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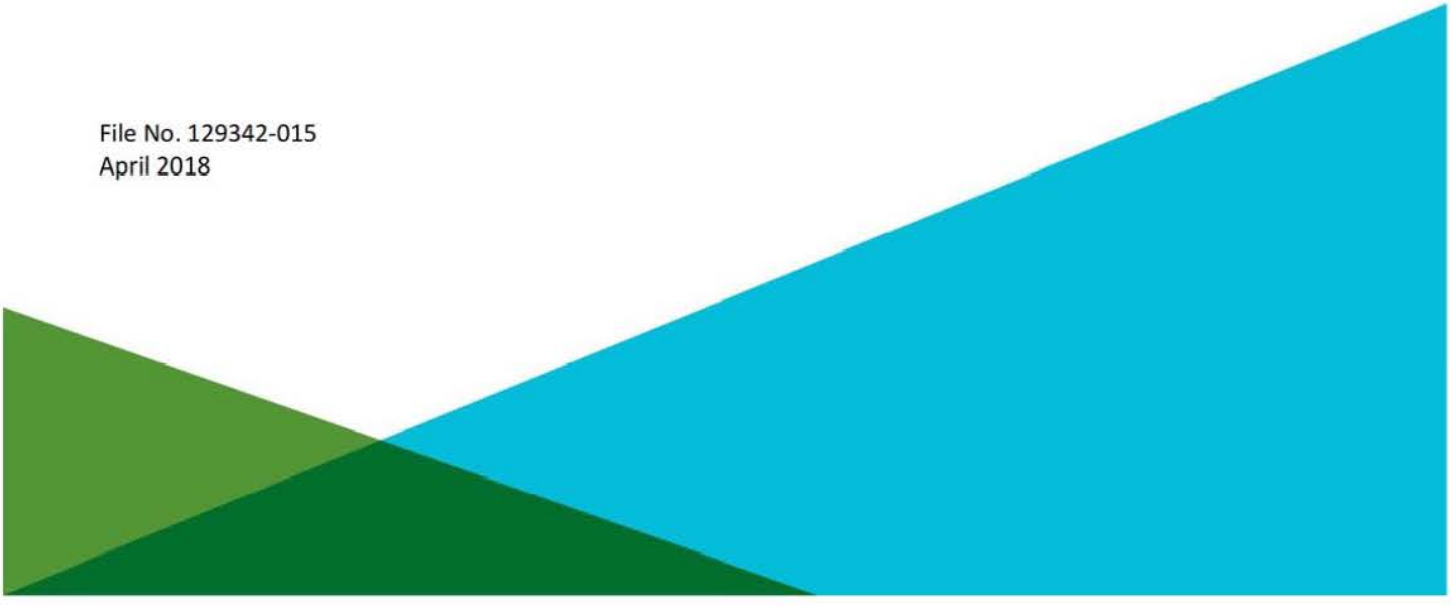
REPORT ON
INITIAL SAFETY FACTOR ASSESSMENT
INACTIVE LINED POND
NEW MADRID POWER PLANT
NEW MADRID, MISSOURI

by Haley & Aldrich, Inc.
Cleveland, Ohio

for Associated Electric Cooperative, Inc.
Springfield, Missouri

File No. 129342-015
April 2018



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Associated Electric Cooperative, Inc.
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Attention: Jenny Burns
Environmental Analyst

Subject: Report on Initial Safety Factor Assessment
Inactive Lined Pond
New Madrid Power Plant
Marston, Missouri

Ms. Burns:

We are pleased to submit herewith our report entitled, "Report on Initial Safety Factor Assessment, Inactive Lined Pond, New Madrid Power Plant, New Madrid, Missouri." This report includes background information regarding the project 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). Based on the USEPA's issued CCR Rule Partial Vacatur in 2016, the inactive Lined Pond impoundment at the NMPP is subject to applicable requirements of the CCR Rule. The safety factor assessment discussed herein has been referred to as an "initial" assessment to coincide with the terminology used in §257.73(e) and §257.73(f) to distinguish it from the "periodic" assessments that are required every five years following the "initial" assessment has been completed.

The scope of our work in our initial safety factor assessment consisted of the following: 1) reviewing readily available reports, investigations, plans and data pertaining to the surface impoundment; 2) performing engineering evaluations related to seismic response analysis, 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.
Project Principal

Enclosures

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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 the Inactive Lined Pond located at New Madrid Power Plant in New Madrid, Missouri shown on **Figure 1**, "Project Locus". 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 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 review the subsurface soil and water conditions at the site and to perform an 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 investigation included the tasks listed below.

- Reviewing readily available reports, investigations, plans and data pertaining to the Lined Pond.
- Performing an advanced site-specific seismic response analysis and Newmark displacement analysis of the impoundment embankment.
- 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 used in this report are in feet and reference the North American Vertical Datum of 1988 (NAVD88) unless otherwise noted. The horizontal control is Missouri State Plane East, which is based on North American Datum 83 (NAD83).

2. Description of Impoundment

2.1 DESCRIPTION OF LINED POND

The Lined Pond is an inactive lined surface impoundment with an approximate footprint of 78 acres located south of Pond 003. The Lined Pond was designed by Burns & McDonnell and was constructed in 1994. Access roads run along the entire perimeter of the pond and the approximate crest elevation is approximately 308 feet MSL. The impoundment is located on the east side of the US Army Corps of Engineers levee system of the Mississippi River. The east embankment of the Lined Pond serves as a separator dike that bisects the Lined Pond and the Raw Water Pond. The Raw Water Pond exists as an overflow for high water level conditions and was intended as a future phase of the Lined Pond. The Lined Pond at the New Madrid Power Plant (NMPP) is currently inactive as defined by the CCR Rule. The interior and exterior slopes of the pond were designed as 3 horizontal to 1 vertical (3H:1V) slopes. The maximum height of the west embankment (levee side) is approximately 9 ft, and the maximum heights of the south and east embankments (non-levee side) are approximately 15 ft and 24 ft respectively. As mentioned above, the north side of the pond is adjacent to Pond 003, which is at the same surface elevation as the access road that separates the two ponds. As a result, an exposed embankment does not exist on the north side of the pond.

AECI managed CCR by placing fly ash in the Lined Pond via a wetting head from 1994 to approximately 2007 when the plant converted to dry fly ash handling. The impoundment relied on evaporation as the main source of discharge from the unit, with no primary spillway existing (emergency flows can be diverted to the Raw Water Pond, Pond 003, or the 003 Outfall discharge channel). The majority of the Lined Pond is full and contains an unused area in the southeastern corner that collects runoff. The Lined Pond subgrade and embankments were constructed of native soils and were overlaid with 60 mil (side slopes) and 80 mil (bottom) geomembranes. Two 18 in. pipes in the southeastern corner of the pond have historically been used to pump water from the Raw Water Pond to the Lined Pond in order to prevent uplift of the liner.

The downstream side of the east embankment experienced surficial slope movement and sloughing in the past and plate piles were used to stabilize the slope 2012. Additionally, localized areas of sloughing/erosion have recently been repaired by infilling with riprap.

3. Subsurface Explorations, Laboratory Testing, and Subsurface Conditions

The geotechnical data used as the basis of this report can be found in the Haley & Aldrich report entitled "Data Report on Subsurface Investigation and Laboratory Testing, Lined Pond, New Madrid Power Plant, Marston, Missouri", dated April 2018 (Data Report). The referenced geotechnical data report contains recent and historic exploration logs (i.e. cone penetrometer soundings, test pits, observation well installation reports, and test borings), subsurface exploration location plans, and laboratory testing results. The Data Report also includes a detailed description of the site geology, soil conditions encountered in the recent and historic subsurface explorations, and groundwater conditions. The reference data report can be found in **Appendix B**.

4. Safety Factor Assessment

As mentioned previously, the purpose of this study was to perform an initial safety factor assessment in accordance with Section §257.73(e)(1) of the CCR Rule. As required by the Rule, the certified 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:

- For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.
- 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.

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 Lined Pond are presented in the following sections of this report.

4.1 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 also used to model the ponded water for the static drained analyses. A summary of the maximum storage pool and surcharge pool water levels used in our analyses at the Lined Pond are provided below.

Location	Maximum Storage Pool Level	Maximum Surcharge Pool Level	Available Freeboard
Lined Pond	El. 293	El. 308	15 ft

As shown above, the maximum storage pool water level within the pond has been modeled at El. 293, which corresponds to a level that is approximately 5 ft below water levels observed during our recent exploration program. It is our understanding that AECI has recently lowered the water level within the pond and it will be maintained at or below El. 293 for the future.

The elevation of the groundwater table within the embankment and at the toe of slope were estimated based on groundwater conditions encountered in nearby subsurface explorations and observation wells. Additionally, there is no current evidence of seepage emanating from the exterior slopes of the ponds,

suggesting that the phreatic surface is contained within and/or below the embankments. Accordingly, the following static water levels outside of the impoundment were conservatively used in our analyses.

Location	Elevation
Lined Pond	West Embankment (Toe) – El. 279
	South Embankment (Toe)– El. 281
	East Embankment (Toe)– El. 281
Raw Water Pond	Pond Interior - El. 296

Given the observed static groundwater levels discussed above, a seepage analysis was performed on the east embankment (cross section C-C') to determine the piezometric head between the Raw Water Pond and the interior slope of the Lind Pond's east embankment. The computer software program, Slide 7.0, 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 model that were used in the stability analysis for the east embankment.

The models suggest that much of the seepage emanating from the Raw Water Pond into the east embankment is moving downward into the more permeable foundation soils and establishing a groundwater table at or near approximately El. 281 beneath the pond rather than moving laterally through the embankment.

At the south and west embankments, the static water level was modeled flowing horizontally at El. 281 and 279, respectively. The phreatic surfaces used in the slope stability models are shown on the slope stability graphical output included in **Appendix A**.

4.2 MATERIAL PROPERTIES

The material properties used in our analyses have been developed using the results of the referenced test borings, CPT soundings, and laboratory testing. When evaluating the CPT results, material strengths were typically determined by averaging the measurements in a particular stratum and choosing conservative strength properties equal to the average value minus one standard deviation. A summary of the material properties is provided below in **Table I**. Additional details are provided in the Data Report contained in **Appendix B**.

TABLE I
MATERIAL PROPERTIES

Material	Material Strength	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degrees)	Vertical Stress Ratio	Minimum Shear Strength (psf)
Fly Ash Fill	Drained	105	0	34	--	--
	Undrained	105	--	0	0.30	500
Geomembrane Liner Interface	Drained	120	0	19	--	--
	Undrained	120				
Embankment Fill (Levee)	Drained	120	300	15	--	--
	Undrained	120	--	0	0.27	550
Embankment Fill (Non-Levee)	Drained	120	300	28	--	--
	Undrained	120	--	0	0.39	1,000
Alluvial Deposits (Cohesive)	Drained	120	0	30	--	--
	Undrained	120	--	0	0.50	1,000
Alluvial Deposits (Granular)	Drained	120	0	34	--	--
	Undrained	120				
Fluvial Deposits	Drained	125	0	38	--	--
	Undrained	125				

Seismic cone penetration testing was used to obtain in-situ measurements of shear wave velocity during the subsurface exploration program. The insitu measurements were performed to a depth of 95 ft below ground surface. Below that depth, shear wave velocity measurements of the underlying soils were approximated using published data specific to the Mississippi Embayment and the New Madrid Seismic Zone (Cramer, Hashash, Romero, Rosenblad, Van Arsdale). The site-specific shear wave velocity profile is shown on **Figure 3**.

4.3 SITE SPECIFIC SEISMIC RESPONSE ANALYSIS

4.3.1 Seismic Response Analysis

As mentioned previously, the New Madrid Power Plant is located within the New Madrid Seismic Zone and the Mississippi embayment. The natural embayment soils underlying the Lined Pond are estimated to be approximately 1,900-ft thick. It has been demonstrated that strong ground motions are significantly de-amplified at both the short and long periods due to the nonlinear behavior of the soils in the Mississippi embayment. It has also been shown that at short periods, increasing soil thickness correlates with a decreasing hazard due the nonlinear soil behavior. Similarly, at long periods, increasing soil thickness correlates with increasing hazard due to soil resonance (Cramer, 2015).

Accordingly, a site-specific target response spectrum was created for the New Madrid Power Plant to develop the 2,500-year earthquake motions for use in this study. This target spectrum was developed based on the maximum critical risk-targeted (MCE_R) spectral response acceleration for a representative earthquake with a magnitude between 7.5 and 8.0. Two different design methods (probabilistic and deterministic) were used to approximate the MCE_R spectrum and the lesser of the spectral response accelerations from each method at each period was used to create the site-specific target spectrum. The seismic hazard analysis results were then used to compute a 2,500-yr return period deterministic target

spectrum. A special type of target spectrum, called the conditional mean spectrum (CMS), was created for the study because it focuses the mean spectral response of all the ground motions to a particular period along the target spectrum. The CMS target spectrum was generated for the short period (T*=0.1s) related to the sliding mass.

Six time-history records were used to match the CMS target spectrum for the site. The time histories represent the site-specific ground motions associated with the controlling earthquake event and consider the magnitude, distance and focal mechanism. Five of these rock motions were obtained from naturally occurring events and one rock motion was synthetically generated to match a magnitude 8 earthquake associated with the ground response for the Mississippi embayment at Memphis, Tennessee.

A one-dimensional ground response analysis was performed to estimate the surface ground motion at the site using the computer software program Shake2000 to numerically simulate the propagation of rock motions applied to the base of the soil column up through the soil layers to the top of the soil column. **Table II** summarizes the surface PGA estimates at the New Madrid Power Plant. Additional details of the seismic response analysis are included in **Appendix A**.

TABLE II
PREDICTED SURFACE PGA AND NEWMARK MAGNITUDE CORRECTION FACTORS

Earthquake	Original Magnitude	CMS Scaled-Matched PGA	Shake Surface PGA	Newmark Magnitude Correction Factor[1]
Nahinni	6.76	1.60 g	0.33 g	1.41
Chalfant	6.19	1.77 g	0.33 g	1.65
L'Aquila	6.30	1.60 g	0.66 g	1.60
Cape Mendocino	7.01	1.40 g	0.41 g	1.32
Christ Church	6.25	2.00 g	0.41 g	1.65
Synthetic (Atkinson and Beresnev)	8.00	0.95 g	0.47 g	1.00

[1] Determined using the method developed by Bray and Traversarou

4.3.2 Newmark Displacement Analysis

The Newmark displacement analysis is based on the shear stress time history acting along the failure plane within the slope. The yield acceleration determined by the analysis is the minimum amount of ground acceleration necessary to initiate motion along the failure surface and is used to determine the appropriate pseudo-static coefficient for seismic stability analyses.

Shake 2000 was used to perform the Newmark displacement analysis by incorporating the results of the one-dimensional ground response analysis and estimating slope displacement for each of the seven time-histories discussed above. The impoundment cross-sections were evaluated, and the maximum depth of the failure plane was determined to range from 19 to 37 ft below the top of slope, so a conservative value of 15 ft was used in our analyses. Correction factors were applied to scale the displacements to the target magnitude 8 event. Details of the analysis are included in **Appendix A** along with graphical presentation of the results.

4.4 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 embankment.

The results of the subsurface explorations performed at the site indicate that the soils used to construct the impoundment embankments primarily consist of lean CLAY, fat CLAY, SILT, sandy SILT, and silty SAND. The lean CLAY and fat CLAY materials are generally not susceptible to liquefaction. The SILT, sandy SILT and silty SAND materials can be susceptible to liquefaction when saturated. However, groundwater was observed to be located approximately 12 to 22.5 ft below the embankments. Consequently, the existing embankment soils are not saturated and as a result, are not susceptible to liquefaction. In accordance with the requirements of §257.73(e)(1), a post-liquefaction stability analysis is not required since the soils used to construct the embankment are not susceptible to liquefaction in their current state.

4.5 STABILITY ANALYSIS

4.5.1 Methodology for Analyses

The computer software program Slide 7.0 was used to evaluate the static and seismic stability of the impoundment embankment. Analyses for static stability were performed to evaluate long-term maximum storage pool condition and maximum surcharge pool condition 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).

Both circular and translational (block) failures were evaluated. Translational failures were only evaluated where subsurface conditions included a relatively weak embankment or foundation layer located above or below a relatively strong foundation layer, such as soft clay overlying dense sand. The results of our evaluation of circular and translational failures indicated that circular failure surfaces represent the critical slope failure case. Accordingly, the results presented herein are limited to the critical case analyses performed for circular failure surfaces.

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 conservatively incorporated in the pseudo-static analyses to represent the approximate threshold between large and small strains induced by cyclic loading (Duncan, 2014). In pseudo-static analyses, a safety factor greater than or equal to one ($FS \geq 1.0$) generally indicates a slope is stable and a safety factor below one ($FS < 1.0$) generally indicates that a slope is unstable.

4.5.2 Pseudo-static Coefficient

The pseudo-static coefficient, k_s, used in our seismic analyses was selected using the results of the Newmark displacement analysis discussed previously. According to the MSHA Impoundment Design Manual, the acceptable displacement of coal refuse impoundments is 25% of the upstream freeboard (MSHA, 2009)[1]. At the Lined Pond, that equates to 45 in. based on 15 ft of freeboard.

For a 45-in. acceptable displacement, the Newmark displacement curves in **Appendix A** show that the minimum allowable yield acceleration corresponding to the average displacement is approximately 0.195g. A pseudostatic coefficient lower than 0.195g will result in more than 45 in. deformation and one higher than 0.195g will result in less than 45 in. deformation. For the seismic stability analyses performed for the impoundments, a pseudostatic coefficient of 0.20g was selected. This value was selected because it is slightly above the minimum value, which is conservative, and will result in displacements that are below MSHA acceptable values.

4.5.3 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 the impoundment:

a. the geometry of the upstream and downstream 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 three cross sections at the Lined Pond that could potentially be considered the critical cross section. The location of each cross section is shown on **Figure 2**. The results of our analyses are presented below in **Table III** and are shown on the Slide output files included in **Appendix A**.

As shown below, the static safety factors are above the minimum required values for the three cross-sections that were evaluated. Similarly, the pseudo-static analyses for the analyzed section indicates an acceptable seismic safety factor.

[1] This document is mentioned in the preamble of the Rule and is one of the reference documents that was used by the EPA to evaluate how to perform static and seismic stability analyses.

TABLE III
SUMMARY OF STABILITY EVALUATIONS

Cross- Section	Condition[1]	Earthquake Event	Soil Strength	Pool Level	Required Safety Factor	Safety Factor: Rotational Failure Surface
A-A' (Lined Pond - West Embankment)	Static	-	Drained	Maximum Storage	1.5	3.94
			Drained	Maximum Surcharge	1.4	3.95
	Seismic	2,500-year	Undrained[2]	Maximum Storage	1.0	1.60
B-B' (Lined Pond - South Embankment)	Static	-	Drained	Maximum Storage	1.5	3.28
			Drained	Maximum Surcharge	1.4	3.28
	Seismic	2,500-year	Undrained[2]	Maximum Storage	1.0	1.29
C-C' (Lined Pond – East Embankment)	Static	-	Drained	Maximum Storage	1.5	2.43
			Drained	Maximum Surcharge	1.4	2.43
	Seismic	2,500-year	Undrained[2]	Maximum Storage	1.0	1.28

1. Refer to **Table I** for material properties.
2. Soil strengths have been reduced by 20 percent for seismic analyses to account for the threshold between large and small strains induced by cyclic loading.

4.6 CONCLUSIONS

The analyses associated with the safety factor assessment have been performed in accordance with the requirement of Section §257.73 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 III**, the static safety factors for the long-term 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 III**, the static safety factors for the maximum surcharge pool loading condition 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 III**, 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 historic subsurface investigations indicate that the material used to construct the impoundment embankment are not susceptible to liquefaction because they are not saturated. Accordingly, this requirement has been met.

5. 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 sections of the impoundment embankment meet the minimum factors of safety specified in §257.73(e)(1)(i) through (iv) of the EPA's Final CCR Rule.

Certification Statement

I certify that the Initial Safety Factor Assessment for the Lined Pond at the New Madrid Power Plant meets the requirements of §257.73(e) of the EPA's Final CCR Rule.

Signed: _____

Consulting Engineer

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

Professional Engineer's Seal:

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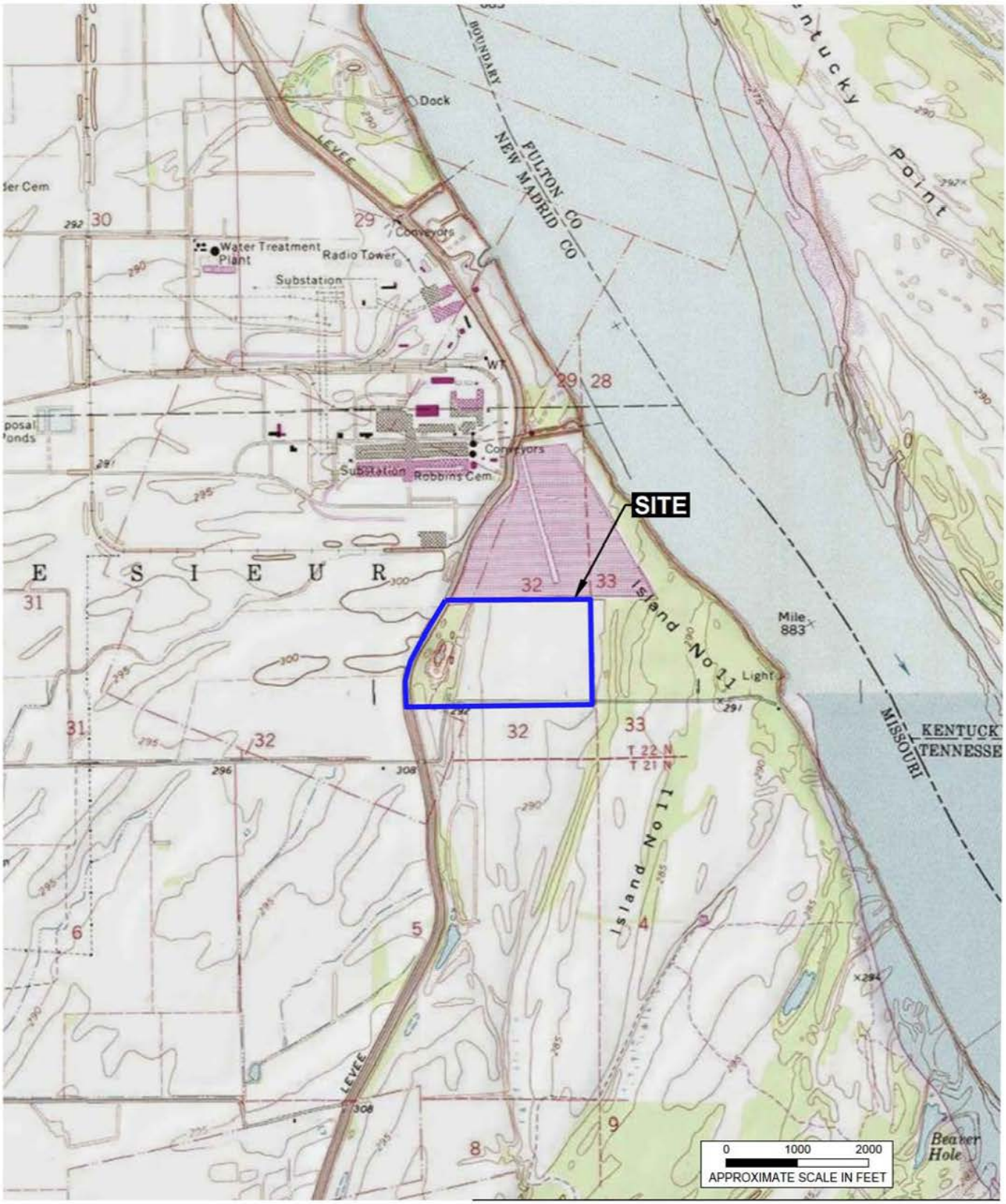
FIGURES



MAP SOURCE: ESRI

SITE COORDINATES: 36°30'14"N, 89°33'36"W

HALEY ALDRICH

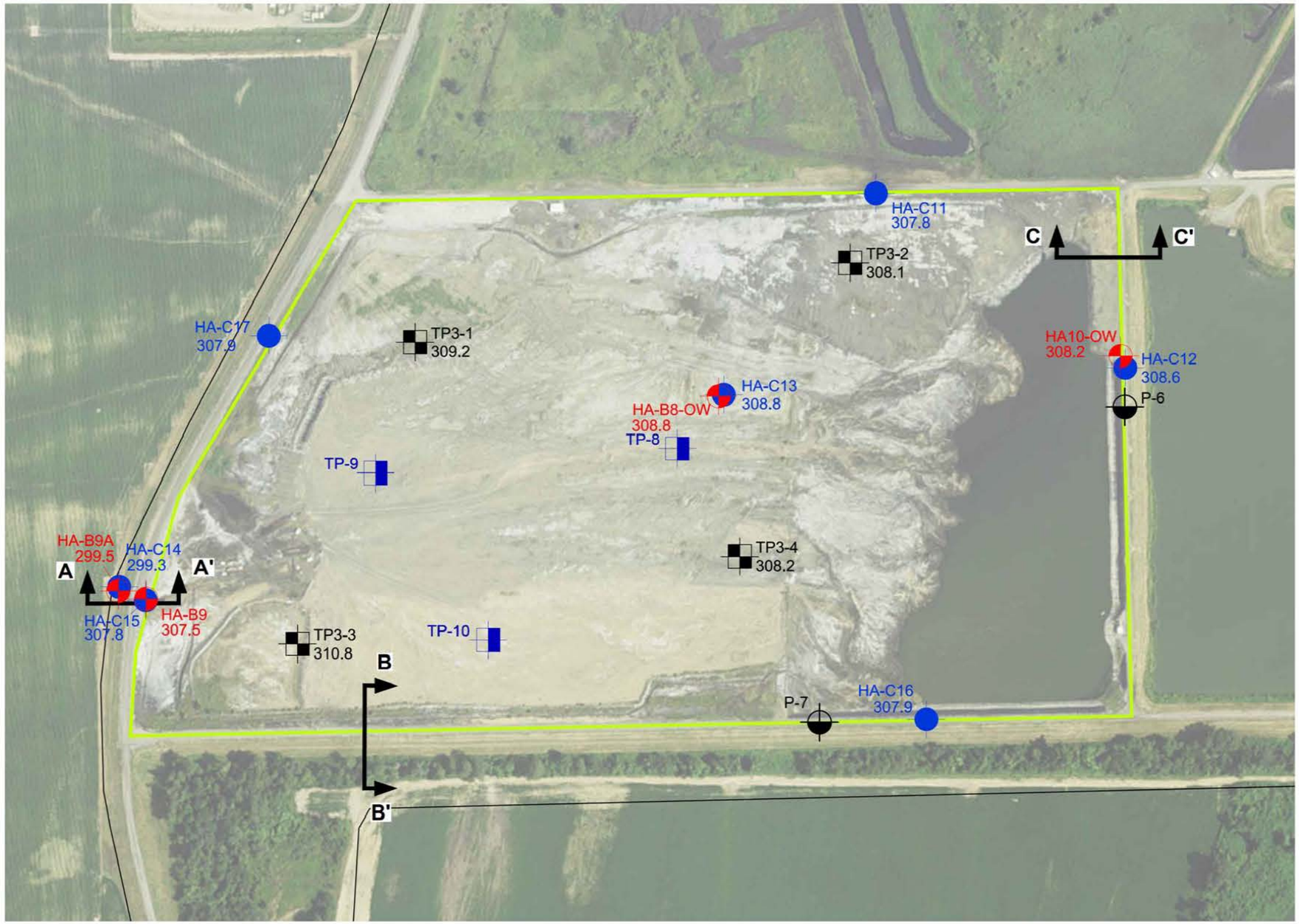
LINED POND
AECI, NEW MADRID POWER PLANT
MARSTON, MISSOURI

SITE LOCUS

SCALE: AS SHOWN
APRIL 2018

FIGURE 1

POSTOLOWSKI, KEVIN Printed: 4/9/2018 9:52 AM Layout: FIG 1 (2018-ARPIL)
Z:\CLE_COMMON\PROJECTS\129342 AECI-NMPP\CAD\LINED POND\FIGURES\129342 005 FIG-1 LOCUS.DWG



LEGEND

- APPROXIMATE LIMIT OF CCR UNIT
- HA-B10-OW 308.2 — DESIGNATION, LOCATION AND GROUND SURFACE ELEVATION OF TEST BORINGS PERFORMED BY BULLDOG DRILLING OF DUPO, ILLINOIS DURING THE PERIOD 12 JUNE 2017 TO 14 JUNE 2017. BORINGS WITH AN "OW" DESIGNATION INDICATES THE BORING WAS CONVERTED TO AN OBSERVATION WELL
- HA-C12 308.6 — DESIGNATION, LOCATION AND GROUND SURFACE ELEVATION OF CONE PENETROMETER SOUNDINGS PERFORMED BY CONETEC, INC. OF WEST BERLIN, NEW JERSEY DURING THE PERIOD 12 JUNE 2017 TO 13 JUNE 2017.
- P-7 — APPROXIMATE LOCATION OF EXISTING BORING PERFORMED BY GEOTECHNOLOGY IN 2009.
- TP3-1 309.2 — DESIGNATION, LOCATION AND GROUND SURFACE ELEVATION OF TEST PITS PERFORMED BY DUMEY CONTRACTING OF BENTON, MISSOURI ON 21 JUNE 2017.
- TP-8 — DESIGNATION AND APPROXIMATE LOCATION OF EXISTING TEST PITS PERFORMED BY GEOTECHNOLOGY IN 2009.
- A A' — CROSS-SECTION LOCATION

NOTES:

1. BACKGROUND IMAGE IS DATED 2 AUGUST 2014 FROM ESRI GIS.
2. ELEVATIONS INDICATED ON THIS DRAWING ARE IN FEET AND REFER TO NAVD88 DATUM. HORIZONTAL DATUM IS MISSOURI STATE PLANE NAD83, EAST ZONE US FOOT.
3. TECHNICAL MONITORING OF TEST BORINGS, CONE PENETROMETER SOUNDINGS, AND TEST PITS COMPLETED DURING THE PERIOD 12 JUNE 2017 TO 21 JUNE 2017 WAS PERFORMED BY HALEY & ALDRICH, INC.
4. AS DRILLED LOCATIONS AND GROUND SURFACE ELEVATIONS OF 2017 TEST BORINGS, CONE PENETROMETER SOUNDINGS, AND TEST PITS WERE DETERMINED IN THE FIELD BY AECI BY ROVER GPS UNIT.

N

0 300 601
SCALE IN FEET

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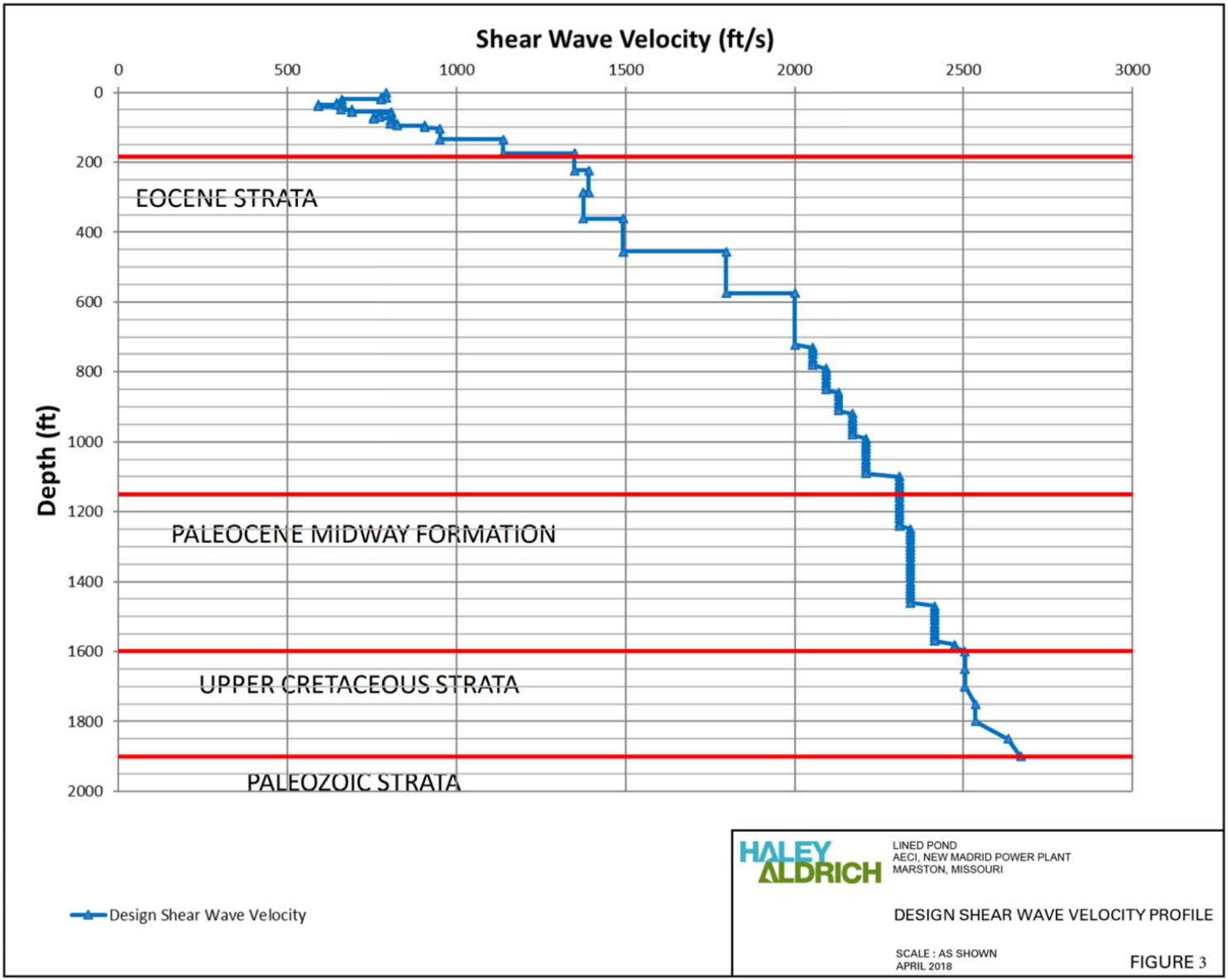
MARSTON, MISSOURI

SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
APRIL 2018

FIGURE 2



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LINED POND
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MARSTON, MISSOURI

DESIGN SHEAR WAVE VELOCITY PROFILE

SCALE : AS SHOWN
APRIL 2018

FIGURE 3

129342-015_FIG 4.PPT

APPENDIX A

Analyses

Seismic Response Analysis

SITE SPECIFIC SEISMIC RESPONSE ANALYSIS

Introduction

The New Madrid Power Plant is located within the New Madrid Seismic Zone (NMSZ) and the Mississippi embayment. The NMSZ is associated with strong ground motions and the Mississippi embayment is associated with thick soil. The natural embayment soils underlying the Lined Pond is estimated to be approximately 1,900-ft thick. It has been demonstrated that the strong ground motions migrating up through the thick soil alter the spectral response at the ground surface so that it is much different than the response in the bedrock below the site. At short periods increasing soil thickness correlates with a decreasing hazard due to the nonlinear soil behavior. Similarly, at long periods, increasing soil thickness correlates with increasing hazard due to soil resonance (Cramer, 2015).

Overview of Site-Specific Seismic Analysis

A one-dimensional ground response analysis was performed to estimate the subsurface response to an earthquake event at New Madrid. Due to the complex nature of the analyses required, Dr. Professor Edward Kavazanjian, Jr. at Arizona State University and Dr. Professor Chris Cramer at the University of Memphis were retained as part of our team to assist with the site-specific seismic analyses.

It is important that the rock and soil characteristics used to develop the ground response model match the engineering and seismic characteristics of the soil and rock at the New Madrid Power Plant. Properly conditioned bedrock strong ground motions (acceleration time histories) are required to perform a site-specific seismic analysis. These rock motions should match the spectral response of characteristic ground motions with respect to the dominant seismic sources affecting New Madrid. Unfortunately, strong motion records from large magnitude events are not available for Central U.S. (Romero and Rix, 2001). Therefore, records were obtained from other sources that approximate the spectral response characteristics at the site.

A site-specific target response spectrum was created for the site to be used as a guide in selecting the proper ground motions for the study. This target spectrum was developed following well established criteria developed for building and infrastructure standards. The common design is based on the maximum critical risk-targeted (MCE_R) spectral response acceleration. Two different design methods (probabilistic and deterministic) are used to approximate the MCE_R spectrum and the lesser of the spectral response accelerations from each method at each period is used to create the site-specific target spectrum. The probabilistic target spectrum is created from the uniform hazard spectrum (UHS) by performing a probabilistic seismic hazard analysis (PSHA). [1] It is then adjusted for maximum ground motion and targeted risk. The deterministic target spectrum is calculated from 84th-percentile ground motions representing a characteristic earthquake on a known or perceived active fault within the region.

[1] The uniform hazard spectrum is calculated by research on potential sources of earthquakes (e.g., faults and locations of past earthquakes), the potential magnitudes of earthquakes from these sources and their frequencies of occurrence, and the potential ground motions generated by these earthquakes. Uncertainty and randomness in each of these components is accounted for in the computation.

The bedrock at the site is classified as NEHRP Site Class A, hard rock. The 2008 UHS, provided by USGS, for a hypothetical Site Class A rock, based on the 2,500 –year return period ground motions, was used to identify the Probabilistic Target Spectrum used for the site-specific evaluation. Ground motions scaled to this spectrum were input in Shake at the base of the soil column as outcrop motions. Shake performs the necessary deconvolution techniques on the motions to adjust to within motions used for the one-dimensional analysis.

USGS Deaggregation and Deterministic Target Spectrum

Unlike the west coast, central and eastern U.S. does not have a well-defined fault system and associated seismic sources needed to properly develop a Deterministic spectral response. Therefore, it is common practice to use pseudo fault locations to develop the deterministic target. Deaggregation data obtained from a probabilistic seismic hazard analysis (PSHA) is used to provide the relevant information needed to develop the deterministic target. The NSHMP PSHA interactive deaggregation web site was used to obtain the characteristics of the most significant earthquakes deemed to contribute the most to the seismic activity at the New Madrid Power Plant. It should be noted that at the time our analyses were performed, USGS had not formerly released the deaggregation data for the 2014 hazard maps. As such, the slightly more conservative 2008 deaggregation data was used to determine the most significant earthquakes that are considered for the seismic hazard for New Madrid. The deaggregation data suggests that the representative design earthquake for ground motions with a return period of 2,500 years should be between magnitude 7.5 and 8.0 at a distance of approximately 11 km from the site (**Figure A-1**). The deterministic spectrum for scenario events (i.e. for events that conformed to the CMS to be discussed later) was based upon the location and magnitude information obtained from the PSHA.

The deterministic target spectrum is based on ground motion prediction equations (GMPEs) that use magnitude and distance to predict the spectral response of the ground motion. According to the USGS PSHA, the largest event predicted to affect New Madrid Power Plant is a magnitude 8 earthquake that is 10.5 km from the site. The computer software program Shake 2000, developed by GeoMotions, provided the central and eastern U.S. (CEUS) GMPEs and the CMS algorithms used to create the target spectrum. Site-specific spectral responses were generated from five appropriate CEUS attenuation relationships using Shake 2000 as shown on **Figure A-2**. These attenuation relationships were based on a magnitude 8 earthquake as a distance of 10.5 km from the source. The GMPE representing the Campbell 2003 attenuation relationship was selected to produce the deterministic target spectrum for the site because it had the largest spectral response among all GMPEs tested.

A special type of target spectrum, called the conditional mean spectrum (CMS), was created for the study because it focuses the mean spectral response of all the ground motions to a particular period along the target spectrum (Baker, 2011). According to a joint venture between NIST and NEHRP (NEHRP, 2011):

> *"The Uniform Hazard Spectrum (UHS) is constructed by enveloping the spectral amplitudes at all periods that are exceeded with a given probability, computed using probabilistic seismic hazard analysis. However, those spectral values at each period are unlikely to all occur in a single ground motion. These conditional spectra instead condition the spectrum calculation on spectral acceleration at a single period, and then compute associated spectral acceleration*

values at all other periods. This conditional calculation assures that ground motions selected to match that spectrum have appropriate properties for naturally occurring ground motions that would occur at the site of interest."

The particular target period selected is related to fundamental period of the structure being analyzed. The fundamental period for the Lined Pond impoundment at New Madrid Power Plant is related to the anticipated height of the sliding mass if failure were to occur. Based on the characteristics of general failure planes determined from slope stability analyses for the impoundment, a target period of 0.1s was chosen for the CMS target spectrum.

Conditional Mean Spectrum Groundmotions Scaled to Target Period T=0.1 s

The CMS spectrum according to Baker, 2011 is to be constructed with the ground motion scaled so that its mean spectral response at the target period, T* matches the spectral response at the CMS Target Spectrum. The target period, T* 0.1s was chosen to approximate the fundamental frequency of the sliding mass which is determined form the location of the failure plane within the slope at a condition of equilibrium (i.e., safety factor equal to 1.0). The shear wave velocity, V_s of the sliding mass was estimated to range between 450 ft/sec and 1,000 ft/sec for the Lined Pond. Our analyses assumed the height of the sliding mass varied from 19 ft to 37 ft.

Shake 2000 software by Geomotion, Inc. was used to provide the CMS spectrum for Campbell 2003 CEUS GMPE using a target period T* = 0.1s and amplifying the CMS to correspond to a mean plus one standard deviation spectrum. The mean plus one standard deviation spectrum shown on **Figure A-3** was used as the deterministic CMS target spectrum for the New Madrid Power Plant.

Rock Motions for the CMS

Six time-history records were selected to match the target response spectrum for the site. Five of these rock motions were obtained from naturally occurring events and one rock motion was synthetically generated to match a magnitude 8 earthquake associated with the ground response for the Mississippi Embayment at Memphis, TN (Atkinson 2002). A primary focus was to match the ground motion spectra to the CMS target spectrum, as suggested by NEHRP (2011) when considering magnitude, distance, and focal mechanism. Rock motion records were selected from the Pacific Earthquake Engineering Research (PEER) Center's Strong Motion Database. The motions are summarized below in **Table I** and depicted graphically on **Figure A-4**. As shown on **Figure A-5**, the arithmetic mean spectrum of the generated records closely matches the CMS bedrock spectrum over the period range of significance.

TABLE I
EARTHQUAKE RECORDS

Event	Return Period	PEER File Name	Earthquake Record Used			
			Earthquake	M	Mechanism	Distance (km)
Conditional Mean Response	2,500-year	RSN497-Nahanni_S3270.AT2	Nahinni	6.76	Reverse	5.32
		RSN550_Chalfant.A_A-CPL070.AT2	Chalfant	6.19	Strike-slip	18.31
		RSN4481_L-Aquila_FA030XTE.AT2	L'Aquila	6.3	Normal	6.81
		RSN825_ CAPEMEND_CPM000.AT2	Cape Mendocino	7.1	Reverse	6.96
		RSN8158_CChurch_LPCCN10W.AT2	Christ Church	6.2	Reverse Oblique	6.12
		N/A	Synthetic (Atkinson and Beresnev)	8.0	N/A	N/A

Due to the unusually large magnitude and close proximity of the earthquake projected for the site, there are not many recorded ground motions that effectively scale to the shorter period portion of the CMS target spectrum. According to the Federal Highway Administration, due to the low number of available ground motions for central and eastern U.S., it is acceptable to spectrally match the ground motions to the lower period portions of the target spectrum (FHWA, 2011). For this reason, the ground motions were spectrally matched to the CMS target spectrum between T=0.02 sec to 0.06 sec as shown on **Figure A-6.**

One-Dimensional Ground Response Analysis

As mentioned previously, a one-dimensional ground response analysis was performed to estimate the surface ground motion at the site. The soil column used as input into the model was constructed from the shear wave velocity profile at the site (from in-situ testing) along with other characteristics such as layer thickness, soil density and the dynamic behavior. The dynamic geotechnical properties (damping, modulus-damping curves, density, etc.) used in the ground response analysis were obtained from prior models developed by Dr. Chris Cramer and are representative of the non-linear, pressure dependent soil properties attributed to the Mississippi Embayment (Romero and Rix, 2005).

The computer software program Shake 2000 was used to numerically simulate the propagation of rock motions applied to the base of the soil column up through the soil layers to the top of the soil column. Shake2000 uses an equivalent linear numerical technique to model the non-linear dynamic soil behavior in the soil column. **Figure A-7** shows the results of the Shake ground response analysis for the six representative rock motions. This figure compares the spectral response of the scaled bedrock motions to the surface ground response and shows the transformation in response caused by wave propagation through the 1,900-ft thick soil column. **Table II** summarizes the surface PGA estimates at the New Madrid Power Plant.

TABLE II
PREDICTED SURFACE PGA AND NEWMARK MAGNITUDE CORRECTION FACTOR

Earthquake	Original Magnitude	CMS Scaled-Matched PGA[1]	Shake Surface PGA	Newmark Magnitude Correction Factor[2]
Nahinni	6.76	1.60 g	0.33 g	1.41
Chalfant	6.19	1.77 g	0.33 g	1.65
L'Aquila	6.30	1.60 g	0.66 g	1.60
Cape Mendocino	7.01	1.40 g	0.41 g	1.32
Christ Church	6.25	2.00 g	0.41 g	1.65
Synthetic (Atkinson and Beresnev)	8.00	0.95 g	0.47 g	1.00

[1] CMS scaled to period range of significance at T*=1.0s
[2] Determined using the method developed by Bray and Traversarou

Newmark Displacement Analysis

The Newmark method predicts the amount of block displacement for a given value of yield acceleration. The Newmark displacement analysis is based on the shear stress time history acting along the failure plane within the slope. The yield acceleration is the minimum amount of ground acceleration necessary to initiate motion along the failure surface and is used to determine the appropriate pseudo-static coefficient for seismic stability analyses.

Shake 2000 was used to perform the Newmark displacement analysis by incorporating the results of the one-dimensional ground response analysis to estimate slope displacement. Shake 2000 incorporates several different variants of the Newmark block displacement method and the numerical approach known as YSLIP developed by Kavazanjian and Matasovic (1996) was chosen for our analysis. All six site-specific bedrock motions were used to evaluate relationships between the Newmark permanent displacements and the associated yield acceleration. Several impoundment cross-sections were evaluated, and the most conservative location of the failure plane was determined to be 15 ft below the top of slope.

After performing the Newmark displacement analysis, it was necessary to adjust the displacement predictions to correspond to the difference between the magnitudes of the ground motions used in the analysis and the magnitude of the representative earthquake event established for the New Madrid Power Plant. Correction factors were applied to scale the displacements to the target magnitude 8 event. The correction factors were determined using the approach developed by Bray and Travasarou (2007), which relates permanent displacement from a Newmark analysis with the magnitude of the earthquake event (Bray, 2007). **Figure A-8** presents the magnitude scaled permanent displacement versus yield acceleration.

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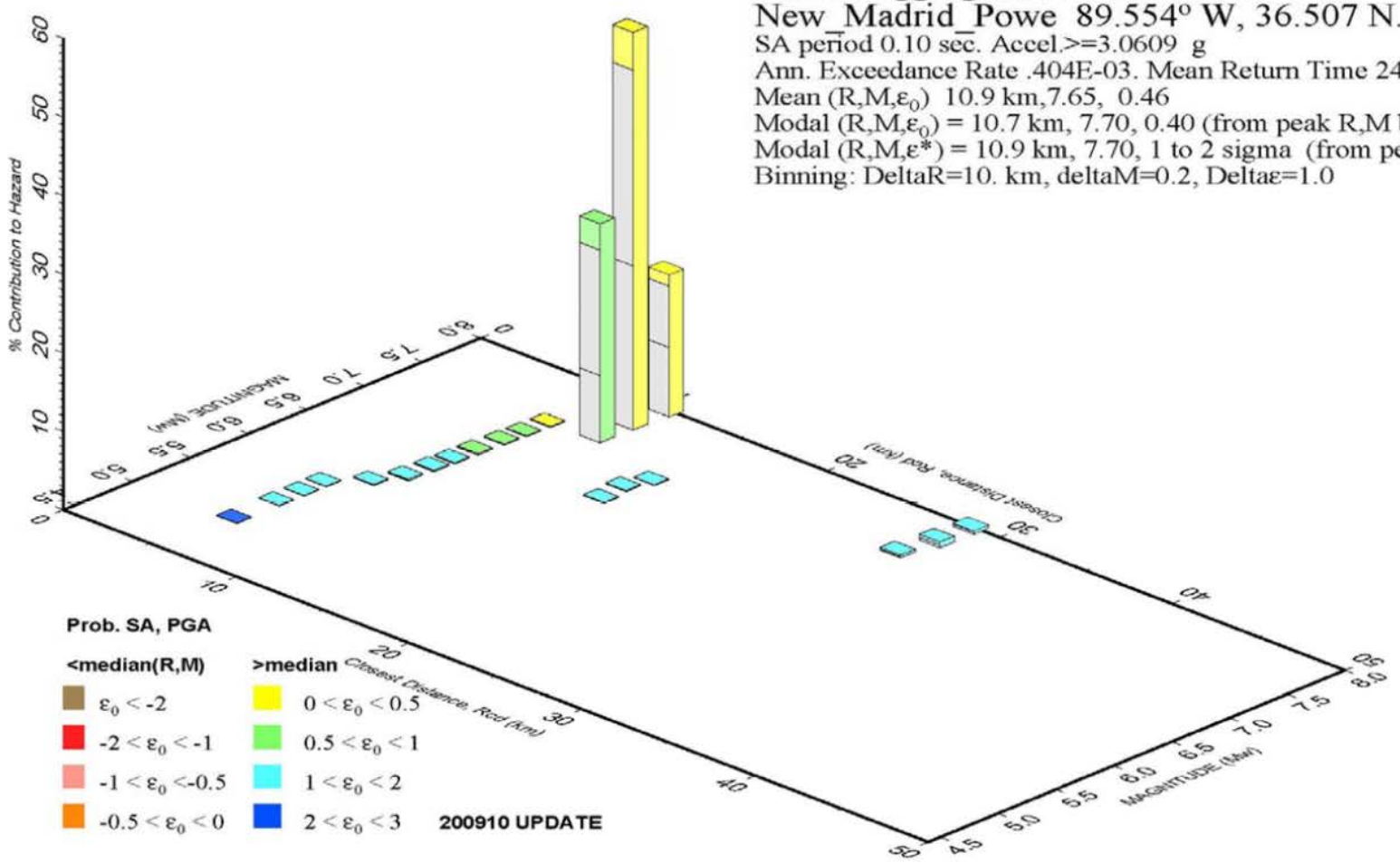
FIGURES



GMT 2015 Nov 17 16:59:44 Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on rock with average vs=2000. m/s top 30 m. USGS CGHTPSHA2008 UPDATE Bins with lt 0.05% contrib. omitted

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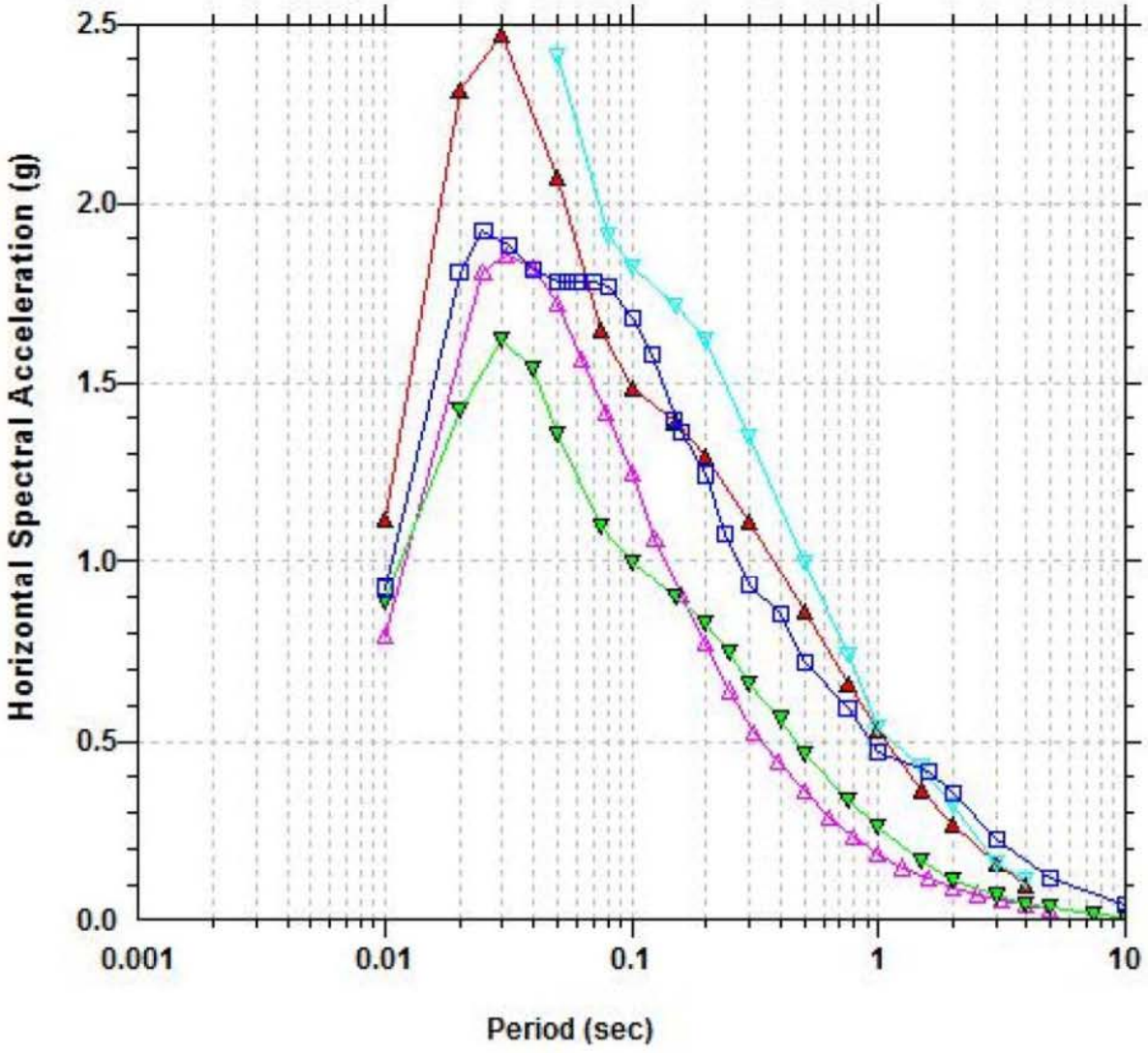
NEW MADRID POWER PLANT
LINED POND
MARSTON, MISSOURI

2008 DEGRADATION PLOT AT PERIOD T=0.1s

SCALE : AS SHOWN
APRIL 2018

FIGURE A-1

129342-015_FIG_A-1.PPT



NOTES
1. Reference: SHAKE 2000

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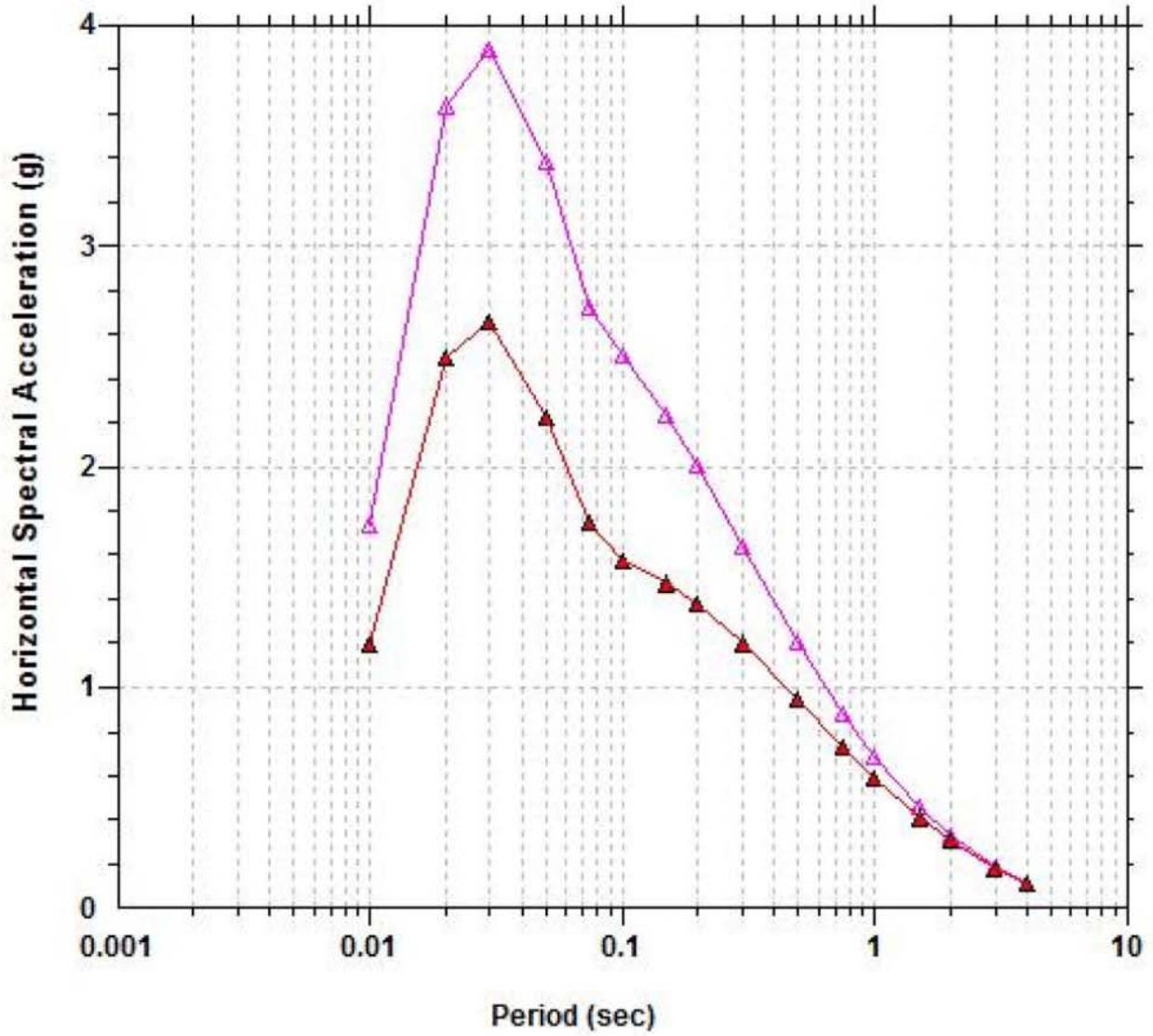
LINED POND
MARSTON, MISSOURI

CENTRAL AND EASTERN U.S. GROUND MOTION ATTENUATION MODELS

SCALE : AS SHOWN
APRIL 2018

FIGURE A-2

129342-015_FIG A-3.PPT



NOTES
1. Reference: SHAKE 2000

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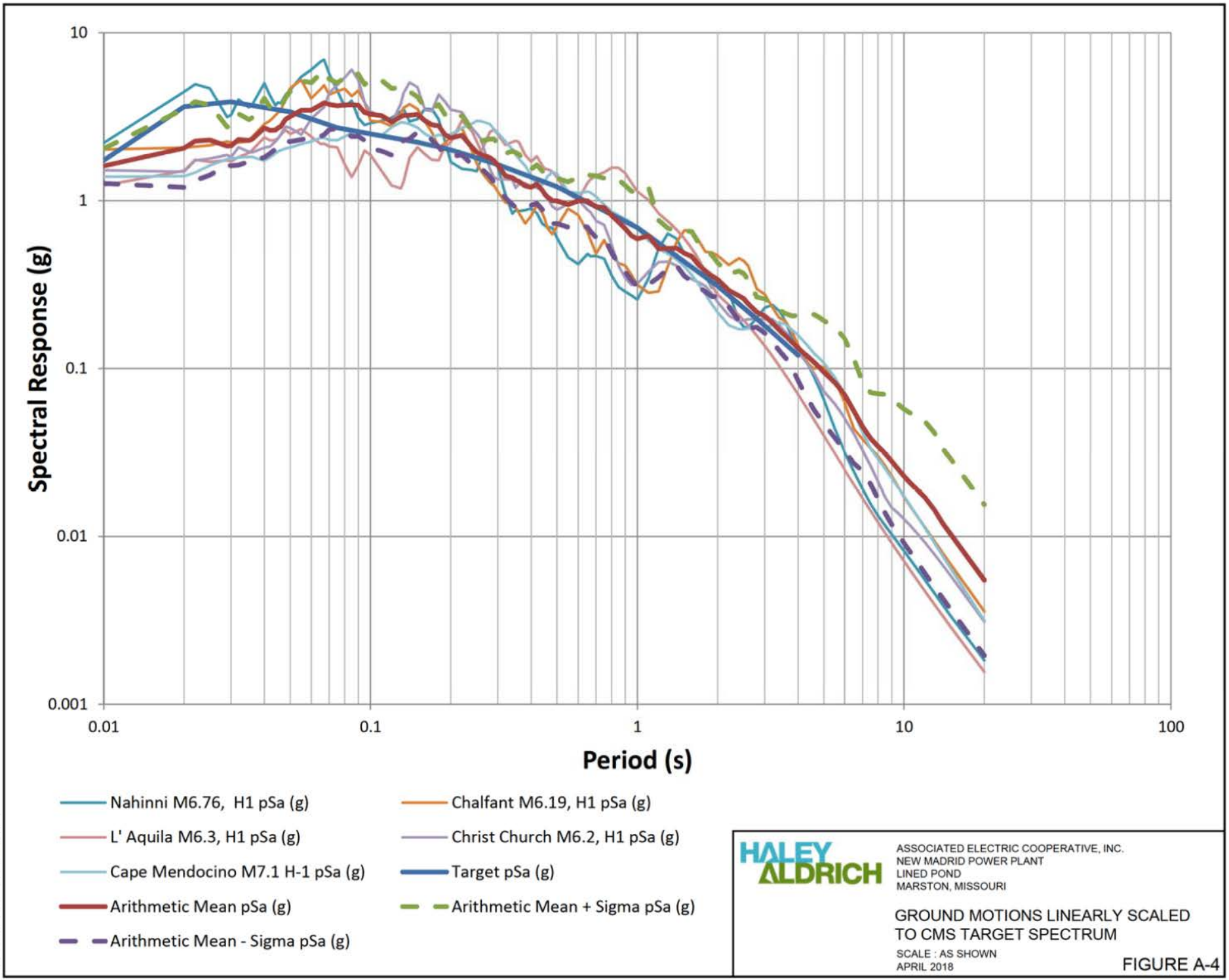
LINED POND
MARSTON, MISSOURI

DETERMINISTIC CONDITIONAL MEAN SPECTRUM (CMS)

SCALE : AS SHOWN
APRIL 2018

FIGURE A-3

129342-015_FIG A-4.PPT



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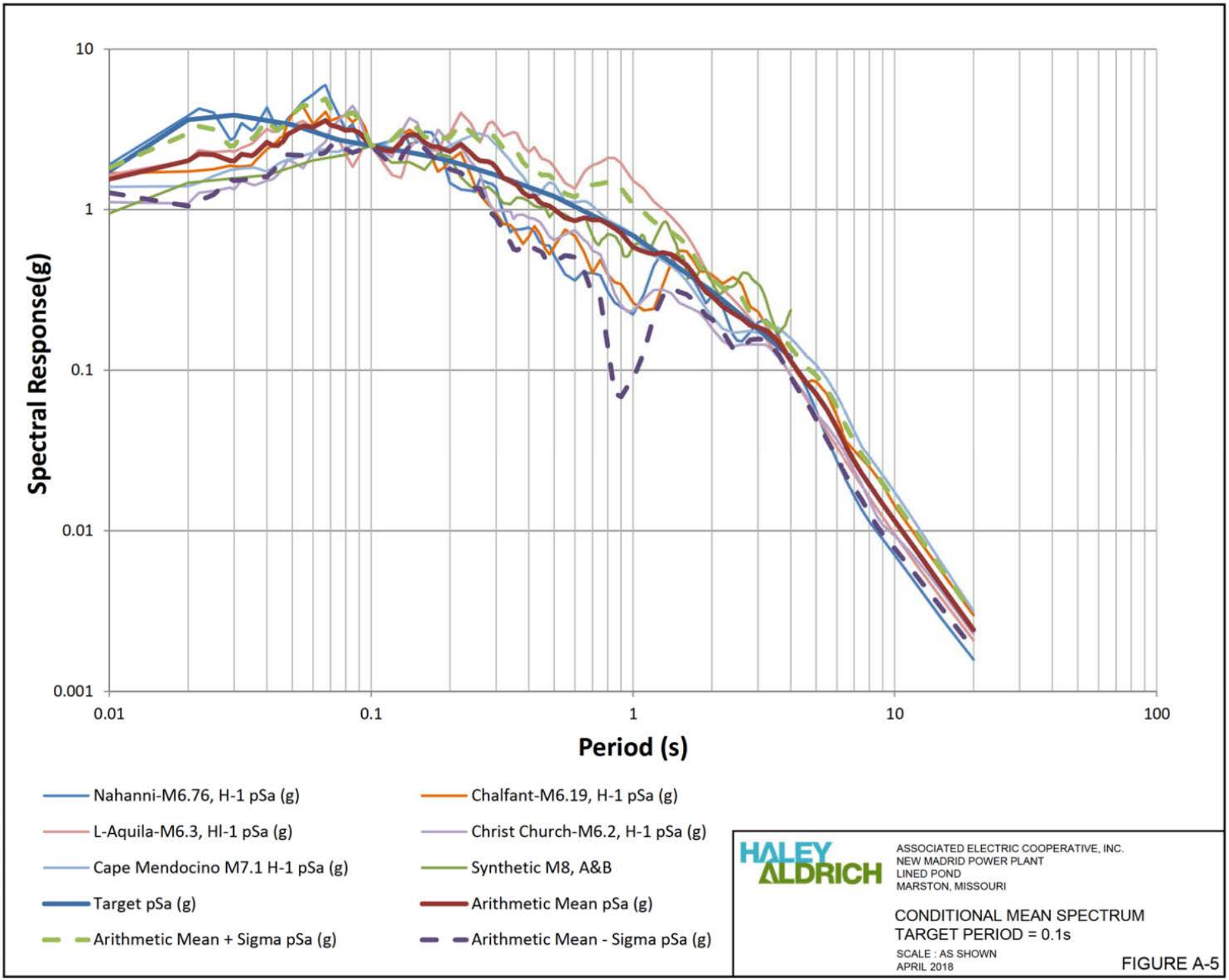
NEW MADRID POWER PLANT
LINED POND
MARSTON, MISSOURI

GROUND MOTIONS LINEARLY SCALED TO CMS TARGET SPECTRUM

SCALE : AS SHOWN
APRIL 2018

FIGURE A-4

129342-015_FIG A-5.PPT



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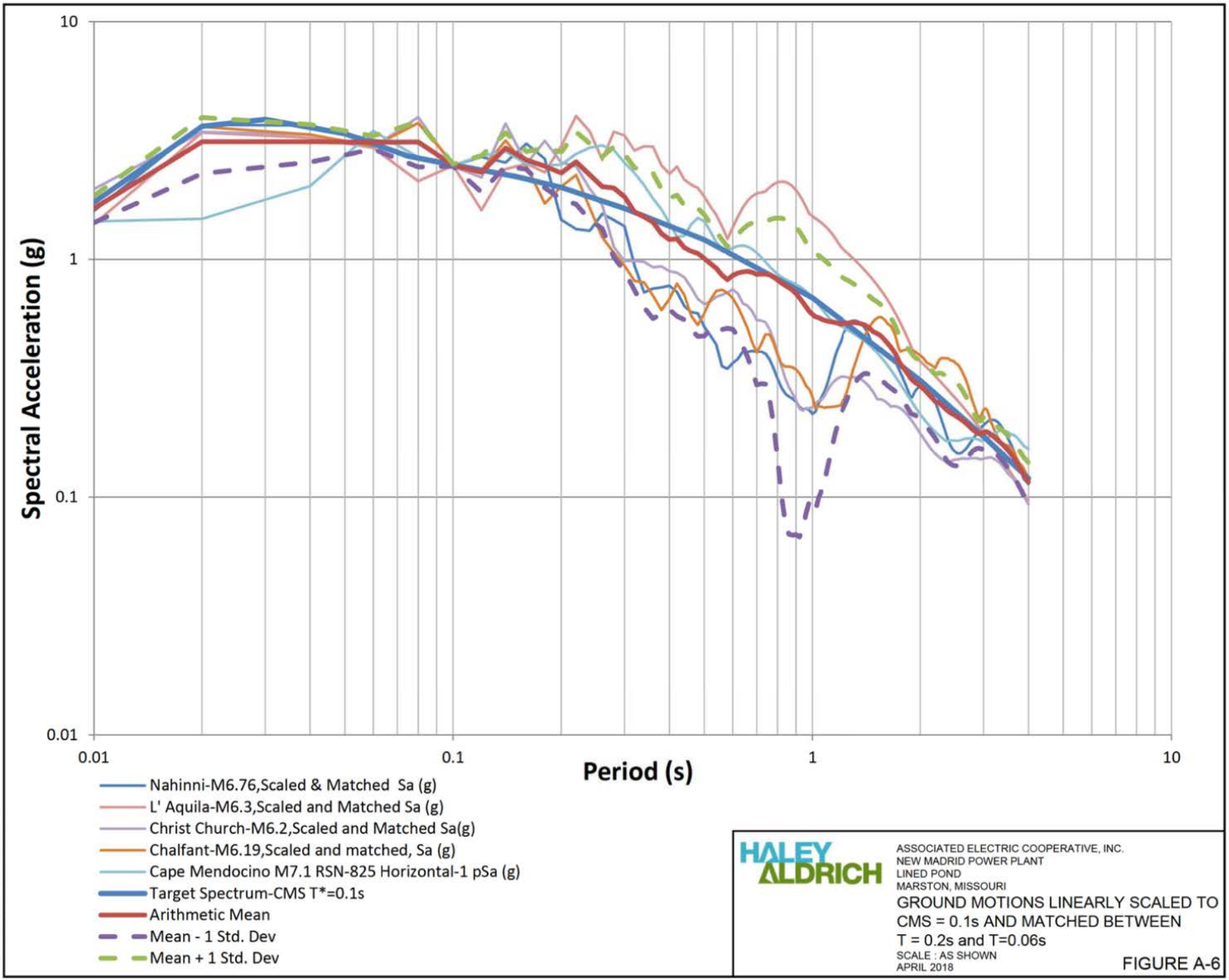
LINED POND
MARSTON, MISSOURI

