REPORT ON

PERIODIC SAFETY FACTOR ASSESSMENT
CELL 001
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

by
Haley & Aldrich, Inc.
Cleveland, Ohio

for
Associated Electric Cooperative, Inc.
Springfield, Missouri

File No. 128064-022
October 2021

HALEY ALDRICH

HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Independence, OH 44131
216.739.0555

15 October 2021
File No. 128064-022

Associated Electric Cooperative, Inc.
2814 South Golden Avenue
P.O. Box 754
Springfield, MO 65801-0754

Attention: Jenny Jones

Subject: Periodic Safety Factor Assessment
Cell 001
Thomas Hill Energy Center
Clifton Hill, Missouri

Dear Ms. Jones:

We are pleased to submit herewith our report entitled "Report on Periodic Safety Factor Assessment, Cell 001, Thomas Hill Energy Center, Clifton Hill, Missouri". This report includes background information regarding the project and the results of our periodic safety factor assessment.

This work was performed by Haley & Aldrich, Inc. (Haley & Aldrich) on behalf of Associated Electric Cooperative, Inc. (AECI) in accordance with the United States Environmental Protection Agency's (EPA's) Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals (CCR) from Electric Utilities, 40 CFR Part 257, specifically §257.73(e).

Background

Cell 001 is a 2.3-acre CCR surface impoundment historically used for settling and temporary wet storage of bottom ash and boiler slag sluiced from Thomas Hill Units 1 and 2. It was originally designed by Burn & McDonnell in 1985-1985 and constructed shortly thereafter. CCR slurry was pumped from the power plant and discharged into the southwest corner of Cell 001. After initial settling, water and suspended CCR discharged into Cell 003. The location of the Cell 001 is shown on **Figure 1**.

In 2015, AECI constructed a CCR Processing and Containment Pad (Cell 001 Dewatering Pad) to allow continued removal and dewatering of CCR from Cell 001. The Dewatering Pad was designed to allow removal and dewatering of CCR from Cell 001, with free liquids from the dredged CCR draining back into Cell 001. The construction included a 5-ft. high containment berm on the southern edge of the Dewatering Pad to prevent CCR and free liquids from migrating outside the pad. Fill for the processing pad and containment berm consisted of clayey fill obtained from on-site borrow sources. The clayey fill was keyed into the underlying natural clays, and a 2-ft. thick compacted clay liner was placed below the processing and containment pad.

Haley & Aldrich conducted an initial safety factor assessment for Cell 001 in October 2016 (see **Appendix B**). The results of that assessment indicated that the calculated factors of safety met the requirements of Section §257.73(e) of the CCR Rule. In accordance with Section §257.73(f)(3) of the CCR Rule, periodic safety factor assessments are required every five years. This report presents the results of our 2021 periodic safety factor assessment for Cell 001.

To achieve the objective discussed above, the scope of work undertaken for this assessment included the tasks listed below.

- Reviewing existing information and prior analyses to determine appropriate updates to the 2016 safety factor assessment.

- Performing engineering evaluations related to slope stability and liquefaction.

- Preparing and submitting this report presenting the results of our periodic safety factor assessment.

Safety Factor Assessment

REVIEW OF EXISTING INFORMATION AND METHODOLOGY

Since an initial assessment was conducted by Haley & Aldrich in 2016, the focus of this periodic assessment was to determine what updates to the analyses performed in 2016 were appropriate. This evaluation involved reviewing the following:

- changes to operating conditions;
- surface topography and impoundment geometry;
- subsurface soil and water conditions;
- seismic conditions (PGA, liquefaction, etc.);
- observed distress; and
- analysis methodology.

Based on our review of the items mentioned above, we identified several updates to the stability analyses that were appropriate as summarized below.

1. Static-Drained-Maximum Storage Analysis:
    a. Analyses were performed using an updated version of slope stability software by Rocscience (Slide2).
    b. Search limits, which are used in slope stability analyses to identify the limits where failure surfaces initiate and terminate, were updated to better capture all potential failure surfaces.

   c. Material strength and unit weight properties were updated based on a review of additional sitewide subsurface explorations and laboratory testing that were performed after 2016. The recent sitewide data, including test borings, CPTs, and laboratory results, was compared to the 2016 soil properties. As a result of that review, minor updates were made to material strengths and unit weight properties to take site variability into account. See **Appendix A** for a comparison of properties used in the 2016 analyses and the updated 2021 analyses. See **Appendix C** for a compilation of the supplemental subsurface information. Subsurface explorations are shown on **Figure 1**.
   d. The geometry of the clay liner was modified to represent as-built conditions. In addition, the vegetative soil cover on the exterior of the berm (Cell 002 side) and a layer of aggregate base at the surface were added to the slope stability model to represent existing conditions. Refer to the Design Soil Properties table in **Appendix A** for material properties.
   e. The phreatic water level within the embankment was updated based on the revisions to the clay liner geometry mentioned above. The same maximum storage pool elevation that was used in 2016 was used for this update.

2. <u>Static-Drained-Maximum Surcharge Analysis:</u>
   a. Analyses were performed using an updated version of slope stability software by Rocscience (Slide2).
   b. In 2016, the maximum surcharge analyses were performed using undrained (total) strengths for cohesive soils, which is consistent with the approaches used by Federal Energy Regulatory Commission (FERC) and the U.S. Bureau of Reclamation (USBR). Haley & Aldrich's methodology has been subsequently updated to use drained (effective) strengths for cohesive soils for the maximum surcharge analyses, which is consistent with current guidance by the U.S. Army Corps of Engineers Manual EM 1110-2-1902. Accordingly, the strength of all cohesive soils (Levee Fill, Embankment Fill, Impounded CCR, and Alluvial Clay) was updated to incorporate drained (effective) strengths.
   c. Material strength and unit weight properties were updated based on a review of additional sitewide subsurface explorations and laboratory testing that were performed after 2016. The recent sitewide data, including test borings, CPTs, and laboratory results, was compared to the 2016 soil properties. As a result of that review, minor updates were made to material strengths and unit weight properties to take site variability into account. See **Appendix A** for a comparison of properties used in the 2016 analyses and the updated 2021 analyses. See **Appendix C** for a compilation of the supplemental subsurface information. Subsurface explorations are shown on **Figure 1**.
   d. The geometry of the clay liner was modified to represent as-built conditions. In addition, the vegetative soil cover on the exterior of the berm (Cell 002 side) and a layer of aggregate base at the surface were added to the slope stability model to represent existing conditions. Refer to the Design Soil Properties table in **Appendix A** for material properties.
   e. The phreatic water level within the embankment was updated based on the revisions to the clay liner geometry mentioned above. The same maximum storage pool elevation that was used in 2016 was used for this update.

3. Pseudo-static-Undrained-Maximum Surcharge Analysis:
    a. Analyses were performed using an updated version of slope stability software by Rocscience (Slide2).
    b. Search limits, which are used in slope stability analyses to identify the limits where failure surfaces initiate and terminate, were updated to better capture all potential failure surfaces.
    c. The pseudo-static coefficient was updated from 0.046g to 0.058g. This update was made so that amplification due to the height of the embankment slope was taken into consideration. The pseudo-static calculation is included in **Appendix A**. Note that the design seismic event and site amplification factor used in 2016 did not change.
    d. Material strength and unit weight properties were updated based on a review of additional sitewide subsurface explorations and laboratory testing that were performed after 2016. The recent sitewide data, including test borings, CPTs, and laboratory results, was compared to the 2016 soil properties. As a result of that review, minor updates were made to material strengths and unit weight properties to take site variability into account. See **Appendix A** for a comparison of properties used in the 2016 analyses and the updated 2021 analyses. See **Appendix C** for a compilation of the supplemental subsurface information. Subsurface explorations are shown on **Figure 1**.
    e. In 2016, our analysis was performed by reducing all material strengths by 20%. Subsequent to 2016, Haley & Aldrich's methodology was updated such that the 20% reduction in soil strength is only applied to saturated cohesive soils. This change is based on a better understanding of modeling the threshold between large and small strains induced by cyclic loading (Duncan, 2014).
    f. The geometry of the clay liner was modified to represent as-built conditions. In addition, the vegetative soil cover on the exterior of the berm (Cell 002 side) and a layer of aggregate base at the surface were added to the slope stability model to represent existing conditions. Refer to the Design Soil Properties table in **Appendix A** for material properties.
    g. The phreatic water level within the embankment was updated based on the revisions to the clay liner geometry mentioned above. The same maximum storage pool elevation that was used in 2016 was used for this update.

STABILITY ANALYSES

With the exception of the items mentioned above, the design surcharge and storage pool levels, design seismic event, liquefaction evaluation, methodology for stability analyses used to perform the initial safety factor assessment in 2016 were determined to remain valid and are still applicable for this periodic assessment.

As shown in **Table I**, the static safety factors are above the minimum required values for the same critical cross sections evaluated in 2016. Similarly, the pseudo-static analysis for the analyzed section indicates an acceptable seismic safety factor. The results of the analyses that include these identified updates are included in **Appendix A**.

TABLE I
SUMMARY OF STATIC AND SEISMIC STABILITY EVALUATIONS

Cross Section	Condition	Earthquake Event	Soil Strength[1]	Water Level	Required Safety Factor[2]	2016 SFA Safety Factor		2021 SFA Safety Factor	
						Rotational Failure Surfaces	Block Failure Surfaces	Rotational Failure Surfaces	Block Failure Surfaces
1A-1A’	Static	-	Drained	Maximum Storage	1.50	1.89	2.18	1.69	1.94
			Drained	Maximum Surcharge	1.40	1.89	2.07	1.69	1.94
	Seismic	2,500-year	Undrained[3]	Maximum Storage	1.00	1.33	1.42	1.11	1.19

1. Refer to **Appendix A** for material properties.
2. The calculated safety factor must equal or exceed the required safety factor.
3. The strength of saturated cohesive soil has been reduced by 20 percent for seismic analyses to account for the approximate threshold between large and small strains induced by cyclic loading.

Conclusions

The analyses associated with this periodic safety factor assessment have been performed in accordance with the requirement of Section §257.73(e) of the CCR Rule. A summary of our conclusions as they relate to the rule requirements are provided below.

- §257.73(e)(1)(i) - *The calculated static factor of safety under the long-term, maximum storage pool loading conditions must equal or exceed 1.50.*

  As shown in **Table I**, the static safety factors for the long-term (drained) maximum storage pool condition are above the minimum required value for the critical section analyzed. Accordingly, this requirement has been met.

- §257.73(e)(1)(ii) - *The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.*

  As shown in **Table I**, the static safety factors for the maximum surcharge pool loading condition (drained) are above the minimum required value for the critical section analyzed. Accordingly, this requirement has been met.

- §257.73(e)(1)(iii) - *The calculated seismic factor of safety must equal or exceed 1.00.*

  As shown in **Table I**, the calculated seismic safety factor is above the minimum required value for the critical section analyzed. Accordingly, this requirement has been met.

- §257.73(e)(1)(iv) - *For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.*

  The results of previous subsurface investigations indicate that the dikes at the Cell 001 are primarily constructed of clay soils that are not susceptible to liquefaction. Accordingly, this requirement has been met.

We appreciate the opportunity to provide engineering services on this project. Please do not hesitate to call if you have any questions or comments.

Sincerely yours,
HALEY & ALDRICH, INC.

Derrick A. Shelton
Geotechnical Program Manager | Senior Associate

Steven F. Putrich, P.E,
Principal

Enclosures:
Figure 1 – Subsurface Exploration Location Plan
Appendix A – 2021 Updated Analyses
Appendix B – 2016 Report on Safety Factor Assessment
Appendix C – Supplemental Subsurface Information

\\haleyaldrich.com\share\was_common\Projects\128064-AECI Thomas Hill\022- TH 2021 SFA\Deliverables\Reports\Cell 001\2021-1015-HAI-AECI THEC Cell 001 SFA-F.docx

Certification

Based on our review of the information provided to us by AECI and the results of our analyses, it is our opinion that the calculated factors of safety for the critical cross section of the impoundment embankment meet the minimum factors of safety specified in §257.73(e)(1)(i) through (iv) of the EPA's CCR Rule.

Certification Statement

I certify that the Periodic Safety Factor Assessment for Cell 001 at the Thomas Hill Energy Center meets the requirements of §257.73(e) of the EPA's CCR Rule.

Signed: ______________________________________
Consulting Engineer

Print Name: Steven F. Putrich
Missouri License No.: 2014035813
Title: Principal
Company: Haley & Aldrich, Inc.

Professional Engineer's Seal:

STEVEN F.
PUTRICH
NUMBER
PE-2014035813
10/15/2021

Steven F. Putrich
Digitally signed by Steven F. Putrich
Date: 2021.10.15 14:19:38 -04'00'

References

1. Duncan, J.M., Wright, S.G, and Brandon, T.L. (2014). Soil Strength and Slope Stability. John Wiley & Sons, Upper Saddle River, 2nd Edition.

2. Environmental Protection Agency, (2015). Code of Federal Regulations, “Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule, “Title 40, Chapter I, Parts 257 and 261, April 17.

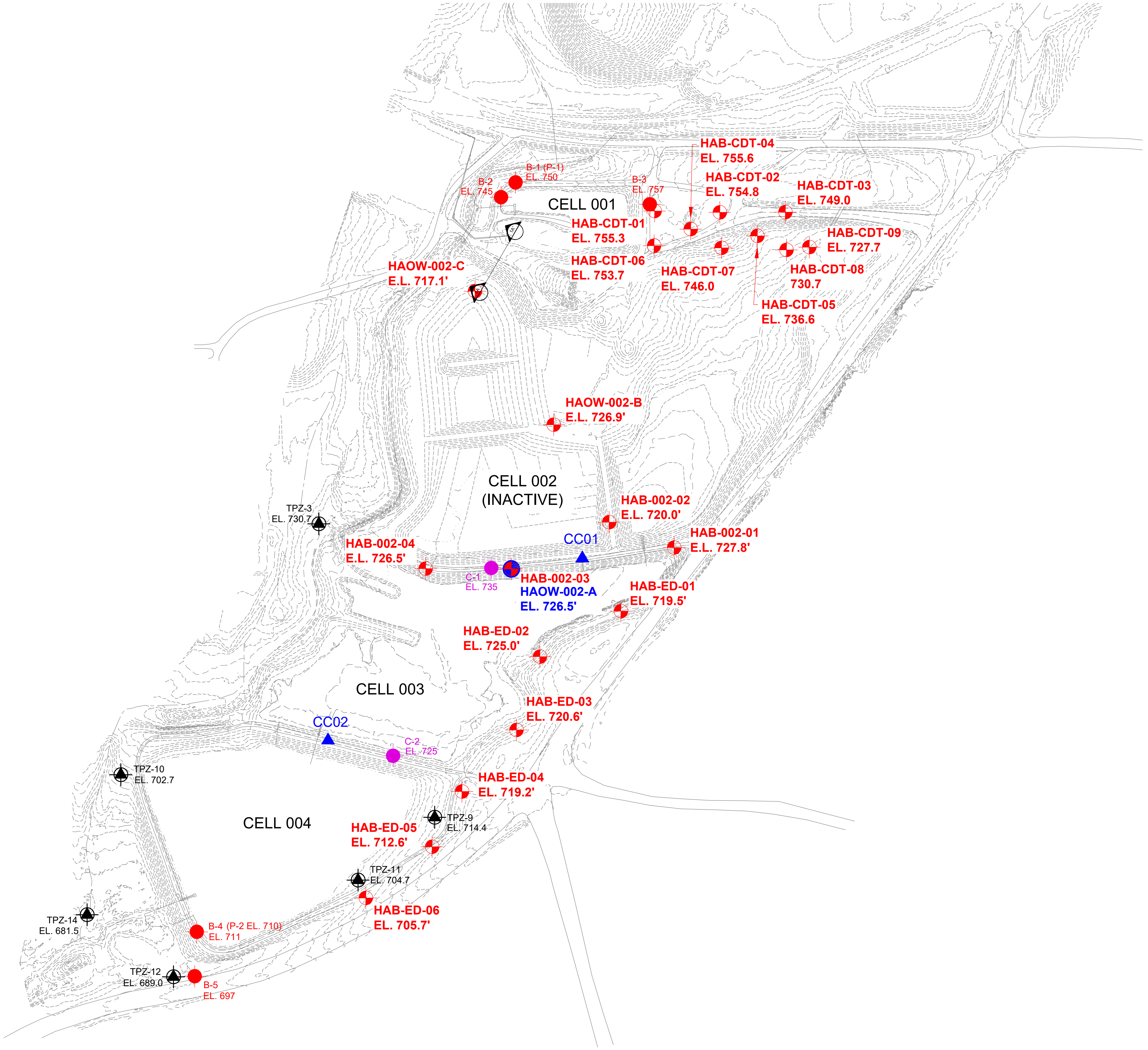
3. Geotechnology, Inc. (February 2012a). “Slope Stability and Seepage Analysis, Slag Dewatering Basin, Thomas Hill Energy Center”.

4. Geotechnology, Inc. (February 2012b). “Slope Stability and Seepage Analysis, Ash Pond No. 3, Thomas Hill Energy Center”.

5. Geotechnology, Inc. (2021). “Global Stability Evaluations, Mine Waste and Ash Pond Embankments, AECI Facilities, Bee Veer and Thomas Hill, Missouri”.

6. Haley & Aldrich, Inc. (April 2018). “Report on Initial Safety Factor Assessment, Thomas Hill Energy Center, Cell 001, Cell 003, and Cell 004, Clifton Hill, Missouri”.

FIGURES

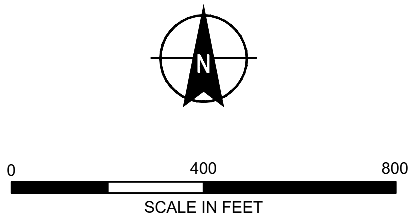


LEGEND

B-1 (P-1) EL. 750 ●	DESIGNATION, LOCATION AND GROUND SURFACE ELEVATION OF TEST BORINGS PERFORMED BY GEOTECHNOLOGY, INC. OF ST. LOUIS, MISSOURI DURING THE PERIOD NOVEMBER 7 TO NOVEMBER 8, 2011. A "P" DESIGNATION INDICATES TEMPORARY PIEZOMETER WAS INSTALLED IMMEDIATELY ADJACENT TO CORRESPONDING TEST BORING.
HAB-CDT-01 EL. 755.3 ◐	DESIGNATION, LOCATION AND GROUND SURFACE ELEVATION OF TEST BORINGS PERFORMED BY BULLDOG DRILLING OF DUPO, ILLINOIS DURING THE PERIOD SEPTEMBER 24, 2019 TO OCTOBER 7, 2019.
HAOW-002-A EL. 726.5' ▲	DESIGNATION, LOCATION, AND GROUND SURFACE ELEVATION OF PIEZOMETER INSTALLED BY BULLDOG OF DUPO, ILLINOIS ON OCTOBER 7 TO 8, 2019.
CC01 ▲	DESIGNATION AND APPROXIMATE LOCATION OF CONE PENETROMETER SOUNDING PERFORMED BY STRATIGRAPHICS OF PROPHETSTOWN, ILLINOIS ON FEBRUARY 3, 2010.
C-1 EL. 735 ●	DESIGNATION AND APPROXIMATE LOCATION OF TEST BORINGS PERFORMED BY GEOTECHNOLOGY, INC. OF ST. LOUIS, MISSOURI DURING THE PERIOD JANUARY 13 TO 14, 2010.
TPZ-3 EL. 730.7 ▲	DESIGNATION, LOCATION, AND GROUND SURFACE ELEVATION OF PIEZOMETERS INSTALLED BY BULLDOG DRILLING OF DUPO, ILLINOIS DURING THE PERIOD OF AUGUST 19, 2015 TO AUGUST 27, 2015 AND AUGUST 2, 2016.
1A' — 1A'	LOCATION OF SLOPE STABILITY CROSS-SECTION

NOTES

1. THIS PLAN WAS PREPARED FROM A COMBINATION OF HLR DRONE TOPOGRAPH AND ORTHOIMAGERY SURVEYS OBTAINED WITH AN EBEE UNMANNED AIRCRAFT SYSTEM ON MAY 6TH, 2019 BY HAMPTON, LENZINI AND RENWICK, INC.; MCCLURE UAV FLIGHT ON DECEMBER 17, 2020; AND CELL 002 CONSTRUCTION DESIGN SURFACE DATED JUNE 9TH, 2020.
   - ALL COORDINATES AND DATA ARE BASED ON NAD 1983 (2011) (CONUS) MISSOURI CENTRAL 2402, US SURVEY FOOT, NAVD 88, GEOID12B.
   - MISSOURI LIDAR DATA WAS ALSO UTILIZED IN THE TOPOGRAPHY DATA PROVIDED. LIDAR DATA UTILIZED WAS ACQUIRED BY SURDEX CORPORATION FOR RANDOLPH CO ON JANUARY 9TH AND 10TH 2012 AND ALSO UTILIZED THE MODOT REAL-TIME GPS NETWORK.
2. AS DRILLED LOCATIONS AND GROUND SURFACE ELEVATIONS OF PIEZOMETERS INSTALLED BY BULLDOG DRILLING WERE SURVEYED BY GREDELL RESOURCES ENGINEERING, INC. OF JEFFERSON CITY, MISSOURI BY OPTICAL SURVEY.
3. AS-DRILLED LOCATIONS OF TEST BORINGS PERFORMED BY GEOTECHNOLOGY, INC. AND CONE PENETROMETER SOUNDINGS PERFORMED BY STRATIGRAPHICS, INC. HAVE BEEN APPROXIMATED. GROUND SURFACE ELEVATIONS OF TEST BORINGS PERFORMED BY GEOTECHNOLOGY, INC. ARE BASED ON MEAN SEA LEVEL (MSL) DATUM AND WERE TAKEN FROM BORING LOGS PREPARED BY GEOTECHNOLOGY, INC.
4. AS DRILLED LOCATIONS AND GROUND SURFACE ELEVATIONS OF THE TEST BORINGS PERFORMED BY BULLDOG DRILLING WERE BASED ON NGVD DATUM AND WERE TAKEN FROM BORING LOGS PREPARED BY BULLDOG DRILLING.
5. TECHNICAL MONITORING OF PIEZOMETERS INSTALLED BY BULLDOG DRILLING WAS PERFORMED BY HALEY & ALDRICH.
6. TECHNICAL MONITORING OF SUBSURFACE EXPLORATIONS PERFORMED BY GEOTECHNOLOGY, INC. AND STRATIGRAPHICS, INC. WAS PERFORMED BY OTHERS.



HALEY
ALDRICH

ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MO

SUBSURFACE EXPLORATION
LOCATION PLAN

SCALE: AS SHOWN
OCTOBER 2021

FIGURE 1

KRAKORA, MATTHEW Printed: 10/5/2021 11:23 AM Layout: FIG 2
G:\40616_AECI-CCR ELG MANAGEMENT SUPPORT\CAD-TH\FIGURES\SUBSURFACE EXPLORATION\SUBSURFACE EXPLORATION LOCATION PLAN SITEWIDE V1.DWG

APPENDIX A

2021 Updated Analyses

Seismic Documents

HALEY ALDRICH	CALCULATIONS	File No.	128064-022
		Sheet	1 of 2
Client	Associated Electric Cooperative, Inc.	Date	8-Oct-21
Project	Thomas Hill Energy Center - Cells 001, 003, and 004	Computed by	RJW
Subject	Pseudostatic Coefficient	Checked by	DASh

Objective:

-Determination of the pseudostatic coefficient for stability analyses of the Cell 002 embankment.

Step 1

Estimate peak horizontal bedrock acceleration, A_{max}, for 2% in 50 year using the USGS Unified Hazard Tool.

http://earthquake.usgs.gov/ws/designmaps/asce7-16

Site Coordinates:

Latitude	39.545
Longitude	-92.637

PGA for 2% in 50 yr event = 0.057 g

Step 2

Classify site stiffness.

http://earthquake.usgs.gov/ws/designmaps/

Use USGS design application tool

2016 ASCE 7

Site Class = D

Step 3

Using the site latitude and longitude, determined site class, and the USGS design application tool 2016 ASCE 7 estimate peak free field (ground surface) acceleration using the empirical charts. The peak free field acceleration corresponds to the bedrock acceleration at the base of the embankment, which is propogated upward through the existing soils at the site.

http://earthquake.usgs.gov/ws/designmaps/asce7-16

Using Table 11.8-1 from the ASCE-10 Summary Report

USGS Site Coefficient, F_{PGA} = 1.6

Peak Free Field Acceleration* = PGA x F_{PGA} = 0.091 g

Step 4

Estimate peak acceleration at the top of the embankment using Figure 2 (Singh and Sun,1995).

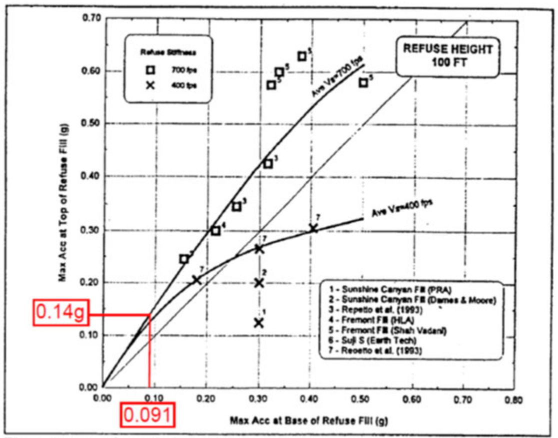


Figure 2 Approximate Relationship Between Max Accelerations at Base and Crest, 100-ft Refuse

(Singh and Sun, 1995)

Using Figure 2

peak acceleration at top of embankment = 0.14

Note: The peak acceleration at the top of the embankment has been conservatively estimated using Figure 2 from the Singh and Sun (1995) approach, which was developed for refuse.

HALEY ALDRICH	CALCULATIONS	File No.	128064-022
		Sheet	2 of 2
Client	Associated Electric Cooperative, Inc.	Date	8-Oct-21
Project	Thomas Hill Energy Center - Cells 001, 003, and 004	Computed by	RJW
Subject	Pseudostatic Coefficient	Checked by	DASh

Step 5

Calculate pseudo-static coefficeint using approach developed by Hynes-Griffin and Franklin (1984).

Pseudo-Static Coefficient = Peak Acceleration at Midheight of Embankment = 0.5 x ((0.091+0.14) x 0.5) = 0.058 g

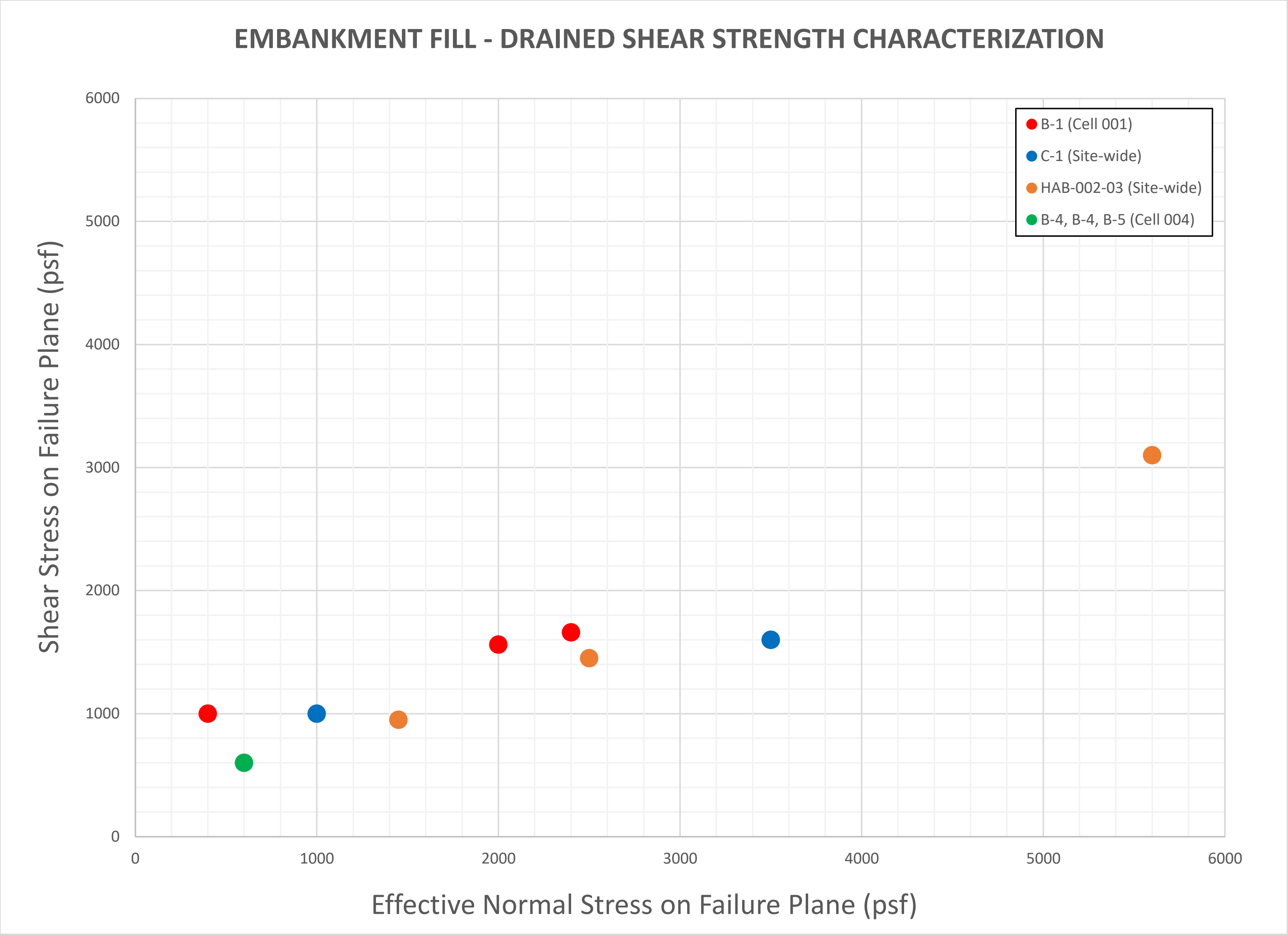
Design Soil Properties

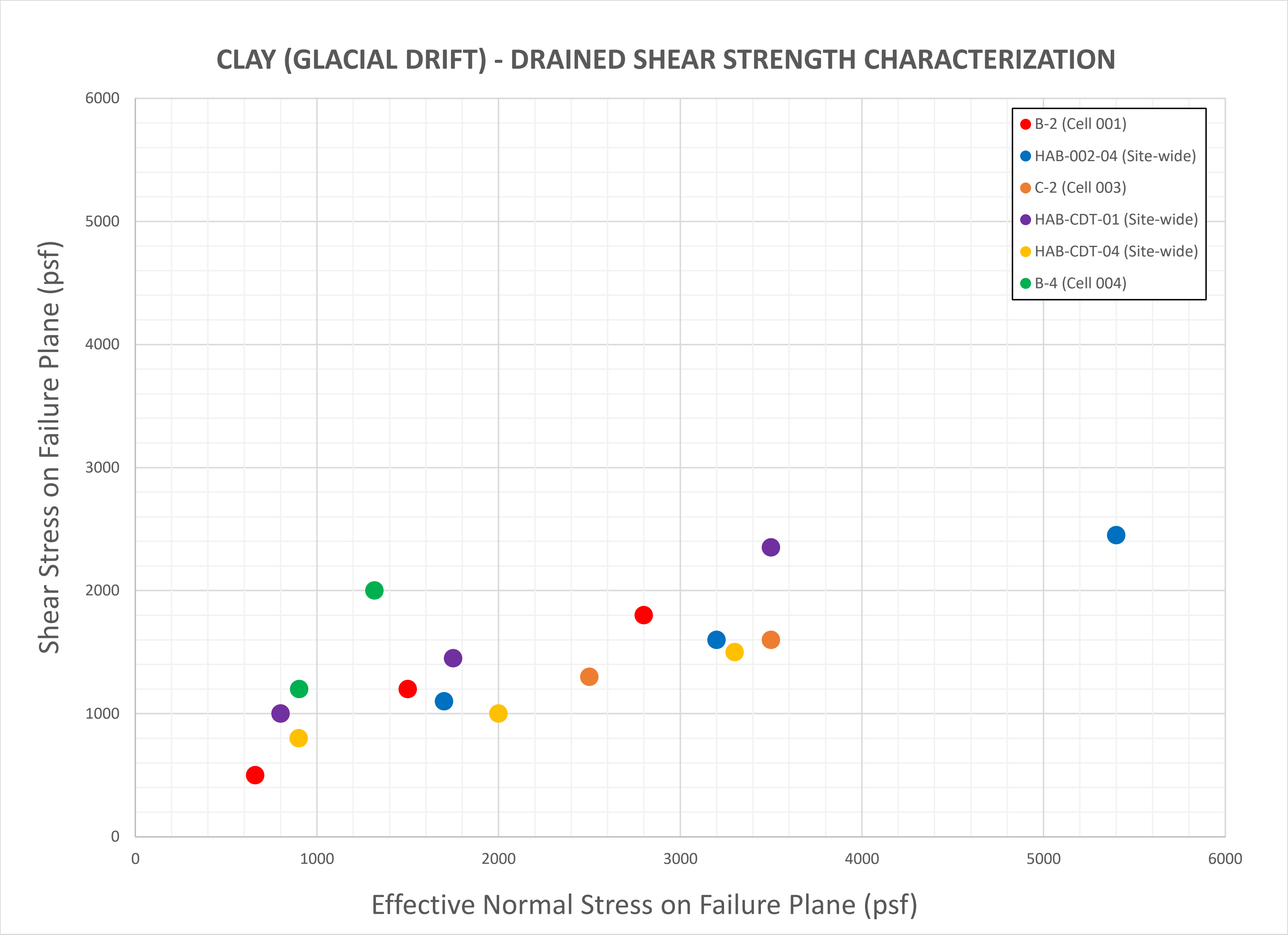
SOIL PROPERTY CHARACTERIZATION - THOMAS HILL ENERGY CENTER CELL 001

Material	Location	Total Unit Weight, γ_T				Undrained Shear Strength, S_u												Drained Shear Strength											
		CPT	Laboratory[2]	2016 SFA Design	Current Design	SPT		CPT[4]		UCS[2]	CU Trx	2016 SFA Design			Current Design			SPT		CPT[5,6]				Laboratory CU Trx[2]		2016 SFA Design		Current Design	
		avg	avg.			avg	avg - 1σ	avg	avg - 1σ	avg								avg	avg - 1σ	avg	avg - 1σ	avg	avg - 1σ	avg					
		γ_T	γ_T	γ_T	γ_T	S_u	S_u	S_u	S_u	S_u	S_u	c	ϕ	S_u	c	ϕ	S_u	ϕ'	ϕ'	c'	c'	ϕ'	ϕ'	c'	ϕ'	c'	ϕ'	c'	ϕ'
Vegetative Soil Cover	Cell 001	--	--	--	**115 pcf[3]**	--	--	--	--	--	--	--	--	--	**--**	**--**	**600 psf[3]**	--	--	--	--	--	--	--	--	--	--	**50 psf[3]**	**28°[3]**
	Sitewide[1]	--	--			--	--	--	--	--								--	--	--	--	--	--	--	--				
Base (Aggregate)	Cell 001	--	--	0 pcf	**130 pcf[3]**	--	--	--	--	--	--	--	--	--	**0 psf[3]**	**38°[3]**	**--**	--	--	--	--	--	--	--	--	--	--	**0 psf[3]**	**38°[3]**
	Sitewide[1]	--	--			--	--	--	--	--								--	--	--	--	--	--	--	--				
Clay Liner	Cell 001	--	--	125 pcf	**125 pcf[3]**	--	--	--	--	--	--	--	--	1,300 psf	**--**	**--**	**1,000 psf[3]**	--	--	--	--	--	--	--	--	0 psf	28°	**50 psf[3]**	**28°[3]**
	Sitewide[1]	--	--			--	--	--	--	--								--	--	--	--	--	--	--	--				
Bottom Ash/Boiler Slag	Cell 001	--	--	90 pcf	**110 pcf[3]**	--	--	--	--	--	--	--	--	750 psf	**0 psf[3]**	**30°[3]**	**--**	--	--	--	--	--	--	--	--	0 psf	30°	**0 psf[3]**	**30°[3]**
	Sitewide[1]	--	--			--	--	--	--	--								--	--	--	--	--	--	--	--				
Embankment Fill	Cell 001	--	131 psf	125 pcf	**130 pcf**	479 psf	365 psf	N/A	N/A	N/A	S_u/σ_v' = 0.360	--	--	$S_{u,min}$ = 600 psf S_u/σ_v' = 0.360	**--**	**--**	**Su,min = 600 psf Su/sv' = 0.360**	--	--	N/A	N/A	N/A	N/A	640 psf	23°	200 psf	25°	**200 psf**	**25°**
	Sitewide[1]	--	124 psf			831 psf	411 psf	1,621 psf	1,303 psf	900 psf	S_u/σ_v' = 0.170							--	--	313 psf	208 psf	41°	36°	273 psf	26°				
Clay (Glacial Drift)	Cell 001	--	125 pcf	120 pcf	**125 pcf**	2160 psf	692 psf	N/A	N/A	1,600 psf	S_u/σ_v' = 0.418	--	--	$S_{u,min}$ = 800 psf S_u/σ_v' = 0.253	**--**	**--**	**Su,min = 560 psf Su/sv' = 0.40**	--	--	N/A	N/A	N/A	N/A	500 psf	27°	125 psf	26°	**125 psf**	**26°**
	Sitewide[1]	--	127 pcf			1,507 psf	201 psf	1,641 psf	1,141 psf	N/A	S_u/σ_v' = 0.253							--	--	280 psf	131 psf	27°	22°	404 psf	23°				
Limestone/Shale Bedrock	Cell 001	--	--	130 pcf	**130 pcf[3]**	--	--	--	--	--	--	0 psf	38°	--	**0 psf[3]**	**30°[3]**	**--**	--	--	--	--	--	--	--	--	0 psf	38°	**0 psf[3]**	**30°[3]**
	Sitewide[1]	--	--			--	--	--	--	--								--	--	--	--	--	--	--	--				

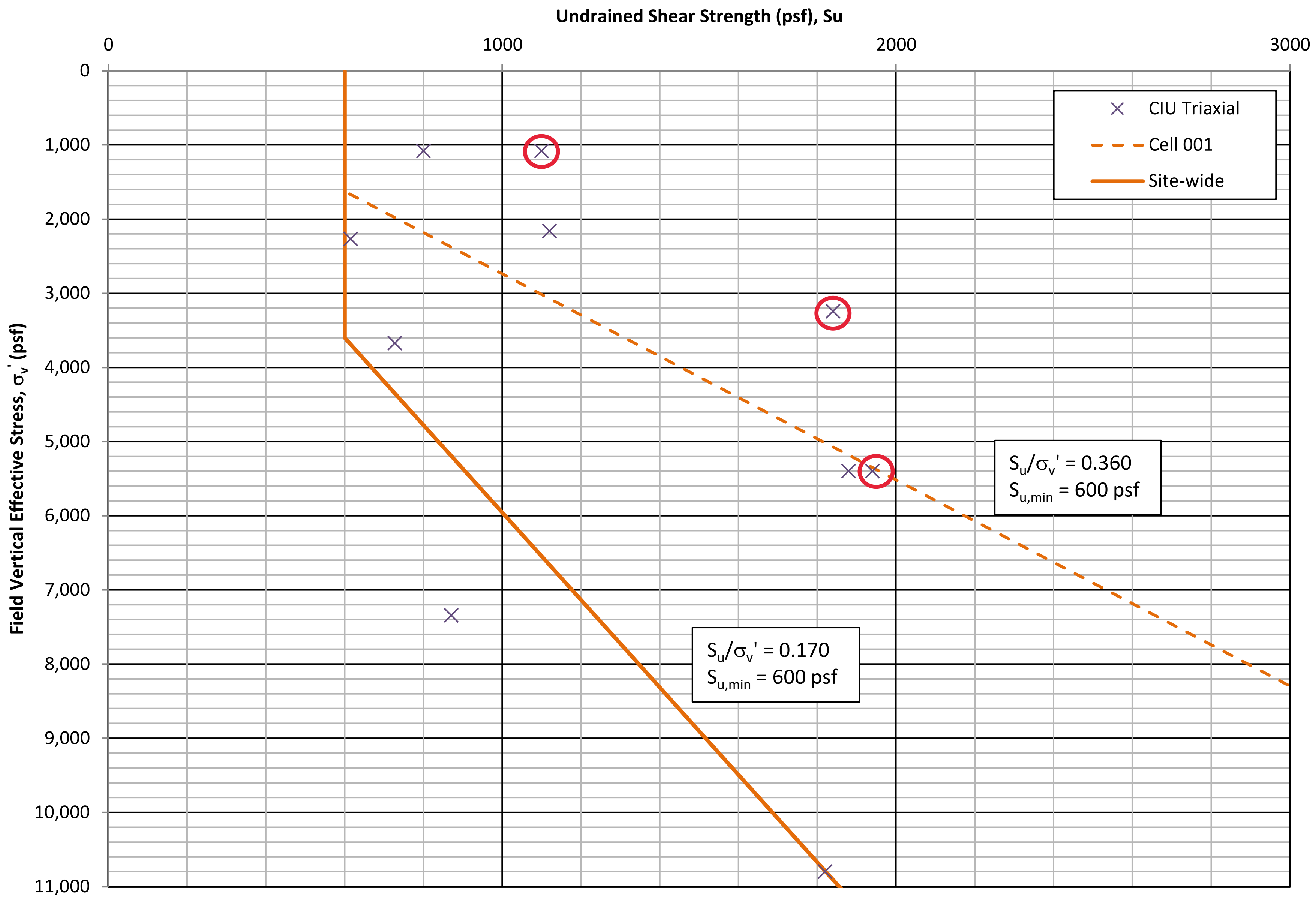
Notes:

1. Sitewide properties take into consideration investigations performed during 2010, 2012, 2018, and 2020.
2. Laboratory values shown represent Haley & Aldrich's interpretation of the laboratory test results and may differ from the results reported by the laboratory.
3. In cases where historic design properties, SPT/CPT correlations, and laboratory test data do not exist, the current design properties for these materials have been conservatively estimated using typical published values and Haley & Aldrich's experience with similar materials.
4. Undrained shear strength correlations from CPT data are based on an N_k factors ranging between 10 and 25.
5. CPT effective cohesion based on Mayne and Stuart (1988), $c'/\sigma_p'=0.03$.
6. CPT effective friction angle for cohesive materials is based on the NTNU method (Mayne and Campanella, 2005). CPT effective friction angle for granular materials is based on Kulhawy and Mayne (2014).

EMBANKMENT FILL - DRAINED SHEAR STRENGTH CHARACTERIZATION
Shear Stress on Failure Plane (psf)
6000
5000
4000
3000
2000
1000
0
0
1000
2000
3000
4000
5000
6000
Effective Normal Stress on Failure Plane (psf)
B-1 (Cell 001)
C-1 (Site-wide)
HAB-002-03 (Site-wide)
B-4, B-4, B-5 (Cell 004)

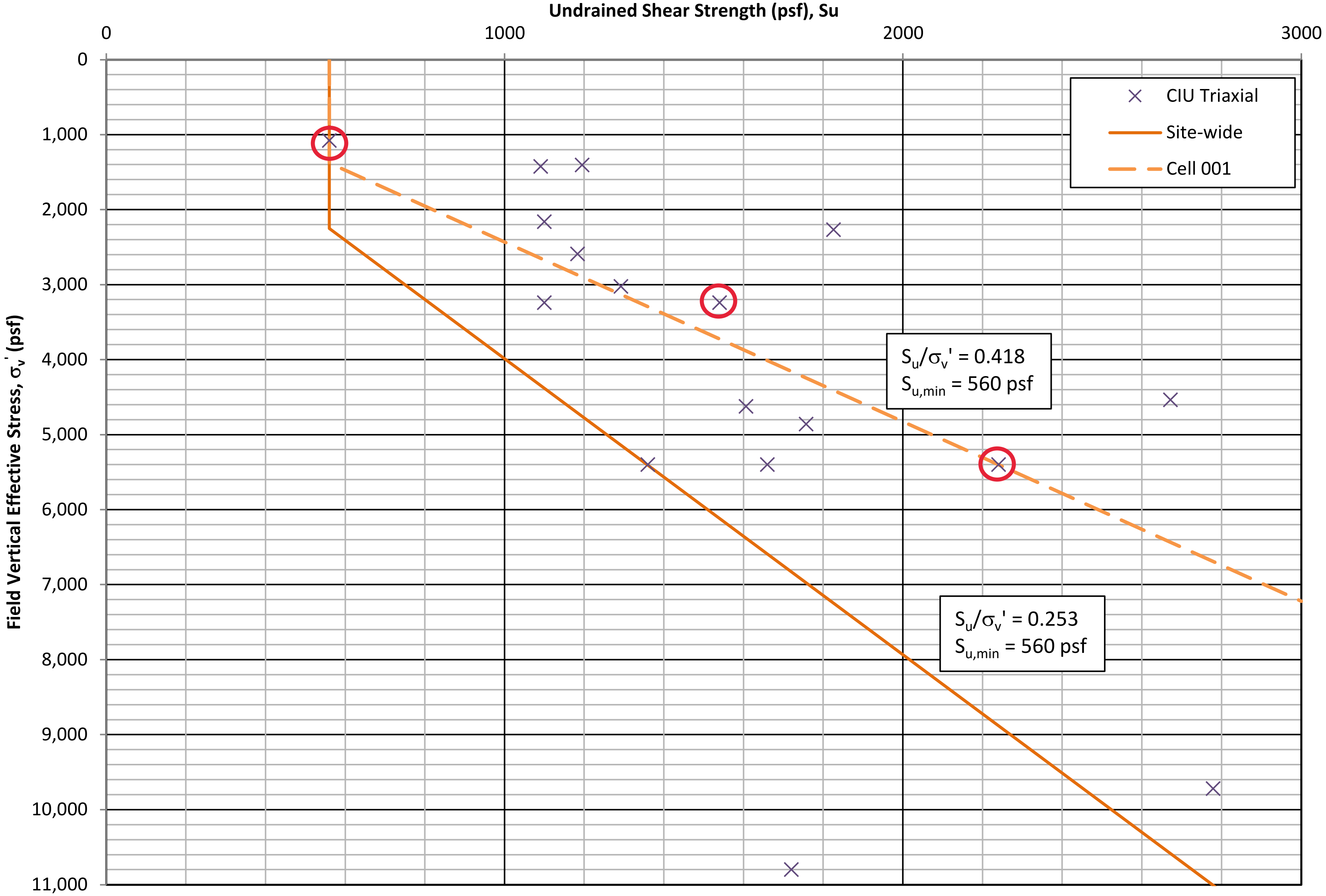

CLAY (GLACIAL DRIFT) - DRAINED SHEAR STRENGTH CHARACTERIZATION
Shear Stress on Failure Plane (psf)
6000
5000
4000
3000
2000
1000
0
0
1000
2000
3000
4000
5000
6000
Effective Normal Stress on Failure Plane (psf)
● B-2 (Cell 001)
● HAB-002-04 (Site-wide)
● C-2 (Cell 003)
● HAB-CDT-01 (Site-wide)
● HAB-CDT-04 (Site-wide)
● B-4 (Cell 004)

EMBANKMENT FILL UNDRAINED SHEAR STRENGTH CHARACTERIZATION



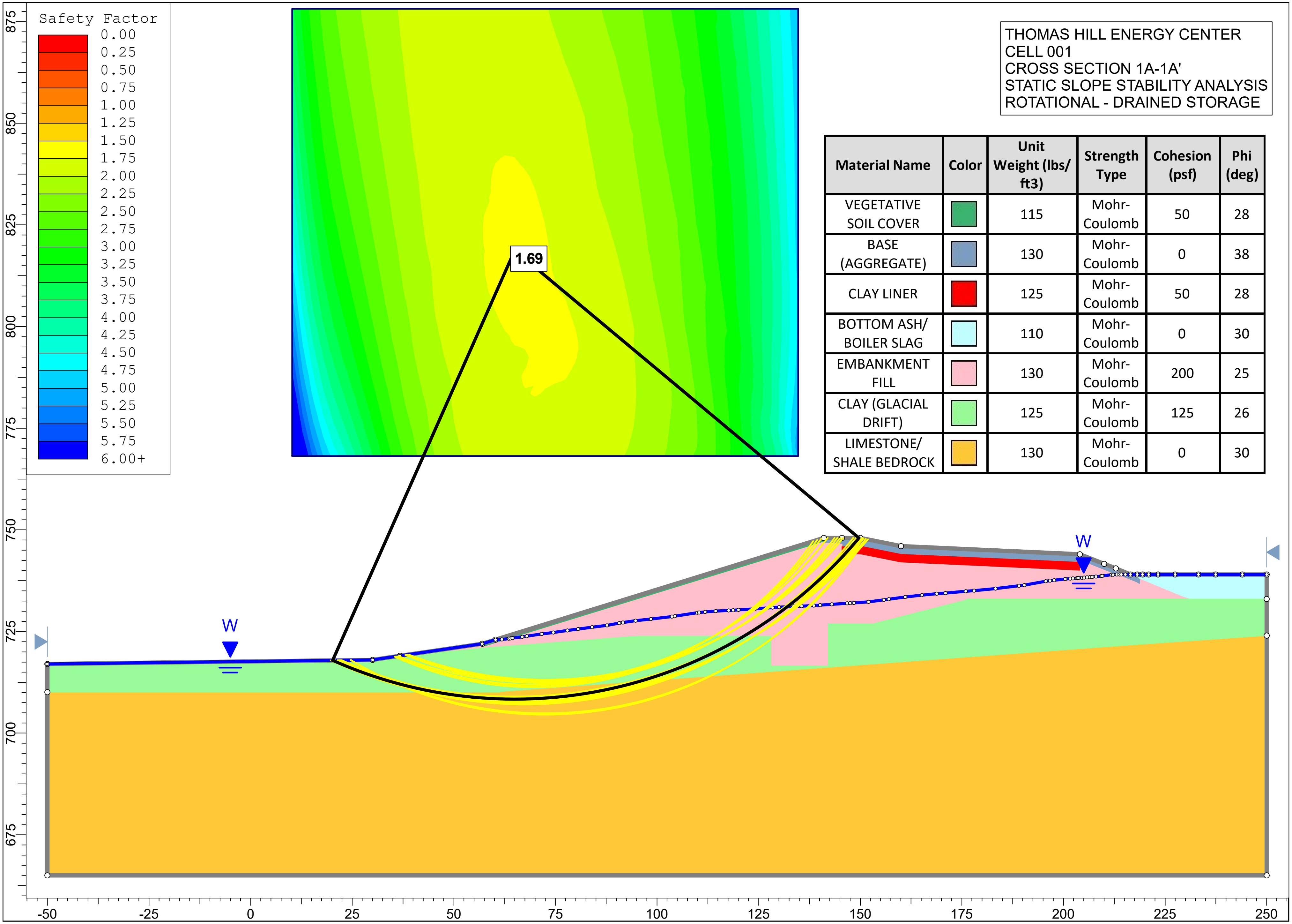
○ INDICATES TESTING SPECIFIC TO SAMPLE FROM CELL 001

CLAY (GLACIAL DRIFT) UNDRAINED SHEAR STRENGTH CHARACTERIZATION



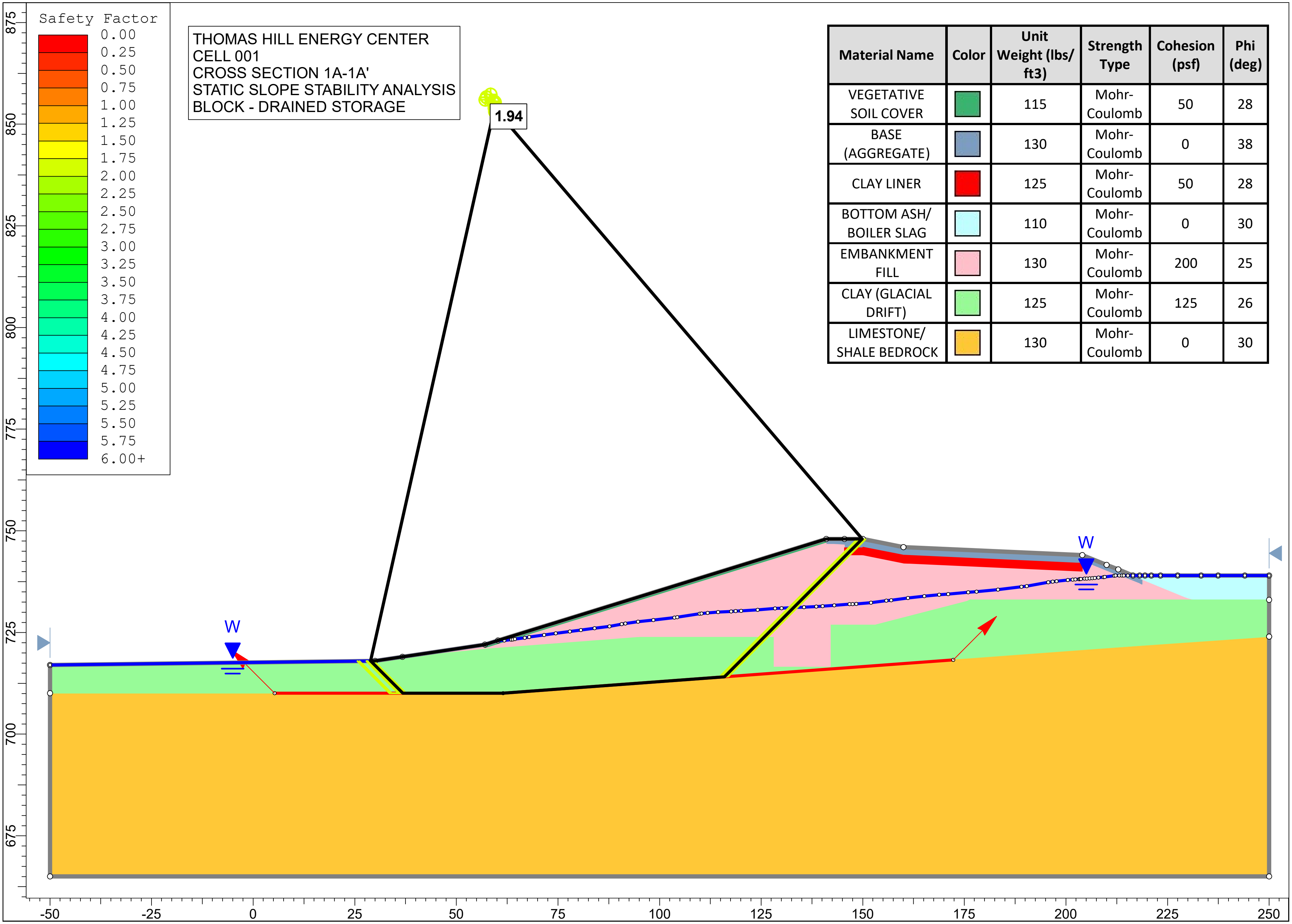
○ INDICATES TESTING SPECIFIC TO SAMPLE FROM CELL 001

Slope Stability



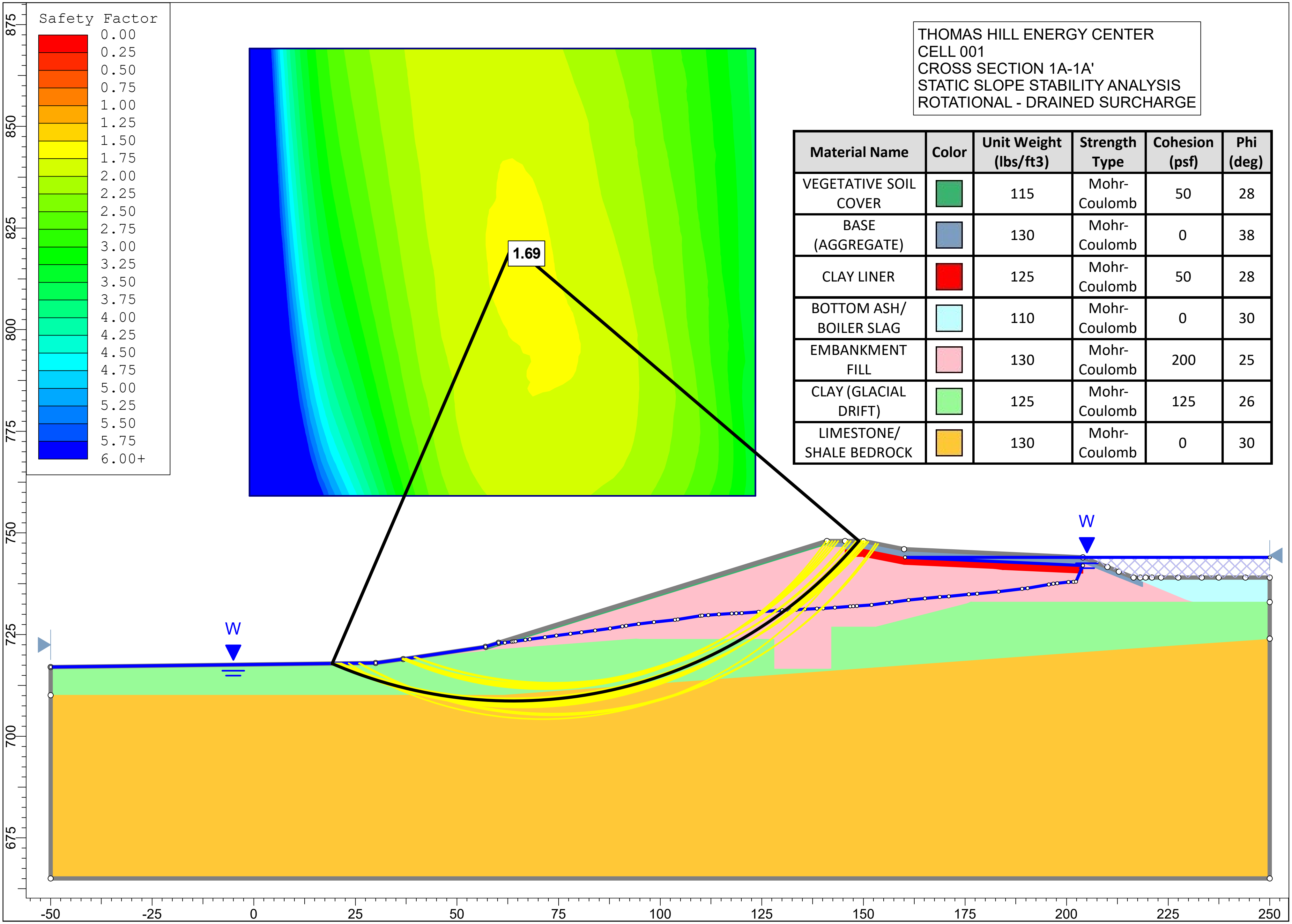
THOMAS HILL ENERGY CENTER
CELL 001
CROSS SECTION 1A-1A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - DRAINED STORAGE

Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)
VEGETATIVE SOIL COVER	🟩	115	Mohr-Coulomb	50	28
BASE (AGGREGATE)	🟦	130	Mohr-Coulomb	0	38
CLAY LINER	🟥	125	Mohr-Coulomb	50	28
BOTTOM ASH/ BOILER SLAG	🟦	110	Mohr-Coulomb	0	30
EMBANKMENT FILL	🟪	130	Mohr-Coulomb	200	25
CLAY (GLACIAL DRIFT)	🟩	125	Mohr-Coulomb	125	26
LIMESTONE/ SHALE BEDROCK	🟧	130	Mohr-Coulomb	0	30



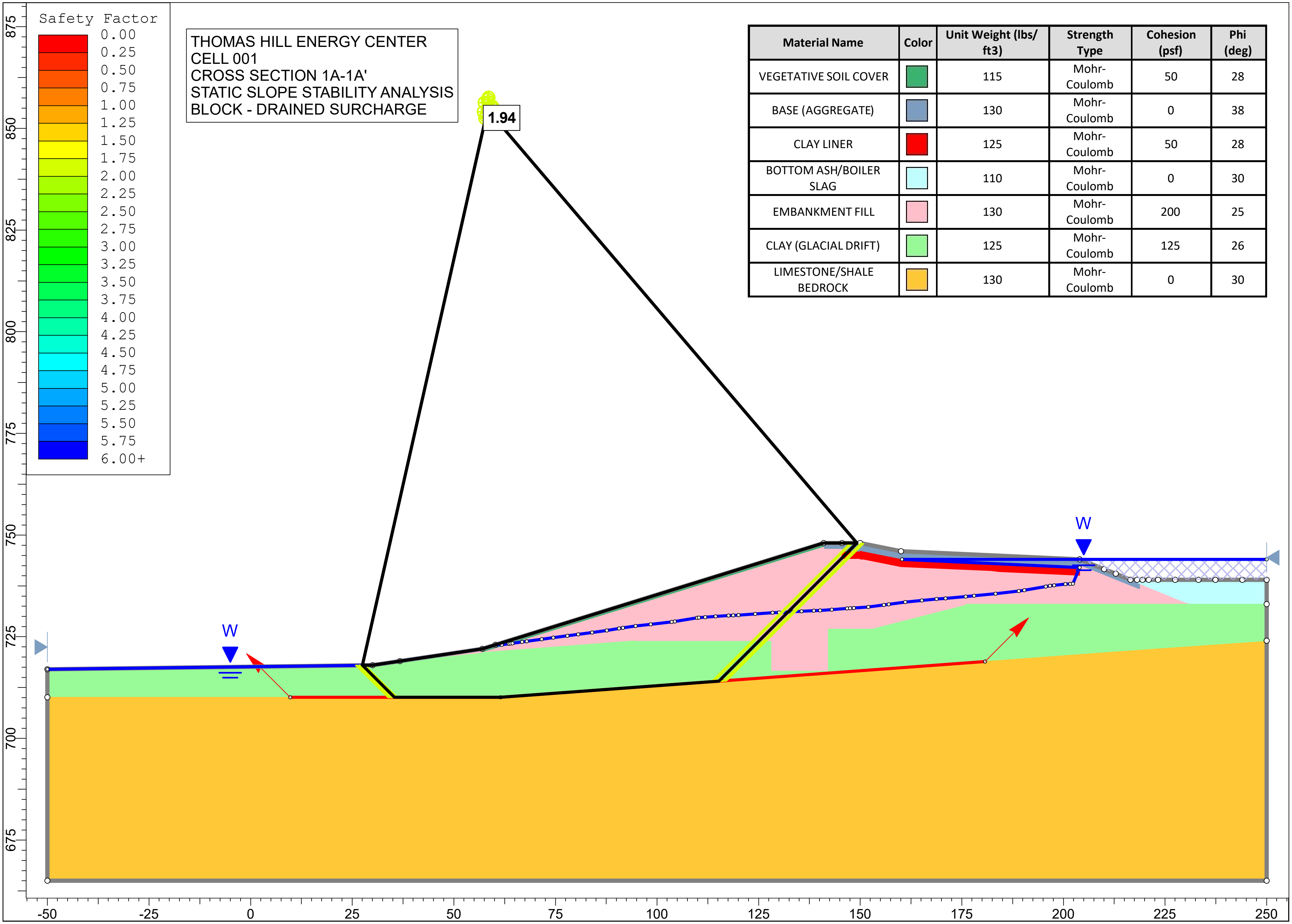
THOMAS HILL ENERGY CENTER
CELL 001
CROSS SECTION 1A-1A'
STATIC SLOPE STABILITY ANALYSIS
BLOCK - DRAINED STORAGE

Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)
VEGETATIVE SOIL COVER	🟩	115	Mohr-Coulomb	50	28
BASE (AGGREGATE)	🟦	130	Mohr-Coulomb	0	38
CLAY LINER	🟥	125	Mohr-Coulomb	50	28
BOTTOM ASH/ BOILER SLAG	🟦	110	Mohr-Coulomb	0	30
EMBANKMENT FILL	🟪	130	Mohr-Coulomb	200	25
CLAY (GLACIAL DRIFT)	🟩	125	Mohr-Coulomb	125	26
LIMESTONE/ SHALE BEDROCK	🟧	130	Mohr-Coulomb	0	30



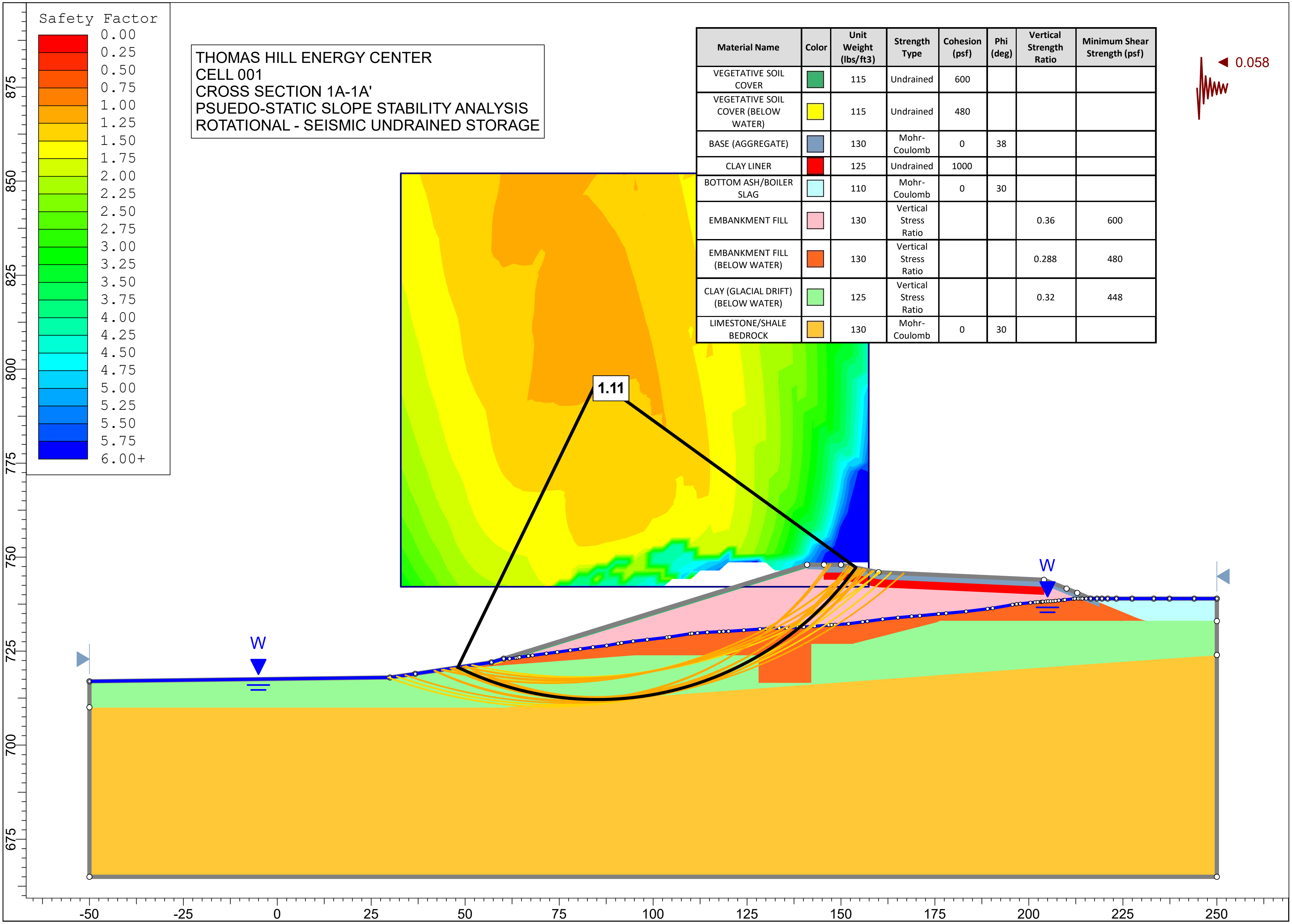
THOMAS HILL ENERGY CENTER
CELL 001
CROSS SECTION 1A-1A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - DRAINED SURCHARGE

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
VEGETATIVE SOIL COVER	🟩	115	Mohr-Coulomb	50	28
BASE (AGGREGATE)	🟦	130	Mohr-Coulomb	0	38
CLAY LINER	🟥	125	Mohr-Coulomb	50	28
BOTTOM ASH/ BOILER SLAG	🟦	110	Mohr-Coulomb	0	30
EMBANKMENT FILL	🟪	130	Mohr-Coulomb	200	25
CLAY (GLACIAL DRIFT)	🟩	125	Mohr-Coulomb	125	26
LIMESTONE/ SHALE BEDROCK	🟧	130	Mohr-Coulomb	0	30



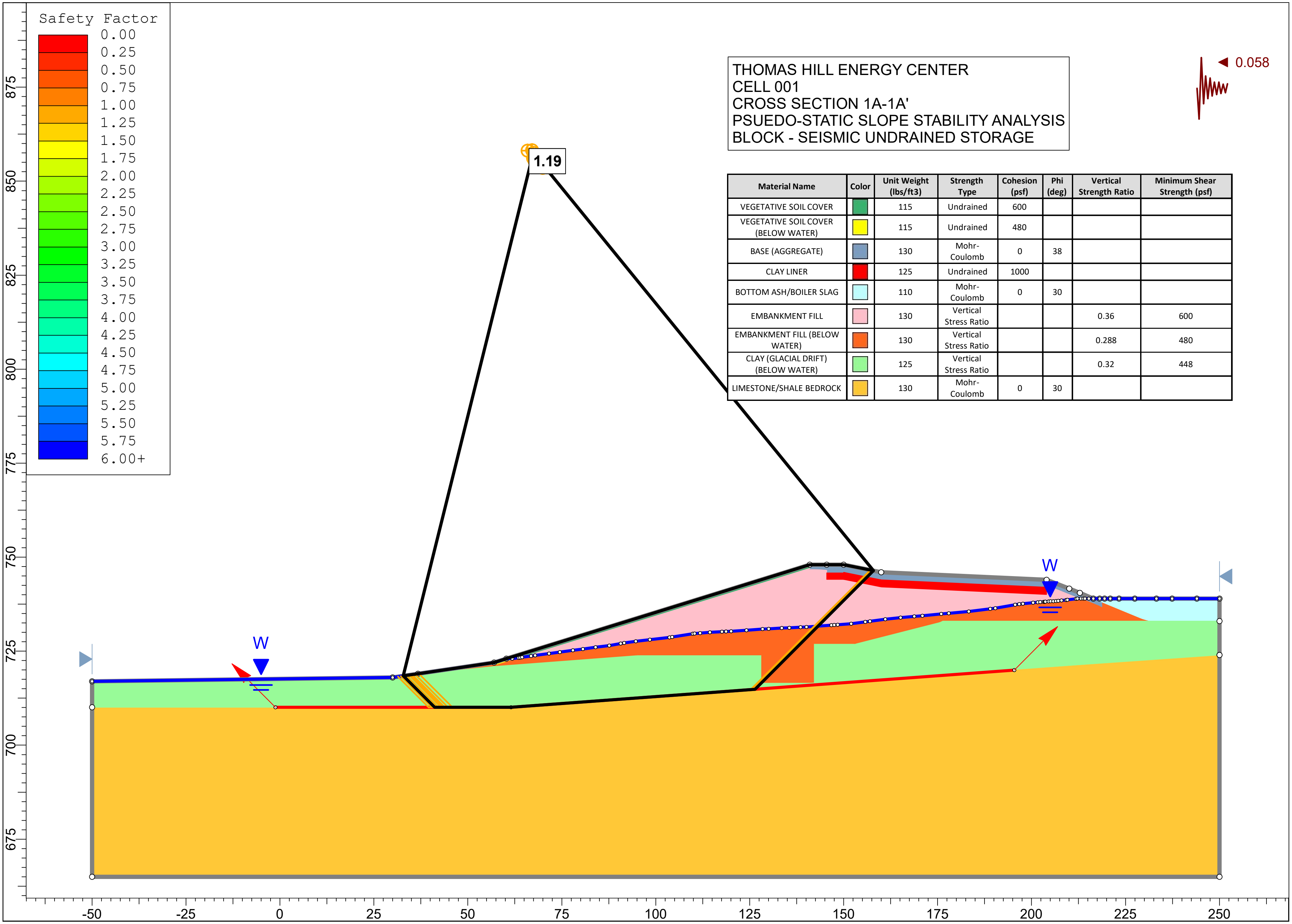
THOMAS HILL ENERGY CENTER
CELL 001
CROSS SECTION 1A-1A'
STATIC SLOPE STABILITY ANALYSIS
BLOCK - DRAINED SURCHARGE

Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)
VEGETATIVE SOIL COVER	🟩	115	Mohr-Coulomb	50	28
BASE (AGGREGATE)	🟦	130	Mohr-Coulomb	0	38
CLAY LINER	🟥	125	Mohr-Coulomb	50	28
BOTTOM ASH/BOILER SLAG	🟦	110	Mohr-Coulomb	0	30
EMBANKMENT FILL	🟥	130	Mohr-Coulomb	200	25
CLAY (GLACIAL DRIFT)	🟩	125	Mohr-Coulomb	125	26
LIMESTONE/SHALE BEDROCK	🟨	130	Mohr-Coulomb	0	30



THOMAS HILL ENERGY CENTER
CELL 001
CROSS SECTION 1A-1A'
PSUEDO-STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - SEISMIC UNDRAINED STORAGE

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
VEGETATIVE SOIL COVER	🟩	115	Undrained	600			
VEGETATIVE SOIL COVER (BELOW WATER)	🟨	115	Undrained	480			
BASE (AGGREGATE)	🟦	130	Mohr-Coulomb	0	38		
CLAY LINER	🟥	125	Undrained	1000			
BOTTOM ASH/BOILER SLAG	🟦	110	Mohr-Coulomb	0	30		
EMBANKMENT FILL	🟪	130	Vertical Stress Ratio			0.36	600
EMBANKMENT FILL (BELOW WATER)	🟧	130	Vertical Stress Ratio			0.288	480
CLAY (GLACIAL DRIFT) (BELOW WATER)	🟩	125	Vertical Stress Ratio			0.32	448
LIMESTONE/SHALE BEDROCK	🟧	130	Mohr-Coulomb	0	30		



THOMAS HILL ENERGY CENTER
CELL 001
CROSS SECTION 1A-1A'
PSUEDO-STATIC SLOPE STABILITY ANALYSIS
BLOCK - SEISMIC UNDRAINED STORAGE

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
VEGETATIVE SOIL COVER	🟩	115	Undrained	600			
VEGETATIVE SOIL COVER (BELOW WATER)	🟨	115	Undrained	480			
BASE (AGGREGATE)	🟦	130	Mohr-Coulomb	0	38		
CLAY LINER	🟥	125	Undrained	1000			
BOTTOM ASH/BOILER SLAG	🟦	110	Mohr-Coulomb	0	30		
EMBANKMENT FILL	🟪	130	Vertical Stress Ratio			0.36	600
EMBANKMENT FILL (BELOW WATER)	🟧	130	Vertical Stress Ratio			0.288	480
CLAY (GLACIAL DRIFT) (BELOW WATER)	🟩	125	Vertical Stress Ratio			0.32	448
LIMESTONE/SHALE BEDROCK	🟧	130	Mohr-Coulomb	0	30		

APPENDIX B

2016 Report on Safety Factor Assessment

www.haleyaldrich.com

REPORT ON

INITIAL SAFETY FACTOR ASSESSMENT
THOMAS HILL ENERGY CENTER
CELL 001, CELL 003, AND CELL 004
CLIFTON HILL, MISSOURI

by Haley & Aldrich, Inc.
Cleveland, Ohio

for Associated Electric Cooperative, Inc.
Springfield, Missouri

File No. 128064-003
October 2016

HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Cleveland, OH 44131
216.739.0555

17 October 2016
File No. 128064-003

Associated Electric Cooperative, Inc.
2814 South Golden Avenue
P.O. Box 754
Springfield, Missouri 65801

Attention: Kim Dickerson
Senior Environmental Analyst

Subject: Report on Initial Safety Factor Assessment
Cells 001, 003, and 004
Thomas Hill Energy Center
Clifton Hill, Missouri

Ms. Dickerson:

We are pleased to submit herewith our report entitled, "Report on Initial Safety Factor Assessment, Cells 001, 003, and 004, Thomas Hill Energy Center, Clifton Hill, Missouri." This report includes background information regarding the project, the results of our field investigation program, and the results of our initial safety factor assessment.

This work was performed by Haley & Aldrich, Inc. (Haley & Aldrich) on behalf of Associated Electric Cooperative, Inc. (AECI) in accordance with the United States Environmental Protection Agency's Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities, 40 CFR Part 257, specifically §257.73(e).

The scope of our work consisted of the following: 1) reviewing readily available reports, investigations, plans and data pertaining to the surface impoundments; 2) performing engineering evaluations related to liquefaction and slope stability; and 3) preparing and submitting this report presenting the results of our assessment.

Thank you for inviting us to complete this assessment and please feel free to contact us if you wish to discuss the contents of the report.

Sincerely yours,
HALEY & ALDRICH, INC.

Derrick A. Shelton
Geotechnical Program Manager | Senior Associate

Steven F. Putrich, P.E.
Principal

Enclosures

REPORT ON
INITIAL SAFETY FACTOR ASSESSMENT
CELLS 001, 003, AND 004
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

by Haley & Aldrich, Inc.
Cleveland, Ohio

for Associated Electric Cooperative, Inc.
Springfield, Missouri

File No. 128064-003
October 2016

Table of Contents

Page

List of Tables iii

List of Figures iii

1. Introduction 1

- 1.1 GENERAL 1
- 1.2 PURPOSE OF SAFETY FACTOR ASSESSMENT 1
- 1.3 ELEVATION DATUM AND HORIZONTAL CONTROL 1

2. Description of Ponds 2

- 2.1 DESCRIPTION OF CELL 001 2
- 2.2 DESCRIPTION OF CELL 003 2
- 2.3 DESCRIPTION OF CELL 004 3

3. Field Investigation Program 4

- 3.1 PREVIOUS EXPLORATIONS AND LABORATORY TESTING PERFORMED BY OTHERS 4
- 3.2 CURRENT SUBSURFACE EXPLORATION PROGRAM 4

4. Subsurface Conditions 6

- 4.1 GEOLOGY 6
- 4.2 SUBSURFACE CONDITIONS 6
- 4.3 GROUNDWATER CONDITIONS 7

5. Safety Factor Assessment 8

- 5.1 DESIGN WATER LEVELS 8
- 5.2 MATERIAL PROPERTIES 9
- 5.3 DESIGN SEISMIC EVENT 10
- 5.4 LIQUEFACTION POTENTIAL EVALUATION 10
- 5.5 STABILITY ANALYSIS 10
  - 5.5.1 Methodology for Analyses 10
  - 5.5.2 Pseudo-static Coefficient 11
  - 5.5.3 Results of Stability Evaluation 11
- 5.6 CONCLUSIONS 12

6. Certification 14

References 16

Table of Contents

Page

Tables
Figures
Appendix A – Historic Test Boring Logs and Laboratory Test Results
Appendix B – Current Subsurface Exploration Logs
Appendix C – Analyses

List of Tables

Table No.	**Title**
I	Summary of Relevant Historic Subsurface Explorations
II	Summary of Current Subsurface Explorations
III	Summary of Historic Laboratory Test Results
IV	Summary of Groundwater Level Measurements
V	Material Properties
VI	Summary of Static and Seismic Stability Analyses

List of Figures

Figure No.	**Title**
1	Project Locus
2	Subsurface Exploration Location Plan

1. Introduction

1.1 GENERAL

Haley & Aldrich, Inc. (Haley & Aldrich) has been contracted by Associated Electric Cooperative, Inc. (AECI) to perform the Initial Safety Factor Assessment for Slag Pond 001 Cells 001, 003, and 004 located at Thomas Hill Energy Center in Clifton Hill, Missouri. This work was completed in accordance with the United States Environmental Protection Agency's (EPA's) Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals (CCR) from Electric Utilities, 40 CFR Part 257, specifically §257.73(e) (EPA, 2015).

1.2 PURPOSE OF SAFETY FACTOR ASSESSMENT

The purpose of this study was to evaluate the subsurface soil and water conditions at the site and to perform the initial safety factor assessment in accordance with Section §257.73(e)(1) of the CCR Rule. To achieve the objective discussed above, the scope of work undertaken for this assessment included the tasks listed below.

- Reviewing readily available reports, investigations, plans and data pertaining to the surface impoundments.

- Evaluating liquefaction susceptibility of material used to construct the impoundment embankments.

- Performing static and seismic stability analyses for rotational failure surfaces using limit equilibrium methods.

1.3 ELEVATION DATUM AND HORIZONTAL CONTROL

The elevations referenced in this report are in feet and are based on the National Geodetic Vertical Datum of 1929 (NGVD29) unless otherwise noted. The horizontal control is the Missouri State Plane North Coordinate System (NAD 83) datum unless otherwise noted.

2. Description of Ponds

A summary of relevant information associated with each pond is provided below. Additional details can be found in the Initial Structural Stability Assessment Reports prepared by AECI under separate cover. Refer to Figure 1, "Project Locus" for the general site location.

2.1 DESCRIPTION OF CELL 001

Cell 001 is a CCR surface impoundment used for settling and temporary wet storage of bottom ash and boiler slag sluiced from Thomas Hill Units 1 and 2. CCR slurry is pumped from the power plant and discharges into the southwest corner of Cell 001 through two approximate 14-in. diameter pipes. After initial settling, water and suspended CCR enter a rectangular concrete decant structure equipped with 60-inch wide concrete stop logs, and flow via a 30-in. diameter concrete outlet pipe to a drainage channel which discharges into Cell 003.

It is understood that Cell 001 was originally designed by Burn & McDonnell in 1978-1979 and constructed shortly thereafter. In 2015, AECI constructed a CCR Processing and Containment Pad to allow continued removal and dewatering of CCR from Cell 001. The processing and containment pad was designed to allow removal and dewatering of CCR from Cell 001, with free liquids from the dredged CCR draining back into Cell 001. The construction included a 5-ft high containment berm to prevent CCR and free liquids from migrating outside the pad. Fill for the processing pad and containment berm consisted of clayey fill obtained from on-site borrow sources. The clay fill was keyed into the underlying natural clays, and a 2-ft thick compacted clay liner was placed below the processing and containment pad.

Cell 001 impoundment has an area of approximately 2.3 acres. Cell 001 embankments are generally 10 ft or less in height, with a crest width generally ranging from 15 to 20 ft. The containment berm defines the southern edge of the processing and containment pad. Beyond the containment berm, ground surface slopes downward to Cell 002 with a slope height of up to 30 ft.

2.2 DESCRIPTION OF CELL 003

Cell 003 is a CCR surface impoundment located to the south of the Thomas Hill power plant. Cell 003 was originally designed by Burn & McDonnell in 1978-1979 and constructed shortly thereafter. It is understood that Cell 003 was modified in 1984. On the south side, an embankment with 16-ft crest width separates Cells 003 and Cell 004. The embankment is constructed from clay fill obtained from an on-site borrow source. The south interior and exterior slopes are typically 3H:1V. In 1984, the current south embankment was constructed and the original embankment was abandoned and left in place. The abandoned embankment is submerged at normal pool level.

Cell 003 receives decant water and suspended coal combustion residuals (CCR) from Cell 001 via an earthen bypass channel which flows from Cell 001 and around Cell 002, discharging into the northwest corner of Cell 003. In addition, stormwater and non-CCR process water from Cell 002 East flows to Cell 003, discharging from an underwater pipe in the northeast corner of the impoundment. During the 2015 modifications to Cell 002 West, a 15-in. corrugated metal pipe was installed through the embankment between Cell 002 and 003 to convey water from Cell 002 to Cell 003. This pipe remains inactive as Cell 002 is maintained in a dry condition to facilitate the ongoing CCR removal from the impoundment.

The outlet structure from Cell 003 consists of a rectangular concrete drop inlet tower equipped with 60-in. wide concrete stop logs. Decant water entering the structure flows through a pipe that penetrates the common embankment between Cell 003 and 004 and discharges underwater into Cell 004. The Cell 003 emergency spillway consists of an 18-ft wide riprap-lined channel which is approximately 2 ft in depth located across the crest of the south dike. To provide vehicle access across the riprapped channel, the riprap has been topped off with a layer of crushed stone within the limits of access road.

Cell 003 is used for wet storage of fly ash, bottom ash, boiler slag and sediments from the coal pile runoff. Cell 003 is incised on the east and west sides. On the north side, an embankment with 18-ft crest width separates Cell 003 and Cell 002. Accumulated CCR is periodically dredged from Cell 003, generally on an approximate 2 to 4-year cycle.

The north interior slope of Cell 003 varies from about 3 Horizontal to 1 Vertical (3H:1V) to 2H:1V, while the north exterior slope is typically 3H:1V. Cell 003 has a surface area of approximately 13 acres and total storage capacity of approximately 160 acre-ft.

2.3 DESCRIPTION OF CELL 004

Cell 004 is a CCR surface impoundment located to the south of the Thomas Hill power plant. Cell 004 was originally designed by Burn & McDonnell in 1978-1979 and constructed shortly thereafter. It is understood that Cell 004 was modified in the 1980's.

Cell 004 is the final settling pond and stores decant water from Cell 003 and a limited quantity of CCR material. The impoundment is surrounded by earthen berms on all sides. Maximum embankment height is approximately 24 ft based on the ground surface elevation contour lines on Figure 2. Exterior slopes range from approximately 4H:1V to 5H:1V with some flatter areas. Interior slopes are typically 3H:1V. Crest width varies from approximately 14 to 16 ft.

Cell 004 has a surface area of approximately 12 acres and total storage capacity of approximately 125 acre-feet as stated in the Initial Annual Inspection.

The outlet structure from Cell 004 consists of a rectangular concrete drop inlet tower equipped with 60-in. wide concrete stop logs. Decant water enters the structure and flows through a 48-in. diameter steel pipe that penetrates the Cell 004 south embankment and discharges from the NPDES-permitted Outfall #001 into a concrete open channel before discharging into the Middle Fork of the Little Chariton River.

The Cell 004 emergency spillway consists of an 18-ft wide riprap-lined channel which is approximately 2 ft in depth located across the crest of the south embankment. To provide vehicle access across the riprapped channel, the riprap has been topped off with a layer of crushed stone within the limits of access road.

3. Field Investigation Program

3.1 PREVIOUS EXPLORATIONS AND LABORATORY TESTING PERFORMED BY OTHERS

Several subsurface exploration and laboratory testing programs were previously completed at the site by others. The approximate locations of the relevant historic subsurface explorations performed by others are shown on the attached Figure 2. A brief summary of the explorations is provided below and details of relevant explorations are presented in Table I[1]. Note that the term "relevant" explorations refers to explorations from previous investigations by others that were directly used in our safety factor assessment.

- Three (3) test borings were drilled and one (1) temporary piezometer was installed by Geotechnology, Inc. (Geotechnology) during the period 7 November 2011 to 8 November 2011 as part of a slope stability and seepage analysis for Cell 001. The test boring logs and laboratory test results associated with this investigation are included in Appendix A.
- Two (2) test borings were performed by Geotechnology during the period 13 January 2010 to 14 January 2010 as part of a slope stability evaluation of Cell 003. The test boring logs and laboratory test results associated with this investigation are included in Appendix A
- Two (2) cone penetrometer soundings were performed by Stratigraphics, Inc. on 3 February 2010 as part of a global stability evaluation of Cell 003. The logs associated with this investigation are included in Appendix A.
- Two (2) test borings were drilled and one (1) temporary piezometer was installed by Geotechnology on 8 November 2011 as part of a slope stability and seepage analysis for Cell 004. The test boring logs and laboratory test results associated with this investigation are included in Appendix A

3.2 CURRENT SUBSURFACE EXPLORATION PROGRAM

A subsurface exploration program was conducted at the project site during the period 19 August 2015 to 27 August 2015 and on 2 August 2016 by Haley & Aldrich. The program consisted of installing six (6) piezometers. The piezometers were installed by Bulldog Drilling of Dupo, Illinois using an ATV-mounted drill rig. A Haley & Aldrich representative was present in the field to observe the piezometer installation activities. The locations of the test borings associated with the piezometers are shown on Figure 2. The as-drilled locations and elevations of the piezometers were determined in the field by Gredell Resources Engineering, Inc. (Gredell) of Jefferson City, Missouri by optical survey. The locations and elevations of the explorations should be considered accurate only to the degree implied by the method used. A summary of the subsurface explorations is presented in Table II.

The test borings associated with the piezometers were drilled to depths ranging from 19.4 ft to 34.5 ft below ground surface. The borings were advanced using hollow stem augers. Standard penetration tests were not performed, but the auger cuttings were used to evaluate the subsurface soil conditions encountered.

---

[1] Note: A table that does not appear near its citation can be found in a separate table at the end of the report.

The observation well installation reports are presented in Appendix B. The installation reports and related information depict subsurface conditions only at the specific locations and at the particular time designated on the installation reports. Subsurface conditions at other locations may differ from conditions occurring at the exploration locations. Also the passage of time may result in a change in the subsurface conditions at these exploration locations.

4. Subsurface Conditions

4.1 GEOLOGY

Thomas Hill Energy Center is located within the Dissected Till Plains subprovince of the Central Lowlands physiographic province and is underlain by recent alluvium and glacial till deposits. These deposits are underlain regionally by a sequence of bedrock formations ranging in age from Cambrian to Pennsylvanian (Miller and Vandike, 1997).

Alluvium and glacial till deposits underlying the ponds typically consist of clay, silty clay, silty clay with trace sand and gravel, and clayey to sandy silt. Siltstone and shale bedrock is present at a depth ranging from 27 to 36 feet (Geotechnology, 2010, 2012a, 2012b).

4.2 SUBSURFACE CONDITIONS

Descriptions of the soil conditions encountered during the historic subsurface exploration programs conducted at the site are provided below in order of increasing depth below ground surface. Actual soil conditions between boring locations may differ from these typical descriptions. Refer to the test boring logs in Appendix A for specific descriptions of soil samples obtained from the historic borings.

The subsurface conditions identified by the historic CPT soundings do not represent material classifications based on grain-size distributions, index tests, or visual observation. Rather, the historic CPT soundings provide an indicator of relative behavior type based on the mechanical characteristics measured during the soundings. For this reason, the descriptions of subsurface conditions discussed below are only based on classifications of samples obtained from historic test borings and the results of historic laboratory testing.

- *EMBANKMENT FILL* – Below the ground surface at all test boring locations, there is a stratum of man-placed EMBANKMENT FILL primarily described as lean clay (CL) with varying amounts of silt, sand, and gravel. This stratum was fully penetrated by all borings. The thickness of this stratum ranged from approximately 3 to 20 ft. The consistency of fine grained soils encountered in this stratum ranged from soft to stiff, but was generally medium stiff.

- *CLAY* - Below the EMBANKMENT FILL, there is a stratum of natural soil primarily described as fat CLAY (CH) and lean CLAY (CL) with varying amounts silt, sand and gravel. This stratum was encountered in all borings. Where encountered, this stratum was fully penetrated in borings B-1, B-2, B-3 and C-1. Where encountered, the thickness of this stratum ranged from 8.5 to 17 ft. The consistency of fine grained soils encountered in this stratum ranged from soft to very stiff but was generally medium stiff to stiff.

- *WEATHERED BEDROCK* – Below the CLAY in borings B-4, B-5, and C-2, there is a stratum natural material described as WEATHERED BEDROCK. Where encountered, this stratum was not fully penetrated in any of the test borings. It should be noted that boring B-2 encountered auger refusal at 16 ft below ground surface and refusal was assumed to occur due to encountering bedrock (Geotechnology, 2012a).

4.3 GROUNDWATER CONDITIONS

Water levels at the site discussed herein are based on the water levels encountered in historic test borings, historic piezometers, and recent piezometers installed by Haley & Aldrich in 2015 and 2016. Measured water levels in the historic test borings are summarized in Table I and measured water levels in historic and current piezometers are summarized in Table IV. A brief summary of measured water levels is provided below.

- At Cell 001, measured water levels in the historic test borings ranged from 5.5 ft to 9.3 ft below ground surface. In temporary piezometer P-1, measured water levels ranged from 9.3 ft to 9.4 ft below ground surface.

- At Cell 003, measured water levels at piezometer TPZ-3 ranged from 4.6 ft to 6.8 ft below ground surface.

- At Cell 004, measured water levels in the historic test borings ranged from 9.7 ft to 15.0 ft below ground surface. In the temporary and recent piezometers, measured water levels ranged from 1.1 ft to 19.6 ft below ground surface.

Water level readings have been made in the subsurface explorations and piezometers at times and under conditions discussed herein. However, it must be noted that fluctuations in the level of the water may occur due to variations in power plant sluicing activities, season, rainfall, temperature, dewatering activities, and other factors not evident at the time measurements were made and reported herein.

5. Safety Factor Assessment

As mentioned previously, the purpose of this study was to perform the initial safety factor assessment in accordance with Section §257.73(e)(1) of the CCR Rule. As required by the CCR Rule, the initial safety factor assessment is performed for a CCR unit to determine calculated factors of safety for each CCR unit relative to the minimum prescribed safety factors for the critical cross section of the embankment. The minimum required safety factors are defined as follows:

- The calculated static factor of safety under the long-term, maximum storage pool loading conditions must equal or exceed 1.50.
- The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.
- The calculated seismic factor of safety must equal or exceed 1.00.
- For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

Stability analyses have been performed in general conformance with the principles and methodologies described in the USACE Slope Stability Manual (U.S. Army Corps of Engineers, 2003). Conventional static and seismic stability analyses of the impoundment embankments were performed for rotational failures using limit equilibrium methods. Limit equilibrium methods compare forces, moments, and stresses which cause instability of the mass of the embankment to those which resist that instability. The principle of the limit equilibrium method is to assume that if the slope under consideration were about to fail, or at the structural limit of failure, then one must determine the resulting shear stresses along the expected failure surface. These determined shear stresses are then compared with the shear strength of the soils along the expected failure surface to determine the safety factor. The details of the analyses performed for the impoundments are presented in the following sections of this report.

5.1 DESIGN WATER LEVELS

In accordance with the CCR Rule, the water retained in an impoundment must be modeled at the maximum storage pool level for the static drained and seismic undrained analyses. The maximum surcharge pool level must be used to model the ponded water for the static undrained analyses. A summary of the maximum storage pool and surcharge pool water levels at each impoundment are provided below.

Location	Crest	Maximum Storage Pool Level	Maximum Surcharge Pool Level	Available Freeboard
Cell 001	El. 744	El. 739	El. 744	5 ft.
Cell 003	El. 718	El. 710	El. 715	8 ft.
Cell 004	El. 706	El. 700	El. 703	6 ft.

The elevation of the phreatic surface within the embankments and at the toe of slope were estimated based on conditions encountered in nearby subsurface explorations and observation wells. Additionally, there is no current evidence of seepage emanating from the exterior slopes of the embankments, suggesting that the phreatic surface is contained within and/or below the embankments.

Given the prescribed impoundment pool levels and the observed static groundwater levels discussed above, a seepage analysis was performed to determine the piezometric head between the upstream slope of the impoundment embankments and the downstream toe of the embankments. The computer software program, Slide 6.029, developed by RocScience, Inc., was used to perform the seepage analyses. Permeability values for each material layer were estimated from typical published values based on material description and correlations to grain size. During the course of the seepage analyses, minor adjustments were made to the permeability values and isotropic permeability ratios to best model the conditions observed in the field. Results from the seepage analysis provided pore pressure values within the seepage model that were then imported into the slope stability model.

The seepage models suggest that much of the seepage emanating from the impoundments is moving downward into the more permeable foundation soils and establishing a groundwater table several feet below ground surface rather than moving laterally through the embankments and discharging from the downstream slope. The phreatic surfaces used in the slope stability models are shown on the slope stability graphical output included in Appendix C.

5.2 MATERIAL PROPERTIES

The material properties used in our analyses have been evaluated using the results of the historic analyses performed by Geotechnology, historic subsurface explorations, and historic laboratory testing. In cases where subsurface explorations, laboratory test data, and historic properties did not exist for certain materials, properties were estimated based on typical values developed from Haley & Aldrich's experience with similar materials as indicated below.

- Bottom Ash/Boiler Slag/Fly Ash – typical values.
- Clay Liner – typical values

Refer to Table V for a summary of material properties and Appendix C for additional details of soil property characterization.

TABLE V
MATERIAL PROPERTIES

Material	Material Strength	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degrees)	Su (psf)	Vertical Stress Ratio	Minimum Shear Strength (psf)
Bottom Ash/Boiler Slag	Drained	90	0	30	--	--	--
	Undrained	90	750	0	--	--	--
Fly Ash/Bottom Ash/Boiler Slag	Drained	90	0	30	--	--	--
	Undrained	90	750	0	--	--	--
Embankment Fill and Embankment Fill (2015)	Drained	125	200	25	--	--	--
	Undrained	125	--	--	--	0.360	600
Clay	Drained	120	125	26	--	--	--
	Undrained	120	--	--	--	0.253	800
Clay Liner	Drained	125	0	28	--	--	--
	Undrained	125	--	--	1,300	--	--
Weathered Bedrock	Drained	130	0	38	--	--	--
	Undrained	130	0	38	--	--	--

5.3 DESIGN SEISMIC EVENT

In accordance with Section §257.53 of the CCR Rule, the seismic safety factor is defined as the factor of safety determined under earthquake conditions using the peak ground acceleration for a seismic event with a 2% probability of exceedance in 50 years (2,500-year return period). The gridded hazard map data associated with the latest USGS National Seismic Hazard maps developed in 2014 indicates that the bedrock peak ground acceleration (PGA) at the site for the 2,500-year earthquake event is 0.057g, with the greatest contribution to the hazard coming from an earthquake with a modal magnitude of 7.7 as indicated on the deaggregation chart included in Appendix C. The bedrock PGA value was adjusted by the USGS site coefficient, F_{PGA}, of 1.6 for Site Class D to determine the peak free field ground acceleration, k_{max}, of 0.091g. Note that the value of k_{max} corresponds to the peak ground acceleration at the base of the impoundment embankment.

5.4 LIQUEFACTION POTENTIAL EVALUATION

During strong earthquake shaking, loose, saturated cohesionless soil deposits may experience a sudden loss of strength and stiffness, sometimes resulting in loss of bearing capacity, large permanent lateral displacements, and/or seismic settlement of the ground. This phenomenon is called soil liquefaction. In accordance with the requirements of §257.73(e)(1), evaluations have been performed to assess the potential for liquefaction of the soils used to construct the impoundment embankments.

A variety of screening techniques exist to distinguish sites that are clearly safe with respect to liquefaction from those sites that require more detailed study. One of the most commonly used screening techniques used to make this assessment is the evaluation of fines content and plasticity index. In general, soils having greater than 15 percent (by weight) finer than 0.005 mm, a liquid limit greater than 35 percent, and an in-situ water content less than 90 percent of the liquid limit generally do not liquefy (Seed and Idriss, 1982).

The results of the historic subsurface explorations performed at the site indicate that the majority of soils used to construct the impoundment embankments consist of lean CLAY and fat CLAY with varying amounts of sand. Generally, these materials are not considered to be liquefiable. However, since limited laboratory sieve analyses were performed during the historic investigations, we performed liquefaction triggering analyses using the historic test boring data to determine if the soils were susceptible to liquefaction. Details of the liquefaction triggering analysis are included in Appendix C and indicate that the materials used to construct the embankments at Cells 001, 003, and 004 have factors of safety against liquefaction triggering that are greater than 1.2, and are not susceptible to liquefaction.

5.5 STABILITY ANALYSIS

5.5.1 Methodology for Analyses

The computer software program Slide 6.029 was used to evaluate the static and seismic stability of the impoundment embankments. Analyses were performed to evaluate static drained (long-term) and undrained (short-term) strength conditions for circular and translational (block) failures using Spencer's method of slices. Spencer's method of slices was selected because it fully satisfies the requirements of force and moment equilibrium (limit equilibrium method). Translational failures were analyzed where subsurface conditions included a relatively weak foundation layer underlain by a relatively strong foundation layer (DeHavilland, 2004).

Seismic stability was evaluated using pseudo-static analyses. Pseudo-static analyses model the seismic shaking as a “permanent” body force that is added to the force-body diagram of a conventional static limit-equilibrium analysis; typically, only the horizontal component of earthquake shaking is modeled because the effects of vertical forces tend to average out to near zero (Jibson, 2011). This is a traditional approach for evaluating the stability of a slope during earthquake shaking and provides a simplified safety factor analysis for one earthquake pulse. A 20 percent reduction in material strength was incorporated in the pseudo-static analyses to represent the approximate threshold between large and small strains induced by cyclic loading (Duncan, 2014). A safety factor greater than or equal to one ($FS \geq 1.0$) indicates a slope is stable and a safety factor below one ($FS < 1.0$) indicates that the slope is unstable.

5.5.2 Pseudo-static Coefficient

The pseudo-static coefficient, k_s, used in our seismic analyses was calculated using the equation below, which uses the peak free field acceleration discussed above and a reduction factor of 0.50 (Hynes-Griffin and Franklin, 1984).

$$k_s = 0.50 \times \frac{k_{\max}}{\mathrm{g}} = 0.50 \times \frac{0.091\mathrm{g}}{\mathrm{g}} = 0.05$$

5.5.3 Results of Stability Evaluation

The critical cross section is defined as that which is anticipated to be most susceptible to failure amongst all cross sections. To identify the critical cross section at our project site, we examined the following conditions at several cross section locations at each impoundment:

a. the geometry of the upstream and downstream embankment slopes;
b. phreatic surface levels within and below the cross sections;
c. subsurface soil conditions;
d. presence or lack of surcharge loads behind the crest of the embankments; and
e. presence or lack of reinforcing measures in front of the embankments.

Examination of the conditions noted above resulted in the identification of one critical cross section at each impoundment. The locations of the critical cross sections are shown on Figure 2. The results of our analyses are presented below in Table VI and are shown on the Slide output files included in Appendix C.

As shown below, the static safety factors are above the minimum required values for the critical cross sections. Similarly, the pseudo-static analyses for the analyzed sections indicate an acceptable seismic safety factor.

TABLE VI
SUMMARY OF STATIC AND SEISMIC STABILITY EVALUATIONS

Impoundment	Cross Section	Condition[1]	Earthquake Event	Soil Strength	Required Safety Factor	Safety Factor	
						Rotational Failure Surface	Block Failure Surface
Cell 001	1A-1A'	Static	-	Drained	1.50	1.89	2.18
				Undrained	1.40	1.89	2.07
		Seismic	2,500-year	Undrained[2]	1.00	1.33	1.42
Cell 003	3A-3A'	Static	-	Drained	1.50	1.62	2.05
				Undrained	1.40	1.86	2.05
		Seismic	2,500-year	Undrained[2]	1.00	1.27	1.39
Cell 004	4A-4A'	Static	-	Drained	1.50	1.93	2.00
				Undrained	1.40	1.80	1.72
		Seismic	2,500-year	Undrained[2]	1.00	1.21	1.10

1. Refer to Table V for material properties.
2. Soil strengths have been reduced by 20 percent for seismic analyses.

5.6 CONCLUSIONS

The analyses associated with the safety factor assessment have been performed in accordance with the requirement of Section §257.73(e) of the CCR Rule. A summary of our conclusions as they relate to the rule requirements are provided below.

- §257.73(e)(1)(i) - *The calculated static factor of safety under the long-term, maximum storage pool loading conditions must equal or exceed 1.50.*

  As shown in Table VI, the static safety factors for the long-term (drained) maximum storage pool condition are above the minimum required value for the critical section analyzed. Accordingly, this requirement has been met.

- §257.73(e)(1)(ii) - *The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.*

  As shown in Table VI, the static safety factors for the maximum surcharge pool loading condition (undrained) are above the minimum required value for the critical section analyzed. Accordingly, this requirement has been met.

- §257.73(e)(1)(iii) - *The calculated seismic factor of safety must equal or exceed 1.00.*

  As shown in Table VI, the calculated seismic safety factor is above the minimum required value for the critical section analyzed. Accordingly, this requirement has been met.

- §257.73(e)(1)(iv) - *For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.*

The results of the subsurface investigations and liquefaction triggering evaluation indicate that the material used to construct the impoundment embankments are not susceptible to liquefaction. Accordingly, this requirement has been met.

6. Certification

Based on our review of the information provided to us by AECI and the results of our field investigations and analyses, it is our opinion that the calculated factors of safety for the critical cross section of the impoundment embankments meet the minimum factors of safety specified in §257.73(e)(1)(i) through (iv) of the EPA's CCR Rule.

Certification Statement – Cell 001

I certify that the Initial Safety Factor Assessment for Cell 001 at the Thomas Hill Energy Center meets the requirements of §257.73(e) of the EPA's CCR Rule.

Signed:________________________________
Certifying Engineer

Print Name: Steven F. Putrich
Missouri License No.: 2014035813
Title: Project Principal
Company: Haley & Aldrich, Inc.

Professional Engineer's Seal:

STEVEN F. PUTRICH
NUMBER
PE-2014035813
10-17-16

Certification Statement – Cell 003

I certify that the Initial Safety Factor Assessment for Cell 003 at the Thomas Hill Energy Center meets the requirements of §257.73(e) of the EPA's CCR Rule.

Signed:________________________________
Certifying Engineer

Print Name: Steven F. Putrich
Missouri License No.: 2014035813
Title: Project Principal
Company: Haley & Aldrich, Inc.

Professional Engineer's Seal:

STEVEN F. PUTRICH
NUMBER
PE-2014035813
10-17-16

Certification Statement – Cell 004

I certify that the Initial Safety Factor Assessment for Cell 004 at the Thomas Hill Energy Center meets the requirements of §257.73(e) of the EPA's CCR Rule.

Signed:__________________________________
Certifying Engineer

Print Name: Steven F. Putrich
Missouri License No.: 2014035813
Title: Project Principal
Company: Haley & Aldrich, Inc.

Professional Engineer's Seal:

STEVEN F.
PUTRICH
NUMBER
PE-2014035813
10-17-16

References

1. DeHavilland, A. et al. (2004). “Geotechnical and Stability Analyses for Ohio Waste Containment Facilities.” Ohio Environmental Protection Agency Geotechnical Resource Group. Columbus, Ohio, p. 8-1.

2. Duncan, J.M., Wright, S.G, and Brandon, T.L. (2014). Soil Strength and Slope Stability. John Wiley & Sons, Upper Saddle River, 2nd Edition, pp. 182-184.

3. Environmental Protection Agency, (2015). Code of Federal Regulations, “Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule, “Title 40, Chapter I, Parts 257 and 261, April 17.

4. Geotechnology, Inc. (February 2012a). “Slope Stability and Seepage Analysis, Slag Dewatering Basin, Thomas Hill Energy Center”. [*Note this refers to the current Cell 001 impoundment*]

5. Geotechnology, Inc. (February 2012b). “Slope Stability and Seepage Analysis, Ash Pond No. 3, Thomas Hill Energy Center”. [*Note this refers to the current Cell 004 impoundment*]

6. Geotechnology, Inc (2010). “Global Stability Evaluation, Mine Waste and Ash Pond Embankments, AECI Facilities, Bee Veer and Thomas Hill, Missouri”. {*Note this report refers to the current Cell 003* impoundment]

7. Hynes-Griffin, M.E. and Franklin, A.G. (1984). “Rationalizing the seismic coefficient method,” [Miscellaneous Paper GL-84-13]. U.S. Army Corp of Engineers Waterways Experiment Station. Vicksburg, Mississippi, p. 21.

8. Jibson, R.W., (2011). “Methods for assessing the stability of slopes during earthquakes—A Retrospective,” Engineering Geology, v. 122, p. 43-50.

9. Miller, D.E and Vandike, J.E. (1997). “Groundwater Resources of Missouri” Missouri State Water Plan Series Volume II, Missouri Department of Natural Resources.

10. Mine Safety and Health Administration – U.S. Department of Labor (MSHA), (May 2009. Rev. August 2010). Engineering and Design Manual Coal Refuse Disposal Facilities - Second Edition.

11. Seed, H.B. and Idriss, I.M. (1982), "Ground Motions and Soil Liquefaction During Earthquakes,” Monograph No. 5, Earthquake Engineering Research Institute, Berkeley, California, p. 134.

12. U.S. Army Corps of Engineers (2003). “Engineering and Design: Slope Stability,” Engineer Manual EM-1110-2-1902, Department of the Army, U.S. Army Corps of Engineers, Washington, DC, October.

TABLES

TABLE I PAGE 1 OF 1

SUMMARY OF RELEVANT HISTORIC SUBSURFACE EXPLORATIONS
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

Exploration Designation[1]	Performed By	Year Drilled	Ground Surface El.[2] (ft)	Total Exploration Depth (ft)	Water[3]
					Depth Below Ground Surface
TEST BORINGS					
B-1	Geotechnology, Inc.	2011	750.0	20.0	9.3
B-2	Geotechnology, Inc.	2011	745.0	16.0	5.5
B-3	Geotechnology, Inc.	2011	757.0	20.0	Not Encountered
B-4	Geotechnology, Inc.	2011	711.0	34.3	9.7
B-5	Geotechnology, Inc.	2011	697.0	29.7	15.0
C-1	Geotechnology, Inc.	2010	735.0	50.0	Not Measured
C-2	Geotechnology, Inc.	2010	725.0	37.2	Not Encountered
CONE PENETROMETER SOUNDINGS					
CC01	Stratigraphics, Inc.	2010	728.4	49.8	Unknown
CC02	Stratigraphics, Inc.	2010	717.9	52.5	Unknown
TEMPORARY PIEZOMETERS					
P-1	Geotechnology, Inc.	2011	750.0	10.5	See Table IV
P-2	Geotechnology, Inc.	2011	710.0	23.0	See Table IV

Notes:

1) Technical monitoring of historic subsurface explorations was performed by others.

2) The elevation data are provided in feet and the vetical datum is unknown. Ground surface elevations of historic test borings were taken from boring logs prepared by Geotechnology, Inc. Ground surface elevations of historic cone penetrometer soundings and piezometers were determined by linear interpolation between ground surface contour lines shown on Figure 2.

3) Groundwater level readings have been made in the explorations at times and under conditions discussed herein. However it must be noted that fluctuations in the level of the groundwater may occur due to variations in season, plant sluicing activities, rainfall, temperature, and other factors not evident at the time measurements were made and reported.

TABLE II

SUMMARY OF CURRENT SUBSURFACE EXPLORATIONS
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

Exploration Designation[1]	Ground Surface El.[2] (ft)	Northing[2]	Easting[2]	Total Exploration Depth (ft)	Water
					Depth Below Ground Surface
PIEZOMETERS					
TPZ-3	730.7	1351172.00	460709.39	28.5	See Table IV
TPZ-9	714.4	1350109.76	461128.86	18.0	See Table IV
TPZ-10	702.7	1350264.13	459992.76	24.5	See Table IV
TPZ-11	704.7	1349882.31	460851.28	19.4	See Table IV
TPZ-12	689.0	1349532.33	460183.30	33.9	See Table IV
TPZ-14	681.5	1349757.46	459870.66	34.5	See Table IV

Notes:

1) Technical monitoring of piezometers installed during the period 19 August 2015 through 2 August 2016 was performed by Haley & Aldrich, Inc.

2) As drilled locations and ground surface elevations of piezometers were determined in the field by Gredell Engineering Resources Inc. of Jefferson City, Missouri by optical survey. The coordinates are provided in units of feet, relative to the Missouri State Plane North Coordinate System (NAD27). The elevation data are provided in feet above sea level, relative to NAVD29.

