Safety Factor Assessment
Periodic 5-year review

30 TAC 352.731 (40 CFR 257.73e)

Bottom Ash Storage Pond

Welsh Plant
Pittsburg, Texas

October, 2021

Prepared for: Southwest Electric Power Company (SWEPCO) – Welsh Plant

Pittsburg, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

GERS-21-048

SAFETY FACTOR ASSESSMENT
PERIODIC 5-YEAR REVIEW
CFR 257.73(e)
WELSH PLANT
BOTTOM ASH STORAGE POND

PREPARED BY Brett A. Dreger DATE 10/1/2021
Brett A. Dreger, P.E.

REVIEWED BY M. A. Ajlouni DATE 10/1/2021
Mohammad A. Ajlouni, P.E.

APPROVED BY Gary F. Zych DATE 10/4/2021
Gary F. Zych, P.E.
Section Manager – AEP Geotechnical Engineering

Gary F. Zych
STATE OF TEXAS
GARY F. ZYCH
127152
LICENSED
PROFESSIONAL ENGINEER
10/4/2021

I certify to the best of my knowledge, information, and belief that the information contained in this safety factor assessment meets the requirements of 40 CFR § 257.73(e)

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1.0 OBJECTIVE

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of 30 TAC 352.731 (40 CFR 257.73(e)) for the safety factor assessment of CCR surface impoundments. This is the first periodic 5-year review of the safety factor assessment.

2.0 DESCRIPTION OF THE CCR UNIT

The AEP J. Robert Welsh Plant is located in southern Titus County, approximately 8 miles northeast of Pittsburg, Texas, and approximately two miles northwest of Cason, Texas. The facility operates two surface impoundments for storing CCR materials called the Primary Bottom Ash Pond and the Bottom Ash Storage Pond. This report addresses the Bottom Ash Storage Pond. The Bottom Ash Storage Pond CCR unit is located at the south end of the Plant and approximately 1,000 feet west of the Welsh Reservoir.

The Bottom Ash Storage Pond embankments are approximately 20 feet in height and are constructed on a 3:1 slope (3 feet horizontal, 1 foot vertical). The elevation at the base of the embankment is approximately 340 feet above msl, and the elevation at the top of the embankment around the perimeter of the Bottom Ash Storage Pond is approximately 360 feet above msl. As of April 11, 2021, the plant has ceased all sluicing operations and all surface water run-on to the Bottom Ash Storage Pond area. Currently, the plant has initiated closure by removal for the Bottom Ash Storage Pond.

3.0 SAFETY FACTOR ASSESSMENT 257.73(e)

The periodic 5-year review was conducted to evaluate if any physical changes have been made to the earthen dike and/or operating changes that could impact the loading on the structure. The assumptions, material properties and operating pools defined in the initial assessment were reviewed. The review concluded that there have been no changes that would impact the stability analyses that were previously conducted. Therefore, the previous report and analyses are still applicable to the current conditions of the facility. The results indicate that the calculated factors of safety meet or exceed the minimum values defined in Section 257.73(e).

ATTACHMENT A

Initial Safety Factor Assessment – Bottom Ash Pond

Initial Safety Factor Assessment – Bottom Ash Pond
Welsh Power Plant
Pittsburg, Texas

Auckland Project No. 2016-007
August 30, 2016

Prepared For:

American Electric Power Company
1 Riverside Plaza
Columbus, Ohio 43215

Prepared By:

Auckland Consulting, LLC
Jacksonville, Texas

TBPE Firm Registration No. F-16721
Expires 2/29/2017

Table of Contents

1.0 Introduction and Embankment Information

1.1 Introduction

The following report and evaluation provides the Initial Safety Factor Assessment of the Bottom Ash Pond, an existing CCR impoundment (as defined by 40 CFR §257.2) located at the Welsh Power Plant near Pittsburg, Texas. In accordance with 40 CFR §257.73(e)(1)(i) through (iv) this initial assessment provides field and laboratory data, model outputs (detailing multiple stability conditions) and summary of safety factors for the Bottom Ash Pond. In accordance with 40 CFR §257.73(e)(2) this report provides the Initial Safety Factor Assessment certification for the Bottom Ash Pond.

1.2 Referenced Information and Data

The impoundment pool elevation data cited herein were provided in a separate hydrology and hydraulic (H&H) analysis report completed by Freese and Nichols titled *Hydraulic Analysis of Welsh Power Plant Ash Ponds* dated December 29, 2010 (not included herein). The referenced report generally meets the demonstration requirements of 40 CFR §257.82(a).

Embankment profile dimensions and elevations were determined by using existing information provided by the client. This information is included in the Appendix of this report.

1.3 Embankment Evaluation Criteria

Based on information provided and collected, the existing embankment is primarily lean clay (CL) with existing side slopes (both up- and downstream) of approximately 3:1 (H:V), maximum embankment height of approximately 34 feet (downstream) and top of dam elevation of 360.0 feet MSL. The downstream slope of the embankment is constructed with a 12-foot wide bench (vertical position on the slope varies along the embankment) that supports a 30-inch HDPE decant pipe. To account for the potential loading of the decant pipe, a surcharge load of 150 psf was applied to the bench. The crest width of the embankment is approximately 12 feet. The impoundment's storage area (side slopes and bottom) is lined with a 60-mil HDPE liner. The critical section for the embankment was determined to occur in the vicinity of Boring No. 4, as depicted on the Plan of Borings.

It is our understanding that the maximum storage elevation of impounded CCR material is 355.0 feet (MSL); however, the facility is managed to maintain an ash level less than this maximum level. The downstream toe of the Bottom Ash Pond is not adjacent to other water bodies that may inundate the downstream slope (or toe) and therefore not subject to 40 CFR §257.73(d)(1)(A)(3)(vii).

In accordance with 40 CFR §257.73(e)(1)(i) and (ii), the maximum storage pool elevation for the Bottom Ash Pond as determined by the 25-year, 24-hour storm event is 355.62 feet (MSL). For the purposes of this evaluation, the maximum storage pool elevation of 356.0 feet (MSL) was utilized. Likewise, the maximum (or flood) surcharge loading elevation as determined by the 100-year, 24-hour event is 355.76 feet (MSL), for this evaluation a maximum surcharge loading elevation of 356.0 feet (MSL) was utilized. Storage pool elevations were determined in accordance with 40 CFR §257.82(a).

2.0 Field and Laboratory Testing

2.1 Field Activities

The subsurface exploration of the embankment consisted of advancing a total of seven (7) borings located in potentially critical areas of the embankment. Four (4) borings (Boring Nos. 2 through 5) were completed along the embankment crest with termination depths ranging from approximately 40 to 50 feet. Three (3) borings (Boring Nos. 6 through 8) were completed along the embankment toe and were advanced to termination depths of approximately 40 feet. Boring No. 1 was not accessible by drilling equipment and therefore not completed. Borings were located in the field as shown on the Plan of Borings included in the Appendix of this report.

Drilling Methods. Field operations were performed in general accordance with ASTM procedures or similar accepted practices. Soil borings were drilled using a track mounted Geoprobe drilling rig equipped with a rotary head and continuous augers. The use of mud rotary or rotary wash was not necessary.

Soil Sampling. Sample intervals were semi-continuous in the upper 10 feet of each boring and five (5) foot intervals thereafter, unless otherwise directed by the onsite engineer. Split-spoon (Standard Penetration Test, SPT) or disturbed samples were collected in general accordance with ASTM Standard Method D 1586. Relatively undisturbed soil samples were collected in general accordance with ASTM D 1587 and extruded in the field and sealed in plastic to protect against moisture loss. Soil shear strengths were determined by using a calibrated hand penetrometer on undisturbed samples.

The collected samples were subsequently examined and selected for laboratory testing by a geotechnical engineer.

Boring Logs. The general subsurface soil and groundwater conditions encountered during field activities are presented on boring logs attached in the Appendix of this report. Information on the boring logs includes groundwater levels, laboratory test data, penetration resistance and soil classifications based on the Unified Soil Classification System (USCS).

Groundwater Level Measurements. Groundwater level observations completed during field activities are noted on the boring logs attached in the Appendix of this report.

2.2 Laboratory Testing Program

Laboratory testing was conducted on selected samples to assist in the classification of the soils encountered and to evaluate the physical and engineering properties of subsurface soils. Laboratory test results are presented on the boring logs included in the Appendix. Laboratory tests were performed in general accordance with ASTM procedures cited in the table below.

Laboratory Test	Test Designation
Atterberg Liquid Limit and Plastic Limit Determination	ASTM D 4318
Percentage Soil Passing No. 200 Sieve	ASTM D 1140
Moisture Content Determination	ASTM D 2216
Particle Size Analysis of Soils	ASTM D 422
Unconsolidated Undrained (UU) Triaxial Compression	ASTM D 2850
Hydraulic Conductivity	ASTM D 5084
Consolidated Undrained (CU) Triaxial Compression	ASTM D 4767
Direct Shear of Soils Under Consolidated Drain Conditions	ASTM D 3080

Soil samples not utilized in laboratory testing will be retained for approximately 30 days from the report issuance date and then disposed, unless specifically requested in writing from the client.

3.0 Slope Stability Analyses

3.1 General

Soil parameters used for stability analyses of the existing embankment are based on findings of the completed laboratory and field testing programs and previous assessments completed as the Welsh Power Plant. The probable failure planes were analyzed using the analytical slope stability software, SLIDE by Rocscience, Inc. Methods of evaluation used in SLIDE are considered to be limited equilibrium methods of analysis, where each individual shear plane is evaluated to determine the resulting shear stress at the point of failure. For the purposes of this evaluation the Bishop Method of analysis, which analyzes circular failure planes through the slope was utilized.

Per 40 CFR §257.73(e)(1)(i) through (iii), three (3) modeled scenarios (presented below) were utilized to evaluate the stability of the existing embankment: steady state seepage (long term) condition under maximum storage pool, steady state seepage (long term) condition under maximum surcharge pool, and steady state seepage condition with seismic loading under maximum storage pool conditions. The following minimum factors of safety (FS) and soil stress parameters were utilized in modeling. Minimum factors of safety are based on demonstration requirements provided in 40 CFR §257.73(e)(1).

Summary of Embankment Condition and Factor of Safety		
Embankment Condition	**Soil Parameters**	**Minimum Factor of Safety**
Steady State Seepage – Maximum Pool	Effective Stress	1.50
Steady State Seepage – Surcharge Pool	Effective Stress	1.40
Steady State Seepage (Seismic) – Maximum Pool	Total Stress	1.00
NOTE: Minimum factors of safety based on demonstration requirements provided in 40 CFR §257.82 (e)(1).		

For evaluation of steady state seepage (long term) conditions with seismic, peak ground acceleration for this location was obtained from the USGS National Seismic Hazard Mapping Project (http://earthquake.usgs.gov/hazards). Based on the seismic survey data, the anticipated site specific peak ground acceleration (PGA) of 0.06g (acceleration at rock sites) for two (2) percent probability of exceedance in 50 years (40 CFR Part 257, Preamble page 21384). Correcting for acceleration at soft soil sites (Seismic Site Classification D) yields an estimated PGA of 0.13g. The seismic coefficient (k) used for pseudo static analysis is determined by reducing the estimated PGA by 50% yielding a seismic coefficient of 0.065g.

3.2 Liquefaction Assessment

Liquefaction of soils occurs when horizontal shearing stresses exceed the strength of existing loose, saturated sand. This sudden loss of shear strength and subsequent soil structure is typically associated with earthquake-induced horizontal movement. Recent engineering publications[1] provide criteria to assess liquefaction potential of sands (little to no fines) and clayey soils of low plasticity (e.g. clayey sands, silts). These criteria indicate that water content of fine-grained or cohesive soils needs to be high (≥ 0.85 *Liquid Limit [LL]), a clay fine content (defined as grains smaller than 0.002 mm) of less than 10 percent (< 10%), and relatively low soil density (assessed in terms of SPT blow counts). In addition, the accepted minimum seismic threshold acceleration to cause liquefaction in loose sands is 0.10g, the anticipated site specific PGA for this site is 0.06g.

Native coarse grained (or sandy) material underlying the Bottom Ash Pond generally consist of medium dense to very dense silty sand (SM), clayey sand (SC) and silt (ML) and fine grained (or clayey) material consist of medium stiff to hard lean clay and fat clay (CL and CH) soils. Based on these soil characteristics and that the Bottom Ash Pond is located in

[1] Seed, R.B., et al, Recent Advances in Soil Liquefaction Engineering: A Unified and Consistent Framework, 26th Annual ASCE Los Angeles Spring Seminar, April 2003

a zone of low peak ground acceleration (PGA), the risk of either embankment or underlying soils liquefying are negligible [40 CFR §257.73(e)(1)(iv)].

3.3 Embankment and Foundation Stratigraphy

The models developed for this evaluation are based on the existing embankment geometry, results of field and laboratory testing and hydrologic site information provided by the client. Selection of the critical slope section was based on both height and subsurface sensitivity to loading. The following tables provide a summary of soil parameters used for these analyses. Specific soil parameters used for each model are presented in the Appendix.

Summary of Long Term, Total Stress Soil Parameters:			
Material Type	**Unit Weight (pcf)**	**Consolidated-Undrained Cohesion (psf)**	**Consolidated-Undrained Angle of Internal Friction (degrees)**
Embankment Fill	125	250	28
Silty, Clayey Sand (SM_SC)	120	225	20
Silty Sand (SM)	120	0	30
Native Fat and Lean Clay (CH_CL)	125	450	14
Ash	100	0	30
NOTE: Properties used for Steady State Seepage with Seismic analyses.			

Summary of Long Term, Effective Stress Soil Parameters			
Material Type	**Unit Weight (pcf)**	**Consolidated-Drained Cohesion (psf)**	**Consolidated-Drained Angle of Internal Friction (degrees)**
Embankment Fill	125	150	32
Silty, Clayey Sand (SM_SC)	120	0	34
Silty Sand (SM)	120	0	36
Native Fat and Lean Clay (CH_CL)	125	300	22
Ash	100	0	30
NOTE: Properties used for Steady State Seepage analyses. Consolidated-drained conditions determined based on pore pressure measurements made during Consolidated-Undrained (CU) triaxial testing.			

The HDPE liner was modeled at the interface of the slope and the ash pond, a nominal strength of 50 psf was assumed for the liner material.

3.4 Seepage Analysis Parameters

The observed groundwater levels while drilling through the embankment (approximate groundwater elevation of 30 to 34 feet, below the crest) correspond with those groundwater elevations encountered while drilling adjacent to the embankment toe (approximately groundwater elevation six [6] feet, below existing grade). No elevated groundwater seepage or groundwater levels were observed in boreholes completed in the embankment that would indicate a prolific and defined phreatic surface in the embankment.

Therefore, based on the available information it appears that the existing impermeable liner has precluded the development of a phreatic surface (internal groundwater elevation) within the embankment. Though the probability of a phreatic surface developing in the embankment is considered low, it is however possible, and therefore was modeled as part of the structural assessment.

The analysis of embankment seepage is based on laboratory results and estimated values for permeability for various embankment and native foundation soils. These soil parameters were utilized in the models to establish a long term steady state condition and corresponding phreatic surface in the embankment. Hydraulic conductivity test results are provided in the Appendix. Hydraulic conductivity properties utilized in the seepage analysis are provided in the below table.

Hydraulic Conductivity of Embankment Soils	
Material Type	**Permeability (ft/sec)**
Embankment Fill	1×10^{-8}
Silty, Clayey Sand (SM_SC)	1×10^{-5}
Silty Sand (SM)	1×10^{-5}
Native Fat and Lean Clay (CH_CL)	1×10^{-8}
Ash	1×10^{-4}

The HDPE liner is assumed to be impermeable; therefore a very low permeability value of $1\text{x}10^{-20}$ ft/sec was utilized.

3.5 Stability Analysis Results

The following table provides the results of the stability analysis for each of the conditions cited herein, as required by 40 CFR §257.73(e)(1)(i) through (iii). The graphical representations of each analysis are included in the Appendix.

Summary of Stability Analyses – Safety Factors		
Modeled Condition	Factor of Safety	
	Actual	Minimum
Steady State Seepage – Maximum Pool	2.60	1.50
Steady State Seepage – Surcharge Pool	2.60	1.40
Steady State Seepage with Seismic – Maximum Pool	1.60	1.00

Summary of Stability Analyses– Safety Factors (Potential Phreatic Surface)		
Modeled Condition	Factor of Safety	
	Actual	Minimum
Steady State Seepage – Maximum Pool	1.78	1.50
Steady State Seepage – Surcharge Pool	1.78	1.40
Steady State Seepage with Seismic – Maximum Pool	1.31	1.00

Based on the findings of this analysis, the evaluated embankment appears to be stable under both modeled conditions (existing conditions and potential phreatic surface) and demonstrate the minimum safety factors, as required by 40 CFR §257.73(e)(1)(i) through (iii).

4.0 Report Limitations

This report has been prepared for the exclusive use of our client for the specific application to the project discussed and has been prepared in accordance with the generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. The analyses contained in the report are based on the data obtained from the soil borings performed within the project site. This report does not reflect variations that may occur between borings or across the site. Soil borings do not necessarily reflect strata variations that may exist at other locations within the project site.

5.0 Initial Structural Stability Assessment Certification

By means of this certification, (i) I have reviewed the requirements of 40 CFR §257.73(e)(1) – *Periodic Safety Factor Assessments*, (ii) I or my agent has visited and examined the facility, (iii) the referenced data used in this evaluation to the best of my knowledge appears correct and appropriate for use, (iv) and this Initial Safety Factor Assessment for the Bottom Ash Pond (Welsh Power Plant) has been prepared to the best of my knowledge in accordance with §257.73(e)(1).

By: ______________________

Dated: August 30, 2016

TBPE Firm Registration No. F-16721
Expires 2/28/2017

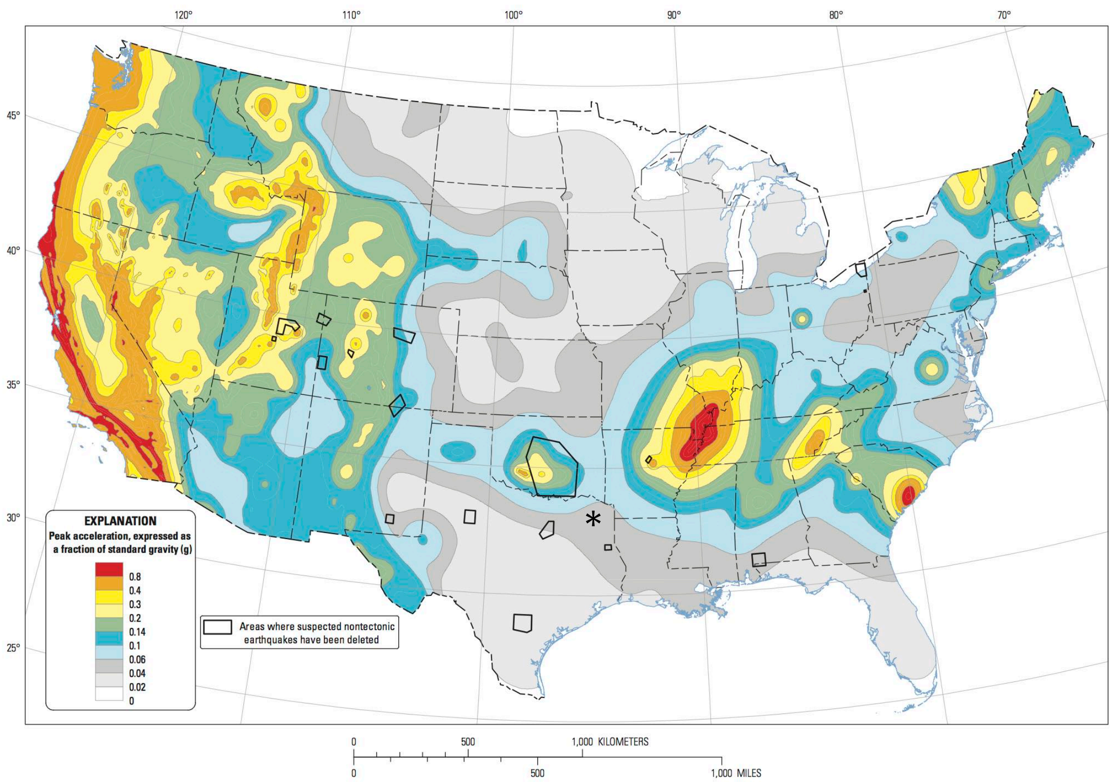
Appendix

Stability Analyses
Reference Data

Aerial image provided by Google Earth.

Soil Boring Location Plan

Scale: N/A	**Welsh Power Plant** **Initial Safety Factor Assessment - Bottom Ash Pond** **Pittsburg, Texas**
Auckland Project No. 2016-007	



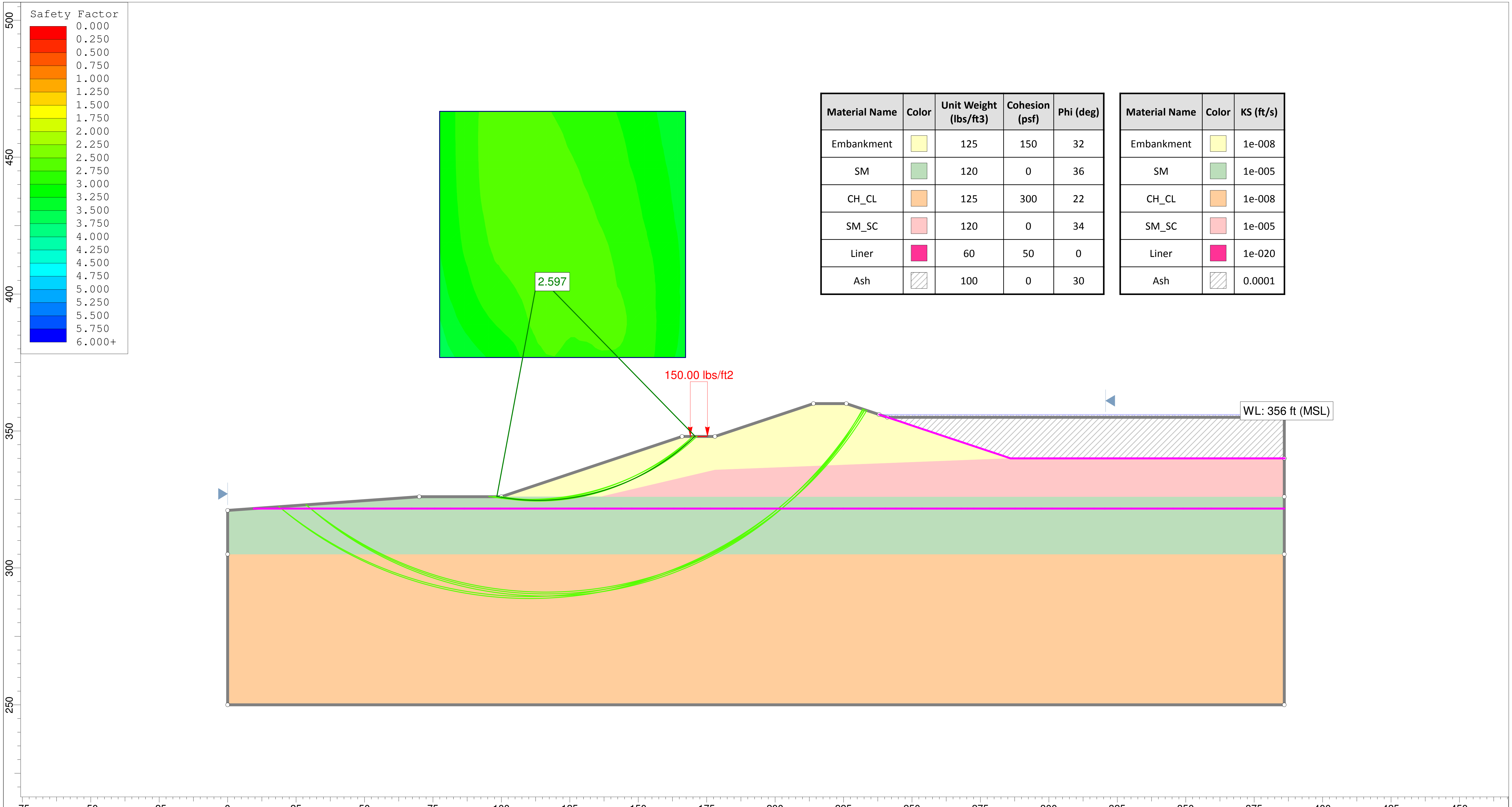
Two-percent probability of exceedance in 50 years map of peak ground acceleration

* Approximate location of Welsh Power Plant

Provided by USGS National Seismic Hazard Mapping Project.

