



GEOTECHNICAL BASELINE REPORT - REV1

US 123 (Calhoun Memorial Hwy.) Northbound Bridge Replacement over Georges Creek
Pickens County, South Carolina

PREPARED FOR

SCDOT

955 Park Street

Columbia, South Carolina 29201



PREPARED BY

F&ME Consultants, Inc.

211 Business Park Boulevard

Columbia, South Carolina 29203

SCDOT Project ID: P041233

FME Project No.: G6400.110

February 15, 2023

February 15, 2023

Mr. Trapp Harris, P.E., DBIA
South Carolina Department of Transportation
955 Park Street
Columbia, South Carolina 29201

Re: Geotechnical Baseline Report – REV1
US 123 (Calhoun Memorial Hwy.) Northbound Bridge Replacement over Georges Creek
Pickens County, South Carolina
SCDOT Project ID: P041233
FME Project No.: G6400.110

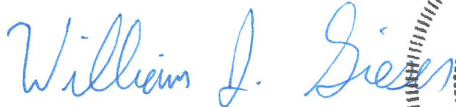
Mr. Harris:

Submitted herein is F&ME Consultants, Inc.'s (FME) Geotechnical Baseline Report for the US 123 (Calhoun Memorial Hwy.) Northbound Bridge Replacement over Georges Creek.

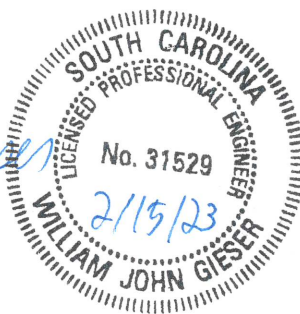
It has been a pleasure working with you on this project and we appreciate the opportunity to be of service. Please notify us if there are any questions or if we can be of further assistance.

Respectfully Submitted,

F&ME CONSULTANTS, INC.

A handwritten signature in blue ink that reads 'William J. Gieser'.

William J. Gieser, P.E.
Project Engineer



Attachments



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1. INTRODUCTION

This Geotechnical Baseline Report (GBR) provides a characterization of the subsurface conditions to the South Carolina Department of Transportation (SCDOT) for the proposed US 123 Northbound Bridge Replacement over Georges Creek, in Pickens County, South Carolina. The proposed bridge intends to replace the existing bridge over Georges Creek on Calhoun Memorial Highway.

This Geotechnical Baseline Report was prepared in general accordance with the 2022 SCDOT Geotechnical Design Manual (GDM). Geotechnical data including standard penetration testing, rock core sampling, and laboratory testing are presented herein to provide generalized geological features and site conditions for the design of the proposed bridge. Preliminary geotechnical considerations for design and construction are also included in this report.

1.1. PROJECT DESCRIPTION

The project site is located six miles east of Easley, approximately a quarter of a mile northeast of the intersection of SC 124 with US 123. It is bound to the east by N. Fishtrap Road and to the west by SC 124. A Site Vicinity Map is included in Appendix A.

The existing bridge over Georges Creek is approximately 200 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 250 feet in length and will accommodate two 12-foot lanes with 10-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 January 23, 2023, through January 27, 2023. The subsurface investigation consisted of standard penetration test (SPT) borings and NQ rock core samples.

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

2.1. DRILLING AND SAMPLING

A total of three (3) SPT borings were performed during the subsurface investigation: NBB-1, NBB-2, and NBB-3. Drilling refusal was encountered in all borings at depths of 41.5 feet, 73.0 feet, and 88.5 feet, respectively. Advancement of the borings below drilling refusal was accomplished with NQ rock coring techniques. These were terminated at depths of 51.5 feet, 91.6 feet and 98.5 feet.

The boring logs from the subsurface investigation are included in Appendix B. The borings were advanced by a CME 550X drill rig using mud rotary and driven casing drilling techniques. Soil sampling and penetration testing was performed in general accordance with ASTM D-1586. SPT's were conducted continuously in the top 10 feet of each boring followed by 5-foot intervals thereafter until drilling 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 85%. The hammer energy ratio is identified on each boring log. SPT hammer energy measurements on the CME 550X is included in Appendix E.

2.2. GROUNDWATER CONDITIONS

The stabilized groundwater level recorded approximately 24 hours after completion of investigation operations indicated a groundwater depth of 24.8 feet and 36.5 feet for boring NBB-1 and NBB-3, respectively. These depths correspond to elevations 813.6 feet and 797.7 feet.

The water level of NBB-2 is the top of Georges Creek, at a depth of 37.0 feet from the bridge deck, corresponding to elevation 798.5 feet.

These reported groundwater levels are interpreted to be dependent upon seasonal fluctuations, individual event intensity, and/or stage elevation of Georges 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 test location plan included in Appendix A.

Table 2-1. Field Soil Testing Summary

Test ID	Test Type	Total Depth (FT)	Elevation (ft-MSL)	Latitude	Longitude
NBB-1	STB/RC	51.5	838.4	34.831207	-82.497219
NBB-2	STB/RC	91.6	835.5	34.831209	-82.496829
NBB-3	STB/RC	98.5	834.2	34.831216	-82.496475

3. LABORATORY TESTING PROGRAM

Laboratory testing was performed by FME on representative samples collected from the geotechnical borings to obtain index and engineering properties. Geotechnical index property testing included natural moisture content, Atterberg limits, and #200 wash. Engineering property tests consisted of unconfined compression of rock 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 Table

Type of Test	Quantity	Procedure
Moisture Content	15	AASHTO T265 (ASTM D2216)
Atterberg Limits	7	AASHTO T89/T90 (ASTM D4318)
Wash 200	7	AASHTO T11 (ASTM D1140)
Compressive Strength of Rock Cores	7	ASTM D7012

3.1. SOIL AND ROCK PROPERTIES

Split spoon soil samples from the 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-2-4 to A-7-6. According to the Unified Soil Classification System, the classifications of these samples ranged from poorly graded sand with silt (SP-SM) to sandy fat clay (CH). Tested samples yielded liquid limits ranging from non-plastic to 55 and plasticity indices ranging from non-plastic to 27.

Seven (7) unconfined compression tests were performed on recovered rock samples with unconfined strength results ranging from 4,300 psi to 19,500 psi. Results of laboratory testing are included in Appendix C.

4. SUBSURFACE CONDITIONS

4.1. REGIONAL GEOLOGY

The bridge site is located on US 123 in Pickens County, South Carolina and crosses over Georges Creek which is part of the Saluda River watershed (DHEC, 2016). The bridge site lies within the Piedmont Physiographic Province of South Carolina. The Piedmont Province is bounded by the Blue Ridge Physiographic Province to the west and the Coastal Plain Province to the east. Elevations throughout the Piedmont vary from 300 feet to 1,400 feet. The Piedmont Province is characterized by gently rolling topography, deeply weathered bedrock, few rock outcrops and complex geology with a multitude of rock types formed during the Paleozoic Era (250 to 570 MYA). The geology of this region is further complicated by the Alleghanian orogeny (325 to 260 MYA), the mountain building event which helped to form the present-day Appalachian Mountain chain, and subsequent deformation/metamorphism of the region. Soils overlying bedrock in the Piedmont are typically considered to be residual soil (soil weathered in place from bedrock). However, Georges Creek provides a transport mechanism for soil eroded from higher elevations to be carried downstream and deposited at banks of the particular bridge site. The contact between soil and bedrock is not strongly defined and is often marked by an intermediate transition zone. The materials of this zone can be soil, partially decomposed rock, and fragments of the underlying bedrock.

4.2. SOIL AND ROCK STRATIFICATION

In general, the soil profile is predominantly silty sand and poorly graded sand. These soils are found in the roadway fill, alluvium, and residual soils overlying biotite gneiss bedrock. Bedrock was encountered between 41.5 feet to 88.5 feet from the existing roadway.

Existing roadway fill was interpreted to range from 22.0 feet to 24.0 feet below the existing roadway. Underlying alluvium ranged from five to six feet in thickness. Piedmont residual soils were found in all borings between the alluvium and the bedrock. Biotite gneiss makes up the bedrock underlying the project site.

Recovered rock cores were in general fresh to slightly weathered. The rock was described as fine to medium grained, foliated, and thinly bedded. Few joints were noted. Rock core recovery ranged from 56 to 100 percent, RQD ranged from 23 to 100 percent, and rock unconfined compression testing revealed medium strong rock to very strong rock with values ranging from 4,300 psi to 19,500 psi.

A summary of the main strata intercepted by the soil test borings is provided in Table 4-1 below. A subsurface profile developed based on the collected soil and rock information is included in Appendix A.

Table 4-1. Soil and Rock Stratification

Geology	Top of Layer Elev. (ft-MSL)	Predominate USCS Soil Type	SPT-N ⁽¹⁾	Plasticity Index ⁽¹⁾	Fines Content ⁽¹⁾	REC/RQD ⁽¹⁾
Existing Fill	834 - 838	SM, SP-SM, SC	3 – 20 (9)	0 – 27 (16.6)	26 – 59 (40.3)	
Alluvium	793 - 816	SP, CL, SP-SM	1 – 9 (4)	0 – 13 (6.5)	8 – 41 (24.5)	
Residuum	787 - 810	SM, ML, SP, CL	2 – 100 (37)	0 – 8 (4)	29 – 55 (42)	
Bedrock	746 - 797					56-100/ 23-100 (91 / 82)

⁽¹⁾Values in parentheses indicate the average of the values in the range.

5. SEISMIC CONDITIONS

The proposed bridge is classified as OC II. Per SCDOT GDM 2022, the bridge approach embankments shall be designed to meet the performance limits that are established by the design team based on the performance objectives for the bridge.

5.1. ACCELERATION DESIGN RESPONSE SPECTRUM (ADRS)

The shear wave velocity results, as measured from the MASW test performed between the northbound and southbound bridges, were provided to SCDOT (Pre-Construction Support - Geotechnical Design Section). SCDOT used these results to determine the site amplification factors that would be used to correct for site effects the bedrock motion determined from regional probabilistic seismic hazard maps.

SCDOT provided a “3-Point Acceleration Design Response Spectrum” data sheet that included pseudo-spectral accelerations (PSA) for 5% critical damping and at selected frequencies, consistent with a Geologically Realistic condition (shear wave velocity, $V_s=11,500$ fps). PSA values were provided for the:

- Functional Evaluation Earthquake (FEE): 15% probability of exceedance in 75 years;
- Safety Evaluation Earthquake (SEE): 3% probability of exceedance in 75 years.

Table 5-1 below summarizes the peak ground acceleration (PGA), the short period acceleration (SDS), and one-second period acceleration (SD1) for the FEE and SEE earthquakes for the ground surface. A copy of the “3-Point Acceleration Design Response Spectrum” output form presenting the PSA data at the B-C boundary and the results of the ADRS analysis are included in Appendix D.

Table 5-1. Seismic Design Parameters

Seismic Design Parameter	FEE	SEE
PGA	0.12 g	0.28 g
S_{DS}	0.19 g	0.42 g
S_{D1}	0.05 g	0.11 g

5.2. SHEAR STRENGTH LOSS (SSL)

Based on a preliminary review of the physical properties of the site soils, there appear to be soil layers that may be susceptible to shear strength loss during the design earthquake. The potential of shear strength loss and contribution to ground deformations that adversely affect the bridge structure should be carefully evaluated during the design phase of the project.

6. DESIGN AND CONSTRUCTION CONSIDERATIONS

6.1. BRIDGE FOUNDATIONS

Driven steel H-piles are anticipated to be the most feasible foundation type for the proposed bridge end bents based on the depth to rock. Based on Table 9-3 in SCDOT GDM 2022, assuming a redundant pile foundation system, a resistance factor of 0.50 will be used for design if wave equation is applied for verification and a resistance factor of 0.65 will be used assuming Dynamic Monitoring (PDA) with wave equation analysis. It is anticipated that foundation piles will be installed following the approach embankment construction. If embankment fill is placed after pile installation is complete, foundation pile design should account for any downdrag loading on the piles.

Due to the variability in the rock surface underlying the site, tip elevations are also anticipated to exhibit variability across the site. For piles driven to practical refusal, their resistance will be limited by their structural capacity and the ability of the pile hammer to mobilize the required pile capacity. Reinforced pile tips should be utilized to penetrate to dense soils and rock and prevent pile tip damage. The wave equation analysis should be performed for predicting the drivability of piles along with estimating stresses during driving and, in general, verifying the ability of the Contractor's selected hammer to drive the piles to the desired penetration while preventing overstressing.

For the bridge interior bents, drilled shafts socketed into rock appear to be the most appropriate foundation type due to potentially anticipated shallow rock, scour conditions, and the length of the foundation unsupported length. Installation of permanent casing will be required for the construction of drilled shafts socketed into rock. In this case, drilled shaft diameters should be a minimum of 6 inches larger than the column and the rock socket diameters. Permanent casing will need to extend into partially weathered rock to ensure sufficient support is provided while advancing the drilled shaft excavation through the overlying saturated soils. For the design of the drilled shafts with rock sockets, a resistance factor of 0.60 for both side friction and end bearing will be used in accordance with Table 9-4 of the SCDOT GDM 2022, assuming a redundant drilled shaft foundation system is used. It must be noted that side resistance along the cased length of the drilled shaft, anticipated to extend to the top of partially weathered rock, will not be considered in the calculated axial resistances. Excavation for bridge foundations is expected to encounter partially weathered rock zones overlying bedrock as well as hard rock conditions within the competent bedrock.

6.2. EMBANKMENT SLOPES

The potential for SSL of the site soils during a seismic event is anticipated to cause instability of the bridge approach embankment side slopes and end slopes. Further assessment of the seismic slope stability in conjunction with lateral spreading effects and evaluation of any necessary ground modification or structural mitigation measures must be explored during the design phase of the project.

6.3. CORROSION AND DETERIORATION

Corrosion series testing was not performed during the preliminary geotechnical investigation for this site. It is recommended to perform corrosion series testing (pH, resistivity, chloride, and sulfate) prior to the construction of the new structure.

6.4. EMBANKMENT CONSTRUCTION

Some fill quantities may be required for construction of the embankments on this project. Fill should be placed in accordance with the 2007 SCDOT Standard Specifications for Highway Construction. If existing embankments are widened, it is recommended that the new fill be benched into the existing embankment.

7. LIMITATIONS TO REPORT

This report has been prepared in general accordance with procedures in SCDOT GDM Chapter 21 and generally accepted soil and foundation engineering practices for specific application to the proposed US 123 Bridge over Georges Creek in Pickens County, South Carolina. No other warranty expressed or implied is made. The Geotechnical Engineer of Record for the project must review the data submitted in this report and develop their own interpretation of the testing results as they apply to design. 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.

US 123 (Calhoun Memorial Hwy.) Northbound Bridge
Replacement over Georges Creek
Geotechnical Baseline Report

APPENDICES

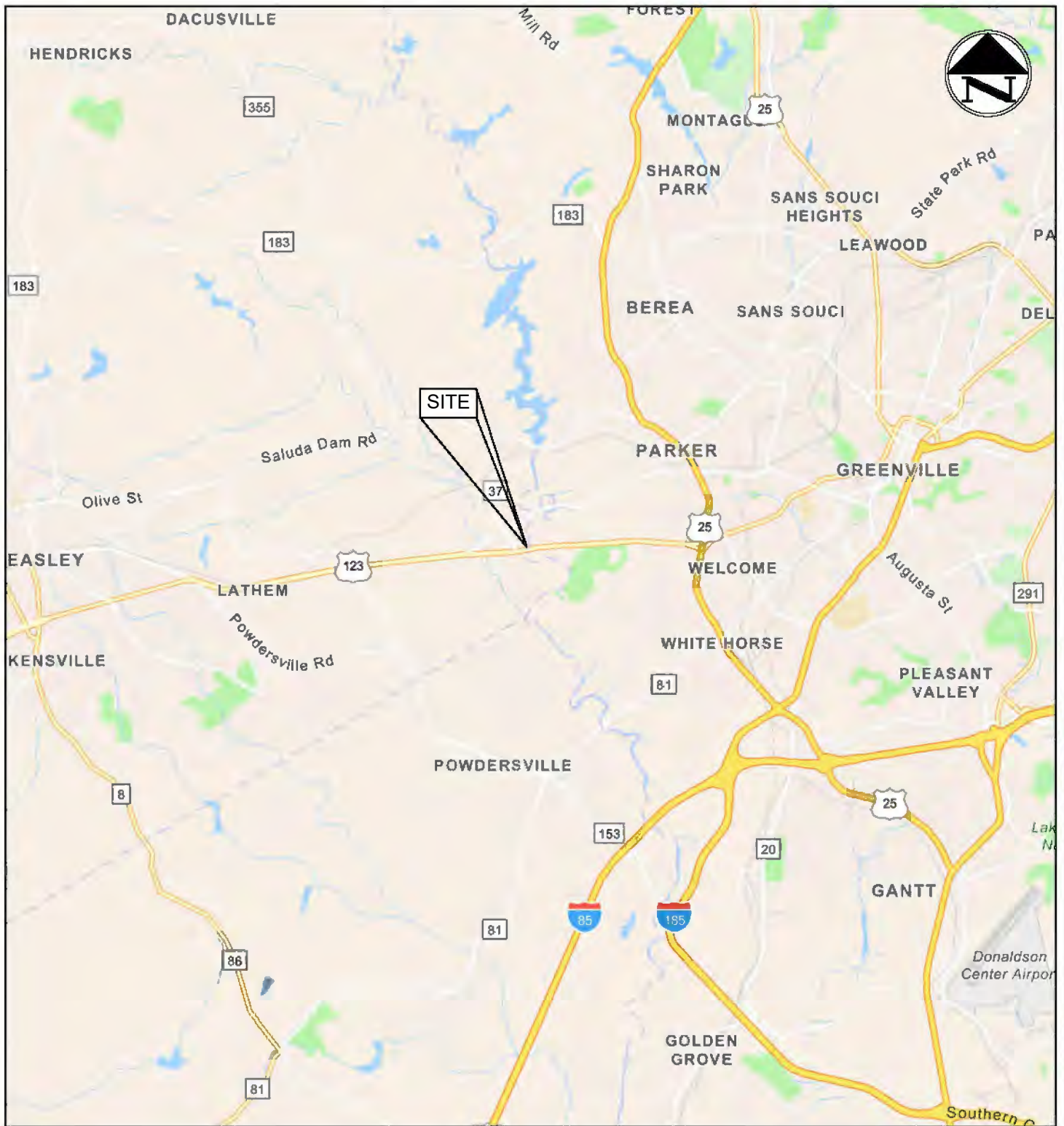
APPENDIX A	SITE VICINITY MAP, TEST LOCATION PLAN
APPENDIX B	BORING LOGS, ROCK CORE PHOTOS
APPENDIX C	LABORATORY TESTING
APPENDIX D	ADRS CUREVES
APPENDIX E	SPT HAMMER ENERGY CALIBRATION

US 123 (Calhoun Memorial Hwy.) Northbound Bridge
Replacement over Georges Creek

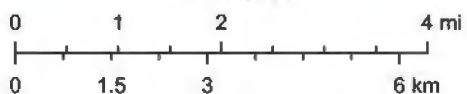
Geotechnical Baseline Report

APPENDICES

APPENDIX A SITE VICINITY MAP, TEST LOCATION PLAN



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F&ME CONSULTANTS, INC.
COLUMBIA, SC

4			
3			
2			
1			
REV.	BY	DATE	DESCRIPTION OF REVISION
TOPO.		DATE	
DWG.	CTC	DATE 2.8.23	GROUP -- --
R/W		DATE	

US 123 NB OVER GEORGES CREEK
PICKENS COUNTY, SOUTH CAROLINA

SITE LOCATION PLAN

SCDOT PROJECT ID: P041233

FME JOB NO. G6400.110

SCALE: AS NOTED

FIGURE 1



SUBSURFACE TESTING LOCATIONS							
Boring ID	Test Type	Northing	Easting	Latitude	Longitude	Test Elevation (MSL)	Test Depth (ft)
NBB-1	STB	1094036.780	1550677.331	34.83120713	-82.49721883	838.4	51.5
NBB-2	STB	1094035.814	1550794.451	34.83120914	-82.49682858	835.5	91.6
NBB-3	STB	1094036.876	1550900.711	34.83121629	-82.49647460	834.2	98.5



LEGEND:



SOIL TEST BORING LOCATION

4			
3			
2			
1			
REV.	BY	DATE	DESCRIPTION OF REVISION
TOPO.		DATE	
DWG.	CTC	DATE 2.8.23	GROUP
R/W		DATE	



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COLUMBIA, SC

US 123 NB OVER GEORGES CREEK
PICKENS COUNTY, SOUTH CAROLINA

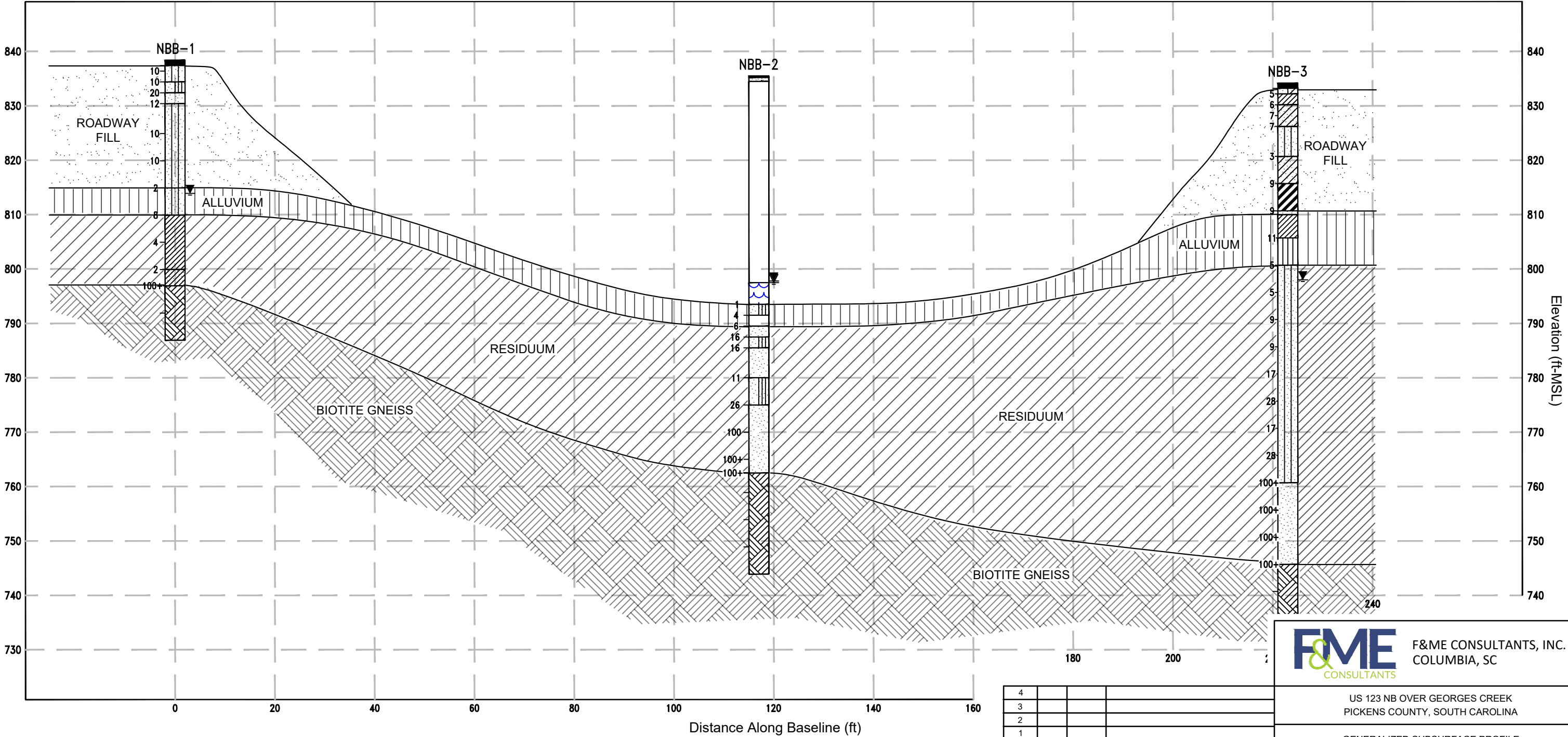
BORING LOCATION PLAN

SCDOT PROJECT ID: P041233

FME JOB NO. G6400.110

SCALE: 1"=40'