TABLE III
SUMMARY OF HISTORIC LABORATORY TEST RESULTS
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

Boring Designation	Pond	Sample Number	Sample Depth (ft)	USCS Symbol	Material Type/Stratum	Moisture Content (%)	LL	PL	PI	Tube Density		Unconfined Compression		CU Triaxial	
										Average Moisture Content (%)	Average Total Density (pcf)	Moisture Content (%)	Undrained Shear Strength (psf)	c' (psf)	ϕ' (degrees)
HISTORIC TESTING BY GEOTECHNOLOGY, INC. IN FEBRUARY 2012															
B-1	1	ST2	3.0-5.0	CL	EMBANKMENT FILL					17	128.7			600	23
B-1	1	ST2	3.0-5.0	CL	EMBANKMENT FILL					17	127.7				
B-1	1	ST3	5.0-7.00	CL	EMBANKMENT FILL		50	17	33	16	133.4				
B-2	1	ST4	7.0-9.0	CH	CLAY					24	124.0			500	27
B-2	1	ST4	7.0-9.0	CH	CLAY		65	20	45	24	122.8				
B-2	1	ST4	7.0-9.0	CH	CLAY					23	100.0				
B-2	1	ST5	9.0-11.0	CH	CLAY					20	129.6	20	1600		
B-3	1	SS1	1.0-2.5	CL	EMBANKMENT FILL	34	92	27	65						
B-3	1	SS3	6.0-7.5	CH	CLAY	21	60	20	40						
B-3	1	SS5	13.5-15.0	CL	CLAY	17	36	16	20						
HISTORIC TESTING BY GEOTECHNOLOGY, INC. IN FEBRUARY 2012															
B-4	4	SS3	6.0-7.5	CH	EMBANKMENT FILL	29	72	23	49						
B-4	4	ST5	11.0-13.0	CH	EMBANKMENT FILL					30	120.9				
B-4	4	ST6	13.0-15.0	CH	CLAY					27	116.8			400	26
B-4	4	ST7	16.0-18.0	CH	CLAY		58	20	38	30	118.3			400	26
B-5	4	ST3	6.0-8.0	CL	EMBANKMENT FILL					25	122.5		1000		
B-5	4	ST4	8.0-10.0	CL	EMBANKMENT FILL					30	118.3			400	26
B-5	4	SS6	13.5-15.0	CL	CLAY	25	44	18	26						
HISTORIC TESTING BY GEOTECHNOLOGY, INC. IN APRIL 2010															
C-1	2	SS3	6.0-7.5	CH	EMBANKMENT FILL	24	52	28	24						
C-1	2	SS4	8.5-10.0	CH	EMBANKMENT FILL	23									
C-1	2	ST5	11.0-13.0	CH	CLAY	14									
C-1	2	ST6	13.5-15.5	CH	CLAY		51	25	26	30	126.1			0	26
C-1	2	ST6	13.5-15.5	CH	CLAY					22	120.8				
C-1	2	SS10	33.5-35.0	CL	CLAY	24	44	18	26						
C-2	3	SS3	6.0-7.5	CL	EMBANKMENT FILL	27	45	17	28						
C-2	3	ST7	18.0-20.0	CH	EMBANKMENT FILL					24	124.0				
C-2	3	ST8	20.0-22.0	CH	CLAY		62	23	39					0	25
C-2	3	SS10	28.5-30.0	CH	CLAY	25	52	20	32						

TABLE IV
SUMMARY OF GROUNDWATER LEVEL MEASUREMENTS
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

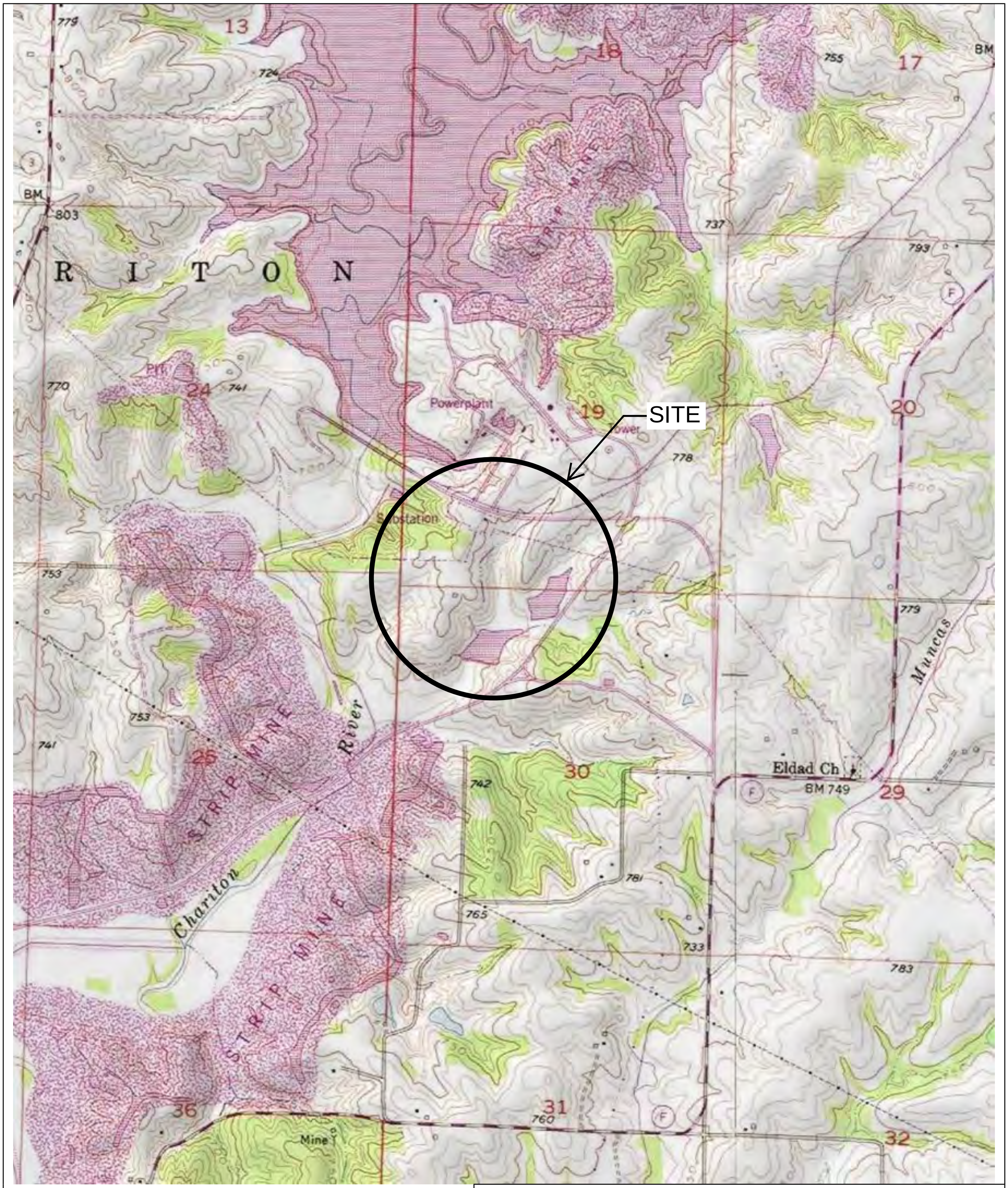
Observation Well Designation	Top of Casing Elevation (ft)[1]	Well Depth (ft)	Measurement Date	Depth to Water[2] (ft)	Groundwater Elevation (ft)	Well Installation Notes
TPZ-3	733.2	28.5	8/28/2015	7.1	726.1	Well installed 8/26/15 by Bulldog Drilling.
			9/16/2015	8.6	724.6	
			9/30/2015	9.3	723.9	
			8/2 to 8/3/16	8.0	725.2	
TPZ-9	716.9	18.0	8/28/2015	3.6	713.2	Well installed 8/24/15 by Bulldog Drilling.
			9/16/2015	3.9	713.0	
			9/30/2015	4.0	712.9	
			8/2 to 8/3/16	3.6	713.2	
TPZ-10	705.2	24.5	8/28/2015	9.5	695.7	Well installed 8/25/15 by Bulldog Drilling.
			9/16/2015	10.6	694.6	
			9/30/2015	14.1	691.1	
			8/2 to 8/3/16	9.8	695.4	
TPZ-11	707.2	19.4	8/28/2015	5.8	701.4	Well installed 8/27/15 by Bulldog Drilling.
			9/16/2015	5.6	701.6	
			9/30/2015	6.7	700.5	
			8/2 to 8/3/16	5.0	702.3	
TPZ-12	691.5	33.9	8/28/2015	3.8	687.7	Well installed 8/19/15 by Bulldog Drilling.
			9/16/2015	4.5	687.1	
			9/30/2015	5.0	686.5	
			8/2 to 8/3/16	4.4	687.1	
TPZ-14	683.7	34.5	8/2 to 8/3/16	6.2	677.6	Well installed 8/2/16 by Bulldog Drilling.
P-1	750.0	10.5	11/7/2011	9.4	740.6	Well installed on 11/7/11 by Geotechnology, Inc.
			11/9/2011	9.3	740.8	
P-2	712.7	23.0	11/8/2011	22.1	690.6	Well installed 11/8/11 by Geotechnology, Inc.
			11/9/2011	12.4	700.3	

Notes:

1) Top of casing elevations of piezometers installed by Bulldog Drilling were determined in the field by Gredell Engineering Resources, Inc. of Jefferson City, Missouri by optical survey, and the elevation data provided are in feet above sea level relative to NGVD29. Top of casing elevations of piezometers installed by Geotechnology, Inc. were taken from boring logs provided by Geotechnology, Inc. and the elevation datum is unknown.

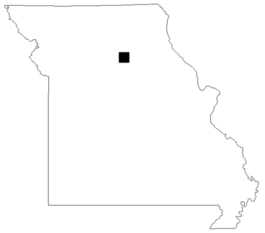
2) Groundwater level readings have been made in the wells at times and under conditions discussed herein. However it must be noted that fluctuations in the level of the groundwater may occur due to variations in season, rainfall, plant sluicing activities, temperature, and other factors not evident at the time measurements were made and reported.

FIGURES



MAP SOURCE: ESRI

SITE COORDINATES: 39°32'42"N, 92°38'14"W



HALEY ALDRICH

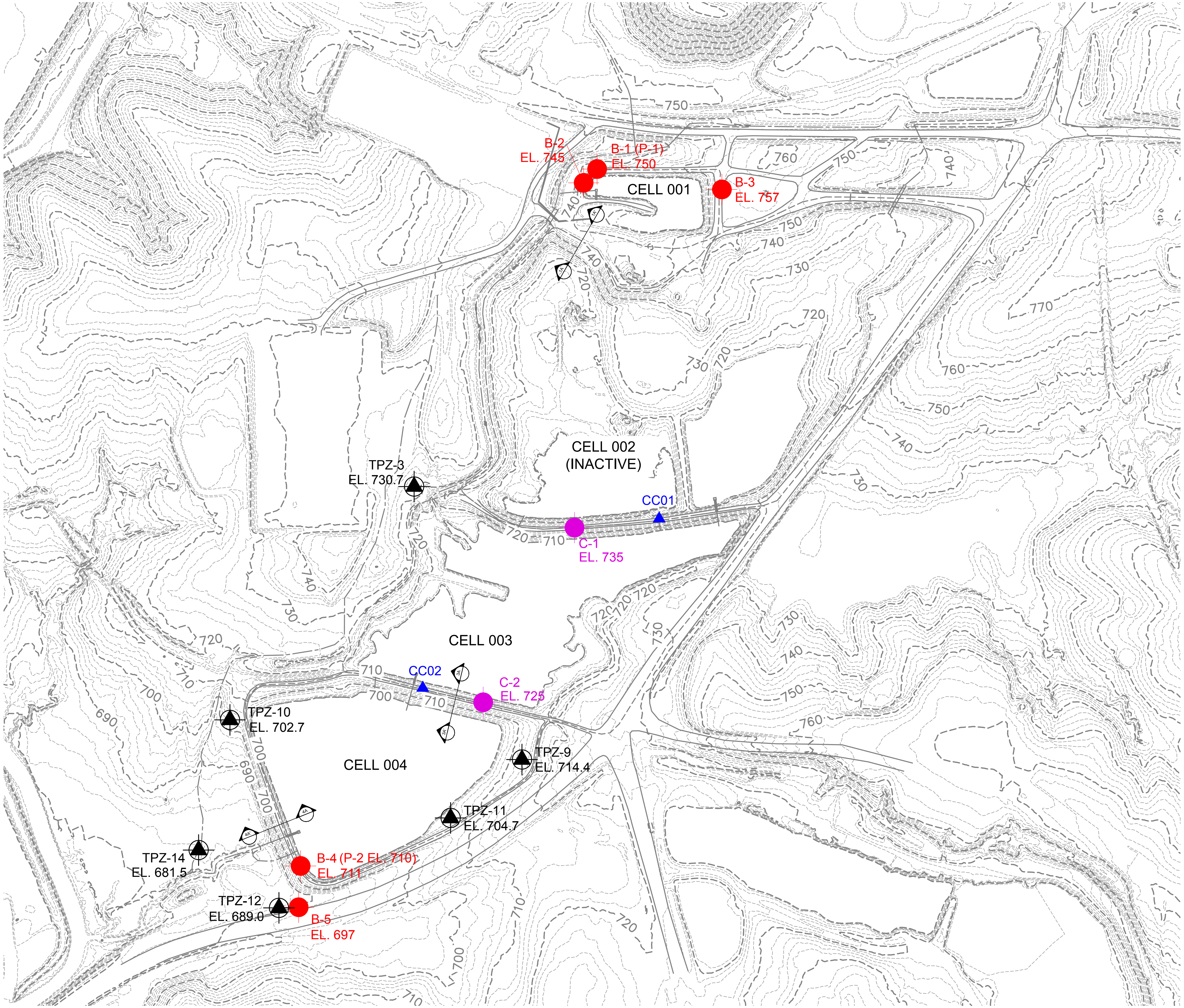
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

PROJECT LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
OCTOBER 2016

FIGURE 1

40616_000_1_LOCUS.PDF

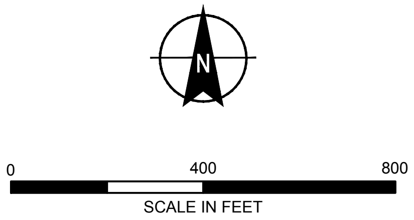


LEGEND

B-1 (P-1) EL. 750 ●	DESIGNATION, LOCATION AND GROUND SURFACE ELEVATION OF TEST BORINGS PERFORMED BY GEOTECHNOLOGY, INC. OF ST. LOUIS, MISSOURI DURING THE PERIOD NOVEMBER 7 TO NOVEMBER 8, 2011. A "P" DESIGNATION INDICATES TEMPORARY PIEZOMETER WAS INSTALLED IMMEDIATELY ADJACENT TO CORRESPONDING TEST BORING.
CC-1 ▲	DESIGNATION AND APPROXIMATE LOCATION OF CONE PENETROMETER SOUNDING PERFORMED BY STRATIGRAPHIC, INC. OF PROPHETSTOWN, ILLINOIS ON FEBRUARY 3, 2010.
C-1 EL. 735 ●	DESIGNATION AND APPROXIMATE LOCATION OF TEST BORINGS PERFORMED BY GEOTECHNOLOGY, INC. OF ST. LOUIS, MISSOURI DURING THE PERIOD JANUARY 13 TO 14, 2010.
TPZ-1 EL. 750.5 ▲	DESIGNATION, LOCATION, AND GROUND SURFACE ELEVATION OF PIEZOMETERS INSTALLED BY BULLDOG DRILLING OF DUPO, ILLINOIS DURING THE PERIOD OF AUGUST 19, 2015 TO AUGUST 27, 2015 AND AUGUST 2, 2016 TO AUGUST 3, 2016.
1A' — 1A'	SLOPE STABILITY CROSS-SECTION

NOTES

1. AERIAL SURVEY USED TO DEVELOP TOPOGRAPHY WAS PERFORMED BY PICTOMETRY INTERNATIONAL CORP. OF ROCHESTER, NEW YORK BETWEEN FEBRUARY 29,2016 AND APRIL 11, 2016.
   - HORIZONTAL CONTROL IS MISSOURI STATE PLANE NORTH COORDINATE SYSTEM (NAD 83).
   - ELEVATIONS IN THIS DRAWING ARE SHOWN IN FEET. THE VERTICAL DATUM FOR GROUND SURFACE ELEVATION CONTOUR LINES IS NGVD 29.
2. AS DRILLED LOCATIONS AND GROUND SURFACE ELEVATIONS OF PIEZOMETERS INSTALLED BY BULLDOG DRILLING WERE SURVEYED BY GREDELL RESOURCES ENGINEERING, INC. OF JEFFERSON CITY, MISSOURI BY OPTICAL SURVEY.
3. AS-DRILLED LOCATIONS OF TEST BORINGS PERFORMED BY GEOTECHNOLOGY, INC. AND CONE PENETROMETER SOUNDINGS PERFORMED BY STRATIGRAPHICS, INC. HAVE BEEN APPROXIMATED. GROUND SURFACE ELEVATIONS OF TEST BORINGS PERFORMED BY GEOTECHNOLOGY, INC. ARE FROM BORING LOGS PREPARED BY GEOTECHNOLOGY, INC.
4. TECHNICAL MONITORING OF PIEZOMETERS INSTALLED BY BULLDOG DRILLING WAS PERFORMED BY HALEY & ALDRICH.
5. TECHNICAL MONITORING OF SUBSURFACE EXPLORATIONS PERFORMED BY GEOTECHNOLOGY, INC. AND STRATIGRAPHICS, INC. WAS PERFORMED BY OTHERS.



HALEY ALDRICH

ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MO

SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
OCTOBER 2016

FIGURE 2

LUCIDO, SAM Printed: 10/17/2016 11:45 AM Layout: FIG 2
G:\40616_AECI-CCR ELG MANAGEMENT SUPPORT\CAD-TH\FIGURES\SUBSURFACE EXPLORATION LOCATION PLAN.DWG

APPENDIX A

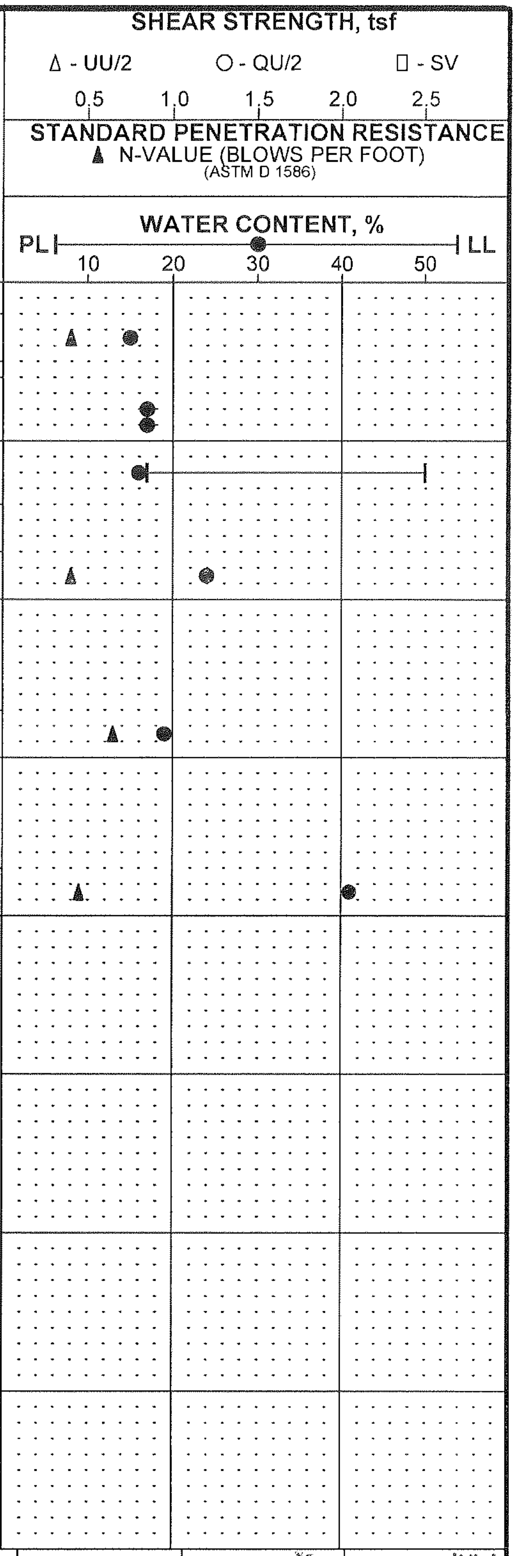
Historic Test Boring Logs and Laboratory Test Results

Surface Elevation: 750

Datum msl

Completion Date: 11/7/11

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	FILL: tan clay with sand, gravel, and slag			
			2-3-5	SS1
5			110 111	ST2
			115	ST3
		▼	1-3-5	SS4
10	black slag layer			
	Stiff, brown and gray CLAY, trace sand and gravel - CH (TILL)			
15			1-6-7	SS5
	Stiff, orange to green, shaley CLAY - CH		3-4-5	SS6
20	Boring terminated at 20 feet.			
25				
30				
35				



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 9.5 FEET ▽

AT 9.25 FEET AFTER 48 HOURS ▼

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER EED LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS: Multi-point consolidated-undrained triaxial compression test conducted on ST2 and ST3.

Drawn by: KA	Checked by: JFB	App'vd. by: MHM
Date: 11/16/11	Date: 12/15/11	Date: 12/15/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Slag Dewatering Basin
Thomas Hill Energy Center

LOG OF BORING: B-1

Project No. J011309.02

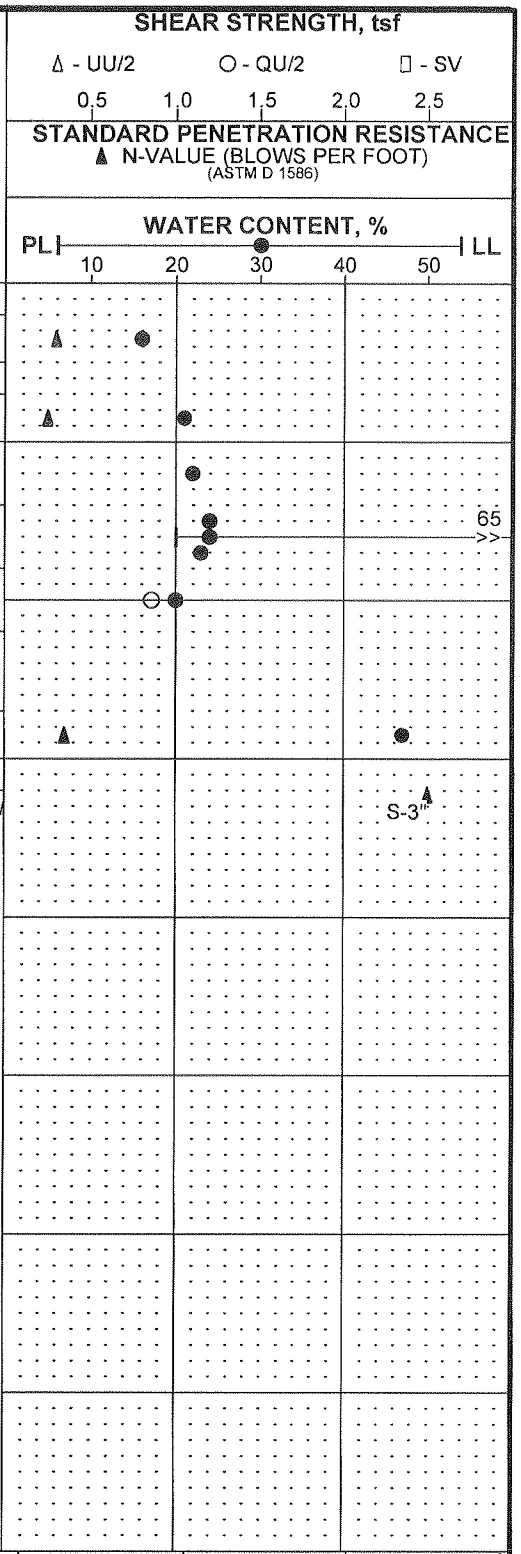
LOG OF BORING 2002 WL J011309.02 - AECI B1-3.GPJ 00 CLONE ME.GPJ 12/15/11

Surface Elevation: 745

Datum msl

Completion Date: 11/8/11

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL: tan clay with gravel and slag	▨		
			1-2-4	SS1
			1-2-3	SS2
5	▽			
				ST3
	Stiff, brown and gray CLAY, trace sand and gravel - (CH) (TILL)	▨		
			100 99 100	ST4
10			108	ST5
	Medium stiff, orange and green, shaley CLAY - CH	▤		
15			1-2-5	SS6
	Auger refusal at 16 feet.		50/3"	SS7
20				
25				
30				
35				



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

LOG OF BORING 2002 WL J011309.02 - AECI B1-3.GPJ 00 CLONE ME.GPJ 12/12/11

GROUNDWATER DATA

ENCOUNTERED AT 5.5 FEET ▽

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER EED LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS: Multi-point consolidated-undrained triaxial compression test conducted on ST4.

Drawn by: KA	Checked by: DB	App'vd. by: MHM
Date: 11/16/11	Date: 12/12/11	Date: 12/13/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Slag Dewatering Basin
Thomas Hill Energy Center

LOG OF BORING: B-2

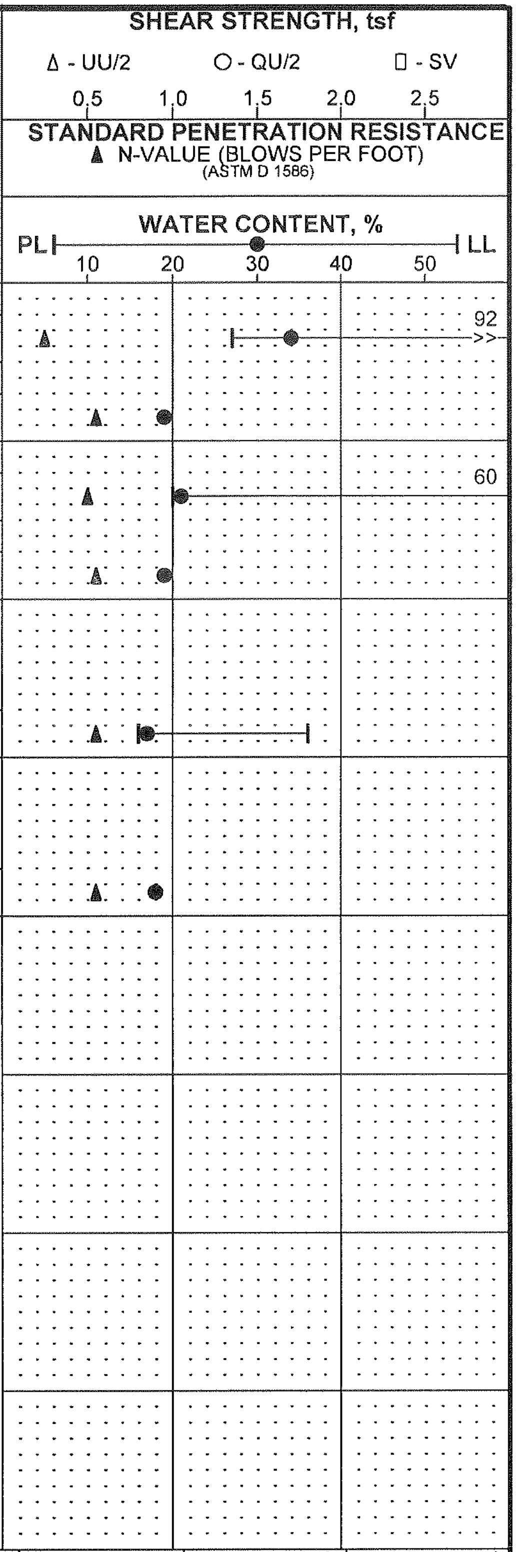
Project No. J011309.02

Surface Elevation: 757

Datum msl

Completion Date: 11/8/11

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL: blackish-brown clay with sand, gravel, and slag	▩	1-2-3	SS1
5	Stiff, orange-brown to brown and gray CLAY, trace sand and gravel - (CH) (TILL)	▨	1-5-6	SS2
		▨	1-3-7	SS3
10		▨	3-4-7	SS4
15	Stiff, brown and gray to tan, silty CLAY, trace sand and gravel - (CL) (TILL)	▒	1-5-6	SS5
	tan	▒	4-5-6	SS6
20	Boring terminated at 20 feet.			
25				
30				
35				



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER EED LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KA	Checked by:	App'vd. by: MHM
Date: 11/16/11	Date: 12/12/11	Date: 12/13/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Slag Dewatering Basin
Thomas Hill Energy Center

LOG OF BORING: B-3

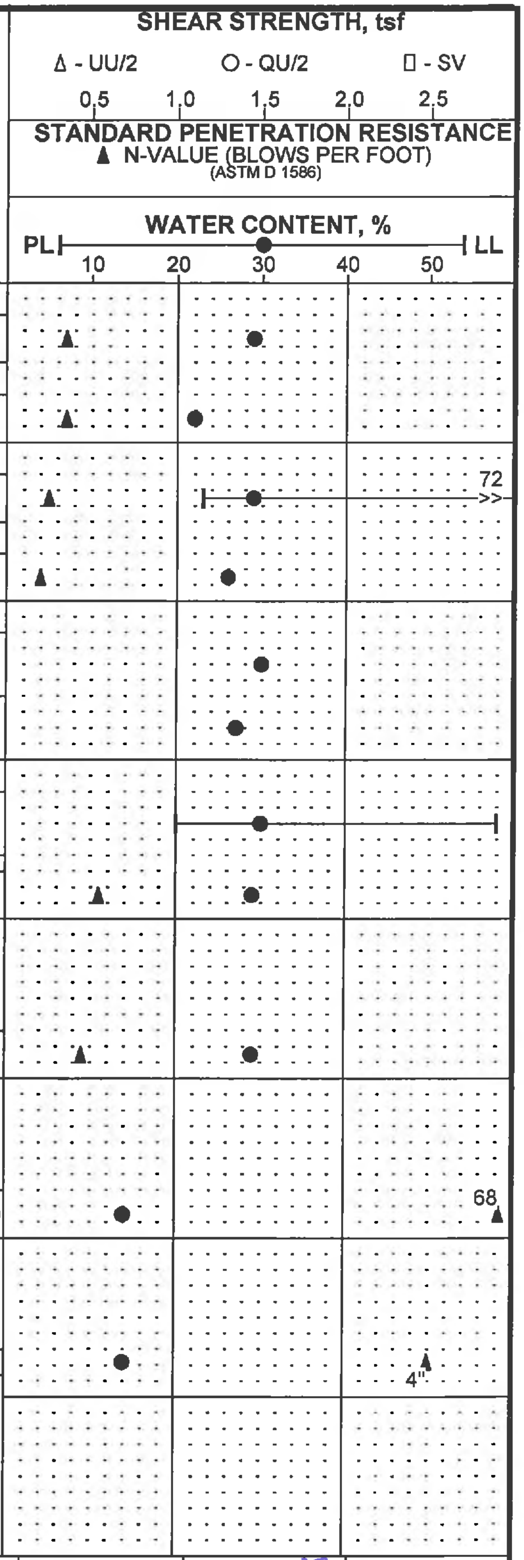
Project No. J011309.02

Surface Elevation: 711

Datum msl

Completion Date: 11/8/11

DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
FILL: brown to tan clay, some to trace gravel with depth	▨	0-3-4	SS1
		2-3-4	SS2
		1-2-3	SS3
	▼	1-1-3	SS4
		93	ST5
Stiff, tan and gray CLAY, trace sand and gravel (CH)	▨	92	ST6
		91	ST7
		4-5-6	SS8
Stiff, blackish-gray, silty CLAY, trace gravel - CL	▨	1-3-6	SS9
Soft, tan, highly to moderately weathered SILTSTONE	✕	26-38-30	SS10
		20-50/4"	SS11
Sampler refusal at 34.3 feet.			



DEPTH IN FEET: 5, 10, 15, 20, 25, 30, 35

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

AT 9.7 FEET AFTER 24 HOURS ▼

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

PH DRILLER EED LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS: Multi-point consolidated-undrained triaxial test conducted on ST6 and ST7.

Drawn by: KA	Checked by: DFB	App'vd. by: MHM
Date: 11/16/11	Date: 12/15/11	Date: 12/15/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ash Pond No. 3
Thomas Hill Energy Center

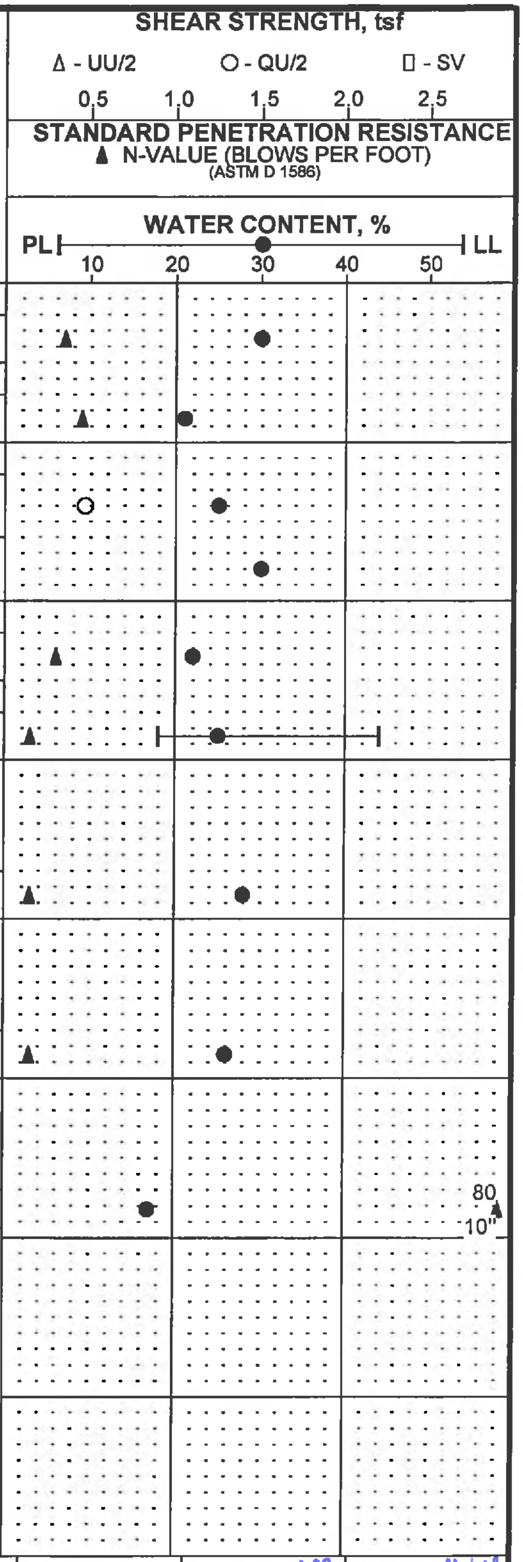
LOG OF BORING: B-4

Project No. J011309.02

Surface Elevation: 697 Completion Date: 11/8/11

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL: gray and brown clay, some gravel and coal		
		3-4-3	SS1
		3-5-4	SS2
5			
		98	ST3
		91	ST4
10	Medium stiff to soft, blackish-gray, silty CLAY, trace gravel - (CL)		
		1-2-4	SS5
		1-1-2	SS6
15	∇		
		1-1-2	SS7
20			
	some sand	0-1-2	SS8
25			
	Soft, gray, highly to moderately weathered SHALE		
		12-30 -50/4"	SS9
30	Sampler refusal at 29.7 feet.		
35			



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 15 FEET ∇

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

PH DRILLER EED LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KA	Checked by: NFB	App'vd. by: MHM
Date: 11/16/11	Date: 12/13/11	Date: 12/17/11

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ash Pond No. 3
Thomas Hill Energy Center

LOG OF BORING: B-5

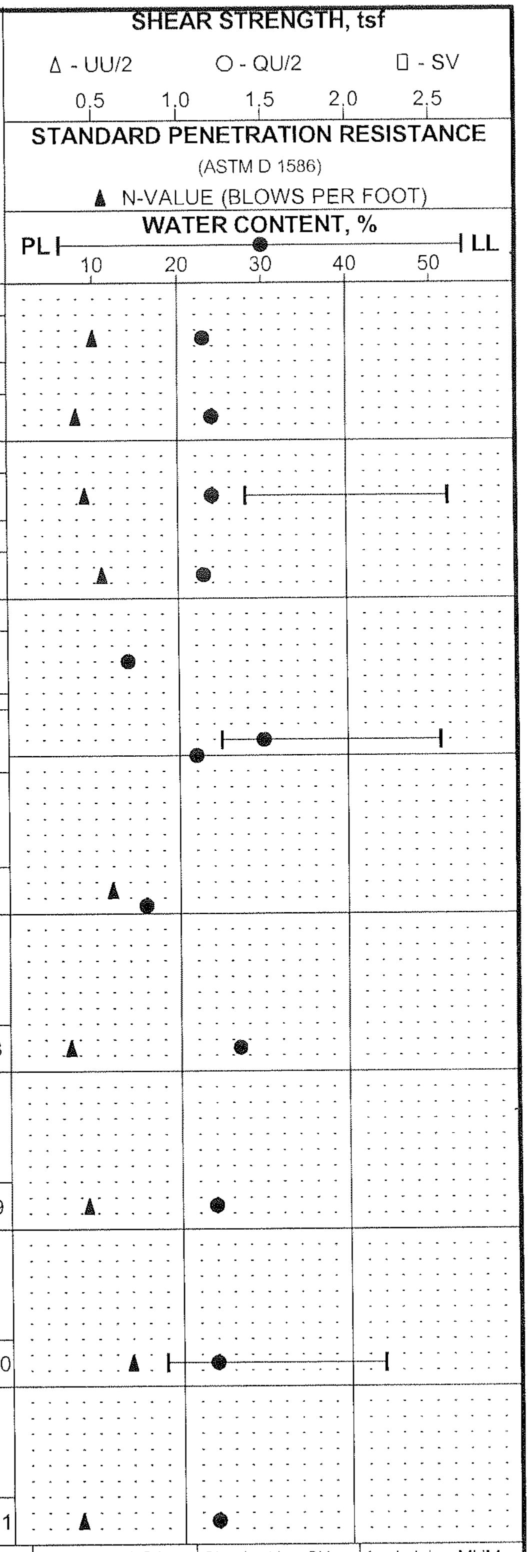
Project No. J011309.02

Surface Elevation: 735

Completion Date: 1/13/10

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Crushed rock, slag and fly ash		
		4-4-6	SS1
	FILL: brown and gray clay, trace silt and sand		
		3-4-4	SS2
5			
		3-4-5	SS3
		4-5-6	SS4
10			
	Very stiff, yellow, brown and gray CLAY - (CH)		
			ST5
		97 99	ST6
15			
	Medium stiff to stiff, brown and gray CLAY with sand and gravel - CH		
		3-5-7	SS7
20			
		3-3-4	SS8
25			
		3-4-5	SS9
30			
	Stiff to medium stiff, gray, silty CLAY - (CL)		
		5-7-7	SS10
35			
		2-4-4	SS11



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM
WASHBORING FROM 40 FEET
BS DRILLER RFW LOGGER
CME 550X DRILL RIG
HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: SK	App'vd. by: MHM
Date: 1/20/10	Date: 4/6/10	Date: 4/19/10

GEOTECHNOLOGY INC
FROM THE GROUND UP

Thomas Hill
Ash Pond Evaluation

LOG OF BORING: C-1

Project No. J011309.01

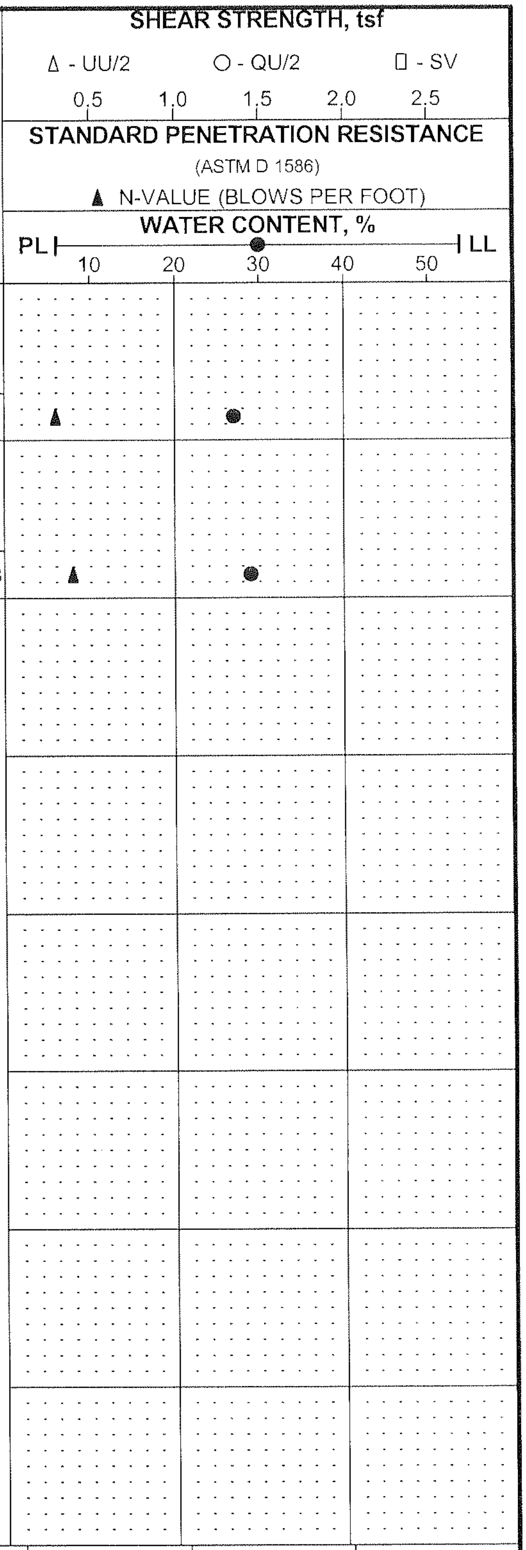
LOG OF BORING 2002 WL 1130901 - ASH POND.GPJ GTINC 0638301.GPJ 4/20/10

Surface Elevation: 735

Datum msl

Completion Date: 1/13/10

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Stiff to medium stiff, gray, silty CLAY - (CL) *(continued)*	▨		
	Medium stiff to stiff, brown and gray CLAY, trace sand - CH	▨		
		▨	2-3-3	SS12
45		▨		
		▨	3-4-4	SS13
50	Boring terminated at 50 feet.			
55				
60				
65				
70				
75				



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 40 FEET

BS DRILLER RFW LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: SK	App'vd. by: MHM
Date: 1/20/10	Date: 4/6/10	Date: 4/19/10

GEOTECHNOLOGY INC
FROM THE GROUND UP

Thomas Hill
Ash Pond Evaluation

CONTINUATION OF
LOG OF BORING: C-1

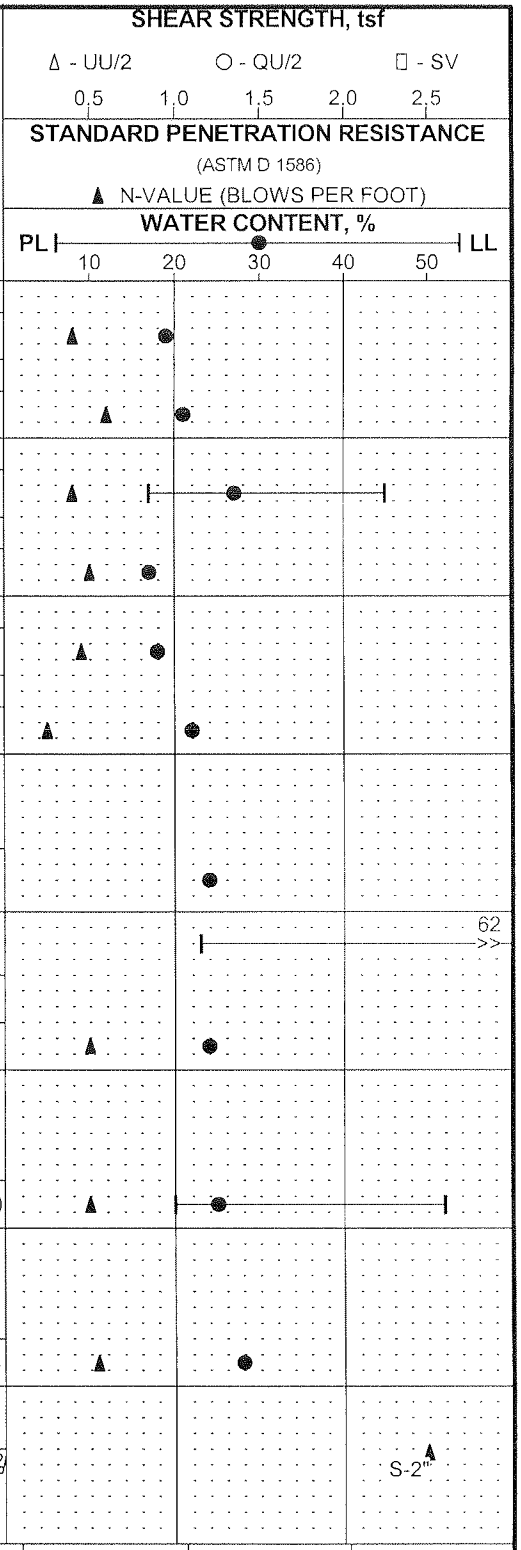
Project No. J011309.01

Surface Elevation: 725

Datum msl

Completion Date: 1/14/10

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Crushed rock and gravel		
	FILL: clay, sand and gravel		
	FILL: brown and gray clay with sand, trace gravel	5-4-4	SS1
		5-6-6	SS2
5			
	FILL: brown and gray, silty clay	4-4-4	SS3
		4-5-5	SS4
10			
	FILL: gray clay, trace silt, sand and gravel	3-4-5	SS5
		2-2-3	SS6
15			
		100	ST7
20			
	Stiff, brown and gray CLAY, trace sand - (CH)		ST8
		4-4-6	SS9
25			
		5-5-5	SS10
30			
		5-5-6	SS11
35			
	Weathered LIMESTONE		
	Auger and sampler refusal at 37.2 feet.	50/2"	SS12



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

BS DRILLER RFW LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: SK	App'vd. by: MHM
Date: 1/20/10	Date: 4/6/10	Date: 4/19/10

GEOTECHNOLOGY INC
FROM THE GROUND UP

Thomas Hill
Ash Pond Evaluation

LOG OF BORING: C-2

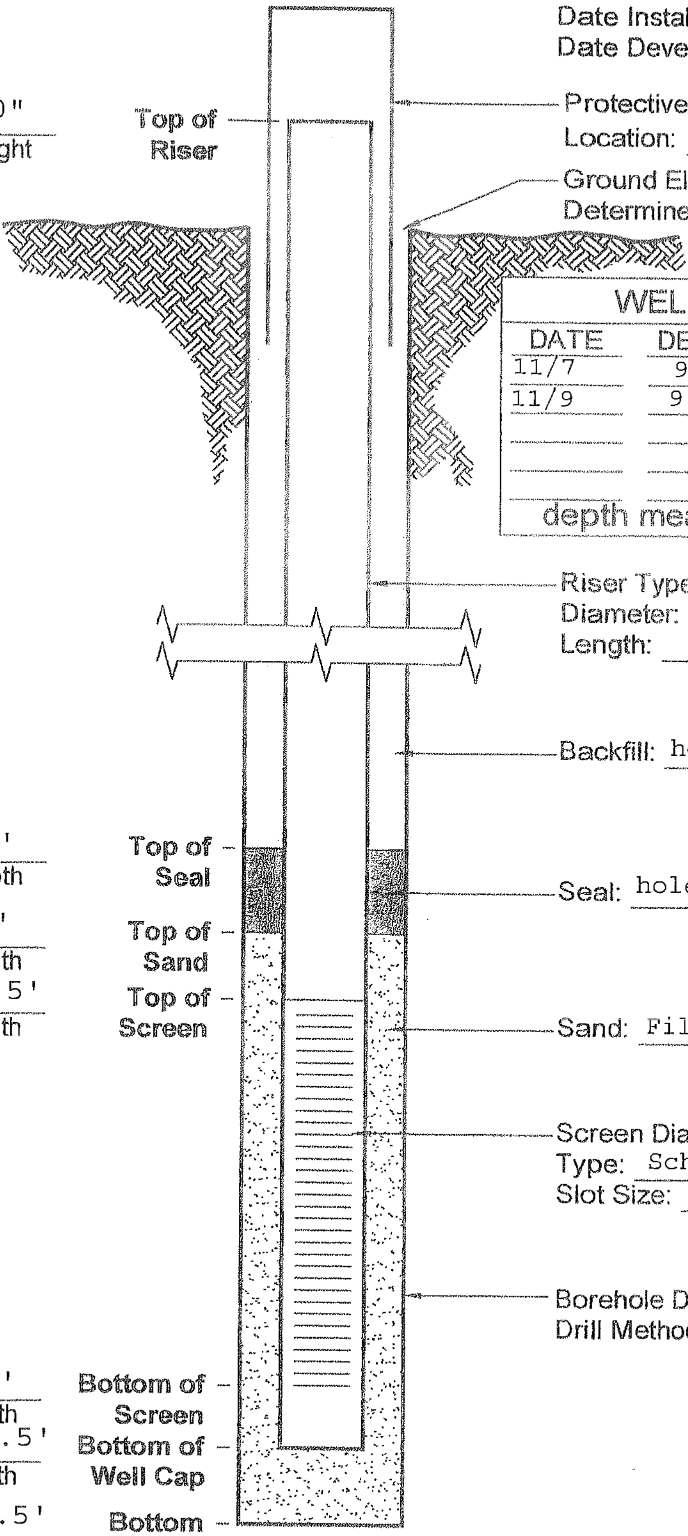
Project No. J011309.01

PROJECT: AECI Thomas Hill Energy Center
Slag Dewatering Basin

NUMBER: J011309.02

P-1

Date Installed: 11/7/11
Date Developed: 11/7/11



Elev.	Height	
750	0"	Top of Riser

Protective Cover: Flush-mount
Location: P-1

Ground Elevation: 750, Datum: msl
Determined By: 2005 topographic survey

WELL WATER LEVELS

DATE	DEPTH	REMARKS
11/7	9.4	after installation
11/9	9.25	

depth measured from top of riser

Riser Type: Schedule 40 PVC
Diameter: 2 inches
Length: 5 ft.

Backfill: holeplug bentonite

Elev.	Depth	
749	1'	Top of Seal
746	4'	Top of Sand
744.5	5.5'	Top of Screen
740	10'	Bottom of Screen
739.5	10.5'	Bottom of Well Cap
739.5	10.5'	Bottom of Hole

Seal: holeplug bentonite

Sand: Filtersil

Screen Diameter: 2"
Type: Schedule 40 PVC
Slot Size: 0.01 inch

Borehole Diameter: 8"
Drill Method: hollow-stem auger

REMARKS: Offset 5' west of Boring B-1

PIEZOMETER SCHEMATIC DIAGRAM

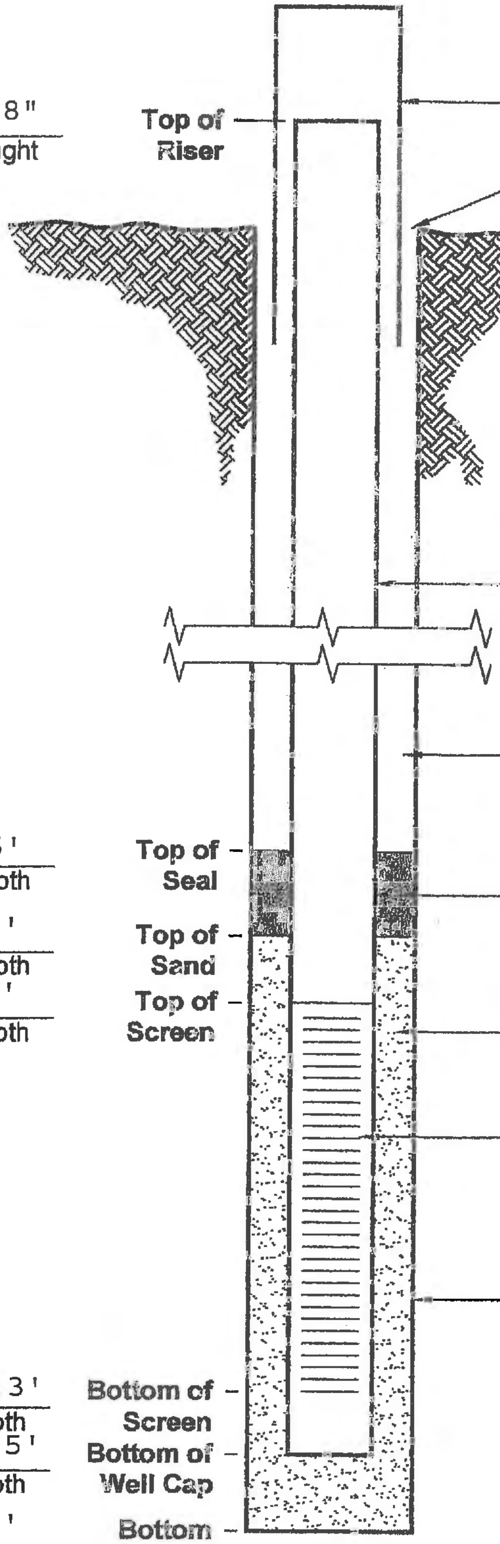
GEOTECHNOLOGY INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
ST. LOUIS • COLLINSVILLE

PROJECT: AECI Thomas Hill Energy Center
Ash Pond No.3

NUMBER: J011309.02

P-2

Date Installed: 11/8/11
Date Developed: 11/8/11



Elev.	Height / Depth	
712.7	2'8"	**Top of Riser**
705	5'	**Top of Seal**
695	15'	**Top of Sand**
693	17'	**Top of Screen**
687.7	22.3'	**Bottom of Screen**
687.5	22.5'	**Bottom of Well Cap**
687	23'	**Bottom of Hole**

Protective Cover: None
Location: P-2
Ground Elevation: 710, Datum: msl
Determined By: 2005 topographic survey

WELL WATER LEVELS

DATE	DEPTH	REMARKS
11/8	22.1	2 hrs. after installation
11/9	12.4	

depth measured from top of riser

Riser Type: Schedule 40 PVC
Diameter: 2 inches
Length: 15 ft.

Backfill: grout

Seal: holeplug bentonite

Sand: Filtersil

Screen Diameter: 2"
Type: Schedule 40 PVC
Slot Size: 0.01 inch

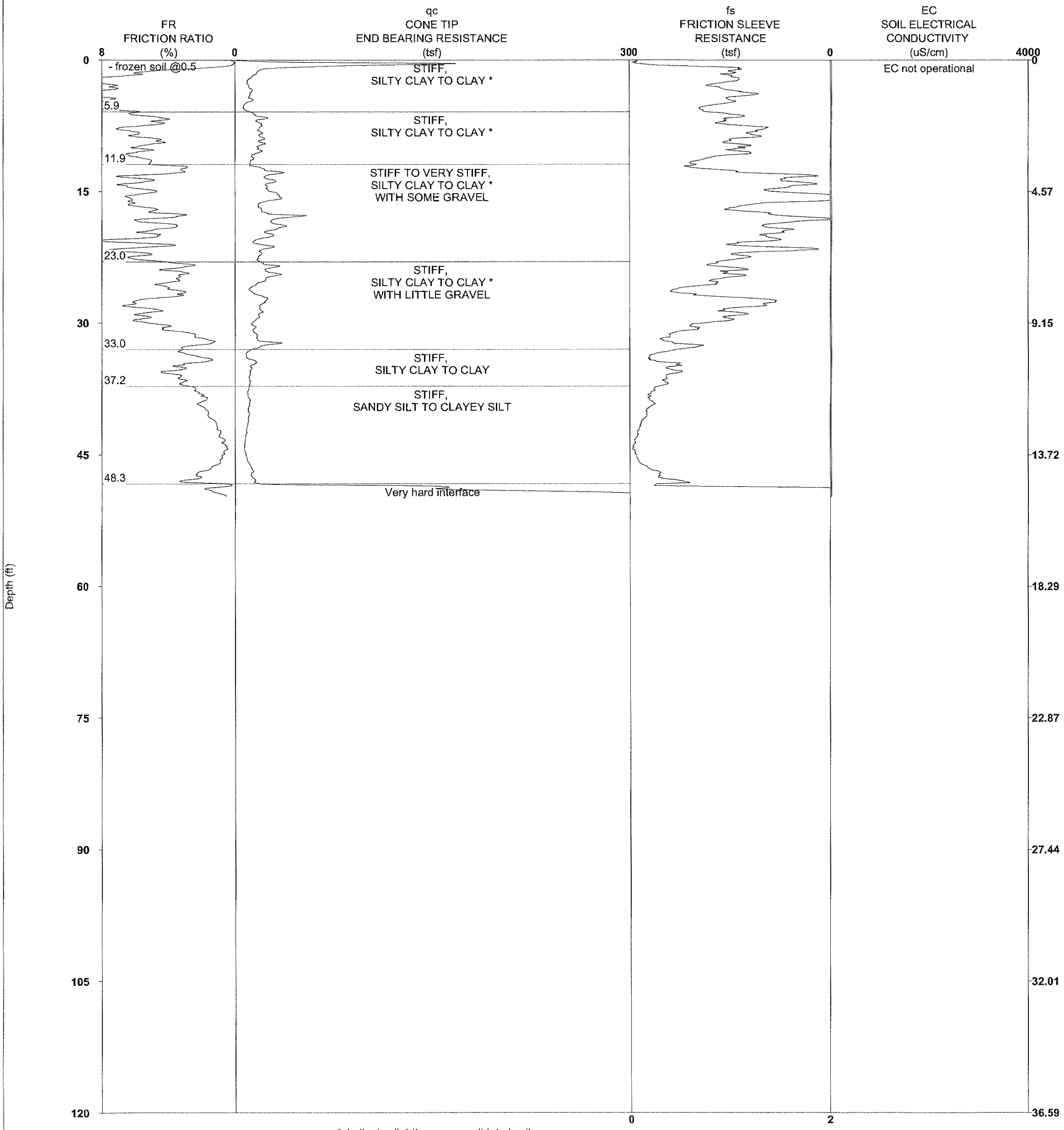
Borehole Diameter: 8"
Drill Method: hollow-stem auger

REMARKS: Offset 5' south of Boring B-4

PIEZOMETER SCHEMATIC DIAGRAM

GEOTECHNOLOGY INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
ST. LOUIS • COLLINSVILLE

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



* Indicates lightly overconsolidated soil

** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54378 Longitude: -92.63682

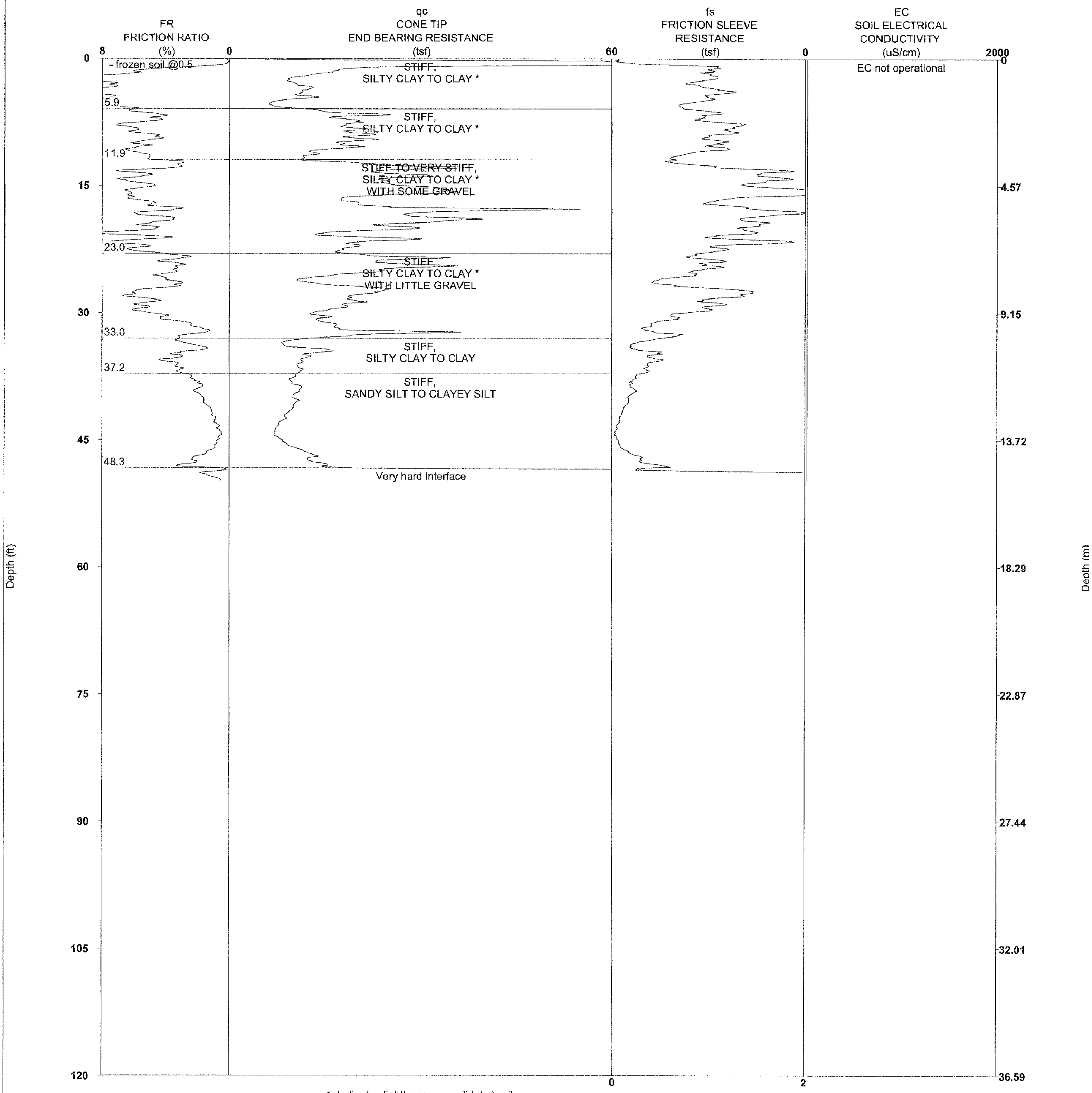
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:8:59 AM
SOUNDING NUMBER:CC-01

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



* Indicates lightly overconsolidated soil
** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54378 Longitude: -92.63682

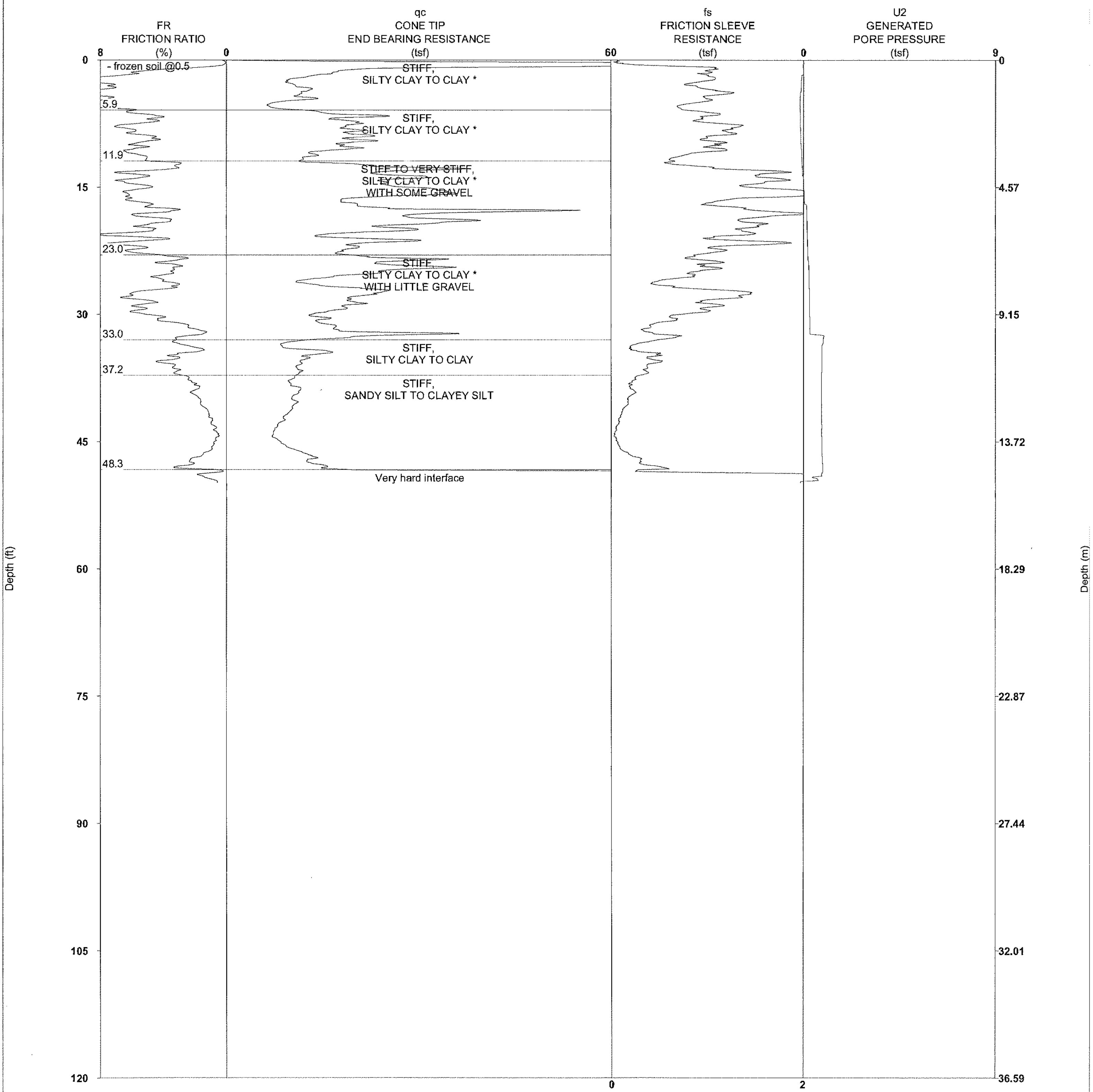
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:8:59 AM
SOUNDING NUMBER:CC-01

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



* Indicates lightly overconsolidated soil
** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54378 Longitude: -92.63682

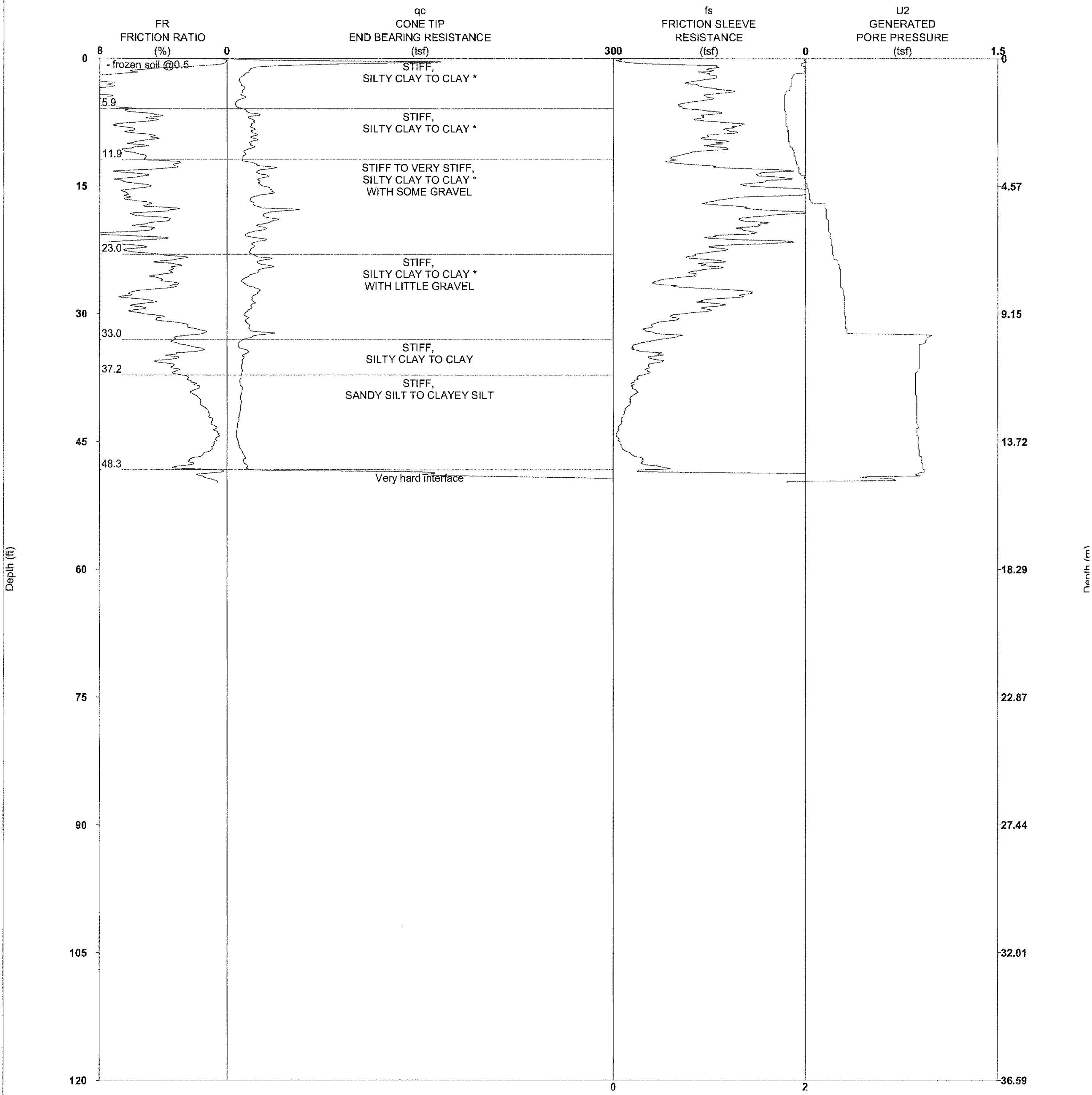
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:8:59 AM
SOUNDING NUMBER:CC-01

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



* Indicates lightly overconsolidated soil
** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54378 Longitude: -92.63682

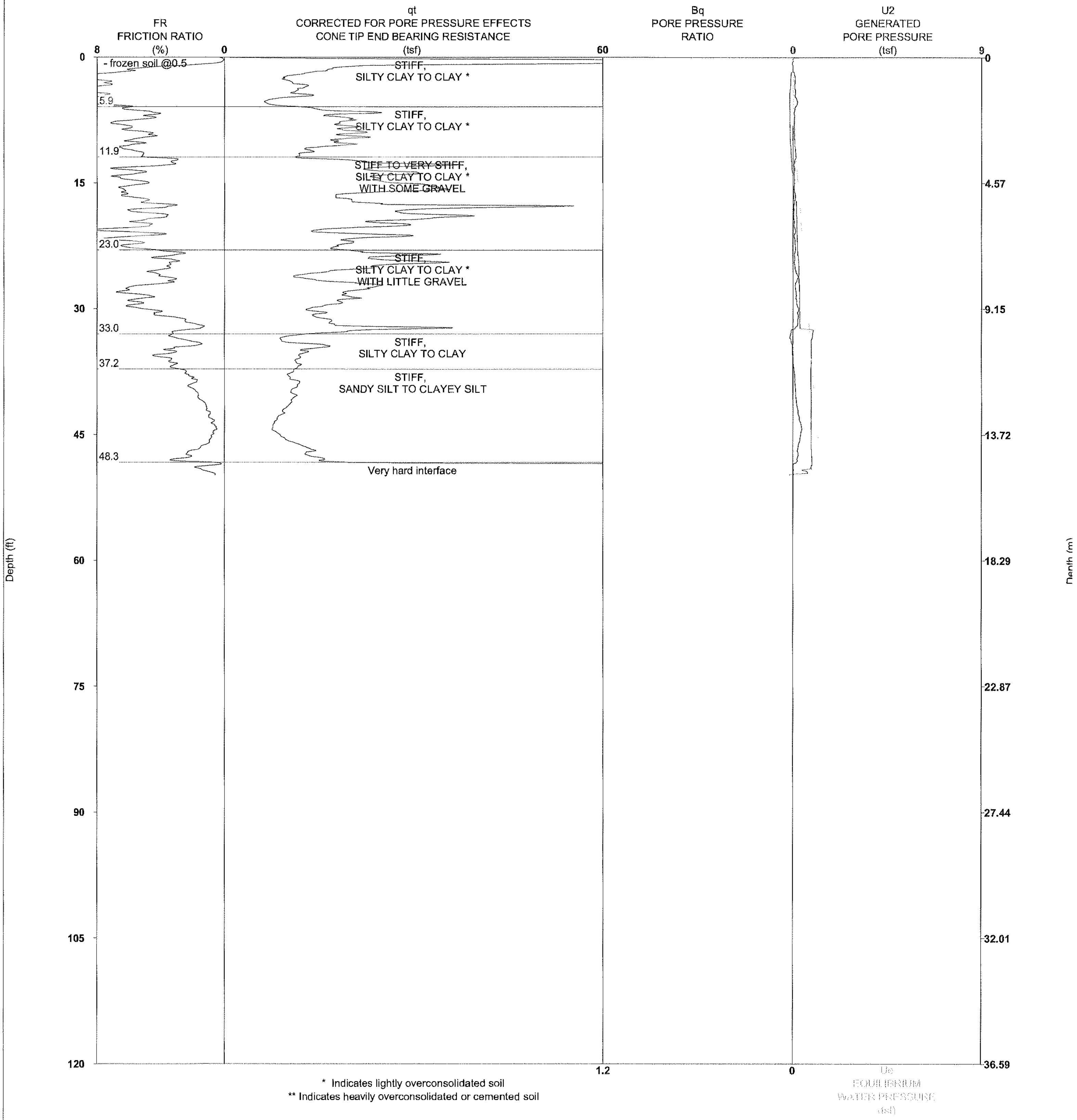
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:8:59 AM
SOUNDING NUMBER:CC-01

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



* Indicates lightly overconsolidated soil

** Indicates heavily overconsolidated or cemented soil

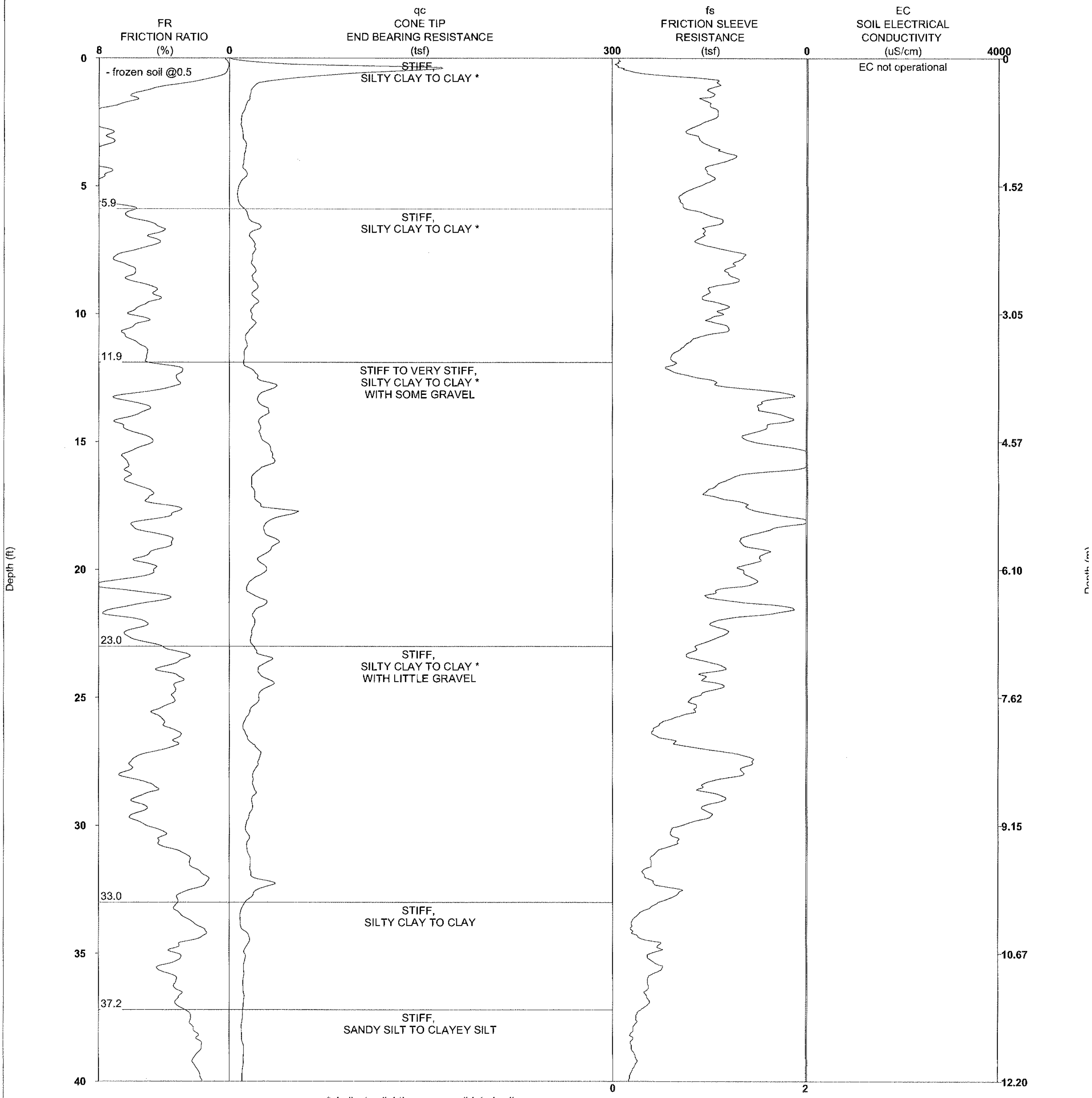
Latitude: 39.54378 Longitude: -92.63682

PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:8:59 AM
SOUNDING NUMBER:CC-01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



* Indicates lightly overconsolidated soil
** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54378 Longitude: -92.63682

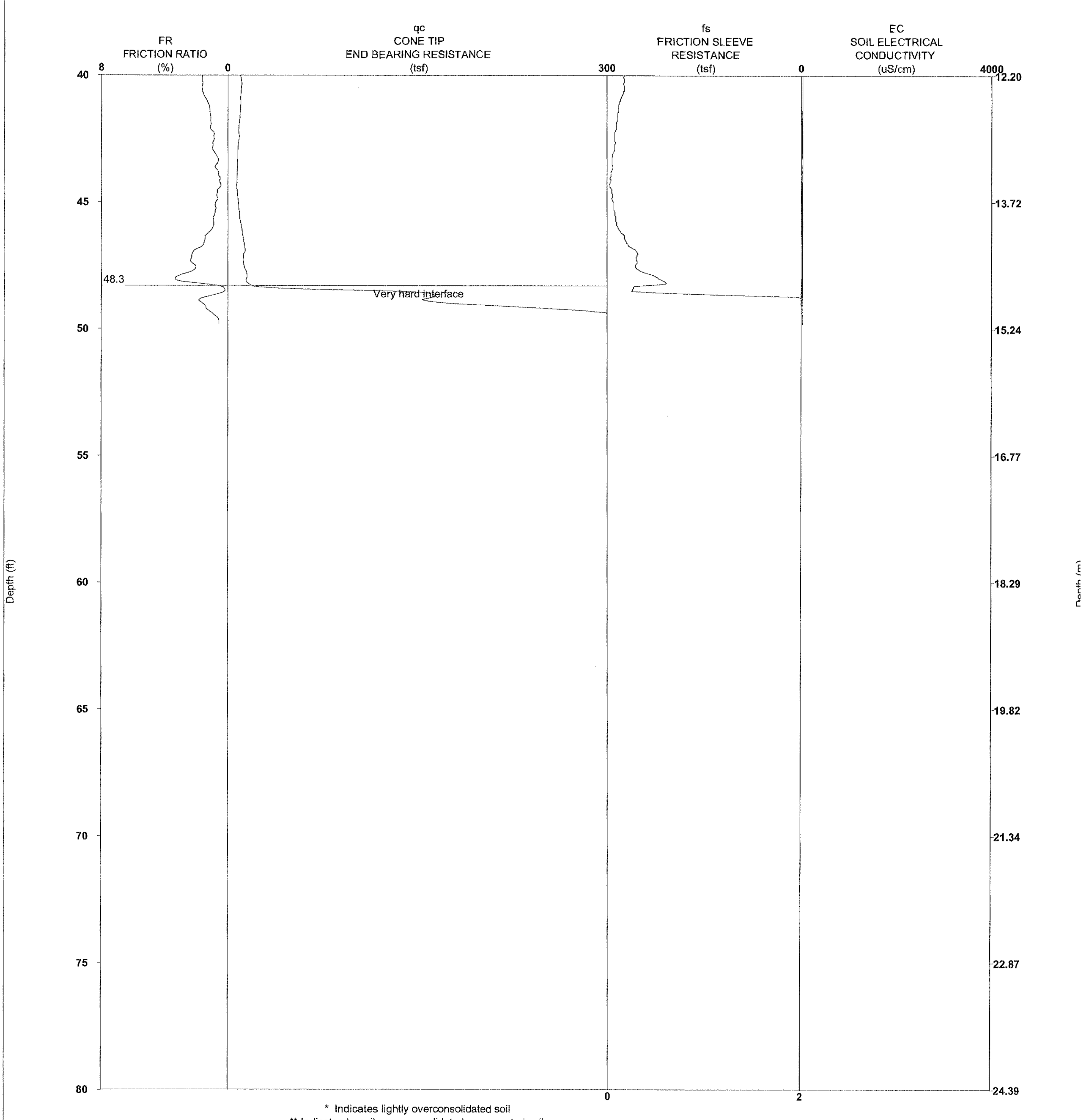
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:8:59 AM
SOUNDING NUMBER:CC-01

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC01



* Indicates lightly overconsolidated soil
** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54378 Longitude: -92.63682

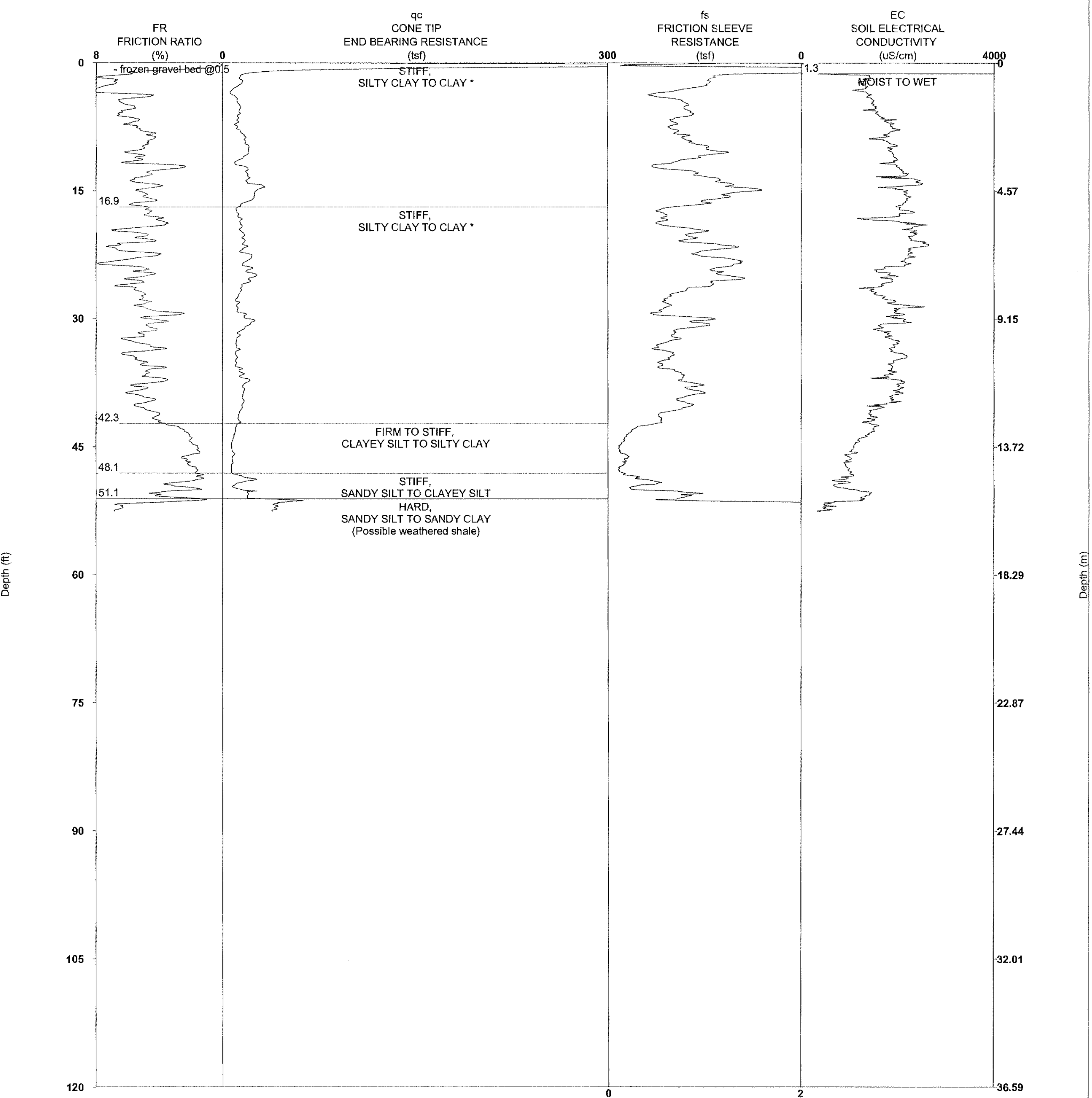
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:8:59 AM
SOUNDING NUMBER:CC-01

CPCC01

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC02



* Indicates lightly overconsolidated soil

** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54198 Longitude: -92.63939

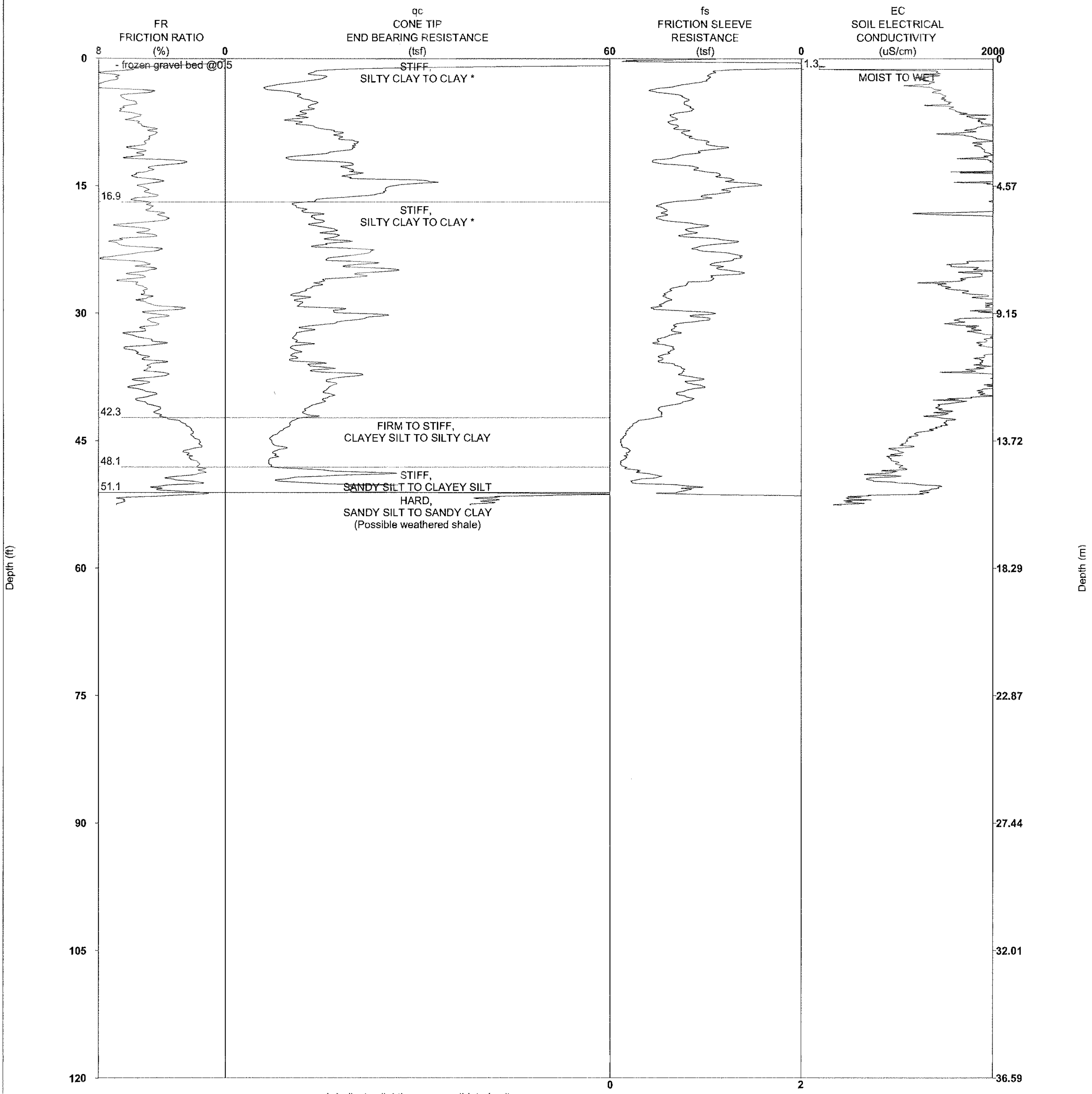
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:11:16 AM
SOUNDING NUMBER:CC-02

CPCC02

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC02



* Indicates lightly overconsolidated soil

** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54198 Longitude: -92.63939

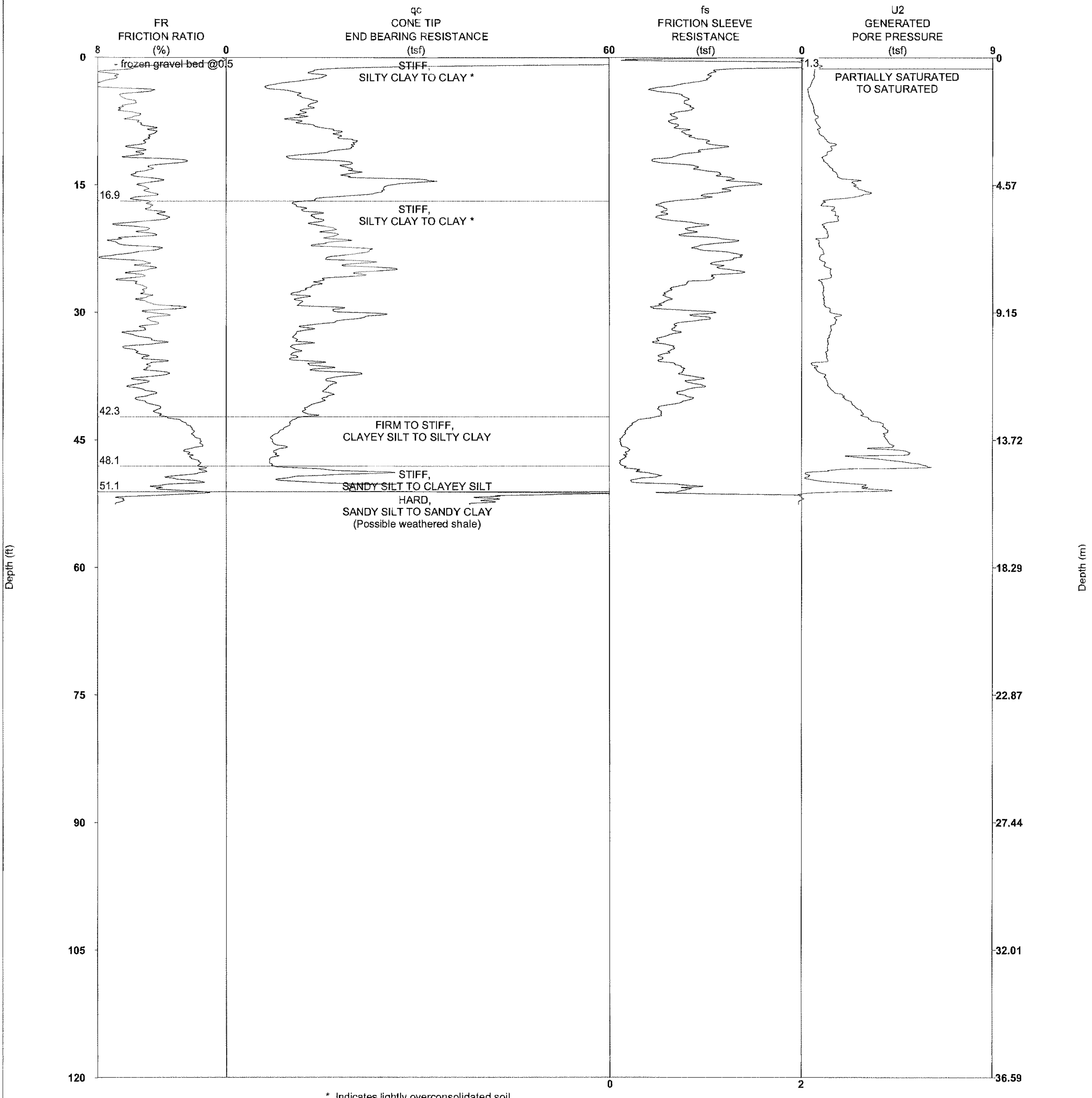
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:11:16 AM
SOUNDING NUMBER:CC-02

CPCC02

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC02



* Indicates lightly overconsolidated soil
** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54198 Longitude: -92.63939

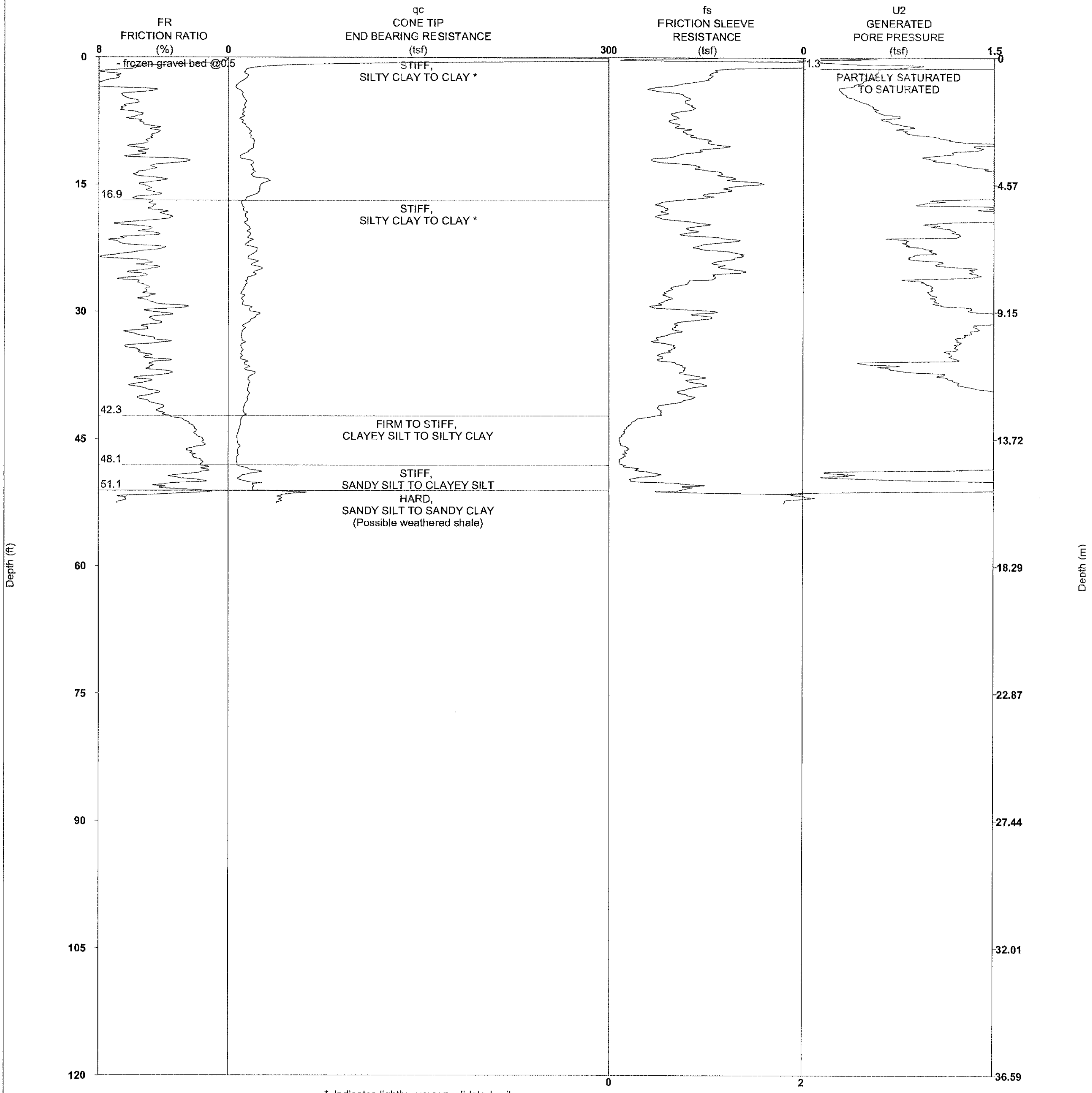
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:11:16 AM
SOUNDING NUMBER:CC-02

CPCC02

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC02



* Indicates lightly overconsolidated soil

** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54198 Longitude: -92.63939

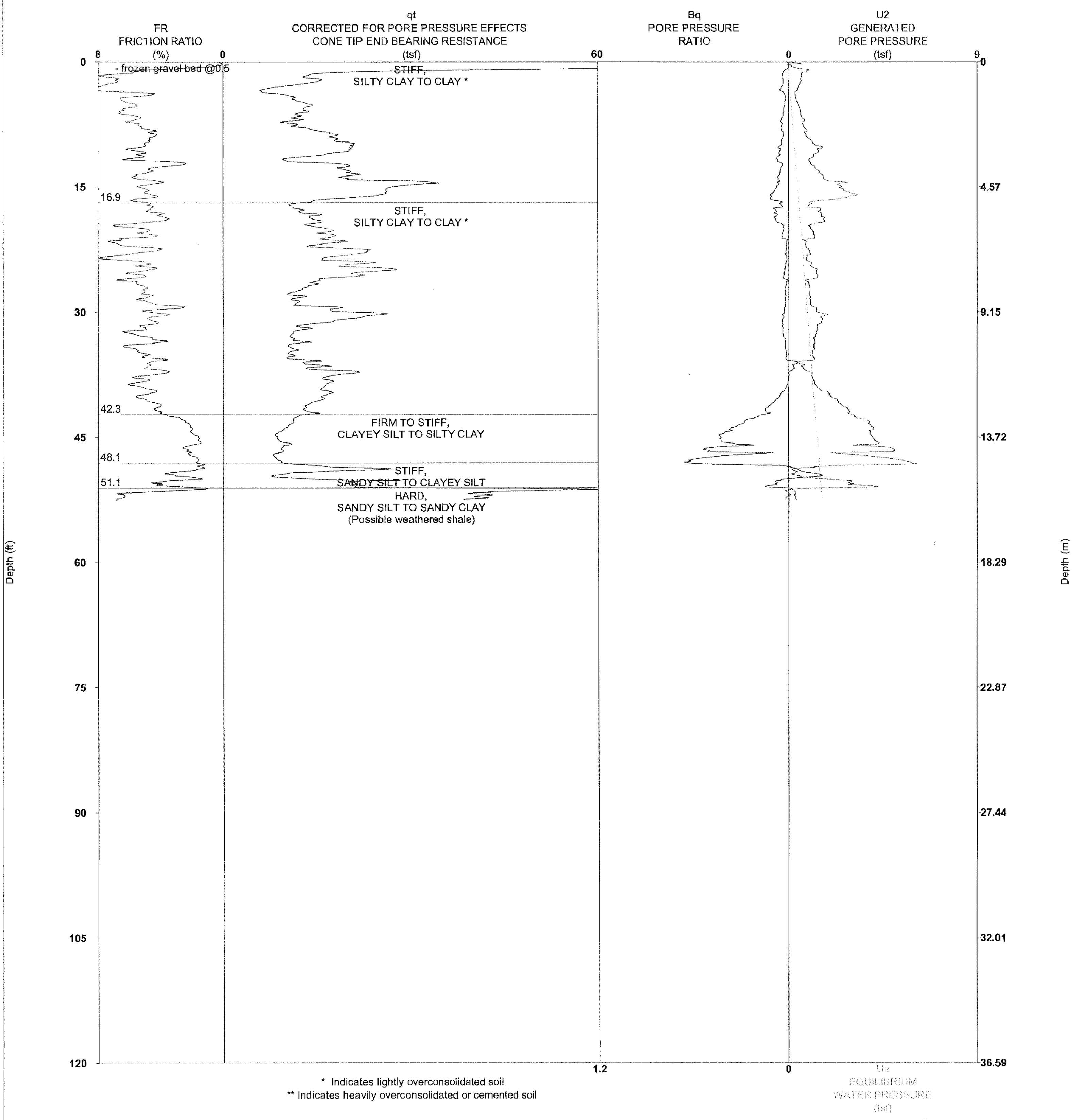
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:11:16 AM
SOUNDING NUMBER:CC-02

CPCC02

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC02



* Indicates lightly overconsolidated soil

** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54198 Longitude: -92.63939

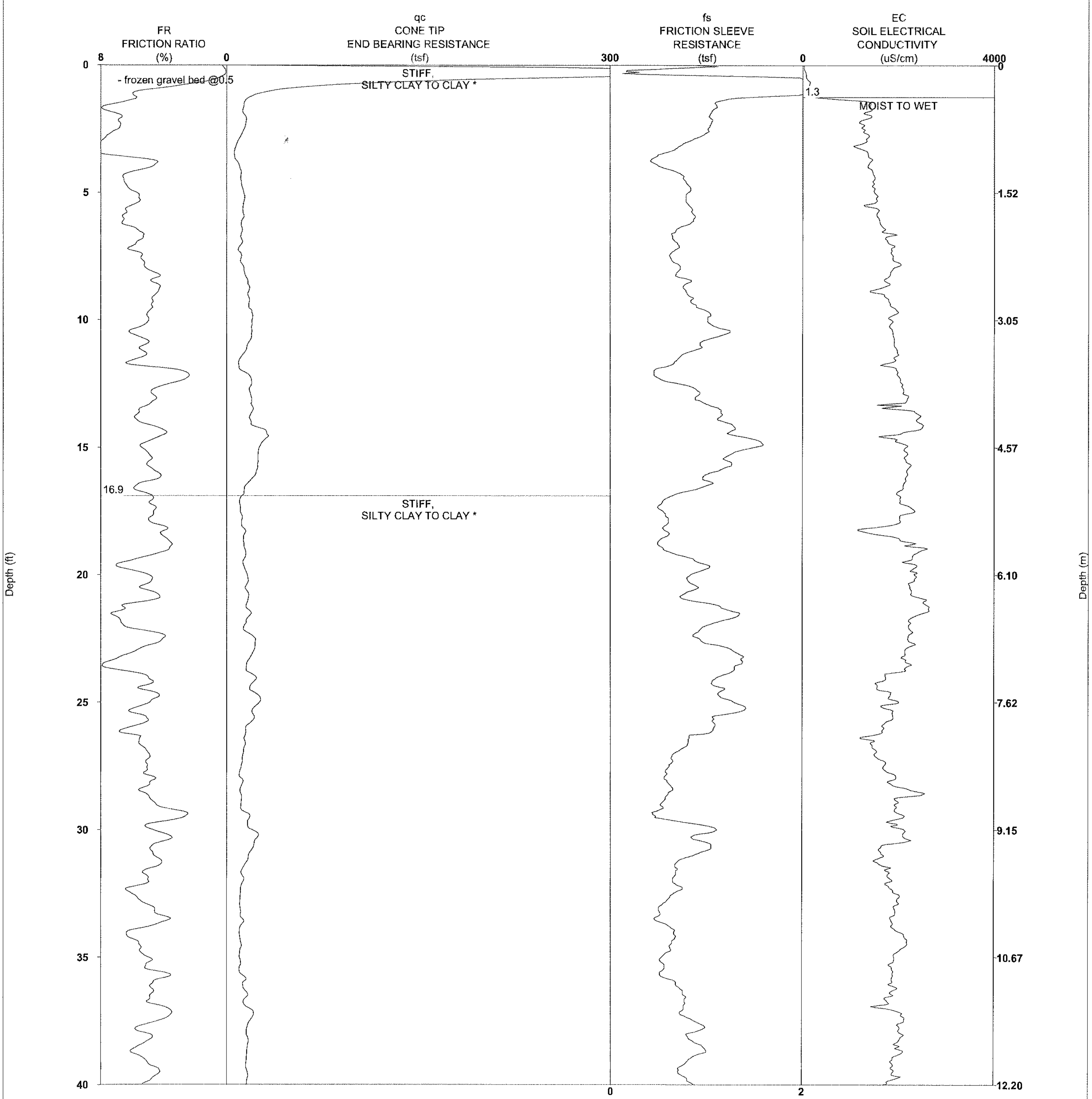
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:11:16 AM
SOUNDING NUMBER:CC-02

CPCC02

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC02



* Indicates lightly overconsolidated soil

** Indicates heavily overconsolidated or cemented soil

Latitude: 39.54198 Longitude: -92.63939

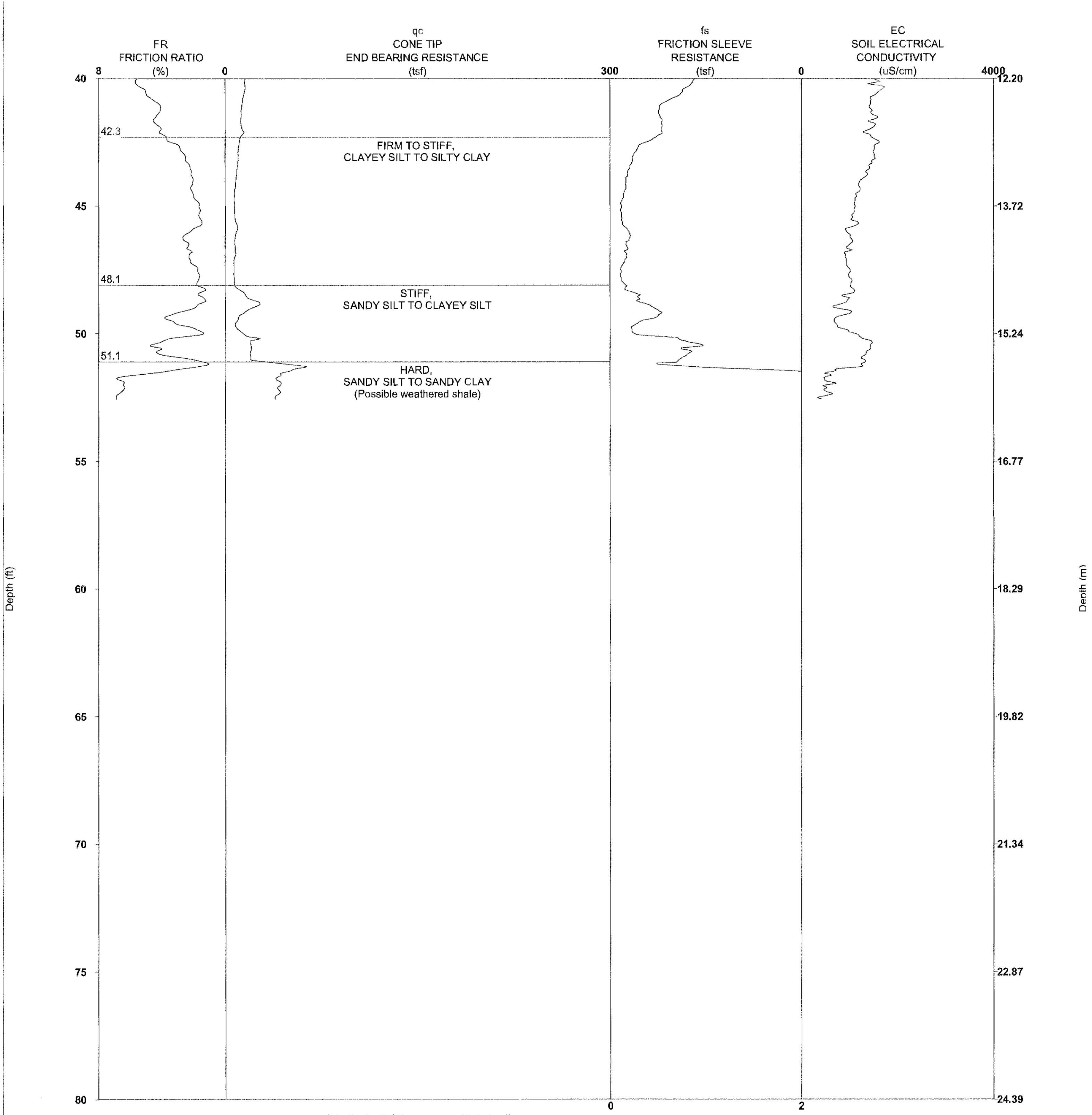
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:11:16 AM
SOUNDING NUMBER:CC-02

CPCC02

CPTU-EC LOG WITH LITHOLOGIC EVALUATION CPCC02



* Indicates lightly overconsolidated soil
** Indicates heavily overconsolidated or cemented soil