Seismic Probability Map

Scale: N/A	**Welsh Power Plant** **Initial Safety Factor Assessment - Bottom Ash Pond** **Pittsburg, Texas**
Auckland Project No. 2016-007	



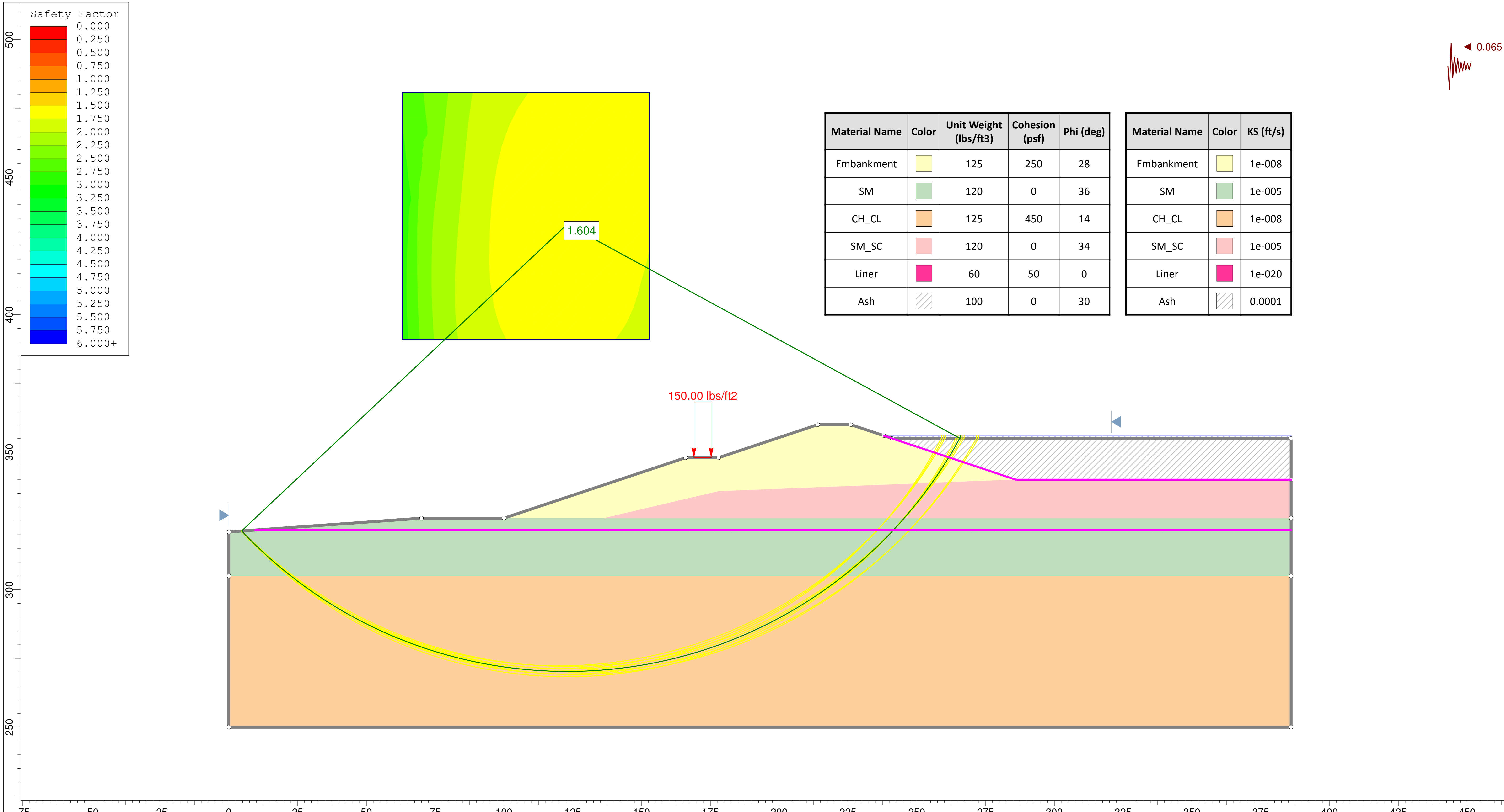
Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Embankment		125	150	32
SM		120	0	36
CH_CL		125	300	22
SM_SC		120	0	34
Liner		60	50	0
Ash		100	0	30

Material Name	Color	KS (ft/s)
Embankment		1e-008
SM		1e-005
CH_CL		1e-008
SM_SC		1e-005
Liner		1e-020
Ash		0.0001

Auckland Consulting LLC

SLIDEINTERPRET 6.036

Project	Welsh Power Station - Bottom Ash Pond
Analysis Description	Steady State Seepage at Maximum and Surcharge Pool
Drawn By	JJT
Company	Auckland
Date	7/11/2016, 3:30:13 PM
File Name	Winston_SS.slim



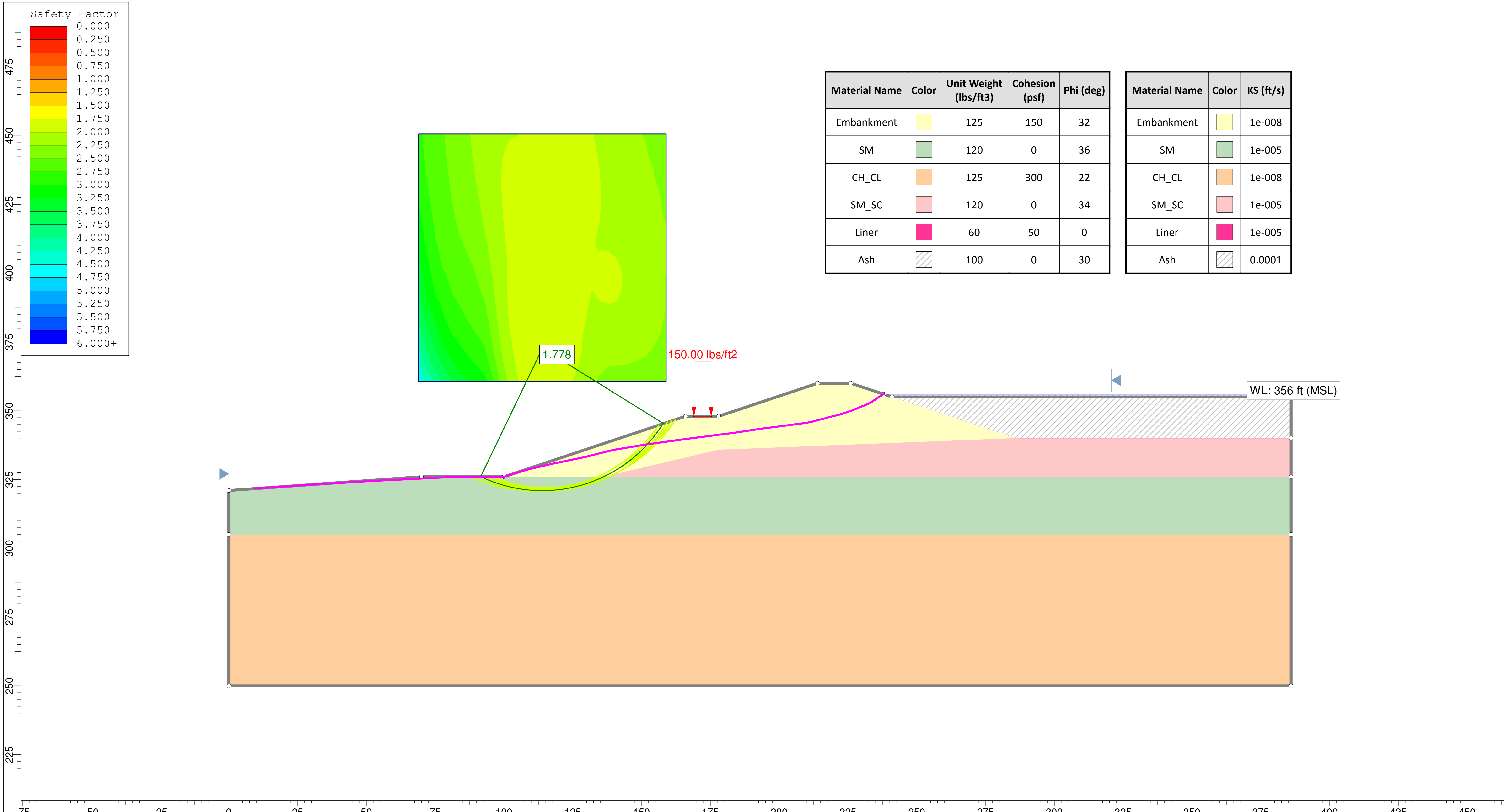
Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Embankment		125	250	28
SM		120	0	36
CH_CL		125	450	14
SM_SC		120	0	34
Liner		60	50	0
Ash		100	0	30

Material Name	Color	KS (ft/s)
Embankment		1e-008
SM		1e-005
CH_CL		1e-008
SM_SC		1e-005
Liner		1e-020
Ash		0.0001

Auckland Consulting LLC

SLIDEINTERPRET 6.036

Project	Welsh Power Station - Bottom Ash Pond
Analysis Description	Steady State Seepage at Maximum and Surcharge Pool, Seismic Analysis
Drawn By	JJT
Company	Auckland
Date	7/11/2016, 3:30:13 PM
File Name	Winston_SSS.slim



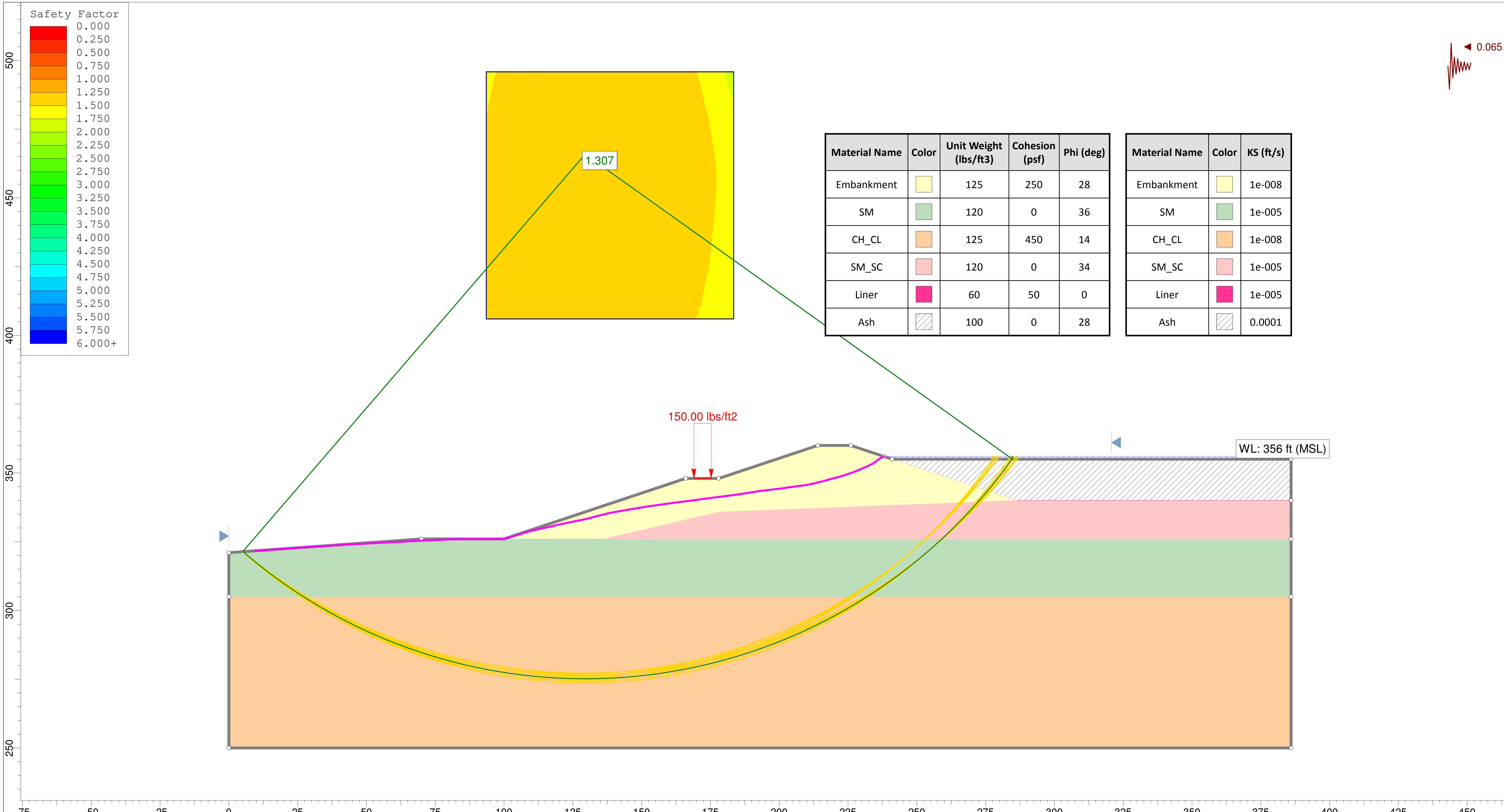
Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Embankment		125	150	32
SM		120	0	36
CH_CL		125	300	22
SM_SC		120	0	34
Liner		60	50	0
Ash		100	0	30

Material Name	Color	KS (ft/s)
Embankment		1e-008
SM		1e-005
CH_CL		1e-008
SM_SC		1e-005
Liner		1e-005
Ash		0.0001

Auckland Consulting LLC

SLIDEINTERPRET 6.036

Project	Welsh Power Station - Bottom Ash Pond
Analysis Description	Steady State Seepage at Maximum and Surcharge Pool (assumed phreatic surface)
Drawn By	JJT
Company	Auckland
Date	7/11/2016, 3:30:13 PM
File Name	Winston_SS_L.slim



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Embankment		125	250	28
SM		120	0	36
CH_CL		125	450	14
SM_SC		120	0	34
Liner		60	50	0
Ash		100	0	28

Material Name	Color	KS (ft/s)
Embankment		1e-008
SM		1e-005
CH_CL		1e-008
SM_SC		1e-005
Liner		1e-005
Ash		0.0001

Auckland Consulting LLC

SLIDEINTERPRET 6.036

Project	Welsh Power Station - Bottom Ash Pond		
Analysis Description	Steady State Seepage at Maximum and Surcharge Pool, Seismic Analysis (assumed phreatic surface)		
Drawn By	JJT	*Company*	Auckland
Date	7/11/2016, 3:30:13 PM	*File Name*	Winston_SSS_L.slim

Auckland Consulting LLC

LOG OF BORING B2

Project Name: Winston Pond Stability Assessment
Project Location: Pittsburg, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-007
Drill Date(s): 05/19/2016

GPS Coordinates: N33° 02' 38.1" W94° 50' 42.3"
Surface Elevation: 360 ft, MSL
Drilling Method: Dry Auger

Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Very Stiff, light gray, red and tan, Sandy Lean Clay (CL), mottled, interbedded sand seams		4.0		57	23	35	18	17	
- medium stiff, mottled	8								
Stiff, tan with gray and red, Sandy Lean Clay (CL), mottled		N/A							
	14			64	23	34	22	12	
- very stiff, between 11 to 18 ft		3.0	2.5	61	16	36	17	19	114
	15								
- hard, between 18 to 20 ft		4.5+							114
- stiff, below 20 ft	15			66	18	38	19	19	
Medium Dense, light gray with tan, Silt with Sand (ML), with few clay		N/A							
	19			73	17				
- medium stiff									
	40								
Hard, light gray with tan, Lean Clay (CL), interbedded sand seams									
Very Stiff, light gray with tan, Fat Clay (CH), interbedded sand seams		3.0		98	30	63	31	32	92
	18								
- dark gray, tan and red, with sand inclusions and ferrous partings below 38 ft		3.0							
Boring terminated at 40 feet.									

Additional Information/Comments:

Logger: R. Pierson

Notes/Comments: Seepage encountered at 30 ft during drilling. Water level at 30 feet upon completion. Boring caved to 32 feet. N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B3

Project Name: Winston Pond Stability Assessment
Project Location: Pittsburg, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-007
Drill Date(s): 05/18/2016

GPS Coordinates: N33° 02' 39.2" W94° 50' 38.1"
Surface Elevation: 360 ft, MSL
Drilling Method: Dry Auger

Groundwater Elevation (ft)	Depth (feet)	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
	0	Stiff, red, tan and gray, Sandy Lean Clay (CL), mottled	9								
				3.0		59	17	33	16	17	113
	5	- with interbedded sand seams	13								
				1.5		67	18	39	21	18	111
	10	- very stiff, tan, gray with red below 10 ft	18								
			16								
	15	Very Stiff, red, brown, tan with gray, Lean Clay with Sand (CL), mottled, with interbedded sand seams		4.0	2.2	71	18	42	20	22	109
	20	- clay with silt and organics (wood debris) at 18 ft	26			61	13				
			30			70	19				
	25	Medium Dense, gray, Sandy Silt (ML), few organics (wood debris), few clay inclusions									
Seepage (30 ft)	30	Very Stiff, tan, red and gray, Sandy Lean Clay (CL), mottled with silt		N/A		52	12	29	21	8	
			16								
Water level (33 ft)		Medium Dense, light gray and red, Sandy Silt (ML), mottled, few clay inclusions	19			91	29	36	24	12	
	35	Very Stiff, tan, orange and red, Lean Clay (CL), mottled, laminated		N/A							
	40	Light gray, tan and red, Sandy Silt (ML), mottled, few clay inclusions	35			70	24				
		Hard, tan, gray with orange, Sandy Lean Clay (CL) with trace silt, mottled, laminated	34								
	45	Very Stiff, gray, Fat Clay (CH), laminated	29			98	27	53	25	28	
	50	Boring terminated at 50 feet.									
	55										

Additional Information/Comments:

Logger: R. Pierson

Notes/Comments: Seepage encountered at 30 ft during drilling. Water level at 33 feet upon completion. Boring caved to 40 feet. N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B4

Project Name: Winston Pond Stability Assessment
Project Location: Pittsburg, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-007
Drill Date(s): 06/08/2016

GPS Coordinates: N33° 02' 43.1" W94° 50' 37.1"
Surface Elevation: 360 ft, MSL
Drilling Method: Dry Auger

Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Stiff, red, brown with gray, Sandy Lean Clay (CL), mottled	9			63	14	38	18	20	
Medium Dense, light gray, red and brown, Clayey Sand (SC), mottled, laminated		3.5		44	19	42	25	17	109
	15								
Very Stiff, light gray, tan and brown, Sandy Lean Clay (CL), mottled, slickensided		3.5		66	16	33	20	13	
	12								
- stiff, light gray, red and tan, with silt and sand seams below 10 ft	13			62	18				
Medium Dense, light gray and brown, Sandy Silt (ML), mottled, few clay inclusions									
Very Stiff, brown, gray and red, Sandy Lean Clay (CL), mottled		3.0		55	17	38	20	18	
	18								
	10								
- stiff below 23 ft									
Dense, brown, light gray and red, Silty Sand (SM)		N/A		43	16	NP	NP	NP	
	37								
- brown with red, some clay between 30 to 33 ft	46			30	30	NP	NP	NP	
- very dense, light gray with tan below 33 ft									
		N/A							116
	48								
	48								
		N/A		26	19	NP	NP	NP	
Boring terminated at 50 feet.									

Additional Information/Comments:

Logger: R. Pierson

Notes/Comments: Seepage encountered at 32 ft during drilling. Water level at 32 feet upon completion. Boring caved to 40 feet. N/A: Not Attempted

LOG OF BORING B5

Auckland Consulting LLC

Project Name: Winston Pond Stability Assessment
Project Location: Pittsburg, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-007
Drill Date(s): 06/08/2016

GPS Coordinates: N33° 02' 45.0" W94° 50' 33.4"
Surface Elevation: 360 ft, MSL
Drilling Method: Dry Auger

Groundwater Elevation (ft)	Depth (feet)	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
	0	Stiff, red, gray and brown, Sandy Lean Clay (CL), mottled		2.0		54	20	40	18	22	
			11								
	5	- very stiff with sand lenses below 5 ft		2.5		60	17	44	20	24	119
		Very Stiff, light gray and brown, Lean Clay with Sand (CL), mottled	16								
	10										
		- stiff with sand and organics (root and wood debris) below 13 ft		2.0		79	18	35	17	18	110
	15		23			62	12	30	16	14	
		Very Stiff, light brown with gray, Sandy Lean Clay (CL), with few organics (root debris)	6								
	20	- medium stiff, silt with sand below 18 ft									
		Medium Dense, light brown, tan with gray, Silty Clayey Sand (SC-SM), mottled, with organics (root debris) between 23 to 25 ft		N/A		47	10	31	23	8	
	25		26								
		- very dense below 28 ft	34			44	20				
	30										
▼ (33 ft)		Very Dense, light gray with tan, Silt (ML)		N/A		91	27	NP	NP	NP	96
	35	- sandy silt below 35 ft	68								
		Very Dense, light gray with tan, Silty Sand (SM)	96			21	28				
	40	Boring terminated at 40 feet.									
	45										

Additional Information/Comments:

Logger: R. Pierson

Notes/Comments: Seepage encountered at 33 ft during drilling. Water level at 33 feet upon completion. Boring caved to 38 feet. N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B6

Project Name: Winston Pond Stability Assessment
Project Location: Pittsburg, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-007
Drill Date(s): 05/17/2016

GPS Coordinates: N33° 02' 43.0" W94° 50' 34.1"
Surface Elevation: 332 ft, MSL (approx)
Drilling Method: Dry Auger

Depth (feet)	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
0	Medium Dense, red, tan and brown, Silt with Sand (ML), mottled	16								
	- with gray	23			73	19	NP	NP	NP	
5	Medium Dense, tan, gray and brown, Silty Sand (SM), mottled		N/A							
	- tan and gray below 8 ft	24			45	26	NP	NP	NP	
10										
	- very dense between 13 and 30 ft	57								
15										
		51			47	27				
20										
	- few clay inclusions below 23 ft	73								
25										
			N/A		36	29	NP	NP	NP	122
30	- dense with few clay inclusions between 30 and 33 ft	34								
	- very dense below 33 ft	79								
35										
	Medium Dense, dark gray, tan and red, Clayey Sand (SC), few silt, trace gypsum	27			39	25	47	21	26	
40	Boring terminated at 40 feet.									
45										

Additional Information/Comments:

Logger: R. Pierson

Notes/Comments: Seepage encountered at 8 ft during drilling. Water level at 6 feet upon completion. Boring caved to 15 feet. N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B7

Project Name: Winston Pond Stability Assessment
Project Location: Pittsburg, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-007
Drill Date(s): 05/17/2016

GPS Coordinates: N33° 02' 40.8" W94° 50' 36.5"
Surface Elevation: 328 ft, MSL (approx)
Drilling Method: Dry Auger

Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Loose, red, brown and tan, Clayey Sand (SC), few organics	8								
- medium dense, gray and tan below 3 ft	26			40	22				
Dense, tan, gray and red, Silty Sand (SM)	32			31	24	NP	NP	NP	
	47								
- light gray with tan, with few clay inclusions between 13 and 18 ft		N/A		31	26	NP	NP	NP	100
- medium dense below 18 ft	30								
Medium Stiff, tan, orange and brown, Fat Clay (CH), laminated with gypsum	5			92	31	55	22	33	
		N/A							
- very stiff below 30 ft	29								
Hard, dark gray and gray, Lean Clay with Sand (CL), laminated with gypsum	57			73	23	33	18	15	
	36								
Boring terminated at 40 feet.									

Additional Information/Comments:

Logger: R. Pierson

Notes/Comments: Seepage encountered at 7 ft during drilling. Water level at 6 feet upon completion. Boring caved to 35 feet. N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B8

Project Name: Winston Pond Stability Assessment
Project Location: Pittsburg, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-007
Drill Date(s): 05/18/2016

GPS Coordinates: N33° 02' 37.8" W94° 50' 38.0"
Surface Elevation: 338 ft, MSL (approx)
Drilling Method: Dry Auger

Depth (feet)	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
0	Stiff, gray, red and tan, Sandy Lean Clay (CL), mottled	12								
			4.5+	1.8	51	18	33	18	15	115
5	- very stiff between 5 and 8 ft	22								
	- stiff, gray and light brown, mottled with interbedded sand seams below 8 ft	11			57	23				
10										
	Stiff, light brown and gray, Fat Clay (CH), laminated, few ferrous partings	13								
15										
	- very stiff, dark gray with brown, gypsum below 18 ft	28			60	25	58	32	26	
20										
	- laminated with gypsum, interbedded sand seams below 23 ft		2.5							
25		22								
		30			88	19	63	32	31	
30										
	- hard below 33 ft	38								
35										
		34			85	29				
40	Boring terminated at 40 feet.									
45										

Additional Information/Comments:

Logger: R. Pierson

Notes/Comments: Seepage encountered at 8 ft during drilling. Water level at 16 feet upon completion. Boring caved to 26 feet. N/A: Not Attempted

Auckland Consulting LLC

Boring Log Terms and Symbols

Symbols and Sampler Types

■ Thin-walled Tube (Shelby Tube)

☒ Standard Penetration Test (SPT)

◩ Auger Sample

⧗ Texas Cone Penetration Test (TCP)

▼ Observed Static-Water Level

▽ Observed Free Water (Seepage)

Soil Consistency and Structure

Strength of Fine Grained Soils		
Consistency	**SPT (Blows/ft)**	**UCS (tsf)**
Very Soft	< 2	< 0.25
Soft	2 – 4	0.25 – 0.5
Medium Stiff	4 – 8	0.5 – 1.0
Stiff	8 – 15	1.0 – 2.0
Very Stiff	15 – 30	2.0 – 4.0
Hard	> 30	> 4.0

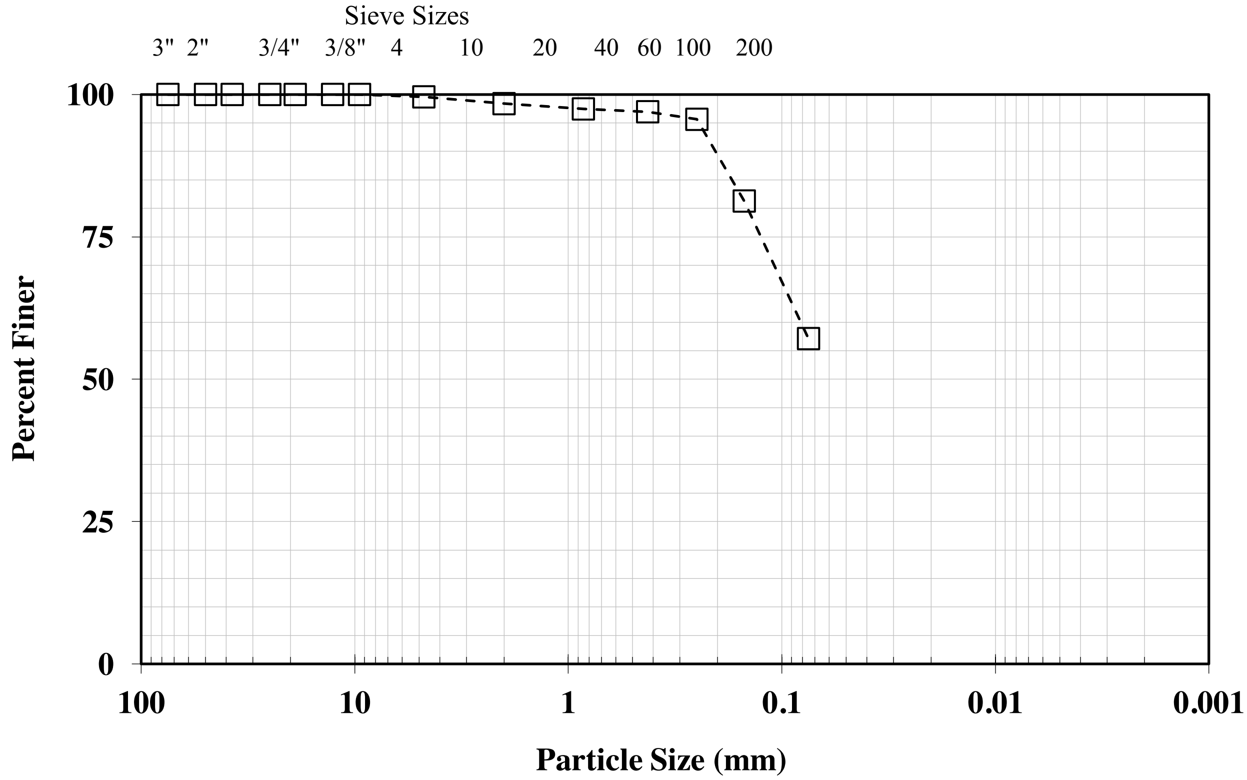
Density of Coarse Grained Soils		
Consistency	**SPT (Blows/ft)**	**TCP (Blows/ft)**
Very Loose	0 – 4	< 8
Loose	5 – 10	9 – 20
Medium Dense	11 – 30	21 – 60
Dense	31 – 50	61 -100
Very Dense	> 50	> 100