CONDITIONAL MEAN SPECTRUM
TARGET PERIOD = 0.1s

SCALE : AS SHOWN
APRIL 2018

FIGURE A-5

129342-015_FIG A-6.PPT



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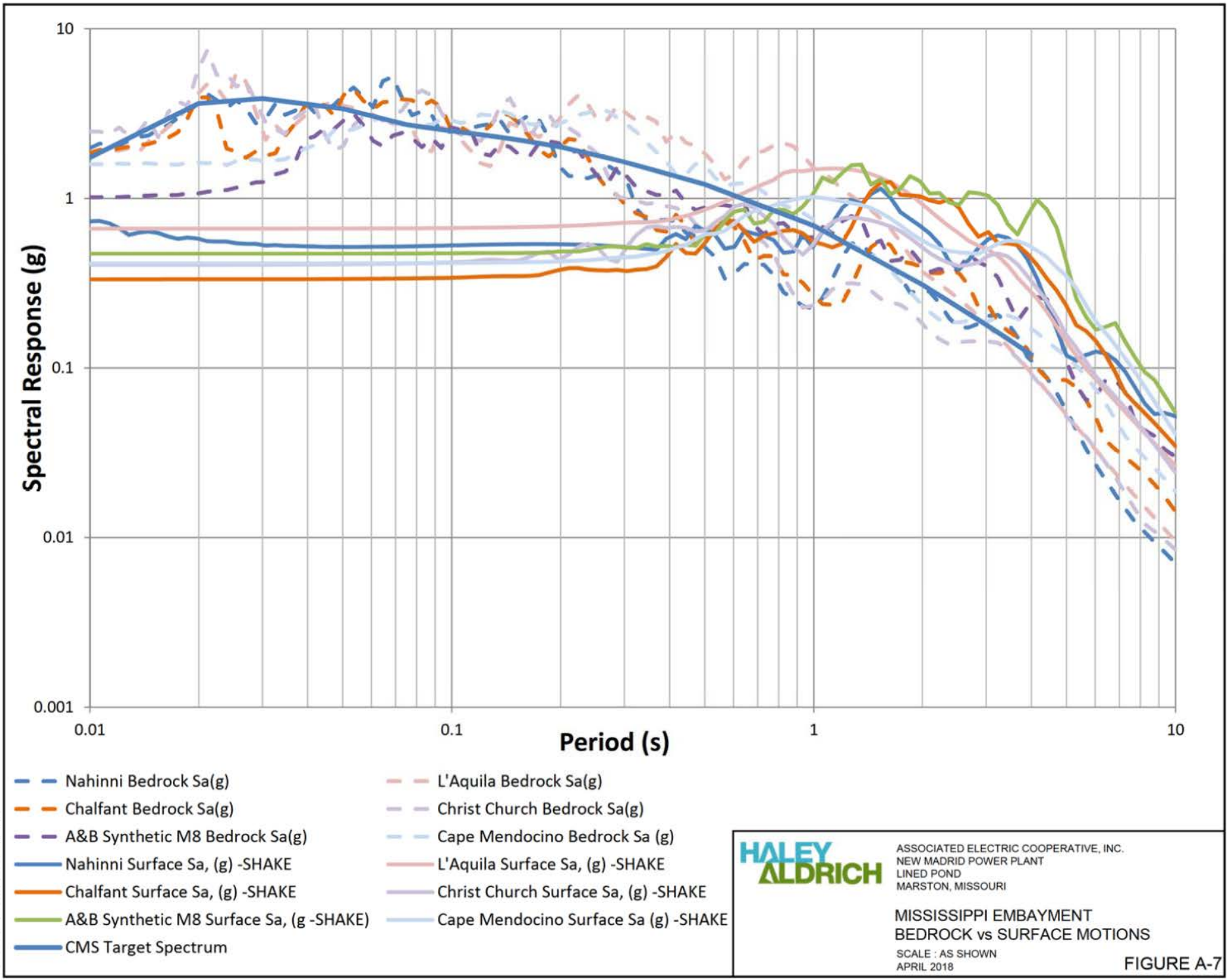
MARSTON, MISSOURI

GROUND MOTIONS LINEARLY SCALED TO CMS = 0.1s AND MATCHED BETWEEN T = 0.2s and T=0.06s

SCALE : AS SHOWN
APRIL 2018

FIGURE A-6

129342-015_FIG A-7.PPT



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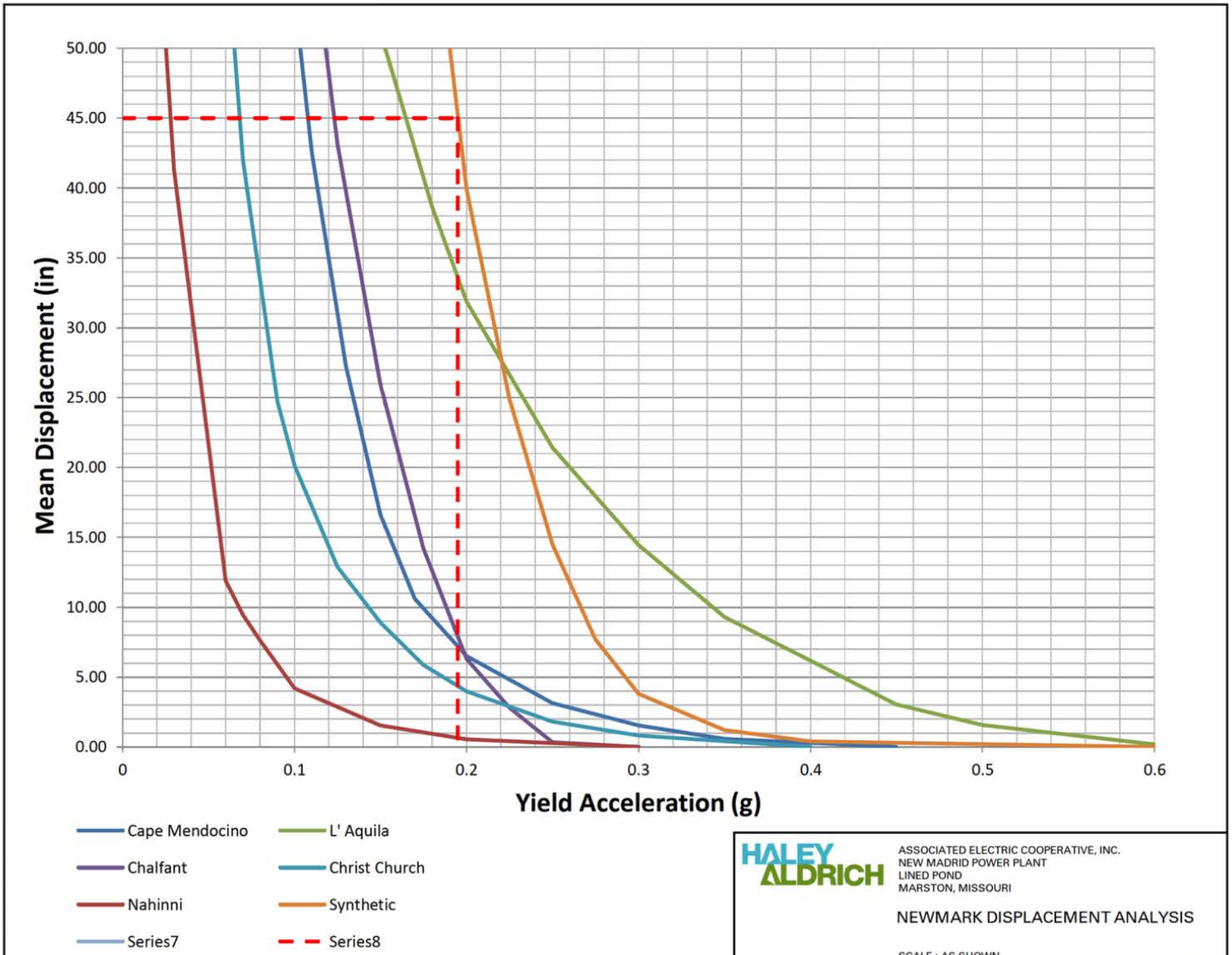
LINED POND
MARSTON, MISSOURI

MISSISSIPPI EMBAYMENT
BEDROCK vs SURFACE MOTIONS

SCALE : AS SHOWN
APRIL 2018

FIGURE A-7

129342-015_FIG A-8.PPT



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NEW MADRID POWER PLANT
LINED POND
MARSTON, MISSOURI

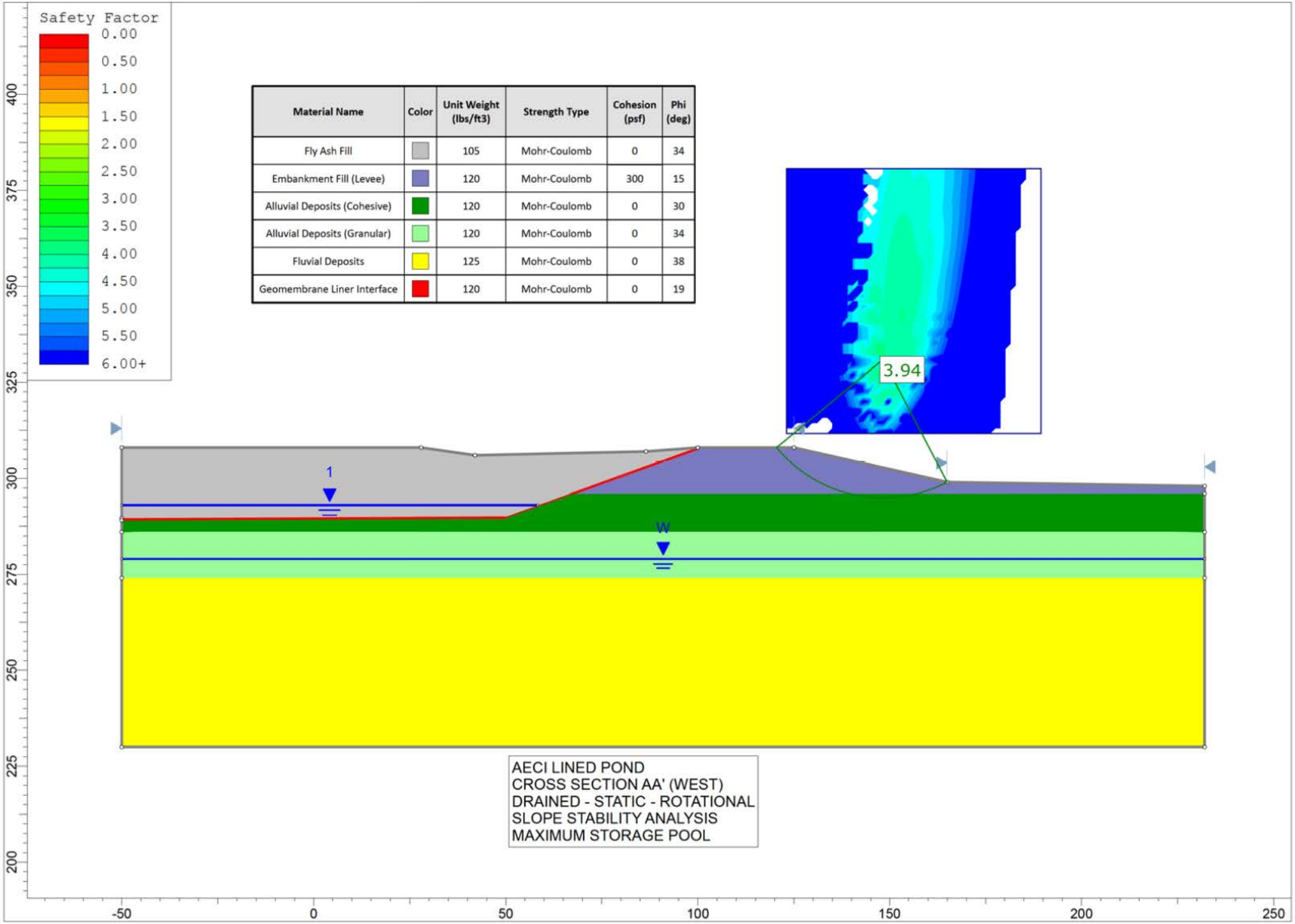
NEWMARK DISPLACEMENT ANALYSIS

SCALE : AS SHOWN
APRIL 2018

FIGURE A-8

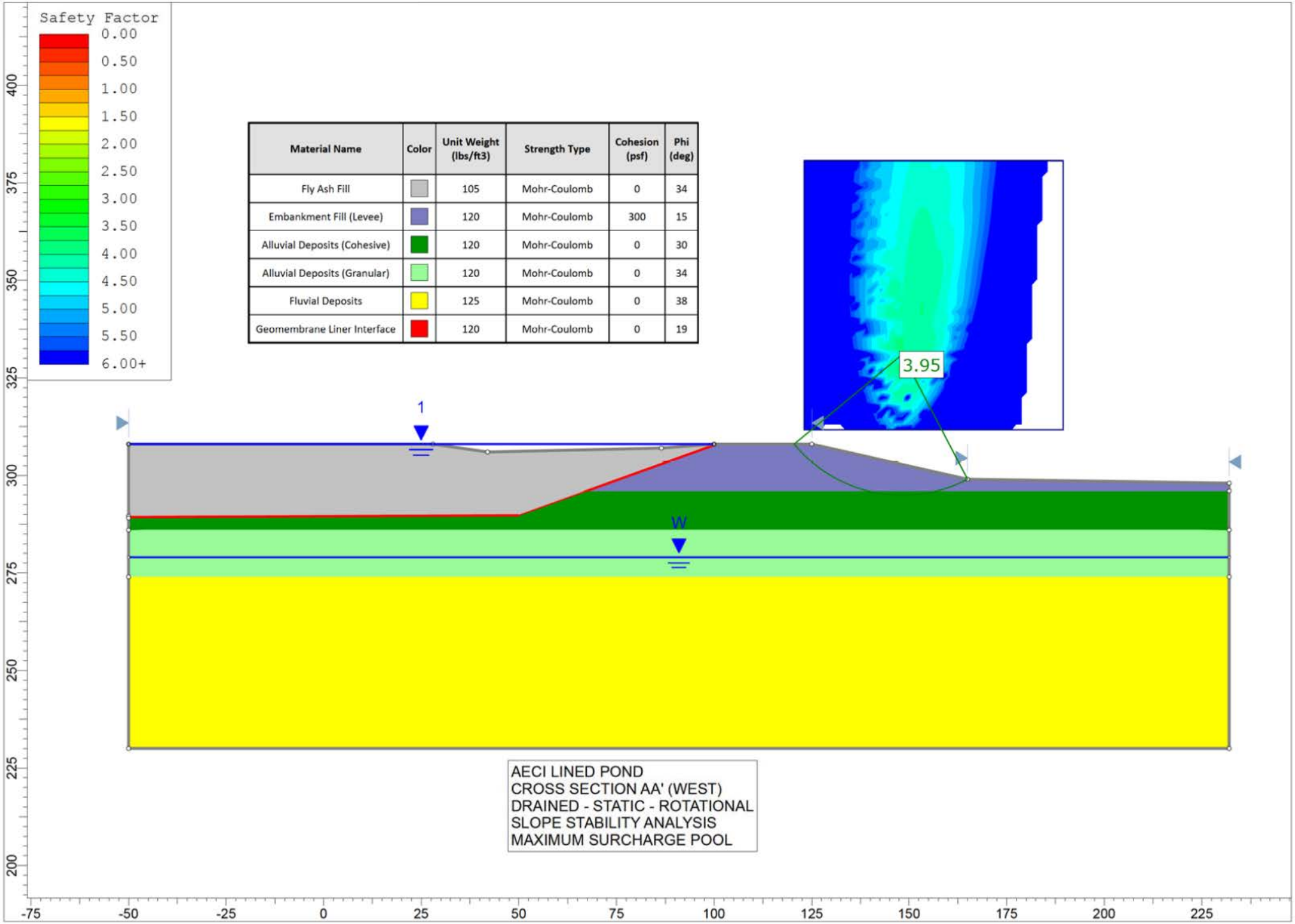
129342-015_FIG A-9.PPT

Slope Stability



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fly Ash Fill		105	Mohr-Coulomb	0	34
Embankment Fill (Levee)		120	Mohr-Coulomb	300	15
Alluvial Deposits (Cohesive)		120	Mohr-Coulomb	0	30
Alluvial Deposits (Granular)		120	Mohr-Coulomb	0	34
Fluvial Deposits		125	Mohr-Coulomb	0	38
Geomembrane Liner Interface		120	Mohr-Coulomb	0	19

AECI LINED POND
CROSS SECTION AA' (WEST)
DRAINED - STATIC - ROTATIONAL
SLOPE STABILITY ANALYSIS
MAXIMUM STORAGE POOL



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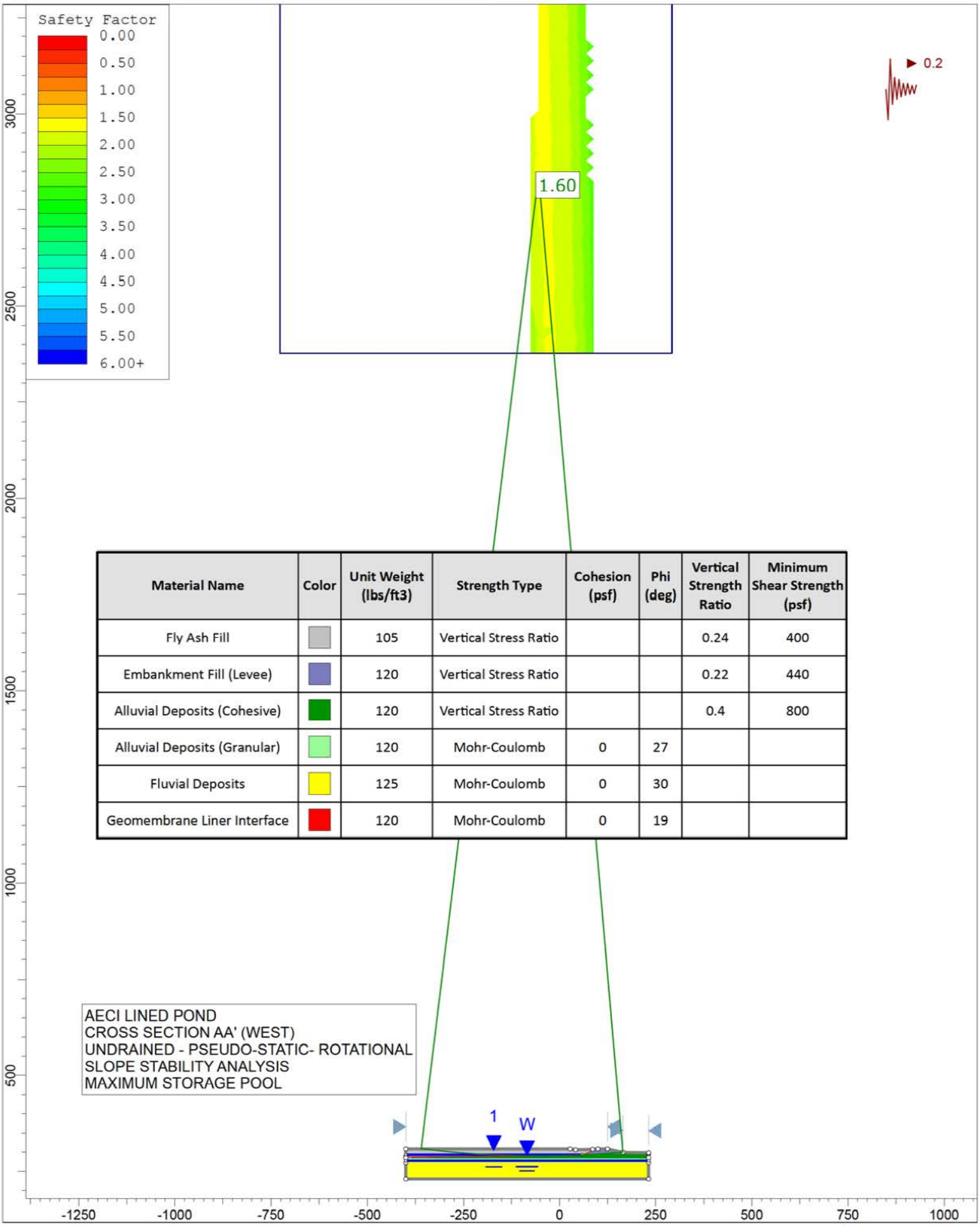
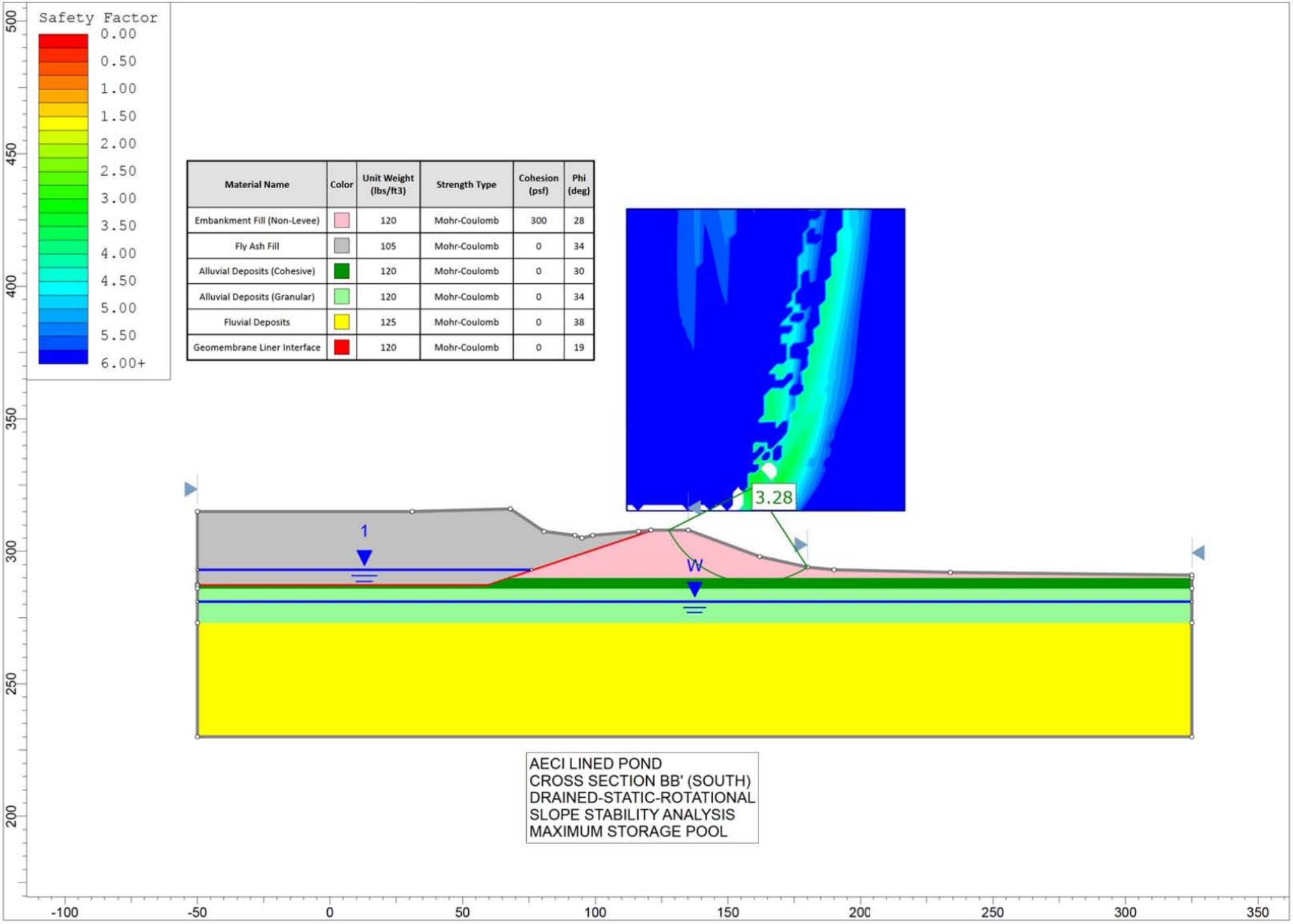
Fluvial Deposits		125	Mohr-Coulomb	0	38
Geomembrane Liner Interface		120	Mohr-Coulomb	0	19



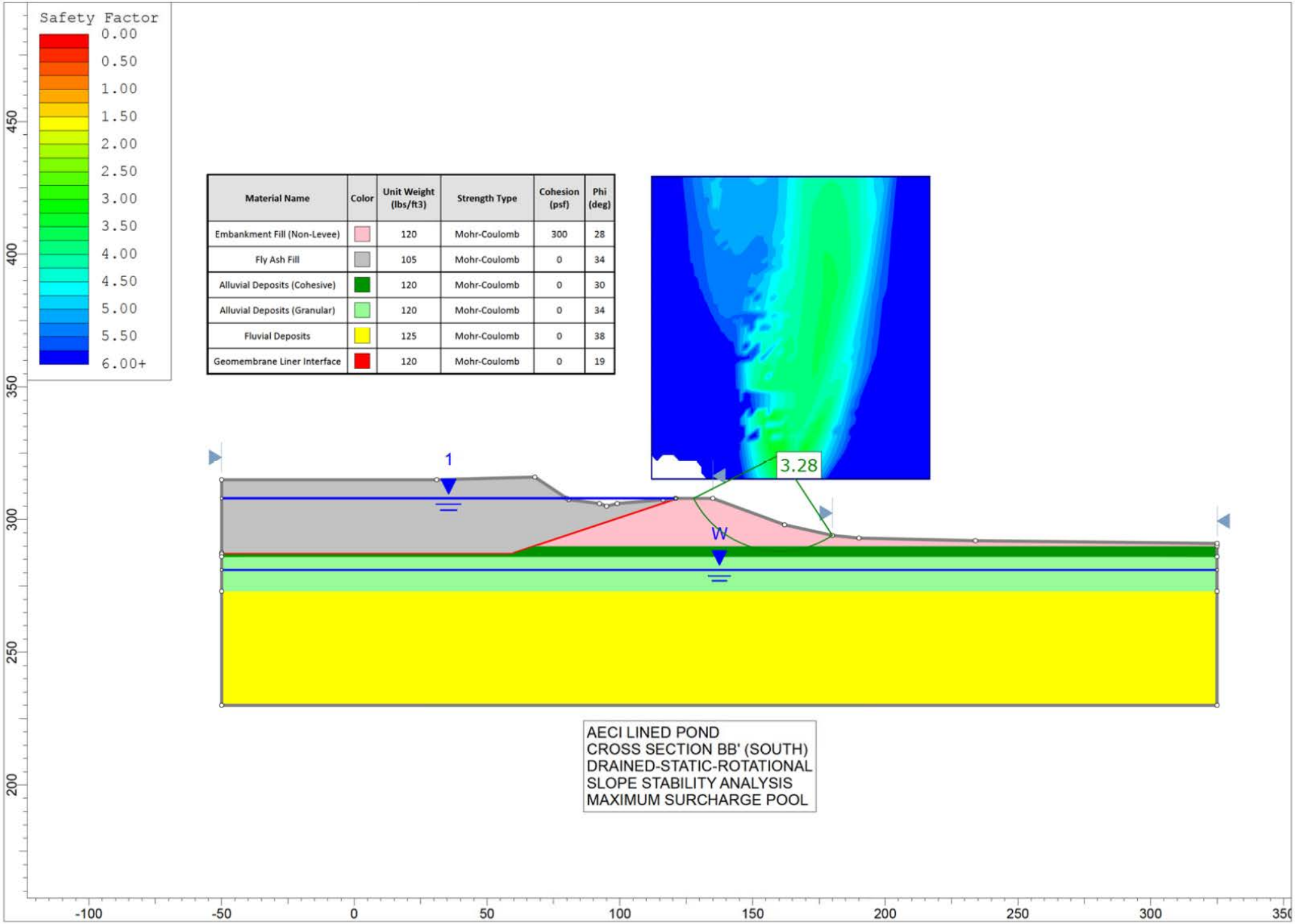
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Fly Ash Fill		105	Vertical Stress Ratio			0.24	400
Embankment Fill (Levee)		120	Vertical Stress Ratio			0.22	440
Alluvial Deposits (Cohesive)		120	Vertical Stress Ratio			0.4	800
Alluvial Deposits (Granular)		120	Mohr-Coulomb	0	27		
Fluvial Deposits		125	Mohr-Coulomb	0	30		
Geomembrane Liner Interface		120	Mohr-Coulomb	0	19		

AECI LINED POND
CROSS SECTION AA' (WEST)
UNDRAINED - PSEUDO-STATIC- ROTATIONAL
SLOPE STABILITY ANALYSIS
MAXIMUM STORAGE POOL



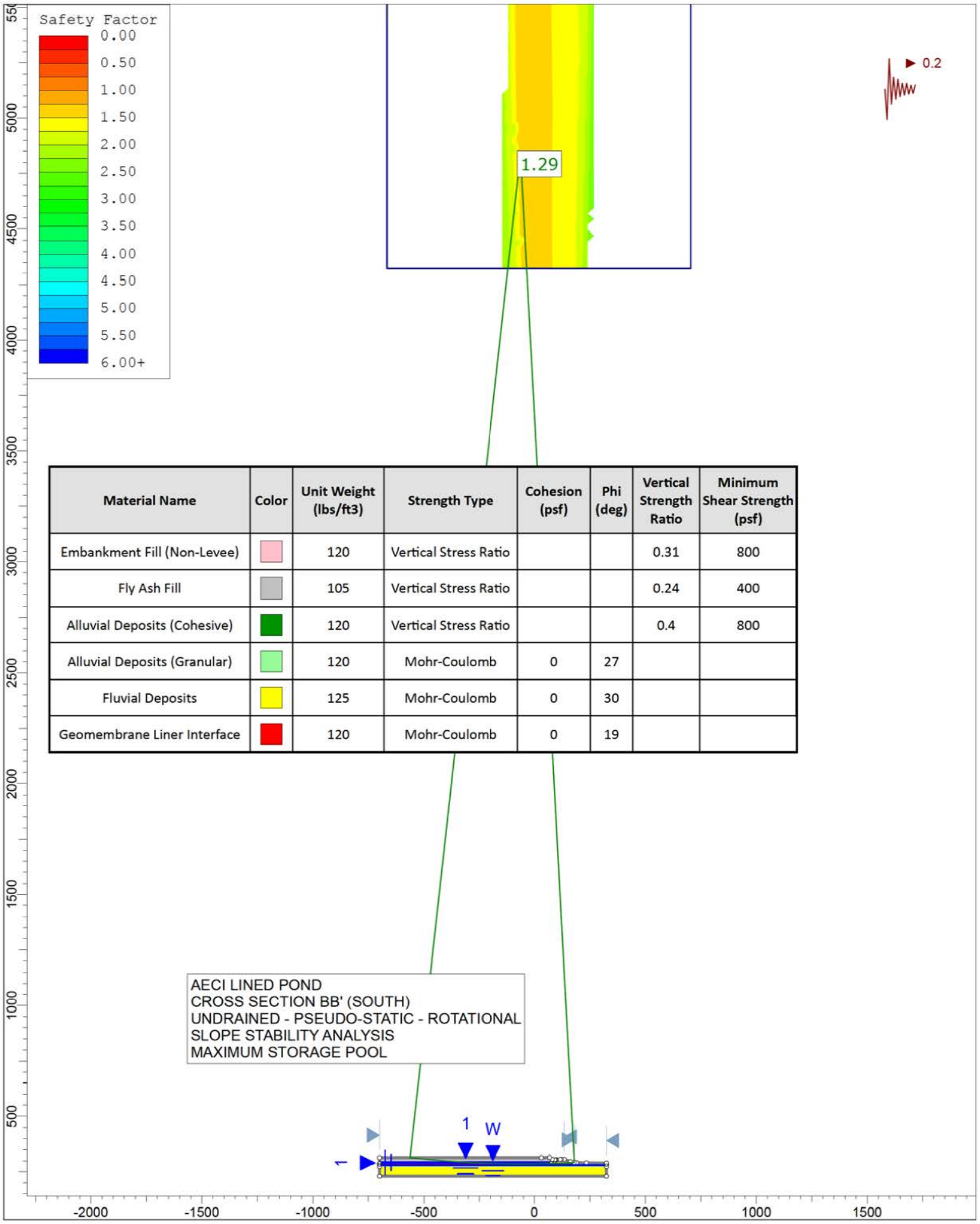
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill (Non-Levee)		120	Mohr-Coulomb	300	28
Fly Ash Fill		105	Mohr-Coulomb	0	34
Alluvial Deposits (Cohesive)		120	Mohr-Coulomb	0	30
Alluvial Deposits (Granular)		120	Mohr-Coulomb	0	34
Fluvial Deposits		125	Mohr-Coulomb	0	38
Geomembrane Liner Interface		120	Mohr-Coulomb	0	19

AECI LINED POND
CROSS SECTION BB' (SOUTH)
DRAINED-STATIC-ROTATIONAL
SLOPE STABILITY ANALYSIS
MAXIMUM STORAGE POOL

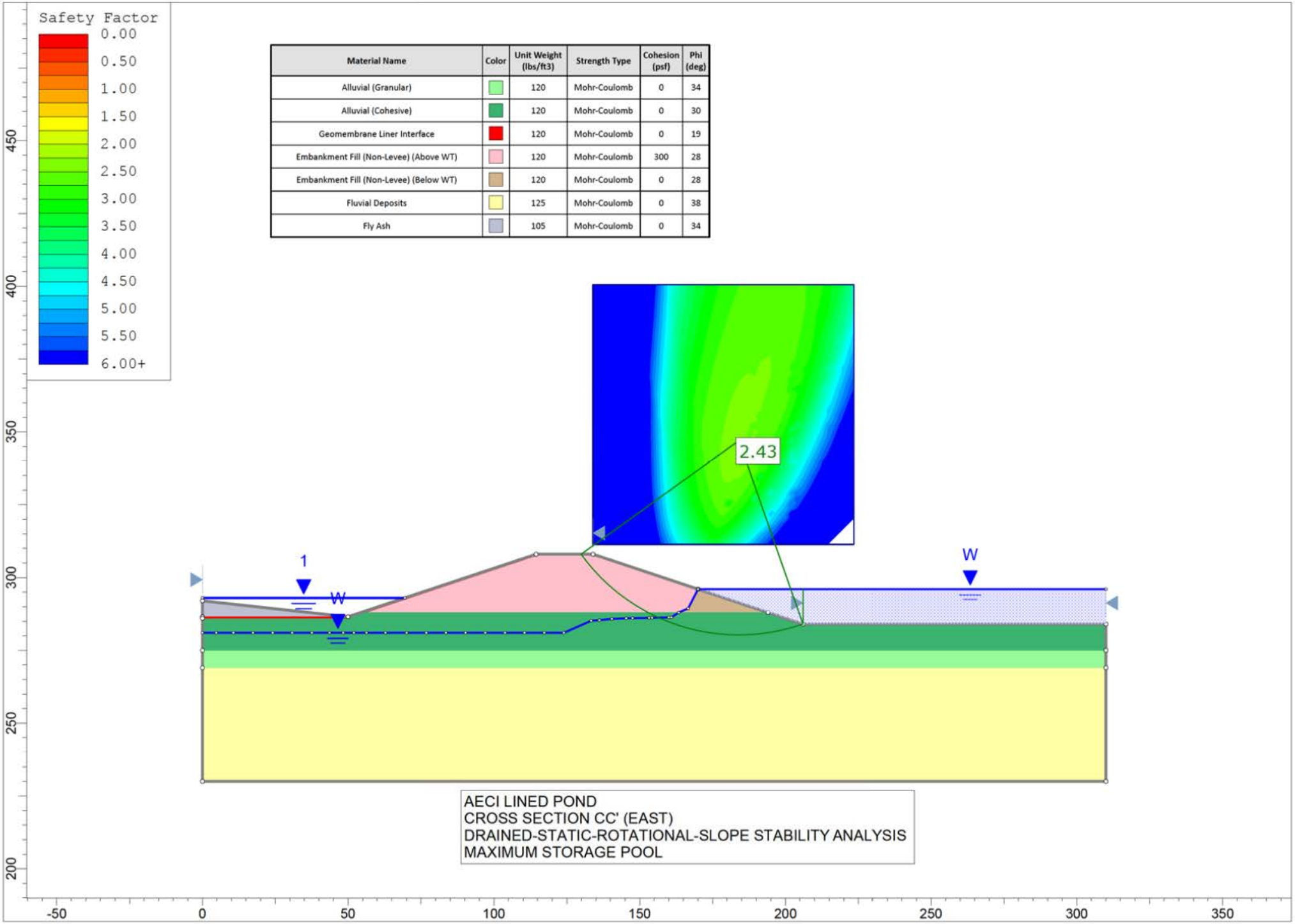


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill (Non-Levee)		120	Mohr-Coulomb	300	28
Fly Ash Fill		105	Mohr-Coulomb	0	34
Alluvial Deposits (Cohesive)		120	Mohr-Coulomb	0	30
Alluvial Deposits (Granular)		120	Mohr-Coulomb	0	34
Fluvial Deposits		125	Mohr-Coulomb	0	38
Geomembrane Liner Interface		120	Mohr-Coulomb	0	19

AECI LINED POND
CROSS SECTION BB' (SOUTH)
DRAINED-STATIC-ROTATIONAL
SLOPE STABILITY ANALYSIS
MAXIMUM SURCHARGE POOL



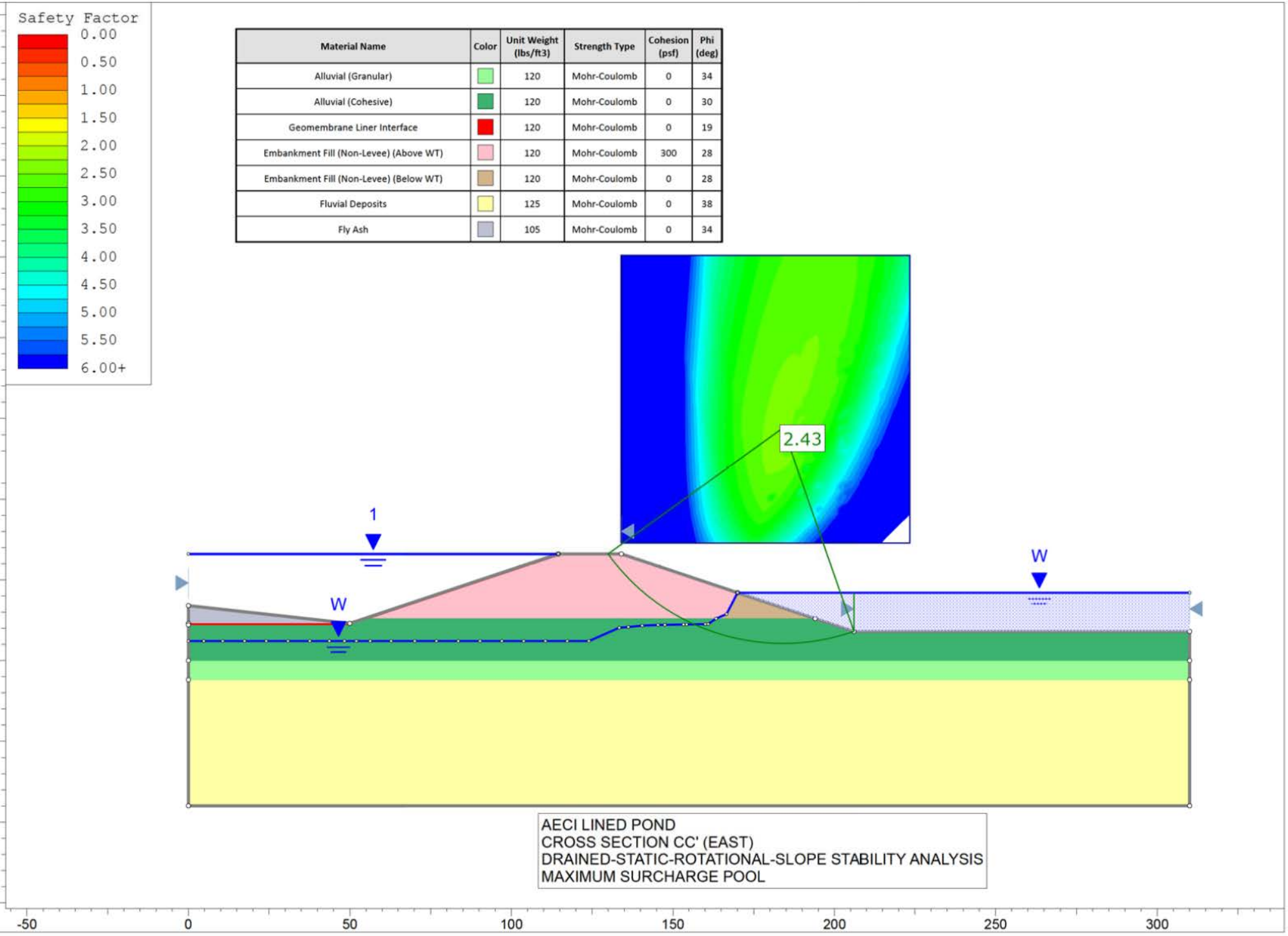
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Embankment Fill (Non-Levee)		120	Vertical Stress Ratio			0.31	800
Fly Ash Fill		105	Vertical Stress Ratio			0.24	400
Alluvial Deposits (Cohesive)		120	Vertical Stress Ratio			0.4	800
Alluvial Deposits (Granular)		120	Mohr-Coulomb	0	27		
Fluvial Deposits		125	Mohr-Coulomb	0	30		
Geomembrane Liner Interface		120	Mohr-Coulomb	0	19		



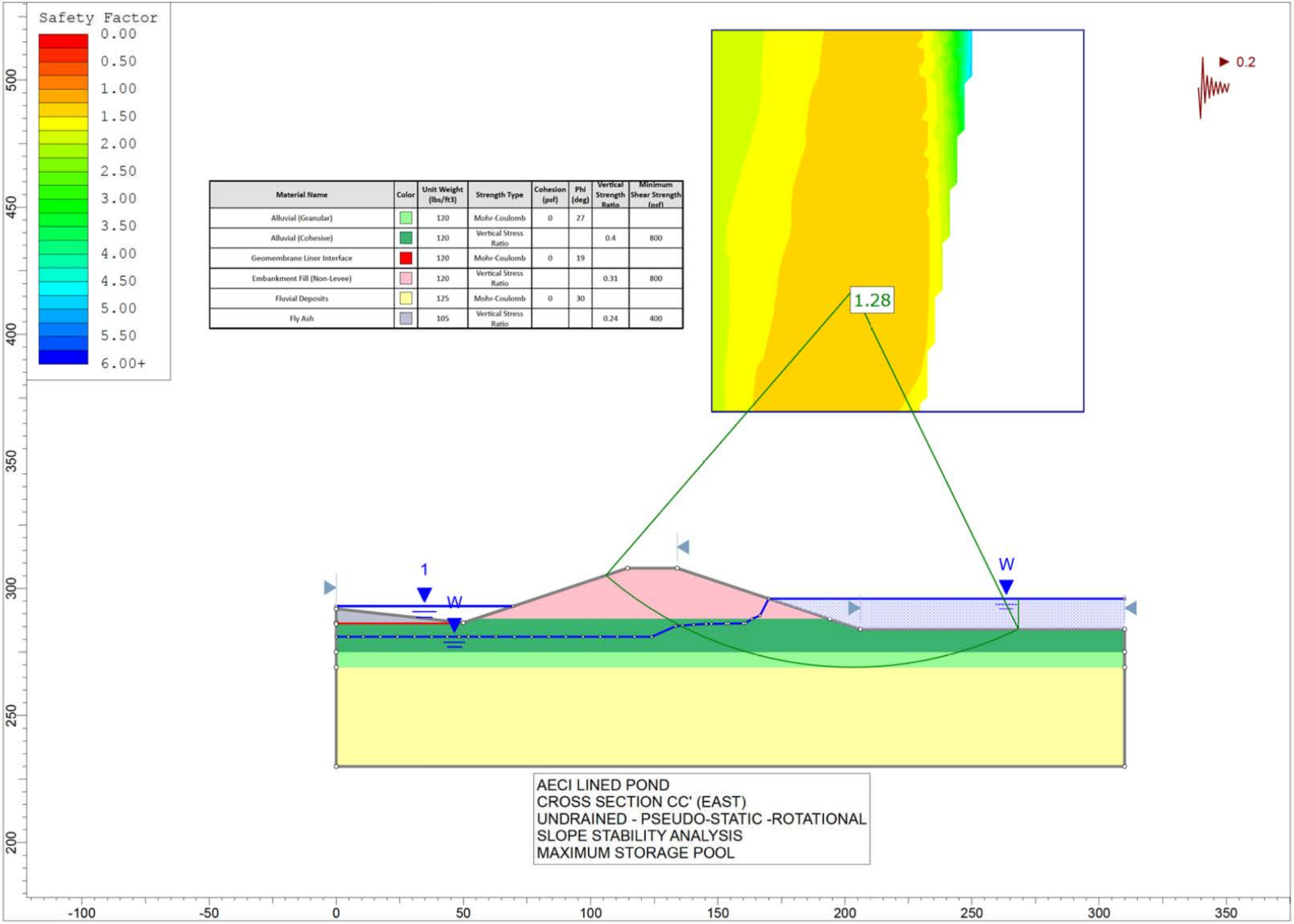
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Granular)		120	Mohr-Coulomb	0	34
Alluvial (Cohesive)		120	Mohr-Coulomb	0	30
Geomembrane Liner Interface		120	Mohr-Coulomb	0	19
Embankment Fill (Non-Levee) (Above WT)		120	Mohr-Coulomb	300	28
Embankment Fill (Non-Levee) (Below WT)		120	Mohr-Coulomb	0	28
Fluvial Deposits		125	Mohr-Coulomb	0	38
Fly Ash		105	Mohr-Coulomb	0	34

AECI LINED POND
CROSS SECTION CC' (EAST)
DRAINED-STATIC-ROTATIONAL-SLOPE STABILITY ANALYSIS
MAXIMUM STORAGE POOL

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Alluvial (Granular)		120	Mohr-Coulomb	0	34
Alluvial (Cohesive)		120	Mohr-Coulomb	0	30
Geomembrane Liner Interface		120	Mohr-Coulomb	0	19
Embankment Fill (Non-Levee) (Above WT)		120	Mohr-Coulomb	300	28
Embankment Fill (Non-Levee) (Below WT)		120	Mohr-Coulomb	0	28
Fluvial Deposits		125	Mohr-Coulomb	0	38
Fly Ash		105	Mohr-Coulomb	0	34



AECI LINED POND
CROSS SECTION CC' (EAST)
DRAINED-STATIC-ROTATIONAL-SLOPE STABILITY ANALYSIS
MAXIMUM SURCHARGE POOL



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)
Alluvial (Granular)		120	Mohr-Coulomb	0	27		
Alluvial (Cohesive)		120	Vertical Stress Ratio			0.4	800
Geomembrane Liner Interface		120	Mohr-Coulomb	0	19		
Embankment Fill (Non-Levee)		120	Vertical Stress Ratio			0.31	800
Fluvial Deposits		125	Mohr-Coulomb	0	30		
Fly Ash		105	Vertical Stress Ratio			0.24	400

AECI LINED POND
CROSS SECTION CC' (EAST)
UNDRAINED - PSEUDO-STATIC -ROTATIONAL
SLOPE STABILITY ANALYSIS
MAXIMUM STORAGE POOL

APPENDIX B

Data Report

HALEY ALDRICH

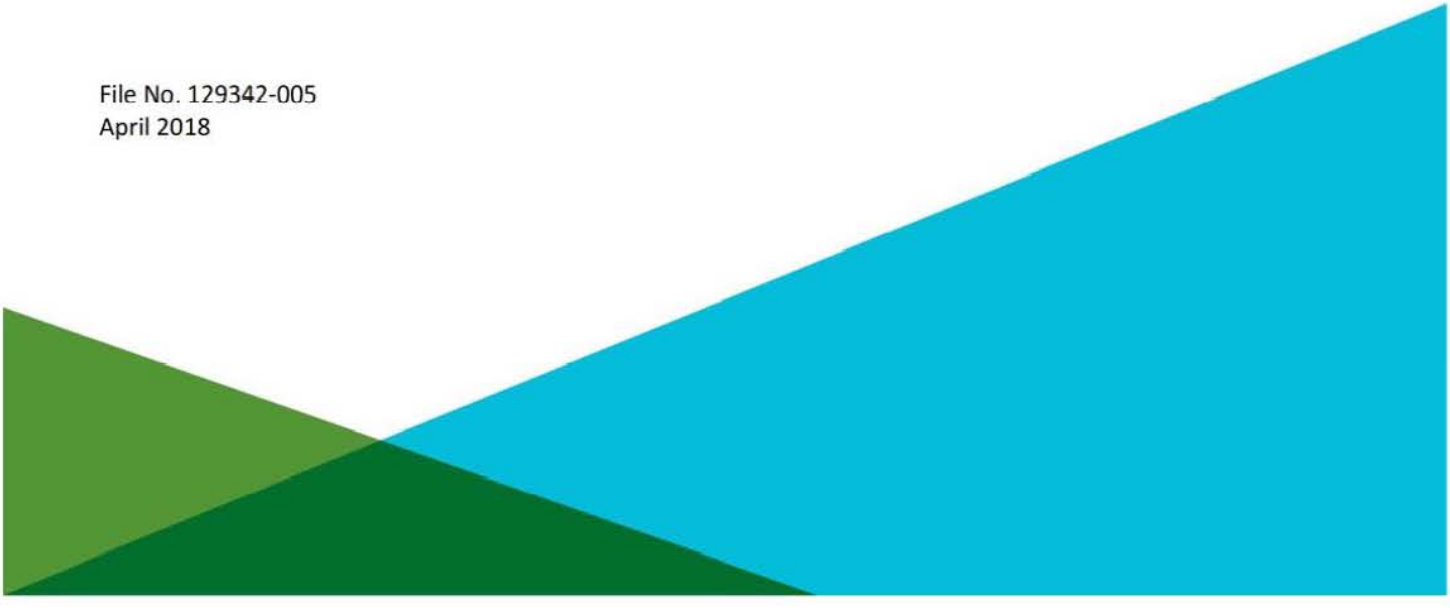
www.haleyaldrich.com

DATA REPORT ON
SUBSURFACE INVESTIGATION AND LABORATORY TESTING
LINED POND
NEW MADRID POWER PLANT
MARSTON, MISSOURI

by Haley & Aldrich, Inc.
Cleveland, Ohio

for Associated Electric Cooperative, Inc.
Springfield, Missouri

File No. 129342-005
April 2018



HALEY & ALDRICH, INC.
6500 ROCKSIDE ROAD
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CLEVELAND, OH 44131
216.739.0555

17 April 2018
File No. 129342-005

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

Attention: Russ Weatherly
Supervisor, Land and Water Resources

Subject: Data Report on Subsurface Investigation and Laboratory Testing
Lined Pond
New Madrid Power Plant
Marston, Missouri

Ladies and Gentlemen:

We are pleased to submit herewith our report entitled, "Data Report on Subsurface Investigation and Laboratory Testing, Lined Pond, New Madrid Power Plant, Marston, Missouri." This report has been prepared in accordance with our Work Scope for Consulting Services dated 23 January 2017 and your subsequent authorization.

The purpose of this study was to evaluate the subsurface soil and groundwater conditions at the project site for the existing Lined Pond. This report includes background information regarding the project and summarizes the results of our field investigation program.

We appreciate the opportunity to provide consulting services for this project and look forward to working with you during design and construction. Please do not hesitate to contact us if you have comments or questions regarding this report.

Sincerely yours,
HALEY & ALDRICH, INC.

Derrick A. Shelton, P.E. (VA, MD, DC, TN)
Geotechnical Program Manager | Senior Associate

Steven F. Putrich, P.E.
Vice President

Enclosures

\\haleyaldrich.com\share\was_common\Projects\129342 - AECI\005 - Lined Pond\Deliverables\Reports\Data Report\2018-0417-HAI-Lined Pond Geotechnical Data Report-F.docx

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1. Introduction

1.1 GENERAL

This report presents the results of field and laboratory investigations for the existing Lined Pond at the New Madrid Power Plant (NMPP), located in Marston, Missouri. The site is located at 41 St. Jude Industrial Park Highway in Marston, Missouri as shown on **Figure 1**, "Project Locus."

Associated Electric Cooperative, Inc. (AECI) operates the coal-fired NMPP, which is located approximately 2.5 miles east of Marston, Missouri.

1.2 PURPOSE AND SCOPE

The purpose of this study was to investigate the subsurface soil and groundwater conditions at the site. To achieve this objective, the scope of work undertaken for this investigation included the following:

- Planning and executing a field investigation program to obtain subsurface information. The program consisted of:
  - Four (4) test borings drilled to depths ranging from approximately 20 to 95 ft below ground surface;
  - Two (2) observation wells installed to depths of 20 ft and 34 ft in completed boreholes.
  - Four (4) test pits excavated to depths ranging from approximately 10 to 11 ft below ground surface; and
  - Seven (7) cone penetrometer soundings (CPTs) advanced to depths ranging from approximately 20 to 95 ft below ground surface.
- Conducting a geotechnical laboratory testing program on coal combustion residuals (CCR) and soil samples recovered from subsurface explorations to aid in soil classification and determination of engineering properties required in site development studies.

1.3 ELEVATION DATUM AND HORIZONTAL CONTROL

The elevations used in this report are in feet and reference the North American Vertical Datum of 1988 (NAVD88) unless otherwise noted. The horizontal control is Missouri State Plane East, which is based on North American Datum 83 (NAD83).

1.4 LIMITATIONS

This report has been prepared for specific application to the proposed construction as understood at this time. In the event that changes in the recommended design are planned, the conclusions and recommendations contained in this report should not be considered valid, unless the changes are reviewed by Haley & Aldrich and the conclusions of this report modified or verified in writing.

The geotechnical evaluations and recommendations are based, in part, upon the data obtained from the referenced subsurface explorations. The nature and extent of variations between explorations may not

become evident until construction. If variations appear at that time, it may be necessary to re-evaluate the recommendations of this report.

This report is prepared for the exclusive use of Associated Electric Cooperative, Inc. and their subconsultants in connection with the Lined Pond at New Madrid Power Plant in Marston, Missouri. There are no intended beneficiaries other than Associated Electric Cooperative, Inc. Haley & Aldrich shall owe no duty whatsoever to any other person or entity on account of the Agreement or the report. Use of this report by any person or entity other than Associated Electric Cooperative, Inc. and their subconsultants for any purpose whatsoever is expressly forbidden unless such other person or entity obtains written authorization from Associated Electric Cooperative, Inc. and from Haley & Aldrich. Use of this report by such other person or entity without the written authorization of Associated Electric Cooperative, Inc. and Haley & Aldrich shall be at such other person's or entity's sole risk, and shall be without legal exposure or liability to Haley & Aldrich.

2. Description of Pond

The Lined Pond is an inactive lined surface impoundment with an approximate footprint of 78 acres located south of Pond 003. The Lined Pond was designed by Burns & McDonnell and was constructed in 1994. Access roads run along the entire perimeter of the pond and the approximate crest elevation is approximately 308 feet MSL. The impoundment is located on the east side of the US Army Corps of Engineers levee system of the Mississippi River. The east embankment of the Lined Pond serves as a separator dike that bisects the Lined Pond and the Raw Water Pond. The Raw Water Pond exists as an overflow for high water level conditions and was intended as a future phase of the Lined Pond. The Lined Pond at the New Madrid Power Plant (NMPP) is currently inactive as defined by the CCR Rule. The interior and exterior slopes of the pond were designed as 3 horizontal to 1 vertical (3H:1V) slopes. The maximum height of the west embankment (levee side) is approximately 9 ft, and the maximum heights of the south and east embankments (non-levee side) are approximately 15 ft and 24 ft respectively. As mentioned above, the north side of the pond is adjacent to Pond 003, which is at the same surface elevation as the access road that separates the two ponds. As a result, an exposed embankment does not exist on the north side of the pond.

AECI managed CCR by placing fly ash in the Lined Pond via a wetting head from 1994 to approximately 2007 when the plant converted to dry fly ash handling. The impoundment relied on evaporation as the main source of discharge from the unit, with no primary spillway existing (emergency flows can be diverted to the Raw Water Pond, Pond 003, or the 003 Outfall discharge channel). The majority of the Lined Pond is full and contains an unused area in the southeastern corner that collects runoff. The Lined Pond subgrade and embankments were constructed of native soils and were overlaid with 60 mil (side slopes) and 80 mil (bottom) geomembranes. Two 18 in. pipes in the southeastern corner of the pond have historically been used to pump water from the Raw Water Pond to the Lined Pond in order to prevent uplift of the liner.

The downstream side of the east embankment experienced surficial slope movement and sloughing in the past and plate piles were used to stabilize the slope 2012. Additionally, localized areas of sloughing/erosion have recently been repaired by infilling with riprap.

3. Field Investigation Program

3.1 PREVIOUS EXPLORATIONS PERFORMED BY OTHERS

A subsurface exploration program was previously performed at the site by others. The approximate locations of the explorations performed by others are shown on **Figure 2**, "Subsurface Exploration Location Plan". A summary of the prior explorations is provided below and details are included in **Table I**[1]. Relevant logs are included in **Appendix E**.

- Two (2) test borings were drilled and three (3) test pits were excavated by Geotechnology, Inc. in 2009 during an investigation for a stability evaluation.

3.2 CURRENT SUBSURFACE EXPLORATIONS

A subsurface exploration program was conducted at the project site during the period 12 June 2017 to 21 June 2017 to obtain subsurface information for engineering evaluations. The program consisted of drilling four (4) test borings, performing seven (7) CPT soundings, and excavating four (4) test pits. Two (2) of the test borings were converted to observation wells upon completion. The test borings were drilled by Bulldog Drilling of Dupo, Illinois using an ATV-mounted CME 550 drill rig. The CPTs were performed by ConeTec, Inc. of West Berlin, New Jersey using a 25-ton, track-mounted CPT rig. Test pits were excavated by Dumey Contracting of Benton, Missouri using as a John Deere 350D LC track excavator. A Haley & Aldrich representative was present in the field to observe the subsurface explorations.

The locations of the subsurface explorations are shown on **Figure 2**. The as-drilled locations and elevations of the explorations were determined in the field by AECI by rover GPS unit. The locations and elevations of the explorations should be considered accurate only to the degree implied by the method used to make the determination. A summary of the subsurface explorations is presented in **Table II**.

3.2.1 Test Borings

The test borings were drilled to depths ranging from approximately 20 to 95 ft below ground surface. Test borings HA-B8OW, HA-B9, and HA-B10OW were advanced using 4.25-in. inside diameter (i.d.) hollow stem augers. Test boring HA-B9A was performed using a combination of 4.25-in. i.d. hollow stem augers and mud rotary methods. Split-spoon samples were typically obtained continuously for the upper 20 ft at each test boring and at 5 ft intervals thereafter. The standard penetration resistance was determined at each sample level by counting the number of blows required to drive a standard split-spoon sampler (1-3/8-in. inside diameter, 2-in. outside diameter) a distance of 24 in. into undisturbed soil and CCR under the impact of a 140-lb hammer free-falling 30 in. The number of blows required to advance the sampler was recorded for each 6-in. interval. The standard penetration resistance N-value is determined by summing the number of blows required to advance the sampler the middle 12 in. of the 24-in. sampling range.

Relatively undisturbed samples were obtained from test borings HA-B9 and HA-B10OW by pushing a 3-in. diameter thin-walled steel tube (Shelby tube) at planned sampling depths. Standard Shelby tube

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

direct push method using the hydraulics of the drill rill was used to advance tubes. The tubes were removed from the ground and sealed on site.

Samples recovered from the borings were taken to Shannon & Wilson in St. Louis, Missouri for laboratory testing. The boring logs are presented in **Appendix A**. The boring logs and related information depict subsurface conditions only at the specific locations and at the particular time designated on the logs. 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.

3.2.2 Groundwater Observation Wells

Groundwater observation wells were installed in boreholes HA-B8OW and HA-B10OW upon completion of drilling. The details of the well installations and the relationship to major soil strata are shown on the test boring logs and observation well reports in **Appendix A**. Details of the construction, materials, and backfill method are shown on the Observation Well Reports.

3.2.3 Test Pits

A total of four (4) test pits were excavated to depths ranging from approximately 10 to 11 feet below the existing ground surface. The test pits were located within the interior of the Lined Pond and were excavated to characterize ponded CCR and collect bulk samples. Upon completion of each test pit excavation, the contractor placed the excavated material back into the test pits and lightly compacted the material using the bucket of the excavator. Bulk samples were collected in select test pits and transported to Shannon & Wilson in St. Louis, Missouri for laboratory testing. The test pit logs are provided in **Appendix B**. The test pit logs and related information depict subsurface conditions only at the specific locations and at the particular time designated on the logs. 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.

3.2.4 Cone Penetrometer Soundings

A total of seven (7) CPT soundings were advanced to depths ranging from approximately 20.0 ft to 95.3 ft below ground surface. Several of the CPT soundings were performed immediately adjacent to SPT borings to facilitate correlating the readings from the CPT sounding with laboratory test results and SPT blowcounts. The CPT soundings were performed using a piezocone penetrometer that provides measurements of pore water pressure at one or more locations on the penetrometer surface in general conformance with ASTM D5778. CPT data, including pore pressure measurements, was collected at 1-cm depth intervals. The rod string and cone were advanced in natural soil and fill materials at the standard rate of 2 cm/sec. The rod string and cone were advanced in CCR at a rate of 0.2 cm/sec.

Seismic cone penetration testing was used to obtain in-situ measurements of shear wave velocity at CPT location HA-C15. Shear wave velocity measurements were taken at 2-meter (6.6-ft) intervals. Pore water dissipation testing was also performed at select depths in CPTs HA-C12, HA-C13, and HA-C15 to estimate hydraulic conductivity/pore pressure dissipation properties. The CPT data report is presented in **Appendix C**.

3.3 LABORATORY TESTING PROGRAM

A laboratory testing program was conducted on selected CCR and soil samples recovered from subsurface explorations to aid in classification and for determination of engineering properties required for design. The primary purpose of the testing program was to evaluate the index, strength, and compressibility properties of the native soil, ponded CCR material, and embankment fill materials. Testing included natural moisture contents, Atterberg limits, grain size distributions, unconsolidated-undrained (UU) triaxial strength, consolidated-undrained (CU) triaxial strength, standard proctor, and consolidation testing. The tests were performed in general conformance with applicable ASTM test procedures. Results of the laboratory testing program are summarized in **Table III** and the full results are included in **Appendix D**.

4. Subsurface Conditions

4.1 GEOLOGY

The site is located within the New Madrid Seismic Zone. The new Madrid Seismic Zone lies at the north end of the Mississippi Embayment, which is a deep, low-lying basin filled with Cretaceous to recent sediments. The stratigraphy at the site is presented on **Figure 3** and is based on the general profile develop by Van Arsdale and TenBrink (2000). The project site is immediately underlain by imported embankment fill and levee fill associated with embankment and levee construction as well as fly ash associated with coal burning operations.

The existing fill is underlain by Quaternary Mississippi River alluvium, which is characterized by silty clay and sand, Pleistocene Loess, which is characterized by silt and clayey silt, and Pliocene-Pleistocene Upland Complex Gravel consisting of fine to very coarse sand and gravel. These sediments are believed to be surficial deposits of fluvial or estuarine origin.

Underlying the Quaternary Deposits is the Jackson Formation, which is characterized by fluvial/deltaic medium to very fine grained silty sand, interbedded with clayey silt. The Jackson Formation overlies the Eocene Claiborne Group that consists of the Cockfield Formation over the Cook Mountain Formation over The Memphis Sand. The Cockfield formation is characterized by fluvial/deltaic silt and clay interbedded with medium to fine grained sand. The Cook Mountain Formation consists of silt and clay containing variable amounts of lignite and sand. The Memphis Sand is predominately described as consisting of fluvial/deltaic fine to very coarse grained quartzose sand containing rock fragments, pyrite and lignite.

Below the Eocene Claiborne Group is Paleocene consisting of the Wilcox Group and Midway Group. The Wilcox Group is comprised of the Flour Island Formation overlying the Fort Pillow Sand. The Flour Island formation is characterized by silty clay and clayey silt with lenses of fine grained sand. The Fort Pillow Sand is described as consisting of fine to very coarse grained quartzose sand. The Midway Group is comprised of Old Breastworks Formation, Porters Creek Clay and The Clayton Formation. Old Breastworks Formation is described as sandy, micaceous silty clay. The Porters Creek Clay is described as a micaceous clay. The Clayton Formation consists of glauconitic, fossiliferous clay.

Underlying the Wilcox and Midway groups is Upper Cretaceous soil consisting of McNairy Sand, Demopolis Formation and Coffee Formation. McNairy Sand is characterized by fine to coarse grained sand interbedded with silty clay. The Demopolis Formation is composed of calcareous clays, marls and some chalky materials. The Coffee Formation is made up of stratified and cross-bedded clays and fine-grained sand.

Below the Upper Cretaceous lies the Paleozoic strata. The Paleozoic strata is described as fine to coarse crystalline dolomite. At the AECI site, the depth to the Paleozoic strata is approximately 1,900 ft below ground surface.

The geologic descriptions discussed herein are credited to various references entitled "General Geology of the Mississippi Embayment" (Cushing, Boswell, Hosman 1964), "Deep Shear Wave Velocity Profiles of Mississippi Embayment Sediments Determined From Surface Wave Measurements" (Rosenblad, 2007) and "Late Cretaceous and Cenozoic Geology of the New Madrid Seismic Zone" (Van Arsdale and TenBrink, 2000).

4.2 SUBSURFACE CONDITIONS

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

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

- *EMBANKMENT FILL* – Below the ground surface in test borings HA-B9 and HA-B10OW there is a stratum of fill material primarily described as lean CLAY (CL), fat CLAY (CH), SILT (ML), sandy SILT (ML), and silty SAND (SM). This stratum was fully penetrated where encountered and the thickness of this stratum ranged from approximately 7.5 ft to 20 ft. The density of coarse-grained soils encountered in this stratum was loose to dense. The consistency of fine-grained soils encountered in this stratum ranged from medium stiff to stiff but was generally stiff.

- *FLY ASH FILL* - Below the ground surface in test boring HA-B8OW and test pits TP3-1 through TP3-4, there is a stratum of CCR material primarily described as SILT (ML) and sandy SILT (ML). Where encountered, this stratum was not fully penetrated by any test borings or test pits. The density of CCR material encountered in this stratum ranged from very loose to medium dense but was generally medium dense.

- *ALLUVIAL DEPOSITS* – Below the EMBANKMENT FILL and FLY ASH FILL there is stratum of natural soil primarily described as sandy SILT (ML), SILT(ML), elastic SILT (MH), lean CLAY (CL), fat CLAY (CH), silty SAND (SM), poorly-graded SAND (SP), and poorly-graded SAND with silt (SP-SM). This stratum was encountered in borings HA-B9, B9A, and B10OW, but was only fully penetrated in boring HA-B9A. Where fully penetrated, the thickness was approximately 26 ft. The density of coarse-grained soils encountered in this stratum ranged from loose to medium dense. The consistency of fine-grained soils encountered in this stratum ranged from soft to very stiff.

- *FLUVIAL DEPOSITS* – Below the ALLUVIAL DEPOSITS there is stratum of natural soil primarily described as poorly-graded SAND (SP) and silty SAND (SM). This stratum was only encountered in boring HA-B9A but was not fully penetrated. The density of coarse-grained soils encountered in this stratum ranged from medium dense to dense but was generally medium dense.

4.3 GROUNDWATER CONDITIONS

Water levels were typically measured in the boreholes when water was encountered during drilling. Measured water levels are summarized in **Table II**. The water level measured within the interior of the Lined Pond was 8.0 ft below ground surface, which corresponds to a water level at El. 300.8. Outside of the lined pond, measured water levels during drilling ranged from a depth of approximately 30.0 to 32.0

ft below ground surface, which corresponds to a water level ranging between approximately El. 276.2 and 277.5. Water was not measured during drilling in test boring HA-B9A or at completion of drilling in the other test borings due to the use of drilling fluid.

Water levels were typically measured in the test pits at the conclusion of excavation. Measured water levels are summarized in **Table II**. Water levels measured during test pit excavation ranged from a depth of approximately 9.0 to 11.0 ft below ground surface, which corresponds to a water level within the interior of the Lined Pond ranging between approximately El. 297.1 and 300.8.

Water levels were also estimated during the CPT soundings. The water level estimated within the interior of the lined pond was 9.5 ft below ground surface, which corresponds to a water level at El. 299.3. Outside of the Lined Pond, estimated water levels during the soundings generally ranged from 20.3 to 30.7 ft below ground surface, which corresponds to a water level ranging between approximately El. 277.1 and El. 279.1. It should be noted that measurements estimated during the soundings did not involve physical observation of water levels, but rather an estimated water level based on pore pressure measurements. The estimates of water levels at each sounding should only be considered accurate to the degree implied by the determination method.

Water levels were measured in the two (2) new observation wells are summarized in **Table IV**. Water levels measured in observation well HAB-08OW generally ranged from 8.0 to 12.3 ft below ground surface, which corresponds to a water level ranging between approximately El. 296.5 and 300.8. Water was not observed in the two recorded reading events in observation well HAB-10OW.

Water level readings have been made in the subsurface explorations 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 season, rainfall, temperature, plant activities, and other factors not evident at the time measurements were made and reported herein.

5. Discussion

5.1 PRELIMINARY MATERIAL PROPERTIES

Preliminary material properties to be used in analyses for slope stability have been evaluated using historic subsurface explorations, current explorations and laboratory testing. Preliminary material properties are summarized in **Table V**. Additional details are included in **Appendix F**.

TABLE V
PRELIMINARY MATERIAL PROPERTIES

Material	Material Strength	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degrees)	Vertical Stress Ratio	Minimum Shear Strength (psf)
Fly Ash Fill	Drained	105	0	34	--	--
	Undrained	105	--	0	0.30	500
Embankment Fill (Levee)	Drained	120	300	15	--	--
	Undrained	120	--	0	0.27	550
Embankment Fill (Non-Levee)	Drained	120	300	28	--	--
	Undrained	120	--	0	0.39	1,000
Alluvial Deposits (Cohesive)	Drained	120	0	30	--	--
	Undrained	120	--	0	0.50	1,000
Alluvial Deposits (Granular)	Drained	120	0	34	--	--
	Undrained	120				
Fluvial Deposits	Drained	125	0	38	--	--
	Undrained	125				

References

1. Cushing, E.M., Boswell, E.H., and Hosman, R.L, (1964), "General Geology of the Mississippi Embayment", Department of the Interior, Geological Survey Professional Paper 448-B.

2. Geotechnology, Inc. (June 2009). "Stability Evaluations Slag Pond 1 and Ash Pond 2 AECI New Madrid Power Generating Facility, New Madrid County, Missouri".

3. Rosenblad, B.L. (2007), "Deep Shear Wave Velocity Profiles of Mississippi Embayment Sediments Determined from Surface Wave Measurements," Research supported by the U.S.G.S., Department of Interior, under USGS award number 06HQGR0131.

4. Van Arsdale, R.B. and TenBrink, R.K. (2000), "Late Cretaceous and Cenozoic Geology of the New Madrid Seismic Zone," Bulletin of the Seismological Society of America, 90, 2, pp. 345-356, April 2000.

TABLES

TABLE I

SUMMARY OF HISTORIC SUBSURFACE EXPLORATIONS
LINED POND
NEW MADRID POWER PLANT
MARSTON, MISSOURI

Exploration Designation[1]	Ground Surface Elevation[2] (ft)	Total Exploration Depth (ft)	Groundwater[3]	
			Depth Below Ground Surface (ft)	Elevation (ft)
TEST BORINGS PERFORMED BY GEOTECHNOLOGY, INC. IN 2009				
P-6	311	85.0	30.2	280.8
P-7	308	55.0	27.4	280.6
TEST PITS PERFORMED BY GEOTECHNOLOGY, INC. IN 2009				
TP-8	308	13.0	Not Encountered	--
TP-9	315	16.0	Not Encountered	--
TP-10	314	16.0	11.0	303.0

Notes:

1. Technical monitoring of explorations shown above was not performed by Haley & Aldrich, Inc.
2. Ground surface elevations are in feet and the datum is unknown.
3. Groundwater level readings represent the highest water level observed either during drilling, after completion of the exploration, or a subsequent piezometer level reading. Refer to the test boring logs for additional water level data.