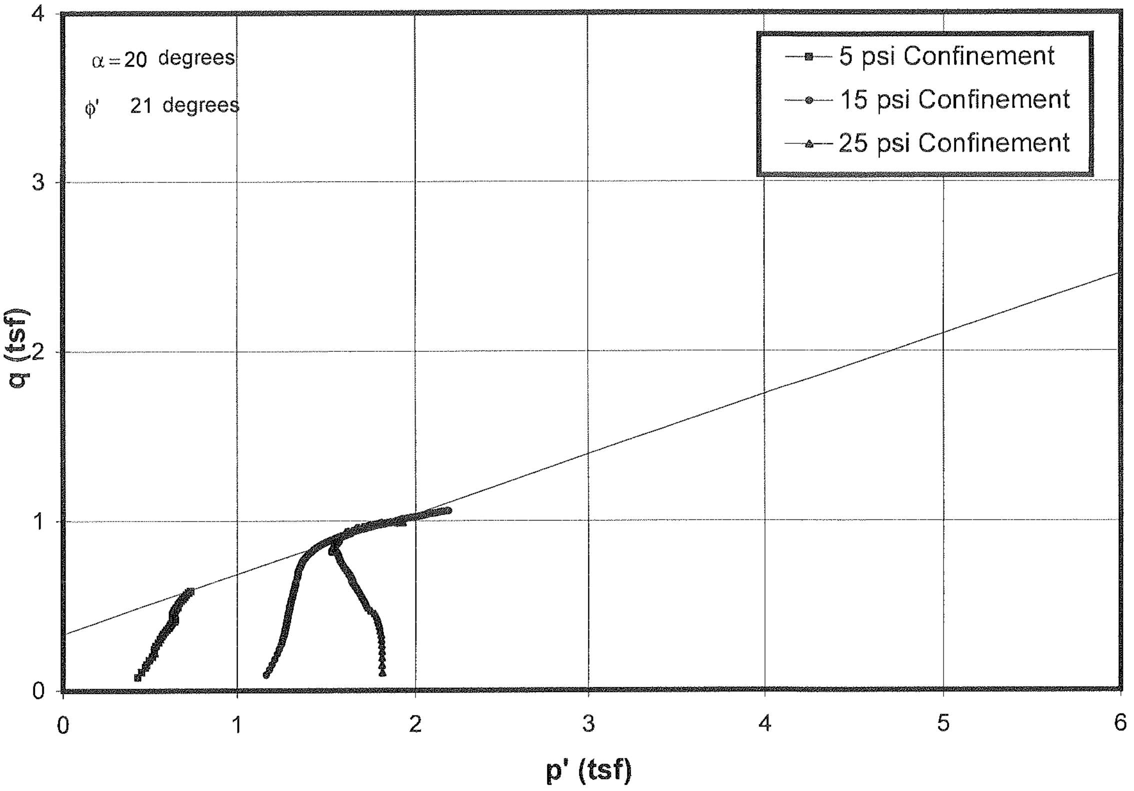
Latitude: 39.54198 Longitude: -92.63939

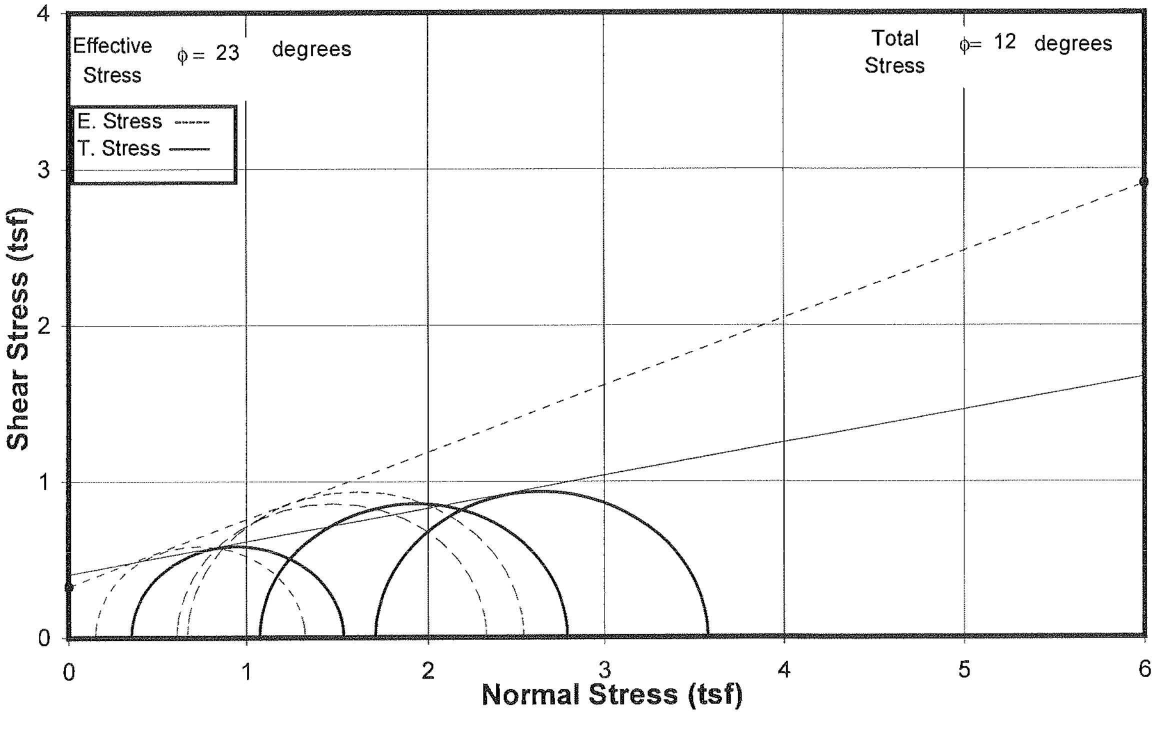
PROJECT NAME:Thomas Hill Site
PROJECT NUMBER:10-110-020

STRATIGRAPHICS

R1 DATE:2/3/2010 TIME:11:16 AM
SOUNDING NUMBER:CC-02

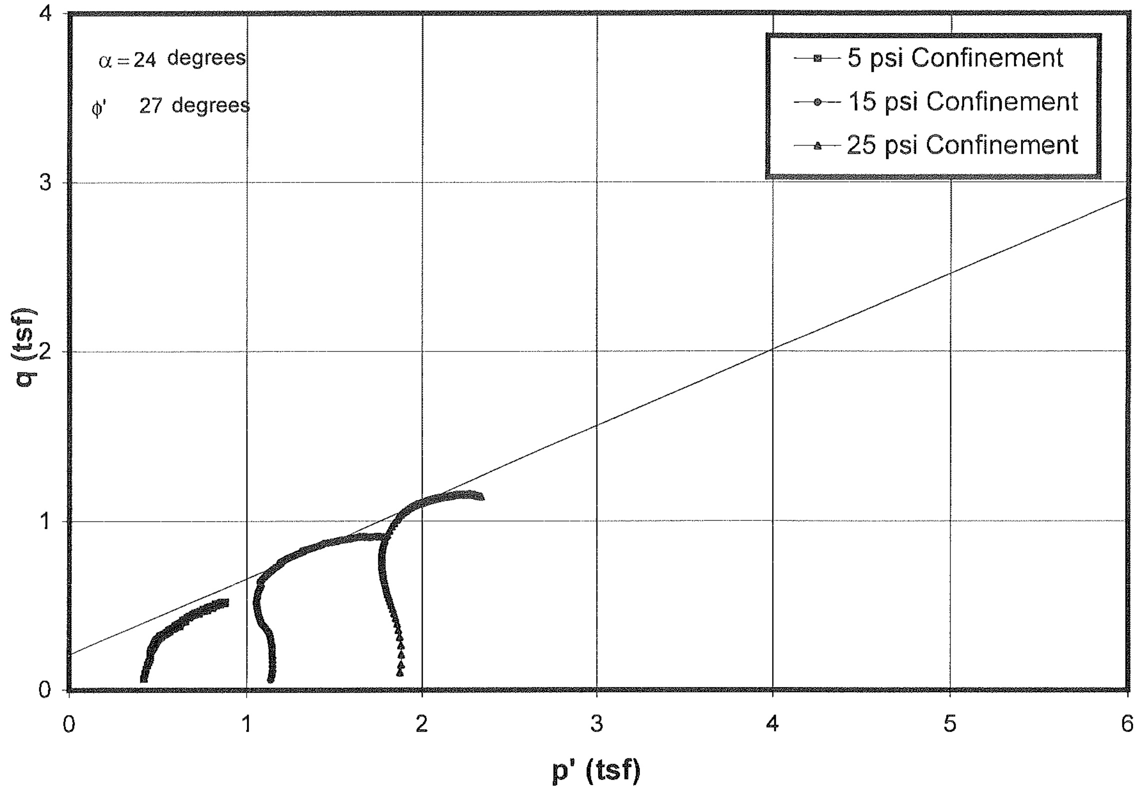
CPCC02

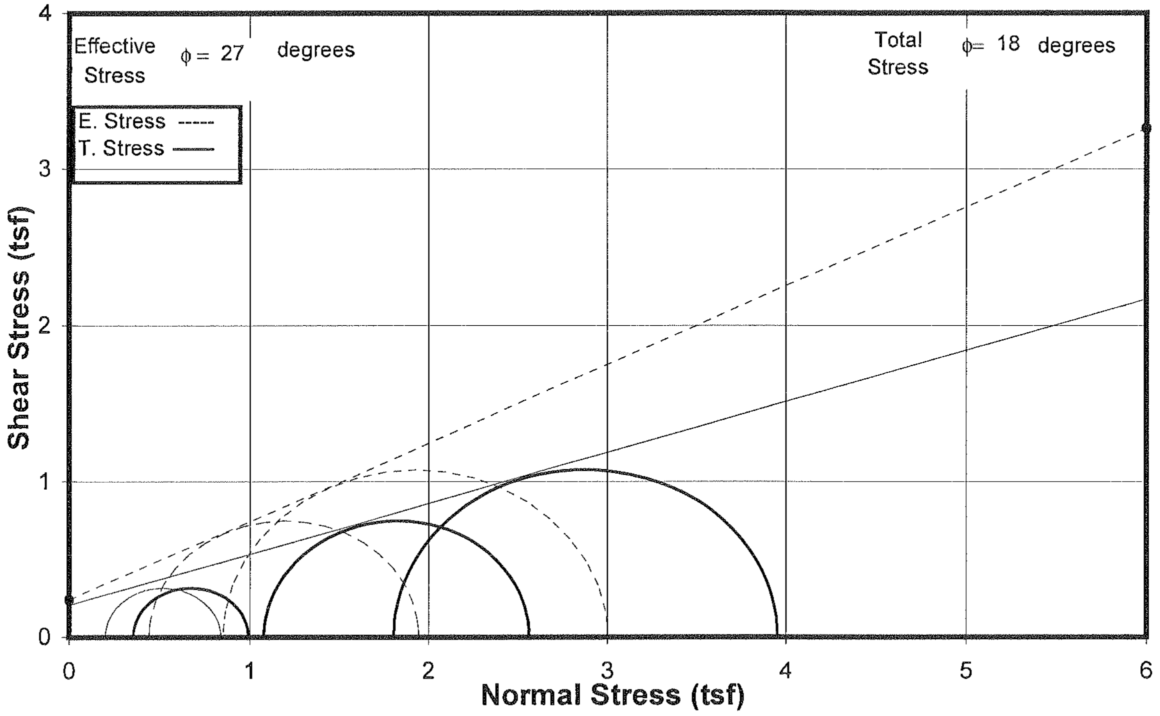




CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

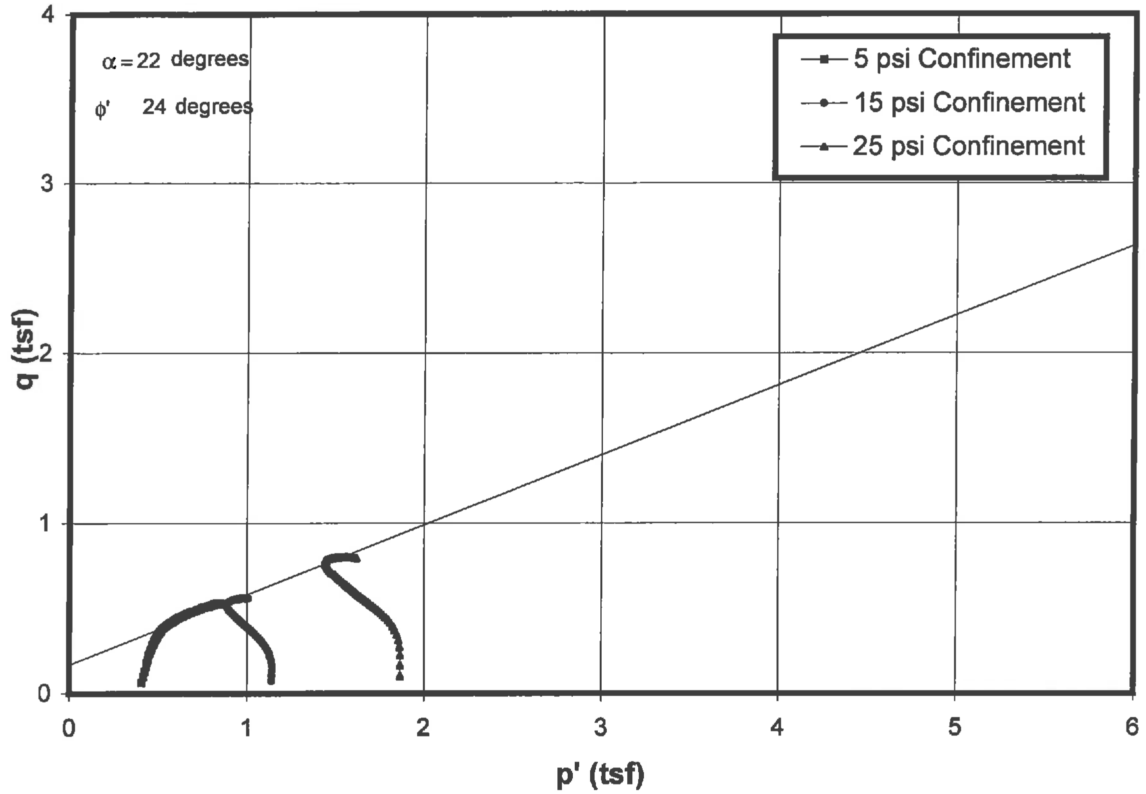
ASTM D 4767
Project No.: J011309.02
Boring: B-1
Sample: ST2, ST2, ST3 - Depth: 3, 3, 5

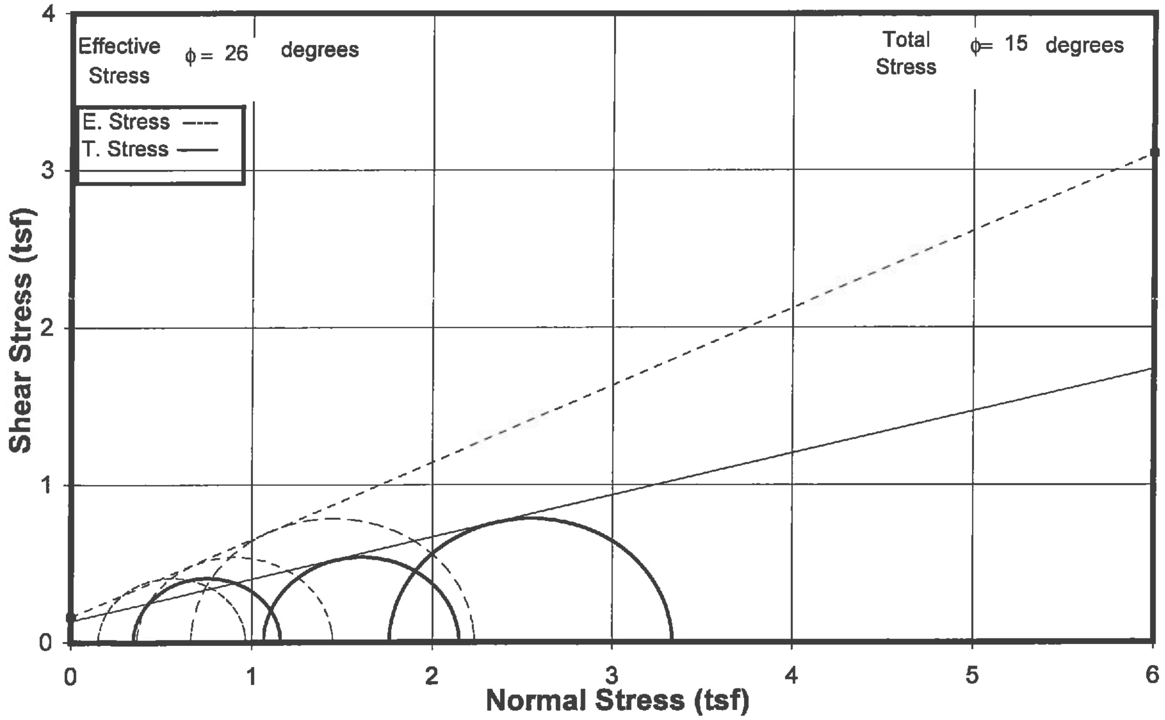




CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

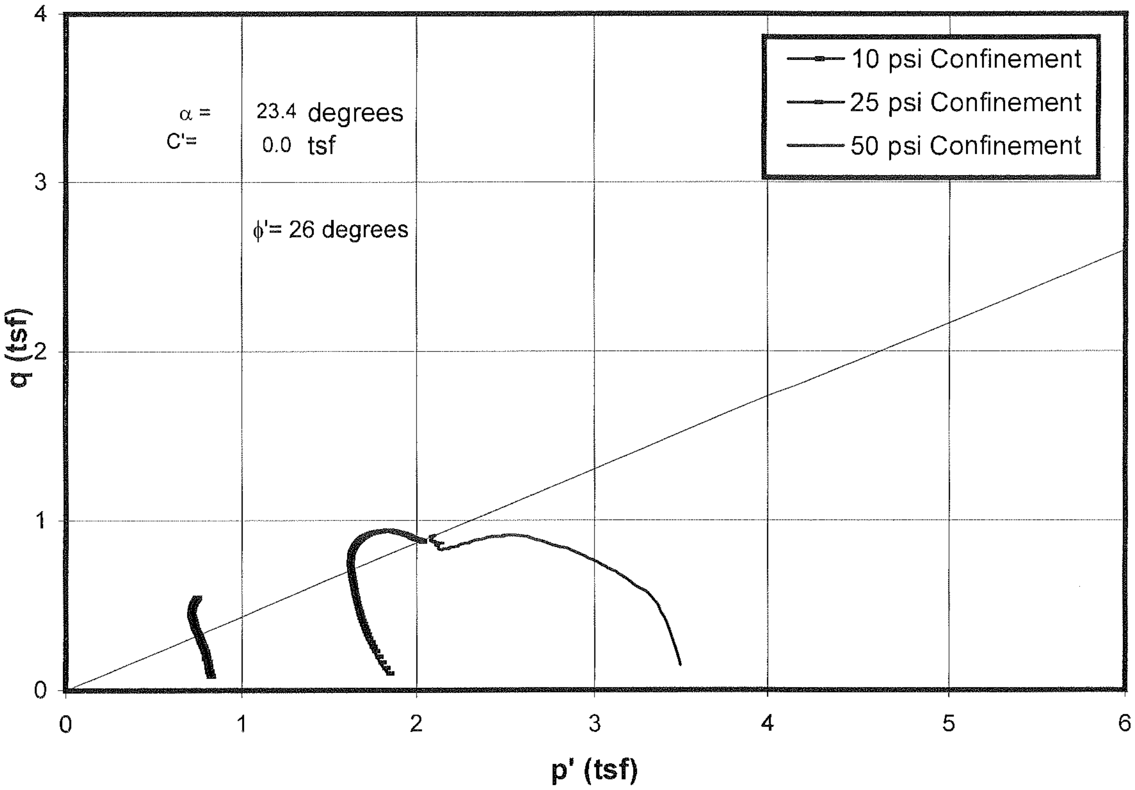
ASTM D 4767
Project No.: J011309.02
Boring: B-2
Sample: ST4 - Depth: 7

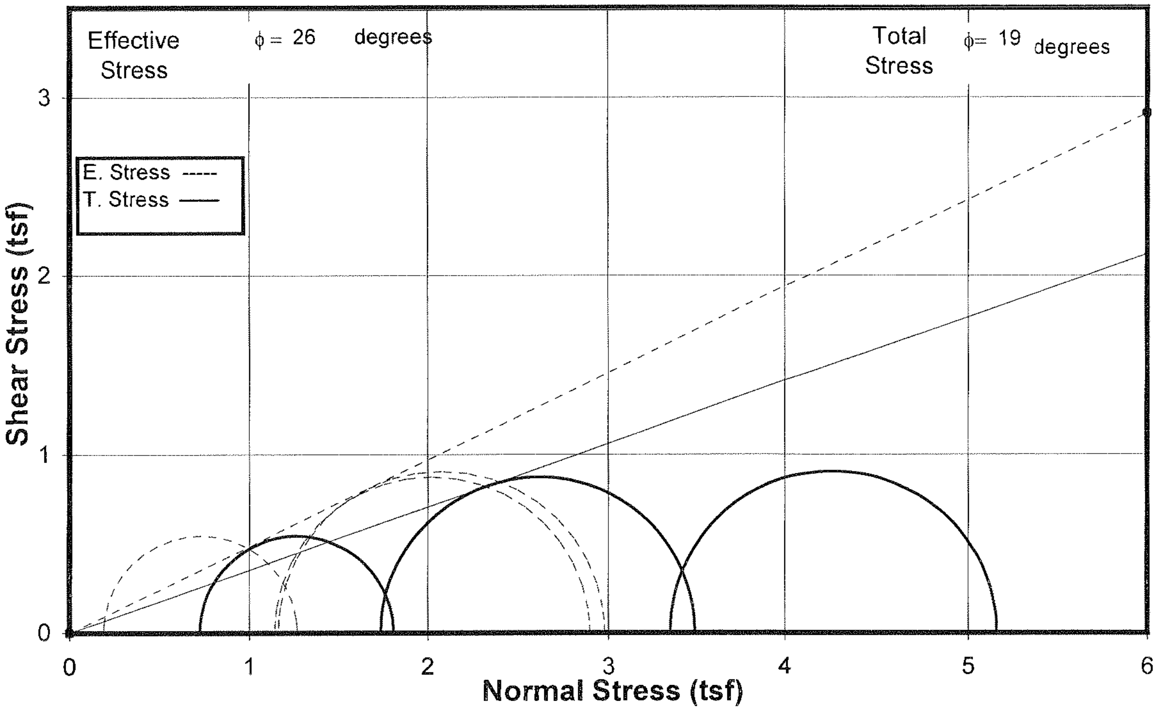




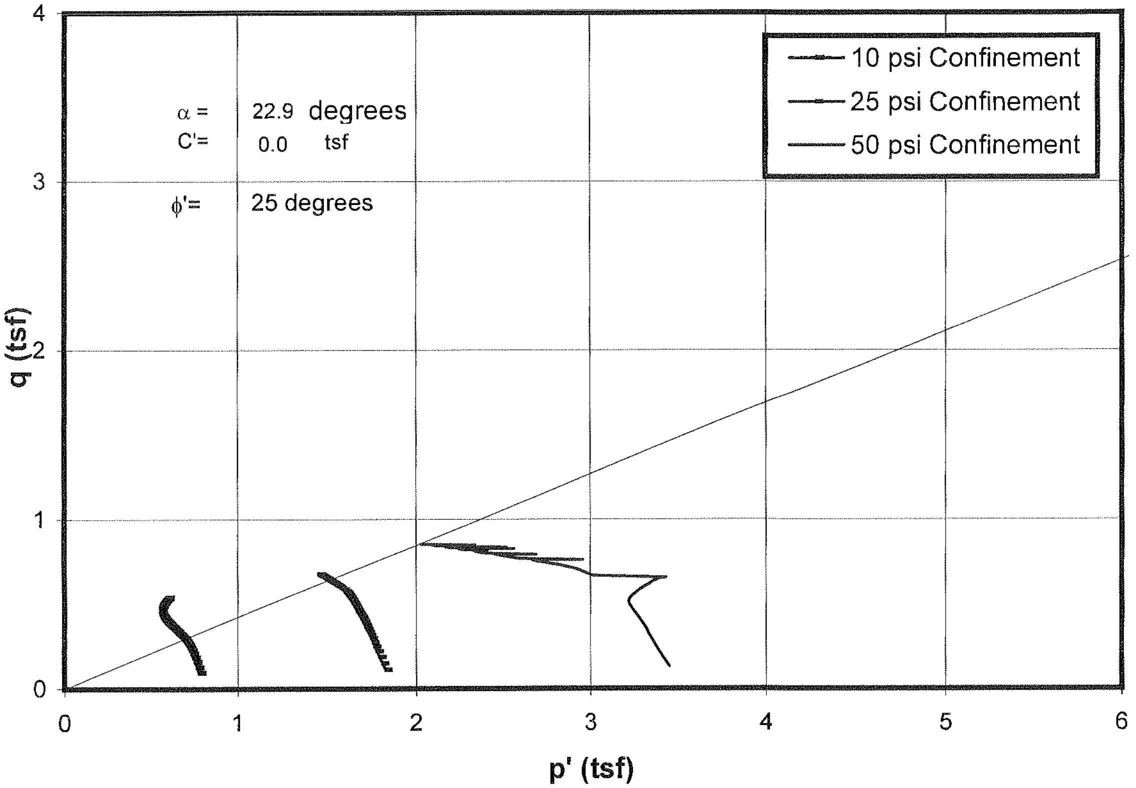
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

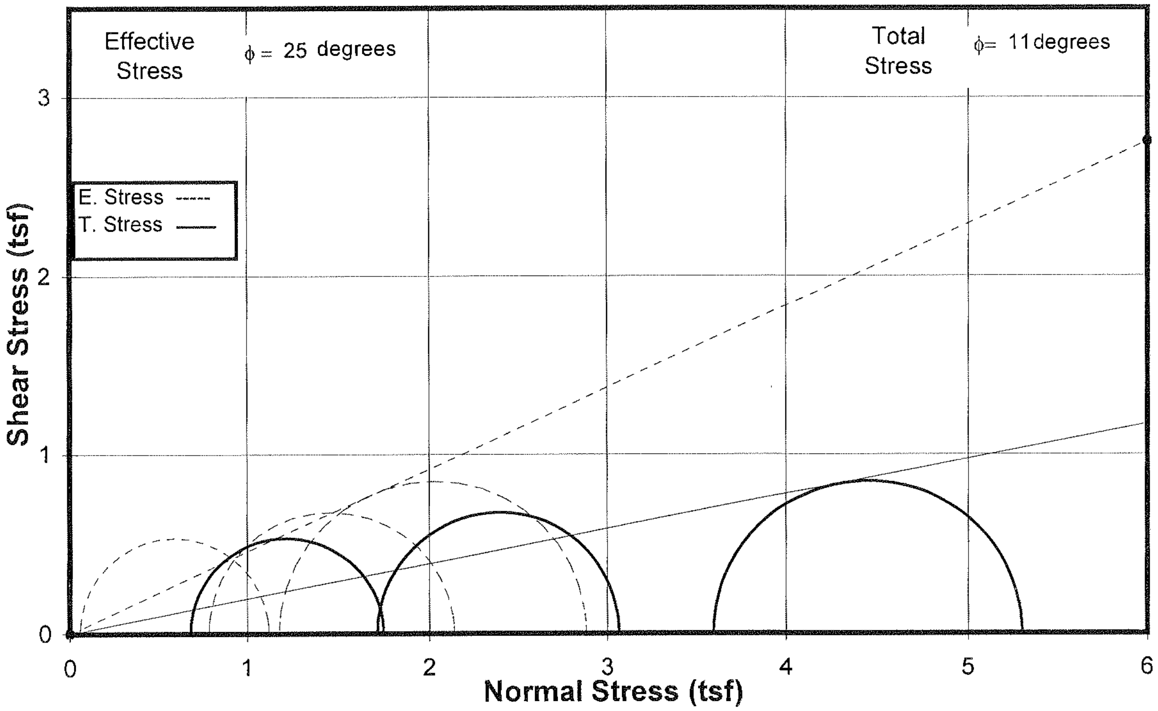
ASTM D 4767
Project No.: J011309.02
Boring: B-5, B-4, B-4
Sample: ST4,ST6,ST7 - Depth: 8, 13,16





CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D 4767
Project No.: J011309.01
Boring: C-1
Sample: ST-6 - Depth: 13.5





CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

ASTM D 4767

Project No.: J011309.01

Boring: C-2

Sample: ST-8 - Depth: 20

APPENDIX B

Current Subsurface Exploration Logs

HALEY ALDRICH

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. TPZ-3

Project: Thomas Hill Energy Center
Location: Clifton Hill, MO
Client: Associated Electric Cooperative, Inc.
Contractor: Bulldog Drilling
Driller: C. Dutton

Well Diagram

▥	Riser Pipe
▤	Screen
░	Filter Sand
▒	Cuttings
■	Grout
▩	Concrete
▨	Bentonite Seal

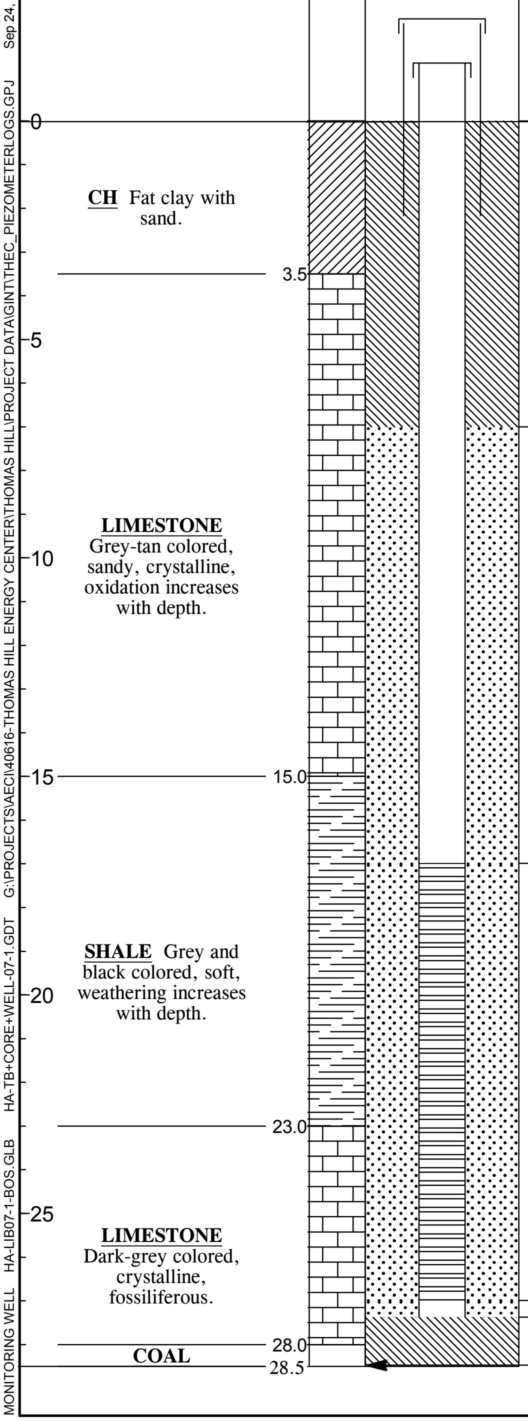
File No.: 40616-400
Date Installed: 26 Aug 2015
H&A Rep.: D. Andersen
Location: See Plan

Ground El.: 730.7
Datum: NGVD

SOIL/ROCK

CONDITIONS	DEPTH (ft.)
CH Fat clay with sand.	3.5
LIMESTONE Grey-tan colored, sandy, crystalline, oxidation increases with depth.	15.0
SHALE Grey and black colored, soft, weathering increases with depth.	23.0
LIMESTONE Dark-grey colored, crystalline, fossiliferous.	28.0
COAL	28.5

GRAPHIC / WELL DETAILS



DEPTH (ft.)	ELEVATION (ft.)
0.0	730.7
7.0	723.7
17.0	713.7
27.0	703.7
27.4	703.3

WELL CONSTRUCTION DETAILS

Type of protective cover: LOCKING CAP

Height of Guard Pipe above ground surface: 2.5 ft

Height of top of riser above ground surface: 2.0 ft

Type of protective casing: Guard Pipe

Length: 5.0 ft

Inside diameter: 4 inches

Depth of bottom of Guard Pipe: 2.5 ft

Type of riser pipe: Schedule 40 PVC

Inside diameter of riser pipe: 2 inch

Depth of bottom of riser pipe: 17.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Bentonite	0.0 ft	7.0 ft
	-	-
	-	-

Diameter of borehole: 9.5 inch

Depth to top of well screen: 17.0 ft

Type of screen: Machine slotted Sch 40 PVC

Screen gauge or size of openings: 0.010 in.

Diameter of screen: 2 inch

Type of Backfill around Screen: No. 12-20 silica sand

Depth to bottom of well screen: 26.99 ft

Bottom of silt trap: NA

Depth of bottom of borehole: 28.5 ft

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

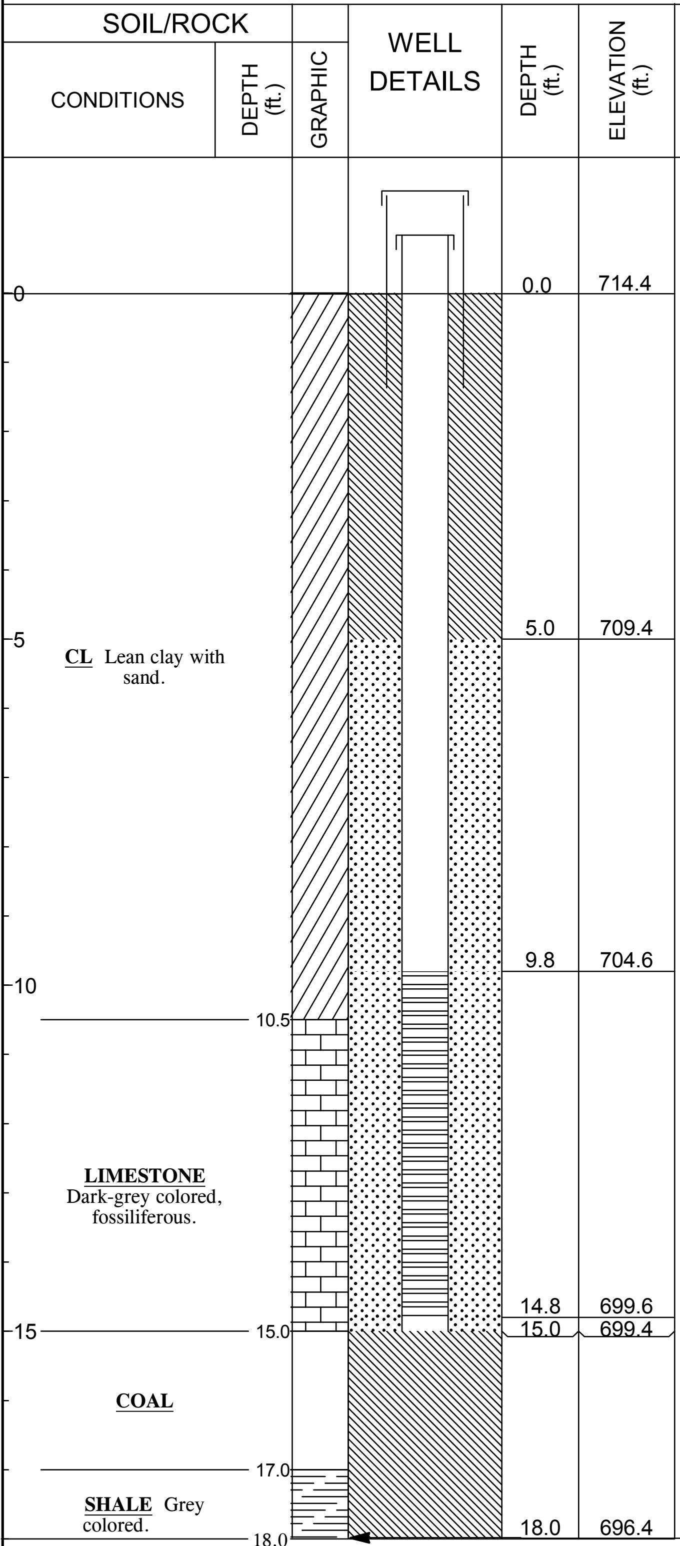
Well No. TPZ-9

Project	Thomas Hill Energy Center
Location	Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling
Driller	C. Dutton

Well Diagram

- ◫ Riser Pipe
- ▤ Screen
- ░ Filter Sand
- ▒ Cuttings
- ■ Grout
- ⁘ Concrete
- ▨ Bentonite Seal

File No.	40616-400
Date Installed	24 Aug 2015
H&A Rep.	D. Andersen
Location	See Plan
Ground El.	714.4
Datum	NGVD



WELL CONSTRUCTION DETAILS

Type of protective cover LOCKING CAP

Height of Guard Pipe above ground surface 2.5 ft

Height of top of riser above ground surface 2.0 ft

Type of protective casing Guard Pipe

Length 5.0 ft

Inside diameter 4 inches

Depth of bottom of Guard Pipe 2.5 ft

Type of riser pipe Schedule 40 PVC

Inside diameter of riser pipe 2 inch

Depth of bottom of riser pipe 9.8 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Bentonite	0.0 ft	5.0 ft
	-	-
	-	-

Diameter of borehole 9.5 inch

Depth to top of well screen 9.8 ft

Type of screen Machine slotted Sch 40 PVC

Screen gauge or size of openings 0.010 in.

Diameter of screen 2 inch

Type of Backfill around Screen No. 12-20 silica sand

Depth to bottom of well screen 14.8 ft

Bottom of silt trap NA

Depth of bottom of borehole 18.0 ft

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. TPZ-10

Project	Thomas Hill Energy Center
Location	Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling
Driller	C. Dutton

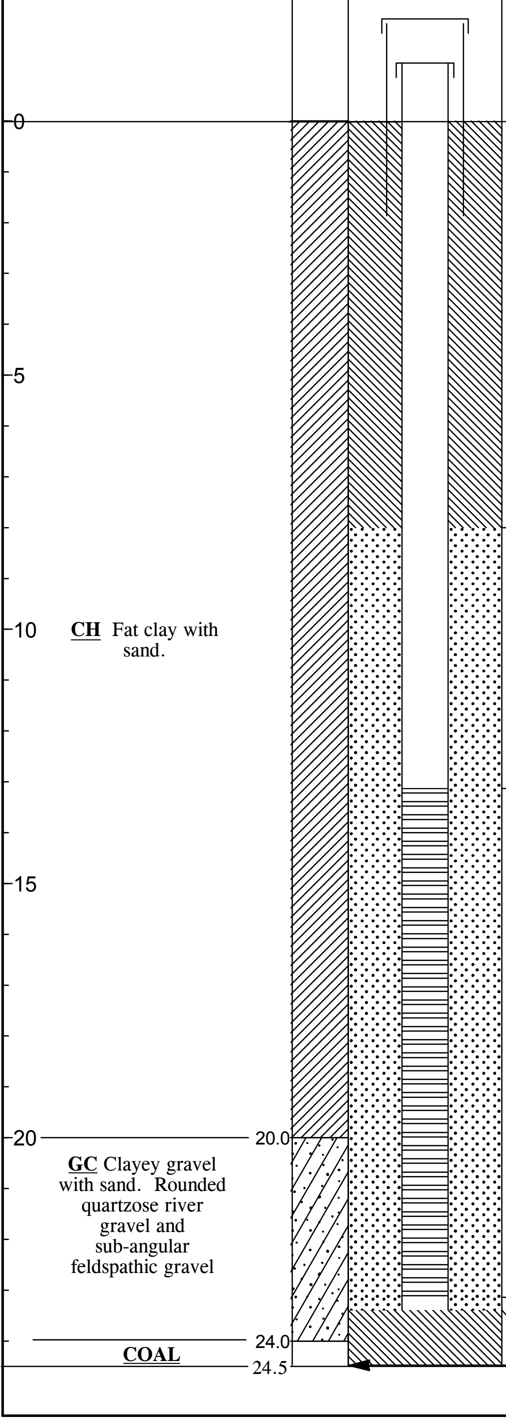
Well Diagram

- ▥ Riser Pipe
- ▤ Screen
- ░ Filter Sand
- ▒ Cuttings
- ■ Grout
- ▦ Concrete
- ▨ Bentonite Seal

File No.	40616-400
Date Installed	25 Aug 2015
H&A Rep.	D. Andersen
Location	See Plan
Ground El.	702.7
Datum	NGVD

SOIL/ROCK

CONDITIONS	DEPTH (ft.)
CH Fat clay with sand.	
GC Clayey gravel with sand. Rounded quartzose river gravel and sub-angular feldspathic gravel	20.0
COAL	24.0
	24.5



DEPTH (ft.)	ELEVATION (ft.)
0.0	702.7
8.0	694.7
13.1	689.5
23.1	679.5
23.4	679.3
24.5	678.2

WELL CONSTRUCTION DETAILS

Type of protective cover	LOCKING CAP
Height of Guard Pipe above ground surface	2.5 ft
Height of top of riser above ground surface	2.0 ft
Type of protective casing	Guard Pipe
Length	5.0 ft
Inside diameter	4 inches
Depth of bottom of Guard Pipe	2.5 ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2 inch
Depth of bottom of riser pipe	13.1 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Bentonite	0.0 ft	8.0 ft
	-	-
	-	-

Diameter of borehole	9.5 inch
Depth to top of well screen	13.1 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2 inch
Type of Backfill around Screen	No. 12-20 silica sand
Depth to bottom of well screen	23.14 ft
Bottom of silt trap	NA
Depth of bottom of borehole	24.5 ft

HALEY ALDRICH

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. TPZ-11

Project Thomas Hill Energy Center
Location Clifton Hill, MO
Client Associated Electric Cooperative, Inc.
Contractor Bulldog Drilling
Driller C. Dutton

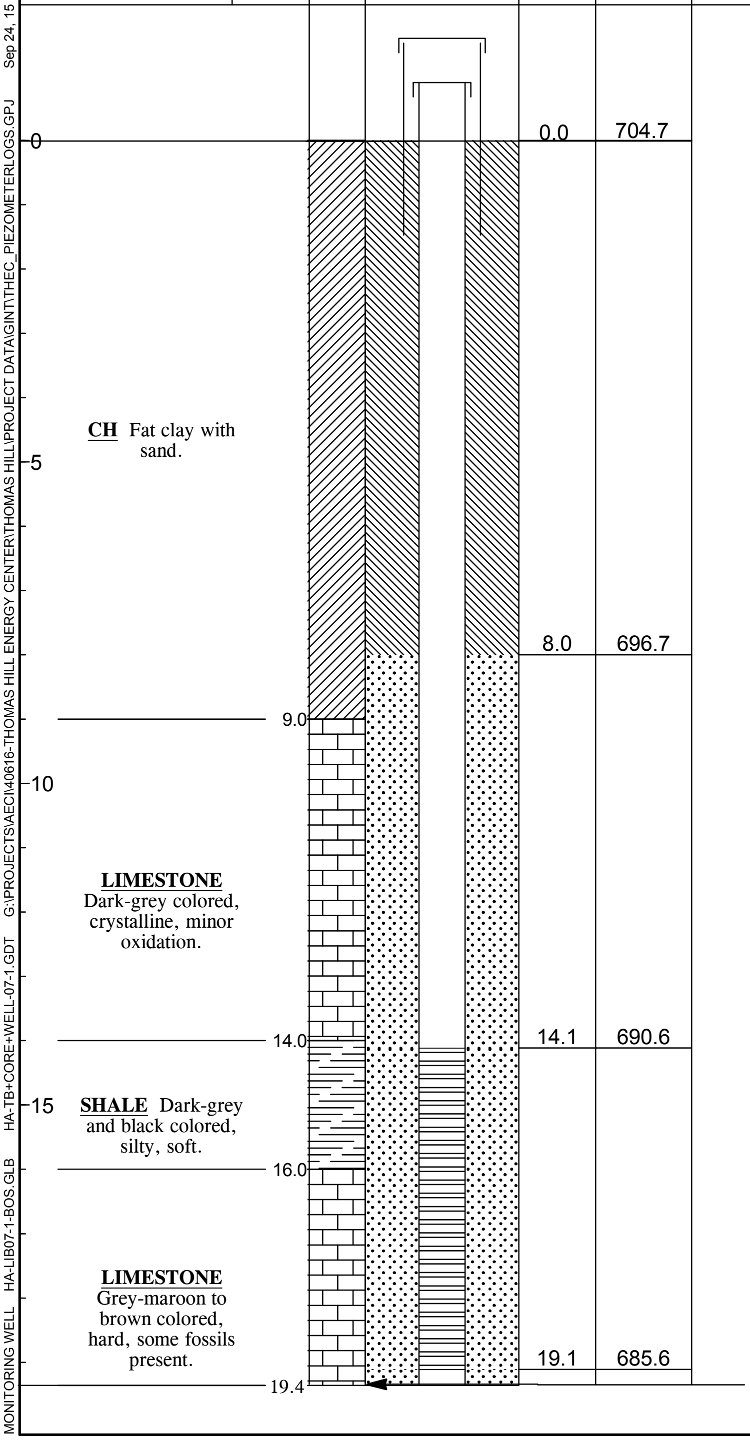
Well Diagram

◫	Riser Pipe
▤	Screen
░	Filter Sand
▒	Cuttings
■	Grout
⁘	Concrete
▧	Bentonite Seal

File No. 40616-400
Date Installed 27 Aug 2015
H&A Rep. D. Andersen
Location See Plan

Ground El. 704.7
Datum NGVD

SOIL/ROCK		
CONDITIONS	DEPTH (ft.)	GRAPHIC
CH Fat clay with sand.	9.0	
LIMESTONE Dark-grey colored, crystalline, minor oxidation.	14.0	
SHALE Dark-grey and black colored, silty, soft.	16.0	
LIMESTONE Grey-maroon to brown colored, hard, some fossils present.	19.4	



WELL CONSTRUCTION DETAILS

Type of protective cover LOCKING CAP

Height of Guard Pipe above ground surface 2.5 ft

Height of top of riser above ground surface 2.0 ft

Type of protective casing Guard Pipe

Length 5.0 ft

Inside diameter 4 inches

Depth of bottom of Guard Pipe 2.5 ft

Type of riser pipe Schedule 40 PVC

Inside diameter of riser pipe 2 inch

Depth of bottom of riser pipe 14.1 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Bentonite	0.0 ft	8.0 ft
	-	-
	-	-

Diameter of borehole 9.5 inch

Depth to top of well screen 14.1 ft

Type of screen Machine slotted Sch 40 PVC

Screen gauge or size of openings 0.010 in.

Diameter of screen 2 inch

Type of Backfill around Screen No. 12-20 silica sand

Depth to bottom of well screen 19.11 ft

Bottom of silt trap NA

Depth of bottom of borehole 19.4 ft

HALEY ALDRICH

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. TPZ-12

Project: Thomas Hill Energy Center
Location: Clifton Hill, MO
Client: Associated Electric Cooperative, Inc.
Contractor: Bulldog Drilling
Driller: C. Dutton

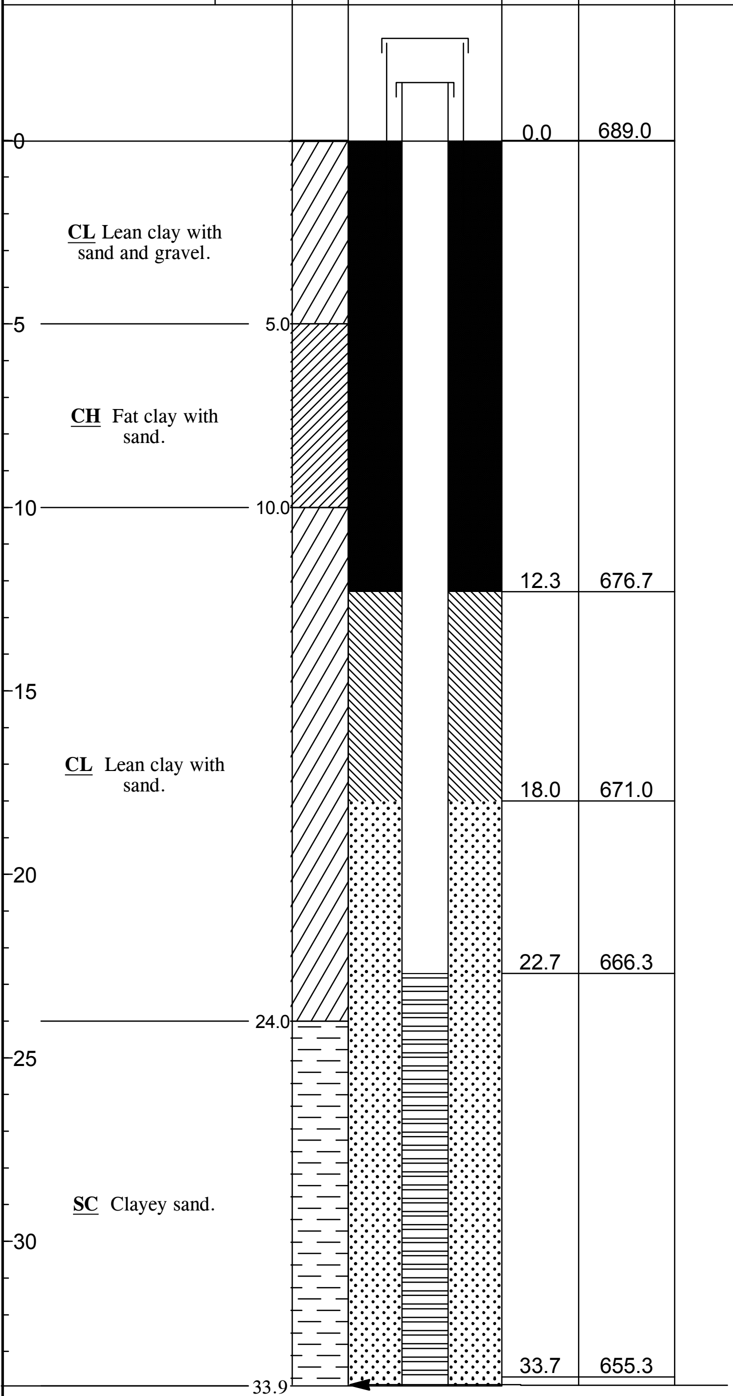
Well Diagram

- ◫ Riser Pipe
- ▤ Screen
- ░ Filter Sand
- ▒ Cuttings
- ■ Grout
- ⁘ Concrete
- ▨ Bentonite Seal

File No.: 40616-400
Date Installed: 19 Aug 2015
H&A Rep.: D. Andersen
Location: See Plan

Ground El.: 689.0
Datum: NGVD

SOIL/ROCK CONDITIONS	DEPTH (ft.)
CL Lean clay with sand and gravel.	5.0
CH Fat clay with sand.	10.0
CL Lean clay with sand.	24.0
SC Clayey sand.	33.9



DEPTH (ft.)	ELEVATION (ft.)
0.0	689.0
12.3	676.7
18.0	671.0
22.7	666.3
33.7	655.3

WELL CONSTRUCTION DETAILS

Type of protective cover: LOCKING CAP

Height of Guard Pipe above ground surface: 2.5 ft

Height of top of riser above ground surface: 2.0 ft

Type of protective casing: Guard Pipe

Length: 5.0 ft

Inside diameter: 4 inches

Depth of bottom of Guard Pipe: 2.5 ft

Type of riser pipe: Schedule 40 PVC

Inside diameter of riser pipe: 2 inch

Depth of bottom of riser pipe: 22.7 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Grout	0.0 ft	12.3 ft
Bentonite	12.3 ft	5.7 ft
	-	-

Diameter of borehole: 8 inch

Depth to top of well screen: 22.7 ft

Type of screen: Machine slotted Sch 40 PVC

Screen gauge or size of openings: 0.010 in.

Diameter of screen: 2 inch

Type of Backfill around Screen: No. 12-20 silica sand

Depth to bottom of well screen: 33.7 ft

Bottom of silt trap: NA

Depth of bottom of borehole: 33.9 ft

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. TPZ-14

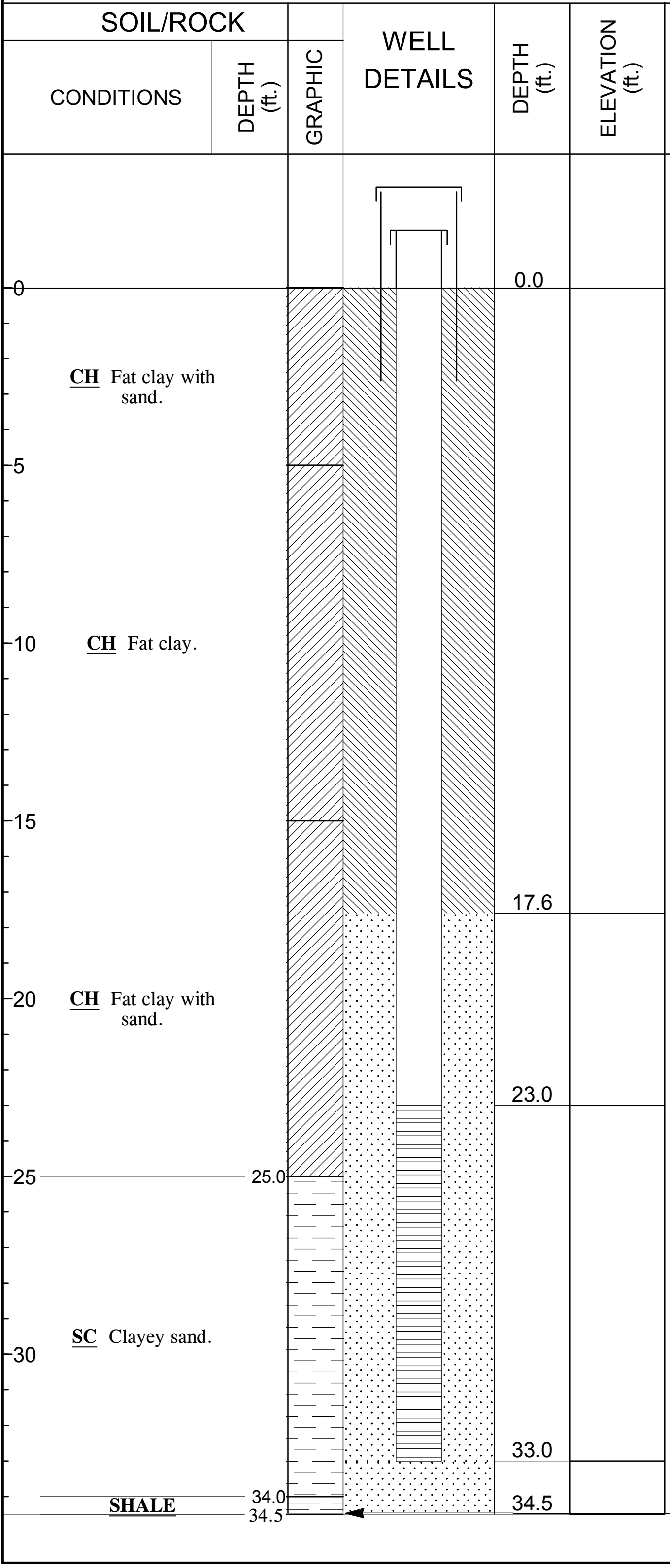
Project: Thomas Hill Energy Center
Location: Clifton Hill, MO
Client: Associated Electric Cooperative, Inc.
Contractor: Bulldog Drilling
Driller: C. Dutton

Well Diagram

- ◫ Riser Pipe
- ▤ Screen
- ░ Filter Sand
- ▒ Cuttings
- ■ Grout
- ▨ Concrete
- ▧ Bentonite Seal

File No.: 128064-001
Date Installed: 02 Aug 2016
H&A Rep.: P. Kroger
Location: See Plan

Ground El.:
Datum: NGVD



WELL CONSTRUCTION DETAILS

Type of protective cover: LOCKING CAP

Height of Guard Pipe above ground surface: 2.2 ft

Height of top of riser above ground surface: 2.1 ft

Type of protective casing: Guard Pipe

Length: 5.0 ft

Inside diameter: 2 inches

Depth of bottom of Guard Pipe: 2.8 ft

Type of riser pipe: Schedule 40 PVC

Inside diameter of riser pipe: 2 inch

Depth of bottom of riser pipe: 23.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Bentonite	0.0 ft	17.6 ft
-	-	-
-		-

Diameter of borehole: 10 inch

Depth to top of well screen: 23.0 ft

Type of screen: Machine slotted Sch 40 PVC

Screen gauge or size of openings: 0.010 in.

Diameter of screen: 2 inch

Type of Filter Pack around Screen: No. 12-20 silica sand

Depth to bottom of well screen: 33 ft

Bottom of silt trap: NA

Depth of bottom of borehole: 34.5 ft

APPENDIX C

Analyses

Design Soil Properties

SOIL PROPERTY CHARACTERIZATION - THOMAS HILL ENERGY CENTER CELL 001

Material[2]	Total Unit Weight, γ_T				Undrained Shear Strength, S_u										Drained Shear Strength											
	CPT	Laboratory	Historic Design[1]	Current Design	SPT		CPT		UU and CIU Trx	Historic Design[1]		Current Design			SPT		CPT		Laboratory CIU Trx (Site-Wide)				Historic Design[1]		Current Design	
	avg	Site-Wide Average			avg	avg - 1σ	avg	avg - 1σ	(Site-Wide)						avg	avg - 1σ	avg	avg - 1σ	avg		min.					
	γ_T	γ_T	γ_T	γ_T	S_u	S_u	S_u	S_u	S_u	c	ϕ	c	ϕ	S_u	ϕ'		ϕ'	ϕ'	c'	ϕ'	c'	ϕ'	c'	ϕ'	c'	ϕ'
Bottom Ash/Boiler Slag	--	--	--	**90 pcf**	--	--	--	--	--	--	--	**--**	**--**	**750 psf**	--	--	--	--	--	--	--	--	--	--	**0 psf**	**30°**
Embankment Fill	--	125 psf	129 pcf	**125 pcf**	638 psf	487 psf	--	--	$S_{u,min}$ = 600 psf S_u/σ_v' = 0.360	600 psf	--	**--**	**--**	**$S_{u,min}$ = 600 psf** **S_u/σ_v' = 0.360**	--	--	--	--	500 psf	25°	400 psf	23°	20 psf	23°	**200 psf**	**25°**
Clay Liner	--	--	--	**125 pcf**	--	--	--	--	--	--	--	**--**	**--**	**1,300 psf**	--	--	--	--	--	--	--	--	--	--	**0 psf**	**28°**
Clay	--	120 pcf	120 to 124 pcf	**120 pcf**	2507 psf	1156 psf	--	--	$S_{u,min}$ = 800 psf S_u/σ_v' = 0.253	700 to 1000 psf	--	**--**	**--**	**$S_{u,min}$ = 800 psf** **S_u/σ_v' = 0.253**	--	--	--	--	260 psf	26°	0 psf	25°	0 psf	20° - 27°	**125 psf**	**26°**
Weathered Bedrock	--	--	--	**130 pcf**	6,000 psf	6000 psf	1531 psf	910 psf	--	'--	--	**--**	**38°**	**--**	--	--	--	--	--	--	--	--	--	--	**--**	**38°**

Notes:

1. Based on historic analyses performed by Geotechnology, Inc.
2. In cases where historic design properties, SPT/CPT correlations, and laboratory test data do not exist, the current design properties for these materials have been conservatively estimated using typical published values and Haley & Aldrich's experience with similar materials.

SOIL PROPERTY CHARACTERIZATION - THOMAS HILL ENERGY CENTER CELL 003

Material[2]	Total Unit Weight, γ_T				Undrained Shear Strength, S_u										Drained Shear Strength											
	CPT	Laboratory	Historic	Current	SPT		CPT		UU and CIU Trx	Historic		Current			SPT		CPT		Laboratory CIU Trx (Site-Wide)				Historic		Current	
	avg	Site-Wide Average	Design[1]	Design	avg	avg - 1σ	avg	avg - 1σ	avg	Design[1]		Design			avg	avg - 1σ	avg	avg - 1σ	avg		min.		Design[1]		Design	
	γ_T	γ_T	γ_T	γ_T	S_u	S_u	S_u	S_u	S_u	c	ϕ	c	ϕ	S_u	ϕ'		ϕ'	ϕ'	c'	ϕ'	c'	ϕ'	c'	ϕ'	c'	ϕ'
Bottom Ash/Boiler Slag/Fly Ash	--	--	--	**90 pcf**	--	--	--	--	--	--	--	**--**	**--**	**750 psf**	--	--	--	--	--	--	--	--	--	--	**0 psf**	**30°**
Embankment Fill	--	125 pcf	120 psf	**125 pcf**	865 psf	631 psf	1621 psf	1303 psf	$S_{u,min}$ = 600 psf S_u/σ_v' = 0.360	--	--	**--**	**--**	**$S_{u,min}$ = 600 psf** **S_u/σ_v' = 0.360**	--	--	--	--	500 psf	25°	400 psf	23°	100 psf	28°	**200 psf**	**25°**
Clay	--	120 pcf	120 pcf	**120 pcf**	2,612 psf	1,946 psf	1610 psf	1282 psf	$S_{u,min}$ = 800 psf S_u/σ_v' = 0.253	--	--	**--**	**--**	**$S_{u,min}$ = 800 psf** **S_u/σ_v' = 0.253**	--	--	--	--	260 psf	26°	0 psf	25°	50 psf	27°	**125 psf**	**26°**
Weathered Bedrock	--	--	--	**130 pcf**	6,000 psf	6000 psf	1531 psf	910 psf	--	--	--	**--**	**38°**	**--**	--	--	--	--	--	--	--	--	--	--	**--**	**38°**

Notes:

1. Based on historic analyses performed by Geotechnology, Inc.
2. In cases where historic design properties, SPT/CPT correlations, and laboratory test data do not exist, the current design properties for these materials have been conservatively estimated using typical published values and Haley & Aldrich's experience with similar materials.

SOIL PROPERTY CHARACTERIZATION - THOMAS HILL ENERGY CENTER CELL 004

Material[2]	Total Unit Weight, γ_T				Undrained Shear Strength, S_u										Drained Shear Strength											
	CPT	Laboratory	Historic Design[1]	Current Design	SPT		CPT		UU and CIU Trx	Historic Design[1]		Current Design			SPT		CPT		Laboratory CIU Trx (Site-Wide)				Historic Design[1]		Current Design	
	avg	Site-Wide Average			avg	avg - 1σ	avg	avg - 1σ	avg						avg	avg - 1σ	avg	avg - 1σ	avg		min.					
	γ_T	γ_T	γ_T	γ_T	S_u	S_u	S_u	S_u	S_u	c	ϕ	c	ϕ	S_u	ϕ'		ϕ'	ϕ'	c'	ϕ'	c'	ϕ'	c'	ϕ'	c'	ϕ'
Embankment Fill	--	125 pcf	129 pcf	**125 pcf**	648 psf	473 psf	--	--	$S_{u,min}$ = 600 psf S_u/σ_v' = 0.360	700 psf	--	**--**	**--**	**$S_{u,min}$ = 600 psf** **S_u/σ_v' = 0.360**	--	--	--	--	500 psf	25°	400 psf	23°	20 psf	23°	**200 psf**	**25°**
Clay	--	120 pcf	118 pcf	**120 pcf**	738 psf	N/A	--	--	$S_{u,min}$ = 800 psf S_u/σ_v' = 0.253	400 to 900 psf	--	**--**	**--**	**$S_{u,min}$ = 800 psf** **S_u/σ_v' = 0.253**	--	--	--	--	260 psf	26°	0 psf	25°	0 psf	26°	**125 psf**	**26°**
Weathered Bedrock	--	--	--	**130 pcf**	6,000 psf	6,000 psf	--	--	--	--	--	**--**	**38°**	**--**	--	--	--	--	--	--	--	--	--	--	**--**	**38°**

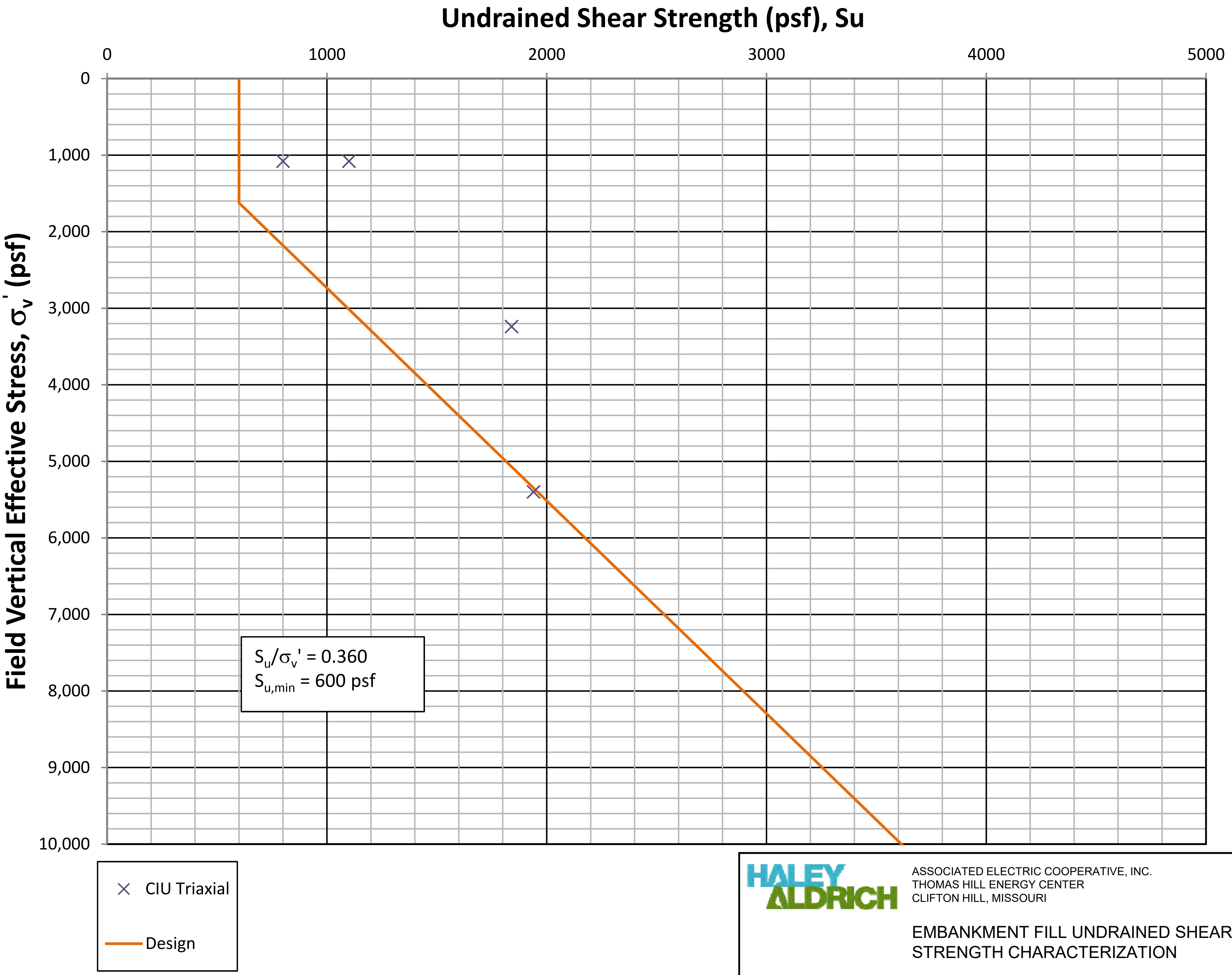
Notes:

1. Based on historic analyses performed by Geotechnology, Inc.
2. In cases where historic design properties, SPT/CPT correlations, and laboratory test data do not exist, the current design properties for these materials have been conservatively estimated using typical published values and Haley & Aldrich's experience with similar materials.

HALEY & ALDRICH, INC.

Printed: 14 October 2016

\\Was\common\Projects\40616\-XXX TH SF Assessment\Analyses_Design Soil Properties\[2016-1014-HAI-AECI Thomas Hill Design Soil Properties_D4.xlsx]Pond 1



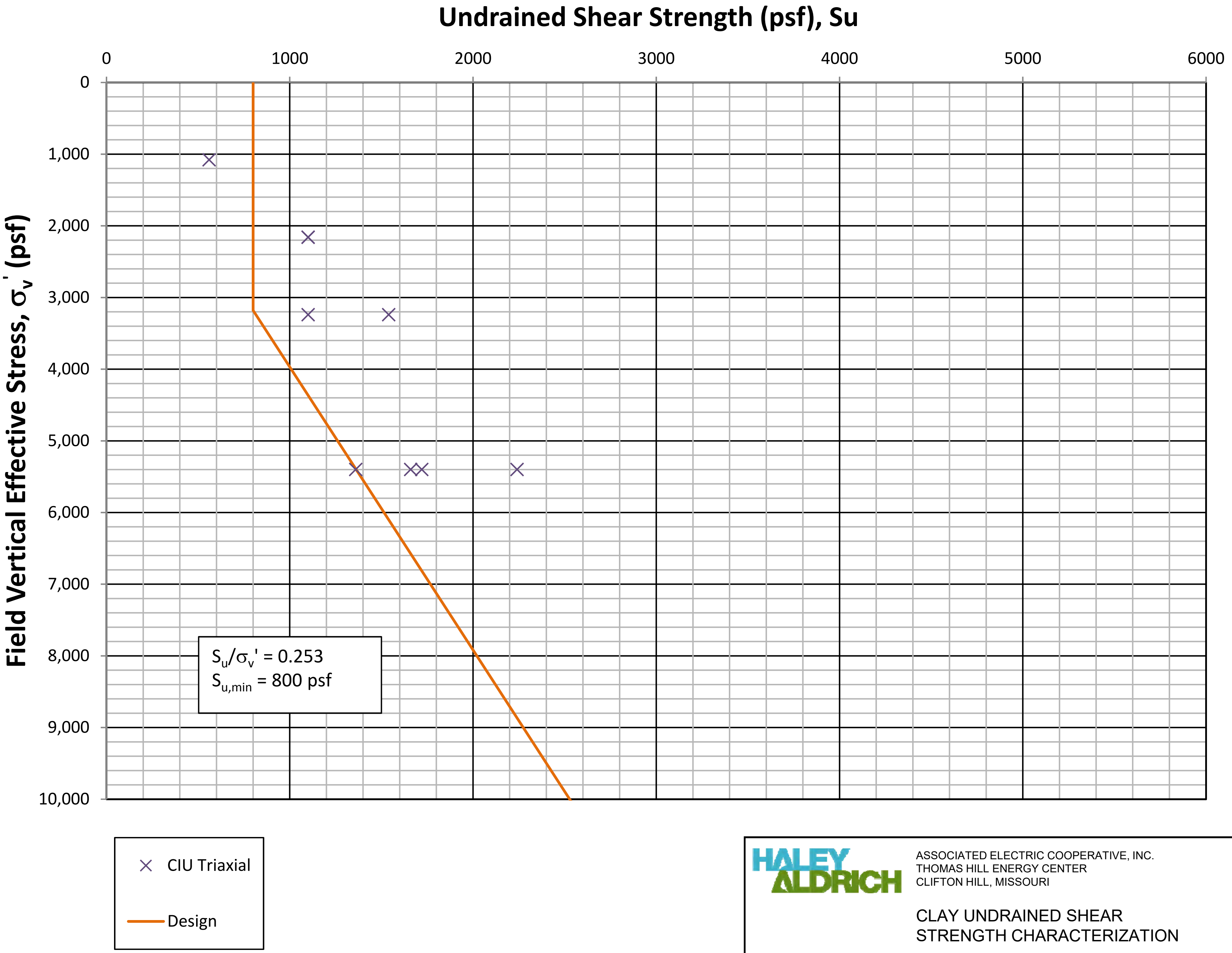
HALEY ALDRICH

ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

EMBANKMENT FILL UNDRAINED SHEAR STRENGTH CHARACTERIZATION

SCALE : AS SHOWN
OCTOBER 2016

FIGURE C1



128064-003_FIG C2.PPT

HALEY ALDRICH

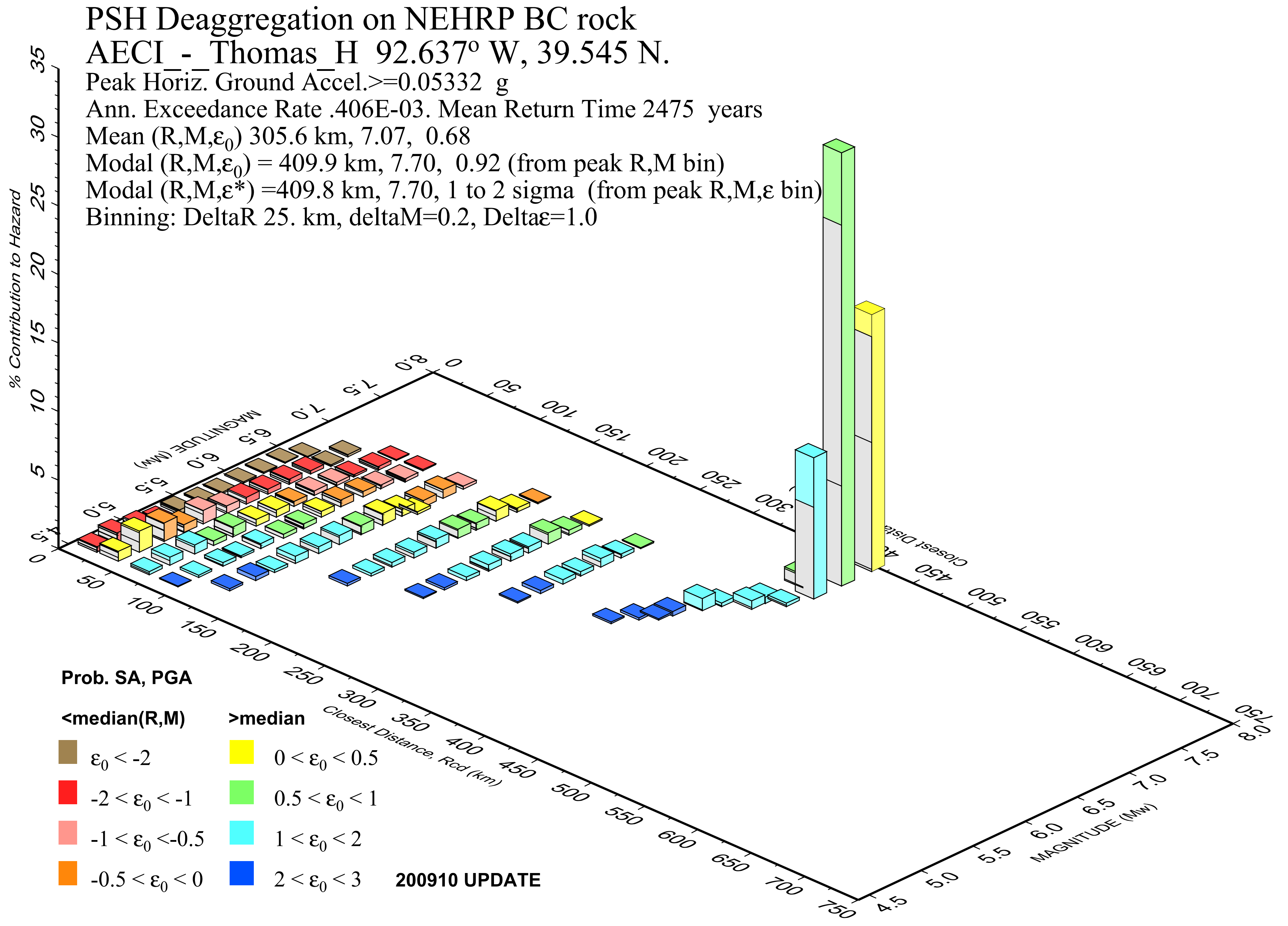
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

CLAY UNDRAINED SHEAR
STRENGTH CHARACTERIZATION

SCALE : AS SHOWN
OCTOBER 2016

FIGURE C2

Seismic Documents



PSH Deaggregation on NEHRP BC rock

AECI_-_Thomas_H 92.637° W, 39.545 N.

Peak Horiz. Ground Accel.>=0.05332 g

Ann. Exceedance Rate .406E-03. Mean Return Time 2475 years

Mean (R,M,ε_0) 305.6 km, 7.07, 0.68

Modal (R,M,ε_0) = 409.9 km, 7.70, 0.92 (from peak R,M bin)

Modal (R,M,ε*) =409.8 km, 7.70, 1 to 2 sigma (from peak R,M,ε bin)

Binning: DeltaR 25. km, deltaM=0.2, Deltaε=1.0

GMT 2016 Sep 30 12:00:55 Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on rock with average vs= 760. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted

USGS Design Maps Detailed Report

ASCE 7-10 Standard (39.545°N, 92.637°W)

Site Class D – “Stiff Soil”, Risk Category IV (e.g. essential facilities)

Section 11.4.1 — Mapped Acceleration Parameters

Note: Ground motion values provided 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_S) and 1.3 (to obtain S_1). Maps in the 2010 ASCE-7 Standard are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 11.4.3.

From Figure 22-1 [1]	$S_S = 0.124$ g
From Figure 22-2 [2]	$S_1 = 0.077$ g

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 11.8.3 — Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

From Figure 22-7 [4]   PGA FROM 2014 HAZARD MAP = 0.057 g

Equation (11.8–1): $PGA_M = F_{PGA}PGA = 1.600 \times \boxed{0.057} = \boxed{0.0912\ g}$

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 = 0.057 g, F_{PGA} = 1.600

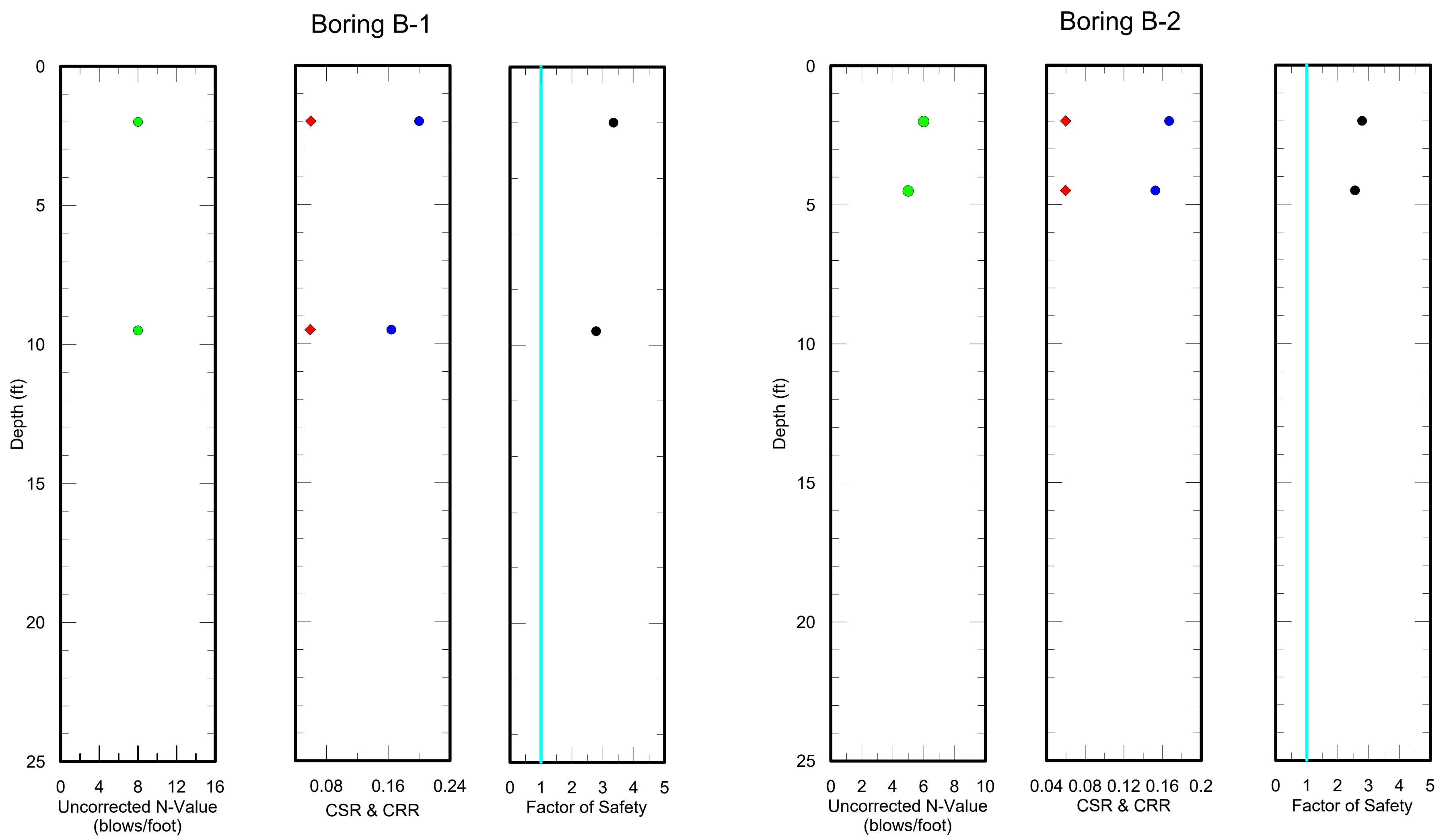
Section 21.2.1.1 — Method 1 (from Chapter 21 – Site-Specific Ground Motion Procedures for Seismic Design)

From Figure 22-17 [5] C_{RS} = 0.866

From Figure 22-18 [6] C_{R1} = 0.838

Liquefaction Analysis

\\was\Common\Projects\40616\-XXX TH SF Assessment\Analyses\Liquefaction\SPT_Liquefaction Triggering_2500 B-1, B-2.grf



LEGEND

◆ Cyclic Stress Ratio$_{M,\sigma'_{vc}}$

● Cyclic Resistance Ratio$_{M,\sigma'_{vc}}$

● Factor of Safety

NOTES:
1) Cyclic Stress Ratio (CSR), Cyclic Resistance Ratio (CRR) and Factor of Safety (FS) values calculated using methods described in EERI's "Soil Liquefaction during Earthquakes" [Idriss & Boulanger, 2008].
2) Effective stresses used in CRR equations calculated based on depth of water at the time of boring advancement. Effective stresses used in CSR equations based on depth to water at maximum storage.
3) CSR values calculated for an earthquake having a PGA of 0.092g and a magnitude of 7.7.
4) CRR values were calcuated using an assumed fines content of 50%.
5) Calculated factors of safety are limited to a value of 5 for graphical representation.

HALEY ALDRICH

Thomas Hill Energy Center Liquefaction Analysis

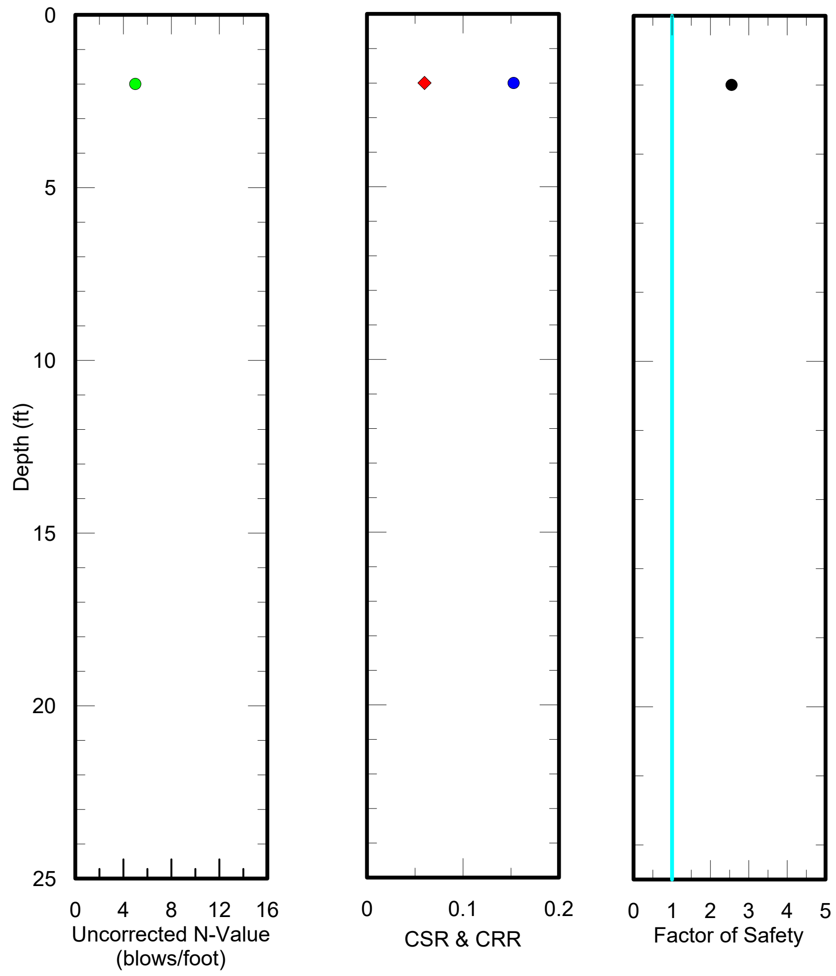
Liquefaction Triggering Evaluation
B-1 & B-2
2,500-Year Return Period

October 2016

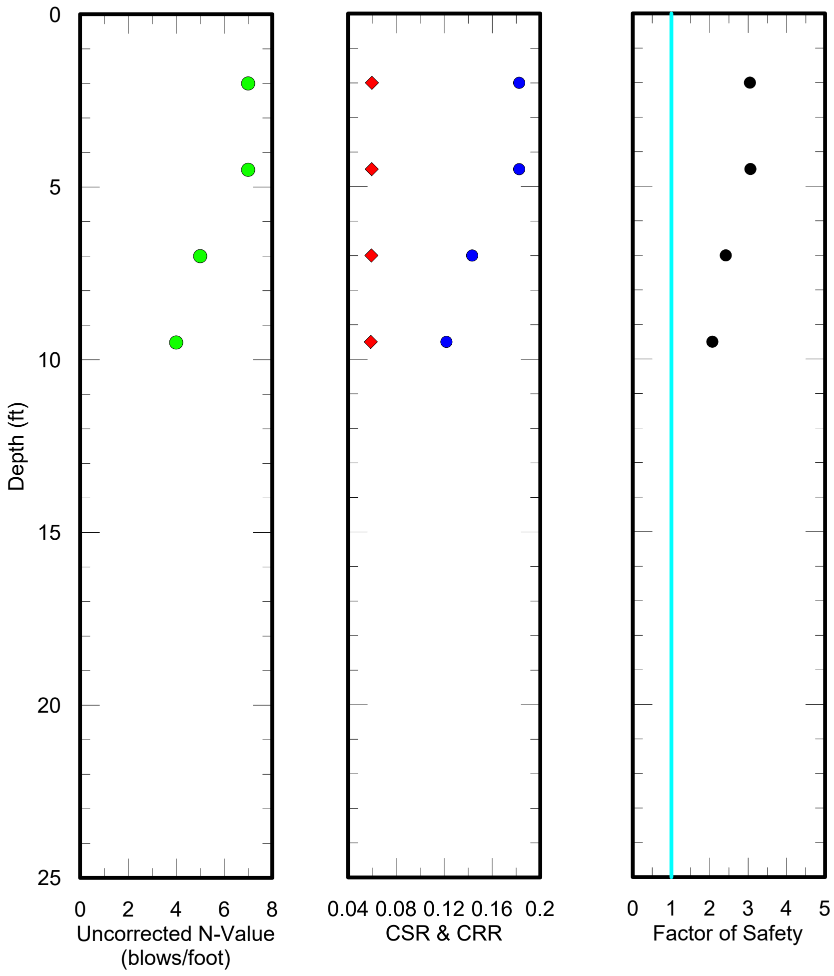
FIGURE NO.

\\was\Common\Projects\40616\-XXX TH SF Assessment\Analyses\Liquefaction\SPT_Liquefaction Triggering_2500 B-3, B-4.grf

Boring B-3



Boring B-4



LEGEND

◆ Cyclic Stress Ratio$_{M,\sigma'_{vc}}$

● Cyclic Resistance Ratio$_{M,\sigma'_{vc}}$

● Factor of Safety

NOTES:

1) Cyclic Stress Ratio (CSR), Cyclic Resistance Ratio (CRR) and Factor of Safety (FS) values calculated using methods described in EERI's "Soil Liquefaction during Earthquakes" [Idriss & Boulanger, 2008].
2) Effective stresses used in CRR equations calculated based on depth of water at the time of boring advancement. Effective stresses used in CSR equations based on depth to water at maximum storage.
3) CSR values calculated for an earthquake having a PGA of 0.092g and a magnitude of 7.7.
4) CRR values were calcuated using an assumed fines content of 50%.
5) Calculated factors of safety are limited to a value of 5 for graphical representation.

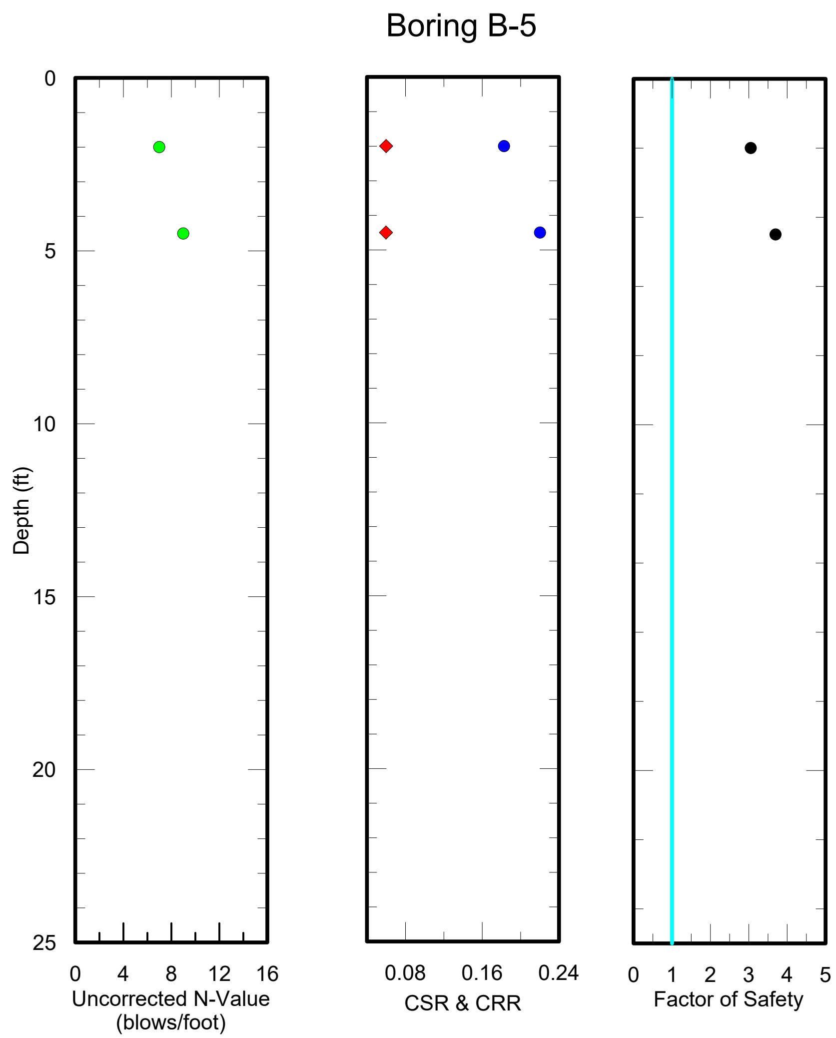
HALEY ALDRICH

Thomas Hill Energy Center Liquefaction Analysis

Liquefaction Triggering Evaluation
B-3 & B-4
2,500-Year Return Period

October 2016

FIGURE NO.



LEGEND

◆ Cyclic Stress Ratio$_{M,\sigma'_{vc}}$

● Cyclic Resistance Ratio$_{M,\sigma'_{vc}}$

● Factor of Safety

NOTES:

1) Cyclic Stress Ratio (CSR), Cyclic Resistance Ratio (CRR) and Factor of Safety (FS) values calculated using methods described in EERI's "Soil Liquefaction during Earthquakes" [Idriss & Boulanger, 2008].
2) Effective stresses used in CRR equations calculated based on depth of water at the time of boring advancement. Effective stresses used in CSR equations based on depth to water at maximum storage.
3) CSR values calculated for an earthquake having a PGA of 0.092g and a magnitude of 7.7.
4) CRR values were calcuated using an assumed fines content of 50%.
5) Calculated factors of safety are limited to a value of 5 for graphical representation.

HALEY
ALDRICH

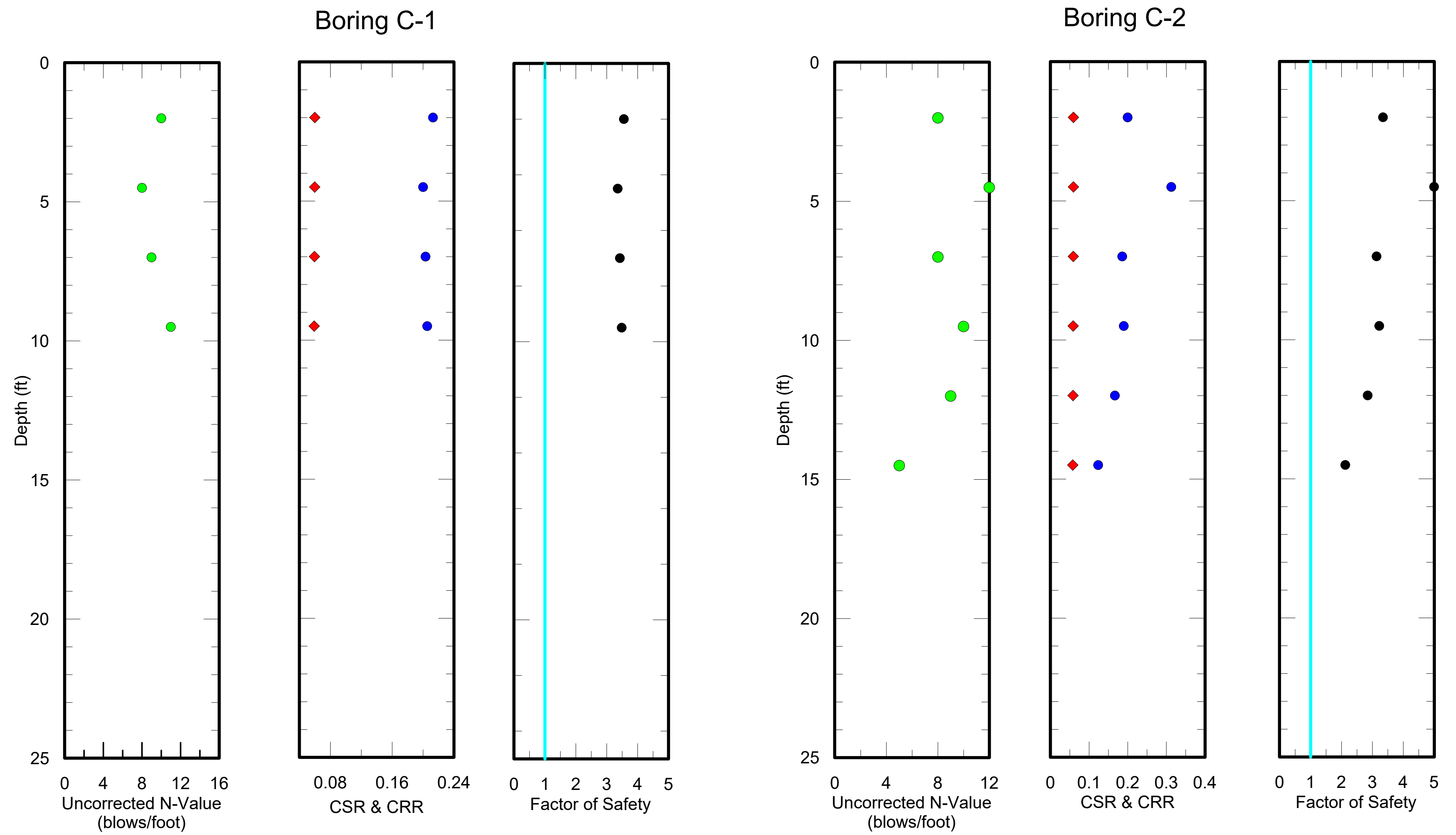
Thomas Hill Energy Center Liquefaction Analysis

Liquefaction Triggering Evaluation
B-5
2,500-Year Return Period

October 2016

FIGURE NO.

\\was\Common\Projects\40616\-XXX TH SF Assessment\Analyses\Liquefaction\SPT_Liquefaction Triggering_2500 C-1, C-2.grf



LEGEND

🟥 Cyclic Stress Ratio$_{M,\sigma'_{vc}}$

● Cyclic Resistance Ratio$_{M,\sigma'_{vc}}$

● Factor of Safety

NOTES:
1) Cyclic Stress Ratio (CSR), Cyclic Resistance Ratio (CRR) and Factor of Safety (FS) values calculated using methods described in EERI's "Soil Liquefaction during Earthquakes" [Idriss & Boulanger, 2008].
2) Effective stresses used in CRR equations calculated based on depth of water at the time of boring advancement. Effective stresses used in CSR equations based on depth to water at maximum storage.
3) CSR values calculated for an earthquake having a PGA of 0.092g and a magnitude of 7.7.
4) CRR values were calcuated using an assumed fines content of 50%.
5) Calculated factors of safety are limited to a value of 5 for graphical representation.

HALEY ALDRICH

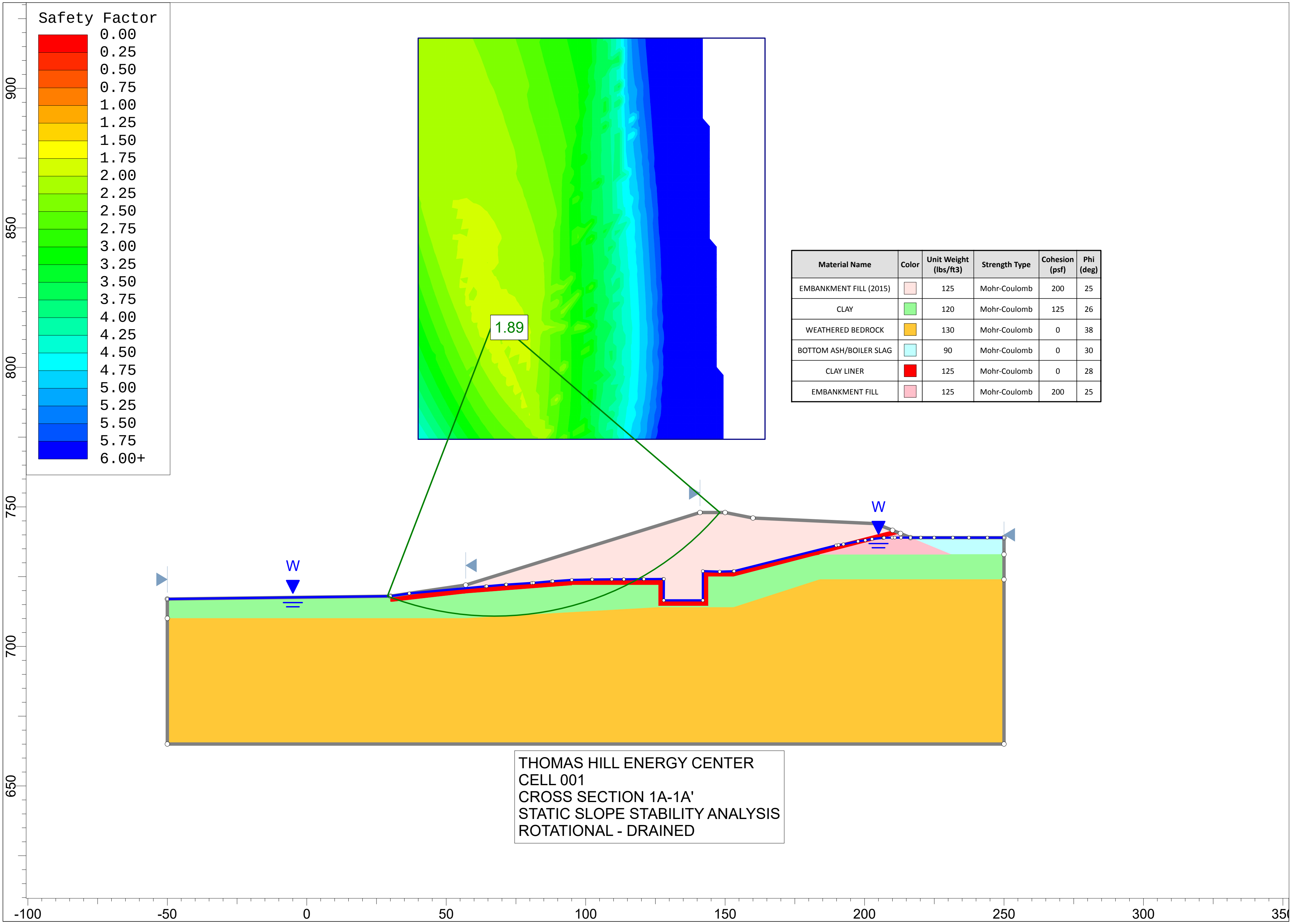
Thomas Hill Energy Center Liquefaction Analysis

Liquefaction Triggering Evaluation
C-1 & C-2
2,500-Year Return Period

October 2016

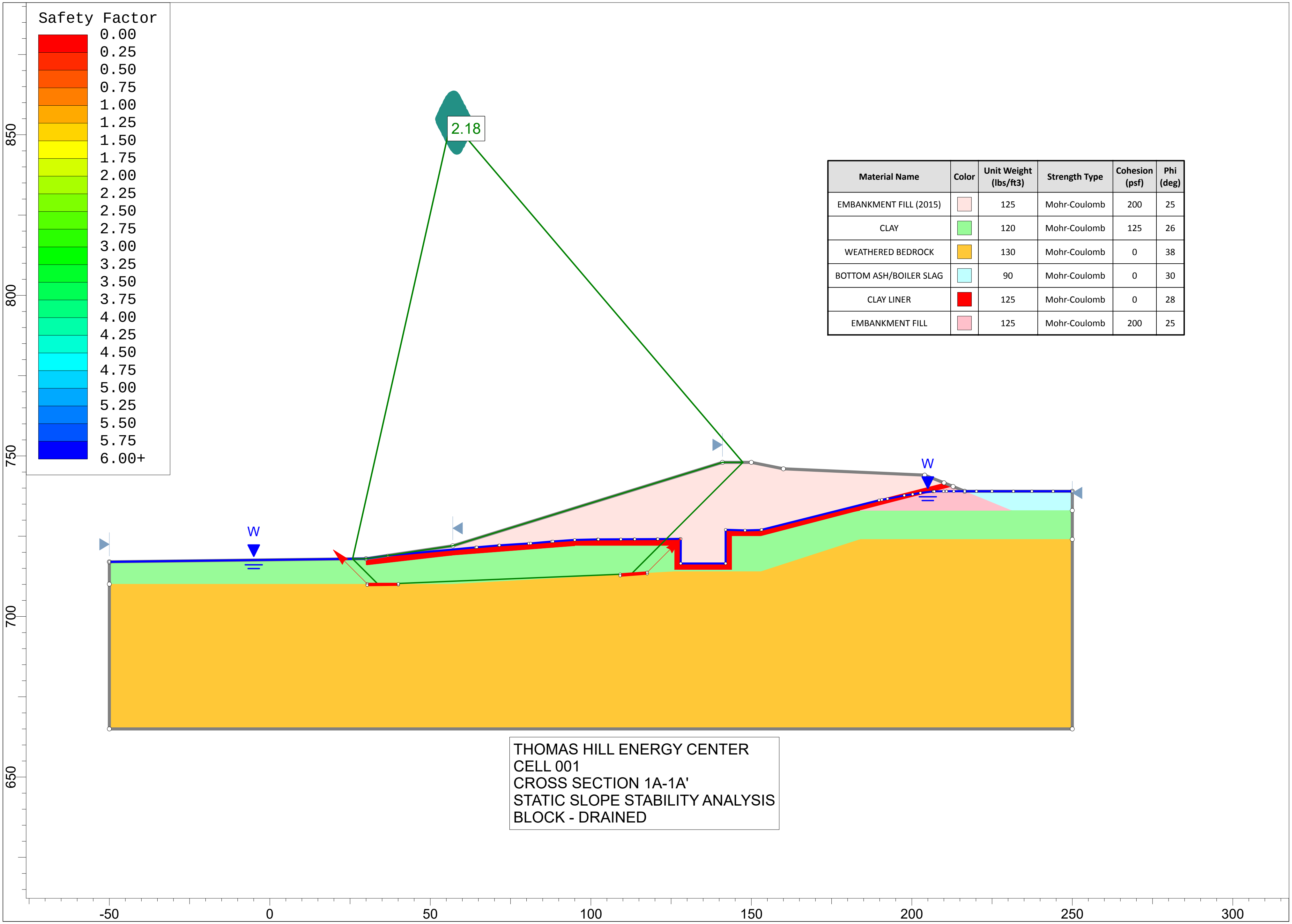
FIGURE NO.

