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dba Vectren Power
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Submitted by
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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.

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[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

JEREMY M. THOMAS
PE11600567

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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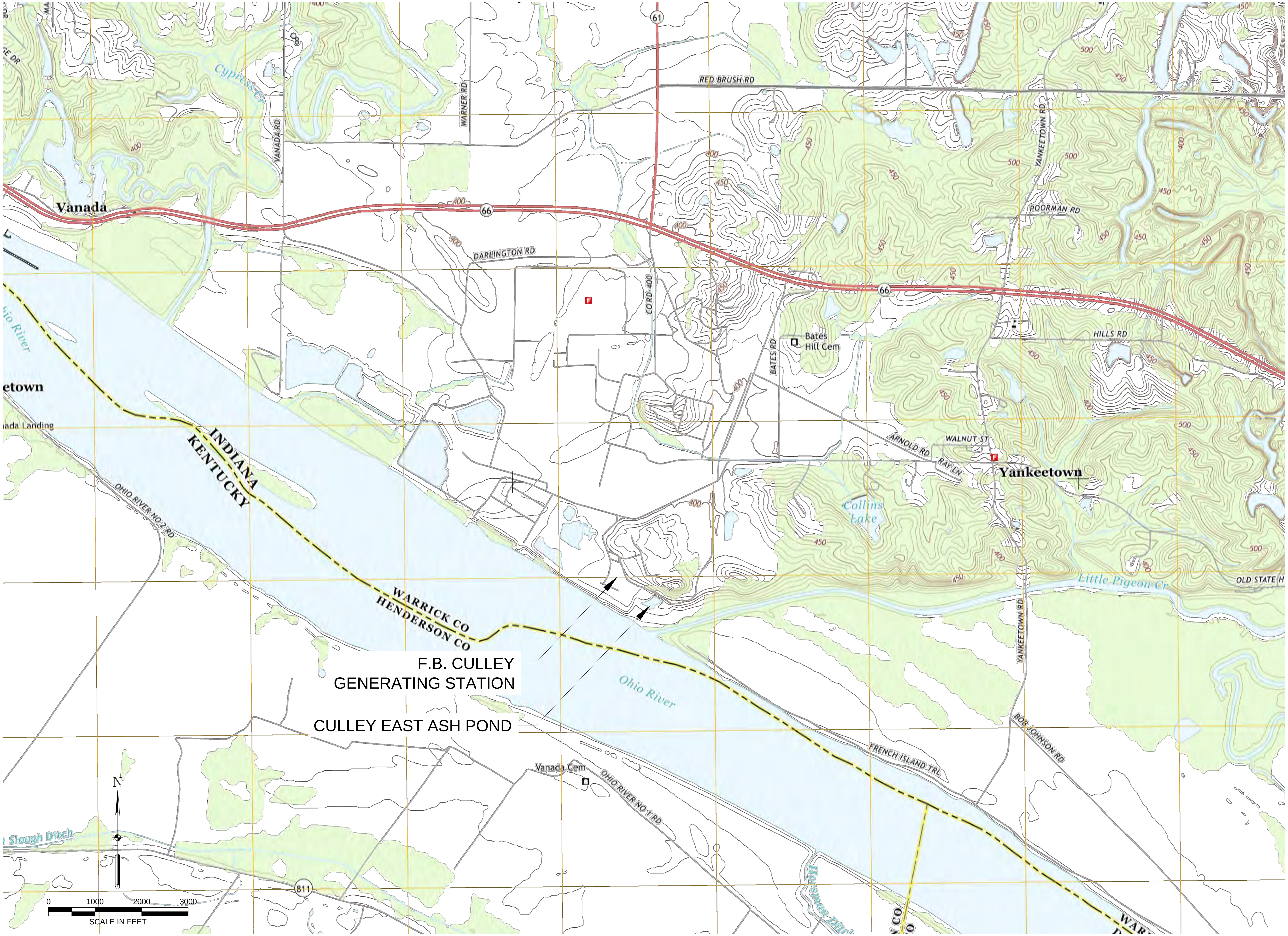

AECOM

9400 Amberglen Boulevard
Austin, TX 78729-1100
512-454-4797 (phone)
512-454-8807 (fax)

VECTREN
P.O. BOX 209
EVANSVILLE, IN 47702
1-800-227-1376

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

NO.	DESCRIPTION	DATE
△		
△		
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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

AECOM

9400 Amberglen Boulevard
Austin, TX 78729-1100
512-454-4797 (phone)
512-454-8807 (fax)

VECTREN
P.O. BOX 209
EVANSVILLE, IN 47702
1-800-227-1376

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

NO.	DESCRIPTION	DATE
△		
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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

SITE MAP

FIGURE 2

SHEET 2 OF 3

CARUSO, MICHAEL, 8/18/2016 10:45 AM

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

ARCH D 24" x 36"

Approved:____

Checked:____

Designer:____

Project Management Initials:

Last saved by: GAMBLINA(2016-10-07) Last Plotted: 2016-10-07

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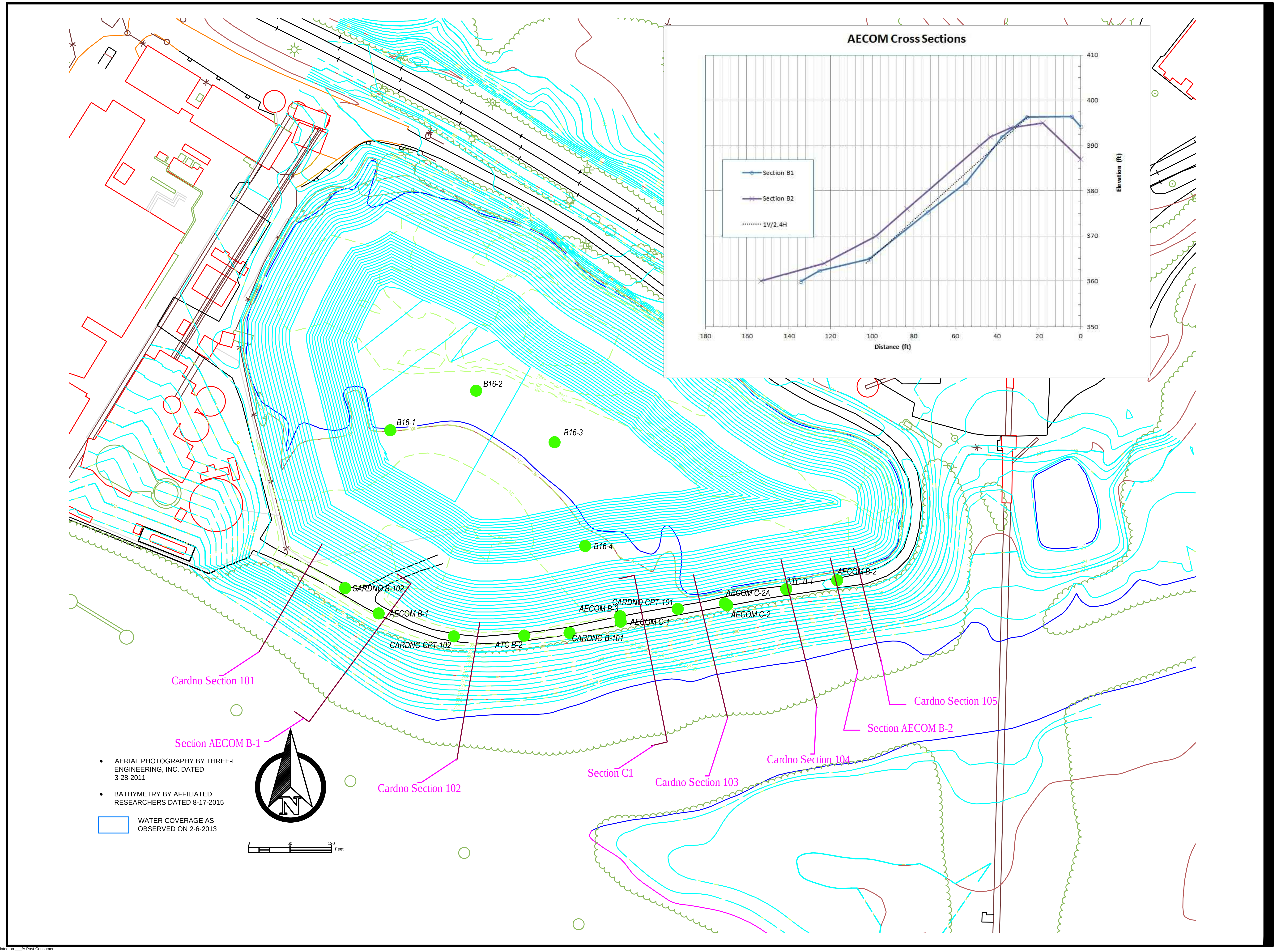

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- BATHYMETRY BY AFFILIATED RESEARCHERS DATED 8-17-2015

▭ 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

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1350 Deming Way
Middleton, WI 53562
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(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

AECOM

OWNER **Vectren**

LOG OF BORING NUMBER **AECOM-B1**

PROJECT NAME **FB Culley East Ash Pond Dam Assesment**

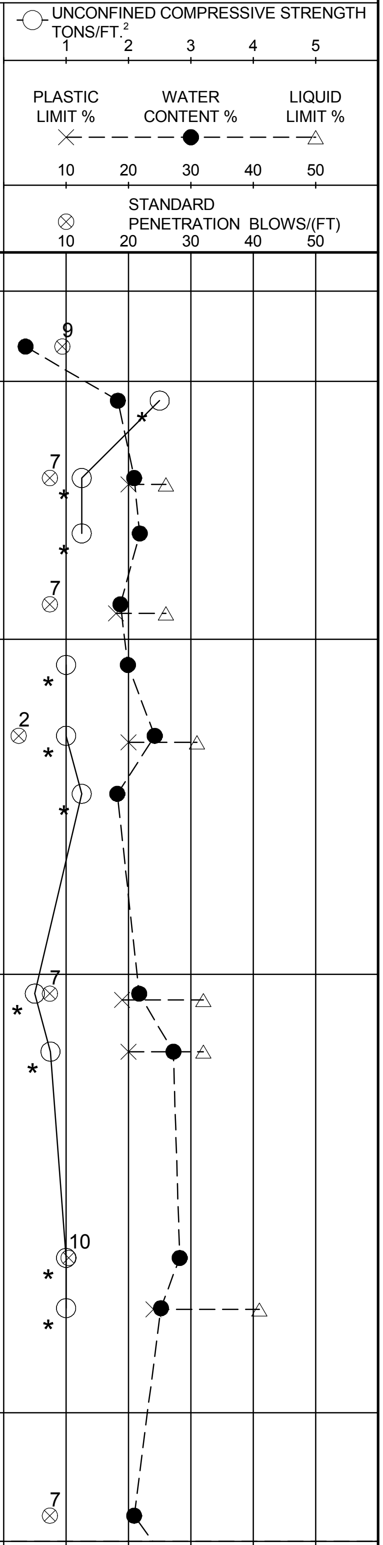
ARCHITECT-ENGINEER **AECOM**

SITE LOCATION

SURFACE ELEVATION +396.7

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
			HSA			FILL: Fine to coarse sand and gravel - gray - dry to moist (SP-GP)	
						1.5	
						FILL: Silty clay - trace sand and coal - brown - stiff (CL)	
5.0		1	SS			5.0	
		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.

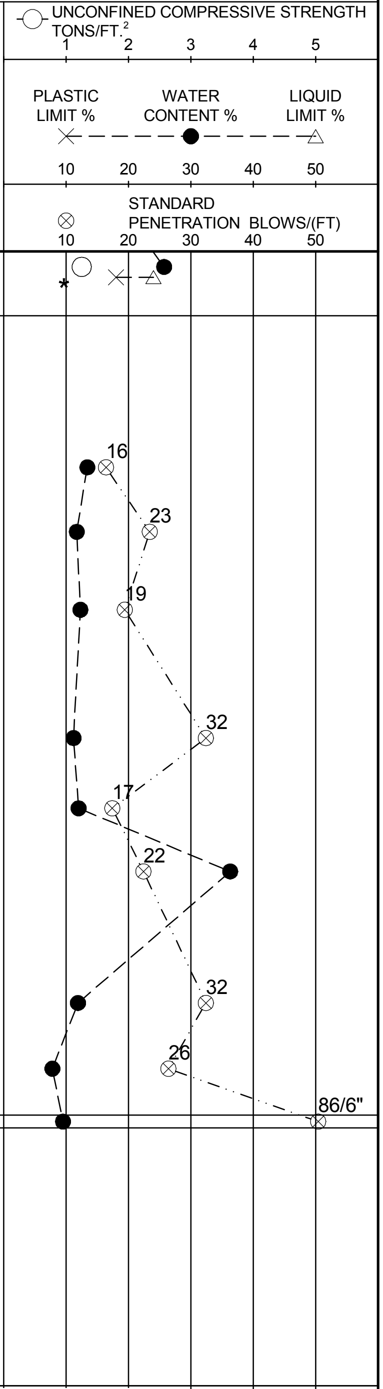
AECOM	OWNER **Vectren**	LOG OF BORING NUMBER	**AECOM-B1**
	PROJECT NAME **FB Culley East Ash Pond Dam Assesment**	ARCHITECT-ENGINEER **AECOM**	

SITE LOCATION

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL SURFACE ELEVATION +396.7 (Continued)	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				
			HSA			83.5	
		25	SS			84.0 SILTY CLAY - gray (CL)	
85.0		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 - fair to good rock quality	
90.0		RUN 2	DB				
94.0						94.0	

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.

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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**

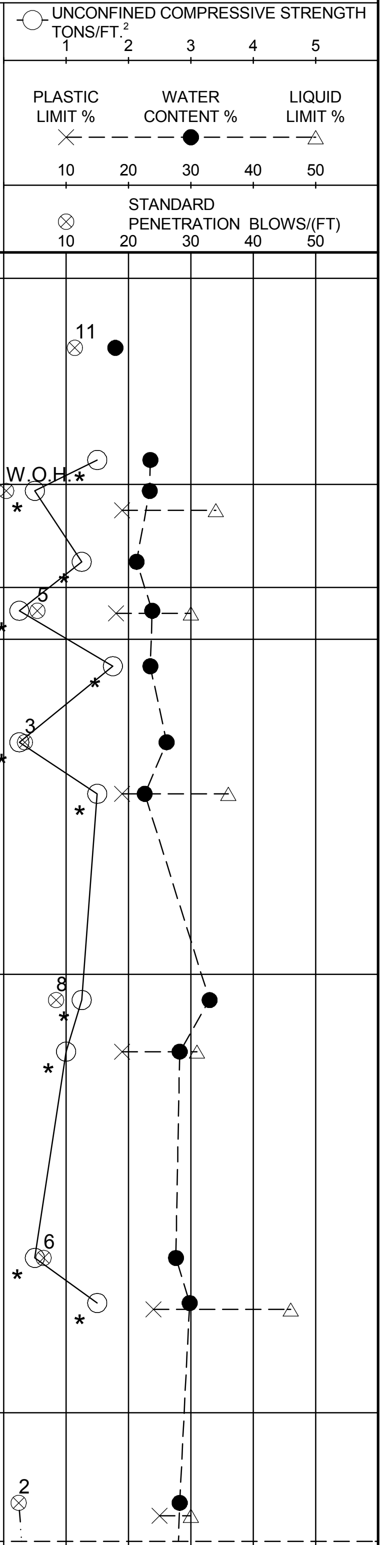
PROJECT NAME
FB Culley East Ash Pond Dam Assesment

ARCHITECT-ENGINEER
AECOM

SITE LOCATION

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL SURFACE ELEVATION +395.1	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	
30.0		10	SS			SILTY CLAY - some sand - gray to brown - stiff to medium (CL)	
		11	ST				94
35.0			HSA				
40.0		12	SS				
		13	ST				93
45.0			HSA			45.0 SANDY SILT - some clay - brown - wet - very loose (ML)	
50.0		14	SS				

. . . continued



* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

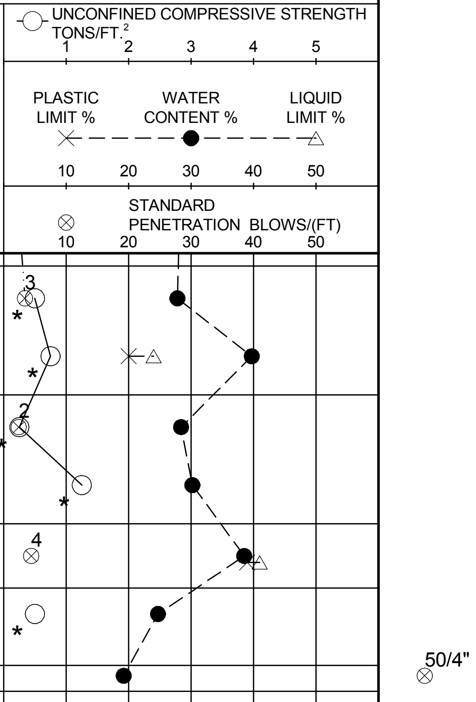
AECOM JOB NO. **60442676**

SHEET NO. **1** OF **2**

AECOM	OWNER **Vectren**	LOG OF BORING NUMBER	**AECOM-B2**
	PROJECT NAME **FB Culley East Ash Pond Dam Assesment**	ARCHITECT-ENGINEER **AECOM**	

SITE LOCATION

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL SURFACE ELEVATION +395.1 (Continued)	UNIT DRY WT. LBS./FT.^{3}
			HSA			50.5 SILTY CLAY - trace sand and gravel - brown to gray - soft to medium (CL-ML)	
		15	SS				
			HSA				
55.0		16	ST				77
			HSA			55.5 SILTY CLAY - trace sand and fine gravel - brown to gray - soft to stiff (CL)	
		17	SS				
			HSA				
60.0		18	ST				90
			HSA			60.5 SANDY SILT - little clay - gray - wet - loose (ML)	
		19	SS				
			HSA			63.0 SILTY CLAY - brown - medium (CL)	
65.0		20	ST				107
			HSA				
		21	SS			66.0 SANDY CLAY - dark gray (CL)	
			HSA			67.0 Weathered bedrock	
70.0		RUN 1	DB			68.8 SHALE - dark gray - very weak to weak field strength - laminated - moderately decomposed - intensely to moderately fractured - infilling of fractures with cohesive sediment	
75.0		RUN 2	DB				
80.0							
81.0						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**

OWNER
Vectren

LOG OF BORING NUMBER **AECOM-B3**

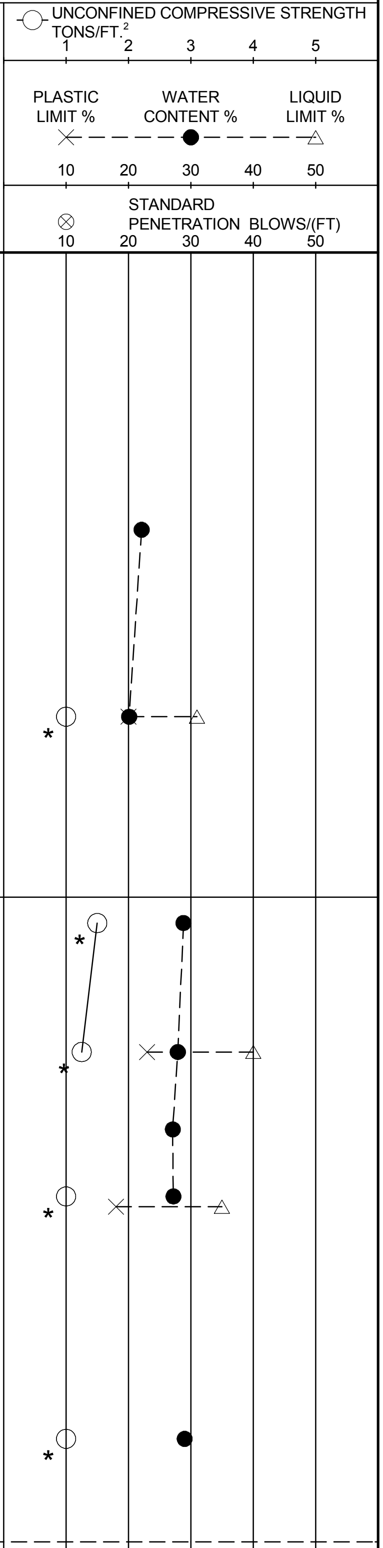
PROJECT NAME
FB Culley East Ash Pond Dam Assesment

ARCHITECT-ENGINEER
AECOM

SITE LOCATION

SURFACE ELEVATION +394.2

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
5.0			HSA			FILL: Silty clay - olive brown to dark gray - stiff (CL)	
		1	ST				
10.0			HSA				
		2	ST				106
15.0			HSA				
		3	ST				97
20.0			HSA				
		4	ST				
25.0			HSA			25.0	
		5	ST			SILTY CLAY - trace sand - brownish gray to brown - stiff (CL)	93
30.0			HSA				
		6	ST				95
			HSA				
35.0		7	ST				94
			HSA				
		8	ST				
40.0			HSA				
		9	ST				
45.0			HSA				
		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	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

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**

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

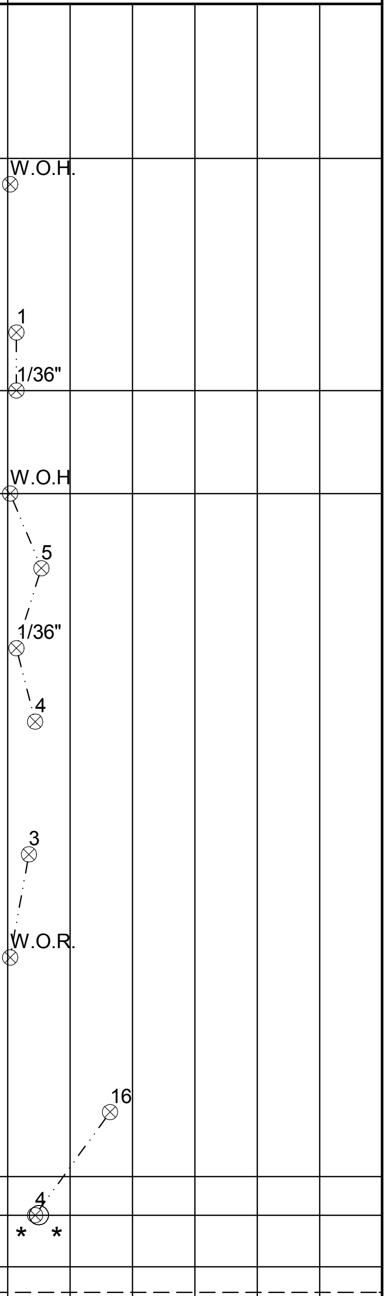
STANDARD PENETRATION BLOWS/(FT) 10 20 30 40 50

UNIT DRY WT. LBS./FT.^{3}

SURFACE ELEVATION +391.0

DEPTH(FT)	DESCRIPTION OF MATERIAL
0.0 – 6.0	BOTTOM ASH - black - loose - moist
6.0 – 15.0	FLY ASH - some bottom ash - gray - very loose - moist
15.0 – 19.0	SLUDGE - brown - very soft - wet
19.0 – 45.5	FLY ASH - trace to some clay - gray - very loose to medium dense - wet
45.5 – 47.0	CLAY - some silt - brown - soft - wet (CL)
47.0 – 49.0	FLY ASH - some clay - gray - loose - wet

SAMPLE NO.	SAMPLE TYPE	STANDARD PENETRATION BLOWS/(FT)
1	SS	W.O.H.
2	ST	
3	SS	1
4	SS	1/36"
5	ST	
6	SS	W.O.H
7	SS	5
8	SS	1/36"
9	SS	4
10	ST	
11	SS	3
12	SS	W.O.R.
13	ST	
14	SS	16
15	SS	4 * *



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.

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						SHALE - gray		
65.0						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}	STANDARD PENETRATION BLOWS/(FT)
				BOTTOM ASH - black - moist - loose		
5.0						
				6.0		
		1	SS	BOTTOM ASH - layers of fly ash - black - moist - very loose		2
		2	SS			W.O.H
10.0						
		3	SS			W.O.H
				13.5		
				FLY ASH - with bottom ash - dark gray - wet - very loose		
15.0		4	ST			
		5	ST			
		6	SS			W.O.H
20.0						
				21.0		
				BOTTOM ASH - dark gray - wet - loose		
		7	ST			
		8	SS			9
25.0				25.0		
				FLY ASH - some silt - some clay - gray - wet - loose to very loose		
		9	SS			1
30.0		10	ST			
		11	SS			3
35.0						
		12	SS			1
40.0		13	ST			
		14	SS			1
45.0						
		15	SS			1
				47.5		
				CLAY - with silt - gray - wet - soft (CL)		
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_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

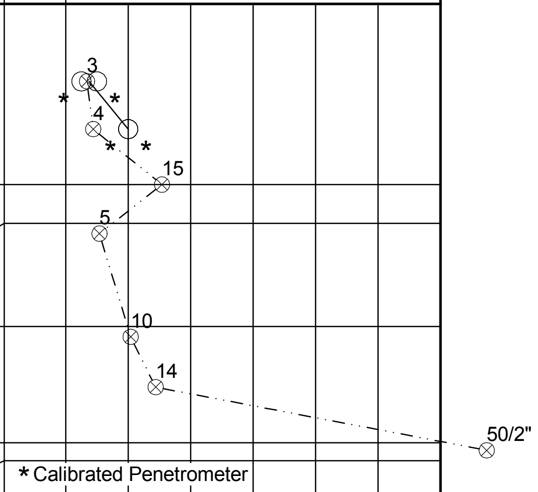
PLASTIC LIMIT % ✕ — — — WATER CONTENT % ● — — — LIQUID LIMIT % △ 10 20 30 40 50

⊗ STANDARD PENETRATION BLOWS/(FT) 10 20 30 40 50

UNIT DRY WT. LBS./FT.^{3}

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	SURFACE ELEVATION +390.0 (Continued) 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) 58.5
60.0		20	SS			SILT - with clay and fine sand - gray - wet - loose (ML)
						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



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 **Vectren**	LOG OF BORING NUMBER **B16-3**
	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

UNIT DRY WT. LBS./FT.^{3}

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	
	1	SS	FLY ASH - gray - wet - very loose	W.O.R.
	2	SS		W.O.R.
10.0				
	3	ST		
	4	SS		W.O.H.
15.0	5	ST		
	6	SS		2
20.0				
	7	ST		
25.0	8	SS		2
			2' Layer of Bottom Ash	
	9	SS		W.O.H.
30.0	10	ST		
	11	SS		W.O.H.
35.0				
	12	SS		W.O.H.
	13	SS	6" Layer of CLAY - some silt - wet - soft	W.O.H.
			39.5 1' Layer of sludge and ash	
40.0	14	SS	SILT - brown - wet - loose (ML)	4
	15	ST	No Recovery Sample 15	
45.0	16	ST	45.0 No Recovery Sample 16	
	17	SS	FLY ASH - some clay - gray - wet - very loose	W.O.H.
50.0	18	SS		W.O.H.

. . . continued

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

AECOM

OWNER
Vectren

LOG OF BORING NUMBER **B16-3**

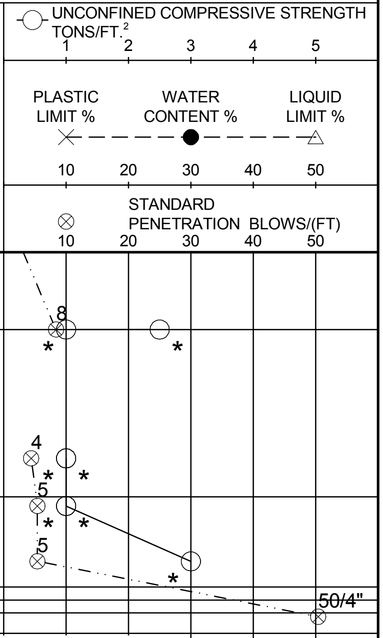
PROJECT NAME
F.B. West Ash Pond Closure

ARCHITECT-ENGINEER
AECOM

SITE LOCATION

SURFACE ELEVATION +390.0 (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
						FLY ASH - some clay - gray - wet - very loose	
		19	SS			53.0 CLAY - with silt - brown to gray - moist - medium stiff (CL)	
55.0		20	ST				
		21	SS				
60.0		22	SS			59.5 CLAY - with silt - silt zones - silt seams - gray - wet - soft (CL)	
		23	SS			63.0 SILT - with fine sand - some clay - brown - wet - loose (ML)	
64.8		24	SS			63.5 coarse to fine SAND - some gravel - gray - wet - loose (SP) 64.0 SHALE - gray 64.8 End of Boring Boring backfilled with cement/bentonite grout from 64.8 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 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

UNIT DRY WT. LBS./FT.^{3}

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE / RECOVERY	DESCRIPTION OF MATERIAL	STANDARD PENETRATION BLOWS/(FT)
					SURFACE ELEVATION +391.0	
					BOTTOM ASH - black - loose - moist	
					2.0 SLUDGE - brown and gray - very loose - wet	
5.0		1	SS			4
					5.5 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		40.5	W.O.H
					41.0 CLAY - some silt - brown - very soft - wet	*
					SILT - trace clay - zones of fly ash - loose - wet	
		15	ST			
45.0		16	SS			W.O.H
		17	SS		47.0	5
					CLAY - some silt - brown - soft - wet	* *
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

OWNER
Vectren

LOG OF BORING NUMBER **B16-4**

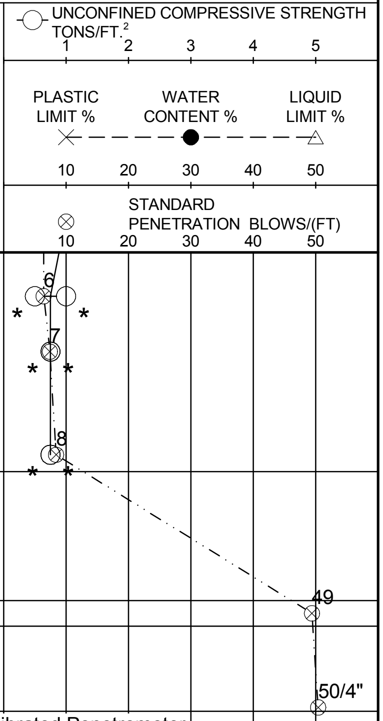
PROJECT NAME
F.B. West Ash Pond Closure

ARCHITECT-ENGINEER
AECOM

SITE LOCATION

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
						CLAY - some silt - brown - soft - wet	
		19	SS				
		20	SS				
55.0							
		21	SS			58.5	
						fine SAND - gray - loose - wet	
60.0							
						63.5	
		22	SS			64.5 coarse to fine SAND - some gravel - gray - dense - wet	
65.0						SHALE - gray	
67.8		23	SS			67.8	
						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**

Cardno ATC

7988 Centerpoint Drive, Suite 100
Indianapolis, IN 46256
(317) 849-4990
Fax (317) 849-4278

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CLIENT **C$D;E$FĀ&E'&E; G&F**
PROJECT NAME **A<HĀ&FJÀ K$;?Ā D; &EÀ<<$<<! $F;**
PROJECT LOCATION **>'0' Ā L#$?Ā FE ;GMÀ; ;G&F**
%$NOLEMHĀFJGF

BORING # **0)+,+**
JOB # **+*,4 .8 ,,+,***
NORTHING **QRQ.-..**
EASTING **-77BR7R**

DRILLING and SAMPLING INFORMATION

Date Started **.979+6**
Date Completed **.979+6**
Drill Foreman **: 'Ā0 ; $<**
Inspector **= 'Ā>&?$**
Boring Method **@ÀA**

Hammer Wt. **+.,** lbs.
Hammer Drop **B,** in.
Spoon Sampler OD **-' ,** in.
Rock Core Dia. **))** in.
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	Sampler Graphics Recovery Graphics	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)			10	4	SS			1-1-2	22.6		
				5	ST						
			15	6	SS			2-4-4	21.7	2.0	
				7	ST						**À ! "#$Ā%&'ÀÀ( )*** Atterberg limits: LL=38, PL=17, PI=21 Passing No. 200 sieve = 83.9%
	374.0	20.5	20	8	SS			2-3-2	26.3	1.0	
Gray, moist, silty clay with trace sand and coal ash				9	SS			5-4-5	22.0	2.5	
			25	10	ST				26.6		**À ! "#$Ā%&'ÀÀ( )+,** 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 ! "#$Ā%&'ÀÀ( )+-** Atterberg limits: LL=47, PL=21, PI=26
	361.5	33.0		13	SS			4-5-7	26.7	2.0	
Gray, moist, soft to stiff, SILTY CLAY (CL) with sandy clay seams			35	14	SS			2-3-3	32.5	1.0	**À ! "#$Ā%&'ÀÀÀ)+.** 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 **C$D;E$FĀ8&E'&E; G&F**
PROJECT NAME **A<HĀ&FJĀÀ K$;?Ā> D; &EĀ<<$<<! $F;**
PROJECT LOCATION **>'0' Ā8 L#$?Ā4 FE ;GFMÀ; ;G&F**
%$NOLEMHĀFJGF

BORING # **0)+,+**
JOB # **+*,4 8 ,,+,***
NORTHING **QRQ.-..**
EASTING **-77BR7R**

DRILLING and SAMPLING INFORMATION

Date Started **.979+6**
Date Completed **.979+6**
Drill Foreman **: 'Ā0 ; $<**
Inspector **= 'Ā>&?$**
Boring Method **@ÀA**

Hammer Wt. **+.,** lbs.
Hammer Drop **B,** in.
Spoon Sampler OD **-' ,** in.
Rock Core Dia. **))** in.
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	
				18	SS		2-3-4	28.7	1.5	
			45							
				19	SS		5-6-6	28.5	2.0	
				20	SS		3-4-4	25.2	1.25	**À ! "#$Ā%&'ĀÀÀ)- ,** Atterberg limits: LL=39, PL=19, PI=20 Passing No. 200 sieve = 90.4%
			50							
				21	SS		5-5-6	25.4	0.75	
				22	SS		1-1-2	27.7		
			55							
				23	SS		3-4-5	28.8	0.75	
	336.5	58.0				●				
Gray, wet, loose, SILTY fine SAND (SC-SM) with sandy clay seams				24	SS		2-1-5			**À ! "#$Ā%&'ĀÀÀ)- .** 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%&'ĀÀÀ)- 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		28	SS		8-11-13			
Gray, wet, medium dense to very dense, fine to coarse SAND (SP) with some gravel			70							
	322.5	72.0		29	SS		18-21-50/0.1'			
Gray, weathered SHALE										
	320.8	73.7								
Bottom of Test Boring at 73.7 ft				30	SS		50/0.2'			

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 **C$D;E$FĀ8&E'&E; G&F**

PROJECT NAME **A<HĀ&FJĀÀ K$;?Ā> D;&EĀA<<$<<! $F;**

PROJECT LOCATION **>'0' Ā8 L#$?Ā4 FE ;GFMĀ; ;G&F**

%$NOLEMHĀFJGF

BORING # **0)+,-**

JOB # **+*,4 .8 ,,+,***

NORTHING **QRQ.76**

EASTING **-77BBR,**

DRILLING and SAMPLING INFORMATION

Date Started **.9Q96**

Date Completed **.9Q96**

Drill Foreman **: 'Ā0 ; $<**

Inspector **= 'Ā>&?$**

Boring Method **@ÀA**

Hammer Wt. **+.,** lbs.

Hammer Drop **B,** in.

Spoon Sampler OD **-' ,** in.

Rock Core Dia. **))** in.

Shelby Tube OD **B',** in.

TEST DATA

SOIL CLASSIFICATION

SURFACE ELEVATION 397.1

SOIL CLASSIFICATION	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	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)	387.1	10.0		1	SS		18-21-24			
				2	SS		9-11-10			
			5	3	SS		4-5-6	19.5	2.0	Borehole backfilled with cement/bentonite grout by tremie.
				4	ST					
Brown, slightly moist, silty clay with coal ash and trace to little sand (EMBANKMENT FILL)	371.6	25.5	10	5	SS		5-6-5	16.2		
				6	SS		2-2-3	22.2	1.0	
			15	7	SS		4-4-3	27.7	0.25	**À ! "#$Ā%&'ĀÀ)*** Atterberg limits: LL=39, PL=19, PI=20 Passing No. 200 sieve = 89.4%
			20	8	SS		0-0-0	20.0		
				9	SS		11-10-9			
				10	ST					
Brown, moist, silty clay with sandy clay seams (EMBANKMENT FILL)	368.1	29.0	25	11	SS		3-3-4	20.3	2.0	
Brown, wet, fine to coarse sand with little silt (EMBANKMENT FILL)	365.6	31.5		12	SS	●	3-4-3			**À ! "#$Ā%&'ĀÀ)+-** Passing No. 200 sieve = 12.8%
Gray and brown, moist to very moist, medium stiff to very stiff, CLAY (CH) with little sand			30	13	SS		3-3-3	17.8		
			35	14	SS		3-5-8	21.1	3.0	**À ! "#$Ā%&'ĀÀ)+.** 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	

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&FJÀÀ K$;?Ā> D;&EĀA<<$<<! $F;**

PROJECT LOCATION **>'0' Ā8 L#$?Ā4 FE ;GFMÀ; ;G&F**
%$NOLEMHĀFJGF

BORING # **0)+,-**

JOB # **+*,4 8 ,,+,***

NORTHING **QRQ.76**

EASTING **-77BBR,**

DRILLING and SAMPLING INFORMATION

Date Started **.9Q96**
Date Completed **.9Q96**
Drill Foreman **: 'Ā0 ; $<**
Inspector **= 'Ā>&?$**
Boring Method **@ÀA**

Hammer Wt. **+.,** lbs.
Hammer Drop **B,** in.
Spoon Sampler OD **-',** in.
Rock Core Dia. **))** in.
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 ! "#$Ā%&'ĀÀÀ)+7** Atterberg limits: LL=45, PL=21, PI=24 Passing No. 200 sieve = 86.4%
	349.1	48.0		19	SS			4-6-7			
Reddish brown, very moist, very soft to soft, SANDY CLAY (CL) with shale fragments			50	20	SS			0-1-1	30.5		
	344.1	53.0		21	SS			6-2-3	29.8		
Reddish brown, wet, loose, fine SAND (SP) with interbedded sand and gravel seams			55	22	SS			3-4-4			**À ! "#$Ā%&'ĀÀÀ)- -** 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 ! "#$Ā%&'ĀÀÀ)- 6** Atterberg limits: LL=NP, PL=NP, PI=NP Passing No. 200 sieve = 5.7%
			65	26	SS			10-13-16			
				27	SS			10-10-12			
			70	28	SS			12-14-16			
	324.1	73.0		29	SS			5-9-14			
Gray, wet, medium dense, SAND (SP-SM) with gravel and trace silt			75	30	SS			7-18-19			**À ! "#$Ā%&'ĀÀÀ)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			

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 **CDEFĀ8&E'&E; G&F**

PROJECT NAME **A<HĀ&FJȀ K$;?Ā D;&EĀ<<$<<! $F;**

PROJECT LOCATION **>'0' Ā8 L#$?Ā4 FE ;GFMȀ; ;G&F**
%$NOLEMHĀFJGF

BORING # **0)+,-**

JOB # **+*,4 .8 ,,+,***

NORTHING **QRQ.76**

EASTING **-77BBR,**

DRILLING and SAMPLING INFORMATION

Date Started **.9Q96**
Date Completed **.9Q96**
Drill Foreman **: 'Ā0 ; $<**
Inspector **= 'Ā&?$**
Boring Method **@ȀA**

Hammer Wt. **+.,** lbs.
Hammer Drop **B,** in.
Spoon Sampler OD **-' ,** in.
Rock Core Dia. **))** in.
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

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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**
Date Completed **4/18/11**
Drill Foreman **W. Bates**
Inspector **D. Warder**
Boring Method **HSA**

Hammer Wt. **140** lbs.
Hammer Drop **30** in.
Spoon Sampler OD **2.0** in.
Rock Core Dia. **--** in.
Shelby Tube OD **--** in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 394	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
Crushed stone	393.3	0.7									
Brown, slightly moist, sandy silty clay with trace gravel (EMBANKMENT FILL)				1	SS	☒ ■		11-10-8	15.5	4.5+	Ground surface elevation estimated from topographic map
				2	SS	☒ ■		12-6-5	17.0	3.0	Borehole backfilled with bentonite
Gray, moist, silty clay with trace sand (EMBANKMENT FILL)	388.5	5.5	5								
				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	
Gray to brown, slightly moist to moist, stiff to soft SILTY CLAY (CL)	366.0	28.0									
				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

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**
Date Completed **4/18/11**
Drill Foreman **W. Bates**
Inspector **D. Warder**
Boring Method **HSA**

Hammer Wt. **140** lbs.
Hammer Drop **30** in.
Spoon Sampler OD **2.0** in.
Rock Core Dia. **--** in.
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	
			45	18	SS	☒ ■		2-3-3	31.6	1.0	
				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

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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**
Date Completed **4/18/11**
Drill Foreman **W. Bates**
Inspector **D. Warder**
Boring Method **HSA**

Hammer Wt. **140** lbs.
Hammer Drop **30** in.
Spoon Sampler OD **2.0** in.
Rock Core Dia. **--** in.
Shelby Tube OD **3.0** in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 394	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
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		
				2	SS			8-7-5	18.8	4.0	Borehole backfilled with bentonite
Brown to gray, moist, silty clay with trace sand (EMBANKMENT FILL)	388.5	5.5	5								
				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 Screen located between depths of 10 and 20 ft
			10								
				4	SS			2-3-3	23.4	1.0	
				ST-2	ST				20.9	1.7	
			15								
				5	SS			1-2-2	23.4	0.75	
				ST-3	ST				19.5	1.2	
			20								
				6	SS			2-2-2	24.0	0.5	
				7	SS			2-3-3	28.6	1.0	
			25								
				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	30								
				10	SS			3-4-5	30.3	0.75	
				11	SS			4-6-7	24.1	3.0	
			35								
				12	SS			4-4-5	23.4		
				13	SS			4-4-4	24.9		

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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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**
Date Completed **4/18/11**
Drill Foreman **W. Bates**
Inspector **D. Warder**
Boring Method **HSA**

Hammer Wt. **140** lbs.
Hammer Drop **30** in.
Spoon Sampler OD **2.0** in.
Rock Core Dia. **--** in.
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											

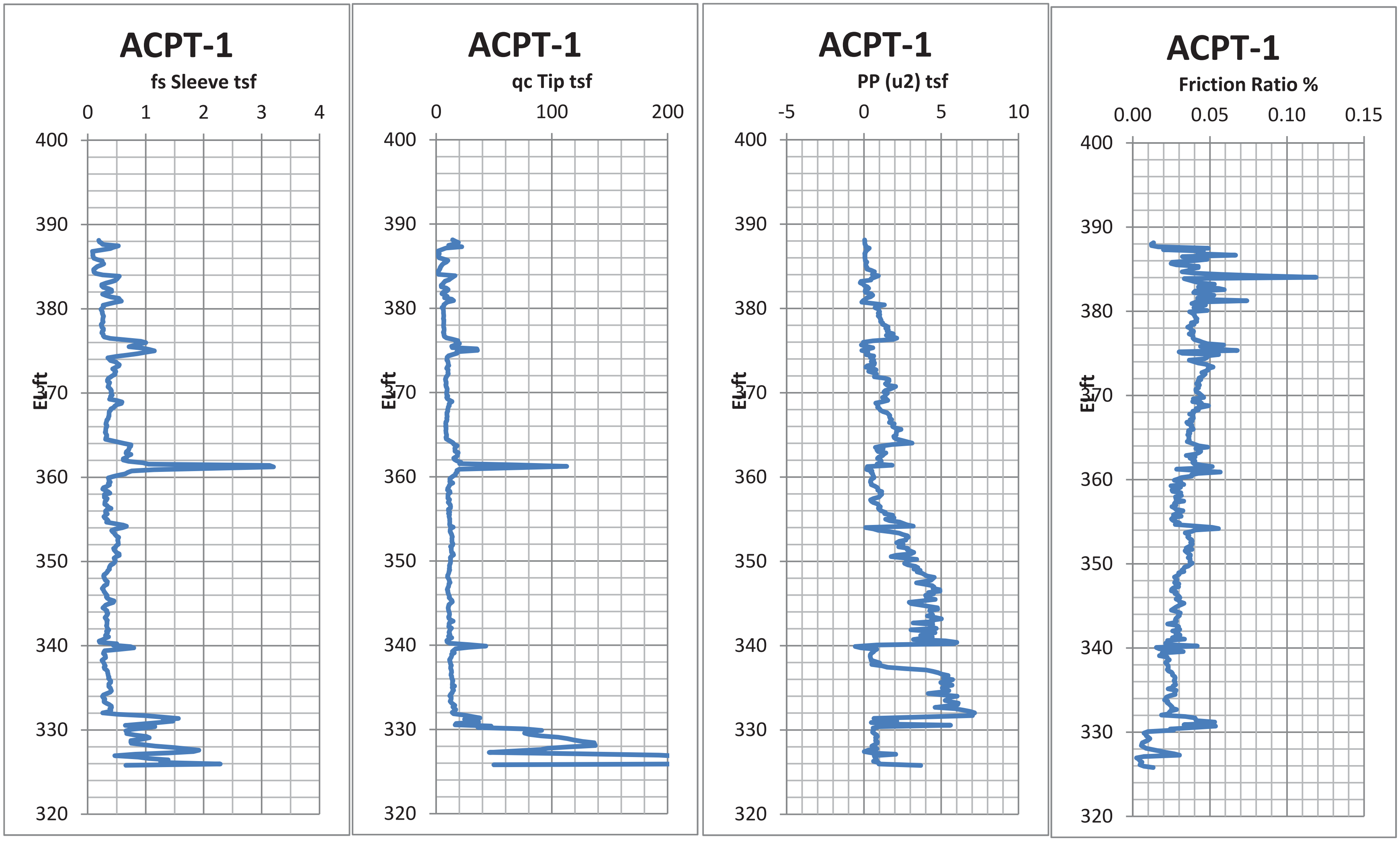
Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools **None** ft.
▽ At Completion **--** ft.
▼ After **--** hours **--** ft.
Cave Depth **--** ft.

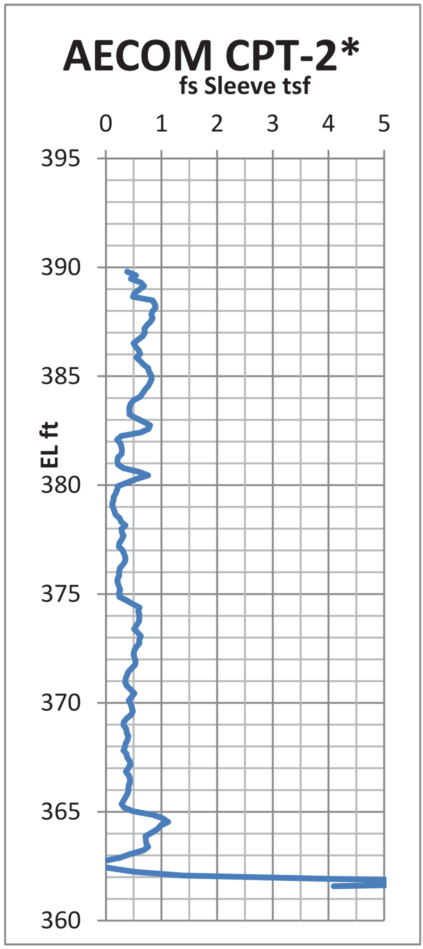
Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

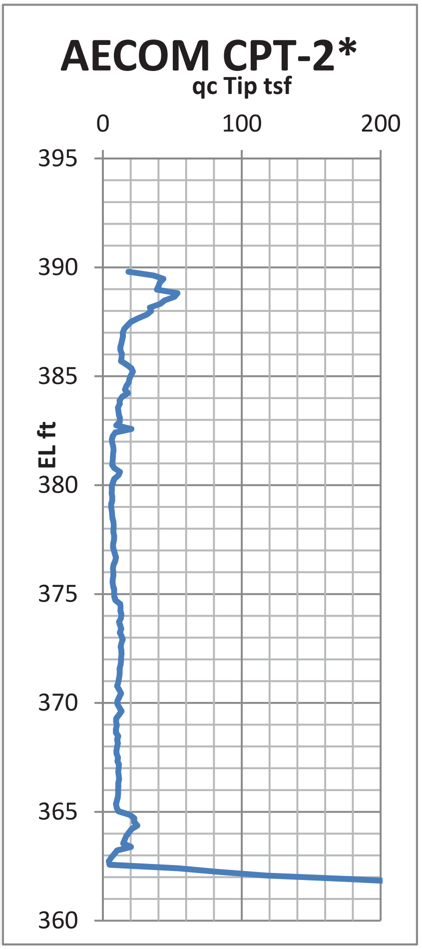
Appendix C
CPT Data

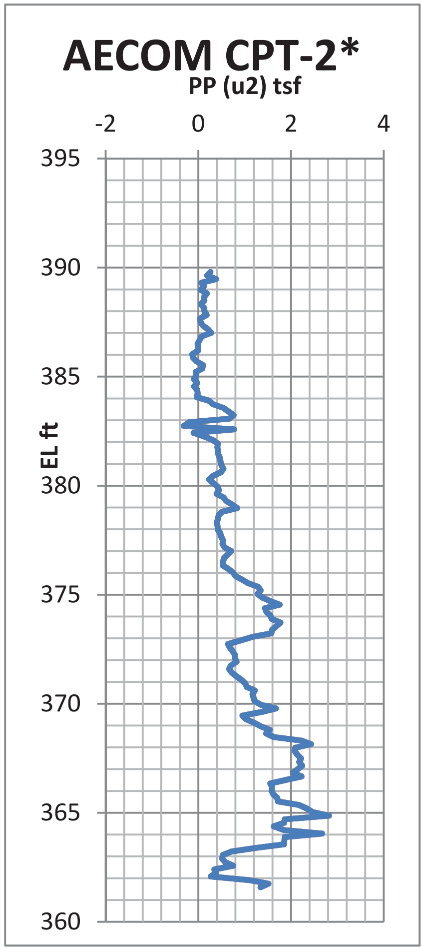
CPT Results   for AECOM CPT-1

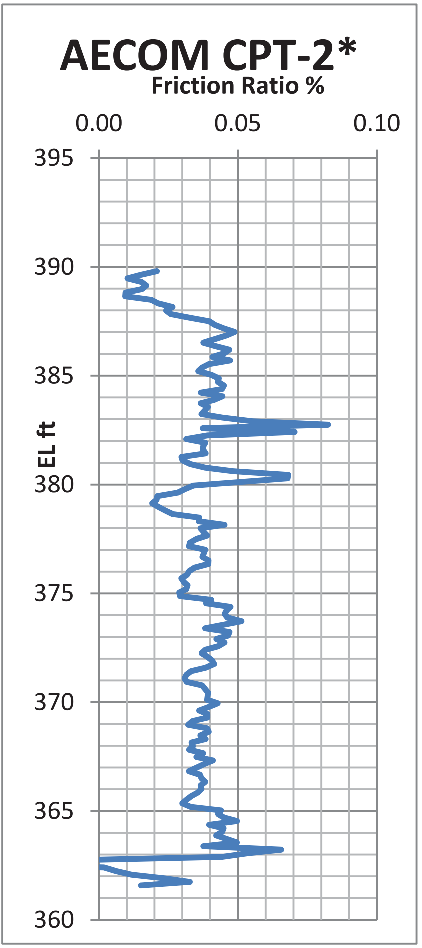


CPT Results   for AECOM CPT-2

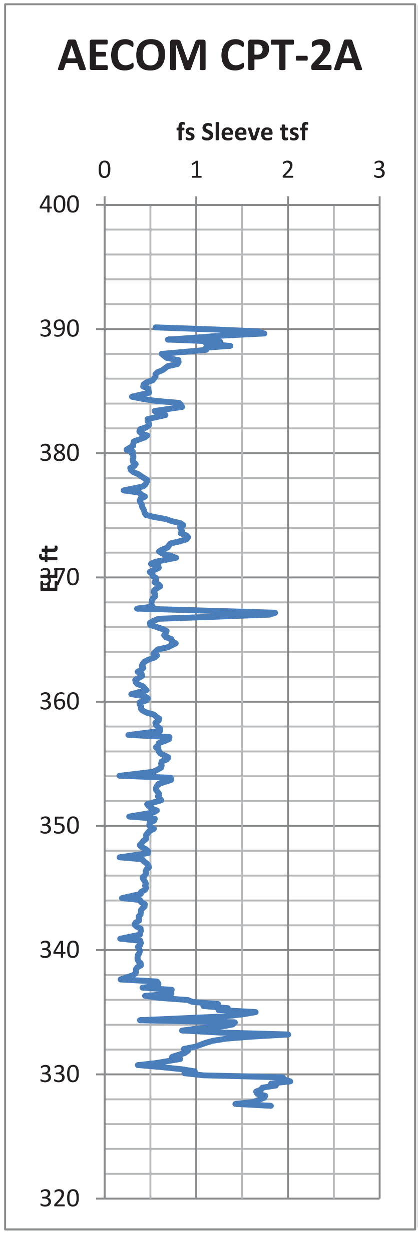


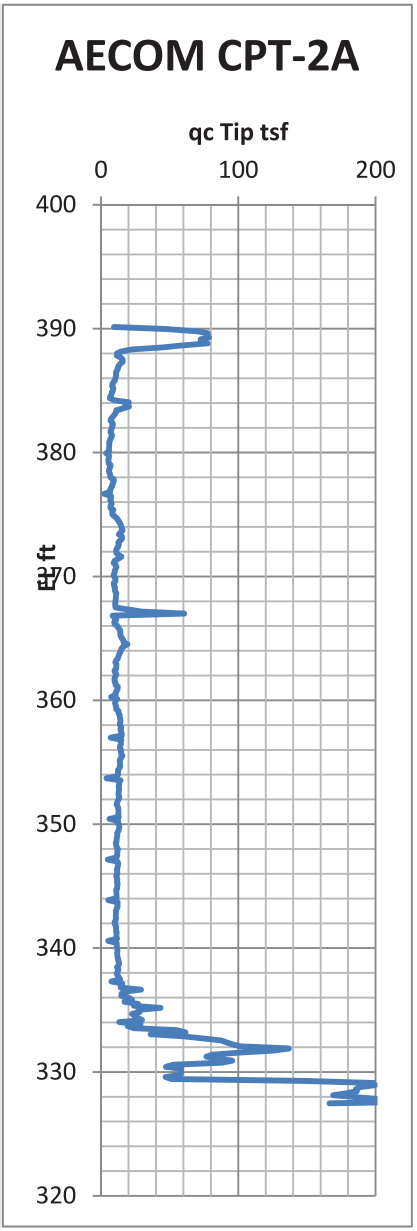


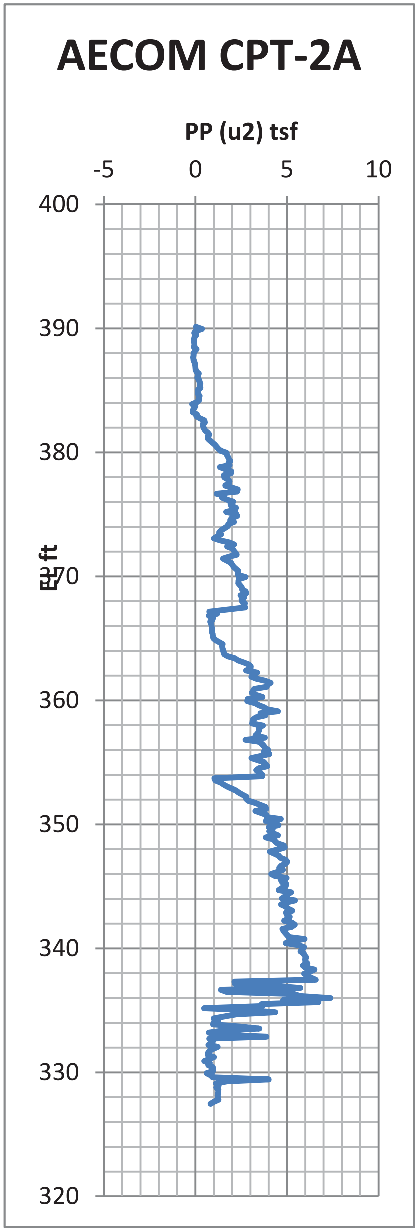


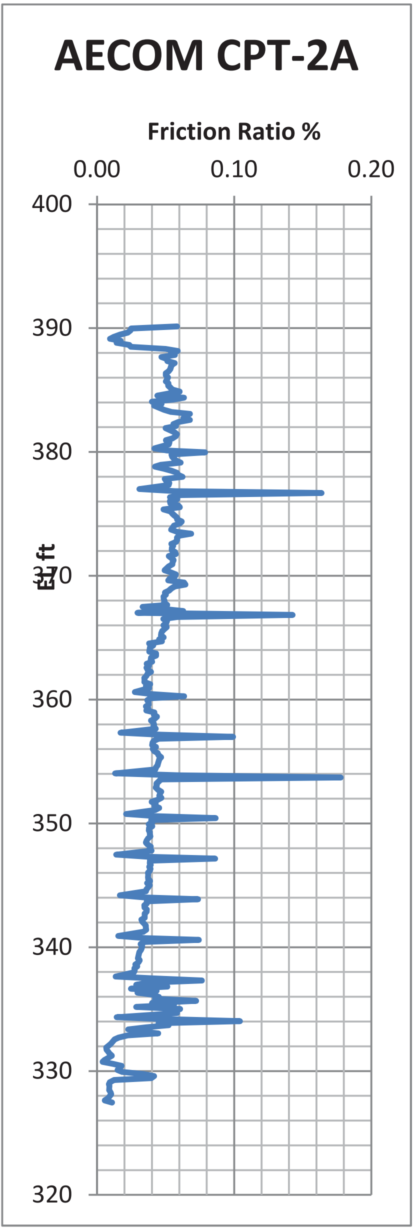


CPT Results for AECOM CPT-2A





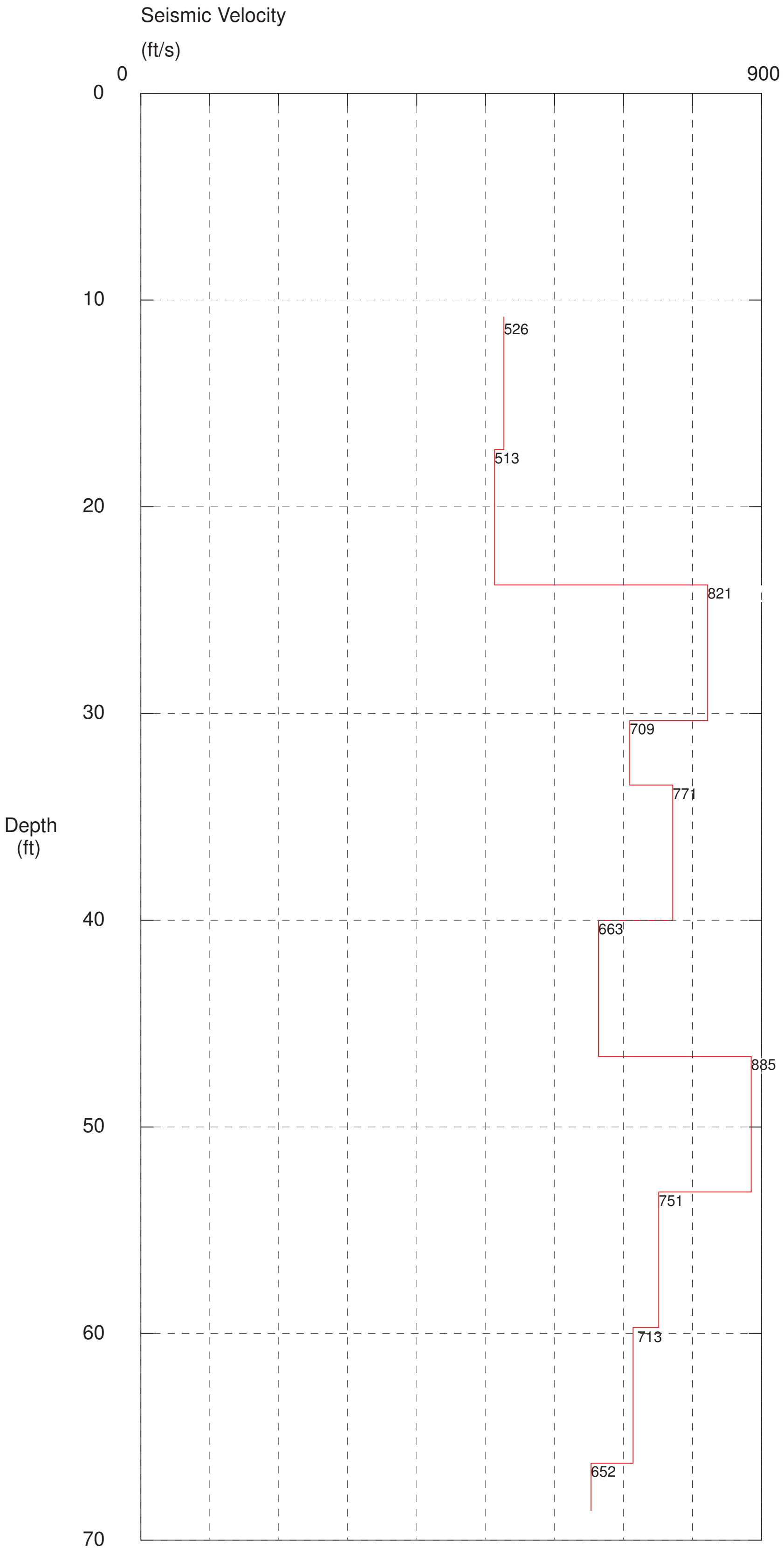




CPT-AECOM-1

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

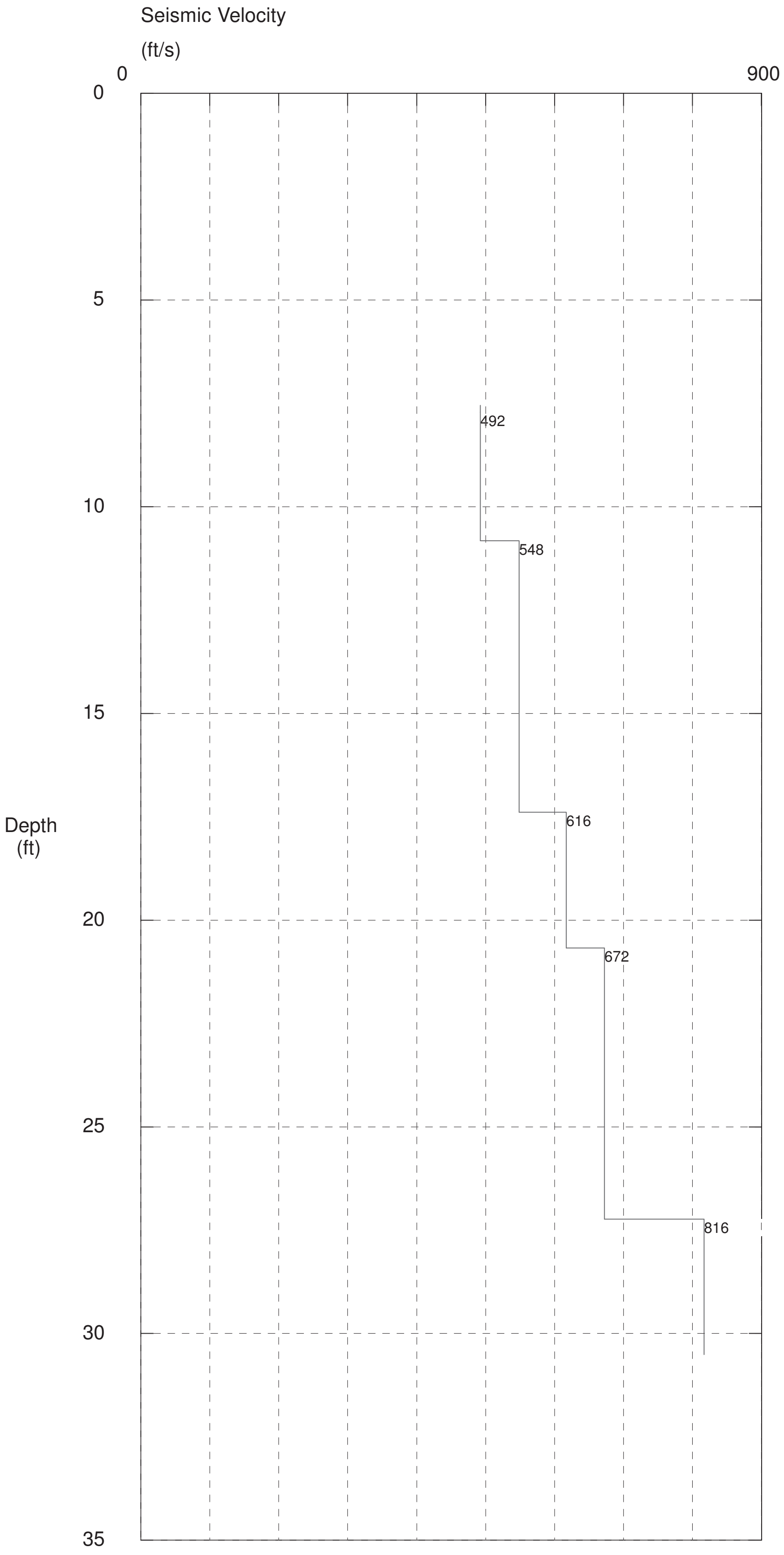


Maximum Depth = 68.57 feet

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

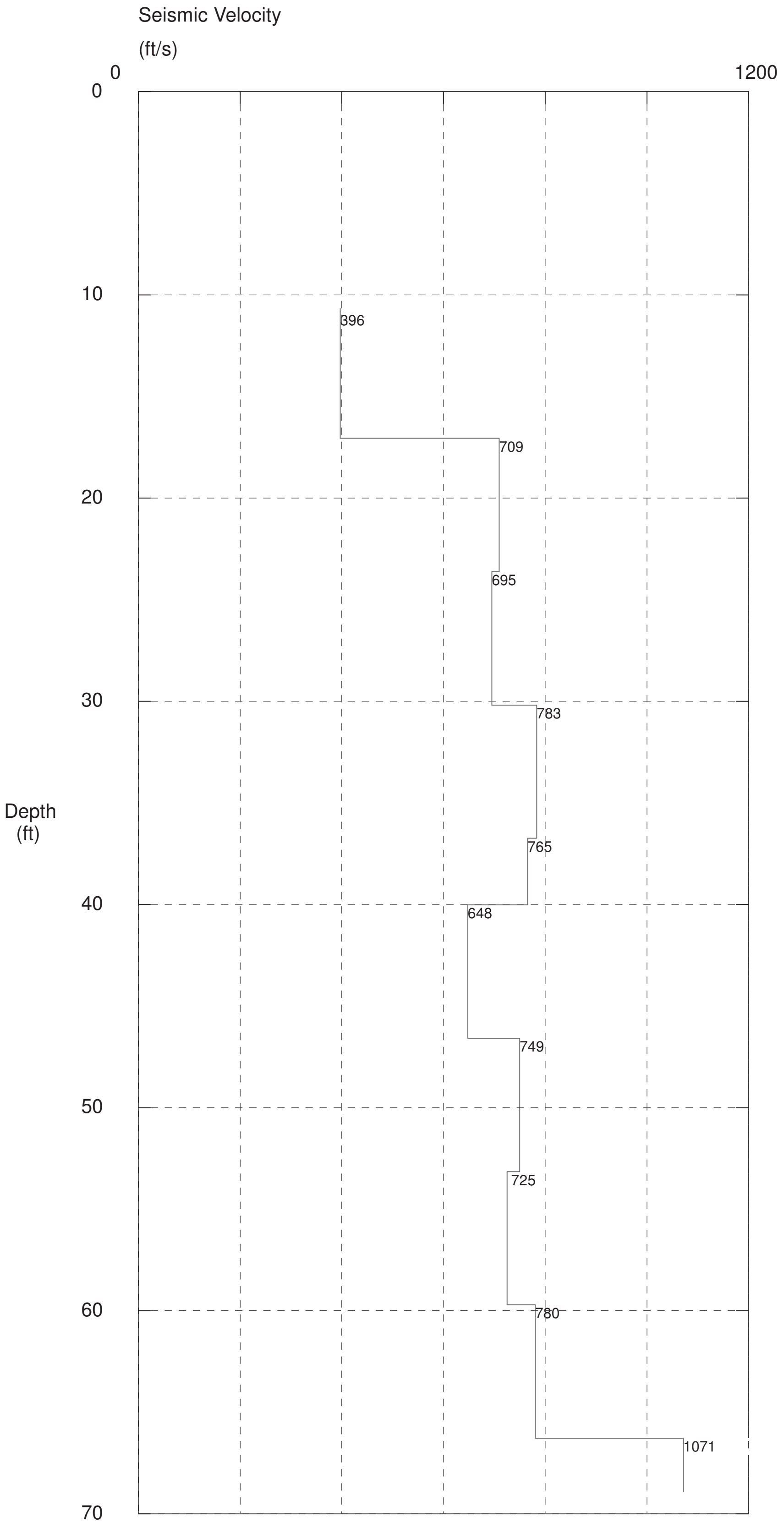


Maximum Depth = 32.48 feet

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

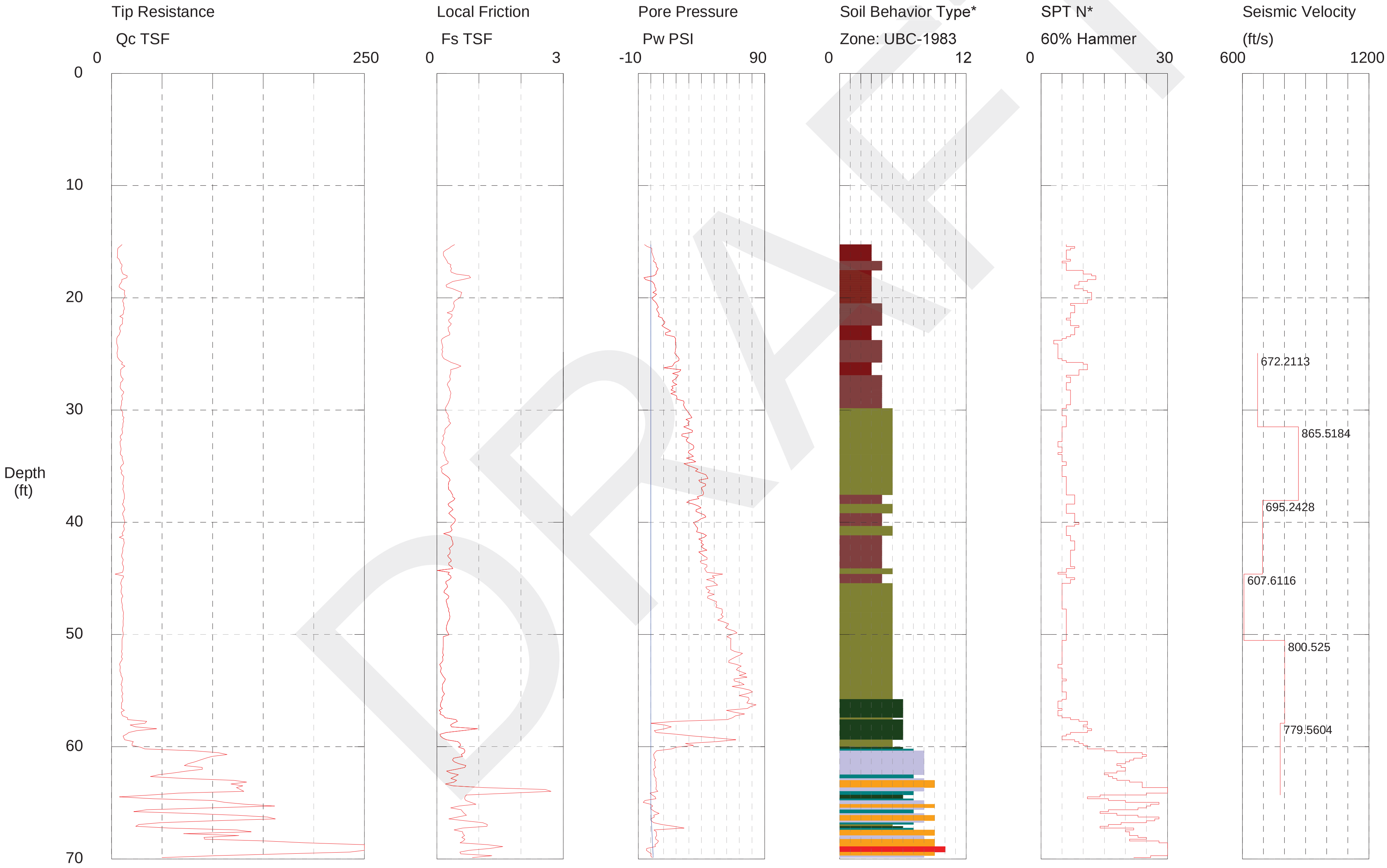


Maximum Depth = 68.90 feet

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
- ▨ 2 organic material
- ▨ 3 clay
- ▨ 4 silty clay to clay
- ▨ 5 clayey silt to silty clay
- ▨ 6 sandy silt to clayey silt
- ▨ 7 silty sand to sandy silt
- ▨ 8 sand to silty sand
- ▨ 9 sand
- 🟥 10 gravelly sand to sand
- ▨ 11 very stiff fine grained (*)
- ▨ 12 sand to clayey sand (*)

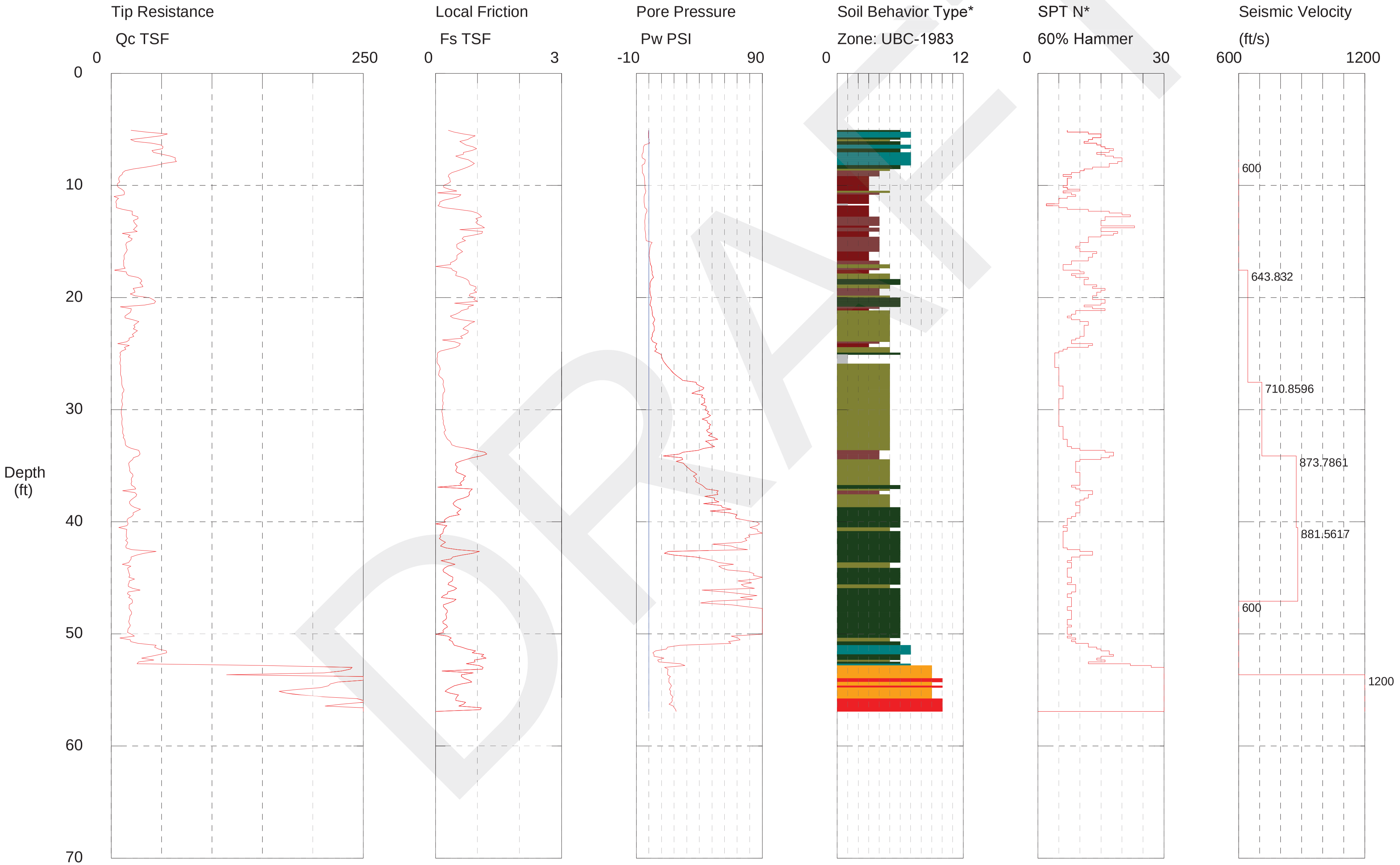
FB Culley - East Ash Pond

*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

PROJECT NAME: VECTREN F.B. CULLEY EAST POND

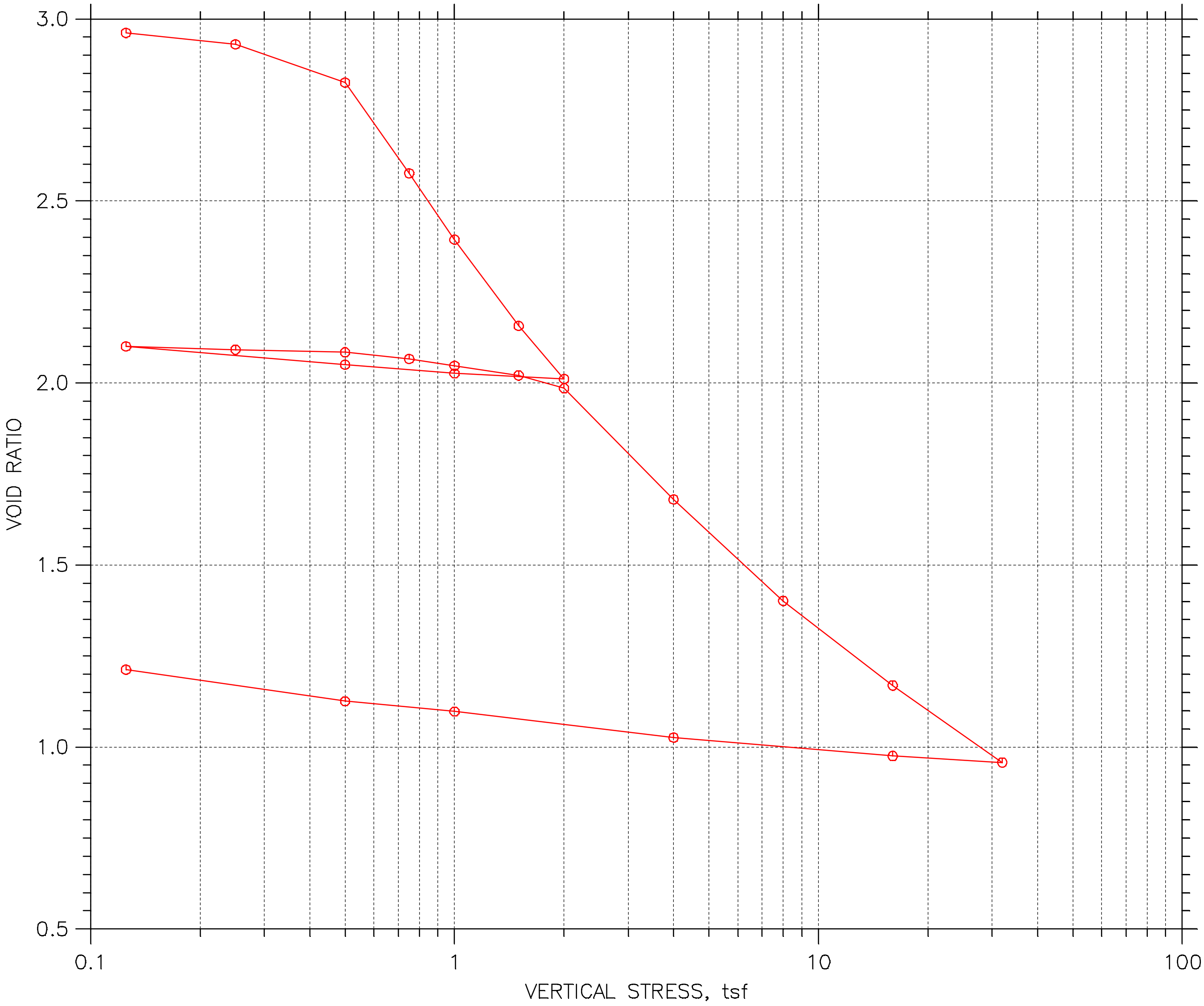
PROJECT NUMBER: AW165009

CLIENT: AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	% Gravel	% Sand	% Silt	% Clay	LL	PL	PI	Specific Gravity	Dry Density (pcf)	Consolidation			CIU Triaxial Testing				Direct Shear		Unconfined
															P_c (tsf)	C_c	C_{cr}	Φ' (deg)	C' (tsf)	Φ (deg)	C (tsf)	Φ (deg)	C (tsf)	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	

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

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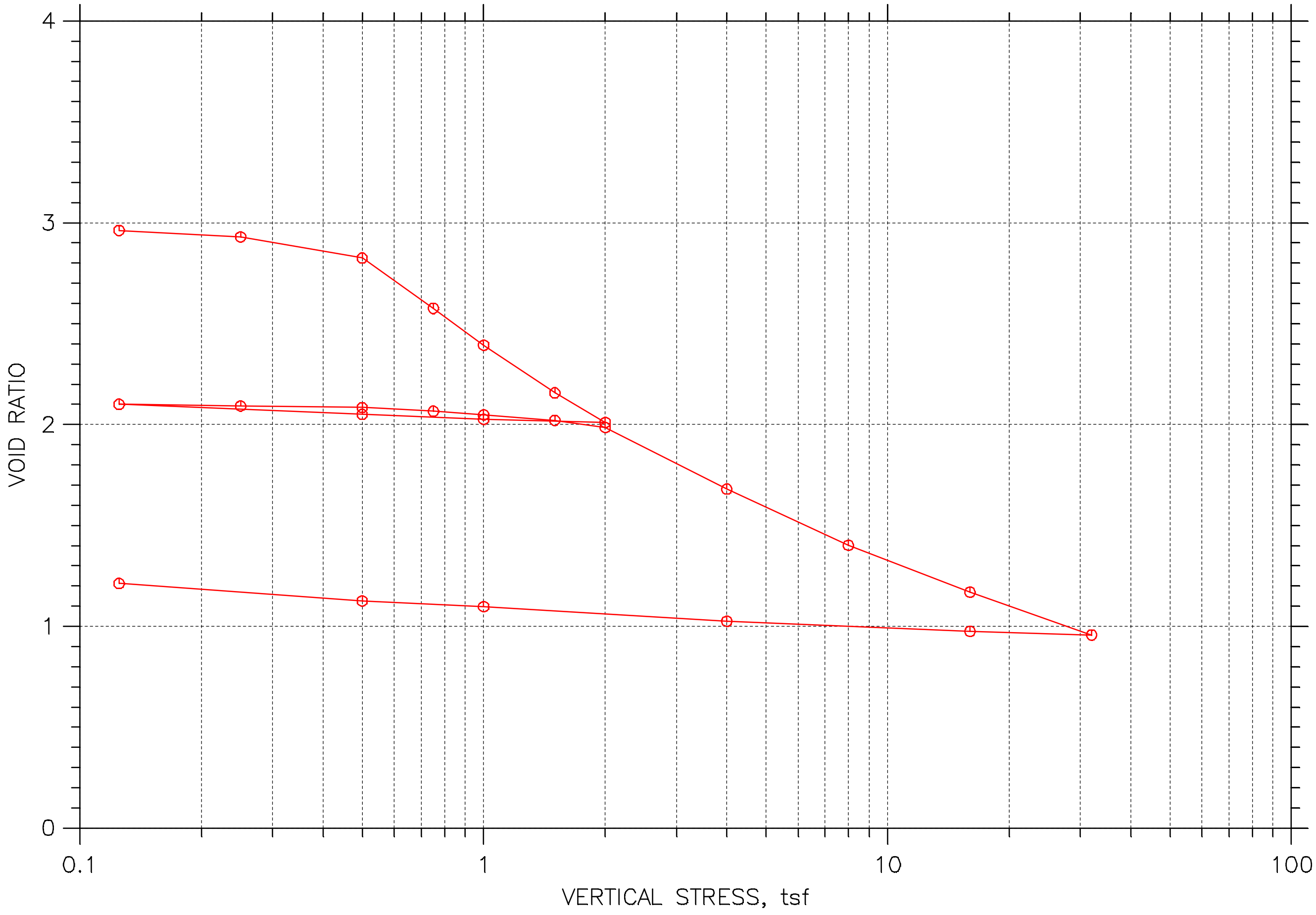
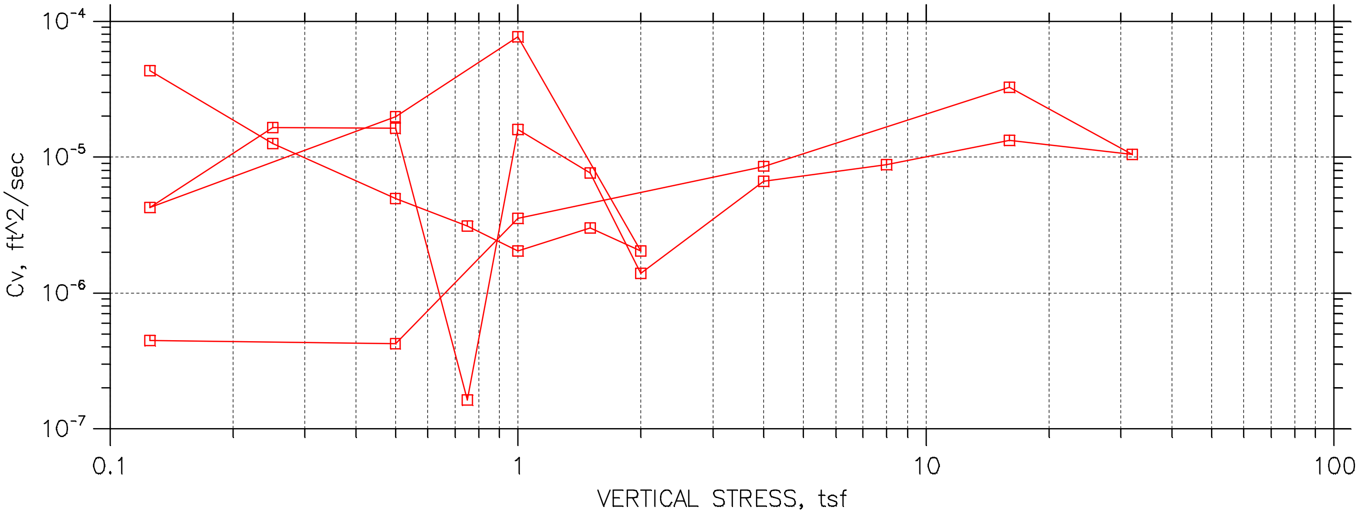
ONE DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS USING INCREMENTAL LOADING ASTM D2435





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
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: -----------

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
Liquid Limit: ---
Initial Height: 0.75 in
Initial Void Ratio: 3.00
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	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
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: -----------

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

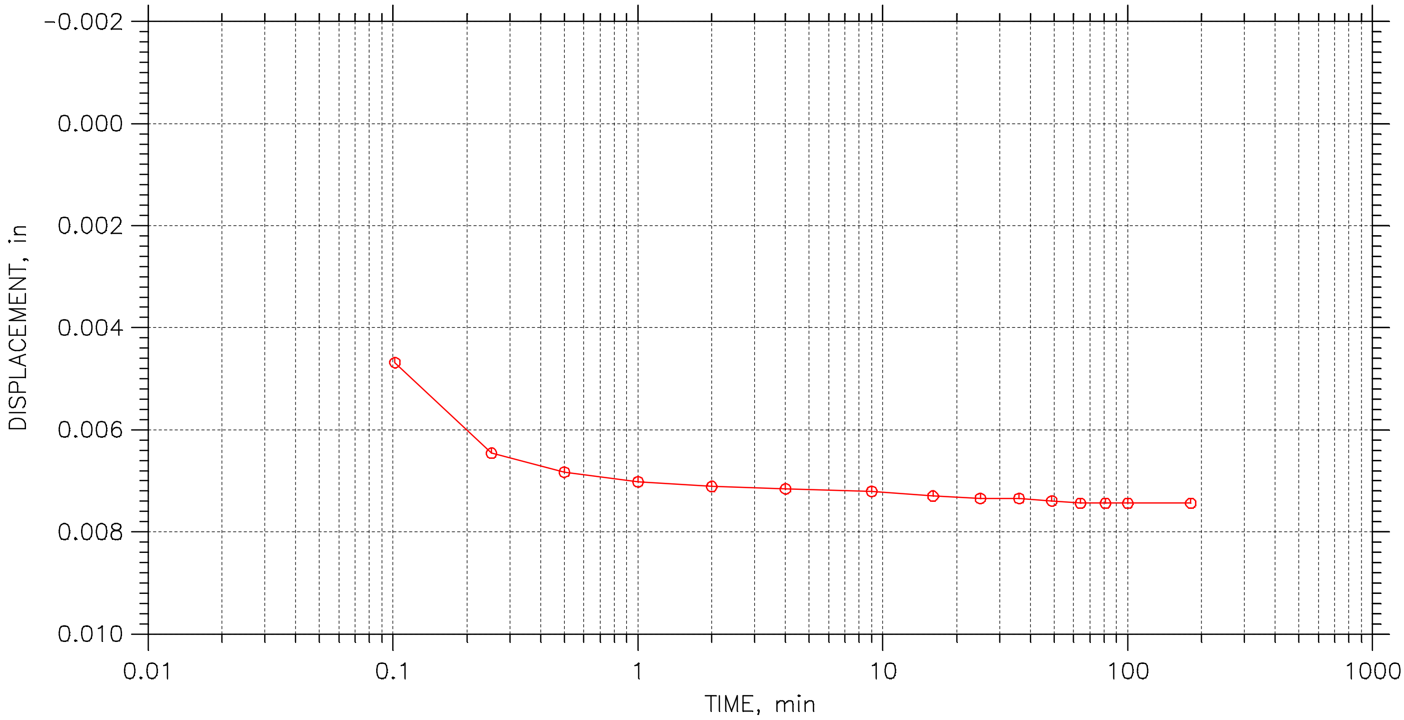
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	T50 Fitting		Coefficient of Consolidation		
					Sq.Rt. min	Log min	Sq.Rt. ft^2/sec	Log ft^2/sec	Ave. ft^2/sec
1	0.125	0.00744	2.962	0.99	0.1	0.0	4.33e-005	0.00e+000	4.33e-005
2	0.25	0.01341	2.930	1.79	0.2	0.0	1.29e-005	0.00e+000	1.29e-005
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

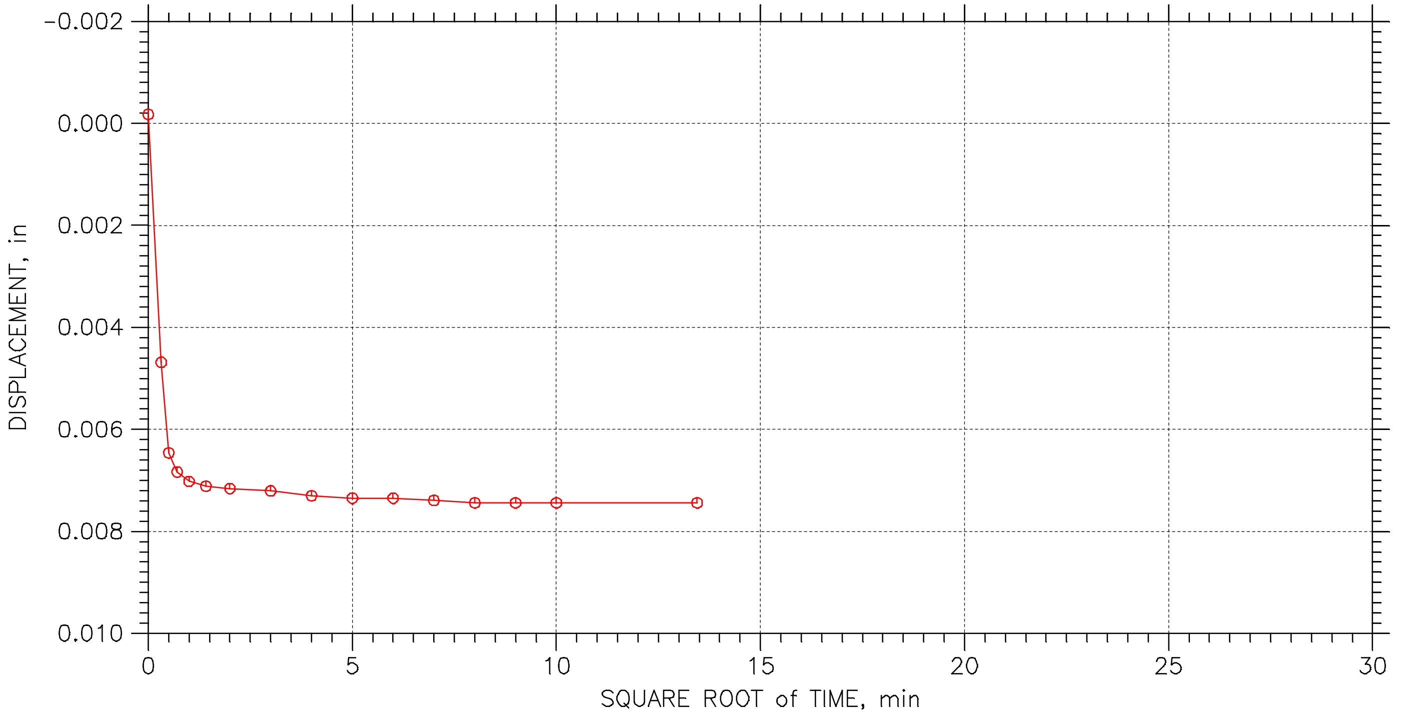
CONSOLIDATION TEST DATA

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		

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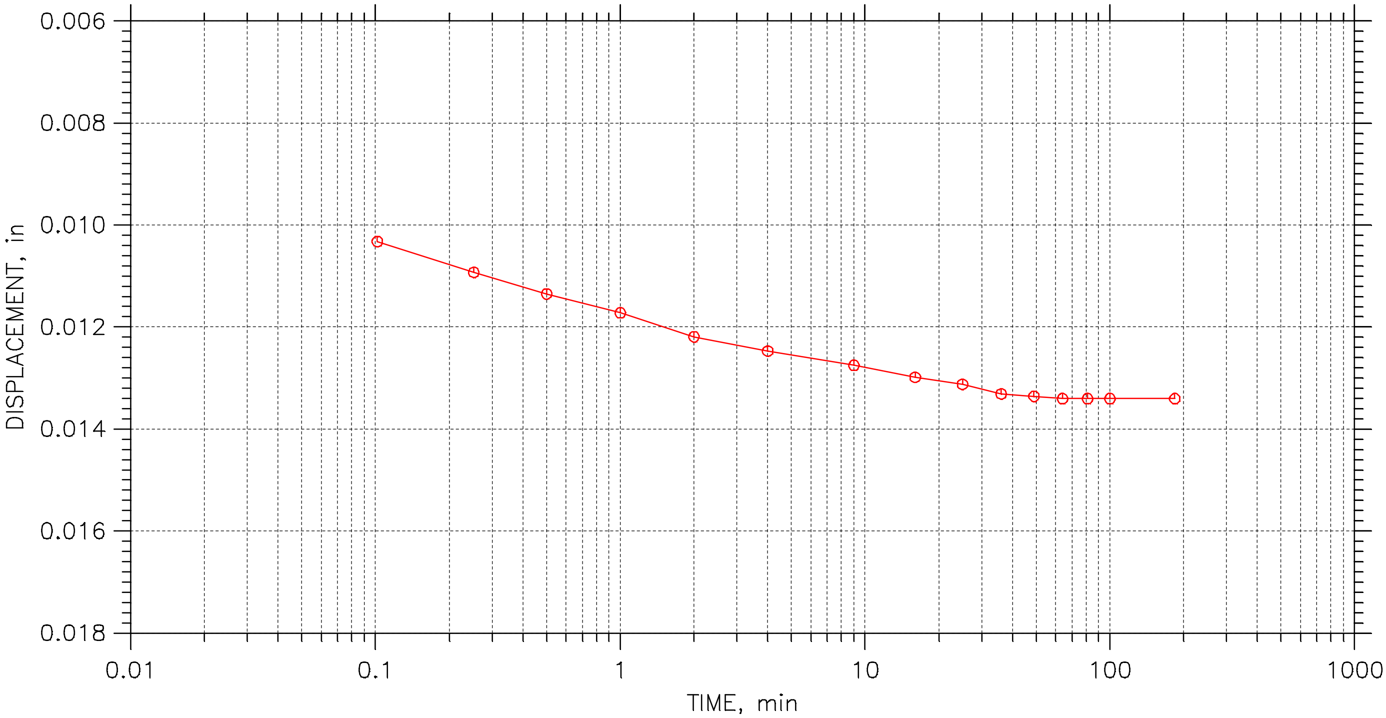
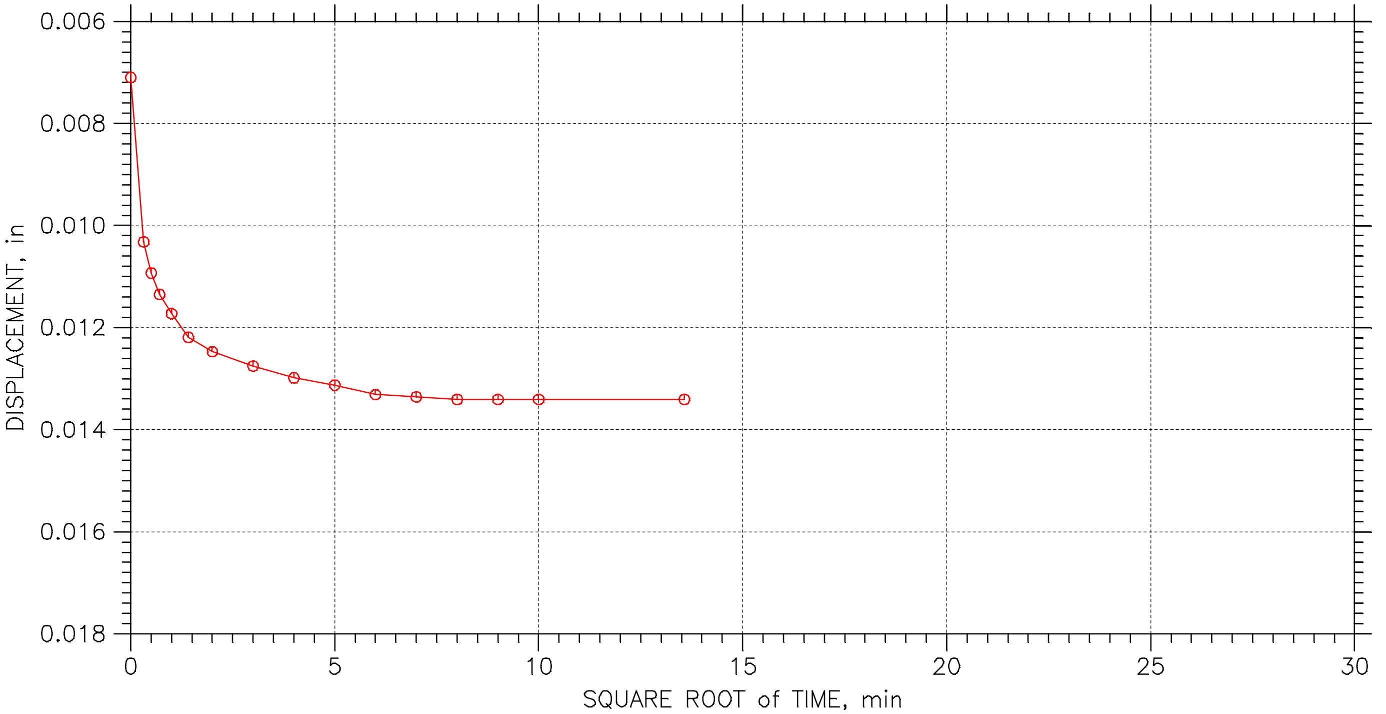
CONSOLIDATION TEST DATA

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		

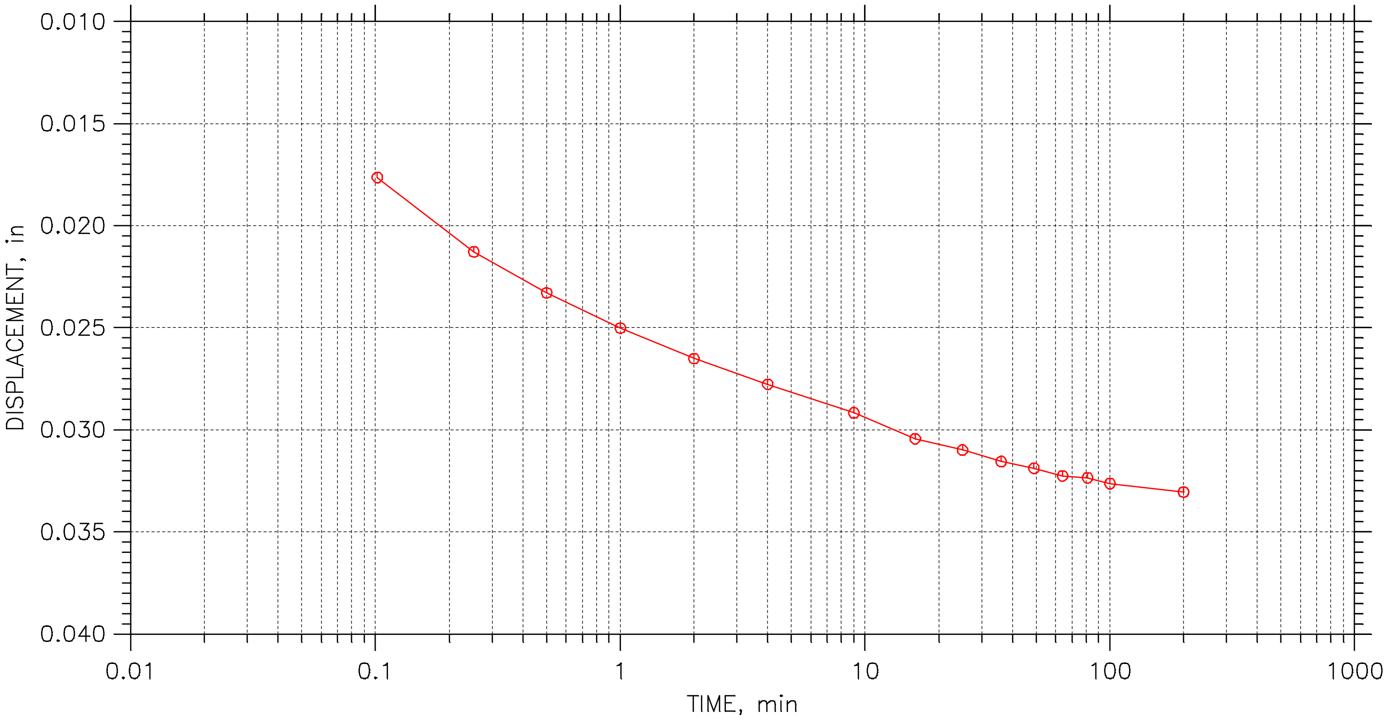
Mon, 25-APR-2016 16:42:22

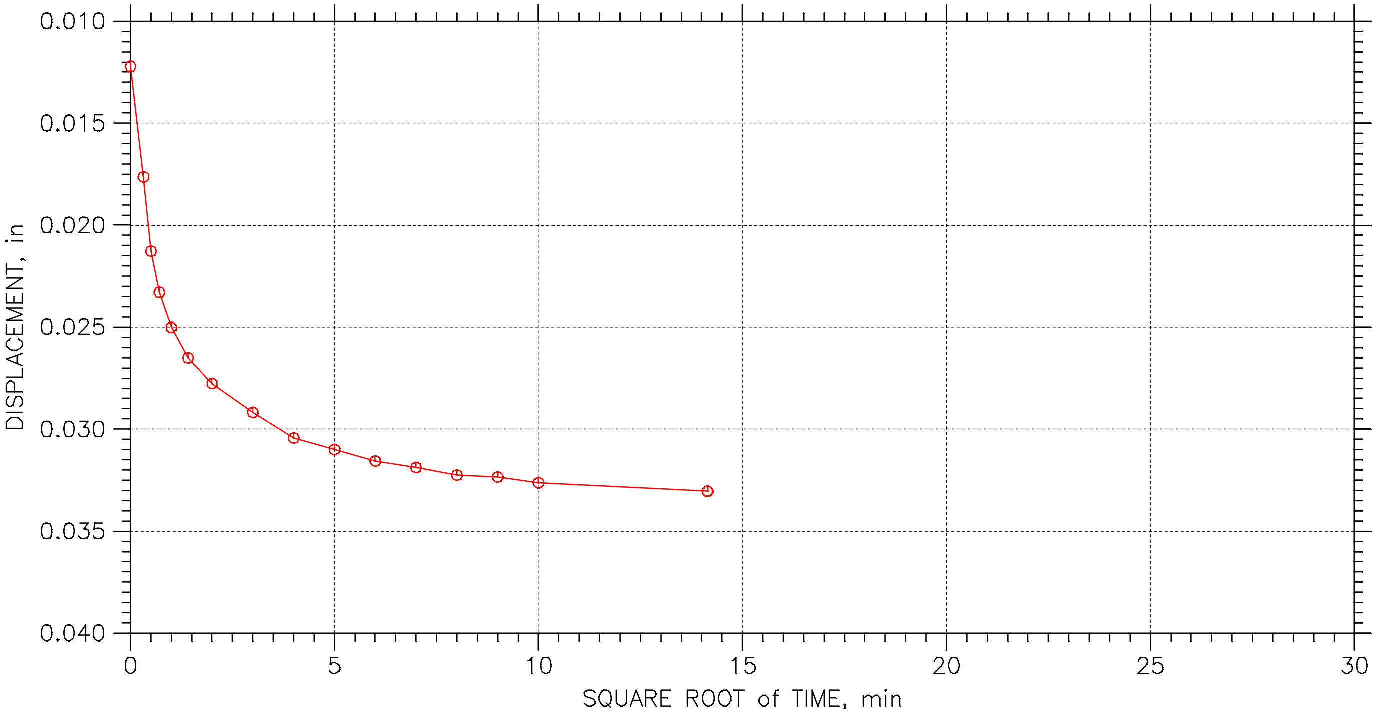
CONSOLIDATION TEST DATA

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		

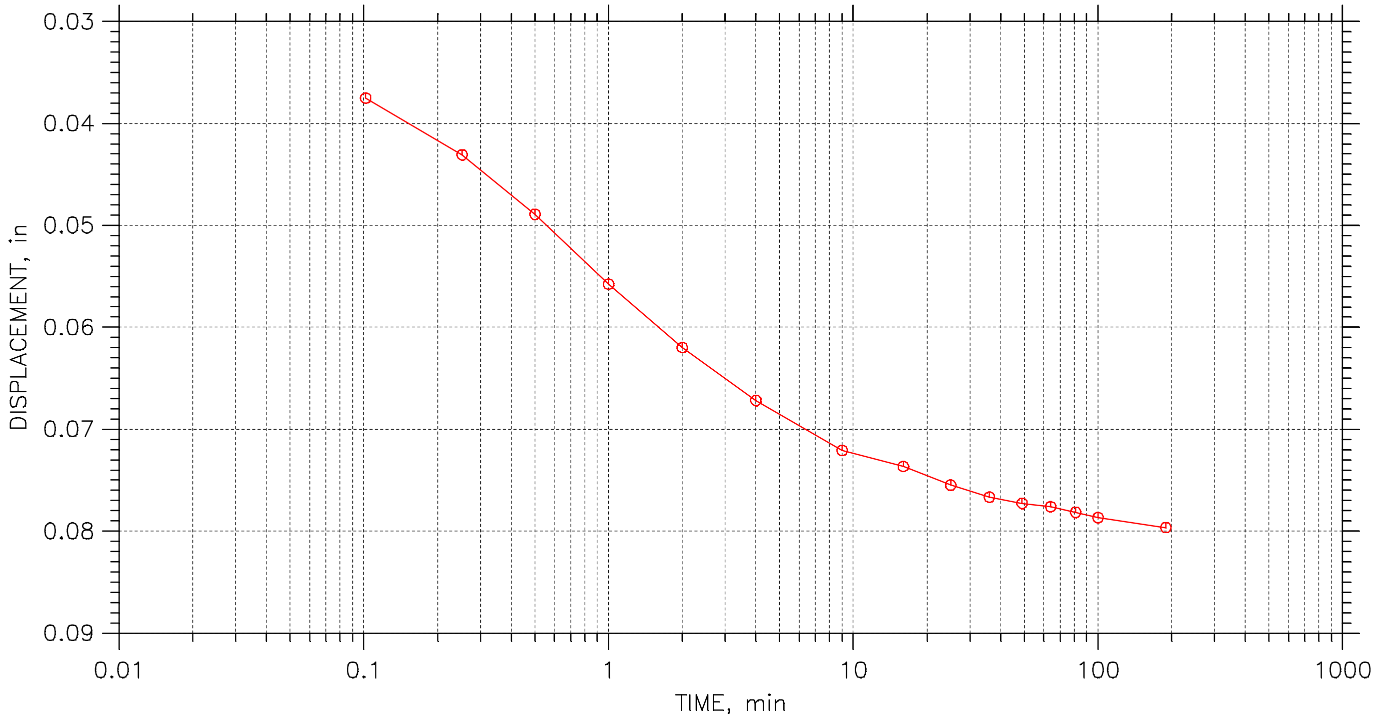
Mon, 25-APR-2016 16:42:23

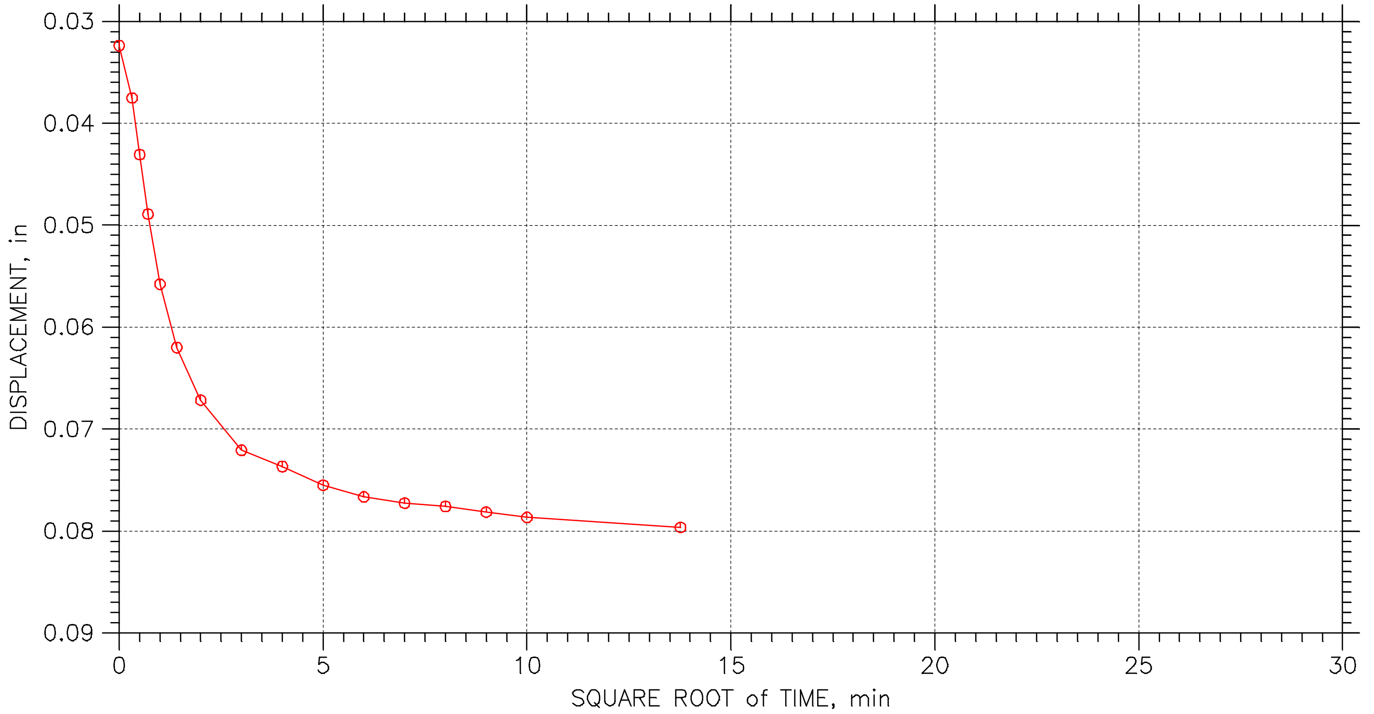
CONSOLIDATION TEST DATA

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		

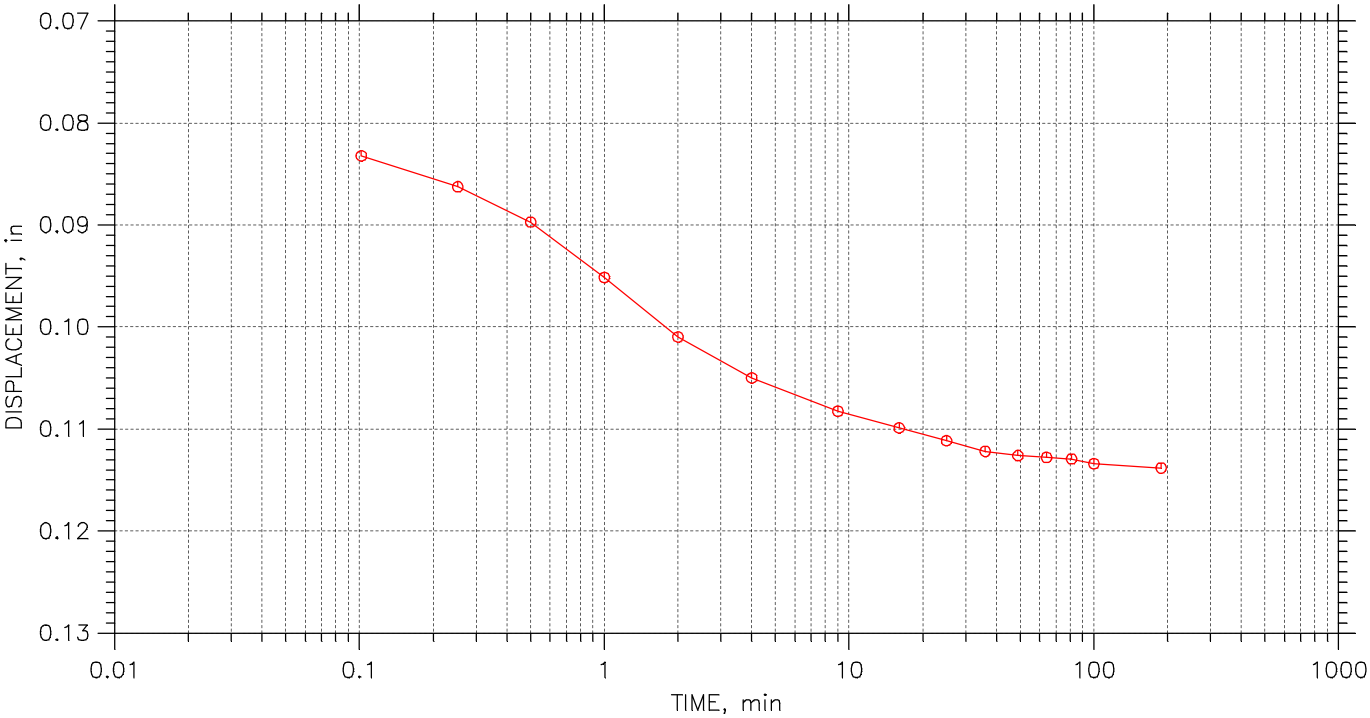
Mon, 25-APR-2016 16:42:25

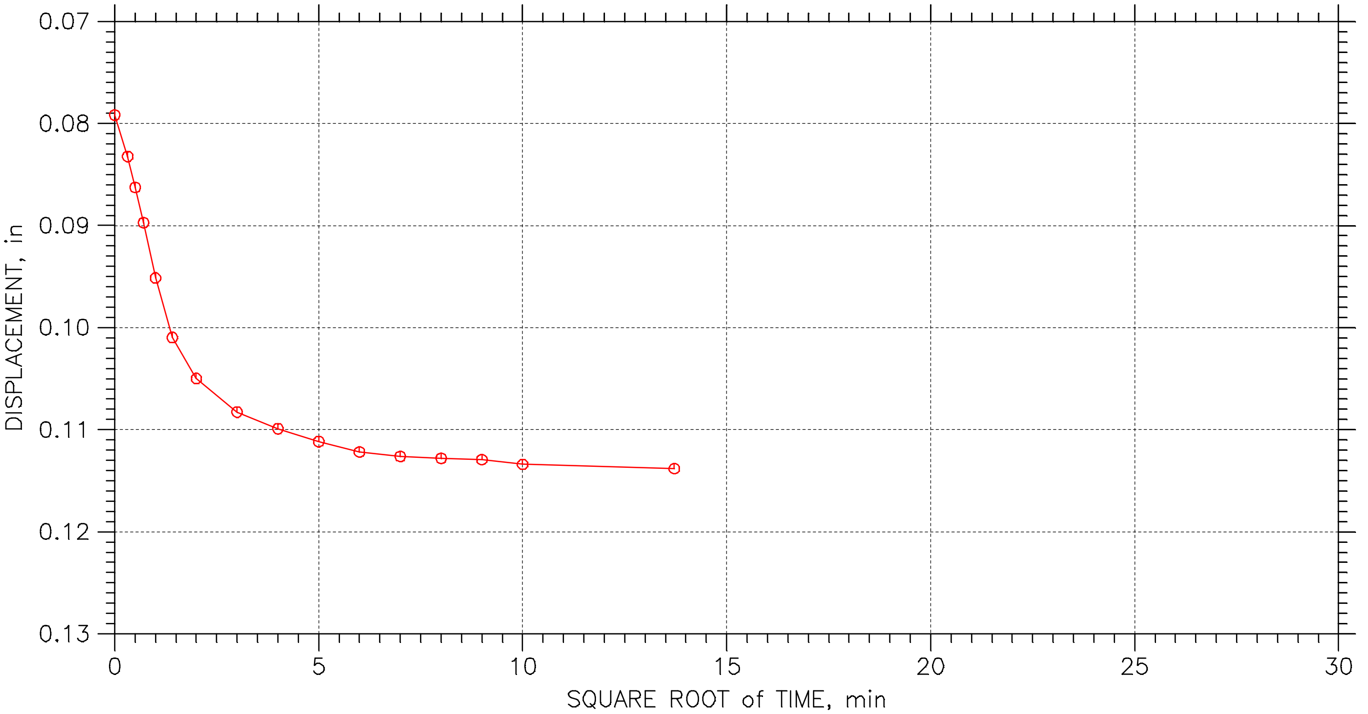
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 5 of 25

Stress: 1. tsf





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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		

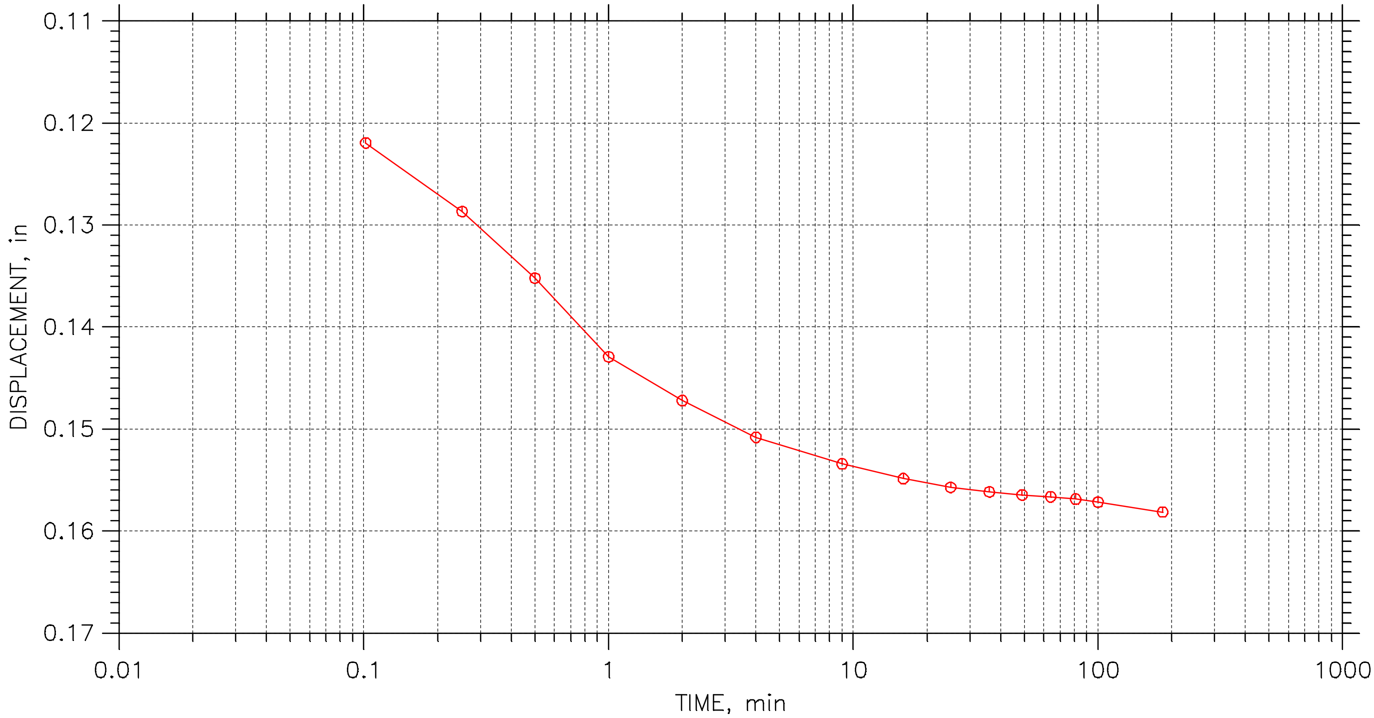
Mon, 25-APR-2016 16:42:26

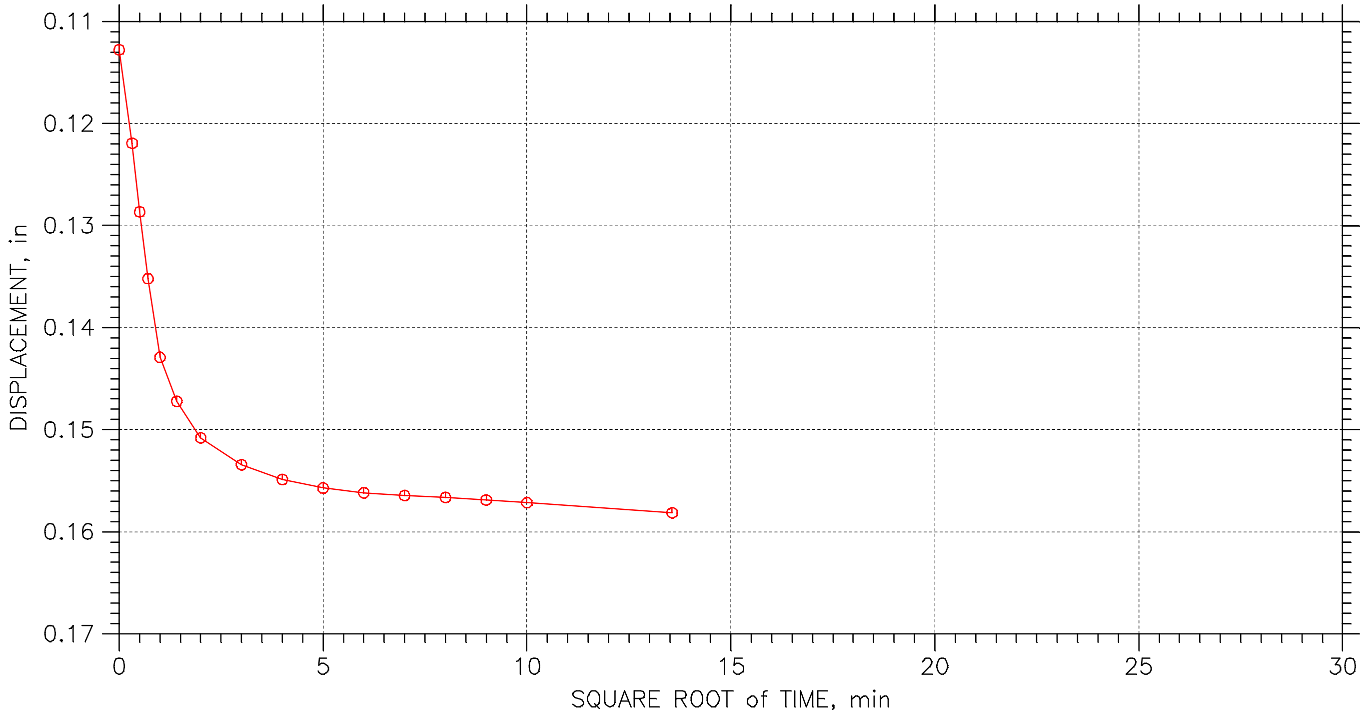
CONSOLIDATION TEST DATA

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		

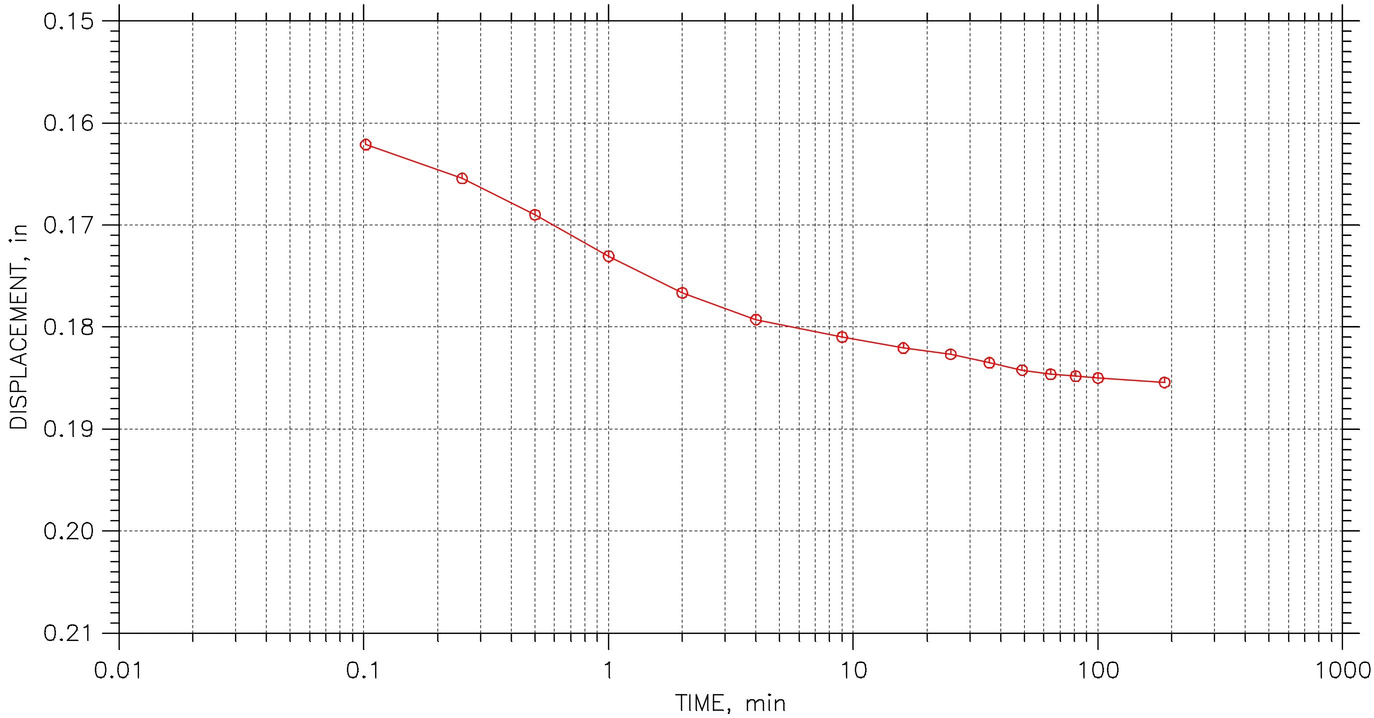
Mon, 25-APR-2016 16:42:28

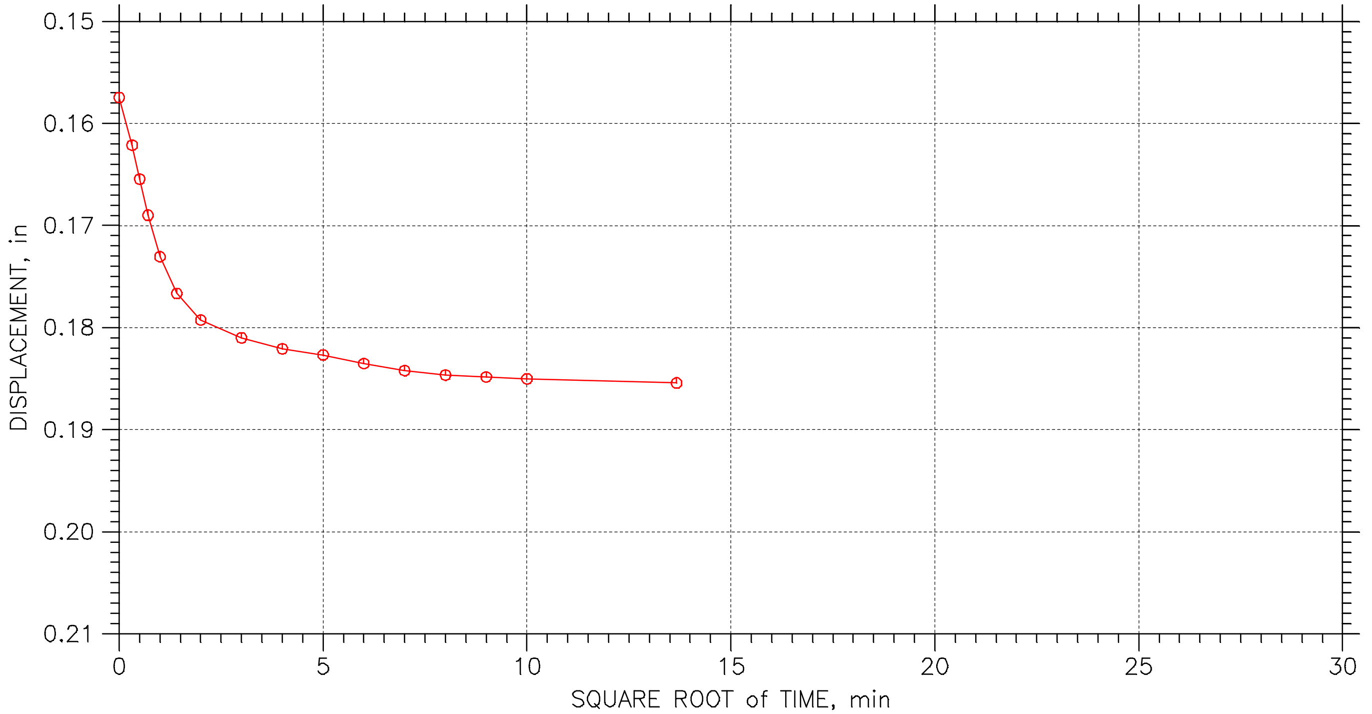
CONSOLIDATION TEST DATA

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		

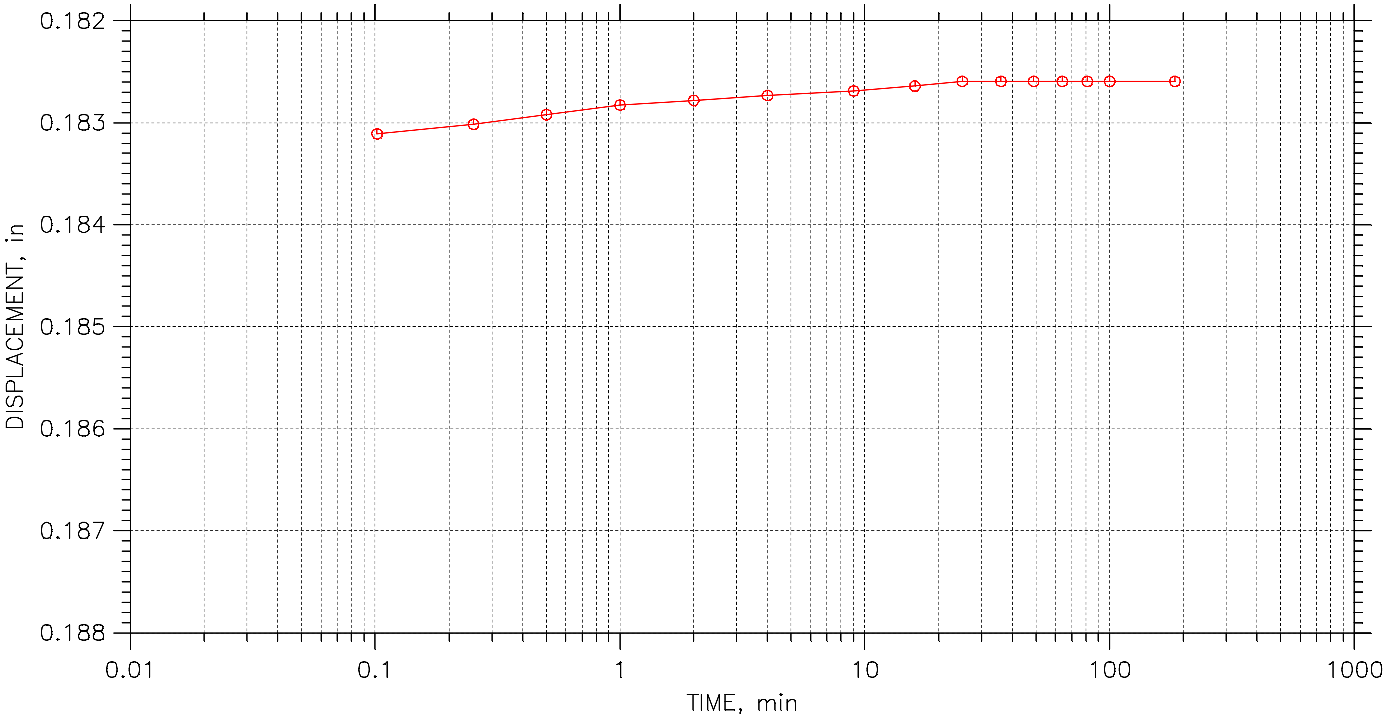
Mon, 25-APR-2016 16:42:29

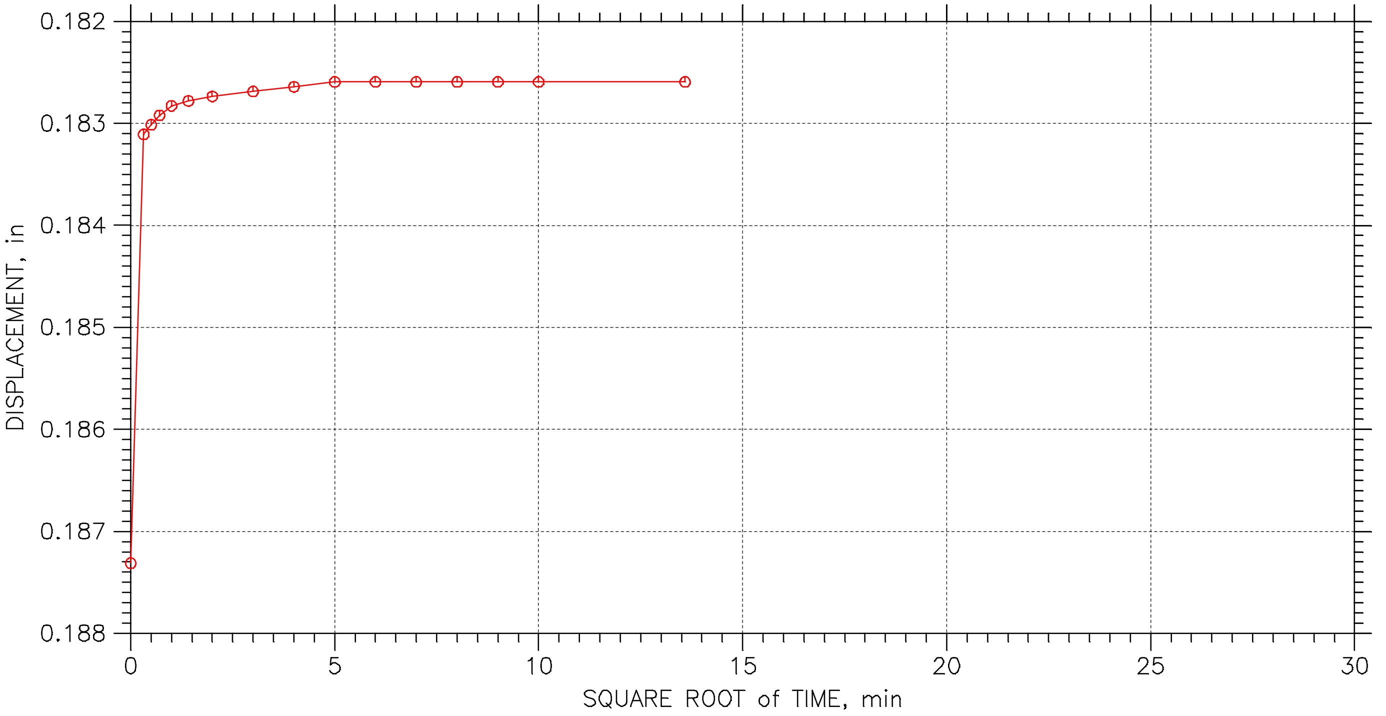
CONSOLIDATION TEST DATA

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		

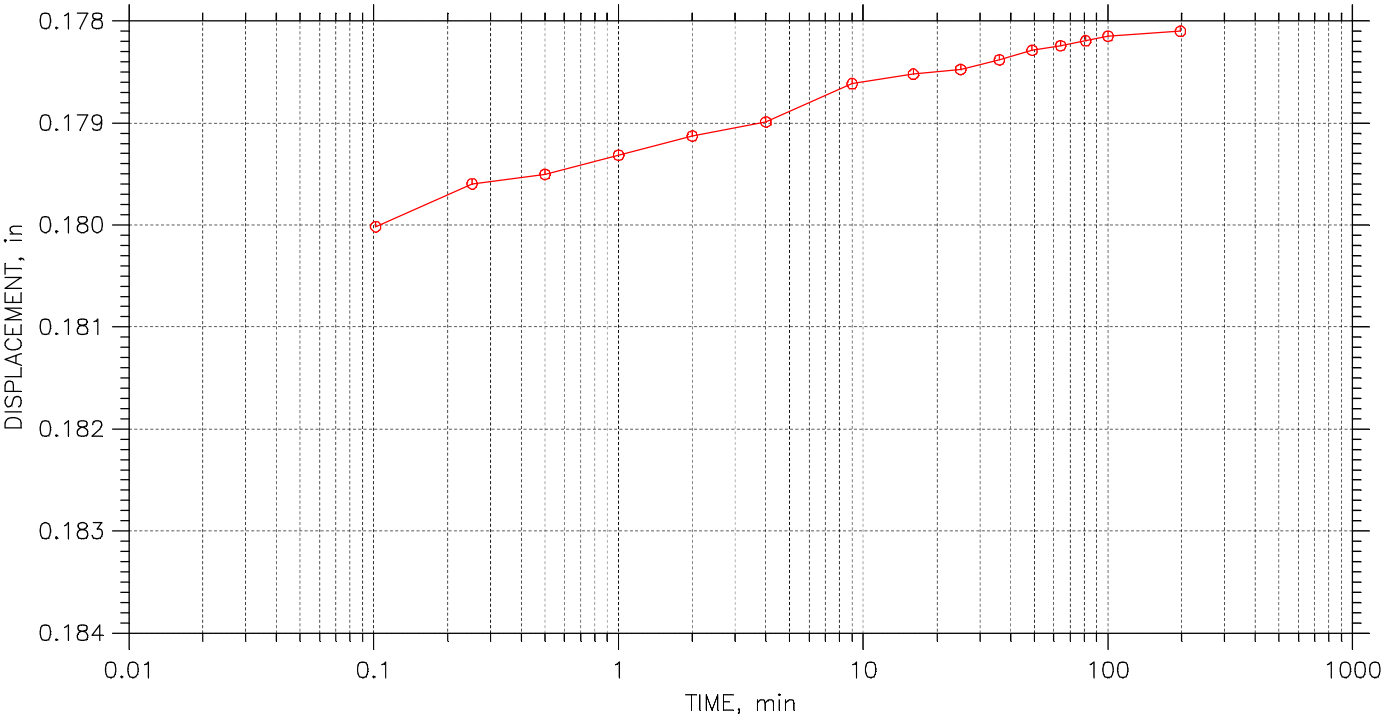
Mon, 25-APR-2016 16:42:31

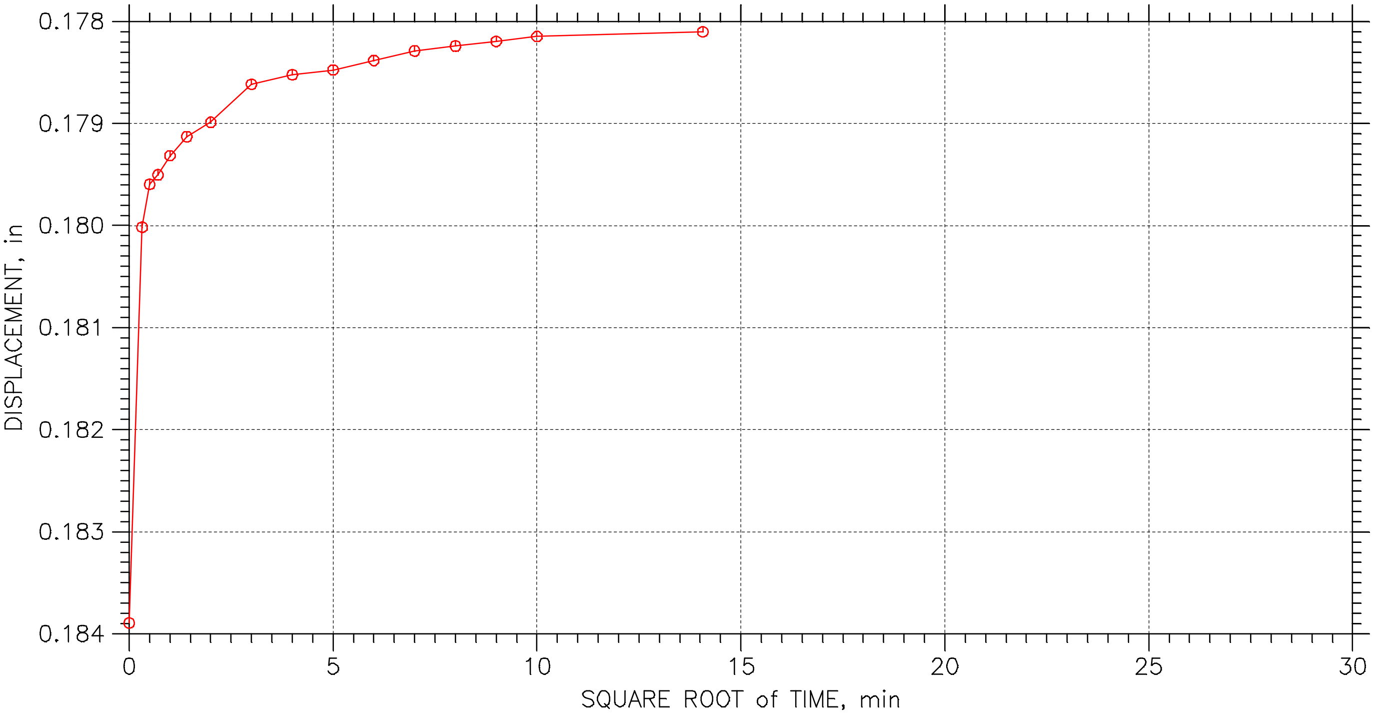
CONSOLIDATION TEST DATA

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		

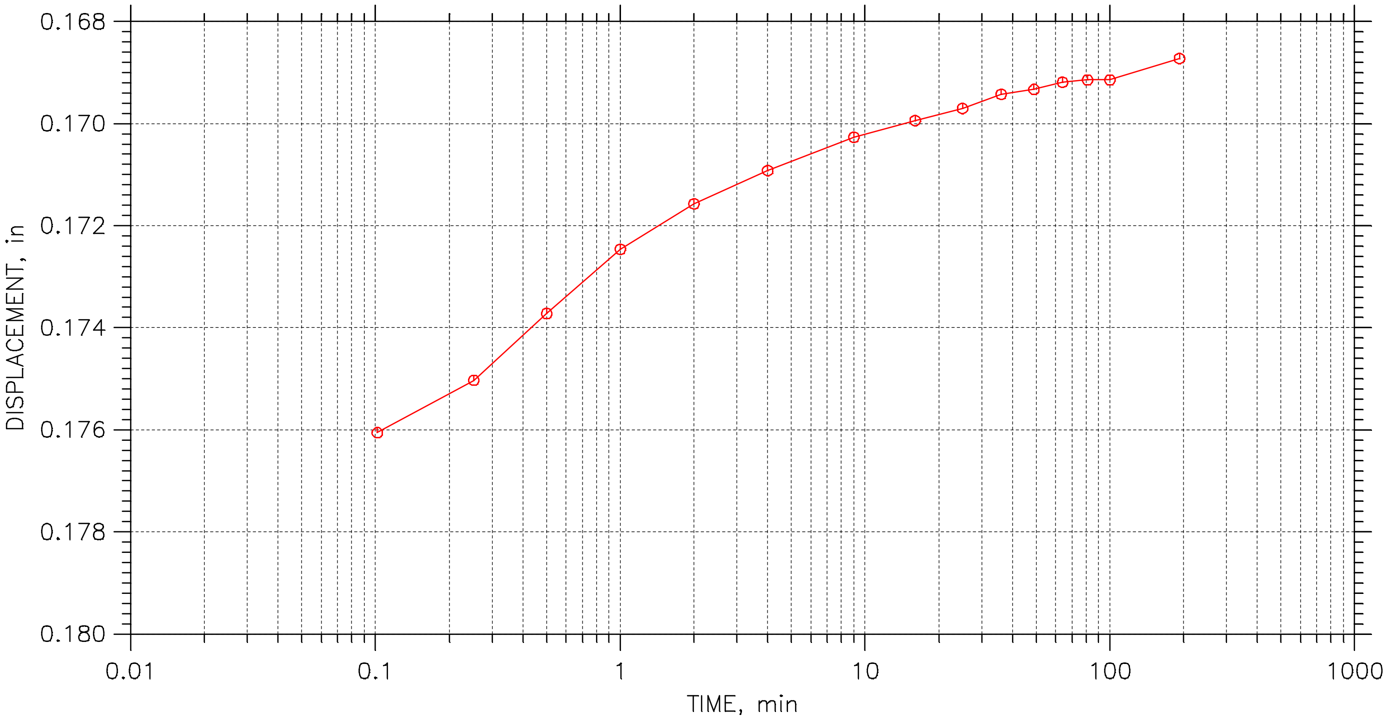
Mon, 25-APR-2016 16:42:32

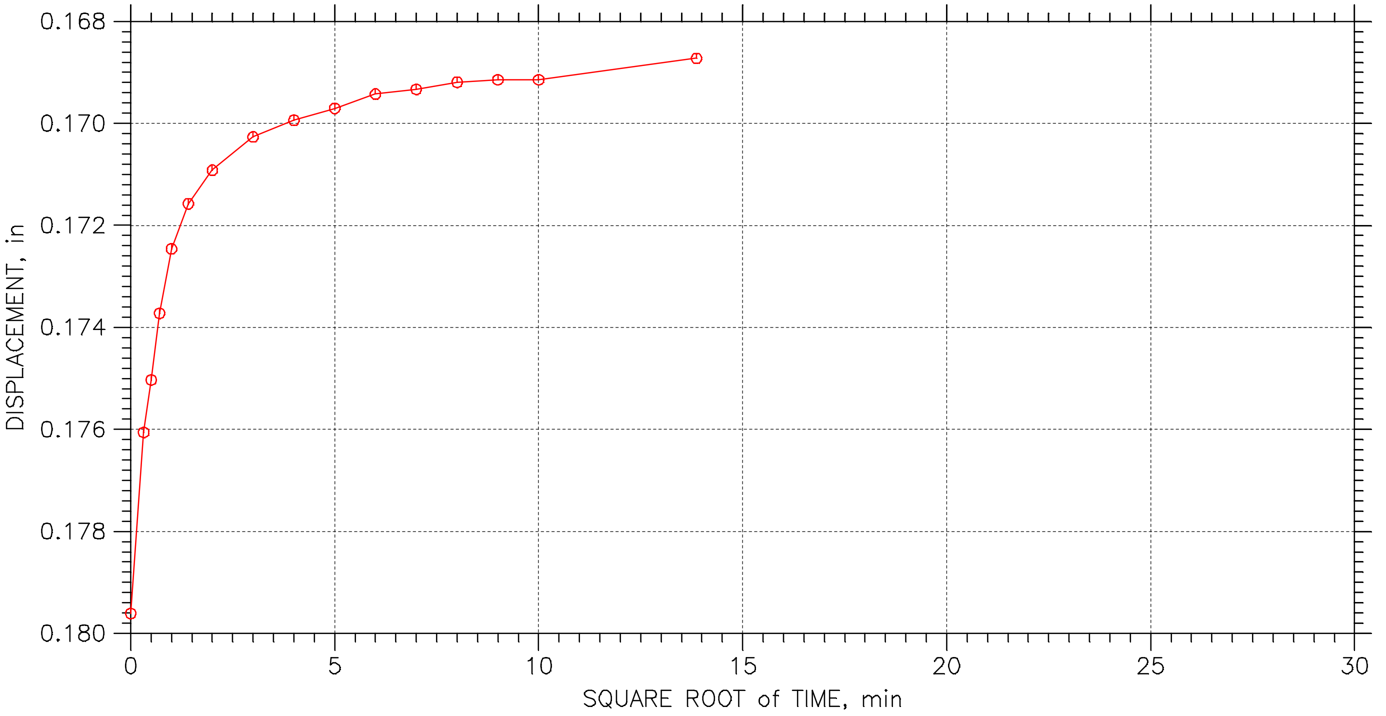
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 10 of 25

Stress: 0.125 tsf





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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

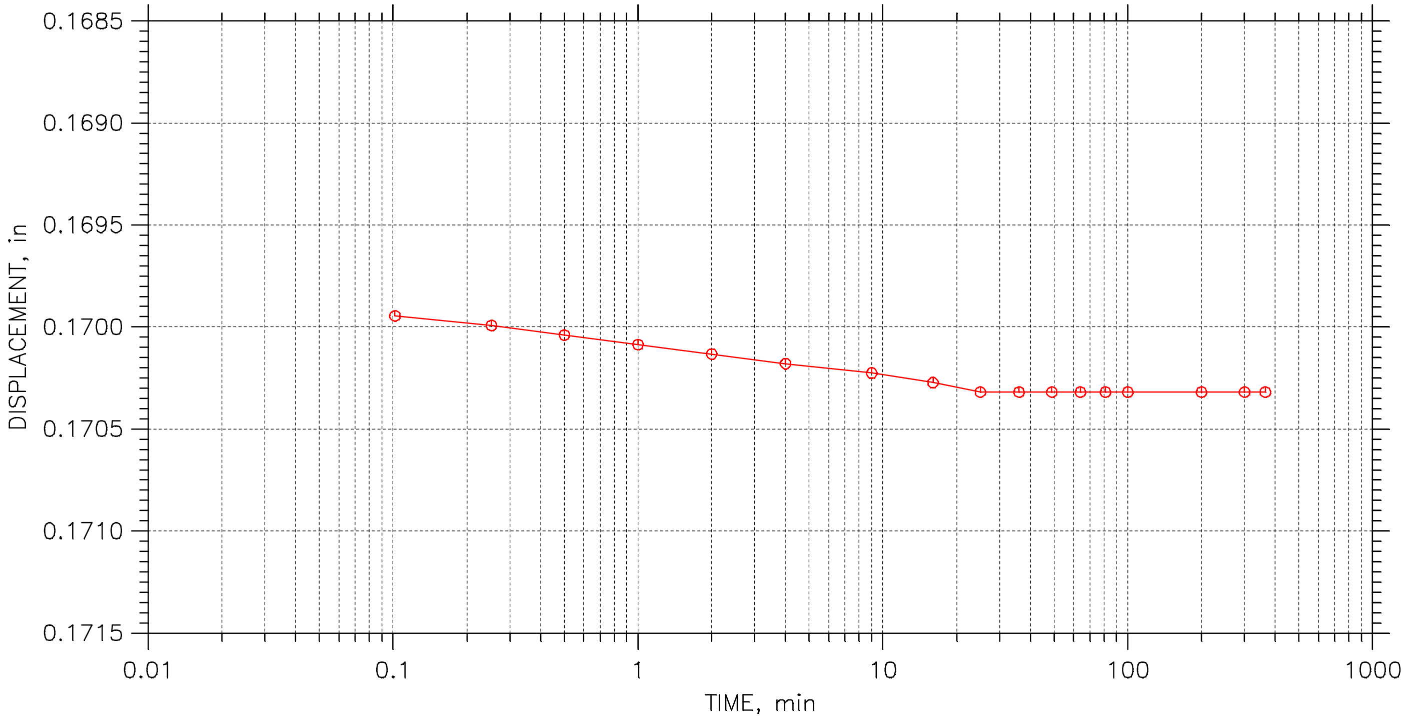
Mon, 25-APR-2016 16:42:33

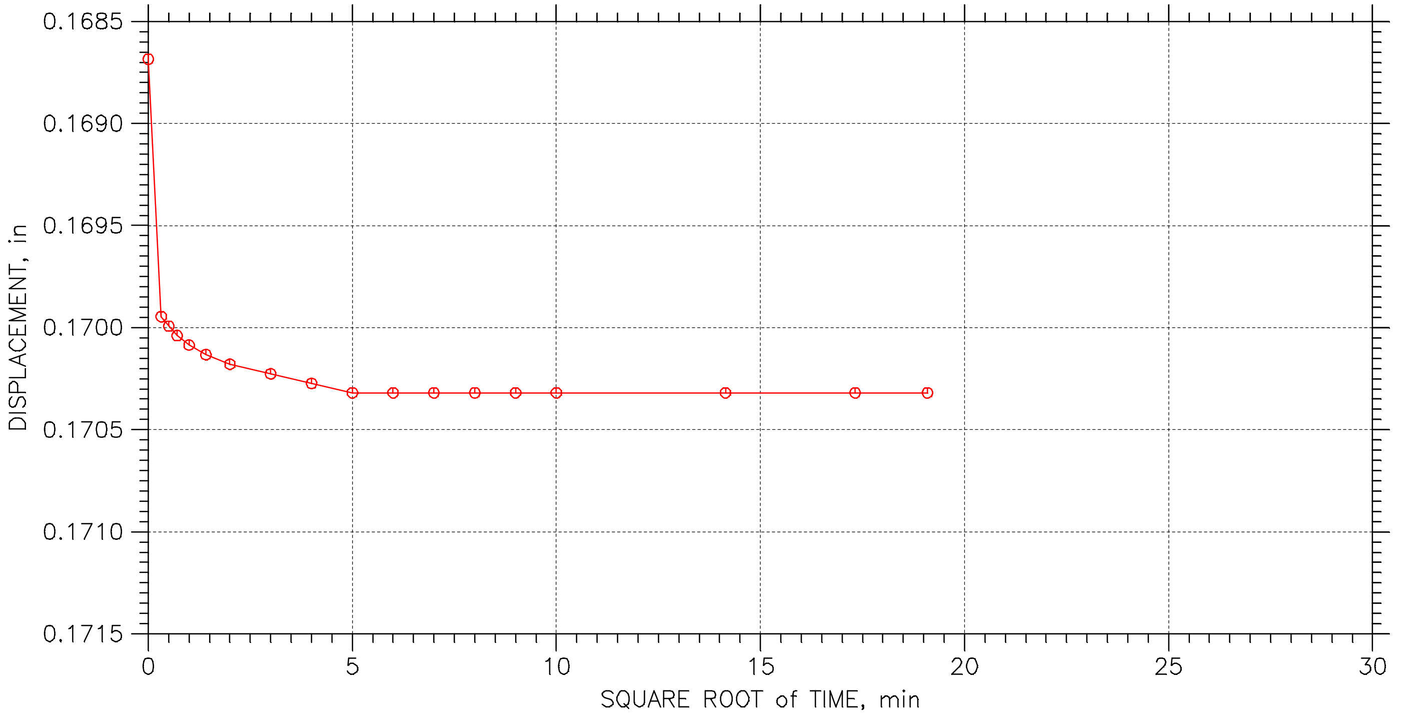
CONSOLIDATION TEST DATA

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.: 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		

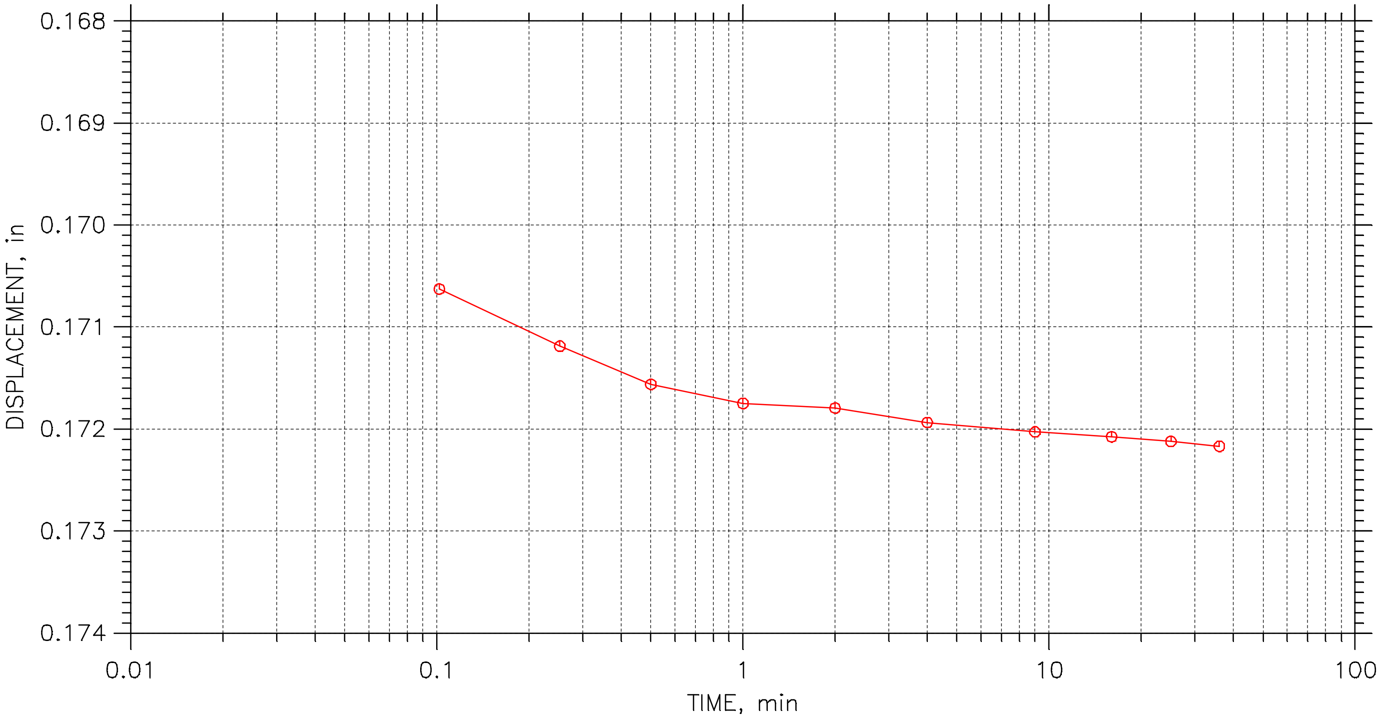
Mon, 25-APR-2016 16:42:35

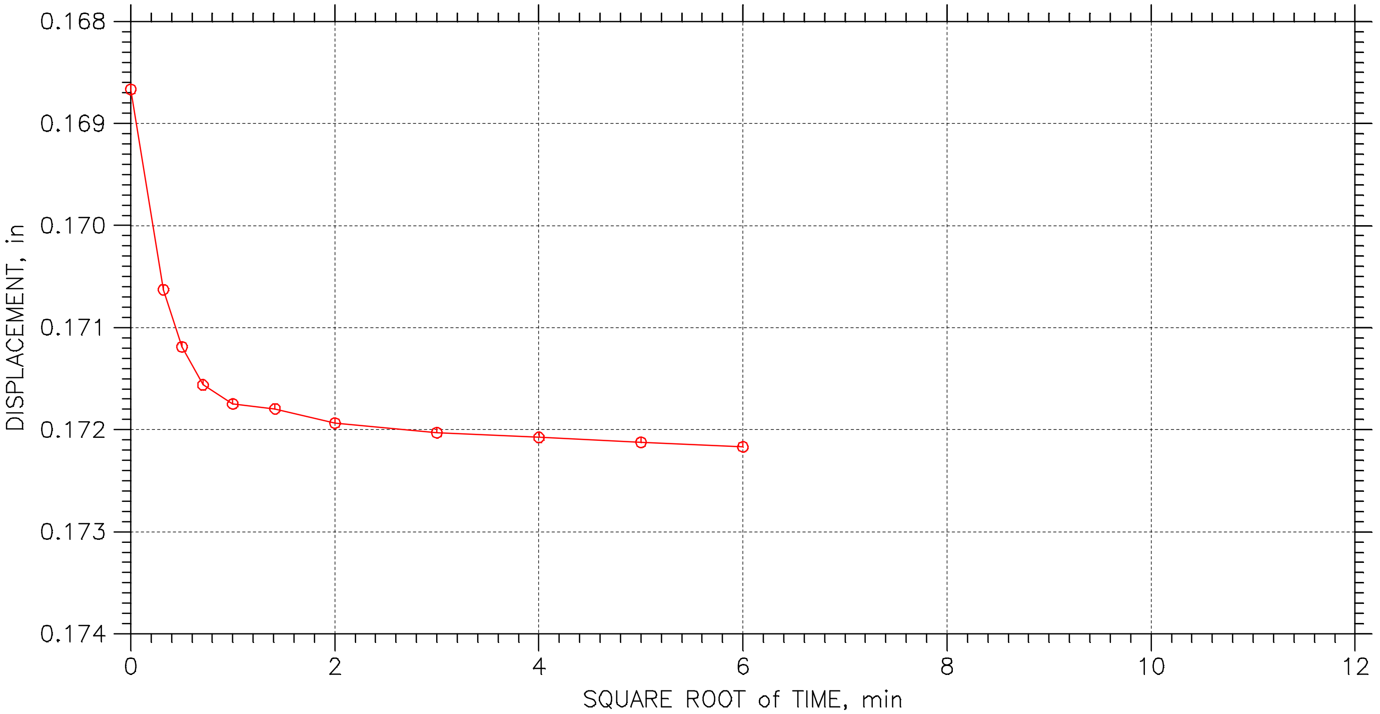
CONSOLIDATION TEST DATA

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		

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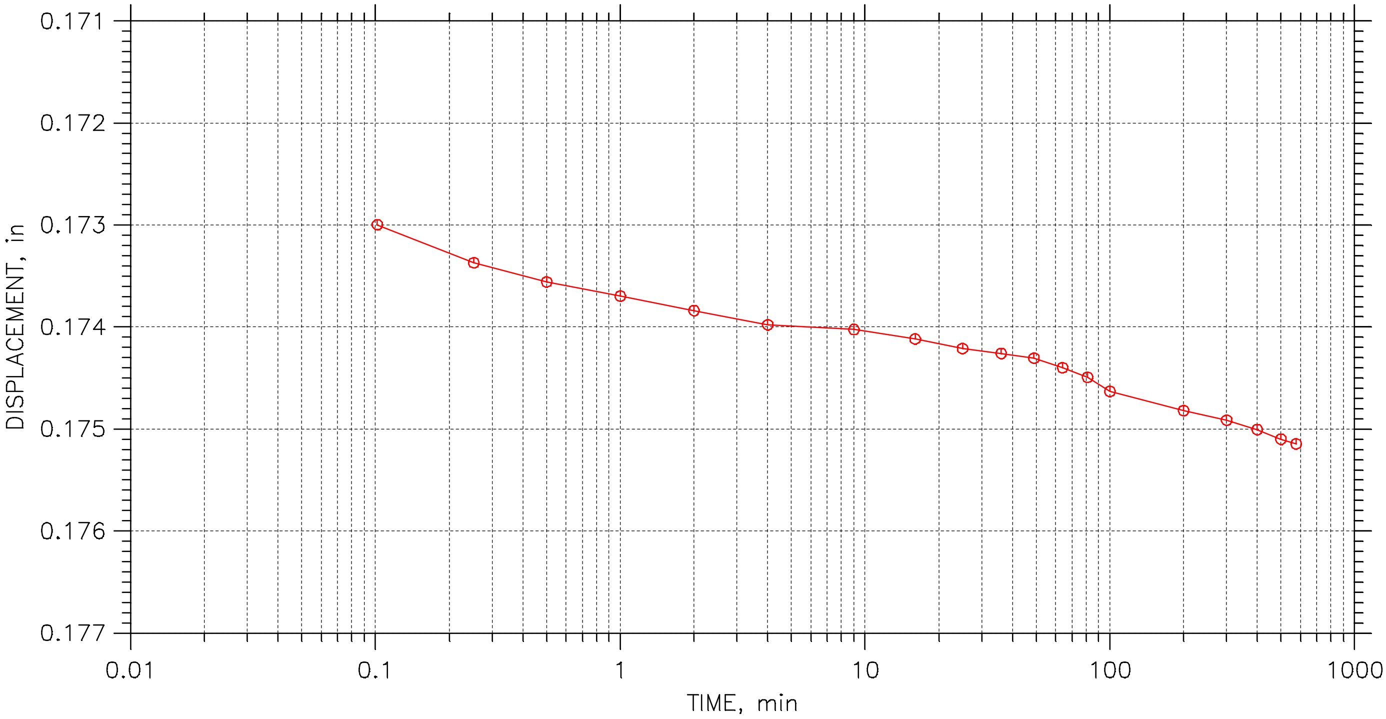
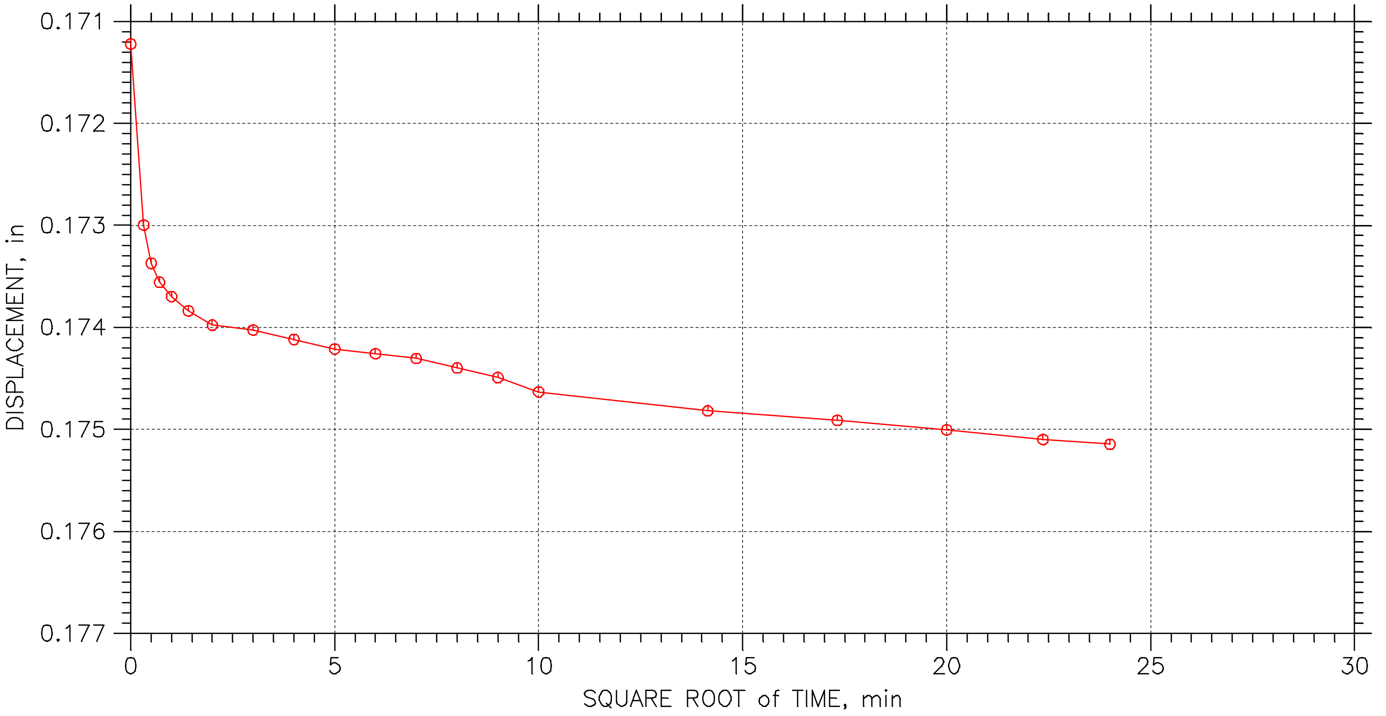
CONSOLIDATION TEST DATA