TABLE II

SUMMARY OF CURRENT SUBSURFACE EXPLORATIONS
LINED POND
NEW MADRID POWER PLANT
MARSTON, MISSOURI

Exploration Designation[1]	Ground Surface EL.[2] (ft)	Northing[2] (ft)	Easting[2] (ft)	Depth (ft)	Water[3]	
					Depth Below Ground Surface (ft)	Elevation (ft)
TEST BORINGS						
HA-B8OW	308.8	244935.6	1096598.5	20.0	8.0	300.8
HA-B9	307.5	244393.7	1095065.9	31.0	30.0	277.5
HA-B9A	299.5	244415.0	1094991.2	95.0	Not Measured	Not Measured
HA-B10OW	308.2	245043.8	1097673.9	34.0	32.0	276.2
TEST PITS						
TP3-1	309.1	245081.1	1095786.0	10.0	9.0	300.1
TP3-2	308.1	245293.0	1096950.5	11.0	11.0	297.1
TP3-3	310.8	244272.9	1095470.8	10.0	10.0	300.8
TP3-4	308.2	244507.6	1096655.0	10.0	9.0	299.2
CONE PENETROMETER SOUNDINGS						
HA-C11	307.8	245478.9	1097019.4	50.9	N/A	N/A
HA-C12	308.6	245012.0	1097686.7	75.1	N/A	N/A
HA-C13	308.8	244939.9	1096612.2	20.0	N/A	N/A
HA-C14	299.3	244425.8	1094993.6	50.0	N/A	N/A
HA-C15	307.8	244389.9	1095064.6	95.3	N/A	N/A
HA-C16	307.9	244071.3	1097154.4	50.0	N/A	N/A
HA-C17	307.9	245097.9	1095393.7	50.0	N/A	N/A

Notes:

1) Technical monitoring of subsurface explorations completed during the period 12 June to 21 June 2017 was performed by Haley & Aldrich, Inc.

2) Ground surface elevations and coordinates of subsurface explorations were determined in the field by AECI by rover GPS unit. Ground surface elevations are in feet and reference North American Vertical Datum of 1988 (NAVD88). The horizontal control is the Missouri State Plane East, which is based on NAD83.

3) Water level readings represent the highest water level observed either during drilling or after completion of the exploration. Refer to the subsurface exploration logs for additional water level data. Water level readings have been made in the subsurface explorations 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 season, rainfall, temperature, plant operations, and other factors not evident at the time measurements were made and reported.

TABLE III
SUMMARY OF LABORATORY TEST RESULTS
LINED POND
NEW MADRID POWER PLANT
MARSTON, MISSOURI

Exploration Designation	Sample Number	Sample Depth (ft)	USCS Symbol	Material Type[1]	Moisture Content (%)	LL	PL	PI[1]	% Gravel	% Sand	% Fines	Standard Proctor		UU Triaxial			CU Triaxial[2]				Consolidation				
												Optimum Moisture Content (%)	Maximum Dry Density (pcf)	Moisture Content (%)	Dry Density (pcf)	Undrained Shear Strength (psf)	Average Moisture Content (%)	Average Dry Density (pcf)	c' (psf)	ϕ' (degrees)	Moisture Content (%)	Dry Density (pcf)	e_o[3]	C_C[3]	C_{CR}[3]
HA-B8OW	S3	4.0-6.0	ML	Fly Ash Fill	115.2				0	28	72														
HA-B8OW	S8	14.0-16.0	ML	Fly Ash Fill	95.4						84														
HA-B9	U1	6.8	CH	Embankment Fill	34.6	90	31	59			98						34.8	86.4	380	14.0					
HA-B9	S4	12.0-14.0	CL	Alluvial	21.4	45	22	23																	
HA-B9	U3	14.4	ML	Alluvial	19.6	35	25	10			97			24.7	94.4	2200					22.6	98.1	0.72	0.109	0.007
HA-B9	U3	15.0	ML	Alluvial										25.7	96.6	2600									
HA-B9	S6	24.0-26.0	SP-SM	Alluvial	4.7				0	90	10														
HA-B9A	S1	18.0-20.0	ML	Alluvial	30.9	26	22	4																	
HA-B9A	S3	28.0-30.0	SP	Fluvial	17.6						5														
HA-B9A	S11	68.0-70.0	SP	Fluvial	20.2				0	97	3														
HA-B10OW	S2	2.0-4.0	CL	Embankment Fill	18.0	31	19	12																	
HA-B10OW	S5	8.0-10.0	CL	Embankment Fill	20.4						87														
HA-B10OW	U1	10.0-12.0	CH	Embankment Fill	29.9	93	27	66			98														
HA-B10OW	U2	18.0-20.0	CH	Embankment Fill	19.0	54	17	37			96						20.4	106.5	750	25.0					
HA-B10OW	U3	30.0-32.0	ML	Alluvial	36.4	21	23	NP			100						31.4	91.9	0	36.5					
TP-3-2	Bulk (remolded)	0.0-11.0	ML	Fly Ash Fill	103.7	Non-Plastic			0	23	77	70.6	53.8				97.5	44.5	0	39	87.2	49.8	2.06	0.294	0.000
																	80.0	51.2	180	41					
TP-3-4	Bulk (remolded)	0.0-9.0	ML	Fly Ash Fill	113.4	Non-Plastic			0	58	52	64.9	54.4												

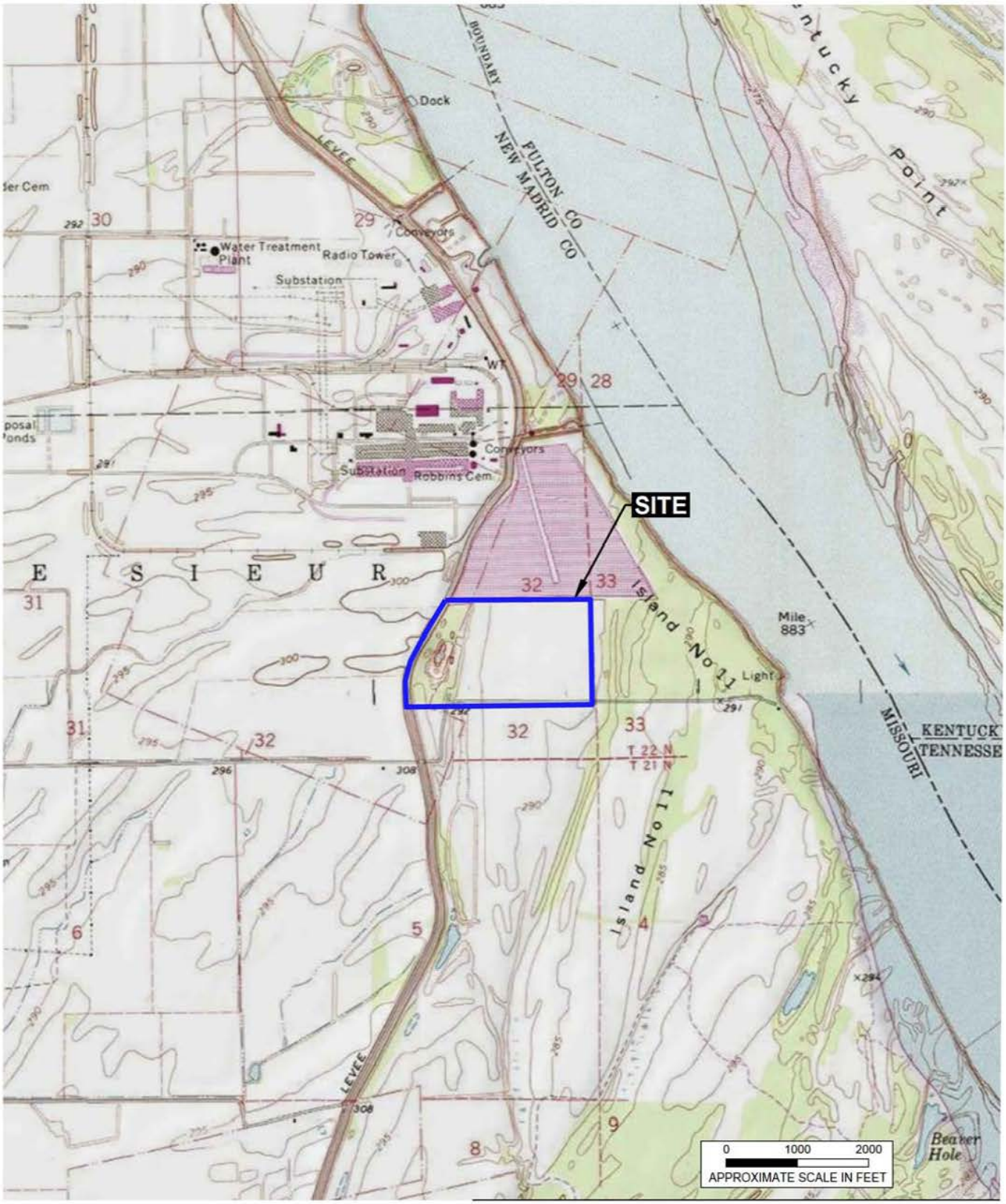
Notes:
1. NP = Non-Plastic
2. All CU Trixial tests were multi-stage tests using a single sample.
3. e_o = Initial Void Ratio, C_C = Compression Index, C_{CR} = Recompression Index

TABLE IV
SUMMARY OF SUBSURFACE WATER LEVEL MEASUREMENTS
LINED POND
NEW MADRID POWER PLANT
MARSTON, MISSOURI

Observation Well Designation	Top of Casing Elevation (ft)	Ground Surface Elevation (ft)	Well Depth (ft)	Measurement Date	Depth to Water[1] (ft)	Subsurface Water Elevation (ft)	Well Installation Notes
HAB-08OW	311.8	308.8	20.0	6/15/2017	8.0	300.8	Installed on 6/12/17 by Bulldog Drilling, Inc.
				11/2/2017	12.3	296.5	
HAB-10OW	311.0	308.2	26.0	6/15/2017	Dry	--	Installed on 6/13/17 by Bulldog Drilling, Inc.
				11/2/2017	Dry	--	

Notes:
1) Subsurface water 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 subruface water may occur due to variations in season, rainfall, temperature, plant activities, and other factors not evident at the time measurements were made and reported.
2) Ground surface elevations of historic piezometers and were provided by AECI. Top of Casing Elevations were approximated using the surveyed ground surface elevations and a field measurement of top of casing to ground surface.

FIGURES



MAP SOURCE: ESRI

SITE COORDINATES: 36°30'14"N, 89°33'36"W

HALEY ALDRICH

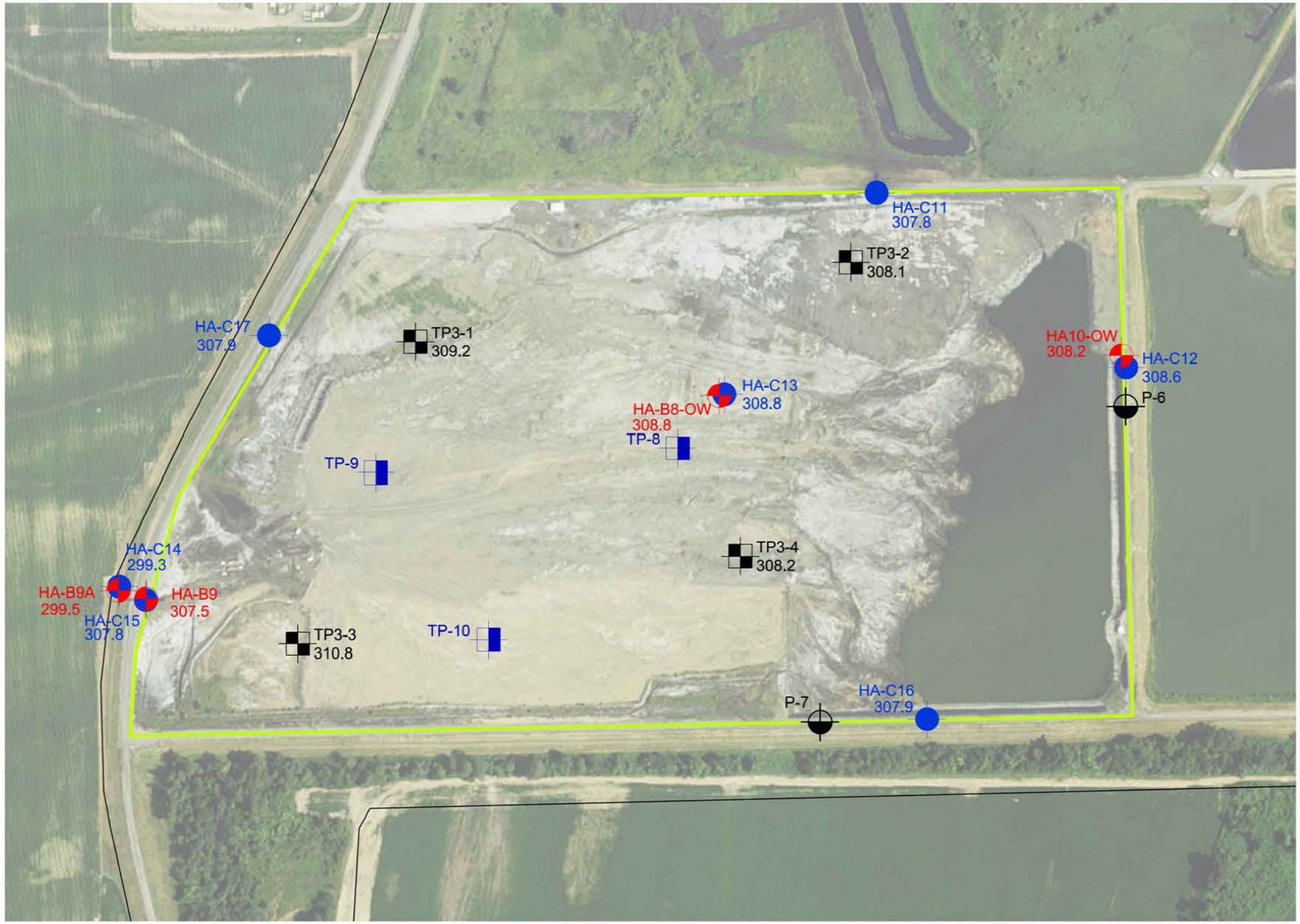
LINED POND
AECI, NEW MADRID POWER PLANT
MARSTON, MISSOURI

SITE LOCUS

SCALE: AS SHOWN
APRIL 2018

FIGURE 1

POSTOLOWSKI, KEVIN Printed: 4/9/2018 9:52 AM Layout: FIG 1 (2018-ARPIL)
Z:\CLE_COMMON\PROJECTS\129342 AECI-NMPP\CAD\LINED POND\FIGURES\129342 005 FIG-1 LOCUS.DWG



LEGEND

- APPROXIMATE LIMIT OF CCR UNIT
- HA-B10-OW 308.2 — DESIGNATION, LOCATION AND GROUND SURFACE ELEVATION OF TEST BORINGS PERFORMED BY BULLDOG DRILLING OF DUPO, ILLINOIS DURING THE PERIOD 12 JUNE 2017 TO 14 JUNE 2017. BORINGS WITH AN "OW" DESIGNATION INDICATES THE BORING WAS CONVERTED TO AN OBSERVATION WELL
- HA-C12 308.6 — DESIGNATION, LOCATION AND GROUND SURFACE ELEVATION OF CONE PENETROMETER SOUNDINGS PERFORMED BY CONETEC, INC. OF WEST BERLIN, NEW JERSEY DURING THE PERIOD 12 JUNE 2017 TO 13 JUNE 2017.
- P-7 — APPROXIMATE LOCATION OF EXISTING BORING PERFORMED BY GEOTECHNOLOGY IN 2009.
- TP3-1 309.2 — DESIGNATION, LOCATION AND GROUND SURFACE ELEVATION OF TEST PITS PERFORMED BY DUMEY CONTRACTING OF BENTON, MISSOURI ON 21 JUNE 2017.
- TP-8 — DESIGNATION AND APPROXIMATE LOCATION OF EXISTING TEST PITS PERFORMED BY GEOTECHNOLOGY IN 2009.

NOTES:

1. BACKGROUND IMAGE IS DATED 2 AUGUST 2014 FROM ESRI GIS.
2. ELEVATIONS INDICATED ON THIS DRAWING ARE IN FEET AND REFER TO NAVD88 DATUM. HORIZONTAL DATUM IS MISSOURI STATE PLANE NAD83, EAST ZONE US FOOT.
3. TECHNICAL MONITORING OF TEST BORINGS, CONE PENETROMETER SOUNDINGS, AND TEST PITS COMPLETED DURING THE PERIOD 12 JUNE 2017 TO 21 JUNE 2017 WAS PERFORMED BY HALEY & ALDRICH, INC.
4. AS DRILLED LOCATIONS AND GROUND SURFACE ELEVATIONS OF 2017 TEST BORINGS, CONE PENETROMETER SOUNDINGS, AND TEST PITS WERE DETERMINED IN THE FIELD BY AECI BY ROVER GPS UNIT.

N

0 300 601
SCALE IN FEET

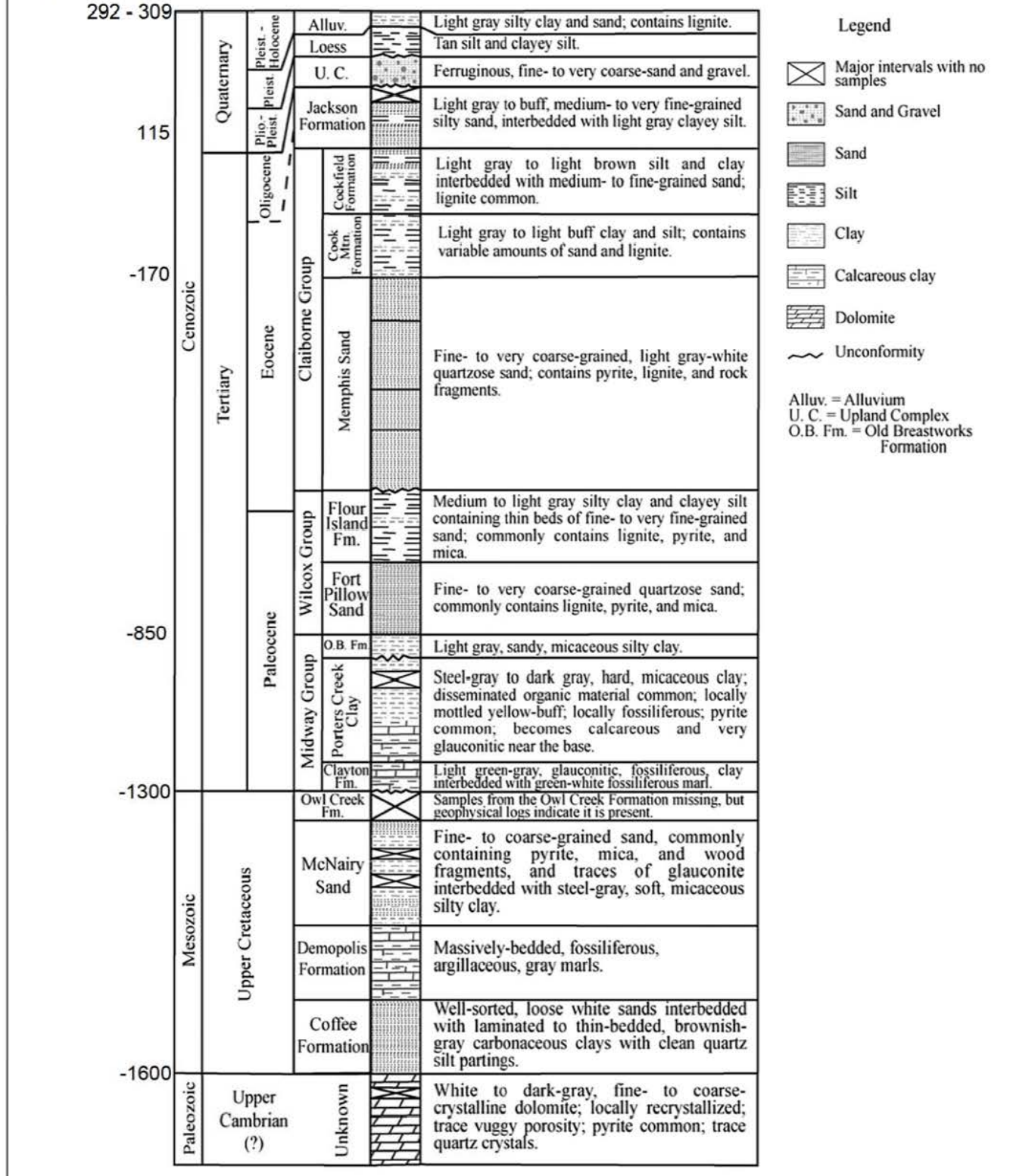
HALEY ALDRICH

LINED POND
AECI, NEW MADRID POWER PLANT
MARSTON, MISSOURI

SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
NOVEMBER 2017

FIGURE 2



NOTES

1. IMAGE REFERENCE: VAN ARSDALE AND TENBRINK (2000).

2. ELEVATIONS SHOWN ARE SPECIFIC TO THE NEW MADRID POWER PLAN SITE AND WERE ESTIMATED USING FIGURES FROM VAN ARSDALE AND TENBRINK (2000) AND ROSENBLAD (2007).

3. ELEVATIONS INDICATED ON THIS DRAWING ARE IN FEET AND REFER TO NAVD 1988 DATUM.

HALEY ALDRICH

LINED POND
AECI, NEW MADRID POWER PLANT
MARSTON, MISSOURI

GEOLOGIC COLUMN FOR THE NEW MADRID SEISMIC ZONE

APPROXIMATE SCALE: AS SHOWN
APRIL 2018

FIGURE 3

129342-015 FIG_3.PDF

APPENDIX A

Current Test Boring Logs and Observation Well Installation Reports

TEST BORING REPORT

Boring No. HA-B8OW

Project	Lined Pond, New Madrid Power Plant Marston, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	None	Rig Make & Model: CME 550
Inside Diameter (in.)	4.25	1.375	--	Bit Type: Cutting Head Drill Mud: None
Hammer Weight (lb)	--	140	-	Casing: HSA
Hammer Fall (in.)	--	30	-	Hoist/Hammer: Winch / Automatic Hammer PID Make & Model:

File No.	129342-005
Sheet No.	1 of 2
Start	12 June 2017
Finish	12 June 2017
Driller	C. Dutton
H&A Rep.	C. Toscano
Elevation	308.8
Datum	NAVD88
Location	N 244,935.6 E 1,096,598.5

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0	3 6 6 5	S1 24	0.0 2.0			ML	Medium dense dark brown to gray-brown SILT (ML), stratified, no odor, wet -FLY ASH-						100				
	1 1 3 8	S2 24	2.0 4.0			ML	Very loose dark brown to gray-brown SILT (ML), stratified, no odor, wet, contains trace fine sand						100				
5	10 6 3 6	S3 24	4.0 6.0			ML	Loose dark brown to gray-brown SILT with sand (ML), no odor, wet, contains intermixed seams and layers of cinders				12	16	72				
	3 9 9 13	S4 24	6.0 8.0			ML	Medium dense dark brown to gray-brown sandy SILT (ML), no odor, wet, contains intermixed seams and layers of cinders				20	10	70				
10	10 12 6 8	S5 24	9.0 11.0			ML	Medium dense dark brown to gray-brown sandy SILT (ML), no odor, wet, contains intermixed seams of cinders				10	20	70				
	6 4 8 4	S6 12	12.0 14.0			ML	Medium dense dark brown to gray-brown sandy SILT (ML), no odor, wet, contains intermixed seams of cinders				15	15	70				
15	6 10 5 5	S7 24	14.0 16.0			ML	Medium dense dark brown to gray-brown sandy SILT (ML), no odor, wet, contains intermixed seams of cinders				15	15	70				
	5 5 16 21	S8 20	16.0 18.0			ML	Medium dense gray-brown SILT with sand (ML), wet				5	11	84				
	10 5	S9 24	18.0 20.0			ML	Medium dense gray-brown SILT with sand (ML), wet				5	20	75				

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
6/12/17		0	8.0	10.0	8.0
6/15/17		3 days	20.0	20.0	9.0
6/21/17		9 days	20.0	20.0	8.0

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)	20.0
Rock Cored (ft)	0.0
Samples	9S

Boring No. HA-B8OW

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. HA-B8OW
File No. 129342-005
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
	18 16				288.8		-FLY ASH-										
20					20.0		BOTTOM OF EXPLORATION 20.0 FT Note: Attempted to push undisturbed tube samples at 4, 6, 8, 11 and 14 ft, but could not due to hardness of material. Attempted five tubes, bent two tubes. Note: Set observation well at 20.0 ft. See Observation Well Report for details.										

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

Boring No. HA-B8OW

TEST BORING REPORT

Boring No. HA-B9

Project	Lined Pond, New Madrid Power Plant Marston, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	None	Rig Make & Model: CME 550
Inside Diameter (in.)	4.25	1.375	--	Bit Type: Cutting Head Drill Mud: None
Hammer Weight (lb)	--	140	-	Casing: HSA
Hammer Fall (in.)	--	30	-	Hoist/Hammer: Winch / Automatic Hammer PID Make & Model:

File No.	129342-005
Sheet No.	1 of 2
Start	13 June 2017
Finish	13 June 2017
Driller	C. Dutton
H&A Rep.	C. Toscano
Elevation	307.5
Datum	NAVD88
Location	N 244,393.7 E 1,095,065.9

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 15 18 13	S1 18	0.0 2.0		ML	Dense dark brown to olive-brown SILT with sand (ML), no odor, moist, contains intermixed cinders with layers of silty fine sand			5	10	10	75				
				305.5 2.0												
	5 5 5 4	S2 24	2.0 4.0		SM	Loose dark brown silty SAND (SM), no odor, moist, contains intermixed cinders -EMBANKMENT FILL-			15	30	30	25				
				303.5 4.0												
5	P U S H	U1A 12	4.0 6.0		ML	Yellow-brown sandy SILT (ML), contains trace cinder particles										
				301.5 6.0												
	P U S H	U1 21	6.0 8.0		CH	Gray and brown fat CLAY (CH)					2	98				
				300.0 7.5												
	3 3 4 3	S3 24	8.0 10.0		SM	Loose yellow-brown silty SAND (SM), no odor, dry -ALLUVIAL DEPOSITS-					60	40				
10	P U S H	U2 20	10.0 12.0		SM	Yellow-brown silty SAND (SM)										
				295.5 12.0												
	5 4 5 5	S4 20	12.0 14.0		CL	Stiff yellow-brown lean CLAY (CL), moist					10	90				
				293.5 14.0												
15	P U S H	U3 21	14.0 16.0		ML	Brown SILT (ML)					3	97				
				289.5 18.0												
	3 3 3 5	S5 24	18.0 20.0		MH	Medium stiff light brown elastic SILT (MH), moist, contains fine sand in frequent partings and layers						100				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
6/13/17	15:10	0.25	29.0	31.0	30.0

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)	31.0
Rock Cored (ft)	0.0
Samples	7S, 3U

Boring No. HA-B9

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. HA-B9
File No. 129342-005
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20				285.5 22.0												
25	6 8 9 11	S6 20	24.0 26.0		SP-SM	Medium dense tan poorly graded SAND with silt (SP-SM), dry -ALLUVIAL DEPOSITS-				3	87	10				
				278.5 29.0												
30 ▽	3 6 7 8	S7 15	29.0 31.0		SP	Medium dense tan poorly graded SAND (SP), wet				80	20					
				276.5 31.0		BOTTOM OF EXPLORATION 31.0 FT Note: Borehole grouted to ground surface upon completion.										

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

Boring No. HA-B9

TEST BORING REPORT

Boring No. HA-B9A

Project	Lined Pond, New Madrid Power Plant Marston, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	None	Rig Make & Model: CME 550
Inside Diameter (in.)	4.25	1.375	--	Bit Type: Roller Bit Drill Mud: Bentonite
Hammer Weight (lb)	--	140	-	Casing: Mud Rotary
Hammer Fall (in.)	--	30	-	Hoist/Hammer: Winch / Automatic Hammer PID Make & Model:

File No.	129342-005
Sheet No.	1 of 4
Start	14 June 2017
Finish	14 June 2017
Driller	C. Dutton
H&A Rep.	C. Toscano
Elevation	299.5
Datum	NAVD88
Location	N 244,415.0 E 1,094,991.2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						Note: HA-B9A was drilled at the toe of the levee embankment slope in line with HA-B9 on the levee embankment crest. Advanced borehole to 18 ft.										
5																
10																
15																
				281.5												
	3 3 3 6	S1 24	18.0 20.0	18.0	ML	Loose brown sandy SILT (ML), no odor, wet, contains fine sand in frequent seams and layers -ALLUVIAL DEPOSITS-					40	60				
20																

Water Level Data

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

Sample ID

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

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	95.0
Rock Cored (ft)	0.0
Samples	16S

Boring No. HA-B9A

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. HA-B9A
File No. 129342-005
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				276.5												
	4 5 6 6	S2 24	23.0 25.0	23.0	SM	Medium dense brown silty SAND (SM), no odor, wet					60	40				
25						-ALLUVIAL DEPOSITS-										
				273.5 26.0												
	11 14 16 21	S3 24	28.0 30.0		SP	Medium dense brown poorly graded SAND (SP), wet				60	35	5				
30						-FLUVIAL DEPOSITS-										
	6 10 9 11	S4 24	33.0 35.0		SP	Medium dense brown poorly graded SAND (SP), wet, contains trace coarse to fine gravel			15	65	20					
35																
	10 13 14 15	S5 10	38.0 40.0		SP	Medium dense brown poorly graded SAND (SP), wet				80	20					
40																
	15 16 14 13	S6 20	43.0 45.0		SP	Medium dense brown poorly graded SAND (SP), wet			15	75	10					
45																
	10 14 16 18	S7 24	48.0 50.0		SP	Medium dense gray poorly graded SAND (SP), wet			5	80	5					

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

HALEY ALDRICH

TEST BORING REPORT

Boring No. HA-B9A
File No. 129342-005
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 % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50																
				246.5												
	6 8 12 16	S8 24	53.0 55.0	53.0	SM	Medium dense gray silty SAND (SM), no odor, wet				5	80	15				
55						-FLUVIAL DEPOSITS-										
				241.5												
	12 14 14 16	S9 20	58.0 60.0	58.0	SP	Medium dense gray poorly graded SAND (SP), wet				25	70	5				
60																
	15 15 18 21	S10 20	63.0 65.0		SP	Dense gray poorly graded SAND (SP), wet			5	80	15					
65																
	13 17 22 22	S11 24	68.0 70.0		SP	Dense gray poorly graded SAND (SP), wet			1	16	80	3				
70																
	11 13 15 15	S12 15	73.0 75.0		SP	Medium dense gray poorly graded SAND (SP), wet			5	85	10					
75																
	11 11 10	S13 18	78.0 80.0		SP	Medium dense gray poorly graded SAND (SP), wet			15	80	5					

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

Boring No. HA-B9A

HALEY ALDRICH

TEST BORING REPORT

Boring No. HA-B9A
File No. 129342-005
Sheet No. 4 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
	10															
80																
	11 13 16 17	S14 15	83.0 85.0		SP	Medium dense gray poorly graded SAND (SP), wet			25	70	5					
85						-FLUVIAL DEPOSITS-										
	10 14 15 15	S15 12	88.0 90.0		SP	Medium dense gray poorly graded SAND (SP), wet			5	90	5					
90																
	11 15 15 16	S16 16	93.0 95.0		SP	Medium dense gray poorly graded SAND (SP), wet			5	90	5					
95				204.5 95.0		BOTTOM OF EXPLORATION 95.0 FT Note: Due to the use of drilling fluid, groundwater was not measured. Borehole grouted to ground surface upon completion.										

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

Boring No. HA-B9A

TEST BORING REPORT

Boring No. HA-B10OW

Project	Lined Pond, New Madrid Power Plant Marston, MO
Client	Associated Electric Cooperative, Inc.
Contractor	Bulldog Drilling

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	None	Rig Make & Model: CME 550
Inside Diameter (in.)	4.25	1.375	--	Bit Type: Cutting Head Drill Mud: None
Hammer Weight (lb)	--	140	-	Casing: HSA
Hammer Fall (in.)	--	30	-	Hoist/Hammer: Winch / Automatic Hammer PID Make & Model:

File No.	129342-005
Sheet No.	1 of 2
Start	13 June 2017
Finish	13 June 2017
Driller	C. Dutton
H&A Rep.	C. Toscano
Elevation	308.2
Datum	NAVD88
Location	N 245,043.8 E 1,097,673.9

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0	6 5 4 6	S1 20	0.0 2.0			CL	Stiff brown lean CLAY (CL), no odor, dry						100	S	N	L	M
	3 4 4 8	S2 12	2.0 4.0			CL	Medium stiff brown lean CLAY (CL), no odor, moist -EMBANKMENT FILL-						100				
5	3 4 6 8	S3 18	4.0 6.0			CL	Stiff brown lean CLAY (CL), no odor, moist, contains trace fine gravel and coarse to fine sand						100				
	3 6 8 4	S4 15	6.0 8.0			CL	Stiff dark brown to gray-brown lean CLAY (CL), mottled, trace fine sand, no odor, moist						100	N	L	M	H
	3 5 5 7	S5 10	8.0 10.0			CL	Stiff dark brown to gray-brown lean CLAY (CL), mottled gray-brown to olive-brown, no odor, moist, fine sand in frequent seams					13	87		L	M	H
10					298.2												
	P U S H	U1 24	10.0 12.0		10.0	CH	Dark gray fat CLAY (CH)					2	98				
	3 3 6 7	S6 20	12.0 14.0			CH	Stiff gray-brown fat CLAY (CH), no odor, moist Note: Pond liner lodged in tip of spoon.						100			H	
					294.2												
	2 5 7 9	S7 16	14.0 16.0		14.0	CL	Stiff dark brown to gray-brown lean CLAY (CL), mottled, no odor, moist, contains trace fine sand						100				
15	3 5 5 7	S8 24	16.0 18.0			CL	Stiff dark brown to gray-brown lean CLAY (CL), mottled, no odor, moist, contains trace fine sand						100				
					290.2												
	P U S H	U2 18	18.0 20.0		18.0	CH	Gray and brown fat CLAY (CH)					4	96				

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
6/13/17		0	32.0	34.0	32.0

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)	34.0
Rock Cored (ft)	0.0
Samples	19S, 3U

Boring No. HA-B10OW

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. HA-B10OW
File No. 129342-005
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	4 8 14 16	S9 24	20.0 22.0		288.2 20.0	ML	Very stiff light brown sandy SILT (ML), no odor, moist -ALLUVIAL DEPOSITS-					40	60				
	5 8 12 12	S10 24	22.0 24.0			ML	Very stiff olive-brown SILT with sand (ML), no structure, no odor, moist					20	80				
	3 7 10 10	S11 24	24.0 26.0		284.2 24.0	MH	Very stiff brown to gray-brown elastic SILT (MH), moist, contains trace fine sand						100				
25	1 2 3 6	S12 24	26.0 28.0		282.2 26.0	CH	Medium stiff brown fat CLAY (CH), no odor, moist						100	N	H	H	H
	1 2 2 2	S13 24	28.0 30.0			CH	Soft brown fat CLAY (CH), no odor, moist						100				
30	PUSH	U3 24	30.0 32.0		278.2 30.0	ML	Brown SILT (ML)						100				
	1 2 2 3	S14 24	32.0 34.0			ML	Soft brown SILT (ML), wet, with fine sand in frequent seams and layers						100				
					274.2 34.0		-BOTTOM OF EXPLORATION 34.0 FT Note: Set observation well at 26.0 ft. See Observation Well Report for details.										

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

Boring No. HA-B10OW

OBSERVATION WELL INSTALLATION REPORT

Privileged and Confidential

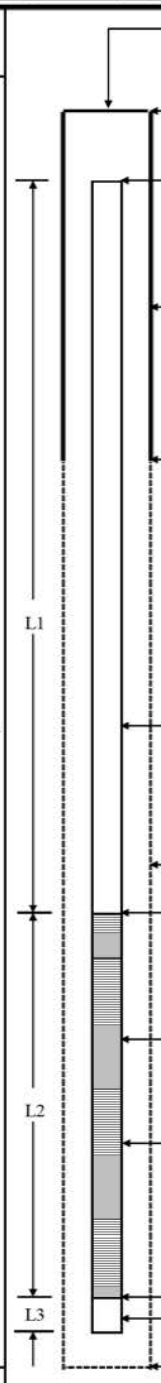
Well No. HA-B8OW
Boring No. HA-B8OW

PROJECT	Lined Pond	**H&A FILE NO.**	129342-005
LOCATION	New Madrid Power Plant - Marston, MO	**PROJECT MGR.**	J. Pokorny
CLIENT	Associated Electric Cooperative, Inc.	**FIELD REP.**	C. Toscano
CONTRACTOR	Bulldog Drilling	**DATE INSTALLED**	6/12/2017
DRILLER	C. Dutton		

Ground El.	308.8	ft	**Location**	See Plan	☑ **Guard Pipe**
El. Datum	**NAVD88**		N 244,935.6/E 1,096,598.5		☐ **Roadway Box**

SOIL/ROCK CONDITIONS	**BOREHOLE BACKFILL**
0.0	0.0
	Concrete
	1.0
	Bentonite
Fly Ash	
	8.0
	Filter Sand
20	20
(Bottom of Exploration)	

(Numbers refer to depth from ground surface in feet)



(Not to Scale)

Type of protective cover/lock	Padlock
Height of guard pipe above ground surface	3.3 ft
Height of riser pipe above ground surface	3.0 ft
Type of protective casing:	Steel Casing
Length	5.0 ft
Inside Diameter	4.0 in
Depth of bottom of guard pipe	1.7 ft

Type of Seals	**Top of Seal (ft)**	**Thickness (ft)**
Concrete	0.0	1.0
Bentonite	1.0	7.0

Type of riser pipe:	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in
Type of backfill around riser	Bentonite, Cuttings
Diameter of borehole	7-5/8 in
Depth to top of well screen	10.0 ft
Type of screen	Machine Slotted
Screen gauge or size of openings	0.100 in
Diameter of screen	2.0 in
Type of backfill around screen	Filter Sand
Depth of bottom of well screen	20.0 ft
Bottom of Silt trap	-- ft
Depth of bottom of borehole	20.0 ft

23	ft	+	10	ft	+	0	ft	=	33	ft
Riser Pay Length (L1)			Length of screen (L2)			Length of silt trap (L3)			Pay length	

COMMENTS:

OBSERVATION WELL INSTALLATION REPORT

Privileged and Confidential

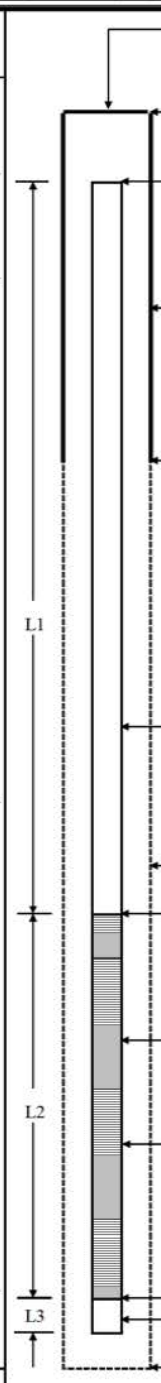
Well No. HA-B10OW
Boring No. HA-B10OW

PROJECT	Lined Pond	**H&A FILE NO.**	129342-005
LOCATION	New Madrid Power Plant - Marston, MO	**PROJECT MGR.**	J. Pokorny
CLIENT	Associated Electric Cooperative, Inc.	**FIELD REP.**	C. Toscano
CONTRACTOR	Bulldog Drilling	**DATE INSTALLED**	6/13/2017
DRILLER	C. Dutton		

Ground El.	308.2 ft	**Location**	See Plan	☑	**Guard Pipe**
El. Datum	NAVD88		N 245,043.8/E 1,097,673.9	☐	**Roadway Box**

SOIL/ROCK CONDITIONS	BOREHOLE BACKFILL
0.0	0.0
	Concrete
	1.0
Embankment FILL	Bentonite
	15.0
	Filter Sand
Alluvial Deposits	
	27.0
	Bentonite
34	34
(Bottom of Exploration)	

(Numbers refer to depth from ground surface in feet)



(Not to Scale)

Type of protective cover/lock	Padlock
Height of guard pipe above ground surface	3.0 ft
Height of riser pipe above ground surface	2.8 ft
Type of protective casing:	Steel Casing
Length	5.0 ft
Inside Diameter	4.0 in
Depth of bottom of guard pipe	2.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	1.0
Bentonite	1.0	14.0

Type of riser pipe:	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in
Type of backfill around riser	Bentonite
Diameter of borehole	7-5/8 in
Depth to top of well screen	16.0 ft
Type of screen	Machine Slotted
Screen gauge or size of openings	0.100 in
Diameter of screen	2.0 in
Type of backfill around screen	Filter Sand
Depth of bottom of well screen	26.0 ft
Bottom of Silt trap	-- ft
Depth of bottom of borehole	34.0 ft

18.8 ft	+	10 ft	+	0 ft	=	28.8 ft
Riser Pay Length (L1)		Length of screen (L2)		Length of silt trap (L3)		Pay length

COMMENTS:

APPENDIX B

Current Test Pit Logs

HALEY ALDRICH

TEST PIT LOG

Test Pit No. TP3-1

Page 1 of 1

PROJECT	Lined Pond, New Madrid Power Plant	**H&A FILE NO.**	129342-005
LOCATION	Marston, Missouri	**PROJECT MGR.**	Jason Pokorny
CLIENT	Associated Electric Cooperative, Inc.	**FIELD REP**	C. Toscano
CONTRACTOR	Dumey Contracting	**DATE**	21 June 2017
EQUIPMENT	John Deere 350D LC Track Excavator	**WEATHER**	Sunny, 80 Degrees

Ground El.	309.1 ft.	**Location**	See Plan	**Groundwater depths/entry rates (in./min.):**
El. Datum	NAVD88		N 245,081.1/E 1,095,786.0	9.0 ft - Slow entry

Depth (ft.)	Sample ID	Stratum Change Depth (ft.)	USCS Symbol	Visual Identification (Color, GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions, geologic interpretation)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0			ML	Dark brown SILT (ML)										
				-FLY ASH-										
4				Note: Distinct increase in hardness at 6.0 ft										
8														
				-BOTTOM OF TEST PIT 10.0 FT-										
12														
16														
20														
24														
28														

Obstructions:

Remarks:

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

Standing water in completed pit:

at depth 9.0 ft.

measured after 0.25 hrs. elapsed

Boulders:

Diameter (in.)	Number		Approx. vol. (cu. ft.)
12 to 24	0	=	-
over 24	0	=	-

Test Pit Dimensions (ft.):

Pit Depth	10.0
Pit Length X Width	10.0 X 5.0

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

Form 2006

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TEST PIT LOG

Test Pit No. TP3-2

Page 1 of 1

PROJECT	Lined Pond, New Madrid Power Plant	**H&A FILE NO.**	129342-005
LOCATION	Marston, Missouri	**PROJECT MGR.**	Jason Pokorny
CLIENT	Associated Electric Cooperative, Inc.	**FIELD REP**	C. Toscano
CONTRACTOR	Dumey Contracting	**DATE**	21 June 2017
EQUIPMENT	John Deere 350D LC Track Excavator	**WEATHER**	Sunny, 80 Degrees

Ground El.	308.1 ft.	**Location**	See Plan	**Groundwater depths/entry rates (in./min.):**
El. Datum	NAVD88		N 245,293.0/E 1,096,950.5	11.0 ft - Slow entry

Depth (ft.)	Sample ID	Stratum Change Depth (ft.)	USCS Symbol	Visual Identification (Color, GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions, geologic interpretation)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0			ML	Dark brown SILT (ML)										
				-FLY ASH-										
4														
8														
				-BOTTOM OF TEST PIT 11.0 FT-										
12				Note: Bulk sample collected 0 to 11.0 ft										
16														
20														
24														
28														

Obstructions:

Remarks:

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

Standing water in completed pit:

at depth 11.0 ft.

measured after 0.25 hrs. elapsed

Boulders:

Diameter (in.)	Number		Approx. vol. (cu. ft.)
12 to 24	0	=	-
over 24	0	=	-

Test Pit Dimensions (ft.):

Pit Depth	11.0
Pit Length X Width	10.0 X 5.0

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

Form 2006

HALEY ALDRICH

TEST PIT LOG

Test Pit No. TP3-3

Page 1 of 1

PROJECT	Lined Pond, New Madrid Power Plant	**H&A FILE NO.**	129342-005
LOCATION	Marston, Missouri	**PROJECT MGR.**	Jason Pokorny
CLIENT	Associated Electric Cooperative, Inc.	**FIELD REP**	C. Toscano
CONTRACTOR	Dumey Contracting	**DATE**	21 June 2017
EQUIPMENT	John Deere 350D LC Track Excavator	**WEATHER**	Sunny, 80 Degrees

Ground El.	310.8 ft.	**Location**	See Plan	**Groundwater depths/entry rates (in./min.):**
El. Datum	NAVD88		N 244,272.9/E 1,095,470.8	10.0 ft - Slow entry

Depth (ft.)	Sample ID	Stratum Change Depth (ft.)	USCS Symbol	Visual Identification (Color, GROUP NAME & SYMBOL, % oversized, maximum 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				Dark brown SILT (ML)										
				-FLY ASH-										
4				Note: Distinct increase in hardness at 5.0 ft										
8														
				-BOTTOM OF TEST PIT 10.0 FT-										
12														
16														
20														
24														
28														

Obstructions:

Remarks:

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

Standing water in completed pit:

at depth 10.0 ft.

measured after 0.25 hrs. elapsed

Boulders:

Diameter (in.)	Number		Approx. vol. (cu. ft.)
12 to 24	0	=	-
over 24	0	=	-

Test Pit Dimensions (ft.):

Pit Depth	10.0
Pit Length X Width	10.0 X 5.0

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

Form 2006

TEST PIT LOG

HALEY ALDRICH

Test Pit No. TP3-4

Page 1 of 1

PROJECT	Lined Pond, New Madrid Power Plant	**H&A FILE NO.**	129342-005
LOCATION	Marston, Missouri	**PROJECT MGR.**	Jason Pokorny
CLIENT	Associated Electric Cooperative, Inc.	**FIELD REP**	C. Toscano
CONTRACTOR	Dumey Contracting	**DATE**	21 June 2017
EQUIPMENT	John Deere 350D LC Track Excavator	**WEATHER**	Sunny, 80 Degrees

Ground El.	308.1 ft.	**Location**	See Plan	**Groundwater depths/entry rates (in./min.):**
El. Datum	NAVD88		N 244,507.6/E 1,096,655.0	9.0 ft - Slow entry

Depth (ft.)	Sample ID	Stratum Change Depth (ft.)	USCS Symbol	Visual Identification (Color, GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions, geologic interpretation)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0			ML	Dark brown SILT (ML)										
				-FLY ASH-										
				Note: Distinct increase in hardness at 3.0 ft										
4														
8				-BOTTOM OF TEST PIT 10.0 FT-										
				Note: Bulk sample collected 0 to 9.0 ft										
12														
16														
20														
24														
28														

Obstructions:

Remarks:

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

Standing water in completed pit:

at depth 9.0 ft.

measured after 0.25 hrs. elapsed

Boulders:

Diameter (in.)	Number		Approx. vol. (cu. ft.)
12 to 24	0	=	-
over 24	0	=	-

Test Pit Dimensions (ft.):

Pit Depth	10.0
Pit Length X Width	10.0 X 5.0

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

Form 2006

APPENDIX C

Current CPT Data

Job No:	17-53075
Client:	Haley & Aldrich
Project:	New Madrid Power Plant, Marston, MO
Sounding ID:	SCPT17-HA-C15
Date:	12-Jun-2017

Seismic Source:	Beam
Source Offset (ft):	1.00
Source Depth (ft):	0.00
Geophone Offset (ft):	0.66

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

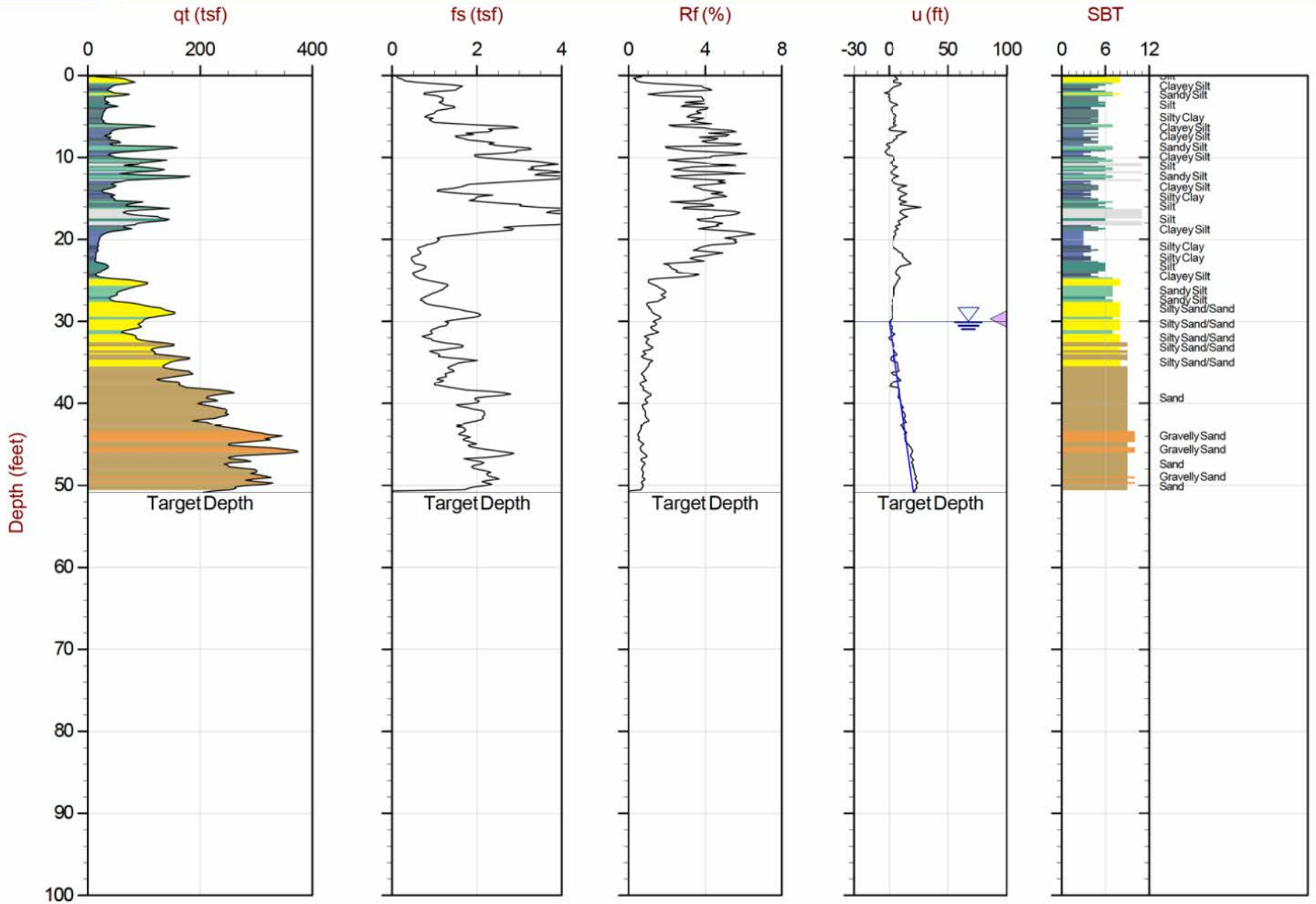
Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Ray Path Difference (ft)	Travel Time Interval (ms)	Interval Velocity (ft/s)
6.56	5.91	5.99			
13.12	12.47	12.51	6.52	8.22	793
19.69	19.03	19.06	6.55	8.43	777
26.25	25.59	25.61	6.55	9.92	661
32.81	32.15	32.17	6.56	10.16	646
39.37	38.71	38.73	6.56	11.11	590
45.93	45.28	45.29	6.56	9.97	658
52.49	51.84	51.85	6.56	9.49	691
59.06	58.40	58.41	6.56	8.13	807
65.62	64.96	64.97	6.56	8.49	773
72.18	71.52	71.53	6.56	8.68	756
78.74	78.08	78.09	6.56	8.11	809
85.30	84.65	84.65	6.56	8.16	804
91.86	91.21	91.21	6.56	7.96	824
95.14	94.49	94.49	3.28	3.62	905

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 2017-06-12 11:40
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C11
Cone: 206:T1500F15U500



Max Depth: 15.500 m / 50.85 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 17-53075_CPHA-C11.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4042888m E: 270893m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

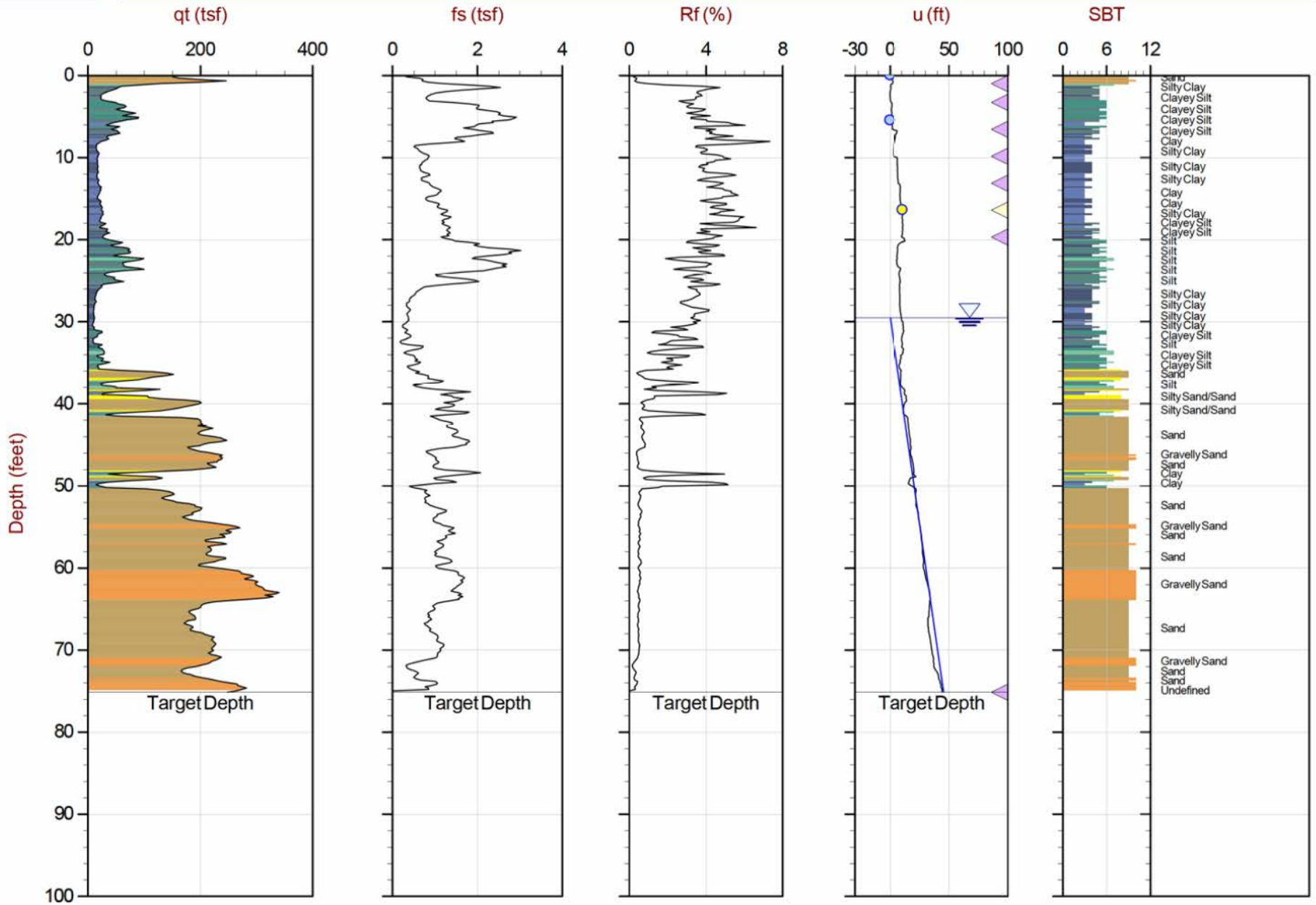
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 2017-06-12 12:55
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C12
Cone: 206:T1500F15U500



Max Depth: 22.900 m / 75.13 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 17-53075_CPHA-C12.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4042742m E: 271089m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

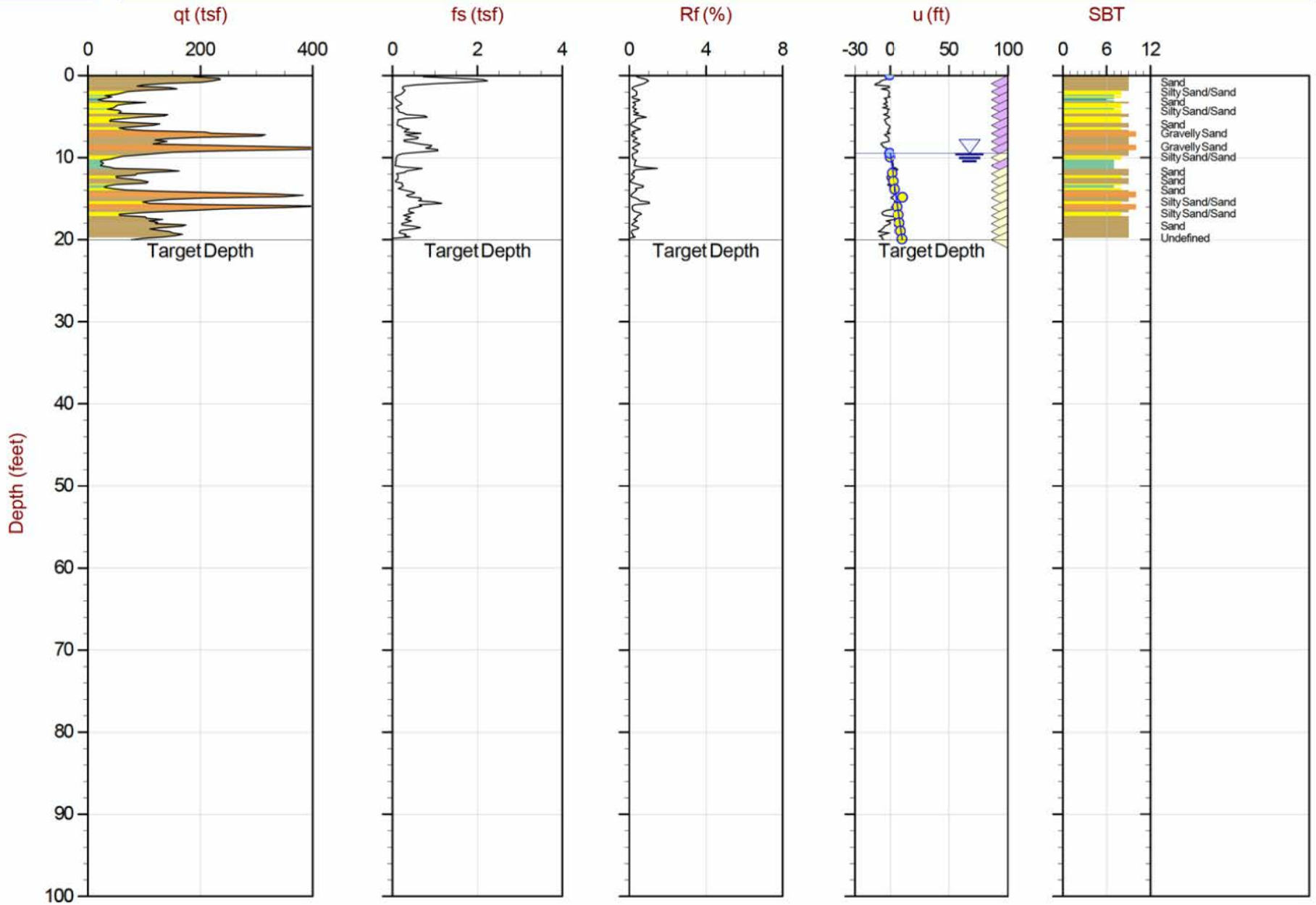
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 2017-06-13 08:41
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: 268:T1500F15U500



Max Depth: 6.100 m / 20.01 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 17-53075_CPHA-C13.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4042731m E: 270764m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

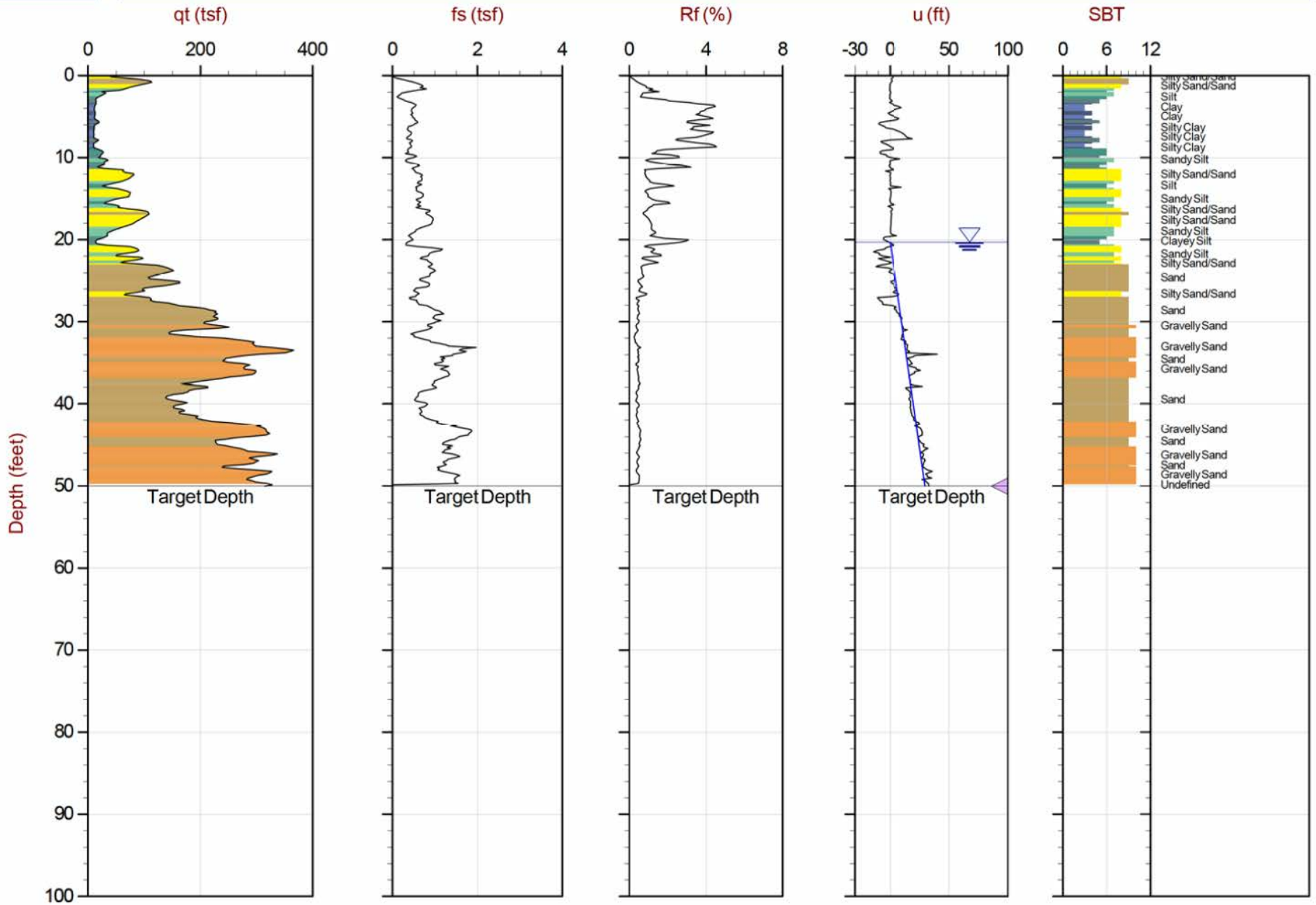
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 2017-06-13 12:30
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C14
Cone: 268:T1500F15U500



Max Depth: 15.250 m / 50.03 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 17-53075_CPHA-C14.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4042595m E: 270264m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

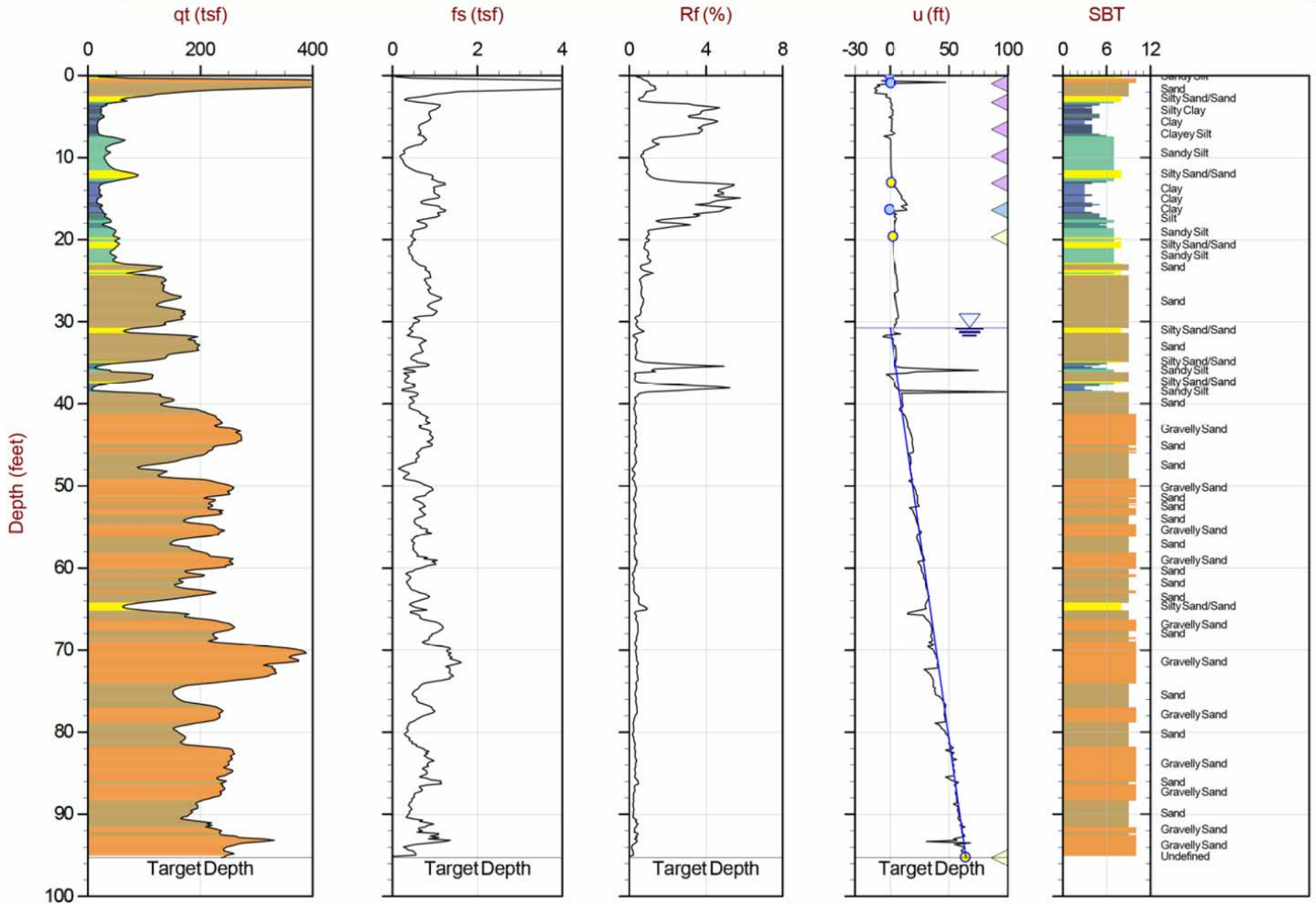
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 2017-06-12 16:20
Site: New Madrid Power Plant, Marston, MO

Sounding: SCPT17-HA-C15
Cone: 206:T1500F15U500



Max Depth: 29.050 m / 95.31 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 17-53075_SPHA-C15.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4042586m E: 270283m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

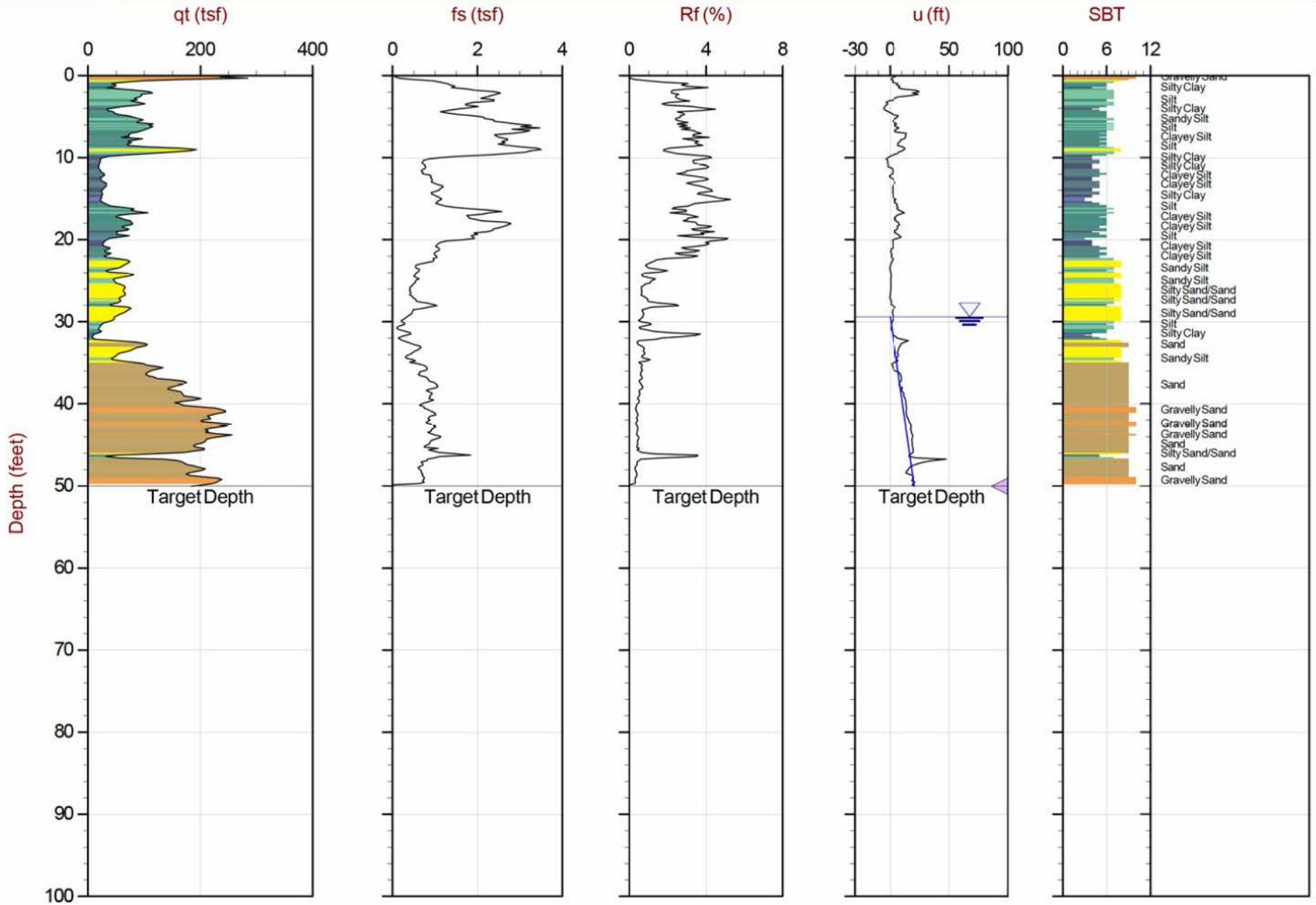
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 2017-06-12 15:12
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C16
Cone: 206:T1500F15U500



Max Depth: 15.250 m / 50.03 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 17-53075_CPHA-C16.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4042456m E: 270919m