Slope Stability



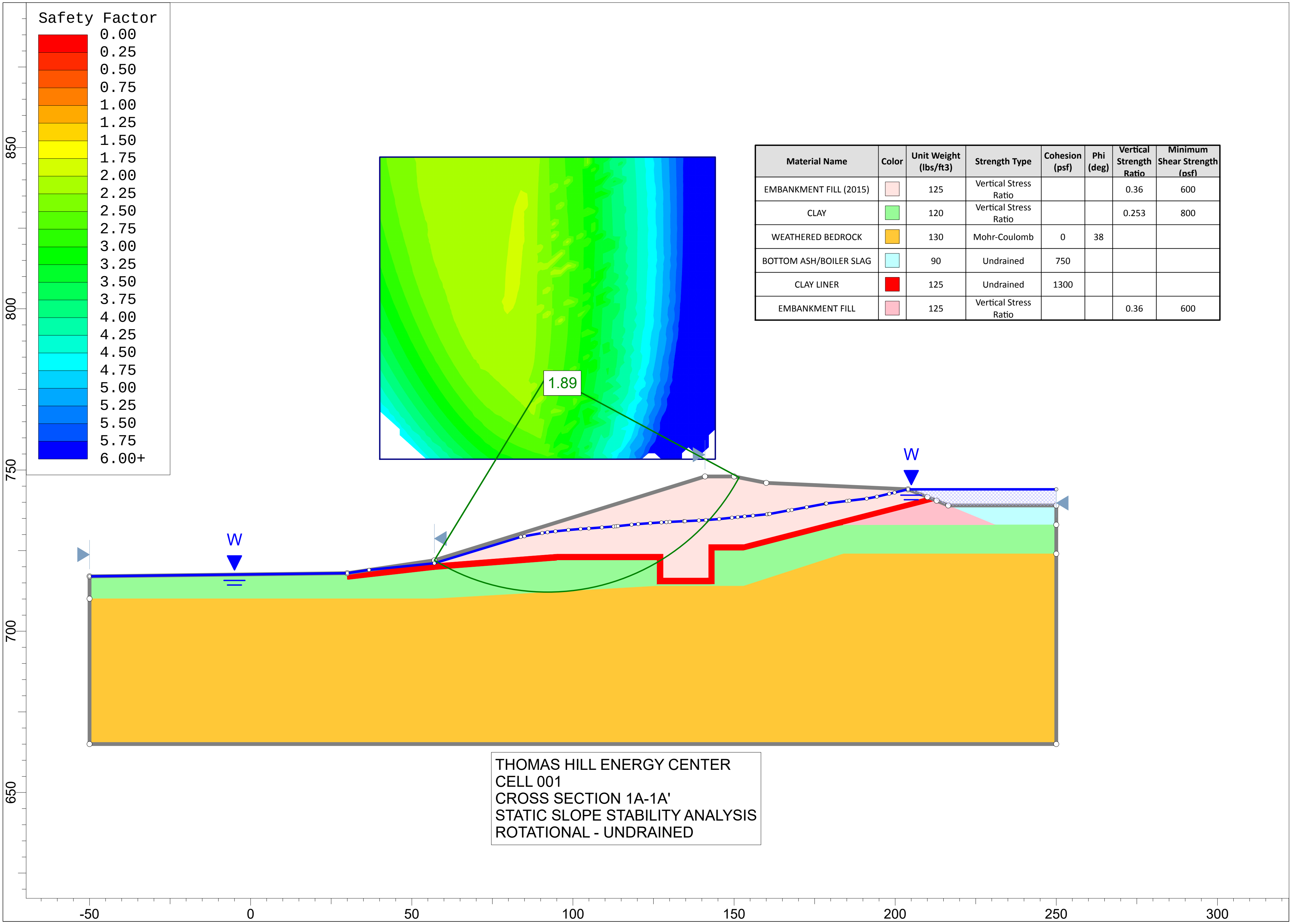
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
EMBANKMENT FILL (2015)	⬜	125	Mohr-Coulomb	200	25
CLAY	🟩	120	Mohr-Coulomb	125	26
WEATHERED BEDROCK	🟧	130	Mohr-Coulomb	0	38
BOTTOM ASH/BOILER SLAG	⬜	90	Mohr-Coulomb	0	30
CLAY LINER	🟥	125	Mohr-Coulomb	0	28
EMBANKMENT FILL	⬜	125	Mohr-Coulomb	200	25

THOMAS HILL ENERGY CENTER
CELL 001
CROSS SECTION 1A-1A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - DRAINED



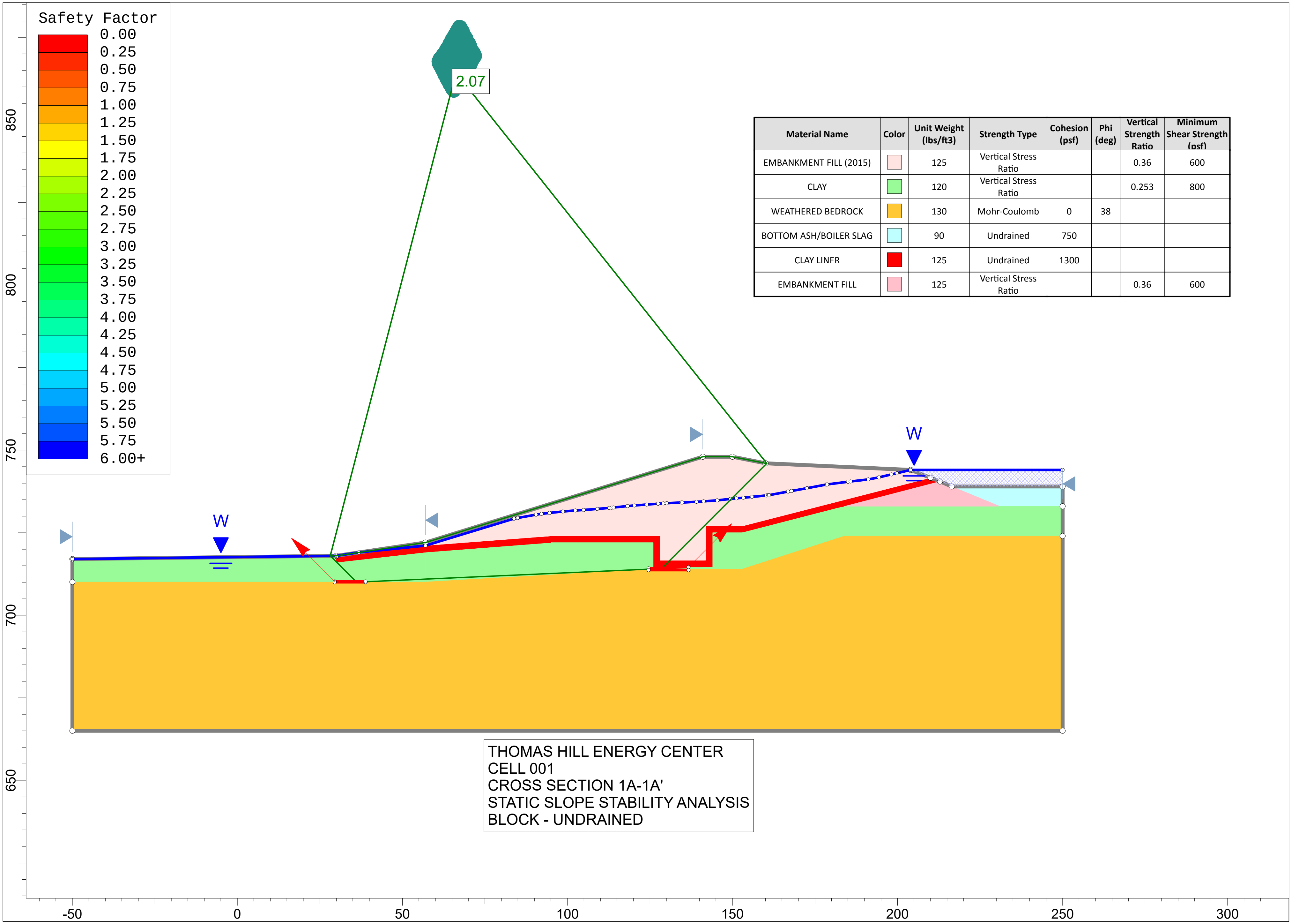
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
EMBANKMENT FILL (2015)	⬜	125	Mohr-Coulomb	200	25
CLAY	🟩	120	Mohr-Coulomb	125	26
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	38
BOTTOM ASH/BOILER SLAG	🟦	90	Mohr-Coulomb	0	30
CLAY LINER	🟥	125	Mohr-Coulomb	0	28
EMBANKMENT FILL	🟪	125	Mohr-Coulomb	200	25

THOMAS HILL ENERGY CENTER
CELL 001
CROSS SECTION 1A-1A'
STATIC SLOPE STABILITY ANALYSIS
BLOCK - DRAINED



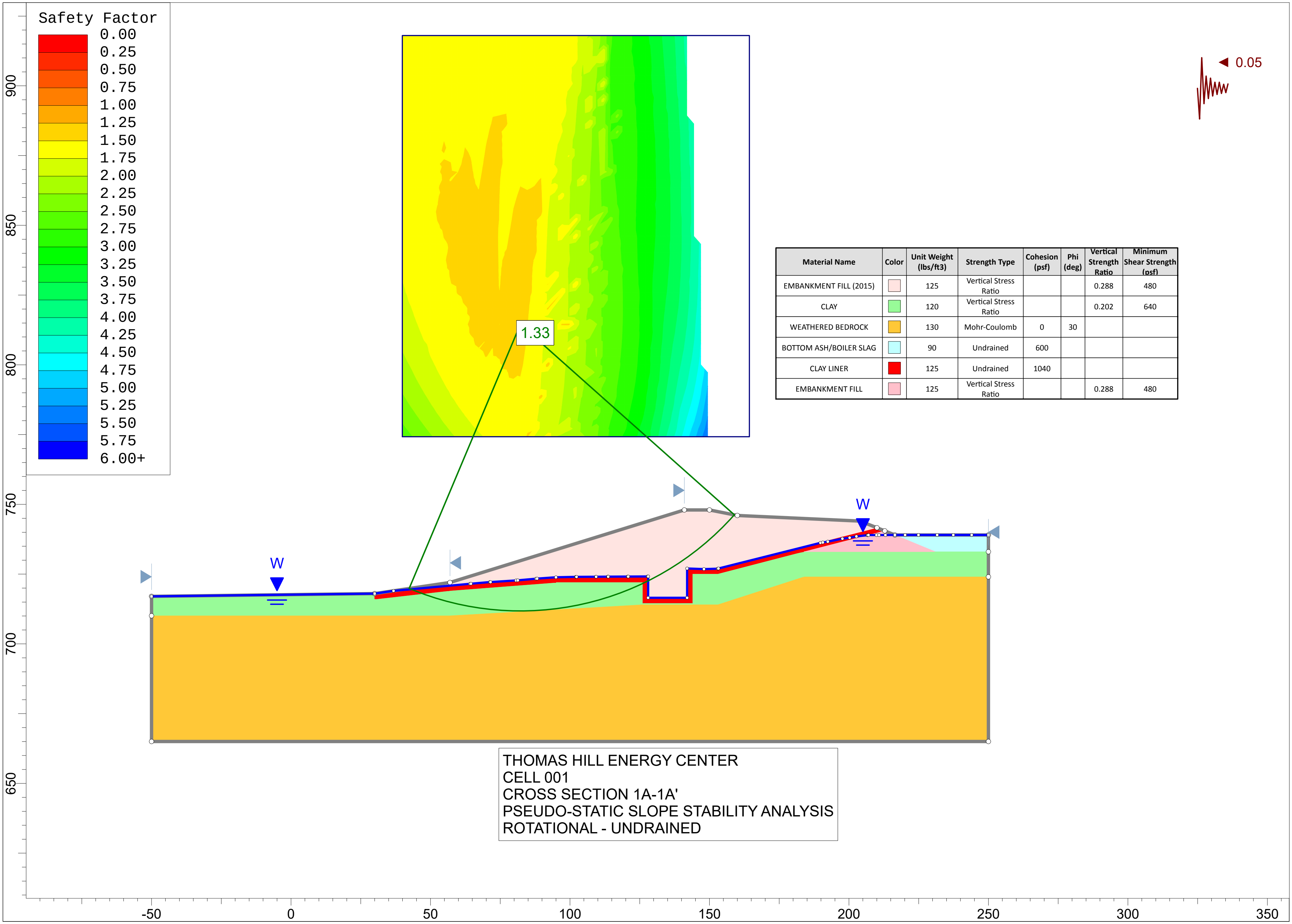
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL (2015)	◻	125	Vertical Stress Ratio			0.36	600
CLAY	🟩	120	Vertical Stress Ratio			0.253	800
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	38		
BOTTOM ASH/BOILER SLAG	🟦	90	Undrained	750			
CLAY LINER	🟥	125	Undrained	1300			
EMBANKMENT FILL	◻	125	Vertical Stress Ratio			0.36	600

THOMAS HILL ENERGY CENTER
CELL 001
CROSS SECTION 1A-1A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



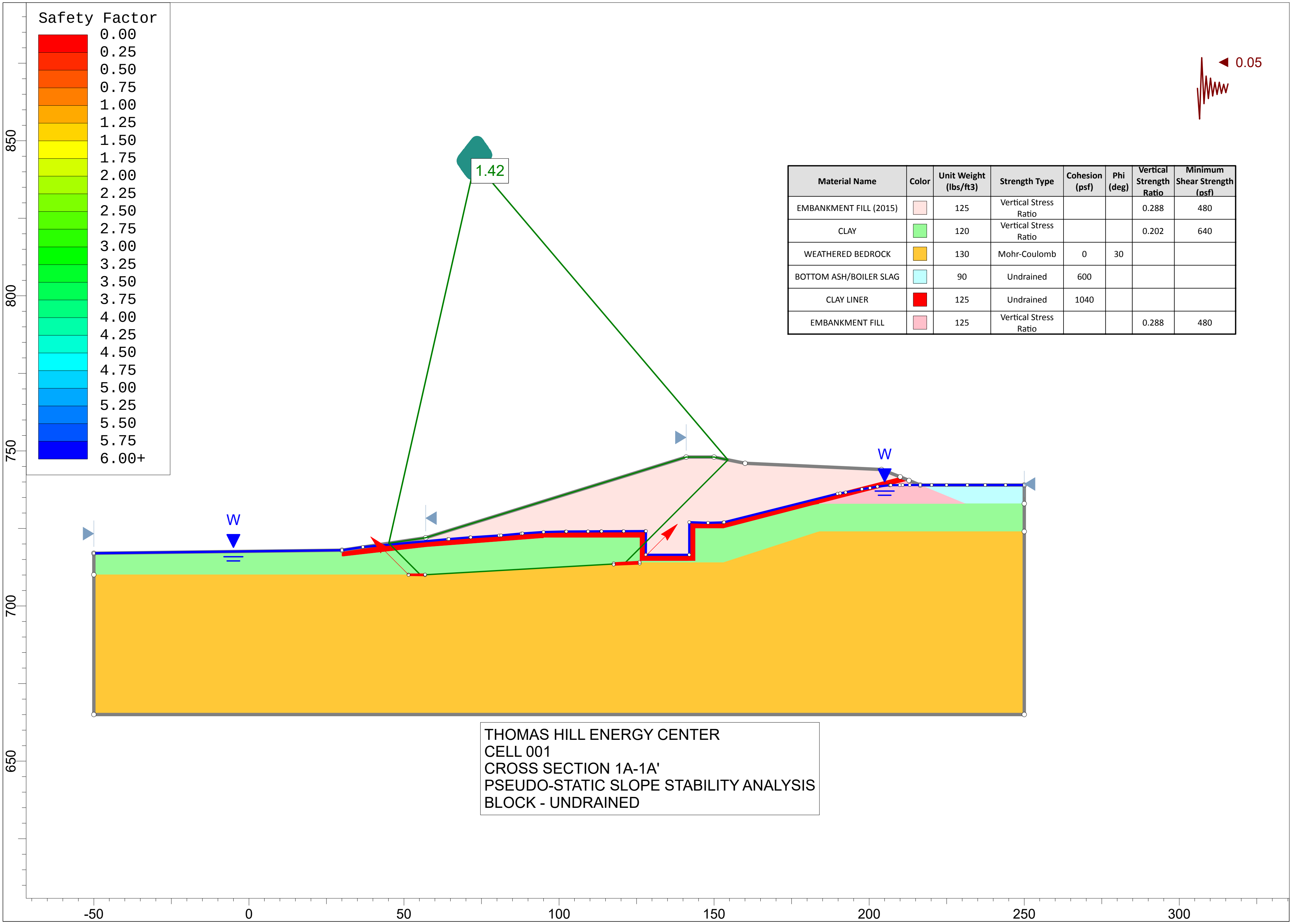
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL (2015)	⬜	125	Vertical Stress Ratio			0.36	600
CLAY	🟩	120	Vertical Stress Ratio			0.253	800
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	38		
BOTTOM ASH/BOILER SLAG	🟦	90	Undrained	750			
CLAY LINER	🟥	125	Undrained	1300			
EMBANKMENT FILL	🟪	125	Vertical Stress Ratio			0.36	600

THOMAS HILL ENERGY CENTER
CELL 001
CROSS SECTION 1A-1A'
STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED



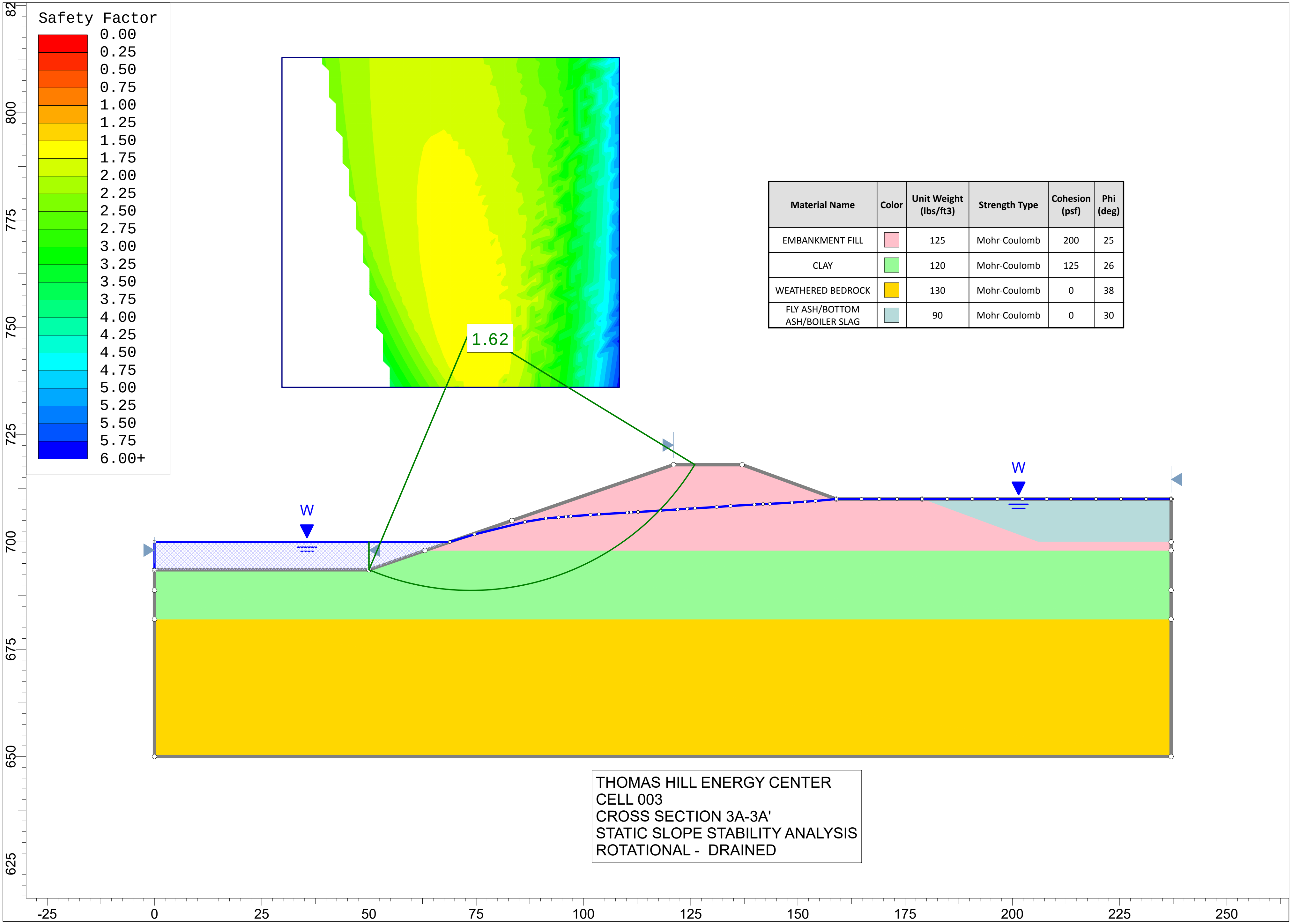
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL (2015)	🟥	125	Vertical Stress Ratio			0.288	480
CLAY	🟩	120	Vertical Stress Ratio			0.202	640
WEATHERED BEDROCK	🟧	130	Mohr-Coulomb	0	30		
BOTTOM ASH/BOILER SLAG	🟦	90	Undrained	600			
CLAY LINER	🟥	125	Undrained	1040			
EMBANKMENT FILL	🟥	125	Vertical Stress Ratio			0.288	480

THOMAS HILL ENERGY CENTER
CELL 001
CROSS SECTION 1A-1A'
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



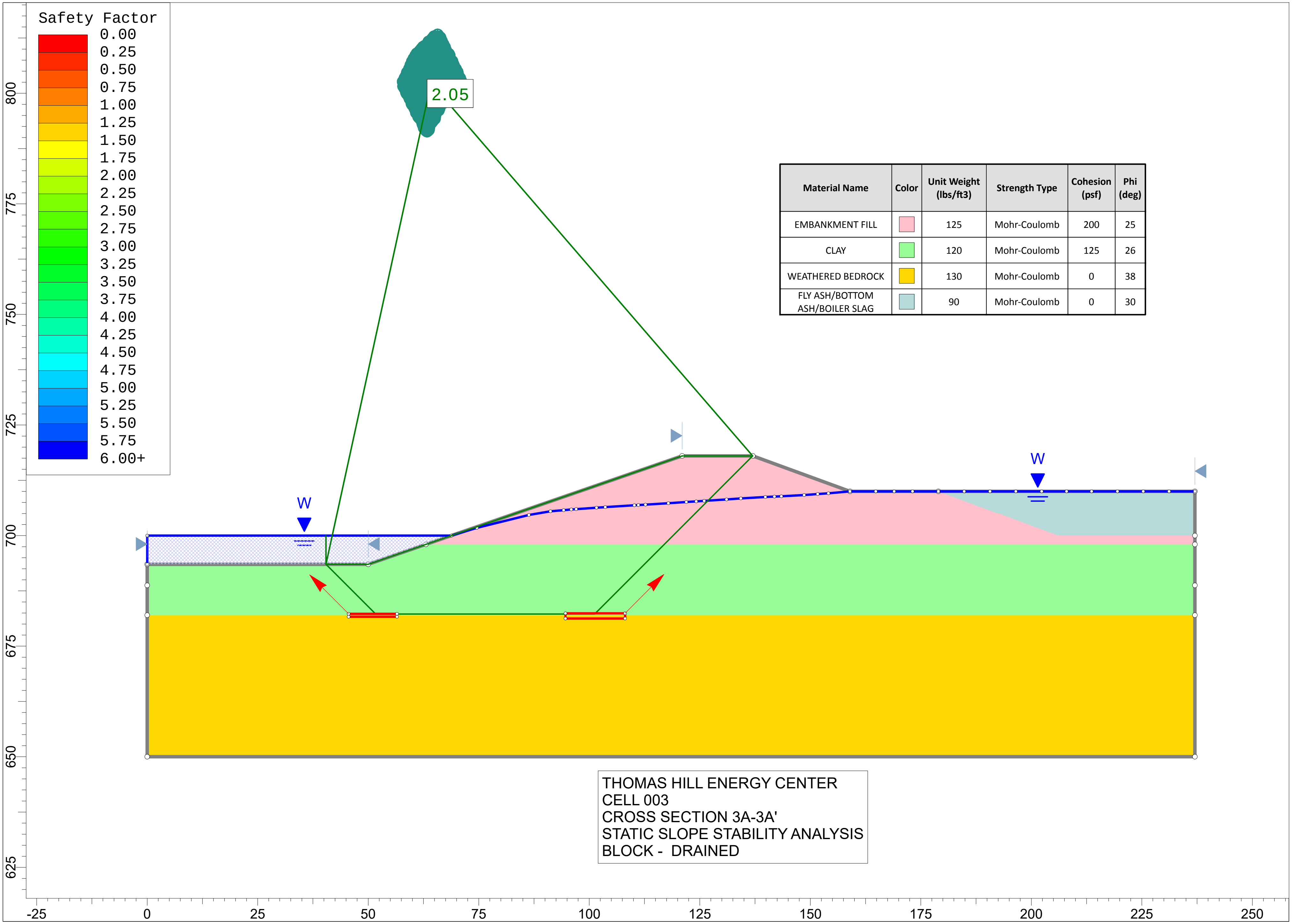
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL (2015)	⬜	125	Vertical Stress Ratio			0.288	480
CLAY	🟩	120	Vertical Stress Ratio			0.202	640
WEATHERED BEDROCK	🟧	130	Mohr-Coulomb	0	30		
BOTTOM ASH/BOILER SLAG	🟦	90	Undrained	600			
CLAY LINER	🟥	125	Undrained	1040			
EMBANKMENT FILL	🟪	125	Vertical Stress Ratio			0.288	480

THOMAS HILL ENERGY CENTER
CELL 001
CROSS SECTION 1A-1A'
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED



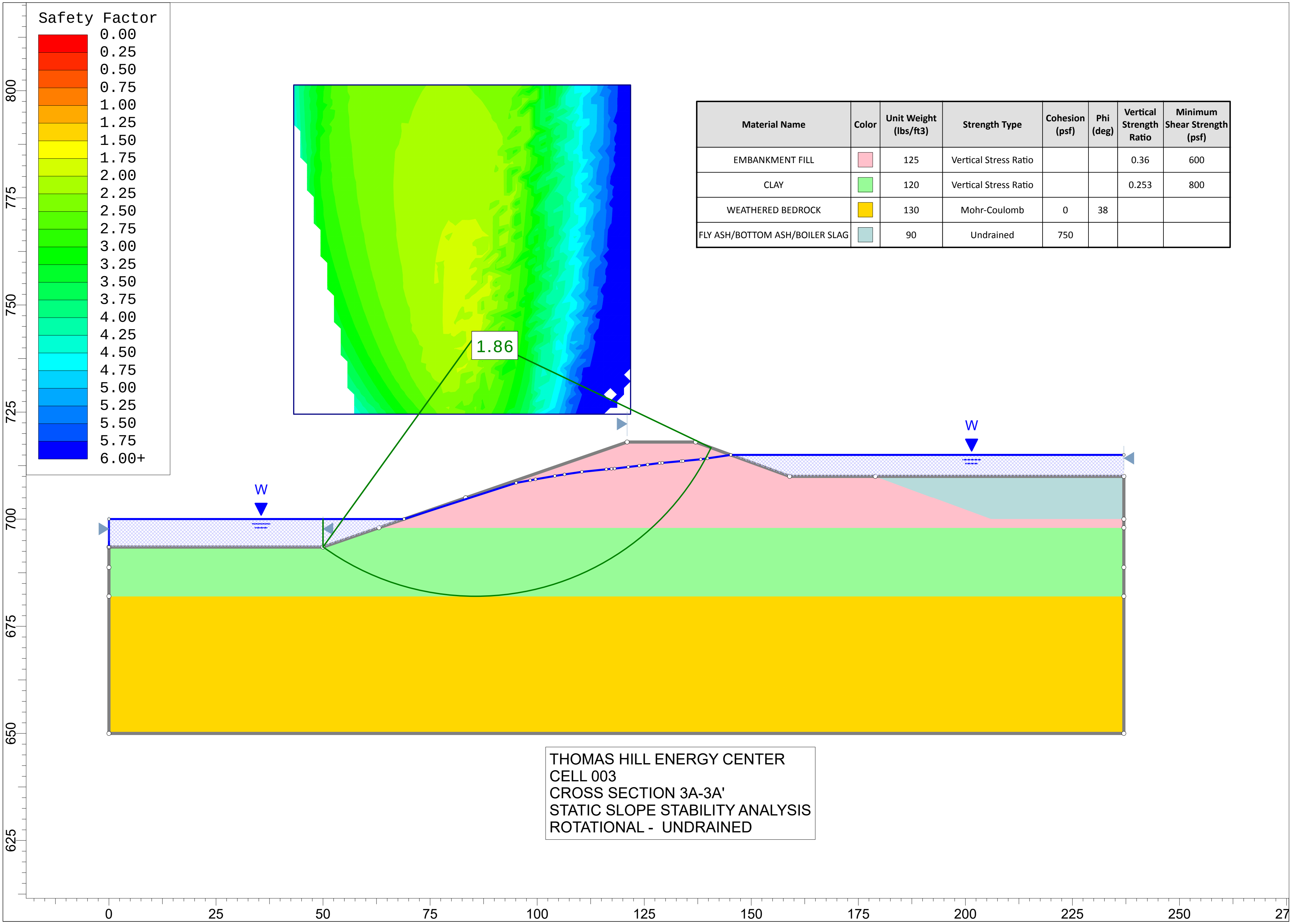
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
EMBANKMENT FILL	🟥	125	Mohr-Coulomb	200	25
CLAY	🟩	120	Mohr-Coulomb	125	26
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	38
FLY ASH/BOTTOM ASH/BOILER SLAG	🟦	90	Mohr-Coulomb	0	30

THOMAS HILL ENERGY CENTER
CELL 003
CROSS SECTION 3A-3A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - DRAINED



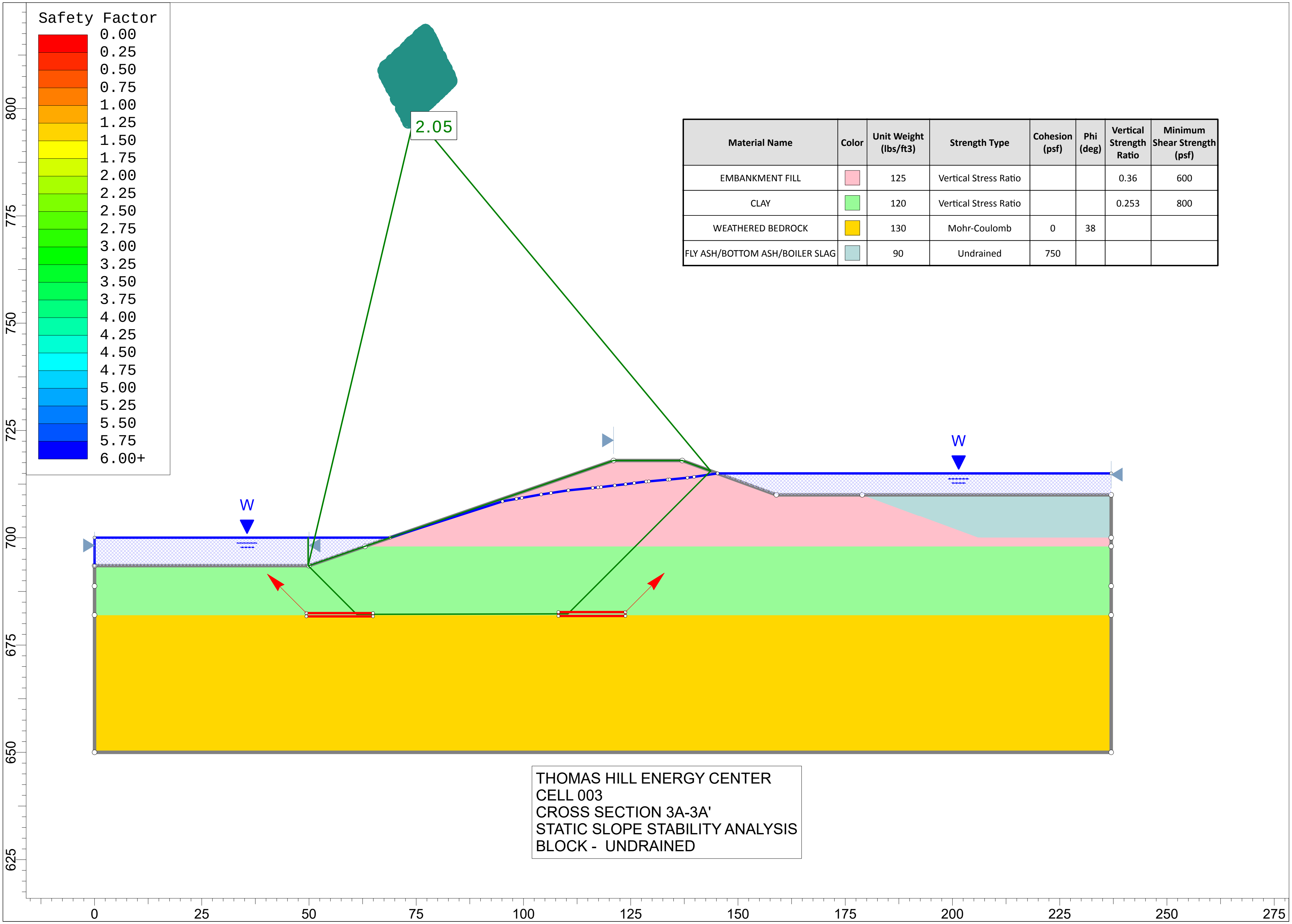
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
EMBANKMENT FILL	🟥	125	Mohr-Coulomb	200	25
CLAY	🟩	120	Mohr-Coulomb	125	26
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	38
FLY ASH/BOTTOM ASH/BOILER SLAG	🟦	90	Mohr-Coulomb	0	30

THOMAS HILL ENERGY CENTER
CELL 003
CROSS SECTION 3A-3A'
STATIC SLOPE STABILITY ANALYSIS
BLOCK - DRAINED



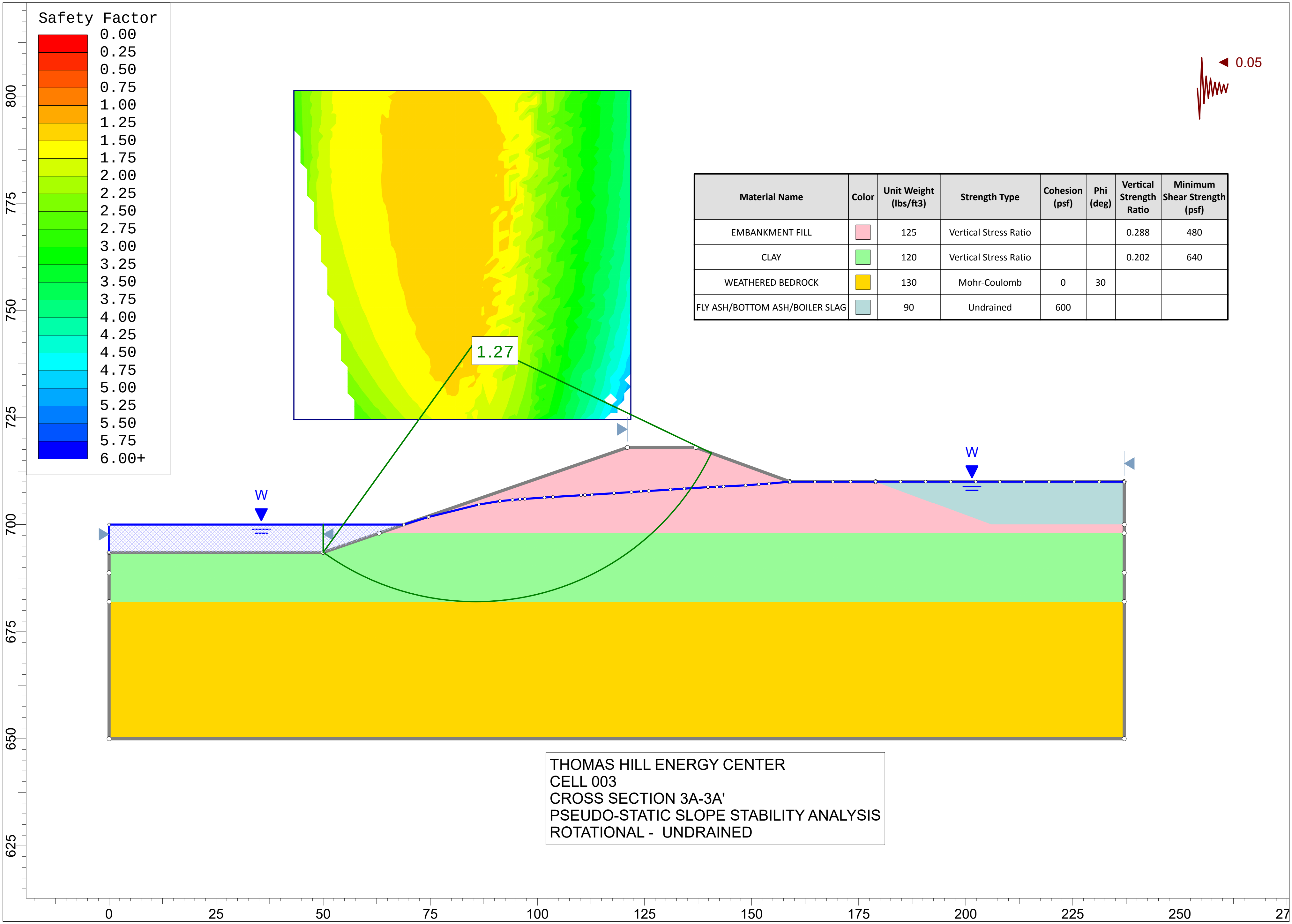
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL	🟥	125	Vertical Stress Ratio			0.36	600
CLAY	🟩	120	Vertical Stress Ratio			0.253	800
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	38		
FLY ASH/BOTTOM ASH/BOILER SLAG	🟦	90	Undrained	750			

THOMAS HILL ENERGY CENTER
CELL 003
CROSS SECTION 3A-3A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



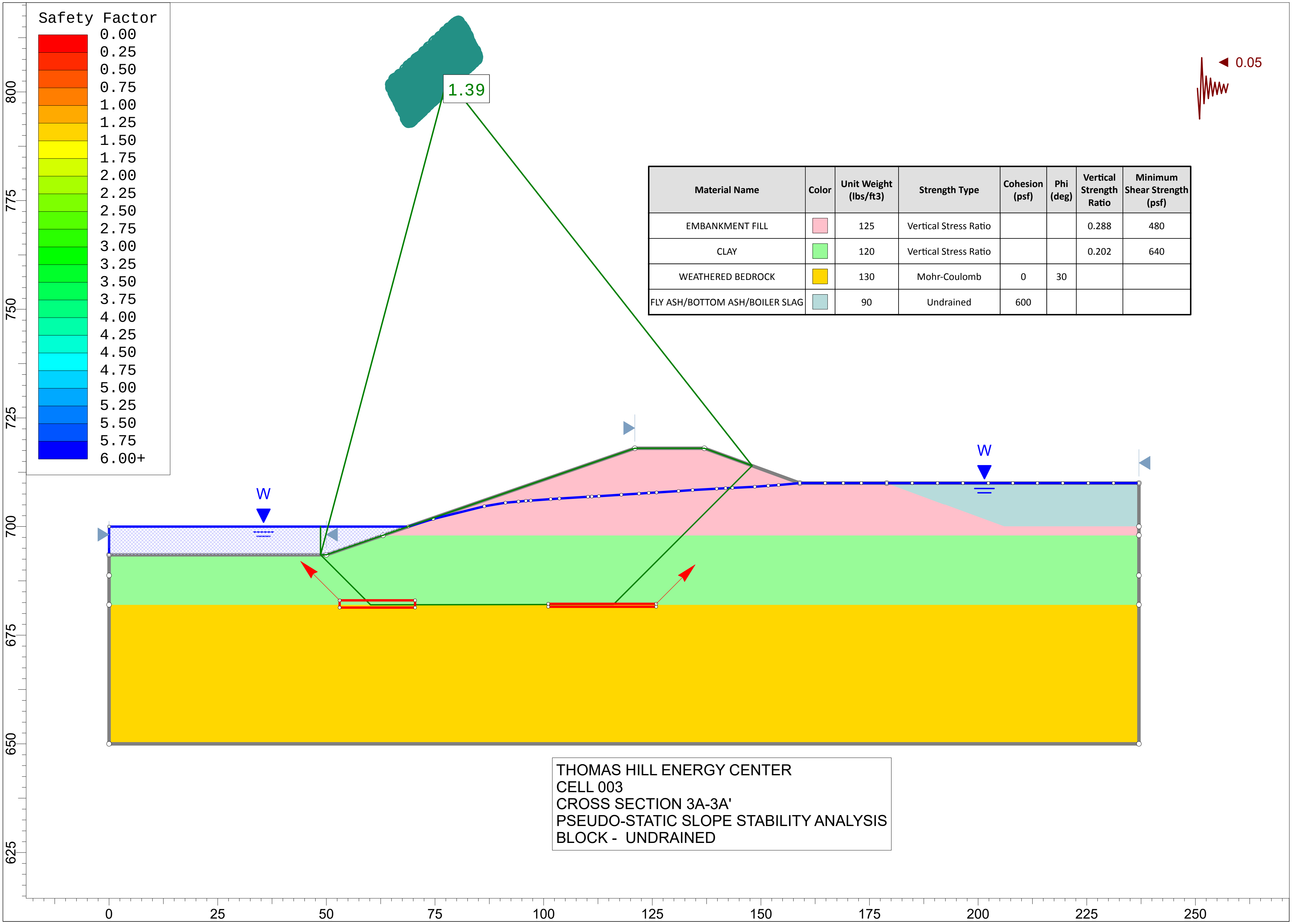
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL	🟥	125	Vertical Stress Ratio			0.36	600
CLAY	🟩	120	Vertical Stress Ratio			0.253	800
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	38		
FLY ASH/BOTTOM ASH/BOILER SLAG	🟦	90	Undrained	750			

THOMAS HILL ENERGY CENTER
CELL 003
CROSS SECTION 3A-3A'
STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED



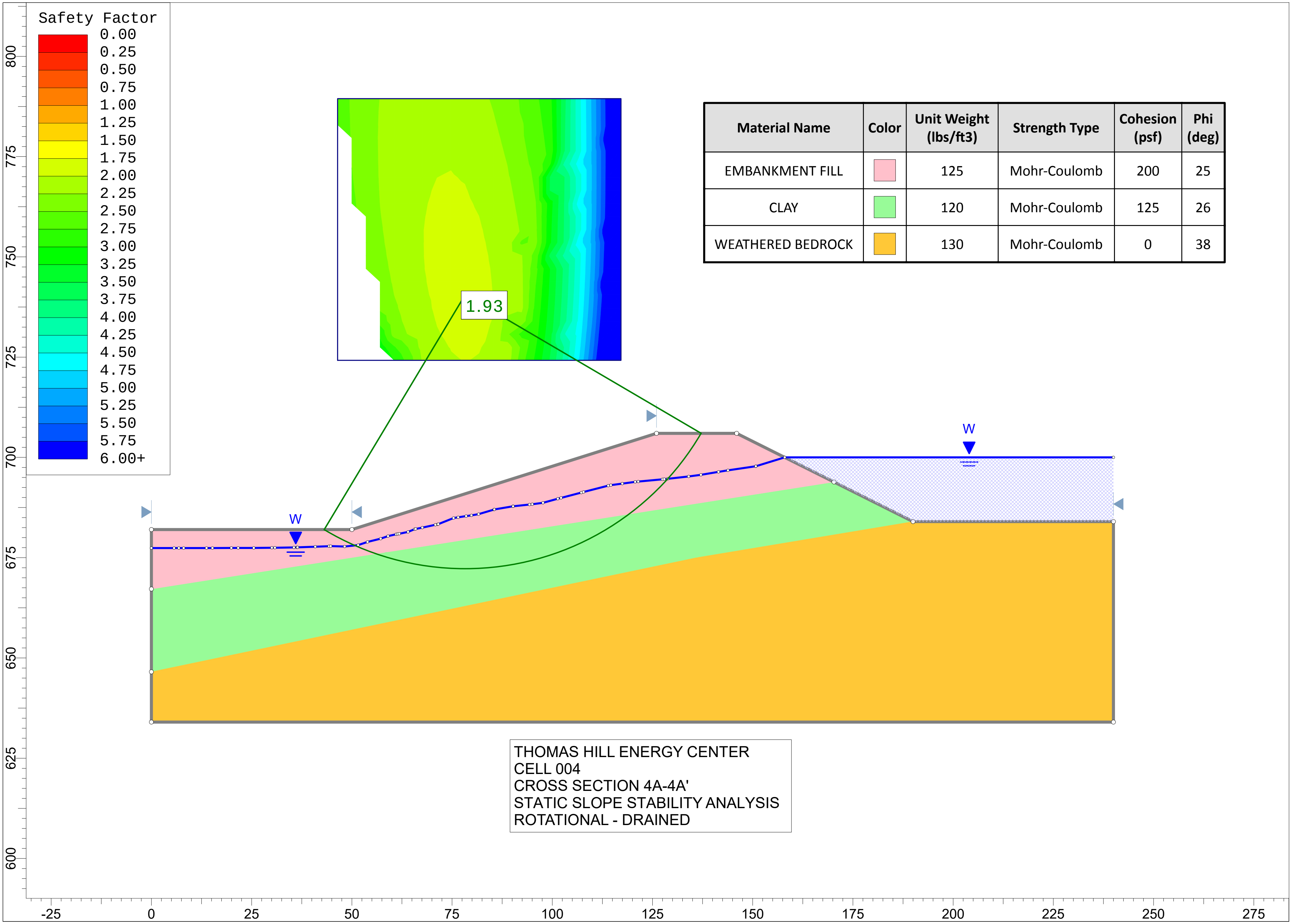
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL	🟥	125	Vertical Stress Ratio			0.288	480
CLAY	🟩	120	Vertical Stress Ratio			0.202	640
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	30		
FLY ASH/BOTTOM ASH/BOILER SLAG	🟦	90	Undrained	600			

THOMAS HILL ENERGY CENTER
CELL 003
CROSS SECTION 3A-3A'
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



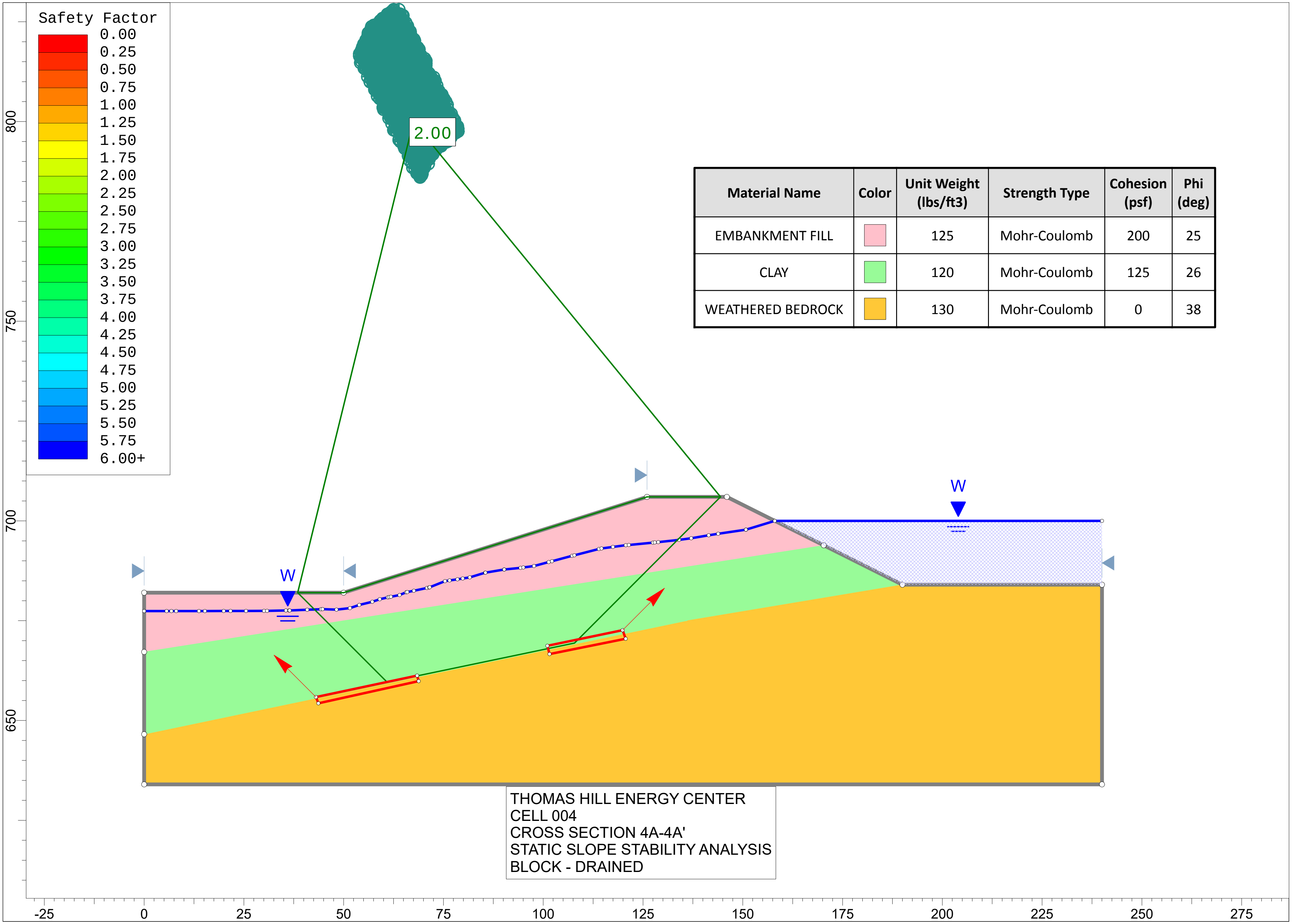
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL	🟥	125	Vertical Stress Ratio			0.288	480
CLAY	🟩	120	Vertical Stress Ratio			0.202	640
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	30		
FLY ASH/BOTTOM ASH/BOILER SLAG	🟦	90	Undrained	600			

THOMAS HILL ENERGY CENTER
CELL 003
CROSS SECTION 3A-3A'
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED



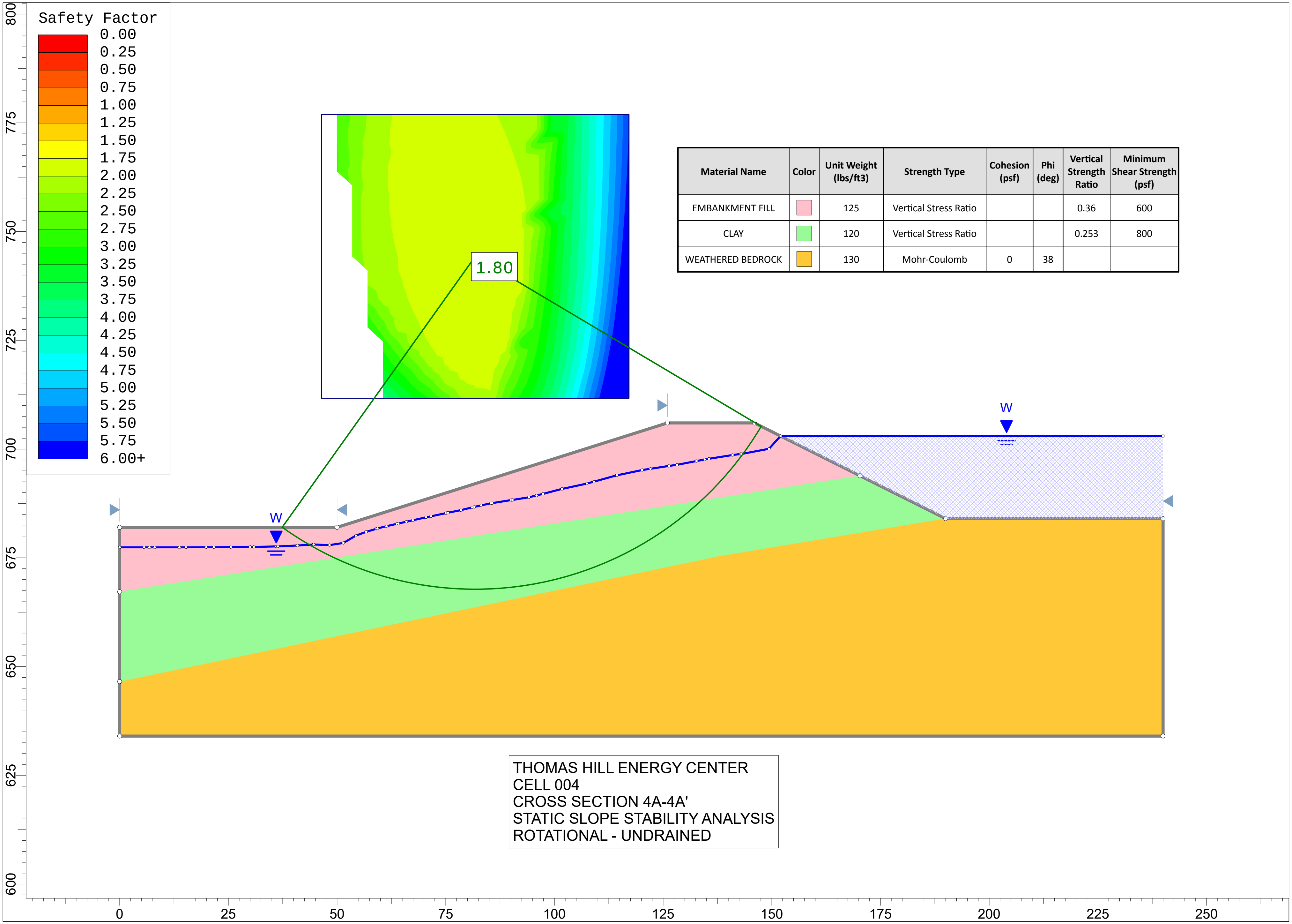
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
EMBANKMENT FILL	🟥	125	Mohr-Coulomb	200	25
CLAY	🟩	120	Mohr-Coulomb	125	26
WEATHERED BEDROCK	🟧	130	Mohr-Coulomb	0	38

THOMAS HILL ENERGY CENTER
CELL 004
CROSS SECTION 4A-4A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - DRAINED



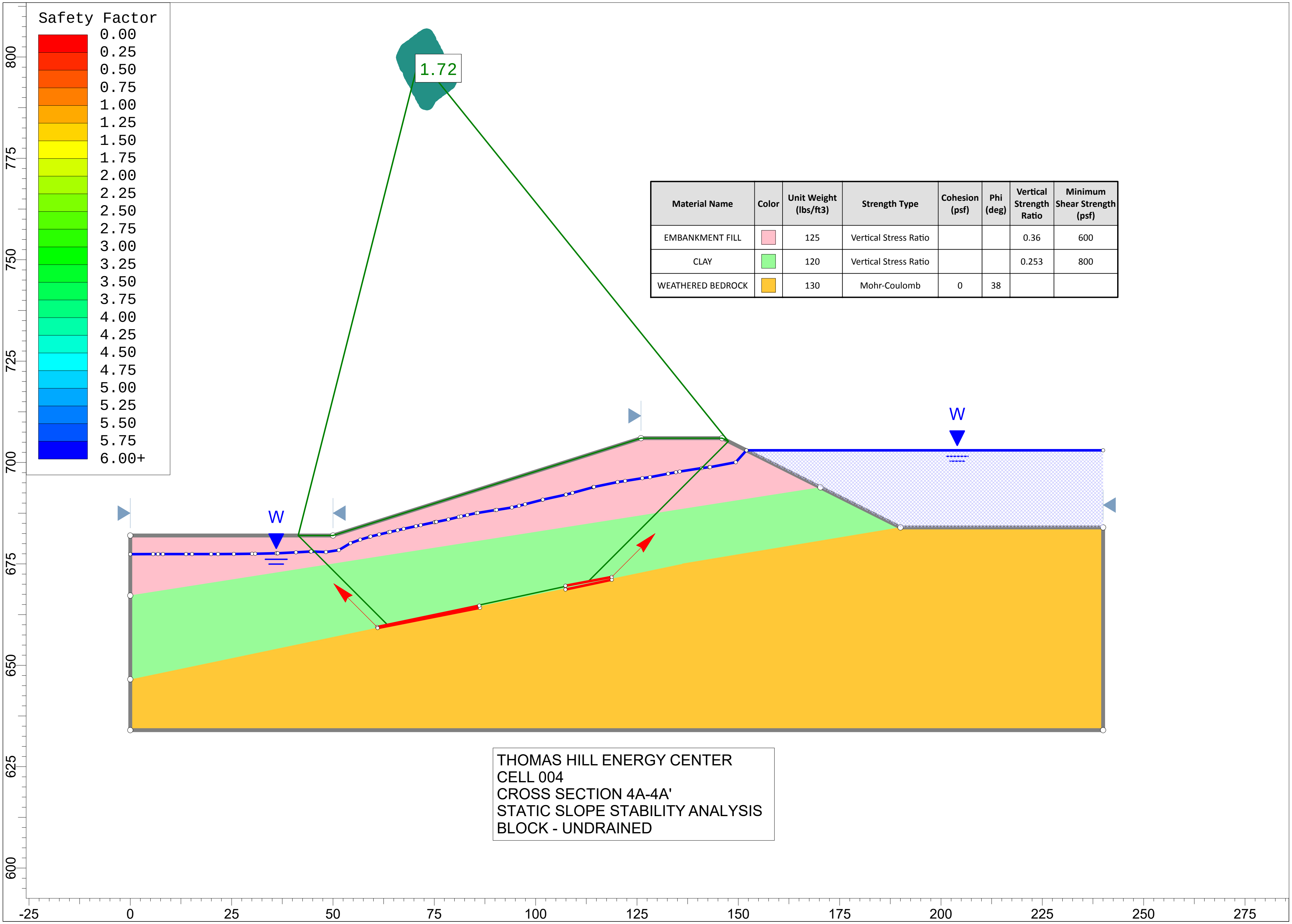
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
EMBANKMENT FILL	🟥	125	Mohr-Coulomb	200	25
CLAY	🟩	120	Mohr-Coulomb	125	26
WEATHERED BEDROCK	🟧	130	Mohr-Coulomb	0	38

THOMAS HILL ENERGY CENTER
CELL 004
CROSS SECTION 4A-4A'
STATIC SLOPE STABILITY ANALYSIS
BLOCK - DRAINED



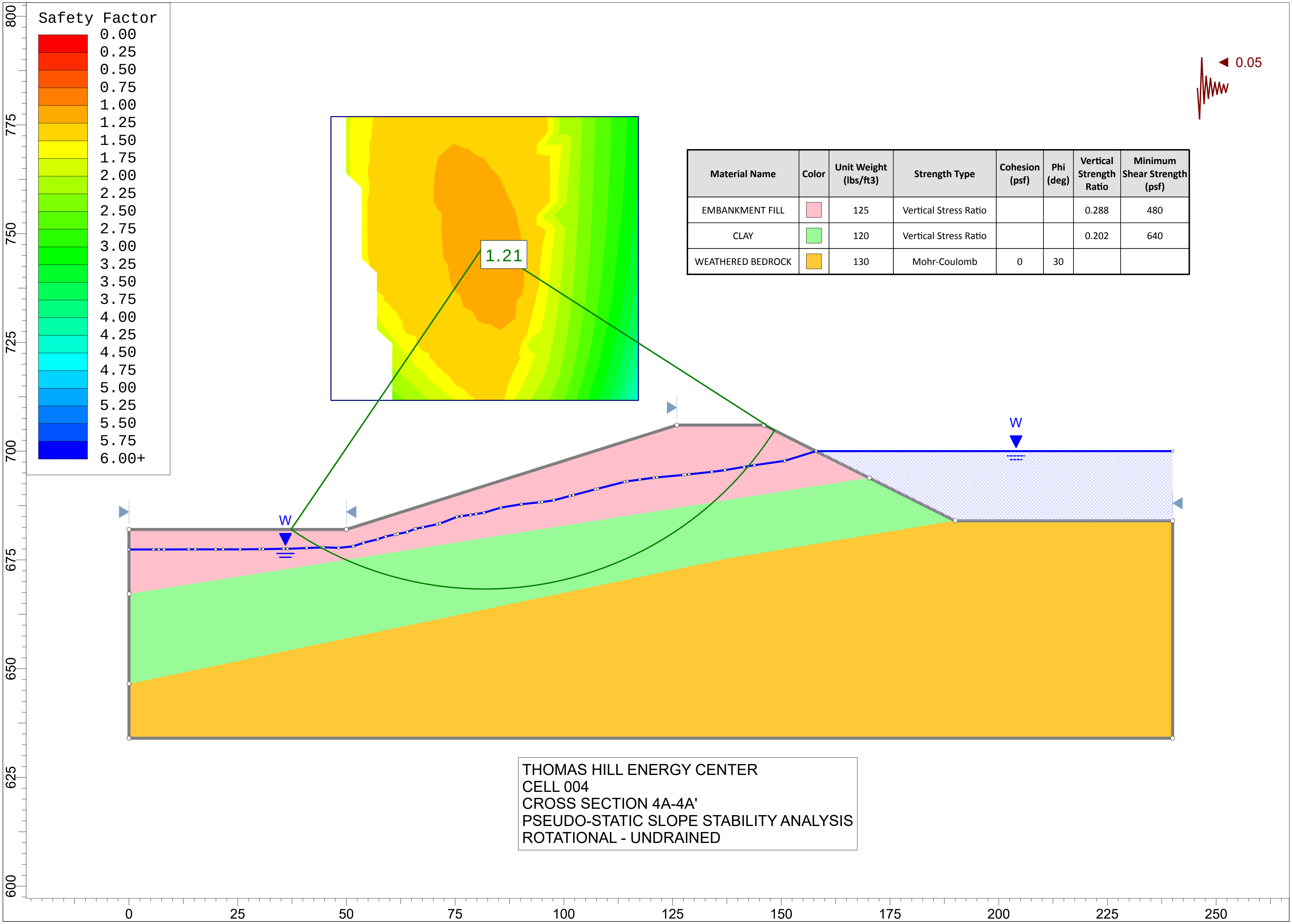
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL	🟥	125	Vertical Stress Ratio			0.36	600
CLAY	🟩	120	Vertical Stress Ratio			0.253	800
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	38		

THOMAS HILL ENERGY CENTER
CELL 004
CROSS SECTION 4A-4A'
STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



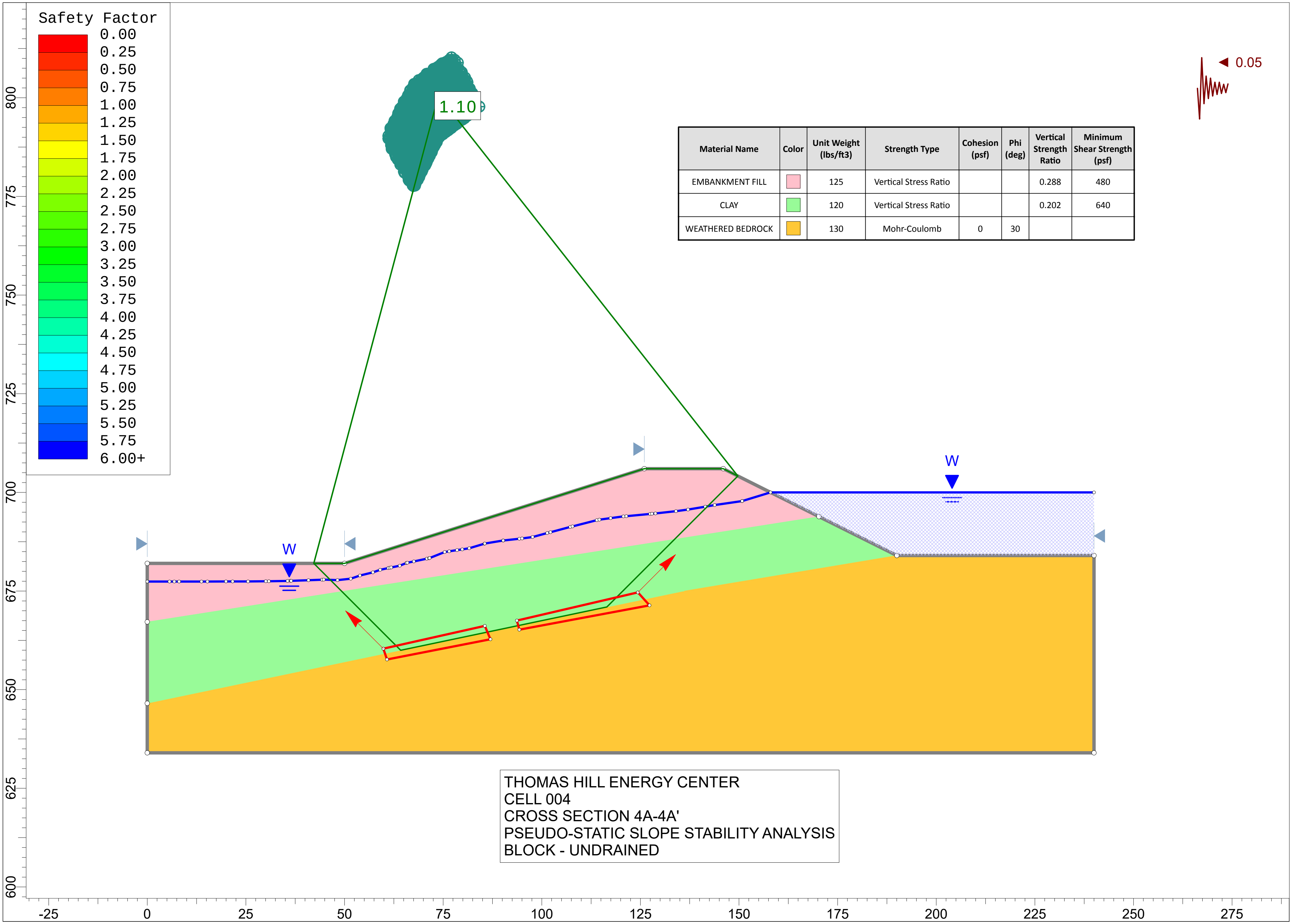
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL	🟥	125	Vertical Stress Ratio			0.36	600
CLAY	🟩	120	Vertical Stress Ratio			0.253	800
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	38		

THOMAS HILL ENERGY CENTER
CELL 004
CROSS SECTION 4A-4A'
STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL	🟥	125	Vertical Stress Ratio			0.288	480
CLAY	🟩	120	Vertical Stress Ratio			0.202	640
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	30		

THOMAS HILL ENERGY CENTER
CELL 004
CROSS SECTION 4A-4A'
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
ROTATIONAL - UNDRAINED



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
EMBANKMENT FILL	🟥	125	Vertical Stress Ratio			0.288	480
CLAY	🟩	120	Vertical Stress Ratio			0.202	640
WEATHERED BEDROCK	🟨	130	Mohr-Coulomb	0	30		

THOMAS HILL ENERGY CENTER
CELL 004
CROSS SECTION 4A-4A'
PSEUDO-STATIC SLOPE STABILITY ANALYSIS
BLOCK - UNDRAINED

APPENDIX C

Supplemental Subsurface Information

TEST BORING REPORT

Boring No. HAB-CDT-01

Project	Thomas Hill Energy Center-CCR Dewatering Tank, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 3
Start	25 September 2019
Finish	25 September 2019
Driller	C. Dutton
H&A Rep.	G. Foushee
Elevation	755.3
Datum	NAVD 88
Location	N 1352345 E 1602290

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing:
Hoist/Hammer: NA Automatic Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						-GLACIAL DRIFT DEPOSITS-										
	4 7 7 7	S1 19	2.0 4.0		CH	Stiff brown to yellow fat CLAY with sand (CH), few roots, moist		5	10	5		80				
5	4 6 6 7	S2 21	4.0 6.0		CH	Stiff brown to yellow and gray fat CLAY (CH), mottled, moist			10			90				
	3 7 9 10	S3 20	6.0 8.0			Note: No Recovery										
		T1 18	8.0 10.0		CL	Note: Shelby Tube from 8.0 to 10.0 ft PSI=400 Brown sandy lean CLAY (CL)		2	2	5	21	70				
10																
15	4 5 8 10	S4 24	14.0 16.0		CH	Stiff brown fat CLAY (CH), occasional chalk, moist		5	5			90				
	4 6	S5 24	19.0 21.0		CH	Stiff brown to black fat CLAY with sand (CH), mottled, weathered gravel 3/8 in.		5	10			85				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Depth (ft) to: Bottom of Hole	Depth (ft) to: Water
9/25/19				32.4	Dry

Sample ID

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

Well Diagram

▥	Riser Pipe
▤	Screen
⁙	Filter Sand
▒	Cuttings
■	Grout
△	Concrete
▨	Bentonite Seal

Summary

Overburden (ft)	32.4
Rock Cored (ft)	5
Samples	7S, 1C, T1

Boring No. HAB-CDT-01

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

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

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

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	9 10															
						-GLACIAL DRIFT DEPOSITS-										
25	4 6 10 10	S6 24	24.0 26.0		CL	Very stiff gray and brown sandy lean CLAY (CL), mottled, moist		5	5	8	7	69				
30	6 7 34 27	S7 24	29.0 31.0		CL	Very stiff brown to grayish-yellow sandy lean CLAY with gravel (CL), mottled		5	5	10	5	70				
				722.9 32.4		SEE CORE BORING REPORT FOR ROCK DETAILS										
35																

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

HALEY ALDRICH

CORE BORING REPORT

DRAFT

Boring No. **HAB-CDT-01**
File No. 128064-011
Sheet No. 3 of 3

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weath-ering	Elev./ Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
	2	C1	32.4 37.4	56 38	93 63	Slight to moderate	722.9 32.4	Hard, slightly to moderately weathered, gray to yellow, very fine grained LIMESTONE. Bedding thick, joints slightly decomposed to disintegrated, moderately fractured, fractured 5 to 10 mm, subhorizontal to sub vertical, filled with clay, oxidized.
35	4 4						721.7 33.6	Soft, moderately weathered, gray to green, fine grained SHALE. Bedding thin, joints moderately decomposed to disintegrated, intensely fractured, oxidized on fractured surfaces.
	3 3						719.5 35.8	Hard, slightly weathered, gray, very fine grained LIMESTONE. Bedding thick, joints slightly decomposed, competent, moderately fractured, fractured sub horizontal, healed.
							717.9 37.4	BOTTOM OF EXPLORATION 37.4 FT
40								
45								
50								
55								
60								

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-CDT-01	C1	32.4-37.4	56 in./93%	38 in./63%	Complete

HAB-CDT-01 Core Box 1 of 1

CONCRETE DEWATERING TANK (CDT)
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

APPENDIX A – ROCK CORE PHOTOS

JANUARY 2020

FILE NO. 128064-012

HALEY ALDRICH

TEST BORING REPORT

Boring No. HAB-CDT-02

Project	Thomas Hill Energy Center-CCR Dewatering Tank, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 3
Start	25 September 2019
Finish	25 September 2019
Driller	C. Dutton
H&A Rep.	G. Foushee
Elevation	754.8
Datum	NAVD 88
Location	N 1352340 E 1602526

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing:
Hoist/Hammer: NA Automatic Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						-GLACIAL DRIFT DEPOSITS-										
	5 7 8	S1 15	2.0 4.0		CH	Stiff dark brown fat CLAY (CH), moist			10			90				
5	3 6 10	S2 16	4.0 6.0		CH	Very stiff dark brown fat CLAY (CH), moist			10			90				
∇	2 2 2	S3 20	6.0 8.0		CH	Soft stiff dark brown fat CLAY (CH), sand at approximately 5.0 ft			10	5		85				
	1 3 5	S4 19	8.0 10.0		CH	Medium stiff yellow fat CLAY (CH), few weathered gravel to 1/4 in., moist		1	10			89				
10																
15	5 7 8	S5 20	14.0 16.0		CH	Stiff yellow fat CLAY (CH), moist			10			90				
	5 6	S6 24	19.0 21.0		CH	Stiff yellow fat CLAY (CH), few weathered 1/4 in. pebbles, moist		1	10			89				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Depth (ft) to: Bottom of Hole	Depth (ft) to: Water
9/25/19		0	6.0	8.0	7.0

Sample ID

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

Well Diagram

⊞ Riser Pipe
⊟ Screen
░ Filter Sand
▒ Cuttings
■ Grout
△ Concrete
▨ Bentonite Seal

Summary

Overburden (ft)	44.15
Rock Cored (ft)	5
Samples	11S, 1C

Boring No. **HAB-CDT-02**

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

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

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

HALEY ALDRICH

TEST BORING REPORT

DRAFT

Boring No. HAB-CDT-02
File No. 128064-011
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand				Field Test			
							% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
20	7															
						-GLACIAL DRIFT DEPOSITS-										
25	5 8 8	S7	24.0 26.0		CH	Very stiff gray fat CLAY (CH), angular 3/8 in. gravel		5	10			85				
30	5 7 10	S8 29	29.0 31.0		CH	Very stiff brown fat CLAY with sand (CH), coarse sand in vertical seams			20			80				
35	10 13 17	S9 24	34.0 36.0		CH	Very stiff gray fat CLAY (CH), moist	5		10			85				
40	26 20 18	S10 24	39.0 41.0	715.8 39.0	CL	Stiff hard gray lean CLAY (CL), moist						100				
45	50/2"	S11	44.0 44.2	710.7 44.2		TOP OF BEDROCK SEE CORE BORING REPORT FOR ROCK DETAILS										

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

H&A-TEST BORING-07-1 HA-LIB09.GLB HA-TB+CORE+WELL-09 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\WAS_COMMON\PROJECTS\128064-AECI THOMAS HILL\012- TH CCR DEWATERING TANK\FIELDWORK\GINT\128064-011TB.GPJ 17 Dec 19

HALEY ALDRICH

CORE BORING REPORT

Boring No. **HAB-CDT-02**
File No. 128064-011
Sheet No. 3 of 3

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD		Weath-ering	Elev./ Depth (ft)	Visual Description and Remarks
				in.	%			
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
	3	C1	44.2 49.2	47 32	78 53	Fresh		Hard, fresh, gray, very fine grained LIMESTONE. Bedding extremely thick, joints fresh to slightly fractured.
45								
	3							
	3					Moderate to High		Soft to medium, moderate to highly weathered, gray, fine grained, SHALE. Bedding thick, joints slightly to moderately decomposed, slightly disintegrated, rubble.
	3							
	3							
							705.7 49.2	BOTTOM OF EXPLORATION 49.15 FT
50								
55								
60								
65								
70								

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-CDT-02	C1	44.2-49.2	47 in./78%	32 in./53%	Complete

HAB-CDT-02 Core Box 1 of 1

HALEY ALDRICH

CONCRETE DEWATERING TANK (CDT)
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

APPENDIX A – ROCK CORE PHOTOS

JANUARY 2020

TEST BORING REPORT

Boring No. HAB-CDT-03

Project	Thomas Hill Energy Center-CCR Dewatering Tank, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 3
Start	25 September 2019
Finish	25 September 2019
Driller	C. Dutton
H&A Rep.	G. Foushee
Elevation	749.0
Datum	NAVD 88
Location	N 1352341 E 1602763

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing:
Hoist/Hammer: NA Automatic Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						-GLACIAL DRIFT DEPOSITS-										
	5 4 5 7	S1 14	2.0 4.0		CH	Stiff brown fat CLAY (CH), moist			5	5		90				
5	3 3 4 3	S2 13	4.0 6.0		CH	Medium stiff brown fat CLAY (CH), moist				10		90				
	2 3 3 2	S3 15	6.0 8.0		CH	Medium stiff brown fat CLAY with sand (CH), moist		10			13	77				
	2 3 3 4	S4 20	8.0 10.0		CH	Medium stiff brown fat CLAY (CH), moist			10			90				
10																
15	2 4 6 6	S5 19	14.0 16.0		CH	Stiff brown to gray fat CLAY (CH), mottled, moist			10			90				
∇																
20	2 4	S6 20	19.0 21.0		CH	Stiff brown to gray fat CLAY with gravel (CH), mottled, gravel 1/2 in. angular, moist	10	10	10			70				

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Depth (ft) to: Bottom of Hole	Depth (ft) to: Water
9/26/19	0700	0	14.0	16.0	16.0

Sample ID

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

Well Diagram

◫	Riser Pipe
▤	Screen
▒	Filter Sand
▩	Cuttings
■	Grout
▵	Concrete
▨	Bentonite Seal

Summary

Overburden (ft)	34.3
Rock Cored (ft)	5
Samples	9S, 1C

Boring No. HAB-CDT-03

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

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

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

TEST BORING REPORT

DRAFT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	6 7															
						-GLACIAL DRIFT DEPOSITS-										
25	3 6 8 8	S7 22	24.0 26.0		CH	Stiff brown fat CLAY (CH), angular 1/4 in. gravel, moist		15	5			80				
30	6 6 9 12	S8 24	29.0 31.0		CH	Stiff brown fat CLAY (CH), wet			5			95				
	50/5"	S9 5	34.0 34.3	714.7 34.3		TOP OF BEDROCK SEE CORE BORING REPORT FOR ROCK DETAILS										
35																

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

CORE BORING REPORT

DRAFT

Boring No. **HAB-CDT-03**
File No. 128064-011
Sheet No. 3 of 3

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weathering	Elev./Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
35		C1	34.3 39.3	49 46	82 77	Slight to High	714.7 34.3	Hard, slightly to highly weathered, very fine grained LIMESTONE, joints slightly decomposed to 36 ft, then moderately to highly decomposed, joints moderately disintegrated below 36 ft, slightly fractured, then intensely below 36 ft. Fractures healed, high angle or open with oxidization on surfaces.
						Moderate		Soft, moderately weathered, gray to green, fine grained SHALE. Foliated, joints moderately decomposed, moderately fractured.
40							709.7 39.3	BOTTOM OF EXPLORATION 39.3 FT
45								
50								
55								
60								

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-CDT-03	C1	34.3-39.3	49 in./ 82%	46 in./77%	Complete

HAB-CDT-03 Core Box 1 of 1

HALEY ALDRICH

CONCRETE DEWATERING TANK (CDT)
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

APPENDIX A – ROCK CORE PHOTOS

JANUARY 2020

HALEY ALDRICH

TEST BORING REPORT

DRAFT

Boring No. HAB-CDT-04

Project	Thomas Hill Energy Center-CCR Dewatering Tank, Clifton Hill, MO	File No.	128064-011
Client	Associated Electric Cooperative, Inc.	Sheet No.	1 of 3
Contractor	Bulldog Drilling	Start	24 September 2019
		Finish	24 September 2019
		Driller	C. Dutton
		H&A Rep.	G. Foushee

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	NQ	Rig Make & Model: Truck: CME 500X
Inside Diameter (in.)	3.75	1.375	1.875	Bit Type: Cutting Head Drill Mud: None
Hammer Weight (lb)	-	140	-	Casing:
Hammer Fall (in.)	-	30	-	Hoist/Hammer: NA Automatic Hammer PID Make & Model: MiniRAE 2000

Elevation 755.6
Datum NAVD 88
Location
N 1352279
E 1602408

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0																
	7 11 11 10	S1 18	2.0 4.0			-CCR DEPOSITS-										
	2 2 3 4	S2 24	4.0 6.0	751.6 4.0	CH	Medium stiff gray to brown fat CLAY (CH), organic odor, moist						100				
5						-GLACIAL DRIFT DEPOSITS-										
	2 3 4 6	S3 18	6.0 8.0		CH	Medium stiff yellow-brown fat CLAY with gravel (CH), moist, fine roots, Note: Shelby Tube from 8.0 to 10.0 ft.						100				
	4 8 10 14	T1 17	8.0 10.0	747.6 8.0	CL	Gray to brown sandy lean CLAY (CL) PSI=500				2	37	61				
10																
	3 6 8 11	S4 22	14.0 16.0	741.6 14.0	CH	Stiff gray to yellow fat CLAY (CH), moist, few weathered 1/2 in. gravel	5		15	10		80				
15																
	3 6	S5 24	19.0 21.0		CH	Stiff gray to yellow fat CLAY (CH), moist, few weathered 1/4 in. gravel	5	5	10			80				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Depth (ft) to: Bottom of Hole	Depth (ft) to: Water
9/24/19				34.5	Dry

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

Well Diagram
◫ Riser Pipe
▤ Screen
░ Filter Sand
▒ Cuttings
■ Grout
△ Concrete
▨ Bentonite Seal

Summary
Overburden (ft) 34.5
Rock Cored (ft) 5
Samples 11S, 2C

Boring No. HAB-CDT-04

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

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

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

HALEY ALDRICH

TEST BORING REPORT

DRAFT

Boring No. HAB-CDT-04
File No. 128064-011
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	**VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION** (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	9 11															
						-GLACIAL DRIFT DEPOSITS-										
25	3 6 10 10	S6 24	24.0 26.0		CH	Very stiff gray to yellow fat CLAY (CH), moist, few weathered 1/4 in. gravel	5	5	10			80				
30	39 50/8"	S7 10	29.0 29.5		CH	Hard brown to yellowish fat CLAY (CH), moist, few weathered 1/4 in. gravel	5	5	10			80				
35				721.1 34.5	CH	Stiff brown fat CLAY (CH), 2 in. gravel	5	5	10			80				
						SEE CORE BORING REPORT FOR ROCK DETAILS										

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

Boring No. HAB-CDT-04

HALEY ALDRICH

CORE BORING REPORT

Boring No. **HAB-CDT-04**
File No. 128064-011
Sheet No. 3 of 3

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weath-ering	Elev./Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
35	3	C1	34.5 37.0	8 0	27 0	High	721.1 34.5	Hard, highly weathered, yellow to gray LIMESTONE to SHALE, rubble.
	3							
	7	C2	37.0 39.5	20 0	67 0	High		Hard to soft, highly weathered, gray to black SHALE, solid/friable/dicastic.
	4							
	3							
40							716.1 39.5	BOTTOM OF EXPLORATION 39.5 FT
45								
50								
55								
60								

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-CDT-04	C1	34.5-37.0	8 in./27%	0 in./0%	Complete
HAB-CDT-04	C2	37.0-39.5	20 in./67%	0 in./0%	Complete

HAB-CDT-04 Core Box 1 of 1

HALEY ALDRICH

CONCRETE DEWATERING TANK (CDT)
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

APPENDIX A – ROCK CORE PHOTOS

JANUARY 2020

HALEY ALDRICH

TEST BORING REPORT

DRAFT

Boring No. HAB-CDT-05

Project	Thomas Hill Energy Center-CCR Dewatering Tank, Clifton Hill, MO	File No.	128064-011
Client	Associated Electric Cooperative, Inc.	Sheet No.	1 of 2
Contractor	Bulldog Drilling	Start	26 September 2019
		Finish	26 September 2019
		Driller	C. Dutton
		H&A Rep.	G. Foushee
		Elevation	736.6
		Datum	NAVD 88
		Location	N 1352255 E 1602661

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing:
Hoist/Hammer: NA Automatic Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0																
						-GLACIAL DRIFT DEPOSITS-										
		T1 15	2.0 4.0		CH	Note: Shelby Tube from 2.0 to 4.0 ft. Yellow fat CLAY (CH) 350 PSI	10		5			85				
5	4 4 4 5	S1 20	4.0 6.0		CH	Medium stiff yellow to gray fat CLAY (CH), mottled, moist	10		5			85				
	2 5 6 8	S2 20	6.0 8.0		CH	Similar to S1, except stiff	10		5			85				
	3 5 7 10	S3 24	8.0 10.0		CH	Similar to S2	10		5			85				
10																
15 ▽	10 12 15	S4 22	14.0 15.5	722.1 14.5	SP	Medium dense yellow poorly graded coarse SAND (SP), wet										
				721.4 15.2	CH	Stiff yellow to brown fat CLAY (CH), moist, weathered 1/2 in. gravel										
	9	S5	15.5 16.0													
20	3 5 11 50/3"	S6 17	19.0 21.0		CH	Very stiff yellow to brown fat CLAY (CH), moist, weathered 1/2 in. gravel										
				715.4 21.2		Refusal at 21.2 SEE CORE BORING REPORT FOR ROCK DETAILS										
25																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Depth (ft) to: Bottom of Hole	Depth (ft) to: Water
9/26/19	1400	0	14.0	16.0	15.0

Sample ID

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

Well Diagram

▥ Riser Pipe
▤ Screen
▒ Filter Sand
▨ Cuttings
■ Grout
▧ Concrete
▨ Bentonite Seal

Summary

Overburden (ft)	21.2
Rock Cored (ft)	5
Samples	6S, 1C, T1

Boring No. HAB-CDT-05

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

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

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

CORE BORING REPORT

Boring No. **HAB-CDT-05**
File No. 128064-011
Sheet No. 2 of 2

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weath-ering	Elev./Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
		C1	21.2 26.2	60 42	100 70	Moderate	715.4 21.2	Hard, gray to yellow, very fine grained LIMESTONE. Joints moderately decomposed to moderately disintegrated, moderately fractured, fractures are sub horizontal, some healed, brown oxidation on fractured surfaces, some with clay and oxide infill.
	3							
	2							
	4							
25	3							
	4						710.4 26.2	BOTTOM OF EXPLORATION 26.2 FT
30								
35								
40								
45								
50								

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-CDT-05	C1	21.2-26.2	60 in./100%	42 in./70%	Complete

HAB-CDT-05 Core Box 1 of 1

HALEY ALDRICH

CONCRETE DEWATERING TANK (CDT)
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

APPENDIX A – ROCK CORE PHOTOS

JANUARY 2020

FILE NO. 128064-012

HALEY ALDRICH

TEST BORING REPORT

DRAFT

Boring No. HAB-CDT-06

Project	Thomas Hill Energy Center-CCR Dewatering Tank, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 3
Start	25 September 2019
Finish	25 September 2019
Driller	C. Dutton
H&A Rep.	G. Foushee
Elevation	753.7 (est.)
Datum	NAVD 88
Location	N 1352219 E 1602288

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing:
Hoist/Hammer: NA Automatic Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						-GLACIAL DRIFT DEPOSITS-										
	5 19 8 8	S1 23	2.0 4.0		CH	Very stiff gray to brown fat CLAY (CH), moist				5	5	90				
5		NR	4.0 6.0			No recovery										
	3 9 6 8	S2 20	6.0 8.0		CH	Stiff yellow to brown fat CLAY (CH), moist, with chalk, weathered 1/4 in. gravel	5		5			90				
10	4 5 7 9	S3 24	8.0 10.0		CH	Stiff yellow to brown fat CLAY (CH), moist, with chalk, weathered 1/4 in. gravel	5		5			90				
15	3 6 7 9	S4 24	14.0 16.0		CH	Similar to S3										
20	4	S5	19.5		CH	Very stiff yellow to brown fat CLAY (CH), moist, with chalk, weathered 1/4 in. gravel	5	5				90				

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
9/25/19	1330	0	19.5	21.5	20.5

Sample ID

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

Well Diagram

▥	Riser Pipe
▤	Screen
░	Filter Sand
▒	Cuttings
■	Grout
△	Concrete
▨	Bentonite Seal

Summary

Overburden (ft)	29.8
Rock Cored (ft)	5
Samples	8S, 1C

Boring No. **HAB-CDT-06**

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

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

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

HALEY ALDRICH

TEST BORING REPORT

DRAFT

Boring No. HAB-CDT-06
File No. 128064-011
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	**VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION** (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20 ▽	8 14 15	19	21.5	733.7 20.0	SP	Medium dense tan poorly graded SAND (SP), wet				45	50	5				
						-GLACIAL DRIFT DEPOSITS-										
25	2 5 6 7	S6 24	24.0 26.0	729.7 24.0	CH	Stiff yellow tobrown fat CLAY (CH), moist, with coarse sand				10		90				
30		S7 11	29.0 29.5	723.9 29.8		Hard weathered yellow SHALE. Hard, oxidized veins, moist. Refusal at 29.8 ft										
						SEE CORE BORING REPORT FOR ROCK DETAILS										

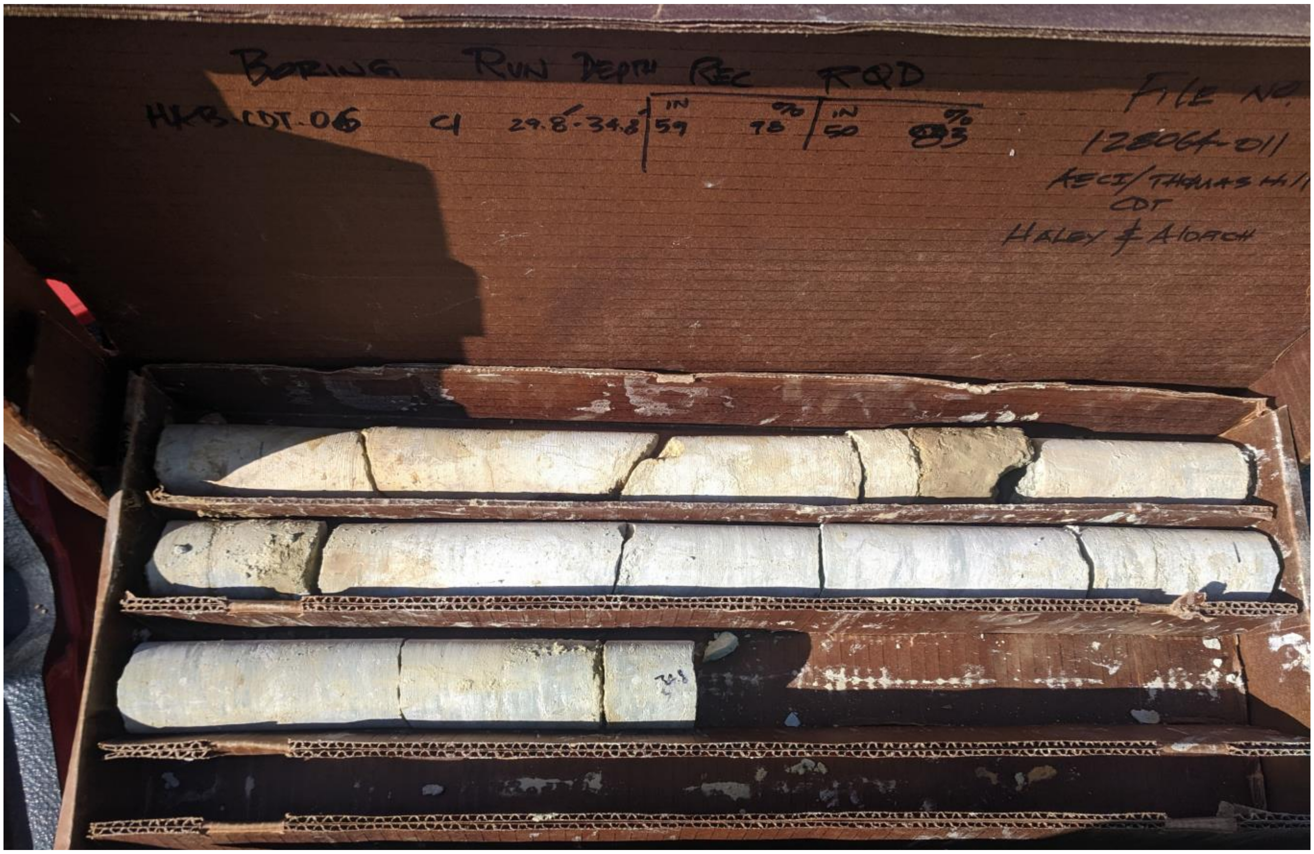
NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

CORE BORING REPORT

Boring No. **HAB-CDT-06**
File No. 128064-011
Sheet No. 3 of 3

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weathering	Elev./ Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
30	2	C1	29.8 34.8	59 50	98 83	Moderate	723.9 29.8	Light gray, LIMESTONE. At 30.2 ft, open fractured 60°, oxidized, rough.
	3							At 30.7 ft, open fractured 60°, oxidized, rough. At 31.1 ft, open fractured, sub horizontal, rough. At 31.2-31.4 ft, Soft, gray-green, SHALE, friable.
	3							
	4							At 32.8, sub horizontal fractured, stepped, rough, oxidized.
	3							
35							718.9 34.8	At 34.6, sub horizontal fractured, smooth, decomposed/disintegrated rock infill. BOTTOM OF EXPLORATION 34.8 FT
40								
45								
50								
55								



Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-CDT-06	C1	29.8-34.8	59 in./98%	50 in./83%	Complete

HAB-CDT-06 Core Box 1 of 1

HALEY ALDRICH

CONCRETE DEWATERING TANK (CDT)
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

APPENDIX A – ROCK CORE PHOTOS

JANUARY 2020

HALEY ALDRICH

TEST BORING REPORT

DRAFT

Boring No. HAB-CDT-07

Project	Thomas Hill Energy Center-CCR Dewatering Tank, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 3
Start	30 September 2019
Finish	30 September 2019
Driller	C. Dutton
H&A Rep.	G. Foushee
Elevation	746.0
Datum	NAVD 88
Location	N 1352211 E 1602531

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing:
Hoist/Hammer: NA Automatic Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0		T1 14	0.0 2.0		CH	Note: Shelby Tube collected from 1.0 ft 2.0 ft 900 PSI				10		90				
						Dark brown fat CLAY (CH)										
	6 6 14 18	S1 22	2.0 4.0	743.7 2.3	ML	Very stiff black SILT with flyash (ML), wet					10	90				
	3 3 4 5	S2 17	4.0 6.0	742.3 3.7	CH	Medium stiff black fat CLAY (CH), wet			10			90				
5						-GLACIAL DRIFT DEPOSITS-										
	2 4 5 7	S3 24	6.0 8.0		CH	Stiff yellow to grayish brown fat CLAY with sand (CH), mottled, wet			15			85				
	3 4 5 6	S4 24	8.0 10.0		CH	Stiff yellow to grayish brown fat CLAY with sand (CH), mottled, wet			15			85				
10																
	4 4 9 9	S5 24	14.0 16.0		CH	Stiff brown to gray fat CLAY with sand (CH), mottled, wet, few 3/8 in. pebbles		5	15			80				
15																
	3 5	S6 22	19.0 21.0		CH	Stiff brown fat CLAY with sand (CH), wet, few SA 1/2 in. pebbles		5	15			80				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
9/30/19		0	2.0	4.0	4.0

Sample ID

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

Well Diagram

⊞	Riser Pipe
☰	Screen
⁘	Filter Sand
▨	Cuttings
■	Grout
△	Concrete
▧	Bentonite Seal

Summary

Overburden (ft)	31
Rock Cored (ft)	5
Samples	8S, 1C

Boring No. HAB-CDT-07

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

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

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

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand				Field Test			
							% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
20	6 9															
						-GLACIAL DRIFT DEPOSITS-										
25	3 4 9 10	S7	24.0 26.0		CH	Stiff brown fat CLAY with sand (CH), wet, few SA 3/8 in. pebbles		5	15			80				
30	16 22 24 25	S8	29.0 31.0		CH	Hard brown fat CLAY with sand (CH), wet, few SA 3/8 in. pebbles		5	15			80				
				715.5 30.5 715.0		-WEATHERED BEDROCK-										
				31.0		SEE CORE BORING REPORT FOR ROCK DETAILS										
35																

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

CORE BORING REPORT

Boring No. **HAB-CDT-07**
File No. 128064-011
Sheet No. 3 of 3

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weath-ering	Elev./ Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
	3	C1	31.0 36.0	47 37	78 62	High	715.0 31.0	Hard, highly weathered, gray, very fine grained LIMESTONE. Bedding thick, joints fresh, moderately fractured, rough, sub horizontal, healed.
	2							
	3							
	3							
35	3							
							710.0 36.0	BOTTOM OF EXPLORATION 36.0 FT
40								
45								
50								
55								
60								

H+A_CORE+WELL07-1 HA-LIB09.GLB HA-TB+CORE+WELL-07-1.GDT \\HALEYALDRICH.COM\SHARE\WAS_COMMON\PROJECTS\128064-AECI THOMAS HILL\012- TH CCR DEWATERING TANK\FIELDWORK\GINT\128064-011TB.GPJ 17 Dec 19

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-CDT-07	C1	31.0-36.0	47 in./78%	37in./62%	Complete

HAB-CDT-07 Core Box 1 of 1

HALEY ALDRICH

CONCRETE DEWATERING TANK (CDT)
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

APPENDIX A – ROCK CORE PHOTOS

JANUARY 2020

HALEY ALDRICH

TEST BORING REPORT

DRAFT

Boring No. HAB-CDT-08

Project	Thomas Hill Energy Center-CCR Dewatering Tank, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 2
Start	26 September 2019
Finish	26 September 2019
Driller	C. Dutton
H&A Rep.	G. Foushee
Elevation	730.7
Datum	NAVD 88
Location	N 1352205 E 1602767

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing:
Hoist/Hammer: NA Automatic Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0		T1	0.0 2.0			-GLACIAL DRIFT DEPOSITS-										
	4 4 6 6	S1 19	2.0 4.0		CH	Stiff red to yellowish brown fat CLAY (CH), mottled, moist			15			85				
5	3 3 6 6	S2 24	4.0 6.0		CH	Stiff gray and reddish brown fat CLAY with sand (CH), mottled, moist			15	5	4	76				
▽	2 3 5 6	S3 18	6.0 8.0		CH	Medium stiff red to yellowish black fat CLAY (CH), moist, little fine angular gravel		2	15			83				
		S4	8.0 10.0		CH	Similar to S3, except one 2.0 in. cobble	2		15			83				
10																
15	5 8 50/3"	S5 13	14.0 15.5	715.2 15.5	CH	Stiff gray to brown fat CLAY (CH), moist, few sample 3/8" gravel		2	15			83				
						SEE CORE BORING REPORT FOR ROCK DETAILS										
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
9/26/19	1040	0	6.0	8.0	7.0

Sample ID

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

Well Diagram

◫	Riser Pipe
☰	Screen
⁘	Filter Sand
▨	Cuttings
■	Grout
△	Concrete
▧	Bentonite Seal

Summary

Overburden (ft)	15.5
Rock Cored (ft)	5
Samples	5S, 1C, T1

Boring No. HAB-CDT-08

Field Tests:

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

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

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

CORE BORING REPORT

DRAFT

Boring No. **HAB-CDT-08**
File No. 128064-011
Sheet No. 2 of 2

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weath- ering	Elev./ Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
	2 1 2 4 2	C1	15.5 20.5	58 28	97 47	Moderate	715.2 15.5	Hard, yellow, very fine grained LIMESTONE, oxide on joint surfaces. Bedding thick to extremely thick, moderately decomposed to disintegrated, joints moderately fractured, fractures are sub horizontal, some healed, some open with clay and oxide infill.
20								
							710.2 20.5	BOTTOM OF EXPLORATION 20.5 FT
25								
30								
35								
40								
45								

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-CDT-08	C1	15.5-20.5	58 in./97%	28 in./47%	Complete

HAB-CDT-08 Core Box 1 of 1

CONCRETE DEWATERING TANK (CDT)
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

APPENDIX A – ROCK CORE PHOTOS

JANUARY 2020

HALEY ALDRICH

TEST BORING REPORT

Boring No. HAB-CDT-09

Project Thomas Hill Energy Center-CCR Dewatering Tank, Clifton Hill, MO
Client Associated Electric Cooperative, Inc.
Contractor Bulldog Drilling

File No. 128064-011
Sheet No. 1 of 2
Start 26 September 2019
Finish 26 September 2019
Driller C. Dutton
H&A Rep. G. Foushee
Elevation 727.7
Datum NAVD 88
Location
N 1352214
E 1602849

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.25	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures
Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing:
Hoist/Hammer: NA Automatic Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0		T1 22	0.0 2.0		CH	Note: Shelby Tube collected from 0.0 to 2.0 ft. Dark brown fat CLAY (CH) 300 PSI -GLACIAL DRIFT DEPOSITS-										
▽																
5	2 4 6 9	S1 15	4.0 6.0		CH	Stiff dark brown gravelly fat CLAY (CH), wet	20		10			70				
	3 4 6 9	S2 16	6.0 8.0		CH	Stiff gray sandy fat CLAY (CH), wet		2	3	14	21	60				
	3 15 8 7	S3 10	8.0 10.0		CH	Very stiff yellow to blackish brown sandy fat CLAY (CH), wet		10	20			70				
10																
				716.1 11.7		SEE CORE BORING REPORT FOR ROCK DETAILS										
15																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Depth (ft) to: Bottom of Hole	Depth (ft) to: Water
9/26/19		0	4.0	6.0	4.0

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

Well Diagram
▯ Riser Pipe
▤ Screen
⁘ Filter Sand
▨ Cuttings
■ Grout
△ Concrete
▧ Bentonite Seal

Summary
Overburden (ft) 11.65
Rock Cored (ft) 4
Samples 3S, 1C, T1

Boring No. HAB-CDT-09

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

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

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

CORE BORING REPORT

Boring No. **HAB-CDT-09**
File No. 128064-011
Sheet No. 2 of 2

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD		Weath-ering	Elev./ Depth (ft)	Visual Description and Remarks
				in.	%			
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
	2	C1	11.7 16.7	40 6	67 10	Moderate to High	716.1 11.7	Soft to medium, gray, very fine grained LIMESTONE. Bedding medium, joints fresh to highly decomposed, intensely fractured, sub horizontal, some healed, some open with clay infill and yellow oxidation.
	2							
	4							
15	5							
							711.1 16.7	
20								
25								
30								
35								
40								

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-CDT-09	C1	11.7-16.7	40 in./67%	6 in./10%	Complete

HAB-CDT-09 Core Box 1 of 1

HALEY ALDRICH

CONCRETE DEWATERING TANK (CDT)
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

APPENDIX A – ROCK CORE PHOTOS

JANUARY 2020

TEST BORING REPORT

Boring No. HAB-002-01

Project	Thomas Hill Energy Center-Cell 002 Embankments, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 3
Start	03 October 2019
Finish	03 October 2019
Driller	C. Dutton
H&A Rep.	G. Foushee
Elevation	727.8
Datum	NAVD88
Location	N 1,350,898 E 1,602,194

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing: Hollow Stem Auger
Hoist/Hammer: NA Automatic Hammer

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	**VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION** (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						-EMBANKMENT FILL-										
	4 6 6 7	S1 13	2.0 4.0		CH	Stiff brown FAT CLAY with sand (CH), moist, contains roots			19			81				
5	2 3 3 4	S2 15	4.0 6.0		CH	Similar to S1, except medium stiff			20			80				
	3 3 4 5	S3 15	6.0 8.0		CH	Similar to S1, except medium stiff			20			80				
	2 3 2 4	S4 16	8.0 10.0	719.8 8.0	CL	Medium stiff brown LEAN CLAY (CL), moist			10			90				
10																
15	2 4 5 4	S5 21	14.0 16.0	713.8 14.0	CH	Stiff yellow-brown to black FAT CLAY with gravel (CH), mottled, moist, gravel weathered to 1/4 in.	10	10				80				
		U1 19	19.0 21.0		CH	Yellow-brown to black FAT CLAY with gravel (CH), moist Note: Shelby tube, 19 in. recovery										
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Depth (ft) to: Bottom of Hole	Depth (ft) to: Water
10/4/19	0800		40.0	40.9	28.0

Sample ID

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

Well Diagram

◫	Riser Pipe
▤	Screen
⠿	Filter Sand
⁂	Cuttings
■	Grout
△	Concrete
▨	Bentonite Seal

Summary

Overburden (ft)	40.9
Rock Cored (ft)	5
Samples	9S, 2C, 1U

Boring No. HAB-002-01

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

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

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

TEST BORING REPORT

Boring No. HAB-002-01
File No. 128064-011
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																
						-EMBANKMENT FILL-										
25	2 4 5 6	S6 24	24.0 26.0		CH	Stiff black FAT CLAY (CH), moist						100				
▽				700.3 27.5		-GLACIAL DRIFT DEPOSITS-										
	2 2 3 4	S7 24	28.0 30.0		CL	Medium stiff brown LEAN CLAY (CL), moist					4	96				
30																
35	2 2 2 3	S8 24	35.0 37.0		CL	Similar to S7, except soft						100				
40	2 2 40/4"	S9 16	40.0 40.9		CL	Similar to S7, except hard Note: Refusal at 40.9 ft.										
						SEE CORE BORING REPORT FOR ROCK DETAILS										
45																

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

HALEY ALDRICH

CORE BORING REPORT

Boring No. **HAB-002-01**
File No. 128064-011
Sheet No. 3 of 3

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD		Weath- ering	Elev./ Depth (ft)	Visual Description and Remarks
				in.	%			
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
	3 3 3 6	C1	40.9 44.9	41 16	85 33	Moder- ate	678.6 40.9	Very hard, moderately weathered, gray, aphanitic LIMESTONE. Joints are slightly decomposed, slightly disintegrated, intensely fractured, fractures are dominantly sub horizontal, rough, oxidized, few sub vertical, healed.
45	8	C2	44.9 45.9	11 0	92 0	Moder- ate	674.6 44.9 673.6 45.9	Soft, moderately weathered, gray to black, fine grained SHALE. Bedding thin, joints are slightly decomposed, slightly disintegrated, intensely fractured, fractured horizontal bedding, plane joints.
								BOTTOM OF EXPLORATION 45.9 FT
50								
55								
60								
65								
70								

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-002-01	C1	40.9-44.9	41 in./85%	16 in./33%	Complete
HAB-002-01	C2	44.9-45.9	11 in./92%	0 in./0%	Complete

HAB-002-01 Core Box 1 of 1

CELL 002 EMBANKMENTS
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

HAB-002-01 ROCK CORE PHOTO

JANUARY 2020

TEST BORING REPORT

Boring No. HAB-002-02

Project	Thomas Hill Energy Center-Cell 002 Embankments, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 3
Start	07 October 2019
Finish	07 October 2019
Driller	C. Dutton
H&A Rep.	G. Foushee
Elevation	720.0
Datum	NAVD88
Location	N 1,350,703 E 1,601,909

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing: Hollow Stem Auger
Hoist/Hammer: NA Automatic Hammer

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						-EMBANKMENT FILL-										
	2 2 3 2	S1 19	2.0 4.0		CL	Medium stiff mottled yellow-brown LEAN CLAY with sand (CL), moist, weathered fine gravel 1/4 in.		5	19			76				
5	2 3 2 2	S2 18	4.0 6.0	715.5 4.5	CH	Medium stiff dark brown to black FAT CLAY (CH), moist, contains fly ash		10	5			85				
	2 3 4 5	S3 17	6.0 8.0		CH	Medium stiff mottled gray-yellow-brown FAT CLAY with gravel (CH), moist, fine weathered gravel to 3/8 in		20				80				
	2 2 3 3	S4 15	8.0 10.0	712.0 8.0	CL	Medium stiff mottled gray to yellow-brown sandy LEAN CLAY with gravel (CL), gravel fine to 3/8 in., well rounded to subangular		2	2	4	22	70				
10																
				708.0 12.0		-GLACIAL DRIFT DEPOSITS-										
15	2 2 2 2	S5 18	14.0 16.0		CH	Soft black FAT CLAY (CH), moist						100				
		U1 15	19.0 21.0		CH	Black FAT CLAY, moist (CH) Note: Shelby tube, 15 in. recovery.										
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Depth (ft) to: Bottom of Hole	Depth (ft) to: Water
10/7/19		0	29.0	30.0	Dry

Sample ID

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

Well Diagram

- ◫ Riser Pipe
- ▤ Screen
- ⁘ Filter Sand
- ▩ Cuttings
- ■ Grout
- ▵ Concrete
- ▨ Bentonite Seal

Summary

Overburden (ft)	30.5
Rock Cored (ft)	5
Samples	7S, 1C, 1U

Boring No. HAB-002-02

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

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

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

TEST BORING REPORT

Boring No. HAB-002-02
File No. 128064-011
Sheet No. 2 of 3

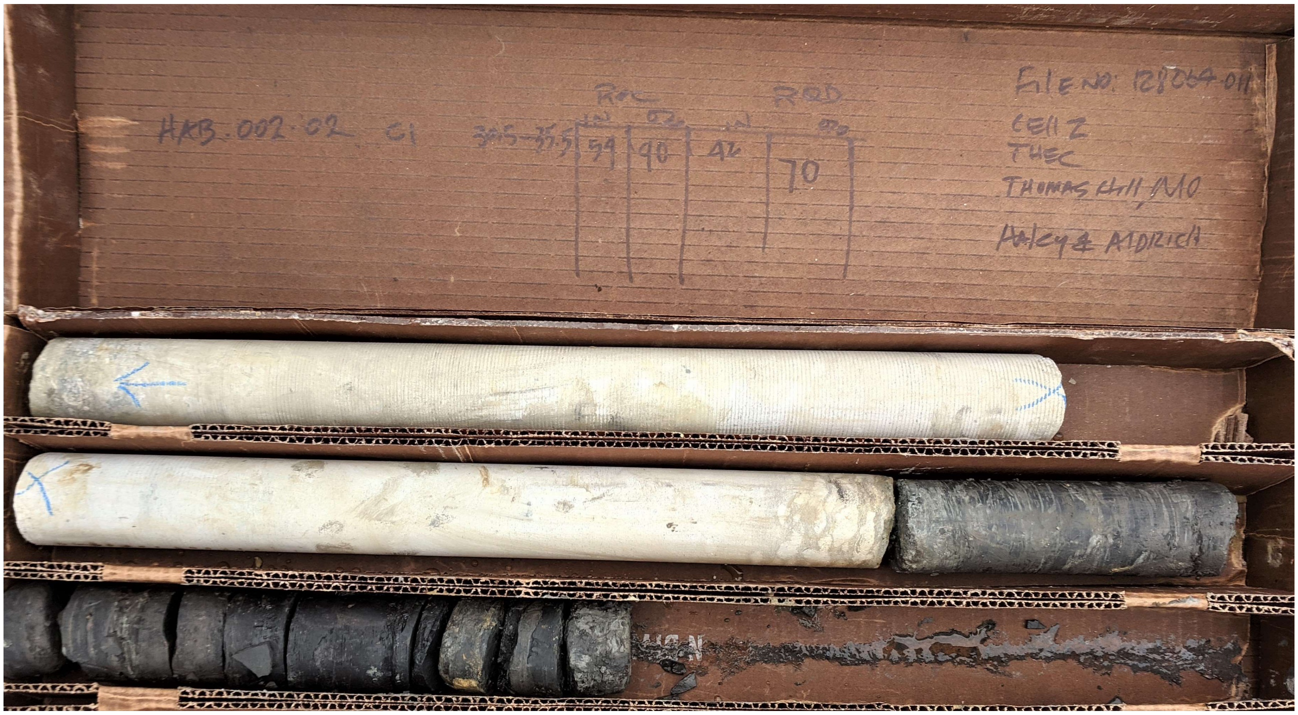
Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																
						-GLACIAL DRIFT DEPOSITS-										
25	2 2 3 4	S6 18	24.0 26.0		CH	Medium stiff black FAT CLAY (CH), moist						100				
30	7 16 50/4"	S7 13	29.0 31.0	691.0 29.0		Weathered gray SHALE -WEATHERED BEDROCK- Note: Refusal at 30.5 ft.										
						SEE CORE BORING REPORT FOR ROCK DETAILS										
35																

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

Boring No. HAB-002-02

CORE BORING REPORT		**Boring No.** HAB-002-02 File No. 128064-011 Sheet No. 3 of 3

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weathering	Elev./Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
	2	C1	30.5 35.5	59 42	98 70	Fresh to Moderate	694.5 30.5	Very hard, fresh, gray, aphanitic LIMESTONE. Massive, fresh, competent, unfractured (36 in. straight stick).
	2							
	2						691.5 33.5	Soft, moderately weathered, black, fine grained SHALE. Bedding thin, fresh, competent, intensely fractured.
	2							
35	3							
							689.5 35.5	BOTTOM OF EXPLORATION 35.5 FT
40								
45								
50								
55								
60								



Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-002-02	C1	30.5-35.5	54 in./90%	42 in./70%	Complete

HAB-002-02 Core Box 1 of 1

HALEY ALDRICH

CELL 002 EMBANKMENTS
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

HAB-002-02 ROCK CORE PHOTO

JANUARY 2020

FILE NO. 128064-011

HALEY ALDRICH

TEST BORING REPORT

Boring No. HAB-002-03

Project	Thomas Hill Energy Center-Cell 002 Embankments, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 4
Start	07 October 2019
Finish	07 October 2019
Driller	C. Dutton
H&A Rep.	G. Foushee
Elevation	726.5
Datum	NAVD88
Location	N 1,350,443 E 1,601,789

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X

Bit Type: Cutting Head

Drill Mud: None

Casing: Hollow Stem Auger

Hoist/Hammer: NA Automatic Hammer

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						-EMBANKMENT FILL-										
	3 4 4 3	S1 16	2.0 4.0		CH	Medium stiff yellow-brown FAT CLAY with sand (CH), mottled, moist			17			83				
5	3 3 3 4	S2 15	4.0 6.0	722.5 4.0	CH	Medium stiff yellow-brown FAT CLAY with sand (CH), moist,			15	5		80				
	3 4 5 6	S3 18	6.0 8.0		CH	Similar to S2, except stiff										
	2 3 5 10	S4 15	8.0 10.0	718.5 8.0	CL	Medium stiff dark brown LEAN CLAY (CL), moist					3	97				
10																
15		U1 17	14.0 16.0		CL	Yellow-brown LEAN CLAY (CL), moist Note: Shelby tube, 17 in. recovery.		5	5	8	9	73				
	3 6	S5 24	19.0 21.0		CL	Stiff dark brown LEAN CLAY (CL), moist			10			90				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Depth (ft) to: Bottom of Hole	Depth (ft) to: Water
10/7/19		0	34.0	36.0	34.0

Sample ID

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

Well Diagram

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

Summary

Overburden (ft)	55
Rock Cored (ft)	5
Samples	12S, 2C, 1U

Boring No. HAB-002-03

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

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

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

HALEY ALDRICH

TEST BORING REPORT

Boring No. HAB-002-03
File No. 128064-011
Sheet No. 2 of 4

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	8 8															
						-EMBANKMENT FILL-										
25	2 5 5 6	S6 22	24.0 26.0	702.5 24.0	CH	Stiff dark brown FAT CLAY with sand (CH), moist			10	10		80				
30	2 3 3 5	S7 24	29.0 31.0		CH	Similar to S6, except medium stiff			10	10		80				
				694.5 32.0		-GLACIAL DRIFT DEPOSITS-										
35	▽ 1 1 1 2	S8 24	34.0 36.0		CL	Very soft gray-brown LEAN CLAY with sand (CL), wet, some organic material			10	10		80				
40	WOH WOH 1 1	S9 24	39.0 41.0	687.5 39.0	CH	Very soft stiff gray-brown FAT CLAY (CH), wet						100				
45	WOH WOH WOH WOH	S10 24	44.0 46.0		CH	Similar to S9						100				
	2	S11	49.0		CH	Medium stiff brown FAT CLAY with sand (CH), wet			10	10		80				

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

TEST BORING REPORT

Boring No. HAB-002-03
File No. 128064-011
Sheet No. 3 of 4

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand				Field Test			
							% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
50	4 4 WOH	22	50.0			-GLACIAL DRIFT DEPOSITS-										
	3 20 40/3"	S12 12	54.0 55.0	672.5 54.0		Weathered SHALE -WEATHERED BEDROCK-										
55						Note: Refusal at 55.0 ft. SEE CORE BORING REPORT FOR ROCK DETAILS										
60																

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

HALEY ALDRICH

CORE BORING REPORT

Boring No. HAB-002-03
File No. 128064-011
Sheet No. 4 of 4

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weath-ering	Elev./ Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
55	16	C1	55.0 57.5	30 4	100 13	Slight	665.6 55.0	Very hard, slightly weathered, gray, aphanitic LIMESTONE. Bedding thin, joints are slight decomposed, slightly disintegrated, intensely fractured.
	22							
	18							
	20	C2	57.5 60.0	24 12	80 40	Slight	663.1 57.5	Soft, slighty weathered, gray, fine grained SHALE. Bedding thin, fresh, competent, intensely fractured. Joints are horizontal, along bedding planes.
	28							
60							660.6 60.0	BOTTOM OF EXPLORATION 60.0 FT
65								
70								
75								
80								
85								

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-002-03	C1	55.0-57.5	30 in./ 100%	4 in./13%	Complete
HAB-002-03	C1	57.5-60.0	24 in./ 80%	12 in./40%	Complete

HAB-002-03 Core Box 1 of 1

HALEY ALDRICH

CELL 002 EMBANKMENTS
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

HAB-002-03 ROCK CORE PHOTO

JANUARY 2020

FILE NO. 128064-011

HALEY ALDRICH

TEST BORING REPORT

Boring No. HAB-002-04

Project	Thomas Hill Energy Center-Cell 002 Embankments, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 3
Start	03 October 2019
Finish	03 October 2019
Driller	C. Dutton
H&A Rep.	G. Foushee
Elevation	726.5
Datum	NAVD88
Location	N 1,350,235 E 1,601,573

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing: Hollow Stem Auger
Hoist/Hammer: NA Automatic Hammer

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						-EMBANKMENT FILL-										
	4 4 4 4	S1 17	2.0 4.0		CH	Medium stiff brown-yellow-gray FAT CLAY (CH), mottled, moist				10		90				
5	3 4 4 4	S2 19	4.0 6.0		CH	Medium stiff mottled brown-yellow-gray FAT CLAY with sand (CH), moist				21		79				
	2 3 4 5	S3 16	6.0 8.0		CH	Similar to S2				20		80				
		U1 17	8.0 10.0		CH	Brown to yellow-gray FAT CLAY (CH), moist Note: Shelby tube, 17 in. recovery.										
10																
15	4 4 4 5	S4 16	14.0 16.0		CH	Medium stiff brown FAT CLAY (CL), moist, weathered fine gravel to 3/8 in.		5	5			90				
	3 3	S5 24	19.0 21.0	707.5 19.0	CL	Medium stiff brown LEAN CLAY (CL), moist, few fine well rounded gravel to 3/8 in.			4	4	2	90				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Depth (ft) to: Bottom of Hole	Depth (ft) to: Water
10/3/19		0	38.5	38.5	35.0

Sample ID

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

Well Diagram

▥	Riser Pipe
▤	Screen
▨	Filter Sand
▧	Cuttings
■	Grout
△	Concrete
▨	Bentonite Seal

Summary

Overburden (ft)	38.5
Rock Cored (ft)	5
Samples	7S, 2C, 2U

Boring No. HAB-002-04

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

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

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

TEST BORING REPORT

Boring No. HAB-002-04
File No. 128064-011
Sheet No. 2 of 3

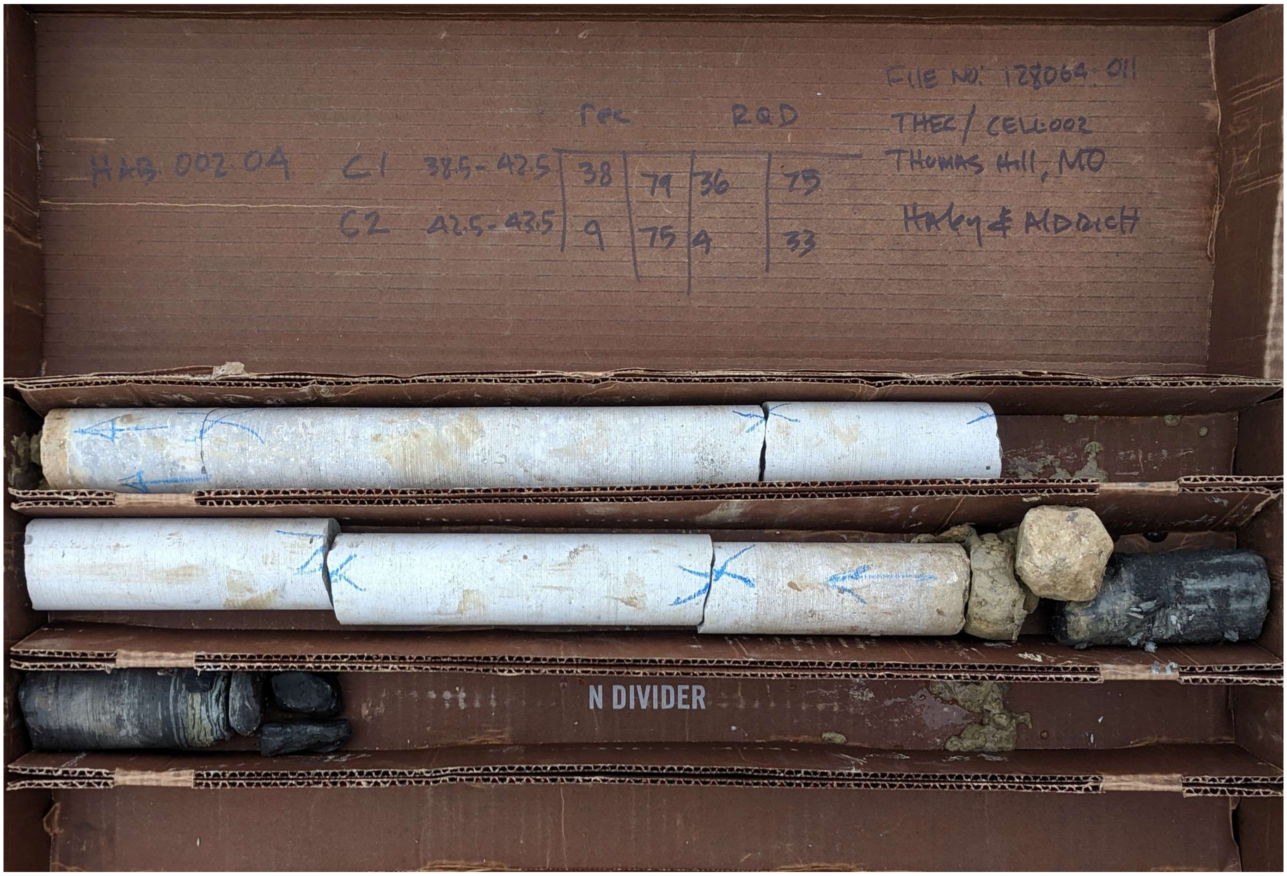
Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	4 5															
				704.0 22.5		-EMBANKMENT FILL- -GLACIAL DRIFT DEPOSITS-										
		U2 24	24.0 26.0		CH	FAT CLAY with sand (CH), moist, few well rounded fine gravel 3/16 in. Note: Shelby tube.		1	1	3	12	83				
25																
30	2 5 6 7	S6 21	29.0 31.0		CH	Stiff brown FAT CLAY with san (CH), moist, few well rounded fine gravel 3/16 in.				5	10	85				
▽ 35	13 14 17 14	S7 22	34.0 36.0		CH	Similar to S6, except hard										
						Note: Refusal at 38.5 ft.										
						SEE CORE BORING REPORT FOR ROCK DETAILS										
40																

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

CORE BORING REPORT

Boring No. HAB-002-04
File No. 128064-011
Sheet No. 3 of 3

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weathering	Elev./Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
		C1	38.5 42.5	38 36	79 75	Slight	680.7 38.5	Very hard, fresh, gray, aphanitic LIMESTONE. Massive, fresh, competent, fractured: 36.0 in. intact (1.0 in. SHALE washed away)
40								
		C2	42.5 43.5	9 4	75 33	Moderate	676.7 42.5	Very soft, moderately fractured, black, fine grained SHALE. Bedding thin, fresh, competent, intensely fractured.
							675.7 43.5	BOTTOM OF EXPLORATION 43.5 FT
45								
50								
55								
60								
65								



Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-002-04	C1	38.5-42.5	38 in./79%	36 in./75%	Complete
HAB-002-04	C2	42.5-43.5	9 in./75%	4 in./33%	Complete

HAB-002-04 Core Box 1 of 1

HALEY ALDRICH

CELL 002 EMBANKMENTS
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

HAB-002-04 ROCK CORE PHOTO

JANUARY 2020

HALEY ALDRICH

TEST BORING REPORT

Boring No. HAOW-002-A

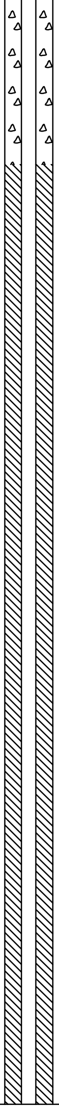
Project Thomas Hill Energy Center-Cell 002 Embankments, Clifton Hill, MO
Client Associated Electric Cooperative, Inc.
Contractor Bulldog Drilling

File No. 128064-011
Sheet No. 1 of 1
Start 07 October 2019
Finish 07 October 2019
Driller C. Dutton
H&A Rep. G. Foushee
Elevation 726.5
Datum NAVD88
Location See Plan

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures
Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing: Hollow Stem Auger
Hoist/Hammer: NA Automatic Hammer

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	**VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION** (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0																	
					723.0 3.0												
5																	
10																	
15																	
20																	



Water Level Data

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

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

Well Diagram
- ▥ Riser Pipe
- ☰ Screen
- ⁘ Filter Sand
- ⁘ Cuttings
- ■ Grout
- △ Concrete
- ▨ Bentonite Seal

Summary
Overburden (ft) 55.9
Rock Cored (ft) -
Samples

Boring No. HAOW-002-A

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

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

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

TEST BORING REPORT

Boring No. HAOW-002-A
File No. 128064-011
Sheet No. 2 of 1

								Gravel		Sand				Field Test			
Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	**VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION** (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
20																	
25																	
30																	
35																	
40					686.0 40.0												
45																	

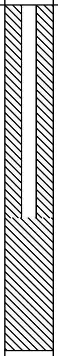
NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. HAOW-002-A

TEST BORING REPORT

Boring No. HAOW-002-A
File No. 128064-011
Sheet No. 3 of 1

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50																	
55																	
					670.1 55.9												



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

Boring No. HAOW-002-A

H&A-TEST BORING-07-1 128064-011_HA-LIB09-REV.GLB HA-TB+CORE+WELL-07-1.GDT \\HALEYALDRICH.COM\SHARE\WAS_COMMON\PROJECTS\128064-AECI THOMAS HILL\011- TH POND 002 AND EAST DITCH\FIELDWORK\GINT\128064-011TB.GPJ Feb 10, 20

HALEY ALDRICH

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

DRAFT

Well No.