Soil Structure - Description	
Description	**Explanation**
Laminated	Alternating layers of varying material or color.
Slickensided	Fractured polished planes, little resistance to fracturing
Blocky	Cohesive soil that can be broken into small angular pieces.
Lensed	Inclusion of small pockets of different soils
Homogeneous	Same appearance and color throughout

Particle Size Analysis for Soils

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B2 1-3

TRI Log#: 20888.1
Test Method: ASTM D422



Sieve Analysis	
Sieve Size	Percent Passing
3 in. (76.2 mm)	100.0
2 in. (50.8 mm)	100.0
1.5 in. (38.1 mm)	100.0
1 in. (25.4 mm)	100.0
3/4 in. (19.0 mm)	100.0
1/2 in. (12.7 mm)	100.0
3/8 in. (9.51 mm)	100.0
No. 4 (4.76 mm)	99.6
No. 10 (2.00 mm)	98.4
No. 20 (0.841 mm)	97.5
No. 40 (0.420 mm)	97.0
No. 60 (0.250 mm)	95.6
No. 100 (0.149 mm)	81.3
No. 200 (0.074 mm)	57.1
Hydrometer Analysis	
Particle Size	Percent Passing
0.005 mm	- -
0.002 mm	- -

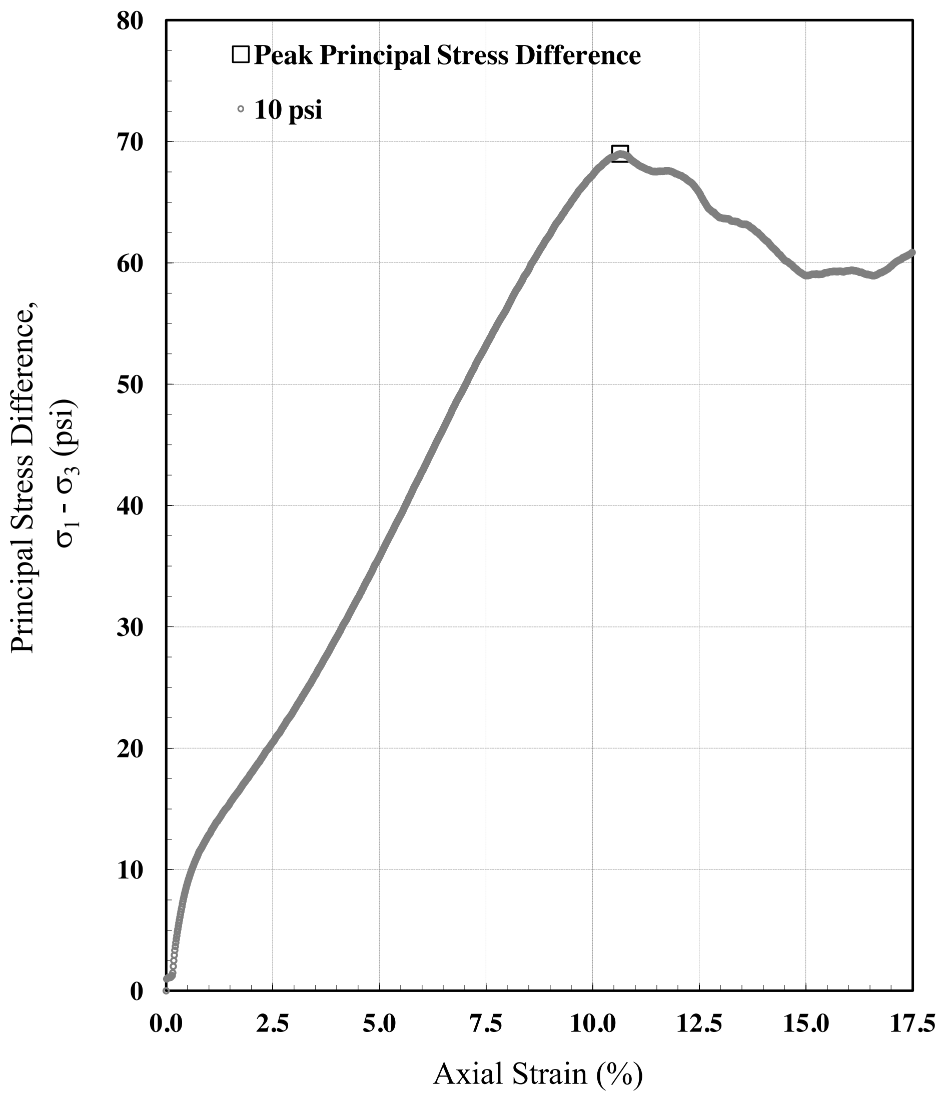
USCS Classification (ASTM D2487)	Sandy lean clay (CL)	
As-Received Moisture Content (%)	(ASTM D2216)	23.0
Atterberg Limits (ASTM D4318, Method A : Multipoint)	Liquid Limit	35
	Plastic Limit	18
	Plastic Index	17
Notes: Specimen was air dried.. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM D4373)	- -

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Quality Review/Date
Tested by: KH & PC

Unconsolidated-Undrained (Q) Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B2: 11-13

TRI Log #: 20888
Test Method: ASTM D2850



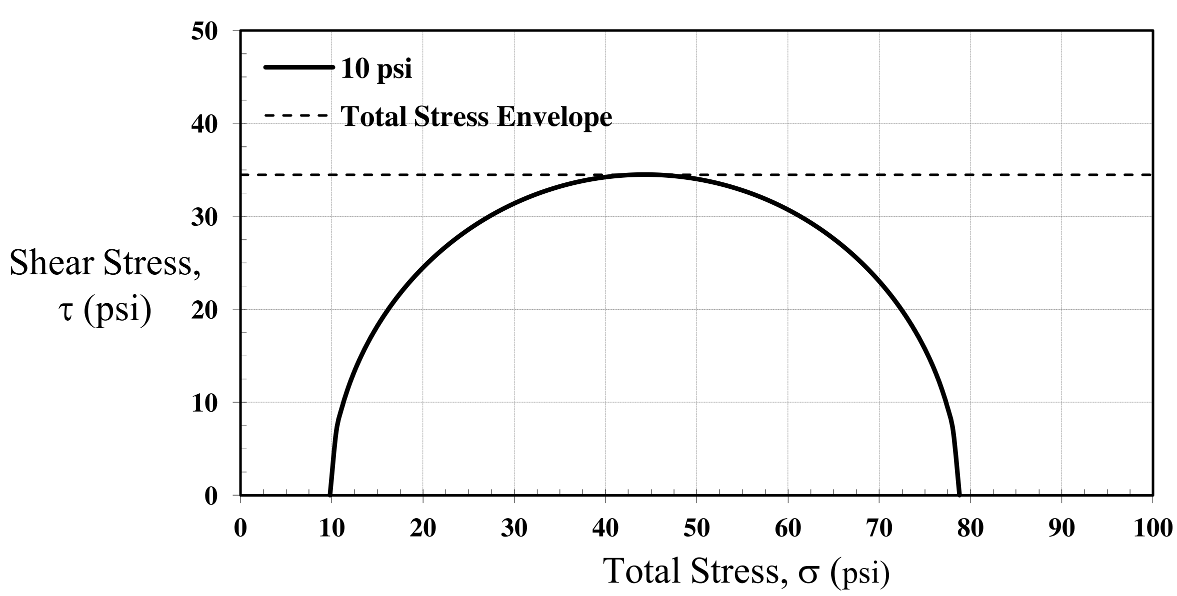
Test Parameters	
Minor Principal Stress (psi)	10.0
Rate of Strain (%/hr)	60

Initial Properties	
Avg. Diameter (in)	2.84
Avg. Height (in)	5.61
Avg. Water Content (%)	15.5
Bulk Density (pcf)	132.1
Dry Density (pcf)	114.4
Saturation (%)	92.0
Void Ratio	0.45
Specific Gravity (Assumed)	2.65

At Failure - Maximum Deviator Stress	
Axial Strain at Failure (%)	10.6
Minor Total Stress (psi)	10.0
Major Total Stress (psi)	79.0
Principal Stress Diff. (psi)	69.0

Total Stress Envelope	
Friction Angle (deg)	0
Undrained Shear Strength, S_u (psi)	34.5
S_u / σ_3	3.4

Note: The Mohr failure envelope was taken as a horizontal straight line. It should, however, be noted that the specimen was partially saturated.

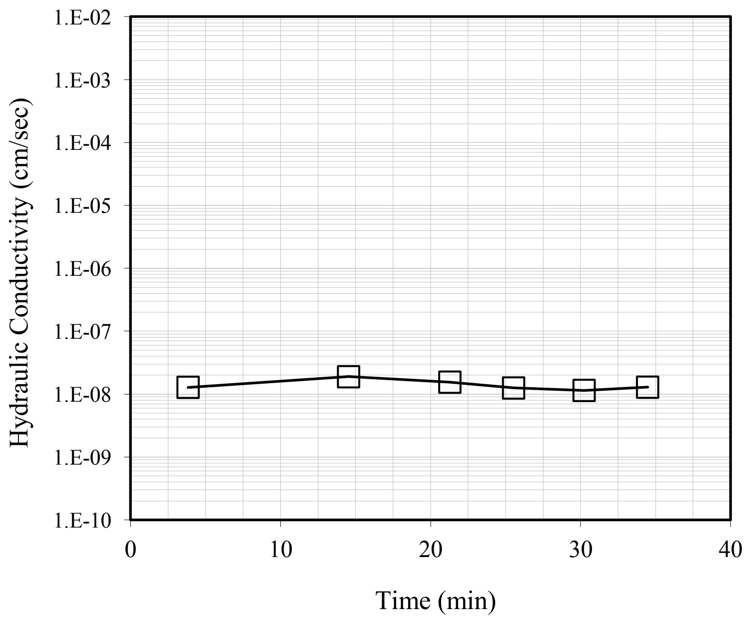


Jeffrey A. Kuhn , Ph.D., P.E., 6/30/2016
Analysis & Quality Review/Date
Laboratory Staff: LC

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

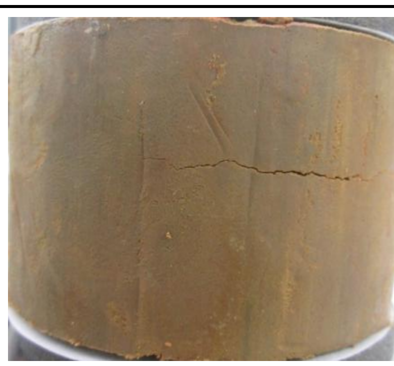
Hydraulic Conductivity

Client:	Auckland Consulting LLC	TRI Log #:	20888
Project:	Winston Pond	Test Method:	ASTM D5084 Method F
Sample ID:	B2: 18-20		



Initial Values	
Sample Condition	Undisturbed
Diameter (in)	2.82
Height (in)	1.81
Initial Mass (g)	389.6
Sample Area (in^2)	6.25
Water Content (%)	15.5
Total Unit Weight (pcf)	131.4
Dry Unit Weight (pcf)	113.8
Specific Gravity (Assumed)	2.65
Degree of Saturation	90.4
Void Ratio	0.45
Porosity	0.31
1 Pore Volume (cc)	57.7
Eff. Confining Stress (psi)	5.0
B-Value Prior to Permeation	0.96

Specimen Image



Time	Hydraulic Conductivity, K at 20° C
Min	cm/s
21.3	1.5E-08
25.5	1.3E-08
30.2	1.1E-08
34.5	1.3E-08
Average, Last 2 Readings	**1.2E-08**

Note: Permeation measurements were made with a mercury U-tube.

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Analysis & Quality Review/Date
Testing Performed By: SOC & LC

TRI Environmental, Inc.
9063 Bee Caves Rd. – Austin, TX 78733 – USA | Ph: 800.880.TEST or 512.263.2101

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B2: 33-35

TRI Log #: 20888
Test Method: ASTM D4767 Mod

Specimens			
Identification	-	-	-
Depth/Elev. (ft)	-	-	-
Eff. Consol. Stress (psi)	14.2	28.3	42.5
Initial Specimen Properties			
Avg. Diameter (in)	2.05	2.05	2.05
Avg. Height (in)	4.33	4.33	4.33
Avg. Water Content (%)	30.8	-	-
Bulk Density (pcf)	119.7	119.7	119.7
Dry Density (pcf)	91.5	-	-
Saturation (%)	98.8	-	-
Void Ratio, n	0.84	0.84	0.84
Specific Gravity (Assumed)	2.70		
Total Back-Pressure (psi)	79.7	80.0	80.2
B-Value, End of Saturation	0.96	-	-

Test Setup	
Specimen Condition	Undisturbed / Intact
Specimen Preparation	Trimmed
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear			
Void Ratio	0.82	0.82	0.82
Area (in^2)	3.28	3.28	3.28

Shear / Post-Shear			
Avg. Water Content (%)	-	-	29.7
Rate of Strain (%/hr)	0.25	0.25	0.25

At Failure						
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$			Ratio, $(\sigma_1'/\sigma_3')_{max}$		
Axial Strain at Failure (%), $\varepsilon_{a,f}$	-	-	-	1.0	1.5	1.9
Minor Effective Stress (psi), $\sigma_3'_f$	-	-	-	5.6	11.9	20.5
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	-	-	-	15.8	25.5	34.0
Pore Water Pressure, Δu_f (psi)	-	-	-	9.8	17.2	22.6
Major Effective Stress (psi), $\sigma_1'_f$	-	-	-	21.4	37.4	54.5
Effective Friction Angle (degrees)	-			22.1		
Effective Cohesion (psi)	-			3.3		

R-Envelope, "Total" Stress		
Friction Angle (deg)	-	14.3
Cohesion (psi)	-	2.3

Note: Multi-stage testing was performed for this sample. The first two stages were terminated in accordance with stress path tangency and/or peak principal stress ratio.

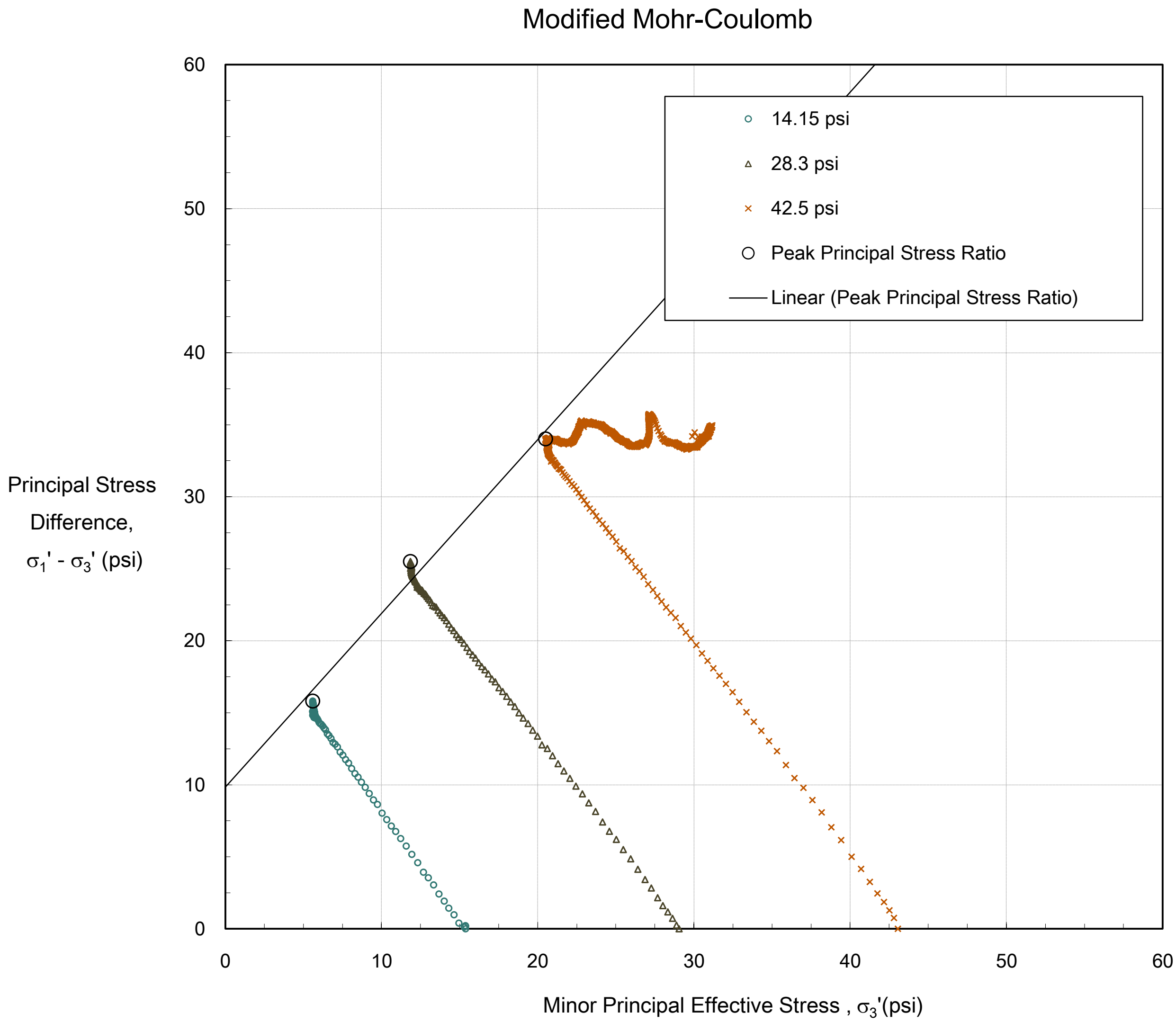
Jeffrey A. Kuhn , Ph.D., P.E., 7/12/2016
Analysis & Quality Review/Date
Laboratory Staff: SOC & LC

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B2: 33-35

TRI Log #: 20888
Test Method: ASTM D4767 Mod



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	22.1
Effective Cohesion (psi)	-	3.3

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC

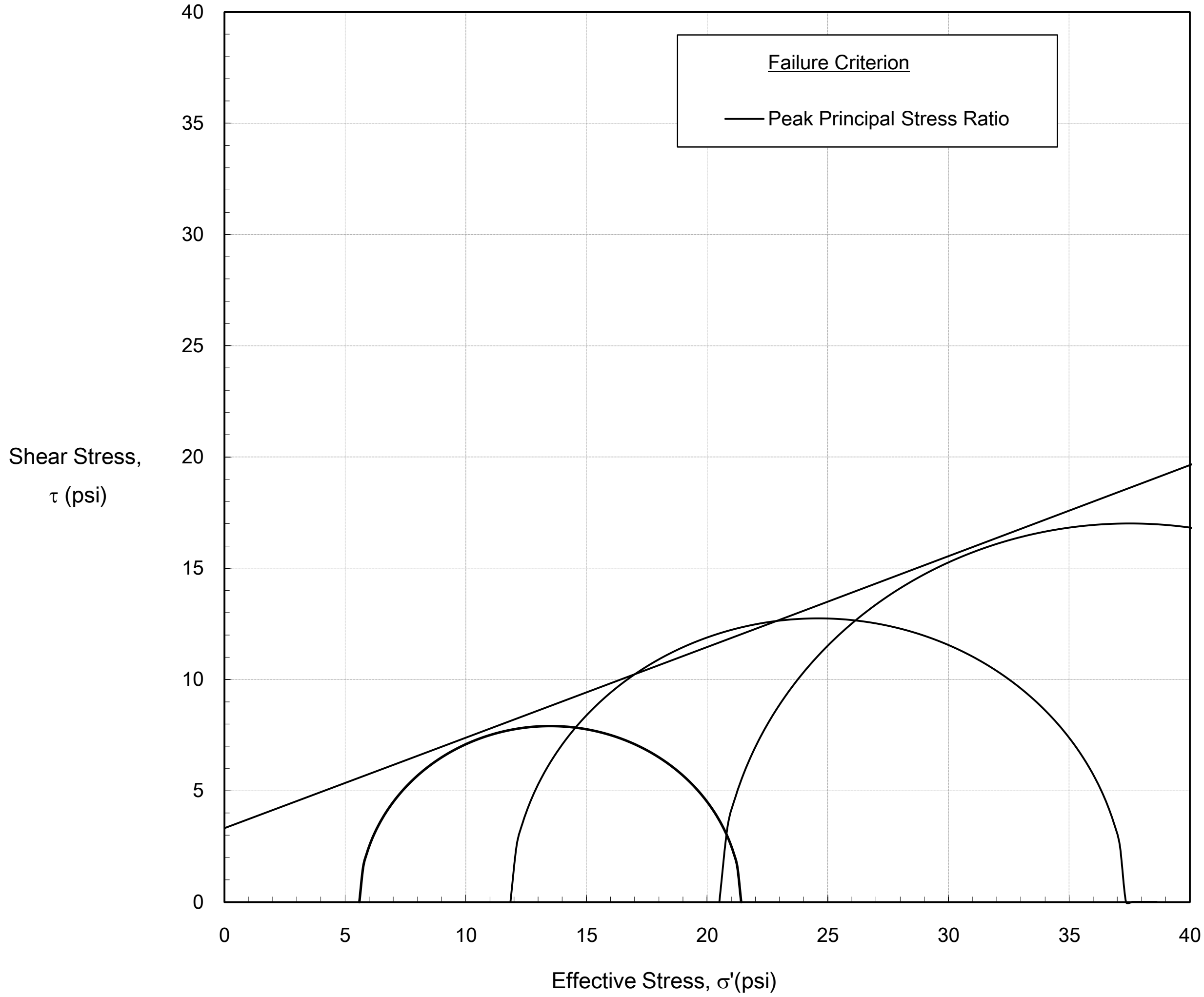
Project: Winston Pond

Sample: B2: 33-35

TRI Log #: 20888

Test Method: ASTM D4767 Mod

Mohr-Coulomb



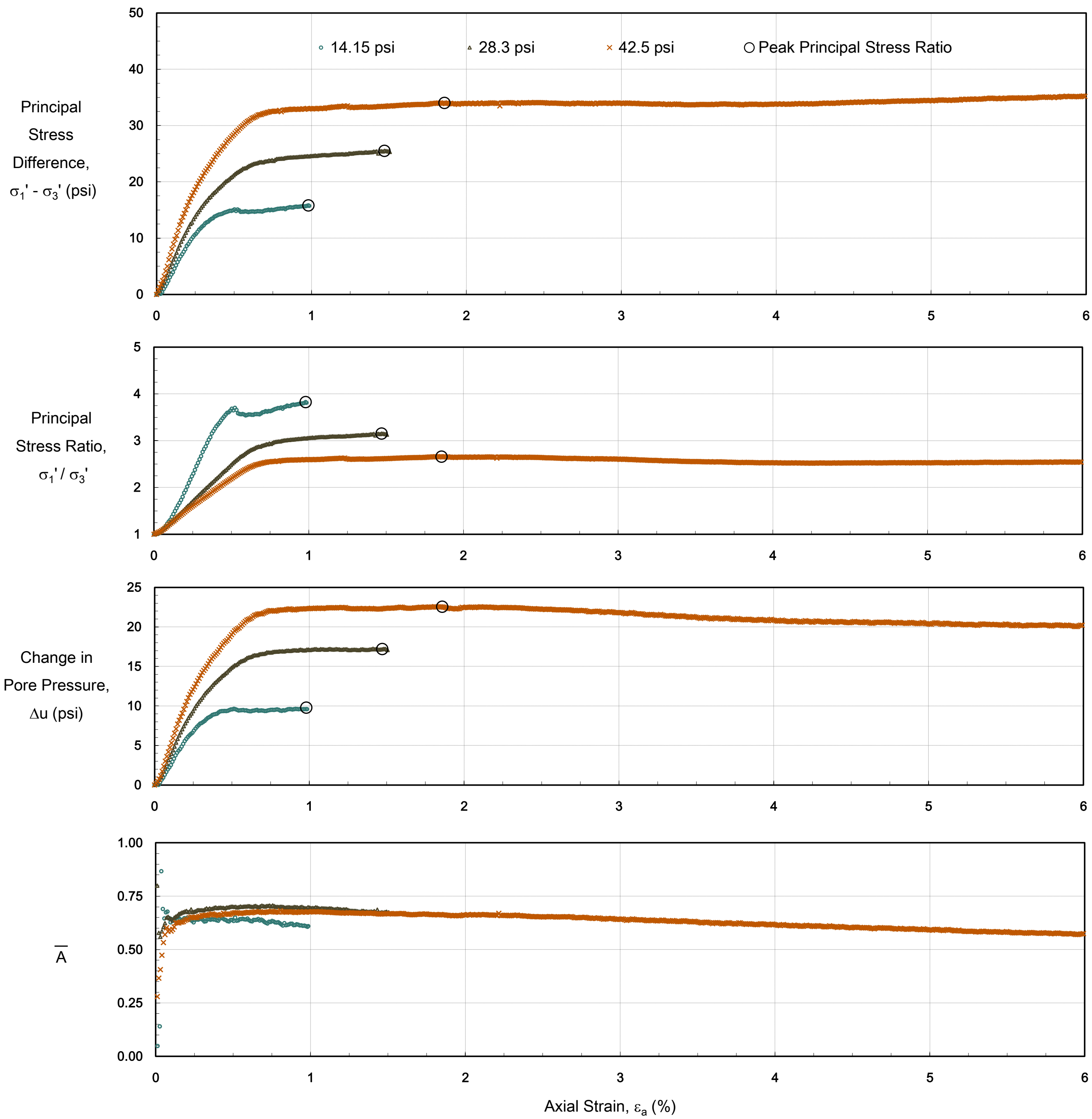
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	22.1
Effective Cohesion (psi)	-	3.3