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		

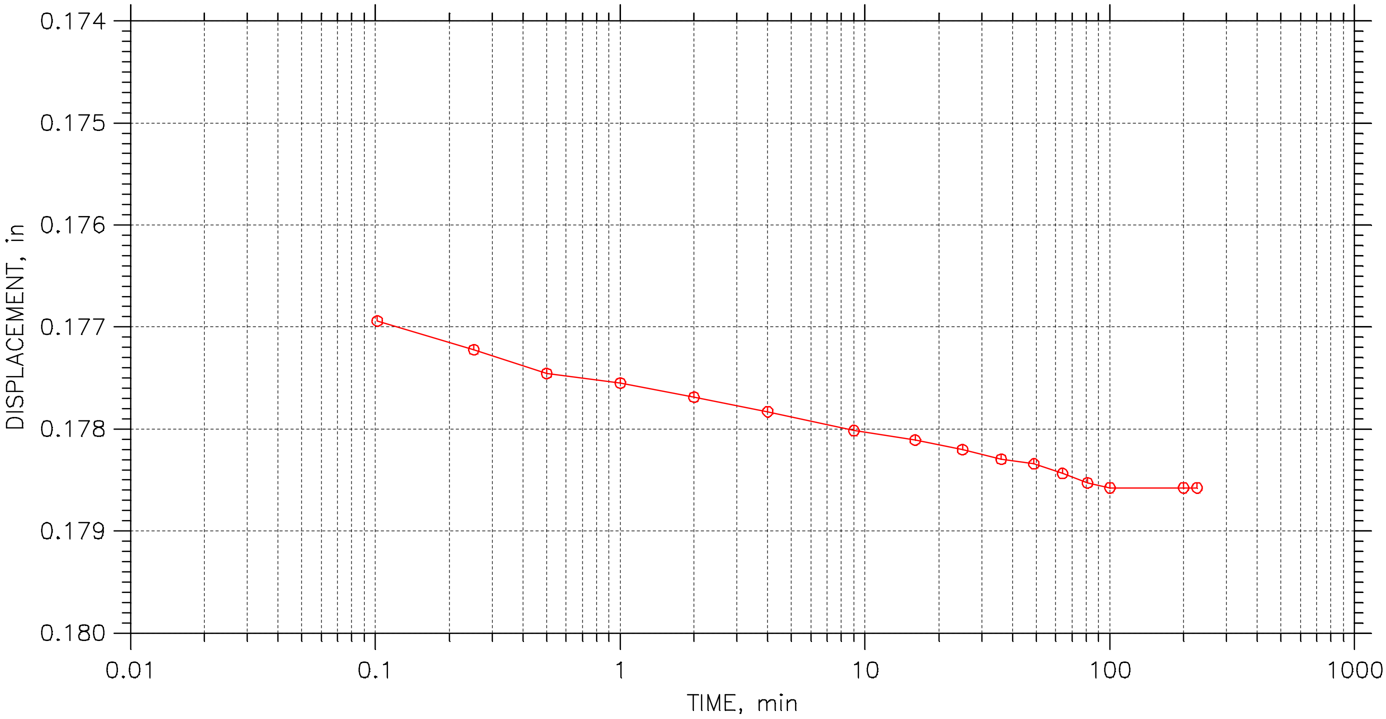
Mon, 25-APR-2016 16:42:38

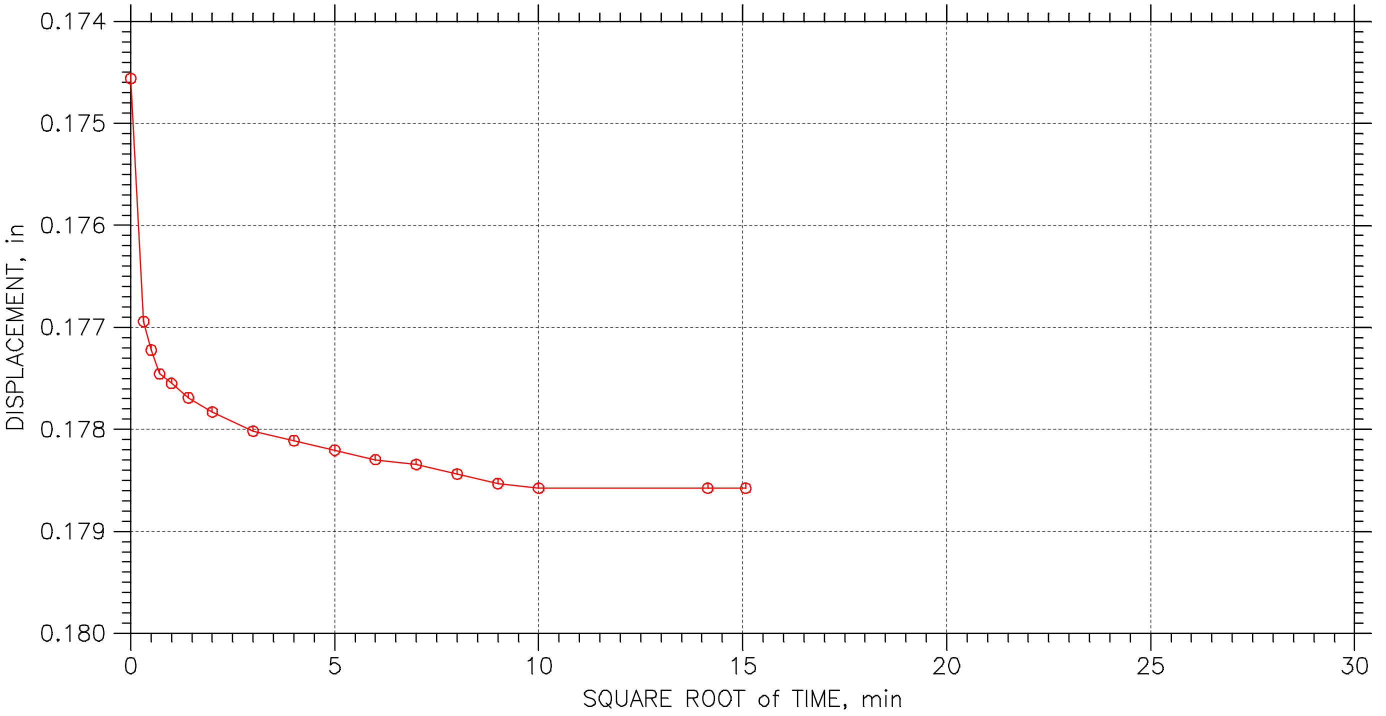
CONSOLIDATION TEST DATA

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		

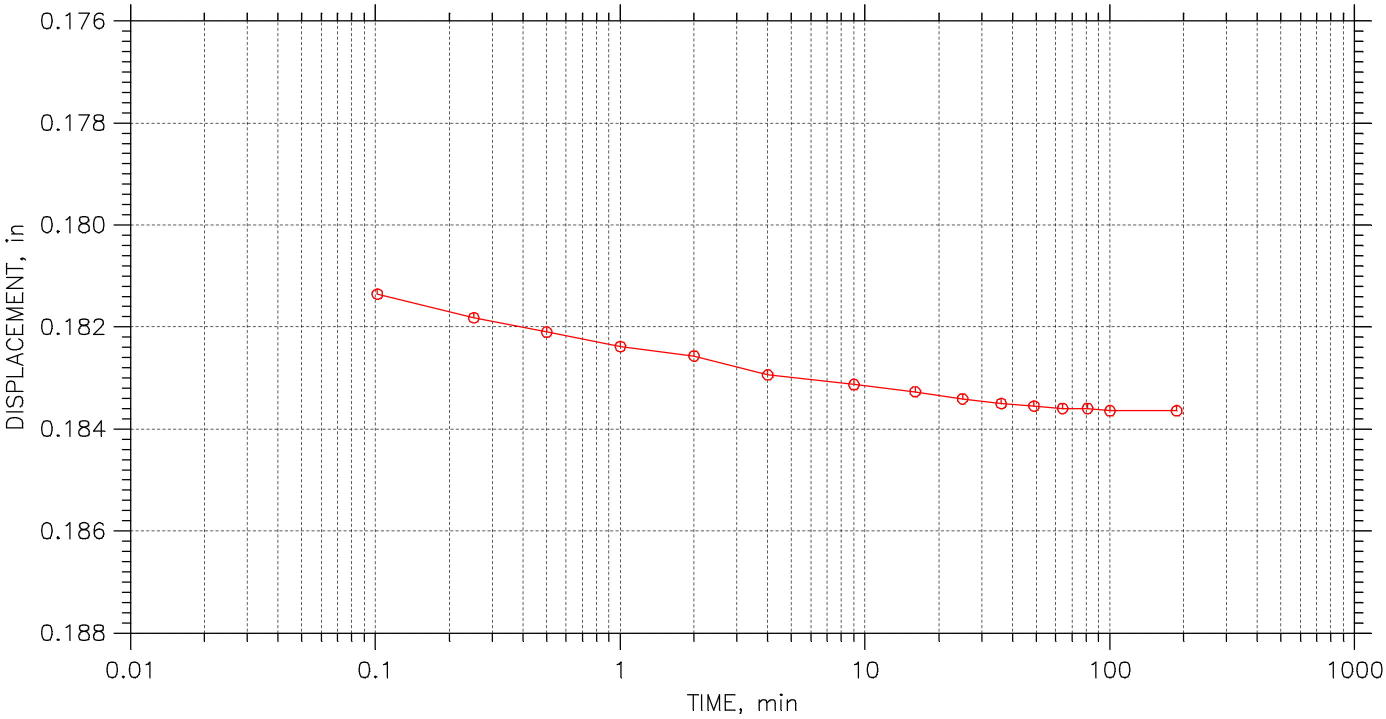
Mon, 25-APR-2016 16:42:39

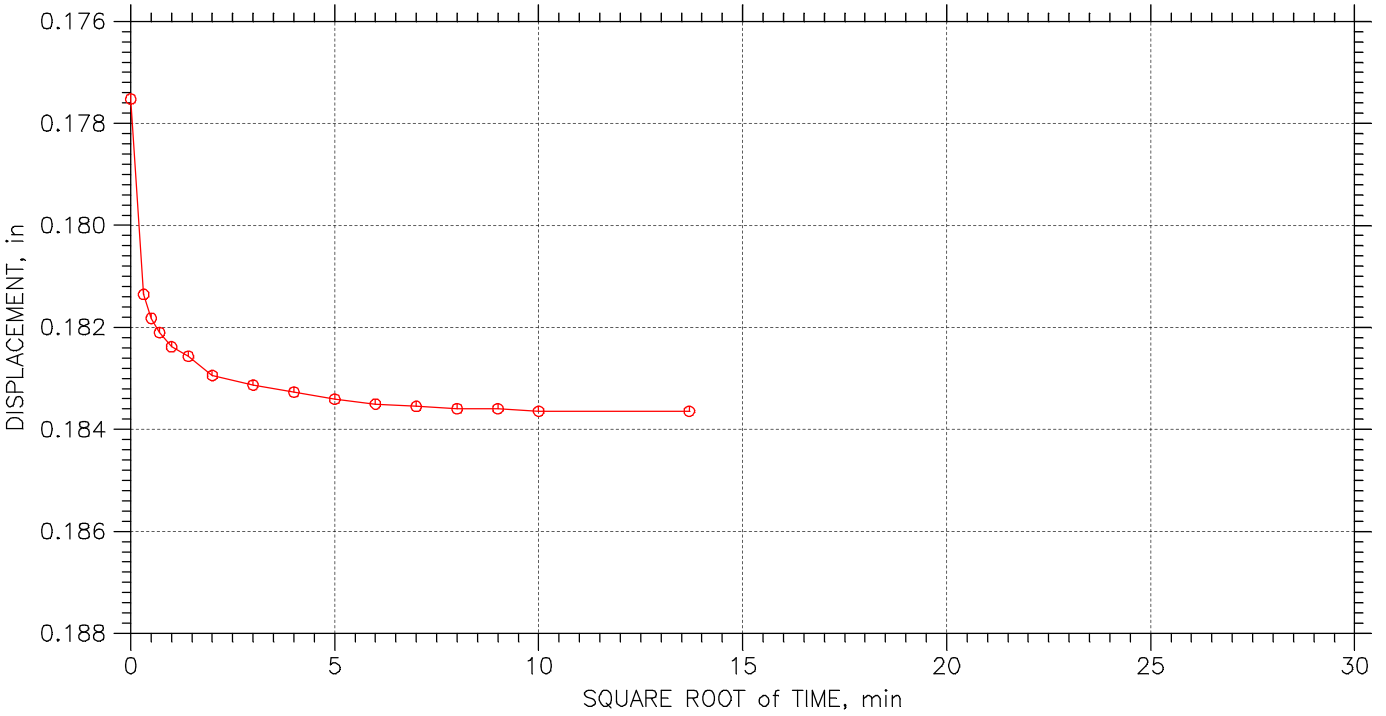
CONSOLIDATION TEST DATA

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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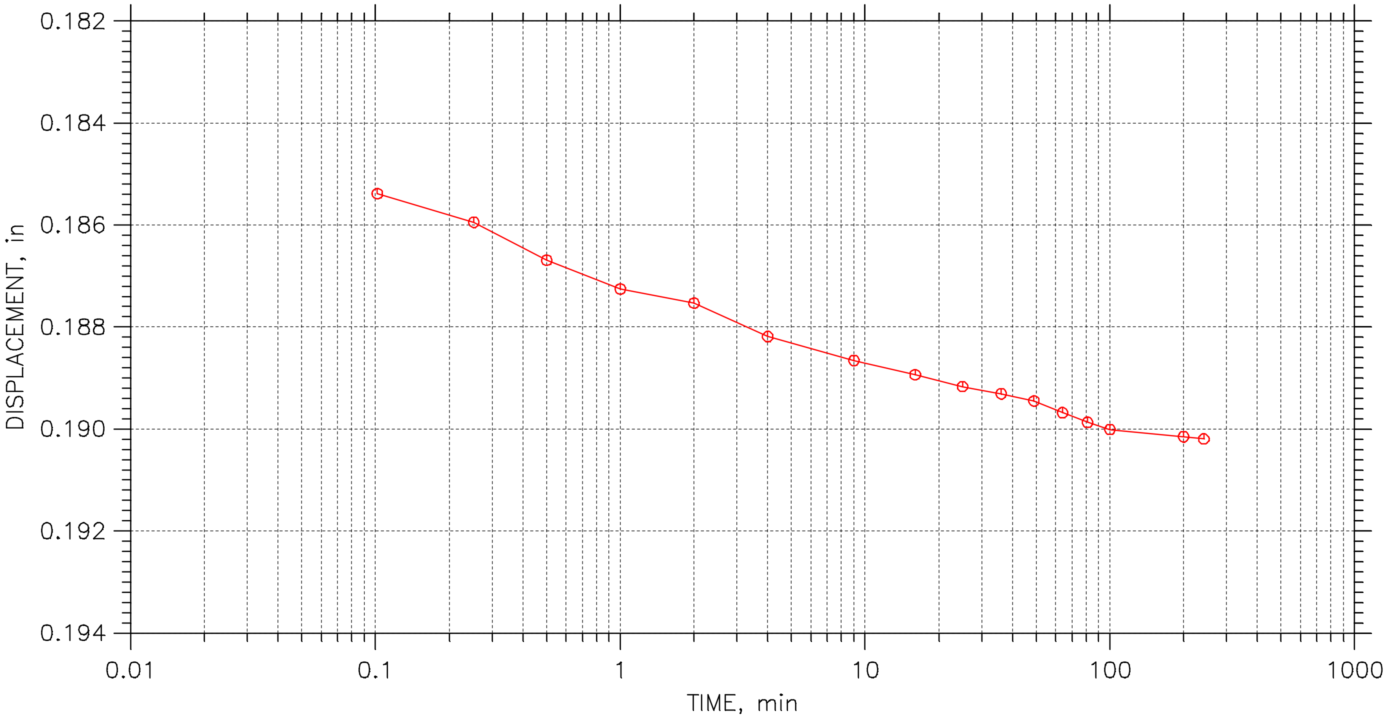
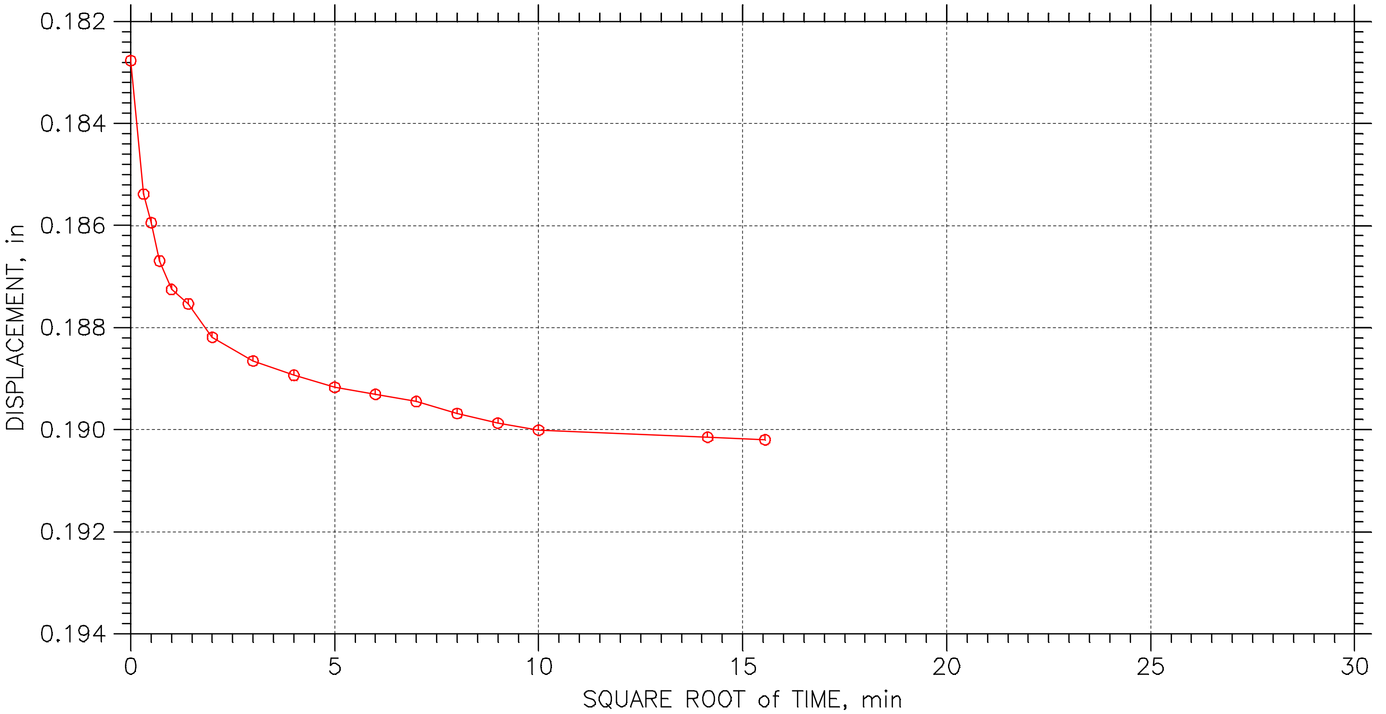
CONSOLIDATION TEST DATA

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		

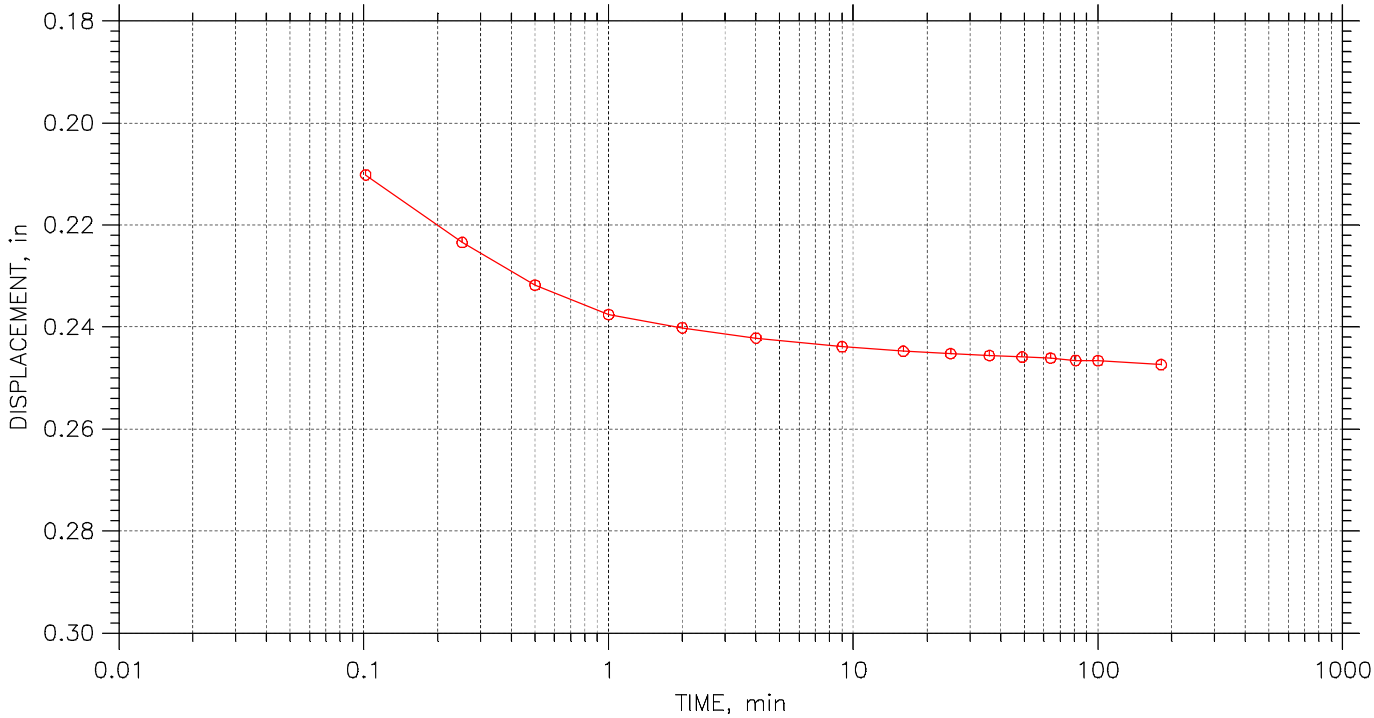
Mon, 25-APR-2016 16:42:42

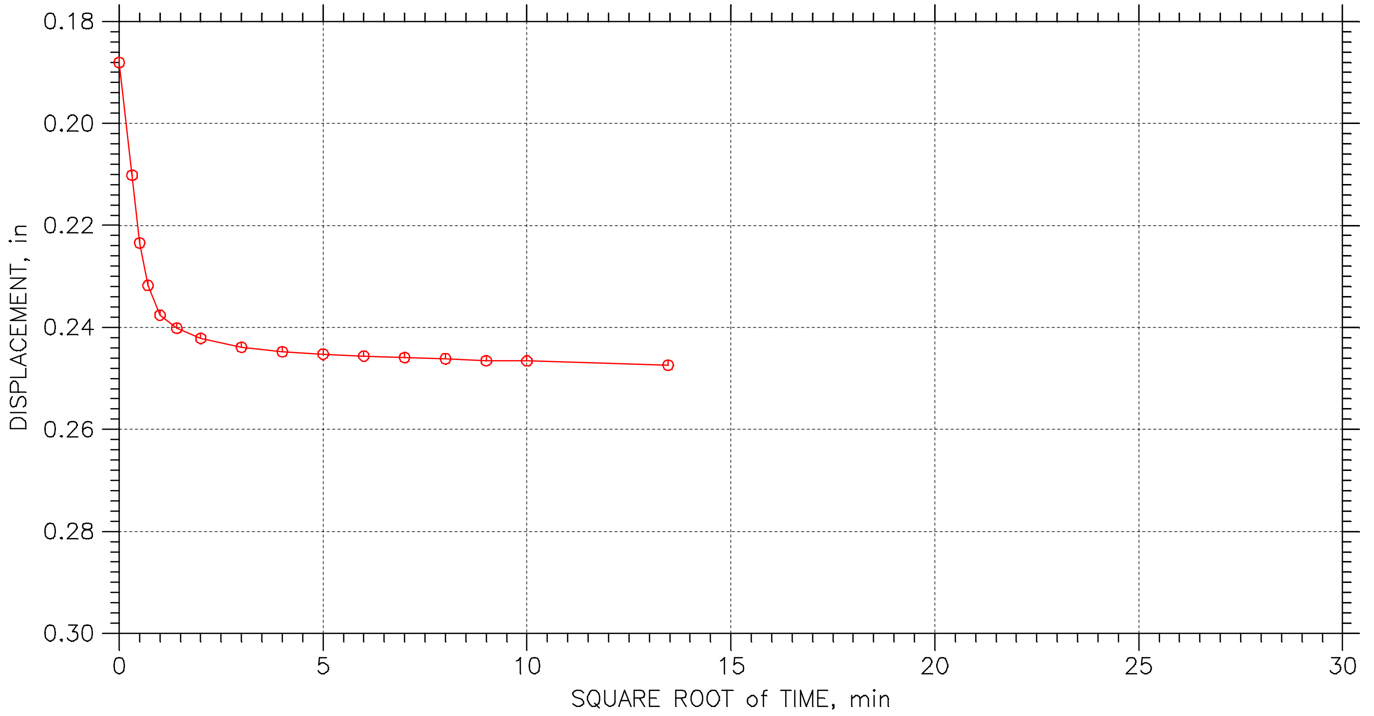
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 17 of 25

Stress: 4. tsf





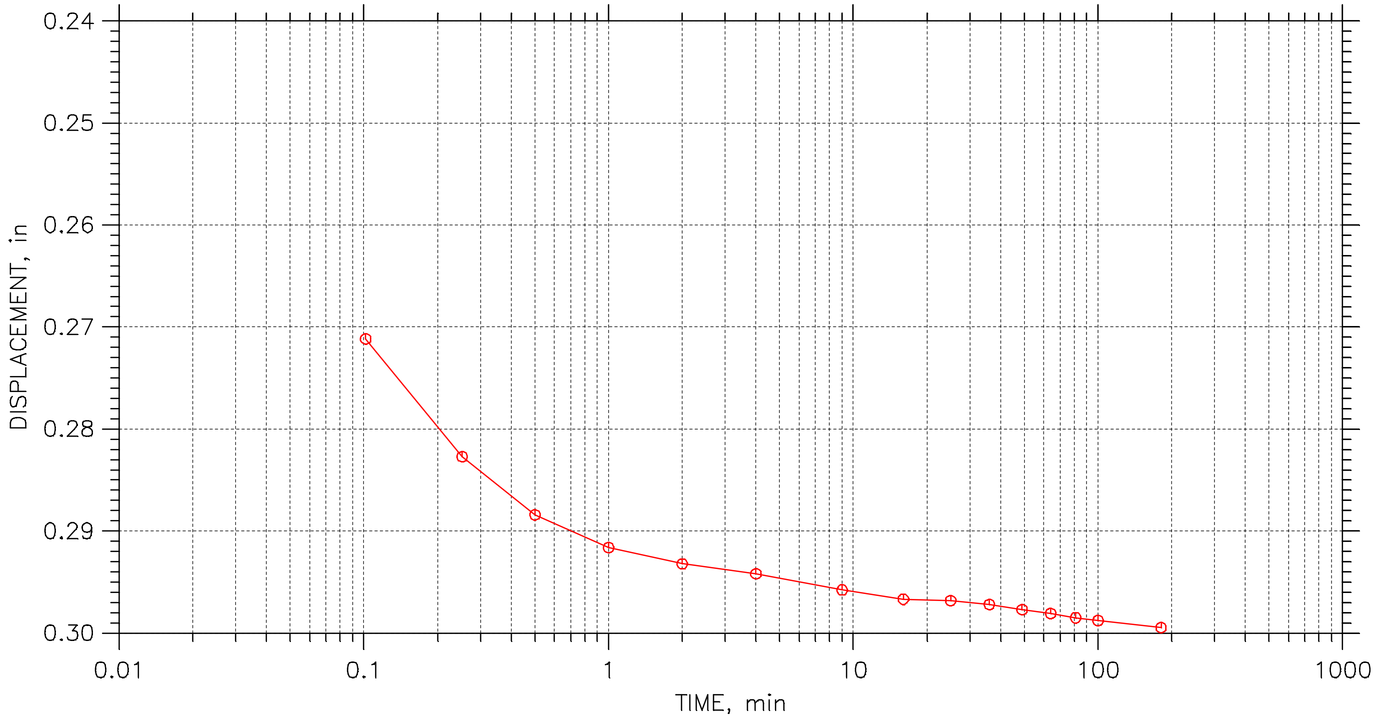
Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: 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		

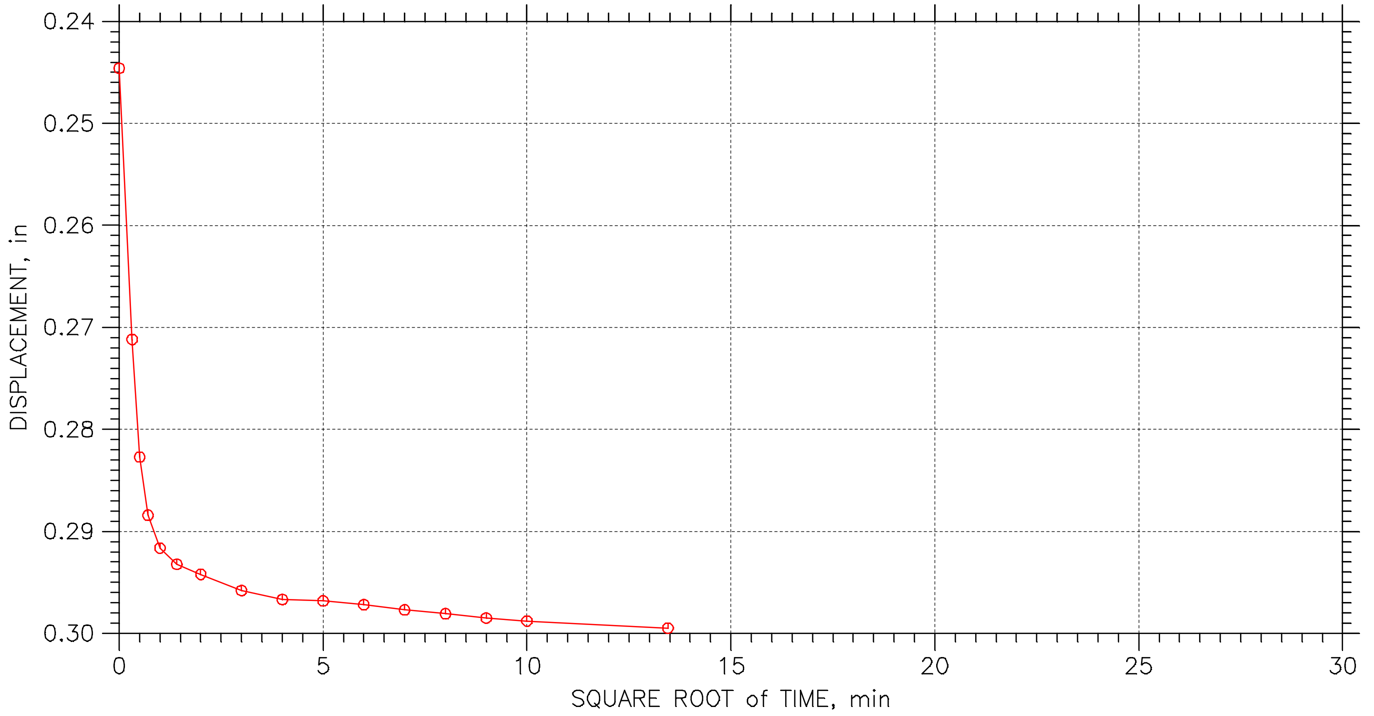
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 18 of 25

Stress: 8. 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.: 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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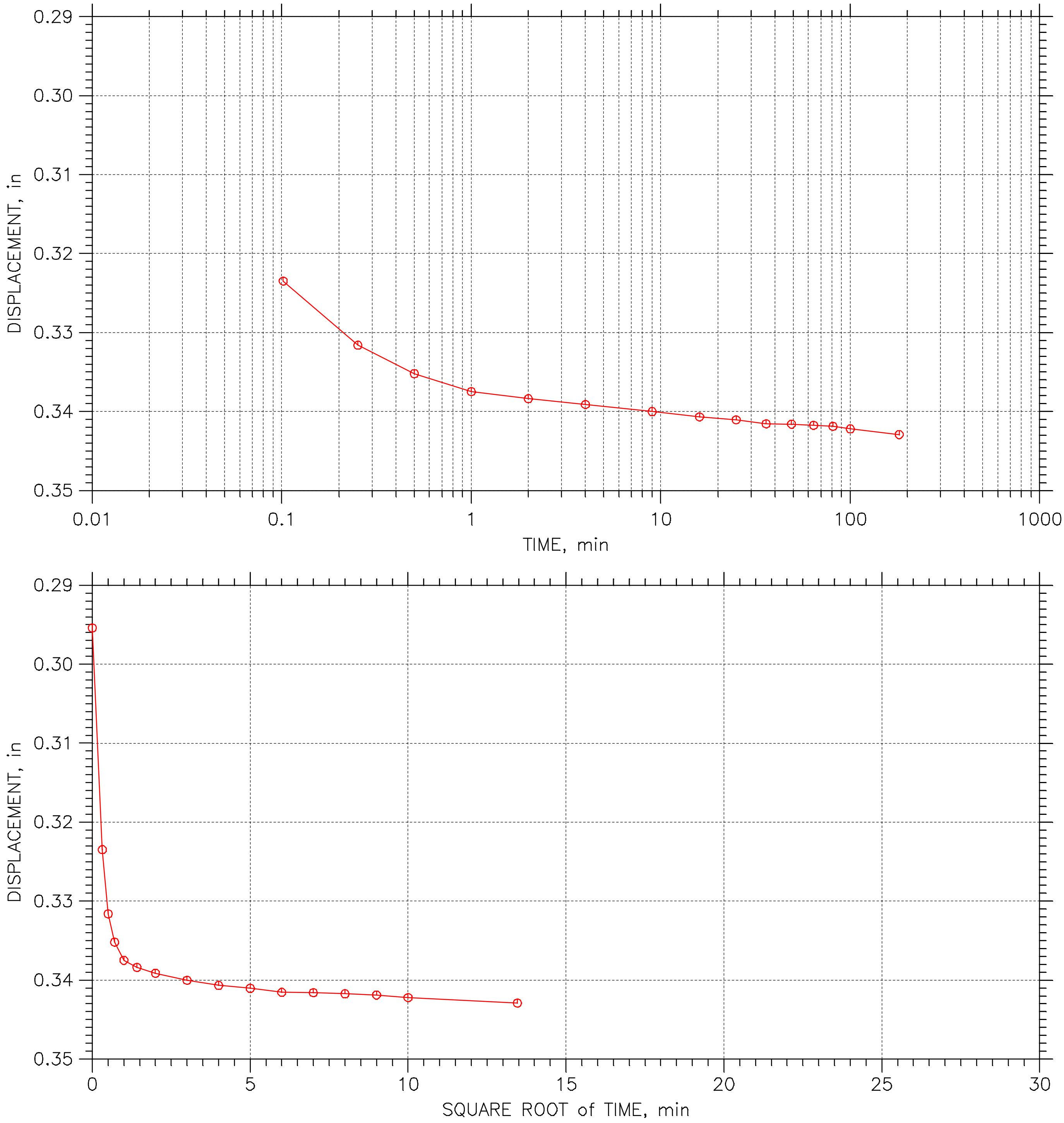
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 19 of 25

Stress: 16. tsf



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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		

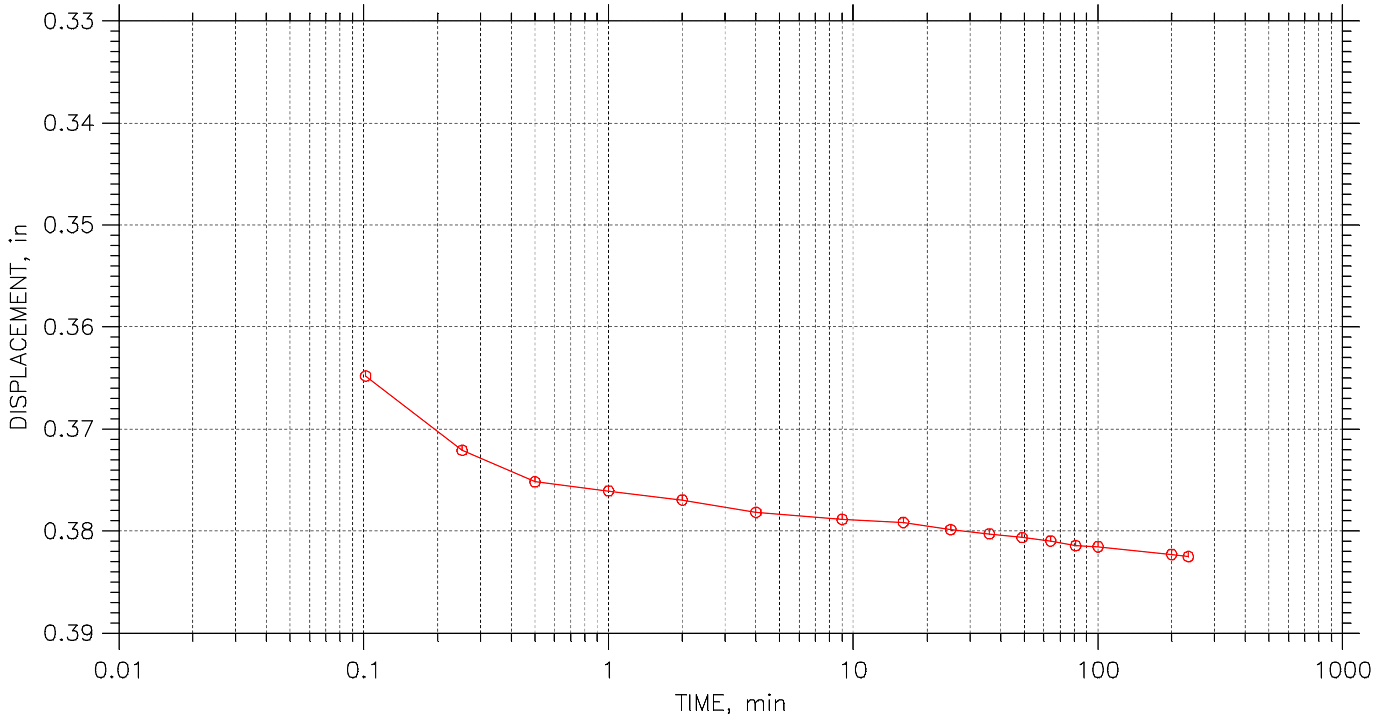
Mon, 25-APR-2016 16:42:46

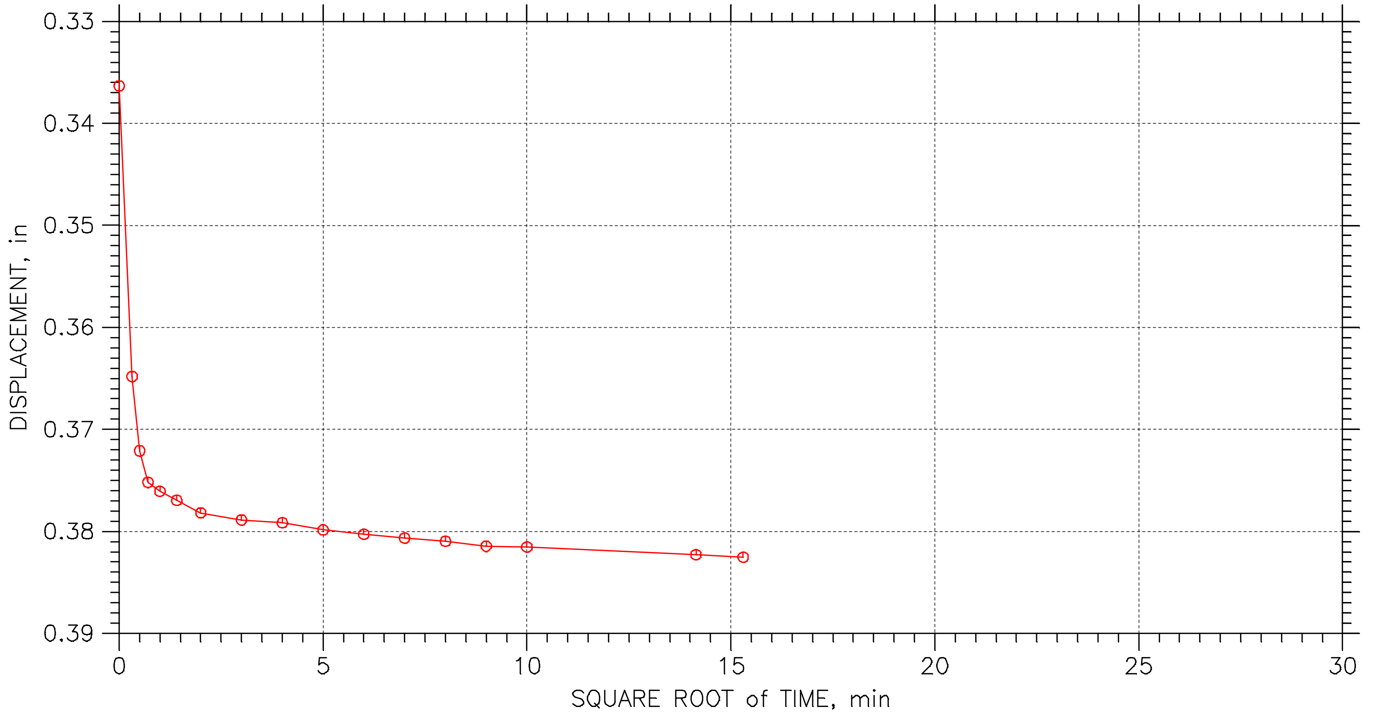
CONSOLIDATION TEST DATA

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		

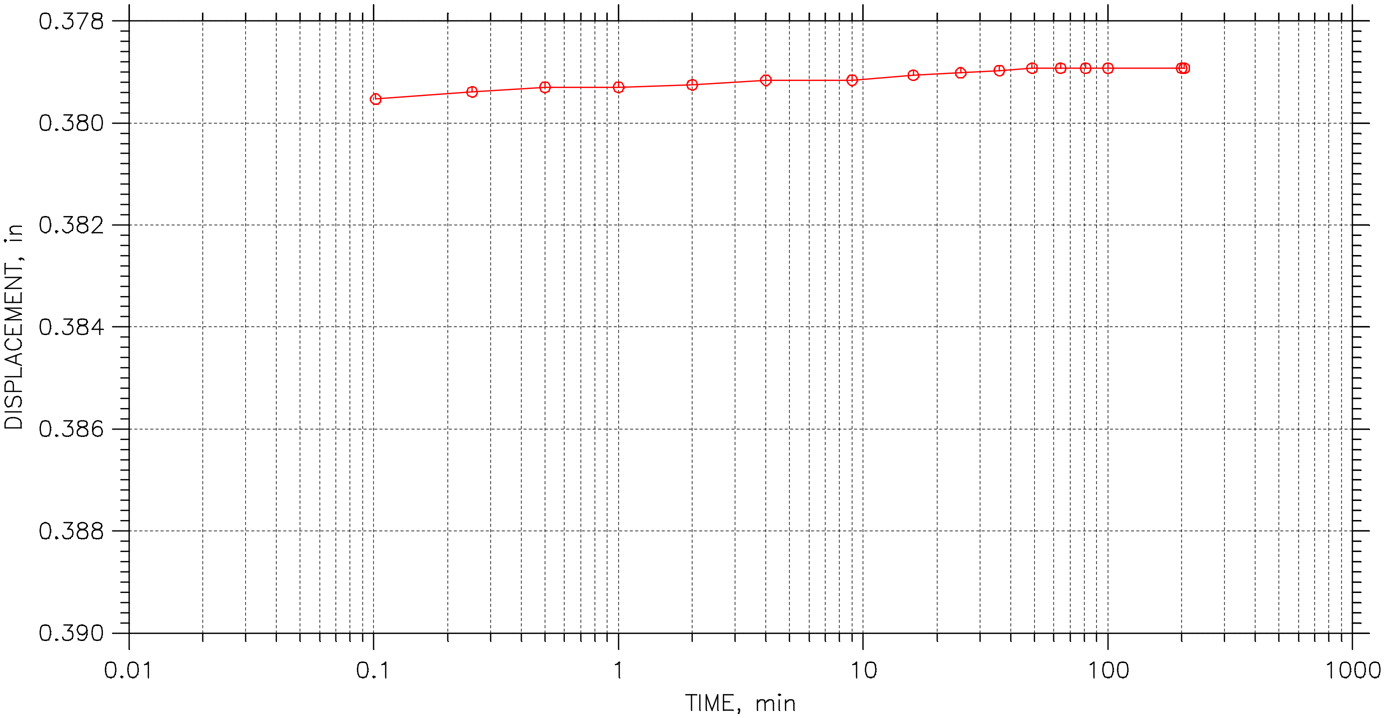
Mon, 25-APR-2016 16:42:48

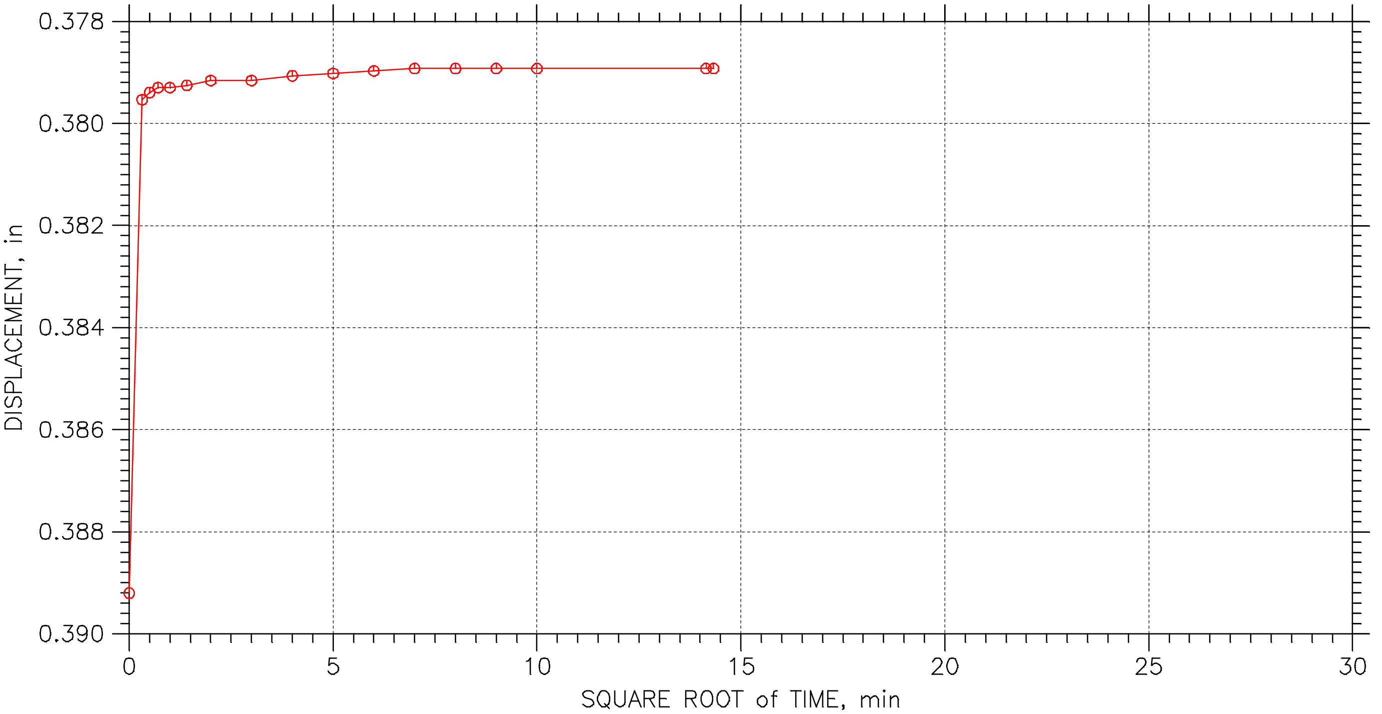
CONSOLIDATION TEST DATA

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		

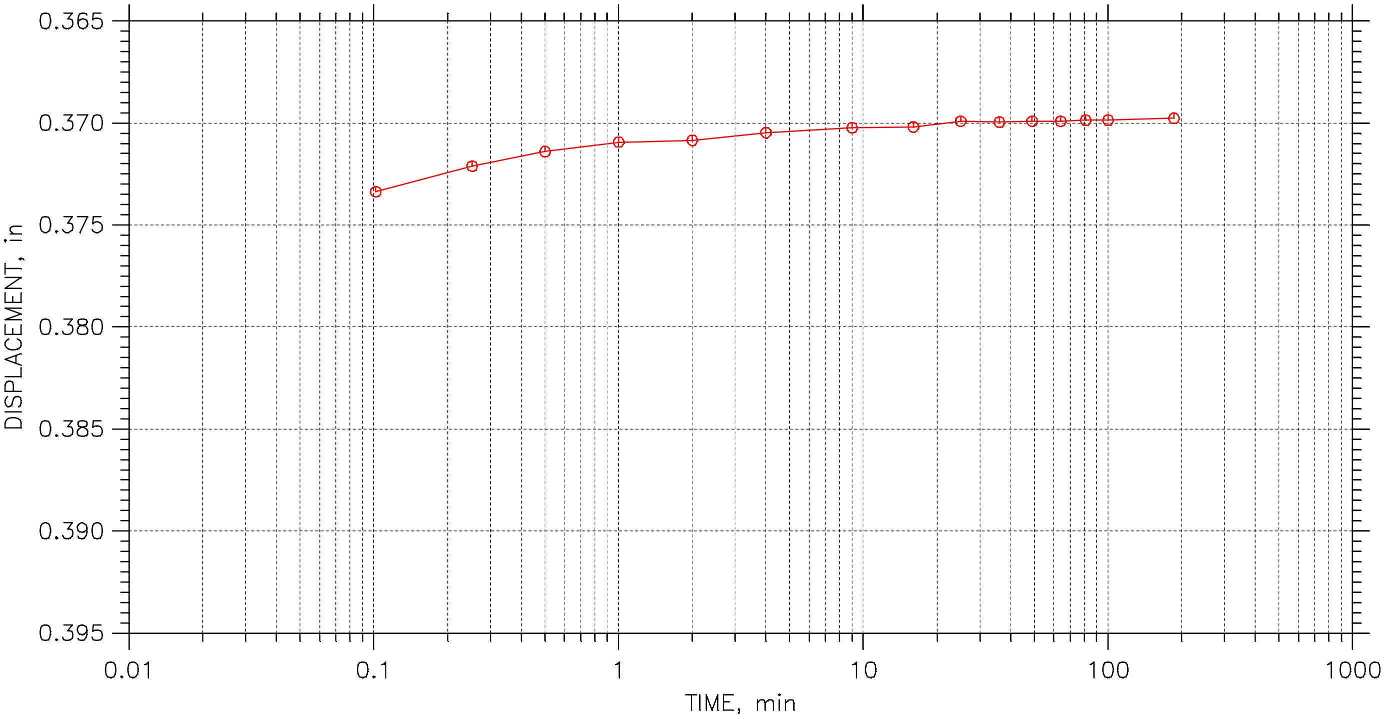
Mon, 25-APR-2016 16:42:49

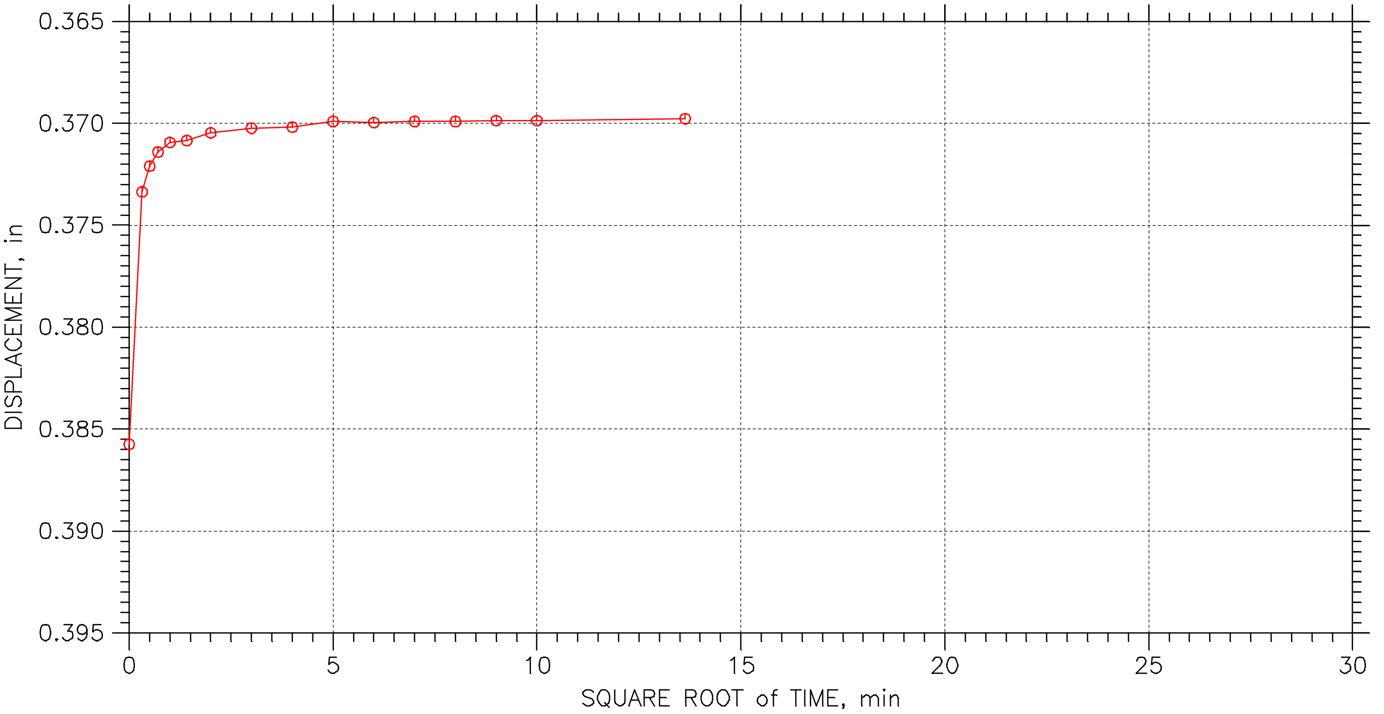
CONSOLIDATION TEST DATA

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		

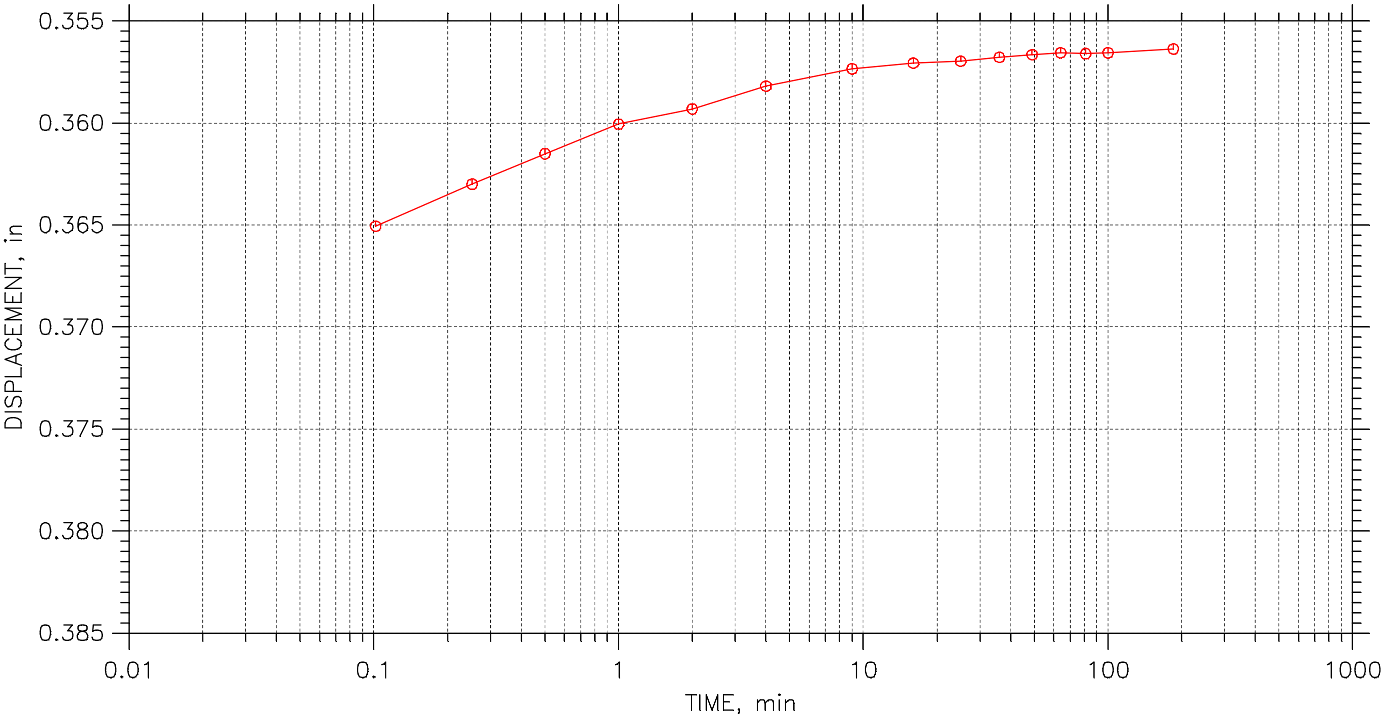
Mon, 25-APR-2016 16:42:51

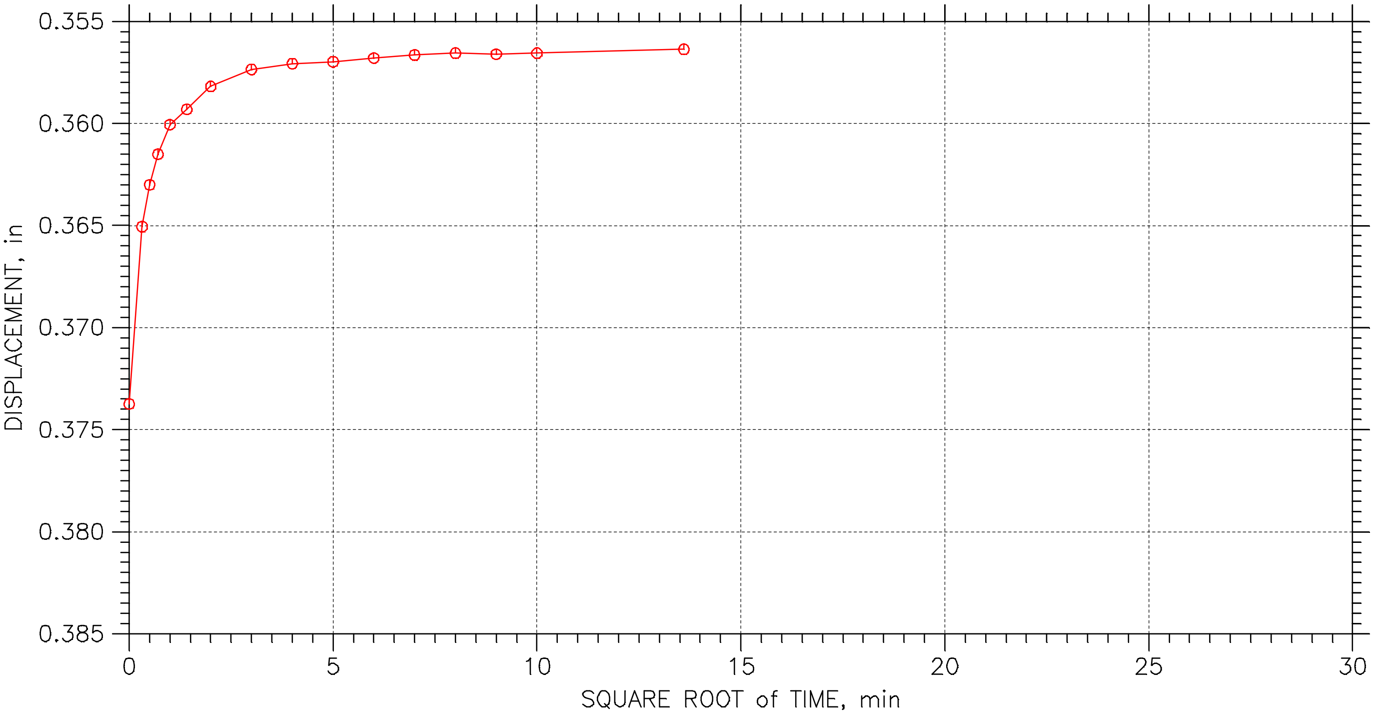
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 23 of 25

Stress: 1. tsf





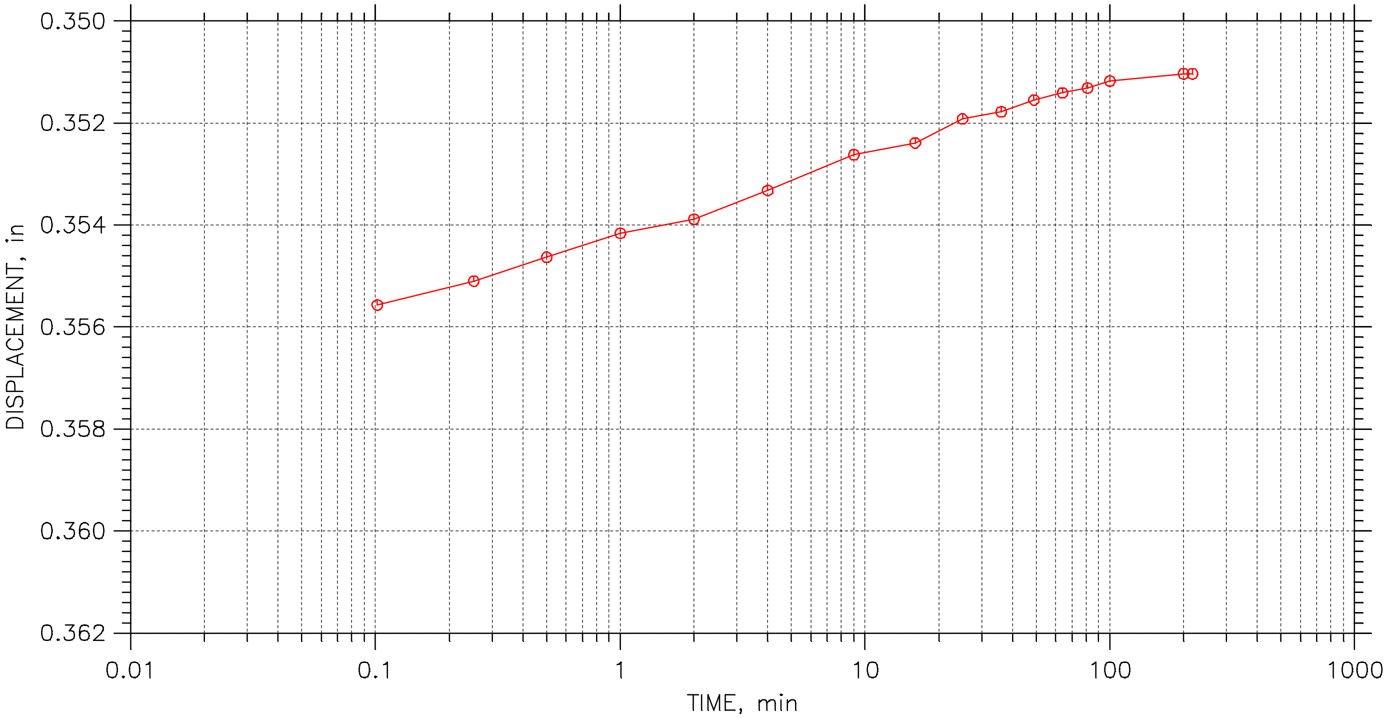
Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: 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		

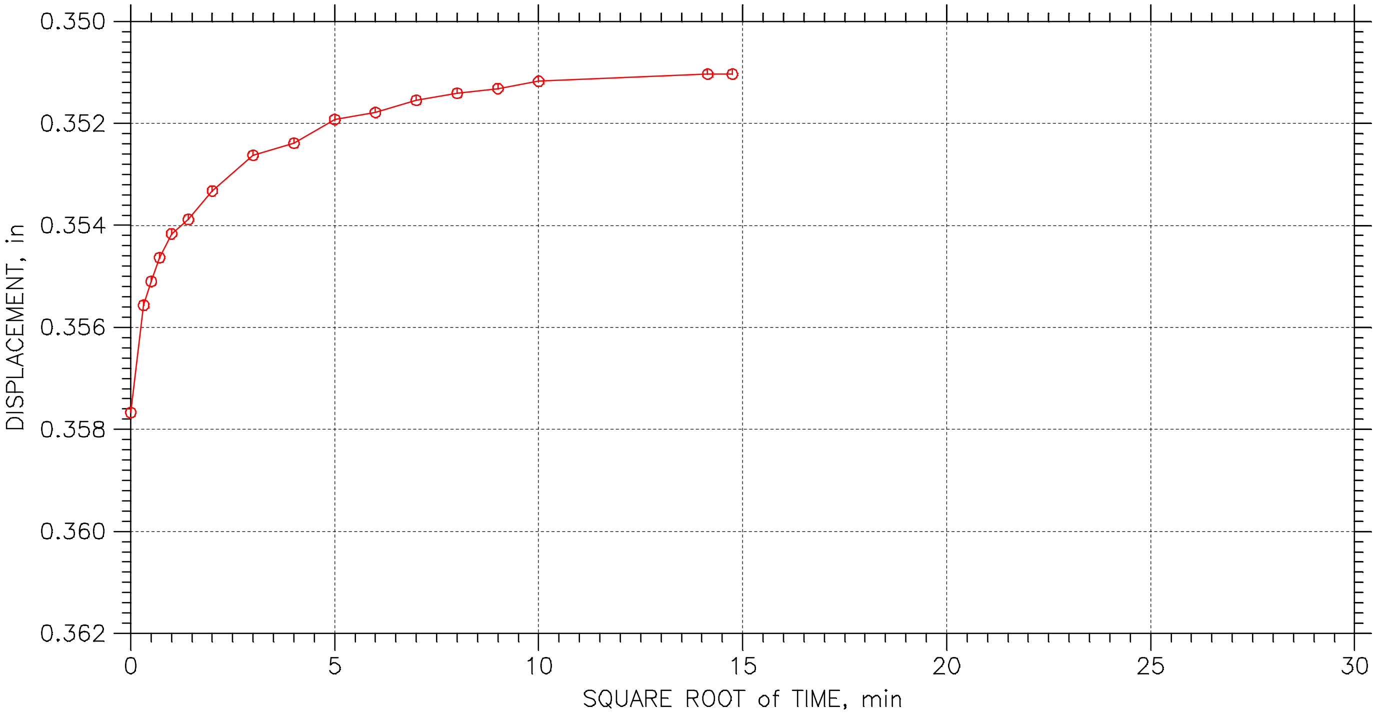
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 24 of 25

Stress: 0.5 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.: 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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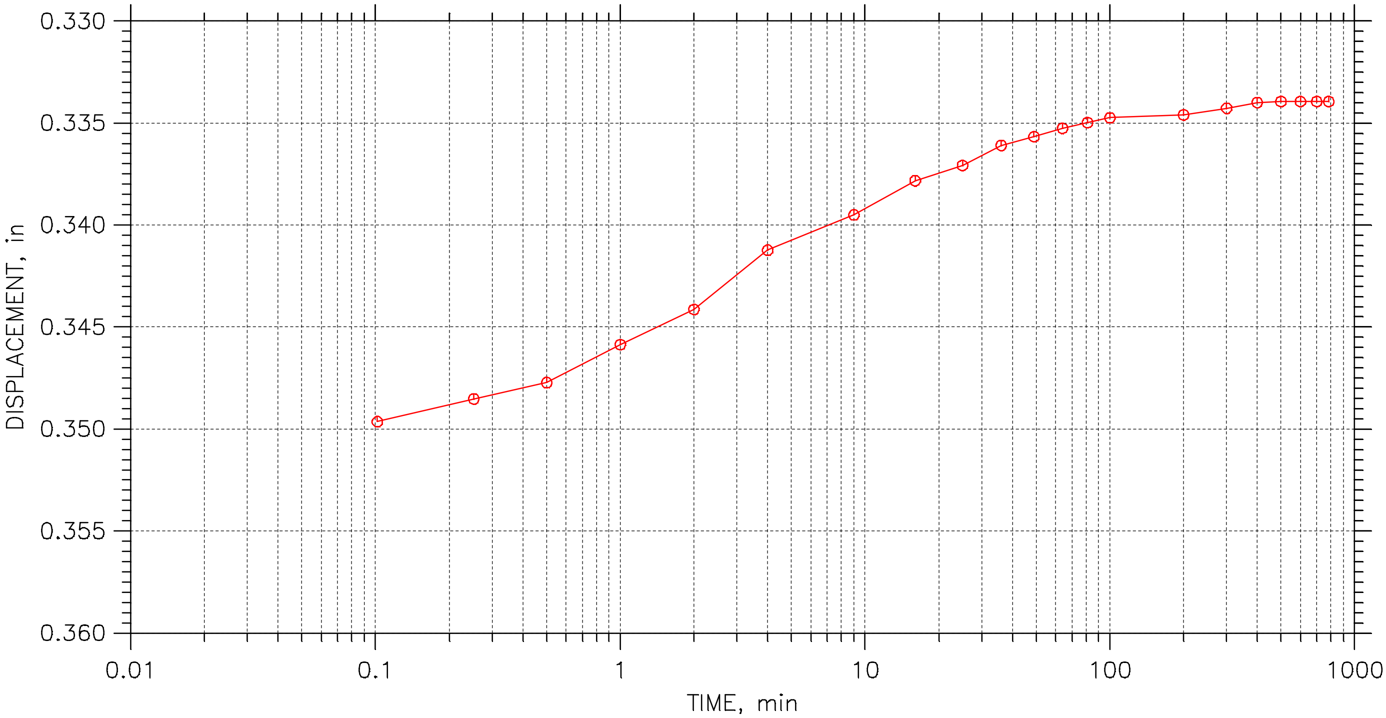
Mon, 25-APR-2016 16:42:54

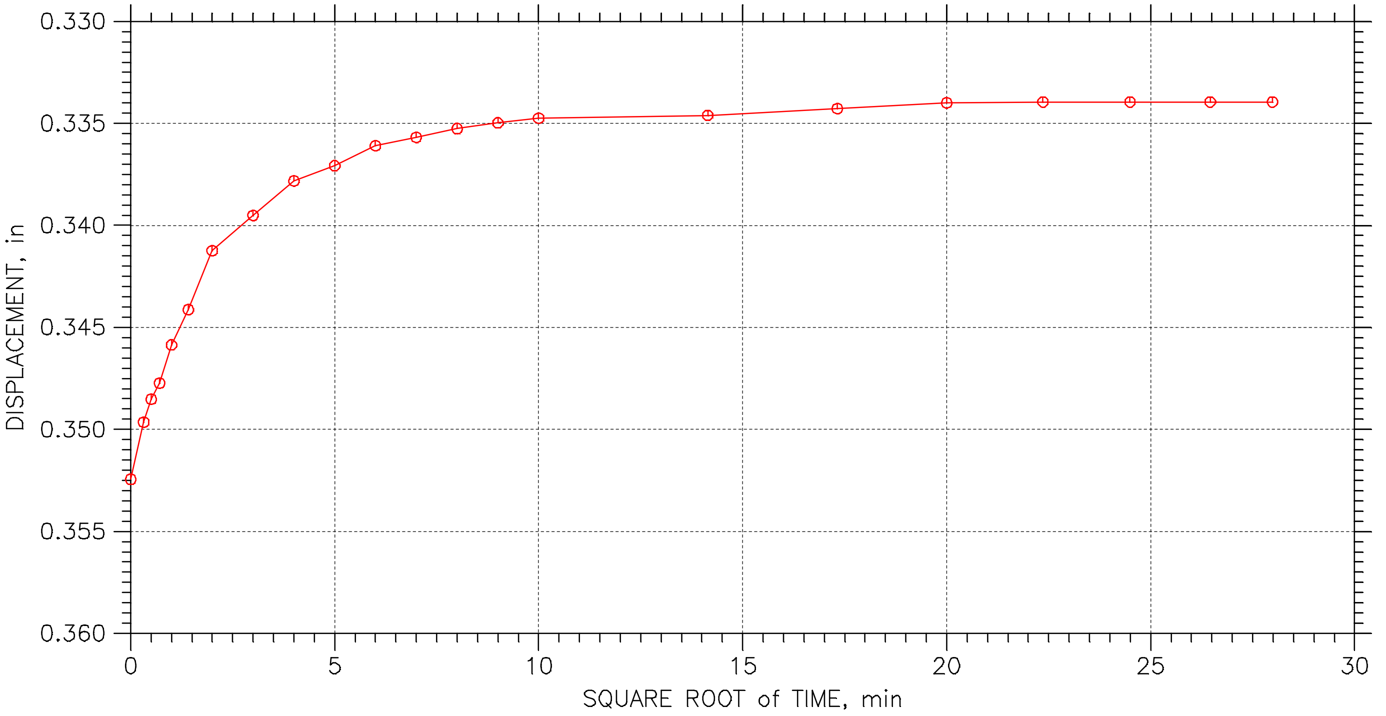
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 25 of 25

Stress: 0.125 tsf

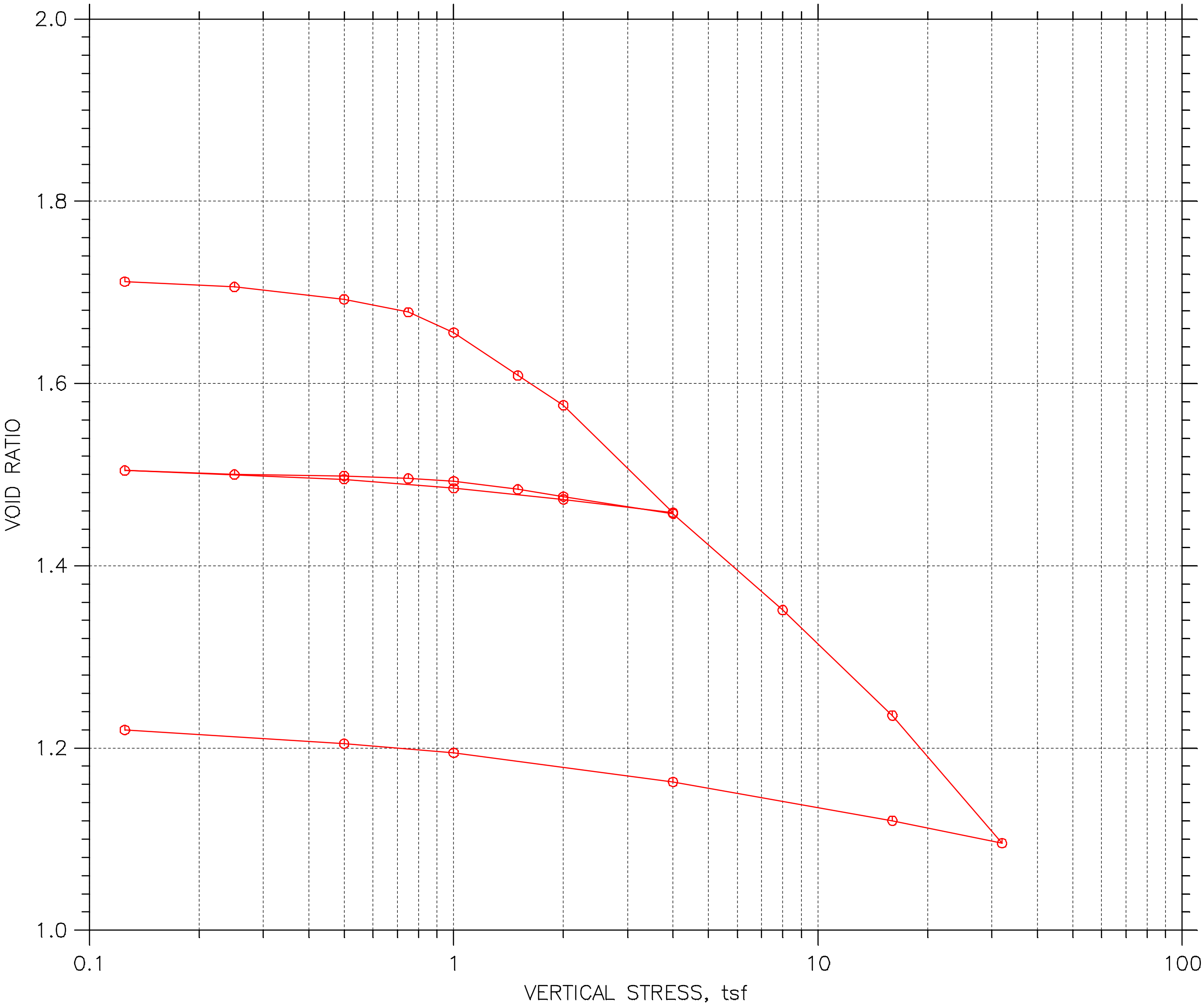




Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST2	Test Date: 04/11/2106	Depth: 17.0'-19.0'
	Test No.: ST2CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: 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					
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		

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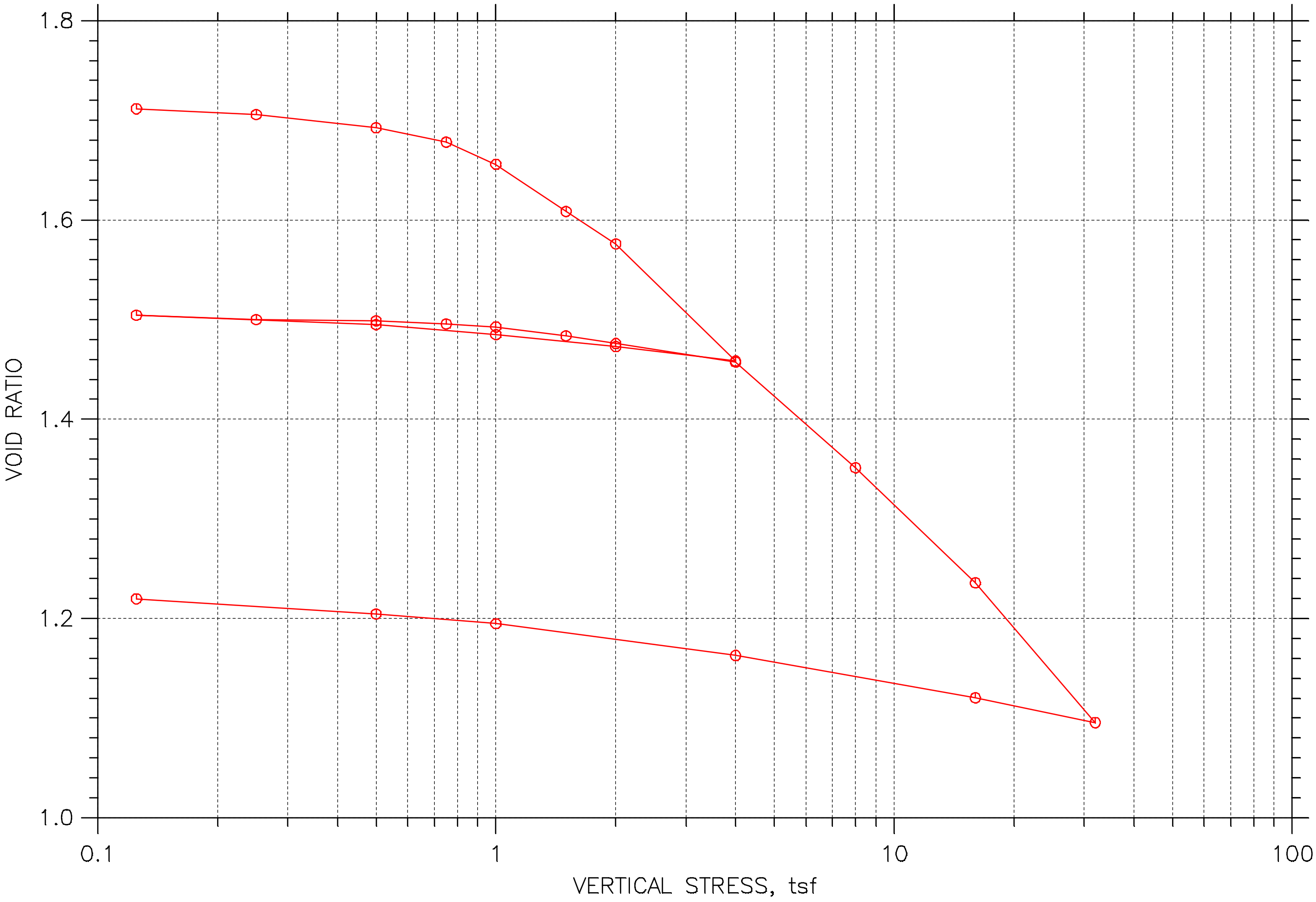
Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
Boring No.: B-16-01	Tested By: HP	Checked By: BCM
Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------

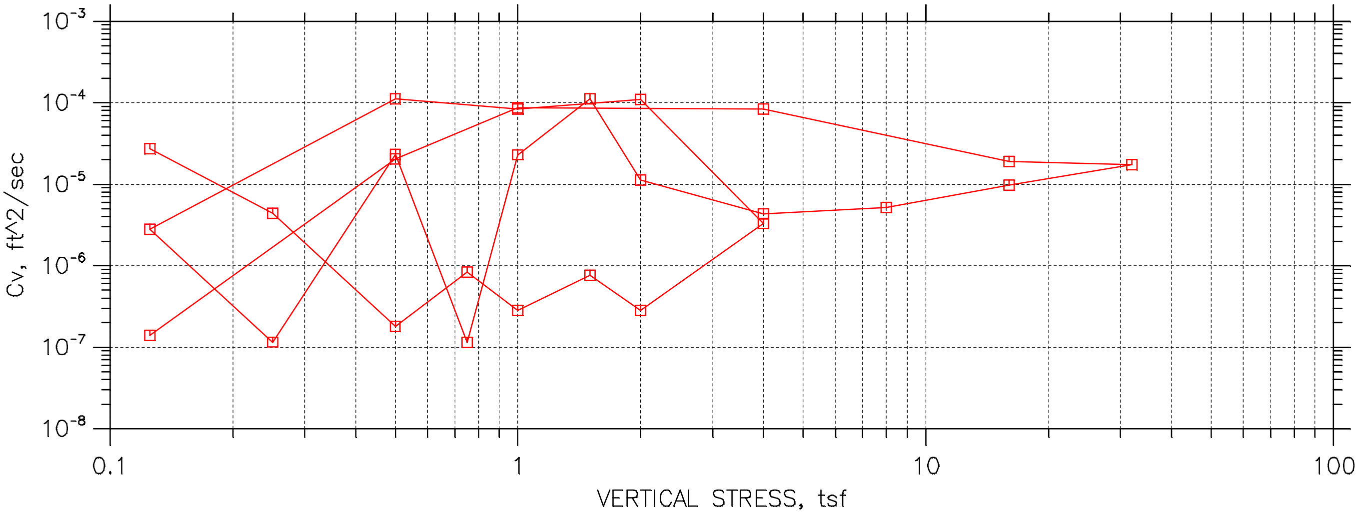
Description: BROWNISH GRAY FLY ASH WITH SILT AND CLAY

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





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		

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Tue, 26-APR-2016 10:09:30

CONSOLIDATION TEST DATA

Project: VECTREN CULLEY E POND
Boring No.: B-16-01
Sample No.: ST4
Test No.: ST4CON

Location: NEWBURGH, IN
Tested By: HP
Test Date: 04/15/2106
Sample Type: 3.0" ST

Project No.: AW165009
Checked By: BCM
Depth: 39.0'-41.0'
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
Initial Void Ratio: 1.72
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	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	---

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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

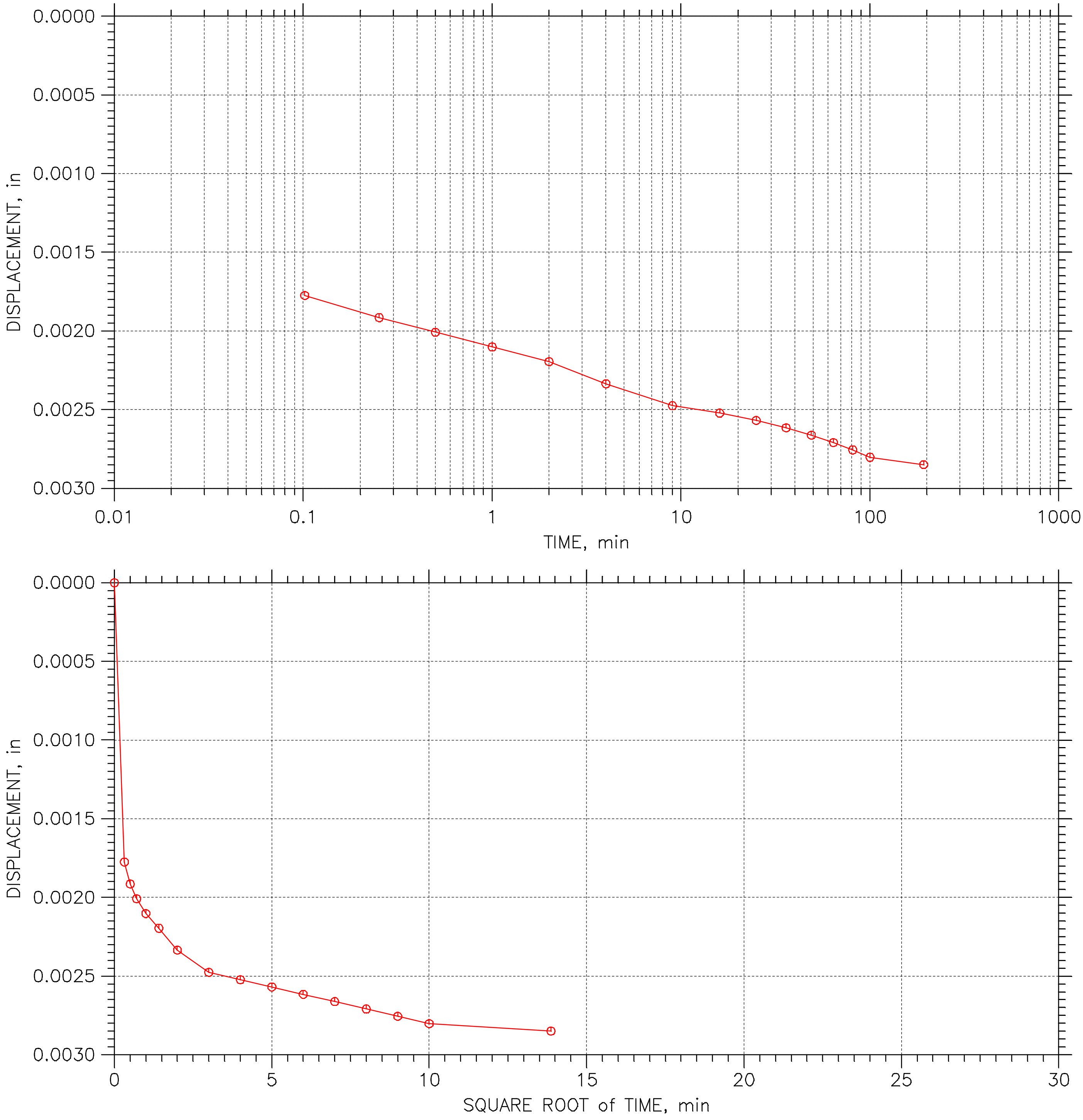
	Applied	Final	Void	Strain	T50 Fitting		Coefficient of Consolidation		
	Stress	Displacement	Ratio	at End	Sq.Rt.	Log	Sq.Rt.	Log	Ave.
	tsf	in		%	min	min	ft^2/sec	ft^2/sec	ft^2/sec
1	0.125	0.002849	1.712	0.38	0.1	0.0	2.73e-005	0.00e+000	2.73e-005
2	0.25	0.004438	1.706	0.59	0.7	0.0	4.43e-006	0.00e+000	4.43e-006
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		

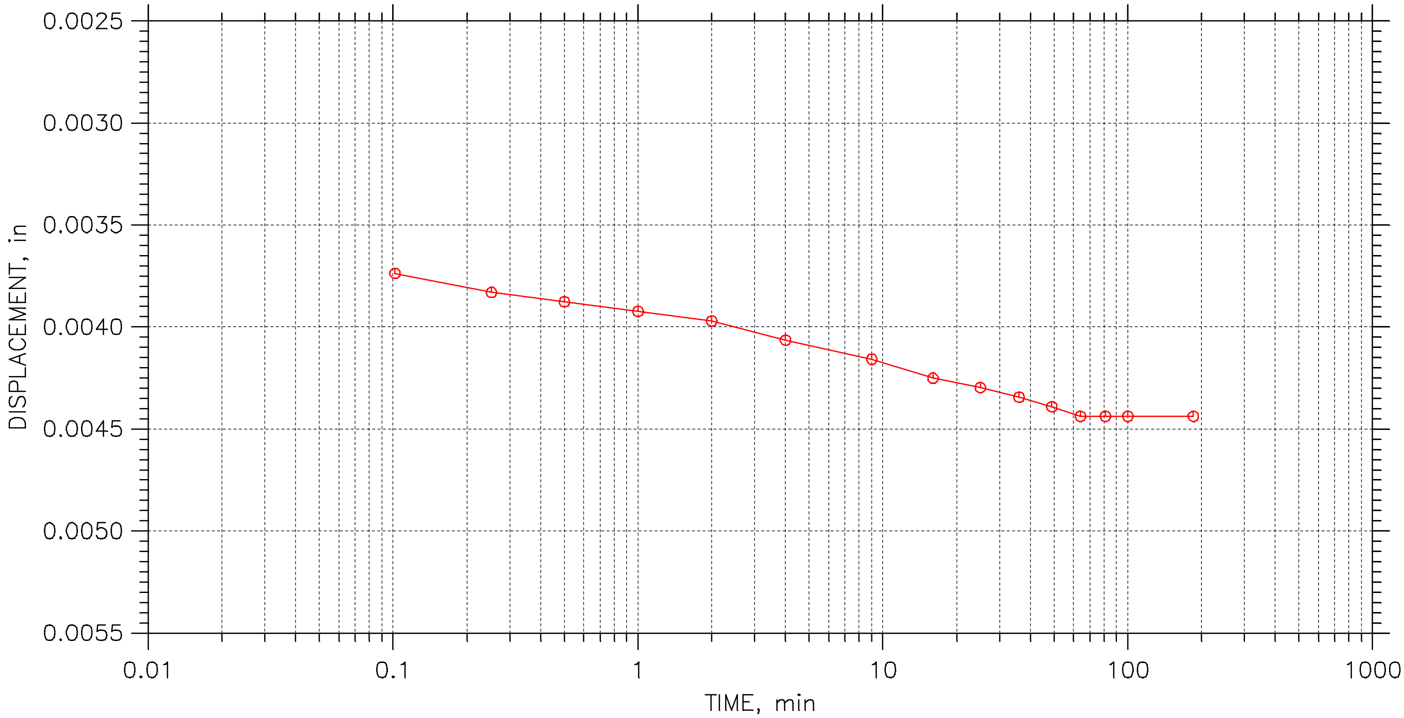
Tue, 26-APR-2016 10:11:36

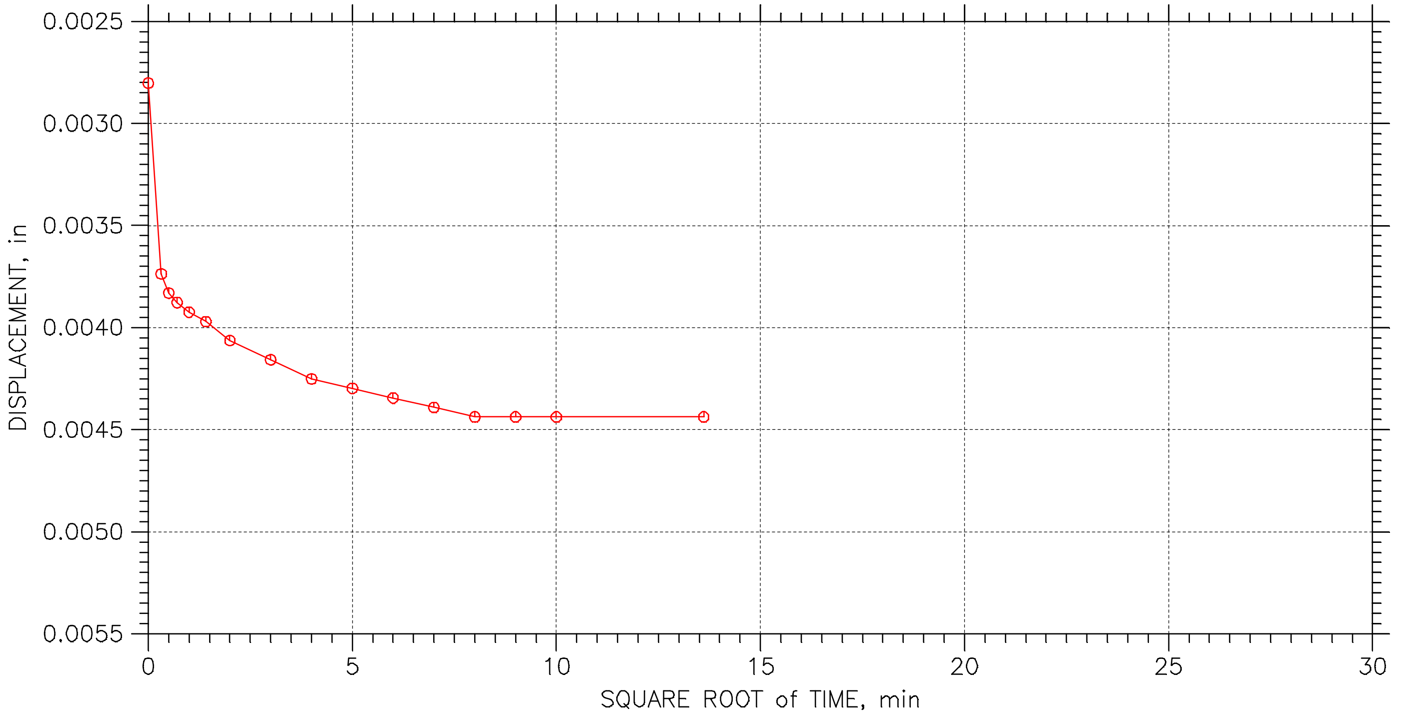
CONSOLIDATION TEST DATA

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		

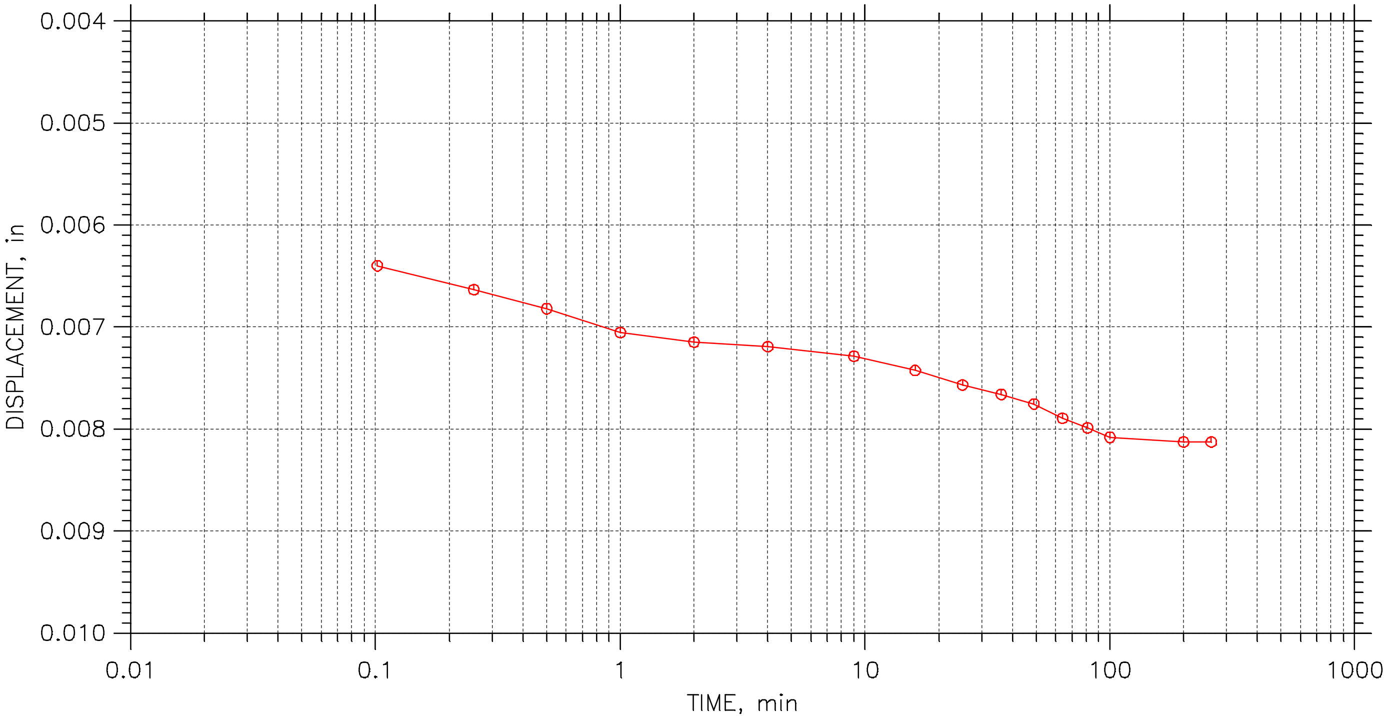
Tue, 26-APR-2016 10:11:38

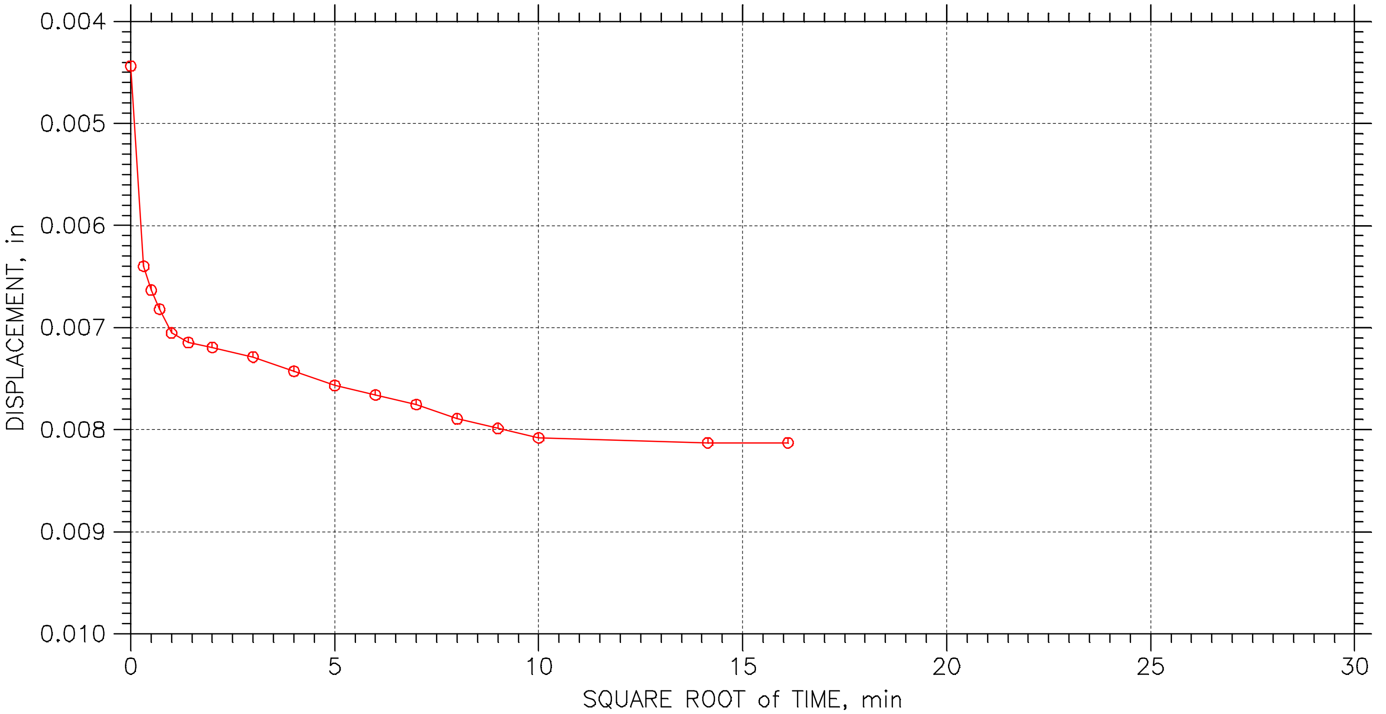
CONSOLIDATION TEST DATA

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		

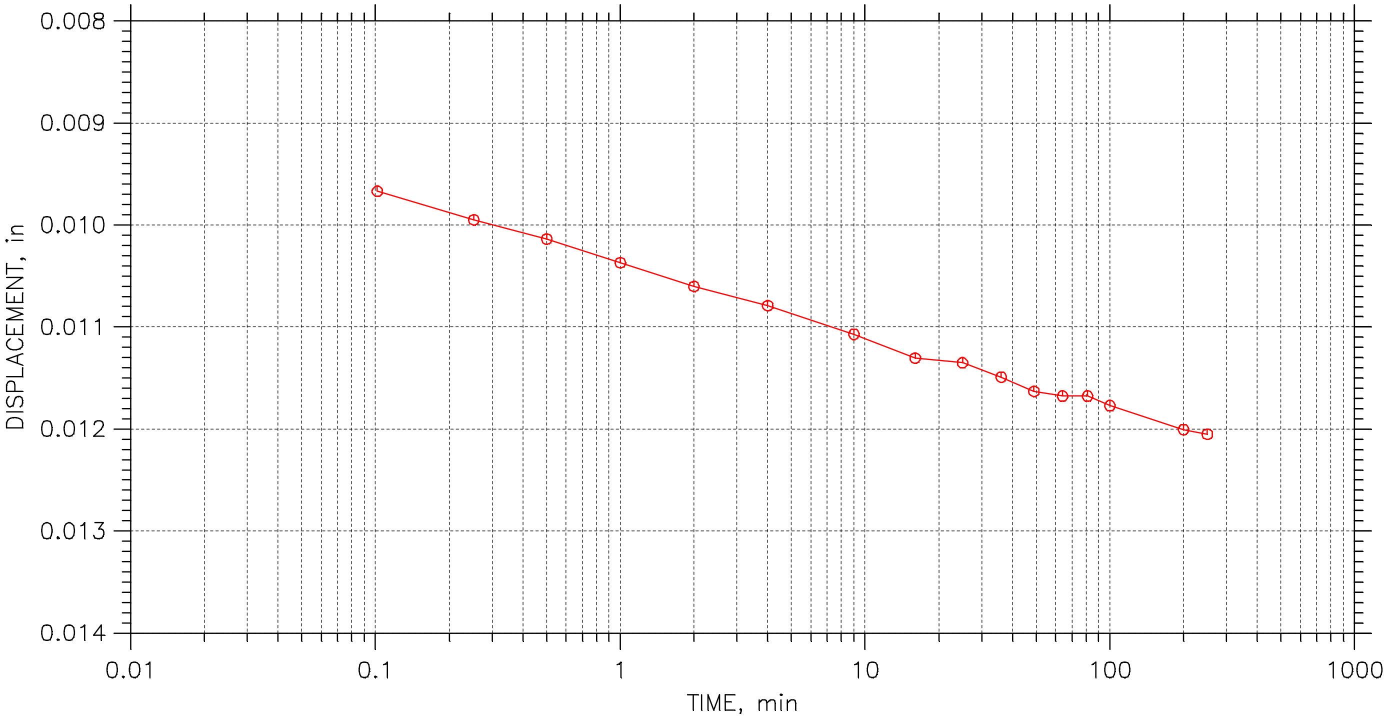
Tue, 26-APR-2016 10:11:39

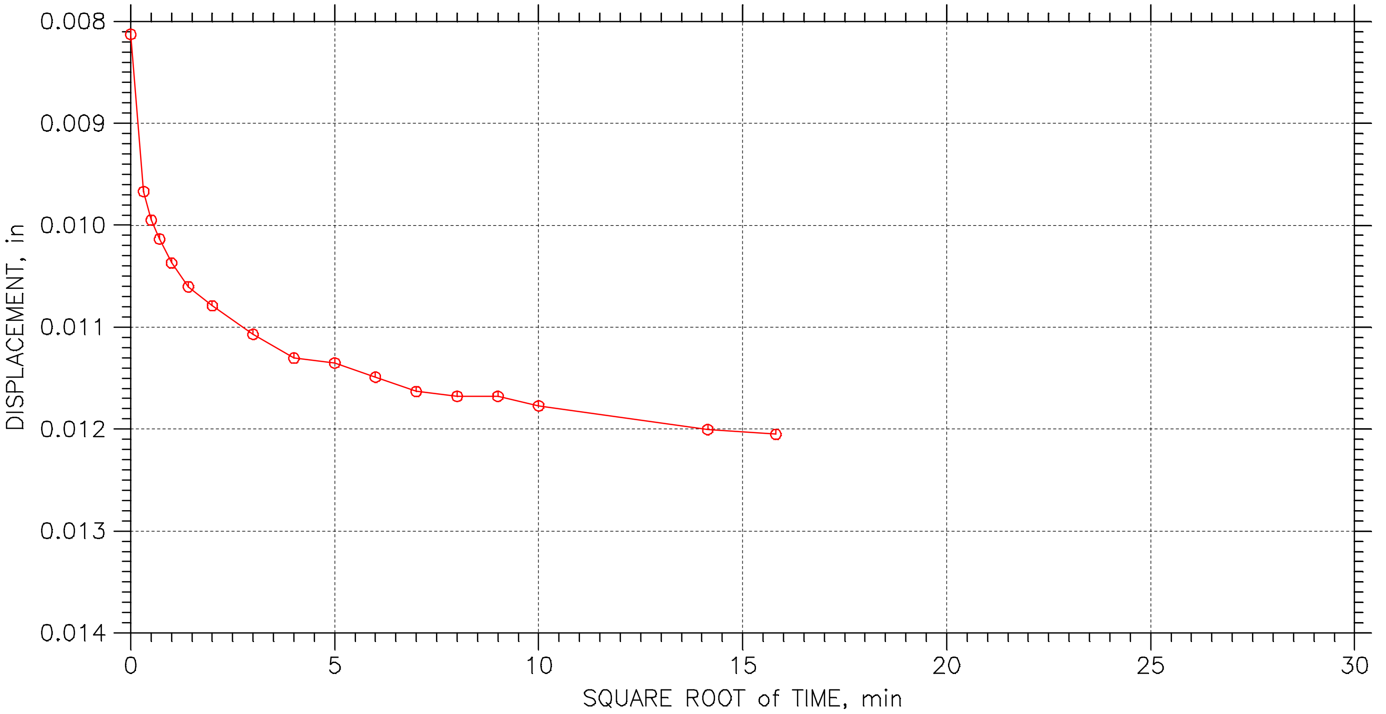
CONSOLIDATION TEST DATA

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		

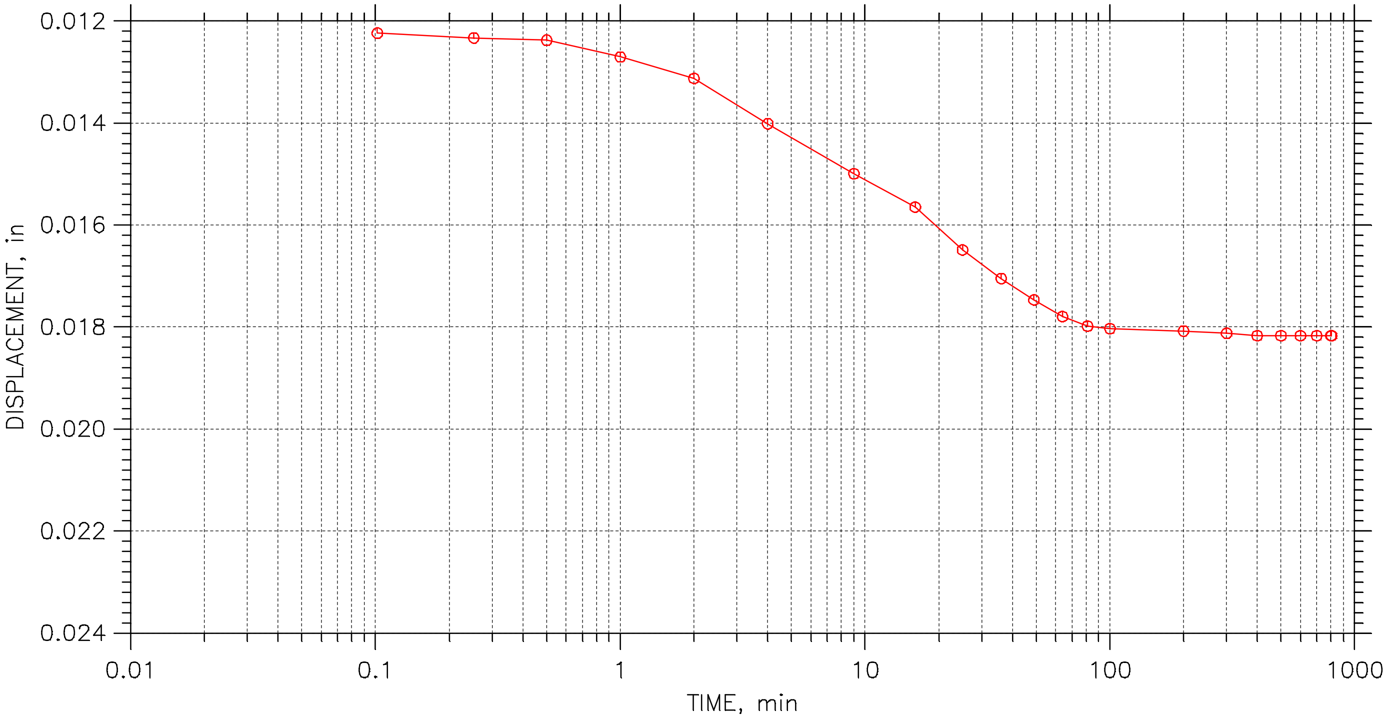
Tue, 26-APR-2016 10:11:41

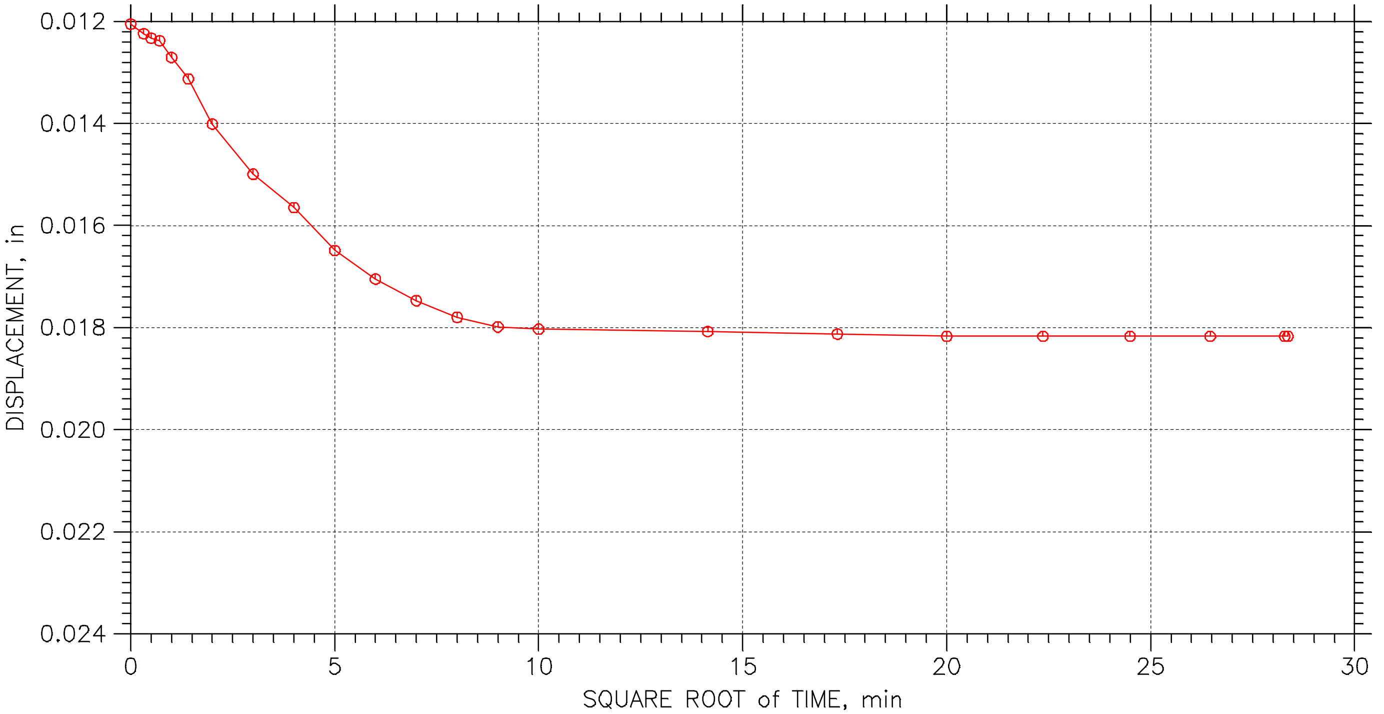
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 5 of 27

Stress: 1. tsf





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		

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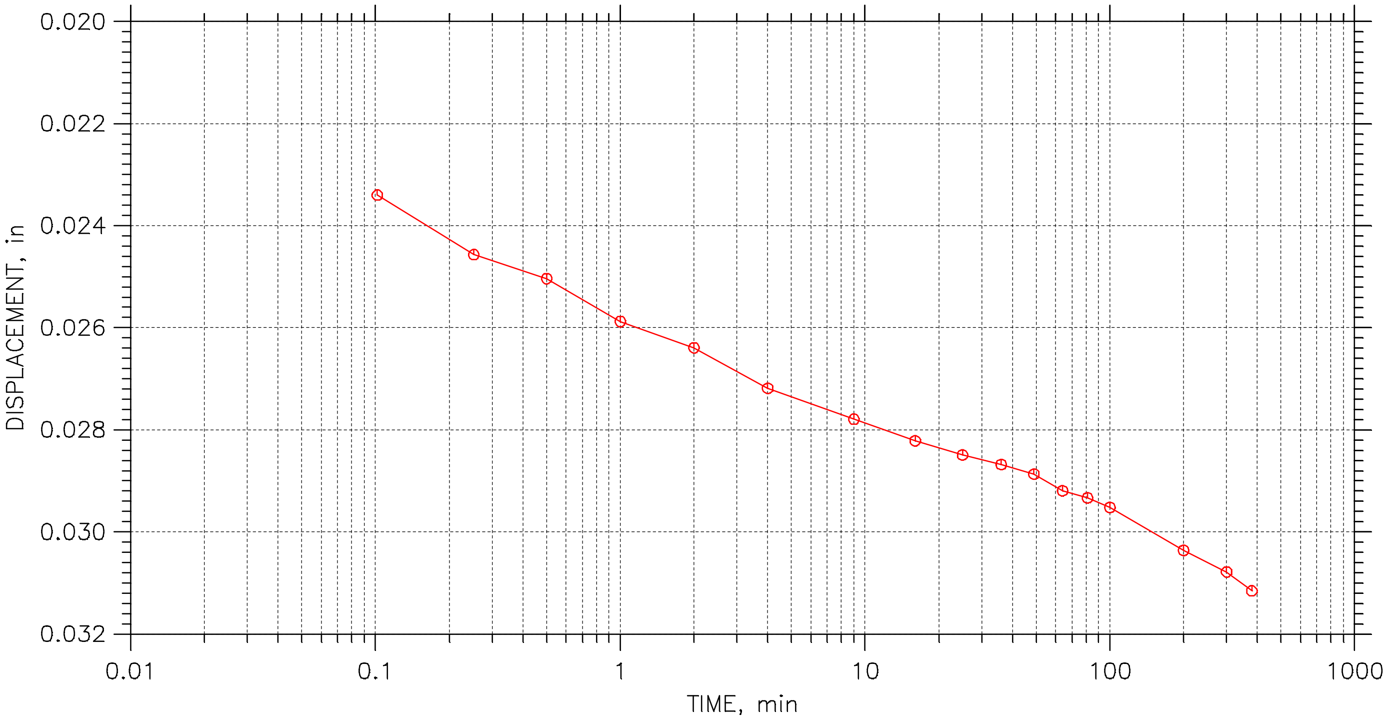
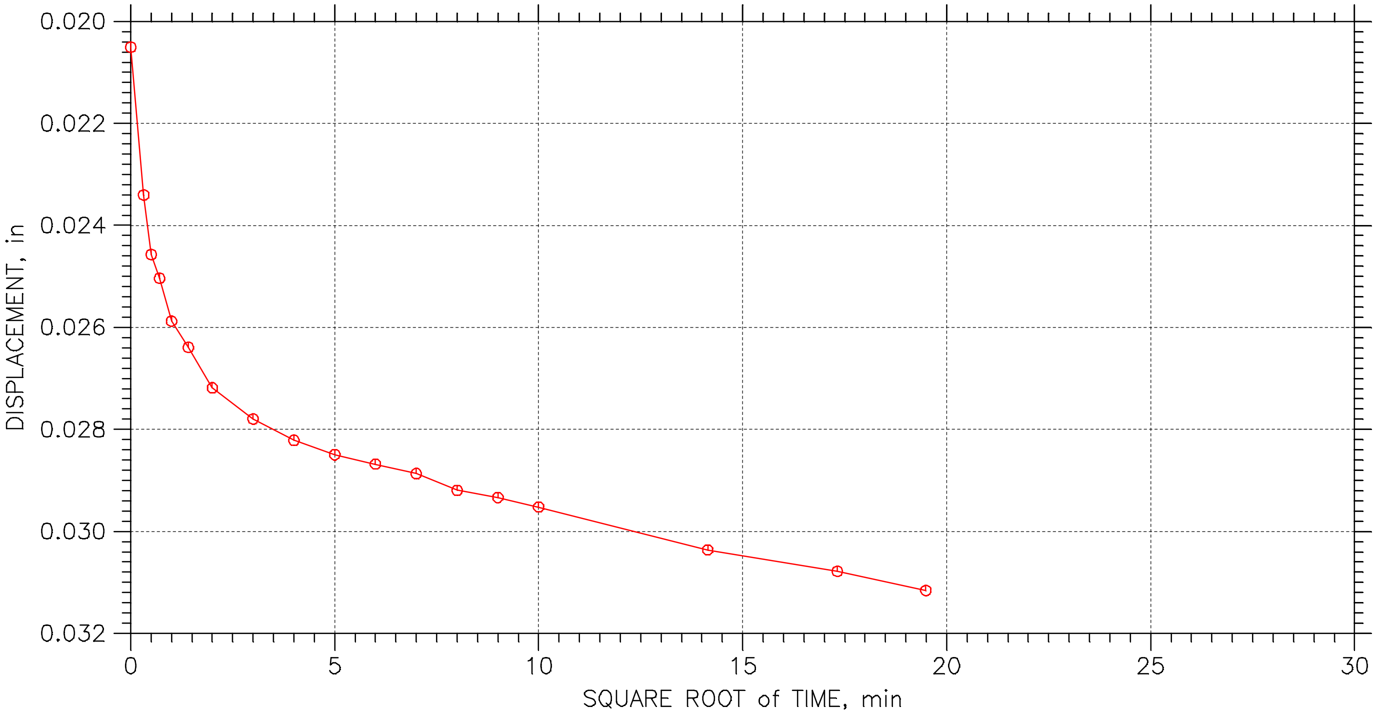
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 6 of 27

Stress: 1.5 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		

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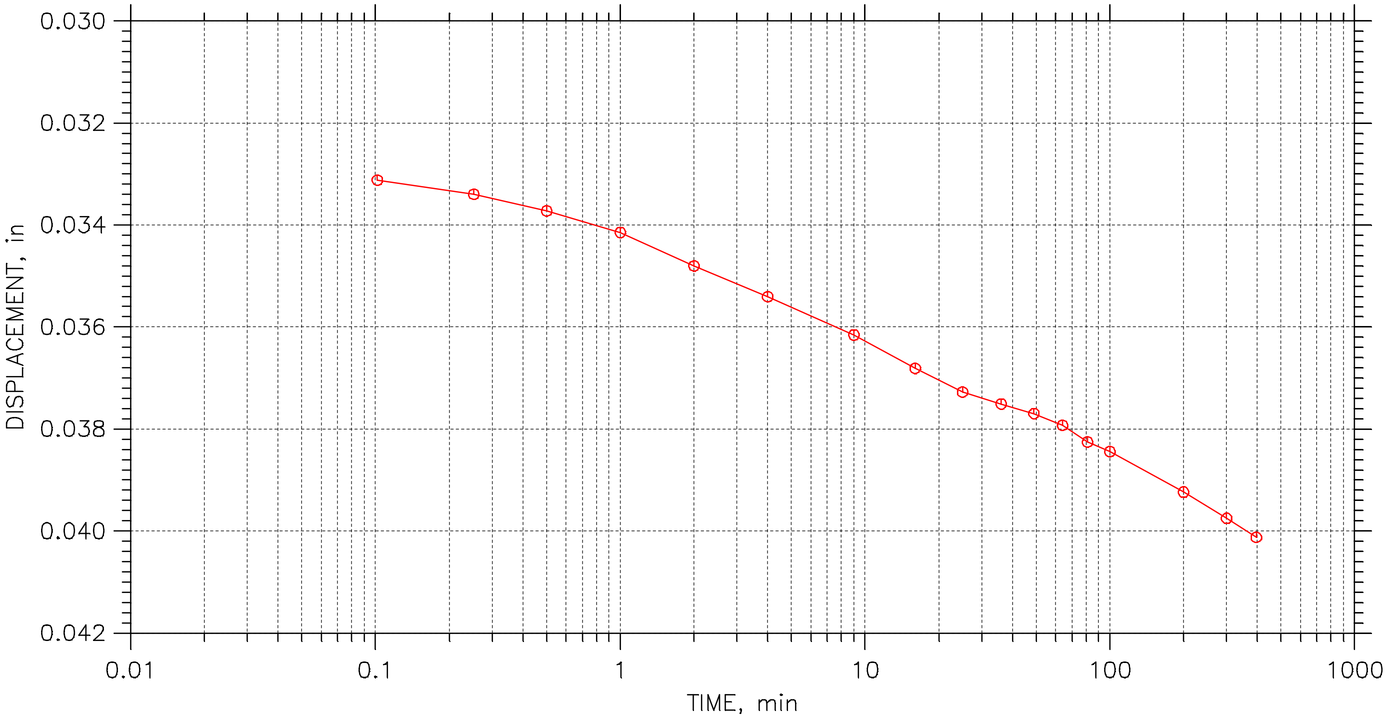
Tue, 26-APR-2016 10:11:44

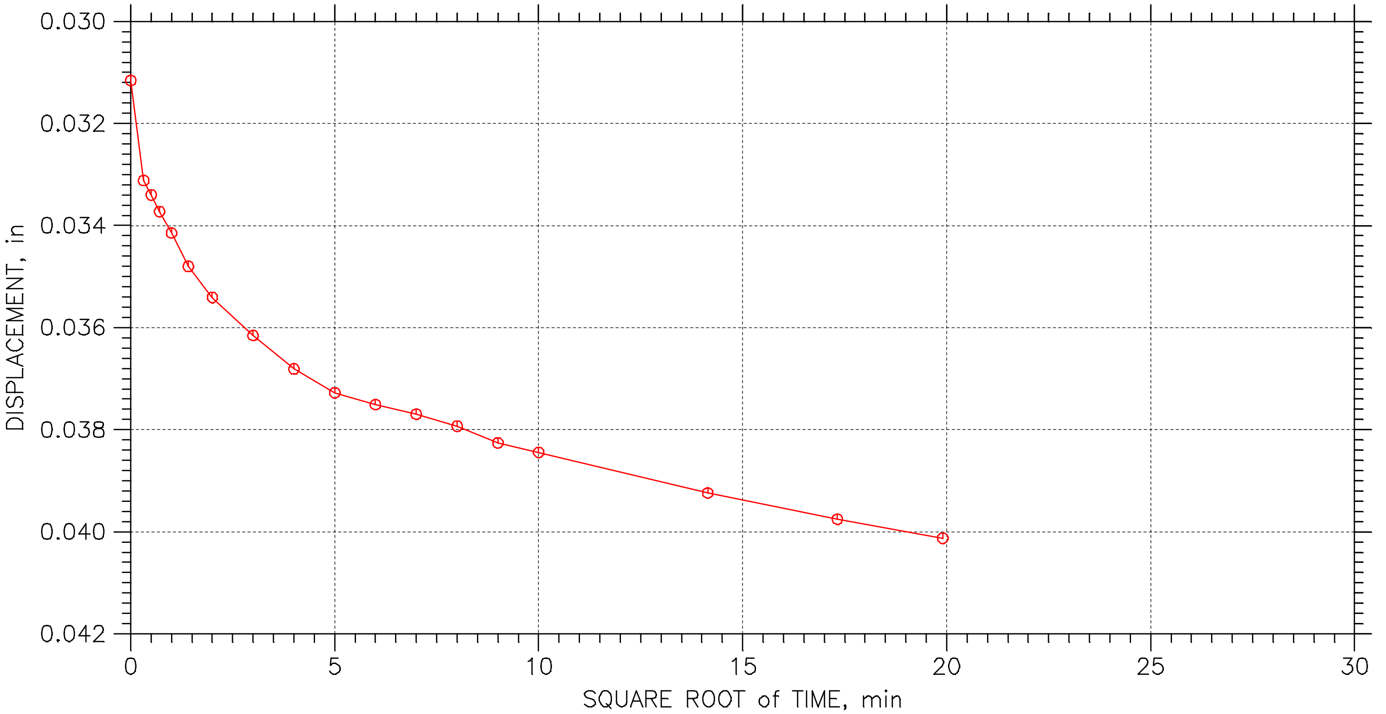
CONSOLIDATION TEST DATA

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		

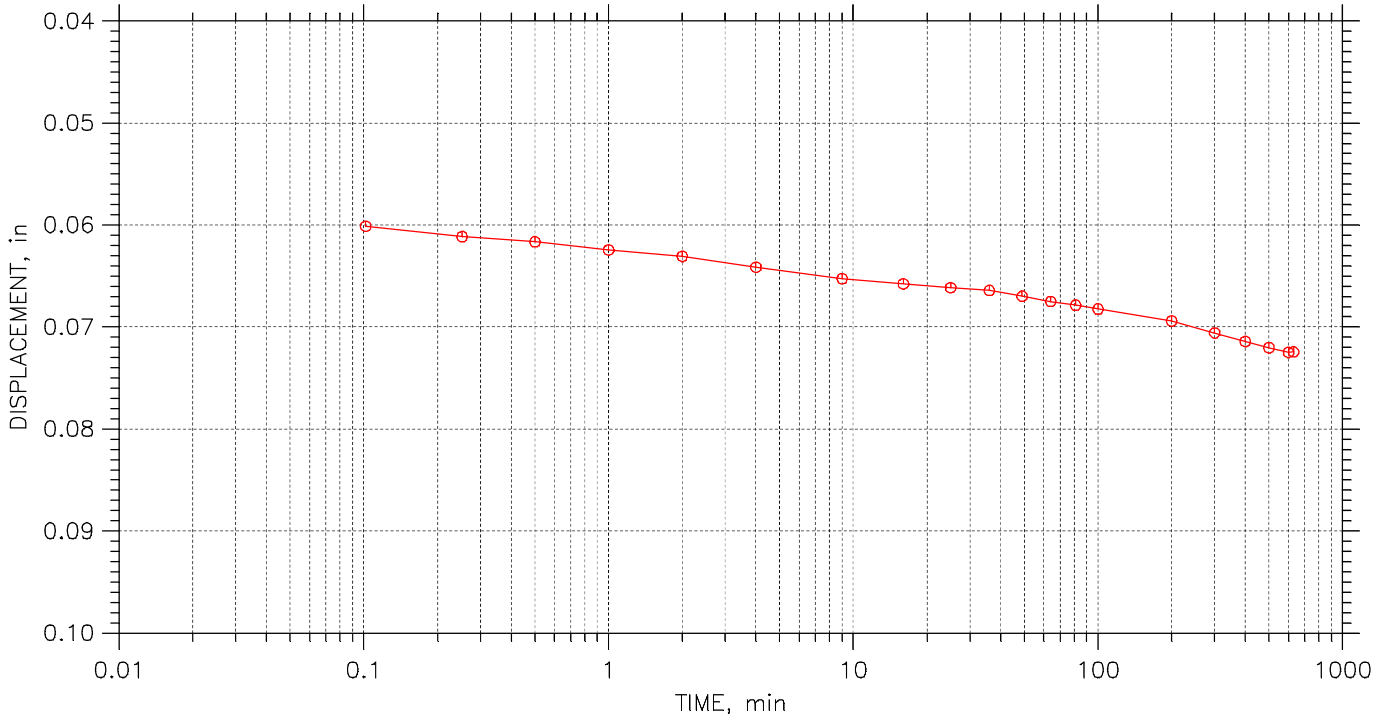
Tue, 26-APR-2016 10:11:45

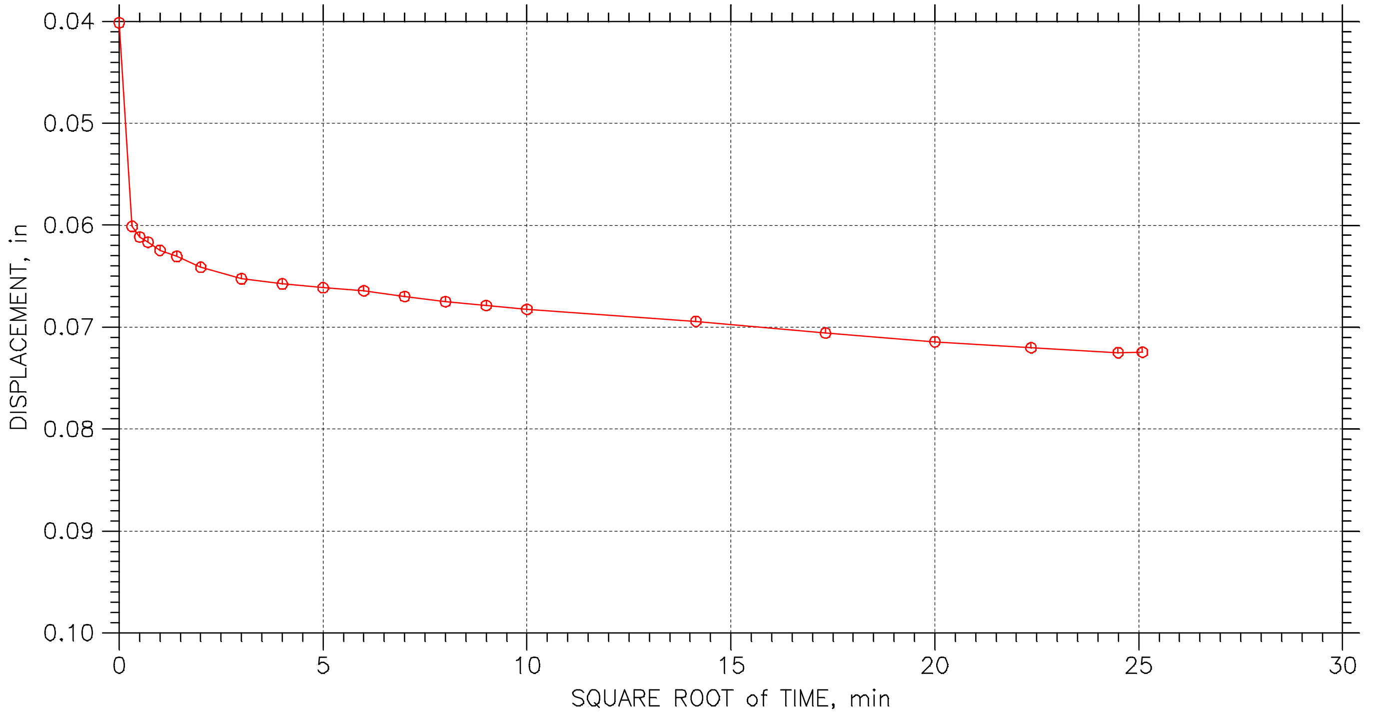
CONSOLIDATION TEST DATA

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		

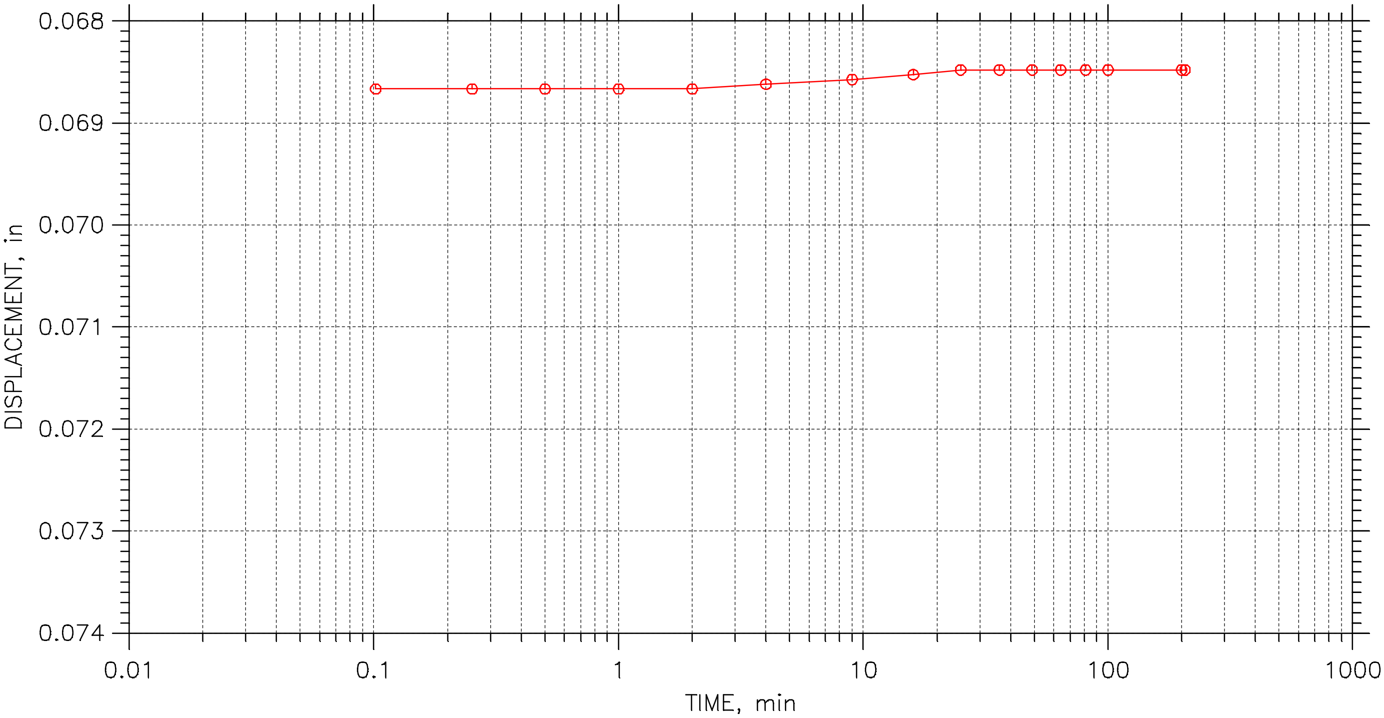
Tue, 26-APR-2016 10:11:47

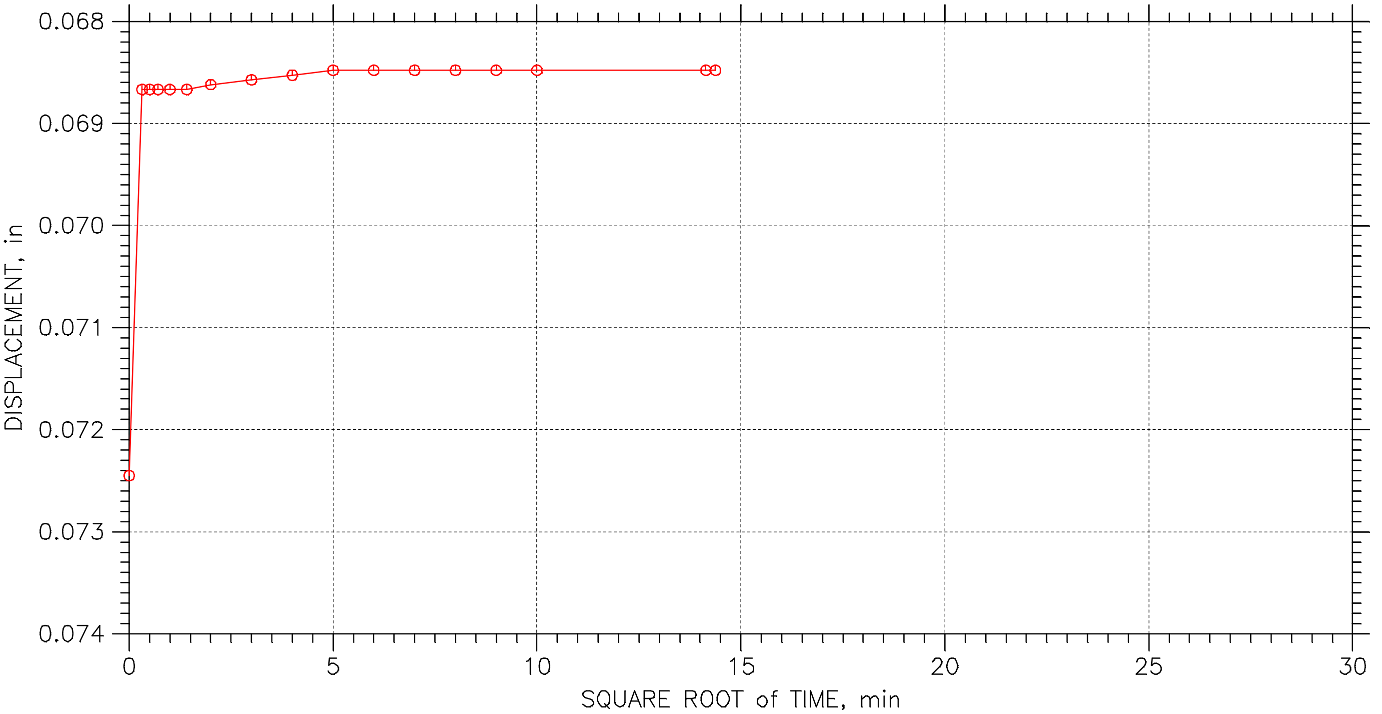
CONSOLIDATION TEST DATA

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		

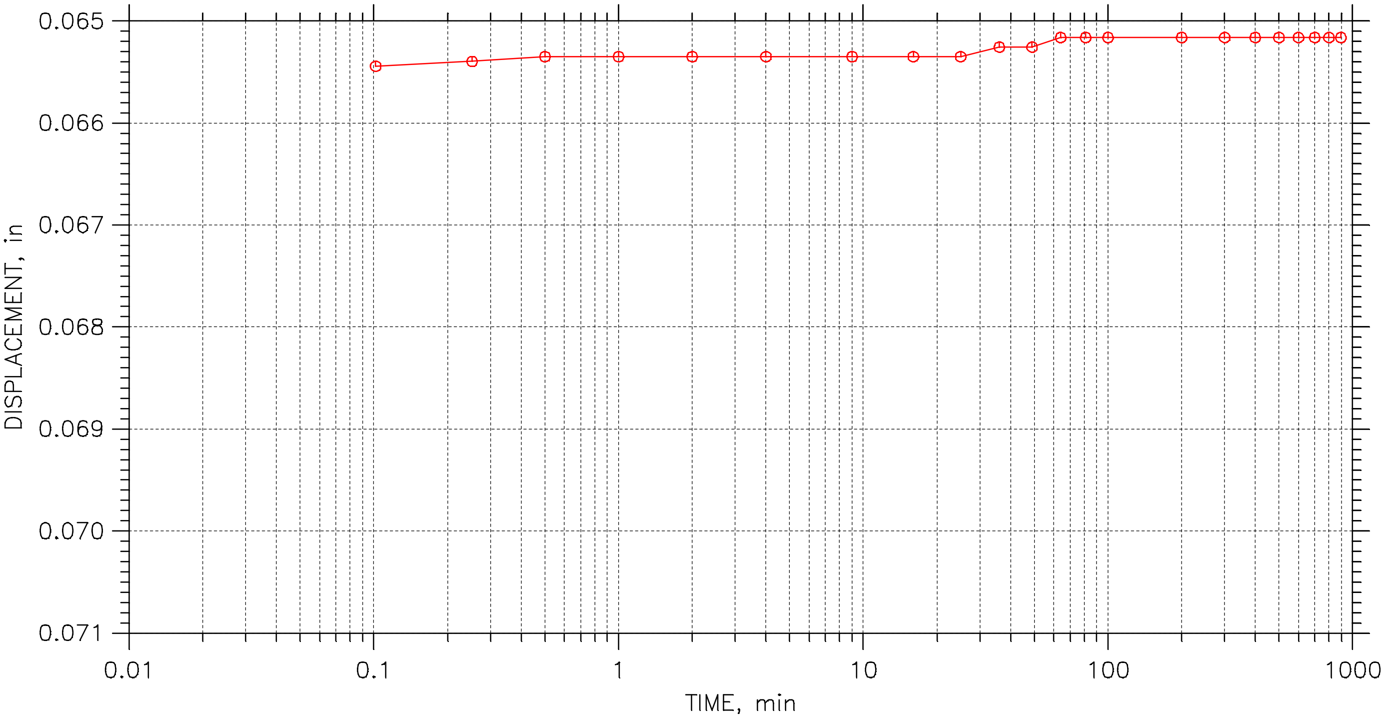
Tue, 26-APR-2016 10:11:48

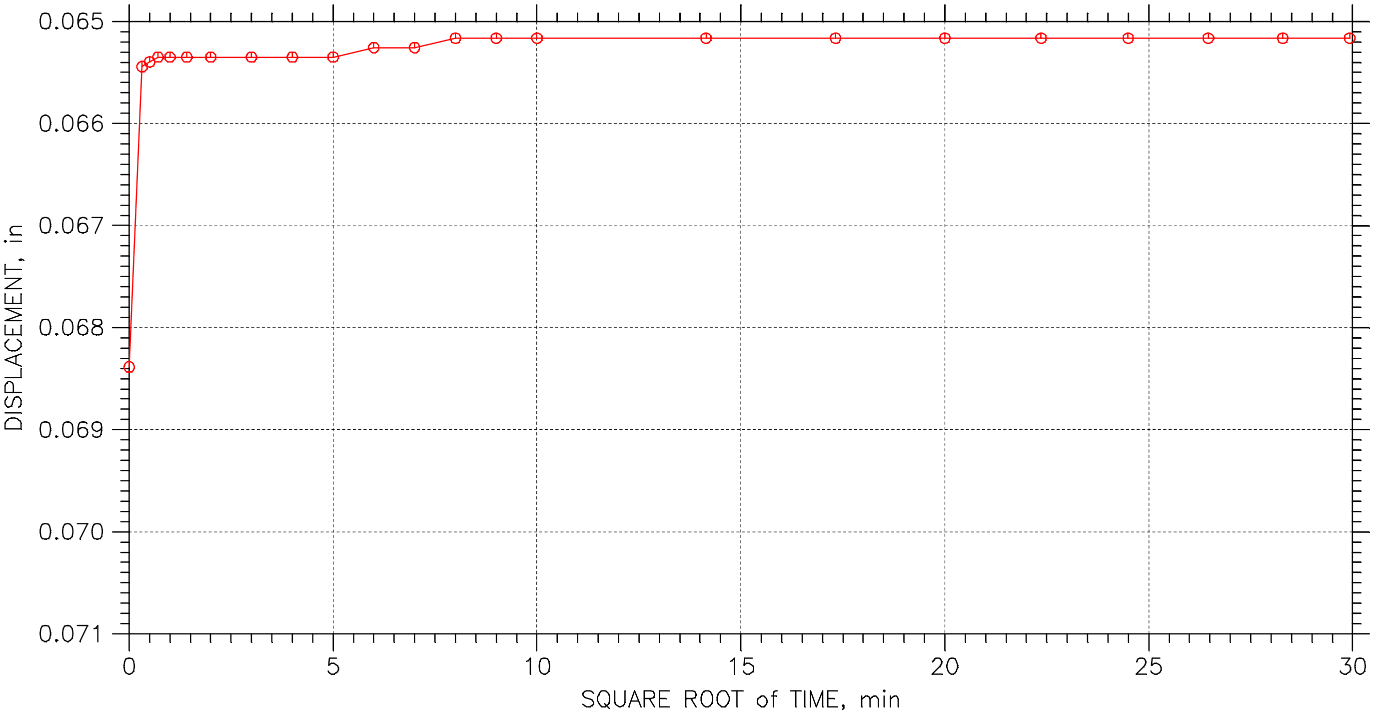
CONSOLIDATION TEST DATA

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		

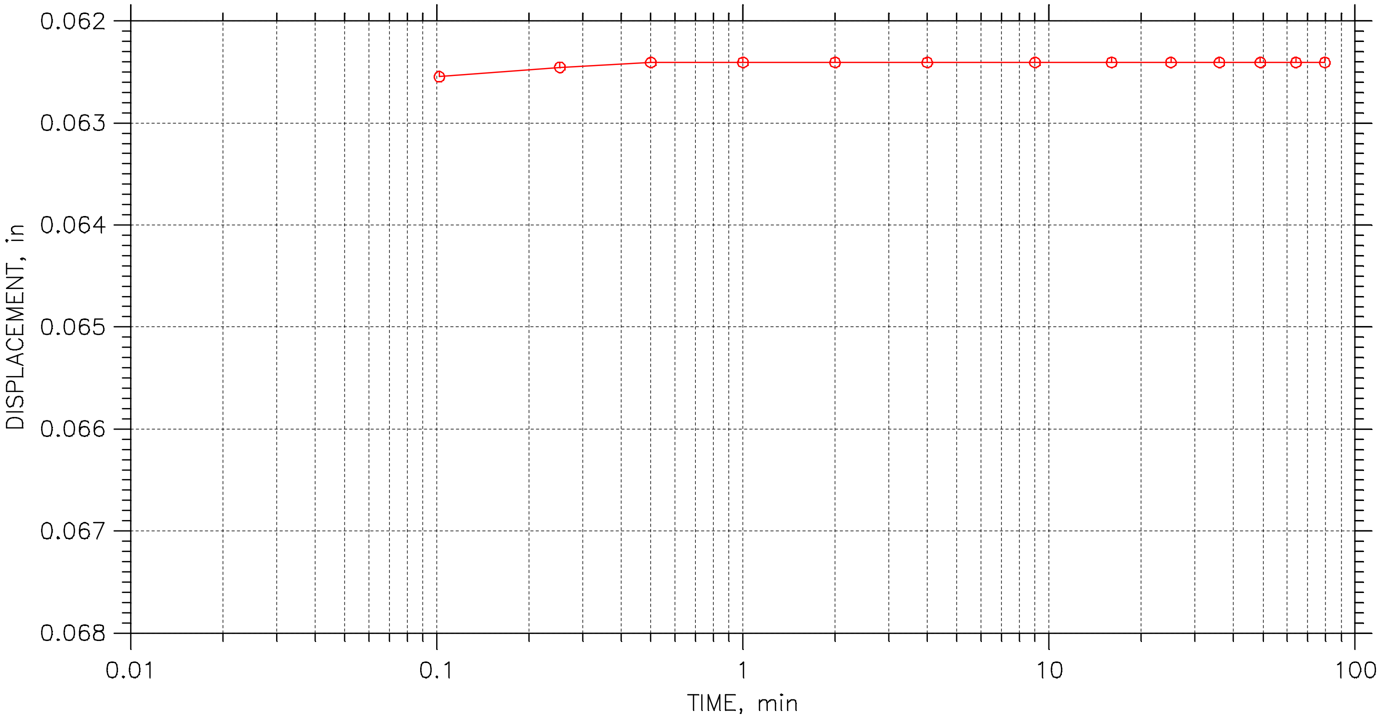
Tue, 26-APR-2016 10:11:49

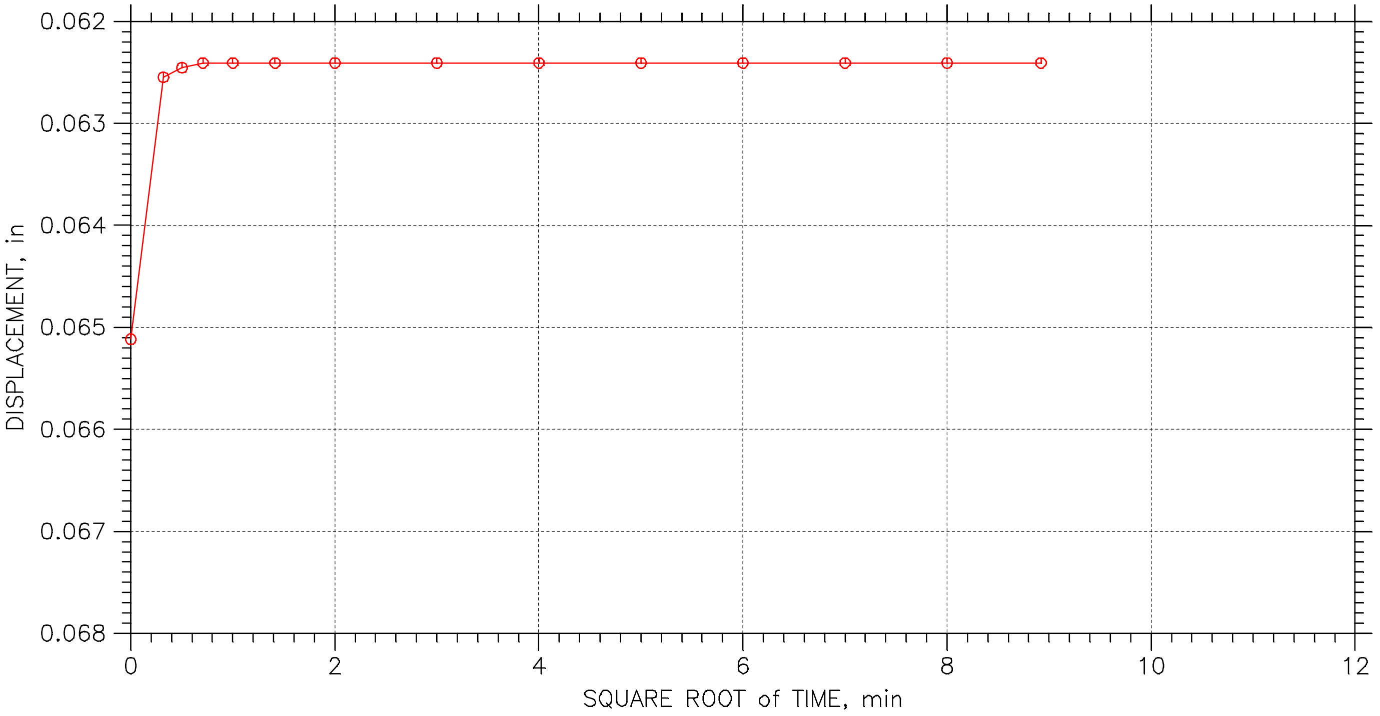
CONSOLIDATION TEST DATA

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		

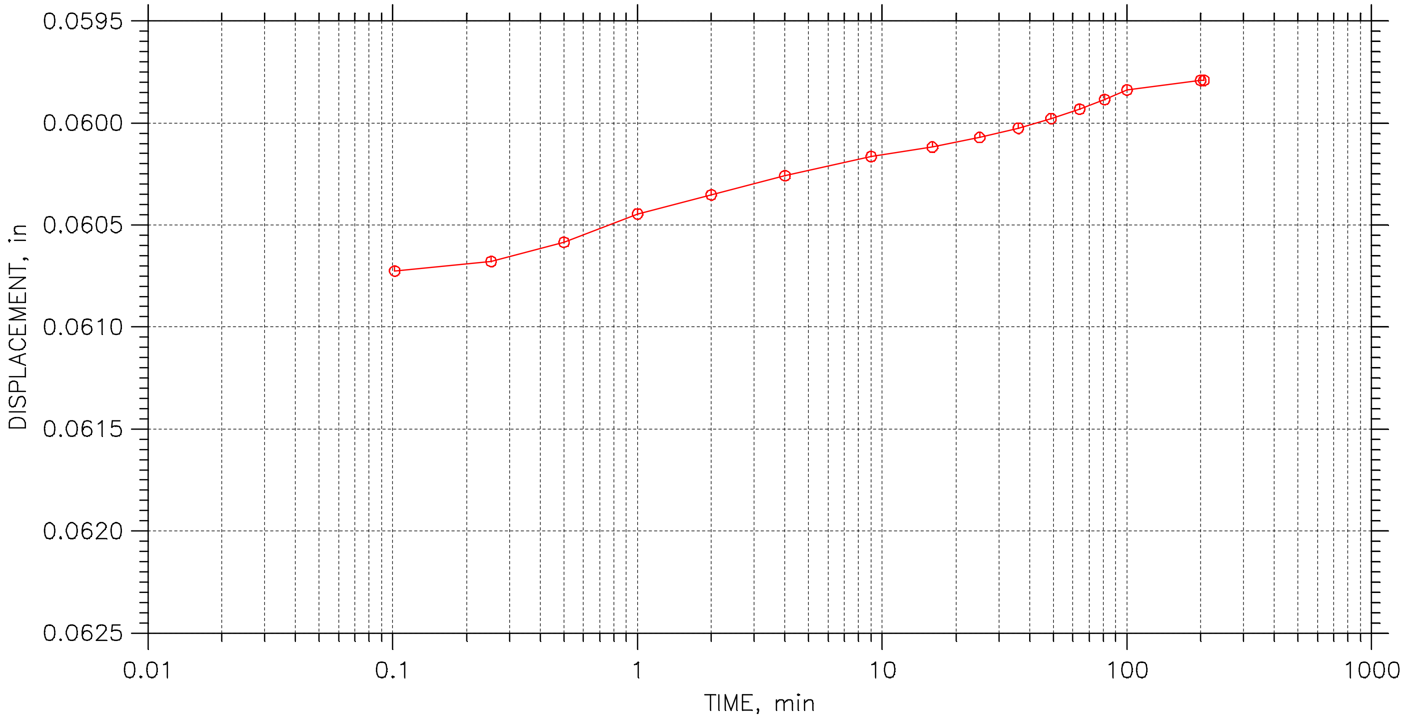
Tue, 26-APR-2016 10:11:51

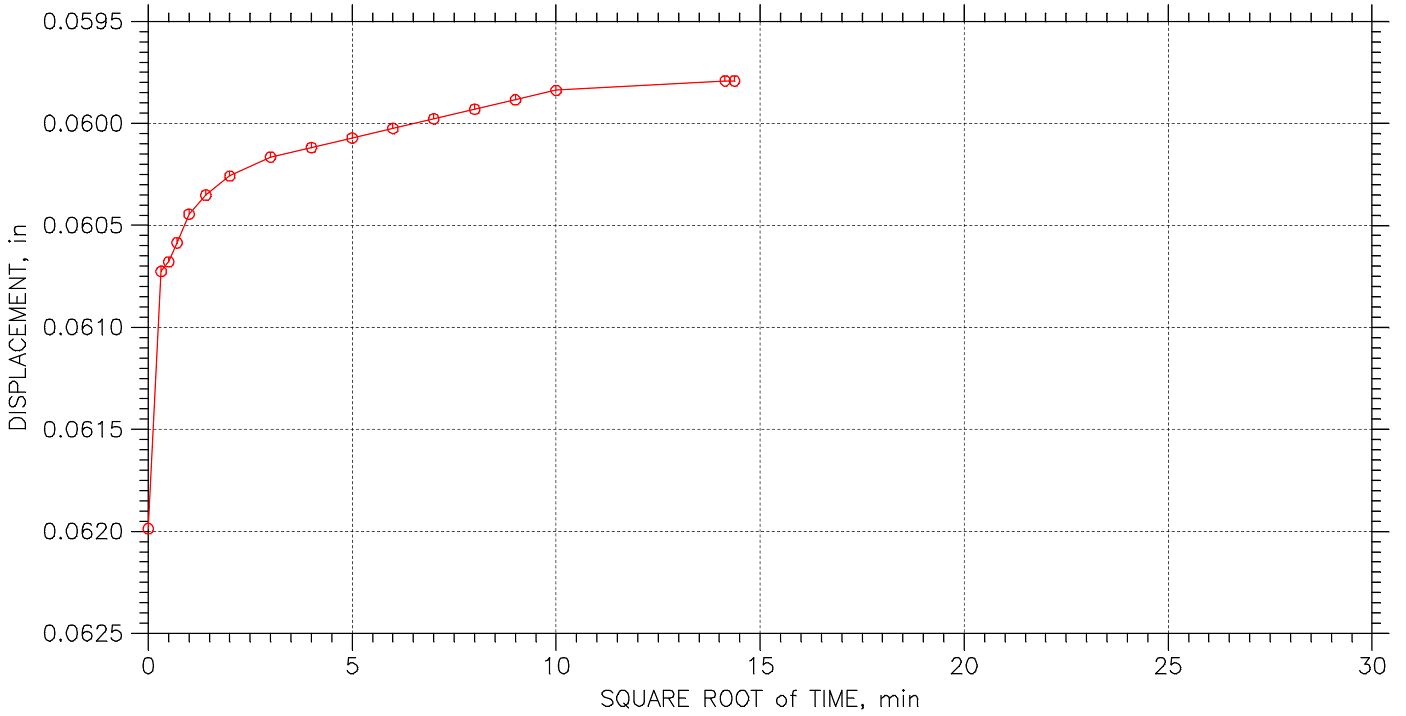
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 12 of 27

Stress: 0.125 tsf





	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
Terracon Consulting Engineers & Scientists	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		

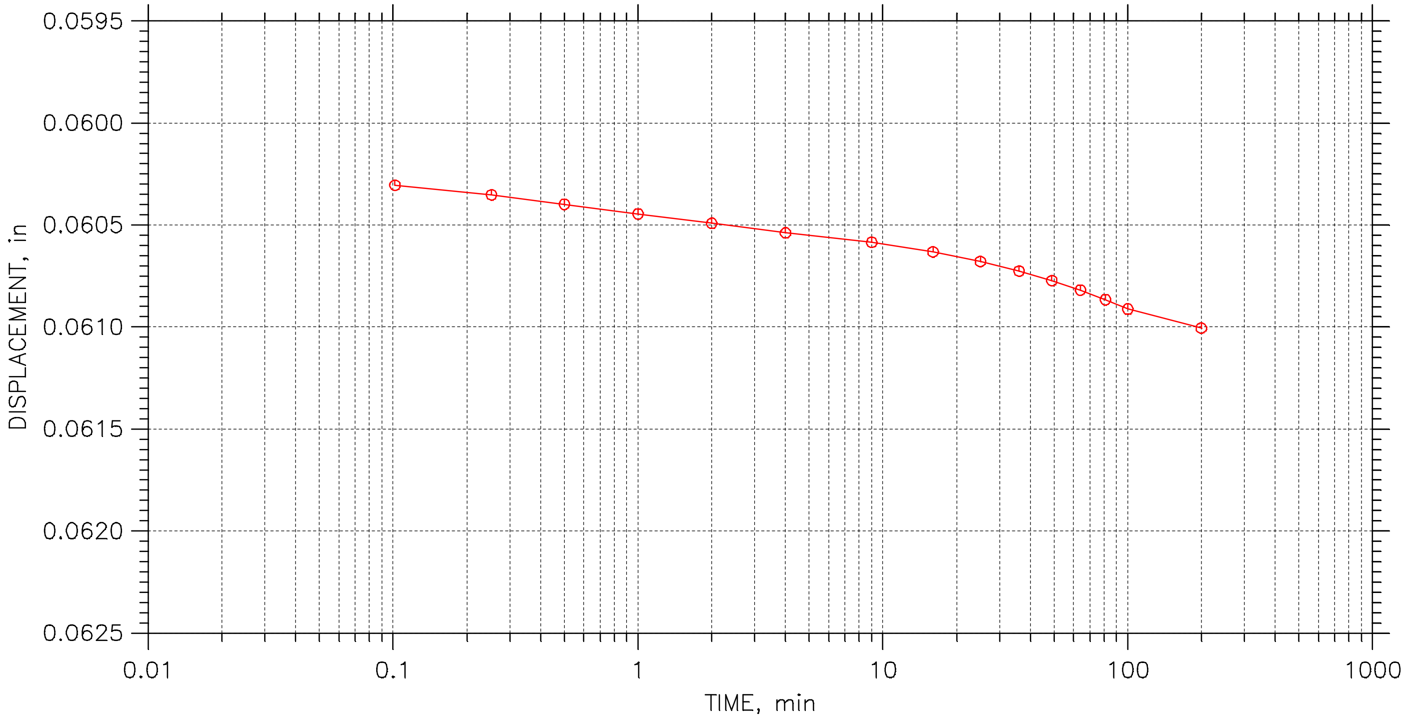
Tue, 26-APR-2016 10:11:52

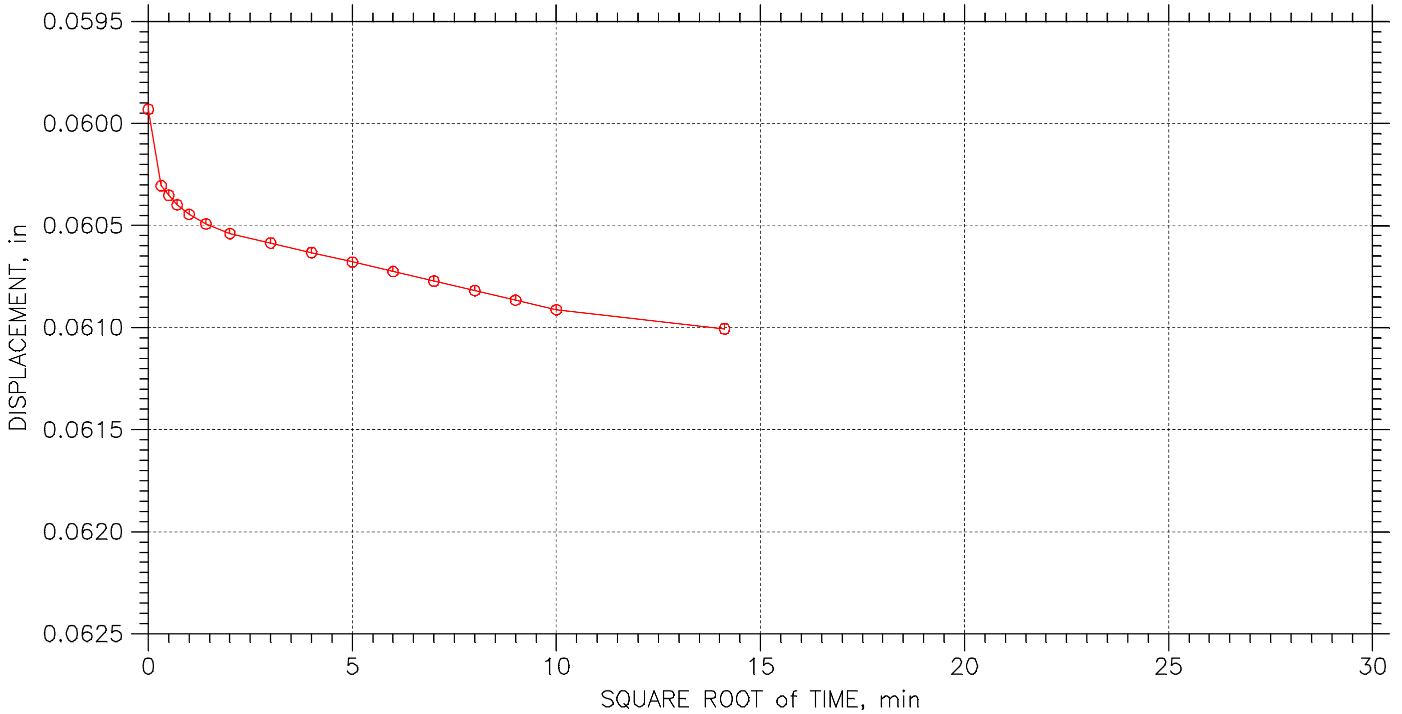
CONSOLIDATION TEST DATA

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		

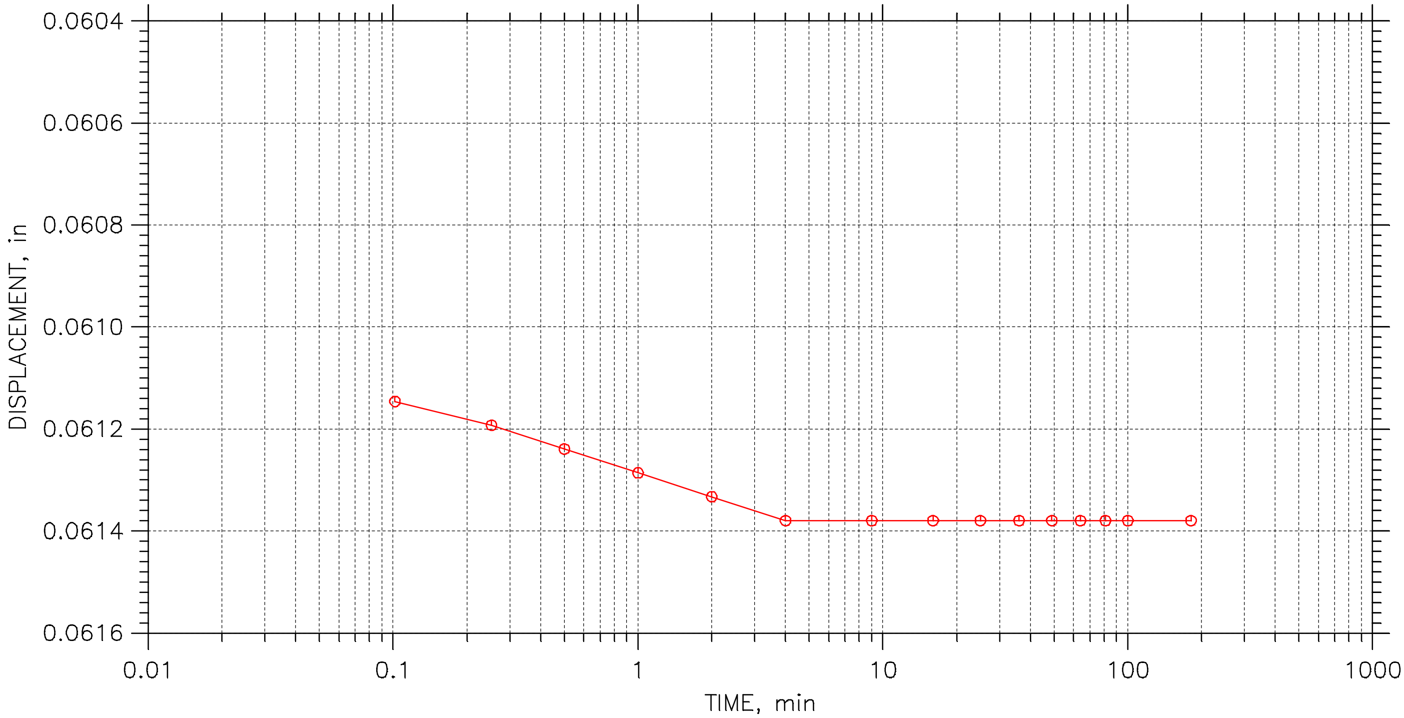
Tue, 26-APR-2016 10:11:54

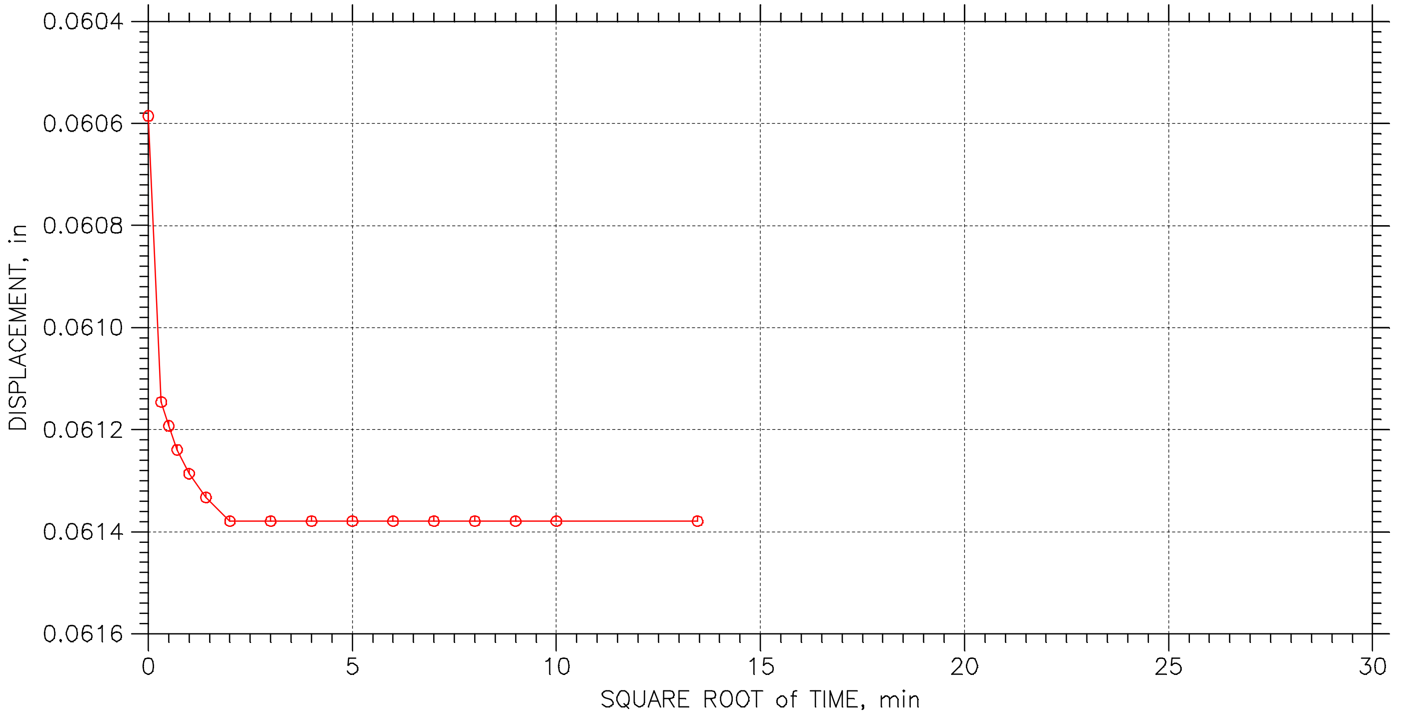
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 14 of 27

Stress: 0.5 tsf





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		

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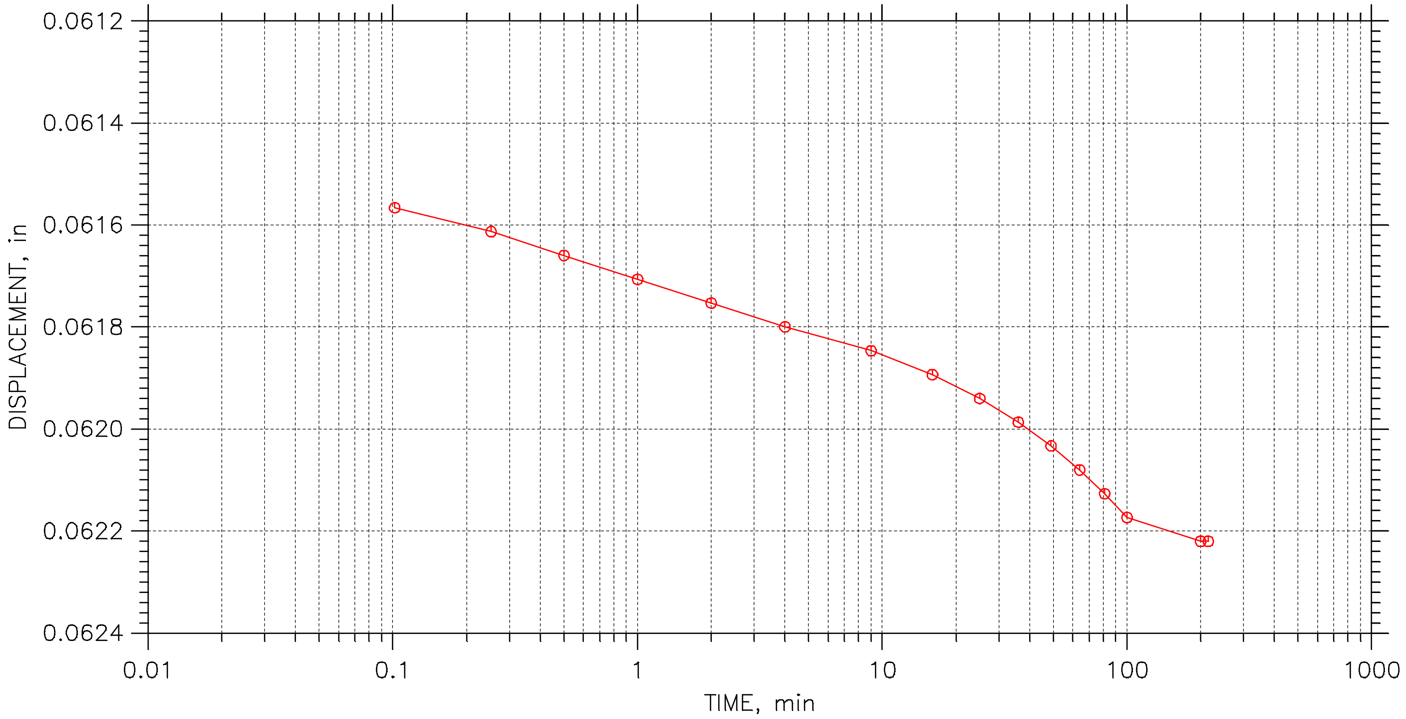
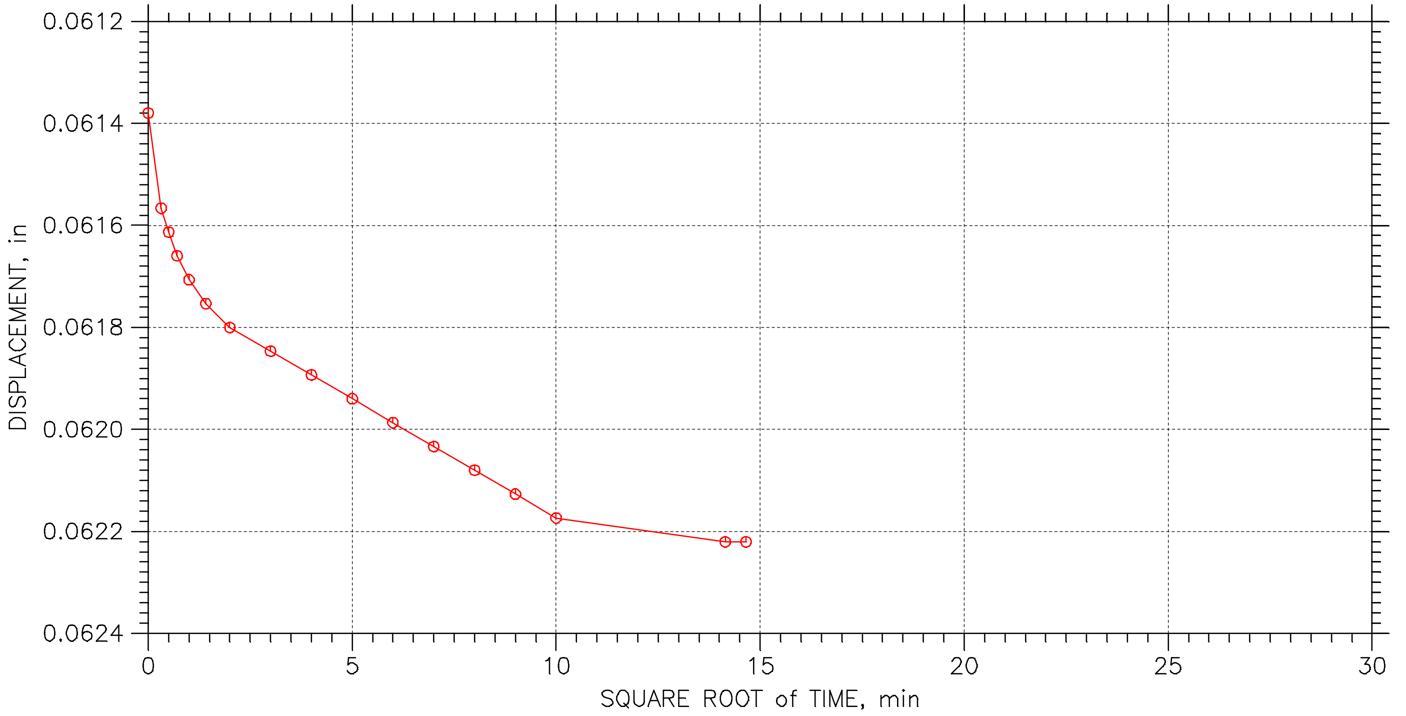
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 15 of 27

Stress: 0.75 tsf





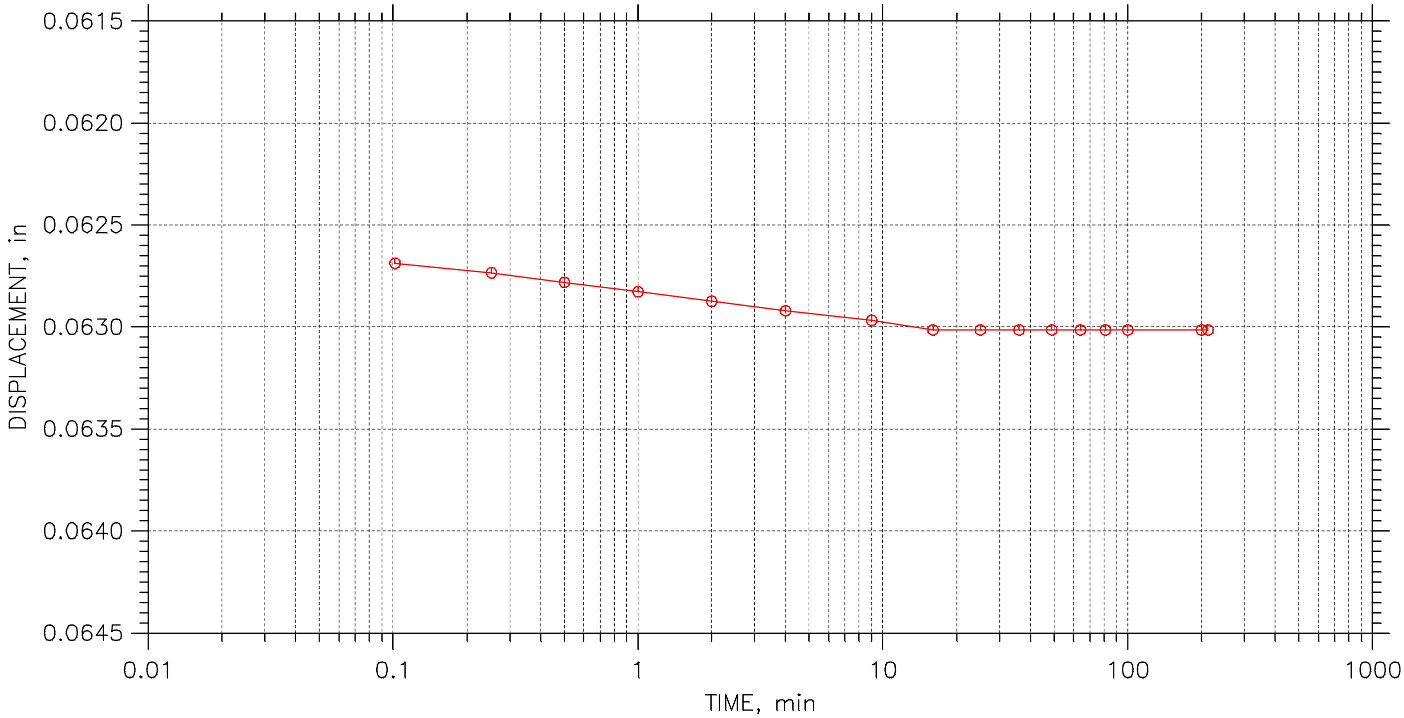
Terracon Consulting Engineers & Scientists			
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: 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		