FIGURE 2



4			
3			
2			
1			
REV.	BY	DATE	DESCRIPTION OF REVISION
TOPO.		DATE	
DWG.	CTC	DATE 2.15.23	GROUP -
R/W		DATE	

F&ME CONSULTANTS, INC.
COLUMBIA, SC

US 123 NB OVER GEORGES CREEK
PICKENS COUNTY, SOUTH CAROLINA

GENERALIZED SUBSURFACE PROFILE

SCDOT PROJECT ID: P041233	FME JOB NO. G6400.110
SCALE: NTS	FIGURE 3

US 123 (Calhoun Memorial Hwy.) Northbound Bridge
Replacement over Georges Creek

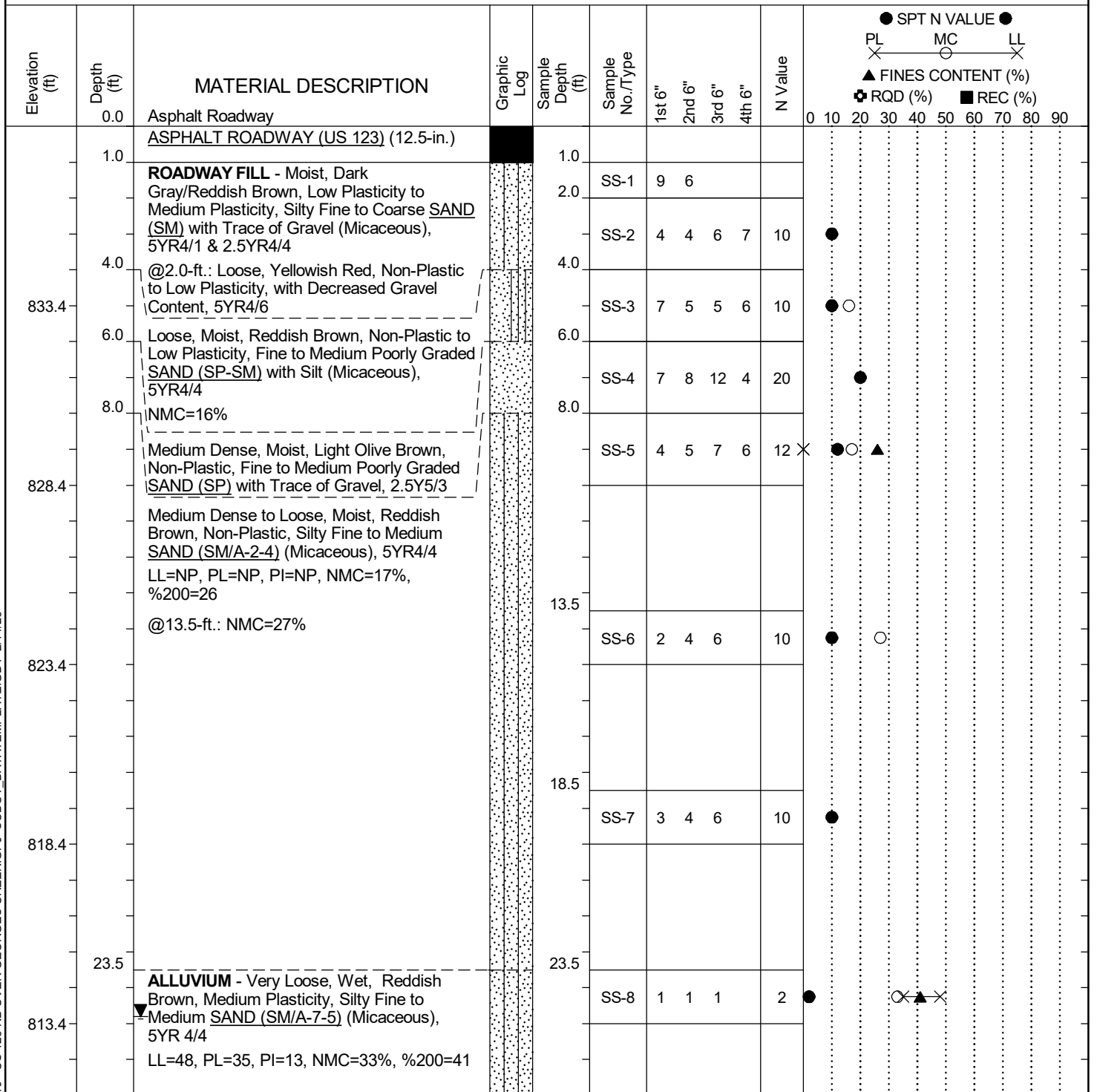
Geotechnical Baseline Report

APPENDICES

APPENDIX B BORING LOGS, ROCK CORE PHOTOS

SCDOT Soil Test Log

Project ID: P041233				County: Pickens		Boring No.: NBB-1		
Site Description:		US 123 NB over Georges Creek					Route:	US 123
Eng./Geo.: T. Peterson		Boring Location: N/A			Offset:	N/A	Alignment:	Existing
Elev.: 838.4 ft	Latitude:	34.83120713	Longitude:	-82.49721883	Date Started:		1/24/2022	
Total Depth:	51.5 ft	Soil Depth:	41.5 ft	Core Depth:	10 ft	Date Completed:		1/25/2023
Bore Hole Diameter (in): 4		Sampler Configuration		Liner Required:		Y (N)	Liner Used: Y (N)	
Drill Machine:	CME 550X	Drill Method: RW/RC		Hammer Type:		Automatic	Energy Ratio: 85%	
Core Size:	NQ	Driller: J. Phillips		Groundwater:	TOB	NR	24HR	24.8(Cave@34)



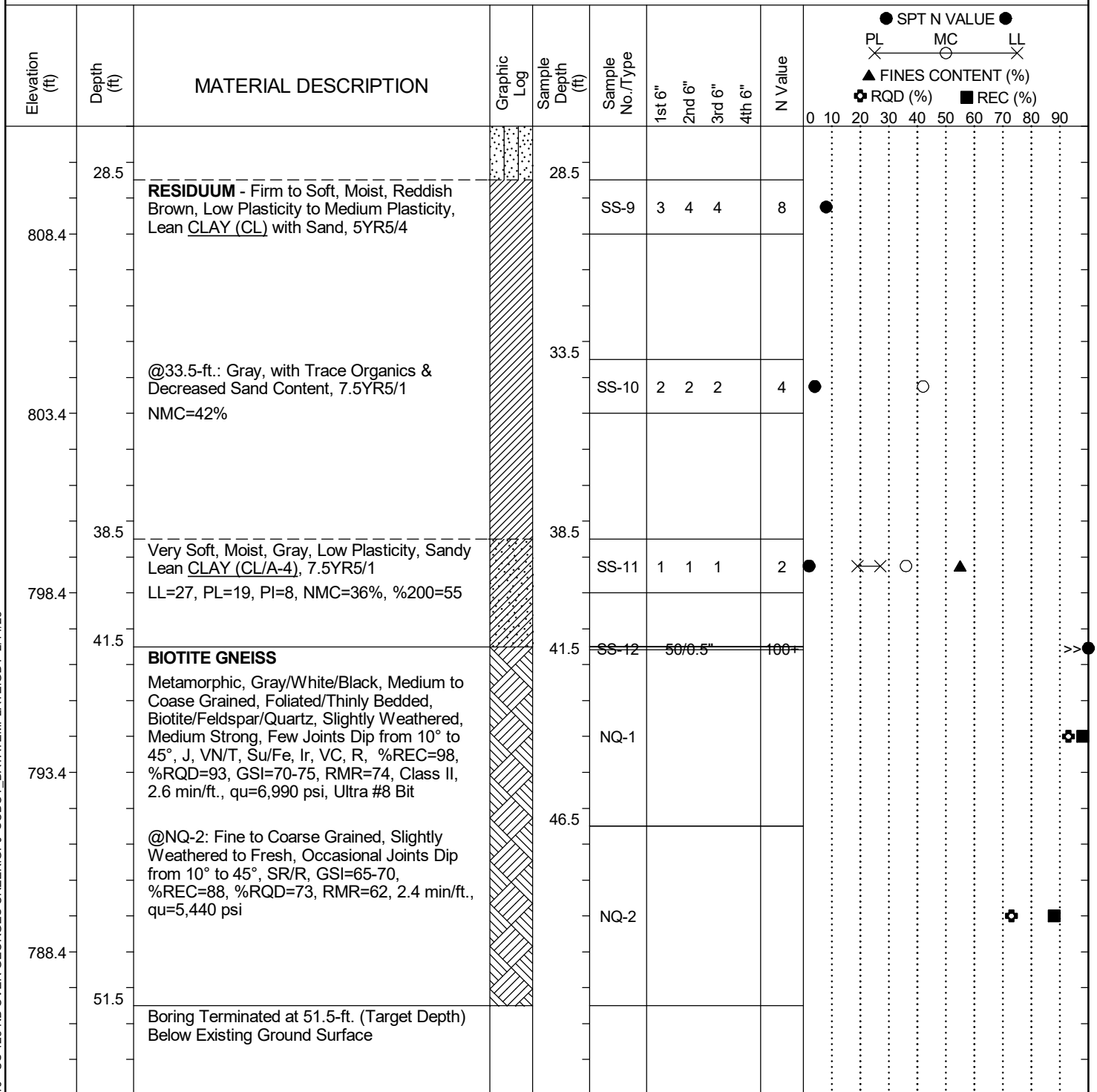
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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving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

SCDOT Soil Test Log

Project ID:	P041233	County:	Pickens	Boring No.:	NBB-1
Site Description:	US 123 NB over Georges Creek			Route:	US 123
Eng./Geo.:	T. Peterson	Boring Location:	N/A	Offset:	N/A
Elev.:	838.4 ft	Latitude:	34.83120713	Longitude:	-82.49721883
Date Started:	1/24/2022				
Total Depth:	51.5 ft	Soil Depth:	41.5 ft	Core Depth:	10 ft
Date Completed:	1/25/2023				
Bore Hole Diameter (in):	4	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW/RC	Hammer Type:	Automatic
Energy Ratio:	85%				
Core Size:	NQ	Driller:	J. Phillips	Groundwater:	TOB NR
24HR	24.8(Cave@34)				



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 G6400.110 - US 123 NB OVER GEORGES CREEK.GPJ SCDOT_DATATEMPLATE.GDT 2/14/23

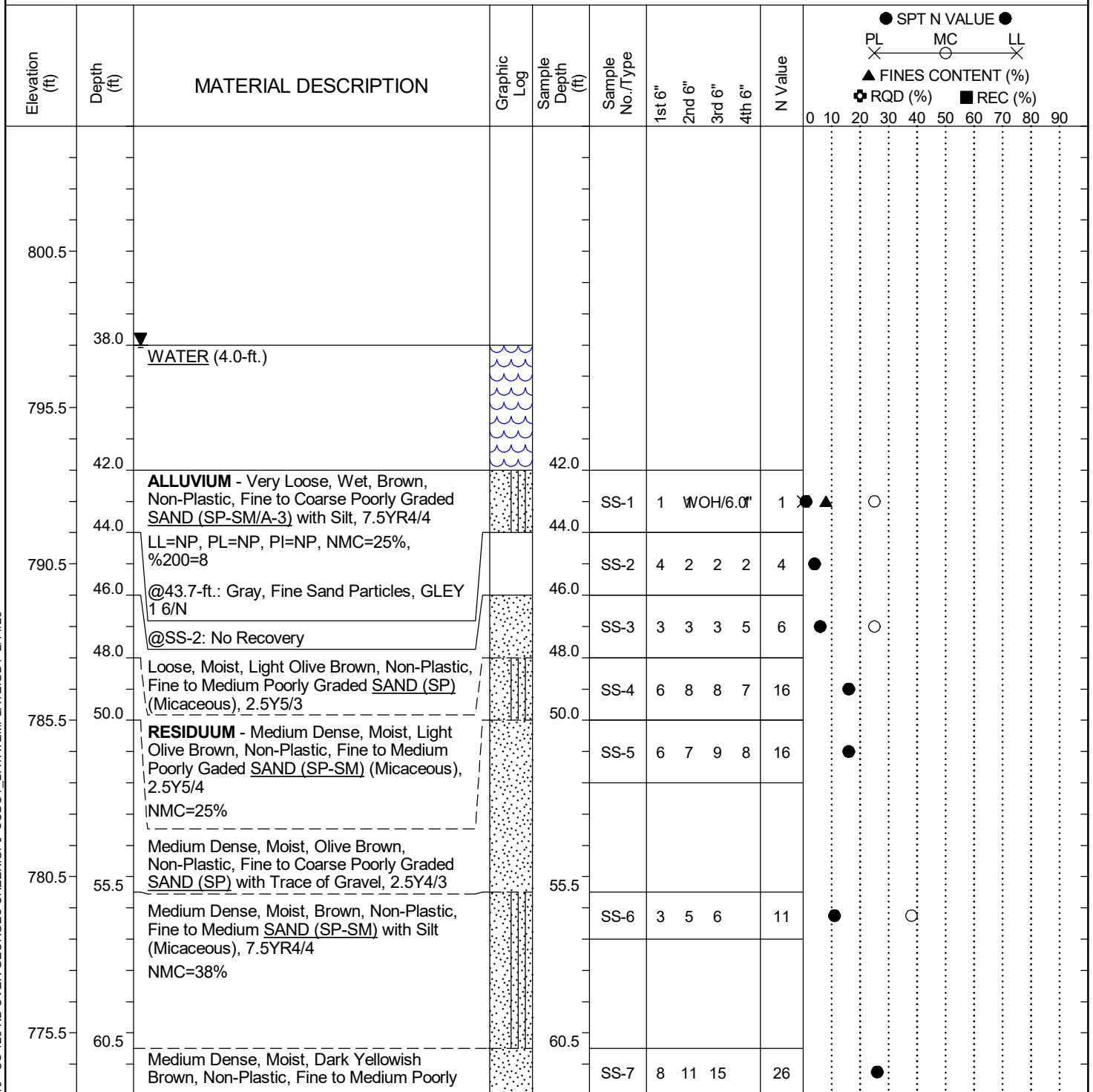
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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving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

SCDOT Soil Test Log

Project ID:	P041233				County:	Pickens			Boring No.:	NBB-2		
Site Description:		US 123 NB over Georges Creek							Route:	US 123		
Eng./Geo.:	T. Peterson		Boring Location:			N/A		Offset:	N/A		Alignment:	Existing
Elev.:	835.5 ft		Latitude:	34.83120914		Longitude:	-82.49682858		Date Started:		1/26/2023	
Total Depth:		91.6 ft		Soil Depth:	31 ft		Core Depth:	18.6 ft		Date Completed:		1/27/2023
Bore Hole Diameter (in):			4		Sampler Configuration			Liner Required:	Y (N)		Liner Used:	Y (N)
Drill Machine:		CME 550X		Drill Method:	RW/RC		Hammer Type:	Automatic		Energy Ratio:	85%	
Core Size:		NQ		Driller:	J. Phillips		Groundwater:	TOB	38 ft		24HR	38 ft



LEGEND

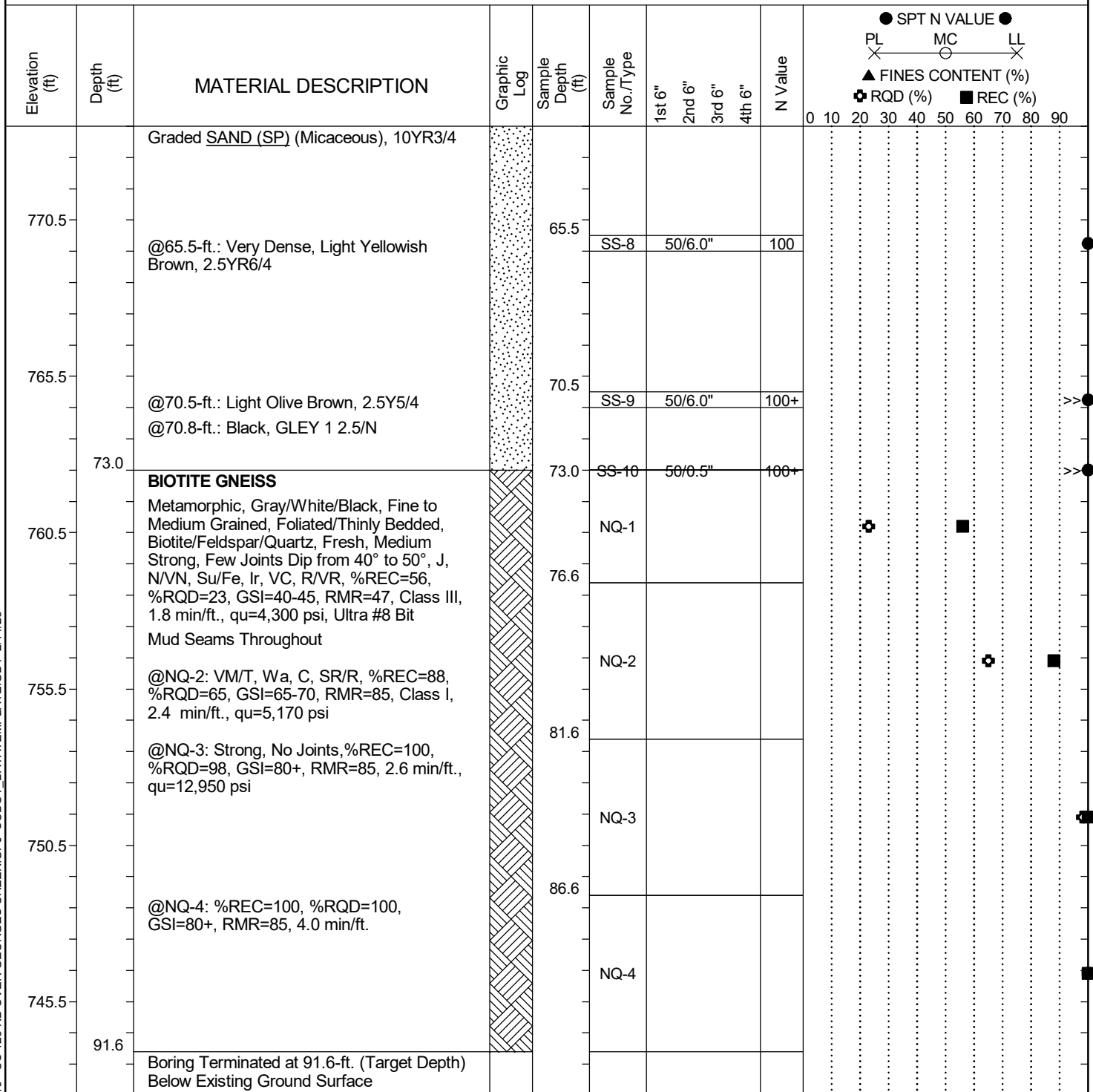
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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
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SC.DOT G6400.110 - US 123 NB OVER GEORGES CREEK.GPJ SCDOT_DATATEMPLATE.GDT 2/14/23

SCDOT Soil Test Log

Project ID:	P041233				County:	Pickens			Boring No.:	NBB-2			
Site Description:		US 123 NB over Georges Creek							Route:	US 123			
Eng./Geo.:	T. Peterson		Boring Location:			N/A		Offset:	N/A		Alignment:	Existing	
Elev.:	835.5 ft		Latitude:	34.83120914		Longitude:	-82.49682858		Date Started:		1/26/2023		
Total Depth:		91.6 ft		Soil Depth:		31 ft		Core Depth:		18.6 ft		Date Completed:	1/27/2023
Bore Hole Diameter (in):			4		Sampler Configuration			Liner Required:		Y (N)		Liner Used:	Y (N)
Drill Machine:		CME 550X		Drill Method:		RW/RC		Hammer Type:		Automatic		Energy Ratio:	85%
Core Size:		NQ		Driller:		J. Phillips		Groundwater:		TOB 38 ft		24HR	38 ft



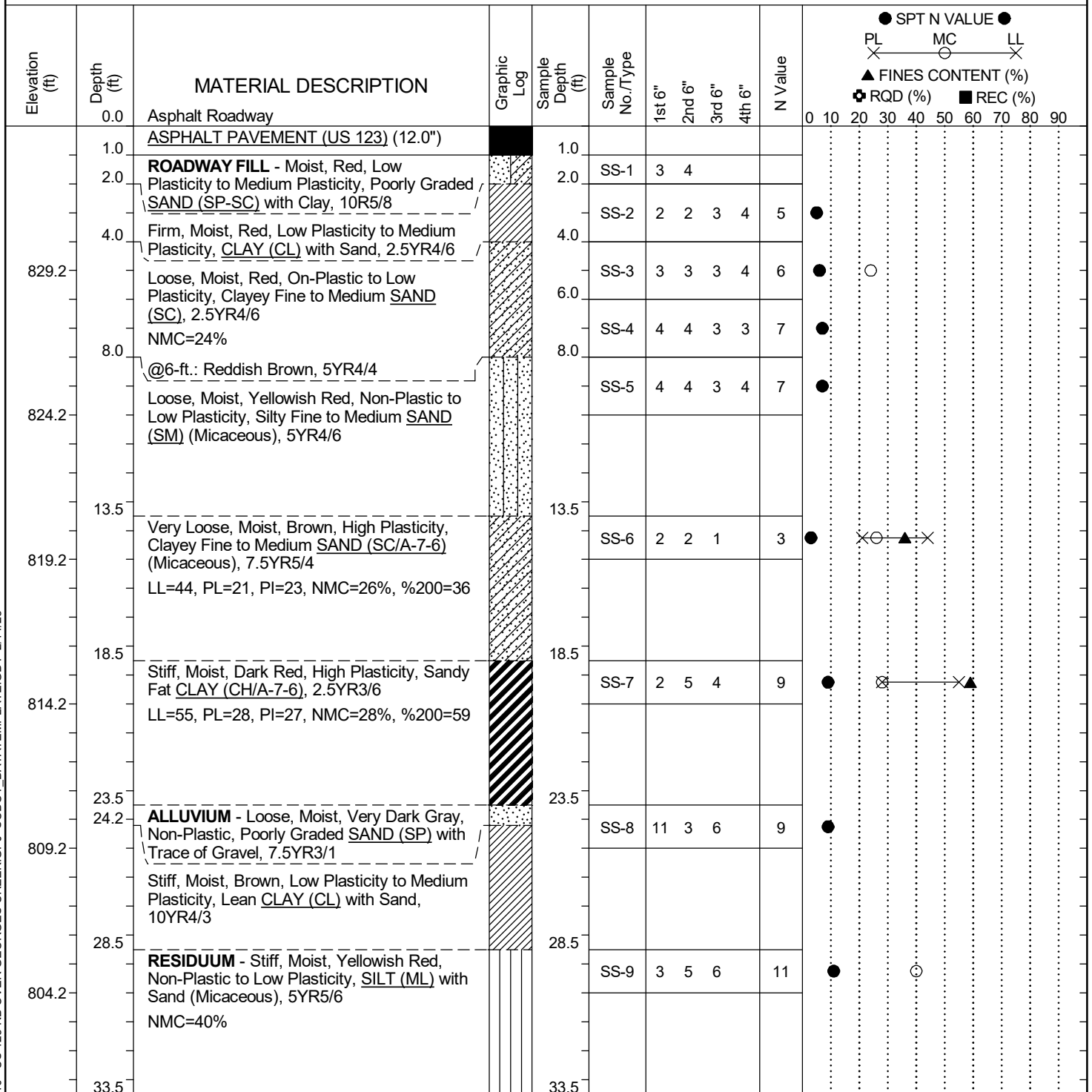
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SAMPLER TYPE		DRILLING METHOD	
SS	- Split Spoon	NQ	- Rock Core, 1-7/8"
UD	- Undisturbed Sample	CU	- Cuttings
AWG	- Rock Core, 1-1/8"	CT	- Continuous Tube
HSA	- Hollow Stem Auger	RW	- Rotary Wash
CFA	- Continuous Flight Augers	RC	- Rock Core
DC	- Driving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

SC.DOT G6400.110 - US 123 NB OVER GEORGES CREEK.GPJ SCDOT_DATATEMPLATE.GDT 2/14/23

SCDOT Soil Test Log

Project ID:	P041233	County:	Pickens	Boring No.:	NBB-3
Site Description:	US 123 NB over Georges Creek			Route:	US 123
Eng./Geo.:	T. Peterson	Boring Location:	N/A	Offset:	N/A
Elev.:	834.2 ft	Latitude:	34.83121629	Longitude:	-82.4964746
Total Depth:	98.5 ft	Soil Depth:	88.5 ft	Core Depth:	10 ft
Date Started:	1/23/23				
Date Completed:	1/23/2023				
Bore Hole Diameter (in):	4	Sampler Configuration		Liner Required:	Y (N)
Liner Used:	Y (N)				
Drill Machine:	CME 550X	Drill Method:	RW/RC	Hammer Type:	Automatic
Energy Ratio:	85%				
Core Size:	NQ	Driller:	J. Phillips	Groundwater:	TOB NR
24HR	36.5(Cave @				



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 G6400.110 - US 123 NB OVER GEORGES CREEK.GPJ SCDOT_DATATEMPLATE.GDT 2/14/23

SCDOT Soil Test Log

Project ID:		P041233			County:		Pickens		Boring No.:		NBB-3				
Site Description:			US 123 NB over Georges Creek							Route:		US 123			
Eng./Geo.:		T. Peterson		Boring Location:		N/A		Offset:		N/A		Alignment:		Existing	
Elev.:		834.2 ft		Latitude:		34.83121629		Longitude:		-82.4964746		Date Started:		1/23/23	
Total Depth:		98.5 ft		Soil Depth:		88.5 ft		Core Depth:		10 ft		Date Completed:		1/23/2023	
Bore Hole Diameter (in):			4		Sampler Configuration			Liner Required:		Y (N)		Liner Used:		Y (N)	
Drill Machine:		CME 550X		Drill Method:		RW/RC		Hammer Type:		Automatic		Energy Ratio:		85%	
Core Size:		NQ		Driller:		J. Phillips		Groundwater:		TOB NR		24HR		36.5(Cave @	