Boring No. HAOW-002-A

Project	Thomas Hill Energy Center-Cell 002 Embankments
Location	Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling
Driller	C. Dutton

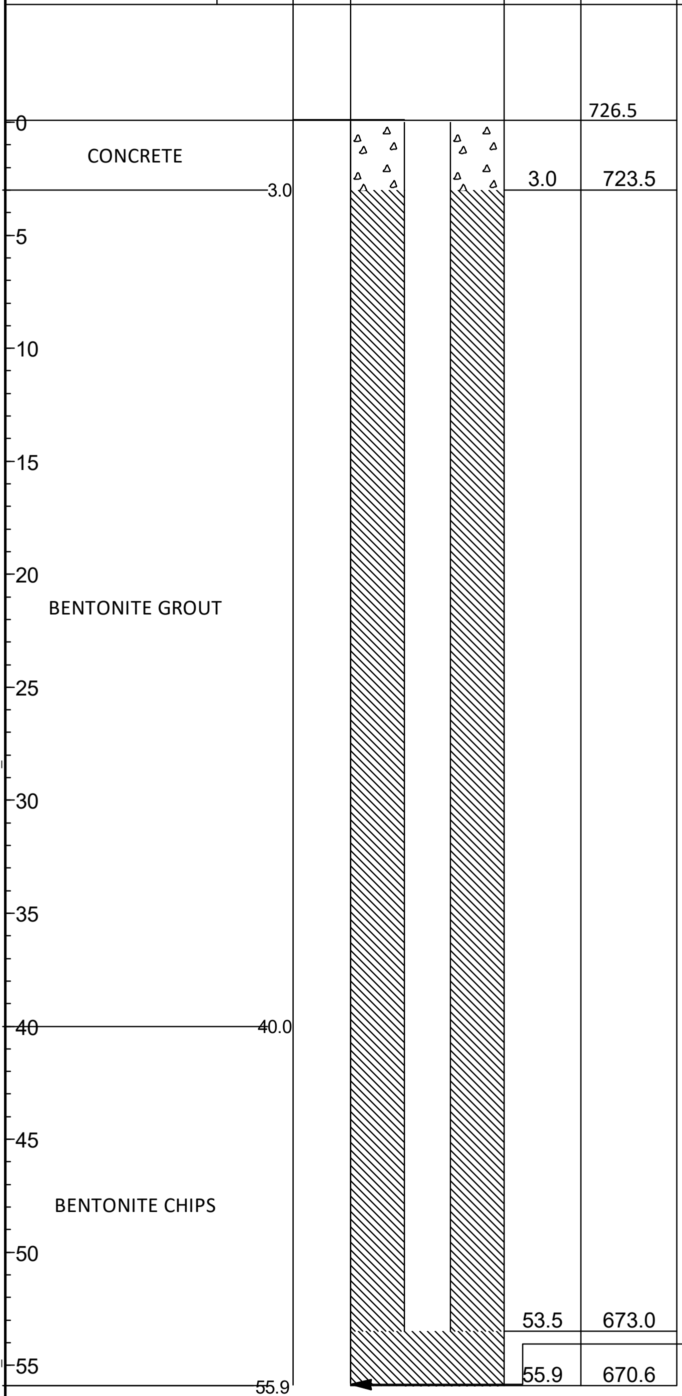
Initial Water Level (depth bgs) ft

Well Diagram

- ◫ Riser Pipe
- ▤ Screen
- ░ Filter Sand
- ▒ Cuttings
- ■ Grout
- ∴ Concrete
- ▨ Bentonite Seal

File No.	128064-011
Date Installed	07 Oct 2019
H&A Rep.	G. Foushee
Location	See Plan
Ground El.	726.5
Datum	NAVD88

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)
					726.5
CONCRETE	3.0			3.0	723.5
BENTONITE GROUT	40.0				
BENTONITE CHIPS	55.9			53.5	673.0
				55.9	670.6



WELL CONSTRUCTION DETAILS

Type of protective cover 4 in. Square Tube

Height of 4 in. Steel Tube, Hinged above ground surface 3.6 ft

Height of top of riser above ground surface 3.0 ft

Type of protective casing 4 in. Steel Tube, Hinged

Length 6.0 ft

Inside diameter 4.0 in.

Depth of bottom of 4 in. Steel Tube, Hinged 2.4 ft

Type of riser pipe Schedule 40 PVC

Inside diameter of riser pipe 2.0 in.

Depth of bottom of riser pipe 43.3 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	3.0
Bentonite Grout	3.0	38.3
Bentonite Chips	41.3	14.6
	-	-

Diameter of borehole 8.0 in.

Depth to top of well screen 43.3 ft

Type of screen Machine slotted Sch 40 PVC

Screen gauge or size of openings 0.010 in.

Diameter of screen 2.0 in.

Type of backfill around screen #1 Quartz Sand

Depth to bottom of well screen 53.1 ft

Bottom of silt trap 53.5 ft

Depth of bottom of borehole 55.9 ft

COMMENTS:

HALEY ALDRICH

TEST BORING REPORT

Boring No. HAOW-002-B

Project	Thomas Hill Energy Center-Cell 002 Embankments, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 1
Start	08 October 2019
Finish	08 October 2019
Driller	C. Dutton
H&A Rep.	G. Foushee
Elevation	726.9
Datum	NAVD88
Location	N 1,351,572 E 1,601,924

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing: Hollow Stem Auger
Hoist/Hammer: NA Automatic Hammer

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						-WEATHERED BEDROCK-										
	17 50/5"	S1 8	2.0 3.0			Yellow WEATHERED BEDROCK, dry Note: Refusal at 3.0 ft.										
				723.9 3.0		BOTTOM OF EXPLORATION 3.0 FT										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Depth (ft) to: Bottom of Hole	Depth (ft) to: Water
10/8/19		N/A	3.0	3.0	Dry

Sample ID

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

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	3
Rock Cored (ft)	-
Samples	1S

Boring No. HAOW-002-B

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

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

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

HALEY ALDRICH

TEST BORING REPORT

Boring No. HAOW-002-C

Project	Thomas Hill Energy Center-Cell 002 Embankments, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 2
Start	08 October 2019
Finish	08 October 2019
Driller	C. Dutton
H&A Rep.	G. Foushee
Elevation	717.1
Datum	NAVD88
Location	N 1,352,055 E 1,601,640

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing: Hollow Stem Auger
Hoist/Hammer: NA Automatic Hammer

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						-GLACIAL DRIFT DEPOSITS-										
	2 2 3 4	S1 17	2.0 4.0		CH	Medium stiff yellow-brown FAT CLAY with sand (CH), moist										
						Note: Auger refusal 4.4 ft.										
						SEE CORE BORING REPORT FOR ROCK DETAILS										
5																
10																
15																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
10/8/19		0	4.4	4.4	2.5

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

Well Diagram
▥ Riser Pipe
☰ Screen
⠿ Filter Sand
⁘ Cuttings
■ Grout
△ Concrete
▨ Bentonite Seal

Summary

Overburden (ft)	4.4
Rock Cored (ft)	15
Samples	2S, 2C

Boring No. HAOW-002-C

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

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

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

HALEY ALDRICH

CORE BORING REPORT

Boring No. **HAOW-002-C**
File No. 128064-011
Sheet No. 2 of 2

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD		Weath-ering	Elev./ Depth (ft)	Visual Description and Remarks
				in.	%			
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
	2	C1	4.4 13.9	60 31	53 27	High	712.7 4.4	Hard, highly weathered, white, aphanitic LIMESTONE. Joints moderately decomposed, moderate disintegrated, rubble to 6.5 ft, then moderately fractured.
5	2							
	2							
	2							
	2						708.3 8.8	Soft, gray, medium grained SANDSTONE RUBBLE from 8.8 to 9.4 ft. Lost core from 9.4 to 14.4 ft.
	2							
10	2							
	2							
	2							
	8							
	2	C2	13.9 19.4	66 30	100 45	High	702.7 14.4	Soft, highly weathered, gray, fine grained SHALE. Bedding thin, joints moderately disintegrated, intensely fractured.
15	2							
	2							
	2							
	2							
							697.7 19.4	BOTTOM OF EXPLORATION 19.4 FT
20								
25								
30								

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAOW-002-C	C1	4.4-13.9	60 in./53%	31 in./27%	Complete

HAOW-002-C Core Box 1 of 2

CELL 002 EMBANKMENTS
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

HAOW-002-C ROCK CORE PHOTO

JANUARY 2020

FILE NO. 128064-011

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAOW-002-C	C2	13.9-19.4	66 in./100%	30 in./45%	Complete

HAOW-002-C Core Box 2 of 2

HALEY ALDRICH

CELL 002 EMBANKMENTS
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

HAOW-002-C ROCK CORE PHOTO

JANUARY 2020

FILE NO. 128064-011

TEST BORING REPORT

Boring No. HAB-ED-01

Project	Thomas Hill Energy Center-Cell 002 Embankments, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 2
Start	01 October 2019
Finish	01 October 2019
Driller	C. Dutton
H&A Rep.	G. Foushee
Elevation	719.5
Datum	NAVD88
Location	N 1,350,898 E 1,602,194

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing: Hollow Stem Auger
Hoist/Hammer: NA Automatic Hammer

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						-GLACIAL DRIFT DEPOSITS-										
	5 4 3 4	S1 6	4.0 6.0		SP	Loose yellow poorly graded SAND (SP), moist					80	20				
5																
	21 24	S2 14	9.0 11.0	709.5 10.0												
10						Gray weathered SHALE, friable, moist										
						-WEATHERED BEDROCK-										
		S3	14.0 15.0			Note: Sampler refusal.										
15						SEE CORE BORING REPORT FOR ROCK DETAILS										
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Depth (ft) to: Bottom of Hole	Depth (ft) to: Water
10/1/19		N/A	0.0	0.0	0.0

Sample ID

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

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	15
Rock Cored (ft)	10
Samples	3S, 2C

Boring No. HAB-ED-01

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

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

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

CORE BORING REPORT

DRAFT

Boring No. **HAB-ED-01**
File No. 128064-011
Sheet No. 2 of 2

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weath-ering	Elev./ Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
15	3	C1	15.0 22.0	77 51	92 61	Fresh	704.5 15.0	Hard, fresh, gray, Aphanitic LIMESTONE.
	2							
	2							
	2							Hard, moderately weathered, black, fine grained SHALE, joints are horizontal, very closely spaced, foliated.
	3							
20	3							
	8							
	8	C2	22.0 25.0	35 16	97 44	Moder-ate		Medium, moderately weathered, dark gray, fine grained SHALE, joints are very closely spaced, foliated.
	10							
	8							
25							694.5 25.0	BOTTOM OF EXPLORATION 25.0 FT Note: Located in saturated ditch.
30								
35								
40								
45								

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-ED-01	C1	15.0-22.0	77 in./92%	51 in./61%	Complete
HAB-ED-01	C2	22.0-25.0	35 in./97%	16 in./44%	Complete

HAB-ED-01 Core Box 1 of 1

HALEY ALDRICH

CELL 002 EMBANKMENTS
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

HAB-ED-01 ROCK CORE PHOTO

JANUARY 2020

TEST BORING REPORT

Boring No. HAB-ED-02

Project	Thomas Hill Energy Center-Cell 002 Embankments, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 2
Start	02 October 2019
Finish	02 October 2019
Driller	C. Dutton
H&A Rep.	G. Foushee
Elevation	725.0
Datum	NAVD88
Location	N 1,350,703 E 1,601,909

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing: Hollow Stem Auger
Hoist/Hammer: NA Automatic Hammer

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0																
5	3 4 7 50/3"	S1 17	4.0 6.0		CH	Stiff brown FAT CLAY (CH), moist Sampler refusal at 5.5 ft						100				
						SEE CORE BORING REPORT FOR ROCK DETAILS										
10																
15																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Depth (ft) to: Bottom of Hole	Depth (ft) to: Water
10/2/20		N/A	4.0	5.5	Dry

Sample ID

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

Well Diagram

▥	Riser Pipe
☰	Screen
⁘	Filter Sand
⁂	Cuttings
■	Grout
△	Concrete
▧	Bentonite Seal

Summary

Overburden (ft)	5.5
Rock Cored (ft)	10
Samples	1S, 2C

Boring No. HAB-ED-02

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

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

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

HALEY ALDRICH

CORE BORING REPORT

DRAFT

Boring No. **HAB-ED-02**
File No. 128064-011
Sheet No. 2 of 2

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weath- ering	Elev./ Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
	4	C1	5.5 9.5	12 5	25 10	Moder- ate	719.5 5.5	Hard, moderately weathered, gray, aphanitic LIMESTONE, thickly bedded, joints are sub horizontal, very closely spaced, rough, decomposed.
	4							
	4							
	4					High		
	6	C2	9.5 15.5	58 35	81 49	Moder- ate	715.5 9.5	Soft, highly weathered, gray, SHALE.
10	2						715.0 10.0	Hard, moderately weathered, brown, medium grained SANDSTONE,thinly bedded, joints are very closely spaced, decomposed.
	3							
	4							
	4							
	5						710.3 14.7	Hard, moderately weathered, gray, aphanitic LIMESTONE, thickly bedded, joints ate horizontal, very closely spaced, fresh.
15							709.5 15.5	BOTTOM OF EXPLORATION 15.5 FT
20								
25								
30								
35								

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-ED-02	C1	5.5-9.5	12 in./25%	5 in./10%	Complete
HAB-ED-02	C2	9.5-15.5	58 in./97%	35 in./58%	Complete

HAB-ED-02 Core Box 1 of 1

HALEY ALDRICH

CELL 002 EMBANKMENTS
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

HAB-ED-02 ROCK CORE PHOTO

JANUARY 2020

FILE NO. 128064-011

TEST BORING REPORT

DRAFT

Boring No. HAB-ED-03

Project	Thomas Hill Energy Center-Cell 002 Embankments, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 3
Start	02 October 2019
Finish	02 October 2019
Driller	C. Dutton
H&A Rep.	E. Foushee
Elevation	720.6
Datum	NAVD88
Location	N 1,350,443 E 1,601,789

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing: Hollow Stem Auger
Hoist/Hammer: NA Automatic Hammer

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0																
5	2 2 4 5	S1 16	4.0 6.0		CH	Medium stiff FAT CLAY (CH), moist -GLACIAL DRIFT DEPOSITS-						100				
10	10 11 13 17	S2 14	9.0 11.0	711.6 9.0		Gray weathered SHALE, foliated, dry -WEATHERED BEDROCK-										
15	11 26 36 48	S3 19	14.0 16.0			Similar to S2										
20	27 26	S4	19.0 21.0			Similar to S2										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
10/2/19		N/A	21.5	31.5	Dry

Sample ID

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

Well Diagram

◫ Riser Pipe
▤ Screen
⛆ Filter Sand
▦ Cuttings
■ Grout
△ Concrete
▨ Bentonite Seal

Summary

Overburden (ft)	21.5
Rock Cored (ft)	10
Samples	4S, 3C

Boring No. HAB-ED-03

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

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

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

HALEY ALDRICH

TEST BORING REPORT

Boring No. HAB-ED-03
File No. 128064-011
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	**VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION** (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	30 30															
						Auger refusal at 21.5 ft										
						SEE CORE BORING REPORT FOR ROCK DETAILS										
25																
30																

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

Boring No. HAB-ED-03

HALEY ALDRICH

CORE BORING REPORT

DRAFT

Boring No. **HAB-ED-03**
File No. 128064-011
Sheet No. 3 of 3

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weathering	Elev./ Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
	3	C1	21.5 28.5	75 47	89 56	Moder-ate	699.1 21.5	Hard, moderately weathered, gray, aphanitic LIMESTONE, joints are closely spaced, fresh. Limestone is fossiliferous.
	4							
	3							
	5						696.0 24.6	Hard, moderately weathered, black, fine grained SHALE, joints are horizontal, very closely spaced, frash. Rubble zone from 25.0 ft to 25.5 ft.
25								
	3							
	3							
	3							
	8	C2	28.5 29.5	11 7	92 58	Moder-ate		Medium, highly weathered, gray, fine grained SHALE, joints are very closely spaced, decomposed and disintegrated.
	6	C3	29.5 31.5	24 18	100 75	High		
30								
	7							
							689.1 31.5	BOTTOM OF EXPLORATION 31.5 FT
35								
40								
45								
50								

H+A_CORE+WELL07-1 128064-011_HA-LIB09-REV.GLB HA-TB+CORE+WELL-07-1.GDT \\HALEYALDRICH.COM\SHARE\WAS_COMMON\PROJECTS\128064-AECI THOMAS HILL\011- TH POND 002 AND EAST DITCH\FIELDWORK\GINT\128064-011TBC_ED.GPJ Feb 10, 20

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-ED-03	C1	21.5-28.5	75 in./89%	47 in./56%	Complete
HAB-ED-03	C2	28.5-29.5	11 in./92%	7 in./64%	Complete
HAB-ED-03	C3	29.5-31.5	24 in./100%	18 in./75%	Complete

HAB-ED-03 Core Box 1 of 1

HALEY ALDRICH

CELL 002 EMBANKMENTS
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

HAB-ED-03 ROCK CORE PHOTO

JANUARY 2020

HALEY ALDRICH

TEST BORING REPORT

Boring No. HAB-ED-04

Project	Thomas Hill Energy Center-Cell 002 Embankments, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 2
Start	02 October 2019
Finish	02 October 2019
Driller	C. Dutton
H&A Rep.	G. Foushee
Elevation	719.2
Datum	NAVD88
Location	N 1,350,235 E 1,601,573

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X

Bit Type: Cutting Head

Drill Mud: None

Casing: Hollow Stem Auger

Hoist/Hammer: NA Automatic Hammer

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0				718.7 0.5	CH	Dark brown FAT CLAY (CH), stiff -GLACIAL DRIFT DEPOSITS-						100				
	9 20 29 34	S3 24	1.0 3.0			Yellow-brown medium grained weathered SANDSTONE										
5	5 10 17 15	S1 22	4.0 6.0		CH	Similar to S1 -WEATHERED BEDROCK-										
	6 24 43 47	S2 24	6.0 8.0	713.2 6.0		Gray fine grained weathered SHALE										
10																
15	7 20 29 34	S3 24	14.0 16.0			Similar to S2										
					CH	Similar to S2 Sample refusal at 19.2 ft.										
20	50/2"	S4 2	19.0 19.2			SEE CORE BORING REPORT FOR ROCK DETAILS										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Depth (ft) to: Bottom of Hole	Depth (ft) to: Water
10/2/19		N/A	19.0	29.0	Dry

Sample ID

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

Well Diagram

▥	Riser Pipe
▤	Screen
⁙	Filter Sand
▦	Cuttings
■	Grout
△	Concrete
▨	Bentonite Seal

Summary

Overburden (ft)	19.2
Rock Cored (ft)	10
Samples	3S, 2C

Boring No. HAB-ED-04

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

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

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

CORE BORING REPORT

DRAFT

Boring No. **HAB-ED-04**
File No. 128064-011
Sheet No. 2 of 2

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weathering	Elev./ Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
		C1	19.2 26.0				700.0 19.2	Hard, fresh, gray, aphanitic LIMESTONE, joints are fresh, closely spaced. Limestone is fossiliferous.
20	3							
	2							
	2							
	3						696.2 23.0	Medium, moderately weathered, black, fine grained SHALE, thinly bedded, joints are horizontal, very closely spaced, fresh.
	2							
25	2							
	3	C2	26.0 29.0	34 30	94 83	Moderate		Medium, moderately weathered, gray, fine grained SHALE, joints are closely spaced, decomposed.
	4							
	4							
							690.2 29.0	BOTTOM OF EXPLORATION 29.0 FT
30								
35								
40								
45								

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-ED-04	C1	19.0-26.0	79 in./94%	60 in./71%	Complete
HAB-ED-04	C2	26.0-29.0	34 in./94%	30 in./83%	Complete

HAB-ED-04 Core Box 1 of 1

HALEY ALDRICH

CELL 002 EMBANKMENTS
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

HAB-ED-04 ROCK CORE PHOTO

JANUARY 2020

FILE NO. 128064-011

HALEY ALDRICH

TEST BORING REPORT

Boring No. HAB-ED-05

Project	Thomas Hill Energy Center-Cell 002 Embankments, Clifton Hill, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

File No.	128064-011
Sheet No.	1 of 2
Start	01 October 2019
Finish	01 October 2019
Driller	C. Dutton
H&A Rep.	G. Foushee
Elevation	712.6
Datum	NAVD88
Location	N 1,350,031 E 1,601,454

	Casing	Sampler	Barrel
Type	HSA	S	NQ
Inside Diameter (in.)	3.75	1.375	1.875
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Truck: CME 500X
Bit Type: Cutting Head
Drill Mud: None
Casing: Hollow Stem Auger
Hoist/Hammer: NA Automatic Hammer

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						-GLACIAL DRIFT DEPOSITS-										
▽	4 7 9 14	S1 22	3.5 5.0													
5					CL	Very stiff brown LEAN CLAY (CL), moist, wet below 5.0 ft -WEATHERED BEDROCK-						100				
	8 1 50/2"	S2 8	8.5 9.3	703.6 9.0	CL	Similar to S1 Sample refusal at 9.3 ft.										
						Weathered SHALE -WEATHERED BEDROCK-										
10						SEE CORE BORING REPORT FOR ROCK DETAILS										
15																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
10/1/19		N/A	8.5	19.3	5.0

Sample ID

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

Well Diagram

◫	Riser Pipe
▤	Screen
⁘	Filter Sand
⁂	Cuttings
■	Grout
△	Concrete
▨	Bentonite Seal

Summary

Overburden (ft)	9.3
Rock Cored (ft)	10
Samples	2S, 3C

Boring No. HAB-ED-05

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

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

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

HALEY ALDRICH

CORE BORING REPORT

Boring No. **HAB-ED-05**
File No. 128064-011
Sheet No. 2 of 2

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weathering	Elev./ Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
	5 8 6 4	C1	9.3 13.3	44 40	92 83	Fresh	703.3 9.3	Hard, fresh, gray, aphanitic LIMESTONE, joints are sub vertical, closely spaced, oxidized on surface. Limestone is fossiliferous.
	4 5 4	C2	13.3 16.3	32 6	89 17	Moderate	699.3 13.3	Medium, moderately weathered, black, fine grained SHALE, thinly bedded, joints are horizontal, closely spaced, fresh.
	4 4 5	C3	16.3 19.3	33 23	92 64	Moderate		Medium, moderately weathered, gray, fine grained SHALE, thinly bedded, joints are horizontal, closely spaced, decomposed.
							693.3 19.3	BOTTOM OF EXPLORATION 19.3 FT

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-ED-05	C1	9.3-13.3	44 in./92%	40 in./83%	Complete
HAB-ED-05	C2	13.3-16.3	32 in./89%	6 in./16%	Complete
HAB-ED-05	C3	16.3-19.3	33 in./92%	23 in./64%	Complete

HAB-ED-05 Core Box 1 of 1

HALEY ALDRICH

CELL 002 EMBANKMENTS
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

HAB-ED-05 ROCK CORE PHOTO

JANUARY 2020

FILE NO. 128064-011

HALEY ALDRICH TEST BORING REPORT

Boring No. HAB-ED-06

Project	Thomas Hill Energy Center-Cell 002 Embankments, Clifton Hill, MO	File No.	128064-011
Client	Associated Electric Cooperative, Inc.	Sheet No.	1 of 2
Contractor	Bulldog Drilling	Start	01 October 2019
		Finish	01 October 2019
		Driller	C. Dutton
		H&A Rep.	G. Foushee
		Elevation	705.7
		Datum	NAVD88
		Location	N 1,349,858 E 1,601,209

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	NQ	Rig Make & Model: Truck: CME 500X
Inside Diameter (in.)	3.75	1.375	1.875	Bit Type: Cutting Head Drill Mud: None
Hammer Weight (lb)	-	140	-	Casing: Hollow Stem Auger
Hammer Fall (in.)	-	30	-	Hoist/Hammer: NA Automatic Hammer

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						-GLACIAL DRIFT DEPOSITS-										
5	3 5 9 10	S1 22	4.0 6.0		CH	Stiff mottled gray-brown FAT CLAY with sand (CH), pronounced needle-like crystals			15			85				
10	3 10 50/5"	S2 15	9.0 11.0		CH	Similar to S1, except hard Sample refusal at 11.0 ft.										
						SEE CORE BORING REPORT FOR ROCK DETAILS										
15																
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
10/1/19		N/A	9.0	21.0	1.5

Sample ID

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

Well Diagram

▥ Riser Pipe
▤ Screen
▒ Filter Sand
▩ Cuttings
■ Grout
△ Concrete
▧ Bentonite Seal

Summary

Overburden (ft)	11
Rock Cored (ft)	10
Samples	2S, 2C

Boring No. HAB-ED-06

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

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

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

CORE BORING REPORT

Boring No. **HAB-ED-06**
File No. 128064-011
Sheet No. 2 of 2

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD		Weath-ering	Elev./ Depth (ft)	Visual Description and Remarks
				in.	%			
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
15	4 4 4 3 6	C1	11.0 16.0	52 14	87 23	High	694.7 11.0	Soft, highly weathered, gray, fine grained SHALE, thinly bedded, joints are very closely spaced, decomposed and disintegrated.
20	5 4 1 1 2	C2	16.0 21.0	34 5	57 8	High	685.2 20.5	Hard, highly weathered, yellow to gray, aphanitic LIMESTONE, medium bedded, joints are closely spaced.
							684.7 21.0	BOTTOM OF EXPLORATION 21.0 FT Note: Either void or clay washout in 17.0 ft to 20.0 ft, string just drops.
25								
30								
35								
40								

Boring ID	Run No.	Depth (ft)	REC (in./%)	RQD (in./%)	Comments
HAB-ED-06	C1	11.0-16.0	52 in./87%	14 in./23%	Complete
HAB-ED-06	C2	16.0-21.0	34 in./57%	5 in./8%	Complete

HAB-ED-06 Core Box 1 of 1

HALEY ALDRICH

CELL 002 EMBANKMENTS
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

HAB-ED-06 ROCK CORE PHOTO

JANUARY 2020

WATER CONTENT DETERMINATION

Project	Thomas Hill Energy Center – CDT Additional Work	Client	Haley & Aldrich, Inc.	
Location	Cilfton Hill, MO	Page	1 of 1	
Job No.	104287-002	Tested by / Date:	LNL	1/22/20
File	104287-002 D2216	Calculated by / Date:	CMB	1/23/20
Procedure	ASTM D2216 / AASHTO T265	Checked by / Date:	CMB	1/23/20

	Boring Number	Sample Number	Sample Depth (feet)	Tare ID	Wet wt. & Tare (gm)	Dry wt. & Tare (gm)	Tare Weight (gm)	Moisture Content %	Remarks Sample Length
1	HAB-002-01	S2	5.0	H-1	23.04	19.54	2.50	20.5	4.0
2	HAB-002-01	S5	15.0	H-2	24.19	20.45	2.50	20.8	4.0
3	HAB-002-01	S6	25.0	H-3	24.33	19.96	2.49	25.0	4.0
4	HAB-002-01	S8	35.0	H-4	23.08	18.79	2.50	26.3	4.0
5	HAB-002-01	S9	40.0	H-5	22.77	18.54	2.50	26.4	4.0
6	HAB-002-02	S1	3.0	H-6	22.78	17.97	2.53	31.2	3.0
7	HAB-002-02	S2	5.0	H-7	22.63	19.29	2.52	19.9	3.5
8	HAB-002-02	S5	15.0	H-8	22.80	19.39	2.49	20.2	3.5
9	HAB-002-02	S7	29.0	H-9	22.63	19.66	2.47	17.3	3.0
10	HAB-002-03	S2	5.0	H-10	22.66	18.92	2.51	22.8	3.0
11	HAB-002-03	S3	7.0	H-11	22.65	19.43	2.49	19.0	2.0
12	HAB-002-03	S5	19-21	H-12	22.96	18.80	2.50	25.5	3.0
13	HAB-002-03	S6	25.0	H-13	22.50	18.62	2.51	24.1	3.0
14	HAB-002-03	S7	30.0	H-14	22.78	18.77	2.48	24.6	3.5
15	HAB-002-03	S9	40.0	H-15	22.56	18.13	2.50	28.3	4.0
16	HAB-002-03	S10	45.0	H-16	22.74	18.09	2.50	29.8	3.0
17	HAB-002-03	S11	50.0	H-17	22.89	19.43	2.53	20.5	4.0
18	HAB-002-03	S12	55.0	H-18	22.62	19.73	2.51	16.8	2.0
19	HAB-002-04	S1	3.0	H-19	22.78	19.15	2.52	21.8	3.5
20	HAB-002-04	S3	7.0	H-20	23.00	19.37	2.50	21.5	3.5
21	HAB-002-04	S4	15.0	H-21	22.50	18.31	2.50	26.5	4.0
22	HAB-002-04	S7	35.0	H-22	22.72	19.85	2.48	16.5	3.5

SUMMARY OF LABORATORY TESTING 11/19/2019
Thomas Hill Energy Center - CDT
104287-002 / 128064-011

Boring	Top Depth (feet)	Sample No.	Sample Type	Water Content
HAB-002-01	6	S3	SPT	
HAB-002-01	7		SPT	25.9

PROJECT Thomas Hill Energy Center – CDT Additional Work
DATE 11/5/19
BORING NO. HAB-002-03
JOB NO. 104287-002
SHEET NO. 1
TESTED BY CMB
CLIENT NAME Haley & Aldrich, Inc.
CHECKED BY CMB

CLASSIFICATION OF UNDISTURBED SAMPLE

SAMPLE NO. T1
DEPTH (ft) 14-16
Sampling Method Push
Type of Sample Shelby Tube
Inch 3"
Brass or [✓ Steel]

DEPTH FT.	NAT. W.C.		TYPE OF TEST	CLASSIFICATION
	Strength info.	W.C.		
14.0				11 INCH RECOVERY Sample: Good Fair [✓ Poor] Disturbed
14.5	PP = 2.25 tsf	TT-1	MC CU Atterberg Sieve	Very stiff to hard, olive gray to yellow-brown, Lean Clay with Sand (CL); moist; 5% fine, subrounded gravel; 22% fine to coarse, subrounded sand; 73% medium dry strength, no dilatancy, medium plasticity.
15.0	PP = 4.5 tsf	TT-2	MC	
15.5				
16.0				

Can/Tare No.	TT-1	TT-2
WET + TARE	72.17	69.27
DRY + TARE	61.30	60.53
TARE	2.49	2.51
% WATER	18.5	15.1

Procedure: ASTM D 2488

NOTE: Soil description is based on visual-manual procedure. This description is not meant for engineering purposes requiring precise classification of soils.

All sample percentages for cobbles and boulders are by volume.

REMARKS: Removed 4 inches of fall in from top of tube before testing.

PROJECT Thomas Hill Energy Center – CDT Additional Work
DATE 11/5/19
BORING NO. HAB-002-04
JOB NO. 104287-002
SHEET NO. 1
TESTED BY CMB
CLIENT NAME Haley & Aldrich, Inc.
CHECKED BY CMB

CLASSIFICATION OF UNDISTURBED SAMPLE

SAMPLE NO. T2
DEPTH (ft) 24-26
Sampling Method Push
Type of Sample Shelby Tube
Inch 3"
Brass or [✓ Steel]

DEPTH FT.	NAT. W.C.		TYPE OF TEST	CLASSIFICATION
	Strength info.	W.C.		
				24 INCH RECOVERY Sample [✓ Good] Fair Poor Disturbed
24.0	PP = 1.75 tsf	TT-3	MC	Stiff, olive gray to yellow-brown, Fat Clay with Sand (CH); moist; 1% fine, subrounded gravel; 16% fine to coarse, subrounded sand; 83% high dry strength, no dilatancy, high plasticity.
24.5			SAVED	
25.0				
25.5			CU Atterberg Sieve	
26.0	PP = 1.5 tsf	TT-4	MC	

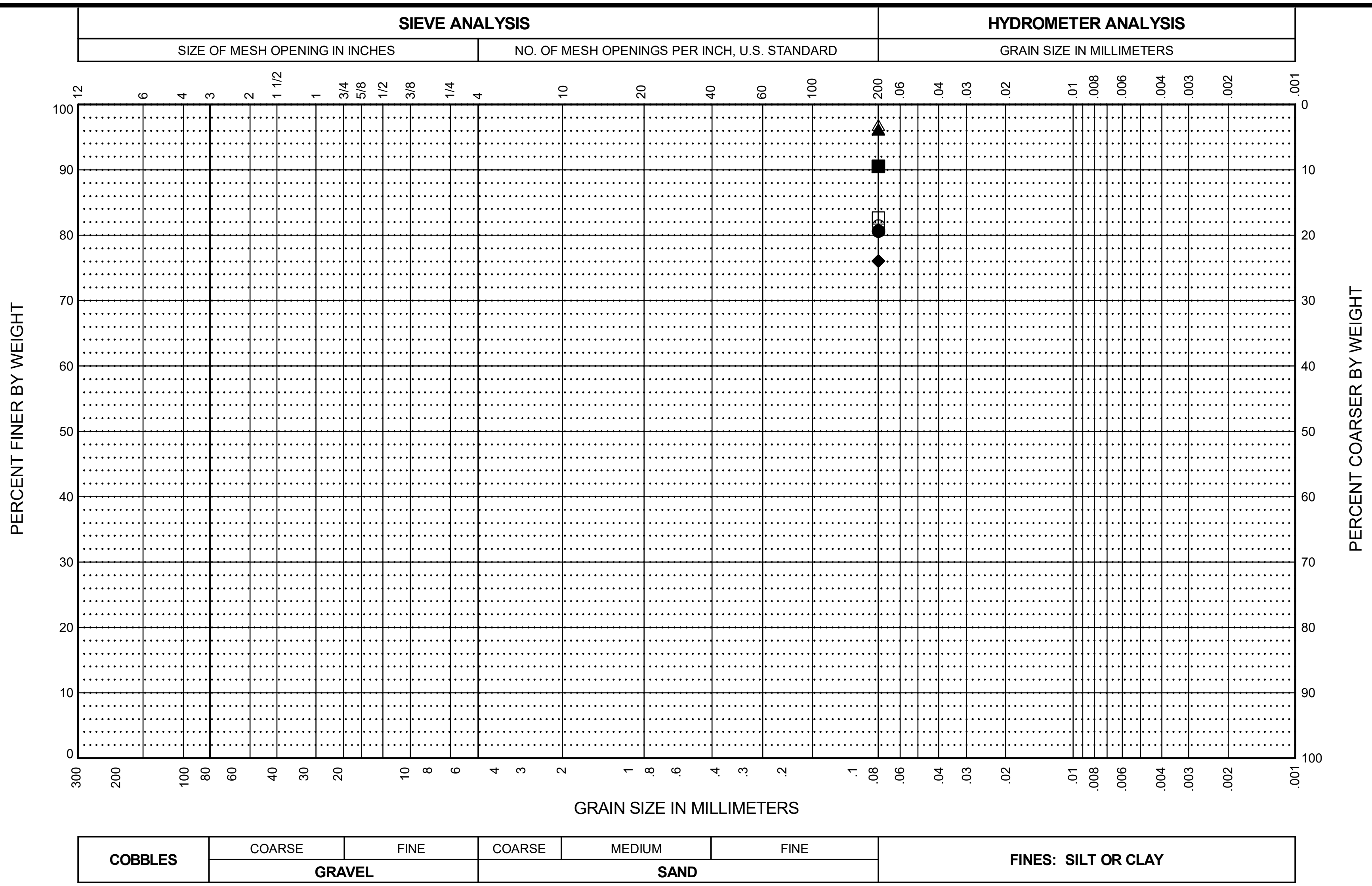
Can/Tare No.	TT-3	TT-4
WET + TARE	81.82	71.38
DRY + TARE	66.03	56.97
TARE	2.51	2.51
% WATER	24.9	26.5

Procedure: ASTM D 2488

NOTE: Soil description is based on visual-manual procedure. This description is not meant for engineering purposes requiring precise classification of soils.

All sample percentages for cobbles and boulders are by volume.

REMARKS: Rock pushed with sample creating a sample only partially round for the first 15 inches of sample.



GSA- WITH SAMPLE INTERVALS 104287-002 LAB DATA.GPJ SHAN_WIL.GDT 11/12/19

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HAB-002-01, S1	2.0 - 4.0	CH	Dark gray, Fat Clay with Sand.	80.6	19.5	54	20	34
■ HAB-002-01, S4	8.0 - 10.0	CL	Olive gray and yellow-brown, Lean Clay.	90.5	19.8			
▲ HAB-002-01, S7	29.0 - 31.0	CL	Dark gray, Lean Clay.	96.2	31.5	44	18	26
◆ HAB-002-02, S3	6.0 - 8.0	CL	Yellow-brown, Lean Clay with Sand.	76.1	24.1			
○ HAB-002-02, S6	24.0 - 26.0	CH	Dark gray, Fat Clay with Sand.	81.4	26.2	54	19	35
□ HAB-002-03, S1	2.0 - 4.0	CH	Dark gray and yellow-brown, Fat Clay with Sand.	82.6	21.8	50	22	28
△ HAB-002-03, S4	8.0 - 10.0	CL	Dark gray, Lean Clay.	96.9	22.1			

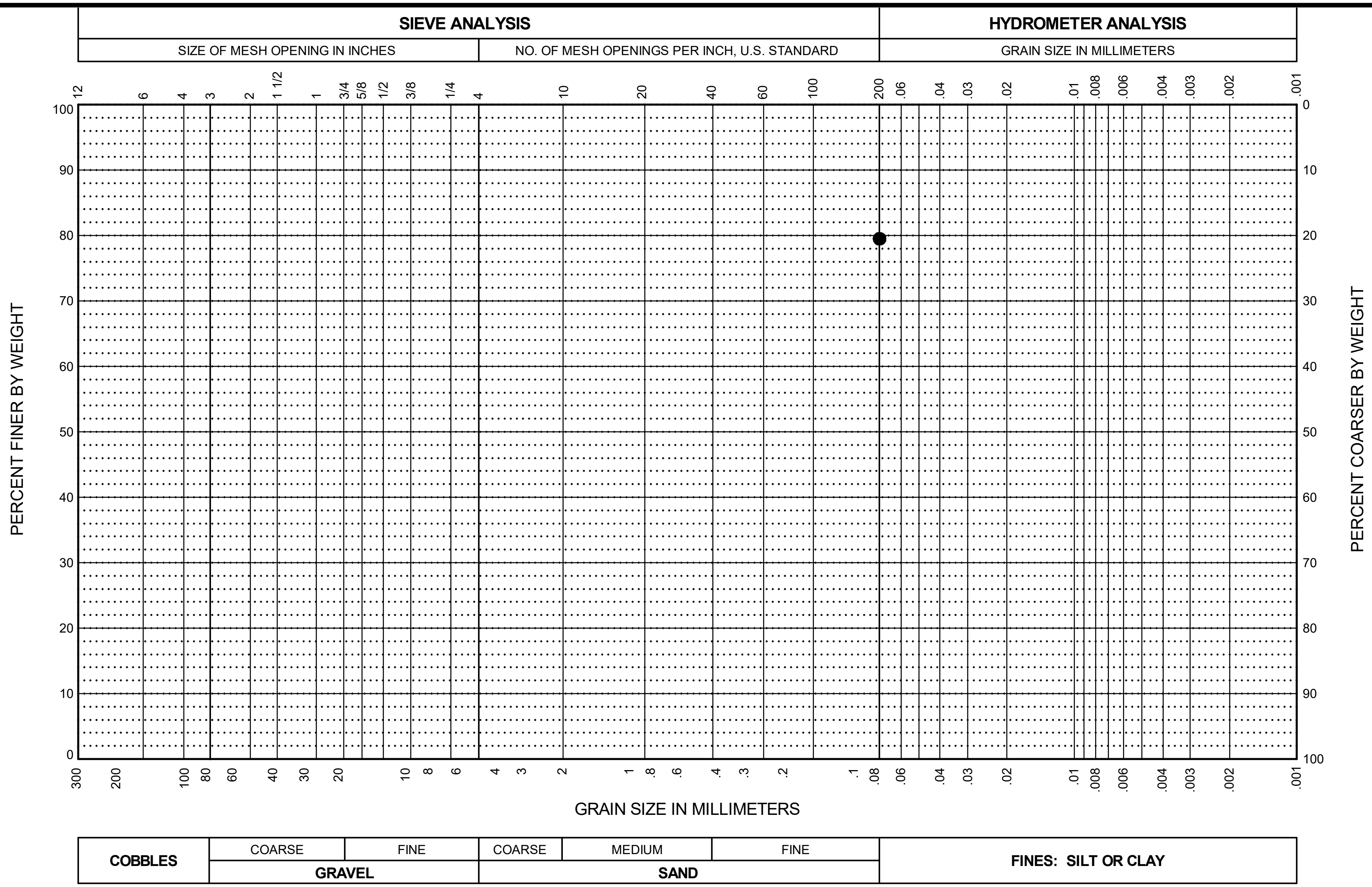
Thomas Hill Energy Center – CDT
Additional Work
Clifton Hill, Missouri

GRAIN SIZE DISTRIBUTION

November 2019 104287-002 / 128064-011

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.
Sheet 1 of 2



GSA- WITH SAMPLE INTERVALS 104287-002 LAB DATA.GPJ SHAN_WIL.GDT 11/12/19

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HAB-002-04, S2	4.0 - 6.0	CH	Yellow-brown, Fat Clay with Sand.	79.5	22.1	65	27	38

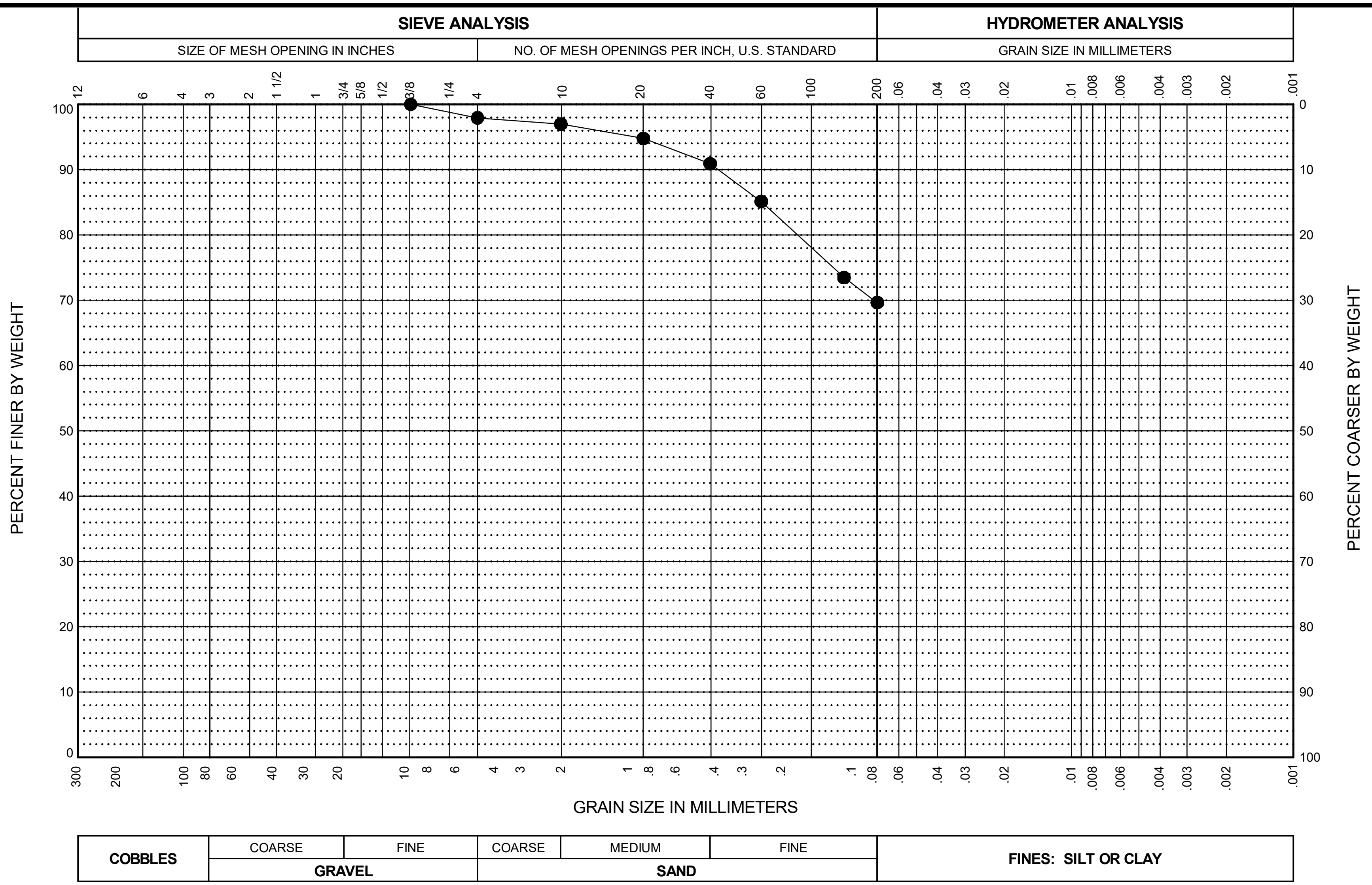
Thomas Hill Energy Center – CDT
Additional Work
Clifton Hill, Missouri

GRAIN SIZE DISTRIBUTION

November 2019 104287-002 / 128064-011

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.
Sheet 2 of 2



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HAB-002-02, S4	8.0 - 10.0	CL	Yellow-brown, Sandy Lean Clay.	69.6	18.4	46	16	30

Thomas Hill Energy Center – CDT
Additional Work
Clifton Hill, Missouri

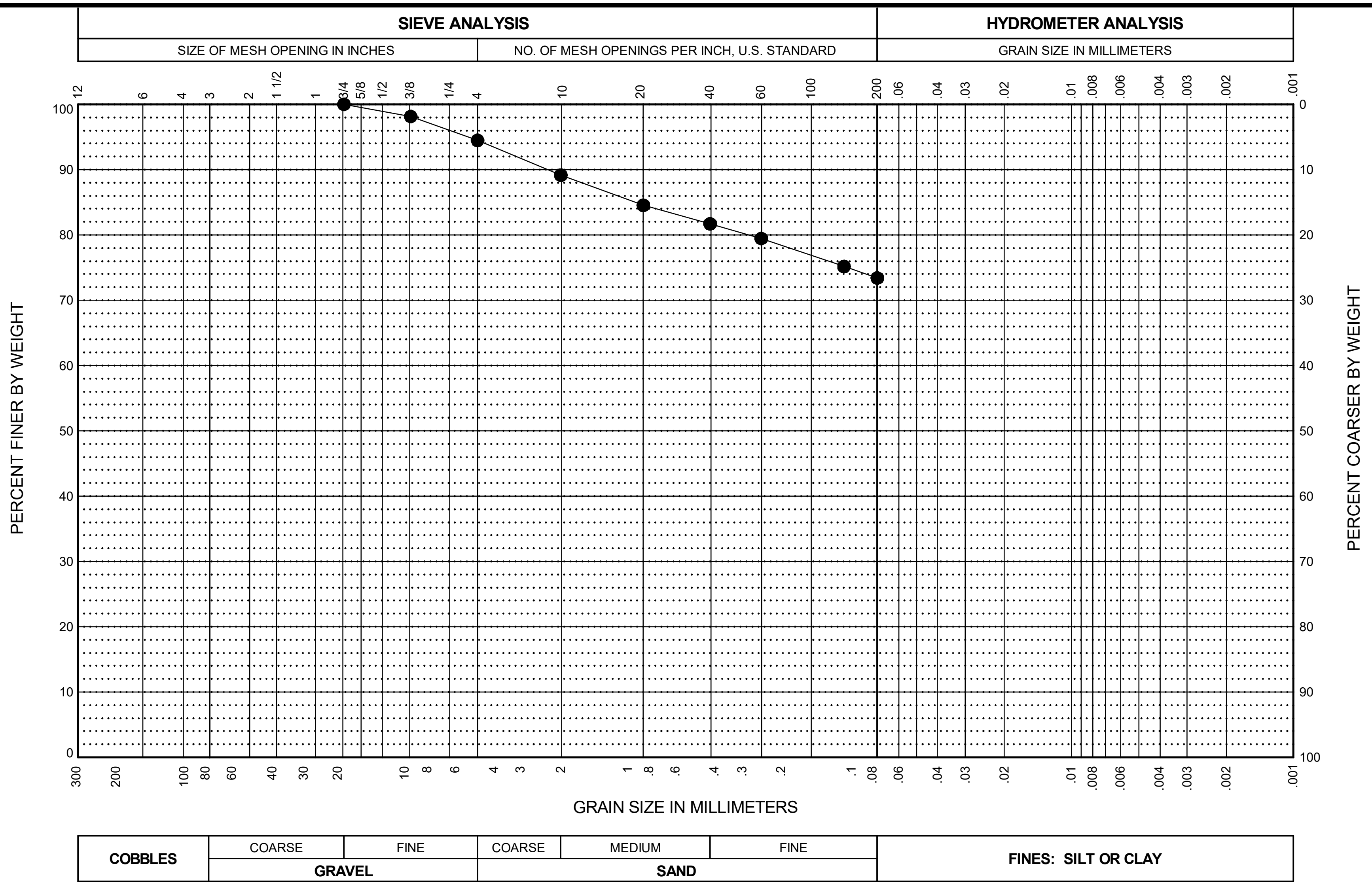
GRAIN SIZE DISTRIBUTION

November 2019 104287-002 / 128064-011

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.
Sheet 1 of 1

GSA- WITH SAMPLE INTERVALS 104287-002 LAB DATA.GPJ SHAN_WIL.GDT 11/12/19



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HAB-002-03, T1	14.0 - 16.0	CL	Olive gray to yellow-brown, Lean Clay with Sand.	73.4	21.7	46	21	25

Thomas Hill Energy Center – CDT
Additional Work
Clifton Hill, Missouri

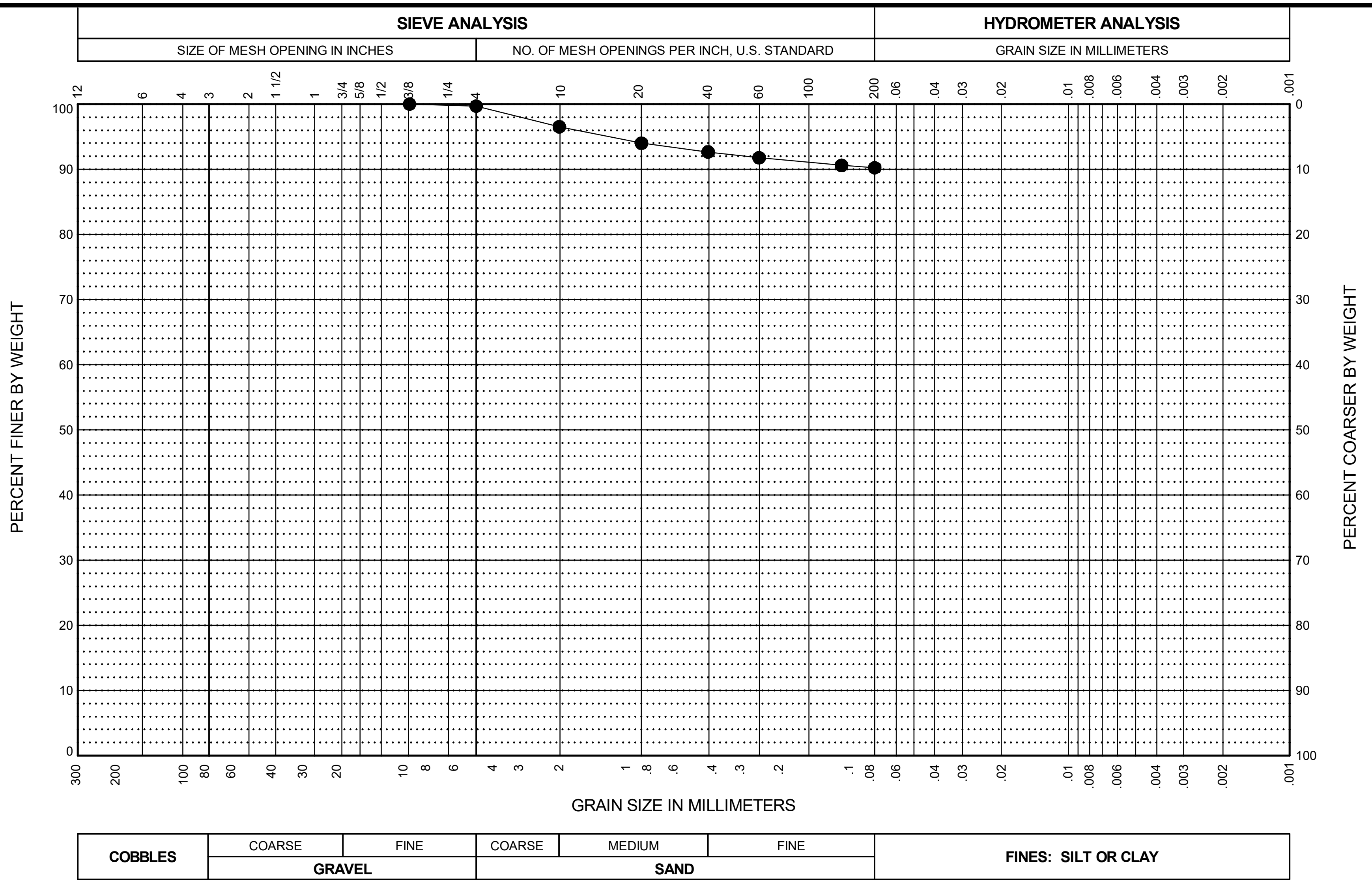
GRAIN SIZE DISTRIBUTION

November 2019 104287-002 / 128064-011

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.
Sheet 1 of 1

GSA- WITH SAMPLE INTERVALS 104287-002 LAB DATA.GPJ SHAN_WIL.GDT 11/12/19



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HAB-002-04, S5	19.0 - 20.0	CL	Dark gray and yellow-brown, Lean Clay.	90.2	27.7			

Thomas Hill Energy Center – CDT
Additional Work
Clifton Hill, Missouri

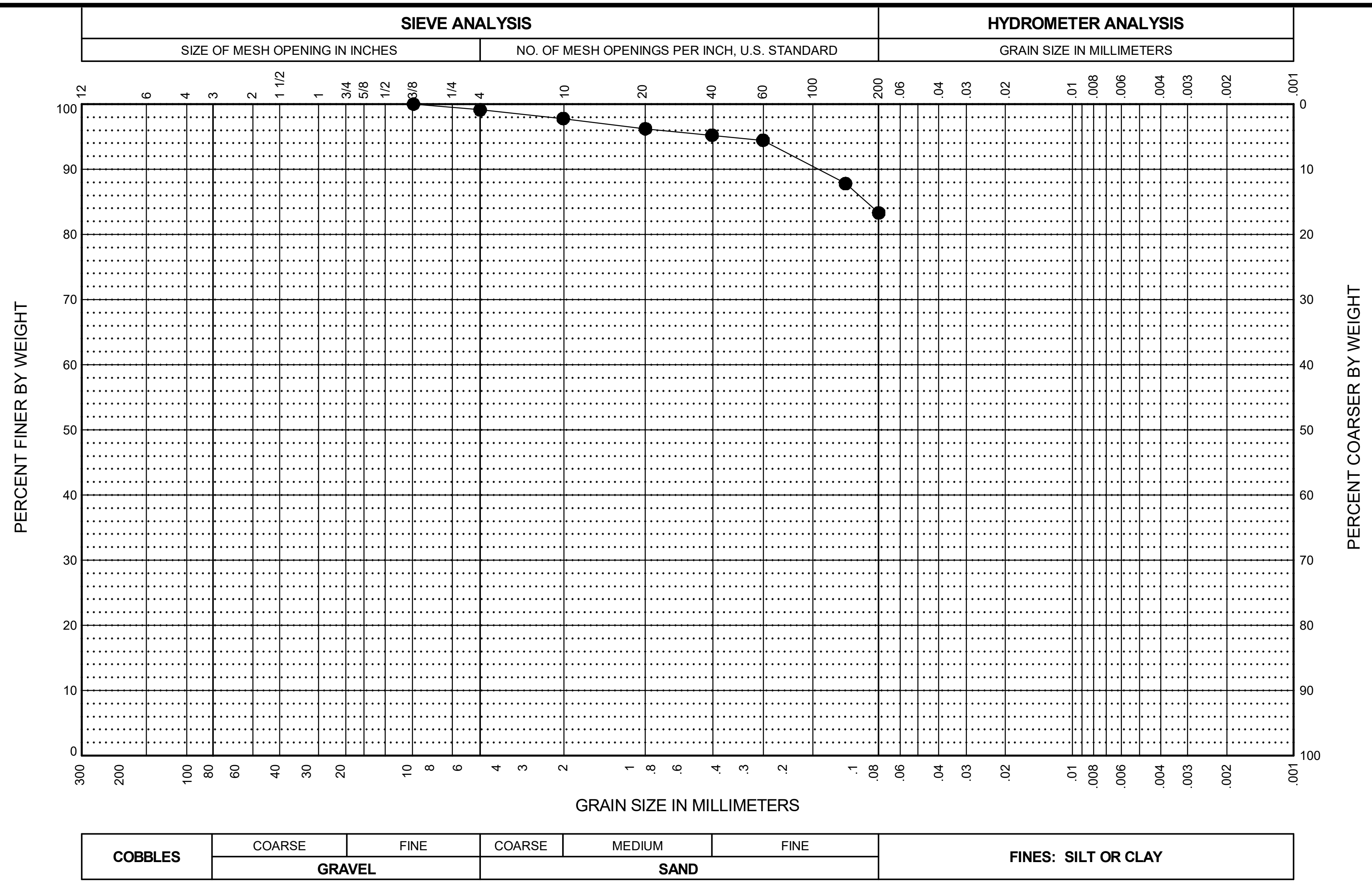
GRAIN SIZE DISTRIBUTION

November 2019 104287-002 / 128064-011

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.
Sheet 1 of 1

GSA- WITH SAMPLE INTERVALS 104287-002 LAB DATA.GPJ SHAN_WIL.GDT 11/12/19



GSA- WITH SAMPLE INTERVALS 104287-002 LAB DATA.GPJ SHAN_WIL.GDT 11/12/19

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HAB-002-04, T2	24.0 - 26.0	CH	Olive gray to yellow-brown, Fat Clay with Sand.	83.3	25.6	65	26	39

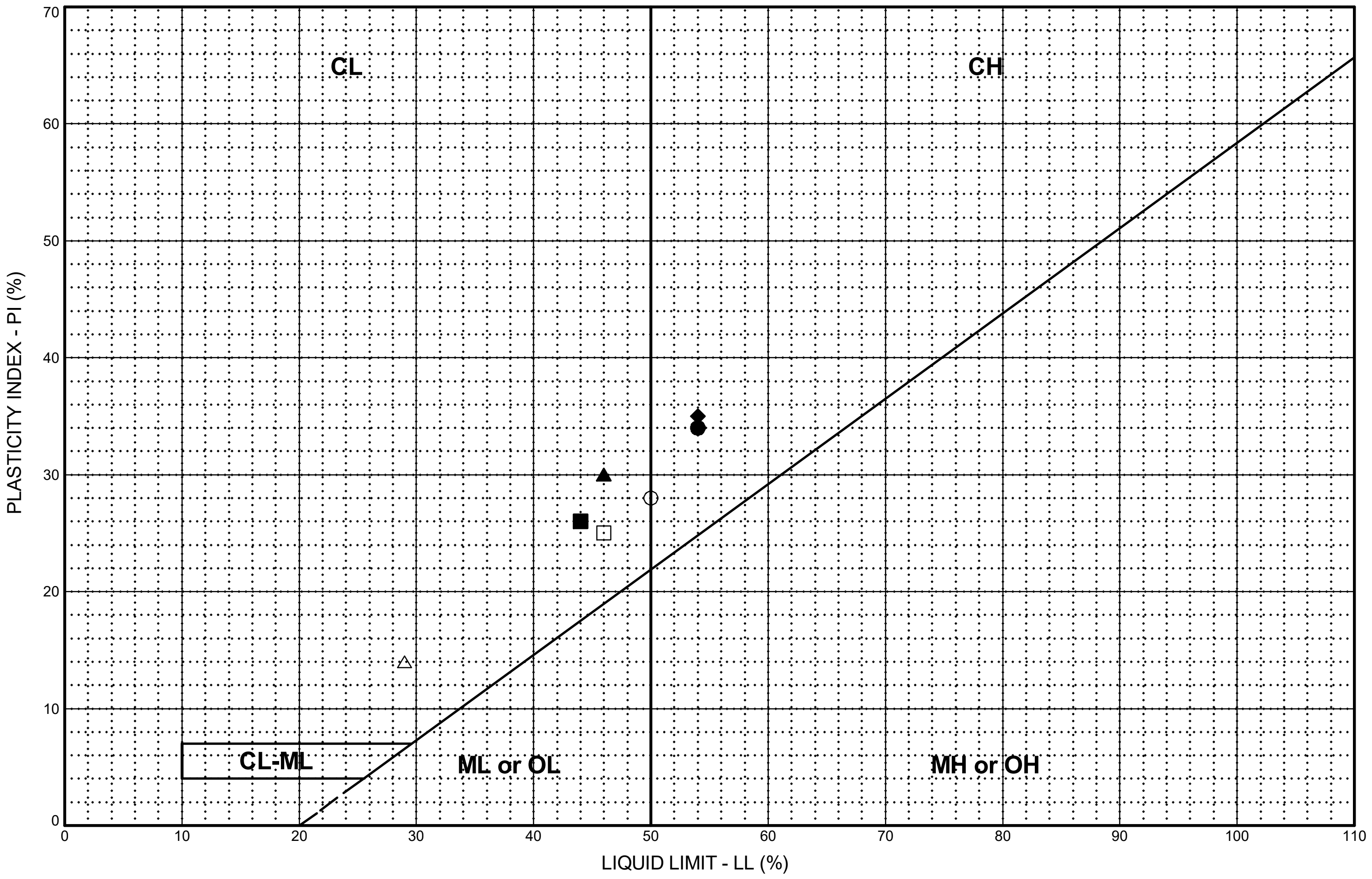
Thomas Hill Energy Center – CDT
Additional Work
Clifton Hill, Missouri

GRAIN SIZE DISTRIBUTION

November 2019 104287-002 / 128064-011

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.
Sheet 1 of 1



LEGEND

CL: Low plasticity inorganic clays; sandy and silty clays

CH: High plasticity inorganic clays

ML or OL: Inorganic and organic silts and clayey silts of low plasticity

MH or OH: Inorganic and organic silts and clayey silts of high plasticity

CL-ML: Silty clays and clayey silts

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION	LL %	PL %	PI %	NAT. W.C. %	PASS. #200, %
● HAB-002-01, S1	2.0 - 4.0	CH	Dark gray, Fat Clay with Sand.	54	20	34	19.5	80.6
■ HAB-002-01, S7	29.0 - 31.0	CL	Dark gray, Lean Clay.	44	18	26	31.5	96.2
▲ HAB-002-02, S4	8.0 - 10.0	CL	Yellow-brown, Sandy Lean Clay.	46	16	30	18.4	69.6
◆ HAB-002-02, S6	24.0 - 26.0	CH	Dark gray, Fat Clay with Sand.	54	19	35	26.2	81.4
○ HAB-002-03, S1	2.0 - 4.0	CH	Dark gray and yellow-brown, Fat Clay with Sand.	50	22	28	21.8	82.6
□ HAB-002-03, T1	14.0 - 16.0	CL	Olive gray to yellow-brown, Lean Clay with Sand.	46	21	25	21.7	73.4
△ HAB-002-03, S8	34.0 - 36.0	CL	Dark gray, Sandy Lean Clay.	29	15	14	25.8	

Thomas Hill Energy Center – CDT
Additional Work
Clifton Hill, Missouri

PLASTICITY CHART

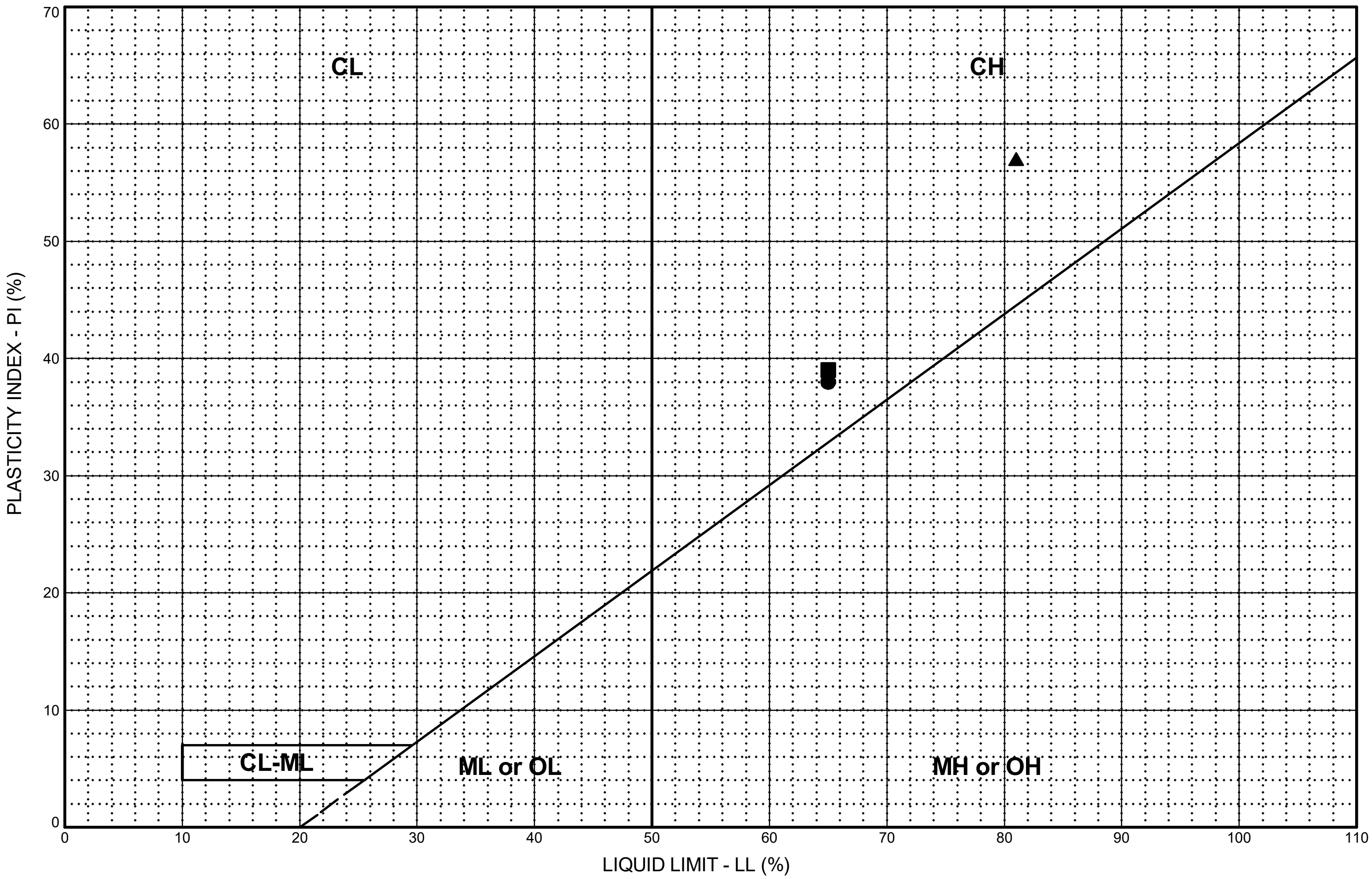
November 2019 104287-002 / 128064-011

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.

FIG.

ATTERBERG - WITH SAMPLE INTERVALS 104287-002 LAB DATA.GPJ SHAN_WIL.GDT 11/12/19



LEGEND

CL:	Low plasticity inorganic clays; sandy and silty clays
CH:	High plasticity inorganic clays
ML or OL:	Inorganic and organic silts and clayey silts of low plasticity
MH or OH:	Inorganic and organic silts and clayey silts of high plasticity
CL-ML:	Silty clays and clayey silts

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION	LL %	PL %	PI %	NAT. W.C. %	PASS. #200, %
● HAB-002-04, S2	4.0 - 6.0	CH	Yellow-brown, Fat Clay with Sand.	65	27	38	22.1	79.5
■ HAB-002-04, T2	24.0 - 26.0	CH	Olive gray to yellow-brown, Fat Clay with Sand.	65	26	39	25.6	83.3
▲ HAB-002-04, S6	29.0 - 31.0	CH	Yellow-brown, Fat Clay with Sand.	81	24	57	28.2	

Thomas Hill Energy Center – CDT
Additional Work
Clifton Hill, Missouri

PLASTICITY CHART

November 2019 104287-002 / 128064-011

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

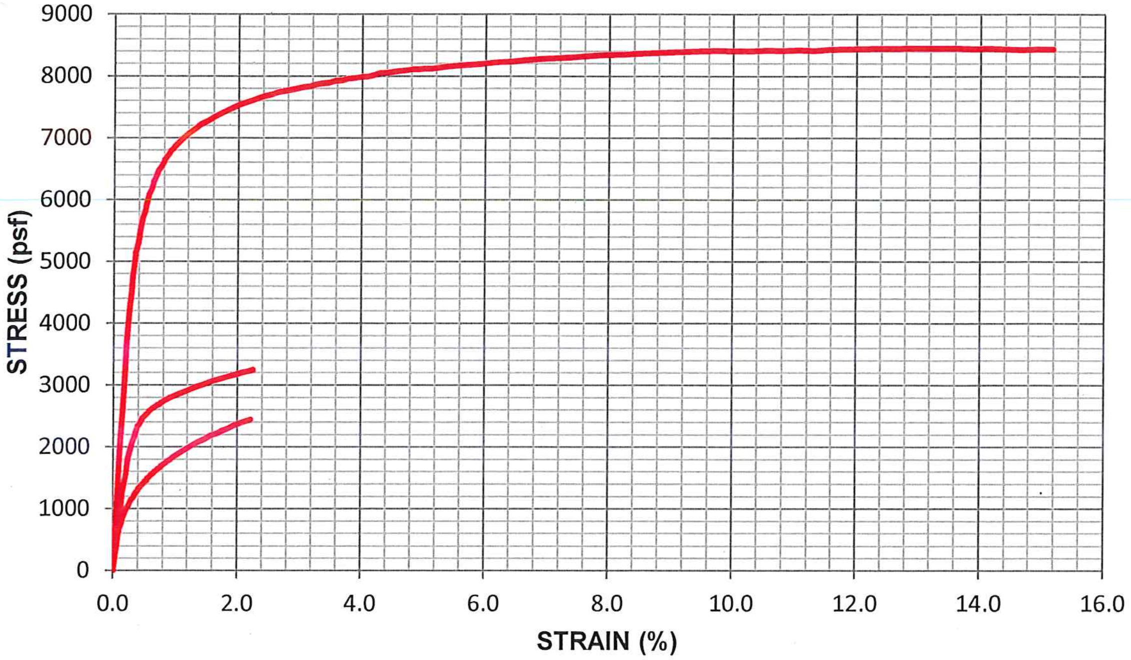
FIG.

ATTERBERG - WITH SAMPLE INTERVALS 104287-002 LAB DATA.GPJ SHAN_WIL.GDT 11/12/19

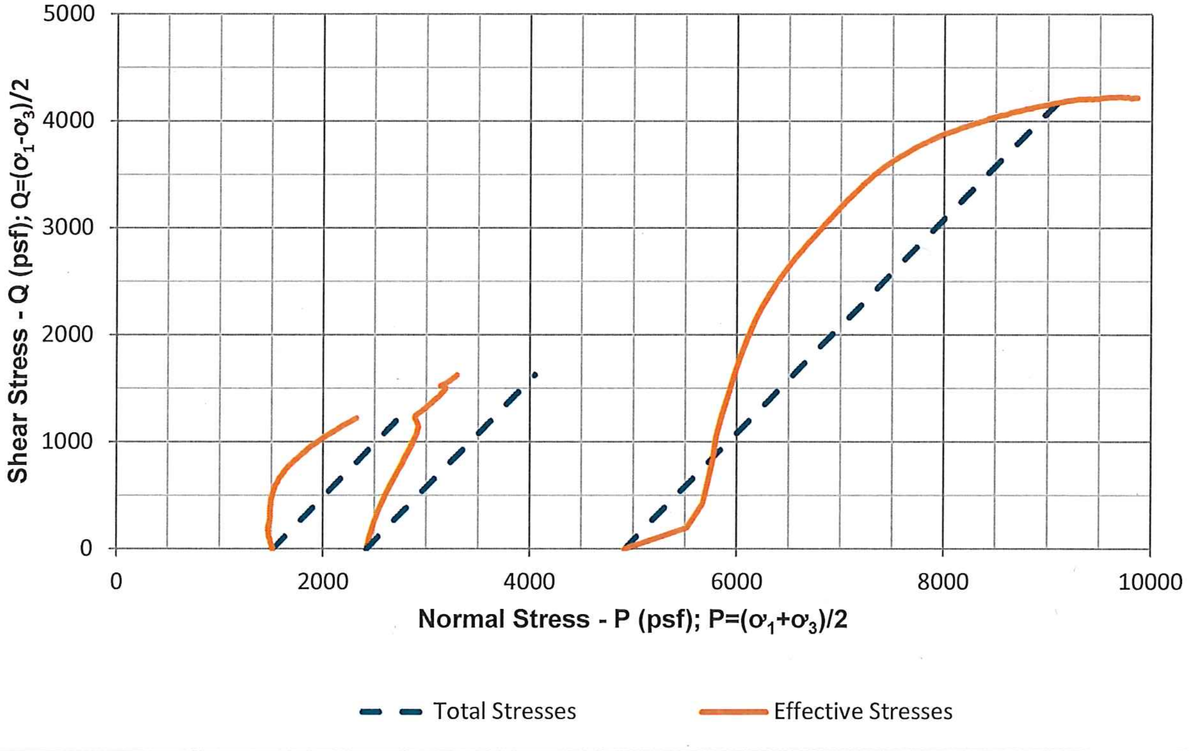
FIG.

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST WITH PORE PRESSURE MEASUREMENT

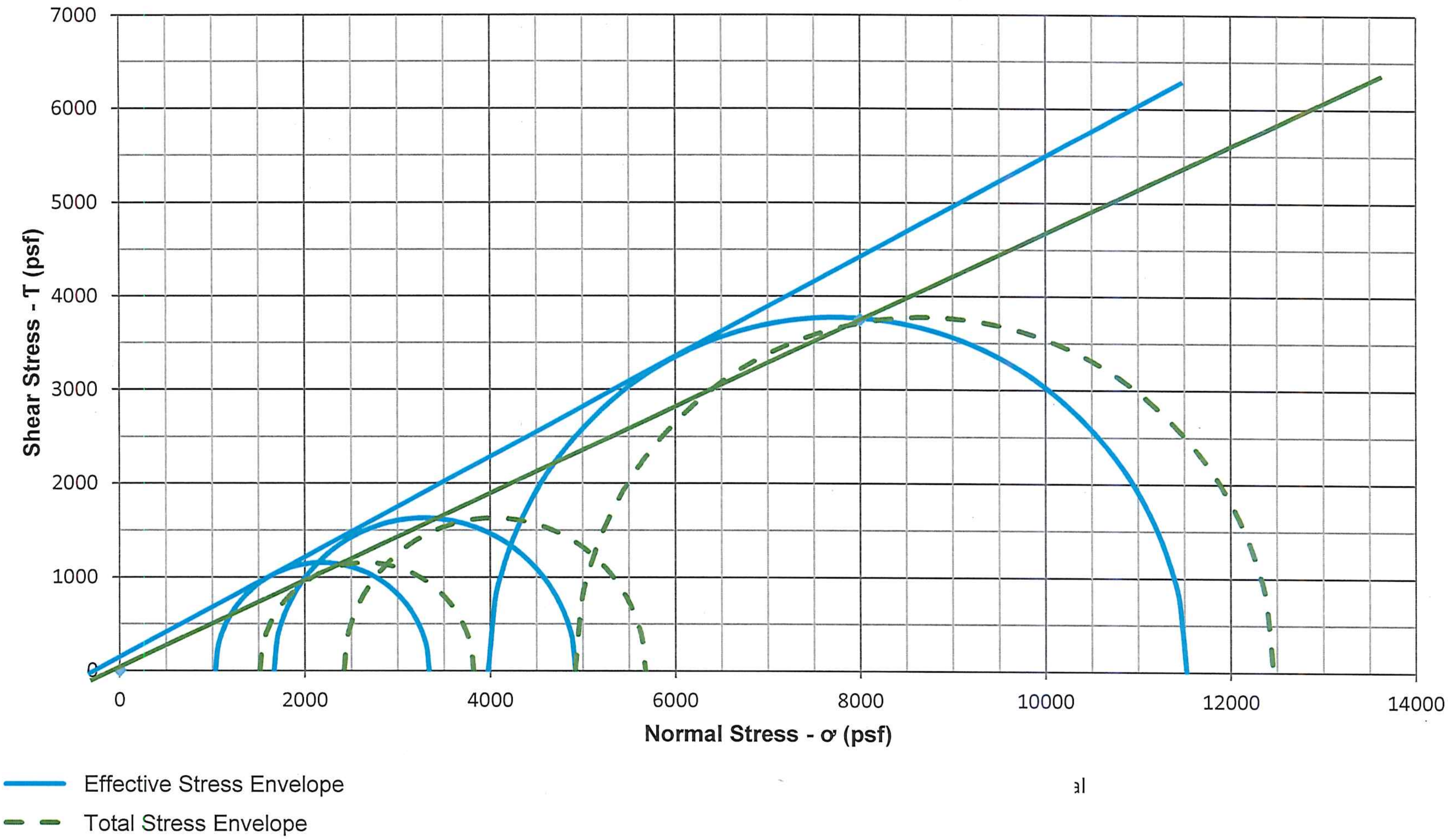
STRESS - STRAIN



P-Q PLOT



SHANNON & WILSON, INC. 2043 WESTPORT CENTER DR. SAINT LOUIS, MISSOURI 63146 104287-002	CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION Thomas Hill Energy Center – Additional Work Clifton Hill, Missouri HAB-002-03 / T1 / 14.0 - 16.0


Mohr's Circle Plots Corresponding to the Peak Principal Stress Ratio

Sample	Strain (%)
Stage 1	1.8
Stage 2	2.2
Stage 3	2.0

c =	390 psf
ϕ =	25.1 deg
c' =	150 psf
ϕ' =	28.1 deg

NOTES:
1. Mohr's circles in this plot are based upon the maximum principal stress difference observed during loading.
2. Strength parameters determined by Shannon & Wilson. Engineer-of-Record should evaluate cohesion and friction commensurate with project conditions.

Thomas Hill Energy Center – Additional Work
Clifton Hill, Missouri

Mohr's Circle Plots
HAB-002-03 / T1

############ 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Figure 1

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	Thomas Hill Energy Center – Additional Work					
Location	Clifton Hill, Missouri			Client	Haley & Aldrich, Inc.	
Job No.	104287-002			Tested by	CMB	Nov-19
Boring	HAB-002-03			Calculated by	CMB	Nov-19
Sample	T1	Specimen Number	Stage 1	Checked by	DPM	11/15/19
Depth (ft)	14.0 - 16.0	Undisturbed/Remold	Undisturbed	File	104287-002 HAB-002-03 T1 ASTM D4767	
Description	Olive-gray to yellow-brown, Lean Clay with Sand (CL).			Procedure	ASTM D4767	
Remarks						

Specimen Data	Initial	Post Consol.	Post Shear
Height (in)	5.984	5.978	5.846
Diameter (in)	2.881	2.870	
Volume (in^3)	39.009	38.663	
Height/Diameter ratio	2.077	2.083	
Weight (g)	1310.83	1309.04	1309.04
Water Content (%)	21.65	21.49	21.49
Bulk Unit Weight (pcf)	128.0	127.8	129.0
Dry Unit Weight (pcf)	105.2	105.2	106.2
Cross-Sectional Area* (in^2)	6.519	6.468	
% Saturation - Wet Method	98.48	100.12	100.12
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	0.589	0.575	0.575
	Trimmings		
Tare ID	TX-1		
Mass wet soil + tare (g)	56.38		
Mass dry soil + tare (g)	46.79		
Mass tare (g)	2.50		

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions

Cell Pressure (psi)	100.5
Pore Pressure (psi)	90.0
Effective Confining Pressure (psi)	10.5
B-value	97.00

Consolidation Phase

Change in Volume (in^3)	0.346
T_{50} (min)	9.6
Platen Travel Rate (in/min)	0.00170

Additional Testing

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results

Peak P (psf)	2665.7
Peak P' (psf)	2186.9
Peak Q (psf)	1153.7
Strain at Peak (%)	1.8
σ_3' (psf)	1033.3
σ_1' (psf)	3340.6
σ_3 (psf)	1512.0
σ_1 (psf)	3819.4

Picture of Failure

See Stage 3

Thomas Hill Energy Center – Additional Work
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-03 / T1 / Stage 1

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
0.00	0.0	0.0	1512.0	1512.0	1.00	1512.0	1512.0	0.0
0.03	261.3	170.1	1603.3	1342.0	1.19	1642.7	1472.6	130.7
0.06	424.5	256.3	1680.3	1255.8	1.34	1724.3	1468.0	212.3
0.07	569.4	312.7	1768.7	1199.3	1.47	1796.7	1484.0	284.7
0.10	679.5	364.9	1826.6	1147.1	1.59	1851.8	1486.9	339.8
0.13	767.2	407.5	1871.7	1104.5	1.69	1895.6	1488.1	383.6
0.15	847.7	445.4	1914.3	1066.6	1.79	1935.9	1490.5	423.8
0.17	913.9	474.5	1951.5	1037.6	1.88	1969.0	1494.5	457.0
0.19	971.1	496.9	1986.2	1015.2	1.96	1997.6	1500.7	485.5
0.22	1026.6	515.8	2022.8	996.2	2.03	2025.3	1509.5	513.3
0.24	1066.0	529.8	2048.2	982.3	2.09	2045.0	1515.3	533.0
0.27	1117.6	546.9	2082.8	965.2	2.16	2070.9	1524.0	558.8
0.29	1153.3	558.9	2106.5	953.2	2.21	2088.7	1529.8	576.7
0.32	1189.2	573.5	2127.7	938.6	2.27	2106.6	1533.1	594.6
0.34	1228.3	578.0	2162.3	934.0	2.32	2126.2	1548.2	614.2
0.36	1261.9	585.0	2189.0	927.1	2.36	2143.0	1558.0	631.0
0.39	1295.2	595.4	2211.8	916.7	2.41	2159.6	1564.2	647.6
0.40	1330.8	603.4	2239.4	908.6	2.46	2177.4	1574.0	665.4
0.43	1360.6	603.2	2269.5	908.9	2.50	2192.4	1589.2	680.3
0.45	1389.3	606.2	2295.2	905.8	2.53	2206.7	1600.5	694.7
0.48	1417.9	611.3	2318.6	900.7	2.57	2221.0	1609.7	708.9
0.50	1444.8	615.3	2341.5	896.7	2.61	2234.4	1619.1	722.4
0.53	1463.6	619.4	2356.3	892.6	2.64	2243.8	1624.4	731.8
0.54	1498.1	619.0	2391.1	893.1	2.68	2261.1	1642.1	749.0
0.58	1523.5	620.6	2415.0	891.4	2.71	2273.8	1653.2	761.8
0.59	1549.4	620.0	2441.4	892.0	2.74	2286.7	1666.7	774.7
0.62	1566.6	623.1	2455.5	888.9	2.76	2295.3	1672.2	783.3
0.64	1587.4	622.0	2477.5	890.0	2.78	2305.8	1683.7	793.7
0.66	1613.3	616.7	2508.6	895.3	2.80	2318.7	1702.0	806.7
0.69	1628.4	621.4	2519.0	890.6	2.83	2326.2	1704.8	814.2
0.72	1654.1	619.2	2547.0	892.9	2.85	2339.1	1719.9	827.1
0.75	1672.2	619.6	2564.7	892.5	2.87	2348.1	1728.6	836.1
0.76	1696.2	613.6	2594.7	898.4	2.89	2360.2	1746.6	848.1
0.79	1711.4	613.7	2609.7	898.3	2.91	2367.7	1754.0	855.7
0.81	1731.9	612.6	2631.4	899.5	2.93	2378.0	1765.4	866.0
0.84	1747.7	611.3	2648.4	900.7	2.94	2385.9	1774.6	873.9
0.85	1765.1	609.0	2668.1	903.0	2.95	2394.6	1785.6	882.6
0.89	1786.2	610.6	2687.6	901.4	2.98	2405.1	1794.5	893.1
0.91	1801.0	606.3	2706.7	905.7	2.99	2412.5	1806.2	900.5
0.93	1816.9	603.1	2725.8	909.0	3.00	2420.5	1817.4	908.4
0.95	1833.7	599.1	2746.6	913.0	3.01	2428.9	1829.8	916.8
0.98	1853.3	603.1	2762.3	909.0	3.04	2438.7	1835.6	926.7
1.08	1916.3	592.6	2835.7	919.4	3.08	2470.2	1877.6	958.2
1.17	1977.9	574.9	2915.0	937.1	3.11	2501.0	1926.1	988.9
1.26	2027.4	563.9	2975.6	948.2	3.14	2525.7	1961.9	1013.7
1.36	2083.0	551.7	3043.4	960.3	3.17	2553.6	2001.8	1041.5
1.46	2129.8	536.1	3105.7	975.9	3.18	2576.9	2040.8	1064.9
1.55	2183.2	518.3	3177.0	993.8	3.20	2603.7	2085.4	1091.6
1.66	2224.0	503.3	3232.7	1008.7	3.20	2624.0	2120.7	1112.0
1.75	2264.9	491.1	3285.8	1020.9	3.22	2644.5	2153.3	1132.4
1.84	2307.3	478.8	3340.6	1033.3	3.23	2665.7	2186.9	1153.7

Thomas Hill Energy Center – Additional Wor
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-03 / T1 / Stage 1

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
1.93	2349.7	457.0	3404.7	1055.0	3.23	2686.9	2229.9	1174.8
2.04	2389.5	440.0	3461.6	1072.0	3.23	2706.8	2266.8	1194.8
2.14	2423.2	426.4	3508.9	1085.6	3.23	2723.7	2297.2	1211.6
2.21	2448.5	413.6	3546.9	1098.5	3.23	2736.3	2322.7	1224.2

Thomas Hill Energy Center – Additional Wor
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-03 / T1 / Stage 1

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	Thomas Hill Energy Center – Additional Work					
Location	Clifton Hill, Missouri			Client	Haley & Aldrich, Inc.	
Job No.	104287-002			Tested by	CMB	Nov-19
Boring	HAB-002-03			Calculated by	CMB	Nov-19
Sample	T1	Specimen Number	Stage 2	Checked by	DPM	11/15/19
Depth (ft)	14.0 - 16.0	Undisturbed/Remold	Undisturbed	File	104287-002 HAB-002-03 T1 ASTM D4767	
Description	Olive-gray to yellow-brown, Lean Clay with Sand (CL).			Procedure	ASTM D4767	
Remarks						

Specimen Data	Initial	Post Consol.	Post Shear
Height (in)	5.846	5.855	5.723
Diameter (in)	2.902	2.889	
Volume (in^3)	38.663	38.380	
Height/Diameter ratio	2.014	2.027	
Weight (g)	1309.04	1304.39	1304.39
Water Content (%)	21.49	21.05	21.05
Bulk Unit Weight (pcf)	129.0	129.5	129.5
Dry Unit Weight (pcf)	106.2	107.0	107.0
Cross-Sectional Area* (in^2)	6.614	6.555	
% Saturation - Wet Method	100.12	100.12	100.12
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	0.575	0.564	0.564
Tare ID			
Mass wet soil + tare (g)			
Mass dry soil + tare (g)			
Mass tare (g)			

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions

Cell Pressure (psi)	116.0
Pore Pressure (psi)	99.2
Effective Confining Pressure (psi)	16.8
B-value	97.00

Consolidation Phase

Change in Volume (in^3)	0.284
T_{50} (min)	20.7

Platen Travel Rate (in/min)	0.00115

Additional Testing

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results

Peak P (psf)	4048.3
Peak P' (psf)	3293.2
Peak Q (psf)	1627.2
Strain at Peak (%)	2.2
σ_3' (psf)	1666.0
σ_1' (psf)	4920.3
σ_3 (psf)	2421.1
σ_1 (psf)	5675.4

Picture of Failure

See Stage 3

Thomas Hill Energy Center – Additional Work
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-03 / T1 / Stage 2

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
0.00	0.0	0.0	2421.1	2421.1	1.00	2421.1	2421.1	0.0
0.03	251.6	94.2	2578.6	2327.0	1.11	2546.9	2452.8	125.8
0.05	482.4	172.4	2731.1	2248.7	1.21	2662.3	2489.9	241.2
0.07	680.1	233.6	2867.6	2187.5	1.31	2761.2	2527.6	340.0
0.10	877.6	287.1	3011.6	2134.1	1.41	2859.9	2572.8	438.8
0.12	1066.5	337.1	3150.5	2084.0	1.51	2954.4	2617.2	533.2
0.14	1251.9	379.4	3293.6	2041.7	1.61	3047.1	2667.6	625.9
0.17	1423.6	417.4	3427.3	2003.7	1.71	3132.9	2715.5	711.8
0.20	1584.8	453.1	3552.8	1968.0	1.81	3213.5	2760.4	792.4
0.22	1725.0	488.1	3658.1	1933.0	1.89	3283.6	2795.5	862.5
0.24	1851.4	517.3	3755.2	1903.8	1.97	3346.8	2829.5	925.7
0.27	1964.7	544.6	3841.3	1876.6	2.05	3403.5	2858.9	982.4
0.29	2060.5	567.3	3914.3	1853.8	2.11	3451.4	2884.0	1030.3
0.33	2146.8	591.7	3976.2	1829.4	2.17	3494.5	2902.8	1073.4
0.35	2222.0	618.5	4024.6	1802.6	2.23	3532.1	2913.6	1111.0
0.37	2289.9	643.4	4067.7	1777.8	2.29	3566.1	2922.7	1145.0
0.39	2342.8	673.0	4090.9	1748.2	2.34	3592.5	2919.5	1171.4
0.42	2387.3	705.9	4102.5	1715.2	2.39	3614.8	2908.9	1193.7
0.44	2431.4	739.8	4112.7	1681.3	2.45	3636.8	2897.0	1215.7
0.46	2470.6	767.9	4123.8	1653.2	2.49	3656.4	2888.5	1235.3
0.49	2499.9	775.9	4145.2	1645.3	2.52	3671.1	2895.2	1250.0
0.52	2531.3	770.8	4181.6	1650.3	2.53	3686.8	2916.0	1265.7
0.55	2557.5	762.7	4216.0	1658.5	2.54	3699.9	2937.2	1278.8
0.57	2582.9	756.4	4247.6	1664.7	2.55	3712.6	2956.2	1291.4
0.60	2606.6	753.7	4274.0	1667.4	2.56	3724.4	2970.7	1303.3
0.62	2627.6	752.2	4296.5	1668.9	2.57	3734.9	2982.7	1313.8
0.65	2643.7	745.5	4319.3	1675.6	2.58	3743.0	2997.4	1321.9
0.68	2664.3	748.2	4337.3	1672.9	2.59	3753.3	3005.1	1332.2
0.70	2684.6	743.6	4362.1	1677.6	2.60	3763.4	3019.8	1342.3
0.74	2695.5	744.1	4372.5	1677.0	2.61	3768.9	3024.7	1347.7
0.75	2715.5	740.5	4396.1	1680.6	2.62	3778.9	3038.4	1357.7
0.78	2729.4	741.2	4409.3	1679.9	2.62	3785.8	3044.6	1364.7
0.81	2742.1	735.6	4427.7	1685.5	2.63	3792.2	3056.6	1371.1
0.82	2757.1	740.2	4438.0	1681.0	2.64	3799.6	3059.5	1378.5
0.86	2771.8	739.3	4453.7	1681.8	2.65	3807.0	3067.7	1385.9
0.88	2785.3	737.1	4469.3	1684.0	2.65	3813.8	3076.6	1392.6
0.90	2797.5	735.7	4482.9	1685.4	2.66	3819.9	3084.1	1398.7
0.93	2810.1	735.3	4496.0	1685.9	2.67	3826.2	3090.9	1405.1
1.04	2860.8	727.6	4554.3	1693.5	2.69	3851.5	3123.9	1430.4
1.14	2899.3	729.3	4591.1	1691.8	2.71	3870.8	3141.4	1449.6
1.25	2943.2	732.0	4632.4	1689.2	2.74	3892.7	3160.8	1471.6
1.34	2980.8	731.7	4670.2	1689.4	2.76	3911.5	3179.8	1490.4
1.45	3014.5	743.7	4691.9	1677.4	2.80	3928.4	3184.7	1507.2
1.54	3057.6	811.1	4667.6	1610.0	2.90	3949.9	3138.8	1528.8
1.64	3088.8	788.6	4721.4	1632.5	2.89	3965.5	3177.0	1544.4
1.75	3117.0	781.6	4756.5	1639.5	2.90	3979.6	3198.0	1558.5
1.85	3148.5	769.0	4800.6	1652.1	2.91	3995.4	3226.4	1574.2
1.96	3178.3	762.7	4836.8	1658.5	2.92	4010.3	3247.6	1589.2
2.06	3206.4	762.2	4865.3	1658.9	2.93	4024.3	3262.1	1603.2
2.17	3231.4	758.3	4894.2	1662.8	2.94	4036.8	3278.5	1615.7
2.25	3254.3	755.1	4920.3	1666.0	2.95	4048.3	3293.2	1627.2

Thomas Hill Energy Center – Additional Wor
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-03 / T1 / Stage 2

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	Thomas Hill Energy Center – Additional Work					
Location	Clifton Hill, Missouri			Client	Haley & Aldrich, Inc.	
Job No.	104287-002			Tested by	CMB	Nov-19
Boring	HAB-002-03			Calculated by	CMB	Nov-19
Sample	T1	Specimen Number	Stage 3	Checked by	DPM	11/15/19
Depth (ft)	14.0 - 16.0	Undisturbed/Remold	Undisturbed	File	104287-002 HAB-002-03 T1 ASTM D4767	
Description	Olive-gray to yellow-brown, Lean Clay with Sand (CL).			Procedure	ASTM D4767	
Remarks						

Specimen Data

	Initial	Post Consol.	Post Shear
Height (in)	5.723	5.729	4.860
Diameter (in)	2.922	2.906	
Volume (in^3)	38.380	37.996	
Height/Diameter ratio	1.959	1.972	
Weight (g)	1304.39	1298.10	1298.10
Water Content (%)	21.05	20.47	20.47
Bulk Unit Weight (pcf)	129.5	130.2	130.2
Dry Unit Weight (pcf)	107.0	108.0	108.0
Cross-Sectional Area* (in^2)	6.706	6.632	
% Saturation - Wet Method	100.12	100.13	100.13
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	0.564	0.548	0.548
			Entire Sample
Tare ID			11
Mass wet soil + tare (g)			1412.50
Mass dry soil + tare (g)			1179.50
Mass tare (g)			99.66

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions

Cell Pressure (psi)	124.0
Pore Pressure (psi)	89.9
Effective Confining Pressure (psi)	34.1
B-value	97.00

Consolidation Phase

Change in Volume (in^3)	0.384
T_{50} (min)	26.7
Platen Travel Rate (in/min)	0.00090

Additional Testing

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results

Peak P (psf)	8688.3
Peak P' (psf)	7750.6
Peak Q (psf)	3773.5
Strain at Peak (%)	2.0
σ_3' (psf)	3977.1
σ_1' (psf)	11524.1
σ_3 (psf)	4914.8
σ_1 (psf)	12461.8

Picture of Failure

Thomas Hill Energy Center – Additional Work
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-03 / T1 / Stage 3

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
0.00	0.0	0.0	4914.8	4914.8	1.00	4914.8	4914.8	0.0
0.02	396.2	-402.3	5713.3	5317.1	1.07	5112.9	5515.2	198.1
0.05	850.3	-326.3	6091.5	5241.1	1.16	5340.0	5666.3	425.2
0.06	1287.6	-162.8	6365.2	5077.6	1.25	5558.6	5721.4	643.8
0.09	1723.0	6.6	6631.2	4908.2	1.35	5776.3	5769.7	861.5
0.11	2103.5	169.9	6848.4	4744.9	1.44	5966.5	5796.7	1051.7
0.14	2507.7	316.1	7106.4	4598.7	1.55	6168.7	5852.6	1253.8
0.16	2914.9	453.8	7376.0	4461.0	1.65	6372.3	5918.5	1457.5
0.18	3282.3	579.6	7617.6	4335.2	1.76	6556.0	5976.4	1641.2
0.20	3630.3	693.5	7851.6	4221.3	1.86	6730.0	6036.4	1815.2
0.23	3961.5	794.7	8081.6	4120.1	1.96	6895.6	6100.9	1980.8
0.25	4266.3	877.1	8304.0	4037.7	2.06	7048.0	6170.9	2133.1
0.28	4529.8	940.9	8503.7	3973.9	2.14	7179.7	6238.8	2264.9
0.30	4763.4	988.8	8689.4	3926.0	2.21	7296.5	6307.7	2381.7
0.33	4977.4	1022.0	8870.2	3892.8	2.28	7403.5	6381.5	2488.7
0.35	5160.3	1046.0	9029.2	3868.9	2.33	7495.0	6449.0	2580.2
0.39	5314.6	1062.6	9166.8	3852.2	2.38	7572.1	6509.5	2657.3
0.41	5457.1	1075.6	9296.4	3839.3	2.42	7643.4	6567.8	2728.6
0.43	5591.0	1082.1	9423.7	3832.7	2.46	7710.3	6628.2	2795.5
0.45	5710.5	1091.1	9534.2	3823.7	2.49	7770.1	6679.0	2855.2
0.49	5817.1	1093.1	9638.9	3821.7	2.52	7823.4	6730.3	2908.6
0.51	5919.6	1098.8	9735.7	3816.0	2.55	7874.6	6775.9	2959.8
0.54	6013.0	1104.0	9823.8	3810.8	2.58	7921.3	6817.3	3006.5
0.56	6093.5	1108.8	9899.6	3806.1	2.60	7961.6	6852.8	3046.8
0.59	6164.2	1109.7	9969.3	3805.1	2.62	7996.9	6887.2	3082.1
0.61	6238.1	1111.0	10041.9	3803.8	2.64	8033.9	6922.9	3119.1
0.63	6300.7	1113.3	10102.2	3801.6	2.66	8065.2	6951.9	3150.3
0.66	6363.6	1116.1	10162.4	3798.7	2.68	8096.6	6980.6	3181.8
0.69	6417.7	1117.4	10215.2	3797.5	2.69	8123.7	7006.3	3208.9
0.70	6475.0	1119.2	10270.7	3795.6	2.71	8152.3	7033.1	3237.5
0.74	6523.5	1120.9	10317.5	3793.9	2.72	8176.6	7055.7	3261.8
0.77	6567.2	1118.7	10363.4	3796.1	2.73	8198.4	7079.8	3283.6
0.79	6609.0	1115.0	10408.8	3799.8	2.74	8219.3	7104.3	3304.5
0.81	6654.9	1116.1	10453.6	3798.7	2.75	8242.2	7126.2	3327.4
0.84	6691.2	1114.4	10491.6	3800.4	2.76	8260.4	7146.0	3345.6
0.87	6730.1	1114.4	10530.5	3800.4	2.77	8279.9	7165.4	3365.0
0.89	6766.3	1111.5	10569.6	3803.3	2.78	8298.0	7186.5	3383.1
0.91	6800.9	1109.5	10606.3	3805.3	2.79	8315.3	7205.8	3400.5
0.94	6823.9	1108.7	10630.0	3806.1	2.79	8326.8	7218.0	3411.9
0.97	6858.7	1105.6	10667.9	3809.2	2.80	8344.2	7238.5	3429.4
0.99	6885.8	1103.0	10697.6	3811.8	2.81	8357.7	7254.7	3442.9
1.09	6991.5	1101.2	10805.1	3813.6	2.83	8410.6	7309.3	3495.8
1.20	7080.2	1085.1	10909.9	3829.7	2.85	8454.9	7369.8	3540.1
1.30	7154.9	1071.0	10998.7	3843.8	2.86	8492.3	7421.3	3577.4
1.40	7228.2	1053.6	11089.5	3861.2	2.87	8528.9	7475.4	3614.1
1.51	7283.1	1038.9	11159.0	3875.9	2.88	8556.4	7517.5	3641.6
1.61	7346.0	1016.5	11244.3	3898.4	2.88	8587.8	7571.3	3673.0
1.71	7402.9	988.5	11329.2	3926.3	2.89	8616.3	7627.8	3701.4
1.82	7453.7	973.5	11395.0	3941.3	2.89	8641.7	7668.2	3726.9
1.91	7495.3	957.4	11452.6	3957.4	2.89	8662.4	7705.0	3747.6
2.02	7547.0	937.7	11524.1	3977.1	2.90	8688.3	7750.6	3773.5

Thomas Hill Energy Center – Additional Wor
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-03 / T1 / Stage 3

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf) P	P'	Q
2.12	7580.1	917.3	11577.6	3997.5	2.90	8704.9	7787.5	3790.1
2.23	7615.0	894.6	11635.2	4020.2	2.89	8722.3	7827.7	3807.5
2.32	7654.3	872.6	11696.5	4042.2	2.89	8742.0	7869.3	3827.1
2.43	7684.0	855.3	11743.6	4059.5	2.89	8756.8	7901.6	3842.0
2.53	7712.0	836.1	11790.7	4078.7	2.89	8770.8	7934.7	3856.0
2.64	7744.0	808.8	11850.0	4106.0	2.89	8786.8	7978.0	3872.0
2.74	7763.2	794.8	11883.2	4120.1	2.88	8796.4	8001.6	3881.6
2.84	7784.2	772.2	11926.8	4142.6	2.88	8806.9	8034.7	3892.1
2.95	7804.3	756.7	11962.4	4158.2	2.88	8817.0	8060.3	3902.1
3.04	7825.7	733.1	12007.4	4181.7	2.87	8827.7	8094.5	3912.9
3.15	7838.3	717.5	12035.6	4197.3	2.87	8834.0	8116.4	3919.2
3.25	7869.7	693.3	12091.2	4221.5	2.86	8849.7	8156.3	3934.8
3.36	7887.2	673.7	12128.3	4241.1	2.86	8858.4	8184.7	3943.6
3.47	7898.5	656.8	12156.6	4258.0	2.85	8864.1	8207.3	3949.3
3.57	7927.1	635.3	12206.7	4279.6	2.85	8878.4	8243.1	3963.6
3.67	7935.4	620.0	12230.2	4294.8	2.85	8882.5	8262.5	3967.7
3.77	7961.7	602.3	12274.2	4312.5	2.85	8895.6	8293.4	3980.8
3.88	7971.8	583.0	12303.6	4331.8	2.84	8900.7	8317.7	3985.9
3.98	7995.5	565.5	12344.8	4349.4	2.84	8912.5	8347.1	3997.7
4.09	7999.5	546.8	12367.4	4368.0	2.83	8914.5	8367.7	3999.7
4.19	8021.3	526.0	12410.1	4388.8	2.83	8925.4	8399.5	4010.6
4.29	8054.1	510.2	12458.8	4404.7	2.83	8941.9	8431.7	4027.1
4.39	8056.2	494.5	12476.6	4420.4	2.82	8942.9	8448.5	4028.1
4.50	8070.9	474.5	12511.3	4440.4	2.82	8950.3	8475.8	4035.5
4.60	8089.5	459.5	12544.8	4455.3	2.82	8959.6	8500.0	4044.8
4.70	8099.9	438.8	12575.9	4476.0	2.81	8964.8	8525.9	4049.9
4.81	8115.7	426.5	12604.1	4488.3	2.81	8972.7	8546.2	4057.9
4.90	8115.6	407.2	12623.2	4507.6	2.80	8972.6	8565.4	4057.8
5.00	8127.2	393.4	12648.6	4521.4	2.80	8978.4	8585.0	4063.6
5.12	8126.2	377.8	12663.2	4537.0	2.79	8977.9	8600.1	4063.1
5.38	8161.1	360.1	12715.8	4554.7	2.79	8995.4	8635.3	4080.5
5.63	8182.9	319.4	12778.2	4595.4	2.78	9006.2	8686.8	4091.4
5.89	8199.7	280.7	12833.8	4634.1	2.77	9014.7	8733.9	4099.9
6.14	8229.2	247.6	12896.4	4667.2	2.76	9029.4	8781.8	4114.6
6.40	8242.8	207.3	12950.4	4707.5	2.75	9036.2	8828.9	4121.4
6.66	8268.0	173.3	13009.6	4741.5	2.74	9048.8	8875.6	4134.0
6.91	8285.6	137.5	13062.9	4777.3	2.73	9057.6	8920.1	4142.8
7.17	8298.5	103.9	13109.3	4810.9	2.72	9064.1	8960.1	4149.2
7.44	8311.1	72.8	13153.1	4842.0	2.72	9070.4	8997.5	4155.6
7.68	8331.7	42.9	13203.6	4871.9	2.71	9080.7	9037.8	4165.8
7.94	8346.3	10.9	13250.2	4903.9	2.70	9088.0	9077.1	4173.1
8.20	8357.4	-20.6	13292.9	4935.4	2.69	9093.5	9114.2	4178.7
8.47	8373.3	-50.8	13338.9	4965.6	2.69	9101.5	9152.2	4186.6
8.72	8382.7	-80.9	13378.5	4995.8	2.68	9106.2	9187.1	4191.4
8.98	8390.8	-113.0	13418.6	5027.8	2.67	9110.2	9223.2	4195.4
9.24	8403.4	-137.1	13455.3	5051.9	2.66	9116.5	9253.6	4201.7
9.50	8411.4	-161.5	13487.7	5076.3	2.66	9120.5	9282.0	4205.7
9.75	8414.7	-188.7	13518.2	5103.5	2.65	9122.1	9310.9	4207.3
10.01	8413.3	-220.4	13548.5	5135.2	2.64	9121.5	9341.8	4206.6
10.28	8412.4	-243.4	13570.6	5158.2	2.63	9121.0	9364.4	4206.2
10.53	8419.5	-267.6	13601.9	5182.4	2.62	9124.6	9392.2	4209.8

