Geotechnical Subsurface Data Report

S-13-108 (Outen Rd.) Bridge Replacement over Brown Creek

Chesterfield County, SC

September 23, 2022

September 23, 2022

Mr. Trapp Harris, PE, DBIA
Geotechnical Engineer
Alternative Delivery
South Carolina Department of Transportation
955 Park Street
Columbia, SC 29201

Dear Mr. Harris,

We have completed the Geotechnical Subsurface Data Report for the S-13-108 (Outen Rd.) Bridge Replacement over Brown Creek in Chesterfield County, SC. Please call at your convenience if you have questions or comments. HDR appreciates the opportunity to provide geotechnical engineering services to the South Carolina Department of Transportation.

Sincerely,
HDR

Kiera Hughes, E.I.T.
Engineer-in-Training

Lila Leon, P.E., Ph.D.
Senior Geotechnical Engineer

SOUTH CAROLINA
HDR ENGINEERING, INC. OF THE CAROLINAS
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CERTIFICATE OF AUTHORIZATION

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Contents

1 Introduction 1
1.1 Project Description 1
2 Investigative Procedures 1
2.1 Drilling and Sampling 1
2.2 Groundwater Conditions 2
2.3 Field Testing Summary 2
3 Laboratory Test Program 2
3.1 Soil Properties 3
4 Limitations to Report 3
5 References 4

Tables

Table 2-1. Field Soil Testing Summary 2
Table 3-1. Laboratory Testing Summary 3

Appendices

Appendix A. Site Vicinity Map, Test Location Plan

Appendix B. Boring Logs

Appendix C. Laboratory Testing

Appendix D. SPT Hammer Energy Calibration Report

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1 Introduction

This Geotechnical Subsurface Data Report (GSDR) provides a characterization of the subsurface conditions to the South Carolina Department of Transportation (SCDOT) for the proposed S-13-108 Bridge Replacement over Brown Creek, in Chesterfield County, South Carolina. The proposed bridge intends to replace the existing bridge over Brown Creek on Outen Road.

This Geotechnical Subsurface Data Report was prepared in general accordance with the 2022 SCDOT Geotechnical Design Manual (GDM) and PCDM-11 Supplemental Design Criteria for Low Volume Bridge Replacement Projects. Geotechnical data including standard penetration testing (SPT), bulk sampling, and a variety of laboratory tests are presented herein to provide geological features and site conditions for the design of the proposed bridge. Geotechnical recommendations are not included in this report.

1.1 Project Description

The project site is located approximately two miles northeast of Pageland, approximately a mile south of the South Carolina/North Carolina State Line. It is bound to the west by U.S. Route 601 and to the east by State Road S-13-445. It is placed within an area experiencing a low volume of traffic. A Site Vicinity Map is included in Appendix A.

The existing bridge over Brown Creek is approximately 45 feet in length and 32 feet wide and will be removed and replaced with a new bridge along the existing alignment. The proposed multi span replacement bridge will be approximately 180 feet in length and will accommodate two 11-foot lanes with 4-foot shoulders. Construction is anticipated to be completed with a temporary detour of traffic.

2 Investigative Procedures

The geotechnical subsurface exploration at the project site was performed by F&ME Consultants in August 2022. The subsurface investigation consisted of standard penetration test (SPT) borings, and bulk sample soil collection.

A test location plan showing all testing locations is included in Appendix A. The boring logs from the subsurface investigation are included in Appendix B.

2.1 Drilling and Sampling

A total of two (2) SPT borings were performed during the subsurface investigation, B-19 and B-20. Auger refusal was encountered in both borings at depths of 98.6 feet and 95.8 feet, respectively. The borings were terminated at depths of 98.6 feet and 95.8 feet.

The boring logs from the subsurface investigations are included in Appendix B. The borings were advanced by a CME 45B using mud rotary and driven casing drilling techniques. Soil sampling and penetration testing was performed in general accordance with ASTM D-1586 and ASTM D-1587. SPT’s were typically conducted continuously in the

top 10 feet of each boring followed by 5-foot intervals thereafter until auger refusal was encountered. SPT's were carried out utilizing a standard 1.4-inch I.D., 2-inch O.D, split barrel, or split-spoon sampler. Blow counts recorded at these intervals were produced from SPT hammer with energy ratio of 81.4%. The hammer energy ratio is identified on each boring log. SPT hammer energy measurements on the CME 45B drill rig were performed with a pile driving analyzer (PDA) and the SPT Hammer Energy Calibration Report is included in Appendix D.

One (1) bulk sample was obtained at boring BS-4 collectively from 5 feet below the existing ground surface from auger cuttings.

Recovered SPT and bulk sample were sent to the F&ME laboratory for testing.

2.2 Groundwater Conditions

The stabilized groundwater level recorded approximately 24 hours after completion of investigation operations indicated the groundwater depth of boring B-20 at 11.1 feet. This depth corresponds to elevation 386.4 feet.

The reported groundwater level is interpreted to be dependent upon seasonal fluctuations, individual event intensity and/or level of Brown Creek.

2.3 Field Testing Summary

The field testing locations and other pertinent information are summarized in Table 2-1 below, and are also plotted on the field test location plan included in Appendix A.

Table 2-1. Field Soil Testing Summary

Test Hole No.	Station[a]	Offset (ft)	Latitude	Longitude	Top of Boring Elevation (ft)	Test Type	Total Depth (ft)
B-19	117+81	6 RT	34.80375	-80.37560	397.8	SPT/RC	98.6
B-20	118+39	7 RT	34.80389	-80.37568	397.5	SPT/RC	95.8
BS-4	117+81	6 RT	34.80375	-80.37560	397.8	BULK	5.0

[a] Stations based on latest S-13-108 alignment.

3 Laboratory Test Program

Laboratory testing was performed by F&ME Consultants on representative samples collected from the geotechnical borings to obtain index and engineering properties. Geotechnical index property testing included natural moisture content, Atterberg limits, #200 wash, and sieve analysis. Engineering property tests included consolidated undrained (CU) triaxial compression, Standard Proctor, and corrosion series testing.

Laboratory testing was performed in general accordance with ASTM or AASHTO test procedures. Representative samples were classified in accordance with the AASHTO and

Unified Soil Classification System (USCS). Table 3-1 summarizes the testing types and quantity of each test performed. For detailed laboratory information, refer to Appendix C.

Table 3-1. Laboratory Testing Summary

Test Type	Quantity
Natural Moisture Content	9
Atterberg Limits	8
Grain Size Analysis with Hydrometer	2
Grain Size Analysis with #200 Wash	6
#200 Wash	1
CU Triaxial	1
Standard Proctor	1
Corrosion Series	1

3.1 Soil Properties

Split spoon soil samples from the preliminary geotechnical subsurface site exploration for this bridge site were grouped and classified into AASHTO and USCS soil classifications. According to the AASHTO Soil Classification System, the classifications of these samples ranged from A-2-6 to A-7-6. According to the Unified Soil Classification System, the classifications of these samples ranged from clayey sand (SC) to lean clay (CL). Tested samples yielded liquid limits ranging from 30 to 42 and plasticity indices ranging from 10 to 21.

Corrosion series test were performed on select split spoon samples. Standard proctor testing and remolded CU triaxial tests were performed on the collected bulk sample. Results of laboratory testing are included in Appendix C.

4 Limitations to Report

This report has been prepared for the exclusive use of the South Carolina Department of Transportation or their agent, for specific application to the proposed S-13-108 Bridge over Brown Creek in Chesterfield County, South Carolina in accordance with generally accepted soil and foundation engineering practices. No other warranty expressed or implied is made. The subsurface investigation logs included herein, do not reflect variations in subsurface conditions which could exist intermediate of the boring locations or in unexplored areas of the site. Should such variations become apparent during construction, it will be necessary to perform additional subsurface exploration based upon on-site observations of the conditions.

5 References

Butler, J.R. (1991). "Metamorphism". In Horton, J.W., Jr., and Zullo, V.A., Eds., the Geology of the Carolinas: Knoxville, University of Tennessee Press: 127.

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Horton, J Wright, and Dicken, Connie L., 2001, Preliminary Geologic Map of the Appalachian Piedmont and Blue Ridge, South Carolina Segment; U.S. Geological Survey, Open-File Report 01-298, CD, scale 1:500,00.

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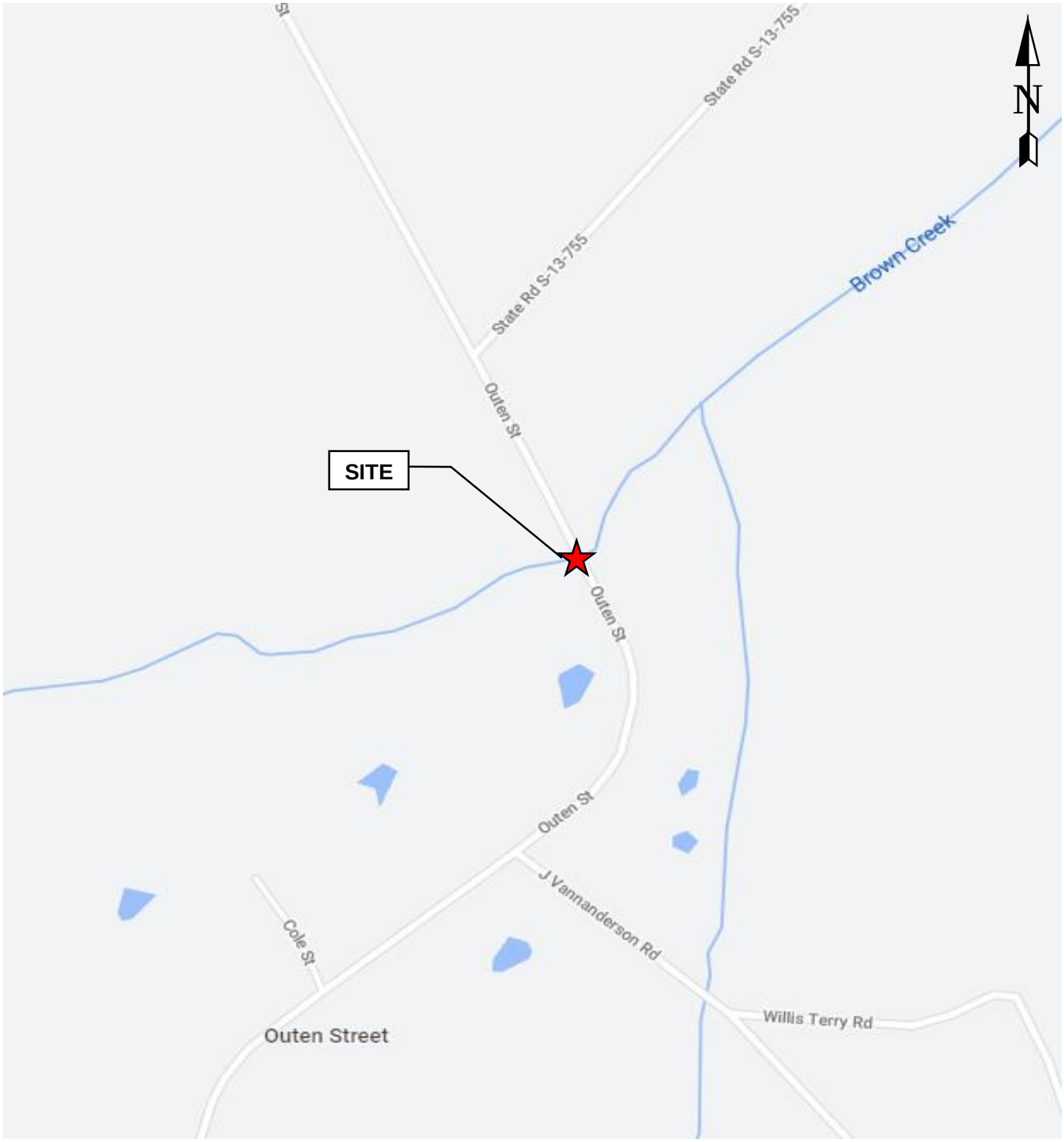
SCDOT (2022) “Geotechnical Design Manual”, Version 3.0; https://www.scdot.org/business/pdf/geotech/SCDOT-Geotechnical-Design-Manual-2022.pdf

Appendix A. Site Vicinity Map, Test Location Plan



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S-13-108 (Outen Rd.) over Brown Creek

COUNTY	SITE VICINITY MAP
CHESTERFIELD	Source: Google Maps

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S-13-108 (Outen Rd.) over Brown Creek

COUNTY	FIELD TEST LOCATION PLAN
CHESTERFIELD	Source: Google Earth

Appendix B. Boring Logs

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

SCDOT Soil Test Log Descriptors

a - **Relative Density / Consistency Terms**

Relative Density[1]

Descriptive Term	Relative Density	SPT Blow Count
Very Loose	0 to 15%	< 4
Loose	16 to 35%	5 to 10
Medium Dense	36 to 65%	11 to 30
Dense	66 to 85%	31 to 50
Very Dense	86to 100%	>51

Consistency[2]

Descriptive Term	Unconfined Compression Strength (q_u) (tsf)	SPT Blow Count
Very Soft	<0.25	<2
Soft	0.26 to 0.50	3 to 4
Firm	0.51 to 1.00	5 to 8
Stiff	1.01 to 2.00	9 to 15
Very Stiff	2.01 to 4.00	16 to 30
Hard	>4.01	> 31

b **Moisture Condition**

Descriptive Term	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually in coarse-grained soils below the water table

c **Color**

Describe the sample color while sample is still moist, using Munsell color chart.

d **Angularity**[1]

Descriptive Term	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

e **HCl Reaction**[3]

Descriptive Term	Criteria
None Reactive	No visible reaction
Weakly Reactive	Some reaction, with bubbles forming slowly
Strongly Reactive	Violent reaction, with bubbles forming immediately

f **Cementation**[3]

Descriptive Term	Criteria
Weakly Cemented	Crumbles or breaks with handling or little finger pressure
Moderately Cemented	Crumbles or breaks with considerable finger pressure
Strongly Cemented	Will not crumble or break with finger pressure

g **Particle-Size Range**[1]

Gravel

	mm	Sieve size
Fine	4.76 to 19.1	#4 to ¾ inch
Coarse	19.1 to 76.2	¾ inch to 3 inch

Sand

	mm	Sieve size
Fine	0.074 to 0.42	#200 to #40
Medium	0.42 to 2.00	#40 to #10
Coarse	4.00 to 4.76	#10 to #4

h **Primary Soil Type**[1, 2]

The primary soil type will be shown in all capital letters

i **USCS Soil Designation**

Indicate USCS soil designation as defined in ASTM D-2487 and D-2488

j **AASHTO Soil Designation**

Indicate AASHTO soil designation as defined in AASHTO M-145 and ASTM D-3282

[1]Applies to coarse-grained soils (major portion retained on No. 200 sieve)
[2]Appiles to fine-grained soils (major portion passing No. 200 sieve)
[3]Use as required

Figure 6-15, SCDOT Soil Test Log Descriptors – Soil

Appendix B. Subsurface Investigation

Boring Logs

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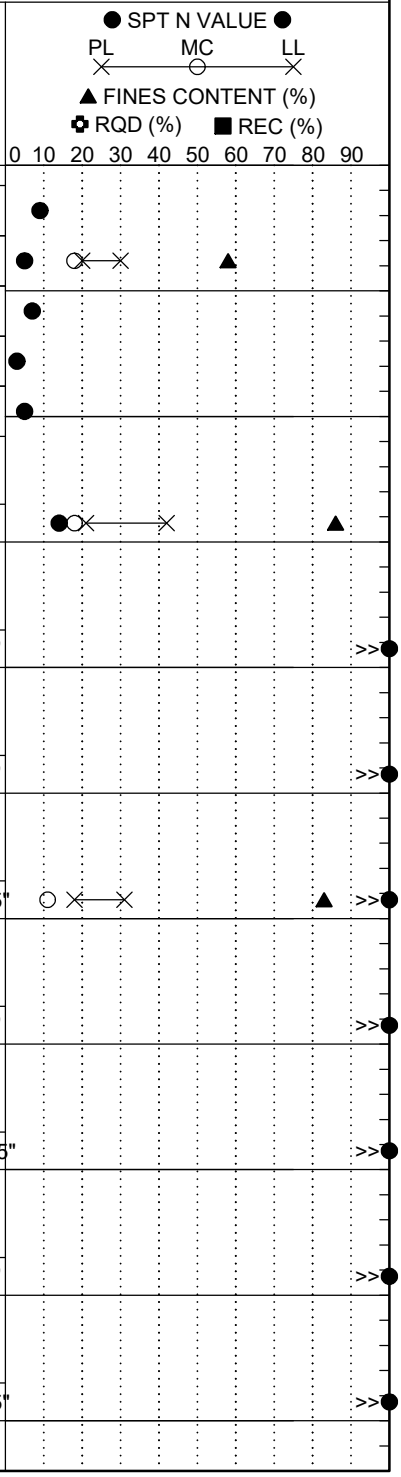
SCDOT Soil Test Log

Project ID:	P041181	**County:**	Chesterfield, SC	**Boring No.:**	B-19
Site Description:	S-13-108 (Outen Rd.) over Brown Creek			**Route:**	S-13-108
Eng./Geo.:	N. Yacobi /HDR	**Boring Location:**	117+81	**Offset:**	6 RT
Alignment:	S-13-108				
Elev.:	397.8 ft	**Latitude:**	34.80375	**Longitude:**	-80.3756
Date Started:	8/2/2022				
Total Depth:	98.6 ft	**Soil Depth:**	98.6 ft	**Core Depth:**	0 ft
Date Completed:	8/2/2022				
Bore Hole Diameter (in):	4"	**Sampler Configuration**		**Liner Required:**	Y (N)
Liner Used:	Y (N)				
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic
Energy Ratio:	81.4%				
Core Size:	NQ	**Driller:**	L. Guempel/ F&ME	**Groundwater:**	**TOB** N.M.
24HR	N.M.				

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION
	0.0	
	0.8	0.8' ASPHALT
	2.8	**ROADWAY FILL** - Loose, dry, brown, subangular, fine to coarse grained, SAND (SP), contains wood fragments. 7.5YR4/3
392.8	6.8	Firm, moist, brown and red, Sandy Lean CLAY (CL/A-4). 7.5YR4/4 2.5YR4/6 LL=30, PL=20, PI=10, NMC=18.4, %200=58.0
387.8		**RESIDUUM** - Firm to stiff, wet, brownish red, weakly to moderately cemented, Lean CLAY (CL/A-7-6). 2.5YR4/4 LL=42, PL=21, PI=21, NMC=18.1, %200=86.3 (%Silt=45.6, %Clay=40.7)
382.8	17.0	Hard, wet, dark red and brown, moderately cemented, Lean CLAY with sand (CL/A-6). 2.5YR3/6 7.5YR4/4 LL=31, PL=18, PI=13, NMC=10.9, %200=82.7
377.8		
372.8		
367.8	32.0	**PARTIALLY WEATHERED ROCK (PWR)** Hard, wet, light gray, red and brown, highly cemented, Lean CLAY (CL/A-6) with rock fragments. 5YR7/1 2.5YR3/6 7.5YR4/4
362.8		
357.8		
352.8		SS-12: no recovery
347.8		

Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
0.8	SS-1	8	6	3	4	9
2.8	SS-2	5	3	2	2	5
4.8	SS-3	3	3	4	5	7
6.8	SS-4	1	2	1	1	3
8.8	SS-5	1	2	3	2	5
13.5	SS-6	4	6	8		14
18.5	SS-7	50/1"				50/1"
23.5	SS-8	50/1"				50/1"
28.5	SS-9	50/1.5"				50/1.5"
33.5	SS-10	50	50/2"			50/2"
38.5	SS-11	50/1.25"				50/1.25"
43.5	SS-12	50/1"				50/1"
48.5	SS-13	50/1.5"				50/1.5"



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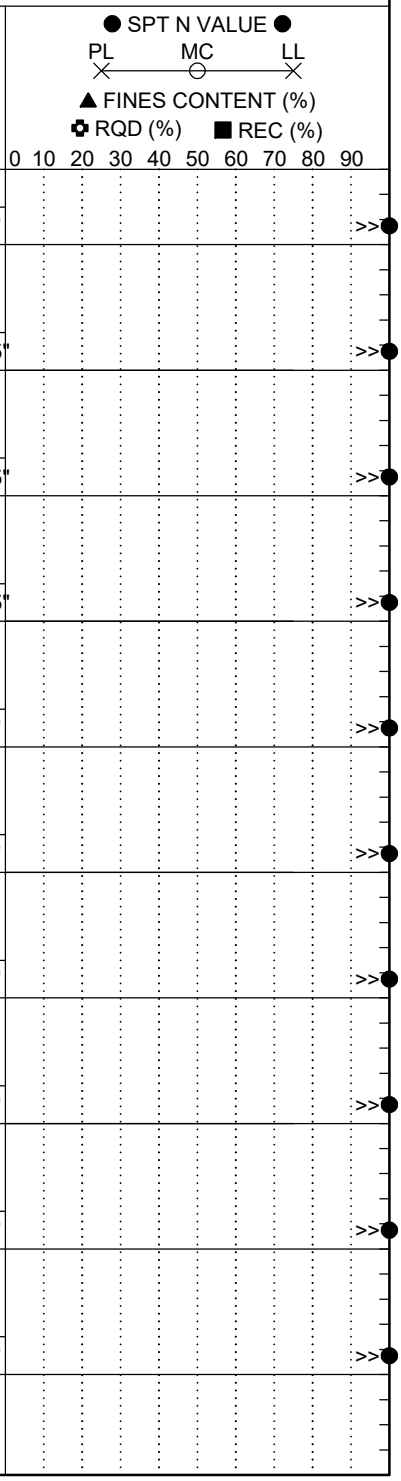
SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P041181			**County:**	Chesterfield, SC	**Boring No.:**	B-19
Site Description:	S-13-108 (Outen Rd.) over Brown Creek					**Route:**	S-13-108
Eng./Geo.:	N. Yacobi /HDR	**Boring Location:**	117+81	**Offset:**	6 RT	**Alignment:**	S-13-108
Elev.:	397.8 ft	**Latitude:**	34.80375	**Longitude:**	-80.3756	**Date Started:**	8/2/2022
Total Depth:	98.6 ft	**Soil Depth:**	98.6 ft	**Core Depth:**	0 ft	**Date Completed:**	8/2/2022
Bore Hole Diameter (in):	4"	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	81.4%
Core Size:	NQ	**Driller:**	L. Guempel/ F&ME	**Groundwater:**	**TOB** N.M.	**24HR**	N.M.

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
			53.5	SS-14	50/1"				50/1"
342.8									
			58.5	SS-15	50/1.5"				50/1.5"
337.8									
			63.5	SS-16	50/1.5"				50/1.5"
332.8									
		SS-17: no recovery	68.5	SS-17	50/0.5'				50/0.5"
327.8									
			73.5	SS-18	49	8	50/5"		50/5"
322.8									
			78.5	SS-19	50/2"				50/2"
317.8									
		SS-20: no recovery	83.5	SS-20	50/2"				50/2"
312.8									
		SS-21: no recovery	88.5	SS-21	50/1"				50/1"
307.8									
		SS-22: no recovery	93.5	SS-22	50/1"				50/1"
302.8									
	98.6	SS-23: no recovery	98.5	SS-23	50/1"				50/1"
297.8		Boring Terminated at 98.6 ft (Elev. 299.2')							



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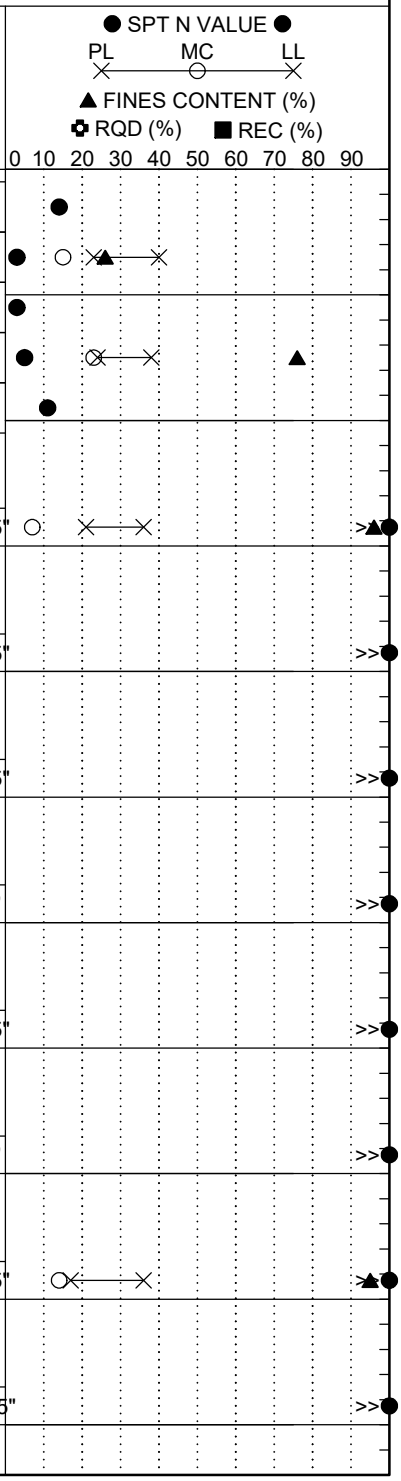
SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P041181			**County:**	Chesterfield, SC	**Boring No.:**	B-20
Site Description:	S-13-108 (Outen Rd.) over Brown Creek					**Route:**	S-13-108
Eng./Geo.:	N. Yacobi /HDR	**Boring Location:**	118+39	**Offset:**	7 RT	**Alignment:**	S-13-108
Elev.:	397.5 ft	**Latitude:**	34.80389	**Longitude:**	-80.37568	**Date Started:**	8/1/2022
Total Depth:	95.8 ft	**Soil Depth:**	95.8 ft	**Core Depth:**	0 ft	**Date Completed:**	8/1/2022
Bore Hole Diameter (in):	2.97"	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	81.4%
Core Size:	NQ	**Driller:**	L. Guempel/ F&ME	**Groundwater:**	**TOB** N.M.	**24HR**	11.1 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION
	0.0	
	0.5	0.5' ASPHALT
	2.5	**ROADWAY FILL** - Medium dense, dry, brown, subangular, fine to coarse grained, SAND with clay (SP-SC). 7.5YR4/3
392.5	6.5	Very loose, wet, brown and orange, subangular, fine to coarse grained, Clayey SAND (SC/A-2-6). 7.5YR4/4 5YR6/8 LL=40, PL=23, PI=17, NMC=15.1, %200=25.7
387.5	12.0	**RESIDUUM** - Firm, wet, brown, orange and dark red, moderately cemented, Lean CLAY with sand (CL/A-6). 7.5YR4/4 5YR6/8 2.5YR3/6 LL=38, PL=24, PI=14, NMC=22.9, %200=75.8 (%Silt=43.1, %Clay=32.7)
382.5		
377.5		Hard, wet, dark red/brown/gray, moderately to highly cemented, Lean CLAY (CL/A-6). 2.5YR3/3 10R5/1 LL=36, PL=21, PI=15, NMC=7.4, %200=96.2
372.5		
367.5		
362.5		SS-10: no recovery
357.5		
352.5		SS-12: LL=36, PL=17, PI=19, NMC=13.8, %200=94.6
	47.0	**PARTIALLY WEATHERED ROCK (PWR)**
347.5		Hard, wet, dark red and brown, highly cemented, Lean CLAY (CL/A-6) with rock fragments. 2.5YR3/6 7.5YR4/4

Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
0.5	SS-1	6	8	6	5	14
2.5	SS-2	3	2	1	2	3
4.5	SS-3	2	1	2	1	3
6.5	SS-4	1	2	3	4	5
8.5	SS-5	1	3	8	11	11
13.5	SS-6	50/2.5"				50/2.5"
18.5	SS-7	50/3.5"				50/3.5"
23.5	SS-8	50/3.5"				50/3.5"
28.5	SS-9	50/2"				50/2"
33.5	SS-10	50/0.5"				50/0.5"
38.5	SS-11	50/2"				50/2"
43.5	SS-12	50/1.5"				50/1.5"
48.5	SS-13	50/0.75"				50/0.75"



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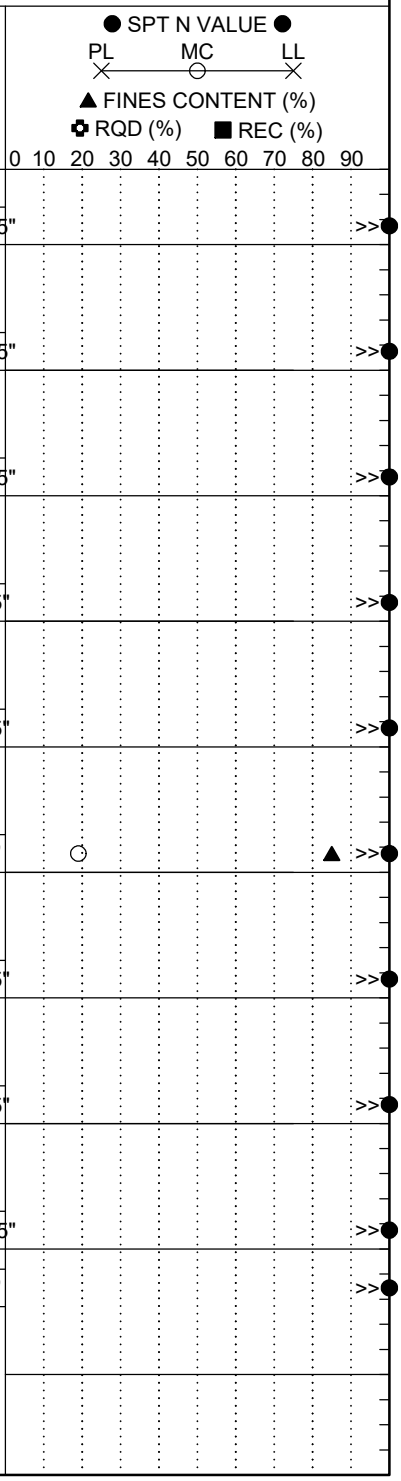
LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P041181			**County:**	Chesterfield, SC	**Boring No.:**	B-20
Site Description:	S-13-108 (Outen Rd.) over Brown Creek					**Route:**	S-13-108
Eng./Geo.:	N. Yacobi /HDR	**Boring Location:**	118+39	**Offset:**	7 RT	**Alignment:**	S-13-108
Elev.:	397.5 ft	**Latitude:**	34.80389	**Longitude:**	-80.37568	**Date Started:**	8/1/2022
Total Depth:	95.8 ft	**Soil Depth:**	95.8 ft	**Core Depth:**	0 ft	**Date Completed:**	8/1/2022
Bore Hole Diameter (in):	2.97"	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	81.4%
Core Size:	NQ	**Driller:**	L. Guempel/ F&ME	**Groundwater:**	**TOB** N.M.	**24HR**	11.1 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
342.5			53.5	SS-14	50/0.75"				50/0.75"
337.5		SS-15: no recovery	58.5	SS-15	50/0.75"				50/0.75"
	62.0	Hard, wet, dark red, highly cemented, Lean CLAY (CL/A-6) with gravel. 10R3/6	63.5	SS-16	50/0.75"				50/0.75"
332.5									
327.5		SS-17: no recovery	68.5	SS-17	50/0.5"				50/0.5"
322.5			73.5	SS-18	50/0.5"				50/0.5"
317.5		SS-19: NMC=18.5, %200=84.9	78.5	SS-19	50/1"				50/1"
312.5			83.5	SS-20	50/1.5"				50/1.5"
	87.0	Hard, wet, dark red and brown, highly cemented, Lean CLAY (CL/A-6) with rock fragments. 2.5YR3/6 5YR4/4	88.5	SS-21	50/1.5"				50/1.5"
307.5									
302.5		SS-22, SS-23: No recovery.	93.5	SS-22	50/0.75"				50/0.75"
	95.8	Auger & Split-spoon Refusal at 95.8'	95.8	SS-23	50/0"				50/0"
		Boring Terminated at 95.8 ft (Elev. 301.7')							
297.5									



LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

Appendix C. Laboratory Testing

SUMMARY OF LABORATORY RESULTS

PROJECT ID P041181 **PROJECT NAME** S-13-108 (Outen Rd.) over Brown Creek

PROJECT COUNTY Chesterfield, SC

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-19	4.8	30	20	10	0.075	58	CL	18.4			
B-19	15.0	42	21	21	0.075	86	CL	18.1			
B-19	20.0	31	18	13	0.075	83	CL	10.9			
B-19	25.0	31	18	13	0.075	83	CL	10.9			
B-19	30.0	31	18	13	0.075	83	CL	10.9			
B-20	4.5	40	23	17	0.075	26	SC	15.1			
B-20	8.5	38	24	14	0.075	76	CL	22.9			
B-20	15.0	36	21	15	0.075	96	CL	7.4			
B-20	40.0	36	17	19	0.075	95	CL	13.8			
B-20	45.0	36	17	19	0.075	95	CL	13.8			

INDEX PROPERTIES VERSUS DEPTH

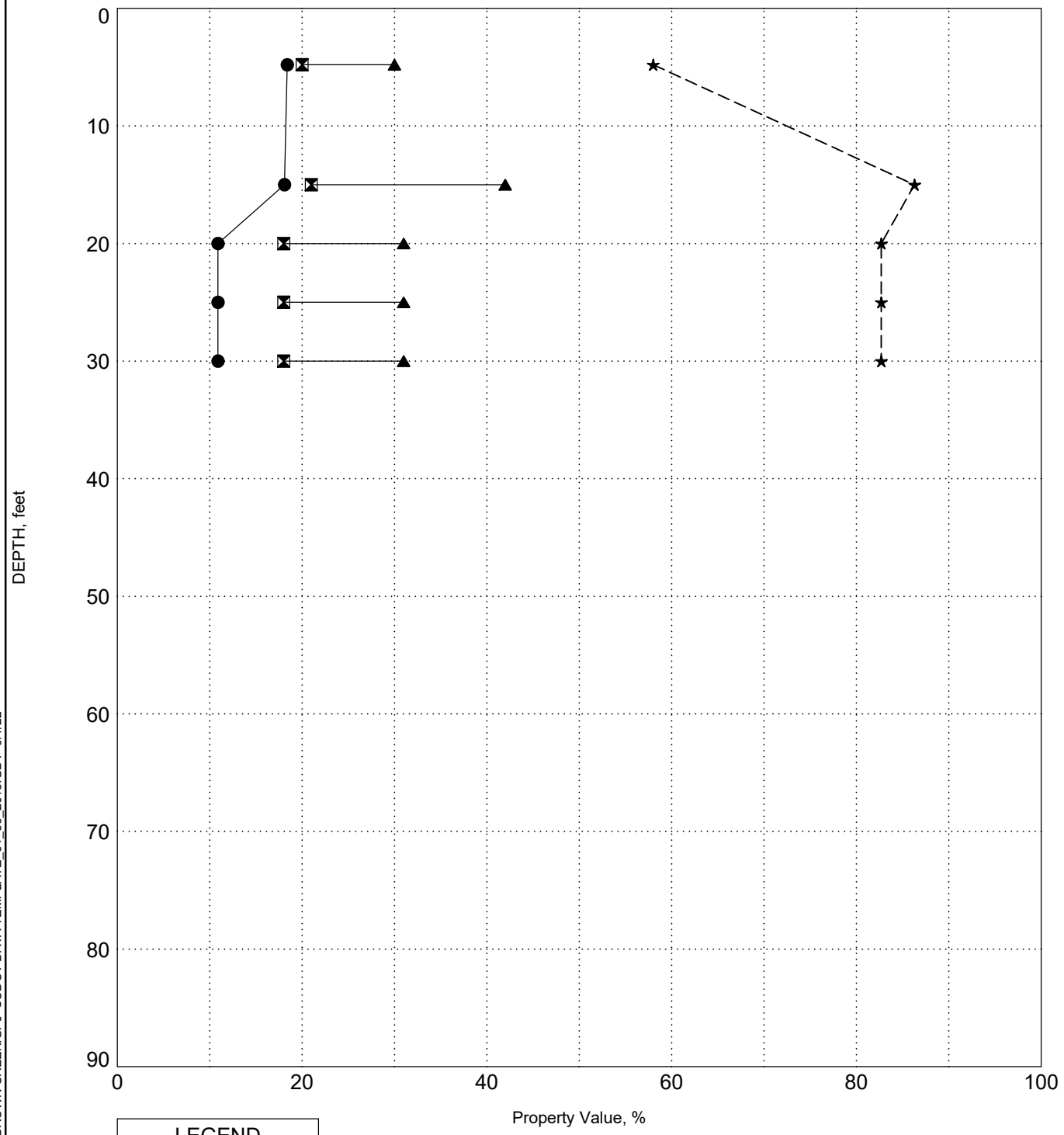
PROJECT ID P041181

PROJECT NAME S-13-108 (Outen Rd.) over Brown Creek

PROJECT COUNTY Chesterfield, SC

BORING B-19

SURFACE ELEVATION: 397.8



LEGEND
● Water Content
⊠ Plastic Limit
▲ Liquid Limit
★ Fines

INDEX PROPERTIES VERSUS DEPTH

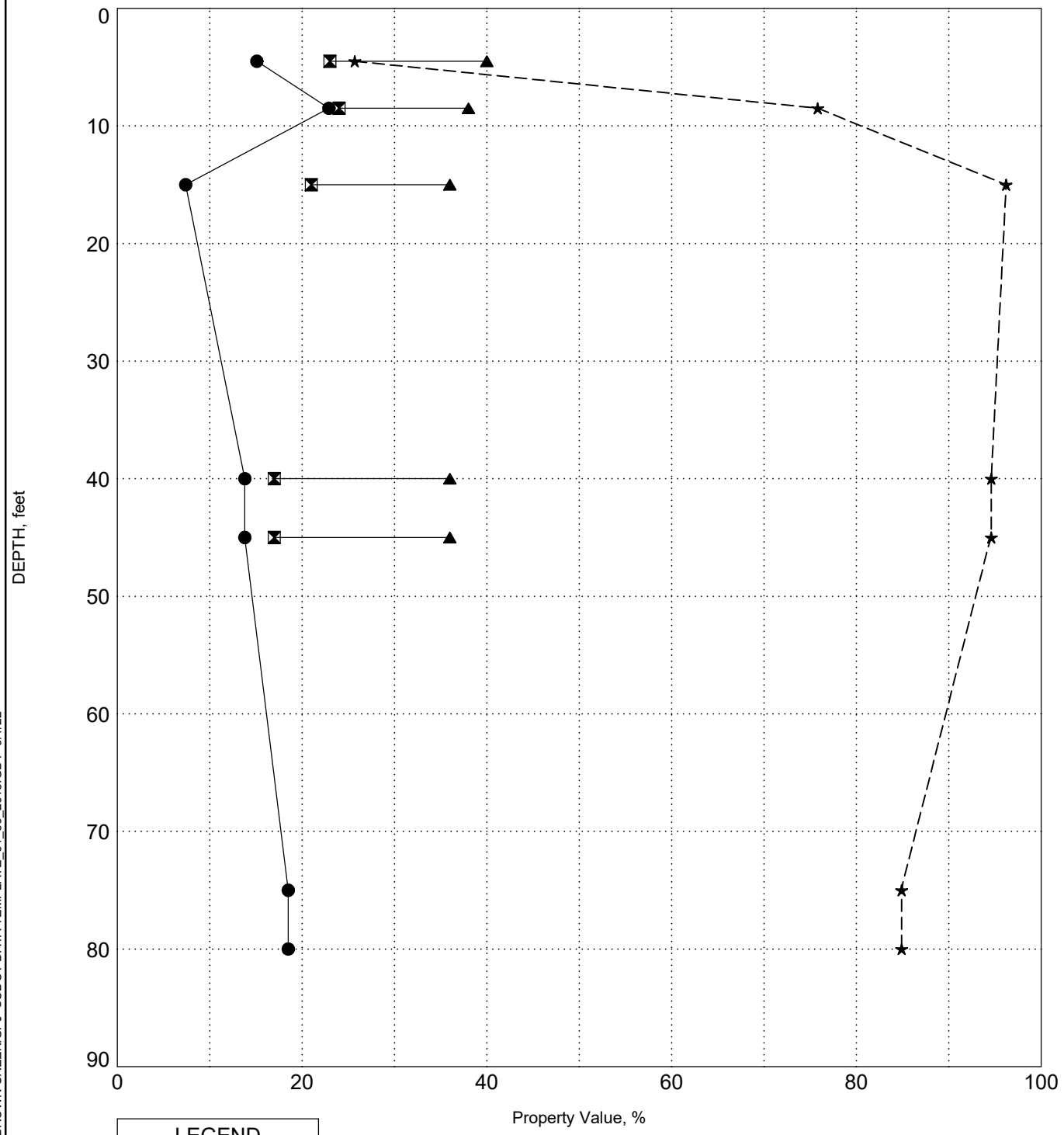
PROJECT ID P041181

PROJECT NAME S-13-108 (Outen Rd.) over Brown Creek

PROJECT COUNTY Chesterfield, SC

BORING B-20

SURFACE ELEVATION: 397.5



LEGEND
● Water Content
⊠ Plastic Limit
▲ Liquid Limit
★ Fines

Laboratory Testing Procedures

Grain Size Distribution

Wash #200 Testing has been conducted following ASTM D1140 Standard Test Methods for Determining the Amount of Material Finer that 75-µm (No. 200) Sieve in Soils by Washing. Full grain size analysis was conducted on select samples following ASTM D6913 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

Hydrometer

Hydrometer grain size analysis for soils was conducted following ASTM D7928 Standard Test Method for Particle Size Analysis of Soils.

Atterberg Limits

Atterberg limits testing have been conducted following ASTM D4318 Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

Moisture Content

Moisture content testing has been conducted following ASTM D2216 Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.

Standard Proctor

Standard Proctor testing has been conducted following ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft 3 (600kN-m/m3)).

Consolidated-Undrained Triaxial Test

CU testing allows the soil specimen to be consolidated under a confining pressure prior to shear and has been conducted following ASTM D4767 Standard Test Method for Consolidated-Undrained Triaxial Compression Test for Cohesive Soils. The soil specimens in this case were bulk samples that were remolded and compacted to 95% of the Standard Proctor.

Corrosion Series

Corrosion series testing has been conducted including pH, chloride content, sulfate content, and resistivity. PH testing was conducted AASHTO T289 Standard Method of Test for Determining pH of Soil for Use is Corrosion Testing. Chloride content testing was conducted following AASHTO T291 Standard Method of Test for Determining Water-Soluble Chloride Ion Content in Soil. Sulfate content testing was conducted following AASHTO T290 Standard Method of Test for Determining Water-Soluble Sulfate Content in Soil. Resistivity testing was conducted following AASHTO T288 Standard Method of Test for Determining Minimum Laboratory Soil Resistivity.

Appendix C. Laboratory Testing

Split Spoon Samples

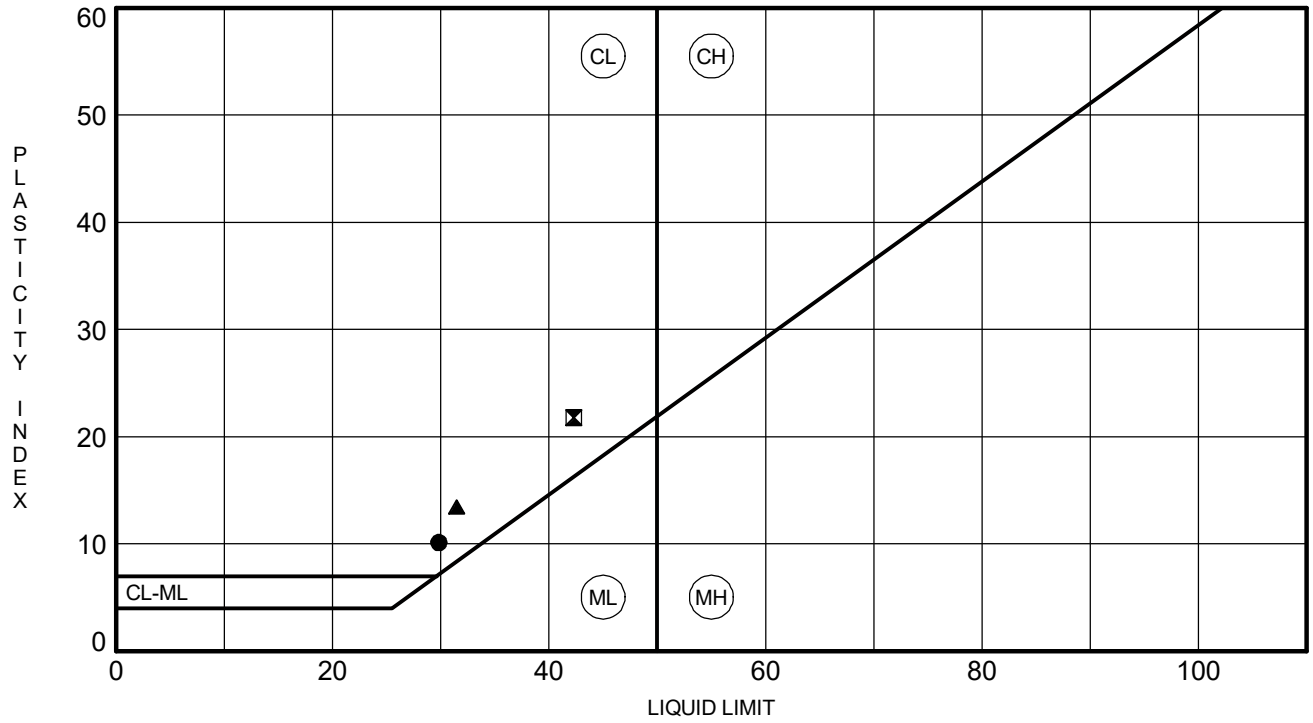
hdrinc.com

1201 Main Street, Suite 800 Columbia, SC 29201
T 803.254.5800

ATTERBERG LIMITS' RESULTS

PROJECT ID P041181 **PROJECT NAME** S-13-108 RBO Brown Creek

PROJECT COUNTY Chesterfield, SC



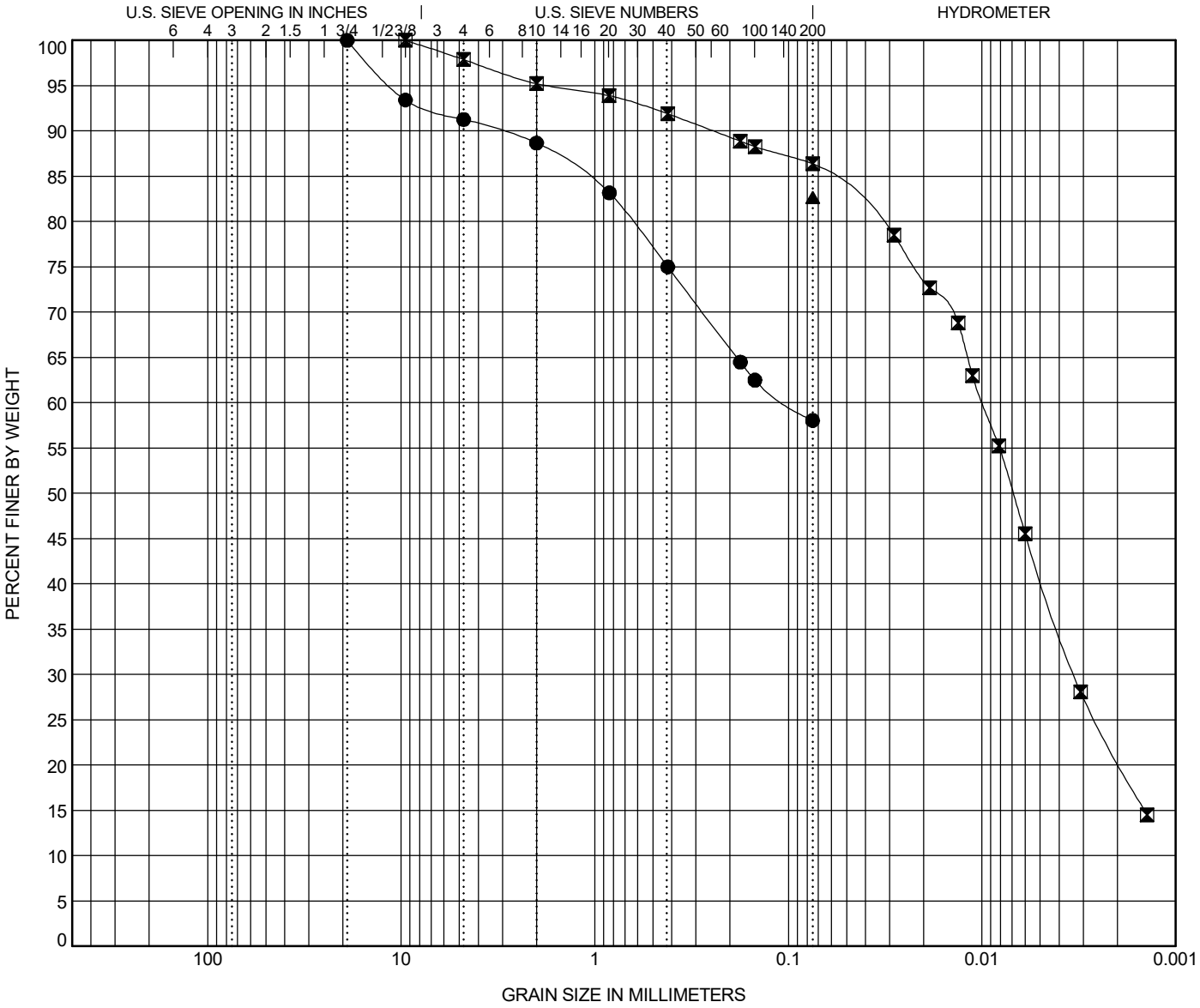
	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-19**	**4.8**	**30**	**20**	**10**	**58**	**SANDY LEAN CLAY (CL/A-4)**
⊠	**B-19**	**15.0**	**42**	**21**	**21**	**86**	**LEAN CLAY (CL/A-7-6)**
▲	**B-19**	**30.0**	**31**	**18**	**13**	**83**	**LEAN CLAY with SAND (CL/A-6)**

ATTERBERG LIMITS G6656.003 - S-108 RBO BROWN CREEK.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 8/17/22

GRAIN SIZE DISTRIBUTION

PROJECT ID P041181 **PROJECT NAME** S-13-108 RBO Brown Creek

PROJECT COUNTY Chesterfield, SC



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-19**	**4.8**	**SANDY LEAN CLAY (CL/A-4)**	**30**	**20**	**10**		
⊠	**B-19**	**15.0**	**LEAN CLAY (CL/A-7-6)**	**42**	**21**	**21**		
▲	**B-19**	**30.0**	**LEAN CLAY with SAND (CL/A-6)**	**31**	**18**	**13**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-19**	**4.8**	**19**	**0.101**			**8.7**	**33.2**	**58.0**	
⊠	**B-19**	**15.0**	**9.51**	**0.01**	**0.003**		**2.1**	**11.5**	**45.6**	**40.7**
▲	**B-19**	**30.0**	**0.075**						**82.7**	

GRAIN SIZE G6656.003 - S-108 RBO BROWN CREEK.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 8/17/22

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	S-13-108 RBO Brown Creek	**SCDOT PROJECT ID:**	P041181
SAMPLE NUMBER:	22-2317	**DATE SAMPLE RECEIVED:**	8/4/2022
DESCRIPTION OF SOIL:	Various		
TESTED BY:	CM	**DATE SETUP:**	8/4/2022
WEIGHED BY:	AP	**DATE OF WEIGHING:**	8/5/2022

BORING NO.	B-19	B-19	B-19		
SAMPLE NO.	SS-2	SS-6	SS-7/SS-8/SS- 9		
SAMPLE DEPTH (FT.)	2.8 - 4.8	13.5 - 15.0	18.5 - 30.0		
WATER CONTENT, W%	18.4	18.1	10.9		

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

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Client:	F&ME Consultants
Project:	S-13-08 RBO Brown Creek
Location:	Chesterfield County, SC
GTX#:	316004
Test Date:	08/31/22
Tested By:	mgh
Checked By:	mcm

Minimum Laboratory Soil Resistivity by AASHTO T 288

Boring ID	Sample ID	Depth, ft.	Sample Description	Minimum Soil Resistivity, ohm-cm
B-19	---	8.8-15	Moist, strong brown clay	12,232

Notes: Test Equipment: Nilsson Model 400 Soil Resistance Meter, MC Miller Soil Box
Test conducted in standard laboratory atmosphere: 68-73 F

Client:	F&ME Consultants
Project Name:	S-13-08 RBO Brown Creek
Project Location:	Chesterfield County, SC
GTX #:	316004
Test Date:	09/01/22
Tested By:	mgh
Checked By:	mcm

pH by AASHTO T 289

Boring ID	Sample ID	Depth, ft	Description	pH
B-19	---	8.8-15	Moist, strong brown clay	5.1

Notes:

PO Box 572455 / Salt Lake City UT 84157-2455 / USA
TEL +1 801 262 2448 · FAX +1 801 262 9870 · www.TEi-TS.com

GEOTESTING EXPRESS INCORPORATED
2358 PERIMETER PARK DRIVE
SUITE 320
ATLANTA GA 30341-1315
USA

Analysis No.	TS-A2210533
Report Date	01 September 2022
Date Sampled	26 August 2022
Date Received	30 August 2022
Where Sampled	Atlanta, GA USA
Sampled By	Client

This is to attest that we have examined: Soil: Project: S-13-08 Bridge Replacement over Brown Creek; Site Location: Chesterfield County, SC; Job Number: GTX-316004

When examined to the applicable requirements of:

AASHTO T-291-18	"Standard Method of Test for Determining Water-Soluble Chloride Ion Content in Soil" Method B
AASHTO T 290-20	"Standard Method of Test for Determining Water-Soluble Sulfate Ion Content in Soil"

Results:

AASHTO T 291 - Chloride Method B

Sample		Results		Detection Limit
		ppm (mg/kg)	%[1]	
- — -		< 10.	< 0.0010	10.
B-19	8.8 – 15.0'			

NOTE: [1]Percent by weight after drying and prepared as per the Standard.

AASHTO T 290 – Sulfates (Soluble)

Sample		Results		Detection Limit
		ppm (mg/kg)	%[1]	
- — -		18.	0.0018	10.
B-19	8.8 – 15.0'			

NOTE: [1]Percent by weight after drying and prepared as per the Standard.

END OF ANALYSIS

USEPA Laboratory ID UT00930

Merrill Gee P.E. – Engineer in Charge

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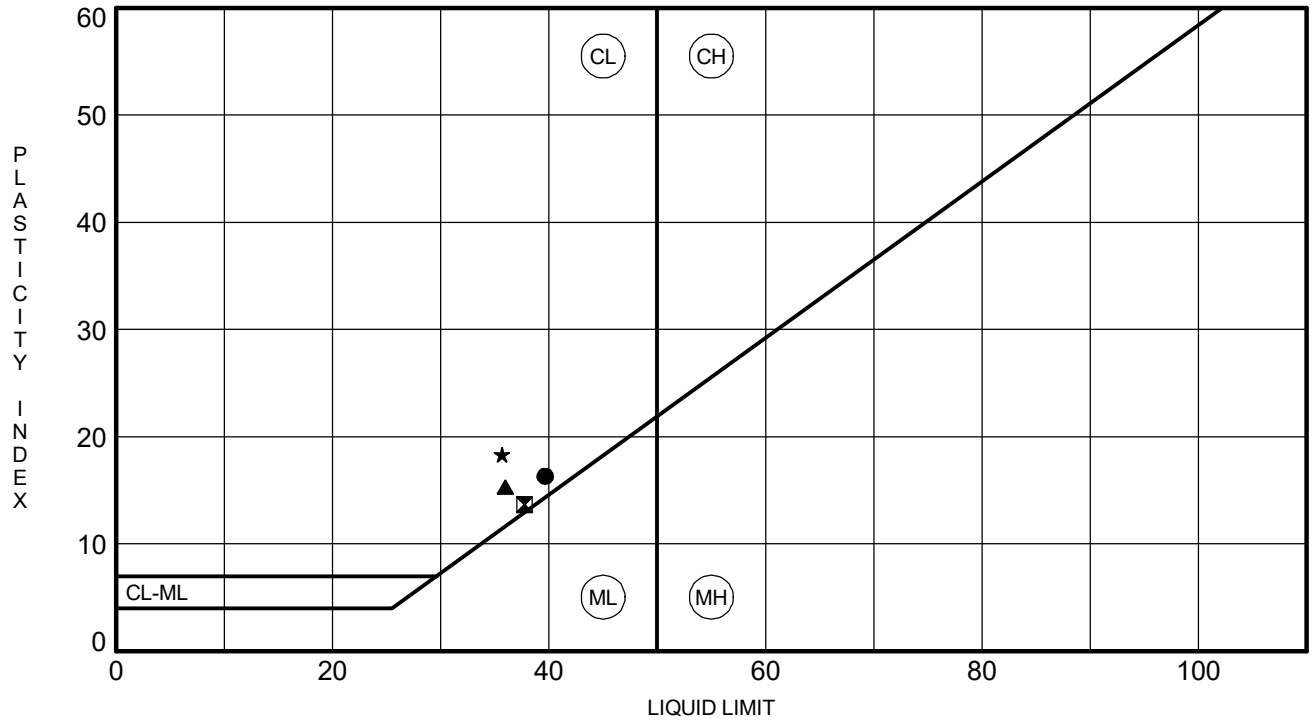
ATTERBERG LIMITS' RESULTS

PROJECT ID P041181 **PROJECT NAME** S-13-108 RBO Brown Creek

PROJECT COUNTY Chesterfield, SC

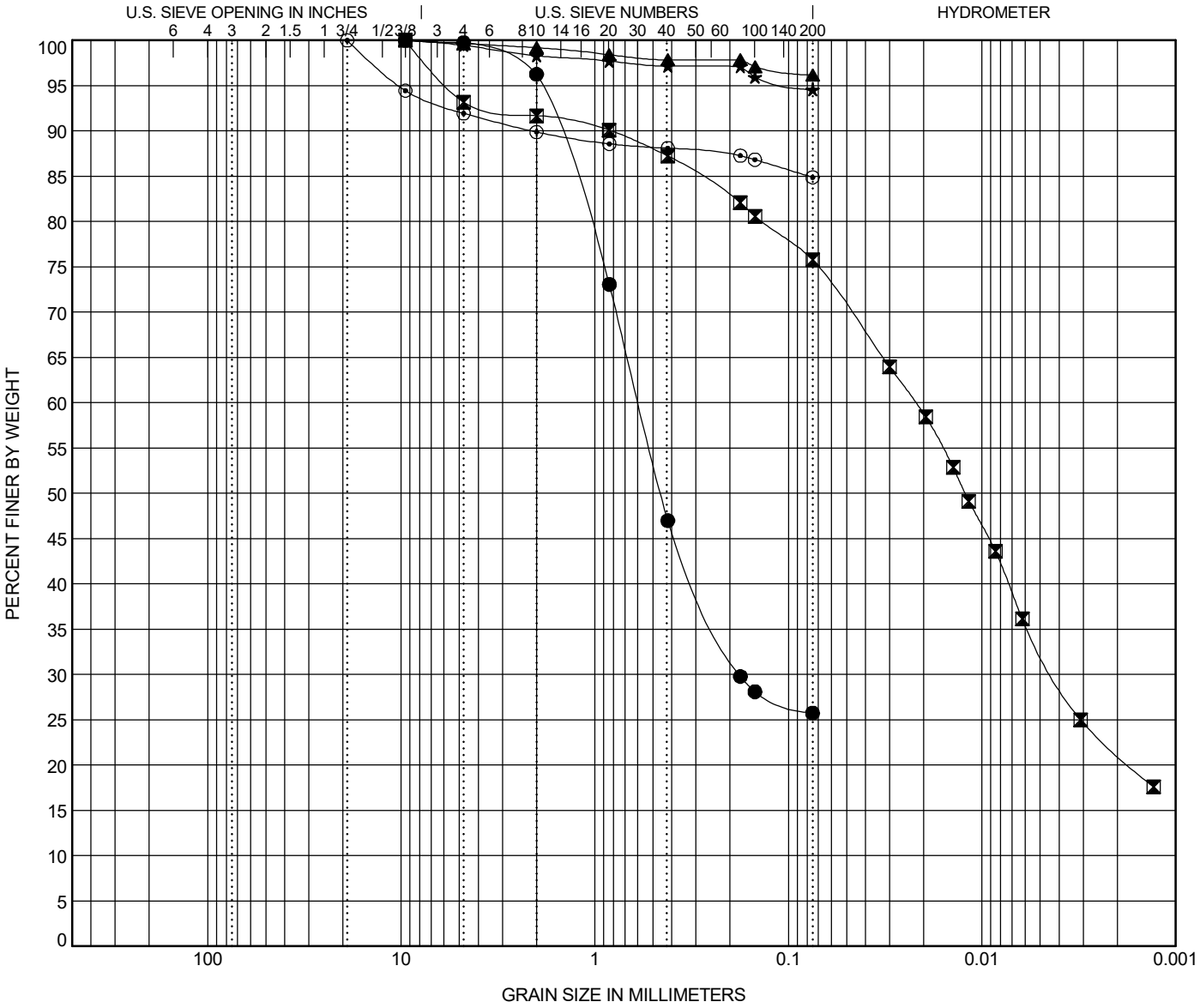


	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-20**	**4.5**	**40**	**23**	**17**	**26**	**CLAYEY SAND (SC/A-2-6)**
⊠	**B-20**	**8.5**	**38**	**24**	**14**	**76**	**LEAN CLAY with SAND (CL/A-6)**
▲	**B-20**	**15.0**	**36**	**21**	**15**	**96**	**LEAN CLAY (CL/A-6)**
★	**B-20**	**45.0**	**36**	**17**	**19**	**95**	**LEAN CLAY (CL/A-6)**

GRAIN SIZE DISTRIBUTION

PROJECT ID P041181 **PROJECT NAME** S-13-108 RBO Brown Creek

PROJECT COUNTY Chesterfield, SC



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-20	4.5	CLAYEY SAND (SC/A-2-6)	40	23	17		
⊠	B-20	8.5	LEAN CLAY with SAND (CL/A-6)	38	24	14		
▲	B-20	15.0	LEAN CLAY (CL/A-6)	36	21	15		
★	B-20	45.0	LEAN CLAY (CL/A-6)	36	17	19		
⊙	B-20	80.0	LEAN CLAY (CL) with GRAVEL					

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-20	4.5	9.51	0.594	0.179		0.3	74.0	25.7	
⊠	B-20	8.5	9.51	0.022	0.004		6.8	17.4	43.1	32.7
▲	B-20	15.0	9.51				0.4	3.5	96.2	
★	B-20	45.0	9.51				0.5	4.9	94.6	
⊙	B-20	80.0	19				8.1	7.1	84.9	

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	S-13-108 RBO Brown Creek	**SCDOT PROJECT ID:**	P041181
SAMPLE NUMBER:	22-2318	**DATE SAMPLE RECEIVED:**	8/4/2022
DESCRIPTION OF SOIL:	Various		
TESTED BY:	CM	**DATE SETUP:**	8/4/2022
WEIGHED BY:	AP	**DATE OF WEIGHING:**	8/5/2022

BORING NO.	B-20	B-20	B-20	B-20	B-20
SAMPLE NO.	SS-2	SS-4	SS-6	SS-11 & SS-12	SS-18 & SS-19
SAMPLE DEPTH (FT.)	2.5 - 4.5	6.5 - 8.5	13.5 - 15.0	38.5 - 45.0	73.5 - 80.0
WATER CONTENT, W%	15.1	22.9	7.4	13.8	18.5

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

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Appendix C. Laboratory Testing

Bulk Samples

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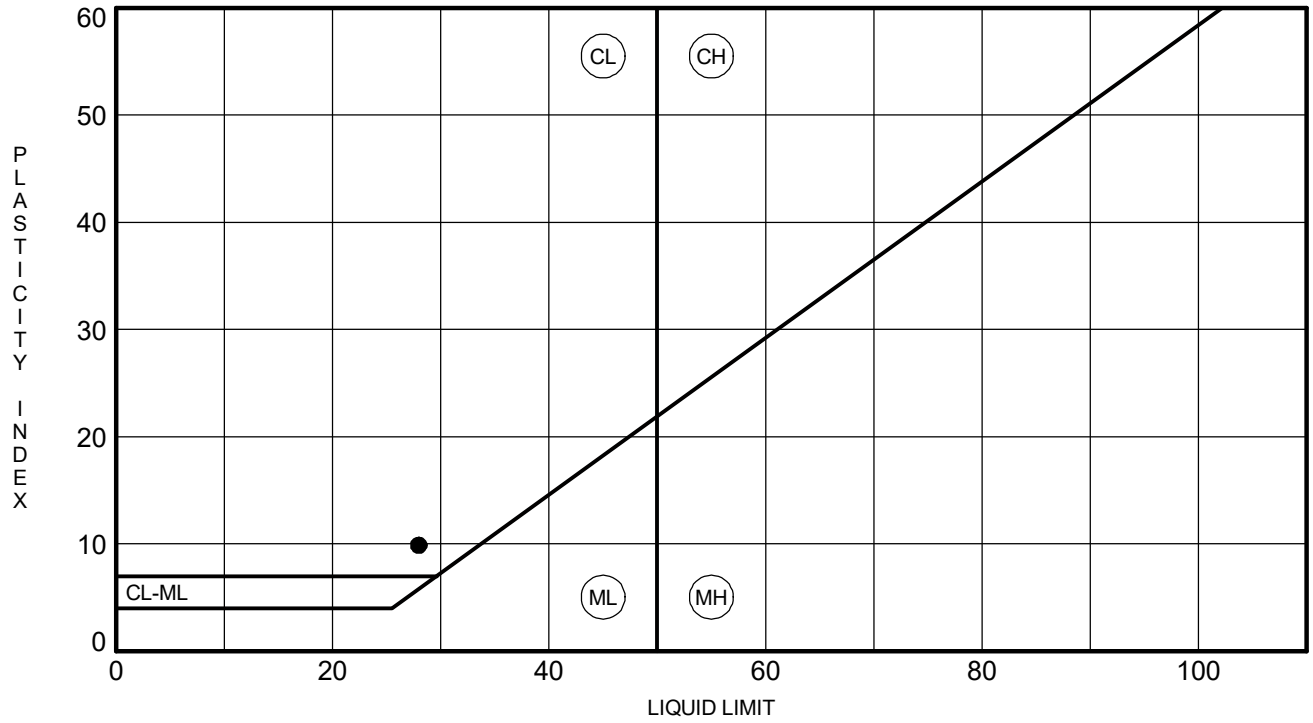
T 803.254.5800

ATTERBERG LIMITS' RESULTS

PROJECT ID P041181 **PROJECT NAME** S-13-108 RBO Brown Creek

PROJECT COUNTY Chesterfield, SC

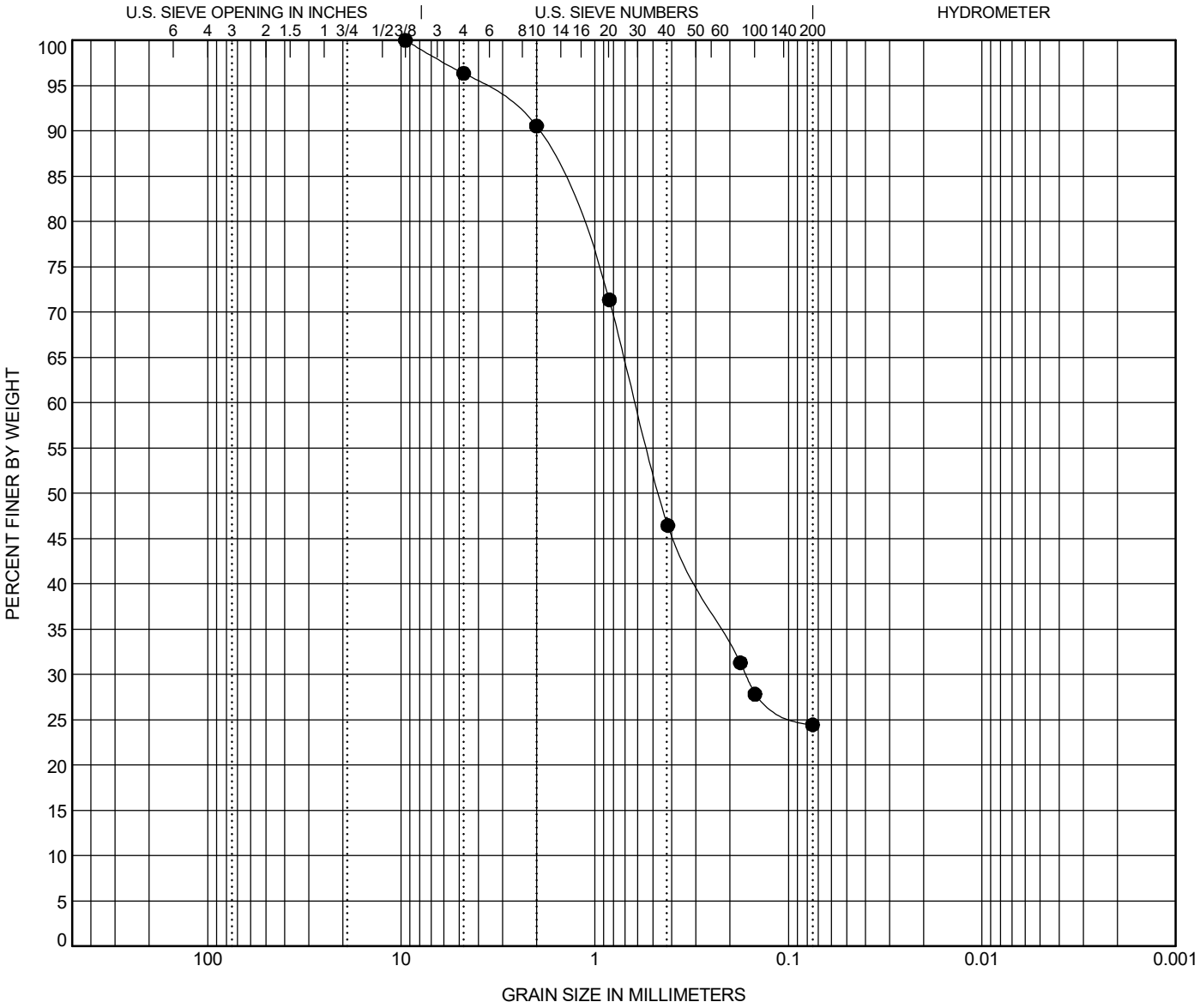


	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**BS-4**	**5.0**	**28**	**18**	**10**	**24**	**CLAYEY SAND (SC/A-2-4)**

GRAIN SIZE DISTRIBUTION

PROJECT ID P041181 **PROJECT NAME** S-13-108 RBO Brown Creek

PROJECT COUNTY Chesterfield, SC



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**BS-4**	**5.0**	**CLAYEY SAND (SC/A-2-4)**	**28**	**18**	**10**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BS-4**	**5.0**	**9.51**	**0.613**	**0.166**		**3.6**	**71.9**	**24.4**	

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	S-13-108 RBO Brown Creek	**SCDOT PROJECT ID:**	P041181
SAMPLE NUMBER:	22-2319	**DATE SAMPLE RECEIVED:**	8/4/2022
DESCRIPTION OF SOIL:	Various		
TESTED BY:	CM	**DATE SETUP:**	8/4/2022
WEIGHED BY:	AP	**DATE OF WEIGHING:**	8/5/2022

BORING NO.	BS-4				
SAMPLE NO.	--				
SAMPLE DEPTH (FT.)	0.0 - 5.0				
WATER CONTENT, W%	10.8				

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					

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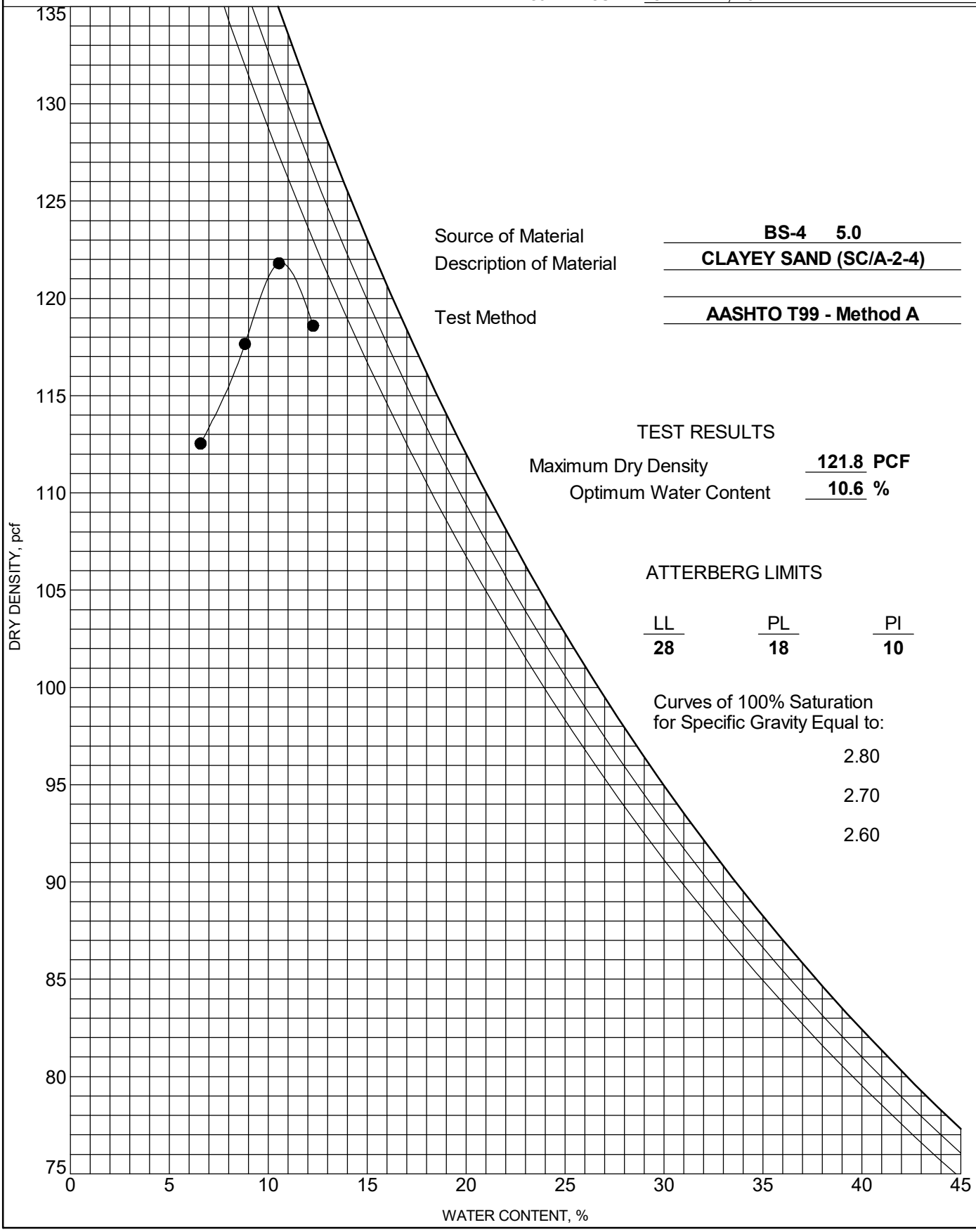
MOISTURE-DENSITY RELATIONSHIP

PROJECT ID P041181 **PROJECT NAME** S-13-108 RBO Brown Creek

PROJECT COUNTY Chesterfield, SC



Source of Material **BS-4 5.0**

Description of Material **CLAYEY SAND (SC/A-2-4)**

Test Method **AASHTO T99 - Method A**

TEST RESULTS

Maximum Dry Density **121.8** **PCF**

Optimum Water Content **10.6** **%**

ATTERBERG LIMITS

LL	PL	PI
28	**18**	**10**

Curves of 100% Saturation for Specific Gravity Equal to:

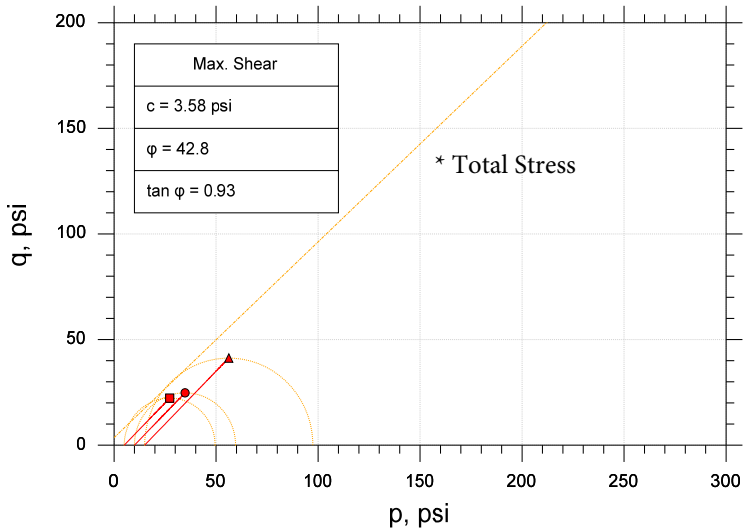
2.80

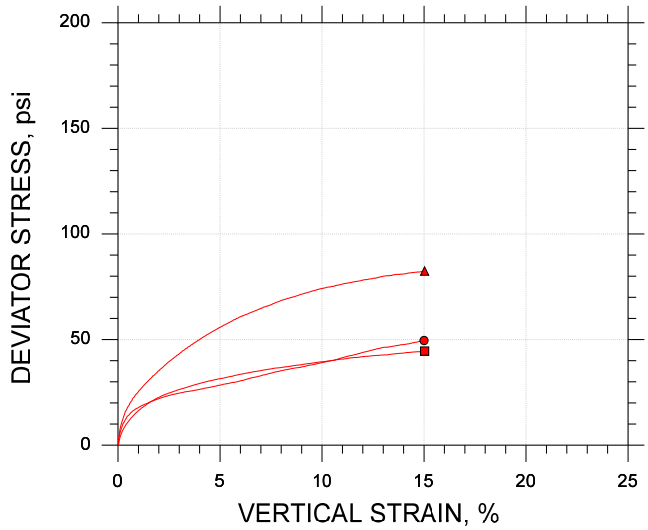
2.70

2.60

Client: F&ME Consultants	
Project Name: S-13-108 RBO Brown Creek	
Project Location: ---	
Project Number: GTX-316004	
Tested By: jm	Checked By: mcm
Boring ID: BS-4	
Preparation: reconstituted	
Description: Moist, brownish yellow clayey sand	
Classification: ---	
Group Symbol: ---	
Liquid Limit: ---	Plastic Limit: ---
Plasticity Index: ---	Estimated Specific Gravity: 2.7

CONSOLIDATED UNDRAINED TRIAXIAL TEST by AASHTO T297





Symbol		■	●	▲
Sample ID		---	---	---
Depth, ft		0-5 ft	0-5 ft	0-5 ft
Test Number		CU-1-1	CU-1-2	CU-1-3
Initial	Height, in	4.040	4.060	4.080
	Diameter, in	2.020	2.020	2.000
	Moisture Content (from Cuttings), %	12.5	12.3	12.7
	Dry Density, pcf	116.	116.	116.
	Saturation (Wet Method), %	74.1	72.2	75.7
	Void Ratio	0.456	0.458	0.452
Before Shear	Moisture Content, %	16.2	16.4	16.0
	Dry Density, pcf	117.	117.	118.
	Cross-sectional Area (Method A), in²	3.175	3.178	3.105
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.437	0.443	0.431
	Back Pressure, psi	134.9	134.9	128.9
Vertical Effective Consolidation Stress, psi		4.990	10.01	14.98
Horizontal Effective Consolidation Stress, psi		4.988	9.995	14.97
Vertical Strain after Consolidation, %		0.01972	0.07641	0.1130
Volumetric Strain after Consolidation, %		0.2755	0.6819	0.8759
Time to 50% Consolidation, min		---	---	1.440
Shear Strength, psi		22.27	24.77	41.23
Strain at Failure, %		15.0	15.0	15.0
Strain Rate, %/min		0.06000	0.06000	0.06000
Deviator Stress at Failure, psi		44.53	49.53	82.46
Effective Minor Principal Stress at Failure, psi		14.90	16.97	31.02
Effective Major Principal Stress at Failure, psi		59.43	66.50	113.5
B-Value		0.96	0.97	0.97

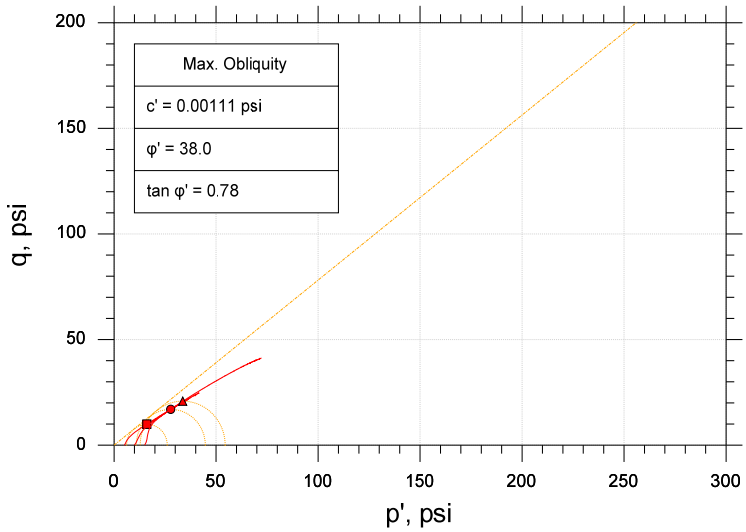
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

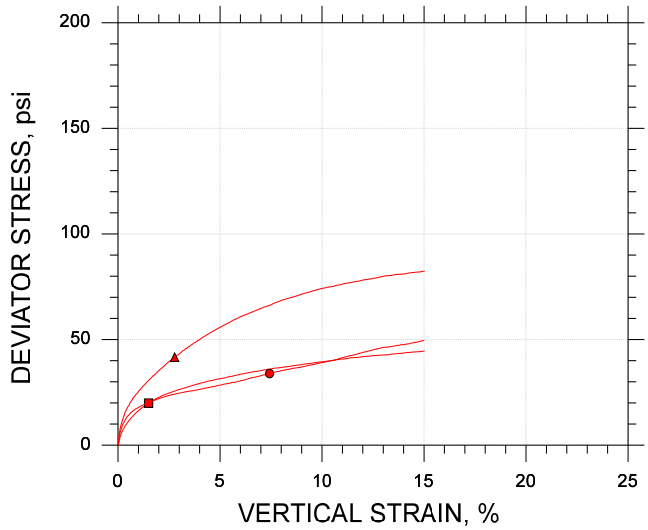
Remarks:

Target Compaction: 95% of (121.8 pcf) at Optimum Moisture Content (10.6%) +/- 2% - Values Provided by Client

Client: F&ME Consultants	
Project Name: S-13-108 RBO Brown Creek	
Project Location: ---	
Project Number: GTX-316004	
Tested By: jm	Checked By: mcm
Boring ID: BS-4	
Preparation: reconstituted	
Description: Moist, brownish yellow clayey sand	
Classification: ---	
Group Symbol: ---	
Liquid Limit: ---	Plastic Limit: ---
Plasticity Index: ---	Estimated Specific Gravity: 2.7

CONSOLIDATED UNDRAINED TRIAXIAL TEST by AASHTO T297





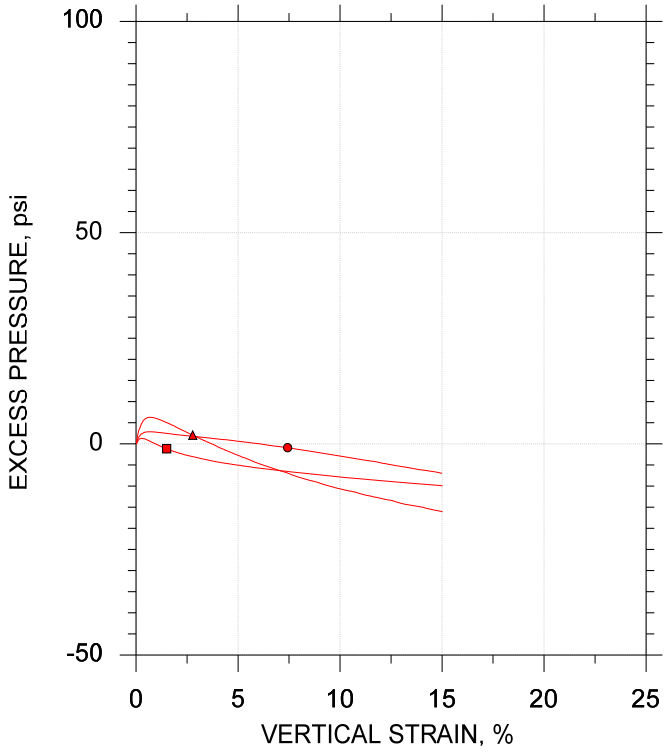
Symbol		■	●	▲
Sample ID		---	---	---
Depth, ft		0-5 ft	0-5 ft	0-5 ft
Test Number		CU-1-1	CU-1-2	CU-1-3
Initial	Height, in	4.040	4.060	4.080
	Diameter, in	2.020	2.020	2.000
	Moisture Content (from Cuttings), %	12.5	12.3	12.7
	Dry Density, pcf	116.	116.	116.
	Saturation (Wet Method), %	74.1	72.2	75.7
	Void Ratio	0.456	0.458	0.452
Before Shear	Moisture Content, %	16.2	16.4	16.0
	Dry Density, pcf	117.	117.	118.
	Cross-sectional Area (Method A), in²	3.175	3.178	3.105
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.437	0.443	0.431
	Back Pressure, psi	134.9	134.9	128.9
Vertical Effective Consolidation Stress, psi		4.990	10.01	14.98
Horizontal Effective Consolidation Stress, psi		4.988	9.995	14.97
Vertical Strain after Consolidation, %		0.01972	0.07641	0.1130
Volumetric Strain after Consolidation, %		0.2755	0.6819	0.8759
Time to 50% Consolidation, min		---	---	1.440
Shear Strength, psi		9.952	16.96	20.82
Strain at Failure, %		1.50	7.43	2.78
Strain Rate, %/min		0.06000	0.06000	0.06000
Deviator Stress at Failure, psi		19.90	33.92	41.64
Effective Minor Principal Stress at Failure, psi		6.132	10.81	12.84
Effective Major Principal Stress at Failure, psi		26.04	44.74	54.47
B-Value		0.96	0.97	0.97

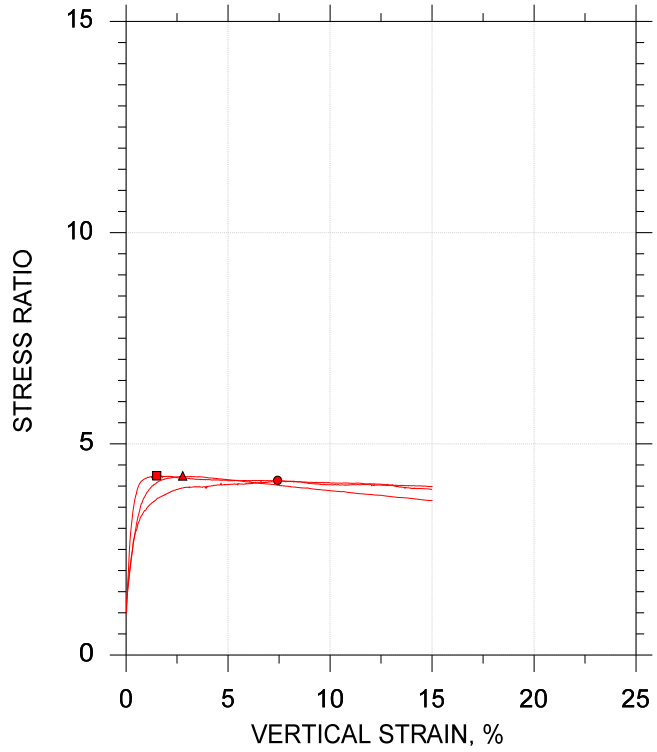
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

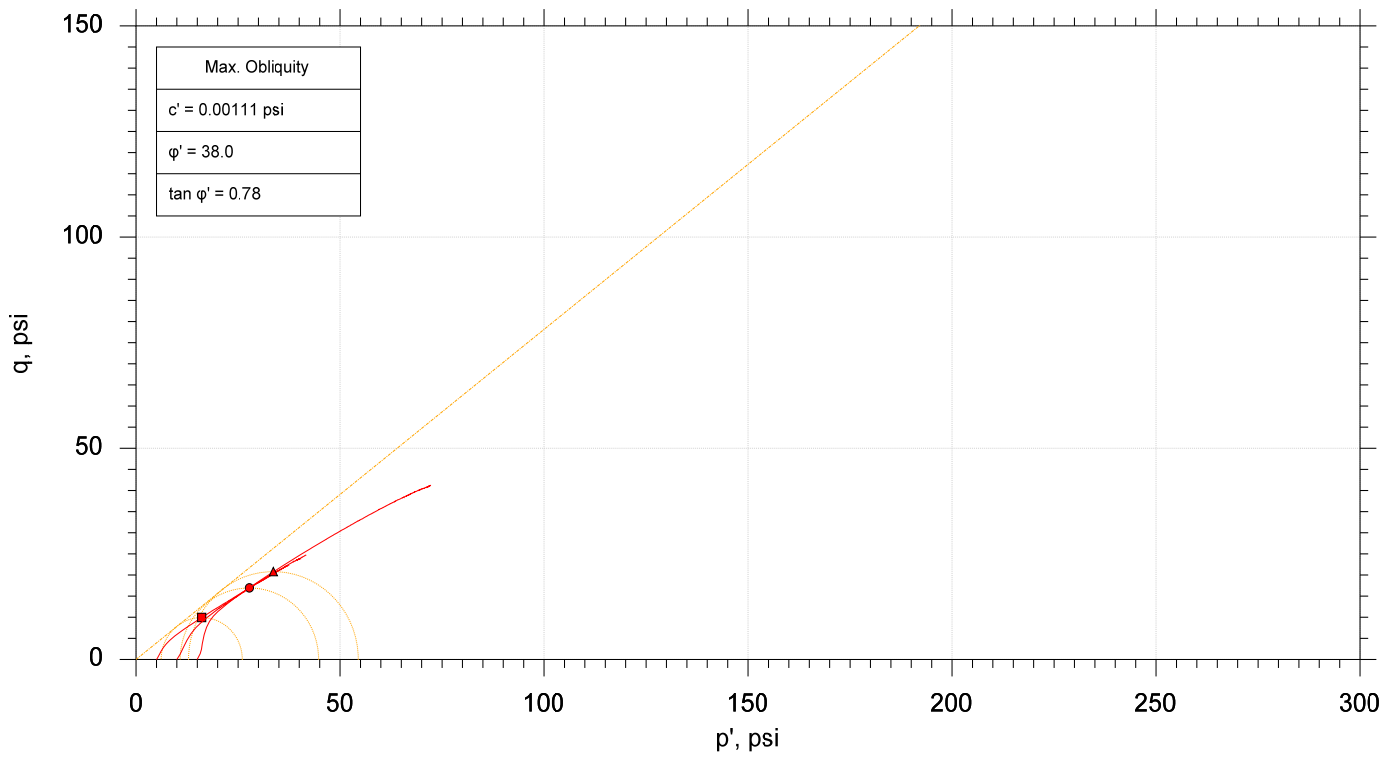
Remarks:

Target Compaction: 95% of (121.8 pcf) at Optimum Moisture Content (10.6%) +/- 2% - Values Provided by Client

CONSOLIDATED UNDRAINED TRIAXIAL TEST by AASHTO T297







	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	---	CU-1-1	0-5 ft	jm	8/30/22	mcm	9/4/22	316004-CU-1-1m.dat
●	---	CU-1-2	0-5 ft	cag	9/2/22	mcm	9/4/22	316004-CU-1-2m.dat
▲	---	CU-1-3	0-5 ft	cag	9/1/22	mcm	9/4/22	316004-CU-1-3m.dat

GeoTesting EXPRESS

Project: S-13-108 RBO Brown Creek	Location: ---	Project No.: GTX-316004
Boring No.: BS-4	Sample Type: reconstituted	
Description: Moist, brownish yellow clayey sand		
Remarks: Target Compaction: 95% of (121.8 pcf) at Optimum Moisture Content (10.6%) +/- 2% - Values Provided by Client		

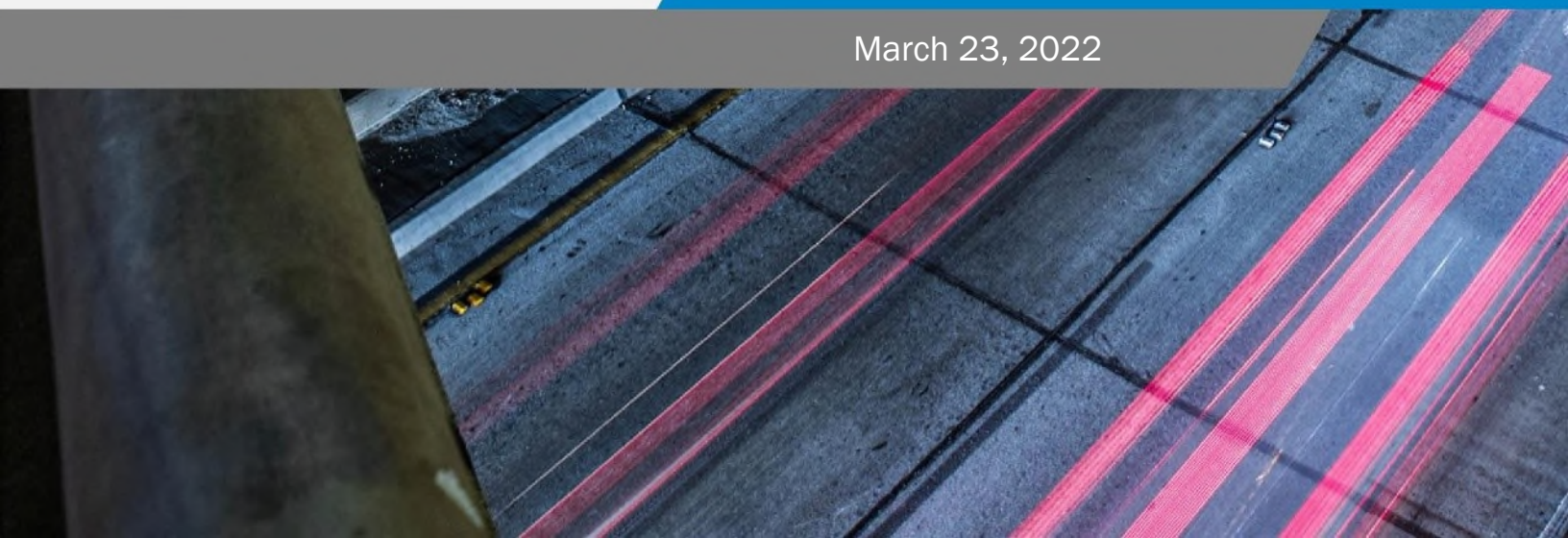
Appendix D. SPT Hammer Energy Calibration Report

CAROLINAS GEOTECHNICAL GROUP

Report of SPT Hammer Energy

Prepared for:
Breccia Construction, LLC
620-B Industrial Way
Chester, South Carolina 29706

March 23, 2022



CAROLINAS GEOTECHNICAL GROUP

N.C. Firm License: P-1904

2400 Crownpoint Executive Drive
Suite 800
Charlotte, NC 28227

(980) 339-8684
contact@carolinasgeotech.com
www.carolinasgeotech.com

March 23, 2022

Mr. Jarod S. Ford
Breccia Construction, LLC
620-B Industrial Way
Chester, South Carolina 29706

SUBJECT: **Report of SPT Hammer Energy**
Breccia Construction, LLC CME 45B Trailer Rig (SN 303304)
Chester, South Carolina
CG2 Project No.: 240021095

Dear Mr. Ford:

Carolinas Geotechnical Group, PLLC (CG2) has completed the Standard Penetration Test (SPT) energy measurements on the automatic hammer mounted on a Breccia Construction, LLC (Breccia) CME 45B trailer-mounted drill rig with a serial number of 303304, see attached Drill Rig Photo Log. This service was performed by Mr. Robert E. Kral, PE on March 11, 2022. SPT energy testing was performed in general accordance with ASTM D4633 and the most recent revision of the North Carolina Department of Transportation (NCDOT), Geotechnical Engineering Unit's requirements. The testing procedures, equipment used during testing, and detailed results are presented in this report.

CG2 recommends Breccia submit this Report of SPT Hammer Energy to the NCDOT Geotechnical Engineering Unit for review and approval no later than April 8, 2022.

DYNAMIC TESTING METHODOLOGY

Testing was performed using a model SPT (Serial No. 4549 TB) Pile Driving Analyzer™ (PDA) manufactured by Pile Dynamics, Inc. The PDA was used to record and interpret data from two piezoresistive accelerometers (Serial Nos. K11957 and K10959) bolted to a 2-foot long AWJ drill rod (SN 528AWJ) internally instrumented with two strain transducers. The instrumented AWJ drill rod has a cross-sectional area of 1.19 square inches, an outside diameter of approximately 1.75 inches, and an inside diameter of 1.25 inches at the gauge location. The accelerometers and strain gauges, which are mounted on opposing axis near the middle of the instrumented rod, monitor acceleration and strain for each hammer blow. The analyzer converts the data to velocities and forces and computes the maximum transferred hammer energies with the "EFV" method described in ASTM D4633. Preliminary results are recorded and displayed in real-time for each blow. Calibration sheets for the PDA, accelerometers, and the instrumented rod are included in the Appendix III.

TESTING AND OBSERVATIONS

CG2 personnel was on site March 11, 2022 to observe and perform high-strain dynamic testing during SPT sampling on the CME 45B trailer-mounted drill rig operated by D. Harris of Breccia. The measurements were taken during drilling operations at 1817 Lowrys Highway in Chester, South Carolina (Chester County). The approximate coordinates (not professionally surveyed) for the test location are 34.770585, -81.245517. No Soil Test Boring Log was maintained. SPT energy measurements were recorded during three intervals at depths of approximately 28½, 33½, and 38½ feet below the existing ground surface. The information presented in the table below summarizes the equipment tested and tooling used during the SPT energy measurements.

Table 1: SPT Field Data

Drill Rig Information	
Manufacturer	CME
Model	45B
Serial Number	303304
Operator	D. Harris
Carrier	Trailer
Hammer Information	
Model / Type	CME / Auto
Serial Number	N/A
Anvil Height (inches)	11.5
Anvil Diameter (inches)	2.5
Drop Height (inches)	30
Ram Weight (pounds)	140
Ram Serial Number	N/A
Drilling and Instrumented Rod Information	
Drill Rod Type	AWJ
OD (inches)	1.75
ID (inches)	1.25
Cross-Sectional Area (in^2)	1.19
Typical Lengths (feet)	5
Instrumented Rod Type	AWJ (SN 528)
OD (inches)	1.75
ID (inches)	1.25
Cross-Sectional Area (in^2)	1.19
Total Instrumented Rod Length (feet)	2.00
Length Below Gages (feet)	0.70
Split-Spoon Length (feet)	2.85

DYNAMIC TESTING RESULTS

The total rod length from the instrumentation to the tip of the split-spoon sampler was determined by adding 3.6 feet to the required drill rod length at each sample depth. Based on the test data, the automatic hammer on the CME 45B Trailer-mounted drill rig operated at a rate of about 53.2 to 61.4 blows per minute (BPM) during dynamic testing. The measured transferred hammer energy (EFV) ranged from 273.5 to 298.0 foot-pounds, which corresponds to Energy Transfer Ratio (ETR) values of 78.2 to 85.1%, respectively.

The SPT Energy Measurement Data Summary tables in the Appendix present the test data from every hammer blow at each sampling interval along with representative force and velocity traces for each test interval. The reported blow counts, obtained by the drill rig personnel, and a summary of the test data and average computed hammer energy and transfer ratio values are provided in Table 2. Plots and tables of the following are also included in the Appendix and present the test data with depth for each test interval:

- Penetration vs. BLC
- Penetration vs. FMX
- Penetration vs. EFV
- Penetration vs. CSX
- Penetration vs. VMX
- Penetration vs. ETR
- Average ETR vs. Rod Length
- ETR vs. Rod Length

Table 2: Summary of Dynamic Testing Results

Data Set ID	Sample Depth (ft)	Drill Rod Length (ft)	Instrumentation to Sampler Tip Length (ft)	Blows per 6" Increment / N-value	Soil Sample Description (Piedmont Residual)	Avg. BPM	Avg. EFV (ft-lbs)	Avg. ETR (%)
1	28½ - 30	30	33.6	4-6-7 / 13	SA SILT	53.4	277.5	79.3
2	33½ - 35	35	38.6	3-5-6 / 11	SA SILT	58.3	291.4	83.3
3	38½ - 40	40	43.6	4-6-9 / 15	SA SILT	55.5	286.8	81.9
					Overall Average	55.6	285.0	81.4

The average hammer rate, transferred energy, and transfer ratio were calculated for each depth interval. Per ASTM D4633, only the blows from the final foot of each sample interval (i.e., the blows that determine the N-value) were included when computing the average values shown in Table 2. The overall average transferred hammer energy for the automatic hammer on the CME 45B trailer-mounted drill rig (for all the depth intervals tested) was 285.0 foot-pounds, with an average ETR of 81.4%.

LIMITATIONS OF REPORT

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The information contained in this report were based on the applicable standards of our profession in this geographic area at the time this report was prepared. No other warranty, express or implied, is made.

CLOSING

CG2 is pleased to have the opportunity to provide these services to you. If you have questions concerning the content of this report, or if CG2 can be of further service, please contact CG2 at (980) 339-8684.

Sincerely,
Carolinas Geotechnical Group, PLLC

DocuSigned by:
D. Matthew Brewer
386129C0A4C1462...
D. Matthew Brewer, PE
Senior Project Engineer

DocuSigned by:
Robert E Kral
8AD703B2A8484F4...
Robert E. Kral, PE
Senior Project Engineer
NC Registration No. 042642

NORTH CAROLINA PROFESSIONAL SEAL 042642 ENGINEER ROBERT E. KRAL

Appendices:

- Appendix I - CME 45B Trailer Rig (SN 303304) SPT Energy Measurements Summary Plots and Tables
- Appendix II - SPT Hammer Energy Field Form (Field Log) and Drill Rig Photo Log
- Appendix III - Instrumented Rod and Accelerometer Calibration Sheets
- Appendix IV - Certificate of Proficiency

APPENDIX I

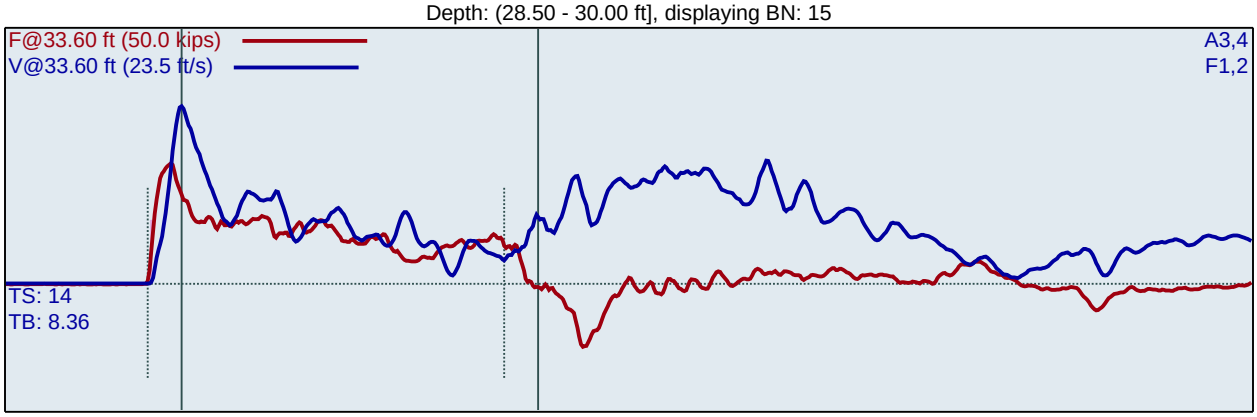
CME 45B (SN 303304)
REK
B-1

B-1
Interval start: 3/11/2022

AR: 1.19 in^2
LE: 33.60 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (28.50 - 30.00 ft], displaying BN: 15



F1 : [528AWJ1] 205.26 PDICAL (1) FF1
F2 : [528AWJ2] 205.86 PDICAL (1) FF1

A3 (PR): [K11957] 407.045 mv/6.4v/5000g (1) VF1
A4 (PR): [K10959] 417.27 mv/6.4v/5000g (1) VF1

BPM: Blows/Minute
FMX: Maximum Force
VMX: Maximum Velocity
DMX: Maximum Displacement

CSX: Compression Stress Maximum
DFN: Final Displacement
EFV: Maximum Energy
ETR: Energy Transfer Ratio - Rated

LP	BL#	BC	BPM	FMX	VMX	DMX	CSX	DFN	EFV	ETR
ft		/6"	bpm	kips	ft/s	in	ksi	in	ft-lb	%
28.63	1	4	1.9	23.8	15.1	2.0	20.0	1.5	258.9	74.0
28.75	2	4	52.7	25.1	15.4	1.6	21.1	1.5	269.5	77.0
28.88	3	4	53.1	25.1	15.7	1.6	21.1	1.5	272.5	77.8
29.00	4	4	53.5	24.6	15.4	1.5	20.7	1.5	269.5	77.0
29.08	5	6	53.4	25.0	15.6	1.2	21.0	1.0	273.5	78.2
29.17	6	6	53.3	24.8	15.7	1.1	20.8	1.0	274.5	78.4
29.25	7	6	53.4	24.6	15.7	1.1	20.7	1.0	277.2	79.2
29.33	8	6	53.3	24.7	16.0	1.1	20.8	1.0	274.8	78.5
29.42	9	6	53.4	24.6	16.0	1.1	20.6	1.0	275.4	78.7
29.50	10	6	53.7	24.3	15.9	1.1	20.4	1.0	276.7	79.1
29.57	11	7	53.3	24.6	16.3	1.0	20.7	0.9	281.6	80.4
29.64	12	7	53.3	24.1	16.2	1.1	20.2	0.9	279.6	79.9
29.71	13	7	53.5	23.8	16.1	1.1	20.0	0.9	280.2	80.0
29.79	14	7	53.7	23.7	16.5	1.0	19.9	0.9	278.2	79.5
29.86	15	7	53.2	23.6	16.3	1.0	19.8	0.9	277.1	79.2
29.93	16	7	53.4	23.3	15.7	0.9	19.6	0.9	278.7	79.6
30.00	17	7	53.5	23.2	17.1	0.9	19.5	0.9	280.6	80.2
		Average	53.4	24.2	16.1	1.1	20.3	0.9	277.5	79.3
		Std Dev	0.1	0.6	0.4	0.1	0.5	0.1	2.4	0.7
		Maximum	53.7	25.0	17.1	1.2	21.0	1.0	281.6	80.4
		Minimum	53.2	23.2	15.6	0.9	19.5	0.9	273.5	78.2

N-value: 13

Sample Interval Time: 17.92 seconds.

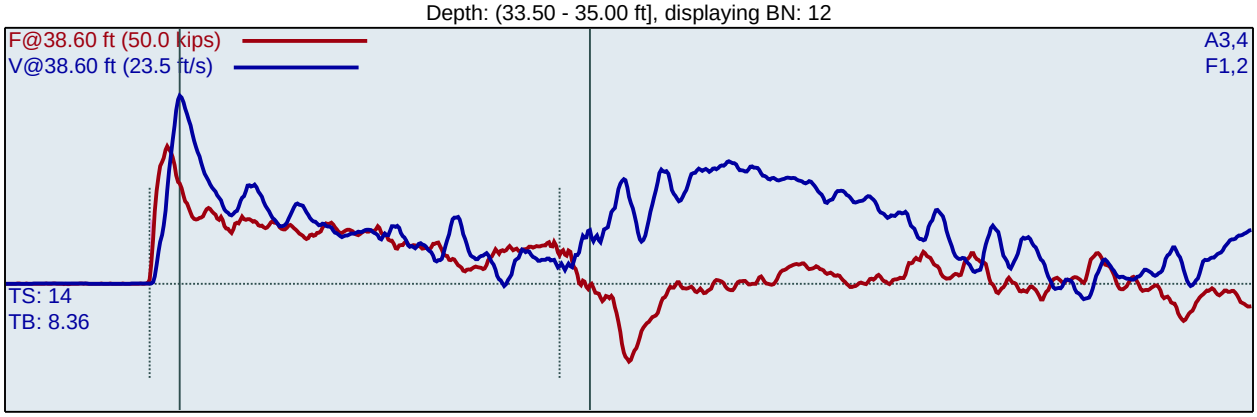
CME 45B (SN 303304)
REK
B-1

B-1
Interval start: 3/11/2022

AR: 1.19 in^2
LE: 38.60 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (33.50 - 35.00 ft], displaying BN: 12



F1 : [528AWJ1] 205.26 PDICAL (1) FF1
F2 : [528AWJ2] 205.86 PDICAL (1) FF1

A3 (PR): [K11957] 407.045 mv/6.4v/5000g (1) VF1
A4 (PR): [K10959] 417.27 mv/6.4v/5000g (1) VF1

LP ft	BL#	BC /6"	BPM bpm	FMX kips	VMX ft/s	DMX in	CSX ksi	DFN in	EFV ft-lb	ETR %
33.67	1	3	1.9	27.2	16.3	2.3	22.8	2.0	290.7	83.0
33.83	2	3	60.1	27.7	17.1	2.0	23.2	2.0	300.3	85.8
34.00	3	3	60.9	27.7	17.1	2.0	23.3	2.0	302.3	86.4
34.10	4	5	61.4	27.6	16.8	1.3	23.2	1.2	293.7	83.9
34.20	5	5	58.8	27.3	16.7	1.3	22.9	1.2	286.9	82.0
34.30	6	5	57.9	27.1	16.9	1.2	22.8	1.2	288.5	82.4
34.40	7	5	57.7	27.5	17.0	1.2	23.2	1.2	288.2	82.3
34.50	8	5	57.9	26.7	16.8	1.2	22.5	1.2	292.5	83.6
34.58	9	6	57.8	26.6	17.0	1.1	22.4	1.0	290.0	82.9
34.67	10	6	58.1	26.9	17.0	1.0	22.6	1.0	287.6	82.2
34.75	11	6	58.1	26.6	17.1	1.0	22.4	1.0	288.5	82.4
34.83	12	6	57.8	26.9	17.3	1.0	22.6	1.0	298.0	85.1
34.92	13	6	58.1	26.5	17.2	1.0	22.3	1.0	295.9	84.6
35.00	14	6	58.2	26.2	17.0	1.0	22.0	1.0	295.4	84.4
		Average	58.3	26.9	17.0	1.1	22.6	1.1	291.4	83.3
		Std Dev	1.0	0.4	0.2	0.1	0.4	0.1	3.7	1.1
		Maximum	61.4	27.6	17.3	1.3	23.2	1.2	298.0	85.1
		Minimum	57.7	26.2	16.7	1.0	22.0	1.0	286.9	82.0

N-value: 11

Sample Interval Time: 13.30 seconds.

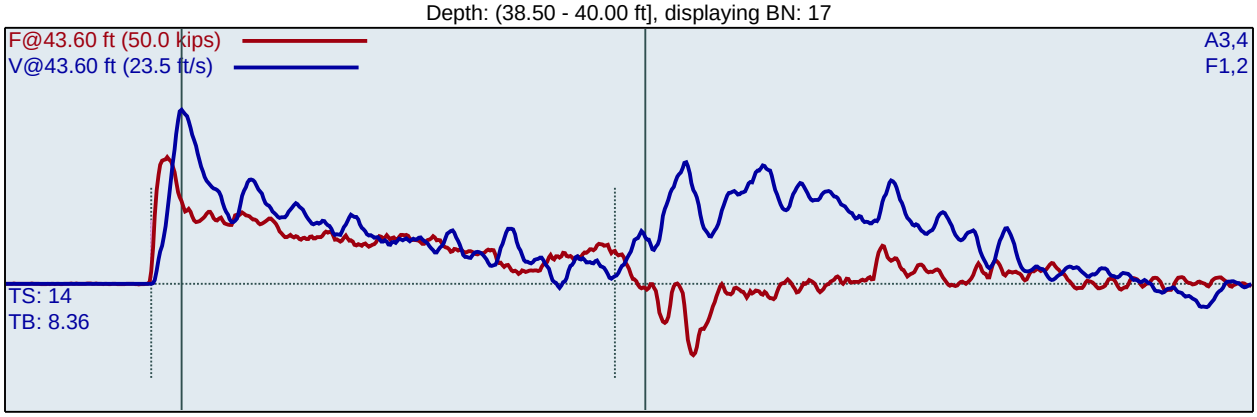
CME 45B (SN 303304)
REK
B-1

B-1
Interval start: 3/11/2022

AR: 1.19 in^2
LE: 43.60 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (38.50 - 40.00 ft], displaying BN: 17



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A3 (PR): [K11957] 407.045 mv/6.4v/5000g (1) VF1
A4 (PR): [K10959] 417.27 mv/6.4v/5000g (1) VF1

LP ft	BL#	BC /6"	BPM bpm	FMX kips	VMX ft/s	DMX in	CSX ksi	DFN in	EFV ft-lb	ETR %
38.63	1	4	1.9	26.6	16.9	2.2	22.3	1.5	303.5	86.7
38.75	2	4	59.6	25.2	16.8	1.8	21.2	1.5	301.7	86.2
38.88	3	4	59.9	25.2	16.3	1.5	21.2	1.5	295.2	84.3
39.00	4	4	56.8	24.6	16.3	1.5	20.7	1.5	291.6	83.3
39.08	5	6	55.7	24.9	16.0	1.2	20.9	1.0	290.3	82.9
39.17	6	6	55.5	24.9	16.0	1.2	21.0	1.0	290.4	83.0
39.25	7	6	56.0	24.7	16.2	1.2	20.8	1.0	288.0	82.3
39.33	8	6	55.4	25.2	16.2	1.1	21.2	1.0	287.7	82.2
39.42	9	6	55.7	25.1	15.8	1.0	21.1	1.0	283.1	80.9
39.50	10	6	55.3	24.9	15.8	1.0	21.0	1.0	288.5	82.4
39.56	11	9	55.5	24.5	16.0	0.8	20.6	0.7	286.8	82.0
39.61	12	9	55.7	24.6	16.0	0.8	20.7	0.7	284.4	81.3
39.67	13	9	55.4	24.4	16.2	0.8	20.5	0.7	289.2	82.6
39.72	14	9	55.4	24.4	15.9	0.8	20.5	0.7	283.6	81.0
39.78	15	9	55.3	24.7	15.9	0.8	20.7	0.7	287.0	82.0
39.83	16	9	55.5	24.0	15.6	0.8	20.2	0.7	284.1	81.2
39.89	17	9	55.6	24.8	16.0	0.7	20.8	0.7	283.9	81.1
39.94	18	9	55.6	24.4	15.7	0.7	20.5	0.7	284.9	81.4
40.00	19	9	55.4	24.2	16.2	0.8	20.3	0.7	289.6	82.7
		Average	55.5	24.7	16.0	0.9	20.7	0.8	286.8	81.9
		Std Dev	0.2	0.3	0.2	0.2	0.3	0.2	2.5	0.7
		Maximum	56.0	25.2	16.2	1.2	21.2	1.0	290.4	83.0
		Minimum	55.3	24.0	15.6	0.7	20.2	0.7	283.1	80.9

N-value: 15

Sample Interval Time: 19.28 seconds.

Summary of SPT Test Results

Project: CME 45B (SN 303304), Test Date: 3/11/2022

BPM: Blows/Minute
FMX: Maximum Force
VMX: Maximum Velocity
DMX: Maximum Displacement
CSX: Compression Stress Maximum
DFN: Final Displacement
EFV: Maximum Energy
ETR: Energy Transfer Ratio - Rated

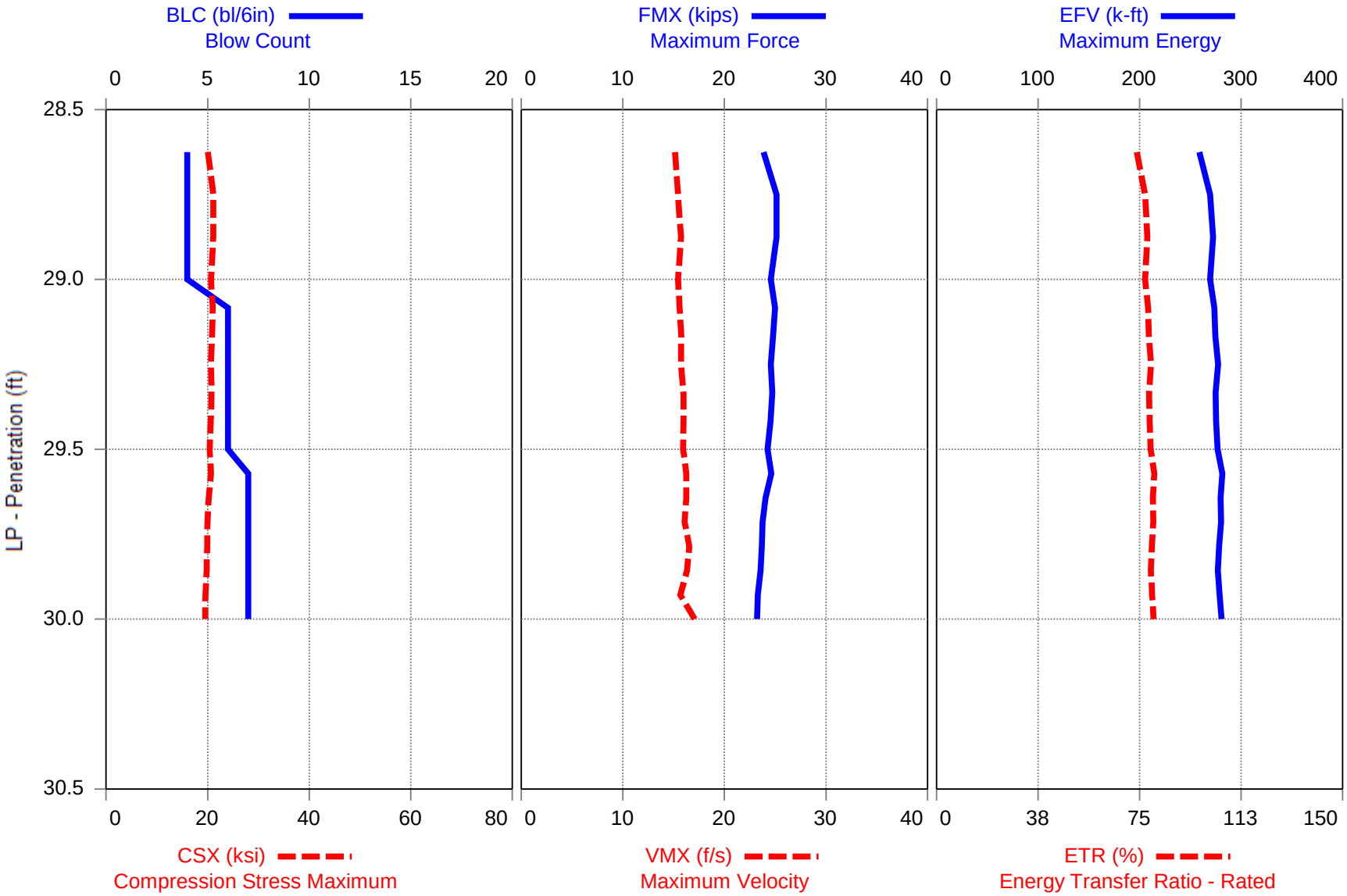
Instr. Length ft	Start Depth ft	Final Depth ft	Blows Applied /6"	**N Value**	**N60 Value**	Average BPM bpm	Average FMX kips	Average VMX ft/s	Average DMX in	Average CSX ksi	Average DFN in	Average EFV ft-lb	Average ETR %
33.60	28.50	30.00	**4-6-7**	**13**	**17**	53.4	24.2	16.1	1.1	20.3	0.9	277.5	79.3
38.60	33.50	35.00	**3-5-6**	**11**	**14**	58.3	26.9	17.0	1.1	22.6	1.1	291.4	83.3
43.60	38.50	40.00	**4-6-9**	**15**	**20**	55.5	24.7	16.0	0.9	20.7	0.8	286.8	81.9
					Overall Average Values:	55.6	25.1	16.3	1.0	21.1	0.9	285.0	81.4
					Standard Deviation:	2.0	1.2	0.5	0.2	1.0	0.2	6.3	1.8
					Overall Maximum Value:	61.4	27.6	17.3	1.3	23.2	1.2	298.0	85.1
					Overall Minimum Value:	53.2	23.2	15.6	0.7	19.5	0.7	273.5	78.2

Pile Dynamics, Inc. - PDIPLOT2 Ver 2021.1.61.0 - Case Method & iCAP® Results

Printed: 23-March-2022

Test started: 11-March-2022

CME 45B (SN 303304) - 28.5 TO 30.0

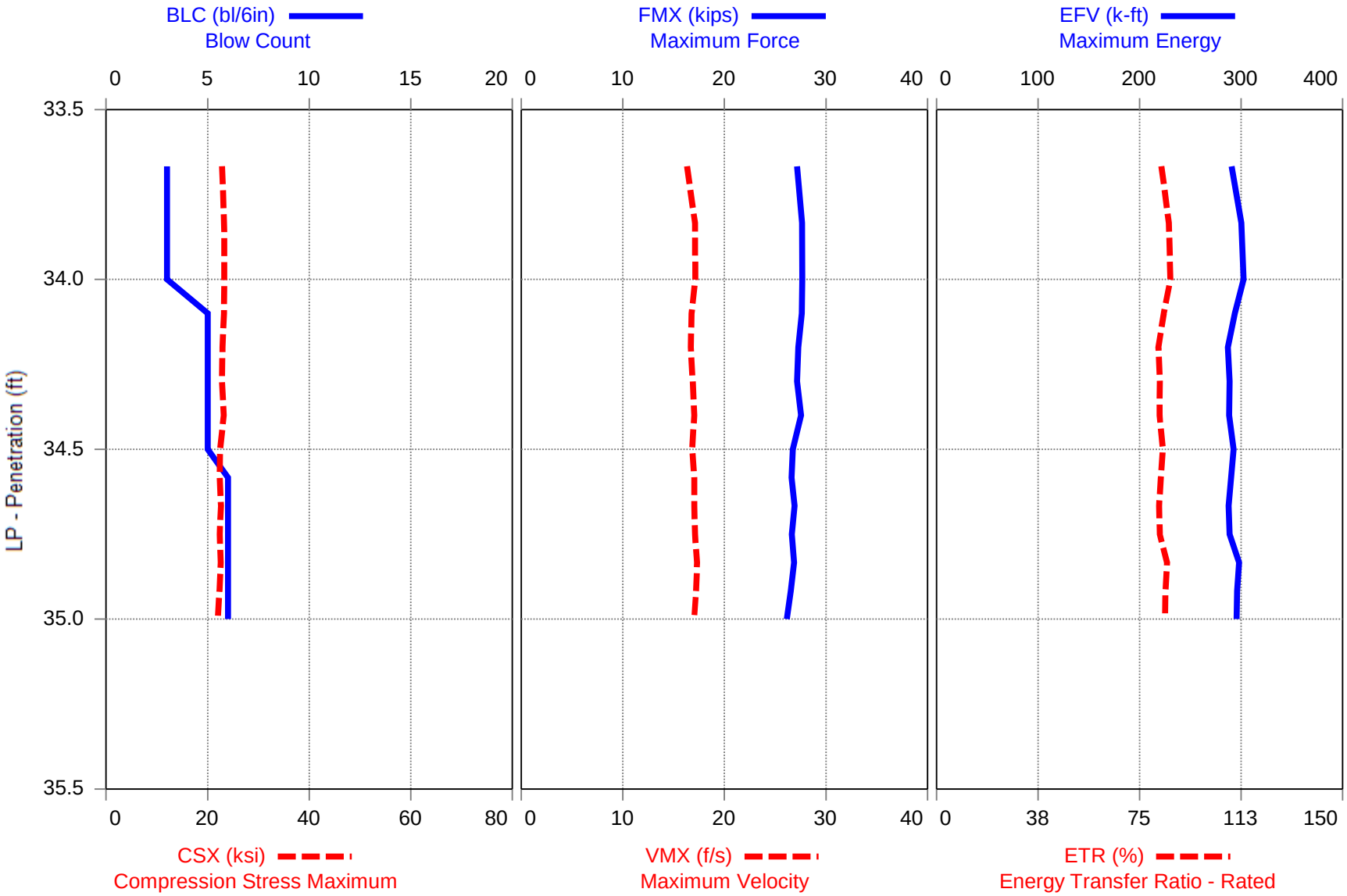


Pile Dynamics, Inc. - PDIPLOT2 Ver 2021.1.61.0 - Case Method & iCAP® Results

Printed: 23-March-2022

Test started: 11-March-2022

CME 45B (SN 303304) - 33.5 TO 35.0

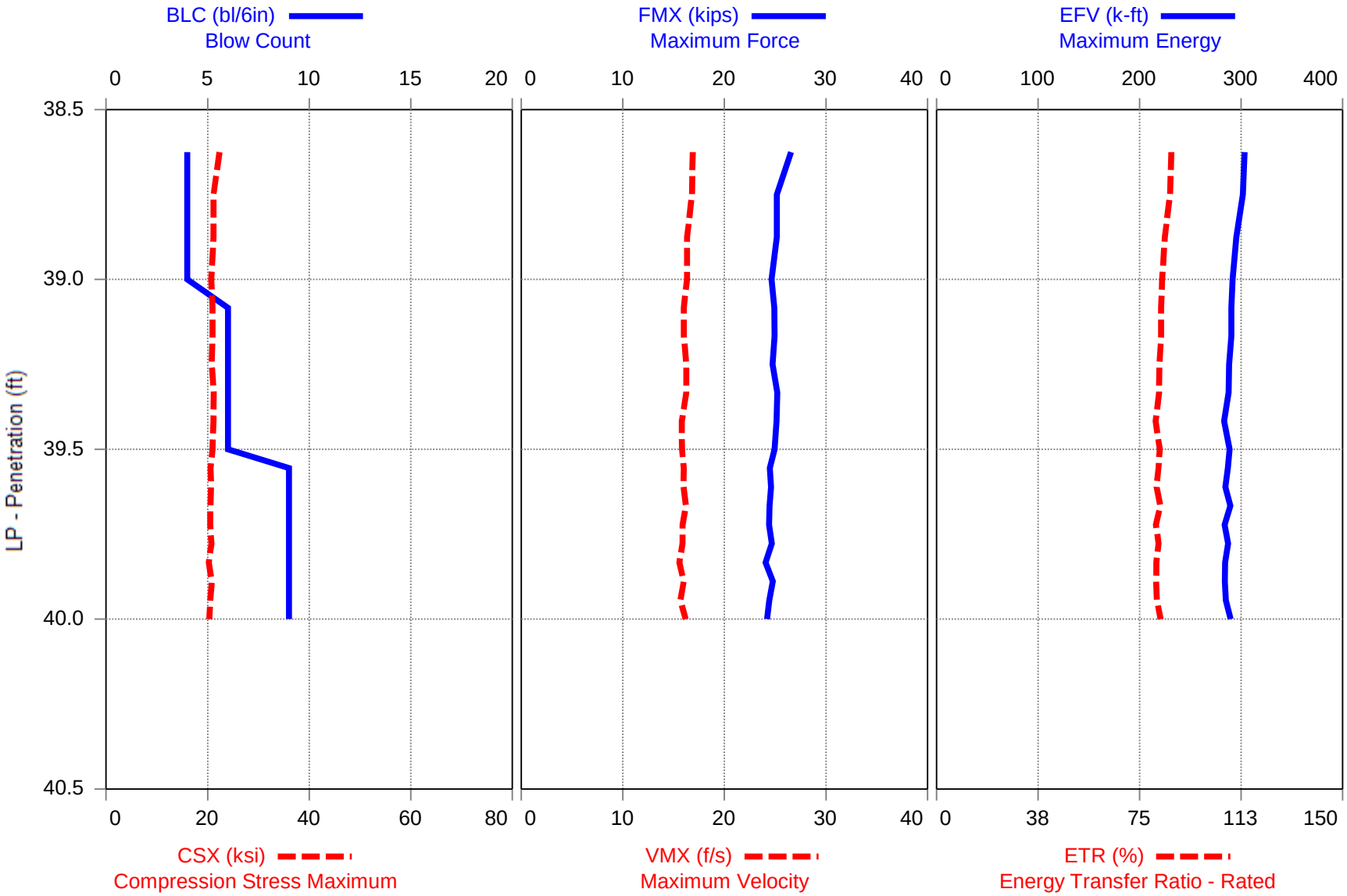


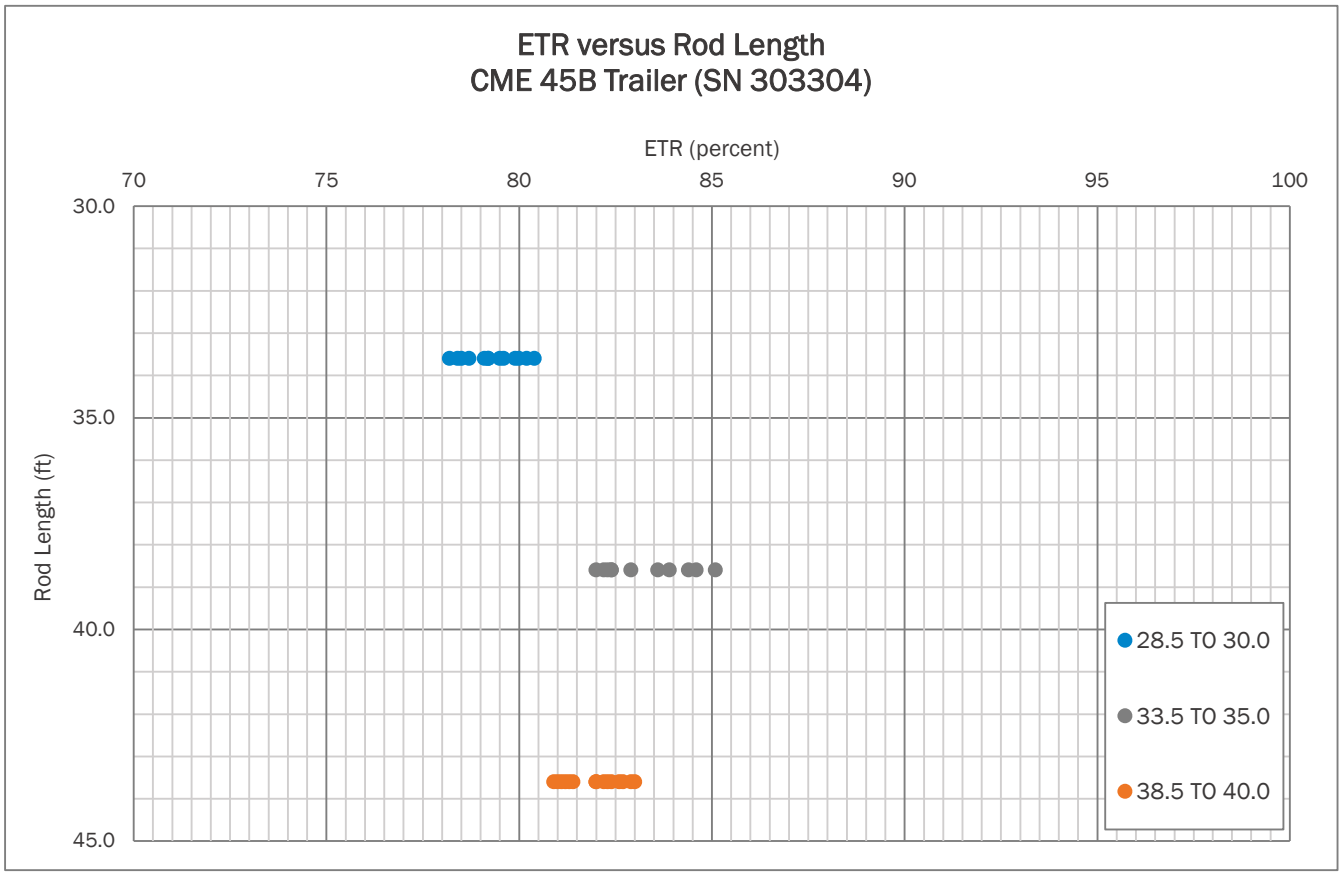
Pile Dynamics, Inc. - PDIPLOT2 Ver 2021.1.61.0 - Case Method & iCAP® Results

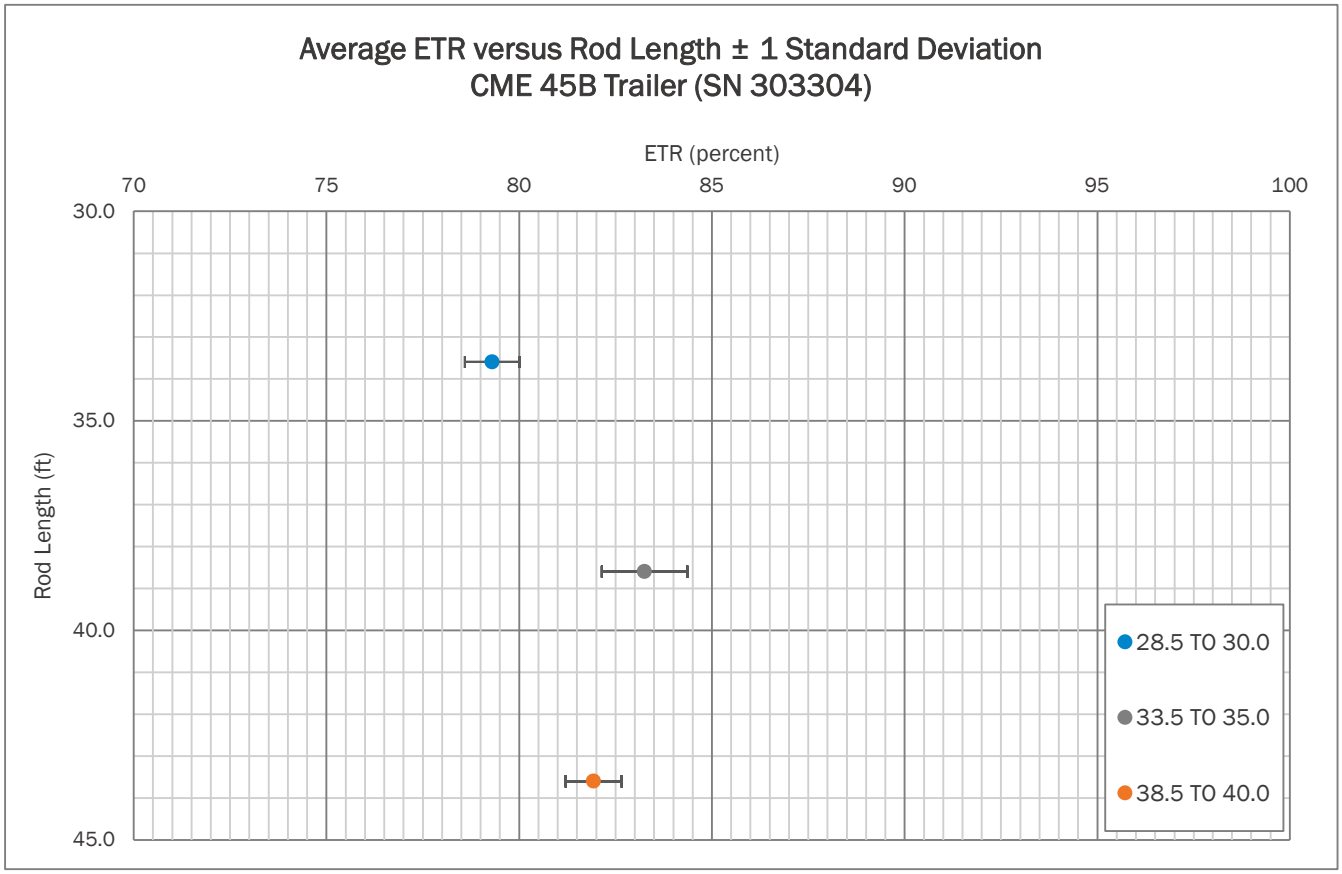
Printed: 23-March-2022

Test started: 11-March-2022

CME 45B (SN 303304) - 38.5 TO 40.0




ETR versus Rod Length
CME 45B Trailer (SN 303304)
ETR (percent)
70
75
80
85
90
95
100
Rod Length (ft)
30.0
35.0
40.0
45.0
28.5 TO 30.0
33.5 TO 35.0
38.5 TO 40.0


Average ETR versus Rod Length ± 1 Standard Deviation
CME 45B Trailer (SN 303304)
ETR (percent)
70
75
80
85
90
95
100
Rod Length (ft)
30.0
35.0
40.0
45.0
28.5 TO 30.0
33.5 TO 35.0
38.5 TO 40.0

APPENDIX II

SPT Hammer Energy Field Form

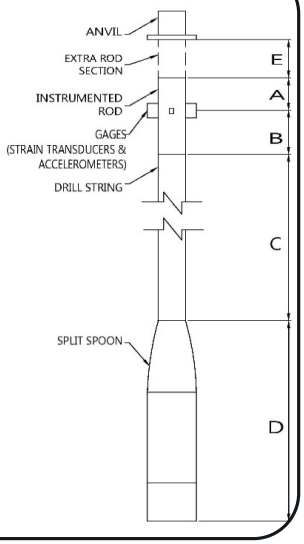
Project:	SPT HAMMER ENERGY	**Date:**	3/11/2022
Project No.:	240021095	**Weather:**	50's CLOUDY
Boring No.:	B-1	**Drill Rod Type:**	AWJ

On-site Personnel

Drilling Company:	BRECCIA CONSTRUCTION, LLC
Rig Operator:	D. HARRIS
Engr/Geologist:	N/A
Client Rep.:	N/A
Analyzer Oper.:	R. KRAL

Rod Info

(A + E) Impact Surface to Gages Length:	1.36	ft
(B) Instr. Rod Length below Gages:	0.70	ft
(A) + (B) Instr. Rod Length:	2.00	ft
(D) Spoon Length:	2.85	ft
(E) Rod Length Above Instr. Rod (if applicable):	0.06	ft
Instr. Rod S/N:	528AWJ	
Instr. Rod Outside Dia.:	1.75	in.
Instr. Rod Area:	1.19	in^2
PDA Make/Model:	SPT	
PDA Serial No.:	4549 TB	
Calib. Pulse Test (y/n):	Y	



Rig/Hammer Info

Drill Rig Make/Model:	CME 45B
Carrier Type:	TRAILER
Rig Serial No.:	303304 (DR-1)
Hammer Type/Model:	CME
Hammer Serial No.:	N/A
Hammer Drop System:	AUTO
Lubrication Condition:	PER MANUFACTURER
Manufacturer Recommended Operation Rate (bpm):	55
Drop Height (in.):	30
Hammer Weight (lbs):	140
Anvil Dimension (in.):	11.5
Drilling Method:	2.25 HSA

Gage Info

Gage		Serial No.	Calibration No.
Accel.	A3	K11957	407.00
	A4	K10959	417.30
Strain	F3	528AWJ-1	205.26
	F4	528AWJ-2	205.86

Date of Test	Test Depth Increment (ft to ft)	Test Time Start / Stop (military)	Length of Drill String (ft) *(C)*	(LE) Length below Gages (ft) *(B) + (C) + (D)*	Avg. Meas. Hammer Rate (BPM)	SPT Blow Counts 6"	12"	18"	N-Value	Drop Height in Tolerance (y/n)	Soil Class.
11-Mar	28.5 TO 30.0	0830/0830	30	33.6	53	4	6	7	13	Y	SA SI
11-Mar	33.5 TO 35.0	0837/0837	35	38.6	57	3	5	6	11	Y	SA SI
11-Mar	38.5 TO 40.0	0842/0843	40	43.6	56	4	6	9	15	Y	SA SI

Notes:
TESTING PERFORMED AT 1817 LOWRYS HIGHWAY IN CHESTER, SOUTH CAROLINA (CHESTER COUNTY). THE APPROXIMATE COORDINATES ARE 34.770585, -81.245517.

NOTE: (1) Note any unusual hammer operating conditions that affect the hammer performance, or changes in operating conditions (e.g. veritcality, weather, or lubrication between trials). (2) Note any changes in rod diameter along drill string and record locations of short rod sections.

Prepared By (print/signature) — Date: 3/11/2022

Figure No. 1: Rear View of Drill Rig

Figure No. 2: Side View of Drill Rig

Figure No. 3: Serial Number Plate

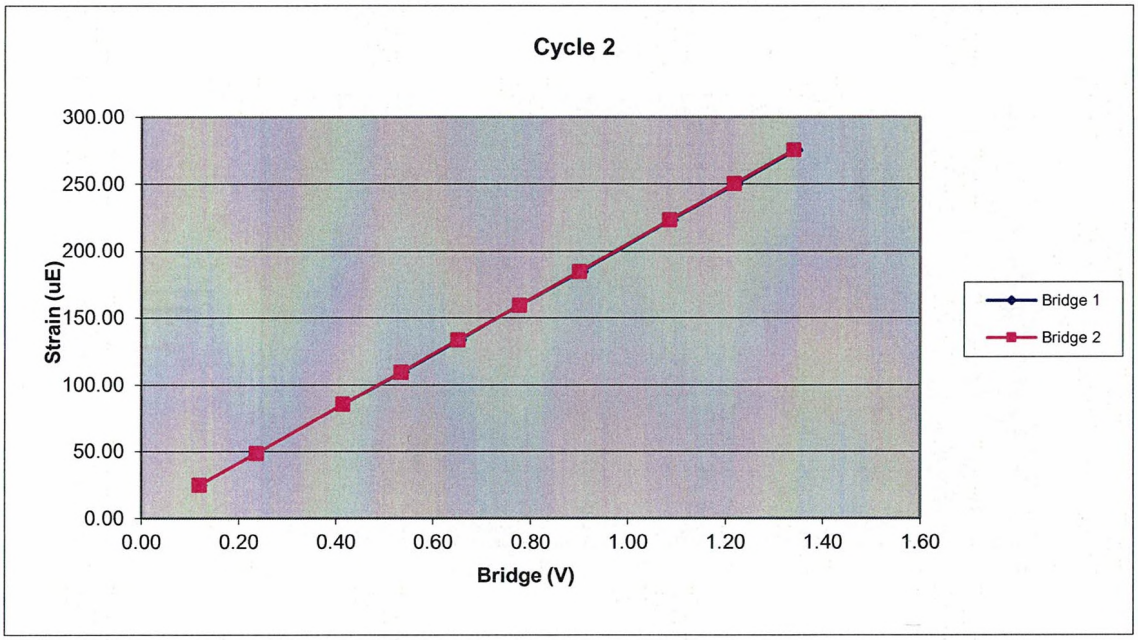
Figure No. 4: Automatic Hammer

APPENDIX III

528AWJ		Cycle 2		
Sample	**Force (lb)**	**Strain (µE)**	**Bridge 1 (V)**	**Bridge 2 (V)**
1	0.00	0.00	0.00	0.00
2	905.16	24.61	0.12	0.12
3	1753.20	48.18	0.24	0.24
4	3064.74	84.99	0.42	0.41
5	3947.87	108.99	0.54	0.53
6	4813.36	133.40	0.65	0.65
7	5727.49	159.02	0.78	0.78
8	6643.67	184.17	0.90	0.90
9	8004.82	222.89	1.09	1.09
10	8980.07	249.70	1.22	1.22
11	9885.91	275.04	1.35	1.34

Bridge 1		**Bridge 2**	
Force Calibration (lb/V)	**7340.27**	**Force Calibration (lb/V)**	**7362.32**
Offset	**12.98**	Offset	**13.21**
Correlation	**1.000000**	Correlation	**0.999999**
Strain Calibration (µE/V)	**204.74**	**Strain Calibration (µE/V)**	**205.35**
Offset	**-0.39**	Offset	**-0.39**
Correlation	**0.999993**	Correlation	**0.999995**

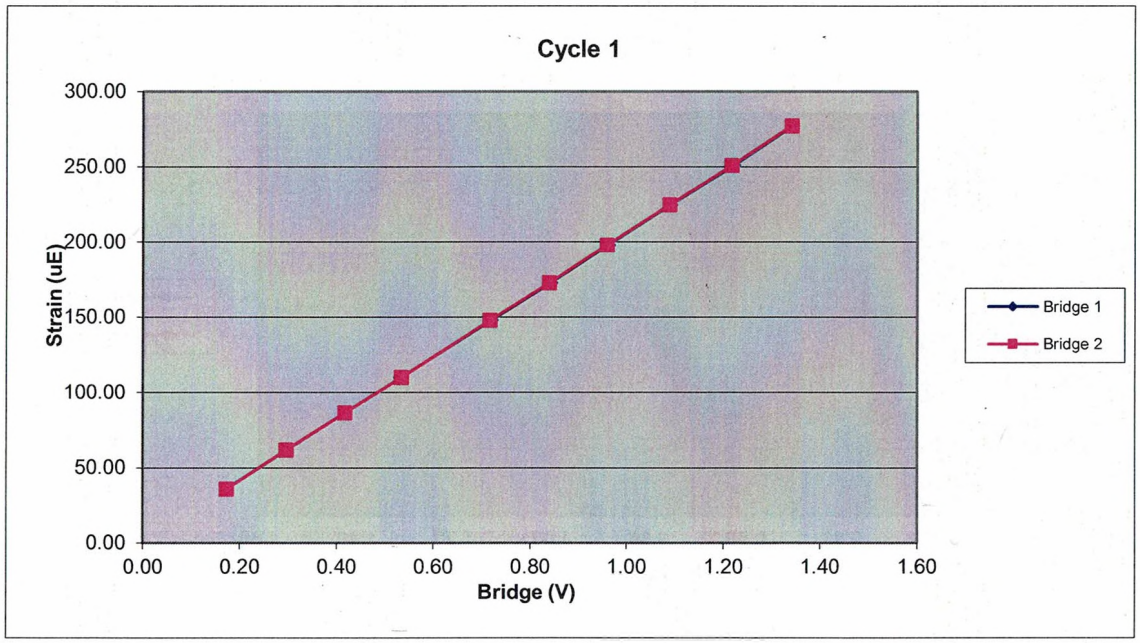
Force Strain Calibration	
EA (Kips)	**35851.72**
Offset	**27.08**
Correlation	**0.999996**



528AWJ		Cycle 1		
Sample	**Force (lb)**	**Strain (μE)**	**Bridge 1 (V)**	**Bridge 2 (V)**
1	0.00	0.00	0.00	0.00
2	1278.49	35.63	0.17	0.17
3	2188.92	61.59	0.30	0.30
4	3085.11	86.16	0.42	0.42
5	3944.56	110.01	0.53	0.54
6	5284.17	147.69	0.72	0.72
7	6199.57	172.59	0.84	0.84
8	7071.20	197.80	0.96	0.96
9	8023.54	224.47	1.09	1.09
10	8958.62	250.45	1.22	1.22
11	9876.55	276.81	1.34	1.34

Bridge 1		**Bridge 2**	
Force Calibration (lb/V)	**7346.16**	**Force Calibration (lb/V)**	**7359.87**
Offset	9.71	Offset	6.72
Correlation	0.999998	Correlation	0.999999
Strain Calibration (μE/V)	**205.65**	**Strain Calibration (μE/V)**	**206.03**
Offset	0.08	Offset	-0.01
Correlation	0.999990	Correlation	0.999993

Force Strain Calibration	
EA (Kips)	**35721.25**
Offset	7.11
Correlation	0.999990



Bridge Excitation (V) 5
Shunt Resitor (ohm) 60.4k

Calibration Factors	528AWJ		
Bridge 1 (µE/V)	205.26	Bridge 2 (µE/V)	205.86
EA Factor (Kips)	35777.05	Area (in^2)	1.19

Calibrated by: _____
Calibrated Date: 1/28/2021

Pile Dynamics Inc
30725 Aurora Rd
Solon, OH 44139

Traceable to N.I.S.T.

Accelerometer Calibration Certificate
Pile Dynamics, Inc.

Calibrated by Pile Dynamics, Inc.
Calibration performed on 19Apr2021

Serial No:	K10959	**Temperature:**	21.0 °C
Model:	PR	**Humidity:**	38%
Calibrated on:	Channel 3 on 8G 5161 LE		

Ref Acc 1:	69096! 978 g's/volt	**Cal on:**	27Jan2021
Ref Acc 2:	69132! 960 g's/volt	**Cal on:**	09Feb2021

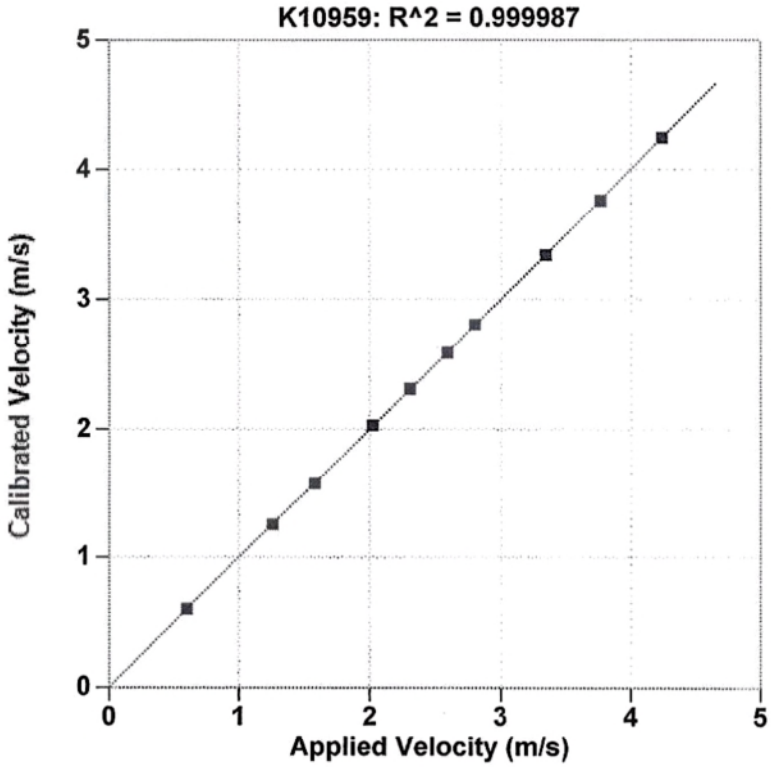
Reference accelerometer calibrations are traceable to the United States National Institute of Standards and Technology (NIST).

PDA CALIBRATION FACTOR

417.3 mv/5000g
(83.5 µv/g)
R^2: 0.999987 [Chip programmed]

Operator: William Johnson

Signed



Reference Velocity	S/N K10959 Velocity
m/s	m/s
0.600	0.600
1.260	1.255
1.578	1.577
2.021	2.028
2.306	2.311
2.590	2.590
2.801	2.806
3.346	3.344
3.767	3.762
4.241	4.241

Maximum Acceleration: 938 g's

Accelerometer Calibration Certificate
Pile Dynamics, Inc.

Calibrated by Pile Dynamics, Inc.
Calibration performed on 22Jan2021

Serial No:	K10960	**Temperature:**	20.0 °C
Model:	PR	**Humidity:**	28%
Calibrated on:	Channel 4 on 8G 5161 LE		

Ref Acc 1:	63479! 1080 g's/volt	**Cal on:**	09Sep2020
Ref Acc 2:	65538! 1040 g's/volt	**Cal on:**	27Jan2020

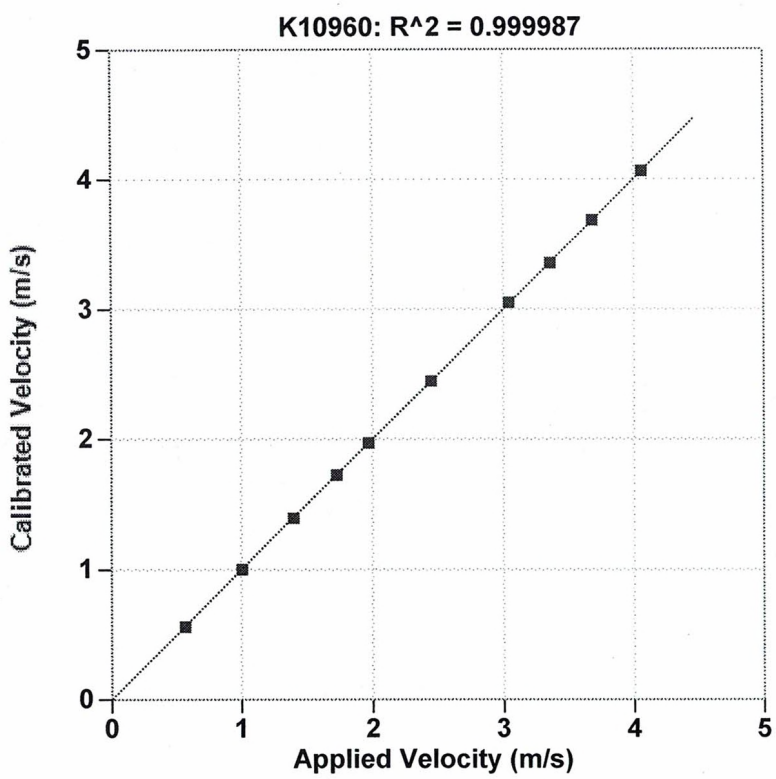
Reference accelerometer calibrations are traceable to the United States National Institute of Standards and Technology (NIST).

PDA CALIBRATION FACTOR

425.7 mv/5000g
(85.1 μv/g)
R^2: 0.999987 [Chip programmed]

Operator: William Johnson

Signed



Reference Velocity	S/N K10960 Velocity
m/s	m/s
0.568	0.564
1.006	1.001
1.400	1.393
1.728	1.726
1.969	1.970
2.447	2.448
3.043	3.051
3.359	3.356
3.683	3.684
4.063	4.062

Maximum Acceleration: 889 g's

Accelerometer Calibration Certificate
Pile Dynamics, Inc.

Calibrated by Pile Dynamics, Inc.
Calibration performed on MAR 2 2021

Serial No:	K11957	**Temperature:**	20.0 °C
Model:	PR	**Humidity:**	27%
Calibrated on:	Channel 4 on 8G 5161 LE		

Ref Acc 1:	63479! 1079 g's/volt	**Cal on:**	22Jan2021
Ref Acc 2:	65538! 1043 g's/volt	**Cal on:**	22Jan2021

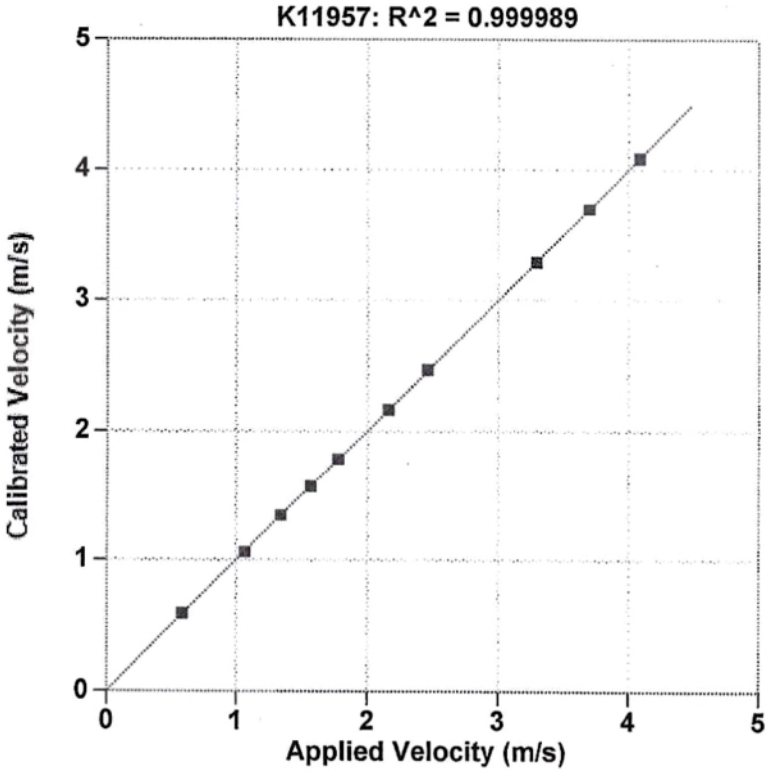
Reference accelerometer calibrations are traceable to the United States National Institute of Standards and Technology (NIST).

PDA CALIBRATION FACTOR

407.0 mv/5000g
(81.4 µv/g)
R^2: 0.999989 [Chip programmed]

Operator: William Johnson

Signed



Reference Velocity	S/N K11957 Velocity
m/s	m/s
0.588	0.589
1.066	1.061
1.344	1.345
1.571	1.570
1.779	1.783
2.161	2.164
2.458	2.465
3.294	3.291
3.701	3.700
4.089	4.086

Maximum Acceleration: 894 g's

APPENDIX IV

PDCA
PILE DRIVING CONTRACTORS ASSOCIATION

Pile Dynamics, Inc.

This documents that

Robert E. Kral
Carolinas Geotechnical Group

has on May 20, 2016 achieved the rank of

ADVANCED

on the **Dynamic Measurement and Analysis Proficiency Test.**

The individual identified on this document demonstrated to the degree granted above an understanding of theory, data quality evaluation, interpretation and signal matching for high strain dynamic testing of deep foundations. ***It is recommended* that Individuals at the Advanced level seek Master or Expert levels through additional study within six years of the date of this document.**

The ability of the individual named to provide appropriate knowledge and advice on a specific project is not implied or warranted by the Pile Driving Contractors Association or Pile Dynamics, Inc. **This certificate can be verified at www.PDAproficiencytest.com.** The Pile Driving Contractors Association or Pile Dynamics, Inc. assumes no liability for foundation testing and analysis work performed by the bearer of this certificate.

Steven A. Hall, Executive Director
Pile Driving Contractors Association

Garland Likins, Senior Partner
Pile Dynamics, Inc.

No. 2072