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	<div> <div>● SPT N VALUE ●</div> <div>PL X MC O LL X</div> <div>▲ FINES CONTENT (%)</div> <div>⊕ RQD (%) ■ REC (%)</div> </div>
799.2		Loose to Medium Dense, Moist, Strong Brown, Non-Plastic, Silty Fine SAND (SM/A-2-4) (Micaceous), 7.5YR4/6			SS-10	2	2	3		5	●
		LL=NP, PL=NP, PI=NP, NMC=39, %200=29									
		@38.5-ft.: Yellowish Brown, 10YR5/6		38.5							
794.2					SS-11	1	2	3		5	●
				43.5							
789.2					SS-12	3	4	5		9	●
		@48.5-ft.: Light Olive Brown, 2.5Y5/4		48.5							
784.2					SS-13	3	4	5		9	●
		@53.5-ft.: Light Olive Brown/White, 2.5Y5/4 & 2.5Y8/1		53.5							
779.2					SS-14	5	5	12		17	●
		@58.5-ft.: Very Dark Gray/White/Light Olive Brown, Fine to Medium Sand Particles, 5Y3/1, 5Y8/1 & 2.5Y5/4		58.5							
774.2		NMC=17%			SS-15	45	17	11		28	○ ●
		@63.5-ft.: Light Olive Brown, 2.5Y5/4		63.5							
769.2					SS-16	5	7	10		17	●

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	

[illegible]

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	

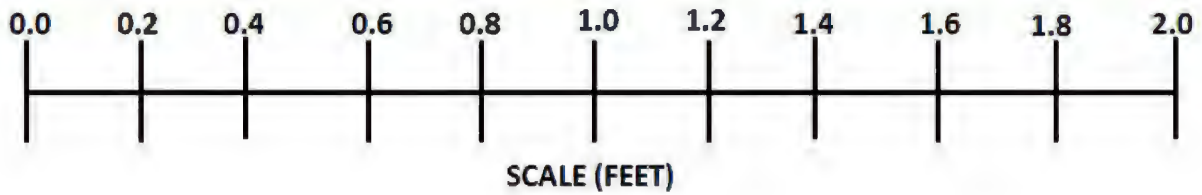
US 123 NB over Georges Creek CORE PHOTOGRAPHS: NBB-1

Begin Run 1
41.5 Feet



Begin Run 2
46.5 Feet

End Run 2
51.5 Feet



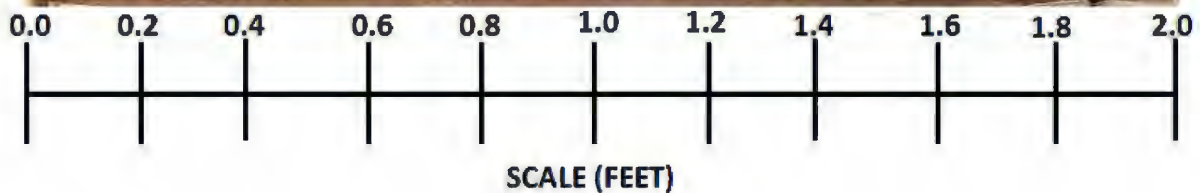
US 123 NB over Georges Creek CORE PHOTOGRAPHS: NBB-2

Begin Run 1
73.0 Feet

Begin Run 2
76.6 Feet



Begin Run 3
81.6 Feet



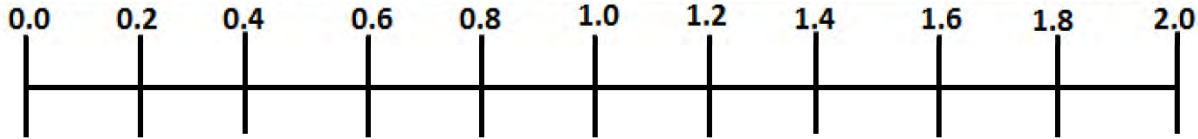
US 123 NB over Georges Creek CORE PHOTOGRAPHS: NBB-3

Begin Run 1
88.5 Feet



Begin Run 4
93.5 Feet

End Run 4
98.5 Feet



SCALE (FEET)

US 123 (Calhoun Memorial Hwy.) Northbound Bridge
Replacement over Georges Creek

Geotechnical Baseline Report

APPENDICES

APPENDIX C LABORATORY TESTING



SUMMARY OF LABORATORY RESULTS

PAGE 1 OF 1

PROJECT ID P041233

PROJECT NAME US 123 NB over Georges Creek

PROJECT COUNTY Pickens

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Classification	Water Content (%)	Dry Density (pcf)	Saturation (%)	Void Ratio
NBB-1	6.0						SP-SM	16.3			
NBB-1	10.0	NP	NP	NP	0.075	26	SM	17.2			
NBB-1	15.0						SM	27.3			
NBB-1	25.0	48	35	13	0.075	41	SM	32.5			
NBB-1	35.0						CL	41.7			
NBB-1	40.0	27	19	8	0.075	55	CL	36.0			
NBB-2	44.0	NP	NP	NP	0.075	8	SP-SM	25.4			
NBB-2	50.0						SP-SM	25.0			
NBB-2	57.0						SP-SM	37.6			
NBB-3	6.0						SC	23.8			
NBB-3	15.0	44	21	23	0.075	36	SC	25.8			
NBB-3	20.0	55	28	27	0.075	59	CH	28.2			
NBB-3	30.0						ML	39.6			
NBB-3	35.0	NP	NP	NP	0.075	29	SM	38.7			
NBB-3	60.0						SM	16.7			



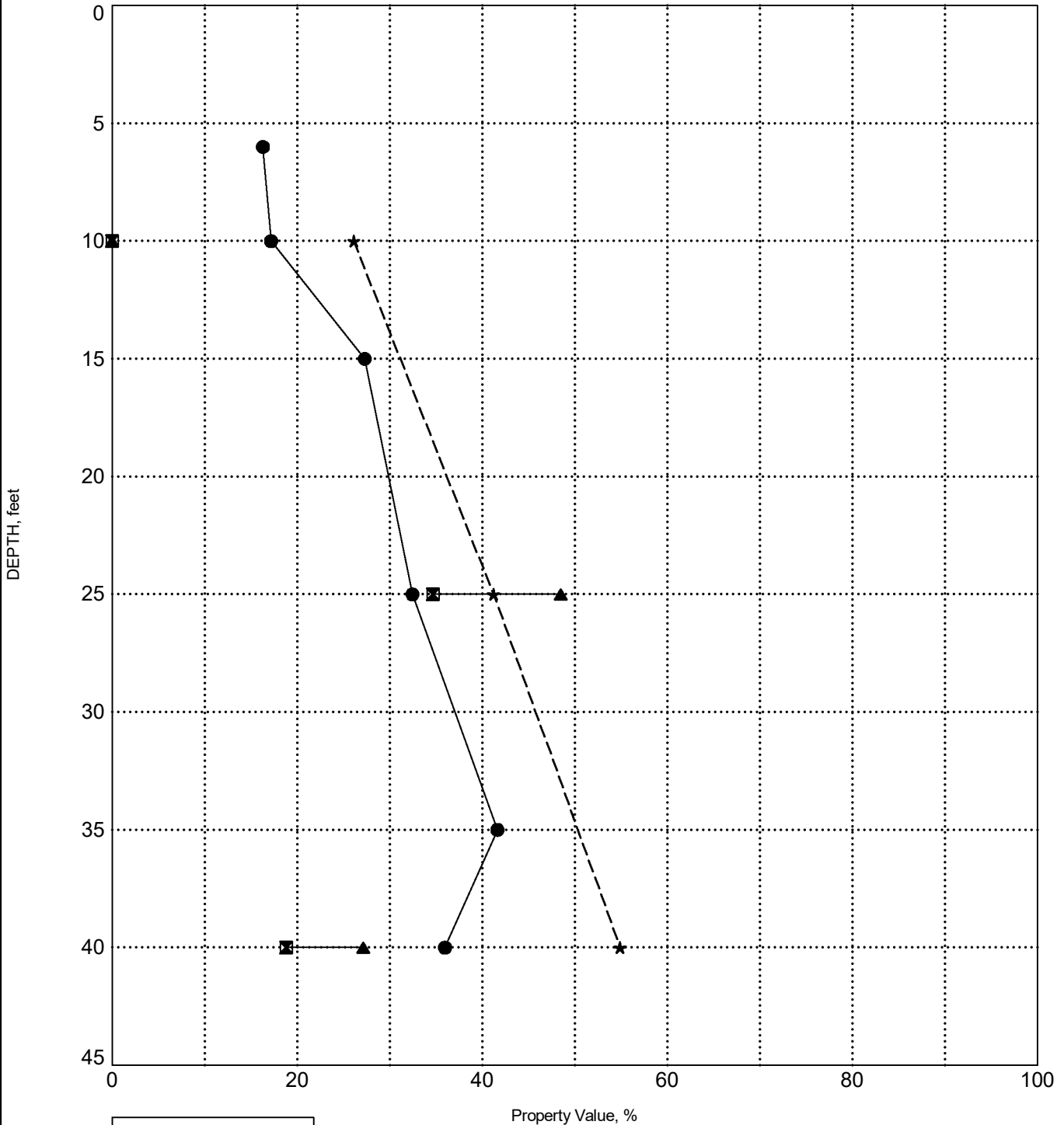
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P041233

PROJECT NAME US 123 NB over Georges Creek

PROJECT COUNTY Pickens

BORING NBB-1

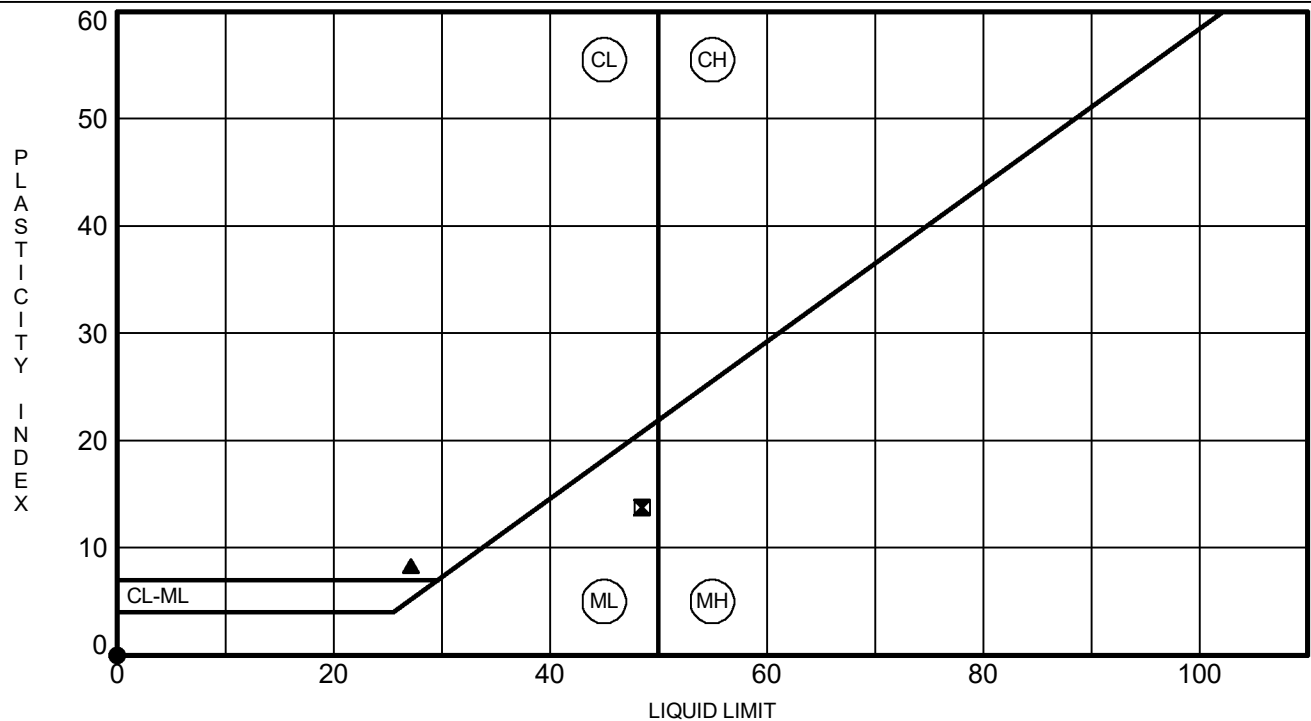


LEGEND	
●	Water Content
■	Plastic Limit
▲	Liquid Limit
★	Fines



PROJECT ID P041233

PROJECT NAME US 123 NB over Georges Creek

PROJECT COUNTY Pickens[illegible]

ATTERBERG LIMITS G6400.110 - US 123 NB OVER GEORGES CREEK.GPJ SCDOT DATA TEMPLATE 01 30 2015.GDT 2/6/23

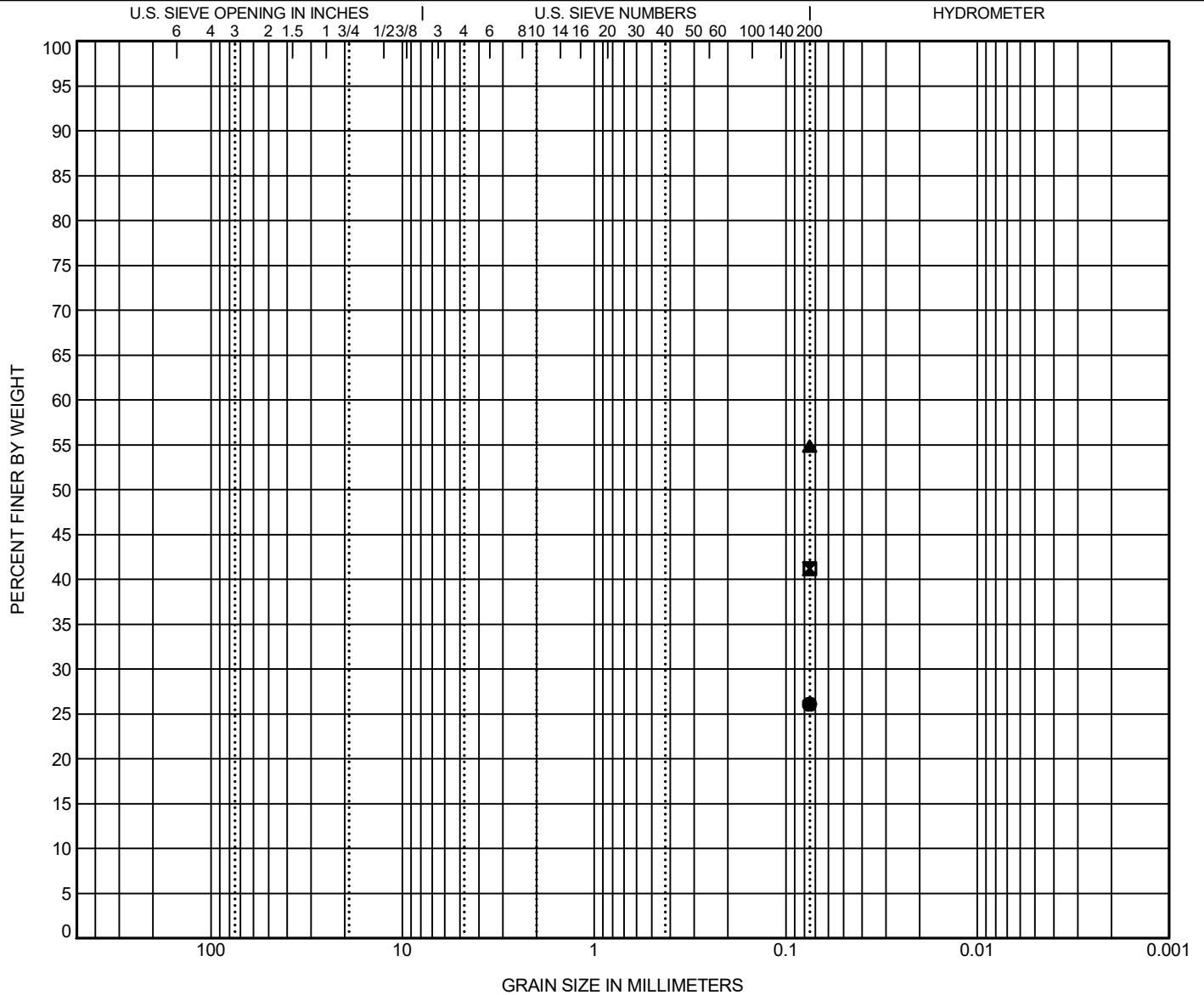


GRAIN SIZE DISTRIBUTION

PROJECT ID P041233

PROJECT NAME US 123 NB over Georges Creek

PROJECT COUNTY Pickens



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● NBB-1	10.0	SILTY SAND (SM/A-2-4)					NP	NP	NP		
■ NBB-1	25.0	SILTY SAND (SM/A-7-5)					48	35	13		
▲ NBB-1	40.0	SANDY LEAN CLAY (CL/A-4)					27	19	8		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay	
● NBB-1	10.0	0.075						26.1			
■ NBB-1	25.0	0.075						41.2			
▲ NBB-1	40.0	0.075						54.9			

GRAIN SIZE G6400.110 - US 123 NB OVER GEORGES CREEK.GPJ SCDOT DATA TEMPLATE 01_30_2015.GDT 2/6/23

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: US 123 NB over Georges Creek **SCDOT PROJECT No.:** P041233

SAMPLE NUMBER: 23-0290 **DATE SAMPLE RECEIVED:** 1/25/2023

DESCRIPTION OF SOIL: Various

TESTED BY: RC **DATE SETUP:** 1/25/2023

WEIGHED BY: DH **DATE OF WEIGHING:** 1/26/2023

BORING NO.	NBB-1	NBB-1	NBB-1	NBB-1	NBB-1
SAMPLE NO.	SS-3	SS-5	SS-6	SS-8	SS-10
SAMPLE DEPTH (FT.)	4.0 - 6.0	8.0 - 10.0	13.5 - 15.0	23.5 - 25.0	33.5 - 35.0
WATER CONTENT, W%	16.3	17.2	27.3	32.5	41.7

BORING NO.	NBB-1				
SAMPLE NO.	SS-11				
SAMPLE DEPTH (FT.)	38.5 - 40.0				
WATER CONTENT, W%	36.0				

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

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



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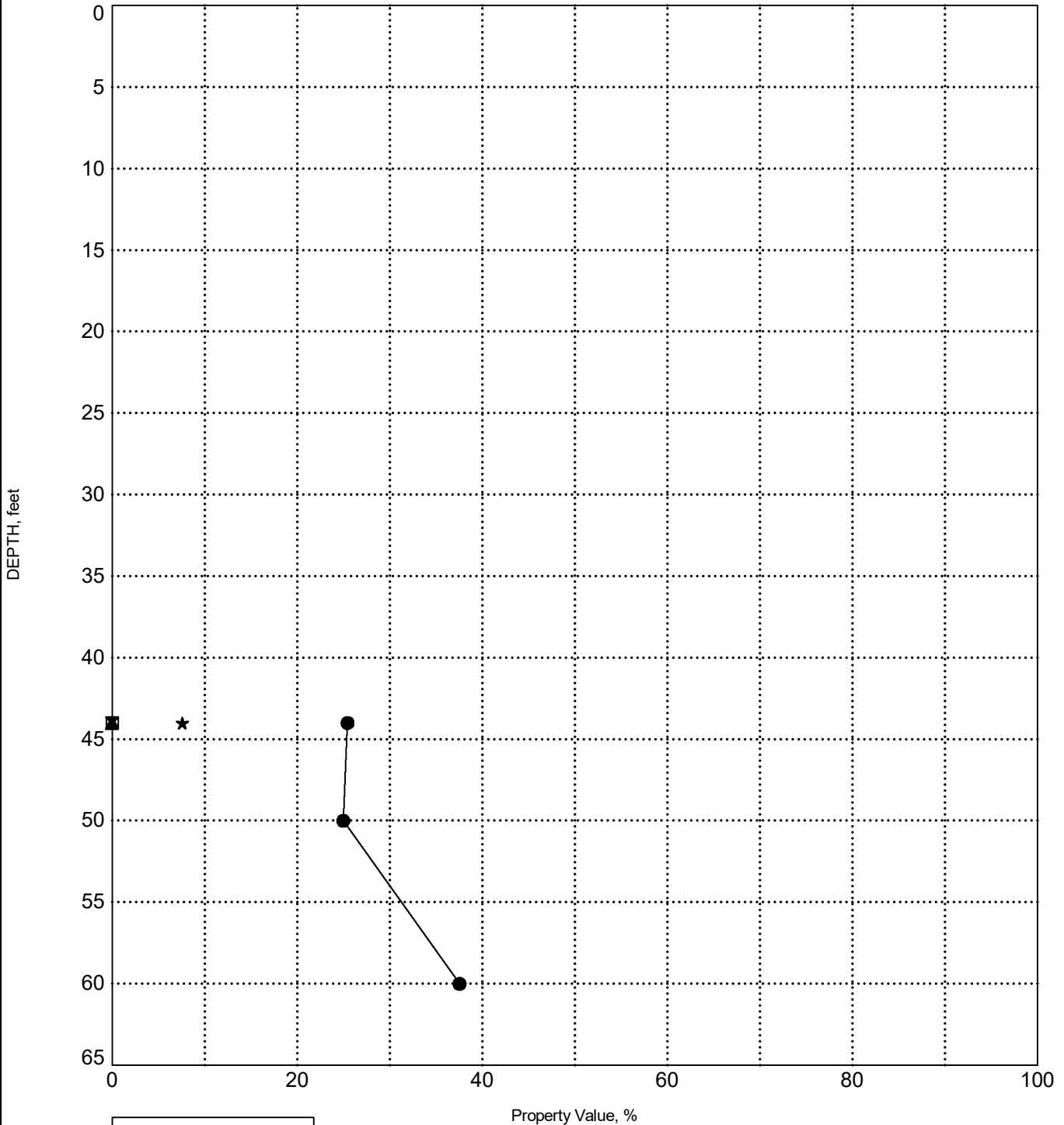
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P041233

PROJECT NAME US 123 NB over Georges Creek

PROJECT COUNTY Pickens

BORING NBB-2

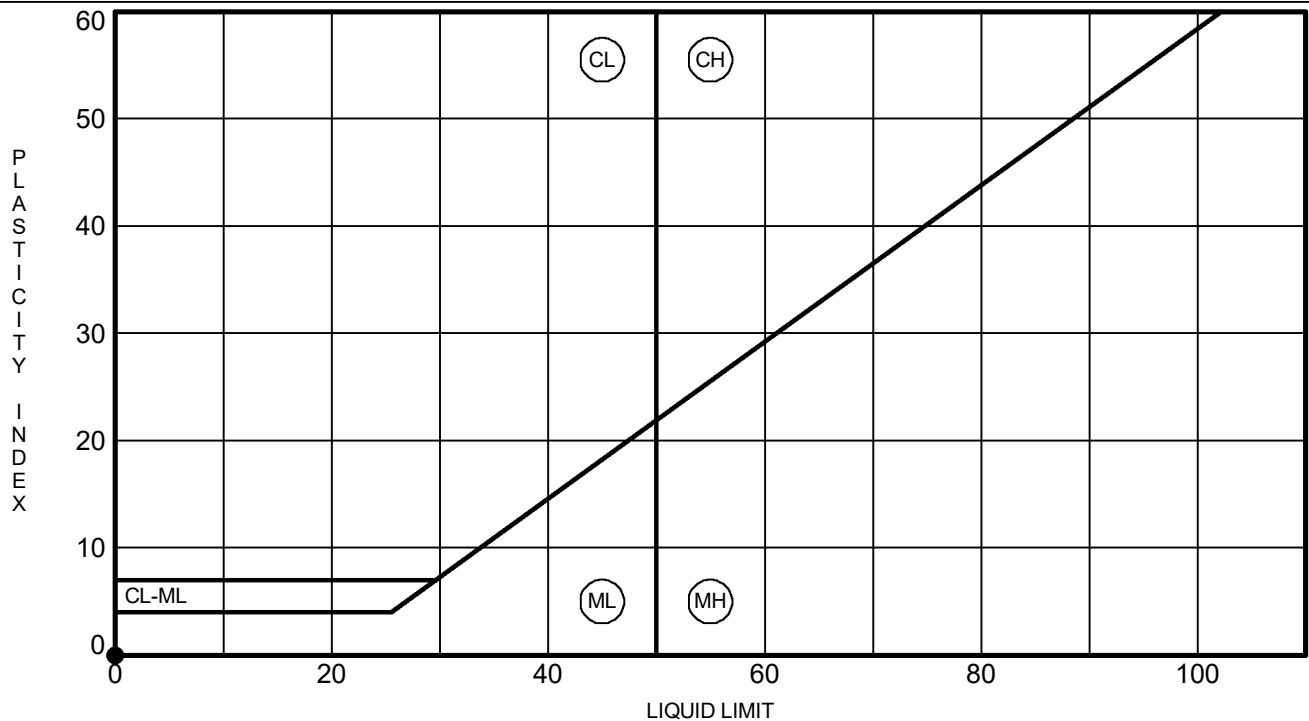


LEGEND	
●	Water Content
■	Plastic Limit
▲	Liquid Limit
★	Fines



PROJECT ID	P041233	PROJECT NAME	US 123 NB over Georges Creek
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PROJECT COUNTY Pickens