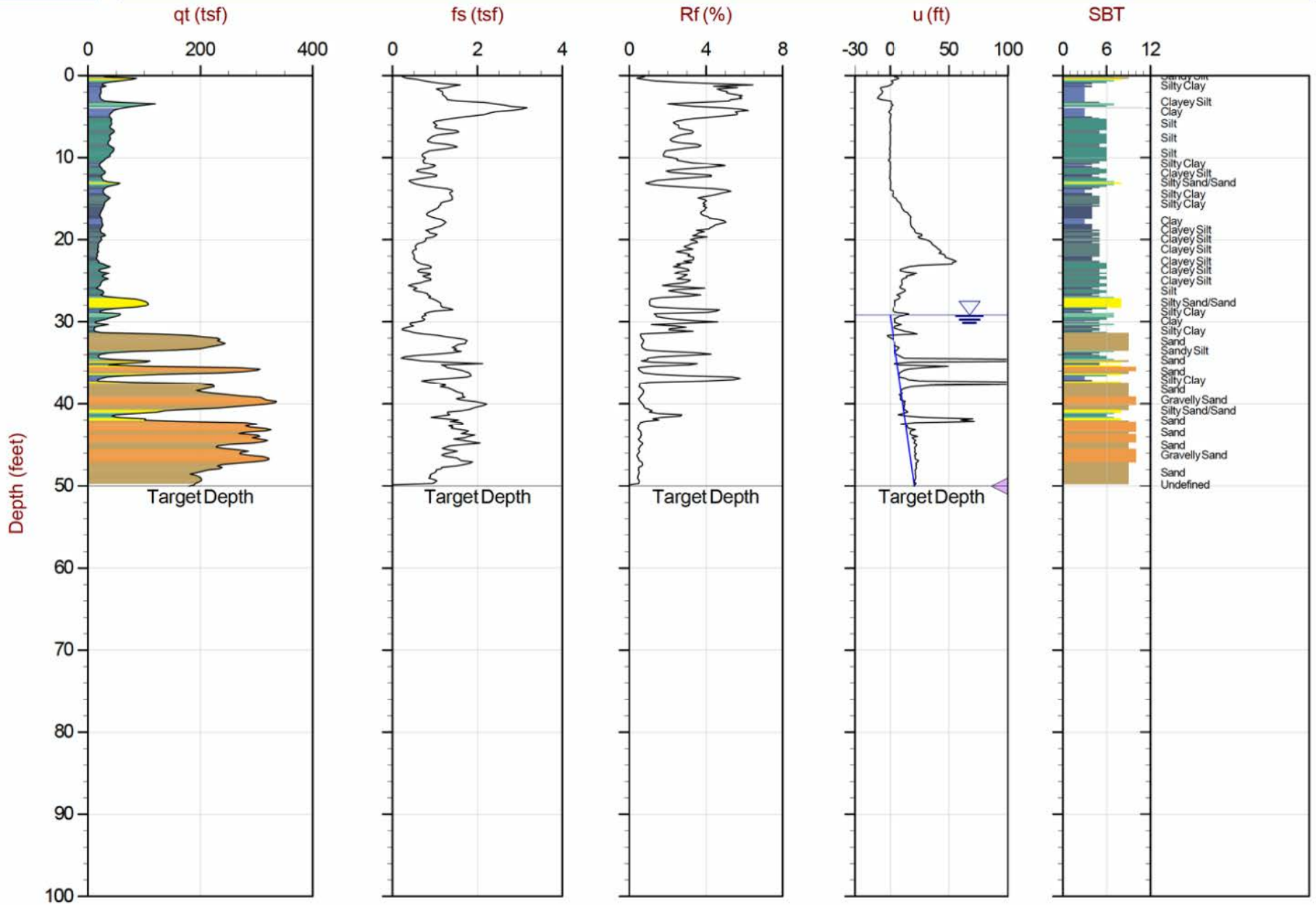
Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 2017-06-13 11:34
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C17
Cone: 268:T1500F15U500



Max Depth: 15.250 m / 50.03 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 17-53075_CPHA-C17.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4042793m E: 270390m

Hydrostatic Line Ueq Assumed Ueq PPD, Ueq achieved PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Job No: 17-53075
Client: Haley & Aldrich
Project: New Madrid Power Plant, Marston, MO
Start Date: 12-Jun-2017
End Date: 13-Jun-2017

CPTu PORE PRESSURE DISSIPATION SUMMARY

Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (ft)	Estimated Equilibrium Pore Pressure U_{eq} (ft)	Calculated Phreatic Surface (ft)	Estimated Phreatic Surface (ft)	t_{50} [a] (s)	Assumed Rigidity Index (I_r)	c_h [b] (cm^2/min)
CPT17-HA-C11	17-53075_CPHA-C11.PPD	15	210	29.69						
CPT17-HA-C12	17-53075_CPHA-C12.PPD	15	400	0.98						
CPT17-HA-C12	17-53075_CPHA-C12.PPD	15	295	3.28						
CPT17-HA-C12	17-53075_CPHA-C12.PPD	15	900	6.56						
CPT17-HA-C12	17-53075_CPHA-C12.PPD	15	900	9.84						
CPT17-HA-C12	17-53075_CPHA-C12.PPD	15	300	13.12						
CPT17-HA-C12	17-53075_CPHA-C12.PPD	15	300	16.40	10.91	5.50				
CPT17-HA-C12	17-53075_CPHA-C12.PPD	15	900	19.68						
CPT17-HA-C12	17-53075_CPHA-C12.PPD	15	355	75.13						
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	200	0.98						
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	250	1.97						
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	200	2.95						
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	200	3.94						
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	200	4.92						
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	200	6.07						
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	400	7.05						
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	200	8.04						
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	200	9.02						
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	200	10.01	0.44	9.57				
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	200	10.99						
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	200	11.97	2.39	9.59				
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	200	12.96	3.32	9.64				

CONETEC

Job No: 17-53075
Client: Haley & Aldrich
Project: New Madrid Power Plant, Marston, MO
Start Date: 12-Jun-2017
End Date: 13-Jun-2017

CPTu PORE PRESSURE DISSIPATION SUMMARY

Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (ft)	Estimated Equilibrium Pore Pressure U_{eq} (ft)	Calculated Phreatic Surface (ft)	Estimated Phreatic Surface (ft)	t_{50} [a] (s)	Assumed Rigidity Index (I_r)	c_h [b] (cm^2/min)
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	350	13.94	4.41	9.54				
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	300	14.93	11.27	3.66				
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	200	16.08	6.65	9.42				
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	400	17.06	7.56	9.50				
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	300	18.04	8.30	9.75				
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	200	19.03	9.45	9.57				
CPT17-HA-C13	17-53075_CPHA-C13.PPD	15	1000	20.01	10.84	9.18				
CPT17-HA-C14	17-53075_CPHA-C14.PPD	15	610	50.03						
SCPT17-HA-C15	17-53075_SPHA-C15.PPD	15	2100	0.98	0.98		0.00	12	100	56.84
SCPT17-HA-C15	17-53075_SPHA-C15.PPD	15	200	3.28						
SCPT17-HA-C15	17-53075_SPHA-C15.PPD	15	300	6.56						
SCPT17-HA-C15	17-53075_SPHA-C15.PPD	15	250	9.84						
SCPT17-HA-C15	17-53075_SPHA-C15.PPD	15	200	13.12	1.56	11.57				
SCPT17-HA-C15	17-53075_SPHA-C15.PPD	15	2705	16.40	0.00		16.40	1040	100	0.68
SCPT17-HA-C15	17-53075_SPHA-C15.PPD	15	300	19.68	2.85	16.83				
SCPT17-HA-C15	17-53075_SPHA-C15.PPD	15	300	95.31	64.58	30.73				
CPT17-HA-C16	17-53075_CPHA-C16.PPD	15	400	50.03						
CPT17-HA-C17	17-53075_CPHA-C17.PPD	15	350	50.03						
Totals	40 dissipations		297.9 min							

a. Time is relative to where umax occurred

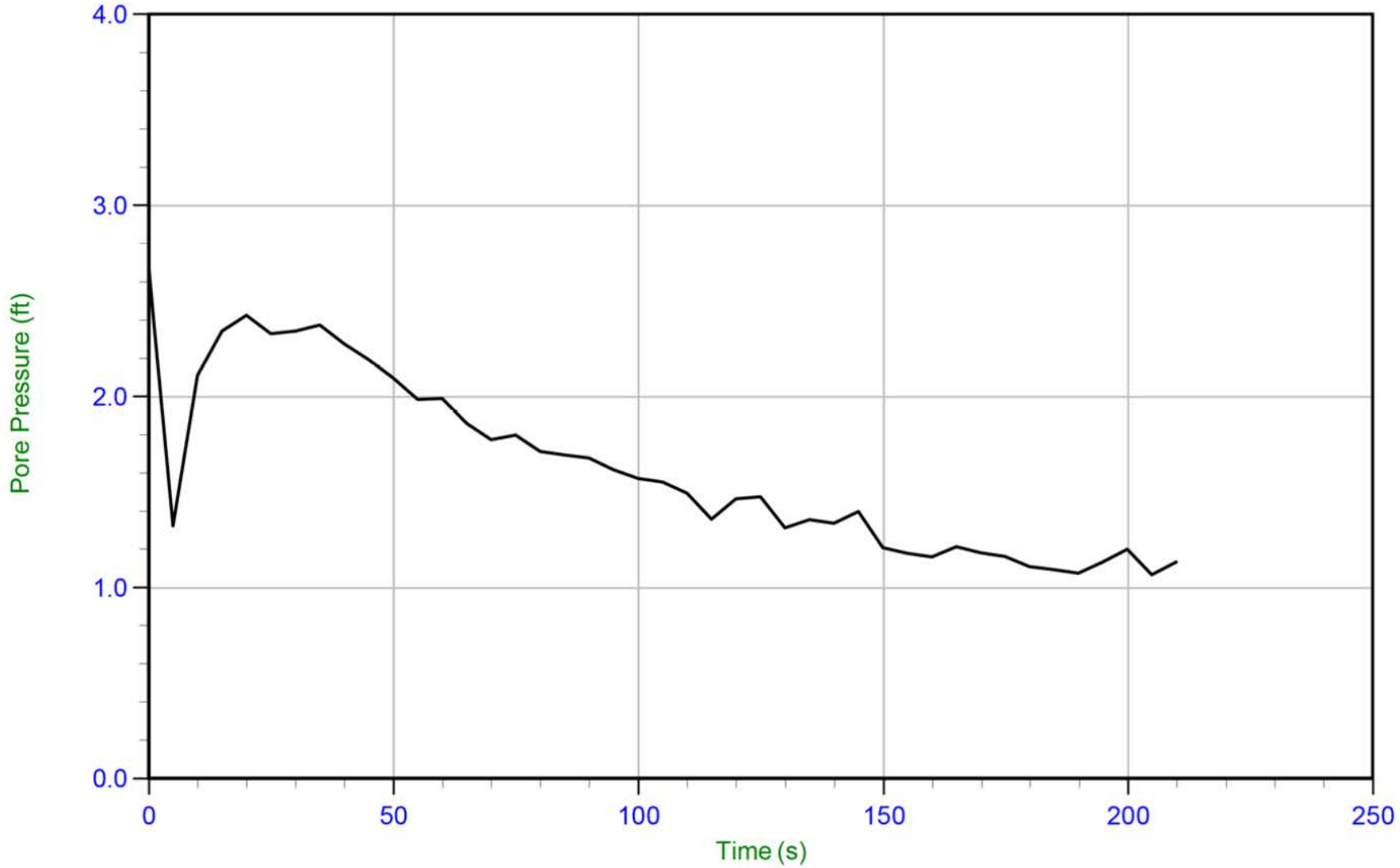
b. Houlsby and Teh, 1991

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 11:40:33
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C11
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C11.PPD
Depth: 9.050 m / 29.691 ft
Duration: 210.0 s

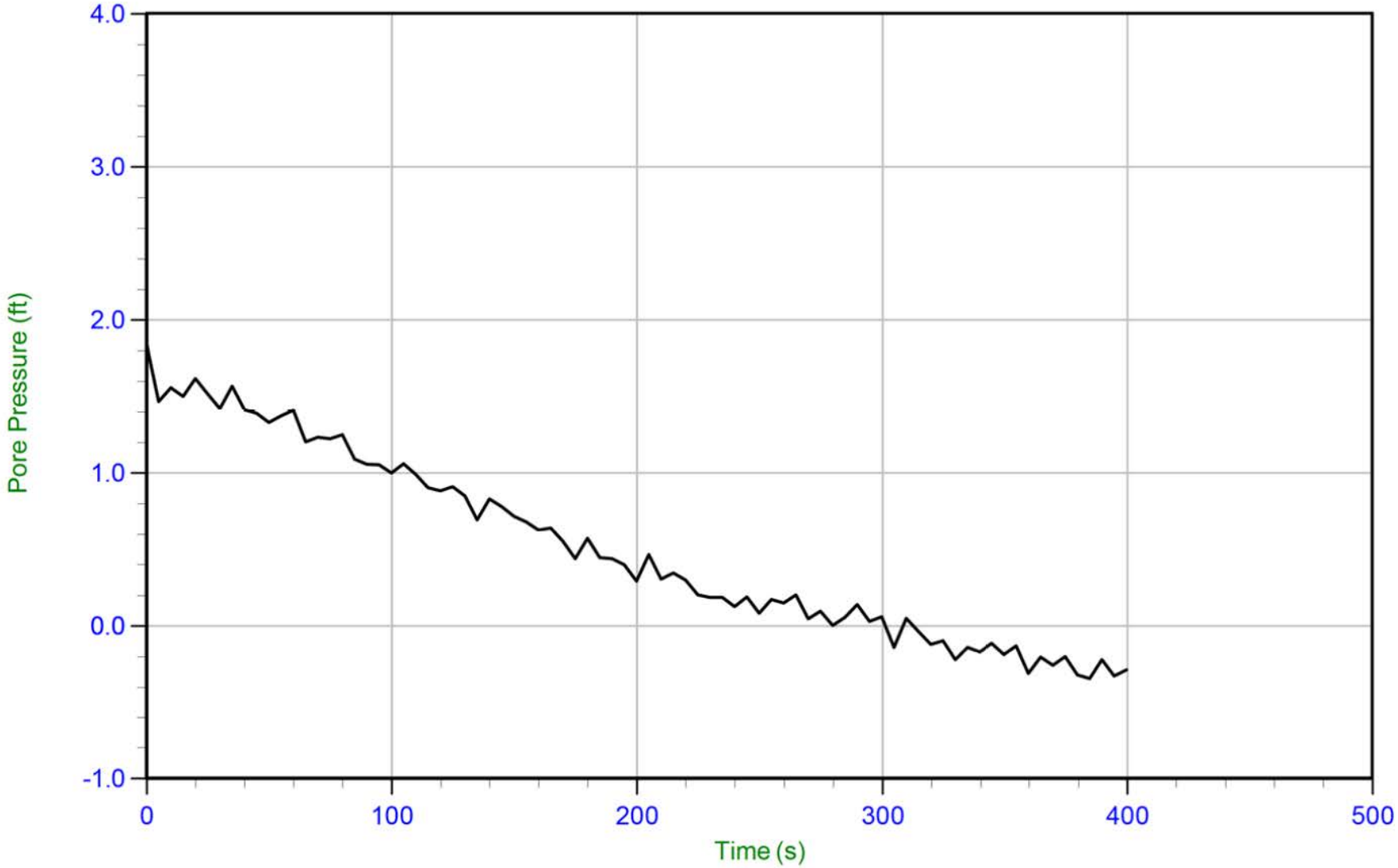
U Min: 1.1 ft
U Max: 2.7 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 12:55:13
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C12
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C12.PPD
Depth: 0.300 m / 0.984 ft
Duration: 400.0 s

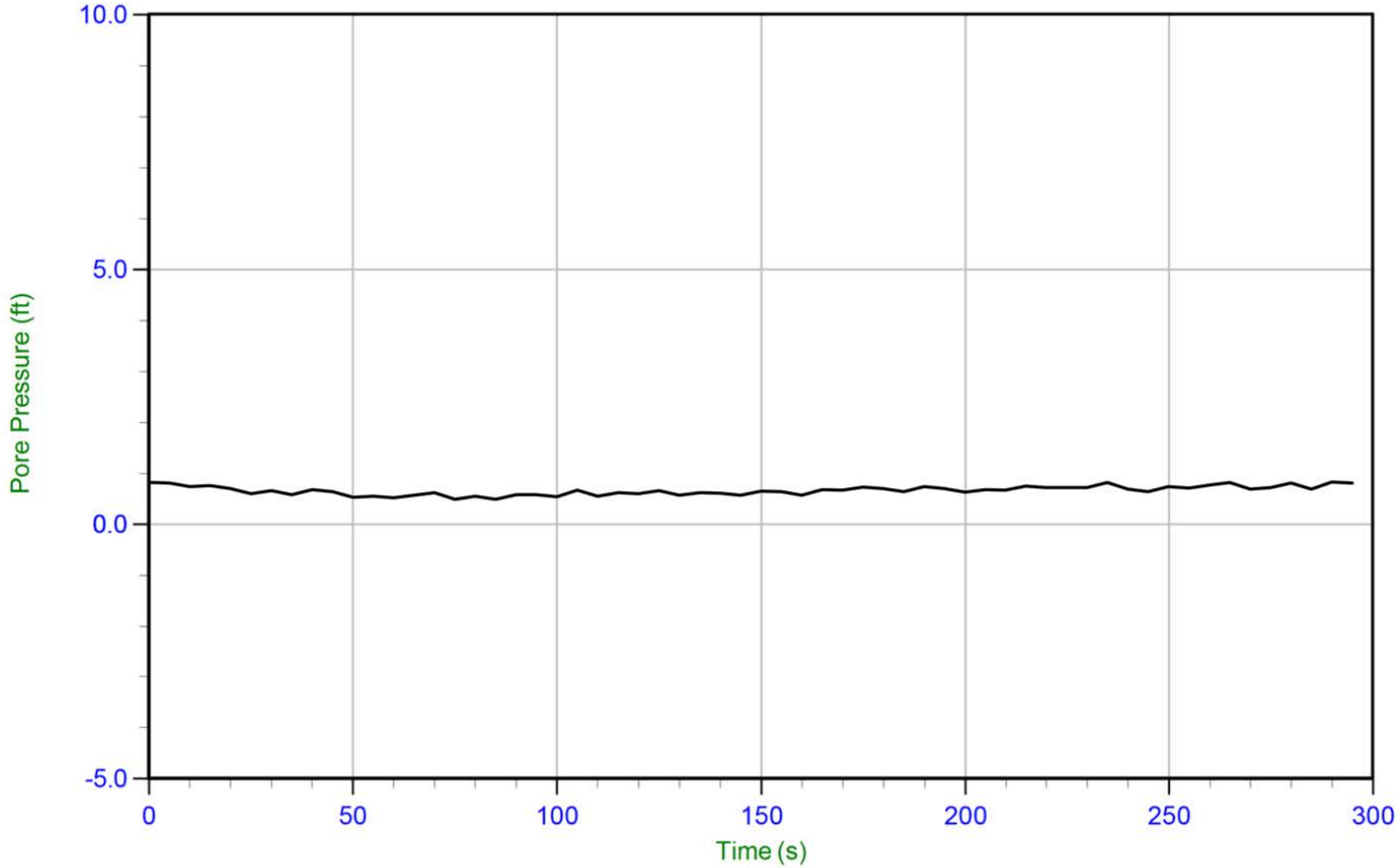
U Min: -0.3 ft
U Max: 1.8 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 12:55:13
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C12
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C12.PPD
Depth: 1.000 m / 3.281 ft
Duration: 295.0 s

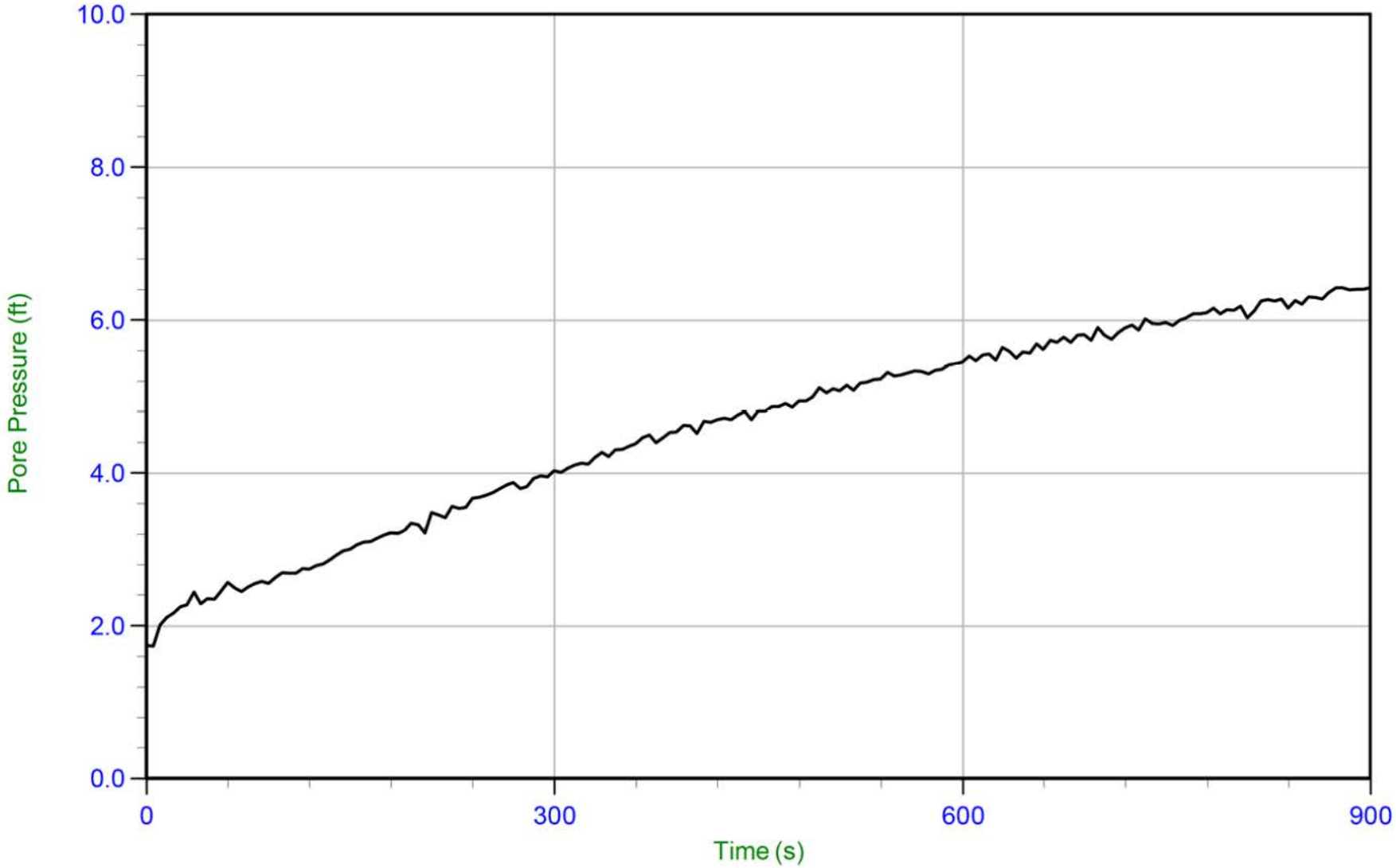
U Min: 0.5 ft
U Max: 0.8 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 12:55:13
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C12
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C12.PPD
Depth: 2.000 m / 6.562 ft
Duration: 900.0 s

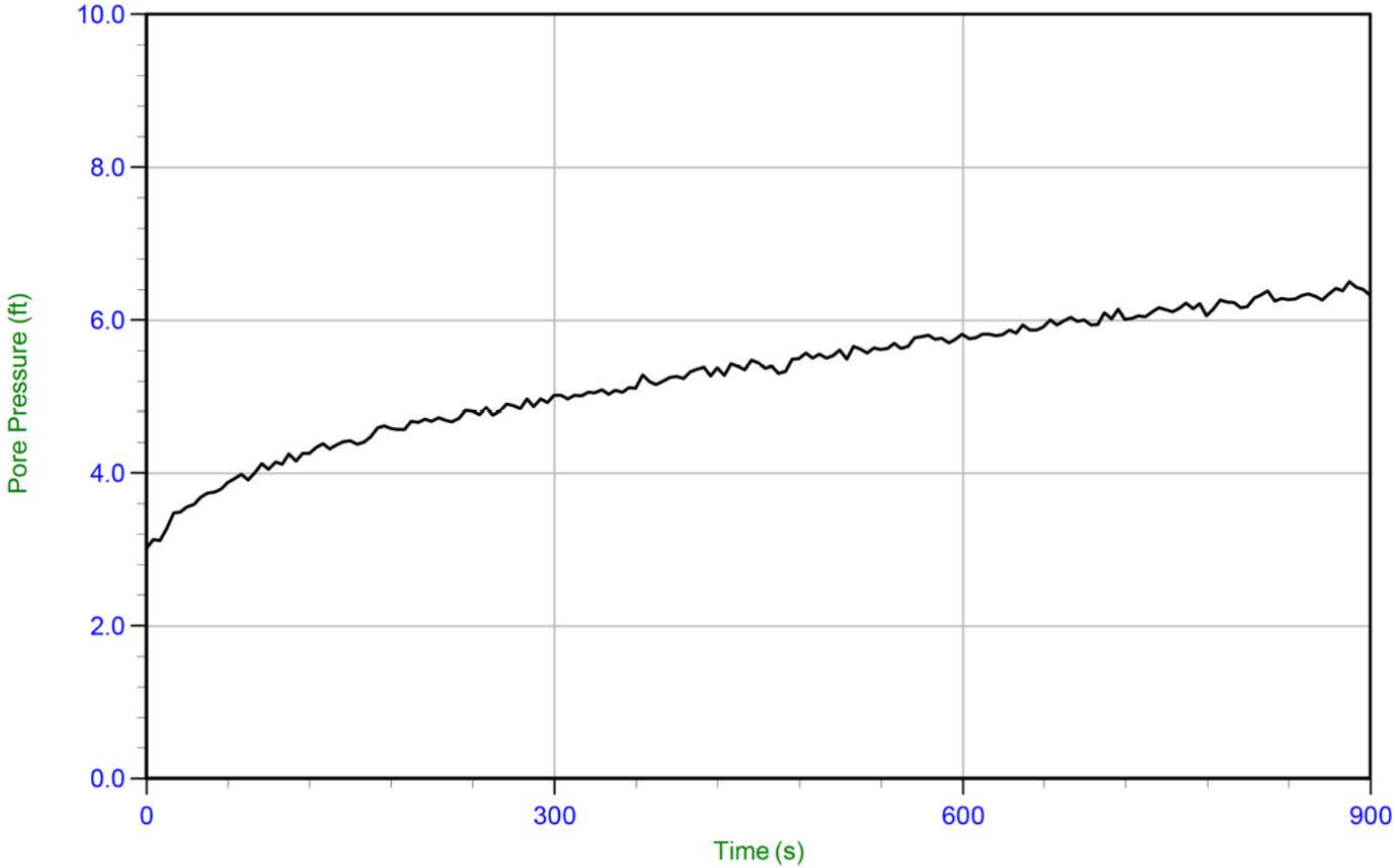
U Min: 1.7 ft
U Max: 6.4 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 12:55:13
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C12
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C12.PPD
Depth: 3.000 m / 9.842 ft
Duration: 900.0 s

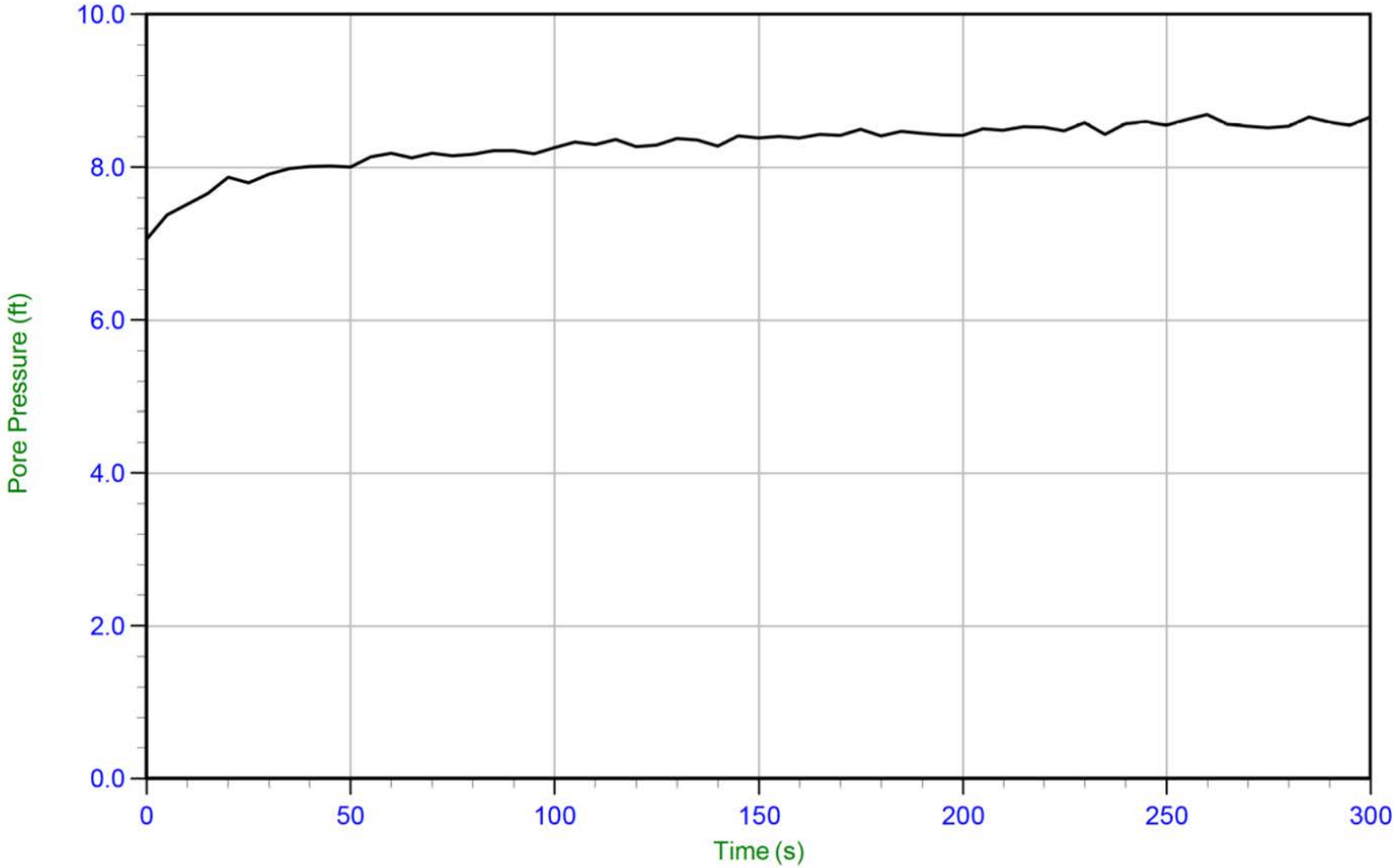
U Min: 3.0 ft
U Max: 6.5 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 12:55:13
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C12
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C12.PPD
Depth: 4.000 m / 13.123 ft
Duration: 300.0 s

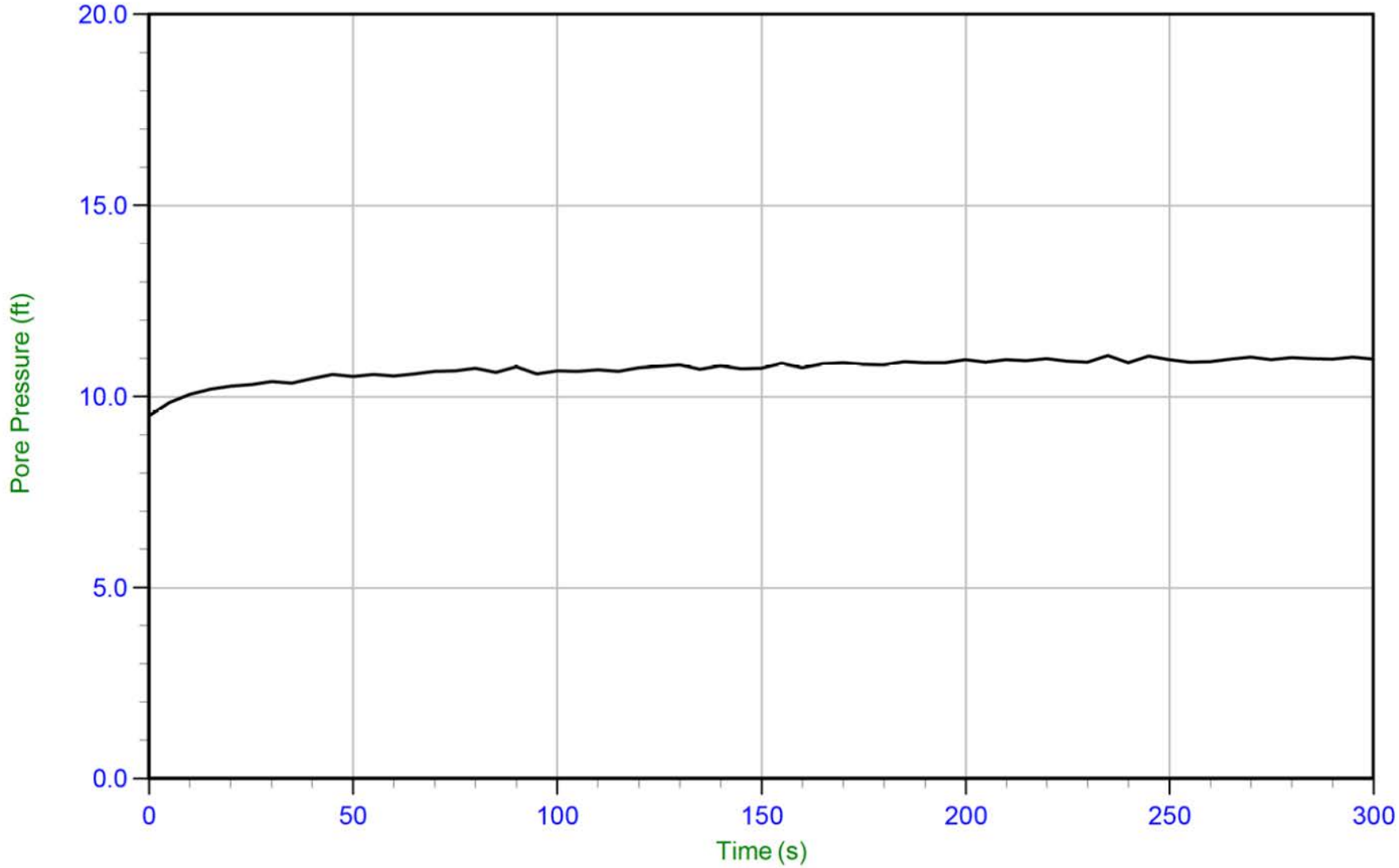
U Min: 7.1 ft
U Max: 8.7 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 12:55:13
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C12
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C12.PPD
Depth: 5.000 m / 16.404 ft
Duration: 300.0 s

U Min: 9.5 ft
U Max: 11.1 ft

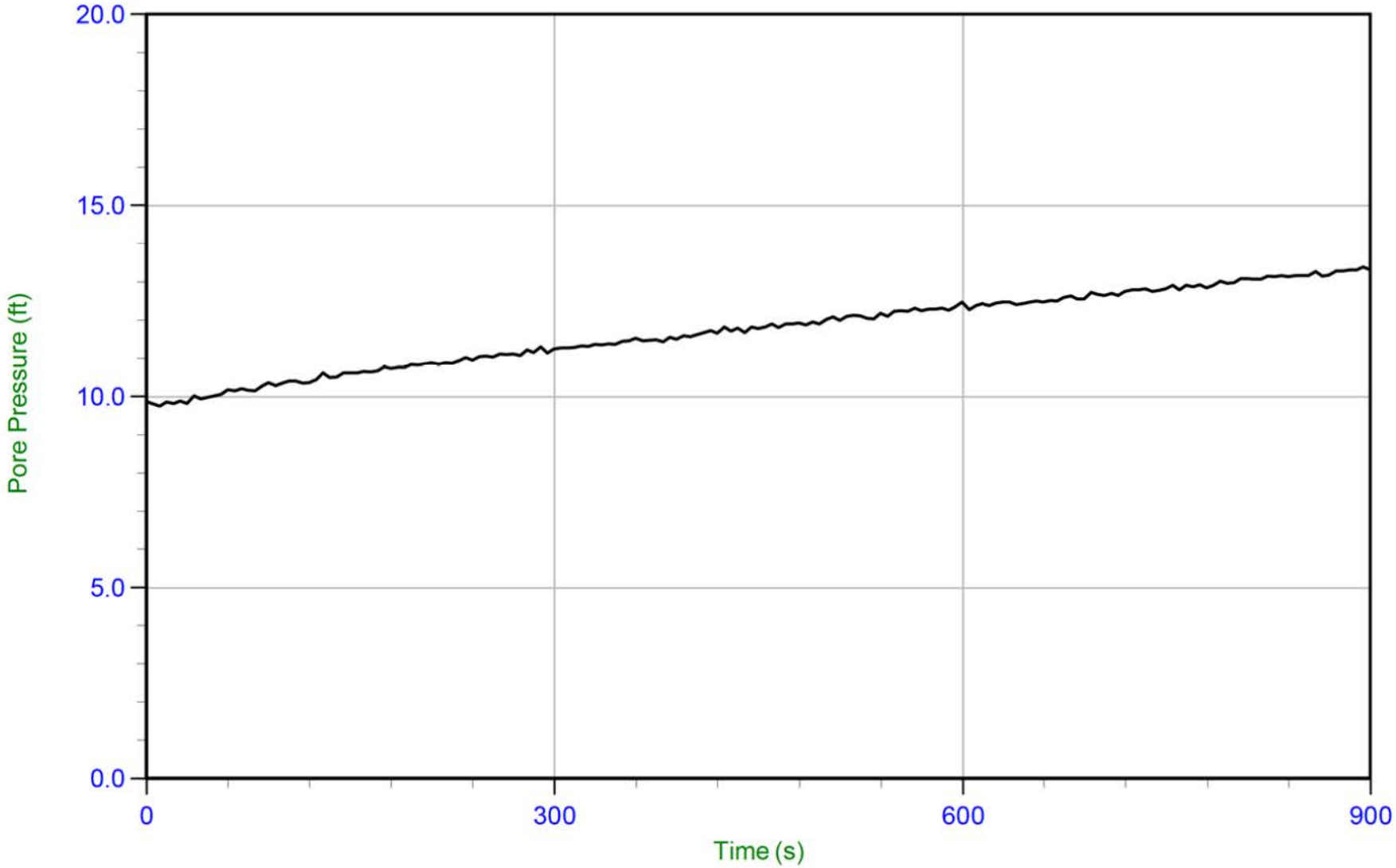
WT: 1.675 m / 5.495 ft
Ueq: 10.9 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 12:55:13
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C12
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C12.PPD
Depth: 6.000 m / 19.685 ft
Duration: 900.0 s

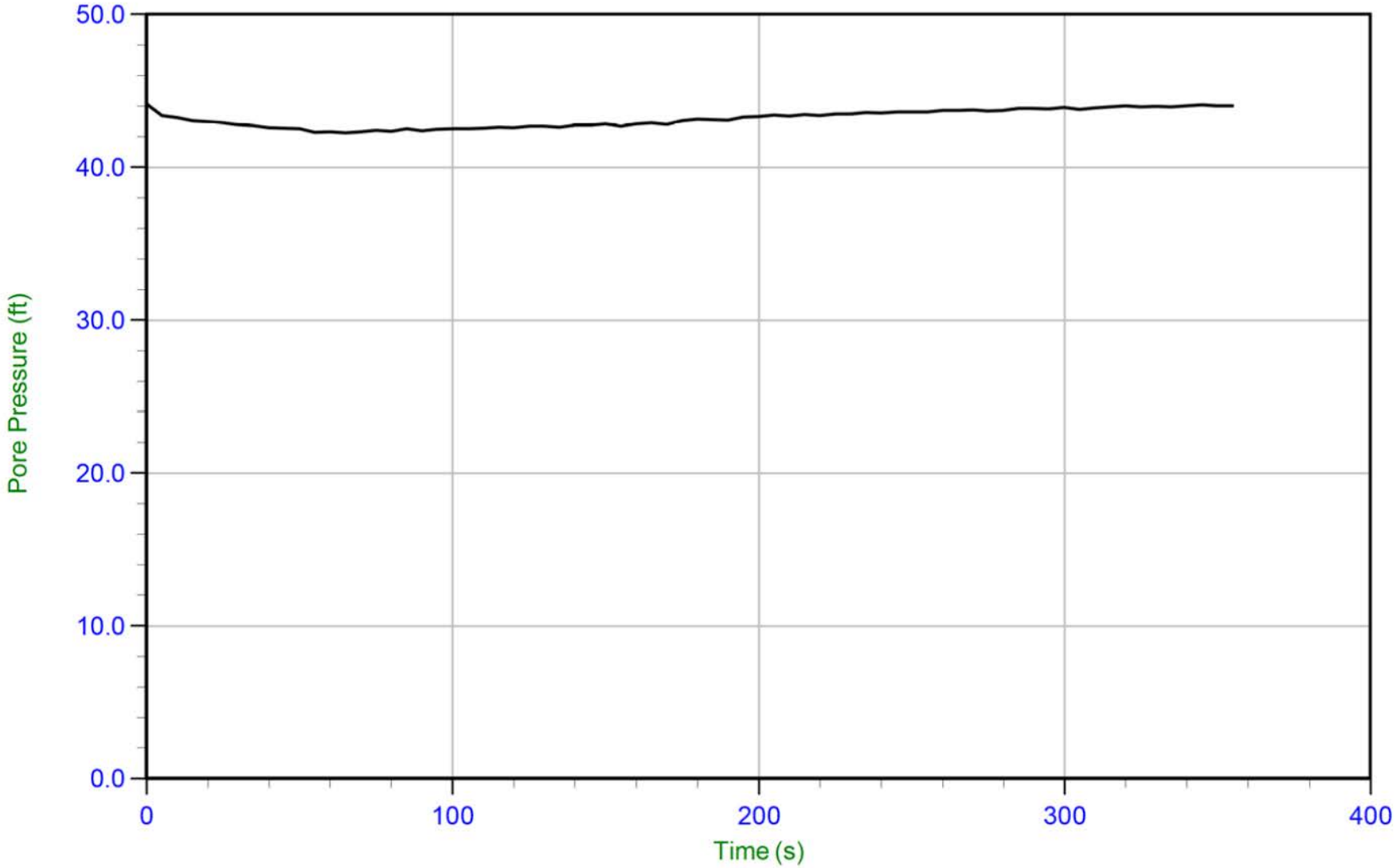
U Min: 9.8 ft
U Max: 13.4 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 12:55:13
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C12
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C12.PPD
Depth: 22.900 m / 75.130 ft
Duration: 355.0 s

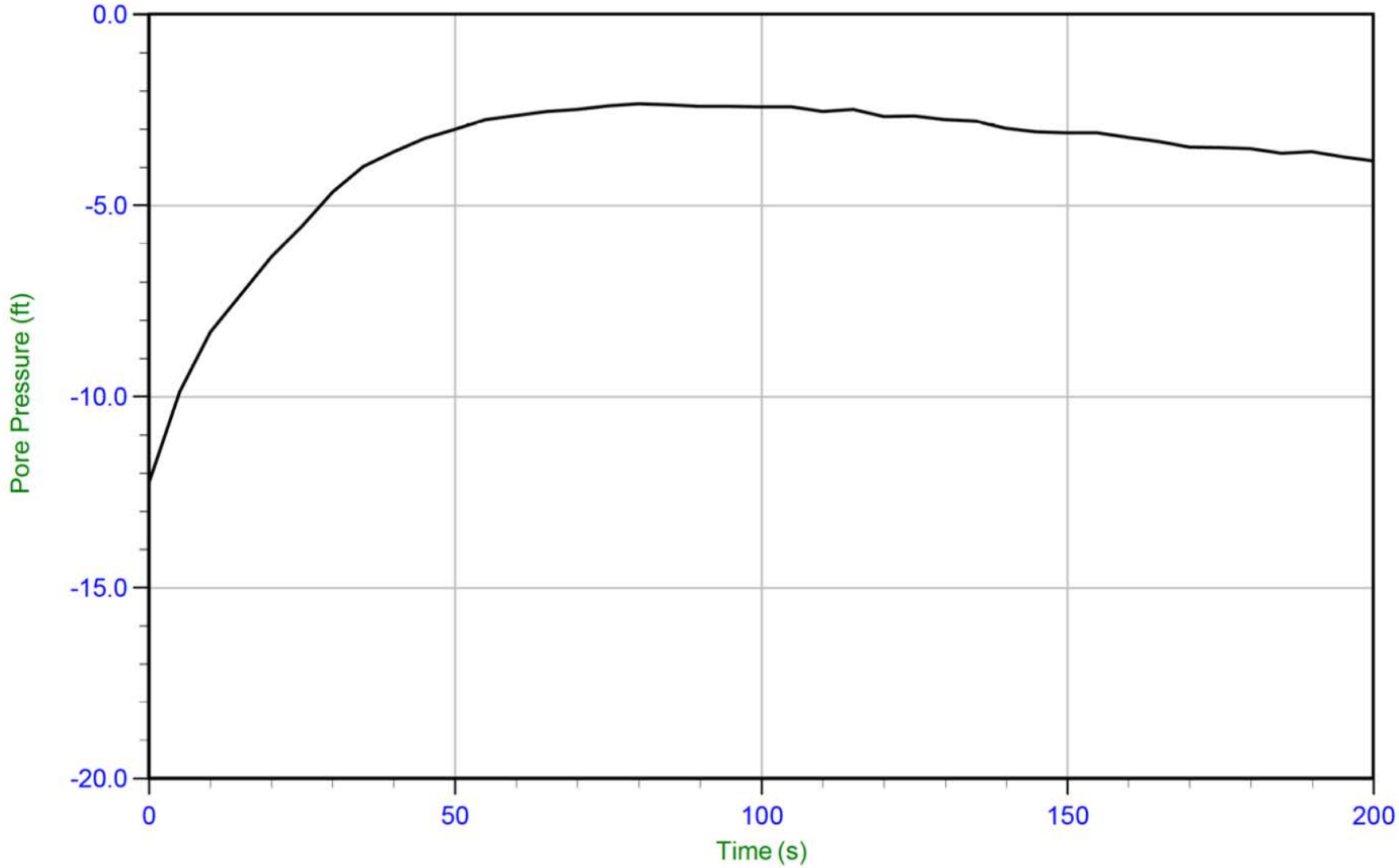
U Min: 42.3 ft
U Max: 44.1 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 0.300 m / 0.984 ft
Duration: 200.0 s

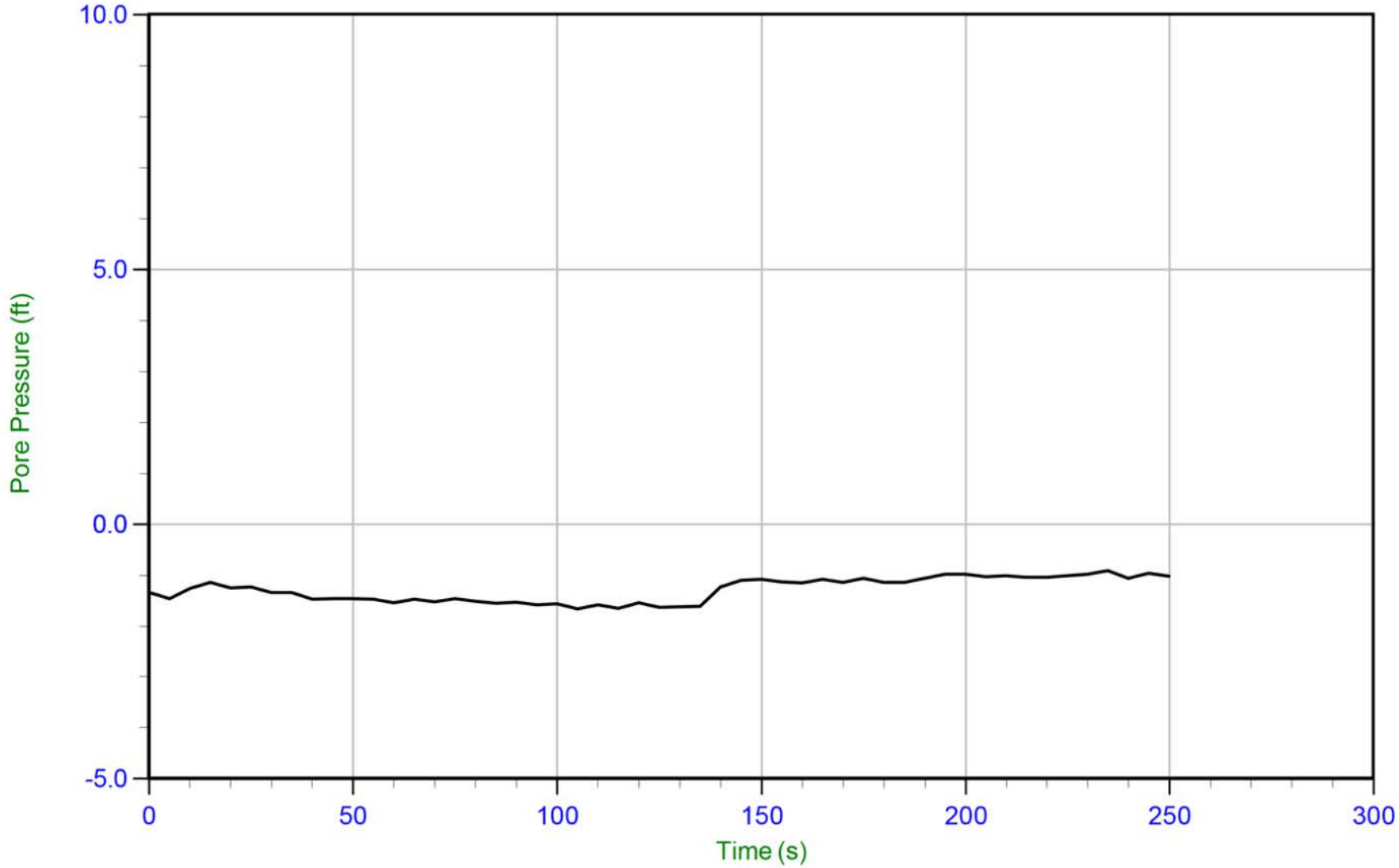
U Min: -12.2 ft
U Max: -2.3 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 0.600 m / 1.968 ft
Duration: 250.0 s

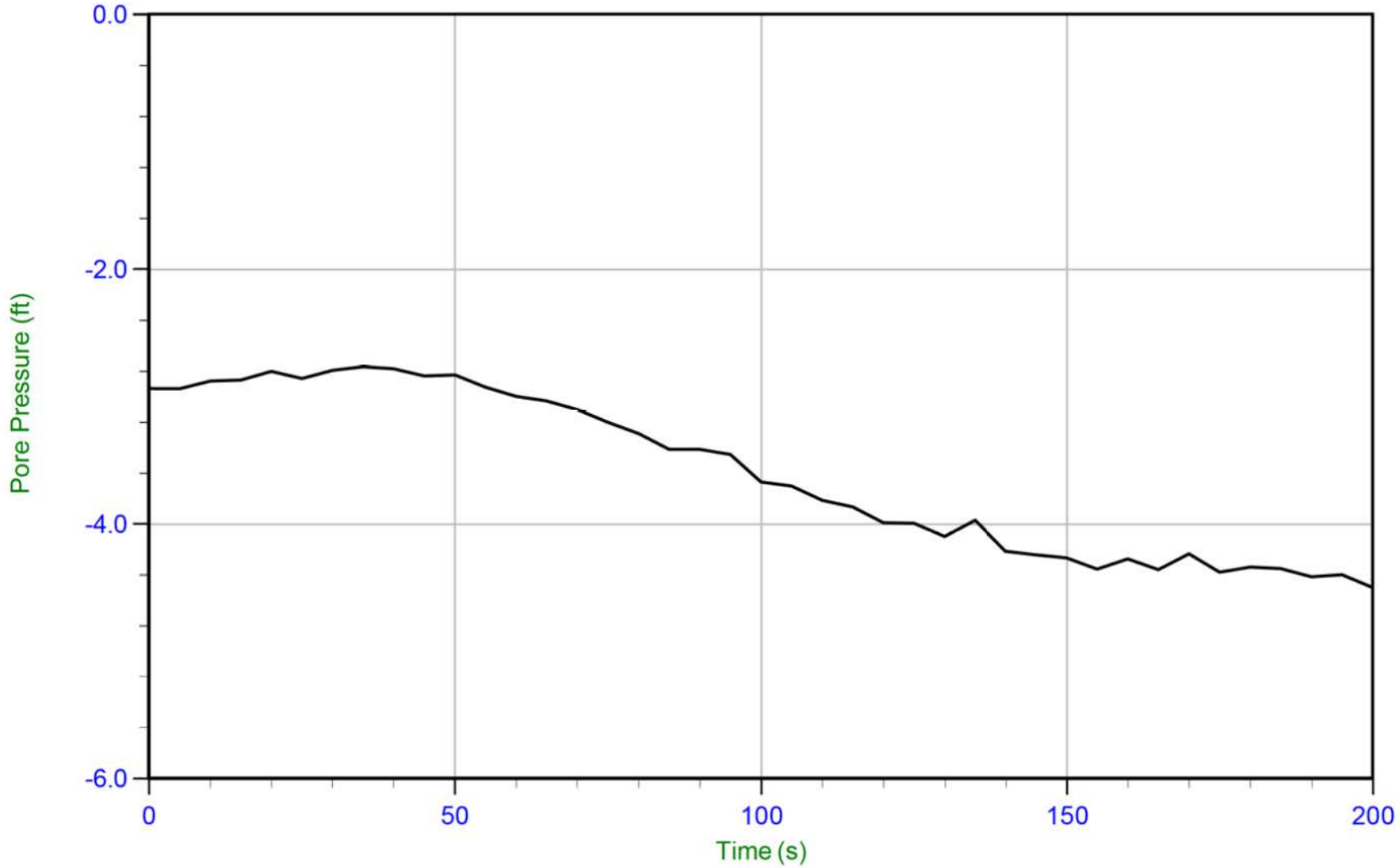
U Min: -1.7 ft
U Max: -0.9 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 0.900 m / 2.953 ft
Duration: 200.0 s

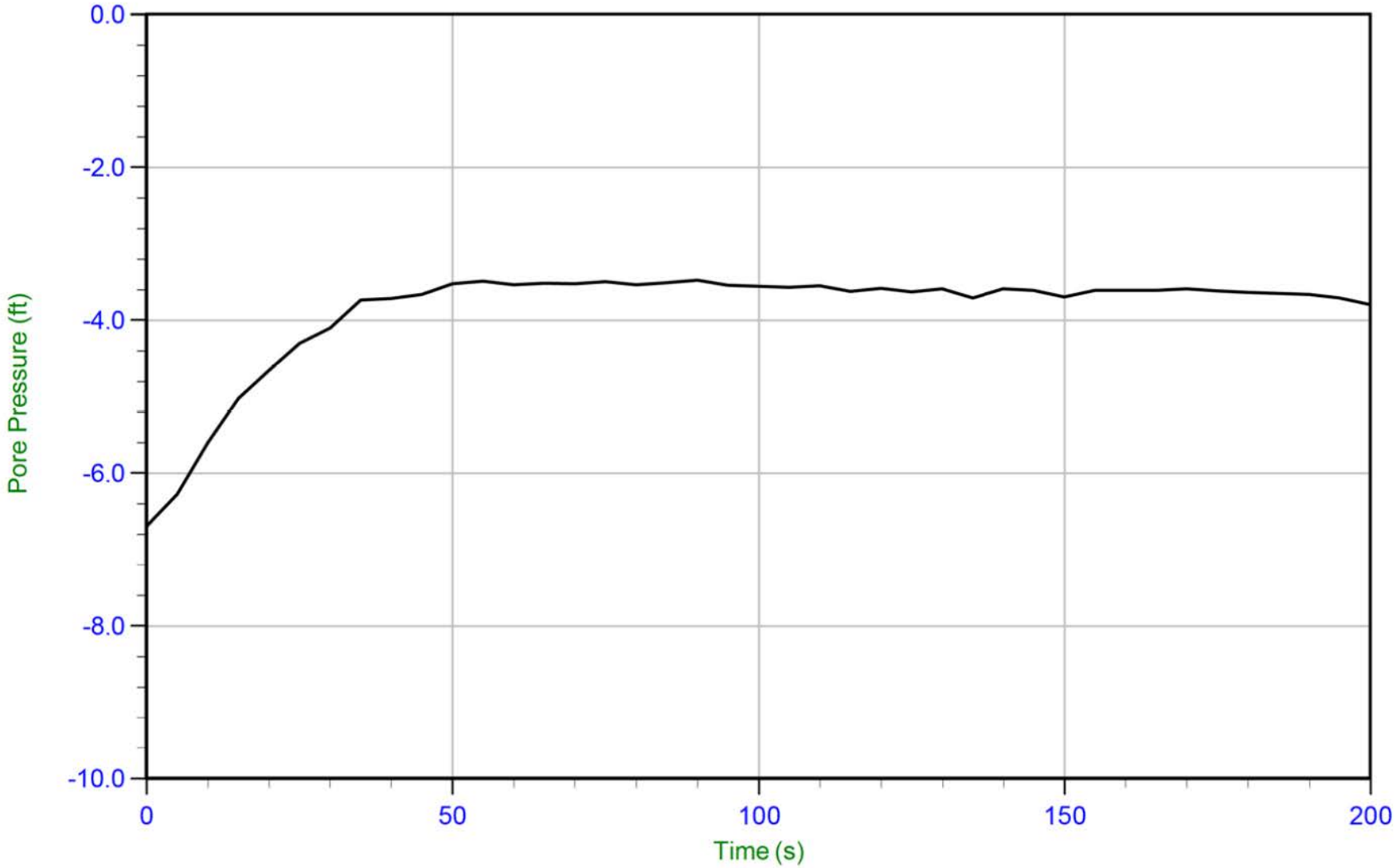
U Min: -4.5 ft
U Max: -2.8 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 1.200 m / 3.937 ft
Duration: 200.0 s

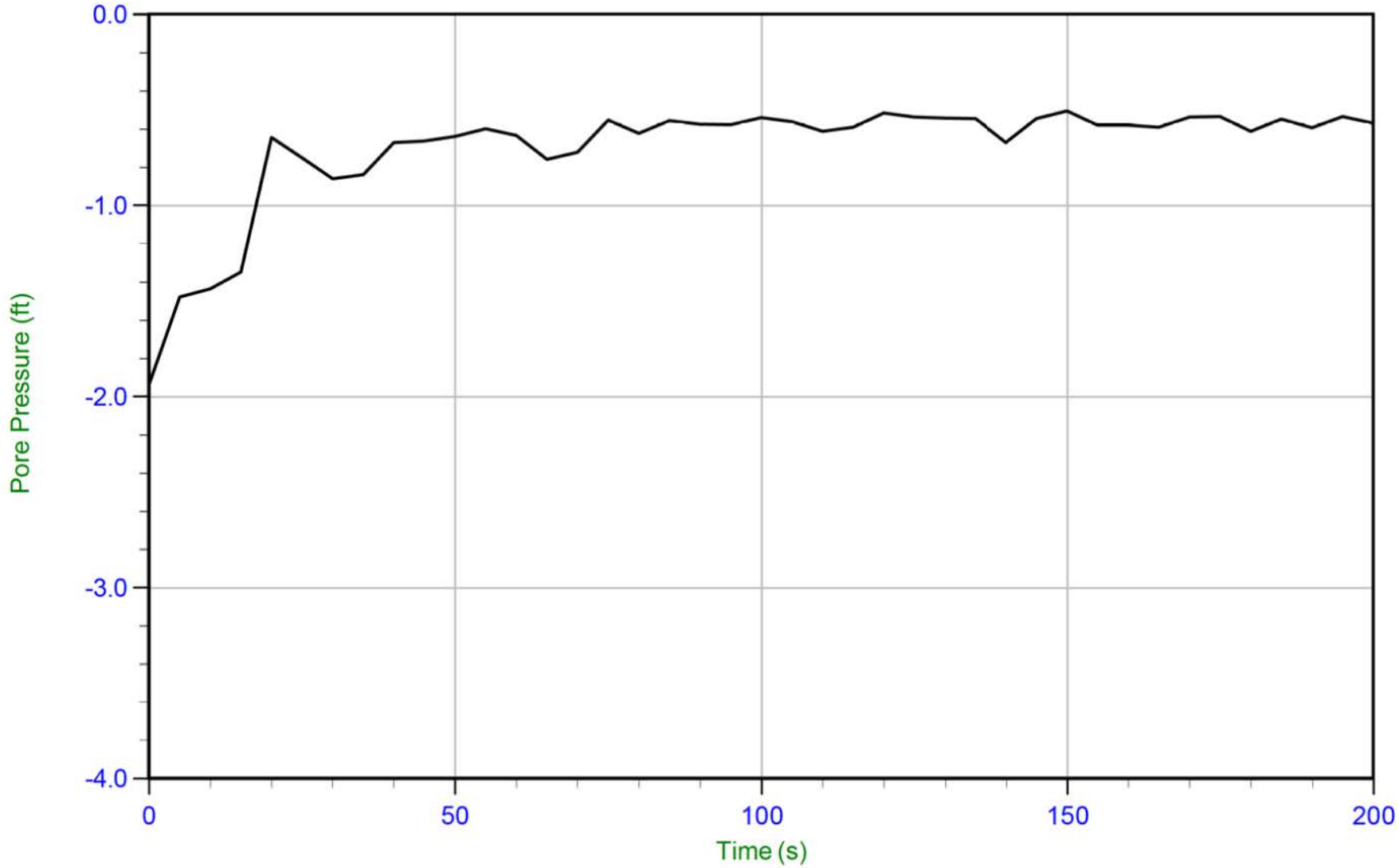
U Min: -6.7 ft
U Max: -3.5 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 1.500 m / 4.921 ft
Duration: 200.0 s

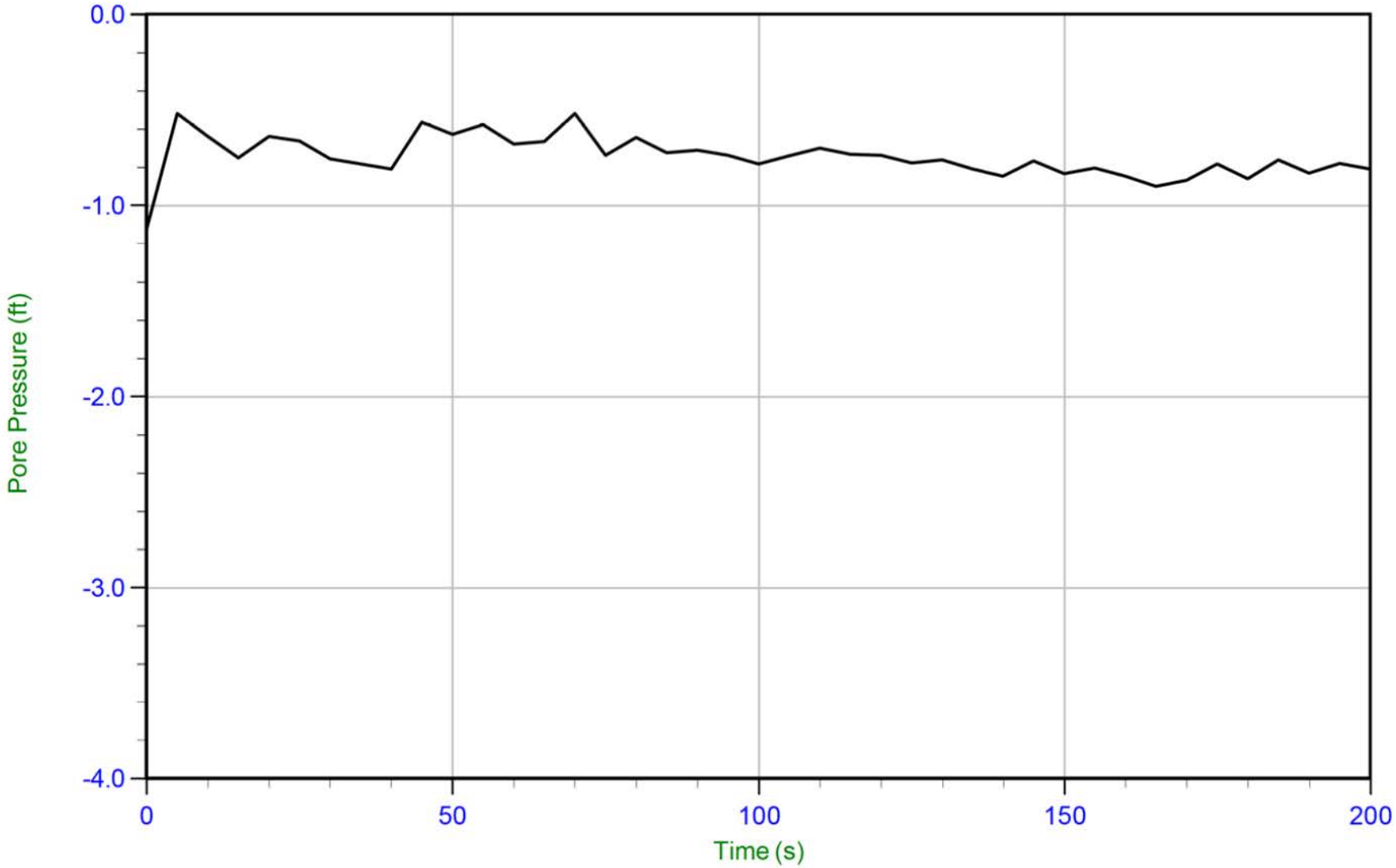
U Min: -1.9 ft
U Max: -0.5 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 1.850 m / 6.069 ft
Duration: 200.0 s

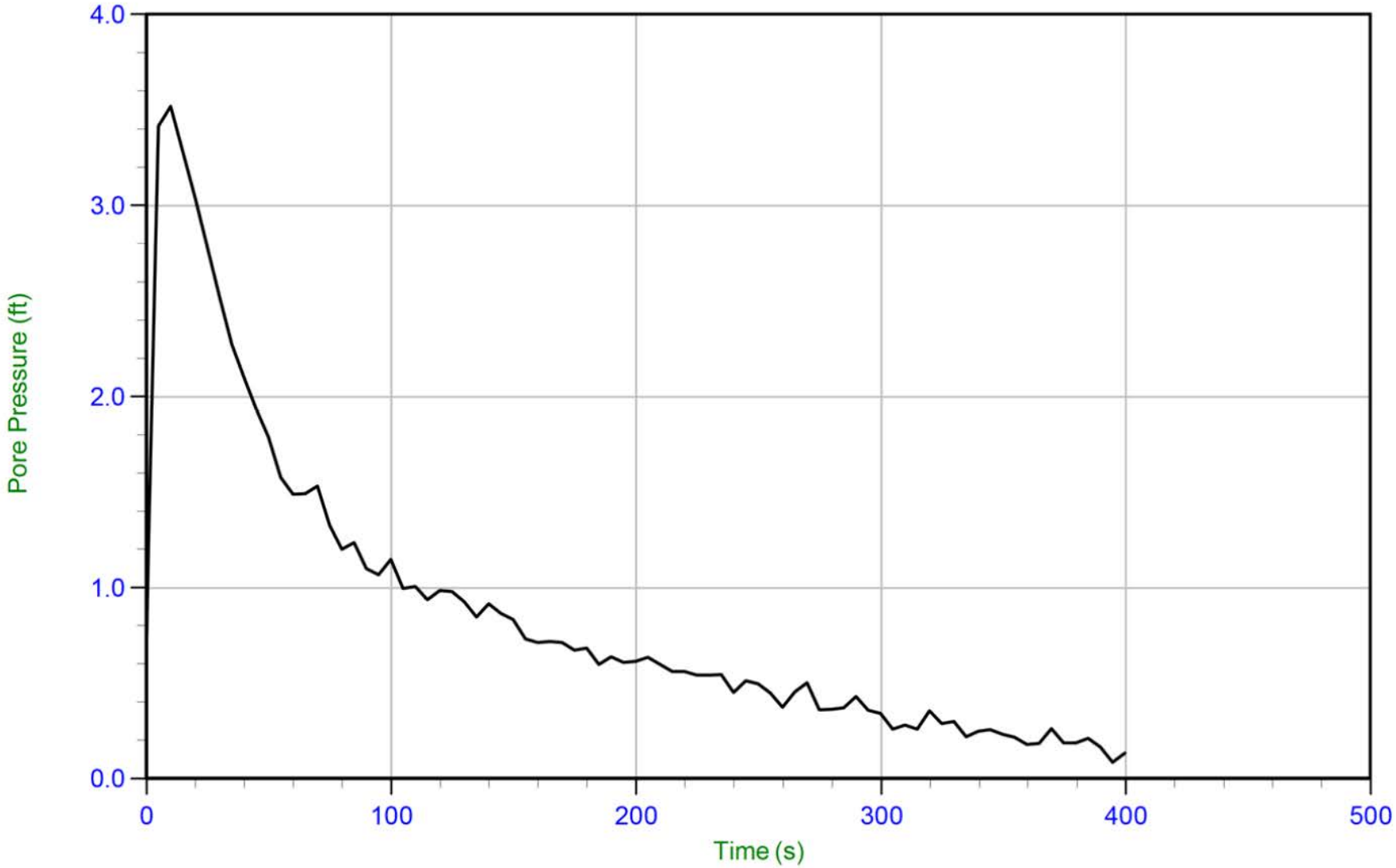
U Min: -1.1 ft
U Max: -0.5 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 2.150 m / 7.054 ft
Duration: 400.0 s

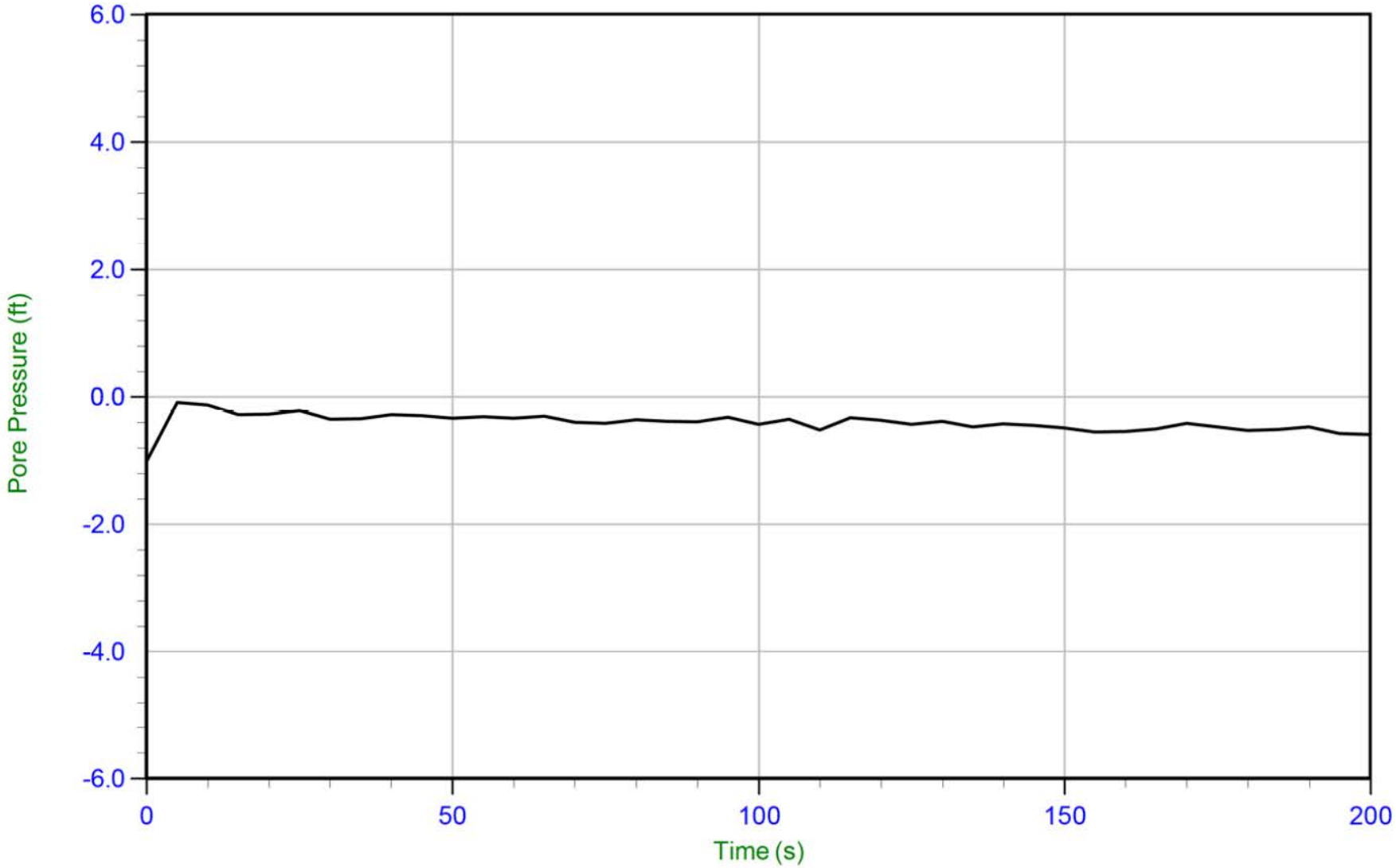
U Min: 0.1 ft
U Max: 3.5 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 2.450 m / 8.038 ft
Duration: 200.0 s

