later than April 17, 2018.

P. Recordkeeping, Notification and Publicly Accessible Internet Site Requirements

Inactive CCR surface impoundments subject to the revised compliance deadlines being finalized in this direct final rule are also subject to the recordkeeping, notification and publicly accessible internet reporting requirements. The CCR rule requires the owner or operator of a CCR unit(s) to maintain files of all required information (*e.g.,* demonstrations, plans, notifications, and reports) that supports implementation and compliance with the rule. Each file must be maintained in the operating record for a period of at least 5 years following submittal of the file into the operating record. Submittal into the operating record is required at the time the documentation becomes available or by the specific compliance deadline. Section 257.105 contains a comprehensive listing of each recordkeeping requirement.

Owners or operators are also required to notify State Directors and/or the appropriate Tribal authority when specific documents have been placed in the operating record and on the owner or operators publicly accessible internet site. In most instances, these notifications must be certified by a qualified professional engineer and may, in certain instances, be accompanied with additional information or data supporting the notification. Notification requirements can be found at 40 CFR 257.106, and are required for location criteria, design criteria, operating criteria, groundwater monitoring and corrective action and closure and post-closure care.

Owners and operators of CCR units are also required to establish and maintain a publicly accessible Internet site, titled ''CCR Rule Compliance Data and Information.'' Unless provided otherwise in the rule, information posted to the Internet site must be available for a period no less than 3 years from the initial posting date. Posting of information must be completed no later than 30 days from the submittal of the information to the operating record. Owners and operators of inactive CCR surface impoundments subject to the new provisions of § 257.100(e) have 30 days from the revised compliance deadlines to post applicable information on their publicly accessible internet site.

The preceding discussion provides an abbreviated summary of the compliance deadlines for owners or operators of inactive CCR surface impoundments affected by this direct final rule. These inactive CCR surface impoundments are now also subject to all applicable requirements under 40 CFR part 257, subpart D for existing CCR surface impoundments. The new compliance deadlines for inactive CCR surface impoundments have been collected in a new paragraph (e) under § 257.100.

V. What is the effect of this rule on state programs?

The CCR rule established minimum federal criteria for existing and new CCR surface impoundments and CCR landfills. The regulations promulgated under subtitle D of RCRA require owner or operators of these units to comply with the requirements of the rule without any additional action by a state or federal regulatory agency. As discussed at length in the CCR rule preamble (80 FR 21429–21433, April 17, 2015), under the provisions of subtitle D applicable to solid waste, states are not required to adopt or implement these regulations, to develop a permit program, or submit a program covering these units to EPA for approval and there is no mechanism for EPA to officially approve or authorize a state program to operate ''in lieu of'' the federal regulations. In the CCR rule, however, EPA strongly encouraged states to adopt at least the federal minimum requirements into their regulations. EPA further acknowledged that some states have already adopted requirements that go beyond the minimum federal requirements; for example, some states currently impose financial assurance requirements for CCR units, and require a permit for some or all of these units. The federal criteria promulgated in the CCR rule are minimum requirements and do not preclude states' from adopting more stringent requirements where they deem to be appropriate. EPA also encouraged states to revise their solid waste management plan (SWMP) to address the issuance of the revised federal requirements and to submit the revisions of these plans to EPA for review, using the provision contained in 40 CFR part 256.

This rule amends the final CCR rule to reflect the vacatur of specific provisions of that rule applicable to certain CCR surface impoundments (*i.e.,* 40 CFR 257.100(b), (c), and (d)). This vacatur will likely affect those states that have begun the process of either revising their state programs (and regulations) to be consistent with the federal requirements or those states that have or are in the process of adopting the federal minimum requirements into their state regulations by reference. These states must now ensure that their regulations take into account this vacatur by ensuring that their regulations provide that inactive CCR surface impoundments are subject to all of the requirements in part 257 applicable to existing CCR surface impoundments regardless of their intent to close by a certain date.

VI. Statutory and Executive Order (EO) Reviews

Under Executive Order 12866 (58 FR 51735, October 4, 1993) and Executive Order 13563 (76 FR 3821, January 21, 2011), this action is not a ''significant regulatory action'' and is therefore not subject to OMB review. Because this action is not subject to notice and comment requirements under the Administrative Procedures Act or any other statute, it is not subject to the Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) or Sections 202 and 205 of the Unfunded Mandates Reform Act of 1999 (UMRA) (Pub. L. 104–4). In addition, this action does not significantly or uniquely affect small governments. This action does not create new binding legal requirements that substantially and directly affect Tribes under Executive Order 13175 (65 FR 67249, November 9, 2000). This action does not have significant Federalism implications under Executive Order 13132 (64 FR 43255, August 10, 1999). Because this final rule has been exempted from review under Executive Order 12866, this final rule is not subject to Executive Order 13211, entitled Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use (66 FR 28355, May 22, 2001) or Executive Order 13045, entitled Protection of Children from Environmental Health Risks and Safety Risks (62 FR 19885, April 23, 1997). This final rule does not contain any information collections subject to OMB approval under the Paperwork Reduction Act (PRA), 44 U.S.C. 3501 *et seq.,* nor does it require any special considerations under Executive Order 12898, entitled Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (59 FR 7629, February 16, 1994). This action does not involve technical standards; thus, the requirements of Section 12(d) of the National Technology Transfer and Advancement Act of 1995 (15 U.S.C. 272 note) do not apply.

Congressional Review Act

The Congressional Review Act, 5 U.S.C. 801 *et seq.,* generally provides that before certain actions may take effect, the agency promulgating the action must submit a report, which includes a copy of the action, to each House of the Congress and to the Comptroller General of the United States. This action is subject to the CRA, and the EPA will submit a rule report to each House of the Congress and to the Comptroller General of the United States. This action is not a ''major rule'' as defined by 5 U.S.C. 804(2).

List of Subjects in 40 CFR Part 257

Environmental protection, Beneficial use, Coal combustion products, Coal combustion residuals, Coal combustion waste, Disposal, Hazardous waste, Landfill, Surface impoundment.

Dated: July 26, 2015.

Gina McCarthy,

Administrator.

For the reasons set out in the preamble, title 40, chapter I, of the Code of Federal Regulations is amended as follows:

PART 257—CRITERIA FOR CLASSIFICATION OF SOLID WASTE DISPOSAL FACILITIES AND PRACTICES

■ 1. The authority citation for part 257 continues to read as follows:

Authority: 42 U.S.C. 6907(a)(3), 6912(a)(1), 6944(a), and 6949a(c); 33 U.S.C. 1345(d) and (e).

■ 2. Section 257.90 is amended by revising paragraph (a) to read as follows:

§ 257.90 Applicability.

(a) All CCR landfills, CCR surface impoundments, and lateral expansions of CCR units are subject to the groundwater monitoring and corrective action requirements under §§ 257.90 through 257.98.

* * * * *

■ 3. Section 257.100 is amended by:
■ a. Revising paragraph (a);
■ b. Removing and reserving paragraphs (b) through (d); and
■ c. Adding paragraph (e).

The revisions and additions read as follows:

§ 257.100 Inactive CCR surface impoundments.

(a) Inactive CCR surface impoundments are subject to all of the requirements of this subpart applicable to existing CCR surface impoundments.

* * * * *

(e) *Timeframes for certain inactive CCR surface impoundments.* (1) An inactive CCR surface impoundment for which the owner or operator has completed the actions by the deadlines specified in paragraphs (e)(1)(i) through (iii) of this section is eligible for the alternative timeframes specified in paragraphs (e)(2) through (6) of this section. The owner or operator of the CCR unit must comply with the applicable recordkeeping, notification, and internet requirements associated with these provisions. For the inactive CCR surface impoundment:

(i) The owner or operator must have prepared and placed in the facility's operating record by December 17, 2015, a notification of intent to initiate closure of the inactive CCR surface impoundment pursuant to § 257.105(i)(1);

(ii) The owner or operator must have provided notification to the State Director and/or appropriate Tribal authority by January 19, 2016, of the intent to initiate closure of the inactive CCR surface impoundment pursuant to § 257.106(i)(1); and

(iii) The owner or operator must have placed on its CCR Web site by January 19, 2016, the notification of intent to initiate closure of the inactive CCR surface impoundment pursuant to § 257.107(i)(1).

(2) *Location restrictions.* (i) No later than April 16, 2020, the owner or operator of the inactive CCR surface impoundment must:

(A) Complete the demonstration for placement above the uppermost aquifer as set forth by § 257.60(a), (b), and (c)(3);

(B) Complete the demonstration for wetlands as set forth by § 257.61(a), (b), and (c)(3);

(C) Complete the demonstration for fault areas as set forth by § 257.62(a), (b), and (c)(3);

(D) Complete the demonstration for seismic impact zones as set forth by § 257.63(a), (b), and (c)(3); and

(E) Complete the demonstration for unstable areas as set forth by § 257.64(a), (b), (c), and (d)(3).

(ii) An owner or operator of an inactive CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (e)(2)(i) of this section is subject to the closure requirements of § 257.101(b)(1).

(3) *Design criteria.* The owner or operator of the inactive CCR surface impoundment must:

(i) No later than April 17, 2018, complete the documentation of liner type as set forth by § 257.71(a) and (b).

(ii) No later than June 16, 2017, place on or immediately adjacent to the CCR unit the permanent identification marker as set forth by § 257.73(a)(1).

(iii) No later than October 16, 2018, prepare and maintain an Emergency Action Plan as set forth by § 257.73(a)(3).

(iv) No later than April 17, 2018, compile a history of construction as set forth by § 257.73(b) and (c).

(v) No later than April 17, 2018, complete the initial hazard potential classification, structural stability, and safety factor assessments as set forth by § 257.73(a)(2), (b), (d), (e), and (f).

(4) *Operating criteria.* The owner or operator of the inactive CCR surface impoundment must:

(i) No later than April 18, 2017, prepare the initial CCR fugitive dust control plan as set forth in § 257.80(b).

(ii) No later than April 17, 2018, prepare the initial inflow design flood control system plan as set forth in § 257.82(c).

(iii) No later than April 18, 2017, initiate the inspections by a qualified person as set forth by § 257.83(a).

(iv) No later than July 19, 2017, complete the initial annual inspection by a qualified professional engineer as set forth by § 257.83(b).

(5) *Groundwater monitoring and corrective action.* The owner or operator of the inactive CCR surface impoundment must:

(i) No later than April 17, 2019, comply with groundwater monitoring requirements set forth in §§ 257.90(b) and 257.94(b); and

(ii) No later than August 1, 2019, prepare the initial groundwater monitoring and corrective action report as set forth in § 257.90(e).

(6) *Closure and post-closure care.* The owner or operator of the inactive CCR surface impoundment must:

(i) No later than April 17, 2018, prepare an initial written closure plan as set forth in § 257.102(b); and

(ii) No later than April 17, 2018, prepare an initial written post-closure care plan as set forth in § 257.104(d).

§ 257.102 [Amended]

■ 4. Section 257.102 is amended by removing and reserving paragraph (e)(4)(i).

■ 5. Section 257.104 is amended by revising paragraph (a)(1) and removing paragraph (a)(3) to read as follows:

§ 257.104 Post-closure care requirements.

(a) * * *

(1) Except as provided by paragraph (a)(2) of this section, § 257.104 applies to the owners or operators of CCR landfills, CCR surface impoundments, and all lateral expansions of CCR units that are subject to the closure criteria under § 257.102.

* * * * *

[FR Doc. 2016–18353 Filed 8–4–16; 8:45 am]

BILLING CODE 6560–50–P

DEPARTMENT OF HOMELAND SECURITY

Federal Emergency Management Agency

44 CFR Part 64

[Docket ID FEMA–2016–0002; Internal Agency Docket No. FEMA–8443]

Suspension of Community Eligibility

AGENCY: Federal Emergency Management Agency, DHS.

ACTION: Final rule.

SUMMARY: This rule identifies communities where the sale of flood insurance has been authorized under the National Flood Insurance Program (NFIP) that are scheduled for suspension on the effective dates listed within this rule because of noncompliance with the floodplain management requirements of the program. If the Federal Emergency Management Agency (FEMA) receives documentation that the community has adopted the required floodplain management measures prior to the effective suspension date given in this rule, the suspension will not occur and a notice of this will be provided by publication in the **Federal Register** on a subsequent date. Also, information identifying the current participation status of a community can be obtained from FEMA's Community Status Book (CSB). The CSB is available at *http://www.fema.gov/fema/csb.shtm.*

DATES: *Effective Dates:* The effective date of each community's scheduled suspension is the third date (''Susp.'') listed in the third column of the following tables.

FOR FURTHER INFORMATION CONTACT: If you want to determine whether a particular community was suspended on the suspension date or for further information, contact Patricia Suber, Federal Insurance and Mitigation Administration, Federal Emergency Management Agency, 400 C Street SW., Washington, DC 20472, (202) 646–4149.

SUPPLEMENTARY INFORMATION: The NFIP enables property owners to purchase Federal flood insurance that is not otherwise generally available from private insurers. In return, communities agree to adopt and administer local floodplain management measures aimed

APPENDIX B

Boring Logs and Construction Diagrams

TEST BORING REPORT

Boring No. WAP-1

Project	Vectren FB Culley West Ash Pond, FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling
File No.	42796-004
Sheet No.	1 of 2
Start	06 February 2016
Finish	06 February 2016
Driller	J. Gryska
H&A Rep.	S. Lewis
Elevation	403.8
Datum	NGVD 88
Location	See Plan N 971,214 E 2,882,824

	Casing	Sampler	Barrel
Type	HSA	S	-
Inside Diameter (in.)	4.25	1.375	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures
- Rig Make & Model: CME 850 XR
- Bit Type: Cutting Head
- Drill Mud:
- Casing:
- Hoist/Hammer:
- PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0						ML	0.0 ft to 4.0 ft brown SILT										
							-FILL-										
5	1 2 2 3	S1 12	4.0 6.0			ML	Medium stiff brown sandy SILT (ML), no odor, moist, mica present, small pieces of coal present (0.1 in.)					30	70	N	L	N	L
10	5 8 10 10	S2 17	9.0 11.0		394.8 9.0	ML	Very stiff grayish brown sandy SILT (ML), no odor, moist, mica present					30	70	N	L	N	L
							-ALLUVIUM-										
15	1 2 2 4	S3 20	14.0 16.0			ML	Soft gray sandy SILT (ML), no odor, moist, mica present, wood fragments present					30	70	N	L	N	L
							Water table approximately 17.0 ft										
20	2 1	S4 24	19.0 21.0			ML	Soft gray SILT with sand (ML), no odor, wet, mica present, trace clay					20	80	N	L	L	L

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary
- Overburden (ft) 41.0
- Rock Cored (ft) -
- Samples 8S

Boring No. WAP-1

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	2 2						-ALLUVIUM-										
25	1 3 3 4	S5 24	24.0 26.0			ML	Similar as above except, moist					20	80	N	L	L	L
30	5 3 4 6	S6 24	29.0 31.0			ML	Medium stiff gray blue-gray SILT with sand (ML), no odor, moist, weathered shale present almost 50% of spoon, trace clay					10	90	N	L	M	L
35	3 3 4 4	S7 24	34.0 36.0			ML	Medium stiff gray brown mottled SILT (ML), no odor, moist, trace clay					10	90	N	L	M	L
40	2 2 3 4	S8 22	39.0 41.0			ML	Medium stiff gray SILT with sand (ML), no odor, wet					40	60	N	L	L	L
					362.8 41.0		BOTTOM OF EXPLORATION 41.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No.
Boring No. WAP-1

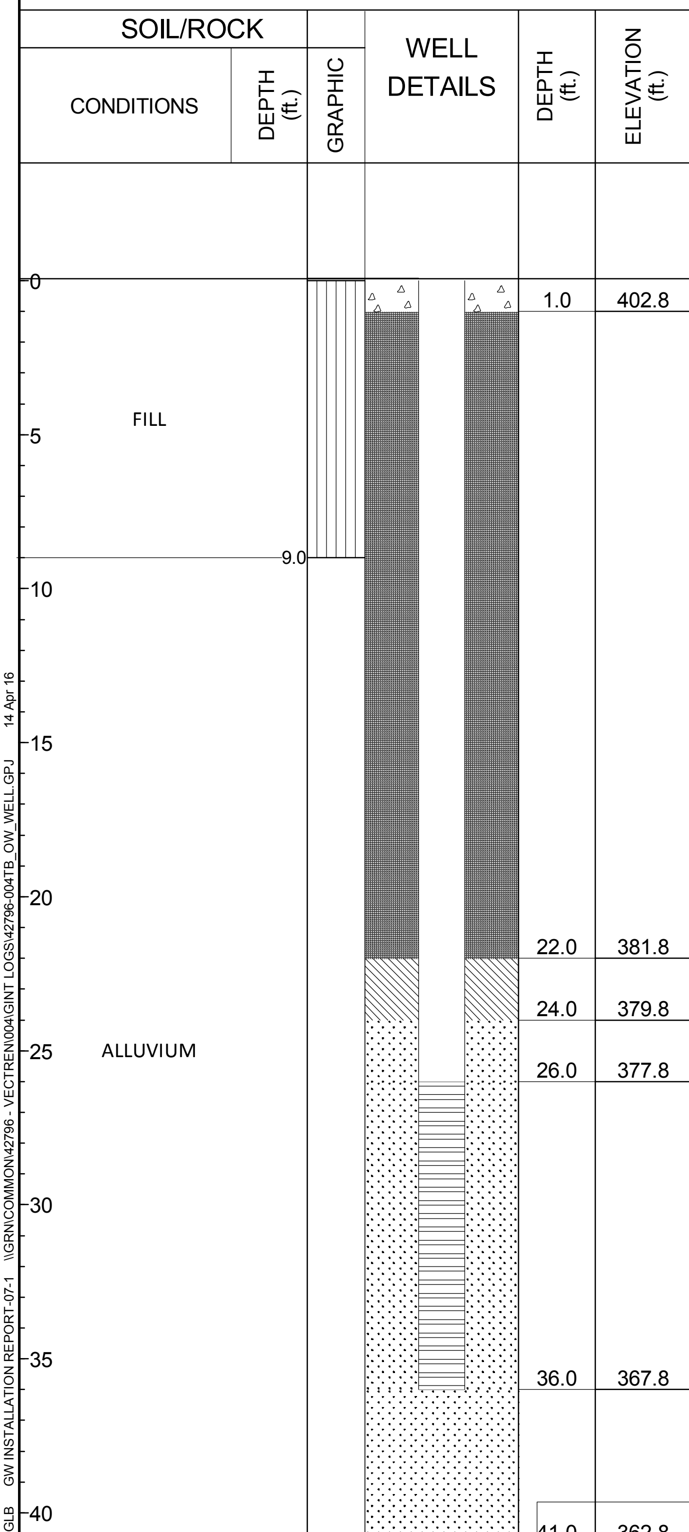
Project	Vectren FB Culley West Ash Pond
Location	FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling
Driller	J. Gryska

Initial Water Level (depth bgs) ft

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No. 42796-004
Date Installed 06 Feb 2016
H&A Rep. S. Lewis
Location N 971214.17
E 2882824.18

Ground El. 403.8
Datum NGVD 88



WELL CONSTRUCTION DETAILS

Type of protective cover	Flush Mount
Depth of Steel below ground surface	NA
Depth of top of riser below ground surface	NA
Type of protective casing	Steel
Length	
Inside diameter	4.0 in.
Depth of bottom of Steel	-
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	26.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	1.0	22.0
Bentonite	22.0	2.0
Sand	24.0	12.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	26.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Quartz Sand
Depth to bottom of well screen	36.0 ft
Bottom of silt trap	36.0 ft
Depth of bottom of borehole	41.0 ft

COMMENTS: North west of west ash pond.

TEST BORING REPORT

Boring No. WAP-2

Project	Vectren FB Culley West Ash Pond, FB Culley Generating Station	File No.	42796-004
Client	Southern Indiana Electric Company	Sheet No.	1 of 2
Contractor	Stearns Drilling	Start	06 February 2016
		Finish	07 February 2016
		Driller	J. Gryska
		H&A Rep.	S. Lewis
		Elevation	391.9
		Datum	NGVD 88
		Location	See Plan N 971,399 E 2,881,507

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	-	Rig Make & Model: CME 850 XR
Inside Diameter (in.)	4.25	1.375	-	Bit Type: Cutting Head
Hammer Weight (lb)	-	140	-	Drill Mud:
Hammer Fall (in.)	-	30	-	Casing:
				Hoist/Hammer:
				PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0						ML	0.0 ft to 4.0 ft brown black SILT -FILL-										
	rock 3 8	S1 5	4.0 6.0			ML	Stiff brown black sandy SILT (ML), mps 1.0 in., no odor, moist, mica present, wood fragments, black cloth in sample	5				30	65				
5							ABANDONDED										
	1 3 5 4	S2 7	9.0 11.0			ML	Stiff brown sandy SILT (ML), no odor, moist, mica present, mottled					30	70				
10																	
	3 5 4 4	S3 19	14.0 16.0			ML	Stiff brown gray clayey SILT with sand (ML), no odor, moist, mottled					20	80				
15																	
	2 4	S4 22	19.0 21.0			ML	Similar as above					20	80				
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	41.0
Rock Cored (ft)	-
Samples	8S

Boring No. WAP-2

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-07-1 HA-LIB09.GLB HA-TB+CORE+WELL-07-1.GDT \\GRN\COMMON\42796 - VECTREN\004\GINT LOGS\42796-004TB_OW_WELL.GPJ 14 Apr 16

TEST BORING REPORT

HALEY ALDRICH

Boring No. WAP-2
File No. 42796-004
Sheet No. 2 of 2

ABANDONED

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	7 13																
					371.1 20.8 370.9 21.0	SM	Bottom 1.0 in. brown SAND with silt (SM), no odor, moist -FILL-					80	20				
							Depth to water is approximately 22.5 ft bgs										
25	1 2 2 2	S5 18	24.0 26.0		367.9 24.0	SP- SC	Loose brown gray poorly graded SAND with clay (SP-SC), no odor, wet -FILL-					90	10				
30	3 5 3 1	S6 16	29.0 31.0		362.9 29.0	SC	Loose brown gray clayey SAND (SC), no odor, wet, mica present Note: Spoon had a lot of water. -ALLUVIUM-					85	15				
					361.1 30.8 360.9 31.0	CL	Bottom 2.0 in. gray CLAY (CL), wet -ALLUVIUM-						100				
35	4 8 9 11	S7 17	34.0 36.0			SP	Medium dense gray SAND (SP), no odor, wet *Water in the augers is bubbling, possibility hit a trapped gas pocket.					95	5				
40	3 1 4 7	S8 18	39.0 41.0			SP	Similar to above					95	5				
					350.9 41.0		BOTTOM OF EXPLORATION 41.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. WAP-2

TEST BORING REPORT

HALEY ALDRICH

Boring No. WAP-2R

Project: FB Culley West Ash Pond, FB Culley Generating Station
Client: Southern Indiana Gas and Electric Company
Contractor: ATC

File No. 129420-007
Sheet No. 1 of 3
Start: 22 January 2018
Finish: 23 January 2018
Driller: Z. Vaughan
H&A Rep.: T. Dennison
Elevation: TBD
Datum: TBD
Location: See Plan

	Casing	Sampler	Barrel
Type		S	--
Inside Diameter (in.)		1 3/8	--
Hammer Weight (lb)		140	-
Hammer Fall (in.)		30	-

Drilling Equipment and Procedures
Rig Make & Model: Geoprobe 8040DT
Bit Type: Cutting Head
Drill Mud: None
Casing: HSA Spun to
Hoist/Hammer: Automatic Hammer
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size[†], structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines
0								See Test Boring Log for WAP-2 for 0-38 feet						
5														
10														
15														
20														

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
					41.40

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 56
Rock Cored (ft) 0
Samples S9

Boring No. WAP-2R

Field Tests:
Dilatancy: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

[†]**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-07-2 REV-W/PID COL-NO FT HA-LIB07-1-CLE2.GLB HA-TB+CORE+WELL-PLUS-2007-1.GDT \\HALEYALDRICH.COM\SHARE\GRN_COMMON\129420 VECTREN\FB CULLEY\WEST ASH POND\GINT\129420.GPJ 26 Jan 18

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines
20														
25														
30														
35														
	5 5 6 6	S1 18/24	38.0 40.0		CL			Firm brown lean CLAY, no odor, moist						
					SP		39.0	Medium dense light brown fine grained poorly-graded SAND, no odor, wet						
40		S2 3/24	40.0 42.0											
	5 5 7 9	S3 11/24	42.0 44.0		SP			Medium dense brown fine grained poorly-graded SAND, no odor, wet						
45	5 6 9 9	S4 0/24	44.0 46.0											
	8 12 16 14	S5 19/24	46.0 48.0		SP		47.2	Medium dense brown very fine grained poorly-graded SAND, no odor, moist						
					SP		47.8	Loose red-brown medium grained poorly-graded SAND, no odor, wet						
	4 5 12 12	S6 10/24	48.0 50.0		SP		48.0	Medium dense brown medium grained poorly-graded SAND, no odor, wet						

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. WAP-2R
File No. 129420-007
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines
50	4 5 7 7	S7 13/24	50.0 52.0		SP			Medium dense brown medium grained poorly-graded SAND, no odor, wet						
	4 4 5 6	S8 10/24	52.0 54.0											
	5 5 5 6	S9 10/24	54.0 56.0											
55					SM		55.0	Dense brown very fine silty SAND, no odor, wet						
					GM		55.8	Loose brown mostly GRAVEL with some coarse sand and little silt, no odor, wet						
							56.0	**END OF BOREHOLE AT 56 FEET**						
60														
65														
70														
75														

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. WAP-2R

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No.	WAP-2R
Boring No.	WAP-2R

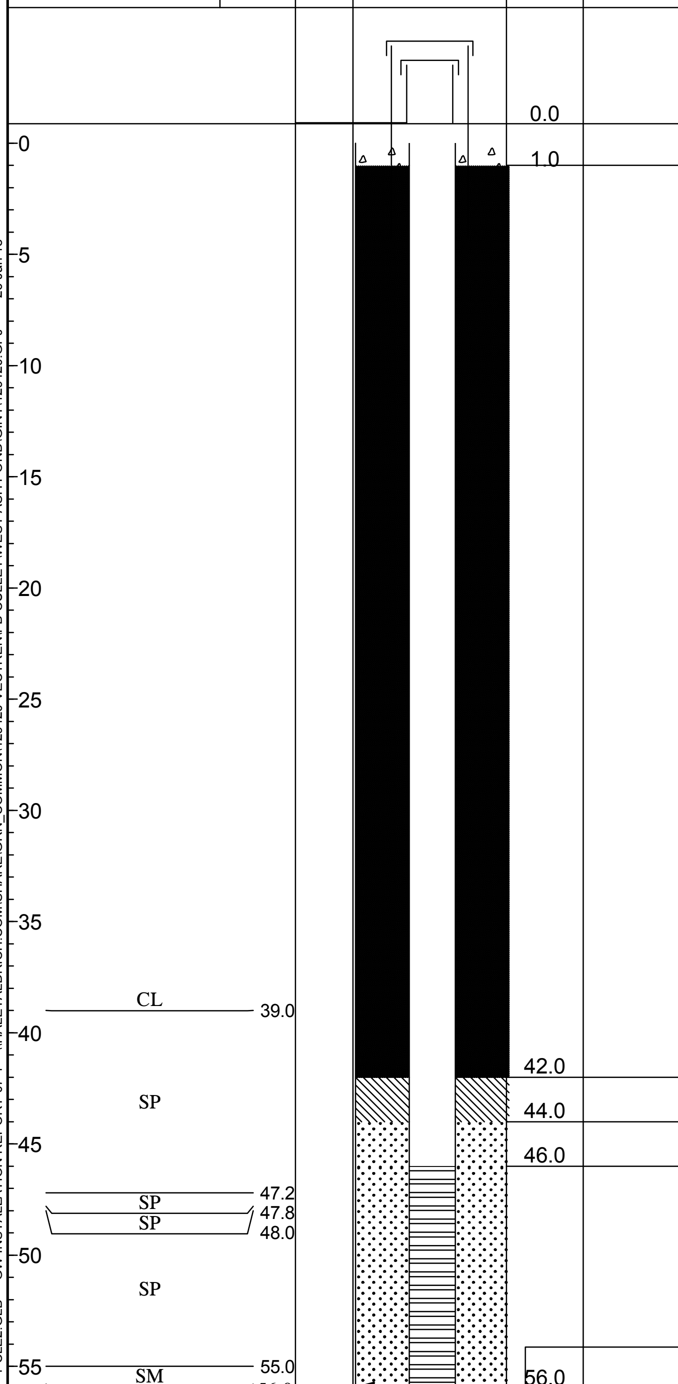
Project	FB Culley West Ash Pond
Location	FB Culley Generating Station
Client	Southern Indiana Gas and Electric Company
Contractor	ATC
Driller	Z. Vaughan
Initial Water Level (depth bgs)	41.4 ft

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No.	129420-007
Date Installed	23 Jan 2018
H&A Rep.	T. Dennison
Location	See Plan
Ground El.	TBD
Datum	TBD

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)



WELL CONSTRUCTION DETAILS

Type of protective cover	Stick-up Guard Pipe
Height of Guard Pipe above ground surface	3.5 ft
Height of top of riser above ground surface	3.0 ft
Type of protective casing	Guard Pipe
Length	5.0 ft
Inside diameter	4.0 in.
Depth of bottom of Guard Pipe	1.5 ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	46.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0 ft	1.0 ft
Grout	1.0 ft	41.0 ft
Bentonite	42.0 ft	2.0 ft

Diameter of borehole	8.0 in.
Depth to top of well screen	46.0 ft
Type of screen	Schedule 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Filter Sand
Depth to bottom of well screen	56 ft
Bottom of silt trap	56.0 ft
Depth of bottom of borehole	56.0 ft

COMMENTS:

HA-LIB07-1-CLE2.GLB GW INSTALLATION REPORT-07-1 \\HALEYALDRICH.COM\SHARE\GRN_COMMON\129420 VECTREN\FB CULLEY\WEST ASH POND\GINT\129420.GPJ 26 Jan 18

TEST BORING REPORT

Boring No. WAP-3

Project	Vectren FB Culley West Ash Pond, FB Culley Generating Station	File No.	42796-004
Client	Southern Indiana Electric Company	Sheet No.	1 of 4
Contractor	Stearns Drilling	Start	07 February 2016
		Finish	08 February 2016
		Driller	J. Gryska
		H&A Rep.	S. Lewis
		Elevation	393.6
		Datum	NGVD 88
		Location	See Plan N 971,000 E 2,881,263

	Casing	Sampler	Barrel
Type	HSA	S	-
Inside Diameter (in.)	4.25	1.375	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: CME 850 XR
Bit Type: Cutting Head
Drill Mud:
Casing:
Hoist/Hammer:
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0							0.0 ft to 4.0 ft crushed angular gravel and silt										
	1 1 0 0	S1 24	3.0 5.0			ASH	Very loose coal ash, wet -FILL-										
5																	
	0 0 0 0	S2 0	8.0 10.0			ASH	Similar to above, no recovery										
10							Piece of wood hit at 11.0 ft										
	6 6 3 6	S3 15	13.0 15.0		380.6 13.0	ML	Stiff black gray SILT with sand (ML), strong creosol-like odor, wet -FILL-					20	80				
15																	
	3 5 8 10	S4 15	18.0 20.0			ML	Very stiff brown SILT with sand (ML), no odor in silt, dry					20	80				
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	87.0
Rock Cored (ft)	-
Samples	18S

Boring No. WAP-3

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-07-1 HA-LIB09.GLB HA-TB+CORE+WELL-07-1.GDT \\GRN\COMMON\42796 - VECTREN\004\GINT LOGS\42796-004TB_OW_WELL.GPJ 14 Apr 16

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20							Wood still coming up in auger and it has a strong creosol-like odor -FILL-										
	4 9 12 13	S5 17	23.0 25.0			ML	Similar as above					20	80				
25																	
	4 6 8 16	S6 22	28.0 30.0		365.6 28.0	ML	Similar as above except, sharp contact between brown and gray SILT at 29.0 ft, gray silt is mottled with olive green and red colors -ALLUVIUM-					20	80				
30																	
	8 11 12 15	S7 18	33.0 35.0			ML	Similar to above except very stiff, dry, varying colors of silt, top 4.0 in. is brown, remaining 13.0 in. is gray mottled with red green, last 1.0 in. is brown					20	80				
35																	
	4 2 5 5	S8 24	38.0 40.0			ML	Medium stiff gray olive green and red SILT with sand (ML), no odor, moist, mottled					20	80				
40																	
	3 4 5 6	S9 24	43.0 45.0		350.6 43.0	CL	Stiff gray lean CLAY (CL), no odor, moist, mica present, laminated layers -ALLUVIUM-					10	90				
45																	
	2 3 3 5	S10 24	48.0 50.0			CL	Similar to above					10	90				