[illegible]

ATTERBERG LIMITS G6400.110 - US 123 NB OVER GEORGES CREEK.GPJ SCDOT DATA TEMPLATE 01 30 2015.GDT 2/7/23

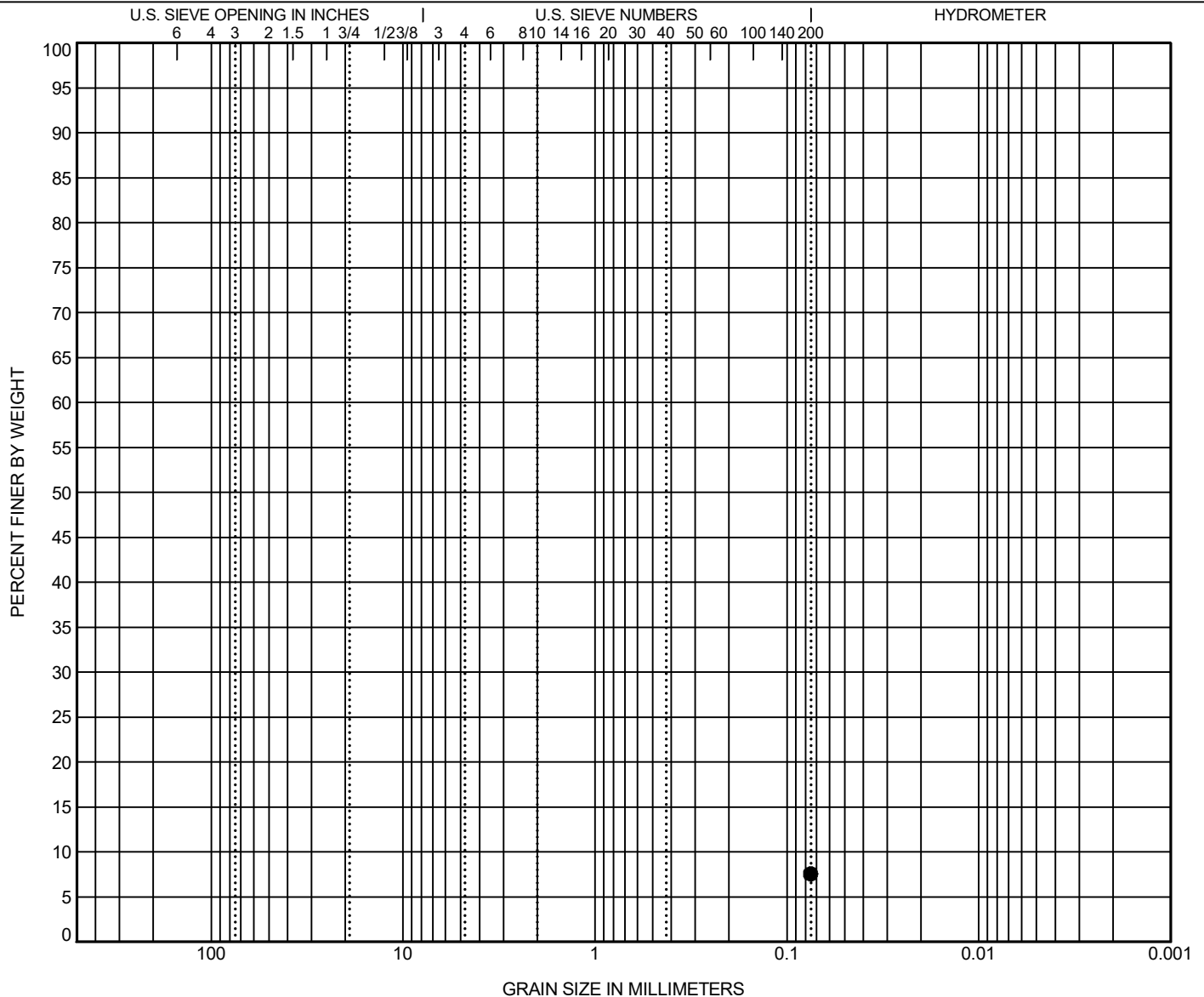


GRAIN SIZE DISTRIBUTION

PROJECT ID P041233

PROJECT NAME US 123 NB over Georges Creek

PROJECT COUNTY Pickens



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● NBB-2	44.0	POORLY GRADED SAND (SP/A-3) with SILT					NP	NP	NP		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay	
● NBB-2	44.0	0.075						7.6			

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: US 123 NB over Georges Creek **SCDOT PROJECT No.:** P041233
SAMPLE NUMBER: 23-0291 **DATE SAMPLE RECEIVED:** 1/30/2023
DESCRIPTION OF SOIL: Various
TESTED BY: RC **DATE SETUP:** 1/30/2023
WEIGHED BY: DH **DATE OF WEIGHING:** 1/31/2023

BORING NO.	NBB-2	NBB-2	NBB-2		
SAMPLE NO.	SS-1	SS-4	SS-6		
SAMPLE DEPTH (FT.)	42.0 - 44.0	48.0 - 50.0	55.5 - 57.0		
WATER CONTENT, W%	25.4	25.0	37.6		

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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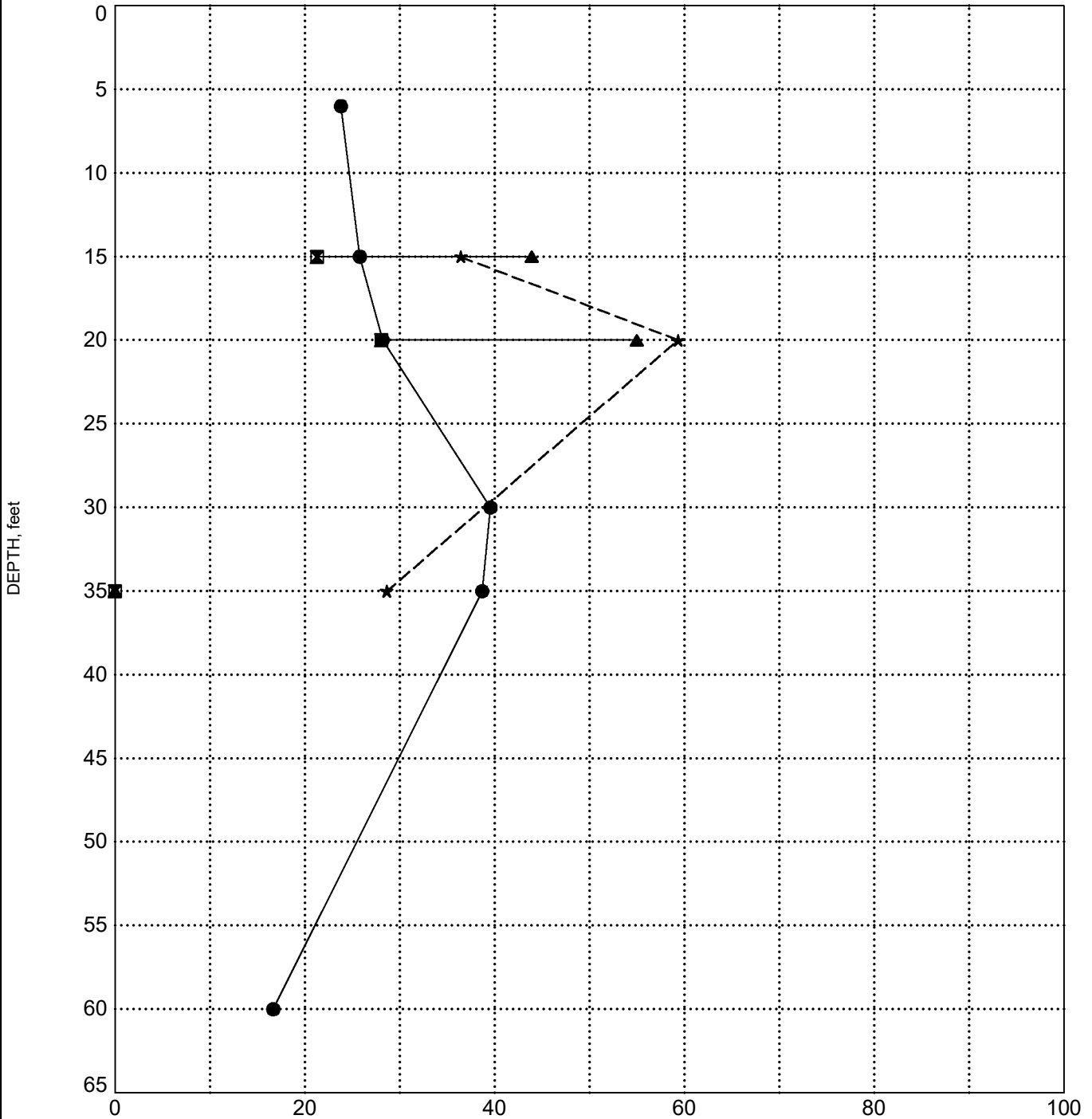
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P041233

PROJECT NAME US 123 NB over Georges Creek

PROJECT COUNTY Pickens

BORING NBB-3



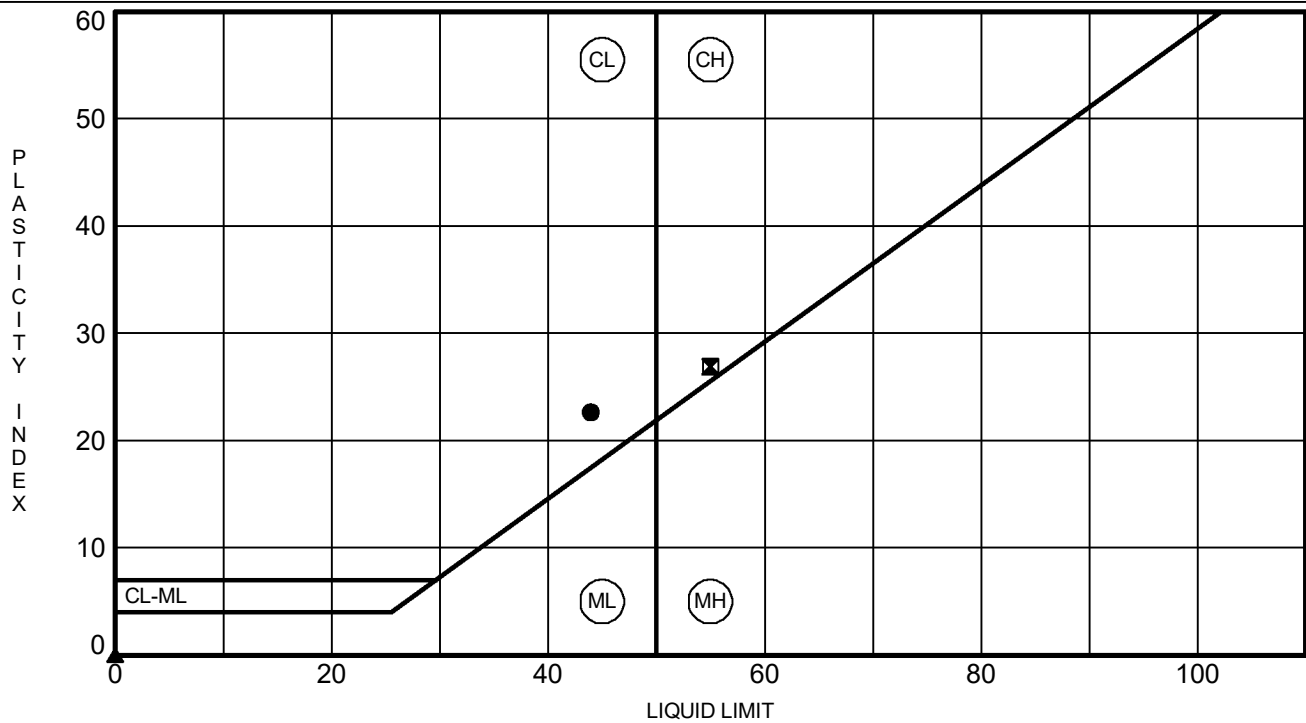
LEGEND	
●	Water Content
■	Plastic Limit
▲	Liquid Limit
★	Fines

ATTERBERG LIMITS' RESULTS

PROJECT ID P041233

PROJECT NAME US 123 NB over Georges Creek

PROJECT COUNTY Pickens

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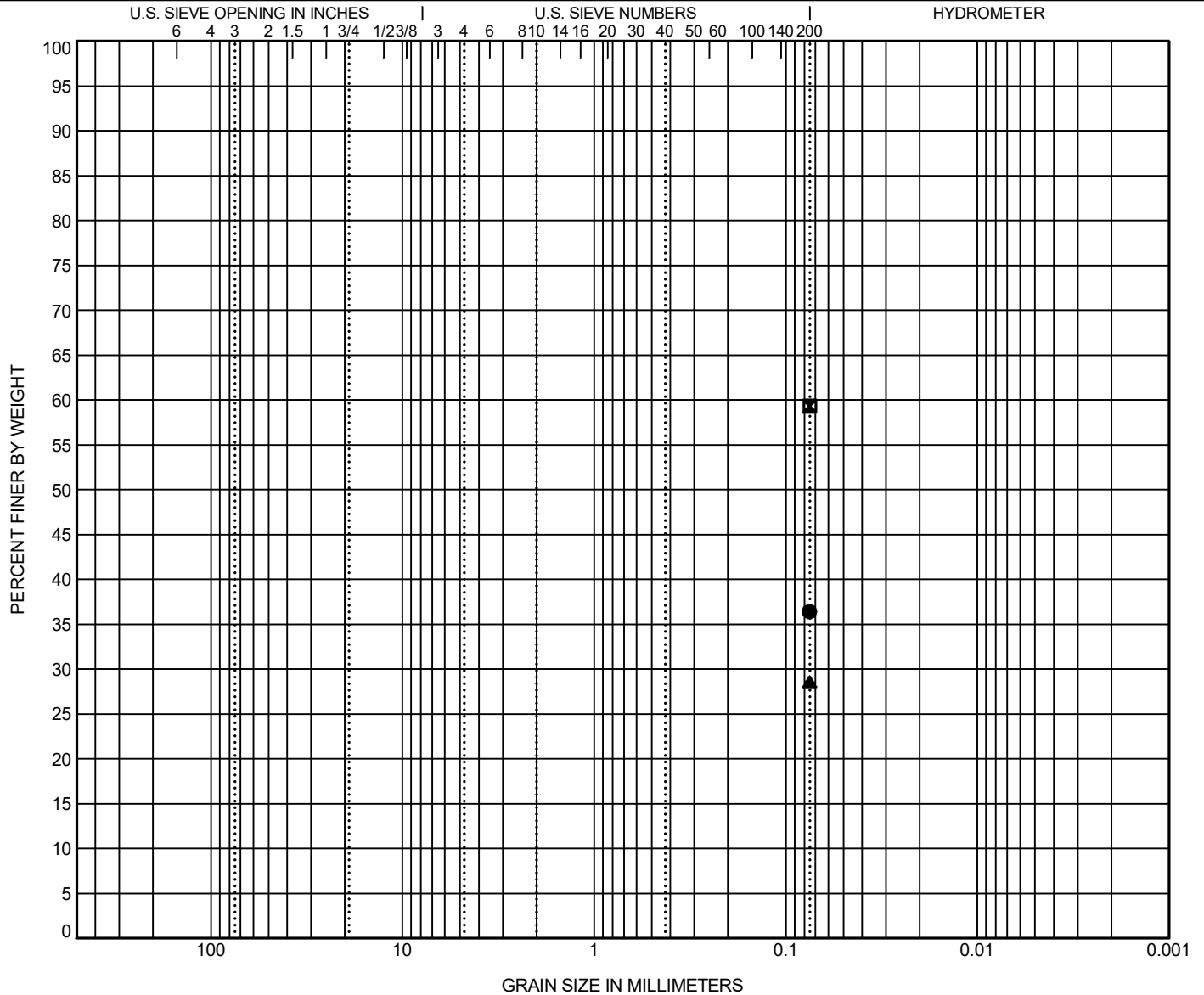


GRAIN SIZE DISTRIBUTION

PROJECT ID P041233

PROJECT NAME US 123 NB over Georges Creek

PROJECT COUNTY Pickens



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● NBB-3	15.0	CLAYEY SAND (SC/A-7-6)					44	21	23		
■ NBB-3	20.0	SANDY FAT CLAY (CH/A-7-6)					55	28	27		
▲ NBB-3	35.0	SILTY SAND (SM/A-2-4)					NP	NP	NP		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay	
● NBB-3	15.0	0.075						36.5			
■ NBB-3	20.0	0.075						59.3			
▲ NBB-3	35.0	0.075						28.6			

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: US 123 NB over Georges Creek **SCDOT PROJECT No.:** P041233
SAMPLE NUMBER: 23-0234 **DATE SAMPLE RECEIVED:** 1/25/2023
DESCRIPTION OF SOIL: Various
TESTED BY: RC **DATE SETUP:** 1/25/2023
WEIGHED BY: DH **DATE OF WEIGHING:** 1/26/2023

BORING NO.	NBB-3	NBB-3	NBB-3	NBB-3	NBB-3
SAMPLE NO.	SS-3	SS-6	SS-7	SS-9	SS-10
SAMPLE DEPTH (FT.)	4.0 - 6.0	13.5 - 15.0	18.5 - 20.0	28.5 - 30.0	33.5 - 35.0
WATER CONTENT, W%	23.8	25.8	28.2	39.6	38.7

BORING NO.	NBB-3				
SAMPLE NO.	SS-15				
SAMPLE DEPTH (FT.)	58.5 - 60.0				
WATER CONTENT, W%	16.7				

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

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



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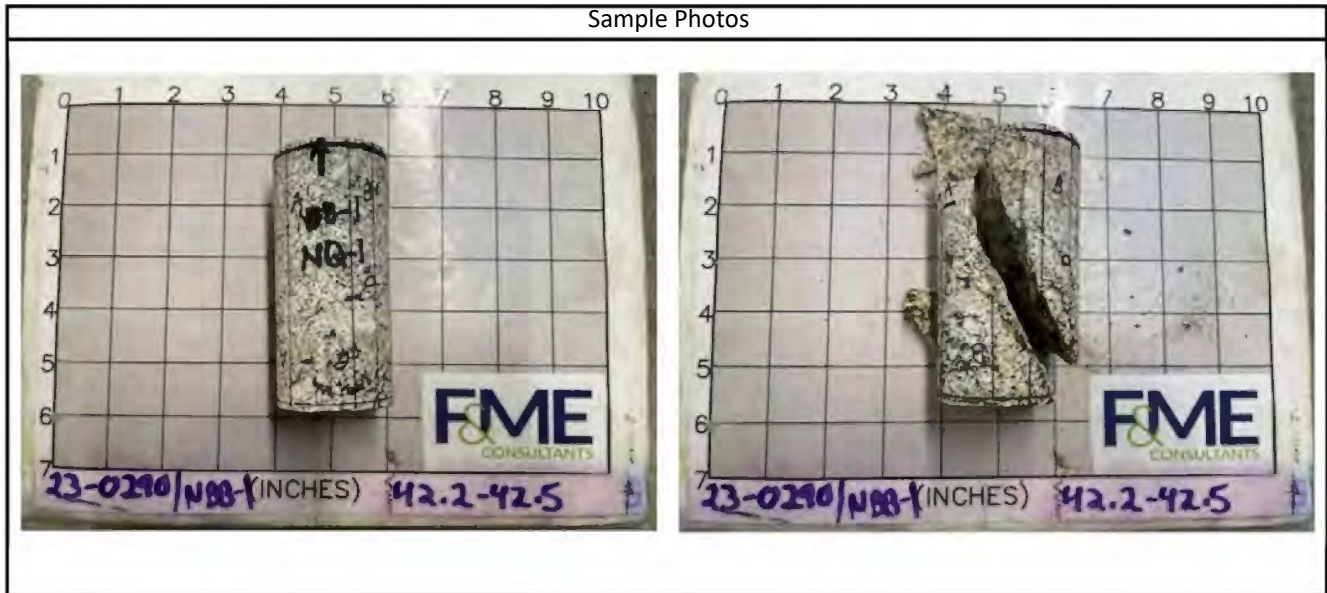
PROJECT ID P041233 PROJECT NAME US 123 NB over Georges Creek
PROJECT COUNTY Pickens

Borehole	Core Run Number	Core Run Top Depth	REC (%)	RQD (%)	qu (psi)	Poisson's Ratio	Elastic Modulus (ksi)	Unit Weight (pcf)	RMR	GSI
NBB-1	NQ-1	41.5	98	93	6,990	0.12	1,210	164	74	75
NBB-1	NQ-2	46.5	88	73	5,440	0.21	1,450	171	62	70
NBB-2	NQ-1	73.0	56	23	4,300	0.29	1,160	163	47	45
NBB-2	NQ-2	76.6	88	65	5,170	0.11	3,270	171	85	70
NBB-2	NQ-3	81.6	100	98	12,950	0.15	4,300	168	85	80
NBB-2	NQ-4	86.6	100	100	N/A	N/A	N/A	N/A	85	80
NBB-3	NQ-1	88.5	100	100	10,220	0.15	3,230	180	75	85
NBB-3	NQ-2	93.5	100	100	19,500	0.15	6,080	182	80	85

Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	US 123 NB RBO Georges Creek			Date	2/6/2023
Project No.	G6400.110	Sample Diameter (in.)	1.869	Tested By	WAP
SCDOT ID	P041233	Sample Length (in.)	4.19	Reviewed By	WJG
Boring	NBB-1	Unit Weight (pcf)	164.4	Core Size	NQ
Sample No.	NQ-1 / 23-0235A	L/D Ratio	2.24	Recovery	98%
Depth	42.2' - 42.5'	Load Rate (psi/sec)	20	RQD	93%
Description	Black/White/Gray Biotite Gneiss				

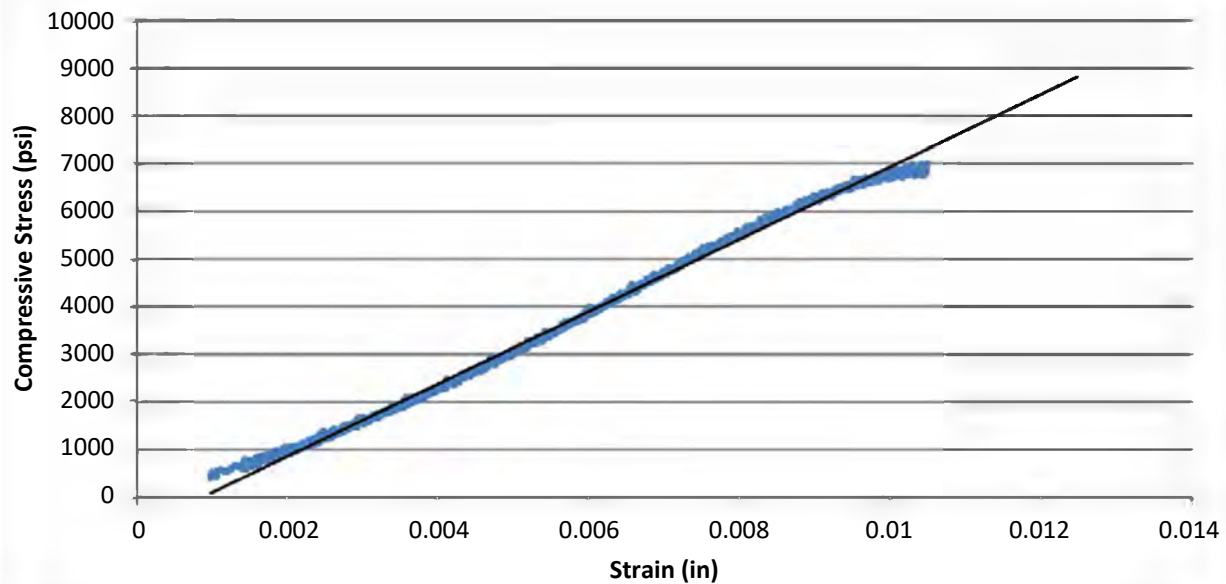
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-1486	111	1,967	717	0.97	0.07
20%	-2720	220	3,830	1,396	1.03	0.08
30%	-3720	353	5,748	2,095	1.13	0.09
40%	-4736	529	7,696	2,805	1.18	0.11
50%	-5579	743	9,578	3,491	1.25	0.13
60%	-6422	1031	11,573	4,218	1.31	0.16
70%	-7256	1447	13,487	4,916	1.36	0.20
80%	-8076	2083	15,323	5,585	1.38	0.26
90%	-9065	2576	17,294	6,303	1.39	0.28
100%	-10481	3525	19,172	6,988		