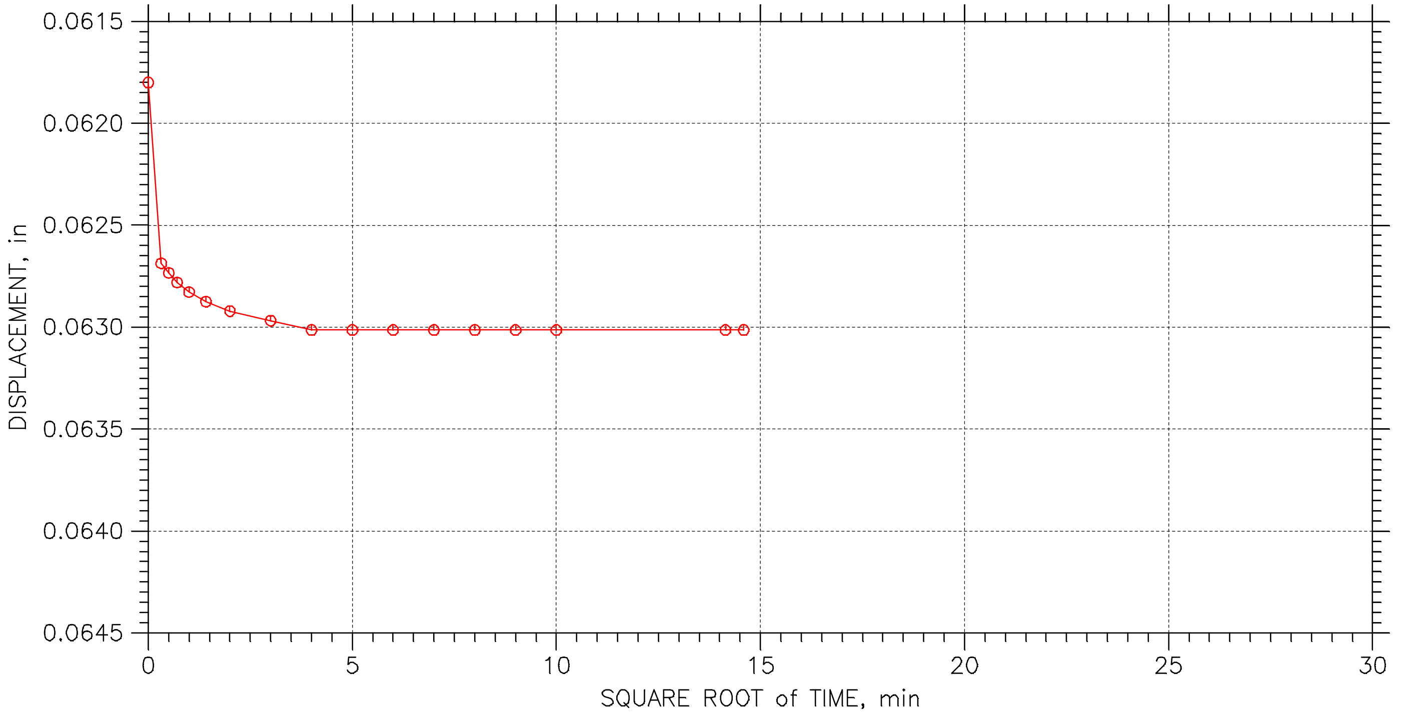
CONSOLIDATION TEST DATA

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		

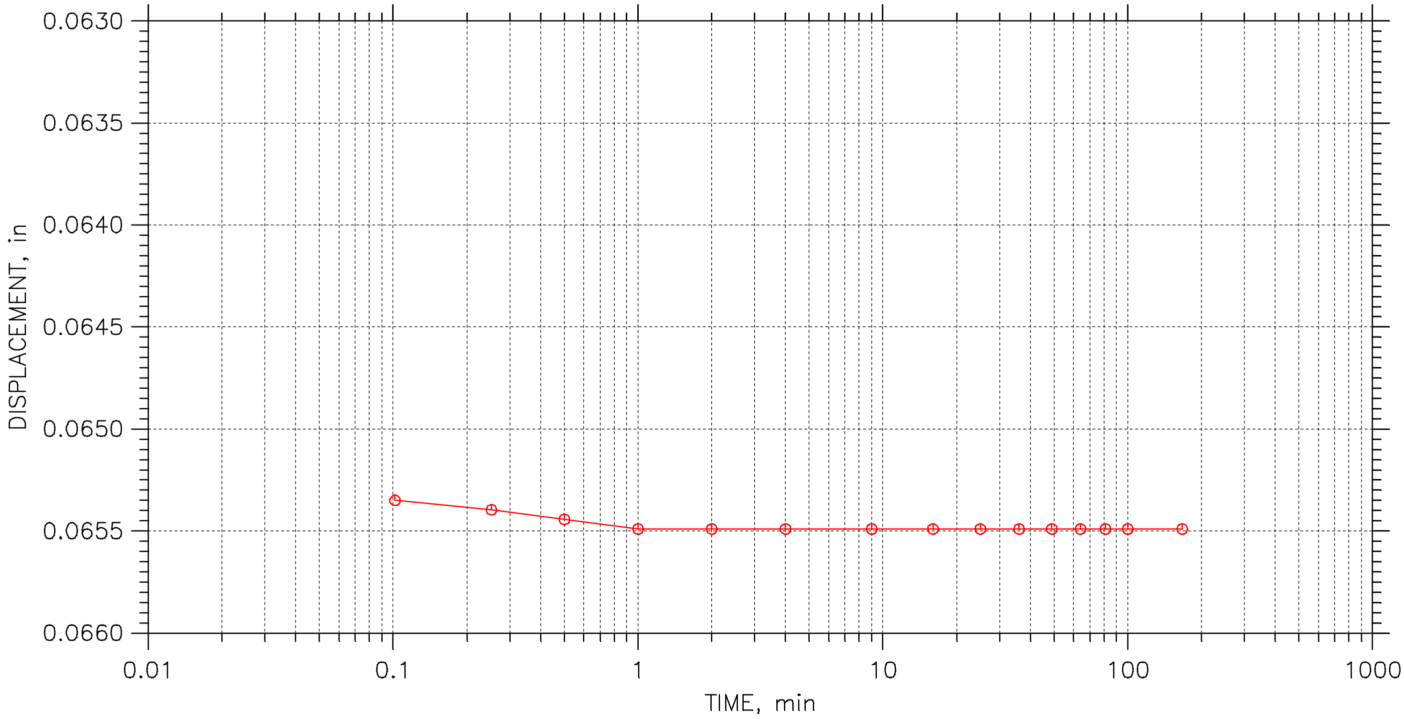
Tue, 26-APR-2016 10:11:58

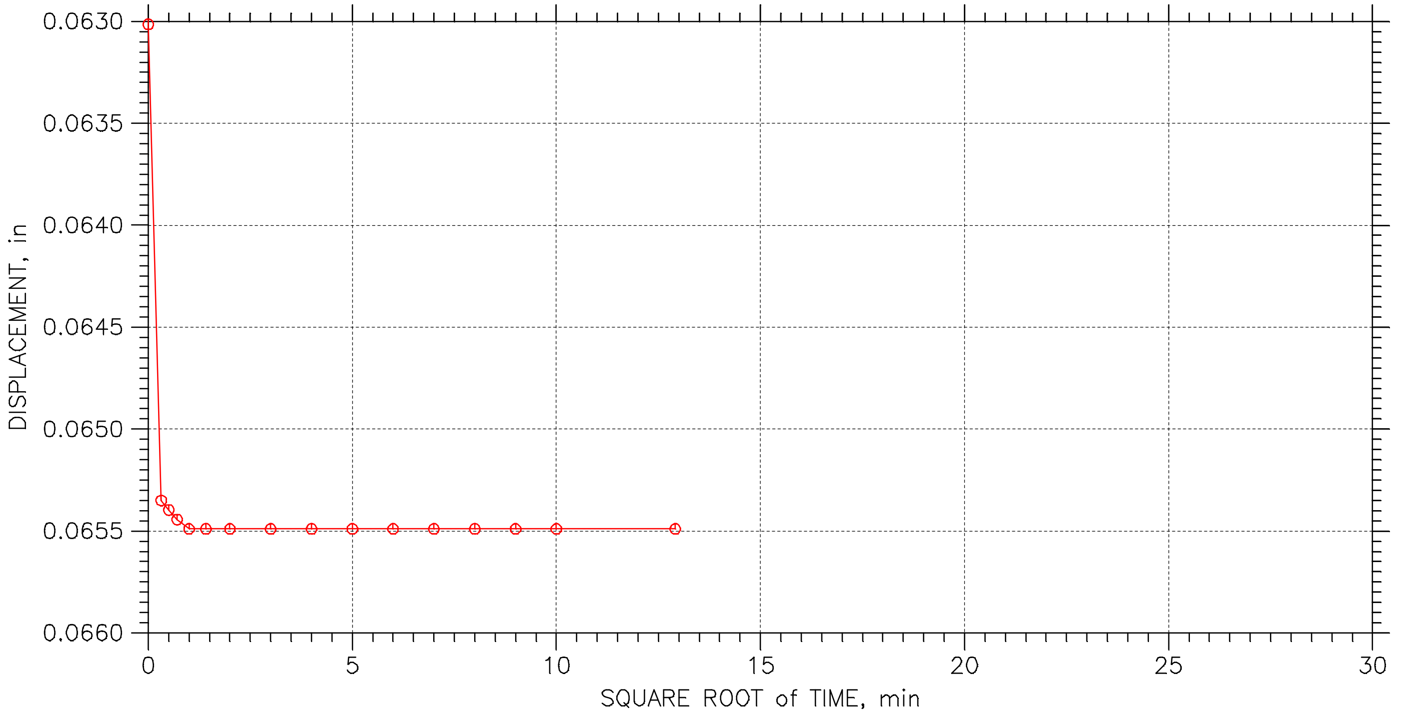
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 17 of 27

Stress: 1.5 tsf





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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		

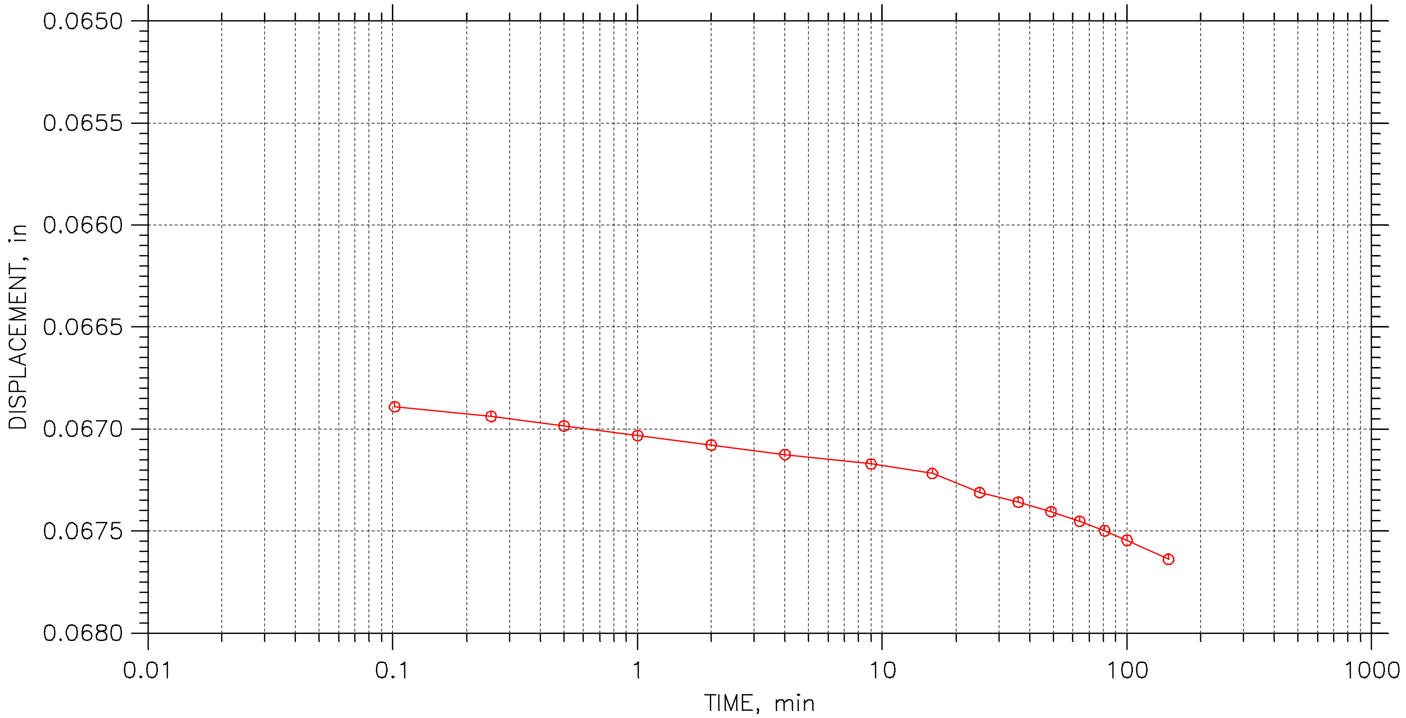
Tue, 26-APR-2016 10:12:00

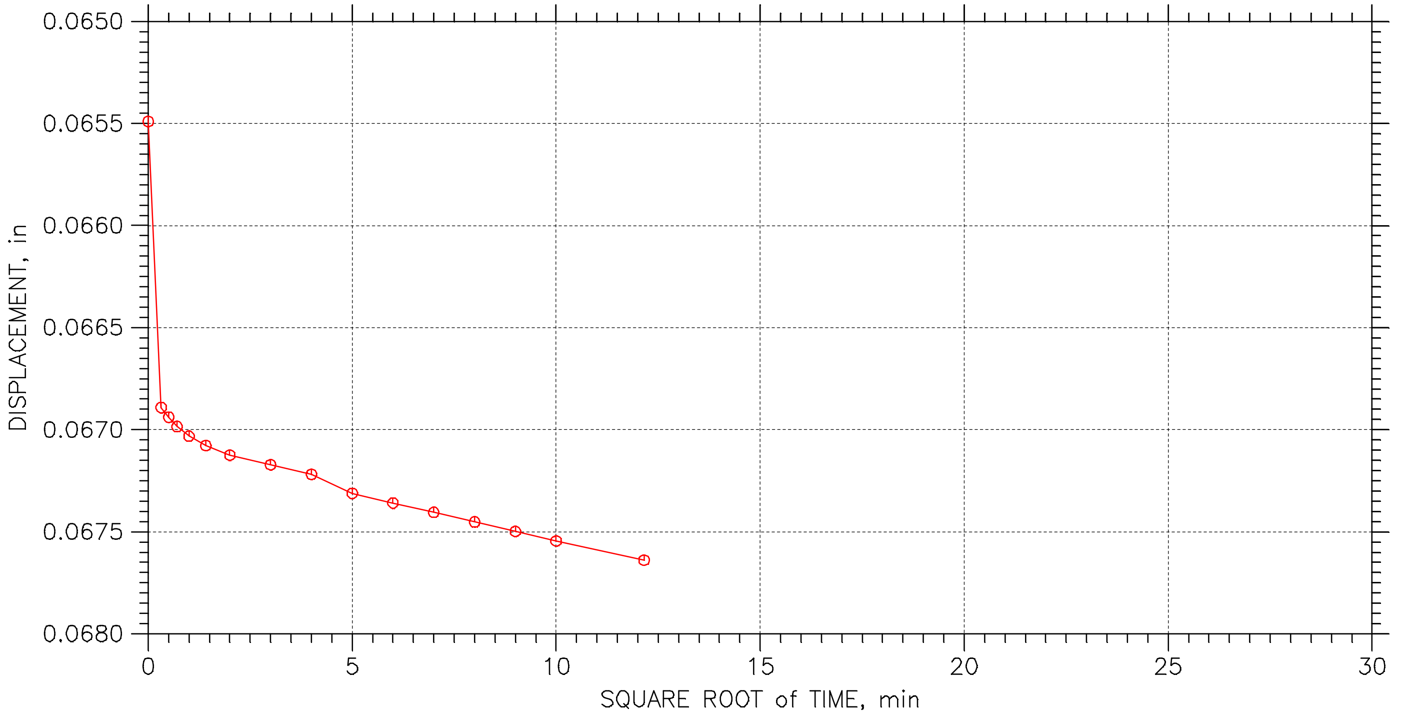
CONSOLIDATION TEST DATA

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		

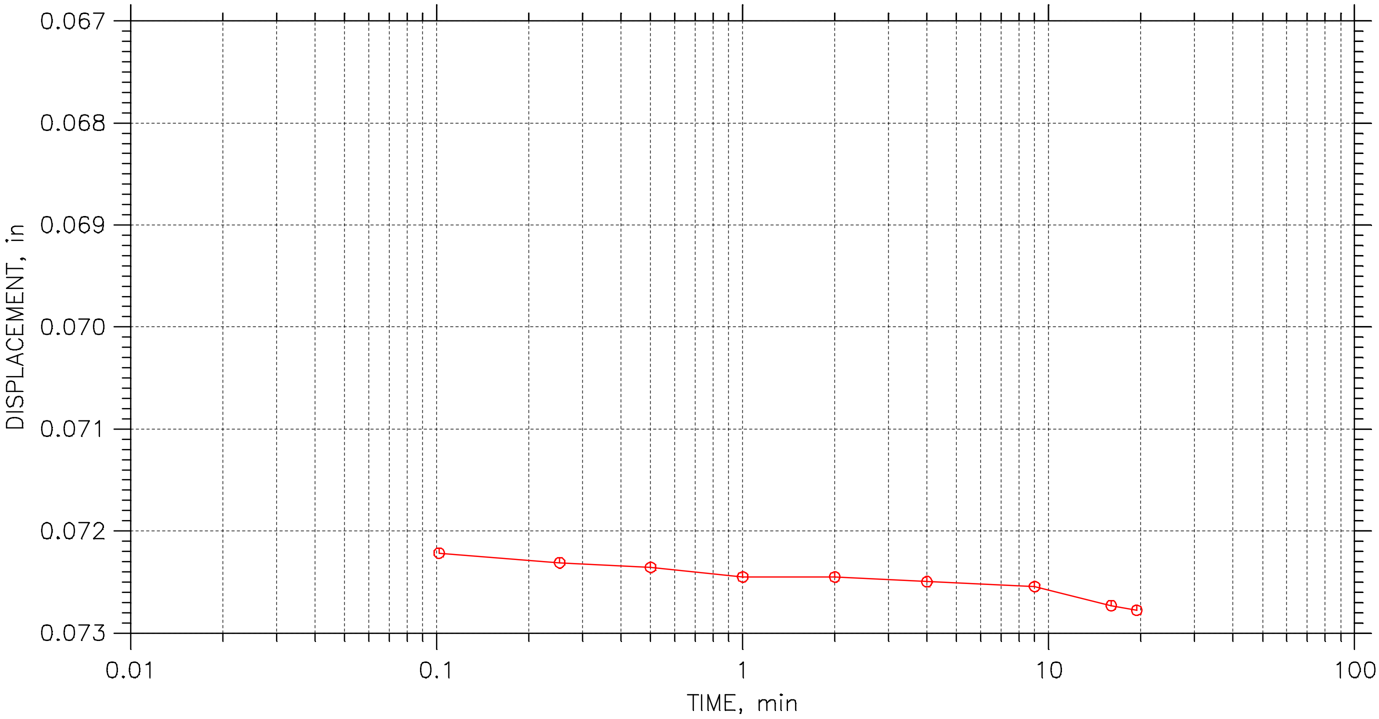
Tue, 26-APR-2016 10:12:01

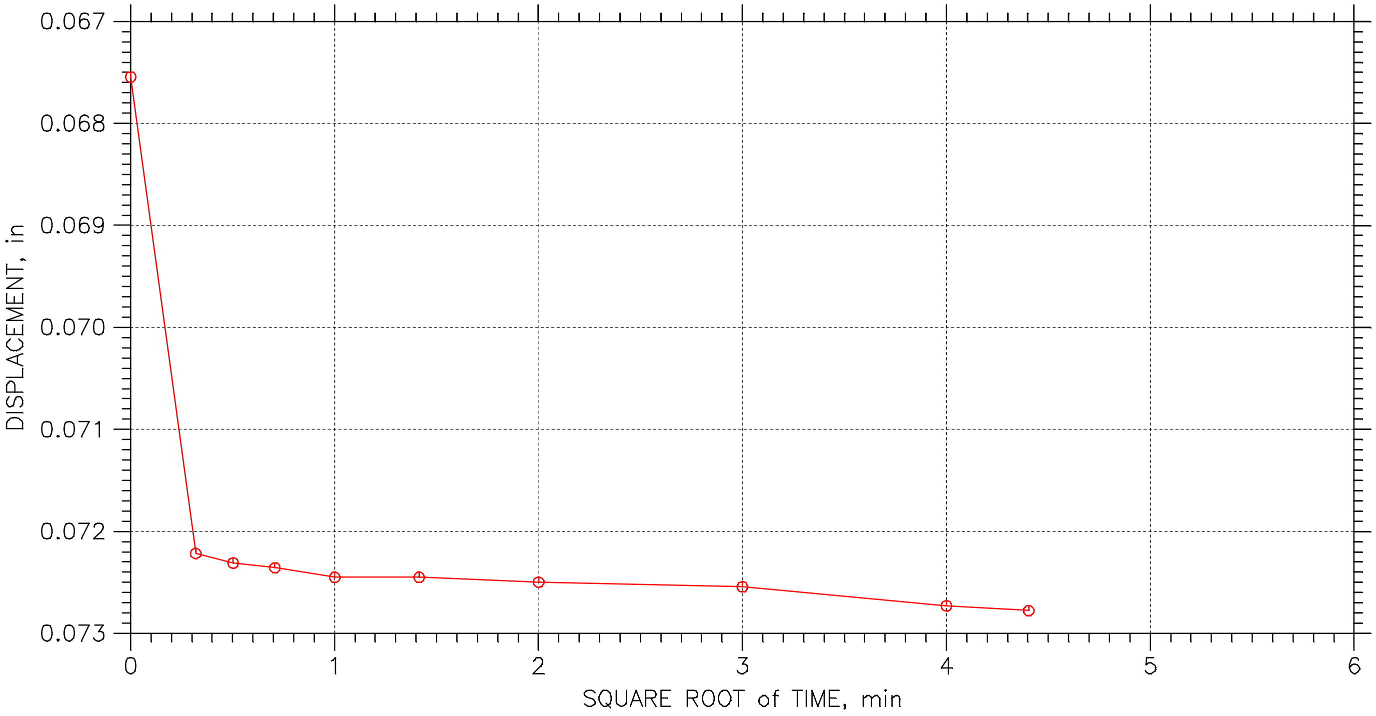
CONSOLIDATION TEST DATA

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		

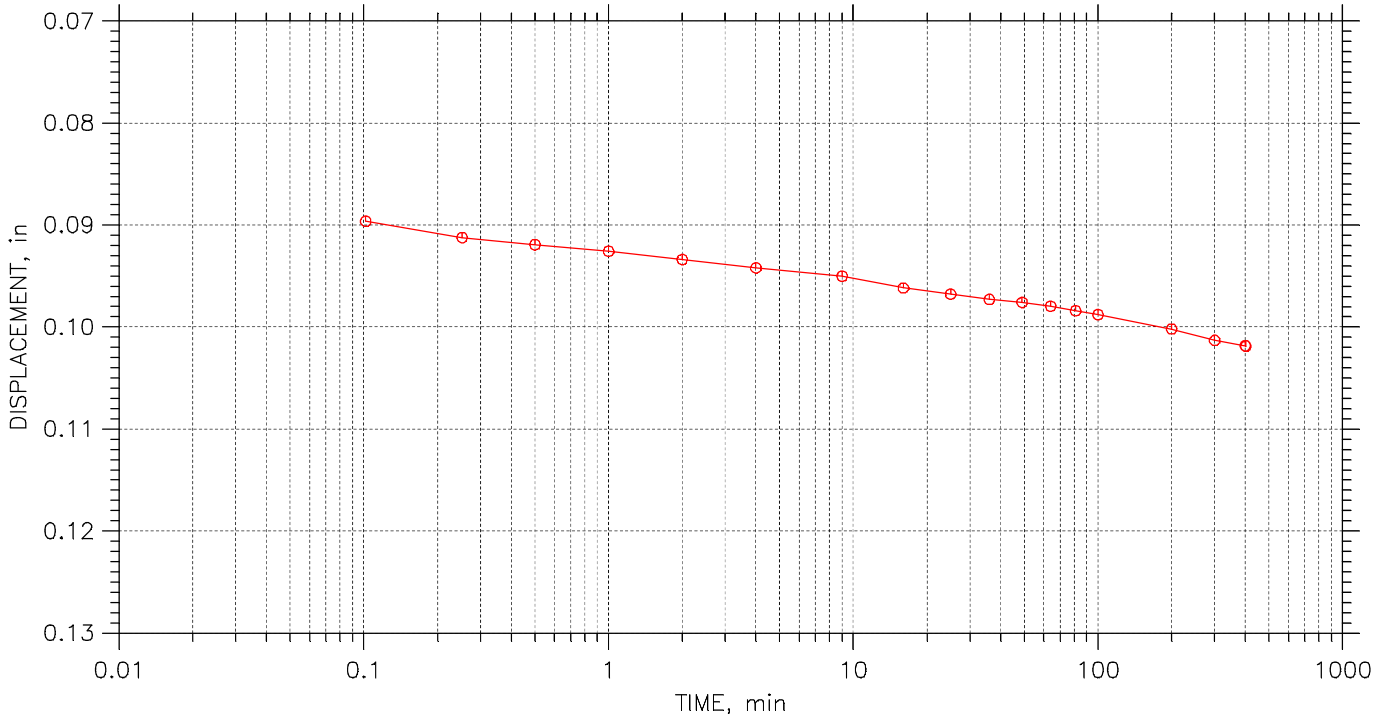
Tue, 26-APR-2016 10:12:03

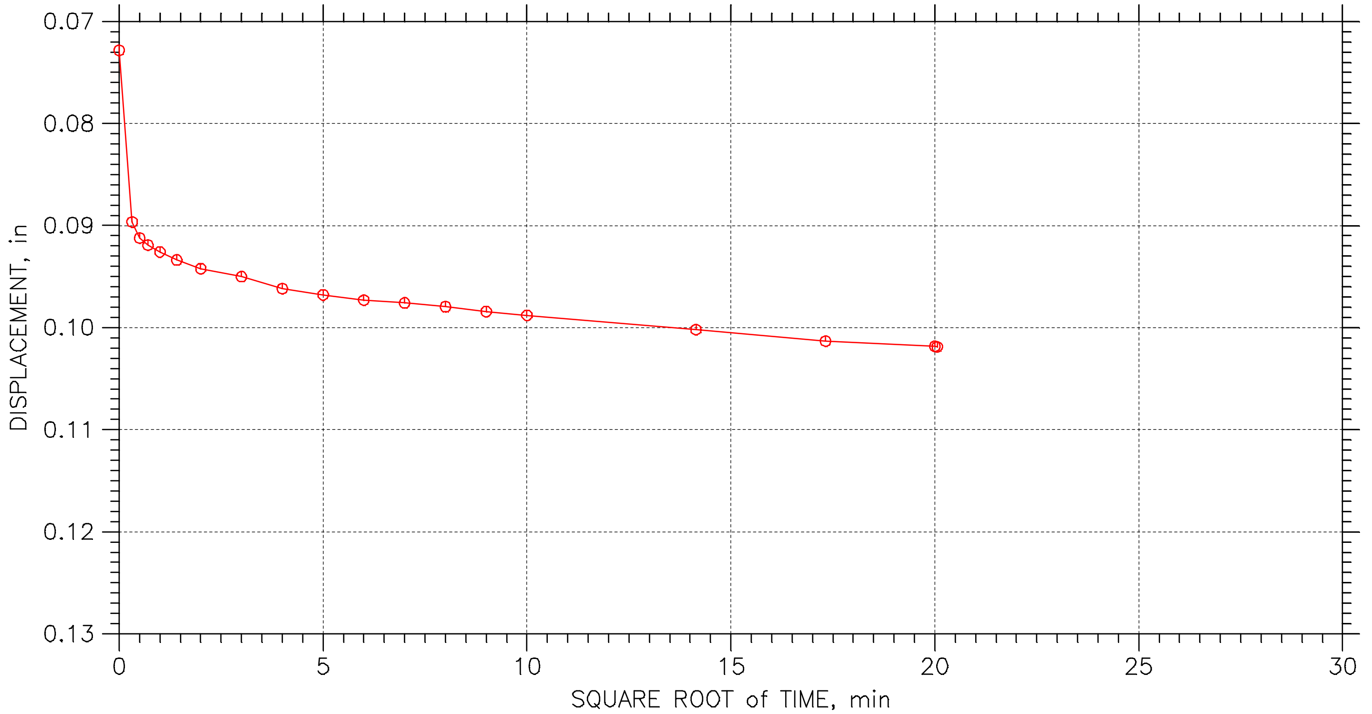
CONSOLIDATION TEST DATA

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		

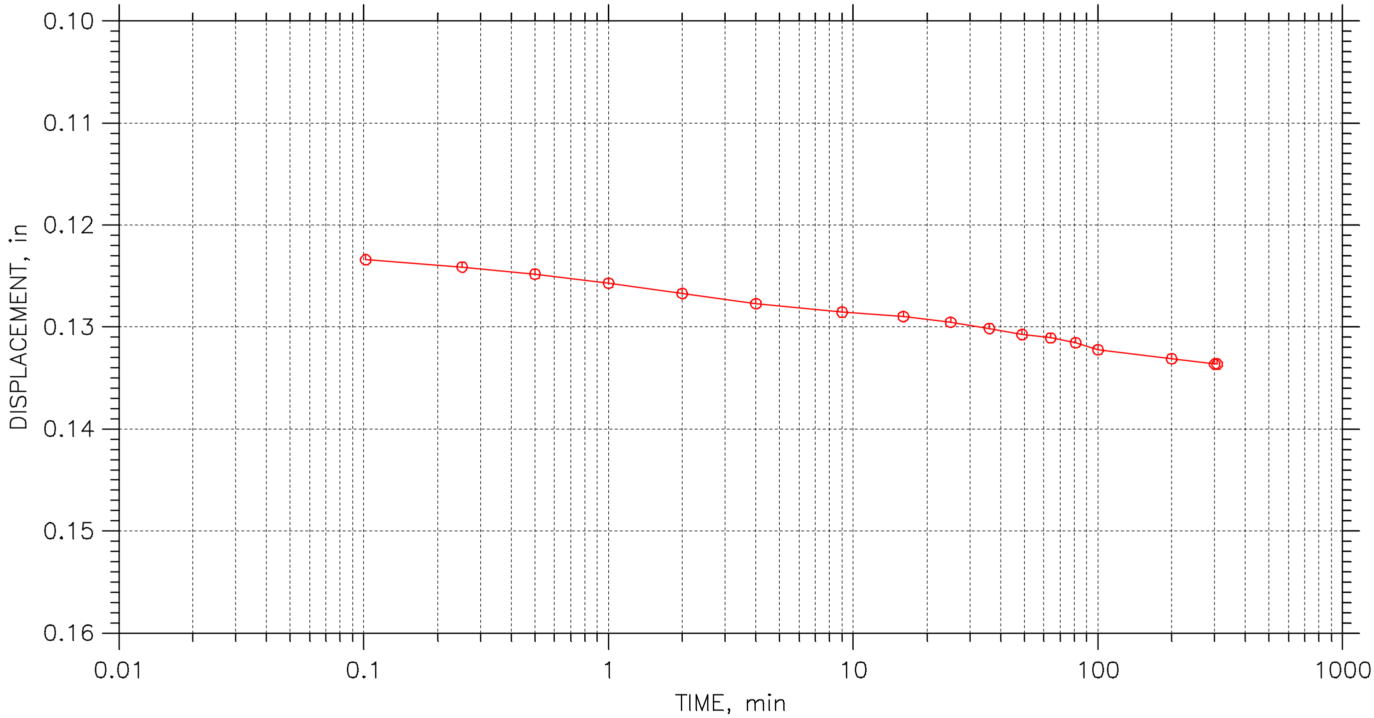
Tue, 26-APR-2016 10:12:04

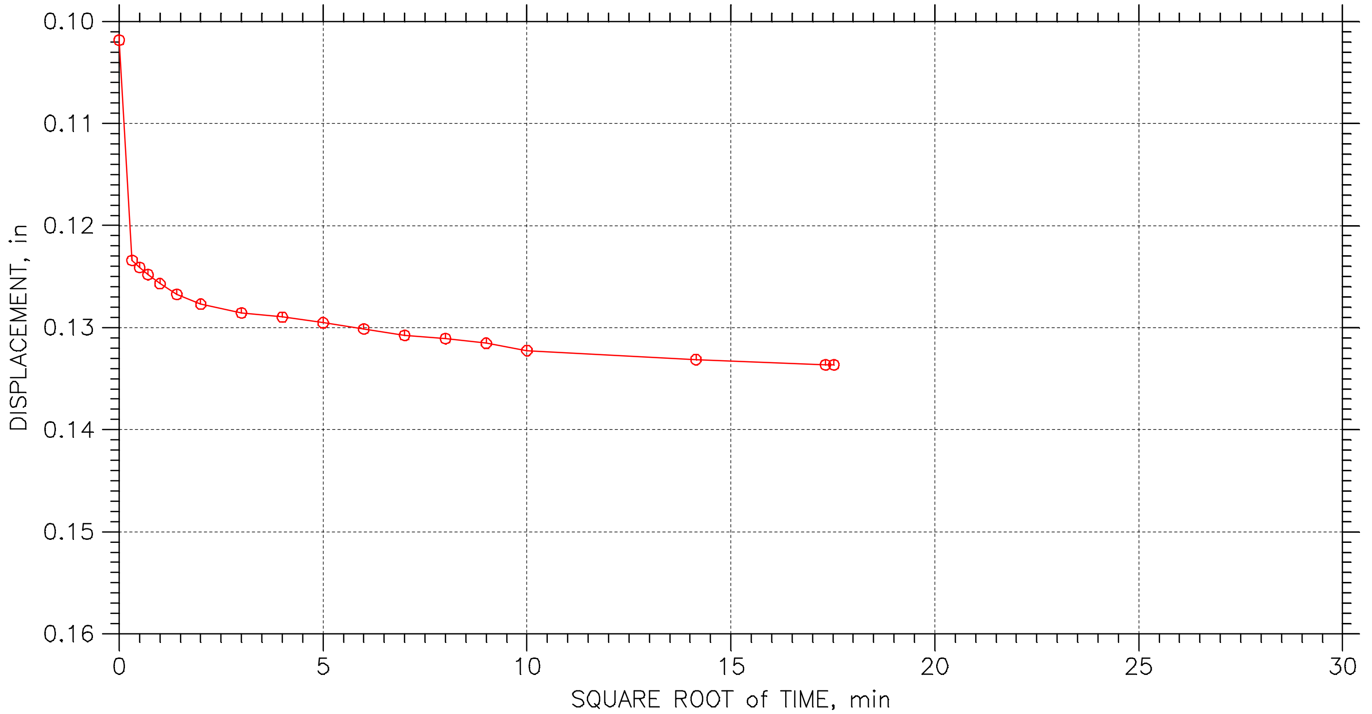
CONSOLIDATION TEST DATA

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		

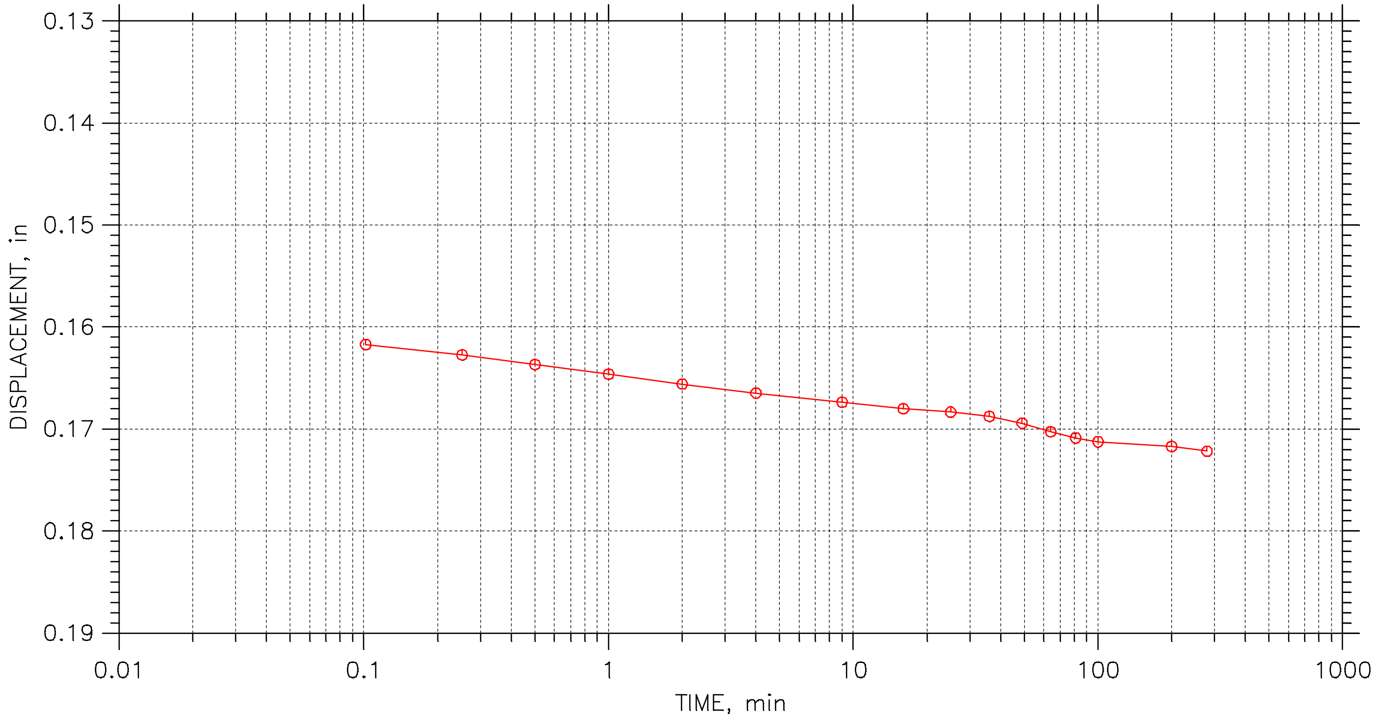
Tue, 26-APR-2016 10:12:06

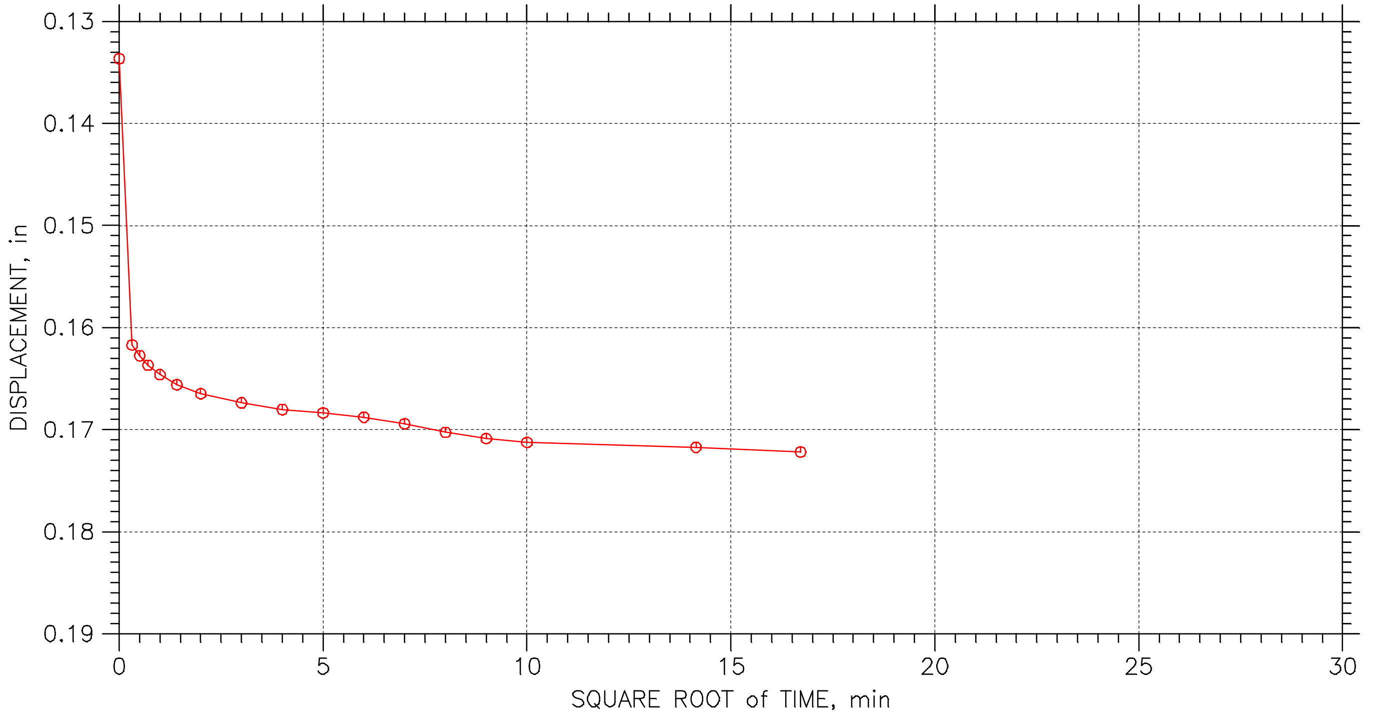
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 22 of 27

Stress: 32. tsf





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		

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Consulting Engineers & Scientists

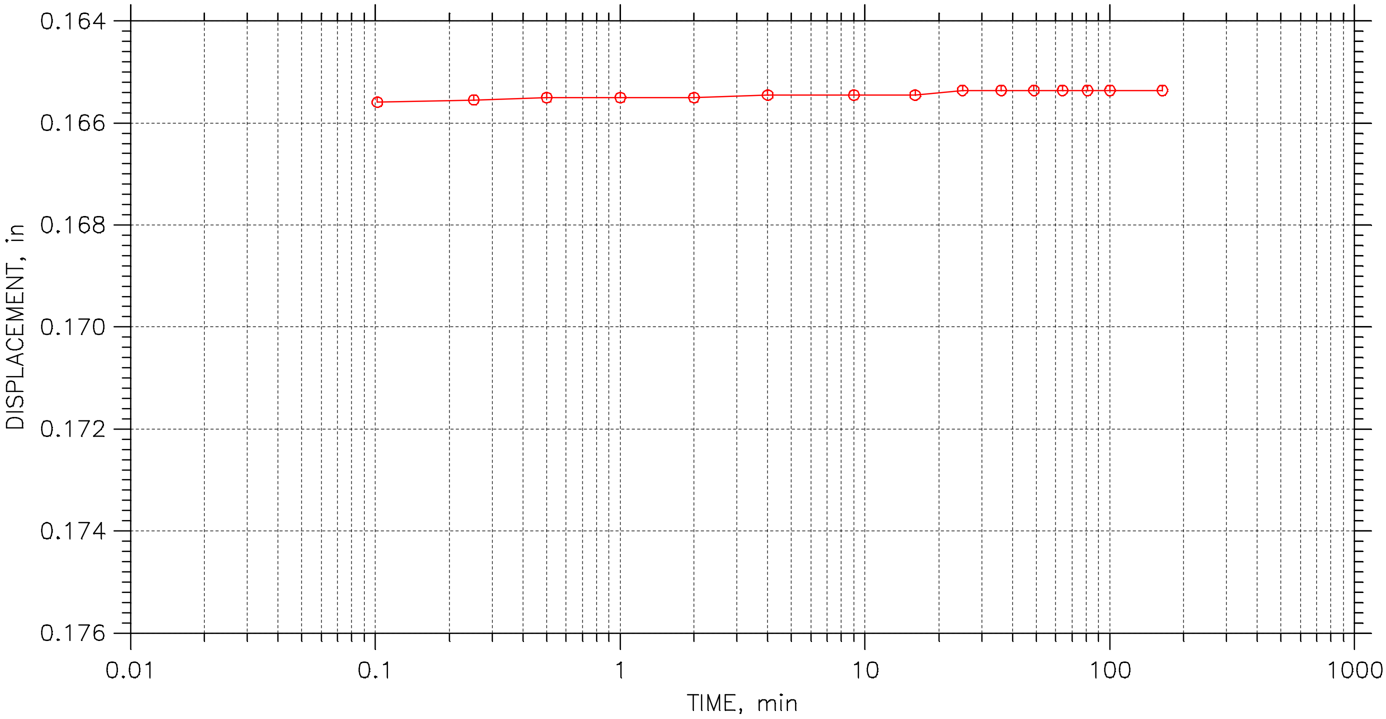
Tue, 26-APR-2016 10:12:07

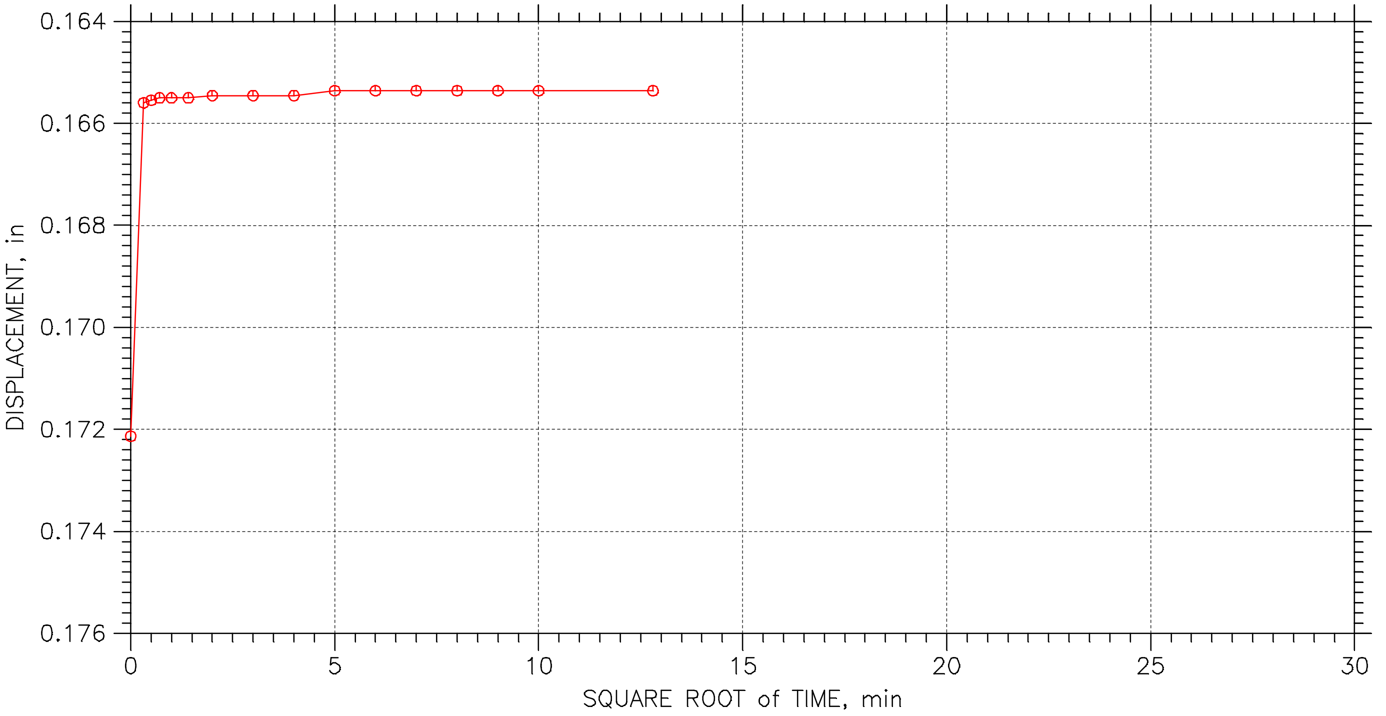
CONSOLIDATION TEST DATA

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		

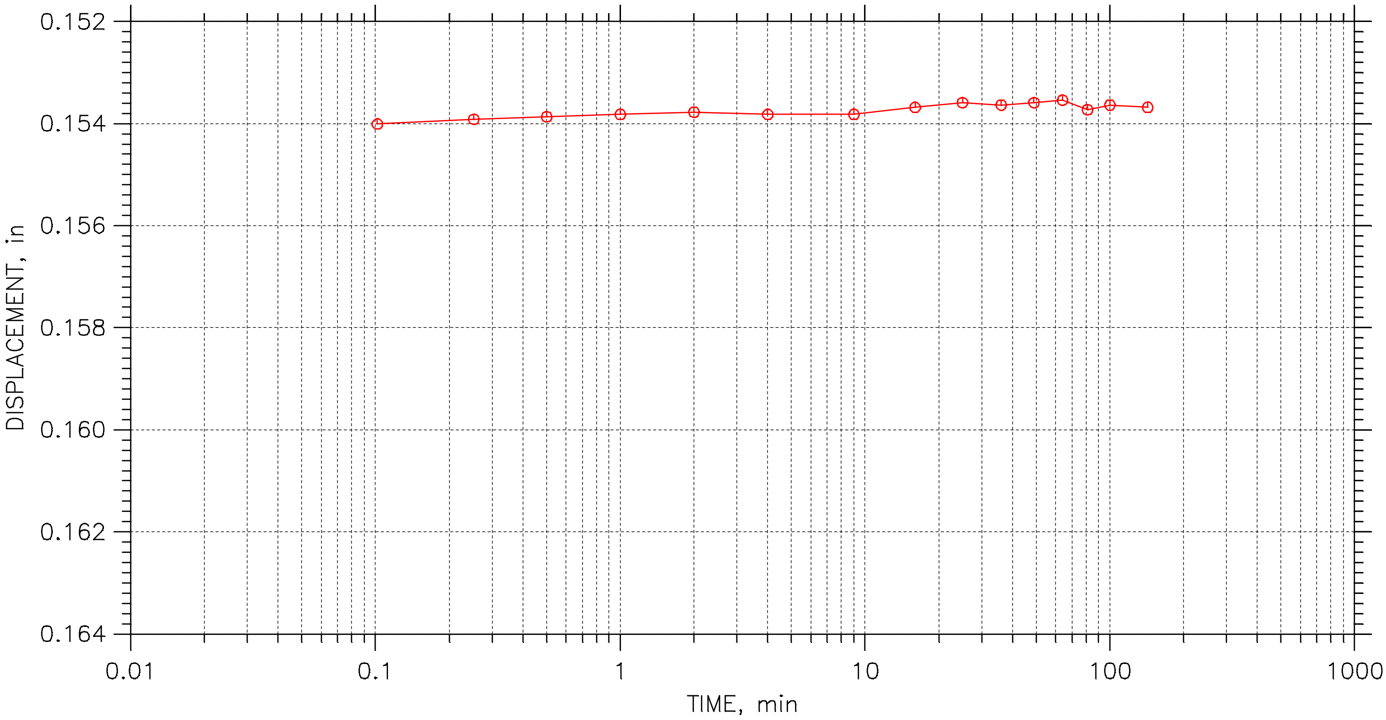
Tue, 26-APR-2016 10:12:08

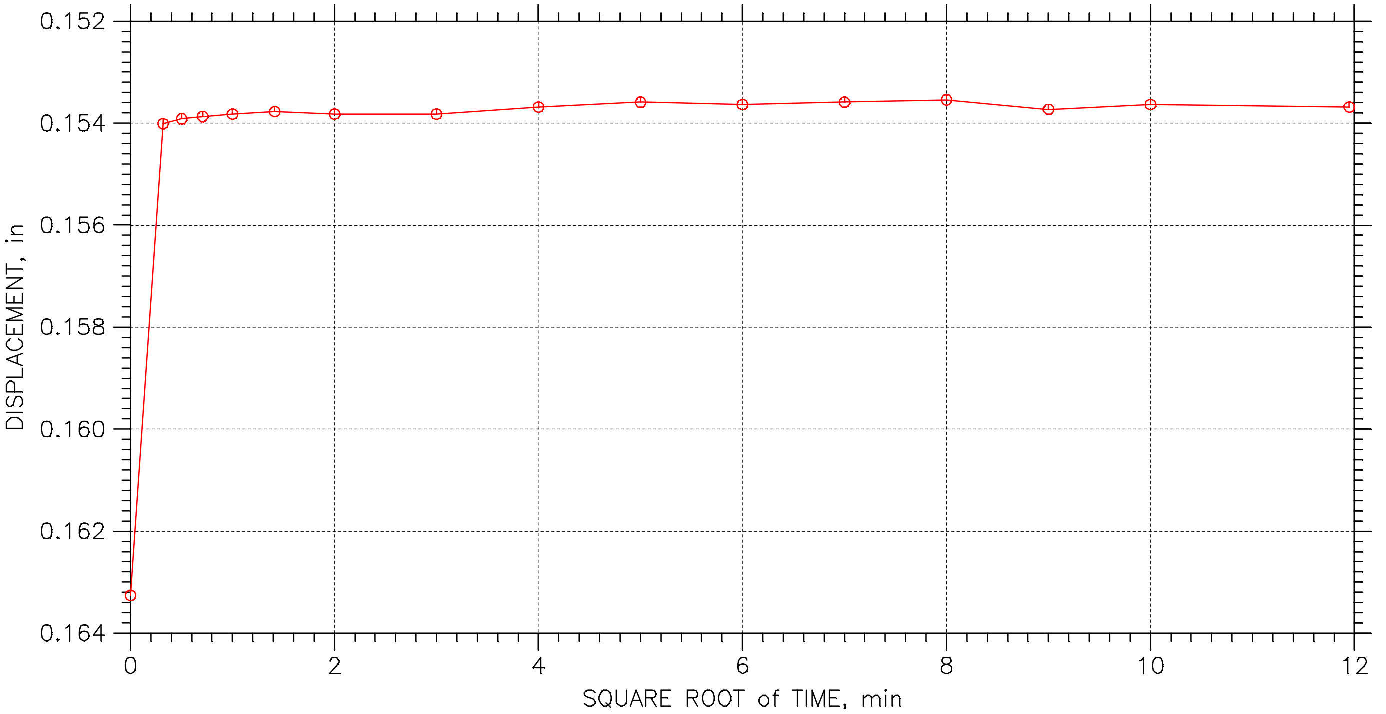
CONSOLIDATION TEST DATA

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		

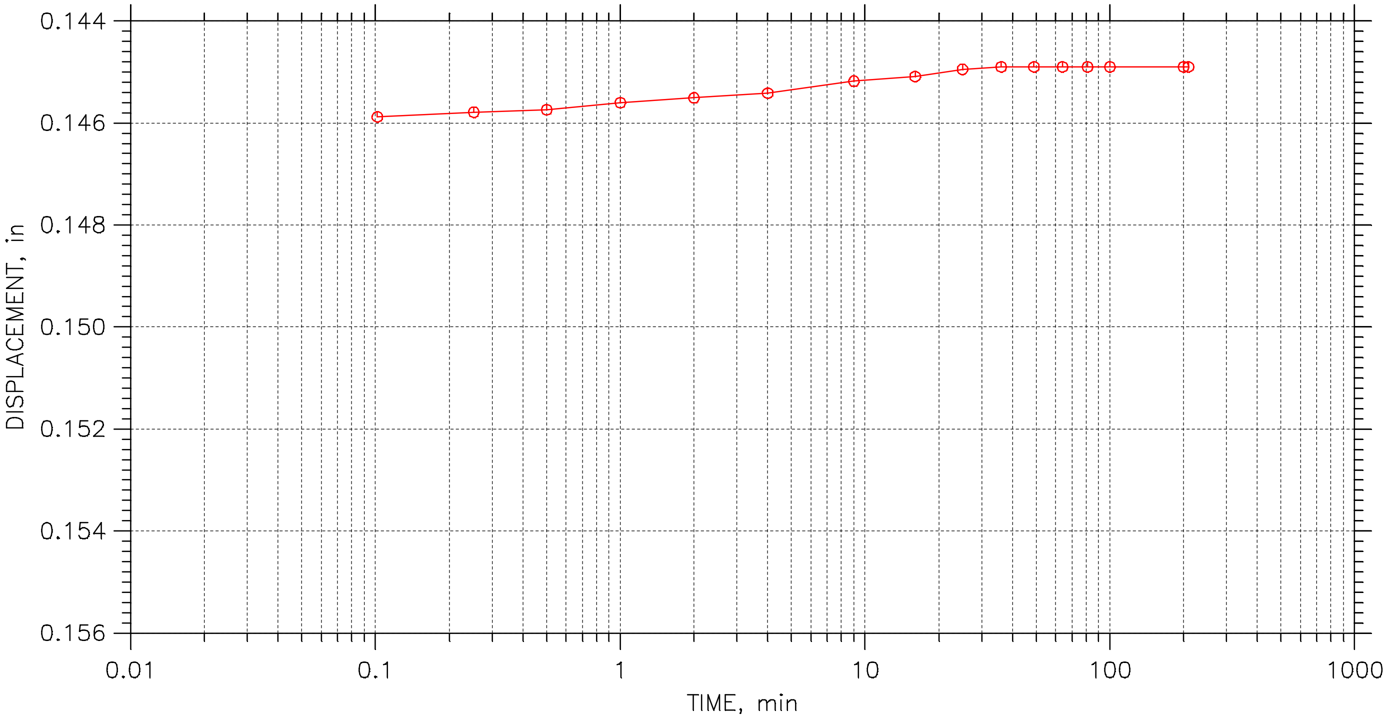
Tue, 26-APR-2016 10:12:10

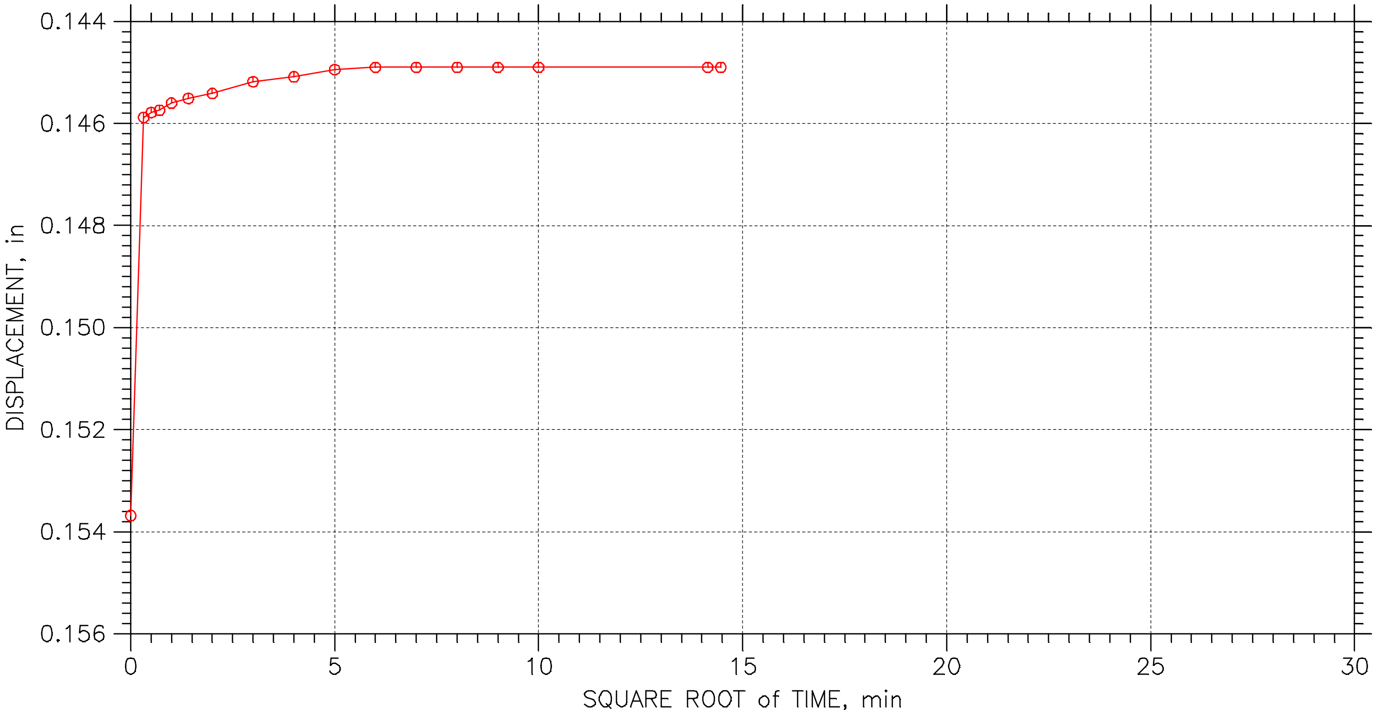
CONSOLIDATION TEST DATA

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		

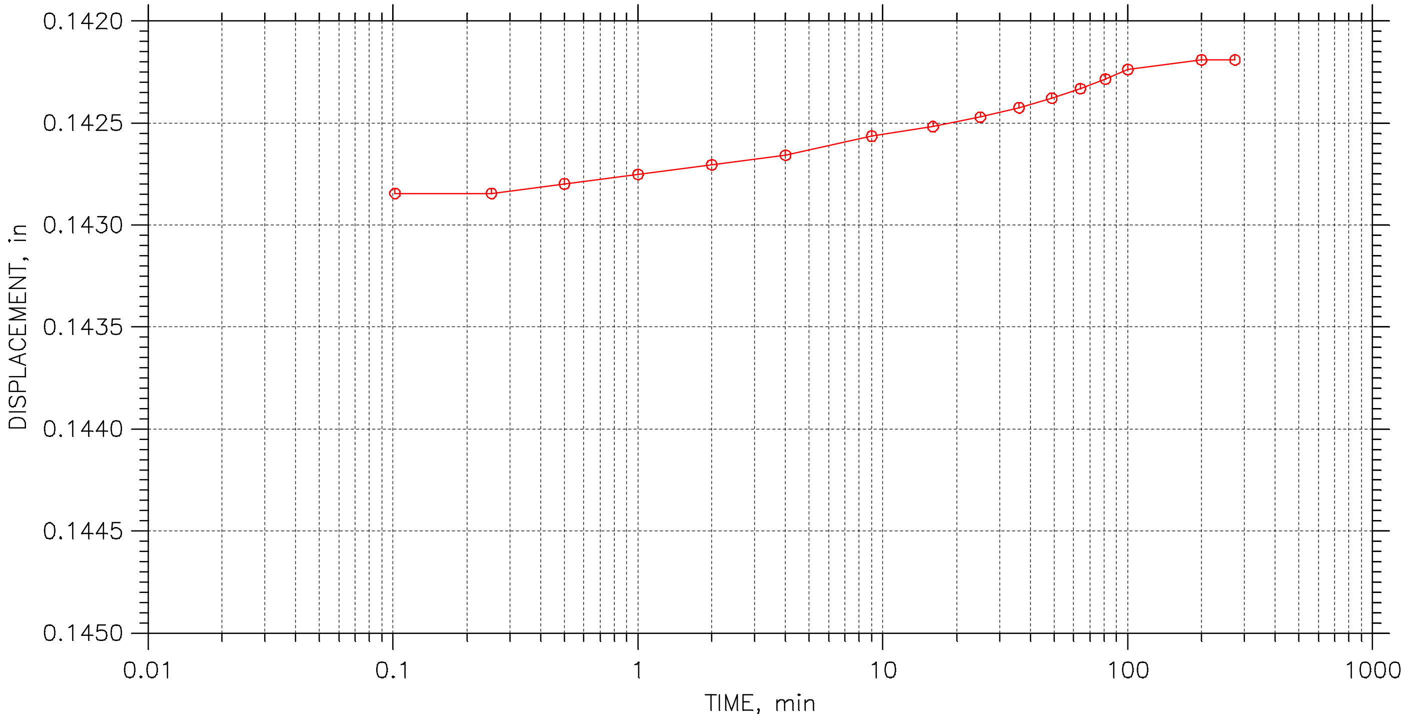
Tue, 26-APR-2016 10:12:11

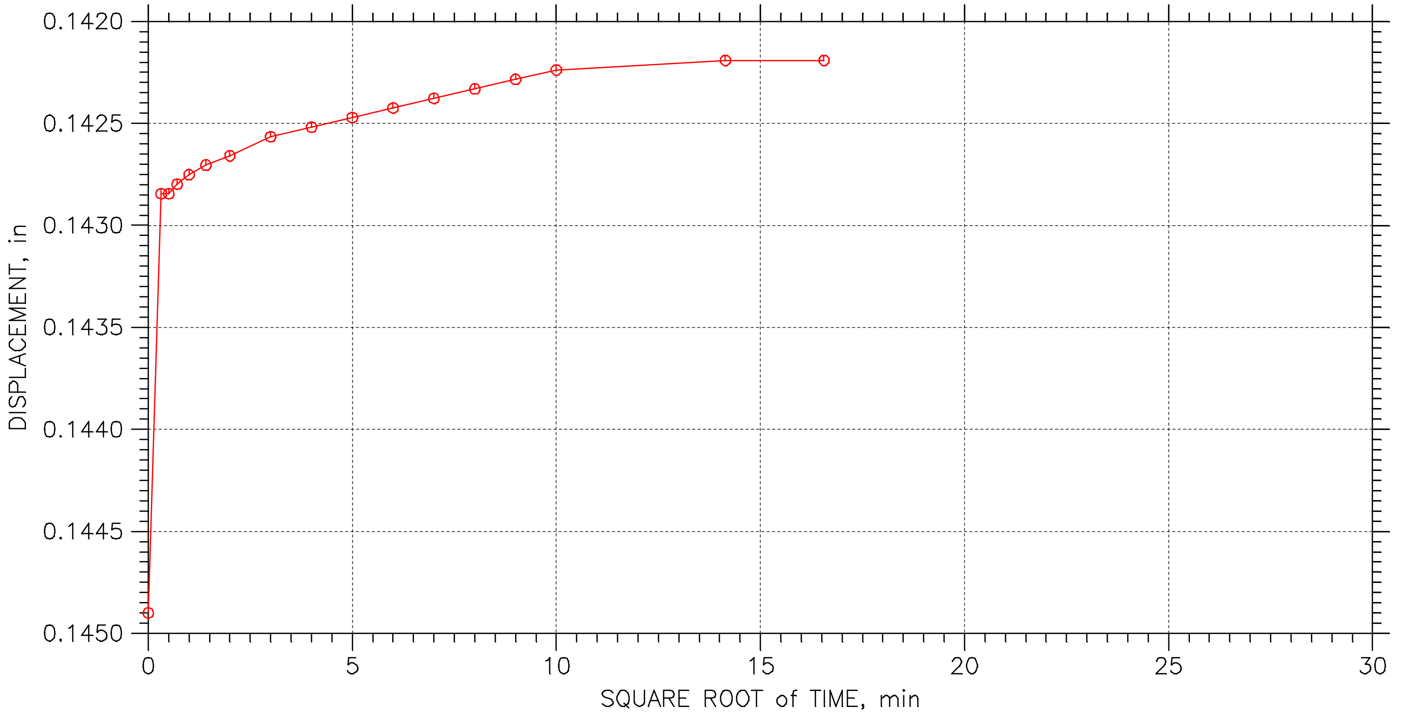
CONSOLIDATION TEST DATA

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		

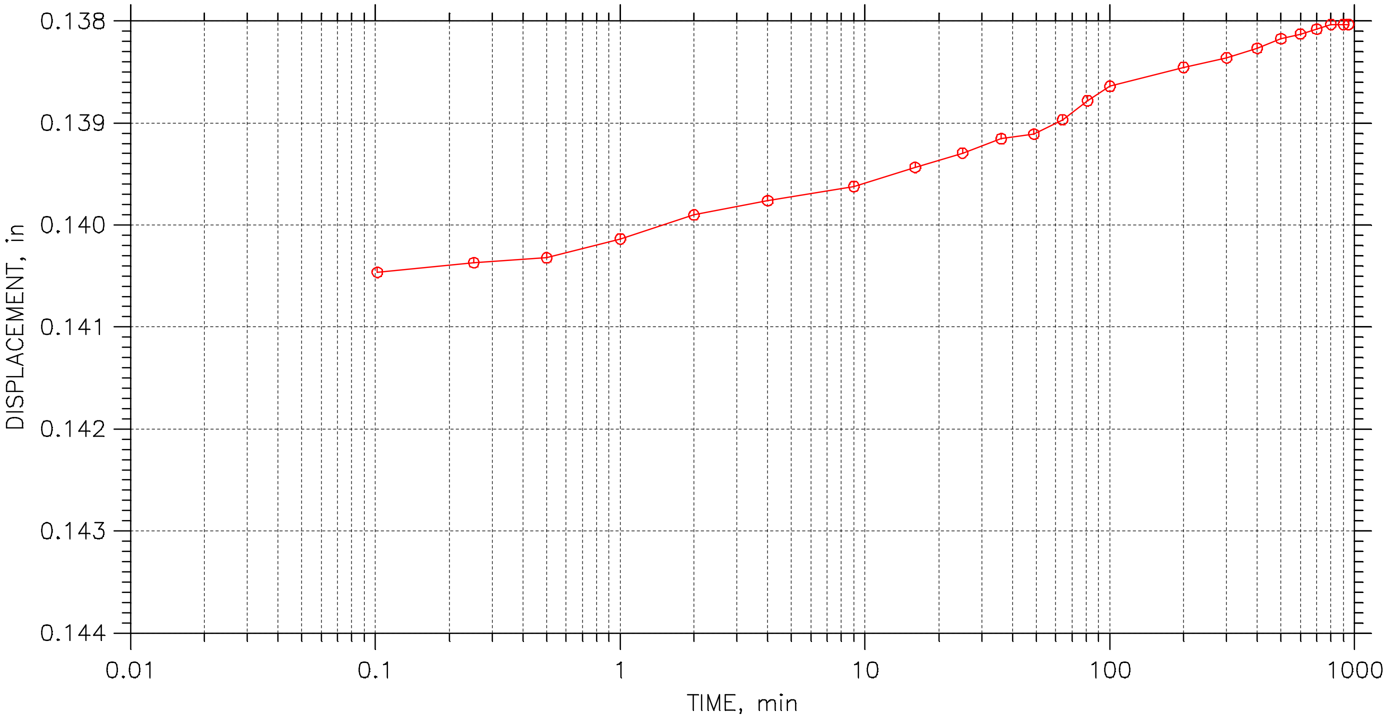
Tue, 26-APR-2016 10:12:13

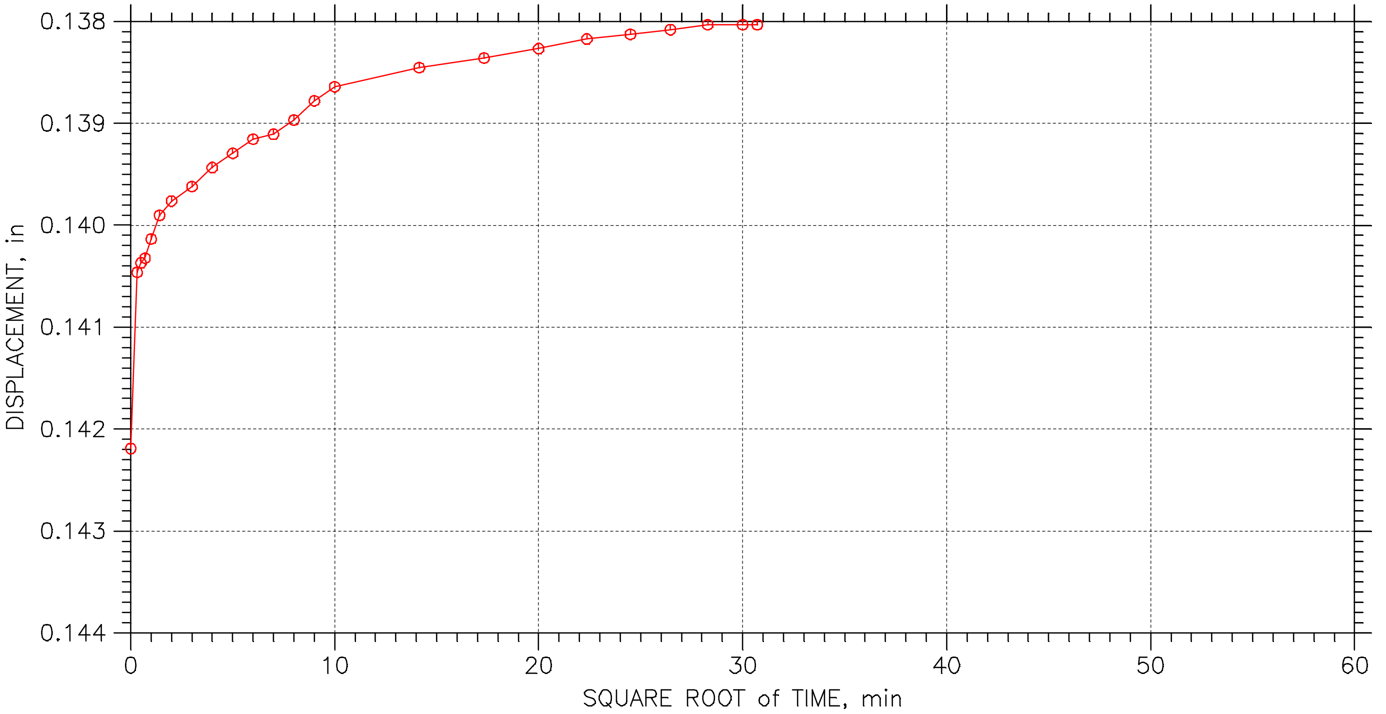
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 27 of 27

Stress: 0.125 tsf

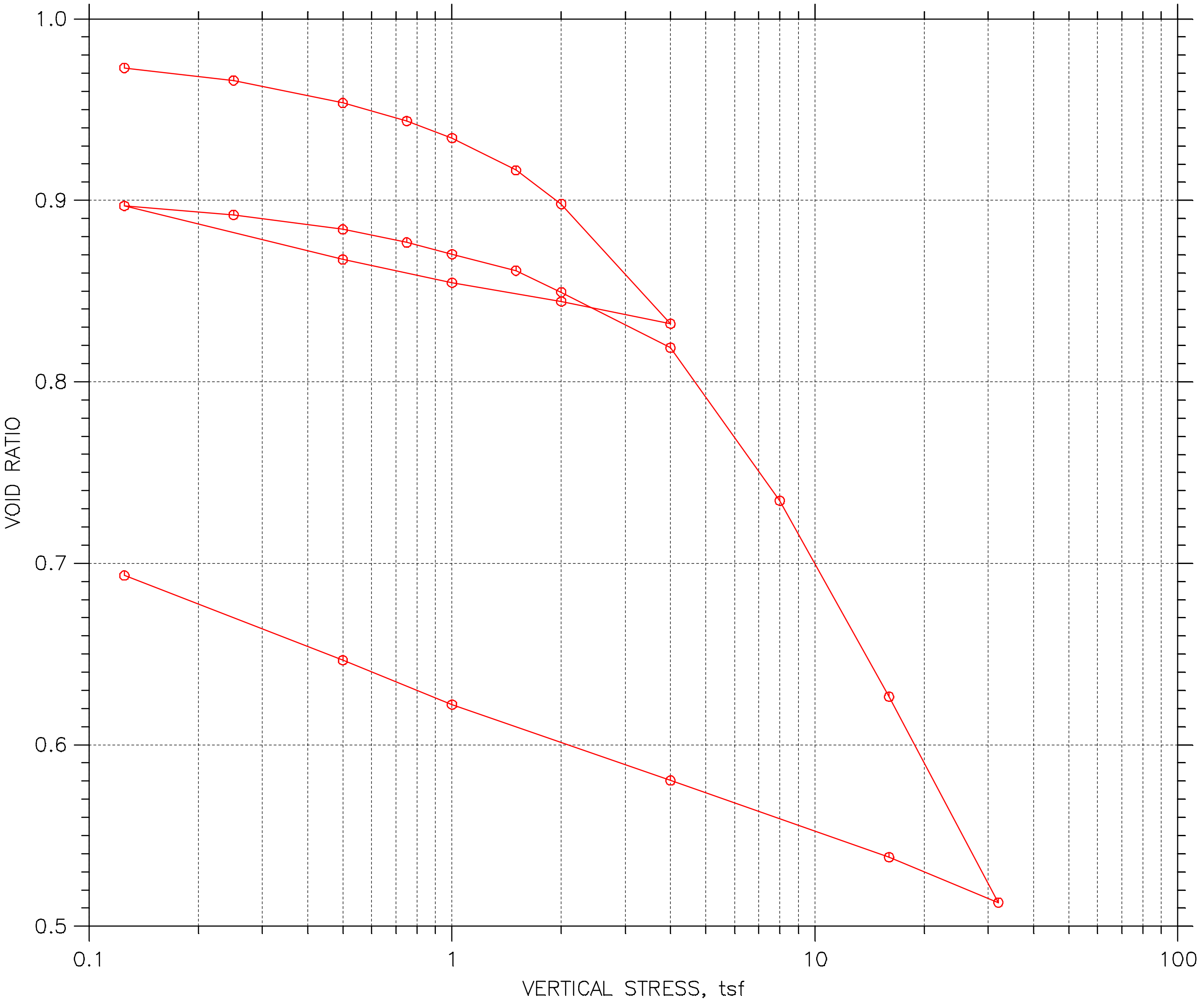




Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B-16-01	Tested By: HP	Checked By: BCM
	Sample No.: ST4	Test Date: 04/15/2106	Depth: 39.0'-41.0'
	Test No.: ST4CON	Sample Type: 3.0'' ST	Elevation: -----------
	Description: 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		

Tue, 26-APR-2016 10:12:14

ONE DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS
USING INCREMENTAL LOADING
ASTM D2435

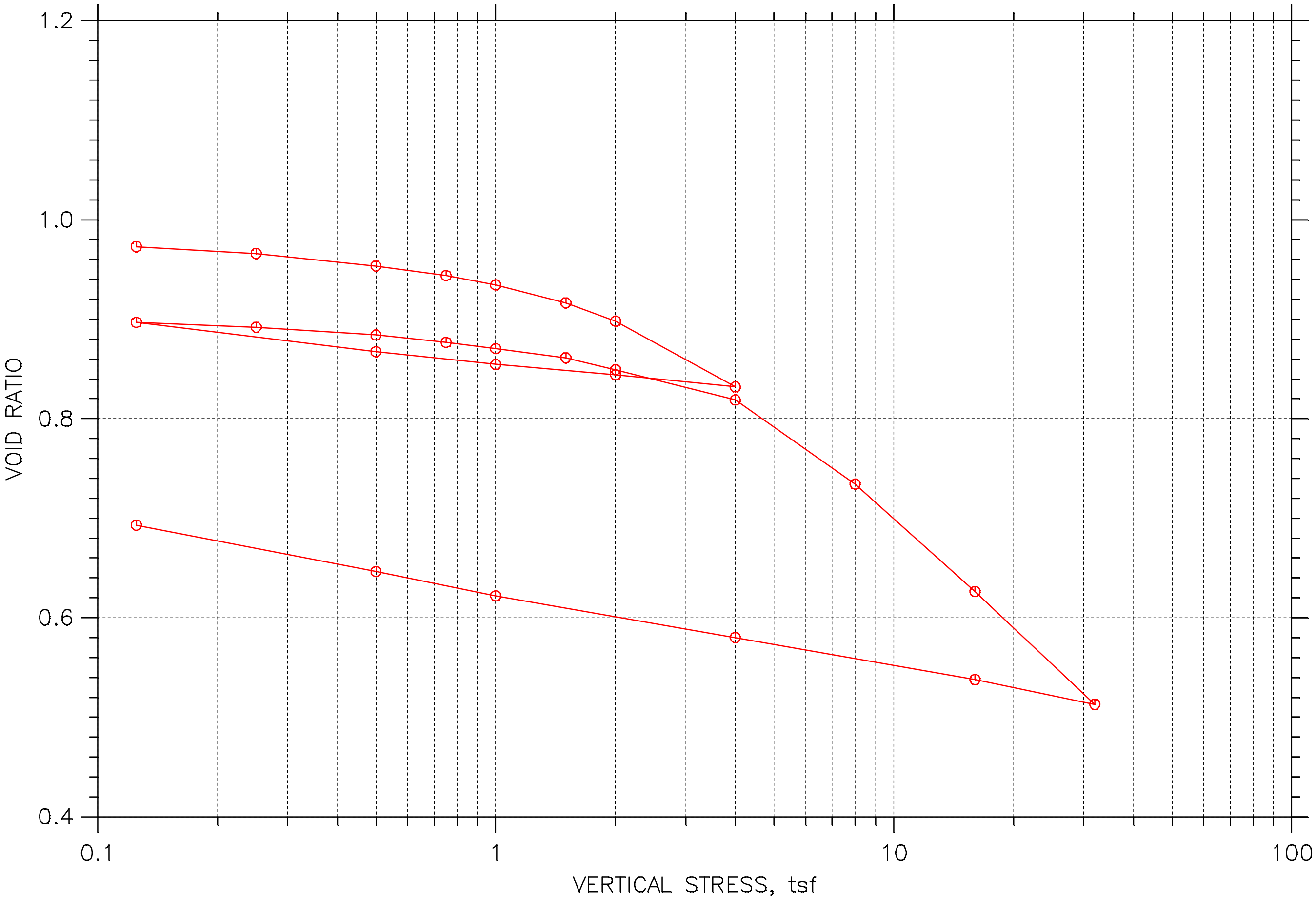


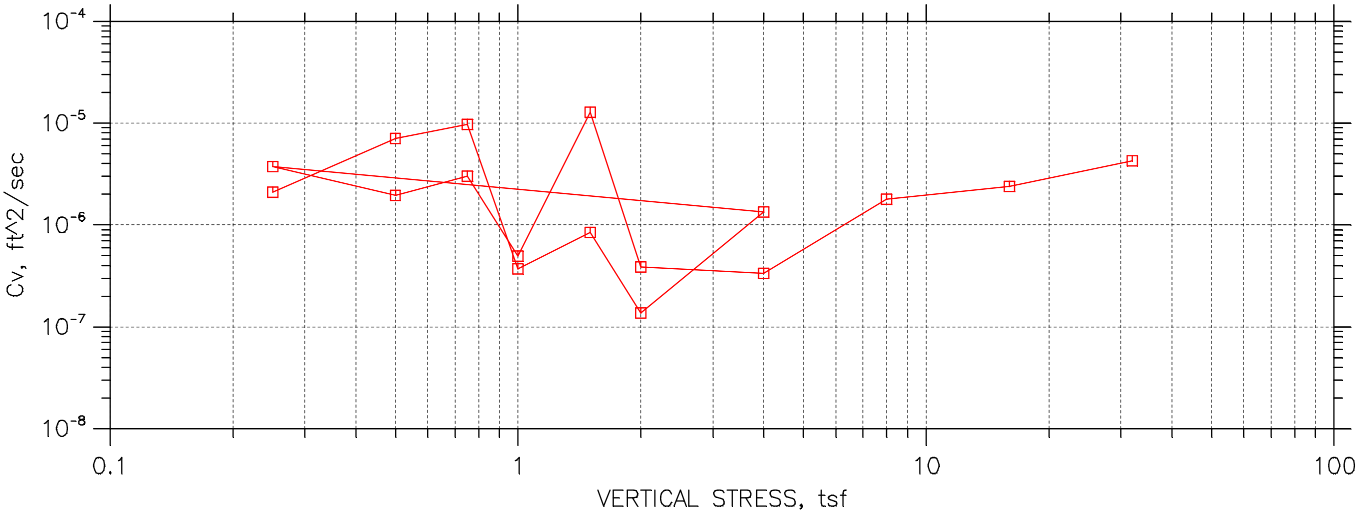
		Before Test	After Test
Overburden Pressure: 2.2 tsf	Water Content, %	33.45	25.14
Preconsolidation Pressure: 2.7 tsf	Dry Unit Weight, pcf	86.04	100.3
	Saturation, %	93.45	98.65
Diameter: 2.504 in Height: 0.7476 in	Void Ratio	0.97	0.69
LL: 35 PL: 20 PI: 15 GS: 2.72			

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





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		

Terracon
Consulting Engineers & Scientists

Tue, 26-APR-2016 10:19:13

CONSOLIDATION TEST DATA

Project: VECTREN CULLEY E POND
Boring No.: B16-1ST5
Sample No.: ST-5
Test No.: B161ST5CON

Location: NEWBURGH, IN
Tested By: BCM
Test Date: 04/14/16
Sample Type: 3.0" 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: Pc = 2.7 tsf Cc = 0.321 Ccr = 0.031 TEST PERFORMED AS PER ASTM D2435

Estimated Specific Gravity: 2.72
Initial Void Ratio: 0.97
Final Void Ratio: 0.69

Liquid Limit: 35
Plastic Limit: 20
Plasticity Index: 15

Initial Height: 0.75 in
Specimen Diameter: 2.50 in

	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

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

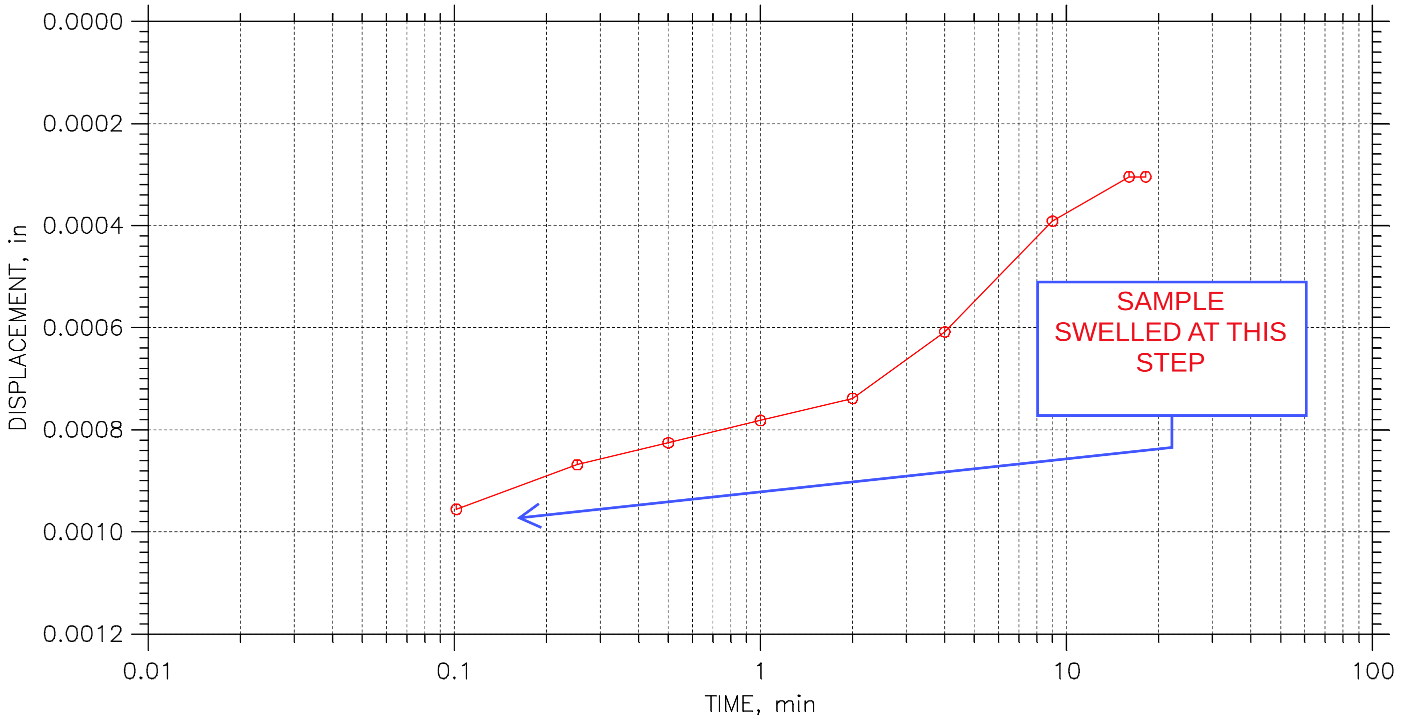
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	T50 Fitting		Coefficient of Consolidation		
					Sq.Rt. min	Log min	Sq.Rt. ft^2/sec	Log ft^2/sec	Ave. ft^2/sec
1	0.125	0.0002606	0.973	0.03	0.0	0.0	0.00e+000	0.00e+000	0.00e+000
2	0.25	0.002867	0.966	0.38	1.5	0.0	2.09e-006	0.00e+000	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

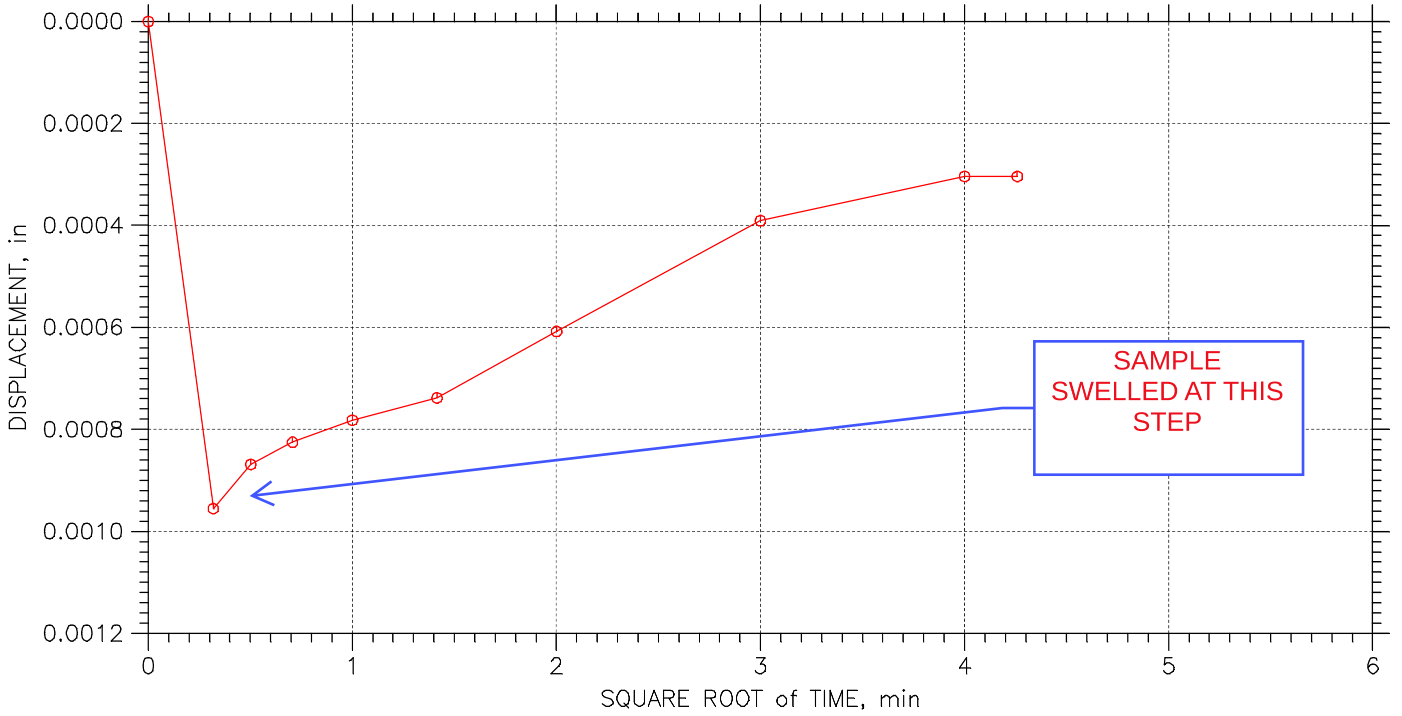
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 1 of 27

Stress: 0.125 tsf





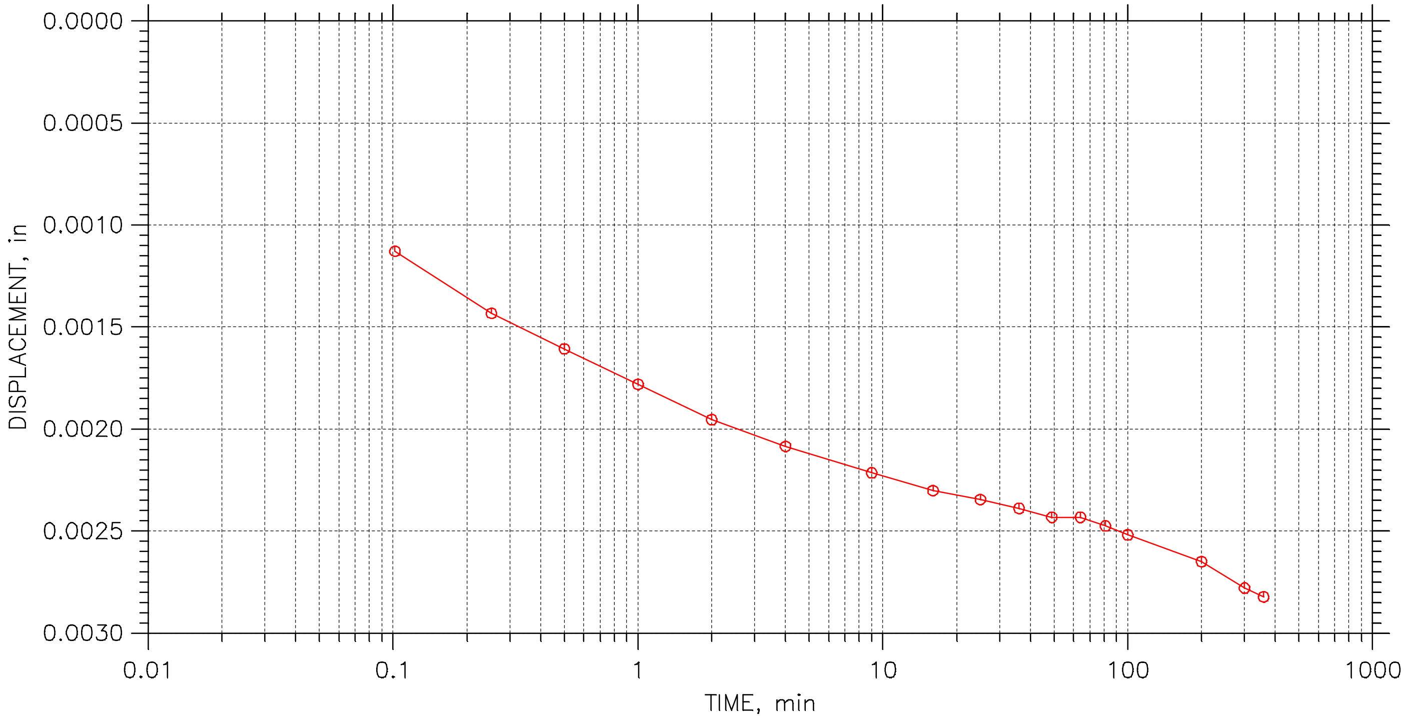
	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
Terracon Consulting Engineers & Scientists	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: 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		

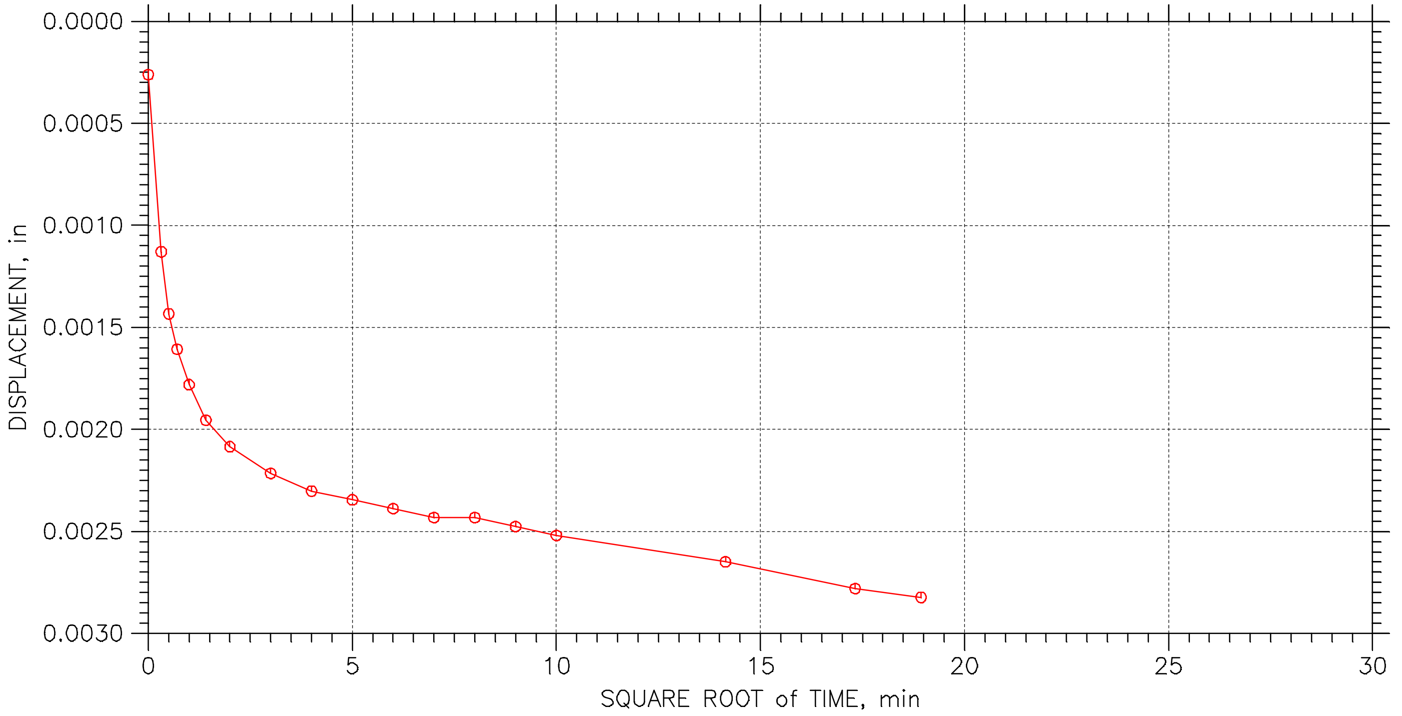
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 2 of 27

Stress: 0.25 tsf





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		

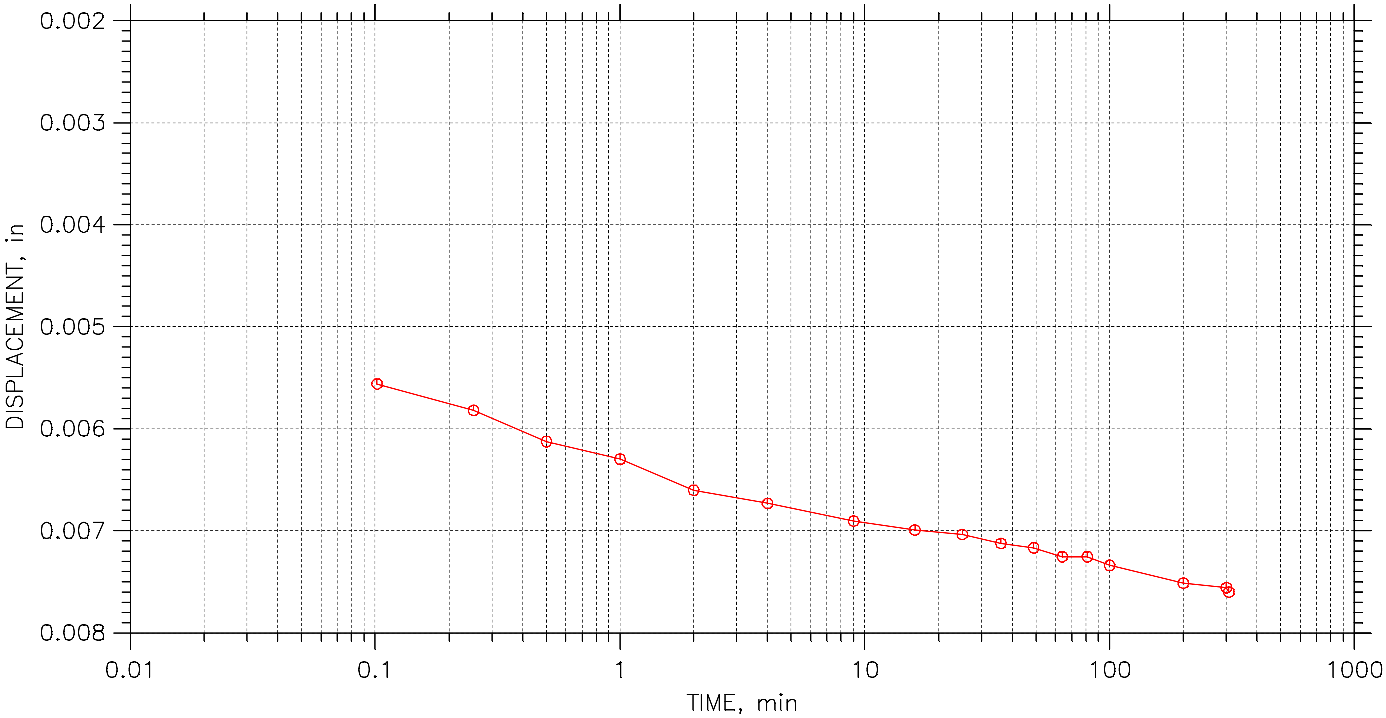
Tue, 26-APR-2016 10:52:01

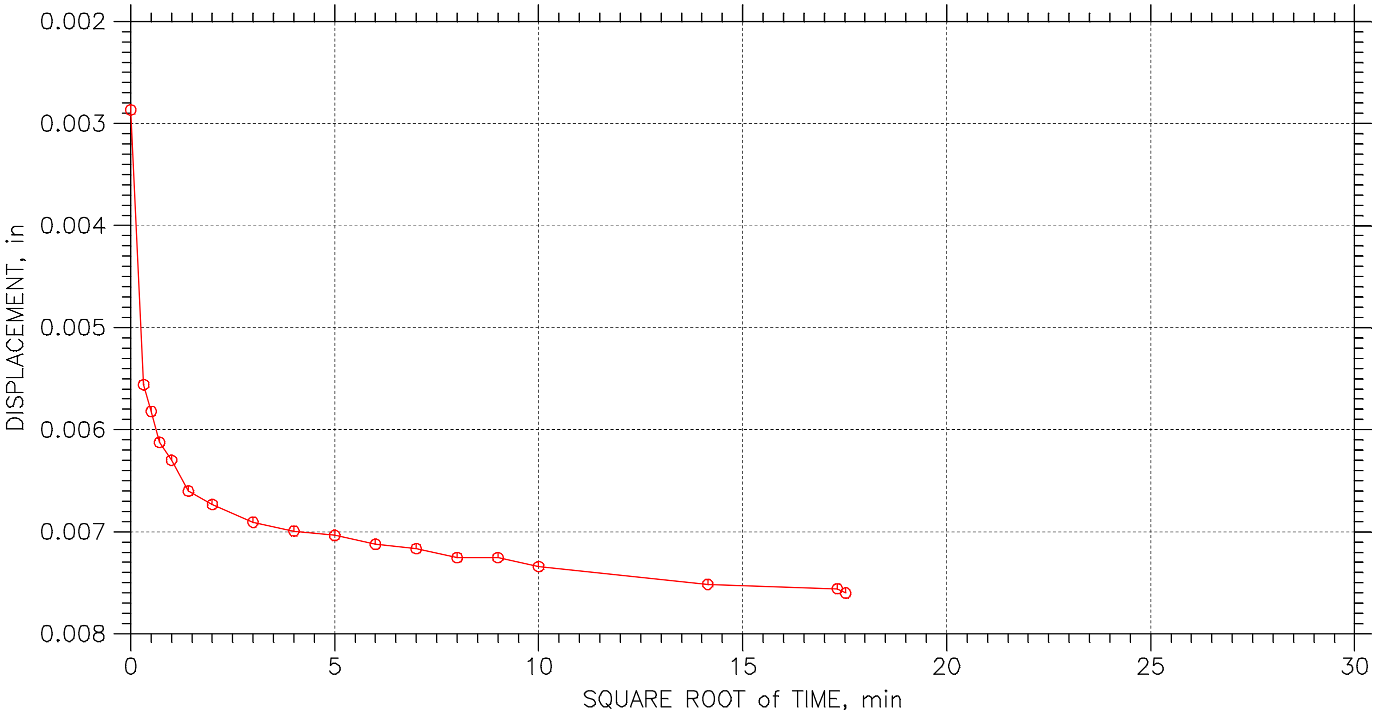
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 3 of 27

Stress: 0.5 tsf





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		

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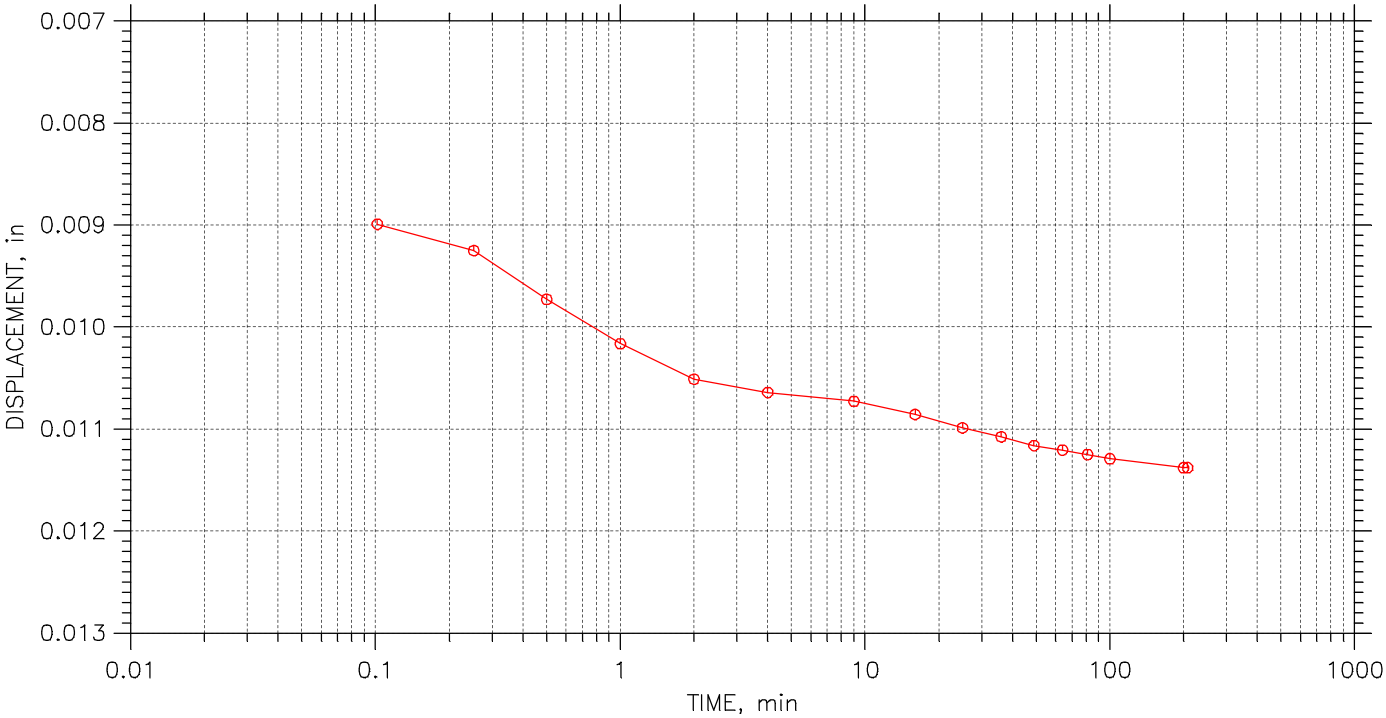
Tue, 26-APR-2016 10:52:02

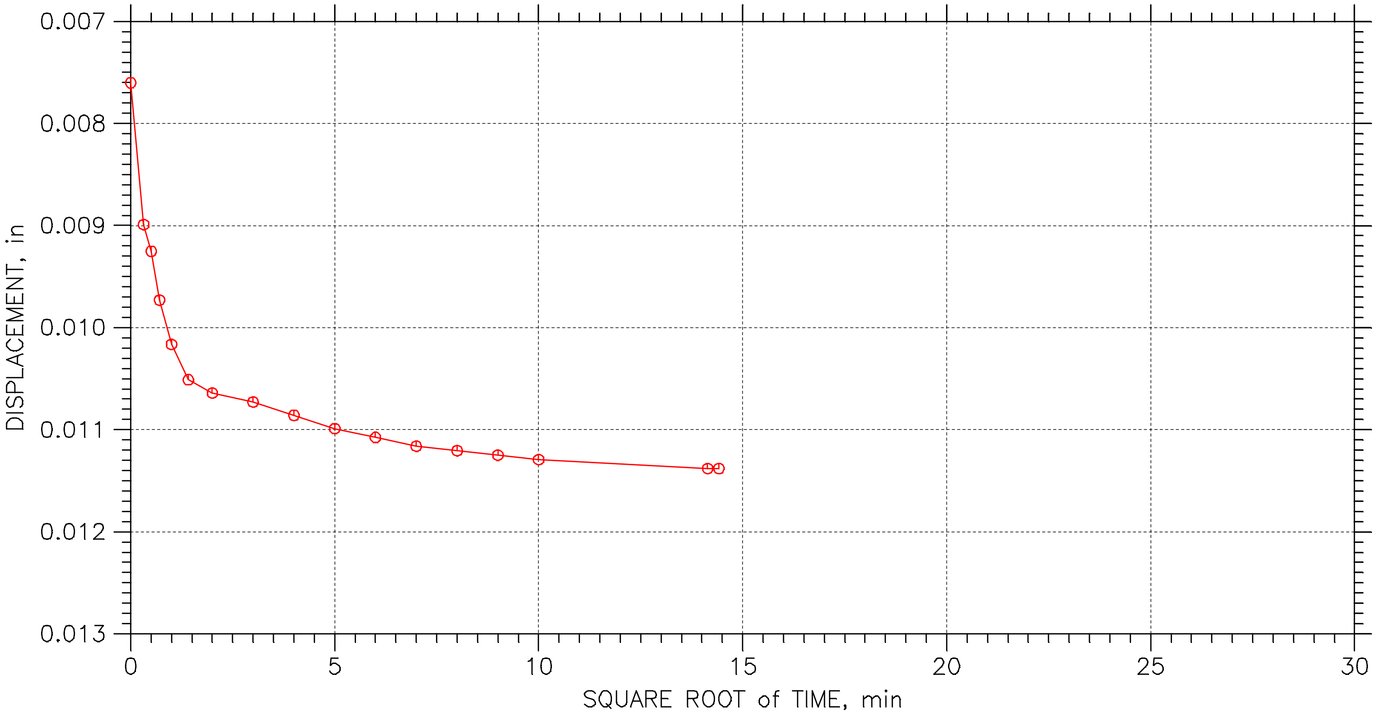
CONSOLIDATION TEST DATA

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		

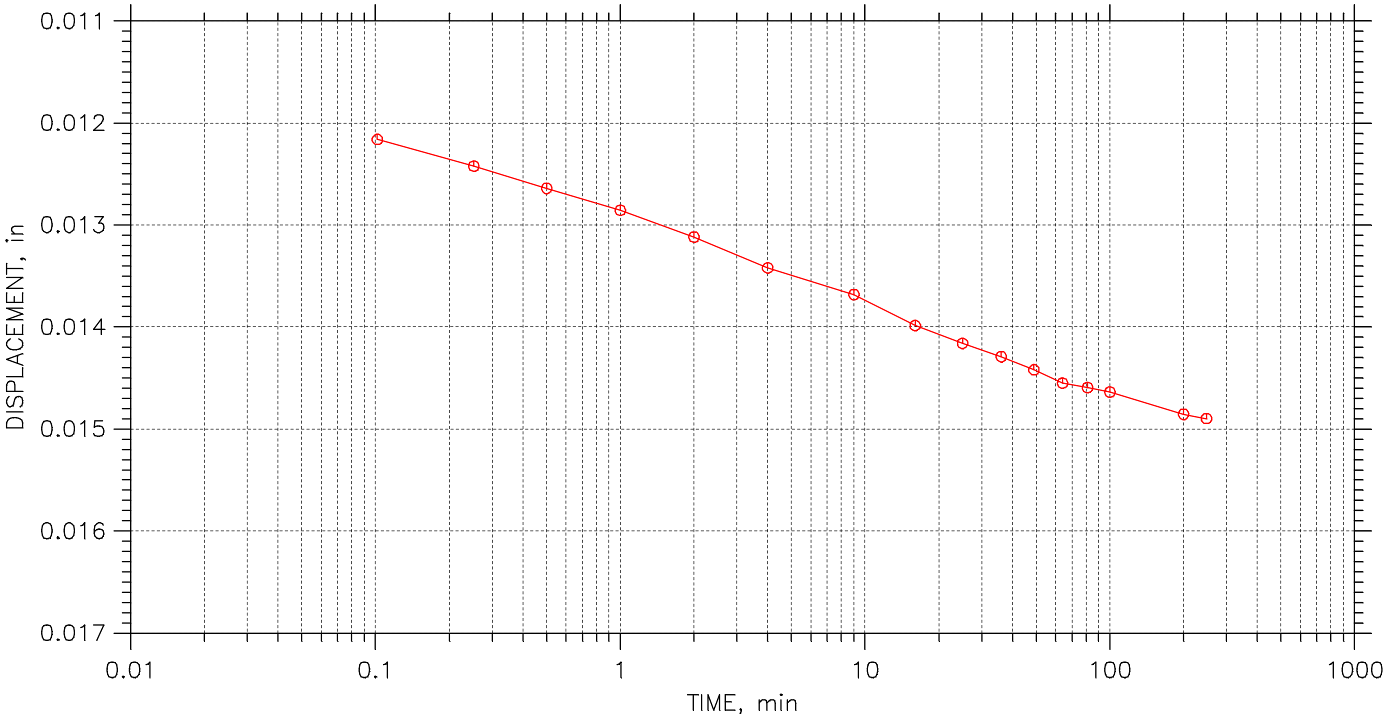
Tue, 26-APR-2016 10:52:04

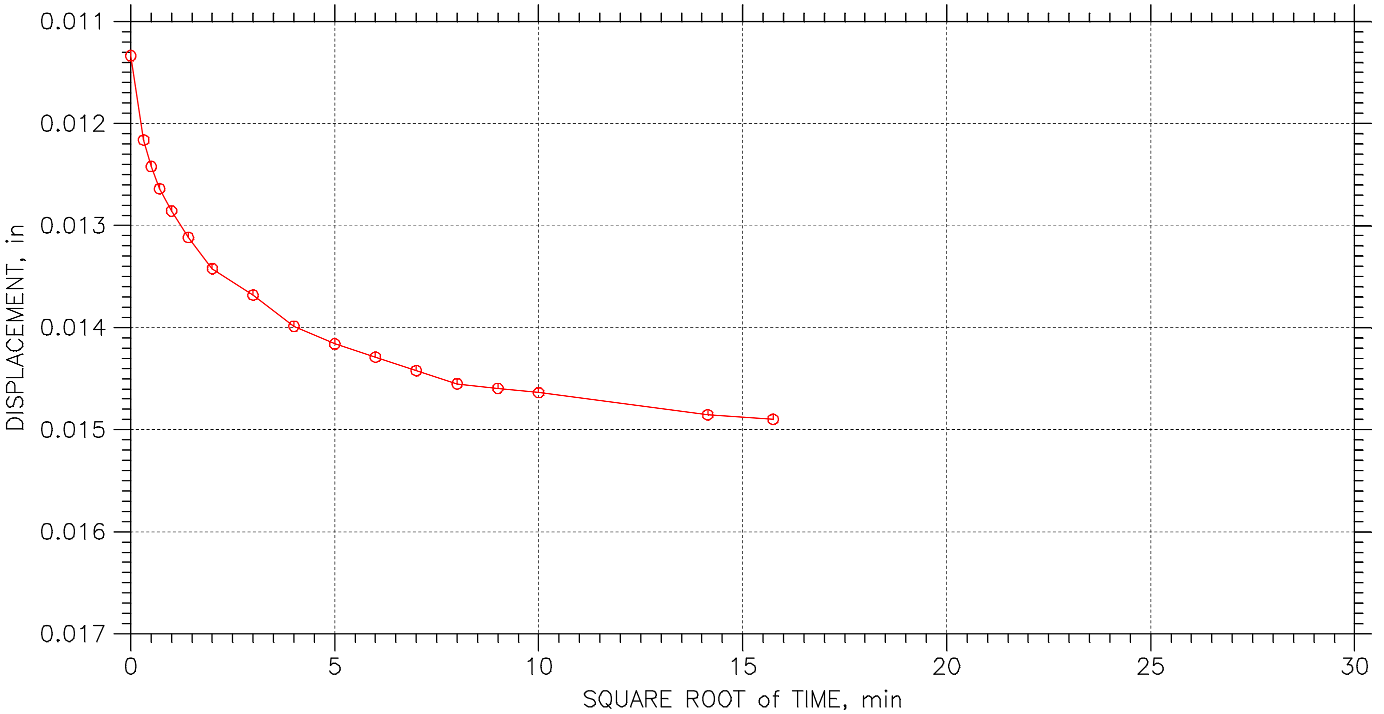
CONSOLIDATION TEST DATA

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		

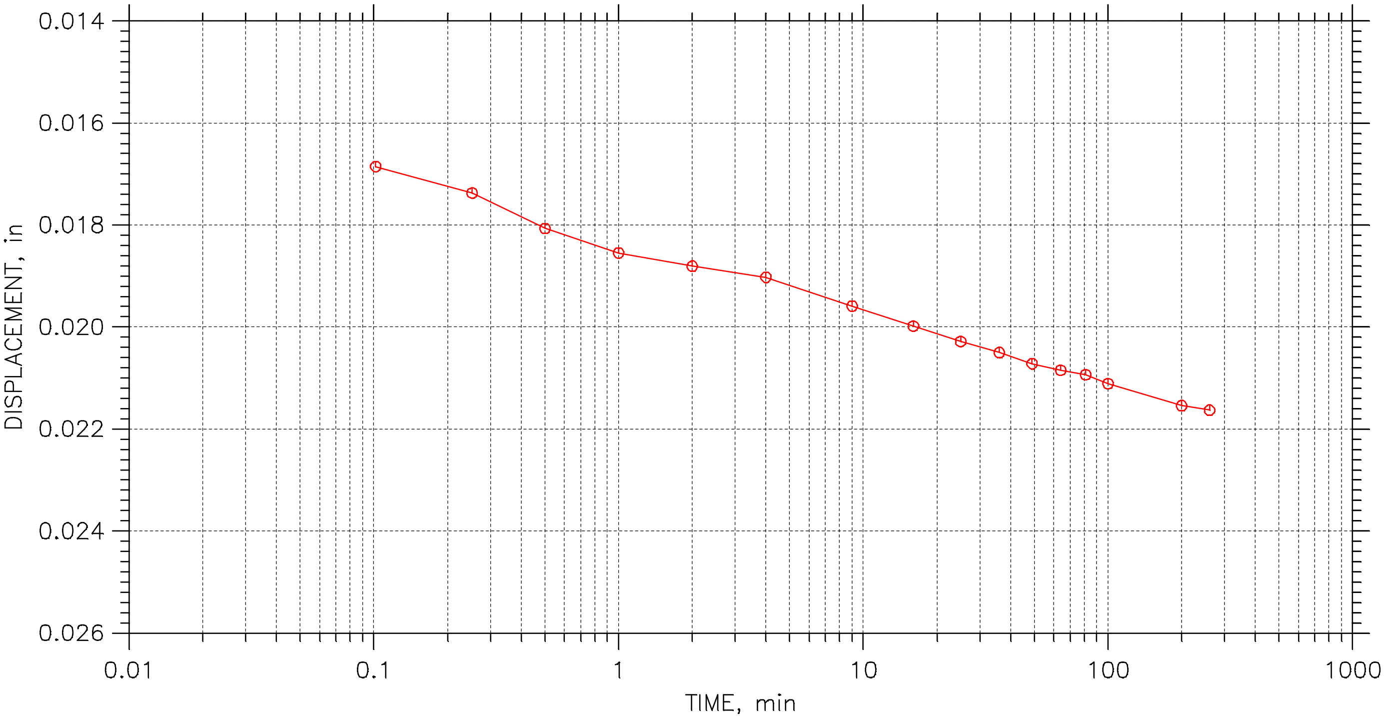
Tue, 26-APR-2016 10:52:05

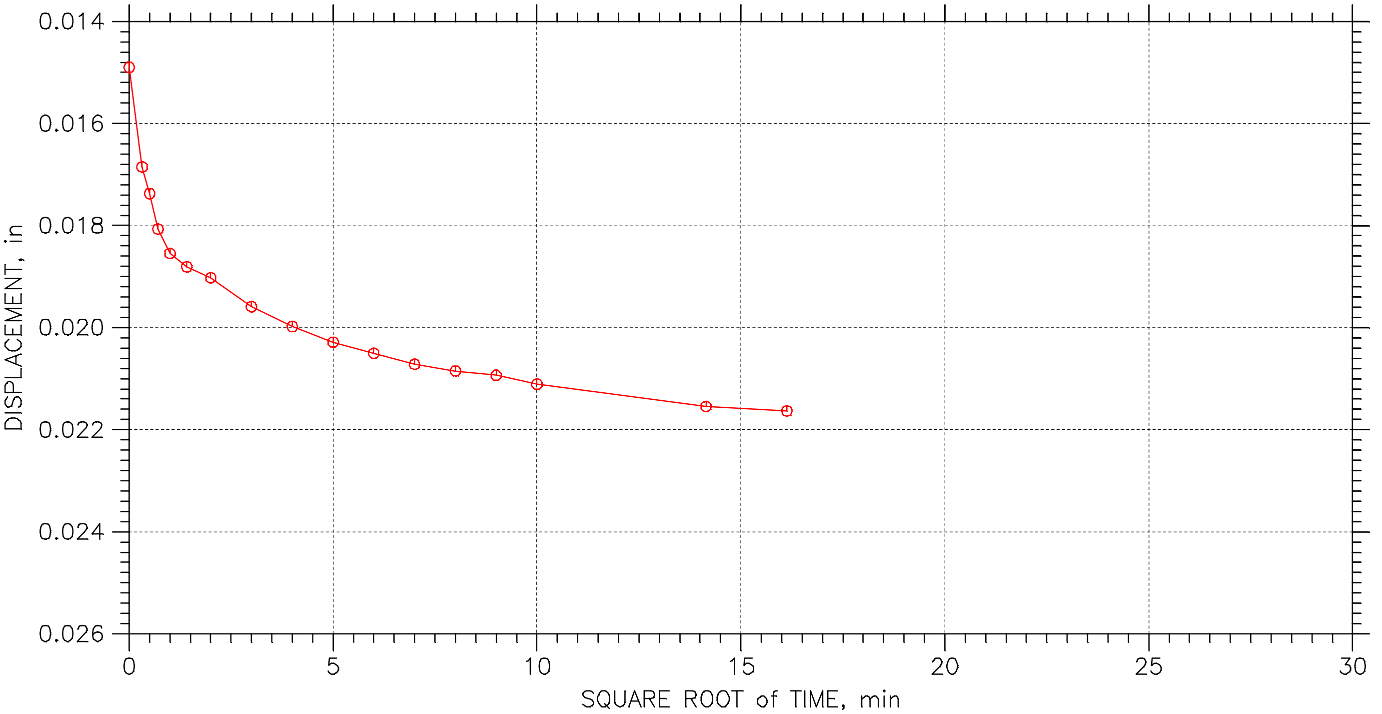
CONSOLIDATION TEST DATA

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		

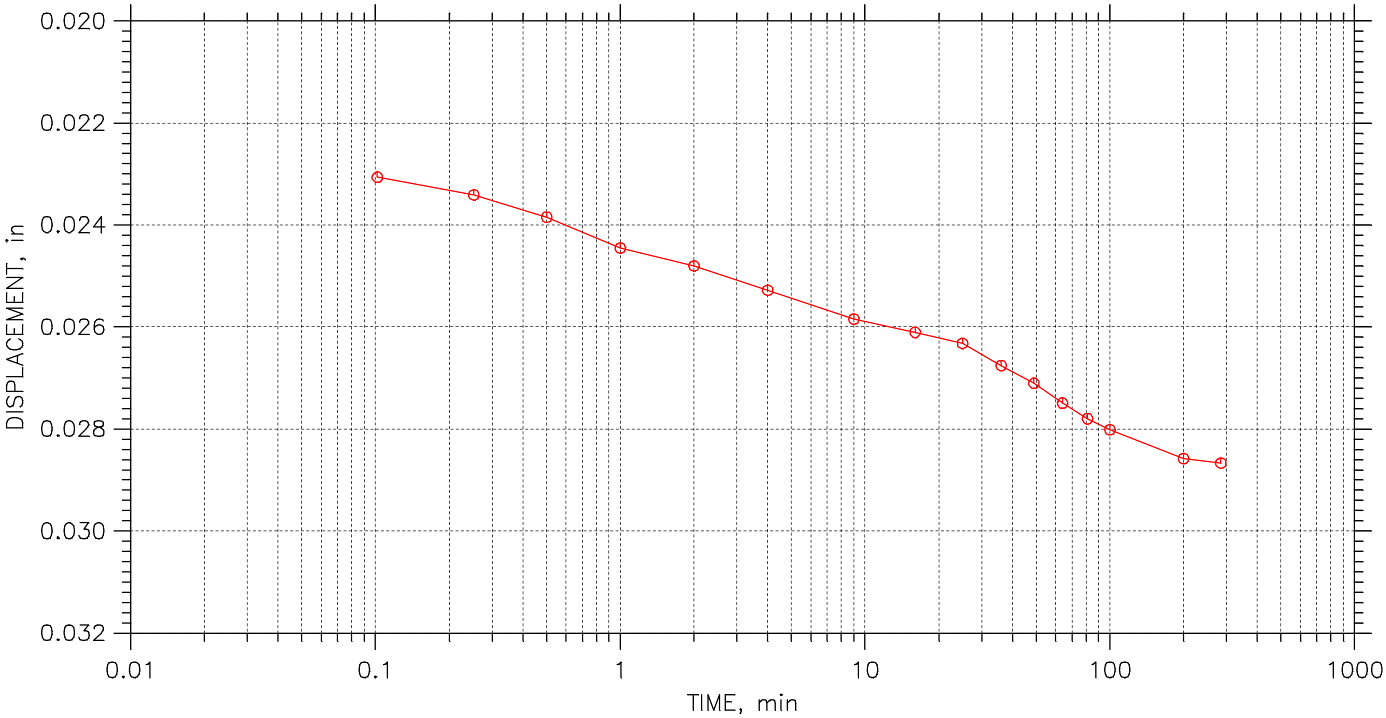
Tue, 26-APR-2016 10:52:07

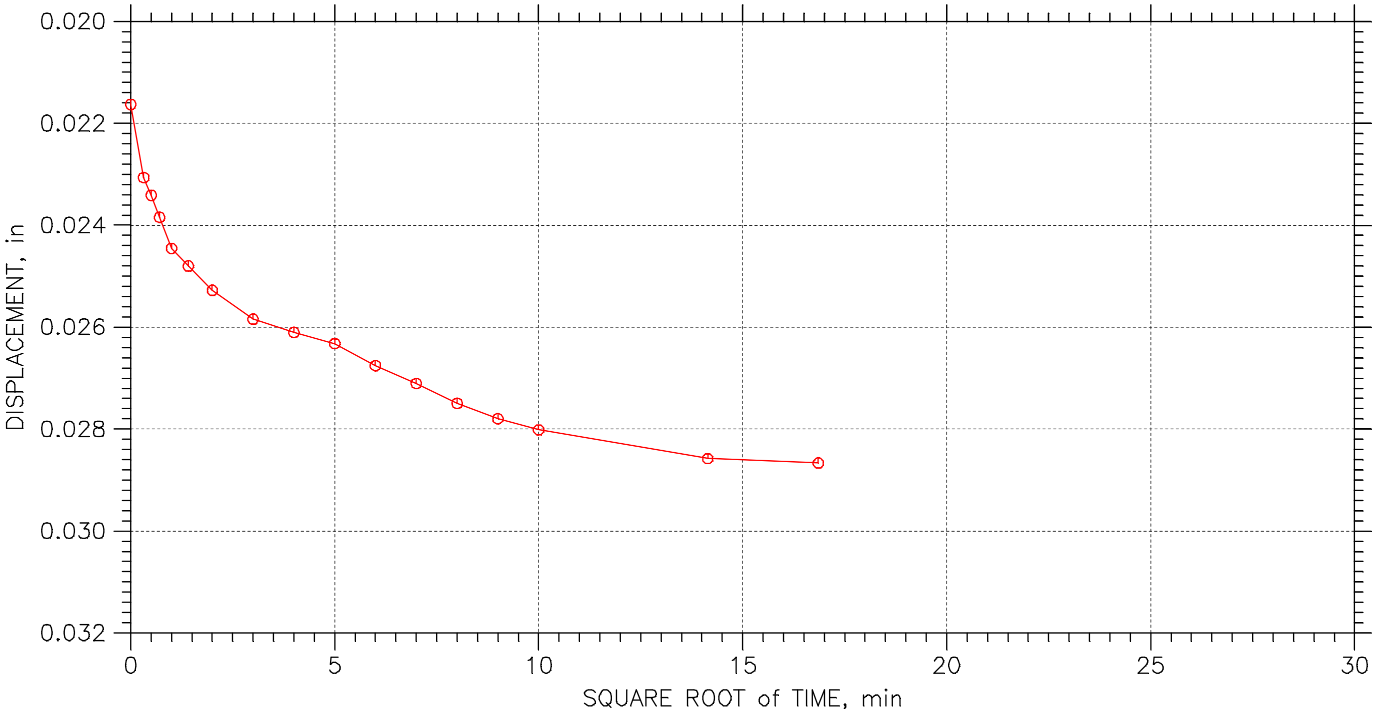
CONSOLIDATION TEST DATA

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		

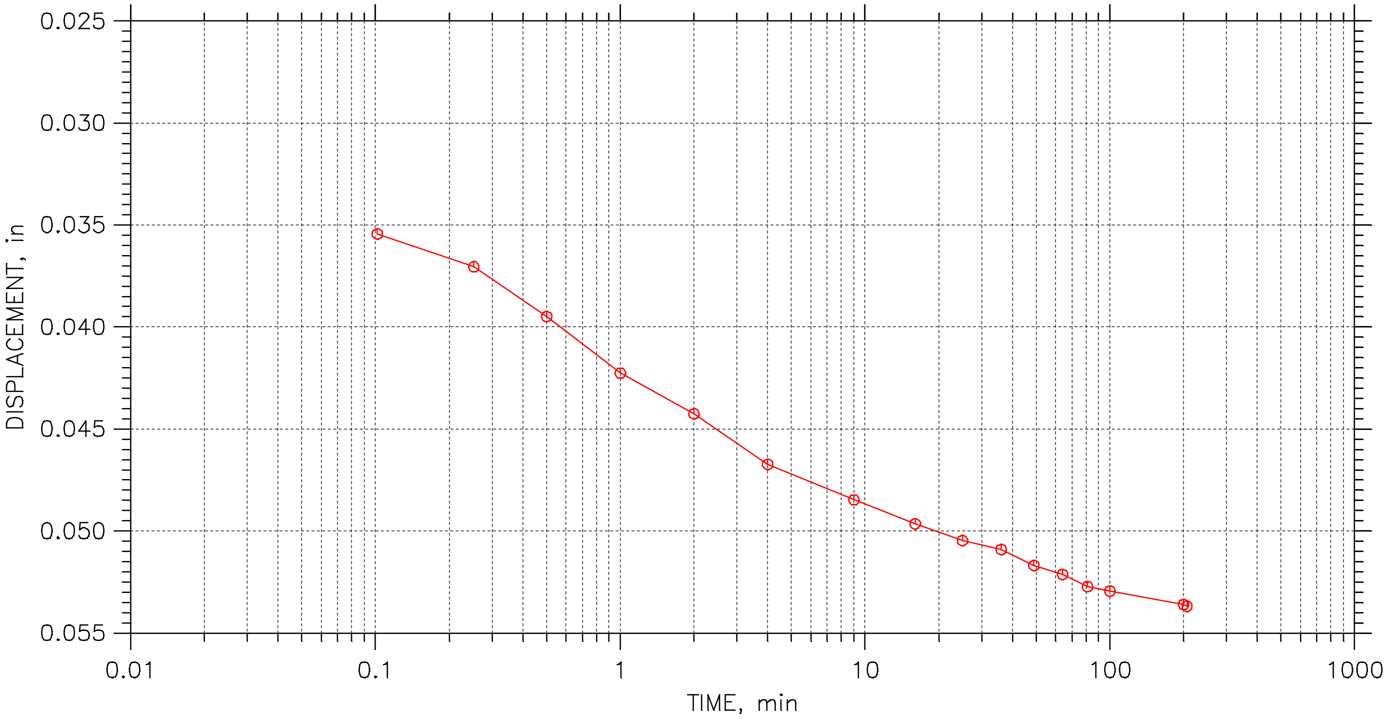
Tue, 26-APR-2016 10:52:08

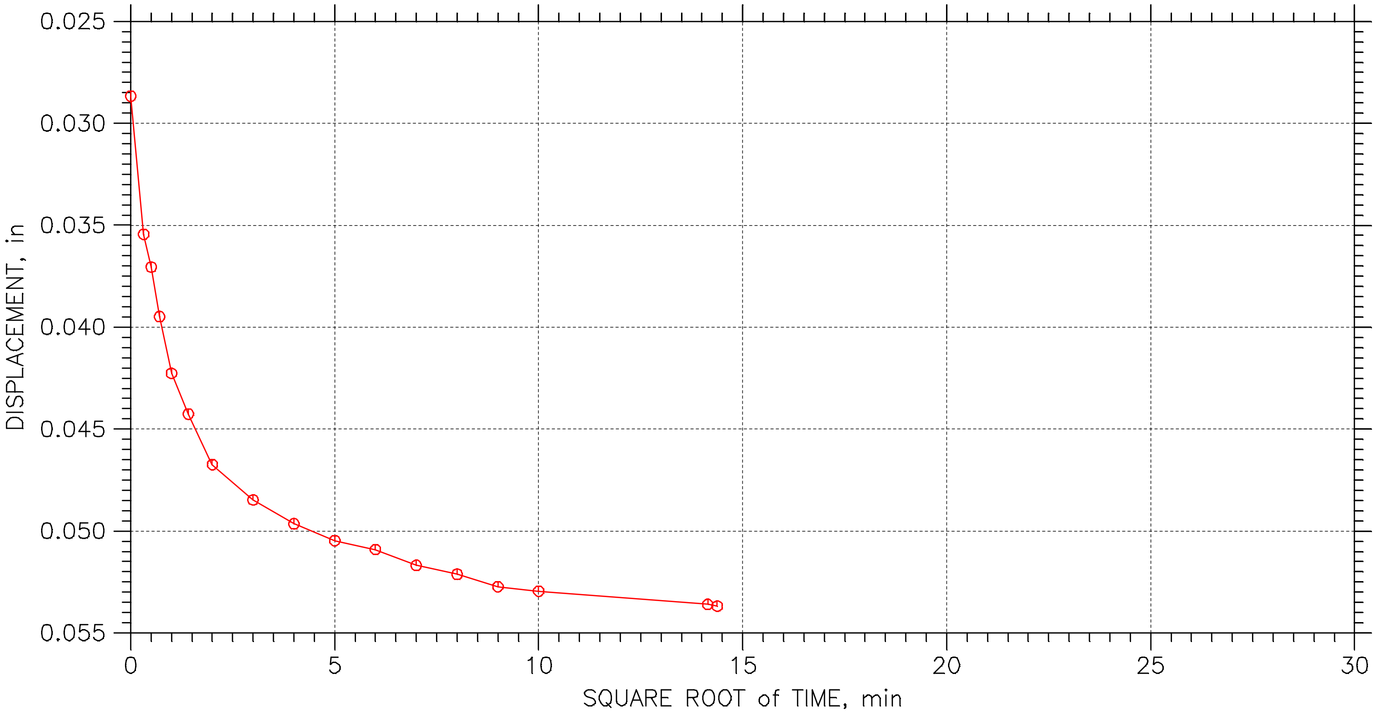
CONSOLIDATION TEST DATA

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		

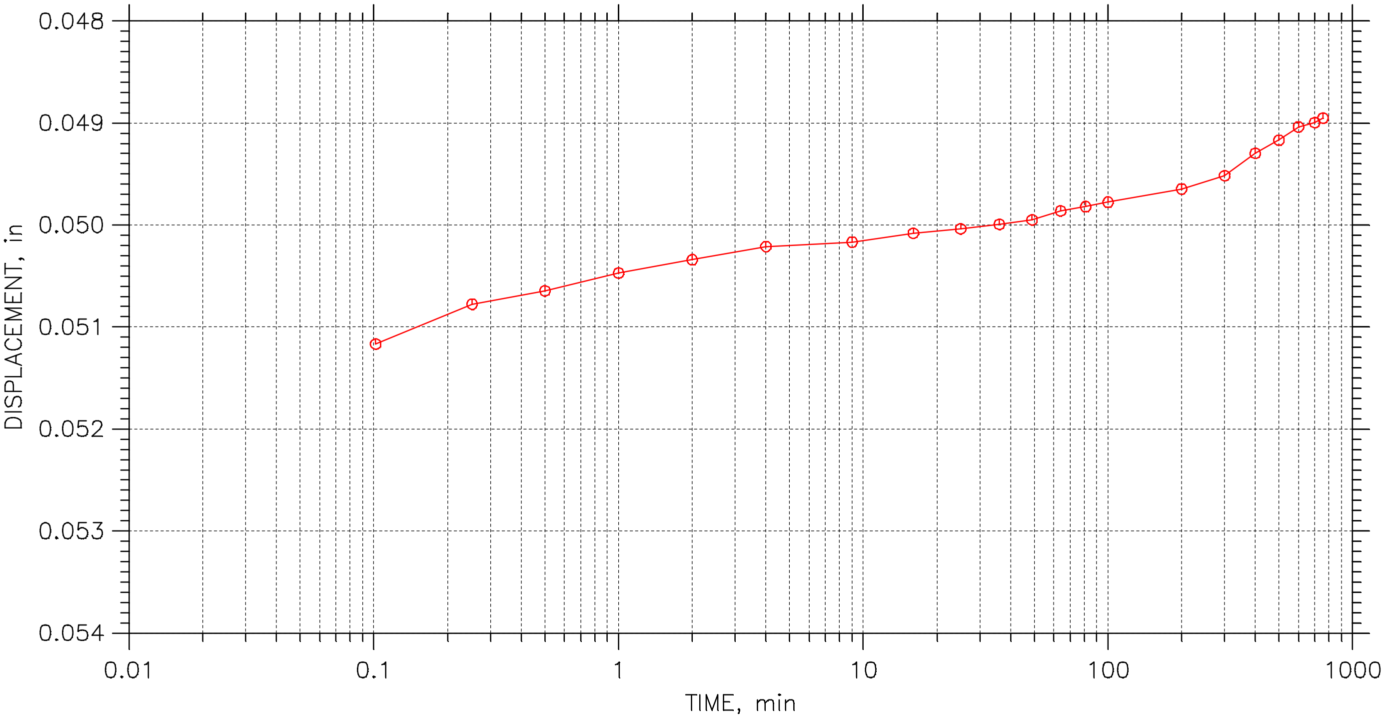
Tue, 26-APR-2016 10:52:09

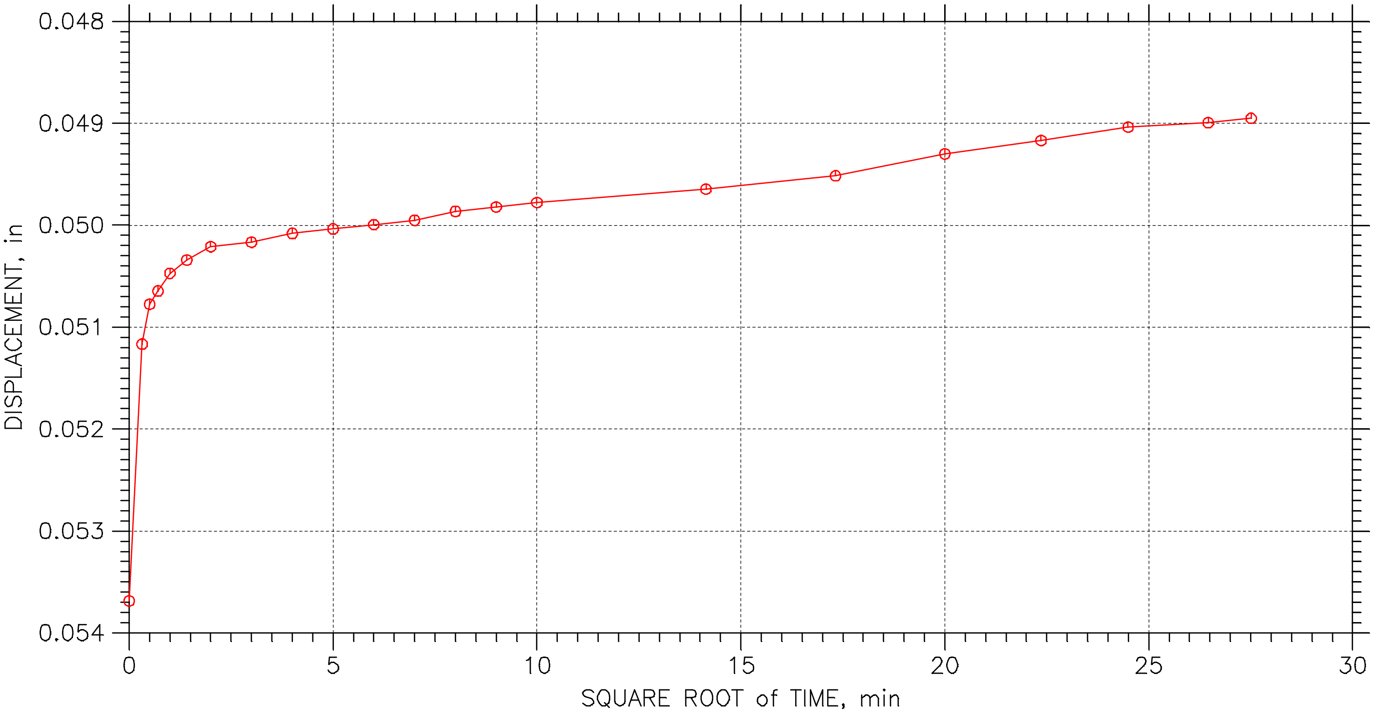
CONSOLIDATION TEST DATA

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		

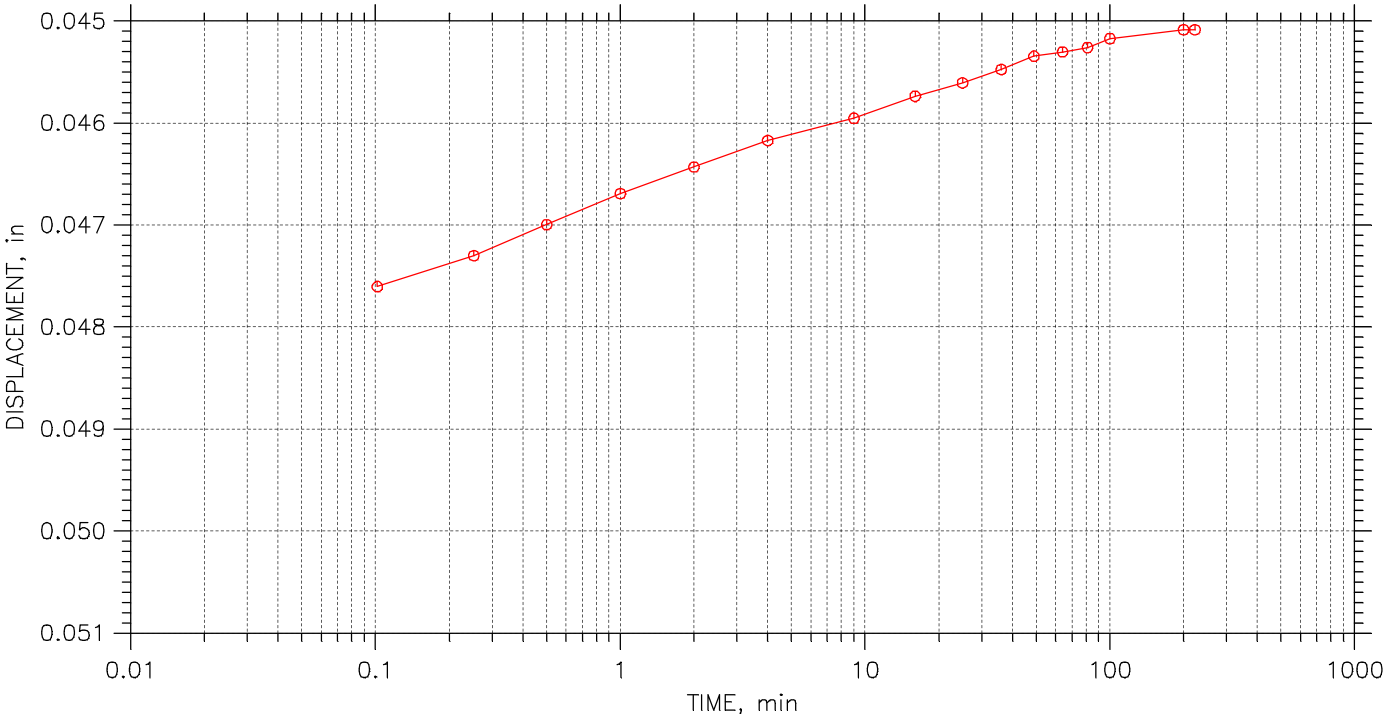
Tue, 26-APR-2016 10:52:11

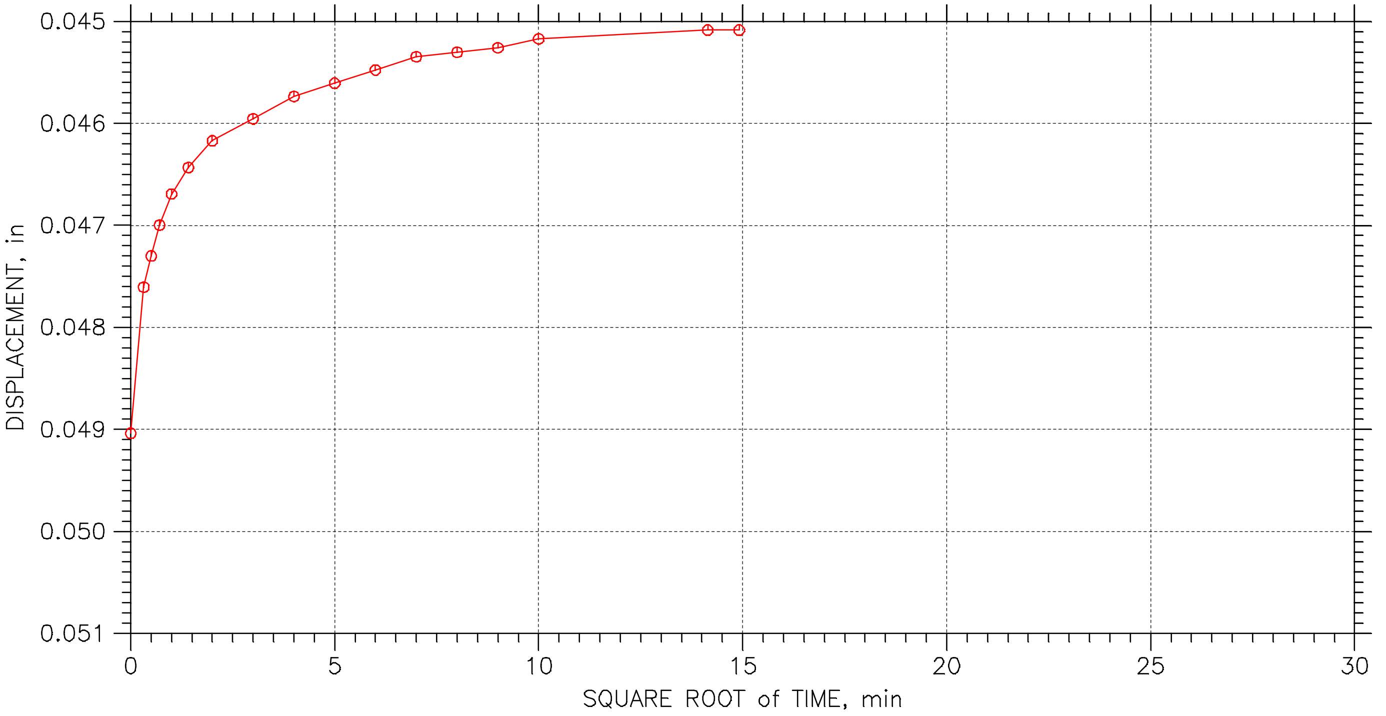
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 10 of 27

Stress: 1. tsf





Terracon
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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