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
50							-ALLUVIUM-										
	0 2 3 5	S11 24	53.0 55.0			CL	Similar to above except, moist, wood fragments present at 55.0 ft, weathered shale present (small rounded piece 0.5 in.)					10	90				
55																	
	3 3 5 5	S12 24	58.0 60.0			CL	Similar to above					10	90				
60																	
	0 1 0 1	S13 12	63.0 65.0		330.6 63.0	GW-GC	Very soft gray well graded GRAVEL with clay and sand (GW-GC), mps 1.0 in., no odor, wet, rounded gravel -ALLUVIUM-	15	35		10	30	10				
65																	
	7 9 12 15	S14 24	68.0 70.0		325.6 68.0	SP-SC	Medium dense poorly graded SAND with clay and gravel (SP-SC), no odor, wet, rounded gravel -ALLUVIUM-	10	25		10	45	10				
70																	
	4 6 8 10	S15 24	73.0 75.0			SP-SC	Medium dense brown gray poorly graded SAND (SP-SC), no odor, wet				30	60	10				
75																	
	2 3 5	S16 24	78.0 80.0			SP-SC	Similar to above				30	60	10				

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. WAP-3
File No. 42796-004
Sheet No. 4 of 4

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
	7																
80							-ALLUVIUM-										
	7 8 9 11	S17 24	83.0 85.0			SP- SC	Medium dense gray SAND with clay and gravel (SP-SC), no odor, wet, rounded gravel Bottom 2.0 in. black wood fragments	5	5		20	60	10				
85																	
	50/2	S18	86.5 87.0		306.6 87.0		Weathered shale at 87.0 ft										
							BOTTOM OF EXPLORATION 87.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. WAP-3

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No.
Boring No. WAP-3

Project	Vectren FB Culley West Ash Pond
Location	FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling
Driller	J. Gryska

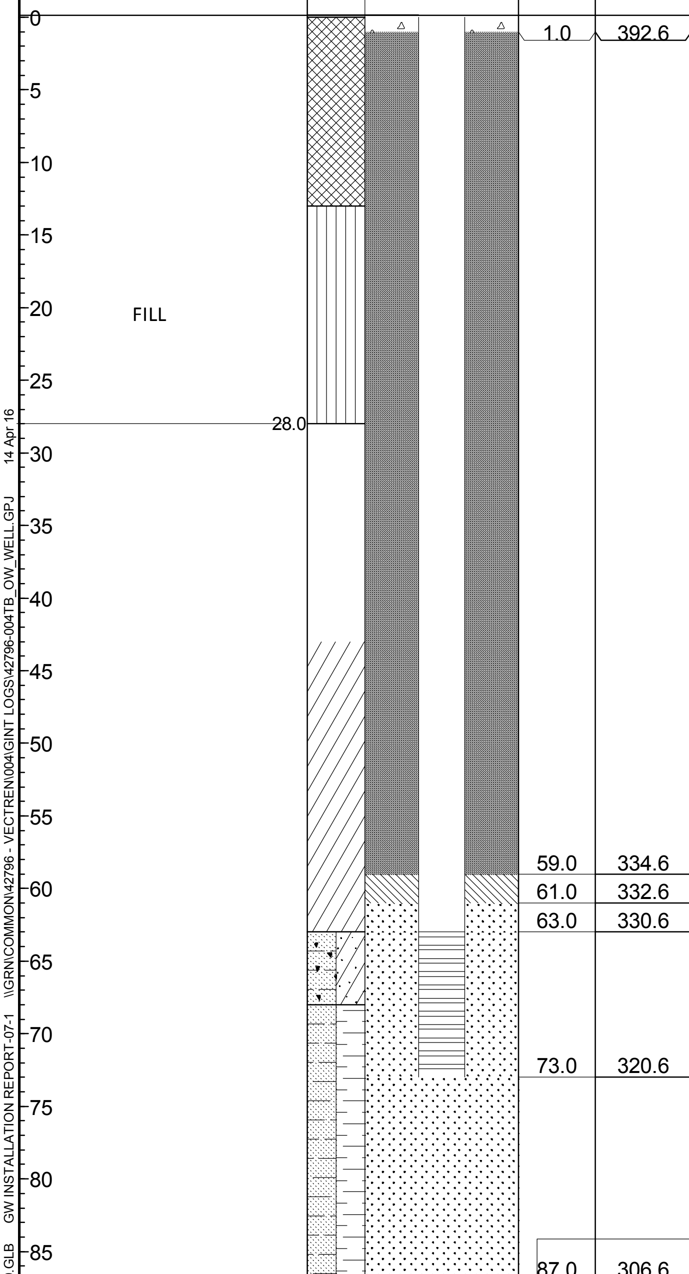
Initial Water Level (depth bgs) ft

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No.	42796-004
Date Installed	08 Feb 2016
H&A Rep.	S. Lewis
Location	N 971000.02 E 2881262.53
Ground El.	393.6
Datum	NGVD 88

SOIL/ROCK CONDITIONS	DEPTH (ft.)	WELL DETAILS DEPTH (ft.)	ELEVATION (ft.)
FILL	0 – 28.0	1.0	392.6
	87.0	59.0	334.6
		61.0	332.6
		63.0	330.6
		73.0	320.6
		87.0	306.6



WELL CONSTRUCTION DETAILS

Type of protective cover	Stick-up Guard Pipe
Depth of Steel below ground surface	NA
Height of top of riser above ground surface	NA
Type of protective casing	Steel
Length	
Inside diameter	4.0 in.
Depth of bottom of Steel	-
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	63.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	1.0	59.0
Bentonite	59.0	2.0
Sand	61.0	12.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	63.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Quartz Sand
Depth to bottom of well screen	73.0 ft
Bottom of silt trap	73.0 ft
Depth of bottom of borehole	87.0 ft

COMMENTS: West side of ash pond.

TEST BORING REPORT

Boring No. WAP-4D

Project	Vectren FB Culley West Ash Pond, FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling

File No.	42796-004
Sheet No.	1 of 5
Start	05 February 2016
Finish	05 February 2016
Driller	J. Gryska
H&A Rep.	S. Lewis
Elevation	395.3
Datum	NGVD 88
Location	See Plan N 970,413 E 2,881,325

	Casing	Sampler	Barrel
Type	HSA	S	-
Inside Diameter (in.)	4.25	1.375	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: CME 850 XR
Bit Type: Cutting Head
Drill Mud:
Casing:
Hoist/Hammer:
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							REFER TO AECOM's BORING B15-13 FOR LITHOLOGY										
5																	
10																	
15																	
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 126
Rock Cored (ft) -
Samples

Boring No. WAP-4D

Field Tests:
Dilatancy: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																	
25																	
30																	
35																	
40																	
45																	

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50																	
55																	
60																	
65																	
70																	
75																	

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
80																	
85																	
90																	
95																	
100																	
105																	

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
110																	
115																	
120																	
125					269.3 126.0												

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No.	
Boring No.	WAP-4D

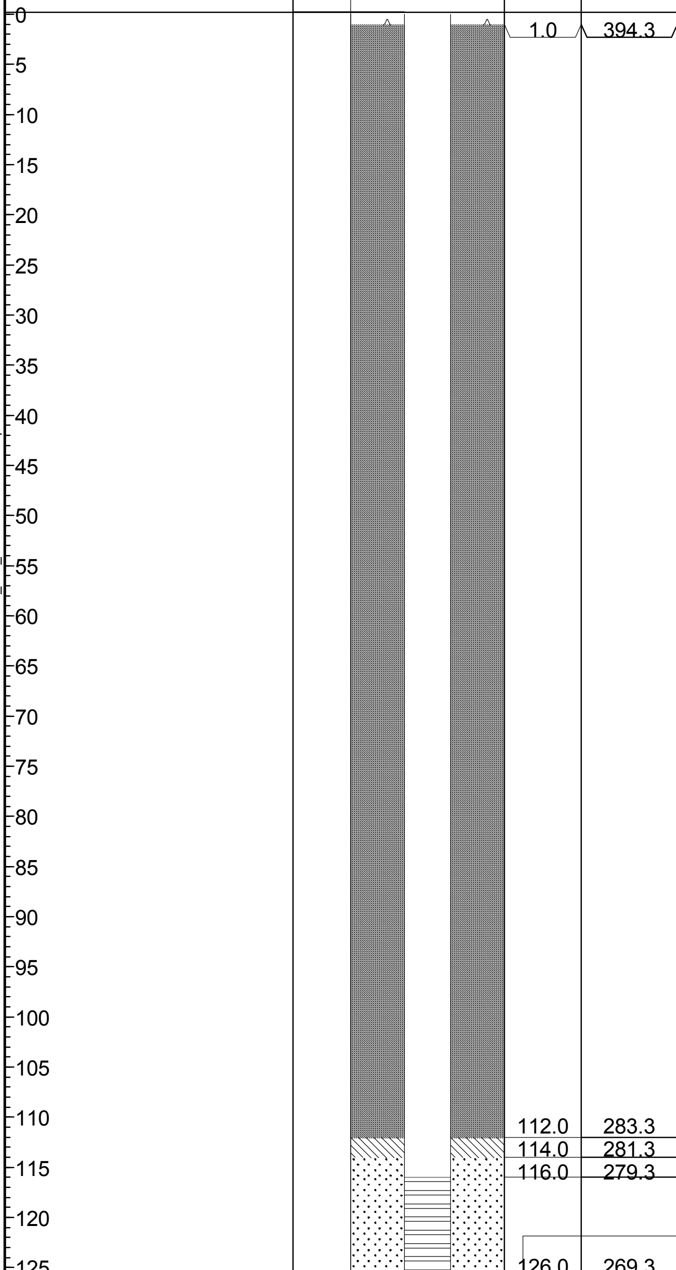
Project	Vectren FB Culley West Ash Pond
Location	FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling
Driller	J. Gryska
Initial Water Level (depth bgs)	ft

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No.	42796-004
Date Installed	05 Feb 2016
H&A Rep.	S. Lewis
Location	N 970412.71 E 2881325.08
Ground El.	395.3
Datum	NGVD 88

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)



WELL CONSTRUCTION DETAILS

Type of protective cover	Stick-up Guard Pipe
Depth of Steel below ground surface	NA
Height of top of riser above ground surface	NA
Type of protective casing	Steel
Length	
Inside diameter	4.0 in.
Depth of bottom of Steel	-
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	116.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	1.0	111.0
Bentonite	112.0	2.0
Sand	114.0	12.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	116.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Quartz Sand
Depth to bottom of well screen	126.0 ft
Bottom of silt trap	126.0 ft
Depth of bottom of borehole	126.0 ft

COMMENTS: South side of west ash pond.

HALEY ALDRICH

TEST BORING REPORT

Boring No. WAP-4I

Project	Vectren FB Culley West Ash Pond, FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling

File No.	42796-004
Sheet No.	1 of 5
Start	05 February 2016
Finish	05 February 2016
Driller	J. Gryska
H&A Rep.	S. Lewis
Elevation	395.3
Datum	NGVD 88
Location	See Plan N 970,409 E 2,881,329

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	-	Rig Make & Model: CME 850 XR
Inside Diameter (in.)	4.25	1.375	-	Bit Type: Cutting Head Drill Mud:
Hammer Weight (lb)	-	140	-	Casing: Hoist/Hammer:
Hammer Fall (in.)	-	30	-	PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							REFER TO AECOM's BORING B15-13 FOR LITHOLOGY										
5																	
10																	
15																	
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	85
Rock Cored (ft)	-
Samples	

Boring No. WAP-4I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

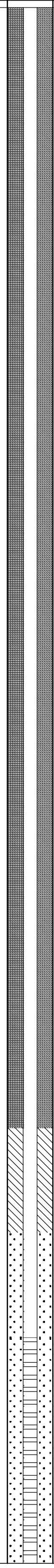
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-07-1 HA-LIB09.GLB HA-TB+CORE+WELL-07-1.GDT \\GRN\COMMON\42796 - VECTREN\004\GINT LOGS\42796-004TB_OW_WELL.GPJ 14 Apr 16

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																	
25																	
30																	
35																	
40																	
45																	

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	**VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION** (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50																	
55																	
60																	
65																	
70																	
75																	



H&A-TEST BORING-07-1 HA-LIB09.GLB HA-TB+CORE+WELL-07-1.GDT \\GRN\COMMON\42796 - VECTREN\004\GINT LOGS\42796-004TB_OW_WELL.GPJ 14 Apr 16

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. WAP-4I
File No. 42796-004
Sheet No. 4 of 5

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
80																	
85					310.3 85.0												

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. WAP-4I

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No.
Boring No. WAP-4I

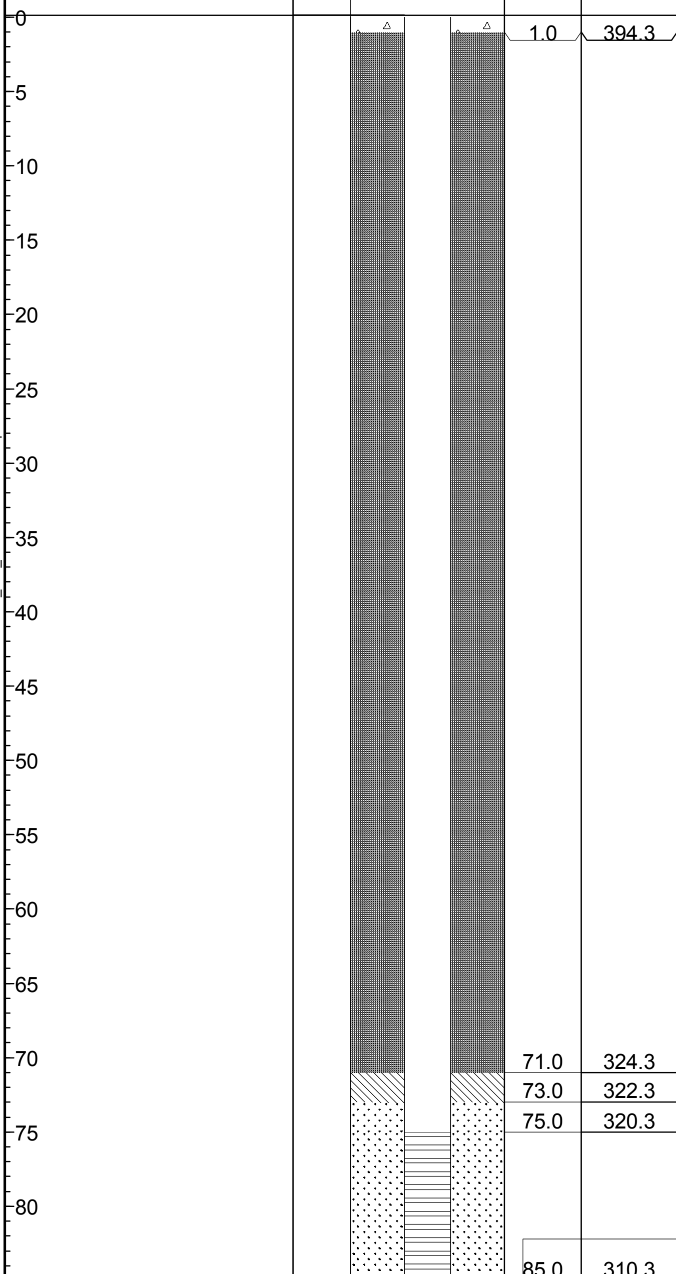
Project	Vectren FB Culley West Ash Pond
Location	FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling
Driller	J. Gryska
Initial Water Level (depth bgs)	ft

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No.	42796-004
Date Installed	05 Feb 2016
H&A Rep.	S. Lewis
Location	N 970408.95 E 2881329.18
Ground El.	395.3
Datum	NGVD 88

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)
	85.0			1.0	394.3
				71.0	324.3
				73.0	322.3
				75.0	320.3
				85.0	310.3



WELL CONSTRUCTION DETAILS

Type of protective cover	Stick-up Guard Pipe
Depth of Steel below ground surface	NA
Height of top of riser above ground surface	NA
Type of protective casing	Steel
Length	
Inside diameter	4.0 in.
Depth of bottom of Steel	-
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	75.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	1.0	70.0
Bentonite	71.0	2.0
Sand	73.0	12.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	75.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Quartz Sand
Depth to bottom of well screen	85.0 ft
Bottom of silt trap	85.0 ft
Depth of bottom of borehole	85.0 ft

COMMENTS: South side of west ash pond.

HALEY ALDRICH

TEST BORING REPORT

Boring No. WAP-4

Project	Vectren FB Culley West Ash Pond, FB Culley Generating Station	File No.	42796-004
Client	Southern Indiana Electric Company	Sheet No.	1 of 1
Contractor	Stearns Drilling	Start	
		Finish	
		Driller	J. Gryska
		H&A Rep.	S. Lewis
		Elevation	395.3
		Datum	NGVD 88
		Location	See Plan N 970,405 E 2,881,333

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	-	Rig Make & Model: CME 850 XR
Inside Diameter (in.)	4.25	1.375	-	Bit Type: Cutting Head
Hammer Weight (lb)	-	140	-	Drill Mud:
Hammer Fall (in.)	-	30	-	Casing:
				Hoist/Hammer:
				PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							REFER TO AECOM's BORING B15-13 FOR LITHOLOGY										
5																	
10																	
15																	
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	55
Rock Cored (ft)	-
Samples	

Boring No. WAP-4

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

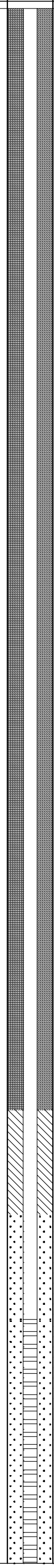
***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-07-1 HA-LIB09.GLB HA-TB+CORE+WELL-07-1.GDT \\GRN\COMMON\42796 - VECTREN\004\GINT LOGS\42796-004TB_OW_WELL.GPJ 14 Apr 16

TEST BORING REPORT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																	
25																	
30																	
35																	
40																	
45																	



NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. WAP-4
File No. 42796-004
Sheet No. 3 of 1

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50																	
55					340.3 55.0												

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. WAP-4

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No.
Boring No. WAP-4

Project	Vectren FB Culley West Ash Pond
Location	FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling
Driller	J. Gryska
Initial Water Level (depth bgs)	ft

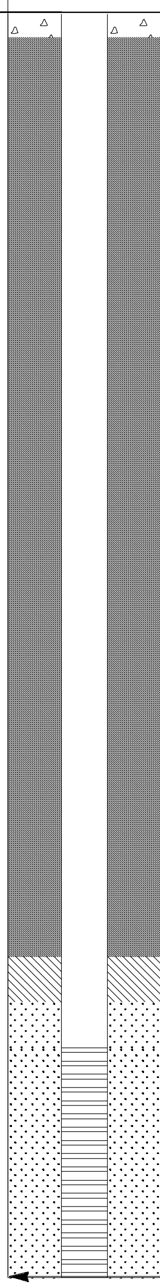
Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No.	42796-004
Date Installed	
H&A Rep.	S. Lewis
Location	N 970405.14 E 2881333.33
Ground El.	395.3
Datum	NGVD 88

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)
	0			1.0	394.3
				41.0	354.3
				43.0	352.3
				45.0	350.3
	55.0			55.0	340.3

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50



WELL CONSTRUCTION DETAILS

Type of protective cover	Stick-up Guard Pipe
Depth of Steel below ground surface	NA
Height of top of riser above ground surface	NA
Type of protective casing	Steel
Length	
Inside diameter	4.0 in.
Depth of bottom of Steel	-
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	45.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	1.0	40.0
Bentonite	41.0	2.0
Sand	43.0	12.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	45.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Quartz Sand
Depth to bottom of well screen	55.0 ft
Bottom of silt trap	55.0 ft
Depth of bottom of borehole	55.0 ft

COMMENTS: South side of west ash pond.

TEST BORING REPORT

Boring No. WAP-5D

Project	Vectren FB Culley West Ash Pond, FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling

File No.	42796-004
Sheet No.	1 of 5
Start	04 February 2016
Finish	04 February 2016
Driller	J. Gryska
H&A Rep.	S. Lewis
Elevation	394.4
Datum	NGVD 88
Location	See Plan N 970,230 E 2,881,529

	Casing	Sampler	Barrel
Type	HSA	S	-
Inside Diameter (in.)	4.25	1.375	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures
Rig Make & Model: CME 850 XR
Bit Type: Cutting Head
Drill Mud:
Casing:
Hoist/Hammer:
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0							0.0 ft to 2.0 ft crushed stone, angular 0.5 ft to 2.0 ft coal ash 2.0 ft to 3.5 ft -FILL-										
	5 6 9 9	S1 15	3.5 5.5		390.9 3.5	SM	Medium dense brown silty SAND with gravel (SM), mps 1.0 in., no odor, moist, rounded gravel -FILL-	5	10	5	10	50	20	N	L	N	N
5																	
	2 5 6 5	S2 18	8.5 10.5			SM	Similar to above	5	10	5	10	50	20	N	L	N	N
10																	
	1 3 3 3	S3 13	13.5 15.5			SM	Similar to above except loose	5	10	5	10	50	20	N	L	N	N
15																	
	1 2 2	S4 12	18.5 20.5			SM	Similar to above except dark brown	5	10	5	10	50	20	N	L	N	N
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	123
Rock Cored (ft)	-
Samples	24S

Boring No. WAP-5D

Field Tests:
Dilatancy: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

*Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. WAP-5D
File No. 42796-004
Sheet No. 2 of 5

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	2																
25	3 5 7 9	S5 24	23.5 25.5		370.9 23.5	CL	Stiff dark gray lean CLAY (CL), no odor, moist, mica present -ALLUVIUM-					5	95	N	M	M	M
30	1 2 3 4	S6 19	28.5 30.5			CL	Medium stiff dark gray lean CLAY with sand (CL), no odor, moist, mica present					25	75	N	M	M	M
35	1 2 2 3	S7 24	33.5 35.5			CL	Soft brown gray sandy lean CLAY (CL), no odor, wet, mica present, clay lenses					20	80	N	M	M	M
	0 0 2 3	S8 24	38.5 40.5			CL	Soft brown lean CLAY with sand (CL), no odor, wet, mica present					20	80	N	M	M	M
40					354.9 39.5	SC	Loose brown clayey SAND (SC), no odor, wet, mica present -ALLUVIUM-					65	35	N	L	M	
	0 0 0 3	S9 24	43.5 45.5		350.9 43.5	CL	Soft brown lean CLAY with sand (CL), no odor, wet, mica present -ALLUVIUM-					30	70				
45					349.9 44.5	SC	Loose brown clayey SAND (SC), no odor, wet -ALLUVIUM-					65	35				
	0 2 2	S10 24	48.5 50.5		345.9 48.5	CL	Soft brown CLAY with sand (CL), no odor, wet, mica present, clay lenses, laminated layers of clay and sand					20	80				

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
50	2						-ALLUVIUM-										
	3 5 7 9	S11 13	53.5 55.5		340.9 53.5	SC	Medium dense brown well graded clayey SAND (SC), no odor, wet, mica present, rounded gravel -ALLUVIUM-		5	10	20	45	20				
55																	
	7 9 14 17	S12 24	58.5 60.5		335.9 58.5	SP- SC	Medium dense brown poorly graded SAND (SP-SC), no odor, wet, fining upward sequence, rounded gravel -ALLUVIUM-		5	5	20	60	10				
60																	
	7 6 7 9	S13 15	63.5 65.5			SP- SC	Medium dense brown poorly graded SAND with clay (SP-SC), no odor, wet, trace rounded gravel		5	5	20	60	10				
65																	
	10 11 7 11	S14 14	68.5 70.5			SP- SC	Similar to above		5	5	30	50	10				
70																	
	10 12 14 15	S15 20	73.5 75.5			SP- SC	Medium dense brown poorly graded SAND with clay and gravel (SP-SC), mps 0.2 in., no odor, wet, rounded gravel and sand	5	5	10	30	40	10				
75																	
	3 4	S16 17	78.5		315.9 78.5	SW- SC	Medium dense brown well graded SAND with clay (SW-SC), mps 0.2 in., no odor, wet, rounded sand			20	30	40	10				

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
80	5 7		80.5				-ALLUVIUM-										
85	8 14 15 18	S17 24	83.5 85.5		310.9 83.5	SP- SC	Dense brown poorly graded SAND with clay (SP-SC), mps 0.5 in., no odor, wet, weathered shale present, weathered sandstone present -ALLUVIUM-		5	10	15	60	10				
90	8 8 12 19	S18 22	88.5 90.5			SP- SC	Medium dense gray poorly graded SAND with clay (SP-SC), mps 1.0 in., no odor, wet, weathered shale, weathered sandstone pieces present, rounded piece of granite found	5	5	10	15	55	10				
95	8 12 13 15	S19 18	93.5 95.5			SP- SC	Medium dense gray poorly graded SAND with clay (SP-SC), mps 1.0 in., no odor, wet, small pieces weathered shale present, rounded gravel	5	5	10	25	45	10				
100	3 5 9 10	S20 15	98.5 100.5		295.9 98.5	SW- SC	Medium dense gray well graded SAND with clay and gravel (SW-SC), mps 1.0 in., no odor, wet, small pieces weathered shale present, rounded sand and gravel, fining upward sequence -ALLUVIUM-		10	10	25	45	10				
105	8 6 6 9	S21 16	103.5 105.5		290.9 103.5	SW	Medium dense gray well graded SAND with gravel (SW), no odor, wet, rounded sand and gravel -ALLUVIUM-	10	20	10	25	30	5				
	19	S22	108.5														

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
110	22 17 6	3	110.5			SW	Similar to above	10	20	10	25	30	5				
115	5 9 8 10	S23 16	113.5 115.5			SW	Medium dense gray well graded SAND with gravel (SW), no odor, wet, rounded sand and gravel	20	20	10	20	25	5				
120	5 9 8 10	S24 20	118.5 120.5			SW	Medium dense gray well graded SAND with gravel (SW), no odor, wet, rounded sand and gravel, shale fragments present, limestone fragments present, possible mollusks in limestone fragment		20	10	35	30	5				
							Coral found when they were bailing sand from augers.										
					271.4 123.0		-BOTTOM OF EXPLORATION 123.0 FT Note: Weathered shale, clayey, soft at 123.0 ft										

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No.
Boring No. WAP-5D

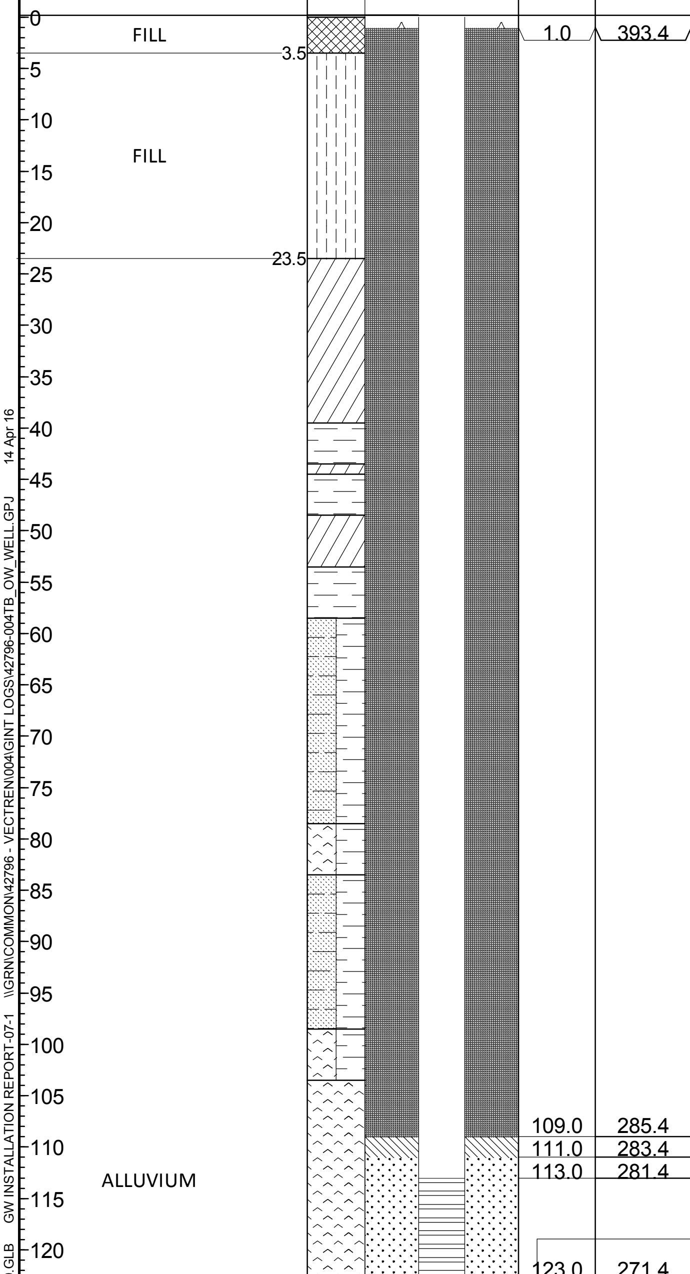
Project	Vectren FB Culley West Ash Pond
Location	FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling
Driller	J. Gryska
Initial Water Level (depth bgs)	ft

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No.	42796-004
Date Installed	04 Feb 2016
H&A Rep.	S. Lewis
Location	N 970229.88 E 2881528.71
Ground El.	394.4
Datum	NGVD 88

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)



WELL CONSTRUCTION DETAILS

Type of protective cover	Stick-up Guard Pipe
Depth of Steel below ground surface	NA
Height of top of riser above ground surface	NA
Type of protective casing	Steel
Length	
Inside diameter	4.0 in.
Depth of bottom of Steel	-
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	113.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	1.0	108.0
Bentonite	109.0	2.0
Sand	111.0	12.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	113.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Quartz Sand
Depth to bottom of well screen	123.0 ft
Bottom of silt trap	123.0 ft
Depth of bottom of borehole	123.0 ft

COMMENTS: South side of west ash pond.