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B2: 33-35

TRI Log #: 20888
Test Method: ASTM D4767 Mod



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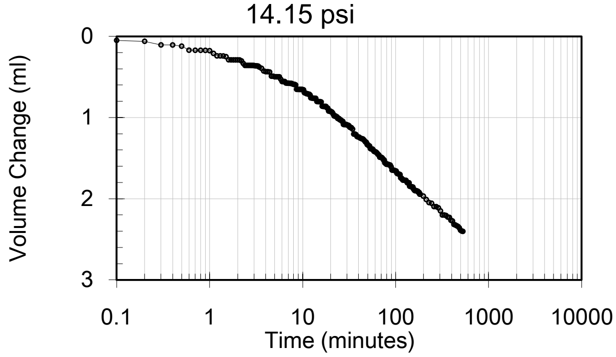
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B2: 33-35

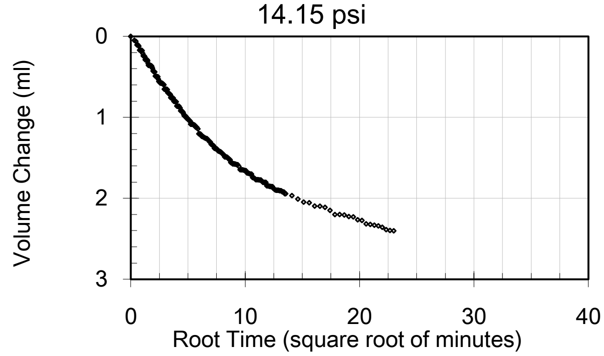
TRI Log #: 20888
Test Method: ASTM D4767 Mod

Consolidation

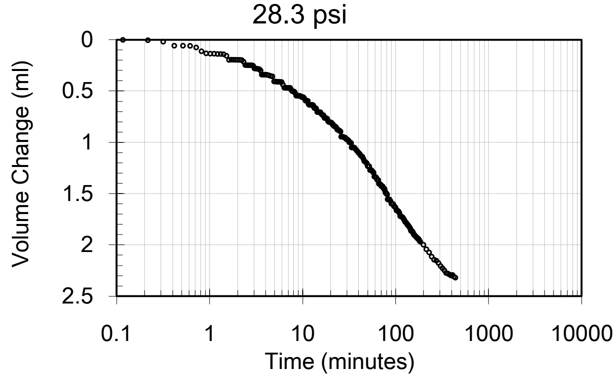
14.15 psi



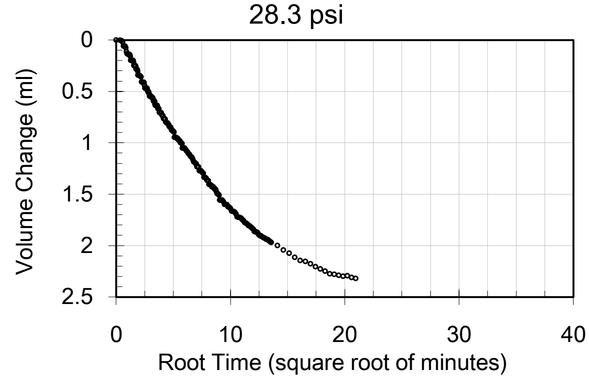
14.15 psi



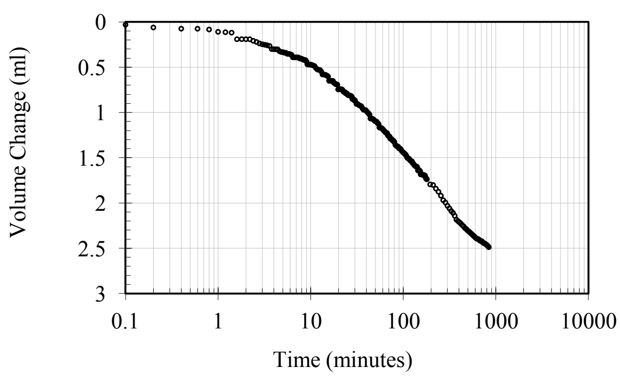
28.3 psi



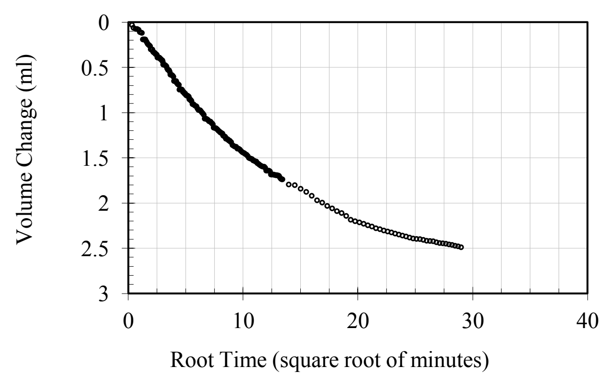
28.3 psi



42.5 psi



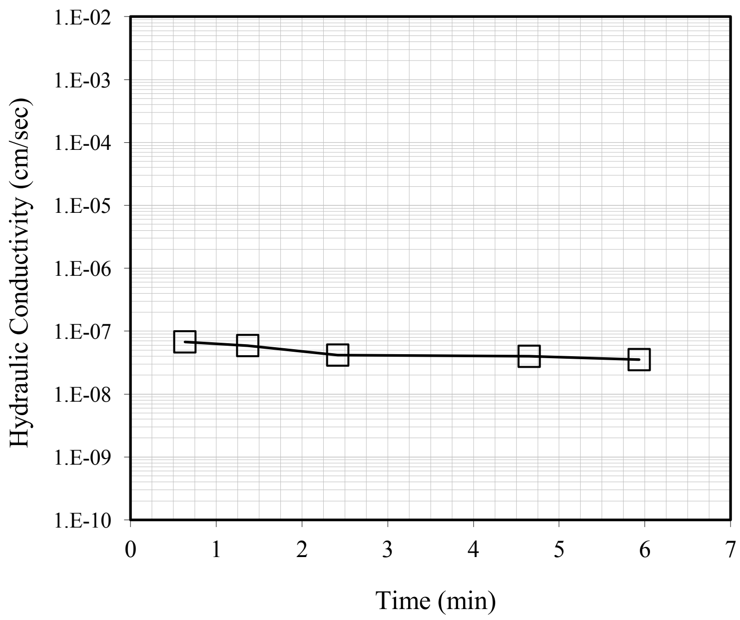
42.5 psi



TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Hydraulic Conductivity

Client:	Auckland Consulting LLC	TRI Log #:	20888
Project:	Winston Pond	Test Method:	ASTM D5084 Method F
Sample ID:	B3: 3-5		



Initial Values	
Sample Condition	Undisturbed
Diameter (in)	2.83
Height (in)	1.59
Initial Mass (g)	341.8
Sample Area (in^2)	6.28
Water Content (%)	15.9
Total Unit Weight (pcf)	130.4
Dry Unit Weight (pcf)	112.6
Specific Gravity (Assumed)	2.65
Degree of Saturation	89.6
Void Ratio	0.47
Porosity	0.32
1 Pore Volume (cc)	52.2
Eff. Confining Stress (psi)	5.0
B-Value Prior to Permeation	0.96

Specimen Image

Time	Hydraulic Conductivity, K at 20° C
Min	cm/s
1.4	5.9E-08
2.4	4.2E-08
4.6	4.0E-08
5.9	3.5E-08
Average, Last 2 Readings	**3.8E-08**

Note: Permeation measurements were made with a mercury U-tube.

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Analysis & Quality Review/Date
Testing Performed By: SOC & LC

TRI Environmental, Inc.
9063 Bee Caves Rd. – Austin, TX 78733 – USA | Ph: 800.880.TEST or 512.263.2101

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B3: 8-10

TRI Log #: 20888
Test Method: ASTM D4767 Mod

Specimens			
Identification	-	-	-
Depth/Elev. (ft)	-	-	-
Eff. Consol. Stress (psi)	3.8	7.5	15.0
Initial Specimen Properties			
Avg. Diameter (in)	2.05	2.05	2.05
Avg. Height (in)	4.46	4.46	4.46
Avg. Water Content (%)	17.8	-	-
Bulk Density (pcf)	130.1	130.1	130.1
Dry Density (pcf)	110.5	-	-
Saturation (%)	91.3	-	-
Void Ratio, n	0.53	0.53	0.53
Specific Gravity (Assumed)	2.70		
Total Back-Pressure (psi)	81.1	81.1	81.1
B-Value, End of Saturation	1.00	-	-

Test Setup	
Specimen Condition	Undisturbed / Intact
Specimen Preparation	Trimmed
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear			
Void Ratio	0.51	0.51	0.51
Area (in^2)	3.27	3.27	3.26

Shear / Post-Shear			
Avg. Water Content (%)	-	-	19.9
Rate of Strain (%/hr)	0.25	0.25	0.25

At Failure						
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$			Ratio, $(\sigma_1'/\sigma_3')_{max}$		
Axial Strain at Failure (%), $\varepsilon_{a,f}$	-	-	-	1.0	0.8	2.7
Minor Effective Stress (psi), $\sigma_3'_f$	-	-	-	2.2	4.4	10.1
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	-	-	-	7.0	11.6	28.5
Pore Water Pressure, Δu_f (psi)	-	-	-	1.6	3.1	4.9
Major Effective Stress (psi), $\sigma_1'_f$	-	-	-	9.2	16.0	38.6
Effective Friction Angle (degrees)	-			35.1		
Effective Cohesion (psi)	-			0.1		

R-Envelope, "Total" Stress		
Friction Angle (deg)	-	28.5
Cohesion (psi)	-	0 (Forced)

Note: Multi-stage testing was performed for this sample. The first two stages were terminated in accordance with stress path tangency and/or peak principal stress ratio.

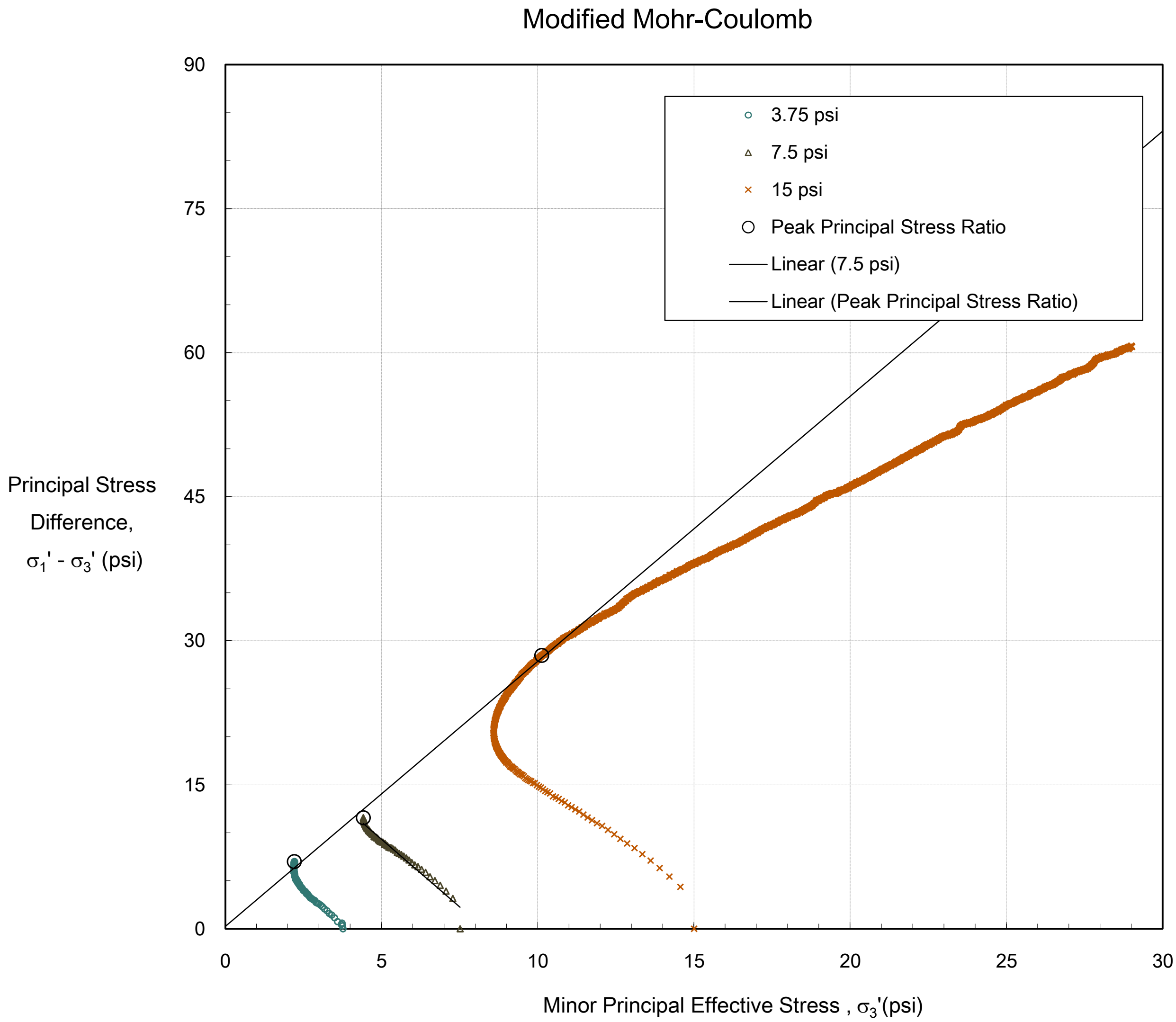
Jeffrey A. Kuhn , Ph.D., P.E., 7/13/2016
Analysis & Quality Review/Date
Laboratory Staff: SOC & LC

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B3: 8-10

TRI Log #: 20888
Test Method: ASTM D4767 Mod



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	35.1
Effective Cohesion (psi)	-	0.1

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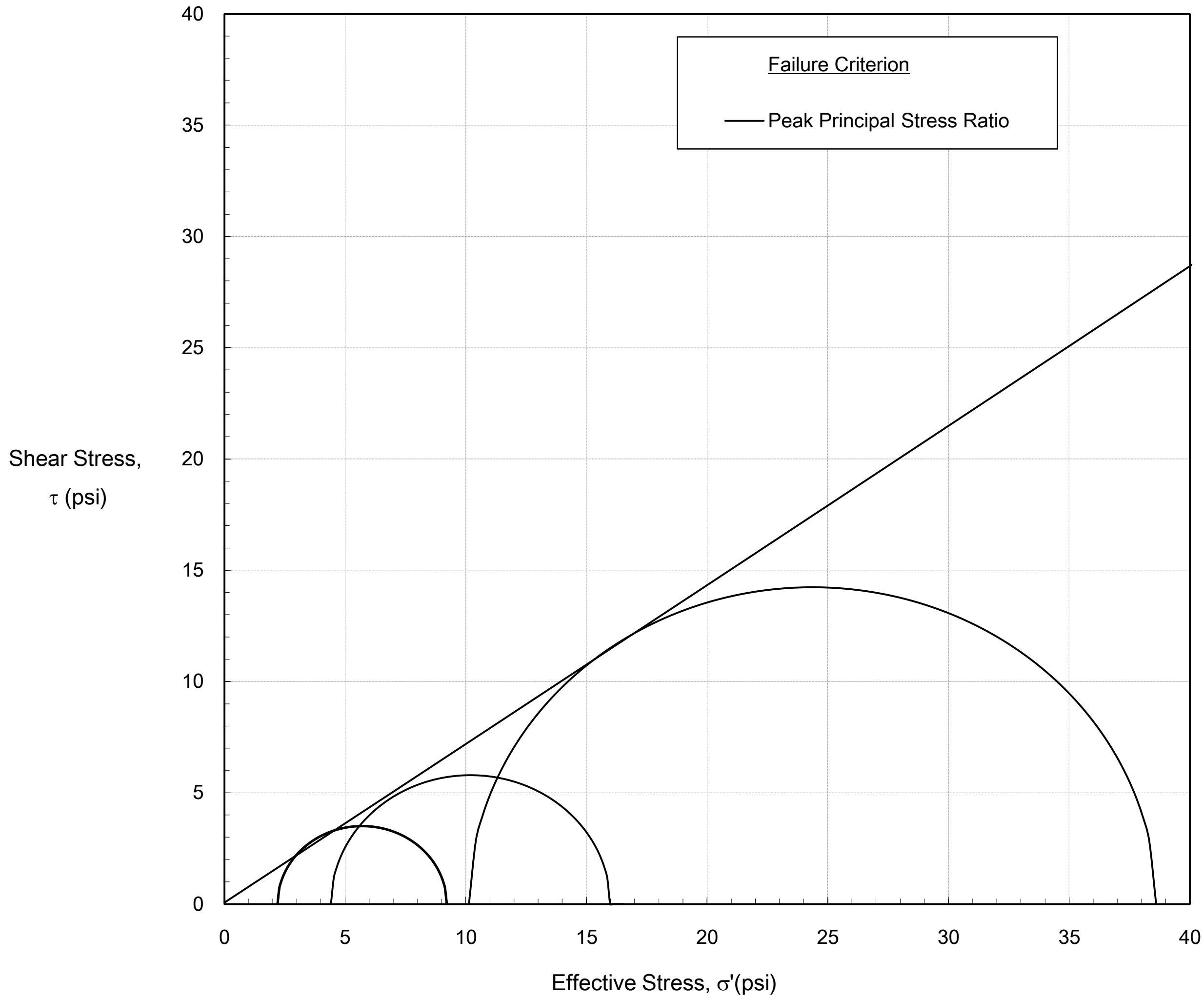
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B3: 8-10

TRI Log #: 20888
Test Method: ASTM D4767 Mod

Mohr-Coulomb



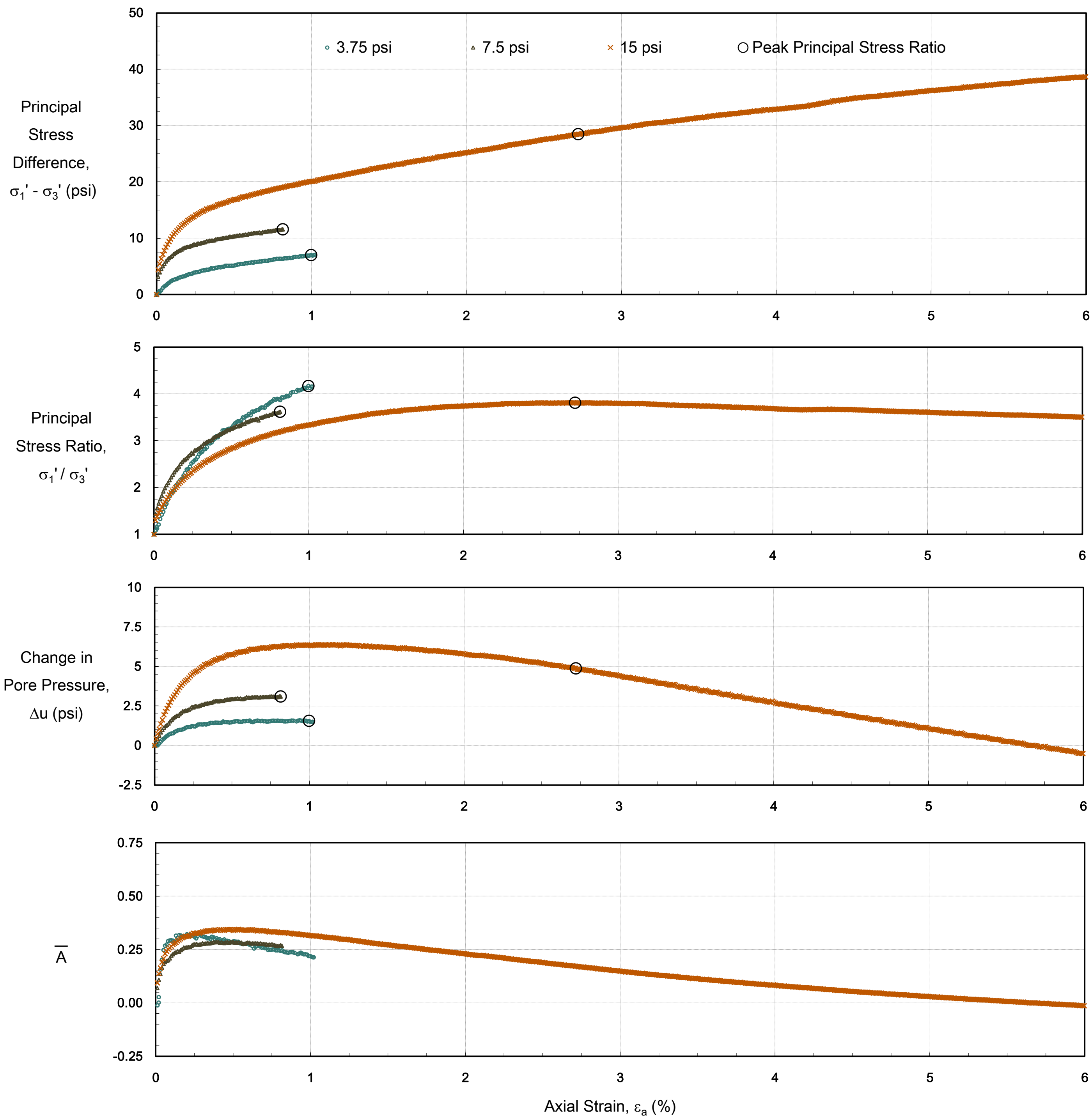
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	35.1
Effective Cohesion (psi)	-	0.1

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B3: 8-10

TRI Log #: 20888
Test Method: ASTM D4767 Mod



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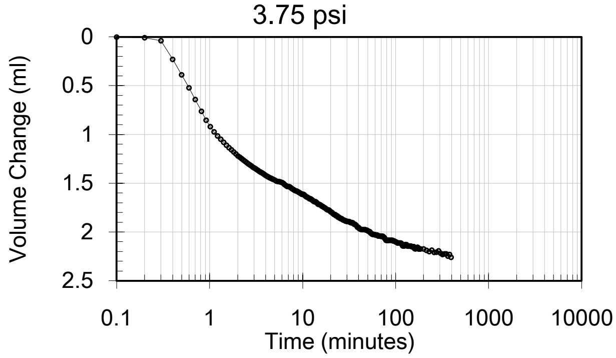
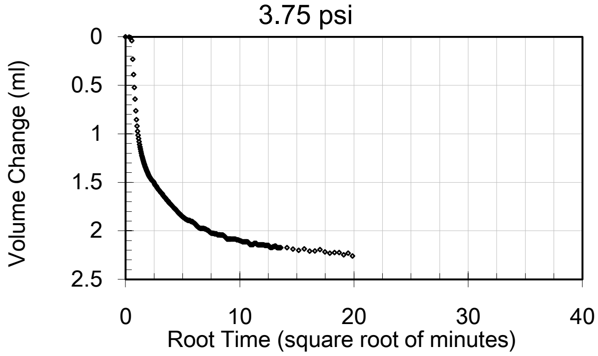
Multi-Stage Consolidated-Undrained Triaxial Compression

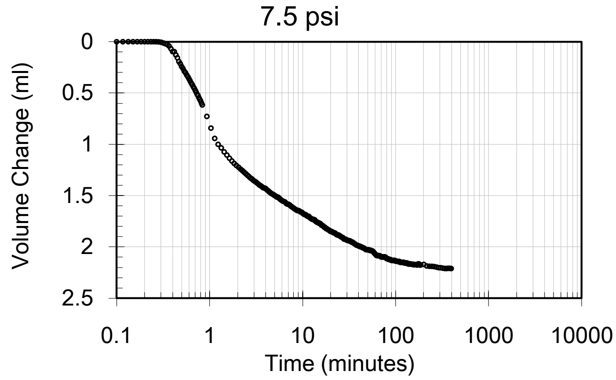
Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B3: 8-10

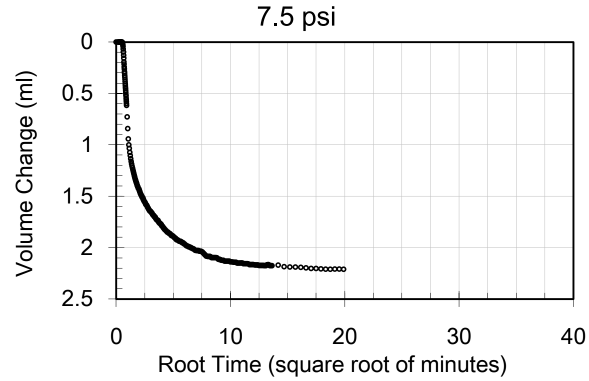
TRI Log #: 20888
Test Method: ASTM D4767 Mod

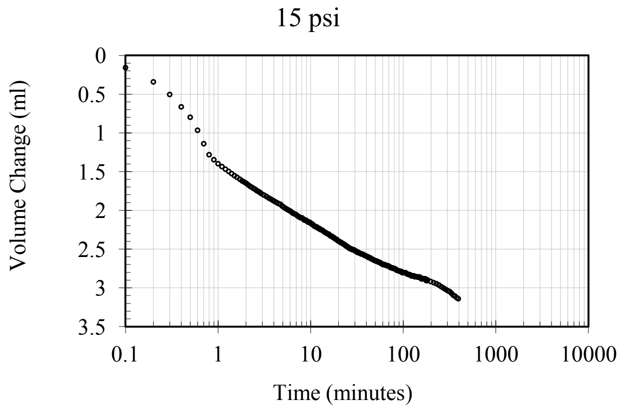
Consolidation

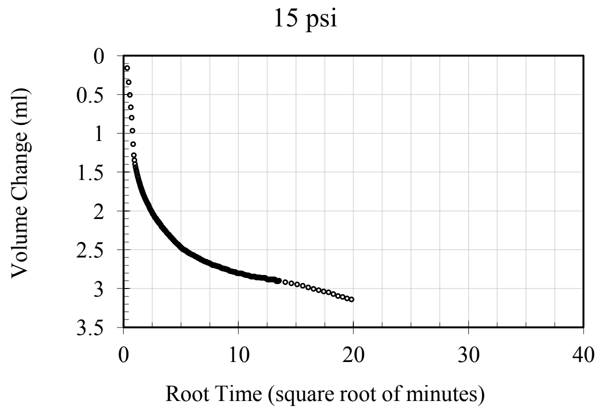










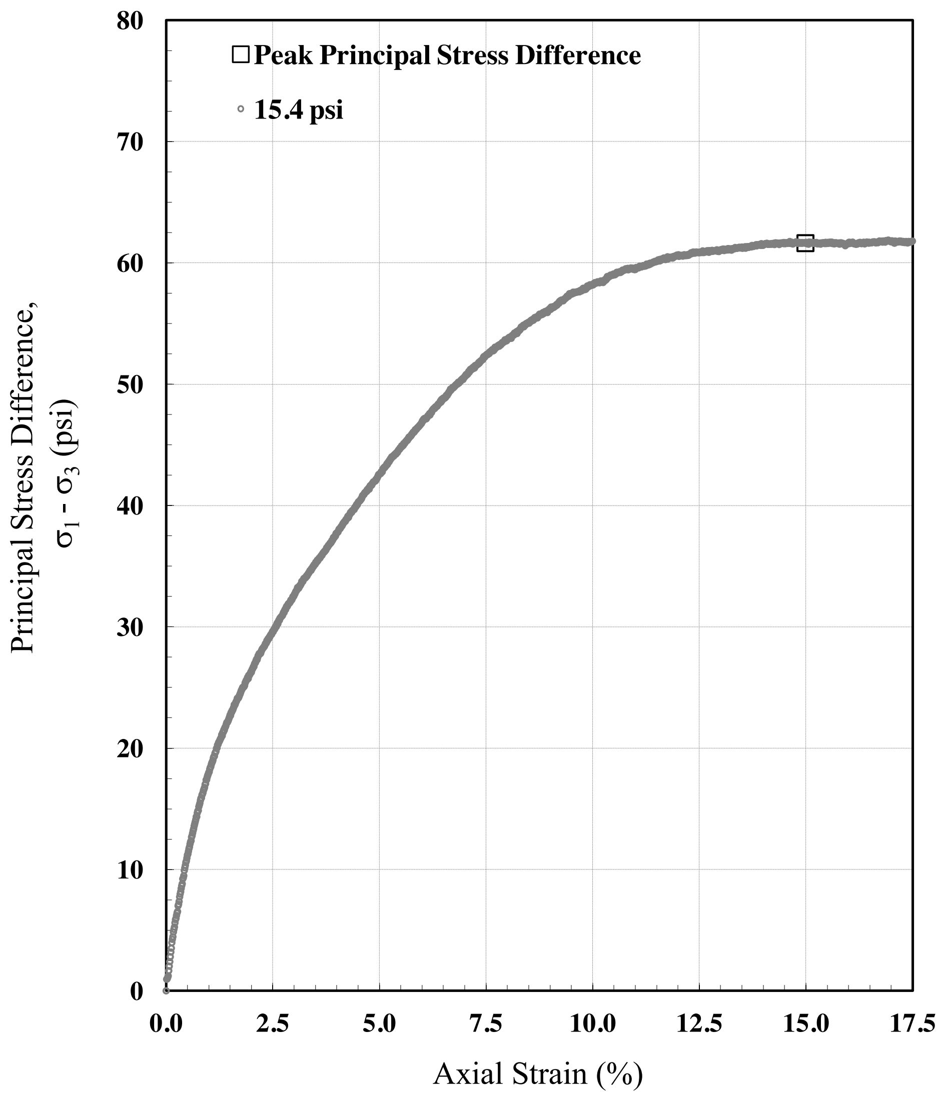


TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Unconsolidated-Undrained (Q) Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B3: 18-19

TRI Log #: 20888
Test Method: ASTM D2850



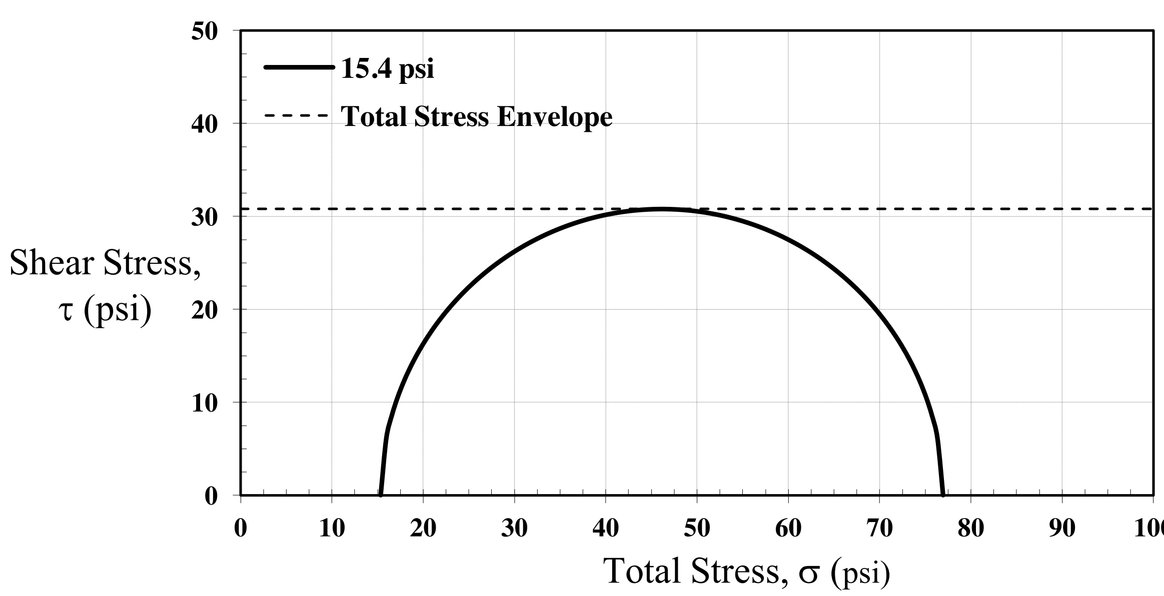
Test Parameters	
Minor Principal Stress (psi)	15.4
Rate of Strain (%/hr)	60

Initial Properties	
Avg. Diameter (in)	1.31
Avg. Height (in)	2.55
Avg. Water Content (%)	18.6
Bulk Density (pcf)	129.6
Dry Density (pcf)	109.2
Saturation (%)	95.9
Void Ratio	0.51
Specific Gravity (Assumed)	2.65

At Failure - Maximum Deviator Stress	
Axial Strain at Failure (%)	15.0
Minor Total Stress (psi)	15.4
Major Total Stress (psi)	77.0
Principal Stress Diff. (psi)	61.6

Total Stress Envelope	
Friction Angle (deg)	0
Undrained Shear Strength, S_u (psi)	30.8
S_u / σ_3	2.0

Note: The Mohr failure envelope was taken as a horizontal straight line. It should, however, be noted that the specimen was partially saturated.



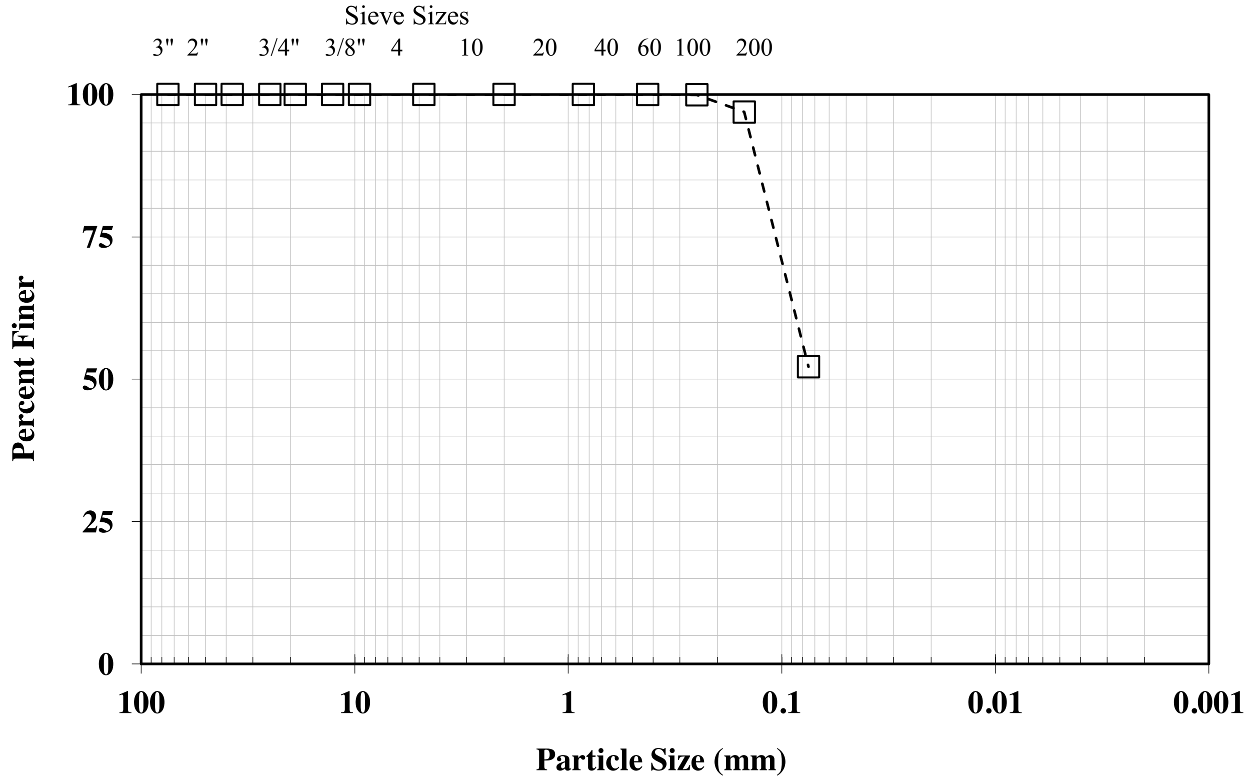
Jeffrey A. Kuhn , Ph.D., P.E., 6/30/2016
Analysis & Quality Review/Date
Laboratory Staff: LC

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Particle Size Analysis for Soils

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B3 28-30

TRI Log#: 20888.13
Test Method: ASTM D422



Sieve Analysis	
Sieve Size	Percent Passing
3 in. (76.2 mm)	100.0
2 in. (50.8 mm)	100.0
1.5 in. (38.1 mm)	100.0
1 in. (25.4 mm)	100.0
3/4 in. (19.0 mm)	100.0
1/2 in. (12.7 mm)	100.0
3/8 in. (9.51 mm)	100.0
No. 4 (4.76 mm)	100.0
No. 10 (2.00 mm)	100.0
No. 20 (0.841 mm)	100.0
No. 40 (0.420 mm)	100.0
No. 60 (0.250 mm)	99.9
No. 100 (0.149 mm)	96.9
No. 200 (0.074 mm)	52.2
Hydrometer Analysis	
Particle Size	Percent Passing
0.005 mm	- -
0.002 mm	- -

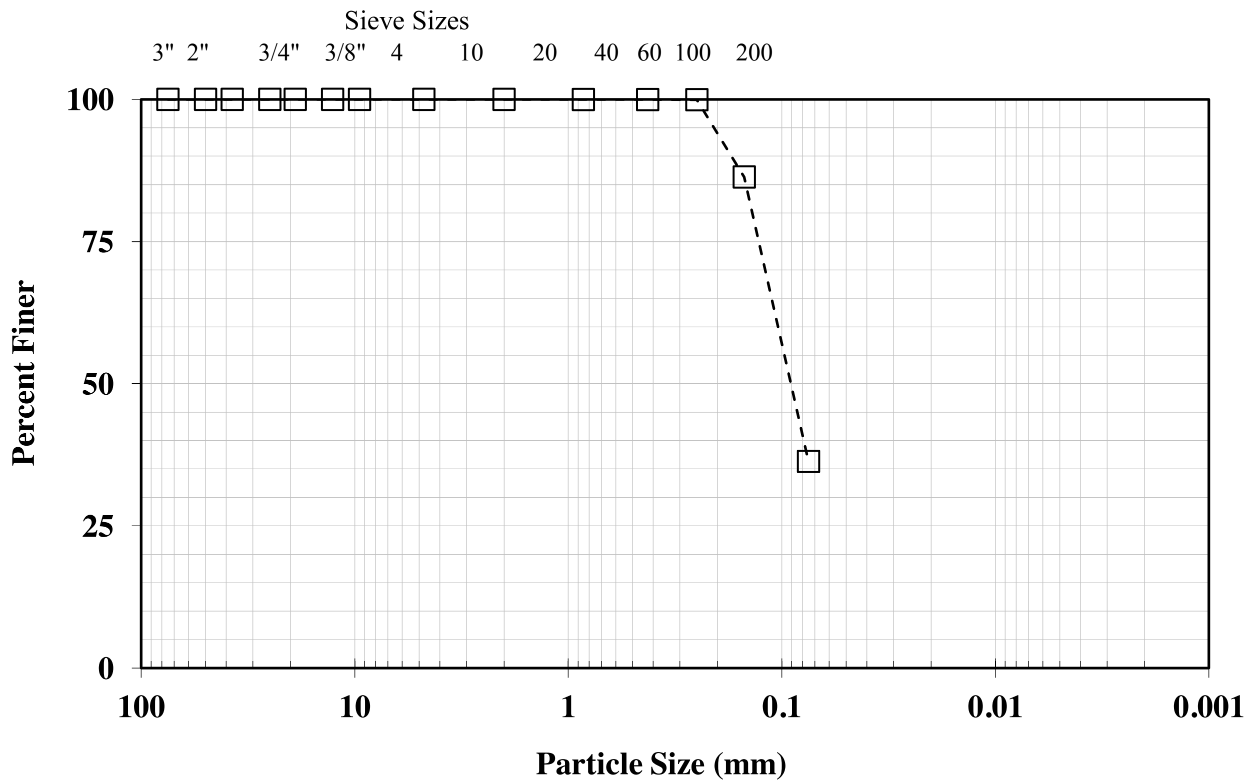
USCS Classification (ASTM D2487)	Sandy lean clay (CL)	
As-Received Moisture Content (%)	(ASTM D2216)	11.9
Atterberg Limits (ASTM D4318, Method A : Multipoint)	Liquid Limit	29
	Plastic Limit	21
	Plastic Index	8
Notes: Specimen was air dried.. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM D4373)	- -

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Quality Review/Date
Tested by: KH & PC

Particle Size Analysis for Soils

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B6: 28-30

TRI Log#: 20888.20
Test Method: ASTM D422



Sieve Analysis	
Sieve Size	Percent Passing
3 in. (76.2 mm)	100.0
2 in. (50.8 mm)	100.0
1.5 in. (38.1 mm)	100.0
1 in. (25.4 mm)	100.0
3/4 in. (19.0 mm)	100.0
1/2 in. (12.7 mm)	100.0
3/8 in. (9.51 mm)	100.0
No. 4 (4.76 mm)	100.0
No. 10 (2.00 mm)	100.0
No. 20 (0.841 mm)	100.0
No. 40 (0.420 mm)	100.0
No. 60 (0.250 mm)	99.9
No. 100 (0.149 mm)	86.3
No. 200 (0.074 mm)	36.3
Hydrometer Analysis	
Particle Size	Percent Passing
0.005 mm	- -
0.002 mm	- -

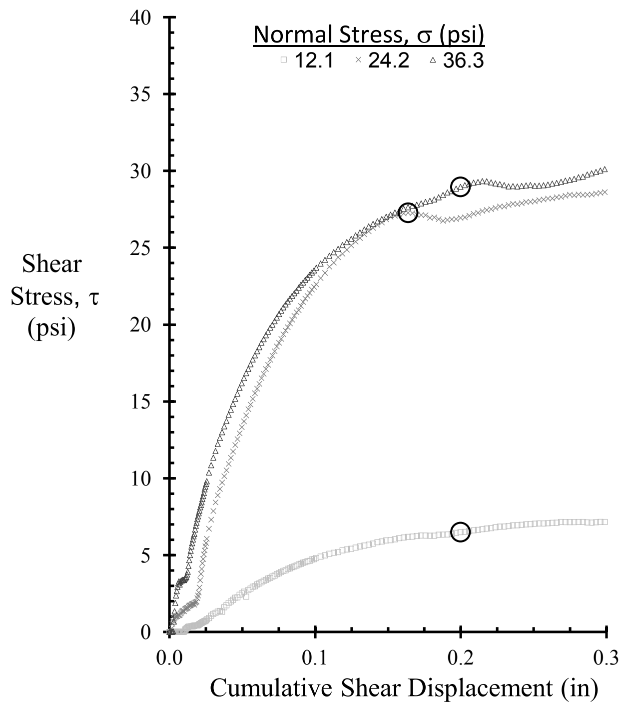
USCS Classification (ASTM D2487)	Silty sand (SM)	
As-Received Moisture Content (%)	(ASTM D2216)	28.9
Atterberg Limits (ASTM D4318, Method A : Multipoint)	Liquid Limit	25
	Plastic Limit	NP
	Plastic Index	- -
Notes: Specimen was air dried.. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM D4373)	- -

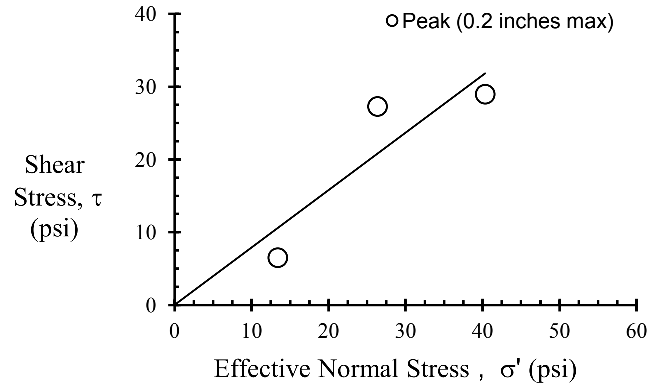
Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Quality Review/Date
Tested by: KH & PC

Direct Shear of Soil Under Consolidated-Drained Conditions

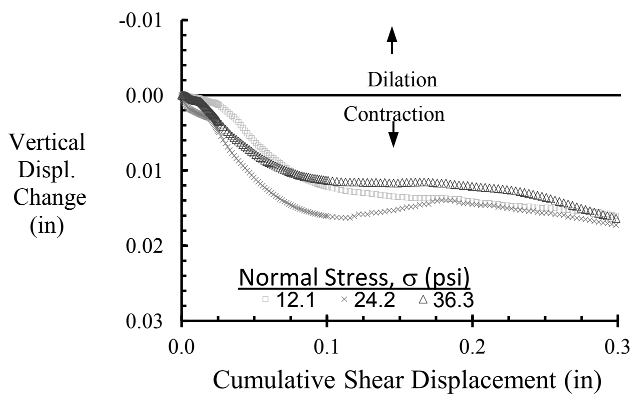
Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B6: 28-30

TRI Log#: 20888
Test Method: ASTM D 3080





Note: Area Correction Has Been Applied



	Sample Number	1	2	3
Initial Condition	Diameter, in	2.50	2.50	2.50
	Height, in (before consol)	1.00	1.00	1.00
	Water Content, %	29.9	27.7	28.8
	Saturation, %	225.9	223.9	225.0
	Dry Density, pcf	122.4	124.5	123.4
	Void Ratio	0.35	0.33	0.34
Post Consol	Height, in (prior to shear)	0.94	0.96	0.97
	Final Water Content, %	25.5	21.5	21.9
	Dry Density, pcf	130.9	129.3	126.6
	Void Ratio	0.26	0.28	0.31
Displacement rate (in/min)		2.0E-03	2.0E-03	2.0E-03
Peak (0.2 inches)	Normal Stress, σ' (psi)	13.40	26.36	40.34
	Shear Stress, τ (psi)	6.50	27.28	28.96
	Displacement (in)	0.20	0.16	0.20
	ϕ'_d, degrees	38.3		
	c'_d, psi	0 (Forced)		

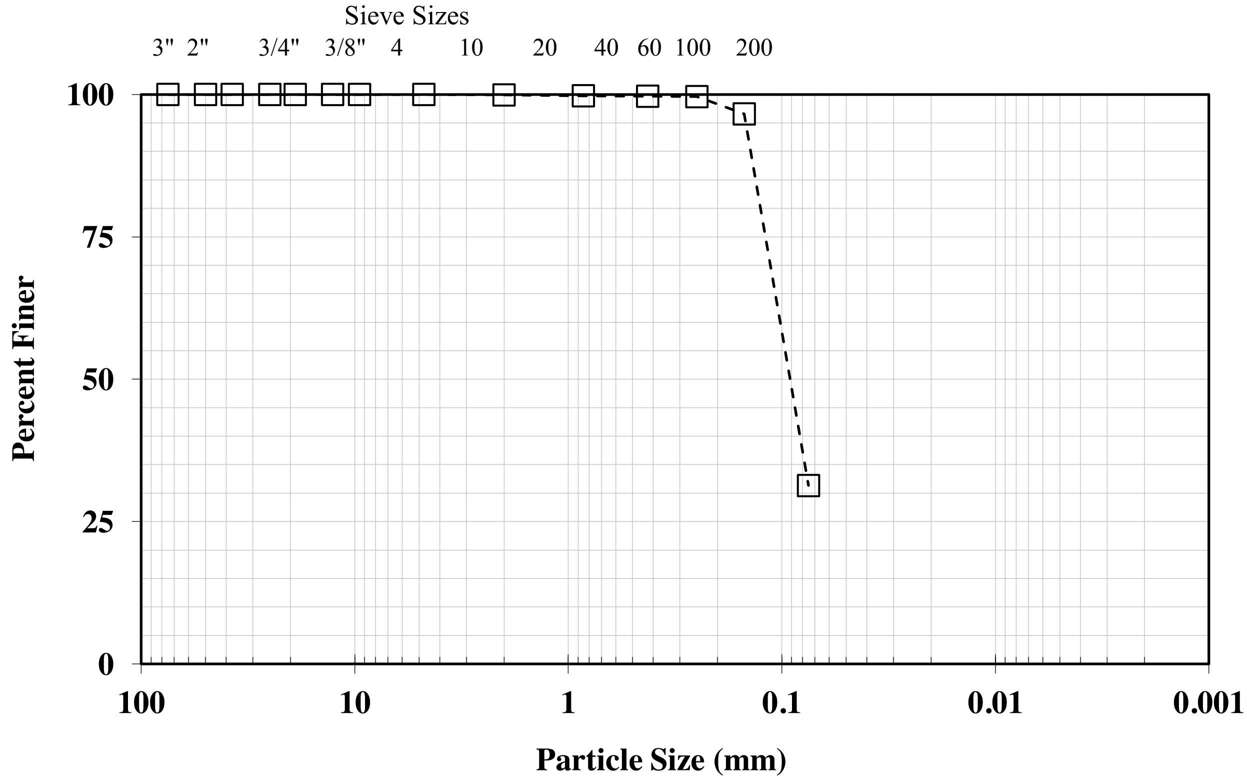
Note: The loose sample was tamped in place. A specific gravity of 2.65 was assumed for weight-volume calculations.

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/16
Analysis & Quality Review/Date
Test Performed By: LC

Particle Size Analysis for Soils

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B7 13-15

TRI Log#: 20888.24
Test Method: ASTM D422



Sieve Analysis	
Sieve Size	Percent Passing
3 in. (76.2 mm)	100.0
2 in. (50.8 mm)	100.0
1.5 in. (38.1 mm)	100.0
1 in. (25.4 mm)	100.0
3/4 in. (19.0 mm)	100.0
1/2 in. (12.7 mm)	100.0
3/8 in. (9.51 mm)	100.0
No. 4 (4.76 mm)	100.0
No. 10 (2.00 mm)	99.9
No. 20 (0.841 mm)	99.8
No. 40 (0.420 mm)	99.7
No. 60 (0.250 mm)	99.6
No. 100 (0.149 mm)	96.6
No. 200 (0.074 mm)	31.3
Hydrometer Analysis	
Particle Size	Percent Passing
0.005 mm	- -
0.002 mm	- -

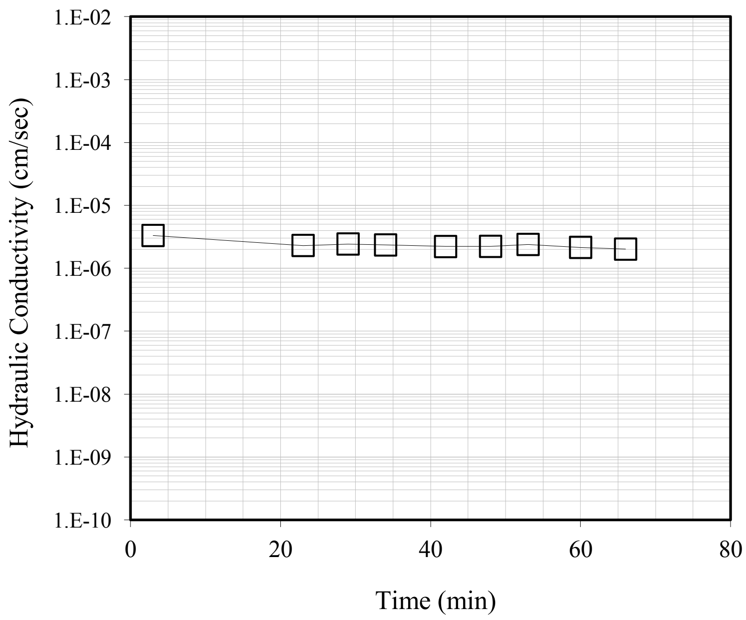
USCS Classification (ASTM D2487)	Silty sand (SM)	
As-Received Moisture Content (%)	(ASTM D2216)	25.6
Atterberg Limits (ASTM D4318, Method A : Multipoint)	Liquid Limit	24
	Plastic Limit	NP
	Plastic Index	- -
Notes: Specimen was air dried.. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM D4373)	- -

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Quality Review/Date
Tested by: KH & PC

Hydraulic Conductivity

Client: Auckland Consulting LLC
Project: Winston Pond
Sample ID: B7: 13-15

TRI Log #: 20888
Test Method: ASTM D5084 Method C



Initial Values	
Sample Condition	Undisturbed
Diameter (in)	2.80
Height (in)	2.21
Initial Mass (g)	444.2
Sample Area (in^2)	6.16
Water Content (%)	24.5
Total Unit Weight (pcf)	124.3
Dry Unit Weight (pcf)	99.9
Specific Gravity (Assumed)	2.65
Degree of Saturation	99.0
Void Ratio	0.66
Porosity	0.40
1 Pore Volume (cc)	88.3
Eff. Confining Stress (psi)	5.0
B-Value Prior to Permeation	0.99

Specimen Image

Time	Hydraulic Conductivity, K at 20° C
Min	cm/s
48.0	2.2E-06
53.0	2.4E-06
60.0	2.2E-06
66.0	2.0E-06
Average, Last 4 Readings	**2.2E-06**

Note: Permeation measurements were made with a mercury U-tube.

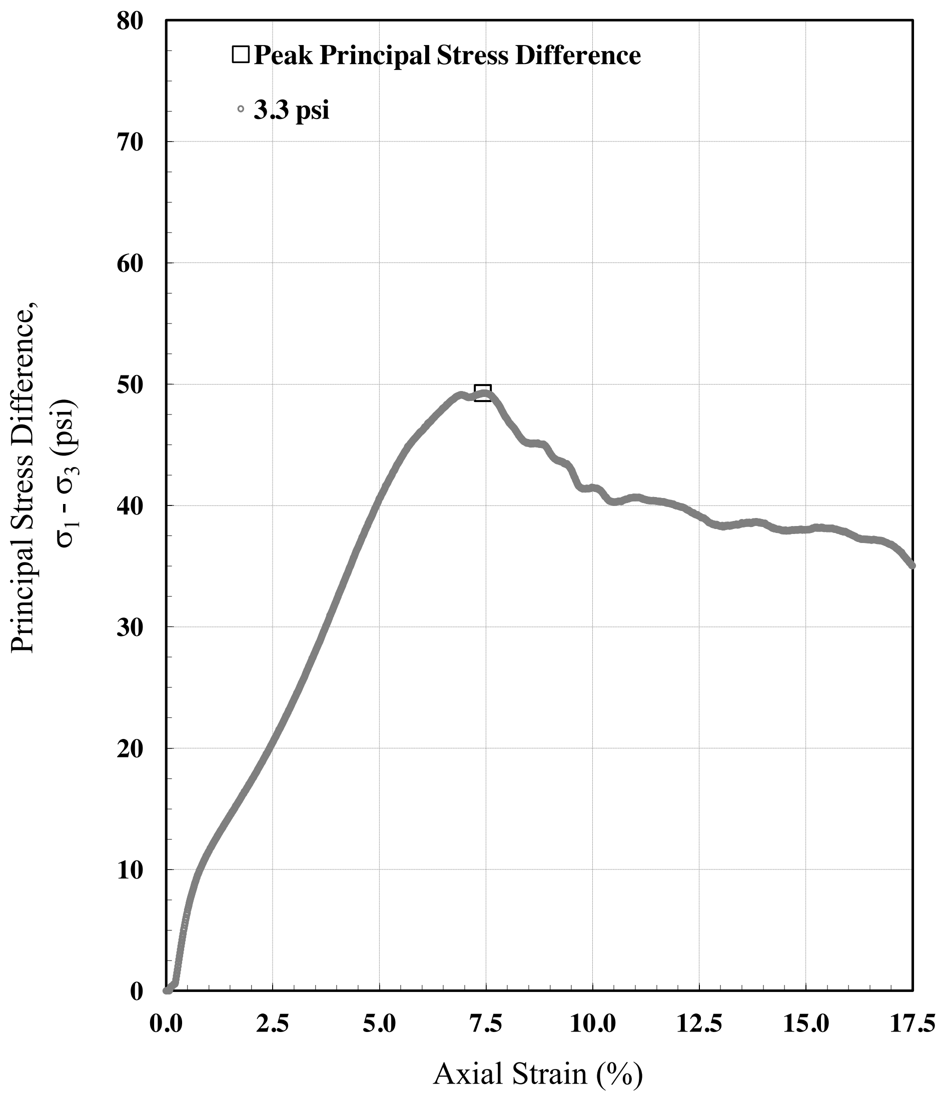
Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Analysis & Quality Review/Date
Testing Performed By: SOC & LC

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Unconsolidated-Undrained (Q) Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B8: 3-5

TRI Log #: 20888
Test Method: ASTM D2850



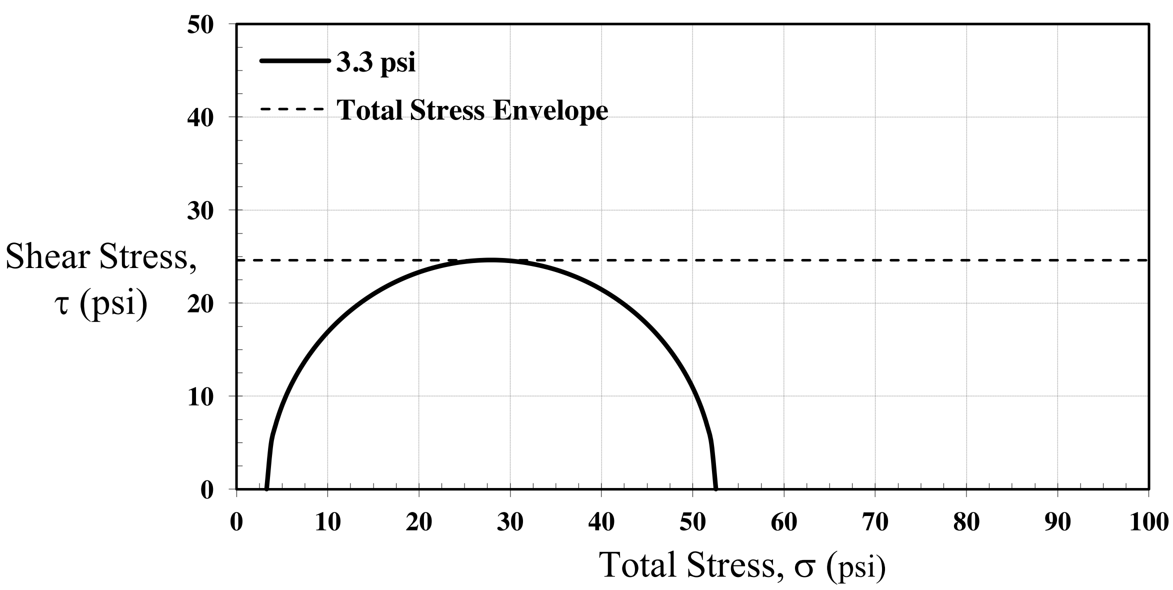
Test Parameters	
Minor Principal Stress (psi)	3.3
Rate of Strain (%/hr)	60

Initial Properties	
Avg. Diameter (in)	2.80
Avg. Height (in)	5.60
Avg. Water Content (%)	15.2
Bulk Density (pcf)	132.9
Dry Density (pcf)	115.4
Saturation (%)	92.8
Void Ratio	0.43
Specific Gravity (Assumed)	2.65

At Failure - Maximum Deviator Stress	
Axial Strain at Failure (%)	7.4
Minor Total Stress (psi)	3.3
Major Total Stress (psi)	52.6
Principal Stress Diff. (psi)	49.3

Total Stress Envelope	
Friction Angle (deg)	0
Undrained Shear Strength, S_u (psi)	24.6
S_u / σ_3	7.5

Note: The Mohr failure envelope was taken as a horizontal straight line. It should, however, be noted that the specimen was partially saturated.



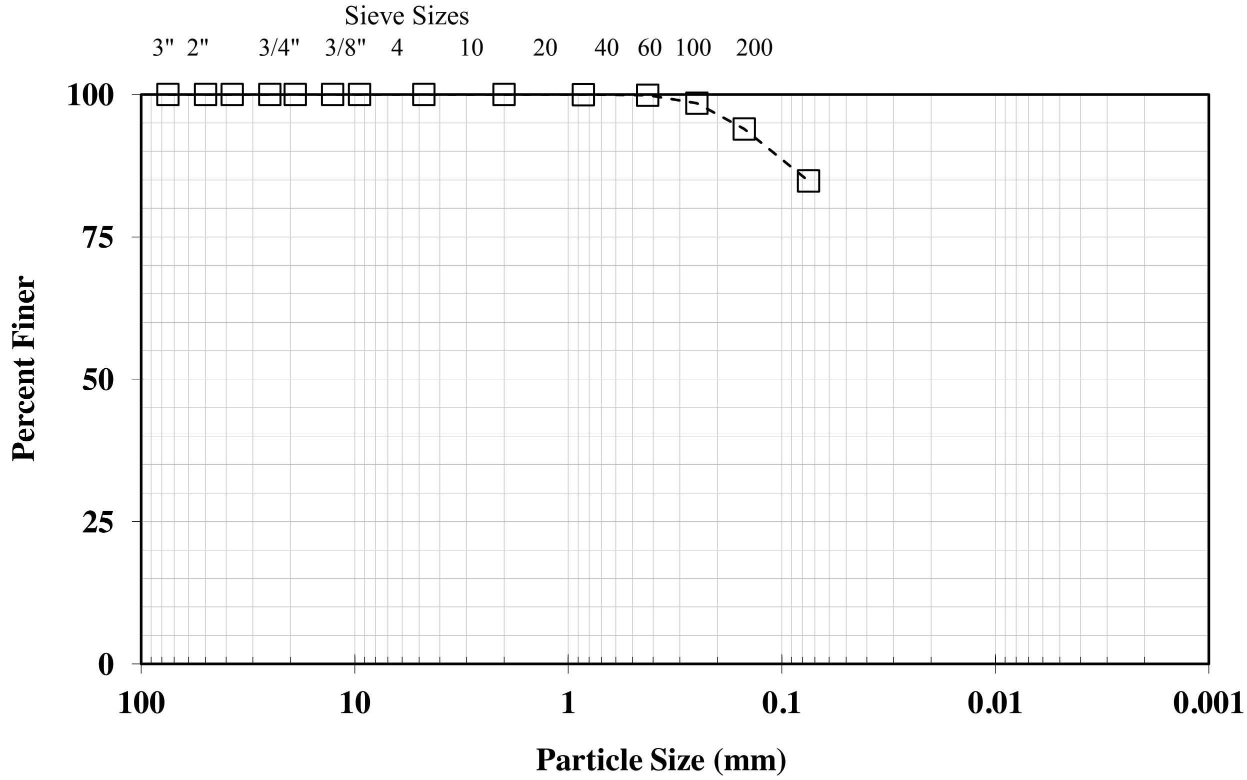
Jeffrey A. Kuhn , Ph.D., P.E., 6/30/2016
Analysis & Quality Review/Date
Laboratory Staff: LC

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Particle Size Analysis for Soils

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B8 38-40

TRI Log#: 20888.32
Test Method: ASTM D422



Sieve Analysis	
Sieve Size	Percent Passing
3 in. (76.2 mm)	100.0
2 in. (50.8 mm)	100.0
1.5 in. (38.1 mm)	100.0
1 in. (25.4 mm)	100.0
3/4 in. (19.0 mm)	100.0
1/2 in. (12.7 mm)	100.0
3/8 in. (9.51 mm)	100.0
No. 4 (4.76 mm)	100.0
No. 10 (2.00 mm)	100.0
No. 20 (0.841 mm)	100.0
No. 40 (0.420 mm)	99.9
No. 60 (0.250 mm)	98.5
No. 100 (0.149 mm)	93.9
No. 200 (0.074 mm)	84.8
Hydrometer Analysis	
Particle Size	Percent Passing
0.005 mm	- -
0.002 mm	- -

USCS Classification (ASTM D2487)	- -	
As-Received Moisture Content (%)	(ASTM D2216)	28.8
Atterberg Limits (ASTM D4318, Method A : Multipoint)	Liquid Limit	- -
	Plastic Limit	- -
	Plastic Index	- -
Notes: Specimen was air dried.. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM D4373)	- -

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Quality Review/Date
Tested by: KH & PC

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-4 (3-5)

TRI Log #: 21381
Test Method: ASTM D4767 Mod

Specimens			
Identification	-	-	-
Depth/Elev. (ft)	-	-	-
Eff. Consol. Stress (psi)	5.0	10.0	15.0
Initial Specimen Properties			
Avg. Diameter (in)	1.95	1.96	1.97
Avg. Height (in)	4.39	4.33	4.24
Avg. Water Content (%)	18.1	-	-
Bulk Density (pcf)	128.7	129.5	130.6
Dry Density (pcf)	109.0	-	-
Saturation (%)	89.4	-	-
Void Ratio, n	0.55	0.54	0.52
Specific Gravity (Assumed)	2.70		
Total Back-Pressure (psi)	81.0	80.9	80.9
B-Value, End of Saturation	0.97	-	-

Test Setup	
Specimen Condition	Undisturbed / Intact
Specimen Preparation	Trimmed
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear			
Void Ratio	0.54	0.52	0.51
Area (in^2)	2.98	3.00	3.04

Shear / Post-Shear			
Avg. Water Content (%)	-	-	20.6
Rate of Strain (%/hr)	0.25	0.25	0.25

At Failure						
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$			Ratio, $(\sigma_1'/\sigma_3')_{max}$		
Axial Strain at Failure (%), $\varepsilon_{a,f}$	-	-	-	0.8	1.3	1.6
Minor Effective Stress (psi), $\sigma_3'_f$	-	-	-	2.7	6.1	11.1
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	-	-	-	9.1	16.6	25.8
Pore Water Pressure, Δu_f (psi)	-	-	-	2.5	4.2	4.2
Major Effective Stress (psi), $\sigma_1'_f$	-	-	-	11.8	22.7	36.9
Effective Friction Angle (degrees)	-			29.9		
Effective Cohesion (psi)	-			1.2		

R-Envelope, "Total" Stress		
Friction Angle (deg)	-	26.9
Cohesion (psi)	-	0.1

Note: Multi-stage testing was performed for this sample. The first two stages were terminated in accordance with stress path tangency and/or peak principal stress ratio.

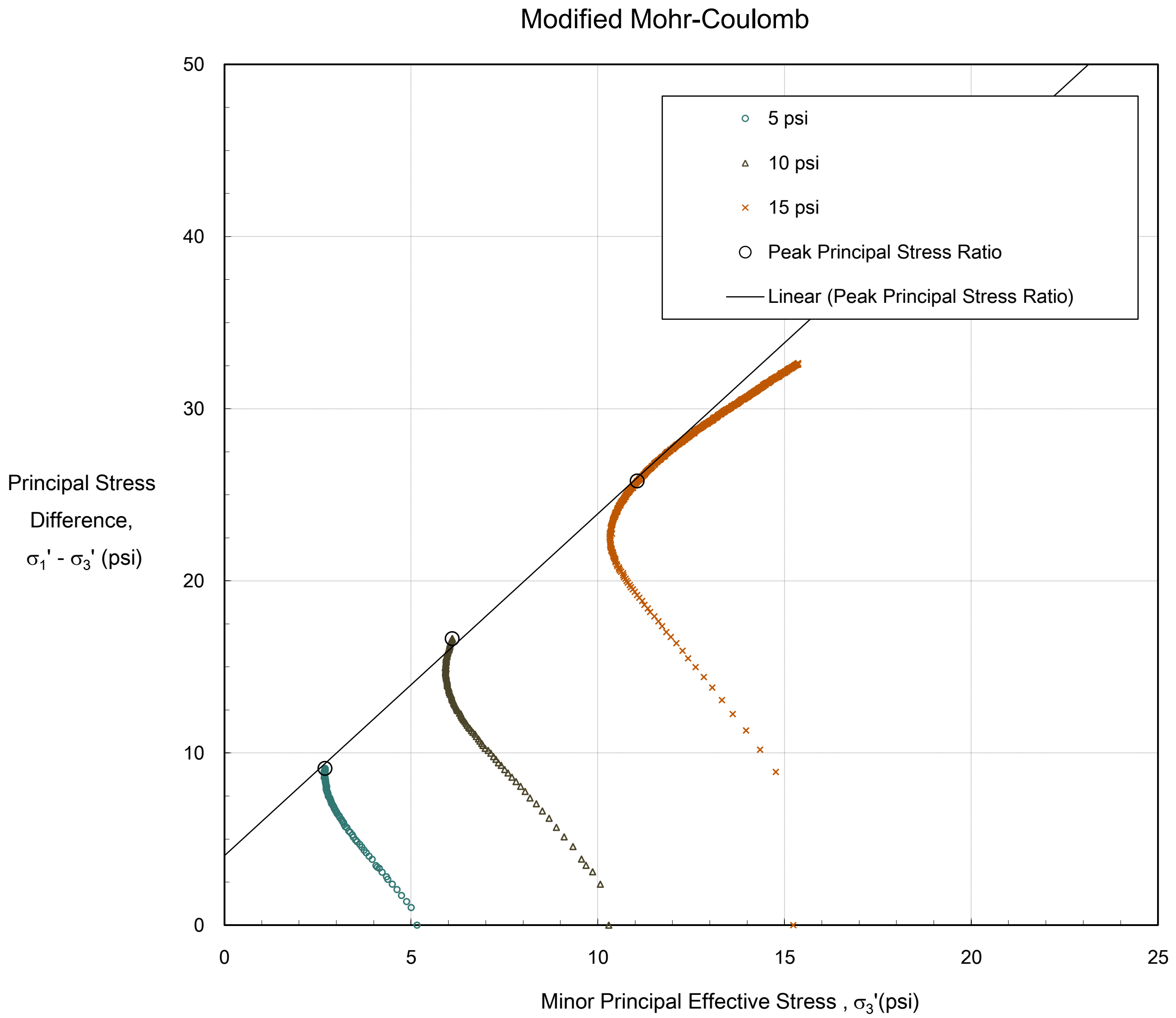
Jeffrey A. Kuhn , Ph.D., P.E., 7/12/2016
Analysis & Quality Review/Date
Laboratory Staff: SOC & LC

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-4 (3-5)

TRI Log #: 21381
Test Method: ASTM D4767 Mod



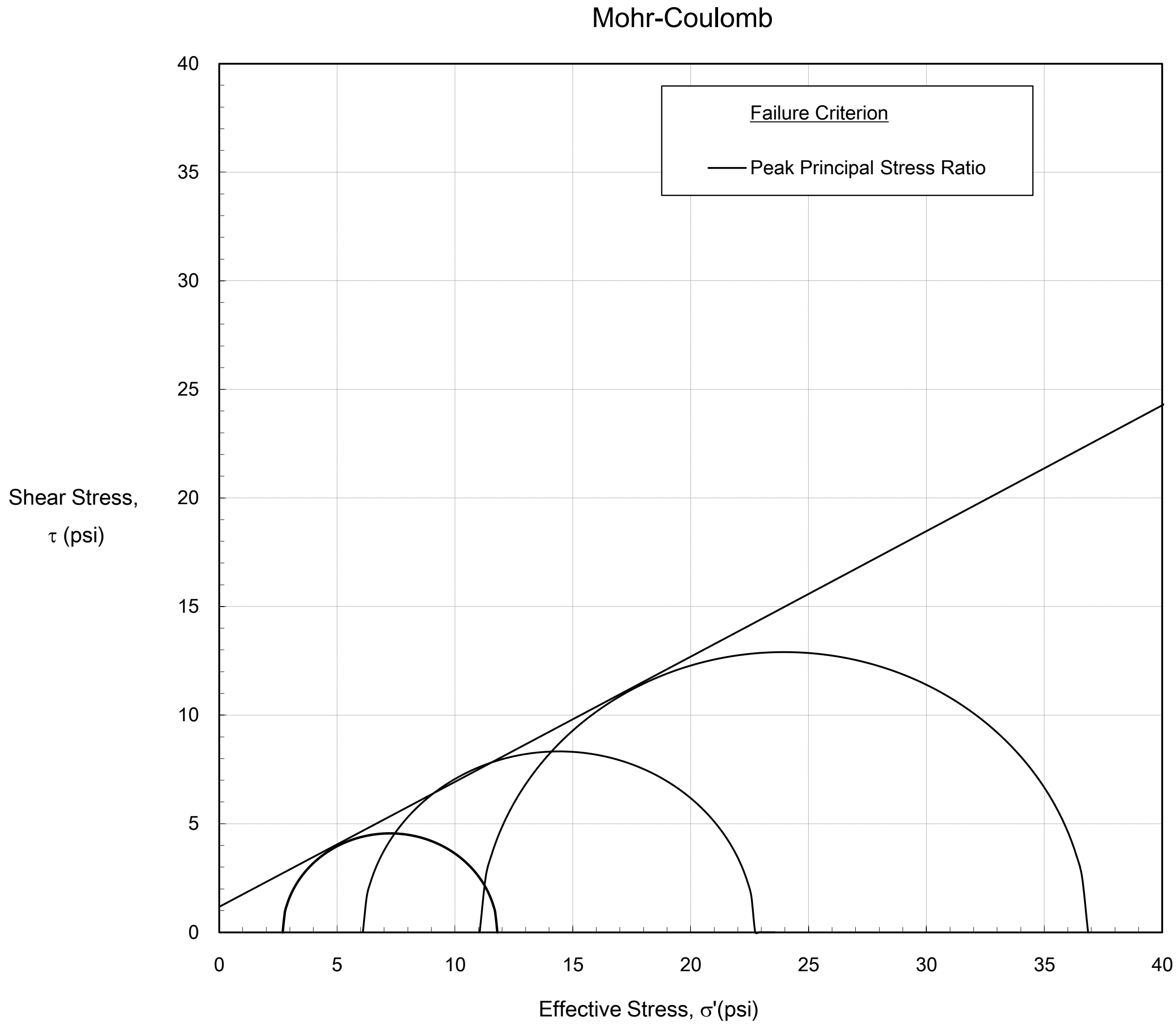
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	29.9
Effective Cohesion (psi)	-	1.2

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-4 (3-5)

TRI Log #: 21381
Test Method: ASTM D4767 Mod



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	29.9
Effective Cohesion (psi)	-	1.2

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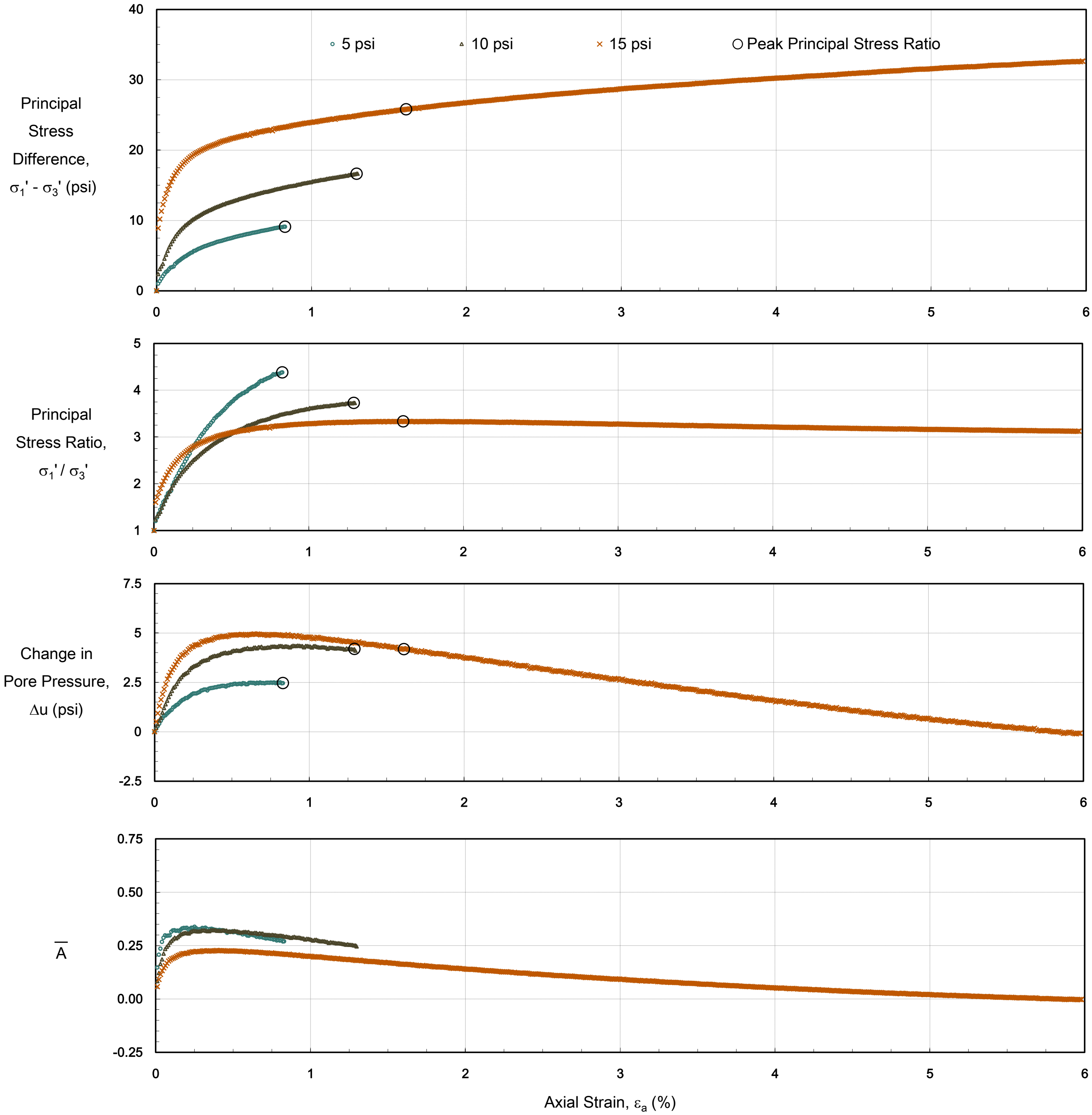
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-4 (3-5)

TRI Log #: 21381
Test Method: ASTM D4767 Mod



TRI Environmental, Inc.
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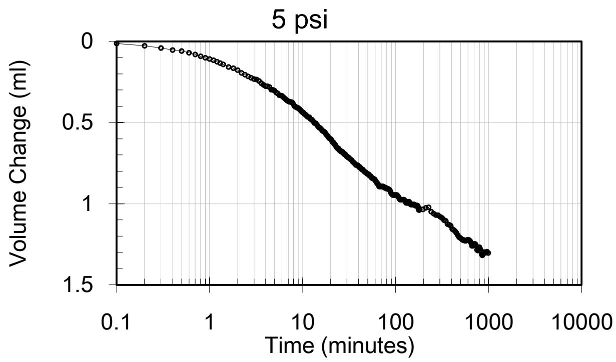
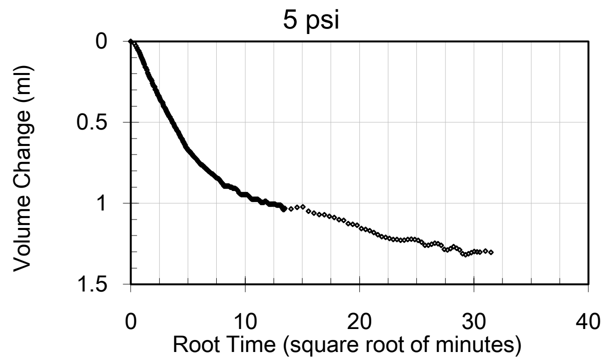
Multi-Stage Consolidated-Undrained Triaxial Compression

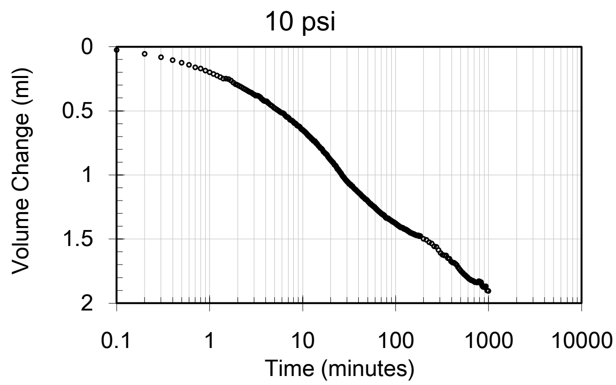
Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-4 (3-5)

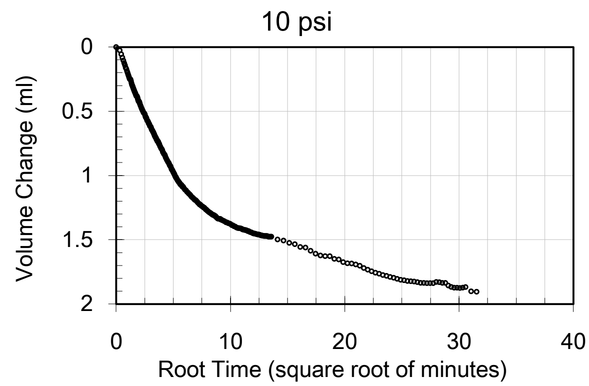
TRI Log #: 21381
Test Method: ASTM D4767 Mod

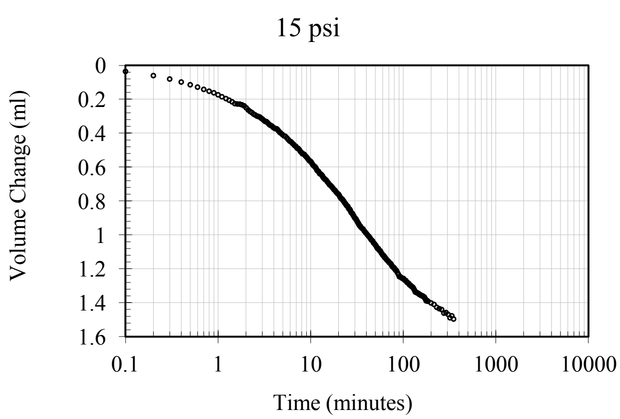
Consolidation

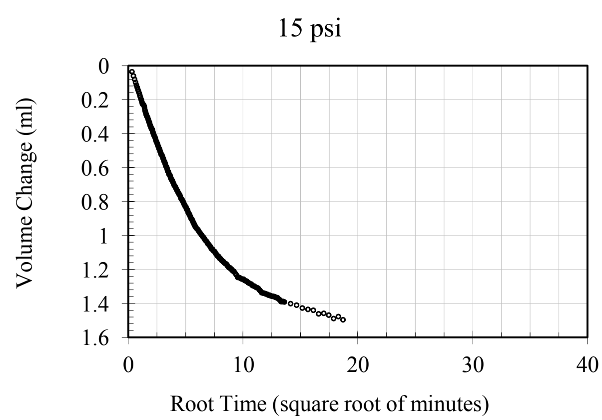












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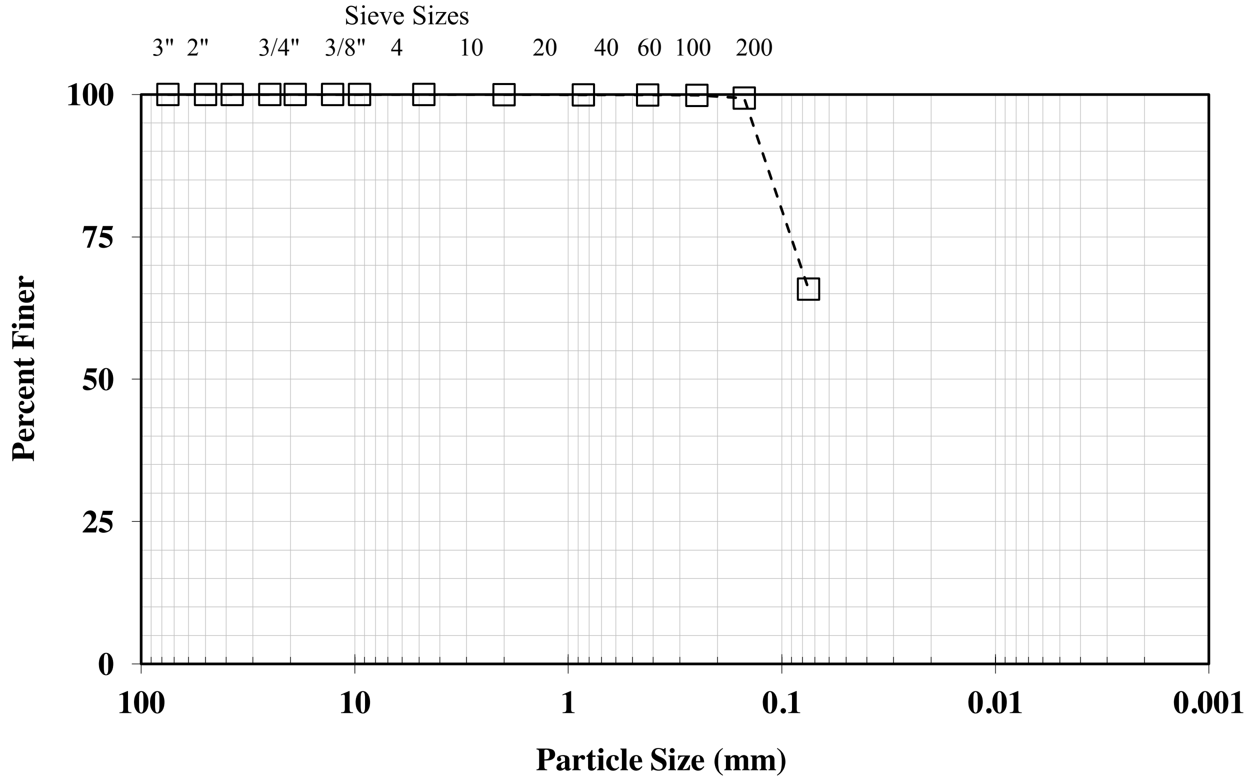
Particle Size Analysis for Soils

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-4 (8-10)

TRI Log#: 21381.3
Test Method: ASTM D422



Sieve Analysis	
Sieve Size	Percent Passing
3 in. (76.2 mm)	100.0
2 in. (50.8 mm)	100.0
1.5 in. (38.1 mm)	100.0
1 in. (25.4 mm)	100.0
3/4 in. (19.0 mm)	100.0
1/2 in. (12.7 mm)	100.0
3/8 in. (9.51 mm)	100.0
No. 4 (4.76 mm)	100.0
No. 10 (2.00 mm)	100.0
No. 20 (0.841 mm)	99.9
No. 40 (0.420 mm)	99.9
No. 60 (0.250 mm)	99.8
No. 100 (0.149 mm)	99.4
No. 200 (0.074 mm)	65.8
Hydrometer Analysis	
Particle Size	Percent Passing
0.005 mm	- -
0.002 mm	- -

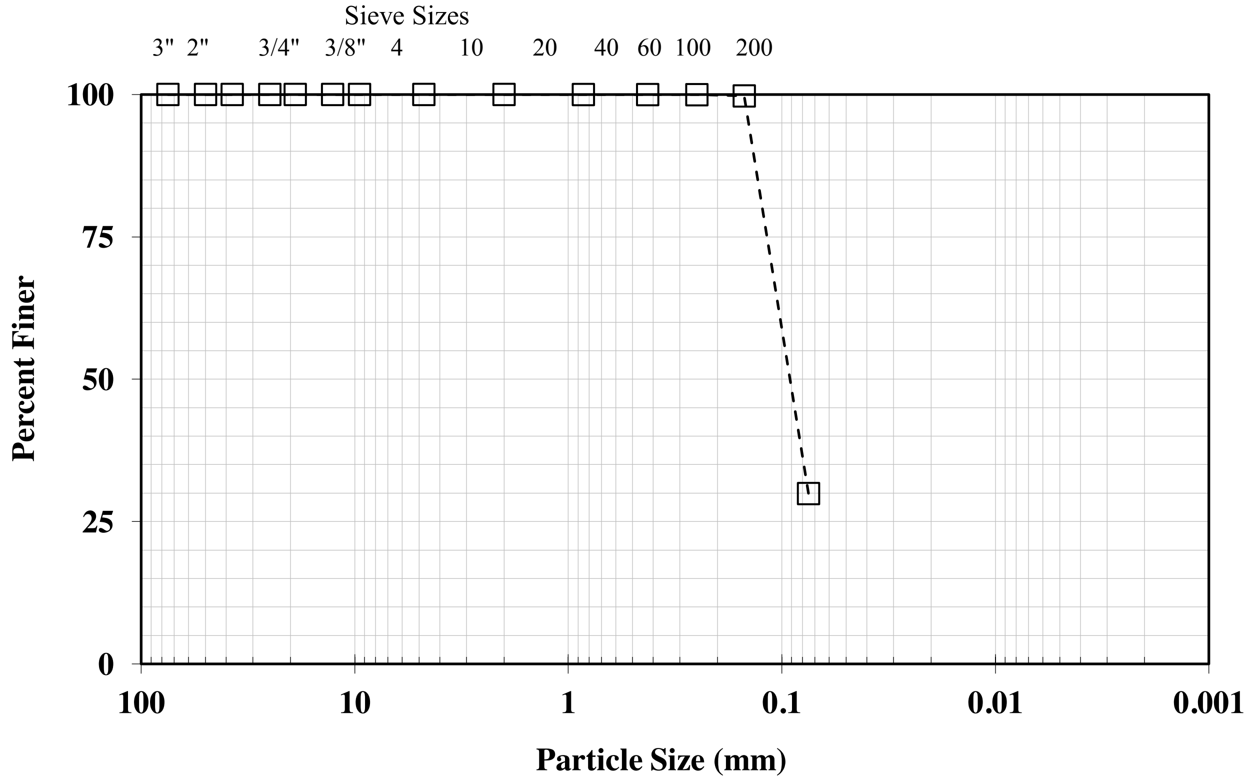
USCS Classification (ASTM D2487)	Sandy lean clay (CL)	
As-Received Moisture Content (%)	(ASTM D2216)	16.3
Atterberg Limits (ASTM D4318, Method A : Multipoint)	Liquid Limit	33
	Plastic Limit	20
	Plastic Index	13
Notes: Specimen was air dried.. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM D4373)	- -

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Quality Review/Date
Tested by: KH & PC

Particle Size Analysis for Soils

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-4 (33-35)

TRI Log#: 21381.7
Test Method: ASTM D422



Sieve Analysis	
Sieve Size	Percent Passing
3 in. (76.2 mm)	100.0
2 in. (50.8 mm)	100.0
1.5 in. (38.1 mm)	100.0
1 in. (25.4 mm)	100.0
3/4 in. (19.0 mm)	100.0
1/2 in. (12.7 mm)	100.0
3/8 in. (9.51 mm)	100.0
No. 4 (4.76 mm)	100.0
No. 10 (2.00 mm)	100.0
No. 20 (0.841 mm)	100.0
No. 40 (0.420 mm)	100.0
No. 60 (0.250 mm)	100.0
No. 100 (0.149 mm)	99.7
No. 200 (0.074 mm)	29.9
Hydrometer Analysis	
Particle Size	Percent Passing
0.005 mm	- -
0.002 mm	- -

USCS Classification (ASTM D2487)	Silty sand (SM)	
As-Received Moisture Content (%)	(ASTM D2216)	29.6
Atterberg Limits (ASTM D4318, Method A : Multipoint)	Liquid Limit	26
	Plastic Limit	NP
	Plastic Index	- -
Notes: Specimen was air dried.. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM D4373)	- -

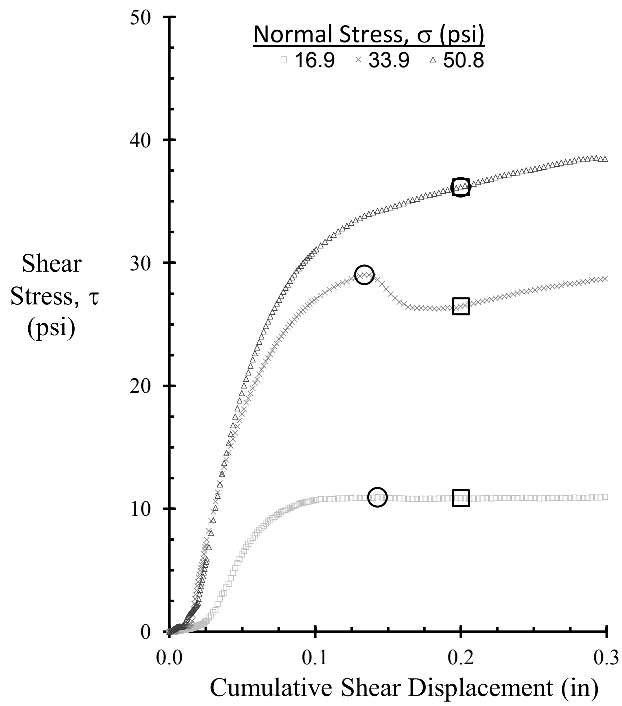
Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Quality Review/Date
Tested by: KH & PC

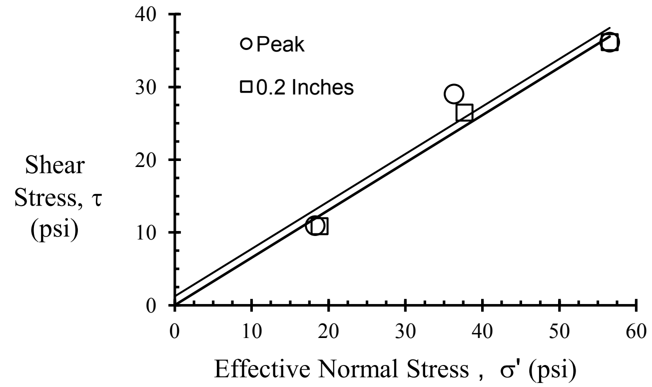
TESTING, RESEARCH, CONSULTING AND FIELD SERVICES
AUSTIN, TX - USA | ANAHEIM, CA - USA | ANDERSON, SC - USA | GOLD COAST - AUSTRALIA | SUZHOU - CHINA

Direct Shear of Soil Under Consolidated-Drained Conditions

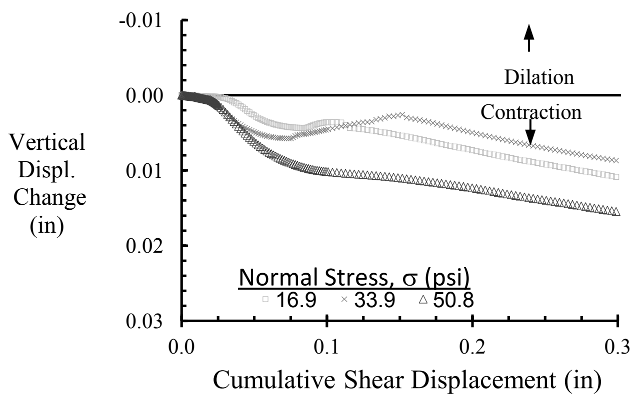
Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-4 (38-40)

TRI Log#: 21381
Test Method: ASTM D 3080





Note: Area Correction Has Been Applied



	Sample Number	1	2	3
Initial Condition	Diameter, in	2.50	2.50	2.50
	Height, in (before consol)	1.00	1.00	1.00
	Water Content, %	24.7	24.9	24.9
	Saturation, %	155.9	156.2	156.2
	Dry Density, pcf	116.4	116.3	116.3
	Void Ratio	0.42	0.42	0.42
Post Consol	Height, in (prior to shear)	1.00	1.00	0.99
	Final Water Content, %	23.9	25.0	23.6
	Dry Density, pcf	116.9	116.5	117.2
	Void Ratio	0.41	0.42	0.41
Displacement rate (in/min)		2.0E-03	2.0E-03	2.0E-03
Peak	Normal Stress, σ' (psi)	18.26	36.30	56.54
	Shear Stress, τ (psi)	10.94	29.03	36.15
	Displacement (in)	0.14	0.13	0.20
	ϕ'_d, degrees	33.1		
	c'_d, psi	1.2		
Post-Peak	Normal Stress, σ' (psi)	18.83	37.66	56.54
	Shear Stress, τ (psi)	10.87	26.47	36.15
	Displacement (in)	0.20	0.20	0.20
	ϕ'_d, degrees	33.1		
	c'_d, psi	0 (Forced)		

Note: The loose sample was tamped in place. A specific gravity of 2.65 was assumed for weight-volume calculations.

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/16

Analysis & Quality Review/Date

Test Performed By: LC

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-5 (5-7)

TRI Log #: 21381
Test Method: ASTM D4767 Mod

Specimens			
Identification	-	-	-
Depth/Elev. (ft)	-	-	-
Eff. Consol. Stress (psi)	5.0	10.0	15.0
Initial Specimen Properties			
Avg. Diameter (in)	1.85	1.85	1.87
Avg. Height (in)	4.51	4.44	4.35
Avg. Water Content (%)	17.6	-	-
Bulk Density (pcf)	139.6	141.0	142.1
Dry Density (pcf)	118.7	-	-
Saturation (%)	100.0	-	-
Void Ratio, n	0.42	0.41	0.40
Specific Gravity (Assumed)	2.70		
Total Back-Pressure (psi)	80.7	80.8	81.5
B-Value, End of Saturation	0.94	-	-

Test Setup	
Specimen Condition	Undisturbed / Intact
Specimen Preparation	Trimmed
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear			
Void Ratio	0.41	0.40	0.38
Area (in^2)	2.67	2.68	2.72

Shear / Post-Shear			
Avg. Water Content (%)	-	-	19.1
Rate of Strain (%/hr)	0.25	0.25	0.25

At Failure						
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$			Ratio, $(\sigma_1'/\sigma_3')_{max}$		
Axial Strain at Failure (%), $\varepsilon_{a,f}$	-	-	-	0.6	1.3	1.4
Minor Effective Stress (psi), $\sigma_3'_f$	-	-	-	4.3	5.6	9.9
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	-	-	-	9.2	11.7	23.4
Pore Water Pressure, Δu_f (psi)	-	-	-	0.7	2.8	3.4
Major Effective Stress (psi), $\sigma_1'_f$	-	-	-	13.5	17.3	33.3
Effective Friction Angle (degrees)	-			32.3		
Effective Cohesion (psi)	-			0 (Forced)		

R-Envelope, "Total" Stress		
Friction Angle (deg)	-	27.1
Cohesion (psi)	-	0 (Forced)

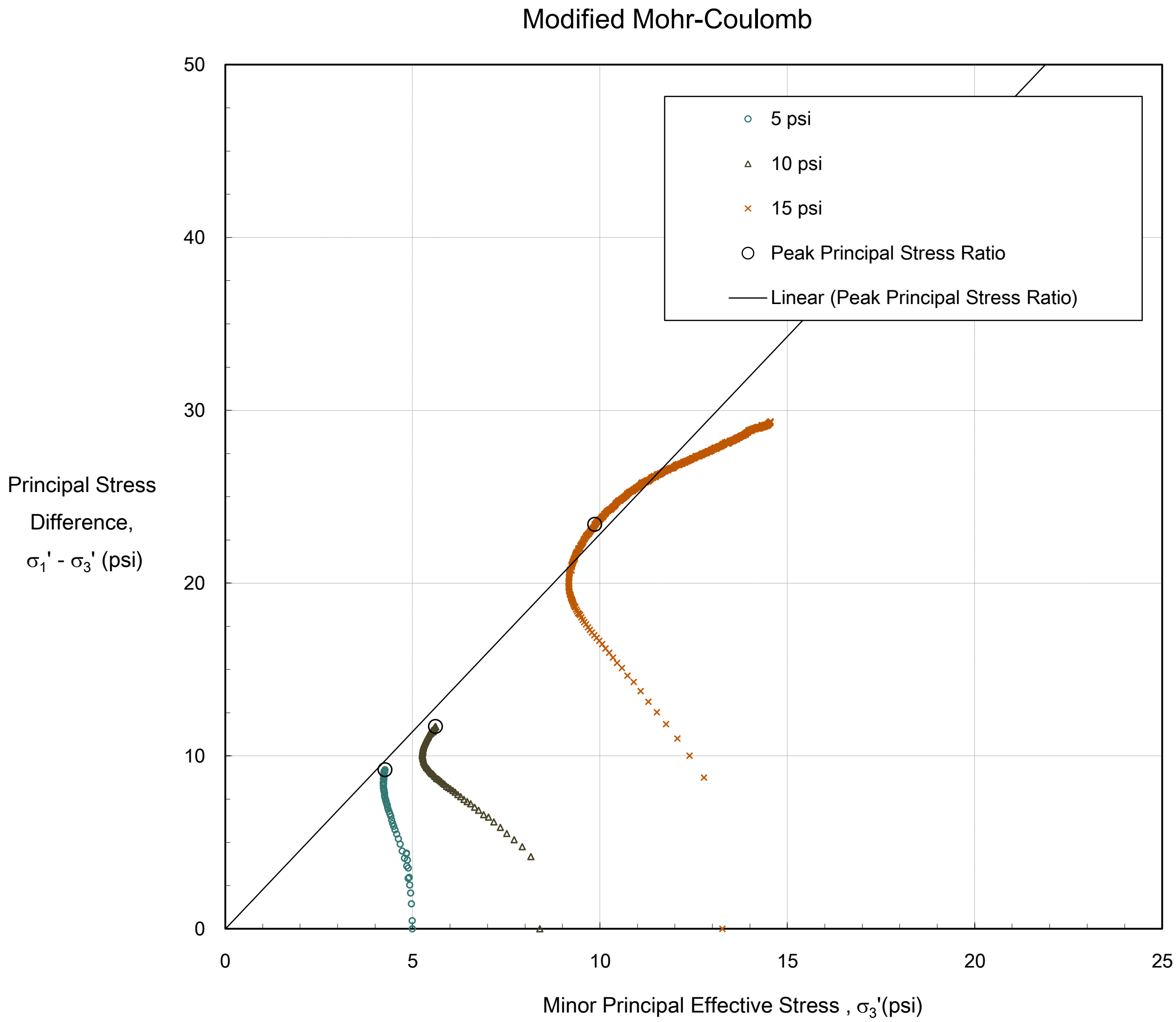
Note: Multi-stage testing was performed for this sample. The first two stages were terminated in accordance with stress path tangency and/or peak principal stress ratio.

Jeffrey A. Kuhn , Ph.D., P.E., 7/12/2016
Analysis & Quality Review/Date
Laboratory Staff: SOC & LC

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-5 (5-7)

TRI Log #: 21381
Test Method: ASTM D4767 Mod



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	32.3
Effective Cohesion (psi)	-	0 (Forced)

TRI ENVIRONMENTAL, INC.
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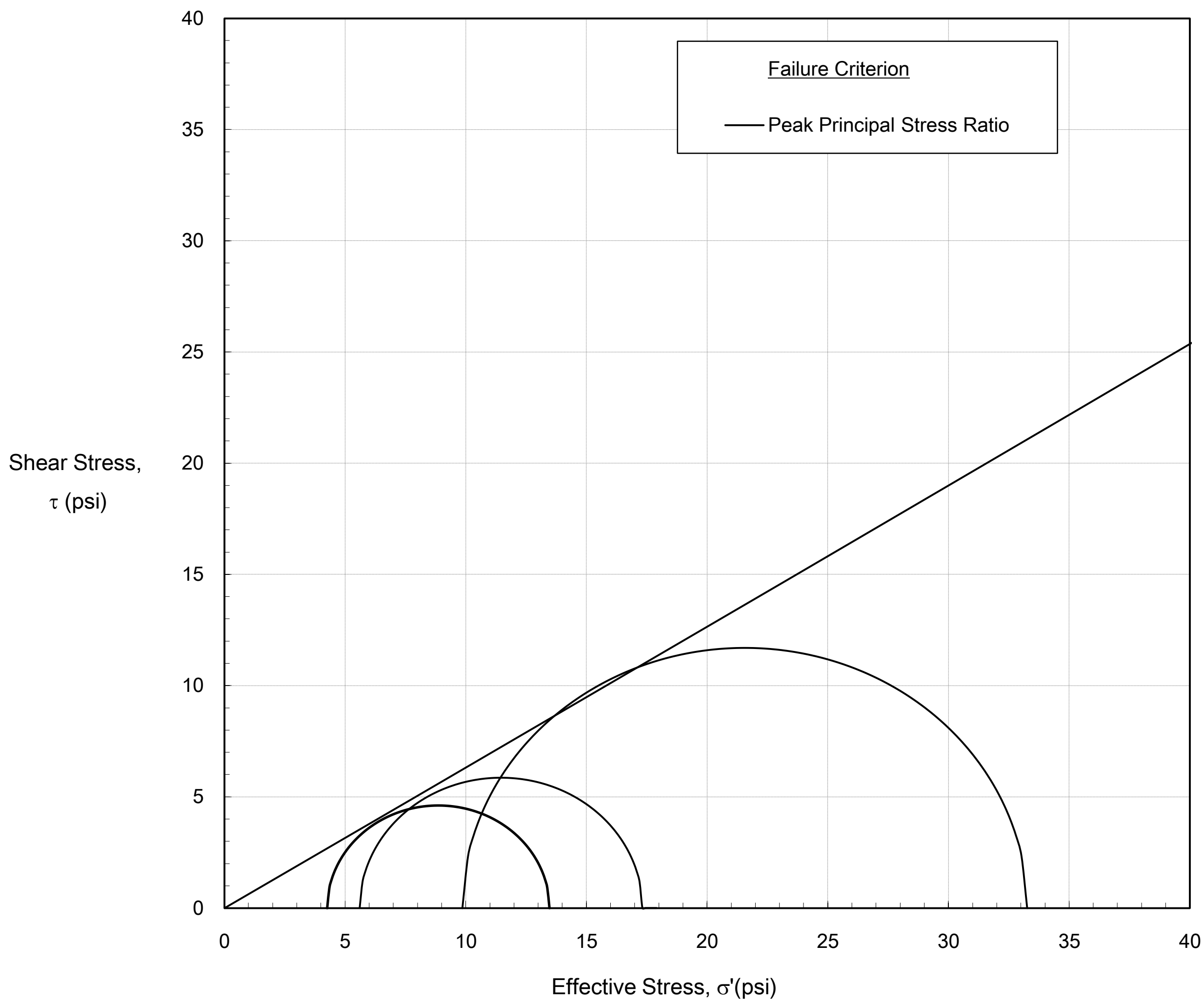
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-5 (5-7)