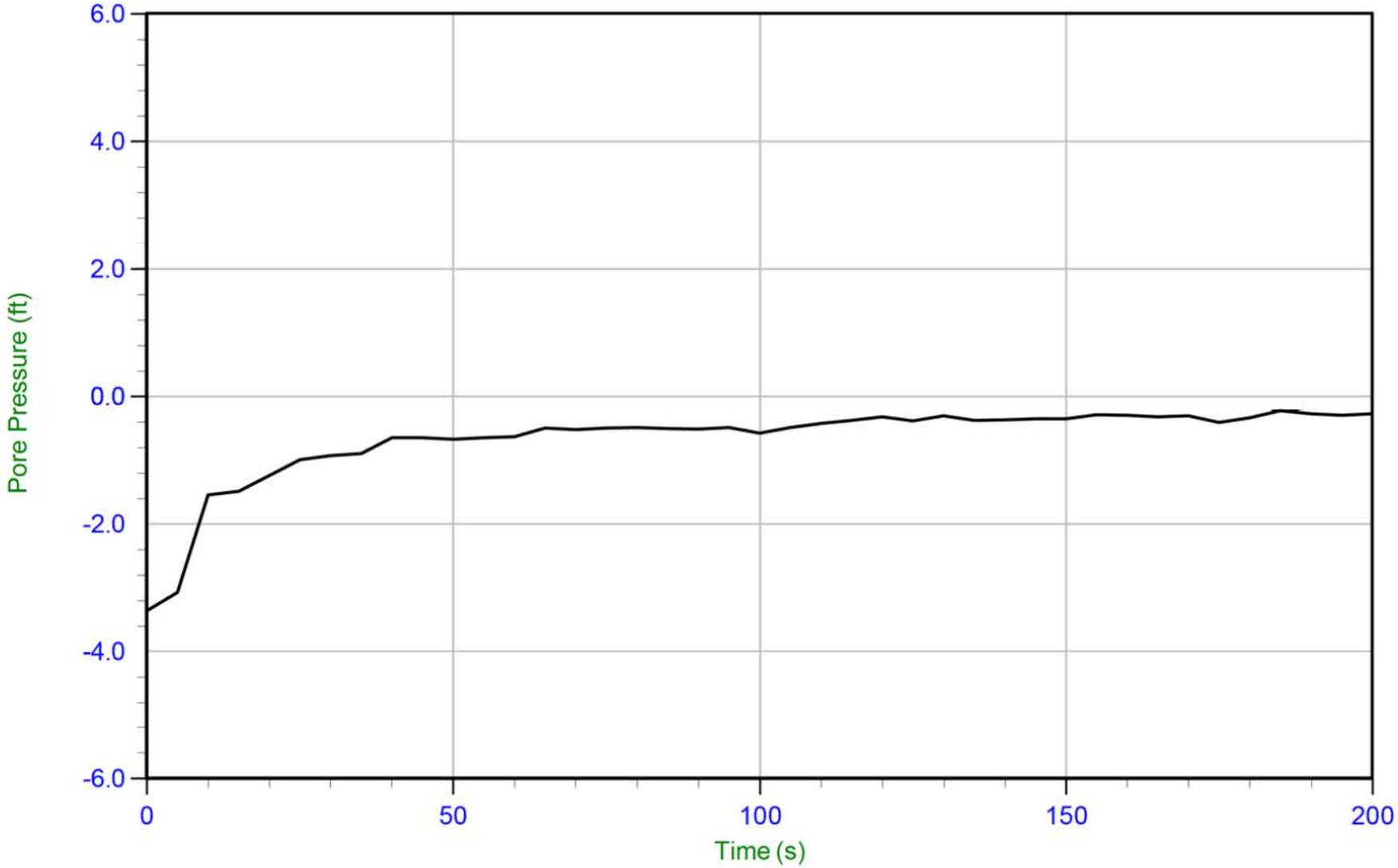
U Min: -1.0 ft
U Max: -0.1 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 2.750 m / 9.022 ft
Duration: 200.0 s

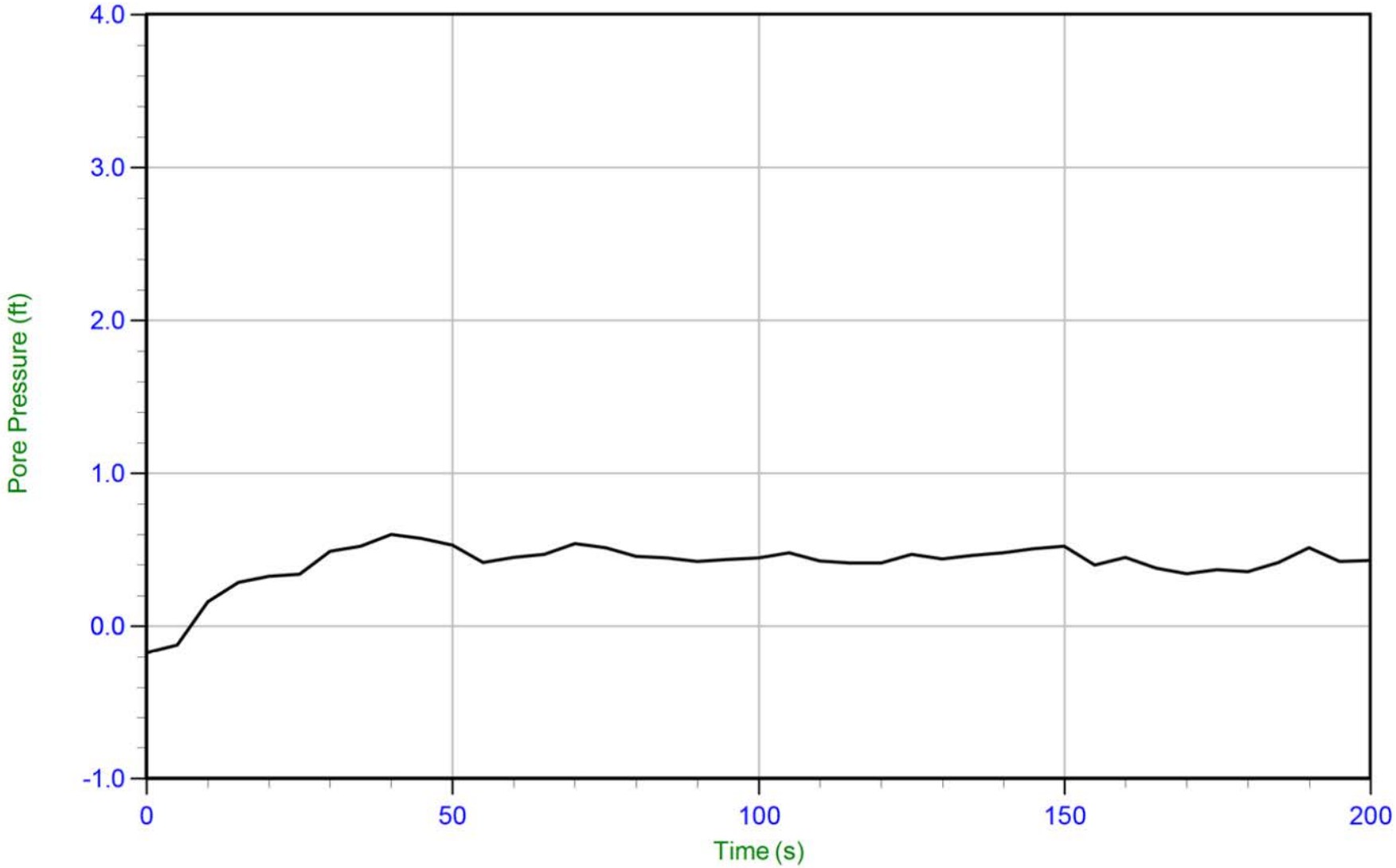
U Min: -3.4 ft
U Max: -0.2 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 3.050 m / 10.006 ft
Duration: 200.0 s

U Min: -0.2 ft
U Max: 0.6 ft

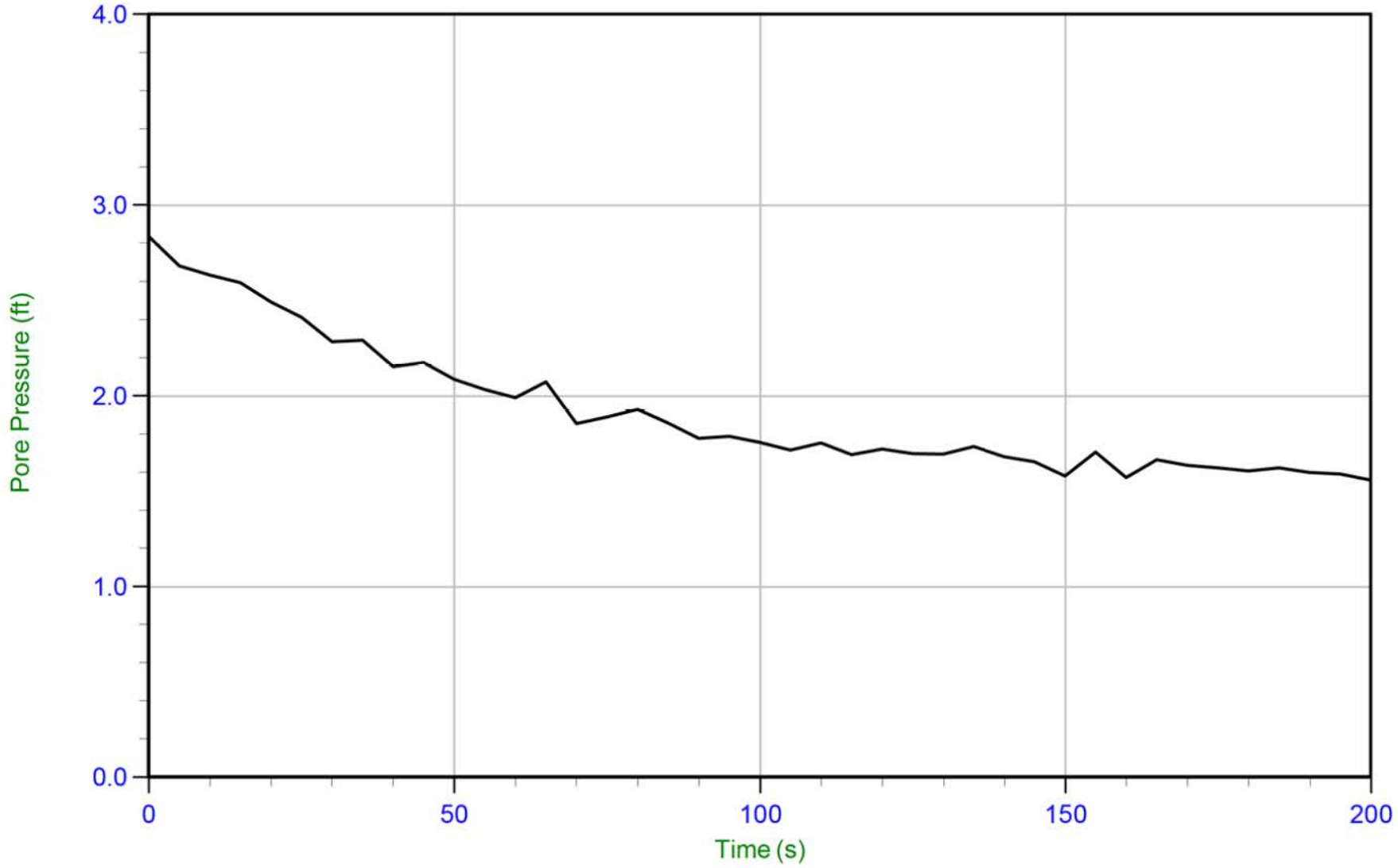
WT: 2.917 m / 9.570 ft
Ueq: 0.4 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 3.350 m / 10.991 ft
Duration: 200.0 s

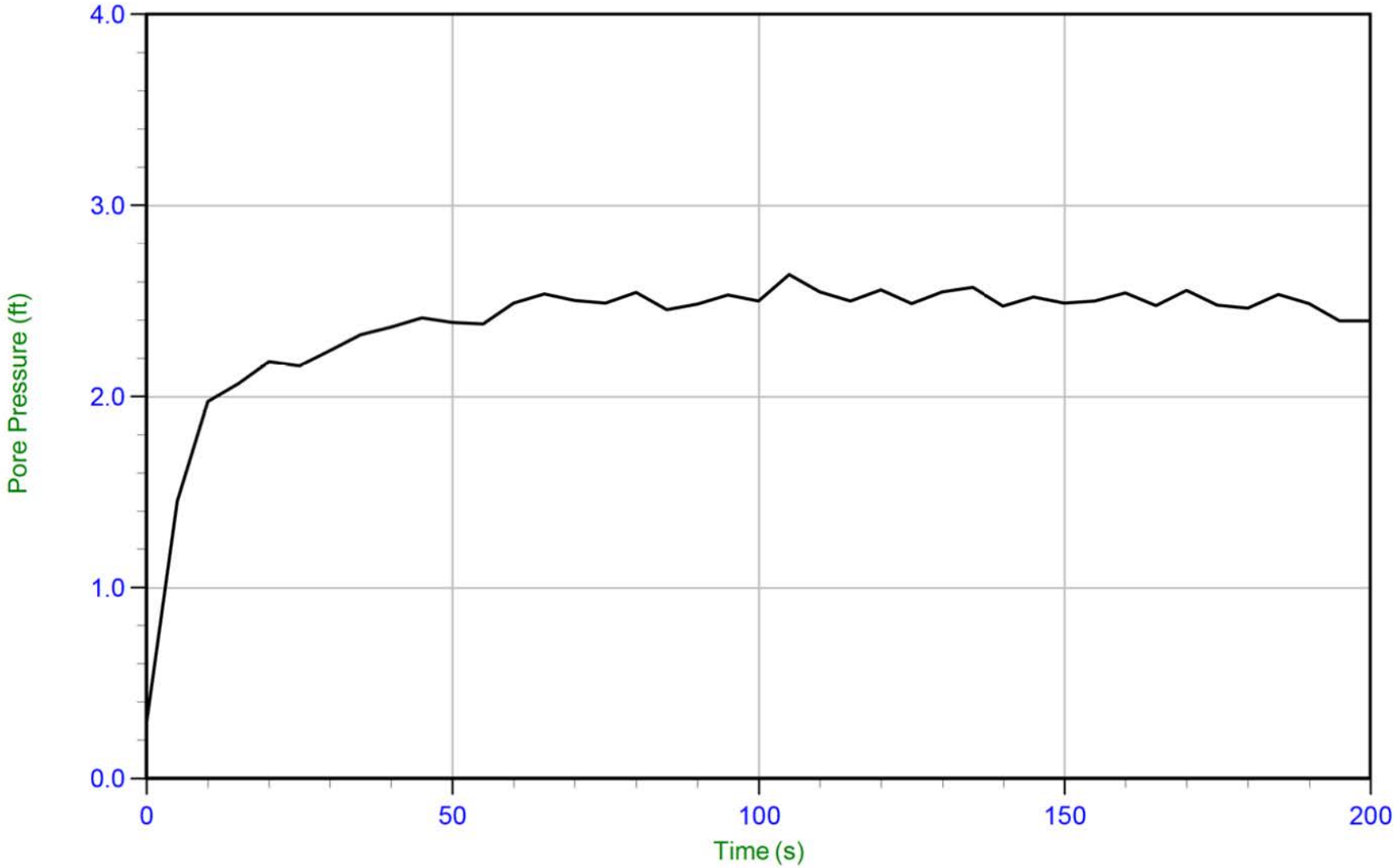
U Min: 1.6 ft
U Max: 2.8 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 3.650 m / 11.975 ft
Duration: 200.0 s

U Min: 0.3 ft
U Max: 2.6 ft

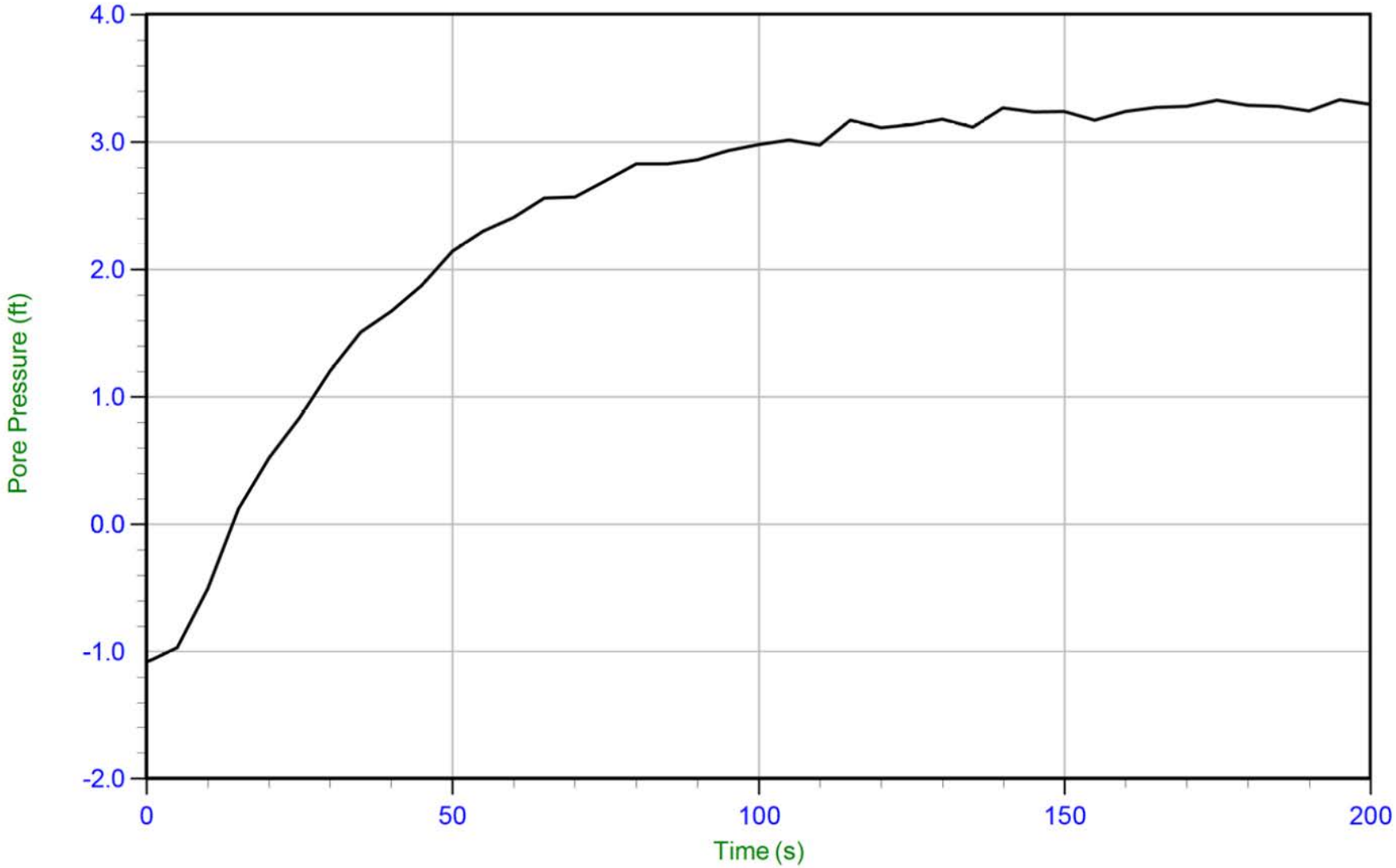
WT: 2.923 m / 9.589 ft
Ueq: 2.4 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 3.950 m / 12.959 ft
Duration: 200.0 s

U Min: -1.1 ft
U Max: 3.3 ft

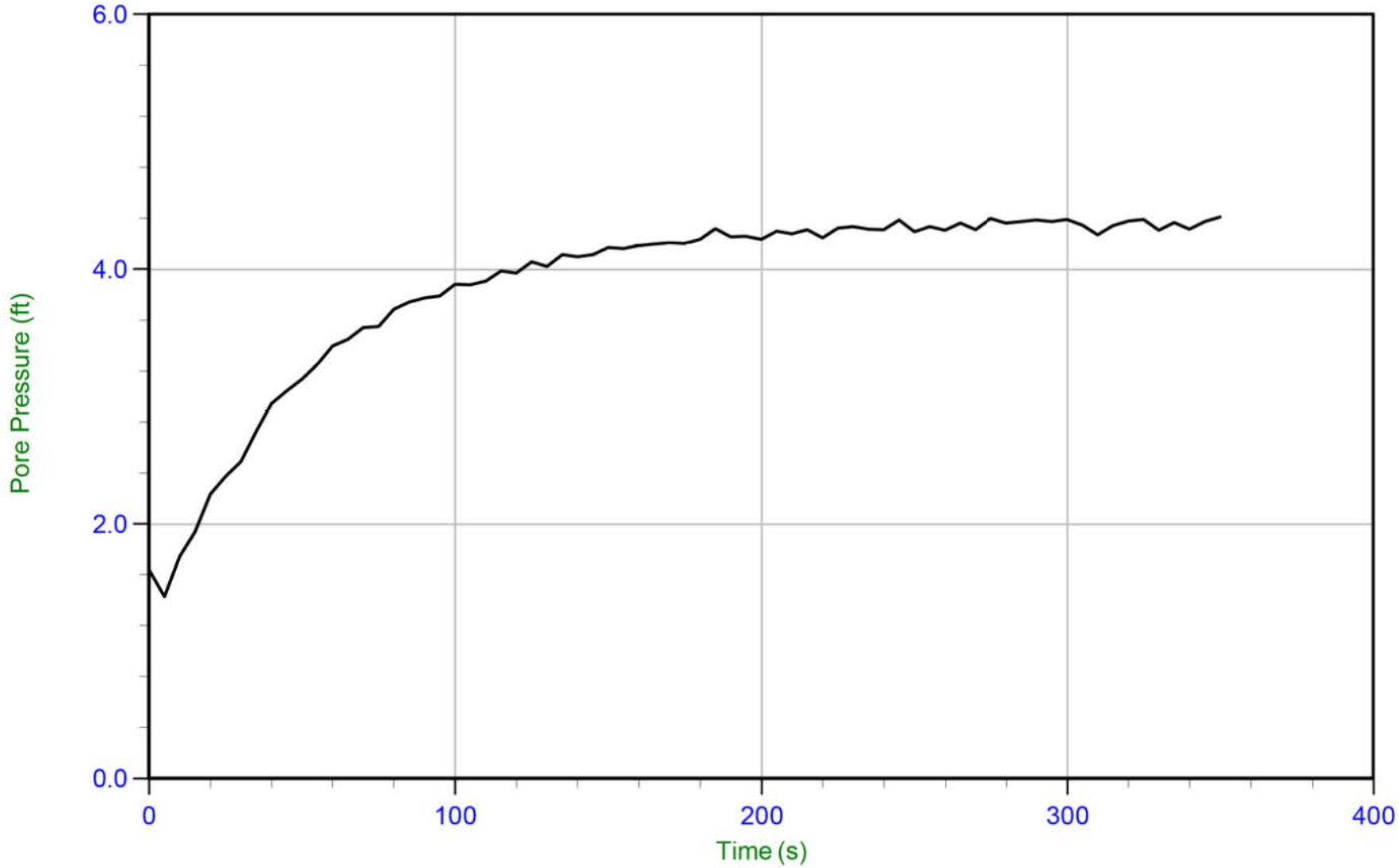
WT: 2.937 m / 9.636 ft
Ueq: 3.3 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 4.250 m / 13.943 ft
Duration: 350.0 s

U Min: 1.4 ft
U Max: 4.4 ft

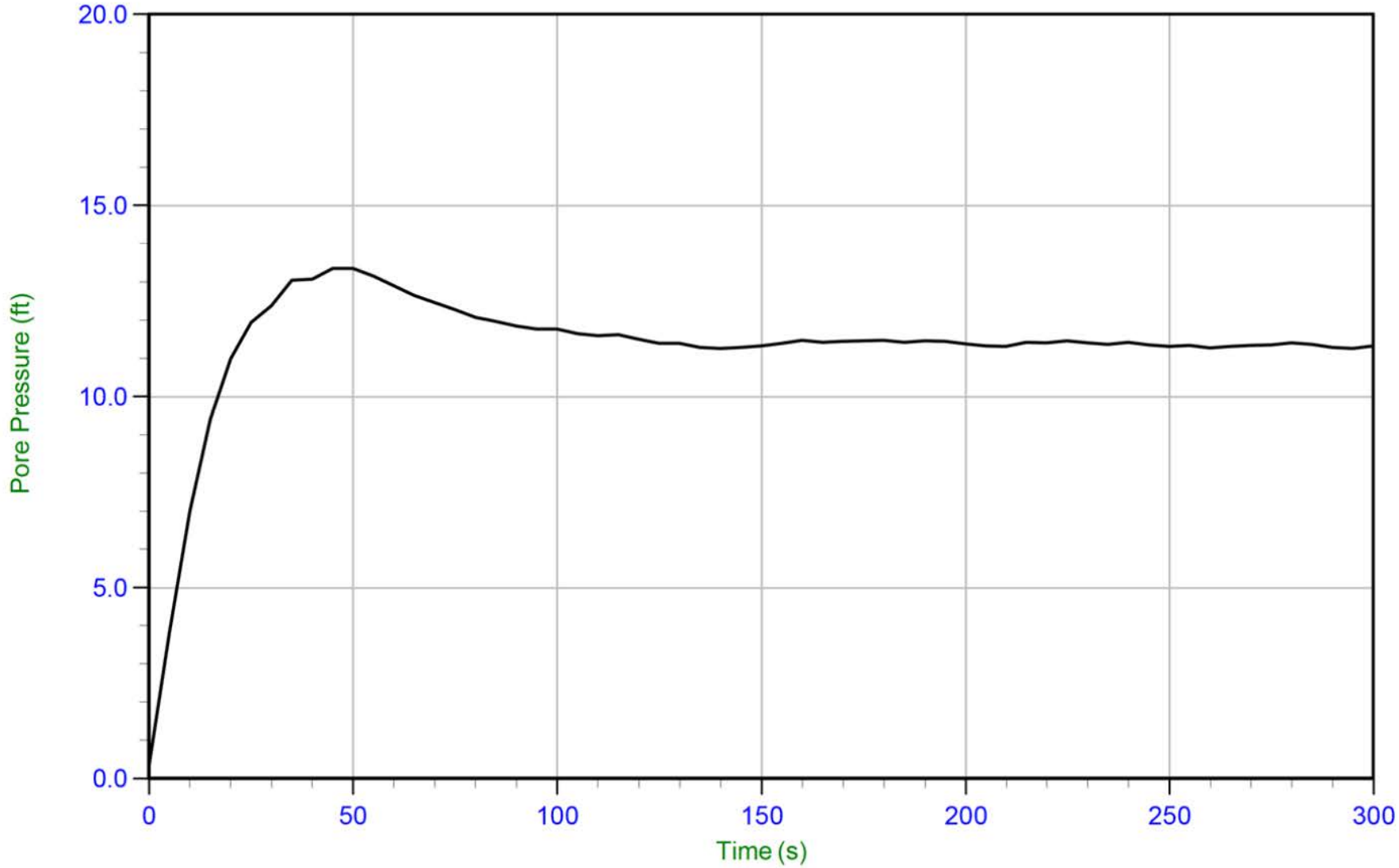
WT: 2.907 m / 9.536 ft
Ueq: 4.4 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 4.550 m / 14.928 ft
Duration: 300.0 s

U Min: 0.4 ft
U Max: 13.4 ft

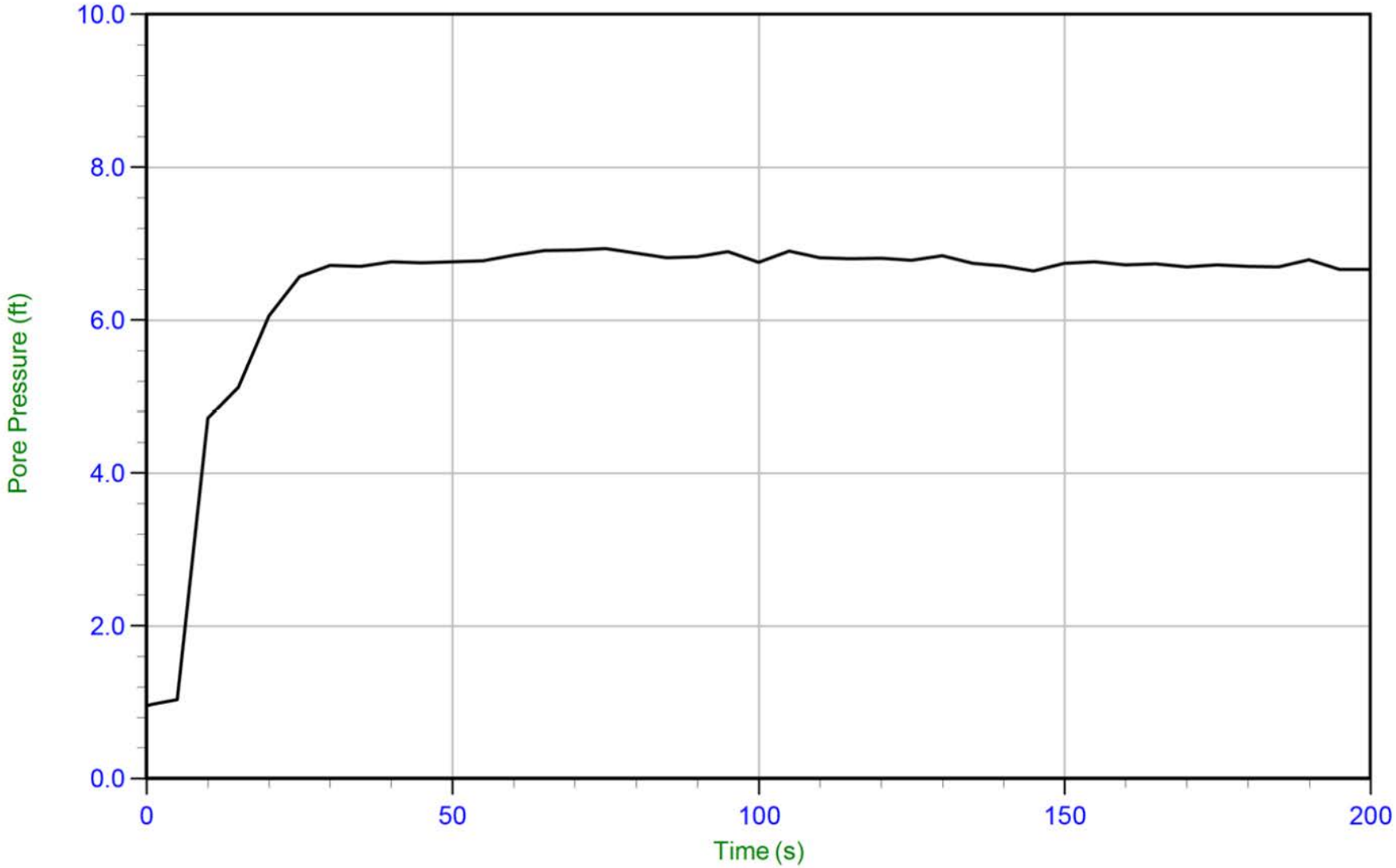
WT: 1.114 m / 3.655 ft
Ueq: 11.3 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 4.900 m / 16.076 ft
Duration: 200.0 s

U Min: 1.0 ft
U Max: 6.9 ft

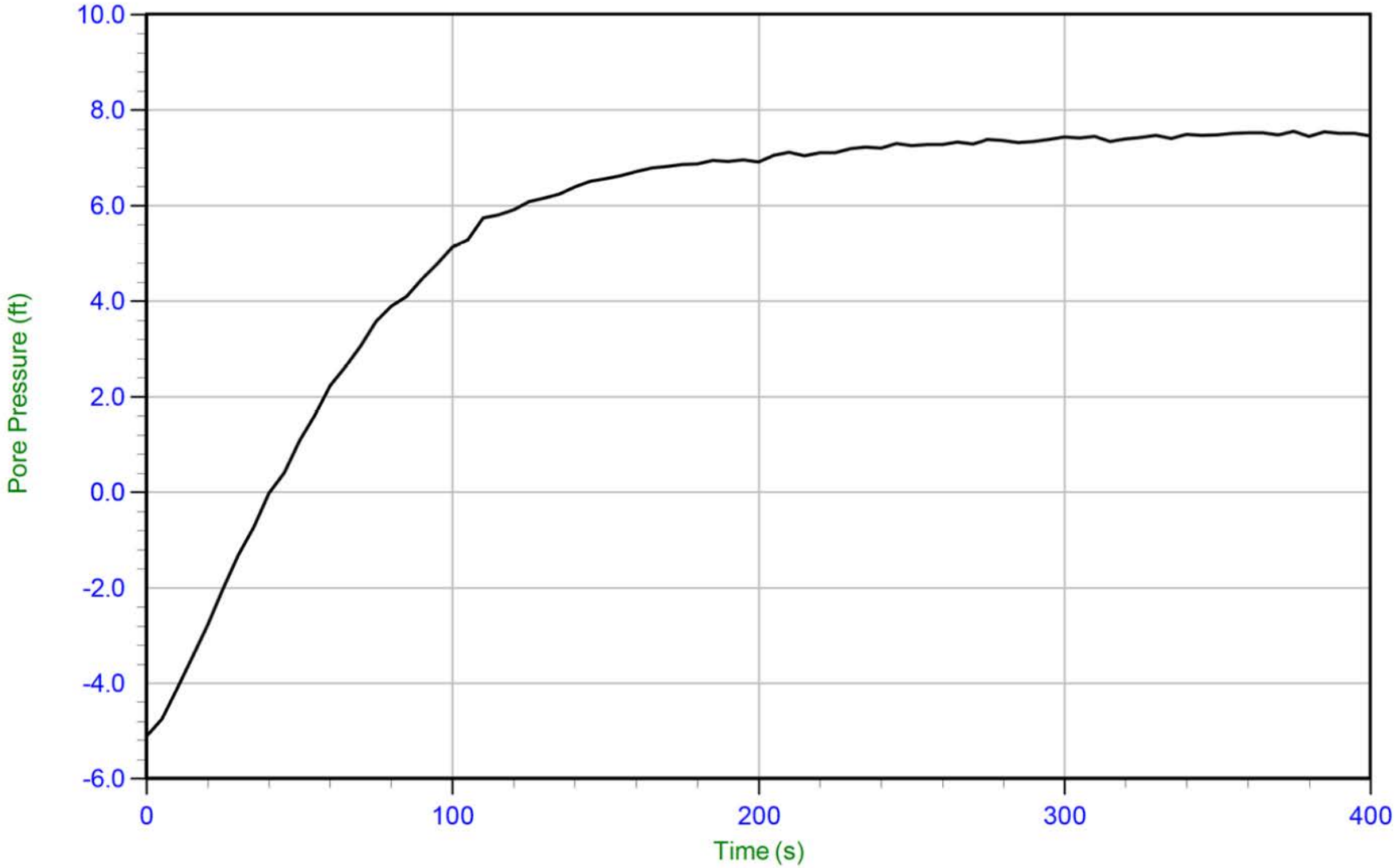
WT: 2.872 m / 9.421 ft
Ueq: 6.7 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 5.200 m / 17.060 ft
Duration: 400.0 s

U Min: -5.1 ft
U Max: 7.6 ft

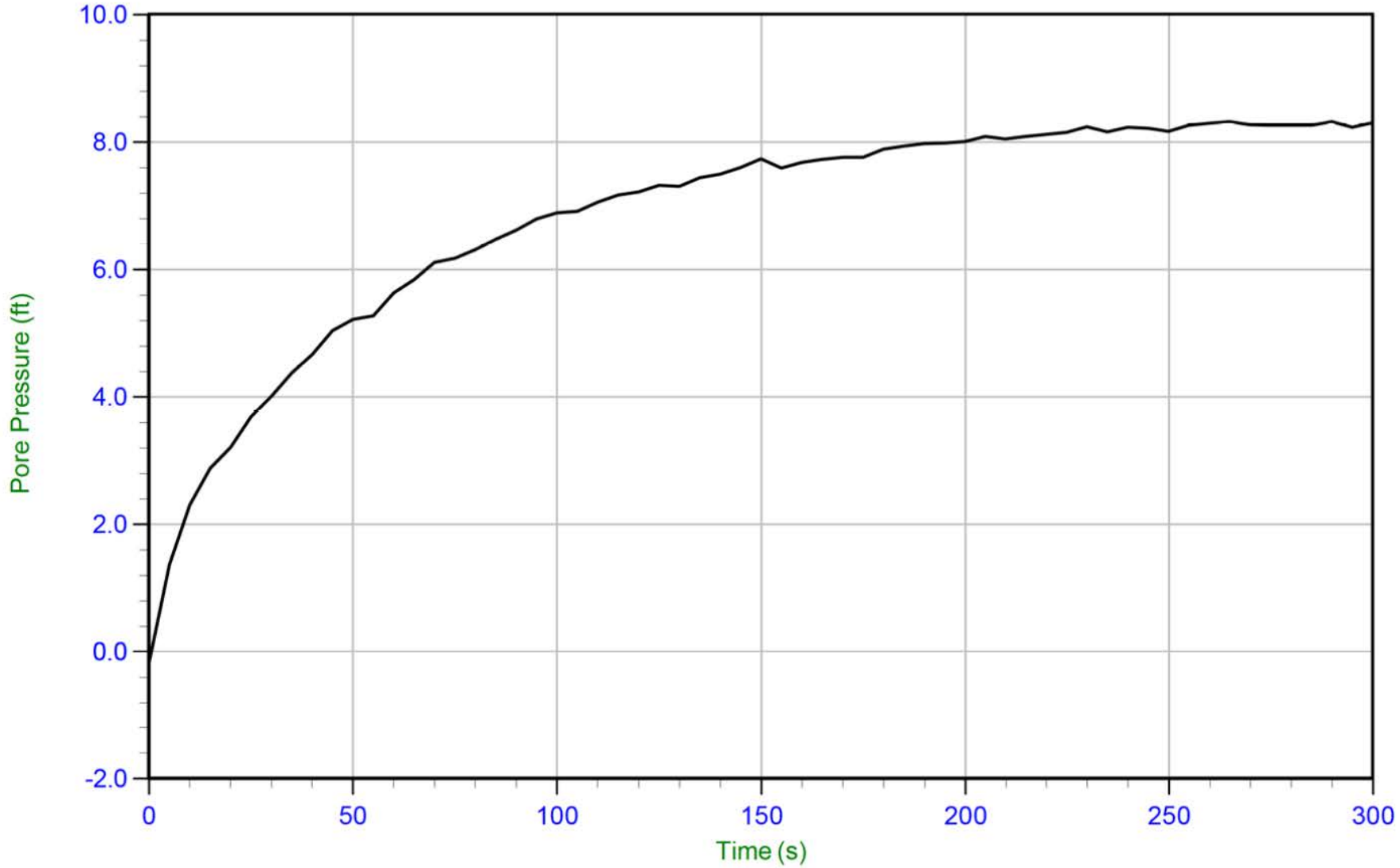
WT: 2.897 m / 9.504 ft
Ueq: 7.6 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 5.500 m / 18.044 ft
Duration: 300.0 s

U Min: -0.2 ft
U Max: 8.3 ft

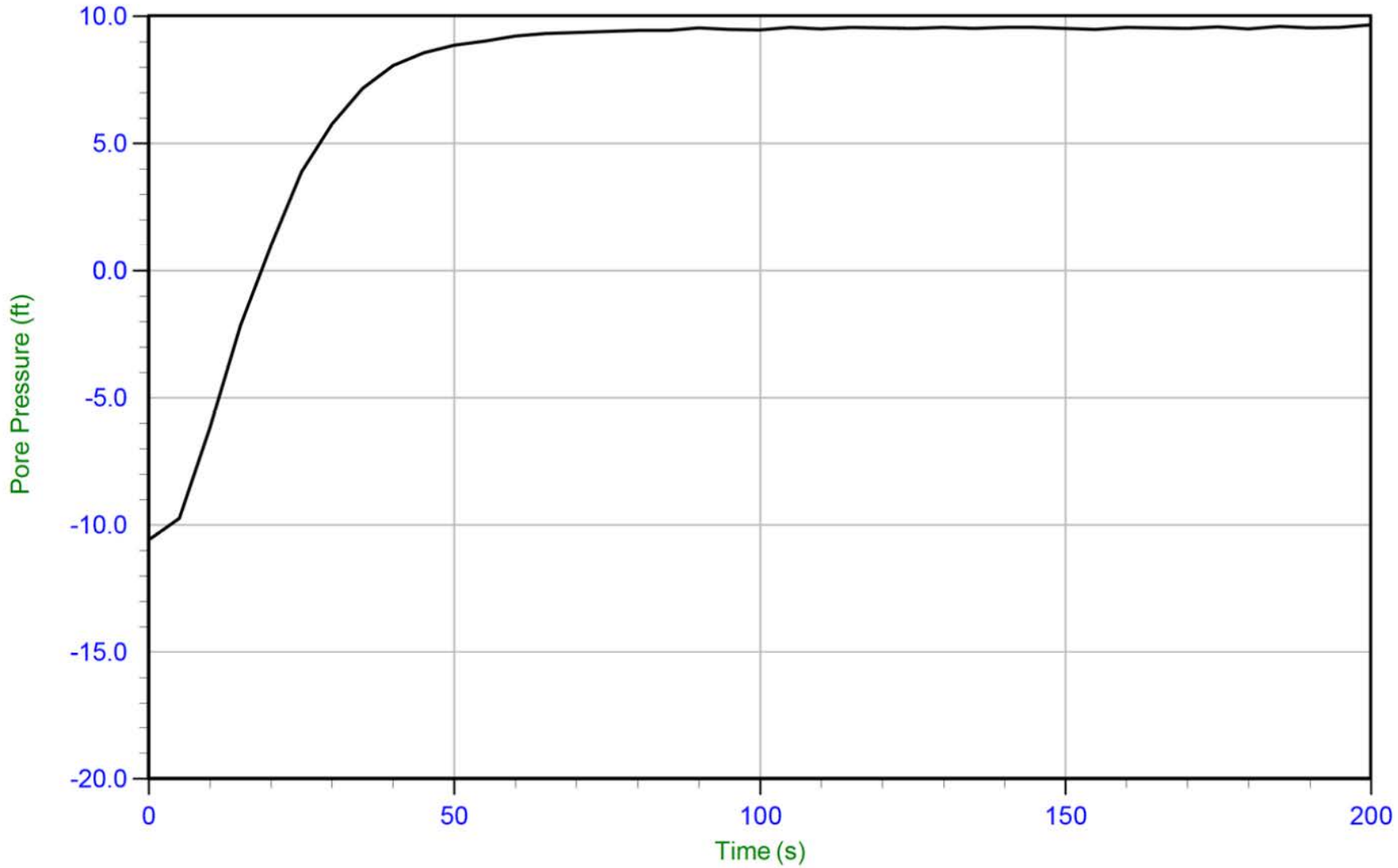
WT: 2.971 m / 9.746 ft
Ueq: 8.3 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 5.800 m / 19.029 ft
Duration: 200.0 s

U Min: -10.6 ft
U Max: 9.6 ft

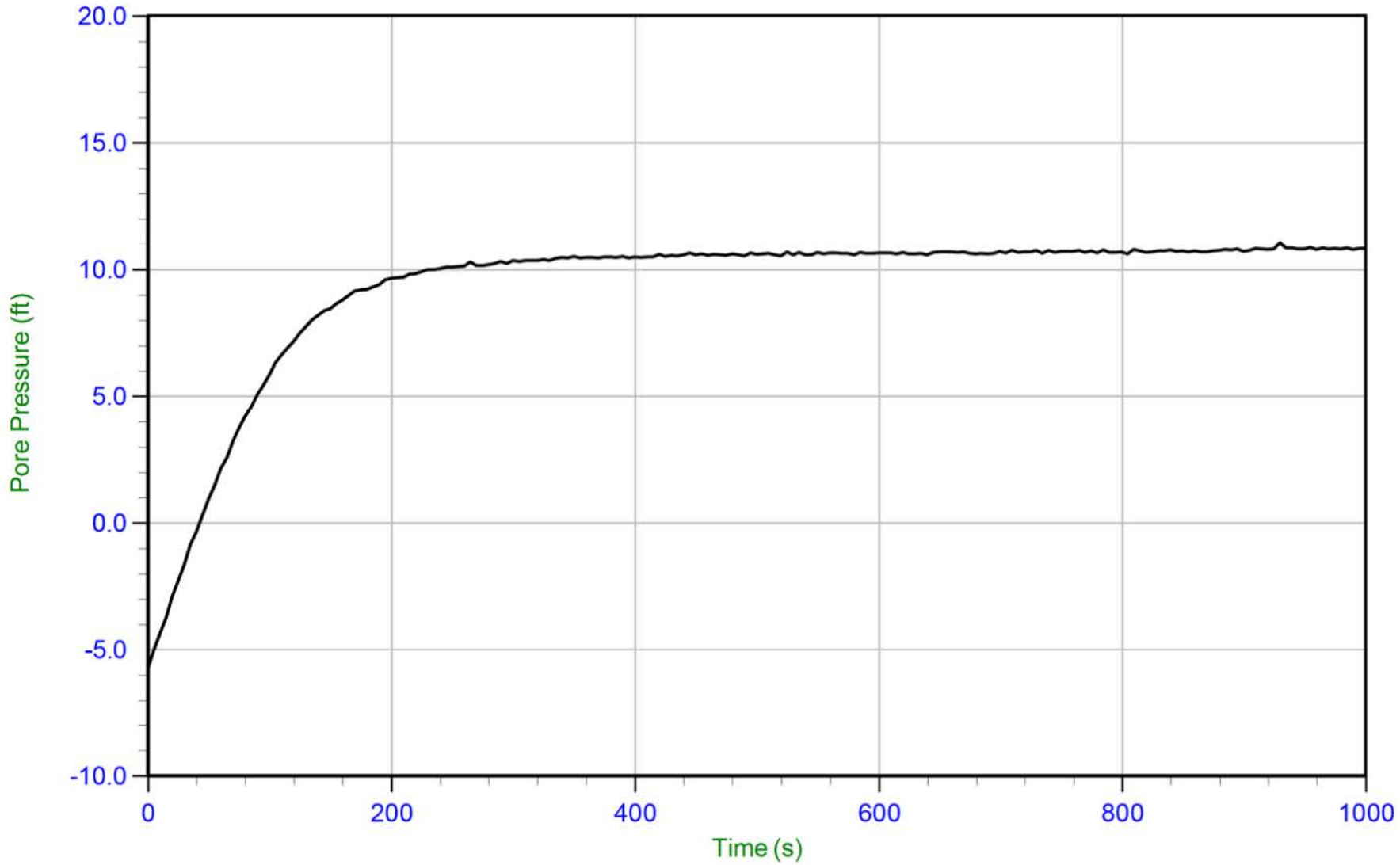
WT: 2.918 m / 9.574 ft
Ueq: 9.5 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 08:41:15
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C13
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C13.PPD
Depth: 6.100 m / 20.013 ft
Duration: 1000.0 s

U Min: -5.7 ft
U Max: 11.1 ft

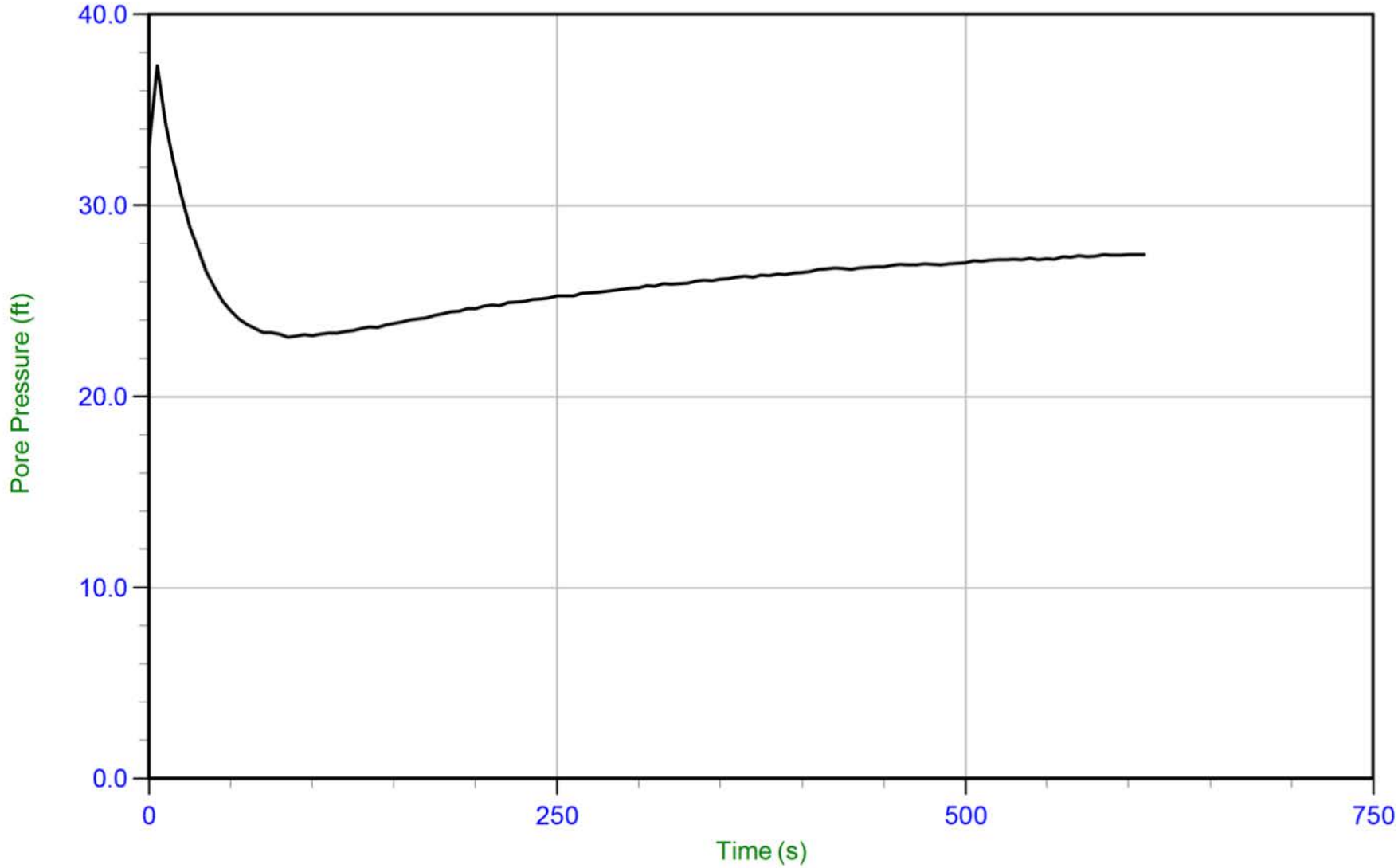
WT: 2.797 m / 9.177 ft
Ueq: 10.8 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 12:30:29
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C14
Cone: AD268 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C14.PPD
Depth: 15.250 m / 50.032 ft
Duration: 610.0 s

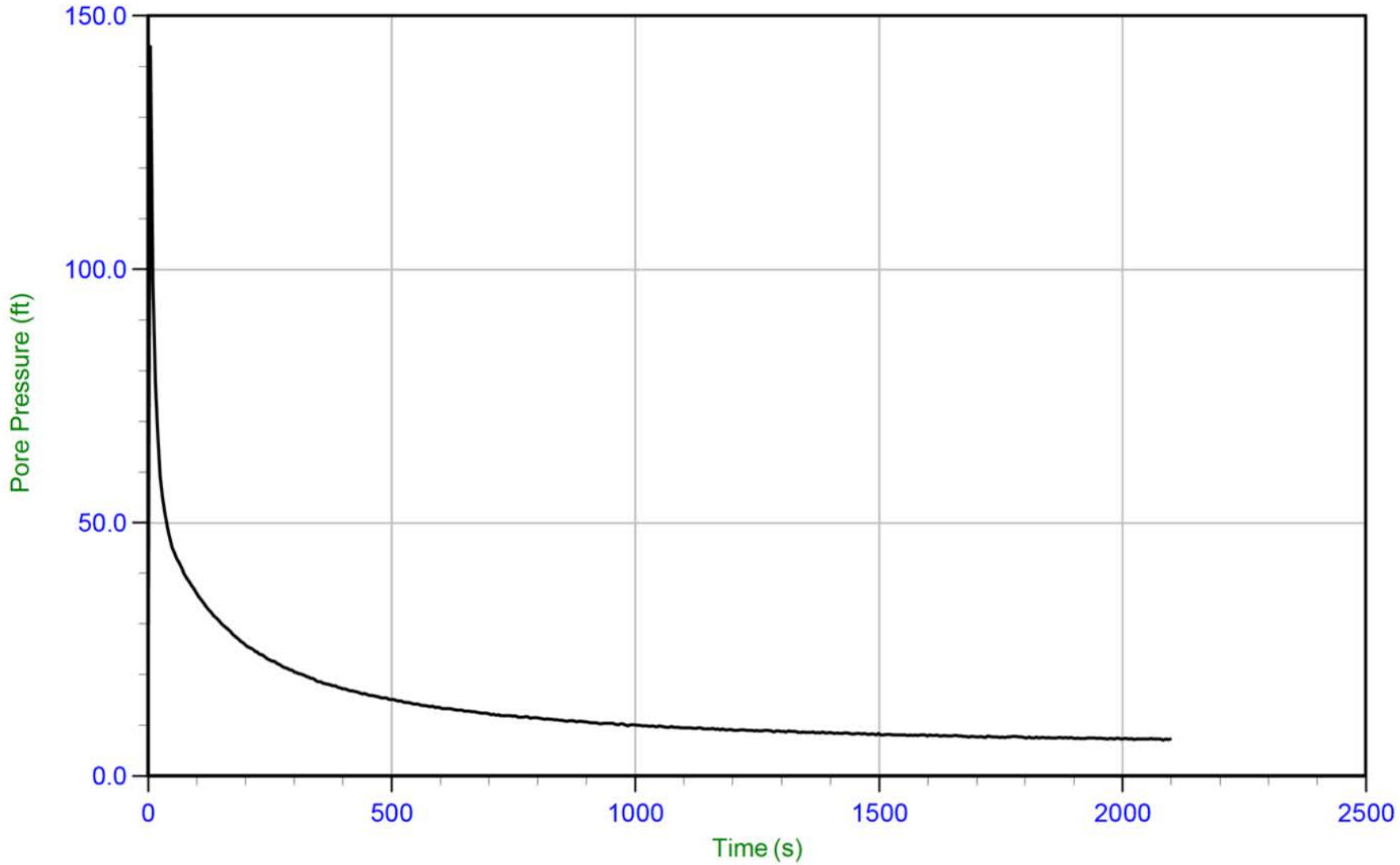
U Min: 23.1 ft
U Max: 37.3 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 16:20:28
Site: New Madrid Power Plant, Marston, MO

Sounding: SCPT17-HA-C15
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_SPHA-C15.PPD
Depth: 0.300 m / 0.984 ft
Duration: 2100.0 s

U Min: 1.7 ft
U Max: 143.9 ft

WT: 0.000 m / 0.000 ft
Ueq: 1.0 ft
U(50): 72.45 ft

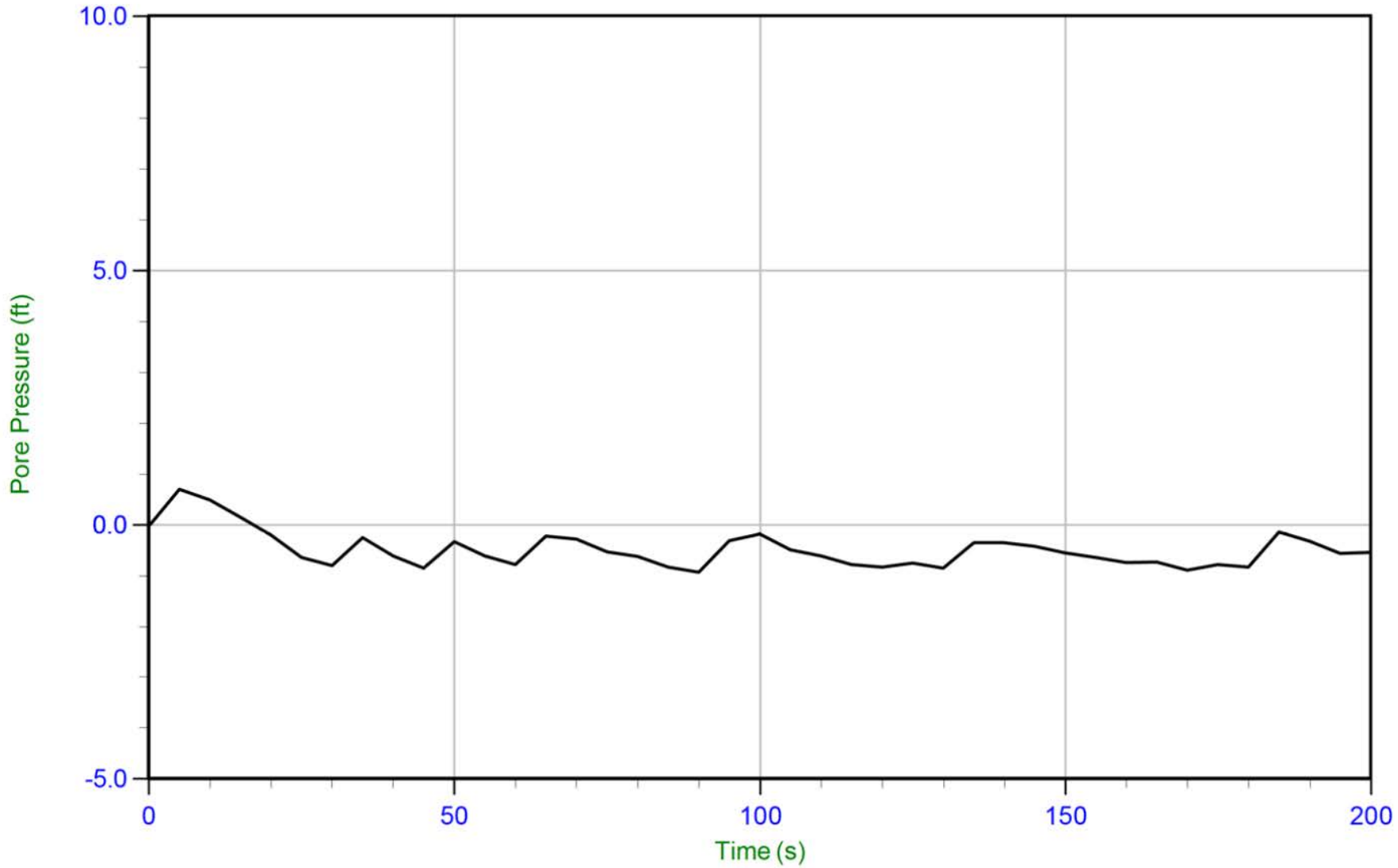
T(50): 12.3 s
Ir: 100
Ch: 56.8 sq cm/min

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 16:20:28
Site: New Madrid Power Plant, Marston, MO

Sounding: SCPT17-HA-C15
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_SPHA-C15.PPD
Depth: 1.000 m / 3.281 ft
Duration: 200.0 s

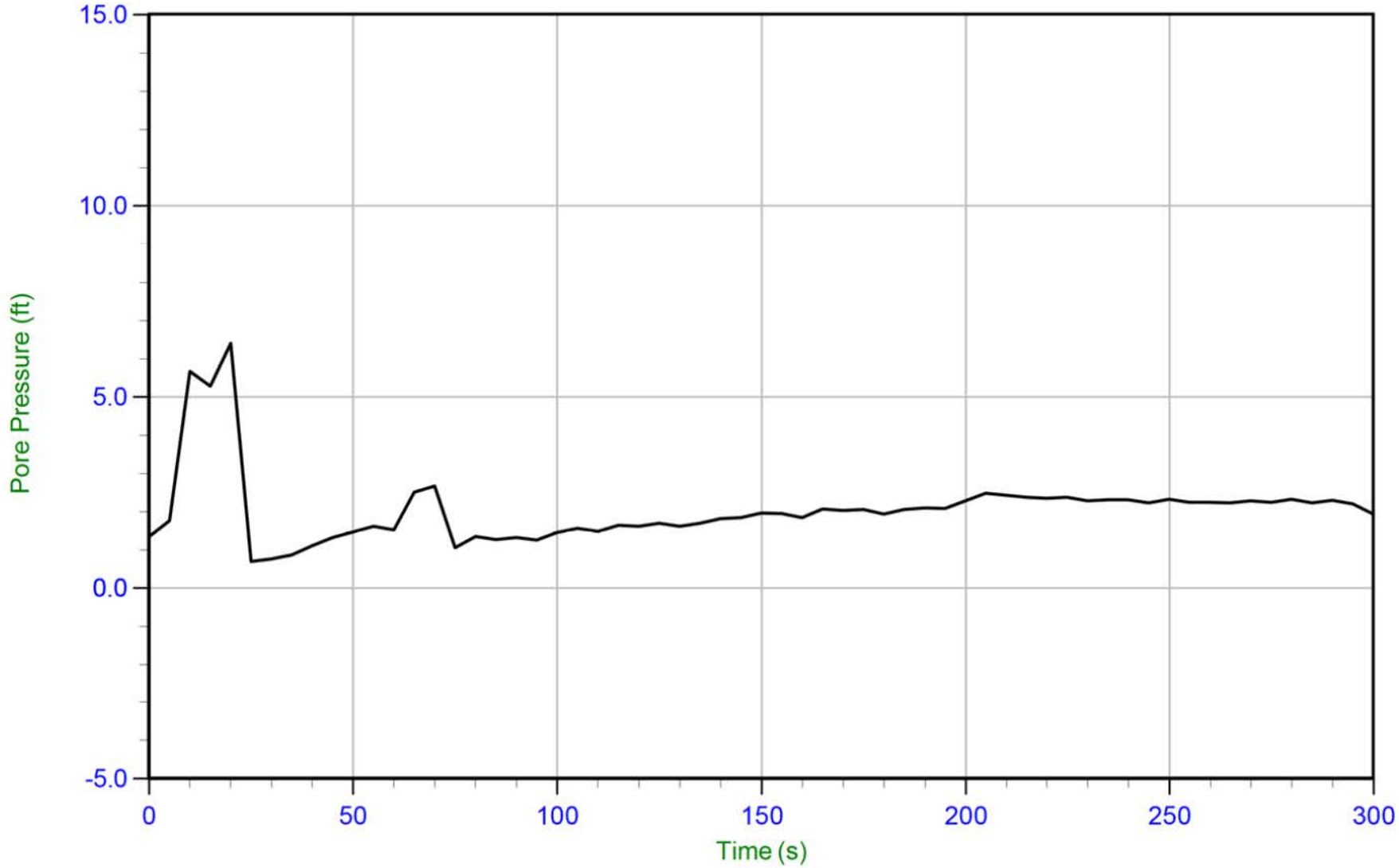
U Min: -0.9 ft
U Max: 0.7 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 16:20:28
Site: New Madrid Power Plant, Marston, MO

Sounding: SCPT17-HA-C15
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_SPHA-C15.PPD
Depth: 2.000 m / 6.562 ft
Duration: 300.0 s

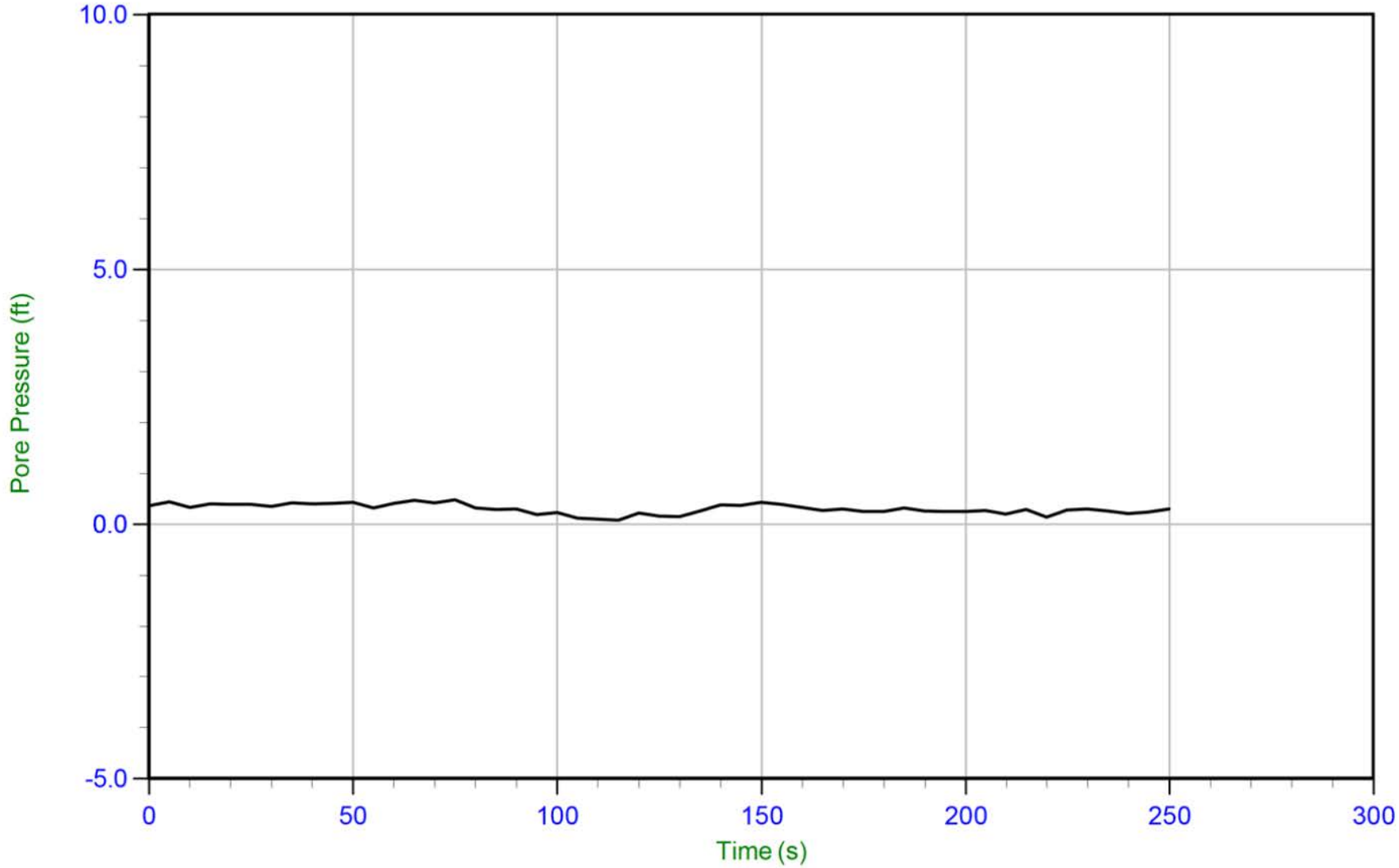
U Min: 0.7 ft
U Max: 6.4 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 16:20:28
Site: New Madrid Power Plant, Marston, MO

Sounding: SCPT17-HA-C15
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_SPHA-C15.PPD
Depth: 3.000 m / 9.842 ft
Duration: 250.0 s

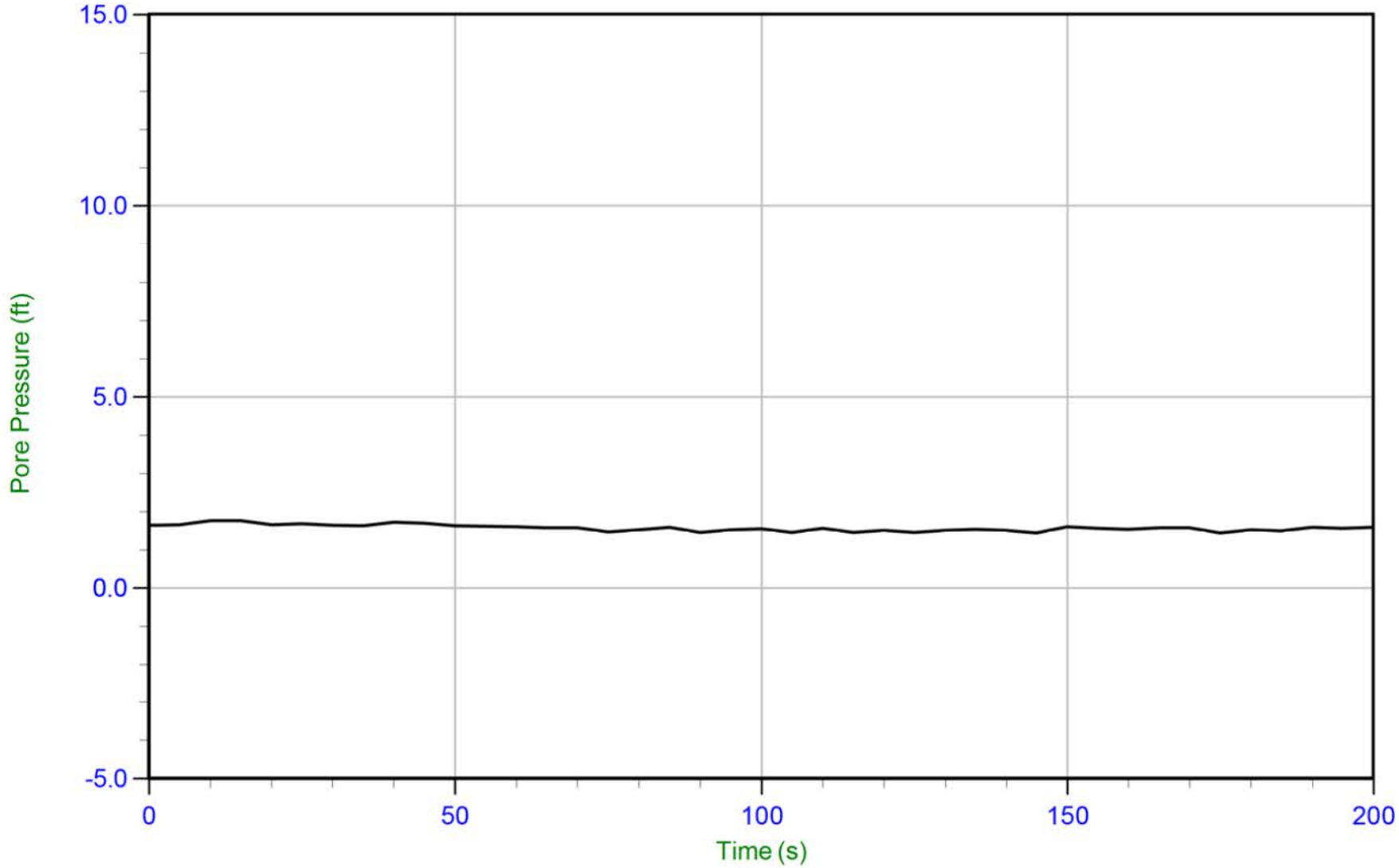
U Min: 0.1 ft
U Max: 0.5 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 16:20:28
Site: New Madrid Power Plant, Marston, MO