Thomas Hill Energy Center – Additional Wor
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-03 / T1 / Stage 3

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
10.79	8413.9	-305.0	13633.7	5219.8	2.61	9121.8	9426.8	4206.9
11.04	8424.5	-321.1	13660.3	5235.9	2.61	9127.0	9448.1	4212.2
11.30	8418.0	-348.2	13681.1	5263.1	2.60	9123.8	9472.1	4209.0
11.55	8437.8	-375.9	13728.5	5290.7	2.59	9133.7	9509.6	4218.9
11.82	8442.0	-396.0	13752.8	5310.8	2.59	9135.8	9531.8	4221.0
12.07	8448.1	-427.1	13790.1	5341.9	2.58	9138.9	9566.0	4224.1
12.33	8450.6	-451.4	13816.7	5366.2	2.57	9140.1	9591.5	4225.3
12.59	8452.0	-475.3	13842.1	5390.2	2.57	9140.8	9616.1	4226.0
12.85	8454.4	-504.0	13873.3	5418.8	2.56	9142.0	9646.0	4227.2
13.11	8456.9	-526.3	13898.0	5441.1	2.55	9143.2	9669.5	4228.4
13.37	8459.1	-553.2	13927.1	5468.1	2.55	9144.3	9697.6	4229.5
13.62	8454.7	-575.3	13944.8	5490.1	2.54	9142.2	9717.5	4227.3
13.89	8446.4	-600.9	13962.2	5515.8	2.53	9138.0	9739.0	4223.2
14.14	8450.6	-621.0	13986.4	5535.8	2.53	9140.1	9761.1	4225.3
14.40	8441.2	-642.0	13998.0	5556.8	2.52	9135.4	9777.4	4220.6
14.66	8429.2	-669.4	14013.5	5584.3	2.51	9129.4	9798.9	4214.6
14.91	8440.8	-687.6	14043.2	5602.4	2.51	9135.2	9822.8	4220.4
15.17	8442.7	-721.1	14078.6	5635.9	2.50	9136.2	9857.3	4221.4

Thomas Hill Energy Center – Additional Wor
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-03 / T1 / Stage 3

November 2019 104287-002

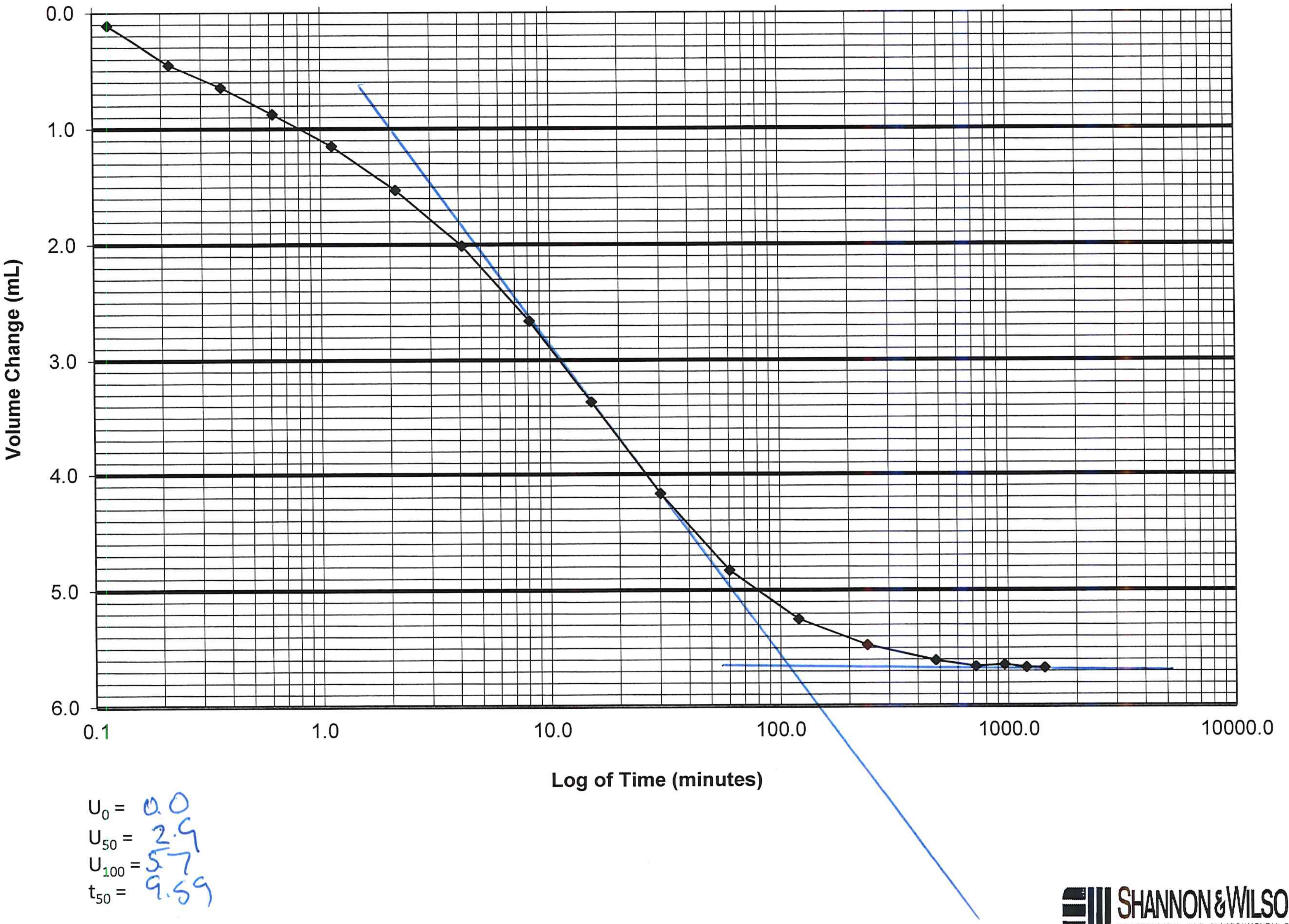
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Thomas Hill Energy Center – Additional Work

104287-002

HAB-002-03 T1

Stage 1 10.5 psi



U_0 = 0.0
U_{50} = 2.9
U_{100} = 5.7
t_{50} = 9.59

90/hr=2.503

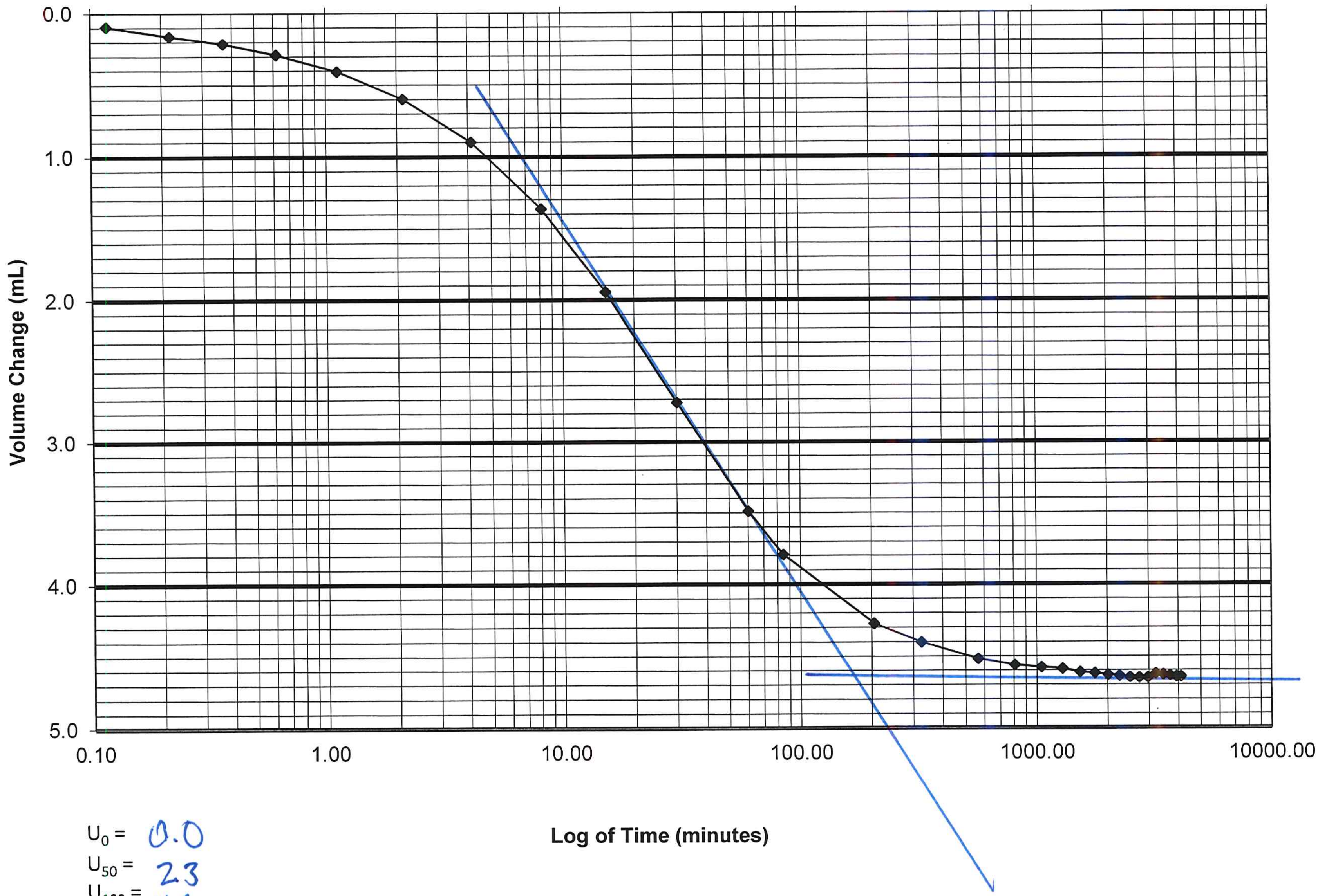
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – Additional Work

104287-002

HAB-002-03 T1

Stage 2 17.0 psi



U_0 = 0.0
U_{50} = 2.3
U_{100} = 4.6
t_{50} = 20.71

cc/hr = 6.16

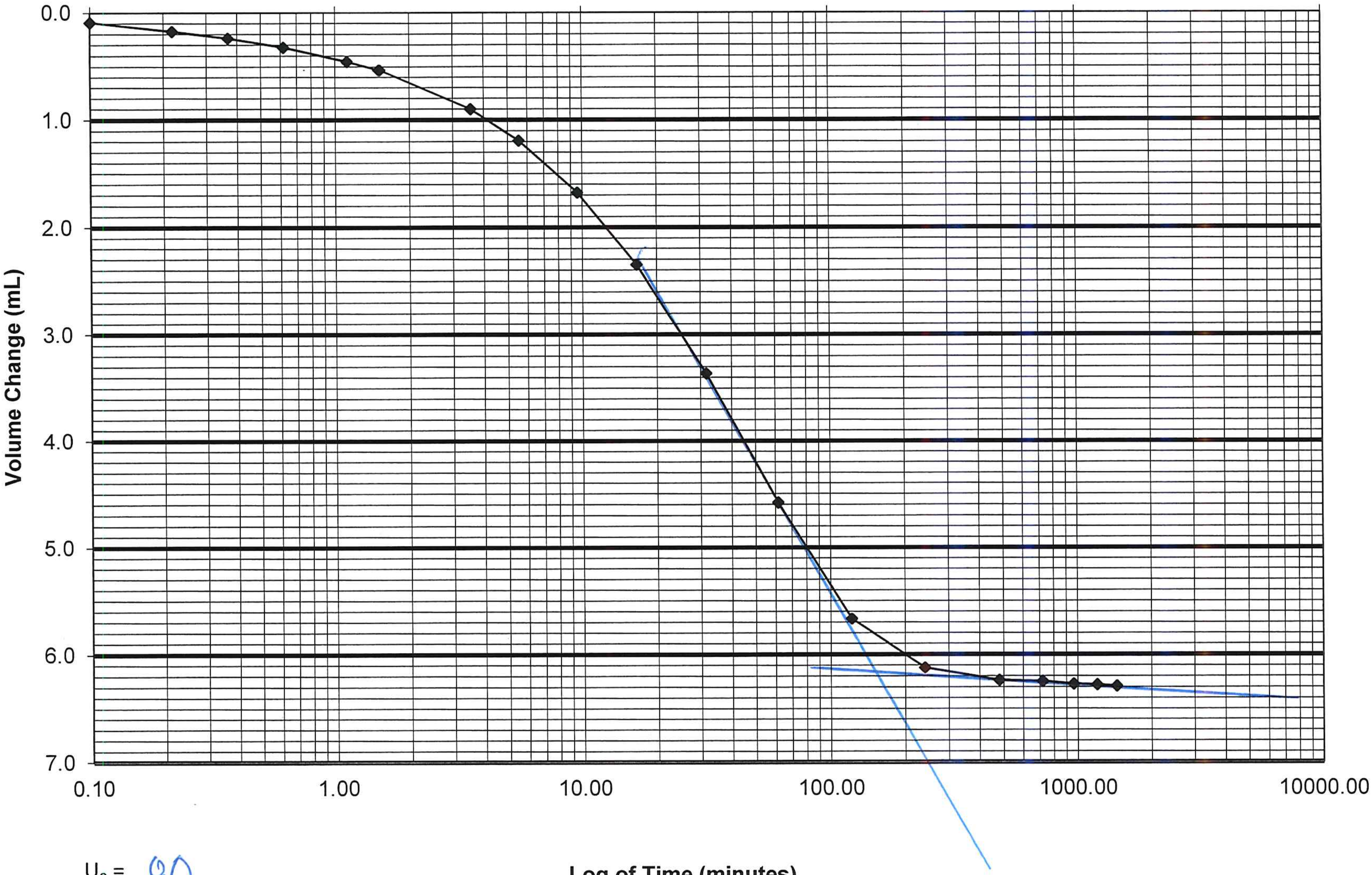
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – Additional Work

104287-002

HAB-002-03 T1

Stage 3 34.0 psi



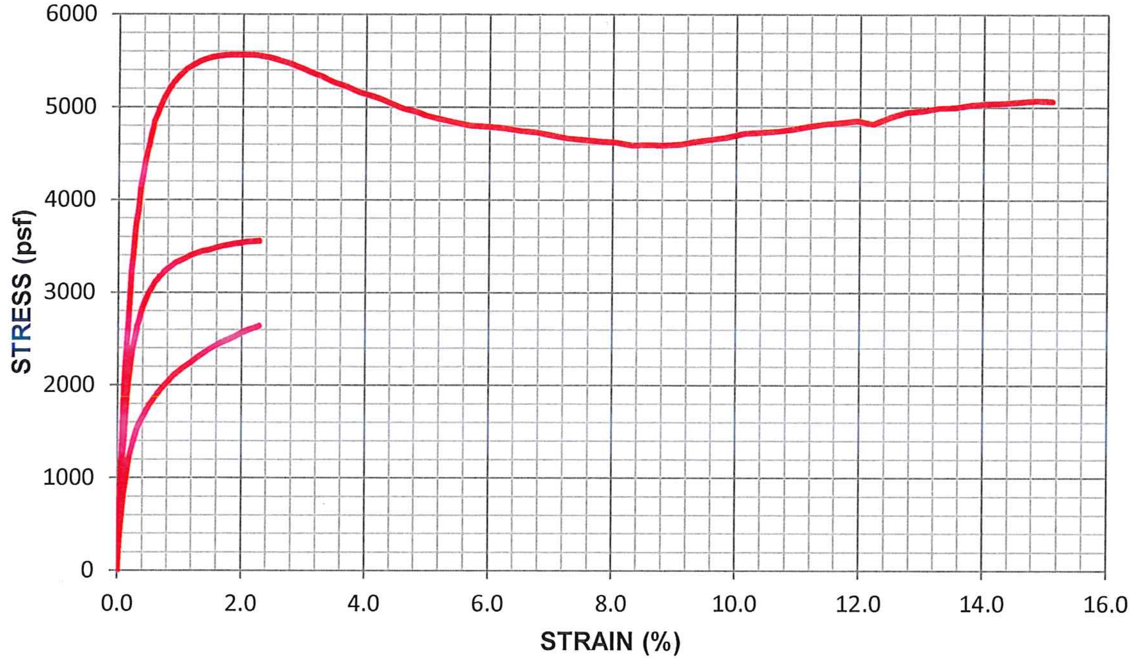
U_0 = 0.0
U_{50} = 3.1
U_{100} = 6.2
t_{50} = 26.67

%/hr = 0.900

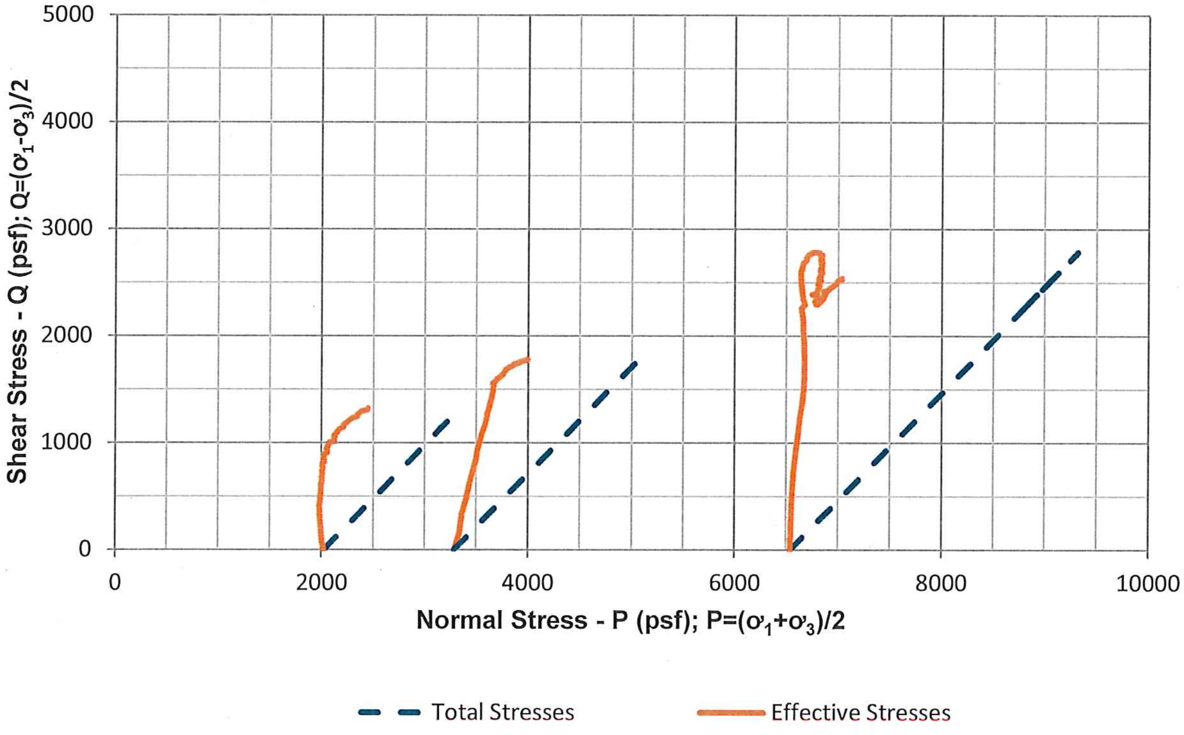
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST WITH PORE PRESSURE MEASUREMENT

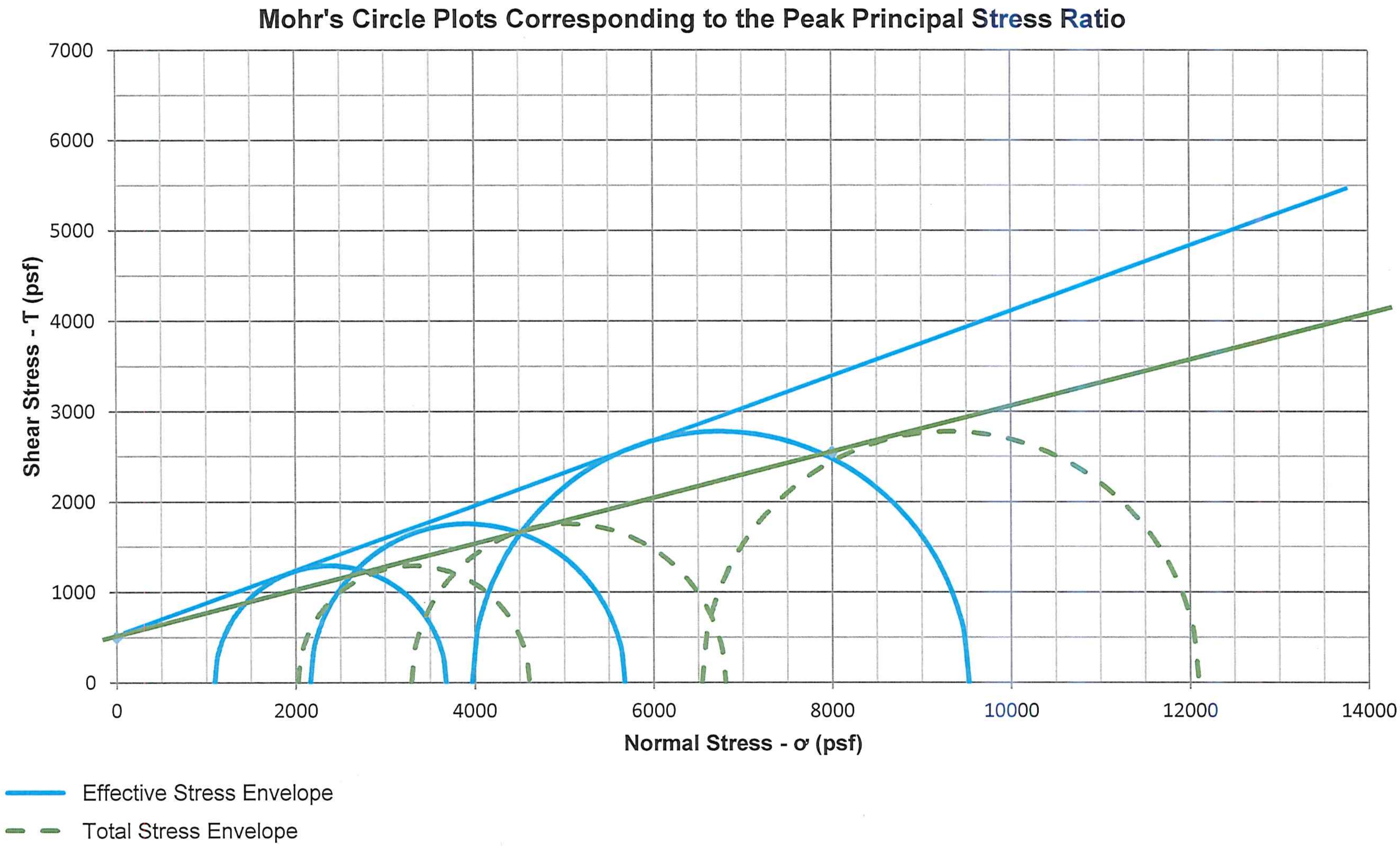
STRESS - STRAIN



P-Q PLOT



SHANNON & WILSON, INC. **2043 WESTPORT CENTER DR.** **SAINT LOUIS, MISSOURI 63146** **104287-002**	**CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION** **Thomas Hill Energy Center – Additional Work** **Clifton Hill, Missouri** **HAB-002-04 / T2 / 24.0 - 26.0**



Sample	Strain (%)
Stage 1	2.1
Stage 2	1.8
Stage 3	1.7

c =	500 psf
ϕ =	14.4 deg
c' =	500 psf
ϕ' =	19.9 deg

NOTES:
1. Mohr's circles in this plot are based upon the maximum principal stress difference observed during loading.
2. Strength parameters determined by Shannon & Wilson. Engineer-of-Record should evaluate cohesion and friction commensurate with project conditions.

Thomas Hill Energy Center – Additional Work
Clifton Hill, Missouri

Mohr's Circle Plots
HAB-002-04 / T2

November 2019
104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Figure 1

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	Thomas Hill Energy Center – Additional Work					
Location	Clifton Hill, Missouri			Client	Haley & Aldrich, Inc.	
Job No.	104287-002			Tested by	CMB	Nov-19
Boring	HAB-002-04			Calculated by	CMB	Nov-19
Sample	T2	Specimen Number	Stage 1	Checked by	DPM	11/14/19
Depth (ft)	24.0 - 26.0	Undisturbed/Remold	Undisturbed	File	104287-002 HAB-002-04 T2 ASTM D4767	
Description	Olive-gray to yellow-brown, Fat Clay with Sand (CH).			Procedure	ASTM D4767	
Remarks						

Specimen Data	Initial	Post Consol.	Post Shear
Height (in)	5.985	5.974	5.851
Diameter (in)	2.886	2.874	
Volume (in^3)	39.151	38.742	
Height/Diameter ratio	2.074	2.079	
Weight (g)	1296.69	1282.13	1282.13
Water Content (%)	25.59	24.17	24.17
Bulk Unit Weight (pcf)	126.2	124.8	126.1
Dry Unit Weight (pcf)	100.5	100.5	101.5
Cross-Sectional Area* (in^2)	6.542	6.485	
% Saturation - Wet Method	103.18	100.11	100.11
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	0.665	0.647	0.647
	Trimmings		
Tare ID	TX-2		
Mass wet soil + tare (g)	64.71		
Mass dry soil + tare (g)	52.03		
Mass tare (g)	2.47		

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions

Cell Pressure (psi)	104.4
Pore Pressure (psi)	90.3
Effective Confining Pressure (psi)	14.1
B-value	97.00

Consolidation Phase

Change in Volume (in^3)	0.409
T_{50} (min)	13.4
Platen Travel Rate (in/min)	0.00243

Additional Testing

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results

Peak P (psf)	3316.4
Peak P' (psf)	2384.5
Peak Q (psf)	1291.9
Strain at Peak (%)	2.1
σ_3' (psf)	1092.6
σ_1' (psf)	3676.4
σ_3 (psf)	2024.5
σ_1 (psf)	4608.2

Picture of Failure

See Stage 3

Thomas Hill Energy Center – Additional Work
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-04 / T2 / Stage 1

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
0.00	0.0	0.0	2024.5	2024.5	1.00	2024.5	2024.5	0.0
0.01	152.7	95.2	2082.0	1929.3	1.08	2100.9	2005.7	76.3
0.03	378.2	218.7	2184.1	1805.9	1.21	2213.6	1995.0	189.1
0.06	574.8	323.4	2275.9	1701.1	1.34	2311.9	1988.5	287.4
0.07	716.1	399.4	2341.3	1625.2	1.44	2382.6	1983.2	358.1
0.09	837.4	463.2	2398.8	1561.4	1.54	2443.2	1980.1	418.7
0.12	945.3	510.6	2459.2	1513.9	1.62	2497.2	1986.6	472.7
0.14	1047.2	558.2	2513.6	1466.4	1.71	2548.1	1990.0	523.6
0.16	1140.2	599.4	2565.4	1425.1	1.80	2594.7	1995.2	570.1
0.18	1226.0	642.2	2608.3	1382.3	1.89	2637.5	1995.3	613.0
0.21	1298.9	668.8	2654.6	1355.7	1.96	2674.0	2005.2	649.4
0.23	1364.5	704.9	2684.2	1319.7	2.03	2706.8	2002.0	682.3
0.26	1422.8	727.8	2719.5	1296.7	2.10	2735.9	2008.1	711.4
0.28	1477.3	757.1	2744.7	1267.4	2.17	2763.2	2006.0	738.7
0.30	1524.6	772.9	2776.2	1251.6	2.22	2786.8	2013.9	762.3
0.33	1562.9	797.4	2790.1	1227.2	2.27	2806.0	2008.6	781.4
0.36	1604.0	817.3	2811.2	1207.3	2.33	2826.5	2009.2	802.0
0.38	1636.1	816.4	2844.2	1208.1	2.35	2842.6	2026.2	818.1
0.41	1673.8	836.9	2861.4	1187.6	2.41	2861.4	2024.5	836.9
0.43	1706.8	855.7	2875.6	1168.8	2.46	2877.9	2022.2	853.4
0.46	1734.8	871.5	2887.8	1153.0	2.50	2891.9	2020.4	867.4
0.49	1761.9	879.8	2906.6	1144.7	2.54	2905.5	2025.7	880.9
0.50	1791.0	888.5	2927.0	1136.1	2.58	2920.0	2031.5	895.5
0.54	1814.9	877.9	2961.5	1146.7	2.58	2932.0	2054.1	907.4
0.56	1836.2	892.2	2968.5	1132.3	2.62	2942.7	2050.4	918.1
0.58	1863.4	905.2	2982.8	1119.3	2.66	2956.3	2051.0	931.7
0.61	1883.4	917.5	2990.5	1107.1	2.70	2966.2	2048.8	941.7
0.64	1905.2	927.9	3001.8	1096.6	2.74	2977.1	2049.2	952.6
0.66	1930.4	929.4	3025.6	1095.1	2.76	2989.8	2060.4	965.2
0.69	1950.0	939.5	3035.0	1085.0	2.80	2999.6	2060.0	975.0
0.71	1971.7	937.4	3058.8	1087.1	2.81	3010.4	2072.9	985.9
0.74	1988.8	946.6	3066.7	1077.9	2.84	3018.9	2072.3	994.4
0.76	2006.5	953.1	3078.0	1071.4	2.87	3027.8	2074.7	1003.3
0.79	2025.0	921.4	3128.1	1103.2	2.84	3037.0	2115.6	1012.5
0.81	2039.4	926.9	3137.1	1097.6	2.86	3044.2	2117.4	1019.7
0.84	2058.6	931.8	3151.3	1092.7	2.88	3053.8	2122.0	1029.3
0.86	2077.3	939.4	3162.4	1085.2	2.91	3063.2	2123.8	1038.6
0.89	2094.5	947.5	3171.6	1077.0	2.94	3071.8	2124.3	1047.3
0.91	2110.8	955.3	3180.0	1069.2	2.97	3079.9	2124.6	1055.4
0.94	2124.0	963.1	3185.4	1061.5	3.00	3086.5	2123.4	1062.0
0.96	2137.5	969.0	3193.0	1055.5	3.03	3093.3	2124.2	1068.7
1.07	2194.1	975.4	3243.2	1049.1	3.09	3121.6	2146.2	1097.1
1.17	2245.1	981.1	3288.5	1043.4	3.15	3147.1	2165.9	1122.6
1.27	2292.1	961.3	3355.3	1063.2	3.16	3170.6	2209.3	1146.1
1.36	2337.1	980.2	3381.4	1044.3	3.24	3193.1	2212.9	1168.6
1.46	2381.1	973.6	3432.0	1050.9	3.27	3215.1	2241.4	1190.5
1.56	2418.8	968.3	3475.0	1056.2	3.29	3233.9	2265.6	1209.4
1.66	2455.6	961.6	3518.5	1062.9	3.31	3252.3	2290.7	1227.8
1.77	2489.9	930.4	3584.1	1094.1	3.28	3269.5	2339.1	1245.0
1.86	2519.7	945.4	3598.8	1079.1	3.34	3284.4	2338.9	1259.9
1.96	2551.6	937.2	3638.9	1087.3	3.35	3300.3	2363.1	1275.8

Thomas Hill Energy Center – Additional Wor
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-04 / T2 / Stage 1

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
2.06	2583.7	931.9	3676.4	1092.6	3.36	3316.4	2384.5	1291.9
2.16	2609.5	890.9	3743.1	1133.6	3.30	3329.3	2438.4	1304.8
2.27	2635.4	898.1	3761.9	1126.5	3.34	3342.2	2444.2	1317.7
2.28	2639.7	898.7	3765.6	1125.9	3.34	3344.4	2445.7	1319.9

Thomas Hill Energy Center – Additional Wor
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-04 / T2 / Stage 1

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	Thomas Hill Energy Center – Additional Work					
Location	Clifton Hill, Missouri			Client	Haley & Aldrich, Inc.	
Job No.	104287-002			Tested by	CMB	Nov-19
Boring	HAB-002-04			Calculated by	CMB	Nov-19
Sample	T2	Specimen Number	Stage 2	Checked by	DPM	11/14/19
Depth (ft)	24.0 - 26.0	Undisturbed/Remold	Undisturbed	File	104287-002 HAB-002-04 T2 ASTM D4767	
Description	Olive-gray to yellow-brown, Fat Clay with Sand (CH).			Procedure	ASTM D4767	
Remarks						

Specimen Data

Specimen Data	Initial	Post Consol.	Post Shear
Height (in)	5.851	5.854	5.721
Diameter (in)	2.904	2.887	
Volume (in^3)	38.742	38.331	
Height/Diameter ratio	2.015	2.028	
Weight (g)	1282.13	1275.39	1275.39
Water Content (%)	24.17	23.52	23.52
Bulk Unit Weight (pcf)	126.1	126.8	126.8
Dry Unit Weight (pcf)	101.5	102.6	102.6
Cross-Sectional Area* (in^2)	6.621	6.548	
% Saturation - Wet Method	100.11	100.12	100.12
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	0.647	0.630	0.630
Tare ID			
Mass wet soil + tare (g)			
Mass dry soil + tare (g)			
Mass tare (g)			

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions

Cell Pressure (psi)	112.8
Pore Pressure (psi)	89.9
Effective Confining Pressure (psi)	22.9
B-value	97.00

Consolidation Phase

Change in Volume (in^3)	0.411
T_{50} (min)	41.6

Platen Travel Rate (in/min)	0.00056

Additional Testing

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results

Peak P (psf)	5047.4
Peak P' (psf)	3918.6
Peak Q (psf)	1756.7
Strain at Peak (%)	1.8
σ_3' (psf)	2162.0
σ_1' (psf)	5675.3
σ_3 (psf)	3290.8
σ_1 (psf)	6804.1

Picture of Failure

See Stage 3

Thomas Hill Energy Center – Additional Work
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-04 / T2 / Stage 2

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
0.00	0.0	0.0	3290.8	3290.8	1.00	3290.8	3290.8	0.0
0.01	301.9	104.5	3488.2	3186.3	1.09	3441.7	3337.2	151.0
0.03	661.3	259.4	3692.7	3031.3	1.22	3621.4	3362.0	330.7
0.06	962.5	366.8	3886.5	2924.0	1.33	3772.0	3405.2	481.3
0.08	1225.4	470.1	4046.0	2820.6	1.43	3903.4	3433.3	612.7
0.11	1464.9	557.8	4197.8	2732.9	1.54	4023.2	3465.4	732.4
0.12	1666.5	627.8	4329.4	2662.9	1.63	4124.0	3496.2	833.2
0.14	1850.2	706.6	4434.3	2584.1	1.72	4215.8	3509.2	925.1
0.16	2010.2	763.6	4537.4	2527.1	1.80	4295.9	3532.3	1005.1
0.19	2149.6	814.8	4625.6	2476.0	1.87	4365.5	3550.8	1074.8
0.21	2274.4	851.0	4714.2	2439.8	1.93	4427.9	3577.0	1137.2
0.23	2381.9	888.6	4784.1	2402.2	1.99	4481.7	3593.1	1191.0
0.26	2484.0	928.4	4846.4	2362.4	2.05	4532.8	3604.4	1242.0
0.28	2561.7	960.6	4891.8	2330.1	2.10	4571.6	3611.0	1280.8
0.30	2638.7	988.2	4941.3	2302.6	2.15	4610.1	3621.9	1319.4
0.34	2707.1	1014.1	4983.7	2276.6	2.19	4644.3	3630.2	1353.6
0.36	2768.4	1036.0	5023.1	2254.8	2.23	4674.9	3638.9	1384.2
0.38	2825.1	1055.6	5060.3	2235.2	2.26	4703.3	3647.7	1412.5
0.41	2870.8	1074.3	5087.3	2216.4	2.30	4726.2	3651.8	1435.4
0.44	2917.4	1092.0	5116.2	2198.8	2.33	4749.5	3657.5	1458.7
0.46	2955.0	1107.7	5138.1	2183.1	2.35	4768.3	3660.6	1477.5
0.48	2992.1	1122.6	5160.2	2168.1	2.38	4786.8	3664.2	1496.1
0.52	3025.3	1135.8	5180.2	2154.9	2.40	4803.4	3667.6	1512.6
0.54	3055.8	1148.4	5198.2	2142.4	2.43	4818.7	3670.3	1527.9
0.57	3083.4	1159.7	5214.4	2131.0	2.45	4832.4	3672.7	1541.7
0.59	3110.5	1186.5	5214.8	2104.3	2.48	4846.0	3659.6	1555.3
0.62	3129.4	1177.3	5242.9	2113.4	2.48	4855.5	3678.2	1564.7
0.65	3148.9	1179.8	5259.9	2111.0	2.49	4865.2	3685.5	1574.5
0.67	3170.7	1184.1	5277.4	2106.6	2.51	4876.1	3692.0	1585.4
0.68	3181.9	1185.7	5286.9	2105.1	2.51	4881.7	3696.0	1590.9
0.71	3199.5	1180.0	5310.2	2110.7	2.52	4890.5	3710.4	1599.7
0.73	3217.5	1174.1	5334.1	2116.6	2.52	4899.5	3725.4	1608.8
0.76	3234.5	1173.0	5352.2	2117.7	2.53	4908.0	3735.0	1617.2
0.78	3248.8	1174.9	5364.7	2115.9	2.54	4915.2	3740.3	1624.4
0.81	3261.0	1172.5	5379.3	2118.2	2.54	4921.3	3748.8	1630.5
0.84	3270.4	1171.2	5390.0	2119.5	2.54	4926.0	3754.8	1635.2
0.86	3285.8	1172.4	5404.2	2118.3	2.55	4933.7	3761.3	1642.9
0.89	3297.4	1174.5	5413.6	2116.3	2.56	4939.4	3765.0	1648.7
0.91	3314.0	1178.7	5426.1	2112.1	2.57	4947.8	3769.1	1657.0
0.93	3323.2	1180.1	5433.8	2110.6	2.57	4952.4	3772.2	1661.6
0.96	3330.5	1180.8	5440.5	2110.0	2.58	4956.0	3775.2	1665.2
1.06	3365.4	1186.1	5470.0	2104.7	2.60	4973.4	3787.3	1682.7
1.16	3397.6	1182.9	5505.4	2107.8	2.61	4989.5	3806.6	1698.8
1.27	3423.3	1162.0	5552.1	2128.7	2.61	5002.4	3840.4	1711.7
1.37	3448.4	1157.2	5581.9	2133.5	2.62	5014.9	3857.7	1724.2
1.46	3458.3	1162.1	5587.0	2128.7	2.62	5019.9	3857.9	1729.2
1.56	3478.7	1145.1	5624.4	2145.7	2.62	5030.1	3885.0	1739.3
1.68	3500.3	1120.8	5670.2	2170.0	2.61	5040.9	3920.1	1750.1
1.78	3513.3	1128.8	5675.3	2162.0	2.63	5047.4	3918.6	1756.7
1.88	3525.5	1103.2	5713.0	2187.5	2.61	5053.5	3950.3	1762.8
1.97	3534.2	1087.0	5737.9	2203.7	2.60	5057.8	3970.8	1767.1

Thomas Hill Energy Center – Additional Wor
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-04 / T2 / Stage 2

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
2.08	3546.9	1085.6	5752.1	2205.2	2.61	5064.2	3978.7	1773.5
2.18	3550.2	1084.9	5756.0	2205.8	2.61	5065.9	3980.9	1775.1
2.28	3558.1	1073.1	5775.7	2217.7	2.60	5069.8	3996.7	1779.0
2.28	3552.3	1072.2	5770.9	2218.5	2.60	5066.9	3994.7	1776.2

Thomas Hill Energy Center – Additional Wor
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-04 / T2 / Stage 2

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	Thomas Hill Energy Center – Additional Work					
Location	Clifton Hill, Missouri			Client	Haley & Aldrich, Inc.	
Job No.	104287-002			Tested by	CMB	Nov-19
Boring	HAB-002-04			Calculated by	CMB	Nov-19
Sample	T2	Specimen Number	Stage 3	Checked by	DPM	11/14/19
Depth (ft)	24.0 - 26.0	Undisturbed/Remold	Undisturbed	File	104287-002 HAB-002-04 T2 ASTM D4767	
Description	Olive-gray to yellow-brown, Fat Clay with Sand (CH).			Procedure	ASTM D4767	
Remarks						

Specimen Data	Initial	Post Consol.	Post Shear
Height (in)	5.721	5.723	5.601
Diameter (in)	2.921	2.897	
Volume (in^3)	38.331	37.727	
Height/Diameter ratio	1.959	1.975	
Weight (g)	1275.39	1265.49	1265.49
Water Content (%)	23.52	22.56	22.56
Bulk Unit Weight (pcf)	126.8	127.8	127.8
Dry Unit Weight (pcf)	102.6	104.3	104.3
Cross-Sectional Area* (in^2)	6.701	6.593	
% Saturation - Wet Method	100.12	100.12	100.12
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	0.630	0.604	0.604
			Entire Sample
Tare ID			81
Mass wet soil + tare (g)			1387.46
Mass dry soil + tare (g)			1148.70
Mass tare (g)			99.98

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions

Cell Pressure (psi)	136.6
Pore Pressure (psi)	91.2
Effective Confining Pressure (psi)	45.4
B-value	97.00

Consolidation Phase

Change in Volume (in^3)	0.604
T_{50} (min)	23.0
Platen Travel Rate (in/min)	0.00103

Additional Testing

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results

Peak P (psf)	9318.9
Peak P' (psf)	6747.3
Peak Q (psf)	2778.7
Strain at Peak (%)	1.7
σ_3' (psf)	3968.5
σ_1' (psf)	9526.0
σ_3 (psf)	6540.1
σ_1 (psf)	12097.6

Picture of Failure

Thomas Hill Energy Center – Additional Work
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-04 / T2 / Stage 3

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
0.00	0.0	0.0	6540.1	6540.1	1.00	6540.1	6540.1	0.0
0.03	466.8	231.3	6775.6	6308.8	1.07	6773.5	6542.2	233.4
0.05	967.8	473.0	7035.0	6067.2	1.16	7024.0	6551.1	483.9
0.07	1419.6	682.1	7277.6	5858.1	1.24	7249.9	6567.8	709.8
0.09	1822.4	861.0	7501.5	5679.1	1.32	7451.3	6590.3	911.2
0.12	2180.5	1016.0	7704.6	5524.1	1.39	7630.4	6614.4	1090.3
0.14	2495.3	1155.2	7880.3	5385.0	1.46	7787.8	6632.6	1247.7
0.17	2762.3	1265.9	8036.5	5274.2	1.52	7921.3	6655.4	1381.1
0.19	3006.0	1376.2	8169.9	5163.9	1.58	8043.1	6666.9	1503.0
0.21	3221.0	1478.2	8282.9	5061.9	1.64	8150.6	6672.4	1610.5
0.24	3408.8	1570.2	8378.7	4969.9	1.69	8244.5	6674.3	1704.4
0.26	3580.8	1656.1	8464.9	4884.0	1.73	8330.6	6674.5	1790.4
0.28	3737.8	1735.1	8542.8	4805.0	1.78	8409.0	6673.9	1868.9
0.31	3878.9	1807.6	8611.5	4732.5	1.82	8479.6	6672.0	1939.5
0.33	4006.7	1876.5	8670.3	4663.7	1.86	8543.5	6667.0	2003.3
0.35	4132.2	1942.3	8730.1	4597.9	1.90	8606.2	6664.0	2066.1
0.38	4242.7	1996.9	8785.9	4543.2	1.93	8661.5	6664.6	2121.4
0.41	4344.3	2052.5	8831.9	4487.6	1.97	8712.3	6659.8	2172.1
0.42	4430.6	2103.5	8867.2	4436.6	2.00	8755.4	6651.9	2215.3
0.45	4513.7	2150.1	8903.8	4390.0	2.03	8797.0	6646.9	2256.9
0.48	4590.7	2157.5	8973.3	4382.6	2.05	8835.5	6678.0	2295.3
0.50	4660.7	2205.3	8995.5	4334.8	2.08	8870.5	6665.2	2330.4
0.53	4727.6	2243.3	9024.4	4296.8	2.10	8903.9	6660.6	2363.8
0.55	4790.0	2279.2	9050.9	4260.9	2.12	8935.1	6655.9	2395.0
0.57	4846.2	2309.9	9076.4	4230.2	2.15	8963.2	6653.3	2423.1
0.60	4900.4	2340.8	9099.7	4199.3	2.17	8990.3	6649.5	2450.2
0.63	4947.4	2367.6	9119.9	4172.5	2.19	9013.9	6646.2	2473.7
0.66	4991.0	2391.7	9139.4	4148.5	2.20	9035.6	6643.9	2495.5
0.69	5037.0	2415.9	9161.3	4124.3	2.22	9058.7	6642.8	2518.5
0.71	5073.5	2435.6	9178.0	4104.5	2.24	9076.9	6641.3	2536.8
0.74	5111.1	2454.5	9196.8	4085.7	2.25	9095.7	6641.2	2555.6
0.77	5141.2	2471.3	9210.1	4068.8	2.26	9110.8	6639.5	2570.6
0.80	5174.7	2487.4	9227.5	4052.8	2.28	9127.5	6640.1	2587.4
0.82	5202.8	2500.4	9242.5	4039.8	2.29	9141.5	6641.1	2601.4
0.84	5227.3	2514.0	9253.4	4026.1	2.30	9153.8	6639.8	2613.7
0.87	5252.5	2510.5	9282.1	4029.6	2.30	9166.4	6655.9	2626.2
0.89	5274.1	2521.7	9292.6	4018.5	2.31	9177.2	6655.5	2637.1
0.92	5294.9	2532.2	9302.8	4007.9	2.32	9187.6	6655.4	2647.5
0.95	5314.3	2542.2	9312.2	3997.9	2.33	9197.3	6655.0	2657.1
0.96	5331.7	2549.1	9322.7	3991.0	2.34	9206.0	6656.9	2665.9
1.00	5353.8	2558.0	9336.0	3982.1	2.34	9217.1	6659.0	2676.9
1.09	5412.2	2553.1	9399.2	3987.0	2.36	9246.2	6693.1	2706.1
1.20	5453.7	2574.1	9419.7	3966.0	2.38	9267.0	6692.9	2726.9
1.30	5494.1	2584.4	9449.9	3955.8	2.39	9287.2	6702.8	2747.1
1.40	5518.6	2588.4	9470.3	3951.7	2.40	9299.4	6711.0	2759.3
1.51	5537.7	2569.2	9508.6	3970.9	2.39	9309.0	6739.8	2768.9
1.60	5549.0	2570.6	9518.5	3969.5	2.40	9314.6	6744.0	2774.5
1.71	5557.5	2571.6	9526.0	3968.5	2.40	9318.9	6747.3	2778.7
1.82	5560.5	2559.4	9541.2	3980.7	2.40	9320.4	6761.0	2780.2
1.92	5560.5	2532.6	9568.0	4007.5	2.39	9320.4	6787.8	2780.3
2.03	5561.2	2530.9	9570.4	4009.2	2.39	9320.7	6789.8	2780.6

Thomas Hill Energy Center – Additional Wor
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-04 / T2 / Stage 3

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
2.13	5561.9	2526.4	9575.6	4013.7	2.39	9321.1	6794.7	2781.0
2.23	5556.3	2499.9	9596.5	4040.2	2.38	9318.3	6818.3	2778.1
2.33	5544.5	2500.5	9584.2	4039.6	2.37	9312.4	6811.9	2772.3
2.44	5533.8	2491.8	9582.2	4048.4	2.37	9307.0	6815.3	2766.9
2.54	5513.2	2453.9	9599.4	4086.2	2.35	9296.7	6842.8	2756.6
2.65	5492.5	2449.4	9583.2	4090.7	2.34	9286.4	6837.0	2746.3
2.76	5470.6	2444.4	9566.4	4095.7	2.34	9275.4	6831.1	2735.3
2.86	5440.4	2422.9	9557.6	4117.2	2.32	9260.3	6837.4	2720.2
2.96	5414.3	2419.0	9535.4	4121.1	2.31	9247.3	6828.3	2707.2
3.08	5382.2	2386.8	9535.5	4153.3	2.30	9231.3	6844.4	2691.1
3.19	5351.9	2382.2	9509.8	4157.9	2.29	9216.1	6833.9	2675.9
3.28	5328.7	2367.2	9501.7	4172.9	2.28	9204.5	6837.3	2664.4
3.39	5294.0	2346.8	9487.3	4193.3	2.26	9187.1	6840.3	2647.0
3.49	5263.8	2341.5	9462.5	4198.7	2.25	9172.1	6830.6	2631.9
3.60	5240.4	2322.9	9457.7	4217.3	2.24	9160.3	6837.5	2620.2
3.70	5216.6	2322.2	9434.5	4217.9	2.24	9148.4	6826.2	2608.3
3.81	5182.8	2286.7	9436.2	4253.4	2.22	9131.5	6844.8	2591.4
3.92	5152.7	2285.5	9407.3	4254.6	2.21	9116.5	6831.0	2576.4
4.01	5136.7	2285.4	9391.4	4254.7	2.21	9108.5	6823.1	2568.4
4.12	5112.7	2267.8	9385.0	4272.3	2.20	9096.5	6828.6	2556.3
4.24	5087.8	2268.5	9359.5	4271.6	2.19	9084.1	6815.5	2543.9
4.34	5059.2	2258.1	9341.3	4282.1	2.18	9069.8	6811.7	2529.6
4.44	5031.6	2223.2	9348.5	4316.9	2.17	9055.9	6832.7	2515.8
4.54	5001.5	2225.5	9316.1	4314.6	2.16	9040.9	6815.3	2500.7
4.64	4978.9	2213.4	9305.7	4326.8	2.15	9029.6	6816.2	2489.4
4.75	4962.9	2218.5	9284.5	4321.6	2.15	9021.6	6803.1	2481.4
4.86	4941.0	2192.6	9288.5	4347.5	2.14	9010.6	6818.0	2470.5
4.96	4912.8	2186.3	9266.6	4353.9	2.13	8996.5	6810.2	2456.4
5.06	4894.2	2181.4	9253.0	4358.7	2.12	8987.3	6805.9	2447.1
5.18	4874.8	2177.0	9238.0	4363.2	2.12	8977.5	6800.6	2437.4
5.44	4836.2	2164.7	9211.6	4375.4	2.11	8958.2	6793.5	2418.1
5.70	4800.4	2148.8	9191.8	4391.4	2.09	8940.3	6791.6	2400.2
5.97	4788.5	2133.7	9195.0	4406.5	2.09	8934.4	6800.7	2394.2
6.21	4774.9	2182.3	9132.8	4357.8	2.10	8927.6	6745.3	2387.5
6.49	4747.4	2122.9	9164.6	4417.2	2.07	8913.8	6790.9	2373.7
6.75	4728.8	2105.7	9163.1	4434.4	2.07	8904.5	6798.8	2364.4
7.01	4696.2	2100.5	9135.8	4439.6	2.06	8888.2	6787.7	2348.1
7.27	4661.3	2074.4	9127.1	4465.8	2.04	8870.8	6796.4	2330.7
7.52	4646.9	2089.9	9097.1	4450.2	2.04	8863.6	6773.7	2323.5
7.78	4631.2	2060.5	9110.9	4479.7	2.03	8855.7	6795.3	2315.6
8.03	4619.0	2055.8	9103.4	4484.3	2.03	8849.7	6793.9	2309.5
8.30	4591.4	2040.6	9090.9	4499.6	2.02	8835.8	6795.2	2295.7
8.56	4592.1	2035.4	9096.8	4504.7	2.02	8836.2	6800.7	2296.1
8.81	4589.5	2053.6	9076.0	4486.5	2.02	8834.9	6781.3	2294.8
9.08	4601.1	2037.2	9104.0	4502.9	2.02	8840.7	6803.4	2300.5
9.34	4629.3	2029.4	9140.1	4510.8	2.03	8854.8	6825.4	2314.7
9.60	4652.9	2039.0	9154.1	4501.2	2.03	8866.6	6827.6	2326.5
9.84	4677.8	2033.8	9184.1	4506.3	2.04	8879.0	6845.2	2338.9
10.11	4715.8	2040.3	9215.5	4499.8	2.05	8898.0	6857.7	2357.9
10.37	4725.6	2052.9	9212.9	4487.3	2.05	8902.9	6850.1	2362.8
10.64	4740.3	2055.6	9224.9	4484.6	2.06	8910.3	6854.8	2370.2

Thomas Hill Energy Center – Additional Wor
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-04 / T2 / Stage 3

November 2019 104287-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
10.90	4761.4	2053.6	9247.9	4486.5	2.06	8920.9	6867.2	2380.7
11.16	4791.5	2074.1	9257.5	4466.0	2.07	8935.9	6861.7	2395.7
11.42	4819.0	2068.3	9290.8	4471.8	2.08	8949.6	6881.3	2409.5
11.68	4833.7	2100.1	9273.8	4440.0	2.09	8957.0	6856.9	2416.9
11.94	4854.3	2065.7	9328.7	4474.4	2.08	8967.3	6901.6	2427.1
12.20	4820.2	2078.4	9282.0	4461.8	2.08	8950.2	6871.9	2410.1
12.48	4895.7	2069.9	9365.9	4470.2	2.10	8988.0	6918.0	2447.9
12.73	4943.5	2052.9	9430.7	4487.2	2.10	9011.9	6958.9	2471.7
13.01	4960.4	2051.7	9448.8	4488.4	2.11	9020.4	6968.6	2480.2
13.26	4991.2	2054.0	9477.3	4486.1	2.11	9035.7	6981.7	2495.6
13.53	4999.2	2056.6	9482.7	4483.5	2.12	9039.7	6983.1	2499.6
13.79	5024.2	2065.4	9498.9	4474.7	2.12	9052.3	6986.8	2512.1
14.06	5037.2	2046.2	9531.1	4494.0	2.12	9058.7	7012.6	2518.6
14.33	5044.0	2060.8	9523.4	4479.4	2.13	9062.2	7001.4	2522.0
14.59	5058.3	2034.8	9563.7	4505.3	2.12	9069.3	7034.5	2529.2
14.85	5073.6	2042.2	9571.5	4497.9	2.13	9076.9	7034.7	2536.8
15.10	5065.5	2047.1	9558.5	4493.0	2.13	9072.9	7025.8	2532.7

Thomas Hill Energy Center – Additional Wor
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-002-04 / T2 / Stage 3

November 2019 104287-002

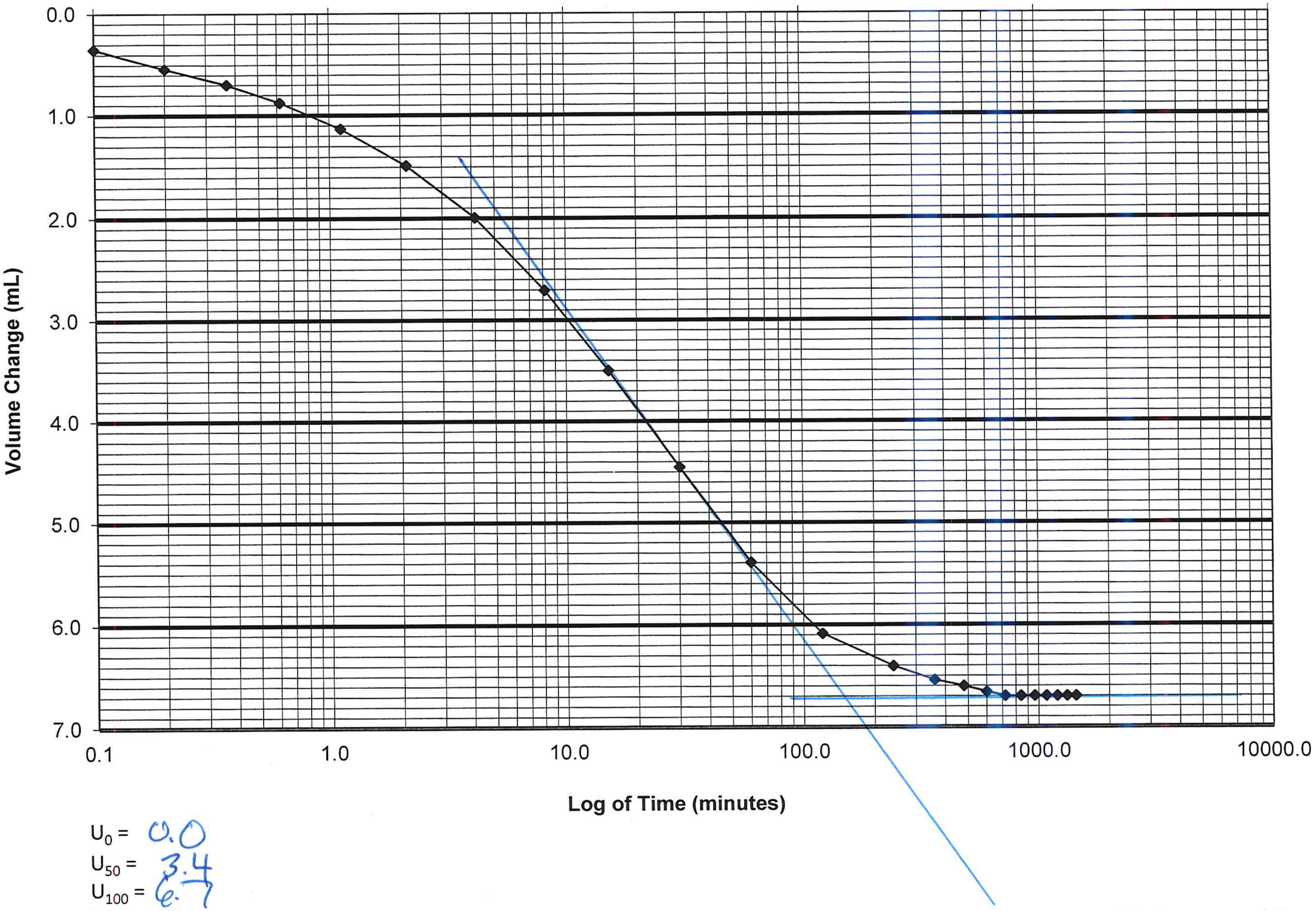
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Thomas Hill Energy Center – Additional Work

104287-002

HAB-002-04 T2

Stage 1 14.0 psi



U_0 = 0.0
U_{50} = 3.4
U_{100} = 6.7
t_{50} = 13.42

%/hr = 1.788

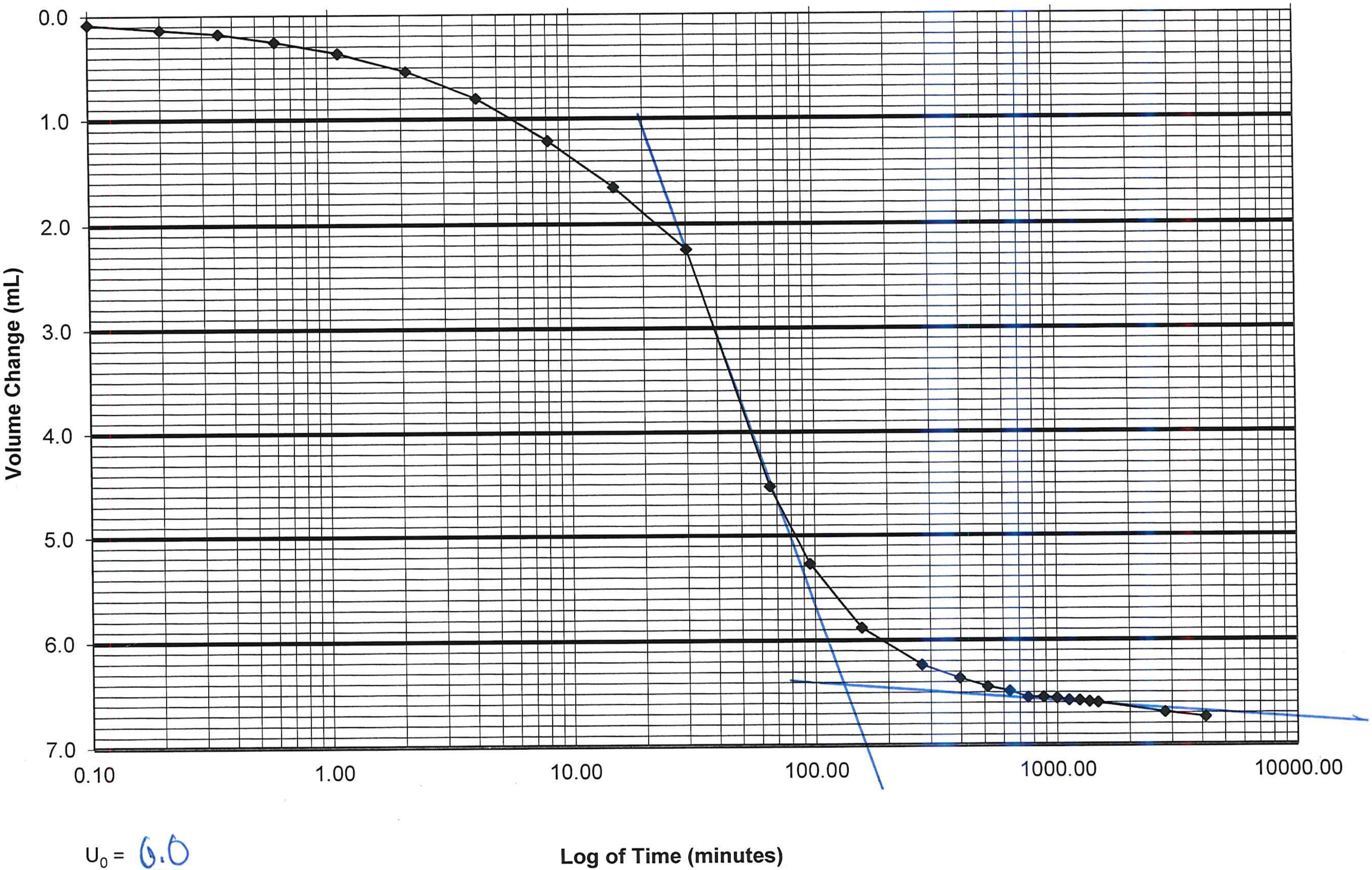
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – Additional Work

104287-002

HAB-002-04 T2

Stage 2 22.5 psi



U_0 = 0.0
U_{50} = 3.2
U_{100} = 6.4
t_{50} = 41.63

%/hr=0.58

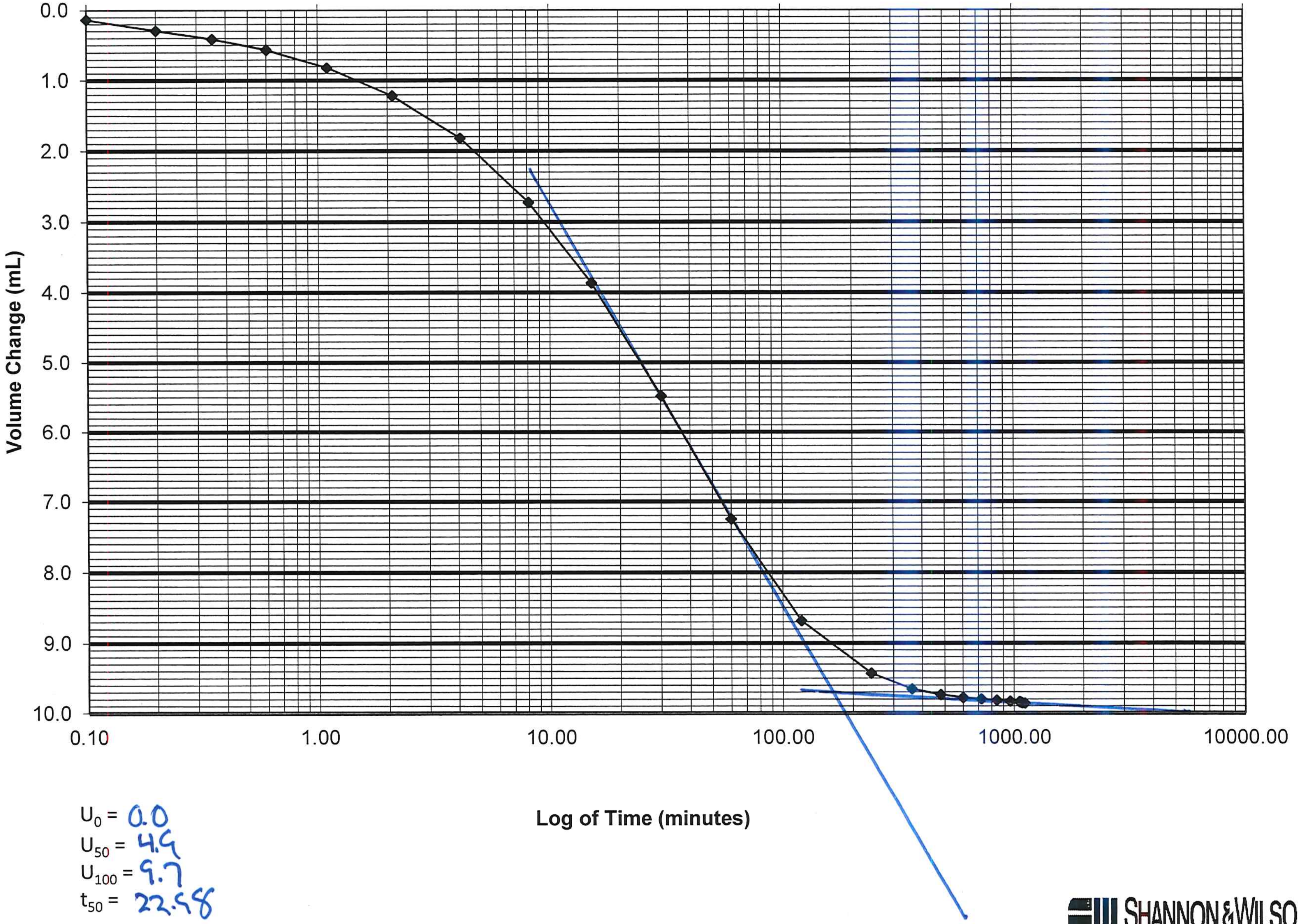
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – Additional Work

104287-002

HAB-002-04 T2

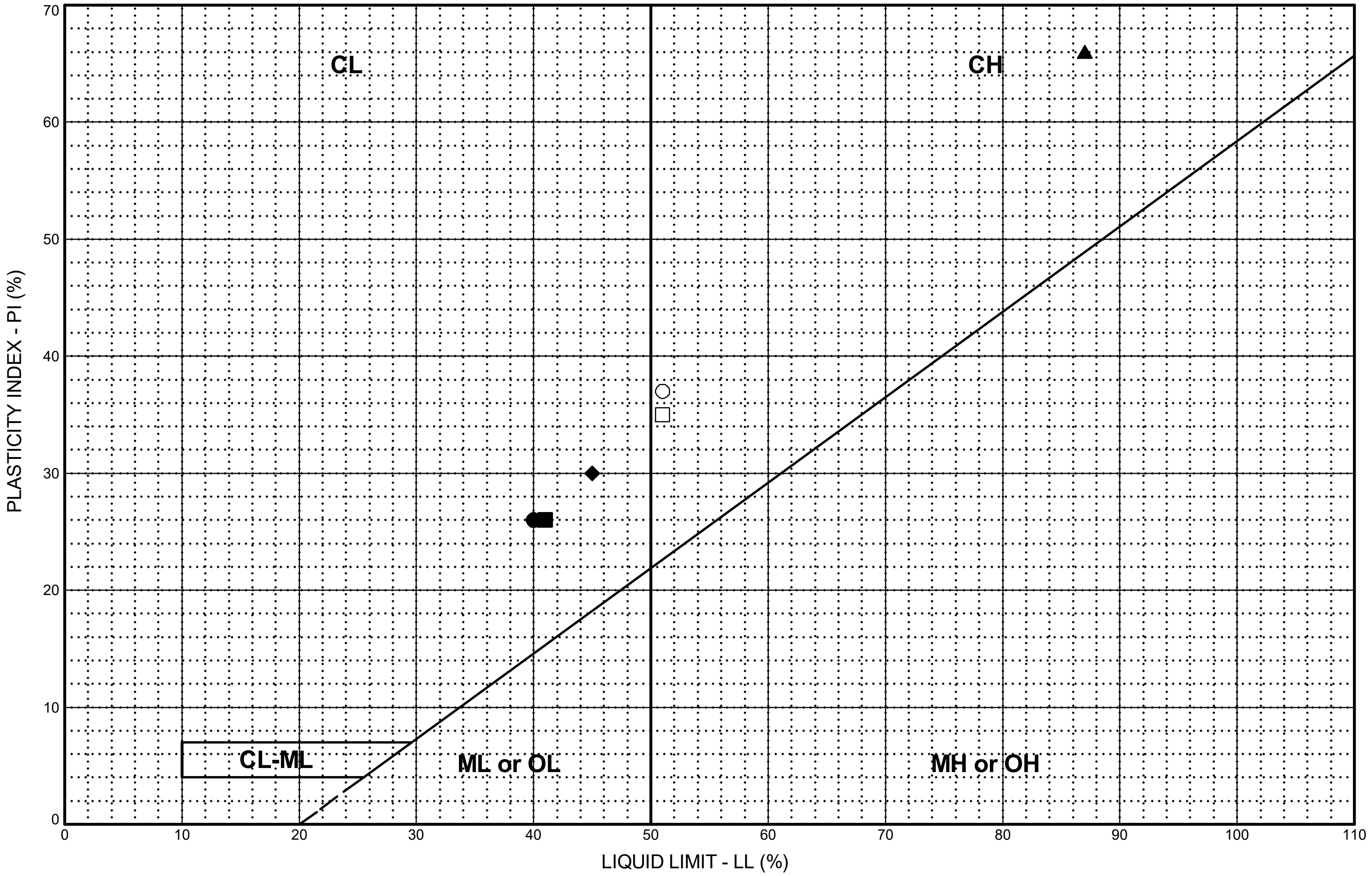
Stage 3 45.0 psi



U_0 = 0.0
U_{50} = 4.9
U_{100} = 9.7
t_{50} = 22.98

90/hr = 1.04

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS



LEGEND

CL: Low plasticity inorganic clays; sandy and silty clays

CH: High plasticity inorganic clays

ML or OL: Inorganic and organic silts and clayey silts of low plasticity

MH or OH: Inorganic and organic silts and clayey silts of high plasticity

CL-ML: Silty clays and clayey silts

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION	LL %	PL %	PI %	NAT. W.C. %	PASS. #200, %
● HAB-CDT-01, T1	8.0 - 10.0	CL	Brown, Sandy Lean Clay.	40	14	26	17.3	69.9
■ HAB-CDT-01, S7	24.0 - 26.0	CL	Gray and brown, Sandy Lean Clay.	41	15	26	17.5	69.3
▲ HAB-CDT-03, S3	6.0 - 8.0	CH	Brown, Fat Clay with Sand.	87	21	66	27.0	76.8
◆ HAB-CDT-04, T1	8.0 - 10.0	CL	Gray and brown, Sandy Lean Clay.	45	15	30	19.2	61.1
○ HAB-CDT-08, S2	4.0 - 6.0	CH	Gray and red-brown, Fat Clay with Sand.	51	14	37	20.7	76.1
□ HAB-CDT-09, S2	6.0 - 8.0	CH	Gray, Sandy Fat Clay.	51	16	35	16.8	60.2

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

PLASTICITY CHART

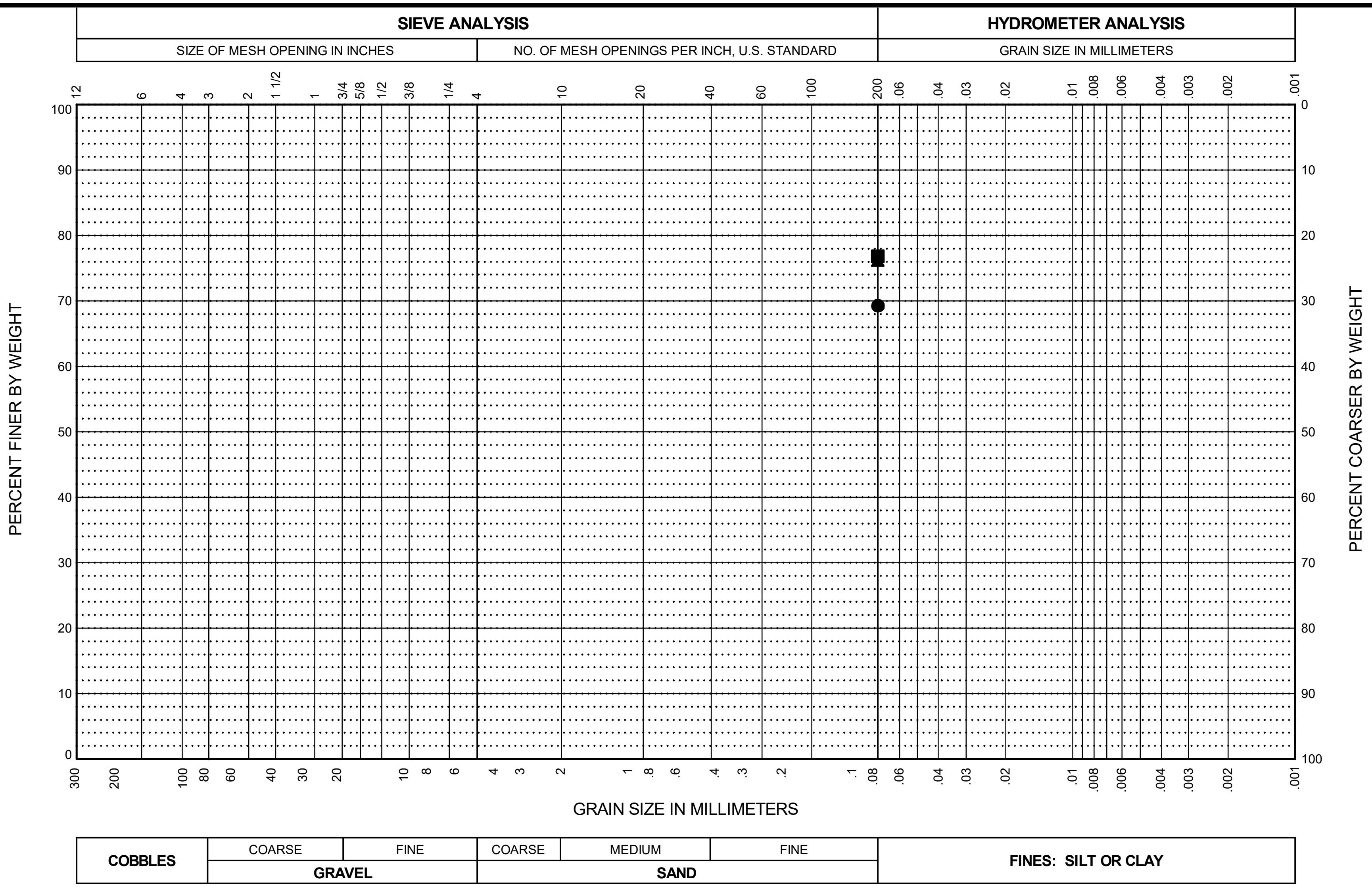
October 2019 104287-001 / 128064-012

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.

FIG.

ATTERBERG - WITH SAMPLE INTERVALS 104287-001 LAB DATA.GPJ SHAN_WIL.GDT 10/16/19



GSA- WITH SAMPLE INTERVALS 104287-001 LAB DATA.GPJ SHAN_WIL.GDT 10/16/19

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HAB-CDT-01, S7	24.0 - 26.0	CL	Gray and brown, Sandy Lean Clay.	69.3	17.5	41	15	26
■ HAB-CDT-03, S3	6.0 - 8.0	CH	Brown, Fat Clay with Sand.	76.8	27.0	87	21	66
▲ HAB-CDT-08, S2	4.0 - 6.0	CH	Gray and red-brown, Fat Clay with Sand.	76.1	20.7	51	14	37

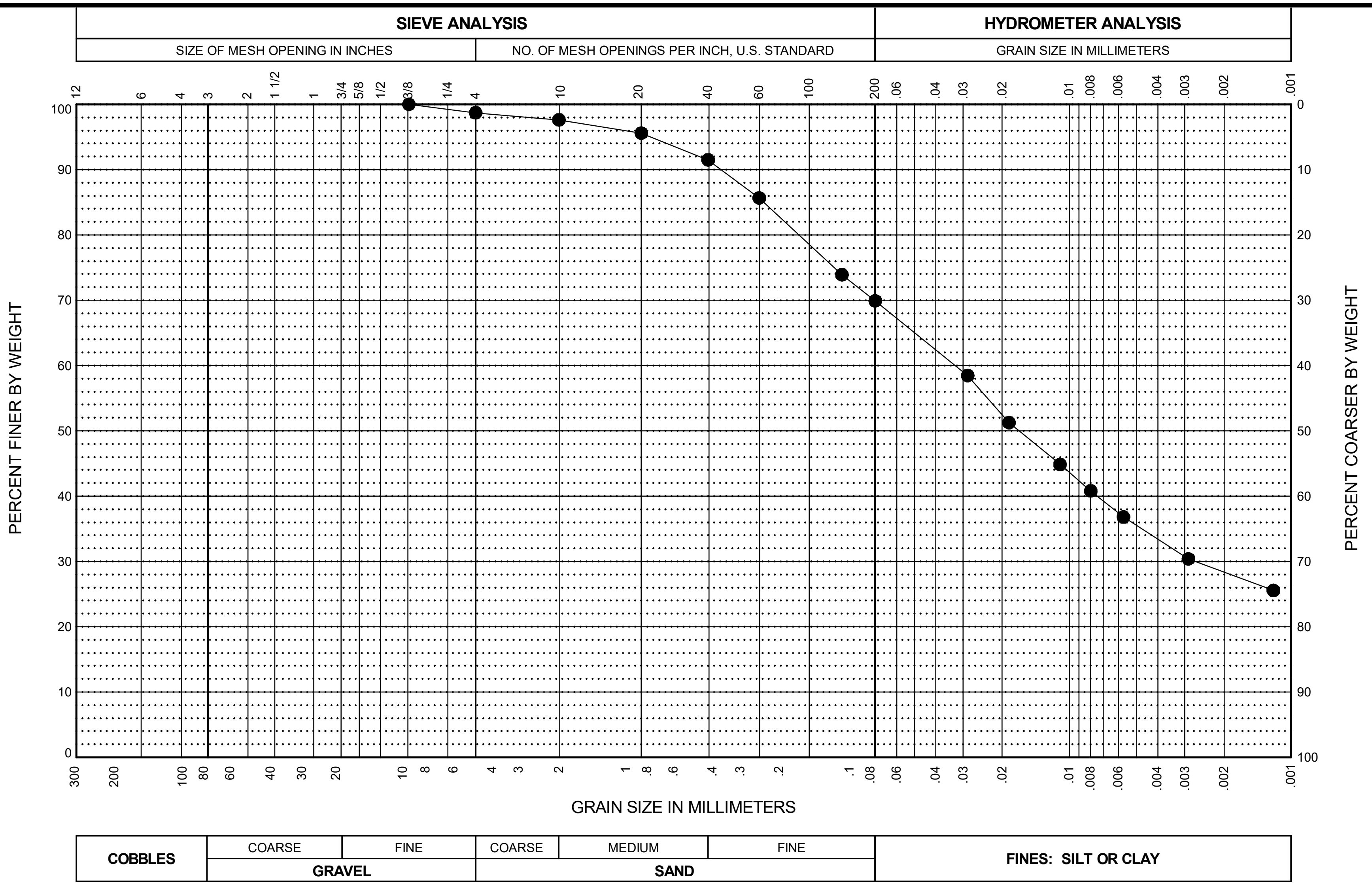
Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

GRAIN SIZE DISTRIBUTION

October 2019 104287-001 / 128064-012

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.



GSA- WITH SAMPLE INTERVALS 104287-001 LAB DATA.GPJ SHAN_WIL.GDT 10/16/19

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HAB-CDT-01, T1	8.0 - 10.0	CL	Brown, Sandy Lean Clay.	69.9	17.3	40	14	26

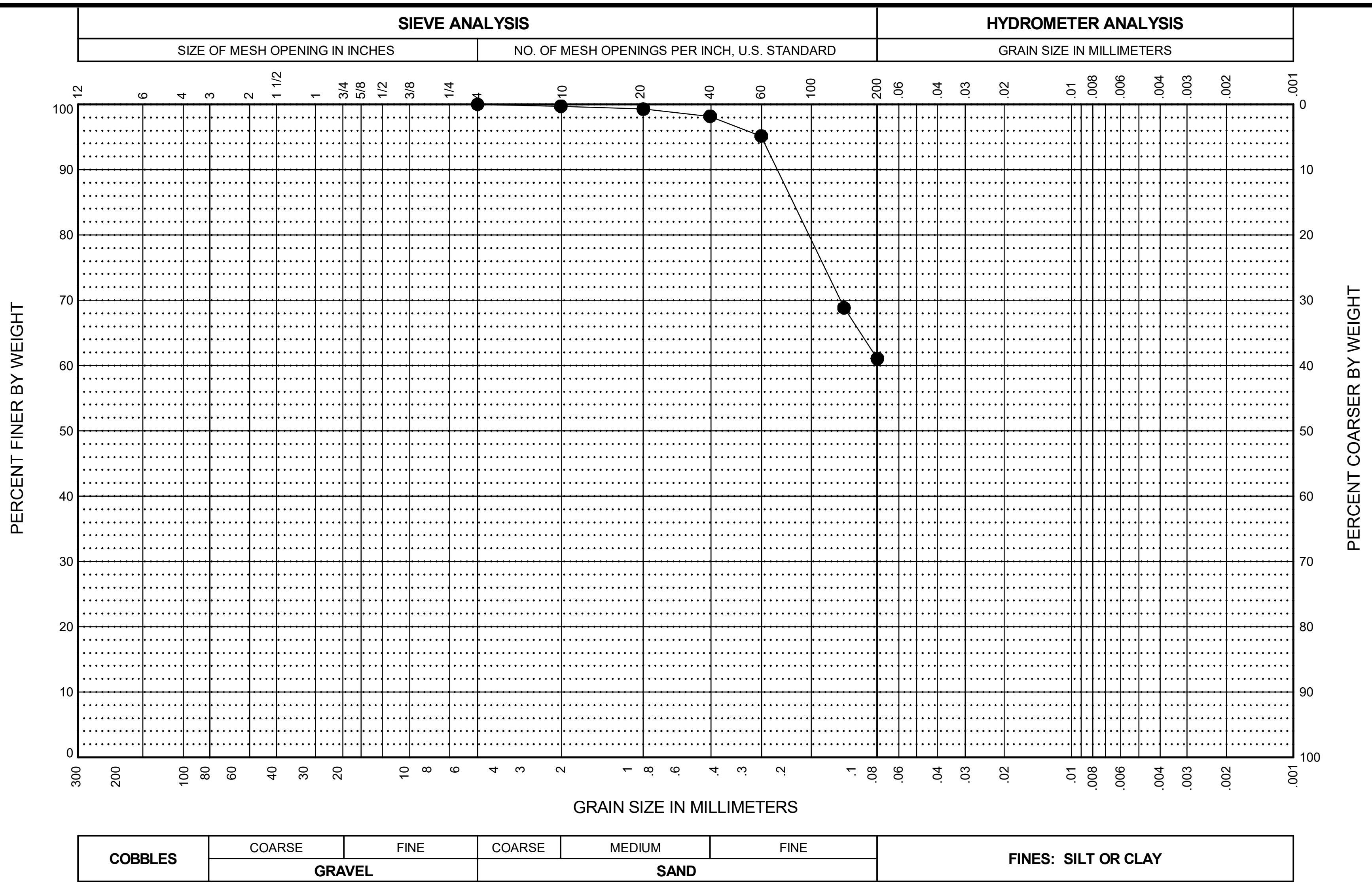
Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

GRAIN SIZE DISTRIBUTION

October 2019 104287-001 / 128064-012

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.



GSA- WITH SAMPLE INTERVALS 104287-001 LAB DATA.GPJ SHAN_WIL.GDT 10/16/19

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HAB-CDT-04, T1	8.0 - 10.0	CL	Gray and brown, Sandy Lean Clay.	61.1	19.2	45	15	30

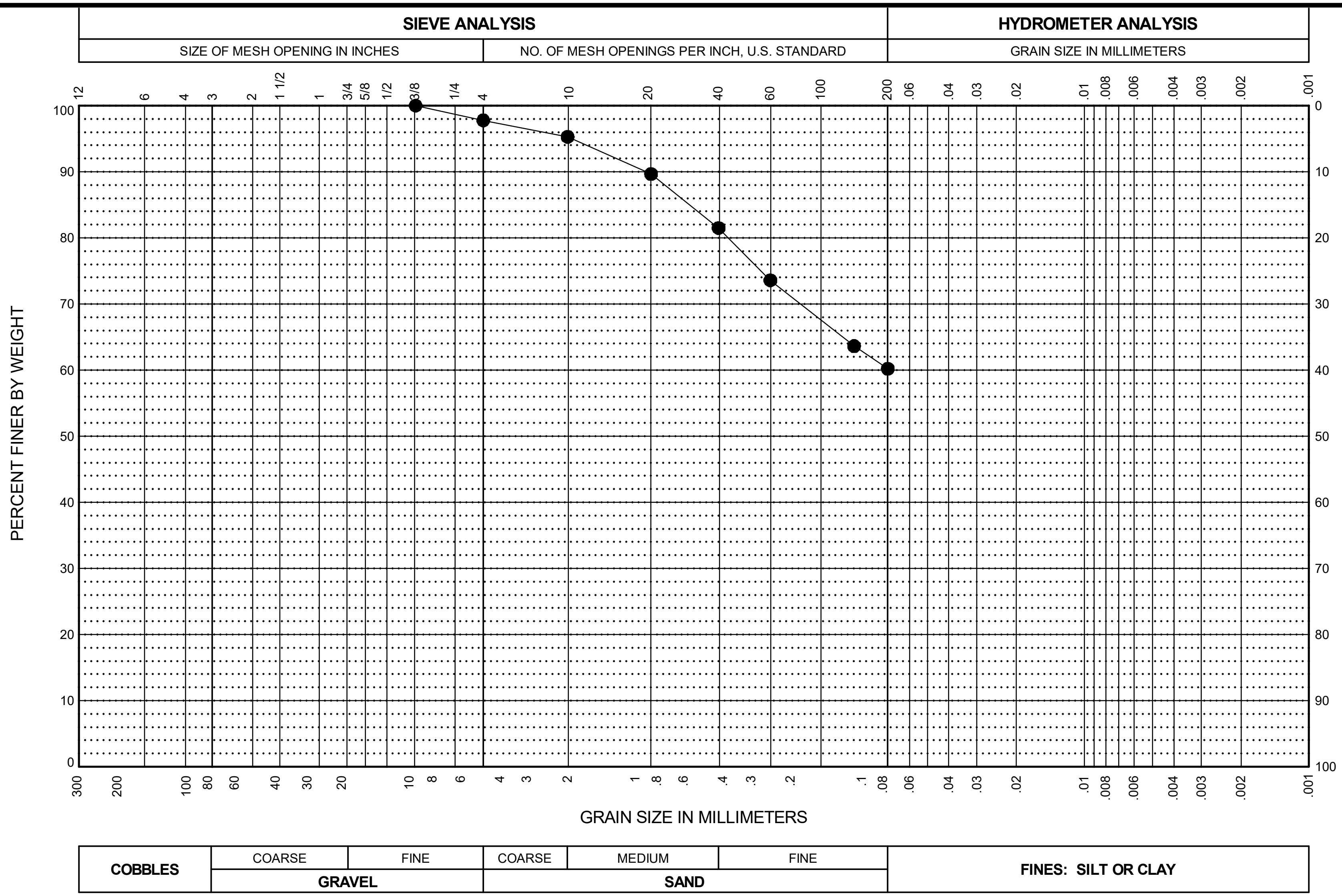
Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

GRAIN SIZE DISTRIBUTION

October 2019 104287-001 / 128064-012

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.



GSA- WITH SAMPLE INTERVALS 104287-001 LAB DATA.GPJ SHAN_WIL.GDT 10/16/19

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HAB-CDT-09, S2	6.0 - 8.0	CH	Gray, Sandy Fat Clay.	60.2	16.8	51	16	35

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

GRAIN SIZE DISTRIBUTION

October 2019 104287-001 / 128064-012

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.

CONSOLIDATION TEST

Project	Thomas Hill Energy Center – CDT	Client	Haley & Aldrich, Inc.	
Location	Clifton Hill, Missouri	Tested By / Date	CMB	10/10/19
Job Number	104287-001	Calculated By / Date	CMB	10/24/19
Boring	HAB-CDT-01	Checked By / Date	DPM	10/24/19
Sample	T1	File	104287-001 HAB-CDT-01 T1 D2435	
Depth (ft)	8.0 - 10.0	Procedure	ASTM D2435	

	Initial Data		*Final Data*				
	Sample Height	*Ring Diameter*	*Sample Height*		*Trimmings #1*		
Measured Reading 1	0.997	2.501	0.947	inches	Tare No.	C-1	
Measured Reading 2	0.992	2.502	0.947	inches	Tare Weight	2.52	
Measured Reading 3	0.995	2.500	0.951	inches	Wet Weight	63.80	
Measured Reading 4	0.996	2.501	0.946	inches	Dry Weight	54.74	
Average Reading	0.995	2.501	0.948	inches	M.C. %	17.3%	
Wet Weight + Ring	305.93		390.86	grams	*Trimmings #2*		
Weight of Ring	145.36	Dry Weight	366.02	grams	Tare No.	C-2	
Specific Gravity	2.70	Tare Weight	83.62	grams	Tare Weight	2.56	
Sample Volume	80.10		75.55	cm^3	Wet Weight	70.27	
Height of Solids	0.630		0.630	inches	Dry Weight	60.09	
Void Ratio	0.58		0.49		M.C. %	17.7%	
Saturation	80.1		100.0	percent	Ring Number	410	
Weight of Water	23.53		24.84	grams	Inundated @	0.25	tsf
Moisture Content	17.2		18.1	percent	Trimming Method		Cutting Shoe
Wet Unit Weight	125.2		133.8	pcf	[Cutting Shoe / Turntable / None (Ring)]		
Dry Unit Weight	106.8		113.2	pcf	Method Used	[✓ A] or B	
Notes: The specific gravity is computed assuming saturation at the end of the test.					Computed Ht.	0.939	inches

Load 1		Load 2		Load 3		Load 4	
Air Press.	1.4	Air Press.	2.1	Air Press.	3.7	Air Press.	6.9
Load, tsf	0.25	Load, tsf	0.5	Load, tsf	1.0	Load, tsf	2.0
Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4
0.1	42	0.1	52	0.1	137	0.1	278
0.25	45	0.25	55	0.25	144	0.25	288
0.5	46	0.5	57	0.5	151	0.5	296
1	46	1	60	1	158	1	303
2	46	2	62	2	163	2	310
4	45	4	64	4	168	4	316
8	40	8	65	8	174	8	321
15	33	15	67	15	177	15	326
30	29	30	70	30	182	30	328
60		60	71	60	184	60	333
120		120	72	120	187	120	335
240		240		240	190	240	336
480		480		480	192	480	340
1440		1440		900	193	4300	351

Load 5		Load 6		Load 7		Load 8	
Air Press.	12.9	Air Press.	25.5	Air Press.	6.9	Air Press.	12.9
Load, tsf	4.0	Load, tsf	8.0	Load, tsf	2.0	Load, tsf	4.0
Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4
0.1	454	0.1	684	0.1	815	0.1	768
0.25	464	0.25	697	0.25	809	0.25	769
0.5	476	0.5	709	0.5	806	0.5	773
1	487	1	719	1	800	1	775
2	497	2	731	2	796	2	776
4	511	4	746	4	790	4	777
8	521	8	766	8	783	8	779
15	533	15	783	15	775	15	781
30	543	30	801	30	768	30	783
60	550	60	816	60	765	60	783
120	553	120	824	120	760	120	784
240	558	240	832	240	760	240	784
480	560	480	839	480	759	480	785
1440	568	1440	847	1440	758	1440	785

CONSOLIDATION TEST

Project	Thomas Hill Energy Center – CDT	Client	Haley & Aldrich, Inc.	
Location	Clifton Hill, Missouri	Tested By / Date	CMB	10/10/19
Job Number	104287-001	Calculated By / Date	CMB	10/24/19
Boring	HAB-CDT-01	Checked By / Date	DPm	10/24/19
Sample	T1	File	104287-001 HAB-CDT-01 T1 D2435	
Depth (ft)	8.0 - 10.0	Procedure	ASTM D2435	

	Initial Data		*Final Data*				
	Sample Height	*Ring Diameter*	*Sample Height*		*Trimmings #1*		
Measured Reading 1	0.997	2.501	0.947	inches	Tare No.	C-1	
Measured Reading 2	0.992	2.502	0.947	inches	Tare Weight	2.52	
Measured Reading 3	0.995	2.500	0.951	inches	Wet Weight	63.80	
Measured Reading 4	0.996	2.501	0.946	inches	Dry Weight	54.74	
Average Reading	0.995	2.501	0.948	inches	M.C. %	17.3%	
Wet Weight + Ring	305.93		390.86	grams	*Trimmings #2*		
Weight of Ring	145.36	Dry Weight	366.02	grams	Tare No.	C-2	
Specific Gravity	2.70	Tare Weight	83.62	grams	Tare Weight	2.56	
Sample Volume	80.10		75.55	cm^3	Wet Weight	70.27	
Height of Solids	0.630		0.630	inches	Dry Weight	60.09	
Void Ratio	0.58		0.49		M.C. %	17.7%	
Saturation	80.1		100.0	percent	Ring Number	410	
Weight of Water	23.53		24.84	grams	Inundated @	0.25	tsf
Moisture Content	17.2		18.1	percent	Trimming Method		Cutting Shoe
Wet Unit Weight	125.2		133.8	pcf	[Cutting Shoe / Turntable / None (Ring)]		
Dry Unit Weight	106.8		113.2	pcf	Method Used	[✓ A] or B	

Load 9		Load 10		Load 11	
Air Press.	25.5	Air Press.	50.2	Air Press.	1.4
Load, tsf	8.0	Load, tsf	16.0	Load, tsf	0.25
Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4
0.1	817	0.1	948	0.1	1064
0.25	824	0.25	959	0.25	1032
0.5	828	0.5	967	0.5	1023
1	832	1	980	1	1009
2	837	2	993	2	997
4	840	4	1015	4	976
8	847	8	1039	8	952
15	849	15	1064	15	920
30	855	30	1091	30	874
60	857	60	1111	60	822
120	862	120	1125	120	761
240	864	240	1134	240	712
480	865	480	1141	480	685
4350	877	1440	1152	1440	671

CONSOLIDATION TEST

Project	Thomas Hill Energy Center – CDT	Client	Haley & Aldrich, Inc.	
Location	Clifton Hill, Missouri	Tested By / Date	CMB	10/10/19
Job Number	104287-001	Calculated By / Date	CMB	10/24/19
Boring	HAB-CDT-01	Checked By / Date	DPM	10/24/19
Sample	T1	File	104287-001 HAB-CDT-01 T1 D2435	
Depth (ft)	8.0 - 10.0	Procedure	ASTM D2435	

	Initial Data		Final Data				
	Sample Height	*Ring Diameter*	*Sample Height*		*Trimmings #1*		
Measured Reading 1	0.997	2.501	0.947	inches	Tare No.	C-1	
Measured Reading 2	0.992	2.502	0.947	inches	Tare Weight	2.52	
Measured Reading 3	0.995	2.500	0.951	inches	Wet Weight	63.80	
Measured Reading 4	0.996	2.501	0.946	inches	Dry Weight	54.74	
Average Reading	0.995	2.501	0.948	inches	M.C. %	17.3%	
Wet Weight + Ring	305.93		390.86	grams	*Trimmings #2*		
Weight of Ring	145.36	Dry Weight	366.02	grams	Tare No.	C-2	
Specific Gravity	2.70	Tare Weight	83.62	grams	Tare Weight	2.56	
Sample Volume	80.10		75.55	cm^3	Wet Weight	70.27	
Height of Solids	0.630		0.630	inches	Dry Weight	60.09	
Void Ratio	0.58		0.49		M.C. %	17.7%	
Saturation	80.1		100.0	percent	Ring Number	410	
Weight of Water	23.53		24.84	grams	Inundated @	0.25	tsf
Moisture Content	17.2		18.1	percent	Trimming Method		Cutting Shoe
Wet Unit Weight	125.2		133.8	pcf	[Cutting Shoe / Turntable / None (Ring)]		
Dry Unit Weight	106.8		113.2	pcf	Method Used	[✓ A] or B	

CALIBRATION OF CONSOLIDATION DEFORMATION

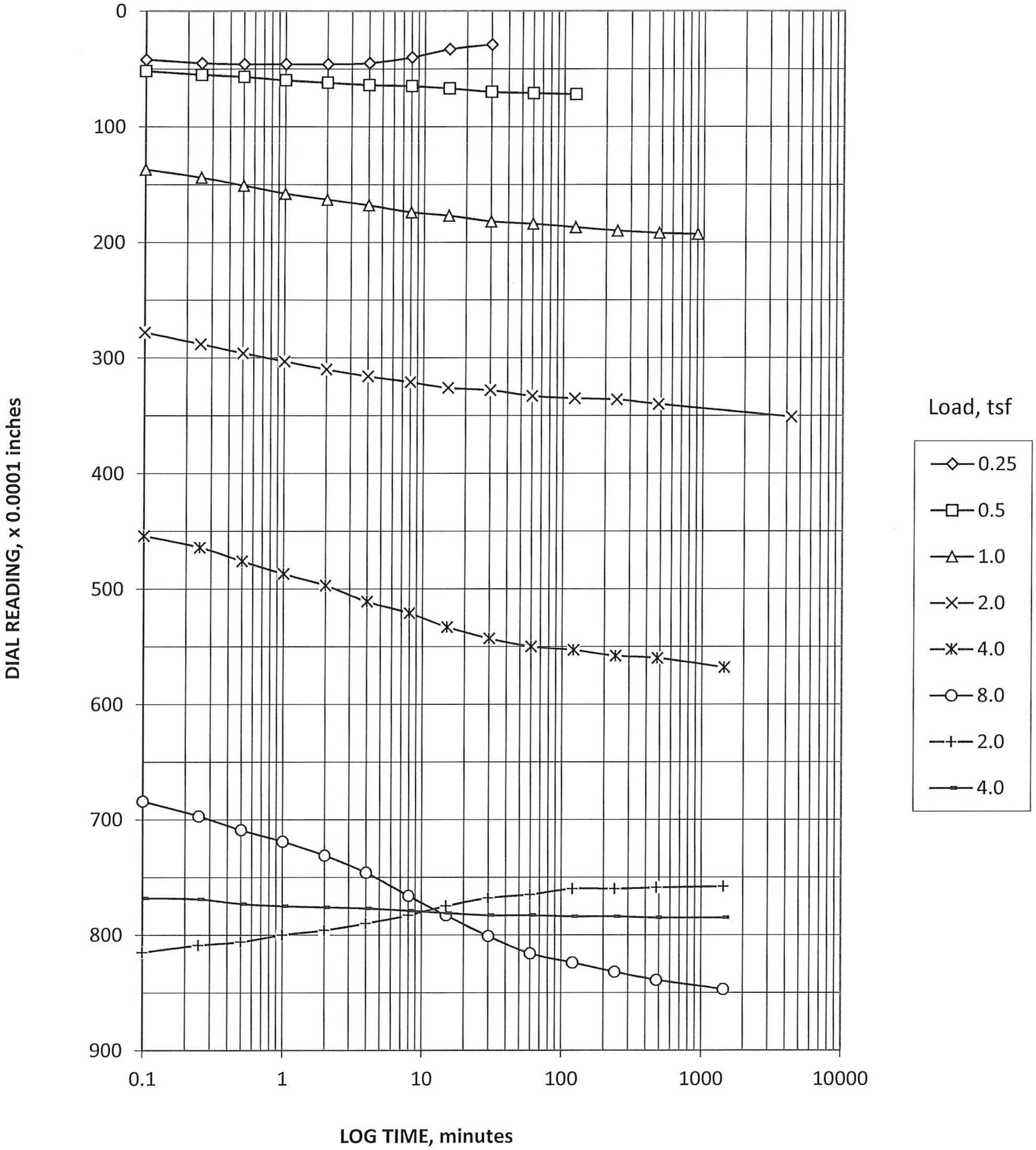
Procedure SWCP-15 (Reference ASTM D2435 AASHTO T216)

Equipment Calibrated:	Consolidation Deformation	Date Calibrated:	10/23/19
Reason for Calibration:	Test Completion	Next Calibration Due:	Next Test
Equipment Used:	Consolidation Appartus	Calibrated By:	CMB
	Steel Calibration Disk	Checked By:	CMB

Machine Number: 410

Load tsf	Machine Def $\times 10^{-4}$	Correction Factor $\times 10^{-4}$	U-100 $\times 10^{-4}$	Corr. U-100 $\times 10^{-4}$	Compression, Percent	C_v	Void Ratio
0.01	0	0	0	0	0.00%	0	0.580
0.25	47	0	46.0	-1	0.00%	2.1E+00	0.580
0.5	61	0	63.0	2	0.00%	1.0E+00	0.579
1.0	99	0	169.0	70	0.70%	1.2E+00	0.568
2.0	129	0	322.0	193	1.93%	8.5E-01	0.549
4.0	147	0	547.0	400	4.00%	2.9E-01	0.516
8.0	170	0	825.0	655	6.55%	9.8E-02	0.476
2.0	153	25	760.0	582	5.82%	NA	0.487
4.0	160	25	774.0	589	5.89%	NA	0.486
8.0	172	25	847.0	650	6.50%	NA	0.476
16.0	194	0	1121.0	927	9.27%	6.9E-02	0.432
0.25	106	31	692.0	555	5.55%	NA	0.491

CONSOLIDATION TEST



Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

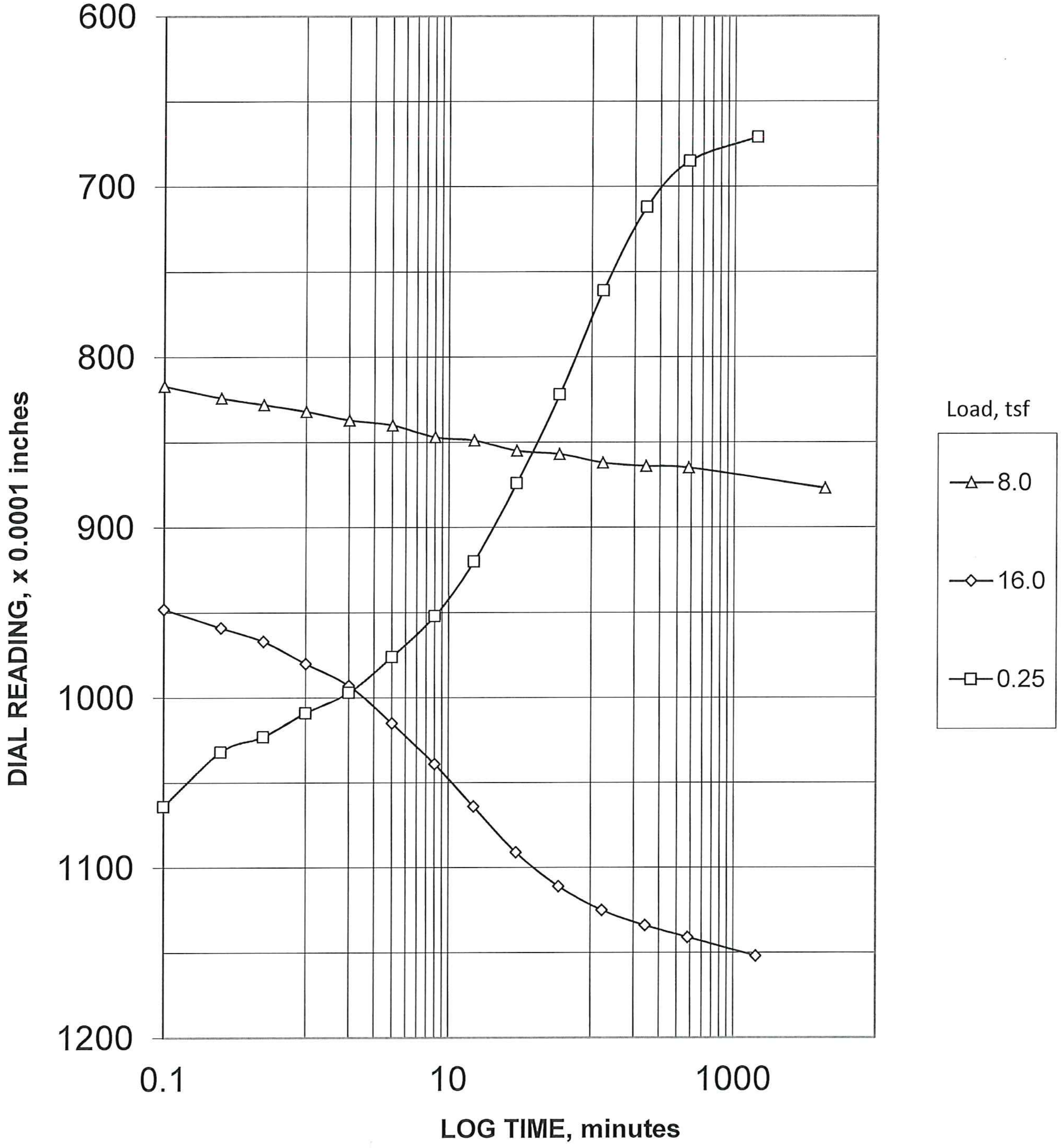
TIME PLOTS
HAB-CDT-01
T1

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.

CONSOLIDATION TEST



Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

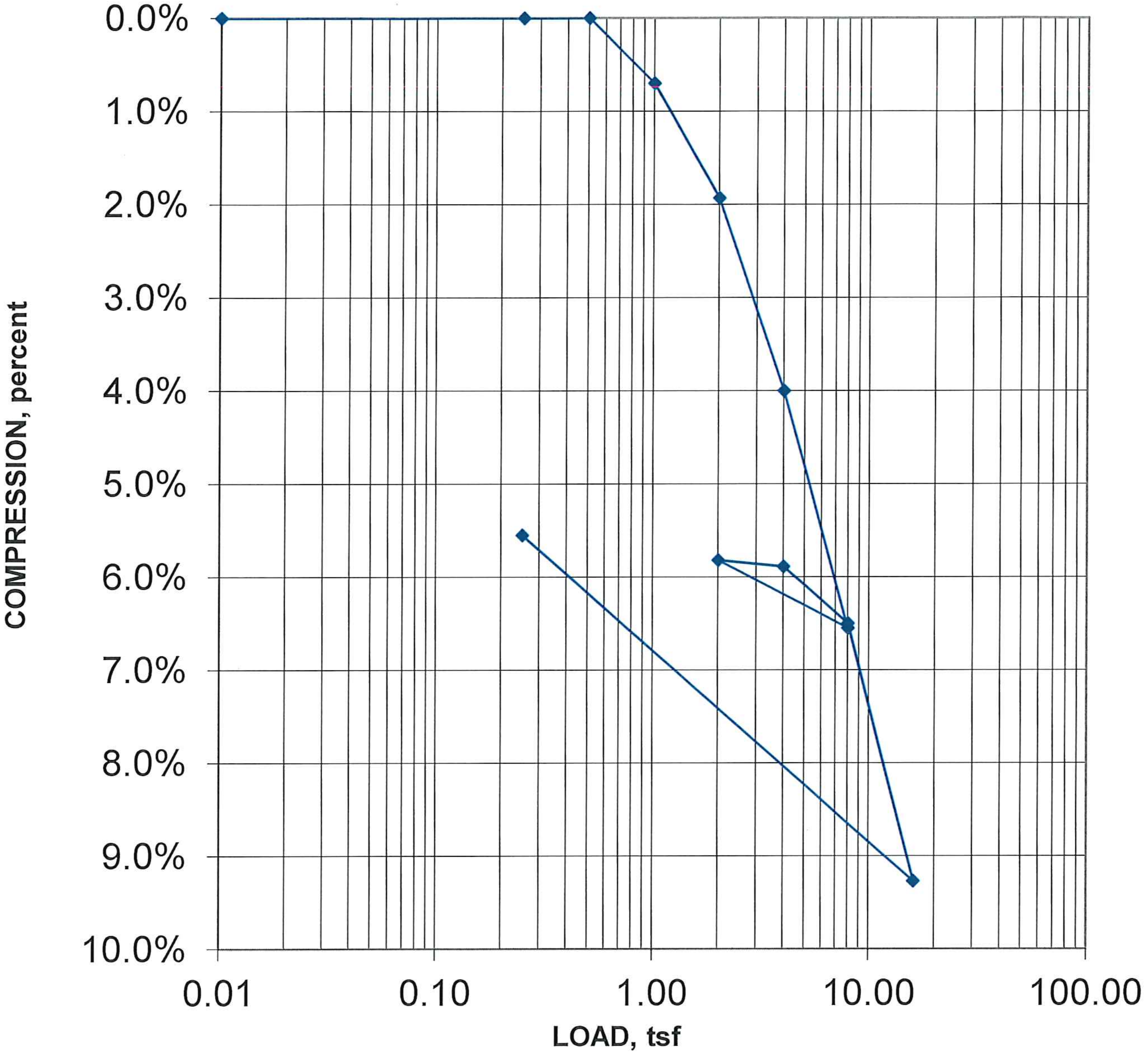
TIME PLOTS
HAB-CDT-01
T1

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.