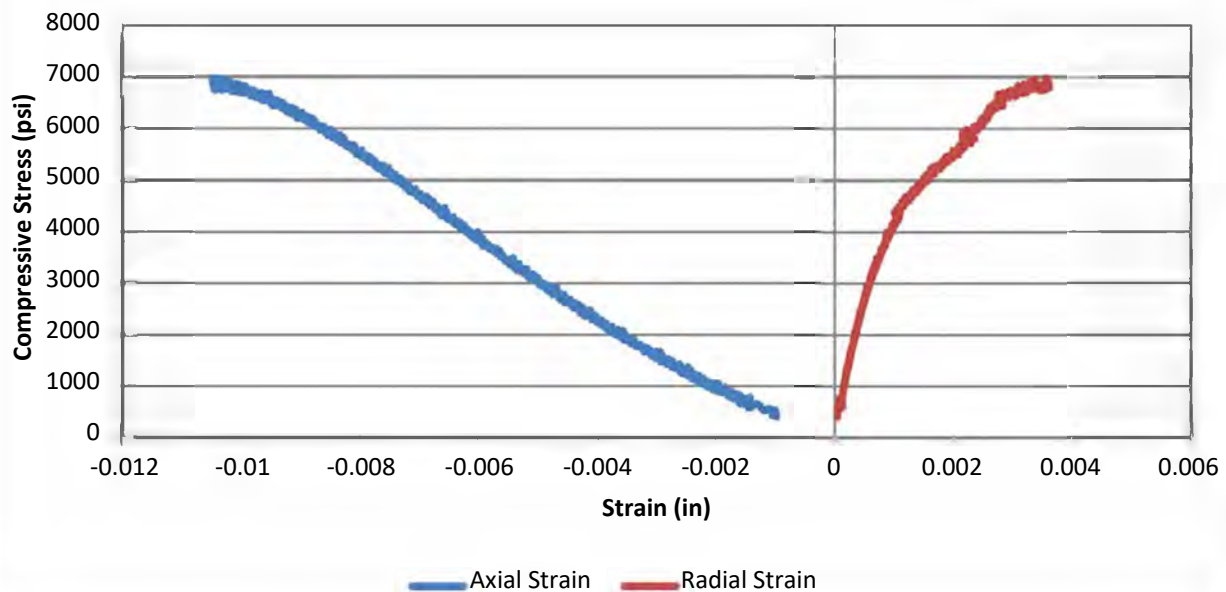
Test Results			
Unconfined Compressive Strength (psi)		6,990	Elastic Modulus (psi)
			1.21E+06
			Poisson's Ratio in Elastic Range
			0.12
Comments	Elastic range was taken as between 0.003 and 0.007 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	US 123 NB RBO Georges Creek			Date	2/6/2023
Project No.	G6400.110	Sample Diameter (in.)	1.869	Tested By	WAP
SCDOT ID	P041233	Sample Length (in.)	4.19	Reviewed By	WJG
Boring	NBB-1	Unit Weight (pcf)	164.4	Core Size	NQ
Sample No.	NQ-1 / 23-0235A	L/D Ratio	2.24	Recovery	98%
Depth	42.2' - 42.5'	Load Rate (psi/sec)	20	RQD	93%
Description	Black/White/Gray Biotite Gneiss				

Axial Stress vs. Strain



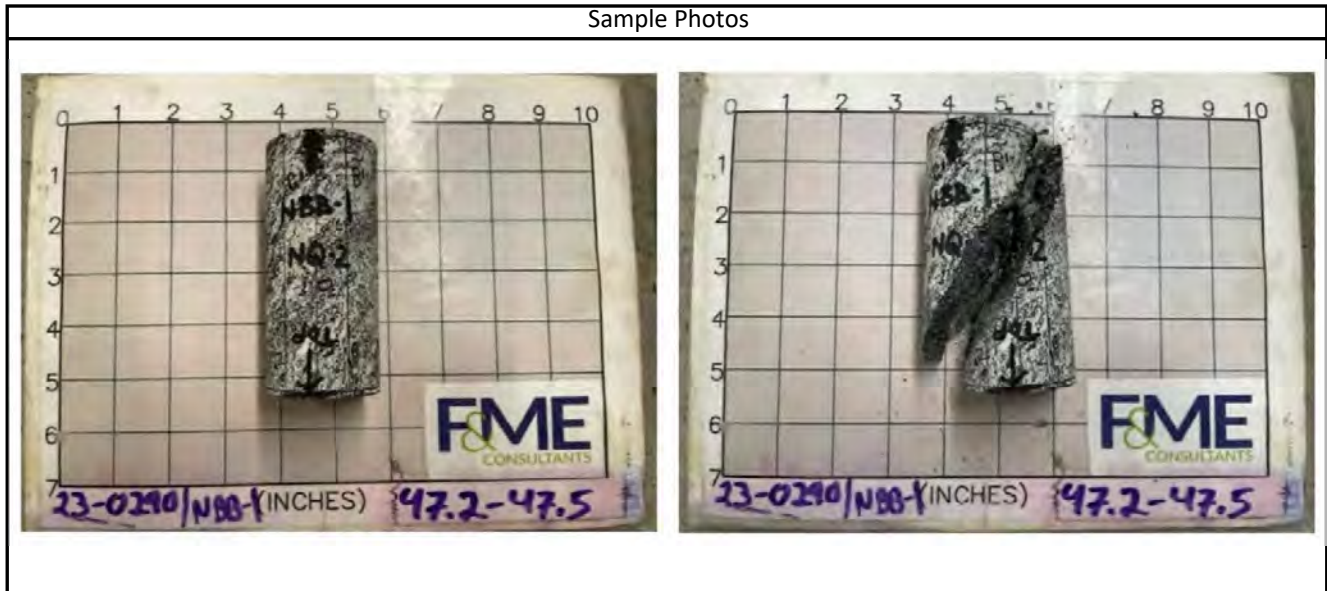
Stress vs. Strain



Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	US 123 NB RBO Georges Creek			Date	2/6/2023
Project No.	G6400.110	Sample Diameter (in.)	1.868	Tested By	WAP
SCDOT ID	P041233	Sample Length (in.)	4.204	Reviewed By	WJG
Boring	NBB-1	Unit Weight (pcf)	171.3	Core Size	NQ
Sample No.	NQ-2 / 23-0235B	L/D Ratio	2.25	Recovery	88%
Depth	47.2' - 47.5'	Load Rate (psi/sec)	20	RQD	73%
Description	Black/White/Gray Biotite Gneiss				

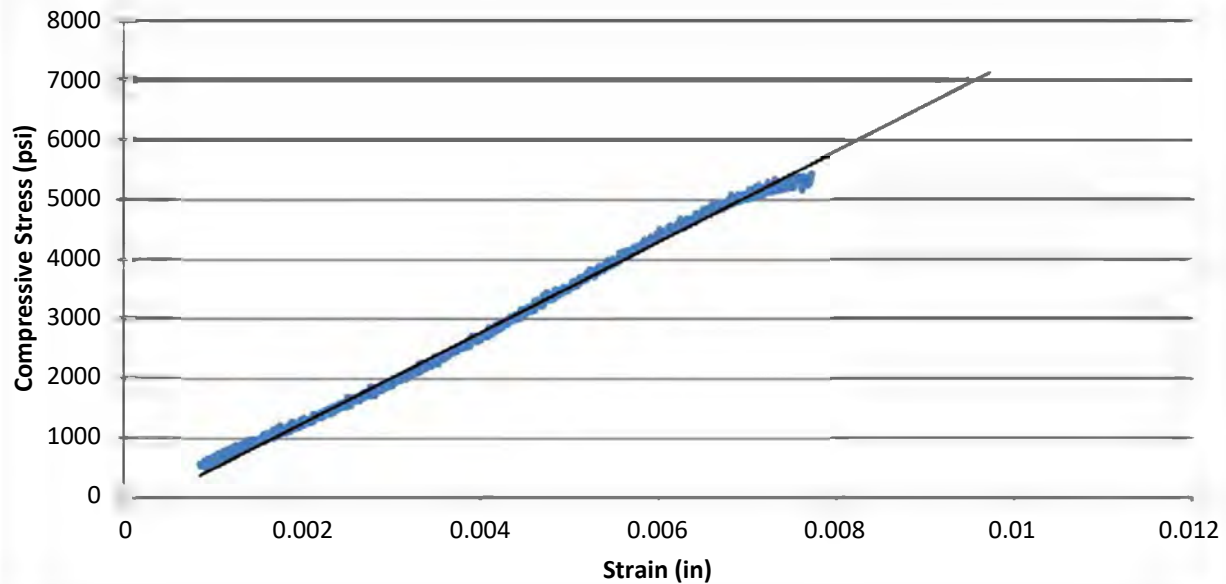
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-922	270	1,450	529	1.15	0.29
20%	-1713	328	2,936	1,071	1.25	0.19
30%	-2597	459	4,471	1,631	1.26	0.18
40%	-3290	588	5,955	2,173	1.32	0.18
50%	-4057	765	7,464	2,723	1.34	0.19
60%	-4685	944	8,939	3,262	1.39	0.20
70%	-5360	1178	10,483	3,825	1.43	0.22
80%	-6003	1447	11,933	4,354	1.45	0.24
90%	-6712	1792	13,420	4,897	1.46	0.27
100%	-7727	2609	14,904	5,438		



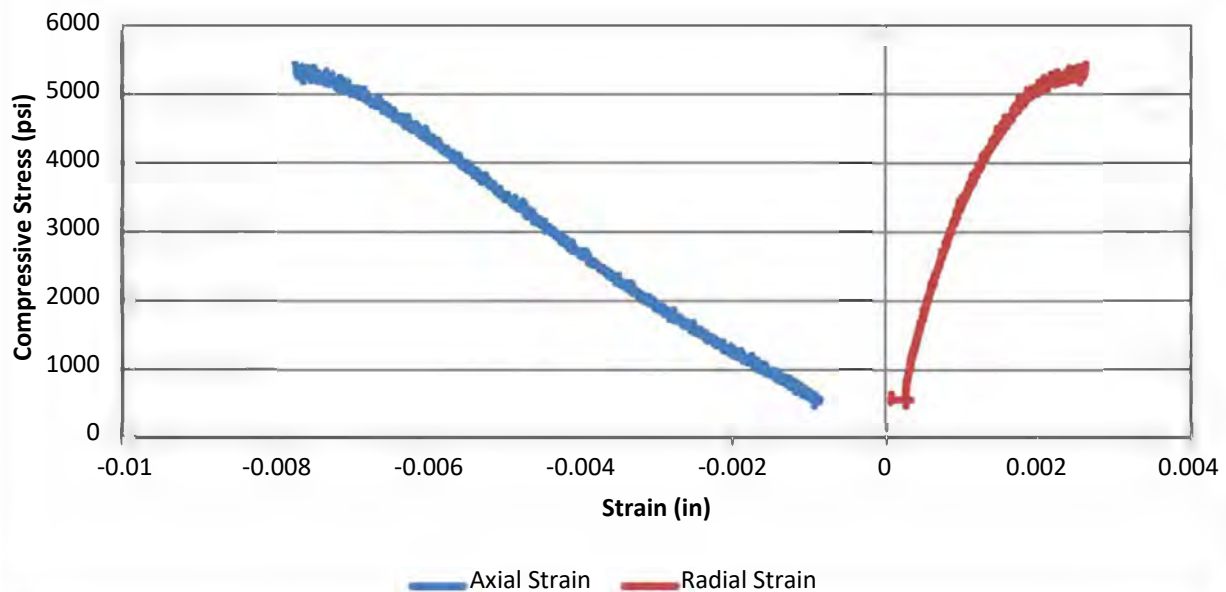
Test Results			
Unconfined Compressive Strength (psi)		5,440	Elastic Modulus (psi)
			1.45E+06
			Poisson's Ratio in Elastic Range
			0.21
Comments	Elastic range was taken as between 0.002 and 0.005 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	US 123 NB RBO Georges Creek			Date	2/6/2023
Project No.	G6400.110	Sample Diameter (in.)	1.868	Tested By	WAP
SCDOT ID	P041233	Sample Length (in.)	4.204	Reviewed By	WJG
Boring	NBB-1	Unit Weight (pcf)	171.3	Core Size	NQ
Sample No.	NQ-2 / 23-0235B	L/D Ratio	2.25	Recovery	88%
Depth	47.2' - 47.5'	Load Rate (psi/sec)	20	RQD	73%
Description	Black/White/Gray Biotite Gneiss				

Axial Stress vs. Strain



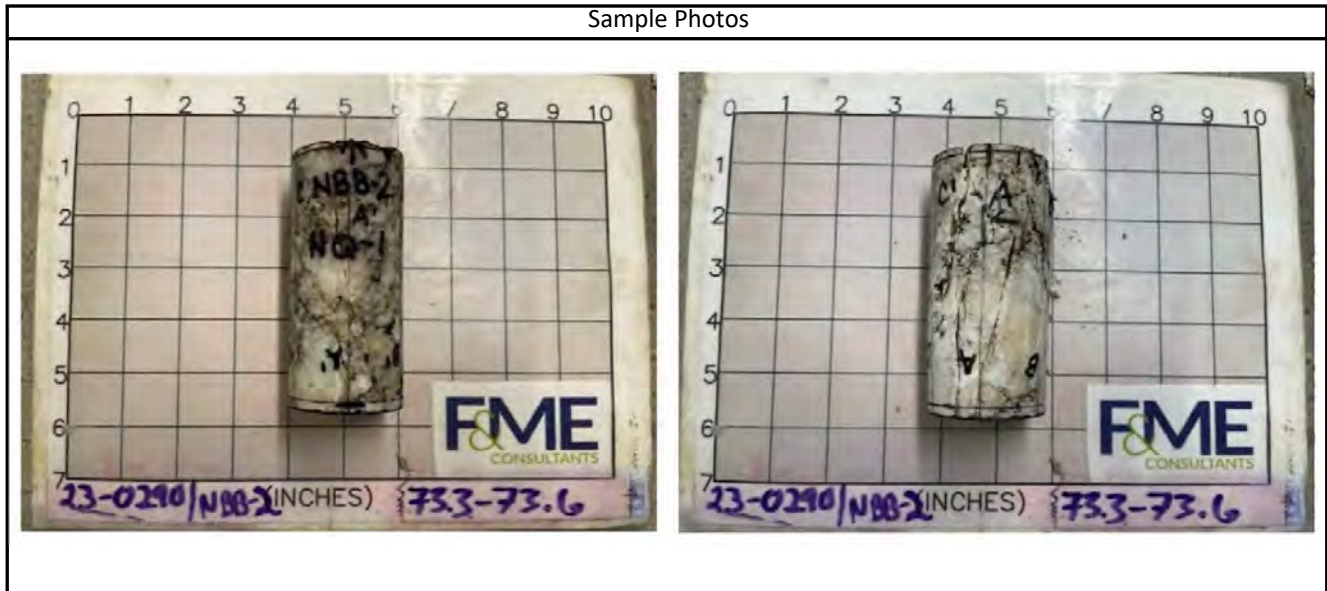
Stress vs. Strain



Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	US 123 NB RBO Georges Creek			Date	2/6/2023
Project No.	G6400.110	Sample Diameter (in.)	1.868	Tested By	WAP
SCDOT ID	P041233	Sample Length (in.)	4.248	Reviewed By	WJG
Boring	NBB-2	Unit Weight (pcf)	162.7	Core Size	NQ
Sample No.	NQ-1 / 23-0291A	L/D Ratio	2.27	Recovery	56%
Depth	73.3' - 73.6'	Load Rate (psi/sec)	10	RQD	23%
Description	Black/White/Gray Biotite Gneiss				

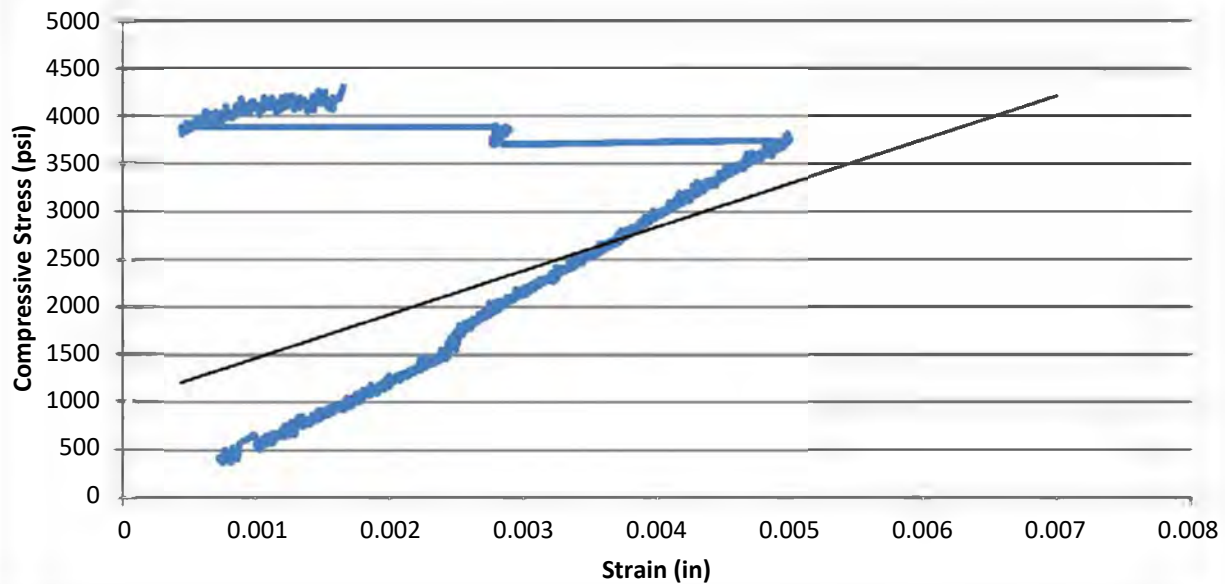
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-781	116	1,180	430	1.10	0.15
20%	-1449	421	2,365	863	1.19	0.29
30%	-2097	769	3,551	1,296	1.24	0.37
40%	-2523	1207	4,756	1,735	1.38	0.48
50%	-2974	1645	5,861	2,139	1.44	0.55
60%	-3582	2068	7,061	2,576	1.44	0.58
70%	-4061	2533	8,256	3,012	1.48	0.62
80%	-4584	3216	9,457	3,451	1.51	0.70
90%	-486	4370	10,632	3,879	15.98	9.00
100%	-1658	7873	11,797	4,305		



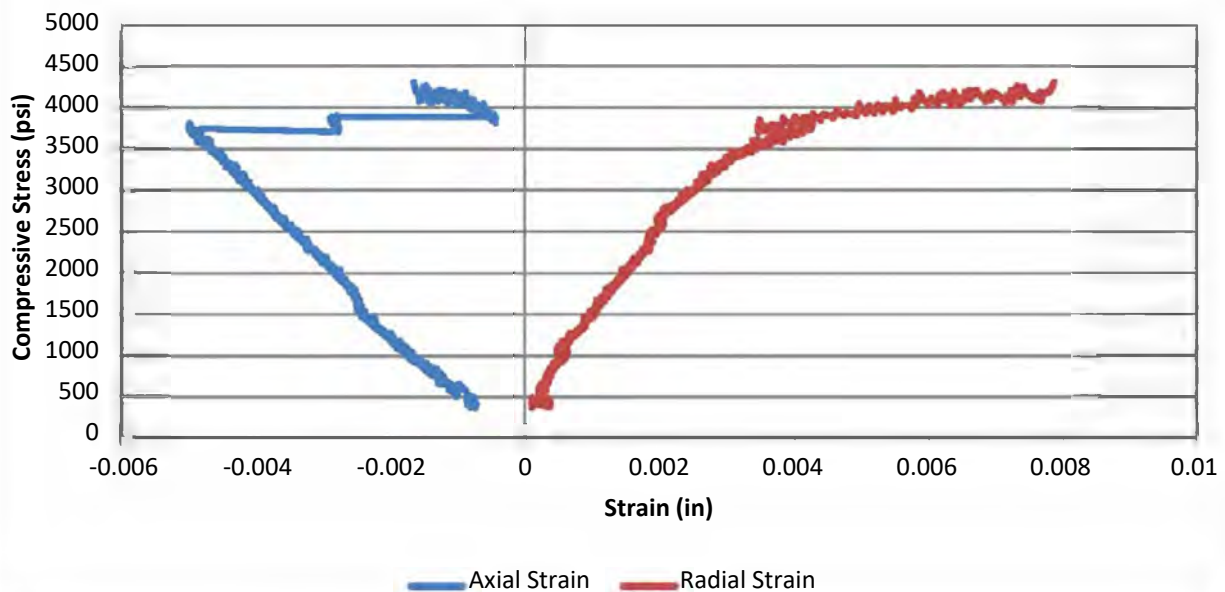
Test Results			
Unconfined Compressive Strength (psi)		4,300	Elastic Modulus (psi)
			1.16E+06
			Poisson's Ratio in Elastic Range
			0.29
Comments	Elastic range was taken as between 0.001 and 0.002 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range. Sample suffered a partial failure around 1,500 psi and 3,600 psi.		

Project	US 123 NB RBO Georges Creek			Date	2/6/2023
Project No.	G6400.110	Sample Diameter (in.)	1.868	Tested By	WAP
SCDOT ID	P041233	Sample Length (in.)	4.248	Reviewed By	WJG
Boring	NBB-2	Unit Weight (pcf)	162.7	Core Size	NQ
Sample No.	NQ-1 / 23-0291A	L/D Ratio	2.27	Recovery	56%
Depth	73.3' - 73.6'	Load Rate (psi/sec)	10	RQD	23%
Description	Black/White/Gray Biotite Gneiss				

Axial Stress vs. Strain



Stress vs. Strain

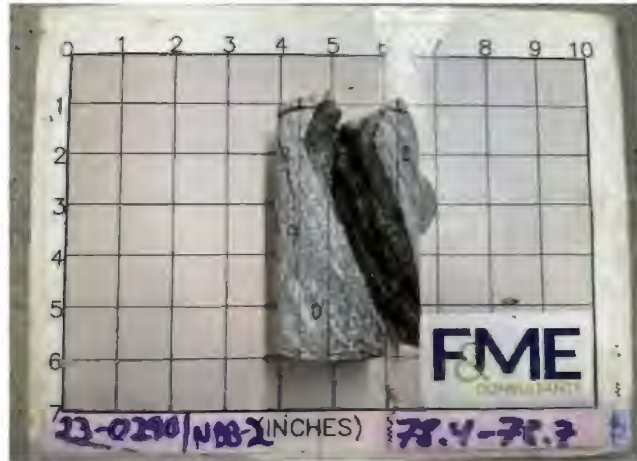


Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	US 123 NB RBO Georges Creek			Date	2/6/2023
Project No.	G6400.110	Sample Diameter (in.)	1.867	Tested By	WAP
SCDOT ID	P041233	Sample Length (in.)	4.207	Reviewed By	WJG
Boring	NBB-2	Unit Weight (pcf)	171.3	Core Size	NQ
Sample No.	NQ-2 / 23-0291B	L/D Ratio	2.25	Recovery	88%
Depth	78.4' - 78.7'	Load Rate (psi/sec)	20	RQD	65%
Description	Black/White/Gray Biotite Gneiss				

Test Data						
Percent of Failure Load	Strain (10 ⁻⁶)		Load (lbs)	Compressive Stress (psi)	Secant Modulus x10 ⁶ (psi)	Poisson's Ratio
	Axial	Radial				
10%	Sample Preload Range					
20%	-684	22	2,812	1,027	3.00	0.03
30%	-1000	72	4,259	1,556	3.11	0.07
40%	-1296	123	5,676	2,073	3.20	0.09
50%	-1575	176	7,043	2,572	3.27	0.11
60%	-1829	231	8,473	3,095	3.39	0.13
70%	-2155	309	9,897	3,615	3.36	0.14
80%	-2457	383	11,303	4,129	3.36	0.16
90%	-2855	515	12,723	4,647	3.26	0.18
100%	-3286	890	14,141	5,166		

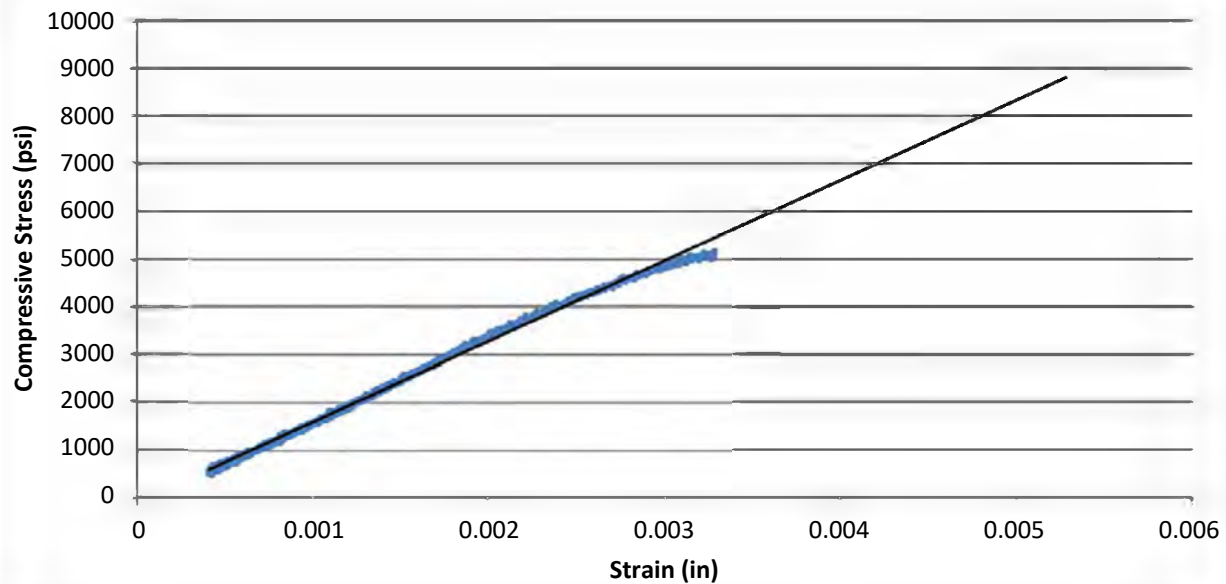
Sample Photos



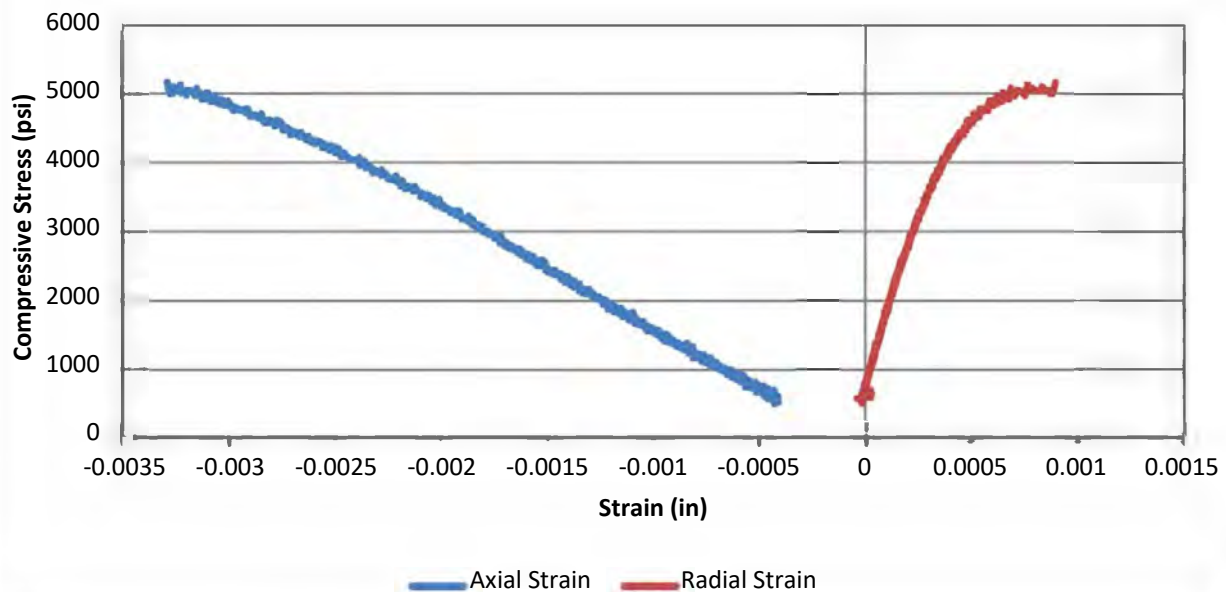
Test Results				
Unconfined Compressive Strength (psi)		5,170	Elastic Modulus (psi)	3.27E+06
			Poisson's Ratio in Elastic Range	0.11
Comments	Elastic range was taken as between 0.001 and 0.002 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.			