Sounding: SCPT17-HA-C15
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_SPHA-C15.PPD
Depth: 4.000 m / 13.123 ft
Duration: 200.0 s

U Min: 1.4 ft
U Max: 1.8 ft

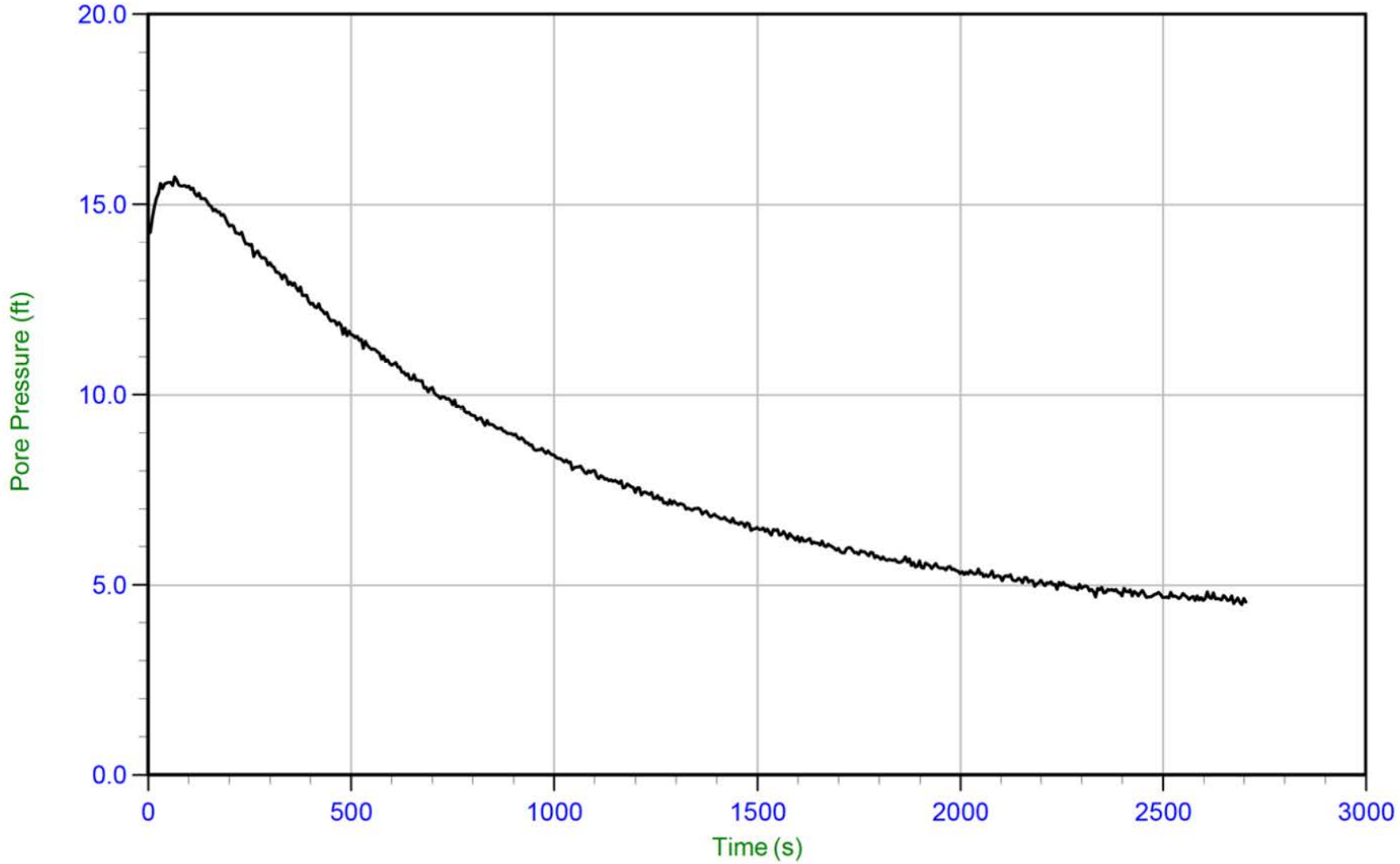
WT: 3.526 m / 11.567 ft
Ueq: 1.6 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 16:20:28
Site: New Madrid Power Plant, Marston, MO

Sounding: SCPT17-HA-C15
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_SPHA-C15.PPD
Depth: 5.000 m / 16.404 ft
Duration: 2705.0 s

U Min: 4.5 ft
U Max: 15.7 ft

WT: 5.000 m / 16.404 ft
Ueq: 0.0 ft
U(50): 7.87 ft

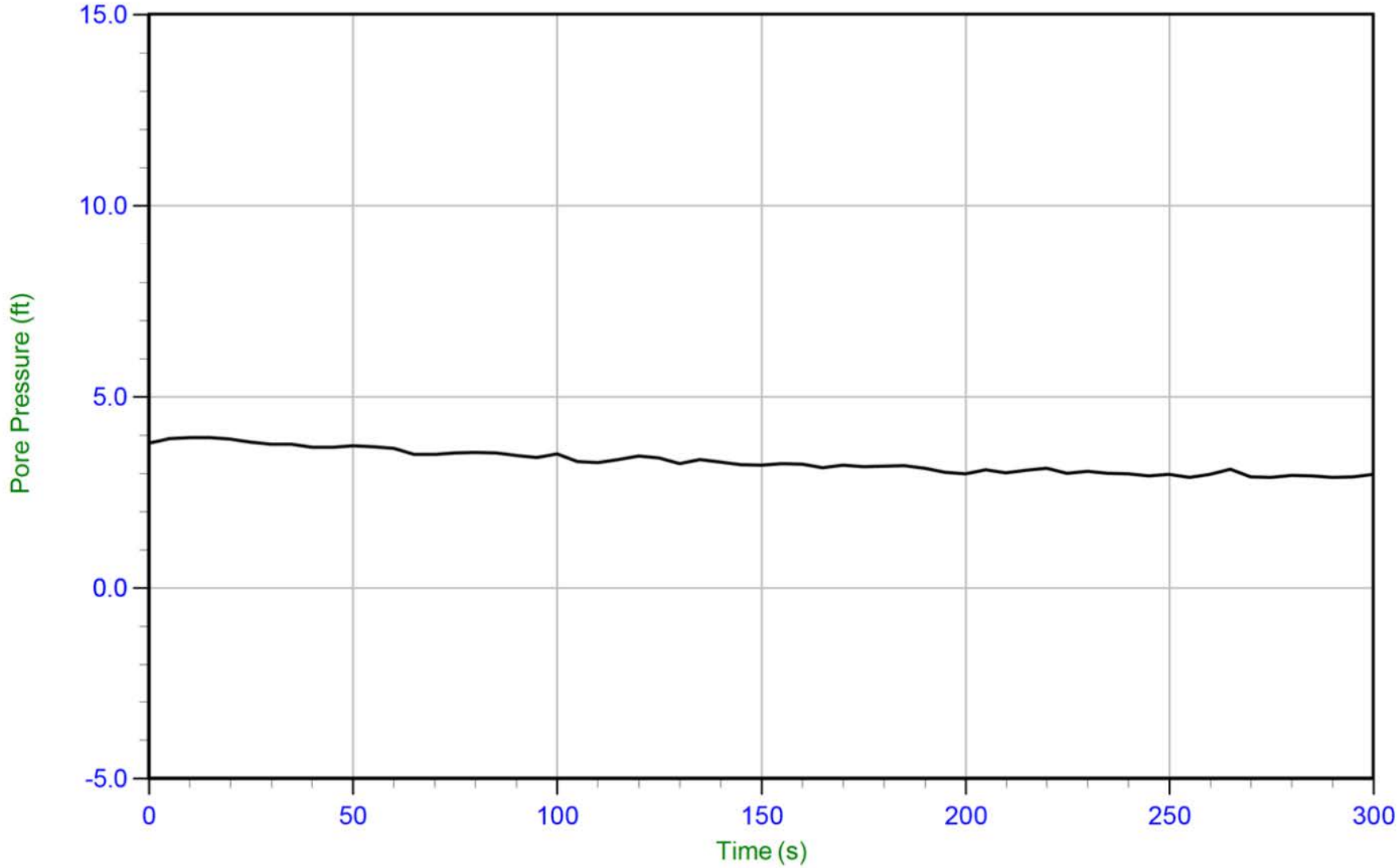
T(50): 1039.7 s
Ir: 100
Ch: 0.7 sq cm/min

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 16:20:28
Site: New Madrid Power Plant, Marston, MO

Sounding: SCPT17-HA-C15
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_SPHA-C15.PPD
Depth: 6.000 m / 19.685 ft
Duration: 300.0 s

U Min: 2.9 ft
U Max: 3.9 ft

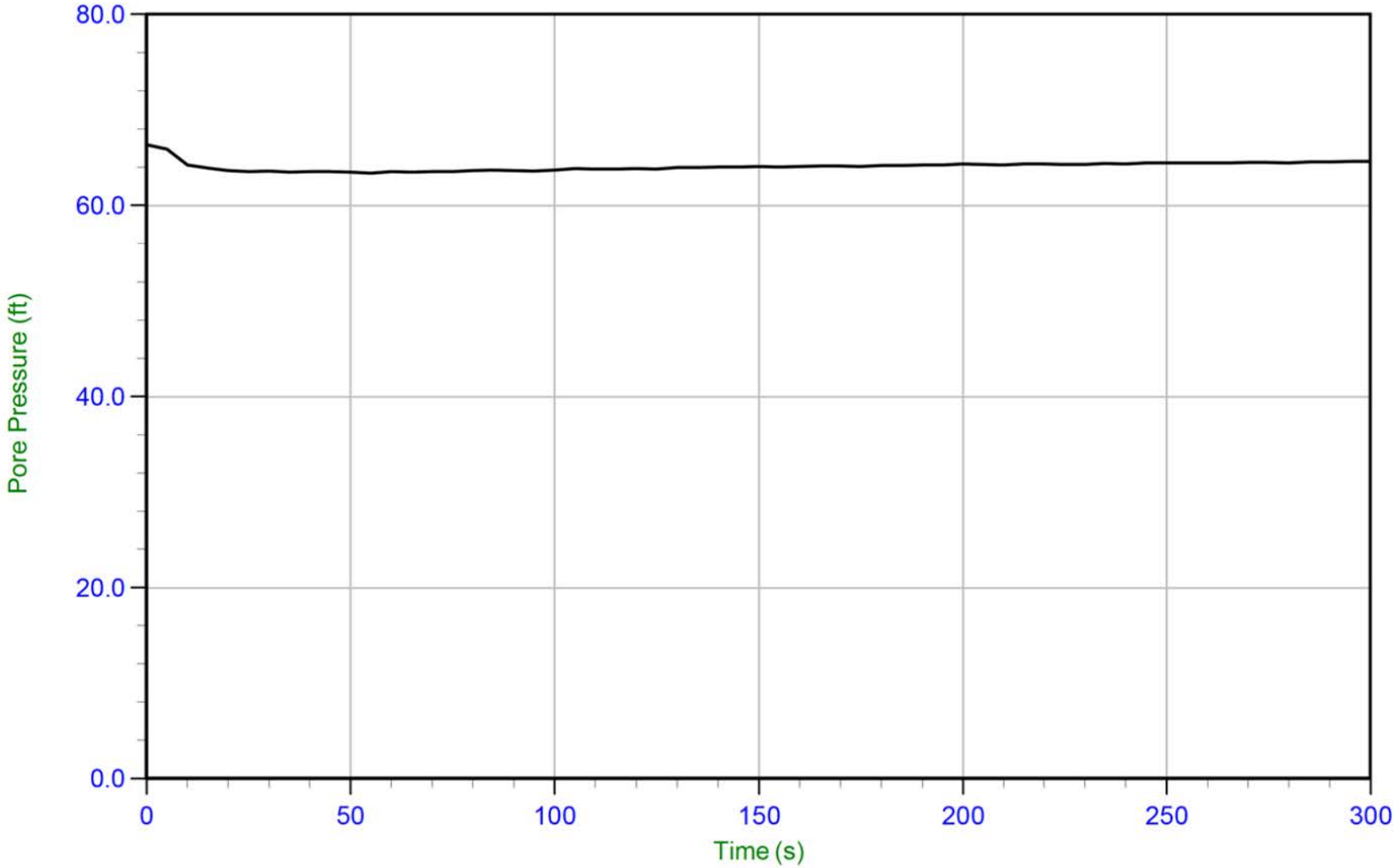
WT: 5.130 m / 16.830 ft
Ueq: 2.9 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 16:20:28
Site: New Madrid Power Plant, Marston, MO

Sounding: SCPT17-HA-C15
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_SPHA-C15.PPD
Depth: 29.050 m / 95.307 ft
Duration: 300.0 s

U Min: 63.4 ft
U Max: 66.4 ft

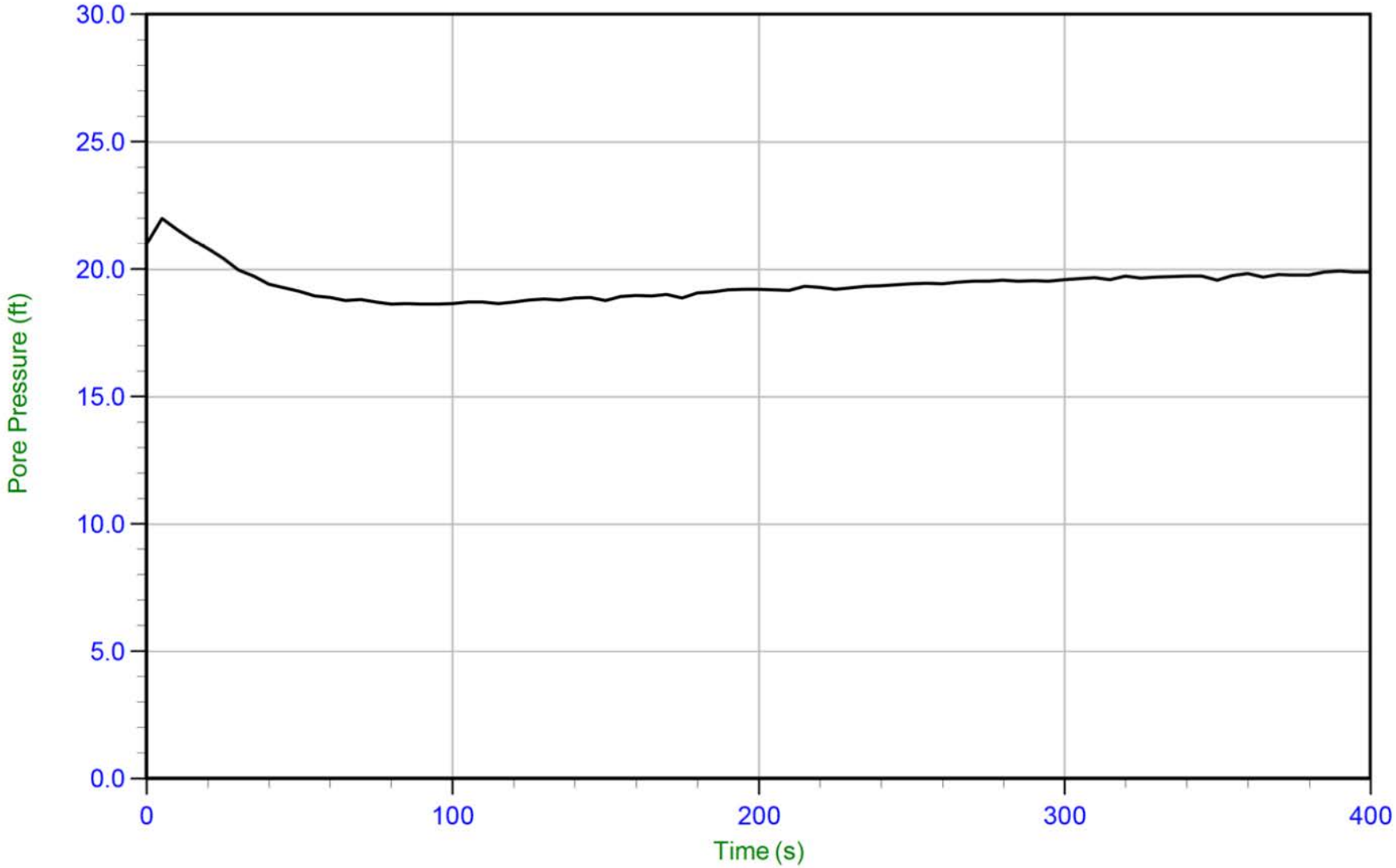
WT: 9.365 m / 30.726 ft
Ueq: 64.6 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 12-Jun-2017 15:12:37
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C16
Cone: AD206 Area=15 cm²



Trace Summary:

Filename: 17-53075_CPHA-C16.PPD
Depth: 15.250 m / 50.032 ft
Duration: 400.0 s

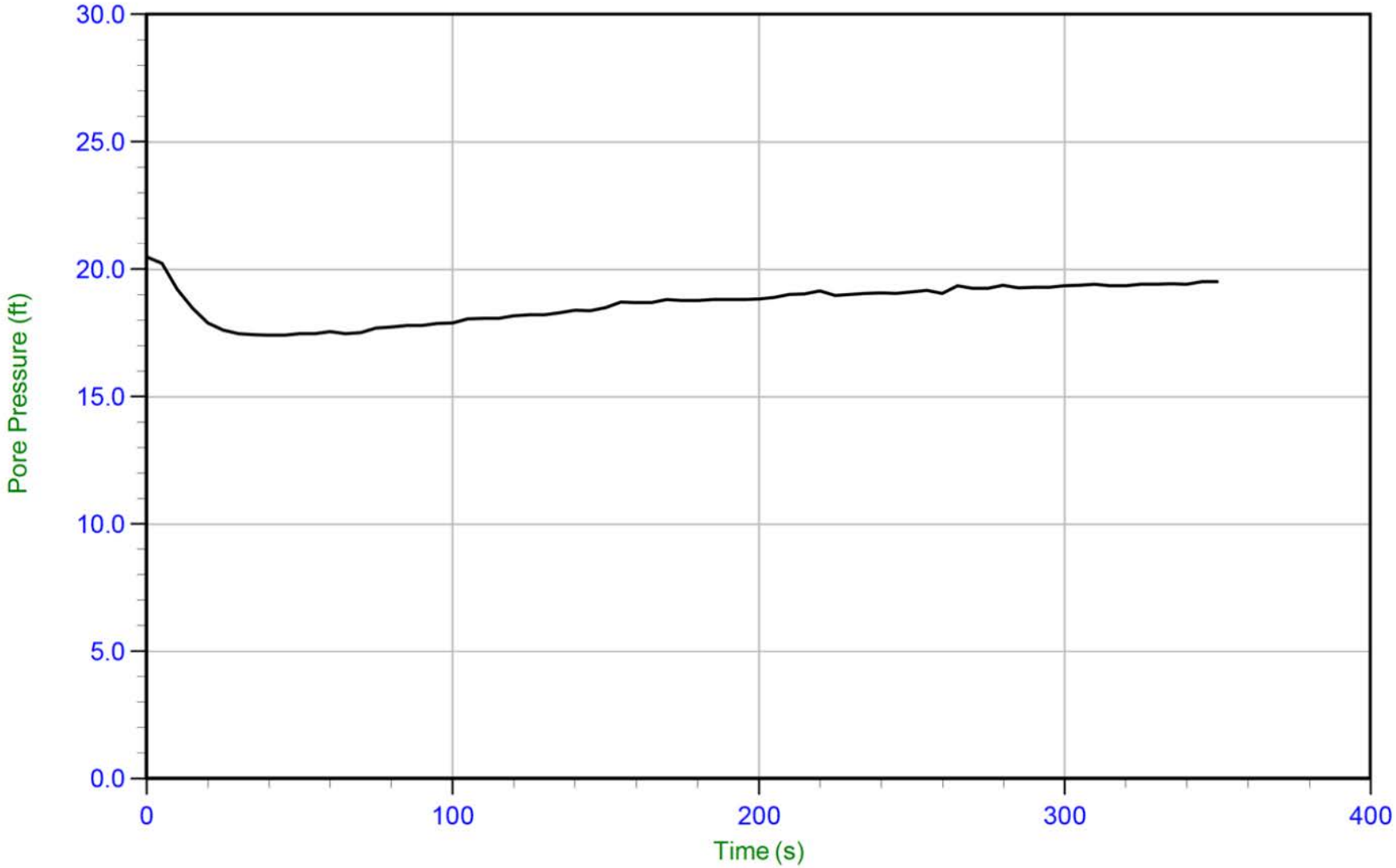
U Min: 18.6 ft
U Max: 22.0 ft

CONETEC

Haley & Aldrich

Job No: 17-53075
Date: 13-Jun-2017 11:34:12
Site: New Madrid Power Plant, Marston, MO

Sounding: CPT17-HA-C17
Cone: AD268 Area=15 cm²



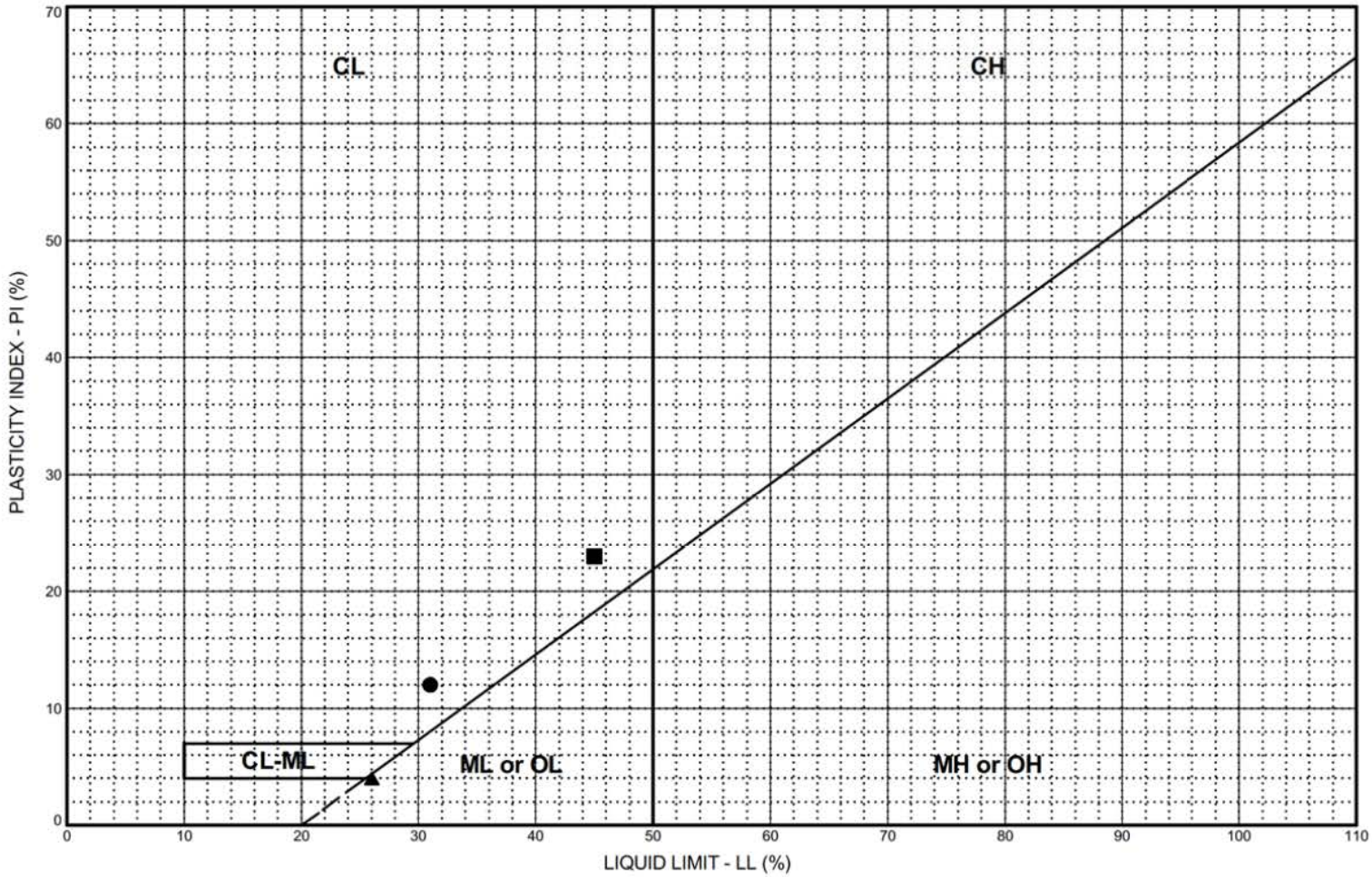
Trace Summary:

Filename: 17-53075_CPHA-C17.PPD
Depth: 15.250 m / 50.032 ft
Duration: 350.0 s

U Min: 17.4 ft
U Max: 20.5 ft

APPENDIX D

Current Laboratory Test Results



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, %
● HA-B10OW, S2	2.0 - 4.0	CL	Gray and brown, Lean Clay.	31	19	12	18.0	
■ HA-B9, S4	12.0 - 14.0	CL	Brown, Lean Clay.	45	22	23	21.4	
▲ HA-B9A, S1	18.0 - 20.0	ML	Brown, Silt.	26	22	4	30.9	

AECI NMPP - LINED POND
Marston, Missouri

PLASTICITY CHART

July 2017 41-1-37431-008

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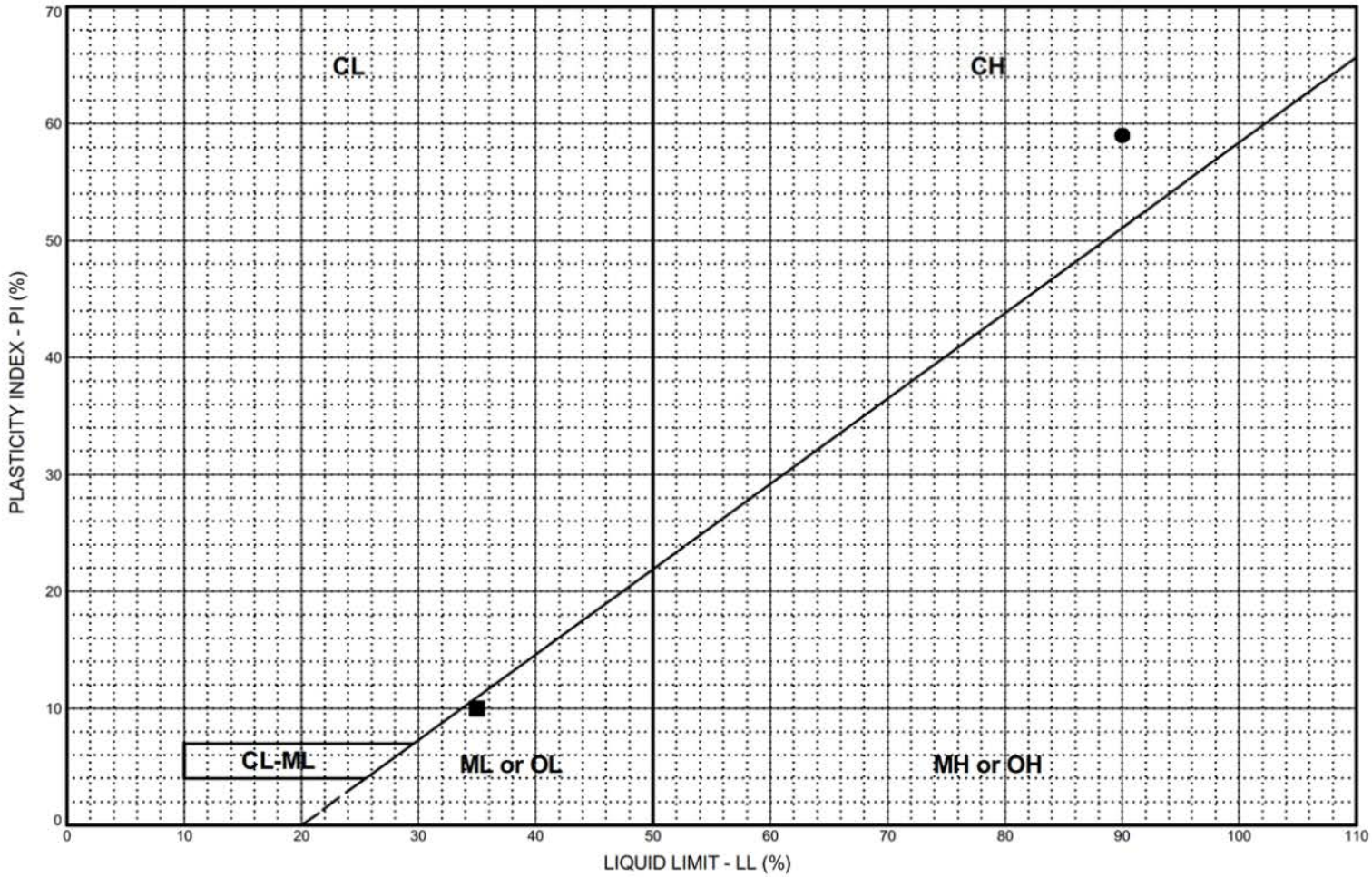
FIG.

FIG.

ATTERBERG - WITH SAMPLE INTERVALS 41-1-37431-008 LAB DATA.GPJ SHAN_WIL.GDT 7/12/17



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, %
● HA-B9, U1	6.8	CH	Mottled gray and brown, Fat Clay.	90	31	59	34.6	98.0
■ HA-B9, U3	14.4	ML	Brown, Silt.	35	25	10	19.6	97.1

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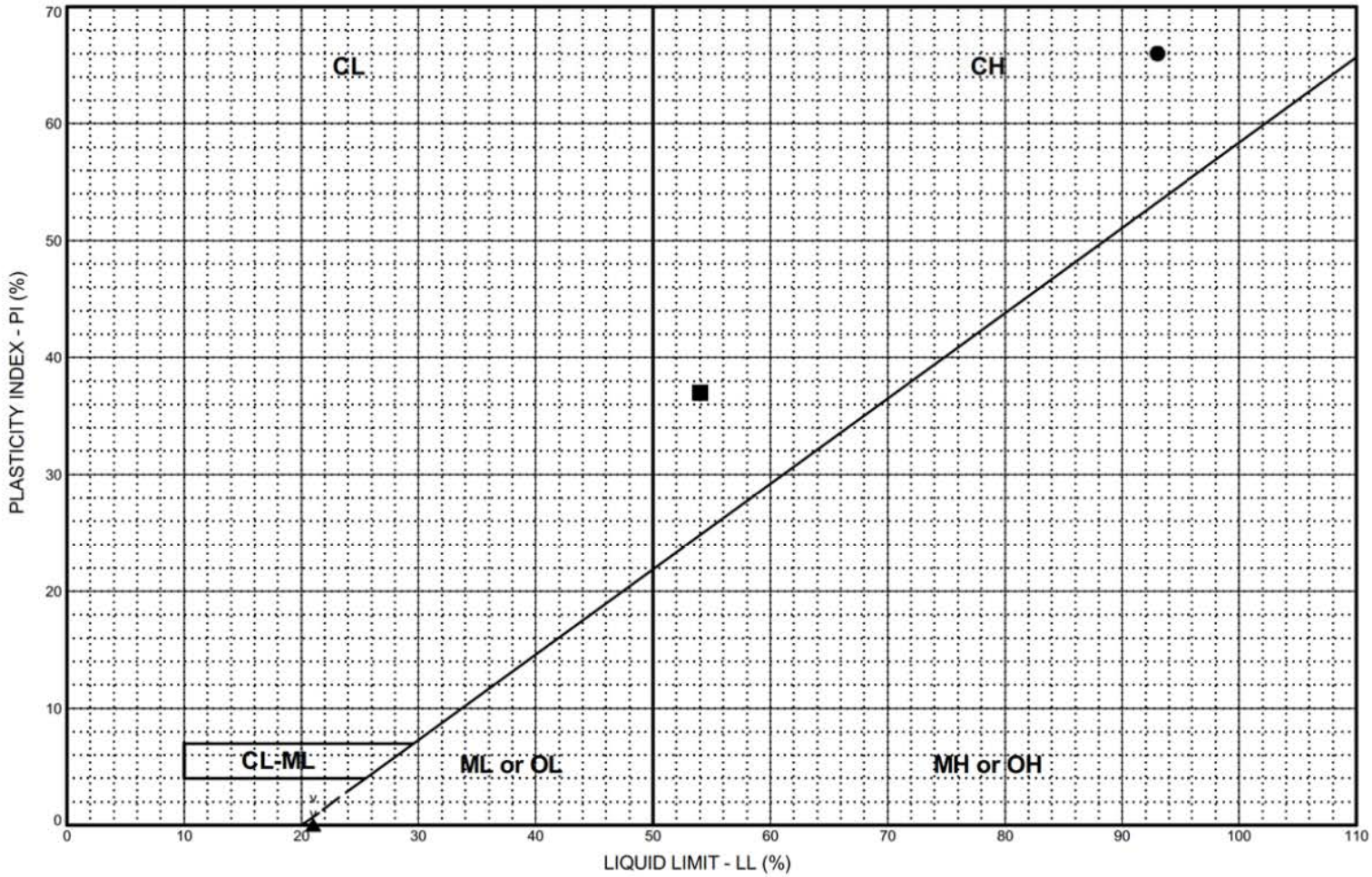
FIG.

FIG.

ATTERBERG - NORMAL 41-1-37431-008 LAB DATA.GPJ SHAN_WIL.GDT 7/26/17



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, %
● HA-B10OW, U1	10.0 - 12.0	CH	Mottled gray and brown, Fat Clay.	93	27	66	29.9	98.0
■ HA-B10OW, U2	18.0 - 20.0	CH	Mottled gray and brown, Fat Clay.	54	17	37	19.0	95.6
▲ HA-B10OW, U3	30.0 - 32.0	ML	Brown, Silt.	21	23	NP	36.4	99.6

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PLASTICITY CHART

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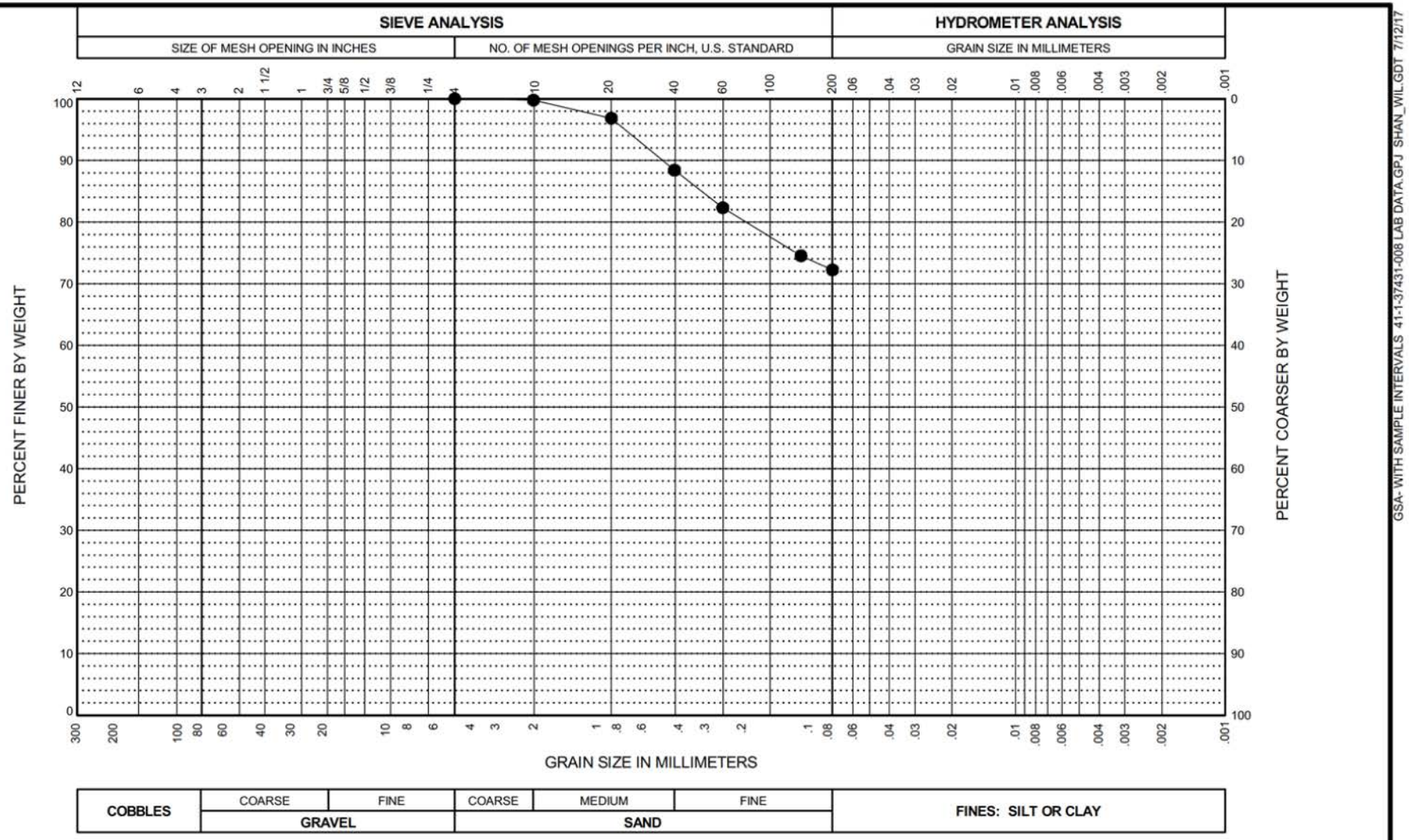
FIG.

FIG.

ATTERBERG - WITH SAMPLE INTERVALS 41-1-37431-008 LAB DATA.GPJ SHAN_WIL.GDT 7/20/17



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HA-B8OW, S3	4.0 - 6.0	ML	Gray, Silt with Sand.	72.2	115.2			

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GRAIN SIZE DISTRIBUTION

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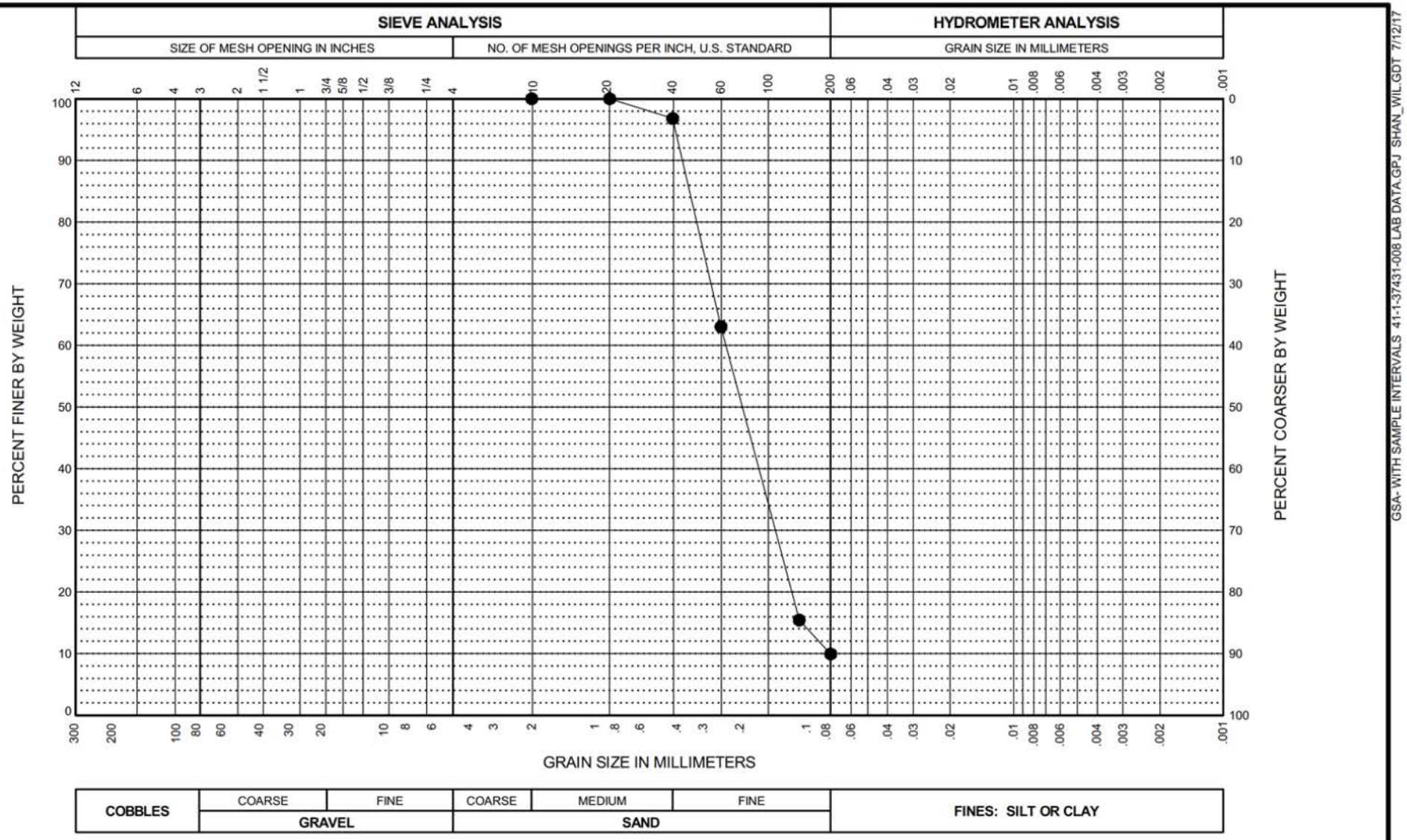
FIG.

GSA- WITH SAMPLE INTERVALS 41-1-37431-008 LAB DATA.GPJ SHAN_WIL.GDT 7/12/17



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HA-B9, S6	24.0 - 26.0	SP-SM	Brown, Poorly Graded Sand with Silt.	9.9	4.7			

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GRAIN SIZE DISTRIBUTION

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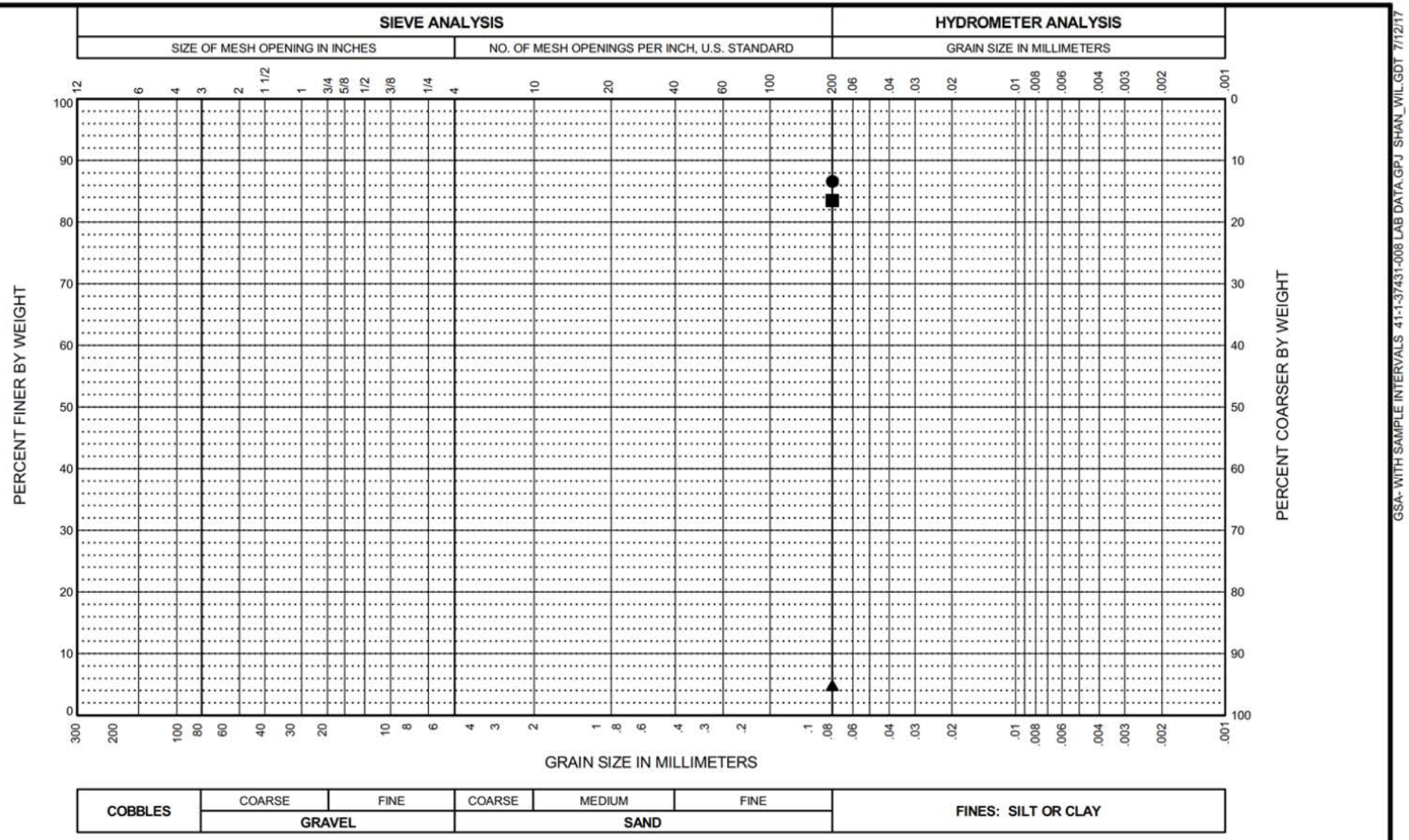
FIG.

GSA- WITH SAMPLE INTERVALS 41-1-37431-008 LAB DATA.GPJ SHAN_WILGDT 7/12/17



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HA-B10OW, S5	8.0 - 10.0	CL	Gray and brown, Lean Clay.	86.6	20.4			
■ HA-B8OW, S8	14.0 - 16.0	ML	Gray, Silt with Sand.	83.5	95.4			
▲ HA-B9A, S3	28.0 - 30.0	SP	Brown, Poorly Graded Sand.	4.9	17.6			

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GRAIN SIZE DISTRIBUTION

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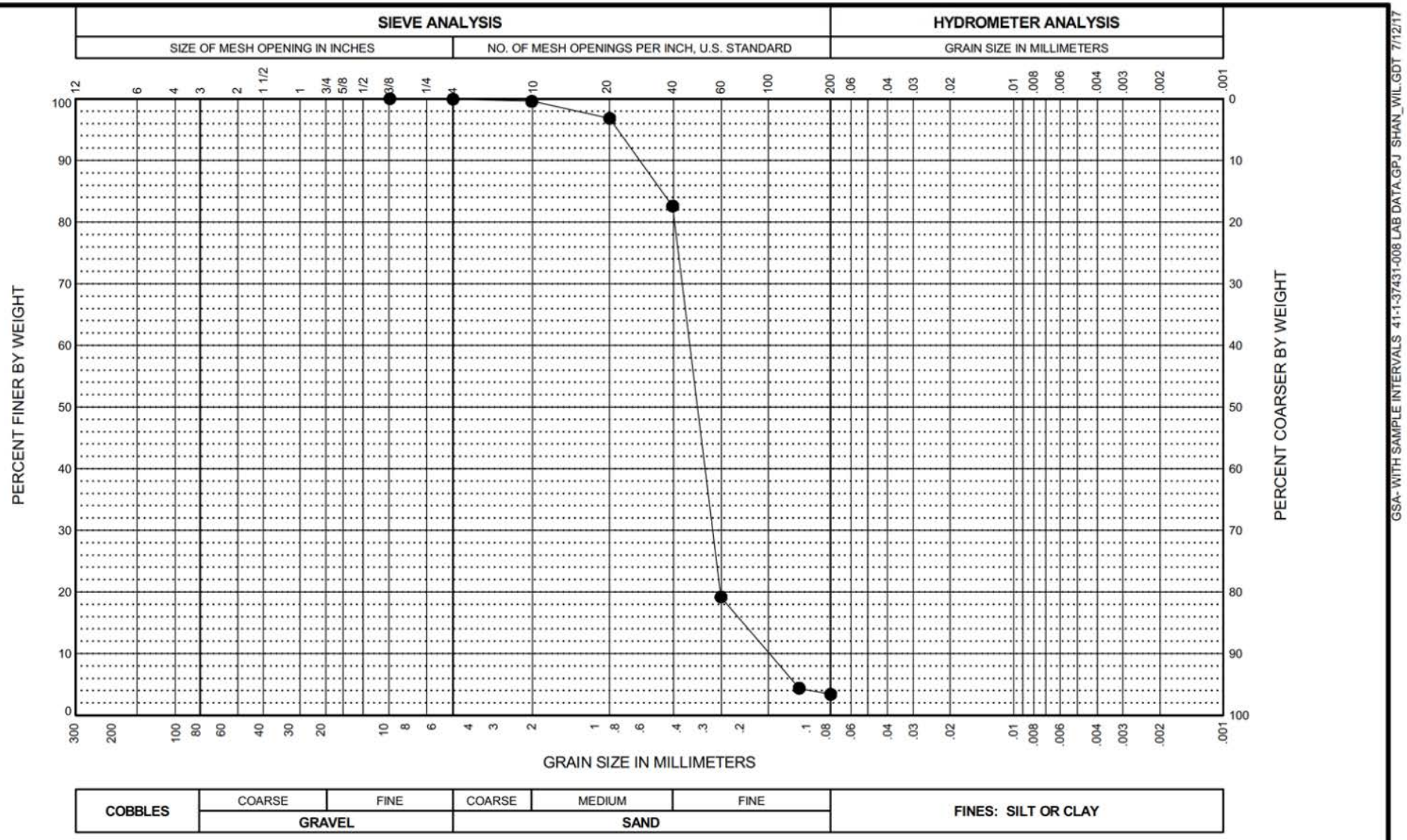
FIG.

GSA- WITH SAMPLE INTERVALS 41-1-37431-008 LAB DATA.GPJ SHAN_WILGDT 7/12/17



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● HA-B9A, S11	68.0 - 70.0	SP	Gray, Poorly Graded Sand.	3.4	20.2			

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GRAIN SIZE DISTRIBUTION

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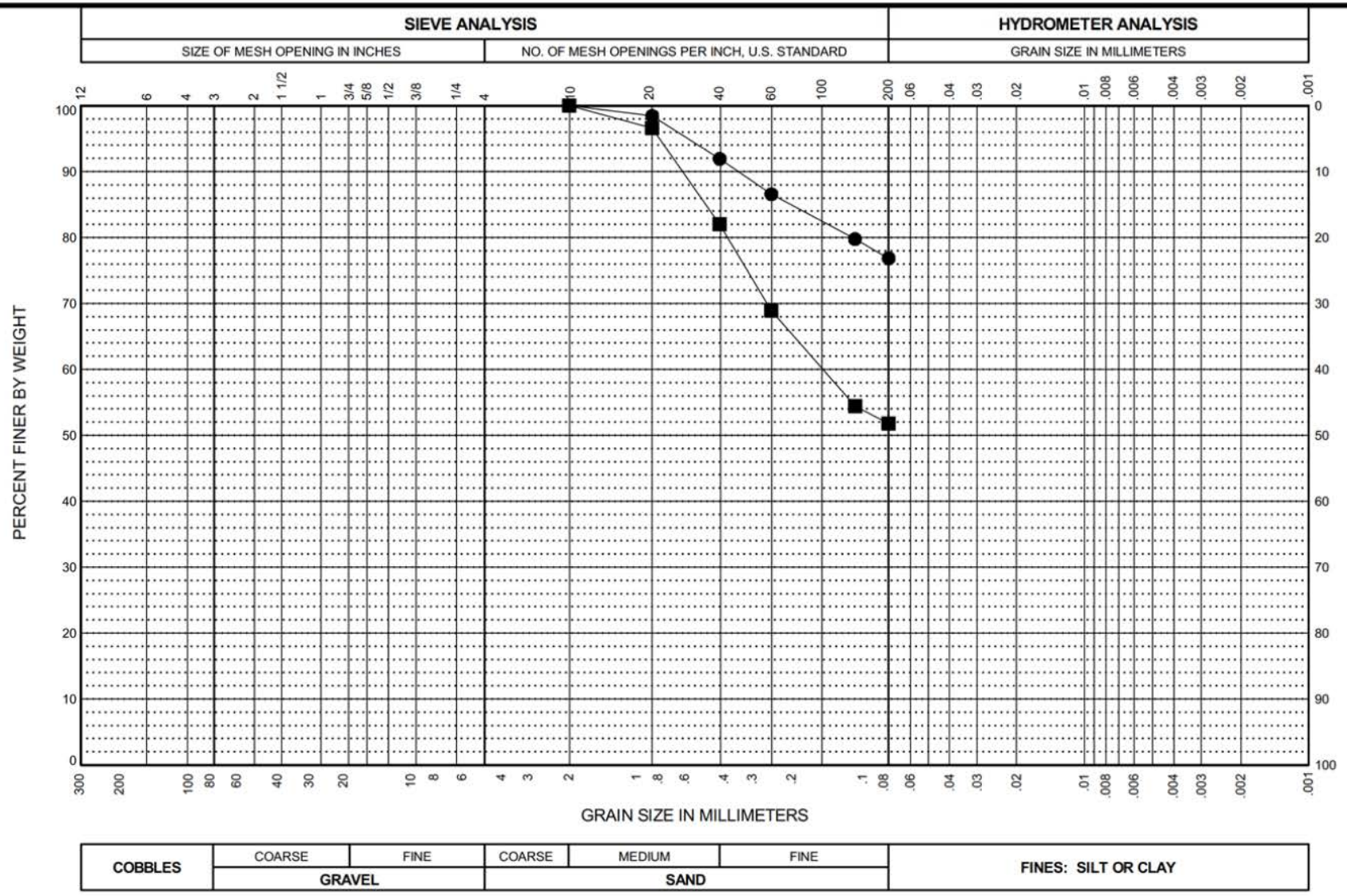
FIG.

GSA- WITH SAMPLE INTERVALS 41-1-37431-008 LAB DATA.GPJ SHAN_WILGDT 7/12/17



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● TP3-2, BULK	0.0 - 11.0	ML	Gray, Silt with Sand.	76.8	103.7	NP	NP	NP
■ TP3-4, BULK	0.0 - 9.0	ML	Tan, Sandy Silt.	51.8	113.4	NP	NP	NP

AECI NMPP - LINED POND
Marston, Missouri

GRAIN SIZE DISTRIBUTION

July 2017 41-1-37431-008

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FIG.

GSA- WITH SAMPLE INTERVALS 41-1-37431-008 LAB DATA.GPJ SHAN_WIL.GDT 7/3/17

PROJECT AECI NMPP - LINED POND | DATE 7/21/17 | BORING NO. HA-B9

JOB NO. 41-1-37431-008 | SHEET NO. 1 | TESTED BY CMB

CLIENT NAME Haley & Aldrich | CHECKED BY CMB

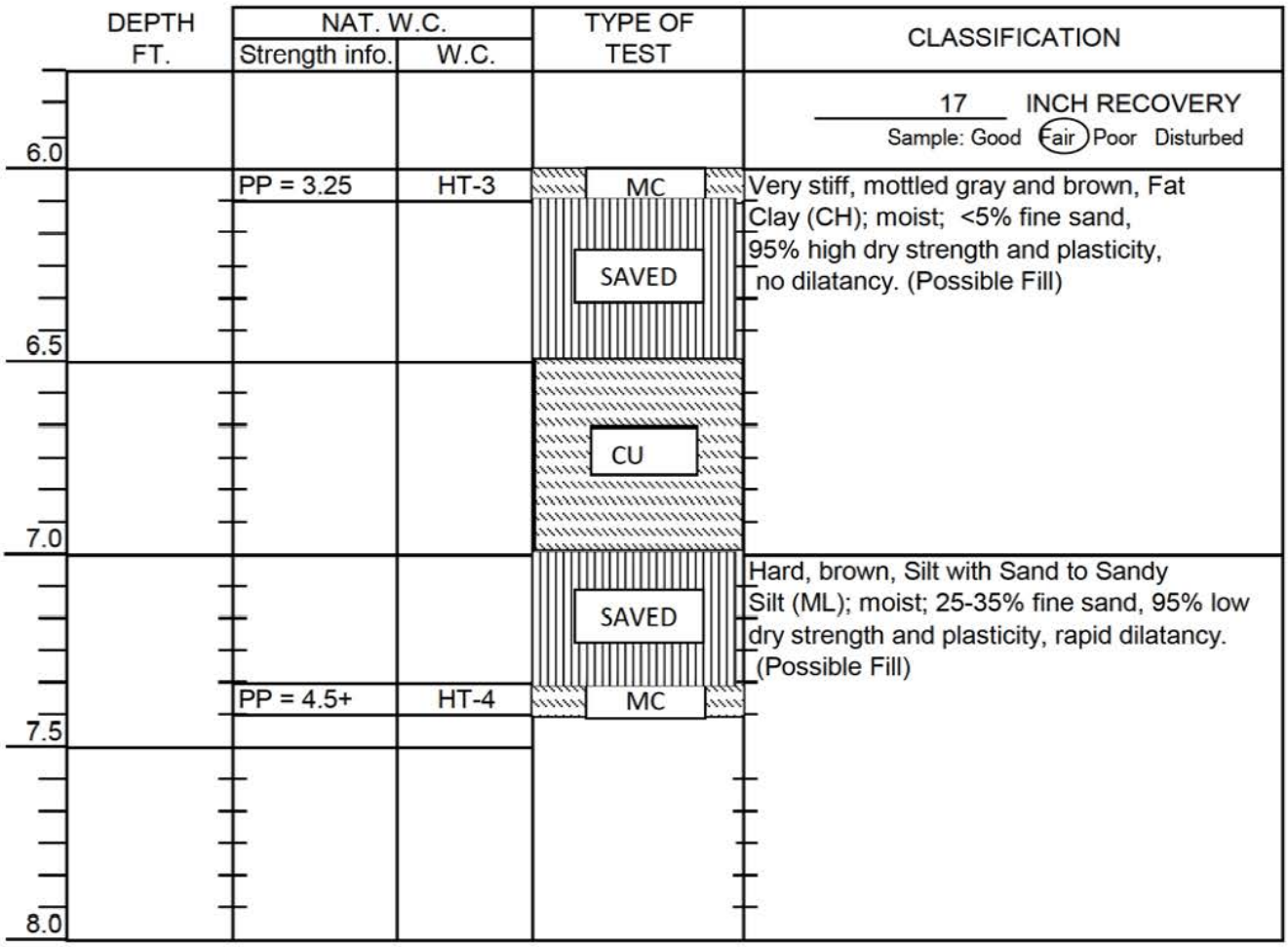
CLASSIFICATION OF UNDISTURBED SAMPLE

SAMPLE NO. U1 | DEPTH (ft) 6-8

Sampling Method Push

Type of Sample Shelby Tube | Inch 3"

Brass or (Steel)



Can/Tare No.	HT-3	HT-4
WET + TARE	57.92	76.99
DRY + TARE	46.37	71.26
TARE	2.52	2.53
% WATER	26.3	8.3

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: Tube would not extrude, had to cut into 6 inch pieces to extrude.

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2043 Westport Center Drive
St. Louis, MO 63146

PROJECT AECI NMPP - LINED POND | DATE 7/20/17 | BORING NO. HA-B9

JOB NO. 41-1-37431-008 | SHEET NO. 1 | TESTED BY CMB

CLIENT NAME Haley & Aldrich | CHECKED BY CMB

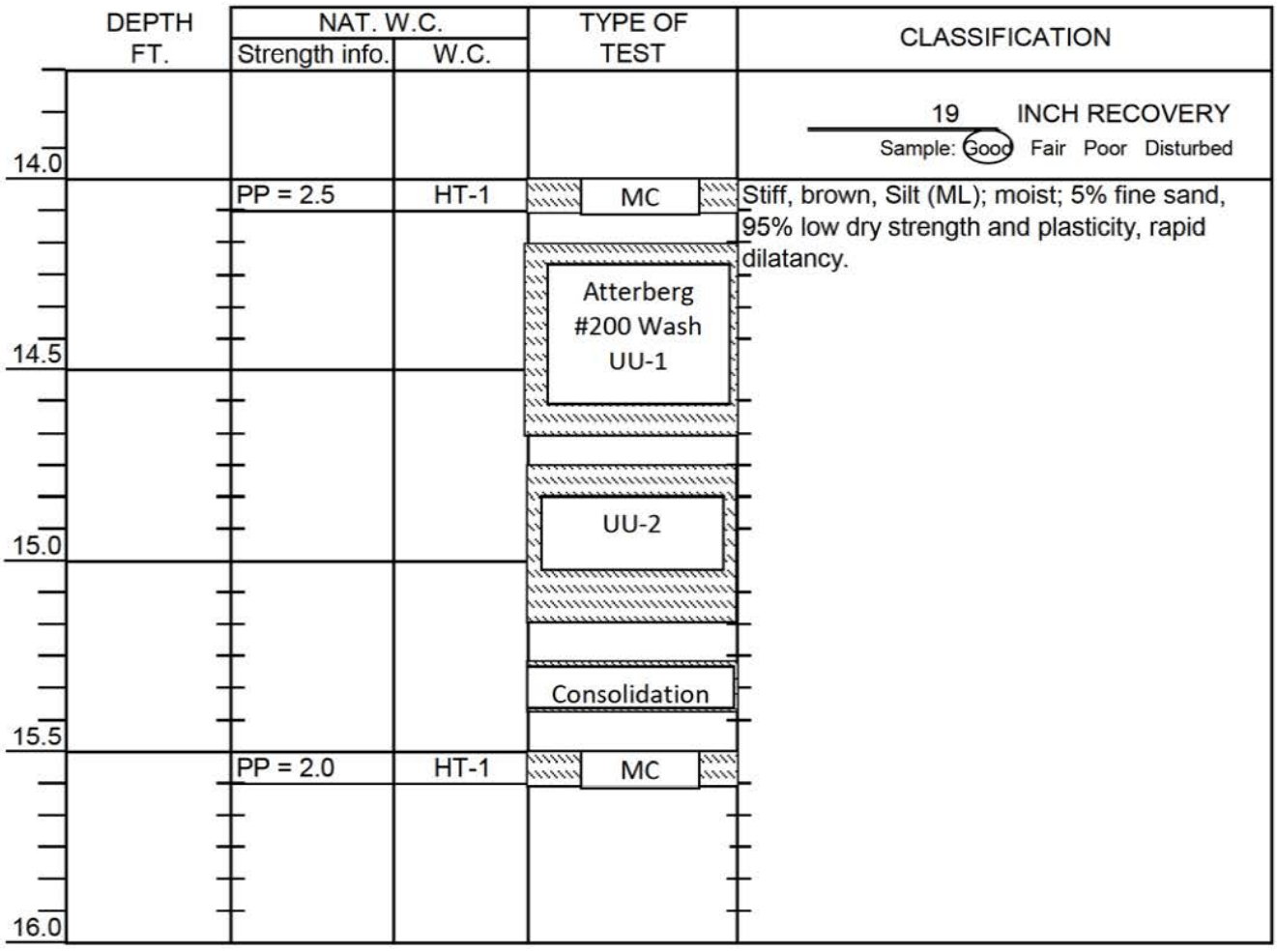
CLASSIFICATION OF UNDISTURBED SAMPLE

SAMPLE NO. U3 | DEPTH (ft) 14-16

Sampling Method Push

Type of Sample Shelby Tube | Inch 3"

Brass or (Steel)



Can/Tare No.	HT-1	HT-2
WET + TARE	95.66	69.31
DRY + TARE	79.51	57.90
TARE	2.52	2.53
% WATER	21.0	20.6

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:

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St. Louis, MO 63146

PROJECT AECI NMPP - LINED POND | DATE 7/11/17 | BORING NO. HA-B10OW

JOB NO. 41-1-37431-008 | SHEET NO. 1 | TESTED BY CMB

CLIENT NAME Haley & Aldrich | CHECKED BY CMB

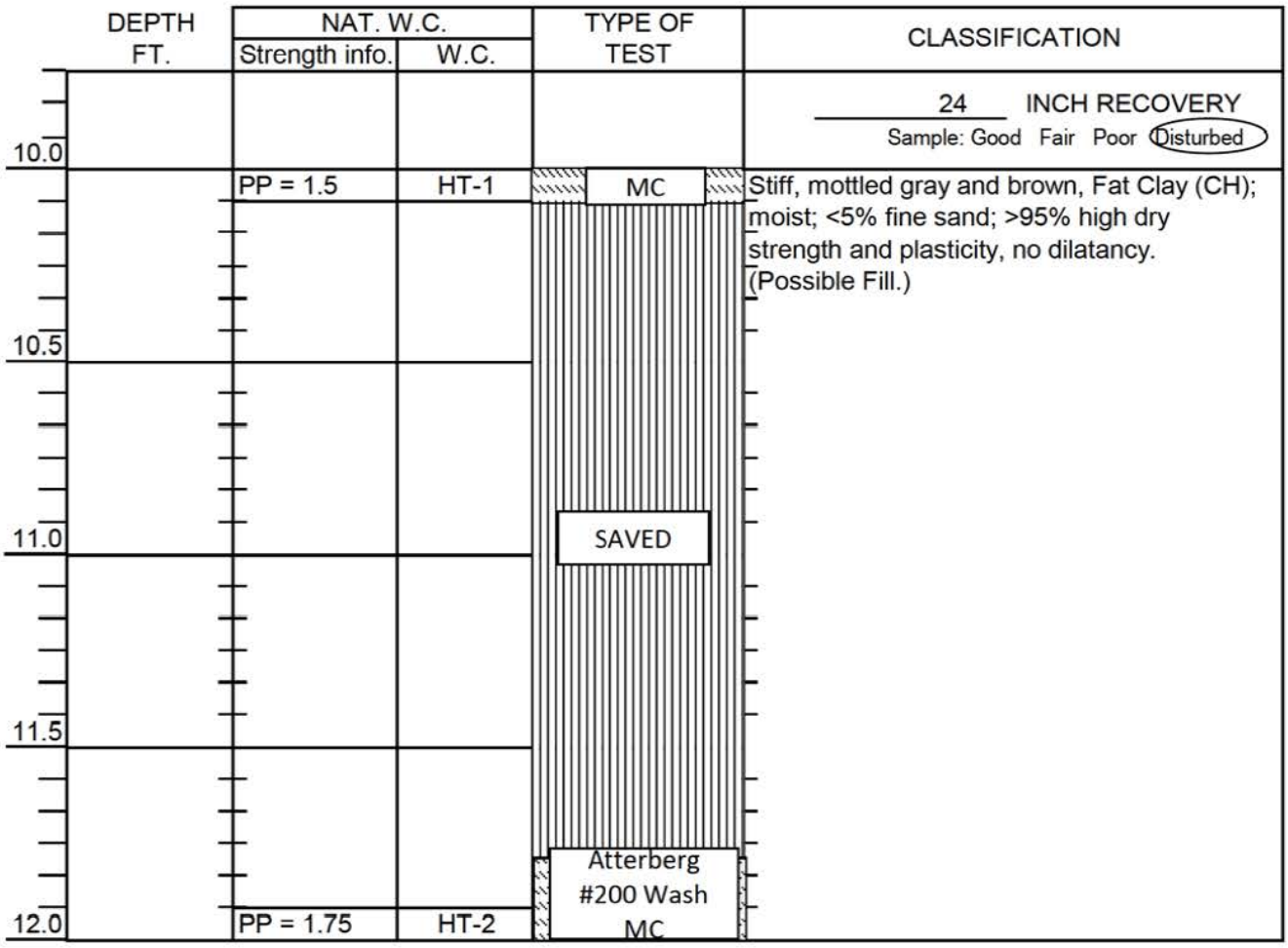
CLASSIFICATION OF UNDISTURBED SAMPLE

SAMPLE NO. U1 | DEPTH (ft) 10-12

Sampling Method Push

Type of Sample Shelby Tube | Inch 3"

Brass or (Steel)



Can/Tare No.	HT-1	HT-2
WET + TARE	80.61	66.72
DRY + TARE	59.89	51.94
TARE	2.51	2.54
% WATER	36.1	29.9

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: Sample disturbed and distorted, possibly hit obstruction .
See picture #7154.

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St. Louis, MO 63146

PROJECT AECI NMPP - LINED POND | DATE 7/11/17 | BORING NO. HA-B10OW

JOB NO. 41-1-37431-008 | SHEET NO. 1 | TESTED BY CMB

CLIENT NAME Haley & Aldrich | CHECKED BY CMB

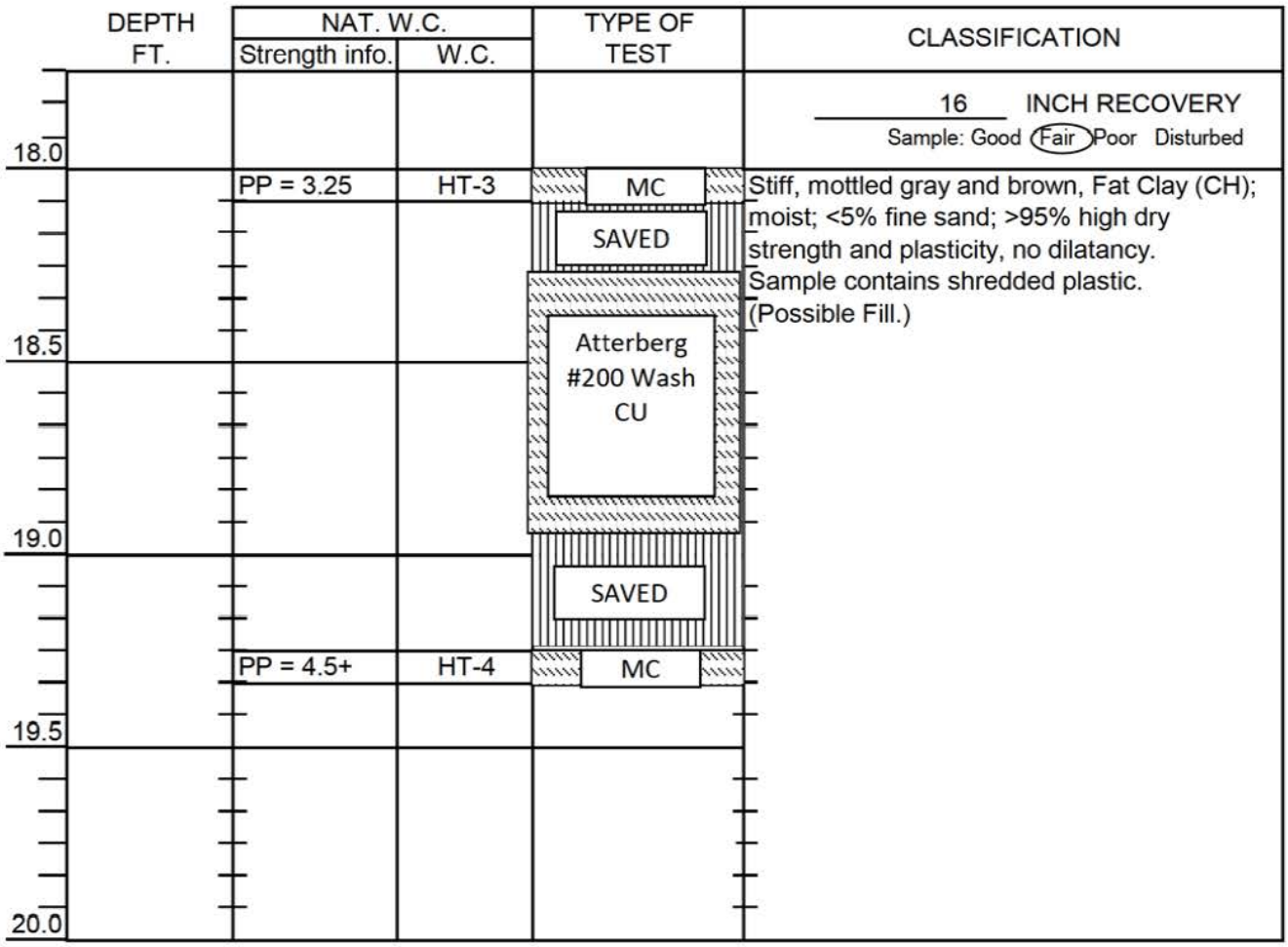
CLASSIFICATION OF UNDISTURBED SAMPLE

SAMPLE NO. U2 | DEPTH (ft) 18-20

Sampling Method Push

Type of Sample Shelby Tube | Inch 3"

Brass or (Steel)



Can/Tare No.	HT-3	HT-4
WET + TARE	77.31	68.50
DRY + TARE	62.67	58.87
TARE	2.54	2.54
% WATER	24.3	17.1

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: Sample contains pieces of plastic, possilbe geotextile.