CONSOLIDATION TEST



Load, tsf	Coefficient of Consolidation, mm^2/second	Load, tsf	Coefficient of Consolidation, mm^2/second
0.25	2.1E+00	4.0	NA
0.5	1.0E+00	8.0	NA
1.0	1.2E+00	16.0	6.9E-02
2.0	8.5E-01	0.25	NA
4.0	2.9E-01		
8.0	9.8E-02		
2.0	NA		

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

SETTLEMENT PLOTS

HAB-CDT-01

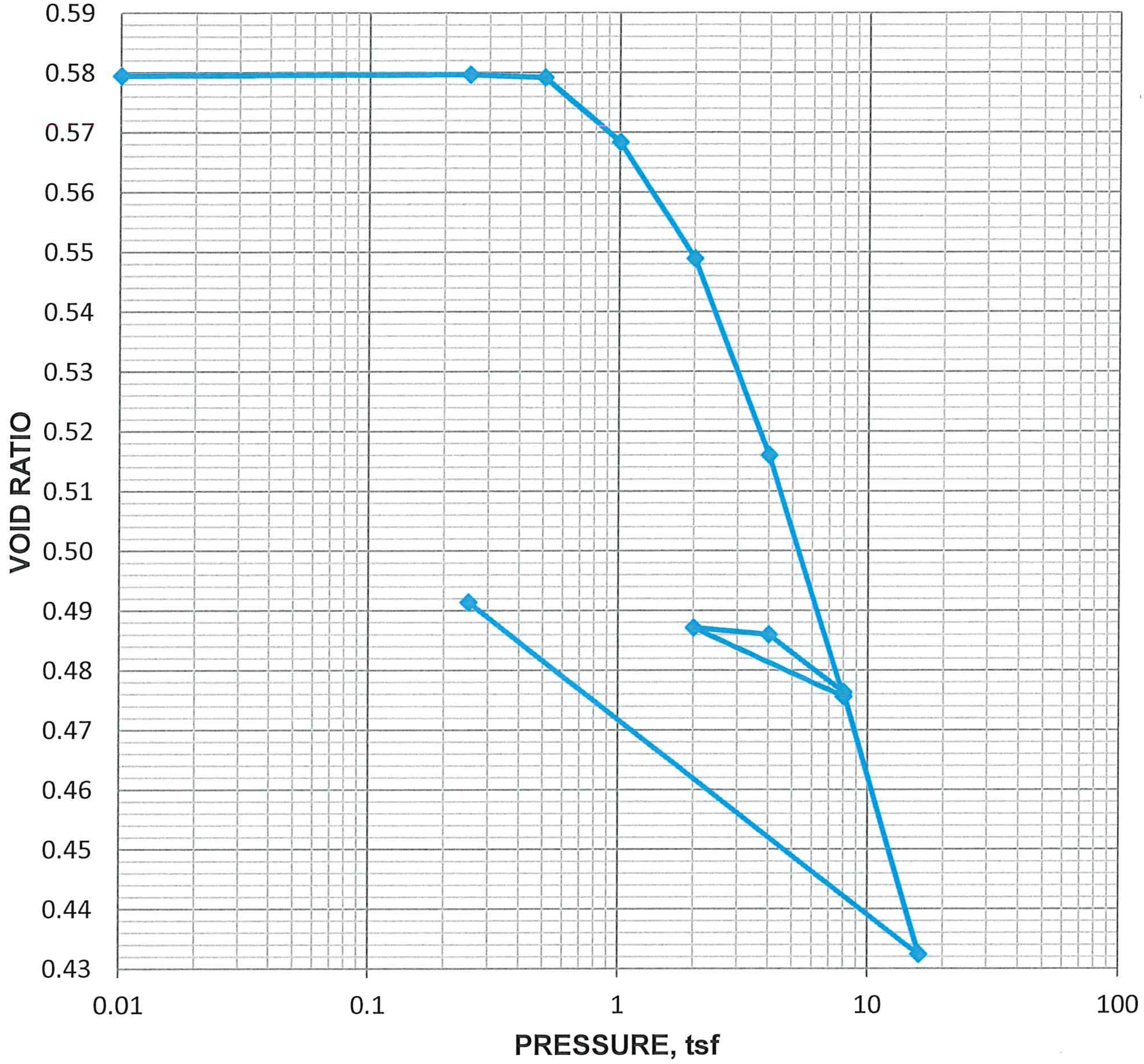
T1

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.

CONSOLIDATION TEST



Load, tsf	Coefficient of Consolidation, mm^2/second	Load, tsf	Coefficient of Consolidation, mm^2/second
0.25	2.1E+00	4.0	NA
0.5	1.0E+00	8.0	NA
1.0	1.2E+00	16.0	6.9E-02
2.0	8.5E-01	0.25	NA
4.0	2.9E-01		
8.0	9.8E-02		
2.0	NA		

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

VOID RATIO PLOT

HAB-CDT-01

T1

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

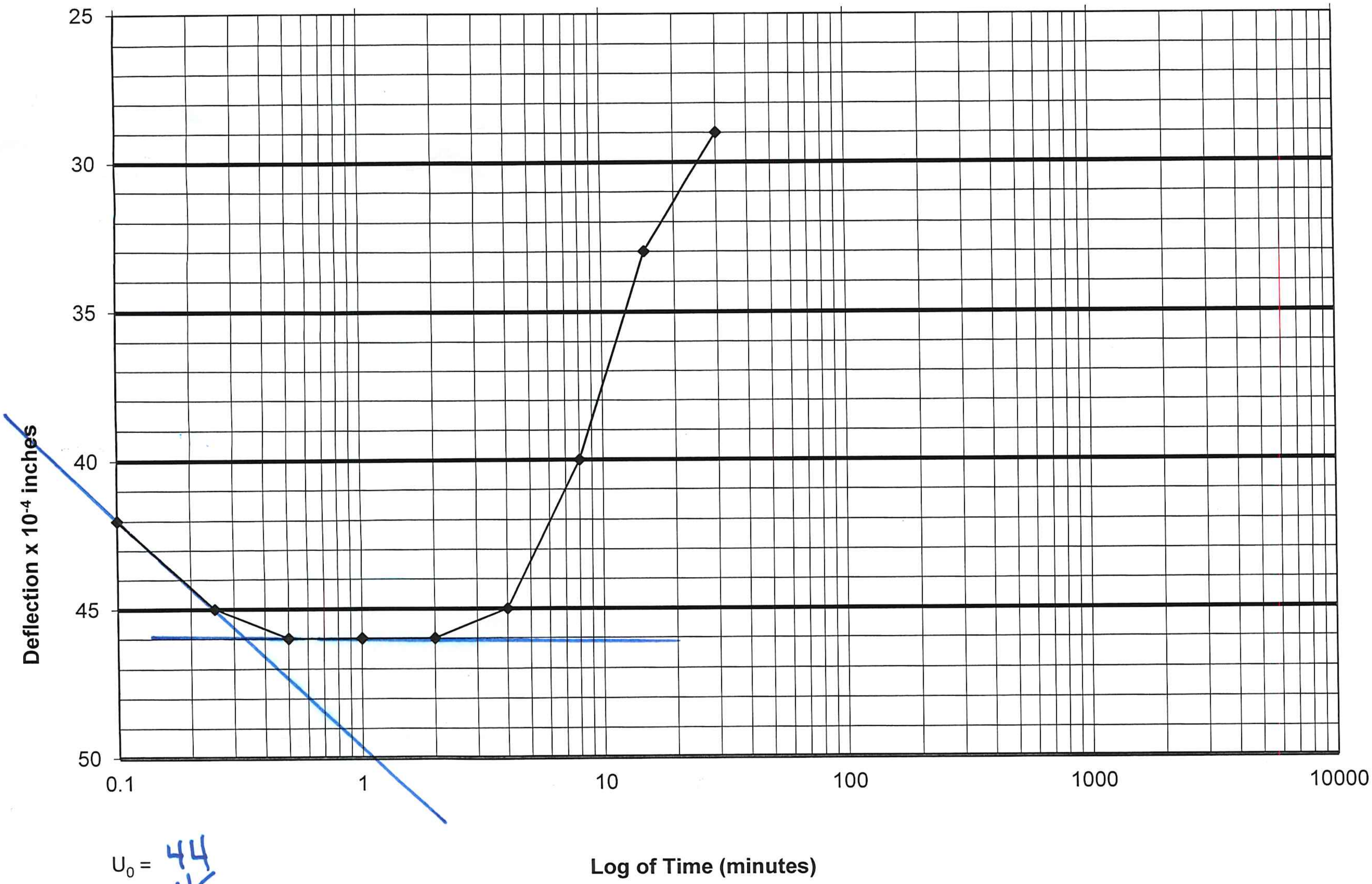
FIG.

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-01 T1

Load 1 0.25 tsf



U_0 = 44
U_{50} = 45
U_{100} = 46
t_{50} = 0.25

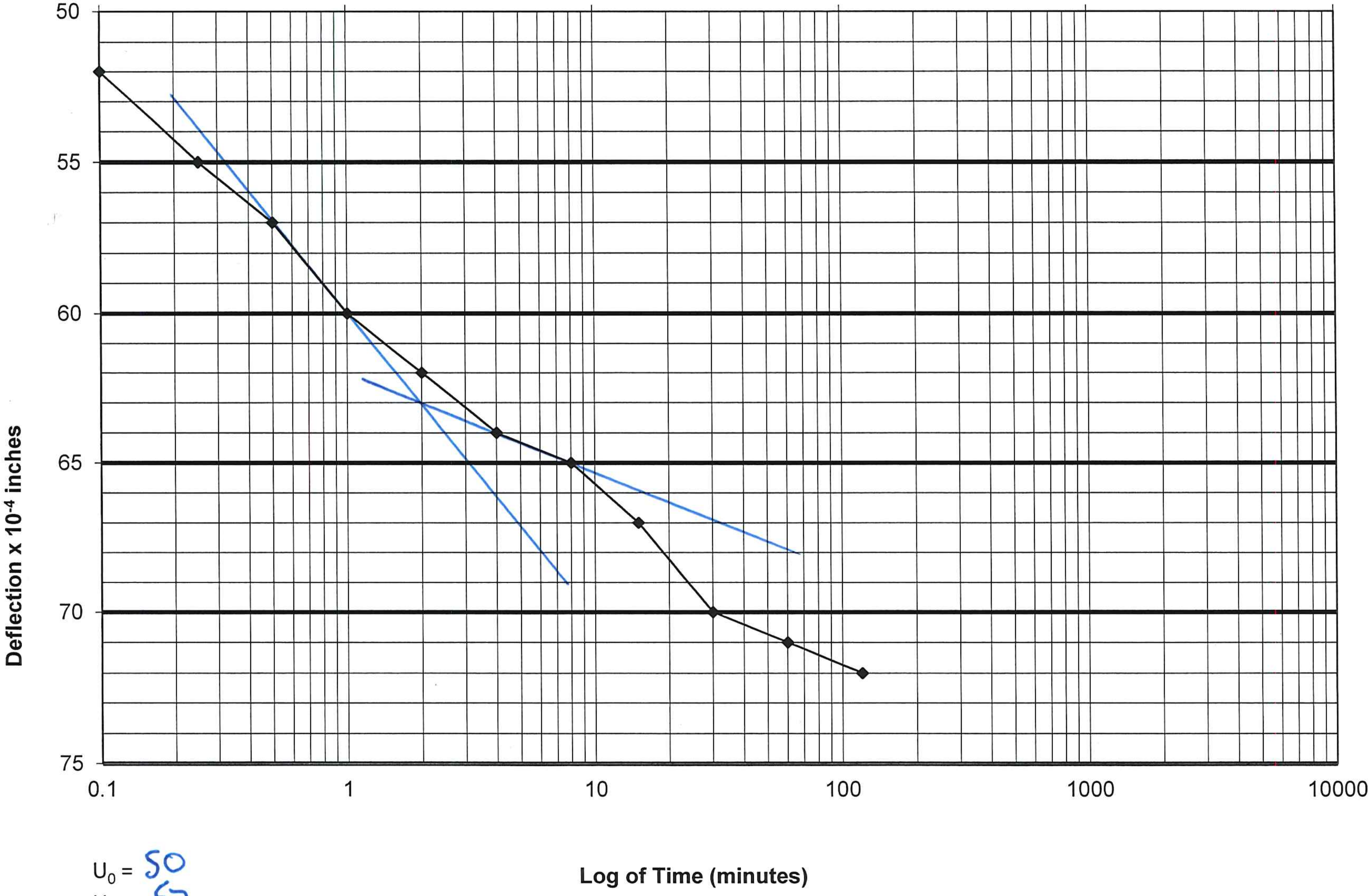
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-01 T1

Load 2 0.5 tsf



U_0 = 50

U_{50} = 57

U_{100} = 63

t_{50} = 0.50

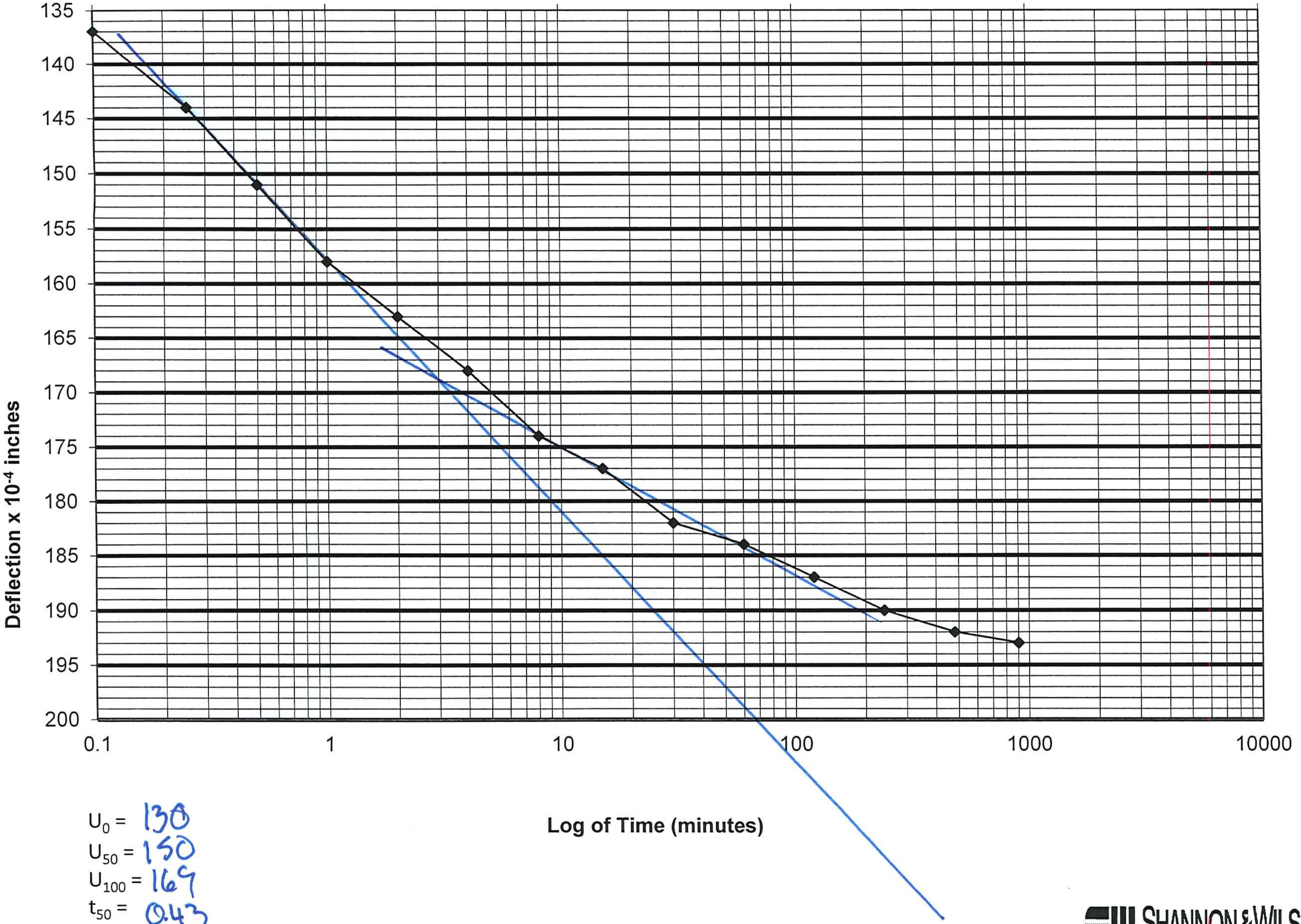
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-01 T1

Load 3 1.0 tsf



U_0 = 138

U_{50} = 150

U_{100} = 169

t_{50} = 0.43

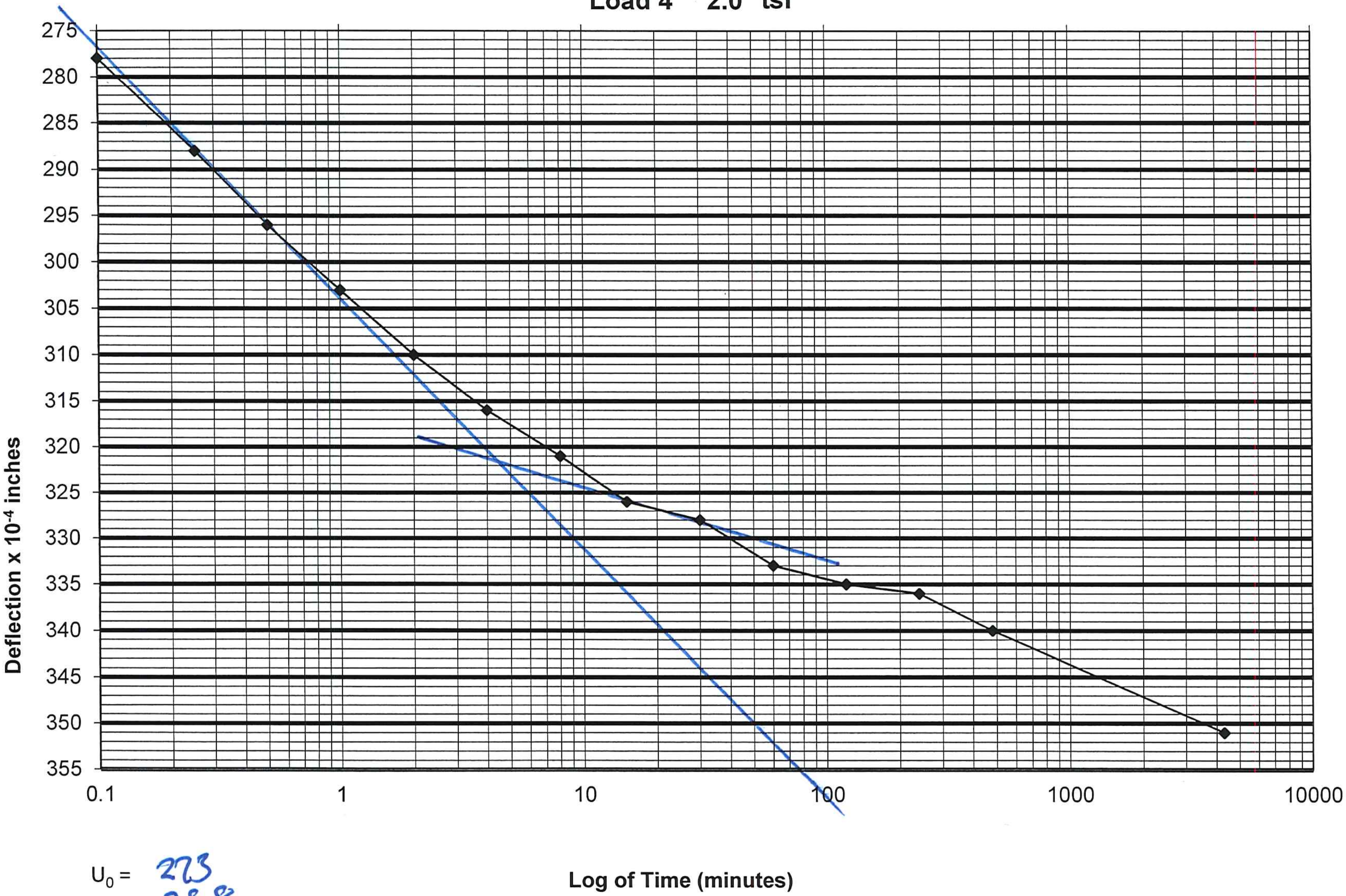
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-01 T1

Load 4 2.0 tsf



U_0 = 273

U_{50} = 298

U_{100} = 322

t_{50} = 0.58

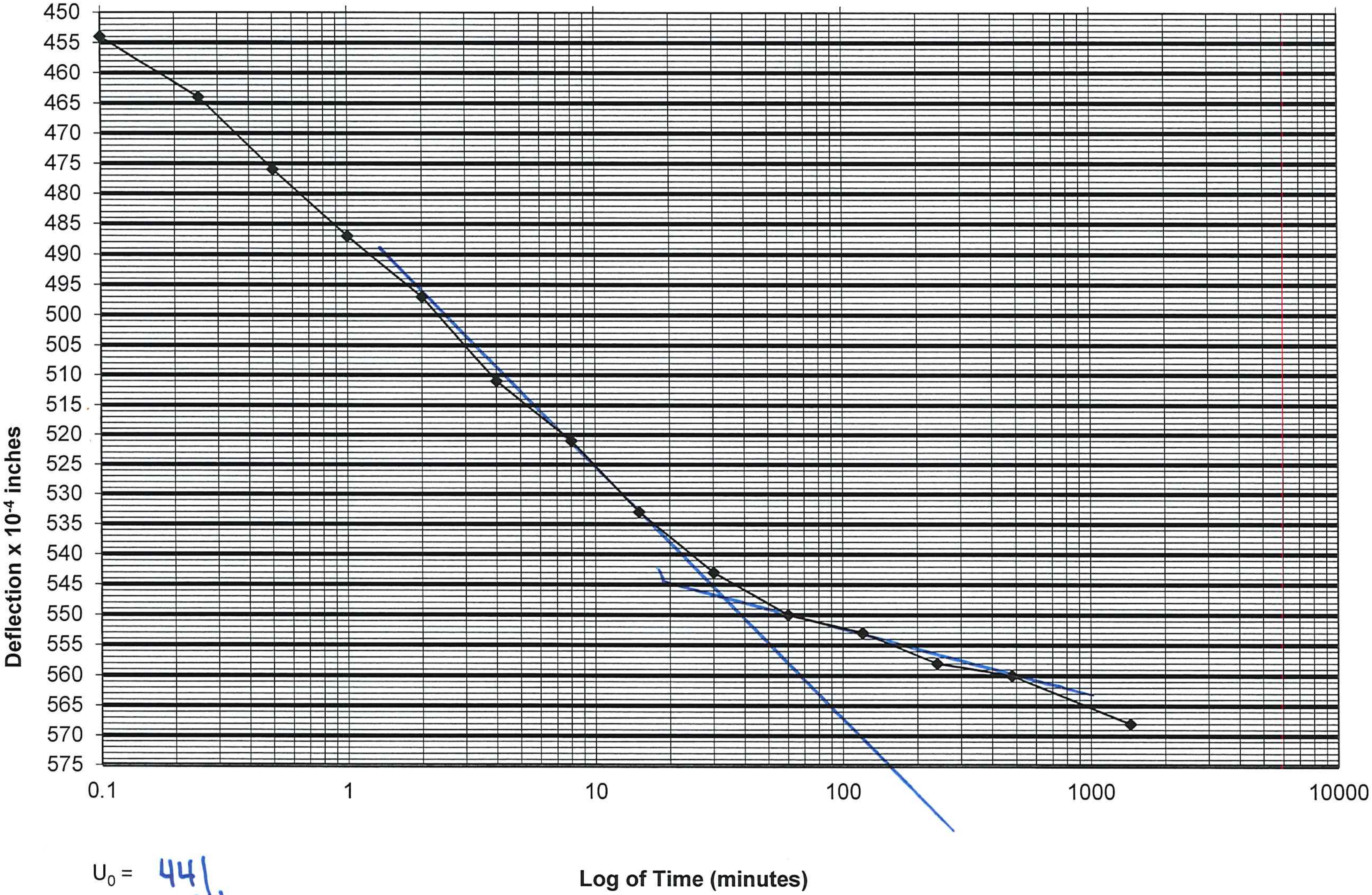
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-01 T1

Load 5 4.0 tsf



U_0 = 441

U_{50} = 494

U_{100} = 547

t_{50} = 1.62

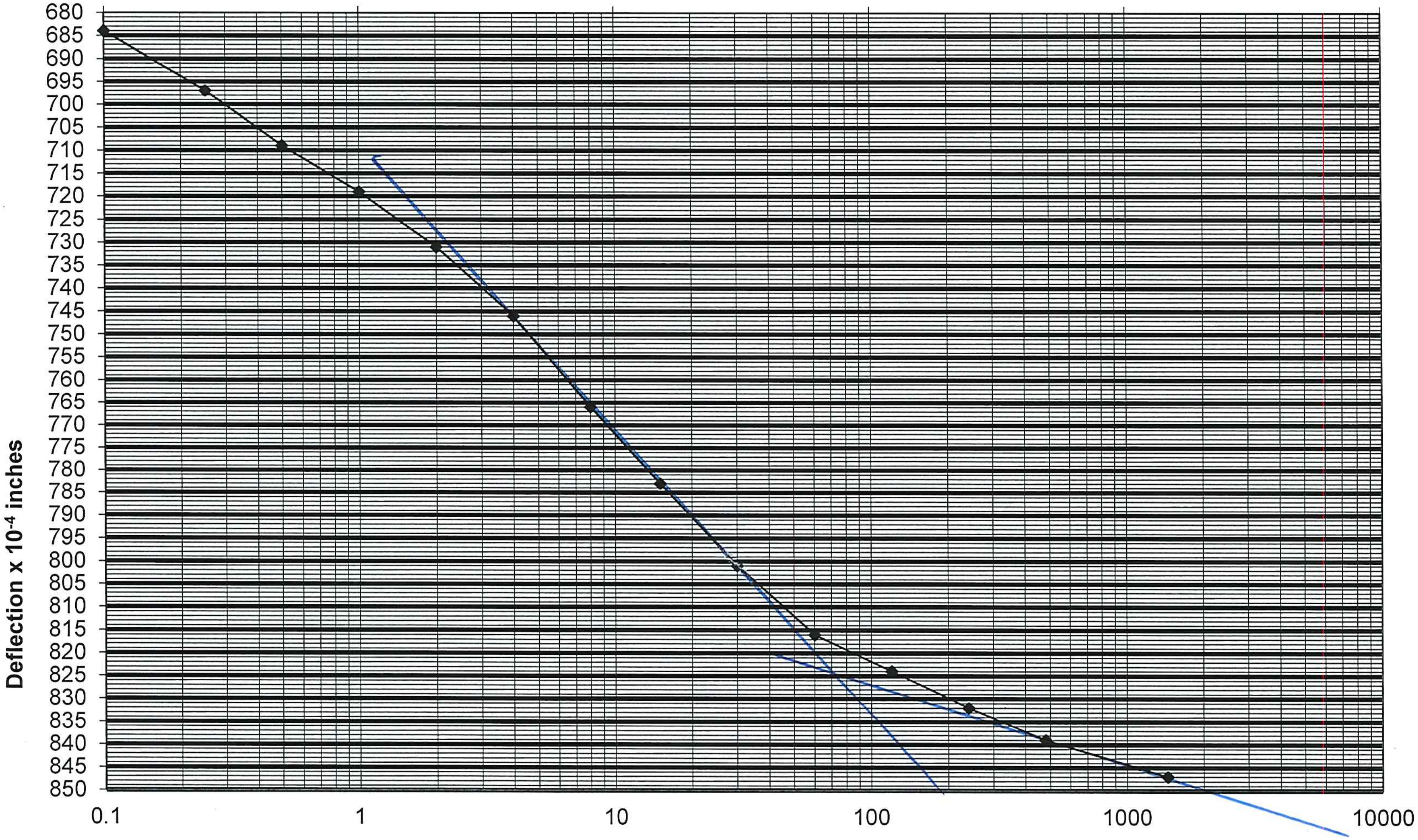
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-01 T1

Load 6 8.0 tsf



Log of Time (minutes)

U_0 = 675

U_{50} = 750

U_{100} = 825

t_{50} = 4.59

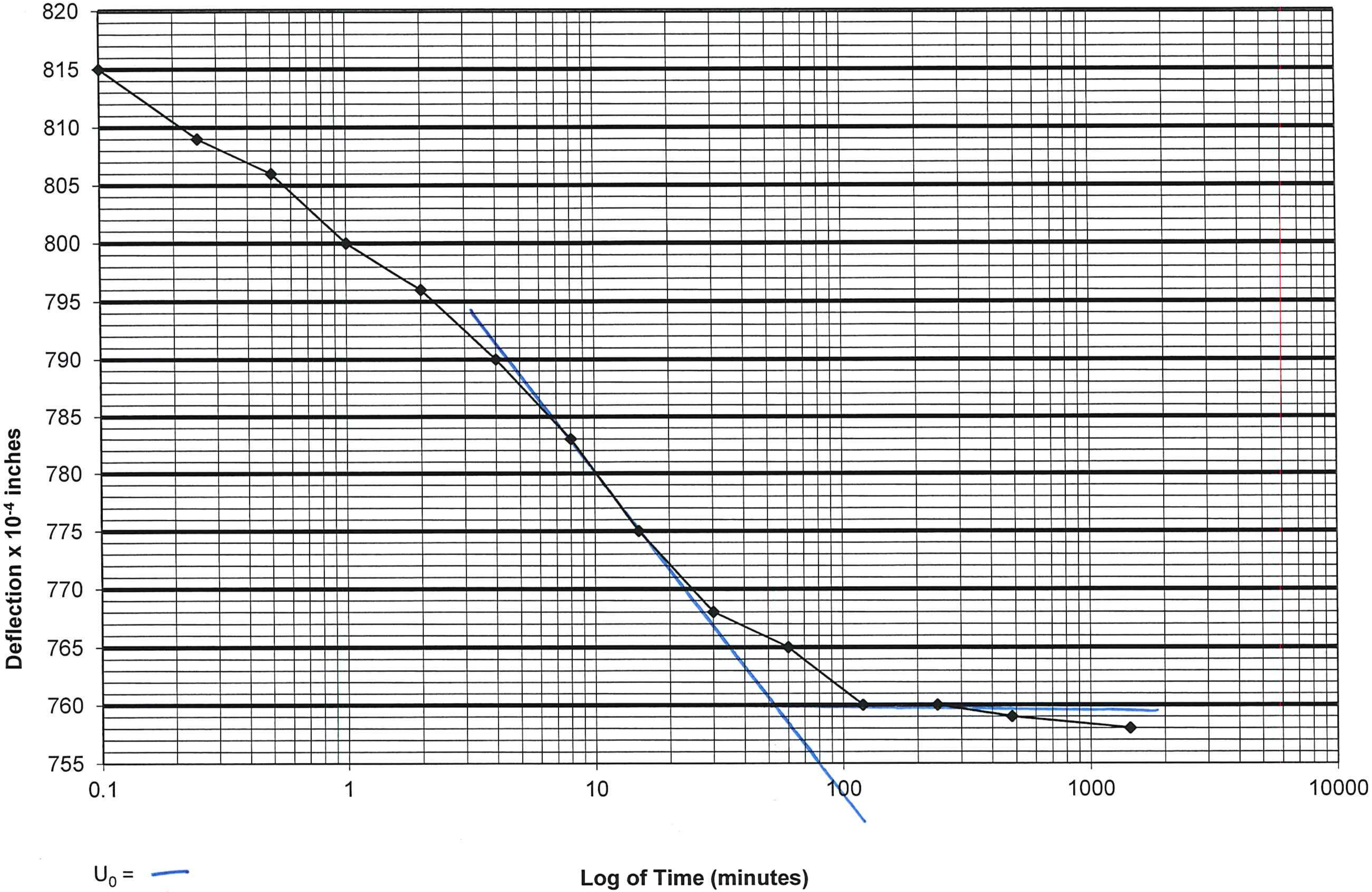
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-01 T1

Load 7 2.0 tsf



U_0 = —

U_{50} = —

U_{100} = 760

t_{50} = —

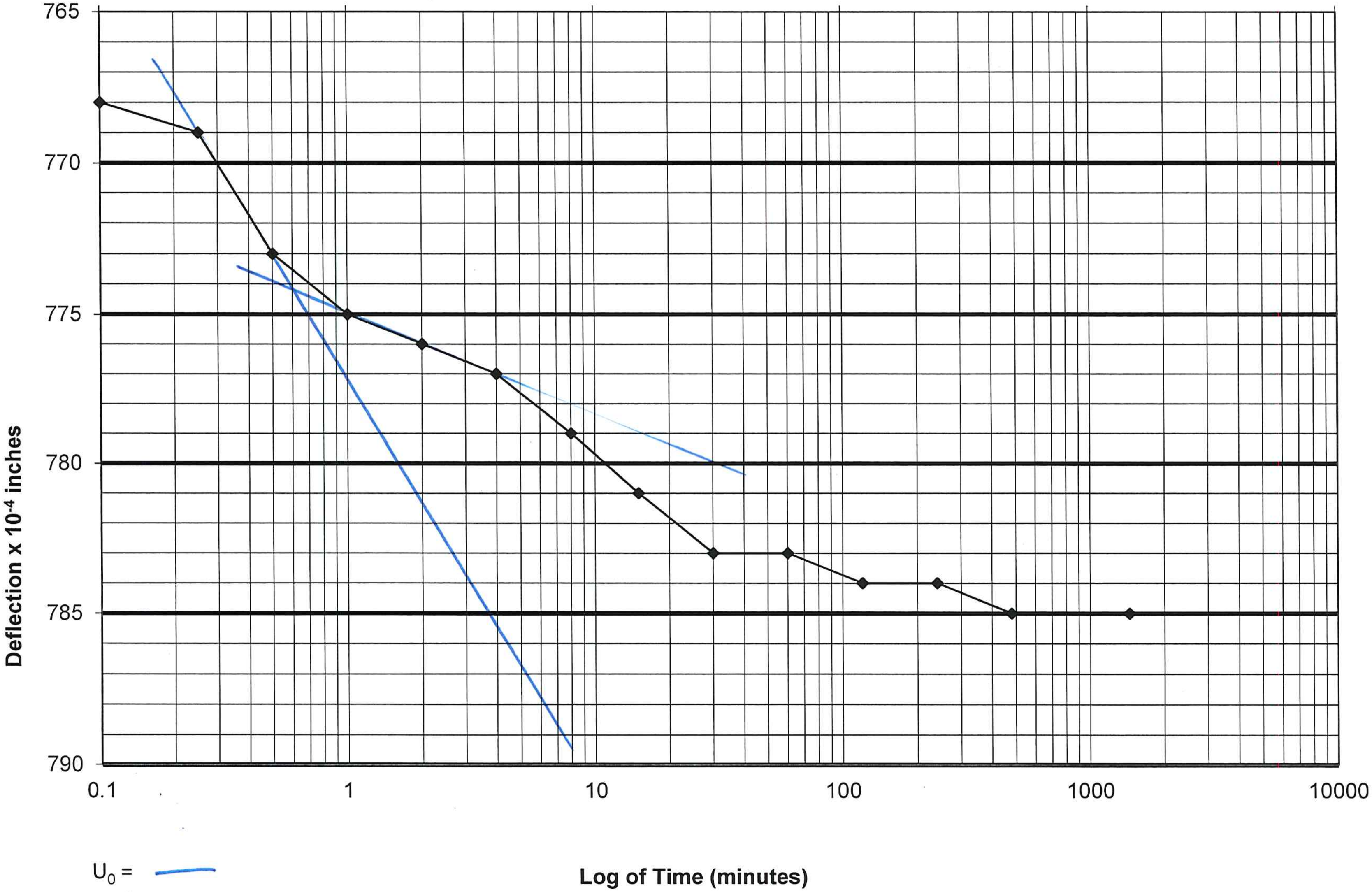
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-01 T1

Load 8 4.0 tsf



U_0 = ——

U_{50} = ——

U_{100} = 774

t_{50} = ——

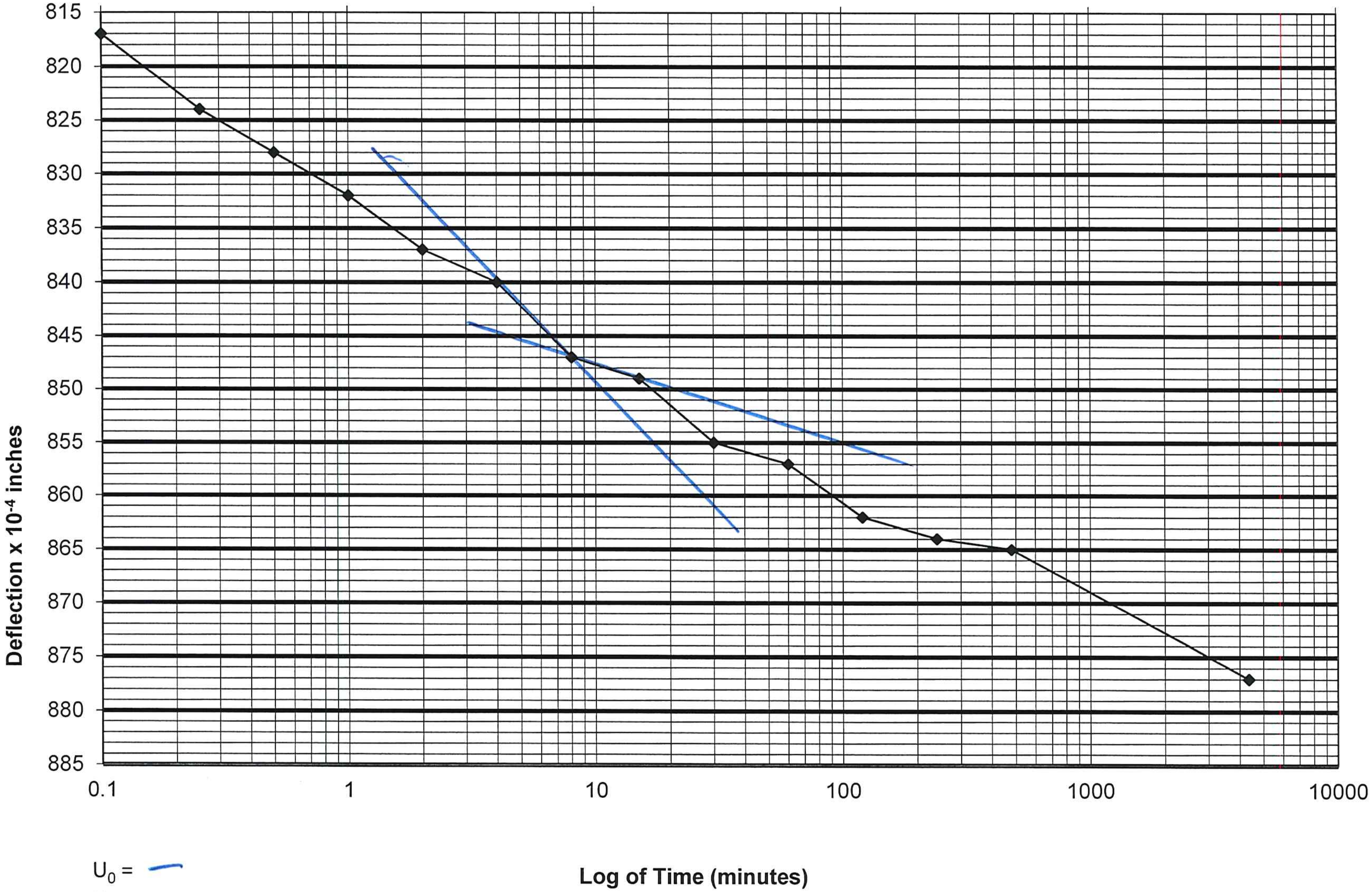
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-01 T1

Load 9 8.0 tsf



U_0 = —

U_{50} = —

U_{100} = 847

t_{50} = —

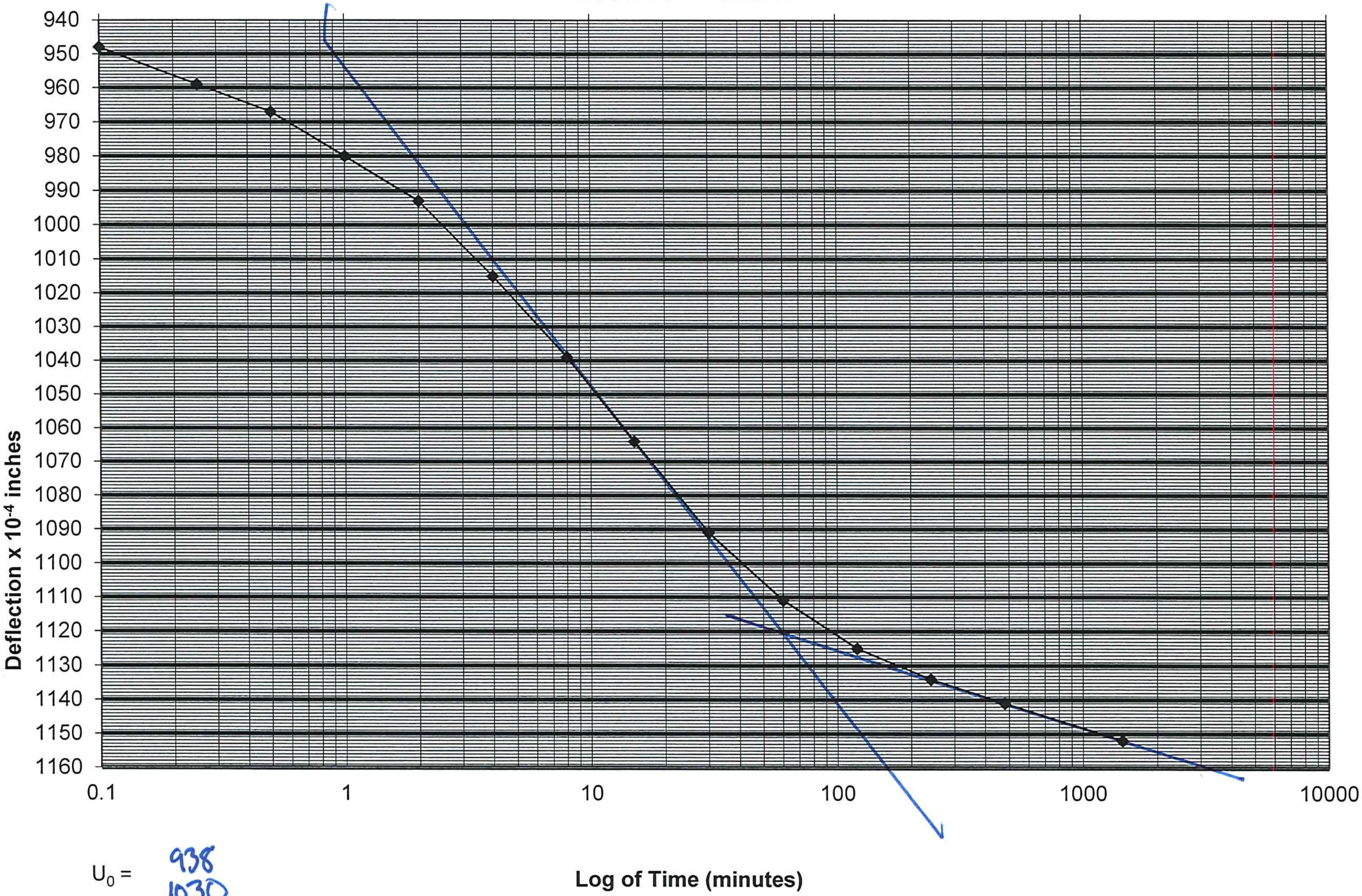
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-01 T1

Load 10 16.0 tsf



U_0 = 938

U_{50} = 1030

U_{100} = 1121

t_{50} = 6.08

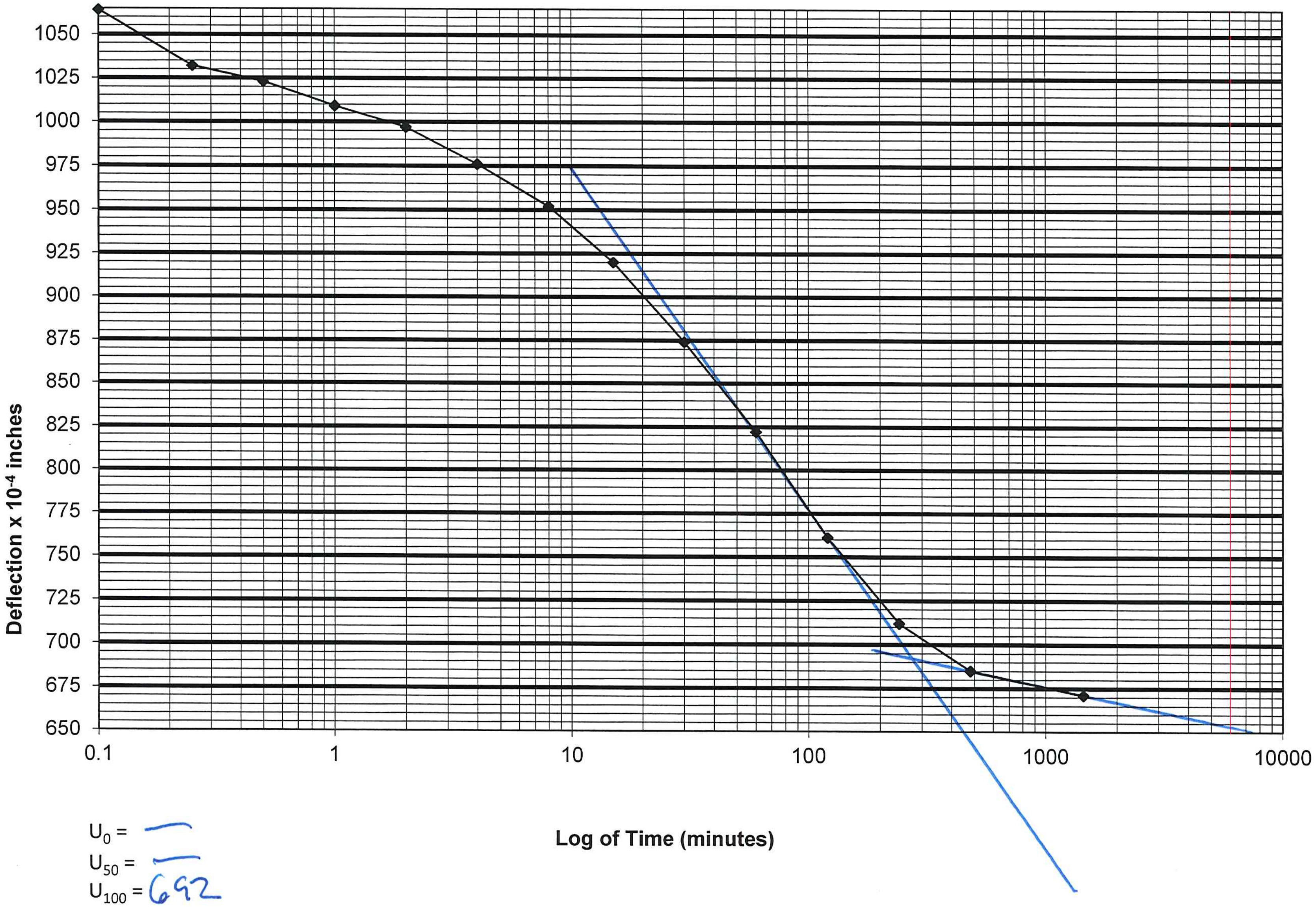
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-01 T1

Load 11 0.25 tsf

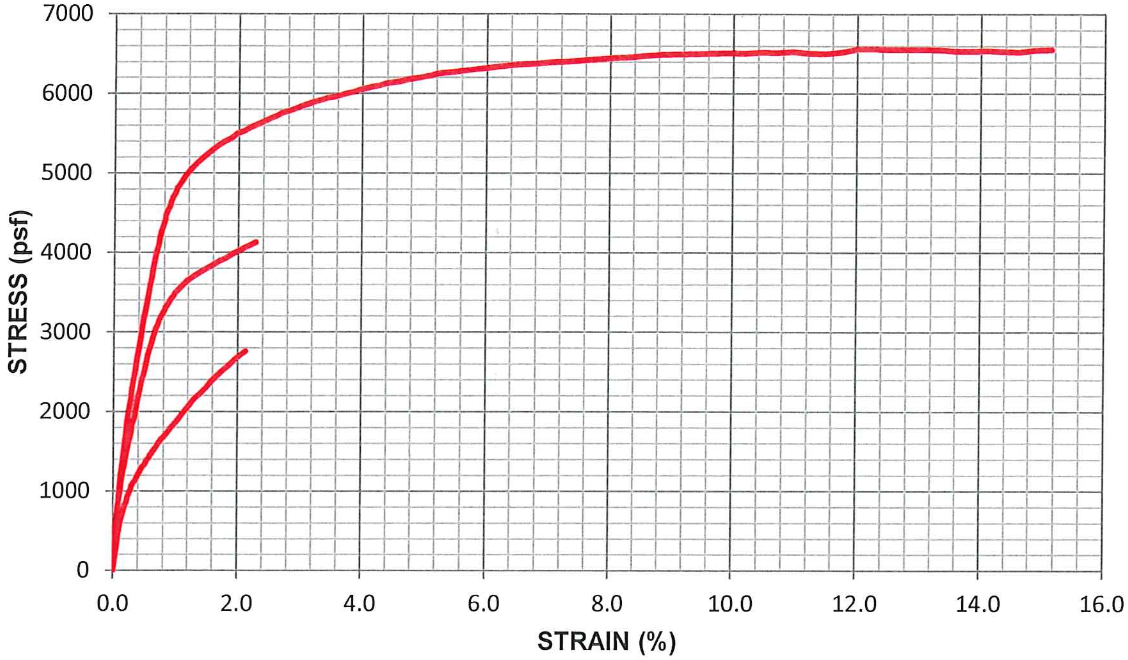


U_0 = —
U_{50} = —
U_{100} = 692
t_{50} = —

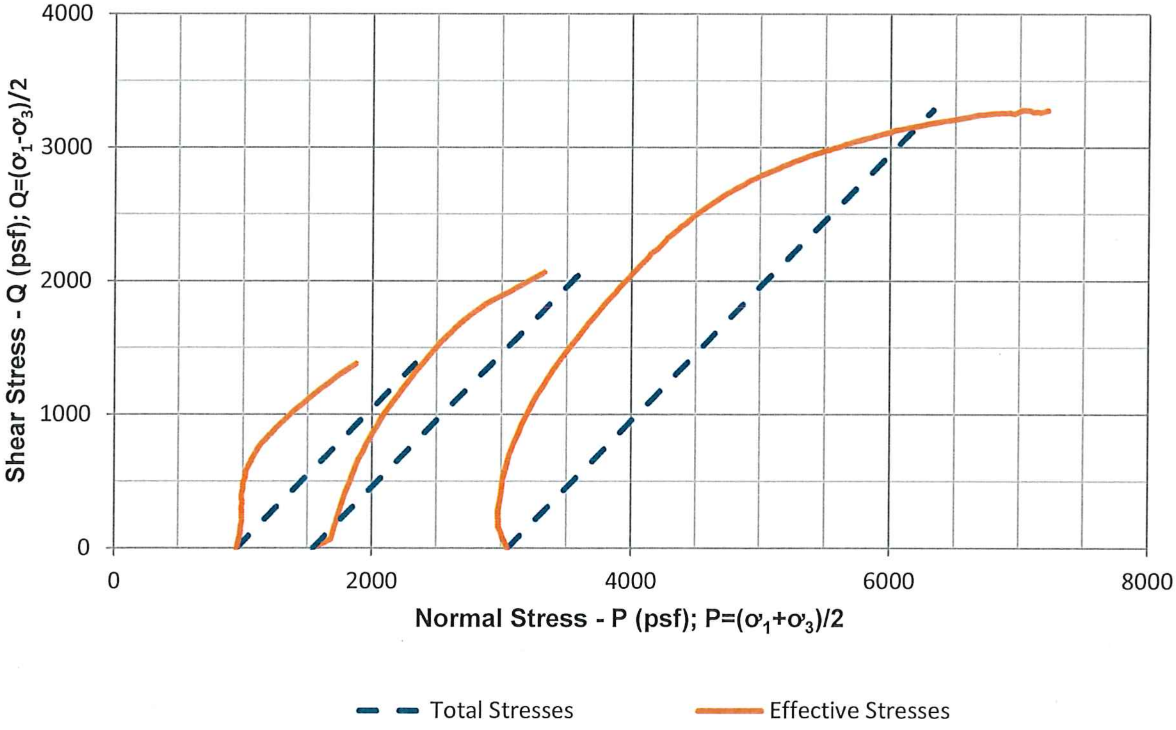
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST WITH PORE PRESSURE MEASUREMENT

STRESS - STRAIN

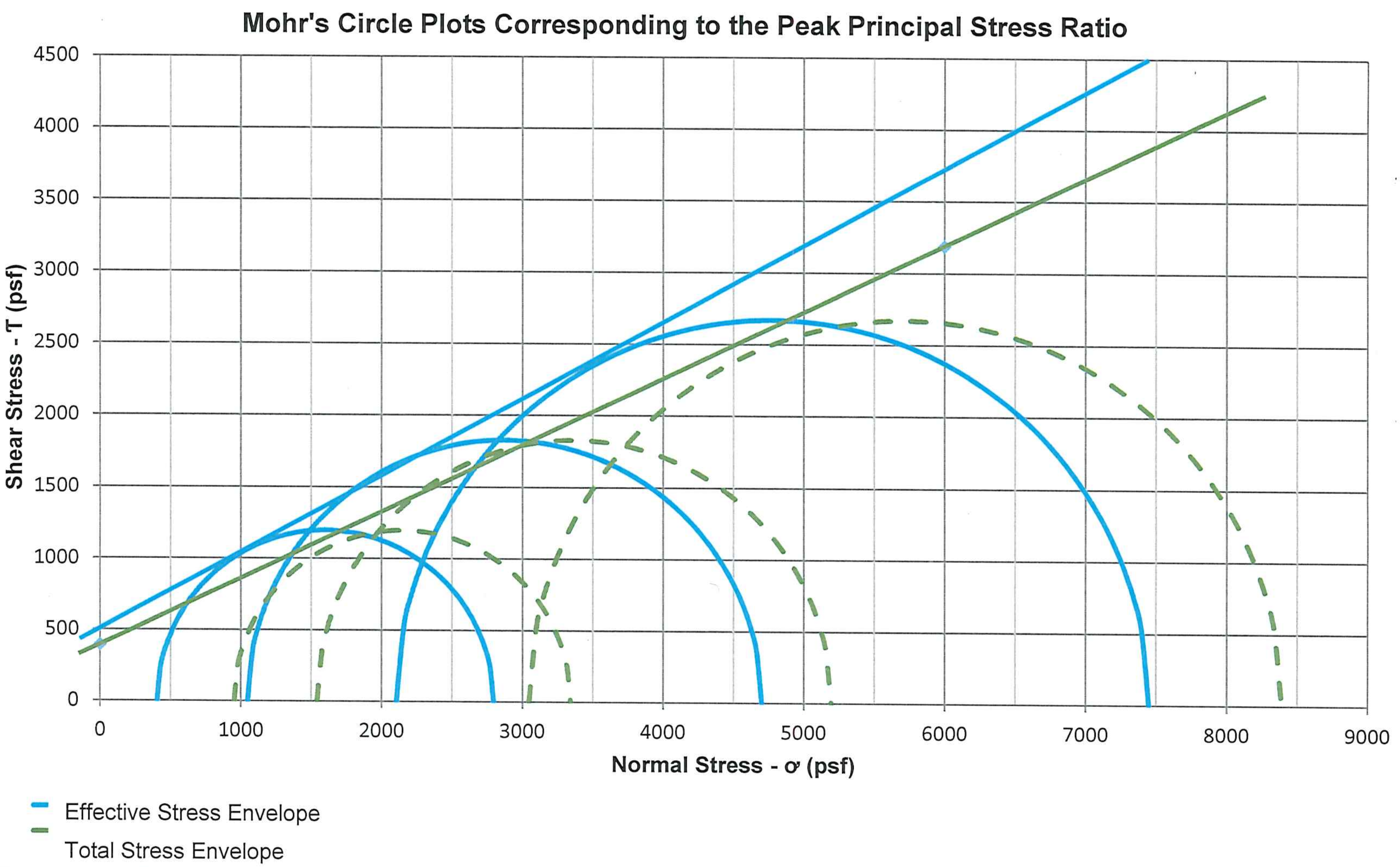


P-Q PLOT



SHANNON & WILSON, INC.
2043 WESTPORT CENTER DR.
SAINT LOUIS, MISSOURI 63146
104287-001

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
Thomas Hill Energy Center – CDT
Clifton Hill, Missouri
HAB-CDT-01 / T1 / 8.0 - 10.0



Sample	Strain (%)
Stage 1	1.6
Stage 2	1.2
Stage 3	1.7

c =	390 psf
ϕ =	25.0 deg
c' =	500 psf
ϕ' =	28.2 deg

NOTES:
1. Mohr's circles in this plot are based upon the maximum principal stress difference observed during loading.
2. Strength parameters determined by Shannon & Wilson. Engineer-of-Record should evaluate cohesion and friction commensurate with project conditions.

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

Mohr's Circle Plots
HAB-CDT-01 / T1

October 2019
104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Figure 1

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	Thomas Hill Energy Center – CDT					
Location	Clifton Hill, Missouri			Client	Haley & Aldrich, Inc.	
Job No.	104287-001			Tested by	CMB	Oct-19
Boring	HAB-CDT-01			Calculated by	CMB	Oct-19
Sample	T1	Specimen Number	Stage 1	Checked by	DPM	10/23/19
Depth (ft)	8.0 - 10.0	Undisturbed/Remold	Undisturbed	File	104287-001 HAB-CDT-01 T1 ASTM D4767	
Description	Brown, Sandy Lean Clay (CL).			Procedure	ASTM D4767	
Remarks						

Specimen Data

	Initial	Post Consol.	Post Shear
Height (in)	5.981	5.978	5.866
Diameter (in)	2.884	2.878	
Volume (in^3)	39.071	38.901	
Height/Diameter ratio	2.074	2.077	
Weight (g)	1345.72	1356.81	1356.81
Water Content (%)	17.27	18.24	18.24
Bulk Unit Weight (pcf)	131.2	132.3	132.9
Dry Unit Weight (pcf)	111.9	111.9	112.4
Cross-Sectional Area* (in^2)	6.533	6.507	
% Saturation - Wet Method	93.58	100.14	100.14
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	0.495	0.488	0.488
	Trimmings		
Tare ID	TX-1		
Mass wet soil + tare (g)	73.62		
Mass dry soil + tare (g)	63.15		
Mass tare (g)	2.53		

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions

Cell Pressure (psi)	106.5
Pore Pressure (psi)	99.9
Effective Confining Pressure (psi)	6.6
B-value	100.00

Consolidation Phase

Change in Volume (in^3)	0.170
T_{50} (min)	43.2
Platen Travel Rate (in/min)	0.00051

Additional Testing

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results

Peak P (psf)	2148.1
Peak P' (psf)	1600.4
Peak Q (psf)	1194.6
Strain at Peak (%)	1.6
σ_3' (psf)	405.8
σ_1' (psf)	2795.1
σ_3 (psf)	953.4
σ_1 (psf)	3342.7

Picture of Failure

See Stage 3

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-01 / T1 / Stage 1

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
0.00	0.0	0.0	953.4	953.4	1.00	953.4	953.4	0.0
0.00	33.0	14.5	972.0	938.9	1.04	970.0	955.4	16.5
0.03	180.3	69.4	1064.3	884.0	1.20	1043.6	974.2	90.1
0.06	322.2	131.8	1143.8	821.6	1.39	1114.5	982.7	161.1
0.07	436.6	178.5	1211.5	774.9	1.56	1171.7	993.2	218.3
0.09	536.7	227.7	1262.4	725.7	1.74	1221.8	994.1	268.4
0.12	621.6	272.2	1302.8	681.2	1.91	1264.2	992.0	310.8
0.14	700.9	307.5	1346.8	645.9	2.09	1303.9	996.3	350.4
0.16	759.2	344.2	1368.5	609.3	2.25	1333.0	988.9	379.6
0.19	821.2	371.6	1403.0	581.8	2.41	1364.0	992.4	410.6
0.22	882.9	396.8	1439.6	556.7	2.59	1394.9	998.1	441.5
0.23	933.2	416.9	1469.7	536.5	2.74	1420.0	1003.1	466.6
0.25	981.7	441.3	1493.8	512.1	2.92	1444.3	1003.0	490.8
0.28	1023.7	455.9	1521.2	497.5	3.06	1465.3	1009.3	511.8
0.29	1065.9	468.0	1551.3	485.4	3.20	1486.4	1018.3	532.9
0.32	1106.0	484.3	1575.1	469.1	3.36	1506.4	1022.1	553.0
0.35	1138.3	499.4	1592.3	454.0	3.51	1522.6	1023.1	569.1
0.37	1174.2	513.7	1614.0	439.7	3.67	1540.5	1026.8	587.1
0.39	1208.5	520.4	1641.5	433.0	3.79	1557.7	1037.3	604.3
0.42	1242.2	530.8	1664.8	422.6	3.94	1574.5	1043.7	621.1
0.44	1272.4	535.9	1689.9	417.5	4.05	1589.6	1053.7	636.2
0.46	1303.9	541.4	1716.0	412.0	4.16	1605.4	1064.0	652.0
0.49	1330.4	554.1	1729.8	399.4	4.33	1618.7	1064.6	665.2
0.51	1360.5	556.1	1757.8	397.3	4.42	1633.7	1077.6	680.2
0.53	1393.8	563.8	1783.5	389.6	4.58	1650.3	1086.5	696.9
0.56	1412.3	570.1	1795.7	383.3	4.68	1659.6	1089.5	706.2
0.58	1449.2	574.4	1828.2	379.0	4.82	1678.0	1103.6	724.6
0.61	1471.3	579.3	1845.5	374.2	4.93	1689.1	1109.8	735.7
0.63	1495.0	586.3	1862.1	367.1	5.07	1700.9	1114.6	747.5
0.65	1521.5	590.1	1884.9	363.3	5.19	1714.2	1124.1	760.8
0.67	1550.1	592.2	1911.3	361.2	5.29	1728.5	1136.3	775.1
0.69	1569.4	594.8	1928.0	358.6	5.38	1738.2	1143.3	784.7
0.72	1603.1	593.5	1963.0	359.9	5.45	1755.0	1161.4	801.5
0.74	1626.9	590.8	1989.5	362.6	5.49	1766.9	1176.1	813.4
0.76	1651.2	596.0	2008.6	357.5	5.62	1779.0	1183.0	825.6
0.79	1670.8	595.6	2028.6	357.8	5.67	1788.8	1193.2	835.4
0.82	1695.4	597.7	2051.2	355.7	5.77	1801.1	1203.5	847.7
0.84	1715.3	593.5	2075.2	359.9	5.77	1811.1	1217.6	857.6
0.87	1743.1	596.1	2100.5	357.3	5.88	1825.0	1228.9	871.6
0.89	1765.8	597.7	2121.5	355.7	5.96	1836.3	1238.6	882.9
0.91	1788.7	599.0	2143.2	354.5	6.05	1847.8	1248.8	894.4
0.94	1813.3	598.7	2168.0	354.8	6.11	1860.1	1261.4	906.6
1.03	1898.1	595.2	2256.3	358.2	6.30	1902.5	1307.2	949.0
1.12	1990.4	591.1	2352.7	362.3	6.49	1948.6	1357.5	995.2
1.22	2078.8	586.0	2446.3	367.5	6.66	1992.8	1406.9	1039.4
1.29	2158.1	574.8	2536.7	378.6	6.70	2032.5	1457.6	1079.0
1.40	2233.3	567.0	2619.7	386.5	6.78	2070.1	1503.1	1116.6
1.50	2311.1	554.7	2709.7	398.7	6.80	2109.0	1554.2	1155.5
1.58	2389.3	547.6	2795.1	405.8	6.89	2148.1	1600.4	1194.6
1.68	2461.5	531.1	2883.9	422.4	6.83	2184.2	1653.1	1230.8
1.78	2532.4	518.7	2967.1	434.7	6.83	2219.6	1700.9	1266.2

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-01 / T1 / Stage 1

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
1.87	2592.2	508.4	3037.2	445.0	6.82	2249.5	1741.1	1296.1
1.96	2659.6	487.6	3125.5	465.9	6.71	2283.2	1795.7	1329.8
2.05	2717.1	472.3	3198.3	481.2	6.65	2312.0	1839.7	1358.6
2.13	2761.3	458.7	3256.0	494.7	6.58	2334.1	1875.3	1380.6

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-01 / T1 / Stage 1

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	Thomas Hill Energy Center – CDT					
Location	Clifton Hill, Missouri			Client	Haley & Aldrich, Inc.	
Job No.	104287-001			Tested by	CMB	Oct-19
Boring	HAB-CDT-01			Calculated by	CMB	Oct-19
Sample	T1	Specimen Number	Stage 2	Checked by	DPM	10/23/19
Depth (ft)	8.0 - 10.0	Undisturbed/Remold	Undisturbed	File	104287-001 HAB-CDT-01 T1 ASTM D4767	
Description	Brown, Sandy Lean Clay (CL).			Procedure	ASTM D4767	
Remarks						

Specimen Data

	Initial	Post Consol.	Post Shear
Height (in)	5.866	5.891	5.757
Diameter (in)	2.906	2.890	
Volume (in^3)	38.901	38.643	
Height/Diameter ratio	2.019	2.039	
Weight (g)	1356.81	1352.58	1352.58
Water Content (%)	18.24	17.87	17.87
Bulk Unit Weight (pcf)	132.9	133.3	133.3
Dry Unit Weight (pcf)	112.4	113.1	113.1
Cross-Sectional Area* (in^2)	6.631	6.559	
% Saturation - Wet Method	100.14	100.14	100.14
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	0.488	0.478	0.478
Tare ID			
Mass wet soil + tare (g)			
Mass dry soil + tare (g)			
Mass tare (g)			

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions

Cell Pressure (psi)	110.5
Pore Pressure (psi)	99.8
Effective Confining Pressure (psi)	10.7
B-value	100.00

Consolidation Phase

Change in Volume (in^3)	0.258
T_{50} (min)	111.3
Platen Travel Rate (in/min)	0.00021

Additional Testing

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results

Peak P (psf)	3368.3
Peak P' (psf)	2875.1
Peak Q (psf)	1826.2
Strain at Peak (%)	1.2
σ_3' (psf)	1048.9
σ_1' (psf)	4701.2
σ_3 (psf)	1542.1
σ_1 (psf)	5194.4

Picture of Failure

See Stage 3

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-01 / T1 / Stage 2

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
0.00	0.0	0.0	1542.1	1542.1	1.00	1542.1	1542.1	0.0
0.00	132.9	-73.6	1748.7	1615.8	1.08	1608.6	1682.2	66.5
0.00	292.1	-14.3	1848.5	1556.4	1.19	1688.2	1702.4	146.1
0.03	520.9	62.2	2000.8	1480.0	1.35	1802.6	1740.4	260.4
0.05	686.4	118.9	2109.6	1423.2	1.48	1885.3	1766.4	343.2
0.07	832.2	165.6	2208.7	1376.5	1.60	1958.2	1792.6	416.1
0.10	976.2	207.6	2310.8	1334.5	1.73	2030.3	1822.7	488.1
0.12	1105.9	245.6	2402.5	1296.6	1.85	2095.1	1849.5	553.0
0.15	1221.0	280.7	2482.4	1261.4	1.97	2152.6	1871.9	610.5
0.18	1331.0	312.0	2561.2	1230.2	2.08	2207.6	1895.7	665.5
0.20	1436.8	333.2	2645.8	1209.0	2.19	2260.5	1927.4	718.4
0.22	1538.1	361.3	2718.9	1180.8	2.30	2311.2	1949.9	769.0
0.25	1635.6	383.2	2794.5	1158.9	2.41	2359.9	1976.7	817.8
0.28	1729.0	402.7	2868.4	1139.4	2.52	2406.6	2003.9	864.5
0.29	1826.1	418.8	2949.4	1123.3	2.63	2455.2	2036.3	913.0
0.33	1920.5	440.2	3022.4	1101.9	2.74	2502.4	2062.2	960.3
0.35	2011.5	458.0	3095.7	1084.1	2.86	2547.9	2089.9	1005.8
0.37	2109.7	467.5	3184.3	1074.6	2.96	2597.0	2129.4	1054.8
0.39	2195.2	478.7	3258.6	1063.4	3.06	2639.7	2161.0	1097.6
0.42	2284.8	487.8	3339.2	1054.3	3.17	2684.6	2196.8	1142.4
0.44	2373.7	500.5	3415.4	1041.7	3.28	2729.0	2228.5	1186.9
0.47	2460.8	509.7	3493.3	1032.4	3.38	2772.5	2262.8	1230.4
0.50	2551.0	515.3	3577.8	1026.8	3.48	2817.6	2302.3	1275.5
0.52	2632.8	525.5	3649.5	1016.7	3.59	2858.6	2333.1	1316.4
0.54	2713.5	530.3	3725.4	1011.8	3.68	2898.9	2368.6	1356.8
0.57	2790.5	535.3	3797.3	1006.8	3.77	2937.4	2402.1	1395.2
0.60	2861.3	540.6	3862.9	1001.6	3.86	2972.8	2432.2	1430.6
0.62	2923.3	544.3	3921.2	997.9	3.93	3003.8	2459.5	1461.7
0.65	2990.0	548.8	3983.4	993.4	4.01	3037.1	2488.4	1495.0
0.67	3045.9	548.6	4039.5	993.6	4.07	3065.1	2516.5	1523.0
0.70	3093.6	556.1	4079.7	986.0	4.14	3089.0	2532.8	1546.8
0.72	3143.7	550.4	4135.5	991.7	4.17	3114.0	2563.6	1571.9
0.75	3195.5	549.6	4188.0	992.5	4.22	3139.9	2590.3	1597.7
0.78	3232.7	546.4	4228.5	995.7	4.25	3158.5	2612.1	1616.4
0.80	3271.9	548.8	4265.2	993.3	4.29	3178.1	2629.3	1635.9
0.82	3313.2	548.1	4307.3	994.0	4.33	3198.8	2650.6	1656.6
0.86	3346.9	545.3	4343.7	996.8	4.36	3215.6	2670.3	1673.4
0.87	3373.5	543.5	4372.1	998.6	4.38	3228.9	2685.4	1686.7
0.90	3405.5	540.0	4407.6	1002.1	4.40	3244.9	2704.8	1702.7
0.93	3432.3	537.0	4437.4	1005.1	4.41	3258.3	2721.2	1716.1
0.95	3458.9	533.2	4467.7	1008.9	4.43	3271.6	2738.3	1729.4
0.97	3490.4	530.4	4502.1	1011.7	4.45	3287.4	2756.9	1745.2
1.08	3574.9	510.5	4606.6	1031.6	4.47	3329.6	2819.1	1787.5
1.19	3652.3	493.2	4701.2	1048.9	4.48	3368.3	2875.1	1826.2
1.28	3700.5	473.5	4769.2	1068.6	4.46	3392.4	2918.9	1850.3
1.39	3756.8	448.9	4850.0	1093.2	4.44	3420.5	2971.6	1878.4
1.49	3799.6	424.6	4917.1	1117.5	4.40	3442.0	3017.3	1899.8
1.59	3845.1	402.8	4984.4	1139.3	4.37	3464.7	3061.9	1922.6
1.69	3893.9	386.0	5050.0	1156.1	4.37	3489.1	3103.1	1947.0
1.79	3930.2	365.1	5107.2	1177.0	4.34	3507.2	3142.1	1965.1
1.90	3982.0	346.0	5178.1	1196.1	4.33	3533.2	3187.1	1991.0

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-01 / T1 / Stage 2

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
2.01	4020.9	329.4	5233.6	1212.8	4.32	3552.6	3223.2	2010.4
2.11	4064.2	310.0	5296.3	1232.1	4.30	3574.2	3264.2	2032.1
2.21	4102.6	290.7	5354.1	1251.5	4.28	3593.4	3302.8	2051.3
2.28	4131.5	283.0	5390.6	1259.1	4.28	3607.9	3324.9	2065.7

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-01 / T1 / Stage 2

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	Thomas Hill Energy Center – CDT					
Location	Clifton Hill, Missouri			Client	Haley & Aldrich, Inc.	
Job No.	104287-001			Tested by	CMB	Oct-19
Boring	HAB-CDT-01			Calculated by	CMB	Oct-19
Sample	T1	Specimen Number	Stage 3	Checked by	DPM	10/23/19
Depth (ft)	8.0 - 10.0	Undisturbed/Remold	Undisturbed	File	104287-001 HAB-CDT-01 T1 ASTM D4767	
Description	Brown, Sandy Lean Clay (CL).			Procedure	ASTM D4767	
Remarks						

Specimen Data	Initial	Post Consol.	Post Shear
Height (in)	5.757	5.788	5.667
Diameter (in)	2.923	2.904	
Volume (in^3)	38.643	38.325	
Height/Diameter ratio	1.969	1.993	
Weight (g)	1352.58	1347.37	1347.37
Water Content (%)	17.87	17.42	17.42
Bulk Unit Weight (pcf)	133.3	133.9	133.9
Dry Unit Weight (pcf)	113.1	114.1	114.1
Cross-Sectional Area* (in^2)	6.712	6.622	
% Saturation - Wet Method	100.14	100.14	100.14
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	0.478	0.466	0.466
			Entire Sample
Tare ID			24
Mass wet soil + tare (g)			1519.62
Mass dry soil + tare (g)			1306.05
Mass tare (g)			166.98

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions	
Cell Pressure (psi)	121.0
Pore Pressure (psi)	99.8
Effective Confining Pressure (psi)	21.2
B-value	100.00

Consolidation Phase	
Change in Volume (in^3)	0.318
T_{50} (min)	128.8

Platen Travel Rate (in/min)	0.00019

Additional Testing	
Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results	
Peak P (psf)	5719.5
Peak P' (psf)	4777.3
Peak Q (psf)	2672.1
Strain at Peak (%)	1.7
σ_3' (psf)	2105.2
σ_1' (psf)	7449.4
σ_3 (psf)	3047.4
σ_1 (psf)	8391.6

Picture of Failure

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-01 / T1 / Stage 3

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
0.00	0.0	0.0	3047.4	3047.4	1.00	3047.4	3047.4	0.0
0.02	322.1	229.5	3139.9	2817.9	1.11	3208.4	2978.9	161.0
0.05	576.5	360.4	3263.6	2687.0	1.21	3335.7	2975.3	288.3
0.07	822.3	462.7	3406.9	2584.7	1.32	3458.5	2995.8	411.1
0.10	1027.3	552.0	3522.7	2495.4	1.41	3561.0	3009.1	513.6
0.12	1209.6	619.6	3637.4	2427.8	1.50	3652.2	3032.6	604.8
0.15	1386.9	686.0	3748.3	2361.4	1.59	3740.9	3054.8	693.5
0.18	1560.5	738.5	3869.3	2308.9	1.68	3827.6	3089.1	780.2
0.20	1724.7	782.6	3989.5	2264.8	1.76	3909.7	3127.2	862.3
0.22	1872.6	826.5	4093.4	2220.9	1.84	3983.7	3157.1	936.3
0.25	2021.5	861.4	4207.5	2186.0	1.92	4058.2	3196.7	1010.8
0.28	2159.6	894.0	4313.0	2153.4	2.00	4127.2	3233.2	1079.8
0.29	2287.7	923.0	4412.2	2124.4	2.08	4191.3	3268.3	1143.9
0.32	2417.8	941.9	4523.3	2105.5	2.15	4256.3	3314.4	1208.9
0.35	2547.4	966.1	4628.8	2081.3	2.22	4321.1	3355.0	1273.7
0.37	2666.7	986.9	4727.2	2060.5	2.29	4380.7	3393.8	1333.4
0.40	2795.8	1003.1	4840.2	2044.3	2.37	4445.3	3442.2	1397.9
0.43	2918.2	1018.8	4946.8	2028.6	2.44	4506.5	3487.7	1459.1
0.45	3033.6	1031.0	5050.0	2016.4	2.50	4564.2	3533.2	1516.8
0.47	3149.6	1041.6	5155.4	2005.8	2.57	4622.2	3580.6	1574.8
0.50	3261.1	1054.0	5254.5	1993.4	2.64	4677.9	3624.0	1630.6
0.53	3370.6	1065.5	5352.5	1981.9	2.70	4732.7	3667.2	1685.3
0.55	3485.5	1072.3	5460.6	1975.1	2.76	4790.2	3717.9	1742.8
0.57	3594.2	1078.9	5562.7	1968.5	2.83	4844.5	3765.6	1797.1
0.61	3697.7	1087.1	5657.9	1960.3	2.89	4896.2	3809.1	1848.8
0.62	3806.9	1083.9	5770.5	1963.5	2.94	4950.9	3867.0	1903.5
0.65	3905.5	1093.1	5859.9	1954.3	3.00	5000.2	3907.1	1952.8
0.67	4005.1	1091.7	5960.7	1955.7	3.05	5049.9	3958.2	2002.5
0.71	4095.8	1093.0	6050.2	1954.4	3.10	5095.3	4002.3	2047.9
0.73	4185.5	1095.1	6137.8	1952.3	3.14	5140.1	4045.0	2092.8
0.75	4272.8	1095.9	6224.3	1951.5	3.19	5183.8	4087.9	2136.4
0.79	4340.5	1096.2	6291.8	1951.2	3.22	5217.7	4121.5	2170.3
0.81	4406.8	1102.7	6351.5	1944.7	3.27	5250.8	4148.1	2203.4
0.82	4478.3	1089.7	6436.0	1957.7	3.29	5286.5	4196.8	2239.1
0.86	4531.8	1087.3	6491.9	1960.1	3.31	5313.3	4226.0	2265.9
0.89	4588.5	1086.2	6549.7	1961.2	3.34	5341.6	4255.4	2294.3
0.91	4646.9	1091.7	6602.6	1955.6	3.38	5370.9	4279.1	2323.5
0.94	4697.1	1079.8	6664.7	1967.6	3.39	5395.9	4316.2	2348.5
0.96	4732.7	1075.4	6704.7	1972.0	3.40	5413.7	4338.3	2366.3
0.99	4771.5	1070.4	6748.5	1977.0	3.41	5433.1	4362.8	2385.7
1.01	4814.3	1074.4	6787.3	1973.0	3.44	5454.6	4380.2	2407.2
1.04	4847.8	1058.2	6836.9	1989.2	3.44	5471.3	4413.1	2423.9
1.14	4967.9	1050.3	6965.0	1997.1	3.49	5531.4	4481.0	2484.0
1.24	5062.1	1025.8	7083.6	2021.5	3.50	5578.4	4552.6	2531.0
1.35	5143.6	1004.0	7187.0	2043.4	3.52	5619.2	4615.2	2571.8
1.46	5214.9	985.8	7276.5	2061.6	3.53	5654.8	4669.0	2607.4
1.56	5279.8	965.7	7361.5	2081.7	3.54	5687.3	4721.6	2639.9
1.66	5344.2	942.1	7449.4	2105.2	3.54	5719.5	4777.3	2672.1
1.77	5397.6	921.0	7524.0	2126.4	3.54	5746.2	4825.2	2698.8
1.88	5440.0	898.4	7589.0	2149.0	3.53	5767.4	4869.0	2720.0
1.97	5497.3	877.9	7666.8	2169.5	3.53	5796.0	4918.2	2748.6

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-01 / T1 / Stage 3

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
2.08	5529.3	854.3	7722.4	2193.1	3.52	5812.0	4957.8	2764.6
2.18	5576.7	829.6	7794.5	2217.8	3.51	5835.8	5006.1	2788.4
2.28	5609.3	807.8	7848.9	2239.6	3.50	5852.1	5044.3	2804.7
2.39	5650.3	776.9	7920.9	2270.5	3.49	5872.6	5095.7	2825.2
2.50	5688.7	753.0	7983.1	2294.4	3.48	5891.8	5138.7	2844.4
2.60	5718.8	737.0	8029.2	2310.4	3.48	5906.8	5169.8	2859.4
2.69	5757.7	702.4	8102.8	2345.0	3.46	5926.3	5223.9	2878.9
2.81	5784.8	685.8	8146.4	2361.6	3.45	5939.8	5254.0	2892.4
2.91	5809.4	660.3	8196.5	2387.1	3.43	5952.1	5291.8	2904.7
3.01	5842.6	631.9	8258.1	2415.5	3.42	5968.7	5336.8	2921.3
3.12	5868.6	605.9	8310.2	2441.5	3.40	5981.7	5375.8	2934.3
3.22	5901.3	580.1	8368.6	2467.3	3.39	5998.0	5418.0	2950.6
3.33	5919.7	549.8	8417.2	2497.6	3.37	6007.2	5457.4	2959.8
3.43	5947.5	530.8	8464.2	2516.6	3.36	6021.2	5490.4	2973.8
3.54	5958.2	503.6	8502.0	2543.8	3.34	6026.5	5522.9	2979.1
3.64	5982.9	485.0	8545.3	2562.4	3.33	6038.9	5553.8	2991.5
3.74	6004.1	453.8	8597.6	2593.6	3.31	6049.4	5595.6	3002.0
3.86	6021.6	430.5	8638.5	2616.9	3.30	6058.2	5627.7	3010.8
3.96	6047.7	416.0	8679.1	2631.4	3.30	6071.2	5655.3	3023.8
4.06	6065.3	388.5	8724.2	2658.9	3.28	6080.1	5691.5	3032.7
4.18	6087.0	369.9	8764.5	2677.5	3.27	6090.9	5721.0	3043.5
4.27	6103.1	342.9	8807.5	2704.4	3.26	6098.9	5756.0	3051.5
4.37	6124.0	317.4	8854.0	2730.0	3.24	6109.4	5792.0	3062.0
4.48	6140.1	292.5	8895.1	2754.9	3.23	6117.5	5825.0	3070.1
4.58	6148.6	272.2	8923.8	2775.2	3.22	6121.7	5849.5	3074.3
4.69	6170.4	254.1	8963.7	2793.3	3.21	6132.6	5878.5	3085.2
4.79	6184.9	232.2	9000.1	2815.2	3.20	6139.8	5907.6	3092.4
4.90	6197.5	211.9	9033.0	2835.4	3.19	6146.2	5934.2	3098.8
5.01	6214.3	187.7	9074.0	2859.7	3.17	6154.6	5966.9	3107.2
5.11	6230.1	156.2	9121.3	2891.2	3.15	6162.4	6006.3	3115.0
5.20	6251.5	147.8	9151.1	2899.6	3.16	6173.1	6025.3	3125.7
5.46	6273.3	92.3	9228.4	2955.1	3.12	6184.0	6091.7	3136.6
5.73	6299.5	50.4	9296.5	2997.0	3.10	6197.2	6146.8	3149.8
5.99	6322.4	-6.1	9375.9	3053.5	3.07	6208.6	6214.7	3161.2
6.25	6343.9	-49.4	9440.7	3096.8	3.05	6219.3	6268.8	3171.9
6.51	6363.0	-87.2	9497.6	3134.6	3.03	6228.9	6316.1	3181.5
6.77	6371.7	-122.4	9541.5	3169.8	3.01	6233.2	6355.6	3185.8
7.04	6392.3	-161.5	9601.2	3208.9	2.99	6243.6	6405.1	3196.2
7.29	6403.4	-200.8	9651.6	3248.2	2.97	6249.1	6449.9	3201.7
7.55	6419.4	-230.5	9697.4	3277.9	2.96	6257.1	6487.7	3209.7
7.81	6432.9	-266.4	9746.6	3313.7	2.94	6263.8	6530.2	3216.4
8.08	6450.7	-301.2	9799.3	3348.6	2.93	6272.7	6573.9	3225.3
8.34	6458.0	-333.7	9839.1	3381.1	2.91	6276.4	6610.1	3229.0
8.60	6475.0	-365.8	9888.2	3413.2	2.90	6284.9	6650.7	3237.5
8.86	6489.2	-399.7	9936.4	3447.1	2.88	6292.0	6691.7	3244.6
9.14	6490.4	-427.0	9964.8	3474.4	2.87	6292.6	6719.6	3245.2
9.39	6500.9	-456.4	10004.7	3503.8	2.86	6297.8	6754.2	3250.4
9.65	6506.6	-484.1	10038.1	3531.5	2.84	6300.7	6784.8	3253.3
9.92	6512.0	-505.0	10064.4	3552.4	2.83	6303.4	6808.4	3256.0
10.17	6509.1	-530.7	10087.2	3578.1	2.82	6302.0	6832.6	3254.6
10.43	6518.7	-550.5	10116.6	3597.9	2.81	6306.7	6857.3	3259.3

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-01 / T1 / Stage 3

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
10.70	6515.6	-588.3	10151.2	3635.7	2.79	6305.2	6893.4	3257.8
10.96	6524.8	-610.9	10183.2	3658.3	2.78	6309.8	6920.7	3262.4
11.22	6507.6	-637.9	10192.9	3685.3	2.77	6301.2	6939.1	3253.8
11.48	6503.5	-658.8	10209.8	3706.2	2.75	6299.2	6958.0	3251.8
11.74	6523.5	-668.0	10238.9	3715.4	2.76	6309.2	6977.2	3261.8
12.00	6562.0	-691.6	10301.0	3739.0	2.76	6328.4	7020.0	3281.0
12.26	6560.5	-705.1	10313.0	3752.5	2.75	6327.7	7032.8	3280.3
12.52	6555.5	-729.8	10332.7	3777.2	2.74	6325.1	7055.0	3277.7
12.79	6555.1	-740.5	10343.0	3787.9	2.73	6324.9	7065.4	3277.5
13.05	6554.7	-756.4	10358.5	3803.8	2.72	6324.7	7081.2	3277.4
13.32	6548.1	-770.3	10365.8	3817.7	2.72	6321.5	7091.8	3274.1
13.58	6533.4	-788.9	10369.7	3836.3	2.70	6314.1	7103.0	3266.7
13.84	6534.5	-802.2	10384.0	3849.6	2.70	6314.6	7116.8	3267.2
14.10	6536.5	-819.5	10403.5	3866.9	2.69	6315.7	7135.2	3268.3
14.35	6529.2	-837.8	10414.4	3885.2	2.68	6312.0	7149.8	3264.6
14.62	6523.6	-850.1	10421.1	3897.5	2.67	6309.2	7159.3	3261.8
14.87	6544.8	-885.0	10477.3	3932.4	2.66	6319.8	7204.8	3272.4
15.14	6553.5	-894.0	10494.9	3941.4	2.66	6324.1	7218.1	3276.7

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-01 / T1 / Stage 3

October 2019 104287-001

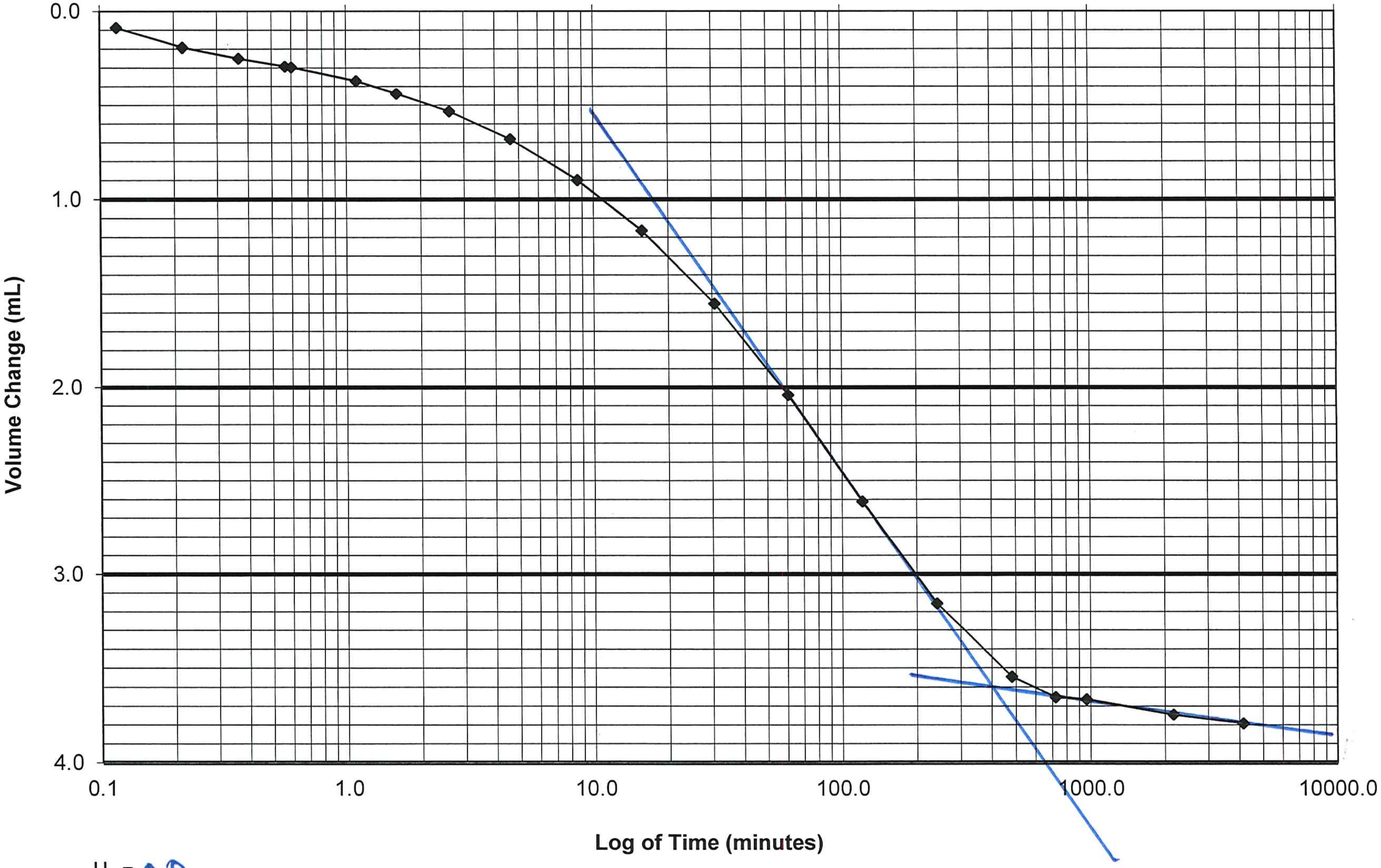
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-01 T1

Stage 1 6.5 psi



U_0 = 0.0

U_{50} = 1.8

U_{100} = 3.6

t_{50} = 43.22

%/hr = 0.555

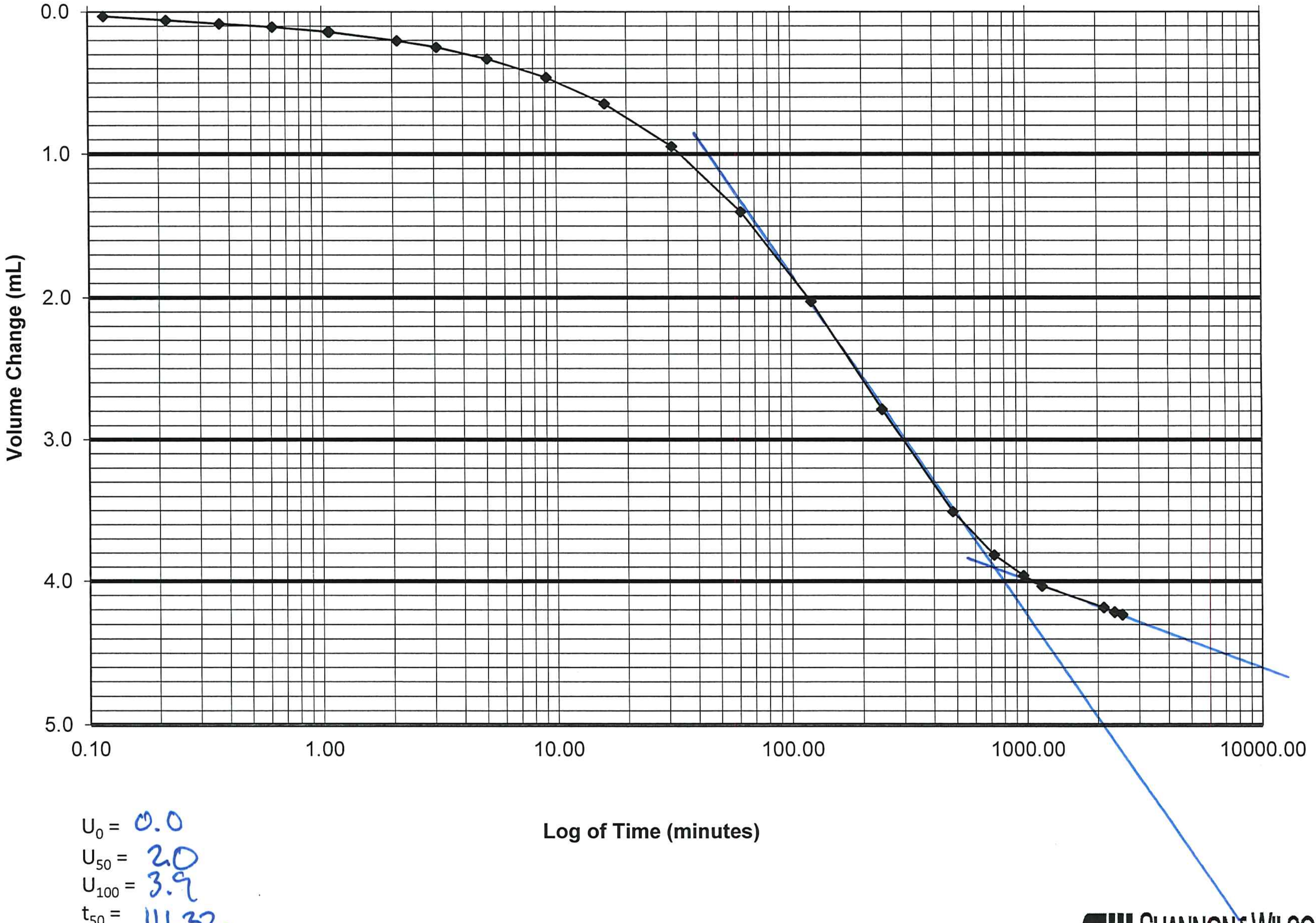
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-01 T1

Stage 2 10.5 psi



U_0 = 0.0
U_{50} = 2.0
U_{100} = 3.9
t_{50} = 111.32

%/hr=0.216

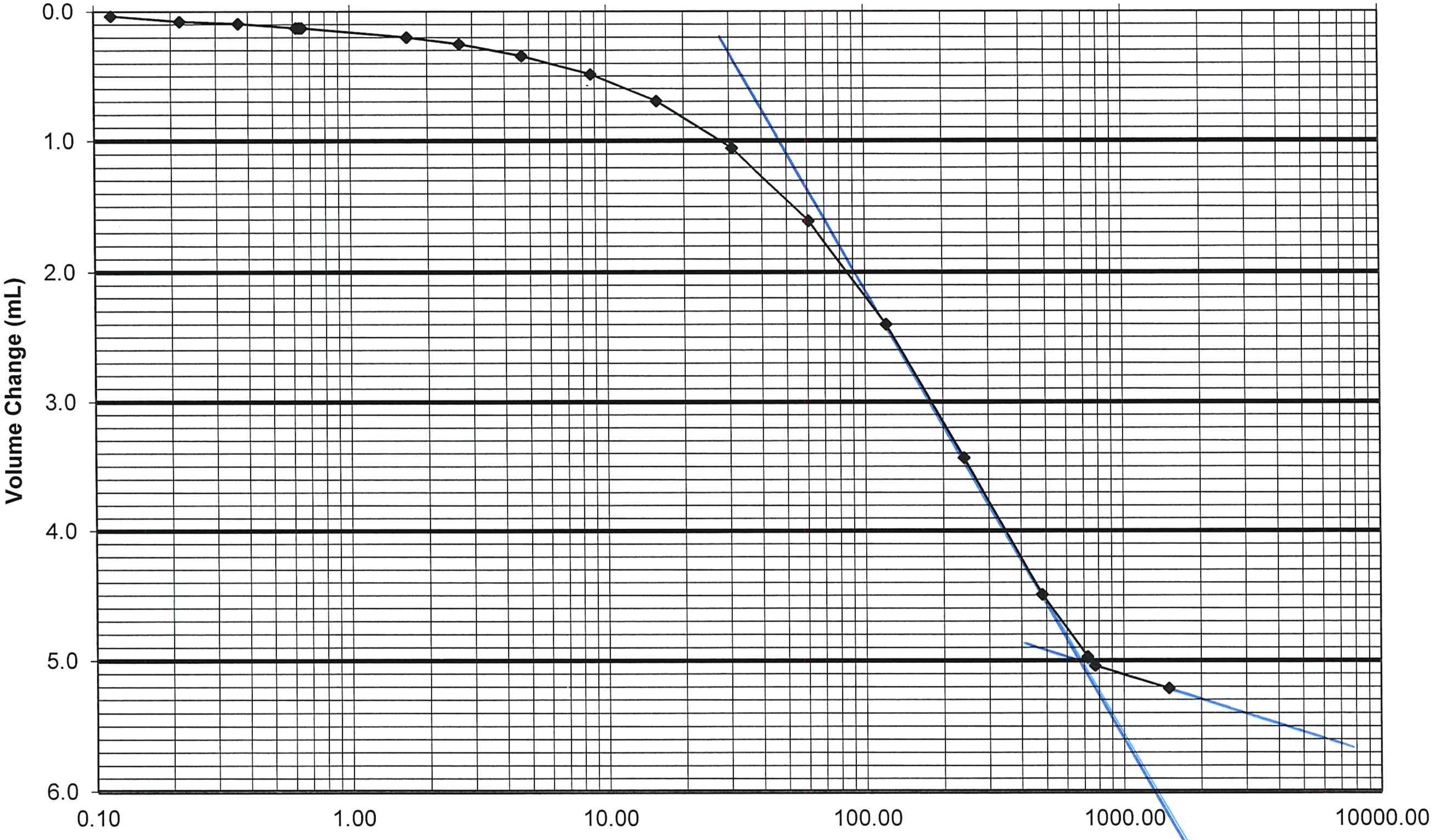
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-01 T1

Stage 3 21.0 psi



U_0 = 0.0
U_{50} = 2.5
U_{100} = 5.0
t_{50} = 128.81

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

%/hr = 0.186

CONSOLIDATION TEST

Project	Thomas Hill Energy Center – CDT	Client	Haley & Aldrich, Inc.	
Location	Clifton Hill, Missouri	Tested By / Date	CMB	10/10/19
Job Number	104287-001	Calculated By / Date	CMB	10/24/19
Boring	HAB-CDT-04	Checked By / Date	DPM	10/24/19
Sample	T1	File	104287-001 HAB-CDT-04 T1 D2435	
Depth (ft)	8.0 - 10.0	Procedure	ASTM D2435	

	Initial Data		*Final Data*				
	Sample Height	*Ring Diameter*	*Sample Height*		*Trimmings #1*		
Measured Reading 1	0.995	2.504	0.964	inches	Tare No.	C-3	
Measured Reading 2	0.996	2.501	0.967	inches	Tare Weight	2.52	
Measured Reading 3	0.997	2.502	0.969	inches	Wet Weight	53.74	
Measured Reading 4	0.995	2.501	0.971	inches	Dry Weight	44.75	
Average Reading	0.996	2.502	0.968	inches	M.C. %	21.3%	
Wet Weight + Ring	305.49		391.13	grams	*Trimmings #2*		
Weight of Ring	146.31	Dry Weight	359.81	grams	Tare No.	C-4	
Specific Gravity	2.90	Tare Weight	82.75	grams	Tare Weight	2.51	
Sample Volume	80.23		76.36	cm^3	Wet Weight	54.33	
Height of Solids	0.559		0.559	inches	Dry Weight	45.15	
Void Ratio	0.78		0.70		M.C. %	21.5%	
Saturation	80.8		100.0	percent	Ring Number	411	
Weight of Water	28.43		31.32	grams	Inundated @	0.25	tsf
Moisture Content	21.7		24.0	percent	Trimming Method		Cutting Shoe
Wet Unit Weight	123.9		132.5	pcf	[Cutting Shoe / Turntable / None (Ring)]		
Dry Unit Weight	101.8		106.9	pcf	Method Used	[✓ A] or B	
Notes: The specific gravity is computed assuming saturation at the end of the test.					Computed Ht.	0.948	inches

Load 1		Load 2		Load 3		Load 4	
Air Press.	1.2	Air Press.	1.9	Air Press.	3.4	Air Press.	6.5
Load, tsf	0.25	Load, tsf	0.5	Load, tsf	1.0	Load, tsf	2.0
Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4
0.1	70	0.1	122	0.1	166	0.1	249
0.25	92	0.25	124	0.25	170	0.25	254
0.5	95	0.5	124	0.5	173	0.5	257
1	96	1	125	1	175	1	262
2	96	2	126	2	177	2	266
4	96	4	127	4	180	4	271
8	93	8	128	8	182	8	275
15	89	15	128	15	183	15	279
30	82	30	129	30	186	30	284
60		60	129	60	189	60	288
120		120	129	120	191	120	292
240		240		240	192	240	295
480		480		480	193	480	297
1440		1440		900	195	4300	304

Load 5		Load 6		Load 7		Load 8	
Air Press.	12.1	Air Press.	25.2	Air Press.	6.5	Air Press.	12.1
Load, tsf	4.0	Load, tsf	8.0	Load, tsf	2.0	Load, tsf	4.0
Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4
0.1	400	0.1	620	0.1	758	0.1	693
0.25	412	0.25	630	0.25	752	0.25	695
0.5	419	0.5	639	0.5	748	0.5	696
1	428	1	648	1	744	1	698
2	437	2	660	2	738	2	701
4	447	4	673	4	732	4	703
8	456	8	691	8	725	8	704
15	467	15	709	15	718	15	706
30	479	30	731	30	707	30	709
60	489	60	751	60	696	60	711
120	497	120	770	120	688	120	712
240	503	240	782	240	682	240	714
480	507	480	790	480	679	480	715
1440	513	1440	799	1440	676	1440	716

CONSOLIDATION TEST

Project	Thomas Hill Energy Center – CDT	Client	Haley & Aldrich, Inc.	
Location	Clifton Hill, Missouri	Tested By / Date	CMB	10/10/19
Job Number	104287-001	Calculated By / Date	CMB	10/24/19
Boring	HAB-CDT-04	Checked By / Date	DPM	10/24/19
Sample	T1	File	104287-001 HAB-CDT-04 T1 D2435	
Depth (ft)	8.0 - 10.0	Procedure	ASTM D2435	

	Initial Data		*Final Data*				
	Sample Height	*Ring Diameter*	*Sample Height*		*Trimmings #1*		
Measured Reading 1	0.995	2.504	0.964	inches	Tare No.	C-3	
Measured Reading 2	0.996	2.501	0.967	inches	Tare Weight	2.52	
Measured Reading 3	0.997	2.502	0.969	inches	Wet Weight	53.74	
Measured Reading 4	0.995	2.501	0.971	inches	Dry Weight	44.75	
Average Reading	0.996	2.502	0.968	inches	M.C. %	21.3%	
Wet Weight + Ring	305.49		391.13	grams	*Trimmings #2*		
Weight of Ring	146.31	Dry Weight	359.81	grams	Tare No.	C-4	
Specific Gravity	2.90	Tare Weight	82.75	grams	Tare Weight	2.51	
Sample Volume	80.23		76.36	cm^3	Wet Weight	54.33	
Height of Solids	0.559		0.559	inches	Dry Weight	45.15	
Void Ratio	0.78		0.70		M.C. %	21.5%	
Saturation	80.8		100.0	percent	Ring Number	411	
Weight of Water	28.43		31.32	grams	Inundated @	0.25	tsf
Moisture Content	21.7		24.0	percent	Trimming Method		Cutting Shoe
Wet Unit Weight	123.9		132.5	pcf	[Cutting Shoe / Turntable / None (Ring)]		
Dry Unit Weight	101.8		106.9	pcf	Method Used	[✓ A] or B	

Load 9		Load 10		Load 11	
Air Press.	25.2	Air Press.	50.2	Air Press.	1.2
Load, tsf	8.0	Load, tsf	16.0	Load, tsf	0.25
Time, min.	Def x10-4	Time, min.	Def x10-4	Time, min.	Def x10-4
0.1	752	0.1	892	0.1	1007
0.25	758	0.25	902	0.25	986
0.5	761	0.5	909	0.5	974
1	766	1	919	1	960
2	771	2	930	2	944
4	776	4	944	4	927
8	783	8	964	8	904
15	790	15	986	15	878
30	798	30	1017	30	840
60	805	60	1052	60	790
120	810	120	1083	120	729
240	815	240	1102	240	662
480	817	480	1113	480	599
4350	829	1440	1127	1440	551

CONSOLIDATION TEST

Project	Thomas Hill Energy Center – CDT	Client	Haley & Aldrich, Inc.	
Location	Clifton Hill, Missouri	Tested By / Date	CMB	10/10/19
Job Number	104287-001	Calculated By / Date	CMB	10/24/19
Boring	HAB-CDT-04	Checked By / Date	DPM	10/24/19
Sample	T1	File	104287-001 HAB-CDT-04 T1 D2435	
Depth (ft)	8.0 - 10.0	Procedure	ASTM D2435	

	Initial Data		*Final Data*				
	Sample Height	*Ring Diameter*	*Sample Height*		*Trimmings #1*		
Measured Reading 1	0.995	2.504	0.964	inches	Tare No.	C-3	
Measured Reading 2	0.996	2.501	0.967	inches	Tare Weight	2.52	
Measured Reading 3	0.997	2.502	0.969	inches	Wet Weight	53.74	
Measured Reading 4	0.995	2.501	0.971	inches	Dry Weight	44.75	
Average Reading	0.996	2.502	0.968	inches	M.C. %	21.3%	
Wet Weight + Ring	305.49		391.13	grams	*Trimmings #2*		
Weight of Ring	146.31	Dry Weight	359.81	grams	Tare No.	C-4	
Specific Gravity	2.90	Tare Weight	82.75	grams	Tare Weight	2.51	
Sample Volume	80.23		76.36	cm^3	Wet Weight	54.33	
Height of Solids	0.559		0.559	inches	Dry Weight	45.15	
Void Ratio	0.78		0.70		M.C. %	21.5%	
Saturation	80.8		100.0	percent	Ring Number	411	
Weight of Water	28.43		31.32	grams	Inundated @	0.25	tsf
Moisture Content	21.7		24.0	percent	Trimming Method		Cutting Shoe
Wet Unit Weight	123.9		132.5	pcf	[Cutting Shoe / Turntable / None (Ring)]		
Dry Unit Weight	101.8		106.9	pcf	Method Used	[✓ A] or B	

CALIBRATION OF CONSOLIDATION DEFORMATION

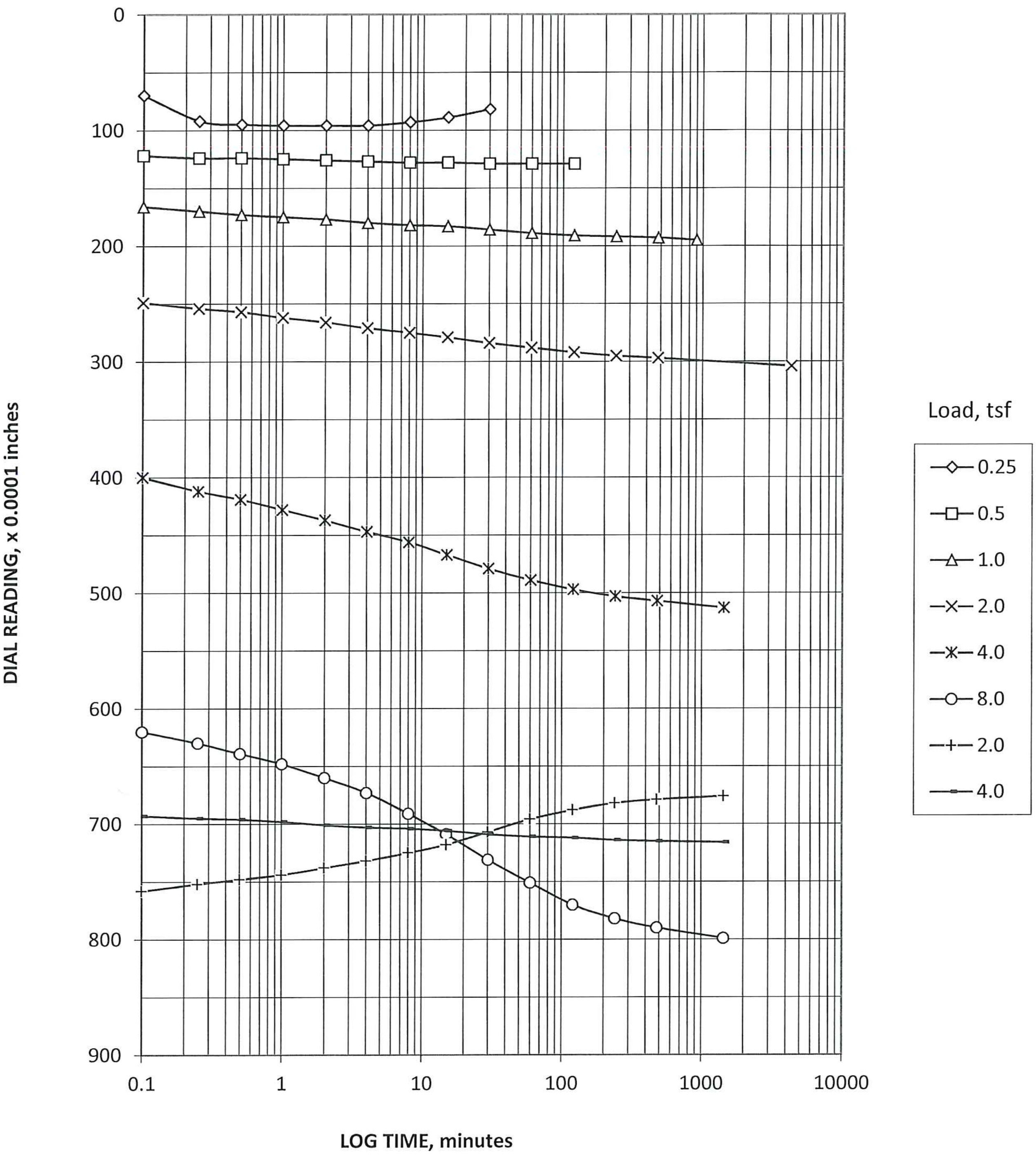
Procedure SWCP-15 (Reference ASTM D2435 AASHTO T216)

Equipment Calibrated:	Consolidation Deformation	Date Calibrated:	10/23/19
Reason for Calibration:	Test Completion	Next Calibration Due:	Next Test
Equipment Used:	Consolidation Appartus	Calibrated By:	CMB
	Steel Calibration Disk	Checked By:	CMB

Machine Number: 411

Load tsf	Machine Def x 10^{-4}	Correction Factor x 10^{-4}	U-100 x 10^{-4}	Corr. U-100 x 10^{-4}	Compression, Percent	C_v	Void Ratio
0.01	0	0	0	0	0.00%	0	0.78
0.25	19	0	96.0	77	0.77%	2.1E+00	0.77
0.5	36	0	124.0	88	0.88%	2.6E+00	0.77
1.0	61	0	173.0	112	1.12%	2.6E+00	0.76
2.0	82	0	292.0	210	2.10%	1.6E-01	0.74
4.0	104	0	498.0	394	3.94%	1.2E-01	0.71
8.0	131	0	781.0	650	6.50%	4.7E-02	0.66
2.0	109	18	682.0	555	5.55%	NA	0.68
4.0	117	18	703.0	568	5.68%	NA	0.68
8.0	131	18	812.0	663	6.63%	NA	0.66
16.0	151	0	1099.0	948	9.48%	2.5E-02	0.61
0.25	71	28	599.0	500	5.00%	NA	0.69

CONSOLIDATION TEST



Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

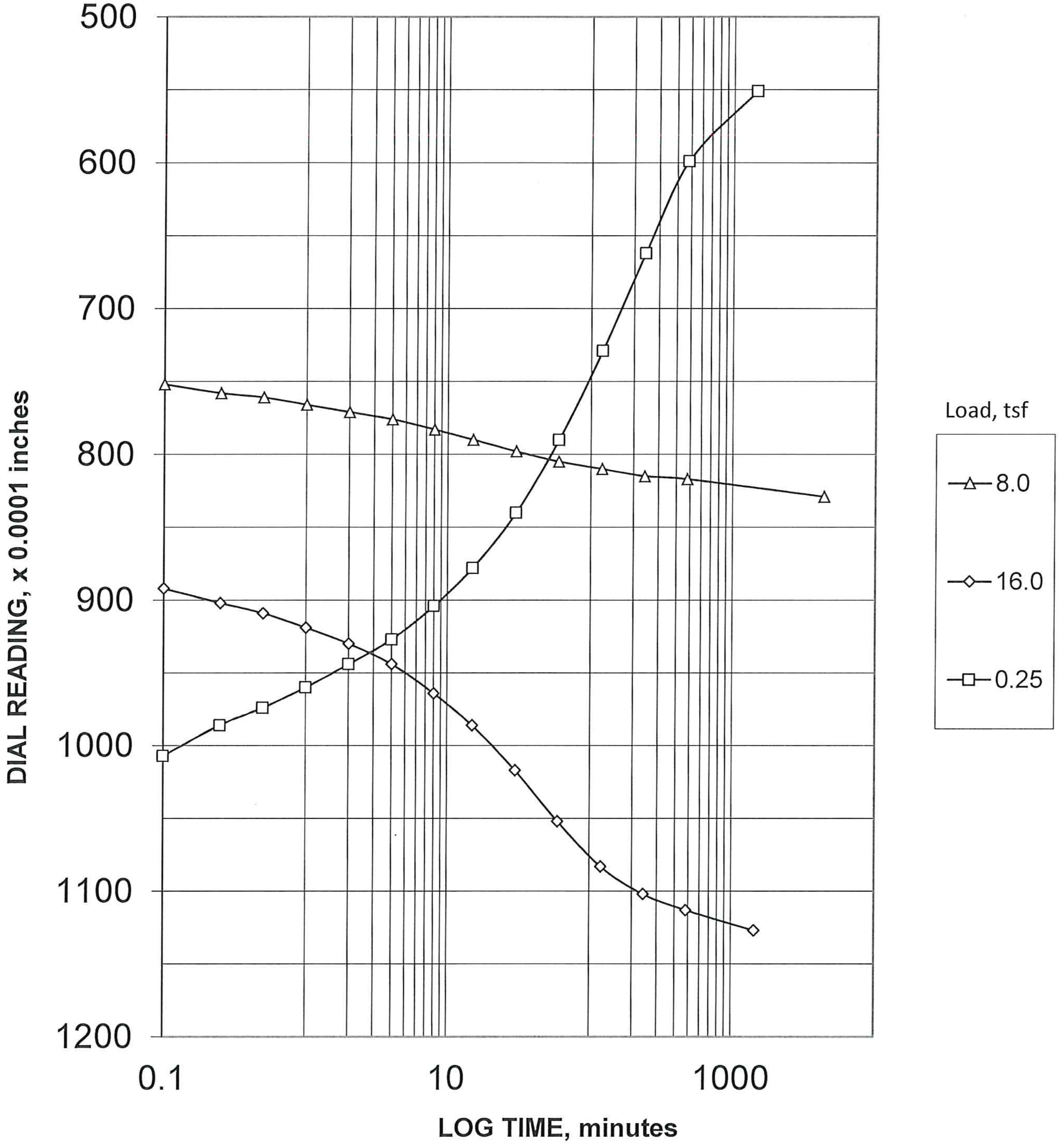
TIME PLOTS
HAB-CDT-04
T1

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.