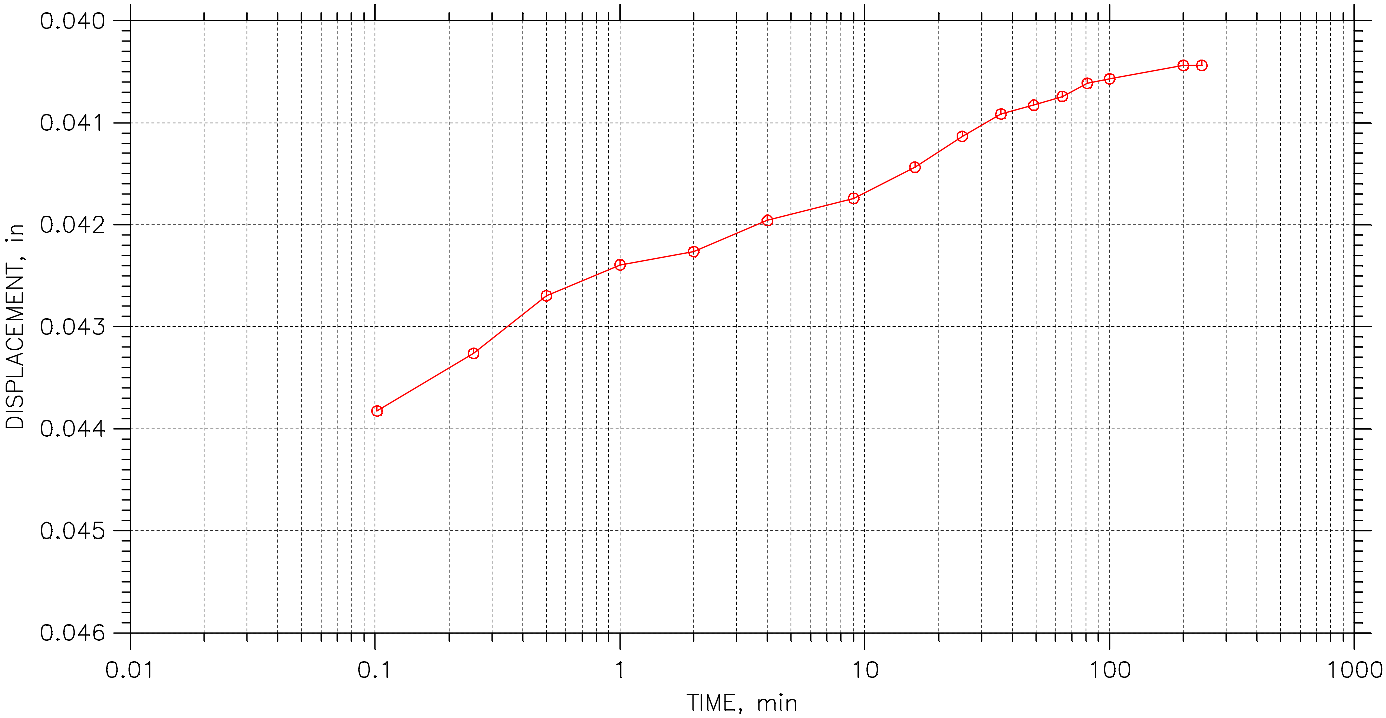
Tue, 26-APR-2016 10:52:12

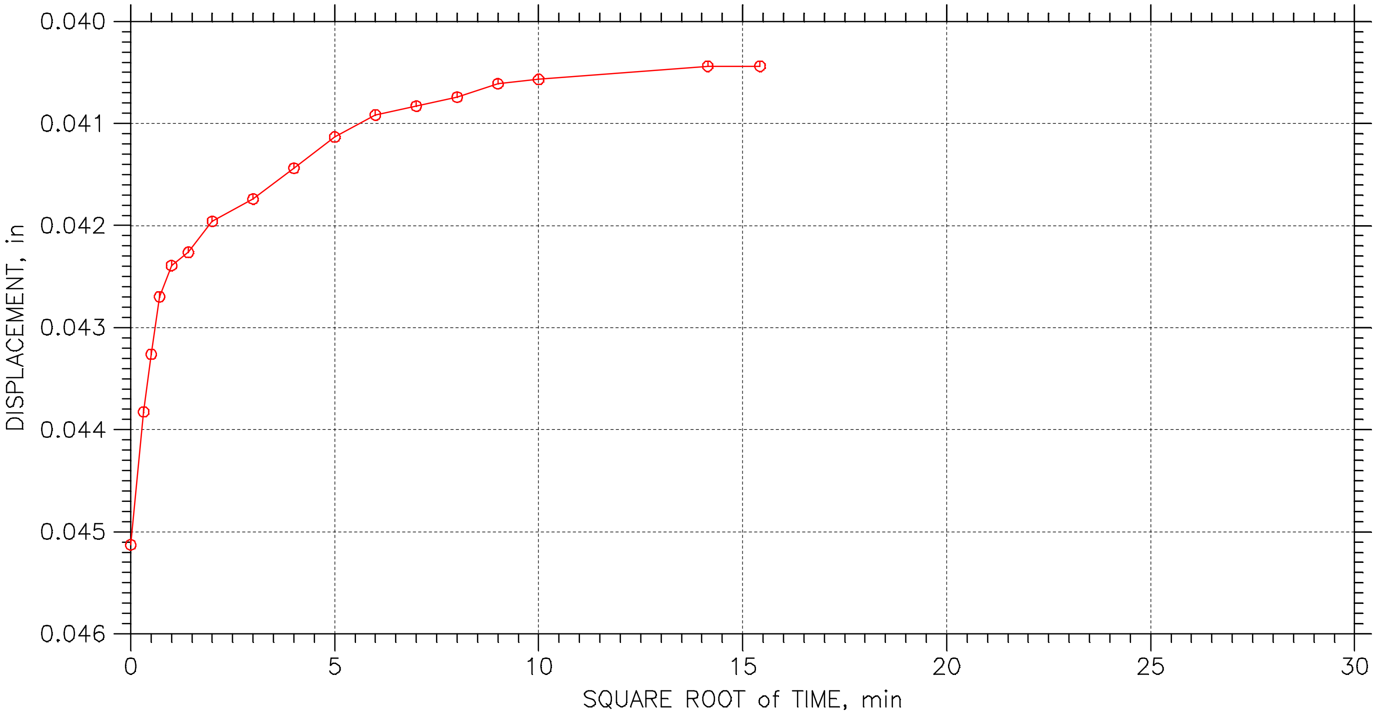
CONSOLIDATION TEST DATA

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		

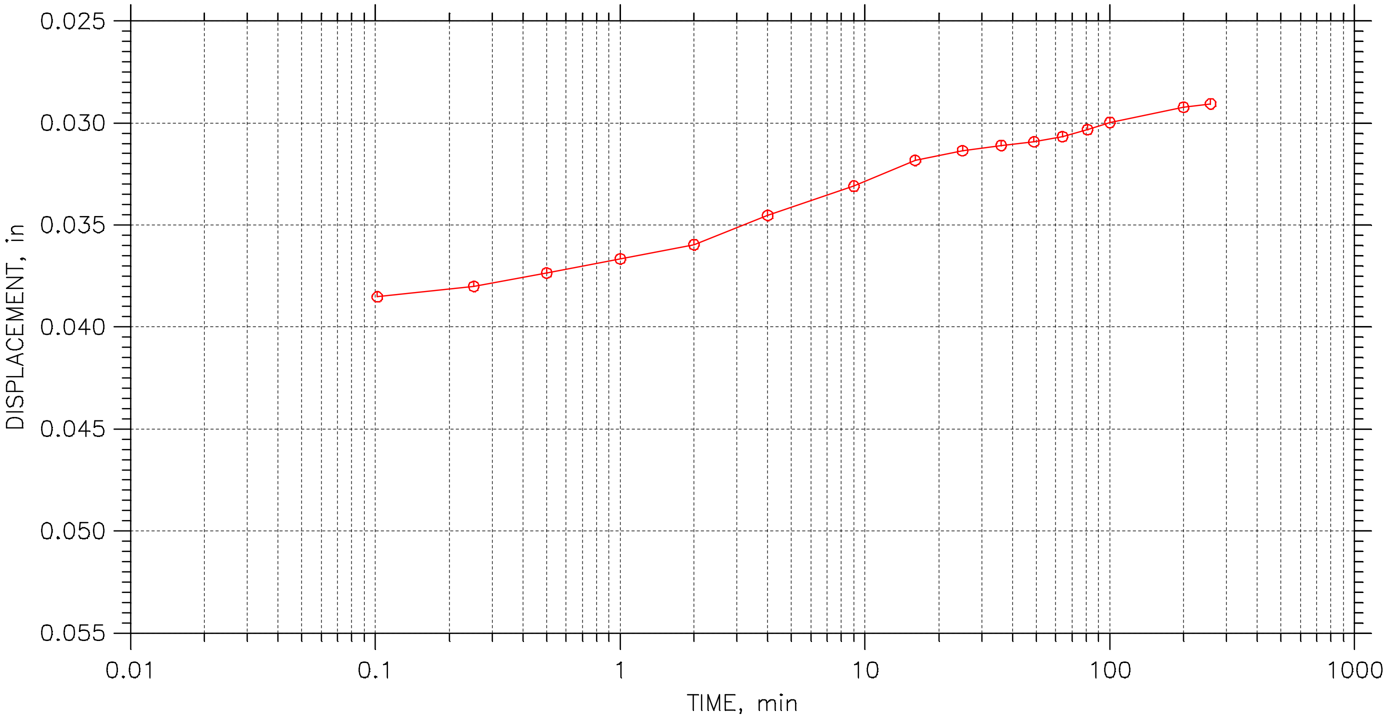
Tue, 26-APR-2016 10:52:14

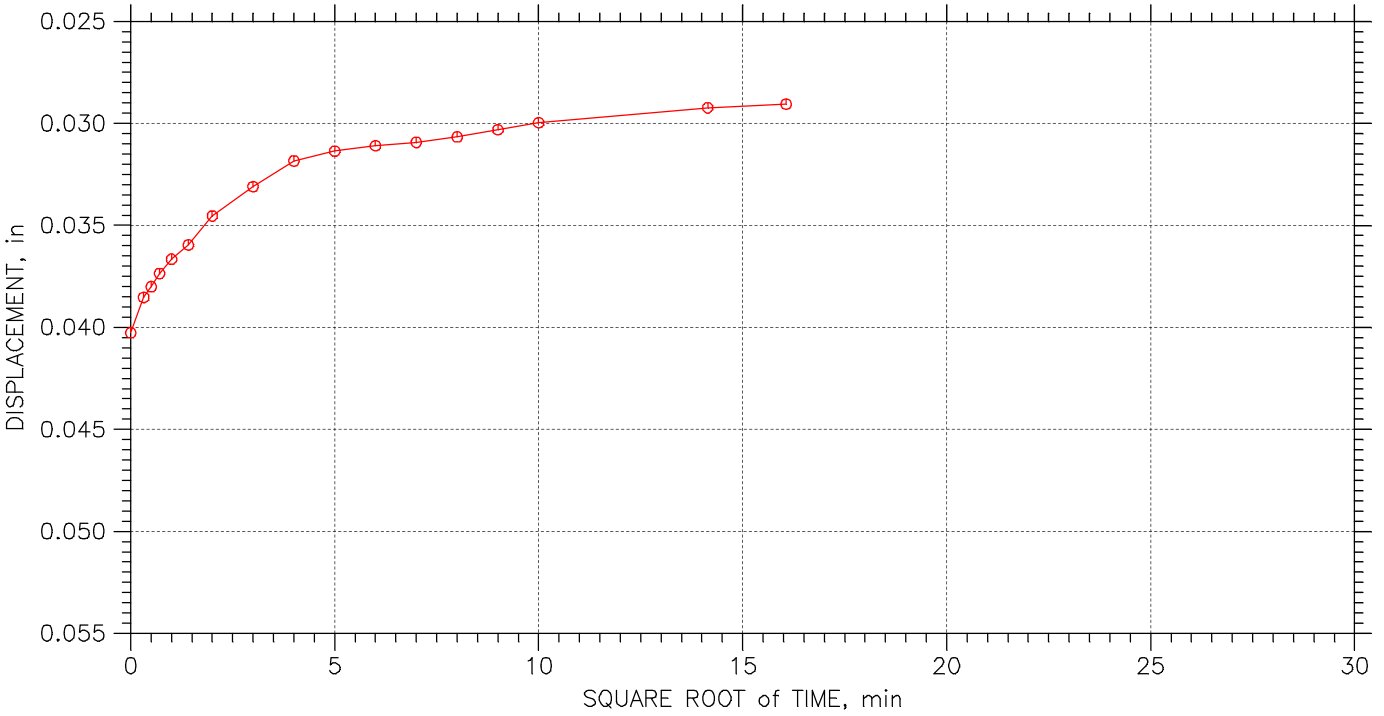
CONSOLIDATION TEST DATA

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		

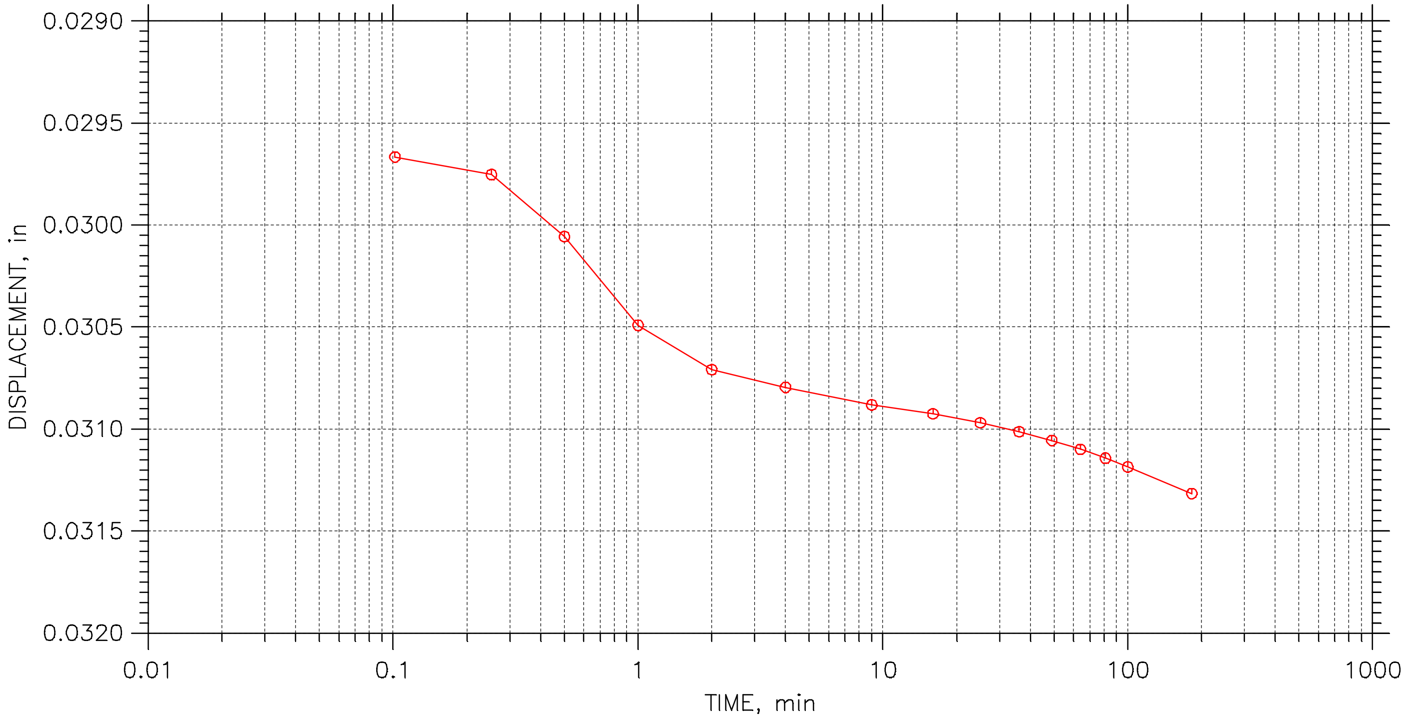
Tue, 26-APR-2016 10:52:15

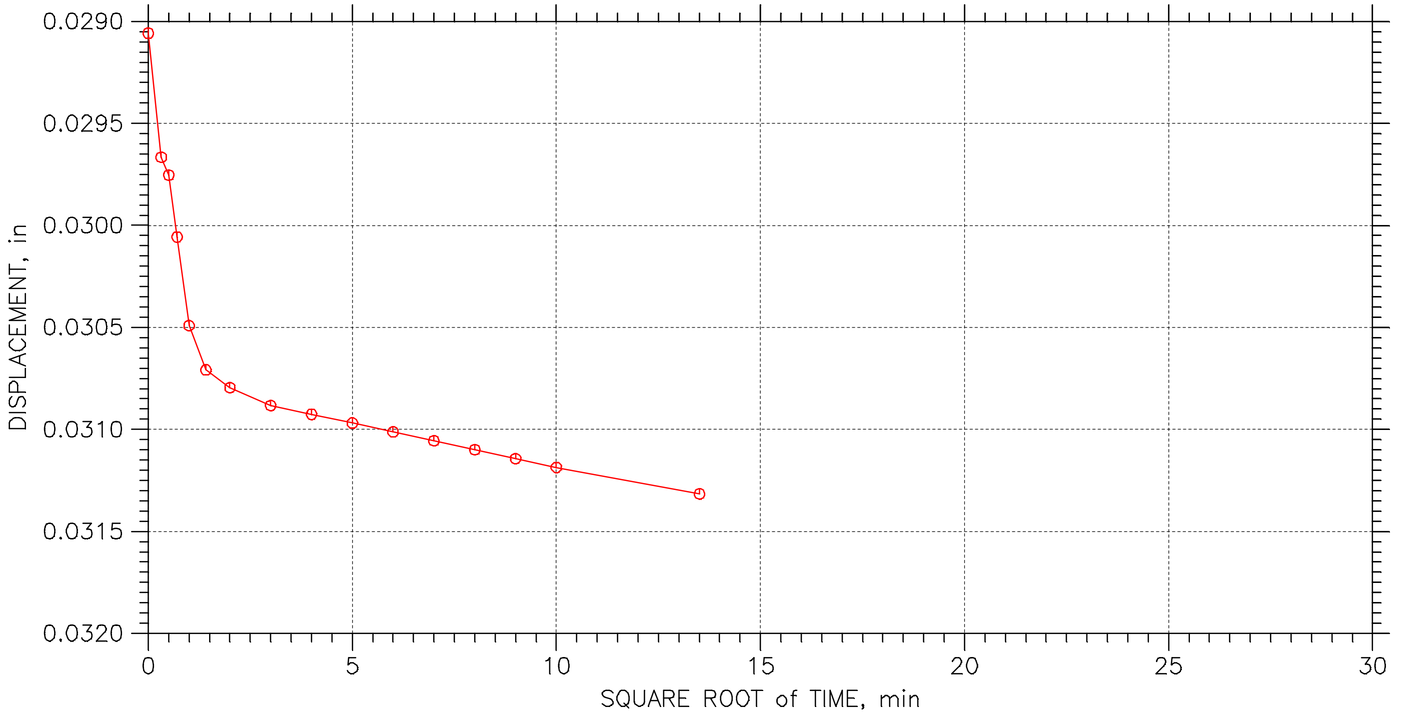
CONSOLIDATION TEST DATA

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		

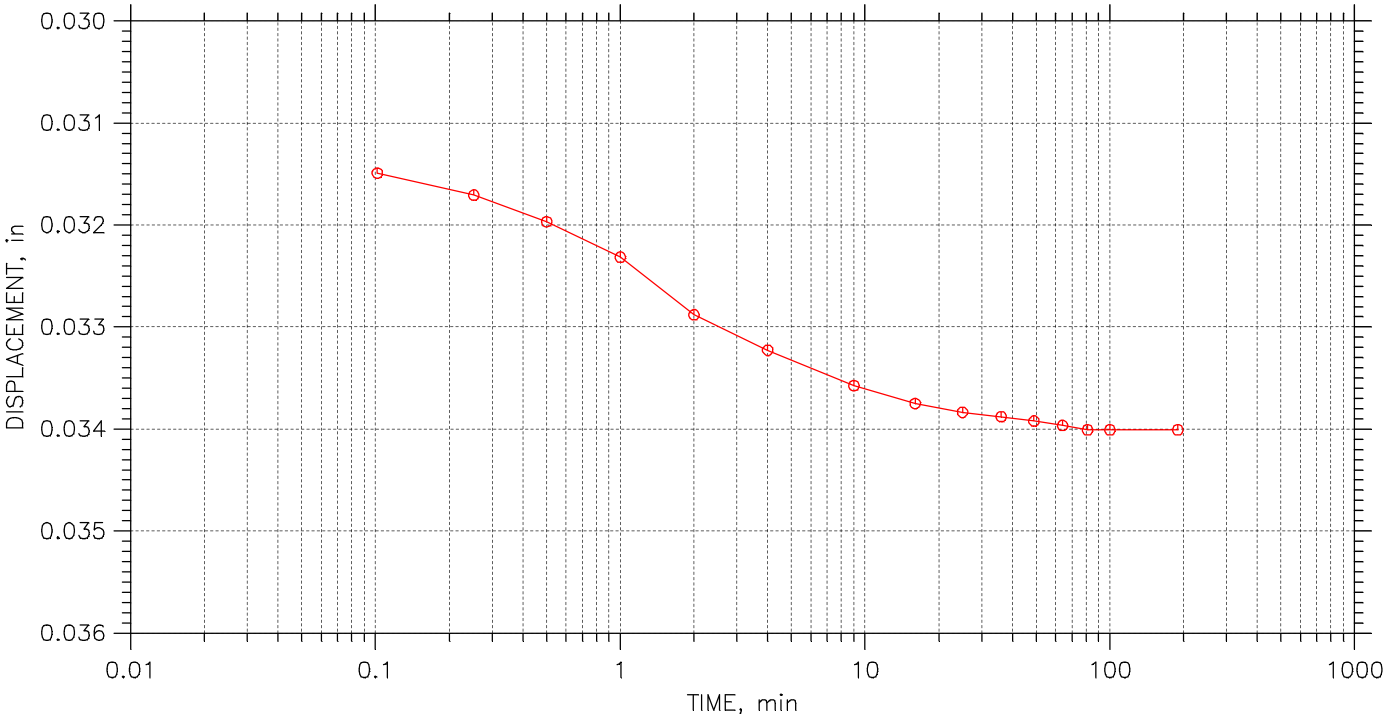
Tue, 26-APR-2016 10:52:17

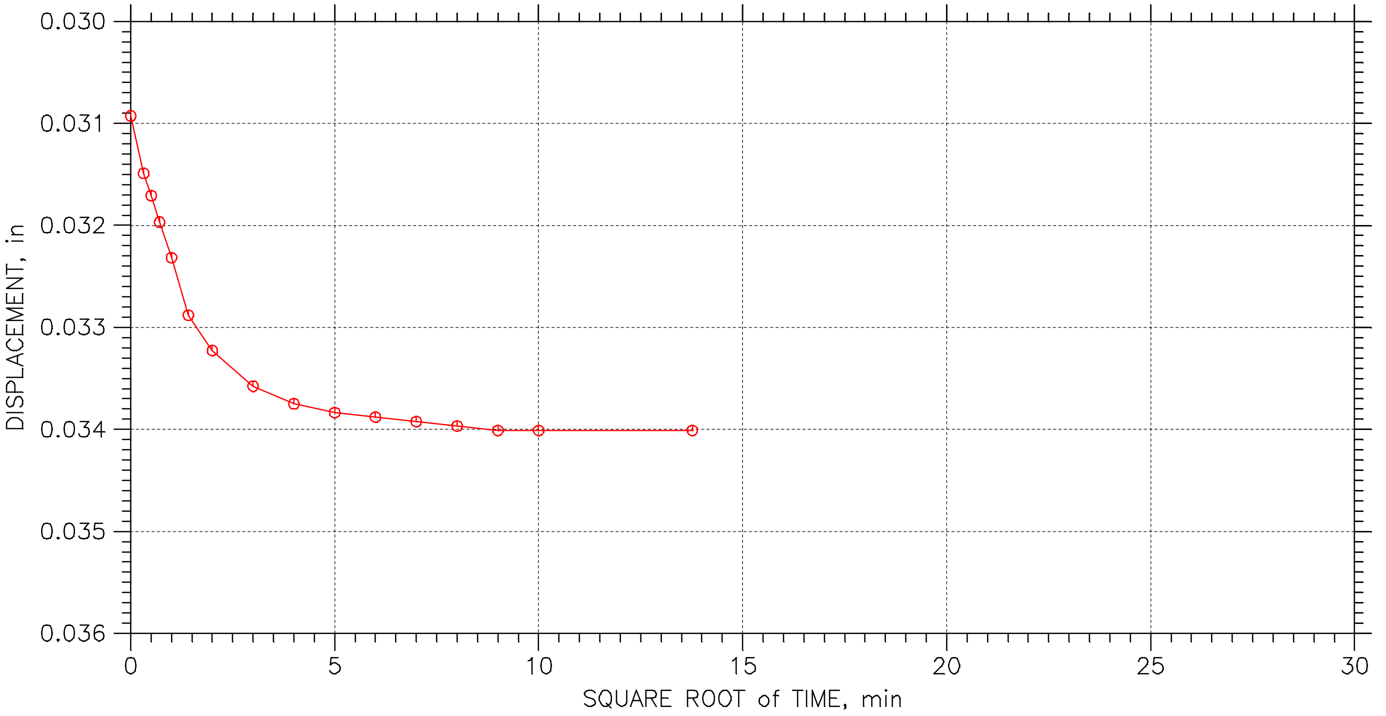
CONSOLIDATION TEST DATA

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		

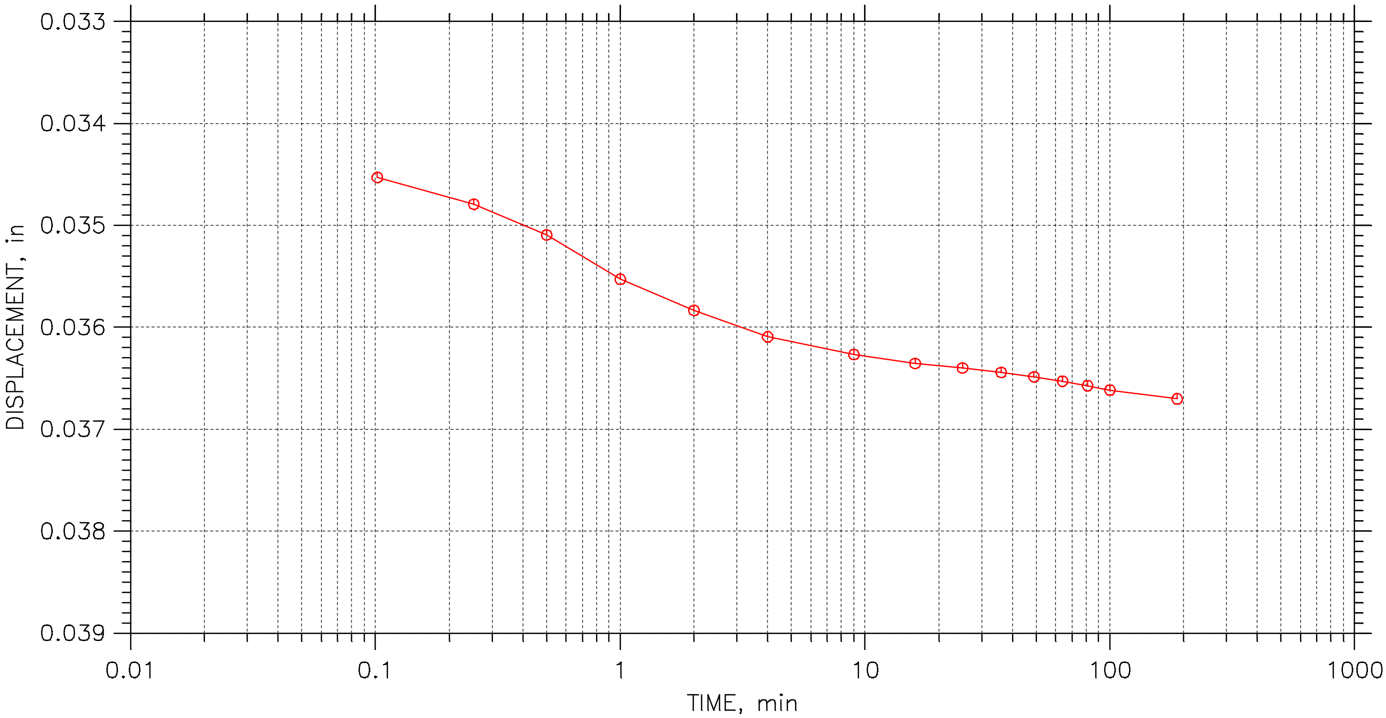
Tue, 26-APR-2016 10:52:18

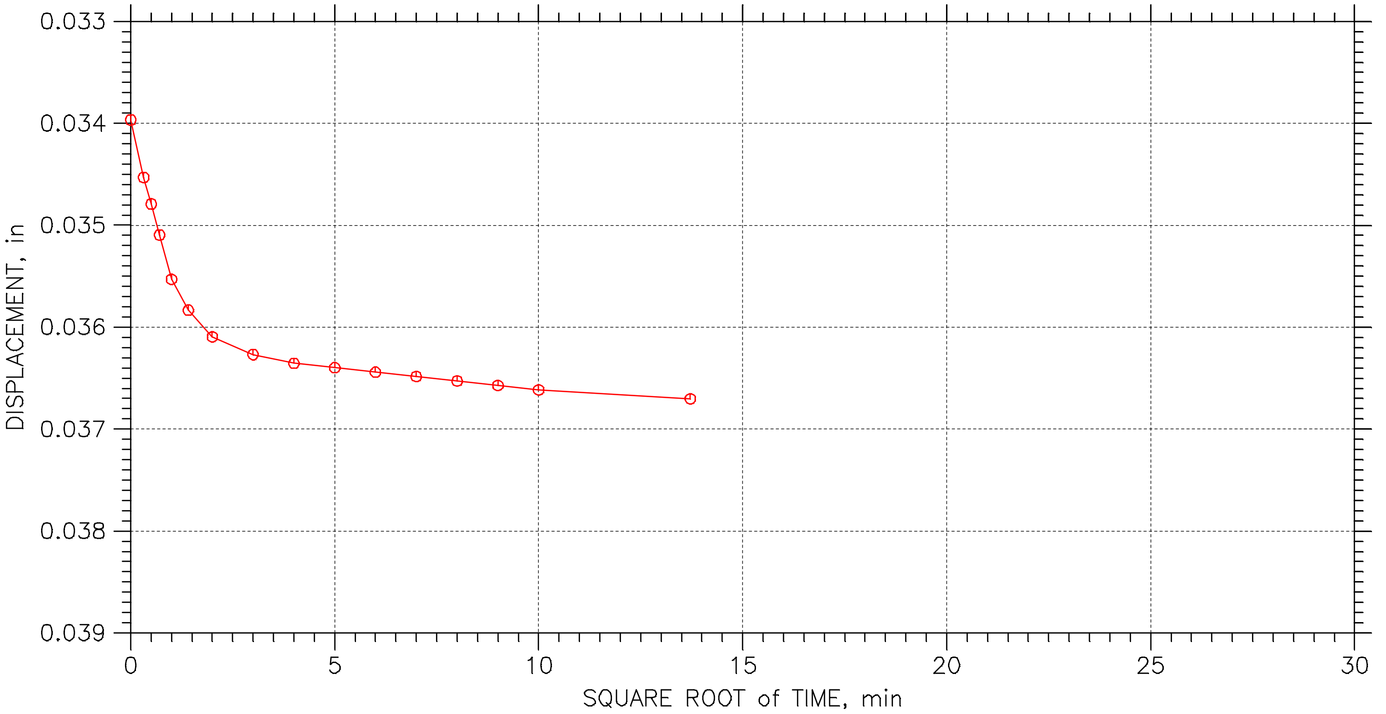
CONSOLIDATION TEST DATA

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		

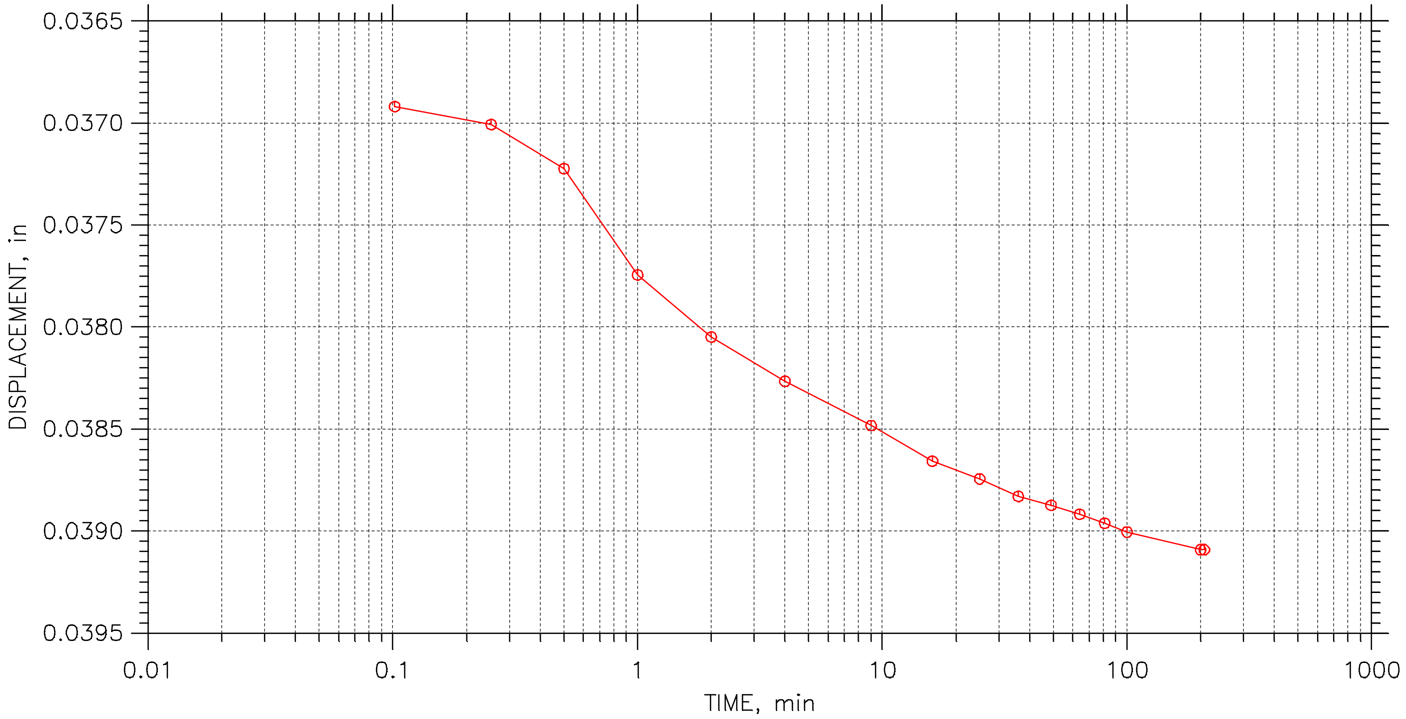
Tue, 26-APR-2016 10:52:20

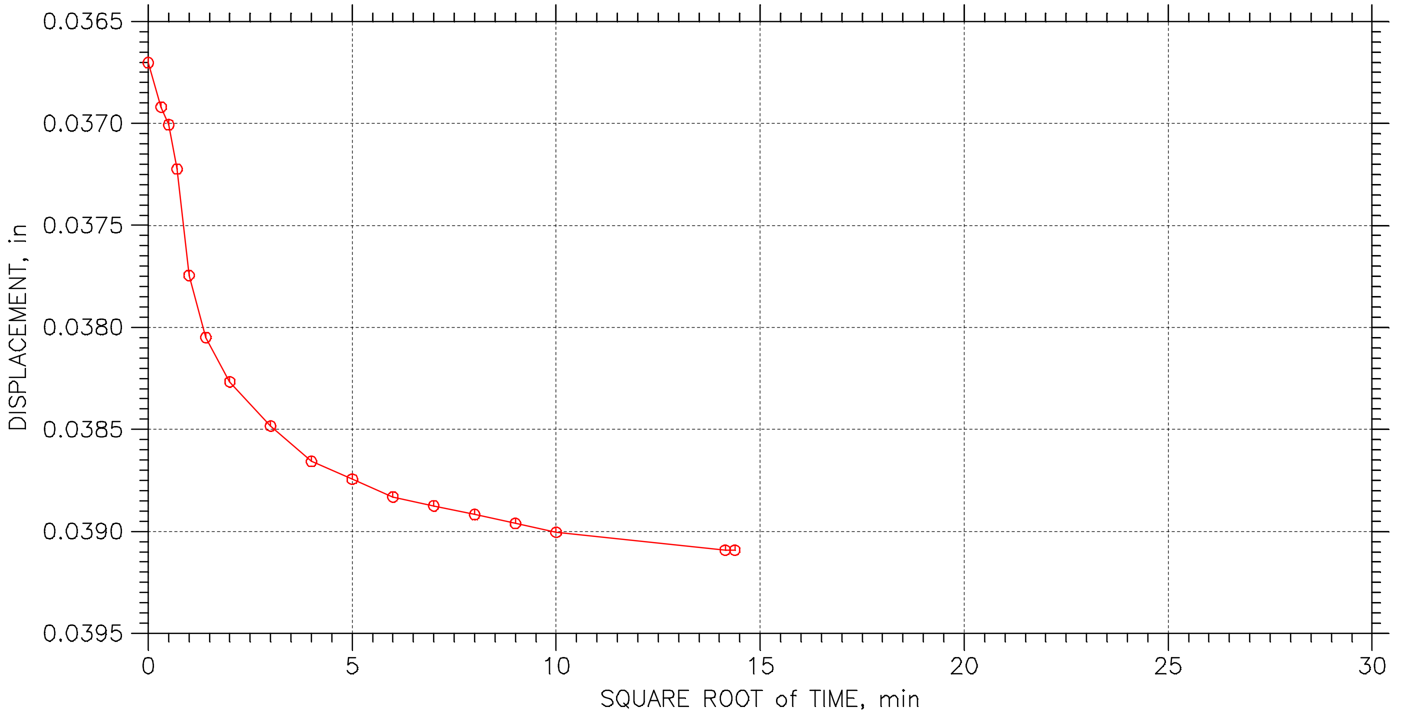
CONSOLIDATION TEST DATA

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		

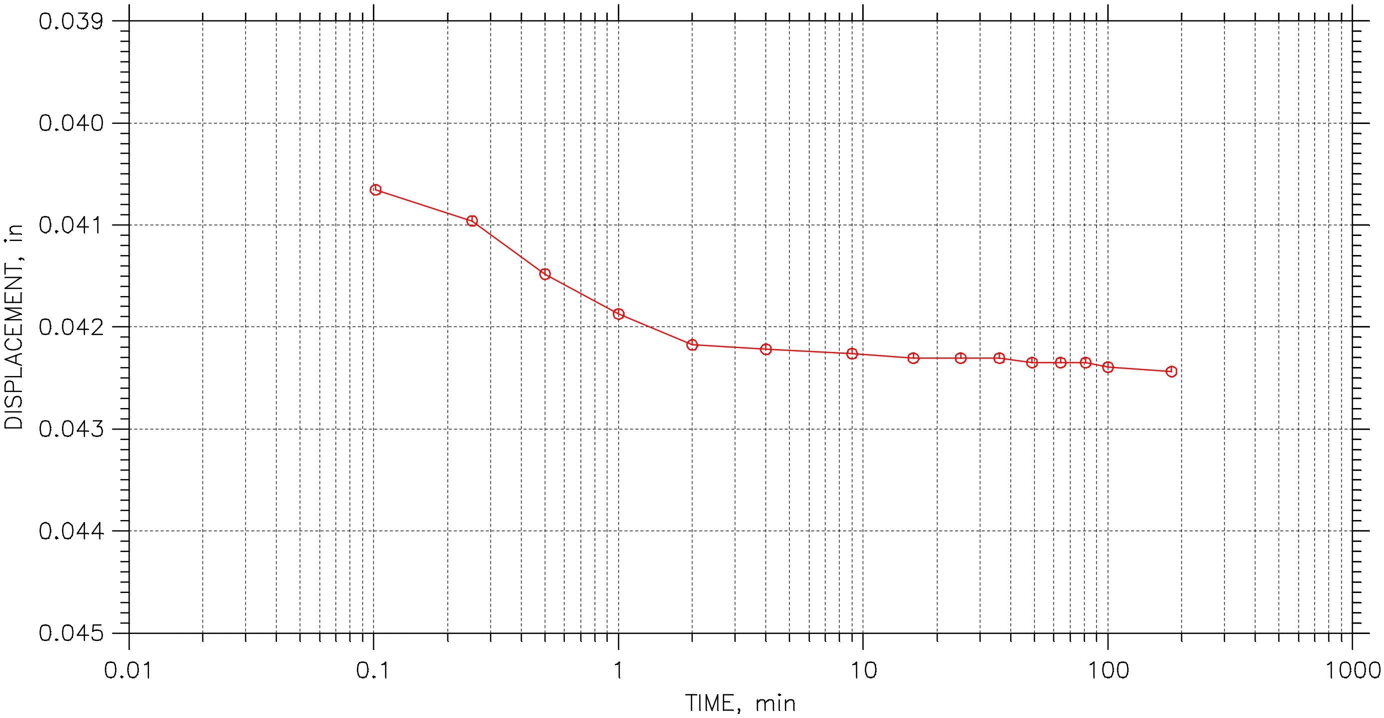
Tue, 26-APR-2016 10:52:21

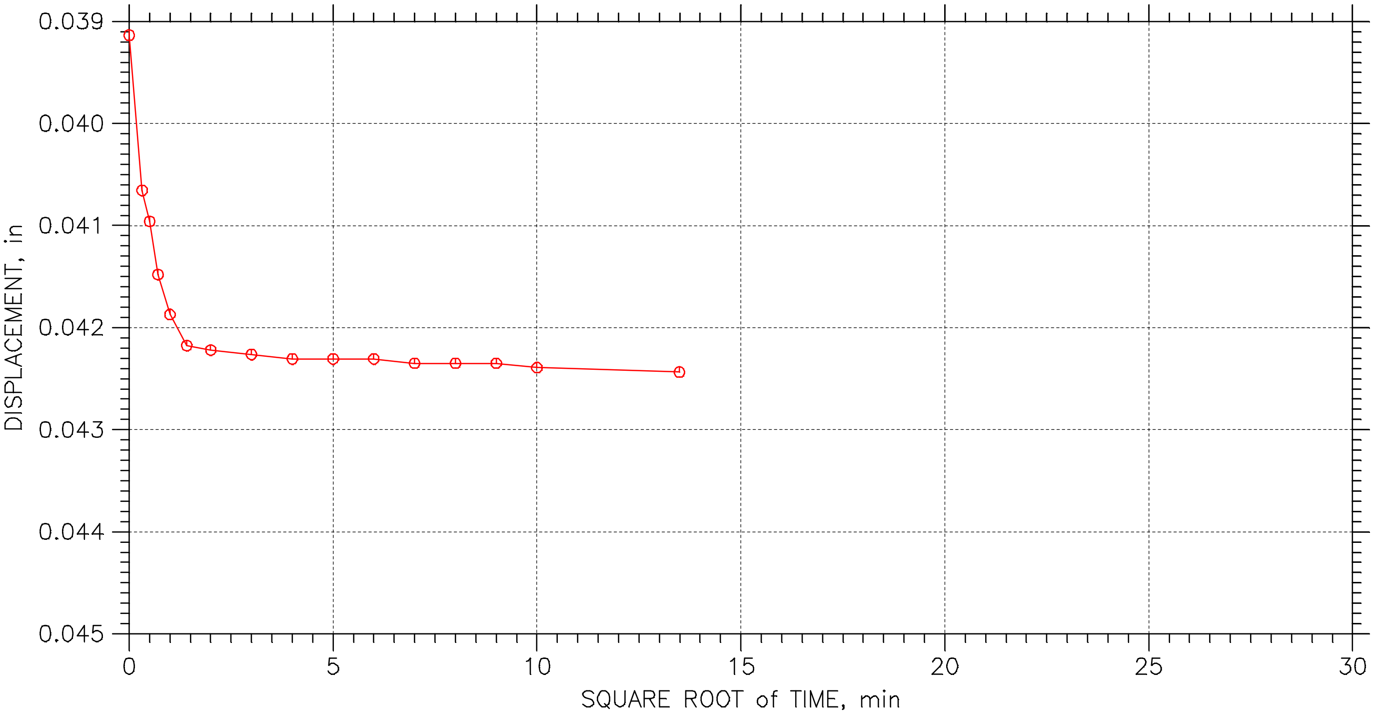
CONSOLIDATION TEST DATA

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		

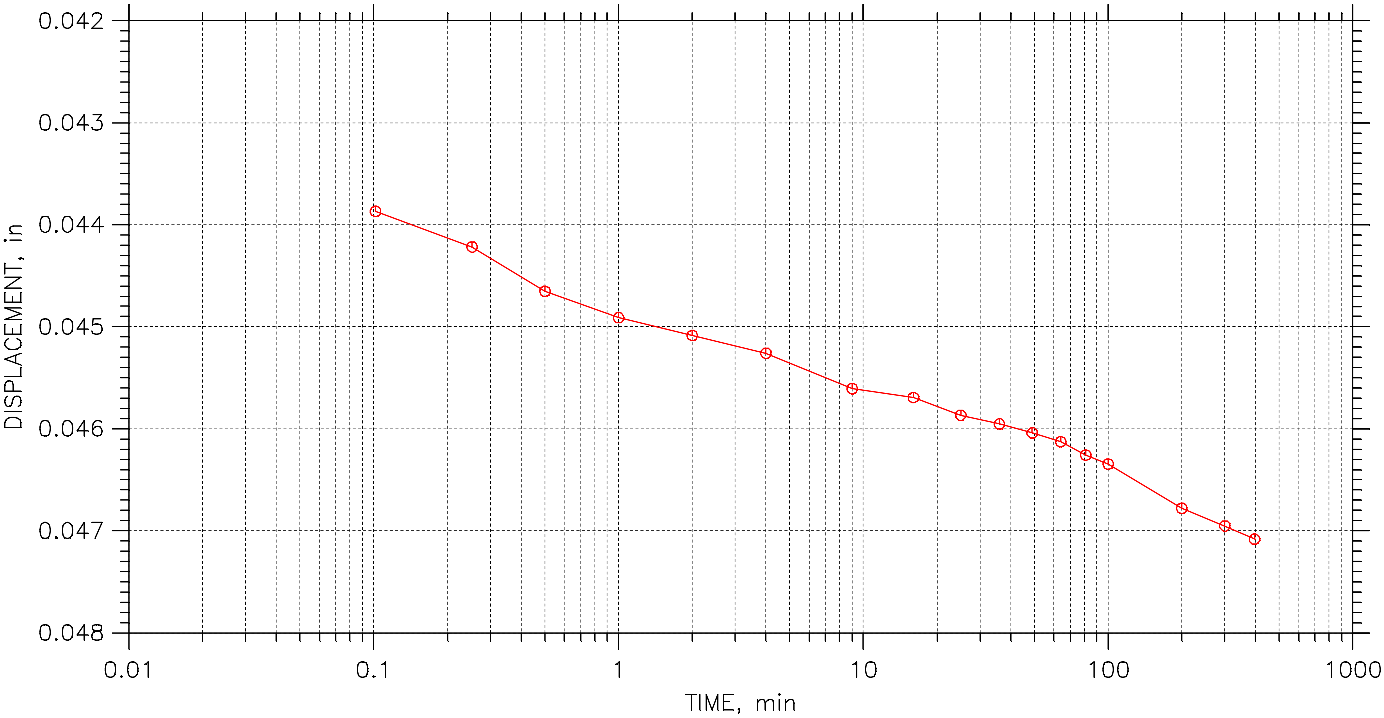
Tue, 26-APR-2016 10:52:23

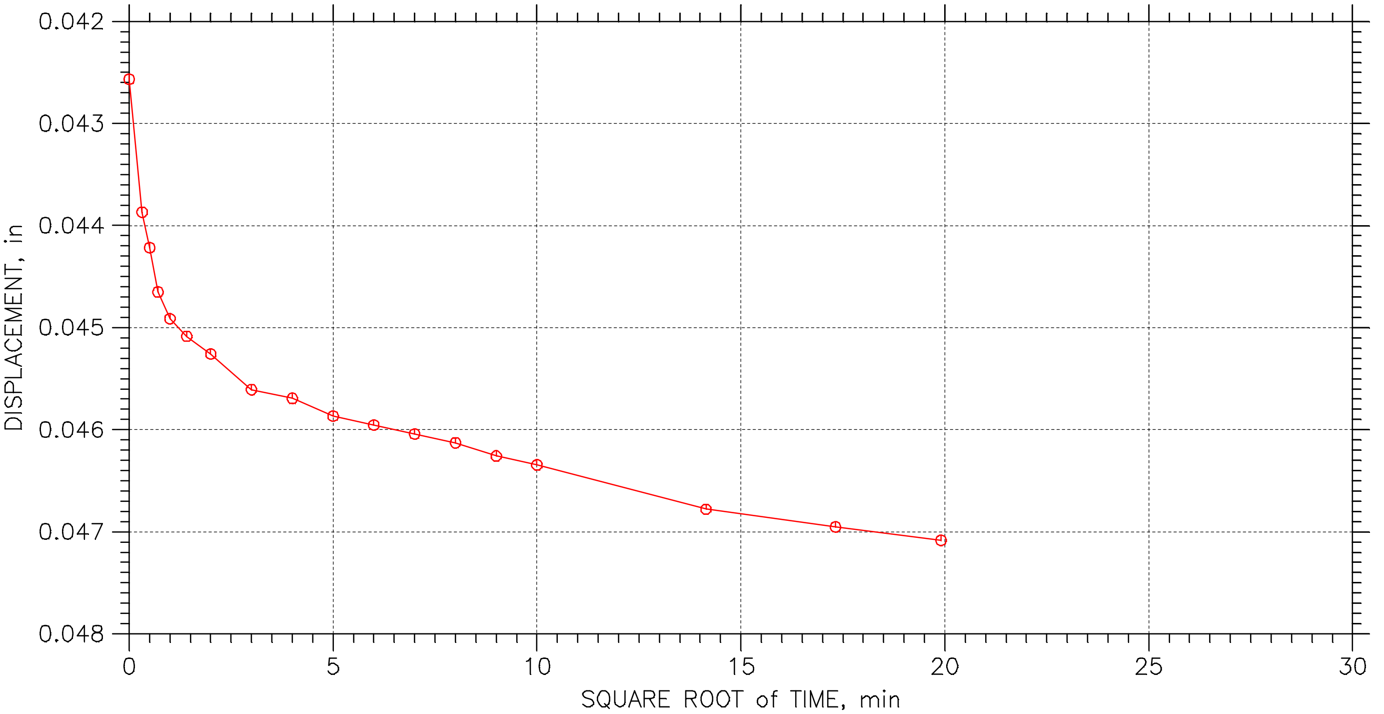
CONSOLIDATION TEST DATA

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		

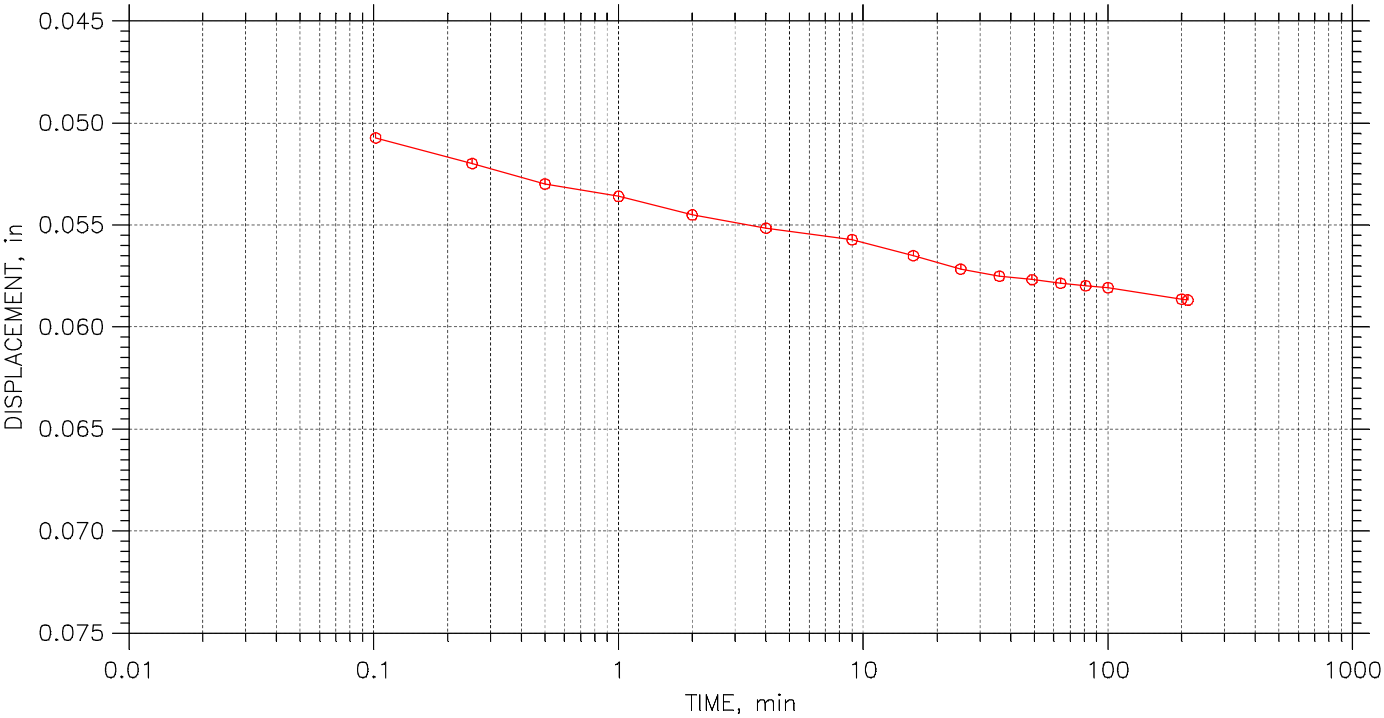
Tue, 26-APR-2016 10:52:24

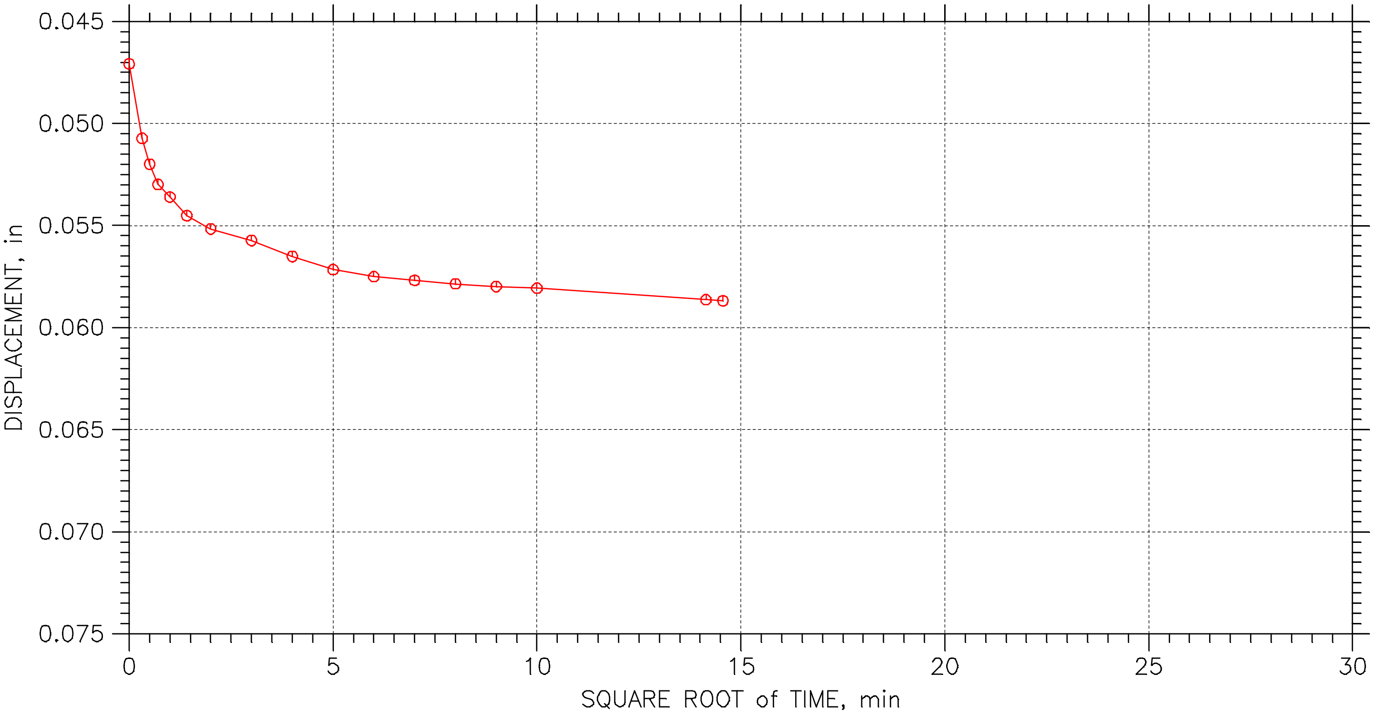
CONSOLIDATION TEST DATA

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		

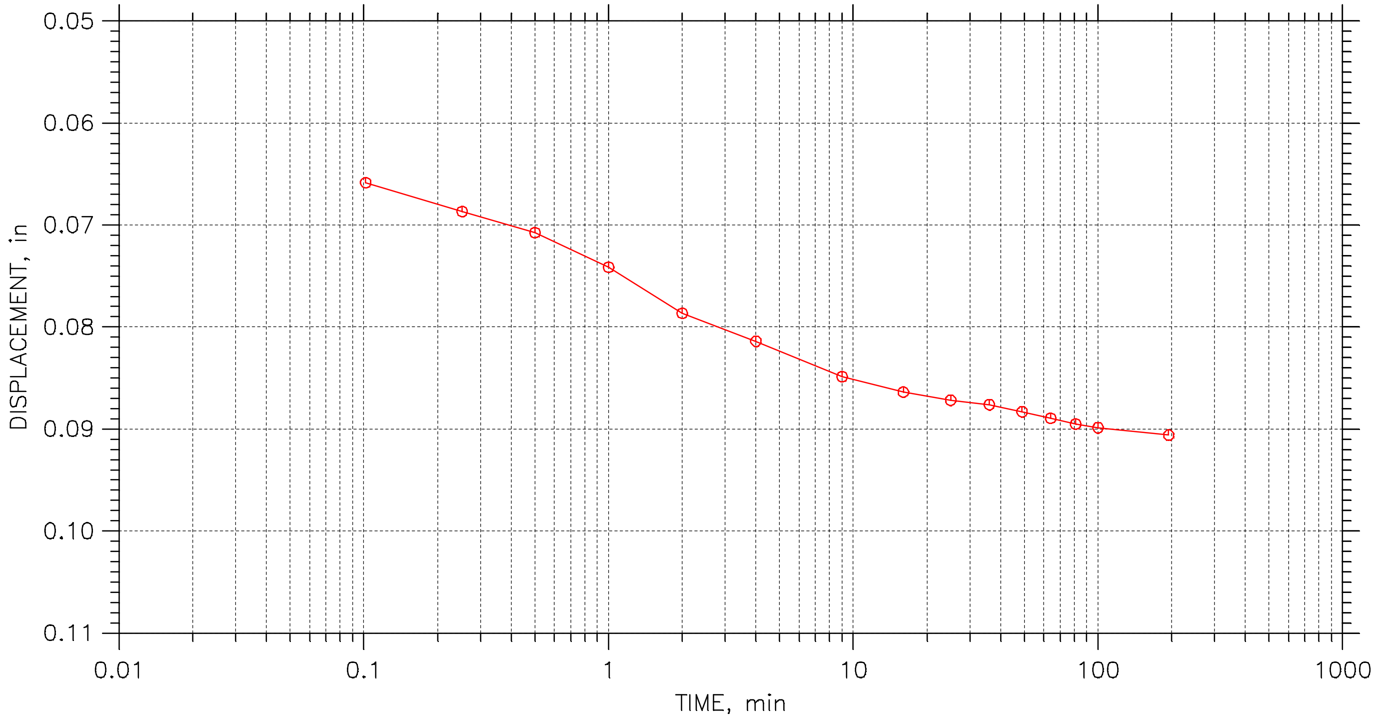
Tue, 26-APR-2016 10:52:25

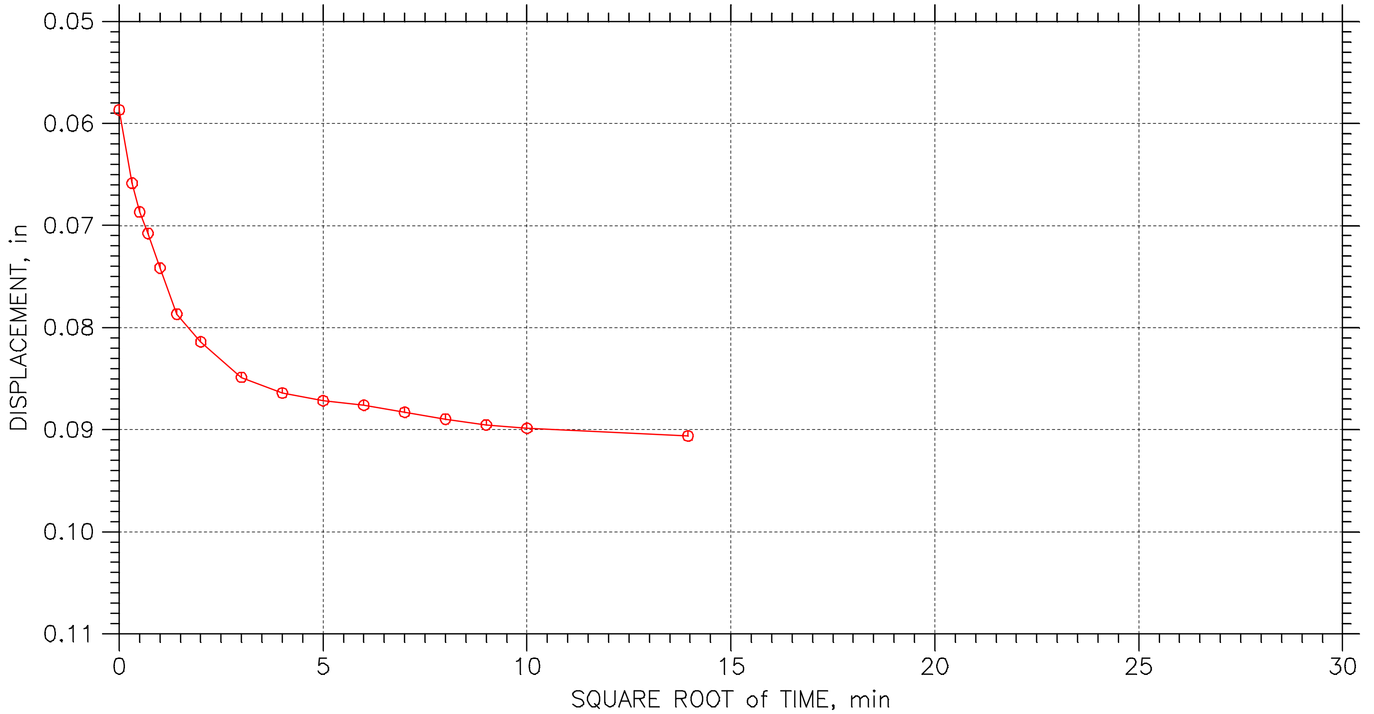
CONSOLIDATION TEST DATA

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		

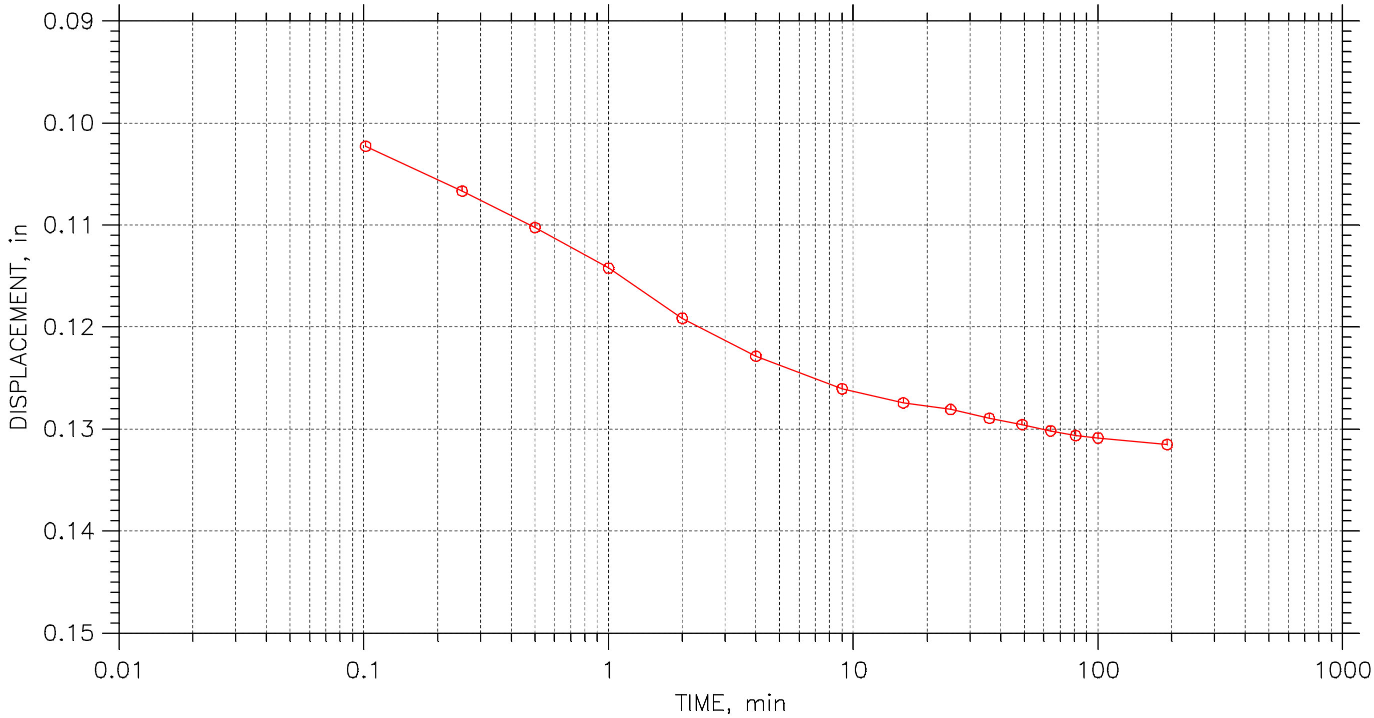
Tue, 26-APR-2016 10:52:27

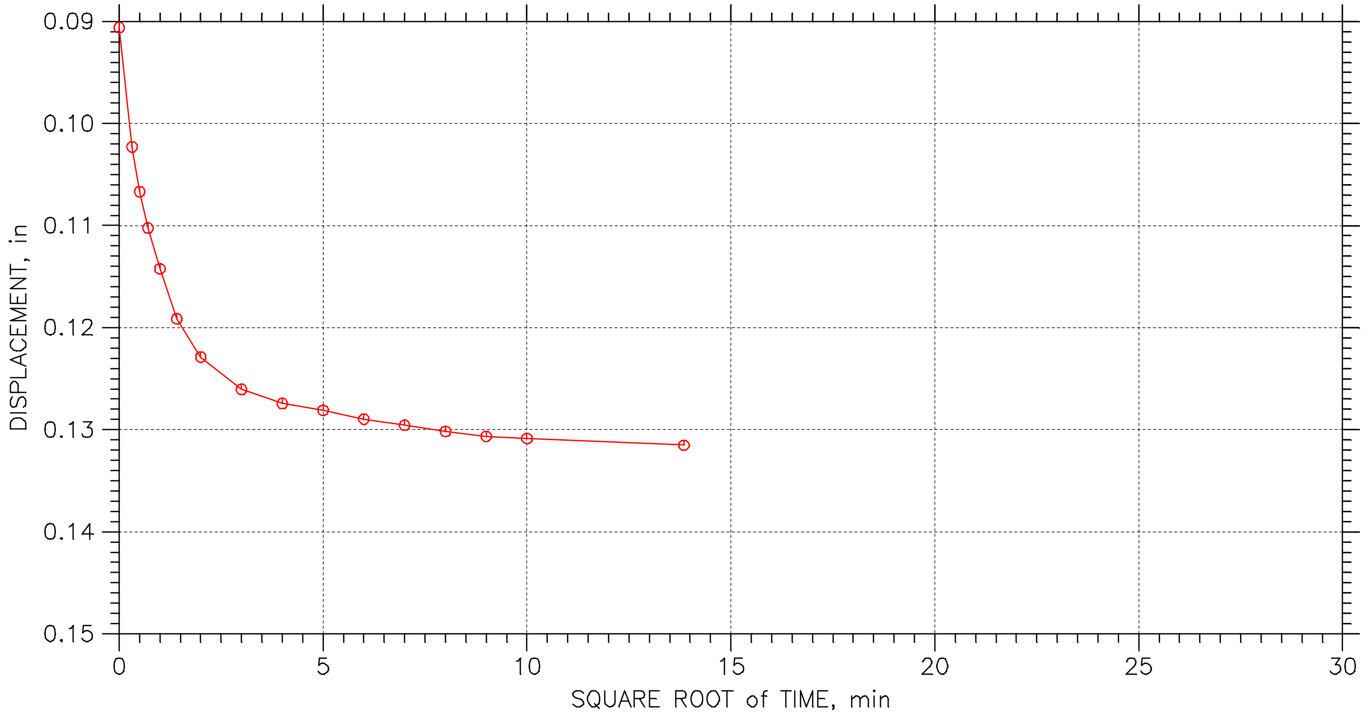
CONSOLIDATION TEST DATA

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		

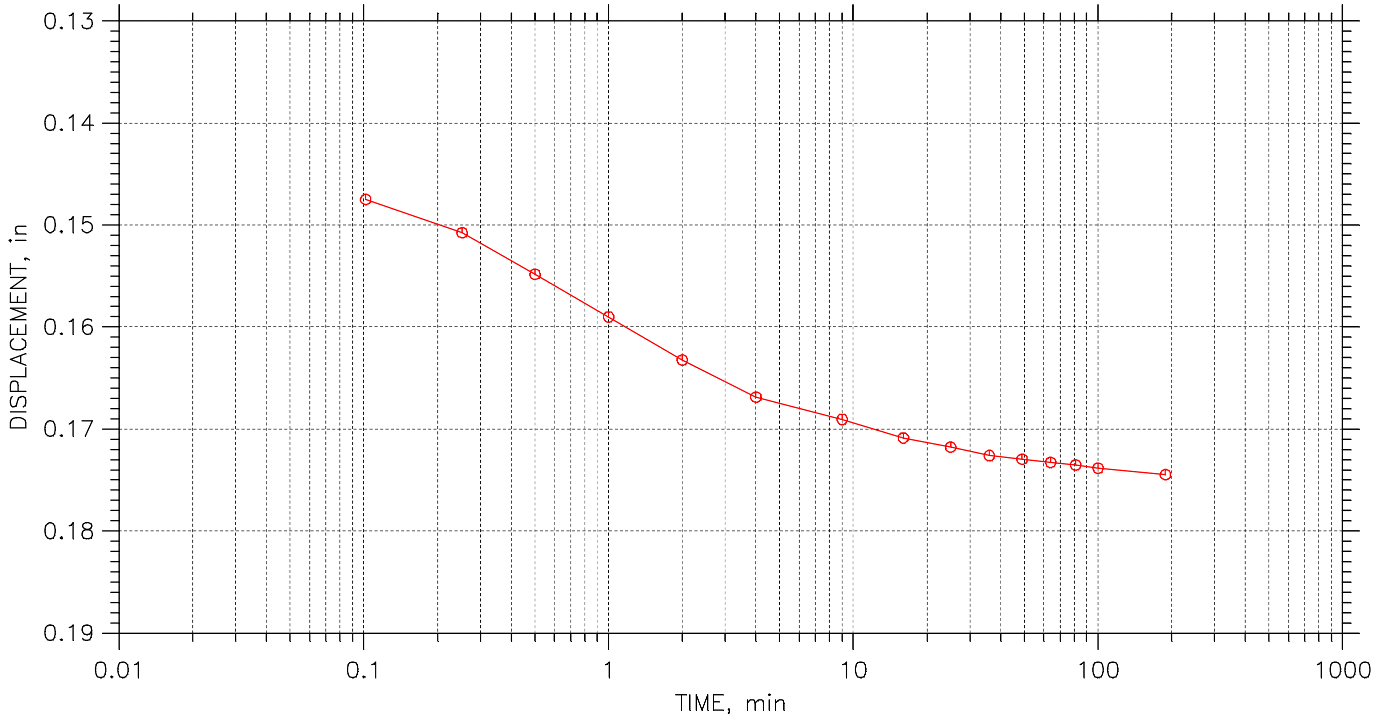
Tue, 26-APR-2016 10:52:28

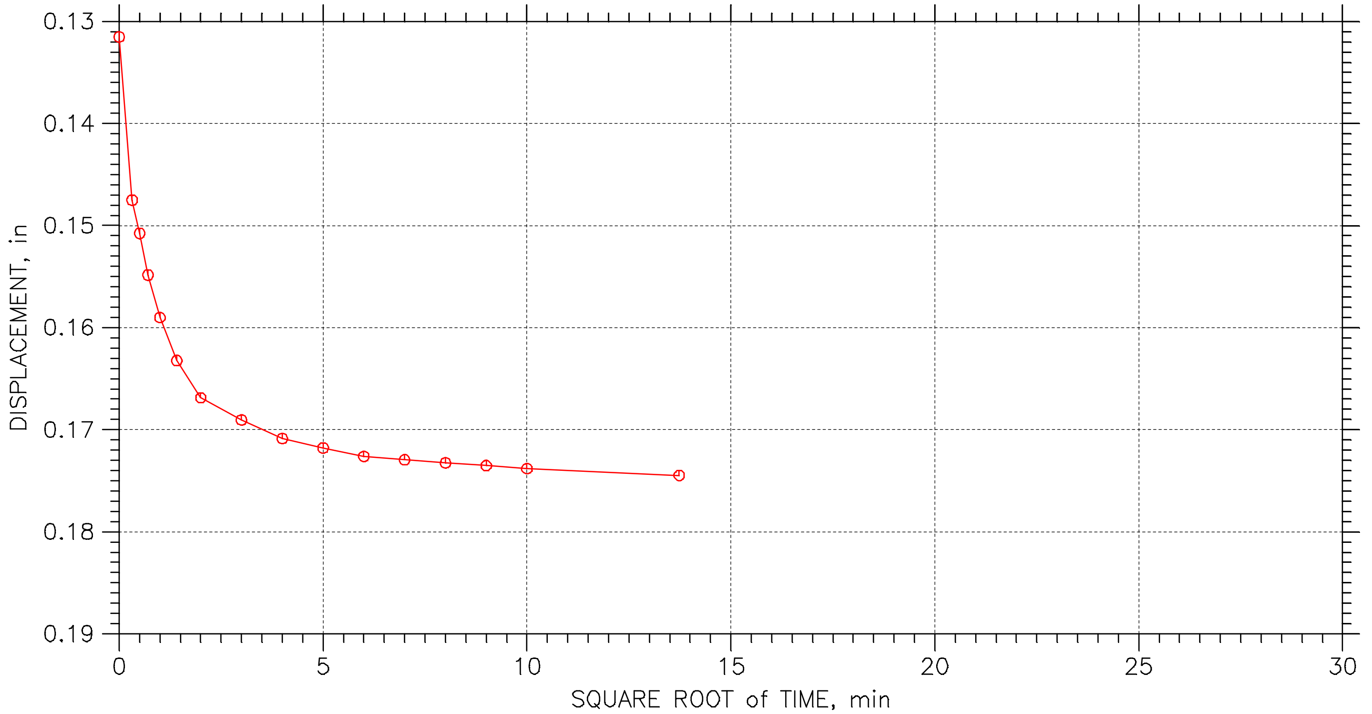
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 22 of 27

Stress: 32. tsf





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		

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Consulting Engineers & Scientists

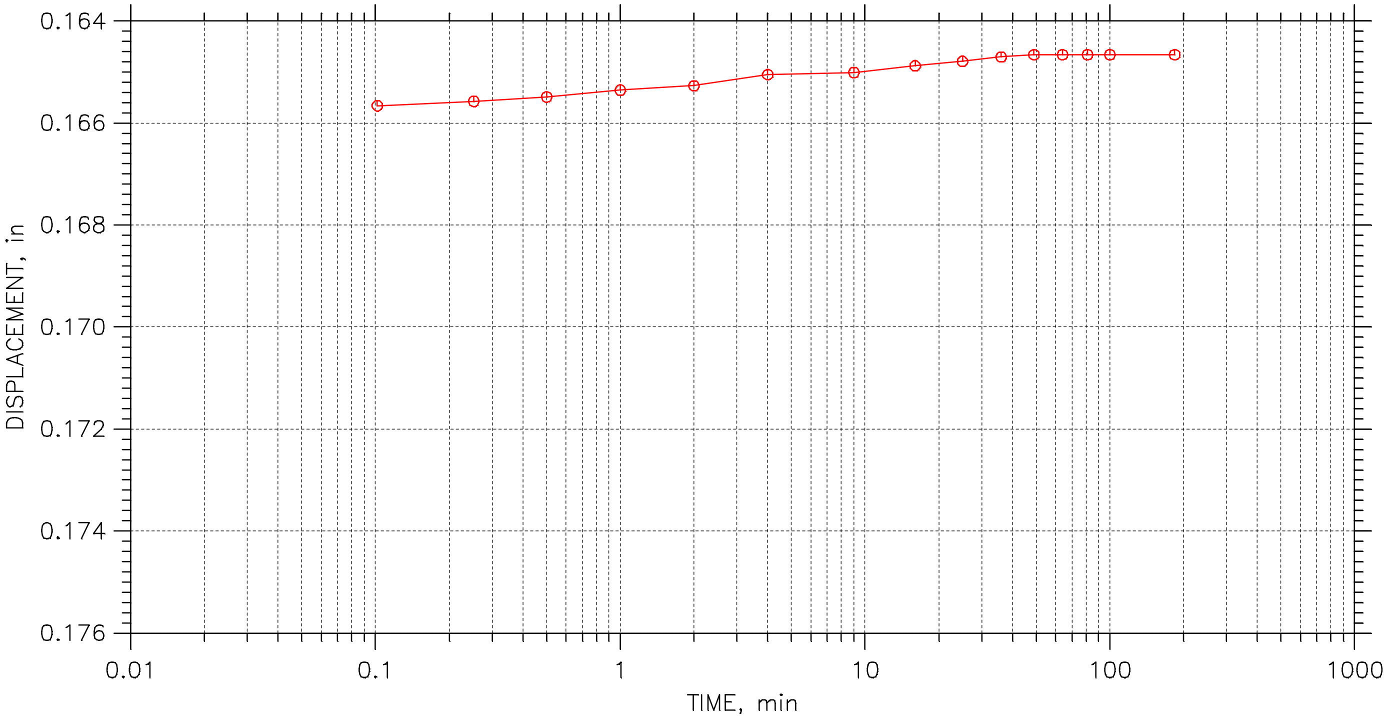
Tue, 26-APR-2016 10:52:30

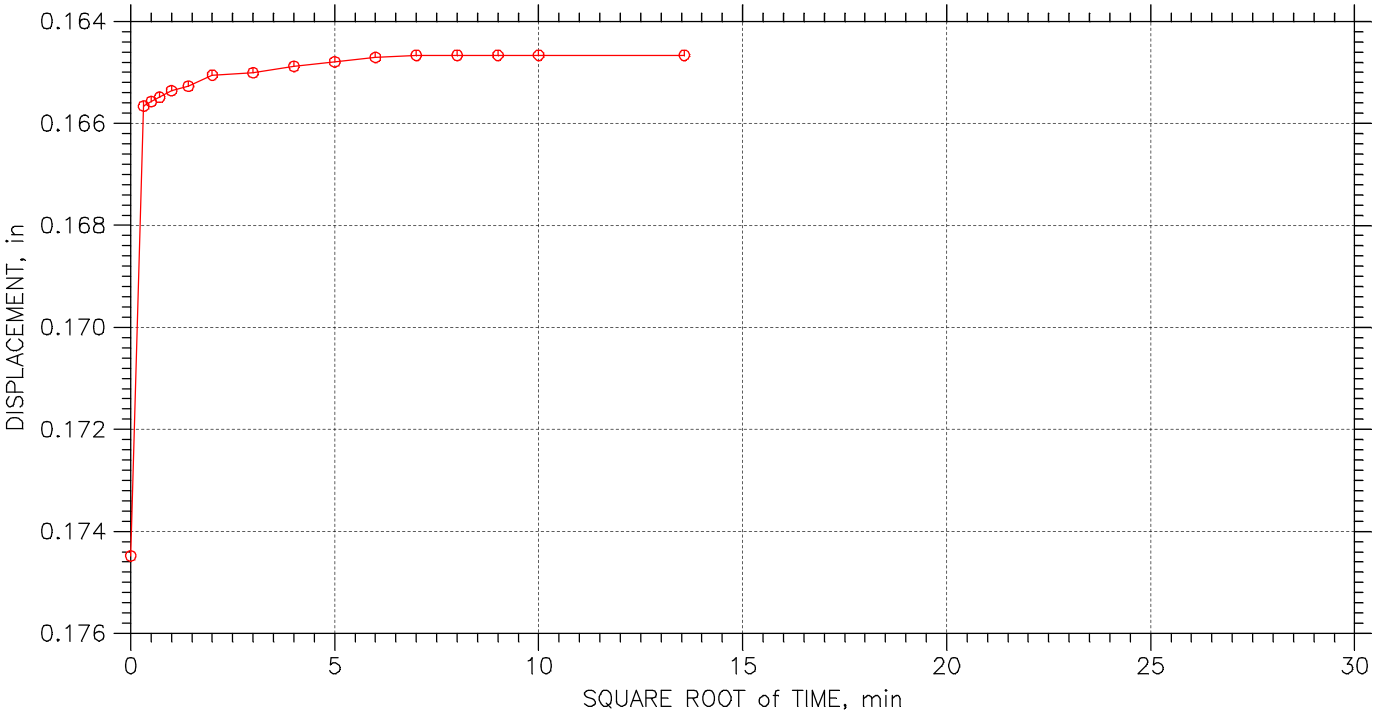
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 23 of 27

Stress: 16. tsf





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		

Terracon
Consulting Engineers & Scientists

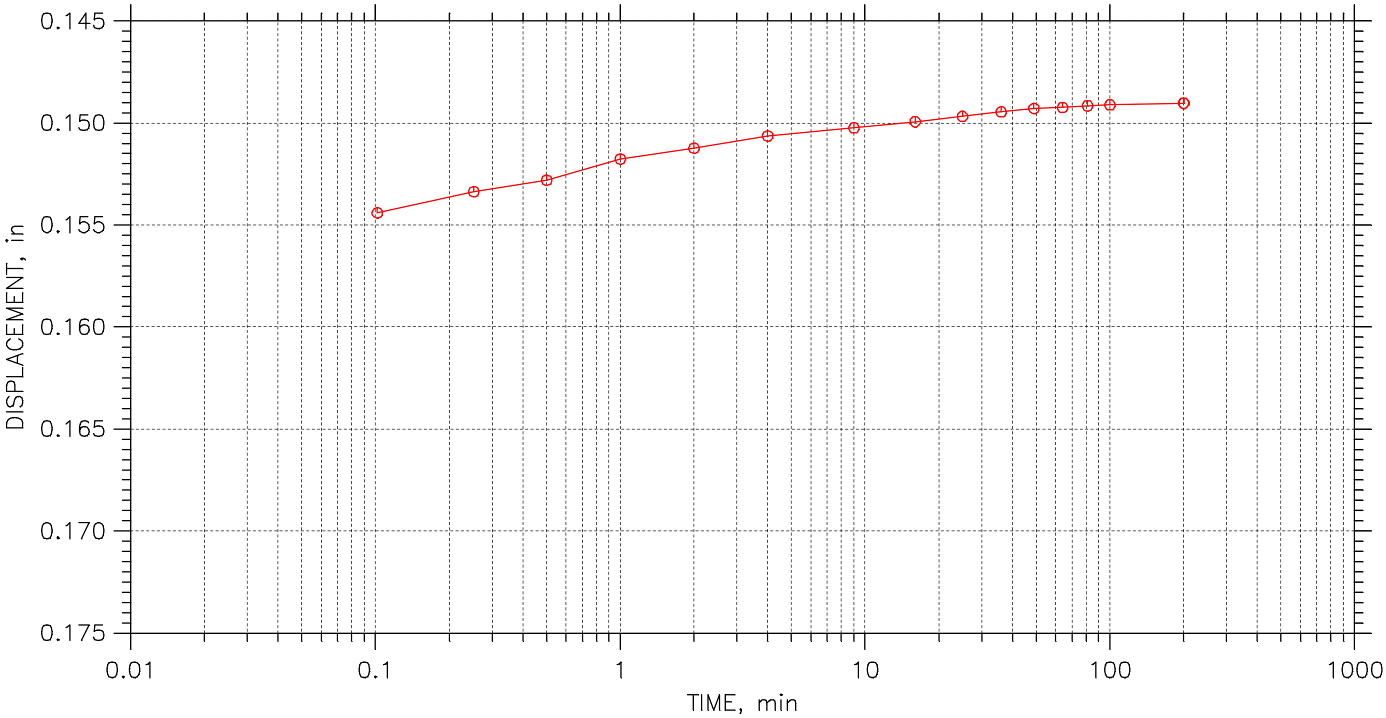
Tue, 26-APR-2016 10:52:31

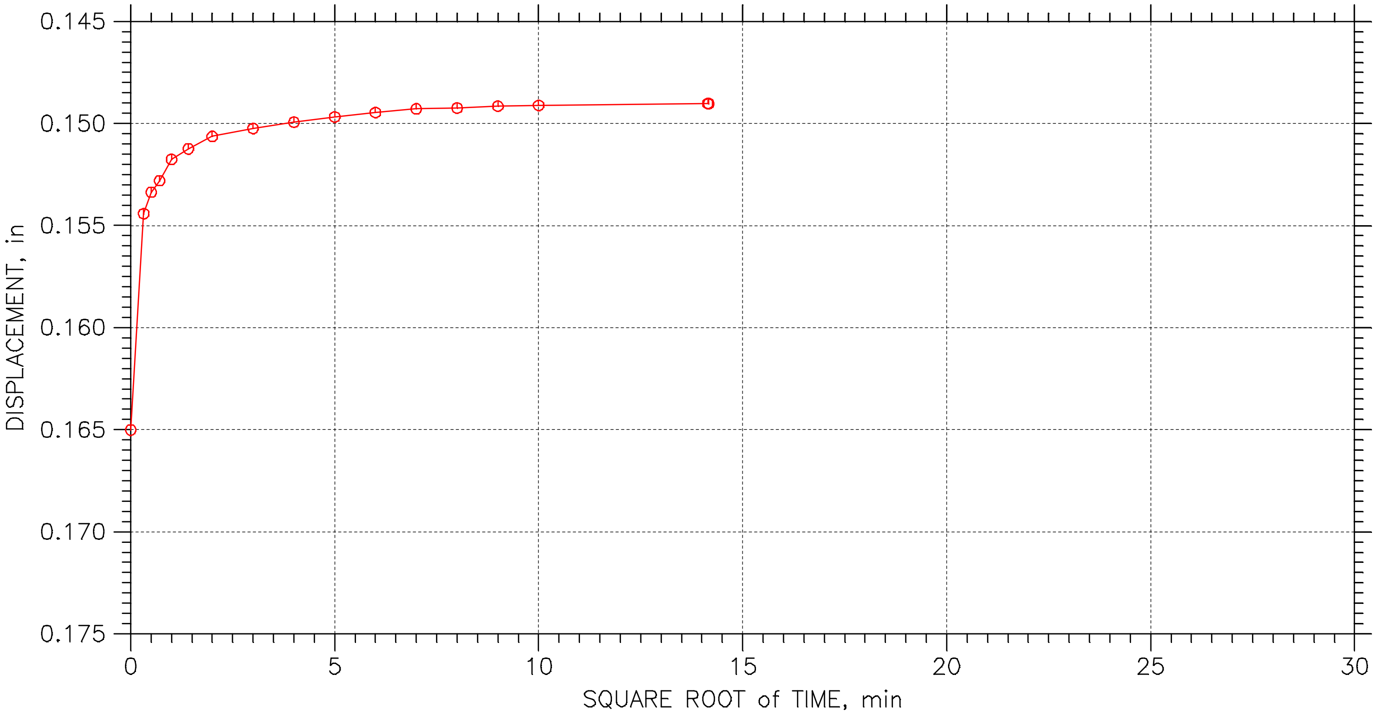
CONSOLIDATION TEST DATA

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		

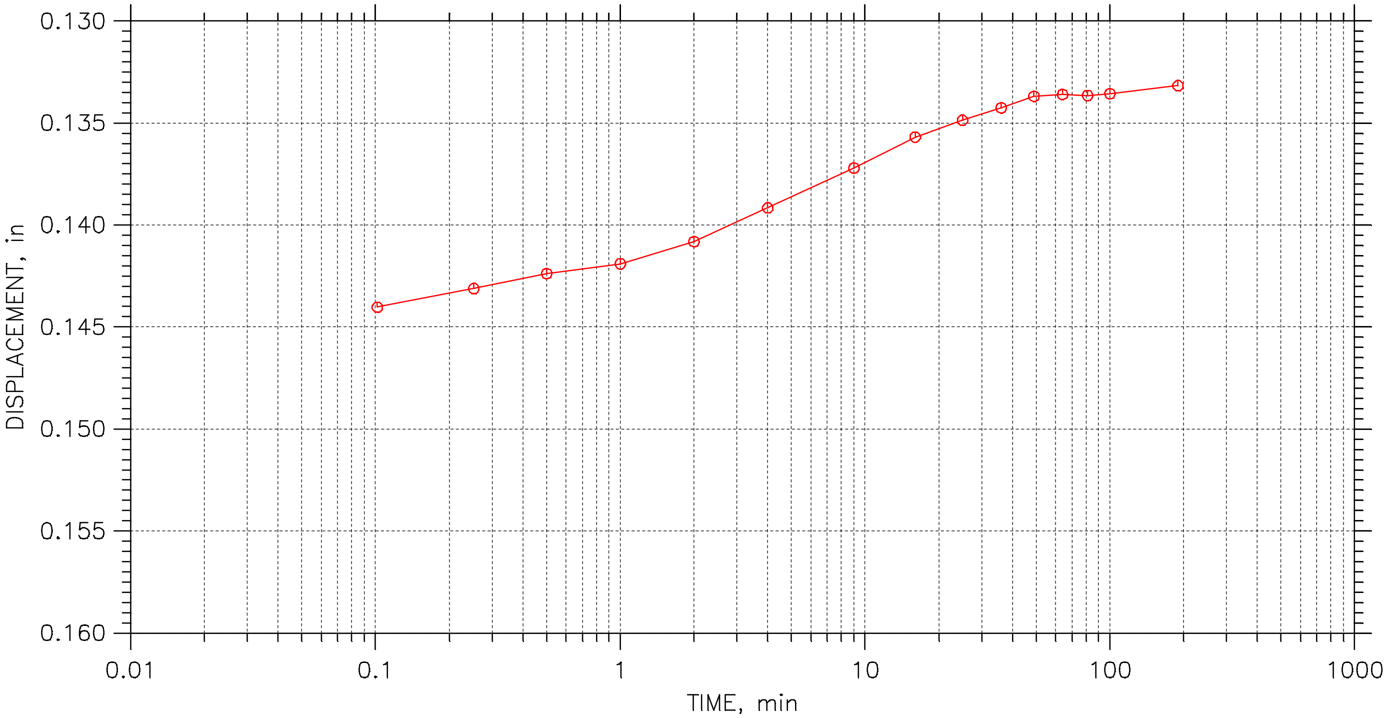
Tue, 26-APR-2016 10:52:32

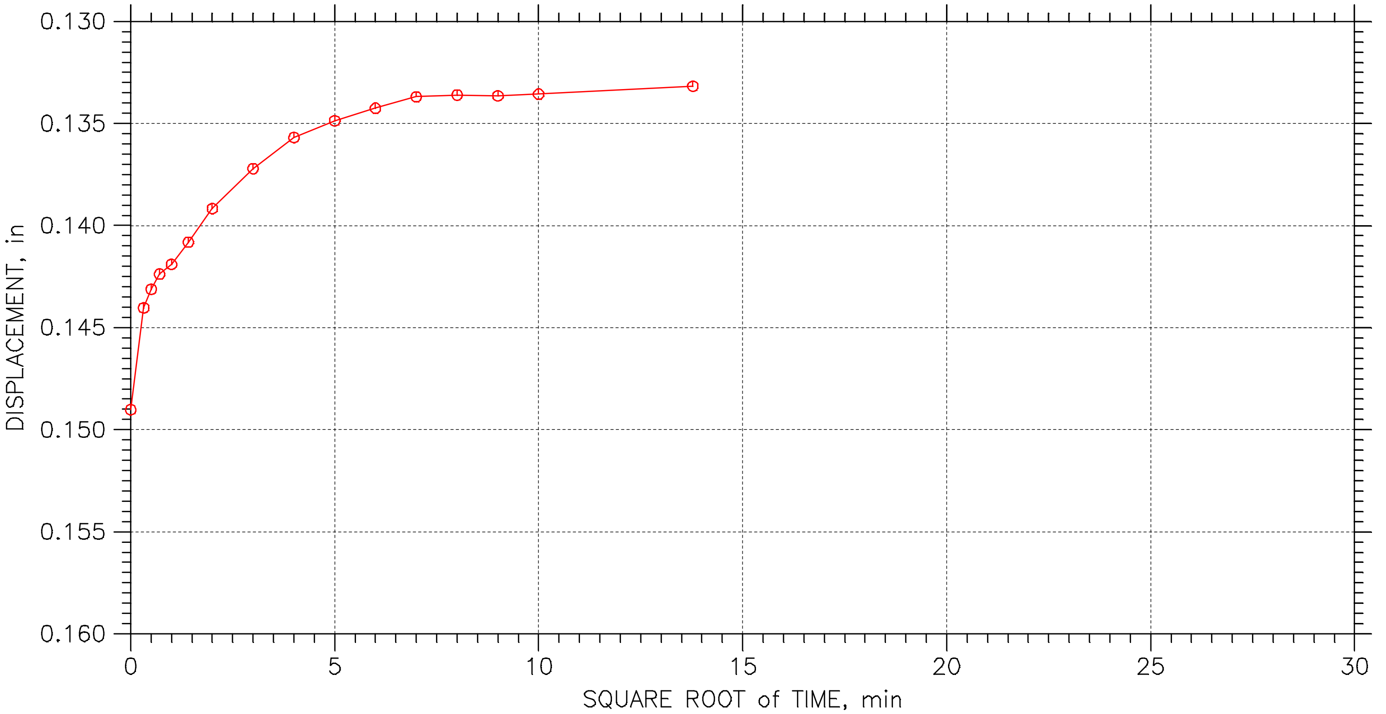
CONSOLIDATION TEST DATA

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		

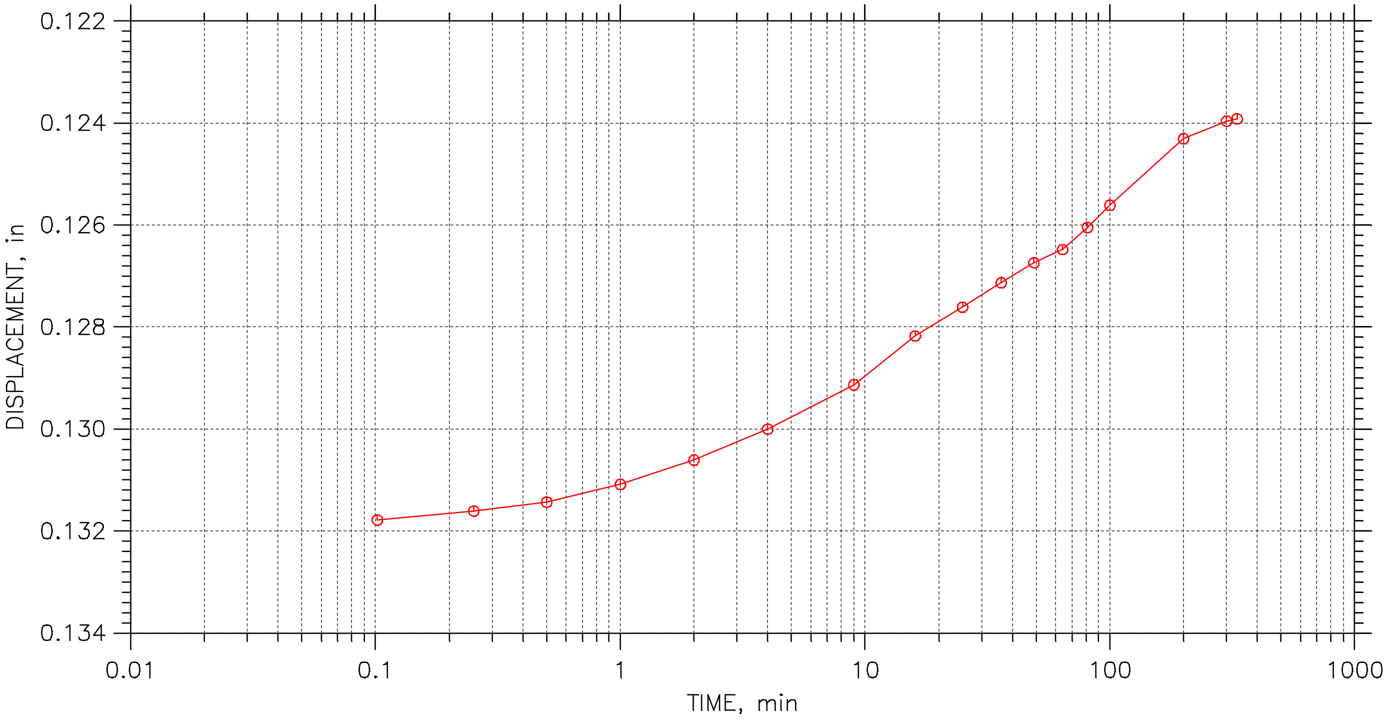
Tue, 26-APR-2016 10:52:34

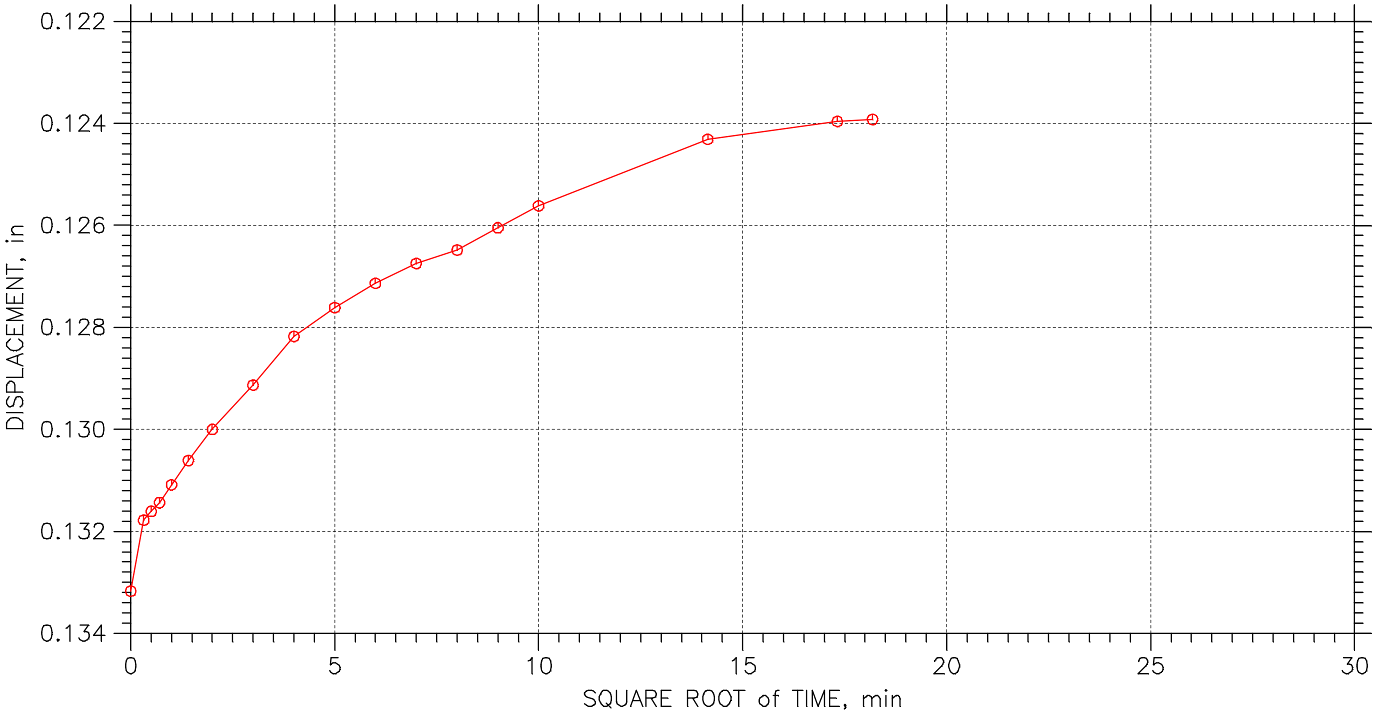
CONSOLIDATION TEST DATA

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		

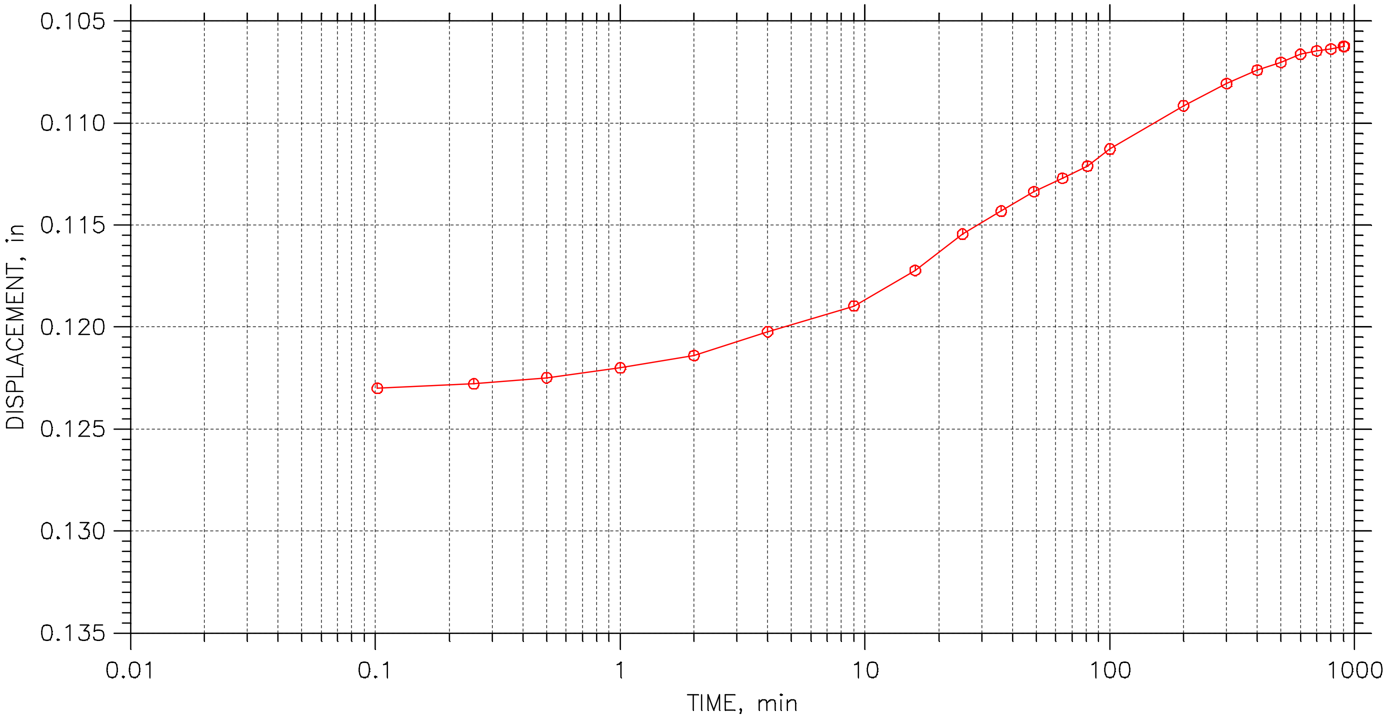
Tue, 26-APR-2016 10:52:35

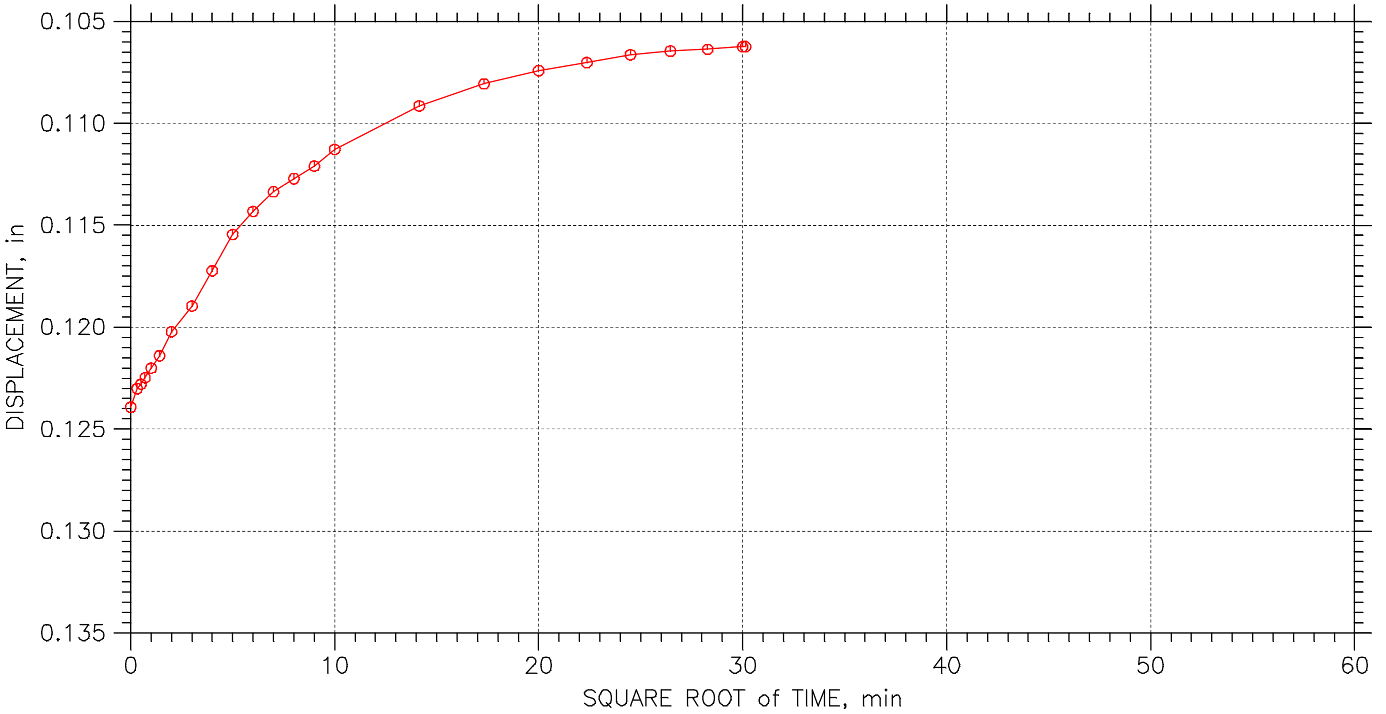
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 27 of 27

Stress: 0.125 tsf

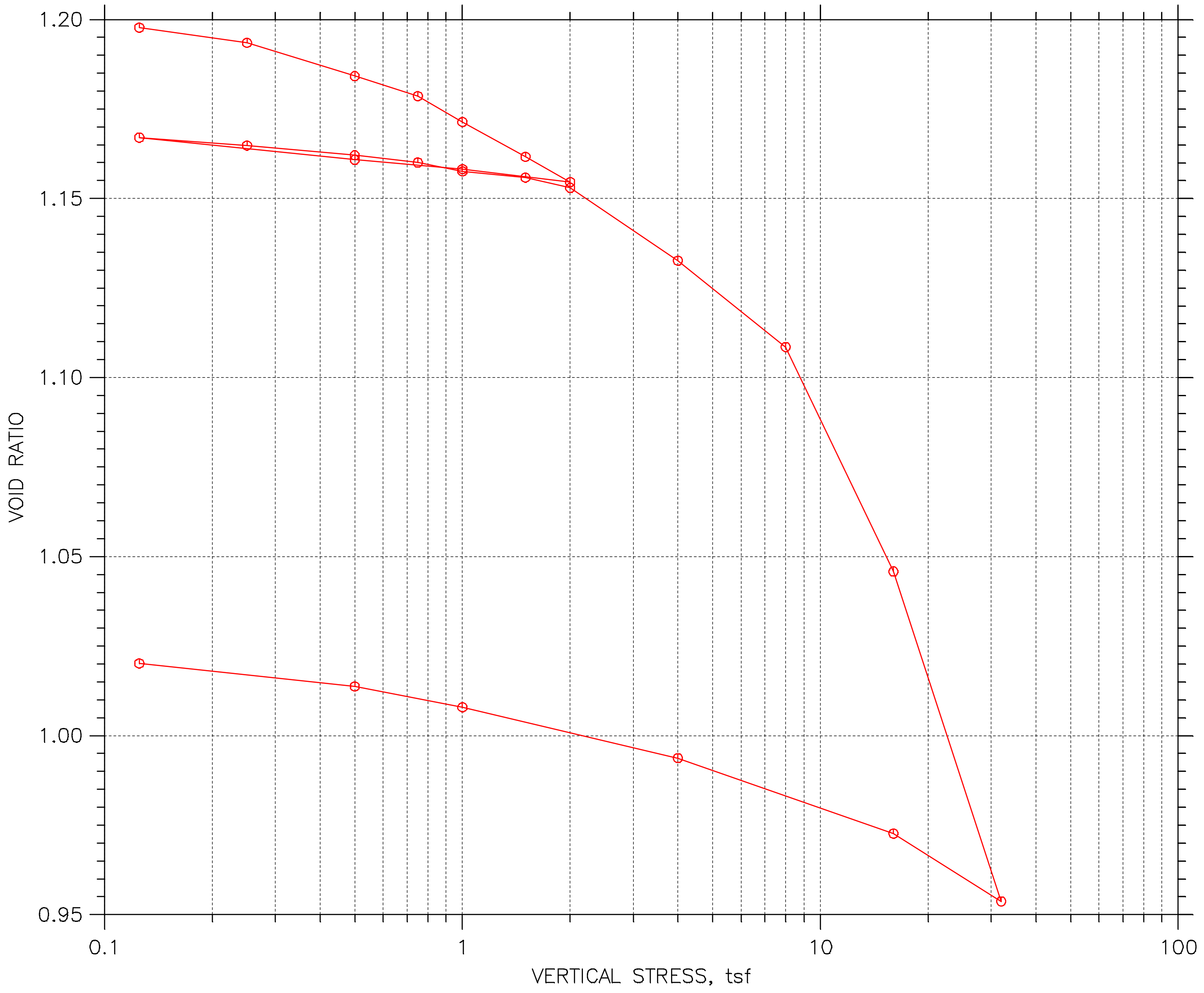




Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-1ST5	Tested By: BCM	Checked By: WPQ
	Sample No.: ST-5	Test Date: 04/14/16	Depth: 49.0'-51.0'
	Test No.: B161ST5CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: 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



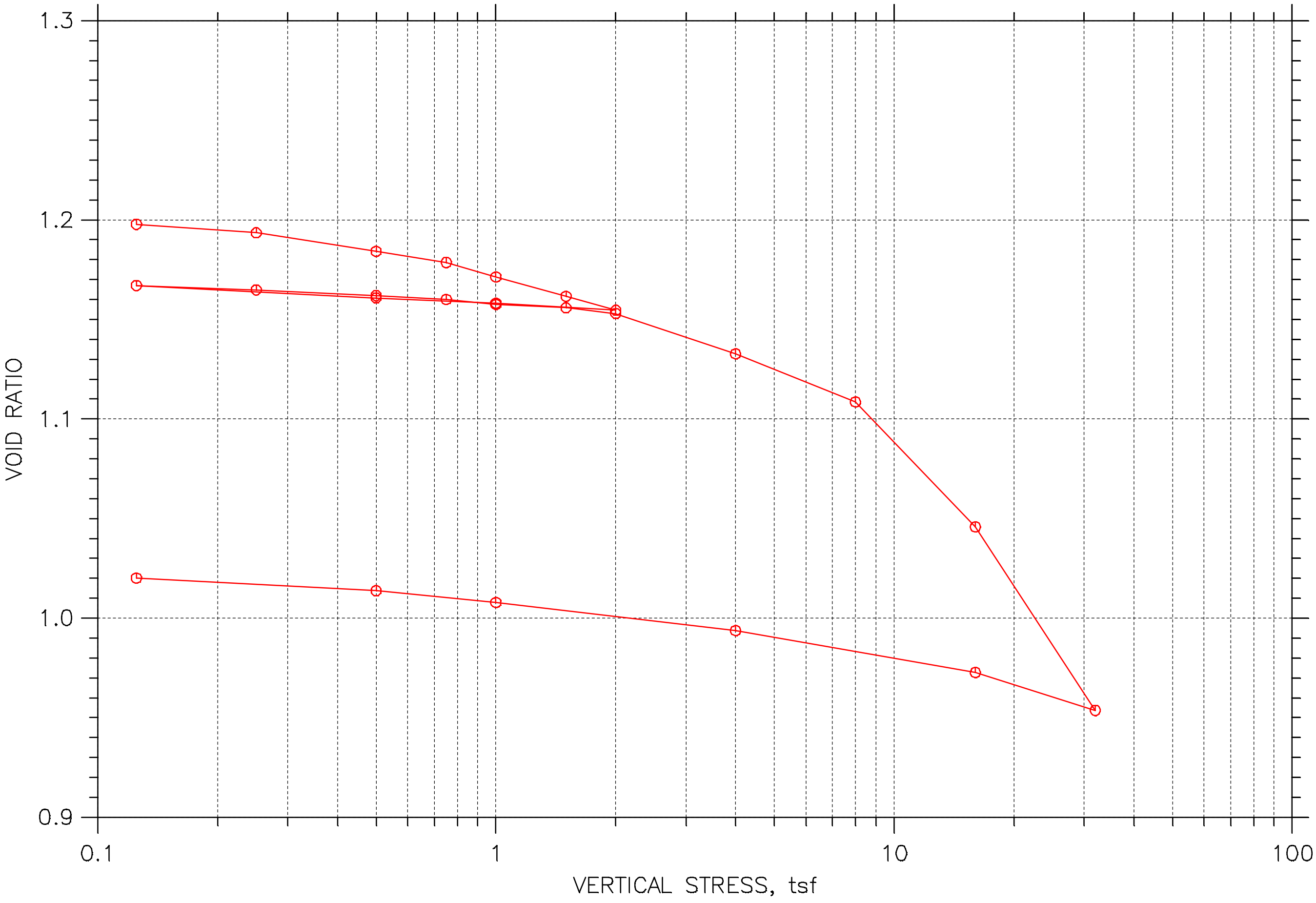
			Before Test	After Test
Overburden Pressure: 1.1 tsf		Water Content, %	45.09	39.22
Preconsolidation Pressure: 6 tsf		Dry Unit Weight, pcf	74.71	81.58
		Saturation, %	98.71	101.49
Diameter: 2.502 in	Height: 1.001 in	Void Ratio	1.21	1.02
LL: --- PL: ---	PI: --- GS: 2.64			

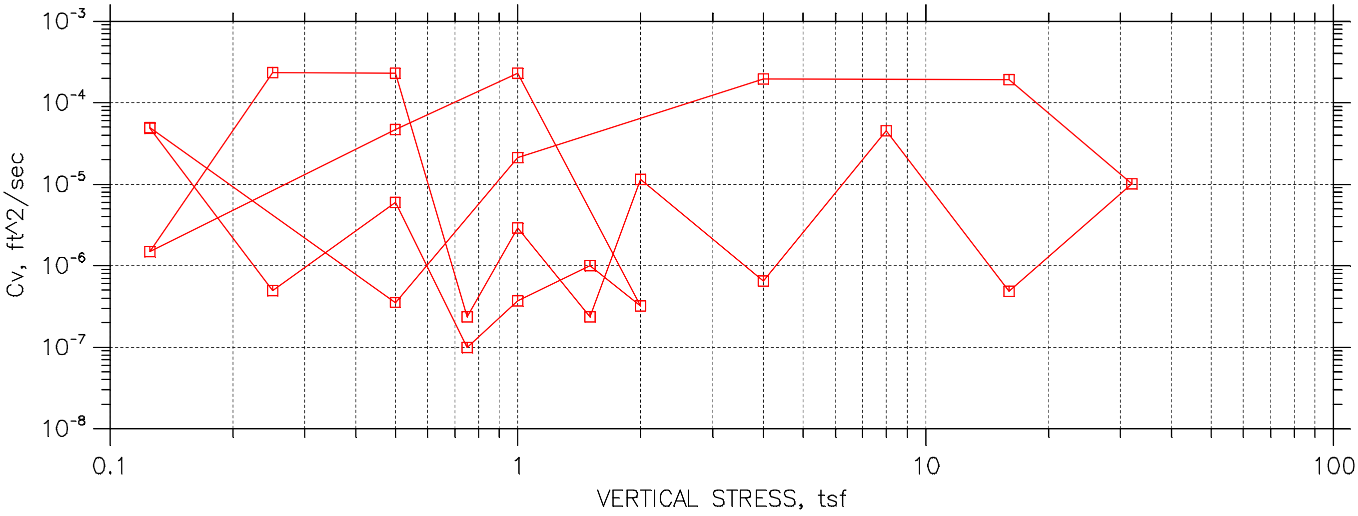
Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

Terracon
Consulting Engineers & Scientists

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

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

Measured Specific Gravity: 2.64
Initial Void Ratio: 1.21
Final Void Ratio: 1.02

Liquid Limit: ---
Plastic Limit: ---
Plasticity Index: ---

Initial Height: 1.00 in
Specimen Diameter: 2.50 in

	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
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

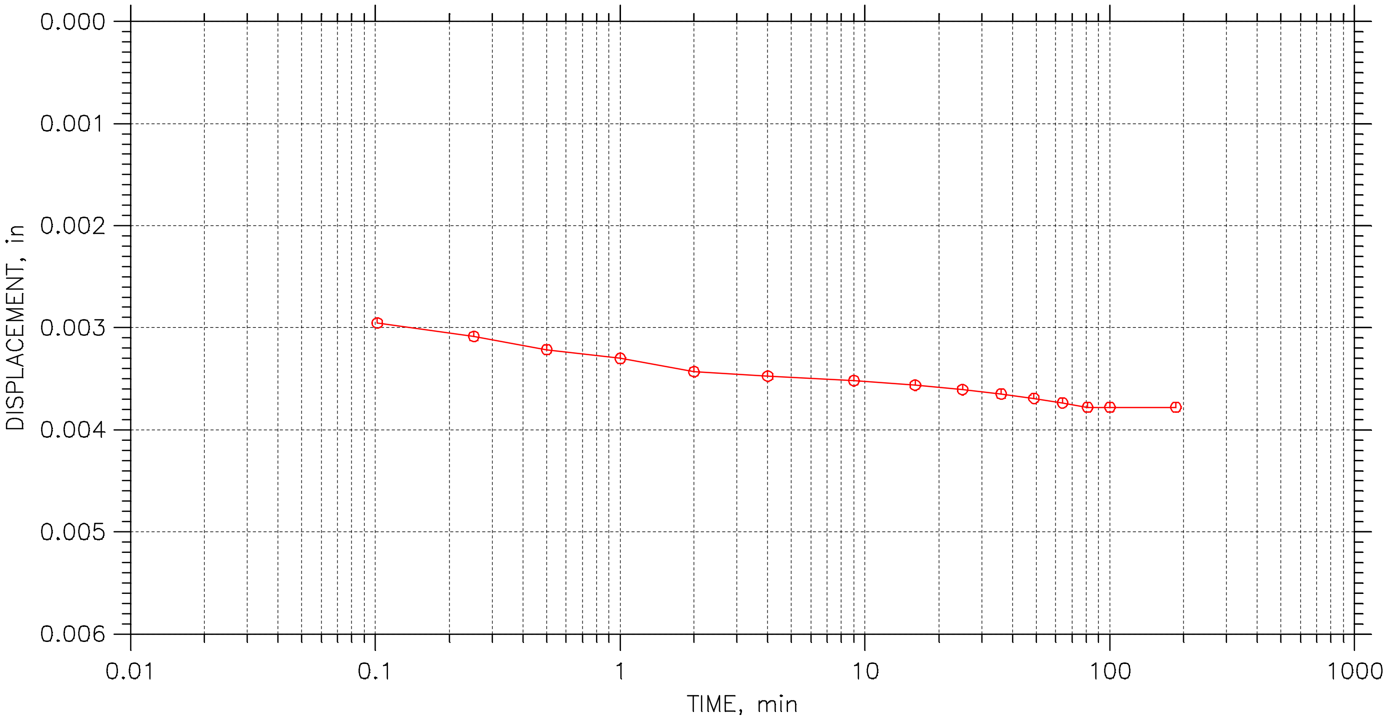
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	T50 Fitting Sq.Rt. min	T50 Fitting Log min	Coefficient of Consolidation Sq.Rt. ft^2/sec	Coefficient of Consolidation Log ft^2/sec	Coefficient of Consolidation Ave. ft^2/sec
1	0.125	0.003779	1.198	0.38	0.1	0.0	4.88e-005	0.00e+000	4.88e-005
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

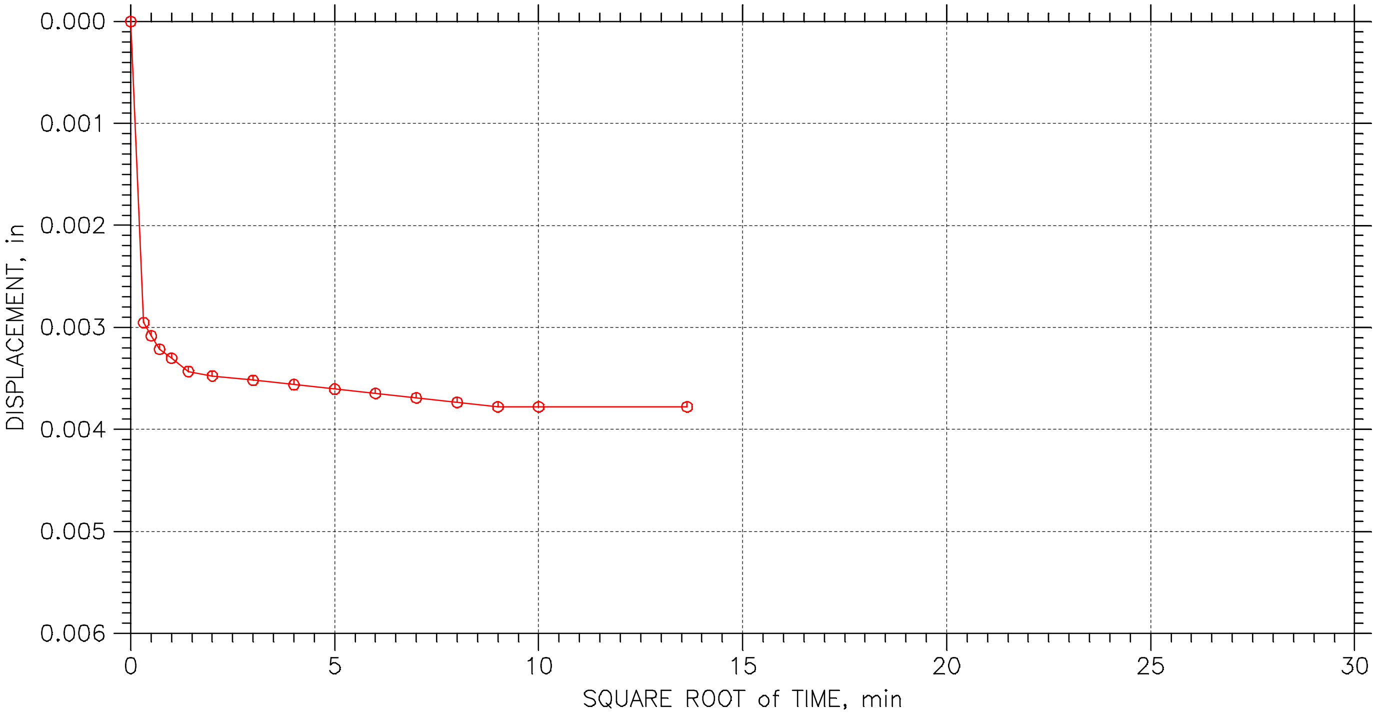
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 1 of 25

Stress: 0.125 tsf





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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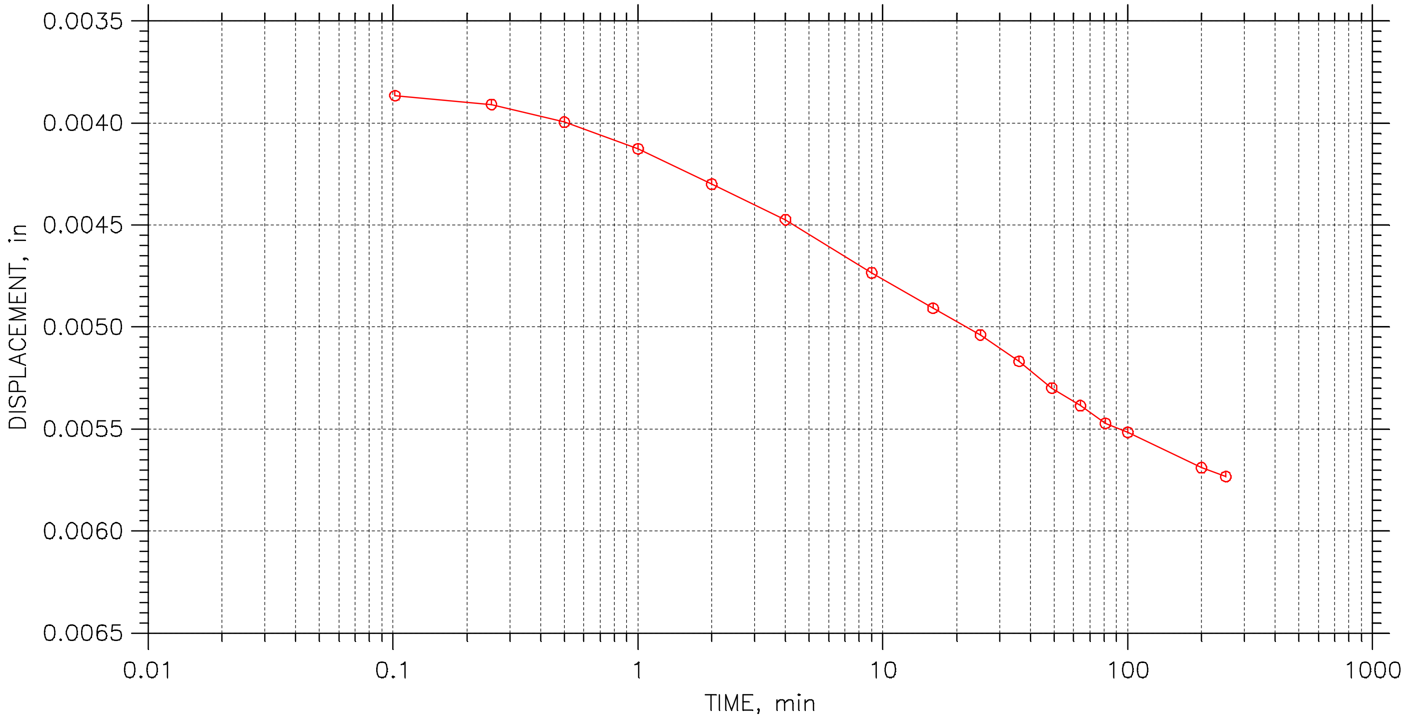
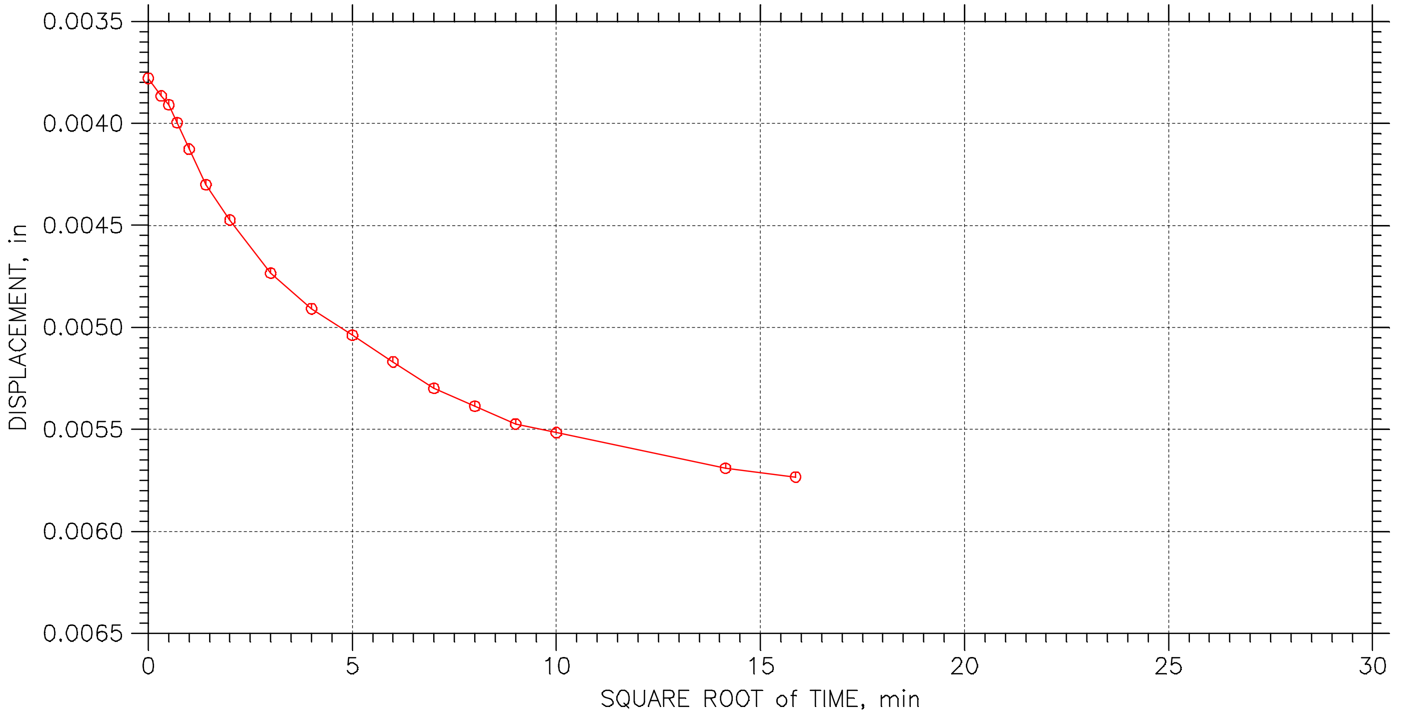
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 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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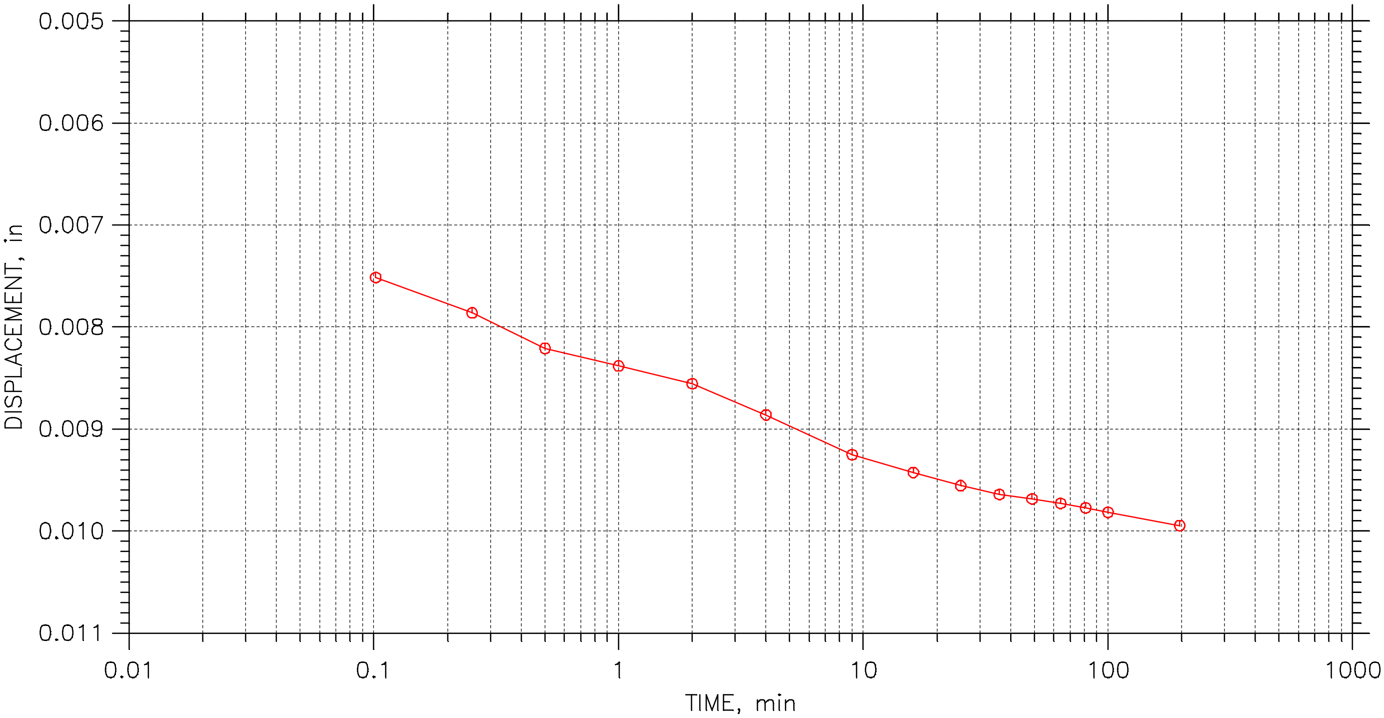
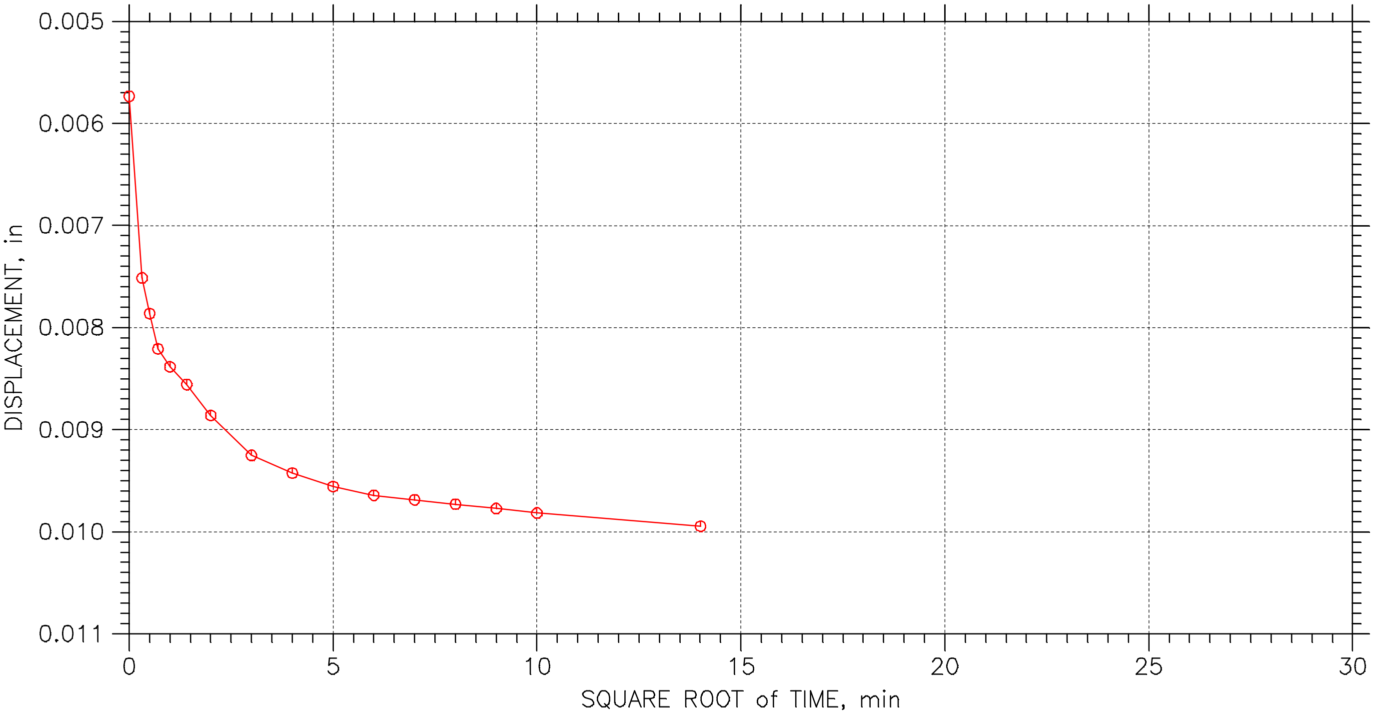
CONSOLIDATION TEST DATA

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		

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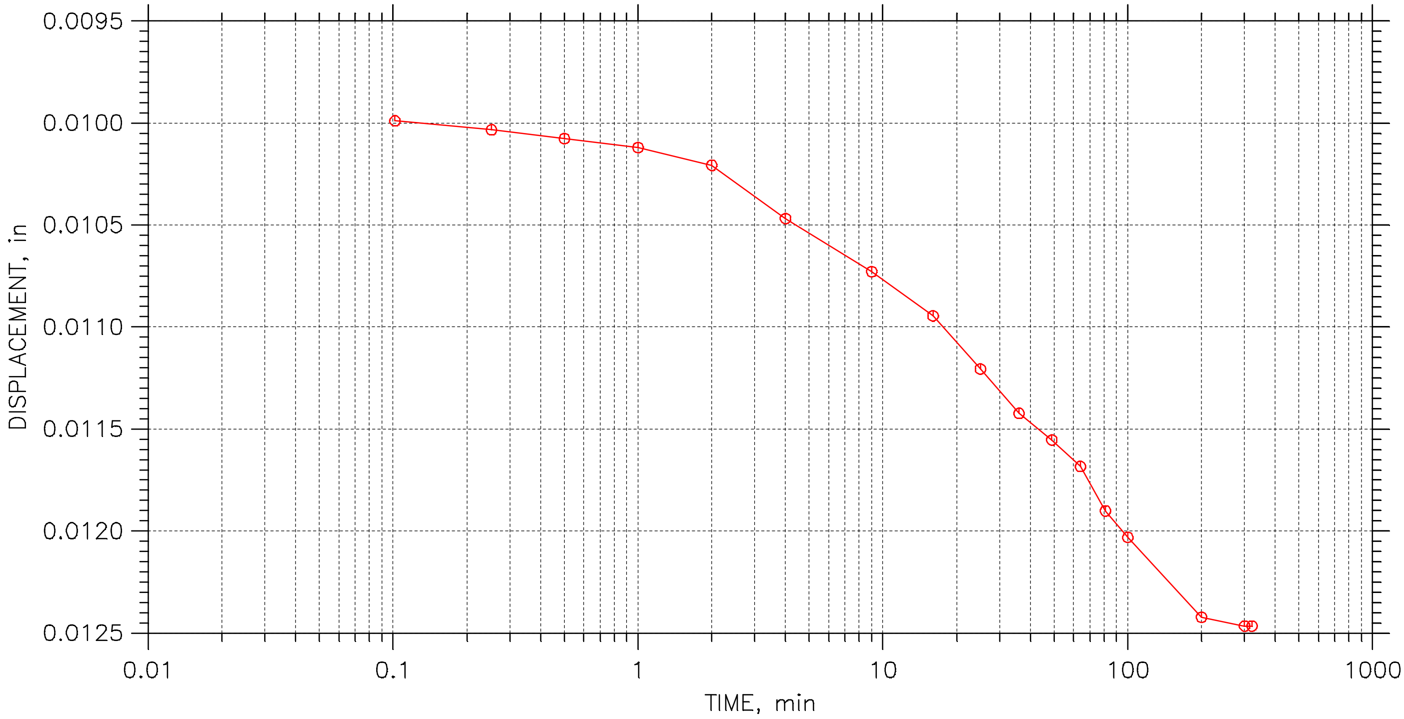
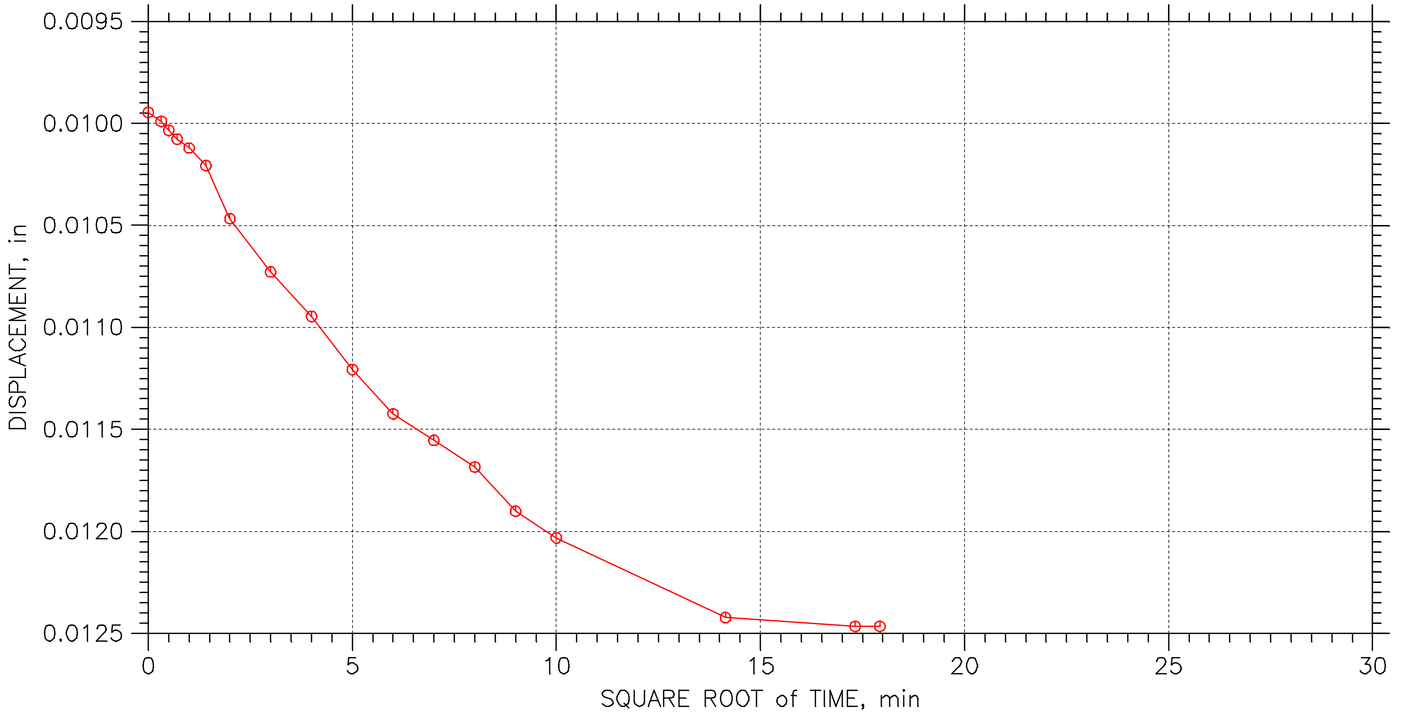
CONSOLIDATION TEST DATA

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		

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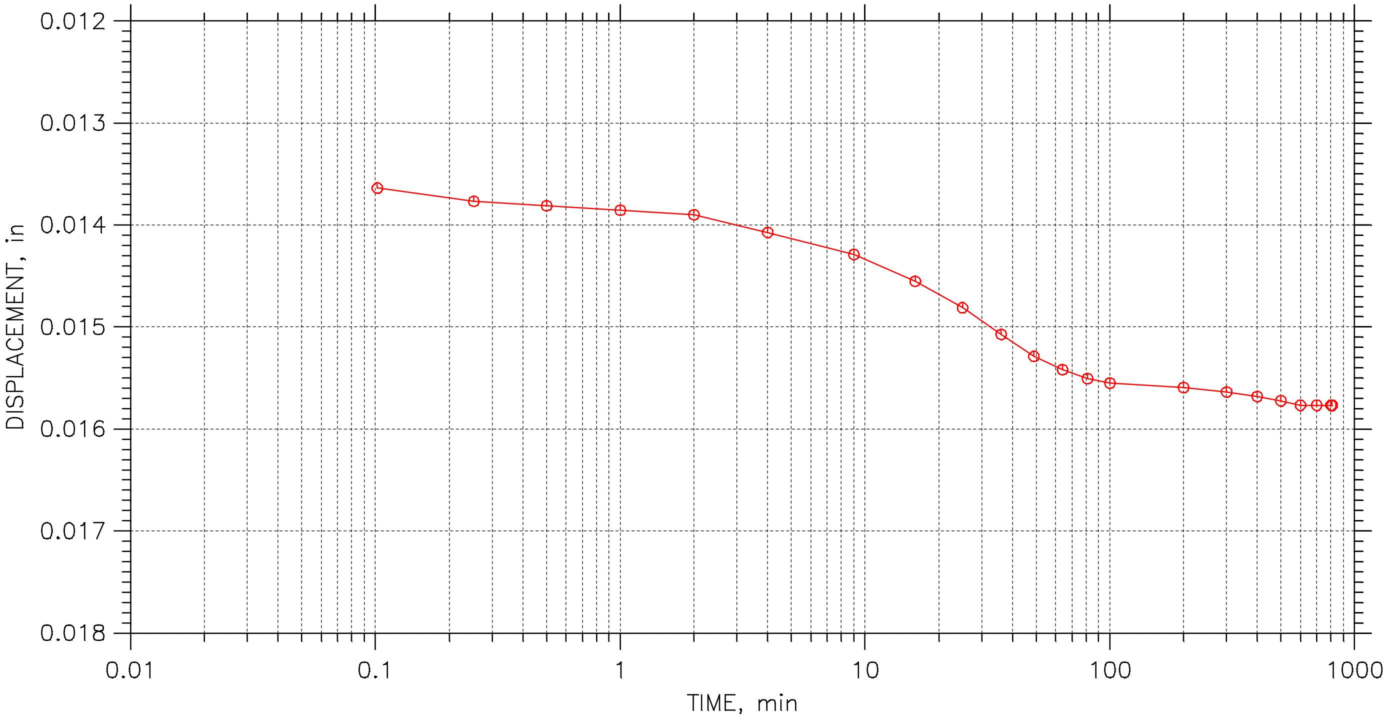
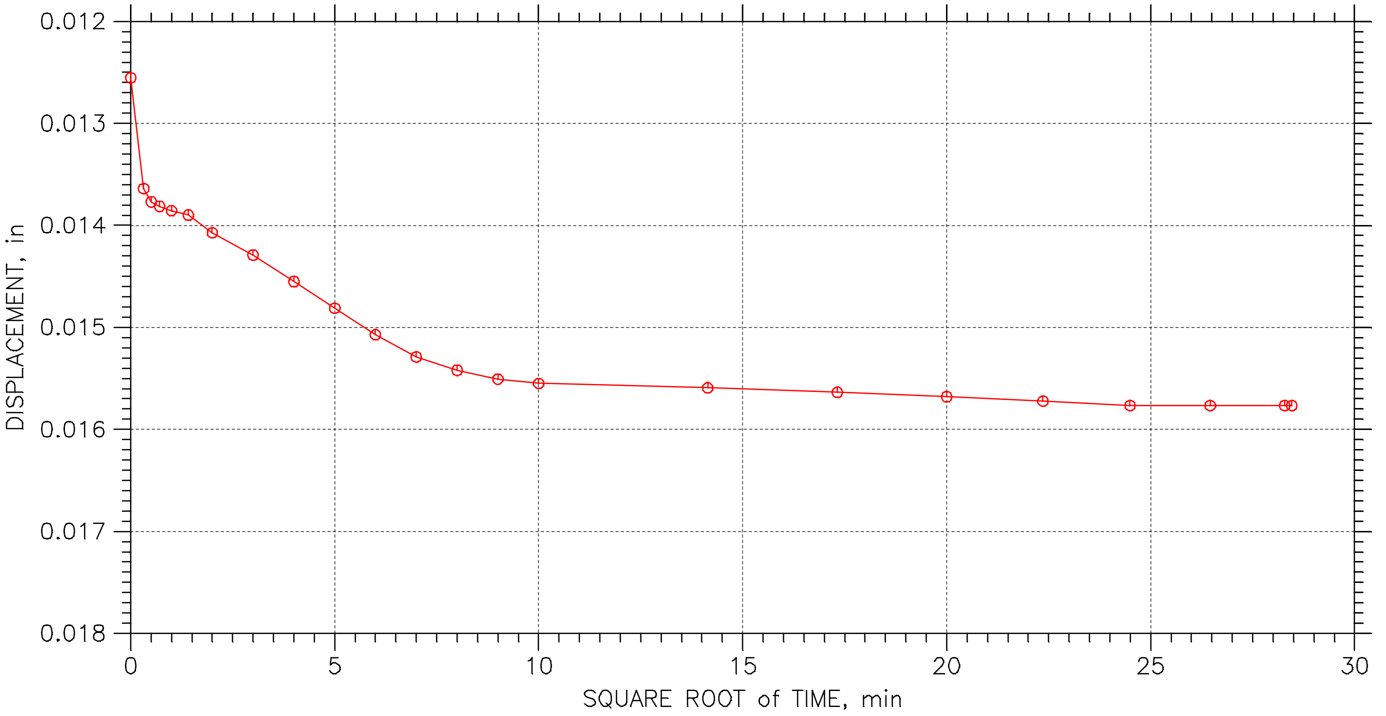
CONSOLIDATION TEST DATA

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		

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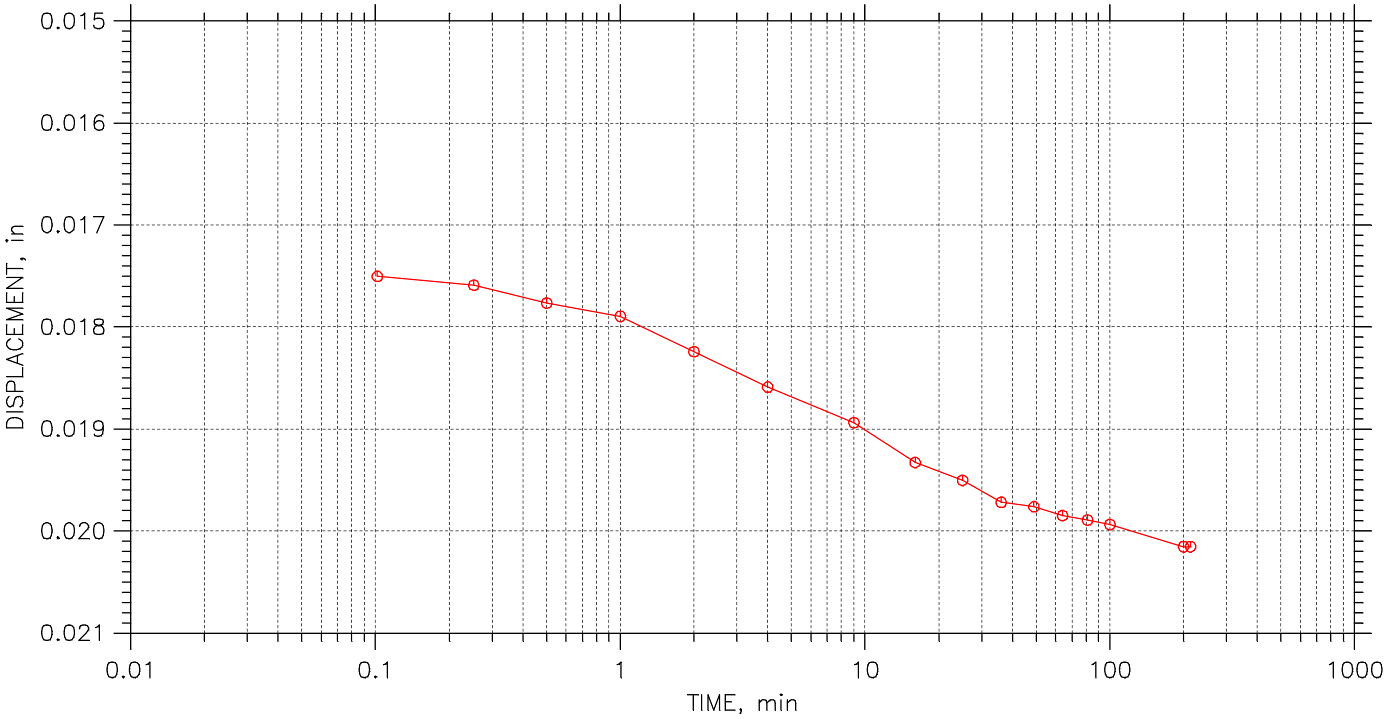
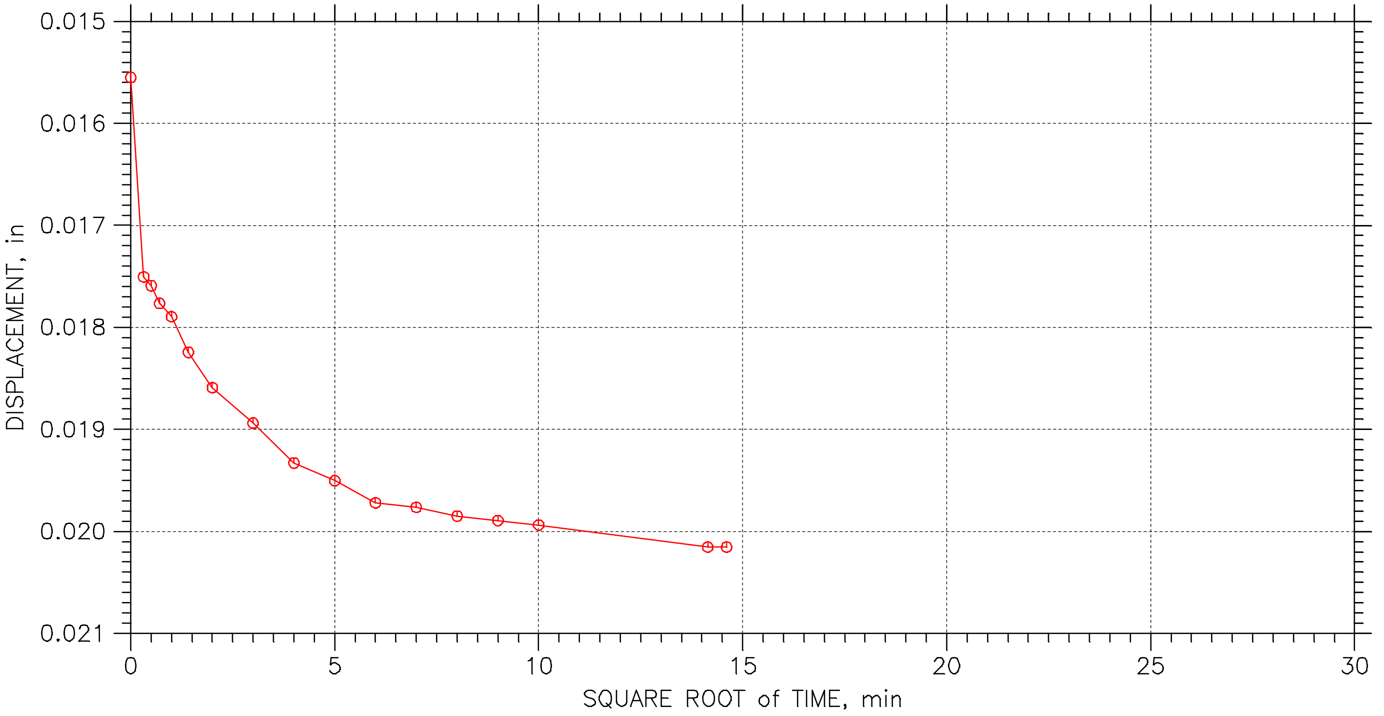
CONSOLIDATION TEST DATA

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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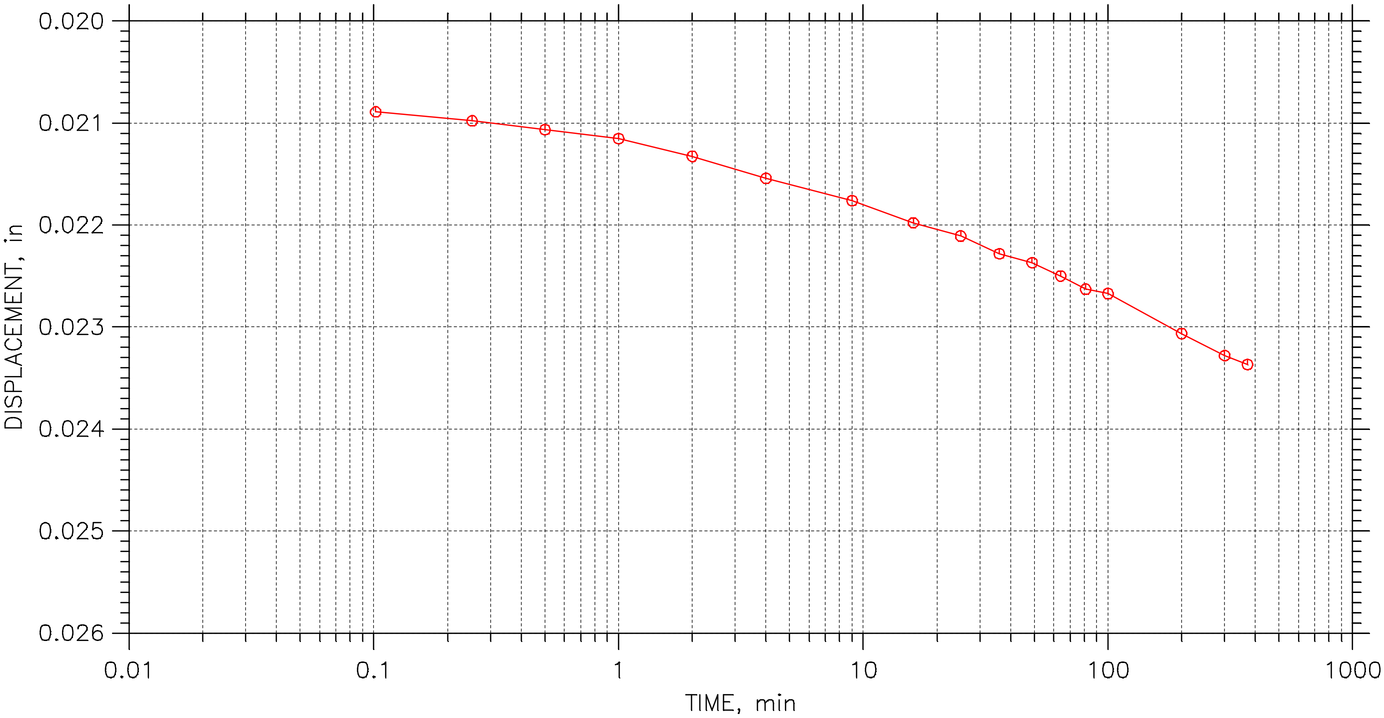
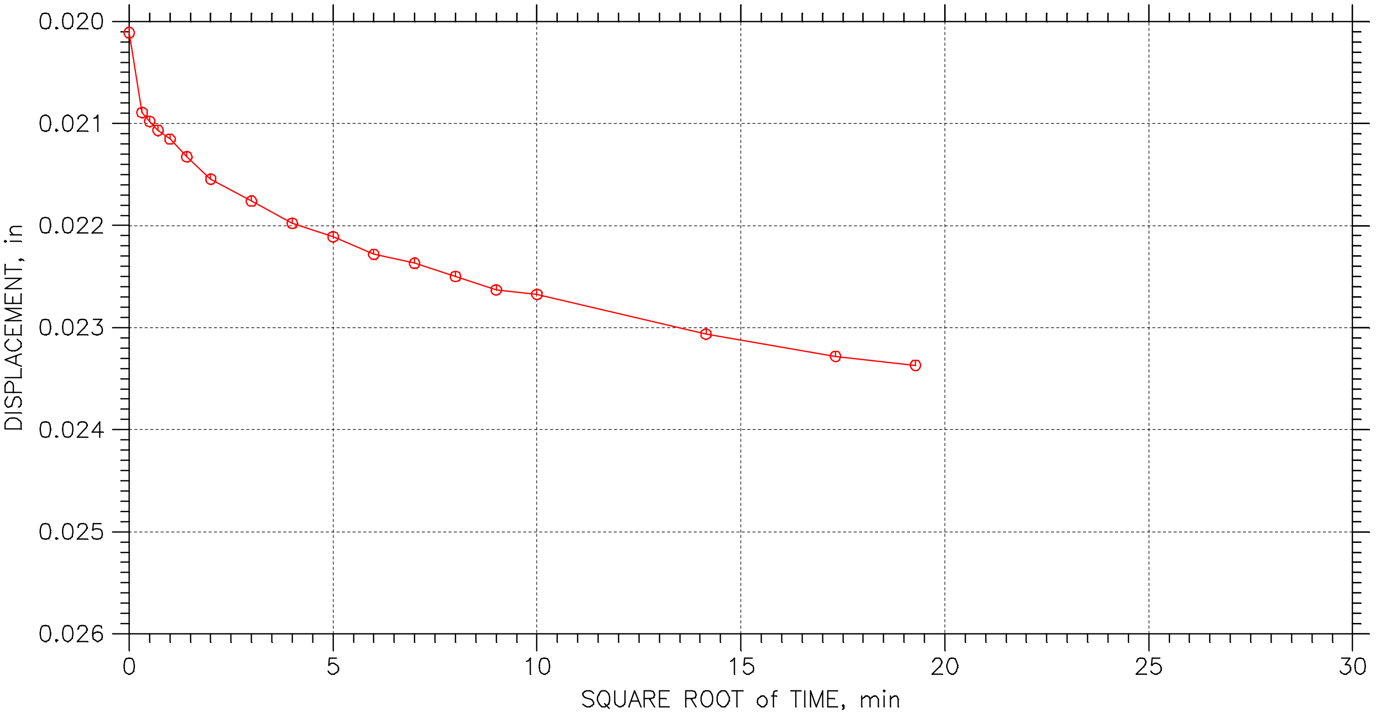
CONSOLIDATION TEST DATA

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		

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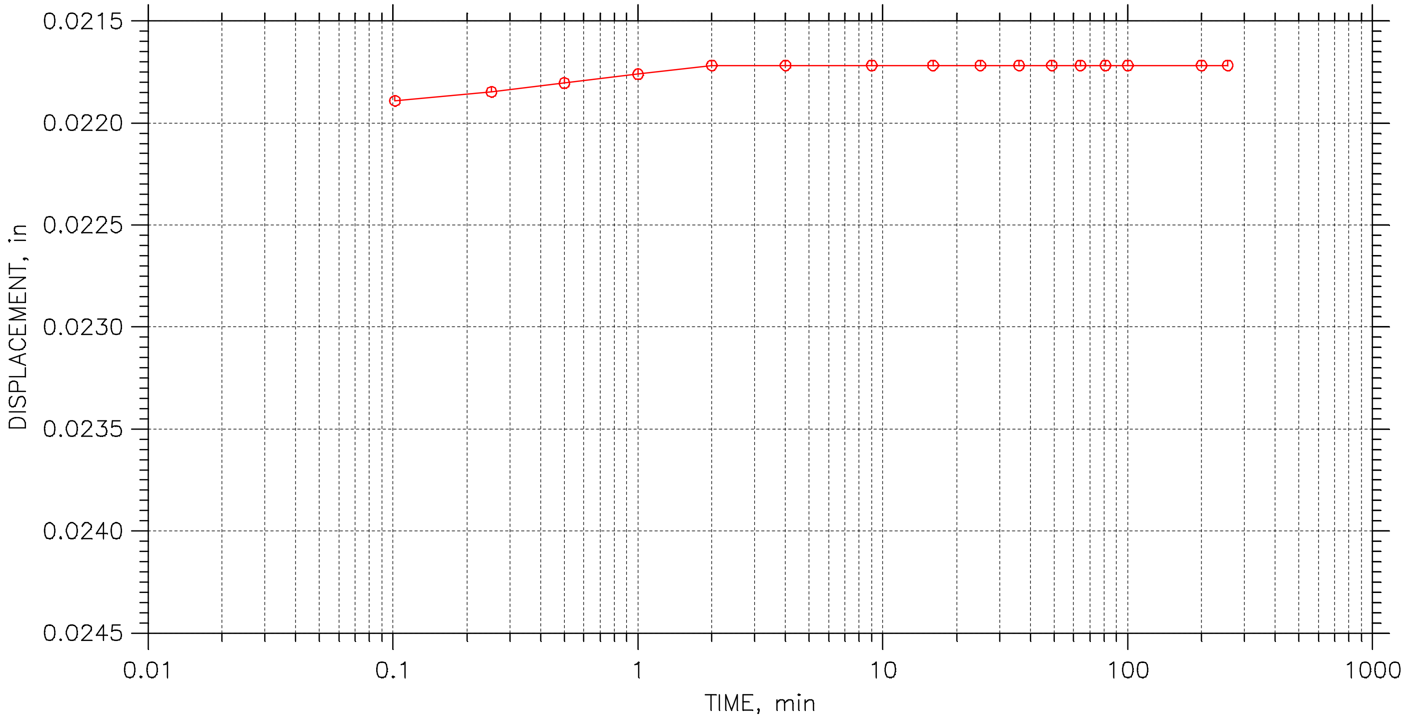
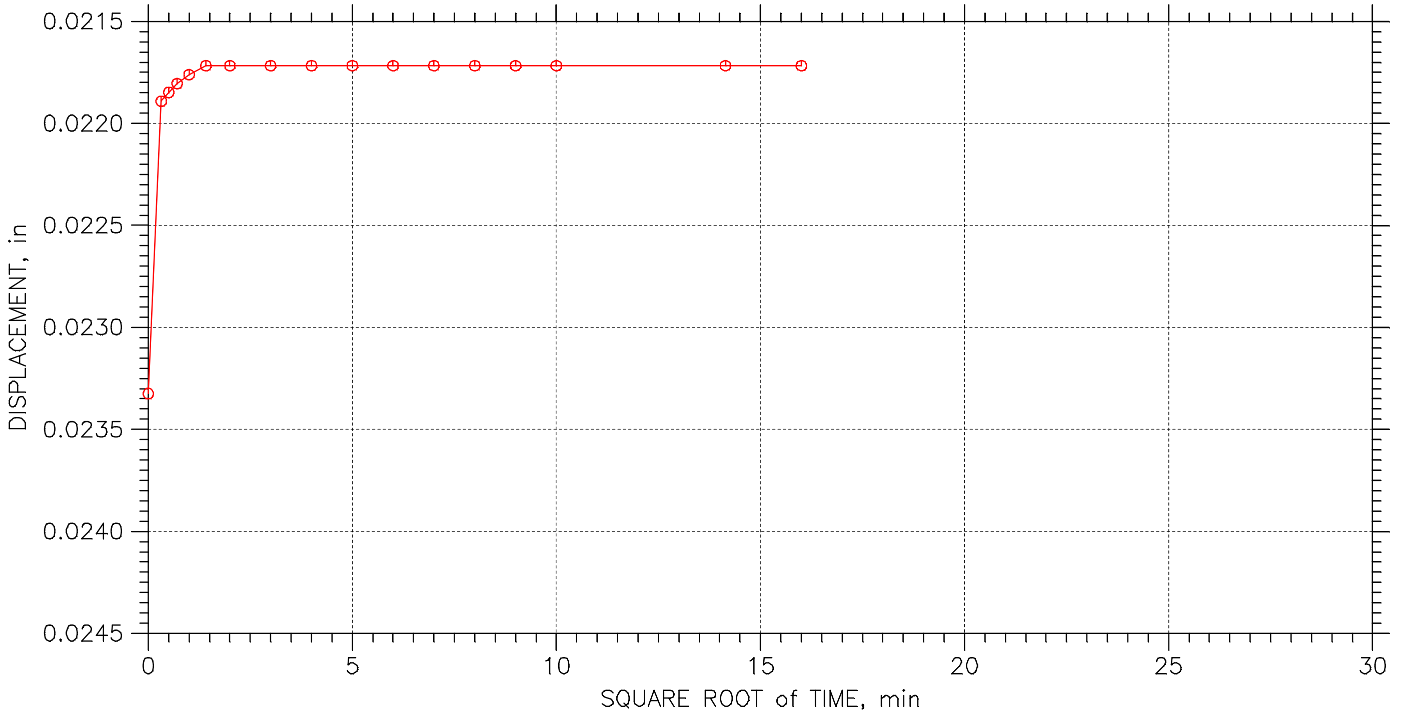
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 8 of 25

Stress: 1. tsf





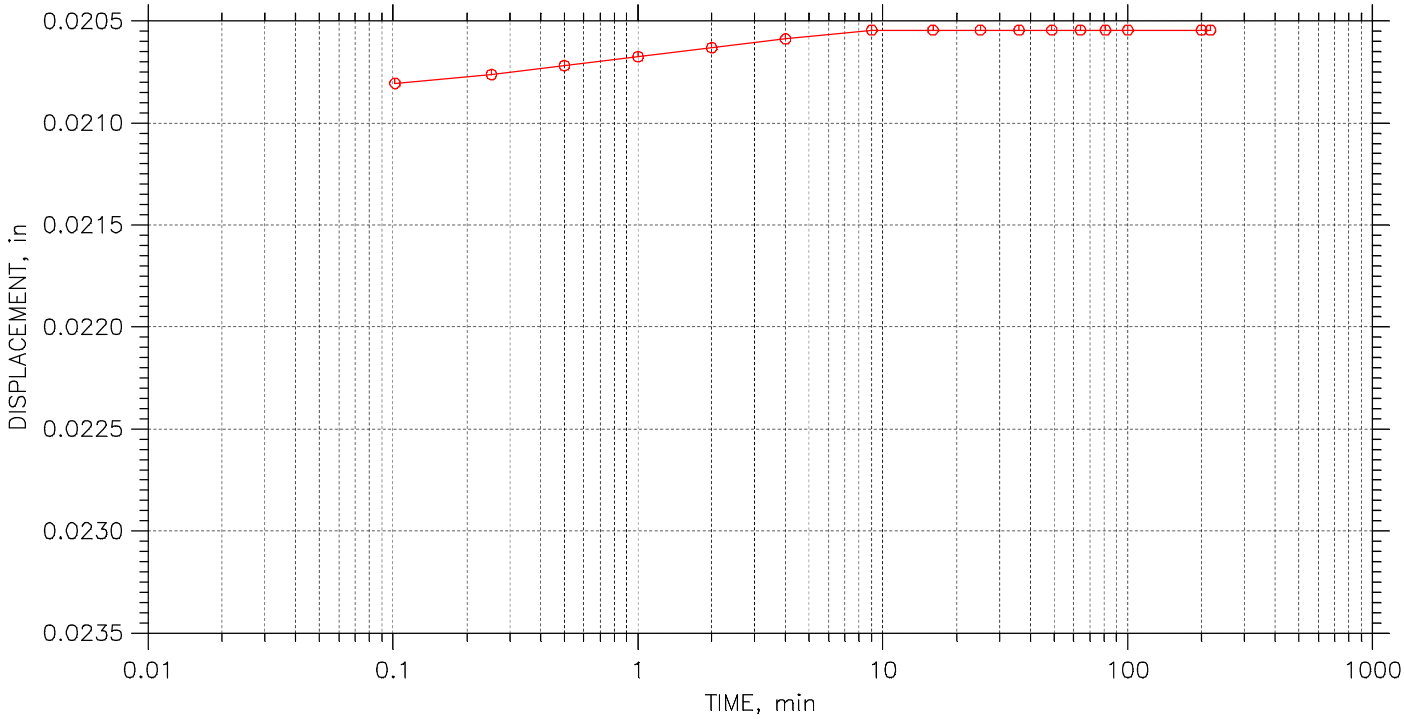
Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

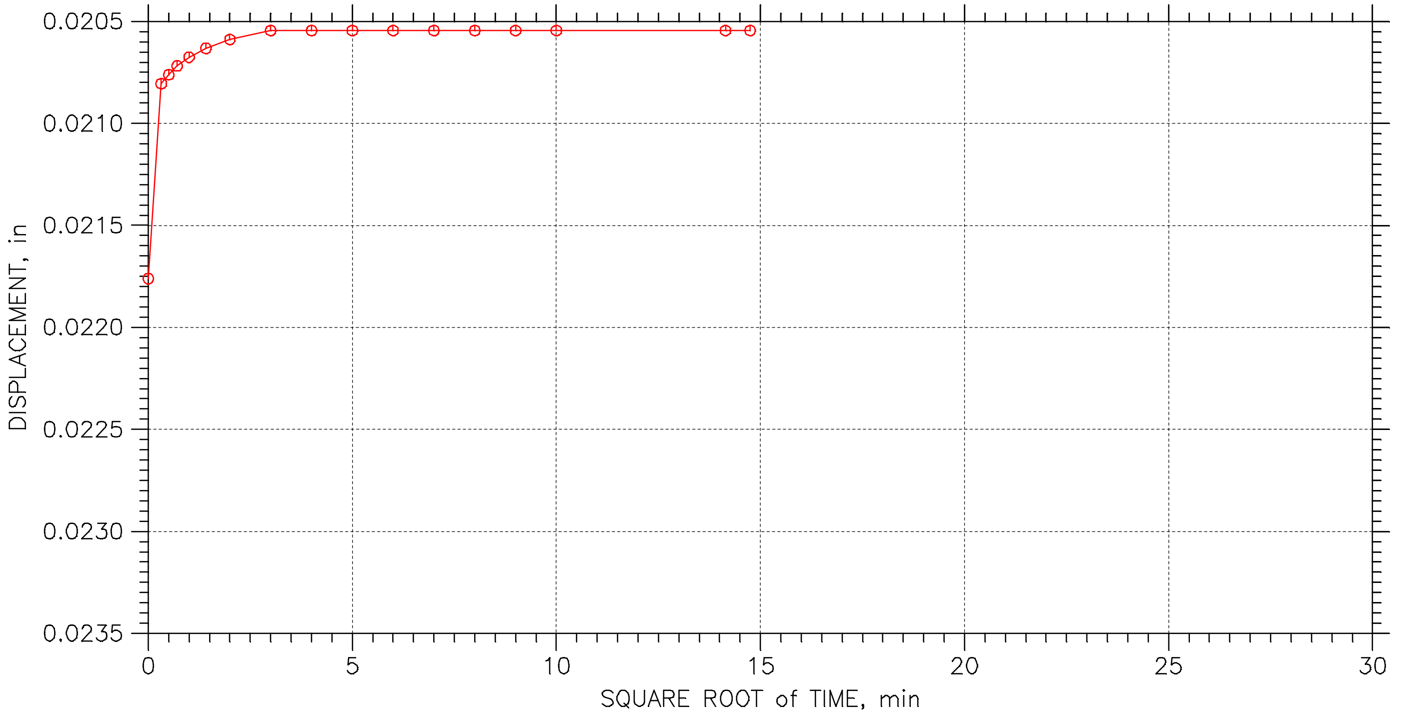
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 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		

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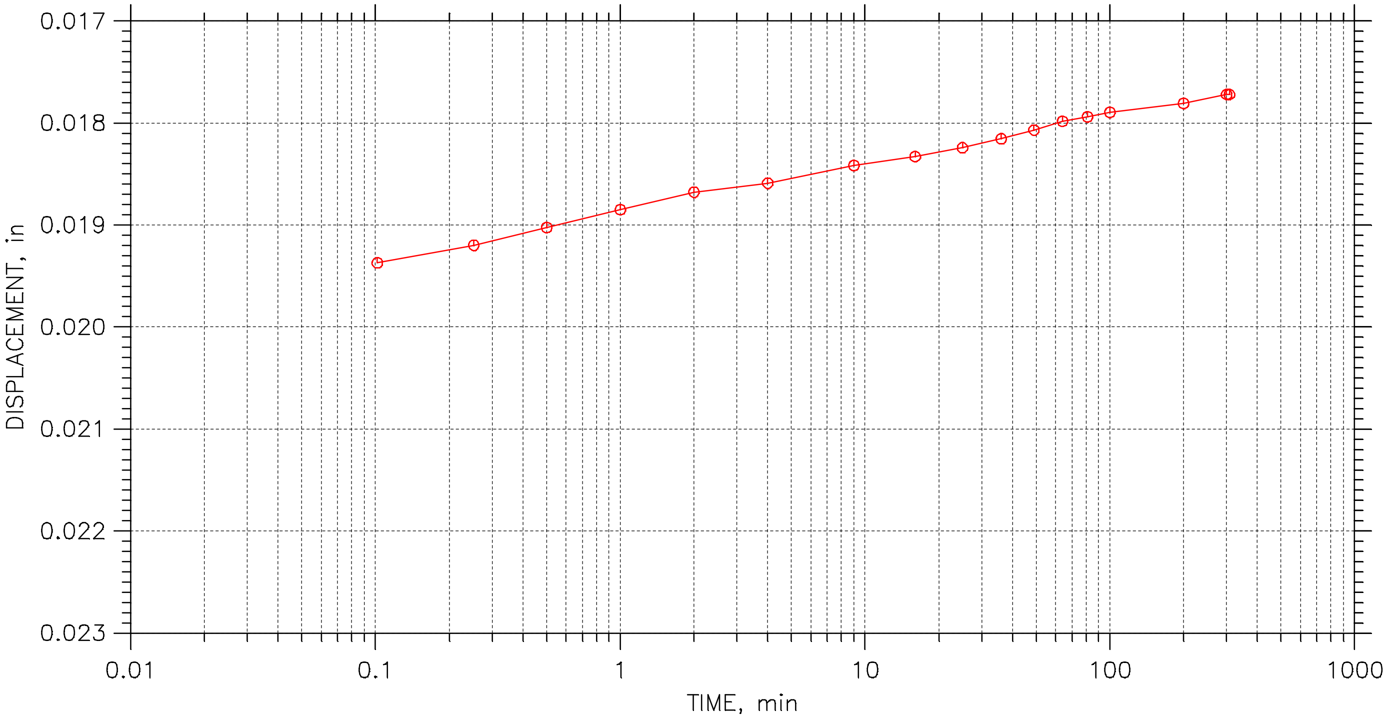
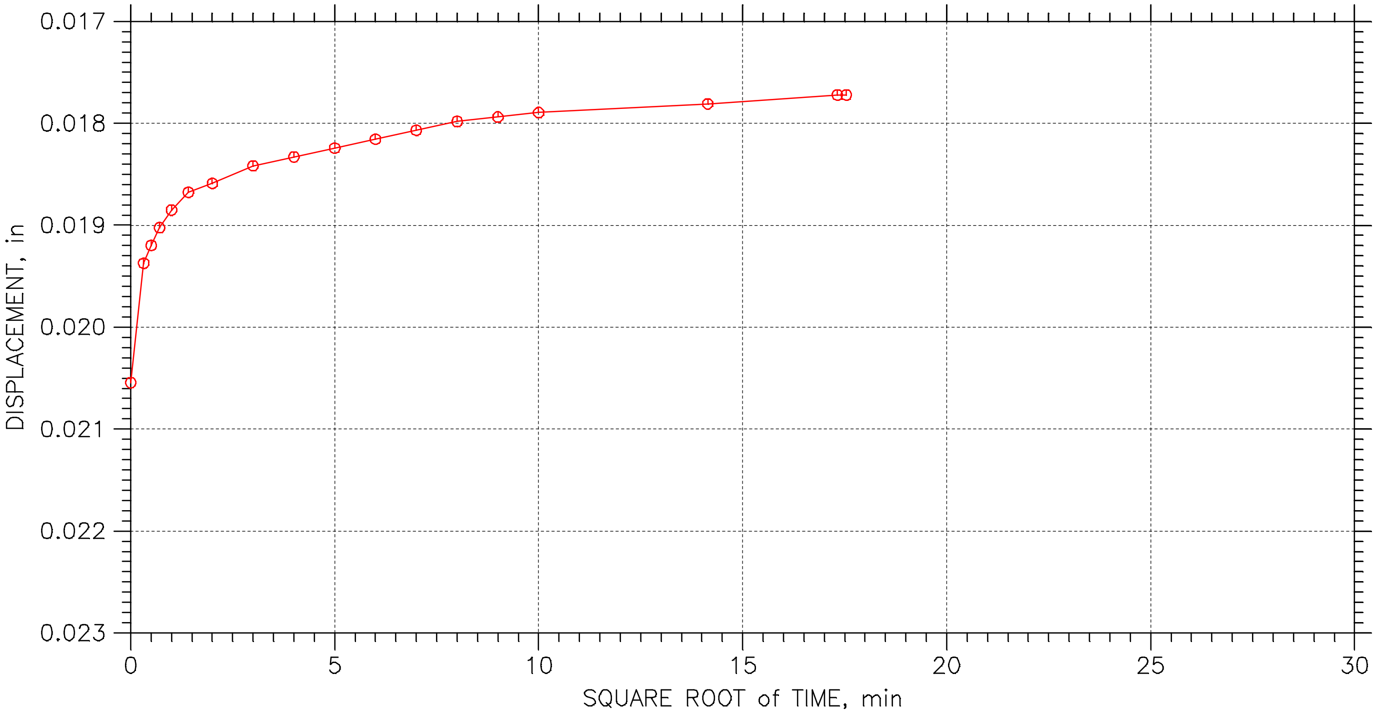
CONSOLIDATION TEST DATA

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		

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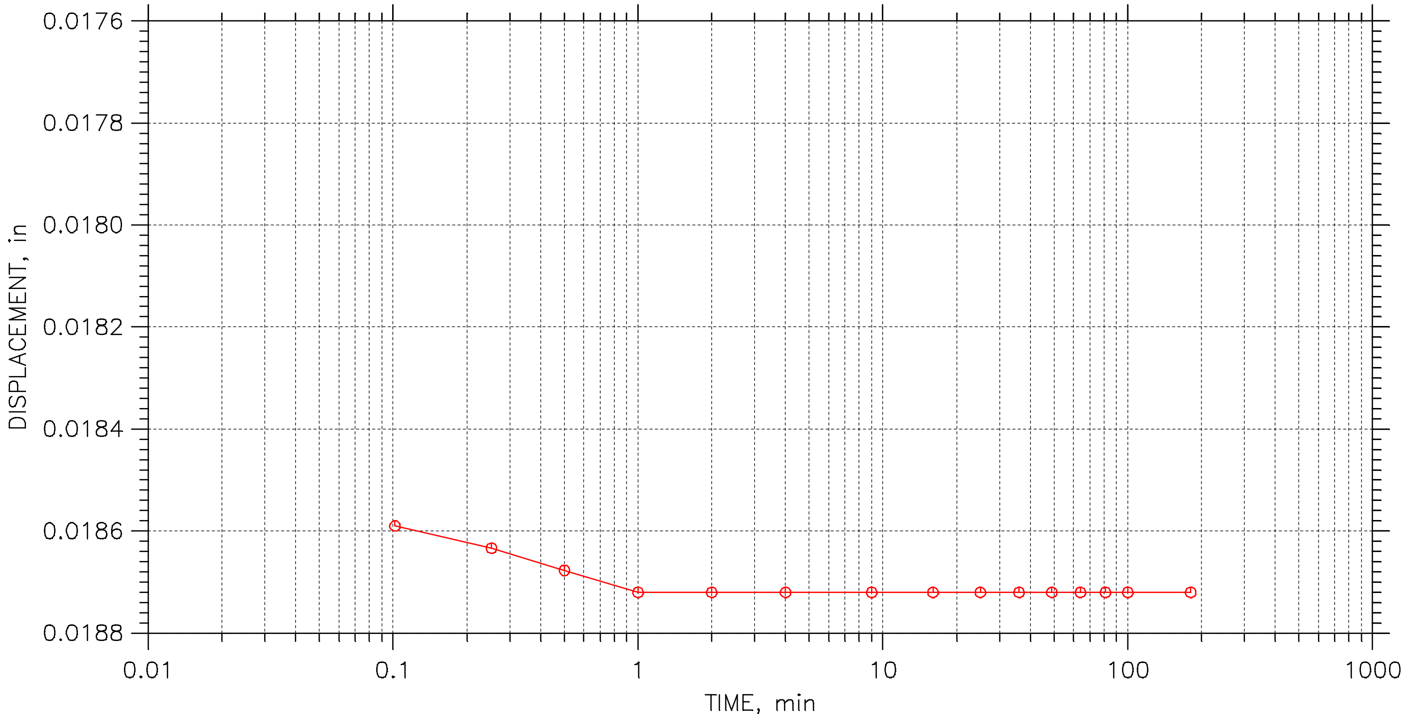
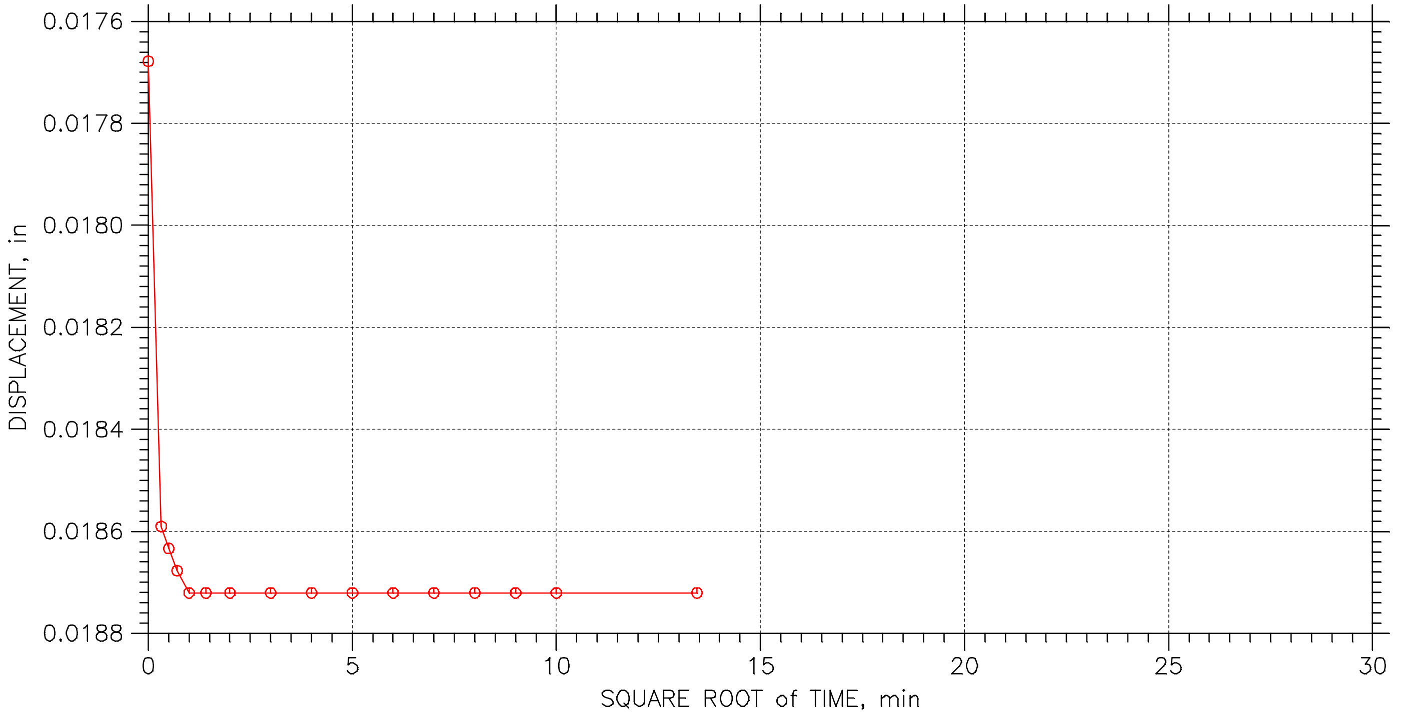
CONSOLIDATION TEST DATA

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		

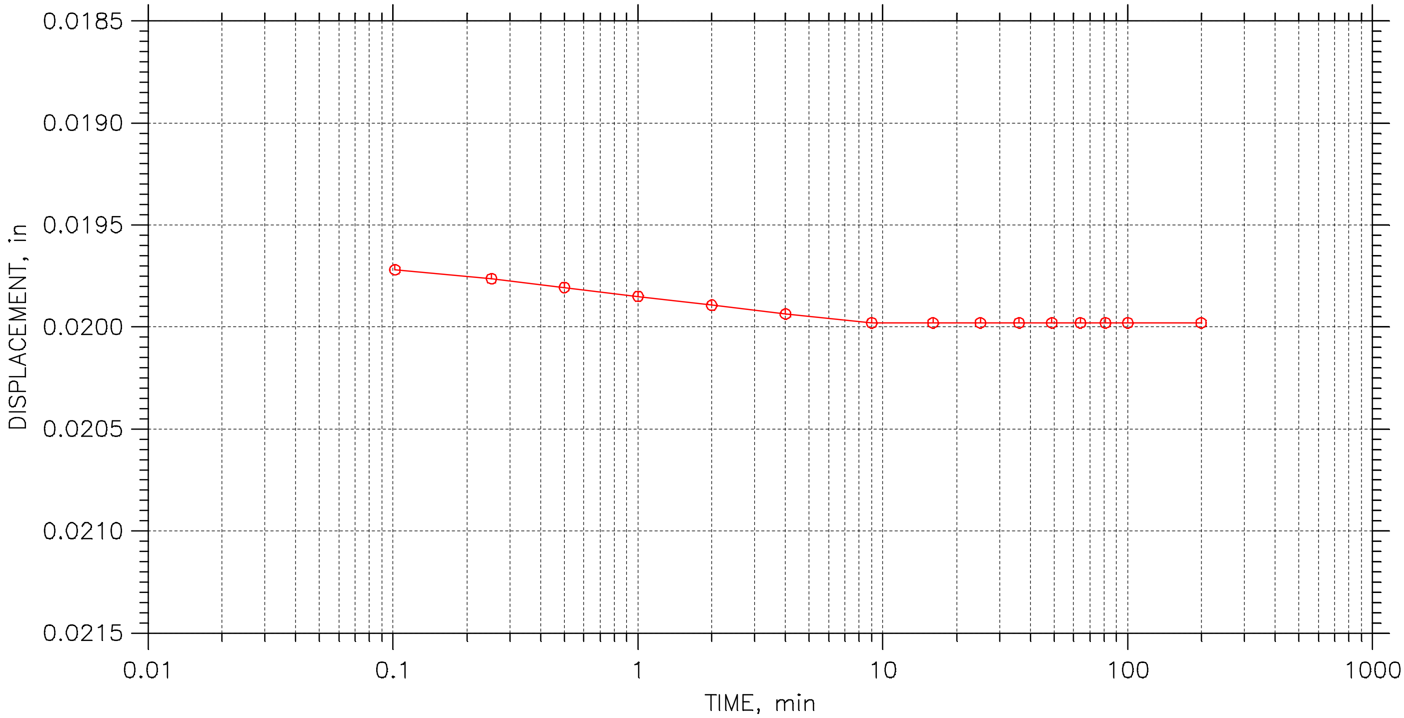
Tue, 26-APR-2016 13:54:06

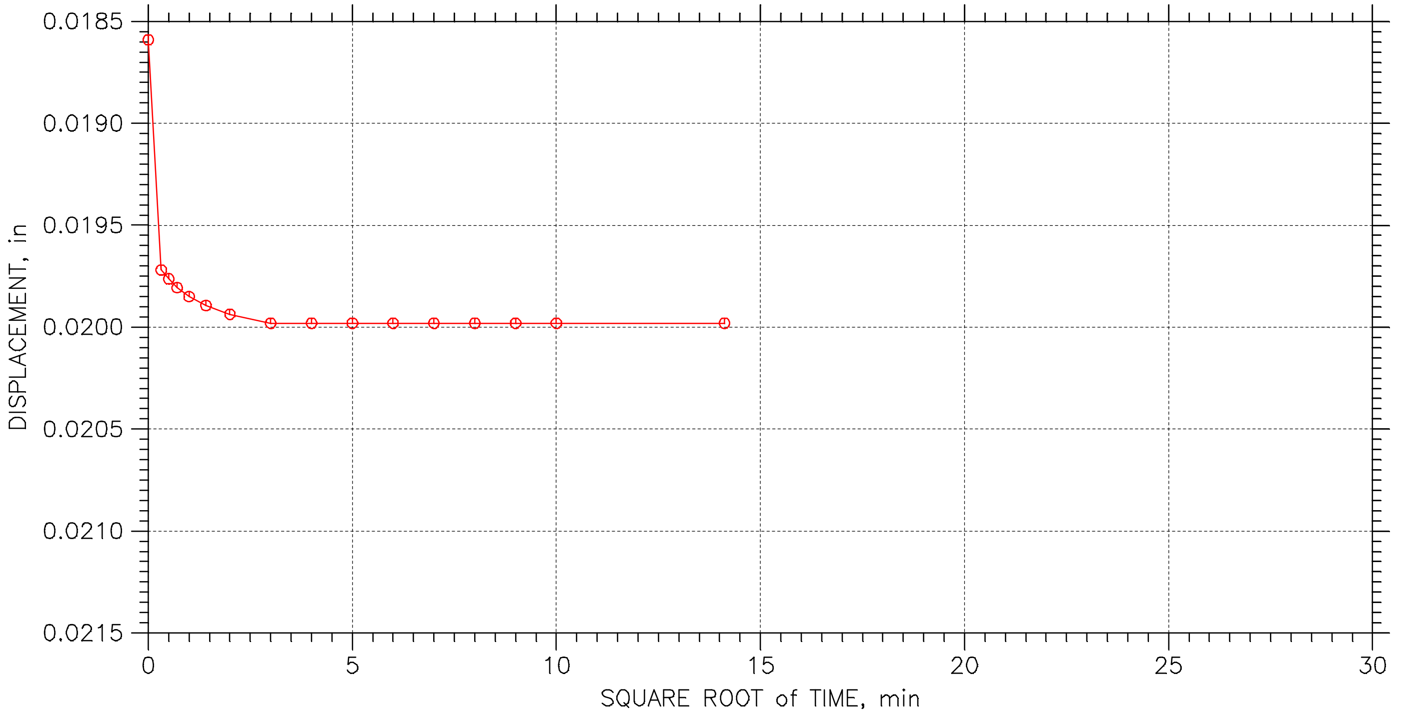
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 12 of 25

Stress: 0.5 tsf





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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		

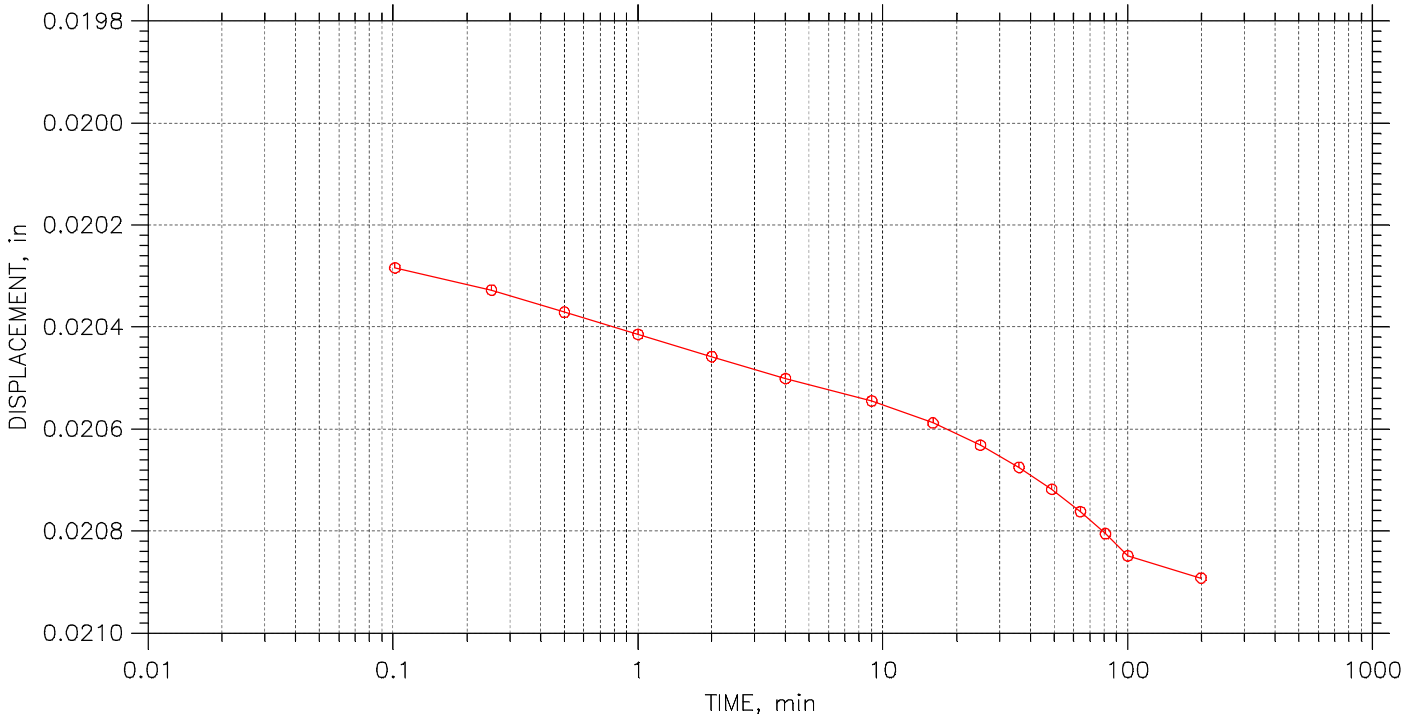
Tue, 26-APR-2016 13:54:07

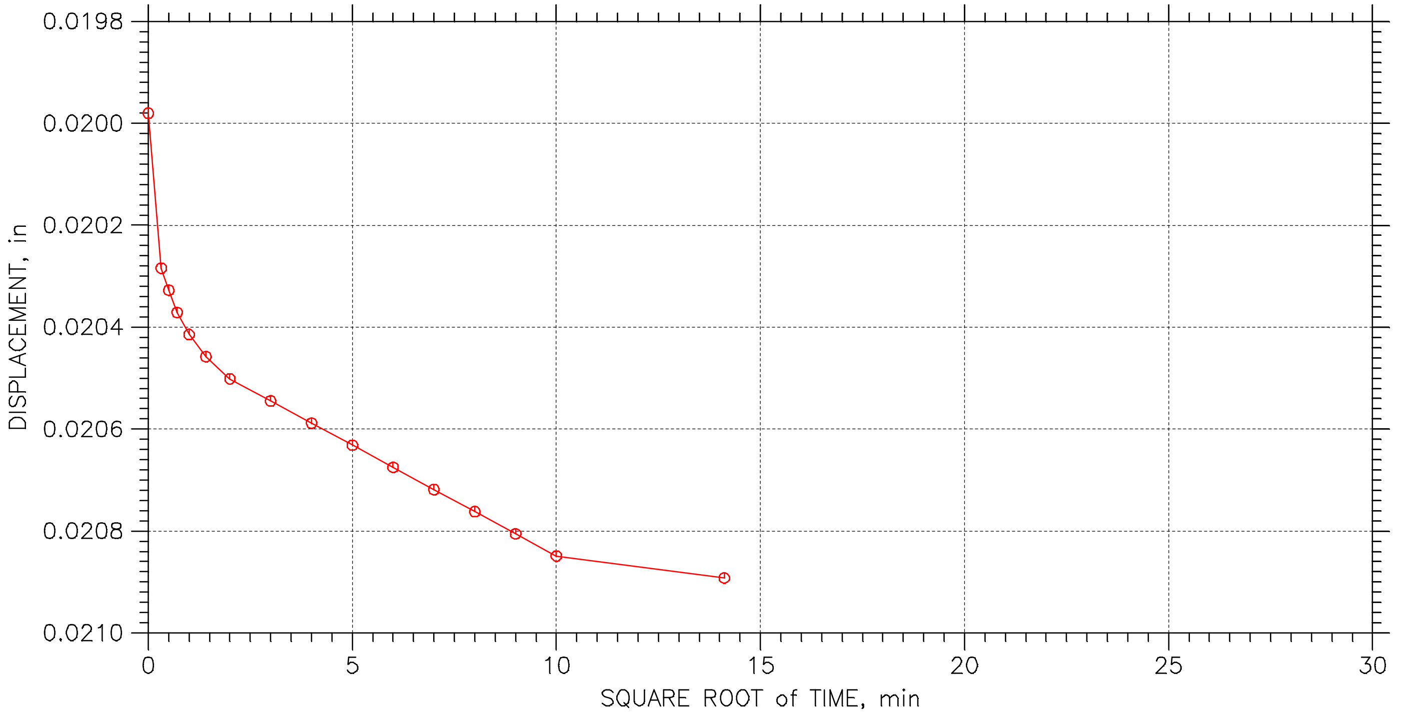
CONSOLIDATION TEST DATA

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		

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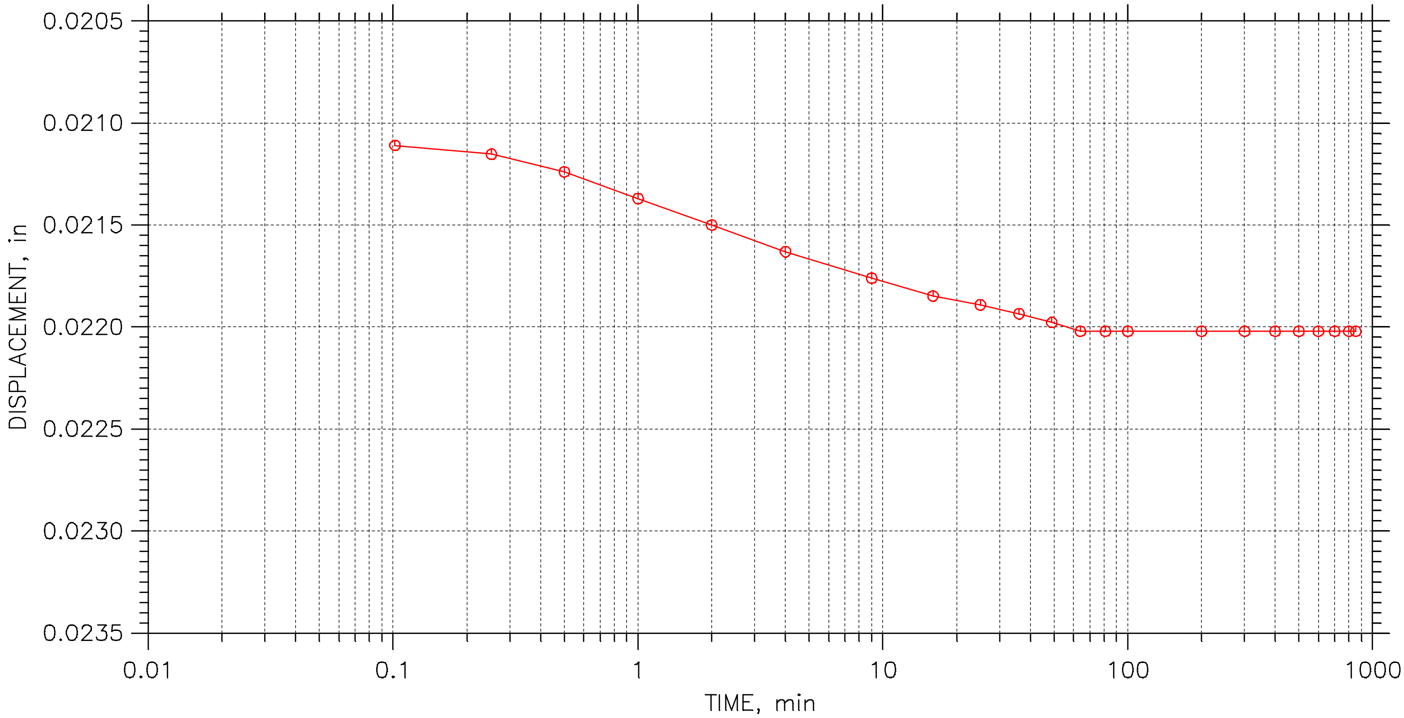
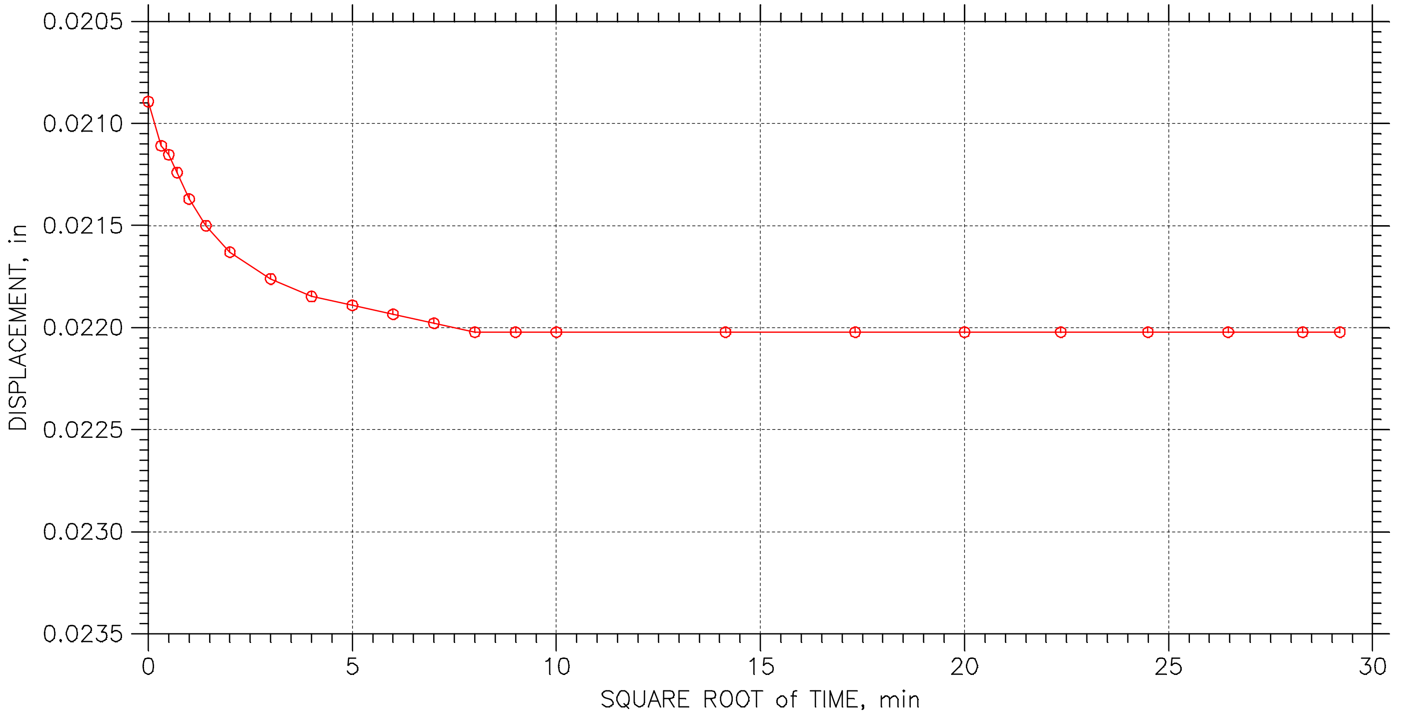
CONSOLIDATION TEST DATA