Project	US 123 NB RBO Georges Creek			Date	2/6/2023
Project No.	G6400.110	Sample Diameter (in.)	1.867	Tested By	WAP
SCDOT ID	P041233	Sample Length (in.)	4.207	Reviewed By	WJG
Boring	NBB-2	Unit Weight (pcf)	171.3	Core Size	NQ
Sample No.	NQ-2 / 23-0291B	L/D Ratio	2.25	Recovery	88%
Depth	78.4' - 78.7'	Load Rate (psi/sec)	20	RQD	65%
Description	Black/White/Gray Biotite Gneiss				

Axial Stress vs. Strain



Stress vs. Strain

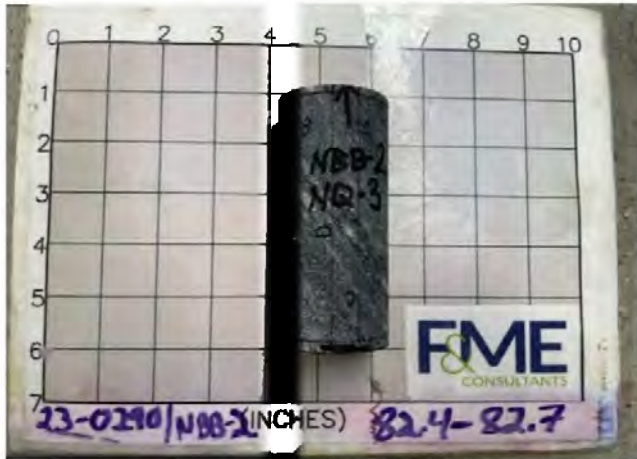


Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	US 123 NB RBO Georges Creek			Date	2/6/2023
Project No.	G6400.110	Sample Diameter (in.)	1.867	Tested By	WAP
SCDOT ID	P041233	Sample Length (in.)	4.231	Reviewed By	WJG
Boring	NBB-2	Unit Weight (pcf)	167.7	Core Size	NQ
Sample No.	NQ-3 / 23-0291C	L/D Ratio	2.27	Recovery	100%
Depth	82.4' - 82.7'	Load Rate (psi/sec)	20	RQD	98%
Description	Black/White/Gray Biotite Gneiss				

Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-771	37	3,479	1,271	3.30	0.05
20%	-1353	142	7,043	2,573	3.80	0.10
30%	-1861	252	10,614	3,877	4.17	0.14
40%	-2313	366	14,168	5,175	4.47	0.16
50%	-2733	494	17,778	6,494	4.75	0.18
60%	-3110	633	21,280	7,773	5.00	0.20
70%	-3490	815	24,888	9,091	5.21	0.23
80%	-3855	1055	28,366	10,361	5.38	0.27
90%	-4210	1407	31,838	11,630	5.52	0.33
100%	-4586	2642	35,461	12,953		

Sample Photos

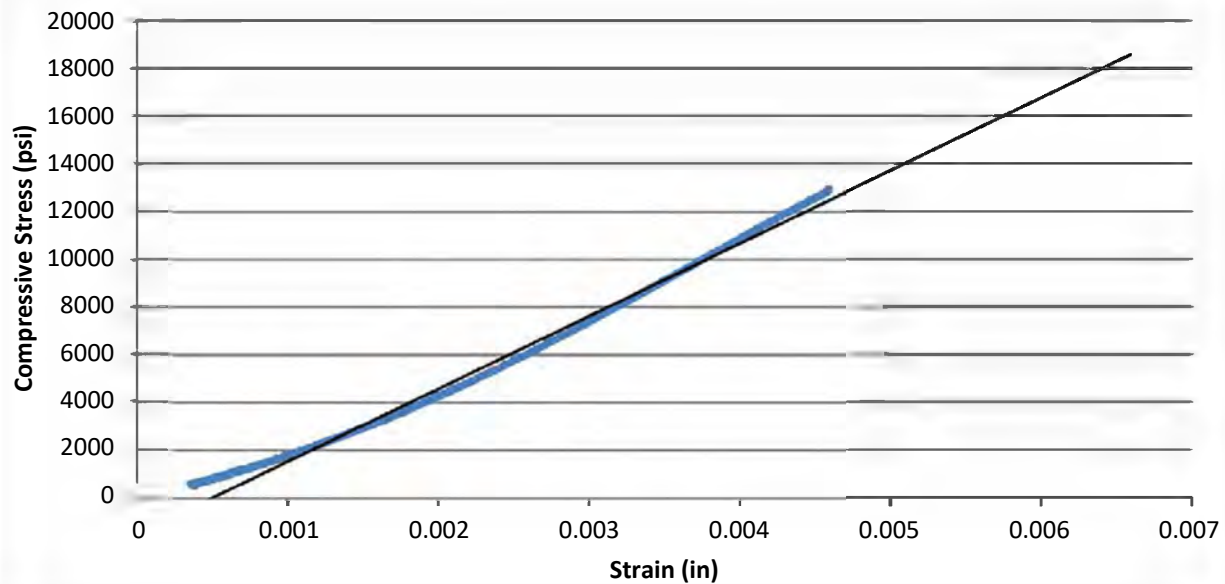


Test Results

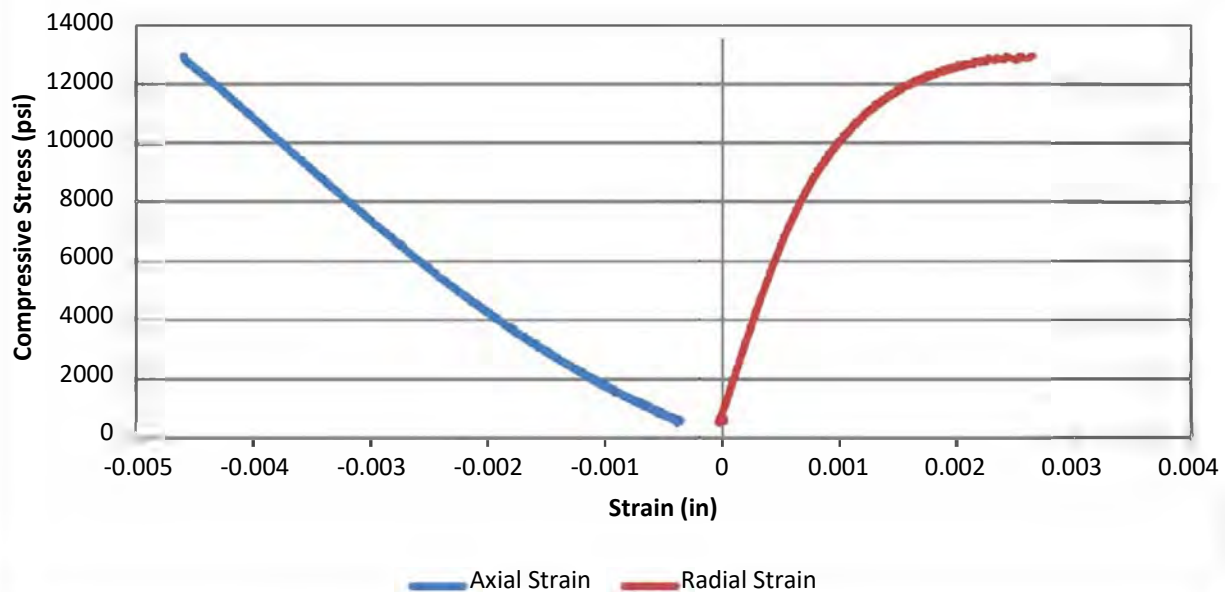
Unconfined Compressive Strength (psi)		12,950	Elastic Modulus (psi)	4.30E+06
			Poisson's Ratio in Elastic Range	0.15
Comments	Elastic range was taken as between 0.001 and 0.003 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.			

Project	US 123 NB RBO Georges Creek			Date	2/6/2023
Project No.	G6400.110	Sample Diameter (in.)	1.867	Tested By	WAP
SCDOT ID	P041233	Sample Length (in.)	4.231	Reviewed By	WJG
Boring	NBB-2	Unit Weight (pcf)	167.7	Core Size	NQ
Sample No.	NQ-3 / 23-0291C	L/D Ratio	2.27	Recovery	100%
Depth	82.4' - 82.7'	Load Rate (psi/sec)	20	RQD	98%
Description	Black/White/Gray Biotite Gneiss				

Axial Stress vs. Strain



Stress vs. Strain

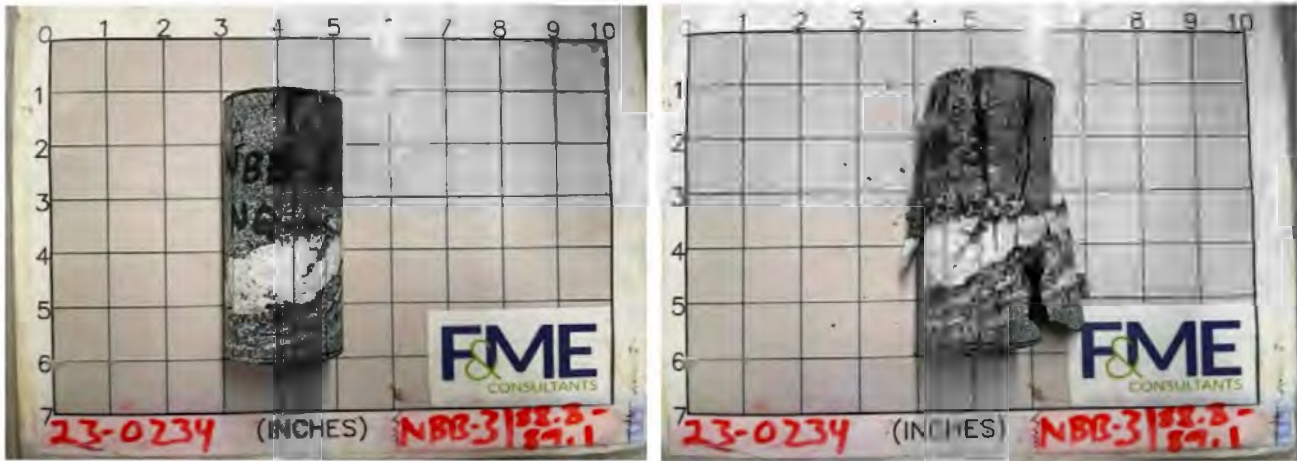


Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	US 123 NB RBO Georges Creek			Date	1/27/2023
Project No.	G6400.110	Sample Diameter (in.)	1.868	Tested By	WAP
SCDOT ID	P041233	Sample Length (in.)	4.116	Reviewed By	WJG
Boring	NBB-3	Unit Weight (pcf)	179.8	Core Size	NQ
Sample No.	NQ-1 / 23-0234A	L/D Ratio	2.20	Recovery	100%
Depth	88.8' - 89.1'	Load Rate (psi/sec)	20	RQD	100%
Description	Black/White/Gray Biotite Gneiss				

Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-949	94	2,828	1,032	2.18	0.10
20%	-1601	191	5,669	2,069	2.58	0.12
30%	-2115	289	8,435	3,078	2.91	0.14
40%	-2547	385	11,257	4,108	3.23	0.15
50%	-2940	488	14,003	5,109	3.48	0.17
60%	-3320	597	16,808	6,133	3.69	0.18
70%	-3681	713	19,608	7,155	3.89	0.19
80%	-4031	845	22,404	8,175	4.06	0.21
90%	-4369	1007	25,227	9,205	4.21	0.23
100%	-8084	1416	28,003	10,218		

Sample Photos

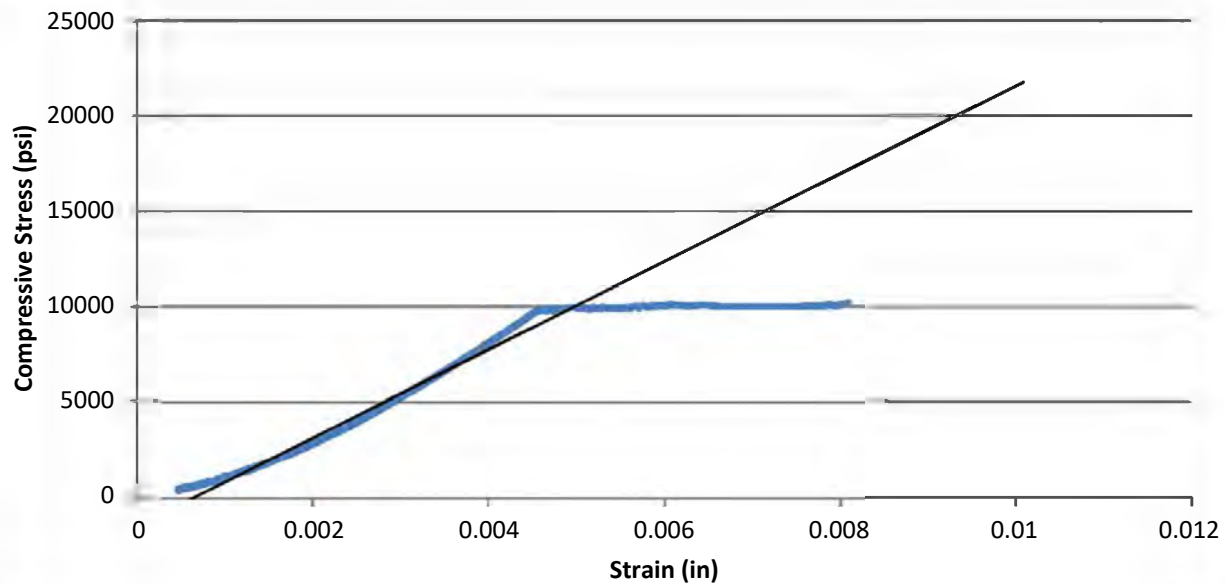


Test Results

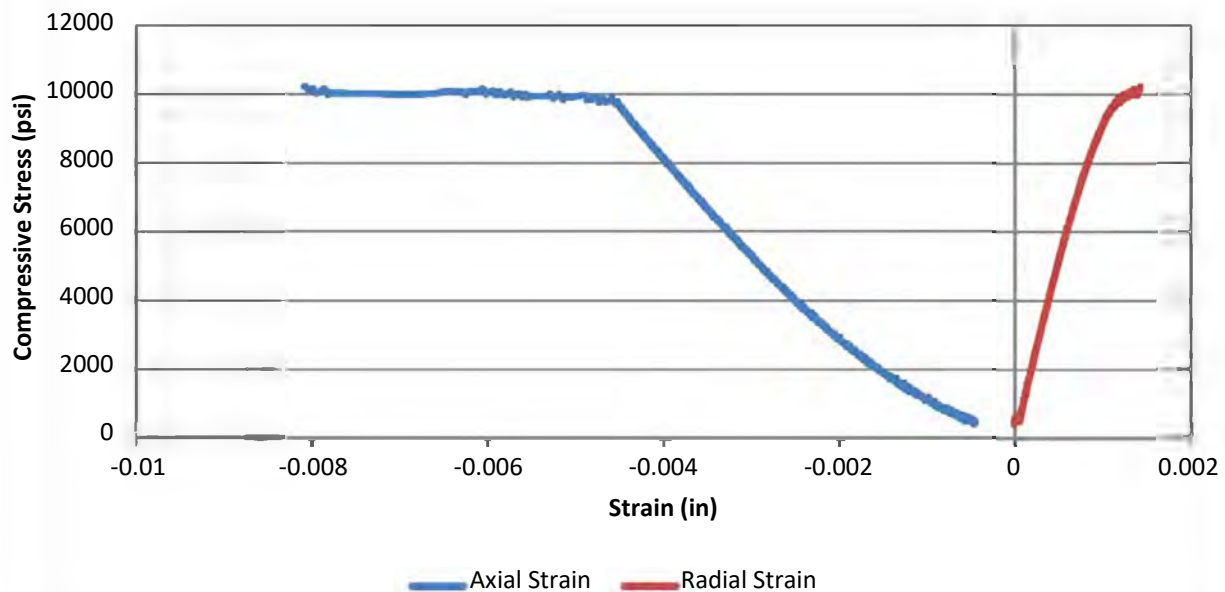
Unconfined Compressive Strength (psi)		10,220	Elastic Modulus (psi)	3.23E+06
			Poisson's Ratio in Elastic Range	0.15
Comments	Elastic range was taken as between 0.0015 and 0.0035 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.			

Project	US 123 NB RBO Georges Creek			Date	1/27/2023
Project No.	G6400.110	Sample Diameter (in.)	1.868	Tested By	WAP
SCDOT ID	P041233	Sample Length (in.)	4.116	Reviewed By	WJG
Boring	NBB-3	Unit Weight (pcf)	179.8	Core Size	NQ
Sample No.	NQ-1 / 23-0234A	L/D Ratio	2.20	Recovery	100%
Depth	88.8' - 89.1'	Load Rate (psi/sec)	20	RQD	100%
Description	Black/White/Gray Biotite Gneiss				

Axial Stress vs. Strain



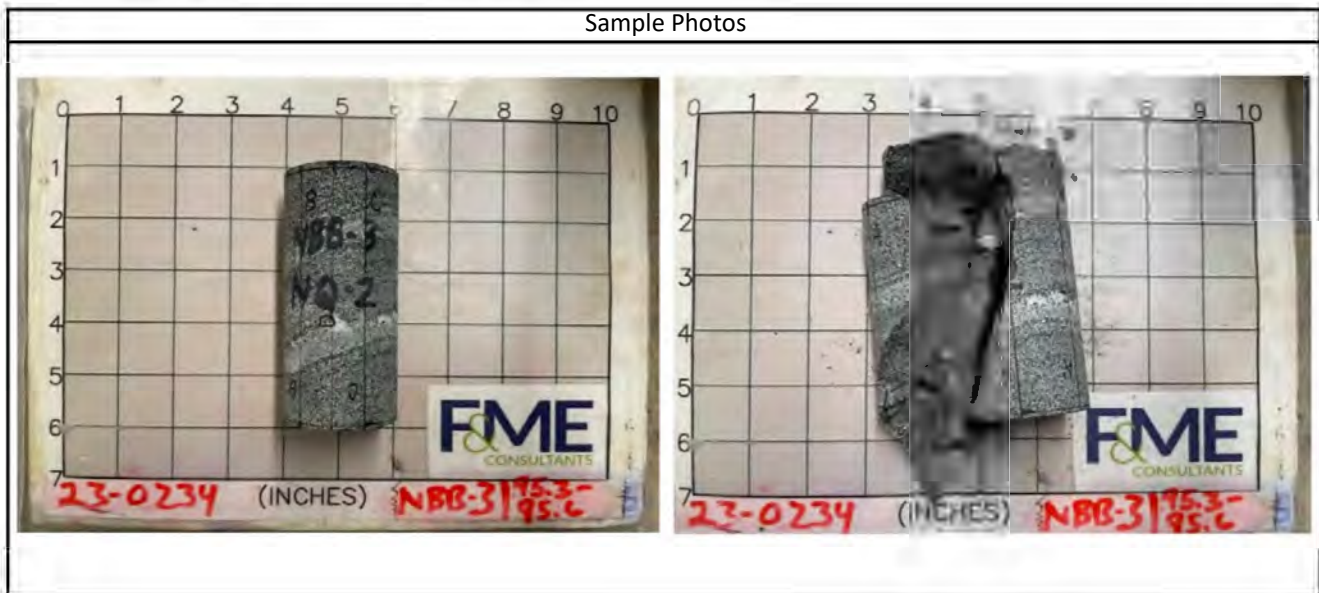
Stress vs. Strain



Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
ASTM D7012 - Method D / SC-T-39

Project	US 123 NB RBO Georges Creek			Date	1/27/2023
Project No.	G6400.110	Sample Diameter (in.)	1.868	Tested By	WAP
SCDOT ID	P041233	Sample Length (in.)	4.149	Reviewed By	WJG
Boring	NBB-3	Unit Weight (pcf)	181.8	Core Size	NQ
Sample No.	NQ-2 / 23-0234B	L/D Ratio	2.22	Recovery	100%
Depth	95.3' - 95.6'	Load Rate (psi/sec)	20	RQD	100%
Description	Black/White/Gray Biotite Gneiss				

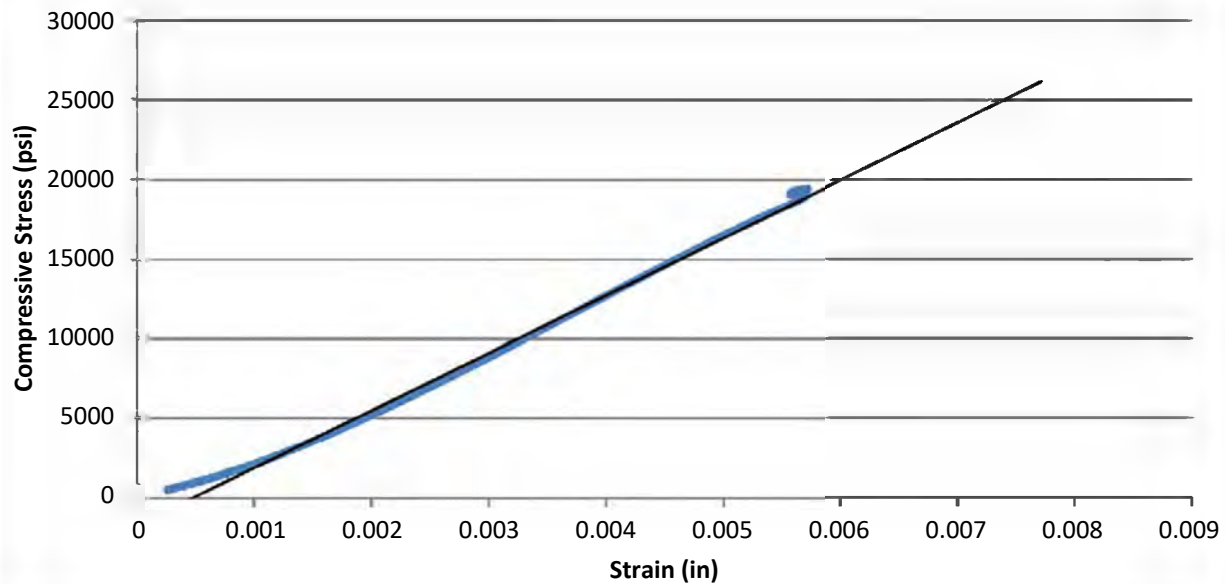
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-928	94	5,348	1,951	4.20	0.10
20%	-1588	173	10,635	3,880	4.89	0.11
30%	-2191	263	16,159	5,896	5.38	0.12
40%	-2721	359	21,387	7,804	5.74	0.13
50%	-3237	462	26,756	9,763	6.03	0.14
60%	-3739	578	32,036	11,690	6.25	0.15
70%	-4249	706	37,446	13,663	6.43	0.17
80%	-4746	861	42,736	15,594	6.57	0.18
90%	-5287	1055	48,079	17,543	6.64	0.20
100%	-5717	2251	53,446	19,502		



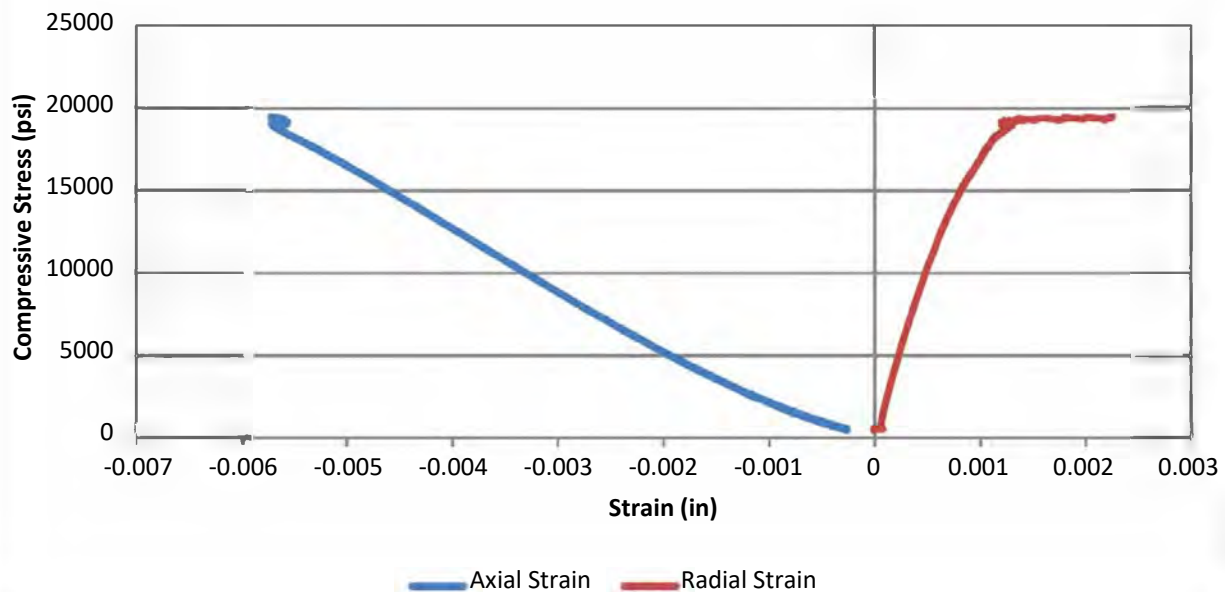
Test Results				
Unconfined Compressive Strength (psi)		19,500	Elastic Modulus (psi)	6.08E+06
			Poisson's Ratio in Elastic Range	0.15
Comments	Elastic range was taken as between 0.002 and 0.005 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.			