TEST BORING REPORT

Boring No. WAP-5I

Project	Vectren FB Culley West Ash Pond, FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling

File No.	42796-004
Sheet No.	1 of 4
Start	02 February 2016
Finish	03 February 2016
Driller	J. Gryska
H&A Rep.	S. Lewis
Elevation	394.4
Datum	NGVD 88
Location	See Plan N 970,233 E 2,881,525

	Casing	Sampler	Barrel
Type	HSA	S	-
Inside Diameter (in.)	4.25	1.375	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

- Rig Make & Model: CME 850 XR
- Bit Type: Cutting Head
- Drill Mud:
- Casing:
- Hoist/Hammer:
- PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0							REFER TO BORING WAP-5D FOR LITHOLOGY -FILL-										
					390.9 3.5	SM	-FILL-										
5																	
10																	
15																	
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID

- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	85
Rock Cored (ft)	-
Samples	26S

Boring No. WAP-5I

Field Tests:
Dilatancy: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. WAP-5I
File No. 42796-004

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																	
					370.9 23.5	CL	-ALLUVIUM-										
25																	
30																	
35																	
					354.9 39.5	SC	-ALLUVIUM-										
40																	
					350.9 43.5	CL	-ALLUVIUM-										
					349.9 44.5	SC	-ALLUVIUM-										
45																	
					345.9 48.5	CL	-ALLUVIUM-										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50																	
					340.9 53.5	SC	-ALLUVIUM-										
55																	
					335.9 58.5	SP- SC	-ALLUVIUM-										
60																	
65																	
70																	
75																	
					315.9 78.5	SW- SC	-ALLUVIUM-										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
80																	
					310.9 83.5	SP- SC	-ALLUVIUM-										
85					309.4 85.0		-BOTTOM OF EXPLORATION 85.0 FT										

H&A-TEST BORING-07-1 HA-LIB09.GLB HA-TB+CORE+WELL-07-1.GDT \\GRN\COMMON\42796 - VECTREN\004\GINT LOGS\42796-004TB_OW_WELL.GPJ 14 Apr 16

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No.
Boring No. **WAP-5I**

Project	Vectren FB Culley West Ash Pond
Location	FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling
Driller	J. Gryska

Initial Water Level (depth bgs) ft

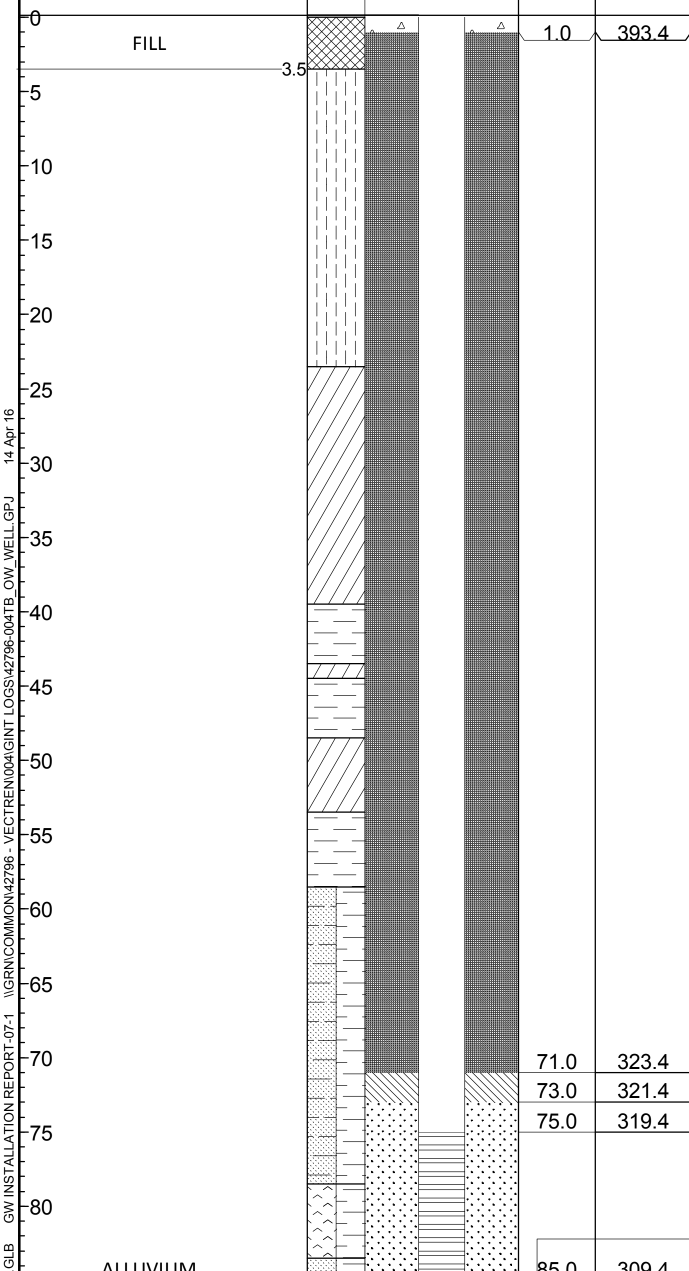
Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No. 42796-004
Date Installed 03 Feb 2016
H&A Rep. S. Lewis
Location N 970232.61
E 2881524.71

Ground El. 394.4
Datum NGVD 88

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)
FILL	0 – 3.5			1.0	393.4
				71.0	323.4
				73.0	321.4
				75.0	319.4
ALLUVIUM	85.0			85.0	309.4



WELL CONSTRUCTION DETAILS

Type of protective cover	Stick-up Guard Pipe
Depth of Steel below ground surface	NA
Depth of top of riser below ground surface	NA
Type of protective casing	Steel
Length	
Inside diameter	4.0 in.
Depth of bottom of Steel	-
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	75.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	1.0	70.0
Bentonite	71.0	2.0
Sand	73.0	12.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	75.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Quartz Sand
Depth to bottom of well screen	85.0 ft
Bottom of silt trap	85.0 ft
Depth of bottom of borehole	85.0 ft

COMMENTS: South side of west ash pond.

TEST BORING REPORT

Boring No. WAP-5

Project	Vectren FB Culley West Ash Pond, FB Culley Generating Station	File No.	42796-004
Client	Southern Indiana Electric Company	Sheet No.	1 of 3
Contractor	Stearns Drilling	Start	03 February 2016
		Finish	03 February 2016
		Driller	J. Gryska
		H&A Rep.	S. Lewis
		Elevation	394.4
		Datum	NGVD 88
		Location	See Plan N 970,236 E 2,881,521

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	-	Rig Make & Model: CME 850 XR
Inside Diameter (in.)	4.25	1.375	-	Bit Type: Cutting Head
Hammer Weight (lb)	-	140	-	Drill Mud:
Hammer Fall (in.)	-	30	-	Casing:
				Hoist/Hammer:
				PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							REFER TO WAP-5D FOR LITHOLOGY -FILL-										
					390.9 3.5	SM	-FILL-										
5																	
10																	
15																	
20																	

Water Level Data						Sample ID	Well Diagram	Summary	
Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water	O - Open End Rod	Riser Pipe	Overburden (ft)	50
						T - Thin Wall Tube	Screen	Rock Cored (ft)	-
						U - Undisturbed Sample	Filter Sand	Samples	26S
						S - Split Spoon Sample	Cuttings		
							Grout	**Boring No.**	**WAP-5**
							Concrete		
							Bentonite Seal		

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH	TEST BORING REPORT	Boring No. WAP-5
		File No. 42796-004
		Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																	
					370.9 23.5	CL	-ALLUVIUM-										
25																	
30																	
35																	
					354.9 39.5	SC	-ALLUVIUM-										
40																	
					350.9 43.5	CL	-ALLUVIUM-										
					349.9 44.5	SC	-ALLUVIUM-										
45																	
					345.9 48.5	CL	-ALLUVIUM-										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. WAP-5

TEST BORING REPORT

HALEY ALDRICH

Boring No. WAP-5
File No. 42796-004
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50					344.4 50.0		BOTTOM OF EXPLORATION 50.0										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. WAP-5

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

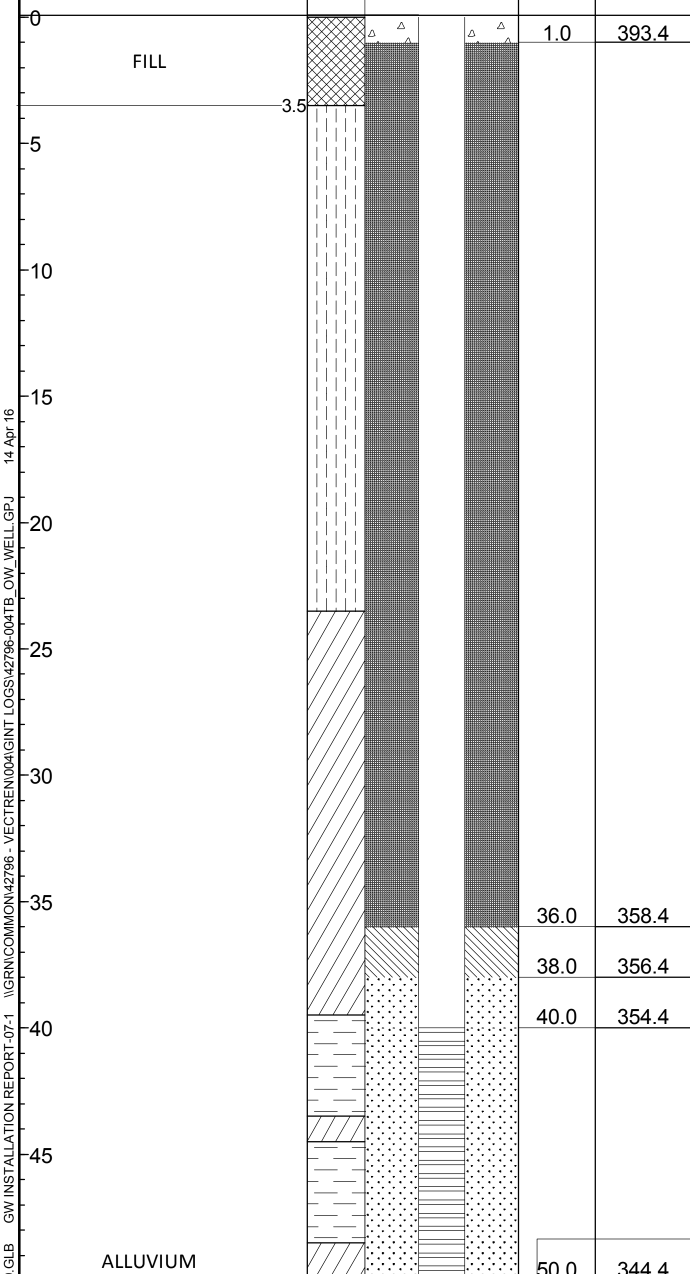
Well No.
Boring No. WAP-5

Project	Vectren FB Culley West Ash Pond
Location	FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling
Driller	J. Gryska
Initial Water Level (depth bgs)	ft

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No.	42796-004
Date Installed	03 Feb 2016
H&A Rep.	S. Lewis
Location	N 970235.87 E 2881521.35
Ground El.	394.4
Datum	NGVD 88

SOIL/ROCK CONDITIONS	DEPTH (ft.)	WELL DEPTH (ft.)	ELEVATION (ft.)
FILL	0 – 3.5	1.0	393.4
		36.0	358.4
		38.0	356.4
		40.0	354.4
ALLUVIUM	50.0	50.0	344.4



WELL CONSTRUCTION DETAILS

Type of protective cover	Stick-up Guard Pipe
Height of Steel above ground surface	NA
Depth of top of riser below ground surface	NA
Type of protective casing	Steel
Length	
Inside diameter	4.0 in.
Depth of bottom of Steel	-
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	40.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	1.0	35.0
Bentonite	36.0	2.0
Sand	38.0	12.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	40.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Quartz Sand
Depth to bottom of well screen	50.0 ft
Bottom of silt trap	50.0 ft
Depth of bottom of borehole	50.0 ft

COMMENTS: South side of west ash pond.

TEST BORING REPORT

Boring No. CCR-AP-7

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station	File No.	42796-001
Client	Southern Indiana Gas & Electric Company	Sheet No.	1 of 2
Contractor	Stearns Drilling	Start	09 March 2016
		Finish	09 March 2016
		Driller	J. Gryska
		H&A Rep.	S. Lewis

	Casing	Sampler	Barrel
Type	-	S	-
Inside Diameter (in.)	-	1 3/8	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures
Rig Make & Model: CME 850 XR Air Track
Bit Type:
Drill Mud: None
Casing: Auger
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model:

Elevation 429.5 (est.)
Datum
Location
N 970,775
E 2,883,090

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0						ML	Brown SILT (ML), trace coarse gravel -FILL-	-	-	-	-	-	-	-	-	-	-
	1 1 2 3	S1 16/24	3.0 5.0			ML	Soft brown SILT with sand (ML), no odor, moist, mottle with gray and red colors	-	-	-	-	15	85	-	-	-	-
5																	
	2 2 2 7	S2 17/24	8.0 10.0		421.5 8.0	ML	Very stiff olive brown SILT (ML), mps 2.0 mm, no odor, dry, wood fragments present -ALLUVIUM-	-	-	-	-	15	85	-	-	-	-
10																	
	1 2 3 2	S3 19/24	13.0 15.0			ML	Medium stiff gray SILT with sand (CL), no odor, moist, wood fragments present	-	-	-	-	15	85	-	-	-	-
15																	
	1 2 3 3	S4 20/24	18.0 20.0			ML	Medium stiff gray SILT with sand (ML), no odor, wet	-	-	-	-	15	85	-	-	-	-
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 35.0
Rock Cored (ft) -
Samples 5S

Boring No. CCR-AP-7

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																	
	1 1 2 1	S5 24/24	23.0 25.0			ML	Soft gray sandy SILT (ML), no odor, wet	-	-	-	-	30	70	-	-	-	-
25																	
	1 1 1 2	S6 24/24	28.0 30.0			CL	Soft gray lean CLAY (CL), no odor, wet, mottled with black colors, possibly organic matter	-	-	-	-	10	90	-	-	-	-
30																	
	1 2 3 3	S7 24/24	33.0 35.0			CL	Medium stiff gray lean CLAY (CL), no odor, wet	-	-	-	-	10	90	-	-	-	-
35					394.5 35.0		BOTTOM OF EXPLORATION 35.5 FT Notes: Well set at 30.0 ft. 35.0 ft o 34.0 ft backfilled with bedtonite. 30.0 ft to 34.0 ft backfilled with sand.										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No.
Boring No. CCR-AP-7

Project	CCR Hydrogeologic Characterization
Location	F.B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	Stearns Drilling
Driller	J. Gryska

Initial Water Level (depth bgs) ft

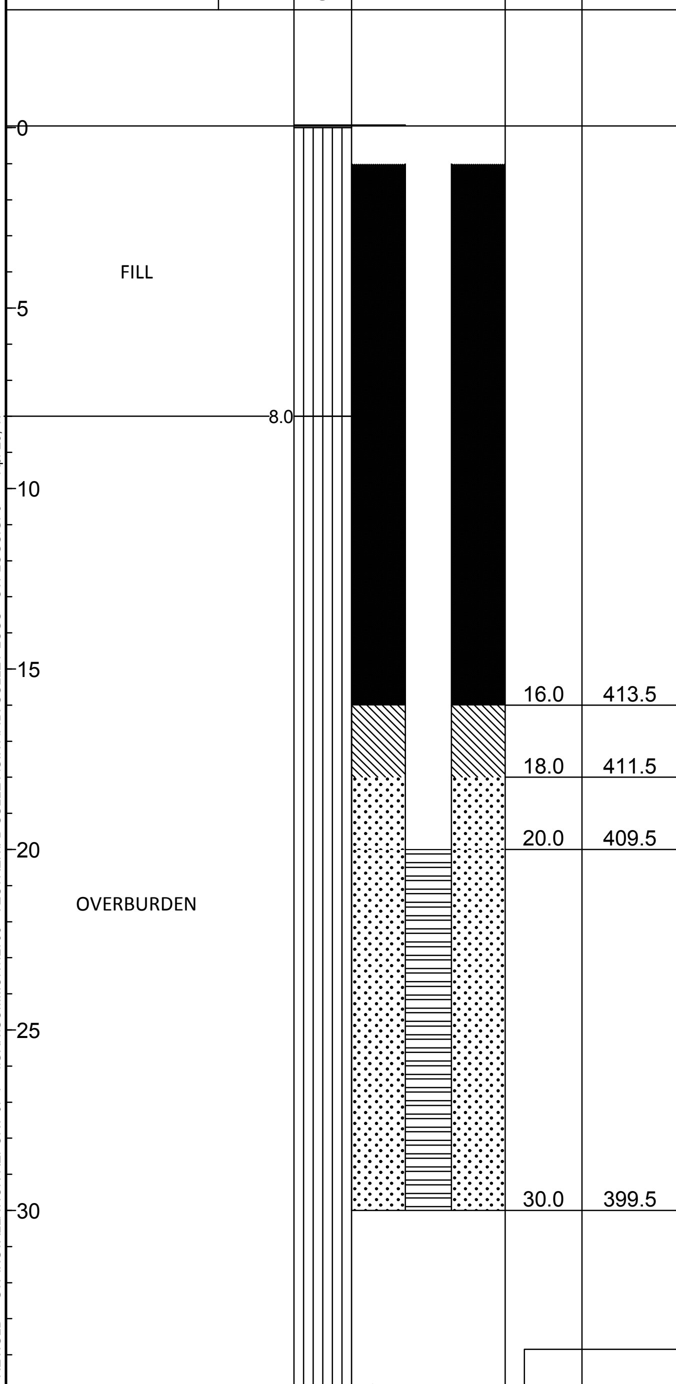
Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No. 42796-001
Date Installed 09 Mar 2016
H&A Rep. S. Lewis
Location N 970774.64
E 2883090.34

Ground El. 429.5 (est.)
Datum

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)



WELL CONSTRUCTION DETAILS

Type of protective cover	Stick Up Guard Pipe
Depth of Steel below ground surface	0.0 ft
Depth of top of riser below ground surface	NA
Type of protective casing	Steel
Length	5.0 ft
Inside diameter	4.0 in.
Depth of bottom of Steel	5.0 ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	19.7 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	1.0	25.0
Bentonite	26.0	2.0
Sand	28.0	12.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	19.7 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of backfill around screen	Quartz Sand
Depth to bottom of well screen	29.7 ft
Bottom of silt trap	30.0 ft
Depth of bottom of borehole	35.0 ft

COMMENTS:

APPENDIX C

Hydraulic Conductivity Results

HALEY ALDRICH

Client:	AECOM		
Project Name:	Vectren Culley West		
Project Location:	---		
GTX #:	306945		
Start Date:	9/12/2017	Tested By:	eec
End Date:	9/15/2017	Checked By:	emm
Boring #:	B-17-01		
Sample #:	ST-2		
Depth:	54-56 ft		
Visual Description:	Wet, dark brown clayey sand		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084
Constant Volume

Sample Type: Intact | Permeant Fluid: De-aired Distilled water

Orientation: Vertical | Cell #: 1/9

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content. Trimmings moisture content = 38.1%.

Assumed Specific Gravity: 2.50

Parameter	Initial	Final
Height, in	2.80	2.83
Diameter, in	2.74	2.74
Area, in^2	5.90	5.90
Volume, in^3	16.5	16.7
Mass, g	477.0	473.4
Bulk Density, pcf	109.8	107.8
Moisture Content, %	38.6	37.6
Dry Density, pcf	79.2	78.4
Degree of Saturation, %	100	95

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	90.02	Increased Cell Pressure, psi:	95.01	Cell Pressure Increment, psi:	4.99
Sample Pressure, psi:	76.19	Corresponding Sample Pressure, psi:	81.02	Sample Pressure Increment, psi:	4.82
				B Coefficient:	0.97

FLOW DATA

Date	Trial #	Pressure, psi Cell	Pressure, psi Sample	Manometer Readings Z_1	Manometer Readings Z_2	Manometer Readings Z_1-Z_2	Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
9/13	1	90.0	76.2	12.0	11.9	0.1	48	21.0	8.2E-08	19.5	1.013	8.3E-08
9/13	2	90.0	76.2	12.0	11.9	0.1	54	21.0	7.3E-08	19.5	1.013	7.4E-08
9/13	3	90.0	76.2	12.0	11.9	0.1	53	21.0	7.4E-08	19.5	1.013	7.5E-08
9/13	4	90.0	76.2	12.0	11.9	0.1	55	21.0	7.2E-08	19.5	1.013	7.3E-08

PERMEABILITY AT 20° C: 7.6 x 10^{-8} cm/sec (@ 14 psi effective stress)

Client:	AECOM		
Project Name:	Vectren Culley West		
Project Location:	---		
GTX #:	306945		
Start Date:	9/12/2017	Tested By:	eec
End Date:	9/15/2017	Checked By:	emm
Boring #:	B-17-09		
Sample #:	ST-2		
Depth:	23-25 ft		
Visual Description:	Moist, grayish brown silt		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084
Constant Volume

Sample Type: Intact
Orientation: Vertical
Permeant Fluid: De-aired Distilled water
Cell #: X

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content. Trimmings moisture content = 39.0%.

Assumed Specific Gravity: 2.65

Parameter	Initial	Final
Height, in	3.35	3.32
Diameter, in	2.70	2.75
Area, in^2	5.73	5.94
Volume, in^3	19.2	19.7
Mass, g	597.3	606.2
Bulk Density, pcf	118.4	116.9
Moisture Content, %	30.8	32.8
Dry Density, pcf	90.5	88.0
Degree of Saturation, %	99	99

B COEFFICIENT DETERMINATION

Cell Pressure, psi: 90.13
Sample Pressure, psi: 80.10
Increased Cell Pressure, psi: 95.02
Corresponding Sample Pressure, psi: 84.97
Cell Pressure Increment, psi: 4.90
Sample Pressure Increment, psi: 4.87
B Coefficient: 0.99

FLOW DATA

Date	Trial #	Pressure, psi		Manometer Readings			Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
		Cell	Sample	Z_1	Z_2	Z_1-Z_2						
9/13	1	90.1	80.1	9.5	9.4	0.1	38	14.2	1.5E-07	19.5	1.013	1.5E-07
9/13	2	90.1	80.1	9.5	9.4	0.1	41	14.2	1.4E-07	19.5	1.013	1.4E-07
9/13	3	90.1	80.1	9.5	9.4	0.1	40	14.2	1.5E-07	19.5	1.013	1.5E-07
9/13	4	90.1	80.1	9.5	9.4	0.1	44	14.2	1.3E-07	19.5	1.013	1.3E-07

PERMEABILITY AT 20° C: 1.2×10^{-7} cm/sec (@ 10 psi effective stress)

Client:	AECOM		
Project Name:	Vectren Culley West		
Project Location:	---		
GTX #:	306945		
Start Date:	9/12/2017	Tested By:	eec
End Date:	9/14/2017	Checked By:	emm
Boring #:	B-17-09		
Sample #:	ST-3		
Depth:	38-40 ft		
Visual Description:	Moist, dark gray clay		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084
Constant Volume

Sample Type: Intact
Permeant Fluid: De-aired Distilled water
Orientation: Vertical
Cell #: 19/3

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content. Trimmings moisture content = 32.7%.

Assumed Specific Gravity: 2.75

Parameter	Initial	Final
Height, in	3.57	3.50
Diameter, in	2.79	2.68
Area, in^2	6.11	5.64
Volume, in^3	21.8	19.7
Mass, g	678.3	654.0
Bulk Density, pcf	118.1	125.9
Moisture Content, %	30.2	25.5
Dry Density, pcf	90.7	100.3
Degree of Saturation, %	93	99

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	90.00	Increased Cell Pressure, psi:	95.02	Cell Pressure Increment, psi:	5.02
Sample Pressure, psi:	78.00	Corresponding Sample Pressure, psi:	82.99	Sample Pressure Increment, psi:	4.99
				B Coefficient:	0.99

FLOW DATA

Date	Trial #	Pressure, psi		Manometer Readings			Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
		Cell	Sample	Z_1	Z_2	Z_1-Z_2						
9/13	1	90.0	78.0	14.0	13.8	0.2	40	19.8	2.2E-07	19.5	1.013	2.2E-07
9/13	2	90.0	78.0	14.0	13.8	0.2	42	19.8	2.1E-07	19.5	1.013	2.1E-07
9/13	3	90.0	78.0	14.0	13.8	0.2	41	19.8	2.1E-07	19.5	1.013	2.2E-07
9/13	4	90.0	78.0	14.0	13.8	0.2	40	19.8	2.2E-07	19.5	1.013	2.2E-07

PERMEABILITY AT 20° C: 2.2×10^{-7} cm/sec (@ 12 psi effective stress)

Client:	AECOM		
Project Name:	Vectren Culley West		
Project Location:	---		
GTX #:	306945		
Start Date:	9/12/2017	Tested By:	eec
End Date:	9/14/2017	Checked By:	emm
Boring #:	B-17-12		
Sample #:	ST-1		
Depth:	13-15 ft		
Visual Description:	Moist, grayish brown silt		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084

Constant Volume

Sample Type: Intact　　Permeant Fluid: De-aired Distilled water

Orientation: Vertical　　Cell #: ---

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content. Trimmings moisture content = 26.8%.

Assumed Specific Gravity: 2.75

Parameter	Initial	Final
Height, in	2.55	2.42
Diameter, in	2.70	2.81
Area, in^2	5.73	6.20
Volume, in^3	14.6	15.0
Mass, g	504.5	512.4
Bulk Density, pcf	131.4	129.8
Moisture Content, %	20.7	22.6
Dry Density, pcf	108.8	105.9
Degree of Saturation, %	99	100

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	90.00	Increased Cell Pressure, psi:	95.02	Cell Pressure Increment, psi:	5.02
Sample Pressure, psi:	84.01	Corresponding Sample Pressure, psi:	88.97	Sample Pressure Increment, psi:	4.96
				B Coefficient:	0.99

FLOW DATA

Date	Trial #	Pressure, psi		Manometer Readings			Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
		Cell	Sample	Z_1	Z_2	Z_1-Z_2						
9/13	1	90.0	84.0	11.0	9.0	2.0	38	22.5	2.0E-06	19.5	1.013	2.1E-06
9/13	2	90.0	84.0	11.0	9.0	2.0	41	22.5	1.9E-06	19.5	1.013	1.9E-06
9/13	3	90.0	84.0	11.0	9.0	2.0	44	22.5	1.8E-06	19.5	1.013	1.8E-06
9/13	4	90.0	84.0	11.0	9.0	2.0	42	22.5	1.8E-06	19.5	1.013	1.9E-06

PERMEABILITY AT 20° C: 1.9×10^{-6} cm/sec (@ 6 psi effective stress)

Client:	AECOM		
Project Name:	Vectren Culley West		
Project Location:	---		
GTX #:	306945		
Start Date:	9/12/2017	Tested By:	eec
End Date:	9/15/2017	Checked By:	emm
Boring #:	B-17-11		
Sample #:	ST-1		
Depth:	13-15 ft.		
Visual Description:	Moist, dark gray silt		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084

Constant Volume

Sample Type: Intact | Permeant Fluid: De-aired Distilled water

Orientation: Vertical | Cell #: Y

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content. Trimmings moisture content = 45.7%.

Assumed Specific Gravity: 2.50

Parameter	Initial	Final
Height, in	2.28	2.15
Diameter, in	2.78	2.78
Area, in^2	6.07	6.07
Volume, in^3	13.8	13.1
Mass, g	368	365
Bulk Density, pcf	101	106
Moisture Content, %	43.1	41.7
Dry Density, pcf	70.7	75.0
Degree of Saturation, %	89	96

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	90.00	Increased Cell Pressure, psi:	95.01	Cell Pressure Increment, psi:	5.01
Sample Pressure, psi:	84.00	Corresponding Sample Pressure, psi:	88.99	Sample Pressure Increment, psi:	4.98
				B Coefficient:	0.99

FLOW DATA

Date	Trial #	Pressure, psi		Manometer Readings			Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
		Cell	Sample	Z_1	Z_2	Z_1-Z_2						
9/14	1	90.0	84.0	14.0	3.5	10.5	31	32.3	1.6E-05	19.5	1.013	1.7E-05
9/14	2	90.0	84.0	14.0	3.5	10.5	36	32.3	1.4E-05	19.5	1.013	1.4E-05
9/14	3	90.0	84.0	14.0	3.5	10.5	34	32.3	1.5E-05	19.5	1.013	1.5E-05
9/14	4	90.0	84.0	14.0	3.5	10.5	35	32.3	1.4E-05	19.5	1.013	1.5E-05

PERMEABILITY AT 20° C: 1.5×10^{-5} cm/sec (@ 6 psi effective stress)

Client:	AECOM		
Project Name:	Vectren Culley West		
Project Location:	---		
GTX #:	306945		
Start Date:	9/12/2017	Tested By:	eec
End Date:	9/14/2017	Checked By:	emm
Boring #:	B-17-12		
Sample #:	ST-2		
Depth:	28-30 ft		
Visual Description:	Moist, grayish brown clay		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D5084

Constant Volume

Sample Type: Intact
Orientation: Vertical
Permeant Fluid: De-aired Distilled water
Cell #: ---

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content. Trimmings moisture content = 20.2%.

Assumed Specific Gravity: 2.70

Parameter	Initial	Final
Height, in	3.22	3.22
Diameter, in	2.80	2.79
Area, in^2	6.16	6.11
Volume, in^3	19.8	19.7
Mass, g	668.4	669.9
Bulk Density, pcf	128.2	129.4
Moisture Content, %	19.8	20.0
Dry Density, pcf	107.0	107.8
Degree of Saturation, %	93	96

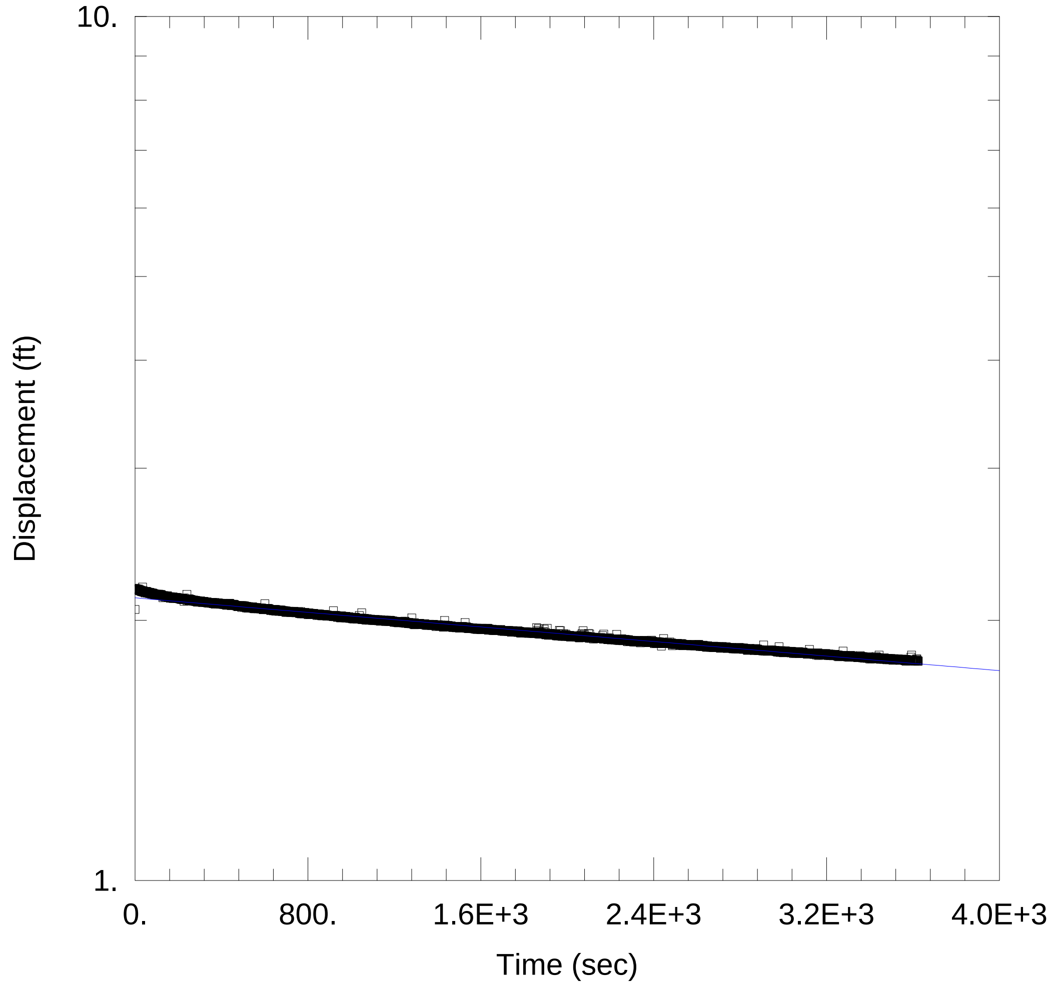
B COEFFICIENT DETERMINATION

Cell Pressure, psi: 90.00
Sample Pressure, psi: 78.01
Increased Cell Pressure, psi: 95.02
Corresponding Sample Pressure, psi: 82.98
Cell Pressure Increment, psi: 5.02
Sample Pressure Increment, psi: 4.97
B Coefficient: 0.99

FLOW DATA

Date	Trial #	Pressure, psi Cell	Pressure, psi Sample	Manometer Readings Z_1	Manometer Readings Z_2	Manometer Readings Z_1-Z_2	Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
9/13	1	90.0	78.0	12.0	11.8	0.2	50	18.5	1.7E-07	19.5	1.013	1.8E-07
9/13	2	90.0	78.0	12.0	11.8	0.2	51	18.5	1.7E-07	19.5	1.013	1.7E-07
9/13	3	90.0	78.0	12.0	11.8	0.2	49	18.5	1.8E-07	19.5	1.013	1.8E-07
9/13	4	90.0	78.0	12.0	11.8	0.2	54	18.5	1.6E-07	19.5	1.013	1.6E-07

PERMEABILITY AT 20° C: 1.7×10^{-7} cm/sec (@ 12 psi effective stress)



WELL TEST ANALYSIS

Data Set: C:\Users\tdennison\Desktop\Vectren Text Files\WAP-1 Slug In.aqt
Date: 02/02/18 Time: 12:50:30

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Southern Indiana Electric
Project: 139420-007
Location: FB Culley
Test Well: WAP-1
Test Date: 1/23/18

AQUIFER DATA

Saturated Thickness: 22.58 ft Anisotropy Ratio (Kz/Kr): 1.