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		

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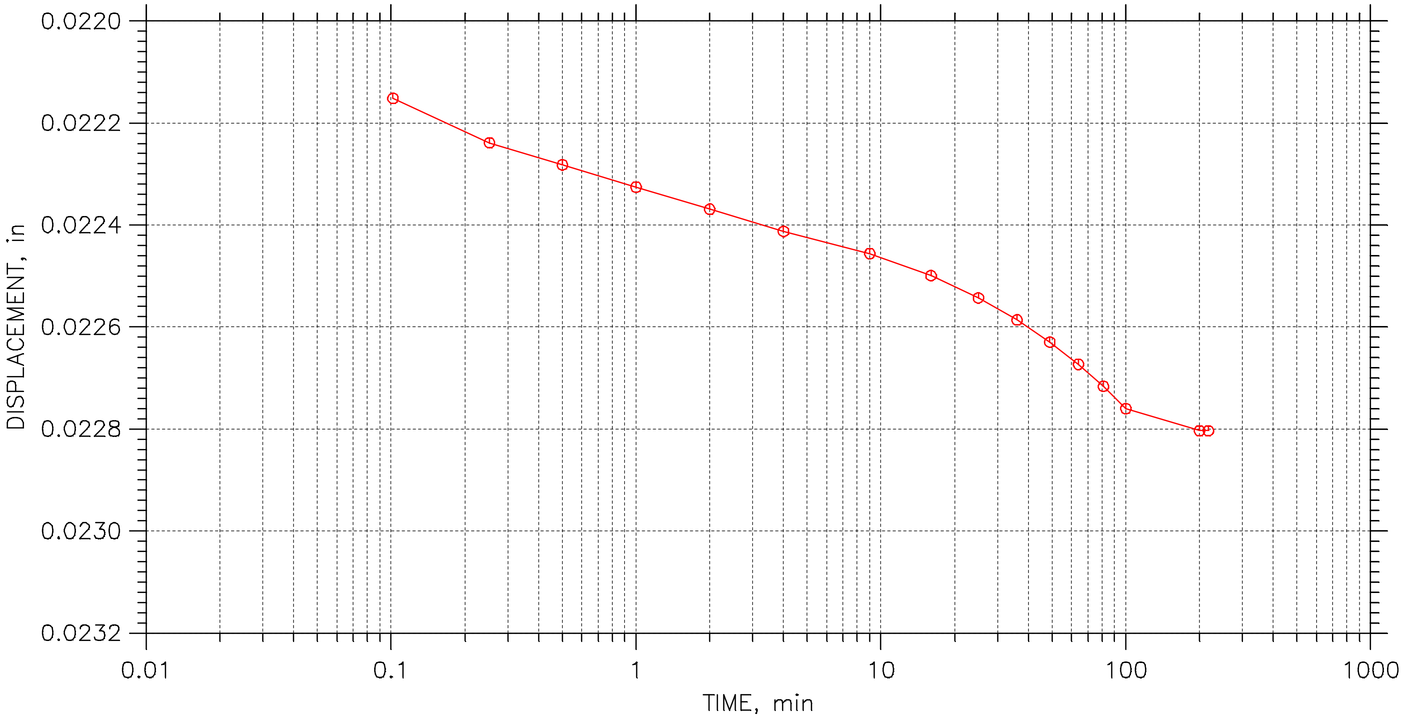
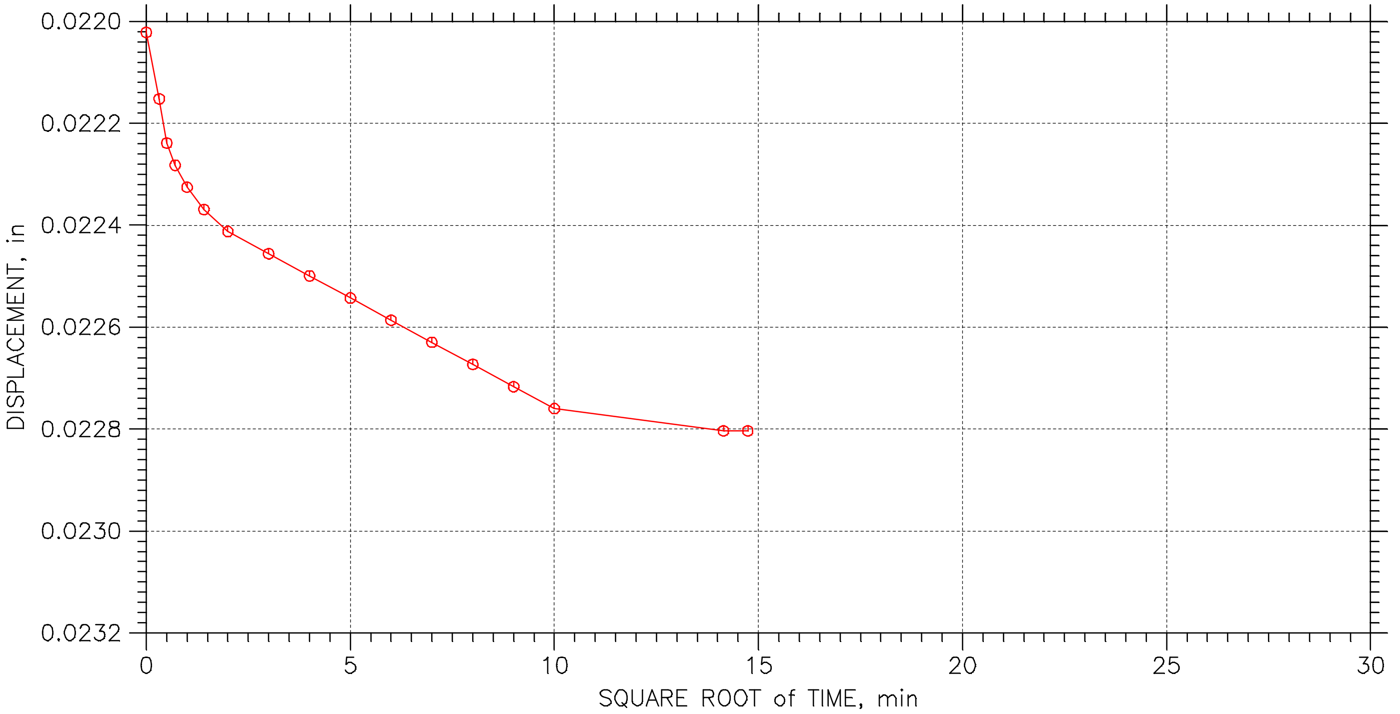
CONSOLIDATION TEST DATA

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.: 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		

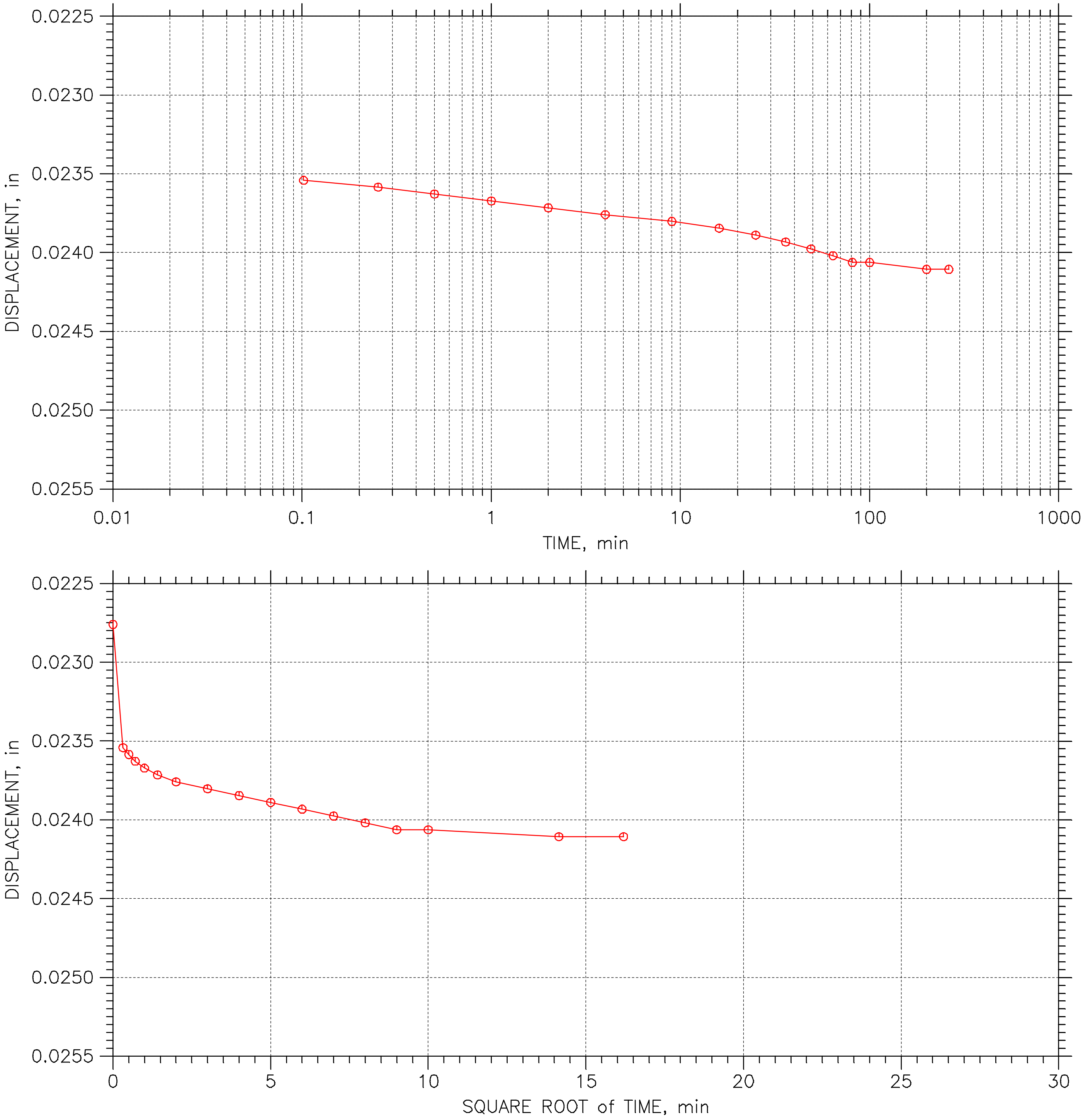
Tue, 26-APR-2016 13:54:12

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		

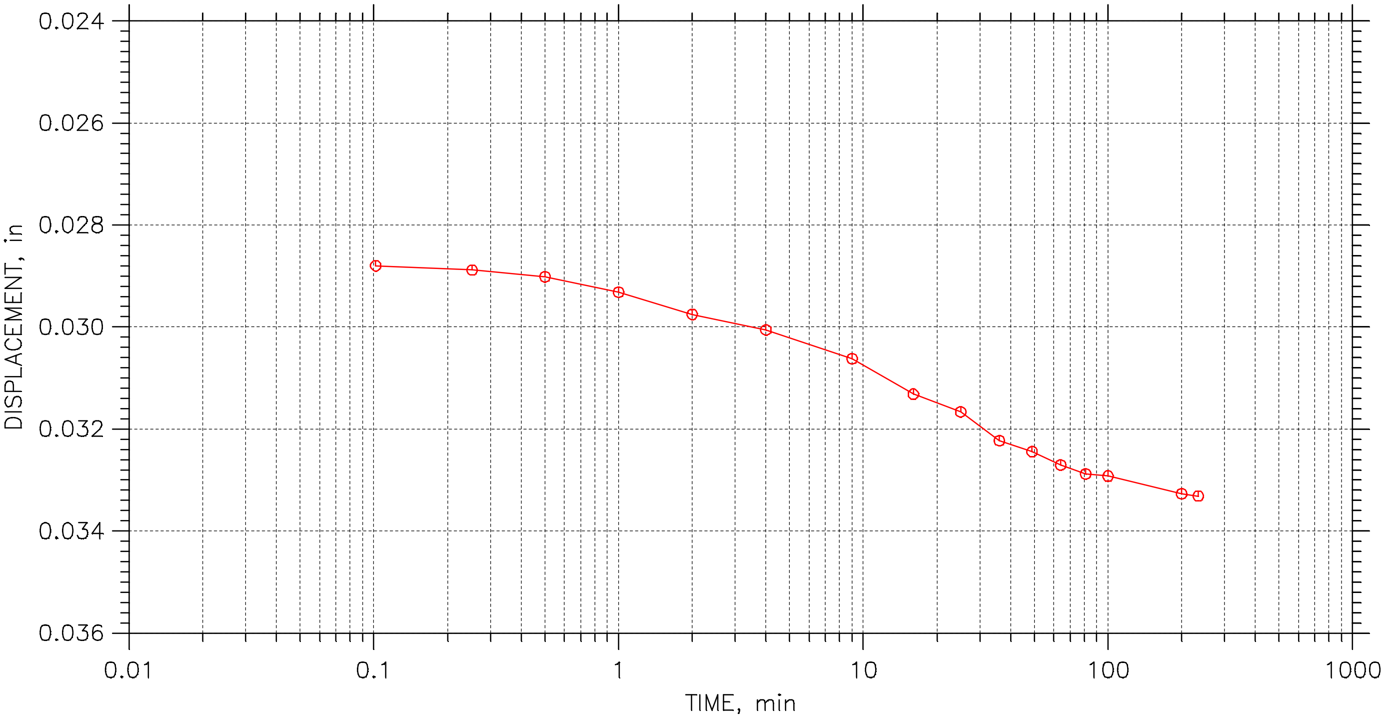
Tue, 26-APR-2016 13:54:13

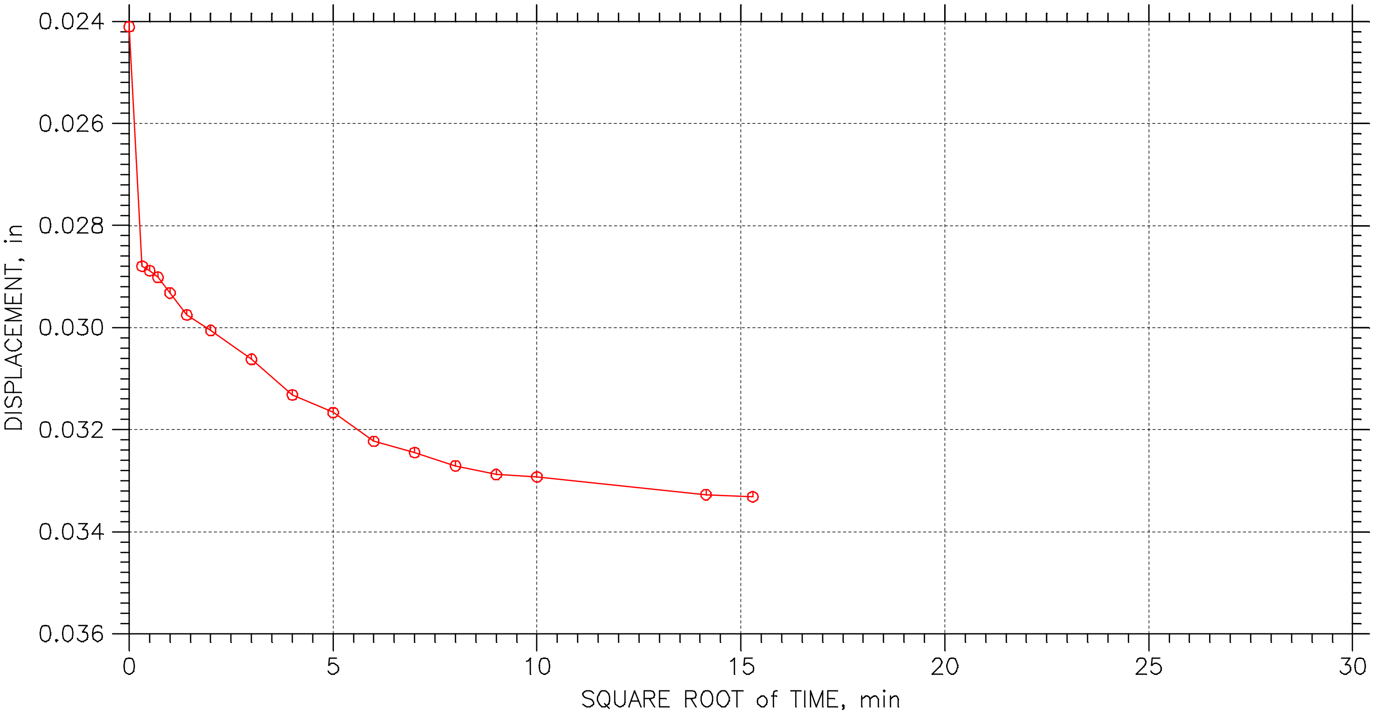
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 17 of 25

Stress: 4. tsf





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
Consulting Engineers & Scientists

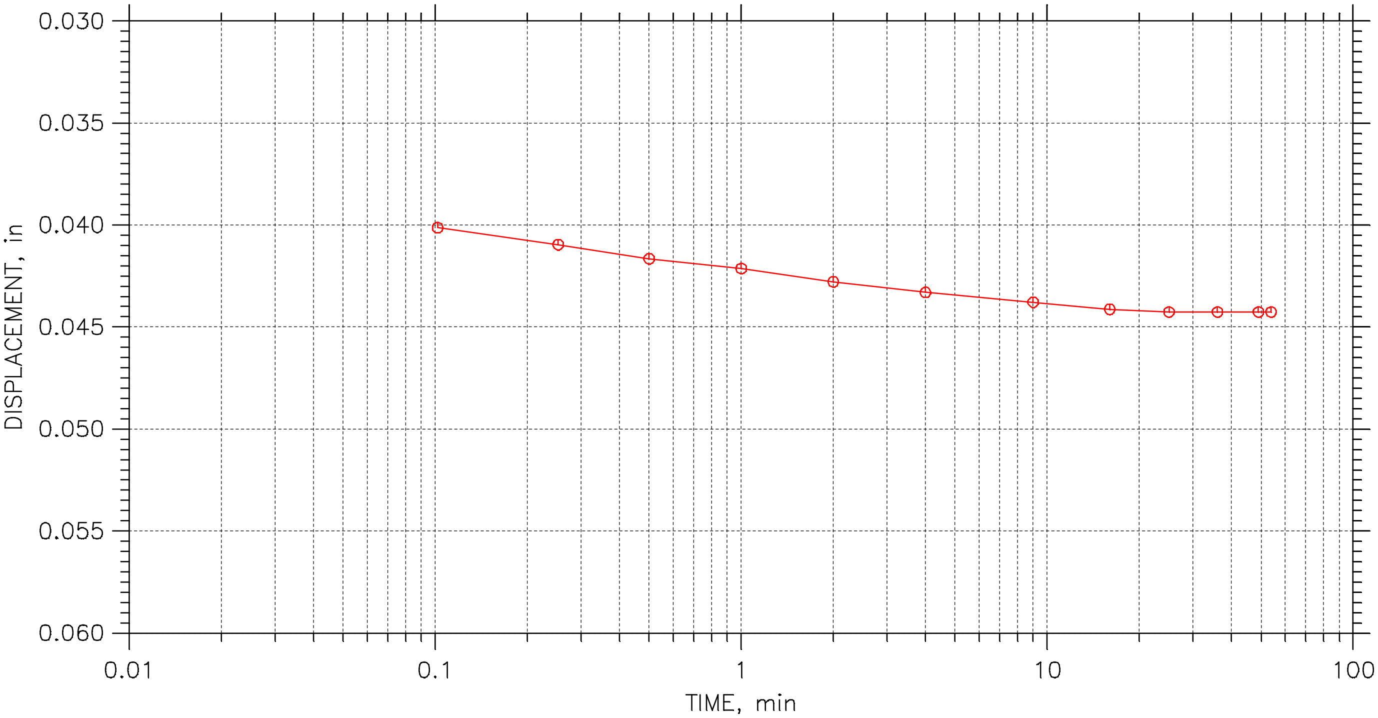
Tue, 26-APR-2016 13:54:15

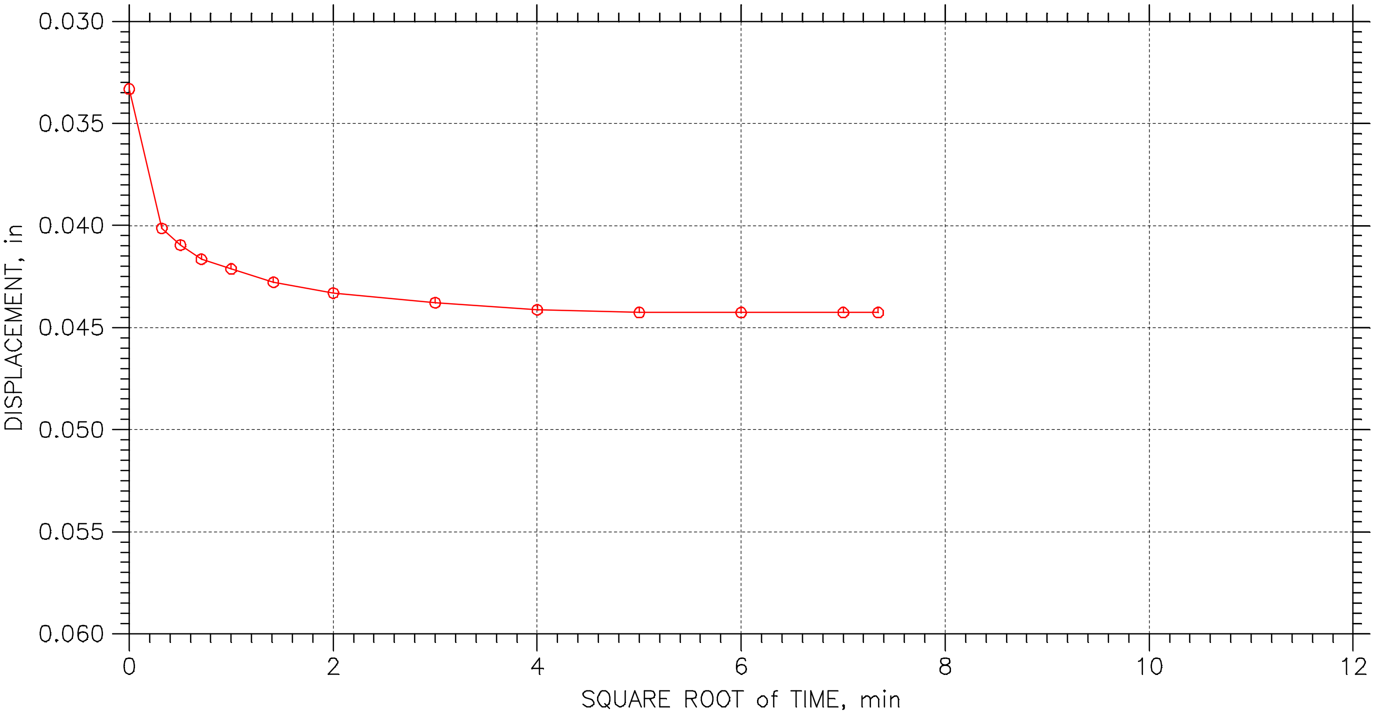
CONSOLIDATION TEST DATA

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		

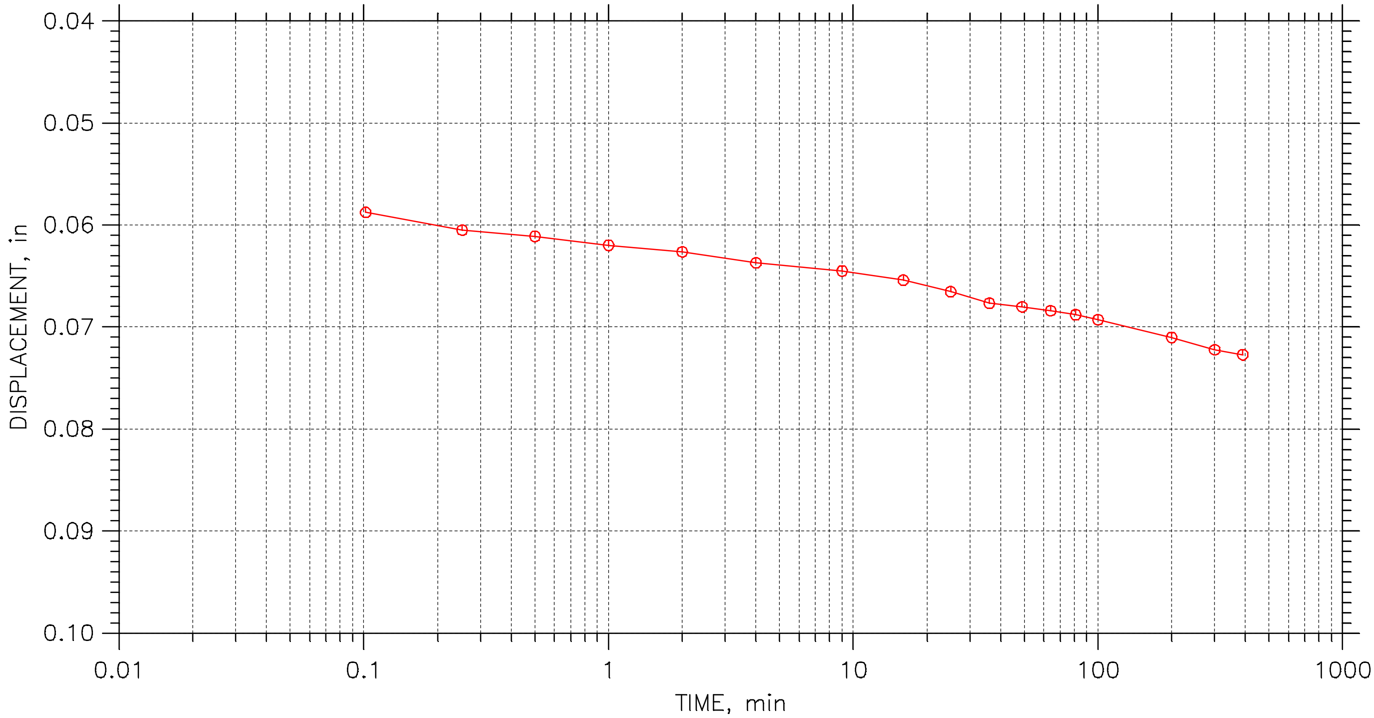
Tue, 26-APR-2016 13:54:16

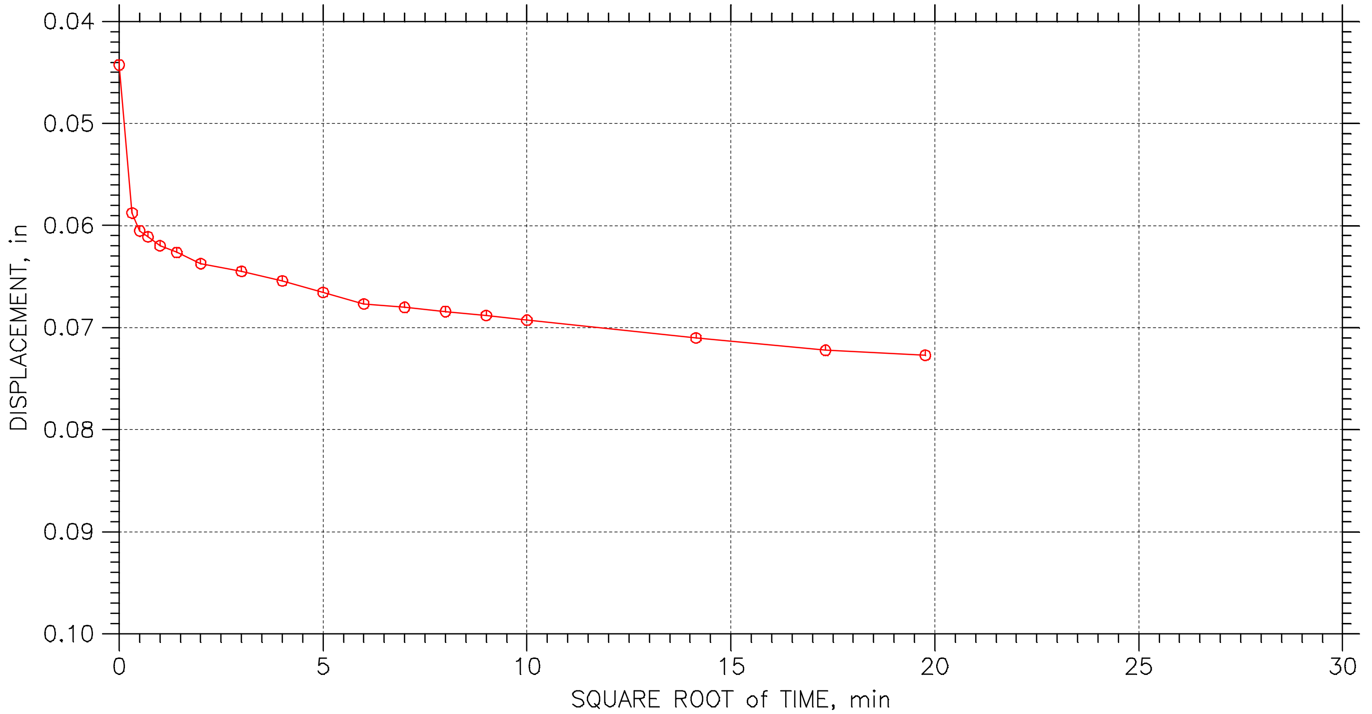
CONSOLIDATION TEST DATA

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		

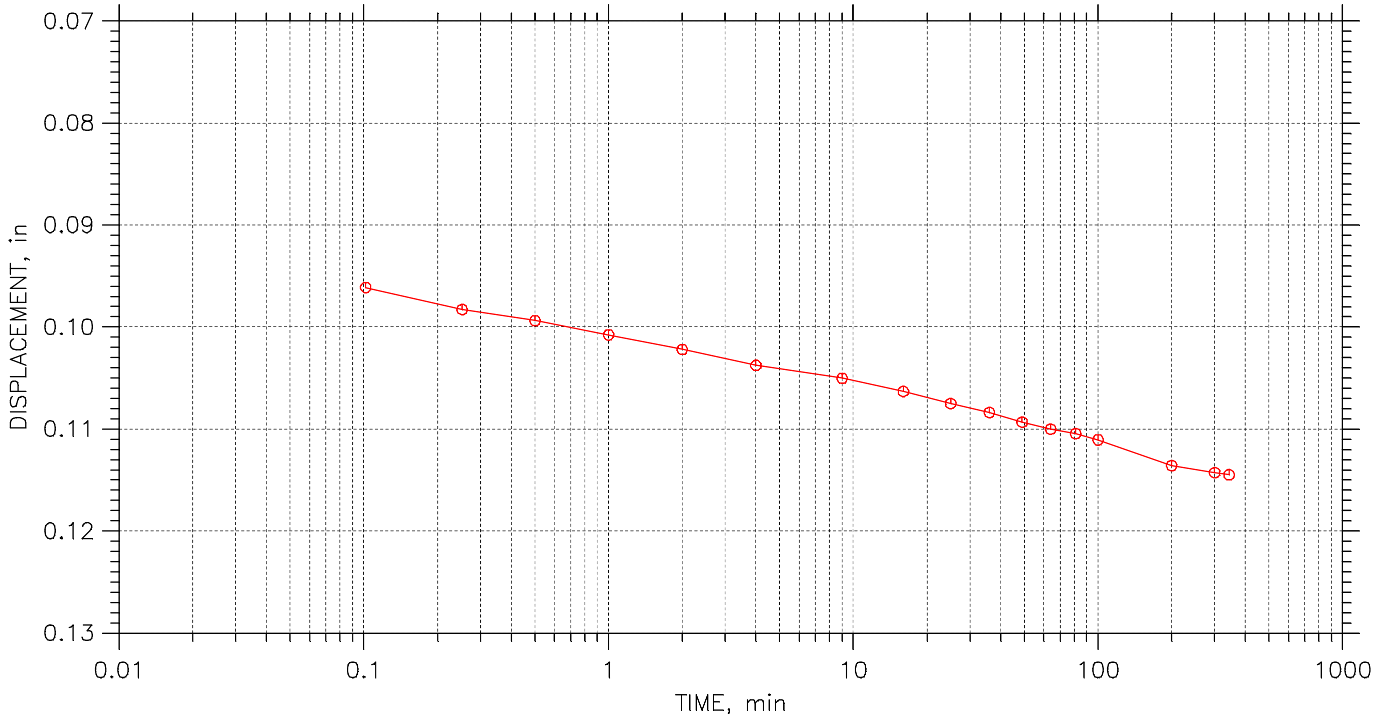
Tue, 26-APR-2016 13:54:18

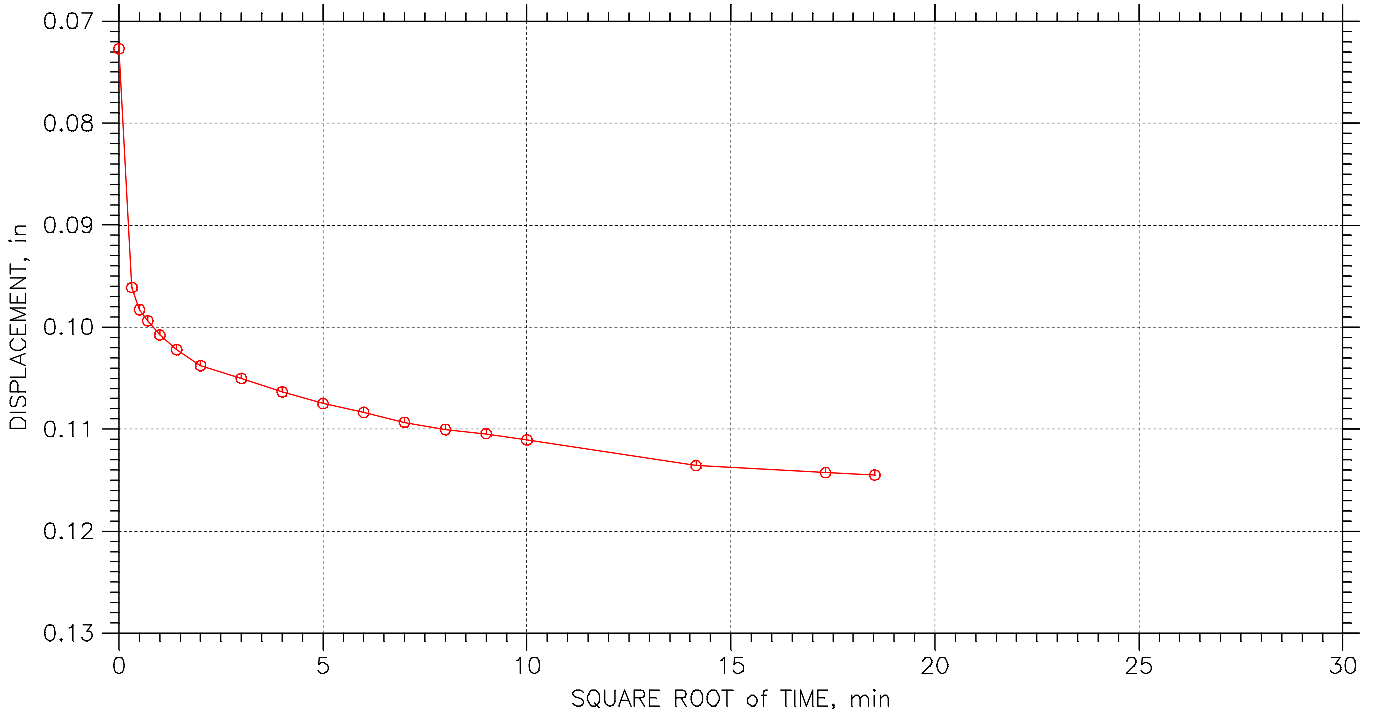
CONSOLIDATION TEST DATA

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		

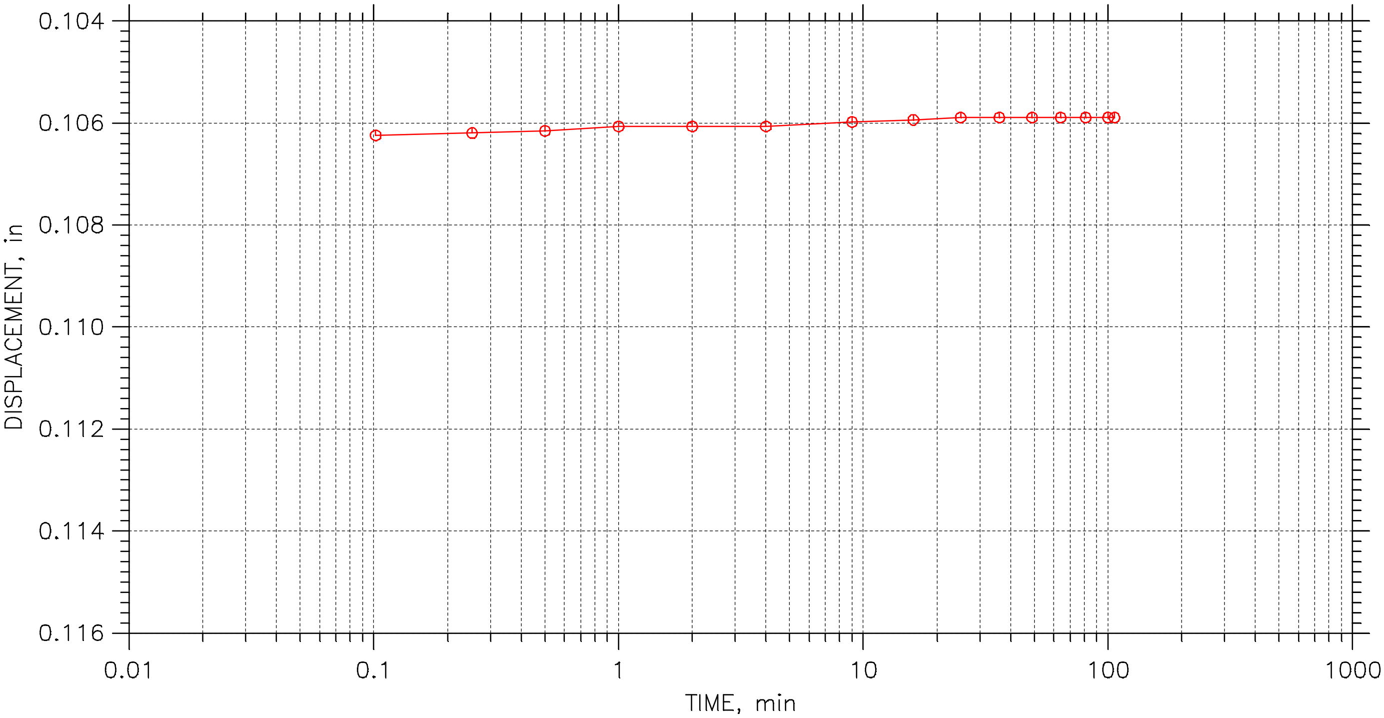
Tue, 26-APR-2016 13:54:19

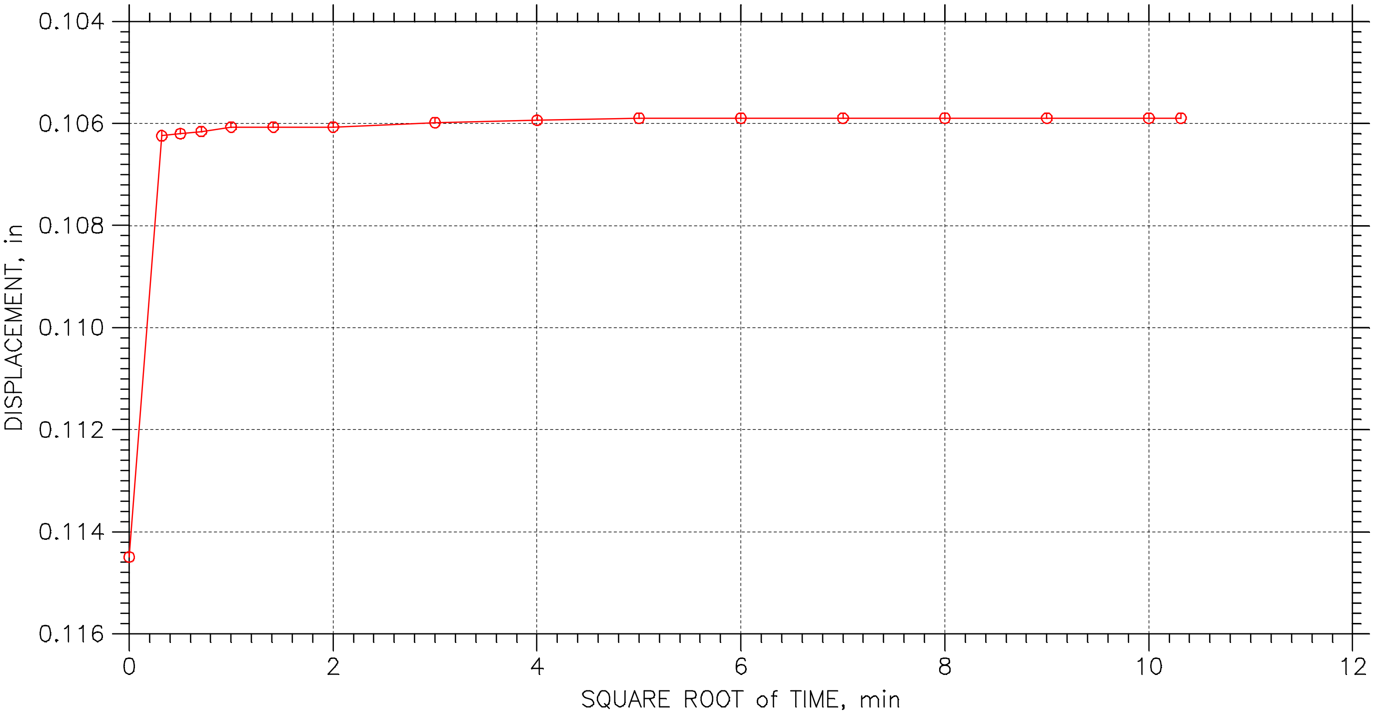
CONSOLIDATION TEST DATA

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		

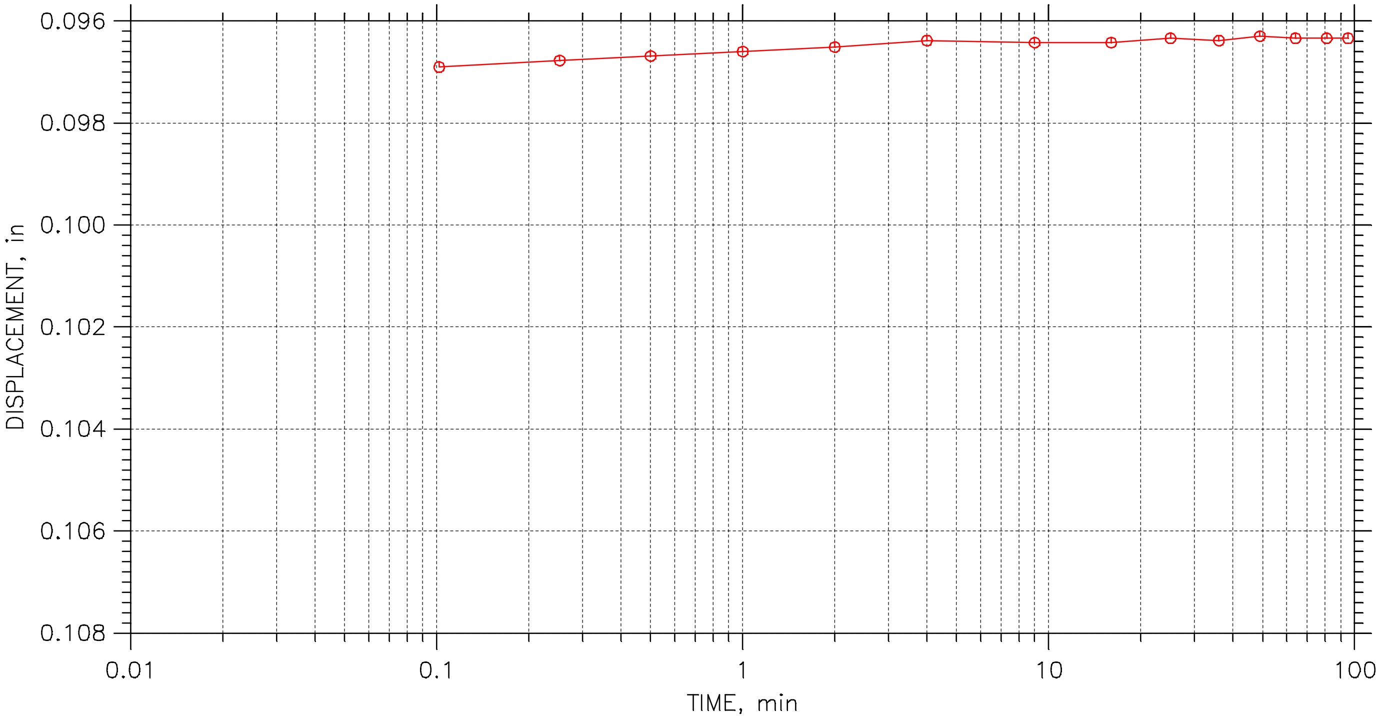
Tue, 26-APR-2016 13:54:21

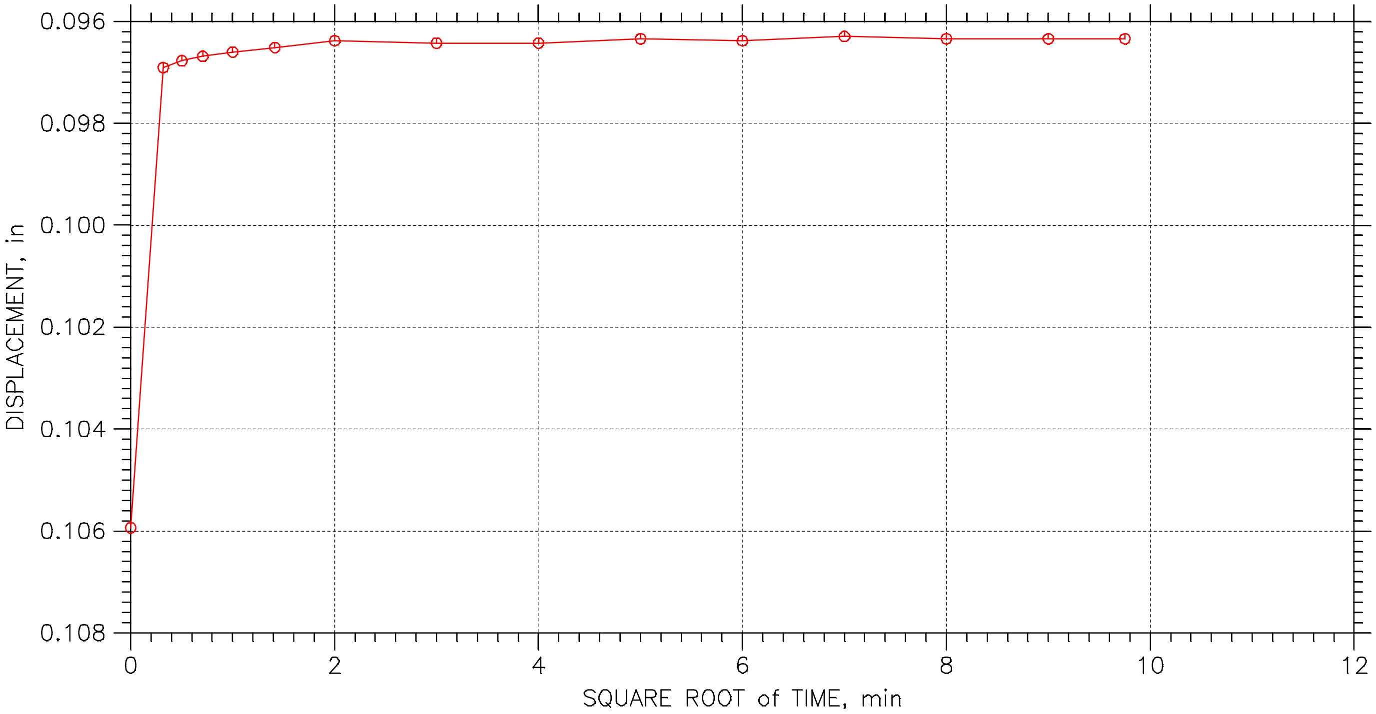
CONSOLIDATION TEST DATA

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		

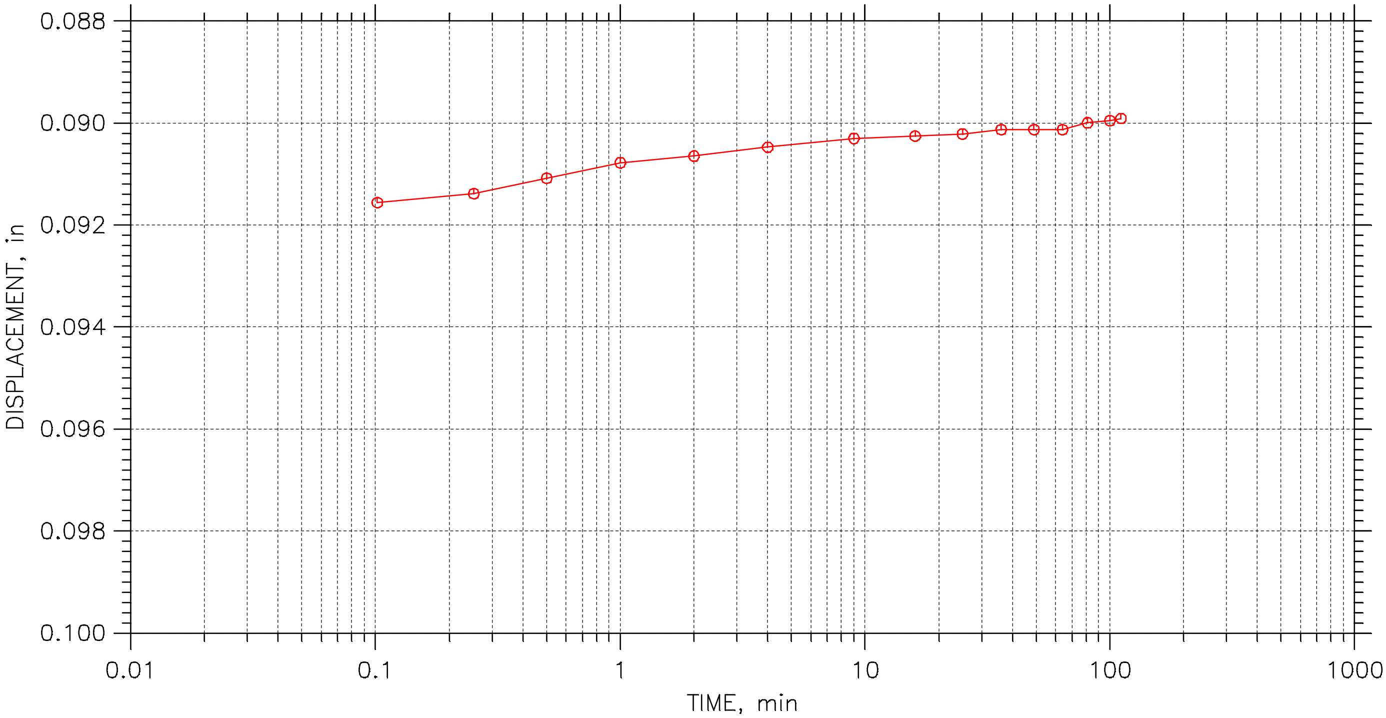
Tue, 26-APR-2016 13:54:22

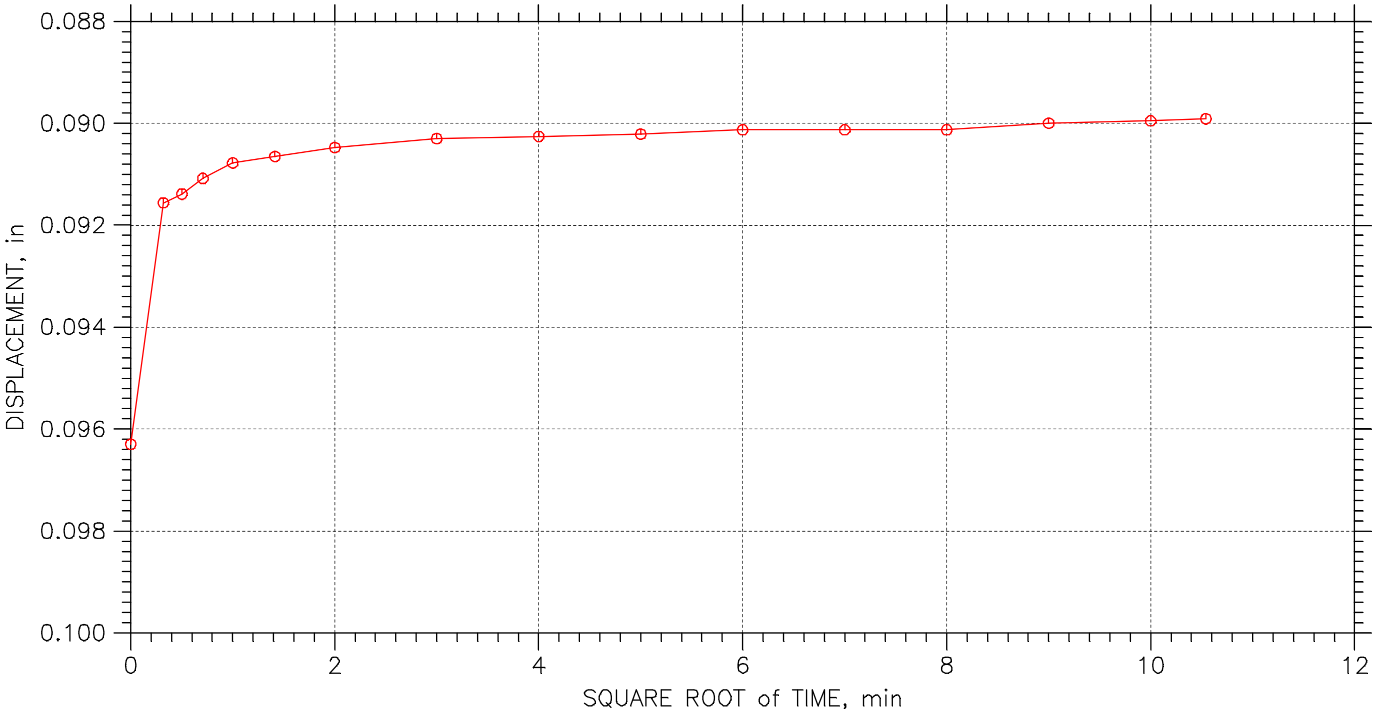
CONSOLIDATION TEST DATA

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		

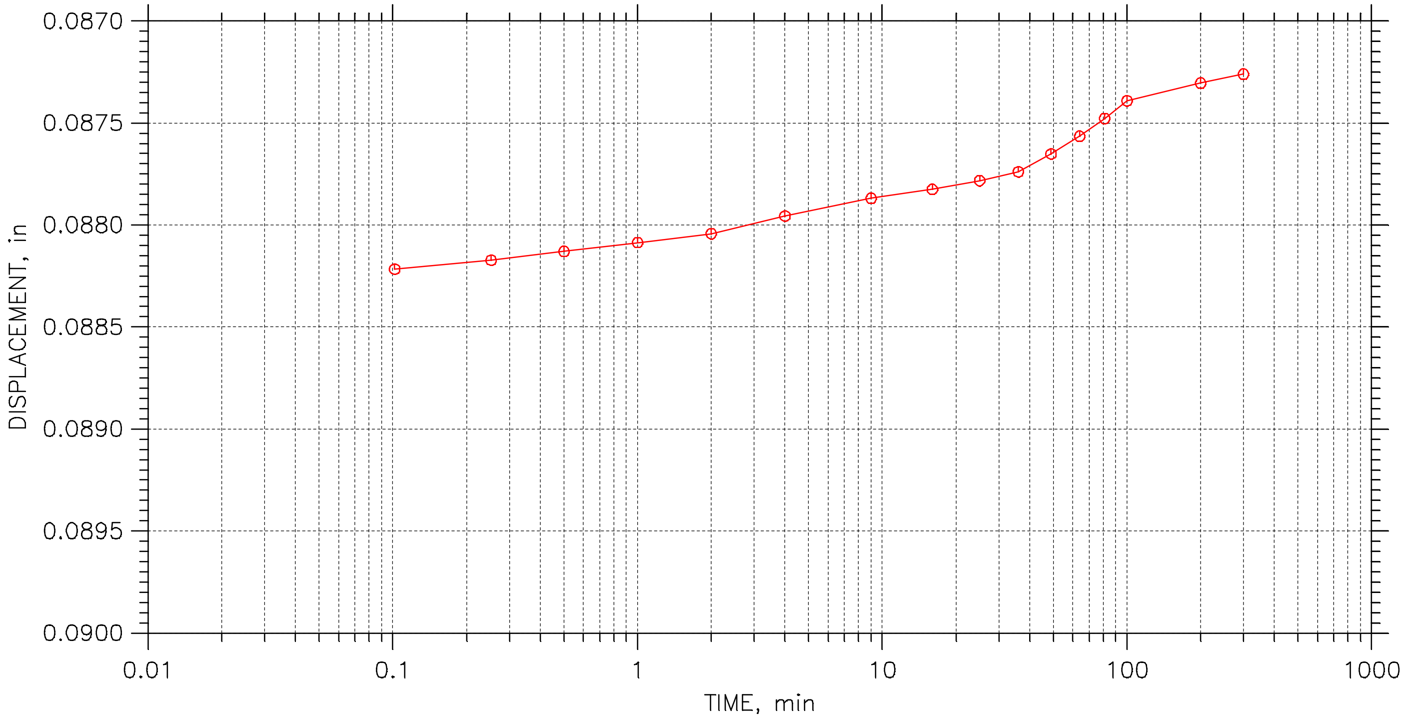
Tue, 26-APR-2016 13:54:23

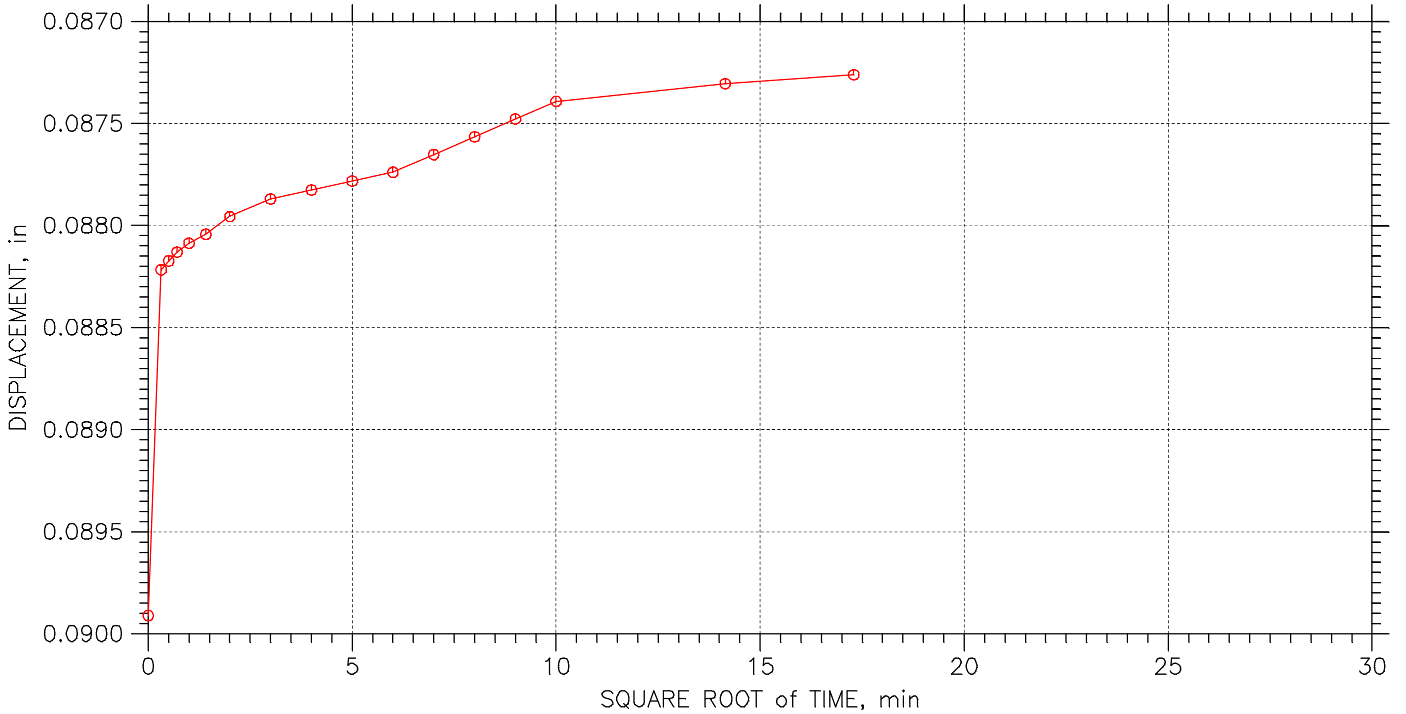
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 24 of 25

Stress: 0.5 tsf





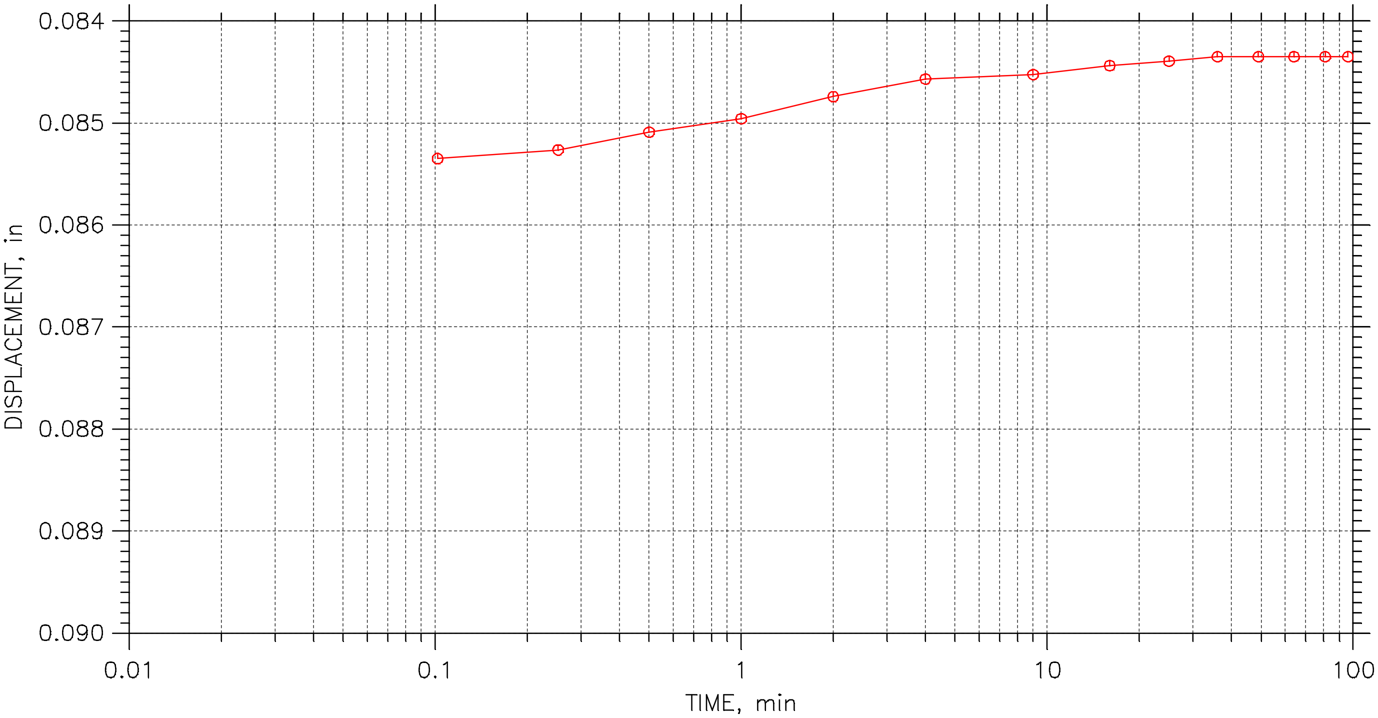
Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: DARK BROWNISH GRAY FLY ASH WITH CLAY		
	Remarks: Pc = 6.0 tsf Cc = 0.259 Ccr = 0.010 TEST PERFORMED AS PER ASTM D2435		

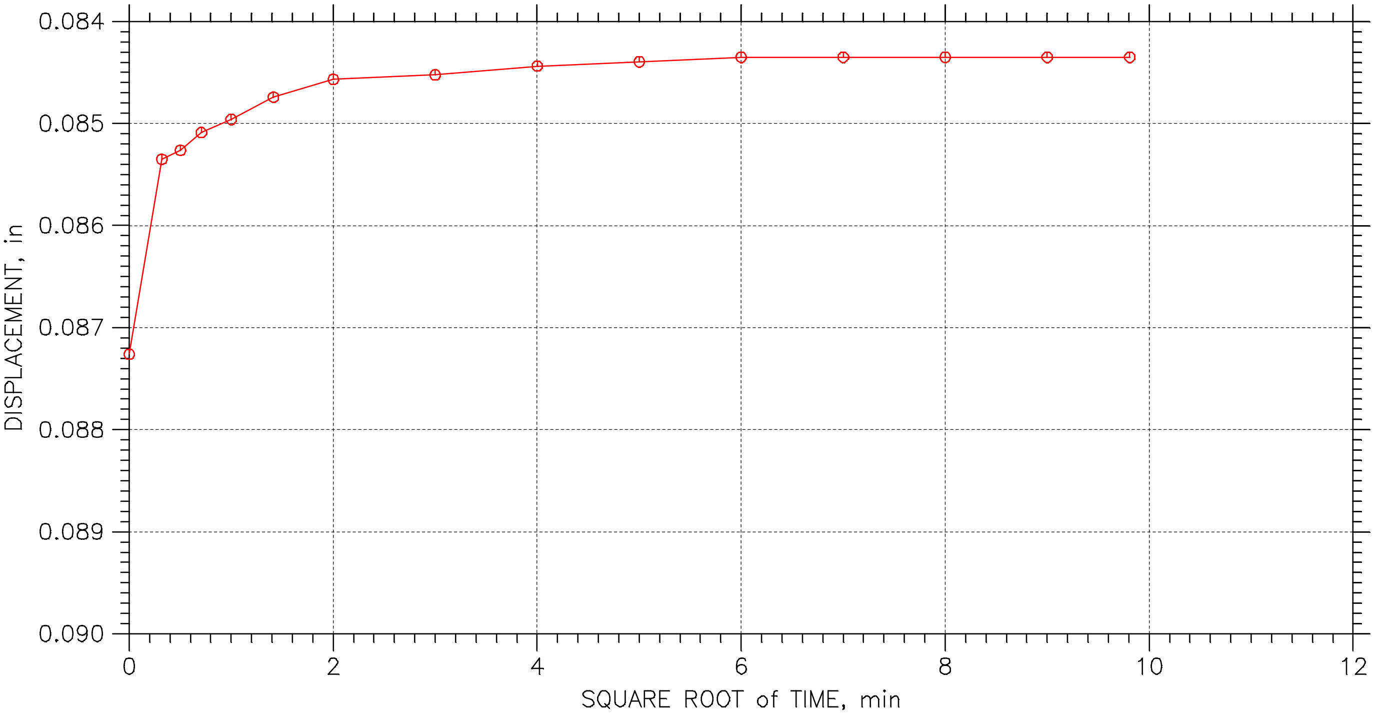
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 25 of 25

Stress: 0.125 tsf



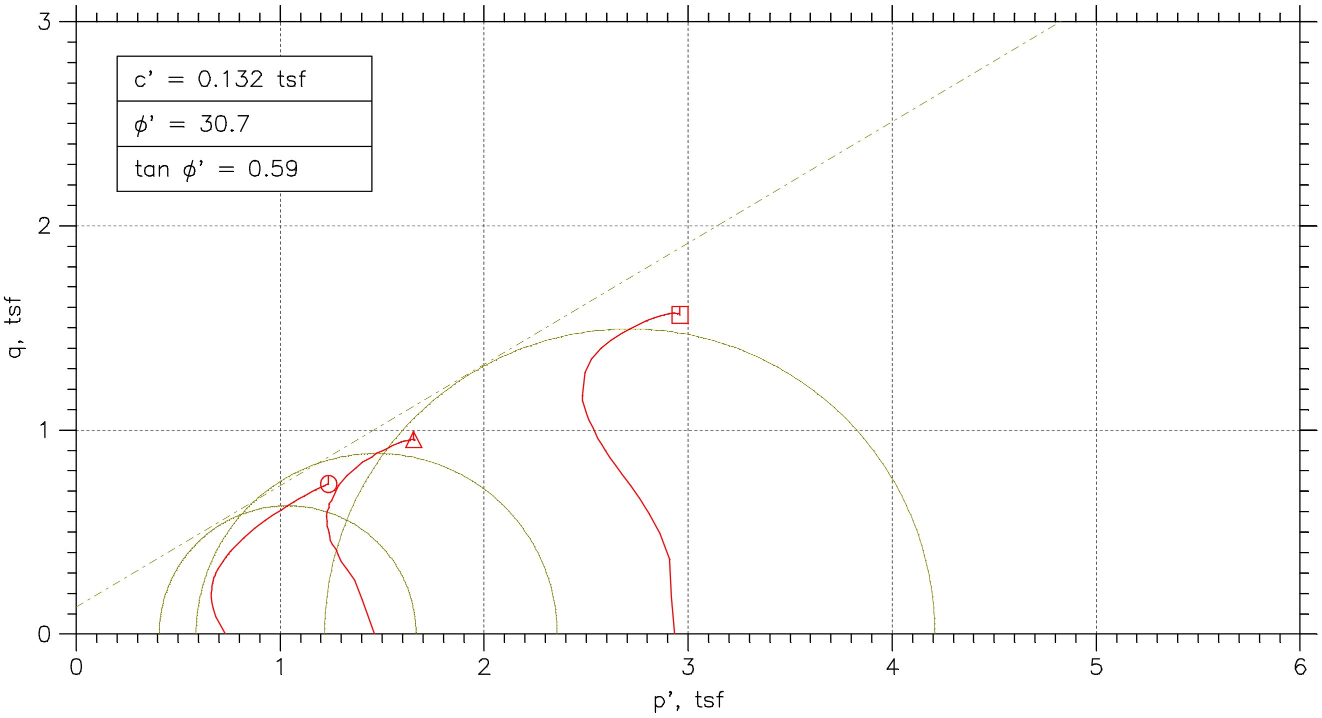


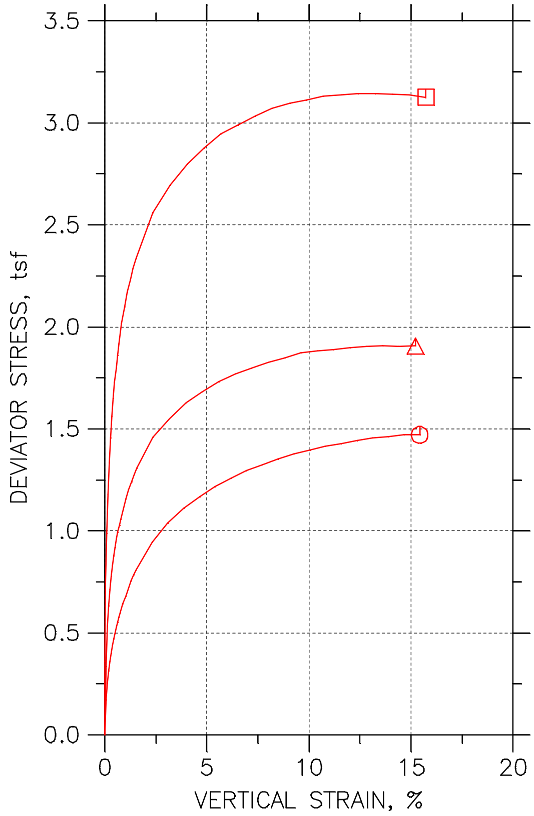
Terracon Consulting Engineers & Scientists	Project: VECTREN CULLEY E POND	Location: NEWBURGH, IN	Project No.: AW165009
	Boring No.: B16-2 ST-4	Tested By: BCM	Checked By: BCM
	Sample No.: ST4	Test Date: 4/22/16	Depth: 29.0'-31.0'
	Test No.: B162ST4CON	Sample Type: 3.0'' ST	Elevation: ----
	Description: 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





Symbol		○	△	□	
Test No.		10.2 PSI	20.4 PSI	40.8 PSI	
Initial	Diameter, in	2.837	2.8539	2.8602	
	Height, in	6.065	6.1339	5.9839	
	Water Content, %	31.42	29.63	27.39	
	Dry Density, pcf	91.54	93.63	96.51	
	Saturation, %	99.97	99.05	98.09	
	Void Ratio	0.85487	0.81349	0.75941	
Before Shear	Water Content, %	30.29	28.03	24.16	
	Dry Density, pcf	93.11	96.35	102.5	
	Saturation, %	100.00	100.00	100.00	
	Void Ratio	0.82377	0.76245	0.65721	
	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

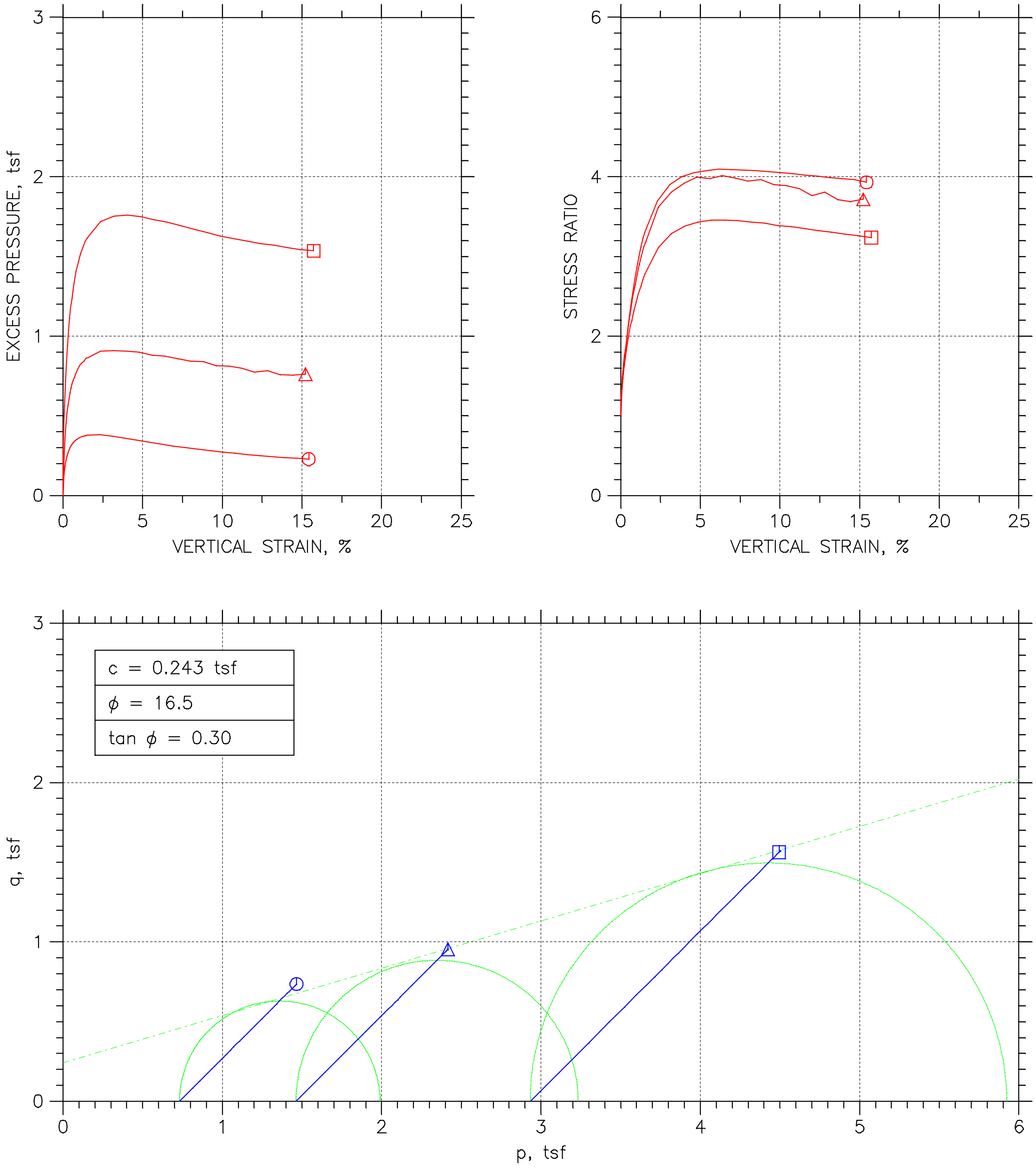
Description: GRAY TO OLIVE GRAY LEAN CLAY WITH SAND CL SILT POCKETS NOTED

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

Terracon
Consulting Engineers & Scientists

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

	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

Terracon
Consulting Engineers & Scientists

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

Terracon
Consulting Engineers & Scientists

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

	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
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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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: 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: ----

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

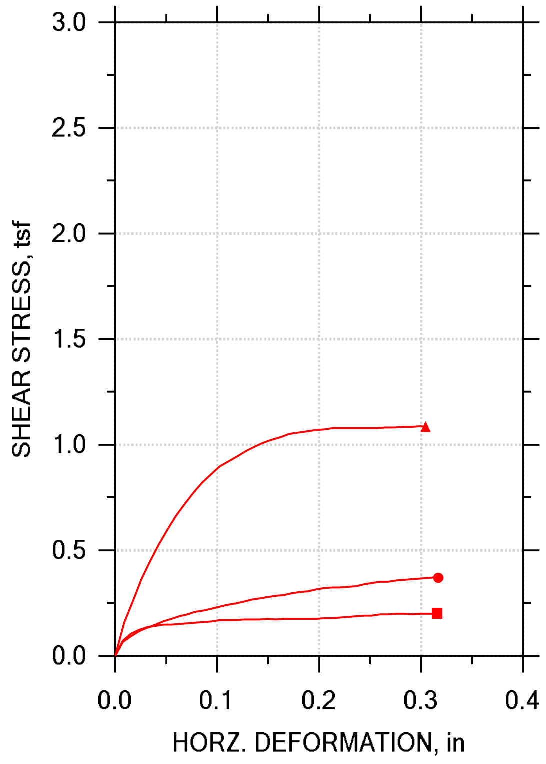
Estimated Specific Gravity: 2.72

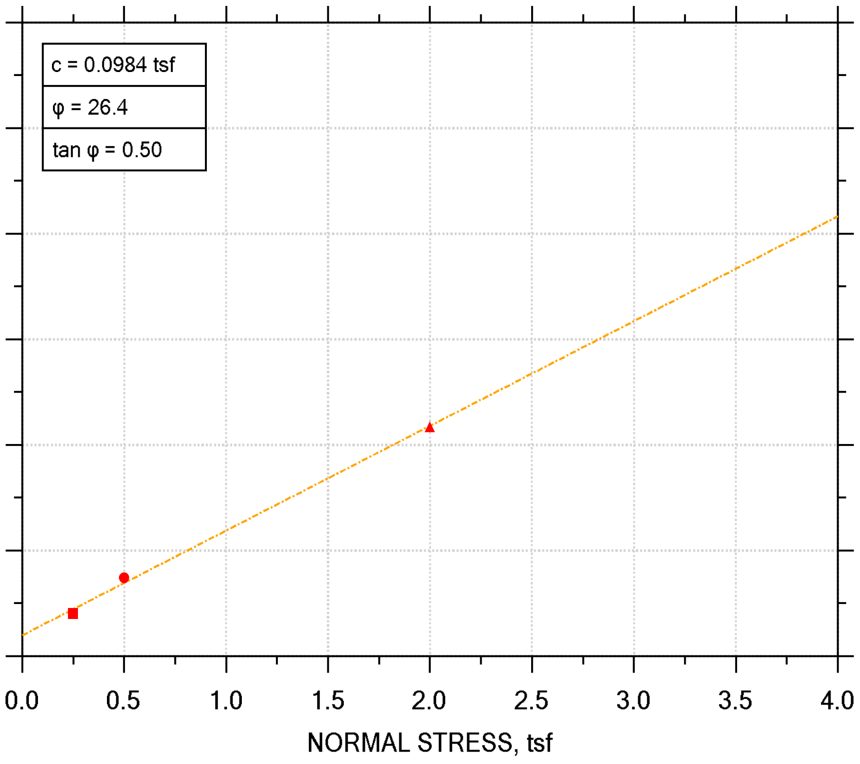
	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	7.9776	7.9776	0	0.000	2.9321	2.9321	1.000	2.9321	0
2	0.01	8.338	7.9776	0.19511	0.541	3.0974	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

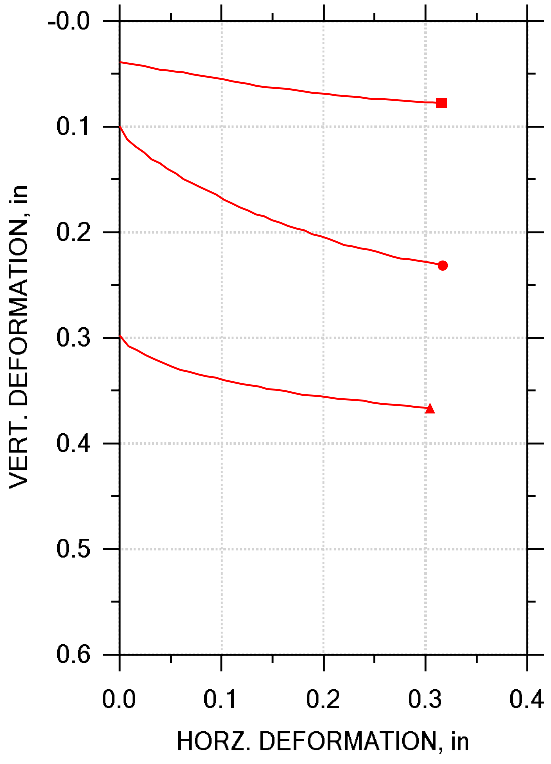
Direct Shear of Soils Under Consolidated Drained Conditions – ASTM D 3080

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

Terracon
Consulting Engineers & Scientists







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

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: 04/11/16
Depth: 17.0'-19.0'
Test No.: 500 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	0.250	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

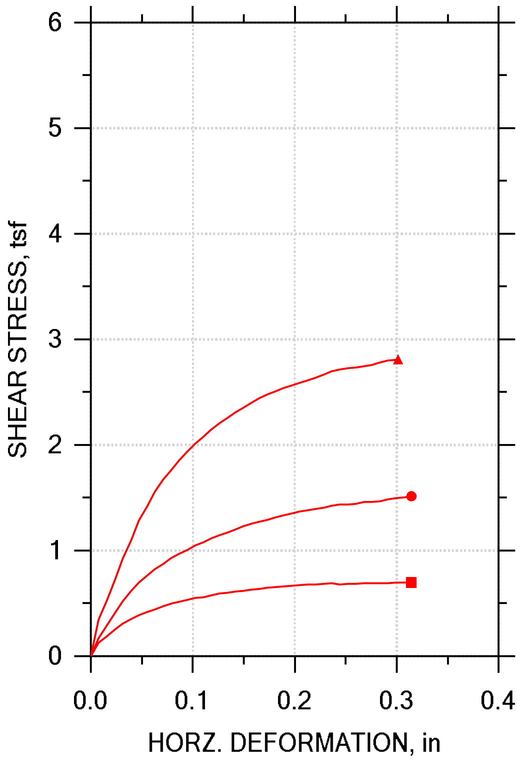
Project: VECTREN CULLEY EAST POND
Location: NEWBURGH,IN
Project No.: AW165009
Boring No.: B16-1 ST-2
Tested By: HP
Checked By: BCM
Sample No.: ST-2
Test Date: 04/13/16
Depth: 17.0'-19.0'
Test No.: 4000 PSF
Sample Type: 3'' ST
Elevation: ----

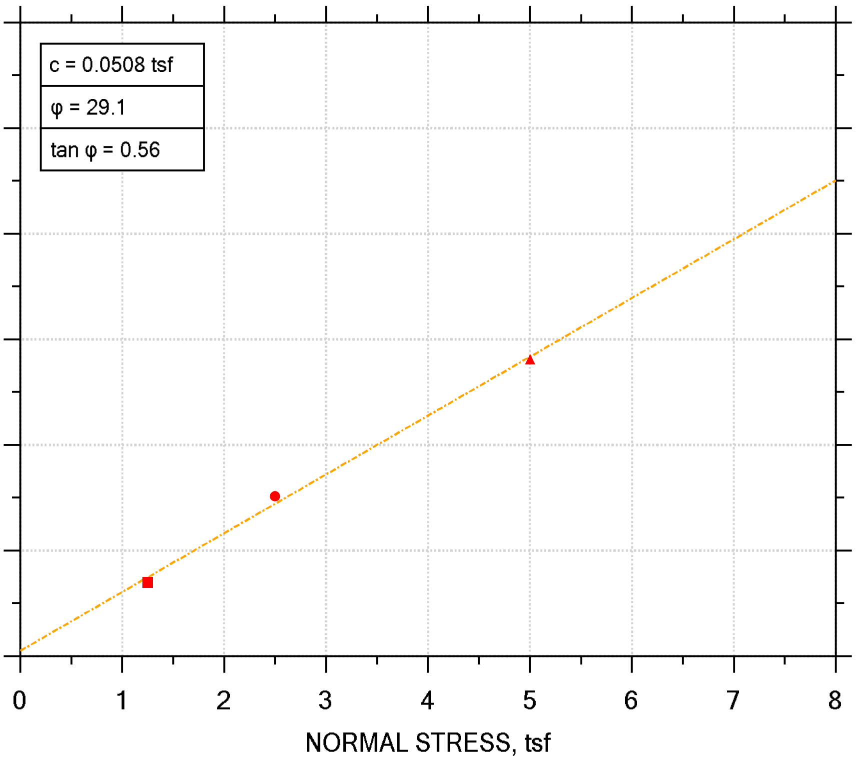
Soil Description: LIGHT BROWN LEAN CLAY AND VARVED BLACK TO DARK GRAY VARVED FLY ASH
Remarks: TEST PERFORMED AS PER ASTM D3080.

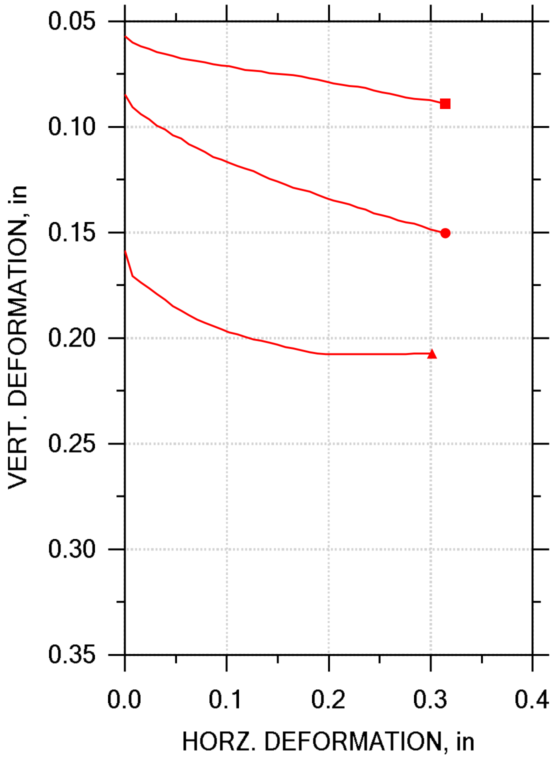
Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	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







	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

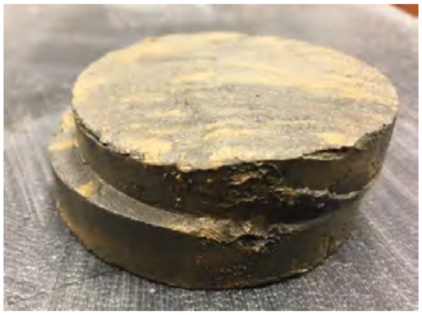
Project: VECTREN CULLEY EAST POND
Boring No.: B16-2 ST6
Sample No.: ST6
Test No.: 2500 PSF

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,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

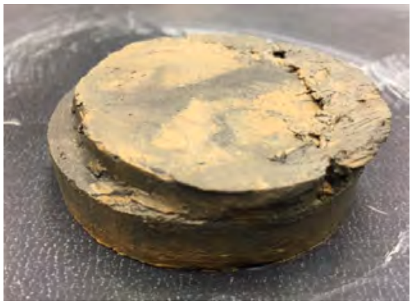
DIRECT SHEAR TEST DATA

Project: VECTREN CULLEY EAST POND
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.: 5000 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	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
Boring No.: B16-2 ST6
Sample No.: ST6
Test No.: 10000 PSF

Location: NEWBURGH, IN
Tested By: BCM
Test Date: WPQ
Sample Type: TRIMMED

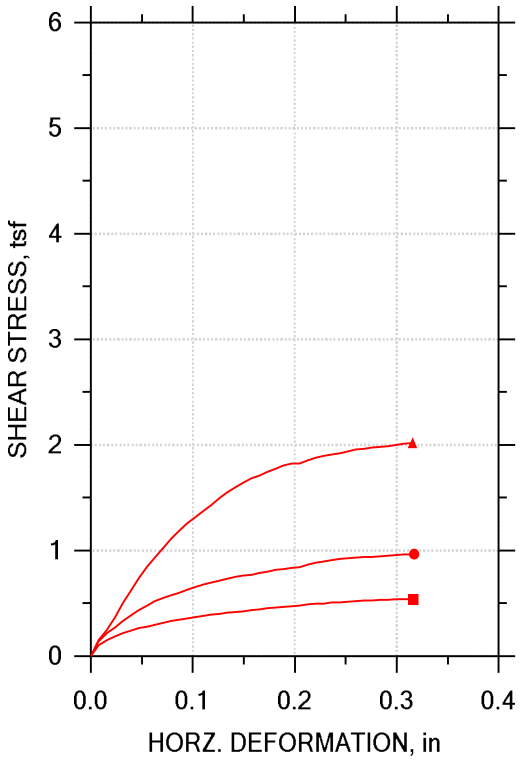
Project No.: AW165009
Checked By: BCM
Depth: 49.0'-51.0'
Elevation: .....

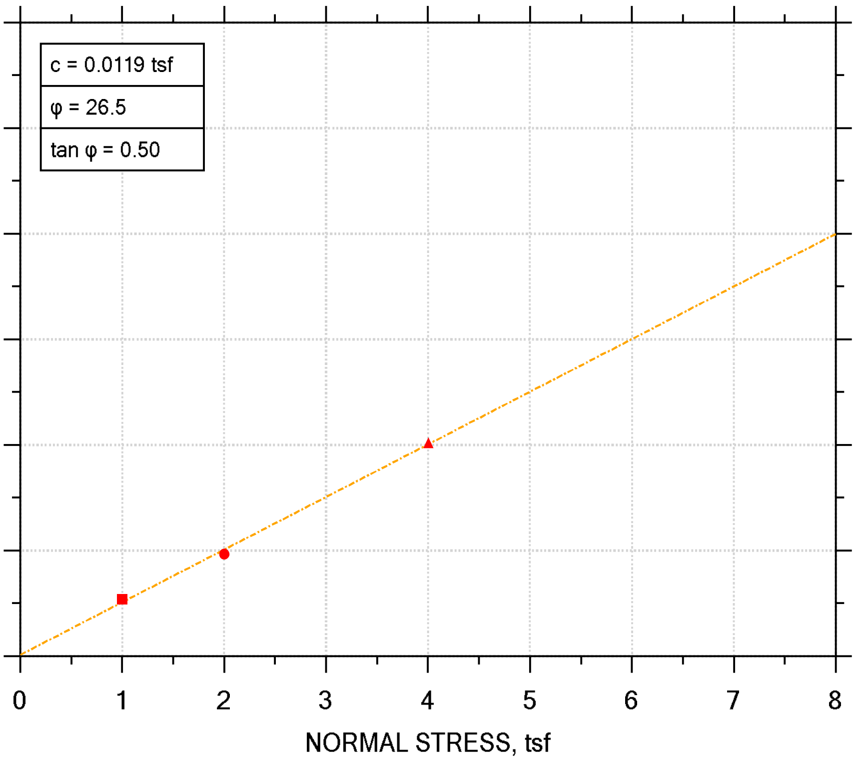
Soil Description: GRAY LEAN CLAY WITH SAND CL ORGANIC POCKETS NOTED.
Remarks: TEST PERFORMED AS PER ASTM D3080.

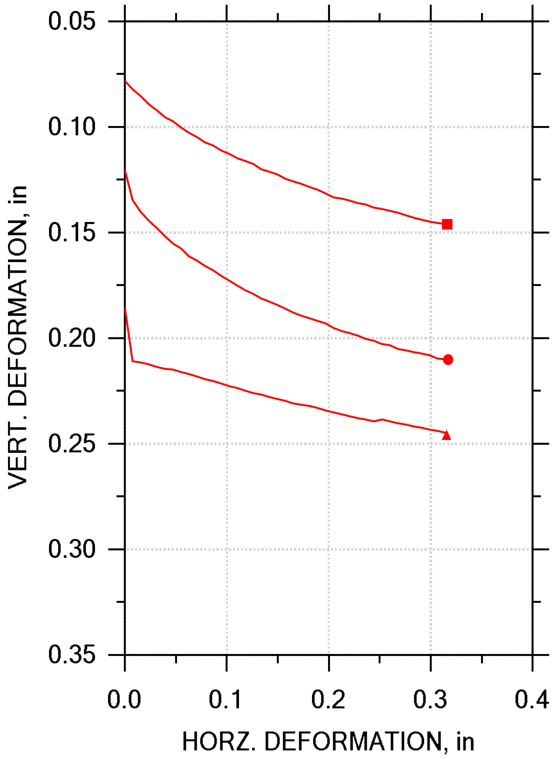
Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	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







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	
	Area, in²	4.9211	4.9211	4.9211	
	Height, in	0.99528	0.99528	0.99646	
	Water Content, %	73.24	73.61	73.45	
	Dry Density, pcf	54.02	54.91	55.05	
	Saturation, %	93.75	96.56	96.71	
	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	
	Dry Density, pcf	63.31	69.61	73.08	
	Saturation, %	98.46	98.98	100.83	
	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
Location: NEWBURGH, IN
Project No.: AW165009
Boring No.: B16-4 ST-6
Tested By: HP
Checked By: BCM
Sample No.: ST-6
Test Date: BCM
Depth: 42.0'-44.0'
Test No.: 8000 PSF
Sample Type: TRIMMED
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

Terracon
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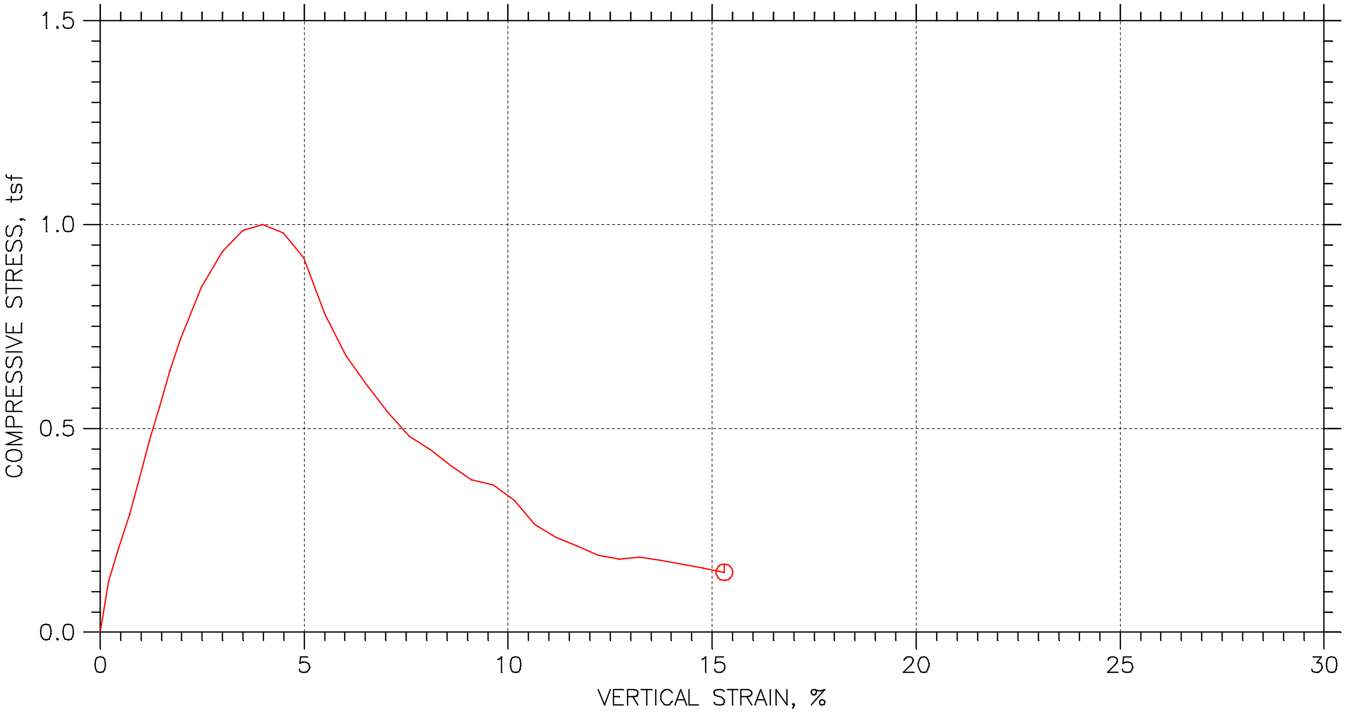

Symbol		⦶			
Test No.		B161ST5QU			
Initial	Diameter, in	2.8528			
	Height, in	6.0685			
	Water Content, %	32.96			
	Dry Density, pcf	88.45			
	Saturation, %	97.46			
	Void Ratio	0.91972			
Unconfined Compressive Strength, tsf		1.0001			
Undrained Shear Strength, tsf		0.50003			
Time to Failure, min		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.

Tue, 26-APR-2016 15:38:32

UNCONFINED COMPRESSION TEST

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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

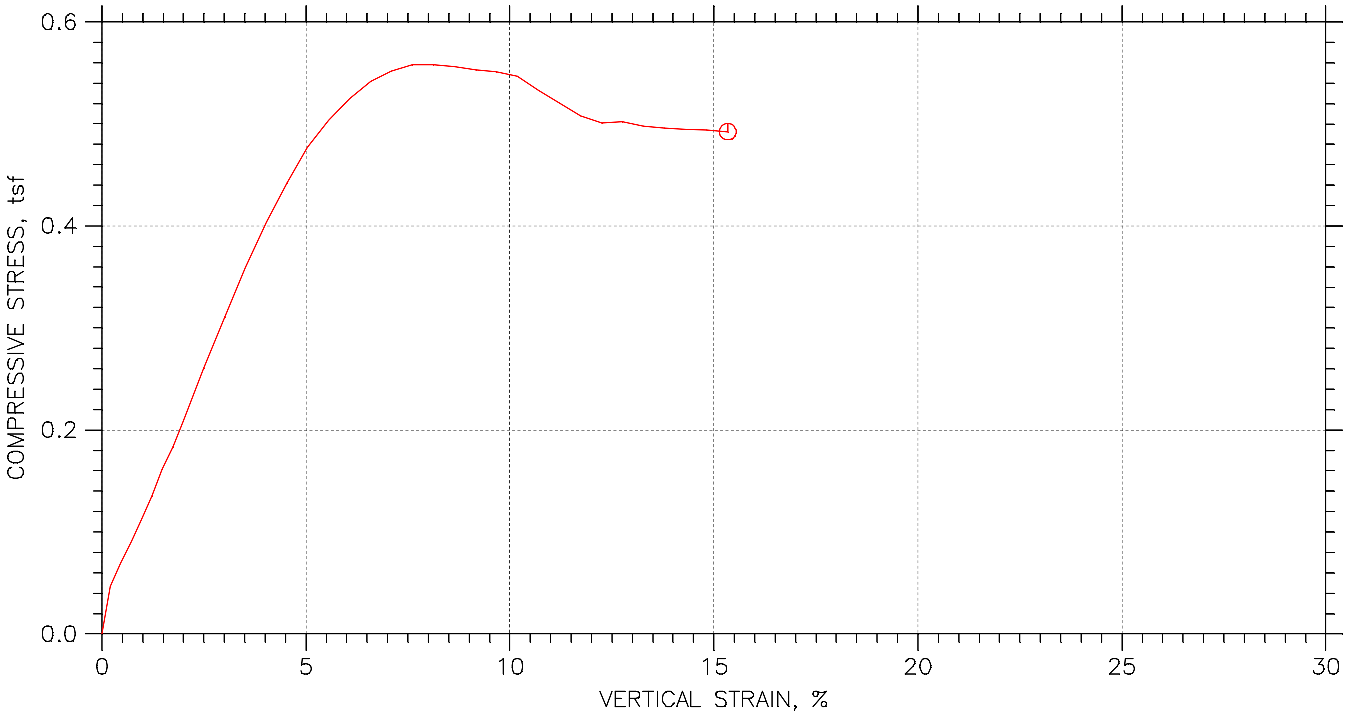
Liquid Limit: 35
Plastic Limit: 20
Estimated Specific Gravity: 2.72

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

Terracon
Consulting Engineers & Scientists



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.

Tue, 26-APR-2016 15:15:36

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOILS ASTM D2166

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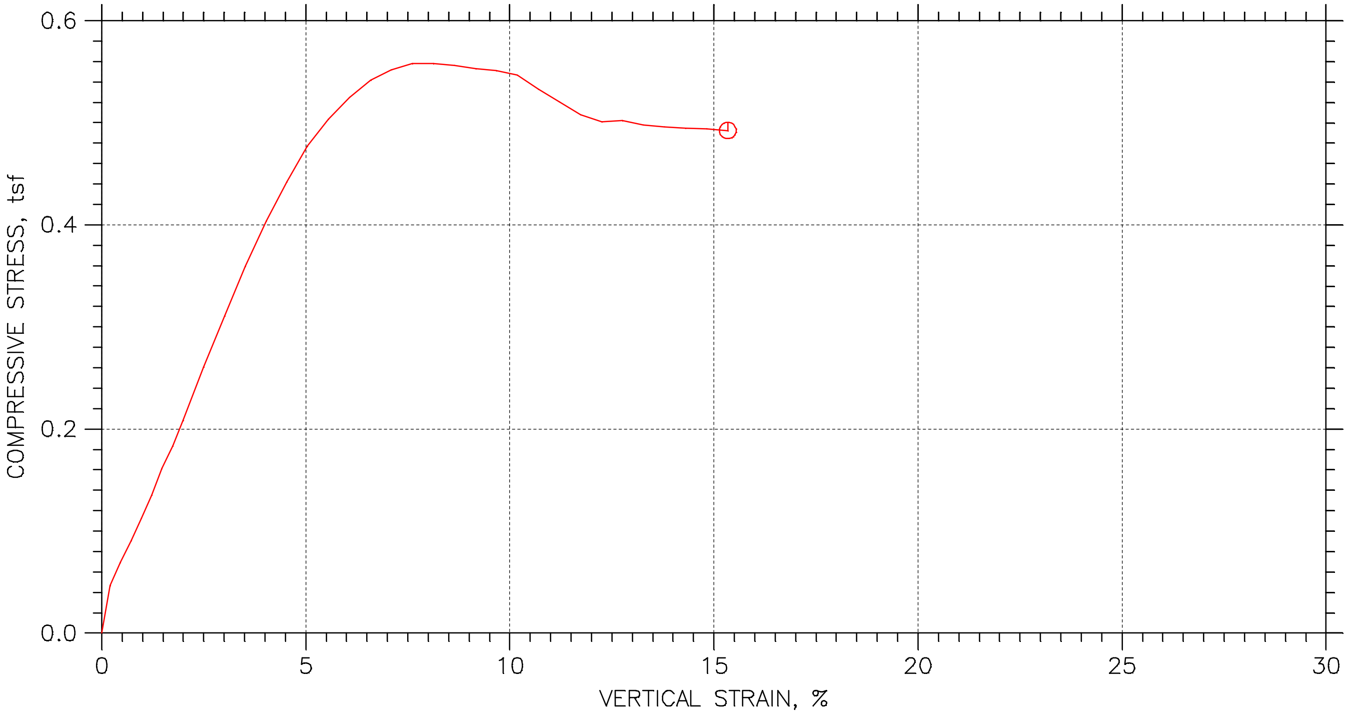


Symbol		⦶			
Test No.		B162ST6QU			
Initial	Diameter, in	2.8445			
	Height, in	6.0701			
	Water Content, %	25.88			
	Dry Density, pcf	98.18			
	Saturation, %	96.47			
	Void Ratio	0.72957			
Unconfined Compressive Strength, tsf		0.55834			
Undrained Shear Strength, tsf		0.27917			
Time to Failure, min		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.

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: -----

Soil Description: GRAY LEAN CLAY WITH SAND CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

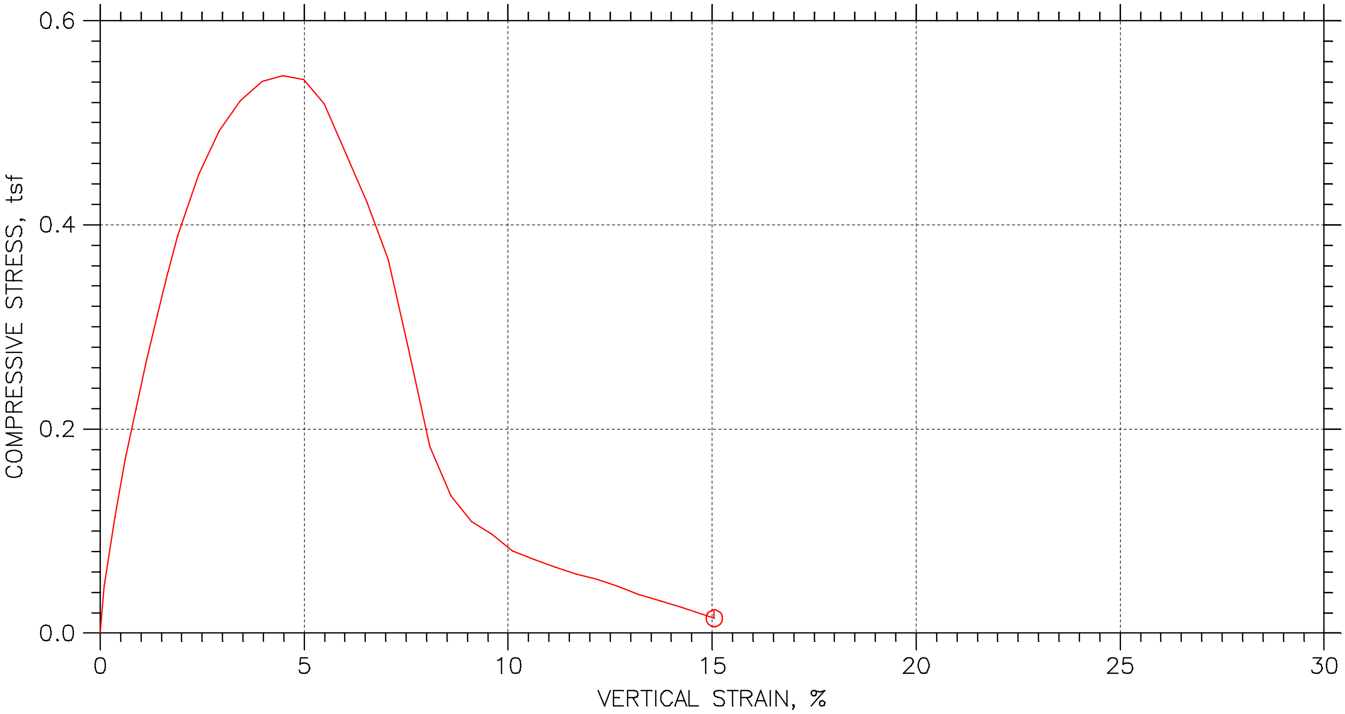
Specimen Height: 6.07 in
Specimen Area: 6.35 in^2
Specimen Volume: 38.57 in^3

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



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.

Tue, 26-APR-2016 15:47:30

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: -----

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

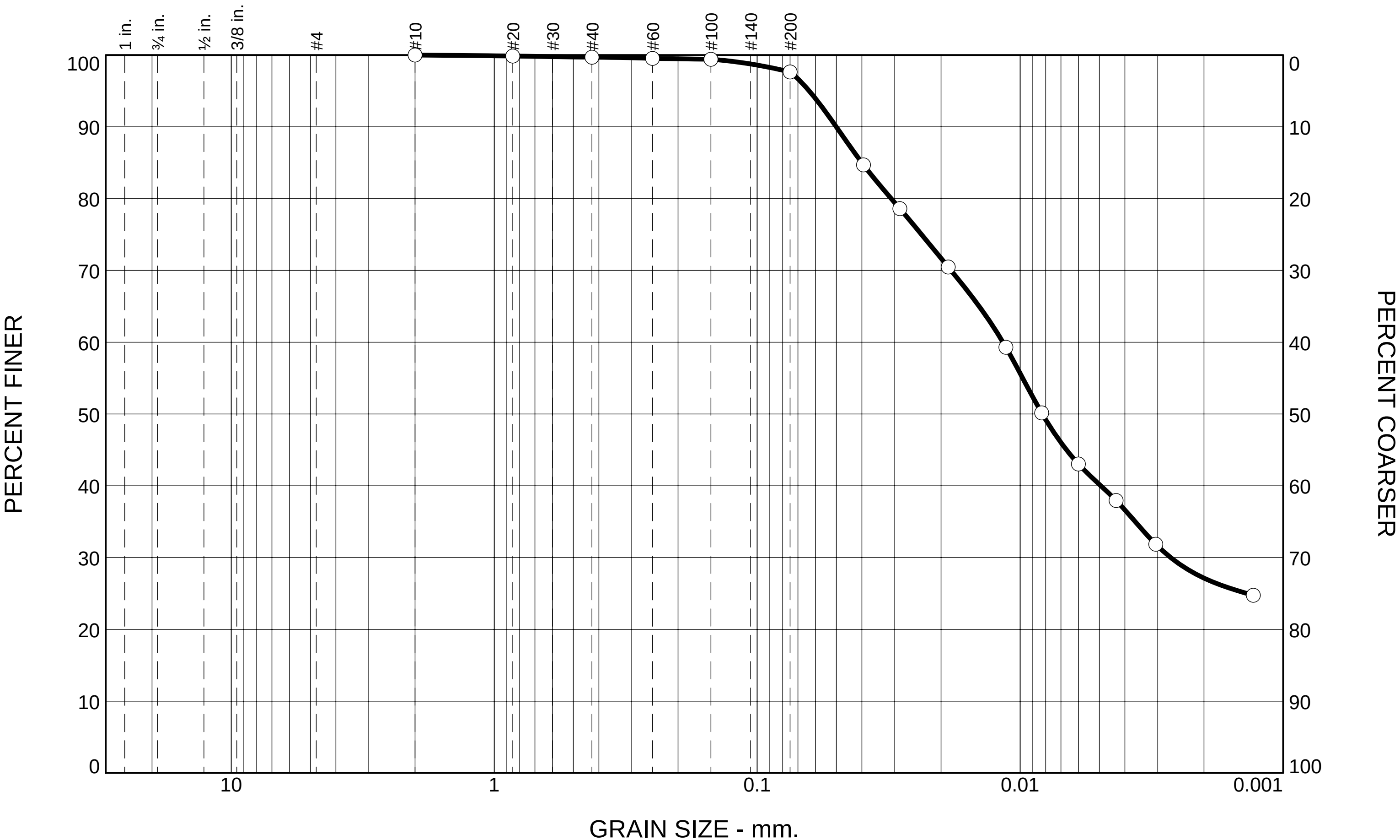
Liquid Limit: 43
Plastic Limit: 21
Estimated Specific Gravity: 2.72

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

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

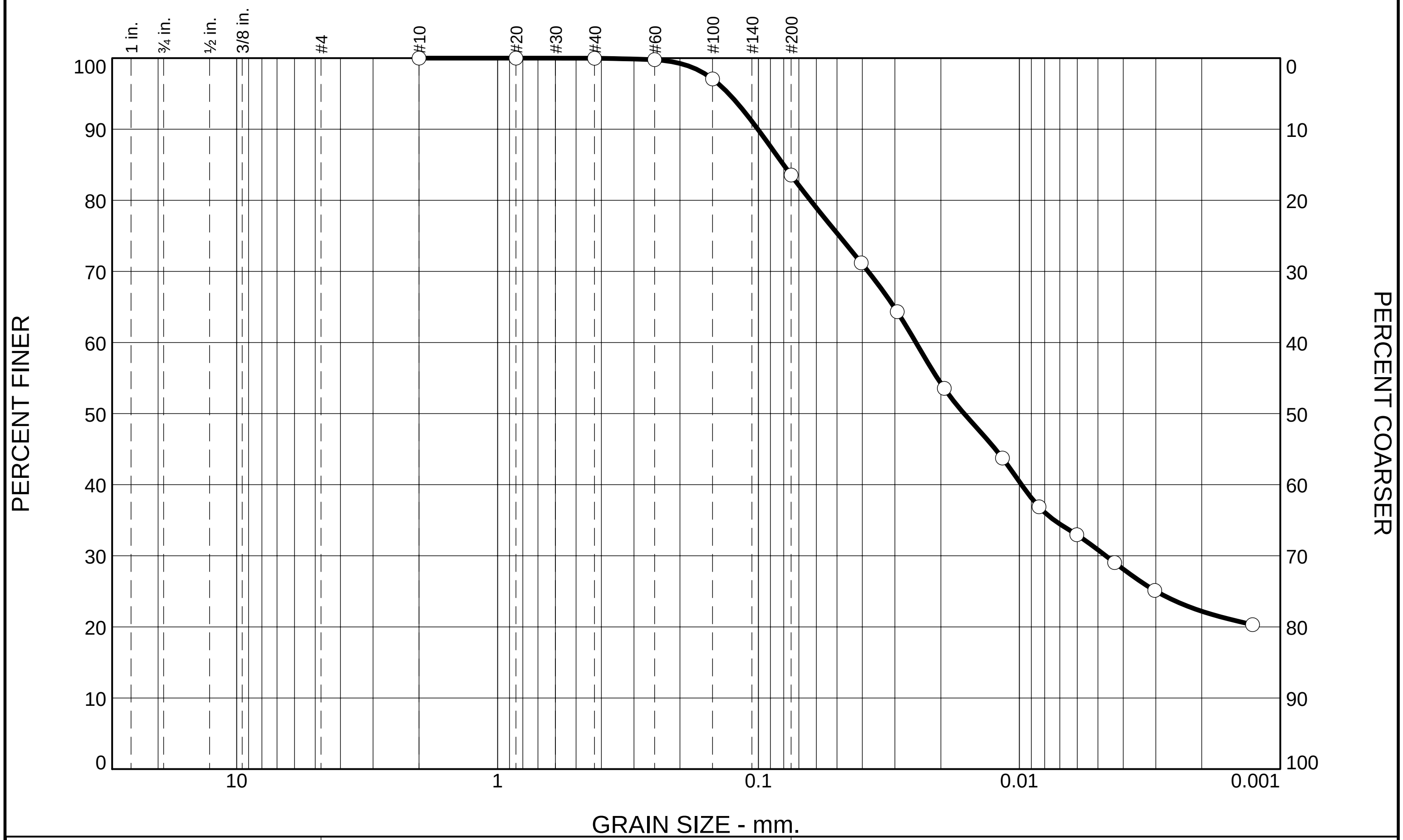
Source of Sample: B16-1 **Depth:** 17.0'-19.0'
Sample Number: ST-2
Date: 4/19/16

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

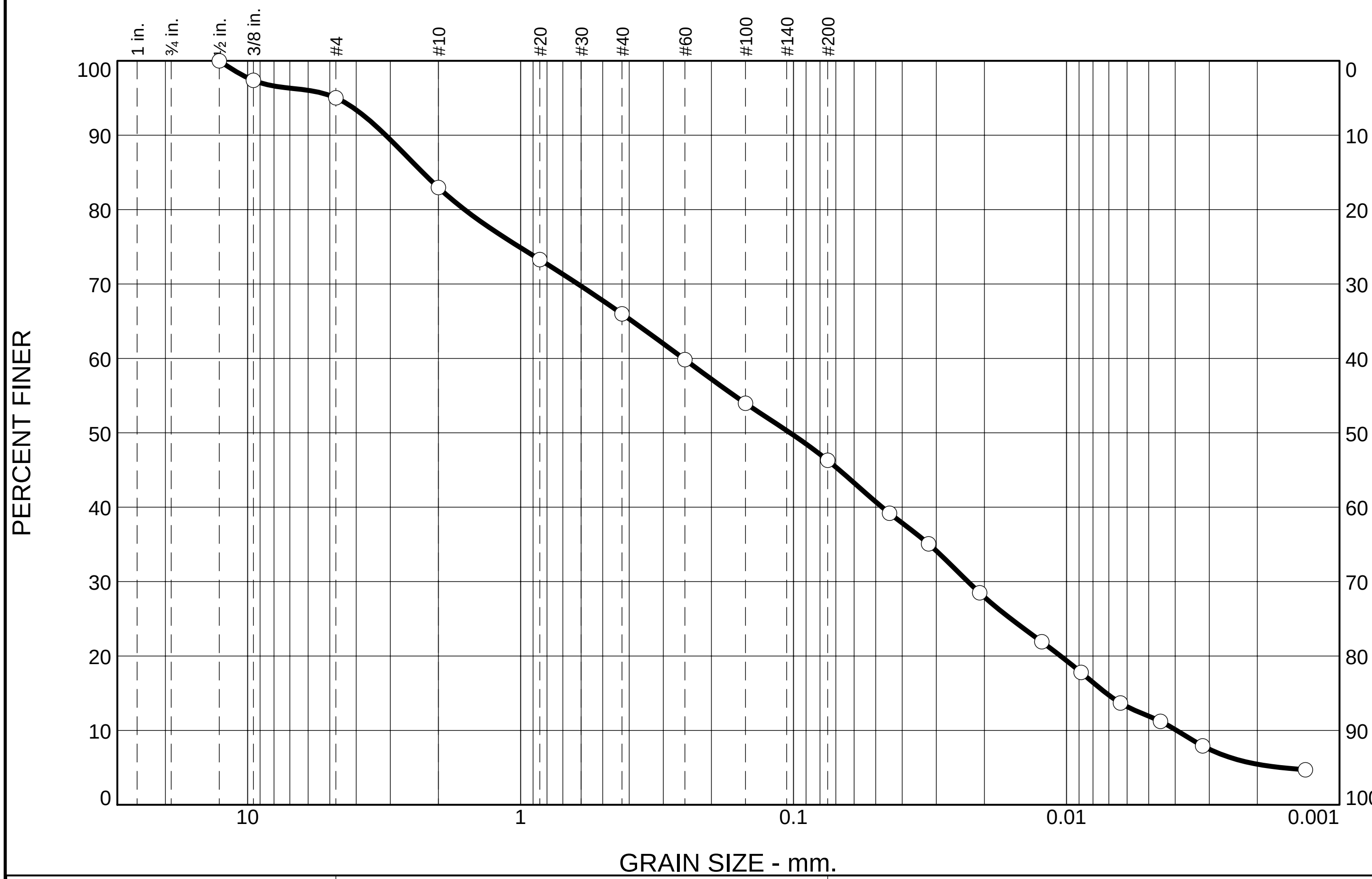
Terracon

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

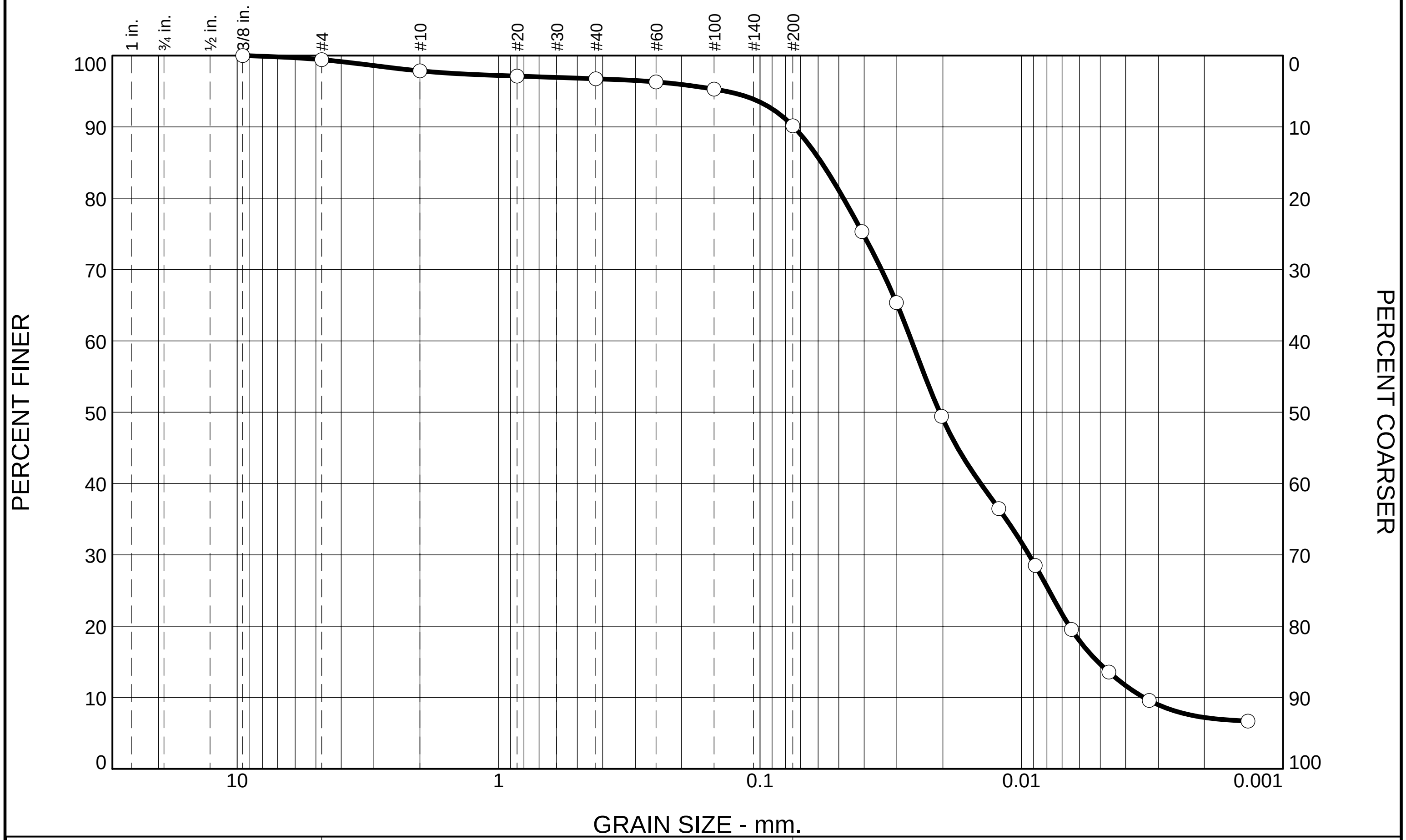
Date: 4/19/16

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

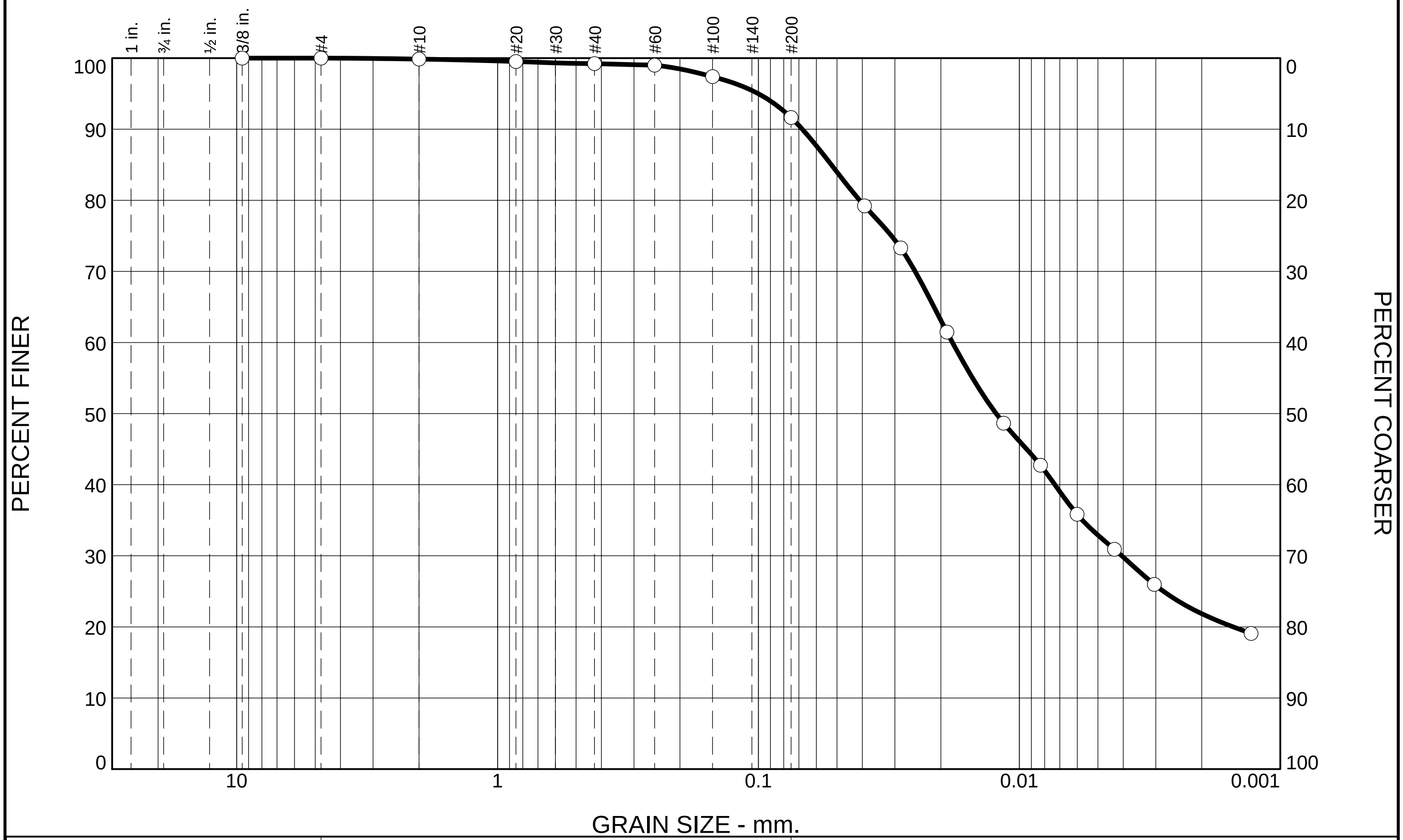
Terracon

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

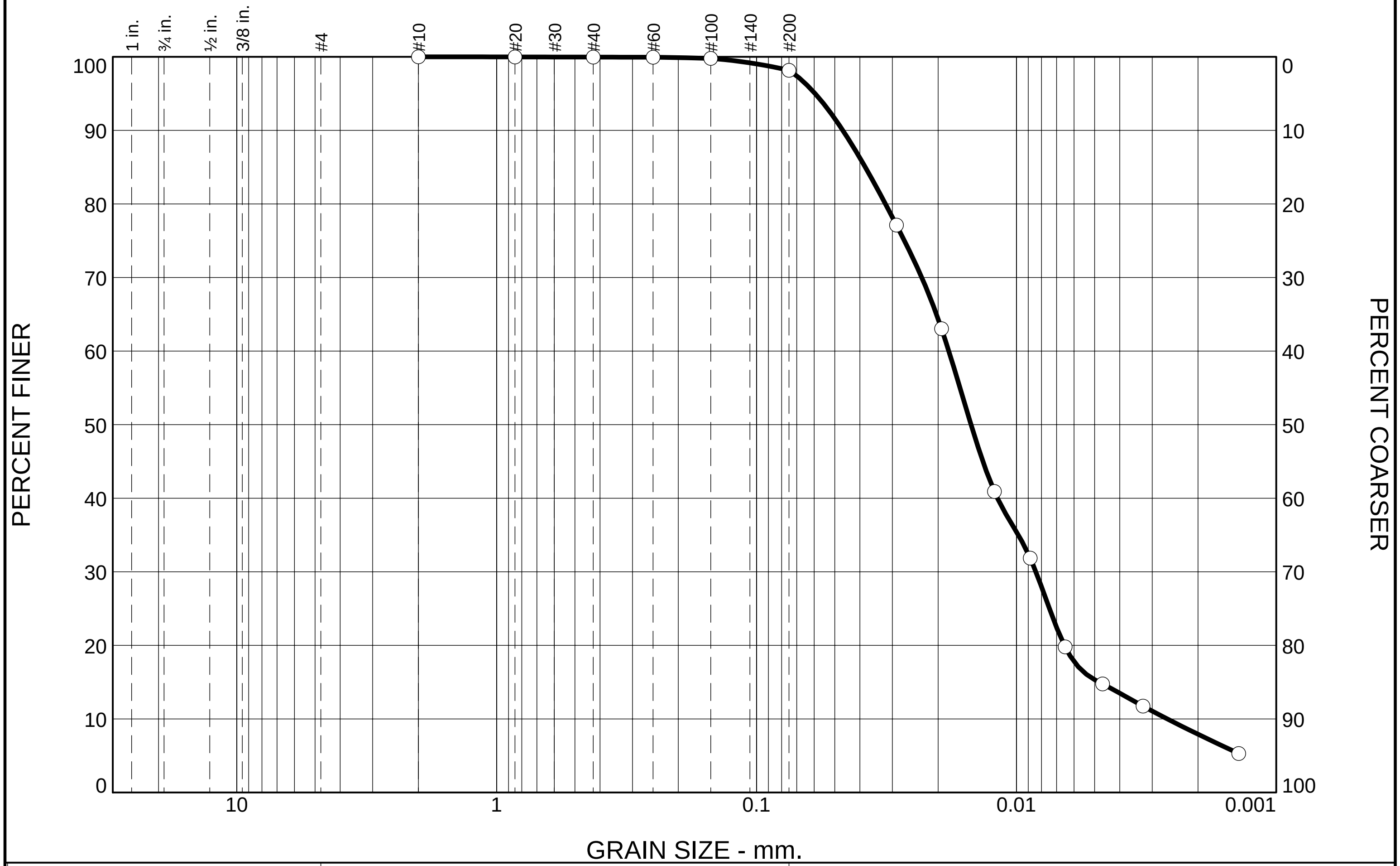
Source of Sample: B16-3 **Depth:** 11.0'-13.0'
Sample Number: ST-1
Date: 4/22/16

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	0.0	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

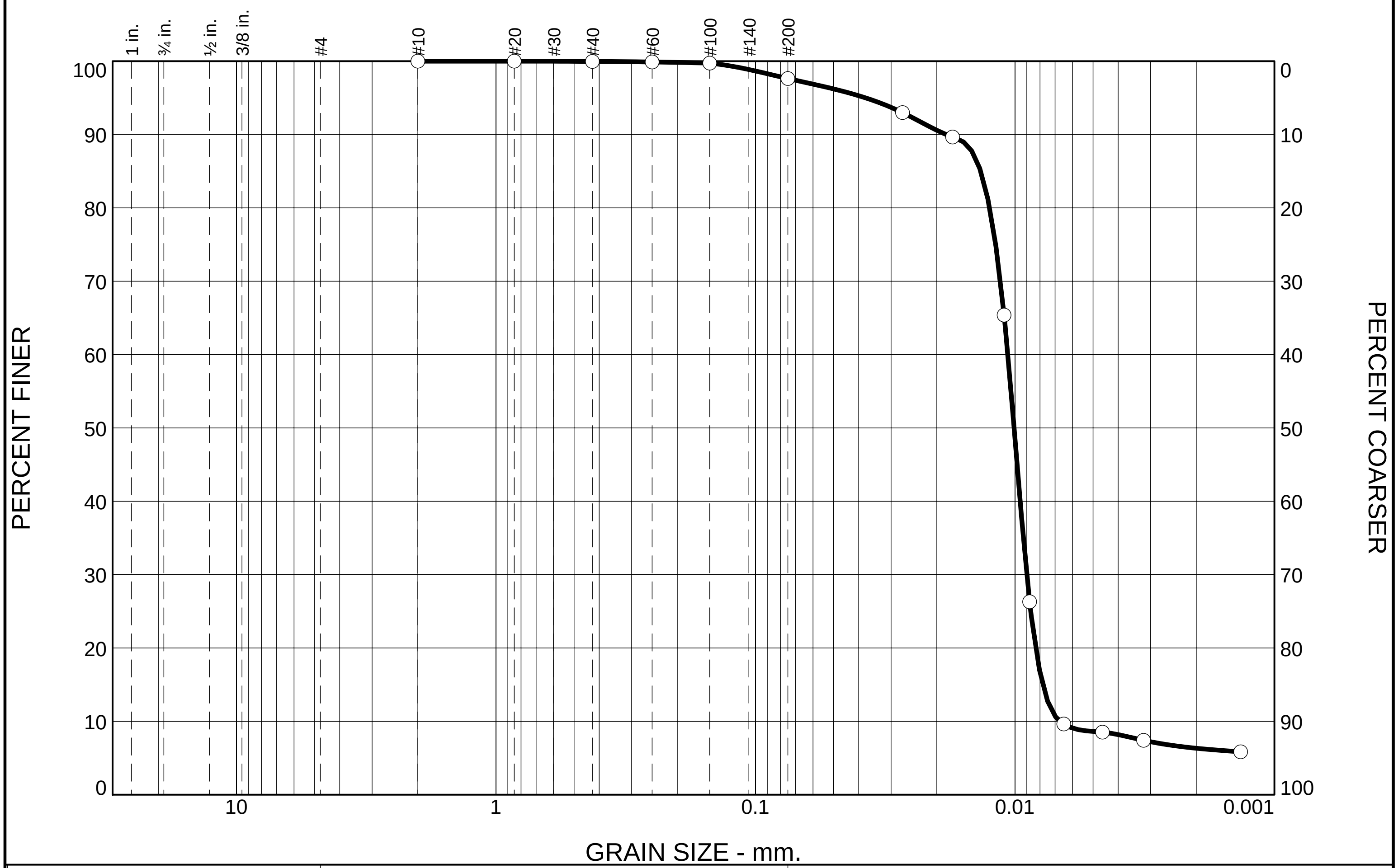
Date: 4/22/16

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	0.0	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=

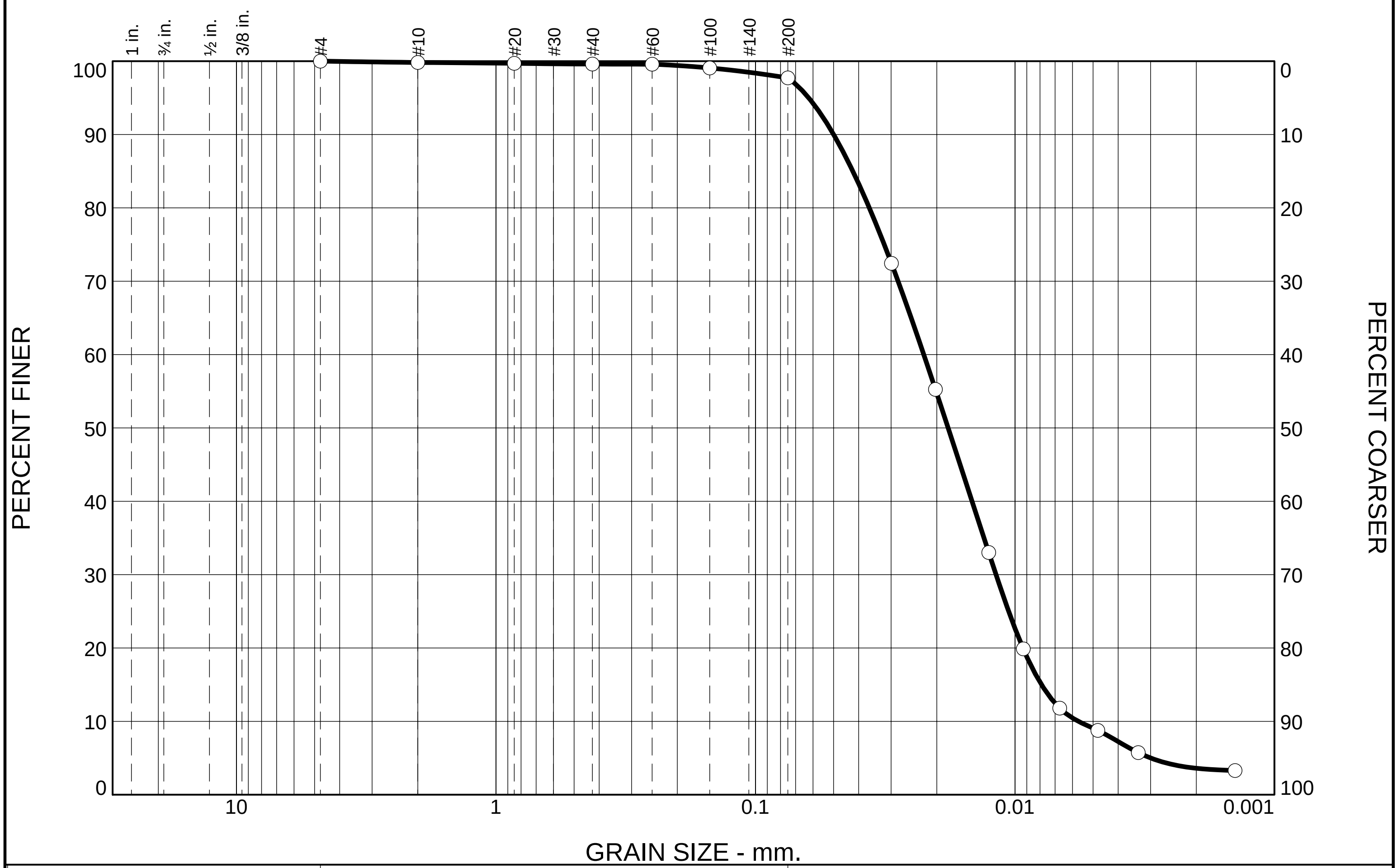
Remarks

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

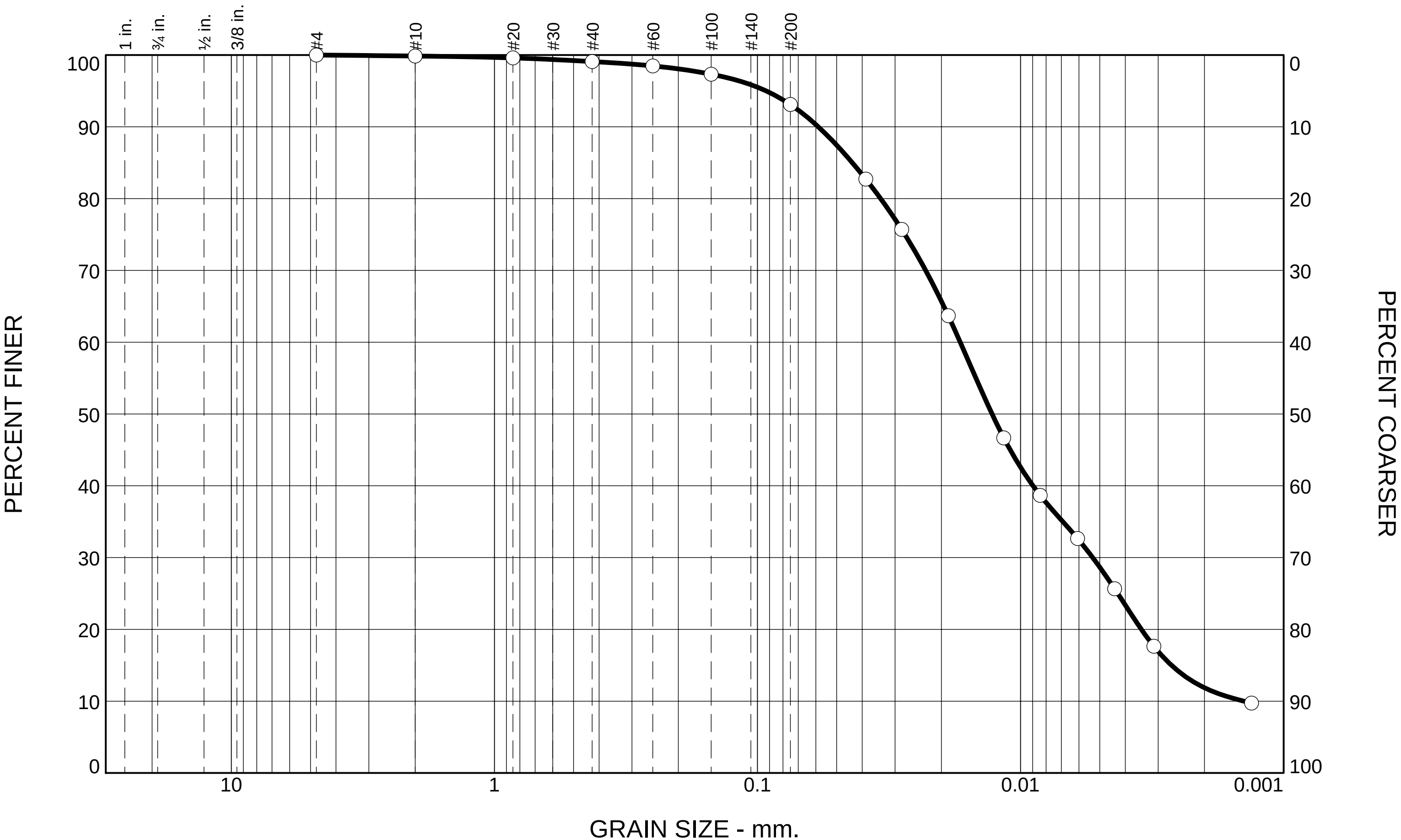
Date: 4/22/16

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

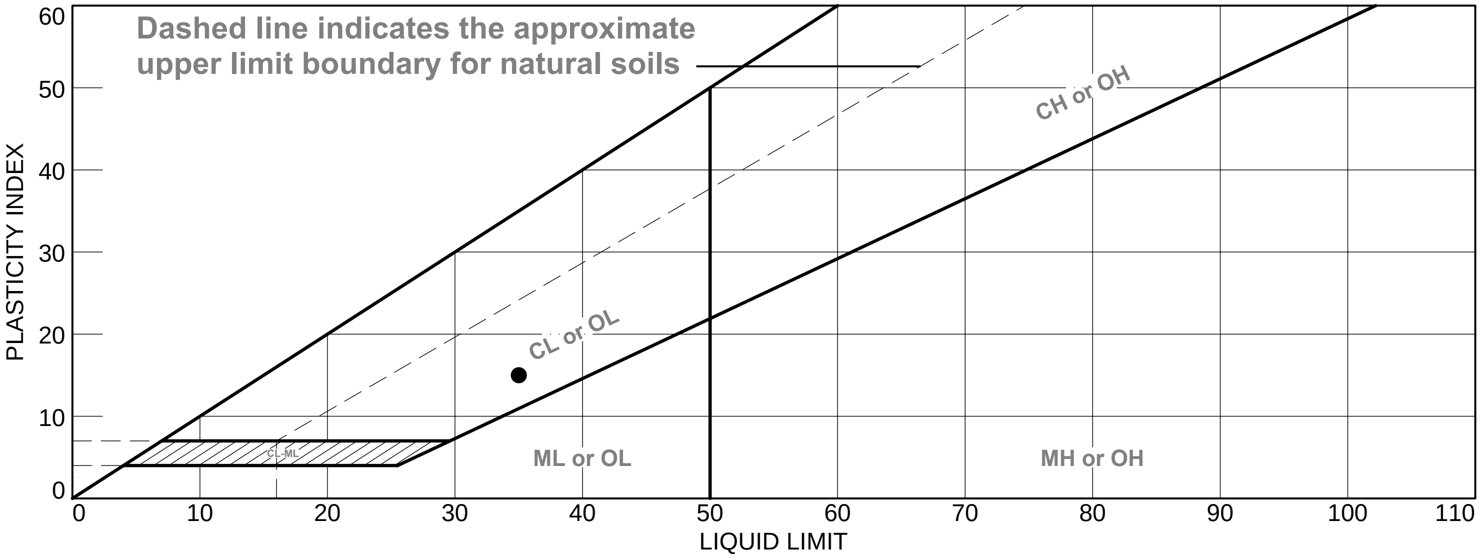
Client: AECOM
Project: VECTREN F.B. CULLEY EAST POND

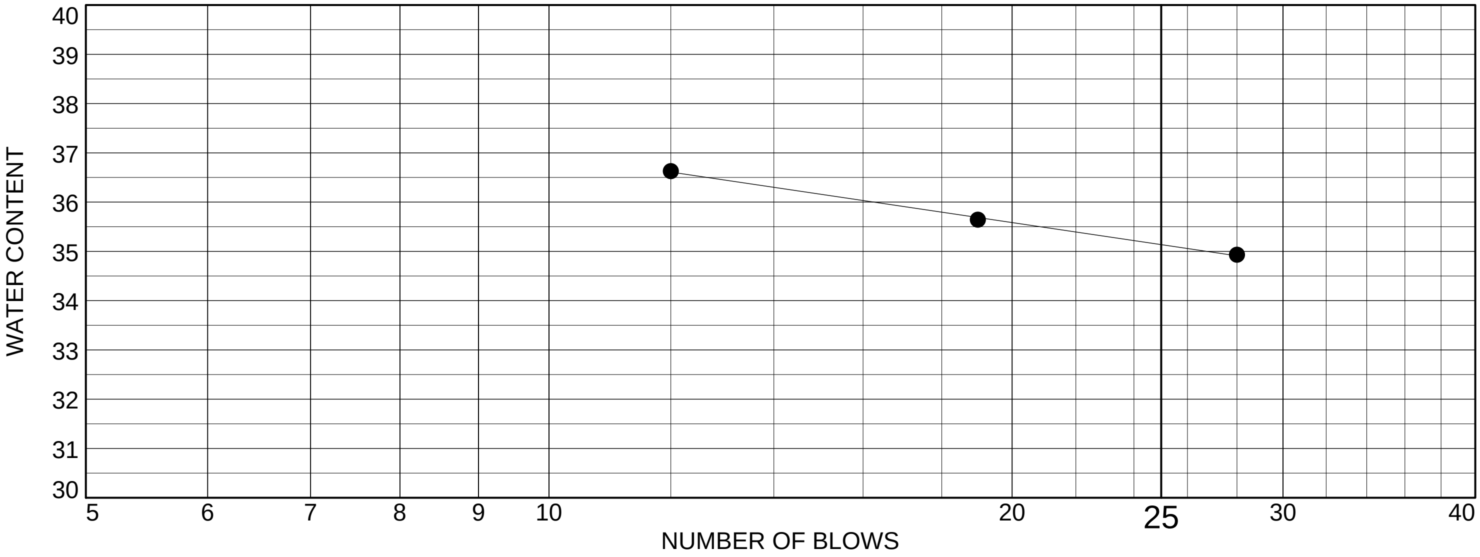
Project No: AW165009 **Figure**

Tested By: SH **Checked By:** BCM

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

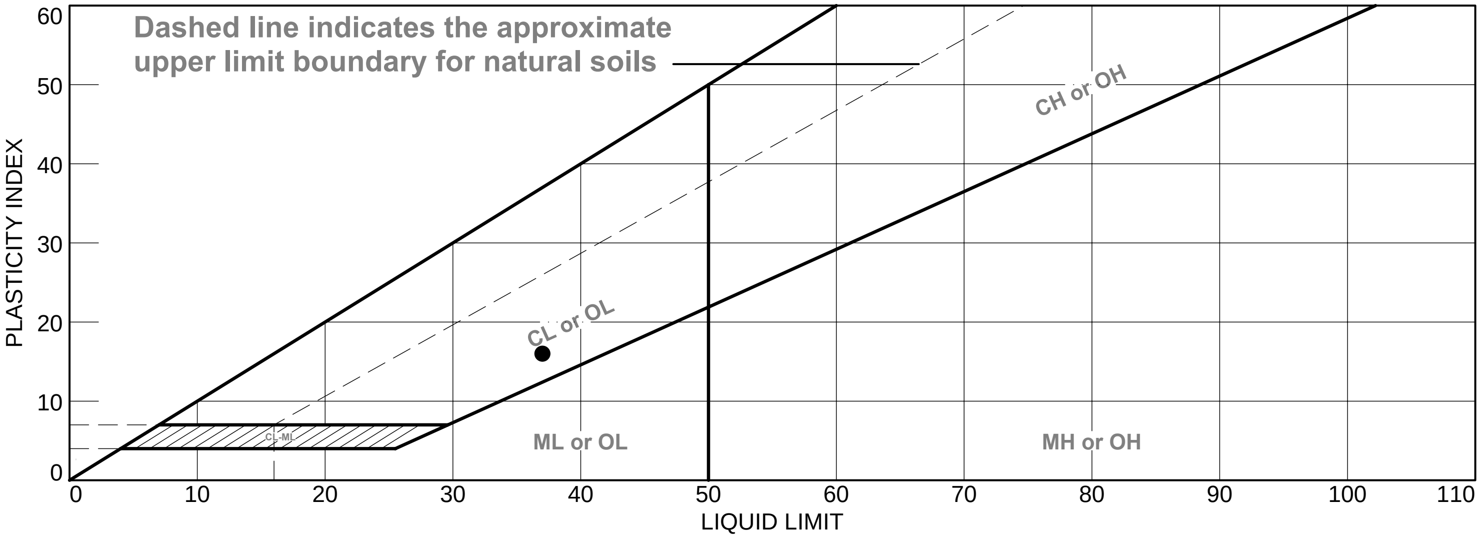
● **Source of Sample:** B16-1 **Depth:** 49.0'-51.0' **Sample Number:** ST-5

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

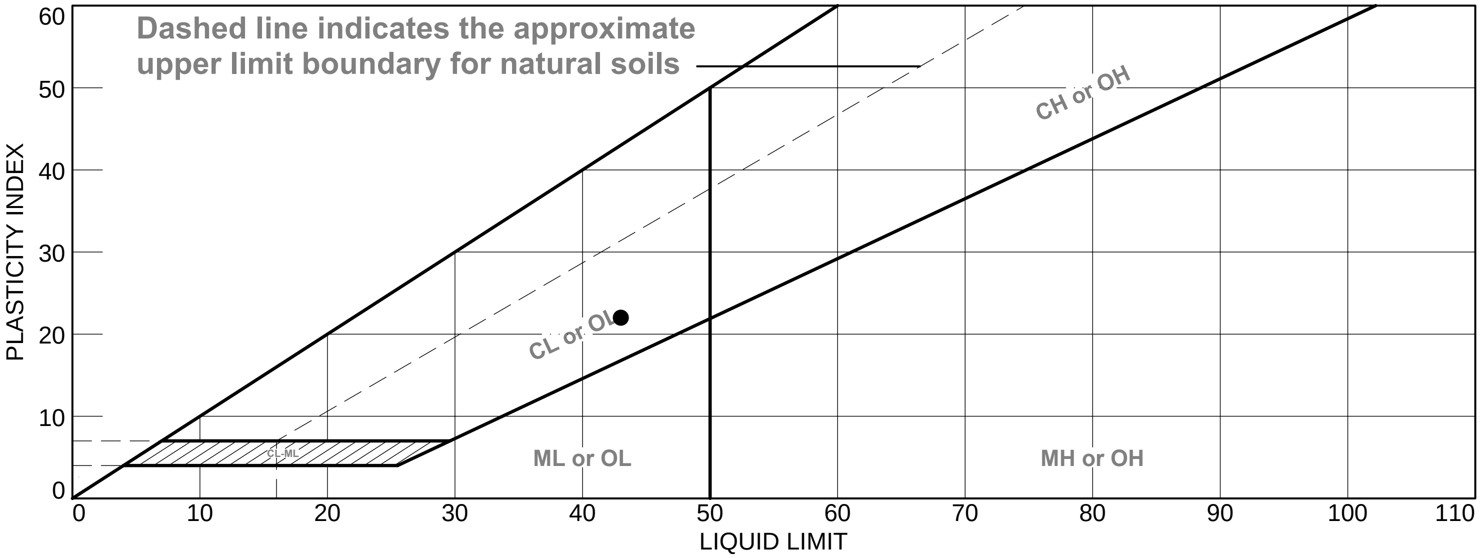
Remarks:

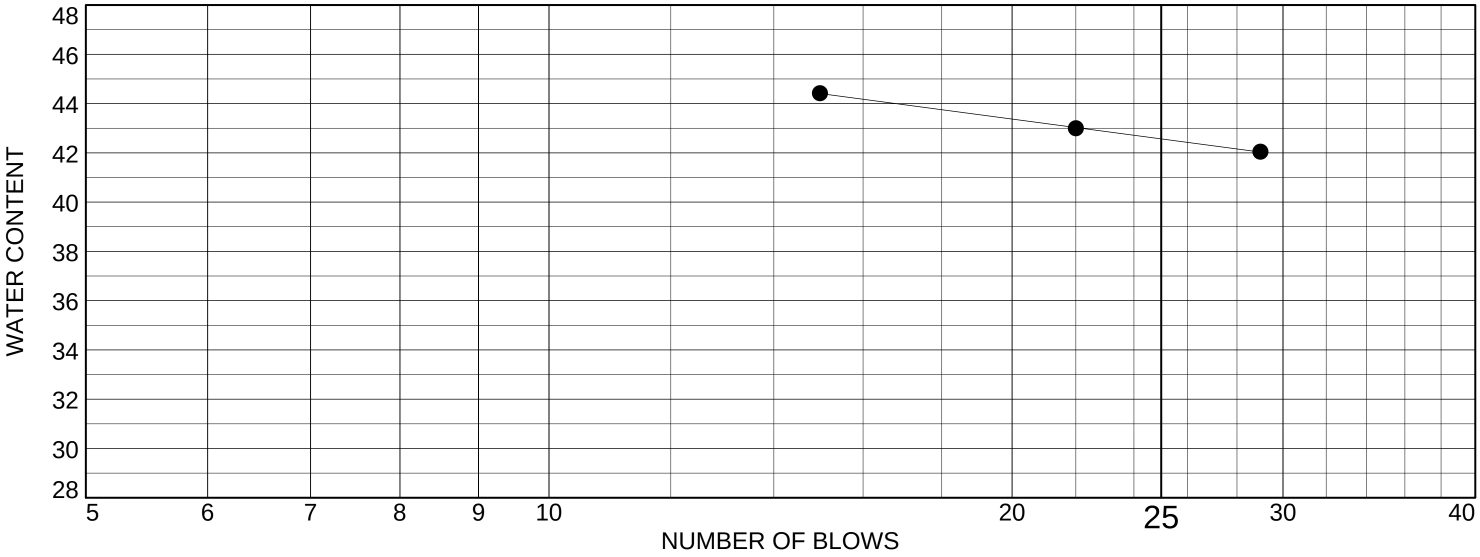
Terracon

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

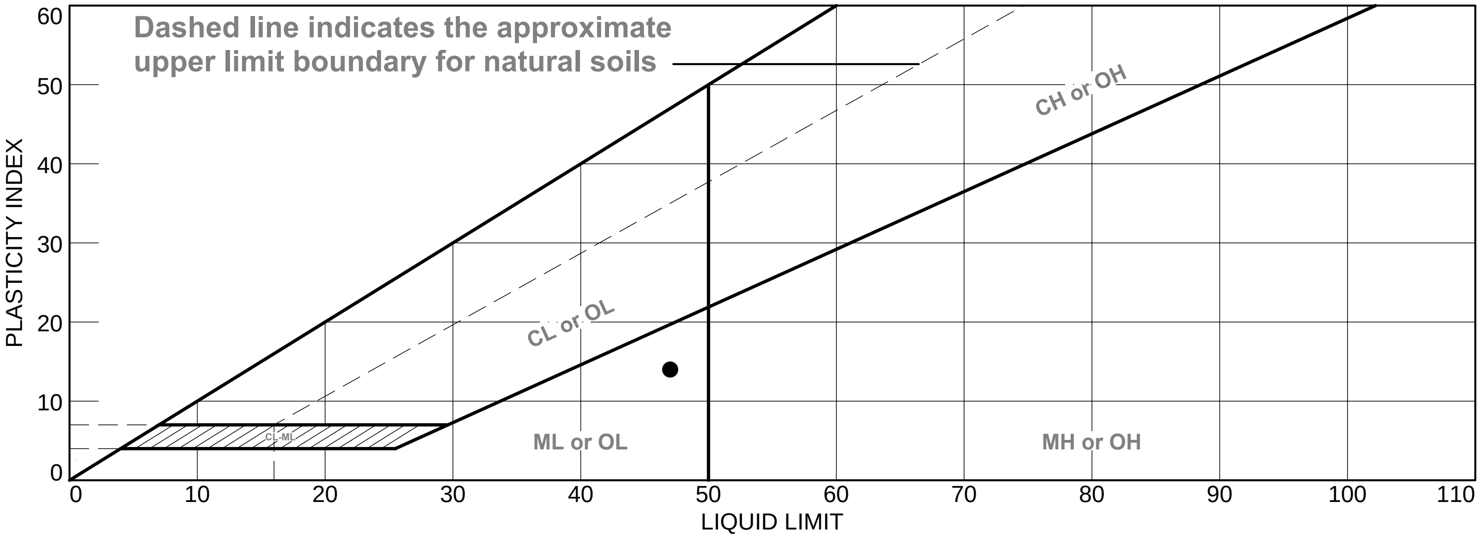
● **Source of Sample:** B16-3 **Depth:** 54.0'-56.0' **Sample Number:** ST-7

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

Specific Gravity of Soils – ASTM D 854

Terracon
Consulting Engineers & Scientists

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

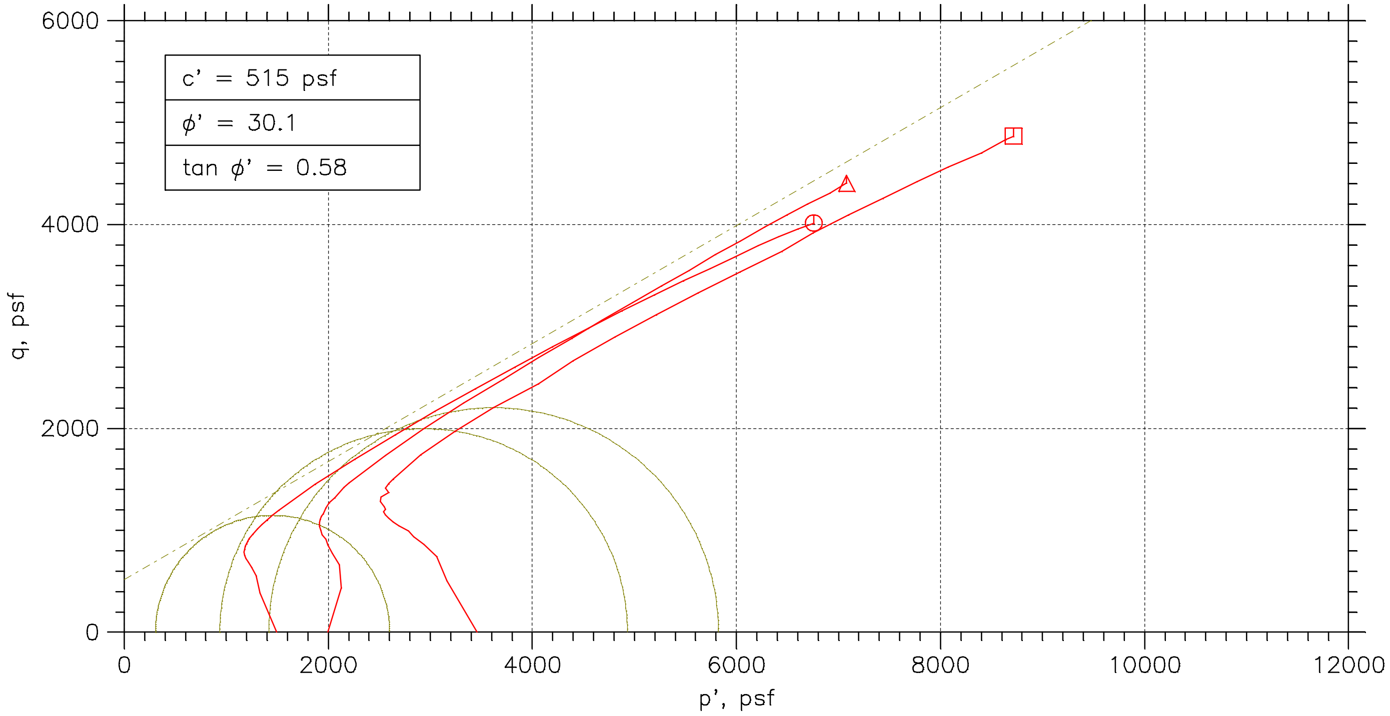
Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI
B-1	S-1	3.0'-5.0'	BROWN SILTY CLAY	CL	3.5									
B-1	S-2	5.0'-7.0'	BROWN TO GRAYISH BROWN LEAN CLAY WITH SILT AND SAND SEAMS AND POCKETS	CL	18.3	2.50								
B-1	S-3	8.0'-10.0'	BROWN SILTY 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									

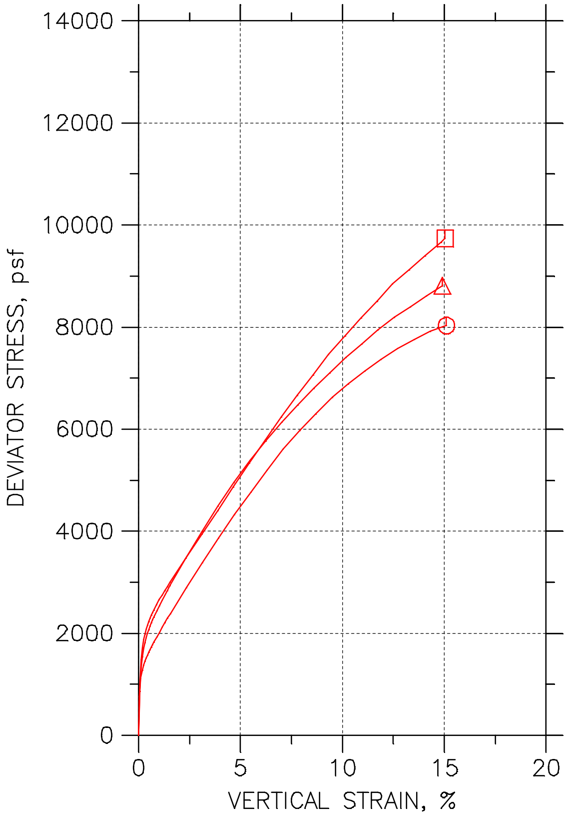
LABORATORY TESTING SUMMARY

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	
	Height, in	6.2287	6.0469	6.2197	
	Water Content, %	21.78	21.61	20.34	
	Dry Density, pcf	105.8	106.4	106.2	
	Saturation, %	97.88	98.54	92.49	
	Void Ratio	0.6051	0.5964	0.59825	
Before Shear	Water Content, %	21.87	20.82	19.81	
	Dry Density, pcf	106.5	108.4	110.3	
	Saturation, %	100.00	100.00	100.00	
	Void Ratio	0.59486	0.5664	0.53891	
	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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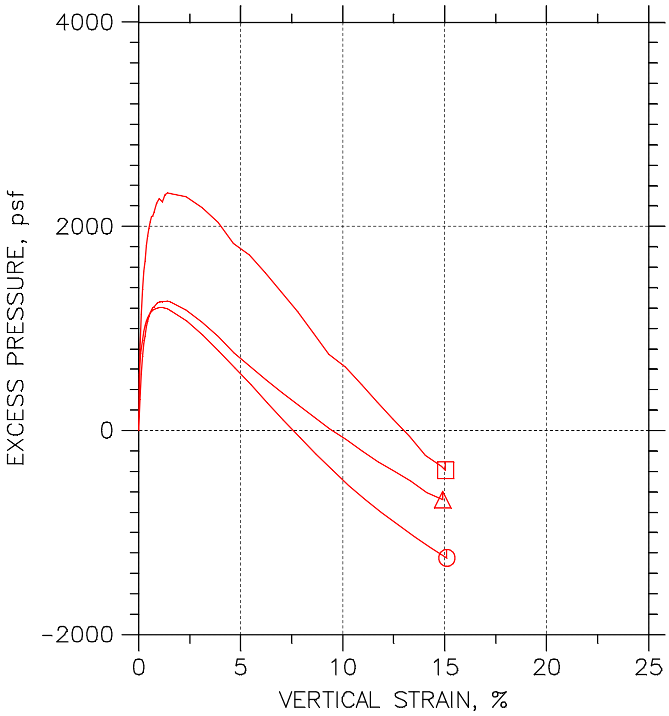

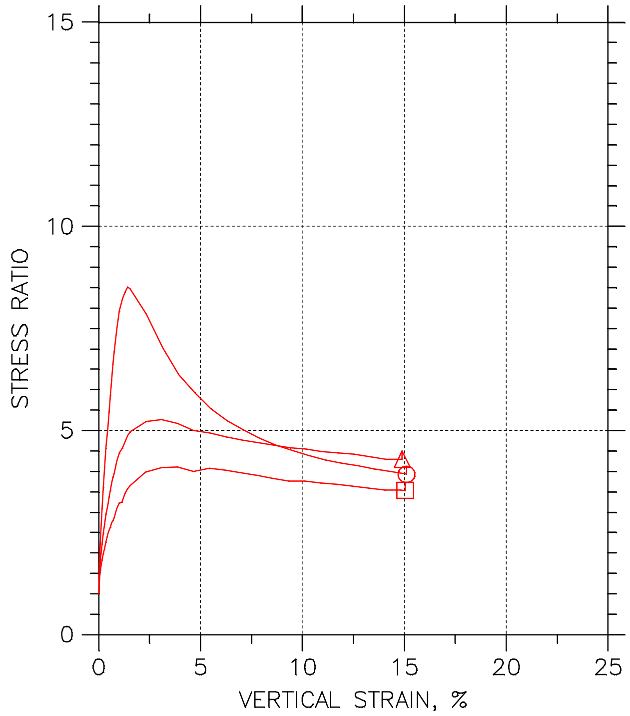

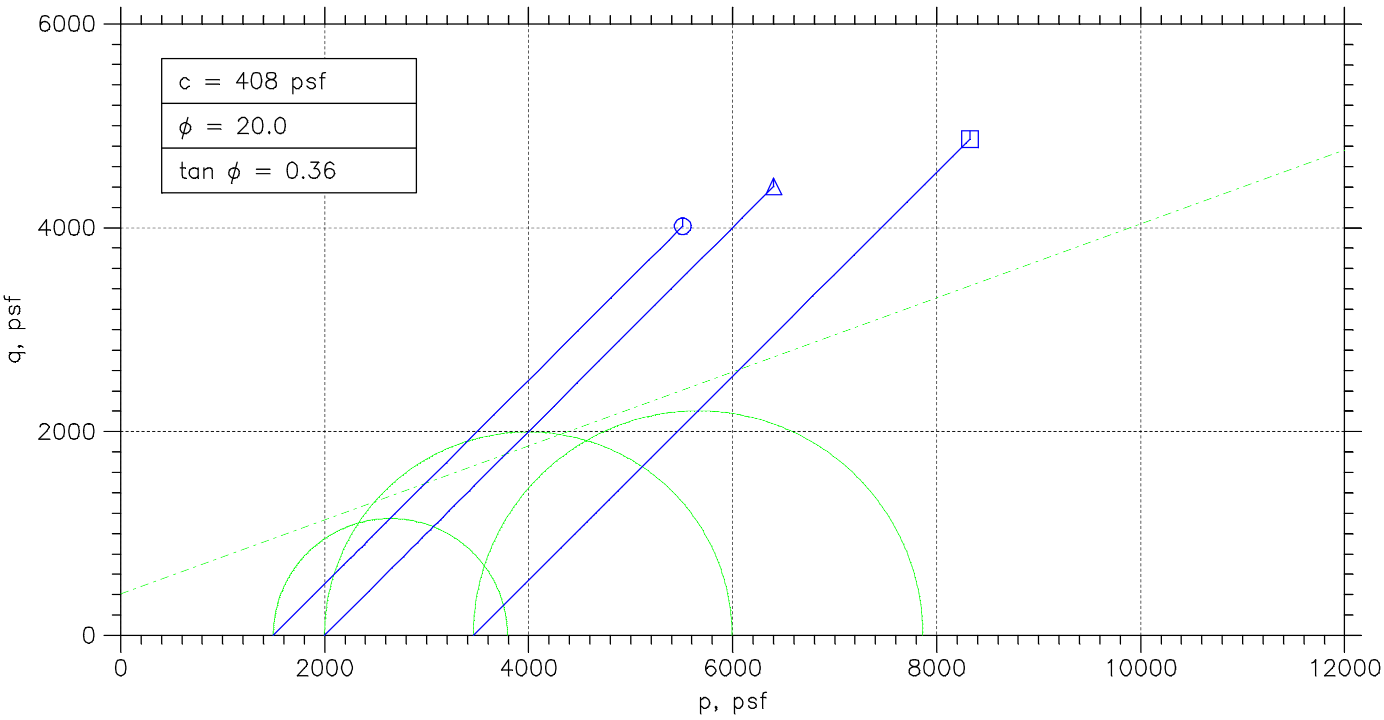

Project: VECTREN F.B. CULLEY	Location: NEWBURGH, IN	Project No.: MR155242
Boring No.: B-1 S-4	Tested By: BCM	Checked By: WPQ
Sample No.: S-4	Test Date: 11/28/15	Depth: 10.0'-12.0'
Test No.: B-1 S-4	Sample Type: 3.0" ST	Elevation: ----
Description: BROWN AND GRAY LEAN CLAY CL		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.		