Project	US 123 NB RBO Georges Creek			Date	1/27/2023
Project No.	G6400.110	Sample Diameter (in.)	1.868	Tested By	WAP
SCDOT ID	P041233	Sample Length (in.)	4.149	Reviewed By	WJG
Boring	NBB-3	Unit Weight (pcf)	181.8	Core Size	NQ
Sample No.	NQ-2 / 23-0234B	L/D Ratio	2.22	Recovery	100%
Depth	95.3' - 95.6'	Load Rate (psi/sec)	20	RQD	100%
Description	Black/White/Gray Biotite Gneiss				

Axial Stress vs. Strain



Stress vs. Strain



US 123 (Calhoun Memorial Hwy.) Northbound Bridge
Replacement over Georges Creek

Geotechnical Baseline Report

APPENDICES

APPENDIX D ADRS CURVES

3-Point Acceleration Design Response Spectrum

SCDOT v3.1.1 - 11/29/2022

Project ID:	P041233	Latitude:	34.8313
Route:	US 123	County:	39 - Pickens
Project:	Calhoun Memorial Highway over Georges Creek		
		Longitude:	82.4972

Designer:	N. Harman - Support
Date:	11/29/2022

Design EQ	PGA	S _{DS}	S _{D1}	M _W	R	PGV	D ₅₋₉₅	T _o
	g	g	g	-	km	inches/sec	sec	sec
FEE	0.12	0.19	0.05	7.38	289.77	1.88	62.98	0.03
SEE	0.28	0.42	0.11	5.63	102.57	4.25	20.11	0.07

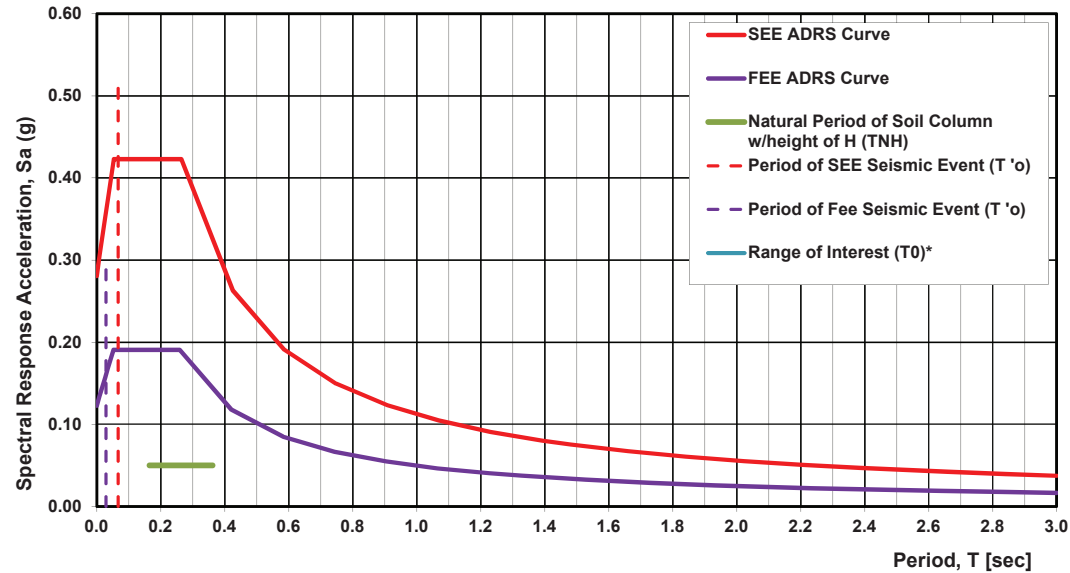
Fundamental Period of Structure, T_o^*	Range of Interest		$V_{s,H}^*$	H	T_{NH}	
	sec				sec	
	sec	0.5^*T_o			2.0^*T_o	ft/sec
0.00	0.00	0.00	1941.33	141.40	0.17	0.36
0.00	0.00	0.00				

Damping:	5%
Geologic Condition:	Geologically Realistic (Q = 100)*
ADRS Location within Soil Column:	SCP
	At Ground Surface

South Carolina Piedmont

*Same Geologic Condition as used in SCENARIO_PC (2006)

SC Seismic ADRS Curve



FEE Data

T	S _a
0.00	0.123
0.01	0.134
0.02	0.145
0.03	0.157
0.03	0.168
0.04	0.179
0.05	0.191
0.07	0.191
0.09	0.191
0.10	0.191
0.12	0.191
0.14	0.191
0.16	0.191
0.17	0.191
0.19	0.191
0.21	0.191
0.23	0.191
0.24	0.191
0.26	0.191
0.42	0.118
0.58	0.085
0.74	0.067
0.90	0.055
1.07	0.046
1.23	0.040
1.39	0.036
1.55	0.032
1.71	0.029
1.87	0.026
2.03	0.024
2.19	0.023
2.36	0.021
2.52	0.020
2.68	0.019
2.84	0.017
3.00	0.017

SEE Data

T	S _a
0.00	0.280
0.01	0.304
0.02	0.328
0.03	0.352
0.04	0.375
0.04	0.399
0.05	0.423
0.07	0.423
0.09	0.423
0.11	0.423
0.12	0.423
0.14	0.423
0.16	0.423
0.18	0.423
0.19	0.423
0.21	0.423
0.23	0.423
0.25	0.423
0.26	0.423
0.43	0.263
0.59	0.191
0.75	0.150
0.91	0.123
1.07	0.105
1.23	0.091
1.39	0.080
1.55	0.072
1.71	0.065
1.87	0.060
2.03	0.055
2.20	0.051
2.36	0.047
2.52	0.044
2.68	0.042
2.84	0.039
3.00	0.037

US 123 (Calhoun Memorial Hwy.) Northbound Bridge
Replacement over Georges Creek
Geotechnical Baseline Report

APPENDICES

APPENDIX E 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





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 550X ATV Rig (SN 269553)
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 550X ATV-mounted drill rig with a serial number of 269553, 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.

Report of SPT Hammer Energy

Chester, South Carolina

CG2 Project No.: 240021095

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 550X ATV-mounted drill rig operated by J. Phillips 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 34.770590, -81.245583. 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	550X
Serial Number	269553
Operator	J. Phillips
Carrier	ATV
Hammer Information	
Model / Type	CME / Auto
Serial Number	269553
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

Report of SPT Hammer Energy
Chester, South Carolina
CG2 Project No.: 240021095

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 550X ATV-mounted drill rig operated at a rate of about 45.9 to 57.8 blows per minute (BPM) during dynamic testing. The measured transferred hammer energy (EFV) ranged from 279.8 to 331.3 foot-pounds, which corresponds to Energy Transfer Ratio (ETR) values of 79.9 to 94.7%, 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. CSX
- Average ETR vs. Rod Length
- Penetration vs. FMX
- Penetration vs. VMX
- ETR vs. Rod Length
- Penetration vs. EFV
- Penetration vs. ETR

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	3-6-8 / 14	SA SILT	51.3	290.2	82.9
2	33½ - 35	35	38.6	6-9-12 / 21	SA SILT	54.7	297.2	84.9
3	38½ - 40	40	43.6	4-7-9 / 16	SA SILT	54.2	305.8	87.4
Overall Average						53.6	298.0	85.1

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 550X ATV-mounted drill rig (for all the depth intervals tested) was 298.0 foot-pounds, with an average ETR of 85.1%.

Report of SPT Hammer Energy
Chester, South Carolina
CG2 Project No.: 240021095

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:

386129CCA4C1462..
D. Matthew Brewer, PE
Senior Project Engineer

DocuSigned by:

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



Appendices:

- Appendix I - CME 550X ATV Rig (SN 269553) 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 550X (SN 269553)

B-3

REK

Interval start: 3/11/2022

B-3

AR: 1.19 in²

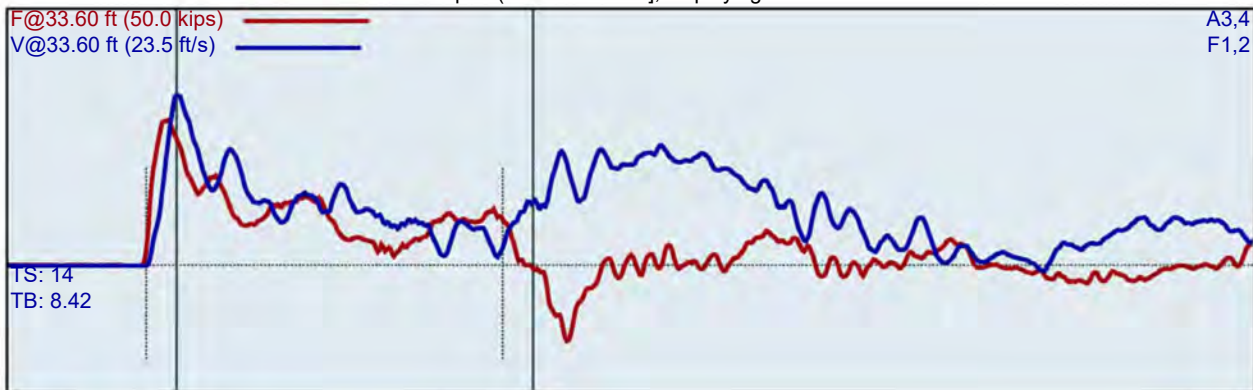
SP: 0.492 k/ft³

LE: 33.60 ft

EM: 30000 ksi

WS: 16807.9 ft/s

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

CSX: Compression Stress Maximum

FMX: Maximum Force

DFN: Final Displacement

VMX: Maximum Velocity

EFV: Maximum Energy

DMX: Maximum Displacement

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	%
28.67	1	3	1.9	25.7	14.4	2.5	21.6	2.0	264.5	75.6
28.83	2	3	47.5	24.8	16.2	2.0	20.8	2.0	281.4	80.4
29.00	3	3	49.5	26.0	16.2	2.0	21.9	2.0	298.2	85.2
29.08	4	6	50.5	26.4	16.3	1.4	22.1	1.0	290.1	82.9
29.17	5	6	51.0	26.9	15.5	1.3	22.6	1.0	284.1	81.2
29.25	6	6	50.7	27.9	15.8	1.3	23.4	1.0	293.0	83.7
29.33	7	6	50.8	28.4	15.6	1.2	23.9	1.0	297.8	85.1
29.42	8	6	51.3	27.3	14.8	1.1	23.0	1.0	280.4	80.1
29.50	9	6	51.0	27.5	15.0	1.1	23.1	1.0	279.8	79.9
29.56	10	8	51.5	28.0	15.5	1.1	23.5	0.7	295.9	84.5
29.63	11	8	51.3	27.8	15.2	1.0	23.4	0.7	294.2	84.1
29.69	12	8	51.6	27.6	15.5	0.9	23.2	0.7	291.7	83.3
29.75	13	8	51.5	27.9	15.4	0.9	23.5	0.7	287.1	82.0
29.81	14	8	51.5	28.0	15.3	0.9	23.6	0.7	293.1	83.7
29.88	15	8	51.9	28.1	15.5	0.8	23.6	0.7	286.8	81.9
29.94	16	8	51.2	28.0	15.0	0.8	23.5	0.7	291.8	83.4
30.00	17	8	51.9	26.9	16.8	0.8	22.6	0.7	297.1	84.9
Average			51.3	27.6	15.5	1.1	23.2	0.9	290.2	82.9
Std Dev			0.4	0.6	0.5	0.2	0.5	0.1	5.6	1.6
Maximum			51.9	28.4	16.8	1.4	23.9	1.0	297.8	85.1
Minimum			50.5	26.4	14.8	0.8	22.1	0.7	279.8	79.9

N-value: 14

Sample Interval Time: 18.86 seconds.

CME 550X (SN 269553)

B-3

REK

Interval start: 3/11/2022

B-3

AR: 1.19 in²

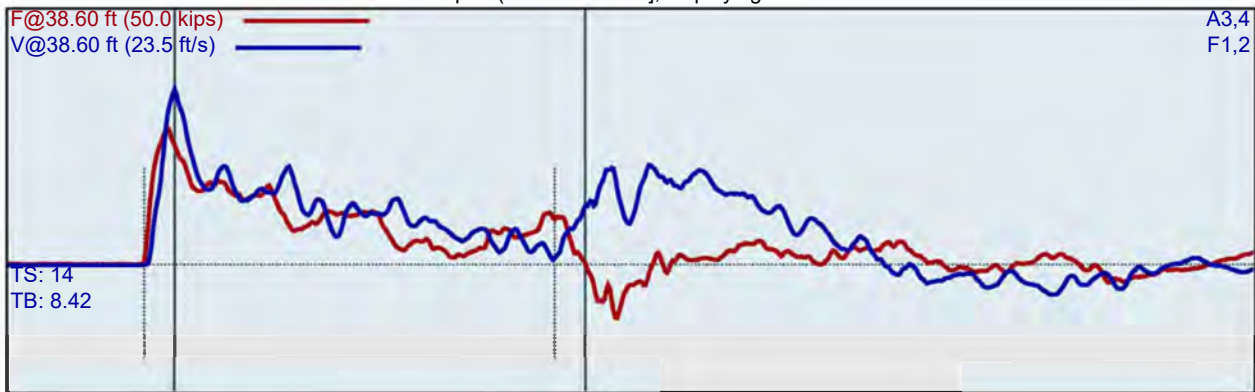
SP: 0.492 k/ft³

LE: 38.60 ft

EM: 30000 ksi

WS: 16807.9 ft/s

Depth: (33.50 - 35.00 ft), displaying BN: 25



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

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

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

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 %
33.58	1	6	1.9	25.0	14.5	1.1	21.0	1.0	247.7	70.8
33.67	2	6	39.8	25.6	15.7	1.1	21.5	1.0	271.2	77.5
33.75	3	6	41.0	26.0	16.1	1.1	21.9	1.0	283.4	81.0
33.83	4	6	52.7	26.6	16.3	1.1	22.3	1.0	297.4	85.0
33.92	5	6	54.0	26.7	17.1	1.0	22.4	1.0	297.0	84.9
34.00	6	6	54.3	26.3	16.1	1.0	22.1	1.0	301.2	86.1
34.06	7	9	54.5	27.3	16.8	0.8	22.9	0.7	299.2	85.5
34.11	8	9	54.3	26.1	15.7	0.8	21.9	0.7	287.4	82.1
34.17	9	9	54.7	26.5	16.0	0.7	22.3	0.7	293.1	83.8
34.22	10	9	54.2	26.6	15.9	0.7	22.3	0.7	297.6	85.0
34.28	11	9	55.1	26.1	16.1	0.7	22.0	0.7	288.5	82.4
34.33	12	9	54.4	26.3	16.3	0.7	22.1	0.7	296.7	84.8
34.39	13	9	54.9	26.9	16.2	0.7	22.6	0.7	295.1	84.3
34.44	14	9	54.5	26.8	15.8	0.7	22.5	0.7	298.5	85.3
34.50	15	9	54.8	26.6	16.1	0.7	22.3	0.7	296.0	84.6
34.54	16	12	54.9	26.0	16.3	0.6	21.9	0.5	293.7	83.9
34.58	17	12	54.4	26.3	16.1	0.6	22.1	0.5	296.7	84.8
34.63	18	12	54.8	26.2	16.1	0.6	22.0	0.5	296.1	84.6
34.67	19	12	54.5	26.2	15.8	0.5	22.0	0.5	298.4	85.3
34.71	20	12	54.9	27.2	16.9	0.5	22.8	0.5	306.1	87.4
34.75	21	12	54.4	26.2	15.6	0.5	22.0	0.5	297.9	85.1
34.79	22	12	54.9	26.2	16.3	0.5	22.0	0.5	296.4	84.7
34.83	23	12	54.5	26.3	17.0	0.5	22.1	0.5	304.0	86.9
34.88	24	12	54.8	26.4	16.9	0.5	22.2	0.5	305.0	87.1
34.92	25	12	54.8	26.5	16.1	0.5	22.3	0.5	301.4	86.1
34.96	26	12	54.8	26.3	16.4	0.5	22.1	0.5	298.2	85.2
35.00	27	12	55.1	26.5	16.1	0.5	22.2	0.5	296.2	84.6

Average	54.7	26.4	16.2	0.6	22.2	0.6	297.2	84.9
Std Dev	0.3	0.3	0.4	0.1	0.3	0.1	4.5	1.3
Maximum	55.1	27.3	17.0	0.8	22.9	0.7	306.1	87.4
Minimum	54.2	26.0	15.6	0.5	21.9	0.5	287.4	82.1

N-value: 21

Sample Interval Time: 29.35 seconds.

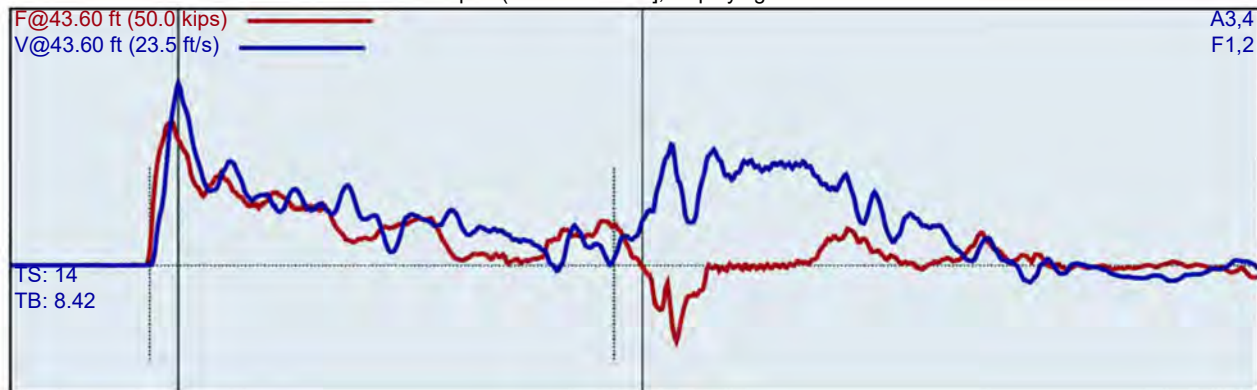
CME 550X (SN 269553)
REK
B-3

B-3
Interval start: 3/11/2022

AR: 1.19 in²
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: 18



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 %
38.63	1	4	1.9	26.1	15.0	1.8	22.0	1.5	274.0	78.3
38.75	2	4	44.8	27.0	15.6	1.7	22.7	1.5	284.1	81.2
38.88	3	4	45.1	27.5	16.5	1.5	23.1	1.5	297.6	85.0
39.00	4	4	45.9	26.3	15.7	1.5	22.1	1.5	294.9	84.3
39.07	5	7	46.0	26.6	15.6	1.1	22.4	0.9	290.1	82.9
39.14	6	7	45.9	26.4	15.6	1.1	22.2	0.9	292.0	83.4
39.21	7	7	46.1	26.4	15.6	1.0	22.2	0.9	289.5	82.7
39.29	8	7	46.0	26.5	15.7	1.0	22.3	0.9	286.2	81.8
39.36	9	7	52.5	27.6	16.5	1.2	23.2	0.9	331.3	94.7
39.43	10	7	57.3	28.2	16.5	1.2	23.7	0.9	316.0	90.3
39.50	11	7	57.8	27.7	16.8	1.1	23.3	0.9	314.8	90.0
39.56	12	9	57.0	27.9	16.0	1.0	23.4	0.7	323.0	92.3
39.61	13	9	57.7	27.5	15.6	1.0	23.1	0.7	310.1	88.6
39.67	14	9	57.4	28.0	16.2	0.9	23.5	0.7	303.8	86.8
39.72	15	9	57.3	28.5	16.7	0.9	24.0	0.7	306.8	87.7
39.78	16	9	57.3	27.7	16.5	0.7	23.3	0.7	303.9	86.8
39.83	17	9	57.0	28.1	16.6	0.8	23.6	0.7	308.5	88.2
39.89	18	9	57.6	27.6	16.6	0.7	23.2	0.7	303.2	86.6
39.94	19	9	56.7	27.9	17.0	0.8	23.5	0.7	308.7	88.2
40.00	20	9	57.5	27.7	17.0	0.7	23.3	0.7	304.2	86.9
Average			54.2	27.5	16.3	1.0	23.1	0.7	305.8	87.4
Std Dev			4.9	0.6	0.5	0.2	0.5	0.1	11.9	3.4
Maximum			57.8	28.5	17.0	1.2	24.0	0.9	331.3	94.7
Minimum			45.9	26.4	15.6	0.7	22.2	0.7	286.2	81.8

N-value: 16

Sample Interval Time: 21.86 seconds.