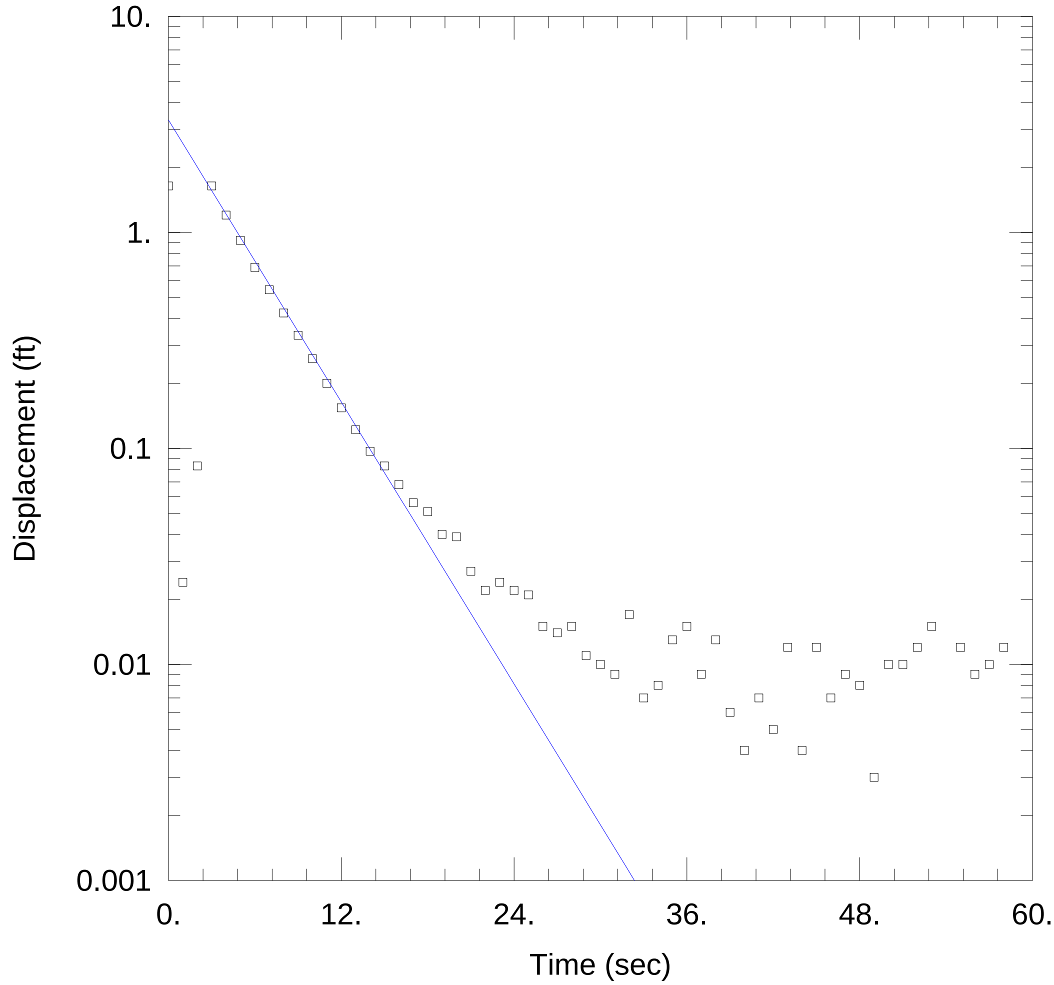
WELL DATA (New Well)

Initial Displacement: 2.059 ft Static Water Column Height: 22.58 ft
Total Well Penetration Depth: 22.58 ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 1.559E-6 cm/sec y0 = 2.124 ft



WELL TEST ANALYSIS

Data Set: C:\Users\tdennison\Desktop\Vectren Text Files\WAP-2R Slug Out.aqt
Date: 02/02/18 Time: 12:48:36

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Southern Indiana Electric
Project: 139420-007
Location: FB Culley
Test Well: WAP-2R
Test Date: 1/24/18

AQUIFER DATA

Saturated Thickness: 17. ft Anisotropy Ratio (Kz/Kr): 1.

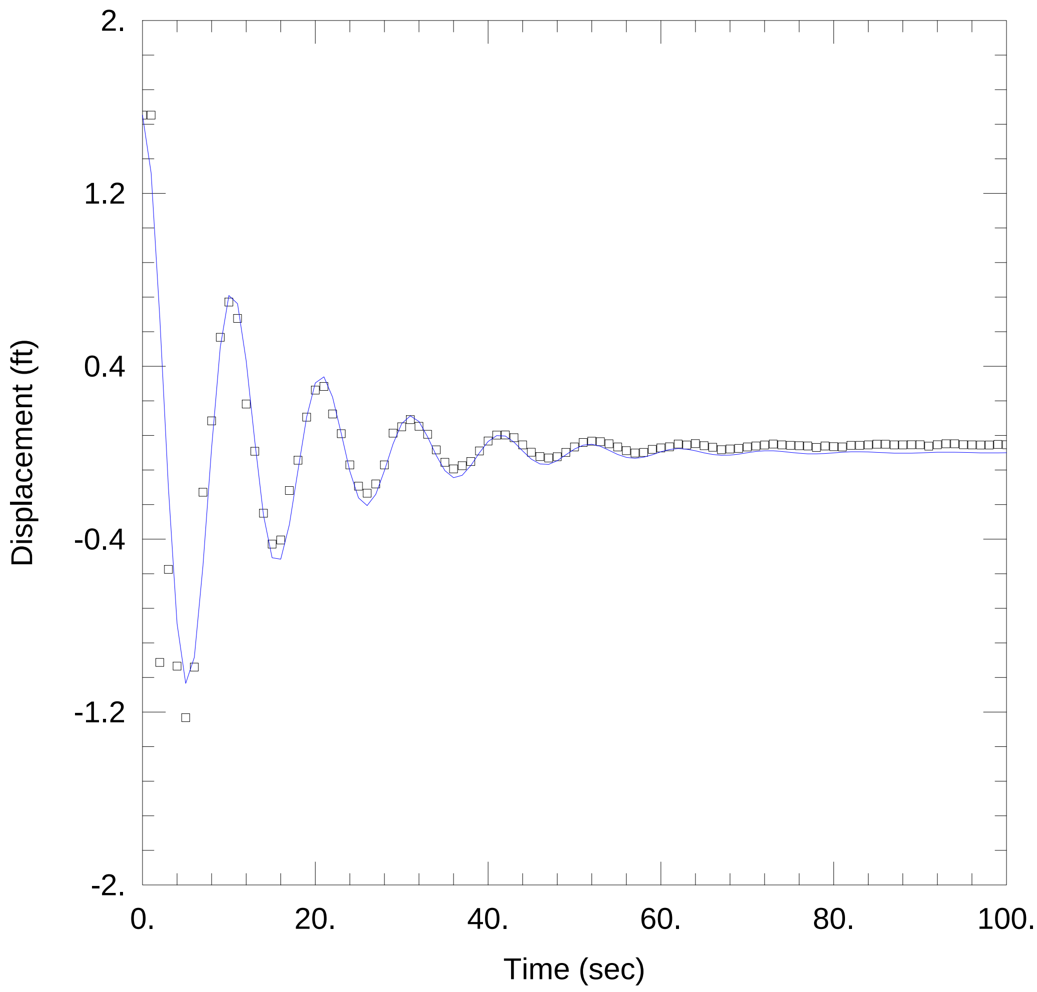
WELL DATA (New Well)

Initial Displacement: 1.642 ft Static Water Column Height: 17.58 ft
Total Well Penetration Depth: 17.58 ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.33 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.007689 cm/sec y0 = 3.313 ft



WELL TEST ANALYSIS

Data Set: \...\WAP-5D slug in 2.aqt
Date: 02/13/18 Time: 13:35:27

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Southern Indiana Electric
Project: 139420-007
Location: FB Culley
Test Well: WAP-5D
Test Date: 1/24/18

AQUIFER DATA

Saturated Thickness: 69.5 ft
Anisotropy Ratio (Kz/Kr): 1.

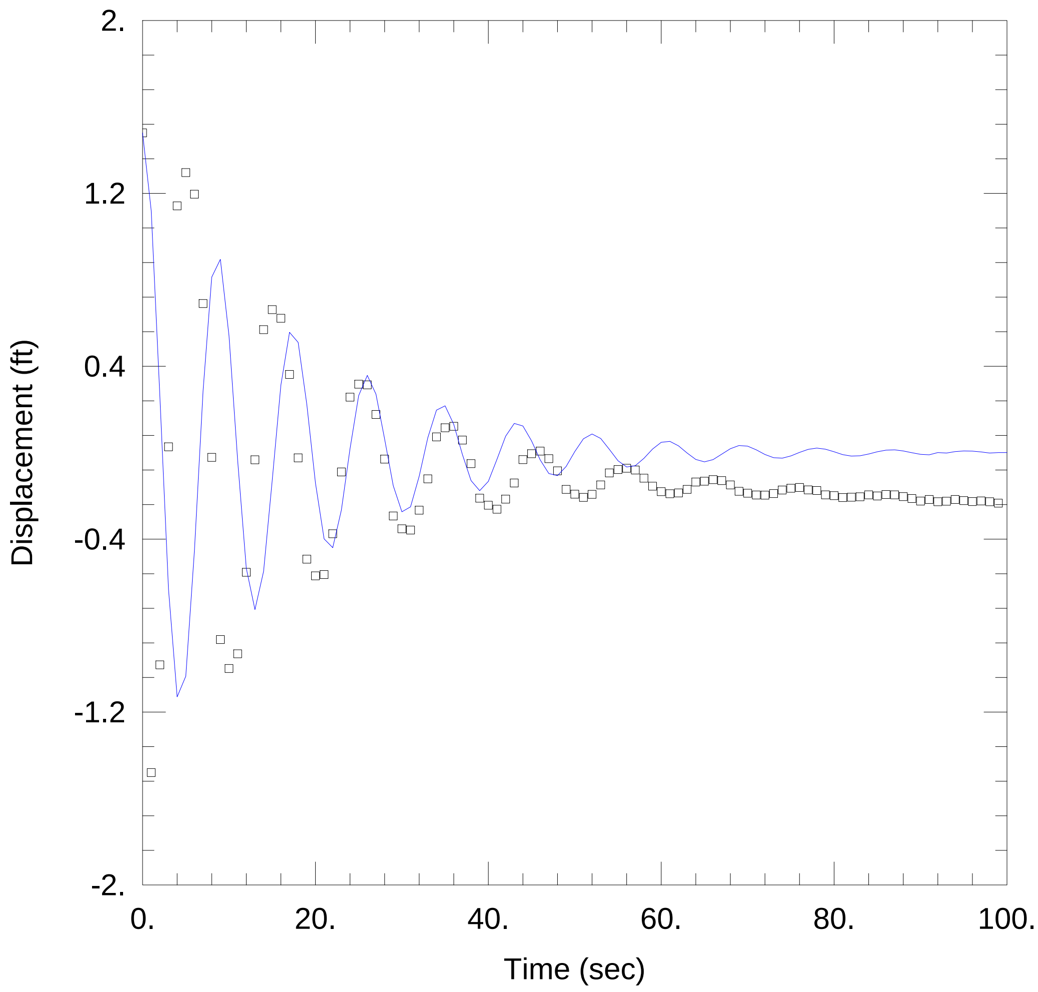
WELL DATA (New Well)

Initial Displacement: 1.562 ft
Total Well Penetration Depth: 69.5 ft
Casing Radius: 0.083 ft
Static Water Column Height: 84.75 ft
Screen Length: 10. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler-Zhan

Kr = 0.1119 cm/sec
Kz/Kr = 1.
Le(o) = 1. ft
Ss = 1.439E-6 ft^{-1}
Le = 86.84 ft



WELL TEST ANALYSIS

Data Set: \...\WAP-5D slug out 2.aqt
Date: 02/13/18 Time: 13:34:07

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Southern Indiana Electric
Project: 139420-007
Location: FB Culley
Test Well: WAP-5I
Test Date: 1/24/18

AQUIFER DATA

Saturated Thickness: 69.5 ft Anisotropy Ratio (Kz/Kr): 1.

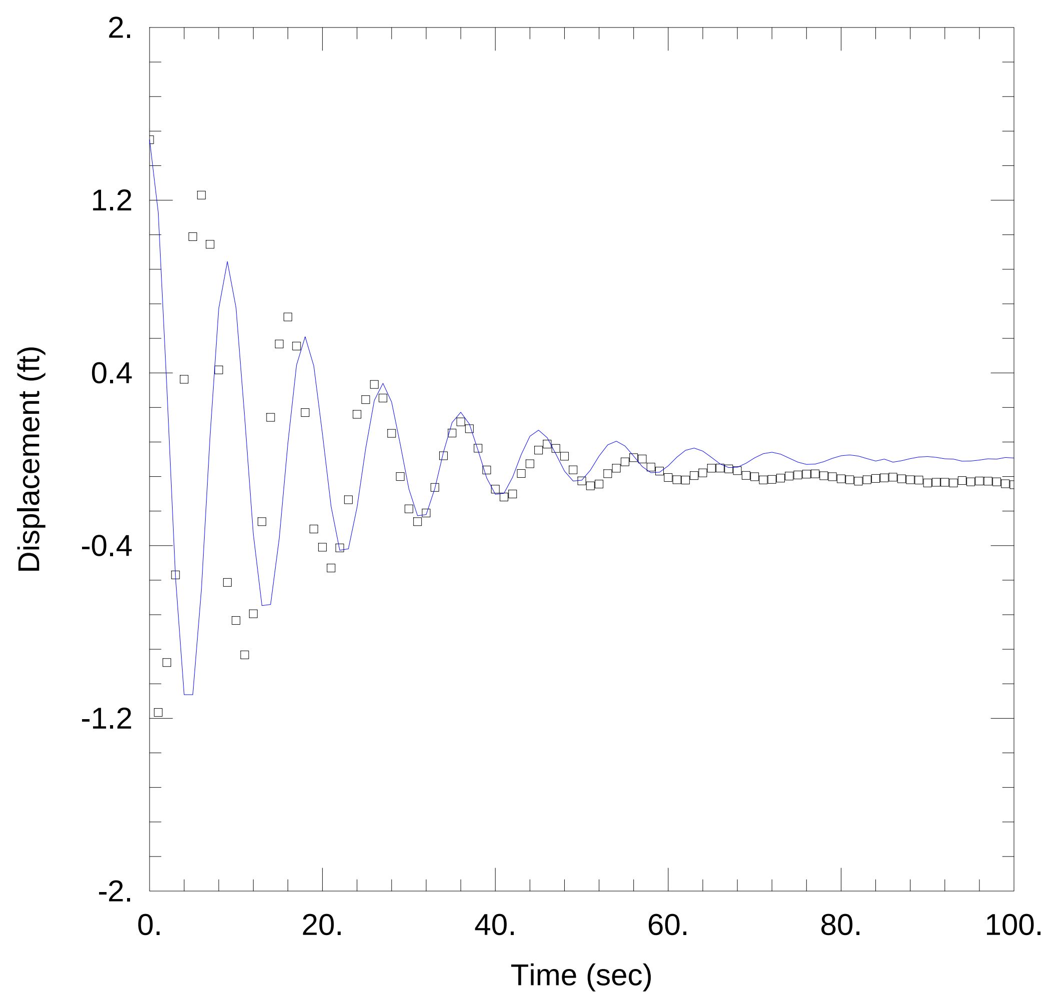
WELL DATA (New Well)

Initial Displacement: 1.48 ft
Total Well Penetration Depth: 69.5 ft
Casing Radius: 0.083 ft
Static Water Column Height: 84.79 ft
Screen Length: 10. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler-Zhan

Kr = 0.2291 cm/sec
Kz/Kr = 1.
Le(o) = 1. ft
Ss = 1.439E-6 ft^{-1}
Le = 61.13 ft



WELL TEST ANALYSIS

Data Set: \...\WAP-5D slug out 3.aqt
Date: 02/13/18 Time: 13:28:52

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Southern Indiana Electric
Project: 139420-007
Location: FB Culley
Test Well: WAP-5D
Test Date: 1/24/18

AQUIFER DATA

Saturated Thickness: 69.5 ft
Anisotropy Ratio (Kz/Kr): 1.

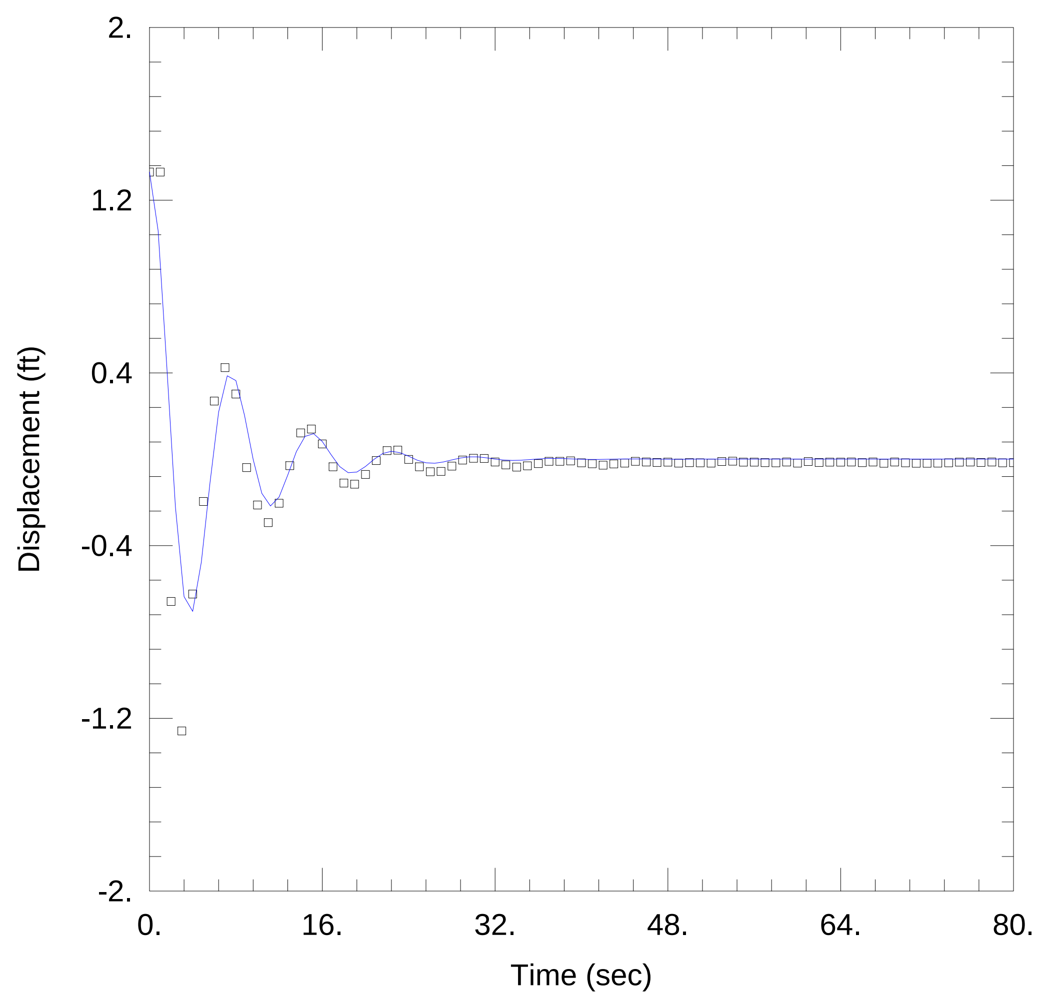
WELL DATA (New Well)

Initial Displacement: 1.48 ft
Total Well Penetration Depth: 69.5 ft
Casing Radius: 0.083 ft
Static Water Column Height: 83.68 ft
Screen Length: 10. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler-Zhan

Kr = 0.2153 cm/sec
Kz/Kr = 1.
Le(o) = 1. ft
Ss = 1.439E-6 ft^{-1}
Le = 65.71 ft



WELL TEST ANALYSIS

Data Set: \...\WAP-5I slug in 2.aqt
Date: 02/13/18 Time: 13:26:59

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Southern Indiana Electric
Project: 139420-007
Location: FB Culley
Test Well: WAP-5I
Test Date: 1/24/18

AQUIFER DATA

Saturated Thickness: 69.5 ft
Anisotropy Ratio (Kz/Kr): 1.

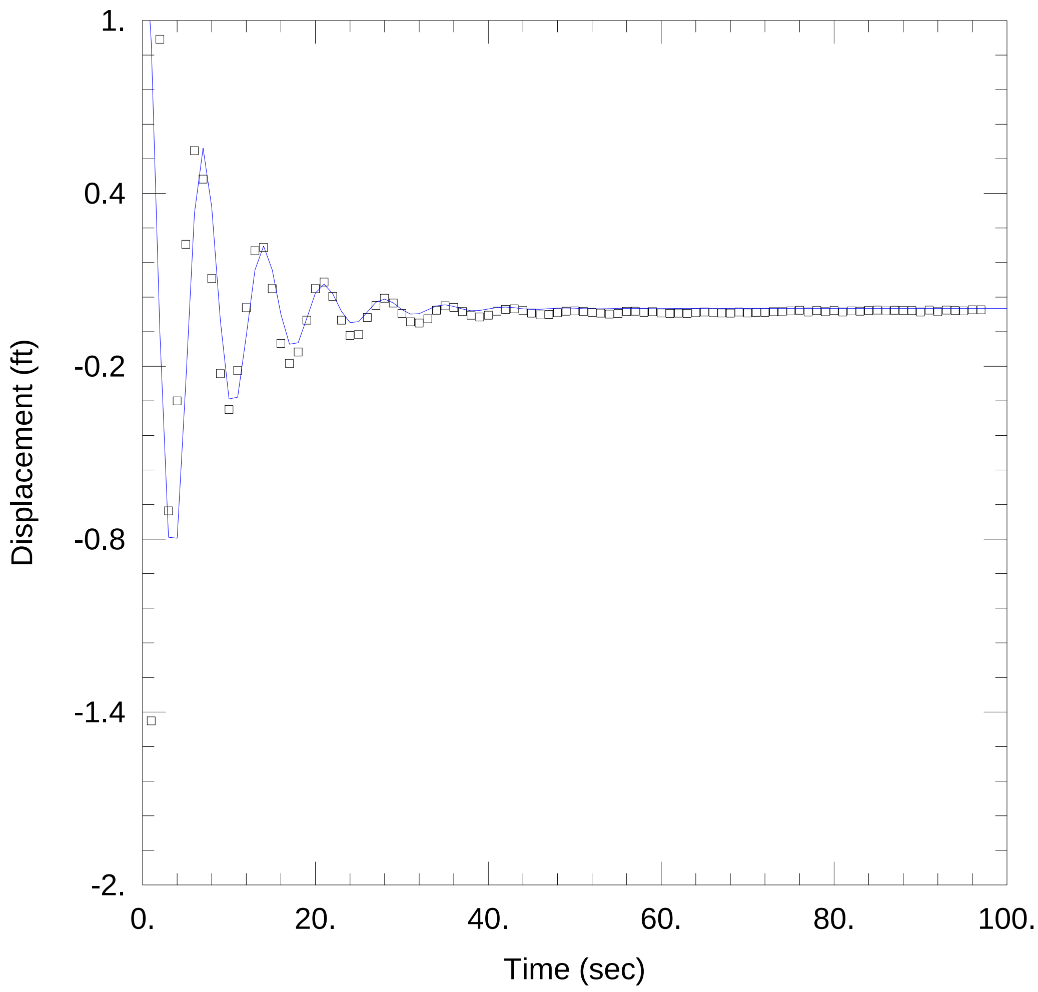
WELL DATA (New Well)

Initial Displacement: 1.33 ft
Static Water Column Height: 83.97 ft
Total Well Penetration Depth: 31.5 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler-Zhan

Kr = 0.08001 cm/sec
Ss = 1.439E-6 ft^{-1}
Kz/Kr = 1.
Le = 44.75 ft
Le(o) = 1. ft



WELL TEST ANALYSIS

Data Set: \...\WAP-5I slug out 1.aqt
Date: 02/13/18 Time: 13:24:21

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Southern Indiana Electric
Project: 139420-007
Location: FB Culley
Test Well: WAP-5I
Test Date: 1/24/18

AQUIFER DATA

Saturated Thickness: 69.5 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 1.431 ft
Total Well Penetration Depth: 31.5 ft
Casing Radius: 0.083 ft
Static Water Column Height: 45.91 ft
Screen Length: 10. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler-Zhan

Kr = 0.1057 cm/sec
Kz/Kr = 1.
Le(o) = 1. ft
Ss = 1.439E-6 ft^{-1}
Le = 39.25 ft

Appendix B
Annual Groundwater Monitoring and Corrective Action Reports

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REPORT ON

2019 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT F.B. CULLEY GENERATING STATION WEST ASH POND WARRICK COUNTY, INDIANA

by Haley & Aldrich, Inc.
Greenville, South Carolina

for Southern Indiana Gas and Electric Company (SIGECO)
Evansville, Indiana

File No. 129420-013
August 2019

Annual Groundwater Monitoring Report Summary

Haley & Aldrich, Inc. (Haley & Aldrich) has prepared this 2019 Annual Groundwater Monitoring Corrective Action Report for the F.B. Culley Generating Station (FBC). This 2019 Annual Report was developed to comply with the United States Environmental Protection Agency (USEPA) Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals (CCR) from Electric Utilities, 40 CFR Part 257, Subpart D dated 17 April 2015 (Rule), specifically subsection §257.90(e)(1) through (5). Southern Indiana Gas and Electric Company (SIGECO) operates the existing coal combustion residuals (CCR) management unit referred to as the West Ash Pond (WAP) at FBC located in Warrick County, Indiana.

The West Ash Pond was previously classified as an inactive surface impoundment as defined by 40 CFR §257.53. SIGECO filed a Notice of Intent (NOI) to initiate closure of the West Ash Pond and placed the NOI in the facility's operating record on December 17, 2015. The WAP is currently in the closure process. However, on 5 August 2016, the EPA issued a "Direct Final Rule" effective on 4 October 2016, constituting a vacatur of 40 CFR §257.100. The Direct Final Rule applies the requirements of existing surface impoundments that had been previously declared inactive. As a result, owners and operators of inactive CCR surface impoundments must comply with the groundwater monitoring requirements for existing CCR surface impoundments. The CCR Rule changes extended the deadlines to comply with the groundwater monitoring requirements with the initial eight-rounds of groundwater sampling to be completed by 17 April 2019. In addition, this annual report must be completed by 1 August 2019 and annually thereafter.

This annual report addresses the WAP at FBC, as described in the Groundwater Monitoring Program report, which was submitted to the Indiana Department of Environmental Management (IDEM) in April 2018 as part of the Closure Plan application. The submittal of the Closure Plan application and the corresponding IDEM Virtual File Cabinet document number was posted to the facility's website. The Groundwater Monitoring Program was updated in April 2019 as part of the modified Closure Plan application that was submitted to IDEM as part of the company's response to IDEM's Request for Additional Information. The Groundwater Monitoring System Certification page was placed in the facility's operating record on 19 April 2019 as required by the Direct Final Rule and §257.105(h)(3) and posted on the facility's website on 17 May 2019 as required by §257.107(h)(2).

To report on the activities conducted at the WAP and document compliance with the Rule, the specific requirements listed in §257.90(e)(1) through (5) are provided below in bold/italic type followed by a short narrative addressing how that specific requirement was met.

§257.90 APPLICABILITY

§257.100(e)(5)(ii) No later than August 1, 2019, prepare the initial groundwater monitoring and corrective action report as set forth in §257.90(e).

§257.90(e) Annual groundwater monitoring and corrective action report. For existing CCR landfills and existing CCR surface impoundments, no later than January 31, 2018, and annually thereafter, the owner or operator must prepare an annual groundwater monitoring and corrective action report. For new CCR landfills, new CCR surface impoundments, and all lateral expansions of CCR units, the owner

or operator must prepare the initial annual groundwater monitoring and corrective action report no later than January 31 of the year following the calendar year a groundwater monitoring system has been established for such CCR unit as required by this subpart, and annually thereafter. For the preceding calendar year, the annual report must document the status of the groundwater monitoring and corrective action program for the CCR unit, summarize key actions completed, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year. For purposes of this section, the owner or operator has prepared the annual report when the report is placed in the facility's operating record as required by §257.105(h)(1).

As outlined in the Groundwater Monitoring Program Plan and required by §257.100(e)(5)(ii), this Annual Report is to be completed to later than 1 August 2019 due to the partial vacatur ordered by the DC Circuit Court on 14 June 2016 and the subsequent Direct Final Rule effective 4 October 2016. As required, this annual report documents the status of the groundwater monitoring program for the WAP at FBC and summarizes key actions completed through 15 July 2019.

At a minimum, the annual groundwater monitoring and corrective action report must contain the following information, to the extent available:

§257.90(e)(1) AERIAL IMAGE OF GROUNDWATER MONITORING PROGRAM

§257.90(e)(1) A map, aerial image, or diagram showing the CCR unit and all background (or upgradient) and downgradient monitoring wells, to include the well identification numbers, that are part of the groundwater monitoring program for the CCR unit;

As required by §257.90(e)(1), a map showing the location of the WAP and associated upgradient and downgradient monitoring wells is included in this report as Figure 1. In addition, this information is presented in the Groundwater Monitoring Program Plan prepared for the WAP at FBC, which was placed in the facility's operating record as required by §257.105(h)(2) and included in the Closure Plan application submitted to IDEM and identified on the facility's website.

§257.90(e)(2) ADJUSTMENTS TO GROUNDWATER MONITORING PROGRAM

§257.90(e)(2) Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a narrative description of why those actions were taken;

To comply with the requirements of §257.91, a groundwater monitoring network comprised of six (6) monitoring wells was installed for the WAP at FBC. As described in the Groundwater Monitoring Program Plan, CCR-AP-7 which was originally installed as part of the East Ash Pond groundwater monitoring network was added to the groundwater monitoring network at the WAP. CCR-AP-7 was added to the monitoring well network to provide an additional dataset of background concentrations that are not affected by the CCR unit. Details of the design, and construction of the monitoring wells are summarized in Table 1. Updating the site conceptual model to reflect current conditions revealed that lowering the water level in the WAP in preparation for closure reduced the water level in monitoring well WAP-2 to less than two feet from the bottom of the well. This water level was not sufficient to provide reliable groundwater samples. As such, Haley & Aldrich replaced this well with a new well screened 15-feet below the original WAP-2 well screen. The new well, WAP-2R, was installed at the same location as the original WAP-2. Additional description of the monitoring network is presented in the Groundwater Monitoring Program Plan, which was placed in the facility's operating record, as required by §257.105(h)(2).

Monitoring wells WAP-4I, WAP-4D, WAP-5I and WAP-5D were originally installed along the southern berm of the West Ash Pond as requested by Indiana Department of Environmental Management (IDEM) to comply with the Solid Waste Land Disposal Facility rules under 329 IAC 10. They are not part of the CCR groundwater monitoring network, as the current groundwater monitoring program satisfies the requirements of §257.91(a). However, if the WAP enters an Assessment Monitoring Program and requires a determination of the Nature and Extent of potential releases, these monitoring wells may be used for data collection. The monitoring wells are currently being used to monitor groundwater elevations and hydraulic gradients of the intermediate and deep aquifers beneath the WAP.

§257.90(e)(3) SUMMARY OF GROUNDWATER ANALYSIS

§257.90(e)(3) In addition to all the monitoring data obtained under §257.90 through §257.98, a summary including the number of groundwater samples that were collected for analysis for each background* [upgradient] *and downgradient well, the dates the samples were collected, and whether the sample was required by the detection monitoring or assessment monitoring programs;

In accordance with §257.94(b), a minimum of eight independent samples from each upgradient and downgradient monitoring well were collected prior to 17 April 2019 deadline as ordered by the DC Circuit Court partial vacatur and subsequent Direct Final Rule described above. A summary of the groundwater monitoring program for the WAP, including the analytical results for the Appendix III and Appendix IV list of constituents, is presented in Table 2 of this report.

§257.90(e)(4) CURRENT GROUNDWATER MONITORING PROGRAM

§257.90(e)(4) A narrative discussion of any transition between monitoring programs (e.g., the date and circumstances for transitioning from detection monitoring to assessment monitoring in addition to identifying the constituent(s) detected at a statistically significant increase over background levels);

As required by § 257.93(h) a statistical analysis of the Appendix III constituents was completed on 12 July 2019. The results of this statistical analysis showed that statistically significant increases (SSI) of boron, calcium, chloride, fluoride, sulfate, and total dissolved solids above background were present in one or more wells located downgradient of the WAP. Consistent with §257.94(e)(2), SIGECO is evaluating options to demonstrate that a source other than the CCR unit caused the SSI and will provide a narrative discussion of any transition between monitoring programs, as appropriate, in subsequent annual reports. The Assessment Monitoring program will be established to meet the requirements of 40 CFR § 257.95 if alternate sources have not been identified.