CONSOLIDATION TEST



Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

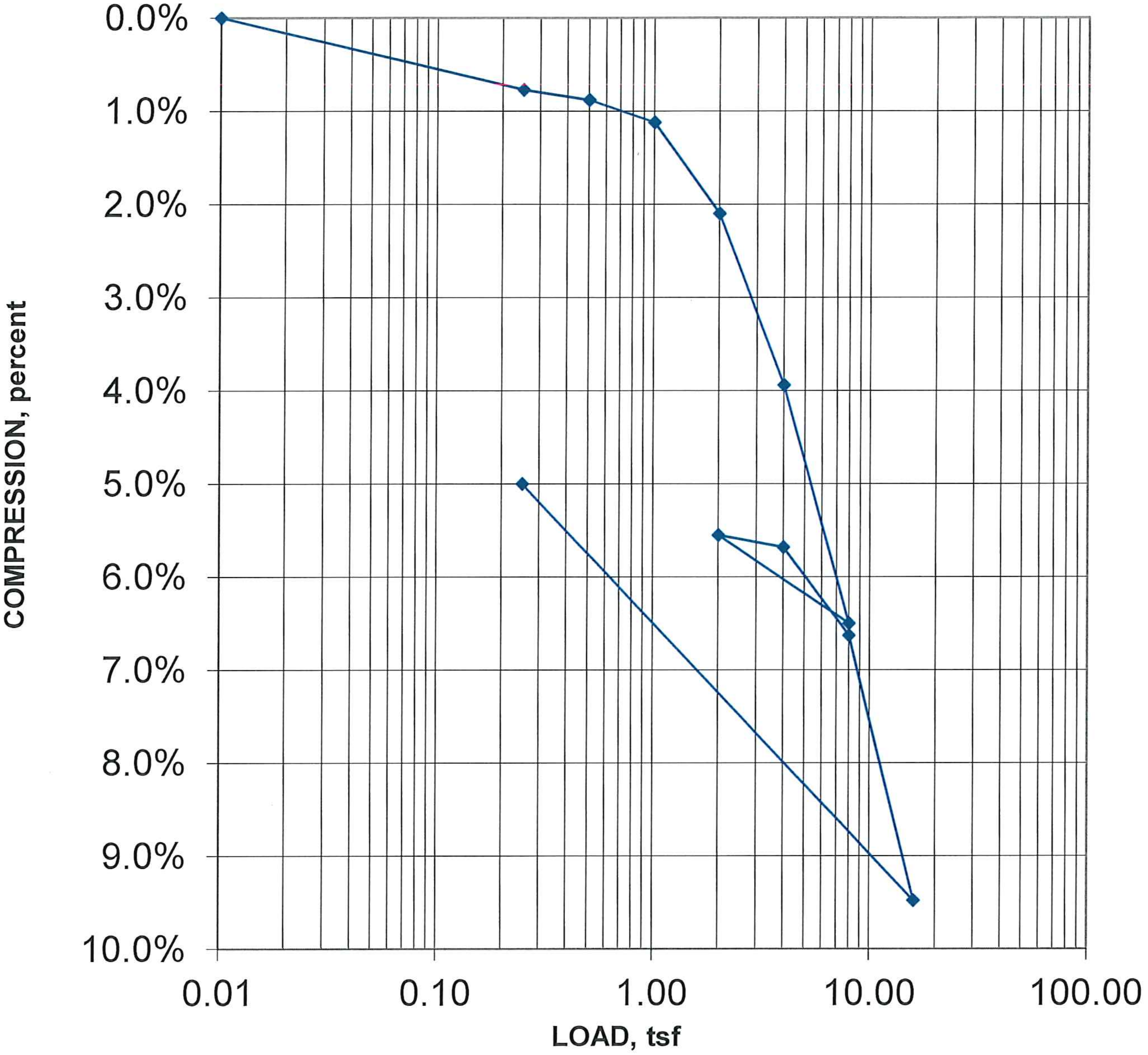
TIME PLOTS
HAB-CDT-04
T1

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.

CONSOLIDATION TEST



Load, tsf	Coefficient of Consolidation, mm^2/second	Load, tsf	Coefficient of Consolidation, mm^2/second
0.25	2.1E+00	4.0	NA
0.5	2.6E+00	8.0	NA
1.0	2.6E+00	16.0	2.5E-02
2.0	1.6E-01	0.25	NA
4.0	1.2E-01		
8.0	4.7E-02		
2.0	NA		

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

SETTLEMENT PLOTS

HAB-CDT-04

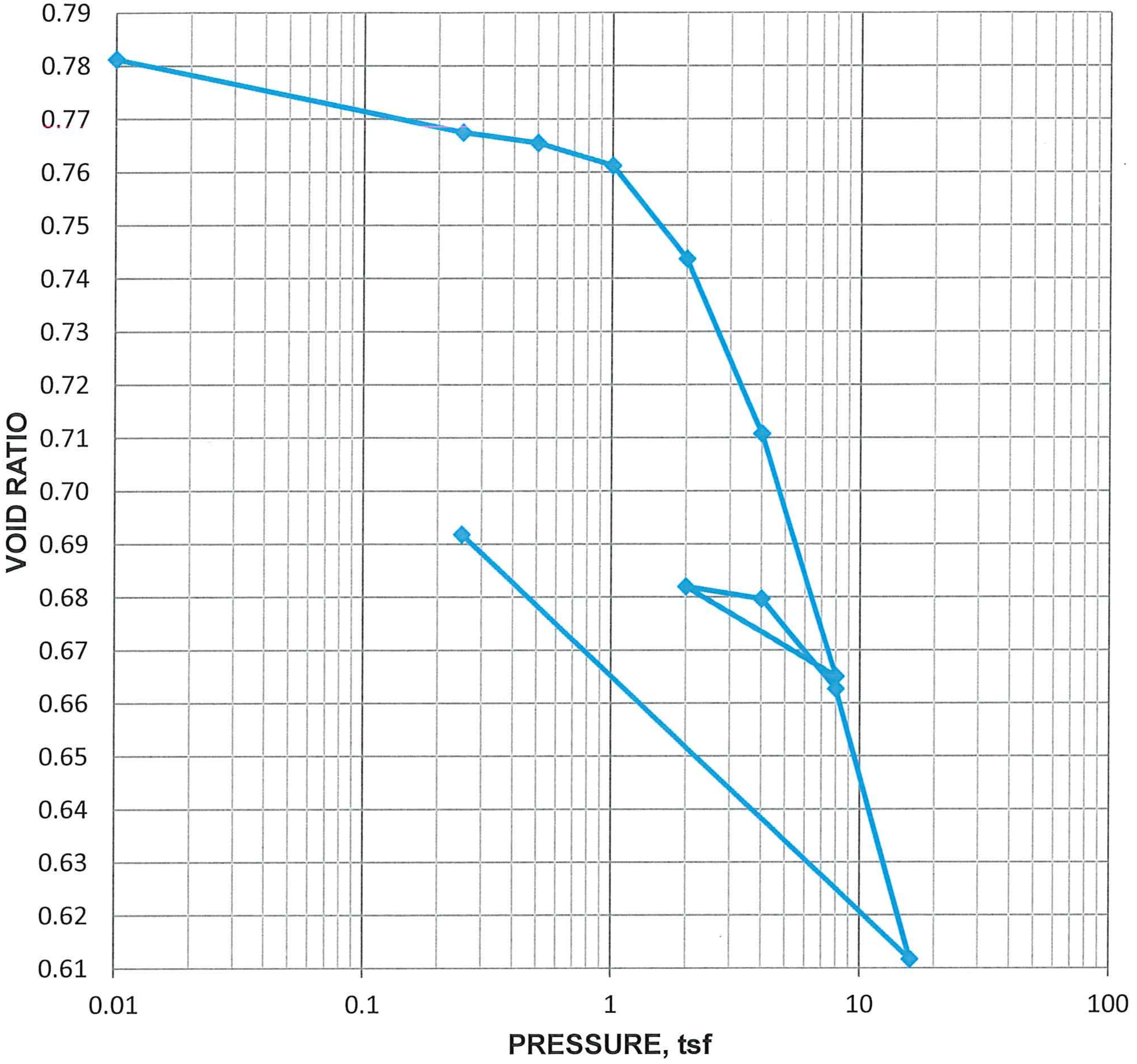
T1

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.

CONSOLIDATION TEST



Load, tsf	Coefficient of Consolidation, mm^2/second	Load, tsf	Coefficient of Consolidation, mm^2/second
0.25	2.1E+00	4.0	NA
0.5	2.6E+00	8.0	NA
1.0	2.6E+00	16.0	2.5E-02
2.0	1.6E-01	0.25	NA
4.0	1.2E-01		
8.0	4.7E-02		
2.0	NA		

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

VOID RATIO PLOT

HAB-CDT-04

T1

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

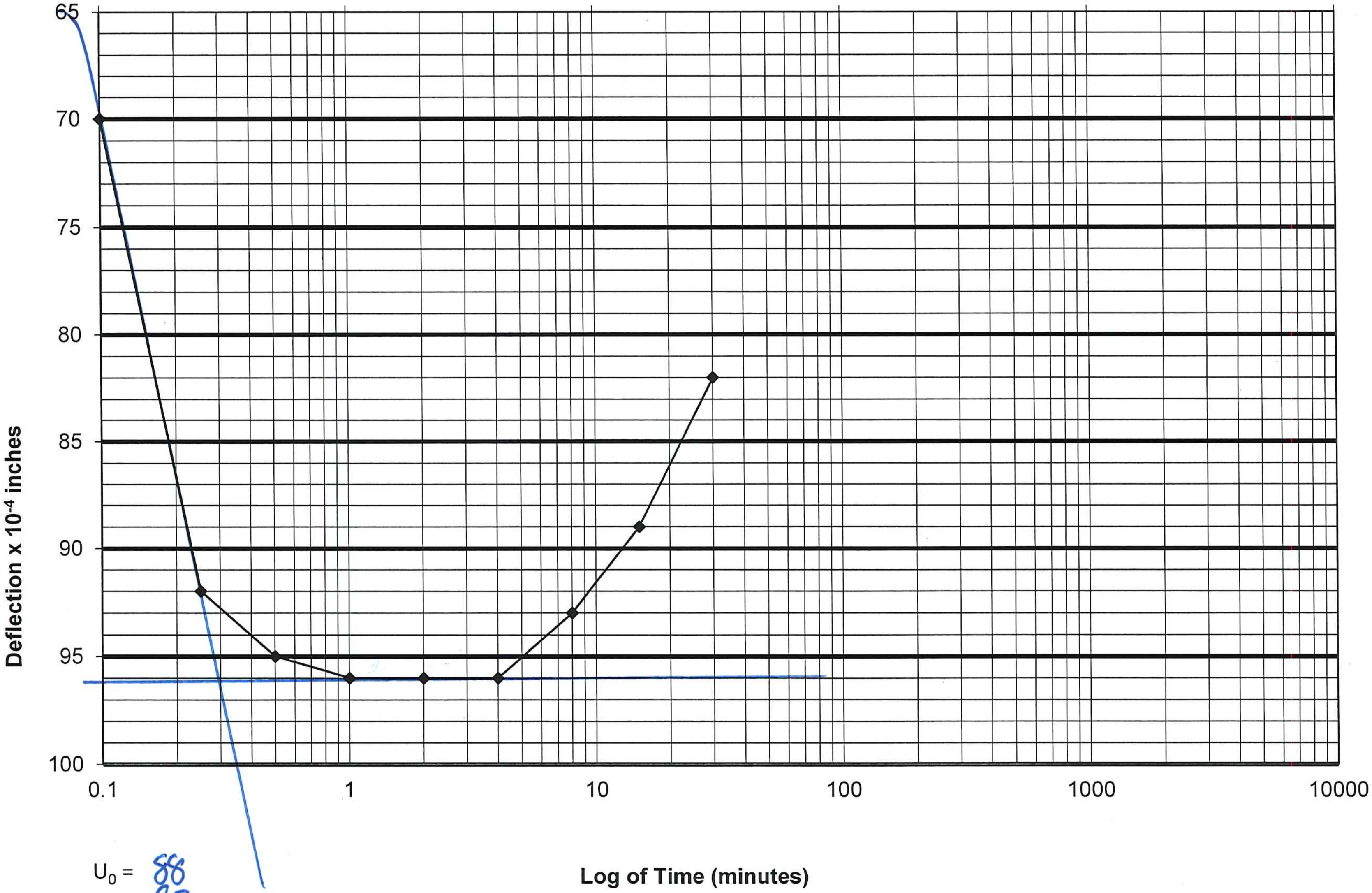
FIG.

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-04 T1

Load 1 0.25 tsf



U_0 = 88
U_{50} = 92
U_{100} = 96
t_{50} = 0.25

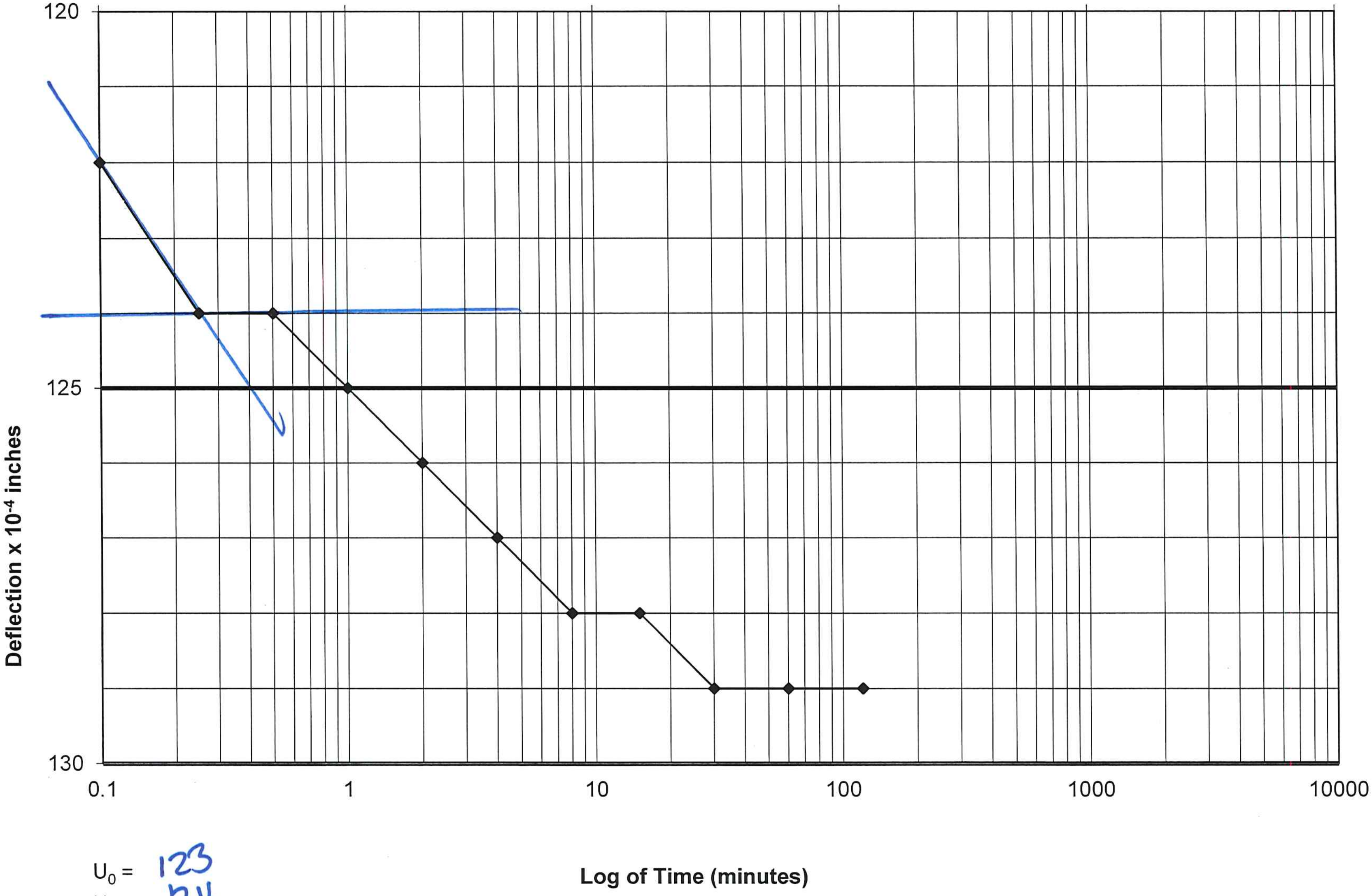
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-04 T1

Load 2 0.5 tsf



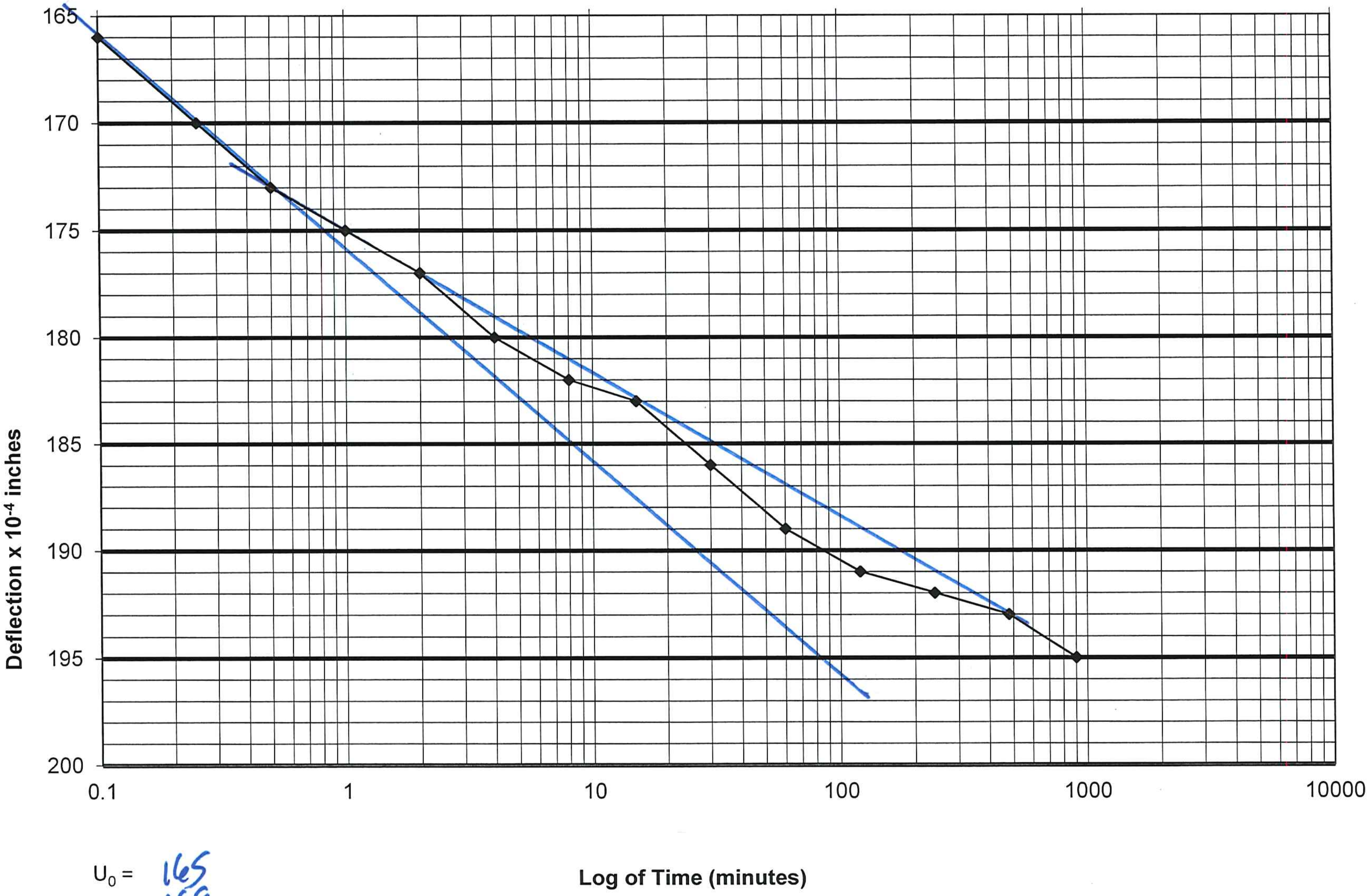
U_0 = 123
U_{50} = 124
U_{100} = 124
t_{50} = 0.20

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-04 T1

Load 3 1.0 tsf



U_0 = 165
U_{50} = 169
U_{100} = 173
t_{50} = 0.20

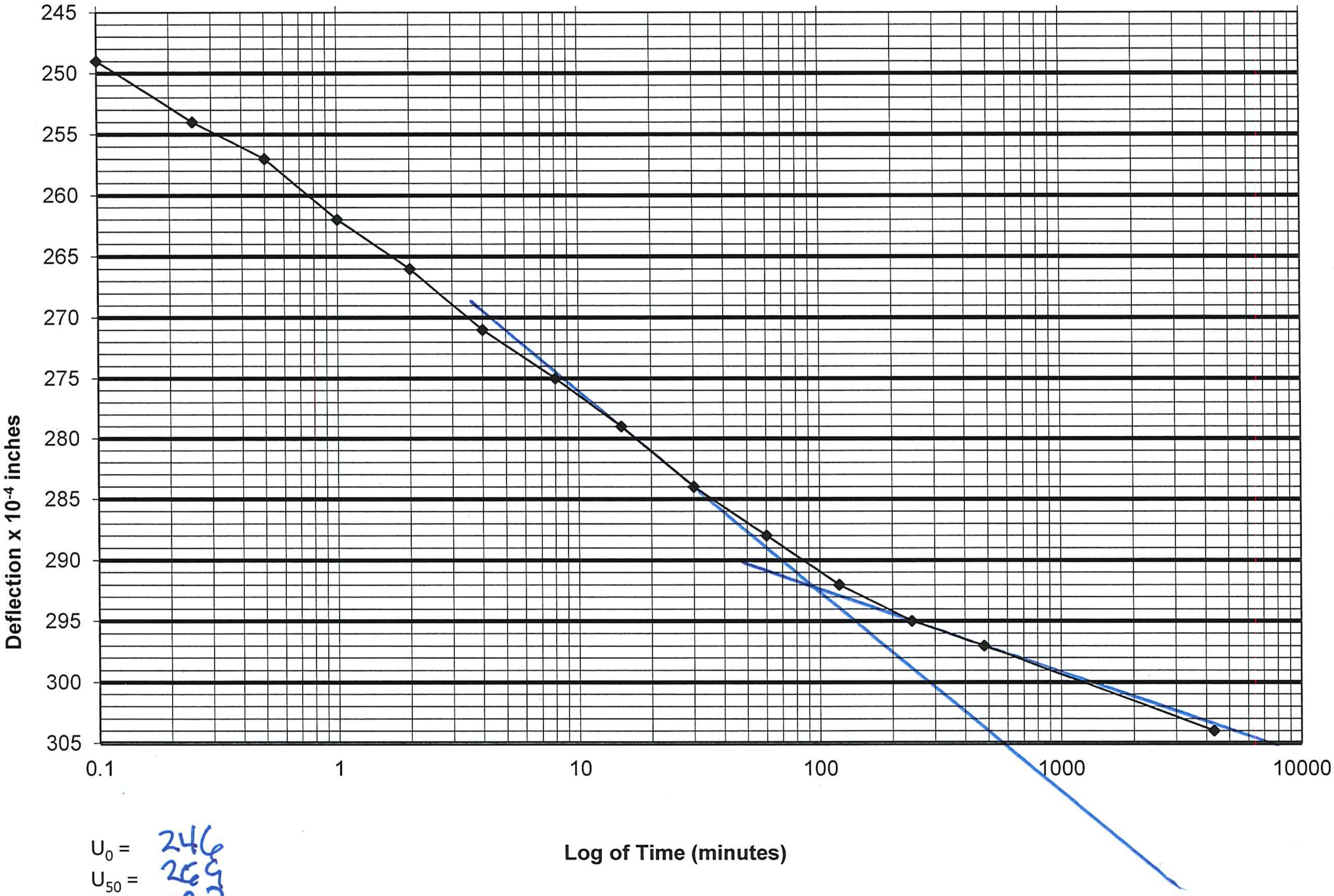
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-04 T1

Load 4 2.0 tsf



U_0 = 246
U_{50} = 269
U_{100} = 292
t_{50} = 3.03

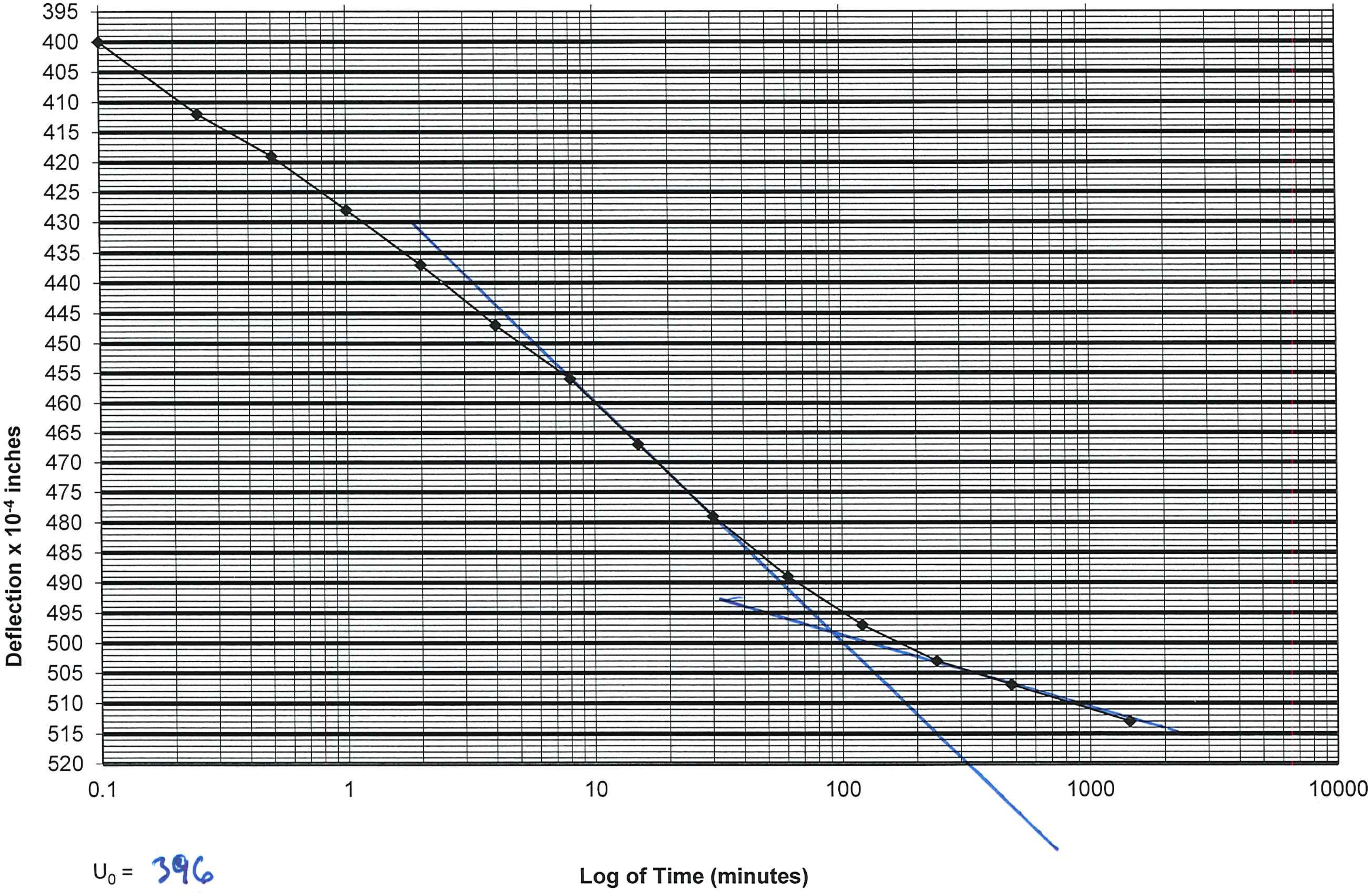
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-04 T1

Load 5 4.0 tsf



U_0 = 396

U_{50} = 447

U_{100} = 498

t_{50} = 400

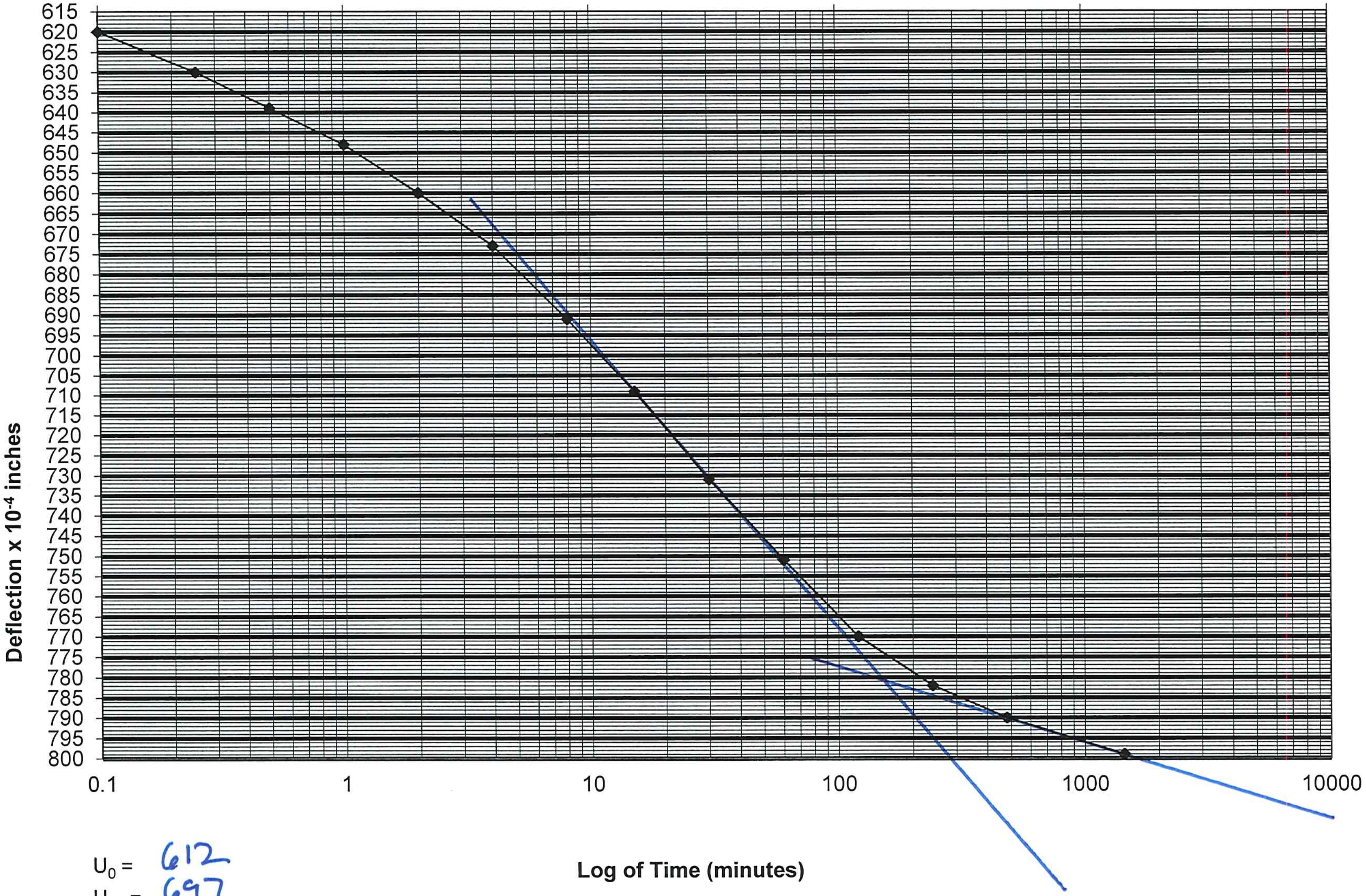
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-04 T1

Load 6 8.0 tsf



U_0 = 612

U_{50} = 697

U_{100} = 781

t_{50} = 9.69

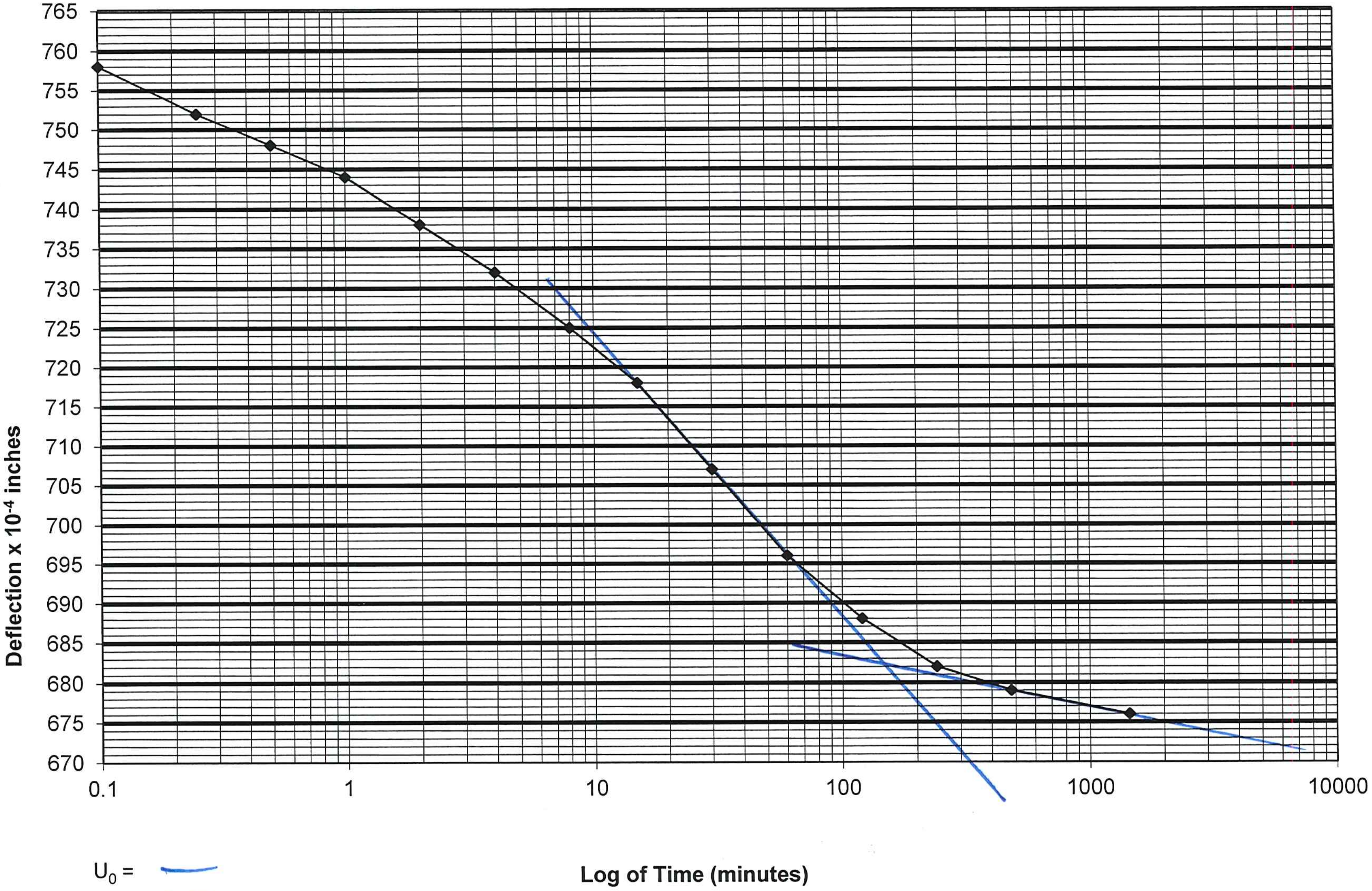
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-04 T1

Load 7 2.0 tsf



U_0 = —

U_{50} = —

U_{100} = 682

t_{50} = —

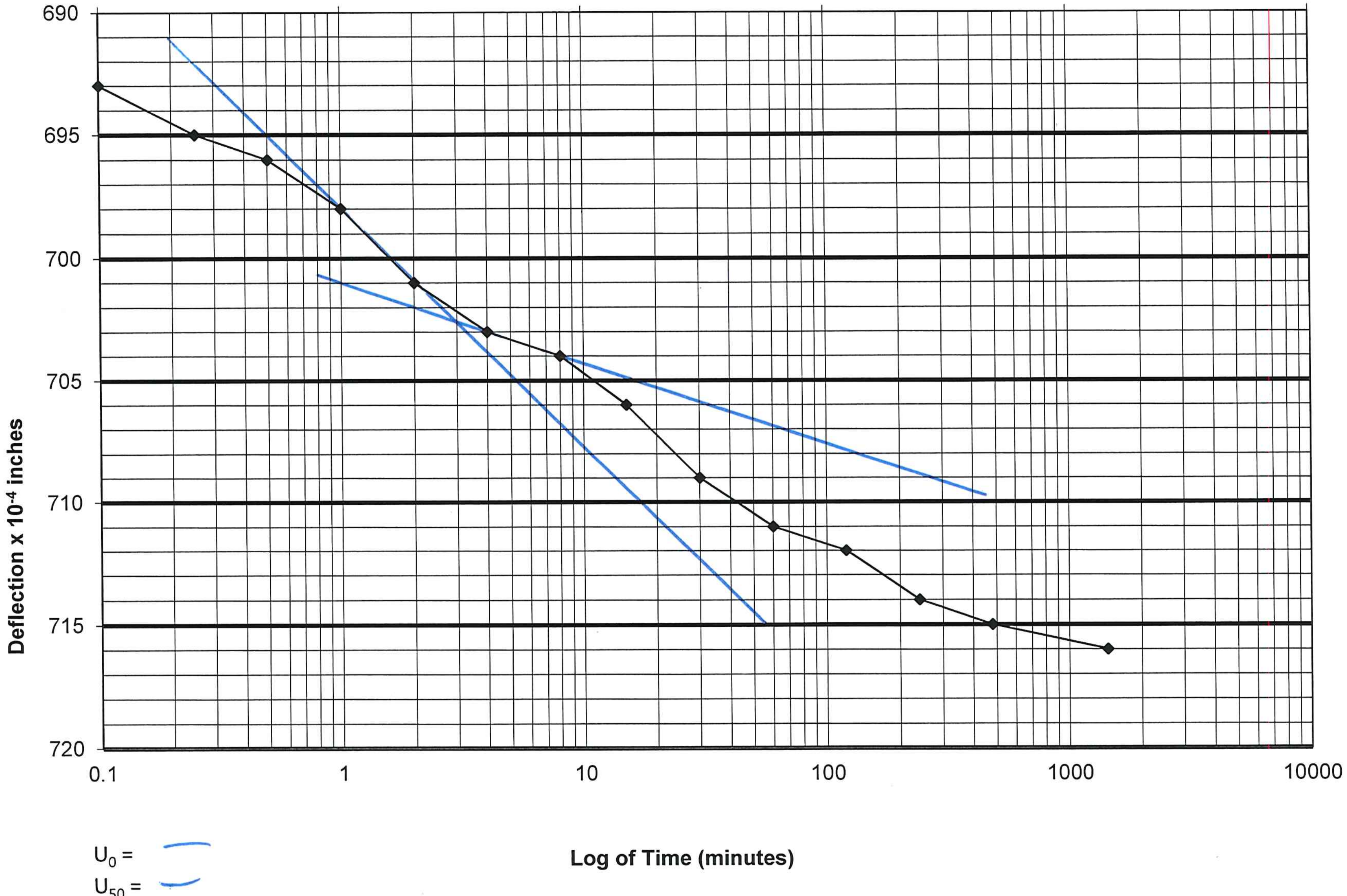
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-04 T1

Load 8 4.0 tsf



U_0 = —

U_{50} = —

U_{100} = 703

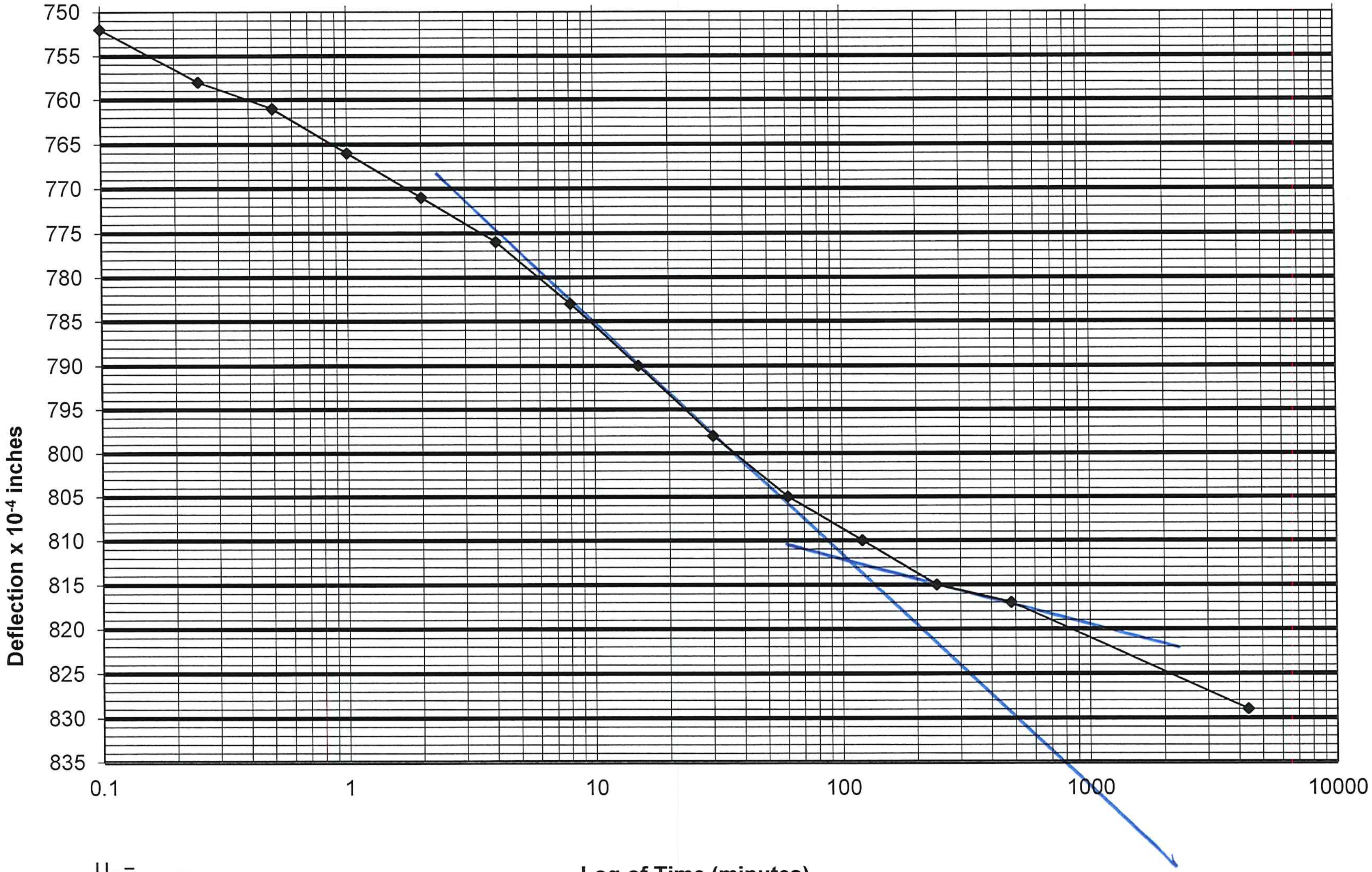
t_{50} = —

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-04 T1

Load 9 8.0 tsf



U_0 = —

U_{50} = —

U_{100} = 812

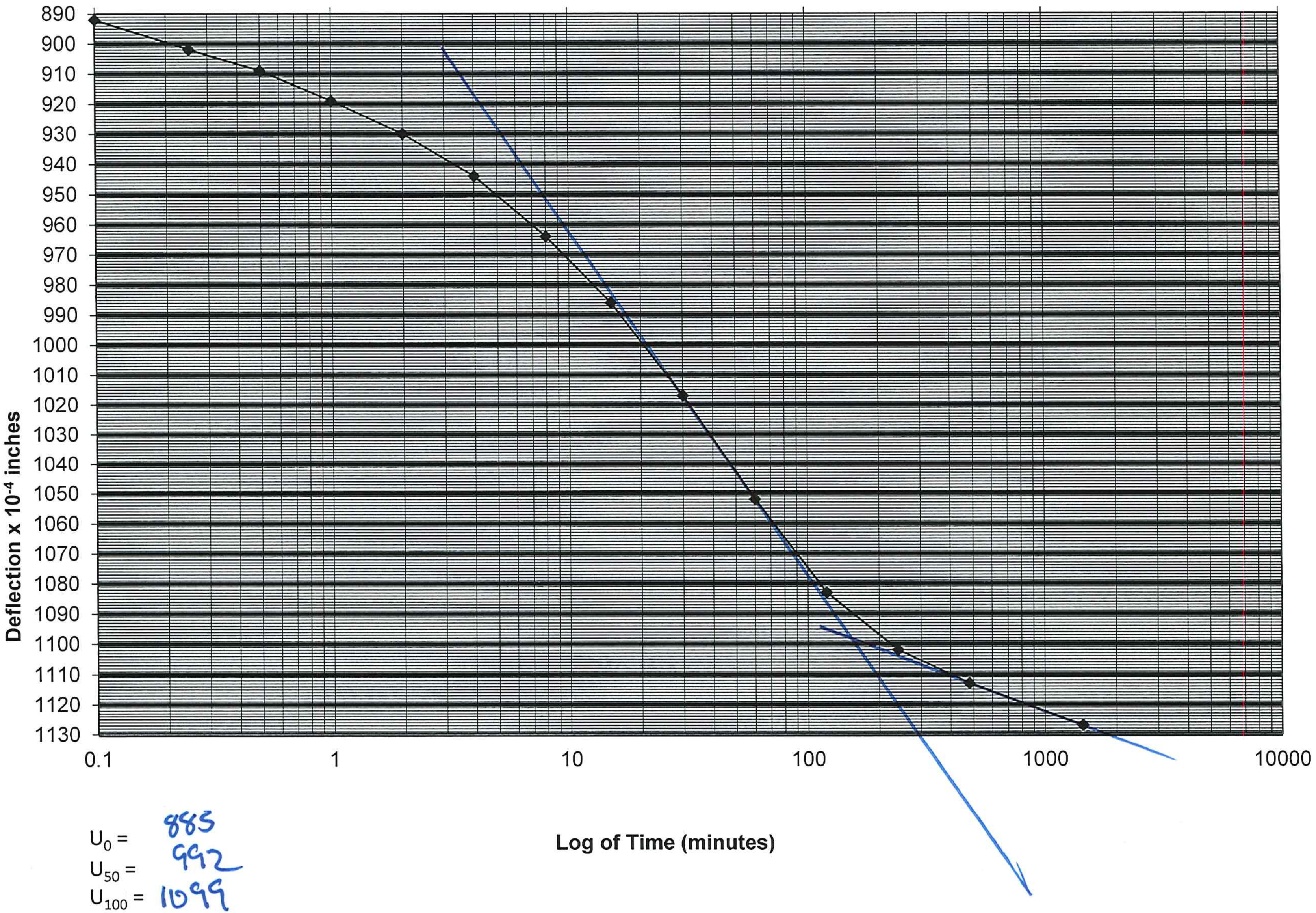
t_{50} = —

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-04 T1

Load 10 16.0 tsf



U_0 = 885

U_{50} = 992

U_{100} = 1099

t_{50} = 17.15

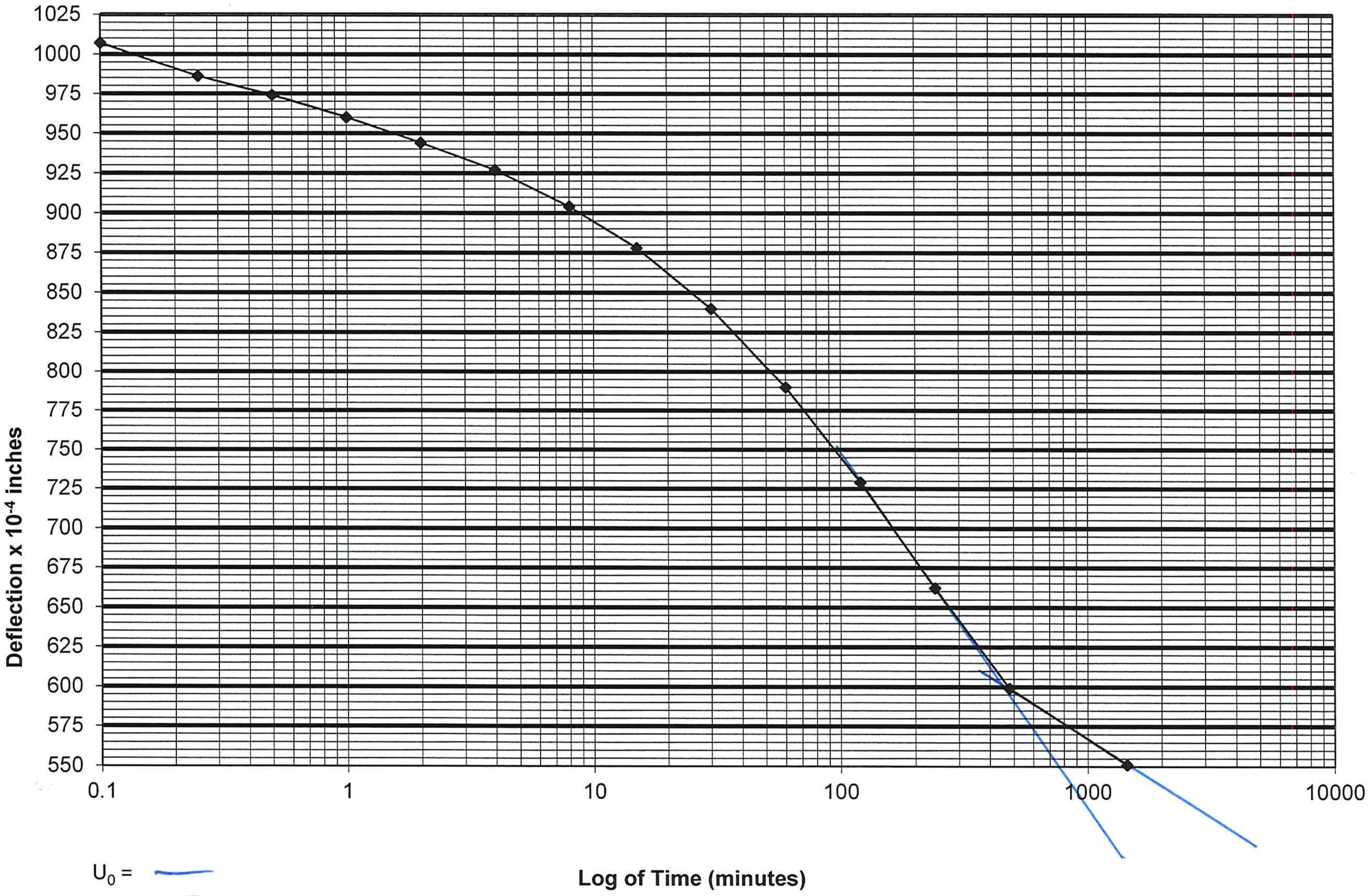
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-04 T1

Load 11 0.25 tsf



U$_0$ = —

U$_{50}$ = —

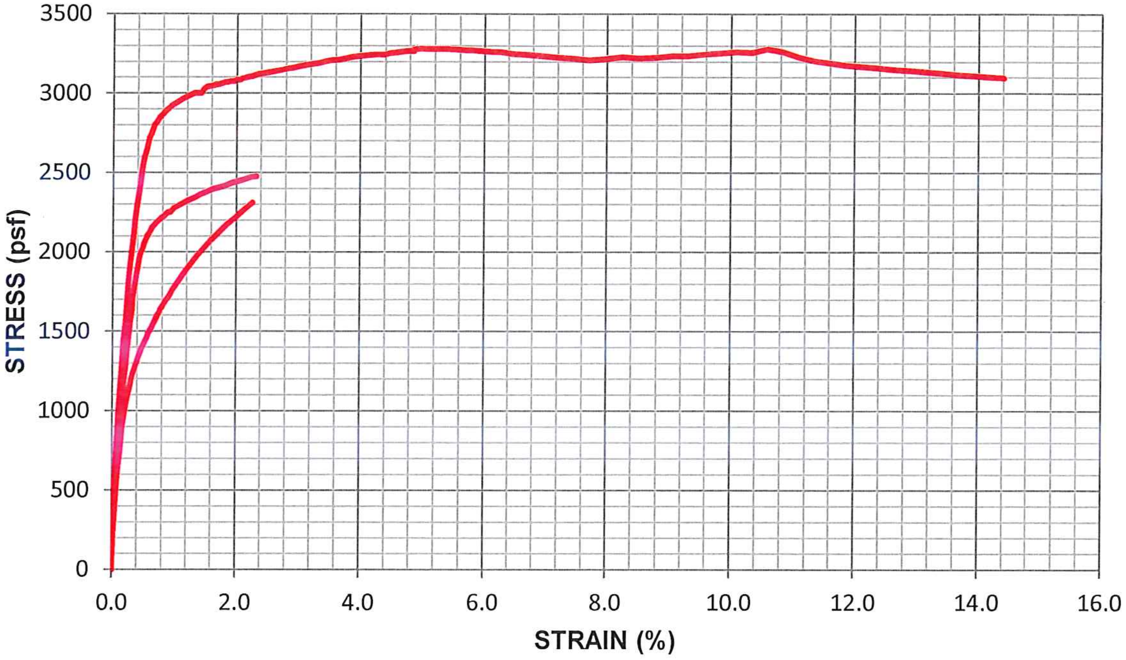
U$_{100}$ = 599

t$_{50}$ = —

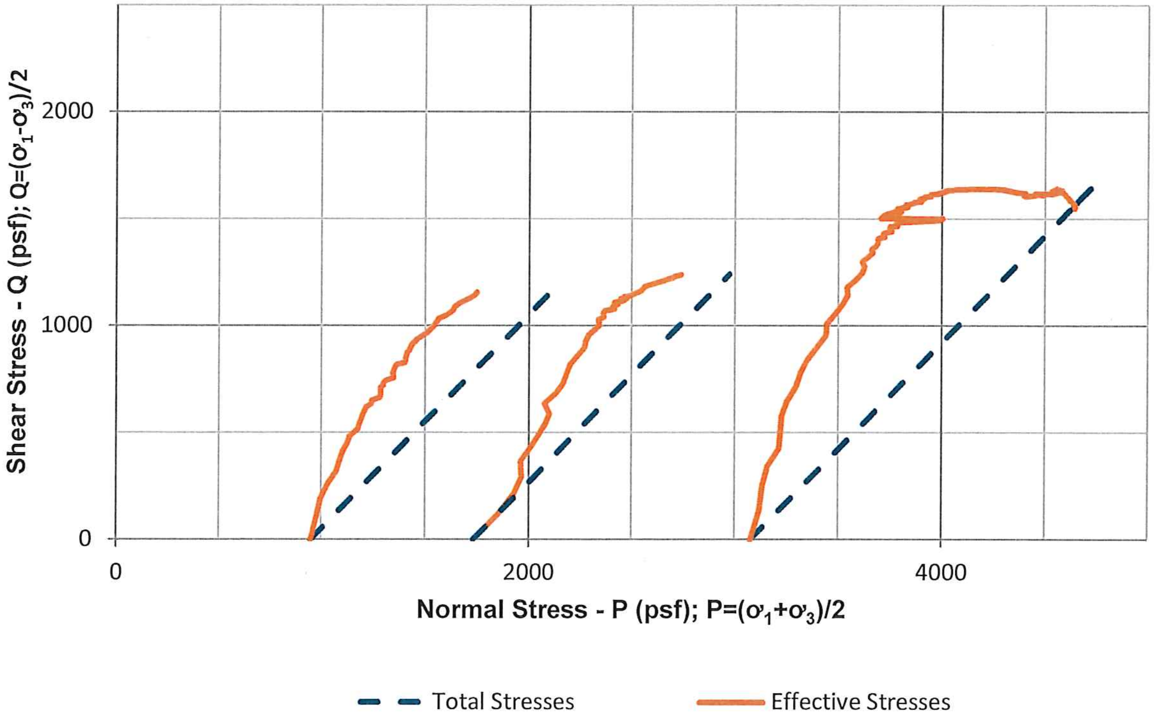
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST WITH PORE PRESSURE MEASUREMENT

STRESS - STRAIN

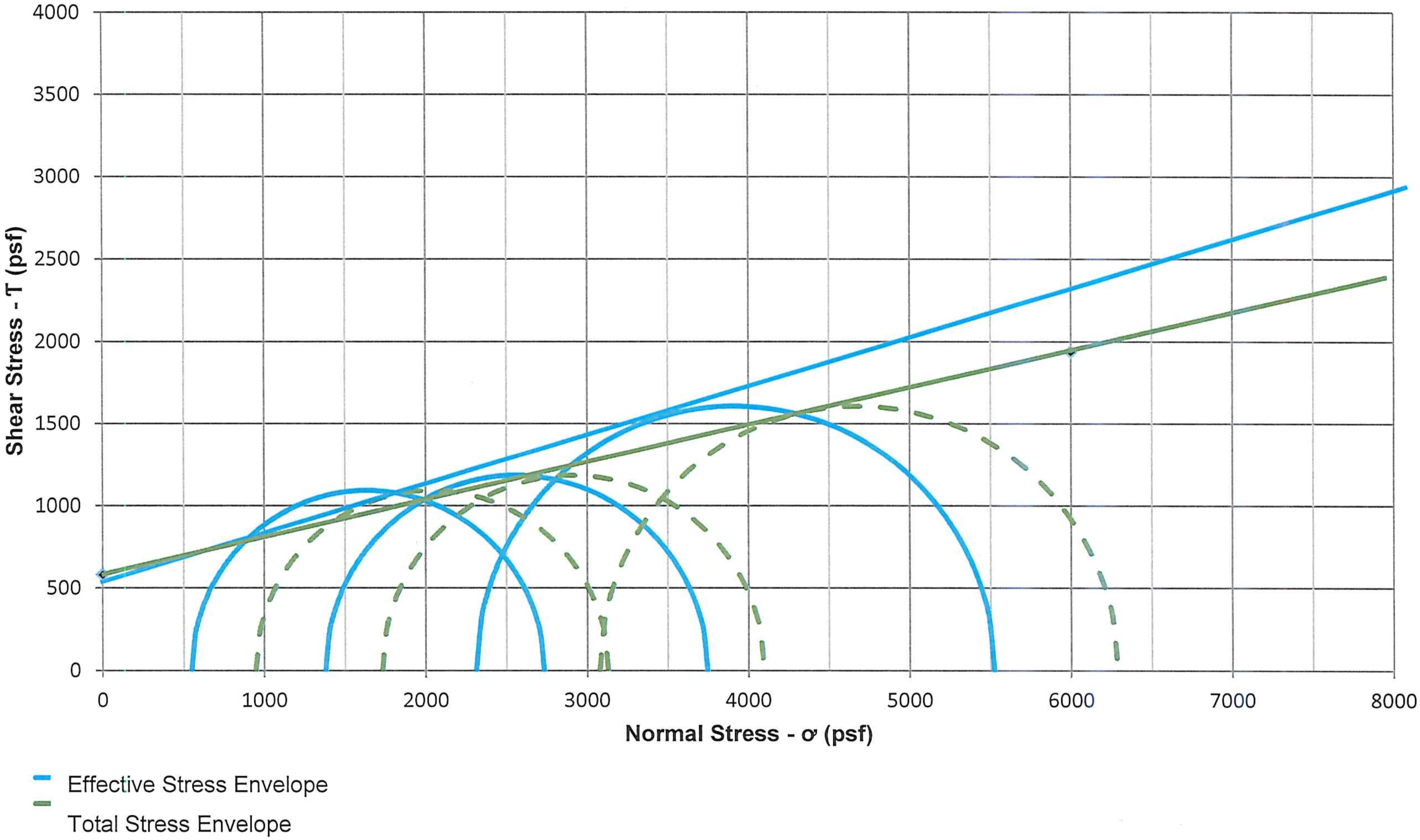


P-Q PLOT



SHANNON & WILSON, INC. **2043 WESTPORT CENTER DR.** **SAINT LOUIS, MISSOURI 63146** **104287-001**	**CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION** **Thomas Hill Energy Center – CDT** **Clifton Hill, Missouri** **HAB-CDT-04 / T1 / 8.0 - 10.0**

Mohr's Circle Plots Corresponding to the Peak Principal Stress Ratio



Sample	Strain (%)
Stage 1	1.9
Stage 2	1.4
Stage 3	3.5

c =	580 psf
ϕ =	12.8 deg
c' =	520 psf
ϕ' =	16.7 deg

NOTES:
1. Mohr's circles in this plot are based upon the maximum principal stress difference observed during loading.
2. Strength parameters determined by Shannon & Wilson. Engineer-of-Record should evaluate cohesion and friction commensurate with project conditions.

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

Mohr's Circle Plots
HAB-CDT-04 / T1

October 2019
104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Figure 1

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	Thomas Hill Energy Center – CDT					
Location	Clifton Hill, Missouri			Client	Haley & Aldrich, Inc.	
Job No.	104287-001			Tested by	CMB	Oct-19
Boring	HAB-CDT-04			Calculated by	CMB	Oct-19
Sample	T1	Specimen Number	Stage 1	Checked by	DPm	10/30/19
Depth (ft)	8.0 - 10.0	Undisturbed/Remold	Undisturbed	File	104287-001 HAB-CDT-04 T1 ASTM D476	
Description	Gray and brown, Sandy Lean Clay (CL).			Procedure	ASTM D4767	
Remarks						

Specimen Data

	Initial	Post Consol.	Post Shear
Height (in)	5.986	5.983	5.847
Diameter (in)	2.859	2.852	
Volume (in^3)	38.429	38.230	
Height/Diameter ratio	2.094	2.098	
Weight (g)	1319.85	1320.79	1320.79
Water Content (%)	19.17	19.25	19.25
Bulk Unit Weight (pcf)	130.8	130.9	131.6
Dry Unit Weight (pcf)	109.8	109.8	110.4
Cross-Sectional Area* (in^2)	6.420	6.390	
% Saturation - Wet Method	98.19	100.13	100.13
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	0.523	0.515	0.515
	Trimmings		
Tare ID	TX-1		
Mass wet soil + tare (g)	57.59		
Mass dry soil + tare (g)	48.73		
Mass tare (g)	2.50		

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions

Cell Pressure (psi)	106.5
Pore Pressure (psi)	99.9
Effective Confining Pressure (psi)	6.6
B-value	98.00

Consolidation Phase

Change in Volume (in^3)	0.198
T_{50} (min)	14.2

Platen Travel Rate (in/min)	0.00166

Additional Testing

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results

Peak P (psf)	2040.7
Peak P' (psf)	1642.1
Peak Q (psf)	1091.2
Strain at Peak (%)	1.9
σ_3' (psf)	550.9
σ_1' (psf)	2733.3
σ_3 (psf)	949.5
σ_1 (psf)	3131.9

Picture of Failure

See Stage 3

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-04 / T1 / Stage 1

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
0.00	0.0	0.0	949.5	949.5	1.00	949.5	949.5	0.0
0.02	229.4	85.6	1093.3	863.9	1.27	1064.2	978.6	114.7
0.05	382.2	143.4	1188.3	806.0	1.47	1140.6	997.2	191.1
0.07	519.0	177.9	1290.6	771.6	1.67	1209.0	1031.1	259.5
0.10	639.5	197.2	1391.7	752.3	1.85	1269.2	1072.0	319.7
0.12	743.3	232.7	1460.1	716.8	2.04	1321.1	1088.5	371.7
0.14	832.6	261.4	1520.7	688.0	2.21	1365.8	1104.4	416.3
0.16	904.4	276.3	1577.6	673.2	2.34	1401.7	1125.4	452.2
0.19	971.9	299.0	1622.4	650.5	2.49	1435.4	1136.5	486.0
0.21	1032.8	291.1	1691.3	658.4	2.57	1465.9	1174.9	516.4
0.24	1085.4	308.9	1725.9	640.6	2.69	1492.2	1183.3	542.7
0.26	1130.0	323.3	1756.2	626.2	2.80	1514.5	1191.2	565.0
0.29	1171.9	334.5	1786.9	615.0	2.91	1535.4	1201.0	586.0
0.31	1210.8	345.1	1815.2	604.4	3.00	1554.9	1209.8	605.4
0.33	1242.4	353.8	1838.1	595.7	3.09	1570.7	1216.9	621.2
0.36	1272.3	343.1	1878.7	606.4	3.10	1585.6	1242.6	636.1
0.39	1303.7	356.0	1897.2	593.5	3.20	1601.3	1245.3	651.8
0.41	1331.2	335.5	1945.2	614.0	3.17	1615.1	1279.6	665.6
0.43	1355.4	340.4	1964.5	609.1	3.23	1627.2	1286.8	677.7
0.45	1383.2	352.9	1979.8	596.5	3.32	1641.1	1288.2	691.6
0.49	1407.0	364.7	1991.7	584.7	3.41	1653.0	1288.2	703.5
0.51	1428.4	375.7	2002.1	573.8	3.49	1663.7	1287.9	714.2
0.53	1448.7	374.2	2023.9	575.2	3.52	1673.8	1299.6	724.3
0.56	1469.1	385.1	2033.5	564.4	3.60	1684.0	1298.9	734.5
0.58	1489.0	383.5	2054.9	566.0	3.63	1694.0	1310.5	744.5
0.60	1510.8	358.3	2101.9	591.2	3.56	1704.9	1346.6	755.4
0.63	1527.8	365.4	2111.9	584.1	3.62	1713.4	1348.0	763.9
0.65	1545.9	376.0	2119.4	573.5	3.70	1722.4	1346.5	773.0
0.67	1562.6	384.8	2127.2	564.6	3.77	1730.8	1345.9	781.3
0.70	1584.5	391.8	2142.3	557.7	3.84	1741.7	1350.0	792.3
0.72	1602.2	398.1	2153.6	551.4	3.91	1750.6	1352.5	801.1
0.75	1622.6	403.2	2168.9	546.2	3.97	1760.8	1357.6	811.3
0.77	1640.8	403.6	2186.7	545.9	4.01	1769.9	1366.3	820.4
0.79	1654.8	375.0	2229.2	574.4	3.88	1776.9	1401.8	827.4
0.82	1671.8	380.3	2241.0	569.2	3.94	1785.4	1405.1	835.9
0.85	1688.5	386.5	2251.4	563.0	4.00	1793.7	1407.2	844.2
0.86	1700.0	391.8	2257.6	557.6	4.05	1799.5	1407.6	850.0
0.90	1716.3	398.1	2267.7	551.4	4.11	1807.6	1409.6	858.2
0.92	1734.6	404.3	2279.7	545.1	4.18	1816.8	1412.4	867.3
0.94	1748.7	410.5	2287.7	539.0	4.24	1823.8	1413.3	874.4
0.97	1764.7	410.2	2303.9	539.3	4.27	1831.8	1421.6	882.3
1.07	1824.7	426.3	2347.9	523.2	4.49	1861.8	1435.6	912.3
1.16	1878.5	423.5	2404.5	526.0	4.57	1888.8	1465.3	939.3
1.26	1932.0	409.7	2471.8	539.8	4.58	1915.5	1505.8	966.0
1.36	1978.7	405.5	2522.7	544.0	4.64	1938.8	1533.4	989.4
1.46	2024.6	409.2	2564.9	540.3	4.75	1961.8	1552.6	1012.3
1.57	2068.5	418.0	2600.0	531.5	4.89	1983.7	1565.7	1034.3
1.67	2104.5	397.9	2656.1	551.6	4.82	2001.7	1603.8	1052.2
1.77	2145.8	387.9	2707.4	561.6	4.82	2022.4	1634.5	1072.9
1.86	2182.4	398.6	2733.3	550.9	4.96	2040.7	1642.1	1091.2
1.97	2214.6	389.9	2774.2	559.6	4.96	2056.8	1666.9	1107.3

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-04 / T1 / Stage 1

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
2.07	2249.9	370.2	2829.2	579.3	4.88	2074.4	1704.2	1125.0
2.16	2282.4	355.9	2875.9	593.6	4.85	2090.7	1734.8	1141.2
2.27	2313.9	357.6	2905.7	591.9	4.91	2106.4	1748.8	1156.9
2.27	2314.4	356.8	2907.1	592.7	4.90	2106.7	1749.9	1157.2

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	Thomas Hill Energy Center – CDT		
Location	Clifton Hill, Missouri		
Job No.	104287-001		
Boring	HAB-CDT-04		
Sample	T1	Specimen Number	Stage 2
Depth (ft)	8.0 - 10.0	Undisturbed/Remold	Undisturbed
Description	Gray and brown, Sandy Lean Clay (CL).		
Remarks			

Client	Haley & Aldrich, Inc.	
Tested by	CMB	Oct-19
Calculated by	CMB	Oct-19
Checked by	DPM	10/30/19
File	104287-001 HAB-CDT-04 T1 ASTM D476	
Procedure	ASTM D4767	

Specimen Data	Initial	Post Consol.	Post Shear
Height (in)	5.847	5.832	5.696
Diameter (in)	2.885	2.884	
Volume (in^3)	38.230	38.098	
Height/Diameter ratio	2.027	2.022	
Weight (g)	1320.79	1318.63	1318.63
Water Content (%)	19.25	19.05	19.05
Bulk Unit Weight (pcf)	131.6	131.9	131.9
Dry Unit Weight (pcf)	110.4	110.8	110.8
Cross-Sectional Area* (in^2)	6.538	6.532	
% Saturation - Wet Method	100.13	100.13	100.13
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	0.515	0.510	0.510
Tare ID			
Mass wet soil + tare (g)			
Mass dry soil + tare (g)			
Mass tare (g)			

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions

Cell Pressure (psi)	111.9
Pore Pressure (psi)	99.8
Effective Confining Pressure (psi)	12.0
B-value	98.00

Consolidation Phase

Change in Volume (in^3)	0.132
T_{50} (min)	103.3
Platen Travel Rate (in/min)	0.00023

Additional Testing

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results

Peak P (psf)	2916.1
Peak P' (psf)	2563.5
Peak Q (psf)	1183.0
Strain at Peak (%)	1.4
σ_3' (psf)	1380.6
σ_1' (psf)	3746.5
σ_3 (psf)	1733.1
σ_1 (psf)	4099.1

Picture of Failure

See Stage 3

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-04 / T1 / Stage 2

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
0.00	0.0	0.0	1733.1	1733.1	1.00	1733.1	1733.1	0.0
0.02	242.7	0.0	1975.8	1733.1	1.14	1854.5	1854.5	121.3
0.03	429.4	20.7	2141.8	1712.4	1.25	1947.8	1927.1	214.7
0.07	595.0	65.2	2262.9	1667.9	1.36	2030.6	1965.4	297.5
0.09	738.2	140.3	2331.1	1592.9	1.46	2102.3	1962.0	369.1
0.11	865.4	156.6	2442.0	1576.6	1.55	2165.8	2009.3	432.7
0.13	983.9	176.7	2540.3	1556.4	1.63	2225.1	2048.4	491.9
0.16	1089.2	196.4	2626.0	1536.8	1.71	2277.8	2081.4	544.6
0.18	1184.6	223.1	2694.7	1510.0	1.78	2325.5	2102.3	592.3
0.21	1278.2	293.6	2717.7	1439.5	1.89	2372.2	2078.6	639.1
0.23	1370.5	285.5	2818.2	1447.6	1.95	2418.4	2132.9	685.3
0.26	1463.1	295.6	2900.6	1437.5	2.02	2464.7	2169.1	731.6
0.28	1554.3	325.0	2962.4	1408.2	2.10	2510.3	2185.3	777.1
0.31	1642.1	350.3	3024.9	1382.8	2.19	2554.2	2203.8	821.0
0.33	1721.4	354.7	3099.8	1378.4	2.25	2593.8	2239.1	860.7
0.35	1795.6	357.4	3171.4	1375.8	2.31	2630.9	2273.6	897.8
0.38	1859.2	383.6	3208.7	1349.5	2.38	2662.7	2279.1	929.6
0.41	1915.1	396.8	3251.4	1336.3	2.43	2690.7	2293.8	957.5
0.43	1965.4	391.8	3306.8	1341.4	2.47	2715.8	2324.1	982.7
0.45	1999.7	390.3	3342.6	1342.9	2.49	2733.0	2342.8	999.9
0.49	2030.1	403.9	3359.3	1329.2	2.53	2748.2	2344.2	1015.0
0.51	2058.7	420.9	3371.0	1312.2	2.57	2762.5	2341.6	1029.4
0.53	2082.7	406.2	3409.7	1326.9	2.57	2774.5	2368.3	1041.4
0.56	2107.0	419.5	3420.7	1313.7	2.60	2786.6	2367.2	1053.5
0.59	2126.4	429.5	3430.0	1303.6	2.63	2796.4	2366.8	1063.2
0.61	2144.3	430.5	3446.9	1302.7	2.65	2805.3	2374.8	1072.1
0.63	2158.9	394.2	3497.9	1338.9	2.61	2812.6	2418.4	1079.5
0.67	2172.3	411.5	3494.0	1321.7	2.64	2819.3	2407.8	1086.1
0.69	2185.4	413.1	3505.5	1320.1	2.66	2825.8	2412.8	1092.7
0.72	2193.4	406.0	3520.5	1327.1	2.65	2829.8	2423.8	1096.7
0.74	2203.6	400.6	3536.1	1332.6	2.65	2834.9	2434.3	1101.8
0.77	2211.9	408.2	3536.8	1324.9	2.67	2839.1	2430.8	1105.9
0.79	2220.4	424.4	3529.1	1308.7	2.70	2843.3	2418.9	1110.2
0.82	2228.1	401.7	3559.5	1331.4	2.67	2847.2	2445.4	1114.0
0.84	2237.6	389.8	3580.9	1343.3	2.67	2851.9	2462.1	1118.8
0.87	2247.3	409.0	3571.4	1324.1	2.70	2856.8	2447.8	1123.6
0.89	2254.7	412.3	3575.5	1320.8	2.71	2860.5	2448.2	1127.3
0.92	2254.5	384.2	3603.4	1348.9	2.67	2860.4	2476.2	1127.3
0.95	2265.9	383.6	3615.4	1349.5	2.68	2866.1	2482.5	1132.9
0.97	2272.8	406.1	3599.8	1327.0	2.71	2869.5	2463.4	1136.4
0.99	2280.5	380.2	3633.5	1353.0	2.69	2873.4	2493.2	1140.2
1.11	2307.1	365.5	3674.7	1367.7	2.69	2886.7	2521.2	1153.5
1.20	2328.5	350.6	3711.0	1382.5	2.68	2897.4	2546.7	1164.2
1.32	2345.1	349.8	3728.5	1383.4	2.70	2905.7	2555.9	1172.6
1.41	2365.9	352.6	3746.5	1380.6	2.71	2916.1	2563.5	1183.0
1.51	2381.8	339.2	3775.8	1394.0	2.71	2924.0	2584.9	1190.9
1.61	2399.4	319.5	3813.0	1413.7	2.70	2932.8	2613.4	1199.7
1.71	2409.3	304.1	3838.4	1429.1	2.69	2937.8	2633.7	1204.6
1.82	2422.4	287.7	3867.8	1445.4	2.68	2944.4	2656.6	1211.2
1.92	2438.4	275.4	3896.1	1457.7	2.67	2952.4	2676.9	1219.2
2.02	2450.3	255.6	3927.9	1477.6	2.66	2958.3	2702.7	1225.2

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-04 / T1 / Stage 2

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
2.13	2461.0	253.5	3940.6	1479.7	2.66	2963.6	2710.2	1230.5
2.23	2473.8	239.4	3967.5	1493.7	2.66	2970.0	2730.6	1236.9
2.33	2480.3	233.4	3980.1	1499.8	2.65	2973.3	2739.9	1240.2

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-04 / T1 / Stage 2

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	Thomas Hill Energy Center – CDT					
Location	Clifton Hill, Missouri			Client	Haley & Aldrich, Inc.	
Job No.	104287-001			Tested by	CMB	Oct-19
Boring	HAB-CDT-04			Calculated by	CMB	Oct-19
Sample	T1	Specimen Number	Stage 3	Checked by	DPM	10/30/19
Depth (ft)	8.0 - 10.0	Undisturbed/Remold	Undisturbed	File	104287-001 HAB-CDT-04 T1 ASTM D476	
Description	Gray and brown, Sandy Lean Clay (CL).			Procedure	ASTM D4767	
Remarks						

Specimen Data	Initial	Post Consol.	Post Shear
Height (in)	5.696	5.683	5.592
Diameter (in)	2.918	2.906	
Volume (in^3)	38.098	37.699	
Height/Diameter ratio	1.952	1.956	
Weight (g)	1318.63	1312.08	1312.08
Water Content (%)	19.05	18.46	18.46
Bulk Unit Weight (pcf)	131.9	132.6	132.6
Dry Unit Weight (pcf)	110.8	111.9	111.9
Cross-Sectional Area* (in^2)	6.688	6.633	
% Saturation - Wet Method	100.13	100.14	100.14
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	0.510	0.494	0.494
			Entire Sample
Tare ID			24
Mass wet soil + tare (g)			1502.91
Mass dry soil + tare (g)			1272.50
Mass tare (g)			166.93

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions

Cell Pressure (psi)	121.3
Pore Pressure (psi)	99.9
Effective Confining Pressure (psi)	21.4
B-value	98.00

Consolidation Phase

Change in Volume (in^3)	0.400
T_{50} (min)	359.0
Platen Travel Rate (in/min)	0.00008

Additional Testing

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results

Peak P (psf)	4685.4
Peak P' (psf)	3918.9
Peak Q (psf)	1606.1
Strain at Peak (%)	3.5
σ_3' (psf)	2312.8
σ'_1 (psf)	5525.0
σ_3 (psf)	3079.4
σ'_1 (psf)	6291.5

Picture of Failure

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-04 / T1 / Stage 3

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
0.00	0.0	0.0	3079.4	3079.4	1.00	3079.4	3079.4	0.0
0.01	268.7	92.9	3255.1	2986.4	1.09	3213.7	3120.8	134.3
0.03	498.9	193.3	3384.9	2886.0	1.17	3328.8	3135.5	249.5
0.06	689.7	263.9	3505.2	2815.5	1.24	3424.2	3160.3	344.9
0.08	857.9	292.8	3644.5	2786.5	1.31	3508.3	3215.5	429.0
0.10	1011.3	363.9	3726.8	2715.4	1.37	3585.0	3221.1	505.7
0.13	1156.7	430.2	3805.8	2649.1	1.44	3657.7	3227.5	578.3
0.15	1294.3	473.7	3899.9	2605.7	1.50	3726.5	3252.8	647.1
0.17	1433.9	500.0	4013.2	2579.3	1.56	3796.3	3296.3	716.9
0.21	1563.9	542.4	4100.9	2537.0	1.62	3861.3	3318.9	782.0
0.23	1684.1	570.0	4193.4	2509.3	1.67	3921.4	3351.4	842.0
0.25	1802.3	581.9	4299.7	2497.4	1.72	3980.5	3398.6	901.1
0.28	1913.9	595.0	4398.3	2484.4	1.77	4036.3	3441.3	956.9
0.31	2019.6	644.2	4454.7	2435.1	1.83	4089.1	3444.9	1009.8
0.34	2119.3	652.4	4546.3	2427.0	1.87	4139.0	3486.6	1059.6
0.36	2210.2	662.3	4627.2	2417.0	1.91	4184.4	3522.1	1105.1
0.39	2291.2	679.4	4691.2	2400.0	1.95	4225.0	3545.6	1145.6
0.42	2368.6	720.6	4727.3	2358.7	2.00	4263.6	3543.0	1184.3
0.44	2435.4	711.0	4803.7	2368.3	2.03	4297.1	3586.0	1217.7
0.46	2499.3	714.2	4864.5	2365.2	2.06	4329.0	3614.8	1249.6
0.49	2556.1	730.9	4904.6	2348.4	2.09	4357.4	3626.5	1278.1
0.51	2605.4	766.3	4918.5	2313.1	2.13	4382.0	3615.8	1302.7
0.54	2647.9	758.8	4968.4	2320.5	2.14	4403.3	3644.4	1323.9
0.57	2687.0	756.2	5010.2	2323.2	2.16	4422.9	3666.7	1343.5
0.59	2722.0	778.4	5022.9	2300.9	2.18	4440.4	3661.9	1361.0
0.62	2749.7	771.3	5057.8	2308.1	2.19	4454.2	3683.0	1374.9
0.64	2776.0	778.4	5077.0	2301.0	2.21	4467.4	3689.0	1388.0
0.66	2800.7	787.2	5092.8	2292.1	2.22	4479.7	3692.5	1400.3
0.69	2817.8	796.6	5100.6	2282.8	2.23	4488.2	3691.7	1408.9
0.72	2832.8	772.4	5139.7	2306.9	2.23	4495.7	3723.3	1416.4
0.75	2849.9	781.6	5147.6	2297.7	2.24	4504.3	3722.7	1424.9
0.78	2862.5	794.4	5147.5	2285.0	2.25	4510.6	3716.2	1431.3
0.80	2870.4	794.3	5155.4	2285.0	2.26	4514.5	3720.2	1435.2
0.83	2886.6	765.4	5200.5	2313.9	2.25	4522.6	3757.2	1443.3
0.85	2894.1	774.0	5199.4	2305.3	2.26	4526.4	3752.4	1447.0
0.88	2902.6	777.6	5204.4	2301.8	2.26	4530.7	3753.1	1451.3
0.91	2912.6	783.1	5208.9	2296.3	2.27	4535.7	3752.6	1456.3
0.94	2923.8	792.7	5210.5	2286.6	2.28	4541.3	3748.6	1461.9
0.96	2931.5	796.2	5214.6	2283.1	2.28	4545.1	3748.9	1465.7
0.98	2935.3	761.5	5253.1	2317.9	2.27	4547.0	3785.5	1467.6
1.01	2942.6	777.0	5245.0	2302.3	2.28	4550.7	3773.6	1471.3
1.11	2967.8	781.8	5265.4	2297.6	2.29	4563.2	3781.5	1483.9
1.21	2986.7	589.6	5476.4	2489.7	2.20	4572.7	3983.1	1493.3
1.32	3006.4	577.2	5508.5	2502.1	2.20	4582.5	4005.3	1503.2
1.43	3007.1	877.9	5208.6	2201.4	2.37	4582.9	3705.0	1503.6
1.45	3026.3	879.2	5226.5	2200.1	2.38	4592.5	3713.3	1513.2
1.48	3036.1	876.8	5238.7	2202.6	2.38	4597.4	3720.6	1518.1
1.51	3042.7	873.1	5248.9	2206.2	2.38	4600.7	3727.6	1521.3
1.53	3044.4	870.5	5253.3	2208.9	2.38	4601.6	3731.1	1522.2
1.56	3047.8	869.9	5257.2	2209.4	2.38	4603.3	3733.3	1523.9
1.58	3051.0	859.3	5271.1	2220.1	2.37	4604.9	3745.6	1525.5

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-04 / T1 / Stage 3

October 2019
104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
1.61	3053.1	860.9	5271.5	2218.4	2.38	4605.9	3745.0	1526.5
1.63	3052.7	859.9	5272.1	2219.5	2.38	4605.7	3745.8	1526.3
1.66	3059.6	847.0	5291.9	2232.3	2.37	4609.1	3762.1	1529.8
1.69	3059.5	852.5	5286.3	2226.8	2.37	4609.1	3756.6	1529.8
1.71	3060.6	811.6	5328.4	2267.8	2.35	4609.7	3798.1	1530.3
1.74	3065.0	826.0	5318.3	2253.4	2.36	4611.8	3785.9	1532.5
1.76	3065.8	846.9	5298.3	2232.5	2.37	4612.3	3765.4	1532.9
1.79	3070.8	845.2	5305.0	2234.2	2.37	4614.8	3769.6	1535.4
1.82	3073.9	845.8	5307.5	2233.6	2.38	4616.3	3770.5	1536.9
1.84	3073.7	835.4	5317.6	2243.9	2.37	4616.2	3780.8	1536.8
1.86	3076.5	812.2	5343.6	2267.1	2.36	4617.6	3805.4	1538.3
1.89	3079.4	818.1	5340.6	2261.2	2.36	4619.1	3800.9	1539.7
1.92	3080.2	818.3	5341.3	2261.0	2.36	4619.5	3801.2	1540.1
1.95	3080.5	817.2	5342.6	2262.1	2.36	4619.6	3802.4	1540.2
1.97	3082.2	817.8	5343.7	2261.5	2.36	4620.5	3802.6	1541.1
2.00	3090.4	819.0	5350.8	2260.4	2.37	4624.5	3805.6	1545.2
2.03	3087.9	819.4	5347.9	2260.0	2.37	4623.3	3804.0	1544.0
2.06	3089.8	820.6	5348.6	2258.8	2.37	4624.3	3803.7	1544.9
2.08	3096.9	824.3	5352.0	2255.1	2.37	4627.8	3803.6	1548.5
2.10	3099.8	844.9	5334.3	2234.5	2.39	4629.2	3784.4	1549.9
2.14	3101.1	835.4	5345.0	2243.9	2.38	4629.9	3794.5	1550.5
2.16	3104.5	829.8	5354.1	2249.6	2.38	4631.6	3801.8	1552.2
2.18	3107.2	831.7	5354.9	2247.6	2.38	4633.0	3801.3	1553.6
2.20	3108.6	820.6	5367.4	2258.8	2.38	4633.7	3813.1	1554.3
2.23	3110.0	810.9	5378.4	2268.4	2.37	4634.4	3823.4	1555.0
2.26	3110.5	803.4	5386.5	2276.0	2.37	4634.6	3831.2	1555.3
2.28	3115.8	803.2	5391.9	2276.2	2.37	4637.2	3834.0	1557.9
2.30	3117.7	804.4	5392.7	2274.9	2.37	4638.2	3833.8	1558.9
2.33	3121.8	806.3	5394.9	2273.1	2.37	4640.3	3834.0	1560.9
2.36	3125.7	806.7	5398.3	2272.6	2.38	4642.2	3835.5	1562.9
2.39	3126.8	807.7	5398.5	2271.7	2.38	4642.8	3835.1	1563.4
2.50	3133.2	820.4	5392.2	2259.0	2.39	4646.0	3825.6	1566.6
2.60	3140.9	808.9	5411.3	2270.4	2.38	4649.8	3840.9	1570.4
2.71	3149.9	791.1	5438.1	2288.3	2.38	4654.3	3863.2	1574.9
2.81	3159.2	792.7	5445.9	2286.7	2.38	4658.9	3866.3	1579.6
2.91	3164.1	763.8	5479.7	2315.5	2.37	4661.4	3897.6	1582.1
3.02	3173.6	764.8	5488.1	2314.5	2.37	4666.2	3901.3	1586.8
3.12	3181.4	764.8	5496.0	2314.6	2.37	4670.1	3905.3	1590.7
3.23	3188.1	781.4	5486.1	2298.0	2.39	4673.4	3892.0	1594.0
3.33	3194.2	760.8	5512.8	2318.6	2.38	4676.5	3915.7	1597.1
3.44	3204.7	768.8	5515.2	2310.5	2.39	4681.7	3912.9	1602.3
3.54	3212.2	766.5	5525.0	2312.8	2.39	4685.4	3918.9	1606.1
3.64	3215.3	739.8	5554.9	2339.6	2.37	4687.0	3947.2	1607.7
3.75	3222.1	748.6	5552.8	2330.7	2.38	4690.4	3941.8	1611.0
3.86	3231.8	748.7	5562.4	2330.6	2.39	4695.3	3946.5	1615.9
3.96	3235.9	730.5	5584.8	2348.9	2.38	4697.3	3966.8	1617.9
4.06	3239.8	708.8	5610.3	2370.5	2.37	4699.3	3990.4	1619.9
4.16	3243.6	719.1	5603.8	2360.3	2.37	4701.1	3982.0	1621.8
4.27	3246.9	710.7	5615.6	2368.7	2.37	4702.8	3992.1	1623.5
4.38	3246.8	708.7	5617.4	2370.6	2.37	4702.7	3994.0	1623.4
4.48	3256.9	689.1	5647.1	2390.3	2.36	4707.8	4018.7	1628.4

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-04 / T1 / Stage 3

October 2019 104287-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Axial Strain (%)	Deviator Stress (psf)	Excess Pore Pressure (psf)	Effective Major Principal Stress (psf)	Effective Minor Principal Stress (psf)	Effective Principal Stress Ratio	Stress Path Parameters (psf)		
						P	P'	Q
4.58	3261.4	693.8	5647.0	2385.6	2.37	4710.1	4016.3	1630.7
4.68	3266.6	694.2	5651.7	2385.1	2.37	4712.7	4018.4	1633.3
4.79	3270.5	680.4	5669.5	2399.0	2.36	4714.6	4034.2	1635.2
4.86	3269.2	667.9	5680.7	2411.5	2.36	4713.9	4046.1	1634.6
4.86	3281.1	649.7	5710.7	2429.6	2.35	4719.9	4070.2	1640.5
4.96	3283.7	541.1	5822.0	2538.3	2.29	4721.2	4180.1	1641.9
5.08	3283.0	520.3	5842.0	2559.0	2.28	4720.8	4200.5	1641.5
5.18	3281.8	500.9	5860.2	2578.5	2.27	4720.2	4219.4	1640.9
5.28	3282.6	498.0	5864.0	2581.4	2.27	4720.7	4222.7	1641.3
5.39	3283.3	457.2	5905.4	2622.1	2.25	4721.0	4263.7	1641.6
5.49	3279.8	441.0	5918.2	2638.3	2.24	4719.3	4278.2	1639.9
5.60	3278.8	447.5	5910.6	2631.8	2.25	4718.8	4271.2	1639.4
5.70	3275.0	415.9	5938.5	2663.4	2.23	4716.9	4300.9	1637.5
5.80	3274.8	408.4	5945.8	2671.0	2.23	4716.8	4308.4	1637.4
5.91	3271.3	418.0	5932.7	2661.4	2.23	4715.0	4297.0	1635.6
6.02	3269.0	398.4	5949.9	2680.9	2.22	4713.9	4315.4	1634.5
6.13	3266.0	398.2	5947.1	2681.1	2.22	4712.3	4314.1	1633.0
6.24	3264.7	378.2	5965.9	2701.2	2.21	4711.7	4333.5	1632.4
6.34	3261.3	380.0	5960.6	2699.3	2.21	4710.0	4330.0	1630.6
6.44	3254.1	357.8	5975.7	2721.6	2.20	4706.4	4348.6	1627.0
6.54	3252.2	353.6	5977.9	2725.8	2.19	4705.4	4351.9	1626.1
6.66	3250.3	338.8	5990.9	2740.6	2.19	4704.5	4365.7	1625.2
6.92	3239.8	290.8	6028.4	2788.6	2.16	4699.3	4408.5	1619.9
7.18	3230.5	288.3	6021.5	2791.0	2.16	4694.6	4406.3	1615.3
7.46	3223.0	292.6	6009.8	2786.8	2.16	4690.8	4398.3	1611.5
7.71	3213.9	279.1	6014.2	2800.3	2.15	4686.3	4407.2	1607.0
7.98	3220.3	251.0	6048.6	2828.3	2.14	4689.5	4438.5	1610.1
8.24	3231.9	222.0	6089.2	2857.3	2.13	4695.3	4473.3	1615.9
8.50	3224.4	203.4	6100.4	2876.0	2.12	4691.5	4488.2	1612.2
8.76	3229.1	198.5	6109.9	2880.8	2.12	4693.9	4495.4	1614.5
9.04	3238.8	249.1	6069.0	2830.2	2.14	4698.7	4449.6	1619.4
9.30	3238.3	160.1	6157.6	2919.3	2.11	4698.5	4538.5	1619.2
9.56	3250.3	143.7	6186.0	2935.6	2.11	4704.5	4560.8	1625.2
9.82	3257.4	125.3	6211.5	2954.1	2.10	4708.1	4582.8	1628.7
10.07	3265.7	129.1	6216.0	2950.3	2.11	4712.2	4583.1	1632.9
10.33	3261.5	179.5	6161.4	2899.9	2.12	4710.1	4530.6	1630.8
10.59	3283.7	164.1	6199.0	2915.3	2.13	4721.2	4557.1	1641.9
10.84	3265.7	131.7	6213.4	2947.7	2.11	4712.2	4580.5	1632.8
11.10	3231.7	99.4	6211.6	2979.9	2.08	4695.2	4595.8	1615.8
11.35	3207.4	75.4	6211.3	3004.0	2.07	4683.0	4607.6	1603.7
11.61	3193.8	59.4	6213.7	3019.9	2.06	4676.3	4616.8	1596.9
11.86	3180.7	49.3	6210.8	3030.0	2.05	4669.7	4620.4	1590.4
12.12	3172.2	43.8	6207.8	3035.6	2.04	4665.4	4621.7	1586.1
12.37	3165.4	32.6	6212.1	3046.8	2.04	4662.0	4629.4	1582.7
12.63	3155.6	22.0	6213.0	3057.4	2.03	4657.2	4635.2	1577.8
12.88	3147.3	14.1	6212.6	3065.3	2.03	4653.0	4638.9	1573.7
13.14	3140.1	9.5	6210.0	3069.9	2.02	4649.4	4639.9	1570.0
13.39	3131.7	3.8	6207.3	3075.5	2.02	4645.2	4641.4	1565.9
13.65	3122.6	-4.8	6206.8	3084.1	2.01	4640.7	4645.4	1561.3
13.90	3116.3	-10.1	6205.8	3089.5	2.01	4637.5	4647.6	1558.2
14.16	3107.9	-12.7	6199.9	3092.0	2.01	4633.3	4646.0	1554.0
14.41	3101.5	-16.5	6197.3	3095.8	2.00	4630.1	4646.6	1550.8

Thomas Hill Energy Center – CDT
Clifton Hill, Missouri

CU TRIAXIAL TEST RESULTS
HAB-CDT-04 / T1 / Stage 3

October 2019 104287-001

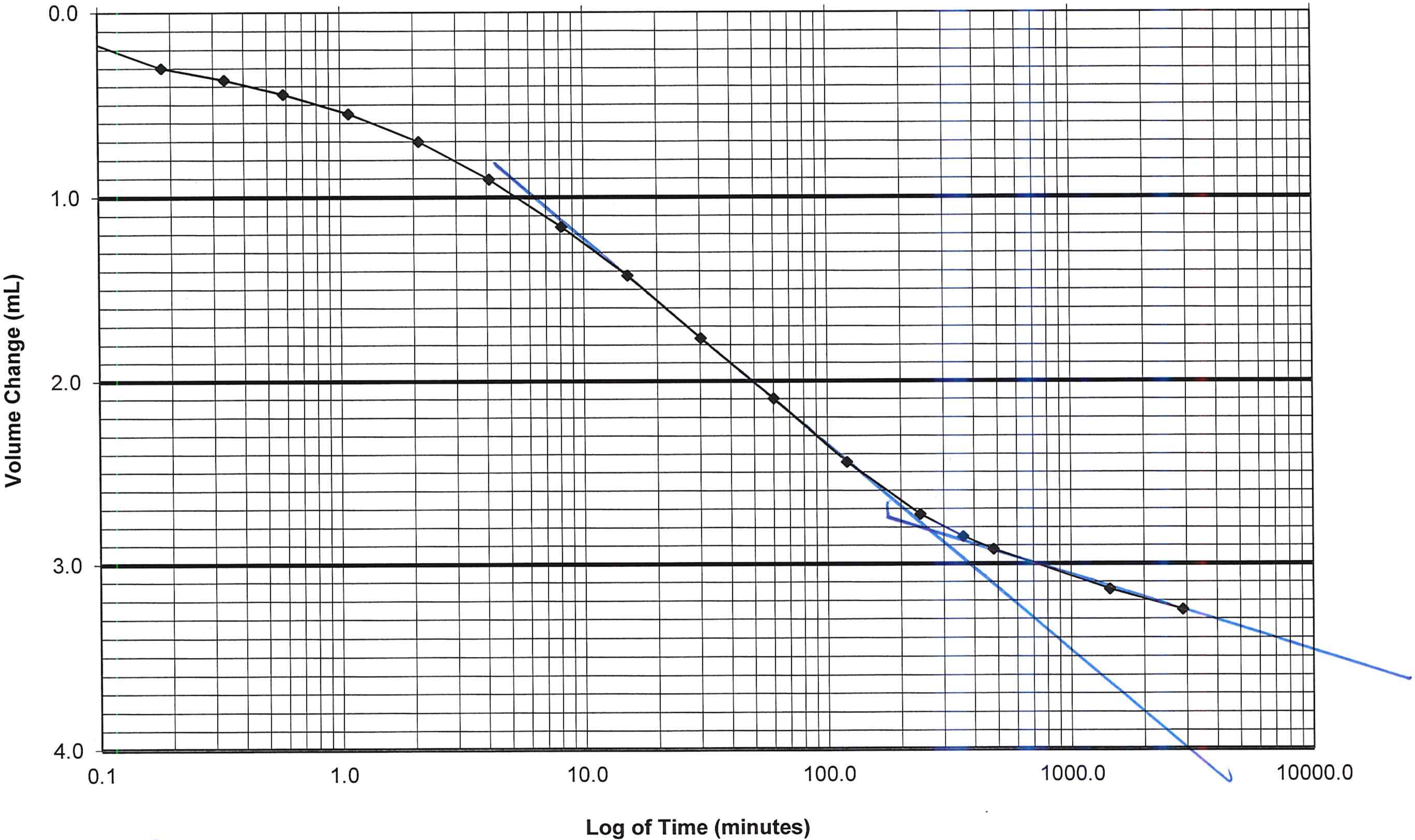
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-04 T1

Stage 1 6.5 psi



U_0 = 0.0
U_{50} = 1.4
U_{100} = 2.8
t_{50} = 14.22

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

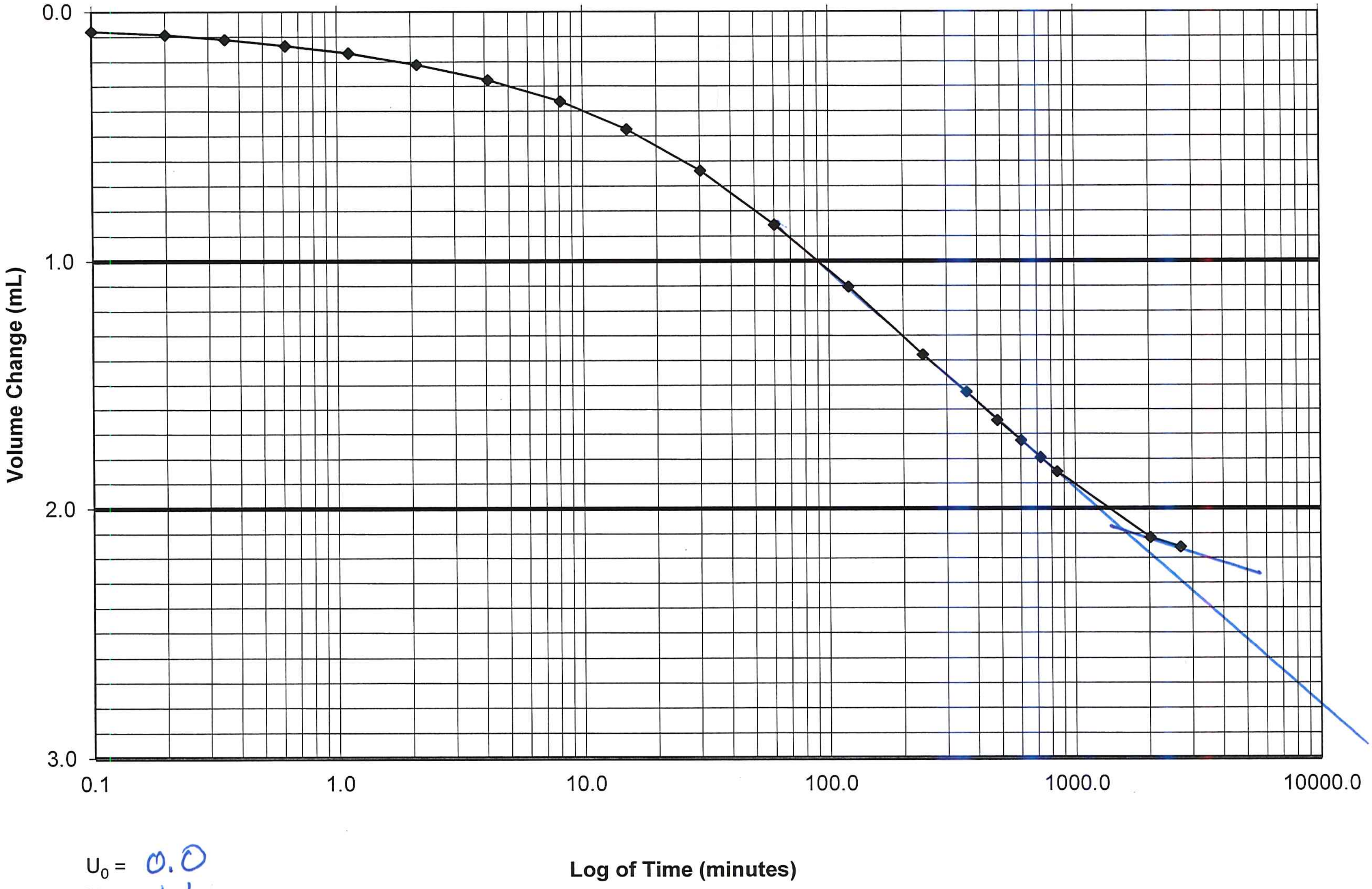
%/hr = 1.688

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-04 T1

Stage 2 10.5 psi



U_0 = 0.0
U_{50} = 1.1
U_{100} = 2.1
t_{50} = 103.34

%/hr=0.232

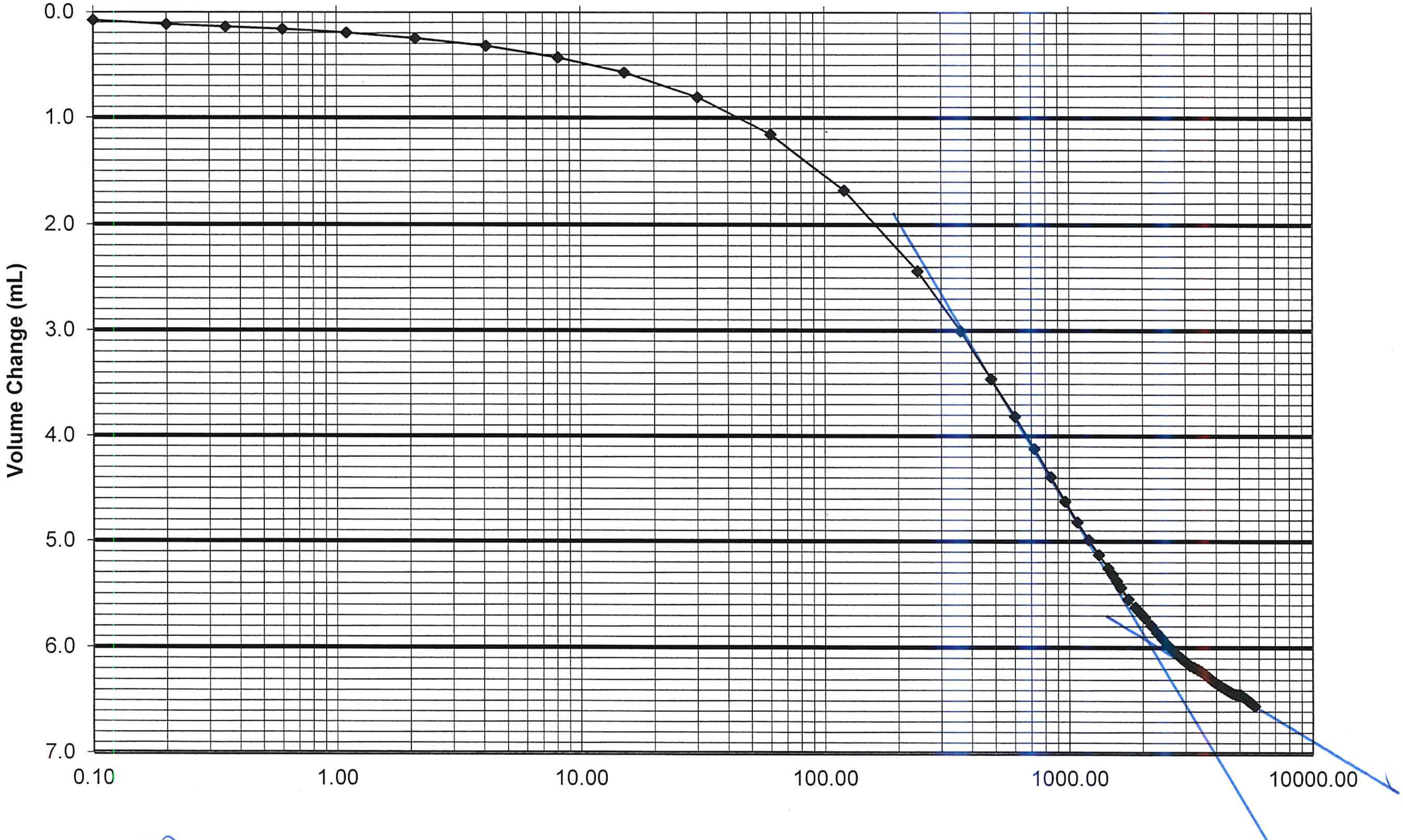
SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Thomas Hill Energy Center – CDT

104287-001

HAB-CDT-04 T1

Stage 3 21.0 psi



U_0 = 0.0
U_{50} = 3.0
U_{100} = 6.0
t_{50} = 359.03

%/hr = 0.067

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PROJECT Thomas Hill Energy Center – CDT DATE 10/10/19 BORING NO. HAB-CDT-01

JOB NO. 104287-001 SHEET NO. 1 TESTED BY CMB

CLIENT NAME Haley & Aldrich, Inc. CHECKED BY CMB

CLASSIFICATION OF UNDISTURBED SAMPLE

SAMPLE NO. T-1 DEPTH (ft) 8-10

Sampling Method Push

Type of Sample Shelby Tube Inch 3"

Brass or [✓ Steel]

DEPTH FT.	NAT. W.C. Strength info.	NAT. W.C. W.C.	TYPE OF TEST	CLASSIFICATION
8.0				19 INCH RECOVERY Sample [✓ Good] Fair Poor Disturbed
8.5	PP = 2.0 tsf	TT-1	MC SAVED	Stiff to very stiff, brown, Sandy Lean Clay (CL); moist; 1% fine, subrounded gravel; 29% fine to coarse, subrounded sand; 70% medium dry strength, no dilatancy, medium plasticity.
9.0			CONSOLIDATION	
9.5			CU Atterberg Hydrometer	
10.0	PP = 3.75 tsf	TT-2	MC	

Can/Tare No.	TT-1	TT-2
WET + TARE	84.51	88.89
DRY + TARE	69.04	75.67
TARE	2.52	2.50
% WATER	23.3	18.1

Procedure: ASTM D 2488

NOTE: Soil description is based on visual-manual procedure. This description is not meant for engineering purposes requiring precise classification of soils.

All sample percentages for cobbles and boulders are by volume.

REMARKS:

PROJECT Thomas Hill Energy Center – CDT
DATE 10/10/19
BORING NO. HAB-CDT-04
JOB NO. 104287-001
SHEET NO. 1
TESTED BY CMB
CLIENT NAME Haley & Aldrich, Inc.
CHECKED BY CMB

CLASSIFICATION OF UNDISTURBED SAMPLE

SAMPLE NO. T-1
DEPTH (ft) 8-10
Sampling Method Push
Type of Sample Shelby Tube
Inch 3"
Brass or [✓ Steel]

DEPTH FT.	NAT. W.C.		TYPE OF TEST	CLASSIFICATION
	Strength info.	W.C.		
8.0				13 INCH RECOVERY Sample: Good [✓ Fair] Poor Disturbed
8.5	PP = 2.0 tsf	TT-3	MC SAVED CONSOLIDATION	Stiff to very stiff, gray and brown, Sandy Lean Clay (CL); moist; 39% fine to coarse, subrounded sand; 61% medium dry strength, no dilatancy, medium plasticity.
9.0			CU Atterberg Sieve	
9.5	PP = 3.0 tsf	TT-4	MC	
10.0				

Can/Tare No.	TT-3	TT-4
WET + TARE	61.92	80.43
DRY + TARE	49.73	68.16
TARE	2.53	2.51
% WATER	25.8	18.7

Procedure: ASTM D 2488

NOTE: Soil description is based on visual-manual procedure. This description is not meant for engineering purposes requiring precise classification of soils.

All sample percentages for cobbles and boulders are by volume.

REMARKS: