

Geotechnical Data Report

**S-13-34 (Wamble Hill Road)
Emergency Bridge Replacement over Little Black Creek
Chesterfield County, South Carolina**

February 7, 2019

SCDOT Project ID.: P038267

Terracon Project No. 7318P119E

Prepared for:

South Carolina Department of Transportation
Columbia, South Carolina

Prepared by:

Terracon Consultants, Inc.
Columbia, South Carolina

Offices Nationwide
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Terracon

Geotechnical ■ Environmental ■ Construction Materials ■ Facilities

February 7, 2019



South Carolina Department of Transportation
955 Park Street, Room 421
Columbia, South Carolina 29201

Attn: Mr. Trapp Harris, P.E.
Geotechnical Design Engineer – Design-Build Section

Re: Geotechnical Data Report
S-13-34 (Wamble Hill Road) Emergency RBO Deep Creek
Chesterfield County, South Carolina
SCDOT Project ID.: P038267
Terracon Project Number: 7318P119E

Dear Mr. Harris:

Terracon Consultants Inc. (Terracon) has completed the geotechnical exploration and testing services for the above referenced project. These services were conducted in general accordance with the SCDOT Request for Subsurface Exploration and Laboratory Testing (SCDOT Project ID: P038267, authorized on December 10, 2018). This geotechnical data report presents the findings of the subsurface exploration and laboratory testing along with an overview of testing activities.

1.0 INTRODUCTION

The South Carolina Department of Transportation (SCDOT) has contracted Terracon to perform subsurface exploration and laboratory testing for the replacement of the S-13-34 (Wamble Hill Road) bridge over Deep Creek in Chesterfield County, SC. The purpose of this work is to develop information relative to subsurface soil and groundwater conditions at the bridge location. No geotechnical recommendations are associated with the requested scope of study.

The following sections of this report contain a summary of the activities for our field exploration and laboratory testing. The logs of the borings, the Site Location Map and the Exploration Plan are included in Appendix A. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included in Appendix B. Descriptions of the field exploration and laboratory testing are included in their respective appendices.



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Geotechnical



Environmental



Construction Materials



Facilities

2.0 PROJECT DESCRIPTION

The project site is located at the bridge crossing of S-13-34 (Wamble Hill Road) and Deep Creek in Chesterfield County, South Carolina. It is our understanding that the project will include the replacement of the previously damaged bridge with a new structure on the existing or similar horizontal alignment. The original structure appears to have been supported with round timber piles.

3.0 GEOTECHNICAL TESTING

The geotechnical exploration for this project was performed between January 14 and 16, 2019. The results of our field work and our associated laboratory testing is attached in Appendixes A and B of this report.

3.1 Field Exploration

Our field exploration at the site consisted of the following:

- Two (2) Standard Penetration Test (SPT) Borings (B-1 and B-2)

The tests were performed at the approximate locations provided by the SCDOT. A description of our testing methods and graphical logs outlining the soil conditions at each test location are presented in Appendix A. Test locations were established in the field by Terracon and surveyed by Construction Support Services, LLC, after completion. Photographs of the drill rig set up at each boring location are provided in Appendix A.

3.2 Laboratory Testing

The following laboratory tests were performed on the soil samples collected at the site.

- Eight (8) Natural Moisture Content Tests
- Eight (8) No. 200 Wash Tests
- Four (4) Atterberg Limits Tests
- Five (5) Unconfined Compressive Strength of Rock Tests

The general scope of the laboratory testing frequency was determined by the SCDOT. The laboratory procedures and results of the laboratory tests are presented in Appendix B.

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4.0 CLOSURE

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or we may be of further service, please contact us.

Sincerely,

Terracon Consultants, Inc.

Ryan D. Starcher, E.I.T.
Senior Staff Engineer

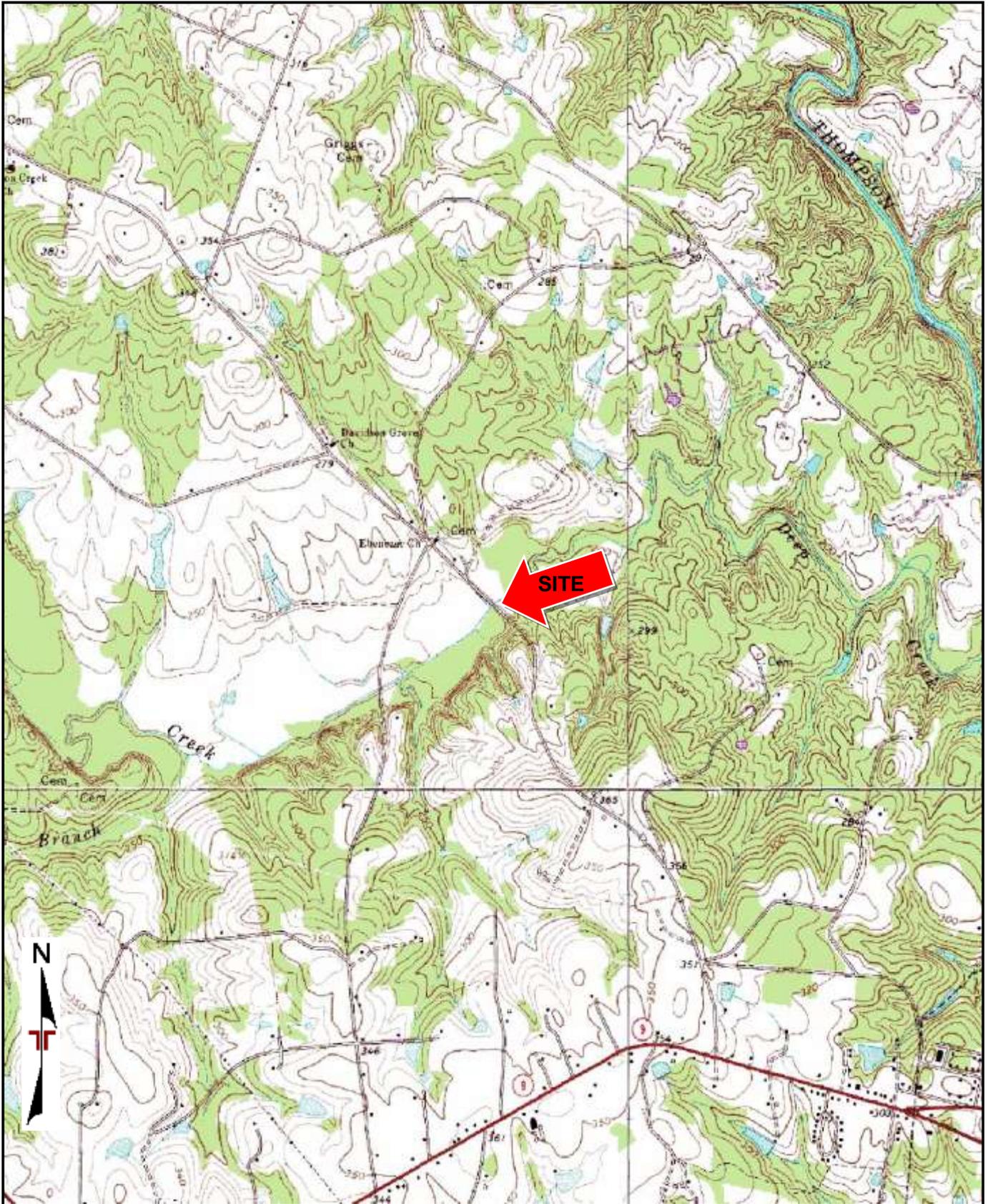
Phillip A. Morrison, P.E.
Geotechnical Department Manager
SC Registration No. 17275

Attachments:

- Appendix A
- Appendix B
- Appendix C

APPENDIX A
FIELD EXPLORATION

- Exhibit A-1 – Site Location Map**
- Exhibit A-2 – Exploration Plan**
- Exhibit A-3 – Summary of Field Data**
- Exhibit A-4 – Field Exploration Description**
- Exhibit A-5 – Soil Description Terms**
- Exhibit A-6 – Rock Description Terms**
- Exhibit A-7 – Soil Rock Symbol Log**
- Exhibit A-8 – Boring Logs**
- Exhibit A-9 – Rock Photographic Log**
- Exhibit A-10 – Drill Rig Photograph Log**



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
 QUADRANGLES INCLUDE: MT CROGHAN, NC (1/1/1983), MORVEN WEST, NC (1/1/1988), RUBY, SC (1/1/1968) and CHESTERFIELD, SC (1/1/1968).

Project Manager: RDS Drawn by: PTK Checked by: RDS Approved by: PAM	Project No. 7318P119E Scale: 1"=2,000' File Name: A-1 & A-2 Date: Feb. 2019	 521 Clemson Rd Columbia, SC 29229-4307	SITE LOCATION MAP S-13-34 (Wamble Hill Road) RBO Deep Creek Chesterfield County, South Carolina	Exhibit A-1
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bing

50 feet

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DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

Project Manager: RDS	Project No. 7318P119	 521 Clemson Rd Columbia, SC 29229-4307	EXPLORATION PLAN	Exhibit
Drawn by: PTK	Scale: AS SHOWN		S-13-34 (Wamble Hill Road) RBO Deep Creek Chesterfield County, South Carolina	A-2
Checked by: RDS	File Name: A-1 & A-2			
Approved by: PAM	Date: Feb. 2019			

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Summary of Field Data

Test No.	Ground Elevation (ft)	Test Depth (ft.)	Northing	Easting	Latitude	Longitude
B-1	210.43	44.7	1065113.190	2260775.458	N34.757671	W80.131822
B-2	210.73	36.2	1065054.052	2260826.197	N34.757508	W80.131654

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FIELD EXPLORATION DESCRIPTION

Overview

The general testing locations were provided by the SCDOT and located in the field by Terracon by taking measurements from existing structures. The borings were surveyed by Construction Support Services, LLC after testing and drilling was complete. The locations are shown on the appended Exploration Plan.

A field log of each test location was prepared by our field engineer. The final boring logs included with this report represent the engineer's description of the encountered conditions modified as necessary based on laboratory test results of the individual samples.

Soil Test Borings (STB)

All boring and sampling operations were conducted in general accordance with the following procedures:

- SCDOT Geotechnical Design Manual 2010
- ASTM D5783, "Standard Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geo-environmental Exploration"
- ASTM D1586 "Test Method for Penetration Test and Split-Barrel Sampling of Soils"
- ASTM D4220 "Standard Practices for Preserving and Transporting Soil"

Each boring was advanced using rotary wash drilling techniques to the planned termination depths. The sampling program is summarized in the following table:

Test ID	Total Depth	Interval of Continuous Sampling
B-1	100 feet or refusal and 20 feet of coring	0 to 10 feet
B-2	100 feet or refusal and 20 feet of coring	0 to 10 feet

Soil samples were obtained with a standard 1.4-inch I.D., 2-inch O.D., split-barrel sampler, also known as a standard split-spoon. The sampler is advanced into the soil a total of 18 to 24 inches by striking the drill rod using a 140-pound automatic hammer falling 30 inches. The number of blows required to advance the sampler for each of three to four, 6-inch increments is recorded. The sum of the number of blows for the second and third increments is called the "Standard Penetration Value", or N-value (N_{meas} , blows per foot). The N-value, when properly evaluated, is an index to the soil strength.

The borings were advanced to refusal of the drilling equipment and continued below this depth using diamond bit rock coring techniques. NQ2 sized cores were recovered from the borehole. The rock recovery ratios (REC, percentage of the total core run), Rock Quality Designation (RQD, percentage of the total core run of pieces greater than 4 inches) were recorded along with a

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description of the rock. An explanation of the rock descriptions shown on the logs is provided in Exhibit 6. Photos of the recovered rock core specimens are provided on Exhibit A-9 of the Appendix.

Soil Classification provides a general guide to the engineering properties of various soil types and enables the engineer to apply his experience to current situations. In our exploration, samples obtained during drilling operations are examined and visually classified by a geotechnical engineer using the procedures outlined in ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System). Laboratory testing was also performed on select split-spoon samples to evaluate index properties for further classification. The soils are described according to color, texture, and relative density or consistency (based on standard penetration resistance). The designations shown on the logs are described on Exhibit A-5.

Consistent with SCDOT GDM, the borings were drilled using mud rotary drilling techniques. As the drilling method introduces water into the borehole, time-of-drilling water levels could not be recorded. As noted on the boring log, the water levels of the borings were recorded at least 1 day after the start of drilling activities. These water levels are indicated on the boring logs. At the conclusion of the work, the boreholes were backfilled with sand and the borings were capped with cold-patch asphalt.

SOIL DESCRIPTION TERMS

Relative Density/Consistency Terms

<u>Relative Density¹</u>			<u>Consistency²</u>		
Descriptive Term	Relative Density	SPT Blow Count	Descriptive Term	Unconfined Compression Strength (q_u) (tsf)	SPT Blow Count
Very Loose	0 to 15%	4 and less	Very Soft	0.25 and less	2 and less
Loose	16 to 35%	5 to 10	Soft	0.26 to 0.50	3 to 4
Medium Dense	36 to 65%	11 to 30	Firm	0.51 to 1.00	5 to 8
Dense	66 to 85%	31 to 50	Stiff	1.01 to 2.00	9 to 15
Very Dense	86 to 100%	51 and more	Very Stiff	2.01 to 4.00	16 to 30
			Hard	4.01 and more	31 and more

Moisture Condition

<u>Descriptive Term</u>	<u>Criteria</u>
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

Color

Describe the sample color while sample is still moist.

Angularity¹

<u>Descriptive Term</u>	<u>Criteria</u>
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.

HCl Reaction³

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

Cementation³

<u>Descriptive Term</u>	<u>Criteria</u>
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

Particle-Size Range¹

<u>Gravel</u>	Diameter, mm	Sieve Size	<u>Sand</u>	Diameter, mm	Sieve Size
Fine	4.76 to 19.1	#4 to ¾ inch	Fine	0.074 to 0.42	#200 to #40
Coarse	19.1 to 76.2	¾ inch to 3 inch	Medium	0.42 to 2.00	#40 to #10
			Coarse	4.00 to 4.76	#10 to #4

Primary Soil Type^{1,2}

The primary soil type will be shown in all capital letters.

USCS Soil Designation

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

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 Applies to fine-grained soils (major portion passing No. 200 sieve)

³ Use as required

DESCRIPTION OF ROCK PROPERTIES

WEATHERING

Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
Very slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately severe	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.
Severe	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
Very severe	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	Rock reduced to "soil". Rock "fabric" not discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.

HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals)

Very hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately hard	Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding, and Foliation Spacing in Rock ^a

Spacing	Joints	Bedding/Foliation
Less than 2 in.	Very close	Very thin
2 in. – 1 ft.	Close	Thin
1 ft. – 3 ft.	Moderately close	Medium
3 ft. – 10 ft.	Wide	Thick
More than 10 ft.	Very wide	Very thick

a. Spacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.

Rock Quality Designator (RQD) a

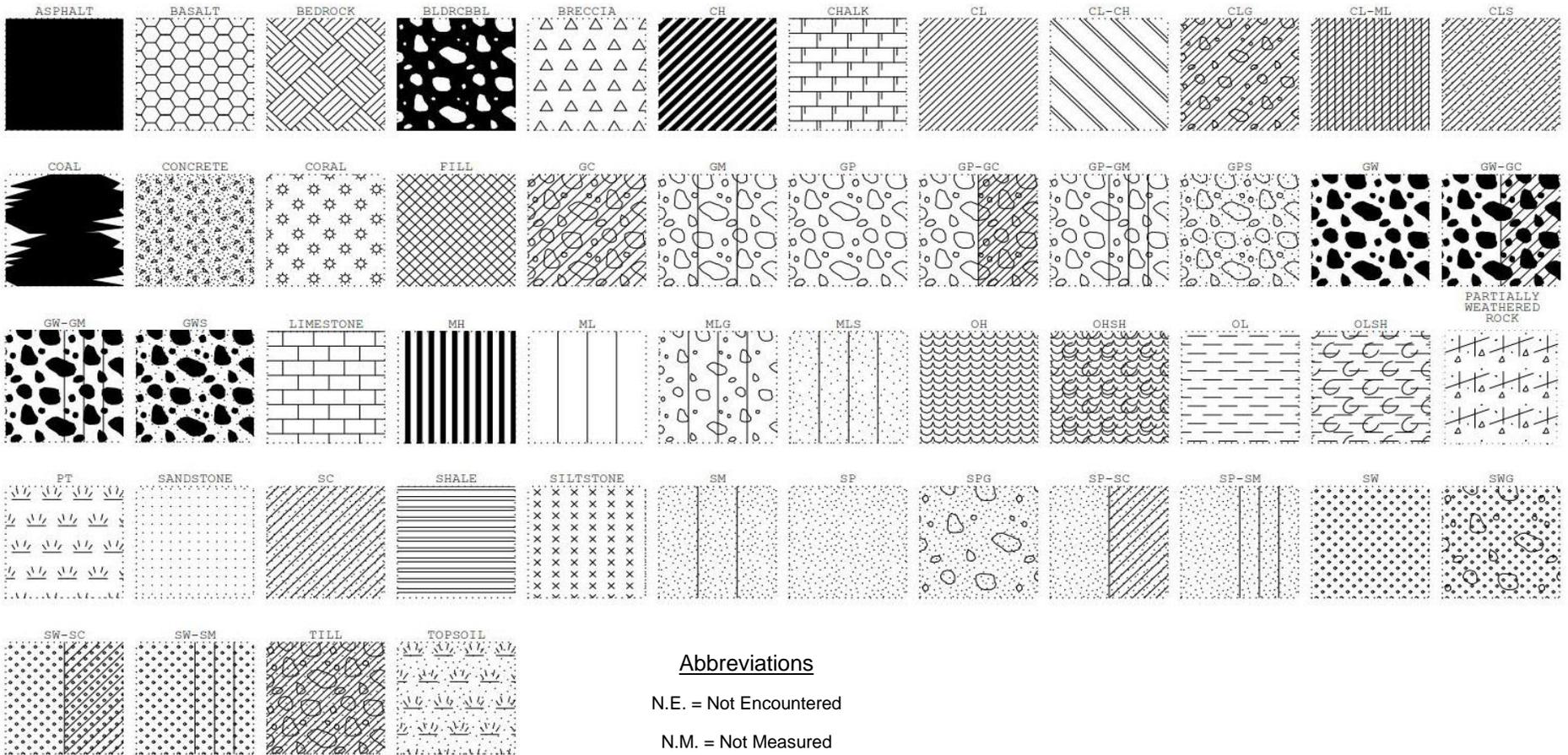
RQD, as a percentage	Diagnostic description
Exceeding 90	Excellent
90 – 75	Good
75 – 50	Fair
50 – 25	Poor
Less than 25	Very poor

a. RQD (given as a percentage) = length of core in pieces 4 in. and longer/length of run.

Joint Openness Descriptors

Openness	Descriptor
No Visible Separation	Tight
Less than 1/32 in.	Slightly Open
1/32 to 1/8 in.	Moderately Open
1/8 to 3/8 in.	Open
3/8 in. to 0.1 ft.	Moderately Wide
Greater than 0.1 ft.	Wide

References: American Society of Civil Engineers. Manuals and Reports on Engineering Practice - No. 56. Subsurface Investigation for Design and Construction of Foundations of Buildings. New York: American Society of Civil Engineers, 1976. U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.



Abbreviations

N.E. = Not Encountered

N.M. = Not Measured

Project Manager:	PAM	Project No.	7318P119E
Drawn by:	KJZ	Scale:	N.T.S.
Checked by:	KJZ	File Name:	Soil - Rock - Log
Approved by:	PAM	Date:	February 7, 2019

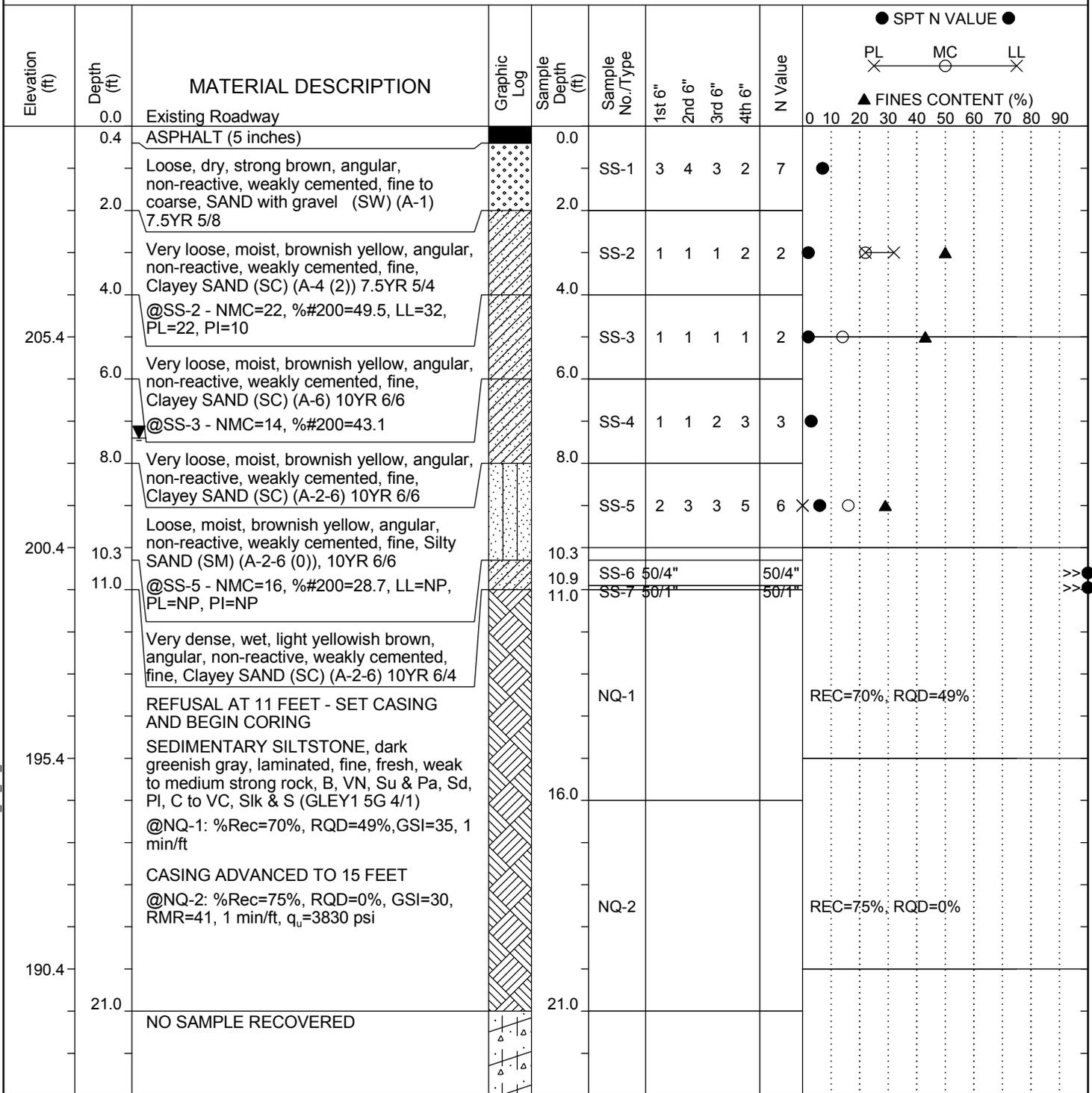
Terracon
Consulting Engineers & Scientists

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SOIL / ROCK / LOG SYMBOL LEGEND

SCDOT Soil Test Log

Project ID:	PO38267	County:	Chesterfield	Boring No.:	B-1
Site Description:	S-13-34 (Wamble Hill Road) RBO Deep Creek			Route:	S-13-34
Eng./Geo.:	RDS	Boring Location:		Offset:	
Elev.:	210.4 ft	Latitude:	34.757671	Longitude:	-80.131822
Total Depth:	44.7 ft	Soil Depth:	11 ft	Core Depth:	33.7 ft
Bore Hole Diameter (in):	3	Sampler Configuration		Liner Required:	Y (N)
Drill Machine:	CME-55/300	Drill Method:	RW/RC	Hammer Type:	Automatic
Core Size:	NQ	Driller:	AM	Energy Ratio:	93.2%
		Groundwater:	TOB	N.A.	24HR
					7.4 ft



LEGEND

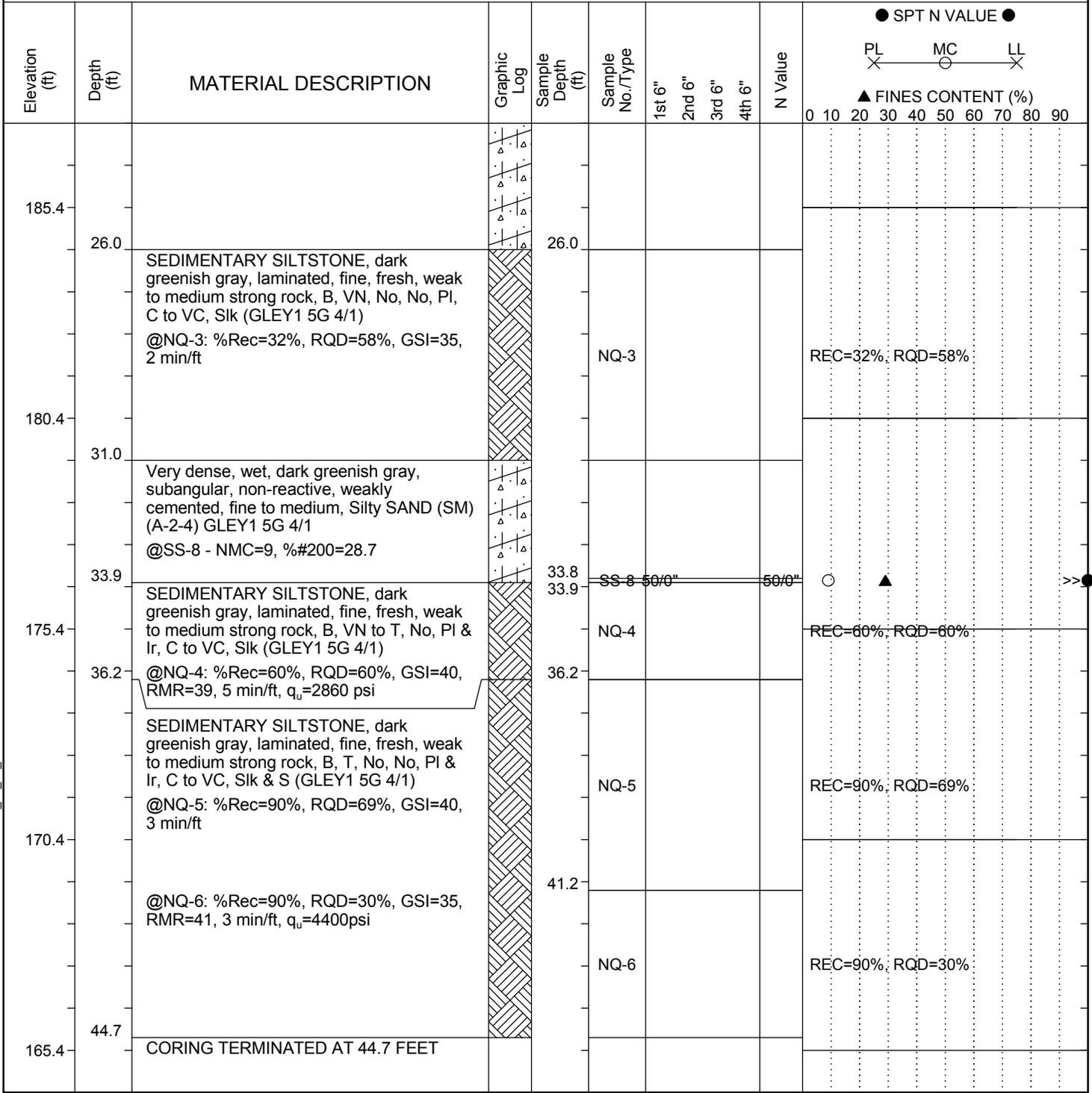
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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving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

SC_DOT_7318P119E S-13-34 SCDOT.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 2/7/19

SCDOT Soil Test Log

Project ID:	PO38267	County:	Chesterfield	Boring No.:	B-1
Site Description:	S-13-34 (Wamble Hill Road) RBO Deep Creek			Route:	S-13-34
Eng./Geo.:	RDS	Boring Location:		Offset:	
Elev.:	210.4 ft	Latitude:	34.757671	Longitude:	-80.131822
Total Depth:	44.7 ft	Soil Depth:	11 ft	Core Depth:	33.7 ft
Bore Hole Diameter (in):	3	Sampler Configuration		Liner Required:	Y (N)
Drill Machine:	CME-55/300	Drill Method:	RW/RC	Hammer Type:	Automatic
Core Size:	NQ	Driller:	AM	Groundwater:	TOB N.A.
				Energy Ratio:	93.2%
				24HR	7.4 ft



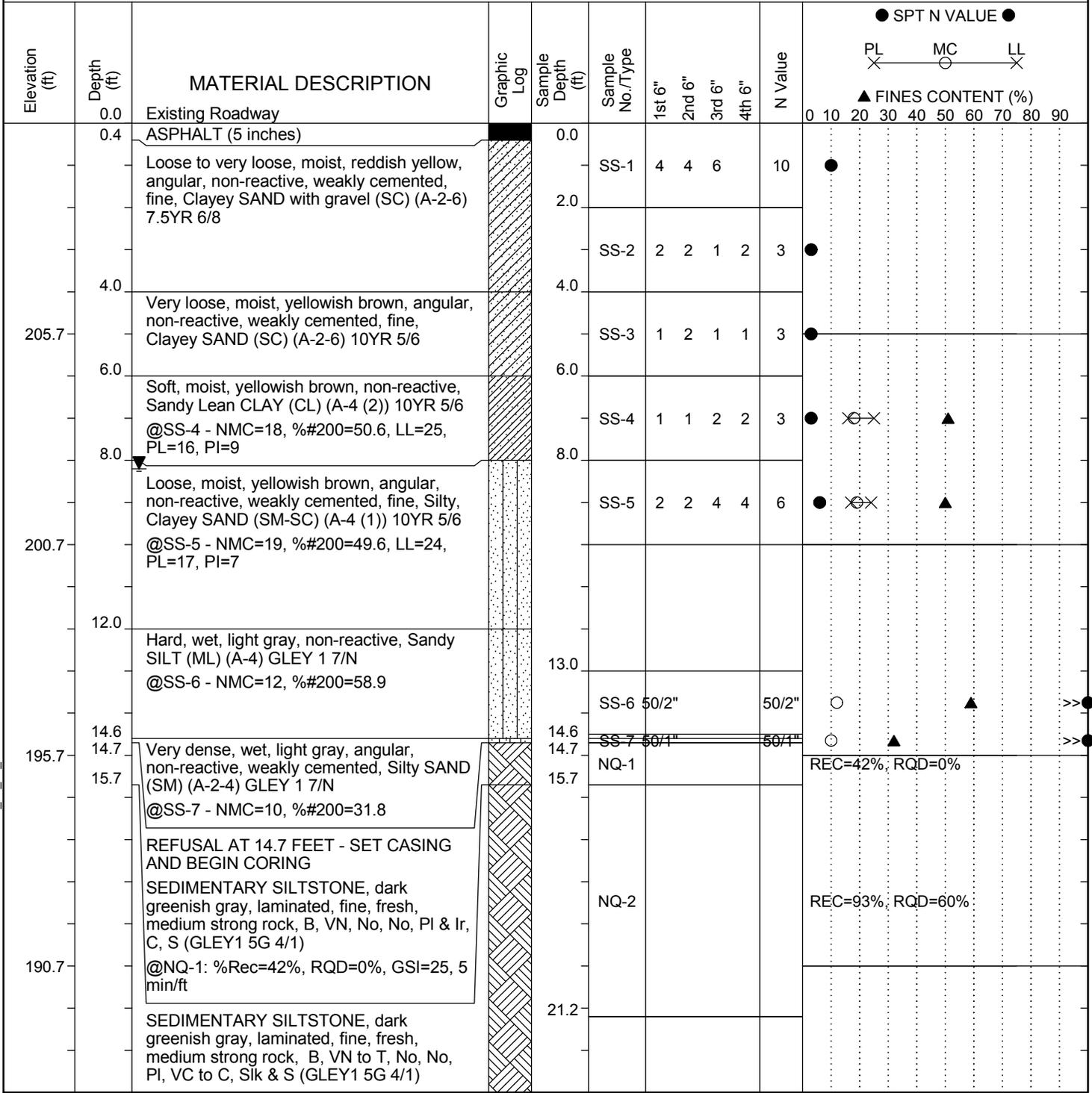
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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving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

SC_DOT_7318P119E S-13-34 SCDOT DATA TEMPLATE_01_30_2015.GDT 2/7/19

SCDOT Soil Test Log

Project ID:	PO38267	County:	Chesterfield	Boring No.:	B-2
Site Description:	S-13-34 (Wamble Hill Road) RBO Deep Creek			Route:	S-13-34
Eng./Geo.:	RDS	Boring Location:		Offset:	
Elev.:	210.7 ft	Latitude:	34.757508	Longitude:	-80.131654
Total Depth:	36.2 ft	Soil Depth:	14.7 ft	Core Depth:	21.5 ft
Bore Hole Diameter (in):	3	Sampler Configuration		Liner Required:	Y (N)
Drill Machine:	CME-55/300	Drill Method:	RW/RC	Hammer Type:	Automatic
Core Size:	NQ	Driller:	AM	Energy Ratio:	93.2%
		Groundwater:	TOB	N.A.	24HR
					8.2 ft



LEGEND

Continued Next Page

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	

SC_DOT_7318P119E S-13-34 SCDOT DATA TEMPLATE_01_30_2015.GDT 2/7/19

SCDOT Soil Test Log

Project ID:	PO38267	County:	Chesterfield	Boring No.:	B-2
Site Description:	S-13-34 (Wamble Hill Road) RBO Deep Creek			Route:	S-13-34
Eng./Geo.:	RDS	Boring Location:		Offset:	
Elev.:	210.7 ft	Latitude:	34.757508	Longitude:	-80.131654
Total Depth:	36.2 ft	Soil Depth:	14.7 ft	Core Depth:	21.5 ft
Bore Hole Diameter (in):	3	Sampler Configuration		Liner Required:	Y (N)
Drill Machine:	CME-55/300	Drill Method:	RW/RC	Hammer Type:	Automatic
Core Size:	NQ	Driller:	AM	Groundwater:	TOB N.A.
				Energy Ratio:	93.2%
				24HR	8.2 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	SPT N VALUE				FINES CONTENT (%)		
						1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	PL	MC
185.7	25.9	@NQ-2: %Rec=93%, RQD=60%, GSI=35, RMR=41, 4 min/ft, $q_u=3700$ psi @NQ-3: %Rec=85%, RQD=26%, GSI=35, RMR=39, 5 min/ft, $q_u=2330$ psi SEDIMENTARY SILTSTONE, dark greenish gray, laminated, fine, fresh, medium strong rock, B, VN to T, No, No, PI to Ir, VC, Sik & S (GLE Y1 5G 4/1) @NQ-4: %Rec=87%, RQD=38%, GSI=35, 4 min/ft		25.9	NQ-3						REC=85%, RQD=26%	
180.7		@NQ-5: %Rec=98%, RQD=81%, GSI=40, 4 min/ft		31.2	NQ-4							REC=87%, RQD=38%
175.7					NQ-5							REC=98%, RQD=81%
170.7	36.2	CORING TERMINATED AT 36.2 FEET										

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	

SC_DOT_7318P119E S-13-34_SCDOT.GPJ_SCDOT DATA TEMPLATE_01_30_2015.GDT 2/7/19

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B-1: NQ-1:11-16 feet; NQ-2:16-21 feet; and NQ-3:26-31 feet



B-1 NQ-3: 26-31 feet, cont.; NQ-4: 33.9-36.2 feet; NQ-5: 36.2-41.2 feet; and NQ-6 41.2-44.7 feet

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B-1 NQ-6: 41.2-44.7 feet cont.

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B-2 NQ-1:14.7-15.7 feet, NQ-2:15.7-21.2 feet, and NQ-3:21.2-25.9 feet



B-2 NQ-4: 25.9-31.2 feet and NQ-5: 31.2-36.2 feet

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Drill rig on B-1



Drill rig on B-2

APPENDIX B
LABORATORY TESTING

Exhibit B-1 – Laboratory Testing Description
Exhibit B-2 – Summary of Laboratory Data
Laboratory Data Sheets

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LABORATORY TESTING DESCRIPTION

The samples collected during the field exploration were taken to our laboratory for additional testing. The laboratory testing program was developed by the SCDOT. Using the provided testing program, the laboratory tests were conducted on selected soil samples from the borings. The test results are presented in this appendix.

The laboratory test results were used to confirm the soil descriptions presented on the boring logs in Appendix A. Laboratory tests were performed in general accordance with the applicable ASTM, AASHTO, SCDOT or other accepted standards.

Selected soil samples obtained from the site were tested for the following engineering properties:

- | | |
|---|----------------------------|
| ■ Materials Finer Than 75- μ m (No. 200) Sieve | AASHTO T11/(ASTM D1140) |
| ■ Liquid Limit, Plastic Limit and Plasticity Index of Soils | AASHTO T89/90/(ASTM D4318) |
| ■ Determination of Moisture Content of Soils | AASHTO T265/(ASTM D2216) |
| ■ Compressive Strength of Rock Cores | AASHTO T226/(ASTM D7012) |



INDEX PROPERTIES VERSUS DEPTH

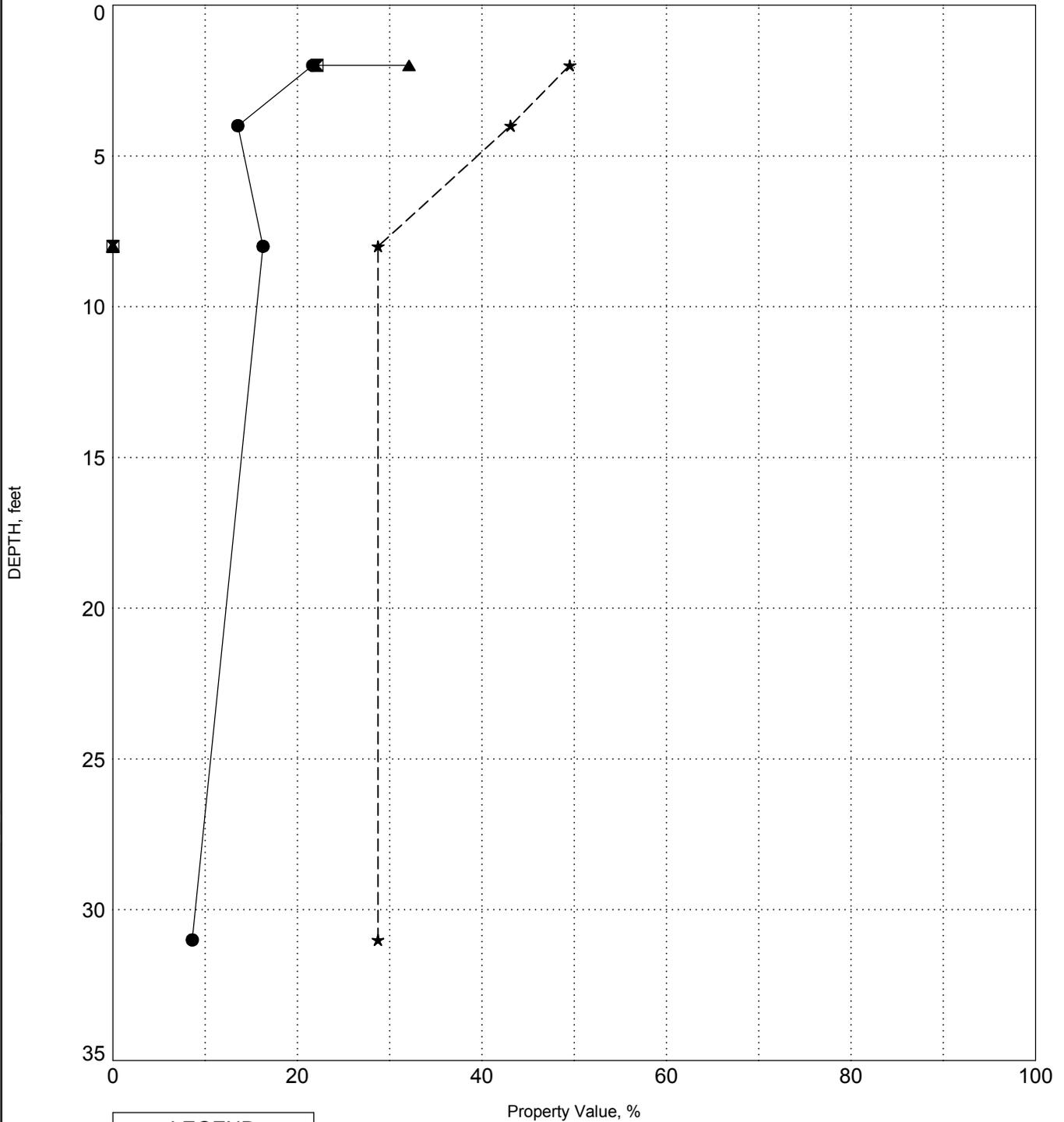
PROJECT ID PO38267

PROJECT NAME S-13-34 (Wamble Hill Road) RBO Deep Creek

PROJECT COUNTY Chesterfield

SURFACE ELEVATION: 217.4

BORING B-1



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

INDEX PROPS 7318P119E S-13-34 SCDOT.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 2/5/19



INDEX PROPERTIES VERSUS DEPTH

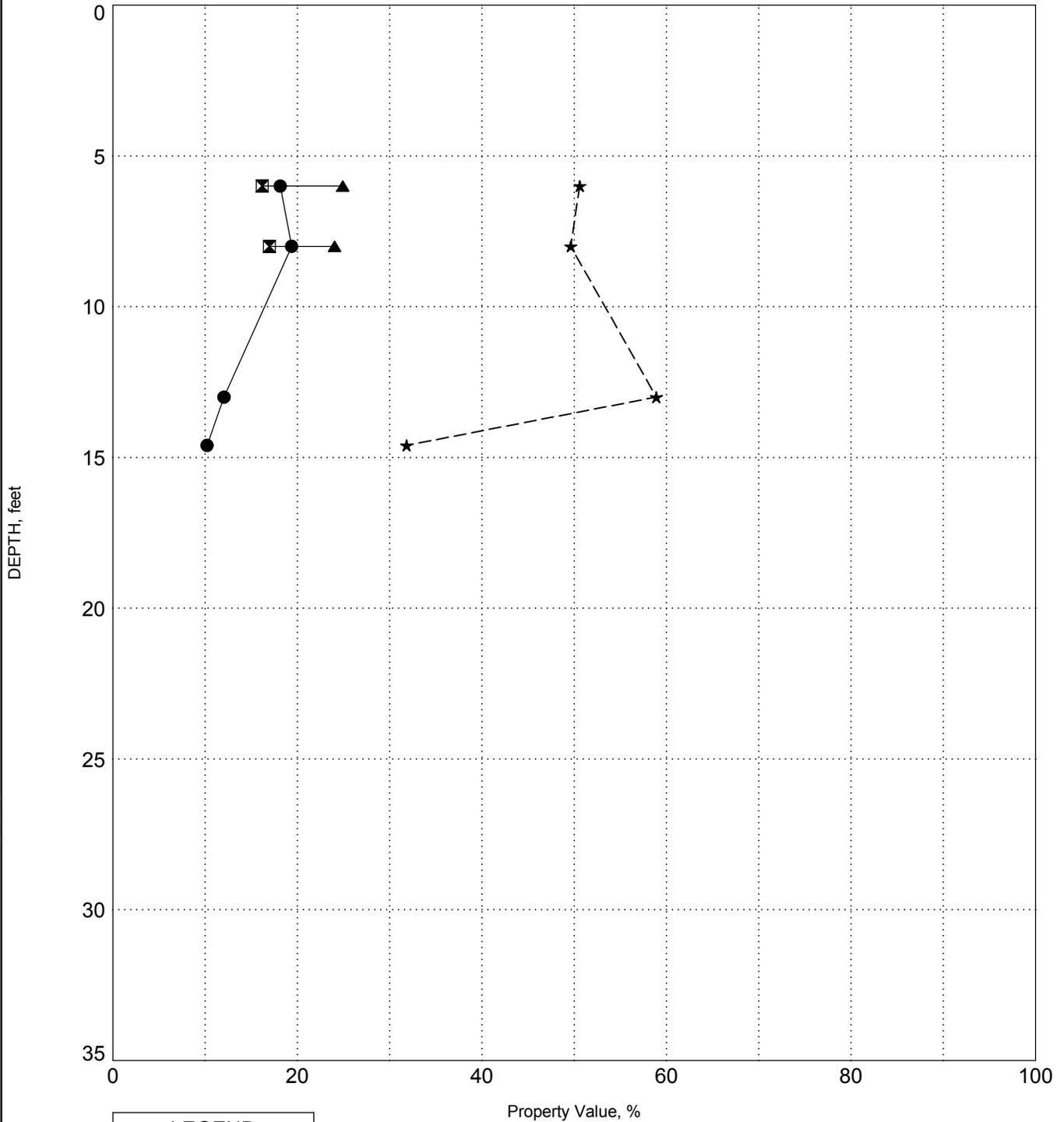
PROJECT ID PO38267

PROJECT NAME S-13-34 (Wamble Hill Road) RBO Deep Creek

PROJECT COUNTY Chesterfield

BORING B-2

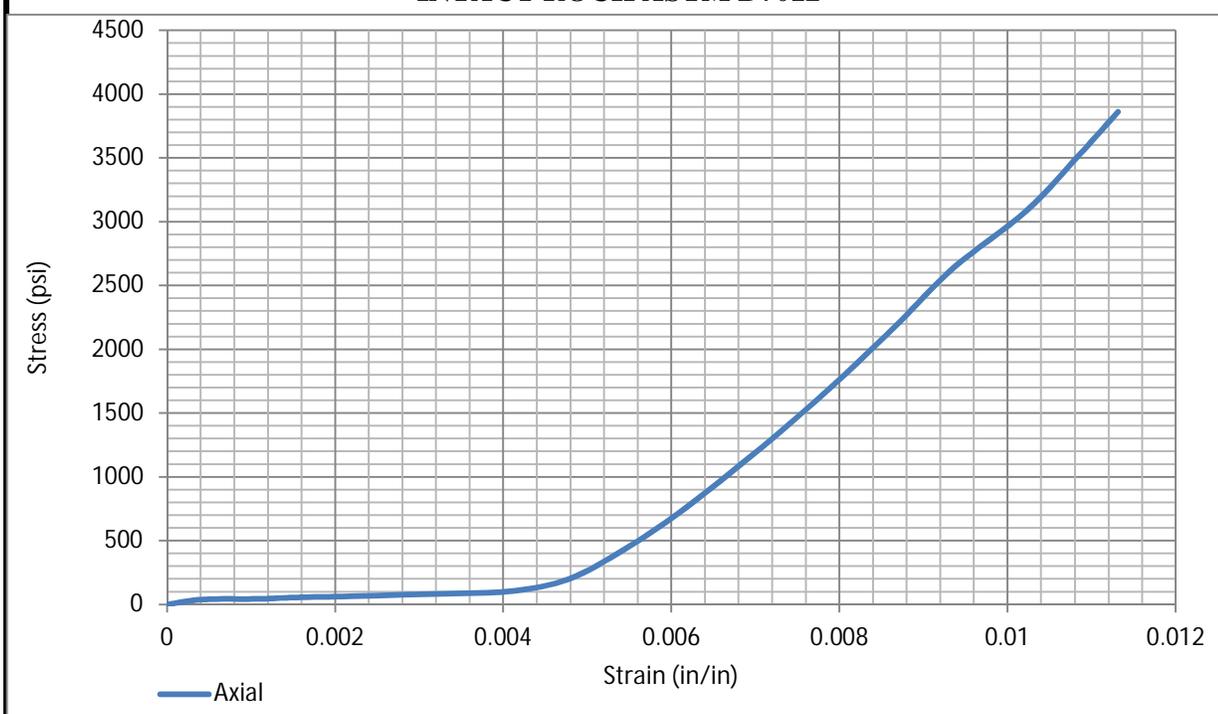
SURFACE ELEVATION: 217.1



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

INDEX PROPS 7318P119E S-13-34 SCDOT.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 2/5/19

**COMPRESSIVE STRENGTH AND ELASTIC MODULUS OF
INTACT ROCK ASTM D7012**



SAMPLE LOCATION			
Site:	S-13-34 RBO Deep Creek		
Boring:	B-1	Depth (feet):	21-26'
SPECIMEN INFORMATION			
Sample No.:	3	Mass (g):	467.91
Length (in.):	4.60	Diameter (in.):	1.83
L/D Ratio:	2.52	Density (pcf):	148.27
TEST RESULTS			
Failure Load (lbs):	10,154		
Failure Strain (%):	1.13		
Unconfined Compressive Strength (psi):	3,861		
Elastic Modulus, E, (ksi):			
Poisson's Ratio, v:			

Description: GRAY SILTSTONE

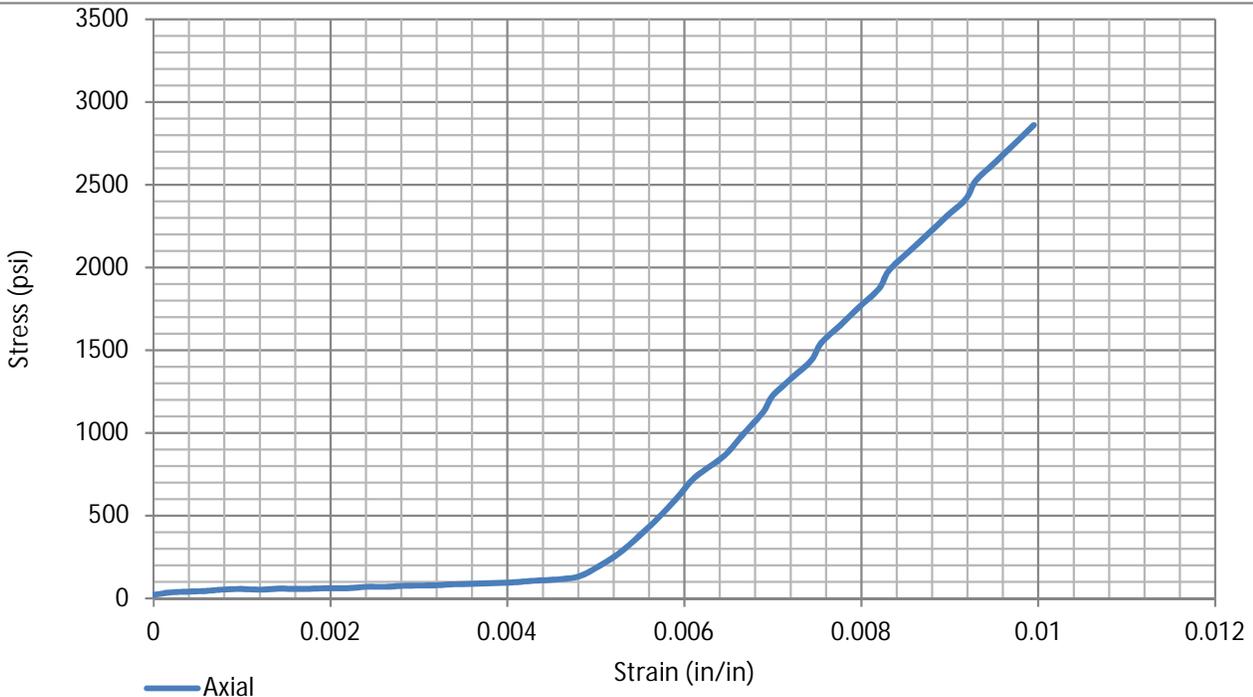
NOTES:

CLIENT: SCDOT
PROJECT: Emergency bridge Package 2018-2
PROJECT NO.: 7318119E



LAB NO.: 712
DATE TESTED: 1/29/19
DATE REDUCED: 2/7/2019
EXHIBIT:

**COMPRESSIVE STRENGTH AND ELASTIC MODULUS OF
INTACT ROCK ASTM D7012**



SAMPLE LOCATION

Site:	S-13-34 RBO Deep Creek		
Boring:	B-1	Depth (feet):	33.9-36.2

SPECIMEN INFORMATION

Sample No.:	5	Mass (g):	521.59
Length (in.):	4.60	Diameter (in.):	1.83
L/D Ratio:	2.52	Density (pcf):	165.10

TEST RESULTS

Failure Load (lbs):	7,491
Failure Strain (%):	0.99
Unconfined Compressive Strength (psi):	2,861
Elastic Modulus, E, (ksi):	
Poisson's Ratio, v:	

Description: GRAY SILTSTONE

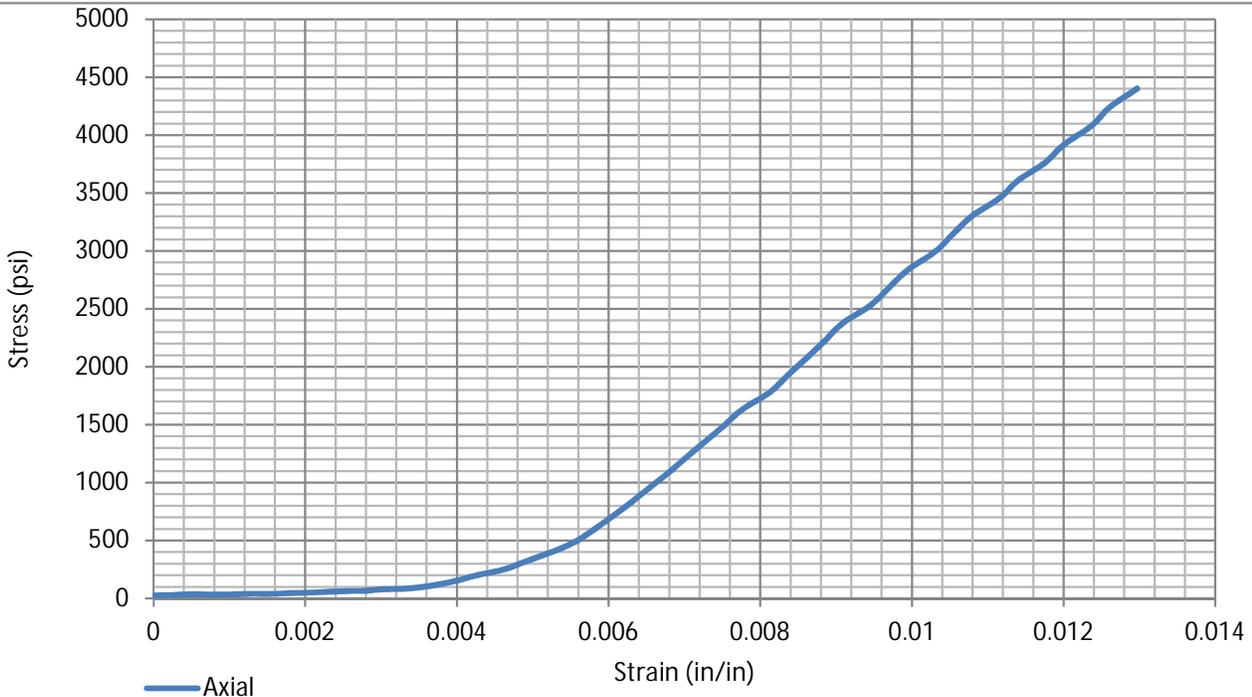
NOTES:

CLIENT: SCDOT
PROJECT: Emergency bridge Package
2018-2
PROJECT NO.: 7318119E



LAB NO.: 712
DATE TESTED: 1/29/19
DATE REDUCED: 2/7/2019
EXHIBIT:

**COMPRESSIVE STRENGTH AND ELASTIC MODULUS OF
INTACT ROCK ASTM D7012**



SAMPLE LOCATION

Site:	S-13-34 RBO Deep Creek		
Boring:	B-1	Depth (feet):	41.2-44.7

SPECIMEN INFORMATION

Sample No.:	7	Mass (g):	469.12
Length (in.):	4.15	Diameter (in.):	1.83
L/D Ratio:	2.27	Density (pcf):	164.64

TEST RESULTS

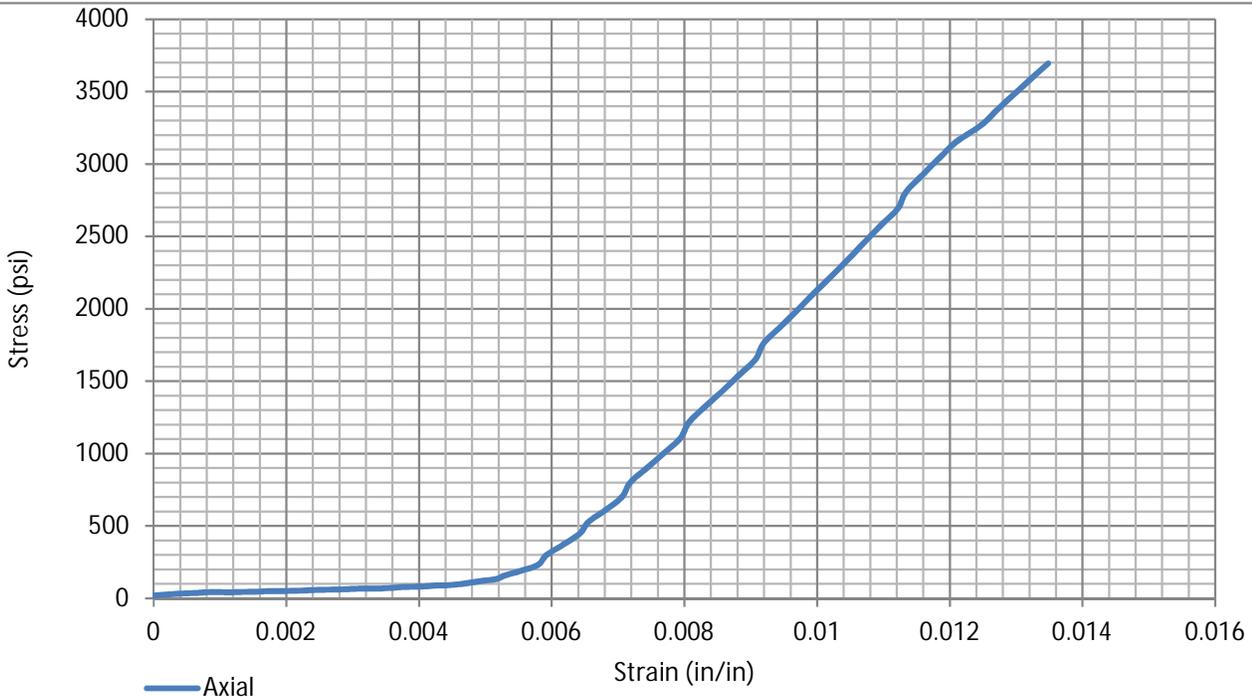
Failure Load (lbs):	11,529
Failure Strain (%):	1.30
Unconfined Compressive Strength (psi):	4,403
Elastic Modulus, E, (ksi):	
Poisson's Ratio, v:	

Description:	GRAY SILTSTONE
--------------	----------------

NOTES:

CLIENT: SCDOT	Terracon Consulting Engineers & Scientists	LAB NO.: 713
PROJECT: Emergency bridge Package 2018-2		DATE TESTED: 1/29/19
PROJECT NO.: 7318119E		DATE REDUCED: 2/7/2019
		EXHIBIT:

**COMPRESSIVE STRENGTH AND ELASTIC MODULUS OF
INTACT ROCK ASTM D7012**



SAMPLE LOCATION

Site:	S-13-34 RBO Deep Creek		
Boring:	B-2	Depth (feet):	15.7-21.2

SPECIMEN INFORMATION

Sample No.:	2	Mass (g):	438.12
Length (in.):	3.99	Diameter (in.):	1.82
L/D Ratio:	2.19	Density (pcf):	160.34

TEST RESULTS

Failure Load (lbs):	9,645
Failure Strain (%):	1.35
Unconfined Compressive Strength (psi):	3,695
Elastic Modulus, E, (ksi):	
Poisson's Ratio, v:	

Description: GRAY SILTSTONE

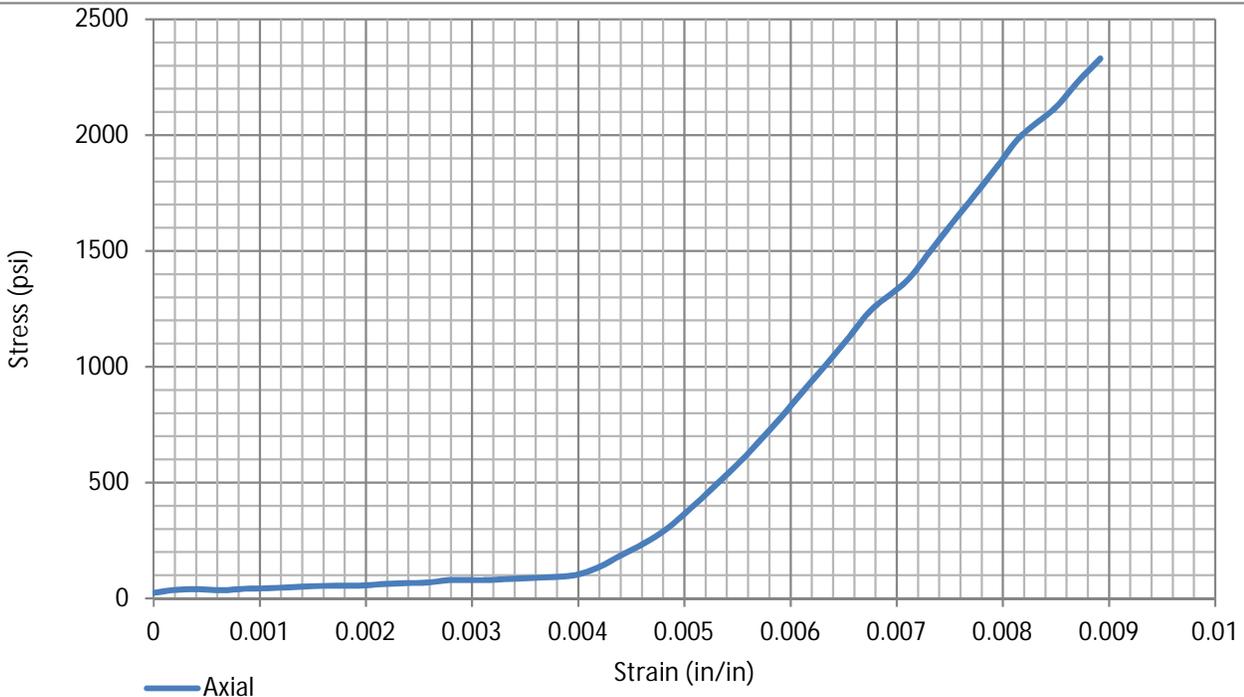
NOTES:

CLIENT: SCDOT
PROJECT: Emergency bridge Package
2018-2
PROJECT NO.: 7318119E



LAB NO.: 714
DATE TESTED: 1/29/19
DATE REDUCED: 2/7/2019
EXHIBIT:

**COMPRESSIVE STRENGTH AND ELASTIC MODULUS OF
INTACT ROCK ASTM D7012**



SAMPLE LOCATION

Site:	S-13-34 RBO Deep Creek		
Boring:	B-2	Depth (feet):	21.2-25.9

SPECIMEN INFORMATION

Sample No.:	3	Mass (g):	523.73
Length (in.):	4.68	Diameter (in.):	1.82
L/D Ratio:	2.56	Density (pcf):	163.26

TEST RESULTS

Failure Load (lbs):	6,090
Failure Strain (%):	0.89
Unconfined Compressive Strength (psi):	2,331
Elastic Modulus, E, (ksi):	
Poisson's Ratio, v:	

Description:	GRAY SILTSTONE
--------------	----------------

NOTES:

CLIENT: SCDOT
PROJECT: Emergency bridge Package 2018-2
PROJECT NO.: 7318119E



LAB NO.: 715
DATE TESTED: 1/29/19
DATE REDUCED: 2/7/2019
EXHIBIT:

APPENDIX C
SUPPORTING DOCUMENTS

Exhibit C-1 – Rig Calibration Documentation

DRILL RIG SPT HAMMER ENERGY CALIBRATION REPORT



September 18, 2018

Terracon Consultants, Inc.
521 Clemson Rd.
Columbia, SC 29229

Attn: Mr. Phillip Morrison, P.E.
P: 803-212-0062
E: pamorrison@terracon.com

Re: SPT Hammer Energy Calibration Report
Terracon Rig # 727, CME-55, SN:359485

Dear Mr. Morrison:

This report provides the Energy Transfer Ratio (ETR) for the SPT hammer found on drill rig model CME-55, Drill Rig # 727 (Serial Number 359485).

If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,

Terracon Consultants, Inc.

Ryan Wakeford
Ryan Wakeford
Staff Engineer

Zachary J. McIntosh
Field Engineer



Susheel R. Kulkarni, Ph.D., P.E.
Senior Engineer



Attachments:

- Exhibit A-1: Representative Blow
- Exhibit A-2: PDA Equipment Calibrations
- Exhibit A-3: SPT Calibration Data Plots and Tables
- Exhibit A-4: Field Log

Terracon Consultants, Inc. 1450 Fifth Street West North Charleston, South Carolina 29405
P [843] 884 1234 F [843] 884 9234 terracon.com



Drill Rig Model CME-55 SN 359485

Terracon Drill Rig # 727

September 18, 2018

Prepared for:
Terracon Consultants, Inc.
Columbia, SC

Prepared by:
Terracon Consultants, Inc.
North Charleston, South Carolina

Offices Nationwide Established in 1965
Employee-Owned terracon.com



Geotechnical ■ Environmental ■ Construction Materials ■ Facilities

Drill Rig SPT Hammer Energy Calibration Report
CME-55, SN: 359485, DR # 727 ■ Columbia, SC
September 18, 2018



1.0 PROJECT INFORMATION

ITEM	DESCRIPTION
Drill Rig Identification	CME-55, SN 359485, DR # 727 (see photograph on cover page)
Drill Rig Owner	Terracon
Drill Rig Operator	Will B.
Testing Date	September 17, 2018
Testing Location	Terracon Parking Lot, Columbia, SC
Boring Identification	SB-1
Energy Measurement Depths	28.5 ft.; 33.5 ft.; 38.5 ft.; 43.5 ft.; 48.5 ft.
Hammer Type	Automatic
Boring Method	Hollow Stem Auger
Drill Rods	n AWJ n 1 1/2" outside diameter n 3/16" wall thickness
SPT Calibration Testing Equipment	n 2 foot AWJ rod instrumented w/ 2 strain gauges and 2 accelerometers n Model PAX Pile Driving Analyzer™ (PDA)
ASTM Methods Used	ASTM D1586-11 – Standard Test Method for Standard Penetration Test and Split Barrel Sampling of Soils ASTM D4633-16 – Standard Methods for Energy Measurement for Dynamic Penetrometers
SPT Calibration Personnel	R. Wakeford & Z. McIntosh

2.0 TEST RESULTS

Table 1: SPT Hammer Energy Calibration Testing Summary

Boring	Start Depth ¹ (ft)	Rod Length ² (ft)	Rod Sections ³				Measured Blow Counts (blows/6 inches)				SPT N _{60,avg} (bpf)	Soil Type ⁴
			2 ft	5 ft	10 ft	1 st Inc.	2 nd Inc.	3 rd Inc.	4 th Inc.			
SB-1	28.5	30.0	0	6	0	6	7	11	-	18	SC	
	33.5	35.0	0	7	0	5	6	10	-	16	SC	
	38.5	40.0	0	8	0	3	5	6	-	11	SC	
	43.5	45.0	0	9	0	5	6	10	-	16	SC	
	48.5	50.0	0	10	0	2	6	5	-	11	SC	

- Depth from existing ground surface to start of SPT
- Total rod length from instrumentation to bottom of sampler
- Two foot section is instrumented and is located at top of drill rods
- Soil type provided by Terracon personnel

Responsive ■ Resourceful ■ Reliable

Drill Rig SPT Hammer Energy Calibration Report
CME-55, SN: 359485, DR # 727 ■ Columbia, SC
September 18, 2018



Table 2: Energy Measurement and Analysis Summary

Boring	Start Depth ¹ (ft)	SPT N ₆₀ (bpf)	No. of Blows ²	EMX ³ (kip-ft)				ETR ³ (%)	
				Max.	Min.	Ave.	Std. Dev.	Ave.	Std. Dev.
SB-1	28.5	18	18	0.34	0.32	0.32	0.005	92.6	1.434
	33.5	16	16	0.33	0.32	0.32	0.004	92.1	1.281
	38.5	11	11	0.34	0.33	0.34	0.006	95.7	1.644
	43.5	16	16	0.34	0.31	0.32	0.009	92.2	2.577
	48.5	11	11	0.34	0.31	0.33	0.008	93.2	2.262
Average:				0.34	0.31	0.33	0.006	93.2	1.840

- Boring ID and depth from existing ground surface to start of SPT
- Number of blows used in energy calibration analysis; limited to measurements recorded during the second and third 6-inch sampling intervals at each depth or during the first increment if refusal were encountered
- EMX = Maximum Transferred Energy, ETR = Energy Transfer Ratio.

Table 3: Hammer Blow Rate Summary

Boring	Start Depth ¹ (ft)	SPT N _{60,avg} (bpf)	No. of Blows ²	BPM ³			
				Max.	Min.	Ave.	Std. Dev.
SB-1	28.5	18	18	54.3	52.8	53.6	0.381
	33.5	16	16	54.8	54.0	54.4	0.236
	38.5	11	11	55.5	53.9	54.5	0.520
	43.5	16	16	55.6	53.4	54.2	0.517
	48.5	11	11	55.2	53.8	54.4	0.469
Average:				55.1	53.6	54.2	0.425

- Boring ID and depth from existing ground surface to start of SPT
- Number of blows used in energy calibration analysis. Limited to measurements recorded during the second and third 6-inch sampling intervals at each depth or during the 1st increment if refusal conditions were encountered.
- BPM = Blows per minute

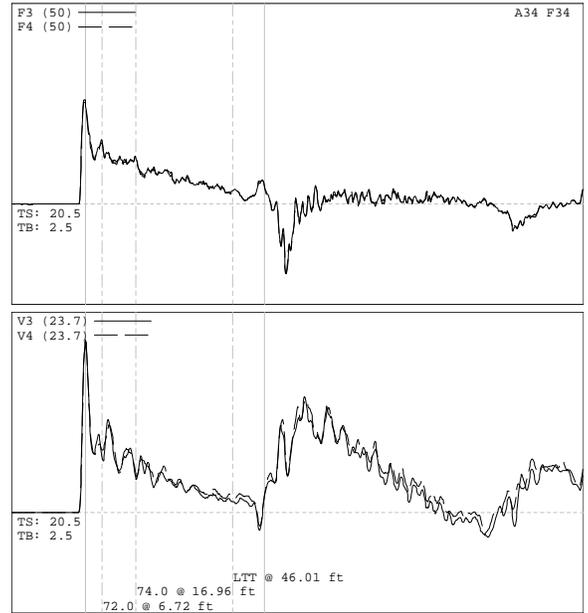
3.0 CONCLUSIONS

3.1 Energy Transfer Ratio (ETR) and Hammer Efficiency Correction (CE)

Based on our testing and subsequent analysis, drill rig CME-55 (No. 727) has an ETR of 93.2% ± 1.84%. Based on this ETR, the hammer efficiency correction (Ce) is 1.55.

Responsive ■ Resourceful ■ Reliable

Exhibit A-1 Representative Blow



Project Information		Quantity Results	
PROJECT: COLUMBIA SPT RIG CAL	ETR 94.9 (%)	CSX 21.8 ksi	F3: [AWJ 1] 216.53 (1)
PILE NAME: CME 55 SERIAL # 359485	DESCR: STB-1 48.5-50	BPM 54.3 bpm	F4: [AWJ 2] 216.2 (1)
OPERATOR: ZM	FILE: CME 55 SERIAL # 359485_6_Log.W01	EMX 0.332 k-ft	A3: [K0059] 317 mv/5000g's (1)
9/17/2018 11:34:31 AM	Blow Number 11	DMX 1.20 in	A4: [K5418] 382 mv/5000g's (1)
Pile Properties		SFR kips	CLIP: OK
LE 53.70 ft	AR 1.18 in ²	VMX 20.4 f/s	
EM 30000 ksi	SP 0.492 k/ft ³		
WS 16807.9 f/s	EA/C 2.1 ksec/ft		
2L/C 6.40 ms	JC []		
LP 49.80 ft			

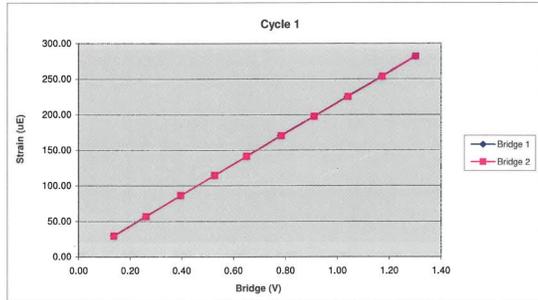
Exhibit A-2 PDA Equipment Calibrations



267AWJ		Cycle 1		
Sample	Force (lb)	Strain (μE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	1034.65	29.80	0.14	0.14
3	1995.74	57.07	0.26	0.26
4	3021.54	86.56	0.40	0.40
5	4013.51	114.64	0.53	0.53
6	4945.09	141.59	0.65	0.65
7	5967.55	170.38	0.78	0.78
8	6935.72	197.78	0.91	0.91
9	7944.21	225.43	1.04	1.04
10	8835.59	253.69	1.17	1.17
11	9924.61	282.06	1.30	1.30

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7636.82	Force Calibration (lb/V)	7622.38
Offset	-7.82	Offset	-11.05
Correlation	0.999996	Correlation	0.999997
Strain Calibration ($\mu\text{E/V}$)	216.43	Strain Calibration ($\mu\text{E/V}$)	216.02
Offset	0.60	Offset	0.51
Correlation	0.999996	Correlation	0.999993

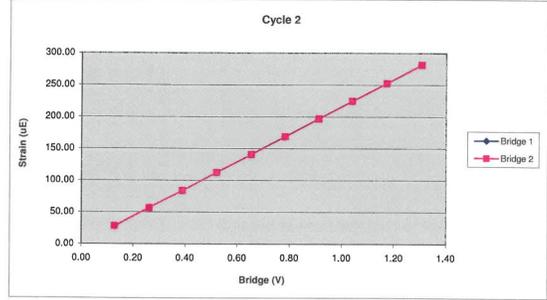
Force Strain Calibration	
EA (Kips)	35284.30
Offset	-29.01
Correlation	0.999989



267AWJ		Cycle 2		
Sample	Force (lb)	Strain (μE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	979.97	28.37	0.13	0.13
3	2002.82	57.00	0.26	0.26
4	2963.52	84.19	0.39	0.39
5	3965.12	112.62	0.52	0.52
6	4973.02	141.14	0.65	0.65
7	5964.01	169.13	0.78	0.78
8	6938.87	197.15	0.91	0.91
9	7932.41	224.93	1.04	1.04
10	8939.72	253.23	1.17	1.17
11	9962.18	281.86	1.30	1.31

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7634.65	Force Calibration (lb/V)	7626.42
Offset	-9.30	Offset	-6.45
Correlation	0.999997	Correlation	0.999997
Strain Calibration ($\mu\text{E/V}$)	215.81	Strain Calibration ($\mu\text{E/V}$)	215.58
Offset	0.30	Offset	0.38
Correlation	0.999997	Correlation	0.999996

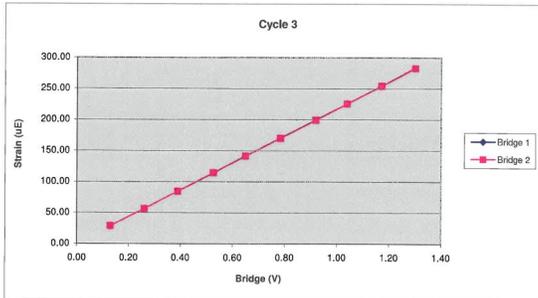
Force Strain Calibration	
EA (Kips)	35375.85
Offset	-19.88
Correlation	0.999997



267AWJ		Cycle 3		
Sample	Force (lb)	Strain (μE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	982.53	28.74	0.13	0.13
3	1993.97	56.89	0.26	0.26
4	2965.68	84.76	0.39	0.39
5	4014.49	114.61	0.53	0.53
6	4944.11	141.53	0.65	0.65
7	5962.04	170.43	0.78	0.78
8	6994.93	199.62	0.92	0.92
9	7922.38	225.92	1.04	1.04
10	8918.48	254.51	1.17	1.17
11	9909.26	283.02	1.30	1.30

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7625.63	Force Calibration (lb/V)	7613.58
Offset	-4.78	Offset	-1.05
Correlation	0.999999	Correlation	0.999998
Strain Calibration ($\mu\text{E/V}$)	217.34	Strain Calibration ($\mu\text{E/V}$)	217.00
Offset	0.23	Offset	0.33
Correlation	0.999995	Correlation	0.999998

Force Strain Calibration	
EA (Kips)	35085.96
Offset	-12.70
Correlation	0.999996

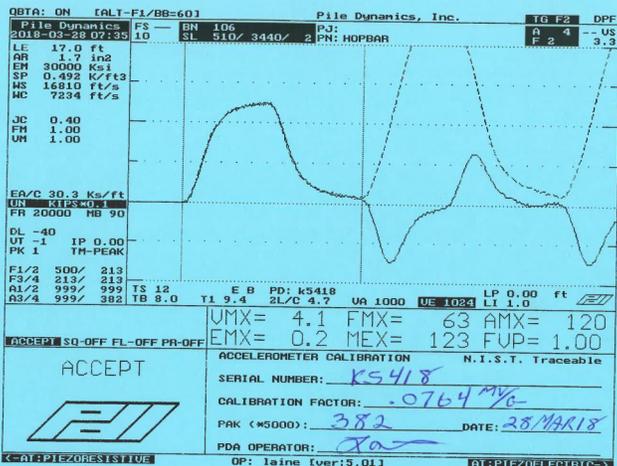
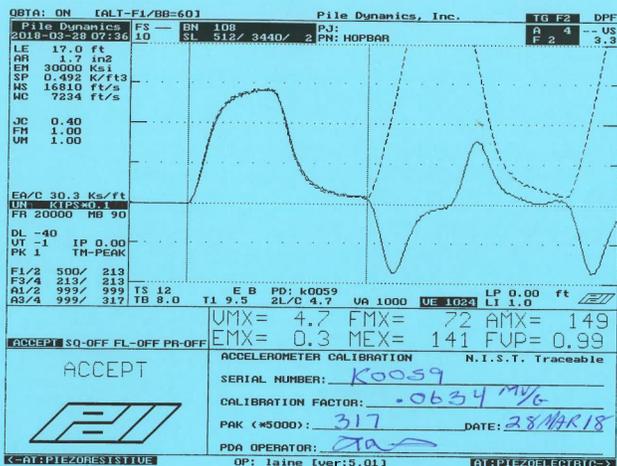


Bridge Excitation (V) 5
Shunt Resistor (ohm) 60.4k

Calibration Factors		267AWJ	
Bridge 1 ($\mu\text{E/V}$)	216.53	Bridge 2 ($\mu\text{E/V}$)	216.20
EA Factor (Kips)	35248.70	Area (in^2)	1.17

Calibrated by: *David Brull*
Calibrated Date: 12/5/2016

Pile Dynamics Inc
30725 Aurora Rd
Solon, OH 44139
Traceable to N.I.S.T.



Smart Sensor

Smart Chip Programmed By J.W. on 28/MAR/18 CRC Value A7E0

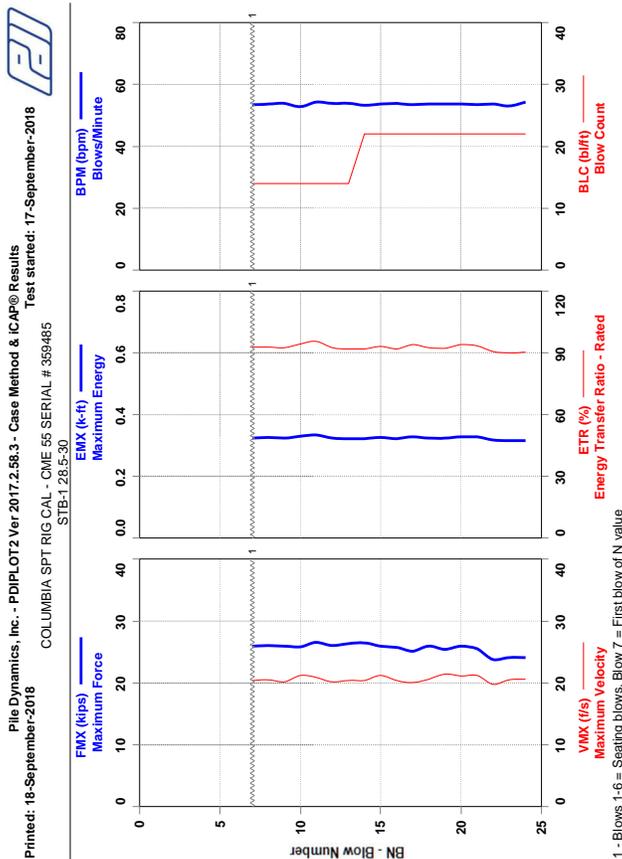
Smart Sensor

Smart Chip Programmed By J.W. on 28/MAR/18 CRC Value 63AE

Drill Rig SPT Hammer Energy Calibration Report
 CME-55, SN: 359485, DR # 727 Columbia, SC
 September 18, 2018



Exhibit A-3 SPT Calibration Data Plots and Tables



COLUMBIA SPT RIG CAL - CME 55 SERIAL # 359485 STB-1 28.5-30
OP: ZM Date: 17-September-2018
AR: 1.18 in² SP: 0.492 klf/ft
LE: 33.70 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.00

FMX: Maximum Force BPM: Blows/Minute
VMX: Maximum Velocity DMX: Maximum Displacement
EMX: Maximum Energy CSX: Compression Stress Maximum

ETR: Energy Transfer Ratio - Rated

BL#	Depth ft	BLC bl/ft	FMX kips	VMX f/s	EMX k-ft	ETR (%)	BPM bpm	DMX in	CSX ksi
7	29.07	14	26	20.4	0.325	92.7	53.5	0.86	22.0
8	29.14	14	26	20.5	0.325	92.8	53.6	0.86	22.1
9	29.21	14	26	20.2	0.324	92.5	53.9	0.86	22.0
10	29.29	14	26	21.2	0.330	94.4	52.8	0.86	21.9
11	29.36	14	27	20.9	0.335	95.7	54.3	0.87	22.5
12	29.43	14	26	20.2	0.324	92.5	53.8	0.86	22.1
13	29.50	14	26	20.4	0.322	91.9	54.0	0.87	22.4
14	29.55	22	26	20.4	0.322	92.1	53.3	0.87	22.5
15	29.59	22	26	21.2	0.326	93.1	53.6	0.89	22.0
16	29.64	22	26	20.4	0.322	92.1	53.8	0.87	21.8
17	29.68	22	25	20.0	0.329	94.0	53.5	0.89	21.3
18	29.73	22	26	20.6	0.324	92.5	53.7	0.82	22.0
19	29.77	22	25	21.4	0.323	92.4	53.6	0.85	21.6
20	29.82	22	26	21.2	0.329	94.0	53.7	0.85	22.0
21	29.86	22	26	21.2	0.327	93.4	53.4	0.84	21.6
22	29.91	22	24	19.8	0.317	90.7	53.7	0.82	20.2
23	29.95	22	24	20.5	0.315	89.9	53.0	0.59	20.5
24	30.00	22	24	20.6	0.316	90.4	54.3	0.59	20.4
Average			26	20.6	0.324	92.6	53.6	0.73	21.7
Std. Dev.			1	0.5	0.005	1.4	0.4	0.11	0.7
Maximum			27	21.4	0.335	95.7	54.3	0.87	22.5
Minimum			24	19.8	0.315	89.9	52.8	0.59	20.2

Total number of blows analyzed: 18

BL# Sensors

7-24 F3: [AWJ 1] 216.5 (1.00); F4: [AWJ 2] 216.2 (1.00); A3: [K0059] 317.0 (1.00);
A4: [K5418] 382.0 (1.00)

BL# Comments

7 Blows 1-6 = Seating blows, Blow 7 = First blow of N value

Time Summary

Drive 25 seconds 10:58 AM - 10:58 AM BN 1 - 24

COLUMBIA SPT RIG CAL - CME 55 SERIAL # 359485 STB-1 33.5-35
OP: ZM Date: 17-September-2018
AR: 1.18 in² SP: 0.492 klf/ft
LE: 38.70 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.00

FMX: Maximum Force BPM: Blows/Minute
VMX: Maximum Velocity DMX: Maximum Displacement
EMX: Maximum Energy CSX: Compression Stress Maximum

ETR: Energy Transfer Ratio - Rated

BL#	Depth ft	BLC bl/ft	FMX kips	VMX f/s	EMX k-ft	ETR (%)	BPM bpm	DMX in	CSX ksi
6	34.08	12	27	20.1	0.322	92.0	54.2	1.14	22.8
7	34.17	12	26	20.1	0.321	91.7	54.6	1.09	22.4
8	34.25	12	27	19.8	0.320	91.4	54.3	1.05	22.6
9	34.33	12	26	20.0	0.323	92.2	54.4	1.01	22.2
10	34.42	12	28	19.9	0.330	94.3	54.6	1.14	23.6
11	34.50	12	27	20.0	0.320	91.5	54.1	1.00	22.8
12	34.55	20	27	20.2	0.325	92.8	54.7	0.89	23.2
13	34.60	20	27	19.8	0.317	90.7	54.2	0.85	22.7
14	34.65	20	27	19.6	0.315	90.0	54.7	0.81	23.0
15	34.70	20	27	20.3	0.318	90.8	54.2	0.75	22.9
16	34.75	20	27	19.7	0.320	91.3	54.0	0.81	22.9
17	34.80	20	28	20.0	0.323	92.3	54.8	0.77	23.4
18	34.85	20	27	19.8	0.320	91.4	54.2	0.77	22.5
19	34.90	20	27	19.8	0.331	94.7	54.4	0.81	23.1
20	34.95	20	27	19.7	0.327	93.3	54.4	0.74	22.7
21	35.00	20	28	19.7	0.326	93.2	54.4	0.71	23.3
Average			27	19.9	0.322	92.1	54.4	0.89	22.9
Std. Dev.			0	0.2	0.004	1.2	0.2	0.15	0.4
Maximum			28	20.3	0.331	94.7	54.8	1.14	23.6
Minimum			26	19.6	0.315	90.0	54.0	0.71	22.2

Total number of blows analyzed: 16

BL# Sensors

6-21 F3: [AWJ 1] 216.5 (1.00); F4: [AWJ 2] 216.2 (1.00); A3: [K0059] 317.0 (1.00);
A4: [K5418] 382.0 (1.00)

BL# Comments

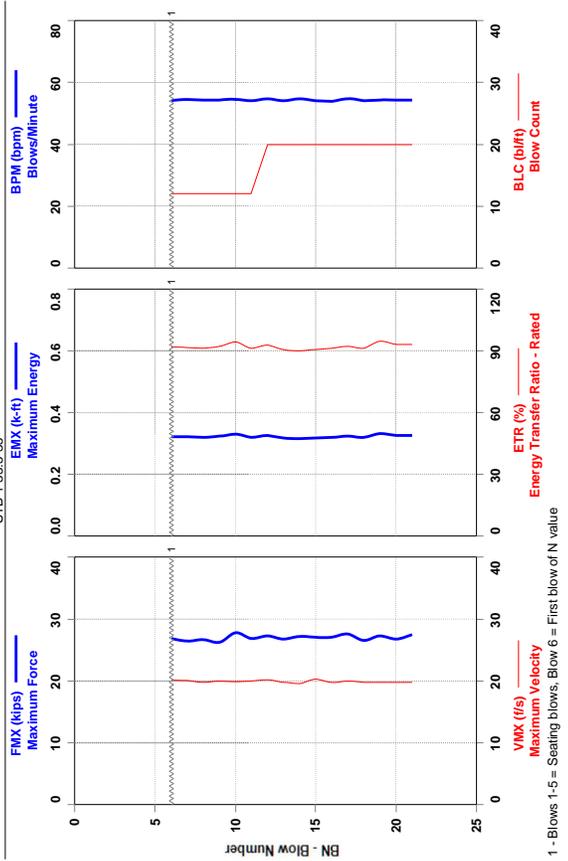
6 Blows 1-5 = Seating blows, Blow 6 = First blow of N value

Time Summary

Drive 22 seconds 11:05 AM - 11:05 AM BN 1 - 21



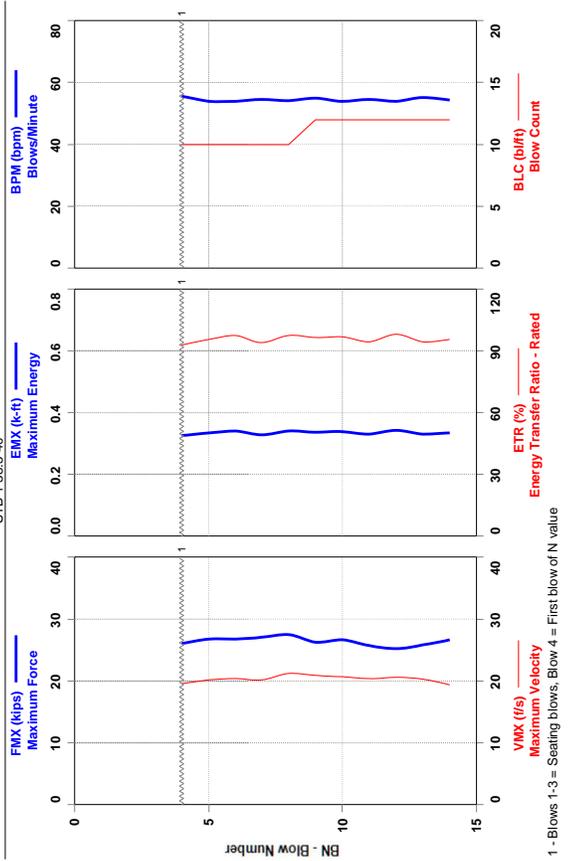
Pile Dynamics, Inc. - PDIPLOT2 Ver 2017.2.58.3 - Case Method & iCAP® Results
Printed: 18-September-2018 Test started: 17-September-2018
COLUMBIA SPT RIG CAL - CME 55 SERIAL # 359485
STB-1 33.5-35



1 - Blows 1-5 = Seating blows, Blow 6 = First blow of N value



Pile Dynamics, Inc. - PDIPLOT2 Ver 2017.2.58.3 - Case Method & iCAP® Results
Printed: 18-September-2018 Test started: 17-September-2018
COLUMBIA SPT RIG CAL - CME 55 SERIAL # 359485
STB-1 38.5-40



1 - Blows 1-3 = Seating blows, Blow 4 = First blow of N value

COLUMBIA SPT RIG CAL - CME 55 SERIAL # 359485 STB-1 38.5-40
OP: ZM Date: 17-September-2018

AR: 1.18 in² SP: 0.492 klf²
LE: 43.70 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.00

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

BL#	Depth ft	BLC bl/ft	FMX kips	VMX f/s	EMX k-ft	ETR (%)	BPM bpm	DMX in	CSX ksi
4	39.10	10	26	19.5	0.325	92.9	55.5	1.42	22.0
5	39.20	10	27	20.2	0.334	95.6	54.0	1.30	22.7
6	39.30	10	27	20.4	0.341	97.4	54.0	1.26	22.7
7	39.40	10	27	20.1	0.329	93.9	54.5	1.20	22.9
8	39.50	10	27	21.2	0.341	97.6	54.2	1.20	23.3
9	39.58	12	26	20.9	0.338	96.4	54.9	1.04	22.3
10	39.67	12	27	20.7	0.339	96.9	53.9	1.11	22.6
11	39.75	12	26	20.3	0.331	94.5	54.5	1.11	21.8
12	39.83	12	25	20.6	0.343	98.0	54.0	1.17	21.4
13	39.92	12	26	20.2	0.331	94.5	55.1	1.10	21.9
14	40.00	12	27	19.4	0.334	95.5	54.4	1.12	22.6
Average			26	20.3	0.335	95.8	54.5	1.18	22.4
Std. Dev.			1	0.5	0.006	1.6	0.5	0.10	0.5
Maximum			27	21.2	0.343	98.0	55.5	1.42	23.3
Minimum			25	19.4	0.325	92.9	53.9	1.04	21.4

Total number of blows analyzed: 11

BL# Sensors

4-14 F3: [AWJ 1] 216.5 (1.00); F4: [AWJ 2] 216.2 (1.00); A3: [K0059] 317.0 (1.00);
A4: [K5418] 382.0 (1.00)

BL# Comments

4 Blows 1-3 = Seating blows, Blow 4 = First blow of N value

Time Summary

Drive 14 seconds 11:14 AM - 11:14 AM BN 1 - 14

COLUMBIA SPT RIG CAL - CME 55 SERIAL # 359485 STB-1 43.5-45
OP: ZM Date: 17-September-2018

AR: 1.18 in² SP: 0.492 klf²
LE: 48.70 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.00

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

BL#	Depth ft	BLC bl/ft	FMX kips	VMX f/s	EMX k-ft	ETR (%)	BPM bpm	DMX in	CSX ksi
6	44.08	12	26	20.2	0.313	89.4	54.2	1.01	21.9
7	44.17	12	26	20.1	0.309	88.2	54.3	1.00	21.8
8	44.25	12	26	19.3	0.314	89.8	54.3	1.00	21.7
9	44.33	12	26	20.3	0.338	96.4	53.9	1.20	22.3
10	44.42	12	25	20.1	0.311	88.8	54.4	1.00	21.5
11	44.50	12	26	20.9	0.323	92.2	54.1	1.00	22.0
12	44.55	20	26	20.2	0.318	90.7	54.2	0.79	22.2
13	44.60	20	26	20.2	0.327	93.5	54.0	0.93	21.8
14	44.65	20	26	20.7	0.332	94.8	53.7	0.77	22.4
15	44.70	20	26	20.7	0.329	94.0	53.5	0.78	21.7
16	44.75	20	27	20.4	0.322	92.0	55.6	0.72	22.5
17	44.80	20	25	18.1	0.315	89.9	53.4	0.89	21.3
18	44.85	20	27	20.9	0.323	92.4	54.0	0.62	22.8
19	44.90	20	26	21.6	0.338	96.6	54.8	0.75	22.3
20	44.95	20	26	20.7	0.328	93.7	54.0	0.70	21.9
21	45.00	20	25	21.3	0.321	91.6	54.4	0.65	21.2
Average			26	20.4	0.322	92.1	54.2	0.85	22.0
Std. Dev.			1	0.8	0.009	2.5	0.5	0.16	0.4
Maximum			27	21.6	0.338	96.6	55.6	1.20	22.8
Minimum			25	18.1	0.309	88.2	53.4	0.62	21.2

Total number of blows analyzed: 16

BL# Sensors

6-21 F3: [AWJ 1] 216.5 (1.00); F4: [AWJ 2] 216.2 (1.00); A3: [K0059] 317.0 (1.00);
A4: [K5418] 382.0 (1.00)

BL# Comments

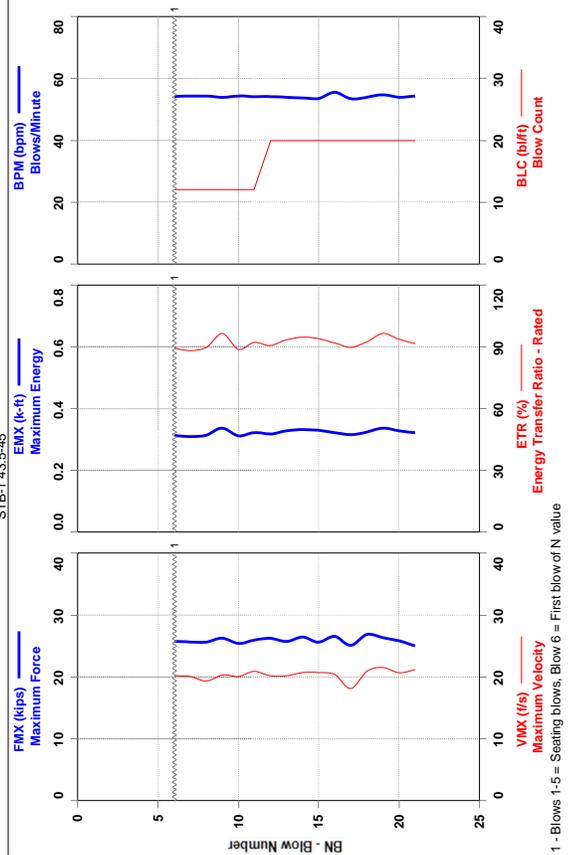
6 Blows 1-5 = Seating blows, Blow 6 = First blow of N value

Time Summary

Drive 22 seconds 11:25 AM - 11:26 AM BN 1 - 21



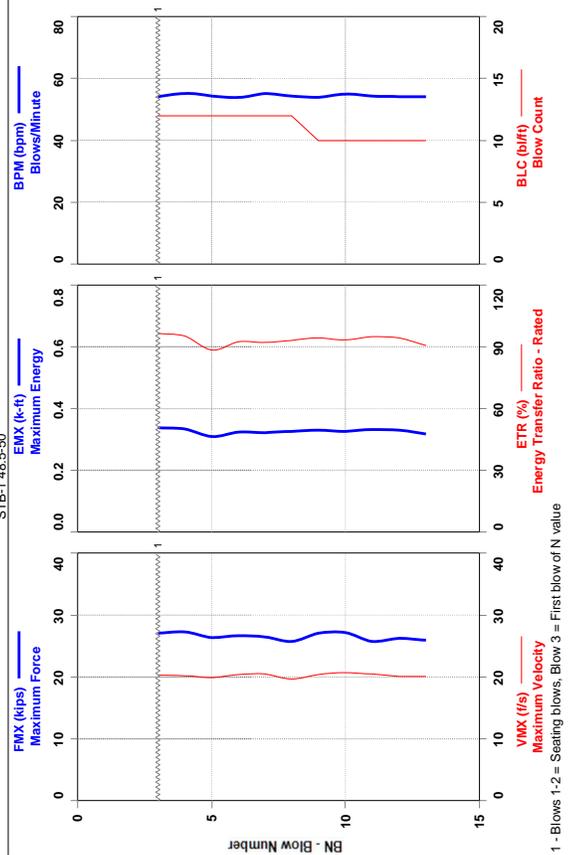
Pile Dynamics, Inc. - PDIPILOT2 Ver 2017.2.58.3 - Case Method & iCAP® Results
Printed: 18-September-2018 Test started: 17-September-2018
COLUMBIA SPT RIG CAL - CME 55 SERIAL # 359485
STB-1 43.5-45



1 - Blows 1-5 = Seating blows, Blow 6 = First blow of N value



Pile Dynamics, Inc. - PDIPILOT2 Ver 2017.2.58.3 - Case Method & iCAP® Results
Printed: 18-September-2018 Test started: 17-September-2018
COLUMBIA SPT RIG CAL - CME 55 SERIAL # 359485
STB-1 48.5-50



1 - Blows 1-2 = Seating blows, Blow 3 = First blow of N value

COLUMBIA SPT RIG CAL - CME 55 SERIAL # 359485 STB-1 48.5-50
 OP: ZM Date: 17-September-2018
 AR: 1.18 in² SP: 0.492 klf²
 LE: 53.70 ft EM: 30,000 klf²
 WS: 16,807.9 f/s JC: 0.00

FMX: Maximum Force BPM: Blows/Minute
 VMX: Maximum Velocity DMX: Maximum Displacement
 EMX: Maximum Energy CSX: Compression Stress Maximum

ETR: Energy Transfer Ratio - Rated

BL#	Depth	BLC	FMX	VMX	EMX	ETR	BPM	DMX	CSX
	ft	bl/ft	kips	f/s	k-ft	(%)	bpm	in	ksi
3	49.08	12	27	20.3	0.338	96.5	54.1	1.27	22.9
4	49.17	12	27	20.2	0.333	95.3	55.2	1.03	23.1
5	49.25	12	26	19.9	0.310	88.4	54.4	1.00	22.4
6	49.33	12	27	20.4	0.324	92.5	53.8	1.00	22.6
7	49.42	12	26	20.5	0.322	92.1	55.1	1.00	22.4
8	49.50	12	26	19.7	0.326	93.3	54.3	1.03	21.8
9	49.60	10	27	20.4	0.331	94.5	54.0	1.20	22.9
10	49.70	10	27	20.7	0.327	93.4	55.0	1.20	23.0
11	49.80	10	26	20.4	0.332	94.9	54.3	1.20	21.8
12	49.90	10	26	20.1	0.330	94.3	54.2	1.20	22.2
13	50.00	10	26	20.1	0.317	90.6	54.2	1.21	22.0
Average			27	20.2	0.326	93.2	54.4	1.12	22.5
Std. Dev.			1	0.3	0.008	2.2	0.4	0.10	0.5
Maximum			27	20.7	0.338	96.5	55.2	1.27	23.1
Minimum			26	19.7	0.310	88.4	53.8	1.00	21.8

Total number of blows analyzed: 11

Exhibit A-4 Field Log

BL# Sensors

3-13 F3: [AWJ 1] 216.5 (1.00); F4: [AWJ 2] 216.2 (1.00); A3: [K0059] 317.0 (1.00);
 A4: [K5418] 382.0 (1.00)

BL# Comments

3 Blows 1-2 = Seating blows, Blow 3 = First blow of N value

Time Summary

Drive 13 seconds 11:34 AM - 11:34 AM BN 1 - 13

Responsive ■ Resourceful ■ Reliable

Terracon

SPT HAMMER CALIBRATION FIELD WORKSHEET

ARRIVAL TIME: 10:50
 DEPART TIME: 19:00
 TOTAL TRAVEL: 5 Hours
 TOTAL TIME: 7 Hours
 CLIENT REP: N/A
 MILEAGE: 198

PROJECT NAME: Columbia, SC
 PROJECT NO.: NA
 BORING NO.: STB-1
 CLIENT: Terracon

DATE: 9-17-18
 TERRACON REP: Columbia
 PDA MODEL/SN: PAX 3755
 TERRACON RIG # DR#: PR 727

DRILL RIG DATA
 Type/Transport: Track
 Manufacturer: CME-55
 Model No.:
 Serial No: 359485
 Year Built: 2008
 Modifications: NA
 Maint. Schedule: As needed

SPT HAMMER DATA
 Type: Auto
 Manufacturer: CME
 Lifting Mechanism: Chain
 Model No.:
 Serial No: -
 Hammer Weight: 140 lbs
 Hammer Operator(s): Will B. Jason

PDA INPUT DATA

Operator: OP ZM
 Project No./Location: PJ Columbia, SC
 Rig Model & SN: PN CME-55
 Hammer Type, LM, Rods: PD Auto Chain AWJ
 Drill Rod Area (in²): AR 1.18

Elastic Modulus (ksi): EM 3000
 Specific Weight (kips/ft³): SP 0.492
 Wave Speed (ft/sec): WS 16808
 Increment Length (ft): LI 0.5
 Sampling Freq. (kHz): FR 50

TRANSDUCER INFORMATION

NOTES: Instrumentation to Bottom of Rod Length
 10.8" Inches 87.5' Feet

SPLIT SPOON SAMPLER LENGTH
 Gauge to Bottom of Cal. Rod length 317" Rod
 * LE is Measured from the Center of the Strain Gauges to the bottom of Split Spoon Sampler

SPT TESTING INFORMATION

Start Time	Soil	Stick Up Length (ft)	Depth (ft)		'LE (ft)	Rods & Lengths	PDA Blows		SPT Blows			N
			Start	End			Start	End	1st 6"	2nd 6"	3rd 6"	
10:55	SC	53.5	23.5	25	28.7	2ft 5ft 10ft	1	29	8	12	18	30
11:00	SC	53.5	21.5	30	33.7	2ft 5ft 10ft	1	25	6	7	11	18
11:07	SC	53.75	21.5	35	39.7	2ft 5ft 10ft	1	22	5	6	10	16
11:16	SC	56	38.5	40	43.7	2ft 5ft 10ft	1	15	3	5	6	11
11:28	SC	58	43.5	45	48.7	2ft 5ft 10ft	4	25	5	6	10	16
11:36	SC	48.5	48.5	50	53.7	2ft 5ft 10ft	2	15	2	6	5	11

Individual pairs of F or V signals versus time shall be very similar for good quality data.
 If you see Force goes negative before 2L/C after impact, drill rod joints should be carefully tightened for good quality data

PICTURE NUMBERS AND INFO: Take Photo of Each Rig, Boring Locations at the Site
 Drilling Method: (16 Hollow Stem Augers, Mud Rotary...)