§257.90(e)(5) OTHER REQUIRED INFORMATION

§257.90(e)(5) Other information required to be included in the annual report as specified in §257.90 through §257.98.

This initial Annual Groundwater Monitoring and Corrective Action Report documents activities conducted to comply with Sections §257.90 through §257.94 of the Rule. There are no applicable requirements from Sections §257.95 through §257.98.

Attachments
Table I. Groundwater Monitoring Well Location and Construction Details
Table II. Summary of Analytical Results
Figure 1. Monitoring Well Network

\\haleyaldrich.com\share\grn_common\129420 Vectren\Deliverables\FB_Culley\West Ash Pond\Annual Report\2019\Text\2019-0729_FBC_Annual_Report_West Ash Pond_DF.docx

TABLE I
GROUNDWATER MONITORING WELL LOCATION AND CONSTRUCTION DETAILS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

	Easting	Northing	Top of Pad Elevation (ft msl)	Top of Casing Elevation (ft msl)	Surface Grout (ft bgs)	Bentonite (ft bgs)	Sand Pack (ft bgs)	Screen Zone (ft bgs)	Screen Length (ft)	Well Radius (in)
Upgradient Wells										
WAP-1	2882824.18	971214.17	403.77	403.39	0 - 22	22 - 24	24 - 36	26 - 36	10	2
CCR-AP-7	2883090.34	970774.64	429.50	434.11	0 - 16	16 - 18	18 - 30	20 - 30	10	2
Downgradient Wells										
WAP-2R	2881511.71	971395.70	391.80	395.29	0 - 42	42 - 44	44 - 56	46 - 56	10	2
WAP-3	2881262.53	971000.02	393.59	393.10	0 - 59	59 - 61	61 - 73	63 - 73	10	2
WAP-4S	2881333.33	970405.14	395.32	397.08	0 - 41	41 - 43	43 - 55	45 - 55	10	2
WAP-5S	2881521.35	970235.87	394.40	396.41	0 - 36	36 - 38	38 - 50	40 - 50	10	2
Other Wells										
WAP-4I*	2881329.18	970408.95	395.26	397.23	0 - 71	71- 73	73 - 85	75 - 85	10	2
WAP-4D*	2881325.08	970412.71	395.31	397.03	0 - 112	112 - 114	114 - 126	116 - 126	10	2
WAP-5I*	2881524.71	970232.61	394.43	396.35	0 - 71	71 - 73	73 - 85	75 - 85	10	2
WAP-5D*	2881528.71	970229.88	394.36	396.35	0 - 109	109 - 111	111 - 123	113 - 123	10	2

NOTES:
bgs = below ground surface
ft = feet
in = inches
msl = mean sea level
*Monitoring wells will only be used to measure groundwater elevations

TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Location Group	Action Level	Upgradient								
Location Name		WAP-1	WAP-1	WAP-1	WAP-1	WAP-1	WAP-1	WAP-1	WAP-1	WAP-1
Sample Name	MCL / RSL	WAP-1-20180315	WAP-1-20180402	WAP-1-20180504	WAP-1-20180524	WAP-1-20180615	WAP-1-20180705	WAP-1-20180725	WAP-1-20180816	WAP-1-20181205
Sample Date	Criteria	03/15/2018	04/02/2018	05/04/2018	05/24/2018	06/15/2018	07/05/2018	07/25/2018	08/16/2018	12/05/2018
Lab Sample ID		180-75879-3	180-76407-1	180-77434-1	180-78136-1	180-78840-1	180-79554-1	180-80247-1	180-81032-1	180-84710-1
Field Parameters										
Temperature (Deg C)	NA	17.27	13.91	20.41	29.81	31.48	29.69	29.52	23.78	8.71
Dissolved Oxygen, Field (mg/L)	NA	4.04	7.03	2.41	3.79	0.28	0.91	1.65	1.03	3.12
Conductivity, Field (mS/cm)	NA	0.66623	0.03373	0.71134	0.97468	1.28582	1.29027	0.16882	1.30809	879.84
ORP, Field (mv)	NA	-24.13	128.13	-86.32	-47.75	-110.05	943.61	-133.38	-123.57	-80.44
Turbidity, Field (NTU)	NA	527.85	1148	1051	417.43	1.03	766.16	472.62	858.99	1111
Turbidity, Field (FNU)										
pH, Field (SU)	NA	7.39	5.62	7.34	7.15	7.16	6.99	7.09	6.66	7.21
Detection Monitoring - EPA Appendix III Constituents (mg/L)										
Boron, Total	NA	0.005 U	0.08 U	0.08 U	0.08 U	0.005 U	0.005 U	0.03	0.005 U	0.005 U
Calcium, Total	NA	150	160	160	160	160	160	160	150	150
Chloride	NA	13	13	12	15	15	15	15	12	17
Fluoride	4	0.31	0.23	0.21	0.28	0.24	0.28	0.28	0.27	0.29
Sulfate	NA	280	340	270	330	330	240	300	290	320
pH (lab) (SU)	NA	7.3 HF	7.5 HF	7.4 HF	7.5 HF	7.3 HF	7.3 HF	7.3 HF	7.3 HF	7.4 HF
Total Dissolved Solids (TDS)	NA	850	870	900	880	870	890	860	900	890
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)										
Antimony, Total	0.006	0.002 U	0.0012 J	0.002 U	0.0012 JB	0.0014 J	0.0018 J	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.01	0.0033	0.0085	0.0038	0.0079	**0.021**	**0.012**	0.0049	0.0051	0.0032
Barium, Total	2	0.37	0.46	0.37	0.51	0.88	0.67	0.39	0.4	0.38
Beryllium, Total	0.004	0.001 U	0.00049 J	0.000072 J	0.00039 J	0.00089 J	0.0012	0.00042 J	0.0003 J	0.000089 J
Cadmium, Total	0.005	0.001 U	0.00021 J	0.001 U	0.00018 J	0.00049 J	0.00044 J	0.00013 J	0.001 U	0.001 U
Chromium, Total	0.1	0.0022	0.016	0.005 B	0.017 B	0.043 B	0.046 B	0.0088	0.014 B	0.0057
Cobalt, Total	0.006	0.00044 J	**0.0067**	0.0013	0.0059	**0.019**	**0.017**	0.0047	0.0045	0.0019
Lead, Total	0.015	0.00068 J	0.014	0.0024	0.012	**0.035**	**0.034**	0.0099	0.0089	0.0036
Lithium, Total	0.04	0.0066	0.015 J	0.01	0.012 B	0.027	0.024	0.0095	0.01	0.01
Molybdenum, Total	0.1	0.0009 J	0.0026 J	0.00086 J	0.0015 J	0.0028 J	0.0028 J	0.0019 J	0.0013 J	0.0011 J
Selenium, Total	0.05	0.005 U	0.005 U	0.005 U	0.005 U	0.0018 J	0.0018 J	0.005 U	0.005 U^	0.005 U
Thallium, Total	0.002	0.001 U	0.00027 J	0.001 U	0.00018 J	0.00047 J	0.00053 J	0.00019 J	0.00014 J	0.000083 J
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.000098 JB	0.0002 U	0.0002 U
Fluoride	4	0.31	0.23	0.21	0.28	0.24	0.28	0.28	0.27	0.29
Radium-226 & 228 (pCi/L)	5	1.48 ± 0.377	1.08 ± 0.306	0.807 ± 0.369	1.08 ± 0.353	1.56 ± 0.445	0.976 ± 0.375	0.480 U ± 0.301	1.76 ± 0.602	-

ABBREVIATIONS AND NOTES:

CFR: Code of Federal Regulations
mg/L: milligram per liter
mS/cm: milliSiemen per centimeter
mv: millivolt
NA: Not Applicable
NTU: Nephelometric Turbidity Units
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CCR: Coal Combustion Residuals

TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Location Group	Action Level	Upgradient								
Location Name	MCL / RSL Criteria	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7
Sample Name		CCR-AP-7-20160610	CCR-AP-7-20160812	CCR-AP-7-20161028	CCR-AP-7-20161207	CCR-AP-7-20170208	CCR-AP-7-20170406	CCR-AP-7-20170607	CCR-AP-7-20170928	CCR-AP-7-20171117
Sample Date		06/10/2016	08/12/2016	10/28/2016	12/07/2016	02/08/2017	04/06/2017	06/07/2017	09/28/2017	11/17/2017
Lab Sample ID		180-55667-7	180-57631-7	180-60350-7	180-61530-7	180-63329-7	180-65041-9	180-67233-7	180-70838-3	180-72640-7
Field Parameters										
Temperature (Deg C)	NA	20.27	19.2	22.01	15.31	13.89	16.15	16.62	17.93	14.47
Dissolved Oxygen, Field (mg/L)	NA	0.21	0.15	0.69	0.23	-0.02	-0.02	0.09	0.13	0.21
Conductivity, Field (mS/cm)	NA	0.96343	0.9769	0.90788	0.76817	1.00796	1.578	0.98246	0.97415	0.97231
ORP, Field (mv)	NA	-105.35	-152.	-141.57	-146.4	-80.23	-115.03	-143.84	-153.3	-103.98
Turbidity, Field (NTU)	NA	27	19	208	370	385	519	193	-	3
Turbidity, Field (FNU)		-	-	-	-	-	-	-	11	-
pH, Field (SU)	NA	7.05	7.13	7.77	7.34	7.21	7.24	7.18	7.11	7.02
Detection Monitoring - EPA Appendix III Constituents (mg/L)										
Boron, Total	NA	0.034 J+	0.034 U	0.02 J+	0.071 U	0.034 U	0.08 U	0.15 U	0.056 J	0.091 U
Calcium, Total	NA	86	88	120 J-	99	150 J-	110 J+	100	94	96
Chloride	NA	31	26	25 J+	26	25	27	28	29	31
Fluoride	4	R	0.24	0.25	0.37 J+	0.28 J+	0.29	0.34	0.19	0.25
Sulfate	NA	93 J-	73	66 J+	96	110	110	100	82	77 J-
pH (lab) (SU)	NA	7.37 J	7.9 J	7.1 J	7.4 J	7.4 J	7.3 J	7.3 J	7.3 J	7.2 J
Total Dissolved Solids (TDS)	NA	590	580	530	620	630	640	620	570	550
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)										
Antimony, Total	0.006	0.002 U	0.002 U	0.002 U	0.00016 J	0.00062 J	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.01	0.0025	0.0048	0.0084	0.0083	**0.018**	0.008	0.0075	0.0058	0.0034
Barium, Total	2	0.1	0.12	0.16	0.14	0.19	0.15	0.15	0.12	0.11
Beryllium, Total	0.004	0.001 U	0.001 U	0.00017 J	0.00012 J	0.00075 J	0.00022 J	0.00015 J	0.001 U	0.001 U
Cadmium, Total	0.005	0.001 U	0.001 U	0.001 U	0.001 U	0.00032 J	0.00014 J	0.001 U	0.001 U	0.001 U
Chromium, Total	0.1	0.00048 J	0.00047 J	0.0026	0.0039	0.019	0.0048	0.0039 J+	0.002 U	0.002 U
Cobalt, Total	0.006	0.0012	0.0023	0.0053 J	0.0037	0.015	0.0054	0.0032	0.00054	0.0003 J
Lead, Total	0.015	0.00062 J	0.00099 J	0.0082 J	0.0036	**0.02**	0.0087 J+	0.0041	0.001 U	0.001 U
Lithium, Total	0.04	0.01 J	0.011 J	0.02 J	0.012 J	0.039 J	0.019 J	0.019 J	0.01 J	0.012 J
Molybdenum, Total	0.1	0.0082	0.0054	0.0044 J	0.0088	0.013	0.0058	0.0069	0.0036 J	0.0028 J
Selenium, Total	0.05	0.00035 J	0.005 U	0.00073 J	0.005 U	0.005 U	0.005 UJ	0.005 U	0.005 U	0.005 U
Thallium, Total	0.002	0.001 U	0.001 U	0.00008 J	0.000066 J	0.00061 J	0.001 U	0.000088 J	0.001 U	0.001 U
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Fluoride	4	R	0.24	0.25	0.37 J+	0.28 J+	0.29	0.34	0.19	0.25
Radium-226 & 228 (pCi/L)	5	0.496 ± 0.284	1.02 J ± 0.363	1.72 J ± 0.792	0.997 ± 0.602	1.11 J ± 0.335	1.55 ± 0.464	1.29 ± 0.433	R	R

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CCR: Coal Combustion Residuals

TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Location Group	Action Level	Downgradient									
Location Name		WAP-2R	WAP-2R	WAP-2R	WAP-2R	WAP-2R	WAP-2R	WAP-2R	WAP-2R	WAP-2R	WAP-2R
Sample Name	MCL / RSL	WAP-2R-20180315	WAP-2R-20180403	BLIND DUPLICATE-20180403	WAP-2R-20180504	WAP-2R-20180524	WAP-2R-20180615	WAP-2R-20180706	WAP-2R-20180726	WAP-2R-20180816	WAP-2R-20181205
Sample Date	Criteria	03/15/2018	04/03/2018	04/03/2018	05/04/2018	05/24/2018	06/15/2018	07/06/2018	07/26/2018	08/16/2018	12/05/2018
Lab Sample ID		180-75879-1	180-76407-2	180-76407-7	180-77434-2	180-78136-2	180-78840-2	180-79554-2	180-80247-2	180-81032-2	180-84710-2
Field Parameters											
Temperature (Deg C)	NA	17.04	17.32	17.32	18.49	18.42	19.88	18.83	18.63	19.23	15.65
Dissolved Oxygen, Field (mg/L)	NA	0.11	0.18	0.18	0.19	0.11	0.38	0.19	0.21	0.22	0.07
Conductivity, Field (mS/cm)	NA	2.01526	2.04425	2.04425	1.93498	2.05395	1.72707	1.89024	1.80727	1.76893	1009
ORP, Field (mv)	NA	377.23	311.59	311.59	-134.17	94.11	-22.63	537.1	390.57	94.21	99.91
Turbidity, Field (NTU)	NA	8.66	242.67	242.67	-0.1	2.87	3.88	-2.52	5.27	0.62	11.18
Turbidity, Field (FNU)											
pH, Field (SU)	NA	6.94	6.76	6.76	6.88	7.17	6.91	6.76	7.14	6.64	6.84
Detection Monitoring - EPA Appendix III Constituents (mg/L)											
Boron, Total	NA	19	12	12	22	17	17	16	12	12	10
Calcium, Total	NA	260	300	310	240	240	260	250	200	210	150
Chloride	NA	260	190	230	190	240	250	230	210	230	91
Fluoride	4	0.24	0.23	0.21	0.13 J	0.17	0.16	0.16	0.15	0.11	0.26
Sulfate	NA	570	680	730	460	600	620 F1	530	520	480	330
pH (lab) (SU)	NA	7.3 HF	7 HF	7 HF	7.2 HF	7.1 HF	7.3 HF	7.1 HF	7 HF	7.1 HF	7 HF
Total Dissolved Solids (TDS)	NA	1500	1600	1600	1500	1500	1500	1400	1200	1300	920
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)											
Antimony, Total	0.006	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.01	0.00093 J	0.0059	0.0068	0.00095 J	0.00081 J	0.00092 J	0.00071 J	0.00047 J	0.00084 J	0.00064 J
Barium, Total	2	0.053	0.062	0.065	0.045	0.042	0.041	0.041	0.032	0.035	0.025
Beryllium, Total	0.004	0.001 U	0.00024 J	0.00031 J	0.001 U	0.001 U	0.001 UF1	0.001 U	0.001 U	0.001 U	0.001 U
Cadmium, Total	0.005	0.00054 J	0.001	0.001	0.00044 J	0.0005 J	0.00043 J	0.00041 J	0.00032 J	0.00044 J	0.00032 J
Chromium, Total	0.1	0.0013 J	0.0041	0.0048	0.0015 JB	0.0014 JB	0.0018 JB	0.0009 JB	0.002 U	0.0015 JB	0.0015 J
Cobalt, Total	0.006	0.0023	**0.0062**	**0.0068**	0.002	0.0024	0.0019	0.0022	0.0017	0.0023	0.00096
Lead, Total	0.015	0.001 U	0.0064	0.0067	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00016 J
Lithium, Total	0.04	**0.059**	0.029 J	0.029 J	**0.06**	**0.041 B**	**0.052**	0.04	0.026	0.033	0.02
Molybdenum, Total	0.1	0.063	0.013	0.014	0.042	0.035	0.04	0.035	0.032	0.034	0.018
Selenium, Total	0.05	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U^	0.005 U
Thallium, Total	0.002	0.0003 J	0.00047 J	0.00052 J	0.00014 J	0.00011 J	0.000082 J	0.000084 J	0.001 U	0.000067 J	0.00014 J
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.000083 JB	0.0002 U	0.0002 U
Fluoride	4	0.24	0.23	0.21	0.13 J	0.17	0.16	0.16	0.15	0.11	0.26
Radium-226 & 228 (pCi/L)	5	0.131 U ± 0.191	0.878 ± 0.346	1.05 ± 0.354	0.382 ± 0.215	0.169 U ± 0.23	0.623 ± 0.29	0.579 ± 0.266	0.621 ± 0.312	0.495 ± 0.264	-

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SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Location Group	Action Level	Downgradient									
Location Name		WAP-3	WAP-3	WAP-3	WAP-3	WAP-3	WAP-3	WAP-3	WAP-3	WAP-3	WAP-3
Sample Name	MCL / RSL	WAP-3-20180315	WAP-3-20180403	WAP-3-20180503	WAP-3-20180524	WAP-3-20180615	BLIND DUPLICATE-20180615	WAP-3-20180706	WAP-3-20180726	WAP-3-20180816	WAP-3-20181205
Sample Date	Criteria	03/15/2018	04/03/2018	05/03/2018	05/24/2018	06/15/2018	06/15/2018	07/06/2018	07/26/2018	08/16/2018	12/05/2018
Lab Sample ID		180-75879-2	180-76407-3	180-77434-3	180-78136-3	180-78840-3	180-78840-6	180-79554-3	180-80247-3	180-81032-3	180-84710-3
Field Parameters											
Temperature (Deg C)	NA	18.6	17.04	16.81	18.21	18.48	18.48	20.1	20.14	18.83	16.78
Dissolved Oxygen, Field (mg/L)	NA	0.2	0.19	0.06	0.13	0.09	0.09	0.15	0.07	0.15	0.02
Conductivity, Field (mS/cm)	NA	1.35962	1.36286	0.99246	0.96549	1.06727	1.06727	1.13254	1.24046	1.2978	1223
ORP, Field (mv)	NA	-114.58	-126.8	-205.17	-115.95	-125.47	-125.47	1012	-100.24	-134.11	-135.29
Turbidity, Field (NTU)	NA	48.67	8.48	9.32	3.86	13.75	13.75	4.96	14.35	7.64	12.89
Turbidity, Field (FNU)											
pH, Field (SU)	NA	6.73	6.8	6.87	7.26	6.84	6.84	7.07	10.41	6.86	7.03
Detection Monitoring - EPA Appendix III Constituents (mg/L)											
Boron, Total	NA	7.8	7.3	7.7	6.9	5.6	5.6	5.5	5.2	7.6	13
Calcium, Total	NA	160	200	140	130	170	170	160	160	180	190
Chloride	NA	62	65	45	52	76	77	72	66	97	120
Fluoride	4	0.43	0.33	0.6	0.77	0.56	0.57	0.68	0.53	0.52	0.55
Sulfate	NA	150	130	110	190	250	240	280	180	290	450
pH (lab) (SU)	NA	7.1 HF	7.3 HF	7 HF	7.4 HF	7.2 HF	7.3 HF	7.3 HF	7 HF	7.3 HF	7.1 HF
Total Dissolved Solids (TDS)	NA	760	850	630	620	770	780	770	730	820	1100
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)											
Antimony, Total	0.006	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.01	0.0038	0.0031	0.003	0.0032	0.003	0.003	0.0022	0.0018	0.0023	0.0027
Barium, Total	2	0.35	0.32	0.23	0.1	0.2	0.19	0.12	0.22	0.17	0.16
Beryllium, Total	0.004	0.000068 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Cadmium, Total	0.005	0.00024 J	0.001 U	0.00022 J	0.0003 J	0.00022 J	0.00022 J	0.00022 J	0.00017 J	0.00022 J	0.00016 J
Chromium, Total	0.1	0.0029	0.00099 J	0.0017 JB	0.0015 JB	0.0021 B	0.0018 JB	0.0012 JB	0.002 U	0.0017 JB	0.0015 J
Cobalt, Total	0.006	0.0015	0.0011	0.00053	0.00044 J	0.00071	0.00061	0.00034 J	0.00037 J	0.00048 J	0.00067
Lead, Total	0.015	0.0018	0.0011	0.001 U	0.0003 J	0.00038 J	0.00038 J	0.00023 J	0.00027 J	0.00037 J	0.00042 J
Lithium, Total	0.04	0.04	0.036 J	**0.052**	**0.061 B**	**0.062**	**0.06**	**0.066**	**0.044**	**0.07**	**0.08**
Molybdenum, Total	0.1	**0.72**	**0.41**	**1.2**	**1.5**	**0.98**	**0.97**	**1.2**	**0.78**	**1**	**0.86**
Selenium, Total	0.05	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U^	0.005 U
Thallium, Total	0.002	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0001 JB	0.0002 U	0.0002 U
Fluoride	4	0.43	0.33	0.6	0.77	0.56	0.57	0.68	0.53	0.52	0.55
Radium-226 & 228 (pCi/L)	5	1.00 ± 0.299	1.07 ± 0.271	0.785 ± 0.287	0.199 U ± 0.29	1.08 ± 0.325	0.951 ± 0.308	0.928 ± 0.285	1.28 ± 0.416	0.943 ± 0.262	-

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CCR: Coal Combustion Residuals

Location Group	Action Level	Downgradient											
Location Name	MCL / RSL Criteria	WAP-4S	WAP-4S	WAP-4S	WAP-4S	WAP-4S	WAP-4S	WAP-4S	WAP-4S	WAP-4S	WAP-4S	WAP-4S	WAP-4S
Sample Name		WAP-4S-20180314	DUP-20180315	WAP-4S-20180402	WAP-4S-20180503	WAP-4S-20180524	WAP-4S-20180614	WAP-4S-20180705	WAP-4S-20180725	BLIND DUPLICATE-20180725	WAP-4S-20180816	BLIND DUPLICATE-20180816	WAP-4S-20181204
Sample Date		03/14/2018	03/15/2018	04/02/2018	05/03/2018	05/24/2018	06/14/2018	07/05/2018	07/25/2018	07/25/2018	08/16/2018	08/16/2018	12/04/2018
Lab Sample ID		180-75879-4	180-75879-12	180-76407-4	180-77434-4	180-78136-4	180-78840-4	180-79554-4	180-80247-4	180-80247-6	180-81032-4	180-81032-6	180-84710-4
Field Parameters													
Temperature (Deg C)	NA	16.37	16.37	16.99	18.78	19.97	19.7	19.43	21.21	21.21	18.68	18.68	15.74
Dissolved Oxygen, Field (mg/L)	NA	0.16	0.16	0.18	0.08	0.25	0.15	0.07	0.31	0.31	0.19	0.19	0.11
Conductivity, Field (mS/cm)	NA	1.92924	1.92924	2.05243	1.91626	1.96336	1.72778	1.92887	1.94006	1.94006	1.91403	1.91403	1443
ORP, Field (mv)	NA	-4.31	-4.31	-26.05	-201.81	-56.14	-76.19	937.4	-19.28	-19.28	-74.08	-74.08	-57.33
Turbidity, Field (NTU)	NA	11.72	11.72	20.72	1.93	5.99	1.01	-0.31	0.14	0.14	0.23	0.23	3.72
Turbidity, Field (FNU)													
pH, Field (SU)	NA	7.03	7.03	6.94	7.07	7.34	7.31	7.11	7.36	7.36	6.99	6.99	7.21
Detection Monitoring - EPA Appendix III Constituents (mg/L)													
Boron, Total	NA	14	14	10	17	12	4.2	13	12	12	12	12	14
Calcium, Total	NA	330	330	360	310	310	250	300	320	320	290	300	270
Chloride	NA	230	220	240 F1	200	220	81	210	220	220	230	230	190
Fluoride	4	0.24	0.23	0.19	0.14 J	0.24	0.11	0.23	0.25	0.23	0.18	0.18	0.24
Sulfate	NA	600	610	650 F1	490	620	510	600	630	640	630	630	600 ^F1
pH (lab) (SU)	NA	7.4 HF	7.4 HF	7.4 HF	7.4 HF	7.5 HF	6.9 HF	7.4 HF	7.3 HF	7.3 HF	7.3 HF	7.3 HF	7.3 HF
Total Dissolved Solids (TDS)	NA	1500	1400	1600	1600	1600	1300	1500	1400	1500	1500	1500	1300
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)													
Antimony, Total	0.006	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.01	0.0036	0.0035	0.0048	0.0042	0.0043	0.00073 J	0.0033	0.003	0.0026	0.0031	0.0032	0.0035
Barium, Total	2	0.063	0.063	0.08	0.06	0.06	0.056	0.058	0.052	0.051	0.05	0.052	0.053
Beryllium, Total	0.004	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.000079 J	0.001 U	0.001 U	0.001 U
Cadmium, Total	0.005	0.001 U	0.001 U	0.00025 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00018 J
Chromium, Total	0.1	0.0015 J	0.0014 J	0.00088 J	0.0014 JB	0.0014 JB	0.0018 JB	0.0012 JB	0.002 U	0.002 U	0.0015 JB	0.0015 JB	0.0018 J
Cobalt, Total	0.006	0.0019	0.0019	0.0026	0.0015	0.0014	**0.0093**	0.0013	0.0014	0.0016	0.0016	0.0018	0.0018
Lead, Total	0.015	0.001 U	0.001 U	0.0007 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.00031 J
Lithium, Total	0.04	0.014	0.014	0.011 J	0.017	0.016 B	0.0037 J	0.011	0.005 U	0.005 U	0.005 U	0.005 U	0.012
Molybdenum, Total	0.1	**0.39**	**0.39**	**0.33**	**0.43**	**0.42**	0.00078 J	**0.41**	**0.4**	**0.39**	**0.45**	**0.45**	**0.43**
Selenium, Total	0.05	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U^	0.005 U^	0.005 U
Thallium, Total	0.002	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.00011 JB	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Fluoride	4	0.24	0.23	0.19	0.14 J	0.24	0.11	0.23	0.25	0.23	0.18	0.18	0.24
Radium-226 & 228 (pCi/L)	5	0.227 U ± 0.212	0.600 ± 0.283	0.693 ± 0.232	0.191 U ± 0.221	0.185 U ± 0.253	0.476 ± 0.289	0.428 ± 0.243	0.726 ± 0.363	0.352 U ± 0.366	0.558 ± 0.232	0.517 ± 0.294	-

ABBREVIATIONS AND NOTES:

CFR: Code of Federal Regulations
mg/L: milligram per liter
mS/cm: milliSiemen per centimeter
mv: millivolt
NA: Not Applicable
NTU: Nephelometric Turbidity Units
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QUALIFIERS:

*: LCS or LCSD is outside acceptance limits
^: QC is outside acceptance limits
F1: MS and/or MSD Recovery is outside acceptance limits
HF: field parameter with a holding time of 15 minutes
J: value is estimated
J+: value is estimated with a potentially high bias
U: Not detected value is the laboratory reporting limit

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CCR: Coal Combustion Residuals

TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Location Group	Action Level	Downgradient										
Location Name		WAP-5S	WAP-5S	WAP-5S	WAP-5S	WAP-5S	WAP-5S	WAP-5S	WAP-5S	WAP-5S	WAP-5S	WAP-5S
Sample Name	MCL / RSL	WAP-5S-20180313	WAP-5S-20180402	WAP-5S-20180503	BLIND DUPLICATE-20180503	WAP-5S-20180523	BLIND DUPLICATE-20180523	WAP-5S-20180614	WAP-5S-20180705	BLIND DUPLICATE-20180705	WAP-5S-20180725	WAP-5S-20180816
Sample Date	Criteria	03/13/2018	04/02/2018	05/03/2018	05/03/2018	05/23/2018	05/23/2018	06/14/2018	07/05/2018	07/05/2018	07/25/2018	08/16/2018
Lab Sample ID		180-75879-7	180-76407-5	180-77434-5	180-77434-6	180-78136-5	180-78136-6	180-78840-5	180-79554-5	180-79554-6	180-80247-5	180-81032-5
Field Parameters												
Temperature (Deg C)	NA	14.31	18.1	19.27	19.27	20.91	20.91	21.18	20.11	19.43	21.2	19.18
Dissolved Oxygen, Field (mg/L)	NA	0.36	0.2	0.07	0.07	0.26	0.26	0.35	0.17	0.07	0.16	0.21
Conductivity, Field (mS/cm)	NA	1.57901	1.60496	1.66252	1.66252	1.75073	1.75073	1.54601	1.69328	1.92887	1.70014	1.69636
ORP, Field (mv)	NA	206.41	58.95	-8.74	-8.74	116.92	116.92	9.61	560.63	937.4	66.42	33.5
Turbidity, Field (NTU)	NA	-1.45	-1.07	1.96	1.96	1.79	1.79	-0.37	-1.43	-0.31	0.14	0.23
Turbidity, Field (FNU)												
pH, Field (SU)	NA	6.46	6.44	6.41	6.41	6.62	6.62	6.54	6.46	7.11	7.15	6.41
Detection Monitoring - EPA Appendix III Constituents (mg/L)												
Boron, Total	NA	4.5	4.5	4.7	4.5	4.2	4.3	14	3.7	13	3.8	4.4
Calcium, Total	NA	230	250	240	230	230	240	320	240	310	250	240
Chloride	NA	79	71	83	83	84	85	220	81	220	81	70
Fluoride	4	0.1	0.11	0.075 J	0.067 J	0.15	0.15	0.21	0.094 J	0.23	0.12	0.087 J
Sulfate	NA	420	420	420	430	470	480	650	470 F1	610	470	420 F1
pH (lab) (SU)	NA	7 HF	6.9 HF	6.8 HF	6.8 HF	6.9 HF	6.8 HF	7.5 HF	6.8 HF	7.4 HF	6.7 HF	6.8 HF
Total Dissolved Solids (TDS)	NA	1200	1200	1300	1300	1300	1300	1500	1300	1500	1200	1300
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)												
Antimony, Total	0.006	0.002 U	0.0021	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.01	0.00075 J	0.00076 J	0.00089 J	0.00081 J	0.00065 J	0.00074 J	0.0042	0.00057 J	0.0034	0.00055 J	0.00086 J
Barium, Total	2	0.058	0.053	0.061	0.058	0.053	0.055	0.063	0.055	0.059	0.049	0.056
Beryllium, Total	0.004	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.000084 J	0.001 U
Cadmium, Total	0.005	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Chromium, Total	0.1	0.0013 J	0.002 U	0.0016 JB	0.0014 JB	0.0014 JB	0.0012 JB	0.0018 JB	0.00098 JB	0.00095 JB	0.002 U	0.0015 JB
Cobalt, Total	0.006	**0.0089**	**0.0085**	**0.0093**	**0.0087**	**0.008**	**0.0085**	0.0016	**0.0079**	0.0015	**0.0074**	**0.0086**
Lead, Total	0.015	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium, Total	0.04	0.0037 J	**0.05 U**	0.0054	0.0049 J	0.0033 JB	0.0029 JB	0.016	0.005 U	0.011	0.005 U	0.005 U
Molybdenum, Total	0.1	0.00064 J	0.0024 J	0.0007 J	0.00061 J	0.00067 J	0.00065 J	**0.4**	0.00065 J	**0.41**	0.0011 J	0.00068 J
Selenium, Total	0.05	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U^
Thallium, Total	0.002	0.001 U	0.00011 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 UF1	0.0002 U	0.0002 U	0.0002 U
Fluoride	4	0.1	0.11	0.075 J	0.067 J	0.15	0.15	0.21	0.094 J	0.23	0.12	0.087 J
Radium-226 & 228 (pCi/L)	5	0.246 U ± 0.234	0.214 U ± 0.199	0.262 U ± 0.257	0.0987 U ± 0.227	0.409 ± 0.263	0.207 U ± 0.253	0.220 U ± 0.272	0.382 ± 0.244	0.597 ± 0.264	0.450 ± 0.279	0.442 ± 0.24

ABBREVIATIONS AND NOTES:
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QUALIFIERS:
*: LCS or LCSD is outside acceptance limits
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F1: MS and/or MSD Recovery is outside acceptance limits
HF: field parameter with a holding time of 15 minutes
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CCR: Coal Combustion Residuals

TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Location Group	Action Level	Downgradient	
Location Name		WAP-5S	WAP-5S
Sample Name	MCL / RSL	WAP-5S-20181204	BLIND DUPLICATE-20181204
Sample Date	Criteria	12/04/2018	12/04/2018
Lab Sample ID		180-84710-5	180-84710-6
Field Parameters			
Temperature (Deg C)	NA	16.96	16.96
Dissolved Oxygen, Field (mg/L)	NA	0.11	0.11
Conductivity, Field (mS/cm)	NA	1400	1400
ORP, Field (mv)	NA	35.4	35.4
Turbidity, Field (NTU)	NA	0.36	0.36
Turbidity, Field (FNU)			
pH, Field (SU)	NA	6.54	6.54
Detection Monitoring - EPA Appendix III Constituents (mg/L)			
Boron, Total	NA	4.5	4.4
Calcium, Total	NA	220	220
Chloride	NA	100	100
Fluoride	4	0.11	0.12
Sulfate	NA	440	450
pH (lab) (SU)	NA	6.7 HF	6.7 HF
Total Dissolved Solids (TDS)	NA	1200	1200
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)			
Antimony, Total	0.006	0.002 U	0.002 U
Arsenic, Total	0.01	0.00069 J	0.00072 J
Barium, Total	2	0.053	0.053
Beryllium, Total	0.004	0.001 U	0.001 U
Cadmium, Total	0.005	0.001 U	0.001 U
Chromium, Total	0.1	0.0015 J	0.0012 J
Cobalt, Total	0.006	**0.0078**	**0.0077**
Lead, Total	0.015	0.001 U	0.001 U
Lithium, Total	0.04	0.0044 J	0.0038 J
Molybdenum, Total	0.1	0.00077 J	0.00073 J
Selenium, Total	0.05	0.005 U	0.005 U
Thallium, Total	0.002	0.001 U	0.001 U
Mercury, Total	0.002	0.0002 U	0.0002 U
Fluoride	4	0.11	0.12
Radium-226 & 228 (pCi/L)	5	-	-

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CCR: Coal Combustion Residuals

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LEGEND

- CCR COMPLIANCE MONITORING WELL
- MONITORING WELL
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: GOOGLE 2018

N

0 200 400
APPROXIMATE SCALE IN FEET

HALEY ALDRICH

SIGECO
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, IN 47630

MONITORING WELL NETWORK

AUGUST 2019

FIGURE 1

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ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT
WEST ASH POND
F.B. CULLEY GENERATING STATION
WARRICK COUNTY, INDIANA

by
Haley & Aldrich, Inc.
Greenville, South Carolina

for
Southern Indiana Gas and Electric Company
Evansville, Indiana

File No. 129420
July 2020

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1. 40 CFR § 257.90 Applicability

1.1 40 CFR § 257.90(a)

Except as provided for in § 257.100 for inactive CCR surface impoundments, all CCR landfills, CCR surface impoundments, and lateral expansions of CCR units are subject to the groundwater monitoring and corrective action requirements under § 257.90 through § 257.98.