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St. Louis, MO 63146

PROJECT AECI NMPP - LINED POND | DATE 7/11/17 | BORING NO. HA-B10OW

JOB NO. 41-1-37431-008 | SHEET NO. 1 | TESTED BY CMB

CLIENT NAME Haley & Aldrich | CHECKED BY CMB

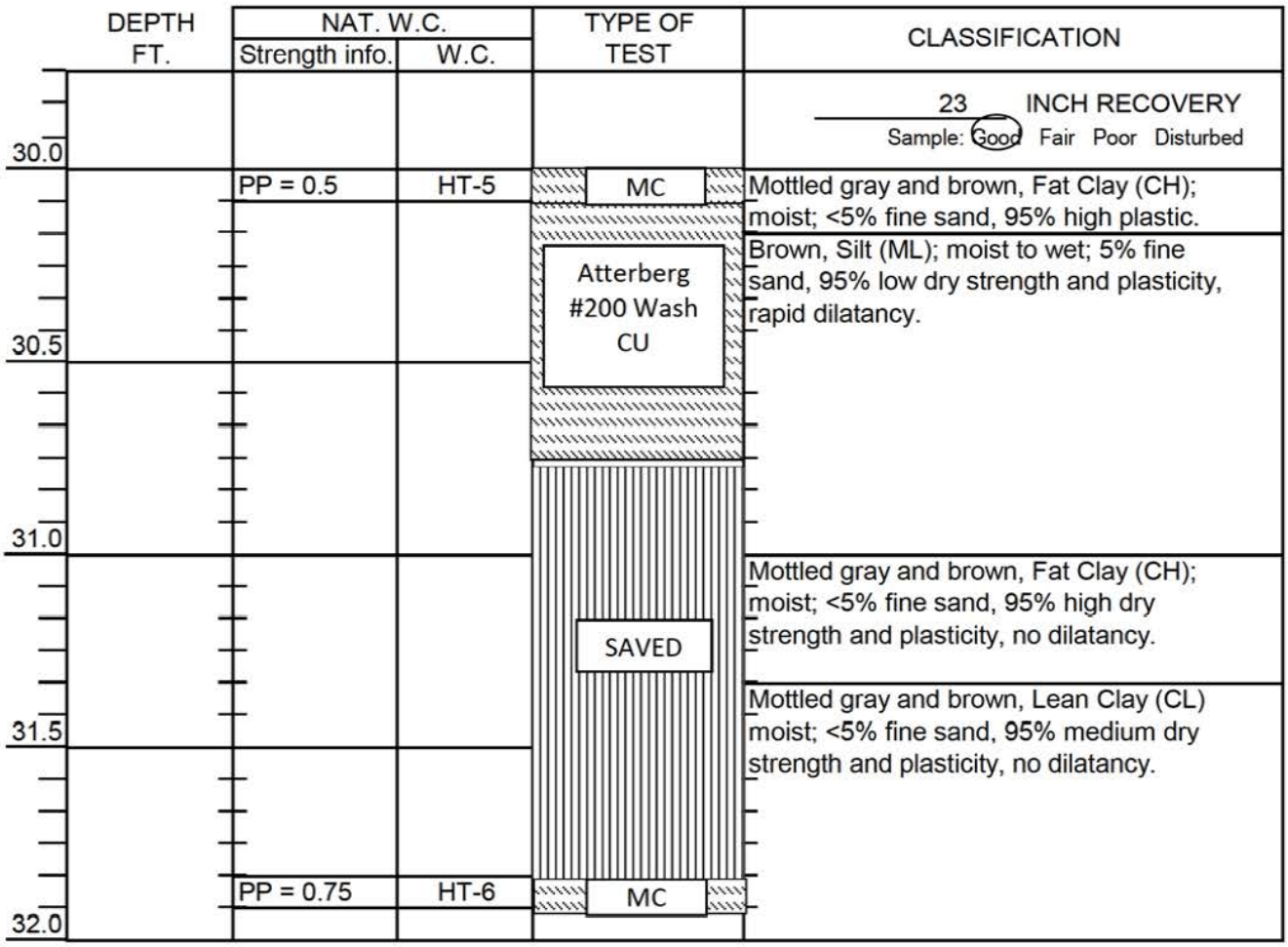
CLASSIFICATION OF UNDISTURBED SAMPLE

SAMPLE NO. U3 | DEPTH (ft) 30-32

Sampling Method Push

Type of Sample Shelby Tube | Inch 3"

Brass or (Steel)



Can/Tare No.	HT-5	HT-6
WET + TARE	46.98	53.62
DRY + TARE	34.88	40.23
TARE	2.54	2.54
% WATER	37.4	35.5

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:

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St. Louis, MO 63146

Sample Identification: TP3-2, Bulk, 0.0 - 11.0 feet.

Description of Material: Gray, Silt with Sand. (ML)

Compaction Test Method: ASTM D698 Method A

Rammer Type: Mechanical

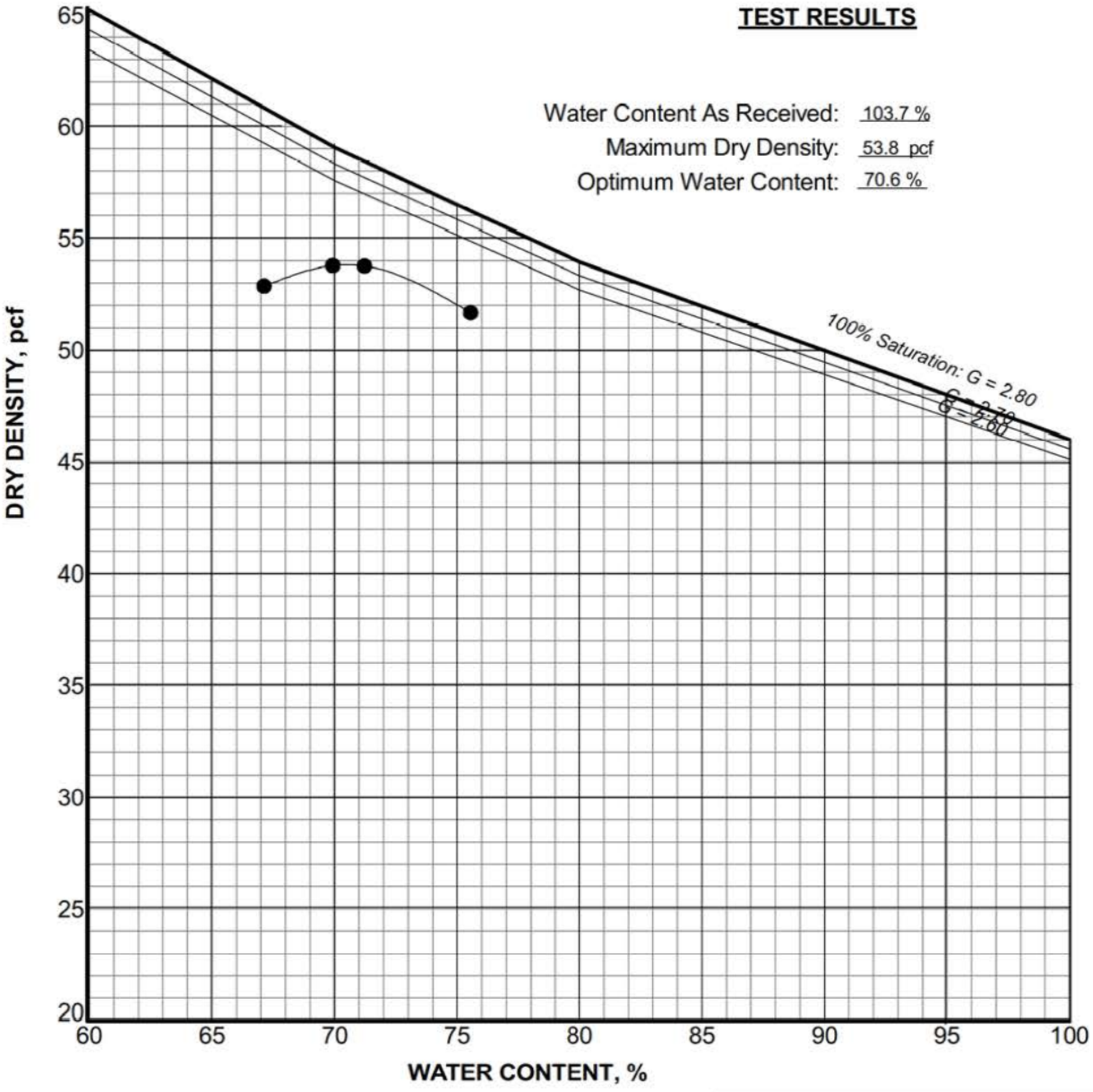
Checked By:

TEST RESULTS

Water Content As Received: 103.7 %

Maximum Dry Density: 53.8 pcf

Optimum Water Content: 70.6 %



OTHER TEST RESULTS

GRAIN SIZE ANALYSES:	% Gravel:	0.0
	% Sand:	23.2
	% Fines:	76.8
ATTERBERG LIMITS:	Liquid Limit:	NP
	Plastic Limit:	NP
	Plasticity Index:	NP

AECI NMPP - LINED POND
Marston, Missouri

MOISTURE-DENSITY TEST

July 2017 41-1-37431-008

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FIG.

Sample Identification: TP3-4, Bulk, 0.0 - 9.0 feet.

Description of Material: Tan, Sandy Silt. (ML)

Compaction Test Method: ASTM D698 Method A

Rammer Type: Mechanical

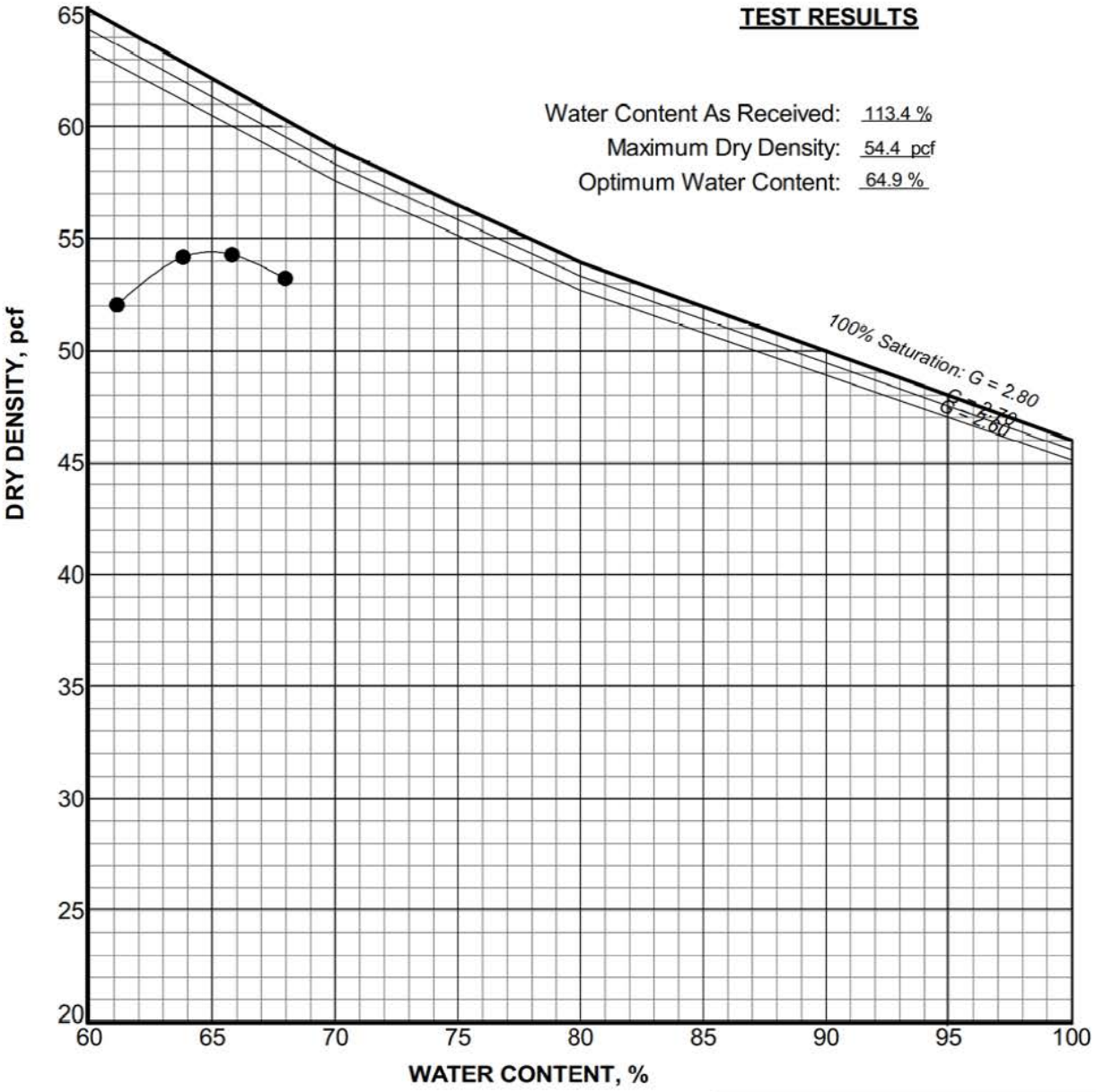
Checked By:

TEST RESULTS

Water Content As Received: 113.4 %

Maximum Dry Density: 54.4 pcf

Optimum Water Content: 64.9 %



OTHER TEST RESULTS

GRAIN SIZE ANALYSES:	% Gravel:	0.0
	% Sand:	48.2
	% Fines:	51.8
ATTERBERG LIMITS:	Liquid Limit:	NP
	Plastic Limit:	NP
	Plasticity Index:	NP

AECI NMPP - LINED POND
Marston, Missouri

MOISTURE-DENSITY TEST

July 2017 41-1-37431-008

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FIG.

UNCONSOLIDATED, UNDRAINED STRENGTH IN TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Boring	HA-B9	Tested by / Date	JAS	07/21/17
Sample	U3	Calculated by / Date	CMB	07/24/17
Depth (ft)	14.4	Checked by / Date	CMB	07/24/17
Description	Stiff, brown, Silt (ML).			

Specimen Data			Instrument Constants		
Height	5.985	inches	Deformation	0.001	inches/div
Diameter	2.854	inches	Load	1	lb/div.
H/D ratio	2.097		Confinment	10	psi
Volume	627.4	cc			
Wet wt.	1184.26	grams	Peak values		
Bulk Density	117.8	pcf	p	1.837	tsf
Dry Density	94.4	pcf	q	1.117	tsf
M.C.	24.7%	percent	strain	15.0%	%
Saturation	85.2%	percent	strain rate	0.040	in. per min.
Void ratio	0.784				
Gs	2.7	assumed			

Deformation div.	Load div.	Strain %	Load lb	Stress tsf	p tsf	q tsf
0.000	0.0	0.0%	0.0	0.000	0.720	0.000
0.005	3.6	0.1%	3.6	0.040	0.740	0.020
0.010	16.3	0.2%	16.3	0.183	0.812	0.092
0.015	23.3	0.3%	23.3	0.262	0.851	0.131
0.020	30.4	0.3%	30.4	0.341	0.891	0.171
0.030	44.5	0.5%	44.5	0.498	0.969	0.249
0.050	68.9	0.8%	68.9	0.769	1.105	0.385
0.075	95.6	1.3%	95.6	1.063	1.251	0.531
0.100	118.0	1.7%	118.0	1.306	1.373	0.653
0.125	133.1	2.1%	133.1	1.467	1.454	0.734
0.150	145.0	2.5%	145.0	1.592	1.516	0.796
0.175	153.8	2.9%	153.8	1.682	1.561	0.841
0.200	160.1	3.3%	160.1	1.744	1.592	0.872
0.225	167.1	3.8%	167.1	1.813	1.626	0.906
0.250	171.3	4.2%	171.3	1.851	1.645	0.925
0.300	179.7	5.0%	179.7	1.926	1.683	0.963
0.350	186.2	5.8%	186.2	1.980	1.710	0.990
0.400	192.8	6.7%	192.8	2.034	1.737	1.017
0.450	196.2	7.5%	196.2	2.054	1.747	1.027
0.500	200.5	8.4%	200.5	2.083	1.761	1.041
0.550	205.4	9.2%	205.4	2.117	1.779	1.059
0.600	209.2	10.0%	209.2	2.140	1.790	1.070
0.650	213.7	10.9%	213.7	2.170	1.805	1.085
0.700	215.9	11.7%	215.9	2.175	1.808	1.088
0.750	219.2	12.5%	219.2	2.192	1.816	1.096
0.800	223.1	13.4%	223.1	2.215	1.827	1.107
0.850	225.8	14.2%	225.8	2.225	1.833	1.113
0.900	228.4	15.0%	228.4	2.235	1.837	1.117

AECI NMPP - Lined Pond
Marston, Missouri

UNCONSOLIDATED, UNDRAINED STRENGTH
IN TRIAXIAL COMPRESSION
BORING - HA-B9 : SAMPLE - U3

July 2017 41-1-37431-008

SHANNON & WILSON, INC.
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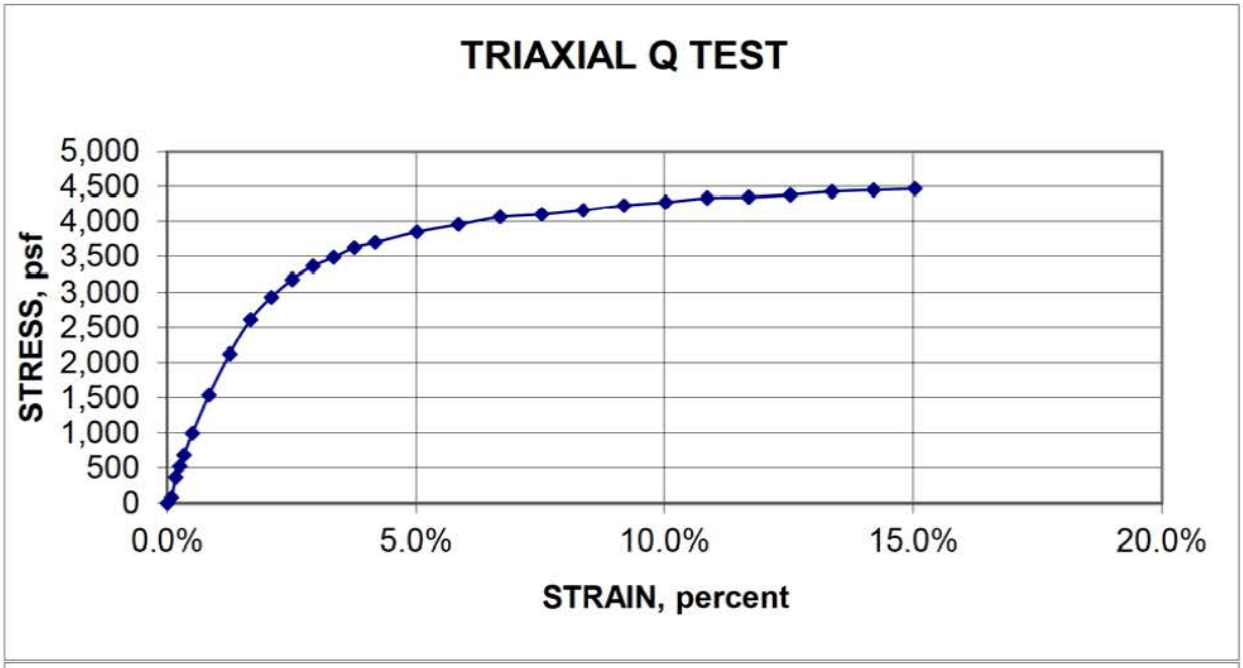
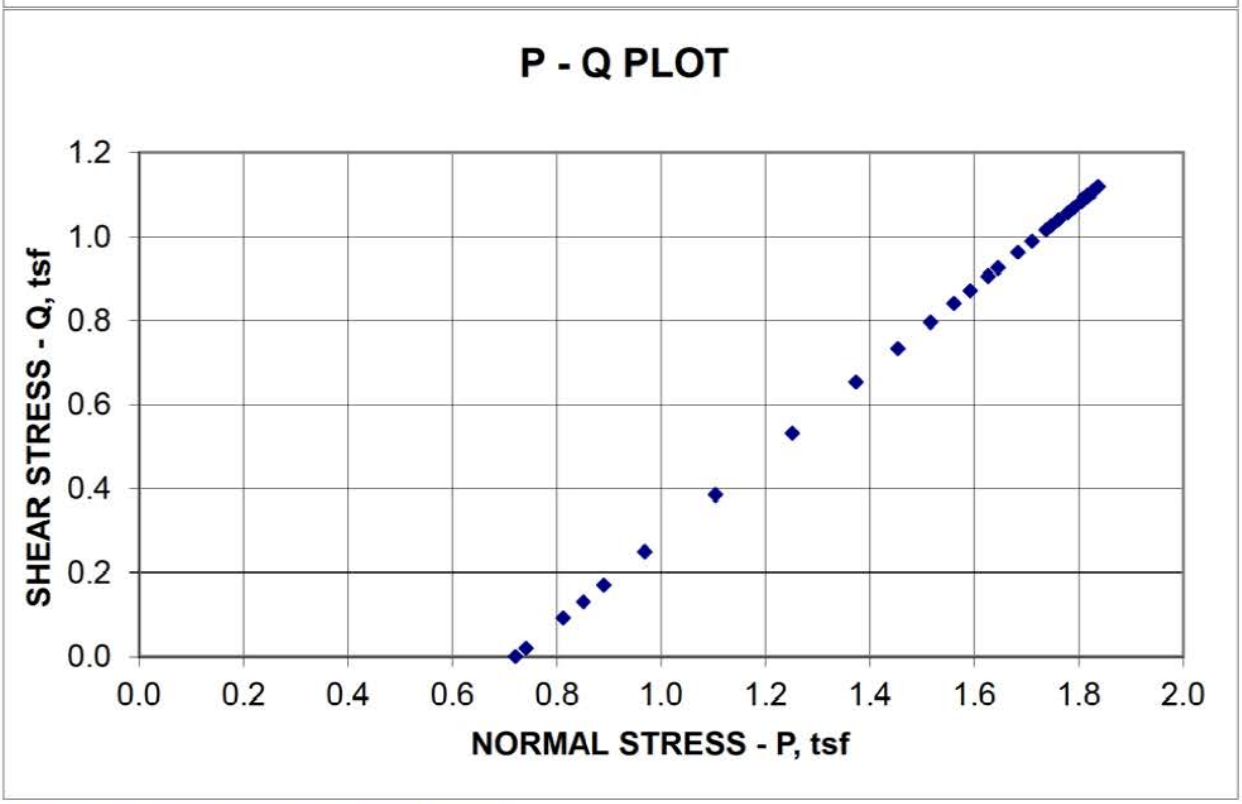
FIG.

UNCONSOLIDATED, UNDRAINED STRENGTH IN TRIAXIAL COMPRESSION
PLOT OF TEST DATA





Photograph of Failure

AECI NMPP - Lined Pond
Marston, Missouri

UNCONSOLIDATED, UNDRAINED STRENGTH IN TRIAXIAL COMPRESSION

BORING - HA-B9 : SAMPLE - U3

July 2017 41-1-37431-008

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FIG.

UNCONSOLIDATED, UNDRAINED STRENGTH IN TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Boring	HA-B9	Tested by / Date	JAS 07/21/17
Sample	U3	Calculated by / Date	CMB 07/24/17
Depth (ft)	15	Checked by / Date	CMB 07/24/17
Description	Stiff, brown, Silt (ML).		

Specimen Data			Instrument Constants		
Height	5.990	inches	Deformation	0.001	inches/div
Diameter	2.861	inches	Load	1	lb/div.
H/D ratio	2.094		Confinment	16.5	psi
Volume	631.0	cc			
Wet wt.	1227.54	grams	Peak values		
Bulk Density	121.4	pcf	p	2.481	tsf
Dry Density	96.6	pcf	q	1.293	tsf
M.C.	25.7%	percent	strain	15.0%	%
Saturation	93.2%	percent	strain rate	0.040	in. per min.
Void ratio	0.745				
Gs	2.7	assumed			

Deformation div.	Load div.	Strain %	Load lb	Stress tsf	p tsf	q tsf
0.000	0.0	0.0%	0.0	0.000	1.188	0.000
0.005	3.0	0.1%	3.0	0.034	1.205	0.017
0.010	7.3	0.2%	7.3	0.082	1.229	0.041
0.015	17.2	0.3%	17.2	0.192	1.284	0.096
0.020	27.1	0.3%	27.1	0.303	1.339	0.151
0.030	43.1	0.5%	43.1	0.480	1.428	0.240
0.050	66.7	0.8%	66.7	0.741	1.558	0.370
0.075	90.7	1.3%	90.7	1.003	1.690	0.502
0.100	110.4	1.7%	110.4	1.216	1.796	0.608
0.125	126.6	2.1%	126.6	1.389	1.882	0.694
0.150	139.5	2.5%	139.5	1.524	1.950	0.762
0.175	150.7	2.9%	150.7	1.640	2.008	0.820
0.200	159.2	3.3%	159.2	1.725	2.051	0.863
0.225	175.0	3.8%	175.0	1.889	2.132	0.944
0.250	180.5	4.2%	180.5	1.941	2.158	0.970
0.300	188.5	5.0%	188.5	2.010	2.193	1.005
0.350	198.6	5.8%	198.6	2.101	2.239	1.051
0.400	208.0	6.7%	208.0	2.184	2.280	1.092
0.450	217.3	7.5%	217.3	2.264	2.320	1.132
0.500	225.2	8.3%	225.2	2.328	2.352	1.164
0.550	233.1	9.2%	233.1	2.391	2.384	1.196
0.600	238.5	10.0%	238.5	2.428	2.402	1.214
0.650	244.8	10.9%	244.8	2.473	2.425	1.237
0.700	250.3	11.7%	250.3	2.510	2.443	1.255
0.750	254.1	12.5%	254.1	2.529	2.453	1.265
0.800	260.2	13.4%	260.2	2.571	2.473	1.285
0.850	263.0	14.2%	263.0	2.579	2.478	1.290
0.900	265.6	15.0%	265.6	2.586	2.481	1.293

AECI NMPP - Lined Pond
Marston, Missouri

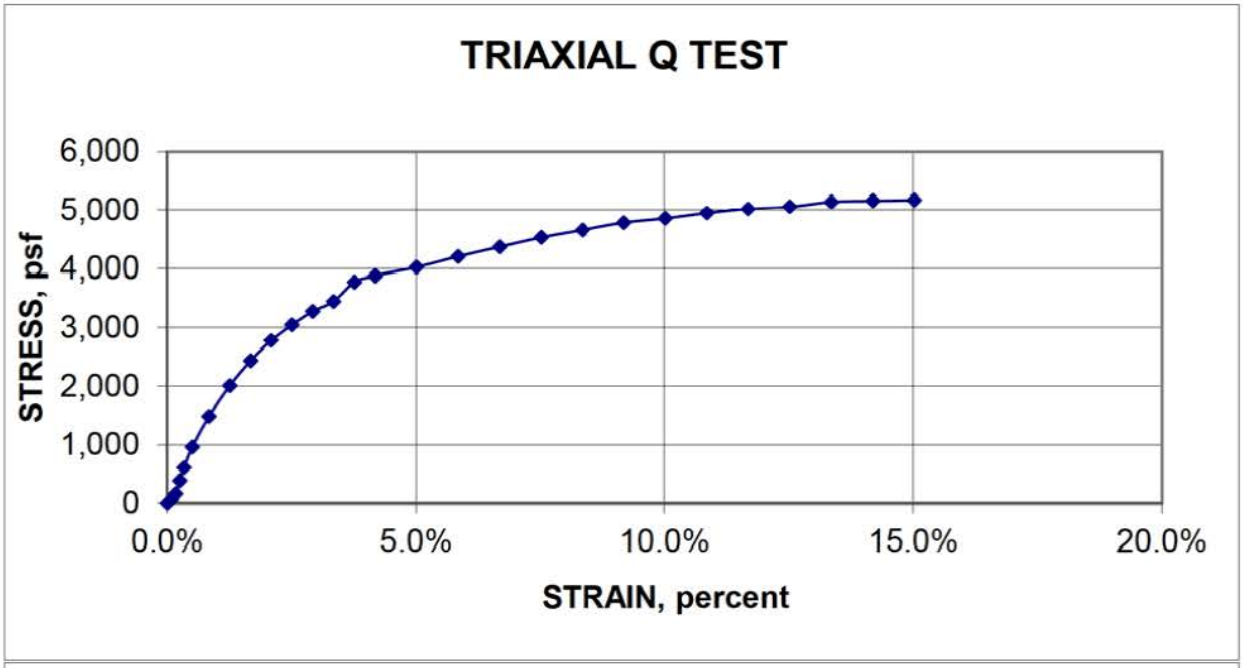
UNCONSOLIDATED, UNDRAINED STRENGTH
IN TRIAXIAL COMPRESSION
BORING - HA-B9 : SAMPLE - U3

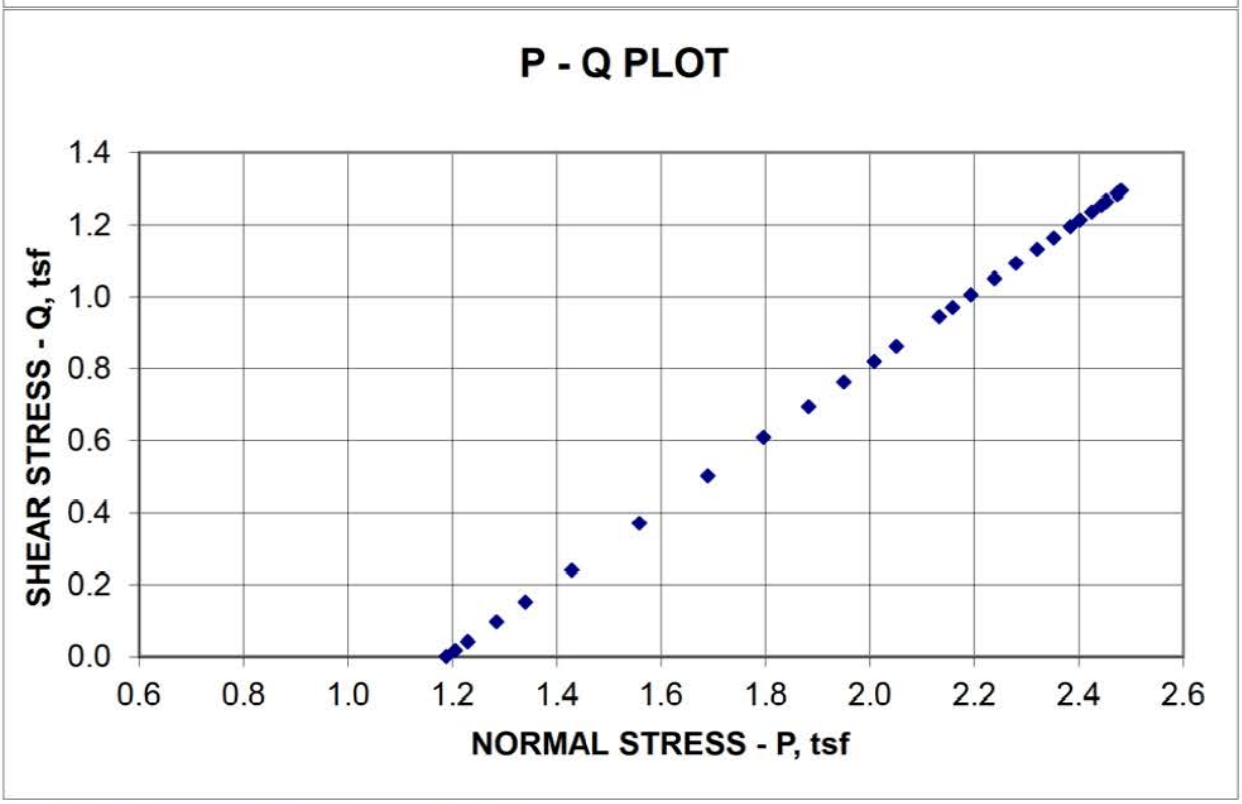
July 2017 41-1-37431-008

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG.

UNCONSOLIDATED, UNDRAINED STRENGTH IN TRIAXIAL COMPRESSION
PLOT OF TEST DATA





Photograph of Failure

AECI NMPP - Lined Pond
Marston, Missouri

UNCONSOLIDATED, UNDRAINED STRENGTH IN TRIAXIAL COMPRESSION

BORING - HA-B9 : SAMPLE - U3

July 2017 41-1-37431-008

SHANNON & WILSON, INC.
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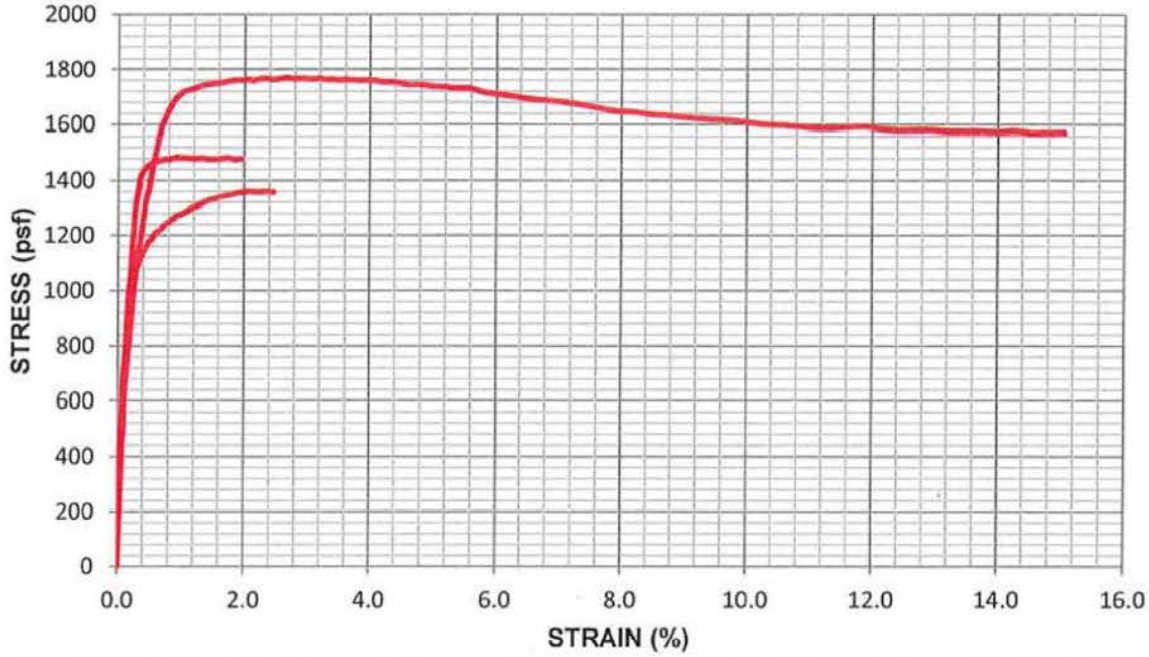
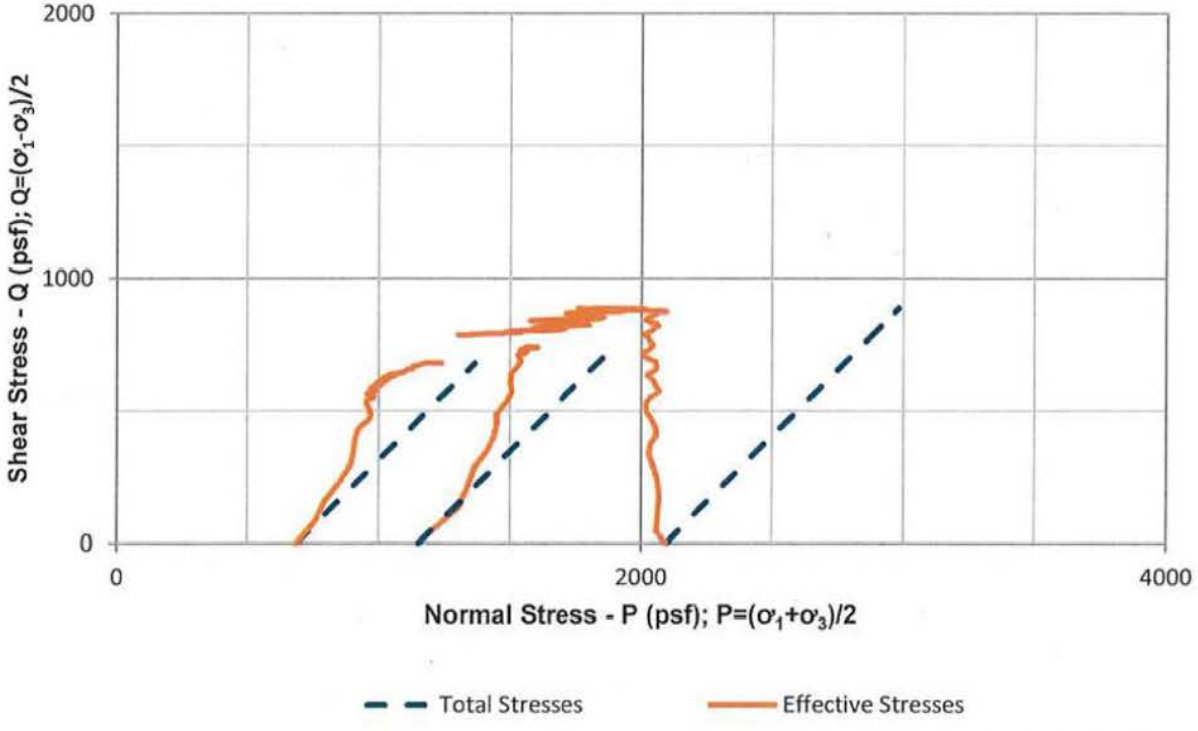
FIG.

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST WITH PORE PRESSURE MEASUREMENT

STRESS - STRAIN

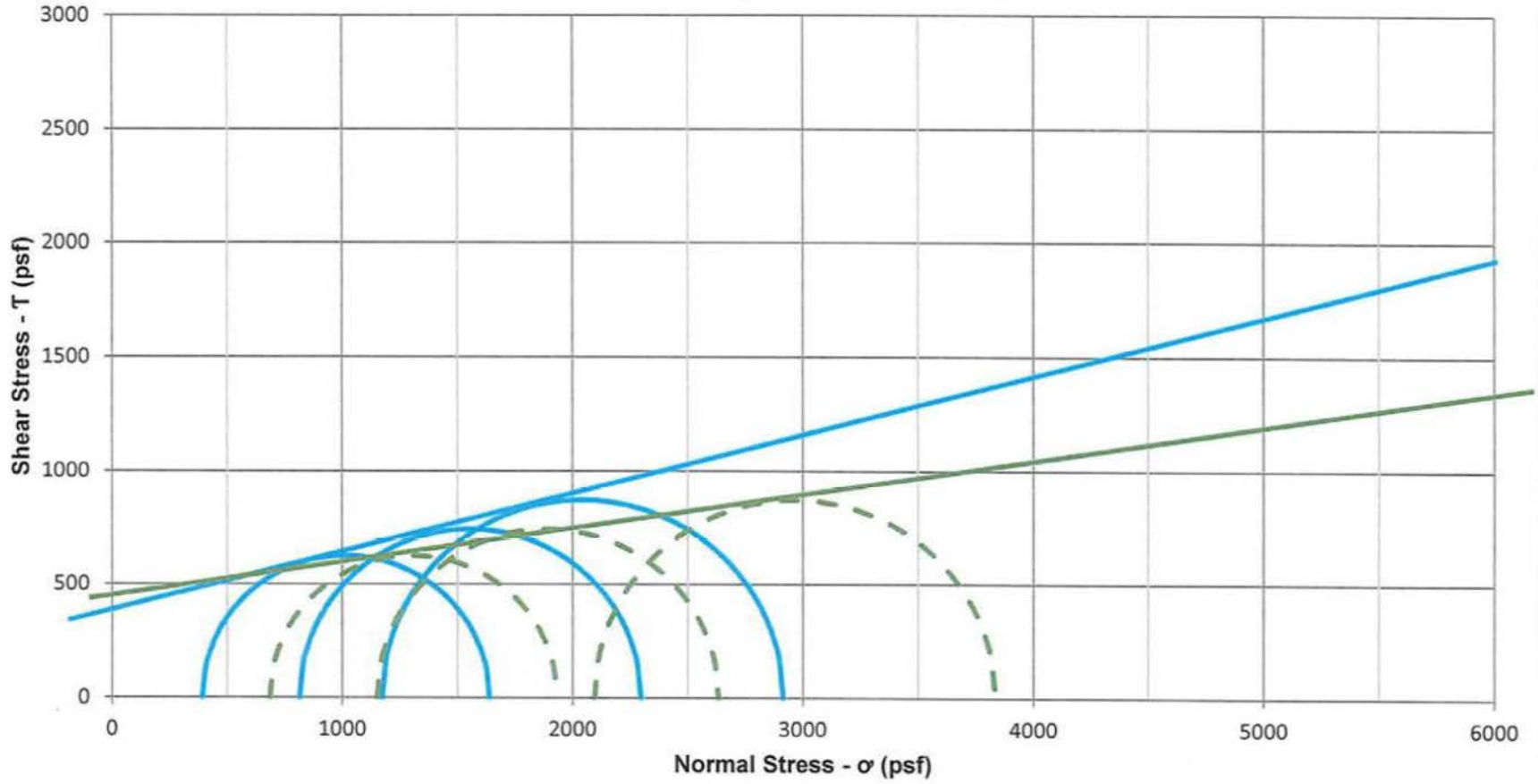


P-Q PLOT



SHANNON & WILSON, INC. 2043 WESTPORT CENTER DR. SAINT LOUIS, MISSOURI 63146 41-1-37431-008	CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION AECI NMPP - Lined Pond Marston, Missouri HA-B9 / U1 / 6.8

Mohr's Circle Plots Corresponding to the Peak Principal Stress Ratio



Sample	Strain (%)
Stage 1	0.8
Stage 2	1.0
Stage 3	1.3

c =	450 psf
ϕ =	8 deg
c' =	380 psf
ϕ' =	14 deg

NOTES:
1. Mohr's circles in this plot are based upon the maximum principal stress difference observed during loading except Stage 3 in which similar strain was chosen.
2. Strength parameters determined by Shannon & Wilson. Engineer-of-Record should evaluate cohesion and friction commensurate with project conditions.

AECI NMPP - Lined Pond
Marston, Missouri

Mohr's Circle Plots
HA-B9 / U1

August 2017 41-1-37431-008

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Figure 1

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	AECI NMPP - Lined Pond			Client	Haley & Aldrich	
Location	Marston, Missouri			Tested by	CMB	Jul-17
Job No.	41-1-37431-008			Calculated by	CMB	Aug-17
Boring	HA-B9			Checked by	DPM	8/16/17
Sample	U1	Specimen Number	Stage 3	File	41-1-37431-008 HA-B9 U1 ASTM D4767	
Depth (ft)	6.8	Undisturbed/Remold	Undisturbed	Procedure	ASTM D4767	
Description	Mottled gray and brown, Fat Clay (CH).					
Remarks	On stage 3 strain, sample sheared far enough to touch cell walls.					

Specimen Data	Initial	Post Consol.	Post Shear
Height (in)	5.546	5.521	4.690
Diameter (in)	2.868	2.848	
Volume (in^3)	35.830	35.171	
Height/Diameter ratio	1.934	1.939	
Weight (g)	1098.49	1087.69	1087.69
Water Content (%)	34.67	33.34	33.34
Bulk Unit Weight (pcf)	116.8	117.8	117.8
Dry Unit Weight (pcf)	86.7	88.4	88.4
Cross-Sectional Area* (in^2)	6.461	6.371	
% Saturation - Wet Method	100.09	100.10	100.10
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	0.928	0.893	0.893
			Entire Sample
Tare ID			31
Mass wet soil + tare (g)			1274.71
Mass dry soil + tare (g)			982.14
Mass tare (g)			164.95

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions	
Cell Pressure (psi)	106.0
Pore Pressure (psi)	91.5
Effective Confining Pressure (psi)	14.6
B-value	0.97

Consolidation Phase	
Change in Volume (in^3)	0.659
T_{50} (min)	351.2

Platen Travel Rate (in/min)	0.00007

Additional Testing

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results

Peak P (psf)	2967.0
Peak P' (psf)	2045.4
Peak Q (psf)	870.7
Strain at Peak (%)	1.3
σ_3' (psf)	1174.7
σ_1' (psf)	2916.0
σ_3 (psf)	2096.3
σ_1 (psf)	3837.7

Picture of Failure

AECI NMPP - Lined Pond
Marston, Missouri

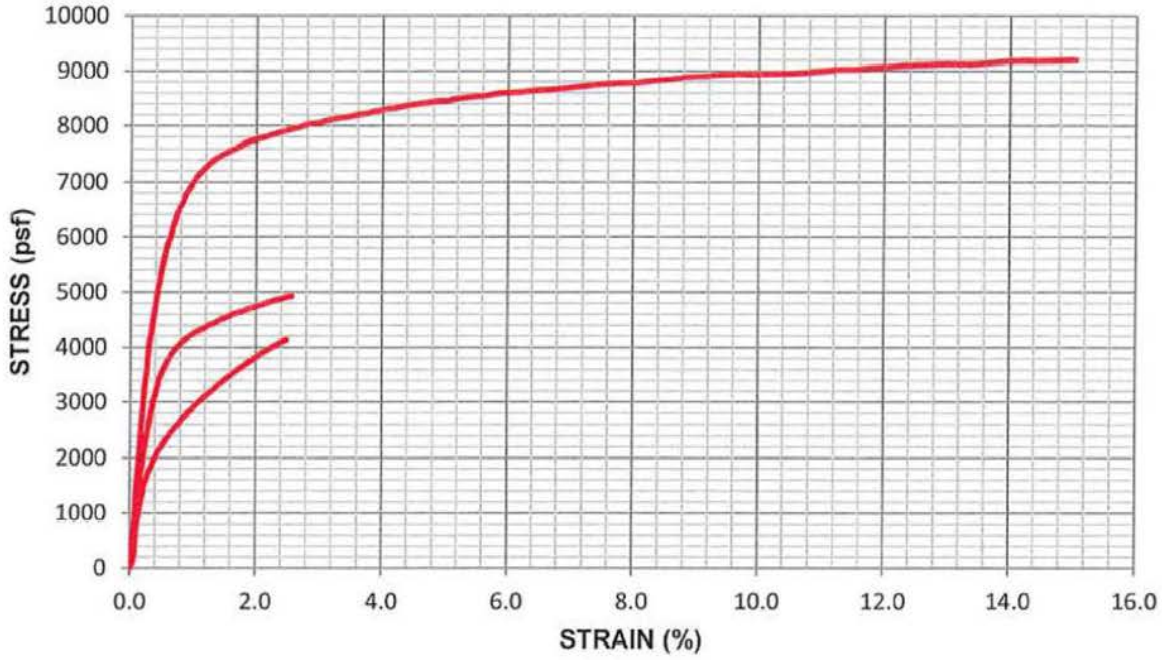
CU TRIAXIAL TEST RESULTS
HA-B9 / U1 / Stage 3

August 2017 41-1-37431-008

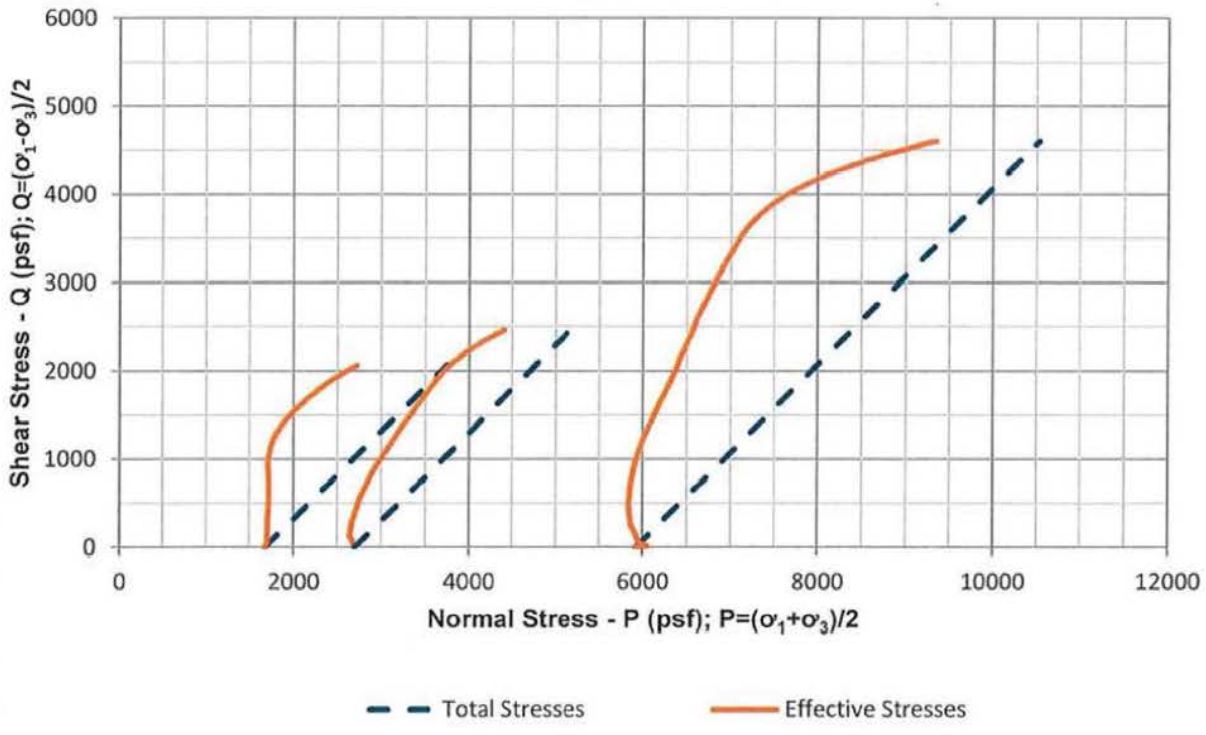
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST WITH PORE PRESSURE MEASUREMENT

STRESS - STRAIN

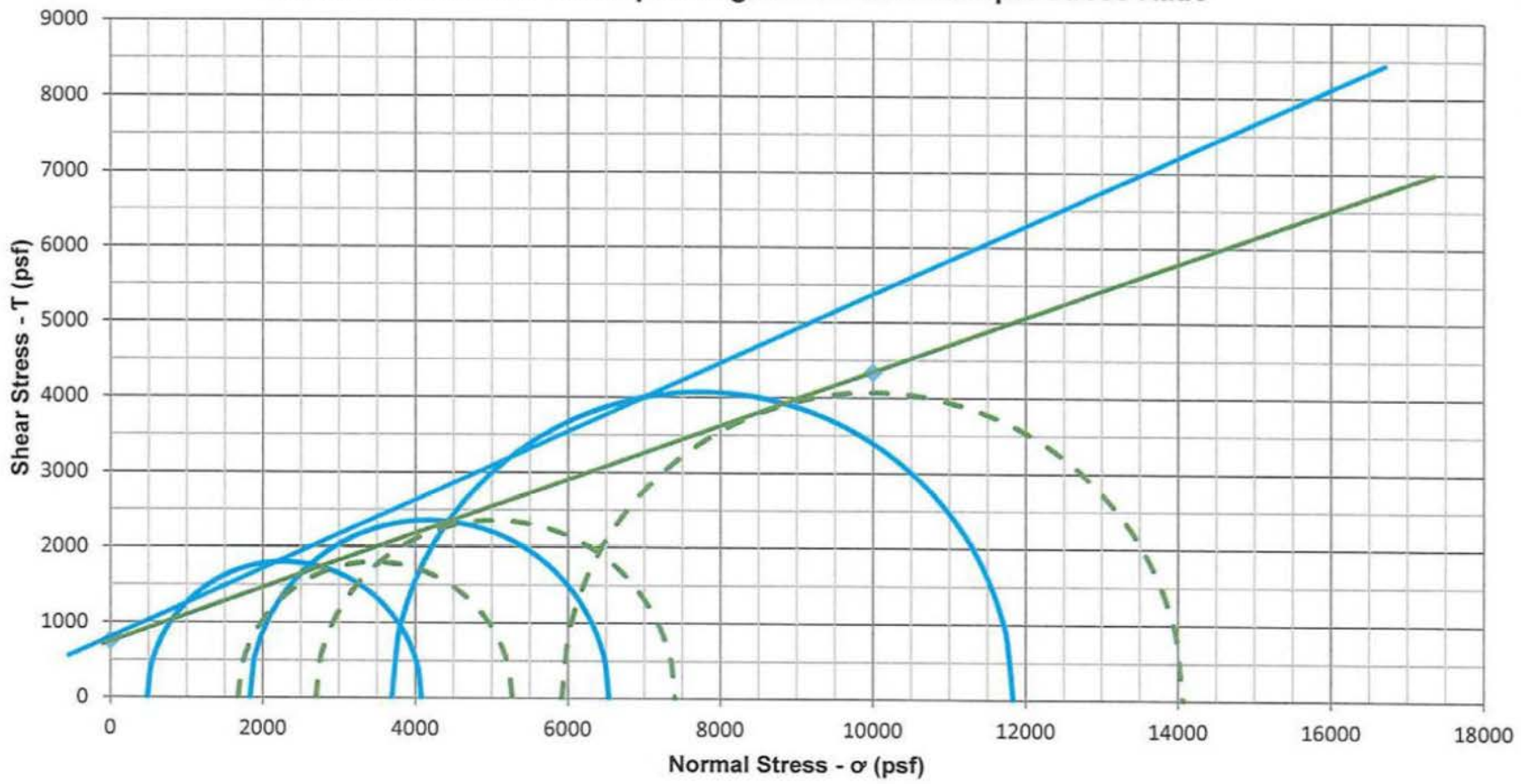


P-Q PLOT



SHANNON & WILSON, INC. 2043 WESTPORT CENTER DR. SAINT LOUIS, MISSOURI 63146 41-1-37431-008	CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION AECI NMPP - Lined Pond Marston, Missouri HA-B10OW / U2 / 18.6

Mohr's Circle Plots Corresponding to the Peak Principal Stress Ratio



Sample	Strain (%)
Stage 1	1.7
Stage 2	1.9
Stage 3	3.3

c =	750 psf
ϕ =	20 deg
c' =	750 psf
ϕ' =	25 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.

AECI NMPP - Lined Pond
Marston, Missouri

Mohr's Circle Plots
HA-B10OW / U2

August 2017 41-1-37431-008

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Figure 1

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	AECI NMPP - Lined Pond					
Location	Marston, Missouri			Client	Haley & Aldrich	
Job No.	41-1-37431-008			Tested by	CMB	Jul-17
Boring	HA-B10OW			Calculated by	CMB	Aug-17
Sample	U2	Specimen Number	Stage 3	Checked by	DPM	8/2/17
Depth (ft)	18.6	Undisturbed/Remold	Undisturbed	File	41-1-37431-008 HA-B10OW U2 ASTM D4	
Description	Mottled gray and brown, Fat Clay (CH).			Procedure	ASTM D4767	
Remarks						

Specimen Data	Initial	Post Consol.	Post Shear
Height (in)	5.630	5.594	5.475
Diameter (in)	2.934	2.922	
Volume (in^3)	38.071	37.522	
Height/Diameter ratio	1.919	1.914	
Weight (g)	1297.70	1288.70	1288.70
Water Content (%)	20.73	19.89	19.89
Bulk Unit Weight (pcf)	129.9	130.8	130.8
Dry Unit Weight (pcf)	107.6	109.1	109.1
Cross-Sectional Area* (in^2)	6.763	6.708	
% Saturation - Wet Method	100.13	100.13	100.13
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	0.555	0.532	0.532
			Entire Sample
Tare ID			25
Mass wet soil + tare (g)			1441.93
Mass dry soil + tare (g)			1210.08
Mass tare (g)			161.28

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions	
Cell Pressure (psi)	132.4
Pore Pressure (psi)	91.3
Effective Confining Pressure (psi)	41.1
B-value	0.96

Consolidation Phase	
Change in Volume (in^3)	0.549
T_{50} (min)	230.9

Platen Travel Rate (in/min)	0.00010

Additional Testing

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results

Peak P (psf)	9996.3
Peak P' (psf)	7767.1
Peak Q (psf)	4072.3
Strain at Peak (%)	3.3
σ_3' (psf)	3694.8
σ_1' (psf)	11839.3
σ_3 (psf)	5924.0
σ_1 (psf)	14068.5

Picture of Failure

AECI NMPP - Lined Pond
Marston, Missouri

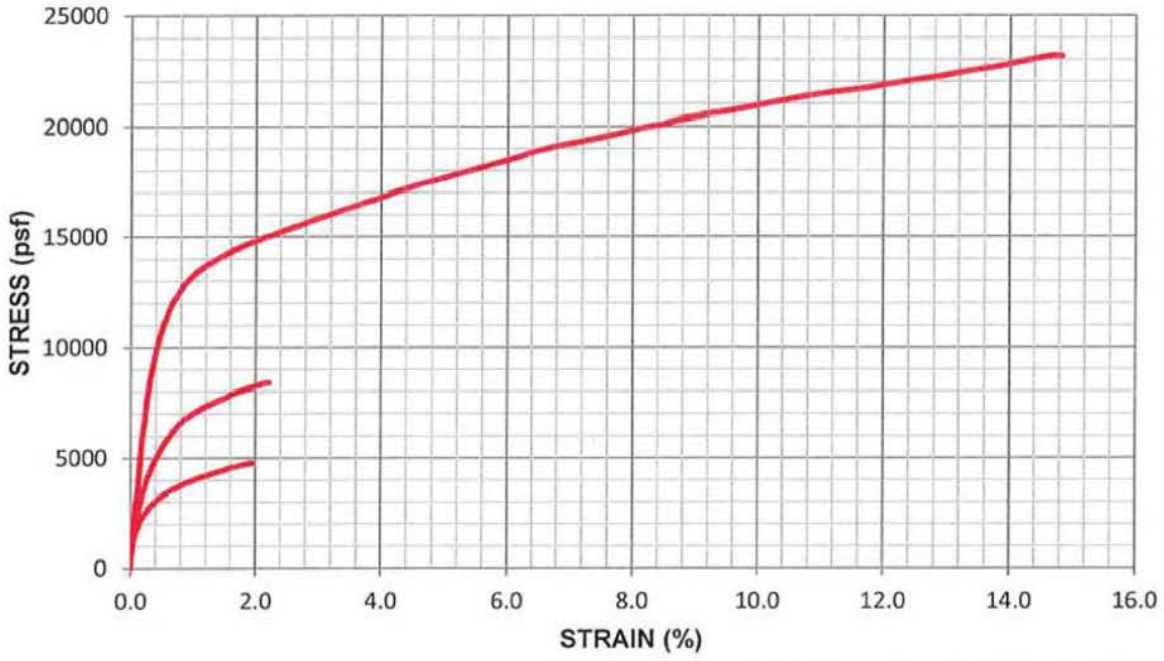
CU TRIAXIAL TEST RESULTS
HA-B10OW / U2 / Stage 3

August 2017 41-1-37431-008

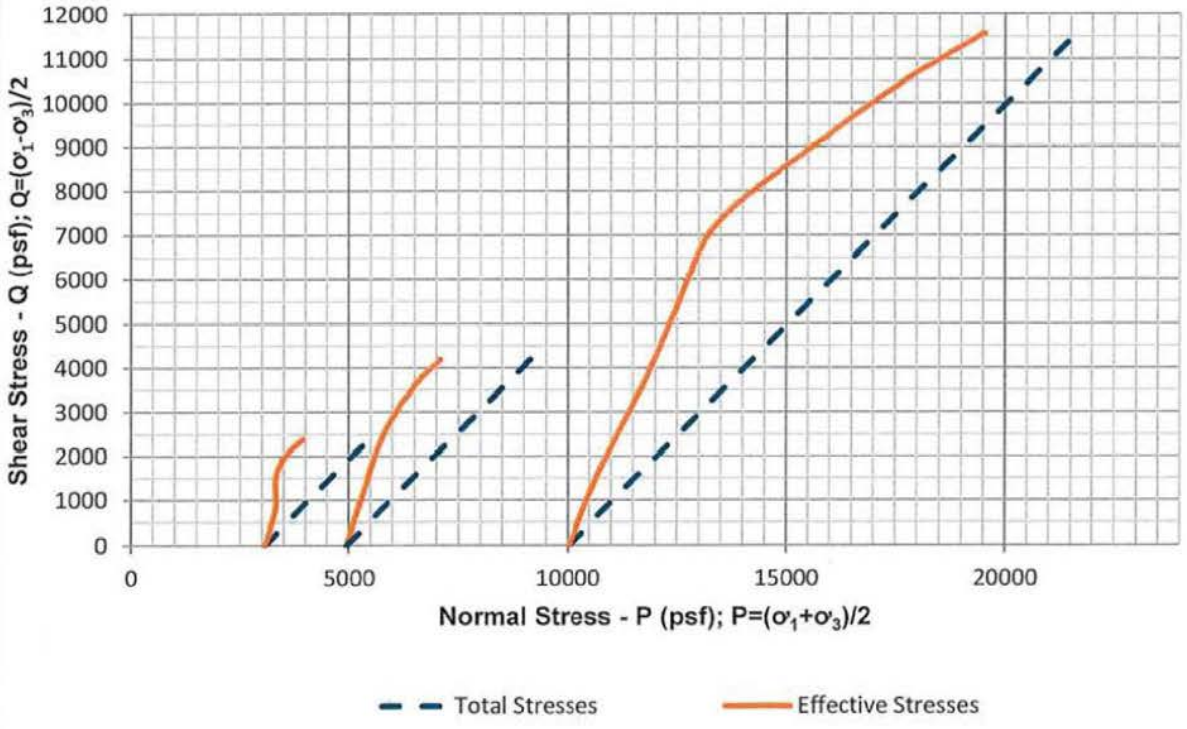
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST WITH PORE PRESSURE MEASUREMENT

STRESS - STRAIN

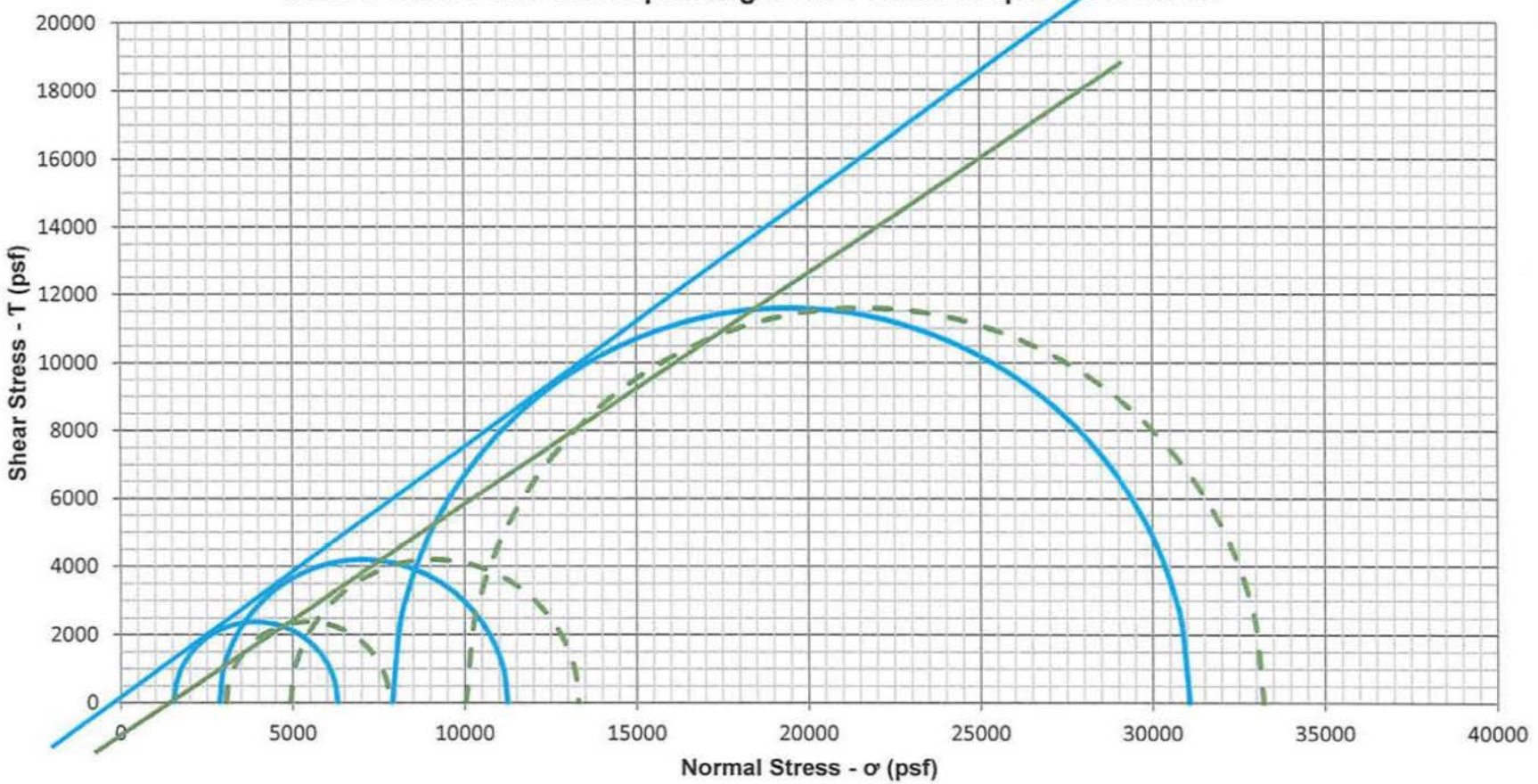


P-Q PLOT



SHANNON & WILSON, INC. 2043 WESTPORT CENTER DR. SAINT LOUIS, MISSOURI 63146 41-1-37431-008	CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION AECI NMPP - Lined Pond Marston, Missouri HA-B10OW / U3 / 30.4

Mohr's Circle Plots Corresponding to the Peak Principal Stress Ratio



Sample	Strain (%)
Stage 1	1.9
Stage 2	2.1
Stage 3	14.7

c =	-1000 psf
ϕ =	34.2 deg
c' =	0 psf
ϕ' =	36.5 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.