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TRIAXIAL TEST

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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: ----

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

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Consulting Engineers & Scientists

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: ----

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: ----

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

Terracon
Consulting Engineers & Scientists

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

Terracon
Consulting Engineers & Scientists

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: ----

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

Terracon
Consulting Engineers & Scientists

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: ----

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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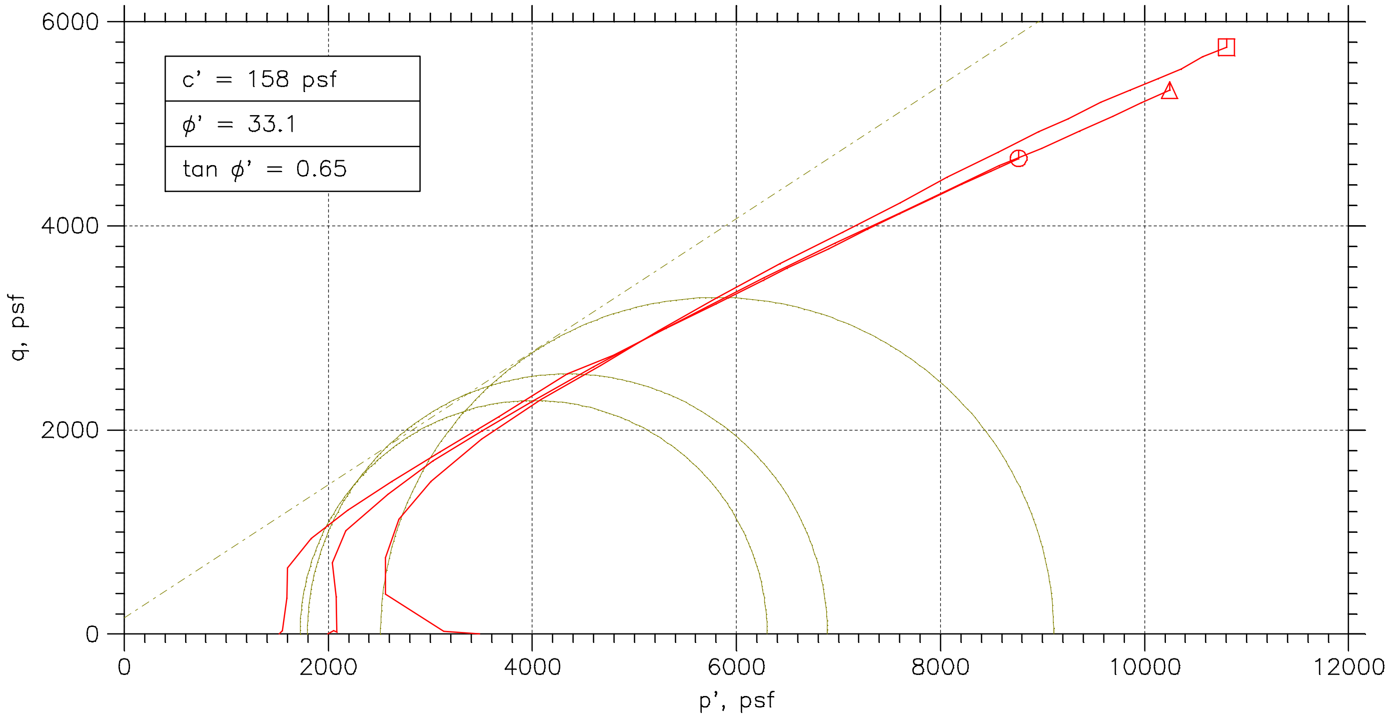
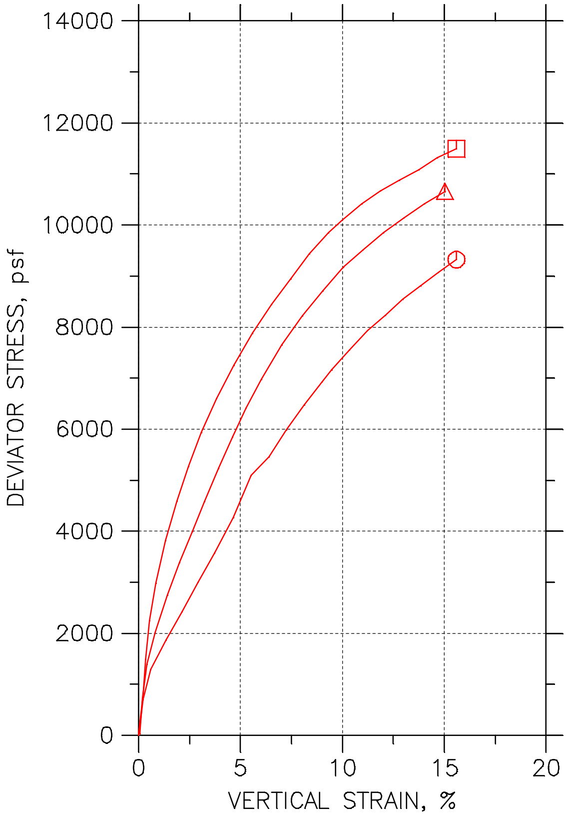


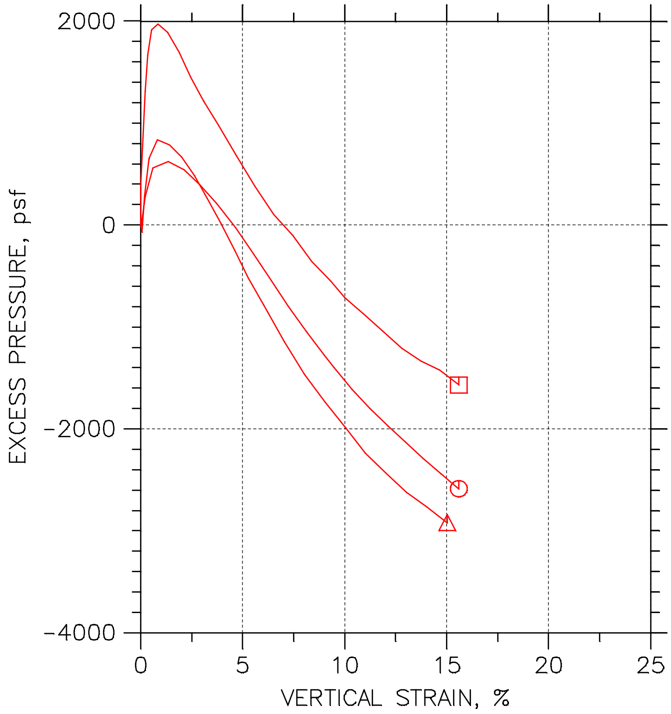


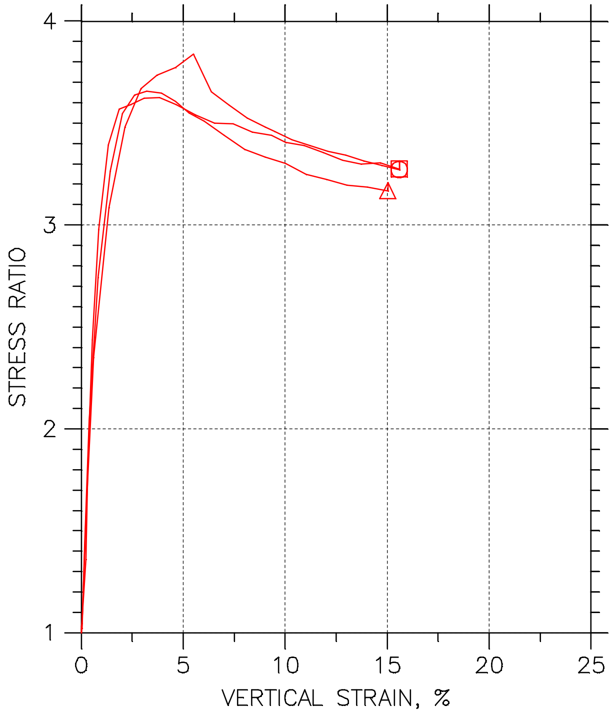
Symbol		○	△	□	
Test No.		1500 PSF	2000 PSF	3500 PSF	
Initial	Diameter, in	2.875	2.85	2.85	
	Height, in	6.29	6.05	5.91	
	Water Content, %	19.95	19.36	20.57	
	Dry Density, pcf	105.9	108.6	108.6	
	Saturation, %	90.05	93.49	99.35	
	Void Ratio	0.60273	0.56326	0.56314	
Before Shear	Water Content, %	20.95	18.99	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					

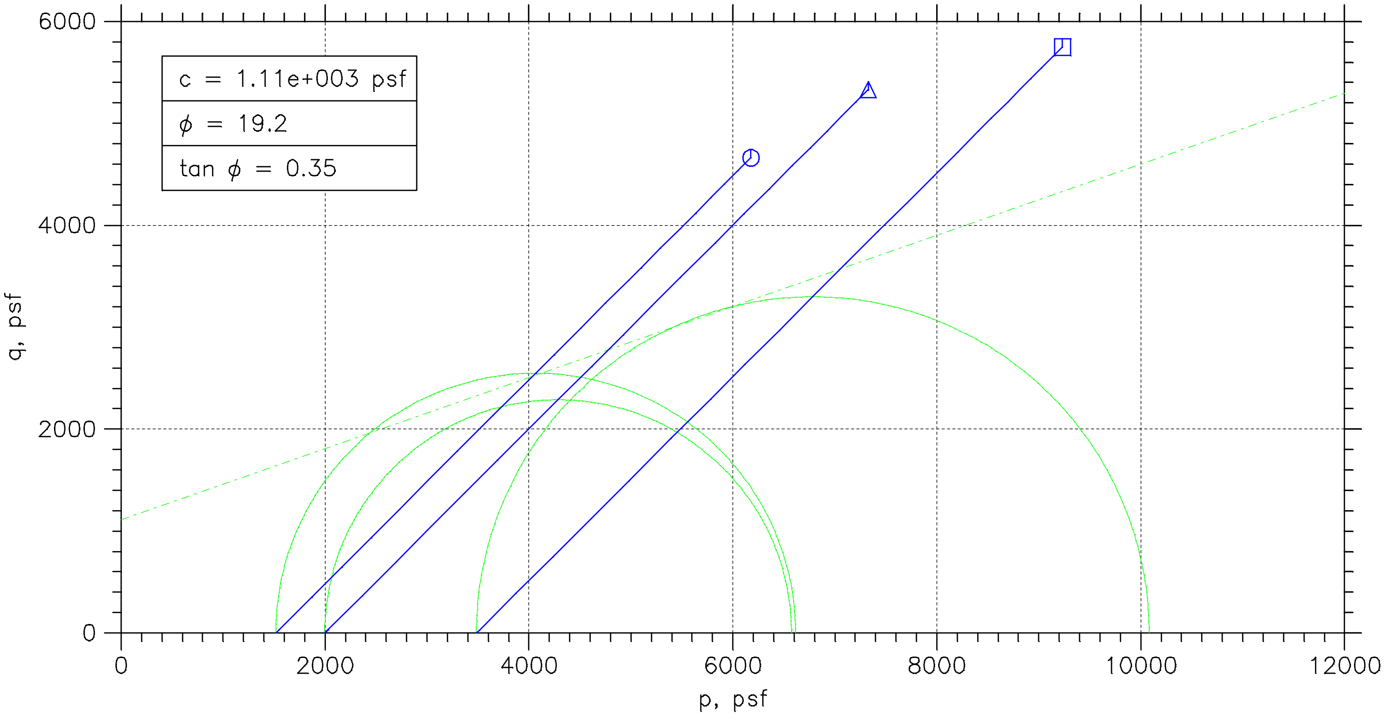
Project: VECTREN F.B. CULLEY
Location: NEWBURGH, IN
Project No.: MR155242
Boring No.: B-1 S-6
Sample Type: 3.0'' ST
Description: BROWN AND GRAY LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Fri, 04-DEC-2015 14:09:50

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767







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

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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

	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

Terracon
Consulting Engineers & Scientists

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: ----

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: ----

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

Terracon
Consulting Engineers & Scientists

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: ----

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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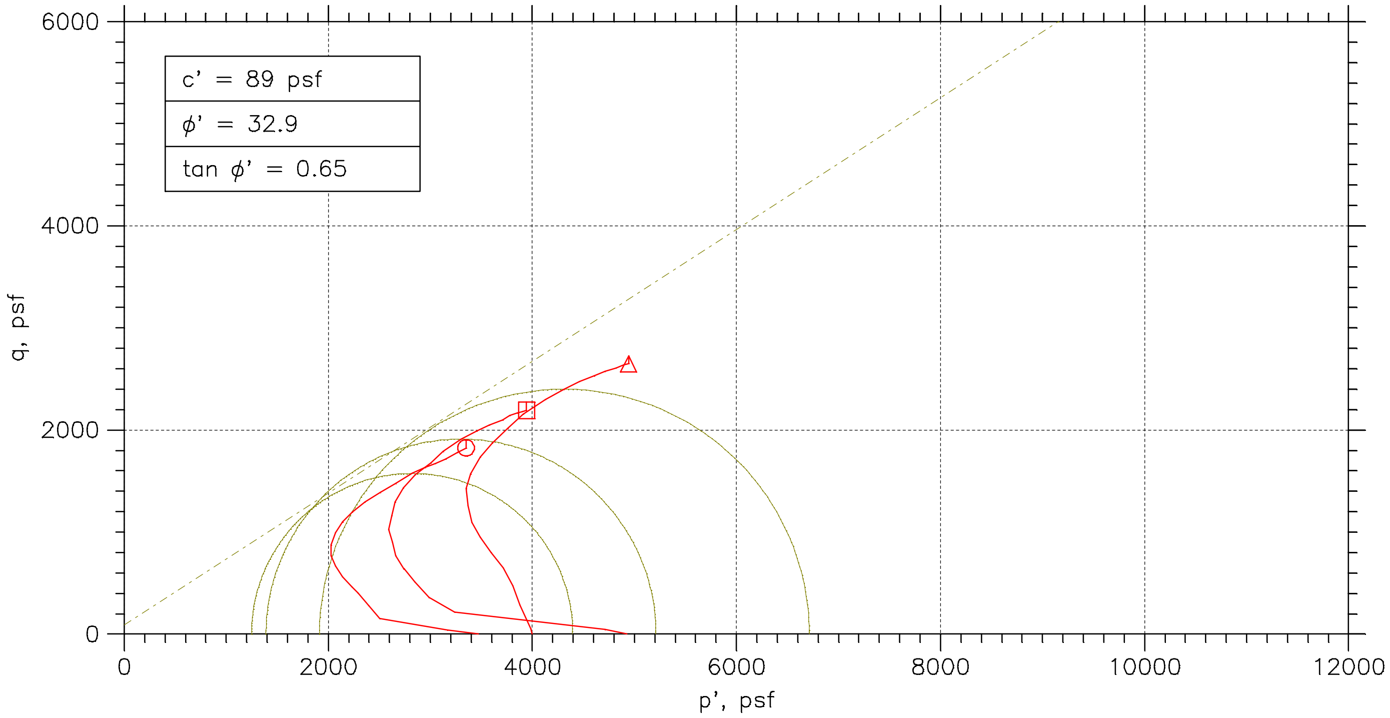

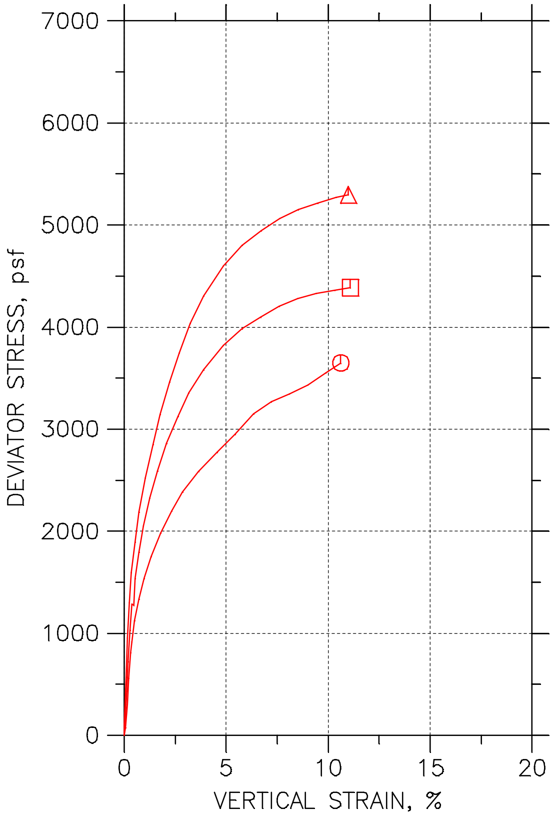

	Symbol	○	△	□	
	Test No.	3500 PSF	4000 PSF	5000 PSF	
Initial	Diameter, in	2.85	2.86	2.847	
	Height, in	6.17	5.965	6.03	
	Water Content, %	25.17	26.36	25.89	
	Dry Density, pcf	97.13	97.45	97.78	
	Saturation, %	91.49	96.56	95.59	
	Void Ratio	0.74825	0.74256	0.73664	
Before Shear	Water Content, %	26.37	25.34	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	

Project: VECTREN F.B. CULLEY
Location: NEWBURGH, IN
Project No.: MR155242
Boring No.: B-1 S-12
Sample Type: 3.0'' ST

Failure Sketch

Description: DARK BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

Terracon
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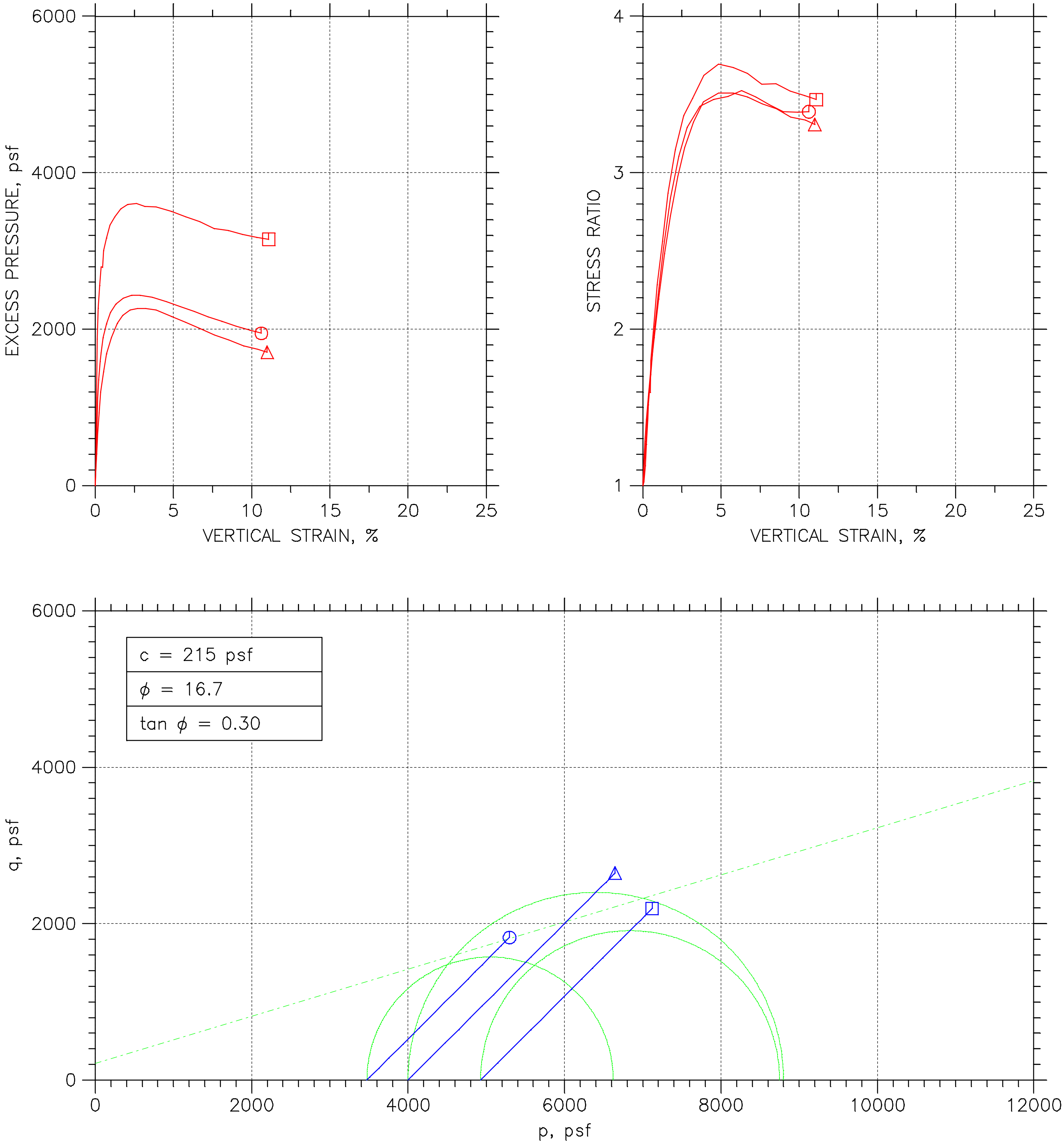

Project: VECTREN F.B. CULLEY	Location: NEWBURGH, IN	Project No.: MR155242
Boring No.: B-1 S-12	Tested By: BCM	Checked By: WPQ
Sample No.: S-12	Test Date: 11/28/15	Depth: 40.0'-42.0'
Test No.: B-1 S-12	Sample Type: 3.0" ST	Elevation: ----
Description: DARK BROWN LEAN CLAY CL		
Remarks: FAILURE CRITERIA = 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

Terracon
Consulting Engineers & Scientists

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: ----

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

	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: ----

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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: 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
Boring No.: B-2 S-12
Sample No.: S-12
Test No.: 5000 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: 6.03 in
Specimen Area: 6.37 in^2
Specimen Volume: 38.39 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	6.366	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

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Project: VECTREN F.B. CULLEY
Boring No.: B-2 S-12
Sample No.: S-12
Test No.: 5000 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: 6.03 in
Specimen Area: 6.37 in^2
Specimen Volume: 38.39 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

	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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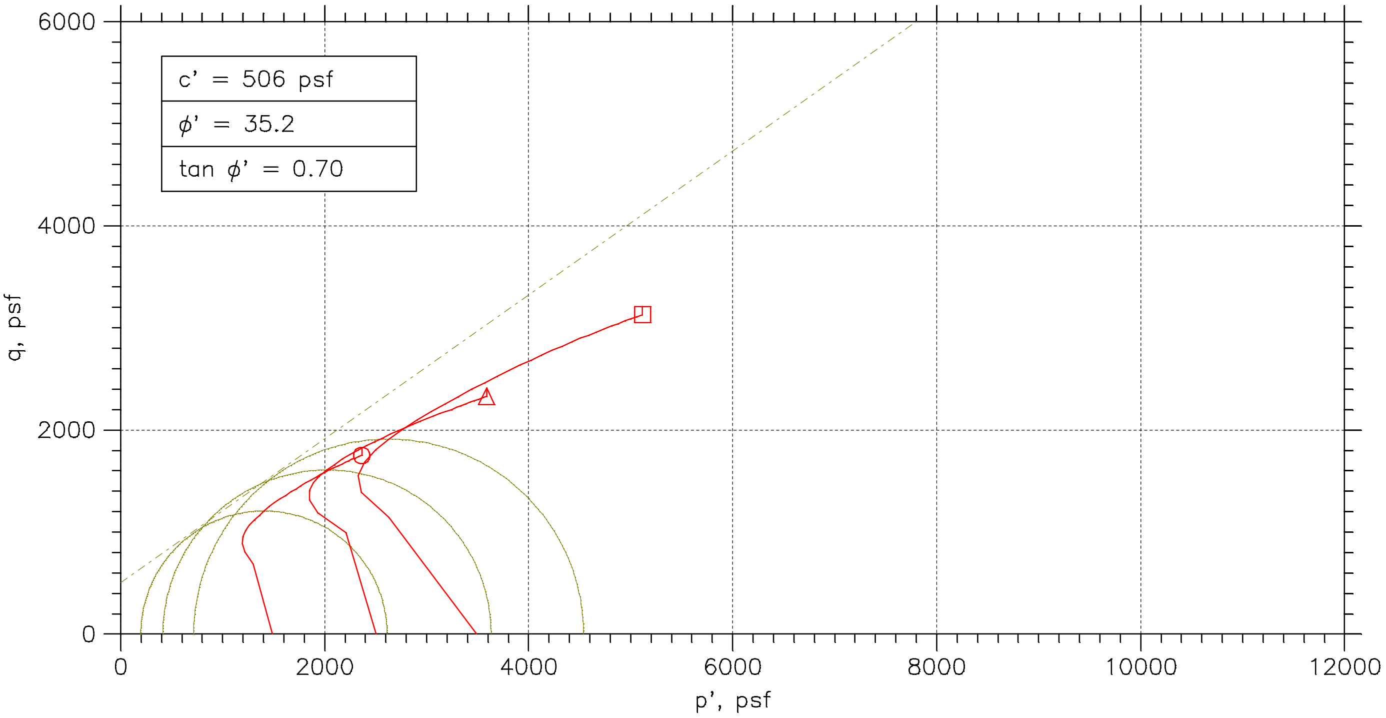
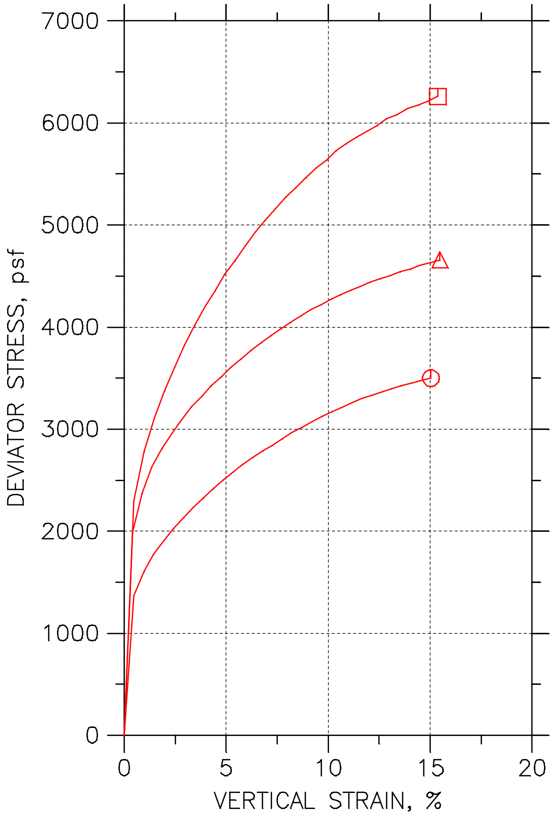




Symbol		○	△	□	
Test No.		1500 PSF	2500 PSF	3500 PSF	
Initial	Diameter, in	2.8665	2.8689	2.8622	
	Height, in	6.0205	6.3382	6.2492	
	Water Content, %	21.71	21.71	20.57	
	Dry Density, pcf	103.7	103.2	104.8	
	Saturation, %	92.69	91.46	90.30	
	Void Ratio	0.63715	0.64577	0.61978	
Before Shear	Water Content, %	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

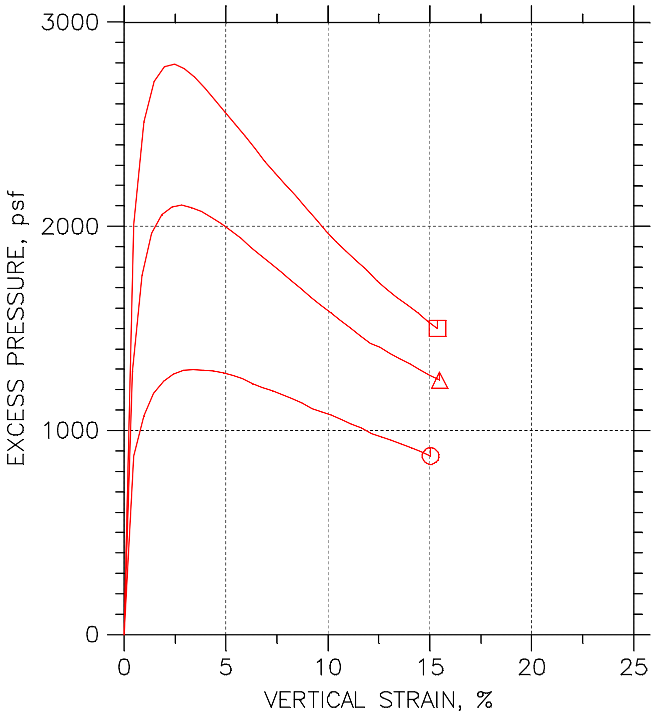
Boring No.: B-2 S-5

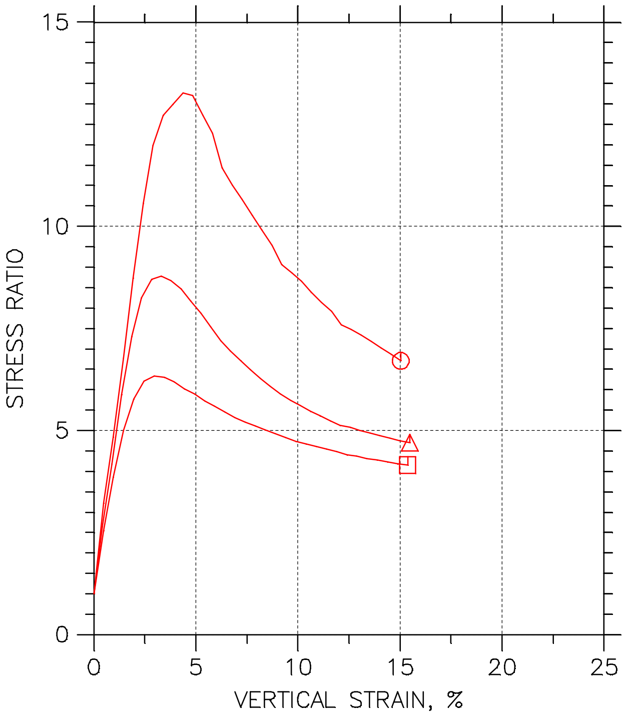
Sample Type: 3.0'' ST

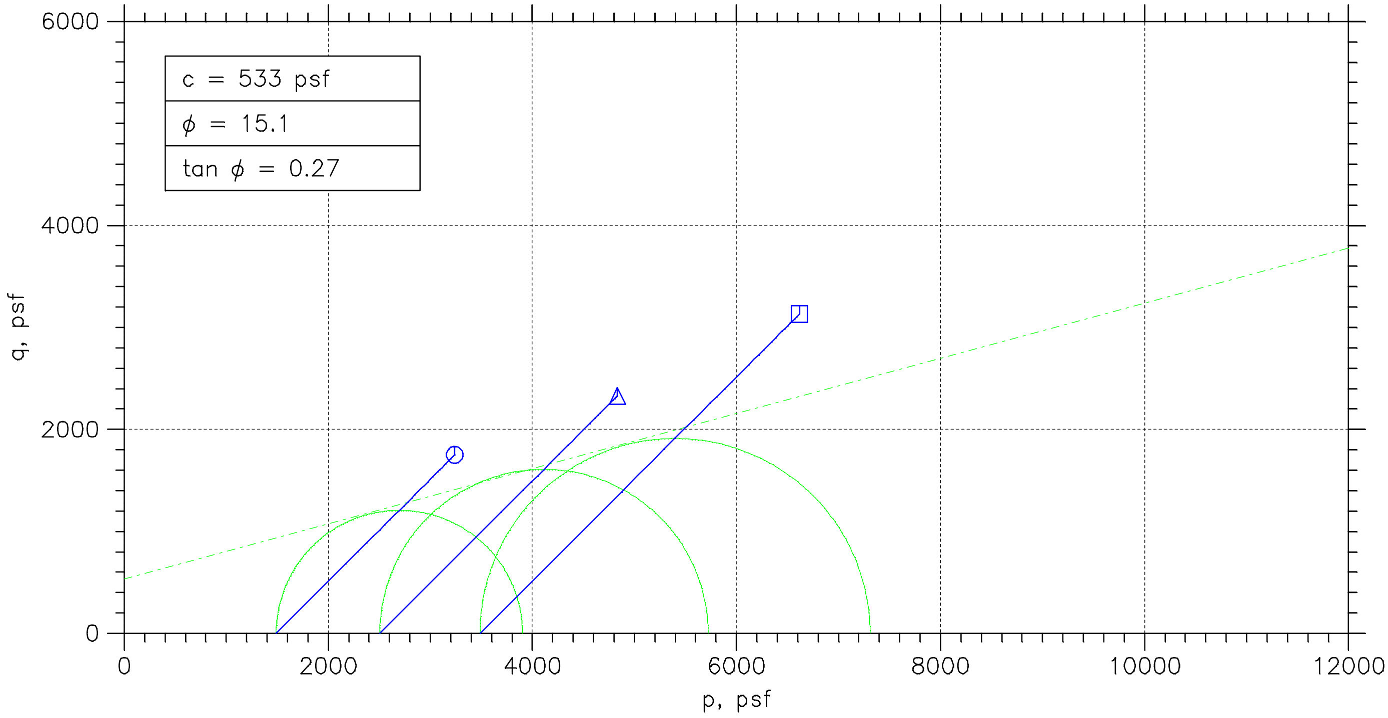
Description: DARK GRAY LEAN CLAY CL SAND POCKETS NOTED

Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767







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
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: -----

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

Terracon
Consulting Engineers & Scientists

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: -----

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

Terracon
Consulting Engineers & Scientists

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

Terracon
Consulting Engineers & Scientists

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: ----

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

Terracon
Consulting Engineers & Scientists

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: ----

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

	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	5056.4	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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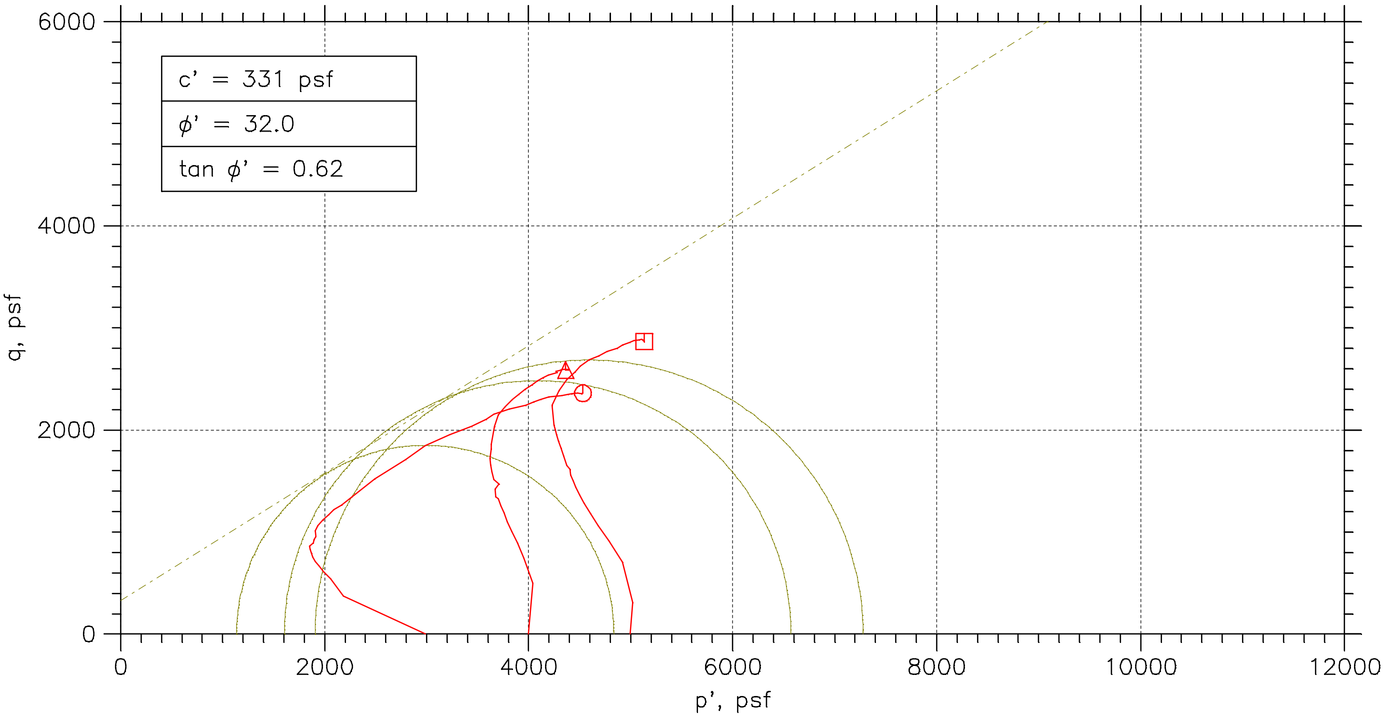
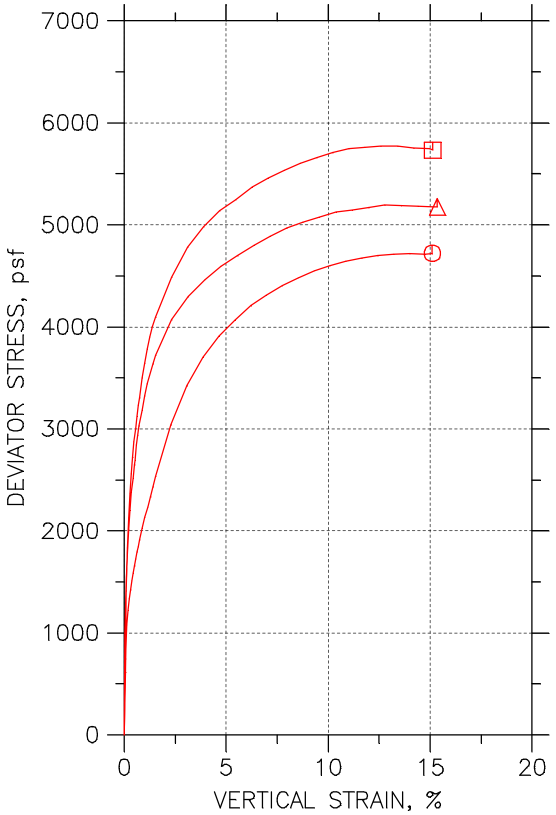




Symbol		○	△	□	
Test No.		3000 PSF	4000 PSF	5000 PSF	
Initial	Diameter, in	2.8504	2.8492	2.8551	
	Height, in	6.2839	6.1752	6.276	
	Water Content, %	28.75	28.28	28.90	
	Dry Density, pcf	93.95	91.68	93.39	
	Saturation, %	96.85	90.28	96.07	
	Void Ratio	0.80747	0.85213	0.8182	
Before Shear	Water Content, %	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

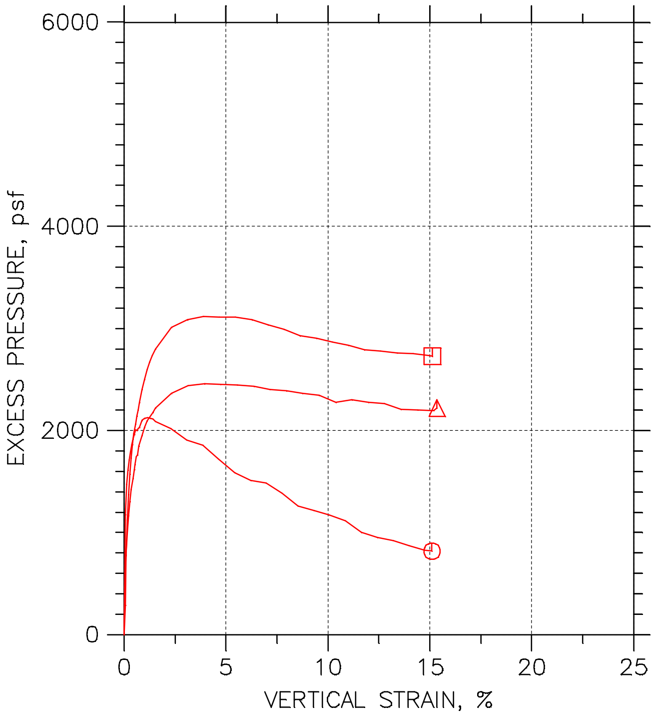
Boring No.: B-2 S-11

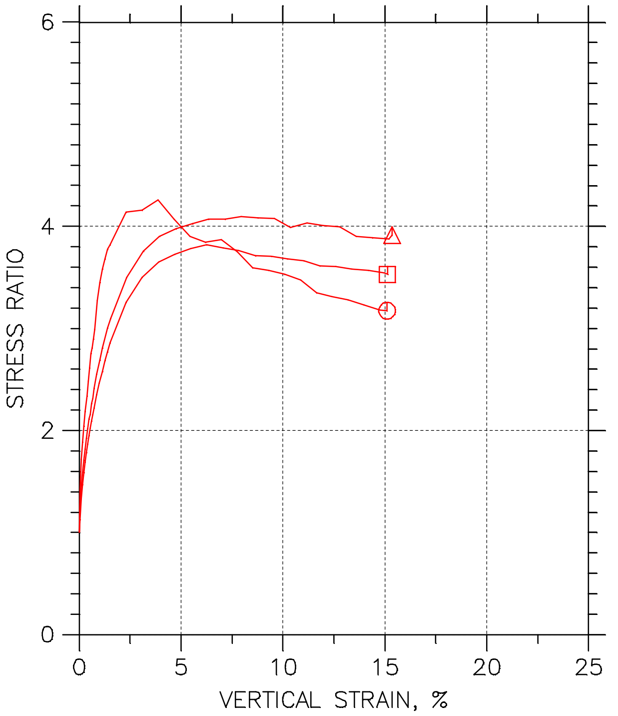
Sample Type: 3.0'' ST

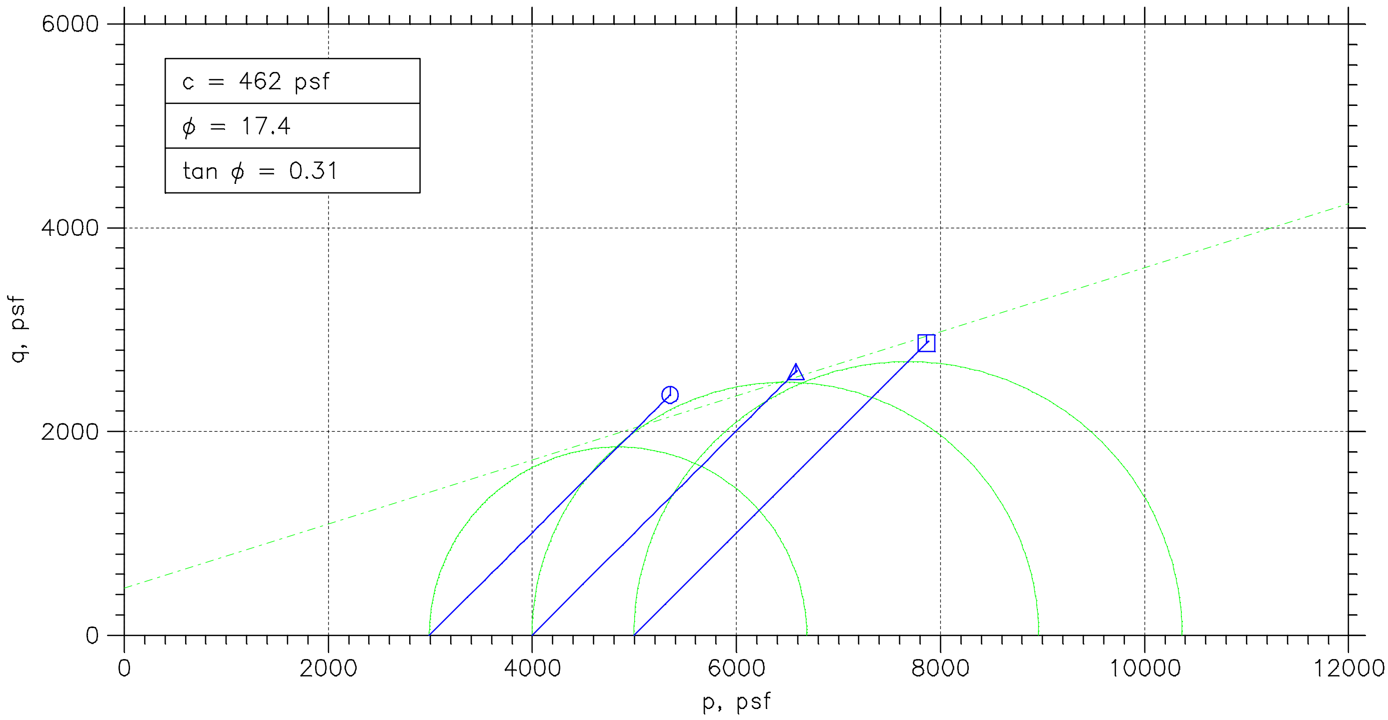
Description: OLIVE BROWN LEAN CLAY CL

Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767







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

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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
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.: 3000 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: 6.28 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: 657.09 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	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
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

	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

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Consulting Engineers & Scientists

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

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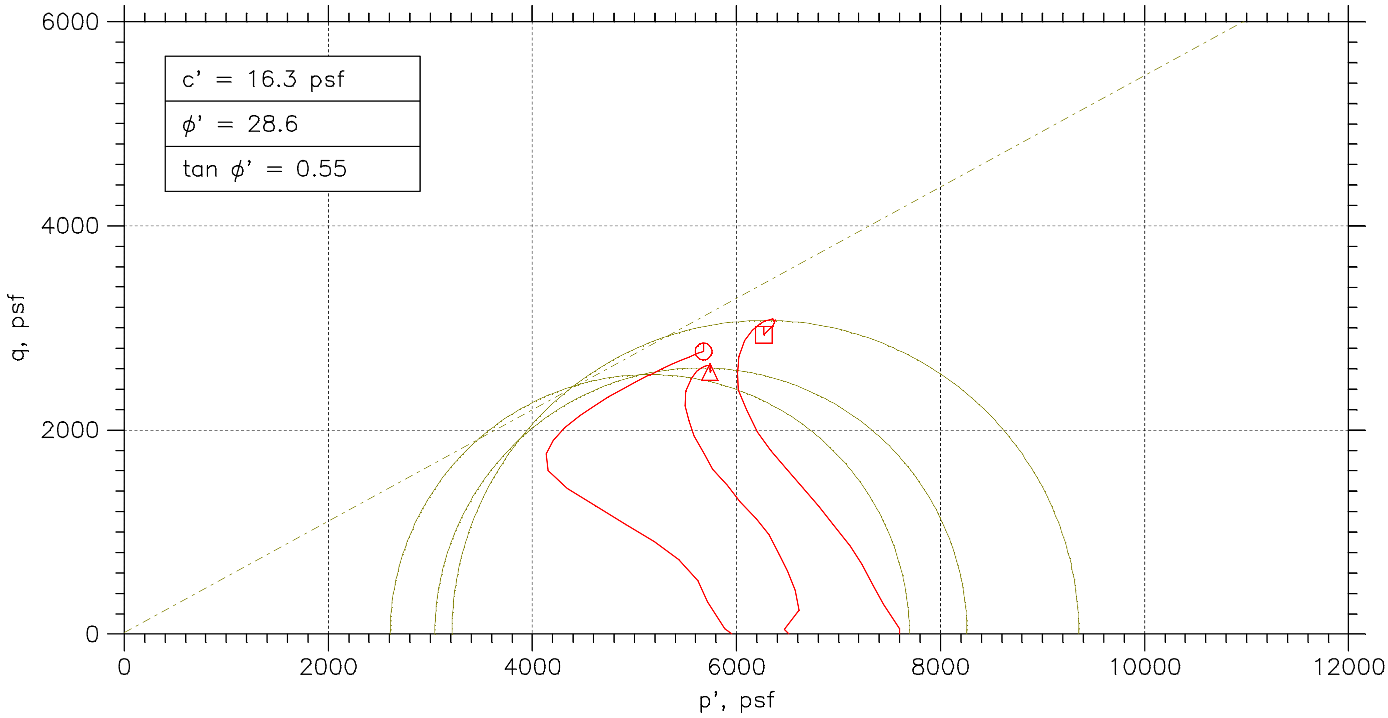

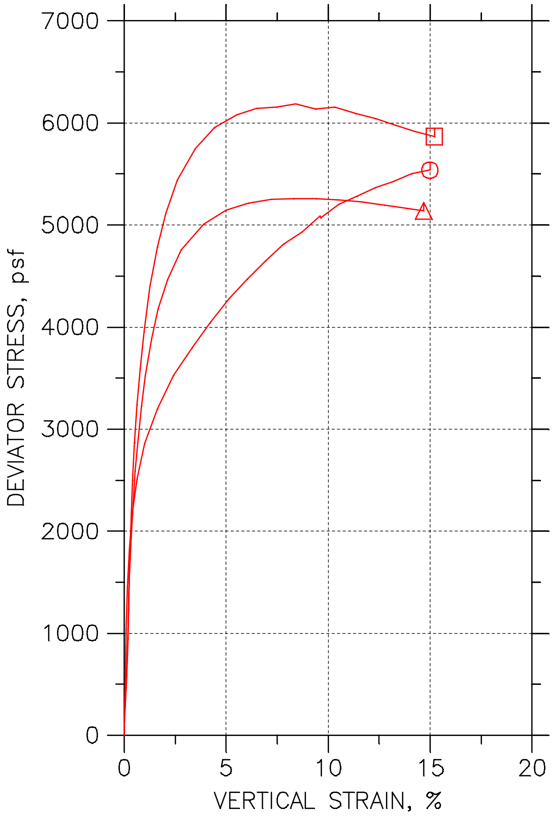

Symbol		○	△	□	
Test No.		5500 PSF	6500 PSF	7500 PSF	
Initial	Diameter, in	2.845	2.86	2.86	
	Height, in	6.165	5.965	5.73	
	Water Content, %	19.24	25.59	25.75	
	Dry Density, pcf	106.8	98.04	96.38	
	Saturation, %	88.79	95.10	91.95	
	Void Ratio	0.58926	0.73193	0.76188	
Before Shear	Water Content, %	22.14	25.71	25.84	
	Dry Density, pcf	106.	99.92	99.72	
	Saturation, %	100.00	100.00	100.00	
	Void Ratio	0.60226	0.69944	0.70282	
	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.

Fri, 04-DEC-2015 14:03:23

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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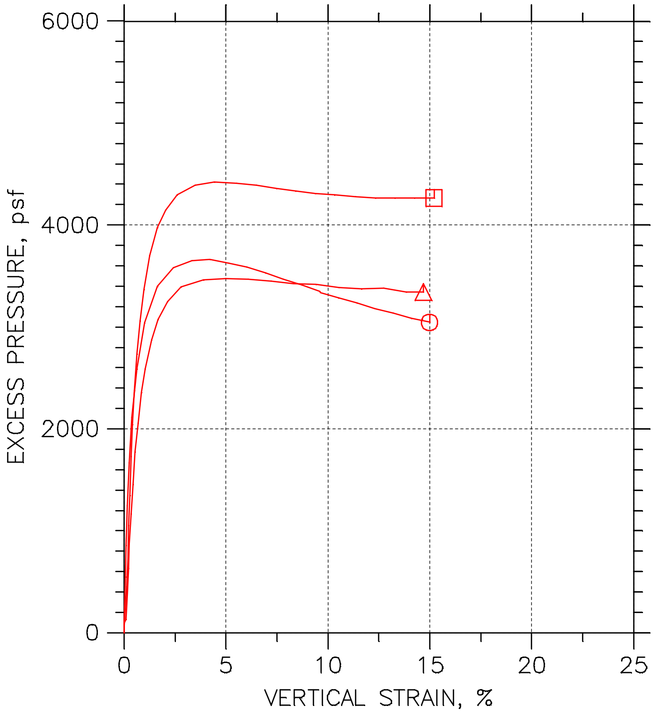

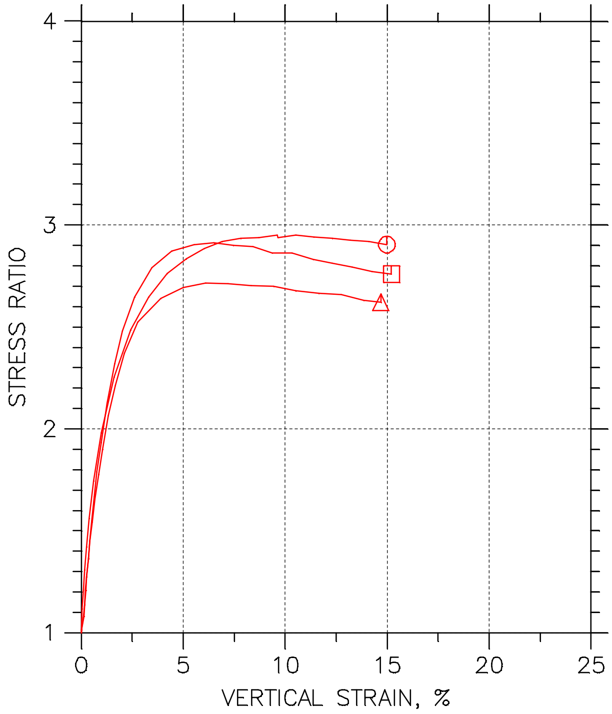

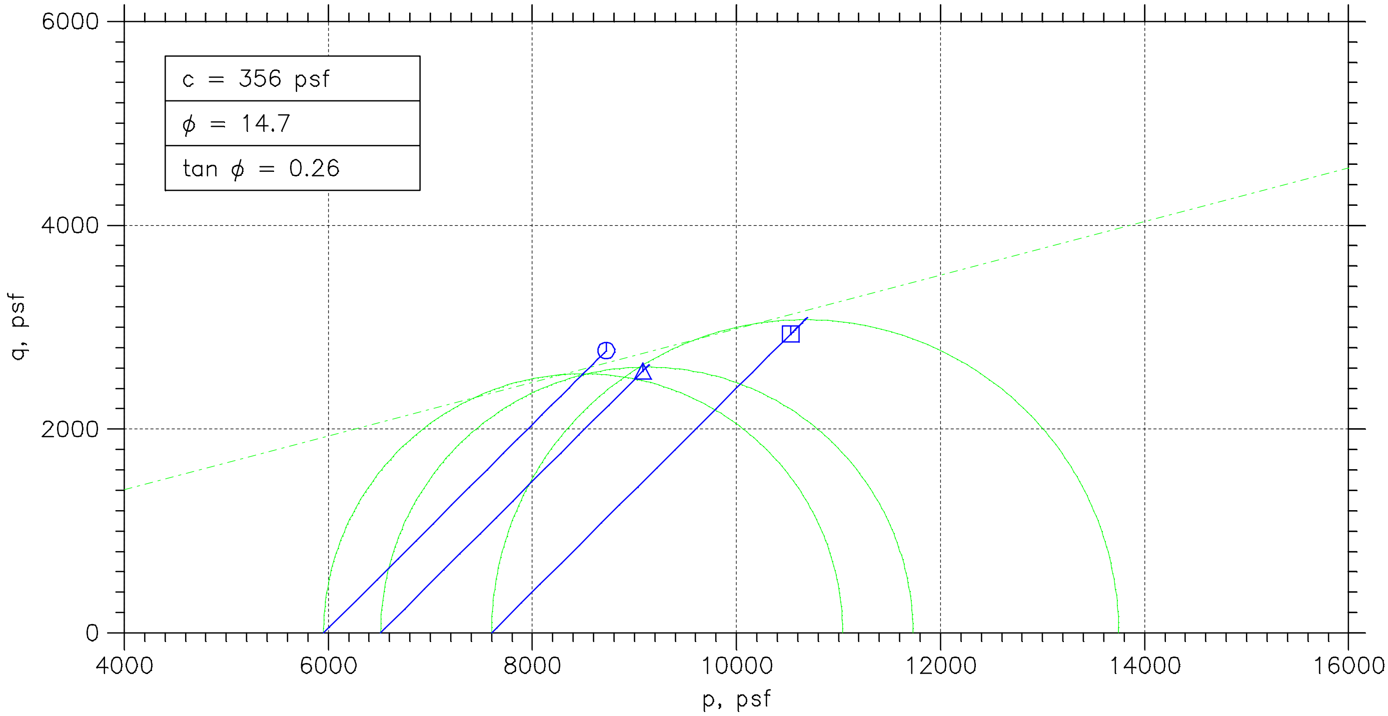

Project: VECTREN F.B. CULLEY	Location: NEWBURGH, IN	Project No.: MR155242
Boring No.: B-2 S-20	Tested By: BCM	Checked By: WPQ
Sample No.: S-20	Test Date: 11/28/15	Depth: 63.0'-65.0'
Test No.: B-2 S-20	Sample Type: 3.0" ST	Elevation: ----
Description: BROWN LEAN CLAY CL		
Remarks: FAILURE CRITERIA = MAXIMUM 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: ----

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

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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: ----

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: ----

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: ----

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

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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

	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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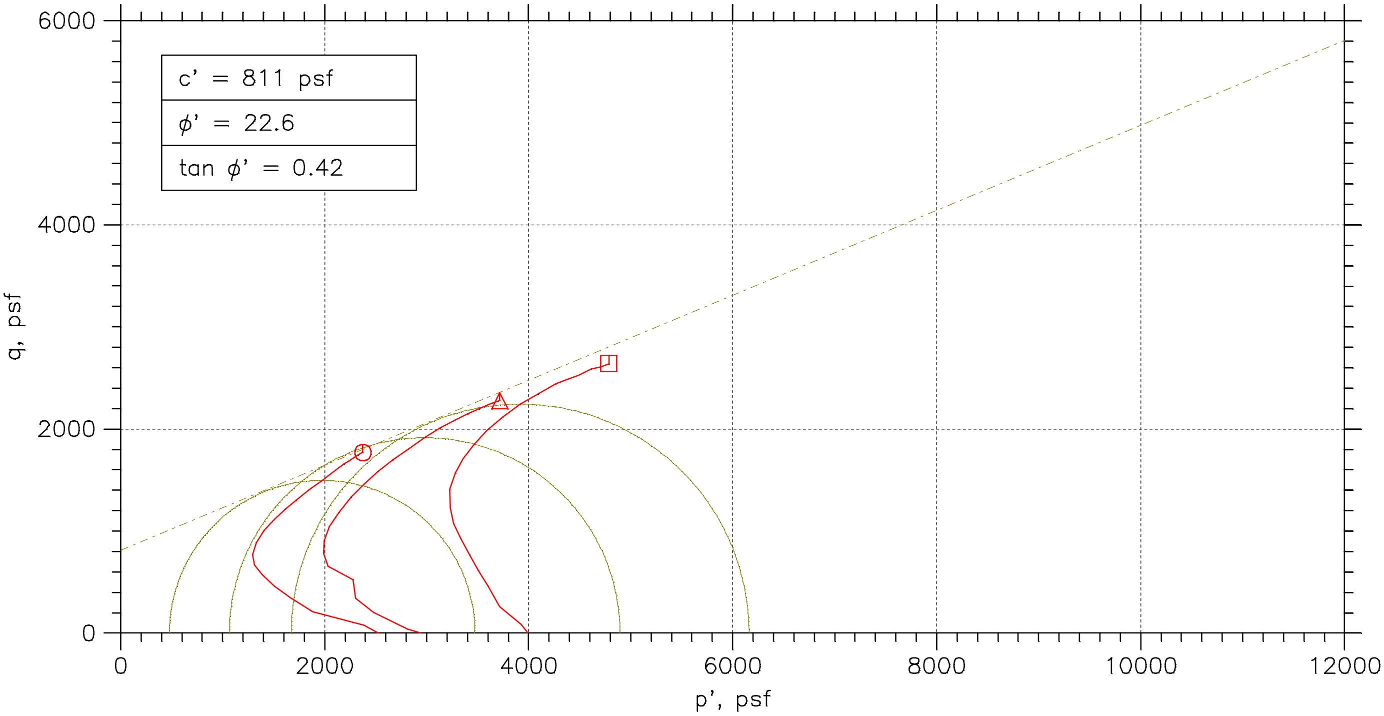
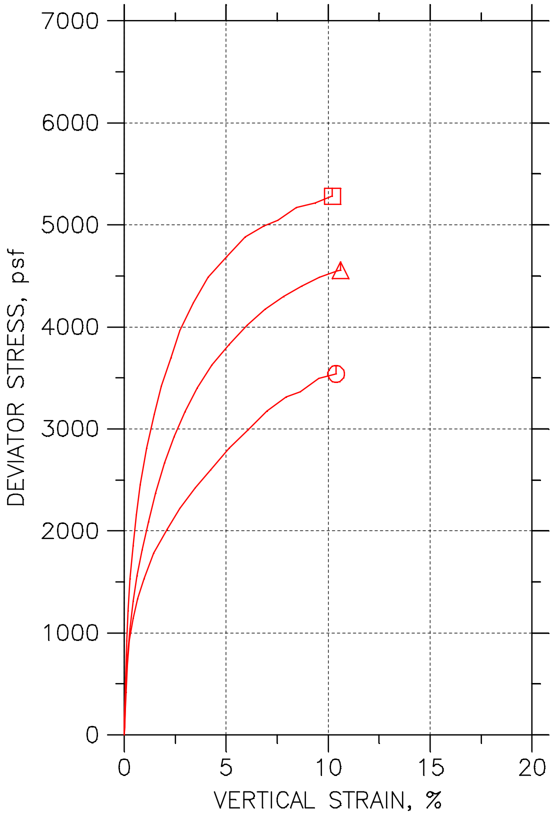


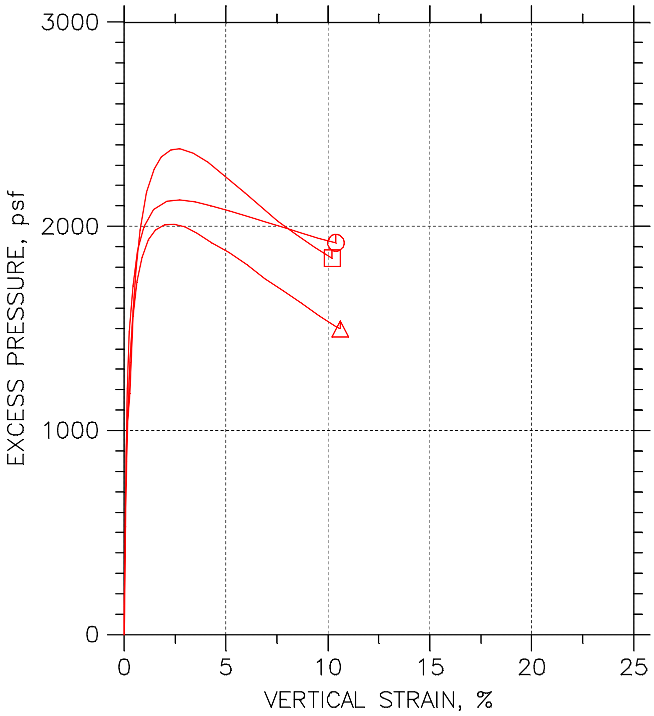


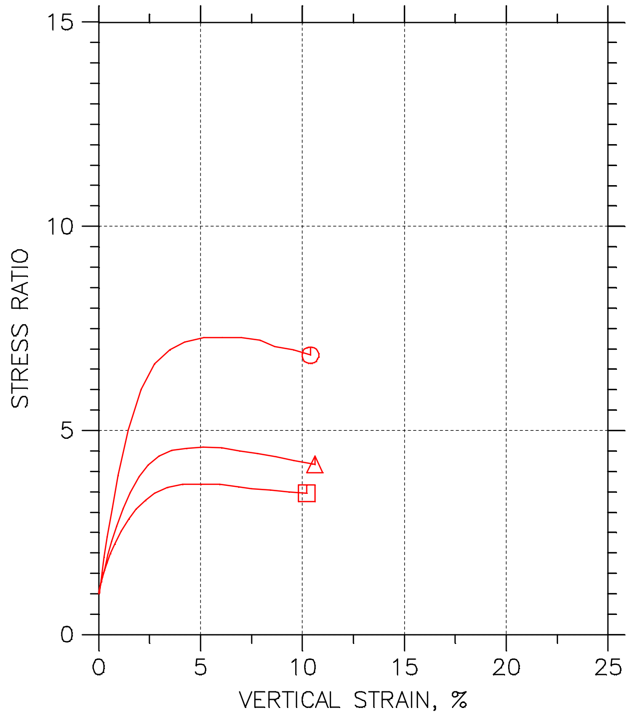
Symbol		○	△	□	
Test No.		2500 PSF	3000 PSF	4000 PSF	
Initial	Diameter, in	2.98	2.82	2.81	
	Height, in	5.94	6.2	6.05	
	Water Content, %	20.06	24.67	24.10	
	Dry Density, pcf	96.93	98.89	99.82	
	Saturation, %	72.56	93.55	93.52	
	Void Ratio	0.7519	0.71718	0.70103	
Before Shear	Water Content, %	23.57	26.62	24.94	
	Dry Density, pcf	103.5	98.48	101.2	
	Saturation, %	100.00	100.00	100.00	
	Void Ratio	0.6411	0.72416	0.6784	
	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					

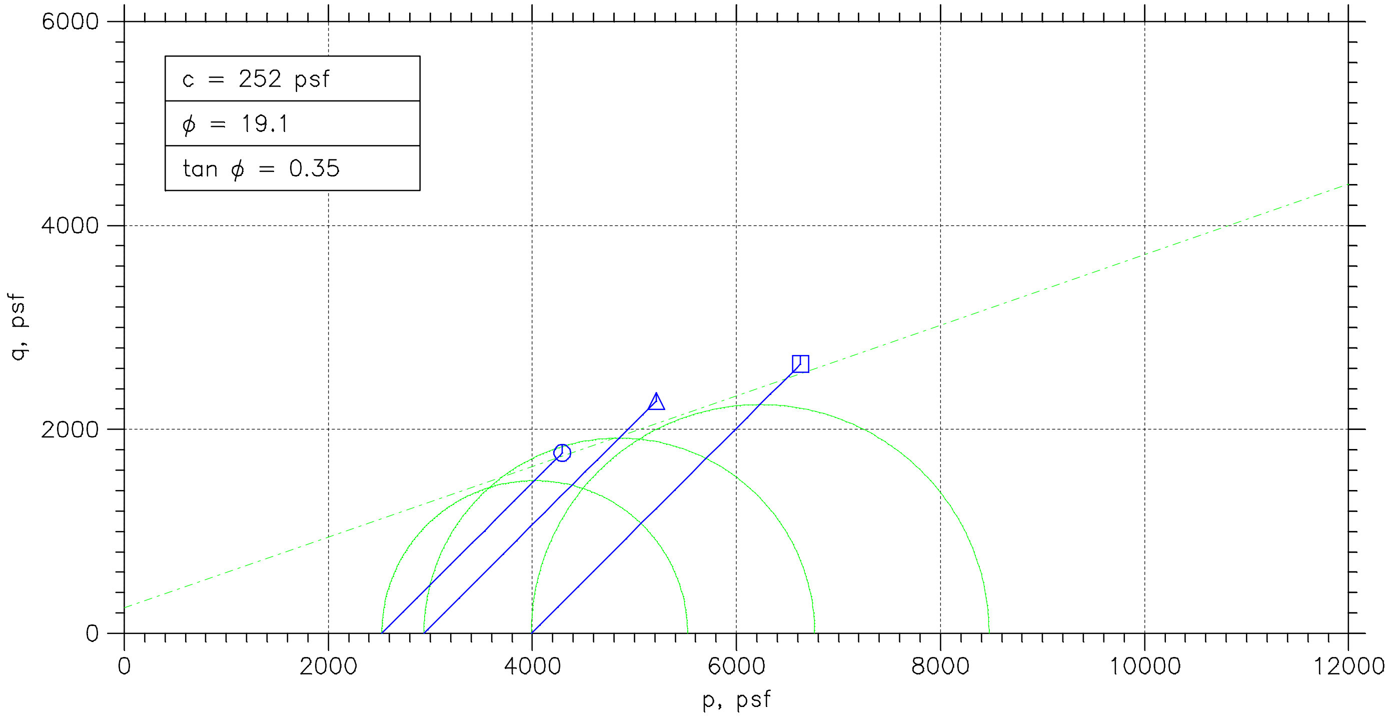
Project: VECTREN F.B. CULLEY
Location: NEWBURGH, IN
Project No.: MR155242
Boring No.: B-3 S-3
Sample Type: 3.0'' ST
Description: BROWN LEAN CLAY CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

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: ----

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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: 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: ----

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
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.: 3000 PSF
Sample Type: 3.0" ST
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
Piston Area: 0.00 in^2
Filter Strip Correction: 0.00 psf
Specimen Area: 6.25 in^2
Piston Friction: 0.00 lb
Membrane Correction: 0.00 lb/in
Specimen Volume: 634.57 cc
Piston Weight: 0.00 lb
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: ----

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: ----

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

Terracon
Consulting Engineers & Scientists

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: ----

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

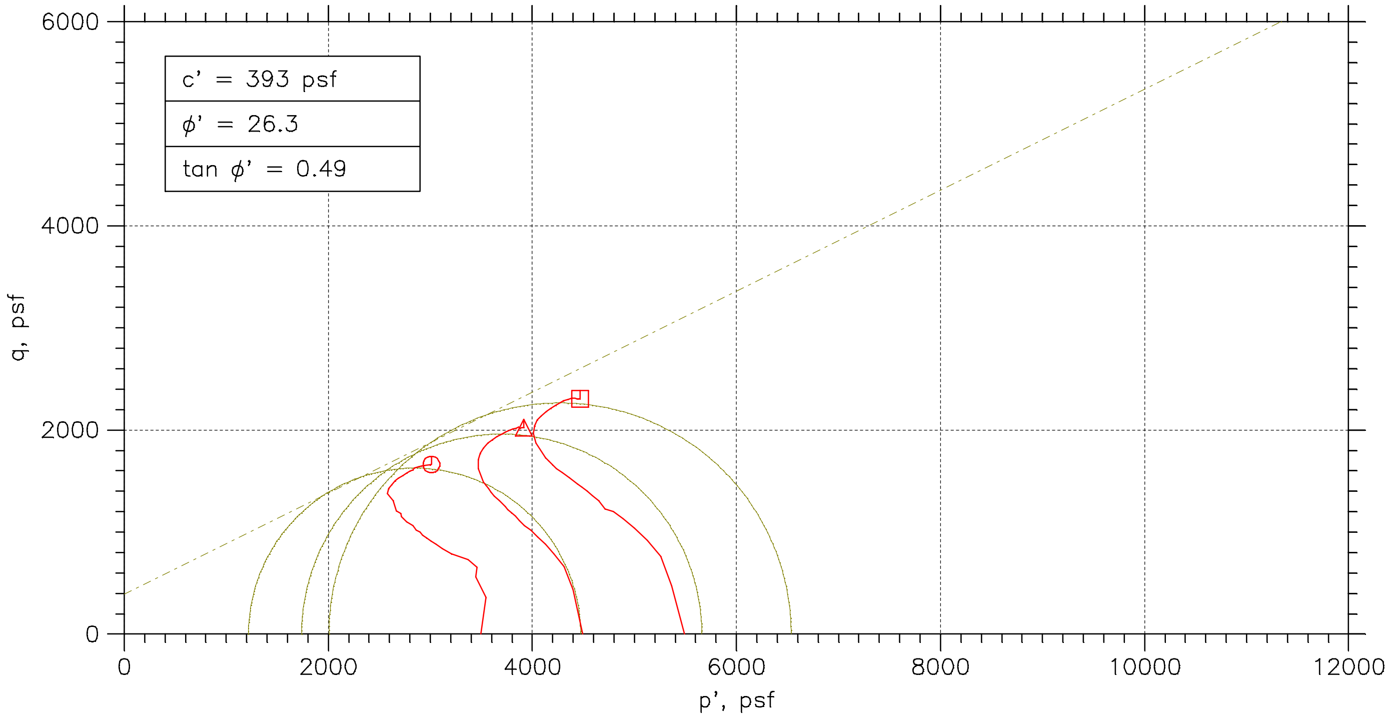
Liquid Limit: 31

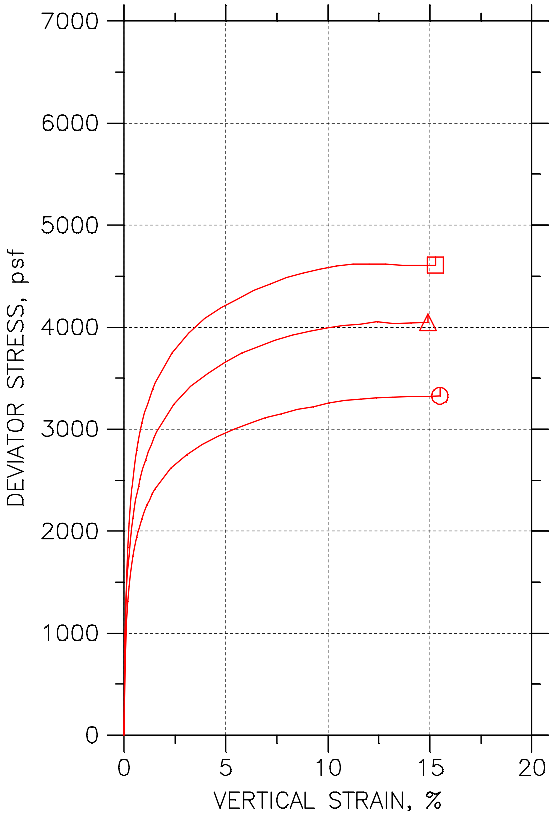
Plastic Limit: 20

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





	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

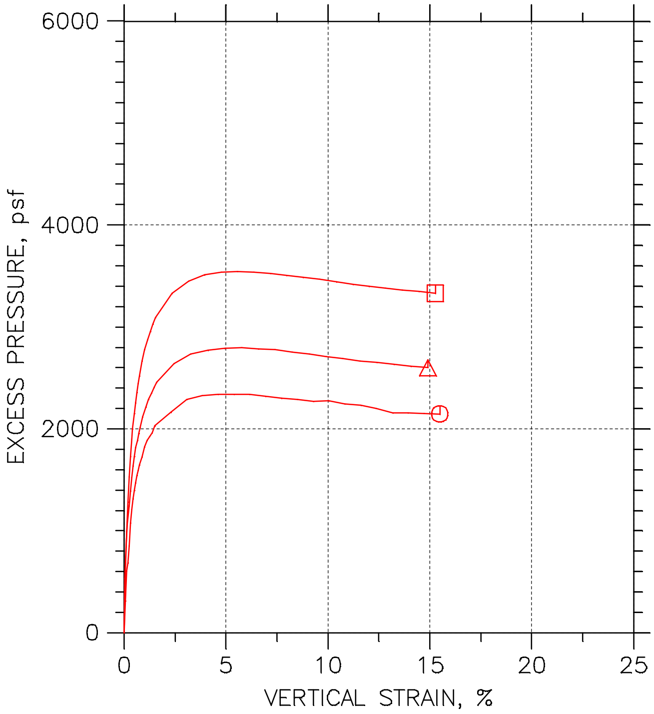
Boring No.: B-3 S-6

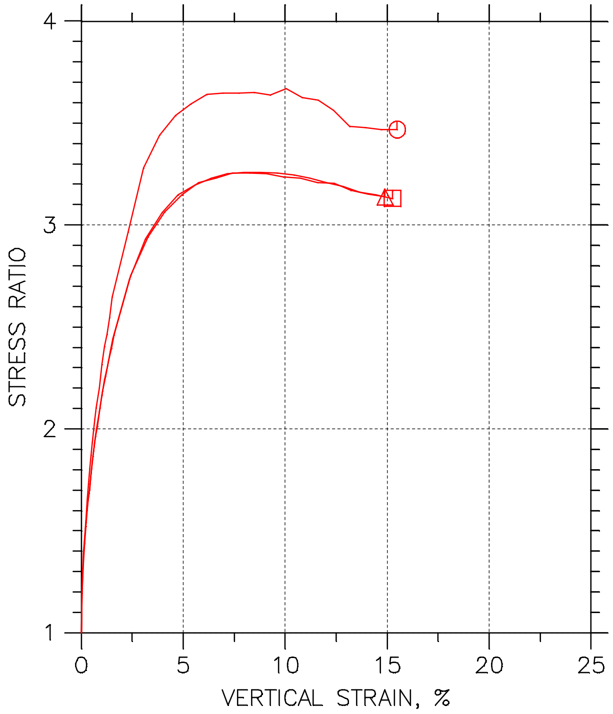
Sample Type: 3.0'' ST

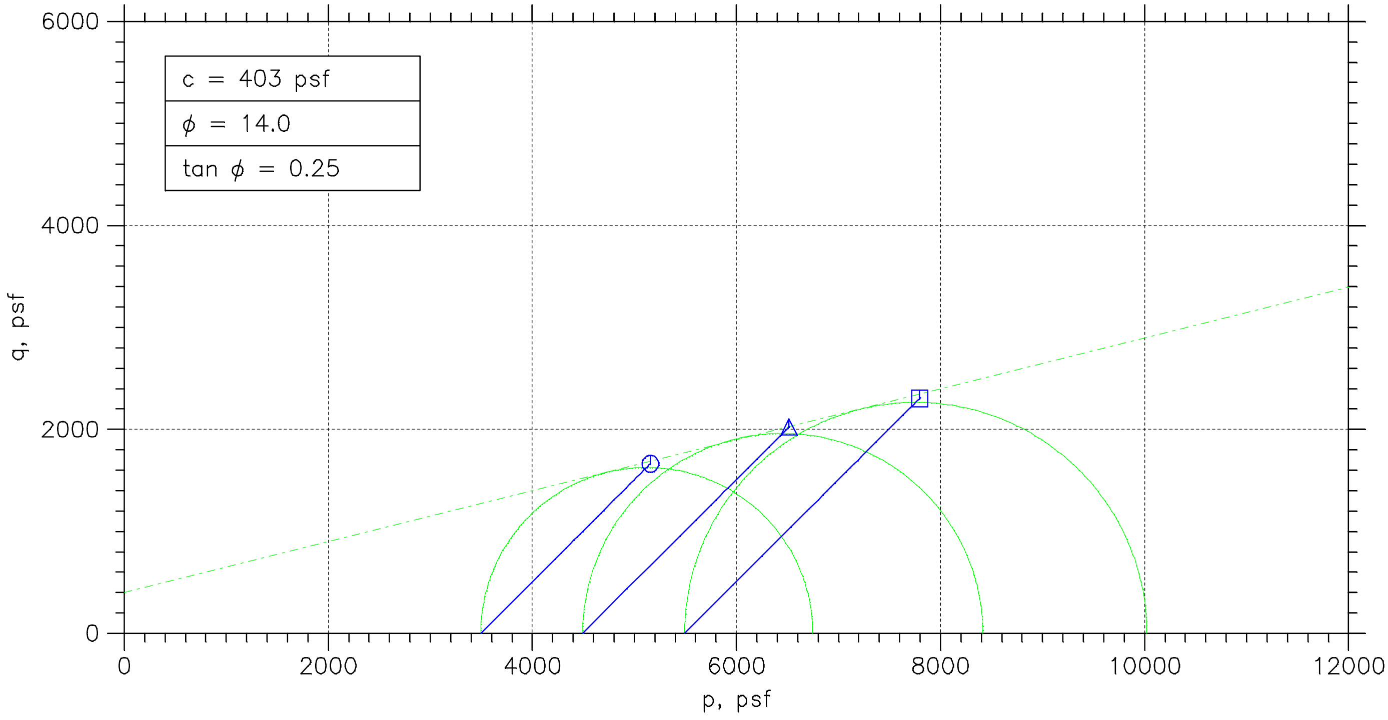
Description: BROWNISH GRAY LEAN CLAY CL

Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767







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

Terracon
Consulting Engineers & Scientists

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: -----

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

Terracon
Consulting Engineers & Scientists

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: -----

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

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.: 4500 PSF
Sample Type: 3.0" ST
Elevation: ----

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: ---
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

Terracon
Consulting Engineers & Scientists

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: ----

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: 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

Terracon
Consulting Engineers & Scientists

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: ----

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

Terracon
Consulting Engineers & Scientists

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: ----

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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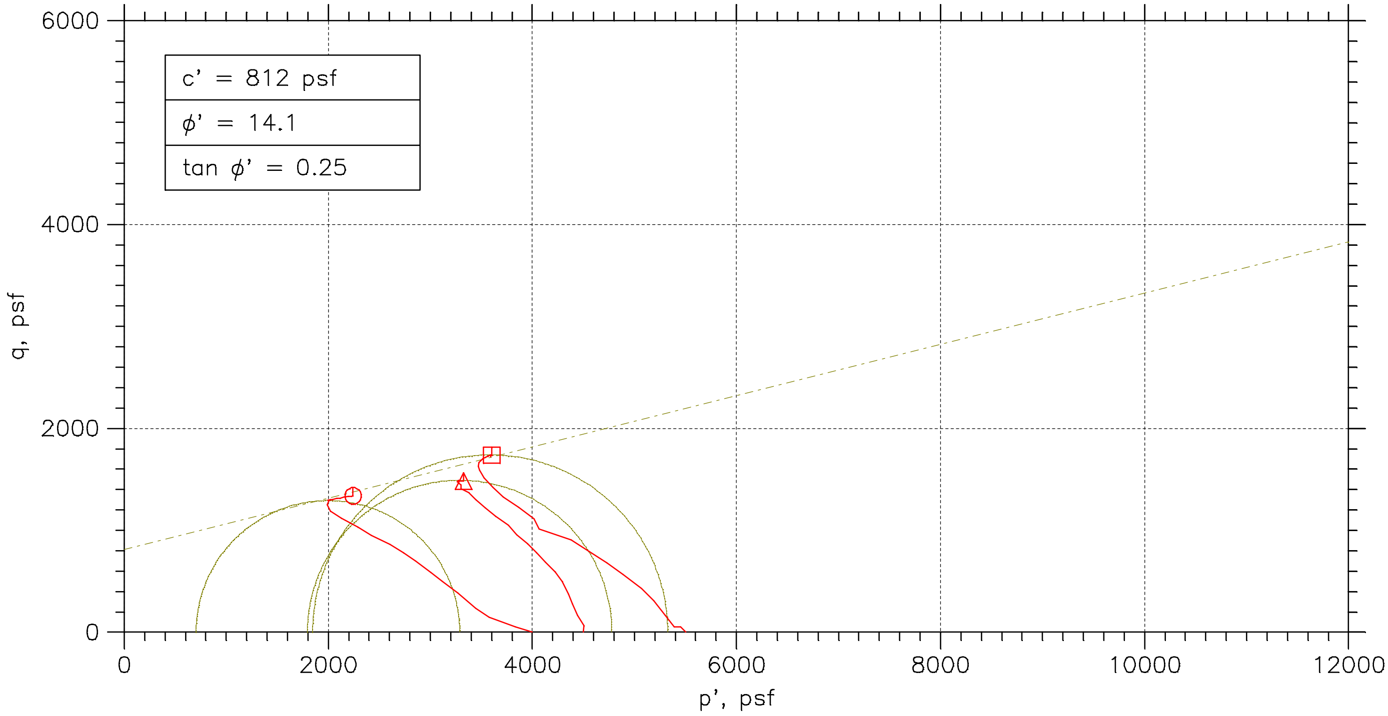

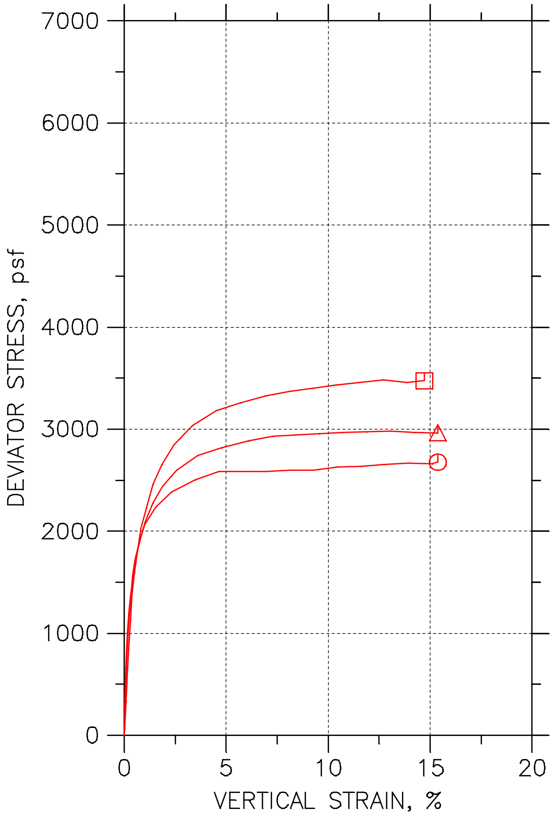

Symbol		○	△	□	
Test No.		4000 PSF	4500 PSF	5500 PSF	
Initial	Diameter, in	2.86	2.86	2.823	
	Height, in	6.17	6.17	6.203	
	Water Content, %	27.72	29.02	29.02	
	Dry Density, pcf	94.67	93.72	95.	
	Saturation, %	95.02	97.23	100.23	
	Void Ratio	0.79364	0.81181	0.78746	
Before Shear	Water Content, %	23.57	23.57	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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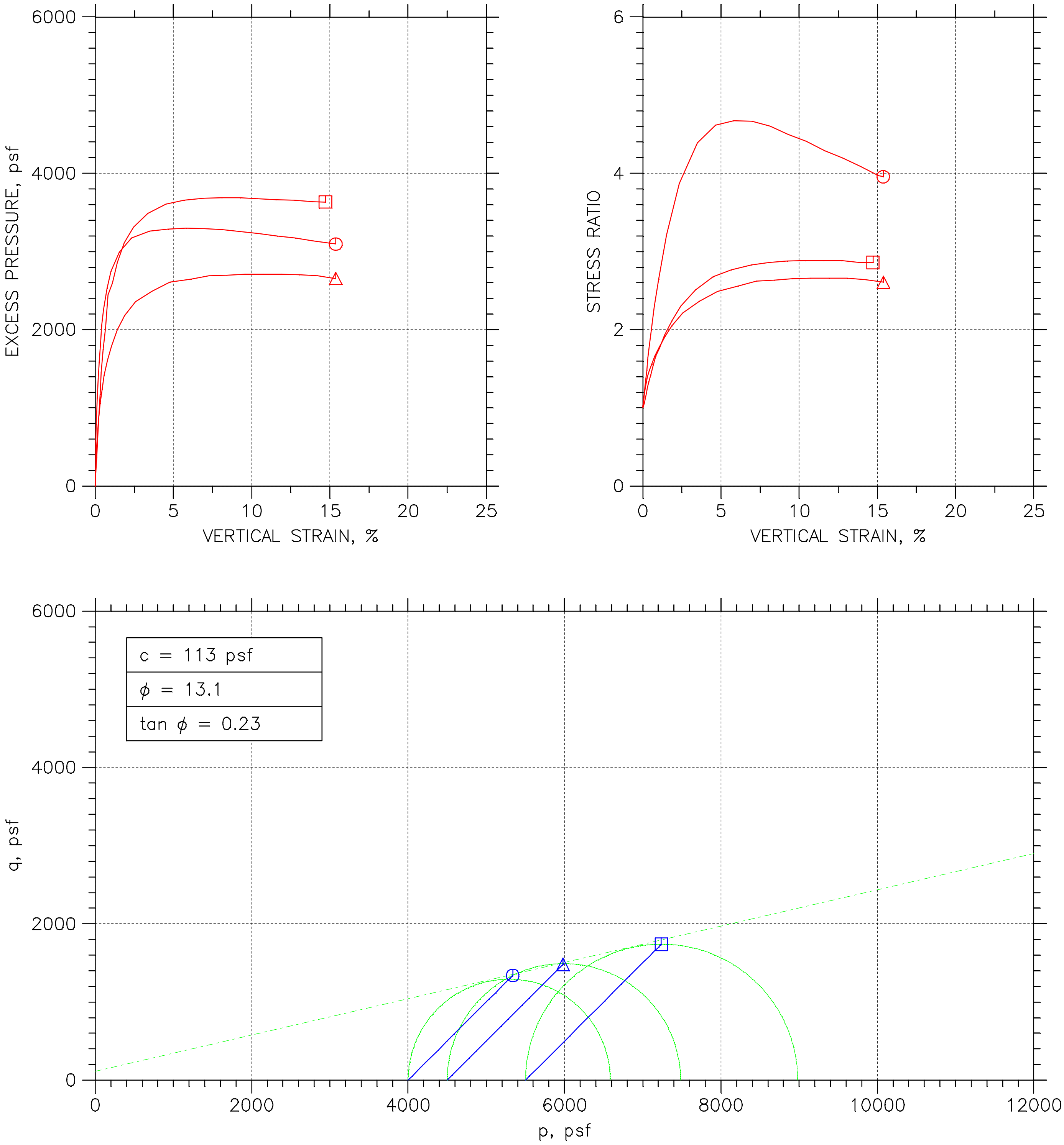

c = 113 psf
ϕ = 13.1
tan ϕ = 0.23

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

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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: ----

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: ----

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: ----

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: ----

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
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.: 5500 PSF
Sample Type: 3.0" ST
Elevation: ----

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
Piston Area: 0.00 in^2
Filter Strip Correction: 0.00 psf
Specimen Area: 6.26 in^2
Piston Friction: 0.00 lb
Membrane Correction: 0.00 lb/in
Specimen Volume: 636.23 cc
Piston Weight: 0.00 lb
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: ----

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

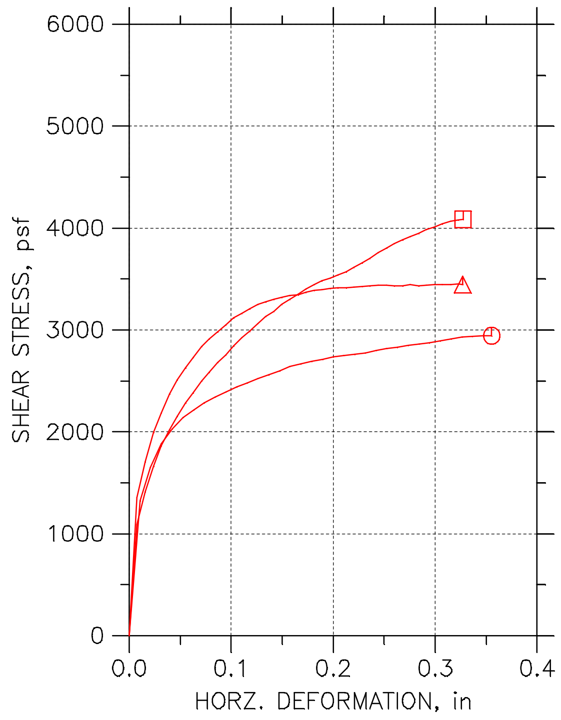
Liquid Limit: ---

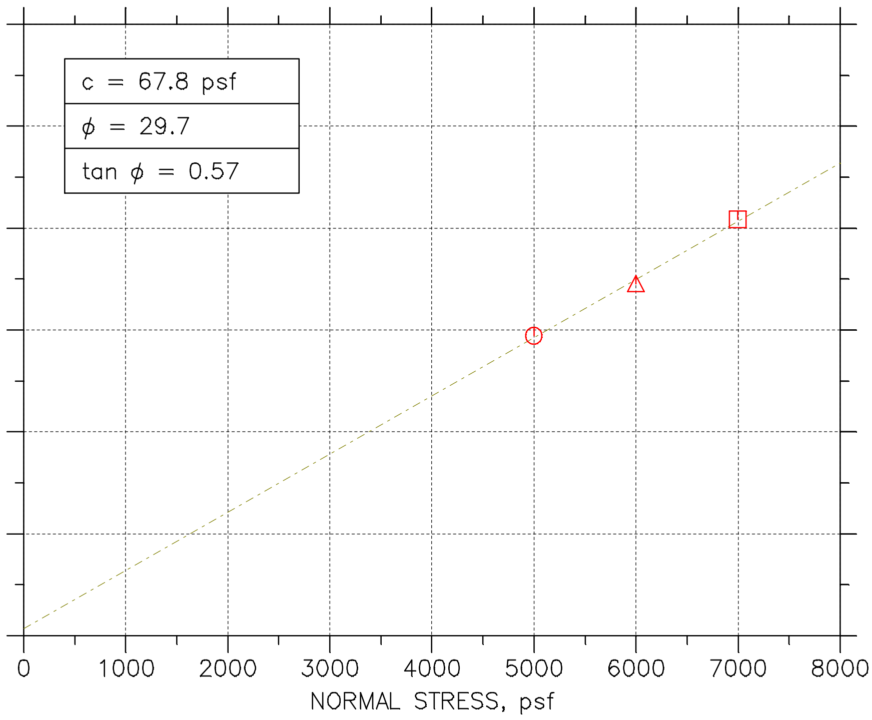
Plastic Limit: ---

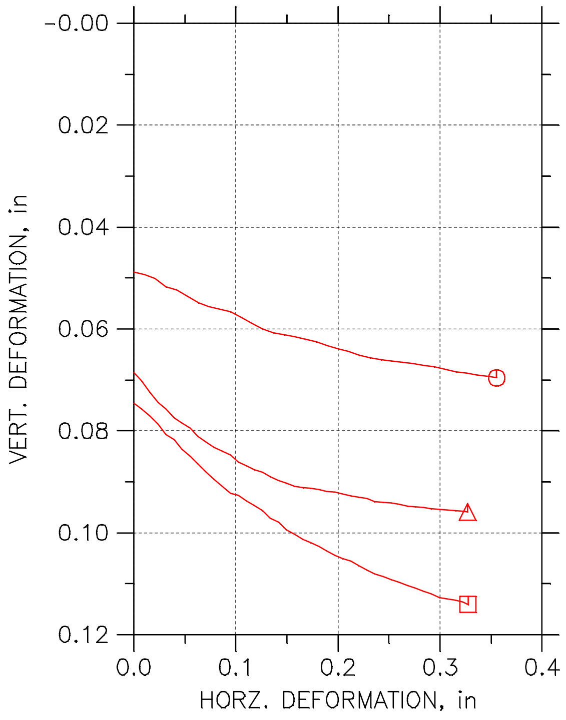
Estimated Specific Gravity: 2.72

	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







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: ----

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: ----

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

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
HYDRAULIC GRADIENT (MAXIMUM)	28.86	
PERCENT SATURATION	100.3	
HYDRAULIC CONDUCTIVITY k (cm/sec)	5.30E-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 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
HYDRAULIC GRADIENT (MAXIMUM)	26.38	
PERCENT SATURATION	99.1	
HYDRAULIC CONDUCTIVITY k (cm/sec)	1.35E-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

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

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-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
HYDRAULIC GRADIENT (MAXIMUM)	28.41	
PERCENT SATURATION	99.6	
HYDRAULIC CONDUCTIVITY k (cm/sec)	3.64E-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

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-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

(Percent saturation calculation is based on final measurements and an estimated specific gravity.)

HYDRAULIC CONDUCTIVITY k (cm/sec) 9.00E-08

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

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-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
HYDRAULIC GRADIENT (MAXIMUM)	25.75	
PERCENT SATURATION	99.3	
HYDRAULIC CONDUCTIVITY k (cm/sec)	9.18E-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

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

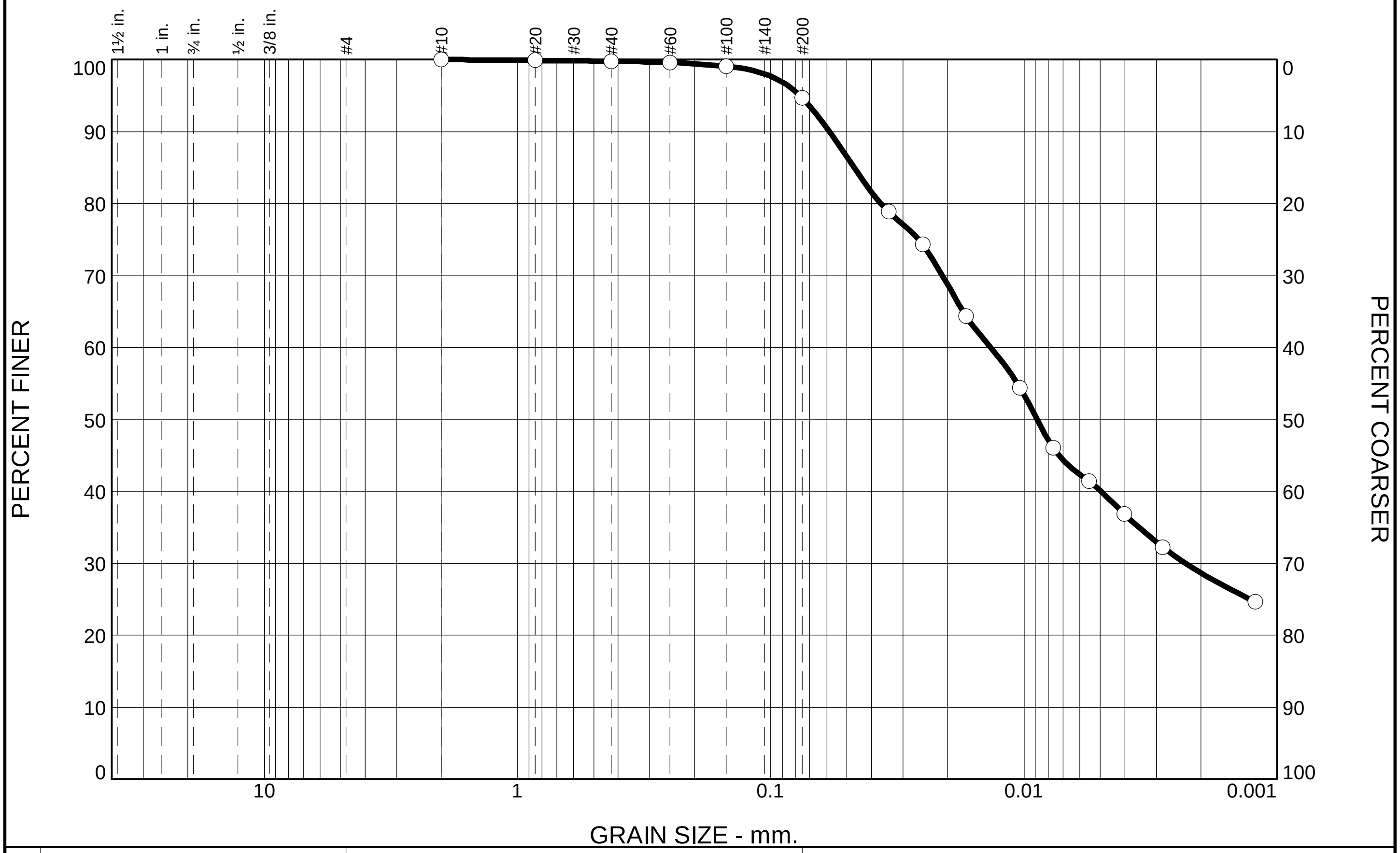
	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	94.3	97.4
WATER CONTENT (%)	27.1	27.1
DIAMETER (cm)	7.206	7.146
LENGTH (cm)	7.894	7.771
HYDRAULIC GRADIENT (MAXIMUM)	29.76	
PERCENT SATURATION	99.6	
HYDRAULIC CONDUCTIVITY k (cm/sec)	1.30E-07	

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

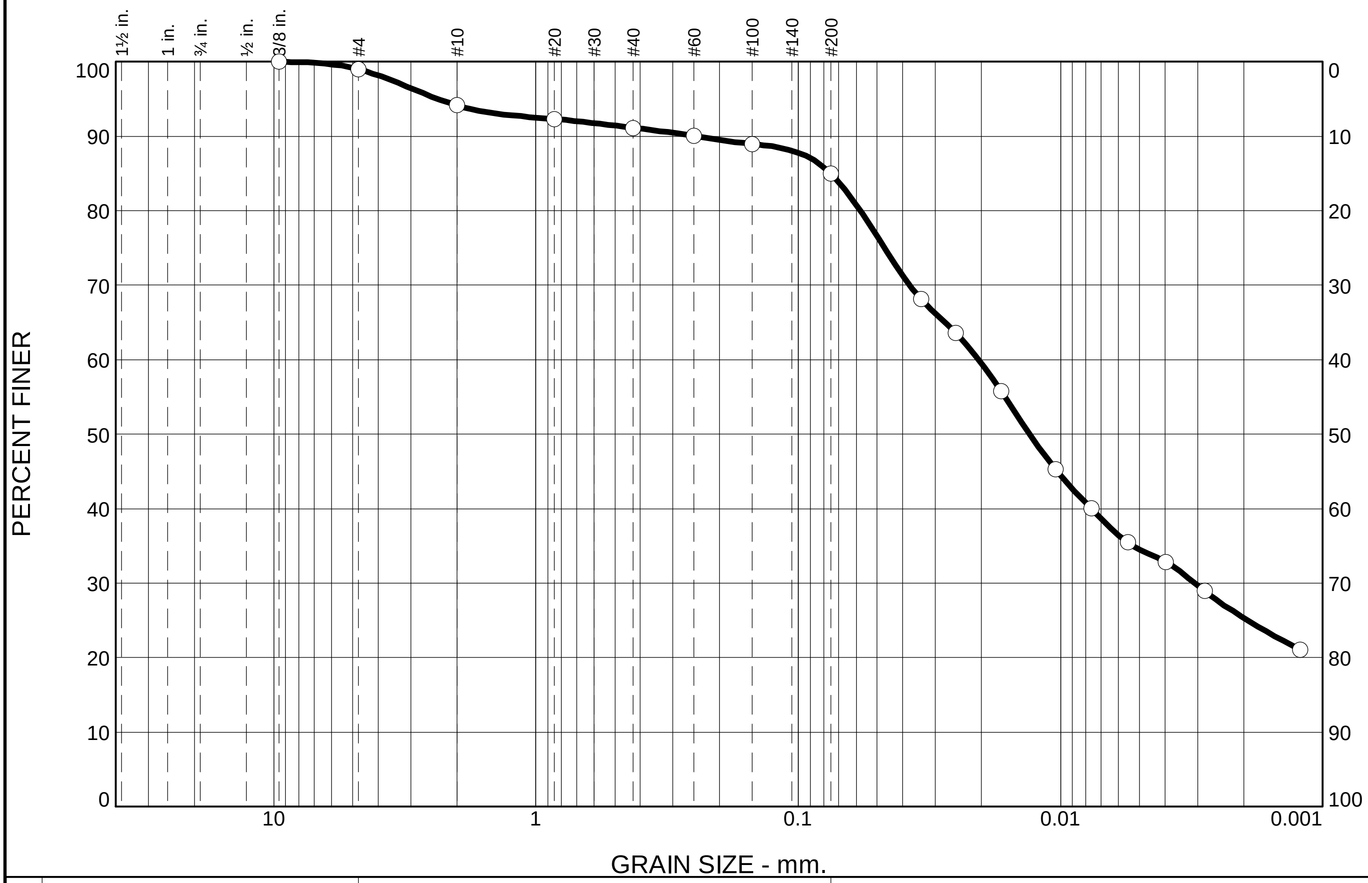
Date: 11-24-15

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

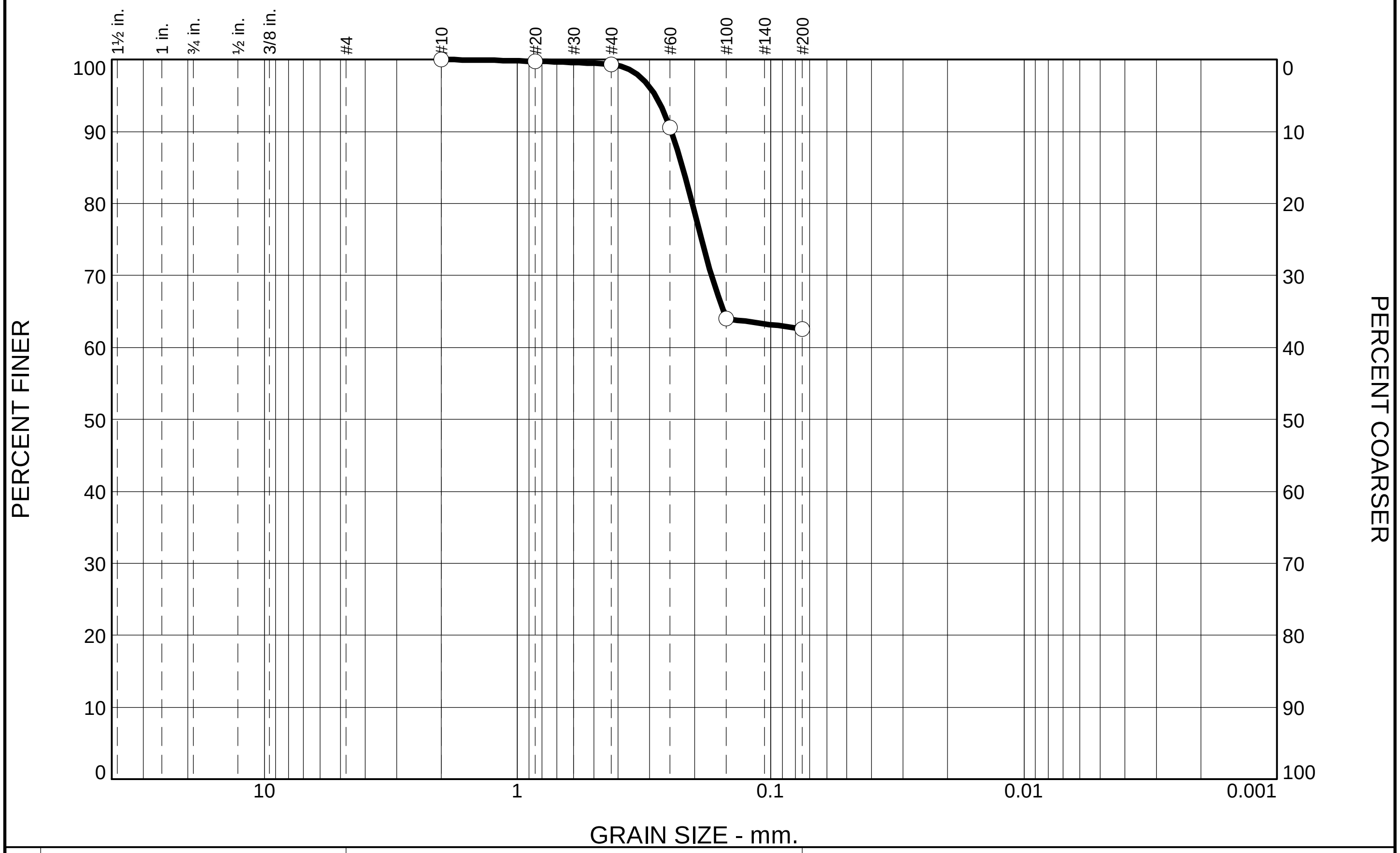
Date: 11-24-15

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

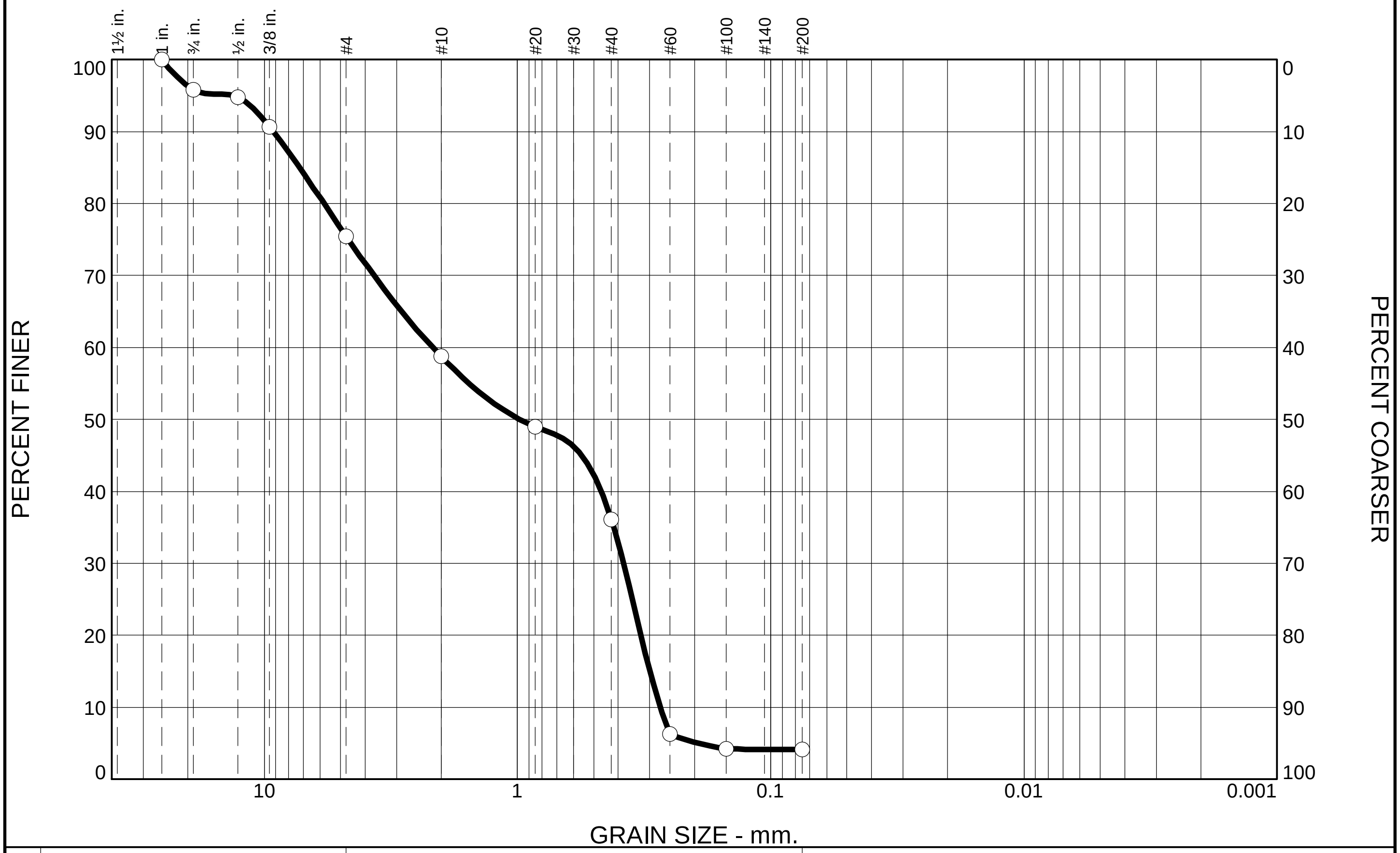
Terracon

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

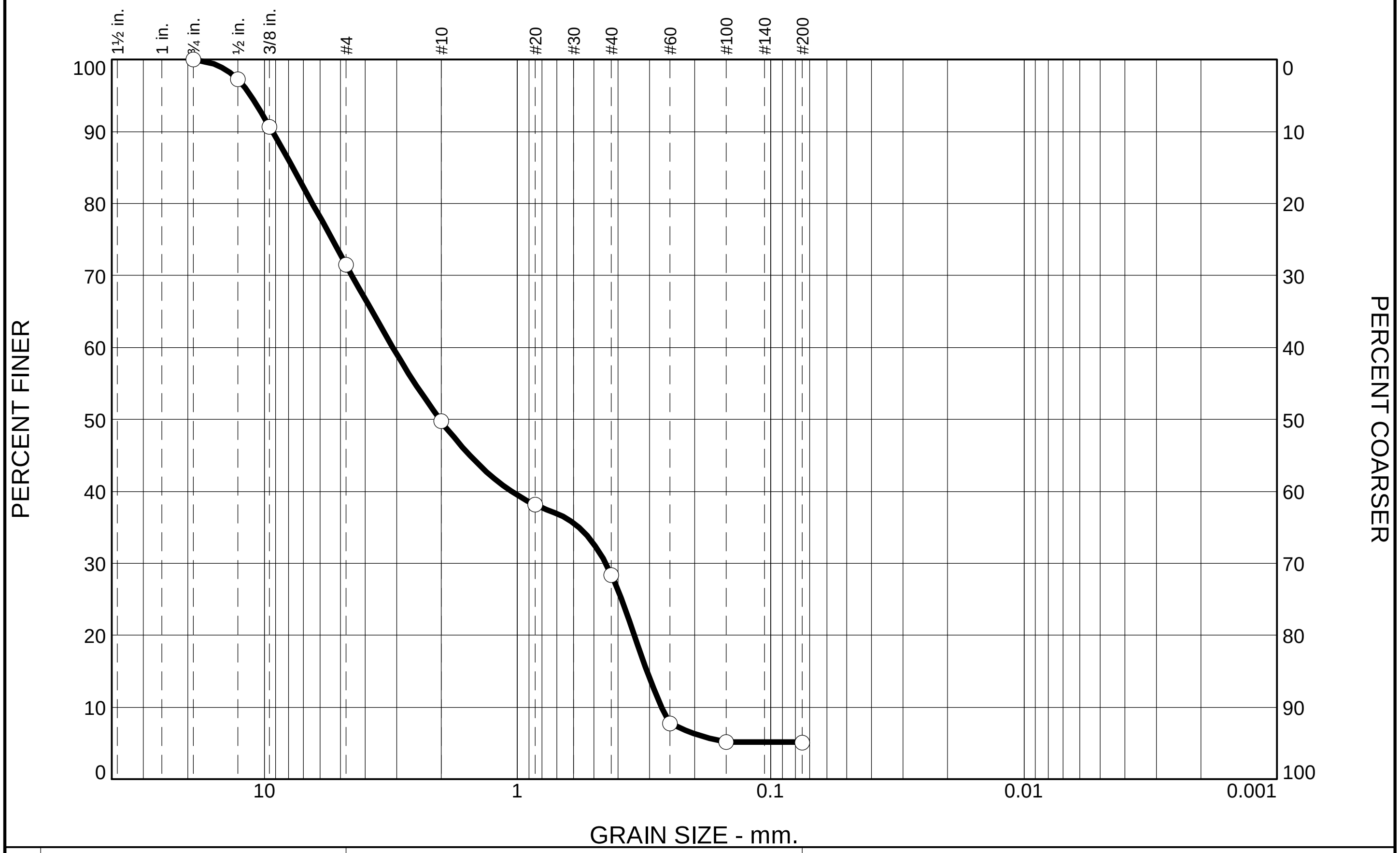
Terracon

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

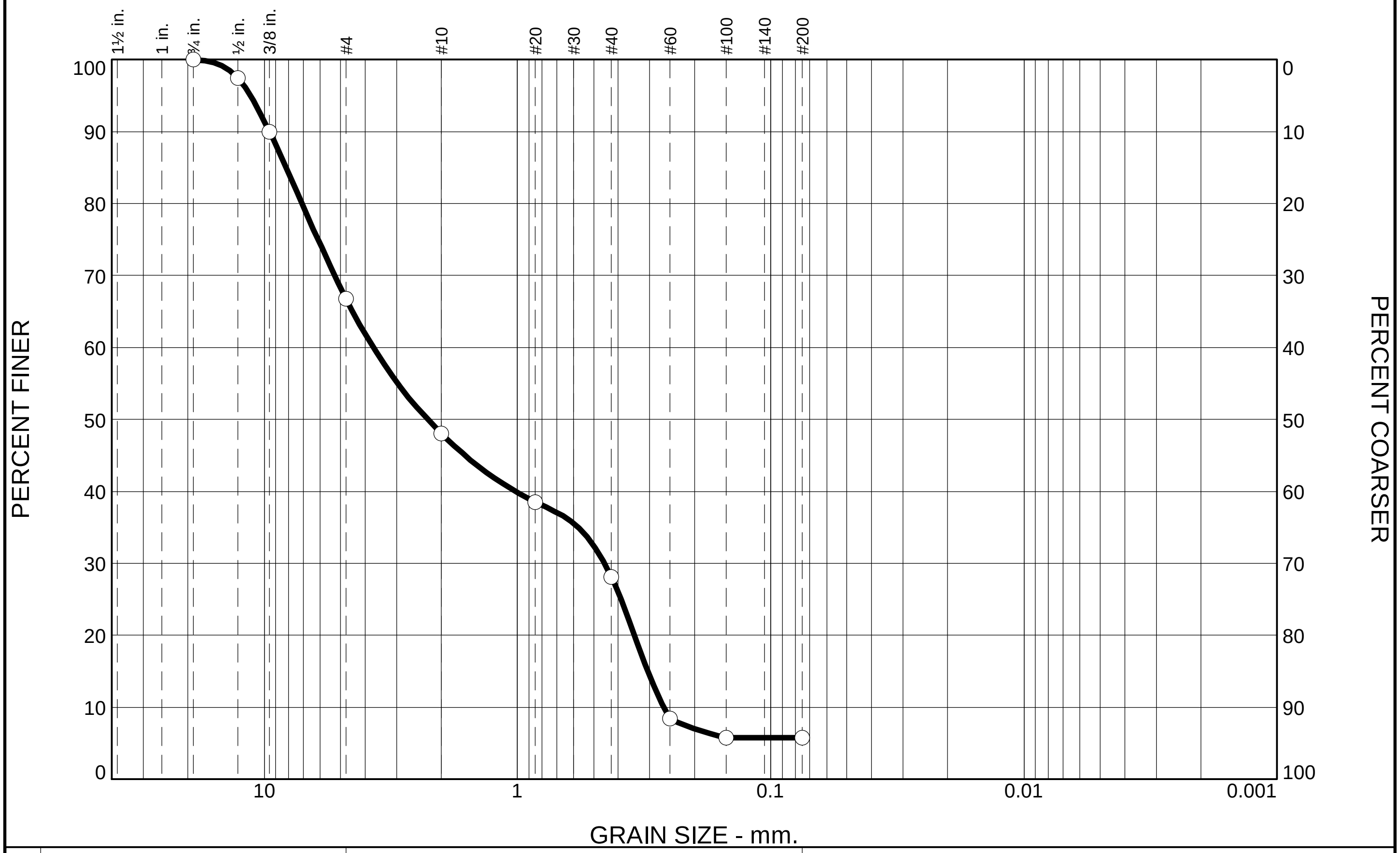
Terracon

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

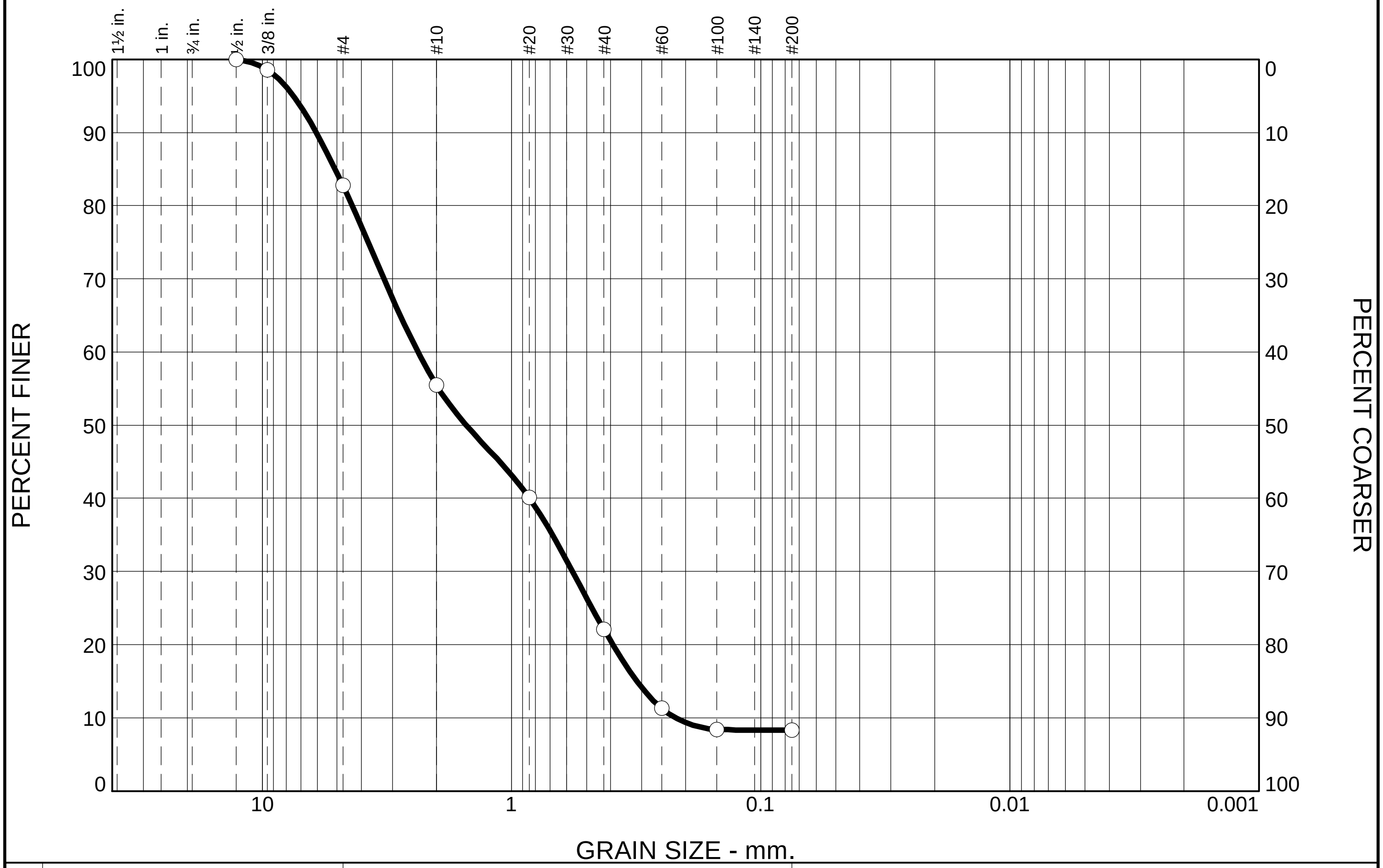
Client: VECTREN

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:

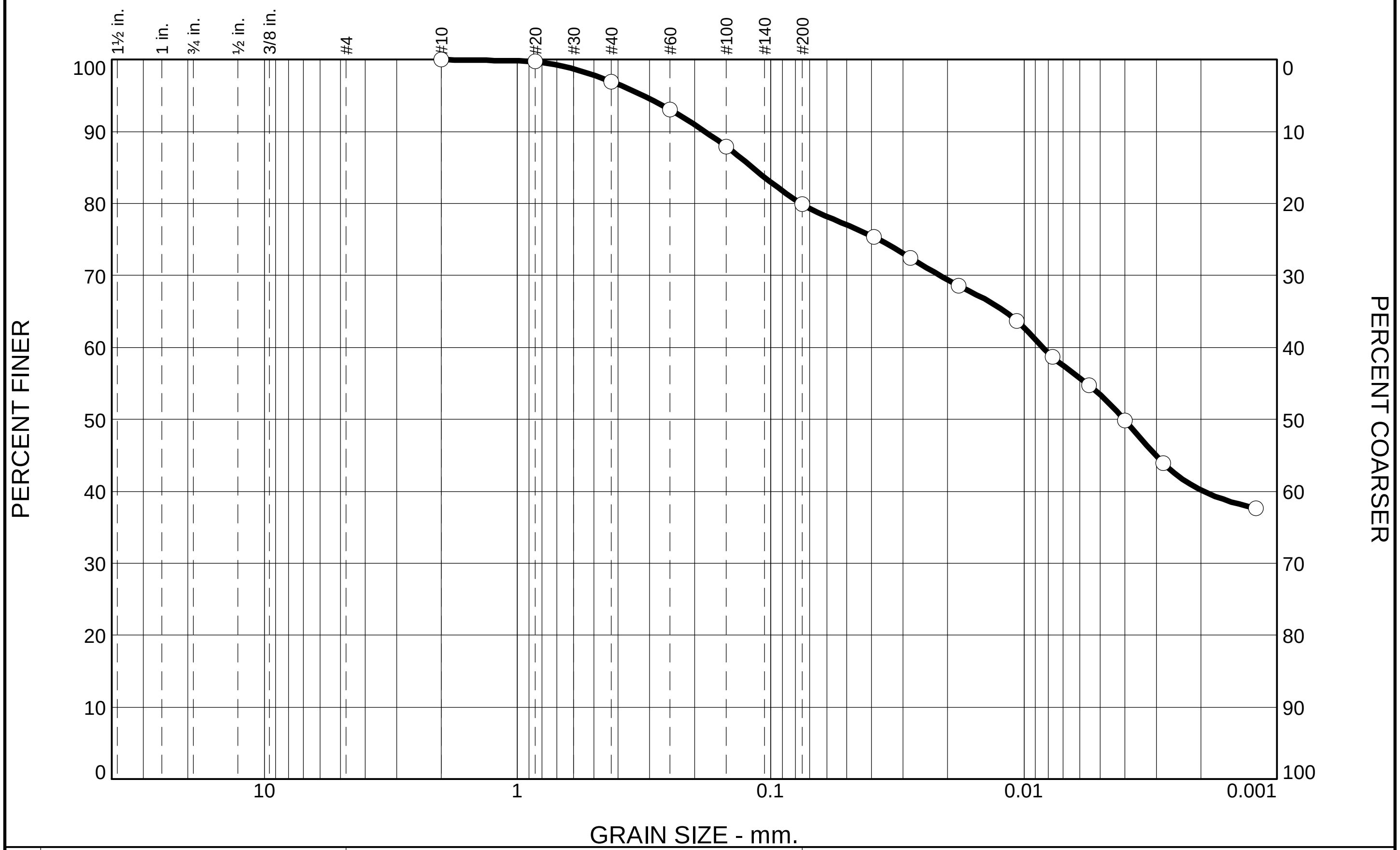
Terracon

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

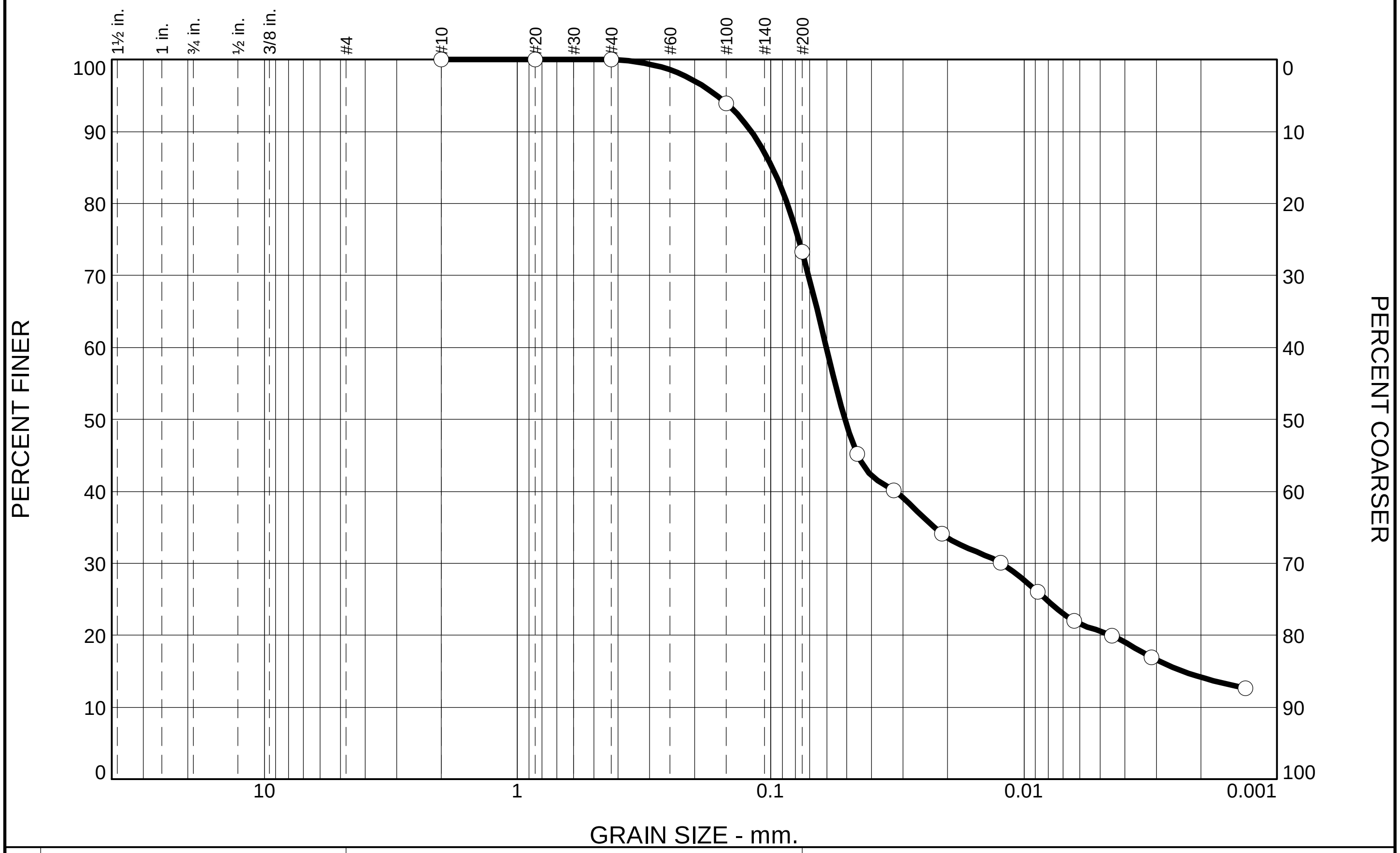
Source of Sample: B-2 **Depth:** 38.0'-40.0'
Sample Number: S-12 **Date:** 12/1/15

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

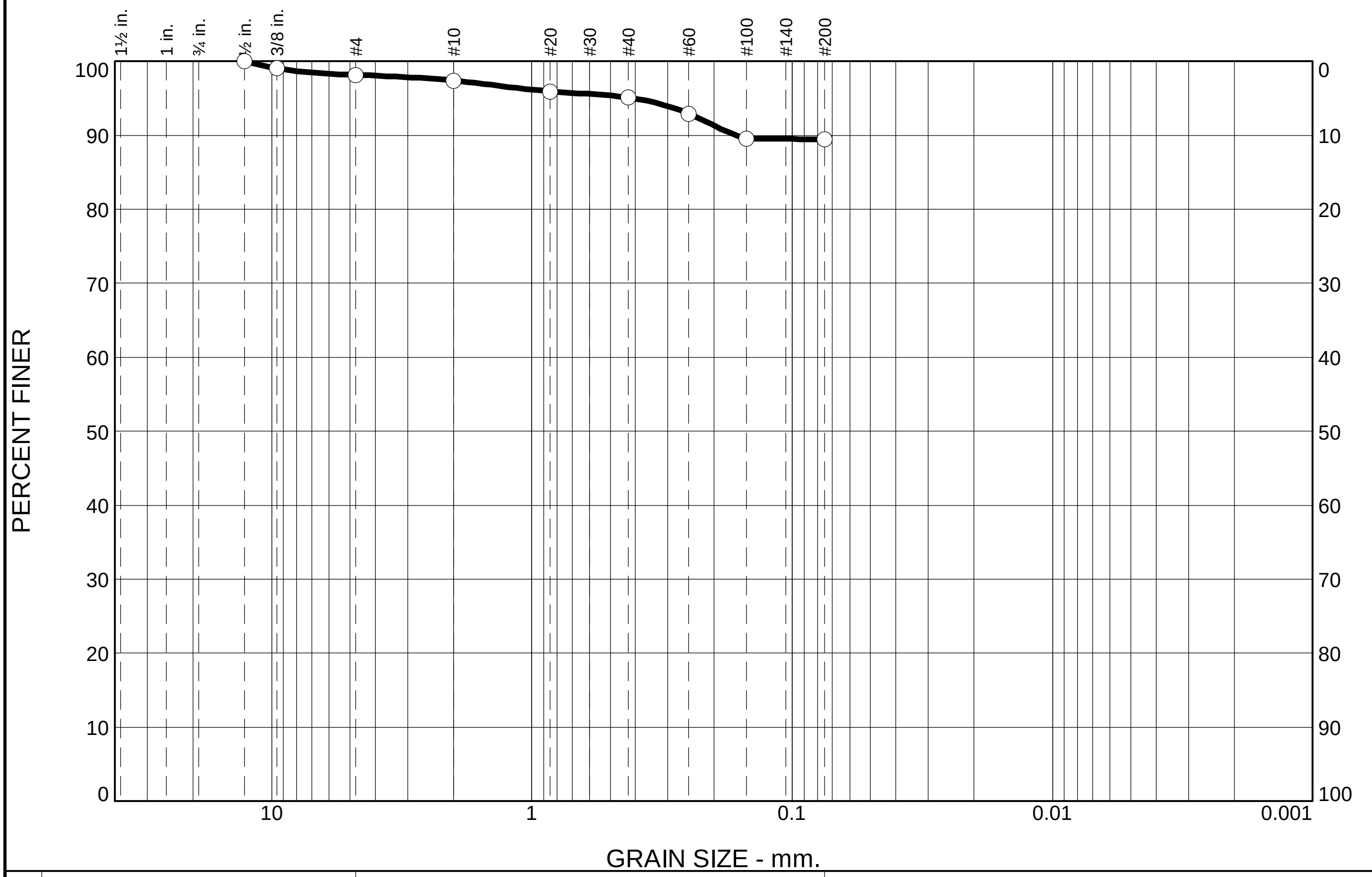
Date: 12/1/15

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

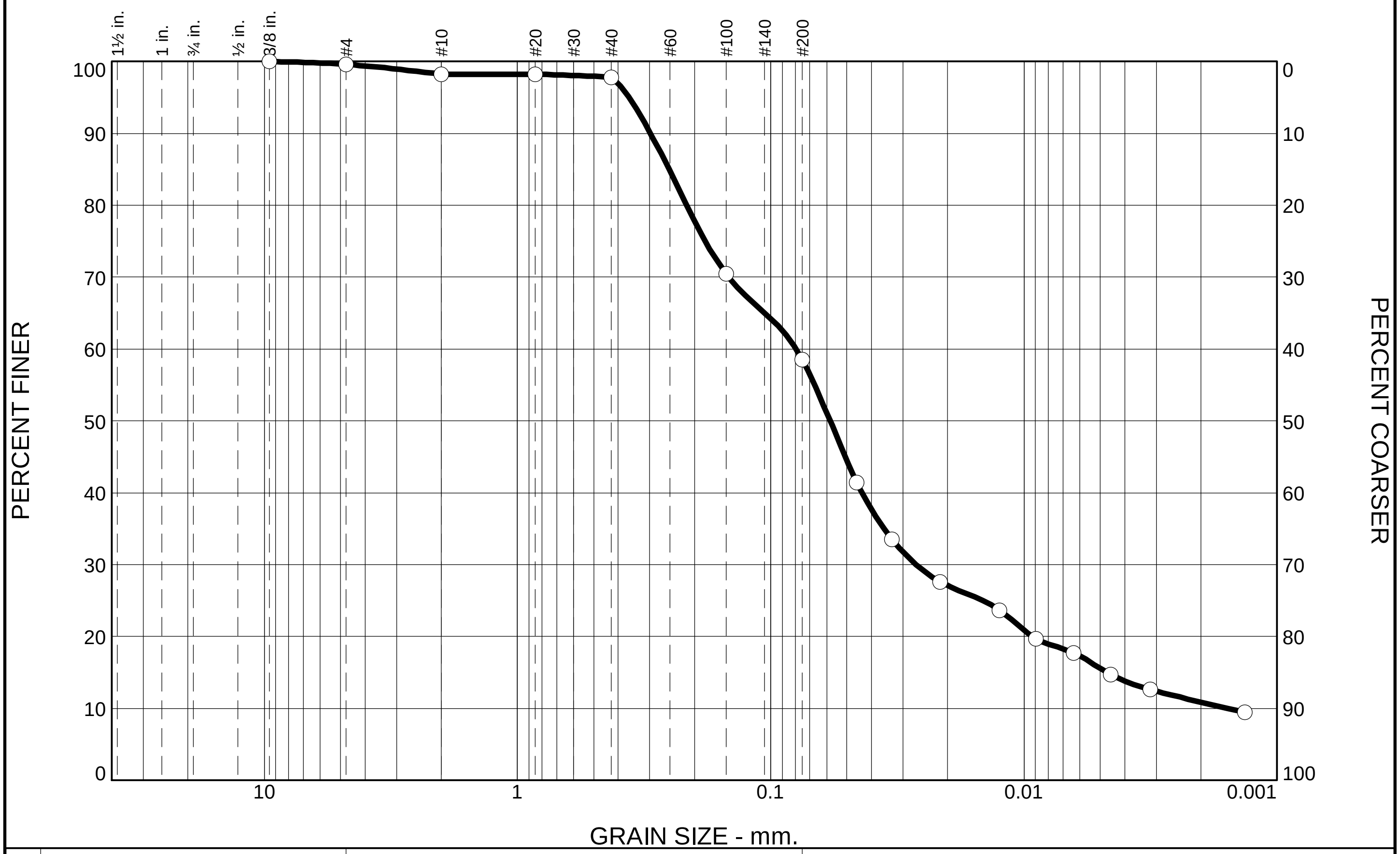
Date: 11-24-15

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:**

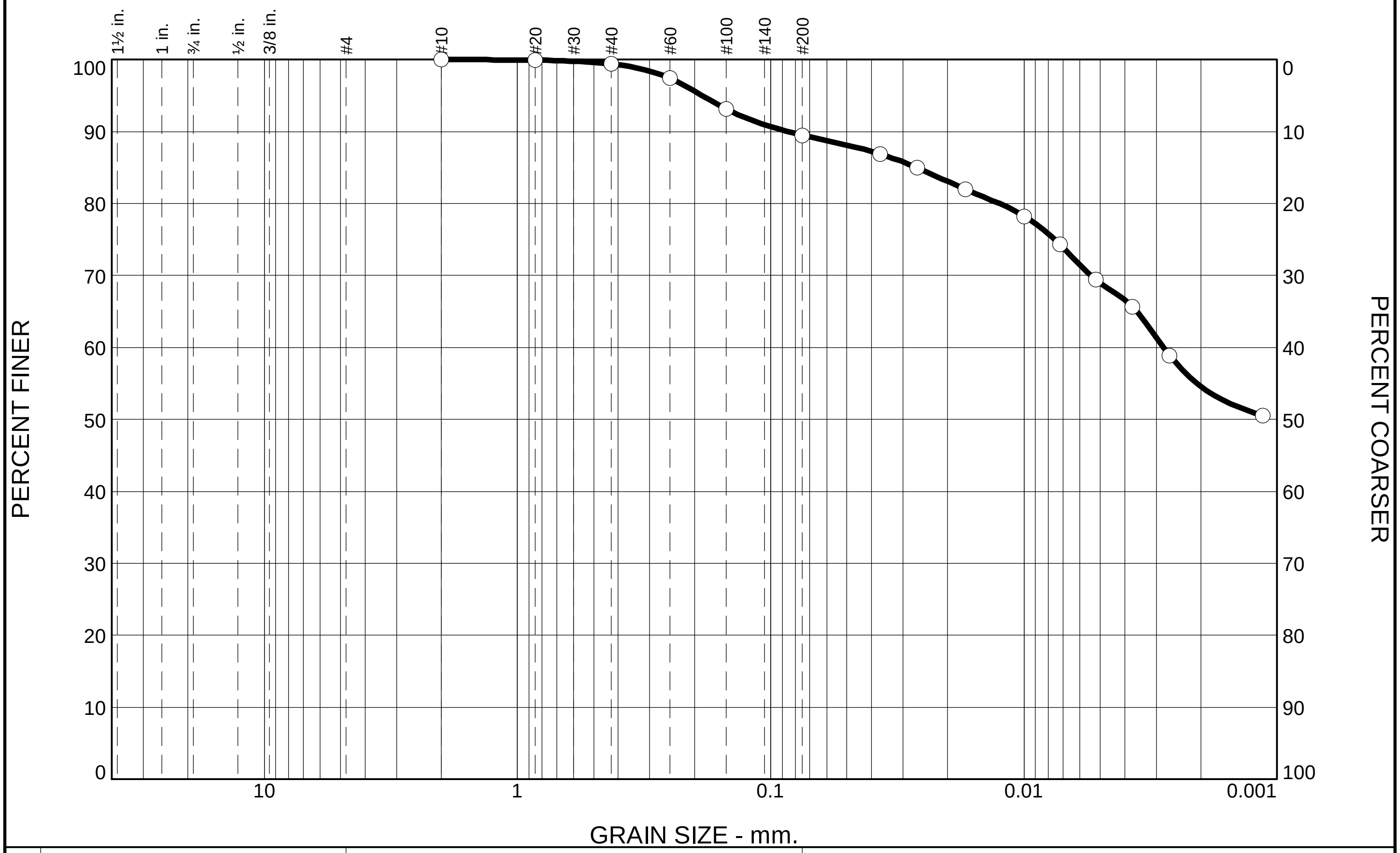
Terracon

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

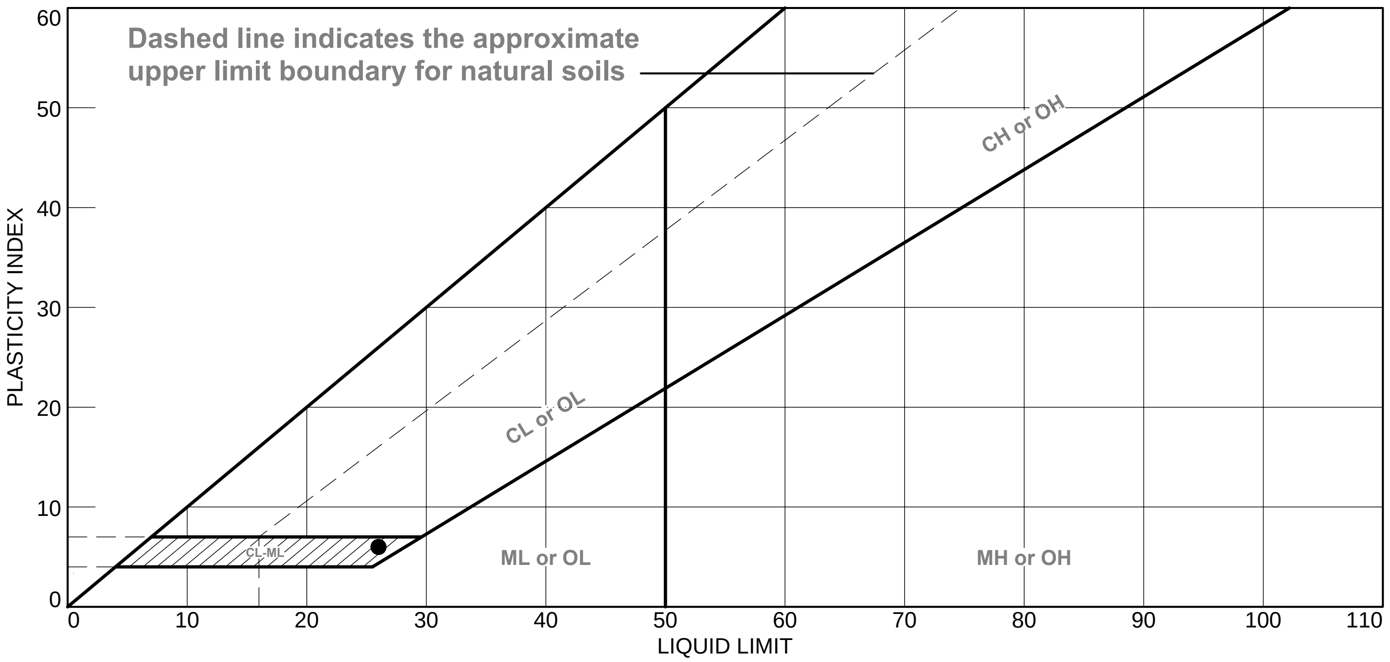
Date: 12/1/15

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

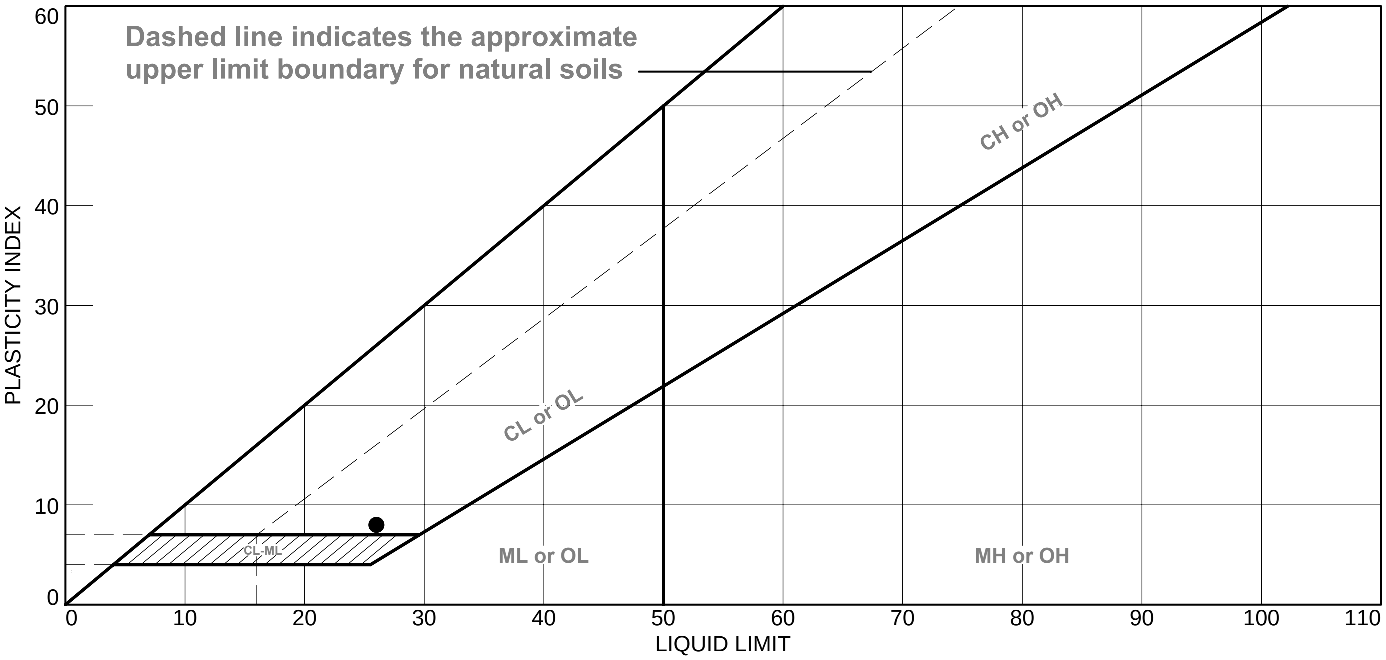
Terracon

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

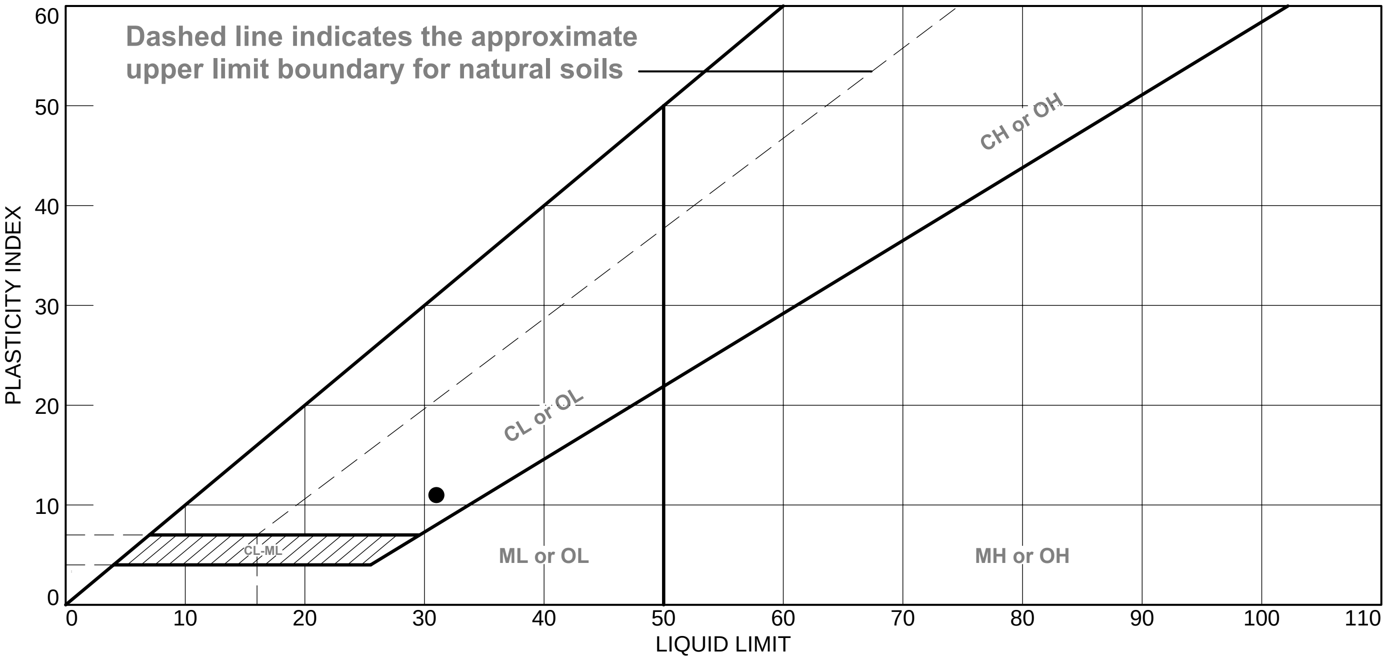
Source of Sample: B-1 **Depth:** 13.0'-15.0'
Sample Number: S-5

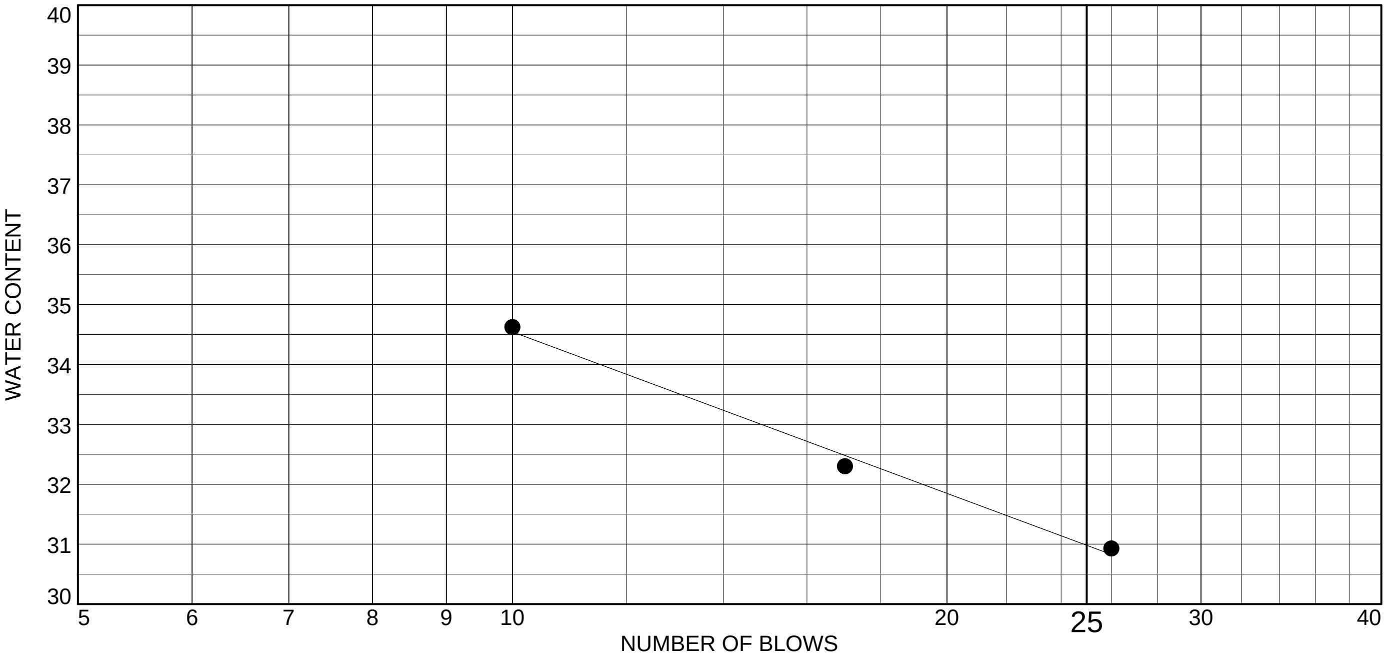
Remarks:

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

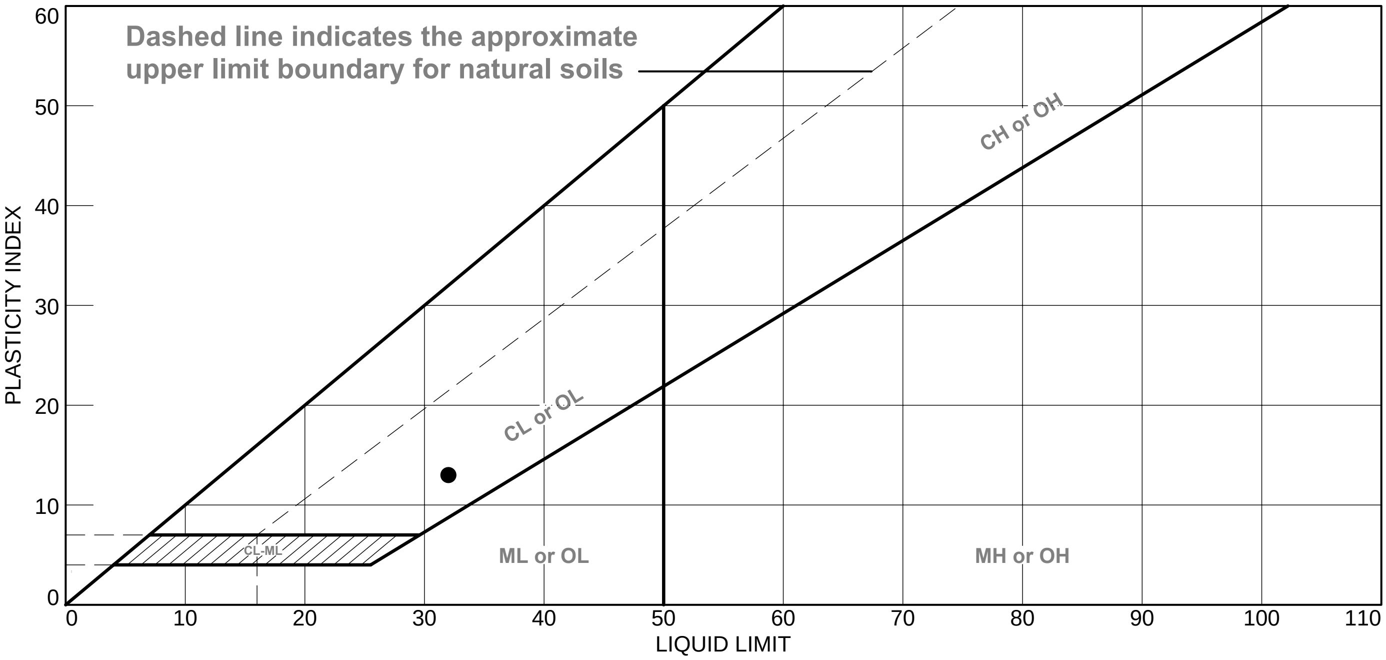
Source of Sample: B-1 **Depth:** 18.0'-20.0'
Sample Number: S-7

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

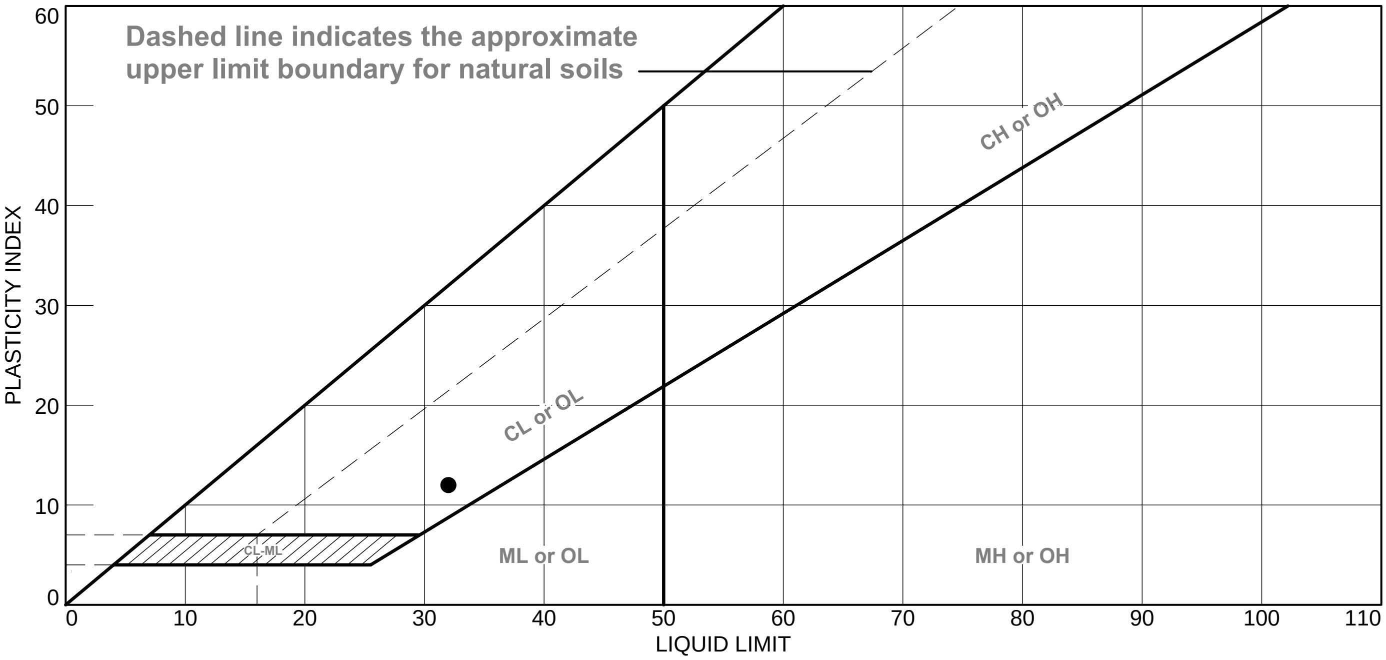
Source of Sample: B-1 **Depth:** 28.0'-30.0'
Sample Number: S-9

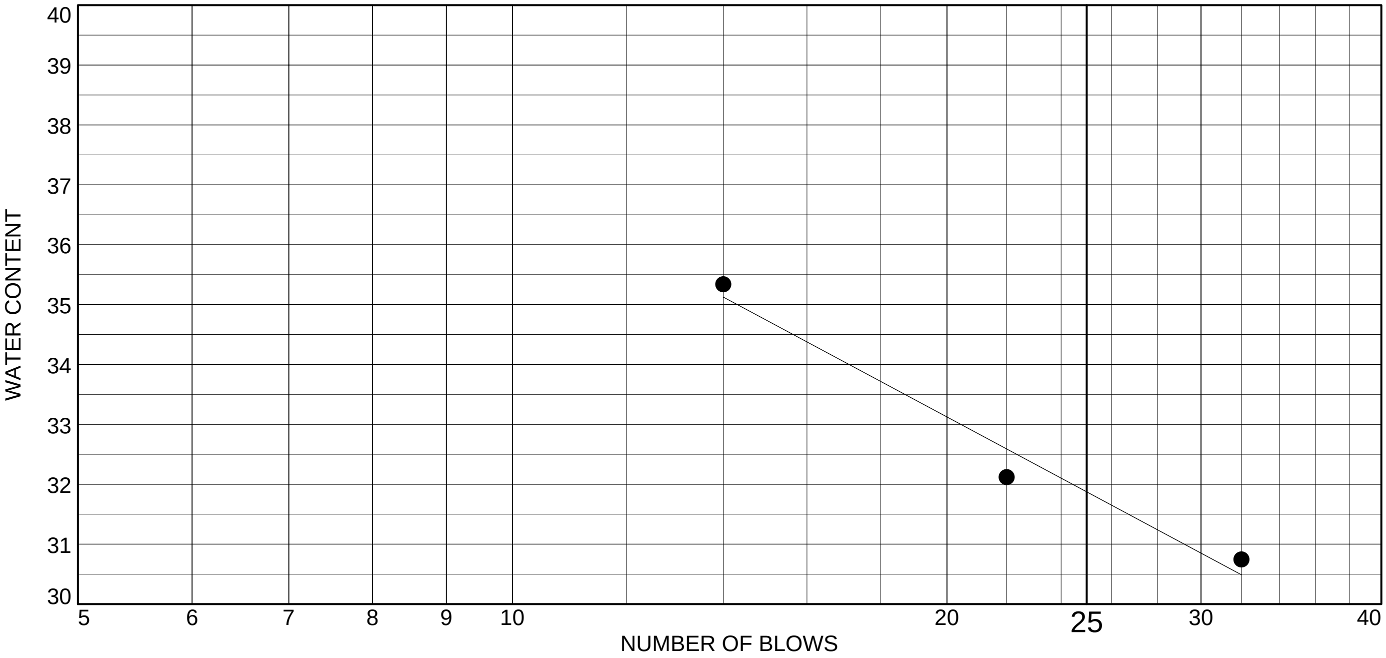
Remarks:

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

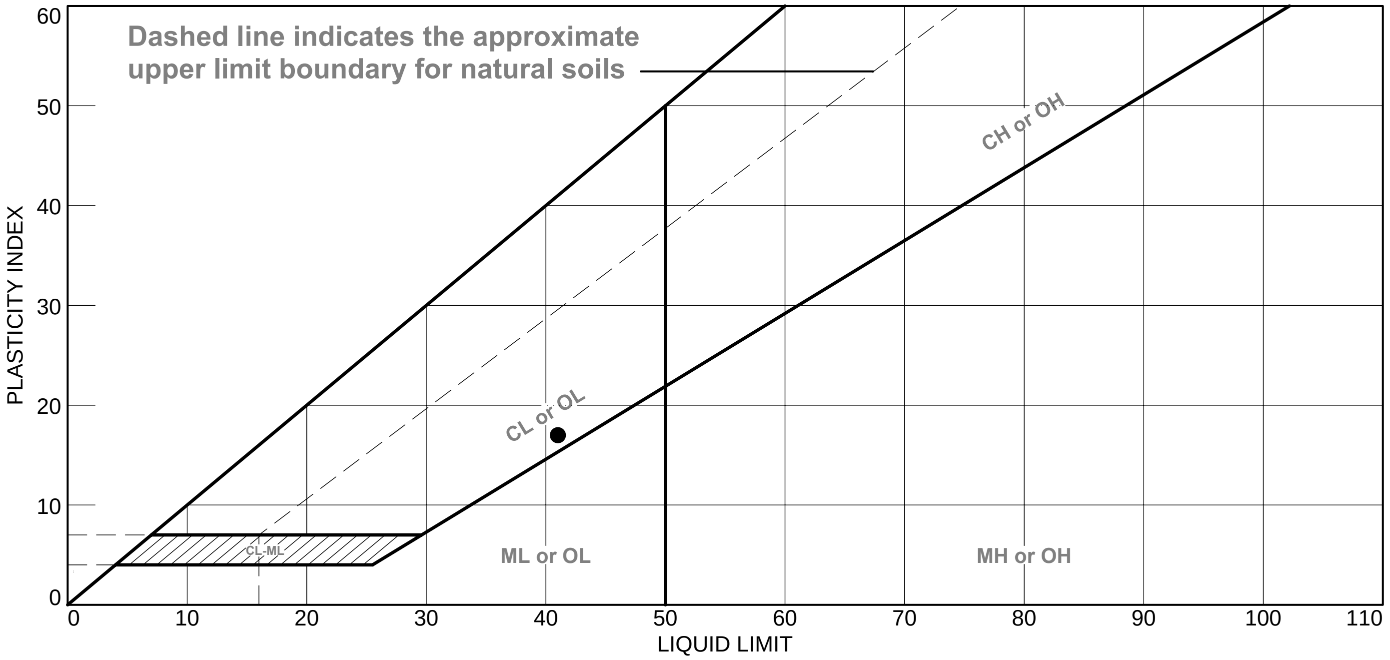
Terracon

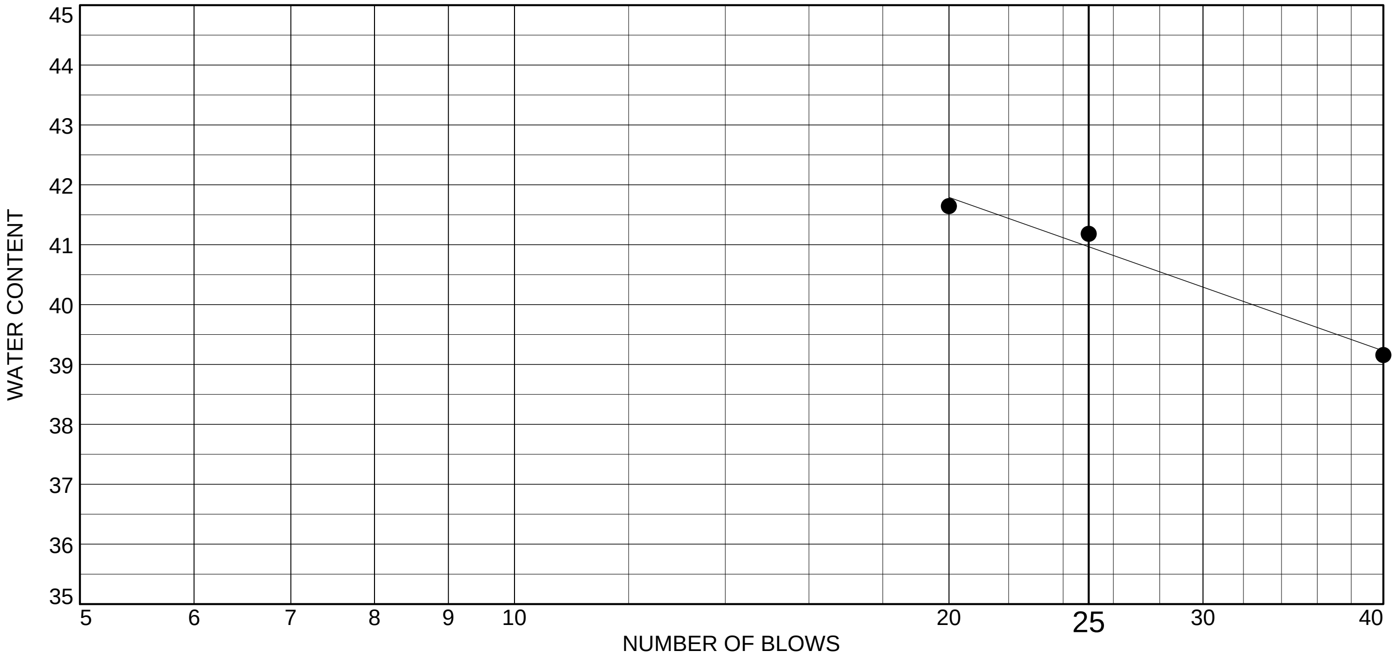
Remarks:

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

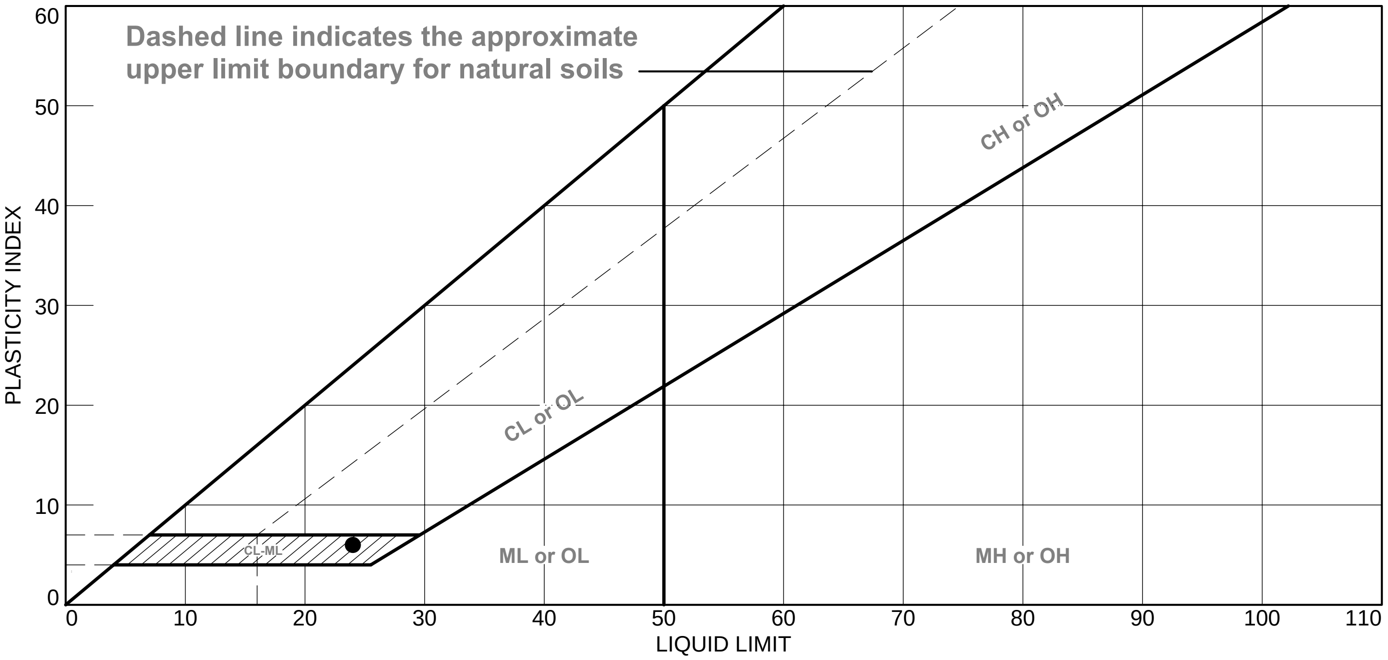
Terracon

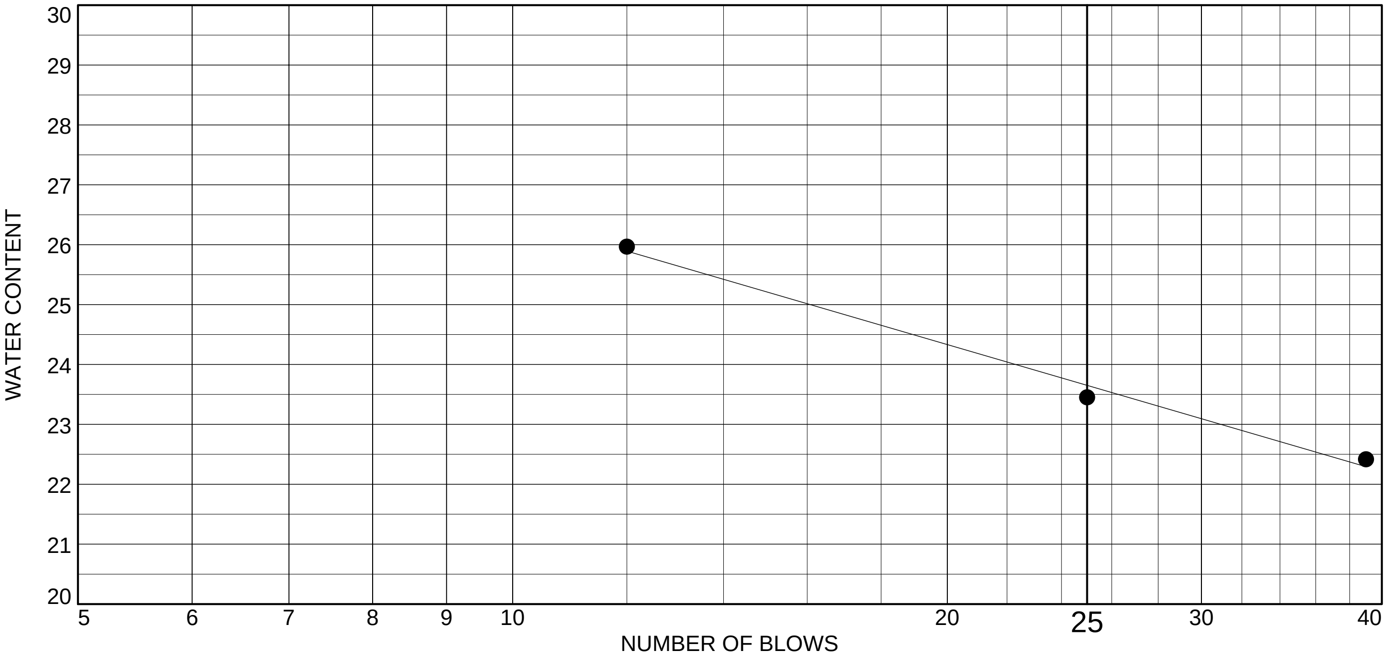
Remarks:

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

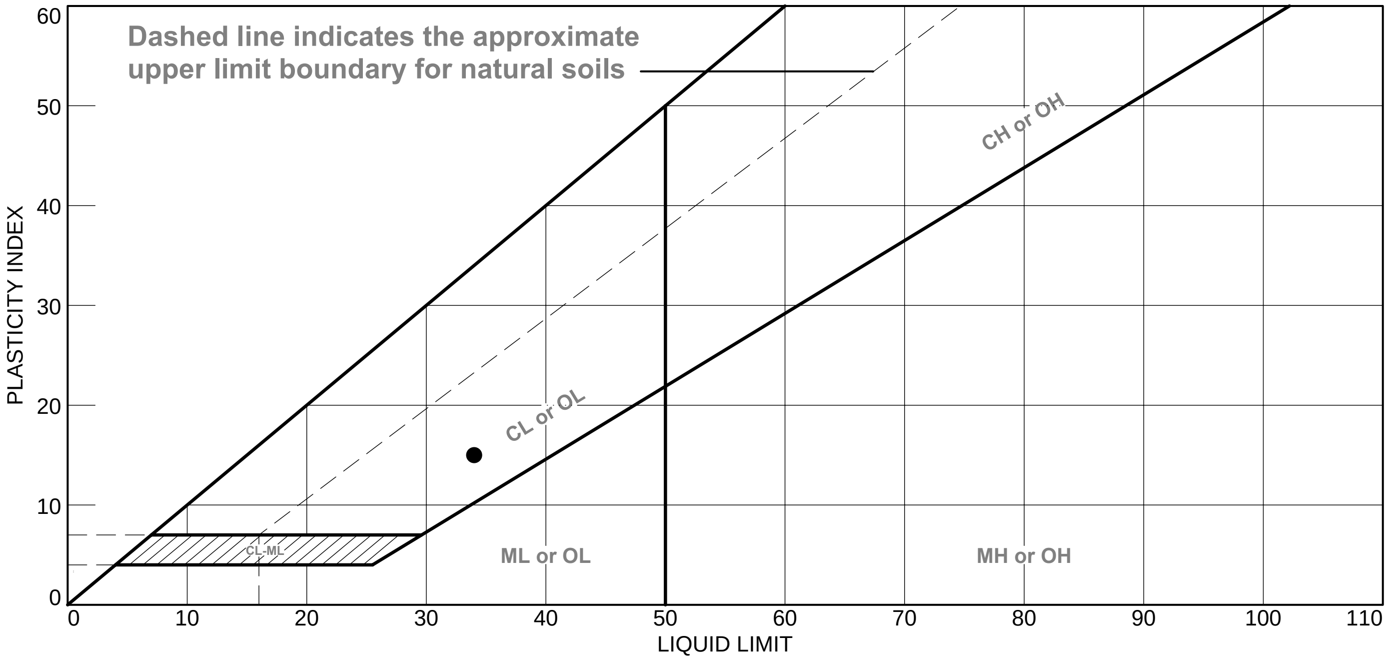
Remarks:

Terracon

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

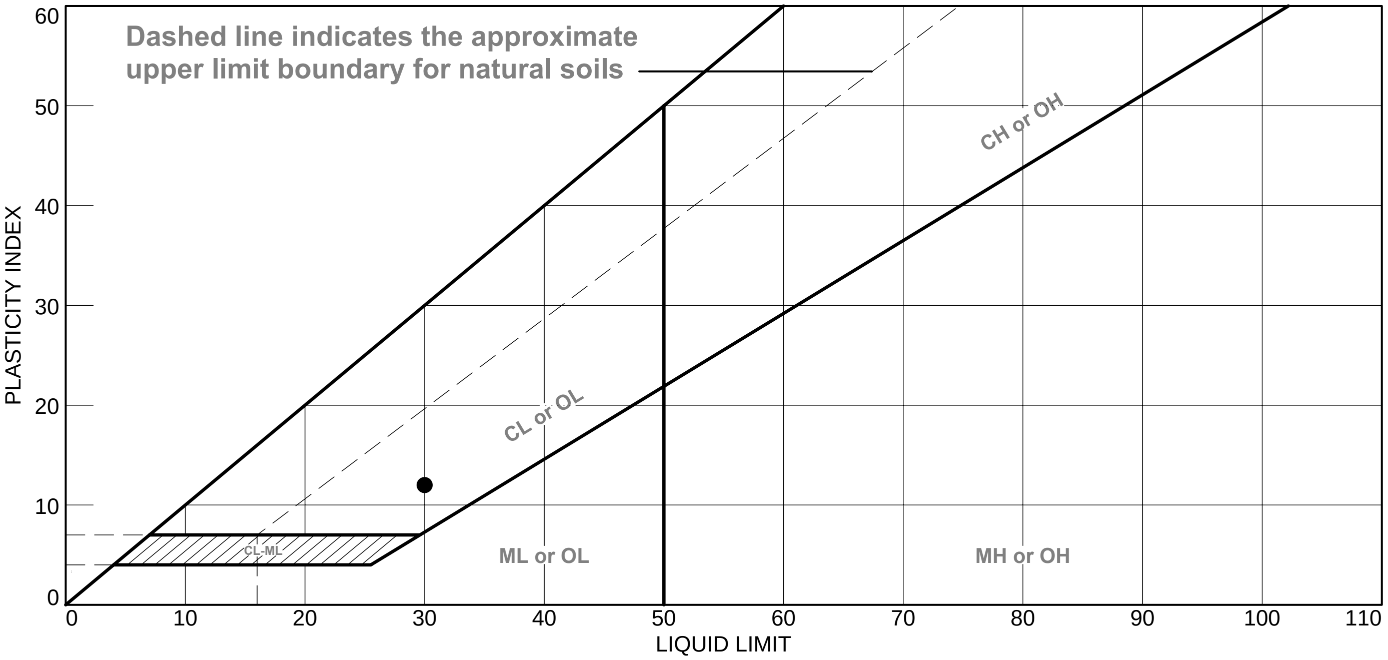
Source of Sample: B-2 **Depth:** 9.0'-11.0'
Sample Number: S-4

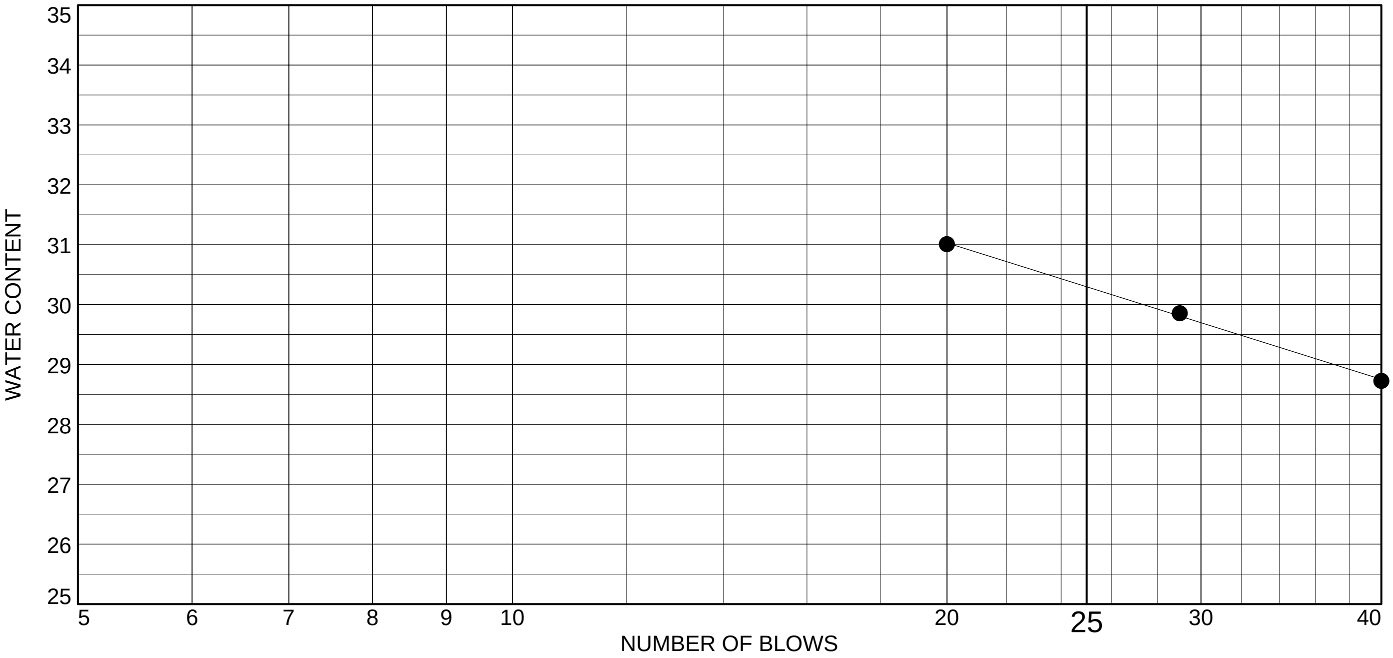
Remarks:

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

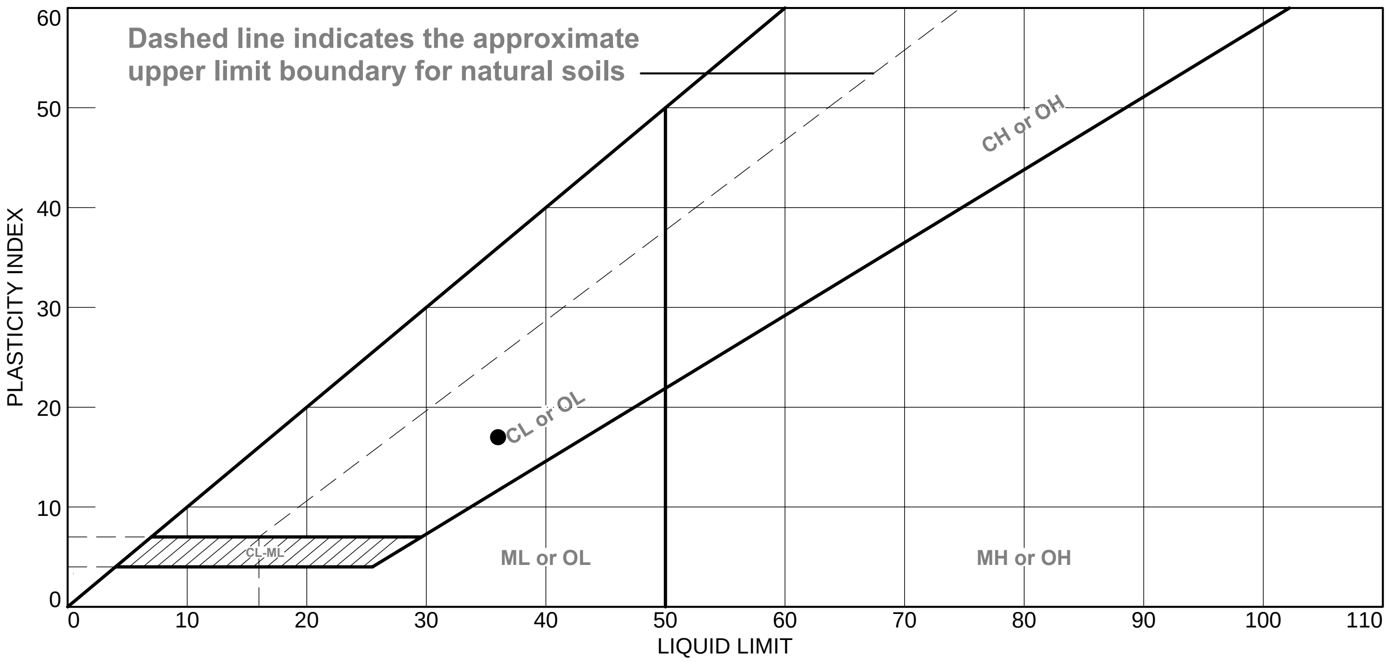
Terracon

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

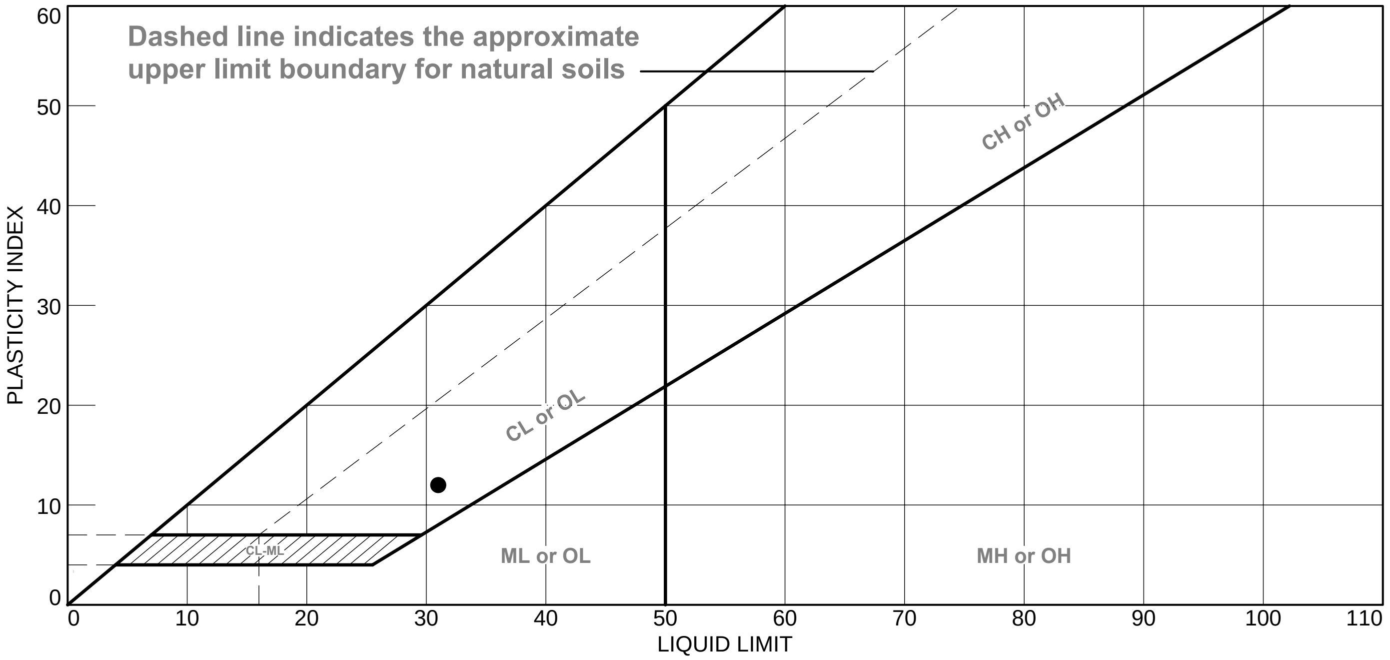
Remarks:

Terracon

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

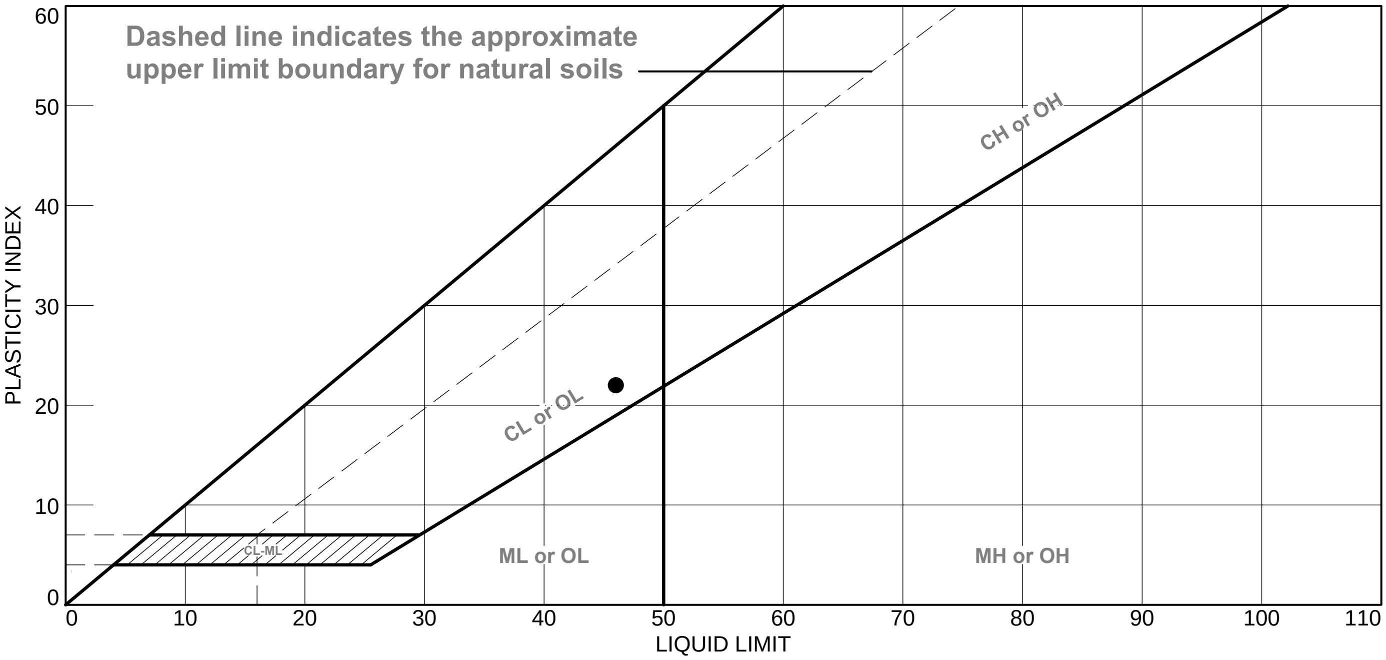
Terracon

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

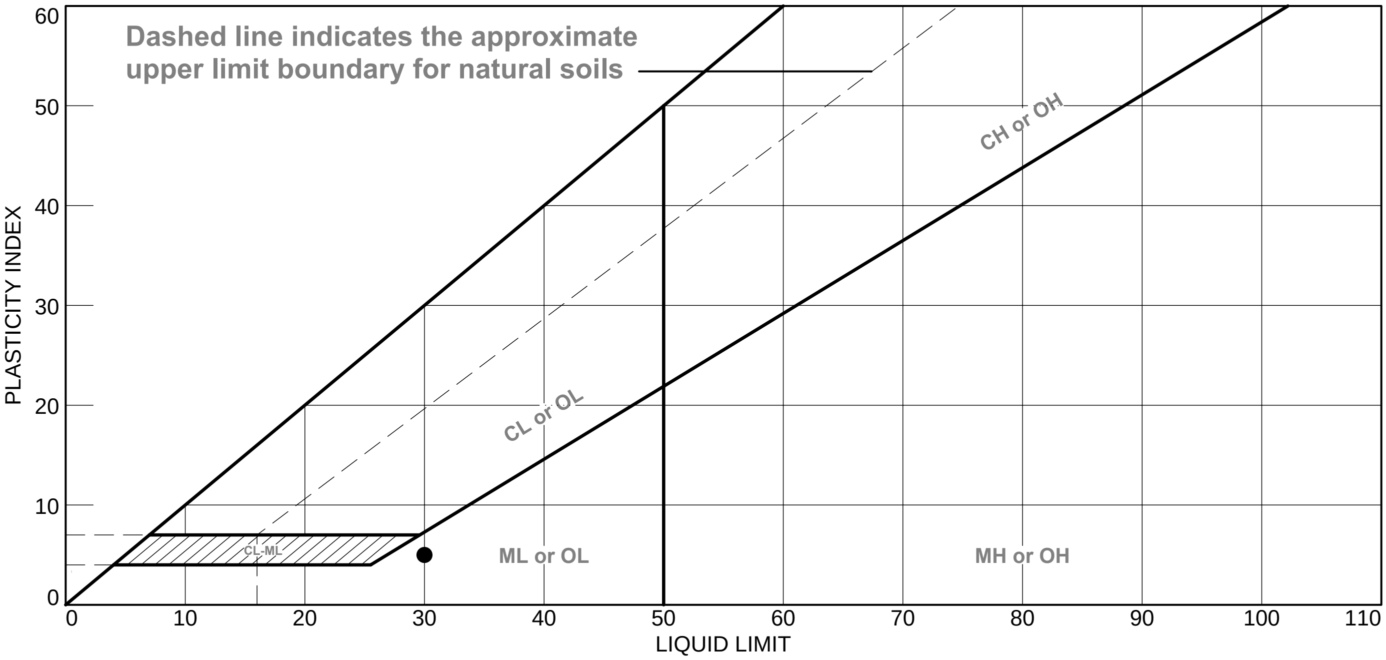
Terracon

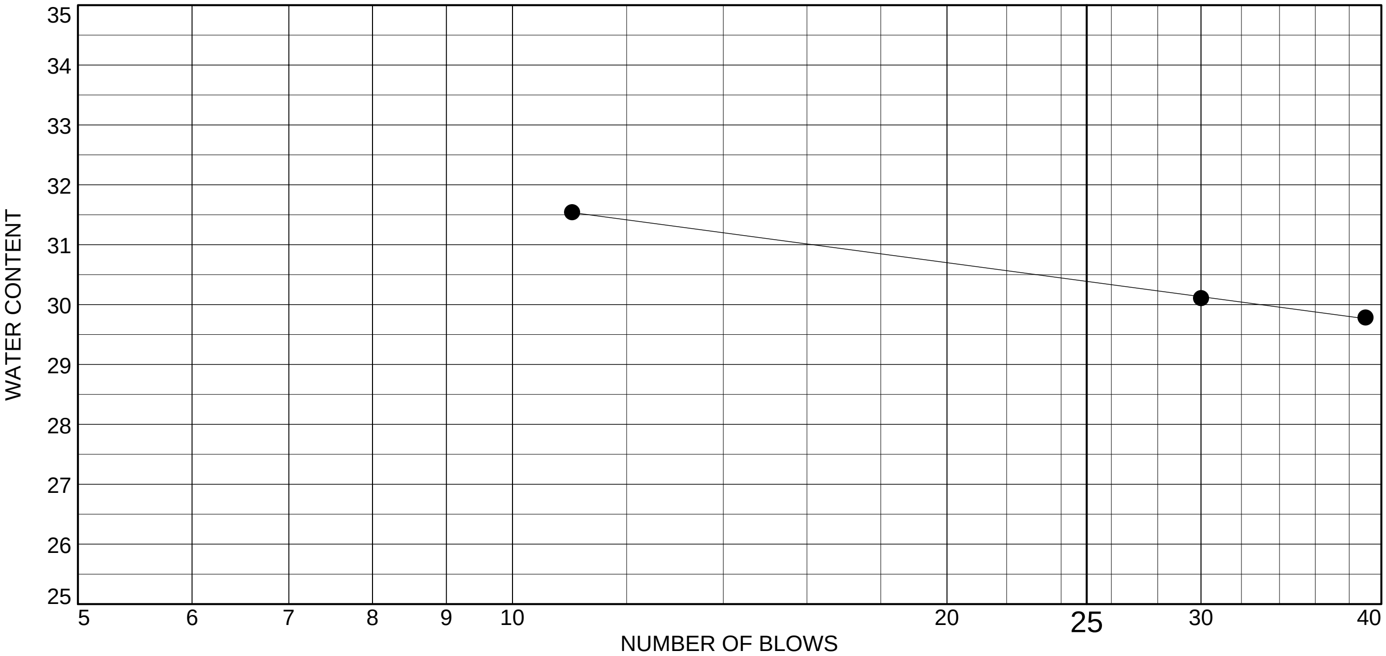
Remarks:

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

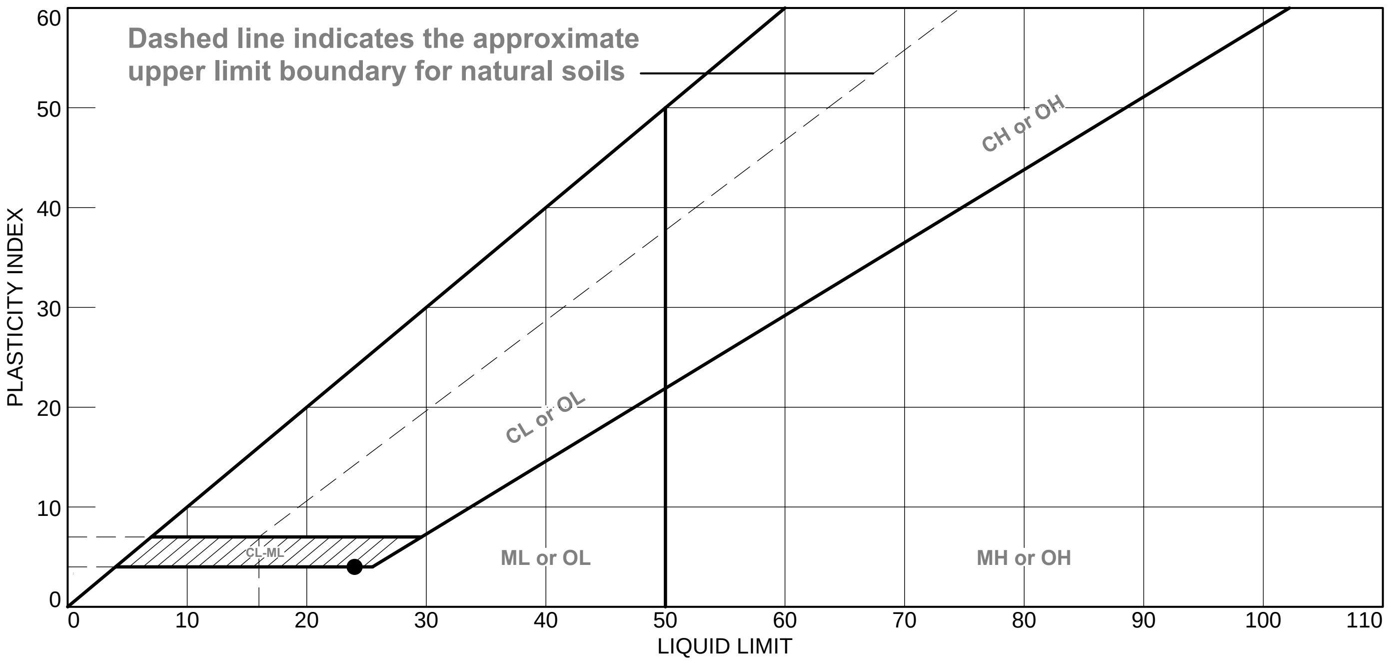
Source of Sample: B-2 **Depth:** 48.0'-50.0'
Sample Number: S-14

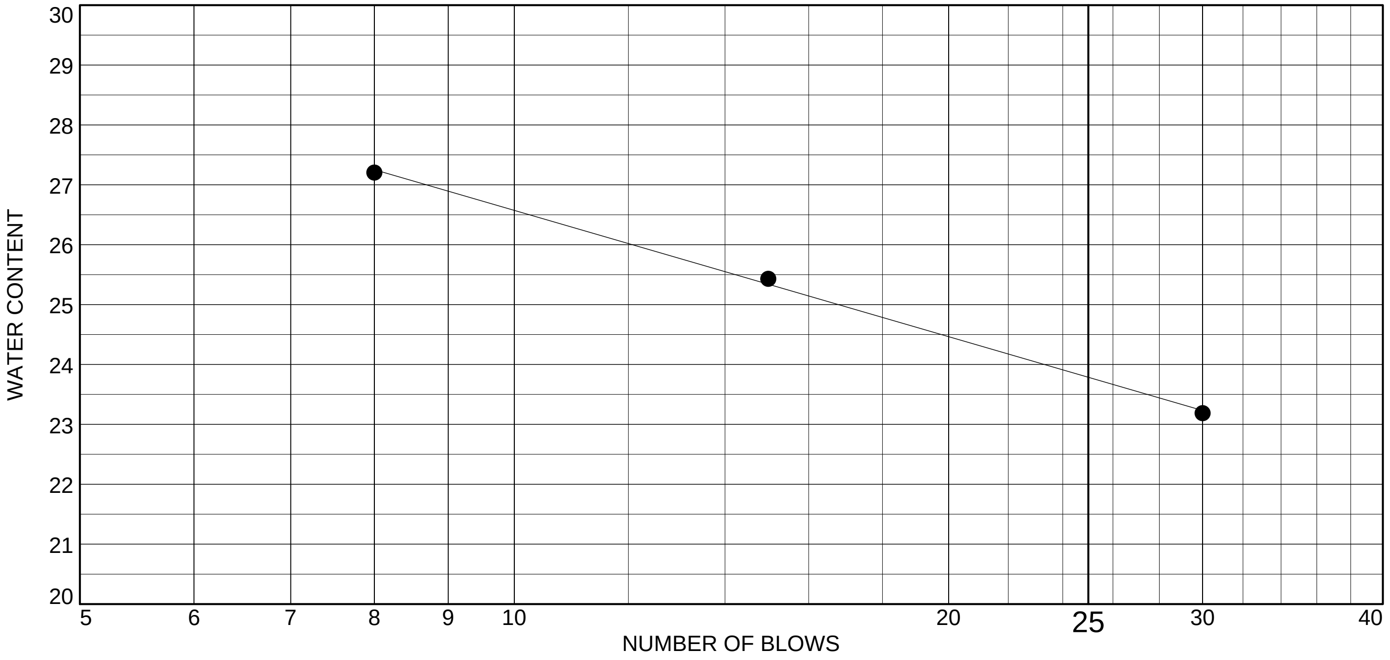
Remarks:
● CLAY POCKETS NOTED

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

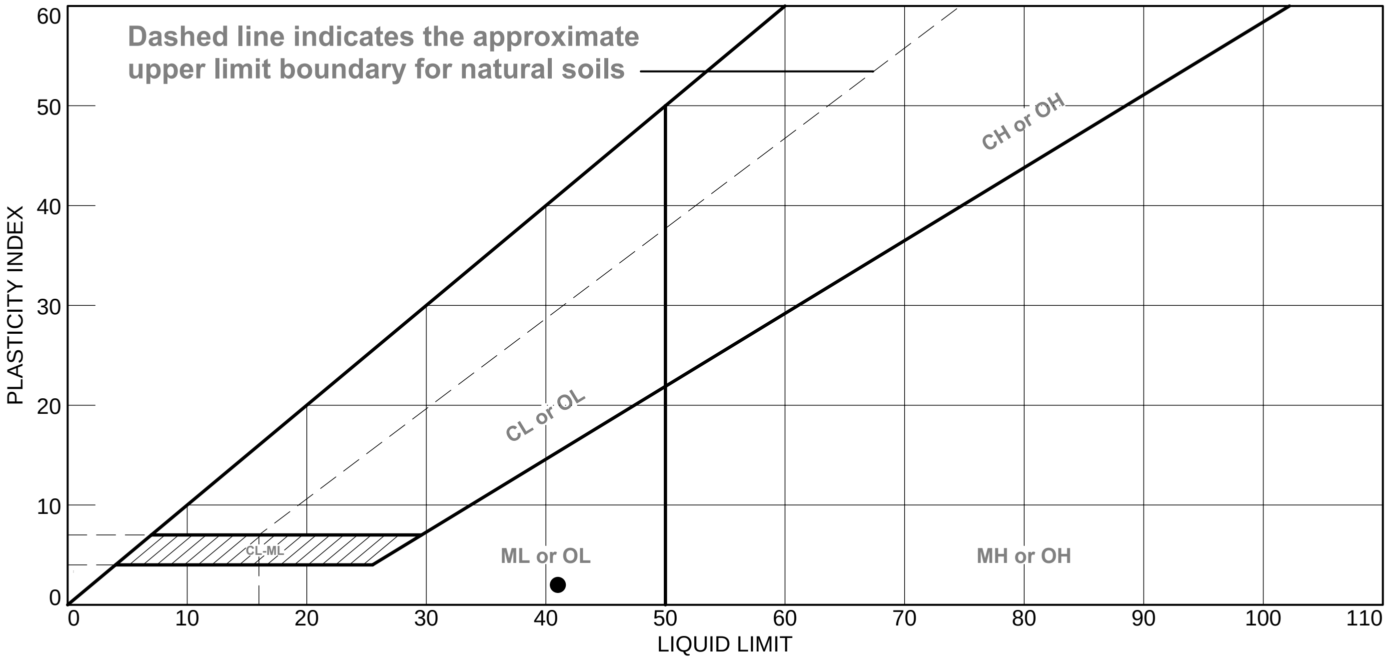
Source of Sample: B-2 **Depth:** 53.0'-55.0'
Sample Number: S-16

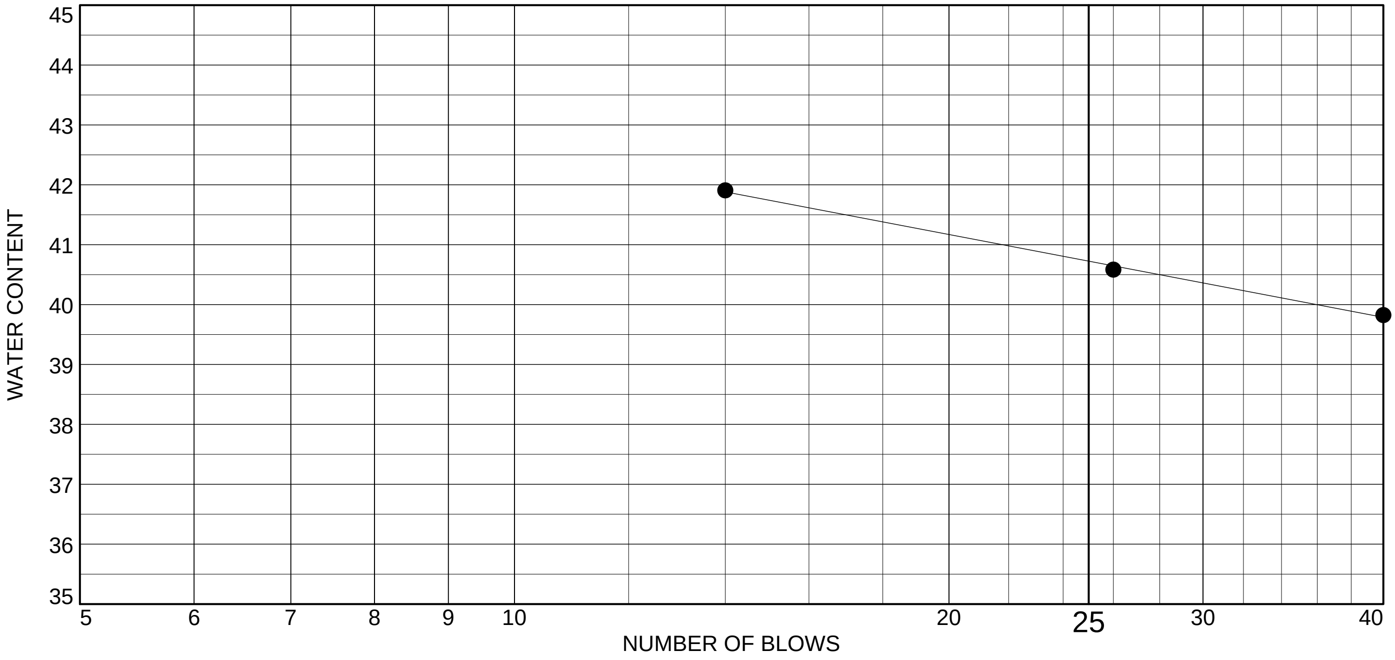
Remarks:

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

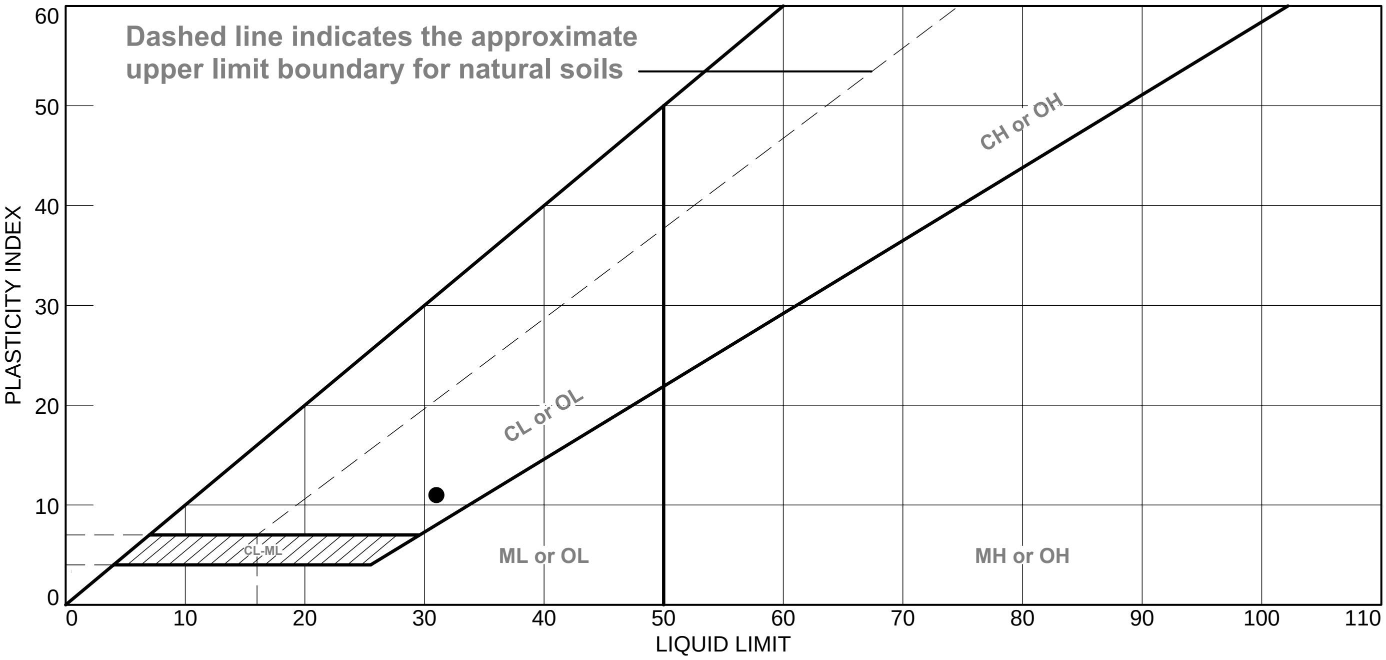
Source of Sample: B-2 **Depth:** 61.0'-62.5'
Sample Number: S-19

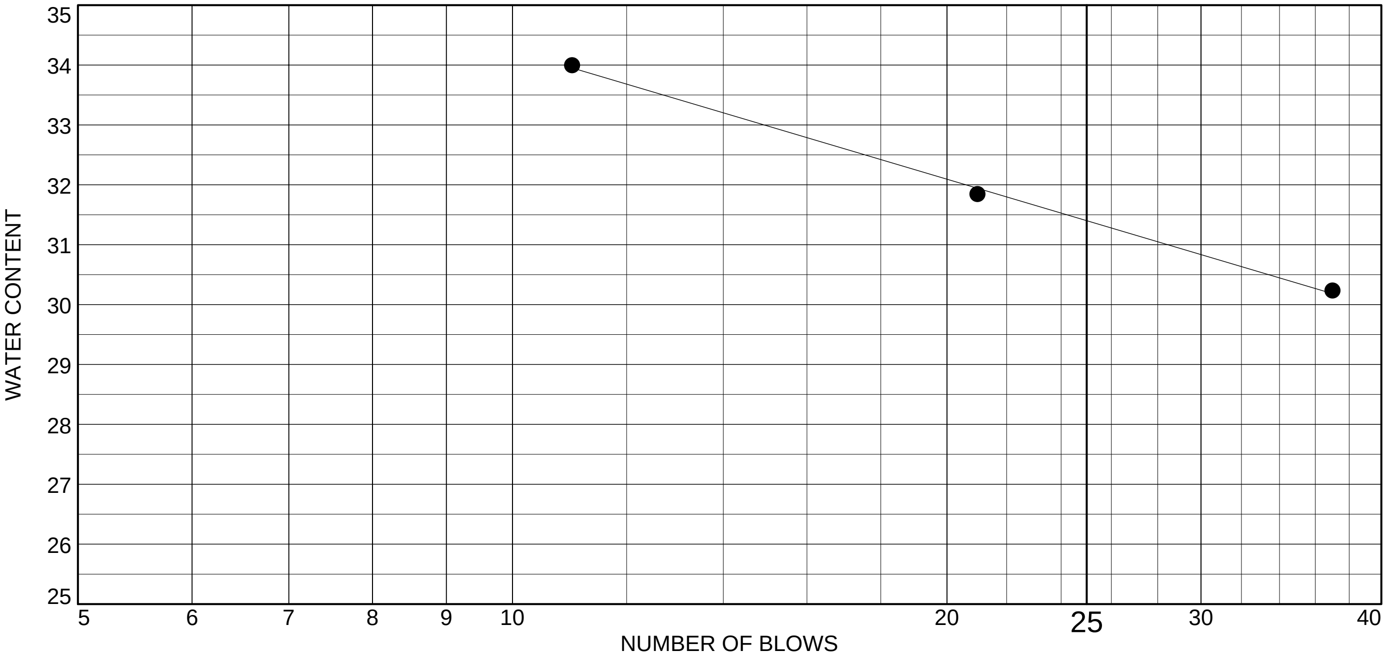
Remarks:

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

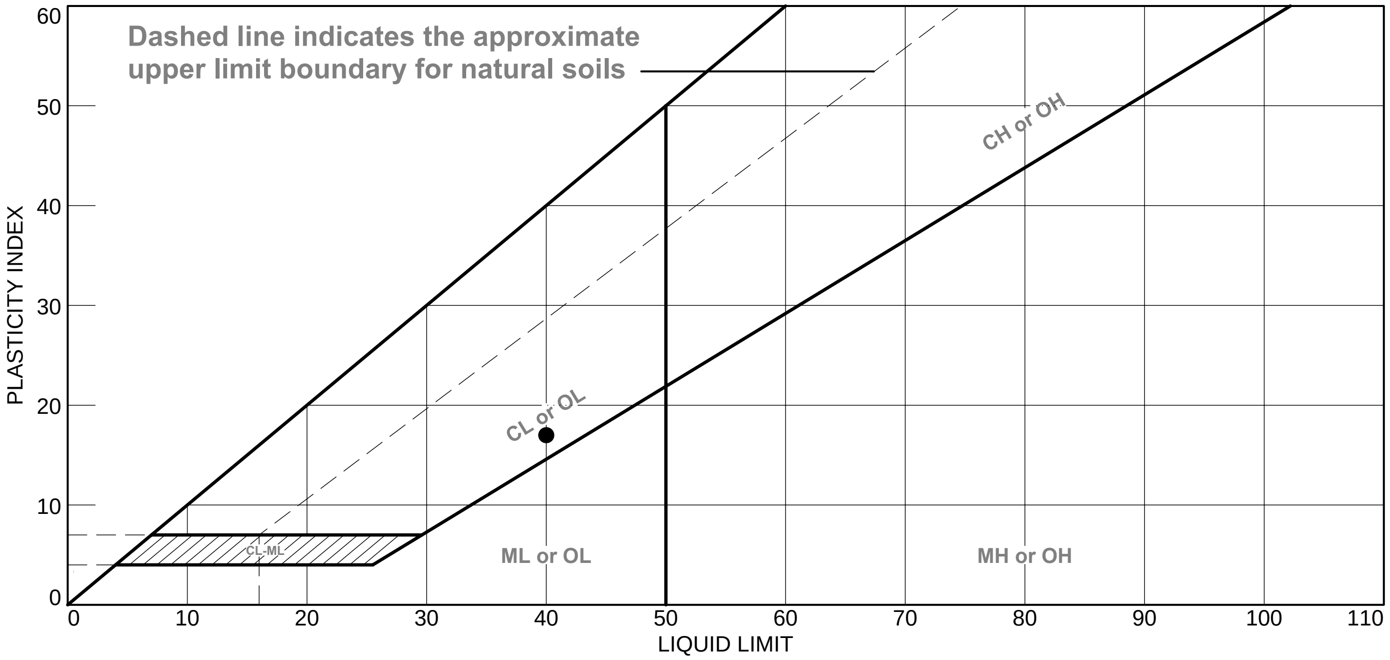
Terracon

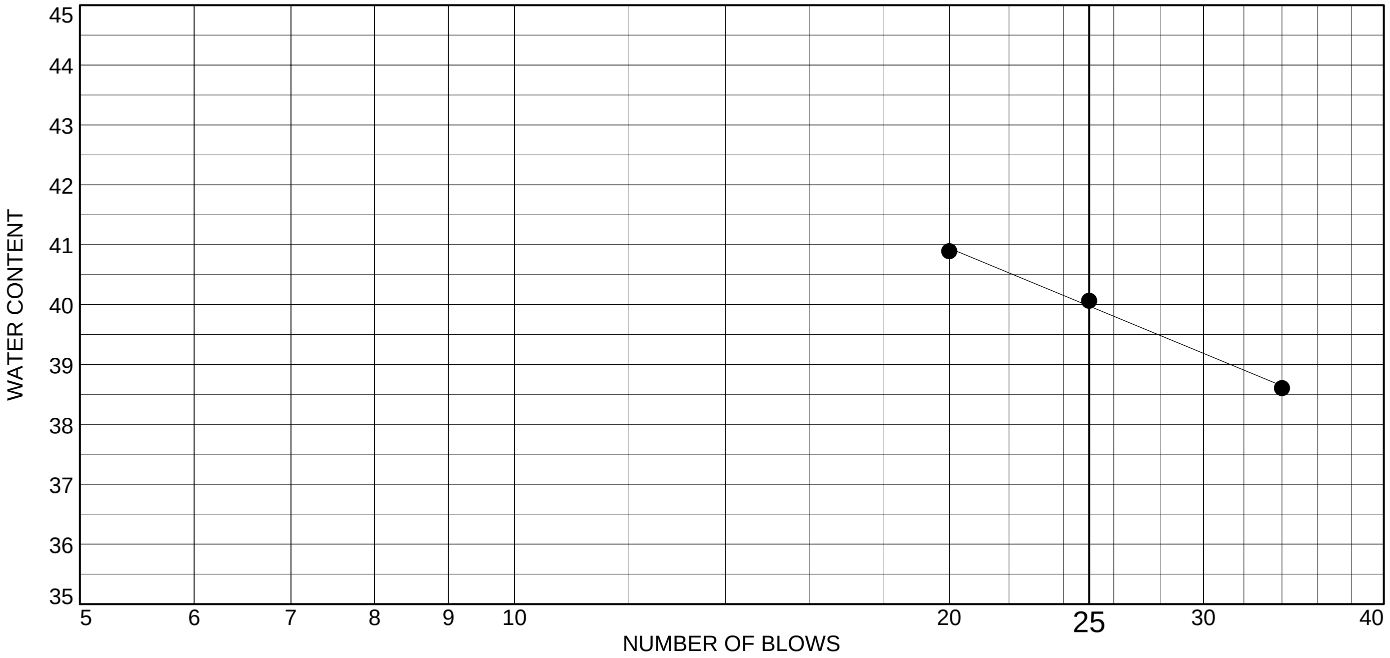
Remarks:

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

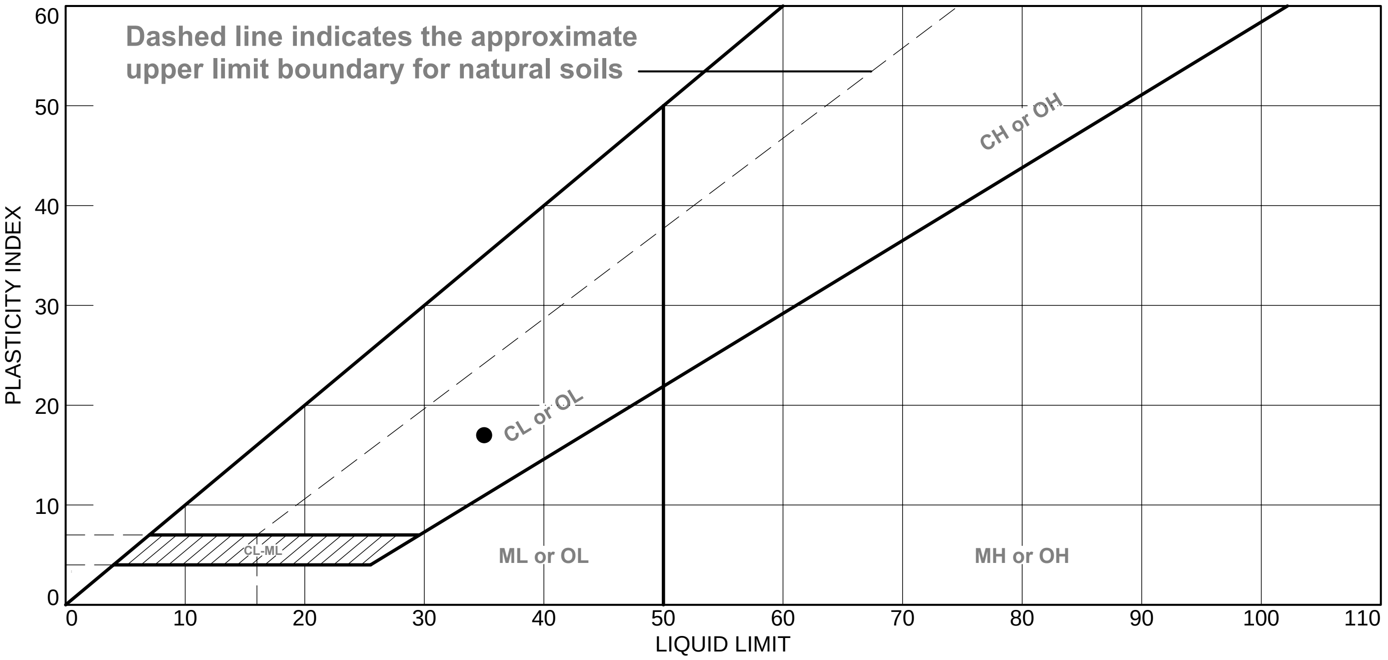
Source of Sample: B-3 **Depth:** 30.0'-32.0'
Sample Number: S-6

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

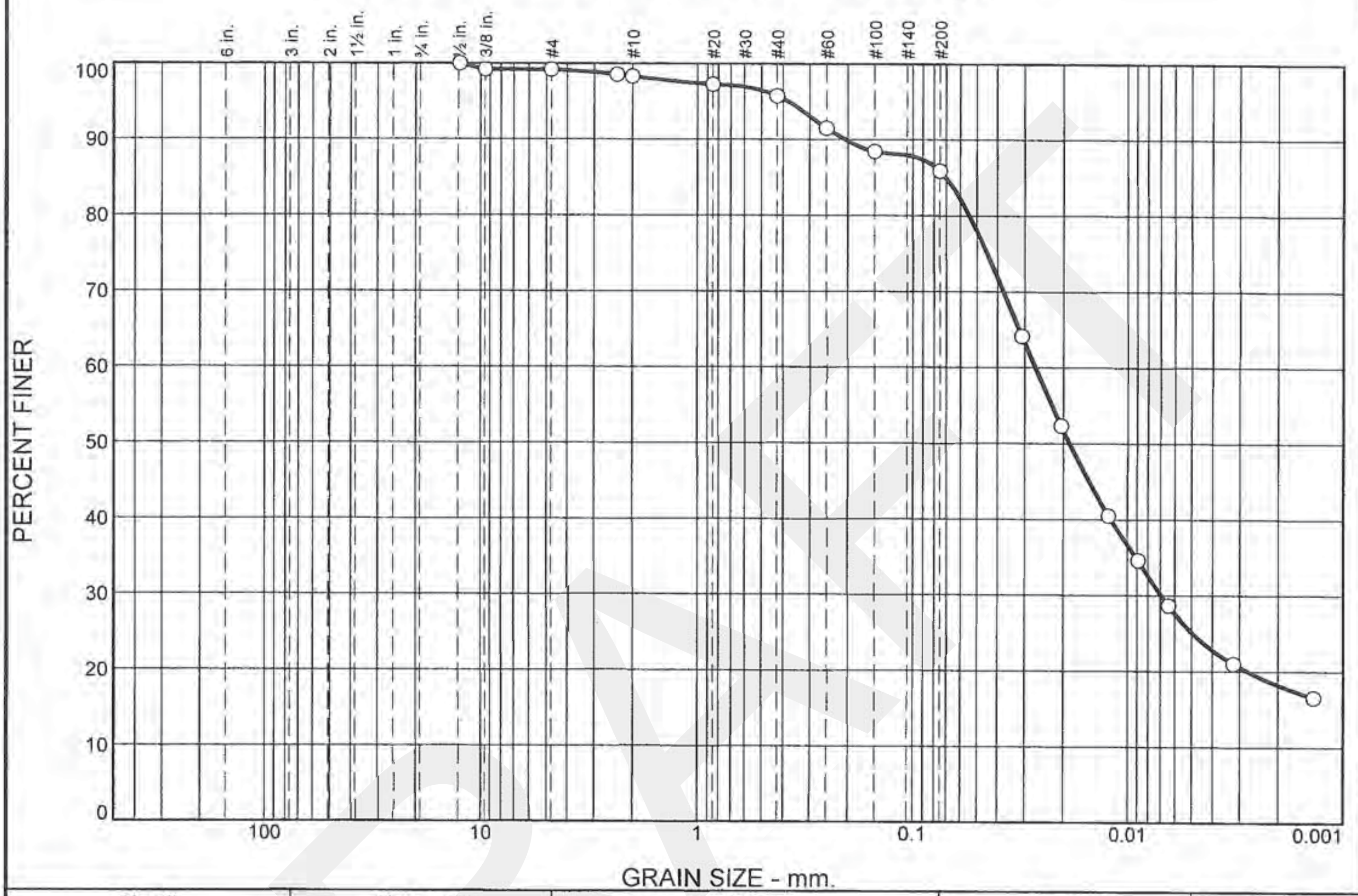
Source of Sample: B-3 **Depth:** 36.0'-38.0'
Sample Number: S-8

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

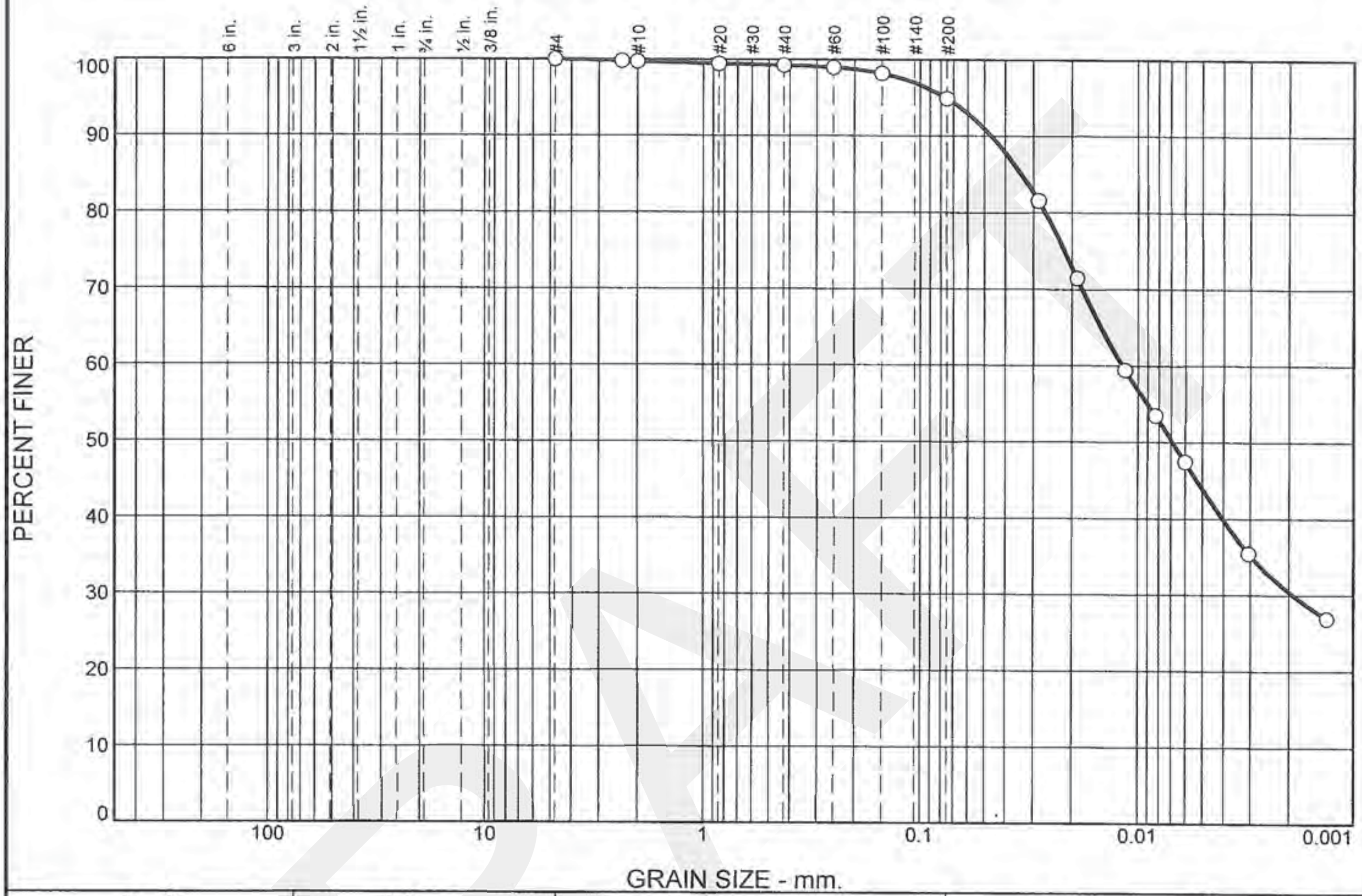
Date:

Cardno ATC, INC.

Indianapolis, Indiana

Client: Vectren
Project: Culley Stability Assessment
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

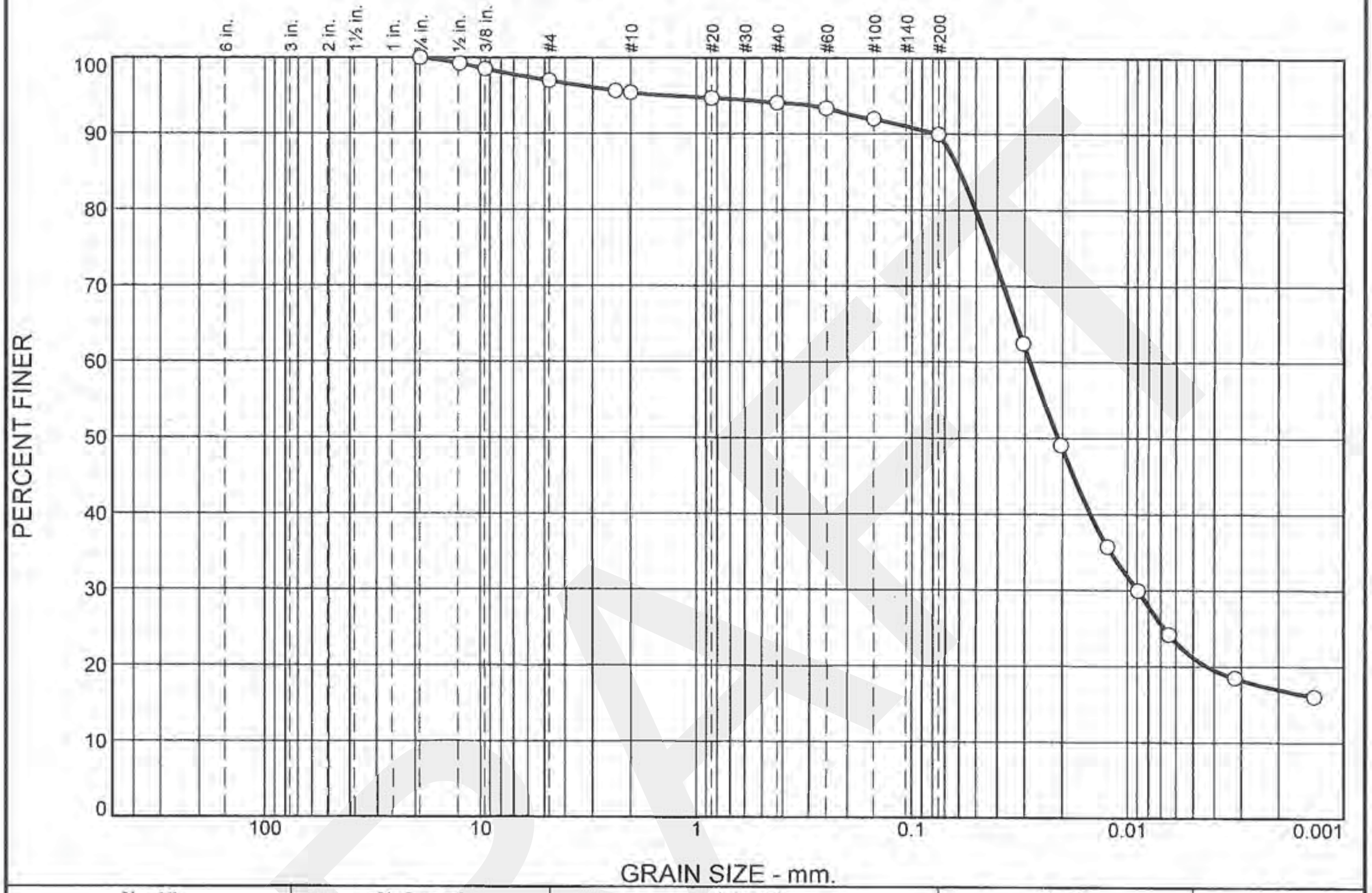
Date:

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

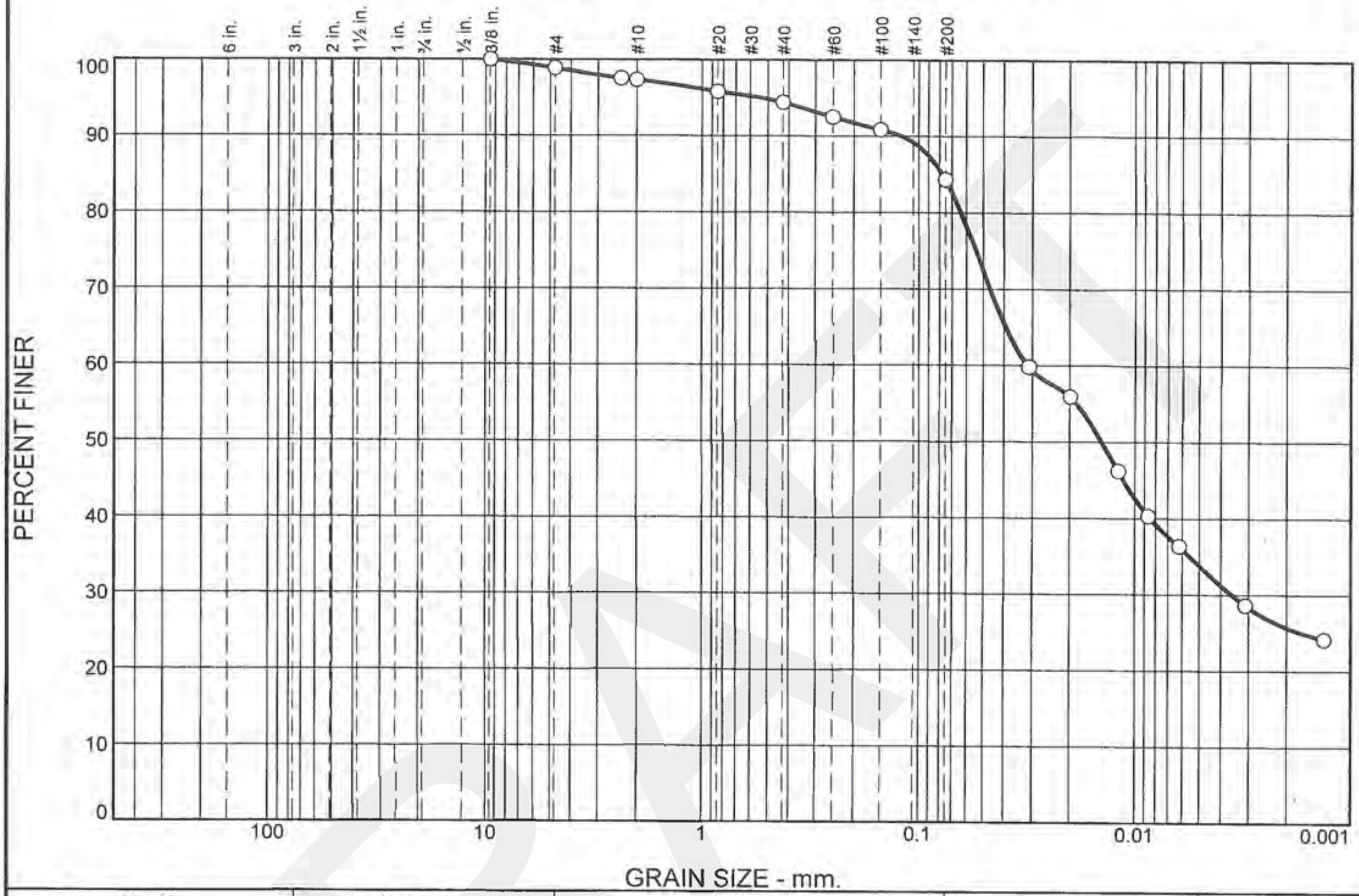
Date:

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

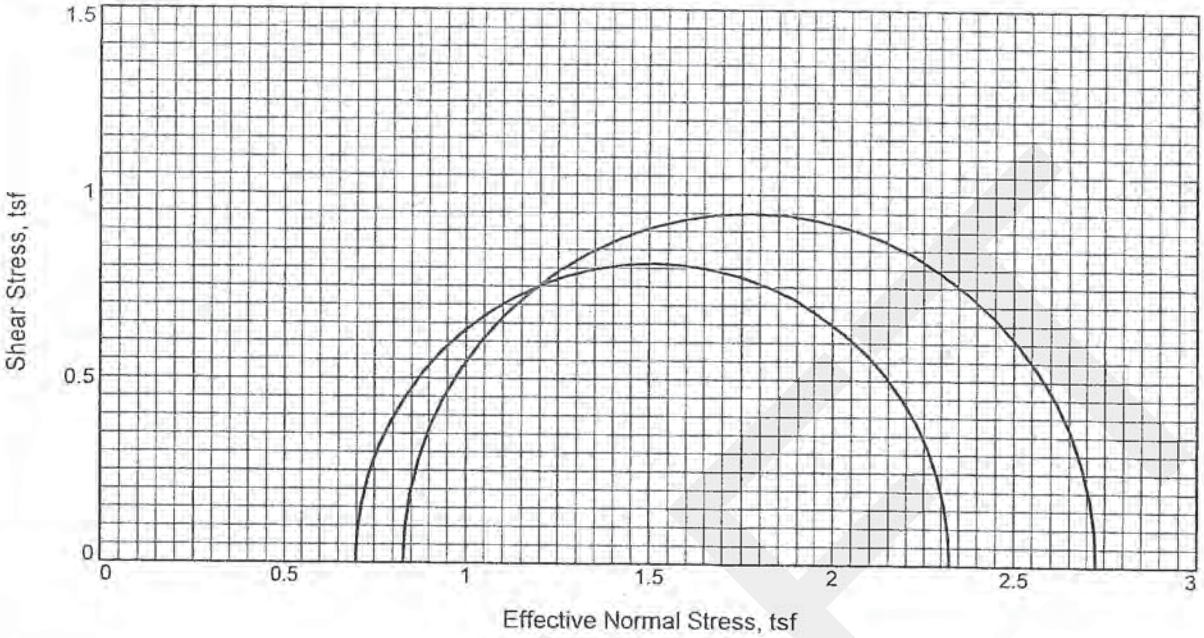
Source of Sample: 7030 **Depth:** 23.5'-25.5'
Sample Number: B-102

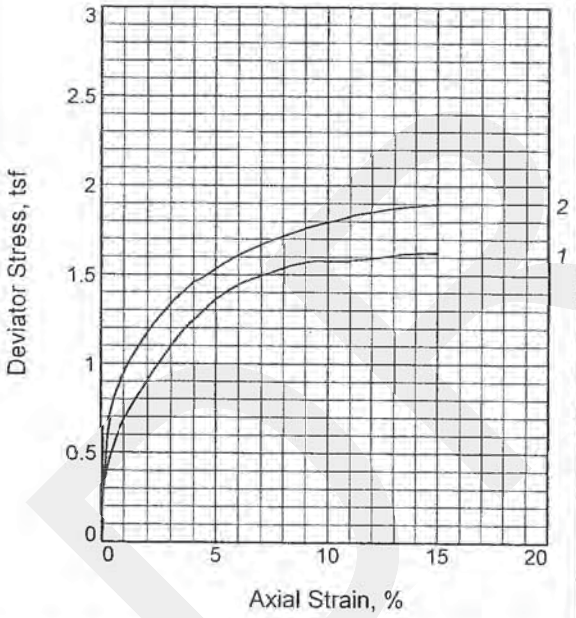
Date:

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

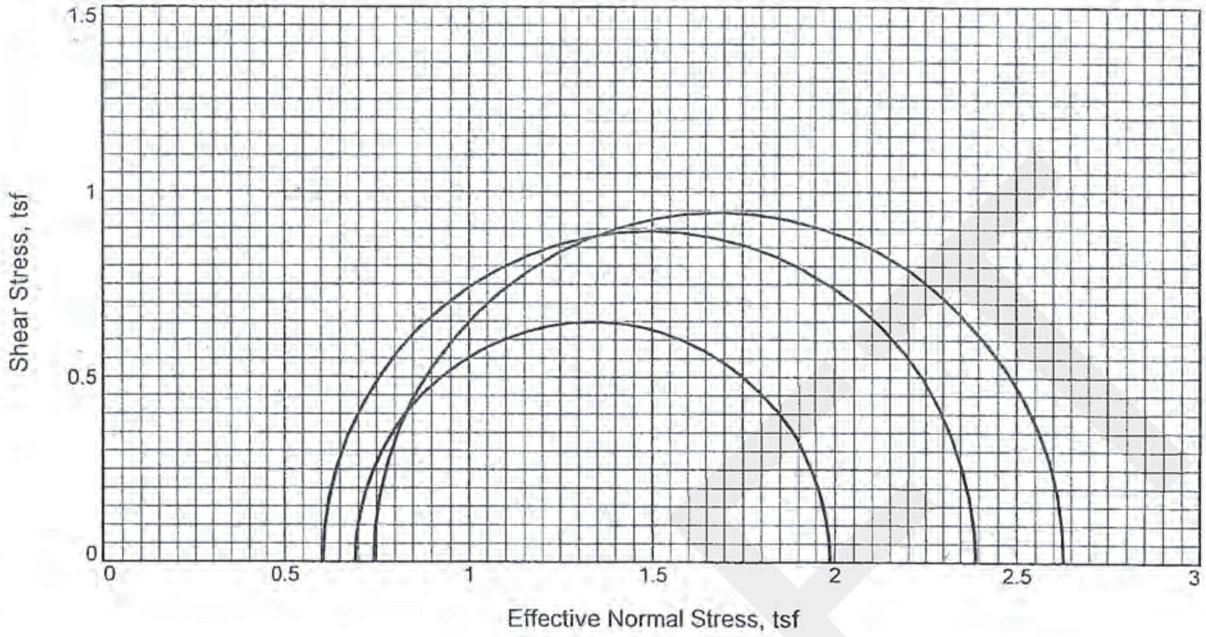
Source of Sample: 7030 **Depth:** 16-18'

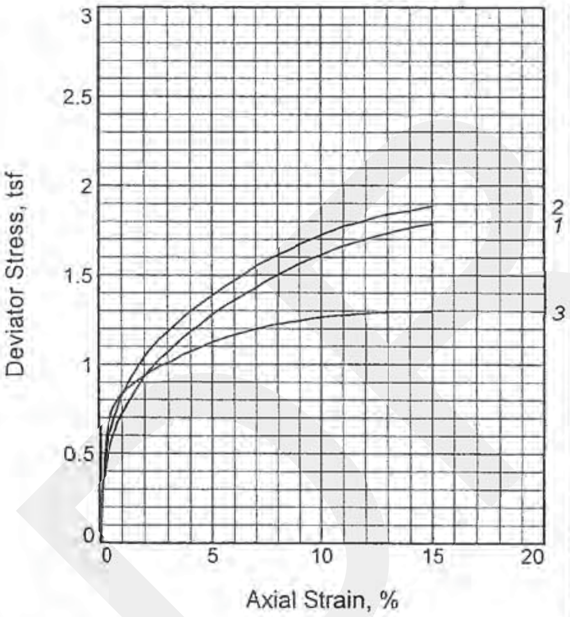
Sample Number: B-101

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.

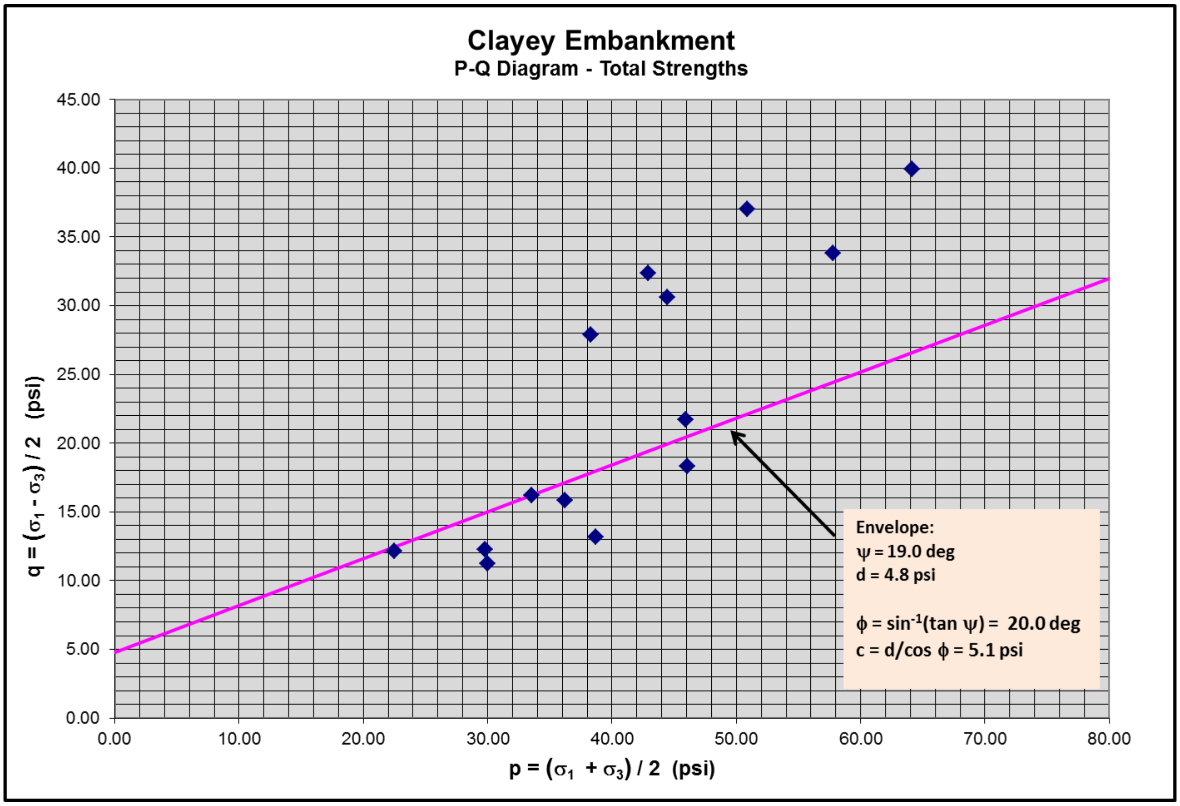
Idriss, I. M., and Boulanger, R. W. (2008). Soil Liquefaction During Earthquakes. Earthquake Engineering Research Institute, Oakland, California, USA.

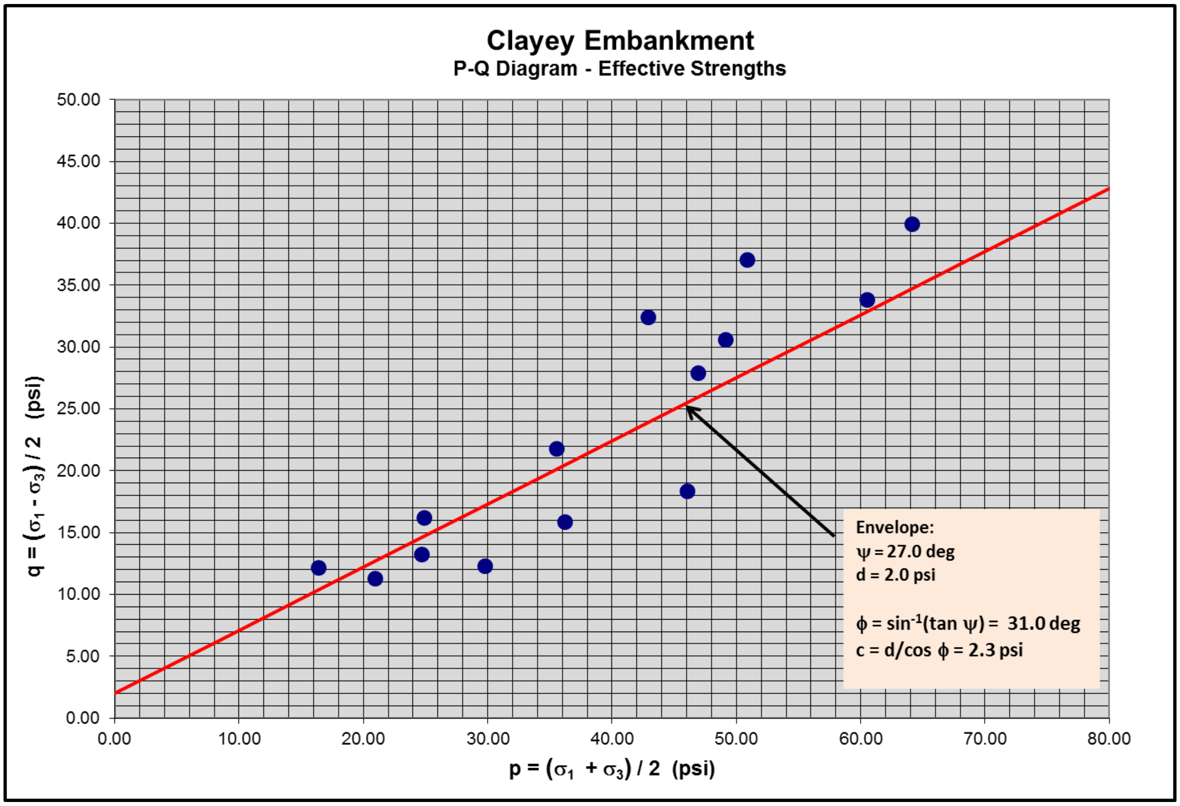
U.S. Army Corps of Engineers [USACE]. (2003). Engineer Manual, EM-1110-2-1902, Slope Stability.

7. Attachments

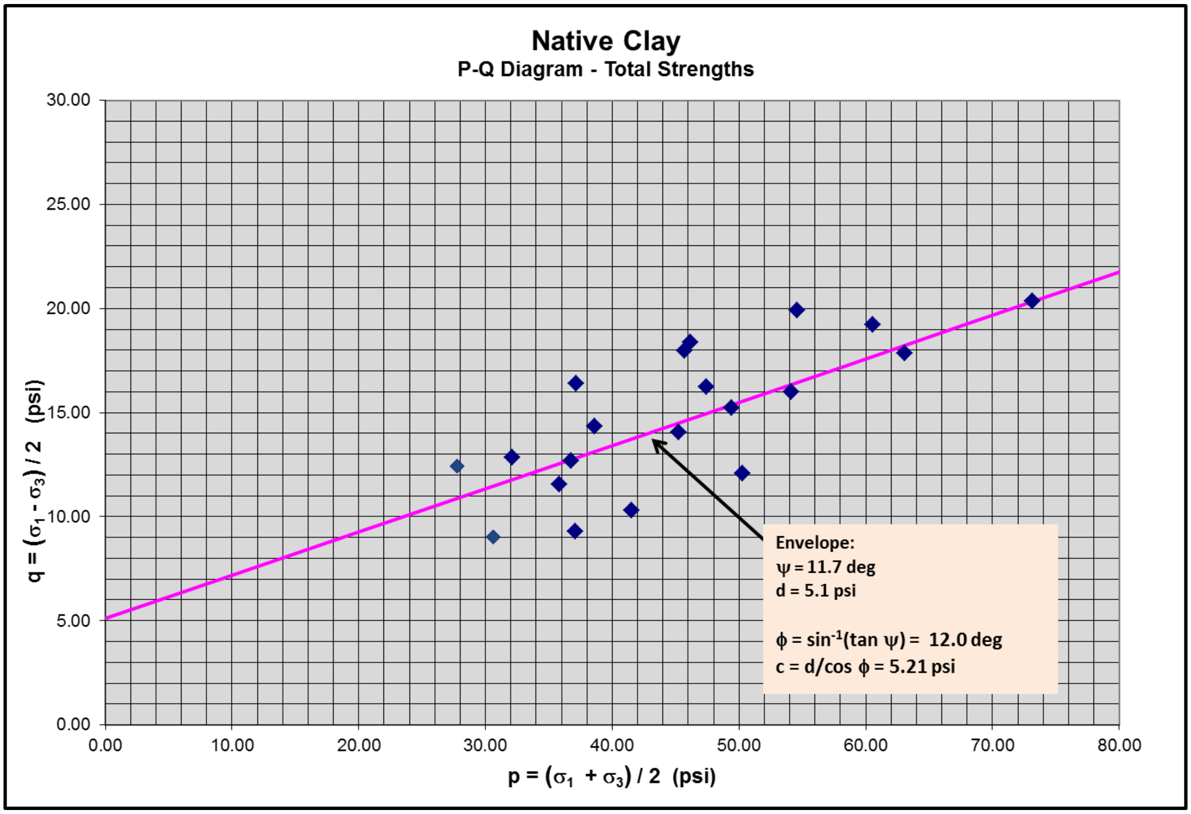
E.1 Material Characterization Plot – Embankment Fill
E.2 Material Characterization Plot – Native Clay

E.1 – Material Characterization Plots – Clayey Embankment





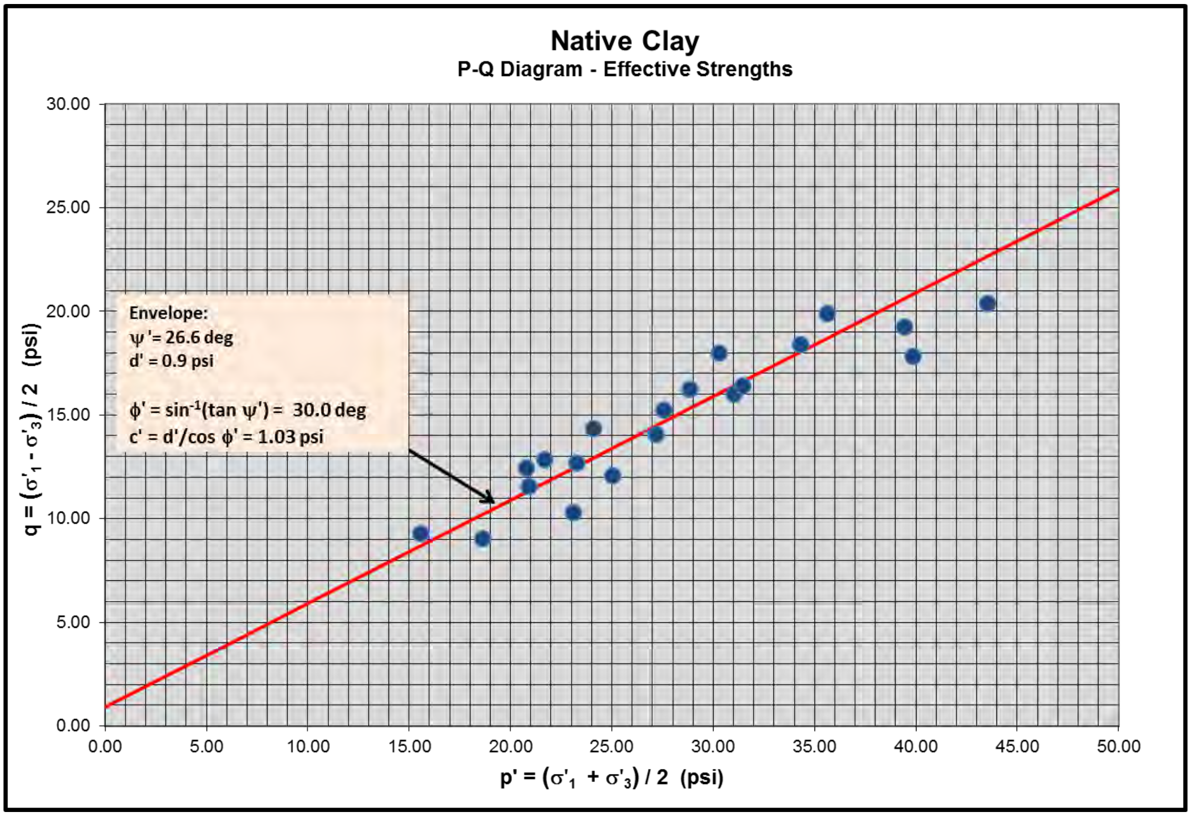
E.2 – Material Characterization Plots – Native Clay


Native Clay

P-Q Diagram - Total Strengths

Envelope:
$\psi = 11.7$ deg
$d = 5.1$ psi

$\phi = \sin^{-1}(\tan \psi) = 12.0$ deg
$c = d/\cos \phi = 5.21$ psi


Native Clay

P-Q Diagram - Effective Strengths

Envelope:
$\psi' = 26.6$ deg
$d' = 0.9$ psi

$\phi' = \sin^{-1}(\tan \psi') = 30.0$ deg
$c' = d'/\cos \phi' = 1.03$ psi

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.

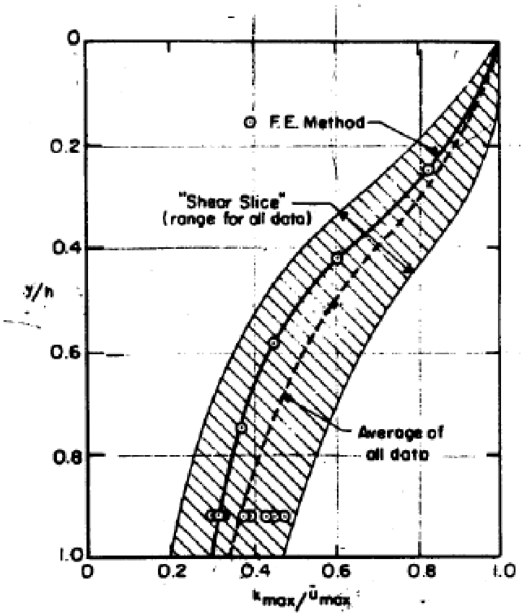
- **Static, Maximum Surcharge Pool Condition:** This case models the conditions under short-term surcharge pool conditions. Undrained (total stress) shear strength parameters were used for fine-grained materials, due to the short-term nature of the surcharge pool duration. The Impounded Ash level of 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.



VARIATION OF "MAXIMUM ACCELERATION RATIO" WITH DEPTH OF SLIDING MASS

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

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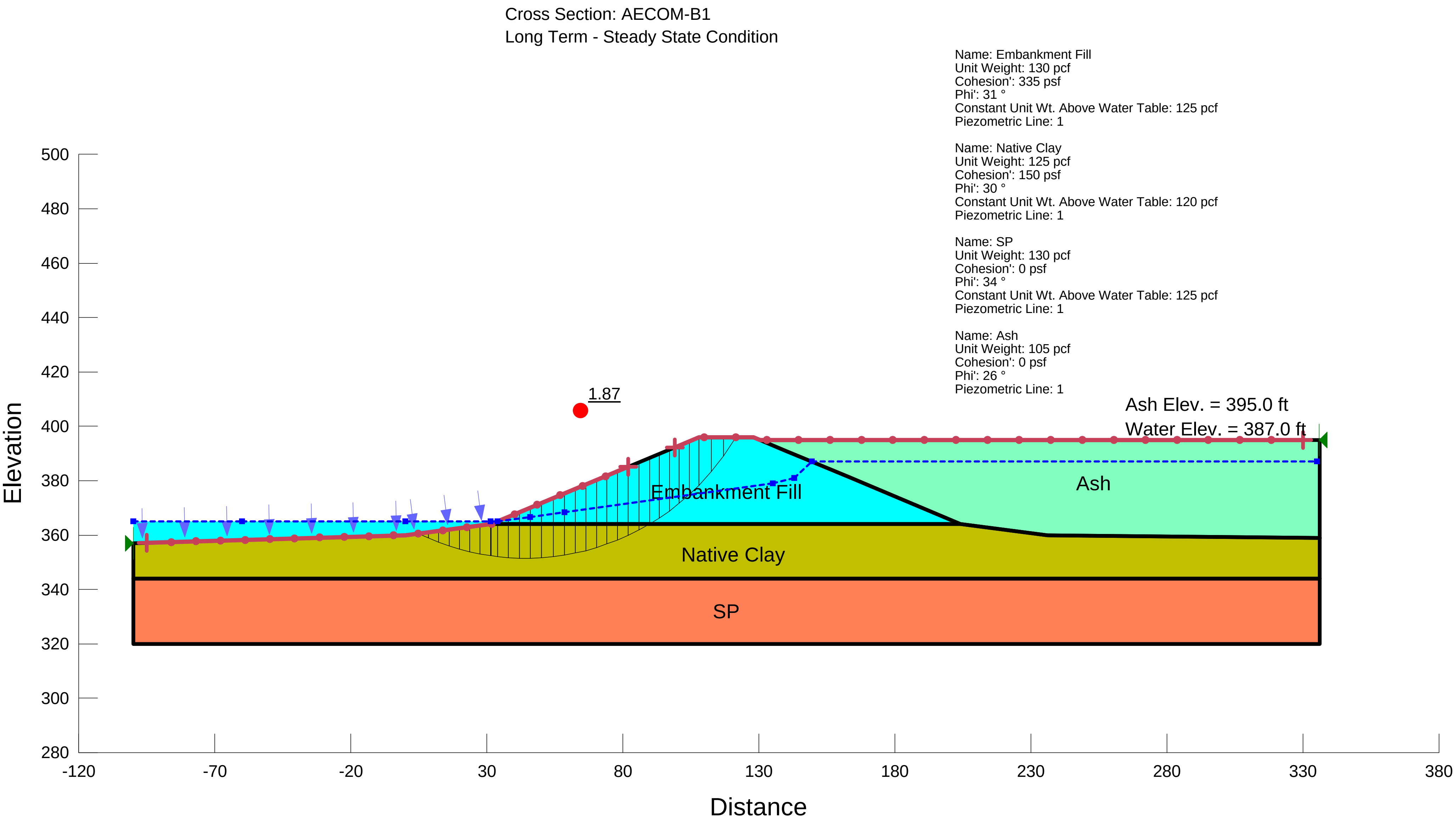
9. Attachments

F.1	Slope Stability Analysis Output Data
F.2	Seismic Parameter Calculations



Cross Section: AECOM-B1
Long Term - Steady State Condition

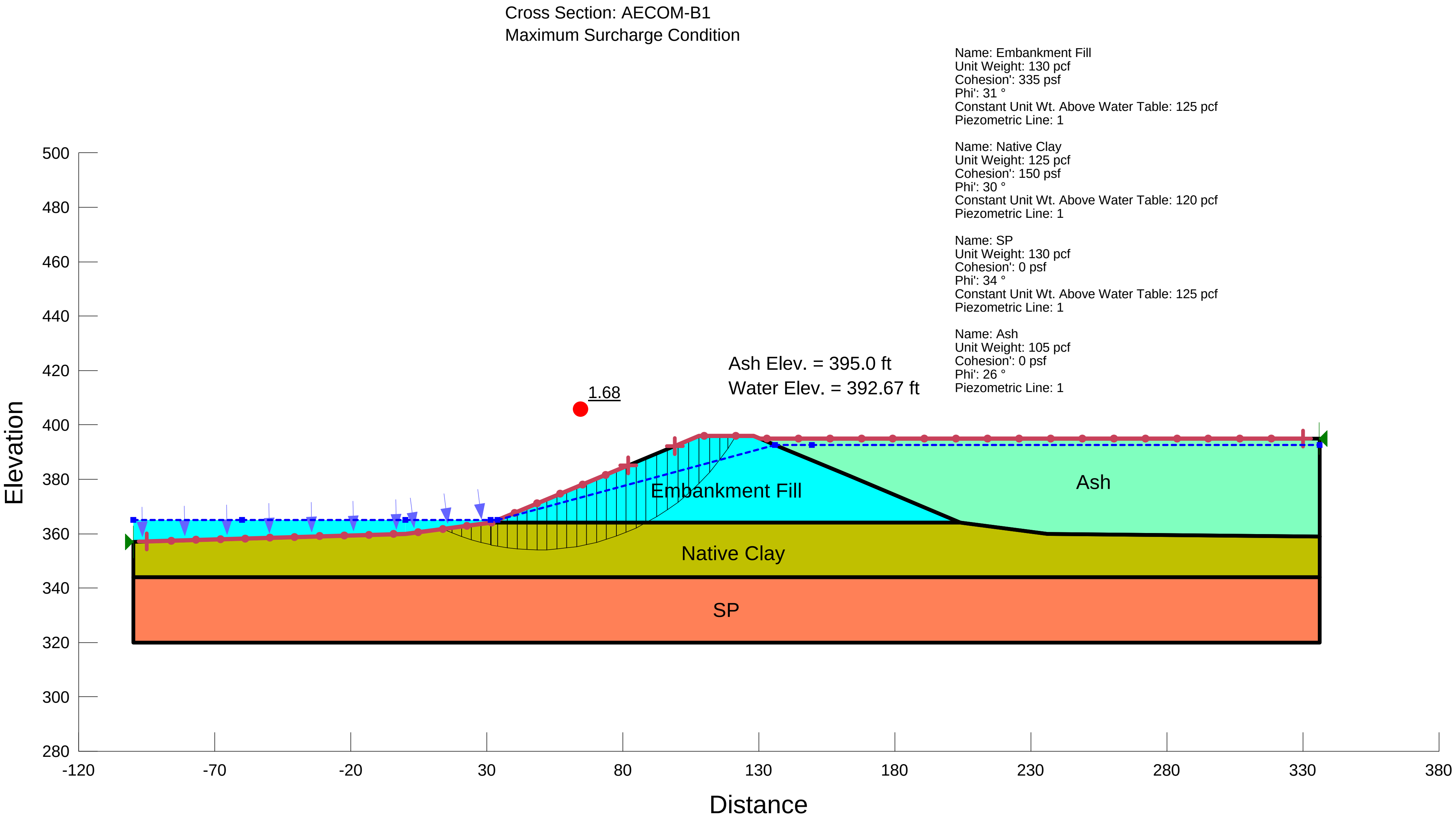
Name: Embankment Fill
Unit Weight: 130 pcf
Cohesion': 335 psf
Phi': 31 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1

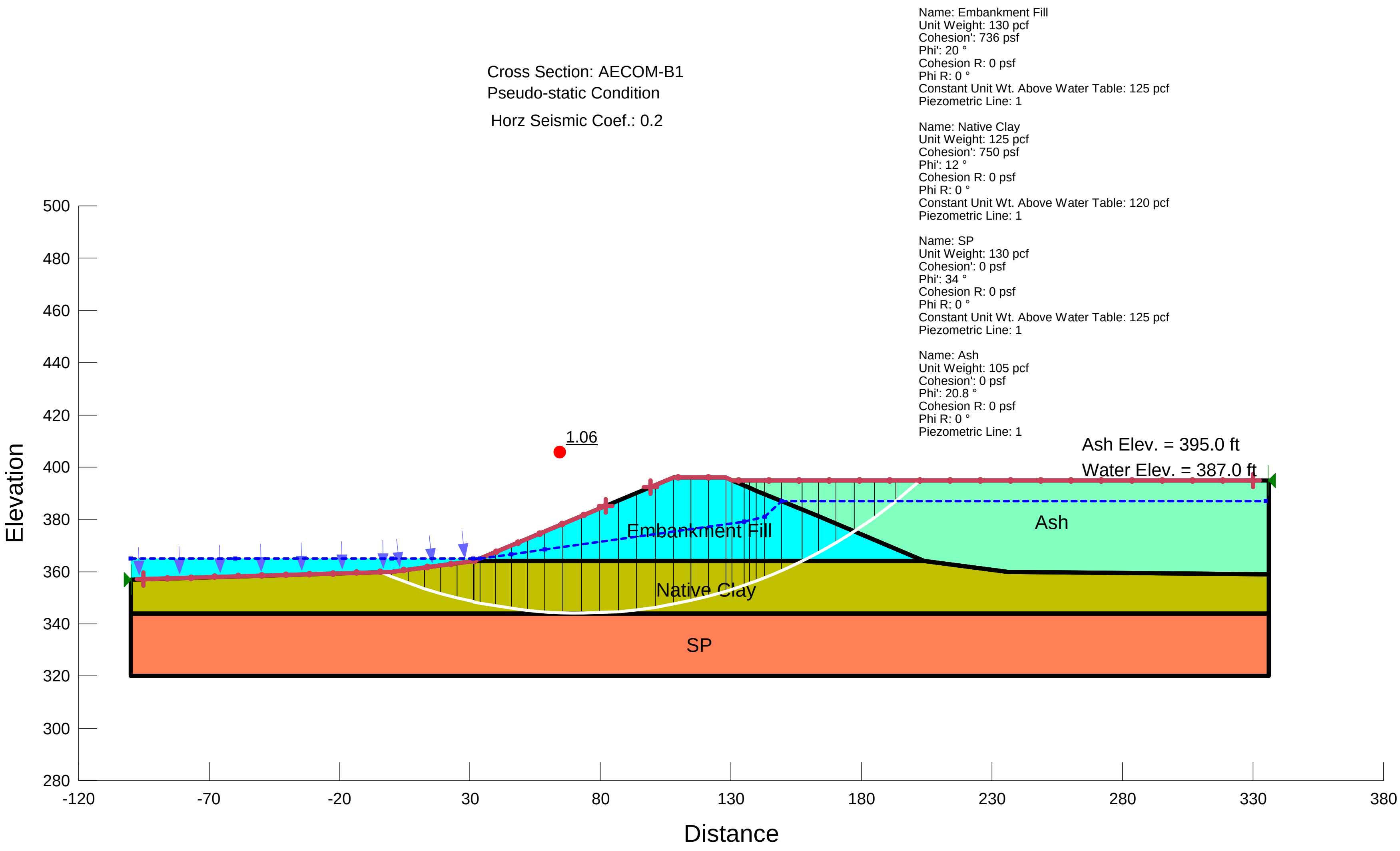
Name: Native Clay
Unit Weight: 125 pcf
Cohesion': 150 psf
Phi': 30 °
Constant Unit Wt. Above Water Table: 120 pcf
Piezometric Line: 1

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

Ash Elev. = 395.0 ft
Water Elev. = 387.0 ft


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

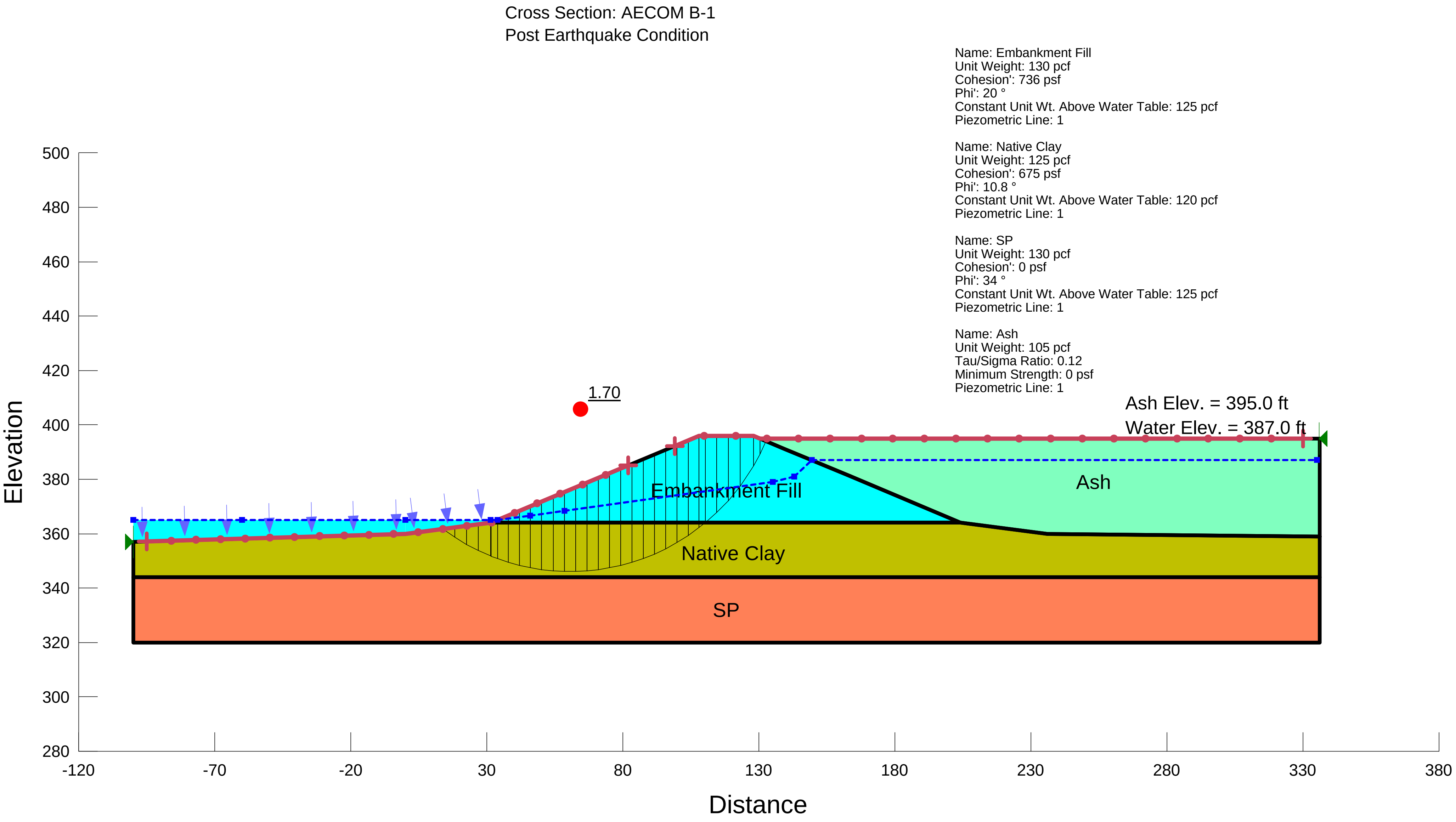
Name: Embankment Fill
Unit Weight: 130 pcf
Cohesion': 736 psf
Phi': 20 °
Cohesion R: 0 psf
Phi R: 0 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1

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

Ash Elev. = 395.0 ft
Water Elev. = 387.0 ft



Cross Section: AECOM B-1
Post Earthquake Condition

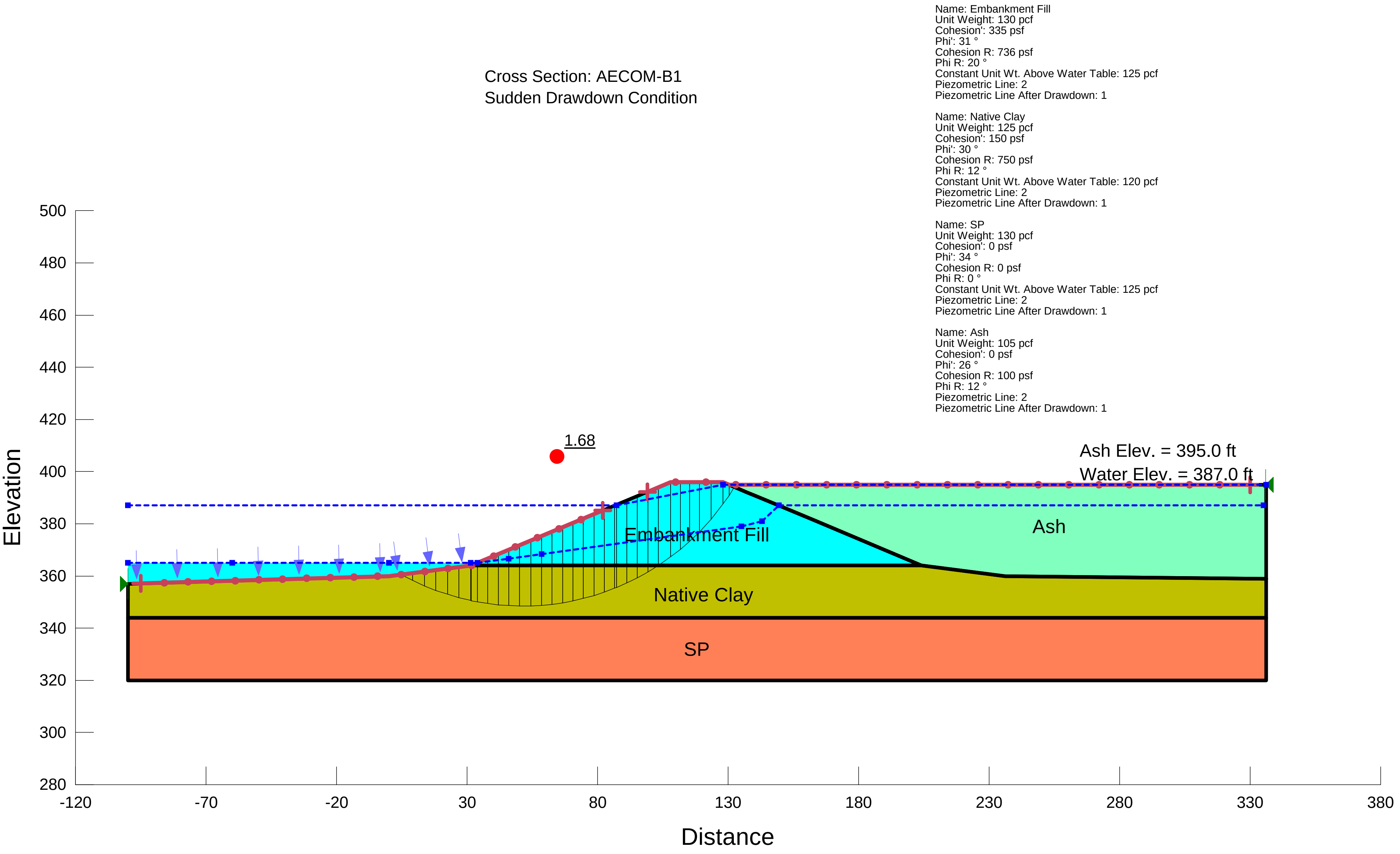
Name: Embankment Fill
Unit Weight: 130 pcf
Cohesion': 736 psf
Phi': 20 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1

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

Ash Elev. = 395.0 ft
Water Elev. = 387.0 ft



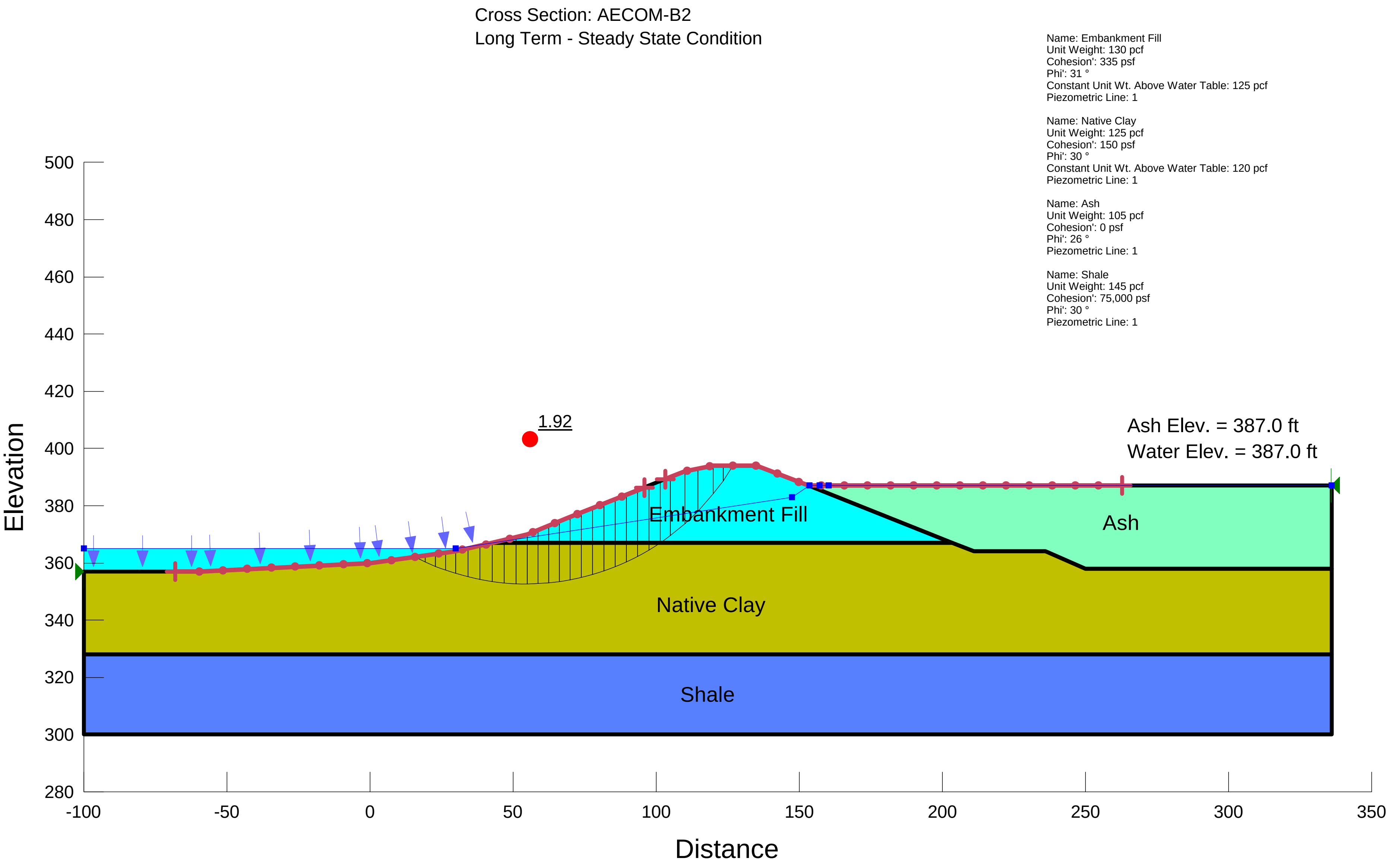
Cross Section: AECOM-B1
Sudden Drawdown Condition

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



Cross Section: AECOM-B2
Long Term - Steady State Condition

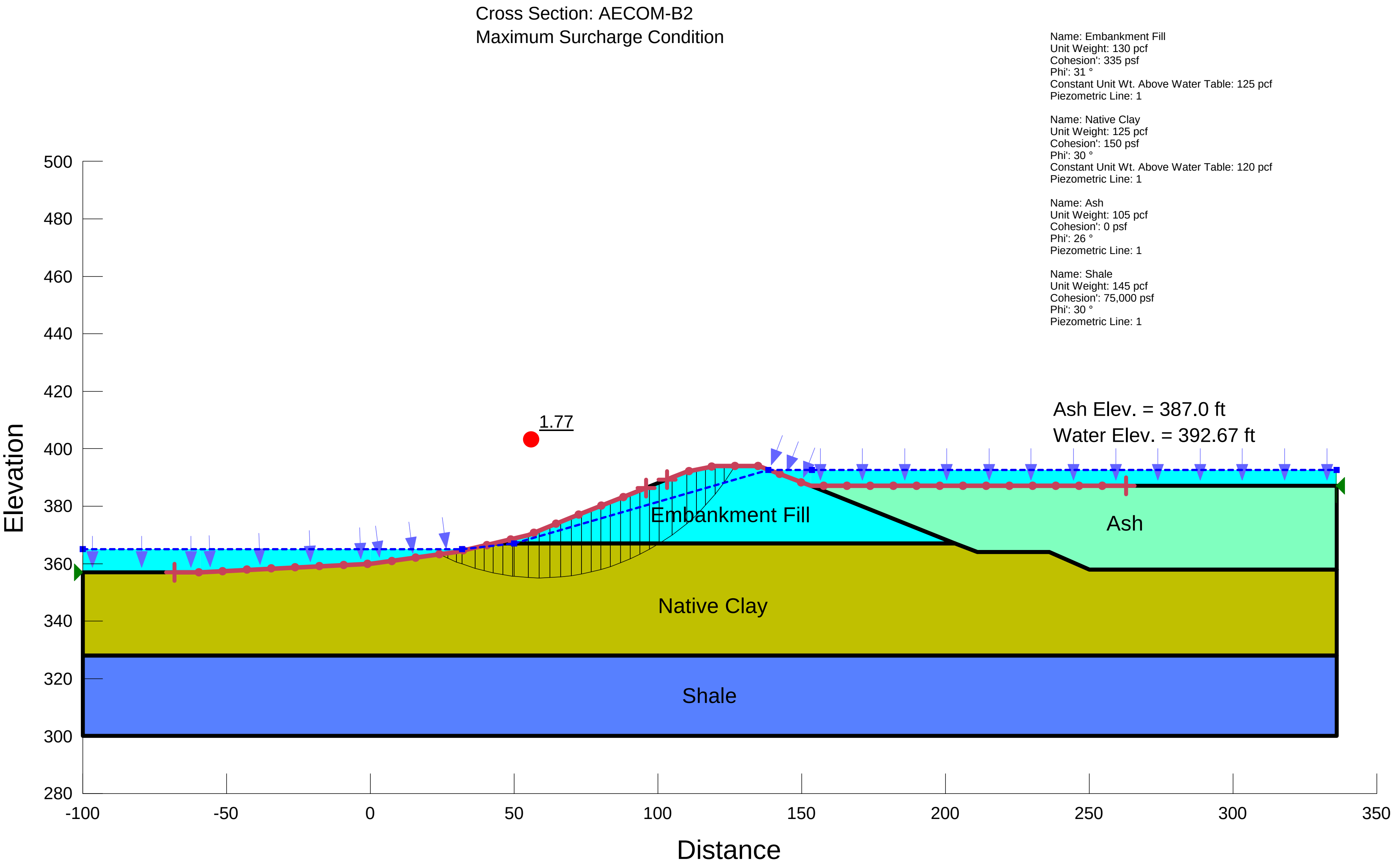
Name: Embankment Fill
Unit Weight: 130 pcf
Cohesion': 335 psf
Phi': 31 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1

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

Ash Elev. = 387.0 ft
Water Elev. = 387.0 ft



Cross Section: AECOM-B2
Maximum Surcharge Condition

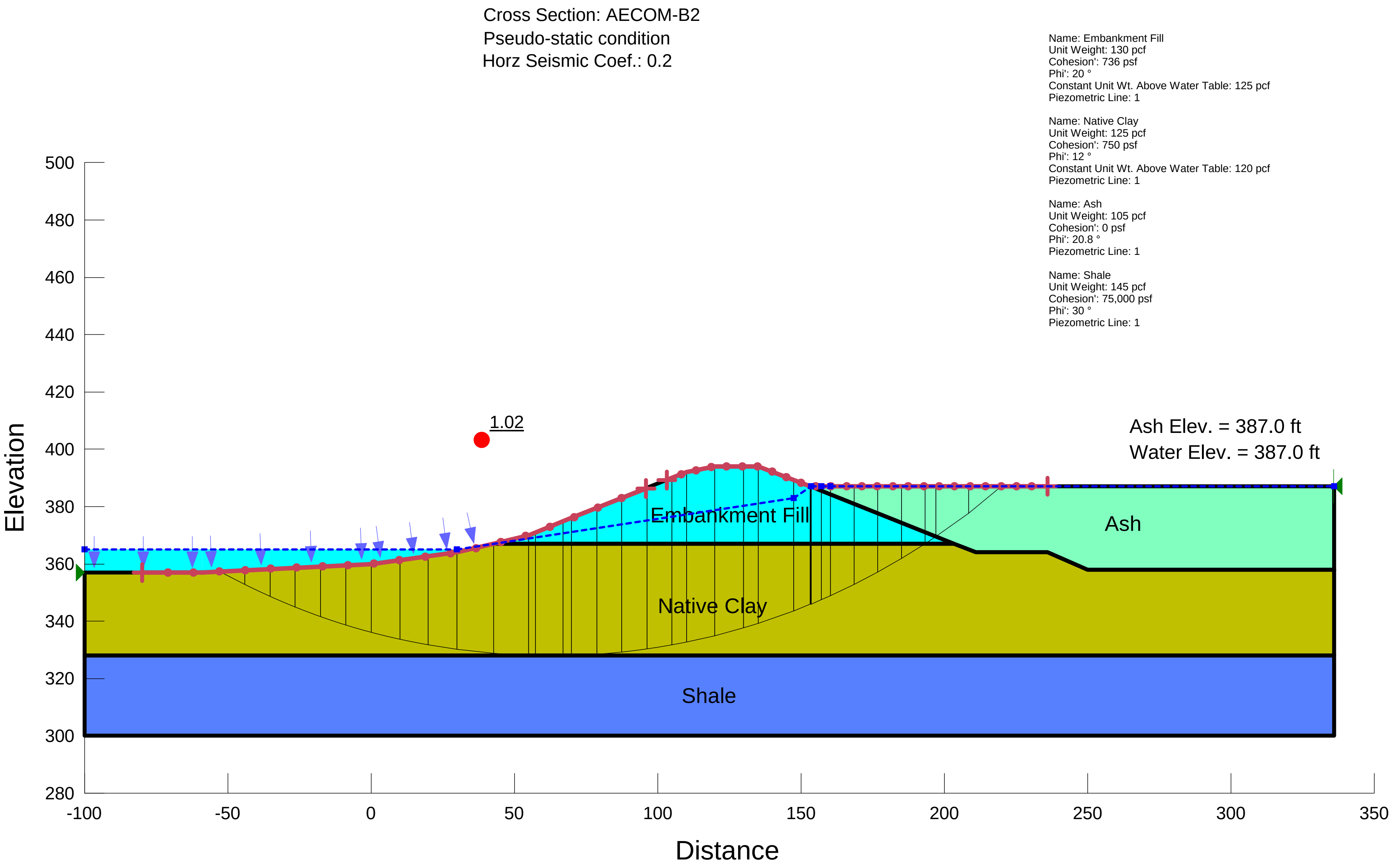
Name: Embankment Fill
Unit Weight: 130 pcf
Cohesion': 335 psf
Phi': 31 °
Constant Unit Wt. Above Water Table: 125 pcf
Piezometric Line: 1

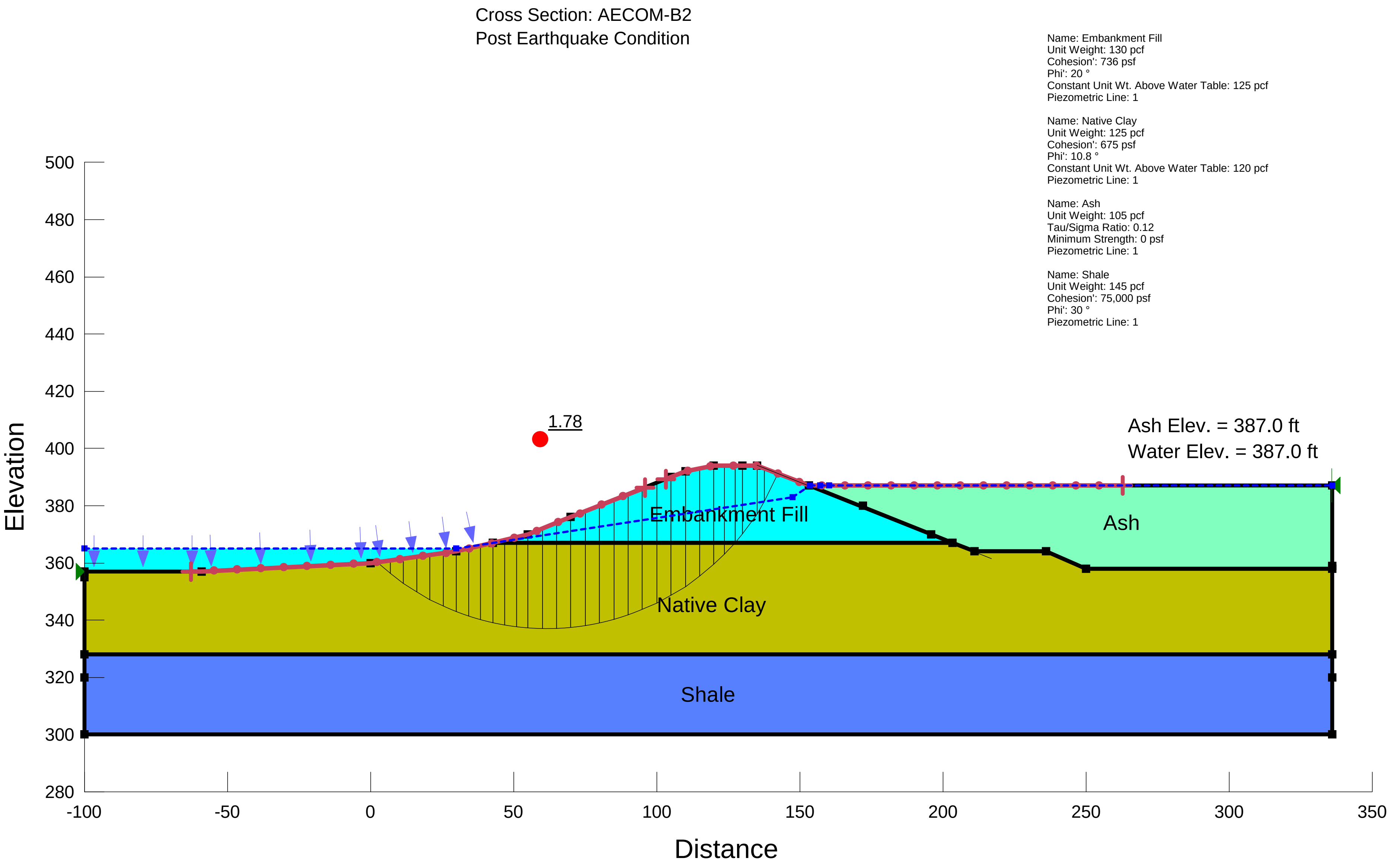
Name: Native Clay
Unit Weight: 125 pcf
Cohesion': 150 psf
Phi': 30 °
Constant Unit Wt. Above Water Table: 120 pcf
Piezometric Line: 1

Name: Ash
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 26 °
Piezometric Line: 1

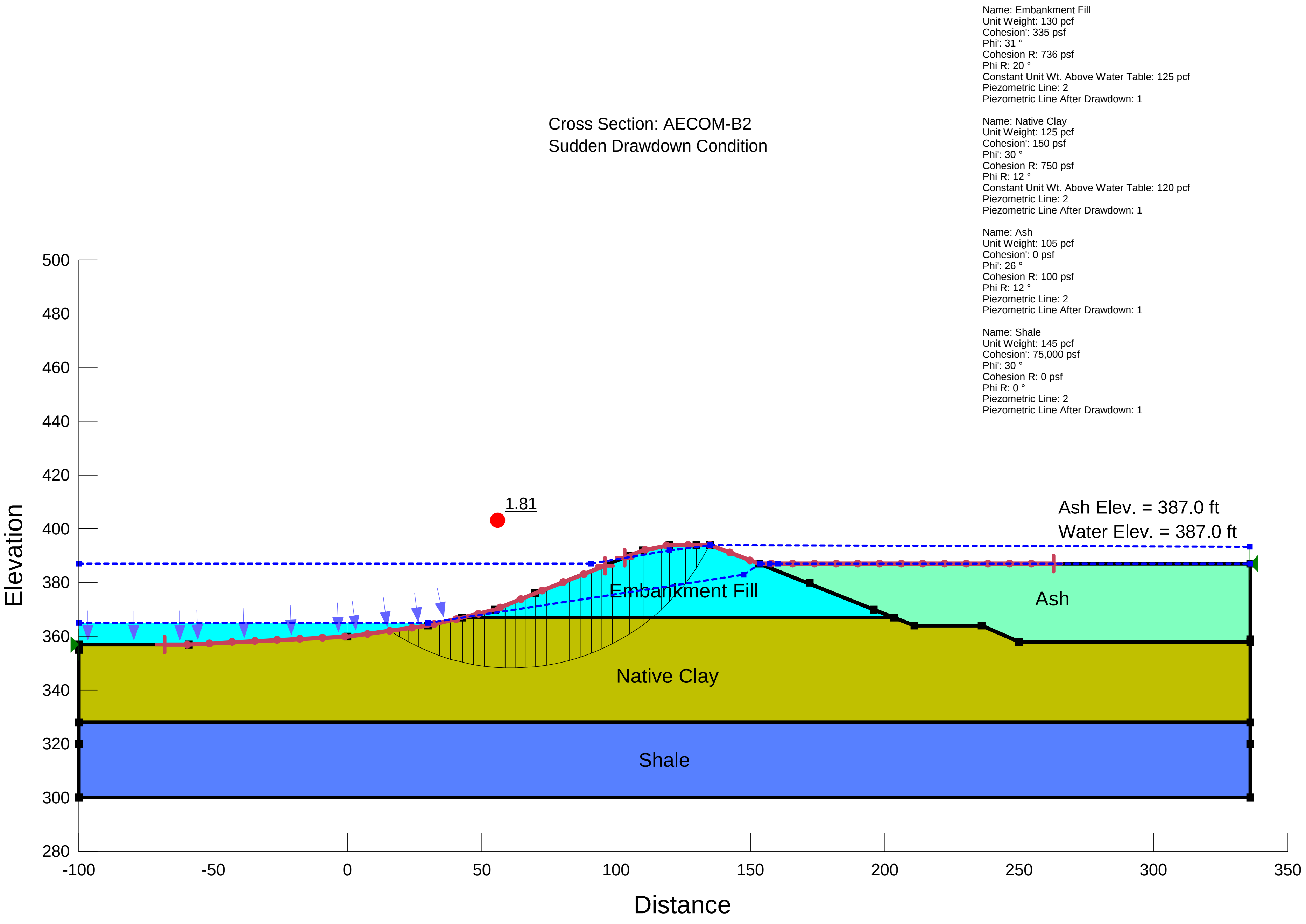
Name: Shale
Unit Weight: 145 pcf
Cohesion': 75,000 psf
Phi': 30 °
Piezometric Line: 1

Ash Elev. = 387.0 ft
Water Elev. = 392.67 ft


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



Cross Section: AECOM-B2
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: 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

Ash Elev. = 387.0 ft
Water Elev. = 387.0 ft

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

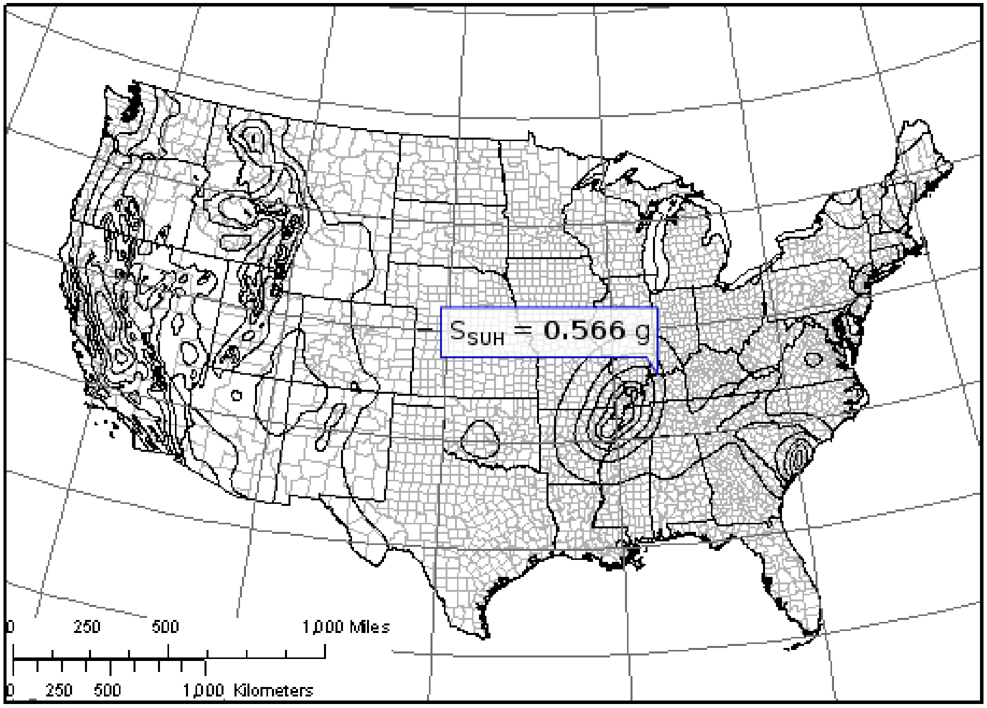
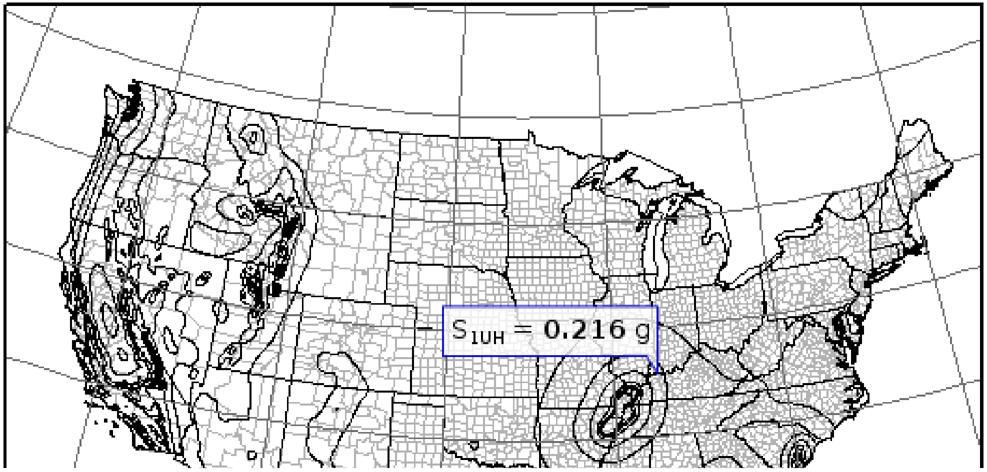


Figure 22–2: Uniform–Hazard (2% in 50–Year) Ground Motions of 1.0-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B



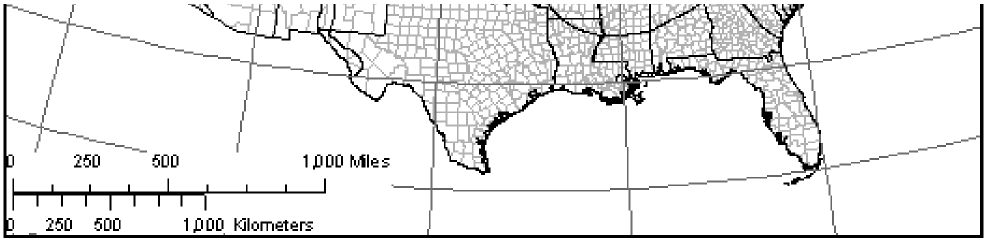

0
250
500
1,000 Miles
0
250
500
1,000 Kilometers

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

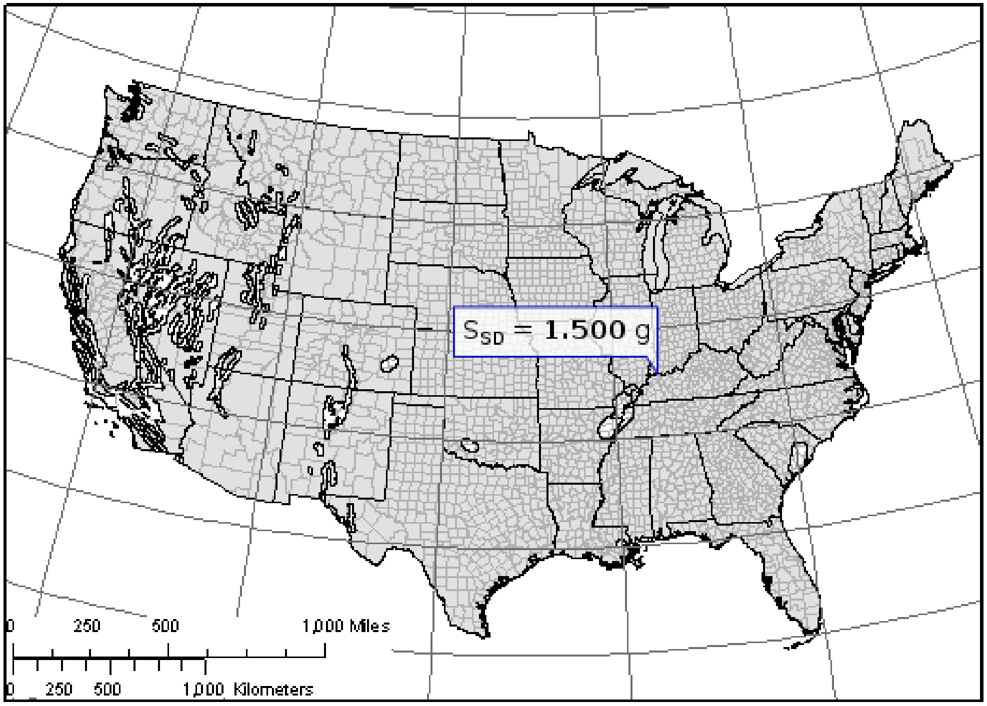
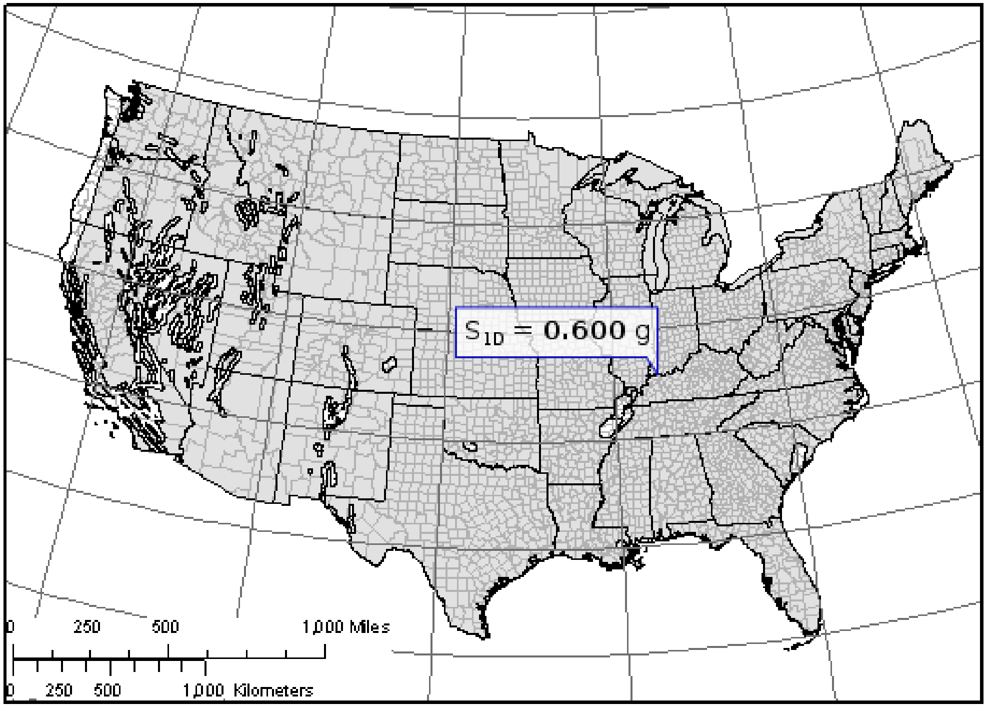


Figure 22–6: Deterministic Ground Motions of 1.0-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B



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				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
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				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
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): $S_{MS} = F_aS_S = 1.402 \text{ x } 0.498 = 0.698$ g

Equation (11.4–6): $S_{M1} = F_vS_1 = 2.067 \text{ x } 0.183 = 0.379$ g

Section 11.4.4 — Design Spectral Acceleration Parameters

Equation (11.4–7): $S_{DS} = ⅔ S_{MS} = ⅔ \text{ x } 0.698 = 0.465$ g

Equation (11.4–8): $S_{D1} = ⅔ S_{M1} = ⅔ \text{ x } 0.379 = 0.252$ g

Section 11.4.5 — Design Response Spectrum

Figure 22–7: Long–period Transition Period, T_L (s)

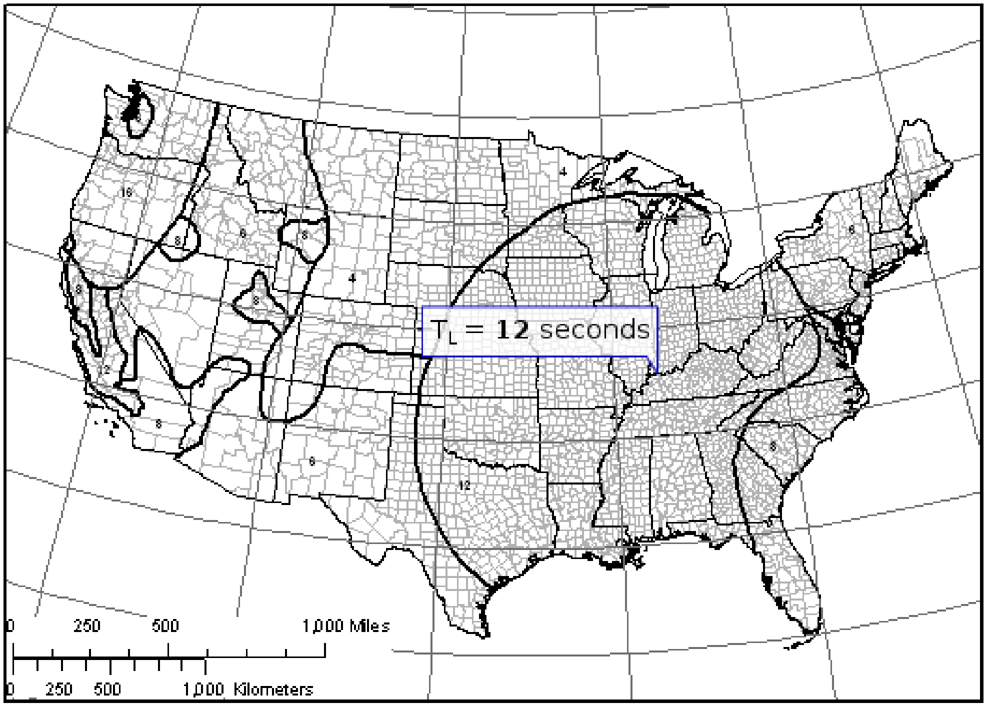
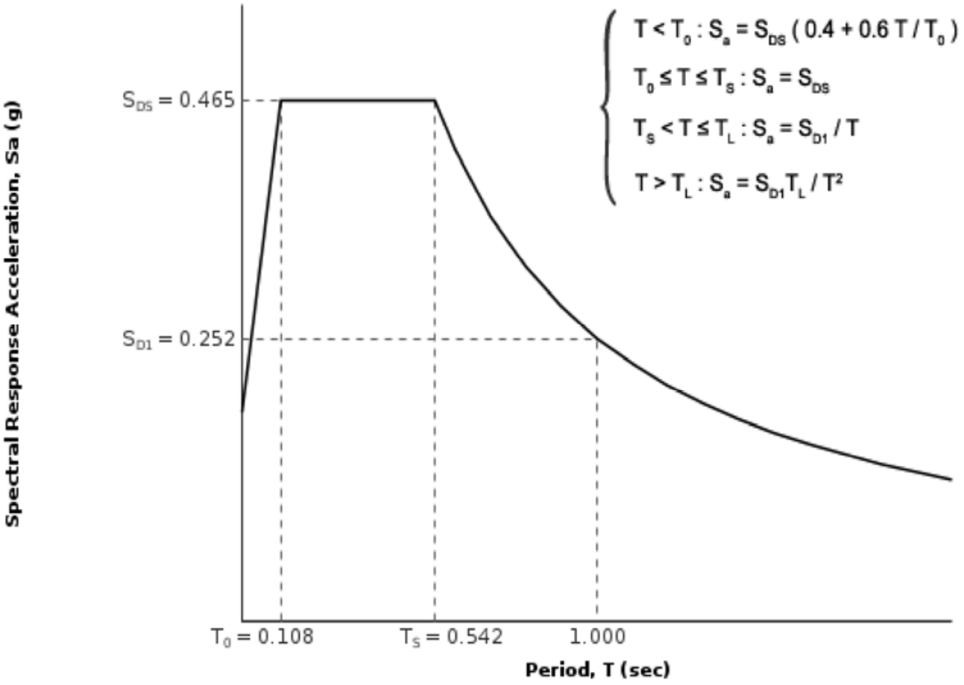
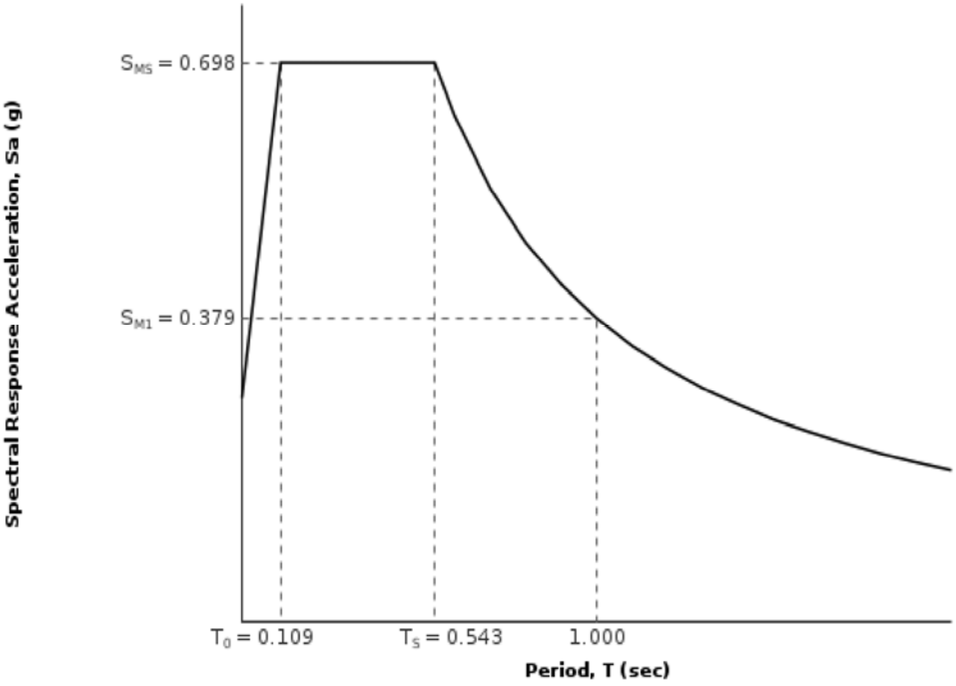


Figure 11.4–1: Design Response Spectrum



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

Patricia Thomas, Melanie Walling, Mark Dober, and Ivan Wong
Seismic Hazards Group
AECOM
1333 Broadway, Suite 800
Oakland, CA 94612

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Tables

Figures

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:

$$p(Z > z) = 1\text{-}e^{-\nu(z)\bullet t} \qquad (2\text{-}1)$$

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:

$$\dot{M}_o = \mu\, A\, S \qquad (2\text{-}6)$$

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):

$$\mathbf{M} = 2/3 \log M_o - 10.7 \qquad (2\text{-}7)$$

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):

$\mathbf{M} = -0.39 + 0.98\text{Mn}$ for magnitudes ≤ 5.5

$\mathbf{M} = 2.715 - 0.277\text{Mn} + 0.127(\text{Mn}^2)$ 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

<table>
<tr><th>Cluster?</th><th>wt</th><th>Localizing Structures</th><th>Southern Fault Geometry</th><th>wt</th><th>Northern Fault Geometry</th><th>wt</th><th>Central Fault Geometry</th><th>wt</th><th>Thickness (km)</th><th>wt</th><th>Mmax</th><th>wt</th><th>Recurrence method</th><th>wt</th><th>Recurrence Data</th><th>wt</th><th>Earthquake Recurrence Model</th><th>wt</th><th>Repeat Time Coefficient of Variation</th><th>wt</th><th>Rate (yrs)</th><th>wt</th></tr>
<tr><td rowspan="20">All In</td><td rowspan="20">0.9</td><td rowspan="20">NMS
NMN
RFT</td><td rowspan="14">BA-BL</td><td rowspan="14">0.6</td><td rowspan="13">NMN-S</td><td rowspan="13">0.7</td><td rowspan="12">RFT-S</td><td rowspan="12">0.7</td><td rowspan="10">13</td><td rowspan="10">0.4</td><td rowspan="5">NMS, RFT, NMN
7.9, 7.8, 7.6</td><td rowspan="5">0.167</td><td rowspan="5">Intervals</td><td rowspan="5">1.0</td><td rowspan="5">1811-1812, 1450, and 900 AD</td><td rowspan="5">1.0</td><td rowspan="5">Poisson</td><td rowspan="5">0.75</td><td rowspan="5" colspan="2">NA</td><td>167</td><td>0.101</td></tr>
<tr><td>270</td><td>0.244</td></tr>
<tr><td>417</td><td>0.310</td></tr>
<tr><td>714</td><td>0.244</td></tr>
<tr><td>1613</td><td>0.101</td></tr>
<tr><td>7.8, 7.7, 7.5</td><td>0.167</td><td rowspan="5" colspan="4">same as above</td><td rowspan="15">Renewal</td><td rowspan="15">0.25</td><td rowspan="5">0.3</td><td rowspan="5">0.2</td><td>286</td><td>0.101</td></tr>
<tr><td>7.6, 7.8, 7.5</td><td>0.25</td><td>909</td><td>0.244</td></tr>
<tr><td>7.2, 7.4, 7.2</td><td>0.085</td><td>3125</td><td>0.310</td></tr>
<tr><td>6.9, 7.3, 7.0</td><td>0.25</td><td>15625</td><td>0.244</td></tr>
<tr><td>6.7, 7.1, 6.8</td><td>0.085</td><td>212766</td><td>0.101</td></tr>
<tr><td>15</td><td>0.4</td><td rowspan="2" colspan="6">same as above</td><td rowspan="5">0.5</td><td rowspan="5">0.5</td><td>208</td><td>0.101</td></tr>
<tr><td>17</td><td>0.2</td><td>455</td><td>0.244</td></tr>
<tr><td>RFT-L</td><td>0.3</td><td colspan="8">same as above</td><td>1124</td><td>0.310</td></tr>
<tr><td>NMN-L</td><td>0.3</td><td colspan="10">same as above</td><td>3846</td><td>0.244</td></tr>
<tr><td rowspan="6">BA-BFZ</td><td rowspan="6">0.4</td><td rowspan="6" colspan="12">same as above</td><td>32258</td><td>0.101</td></tr>
<tr><td rowspan="5">0.7</td><td rowspan="5">0.3</td><td>227</td><td>0.101</td></tr>
<tr><td>455</td><td>0.244</td></tr>
<tr><td>1000</td><td>0.310</td></tr>
<tr><td>2941</td><td>0.244</td></tr>
<tr><td>21277</td><td>0.101</td></tr>
<tr><td rowspan="13">All out except RFT</td><td rowspan="13">0.05</td><td rowspan="13">RFT</td><td rowspan="13">NA</td><td rowspan="13"></td><td rowspan="13">NA</td><td rowspan="13"></td><td rowspan="12">RFT-S</td><td rowspan="12">0.7</td><td rowspan="10">13</td><td rowspan="10">0.4</td><td rowspan="5">7.8</td><td rowspan="5">0.167</td><td rowspan="5">Intervals</td><td rowspan="5">1.0</td><td rowspan="5">2000 BC and 1000 AD</td><td rowspan="5">1.0</td><td rowspan="5">Poisson</td><td rowspan="5">1.0</td><td rowspan="5" colspan="2">NA</td><td>769</td><td>0.101</td></tr>
<tr><td>1389</td><td>0.244</td></tr>
<tr><td>2381</td><td>0.310</td></tr>
<tr><td>4545</td><td>0.244</td></tr>
<tr><td>12500</td><td>0.101</td></tr>
<tr><td>7.7</td><td>0.167</td><td rowspan="5" colspan="10">same as above</td></tr>
<tr><td>7.8</td><td>0.25</td></tr>
<tr><td>7.4</td><td>0.085</td></tr>
<tr><td>7.3</td><td>0.25</td></tr>
<tr><td>7.1</td><td>0.085</td></tr>
<tr><td>15</td><td>0.4</td><td rowspan="2" colspan="12">same as above</td></tr>
<tr><td>17</td><td>0.2</td></tr>
<tr><td>RFT-L</td><td>0.3</td><td colspan="14">same as above</td></tr>
<tr><td>All Out</td><td>0.05</td><td>None</td><td>Revert to background</td><td colspan="19"></td></tr>
</table>

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 (5th percentile, median, and 95th 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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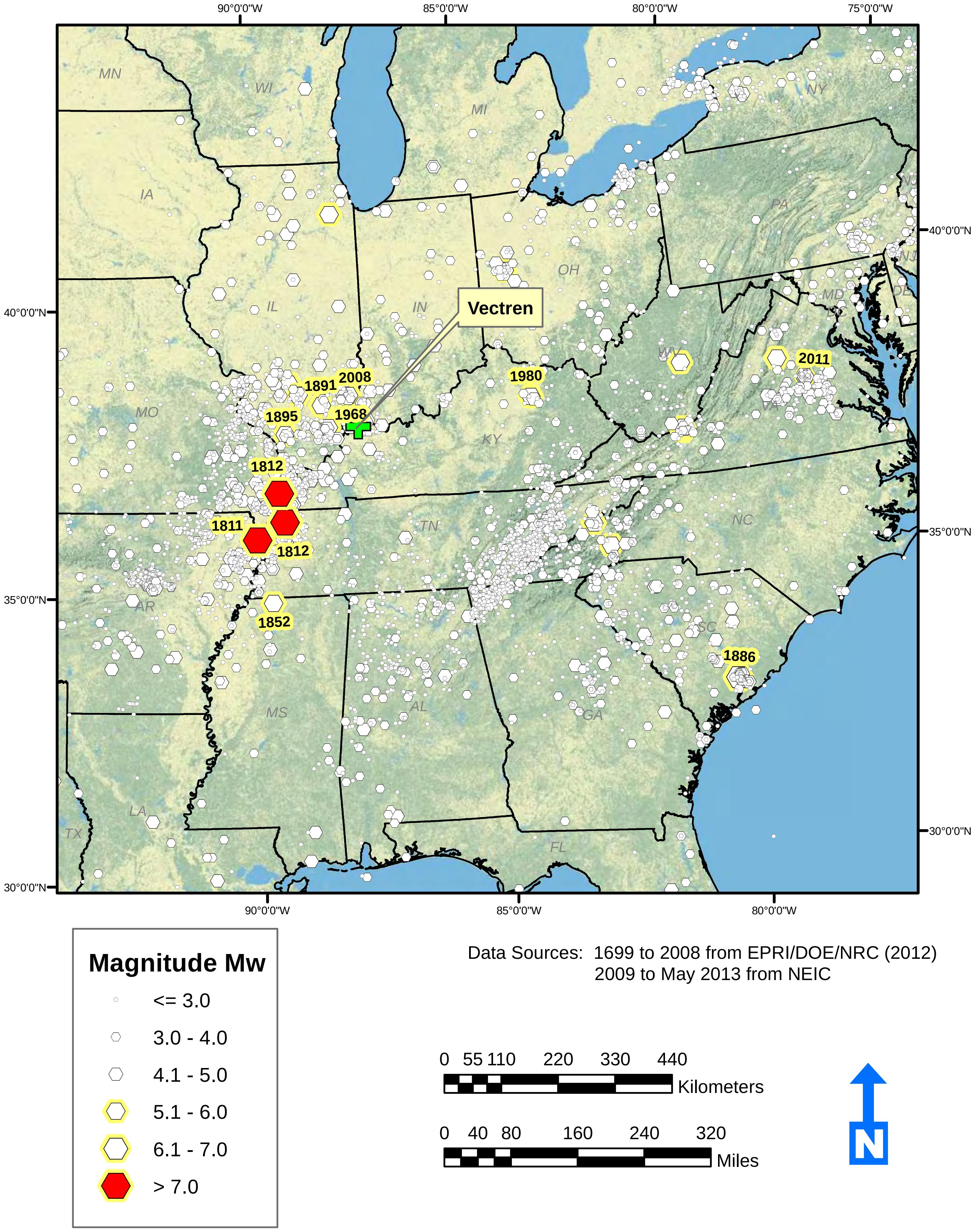
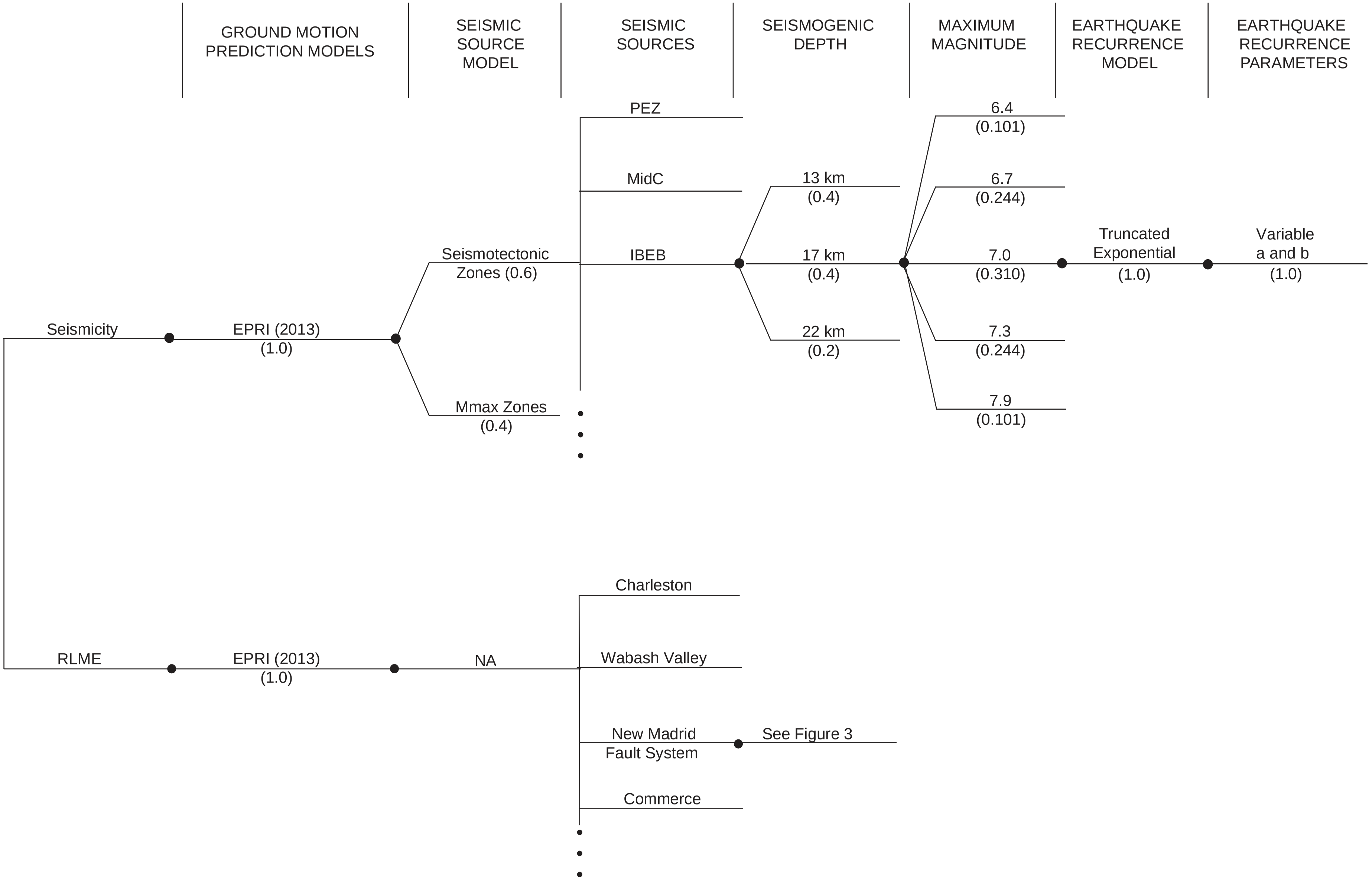


Data Sources: 1699 to 2008 from EPRI/DOE/NRC (2012)
2009 to May 2013 from NEIC

AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	HISTORICAL SEISMICITY OF CENTRAL AND EASTERN UNITED STATES (1699 - 2013)	Figure 1



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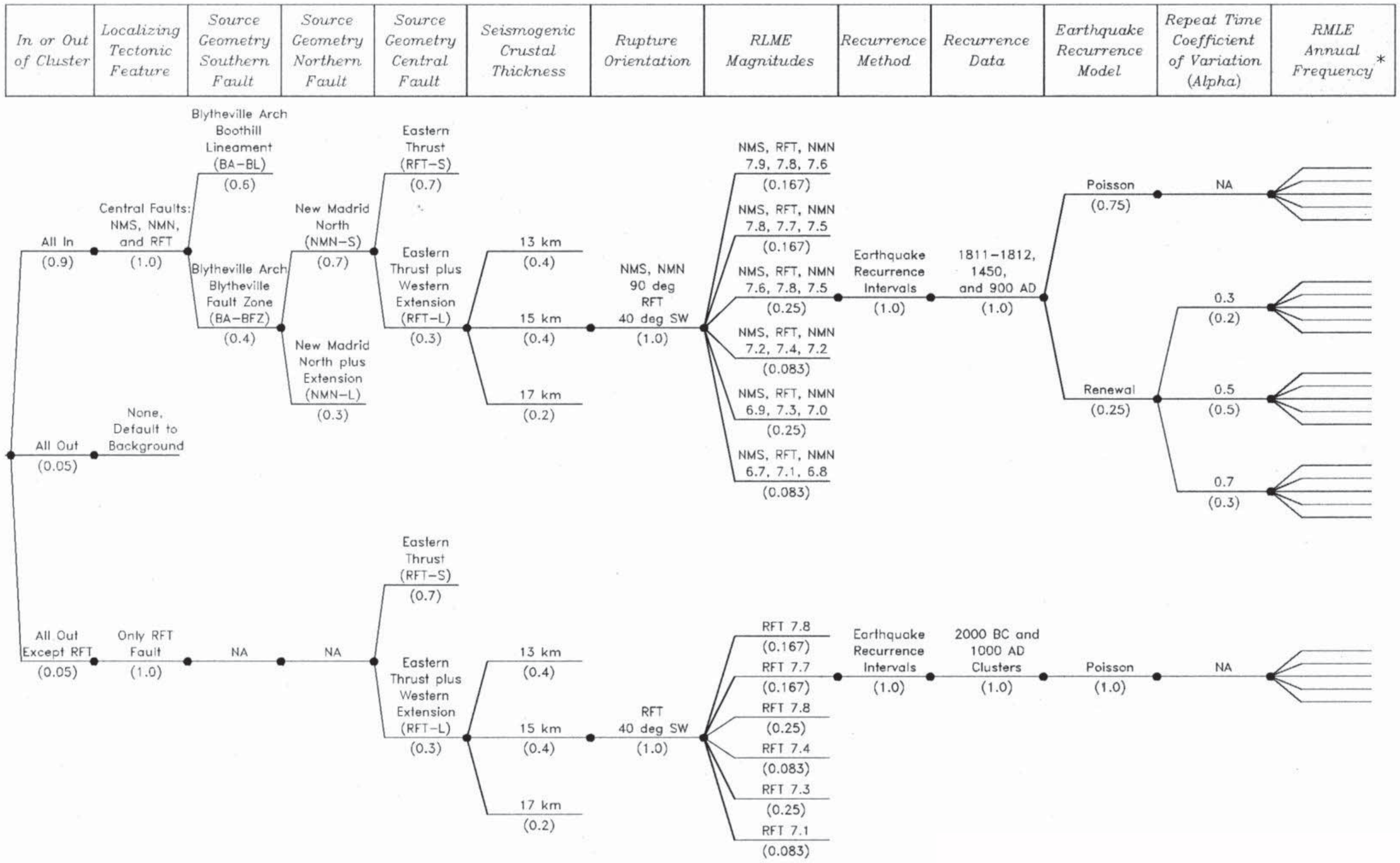
EXAMPLE SEISMIC HAZARD
MODEL LOGIC TREE

Figure
2



* See EPRI/DOE/NRC (2012)

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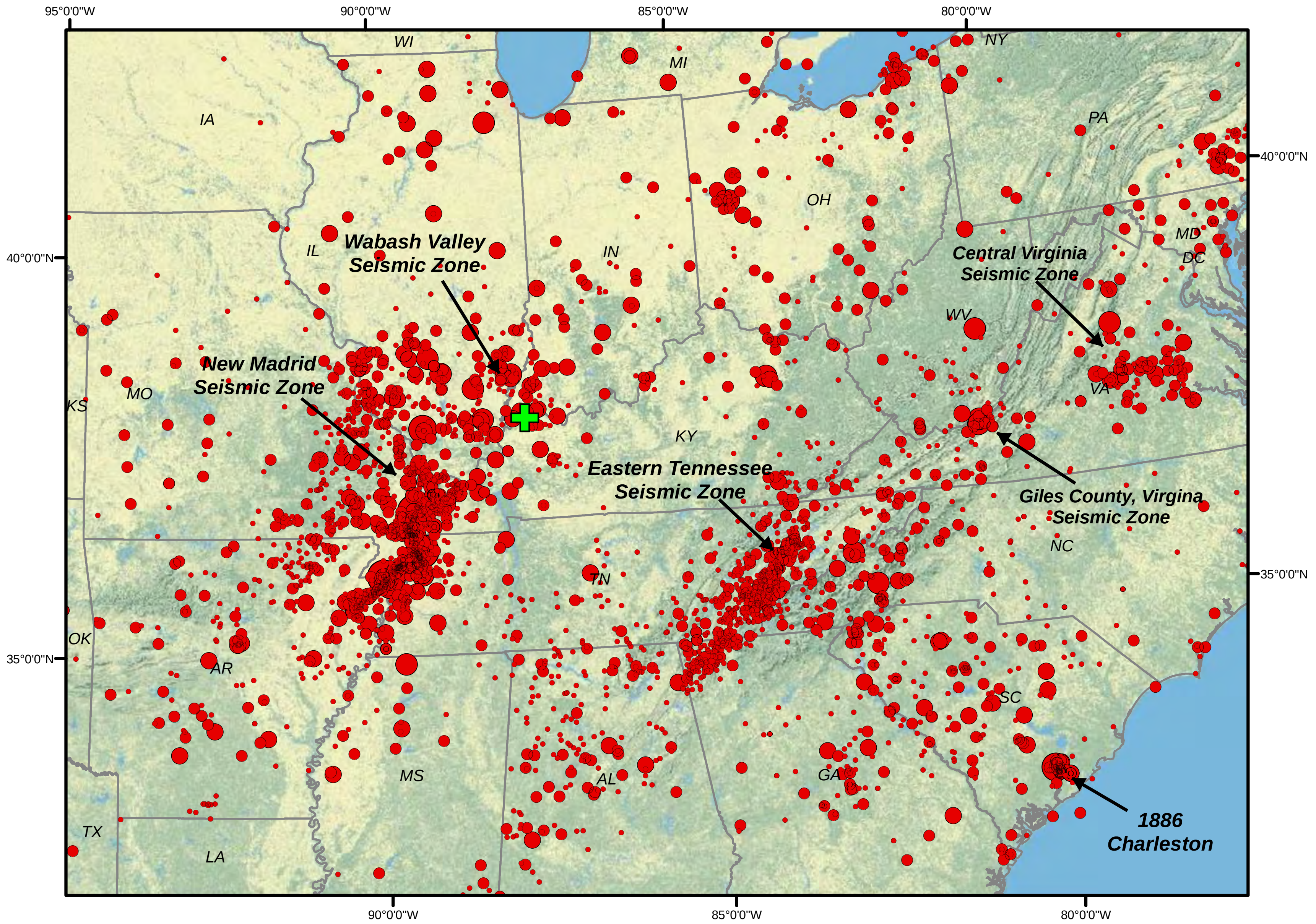
NEW MADRID RLME LOGIC TREE

Figure
3



✚	Project Site
●	Earthquake Epicenters

Seismicity from:
EPRI/DOE/NRC (2012)

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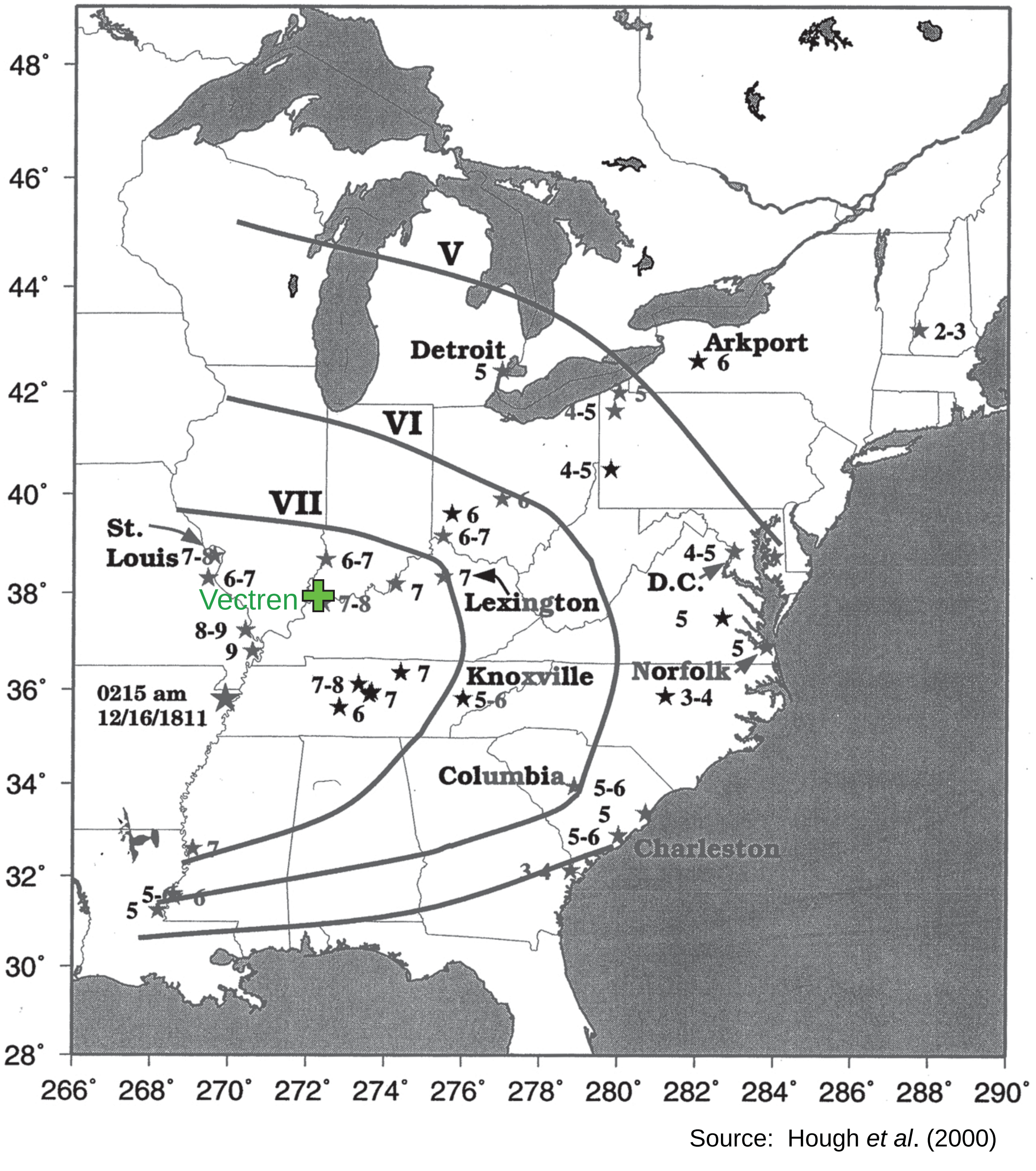
HISTORICAL SEISMICITY AND SEISMIC ZONES
IN THE CENTRAL AND EASTERN U.S.