The West Ash Pond (WAP) at the F.B. Culley Generating Station (FBC) is subject to the groundwater monitoring and corrective action requirements described under Code of Federal Regulations Title 40 (40 CFR) § 257.90 through § 257.98 (Rule). The WAP located at FBC was previously classified as an inactive surface impoundment as defined by 40 CFR §257.53. The Southern Indiana Gas and Electric Company (SIGECO) filed a Notice of Intent (NOI) to initiate closure of the WAP and placed the NOI in the facility's operating record on 17 December 2015. The WAP is currently in the closure process. However, on 5 August 2016, the United States Environmental Protection Agency (USEPA) issued a "Direct Final Rule" effective on 4 October 2016, constituting a vacatur of 40 CFR § 257.100. The Direct Final Rule applies the requirements of existing surface impoundments that had been previously declared inactive. As a result, owners and operators of inactive coal combustion residuals (CCR) surface impoundments must comply with the groundwater monitoring requirements for existing CCR surface impoundments. The CCR Rule changes extended the deadlines to comply with the groundwater monitoring and corrective action requirements with the initial annual groundwater monitoring and corrective action report being placed in the facilities operating record by 1 August 2019 and annually thereafter.

This document addresses the requirement for the Owner/Operator to prepare an Annual Groundwater Monitoring and Corrective Action Report (Annual Report) per § 257.90(e).

1.2 40 CFR § 257.90(e) - SUMMARY

Annual groundwater monitoring and corrective action report. For existing CCR landfills and existing CCR surface impoundments, no later than January 31, 2018, and annually thereafter, the owner or operator must prepare an annual groundwater monitoring and corrective action report. For new CCR landfills, new CCR surface impoundments, and all lateral expansions of CCR units, the owner or operator must prepare the initial annual groundwater monitoring and corrective action report no later than January 31 of the year following the calendar year a groundwater monitoring system has been established for such CCR unit as required by this subpart, and annually thereafter. For the preceding calendar year, the annual report must document the status of the groundwater monitoring and corrective action program for the CCR unit, summarize key actions completed, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year. For purposes of this section, the owner or operator has prepared the annual report when the report is placed in the facility's operating record as required by § 257.105(h)(1).

As required by §257.100(e)(5)(ii), this Annual Report is to be completed no later than 1 August 2020 due to the partial vacatur ordered by the District of Columbia Circuit Court on 14 June 2016 and the subsequent Direct Final Rule effective 4 October 2016, and within one year of the previous annual report being placed into the facility's operating record. As required, this Annual Report documents the status of the groundwater monitoring and corrective action program for the WAP at FBC and summarizes key actions completed through 15 July 2020.

1.2.1 Status of the Groundwater Monitoring Program

As provided in the notification on 12 July 2019, statistically significant increases (SSI) of Appendix III constituents were identified downgradient of the WAP. An evaluation of alternate sources was conducted; however, a successful alternate source demonstration (ASD) was not achieved at that time. As a result, an Assessment Monitoring program was initiated as required by § 257.94(e)(2). Annual and semi-annual groundwater samples were collected as outlined in § 257.95(b) and § 257.95(d)(1) and groundwater protection standards (GWPS) were established as required by § 257.95(d)(2). Statistical analysis was completed on 2 July 2020 as described in § 257.93(h)(2) and statistically significant levels (SSL) of Appendix IV constituents above GWPS (lithium and molybdenum) were identified downgradient of the WAP.

1.2.2 Key Actions Completed

The following key actions were completed in 2019/2020:

- Statistical analysis of assessment monitoring results on 2 July 2020 to evaluate potential for SSLs of Appendix IV constituents present downgradient of the WAP.
- Preparation of the 2018/2019 Annual Report which included the following activities:
  - The 2018/2019 Annual Report was placed in the facility's operating record pursuant to § 257.105(h)(1).
  - Pursuant to § 257.106(h)(1), the notification was sent to the relevant State Director and/or Tribal authority within 30 days of the 2018/2019 Annual Report being placed in the facility's operating record [§ 257.106(d)].
  - Pursuant to § 257.107(h)(1), the 2018/2019 Annual Report was posted to the CCR Website within 30 days of the 2018/2019 Annual Report being placed in the facility's operating record [§ 257.107(d)] and 257.107(h)(1)].
- Assessment monitoring groundwater samples were collected and analyzed in accordance with § 257.95(b) and § 257.95(d)(1). In addition to the two rounds of assessment monitoring required by § 257.95(b) and § 257.95(d)(1), an additional confirmation sampling round was conducted in March 2020 to validate the results obtained during the February 2020 sampling round.

1.2.3 Problems Encountered

No problems, such as damaged wells, issues with sample collection, or lack of sampling, or problems with laboratory analysis were encountered at the WAP in 2019/2020.

1.2.4 Actions to Resolve Problems

Actions to resolve problems were not required.

1.2.5 Project Key Activities for Upcoming Year

Key activities to be completed in 2020 include the following:

- Continue semiannual groundwater monitoring in accordance with § 257.95.

- Complete statistical analysis of the semiannual groundwater sampling results as required by § 257.93(h)(2).
- Characterize the nature and extent of the release and any relevant site conditions that may affect the remedy ultimately selected.
- Initiate an assessment of corrective measures as required by § 257.96.

1.3 40 CFR § 257.90(e) - INFORMATION

At a minimum, the annual groundwater monitoring and corrective action report must contain the following information, to the extent available.

1.3.1 40 CFR § 257.90(e)(1) Aerial Image

A map, aerial image, or diagram showing the CCR unit and all background (or upgradient) and downgradient monitoring wells, to include the well identification numbers, that are part of the groundwater monitoring program for the CCR unit.

As required by § 257.90(e)(1), a map showing the location of the WAP and associated upgradient and downgradient monitoring wells is presented as Figure 1.

1.3.2 40 CFR § 257.90(e)(2) Adjustments to Groundwater Monitoring

Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a narrative description of why those actions were taken.

No additional monitoring wells were installed or decommissioned during 2020. However, the location and construction details of the existing monitoring well network for the WAP are provided for reference as Table I.

1.3.3 40 CFR § 257.90(e)(3) Summary of Groundwater Analysis

In addition to all the monitoring data obtained under § 257.90 through § 257.98, a summary including the number of groundwater samples that were collected for analysis for each background and downgradient well, the dates the samples were collected, and whether the sample was required by the detection monitoring or assessment monitoring programs.

In accordance with § 257.95(b) and § 257.95(d)(1), two independent samples from each background and downgradient monitoring well were collected and analyzed. In addition, a confirmation sampling round was conducted in March 2020 to validate the February sampling results. As required by § 257.95(d)(3), this Annual Report includes the assessment sampling results required by § 257.95(d)(1), the background concentrations established under § 257.94(b), and the GWPS established under § 257.95(d)(2). This information is provided in Table II.

1.3.4 40 CFR § 257.90(e)(4) Current Groundwater Monitoring Program

A narrative discussion of any transition between monitoring programs (e.g., the date and circumstances for transitioning from detection monitoring to assessment monitoring in addition to identifying the constituent(s) detected at a statistically significant increase over background levels); and

As required by § 257.93(h) a statistical analysis of the Appendix III constituents was completed by 12 July 2019. This statistical analysis determined that SSIs of boron, calcium, chloride, fluoride, sulfate, and total dissolved solids were present downgradient of the WAP. An evaluation of alternate sources was initiated as allowed by § 257.94(e)(2). A source causing the SSI over background levels other than the CCR unit was not identified at that time and an Assessment Monitoring Program was initiated. The Assessment Monitoring Program has been established to meet the requirements of 40 CFR § 257.95.

As required by § 257.95, a statistical analysis of the Appendix IV constituents was completed. This statistical analysis determined that SSLs for lithium and molybdenum were present downgradient of the WAP.

1.3.5 40 CFR § 257.90(e)(5) Other Required information

Other information required to be included in the annual report as specified in § 257.90 through § 257.98.

Other information including development of GWPS, recording groundwater monitoring results in the operating record, and an evaluation of alternate sources is discussed in preceding sections.

TABLES

TABLE I
GROUNDWATER MONITORING WELL LOCATION AND CONSTRUCTION DETAILS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

	Easting	Northing	Top of Pad Elevation (ft msl)	Top of Casing Elevation (ft msl)	Surface Grout (ft bgs)	Bentonite (ft bgs)	Sand Pack (ft bgs)	Screen Zone (ft bgs)	Screen Length (ft)	Well Radius (in)
Upgradient Wells										
WAP-1	2882824.18	971214.17	403.77	403.39	0 - 22	22 - 24	24 - 36	26 - 36	10	2
CCR-AP-7	2883090.34	970774.64	429.50	434.11	0 - 16	16 - 18	18 - 30	20 - 30	10	2
Downgradient Wells										
WAP-2R	2881511.71	971395.70	391.80	395.29	0 - 42	42 - 44	44 - 56	46 - 56	10	2
WAP-3	2881262.53	971000.02	393.59	393.10	0 - 59	59 - 61	61 - 73	63 - 73	10	2
WAP-4S	2881333.33	970405.14	395.32	397.08	0 - 41	41 - 43	43 - 55	45 - 55	10	2
WAP-5S	2881521.35	970235.87	394.40	396.41	0 - 36	36 - 38	38 - 50	40 - 50	10	2
Other Wells										
WAP-4I*	2881329.18	970408.95	395.26	397.23	0 - 71	71- 73	73 - 85	75 - 85	10	2
WAP-4D*	2881325.08	970412.71	395.31	397.03	0 - 112	112 - 114	114 - 126	116 - 126	10	2
WAP-5I*	2881524.71	970232.61	394.43	396.35	0 - 71	71 - 73	73 - 85	75 - 85	10	2
WAP-5D*	2881528.71	970229.88	394.36	396.35	0 - 109	109 - 111	111 - 123	113 - 123	10	2

NOTES:
bgs = below ground surface
ft = feet
in = inches
msl = mean sea level
*Monitoring wells will only be used to measure groundwater elevations

TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
WEST ASH POND - OCTOBER 2019 THROUGH MARCH 2020
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA
FILE NO. 129420

Location Group	Action Level	Upgradient					
Location Name	Maximum Contaminant Level	WAP-1	WAP-1	WAP-1	CCR-AP-7	CCR-AP-7	CCR-AP-7
Sample Name		WAP-1-20191028	WAP-1-20200219	WAP-1-20200331	CCR-AP-7/WAP-7-20191023	CCR-AP-7-20200219	WAP-7-20200330
Sample Date		10/28/2019	02/19/2020	03/31/2020	10/23/2019	02/19/2020	03/30/2020
Lab Sample ID		180-97909-1	180-102603-1	180-104189-1	180-97809-16	180-102603-6	180-104189-6
Detection Monitoring - EPA Appendix III Constituents (mg/L)							
Boron, Total	NA	0.08 U	0.08 U	0.08 U	0.08 U	0.082 U	0.047 J
Calcium, Total	NA	-	180	180	110	110	110
Chloride	NA	-	25 J+	260	27	16 J+	27
Fluoride	4	0.19 J+	0.17	2	0.14 J+	0.22	0.3
pH (lab) (su)	NA	7.4 J	7.4 J	7.3 J	7.4 J	7.4 J	7.3 J
Sulfate	NA	-	340 J+	340	65	45 J+	76
Total Dissolved Solids (TDS)	NA	-	930	910	530	570	560
Other							
Antimony, Total	0.006	0.00059 J	0.00045 J	0.00073 J	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.015	0.0066	0.0073	0.004	0.0075	0.004	0.0018
Barium, Total	2	0.54	0.56	0.45	0.15	0.12	0.11
Beryllium, Total	0.004	0.00027 J	0.00023 J	0.001 U	0.001 U	0.001 U	0.001 U
Cadmium, Total	0.005	0.00022 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Chromium, Total	0.1	0.011	0.012	0.005	0.0018 J	0.0018 J	0.002 U
Cobalt, Total	0.019	0.0047	0.0058	0.0033	0.001	0.0011	0.00029 J
Fluoride	4	0.19 J+	0.17	2	0.14 J+	0.22	0.3
Lead, Total	0.032	0.0072	0.0094	0.0041	0.0014 J+	0.0015	0.001 U
Lithium, Total	0.04	0.015	0.011	0.0096	0.02 J+	0.011	0.01
Mercury, Total	0.002	0.0002 U	-	-	0.0002 U	-	-
Molybdenum, Total	0.1	0.0012 J	0.001 J	0.00068 J	0.0017 J	0.0015 J	0.0014 J
Selenium, Total	0.05	0.005 U	-	-	0.005 U	-	-
Thallium, Total	0.002	0.00025 J	0.001 U	0.00021 J	0.001 U	0.001 U	0.001 U
Radiological (pCi/L)							
Radium-226	NA	0.737 ± 0.329	0.549 J- ± 0.241	0.569 ± 0.238	0.194 J ± 0.097	0.309 J- ± 0.125	0.243 ± 0.117
Radium-228	NA	0.715 U ± 1.18	0.962 ± 0.489	0.792 U ± 0.561	1.02 ± 0.324	0.111 U ± 0.217	0.197 U ± 0.268
Radium-226 & 228	5	1.45 UJ ± 1.23	1.51 J- ± 0.545	1.36 J ± 0.609	1.21 ± 0.338	0.419 J- ± 0.25	0.441 UJ ± 0.292
Field Parameters							
Temperature (Deg C)	NA	14.67	13.4	11.86	18.44	15.51	16.79
Dissolved Oxygen, Field (mg/L)	NA	4.01	8.41	5.86	0.18	1.61	0.13
Conductivity, Field (mS/cm)	NA	1.3105	1.4677	1.0865	0.97501	0.95642	0.96873
ORP, Field (mv)	NA	-70.5	-79.4	-86.6	-111.5	-75.1	-44.2
Turbidity, Field (NTU)	NA	647.78	1845.9	658.83	21.59	200.93	21.58
pH, Field (su)	NA	7.22	7.34	6.91	7.01	7.13	7.12

ABBREVIATIONS AND NOTES:

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pCi/L: picoCurie per liter.
su: standard units.
USEPA: United States Environmenta.l Protection Agency
J: Value is estimated
J-: Value is estimated, biased low
J+: Value is estimated, biased high
R: Rejected during validation
U: Not detected, value is the laboratory reporting limit

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TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
WEST ASH POND - OCTOBER 2019 THROUGH MARCH 2020
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA
FILE NO. 129420

Location Group	Action Level	Downgradient								
Location Name	Maximum Contaminant Level	WAP-2R	WAP-2R	WAP-2R	WAP-3I	WAP-3I	WAP-3I	WAP-4S	WAP-4S	WAP-4S
Sample Name		WAP-2R-20191028	WAP-2R-20200218	WAP-2R-20200331	WAP-3-20191028	WAP-3I-20200219	WAP-3-20200330	WAP-4S-20191025	WAP-4S-20200219	WAP-4-20200330
Sample Date		10/28/2019	02/18/2020	03/31/2020	10/28/2019	02/19/2020	03/30/2020	10/25/2019	02/19/2020	03/30/2020
Lab Sample ID		180-97909-2	180-102603-2	180-104189-2	180-97909-3	180-102603-3	180-104189-3	180-97909-4	180-102603-4	180-104189-4
Detection Monitoring - EPA Appendix III Constituents (mg/L)										
Boron, Total	NA	6.1	6.3	6.7	14	9.9	13	12	10	12
Calcium, Total	NA	-	140	140	-	200	280	-	290	320
Chloride	NA	-	47 J+	42	-	89 J+	130	-	150 J+	180
Fluoride	4	0.25 J+	0.2	0.23	0.39 J+	0.24	0.48	0.17 J+	0.16	0.17
pH (lab) (su)	NA	7.1 J	7.2 J	7 J	7 J	7 J	6.9 J	7.3 J	7.4 J	7.2 J
Sulfate	NA	-	180 J+	160	-	230 J+	550	-	530 J+	530
Total Dissolved Solids (TDS)	NA	-	630	650	-	920	1200	-	1200	1200
Other										
Antimony, Total	0.006	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.015	0.001	0.00054 J	0.00056 J	0.002	0.0014	0.0064	0.0054	0.0032	0.0061
Barium, Total	2	0.031	0.023	0.025	0.25	0.39	0.33	0.049	0.056	0.056
Beryllium, Total	0.004	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Cadmium, Total	0.005	0.00027 J	0.001 U	0.001 U	0.0002 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Chromium, Total	0.1	0.002 U	0.002 U	0.002 U	0.0024	0.002 U	0.003	0.002 U	0.002 U	0.002 U
Cobalt, Total	0.019	0.0015 J	0.00052	0.00083	0.00094	0.00043 J	0.0016	0.0023	0.0022	0.0019
Fluoride	4	0.25 J+	0.2	0.23	0.39 J+	0.24	0.48	0.17 J+	0.16	0.17
Lead, Total	0.032	0.00029 J	0.001 U	0.00019 J	0.00094 J	0.00071 J	0.0027	0.001 U	0.001 U	0.001 U
Lithium, Total	0.04	0.016	0.012	0.014	0.079	0.033	0.1	0.0036 J	0.005 U	0.0049 J
Mercury, Total	0.002	0.0002 U	-	-	0.0002 U	-	-	0.0002 U	-	0.0002 U
Molybdenum, Total	0.1	0.16	0.05	0.07	0.92	0.26	0.7	0.5	0.33	0.47
Selenium, Total	0.05	0.005 U	-	-	0.005 U	-	-	0.005 U	-	-
Thallium, Total	0.002	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Radiological (pCi/L)										
Radium-226	NA	0.0181 U ± 0.0789	0.0350 R ± 0.0713	0.112 U ± 0.105	0.308 ± 0.119	0.462 J- ± 0.147	0.500 ± 0.174	0.131 U ± 0.102	0.136 J- ± 0.0915	0.128 U ± 0.122
Radium-228	NA	0.0701 U ± 0.341	0.204 U ± 0.218	-0.0721 U ± 0.334	0.243 U ± 0.34	0.629 ± 0.261	0.650 ± 0.391	-0.0635 U ± 0.322	0.154 U ± 0.227	0.774 U ± 0.589
Radium-226 & 228	5	0.0883 U ± 0.35	0.239 UJ ± 0.229	0.112 U ± 0.35	0.551 UJ ± 0.36	1.09 J- ± 0.3	1.15 ± 0.428	0.131 U ± 0.338	0.289 UJ ± 0.245	0.901 U ± 0.602
Field Parameters										
Temperature (Deg C)	NA	16.35	15.24	15.13	17.34	16.28	17.23	16.02	17.45	17.99
Dissolved Oxygen, Field (mg/L)	NA	0.36	0.37	0.24	0.17	0.13	0.04	0.57	0.31	0.12
Conductivity, Field (mS/cm)	NA	1.0587	1.0161	0.97302	1.2504	1.4541	1.3957	1.7667	1.709	1.7973
ORP, Field (mv)	NA	61.4	112.2	36.2	-103.1	-122.7	-114.6	-14.7	-19.4	-10.6
Turbidity, Field (NTU)	NA	11.61	8.73	0	18.24	5.81	135.89	4.65	2.5	4.55
pH, Field (su)	NA	6.86	6.68	6.56	7.04	6.93	6.79	7.11	7.09	6.99

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SUMMARY OF GROUNDWATER QUALITY DATA
WEST ASH POND - OCTOBER 2019 THROUGH MARCH 2020
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA
FILE NO. 129420

Location Group	Action Level	Downgradient					
Location Name	Maximum Contaminant Level	WAP-4S	WAP-5S	WAP-5S	WAP-5S	WAP-5S	WAP-5S
Sample Name		BLIND DUP-20200330	WAP-5S-20191025	BLIND DUPLICATE-20191025	WAP-5S-20200218	BLIND DUPLICATE-20200218	WAP-5-20200330
Sample Date		03/30/2020	10/25/2019	10/25/2019	02/18/2020	02/18/2020	03/30/2020
Lab Sample ID		180-104189-7	180-97909-5	180-97909-6	180-102603-5	180-102603-7	180-104189-5
Detection Monitoring - EPA Appendix III Constituents (mg/L)							
Boron, Total	NA	13	4.2	4.5	3.9	3.6	4.5
Calcium, Total	NA	320	-	-	210	200	250
Chloride	NA	190	-	-	100 J+	120 J+	130
Fluoride	4	0.2	0.1 U	0.11 U	0.099 J	0.11	0.064 J
pH (lab) (su)	NA	7.3 J	6.8 J	6.8 J	6.9 J	6.9 J	6.7 J
Sulfate	NA	530	-	-	320 J+	340 J+	390
Total Dissolved Solids (TDS)	NA	1300	-	-	940	930	1100
Other							
Antimony, Total	0.006	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.015	0.0068	0.0013	0.0013	0.00058 J	0.00054 J	0.001 U
Barium, Total	2	0.057	0.061	0.059	0.047	0.045	0.046
Beryllium, Total	0.004	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Cadmium, Total	0.005	0.001 U	0.00015 J	0.001 U	0.001 U	0.001 U	0.001 U
Chromium, Total	0.1	0.002 U	0.002 U	0.0016 J	0.002 U	0.002 U	0.002 U
Cobalt, Total	0.019	0.002	0.0094	0.0097	0.0063	0.0062	0.0062
Fluoride	4	0.2	0.1 U	0.11 U	0.099 J	0.11	0.064 J
Lead, Total	0.032	0.00014 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium, Total	0.04	0.0056	0.0047 J	0.0041 J	0.005 U	0.005 U	0.005 U
Mercury, Total	0.002	-	0.0002 U	0.0002 U	-	-	-
Molybdenum, Total	0.1	0.48	0.00097 J	0.00086 J	0.00097 J	0.00091 J	0.00086 J
Selenium, Total	0.05	-	0.005 U	0.005 U	-	-	-
Thallium, Total	0.002	0.00025 J	0.00022 J	0.001 U	0.001 U	0.001 U	0.001 U
Radiological (pCi/L)							
Radium-226	NA	0.0740 U ± 0.097	0.0779 U ± 0.0866	0.00333 U ± 0.0873	0.0104 R ± 0.0669	0.0796 R ± 0.0617	0.000 U ± 0.0649
Radium-228	NA	0.540 U ± 0.484	0.276 U ± 0.271	0.130 U ± 0.26	0.249 U ± 0.224	0.0650 U ± 0.21	0.648 ± 0.364
Radium-226 & 228	5	0.614 U ± 0.494	0.354 U ± 0.285	0.133 U ± 0.274	0.259 UJ ± 0.234	0.145 UJ ± 0.219	0.648 J ± 0.37
Field Parameters							
Temperature (Deg C)	NA	17.99	16.9	16.9	16.82	16.82	19.17
Dissolved Oxygen, Field (mg/L)	NA	0.12	0.51	0.51	0.25	0.25	0.14
Conductivity, Field (mS/cm)	NA	1.7973	1.6219	1.6219	1.4869	1.4869	1.6252
ORP, Field (mv)	NA	-10.6	21.6	21.6	97.3	97.3	-14.2
Turbidity, Field (NTU)	NA	4.55	0.84	0.84	0	0	1.06
pH, Field (su)	NA	6.99	6.55	6.55	6.41	6.41	6.64

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FIGURES

LEGEND

- CCR COMPLIANCE MONITORING WELL
- MONITORING WELL
- APPROXIMATE LOCATION OF CLOSED WEST ASH POND
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: GOOGLE 2018

N

0 200 400
APPROXIMATE SCALE IN FEET

HALEY ALDRICH

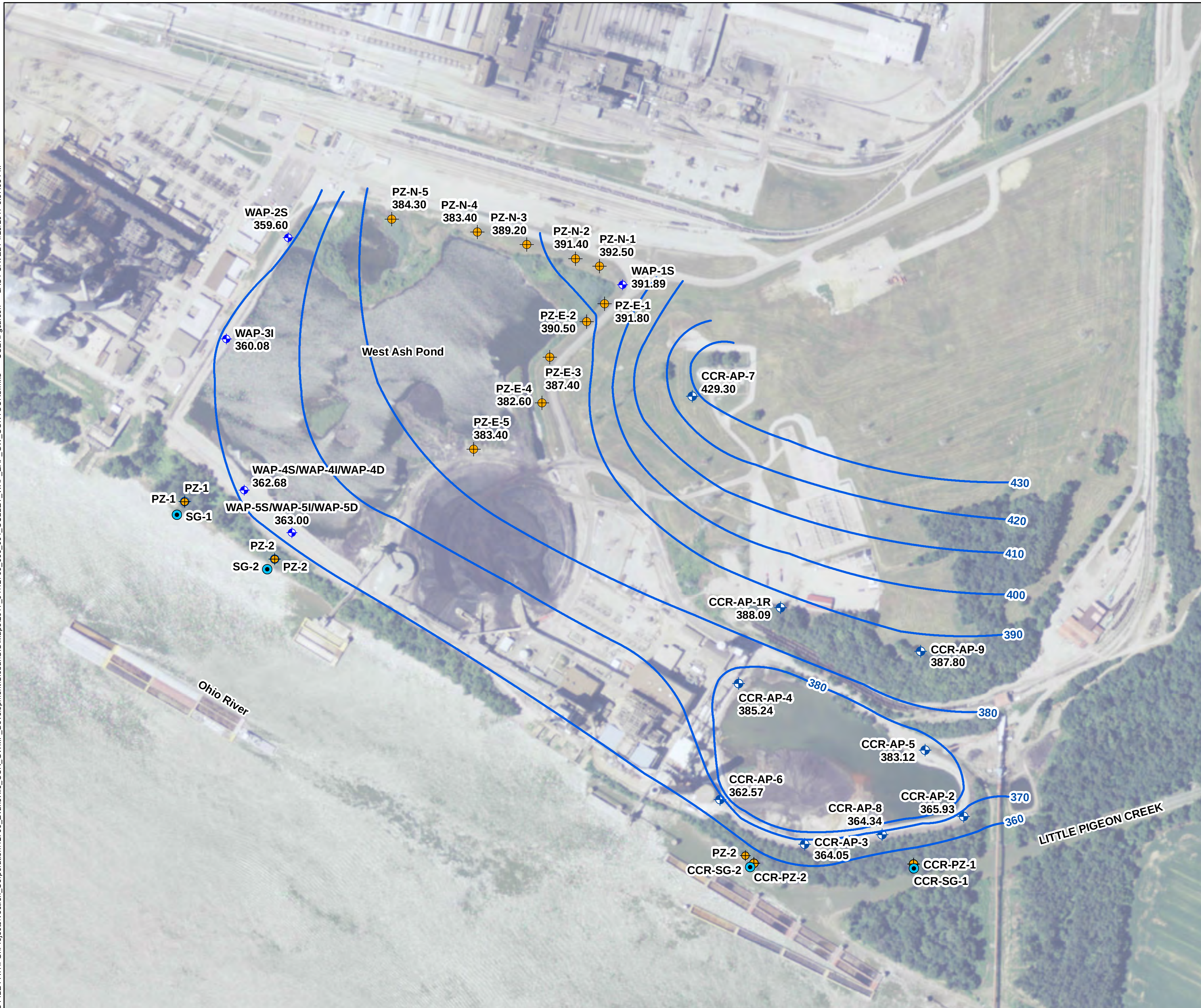
SIGECO
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, IN 47630

GROUNDWATER MONITORING
WELL NETWORK

MAY 2020

FIGURE 1

Appendix C
Groundwater Flow Direction (April 2017)



GIS FILE PATH: G:\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2017_04\42796_000_001_CULLEY_WAP_EAP_GW_CONTOURS.mxd — USER: gcarson — LAST SAVED: 4/25/2017 8:57:08 PM

LEGEND

- WAP-1S EXISTING MONITORING WELL
- PZ-1 EXISTING PIEZOMETER
- SG-1 EXISTING STAFF GAUGE

NOTES

1. AERIAL IMAGERY SOURCE: DIGITAL GLOBE 3/14/2014
2. MONITORING WELLS WITH AN "S" DESIGNATION ARE SCREENED IN THE UPPERMOST AQUIFER. THE "D" DESIGNATION REPRESENTS WELLS SCREENED AT THE TOP OF BEDROCK, AND THE "I" DESIGNATION IS FOR WELLS SCREENED AT AN INTERMEDIATE DEPTH BETWEEN THE TWO.
3. ELEVATIONS ARE FEET ABOVE MEAN SEA LEVEL.

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

VECTREN CORPORATION
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, IN 47630

GROUNDWATER ELEVATION CONTOURS - APRIL 2017

APRIL 2017

FIGURE 3

Appendix D
Work Plan to Install Monitoring Wells and Piezometers

www.haleyaldrich.com

REPORT ON

WORK PLAN TO INSTALL MONITORING WELLS AND PIEZOMETERS
F.B. CULLEY GENERATING STATION – WEST ASH POND
WARRICK COUNTY, INDIANA
SW PROGRAM ID 87-UP-14

by
Haley & Aldrich, Inc.
Greenville, South Carolina

for
Southern Indiana Gas and Electric Company
Evansville, Indiana

File No. 129420-019
February 2020

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1. Introduction

The Closure and Post Closure Plan for the F.B. Culley Generating Station (FBC) West Ash Pond (WAP) was submitted to the Indiana Department of Environmental Management (IDEM) on 17 April 2018 (VFC #82533838). IDEM sent a Request for Additional Information (RAI) dated 17 December 2018 (VFC #82663676) requesting additional information and/or changes needed in order to continue reviewing the WAP Closure and Post-Closure Plan. The Southern Indiana Gas and Electric Company (SIGECO) provided a response and a revised Closure and Post-Closure Plan on 22 April 2019 (VFC #s 82758927, 82758924, 82759126). Additional supplemental information was submitted to IDEM on 7 June 2019 (VFC #82792254), and 24 July 2019 (VFC #82814249). On 20 December 2019, the SIGECO coal combustion residuals (CCR) surface impoundment Closure and Post-Closure Plan for the FBC WAP was approved under 329 IAC 10-9-1(c), which incorporates portions of 40 CFR §257, Subpart D (CCR regulation). The letter granting approval required the installation of additional monitoring wells and piezometers as outlined in F4 of the "Approval of Closure/Post-Closure Plan" to detect groundwater releases, document groundwater flow and evaluate flow reversals at the WAP. The drilling and well installation outlined in this Work Plan will be implemented following completion of closure activities and after obtaining IDEM approval.

To comply with requirements outlined in D3, the monitoring wells and piezometers will be installed by a licensed driller in the State of Indiana, who has drilled, sampled, and constructed monitoring wells at FBC previously. Drilling and well installation will be conducted in a manner that complies with all applicable laws/regulations. The field work will be overseen by a qualified Haley & Aldrich, Inc. (Haley & Aldrich) field geologist who has installed monitoring wells at FBC previously and is familiar with the geology and subsurface conditions anticipated in the vicinity of the WAP.

2. Monitoring Well Cluster WAP-6

Consistent with IDEM expectations pertaining to vertical separation between well screens, the WAP-6 well cluster will monitor three separate intervals within the uppermost aquifer downgradient of the closed CCR unit. The shallow well screen will be set near the observed water table, the deep screen will be set at the top of bedrock, and the third screen will be set at an intermediate position between the two. Each well in the cluster will be placed in the saturated portion of the sand aquifer, the screen lengths will not be greater than 10 feet, and the vertical separation between the bottom of the upper screen and the top of the next deeper screen will not exceed 20 feet. The monitoring well cluster will be installed between WAP-3 and WAP-4 at the south western corner of the former ash pond as requested by IDEM. The proposed location is presented in Figure 1.

The installation of these monitoring wells will comply with the facility safety requirements and ensure work will be performed without the risk of arching overhead powerlines to the rig and mast rods. In addition, the gas line in the vicinity of the proposed location will be marked out by CenterPoint Energy to ensure the line is not struck while drilling. The monitoring well cluster will be constructed to provide representative groundwater samples, adequately monitor the uppermost aquifer, document groundwater flow, and the potential for groundwater flow reversals due to elevated river stages.

The WAP-6 well cluster will be installed in accordance with 329 IAC 10-21-4, as specified in the 20 December 2019 “Approval of Closure/Post-Closure Plan”. The well installation will follow the design of the construction of the WAP-4 and WAP-5 cluster but will be modified to ensure no more than 20 feet of separation between monitoring wells. The construction diagram and soil boring logs for the WAP-4 and WAP-5 cluster are included in Appendix A. Based on the information obtained from previous drilling explorations and mapping of the top of the underlying bedrock, the estimated terminal depth of the WAP-6 well cluster will be 120 feet below ground surface. The anticipated construction details of the WAP-6 cluster are provided in Table 1.

The WAP-6 cluster will be constructed with 2-inch inside diameter Schedule 40 PVC casing; a 10-foot long, 0.01-inch machine slotted PVC screen; and a locking, steel, 5-foot long protective casing or a steel, 8-inch flush mount manway cover. When possible, the shallow well screen will be placed so that the encountered water table is approximately five feet above the top of the well screen. Seasonal low water table elevations were used to determine if sufficient space was available to maintain five feet of water above the well screens and remain within the uppermost aquifer.

At each monitoring well, the top of the PVC well casing will be surveyed by a registered Indiana surveyor to within 0.01 foot, and the ground surface will be surveyed to 0.1 foot. Each sample location will be surveyed to North American Datum of 1988. All downhole drilling equipment will be cleaned prior to use at the next well location. Well casing and screens will be new and protected by factory packaging. Wells will be installed according to the procedures described below.

The WAP-6 cluster will be installed using conventional hollow-stem auger drilling. Soil sampling will be performed while advancing the borehole using standard split-spoon sampling on 5-foot centers to provide samples for soil descriptions and to estimate the depth to groundwater. Filter sand will be added by gravity from the bottom of the borehole to approximately two feet above the top of the well screen as the augers are withdrawn from the borehole. The filter pack will be surged as the sand is emplaced to promote proper packing and to minimize the potential for settlement of the filter pack following placement of the bentonite seal. Approximately two feet of bentonite pellets will be added by gravity above the sand pack to seal the well screen. Grout will be emplaced by tremie pipe into the remaining annular space. The depth of the filter sand, bentonite seal, and annular space seal will be carefully measured to 0.1 feet prior to the installation of the next layer. Steel protective casings or manholes will be installed with a 2-foot by 2-foot square concrete pad sloping away from the casing. If above grade steel protective casings are installed, a weep hole will be drilled at the base of the protective casing just above the concrete pad.

The WAP-6 cluster will be developed after construction by surging and purging each well with a pump. The pump will be decontaminated by submersing the pump and pumping through a soapy water solution, followed by a distilled water rinse. For wells that cannot be purged dry, development will be considered complete when a minimum of ten (10) well volumes of groundwater are removed, purge water is free of turbidity, and field indicator parameters are stable. For wells that can be purged dry, a minimum of four (4) well volumes of groundwater will be removed.

The proposed drilling operations associated with the construction of the WAP-6 cluster will be conducted following completion of pond closure activities.

3. Piezometer Installation

In addition to the WAP-6 well cluster described above, piezometers PZ-S-1 and PZ-S-2 will be located on the south side of the closed WAP as presented in Figure 1.

The installation of these piezometers will comply with safety requirements and ensure work will be performed without the risk of arching overhead powerlines to the rig and mast rods. The piezometers will adequately document groundwater flow and evaluate the potential for groundwater flow reversals. PZ-S-1 and PZ-S-2 will be installed in a location chosen to fill the gap between the southern boundary of the former pond boundary and the boundary of the Closure-in-Place area.

PZ-S-1 and PZ-S-2 will be installed in accordance with 329 IAC 10-21-4 as specified in the 20 December 2019 “Approval of Closure/Post-Closure Plan”. The piezometer installation will follow the design of the construction of the WAP-4S and WAP-5S. The construction diagram and soil boring logs for WAP-4S and WAP-5S are included in Appendix A. The estimated elevation of the PZ-S-1 and PZ-S-2 well screens will be approximately 350 feet above mean sea level which correlates to the base flow elevation of the Ohio River. The anticipated construction details of PZ-S-1 and PZ-S-2 are provided in Table 1. Section 2 of this Work Plan describes the drilling techniques that will be used to install PZ-S-1 and PZ-S-2.

4. Additional Monitoring Well Installation to Comply with the CCR Rule

Haley & Aldrich proposes to install additional monitoring wells at the southern and western boundary of the closed CCR Unit to comply with CCR Rule §257.91(c). Prior to initiating closure of the WAP, a CCR Rule compliant monitoring network was installed to monitor groundwater quality downgradient of the former pond boundary. Closure of the WAP has reduced the footprint of waste, thereby requiring the installation of additional compliance monitoring wells at the boundary of the Closure-in-Place area. The additional monitoring wells will provide sufficient coverage to monitor the closed WAP and comply with §257.91(c). The proposed monitoring well depths are provided in Table 1. The location of these monitoring wells is presented in Figure 1.

The installation of these monitoring wells will comply with safety requirements and ensure work will be performed without the risk of arching overhead powerlines to the rig and mast rods. In addition, the gas line in the vicinity of the proposed locations will be marked out by CenterPoint Energy to ensure the line is not struck while drilling.

The proposed WAP-3 monitoring well cluster will include a new shallow monitoring well (WAP-3S) and a new deep monitoring well (WAP-3D). The existing monitoring well WAP-3, which will now be referred to as WAP-3I, was installed in the former Little Pigeon Creek channel and was set at approximately 73 feet below ground surface.

The proposed WAP-7 and WAP-8 monitoring well clusters will include a shallow monitoring well screened in the uppermost aquifer and a deep monitoring well screened at the top of bedrock. These two proposed monitoring well clusters will be installed on the south and west side of the closed WAP. Geotechnical borings, previously installed in the vicinity of the proposed locations for WAP-7 and WAP-8, showed that the thickness of the uppermost aquifer decreases to the north. As a result, it is anticipated that the uppermost aquifer can be adequately monitored by a two well cluster (shallow and deep) and that a three-well cluster (shallow, intermediate, and deep) will not be required. If bedrock is deeper than anticipated at these locations, a third well will be added to monitor the intermediate zone. The WAP-7 and WAP-8 monitoring well cluster will be used for post-closure monitoring at the boundary of the Closure-in-Place area and establish a monitoring network that complies with §257.91 of the CCR Rule.

These monitoring wells will be installed according to the procedures outlined in Section 2 of this Work Plan.

5. Reporting

A monitoring well installation report detailing the procedures used for drilling and installing the monitoring wells and piezometers will be prepared and submitted to IDEM within sixty (60) days after completion of field activities. The monitoring well installation report will comply with 329 IAC 10-21-4 and D3 of the 20 December 2019 IDEM approval letter and will contain the following:

- Figure(s) showing the location of newly installed monitoring wells and piezometers
- Description of drilling procedures
- Soil boring and construction logs
- Well development information
- Detailed hydraulic conductivity testing

The monitoring well installation report will include the horizontal and vertical survey information with ground surface elevation measured to the nearest 0.1 foot and the referenced top of casing mark measured to the nearest 0.01 foot. The results of hydraulic conductivity testing will be summarized in tables. The installation report for all the monitoring wells and piezometers will also be included in the 2020 Annual Report and placed in the operating record as stated by §257.90(e)(2) and §257.91(e)(1).

TABLES

TABLE 1
PROPOSED CONSTRUCTION DETAILS FOR MONITORING WELLS AND PEIZOMETERS
F.B. CULLEY GENERATING STATION - WEST ASH POND
NEWBURGH, INDIANA

Monitoring Well	Proposed Total Depth (ft bgs)	Poposed Screen Interval (ft bgs)	Screen Length (ft)	Well Radius (in)
WAP-3S	60.0	50.0-60.0	10.0	2.0
WAP-3D	85.0	75.0-85.0	10.0	2.0
WAP-6S	60.0	60.0-70.0	10.0	2.0
WAP-6I	90.0	80.0-90.0	10.0	2.0
WAP-6D	120.0	110.0-120.0	10.0	2.0
WAP-7S	60.0	50.0-60.0	10.0	2.0
WAP-7D	80.0	70.0-80.0	10.0	2.0
WAP-8S	60.0	50.0-60.0	10.0	2.0
WAP-8D	80.0	70.0-80.0	10.0	2.0
PZ-S-1	60.0	50.0-60.0	10.0	2.0
PZ-S-2	60.0	50.0-60.0	10.0	2.0

NOTES:
bgs = below ground surface
ft = feet
in = inches
msl = mean sea level

FIGURES

LEGEND

- EXISTING CCR COMPLIANCE MONITORING WELL
- PROPOSED MONITORING WELL
- EXISTING MONITORING WELL
- PROPOSED PIEZOMETER=
- EXISTING PIEZOMETER
- APPROXIMATE CCR BOUNDARY
- APPROXIMATE F.B. CULLEY PROJECT BOUNDARY
- APPROXIMATE LOCATION OF CLOSED WEST ASH POND

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: GOOGLE 2018

N

0 200 400
APPROXIMATE SCALE IN FEET

HALEY ALDRICH

SIGECO
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, IN 47630

PROPOSED MONITORING WELLS AND PIEZOMETER LOCATIONS

FEBRUARY 2020

FIGURE 1

GIS FILE PATH: G:\boi_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2020_02\129420_001_0001_CULLEY_WAP_PROP_MON_WELLS_PIEZ.mxd — USER: afeigl — LAST SAVED: 2/18/2020

APPENDIX A

WAP-4 and WAP-5 Well Construction and Boring Logs

TEST BORING REPORT

Boring No. WAP-4D

Project	Vectren FB Culley West Ash Pond, FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling

File No. 42796-004
Sheet No. 1 of 5
Start 05 February 2016
Finish 05 February 2016
Driller J. Gryska
H&A Rep. S. Lewis

Elevation 395.3
Datum NGVD 88
Location See Plan
N 970,413
E 2,881,325

	Casing	Sampler	Barrel
Type	HSA	S	-
Inside Diameter (in.)	4.25	1.375	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures
Rig Make & Model: CME 850 XR
Bit Type: Cutting Head
Drill Mud:
Casing:
Hoist/Hammer:
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							REFER TO AECOM's BORING B15-13 FOR LITHOLOGY										
5																	
10																	
15																	
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 126
Rock Cored (ft) -
Samples

Boring No. WAP-4D

Field Tests:
Dilatancy: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-07-1 HA-LIB09.GLB HA-TB+CORE+WELL-07-1.GDT \\GRN\COMMON\42796 - VECTREN\004\GINT LOGS\42796-004TB_OW_WELL.GPJ 14 Apr 16

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																	
25																	
30																	
35																	
40																	
45																	

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No.	WAP-4D
File No.	42796-004
Sheet No.	3 of 5

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50																	
55																	
60																	
65																	
70																	
75																	

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
80																	
85																	
90																	
95																	
100																	
105																	

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
110																	
115																	
120																	
125																	
					269.3 126.0												

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

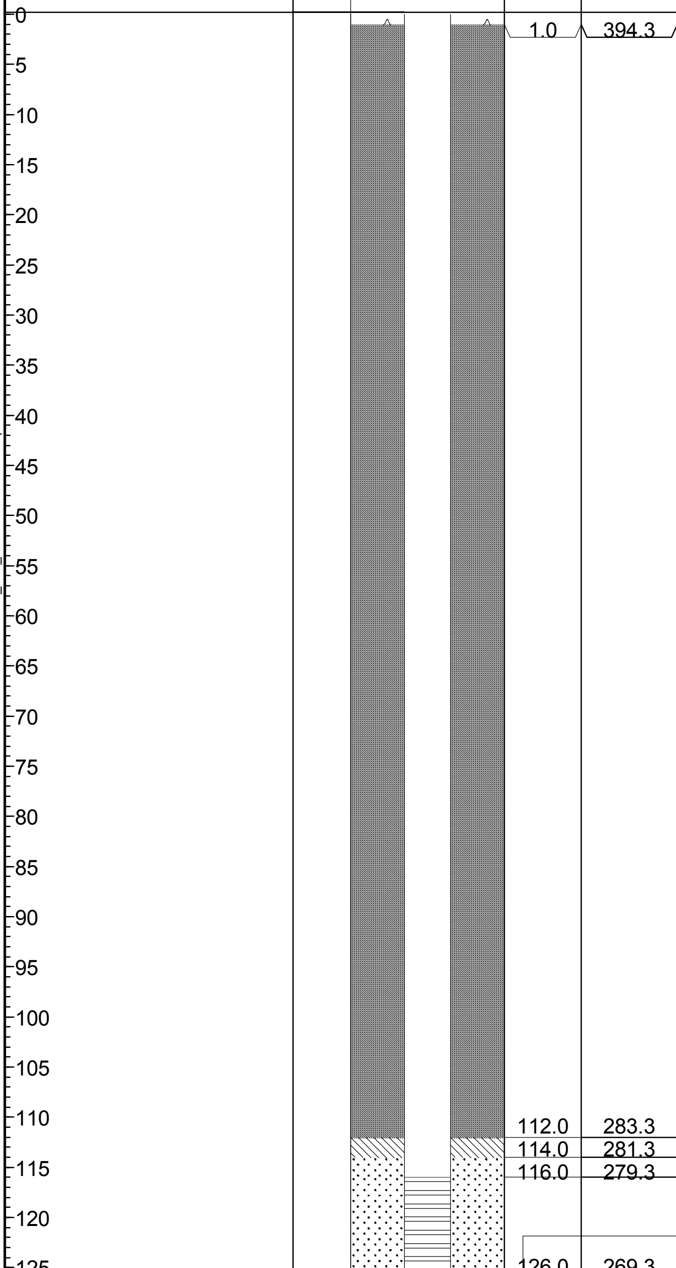
Well No.
Boring No. WAP-4D

Project	Vectren FB Culley West Ash Pond
Location	FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling
Driller	J. Gryska
Initial Water Level (depth bgs)	ft

Well Diagram: Riser Pipe; Screen; Filter Sand; Cuttings; Grout; Concrete; Bentonite Seal

File No.	42796-004
Date Installed	05 Feb 2016
H&A Rep.	S. Lewis
Location	N 970412.71 E 2881325.08
Ground El.	395.3
Datum	NGVD 88

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)
				1.0	394.3
				112.0	283.3
				114.0	281.3
				116.0	279.3
	126.0			126.0	269.3



WELL CONSTRUCTION DETAILS

Type of protective cover	Stick-up Guard Pipe
Depth of Steel below ground surface	NA
Height of top of riser above ground surface	NA
Type of protective casing	Steel
Length	
Inside diameter	4.0 in.
Depth of bottom of Steel	-
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	116.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	1.0	111.0
Bentonite	112.0	2.0
Sand	114.0	12.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	116.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Quartz Sand
Depth to bottom of well screen	126.0 ft
Bottom of silt trap	126.0 ft
Depth of bottom of borehole	126.0 ft

COMMENTS: South side of west ash pond.

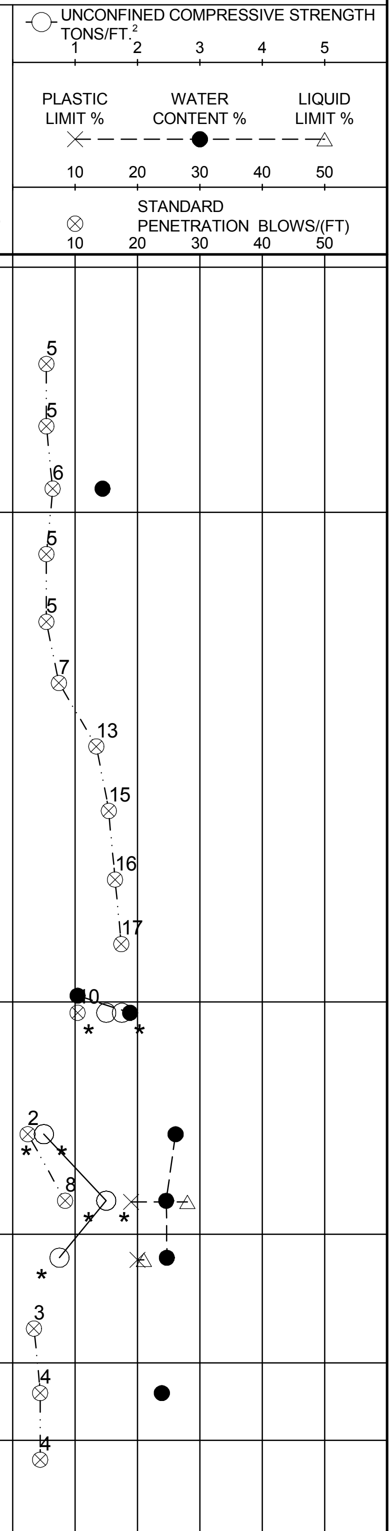
AECOM

OWNER: **Vectren Corporation**	LOG OF BORING NUMBER **B15-13**
PROJECT NAME: **Vectren CCR - West Ash Pond Closure**	ARCHITECT-ENGINEER: **AECOM**

SITE LOCATION
F.B. Culley Generating Station, Warrick County, Indiana

SURFACE ELEVATION +395.4

DEPTH(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
0.5			FILL: GRAVEL (GP)	
			FILL: SAND - some gravel and silt - brown - moist loose (SP)	
5.0	1	SS		
	2	SS		
10.0	3	SS		
10.0			FILL: SAND - some gravel - brown - moist to wet - loose to medium dense (SP)	
	4	SS		
15.0	5	SS		
	6	SS		
20.0	7	SS		
	8	SS		
25.0	9	SS		
	10	SS		
29.0	11A	SS		
30.0	11B	SS	CLAY - some sand - little silt - gray - medium to stiff (CL)	
	12	ST		
35.0	13	SS		
	14	SS		
38.0			fine SILTY SAND - some clay - brown - wet - very loose to loose (SM)	
40.0	15	ST		101
	16	SS		
43.0			SANDY CLAY - some silt - brown (CL)	
45.0	17	SS		
46.0			fine SAND - some clay and silt - brown - wet - very loose - (SP-SM)	
	18	SS		
50.0	19	ST		



. . . continued

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

AECOM JOB NO. 60442676.9050 SHEET NO. 1 OF 3

AECOM	OWNER: **Vectren Corporation**	LOG OF BORING NUMBER: **B15-13**
	PROJECT NAME: **Vectren CCR - West Ash Pond Closure**	ARCHITECT-ENGINEER: **AECOM**

SITE LOCATION
F.B. Culley Generating Station, Warrick County, Indiana

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2}: 1 2 3 4 5
PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %: 10 20 30 40 50
STANDARD PENETRATION BLOWS/(FT): 10 20 30 40 50

SURFACE ELEVATION +395.4 (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}	STANDARD PENETRATION BLOWS/(FT)
		20	SS	fine SAND - some clay and silt - brown - wet - very loose - (SP-SM)		4
52.0				fine SAND - some gravel - brown - wet - loose to medium dense (SP)		
55.0		21	SS			12
60.0		22	SS			4
62.0				SILTY GRAVEL and SAND - trace clay - brown - wet - medium dense (GP-GM)		
65.0		23	SS			15
				Cobbles while drilling		
68.0				fine SAND - some gravel - brown to gray - wet - loose to medium dense (SP)		
70.0		24	SS			9
75.0		25	SS			24
80.0		26	SS			15
85.0		27	SS			19
90.0		28	SS			15
95.0		29	SS			31
100.0		30	SS			22

. . . continued

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

AECOM JOB NO. 60442676.9050 SHEET NO. 2 OF 3

AECOM

OWNER	LOG OF BORING NUMBER
Vectren Corporation	**B15-13**
PROJECT NAME	ARCHITECT-ENGINEER
Vectren CCR - West Ash Pond Closure	**AECOM**

SITE LOCATION
F.B. Culley Generating Station, Warrick County, Indiana

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2}: 1, 2, 3, 4, 5
PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %: 10, 20, 30, 40, 50
STANDARD PENETRATION BLOWS/(FT): 10, 20, 30, 40, 50

SURFACE ELEVATION +395.4 (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}	STANDARD PENETRATION BLOWS/(FT)
				fine SAND - some gravel - brown to gray - wet - loose to medium dense (SP)		
105.0		31	SS			15
				Cobbles while drilling		
110.0		32	SS			22
115.0		33	SS			13
120.0		34	SS			13
125.0		35	SS			11
126.0				SHALE - gray		
127.8		36	SS			50/3"
127.8				End of Boring Pulled Augers to 53' below ground surface Borehole collapsed to 53.5 ' below ground surface Set 2 inch PVC well screen from 53' to 43' below ground surface Placed sand pack from 43' to 41' below ground surface Placed bentonite seal from 41' to 38' below ground surface Boring backfilled with cement/bentonite grout from 38' to the ground surface	* Calibrated Penetrometer	

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

NORTHING **970405.4**	BORING STARTED **1/20/16**	AECOM OFFICE	
EASTING **2881333.1**	BORING COMPLETED **1/20/16**	ENTERED BY	SHEET NO. **3** OF **3**
WL **28.5 WD**	RIG/FOREMAN **Mobil B53 ATV/ATC**	APP'D BY	AECOM JOB NO. **60442676.9050**

TEST BORING REPORT

HALEY ALDRICH

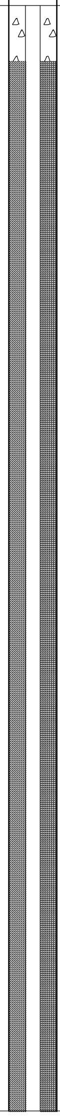
Boring No. WAP-4I

Project	Vectren FB Culley West Ash Pond, FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling

File No.	42796-004
Sheet No.	1 of 5
Start	05 February 2016
Finish	05 February 2016
Driller	J. Gryska
H&A Rep.	S. Lewis
Elevation	395.3
Datum	NGVD 88
Location	See Plan N 970,409 E 2,881,329

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	-	Rig Make & Model: CME 850 XR
Inside Diameter (in.)	4.25	1.375	-	Bit Type: Cutting Head Drill Mud:
Hammer Weight (lb)	-	140	-	Casing: Hoist/Hammer:
Hammer Fall (in.)	-	30	-	PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0							REFER TO AECOM's BORING B15-13 FOR LITHOLOGY										
5																	
10																	
15																	
20																	



Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	85
Rock Cored (ft)	-
Samples	

Boring No. WAP-4I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-07-1 HA-LIB09.GLB HA-TB+CORE+WELL-07-1.GDT \\GRN\COMMON\42796 - VECTREN\004\GINT LOGS\42796-004TB_OW_WELL.GPJ 14 Apr 16

HALEY ALDRICH

TEST BORING REPORT

Boring No. WAP-4I
File No. 42796-004
Sheet No. 2 of 5

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																	
25																	
30																	
35																	
40																	
45																	

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. WAP-4I

TEST BORING REPORT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50																	
55																	
60																	
65																	
70																	
75																	

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. WAP-4I
File No. 42796-004
Sheet No. 4 of 5

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
80																	
85					310.3 85.0												

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. WAP-4I

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No.
Boring No. WAP-4I

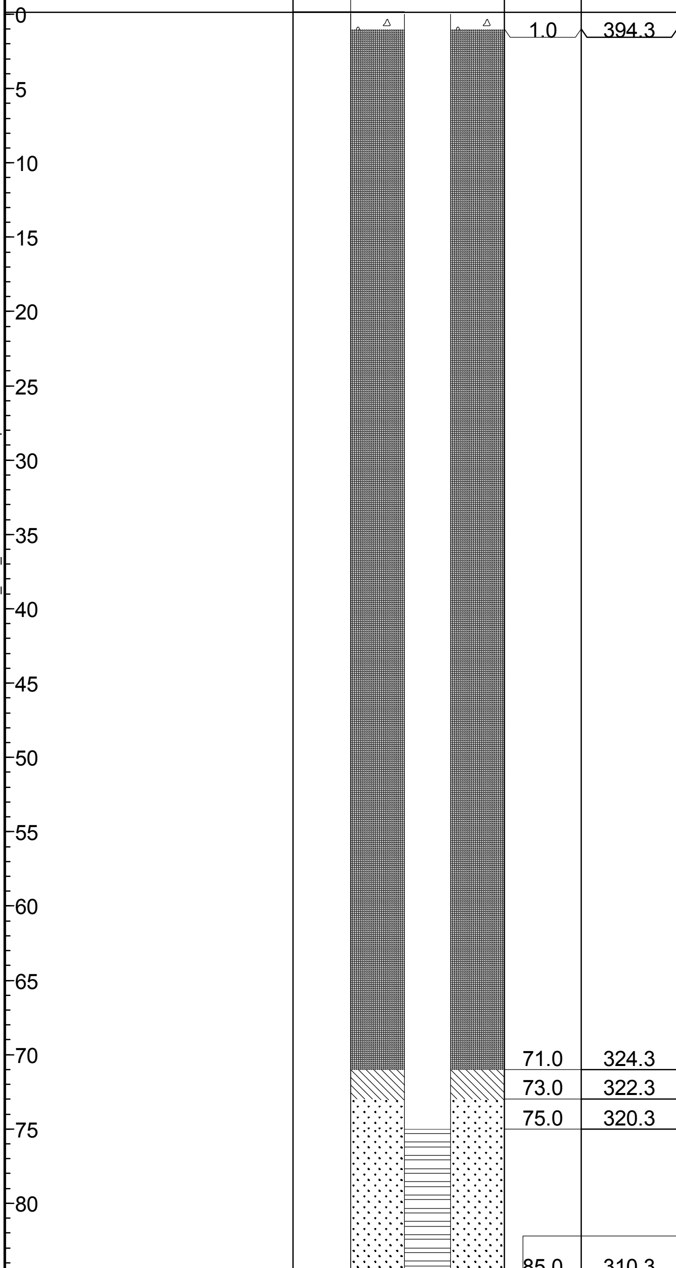
Project	Vectren FB Culley West Ash Pond
Location	FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling
Driller	J. Gryska
Initial Water Level (depth bgs)	ft

Well Diagram: Riser Pipe; Screen; Filter Sand; Cuttings; Grout; Concrete; Bentonite Seal

File No. 42796-004
Date Installed 05 Feb 2016
H&A Rep. S. Lewis
Location N 970408.95
E 2881329.18

Ground El. 395.3
Datum NGVD 88

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)
				1.0	394.3
				71.0	324.3
				73.0	322.3
				75.0	320.3
	85.0			85.0	310.3



WELL CONSTRUCTION DETAILS

Type of protective cover	Stick-up Guard Pipe
Depth of Steel below ground surface	NA
Height of top of riser above ground surface	NA
Type of protective casing	Steel
Length	
Inside diameter	4.0 in.
Depth of bottom of Steel	-
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	75.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	1.0	70.0
Bentonite	71.0	2.0
Sand	73.0	12.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	75.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Quartz Sand
Depth to bottom of well screen	85.0 ft
Bottom of silt trap	85.0 ft
Depth of bottom of borehole	85.0 ft

COMMENTS: South side of west ash pond.

TEST BORING REPORT

HALEY ALDRICH

Boring No. WAP-4

Project	Vectren FB Culley West Ash Pond, FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling

File No.	42796-004
Sheet No.	1 of 1
Start	
Finish	
Driller	J. Gryska
H&A Rep.	S. Lewis
Elevation	395.3
Datum	NGVD 88
Location	See Plan N 970,405 E 2,881,333

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	-	Rig Make & Model: CME 850 XR
Inside Diameter (in.)	4.25	1.375	-	Bit Type: Cutting Head
Hammer Weight (lb)	-	140	-	Drill Mud:
Hammer Fall (in.)	-	30	-	Casing:
				Hoist/Hammer:
				PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							REFER TO AECOM's BORING B15-13 FOR LITHOLOGY										
5																	
10																	
15																	
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	55
Rock Cored (ft)	-
Samples	

Boring No. WAP-4

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

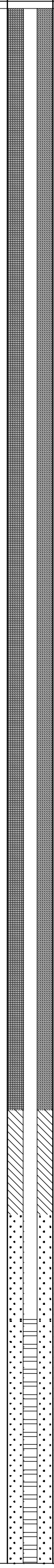
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. WAP-4
File No. 42796-004

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	**VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION** (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand				Field Test			
								% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
20																	
25																	
30																	
35																	
40																	
45																	



NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. WAP-4

TEST BORING REPORT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50																	
55					340.3 55.0												

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No.
Boring No. WAP-4

Project	Vectren FB Culley West Ash Pond
Location	FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling
Driller	J. Gryska

Initial Water Level (depth bgs) ft

Well Diagram: Riser Pipe; Screen; Filter Sand; Cuttings; Grout; Concrete; Bentonite Seal

File No. 42796-004
Date Installed
H&A Rep. S. Lewis
Location N 970405.14, E 2881333.33

Ground El. 395.3
Datum NGVD 88

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)
	0		Concrete	1.0	394.3
			Grout	41.0	354.3
			Bentonite Seal	43.0	352.3
			Filter Sand / Riser Pipe	45.0	350.3
	55.0		Screen / Filter Sand	55.0	340.3

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

WELL CONSTRUCTION DETAILS

Type of protective cover	Stick-up Guard Pipe
Depth of Steel below ground surface	NA
Height of top of riser above ground surface	NA
Type of protective casing	Steel
Length	
Inside diameter	4.0 in.
Depth of bottom of Steel	-
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	45.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	1.0	40.0
Bentonite	41.0	2.0
Sand	43.0	12.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	45.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Quartz Sand
Depth to bottom of well screen	55.0 ft
Bottom of silt trap	55.0 ft
Depth of bottom of borehole	55.0 ft

COMMENTS: South side of west ash pond.