TRI Log #: 21381
Test Method: ASTM D4767 Mod

Mohr-Coulomb



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	32.3
Effective Cohesion (psi)	-	0 (Forced)

TRI ENVIRONMENTAL, INC.
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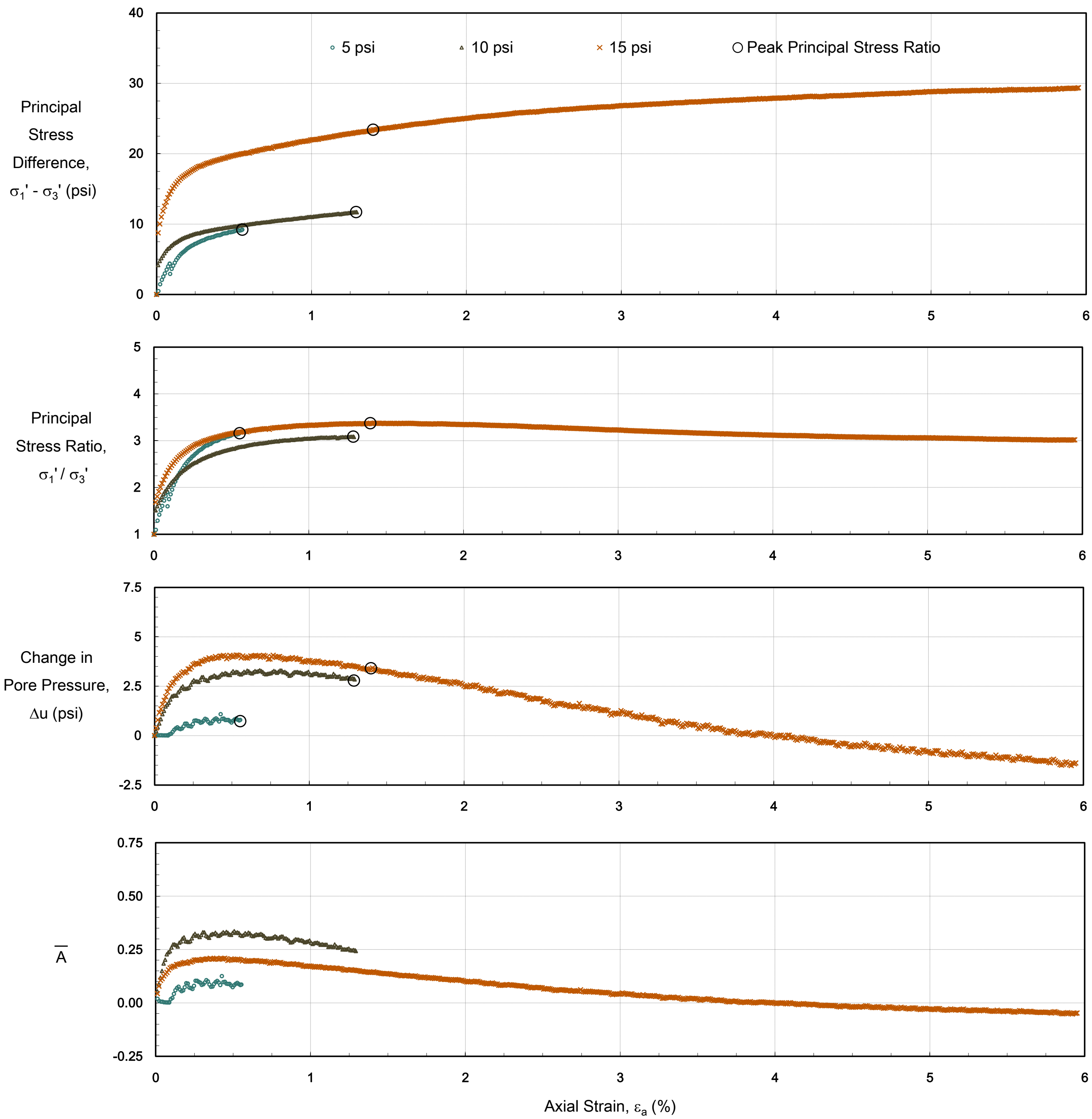
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-5 (5-7)

TRI Log #: 21381
Test Method: ASTM D4767 Mod

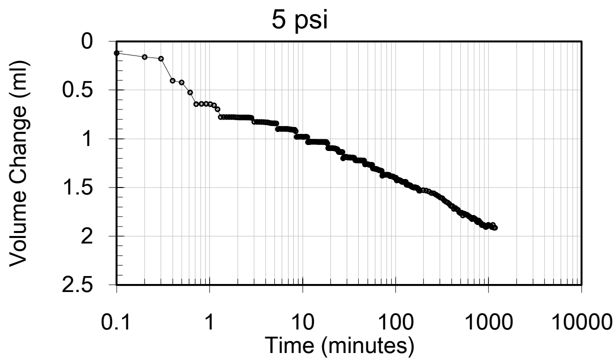


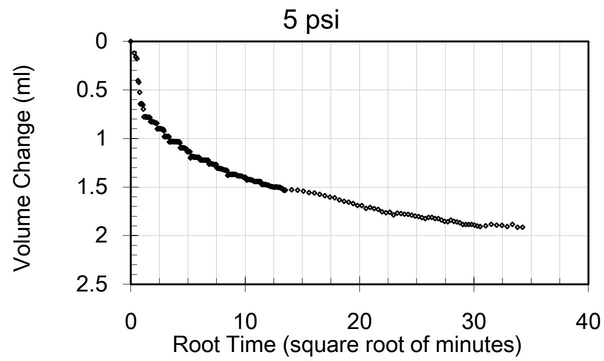
Multi-Stage Consolidated-Undrained Triaxial Compression

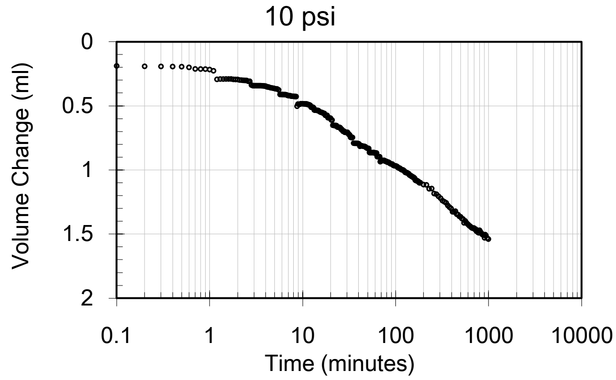
Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-5 (5-7)

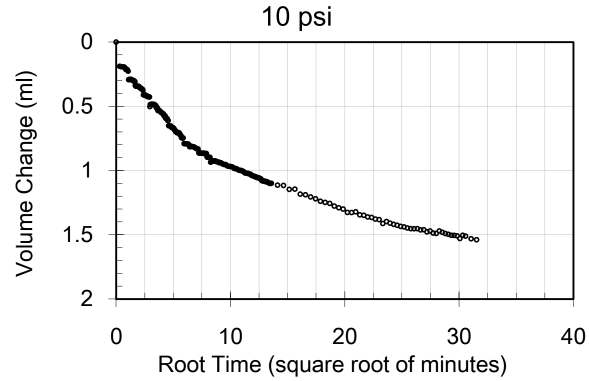
TRI Log #: 21381
Test Method: ASTM D4767 Mod

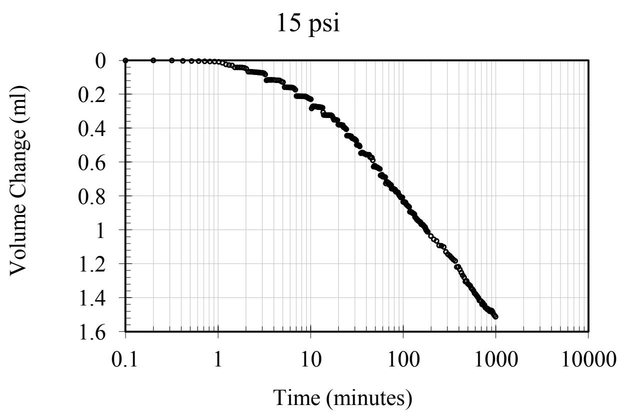
Consolidation

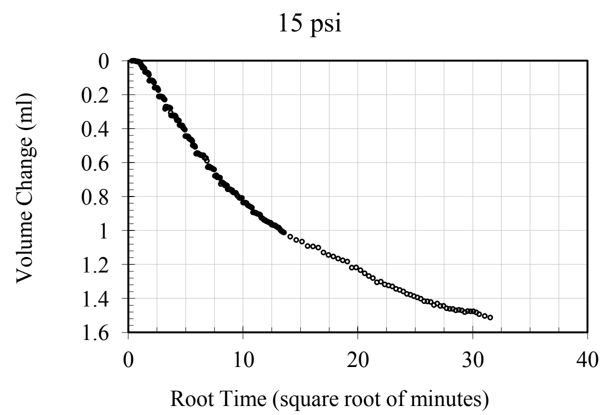










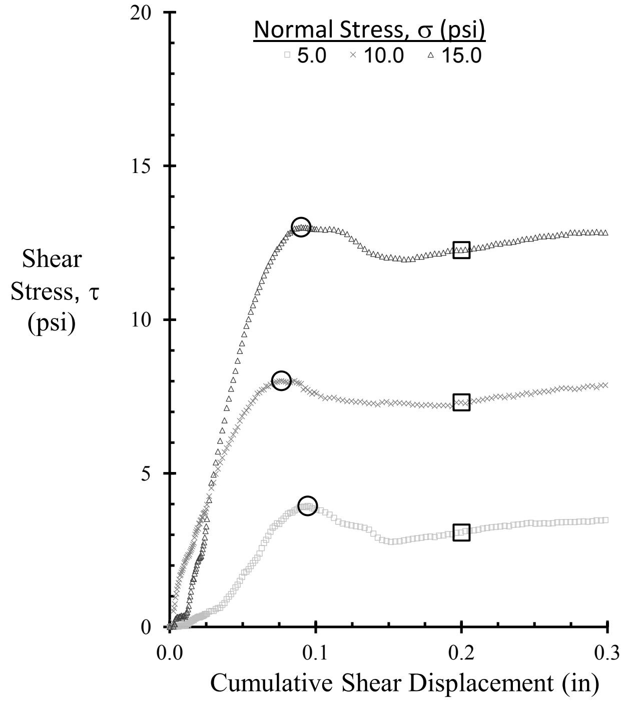


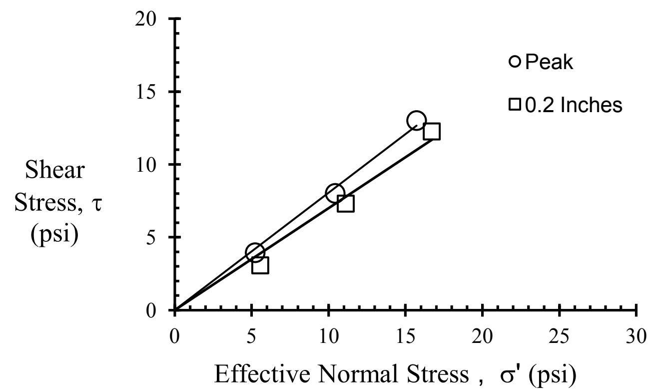
TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Direct Shear of Soil Under Consolidated-Drained Conditions

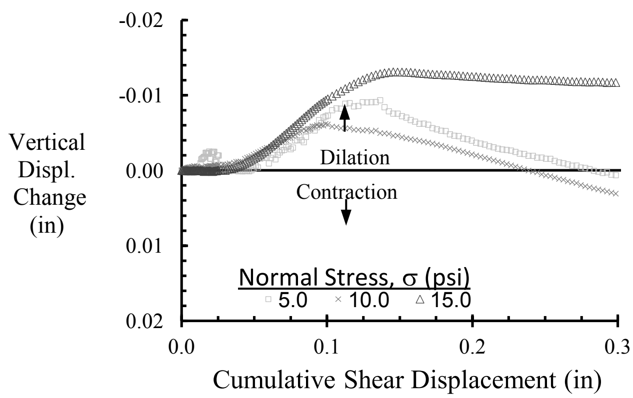
Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-5 (13-15)

TRI Log#: 21381
Test Method: ASTM D 3080





Note: Area Correction Has Been Applied



	Sample Number	1	2	3
Initial Condition	Diameter, in	2.50	2.50	2.50
	Height, in (before consol)	1.00	1.00	1.00
	Water Content, %	16.9	16.0	15.6
	Saturation, %	83.9	83.6	89.1
	Dry Density, pcf	107.9	109.7	112.9
	Void Ratio	0.53	0.51	0.46
Post Consol	Height, in (prior to shear)	1.00	1.00	1.00
	Final Water Content, %	21.1	20.9	19.2
	Dry Density, pcf	108.0	109.9	113.3
	Void Ratio	0.53	0.50	0.46
	Displacement rate (in/min)	6.0E-04	6.0E-04	6.0E-04
Peak	Normal Stress, σ' (psi)	5.23	10.43	15.72
	Shear Stress, τ (psi)	3.94	8.01	13.01
	Displacement (in)	0.09	0.08	0.09
	ϕ'_d, degrees	38.8		
	c'_d, psi	0 (Forced)		
Post-Peak	Normal Stress, σ' (psi)	5.56	11.12	16.70
	Shear Stress, τ (psi)	3.07	7.31	12.26
	Displacement (in)	0.20	0.20	0.20
	ϕ'_d, degrees	35.0		
	c'_d, psi	0 (Forced)		

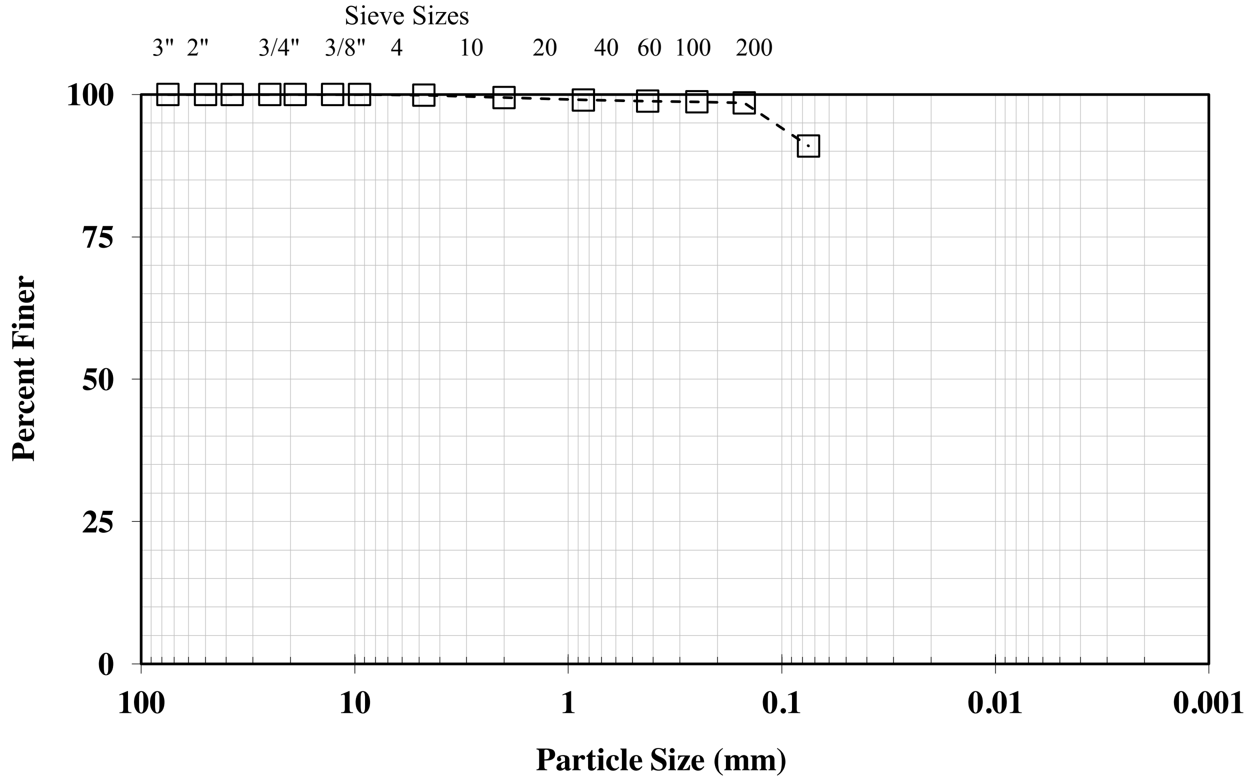
Note: The undisturbed soil samples were extruded and trimmed using a trimming turntable. A specific gravity of 2.65 was assumed for weight-volume calculations.

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/16
Analysis & Quality Review/Date
Test Performed By: LC

Particle Size Analysis for Soils

Client: Auckland Consulting LLC
Project: Winston Pond
Sample: B-5 (33-35)

TRI Log#: 21381.16
Test Method: ASTM D422



Sieve Analysis	
Sieve Size	Percent Passing
3 in. (76.2 mm)	100.0
2 in. (50.8 mm)	100.0
1.5 in. (38.1 mm)	100.0
1 in. (25.4 mm)	100.0
3/4 in. (19.0 mm)	100.0
1/2 in. (12.7 mm)	100.0
3/8 in. (9.51 mm)	100.0
No. 4 (4.76 mm)	99.9
No. 10 (2.00 mm)	99.5
No. 20 (0.841 mm)	99.0
No. 40 (0.420 mm)	98.8
No. 60 (0.250 mm)	98.7
No. 100 (0.149 mm)	98.5
No. 200 (0.074 mm)	90.9
Hydrometer Analysis	
Particle Size	Percent Passing
0.005 mm	- -
0.002 mm	- -

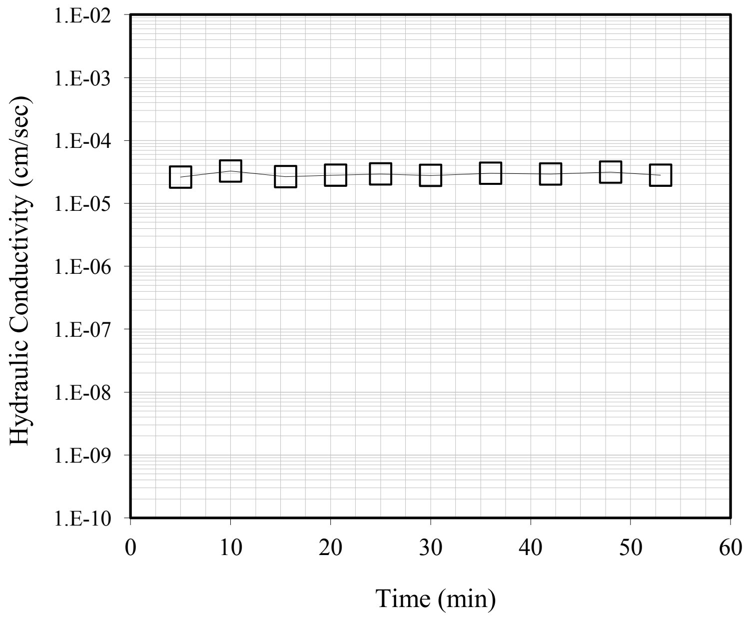
USCS Classification (ASTM D2487)	Silt (ML)	
As-Received Moisture Content (%)	(ASTM D2216)	27.1
Atterberg Limits (ASTM D4318, Method A : Multipoint)	Liquid Limit	28
	Plastic Limit	NP
	Plastic Index	- -
Notes: Specimen was air dried.. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM D4373)	- -

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Quality Review/Date
Tested by: KH & PC

Hydraulic Conductivity

Client: Auckland Consulting LLC
Project: Winston Pond
Sample ID: B-5: (33-35)

TRI Log #: 21381
Test Method: ASTM D5084 Method C



Initial Values	
Sample Condition	Undisturbed
Diameter (in)	2.80
Height (in)	2.55
Initial Mass (g)	500.5
Sample Area (in^2)	6.16
Water Content (%)	26.4
Total Unit Weight (pcf)	121.4
Dry Unit Weight (pcf)	96.1
Specific Gravity (Assumed)	2.65
Degree of Saturation	96.9
Void Ratio	0.72
Porosity	0.42
1 Pore Volume (cc)	107.8
Eff. Confining Stress (psi)	5.0
B-Value Prior to Permeation	0.99

Specimen Image

Time	Hydraulic Conductivity, K at 20° C
Min	cm/s
36.0	3.0E-05
42.0	2.9E-05
48.0	3.1E-05
53.0	2.8E-05
Average, Last 4 Readings	**3.0E-05**

Jeffrey A. Kuhn, Ph.D., P.E., 6/30/2016
Analysis & Quality Review/Date
Testing Performed By: SOC & LC

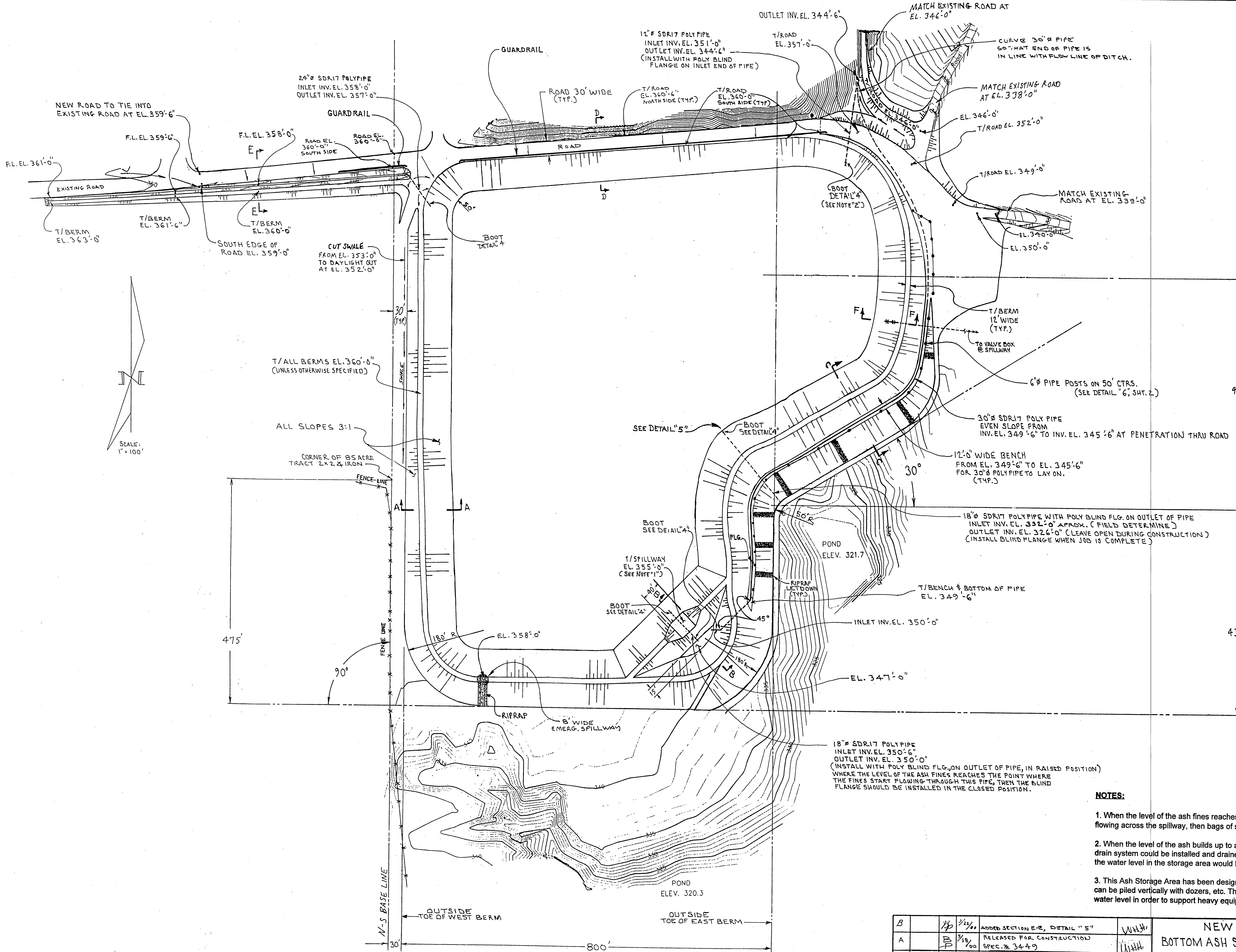
TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

REV	W.O.	BY	DATE	SUBJECT	APPROVED
B		BP	10/23/00	AS BUILT	
A		BP	5/18/00	RELEASED FOR CONSTRUCTION SPEC. # 3449	WHR
1		BP	3/17/00	(ADDENDUM #1) RELEASED FOR BIDS SPEC. # 3449	
		BP	3/10/00	RELEASED FOR BIDS	

NEW
BOTTOM ASH STORAGE AREA
WELSH POWER PLANT

SOUTHWESTERN ELECTRIC POWER CO.

DEPT. DIV.
APPROVED
DRWN. BY: BP DATE: 3-10-00
SCALE: AS SHOWN W.O.
SH. 2 of 2 DRWG. NO. WEPX-335



NOTES:

1. When the level of the ash fines reaches the point where the fines start flowing across the spillway, then bags of sackrete can be installed to raise the spillway elevation.

2. When the level of the ash builds up to approx. elev. 355 along the north and east sides, a french drain system could be installed and drained to this outlet to help hold the water table down. Of course the water level in the storage area would have to be at elev. 351 or above for the french drain to function.

3. This Ash Storage Area has been designed to hold the water level as low as possible so the ash can be piled vertically with dozers, etc. The ash level needs to be approx. 4 ft. to 5 ft. above the water level in order to support heavy equipment.

REV.	W.O.	BY	DATE	SUBJECT	APPROVED
C		BP	10-29-00	AS BUILT	
B		BP	5/24/00	ADDED SECTION E-E, DETAIL "5"	WHH
A		BP	5/18/00	RELEASED FOR CONSTRUCTION SPEC. # 3449	WHH
1		BP	4/13/00	RELEASED FOR BIDS SPEC. #3449 (ADDENDUM #1)	
		BP	3-10-00	RELEASED FOR BIDS	

NEW BOTTOM ASH STORAGE AREA
WELSH POWER PLANT

SOUTHWESTERN ELECTRIC POWER CO.

DEPT.	
DIV.	
APPROVED	
DRWN. BY: BP	DATE: 3-10-00
SCALE: 1"=100'	W.O.
SH. 1 of 2	DRWG. NO. WEPX-335