AECI NMPP - Lined Pond
Marston, Missouri

Mohr's Circle Plots
HA-B10OW / U3

July 2017 41-1-37431-008

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Figure 1

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	AECI NMPP - Lined Pond			Client	Haley & Aldrich	
Location	Marston, Missouri			Tested by	CMB	Jul-17
Job No.	41-1-37431-008			Calculated by	CMB	Jul-17
Boring	HA-B10OW			Checked by	DPM	7/21/17
Sample	U3	Specimen Number	Stage 3	File	41-1-37431-008 HA-B10OW U3 ASTM D4	
Depth (ft)	30.4	Undisturbed/Remold	Undisturbed	Procedure	ASTM D4767	
Description	Brown, Silt (ML).					
Remarks						

Specimen Data	Initial	Post Consol.	Post Shear
Height (in)	5.669	5.646	4.808
Diameter (in)	2.752	2.726	
Volume (in^3)	33.728	32.953	
Height/Diameter ratio	2.060	2.071	
Weight (g)	1082.17	1069.47	1069.47
Water Content (%)	28.13	26.62	26.62
Bulk Unit Weight (pcf)	122.2	123.6	123.6
Dry Unit Weight (pcf)	95.4	97.6	97.6
Cross-Sectional Area* (in^2)	5.950	5.837	
% Saturation - Wet Method	100.10	100.11	100.11
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	0.753	0.713	0.713
			Entire Sample
Tare ID			8
Mass wet soil + tare (g)			1183.42
Mass dry soil + tare (g)			958.52
Mass tare (g)			100.00

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions	
Cell Pressure (psi)	160.9
Pore Pressure (psi)	91.1
Effective Confining Pressure (psi)	69.7
B-value	0.96

Consolidation Phase	
Change in Volume (in^3)	0.775
T_{50} (min)	0.9

Platen Travel Rate (in/min)	0.02538

Additional Testing

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results

Peak P (psf)	21637.2
Peak P' (psf)	19493.6
Peak Q (psf)	11596.5
Strain at Peak (%)	14.7
σ_3' (psf)	7897.1
σ_1' (psf)	31090.1
σ_3 (psf)	10040.7
σ_1 (psf)	33233.7

Picture of Failure

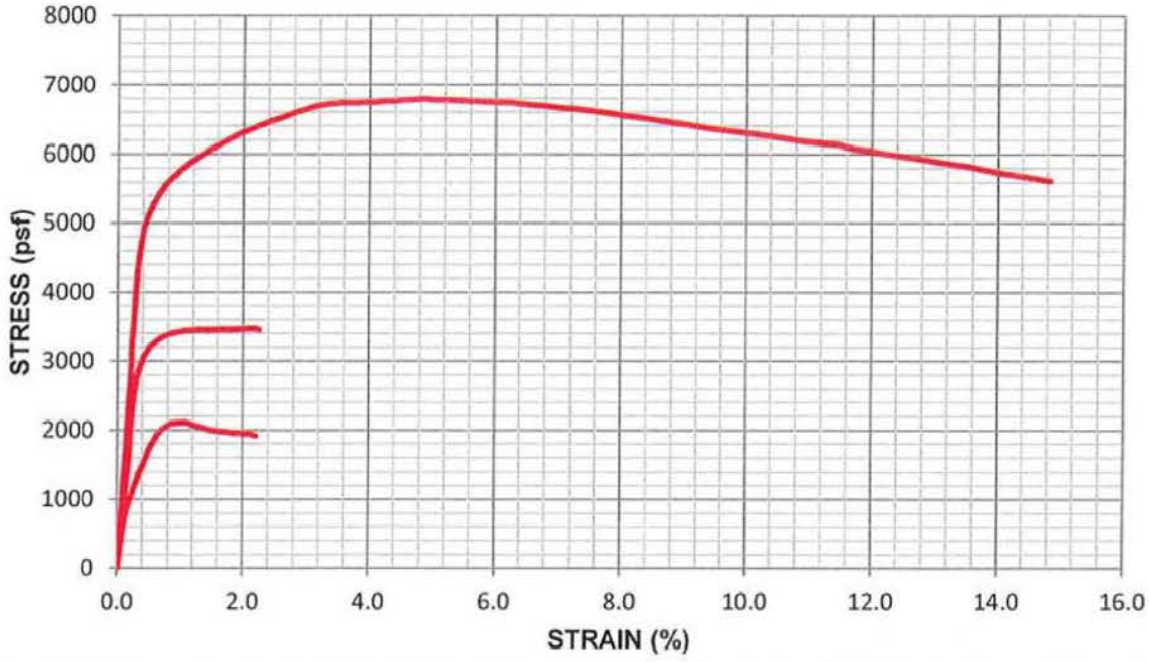
AECI NMPP - Lined Pond
Marston, Missouri

CU TRIAXIAL TEST RESULTS
HA-B10OW / U3 / Stage 3

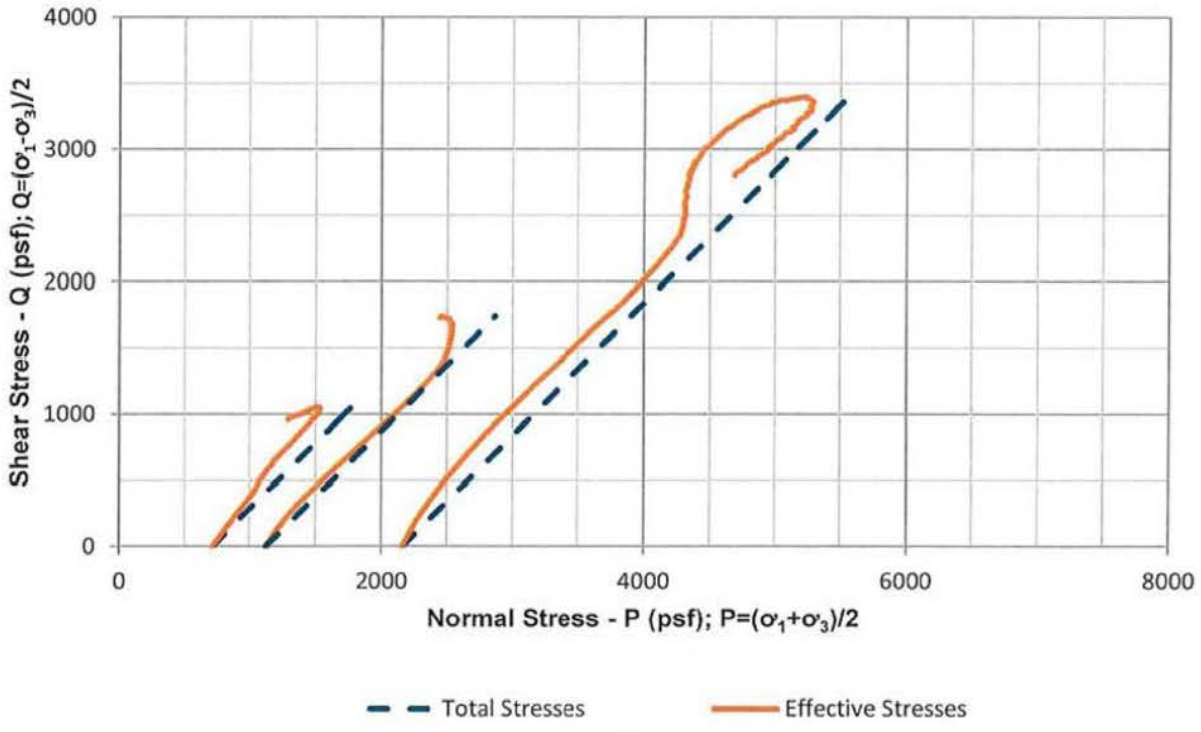
July 2017 41-1-37431-008

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST WITH PORE PRESSURE MEASUREMENT

STRESS - STRAIN

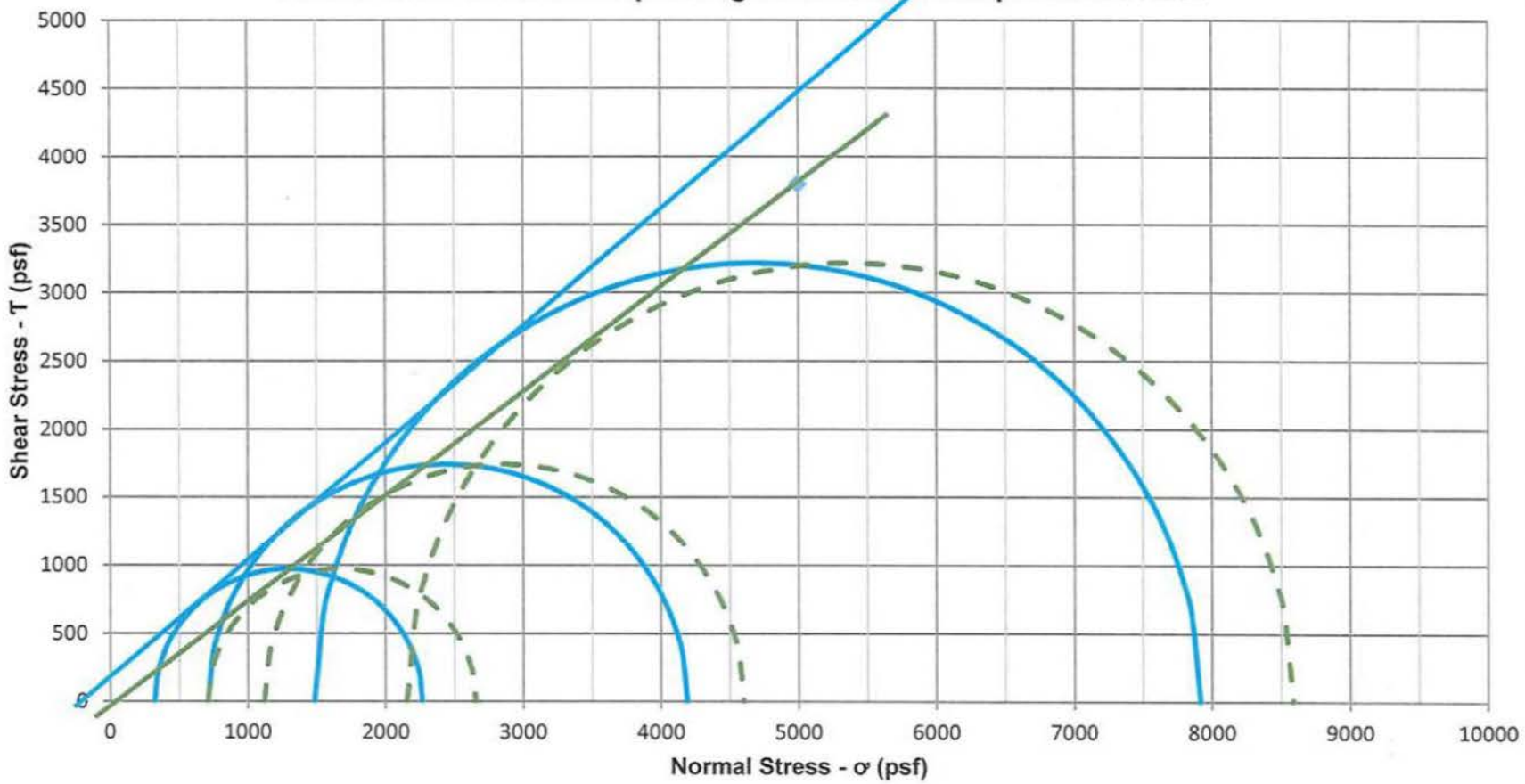


P-Q PLOT



SHANNON & WILSON, INC. 2043 WESTPORT CENTER DR. SAINT LOUIS, MISSOURI 63146 41-1-37431-008	CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION AECI NMPP - Lined Pond Marston, Missouri TP3-2 #1 / Bulk / 0 - 11.0

Mohr's Circle Plots Corresponding to the Peak Principal Stress Ratio



Effective Stress Envelope

Total Stress Envelope

Sample	Strain (%)
Stage 1	2.1
Stage 2	2.2
Stage 3	2.3

c =	-50 psf
ϕ =	38 deg
c' =	180 psf
ϕ' =	41 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.

AECI NMPP - Lined Pond
Marston, Missouri

Mohr's Circle Plots
TP3-2 #1 / Bulk

August 2017 41-1-37431-008

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Figure 1

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	AECI NMPP - Lined Pond					
Location	Marston, Missouri			Client	Haley & Aldrich	
Job No.	41-1-37431-008			Tested by	CMB	Aug-17
Boring	TP3-2 #1			Calculated by	CMB	Aug-17
Sample	Bulk	Specimen Number	Stage 3	Checked by	DPM	8/29/17
Depth (ft)	0 - 11.0	Undisturbed/Remold	Remold	File	41-1-37431-008 TP3-2 #1 Bulk ASTM D47	
Description	Gray, Silt with Sand (ML) (Ash).			Procedure	ASTM D4767	
Remarks						

Specimen Data	Initial	Post Consol.	Post Shear
Height (in)	5.703	5.709	5.582
Diameter (in)	3.000	2.984	
Volume (in^3)	40.310	39.932	
Height/Diameter ratio	1.901	1.913	
Weight (g)	1001.52	995.32	995.32
Water Content (%)	84.14	83.00	83.00
Bulk Unit Weight (pcf)	94.7	95.0	95.0
Dry Unit Weight (pcf)	51.4	51.9	51.9
Cross-Sectional Area* (in^2)	7.068	6.994	
% Saturation - Wet Method	100.06	100.06	100.06
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	2.253	2.223	2.223
			Entire Sample
Tare ID			8
Mass wet soil + tare (g)			1077.42
Mass dry soil + tare (g)			636.69
Mass tare (g)			100.14

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions	
Cell Pressure (psi)	107.6
Pore Pressure (psi)	92.6
Effective Confining Pressure (psi)	15.0
B-value	0.98

Consolidation Phase	
Change in Volume (in^3)	0.378
T_{50} (min)	0.5

Platen Travel Rate (in/min)	0.01969

Additional Testing

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results

Peak P (psf)	5374.2
Peak P' (psf)	4702.4
Peak Q (psf)	3216.7
Strain at Peak (%)	2.3
σ_3' (psf)	1485.8
σ_1' (psf)	7919.1
σ_3 (psf)	2157.6
σ_1 (psf)	8590.9

Picture of Failure

AECI NMPP - Lined Pond
Marston, Missouri

CU TRIAXIAL TEST RESULTS
TP3-2 #1 / Bulk / Stage 3

August 2017 41-1-37431-008

SHANNON & WILSON, INC.
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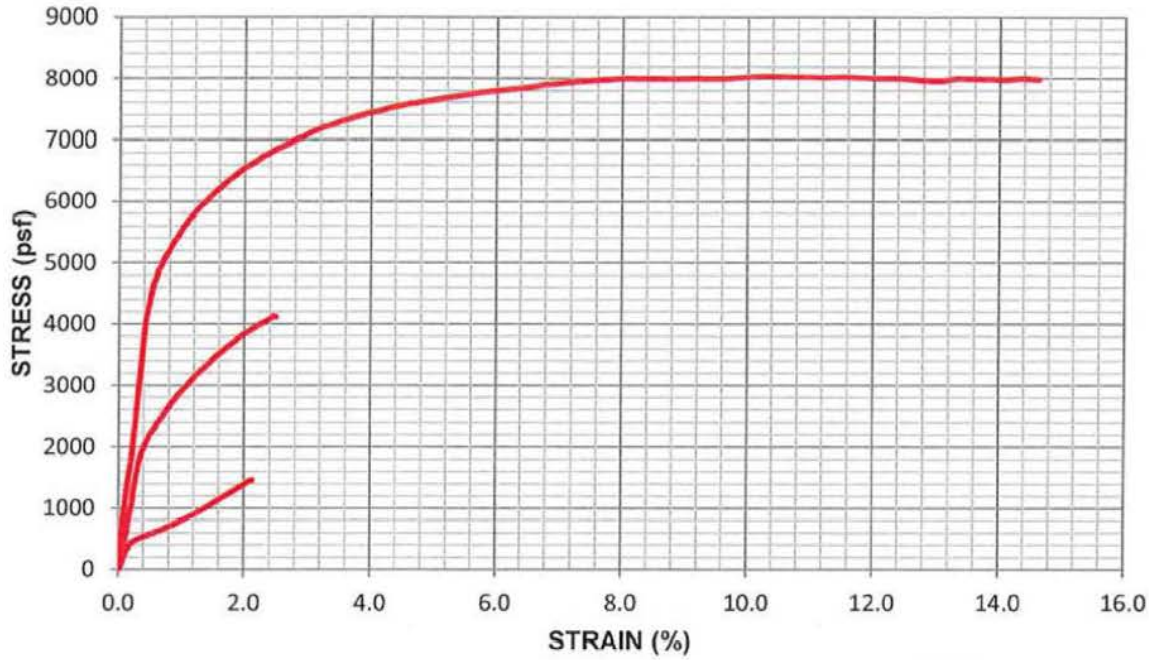
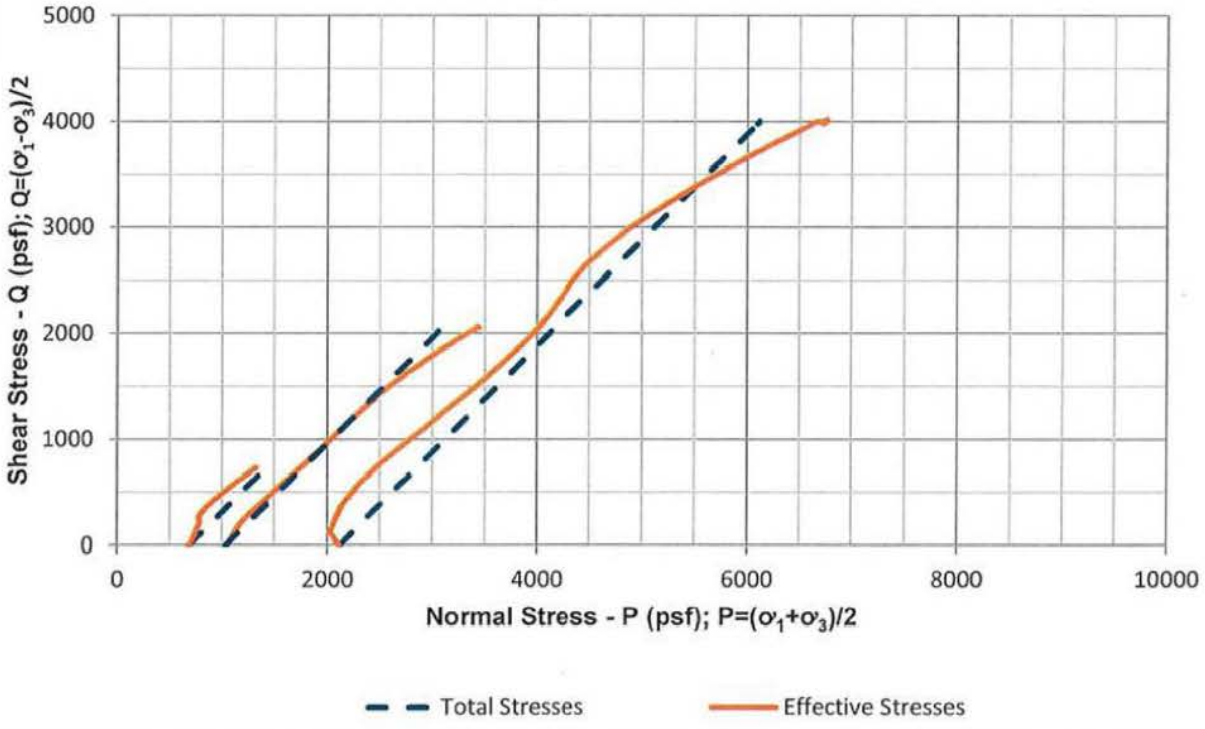
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST WITH PORE PRESSURE MEASUREMENT

STRESS - STRAIN

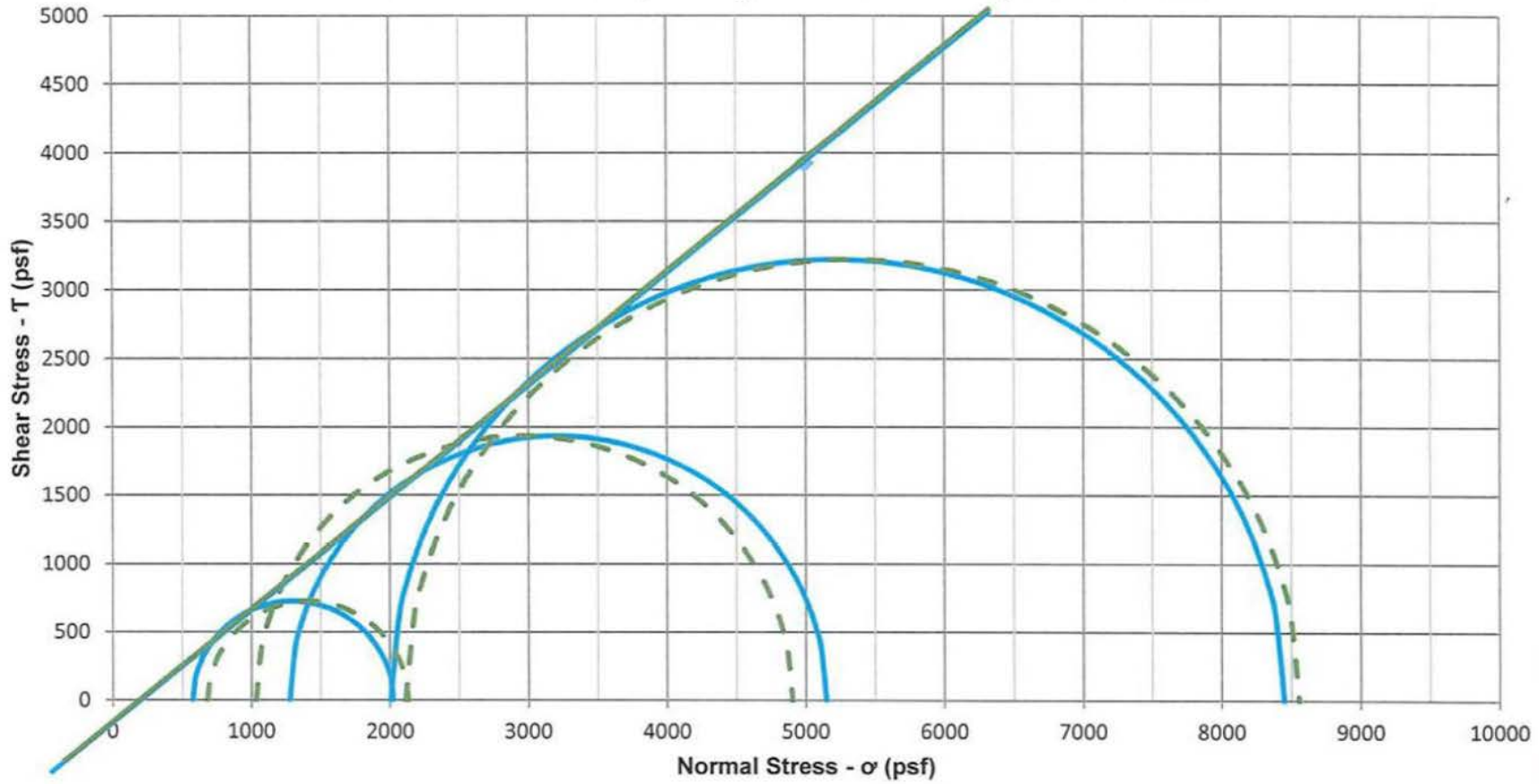


P-Q PLOT



SHANNON & WILSON, INC. 2043 WESTPORT CENTER DR. SAINT LOUIS, MISSOURI 63146 41-1-37431-008	CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION AECI NMPP - Lined Pond Marston, Missouri TP3-2 #2 / Bulk / 0 - 11.0

Mohr's Circle Plots Corresponding to the Peak Principal Stress Ratio



Sample	Strain (%)
Stage 1	2.1
Stage 2	2.0
Stage 3	1.9

c =	-180 psf
ϕ =	39 deg
c' =	-180 psf
ϕ' =	39 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.

AECI NMPP - Lined Pond
Marston, Missouri

Mohr's Circle Plots
TP3-2 #2 / Bulk

August 2017 41-1-37431-008

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Figure 1

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
SUMMARY OF TEST DATA

Project	AECI NMPP - Lined Pond			Client	Haley & Aldrich	
Location	Marston, Missouri			Tested by	CMB	Aug-17
Job No.	41-1-37431-008			Calculated by	CMB	Aug-17
Boring	TP3-2 #2			Checked by	DPM	8/29/17
Sample	Bulk	Specimen Number	Stage 3	File	41-1-37431-008 TP3-2 #2 Bulk ASTM D47	
Depth (ft)	0 - 11.0	Undisturbed/Remold	Remold			
Description	Gray, Silt with Sand (ML) (Ash).			Procedure	ASTM D4767	
Remarks						

Specimen Data	Initial	Post Consol.	Post Shear
Height (in)	5.742	5.759	5.640
Diameter (in)	3.007	2.966	
Volume (in^3)	40.770	39.794	
Height/Diameter ratio	1.910	1.942	
Weight (g)	967.97	951.97	951.97
Water Content (%)	102.35	99.01	99.01
Bulk Unit Weight (pcf)	90.4	91.1	91.1
Dry Unit Weight (pcf)	44.7	45.8	45.8
Cross-Sectional Area* (in^2)	7.100	6.909	
% Saturation - Wet Method	100.06	100.06	100.06
Specific Gravity - Assumed	2.68	2.68	2.68
Void Ratio	2.741	2.652	2.652
			Entire Sample
Tare ID			31
Mass wet soil + tare (g)			1040.63
Mass dry soil + tare (g)			658.42
Mass tare (g)			164.96

*Cross-Sectional Area determined using ASTM D4767 Method A

Pressure Conditions	
Cell Pressure (psi)	104.7
Pore Pressure (psi)	90.0
Effective Confining Pressure (psi)	14.7
B-value	0.98

Consolidation Phase	
Change in Volume (in^3)	0.976
T_{50} (min)	48.9

Platen Travel Rate (in/min)	0.00049

Additional Testing

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Particle-Size (ASTM D422)	
Specific Gravity (ASTM D854)	

Summary of Results

Peak P (psf)	5337.7
Peak P' (psf)	5229.5
Peak Q (psf)	3222.4
Strain at Peak (%)	1.9
σ_3' (psf)	2007.1
σ_1' (psf)	8451.9
σ_3 (psf)	2115.3
σ_1 (psf)	8560.1

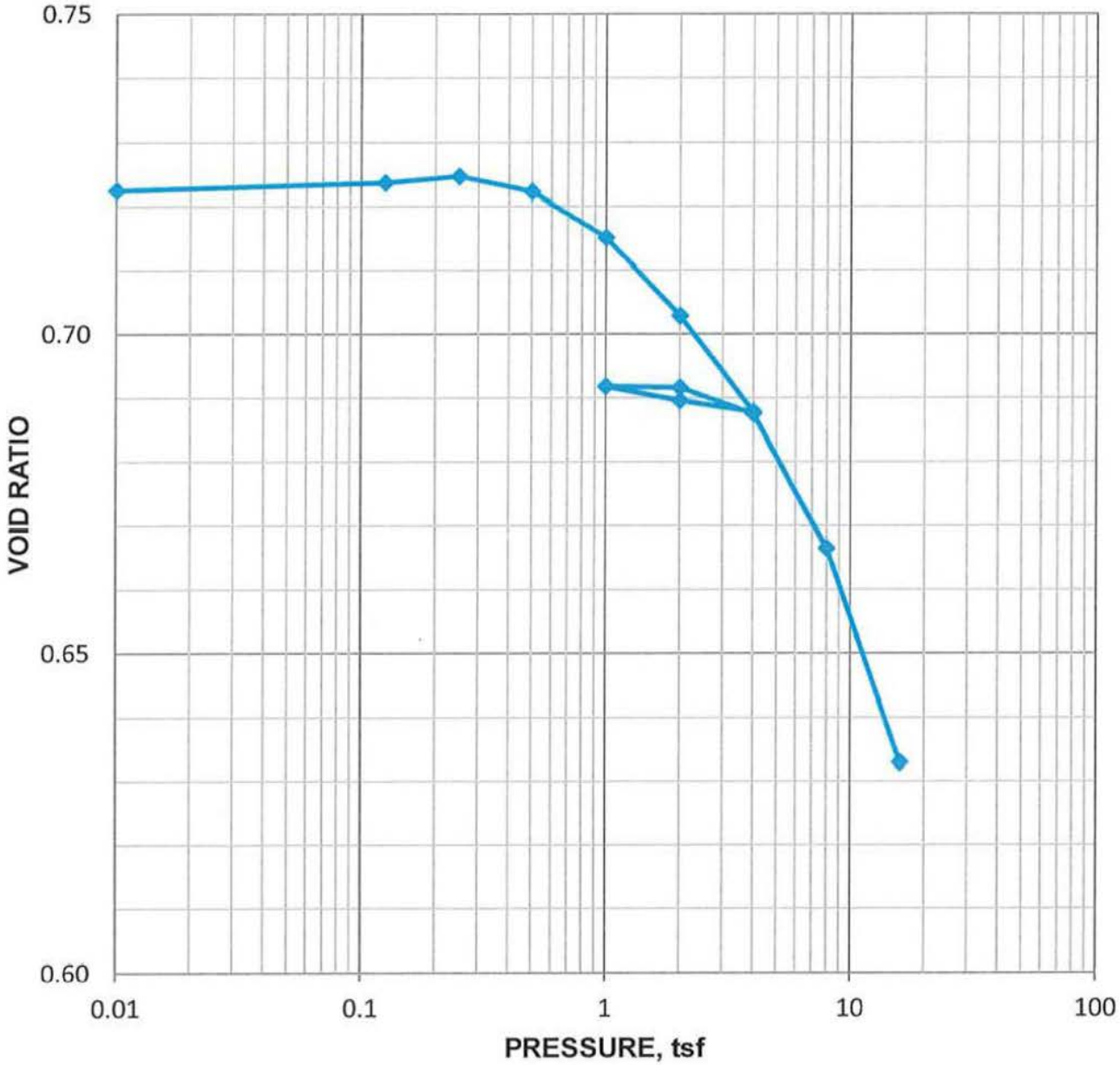
Picture of Failure

AECI NMPP - Lined Pond
Marston, Missouri

CU TRIAXIAL TEST RESULTS
TP3-2 #2 / Bulk / Stage 3

August 2017 41-1-37431-008

CONSOLIDATION TEST



Load, tsf	Coefficient of Consolidation, mm^2/second	Load, tsf	Coefficient of Consolidation, mm^2/second
0.125	5.3E+00	1.0	NA
0.25	3.3E+00	2.0	NA
0.5	3.3E+00	4.0	NA
1.0	2.6E+00	8.0	1.2E+00
2.0	2.0E+00	16.0	9.2E-01
4.0	9.1E-01		
2.0	NA		

AECI NMPP - Lined Pond
Marston, Missouri

VOID RATIO PLOT

HA-B9

U3

July 2017 41-1-37431-008

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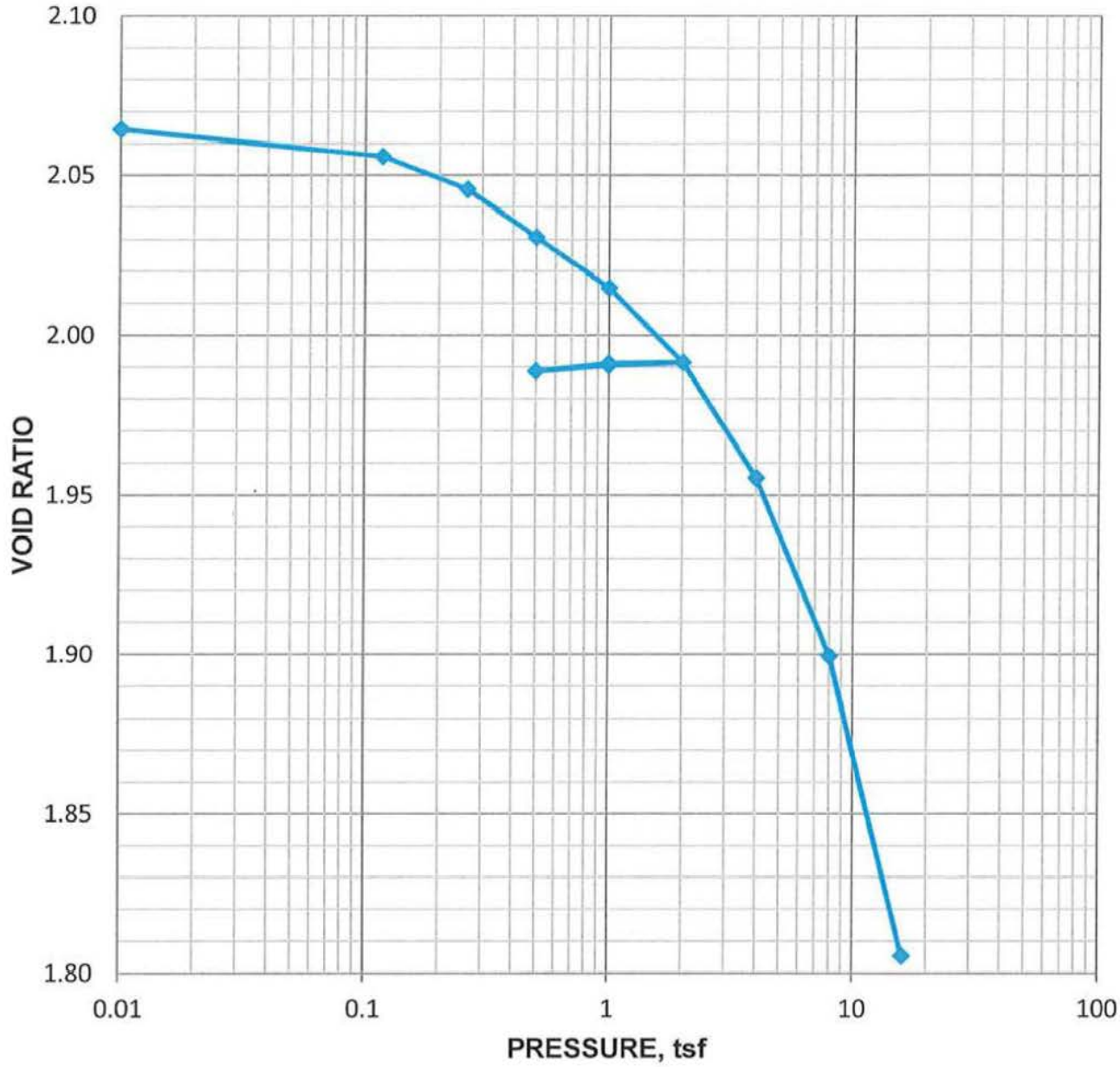
FIG.

CONSOLIDATION TEST



Load, tsf	Coefficient of Consolidation, mm^2/second	Load, tsf	Coefficient of Consolidation, mm^2/second
0.117	5.3E+00	1.0	NA
0.26	3.4E-03	2.0	NA
0.5	2.3E+00	4.0	2.9E-01
1.0	2.0E+00	8.0	1.4E-01
2.0	2.0E+00	16.0	1.6E-01
1.0	NA		
0.5	NA		

AECI NMPP - Lined Pond
Marston, Missouri

VOID RATIO PLOT

TP3-2

Bulk

August 2017 41-1-37431-008

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FIG.

APPENDIX E

Historic Subsurface Explorations

Surface Elevation 311 | Completion Date: 3/23/09

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Topsoil			
	FILL: brown, silty clay with gravel and sand			GB1
			5-8-8	SS2
5			106	ST3
	FILL: gray clay		2-3-5	SS4
10				
	FILL: brown and gray, silty clay		90	ST5
			4-5-6	SS6
15			100	ST7
			5-8-10	SS8
20	Very stiff to soft, brown and gray, silty CLAY - CL			
			6-8-8	SS9
25				
			3-3-3	SS10
30				
			2-2-2	SS11
35				
	Medium dense, occasionally dense, brown to gray SAND, trace silt - SP		5-6-8	SS12

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

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 1011304 - ASH POND.GPJ GTINC 0638301.GPJ 6/12/09

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

AT 31.8 FEET AFTER 74 DAYS ▼

AT 30.2 FEET AFTER 99 DAYS ▼

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 20 FEET

MB DRILLER RFW LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: SJL	App'vd. by: MHM
Date: 3/29/09	Date: 6/12/09	Date: 6/15/09

GEOTECHNOLOGY, INC.

ENGINEERING AND ENVIRONMENTAL SERVICES

ST. LOUIS • COLLINSVILLE • KANSAS CITY

AECI New Madrid Embankment Stability Evaluation

LOG OF BORING: P-6

Project No. 1011304.91IG

Surface Elevation 311 | Completion Date: 3/23/09

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Medium dense, occasionally dense, brown to gray SAND, trace silt - SP *(continued)*			
			11-11-11	SS13
45				
50			12-12-13	SS14
55				
60				
	3 percent passing #200 sieve		12-14-17	SS15
65				
70	Medium dense, gray, fine to coarse SAND - SP			
			8-9-16	SS16
75				

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

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 1011304 - ASH POND GPJ GTINC 0638301 GPJ 6/12/09

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

AT 31.8 FEET AFTER 74 DAYS ▼

AT 30.2 FEET AFTER 99 DAYS ▼

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 20 FEET

MB DRILLER RFW LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: SL	App'vd. by: MHM
Date: 3/29/09	Date: 6/15/09	Date: 6/15/09

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AECI New Madrid Embankment Stability Evaluation

CONTINUATION OF LOG OF BORING: P-6

Project No. 1011304.91IG

Surface Elevation 311 | Completion Date: 3/23/09

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Medium dense, gray, fine to coarse SAND - SP *(continued)*			
			9-10-11	SS17
85	Boring terminated at 85 feet.			

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

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 1011304 ASH POND.GPJ GTINC.0638301.GPJ 6/12/09

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

AT 31.8 FEET AFTER 74 DAYS ▼

AT 30.2 FEET AFTER 99 DAYS ▼

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 20 FEET

MB DRILLER RFW LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: KSA	Checked by: SH	App'vd. by: MHM
Date: 3/29/09	Date: 6/12/09	Date: 6/15/09

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AECI New Madrid Embankment Stability Evaluation

CONTINUATION OF LOG OF BORING: P-6

Project No. 1011304.91IG

Surface Elevation 308 | Completion Date: 3/24/09

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Crushed rock road bed		
	FILL: brown, silty clay, trace sand and gravel	5-6-8	SS1
		4-5-9	SS2
5		*	ST3
		5-7-8	SS4
10		92	ST5
		3-4-5	SS6
15		97	ST7
	Very stiff, gray, silty CLAY - CL	6-11-11	SS8
20	Medium stiff, brown SILT - (ML)	86	ST9
	Stiff, brown, sandy SILT - ML	2-3-3	SS10
25			
		3-5-5	SS11
30			
	Loose, brown, silty SAND - SM	6-3-3	SS12
35			
	Very stiff, brown, sandy SILT - ML	6-9-10	SS13

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

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 1011304 - ASH POND.GPJ GTINC 0638301.GPJ 6/12/09

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

AT 30.6 FEET AFTER 73 DAYS ▼

AT 27.4 FEET AFTER 98 DAYS ▼

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM WASHBORING FROM 30 FEET

MB DRILLER RFW LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS: * Poor sample recovery.

Drawn by: KSA	Checked by: SA	App'vd. by: MHM
Date: 3/29/09	Date: 6/12/09	Date: 6/15/09

GEOTECHNOLOGY, INC.

ENGINEERING AND ENVIRONMENTAL SERVICES

ST. LOUIS • COLLINSVILLE • KANSAS CITY

AECI New Madrid Embankment Stability Evaluation

LOG OF BORING: P-7

Project No. 1011304.91IG

Surface Elevation 308 | Completion Date: 3/24/09

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	Very stiff, brown, sandy SILT - ML *(continued)*			
	Medium dense to dense, brown and gray SAND - SP			
45	6 percent passing #200 sieve		10-11-11	SS14
50			10-12-16	SS15
55			16-24-19	SS16
	Boring terminated at 55 feet.			
60				
65				
70				
75				

SHEAR STRENGTH, tsf

Δ - UU/2 O - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

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 1011304 ASH POND.GPJ GTINC.0638301.GPJ 6/12/09

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

AT 30.6 FEET AFTER 73 DAYS ▼

AT 27.4 FEET AFTER 98 DAYS ▼

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 30 FEET

MB DRILLER RFW LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS: * Poor sample recovery.

Drawn by: KSA	Checked by: SR	App'vd. by: MHM
Date: 3/29/09	Date: 6/14/09	Date: 6/15/09

GEOTECHNOLOGY, INC.

ENGINEERING AND ENVIRONMENTAL SERVICES

ST. LOUIS • COLLINSVILLE • KANSAS CITY

AECI New Madrid Embankment Stability Evaluation

CONTINUATION OF LOG OF BORING: P-7

Project No. 1011304.91IG

Surface Elevation 308 | Completion Date: 3/25/09

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Fly ash			GB1
5				
5	Cemented fly ash			
10				
10	Test pit terminated at 13 feet.			
15				
20				
25				
30				
35				

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

111

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 1011304 - ASH POND.GPJ GTINC 0638301.GPJ 4/29/09

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

___ DRILLER RFW LOGGER

Cat 3242 BACKHOE

HAMMER TYPE ___

REMARKS:

Drawn by: LAH	Checked by: [illegible]	App'vd. by: MHM
Date: 3/31/09	Date: 4/29/09	Date: 6/12/09

GEOTECHNOLOGY, INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
ST. LOUIS • COLLINSVILLE • KANSAS CITY

AECI New Madrid Embankment Stability Evaluation

LOG OF TEST PIT: TP-8

Project No. 1011304.91IG

Surface Elevation 315 | Completion Date: 3/25/09

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Fly ash			
5				
10				GB1
15				
	Test pit terminated at 16 feet.			
20				
25				
30				
35				

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

76

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 1011304 - ASH POND.GPJ GTINC 0638301.GPJ 4/29/09

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

___ DRILLER RFW LOGGER

Cat 3242 BACKHOE

HAMMER TYPE ___

REMARKS:

Drawn by: LAH	Checked by: [illegible]	App'vd. by: MHM
Date: 3/31/09	Date: 4/29/09	Date: 6/12/09

GEOTECHNOLOGY, INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
ST. LOUIS • COLLINSVILLE • KANSAS CITY

AECI New Madrid Embankment Stability Evaluation

LOG OF TEST PIT: TP-9

Project No. 1011304.91IG

Surface Elevation 314 | Completion Date: 3/25/09

Datum msl

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	Fly ash			
15				GB1
16	Test pit terminated at 16 feet.			

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 □ - SV

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

75

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 1011304 - ASH POND.GPJ GTINC.0638301.GPJ 4/29/09

GROUNDWATER DATA

ENCOUNTERED AT 11 FEET ▽

DRILLING DATA

___ AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

___ DRILLER RFW LOGGER

Cat 3242 BACKHOE

HAMMER TYPE ___

REMARKS:

Drawn by: LAH	Checked by: SJC	App'vd. by: MHM
Date: 3/31/09	Date: 4/29/09	Date: 6/12/09

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AECI New Madrid Embankment Stability Evaluation

LOG OF TEST PIT: TP-10

Project No. 1011304.91IG

APPENDIX F

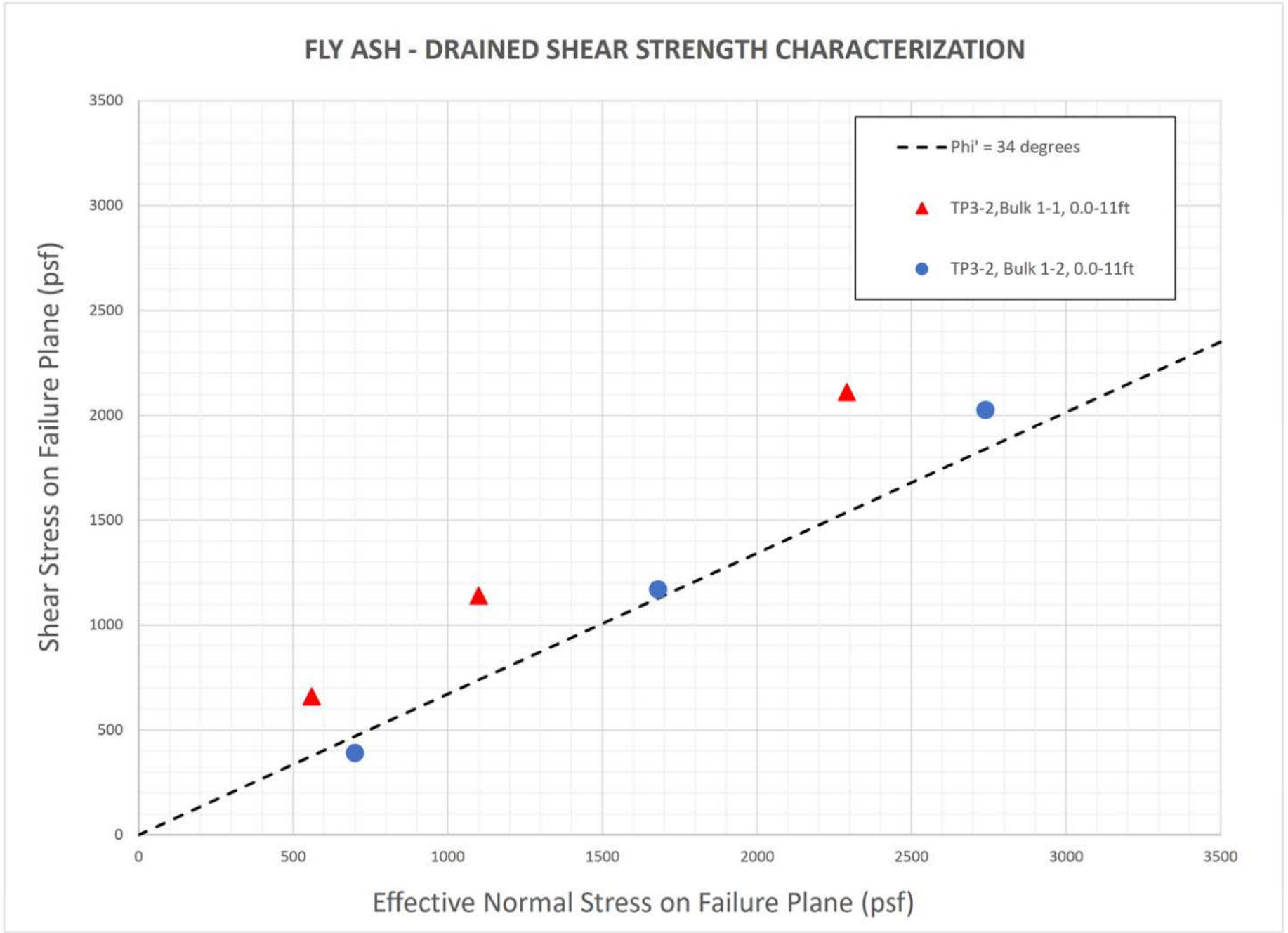
Preliminary Material Properties

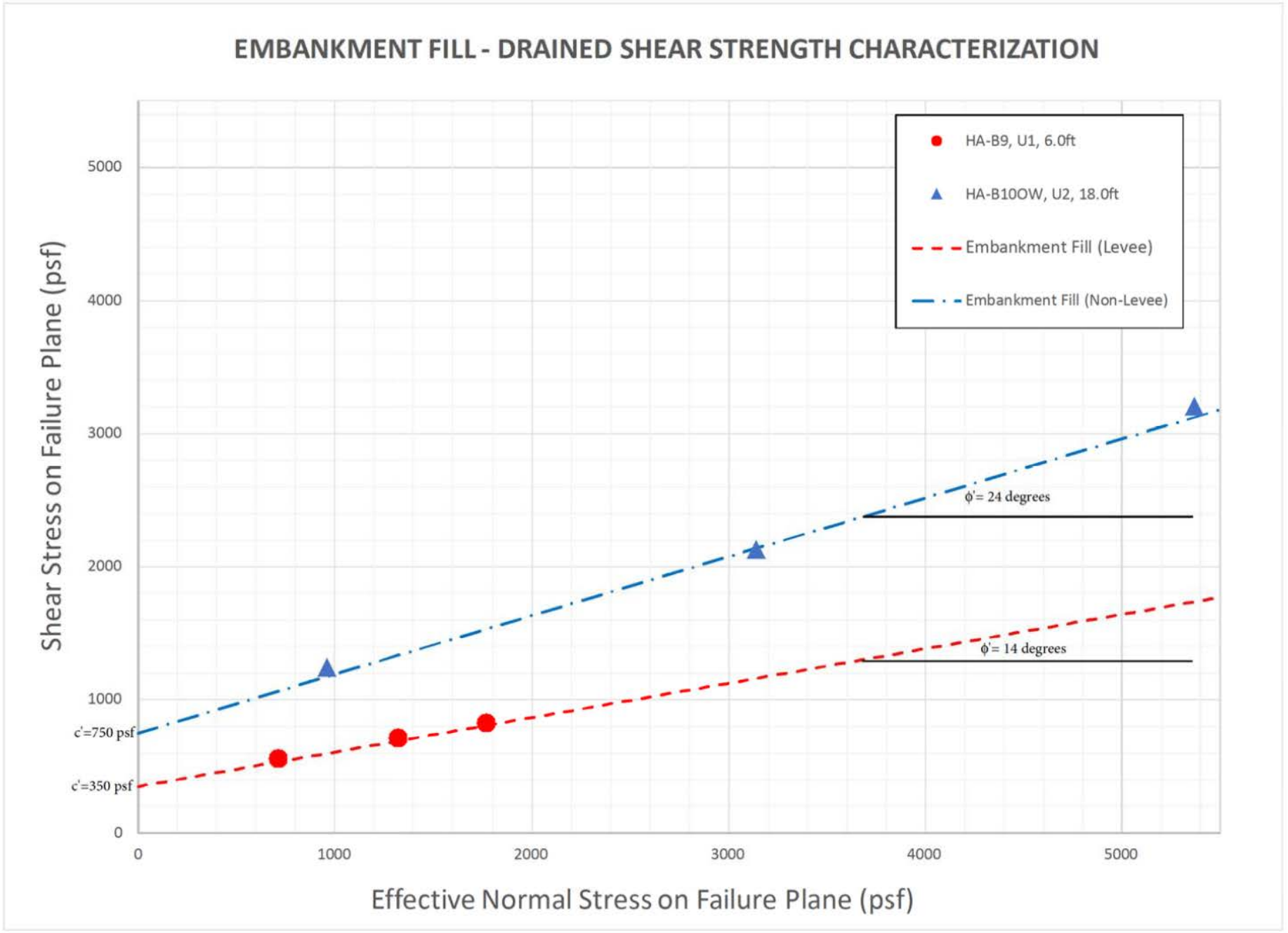
PRELIMINARY MATERIAL PROPERTY CHARACTERIZATION - AECI NMPP Lined Pond

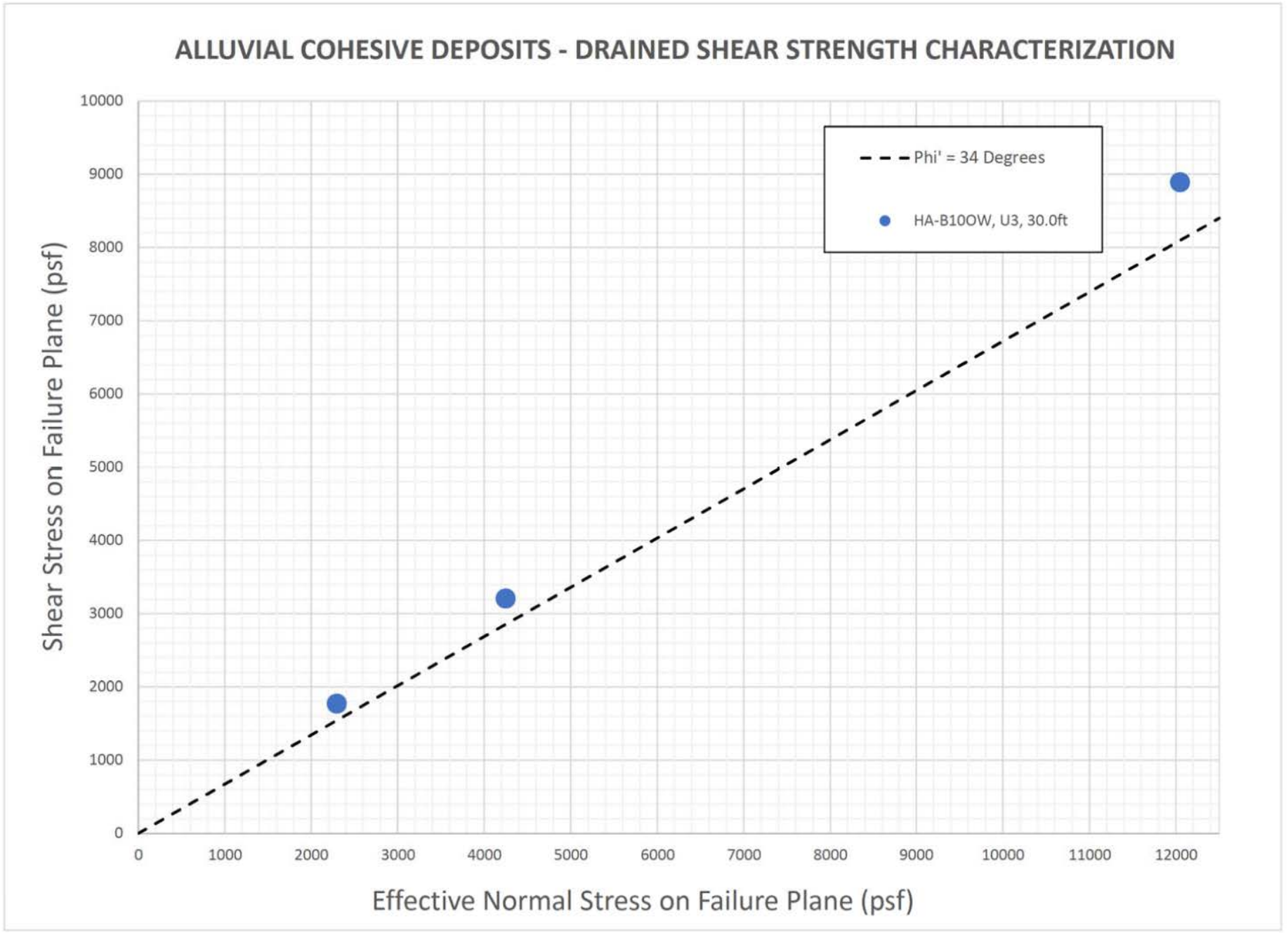
Material	Location	Total Unit Weight						Undrained Shear Strength								Drained Shear Strength											
		CPT	Laboratory[1]		Historic Stability Evaluations		Current Design	SPT		CPT[4]		UU Triaxial[1]	Historic Stability Evaluations		Current Design	SPT		CPT		Laboratory CU Triaxial[1]		Historic Stability Evaluations				Current Design	
		avg	Test Avg.	Tube Avg.	H&A 2016[2]	Geotechnology 2009[3]		avg	avg - 1σ	avg	avg - 1σ	avg	H&A 2016[2]	Geotechnology 2009[3]		avg	avg - 1σ	avg	avg - 1σ			H&A 2016[2]		Geotechnology 2009[3]			
		γ_T	γ_T	γ_T	γ_T	γ_T	γ_T	S_u	S_u	S_u	S_u	S_u	S_u	S_u	S_u	ϕ'	ϕ'	ϕ'	ϕ'	c'	ϕ'	c'	ϕ'	c'	ϕ'	c'	ϕ'
Fly Ash	Lined Pond Only	125 pcf	--	--	--	--	105 pcf	--	--	--	--	--	--	--	$S_u/p' = 0.30$ min = 500 psf	37°	35°	41°	38°	0 psf	34°	--	--	--	--	0 psf	34°
	Site Wide	112 pcf	106 pcf	102 pcf	90 pcf	--		--	--	--	--	600 psf	500 psf	--		32°	28°	38°	33°			0 psf	28°	--	--		
Embankment Fill (Levee)	Lined Pond Only	119 pcf	117 pcf	--	--	--	120 pcf	3,000 psf	3,000 psf	3,800 psf	2,000 psf	--	--	--	$S_u/p' = 0.27$ min = 550 psf	--	--	--	--	350 psf	14°	--	--	50 psf	30°	300 psf	15°
	Site Wide	117 pcf		--	115 pcf	--		1,327 psf	679 psf	2,840 psf	1,160 psf	--	800 psf	--		--	--	--	--			50 psf	30°	--	--		
Embankment Fill (Non-Levee)	Lined Pond Only	118 pcf	128 pcf	--	--	110 pcf	120 pcf	2,176 psf	1,660 psf	5,200 psf	2,200 psf	--	--	800 psf	$S_u/p' = 0.39$ min = 1,000 psf	--	--	--	--	750 psf	24°	--	--	50 psf	30°	300 psf	28°
	Site Wide	116 pcf		--	115 pcf	--		1,834 psf	1,338 psf	3,472 psf	673 psf	--	800 psf	--		--	--	--	--	375 psf	30°	50 psf	30°	--	--		
Alluvial Deposits (cohesive)	Lined Pond Only	115 pcf	120 pcf	--	--	110 pcf	120 pcf	1,441 psf	444 psf	4,000 psf	1,200 psf	2,400 psf	--	1,000 psf	$S_u/p' = 0.50$ min = 1,000 psf	--	--	--	--	0 psf	34°	--	--	50 psf	28°	0 psf	30°
	Site Wide	115 pcf	119 pcf	--	110 pcf	--		1,338 psf	448 psf	3,472 psf	880 psf	2,400 psf	1,300 psf	--		--	--	--	--	180 psf	36°	50 psf	28°	--	--		
Alluvial Deposits (granular)	Lined Pond Only	120 pcf	--	--	--	--	120 pcf	--	--	--	--	--	--	--	0 psf	34°	33°	36°	34°	--	--	--	--	--	--	0 psf	34°
	Site Wide	121 pcf	--	--	108 pcf	--		--	--	--	--	--	0 psf	--		34°	32°	37°	34°	--	--	0 psf	36°	--	--		
Fluvial Deposits	Lined Pond Only	123 pcf	--	--	--	120 pcf	125 pcf	--	--	--	--	--	--	0 psf	0 psf	37°	36°	41°	39°	--	--	--	--	0°	35°	0 psf	38°
	Site Wide	124 pcf	--	--	120 pcf	--		--	--	--	--	--	0 psf	--		36°	34°	41°	39°	--	--	0 psf	38°	--	--		

Notes:

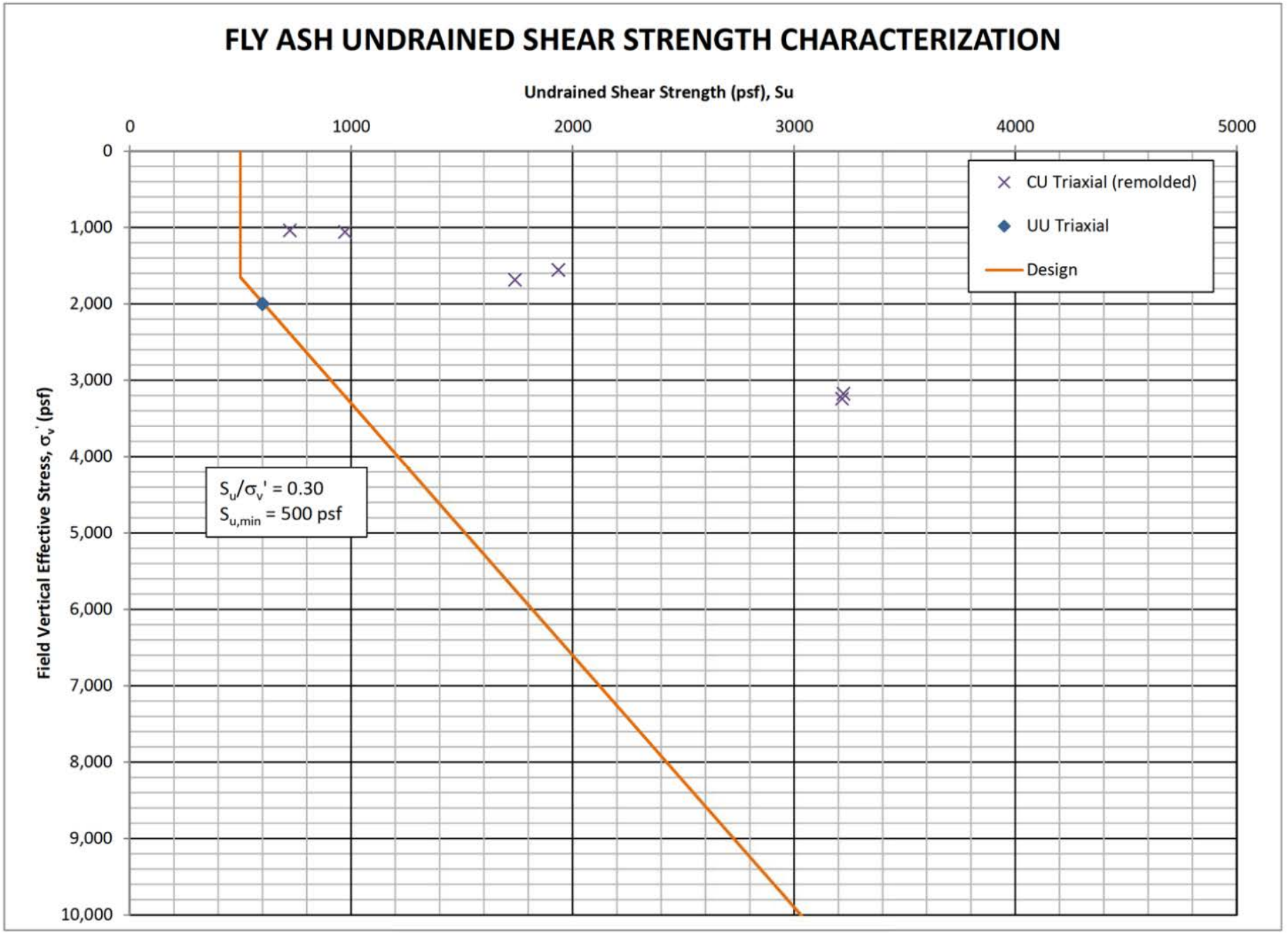
1. Laboratory values shown represent Haley & Aldrich's interpretation of the laboratory test results and may differ from the results reported by the laboratory.
2. Historic stability evaluation properties from Report on Safety Factor Assessment 003 Unlined Pond and 004 Slag Dewatering Pond prepared by Haley & Aldrich, Inc. dated October 2016.
3. Historic stability evaluation properties from Stability Evaluation Slag Pond 1 and Ash Pond 2 prepared by Geotechnology, Inc. dated June 2009.
4. Undrained shear strength correlations from CPT data are based on a N_{kt} factor of 15.


FLY ASH - DRAINED SHEAR STRENGTH CHARACTERIZATION
Shear Stress on Failure Plane (psf)
Effective Normal Stress on Failure Plane (psf)
0
500
1000
1500
2000
2500
3000
3500
Phi' = 34 degrees
TP3-2,Bulk 1-1, 0.0-11ft
TP3-2, Bulk 1-2, 0.0-11ft

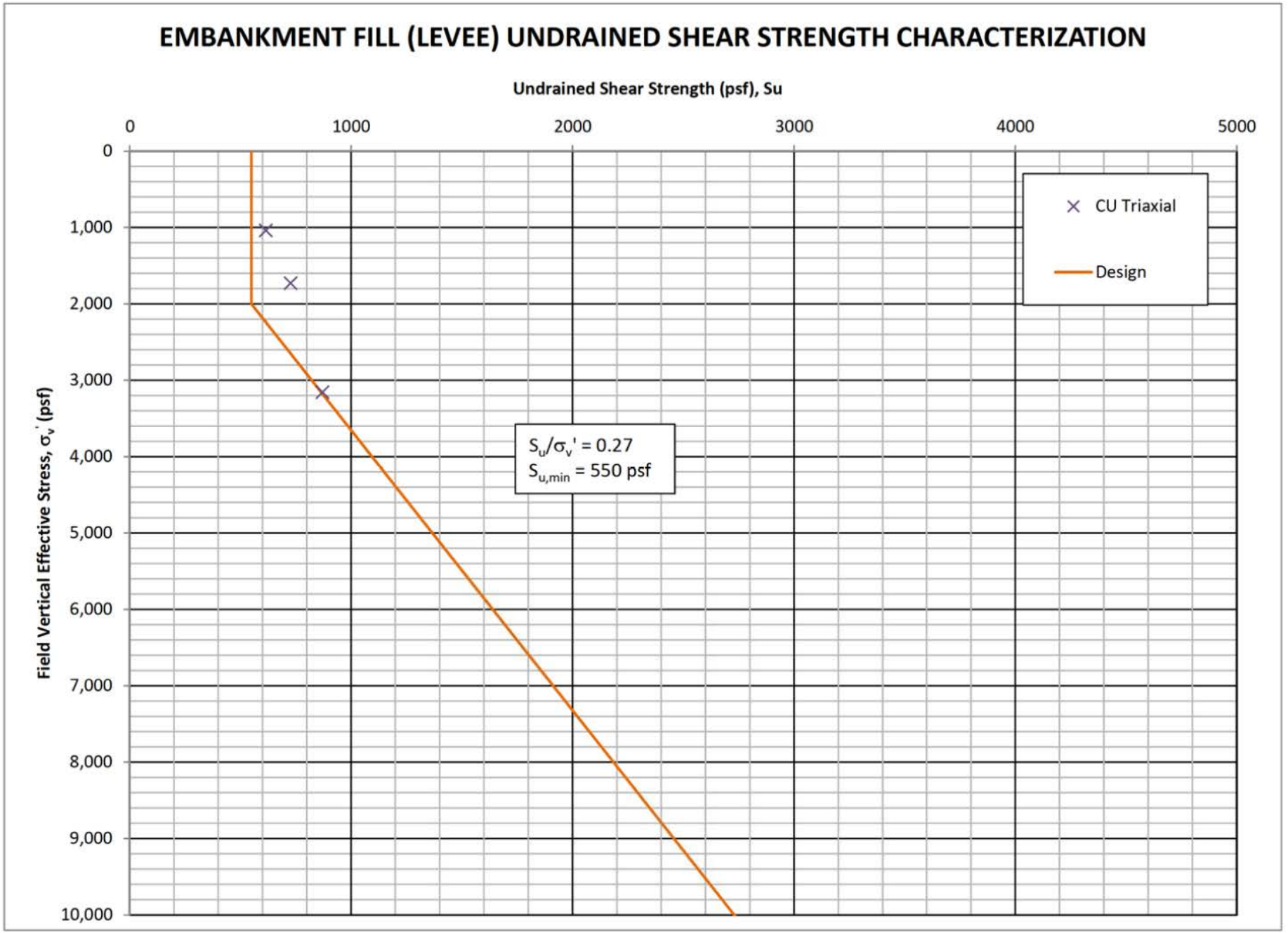

EMBANKMENT FILL - DRAINED SHEAR STRENGTH CHARACTERIZATION
HA-B9, U1, 6.0ft
HA-B10OW, U2, 18.0ft
Embankment Fill (Levee)
Embankment Fill (Non-Levee)
ϕ'= 24 degrees
ϕ'= 14 degrees
c'=750 psf
c'=350 psf
Shear Stress on Failure Plane (psf)
Effective Normal Stress on Failure Plane (psf)
0
1000
2000
3000
4000
5000

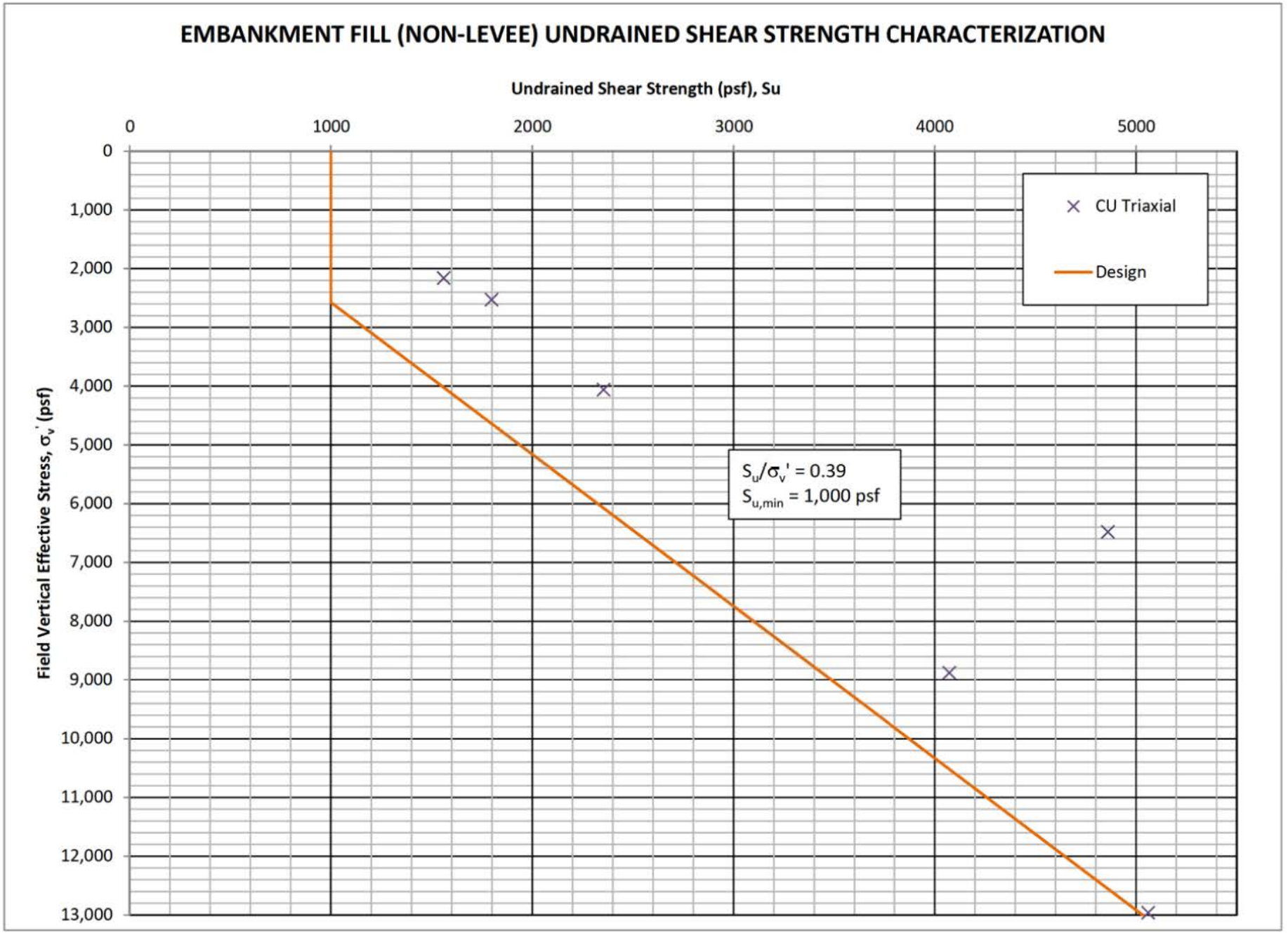

ALLUVIAL COHESIVE DEPOSITS - DRAINED SHEAR STRENGTH CHARACTERIZATION
Shear Stress on Failure Plane (psf)
Effective Normal Stress on Failure Plane (psf)
Phi' = 34 Degrees
HA-B10OW, U3, 30.0ft
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000

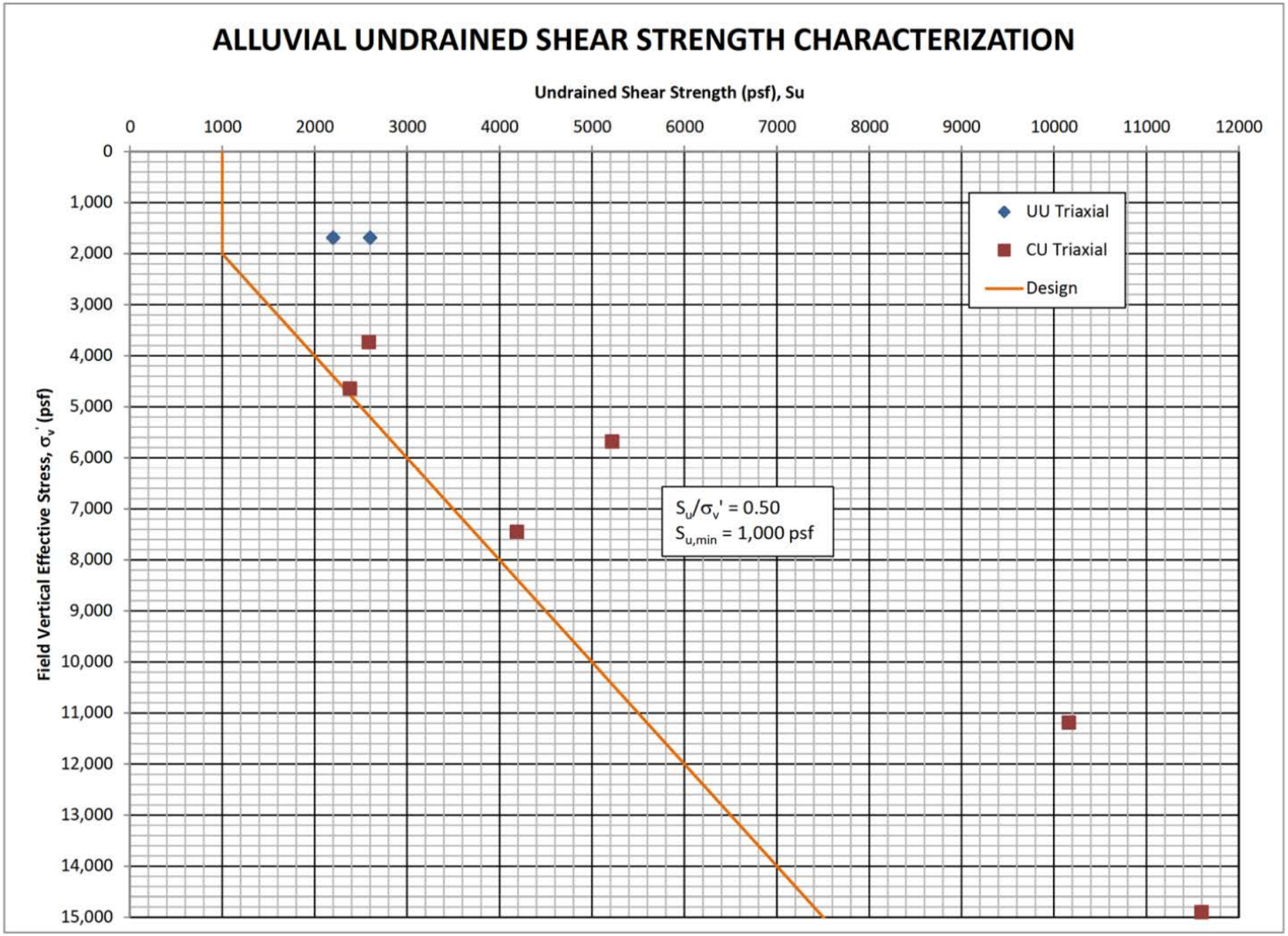
FLY ASH UNDRAINED SHEAR STRENGTH CHARACTERIZATION



EMBANKMENT FILL (LEVEE) UNDRAINED SHEAR STRENGTH CHARACTERIZATION




EMBANKMENT FILL (NON-LEVEE) UNDRAINED SHEAR STRENGTH CHARACTERIZATION
Undrained Shear Strength (psf), Su
0
1000
2000
3000
4000
5000
Field Vertical Effective Stress, σv' (psf)
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
13,000
CU Triaxial
Design
Su/σv' = 0.39
Su,min = 1,000 psf


ALLUVIAL UNDRAINED SHEAR STRENGTH CHARACTERIZATION
Undrained Shear Strength (psf), Su
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
Field Vertical Effective Stress, σv' (psf)
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
13,000
14,000
15,000
UU Triaxial
CU Triaxial
Design
Su/σv' = 0.50
Su,min = 1,000 psf