TEST BORING REPORT

Boring No. WAP-5D

Project	Vectren FB Culley West Ash Pond, FB Culley Generating Station	File No.	42796-004
Client	Southern Indiana Electric Company	Sheet No.	1 of 5
Contractor	Stearns Drilling	Start	04 February 2016
		Finish	04 February 2016
		Driller	J. Gryska
		H&A Rep.	S. Lewis

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	-	Rig Make & Model: CME 850 XR
Inside Diameter (in.)	4.25	1.375	-	Bit Type: Cutting Head
Hammer Weight (lb)	-	140	-	Drill Mud:
Hammer Fall (in.)	-	30	-	Casing:
				Hoist/Hammer:
				PID Make & Model:

Elevation 394.4
Datum NGVD 88
Location See Plan
N 970,230
E 2,881,529

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							0.0 ft to 2.0 ft crushed stone, angular 0.5 ft to 2.0 ft coal ash 2.0 ft to 3.5 ft -FILL-										
	5 6 9 9	S1 15	3.5 5.5		390.9 3.5	SM	Medium dense brown silty SAND with gravel (SM), mps 1.0 in., no odor, moist, rounded gravel -FILL-	5	10	5	10	50	20	N	L	N	N
5																	
	2 5 6 5	S2 18	8.5 10.5			SM	Similar to above	5	10	5	10	50	20	N	L	N	N
10																	
	1 3 3 3	S3 13	13.5 15.5			SM	Similar to above except loose	5	10	5	10	50	20	N	L	N	N
15																	
	1 2 2	S4 12	18.5 20.5			SM	Similar to above except dark brown	5	10	5	10	50	20	N	L	N	N
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 123
Rock Cored (ft) -
Samples 24S

Boring No. WAP-5D

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. WAP-5D
File No. 42796-004
Sheet No. 2 of 5

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	2																
	3 5 7 9	S5 24	23.5 25.5		370.9 23.5	CL	Stiff dark gray lean CLAY (CL), no odor, moist, mica present -ALLUVIUM-					5	95	N	M	M	M
25																	
	1 2 3 4	S6 19	28.5 30.5			CL	Medium stiff dark gray lean CLAY with sand (CL), no odor, moist, mica present					25	75	N	M	M	M
30																	
	1 2 2 3	S7 24	33.5 35.5			CL	Soft brown gray sandy lean CLAY (CL), no odor, wet, mica present, clay lenses					20	80	N	M	M	M
35																	
	0 0 2 3	S8 24	38.5 40.5			CL	Soft brown lean CLAY with sand (CL), no odor, wet, mica present					20	80	N	M	M	M
					354.9 39.5	SC	Loose brown clayey SAND (SC), no odor, wet, mica present -ALLUVIUM-					65	35	N	L	M	
40																	
	0 0 0 3	S9 24	43.5 45.5		350.9 43.5	CL	Soft brown lean CLAY with sand (CL), no odor, wet, mica present -ALLUVIUM-					30	70				
					349.9 44.5	SC	Loose brown clayey SAND (SC), no odor, wet -ALLUVIUM-					65	35				
45																	
	0 2 2	S10 24	48.5 50.5		345.9 48.5	CL	Soft brown CLAY with sand (CL), no odor, wet, mica present, clay lenses, laminated layers of clay and sand					20	80				

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. WAP-5D

TEST BORING REPORT

HALEY ALDRICH

Boring No. WAP-5D
File No. 42796-004
Sheet No. 3 of 5

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50	2						-ALLUVIUM-										
	3 5 7 9	S11 13	53.5 55.5		340.9 53.5	SC	Medium dense brown well graded clayey SAND (SC), no odor, wet, mica present, rounded gravel -ALLUVIUM-		5	10	20	45	20				
55																	
	7 9 14 17	S12 24	58.5 60.5		335.9 58.5	SP- SC	Medium dense brown poorly graded SAND (SP-SC), no odor, wet, fining upward sequence, rounded gravel -ALLUVIUM-		5	5	20	60	10				
60																	
	7 6 7 9	S13 15	63.5 65.5			SP- SC	Medium dense brown poorly graded SAND with clay (SP-SC), no odor, wet, trace rounded gravel		5	5	20	60	10				
65																	
	10 11 7 11	S14 14	68.5 70.5			SP- SC	Similar to above		5	5	30	50	10				
70																	
	10 12 14 15	S15 20	73.5 75.5			SP- SC	Medium dense brown poorly graded SAND with clay and gravel (SP-SC), mps 0.2 in., no odor, wet, rounded gravel and sand	5	5	10	30	40	10				
75																	
	3 4	S16 17	78.5		315.9 78.5	SW- SC	Medium dense brown well graded SAND with clay (SW-SC), mps 0.2 in., no odor, wet, rounded sand			20	30	40	10				

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. WAP-5D

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
80	5 7		80.5				-ALLUVIUM-										
85	8 14 15 18	S17 24	83.5 85.5		310.9 83.5	SP- SC	Dense brown poorly graded SAND with clay (SP-SC), mps 0.5 in., no odor, wet, weathered shale present, weathered sandstone present -ALLUVIUM-		5	10	15	60	10				
90	8 8 12 19	S18 22	88.5 90.5			SP- SC	Medium dense gray poorly graded SAND with clay (SP-SC), mps 1.0 in., no odor, wet, weathered shale, weathered sandstone pieces present, rounded piece of granite found	5	5	10	15	55	10				
95	8 12 13 15	S19 18	93.5 95.5			SP- SC	Medium dense gray poorly graded SAND with clay (SP-SC), mps 1.0 in., no odor, wet, small pieces weathered shale present, rounded gravel	5	5	10	25	45	10				
100	3 5 9 10	S20 15	98.5 100.5		295.9 98.5	SW- SC	Medium dense gray well graded SAND with clay and gravel (SW-SC), mps 1.0 in., no odor, wet, small pieces weathered shale present, rounded sand and gravel, fining upward sequence -ALLUVIUM-		10	10	25	45	10				
105	8 6 6 9	S21 16	103.5 105.5		290.9 103.5	SW	Medium dense gray well graded SAND with gravel (SW), no odor, wet, rounded sand and gravel -ALLUVIUM-	10	20	10	25	30	5				
	19	S22	108.5														

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
110	22 17 6	3	110.5			SW	Similar to above	10	20	10	25	30	5				
115	5 9 8 10	S23 16	113.5 115.5			SW	Medium dense gray well graded SAND with gravel (SW), no odor, wet, rounded sand and gravel	20	20	10	20	25	5				
120	5 9 8 10	S24 20	118.5 120.5			SW	Medium dense gray well graded SAND with gravel (SW), no odor, wet, rounded sand and gravel, shale fragments present, limestone fragments present, possible mollusks in limestone fragment		20	10	35	30	5				
							Coral found when they were bailing sand from augers.										
					271.4 123.0		-BOTTOM OF EXPLORATION 123.0 FT Note: Weathered shale, clayey, soft at 123.0 ft										

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No.
Boring No. WAP-5D

Project	Vectren FB Culley West Ash Pond
Location	FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling
Driller	J. Gryska

Initial Water Level (depth bgs) ft

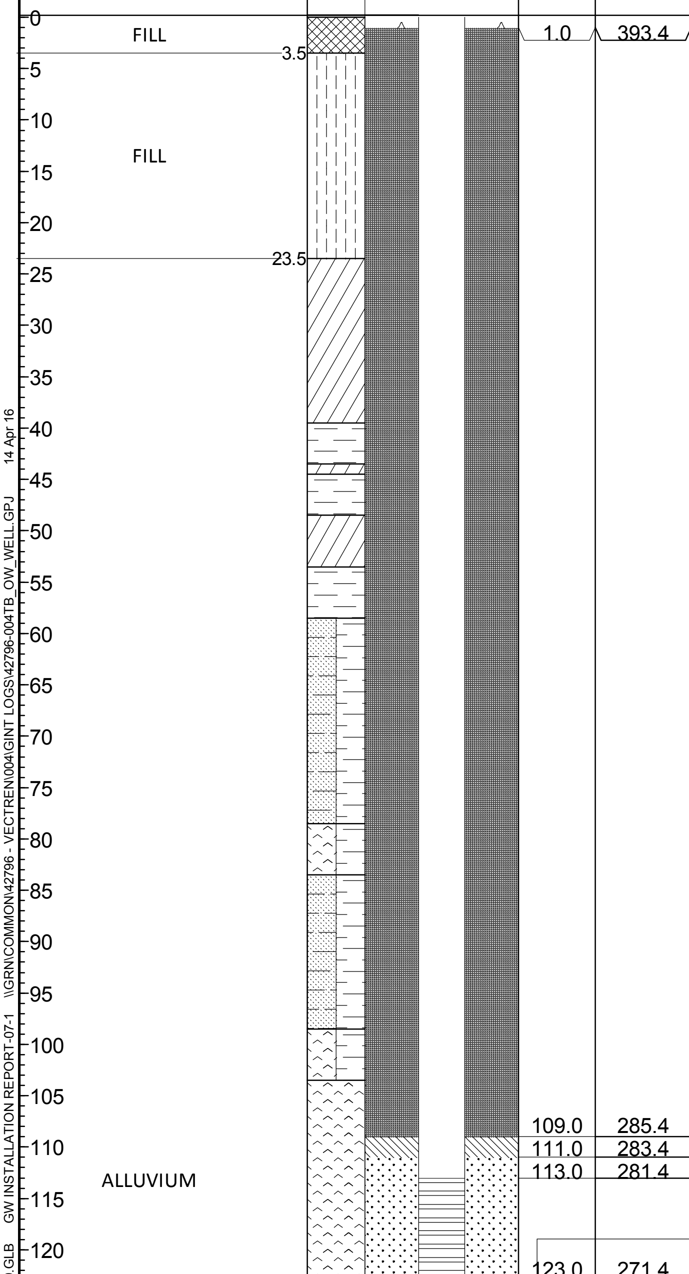
Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No. 42796-004
Date Installed 04 Feb 2016
H&A Rep. S. Lewis
Location N 970229.88
E 2881528.71

Ground El. 394.4
Datum NGVD 88

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)
FILL	0 – 3.5			1.0	393.4
FILL	3.5 – 23.5				
	23.5				
ALLUVIUM				109.0	285.4
				111.0	283.4
				113.0	281.4
	123.0			123.0	271.4



WELL CONSTRUCTION DETAILS

Type of protective cover	Stick-up Guard Pipe
Depth of Steel below ground surface	NA
Height of top of riser above ground surface	NA
Type of protective casing	Steel
Length	
Inside diameter	4.0 in.
Depth of bottom of Steel	-
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	113.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	1.0	108.0
Bentonite	109.0	2.0
Sand	111.0	12.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	113.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Quartz Sand
Depth to bottom of well screen	123.0 ft
Bottom of silt trap	123.0 ft
Depth of bottom of borehole	123.0 ft

COMMENTS: South side of west ash pond.

HALEY ALDRICH

TEST BORING REPORT

Boring No. WAP-5I

Project	Vectren FB Culley West Ash Pond, FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling

File No.	42796-004
Sheet No.	1 of 4
Start	02 February 2016
Finish	03 February 2016
Driller	J. Gryska
H&A Rep.	S. Lewis
Elevation	394.4
Datum	NGVD 88
Location	See Plan N 970,233 E 2,881,525

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	-	Rig Make & Model: CME 850 XR
Inside Diameter (in.)	4.25	1.375	-	Bit Type: Cutting Head
Hammer Weight (lb)	-	140	-	Drill Mud:
Hammer Fall (in.)	-	30	-	Casing:
				Hoist/Hammer:
				PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0							REFER TO BORING WAP-5D FOR LITHOLOGY -FILL-										
					390.9 3.5	SM	-FILL-										
5																	
10																	
15																	
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	85
Rock Cored (ft)	-
Samples	26S

Boring No. WAP-5I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																	
					370.9 23.5	CL	-ALLUVIUM-										
25																	
30																	
35																	
					354.9 39.5	SC	-ALLUVIUM-										
40																	
					350.9 43.5	CL	-ALLUVIUM-										
					349.9 44.5	SC	-ALLUVIUM-										
45																	
					345.9 48.5	CL	-ALLUVIUM-										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50																	
					340.9 53.5	SC	-ALLUVIUM-										
55																	
					335.9 58.5	SP- SC	-ALLUVIUM-										
60																	
65																	
70																	
75																	
					315.9 78.5	SW- SC	-ALLUVIUM-										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
80																	
					310.9 83.5	SP- SC	-ALLUVIUM-										
85					309.4 85.0		-BOTTOM OF EXPLORATION 85.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

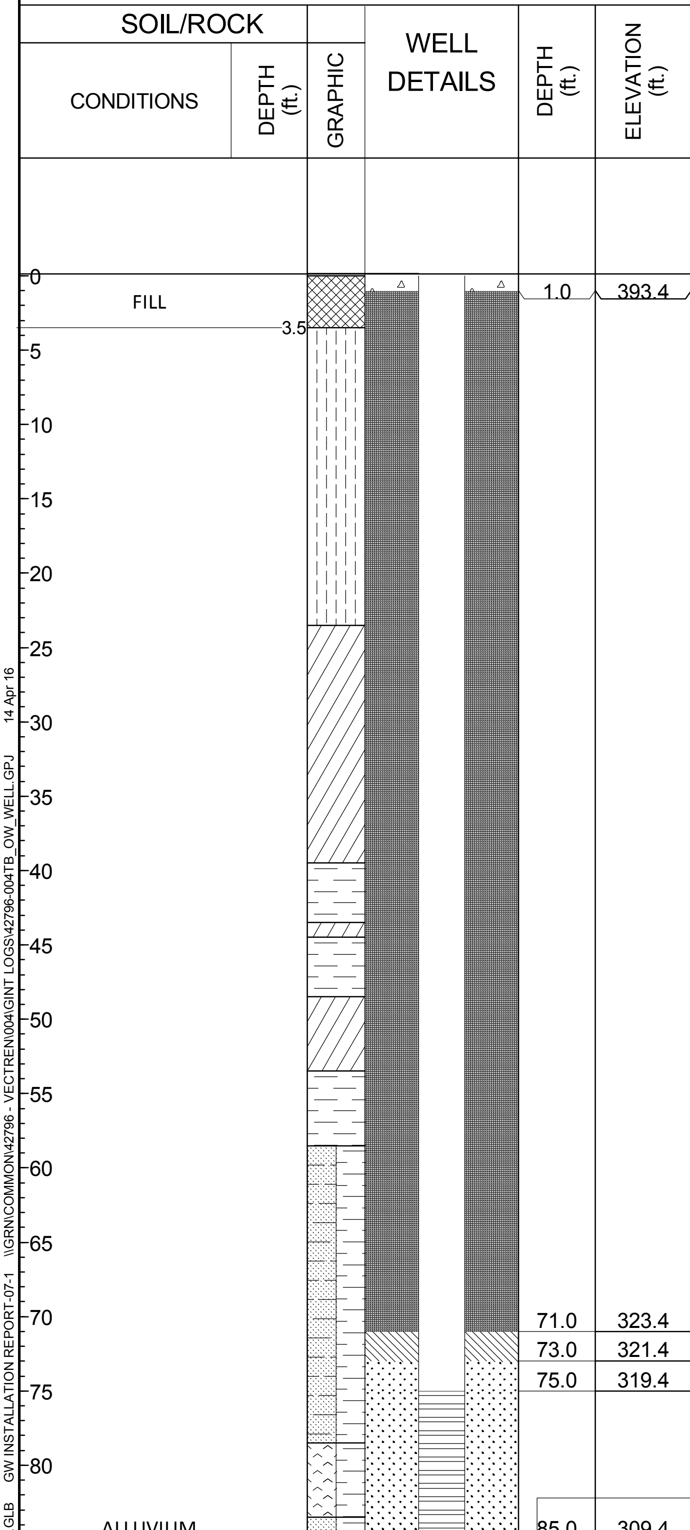
Well No.
Boring No. WAP-5I

Project	Vectren FB Culley West Ash Pond
Location	FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling
Driller	J. Gryska
Initial Water Level (depth bgs)	ft

Well Diagram: Riser Pipe, Screen, Filter Sand, Cuttings, Grout, Concrete, Bentonite Seal

File No. 42796-004
Date Installed 03 Feb 2016
H&A Rep. S. Lewis
Location N 970232.61
E 2881524.71

Ground El. 394.4
Datum NGVD 88



WELL CONSTRUCTION DETAILS

Type of protective cover	Stick-up Guard Pipe
Depth of Steel below ground surface	NA
Depth of top of riser below ground surface	NA
Type of protective casing	Steel
Length	
Inside diameter	4.0 in.
Depth of bottom of Steel	-
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	75.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	1.0	70.0
Bentonite	71.0	2.0
Sand	73.0	12.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	75.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Quartz Sand
Depth to bottom of well screen	85.0 ft
Bottom of silt trap	85.0 ft
Depth of bottom of borehole	85.0 ft

COMMENTS: South side of west ash pond.

TEST BORING REPORT

Boring No. WAP-5

Project	Vectren FB Culley West Ash Pond, FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling

File No.	42796-004
Sheet No.	1 of 3
Start	03 February 2016
Finish	03 February 2016
Driller	J. Gryska
H&A Rep.	S. Lewis
Elevation	394.4
Datum	NGVD 88
Location	See Plan N 970,236 E 2,881,521

	Casing	Sampler	Barrel
Type	HSA	S	-
Inside Diameter (in.)	4.25	1.375	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures
Rig Make & Model: CME 850 XR
Bit Type: Cutting Head
Drill Mud:
Casing:
Hoist/Hammer:
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							REFER TO WAP-5D FOR LITHOLOGY -FILL-										
					390.9 3.5	SM	-FILL-										
5																	
10																	
15																	
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	50
Rock Cored (ft)	-
Samples	26S

Boring No. WAP-5

Field Tests:
Dilatancy: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. WAP-5
File No. 42796-004
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																	
					370.9 23.5	CL	-ALLUVIUM-										
25																	
30																	
35																	
					354.9 39.5	SC	-ALLUVIUM-										
40																	
					350.9 43.5	CL	-ALLUVIUM-										
					349.9 44.5	SC	-ALLUVIUM-										
45																	
					345.9 48.5	CL	-ALLUVIUM-										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50					344.4 50.0		BOTTOM OF EXPLORATION 50.0										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No.
Boring No. WAP-5

Project	Vectren FB Culley West Ash Pond
Location	FB Culley Generating Station
Client	Southern Indiana Electric Company
Contractor	Stearns Drilling
Driller	J. Gryska

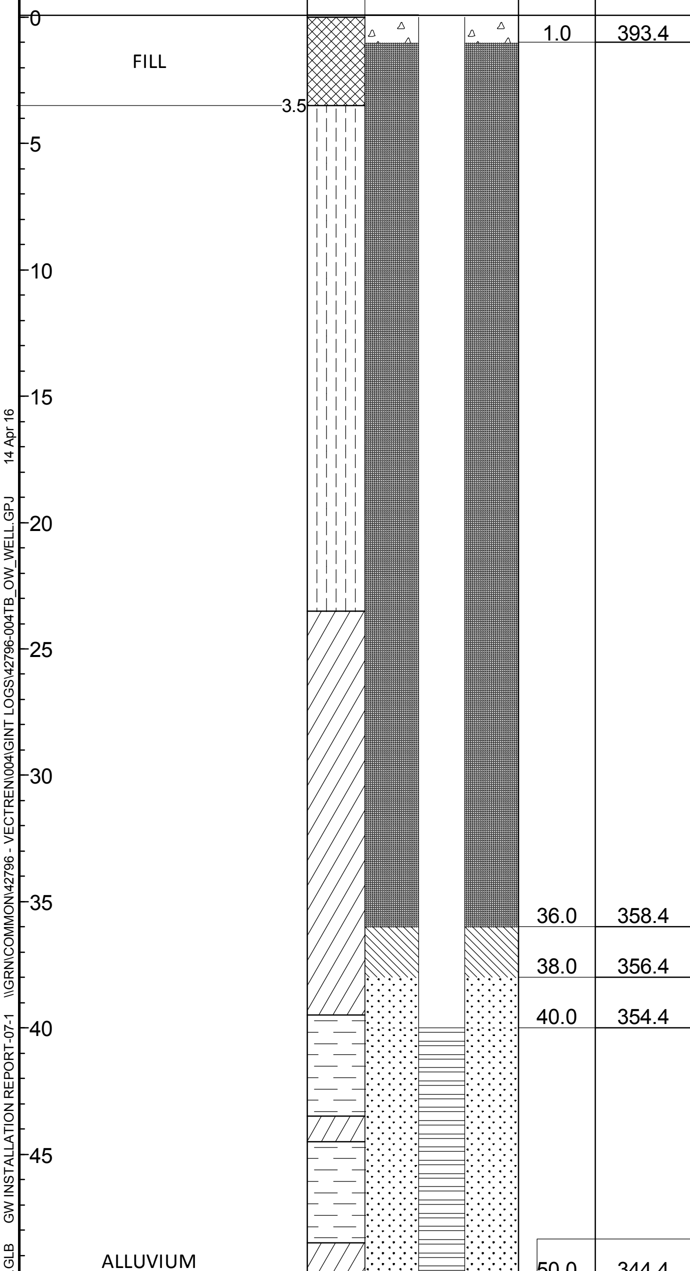
Initial Water Level (depth bgs) ft

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No. 42796-004
Date Installed 03 Feb 2016
H&A Rep. S. Lewis
Location N 970235.87
E 2881521.35

Ground El. 394.4
Datum NGVD 88

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)
FILL	0 – 3.5			1.0	393.4
				36.0	358.4
				38.0	356.4
				40.0	354.4
ALLUVIUM	50.0			50.0	344.4



WELL CONSTRUCTION DETAILS

Type of protective cover: Stick-up Guard Pipe

Height of Steel above ground surface: NA

Depth of top of riser below ground surface: NA

Type of protective casing: Steel

Length:

Inside diameter: 4.0 in.

Depth of bottom of Steel: -

Type of riser pipe: Schedule 40 PVC

Inside diameter of riser pipe: 2.0 in.

Depth of bottom of riser pipe: 40.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	1.0	35.0
Bentonite	36.0	2.0
Sand	38.0	12.0
	-	-

Diameter of borehole: 8.0 in.

Depth to top of well screen: 40.0 ft

Type of screen: Machine slotted Sch 40 PVC

Screen gauge or size of openings: 0.010 in.

Diameter of screen: 2.0 in.

Type of Backfill around Screen: Quartz Sand

Depth to bottom of well screen: 50.0 ft

Bottom of silt trap: 50.0 ft

Depth of bottom of borehole: 50.0 ft

COMMENTS: South side of west ash pond.

TEST BORING REPORT

Boring No. CCR-AP-7

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station	File No.	42796-001
Client	Southern Indiana Gas & Electric Company	Sheet No.	1 of 2
Contractor	Stearns Drilling	Start	09 March 2016
		Finish	09 March 2016
		Driller	J. Gryska
		H&A Rep.	S. Lewis

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	-	S	-	Rig Make & Model: CME 850 XR Air Track
Inside Diameter (in.)	-	1 3/8	-	Bit Type: / Drill Mud: None
Hammer Weight (lb)	-	140	-	Casing: Auger
Hammer Fall (in.)	-	30	-	Hoist/Hammer: Winch Automatic Hammer / PID Make & Model:

Elevation 429.5 (est.)
Datum
Location N 970,775 E 2,883,090

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0						ML	Brown SILT (ML), trace coarse gravel -FILL-	-	-	-	-	-	-	-	-	-	-
	1 1 2 3	S1 16/24	3.0 5.0			ML	Soft brown SILT with sand (ML), no odor, moist, mottle with gray and red colors	-	-	-	-	15	85	-	-	-	-
5																	
	2 2 2 7	S2 17/24	8.0 10.0		421.5 8.0	ML	Very stiff olive brown SILT (ML), mps 2.0 mm, no odor, dry, wood fragments present -ALLUVIUM-	-	-	-	-	15	85	-	-	-	-
10																	
	1 2 3 2	S3 19/24	13.0 15.0			ML	Medium stiff gray SILT with sand (CL), no odor, moist, wood fragments present	-	-	-	-	15	85	-	-	-	-
15																	
	1 2 3 3	S4 20/24	18.0 20.0			ML	Medium stiff gray SILT with sand (ML), no odor, wet	-	-	-	-	15	85	-	-	-	-
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 35.0
Rock Cored (ft) -
Samples 5S

Boring No. CCR-AP-7

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. CCR-AP-7
File No. 42796-001
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																	
	1 1 2 1	S5 24/24	23.0 25.0			ML	Soft gray sandy SILT (ML), no odor, wet	-	-	-	-	30	70	-	-	-	-
25																	
	1 1 1 2	S6 24/24	28.0 30.0			CL	Soft gray lean CLAY (CL), no odor, wet, mottled with black colors, possibly organic matter	-	-	-	-	10	90	-	-	-	-
30																	
	1 2 3 3	S7 24/24	33.0 35.0			CL	Medium stiff gray lean CLAY (CL), no odor, wet	-	-	-	-	10	90	-	-	-	-
35					394.5 35.0		BOTTOM OF EXPLORATION 35.5 FT										

Notes:
Well set at 30.0 ft.
35.0 ft o 34.0 ft backfilled with bedtonite.
30.0 ft to 34.0 ft backfilled with sand.

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-7

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No.
Boring No. CCR-AP-7

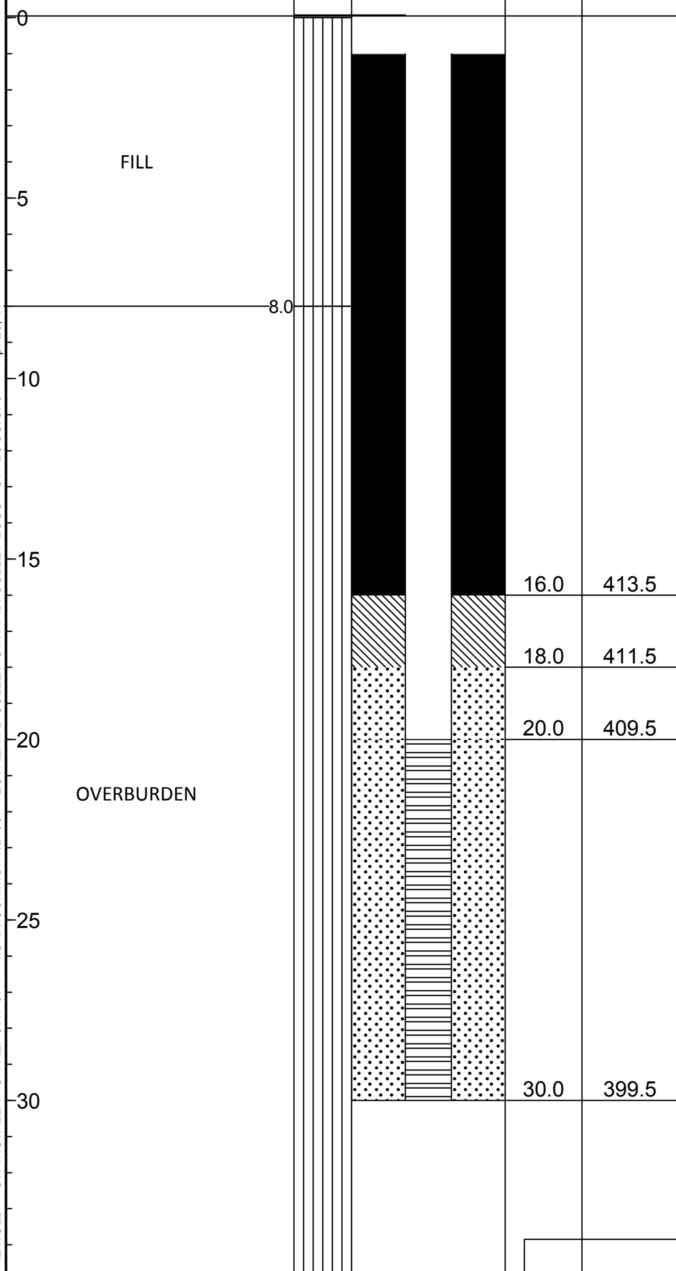
Project	CCR Hydrogeologic Characterization
Location	F.B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	Stearns Drilling
Driller	J. Gryska
Initial Water Level (depth bgs)	ft

File No. 42796-001
Date Installed 09 Mar 2016
H&A Rep. S. Lewis
Location N 970774.64
E 2883090.34

Ground El. 429.5 (est.)
Datum

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)
FILL	8.0			16.0	413.5
OVERBURDEN	35.0			18.0	411.5
				20.0	409.5
				30.0	399.5



WELL CONSTRUCTION DETAILS

Type of protective cover	Stick Up Guard Pipe
Depth of Steel below ground surface	0.0 ft
Depth of top of riser below ground surface	NA
Type of protective casing	Steel
Length	5.0 ft
Inside diameter	4.0 in.
Depth of bottom of Steel	5.0 ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	19.7 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	1.0	25.0
Bentonite	26.0	2.0
Sand	28.0	12.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	19.7 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of backfill around screen	Quartz Sand
Depth to bottom of well screen	29.7 ft
Bottom of silt trap	30.0 ft
Depth of bottom of borehole	35.0 ft

COMMENTS:

Appendix E
Location of Monitoring Wells

VECTREN - CULLEY STATION
Location of new monitoring wells around the west ash pond
(Survey Observation taken on 11/19/2020)

Mon. Well No.	NAD83 State Plane West Zone		NAVD 88	Location of Elev.	NAVD 88
	Northing	Easting	Elev.		Adjacent Ground Elev.
WAP-2R	971367.5	2881499.2	391.74	Top of PVC Pipe	
WAP-3D	970975.0	2881253.2	388.41	Top of PVC Pipe	
WAP-3I	970978.1	2881252.8	388.47	Top of PVC Pipe	
WAP-3S	970979.7	2881255.6	388.43	Top of PVC Pipe	
WAP-4D	970412.5	2881325.4	384.48	Top of PVC Pipe	
WAP-4I	970409.2	2881329.1	384.58	Top of PVC Pipe	
WAP-4S	970405.6	2881333.4	384.61	Top of PVC Pipe	
WAP-5D	970229.9	2881528.8	384.71	Top of PVC Pipe	
WAP-5I	970232.8	2881525.0	384.71	Top of PVC Pipe	
WAP-5S	970236.0	2881521.5	384.68	Top of PVC Pipe	
WAP-6D	970693.1	2881092.6	386.06	Top of PVC Pipe	
WAP-6I	970683.3	2881088.2	386.11	Top of PVC Pipe	
WAP-6S	970688.3	2881090.9	385.95	Top of PVC Pipe	
WAP-7D	971161.5	2881365.2	389.25	Top of PVC Pipe	
WAP-7S	971158.1	2881363.5	389.55	Top of PVC Pipe	
WAP-8D	970636.7	2881309.5	384.72	Top of PVC Pipe	
WAP-8I	970633.6	2881313.4	384.78	Top of PVC Pipe	
WAP-8S	970630.0	2881317.8	384.90	Top of PVC Pipe	

Appendix F
Notification of Initiation of Corrective Measures Assessment

HALEY & ALDRICH, INC.
400 Augusta Street
Suite 130
Greenville, SC 29601
864.214.8750

MEMORANDUM

30 October 2020
File No. 129420-025

TO: Southern Indiana Gas and Electric Company

FROM: Haley & Aldrich, Inc.

SUBJECT: Assessment of Corrective Measures Notification Pursuant to 40 CFR § 257.95(g)(3)(i) and 40 CFR § 257.96, F.B. Culley Generating Station – West Ash Pond

The Southern Indiana Gas and Electric Company (SIGECO) is implementing the 17 April 2015 U.S. Environmental Protection Agency (U.S. EPA) Federal Coal Combustion Residuals (CCR) Rule (40 CFR § 257 and 261) for the F.B. Culley Generating Station West Ash Pond (WAP), located in Warrick County near the communities of Yankeetown and Newburgh, Indiana. The WAP was previously classified as an "inactive" surface impoundment as defined by 40 CFR § 257.53. SIGECO filed a Notice of Intent (NOI) to initiate closure of the WAP and placed the NOI in the facility's operating record on 17 December 2015. The unit is currently in the closure process.

SIGECO has constructed a CCR Rule compliant groundwater monitoring system consistent with 40 CFR § 257.91 and completed detection and assessment monitoring for the WAP. The statistical analysis of the assessment monitoring results for this unit, completed on July 2, 2020, identified Appendix IV constituents at statistically significant levels above Groundwater Protection Standards (GWPS) at the WAP. An alternate source was not identified for the WAP at this time and as a result an assessment of corrective measures pursuant to 40 CFR § 257.95(g)(3)(i) and 40 CFR § 257.96 is required for the WAP.

This memorandum serves as notification required by 40 CFR § 257.95(g)(3)(i) that an assessment of corrective measures has been initiated within 90-days of identifying Appendix IV constituents at statistically significant levels above Groundwater Protection Standards (GWPS) downgradient of the WAP consistent with 40 CFR § 257.96.

525 Vine Street, Suite 1800
Cincinnati, Ohio 45202
1-513.651.3440

About AECOM

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