Figure

4



Source: Hough *et al*. (2000)

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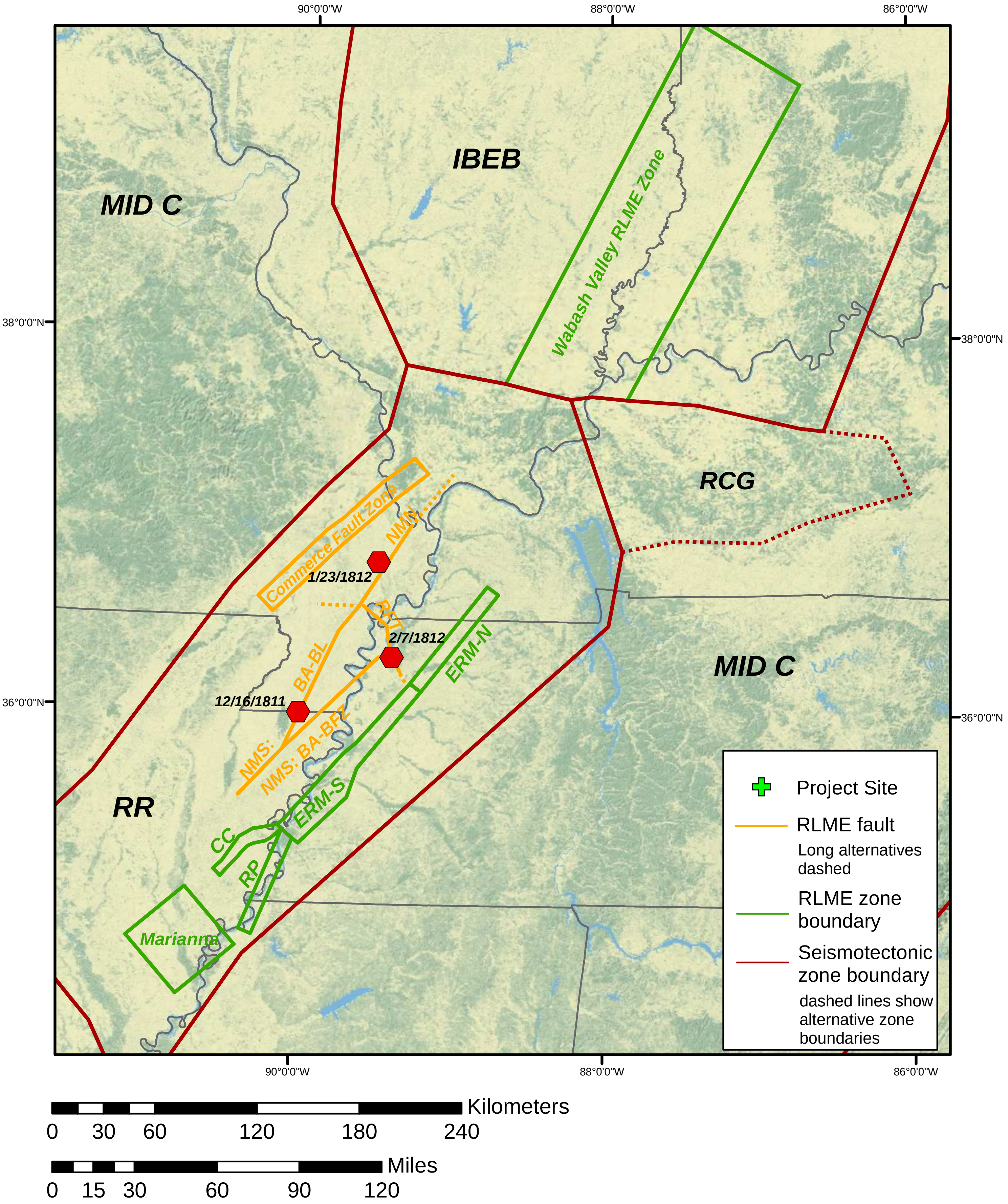
ISOSEISMAL MAP OF THE
16 DECEMBER 1811 **M** 7.2-7.3
NEW MADRID EARTHQUAKE

Figure
5



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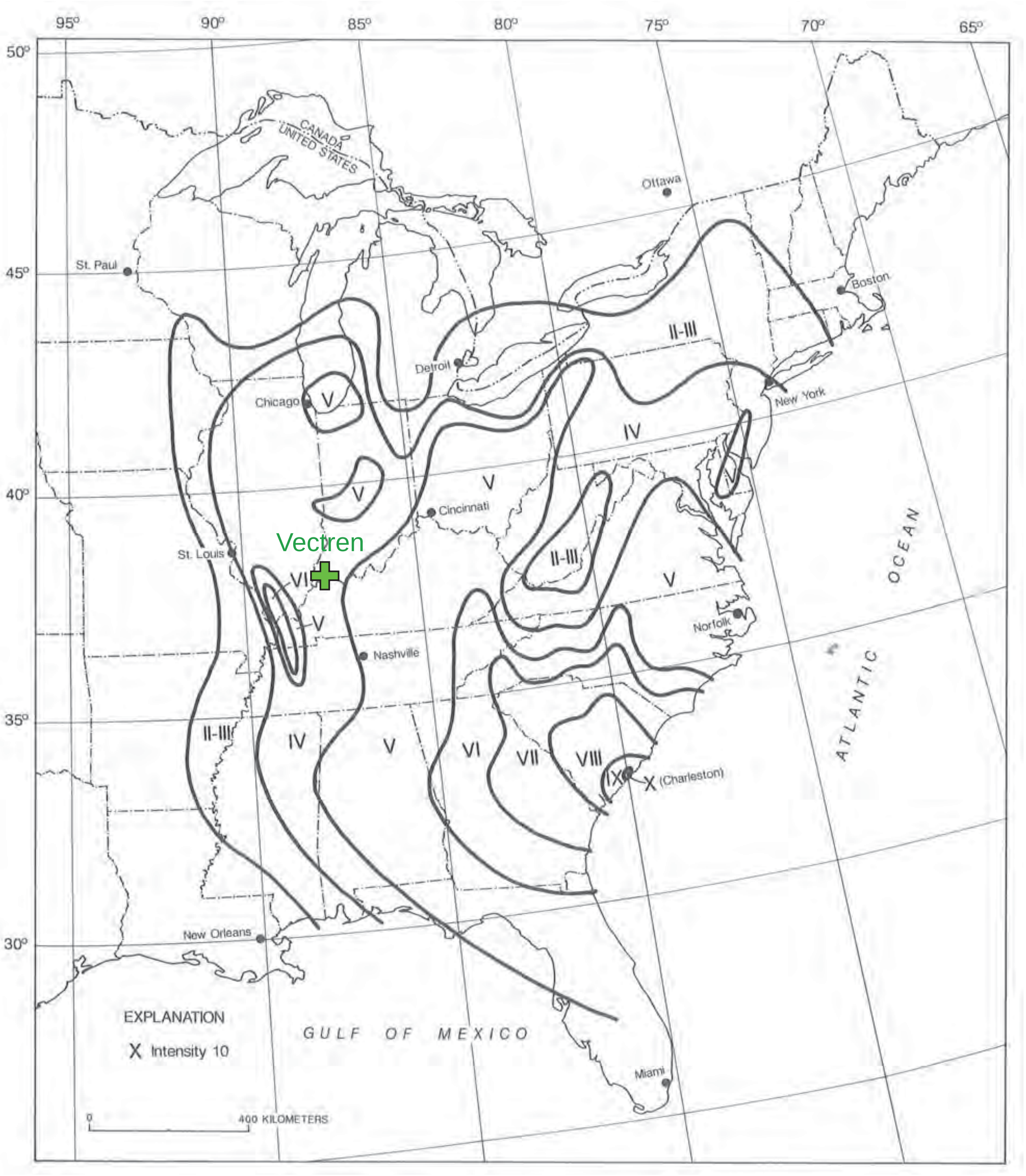
NEW MADRID FAULT SYSTEM, 1811-1812 NMFS EARTHQUAKES, AND NEIGHBORING RLMEs

Figure

6



Source: Stover and Coffman (1993)

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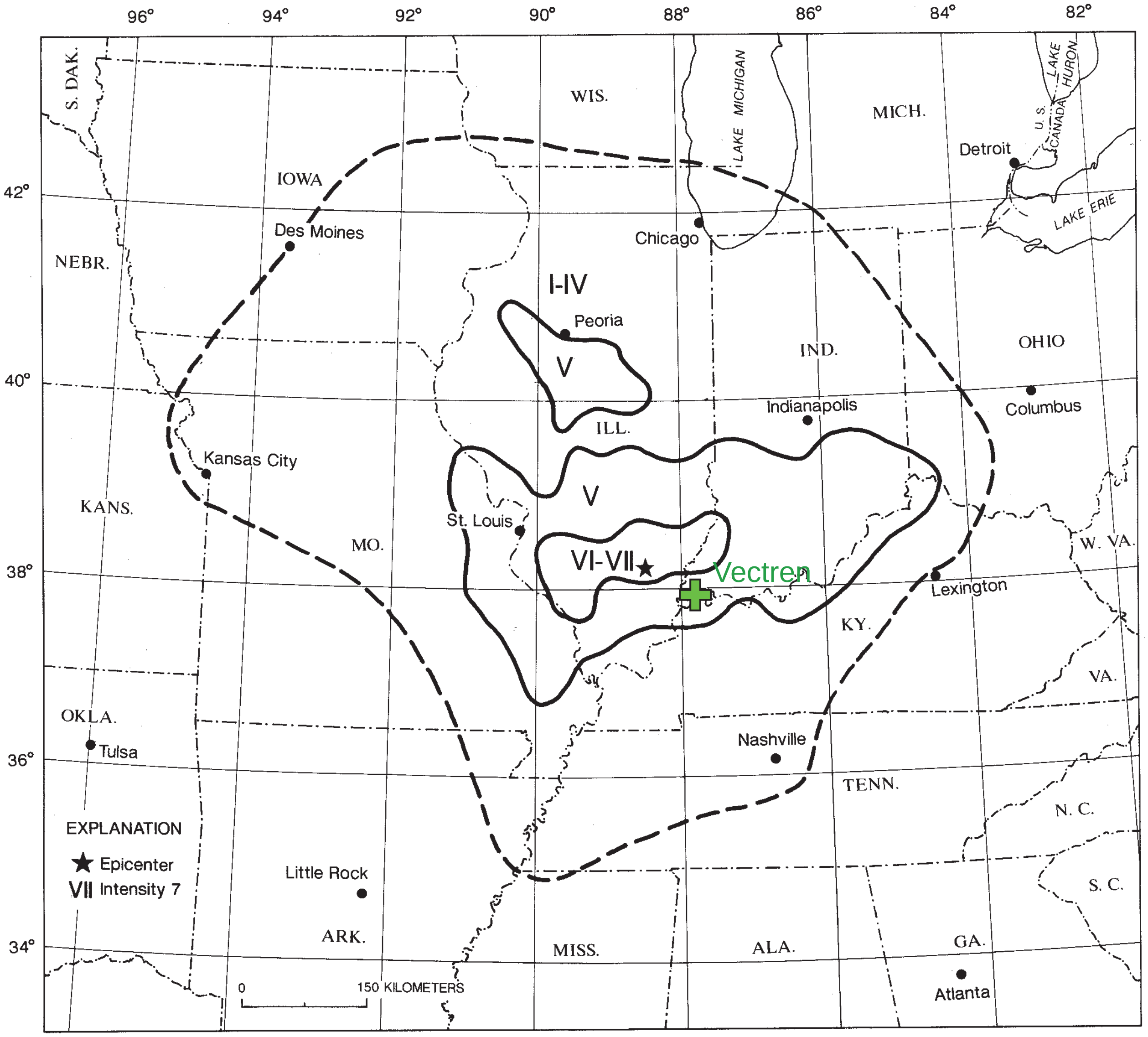
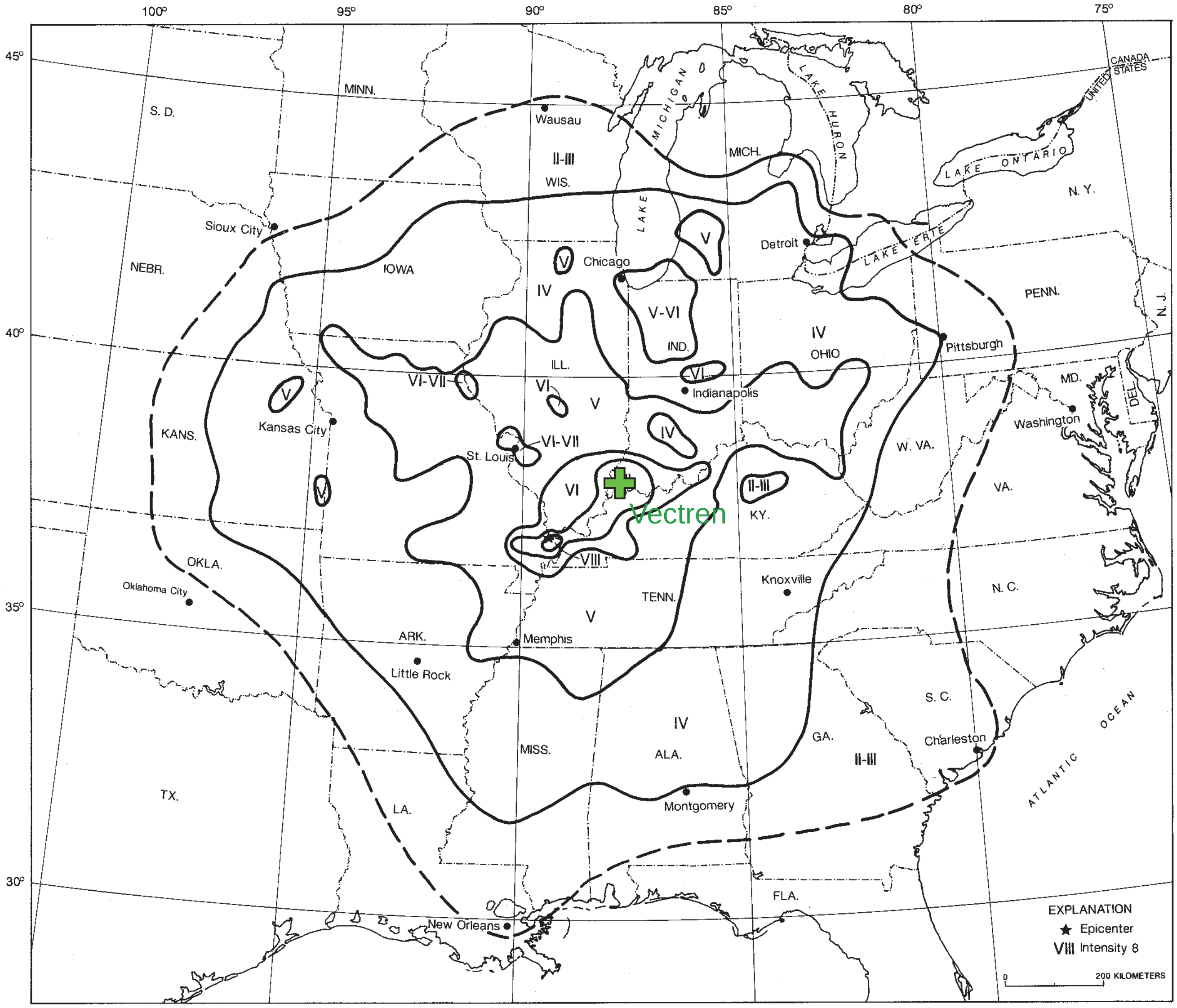
ISOSEISMAL MAP FOR THE 1 SEPTEMBER 1886 **M**~7 CHARLESTON EARTHQUAKE

Figure
7



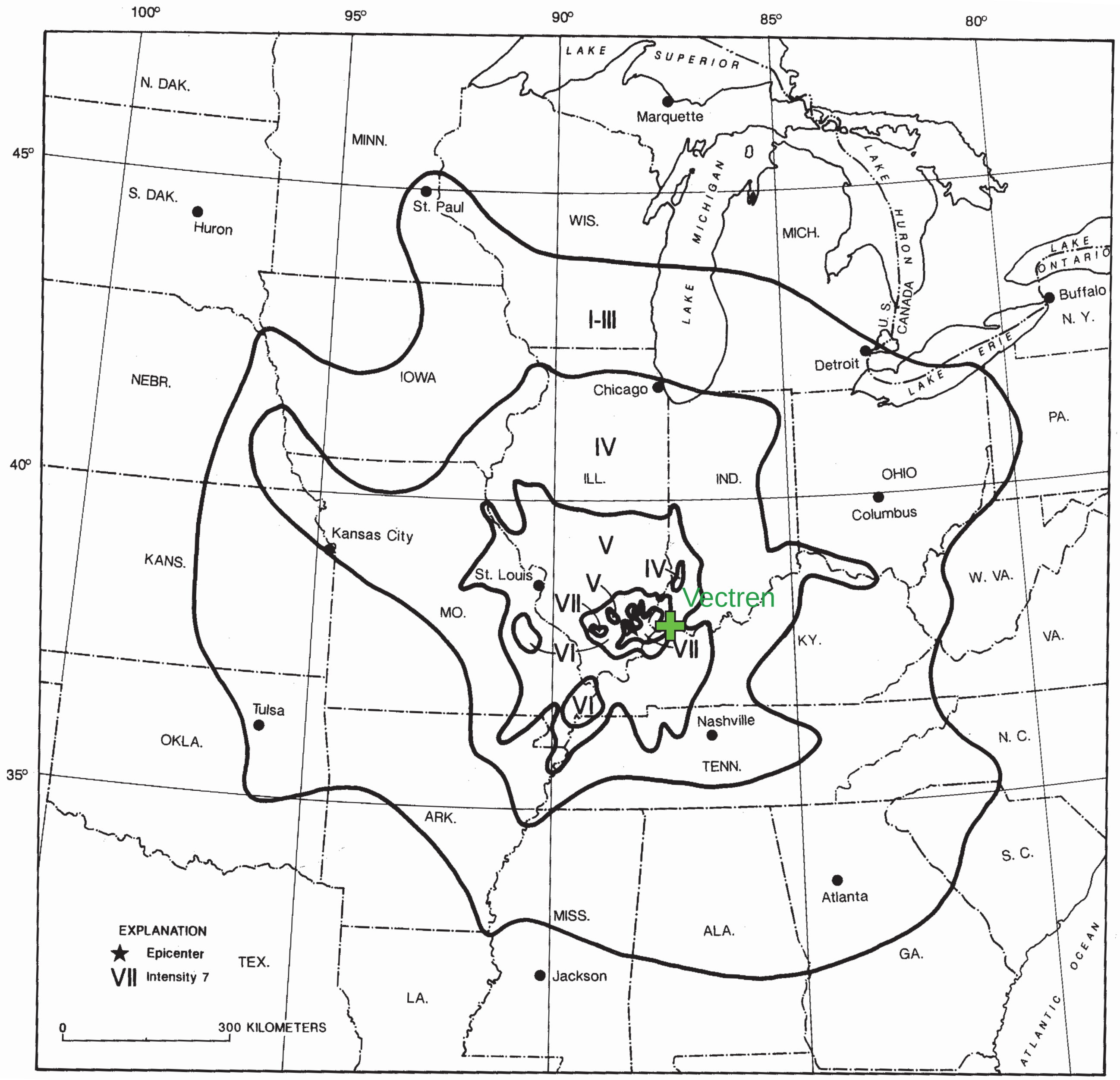
Source: Stover and Coffman (1993)

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		



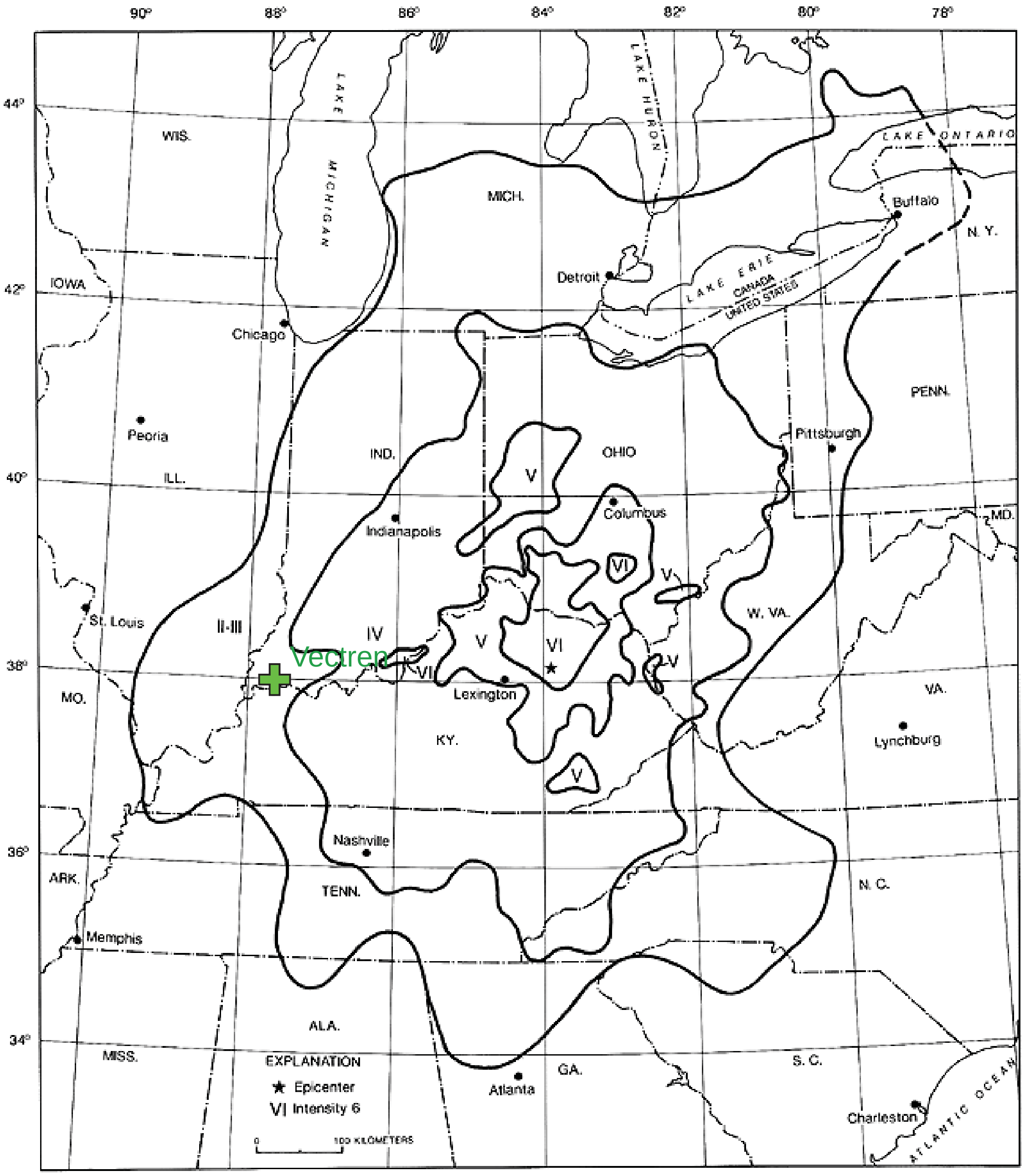
Source: Stover and Coffman (1993)

Project No. 60442676

A.B. Brown
Generating Station
Vectren Corporation

ISOSEISMAL MAP OF THE
9 NOVEMBER 1968 m_b 5.5
SOUTHERN ILLINOIS EARTHQUAKE

Figure
10



Source: Stover and Coffman (1993)

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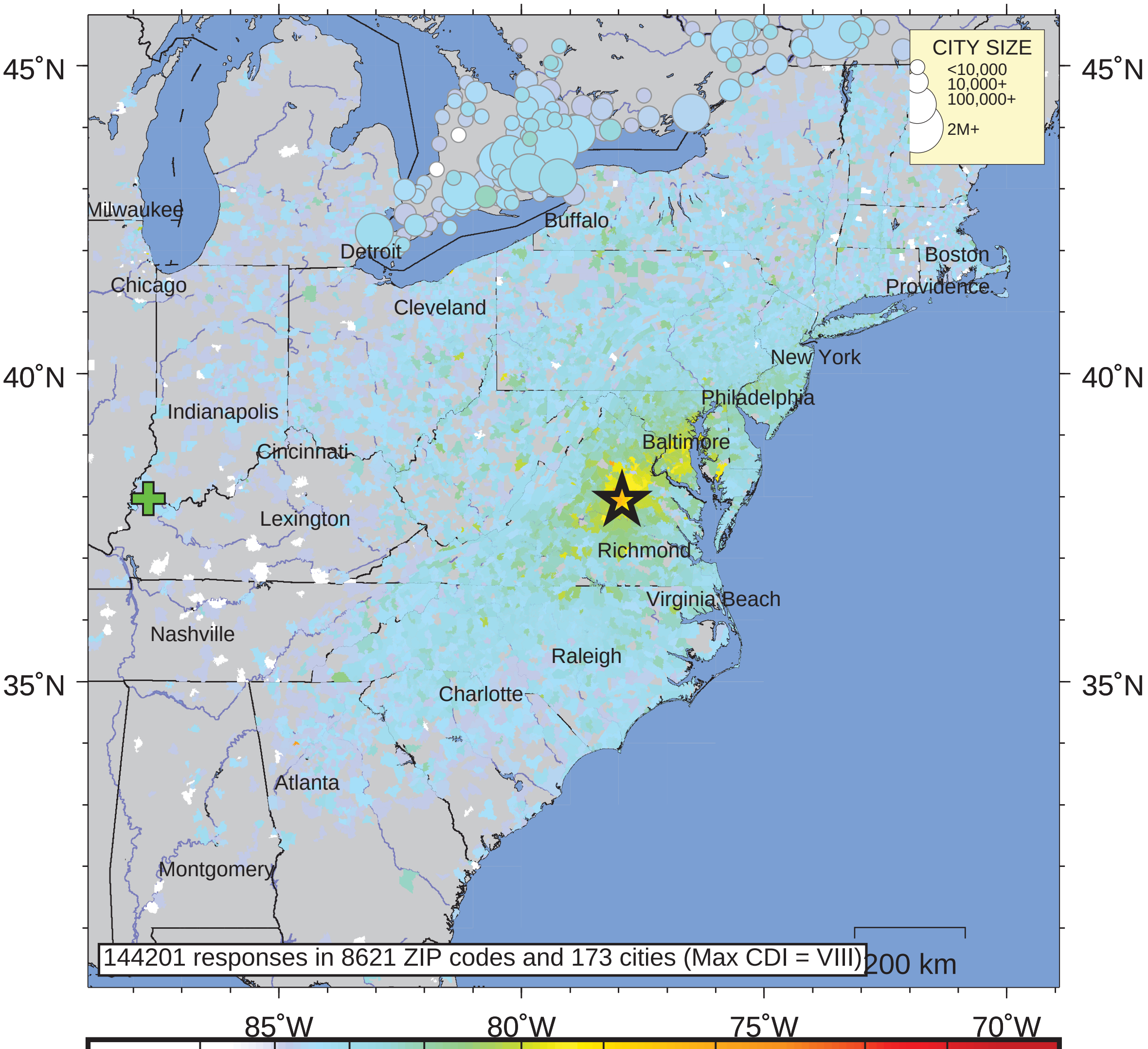
ISOSEISMAL MAP FOR THE 27 JULY 1980
M 5.1 SHARPSBURG, KENTUCKY
EARTHQUAKE

Figure
11

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

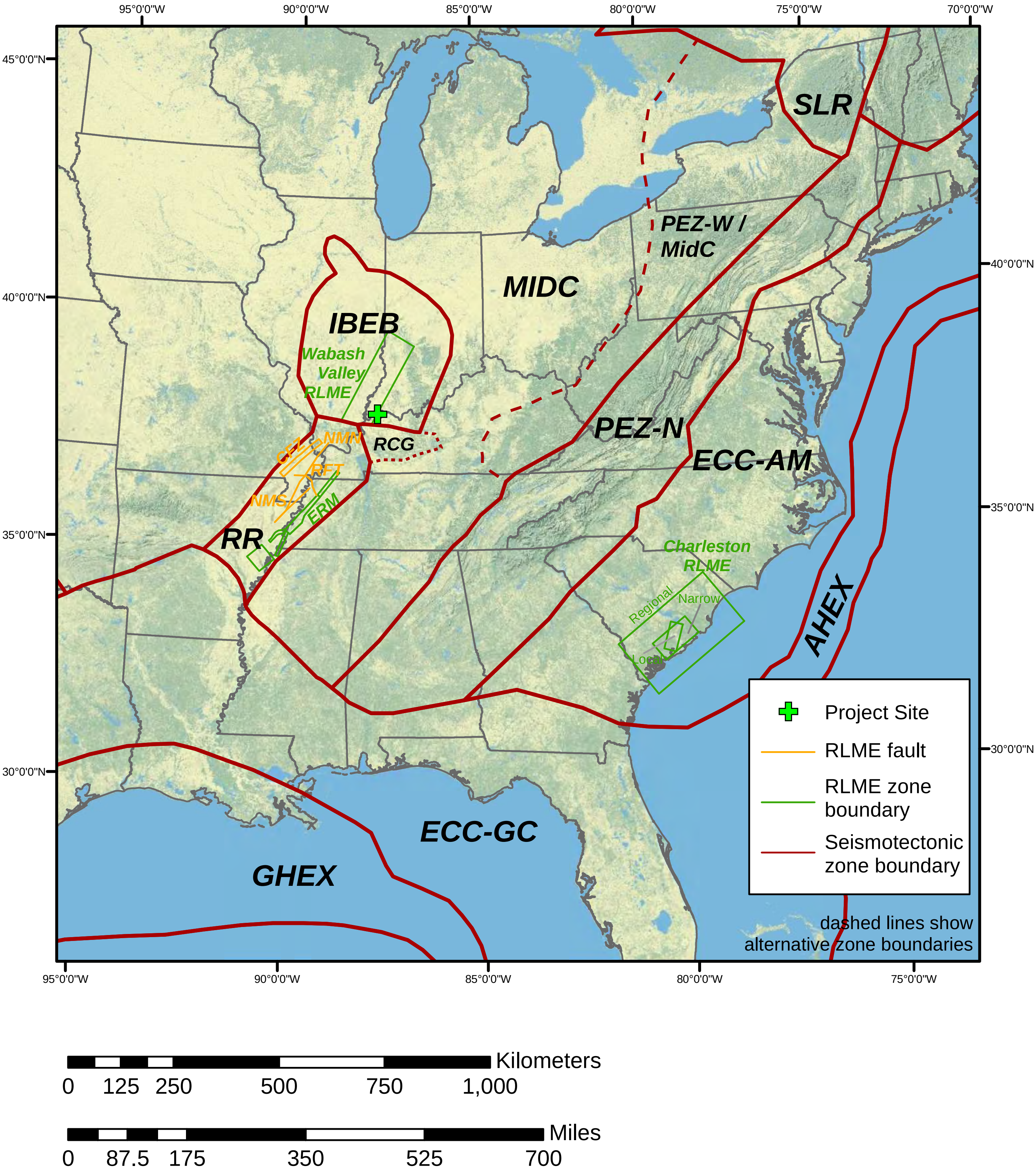


INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy

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



Project No. 60442676

A.B. Brown
Generating Station
Vectren Corporation

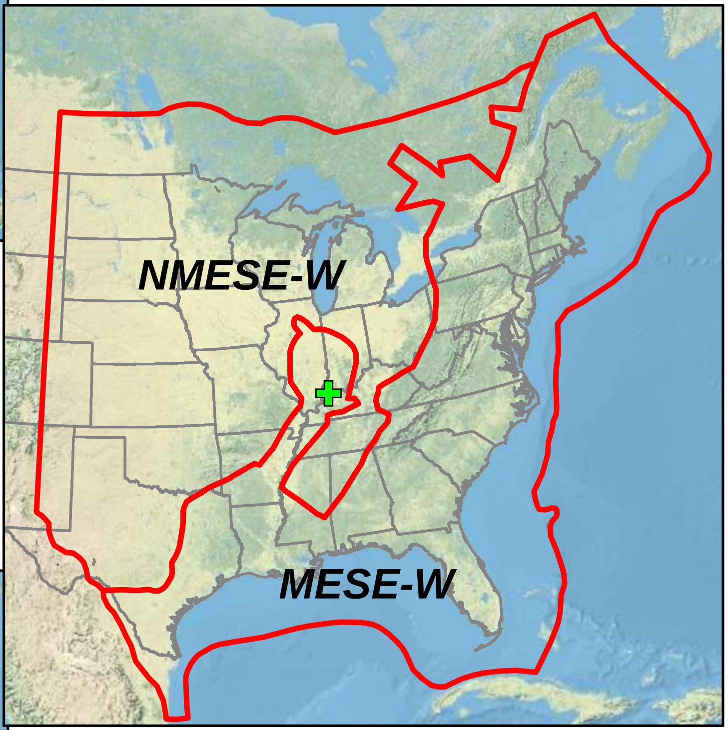
SEISMOTECTONIC ZONES AND RLMES

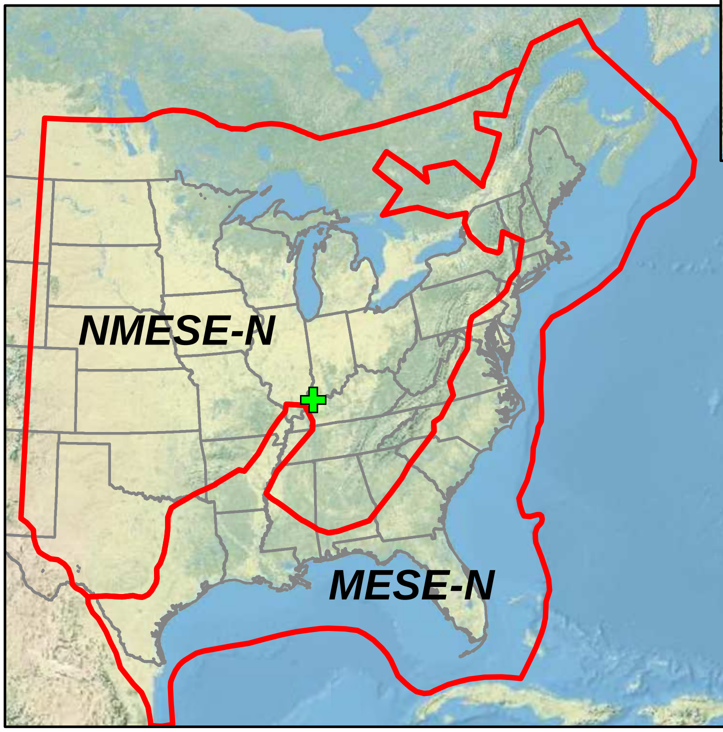
Figure

13

1-Zone Model

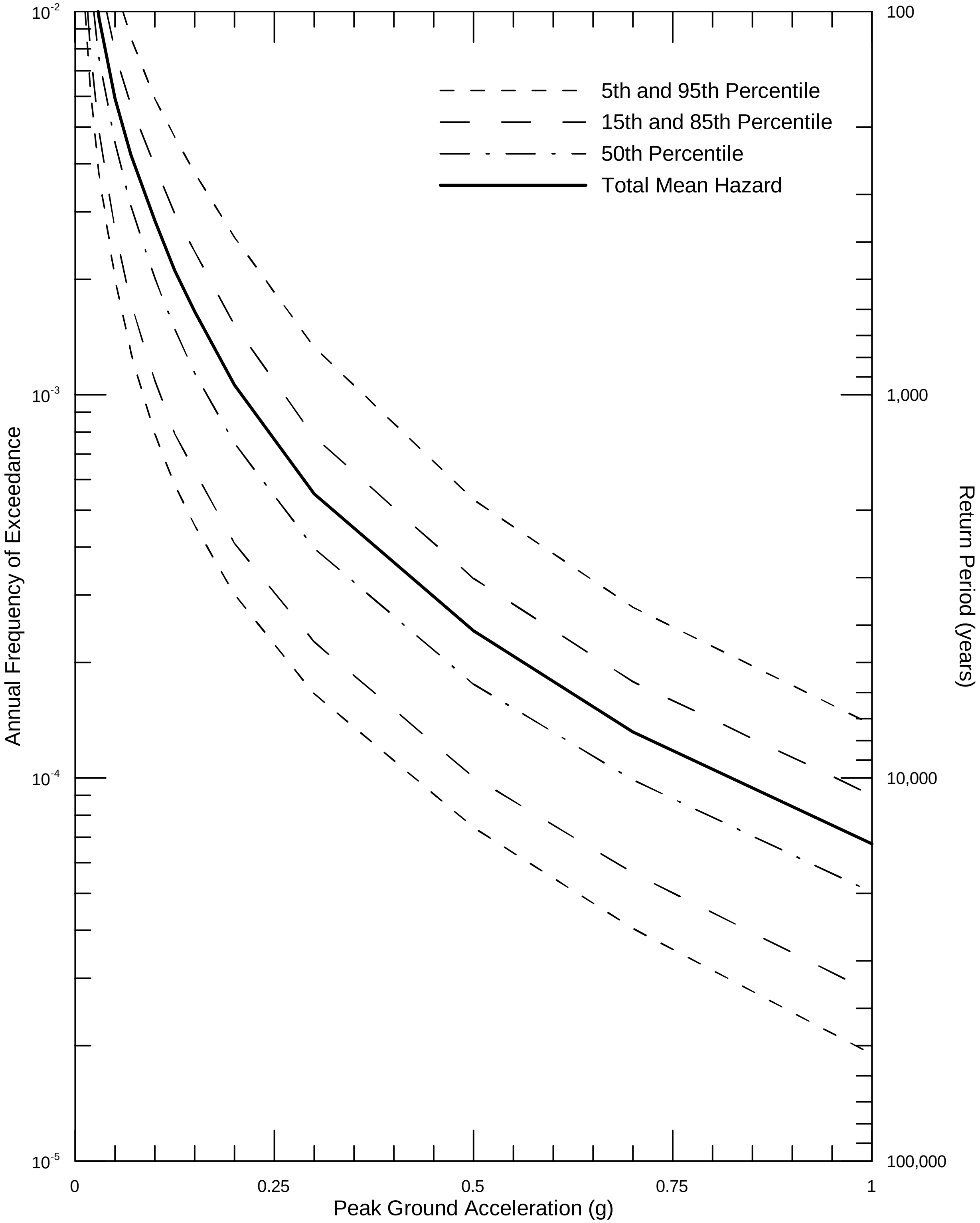
2-Zone Model Wide



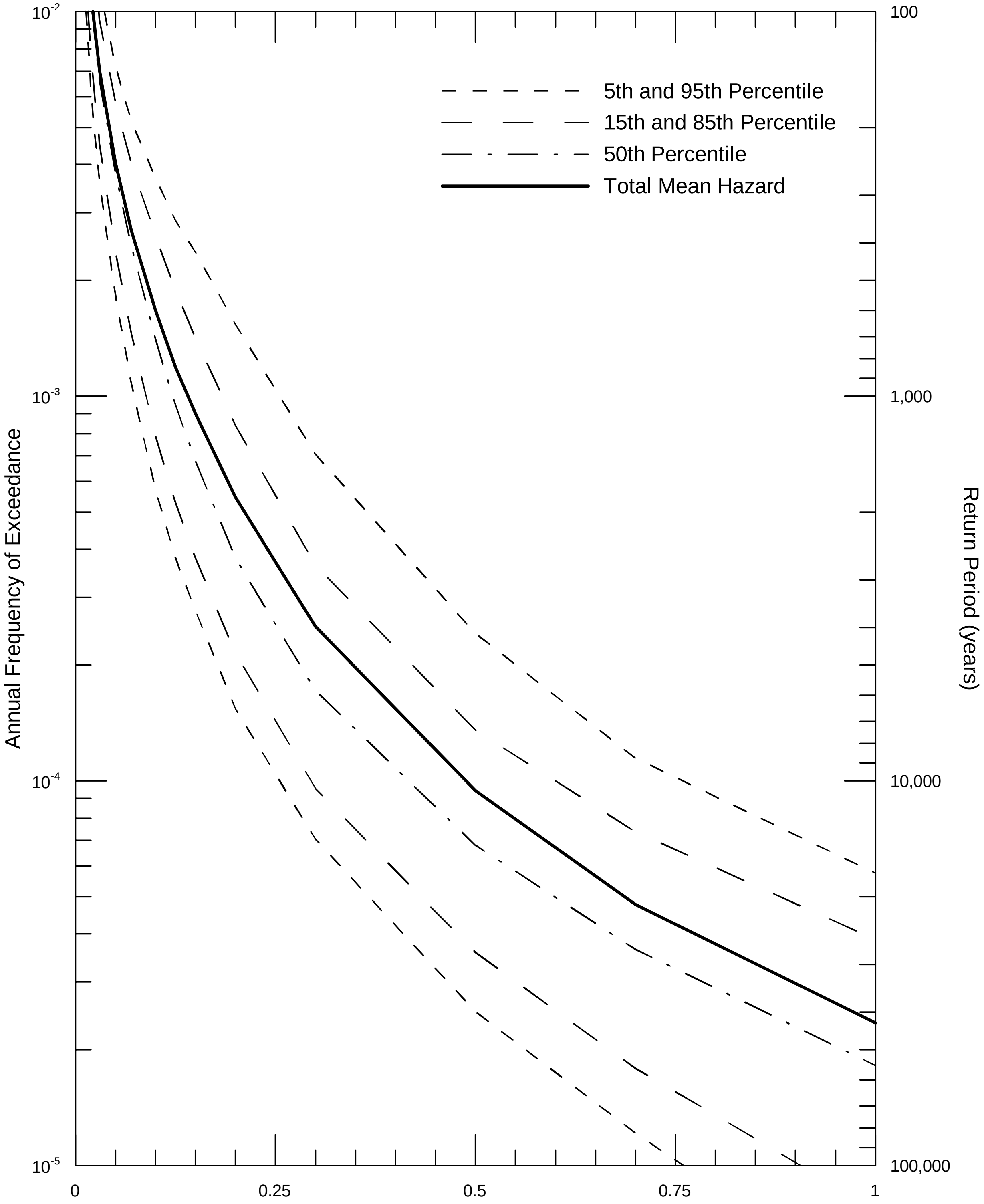


2-Zone Model Narrow

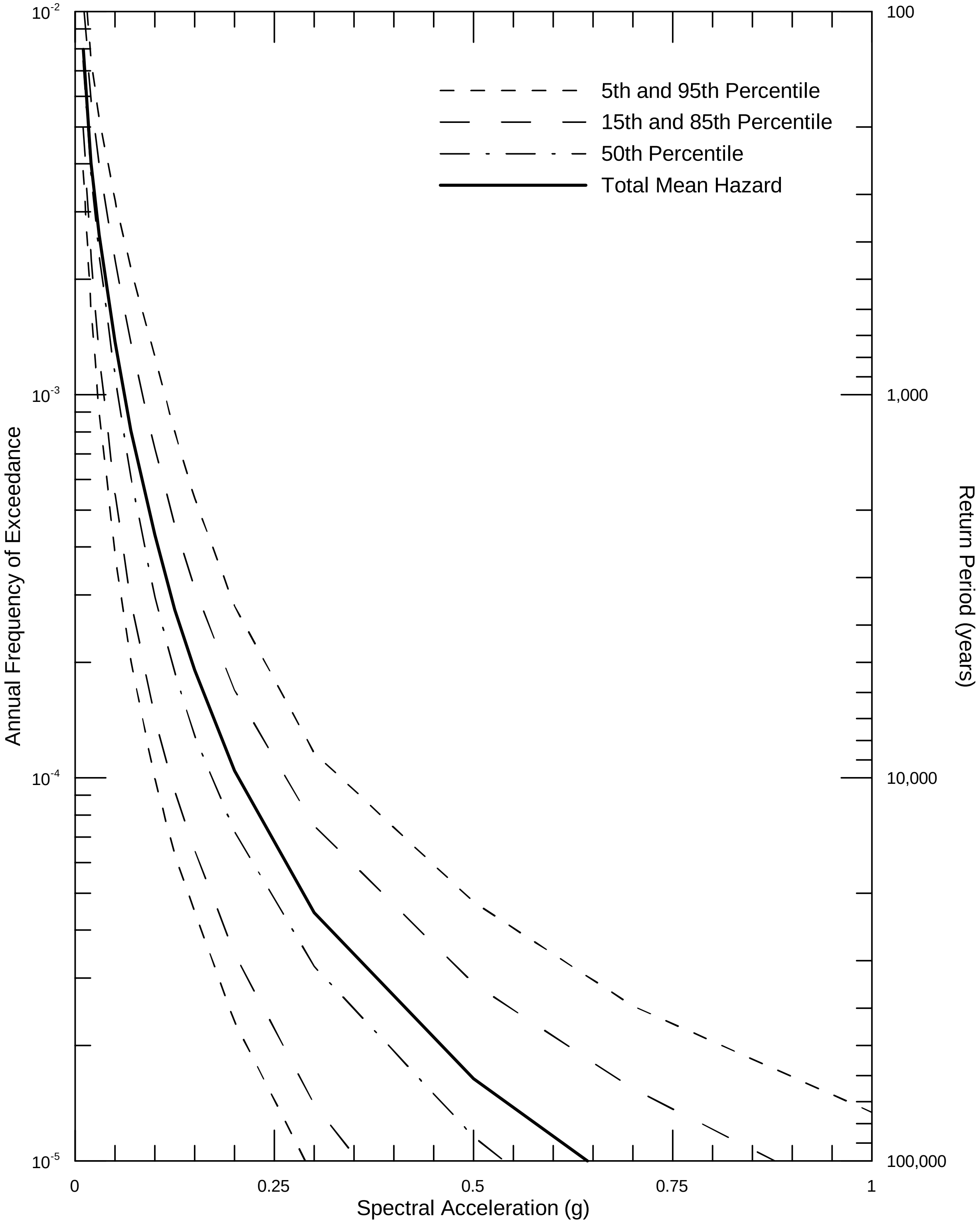
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	Mmax ZONES	Figure 14



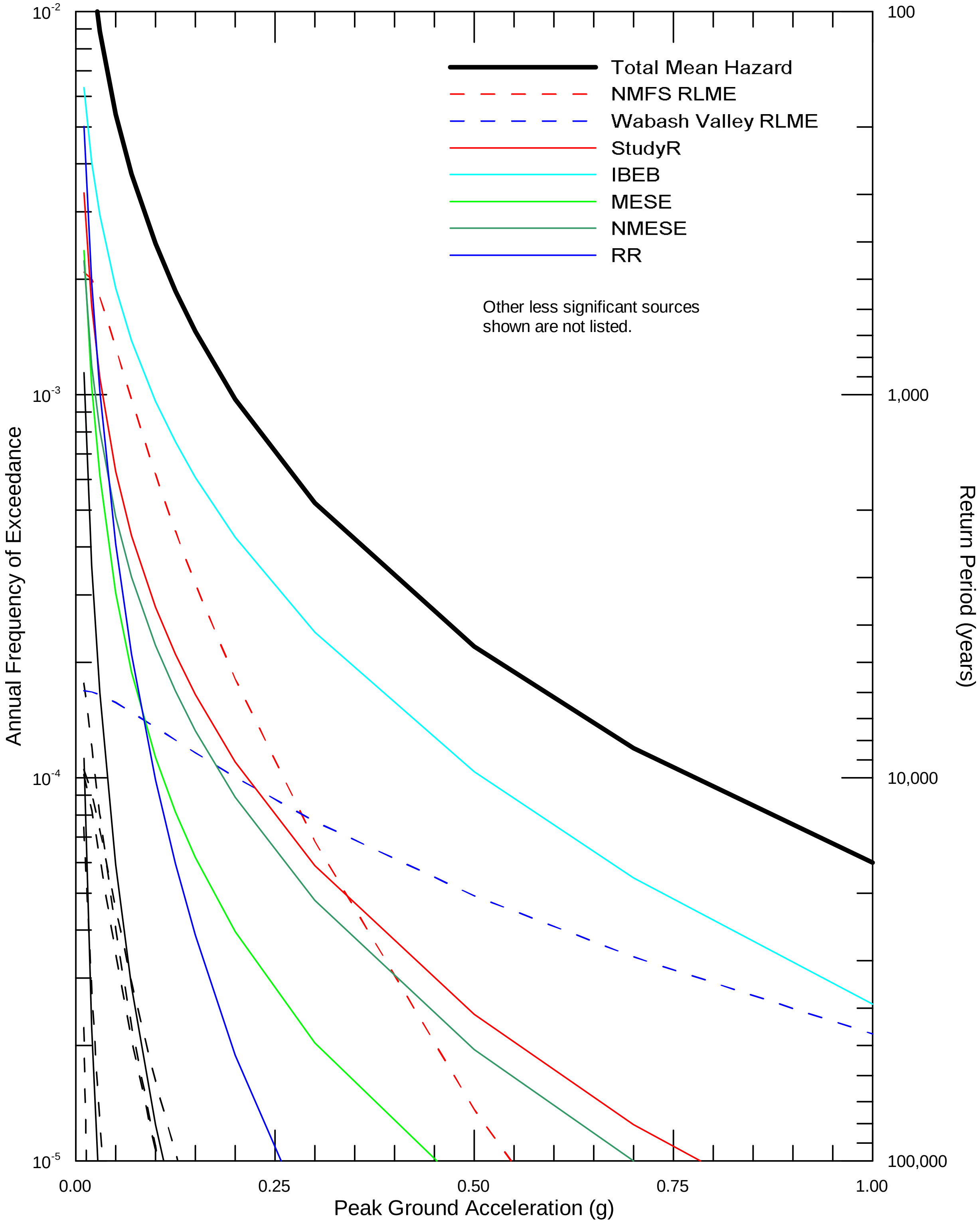
AECOM	Project No. 60442676	SEISMIC HAZARD CURVES FOR PEAK HORIZONTAL ACCELERATION ON HARD ROCK	Figure 15
	A.B. Brown Generating Station Vectren Corporation		



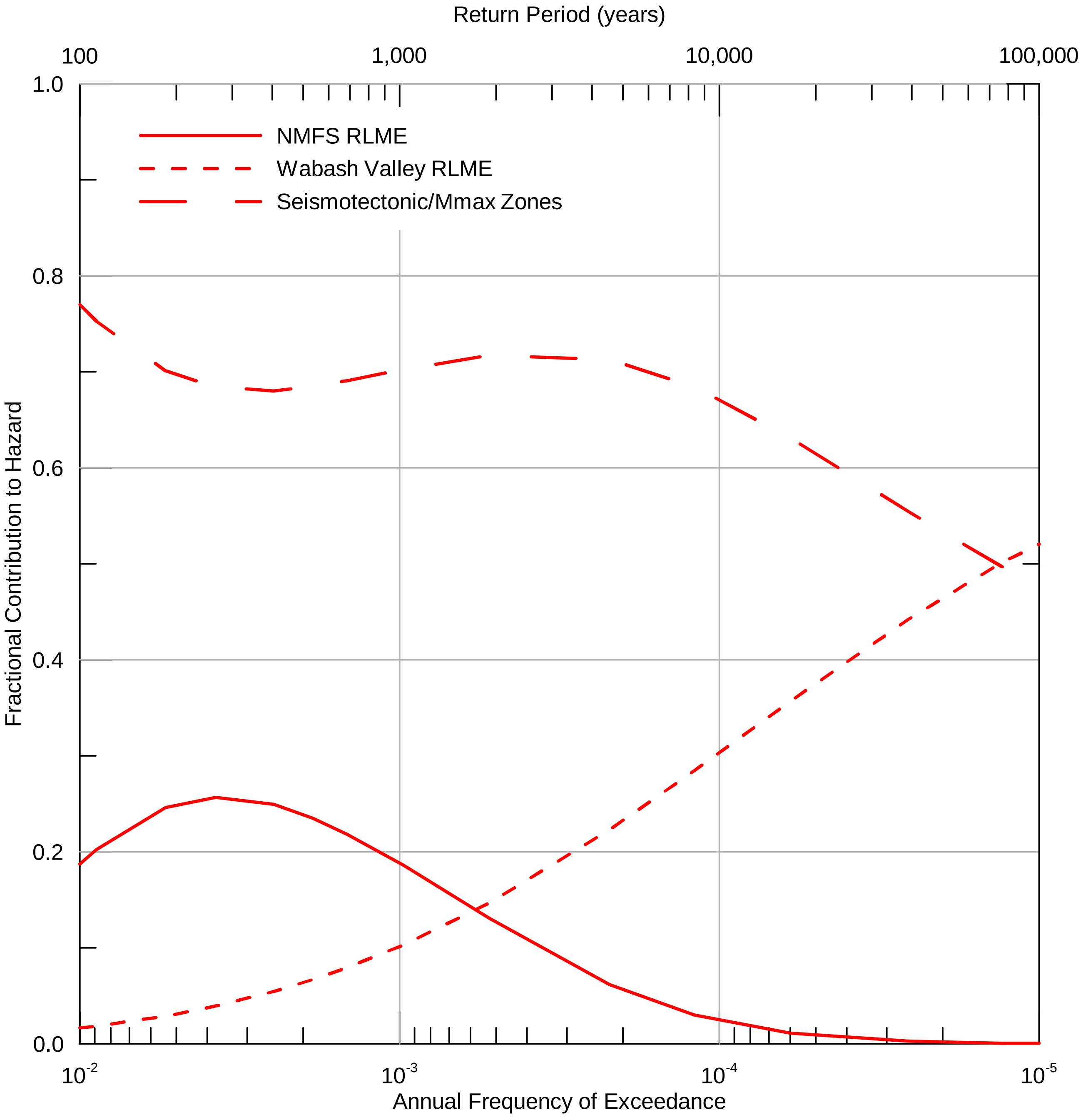
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	SEISMIC HAZARD CURVES FOR 0.4 SEC HORIZONTAL SPECTRAL ACCELERATION ON HARD ROCK	Figure 16



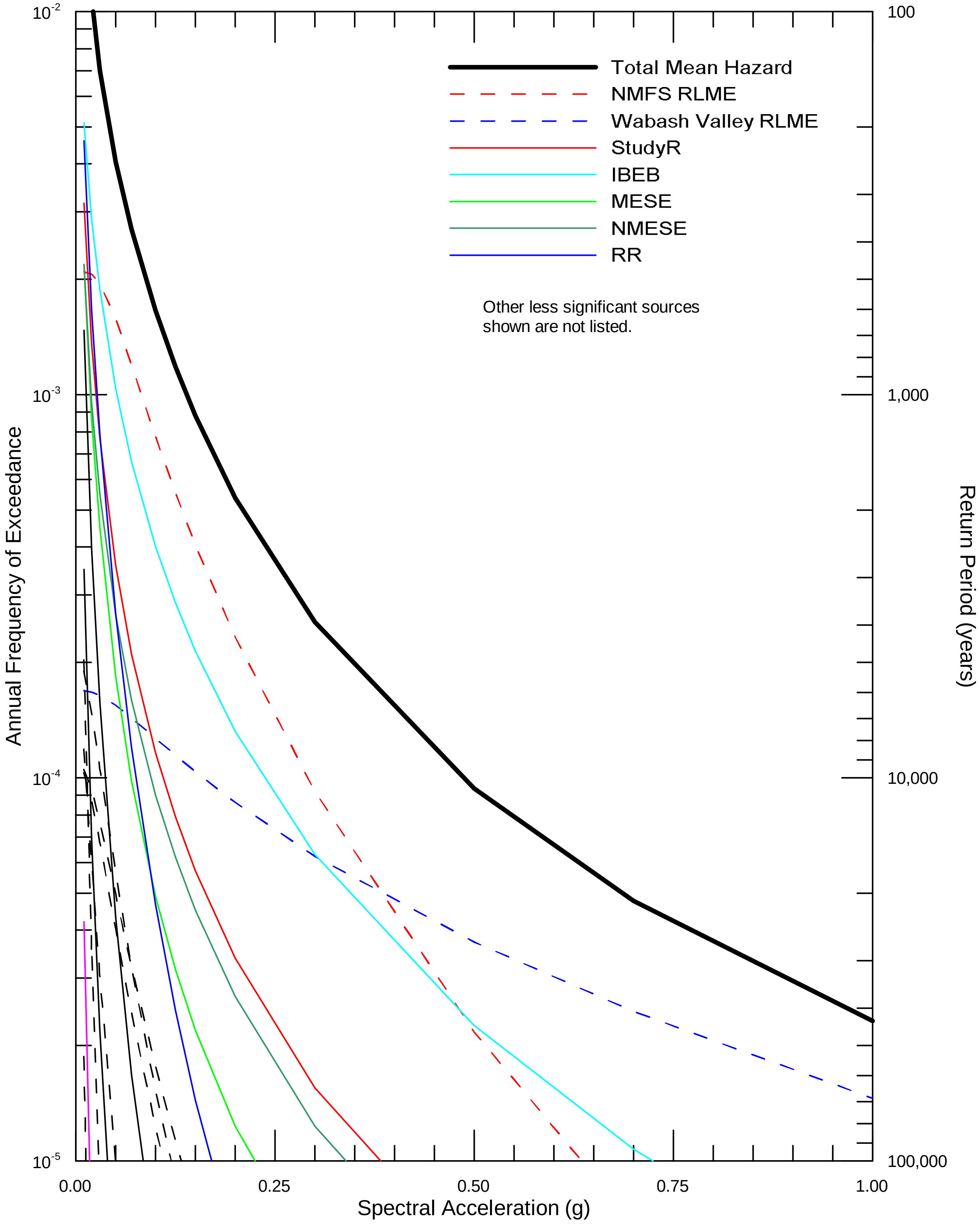
AECOM	Project No. 60442676	SEISMIC HAZARD CURVES FOR 1.0 SEC HORIZONTAL SPECTRAL ACCELERATION ON HARD ROCK	Figure 17
	A.B. Brown Generating Station Vectren Corporation		



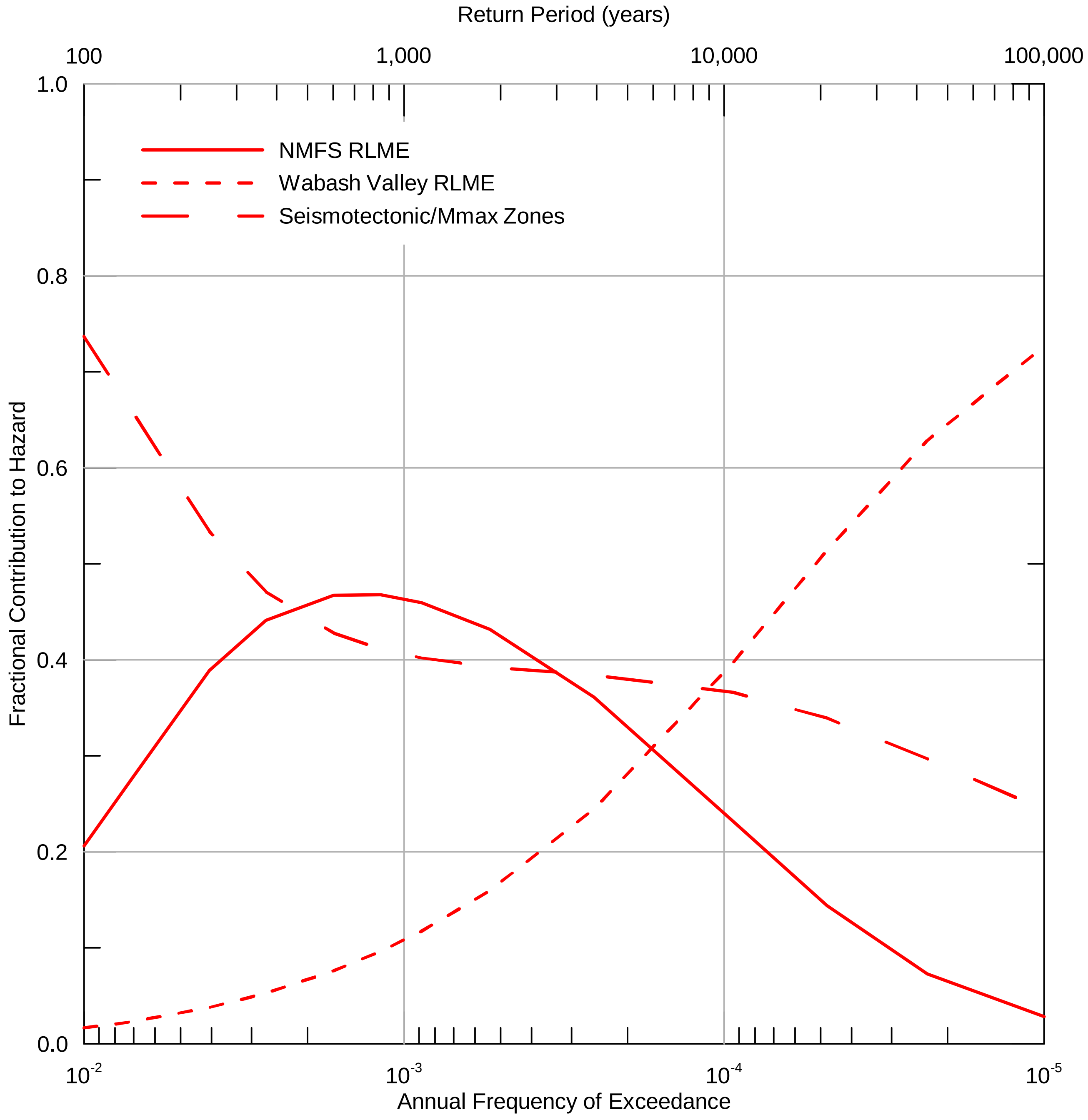
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	SEISMIC SOURCE CONTRIBUTIONS TO MEAN PEAK HORIZONTAL ACCELERATION HAZARD ON HARD ROCK	Figure 18



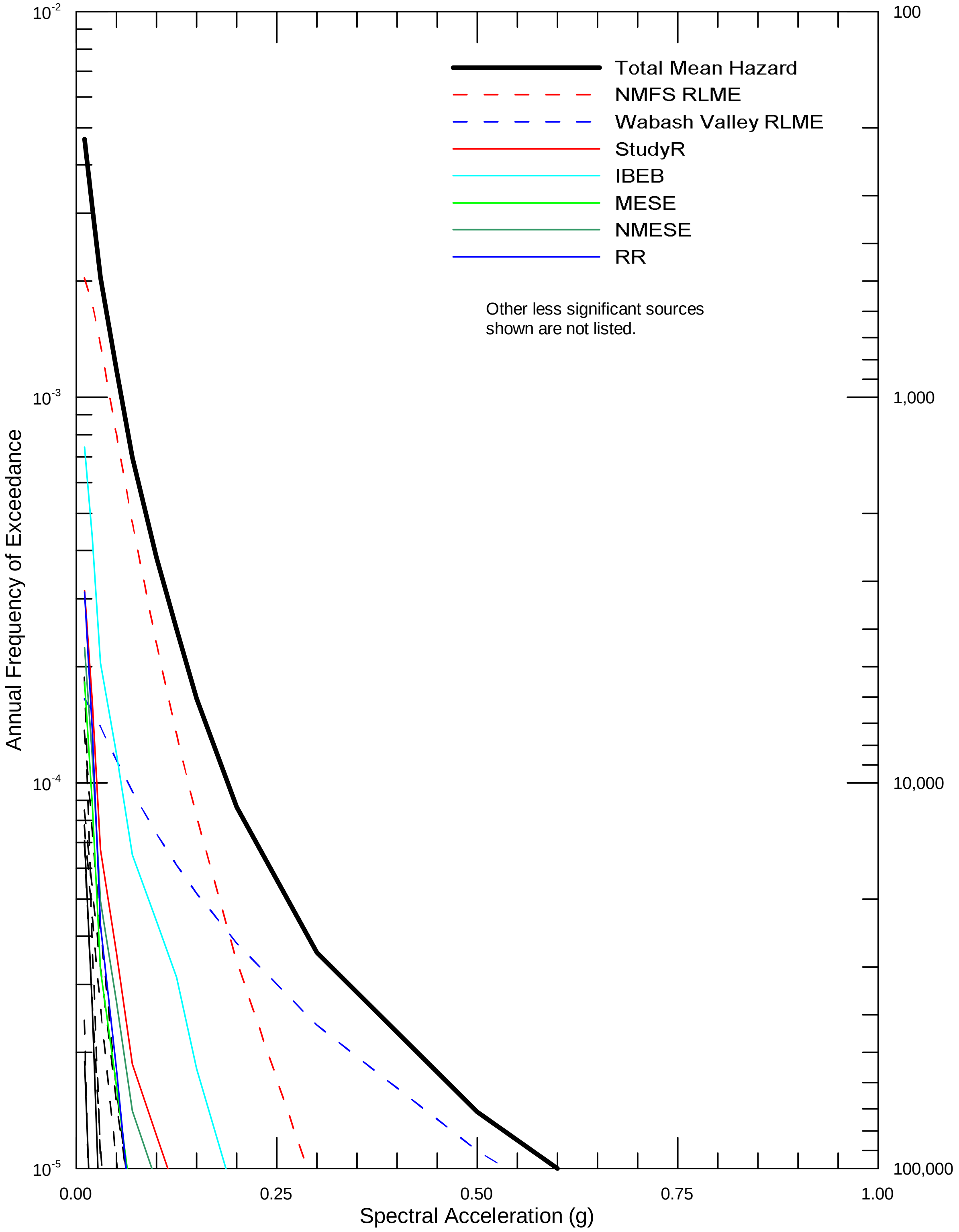
AECOM	Project No. 60442676	SEISMIC SOURCE FRACTIONAL CONTRIBUTION TO MEAN PEAK HORIZONTAL ACCELERATION HAZARD ON HARD ROCK	Figure 19
	A.B. Brown Generating Station Vectren Corporation		



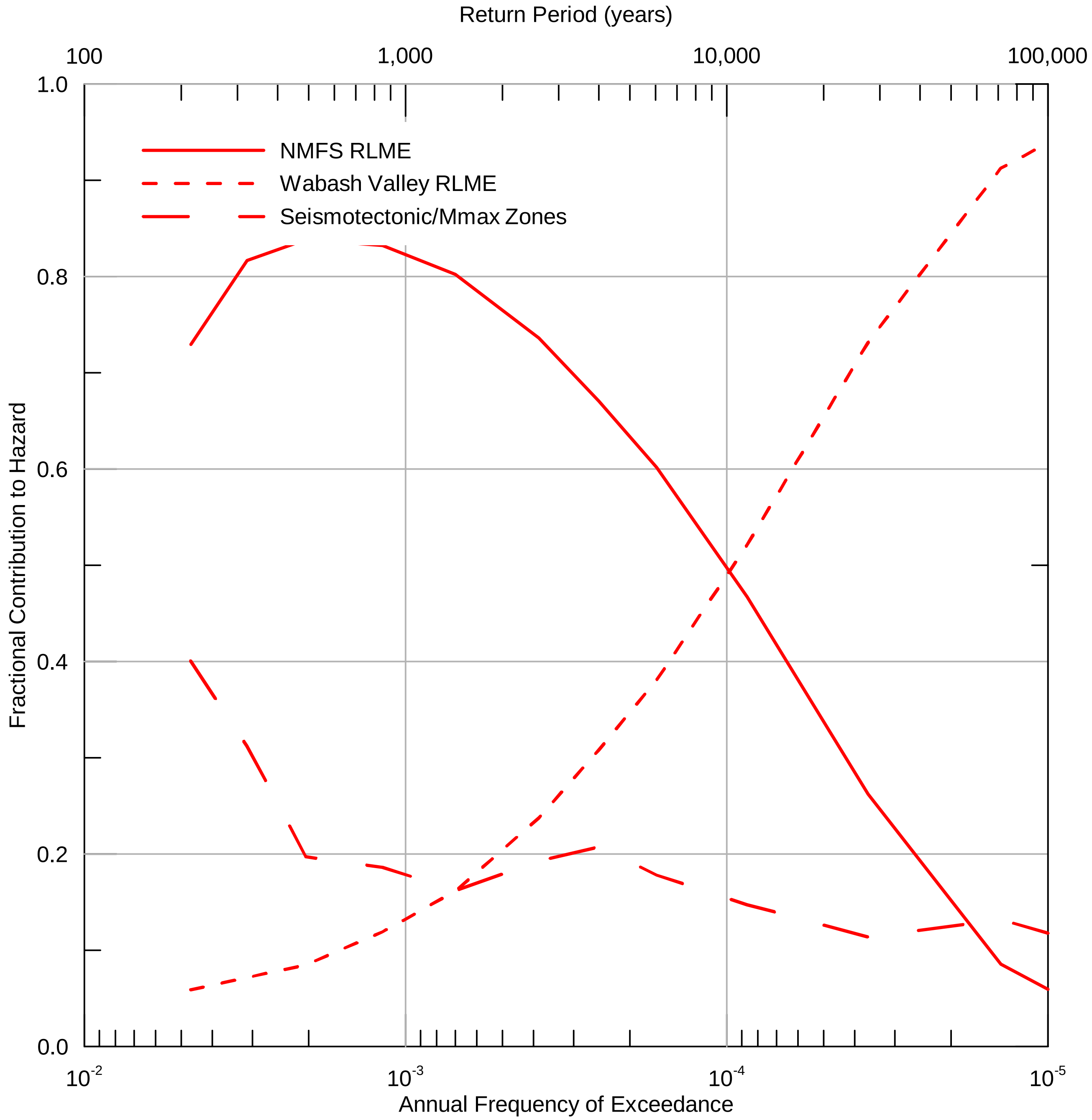
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	SEISMIC SOURCE CONTRIBUTIONS TO MEAN 0.4 SEC HORIZONTAL SPECTRAL ACCELERATION HAZARD ON HARD ROCK	Figure 20



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	SEISMIC SOURCE CONTRIBUTIONS TO MEAN 1.0 SEC HORIZONTAL SPECTRAL ACCELERATION HAZARD ON HARD ROCK	Figure 22
	A.B. Brown Generating Station Vectren Corporation		



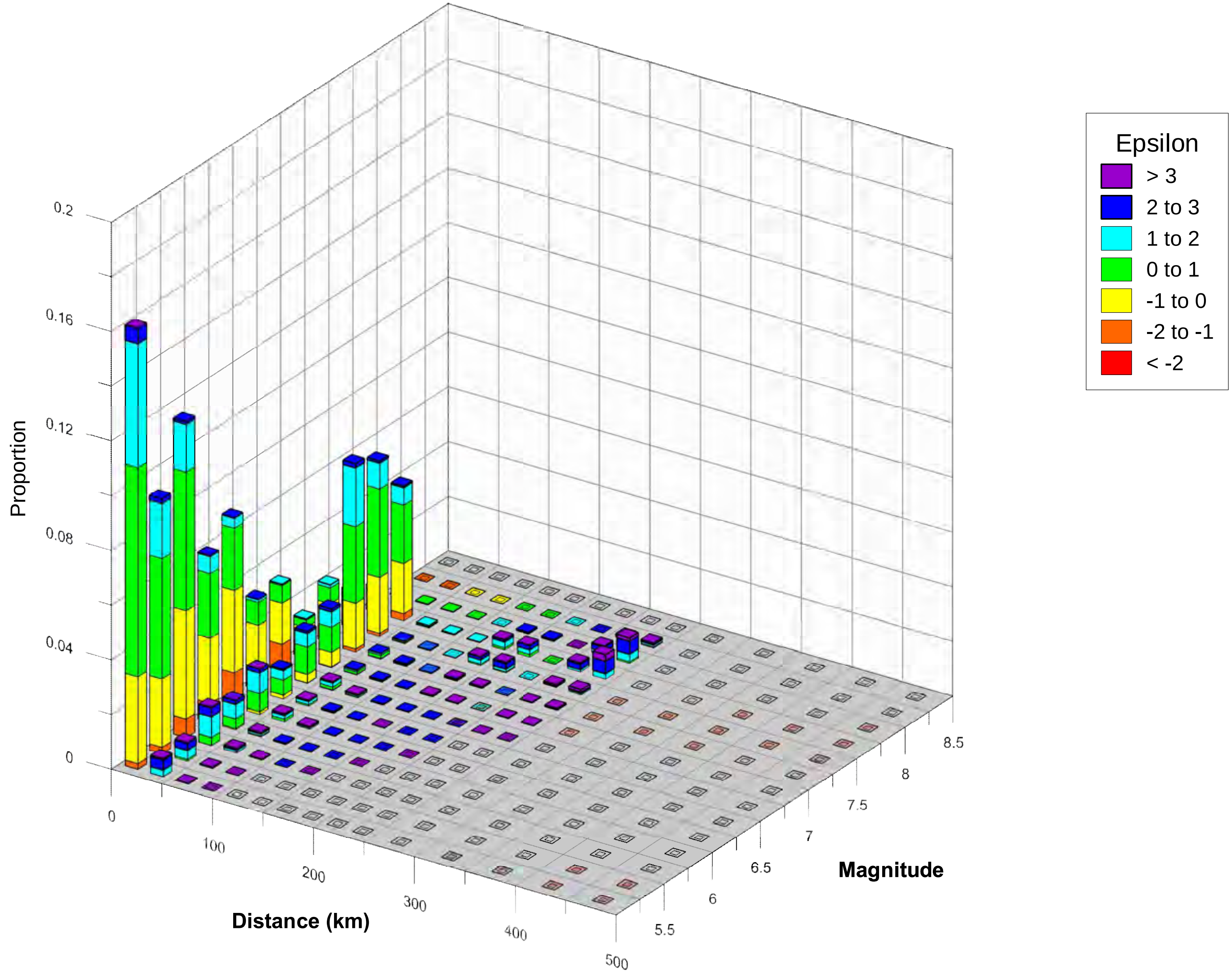
AECOM

Project No. 60442676

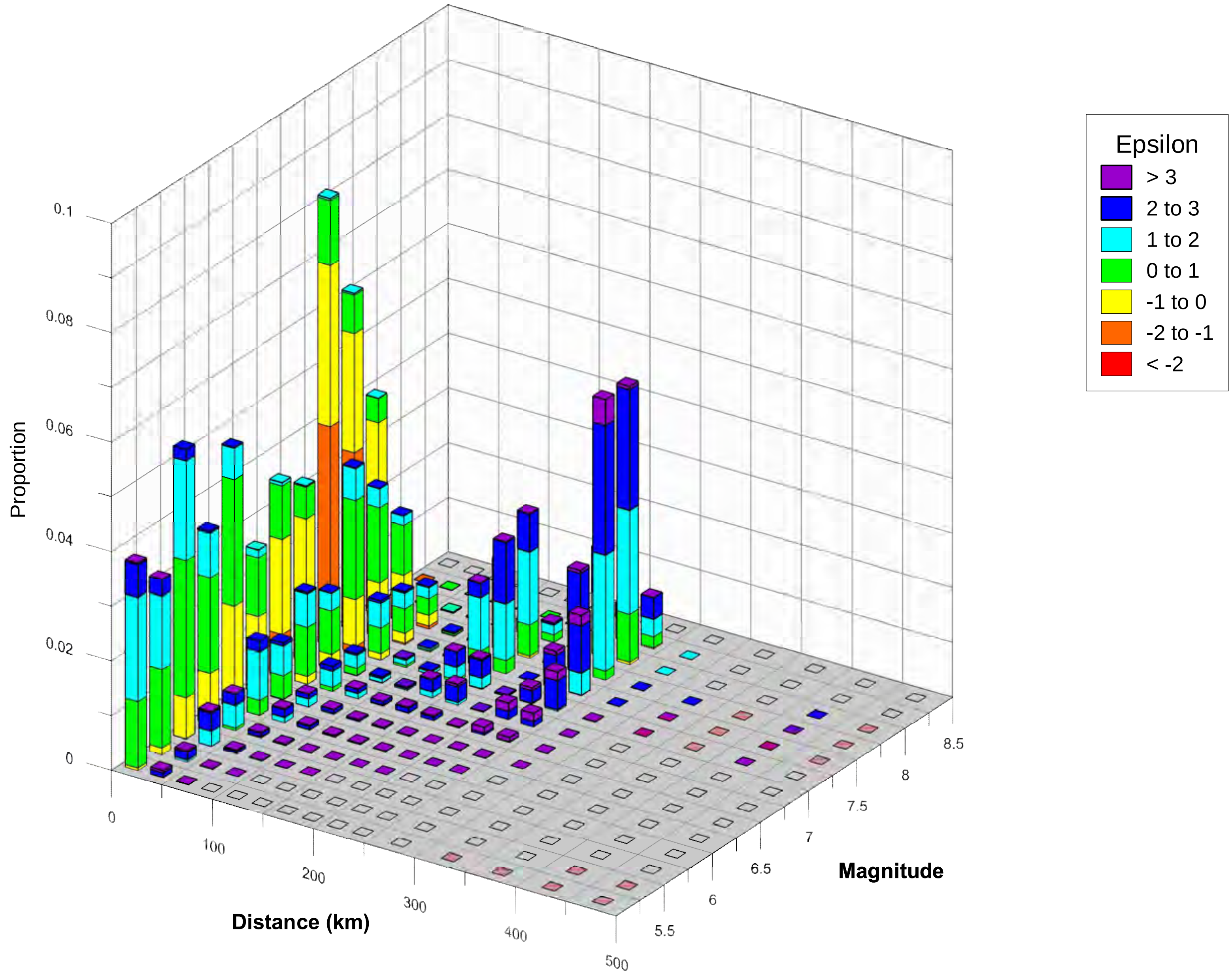
A.B. Brown
Generating Station
Vectren Corporation

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



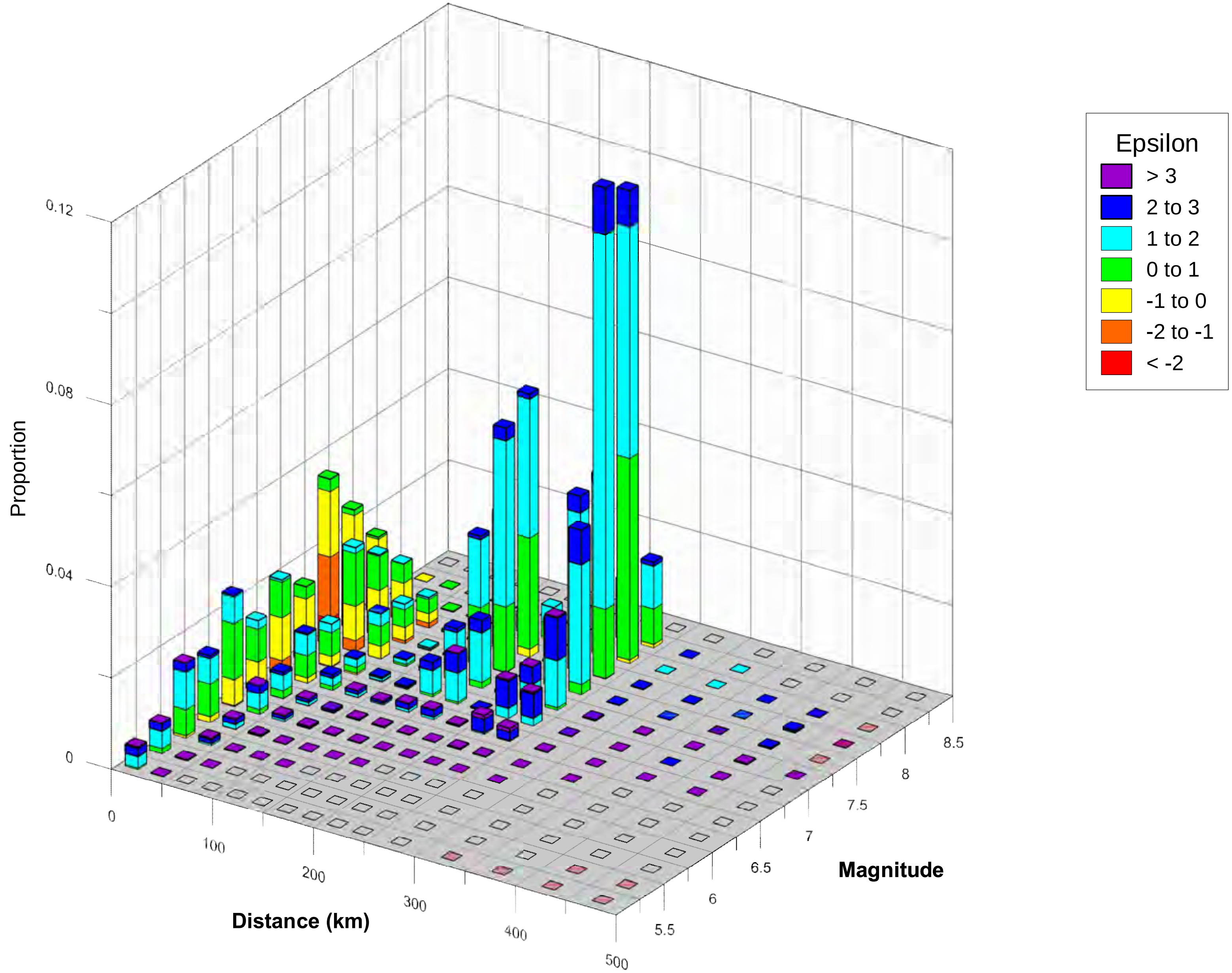
AECOM

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



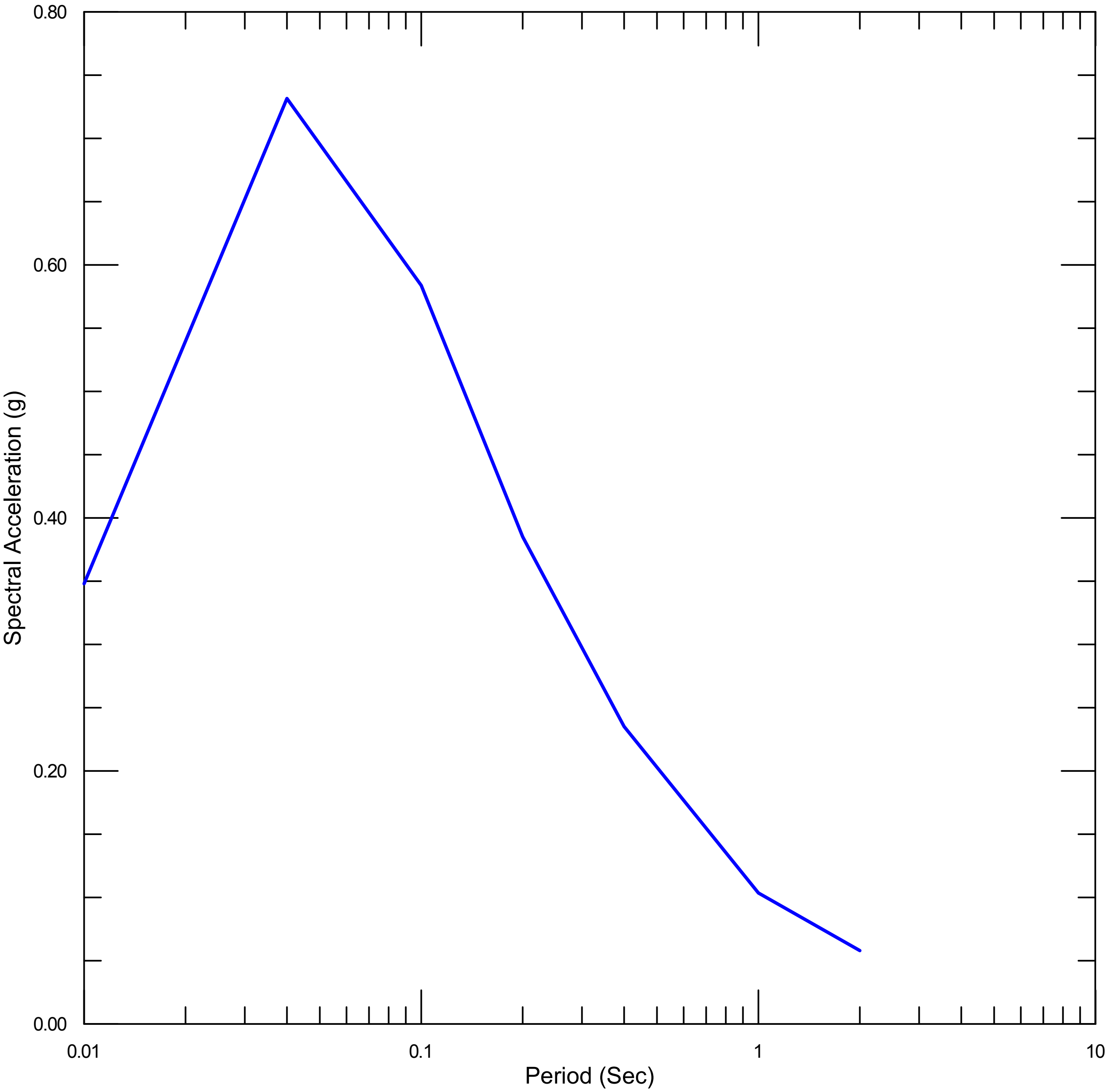
AECOM

Project No. 60442676

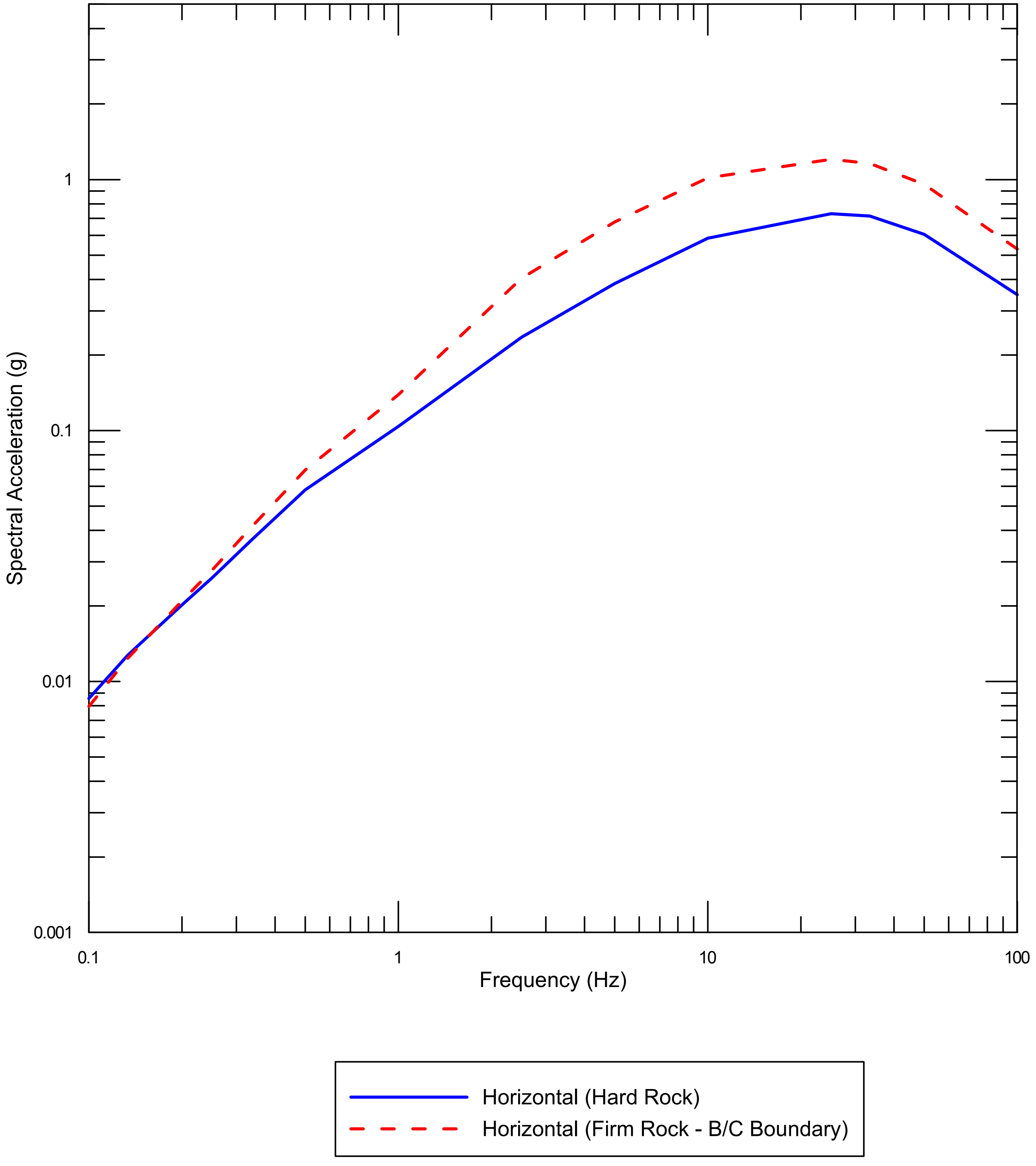
A.B. Brown
Generating Station
Vectren Corporation

MAGNITUDE,DISTANCE AND EPSILON
CONTRIBUTIONS TO THE MEAN 1.0 SEC
HORIZONTAL SPECTRALACCELERATION HAZARD
AT 2,500-YEAR RETURN PERIOD ON HARD ROCK

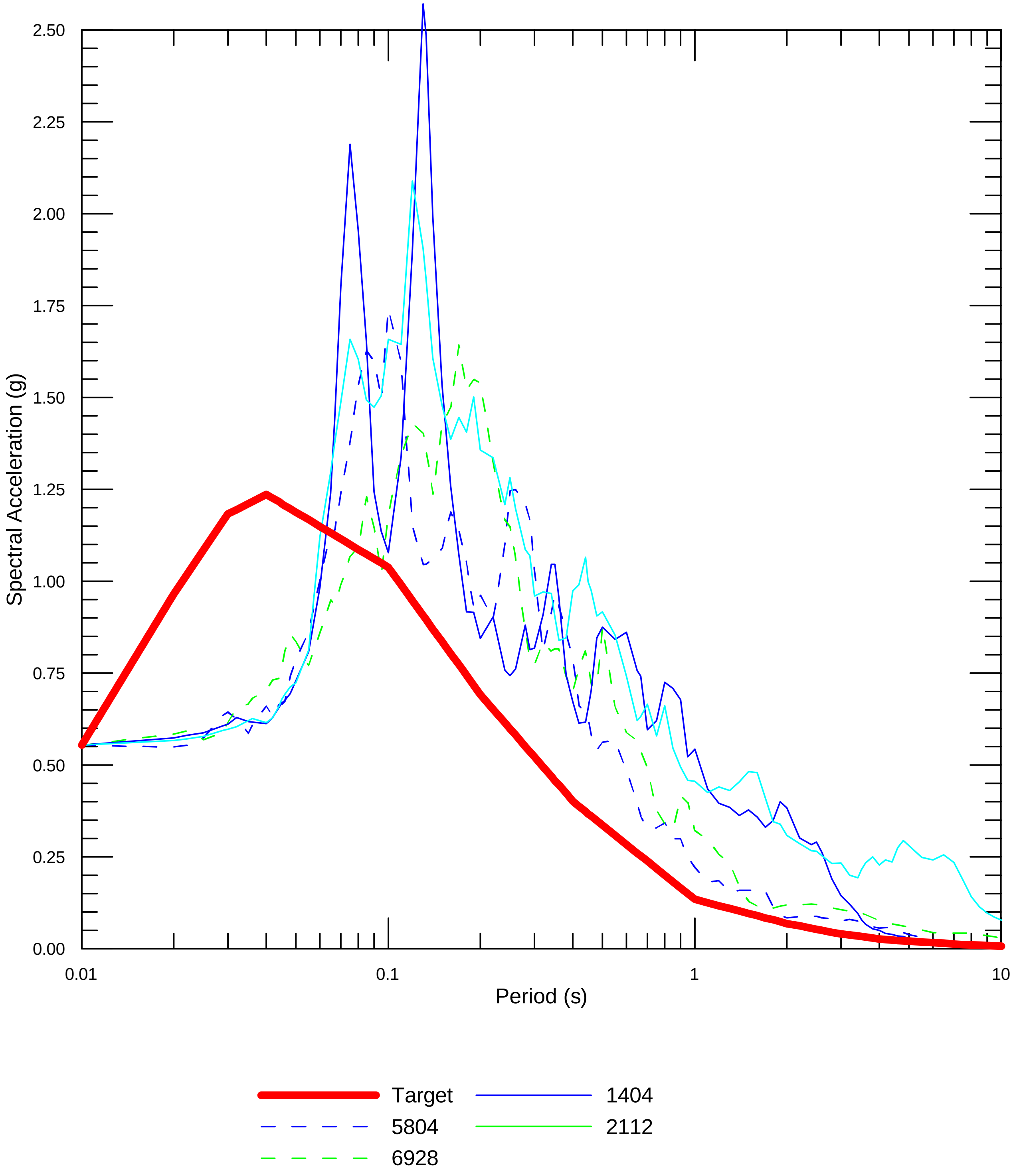
Figure
26



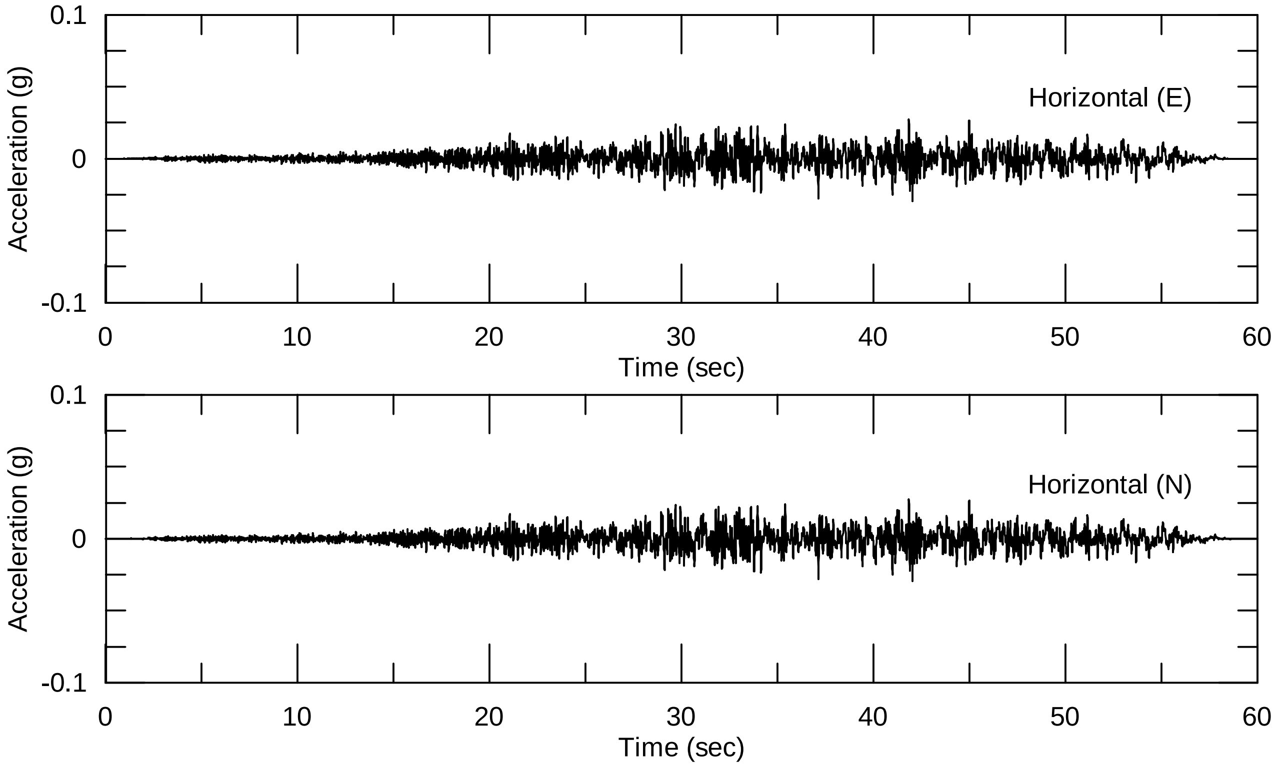
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	HORIZONTAL 5%-DAMPED MEAN UHS AT 2,500-YEAR RETURN PERIOD ON HARD ROCK	Figure 27



AECOM	Project No. 60442676	COMPARISON OF HORIZONTAL 5%-DAMPED MEAN UHS AT 2,500-YEAR RETURN PERIOD ON HARD AND FIRM ROCK	Figure 28
	A.B. Brown Generating Station Vectren Corporation		



AECOM	Project No.60442676	HORIZONTAL TARGET AND SELECTED SEED RESPONSE SPECTRA	Figure 29
	A.B. Brown Generating Station Vectren Corporation		



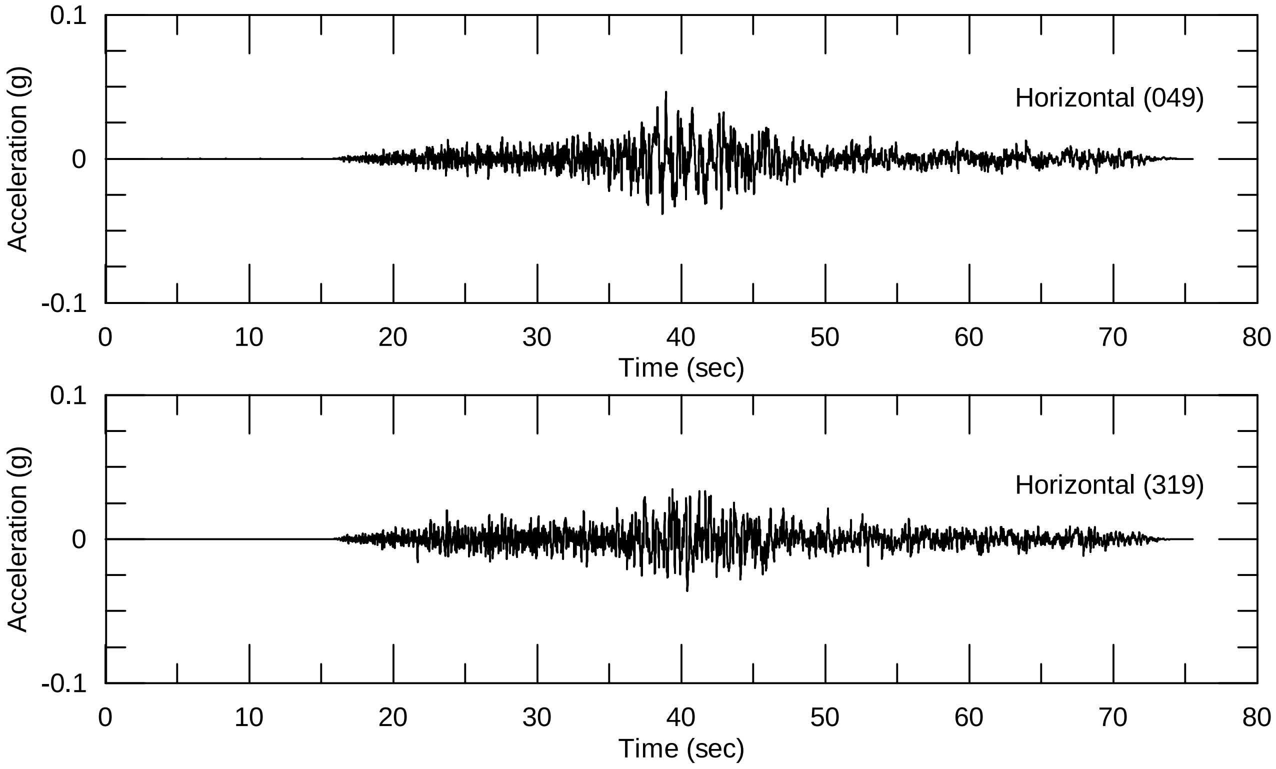
AECOM

Project No. 60442676

A.B. Brown
Generating Station
Vectren Corporation

SEED TIME HISTORIES
RSN1404 - 1999 CHI CHI
PNG

Figure
30

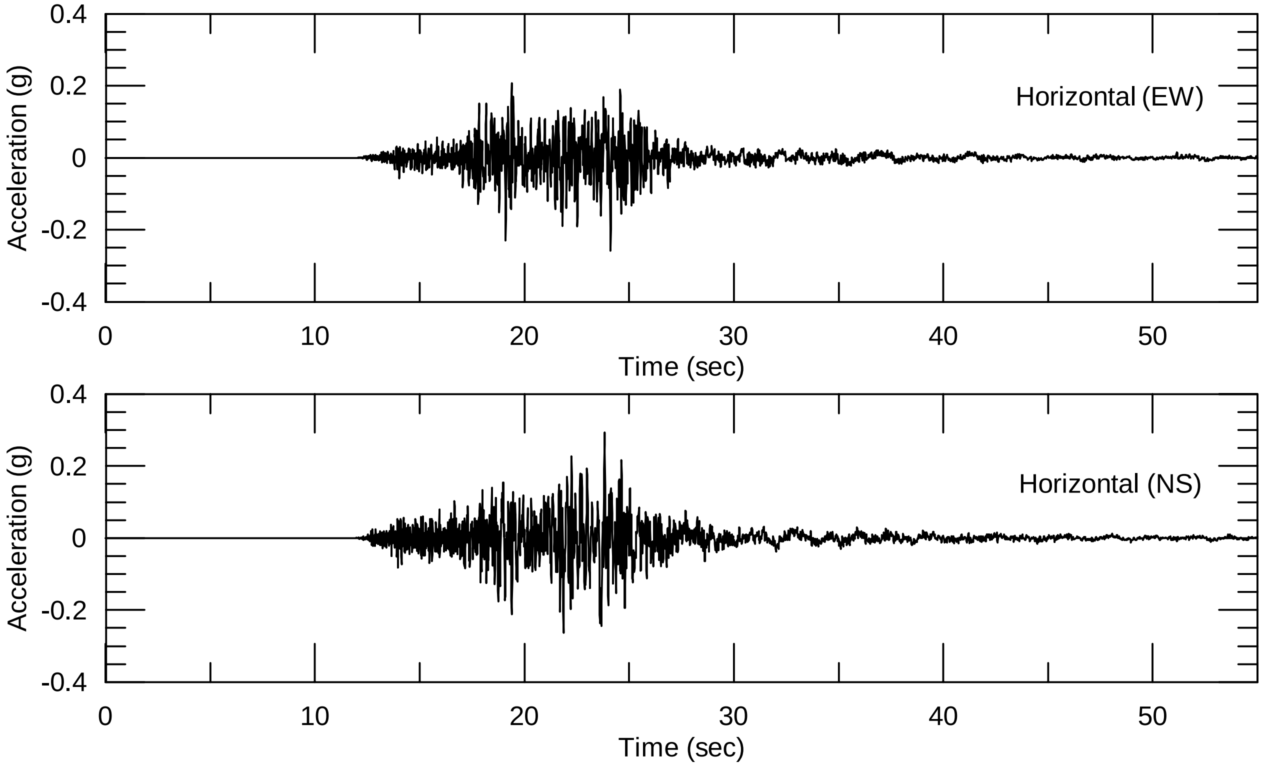


Project No. 60442676

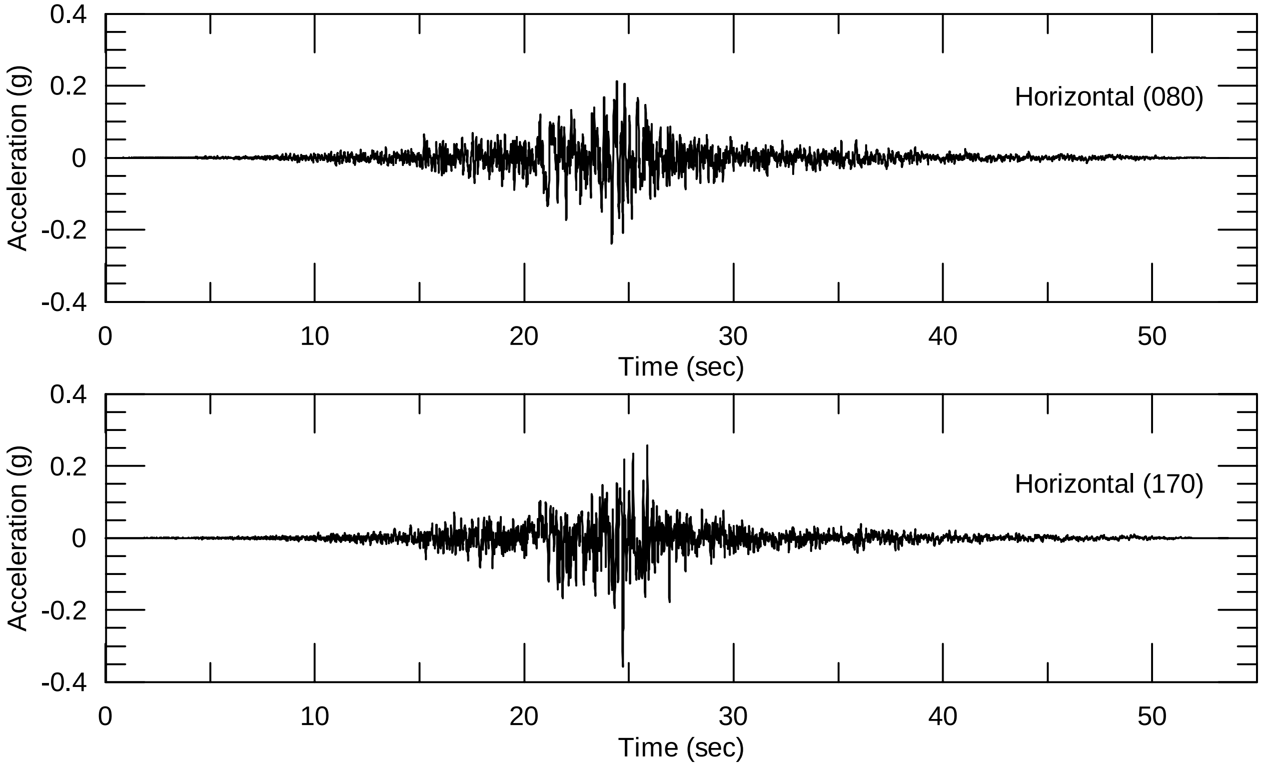
A.B. Brown
Generating Station
Vectren Corporation

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

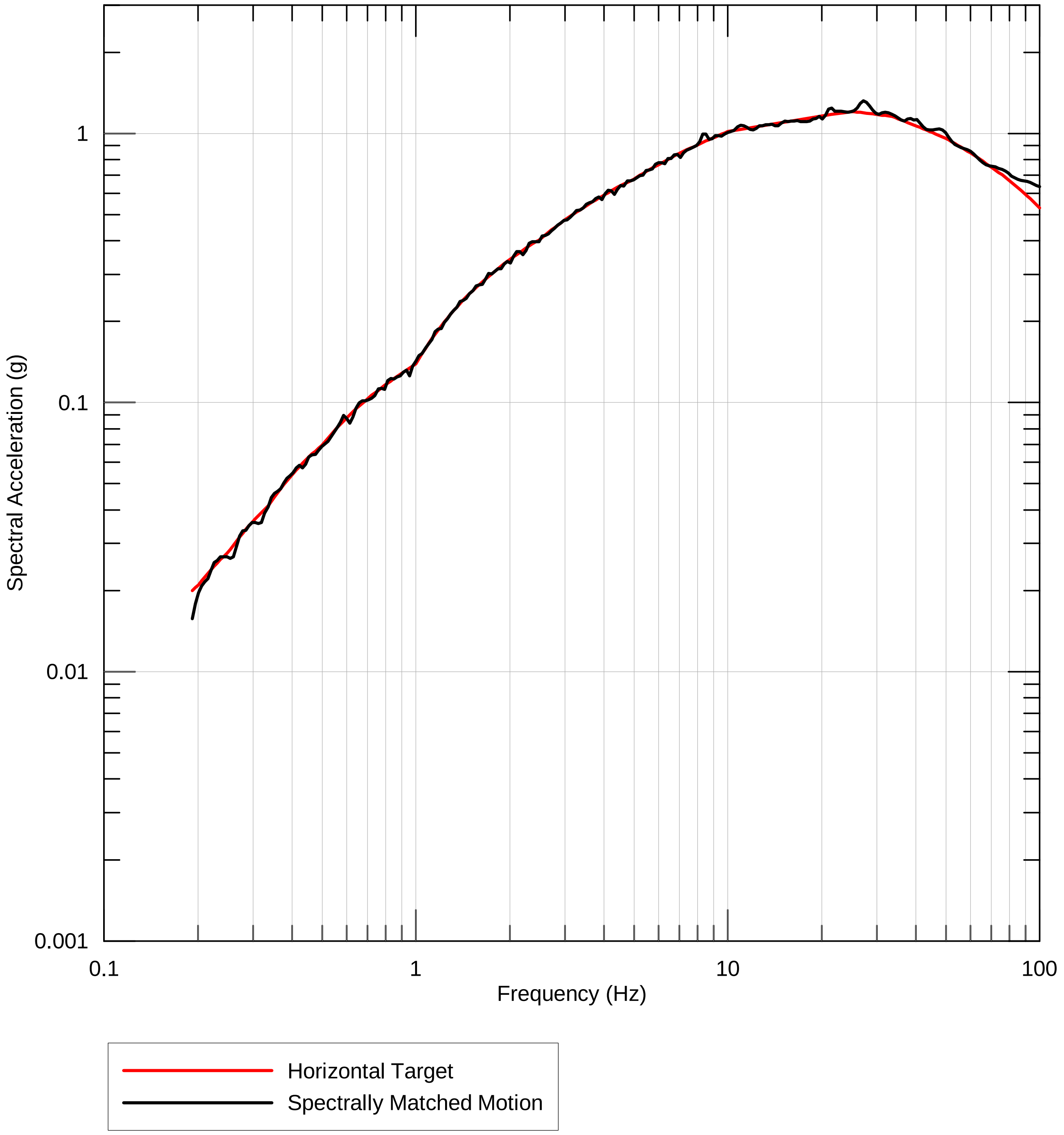


Project No. 60442676

A.B. Brown
Generating Station
Vectren Corporation

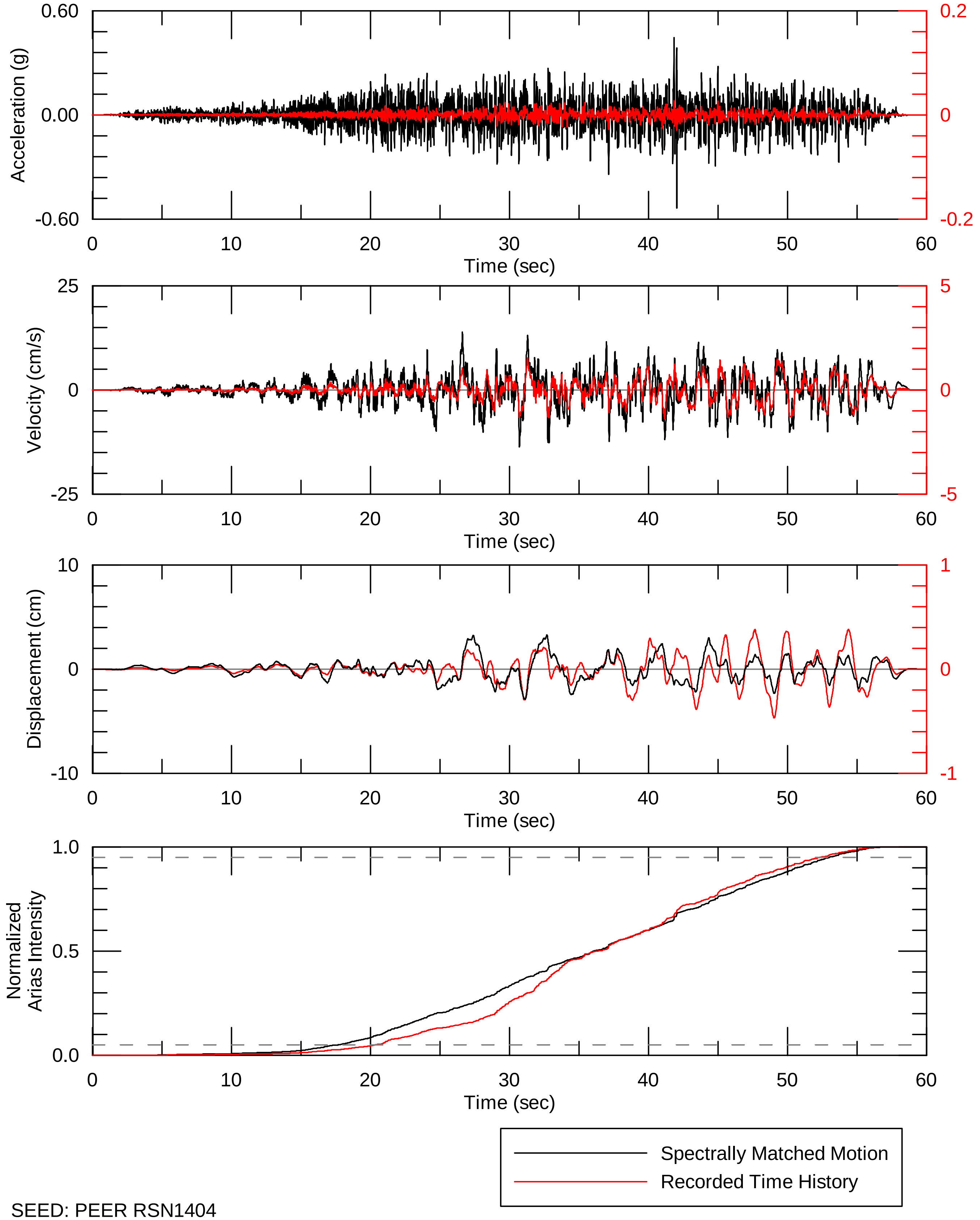
SEED TIME HISTORIES
RSN6928 - DARFIELD
LPCC

Figure
33



SEED: PEER RSN1404

AECOM	Project No. 60442676	RESPONSE SPECTRUM FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 1999 CHI CHI - PNG (E) SEED	Figure 34
	A.B. Brown Generating Station Vectren Corporation		



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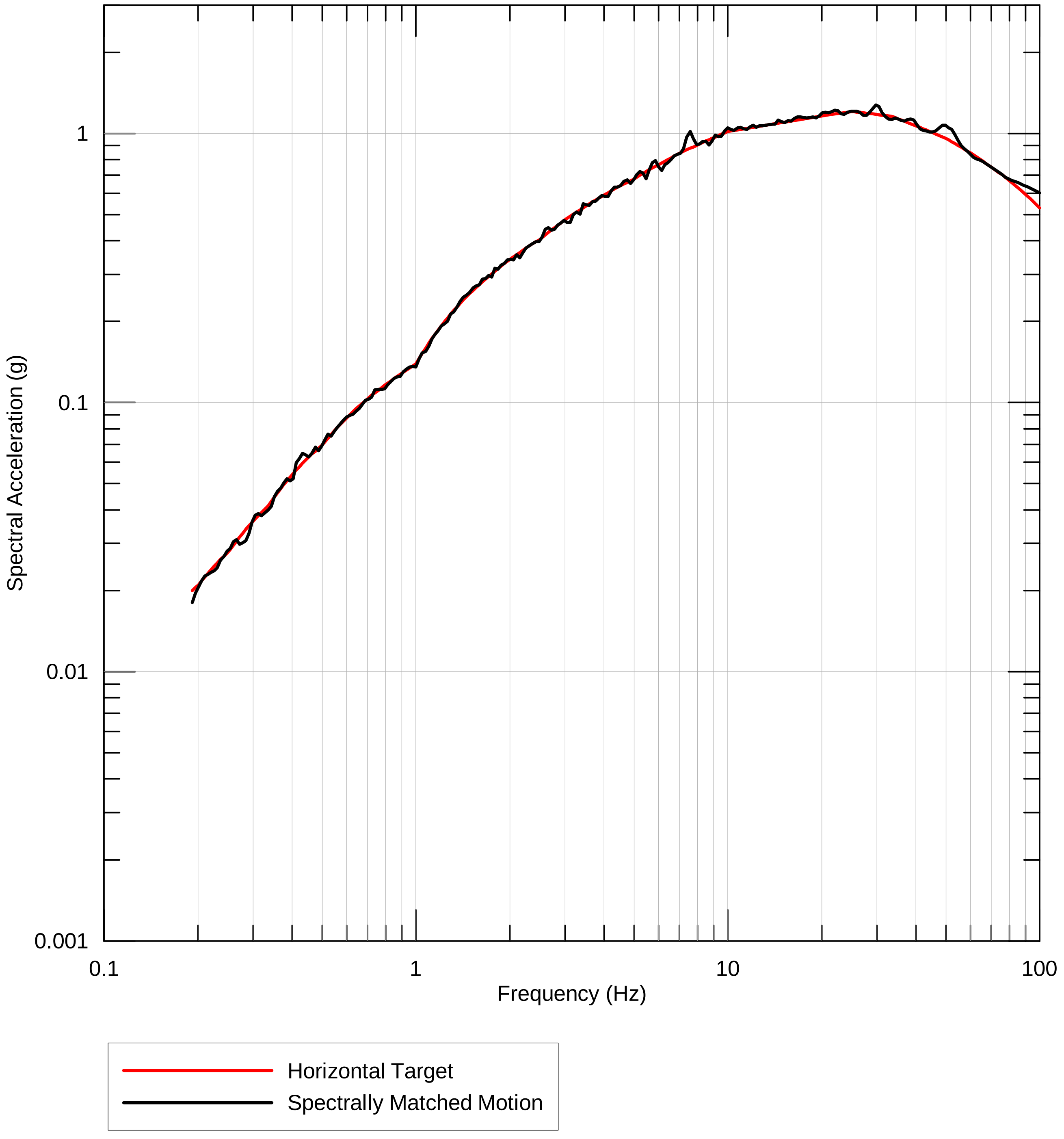
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 1999 CHI CHI - PNG (E) SEED	Figure 35



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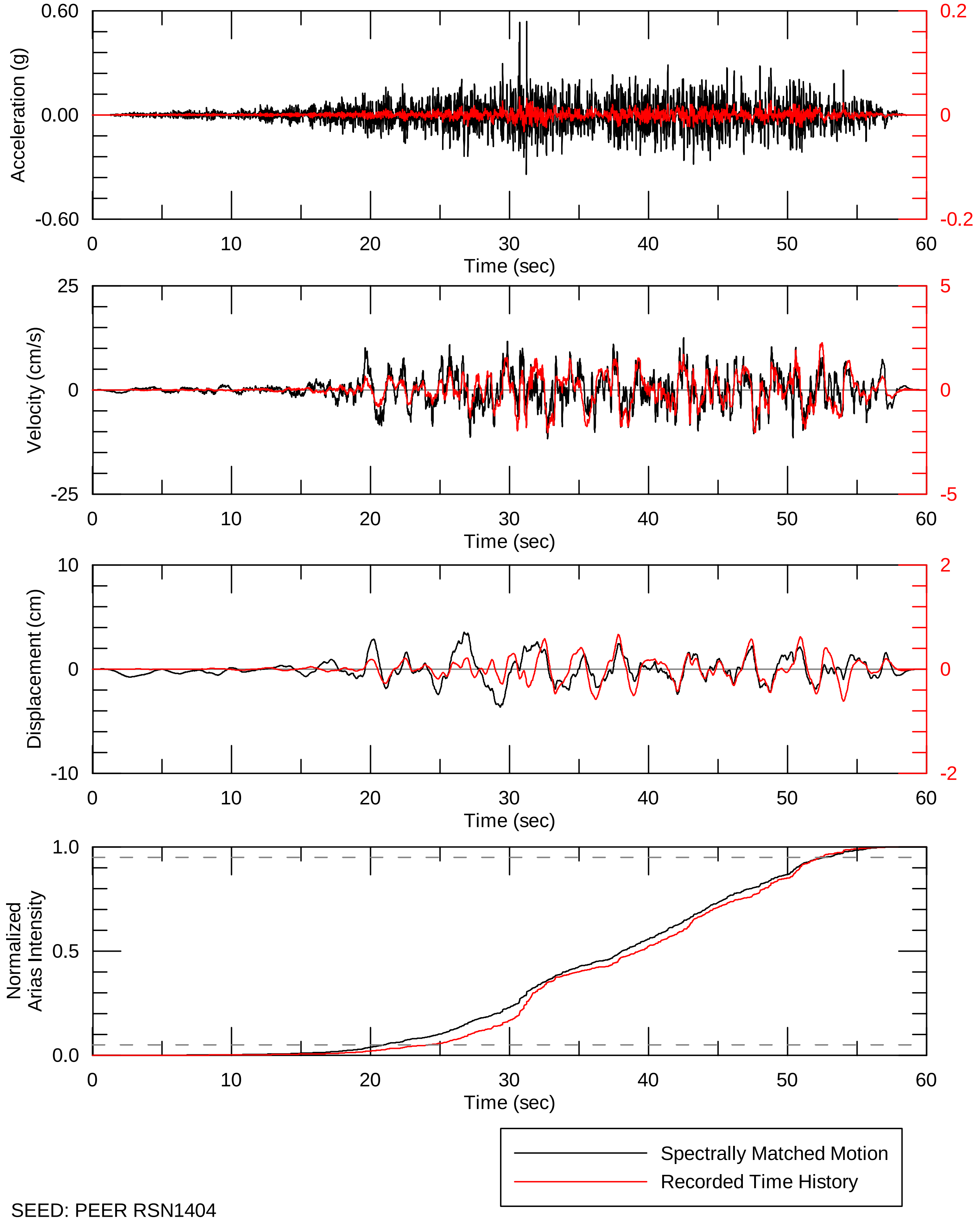
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	RESPONSE SPECTRUM FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 1999 CHI CHI - PNG (N) SEED	Figure 36



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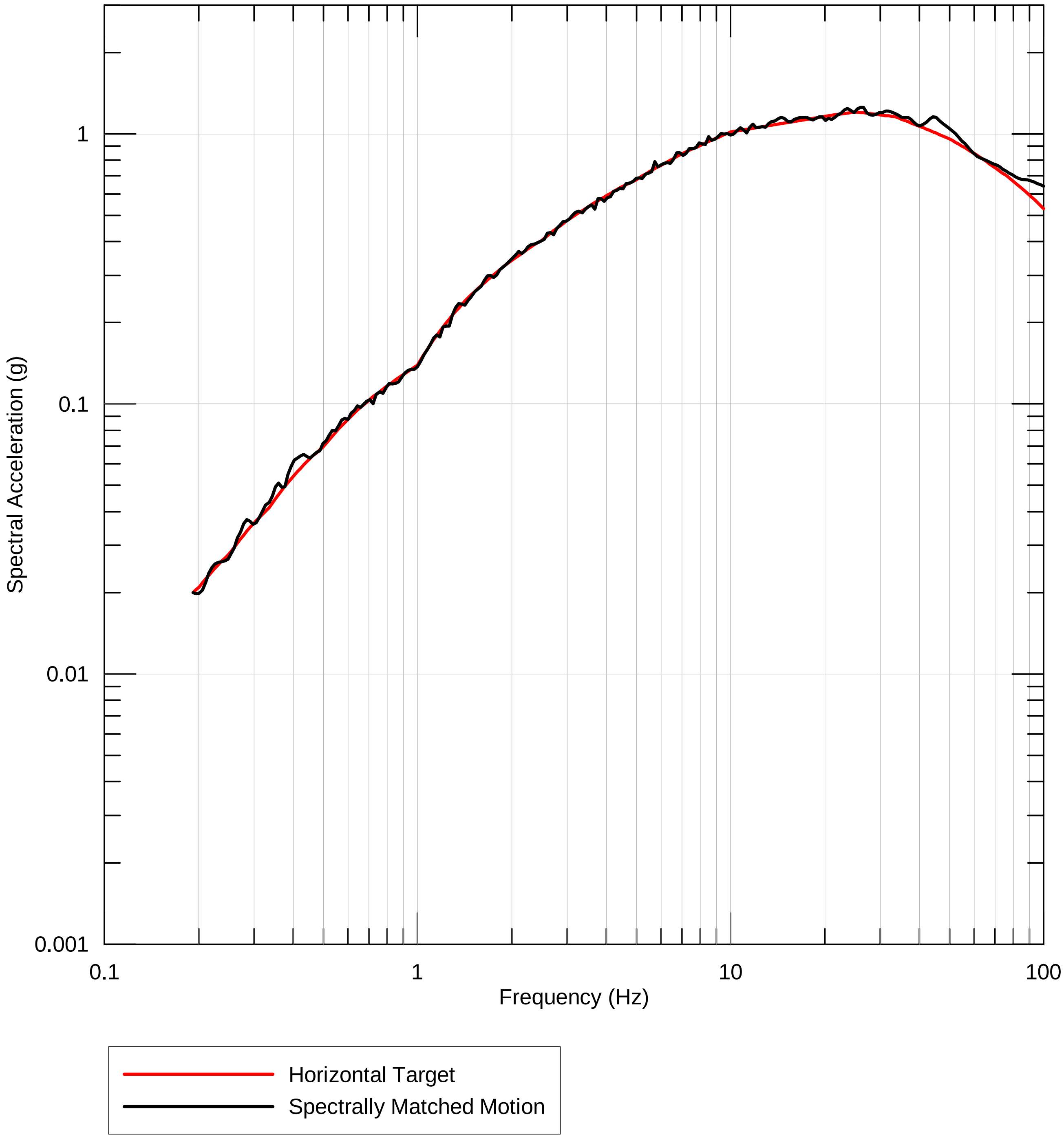
AECOM	Project No. 60442676	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 1999 CHI CHI - PNG (N) SEED	Figure 37
	A.B. Brown Generating Station Vectren Corporation		



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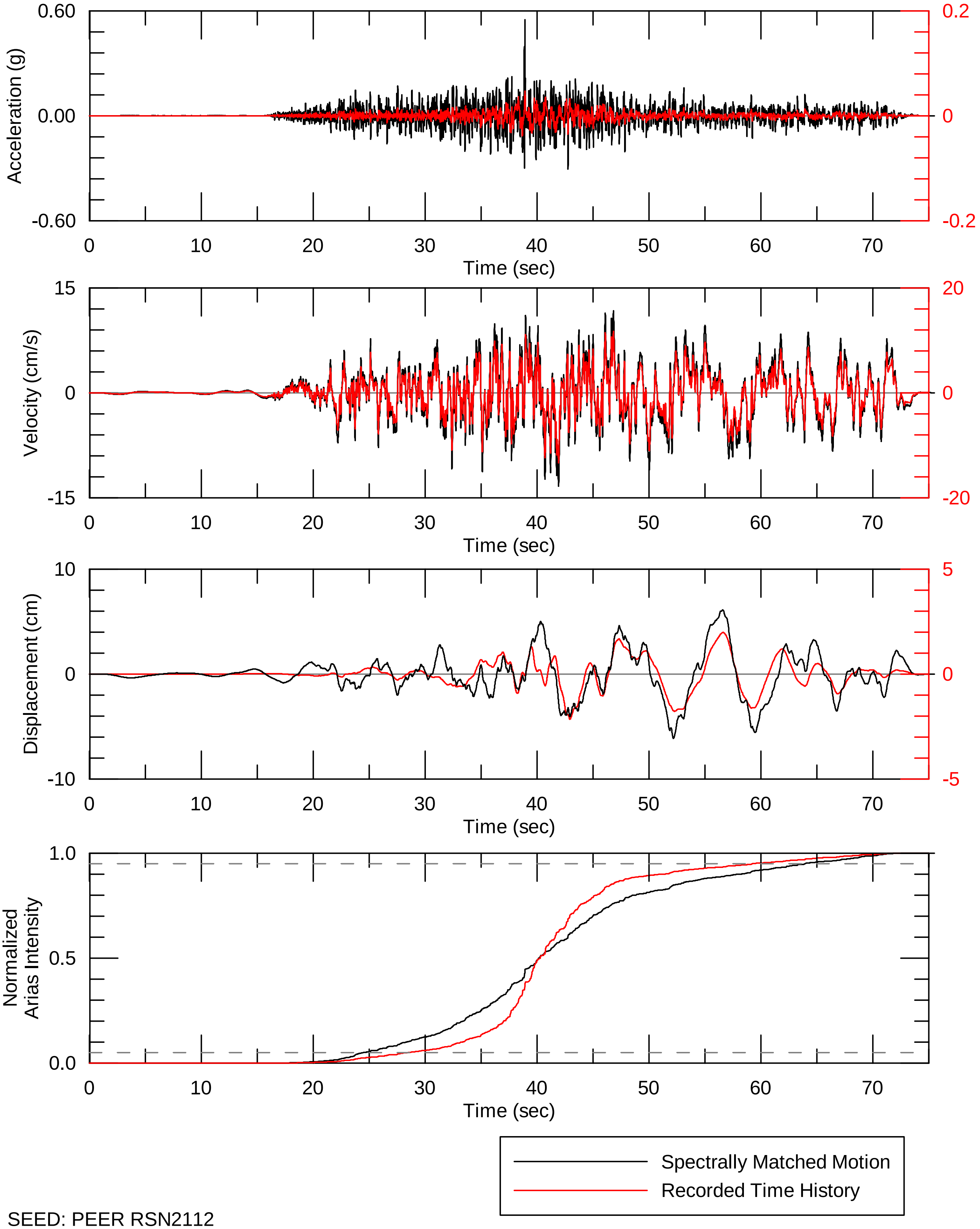
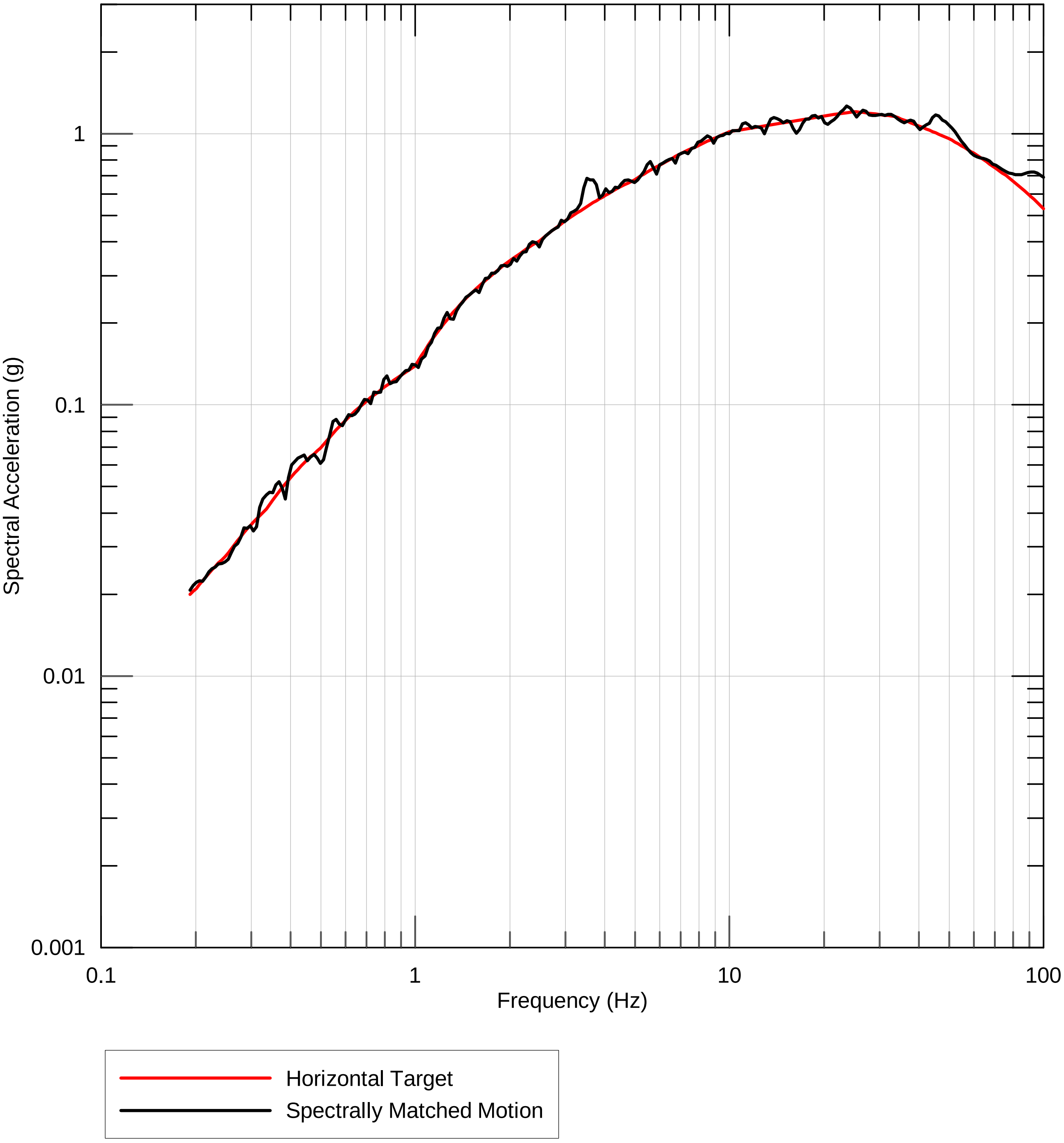
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	RESPONSE SPECTRUM FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2002 DENALI - TAPS PUMP STATION #8 (049) SEED	Figure 38



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



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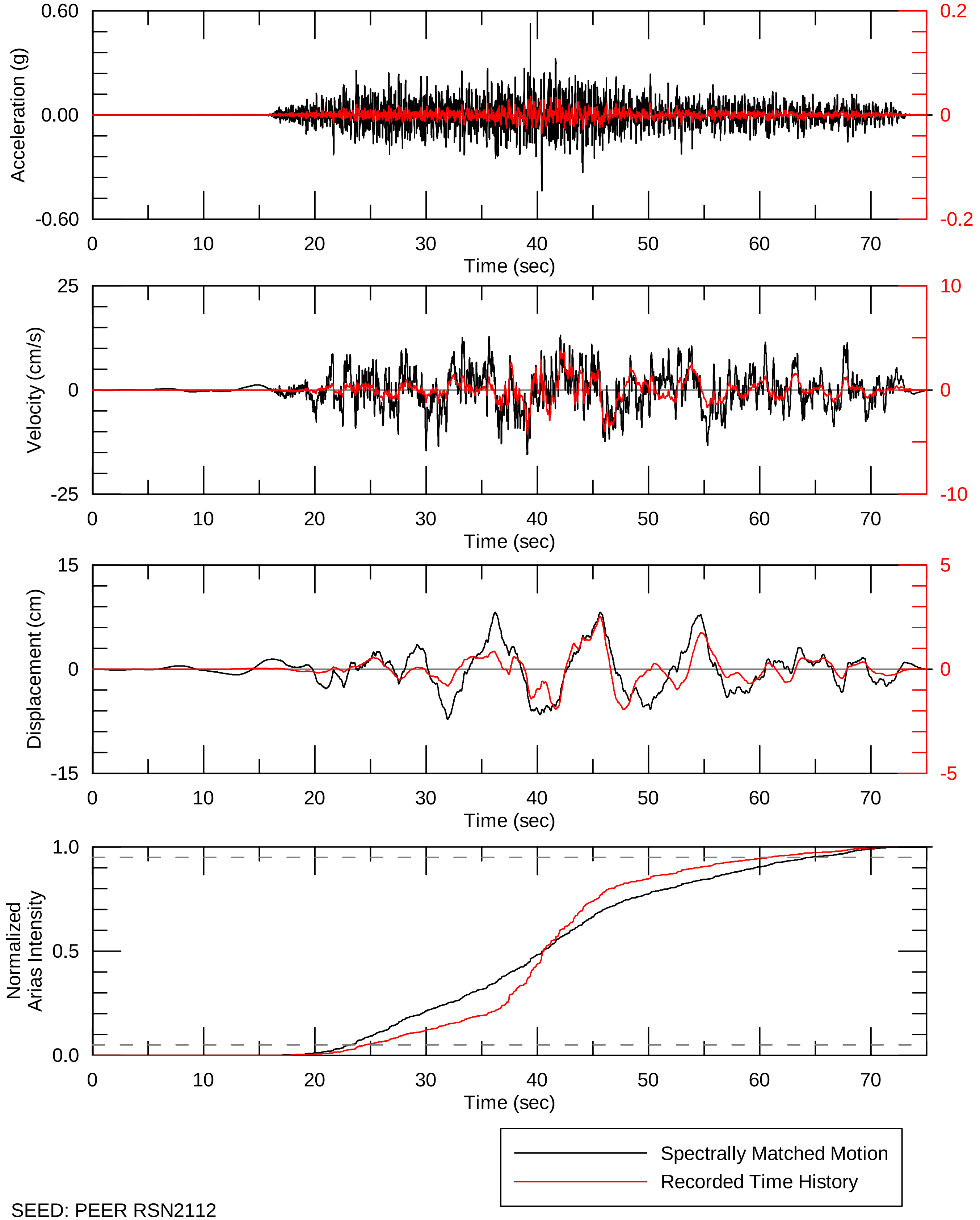
	A.B. Brown Generating Station Vectren Corporation		



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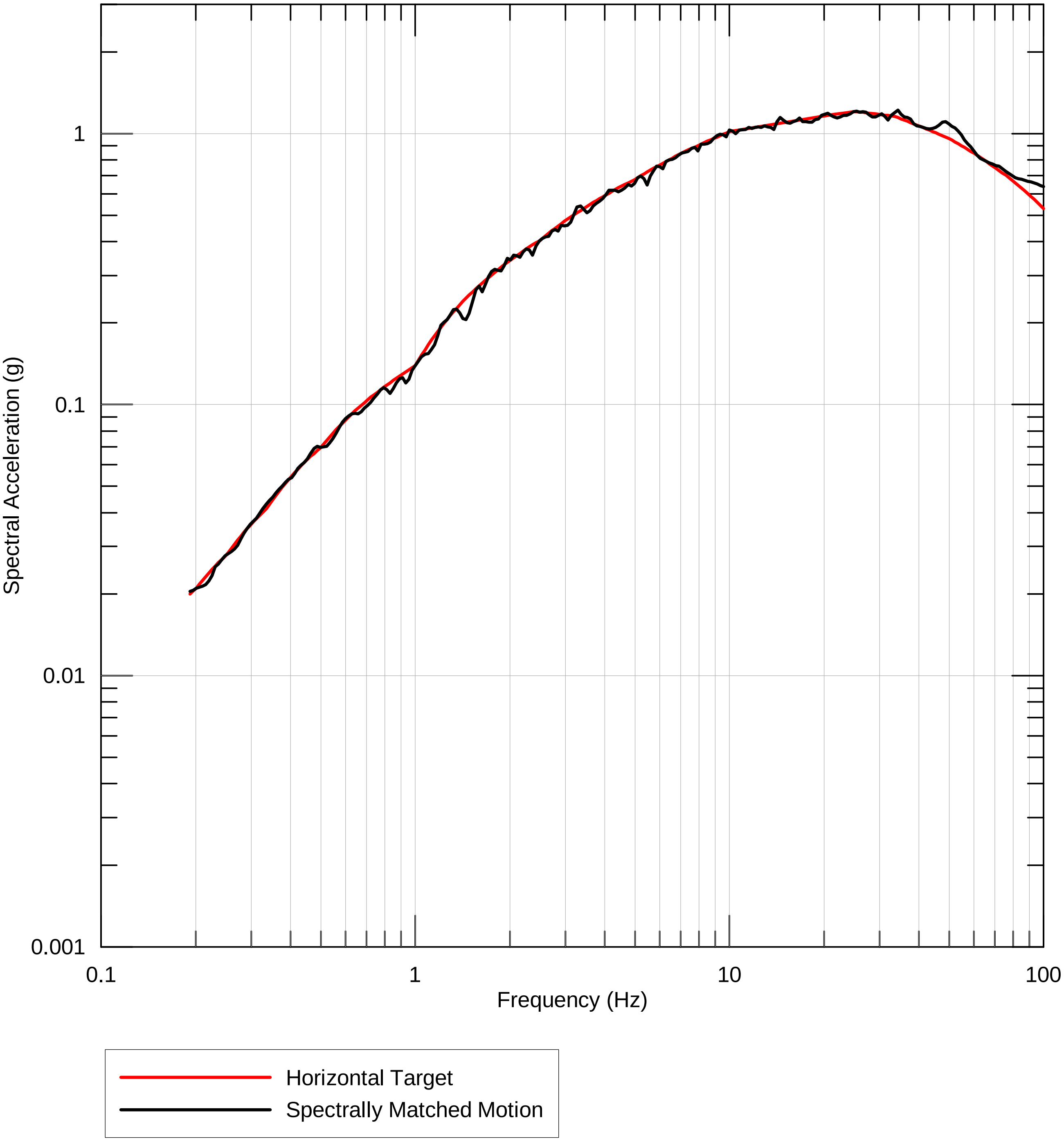
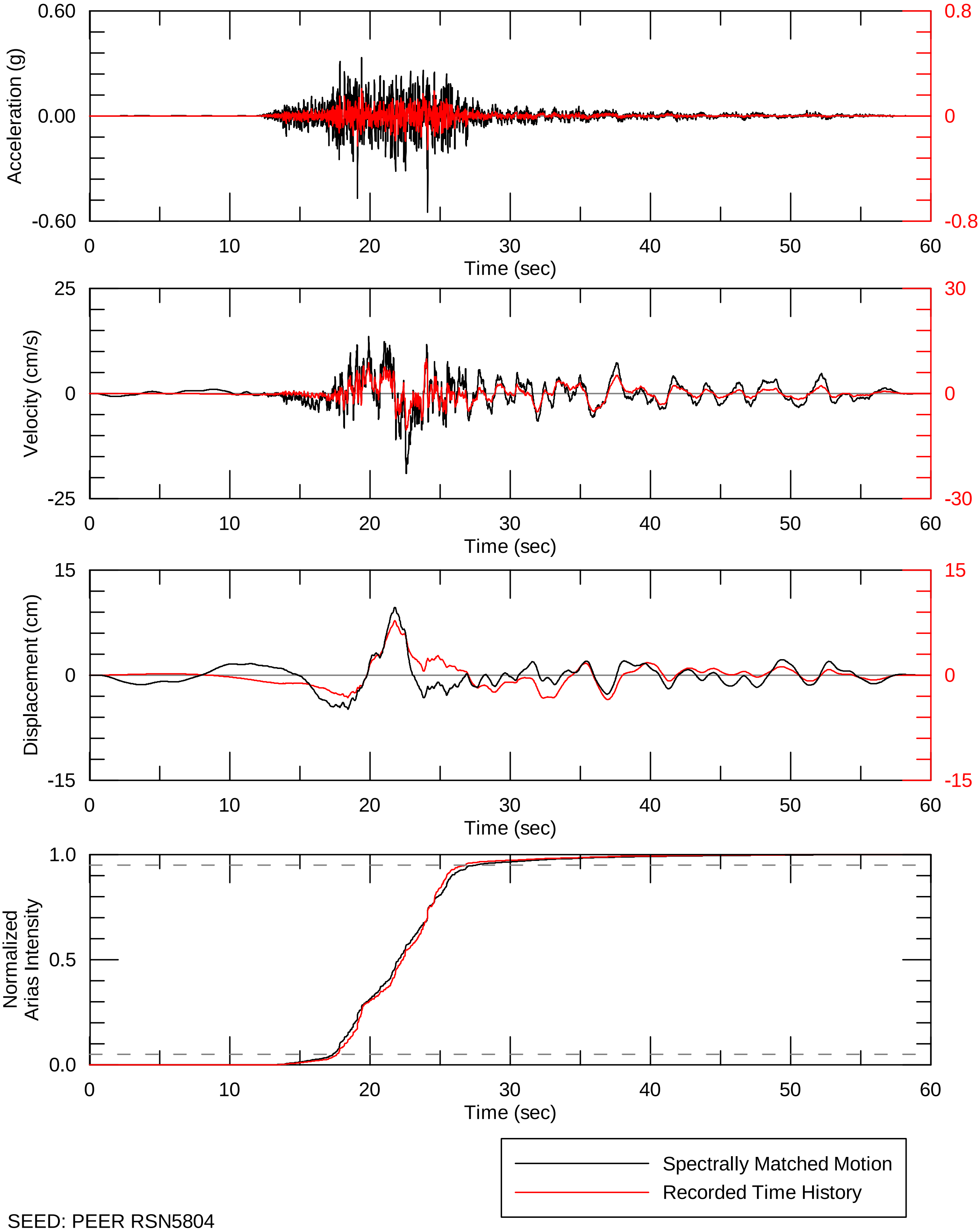
AECOM	Project No. 60442676	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2002 DENALI - TAPS PUMP STATION #8 (319) SEED	Figure 41
	A.B. Brown Generating Station Vectren Corporation		



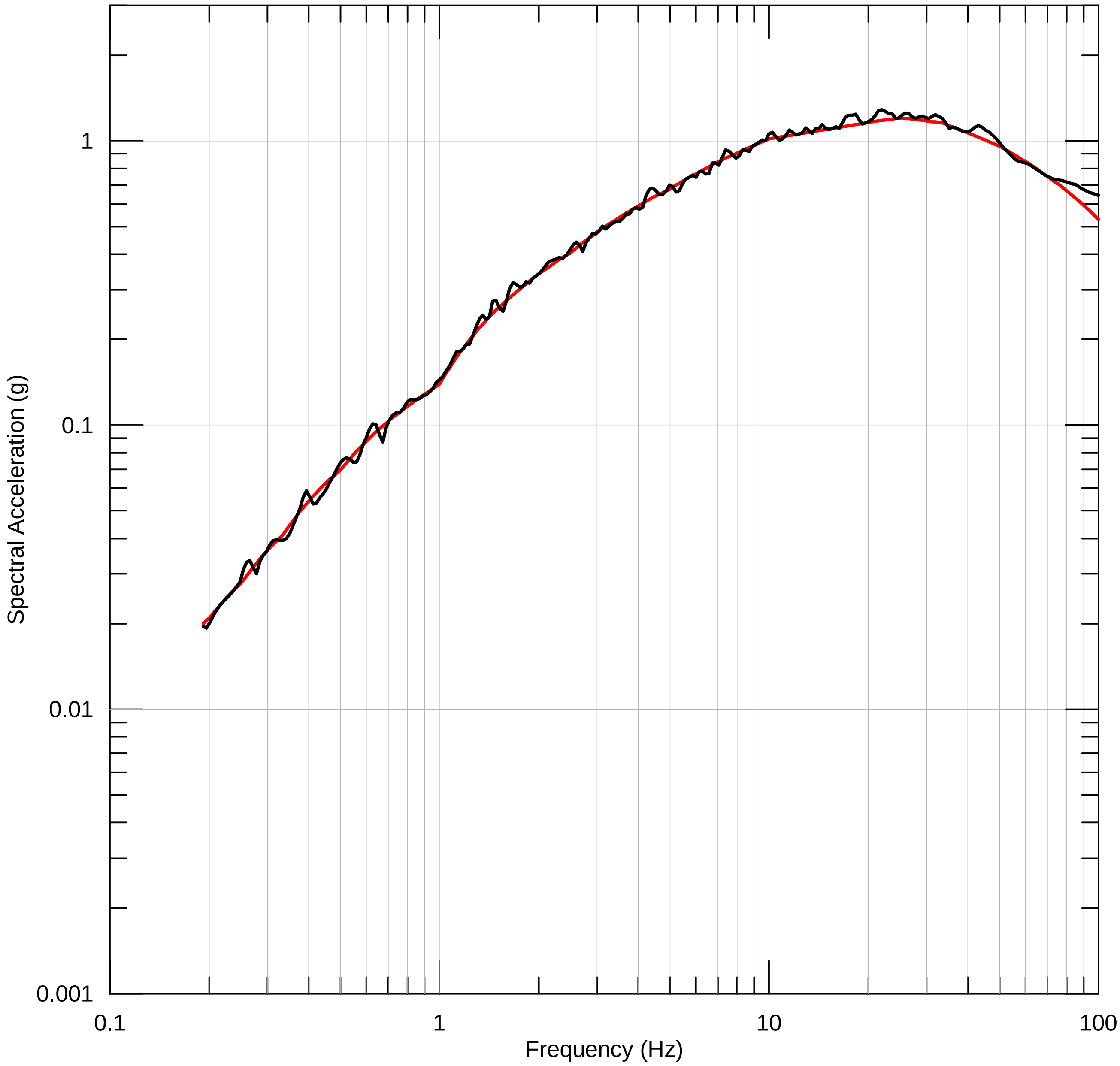
SEED: PEER RSN5804

AECOM	Project No.60442676	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
	A.B. Brown Generating Station Vectren Corporation		



SEED: PEER RSN5804

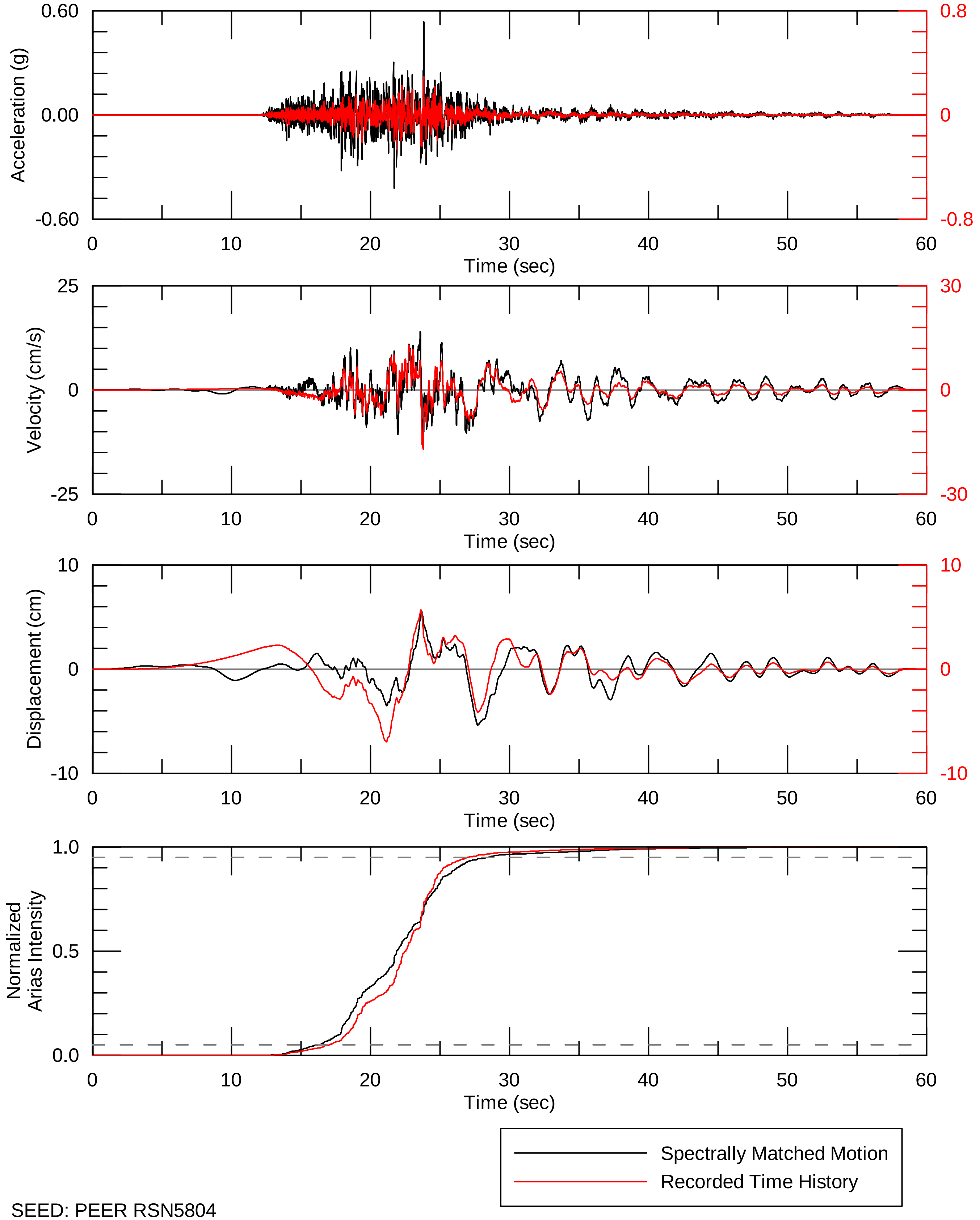
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2008 IWATE - YAMAUCHI TSUCHIBUCHI YOKOTE (EW) SEED	Figure 43



—	Horizontal Target
—	Spectrally Matched Motion

SEED: PEER RSN5804

AECOM	Project No.60442676	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
	A.B. Brown Generating Station Vectren Corporation		



SEED: PEER RSN5804

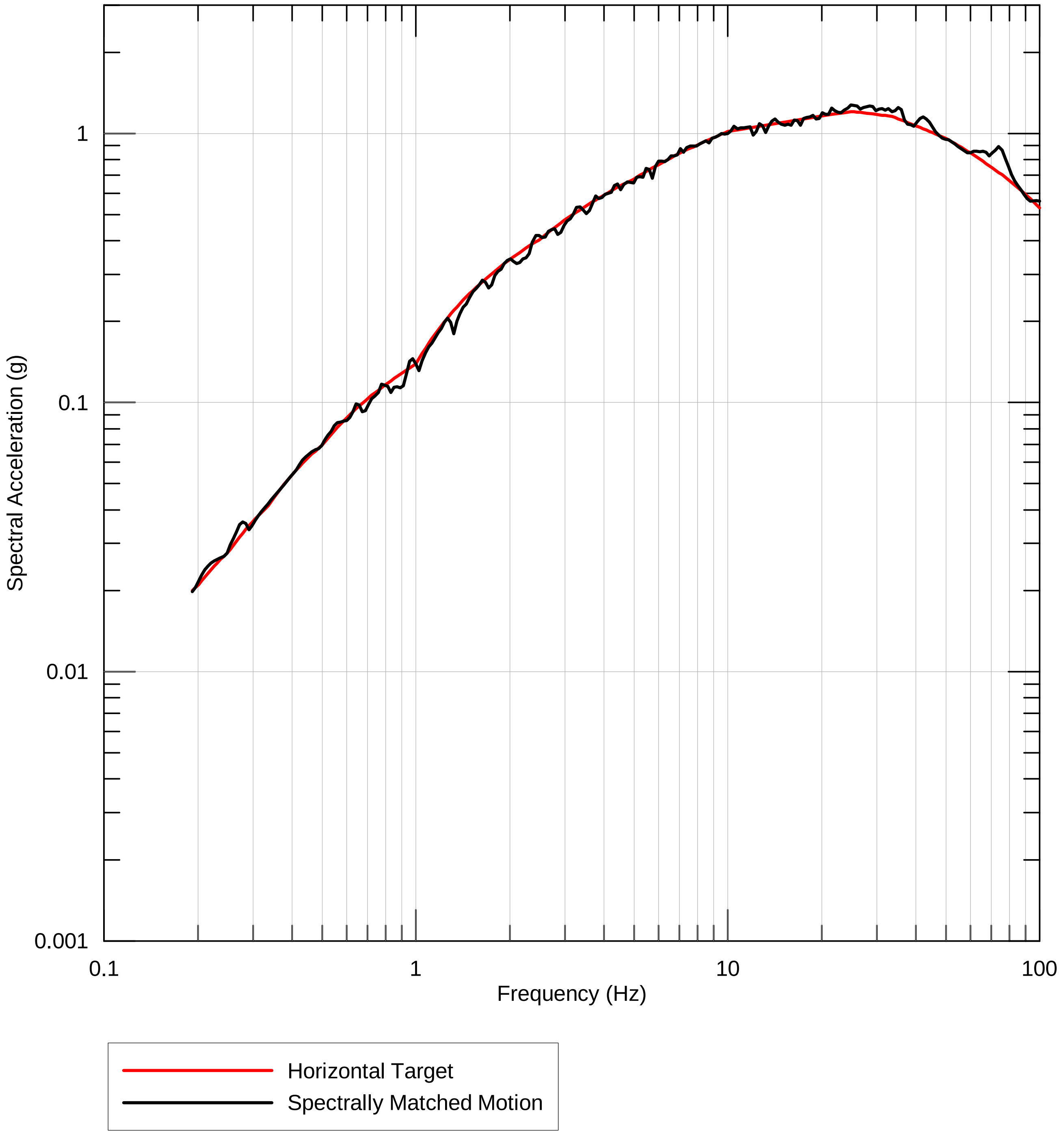
AECOM

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



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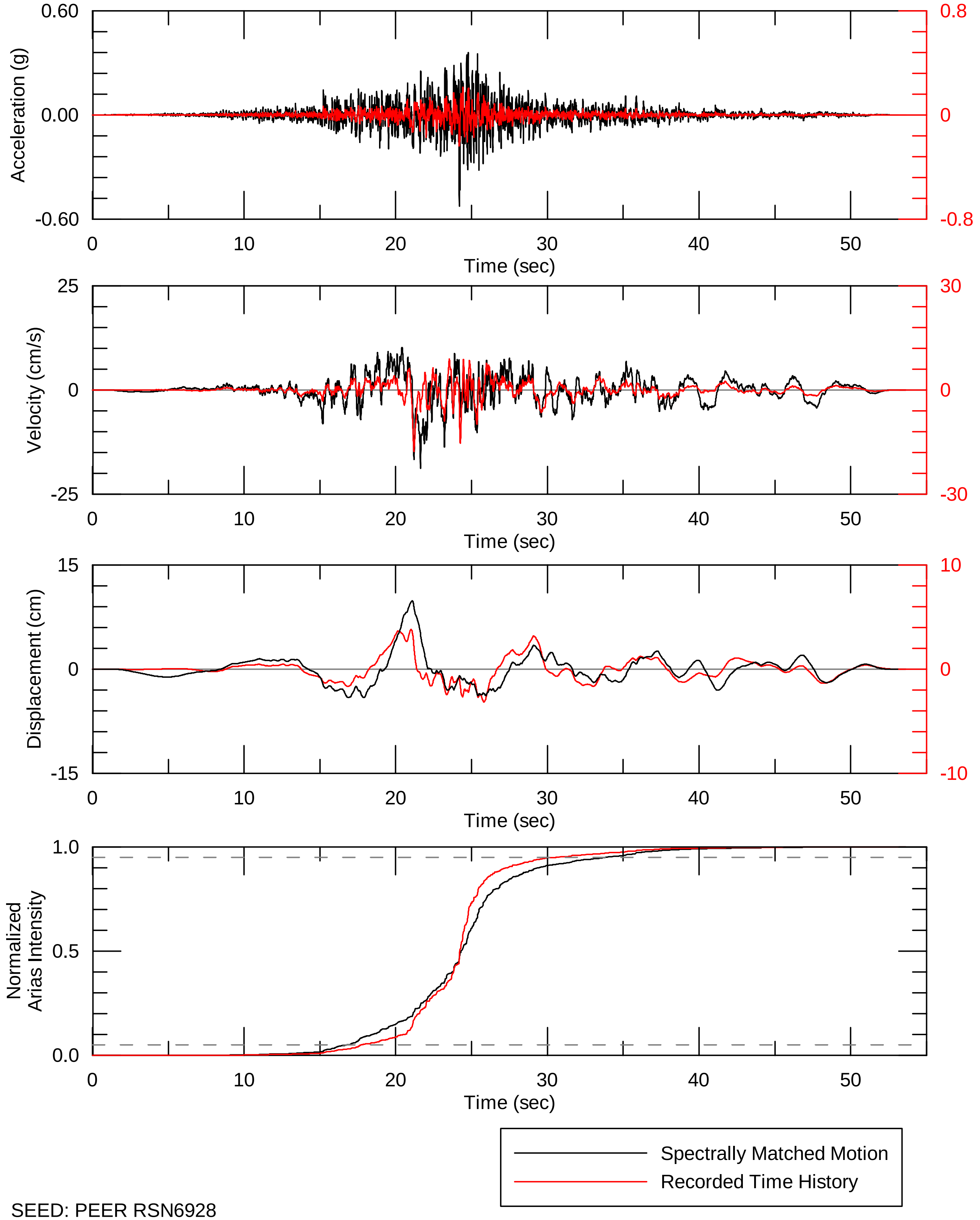
AECOM	Project No.60442676 A.B. Brown Generating Station Vectren Corporation	RESPONSE SPECTRUM FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2010 DARFIELD - LPCC (080) SEED	Figure 46



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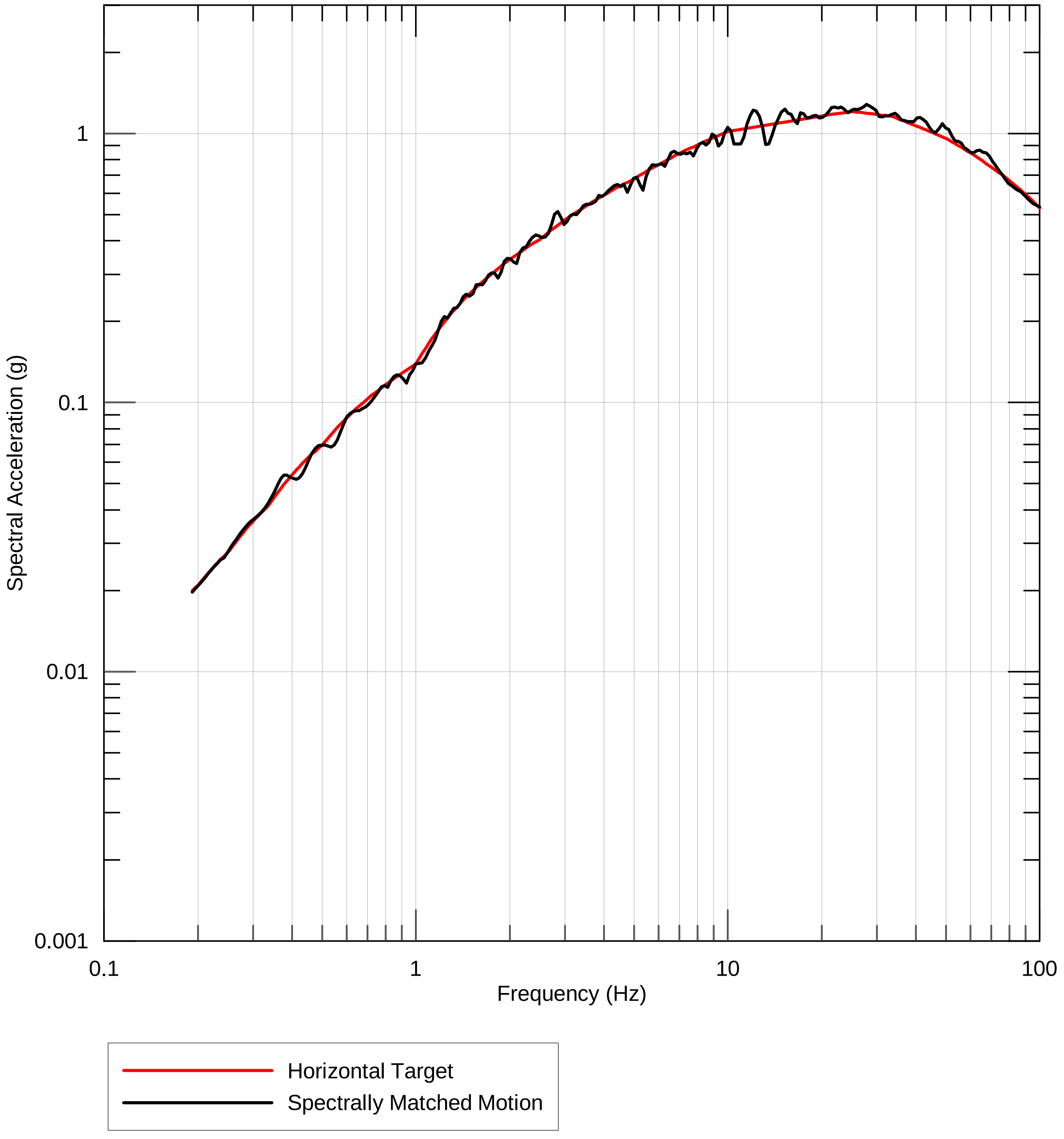
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2010 DARFIELD - LPCC (080) SEED	Figure 47



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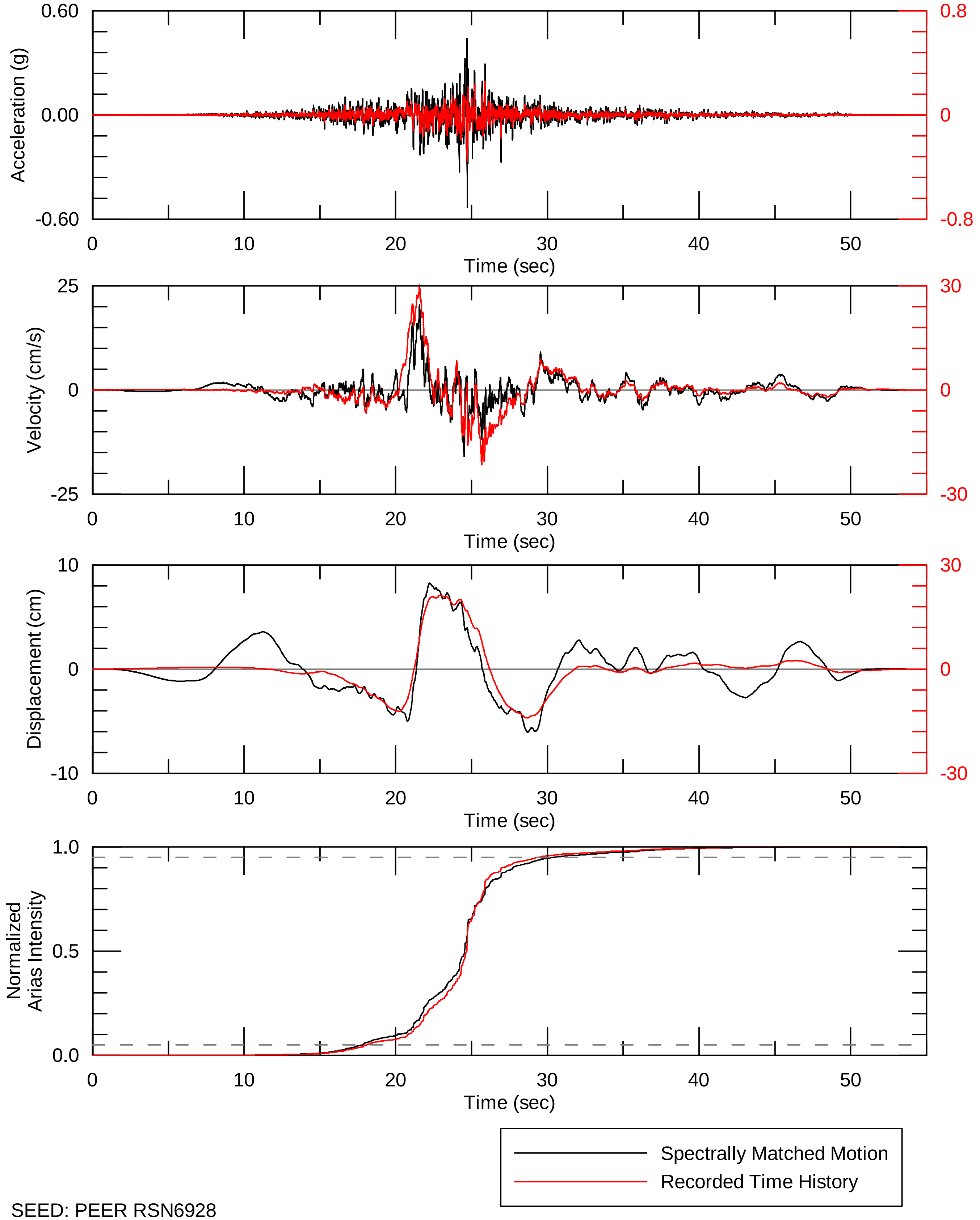
AECOM	Project No. 60442676 A.B. Brown Generating Station Vectren Corporation	RESPONSE SPECTRUM FOR TIME HISTORY SPECTRALLY MATCHED TO 2,500-YEAR RETURN PERIOD UHS HORIZONTAL TARGET 2010 DARFIELD - LPCC (170) SEED	Figure 48



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 (ν), 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_{cvc} = 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.

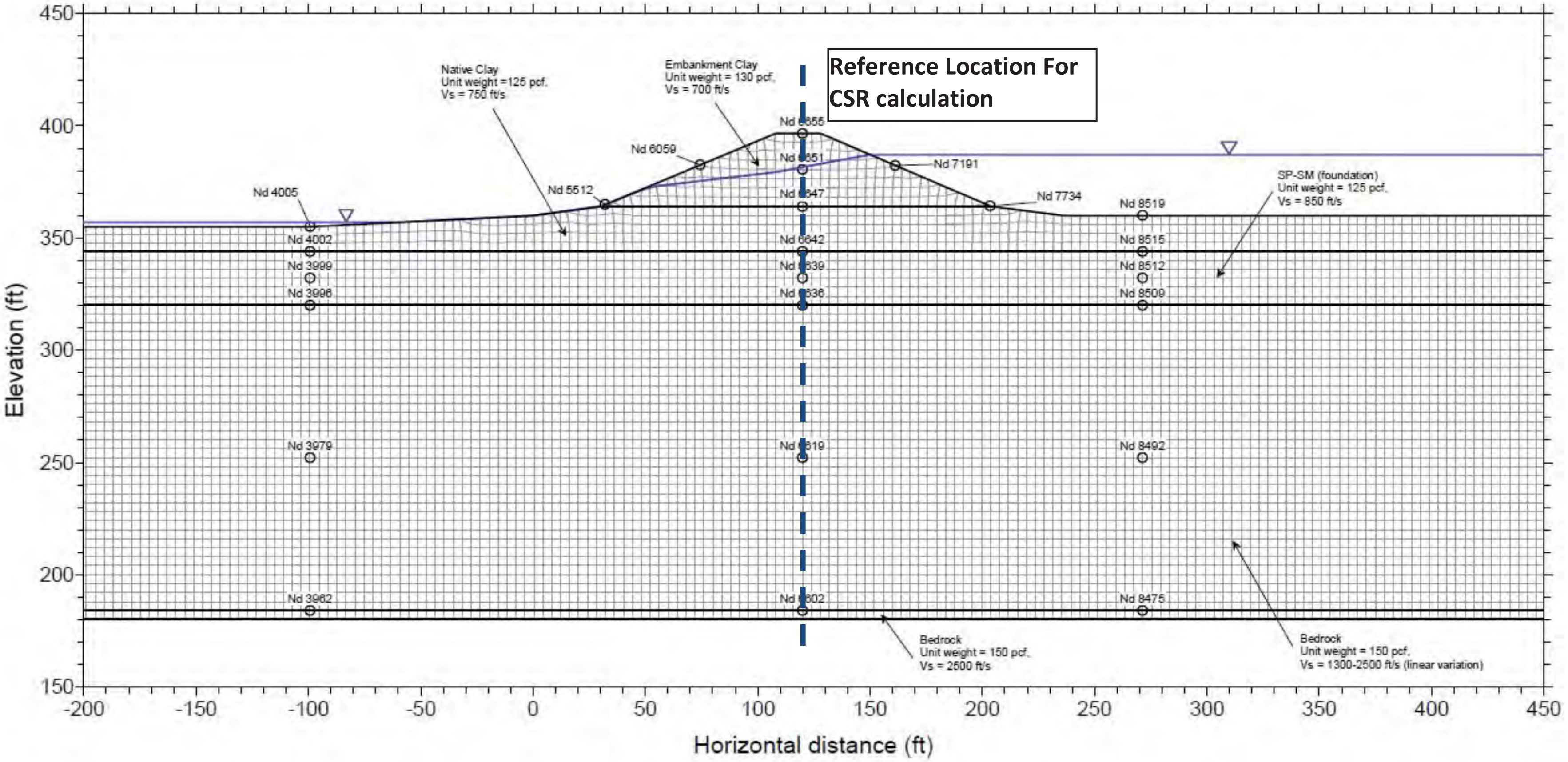
D. Attachments

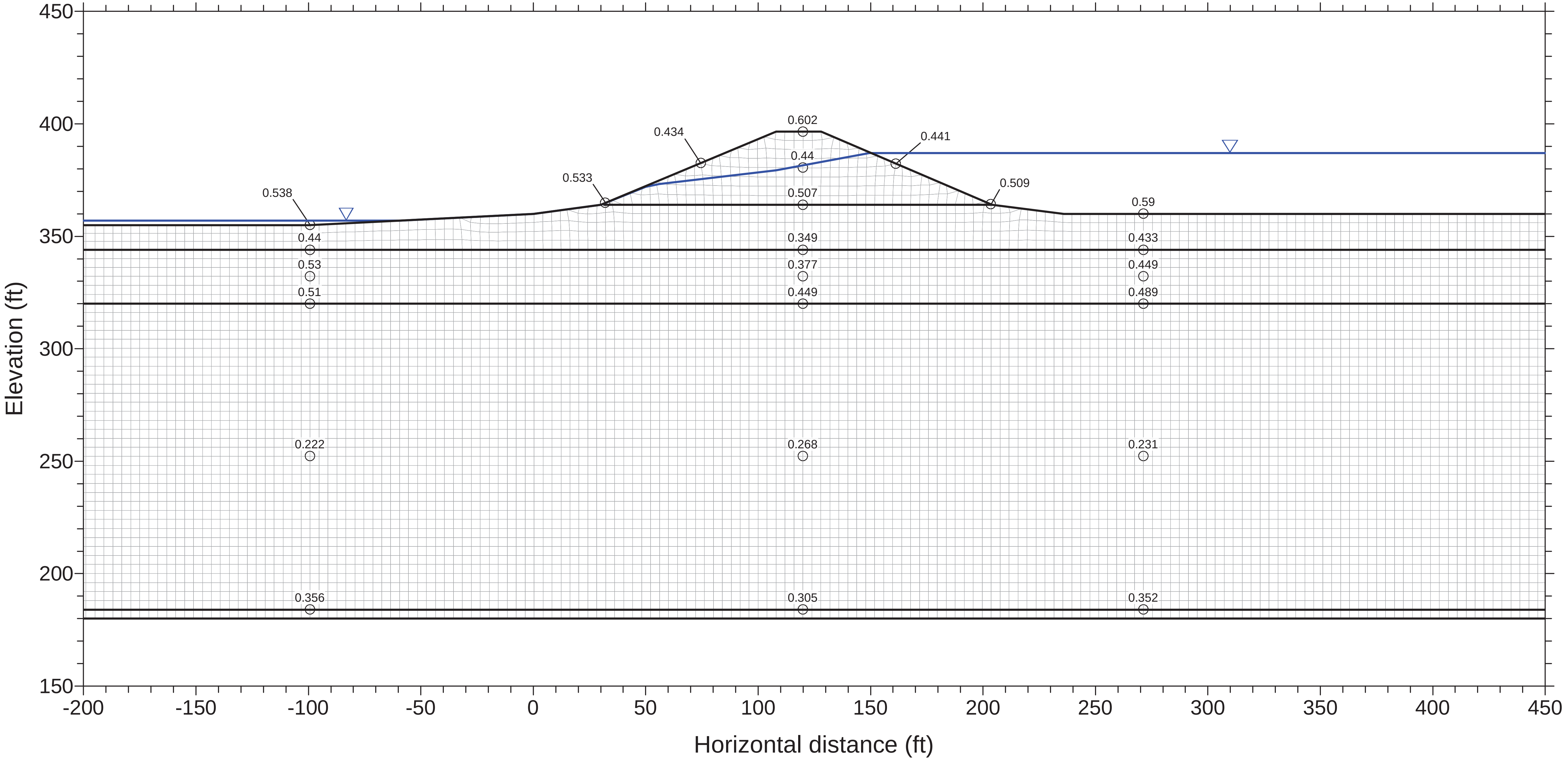
H.1 QUAD-4M Dynamic Response Analysis Output

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 6855
Nd 6851
Nd 6847
Nd 6642
Nd 6839
Nd 6836
Nd 6819
Nd 6802
Nd 7191
Nd 7734
Nd 8519
Nd 8515
Nd 8512
Nd 8509
Nd 8492
Nd 8475
Elevation (ft)
450
400
350
300
250
200
150
Horizontal distance (ft)
-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		

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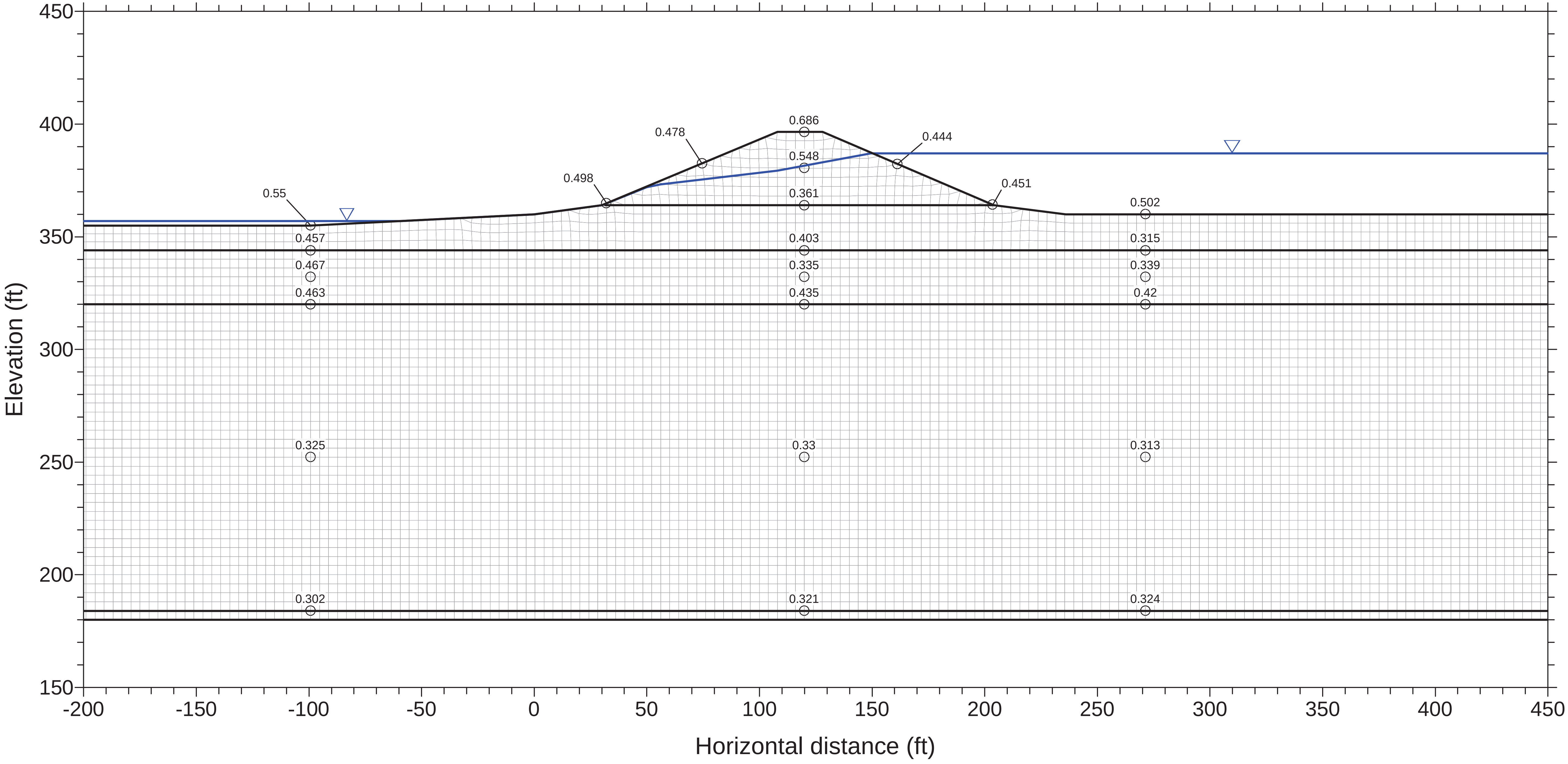
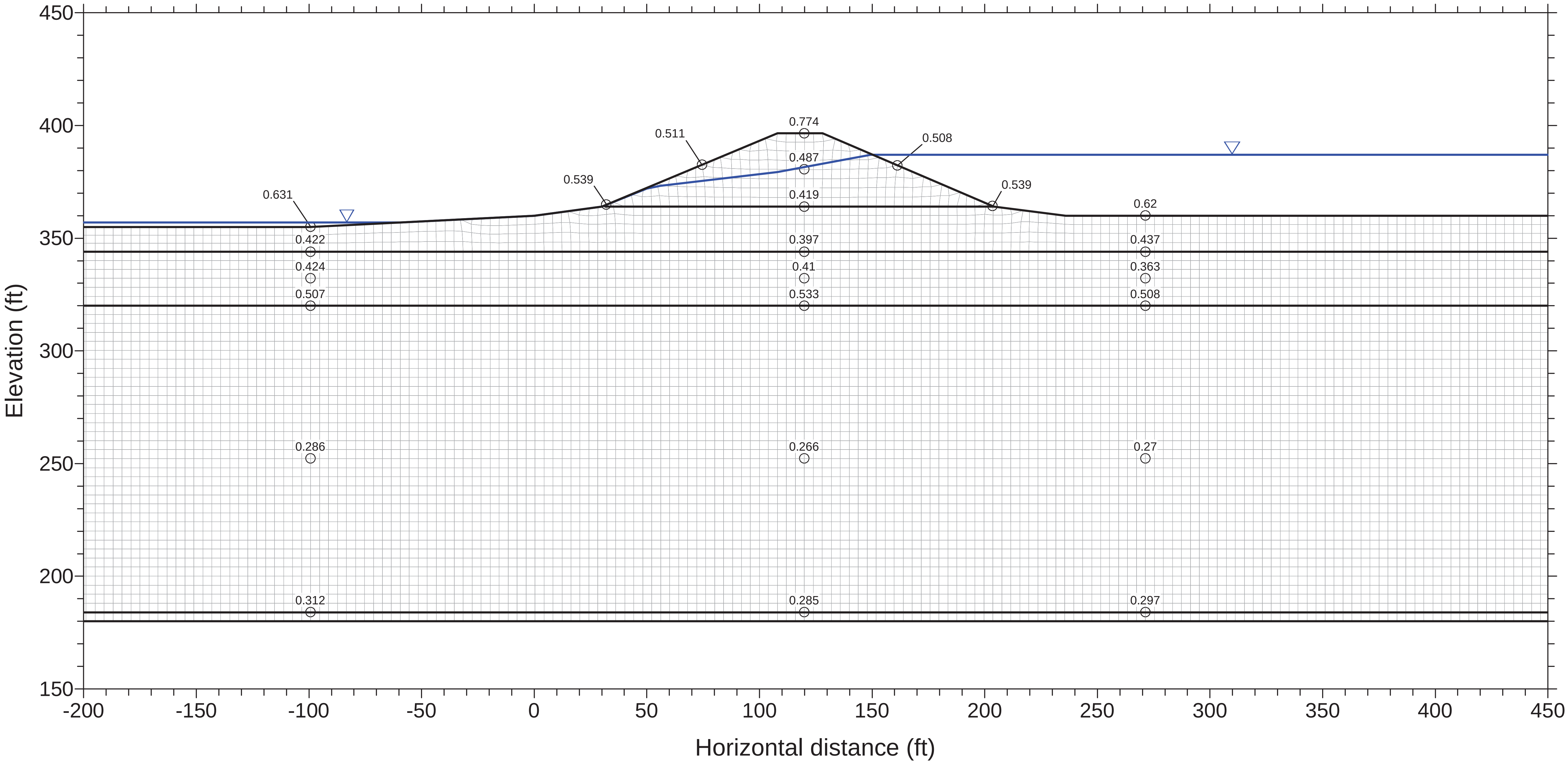


Project No. 60442676	Vectren FB Culley CCR Study	FB Culley East Ash Pond Dam Section QUAD4 Output - Nodal Acceleration (g) Base Motion: TH2	Figure 2-2
	AECOM		



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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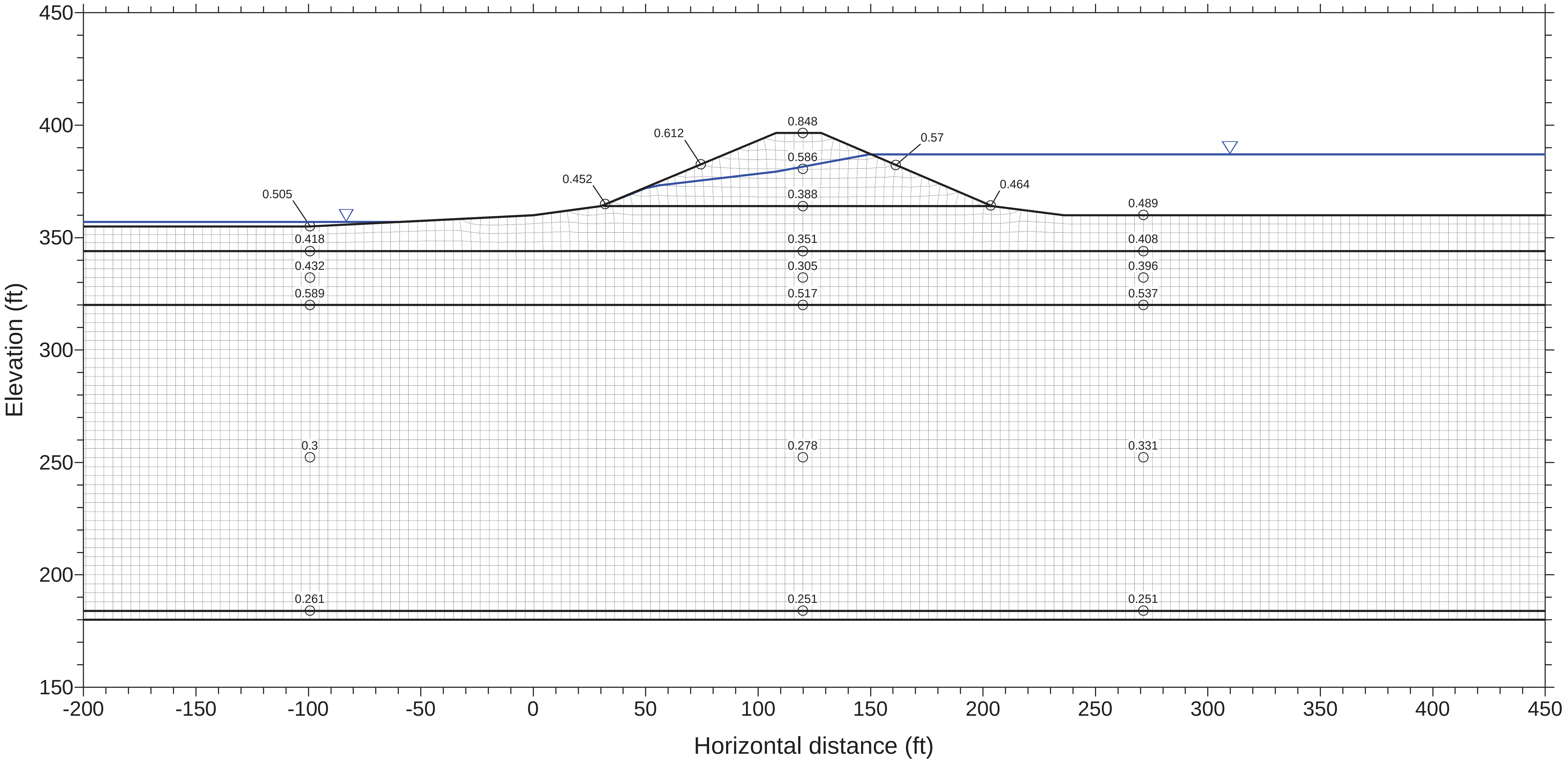
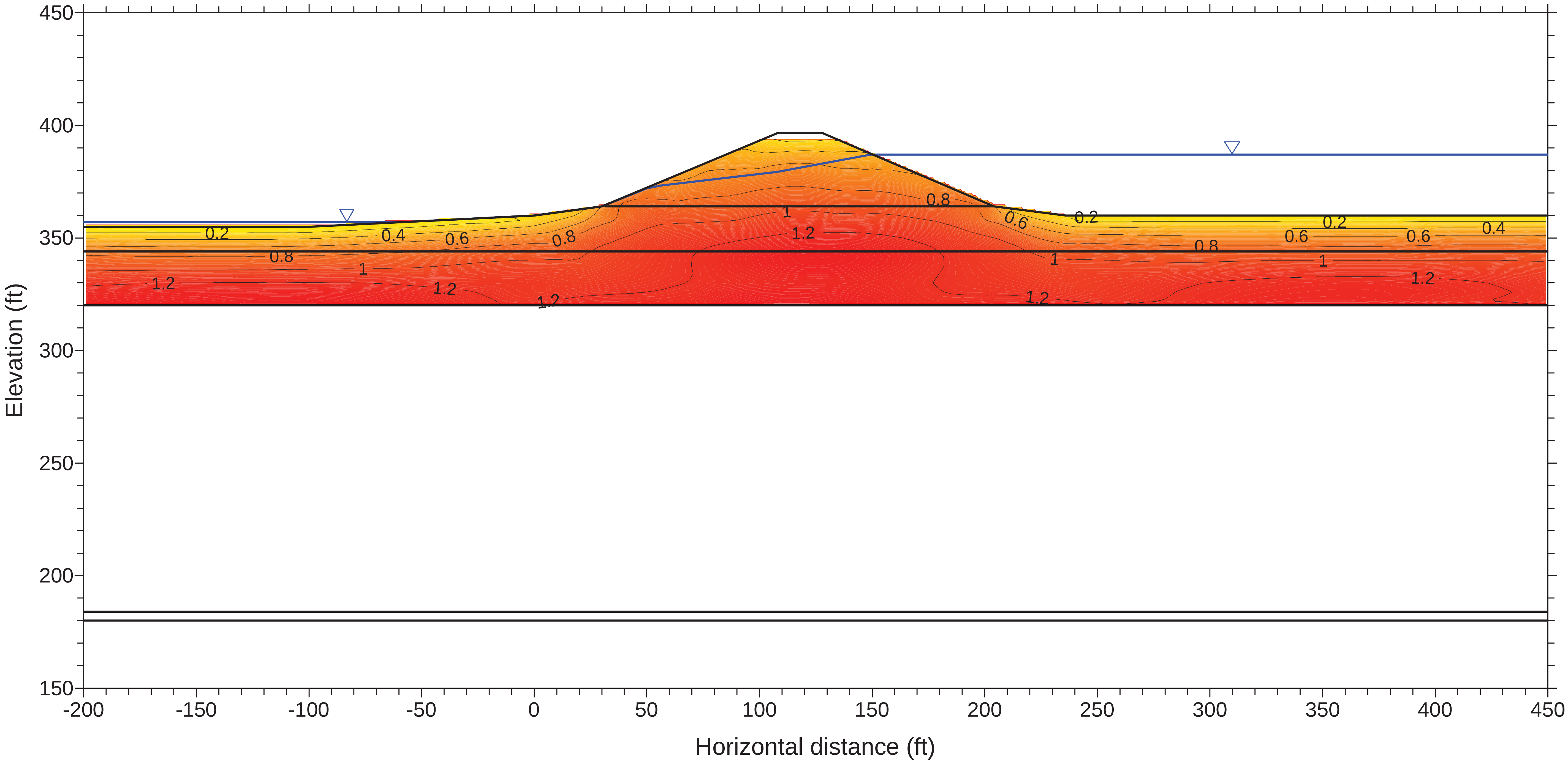
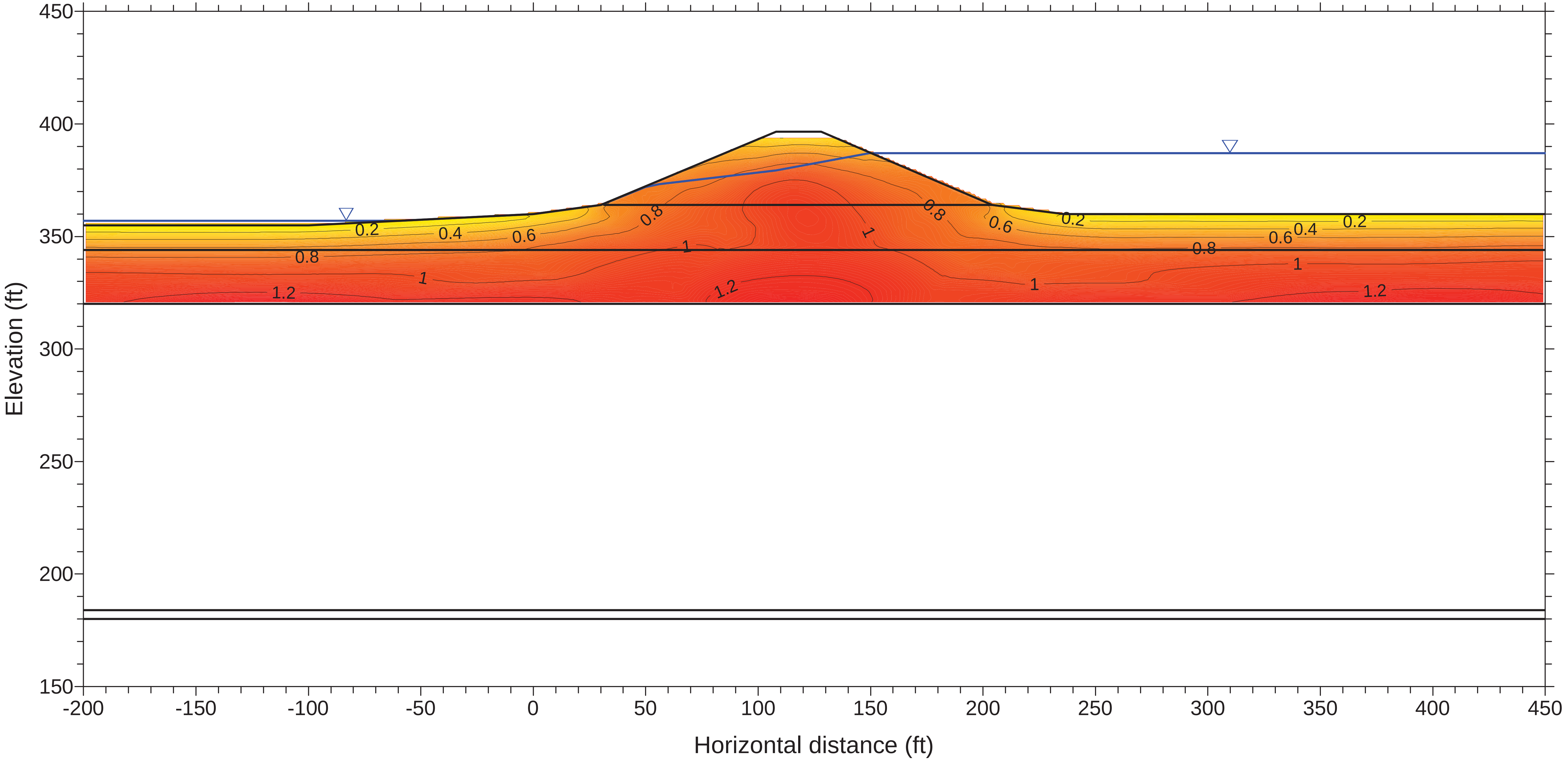


Project No. 60442676	Vectren FB Culley CCR Study	FB Culley East Ash Pond Dam Section QUAD4 Output - Nodal Acceleration (g) Base Motion: TH4	Figure 2-4
	AECOM		



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		



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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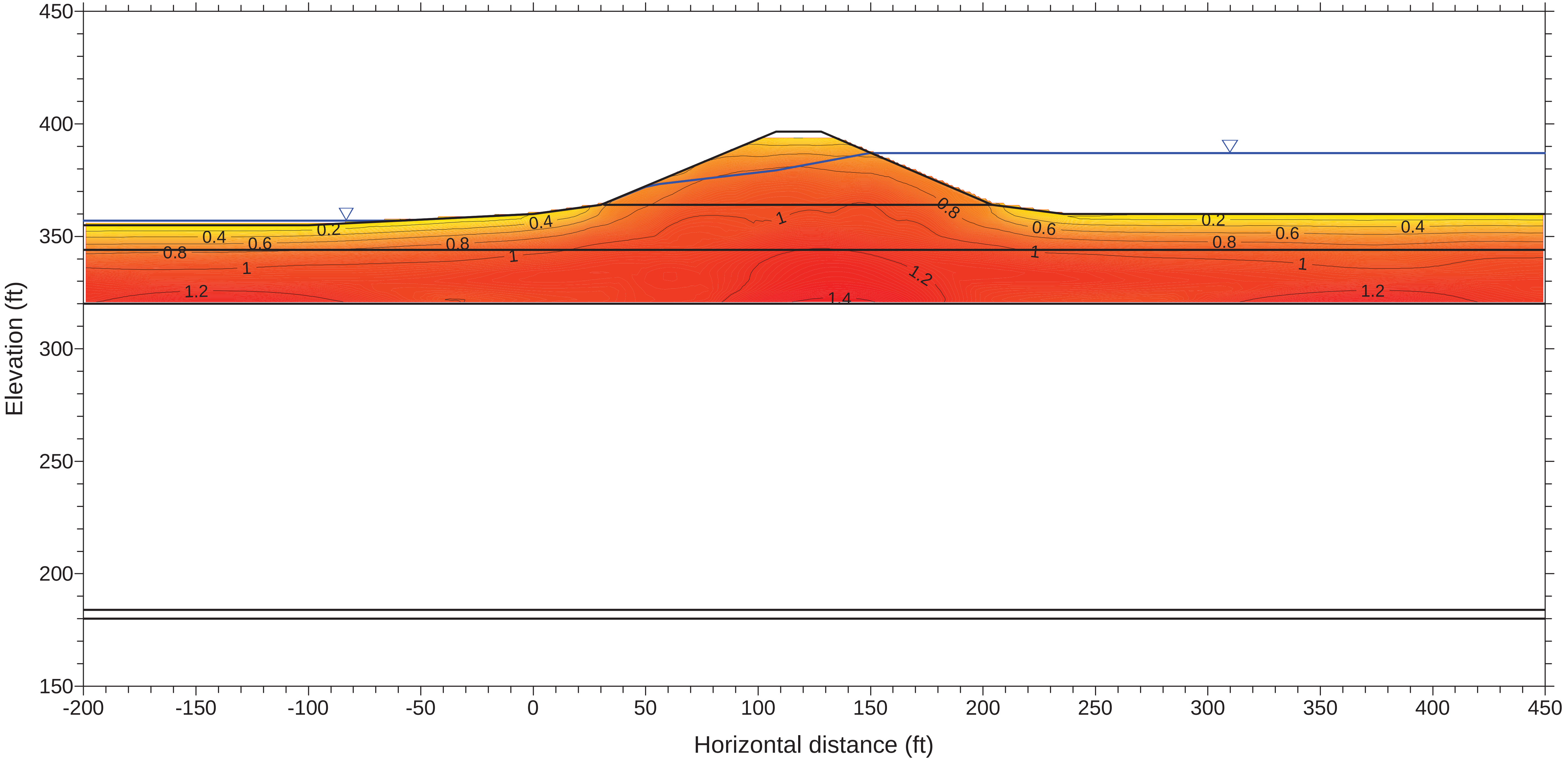

Project No. 60442676	Vectren FB Culley CCR Study	FB Culley East Ash Pond Dam Section QUAD4 Output - Peak Shear Stress (ksf) Base Motion: TH3	Figure 3-3
	AECOM		

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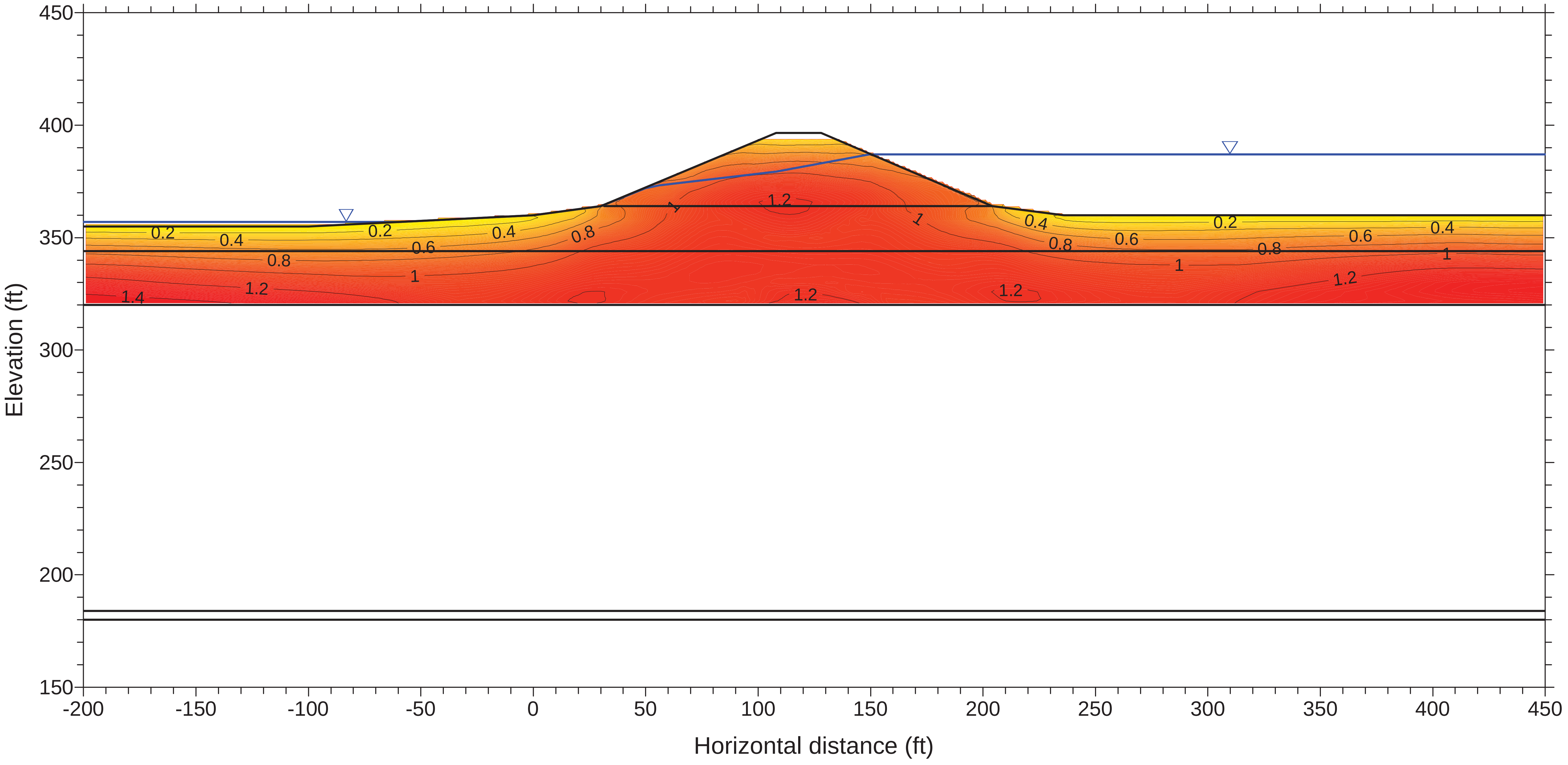

Project No. 60442676	Vectren FB Culley CCR Study	FB Culley East Ash Pond Dam Section QUAD4 Output - Peak Shear Stress (ksf) Base Motion: TH4	Figure 3-4
	AECOM		

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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_{cvc} = 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

Title: Vectren Dam Assesment
Project: East Ash Pond
Project No.: 60442676

Date: 4/18/2015
Boring No. B-2 (ATC)
Units American feet, pounds, pcf

Input Parameters:

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}	$(N_1)_{60}$	$(N_1)_{60\text{-cs}}$ 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:

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}	$(N_1)_{60}$	$(N_1)_{60-cs}$ 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		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:

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}	$(N_1)_{60}$	$(N_1)_{60\text{-cs}}$ 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	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:

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}	$(N_1)_{60}$	$(N_1)_{60\text{-cs}}$ for liquefaction triggering	$(N_1)_{60\text{-cs}}$ 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:				
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}	$(N_1)_{60}$	$(N_1)_{60\text{-cs}}$ 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	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:

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}	$(N_1)_{60}$	$(N_1)_{60\text{-cs}}$ 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	**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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