Summary of SPT Test Results

Project: CME 550X (SN 269553), Test Date: 3/11/2022

BPM: Blows/Minute

FMX: Maximum Force

VMX: Maximum Velocity

DMX: Maximum Displacement

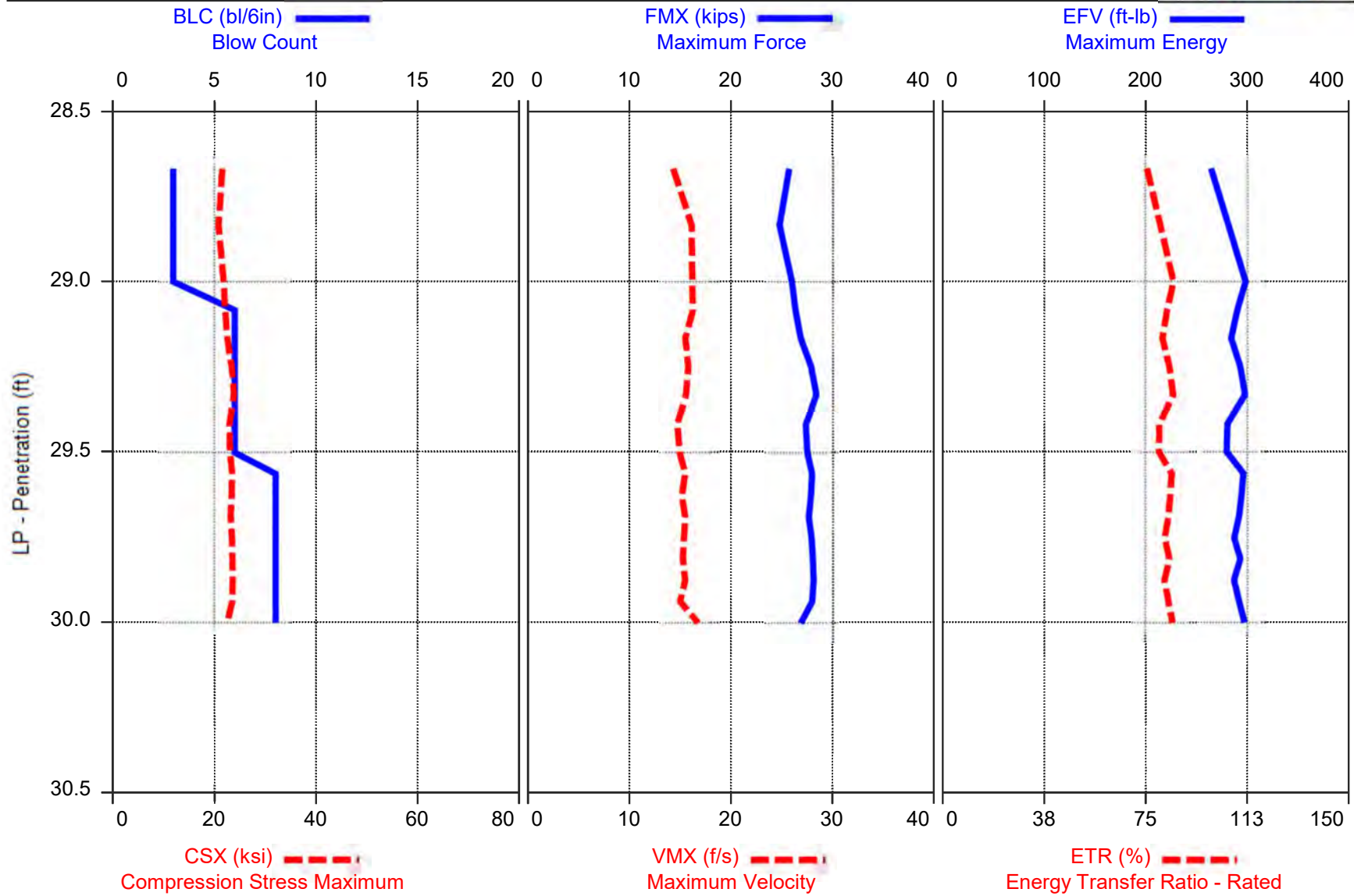
CSX: Compression Stress Maximum

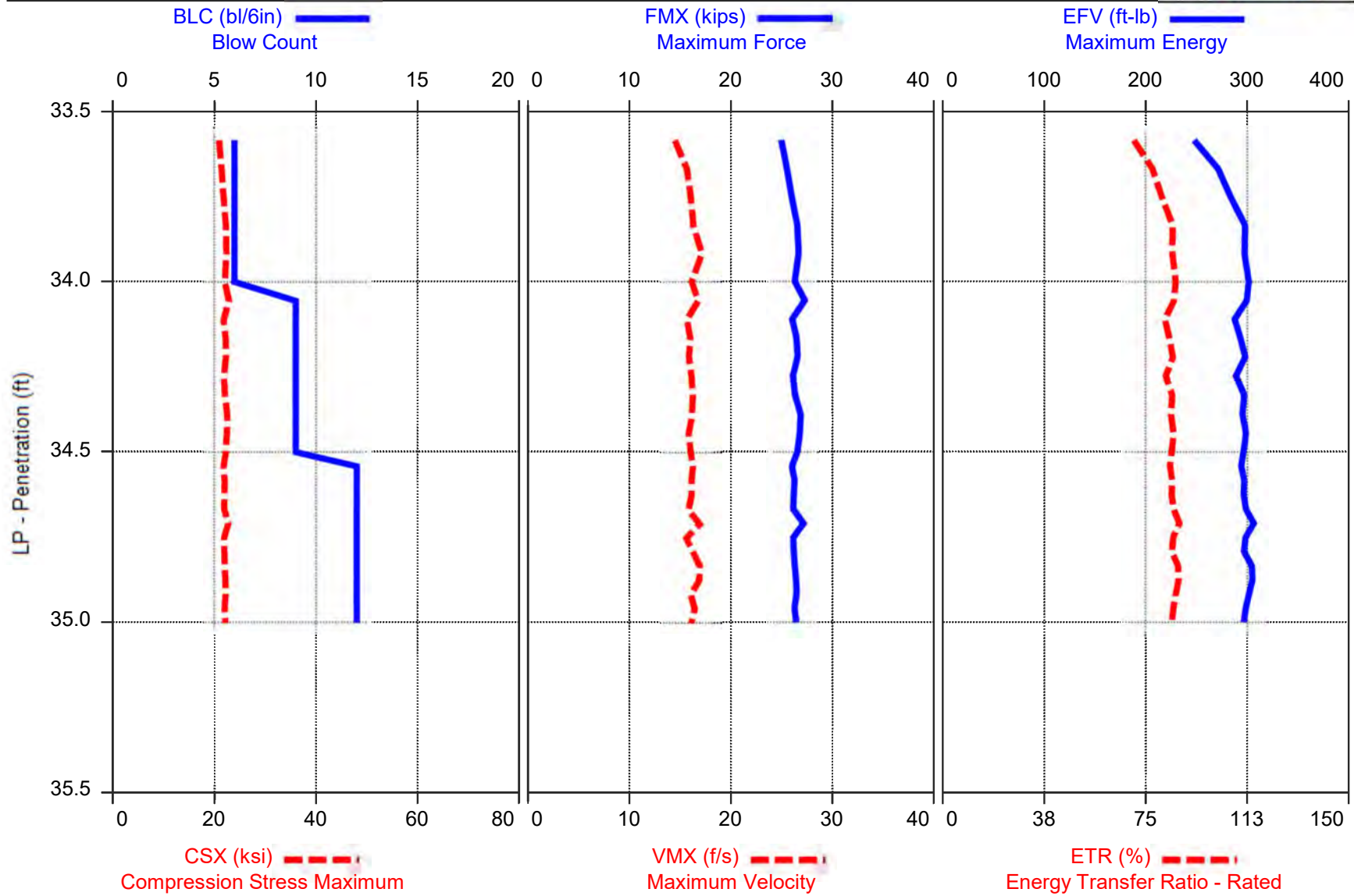
DFN: Final Displacement

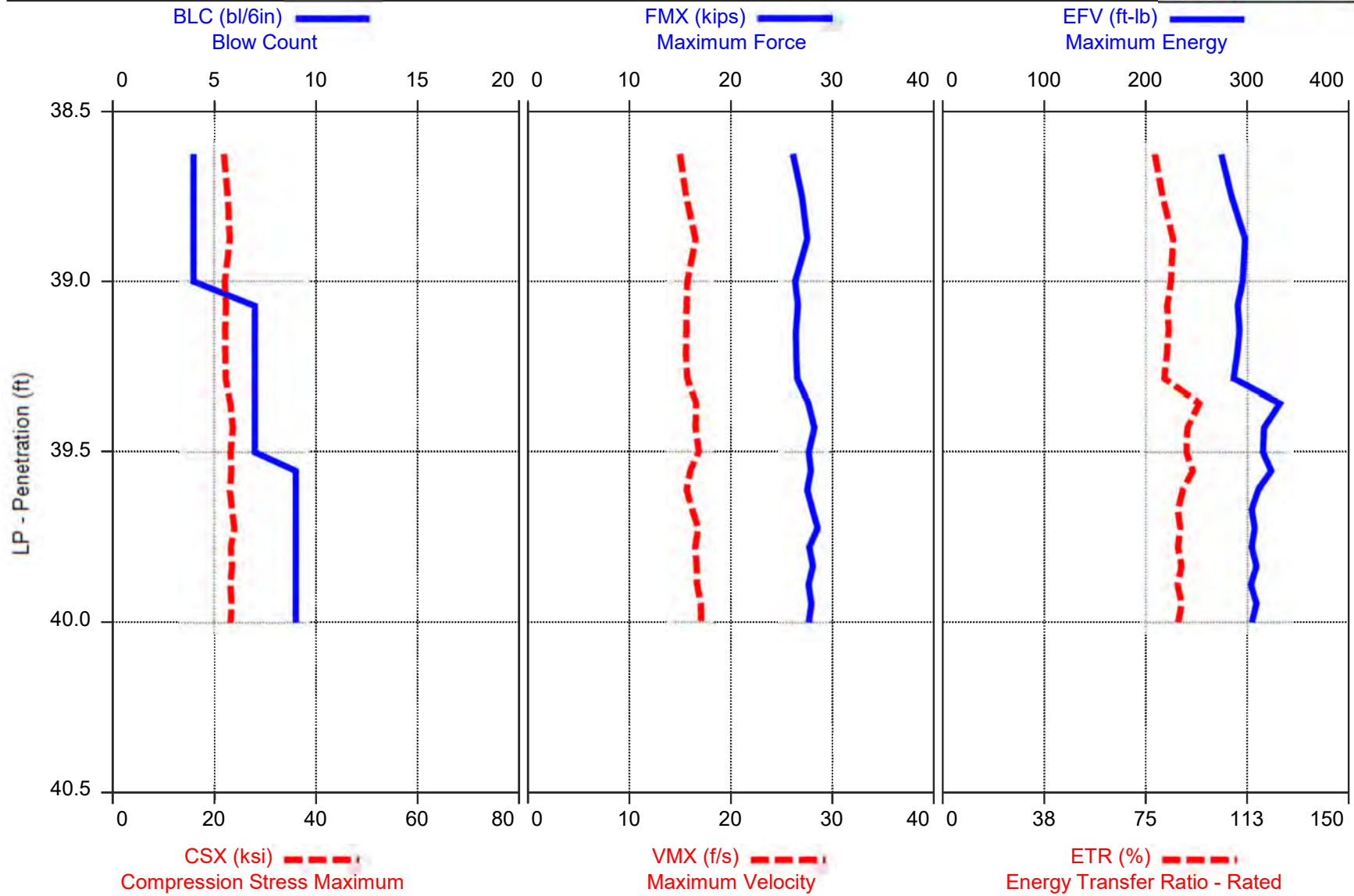
EFV: Maximum Energy

ETR: Energy Transfer Ratio - Rated

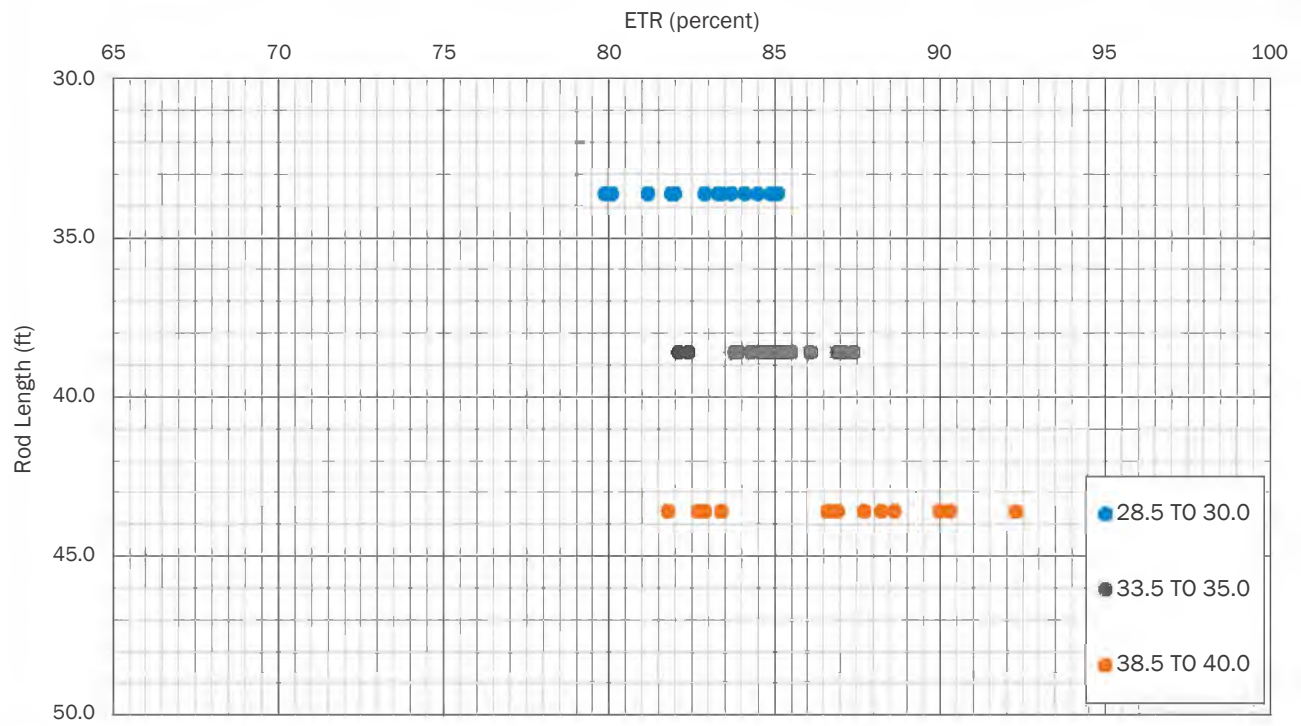
Instr. Length ft	Start Depth ft	Final Depth ft	Blows Applied /6"	N Value	N60 Value	Average BPM bpm	Average FMX kips	Average VMX ft/s	Average DMX in	Average CSX ksi	Average DFN in	Average EFV ft-lb	Average ETR %
33.60	28.50	30.00	3-6-8	14	19	51.3	27.6	15.5	1.1	23.2	0.9	290.2	82.9
38.60	33.50	35.00	6-9-12	21	29	54.7	26.4	16.2	0.6	22.2	0.6	297.2	84.9
43.60	38.50	40.00	4-7-9	16	22	54.2	27.5	16.3	1.0	23.1	0.7	305.8	87.4
Overall Average Values:						53.6	27.1	16.0	0.8	22.8	0.7	298.0	85.1
Standard Deviation:						3.1	0.8	0.6	0.3	0.6	0.2	9.9	2.8
Overall Maximum Value:						57.8	28.5	17.0	1.4	24.0	1.0	331.3	94.7
Overall Minimum Value:						45.9	26.0	14.8	0.5	21.9	0.5	279.8	79.9



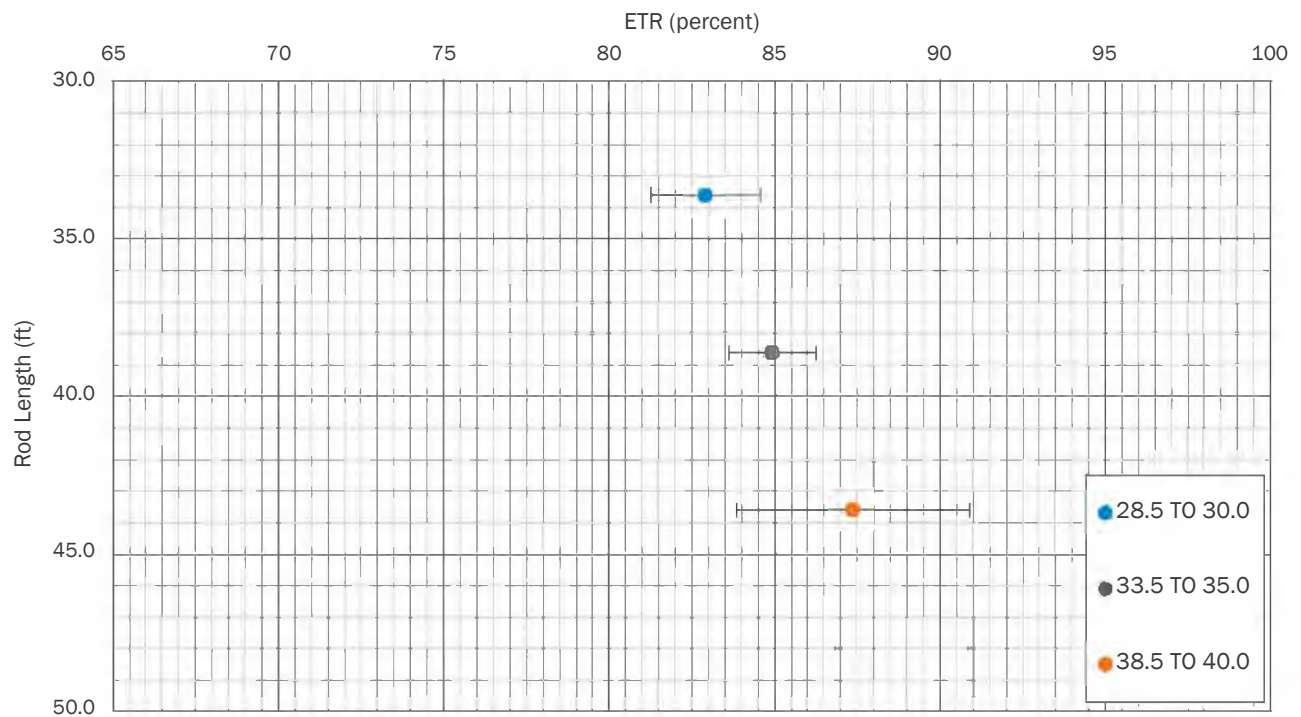




**ETR versus Rod Length
CME 550X ATV (SN 269553)**



**Average ETR versus Rod Length \pm 1 Standard Deviation
CME 550X ATV (SN 269553)**



APPENDIX II

SPT Hammer Energy Field Form

Project: SPT HAMMER ENERGY
Project No.: 240021095
Boring No.: B-3

Date: 3/11/2022
Weather: 50's CLOUDY
Drill Rod Type: AWJ

On-site Personnel

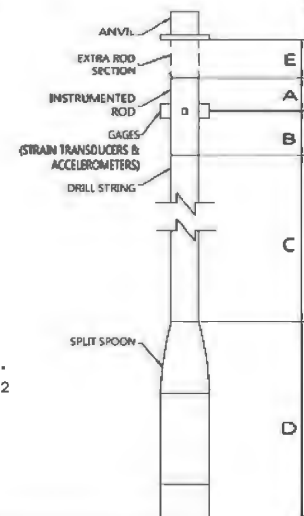
Drilling Company: BRECCIA CONSTRUCTION, LLC
 Rig Operator: J. PHILLIPS
 Engr/Geologist: N/A
 Client Rep.: N/A
 Analyzer Oper.: R. KRAL

Rig/Hammer Info

Drill Rig Make/Model: CME 550X
 Carrier Type: ATV
 Rig Serial No.: 269553 (DR-3)
 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

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 in²
 PDA Make/Model: SPT
 PDA Serial No.: 4549 TB
 Calib. Pulse Test (y/n): Y



Gage Info

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

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				Drop Height in Tolerance (y/n)	Soil Class.
						6"	12"	18"	N-Value		
11-Mar	28.5 TO 30.0	0848/0848	30	33.6	50	3	6	8	14	Y	SA SI
11-Mar	33.5 TO 35.0	0857/0858	35	38.6	54	6	9	12	21	Y	SA SI
11-Mar	38.5 TO 40.0	0905/0906	40	43.6	56	4	7	9	16	Y	SA SI

Notes:

TESTING PERFORMED AT 1817 LOWRYS HIGHWAY IN CHESTER, SOUTH CAROLINA (CHESTER COUNTY). THE APPROXIMATE COORDINATES ARE 34.770590, -81.245583. THROTTLE WAS LOW TO BEGIN 33.5 TO 35.0 SAMPLE AND INCREASED BETWEEN BN 8 AND BN 10.

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


 Digitally signed by: Robert E. Kral
 Prepared By (print/signature)

3/11/2022
 Date



Figure No. 1: Rear View of Drill Rig



Figure No. 2: Side View of Drill Rig



Figure No. 3: Serial Number Plate



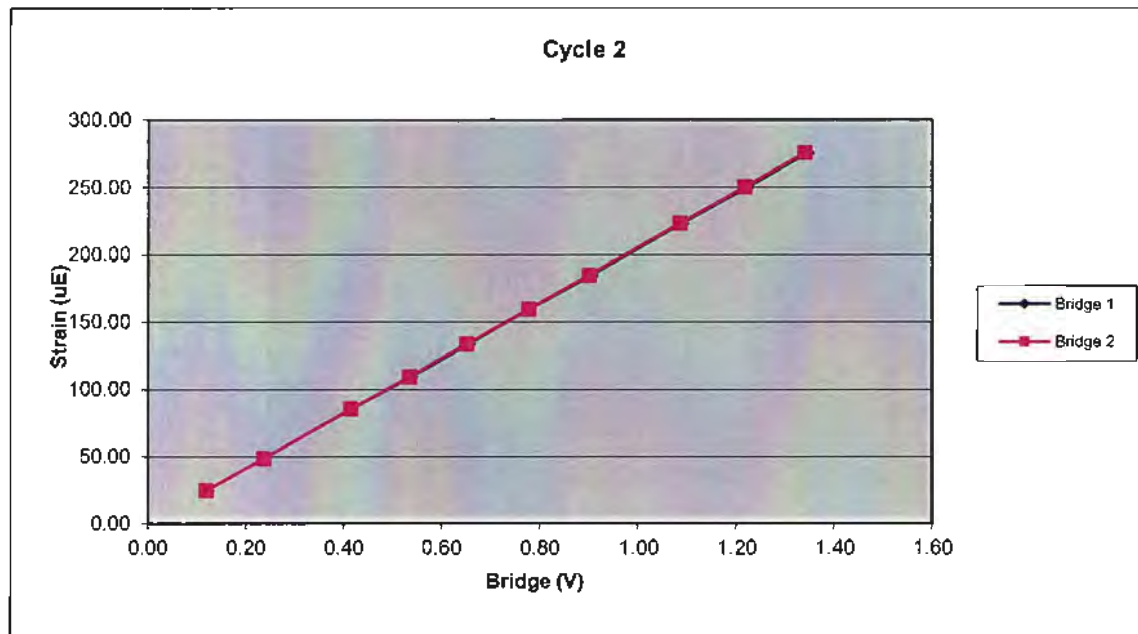
Figure No. 4: Automatic Hammer

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 ($\mu\text{E/V}$)	204.74	Strain Calibration ($\mu\text{E/V}$)	205.35
Offset	-0.39	Offset	-0.39
Correlation	0.999993	Correlation	0.999995

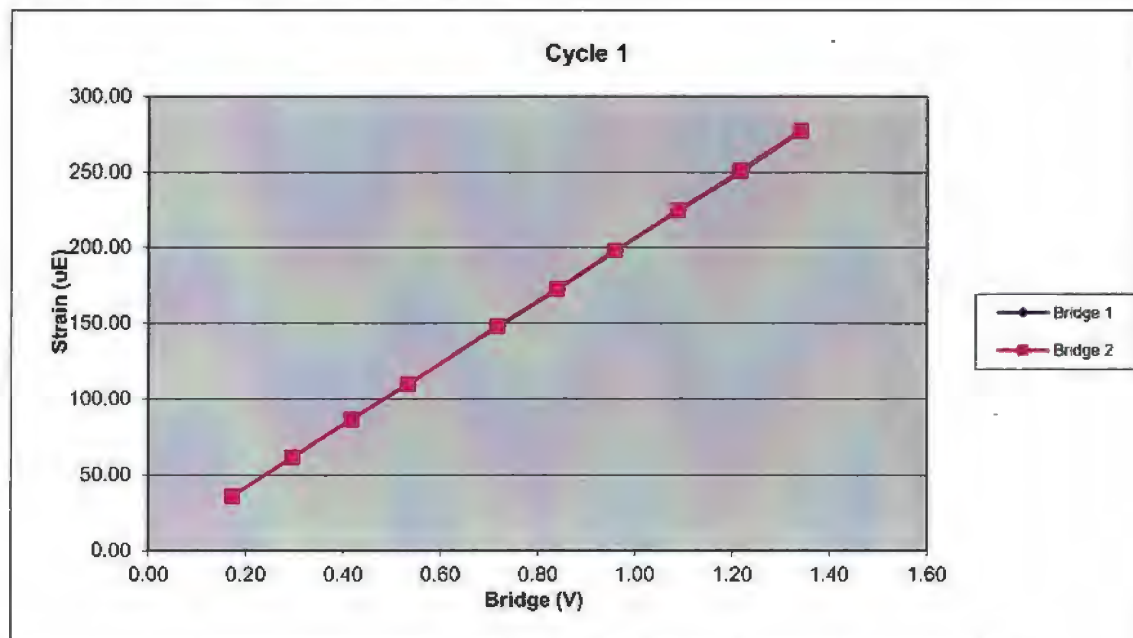
Force Strain Calibration	
EA (Kips)	35851.72
Offset	27.08
Correlation	0.999996



528AWJ		Cycle 1		
Sample	Force (lb)	Strain (μ E)	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 (μ E/V)	205.65	Strain Calibration (μ E/V)	206.03
Offset	0.08	Offset	-0.01
Correlation	0.999990	Correlation	0.999993

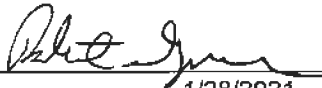
Force Strain Calibration	
EA (Kips)	35721.25
Offset	7.11
Correlation	0.999990



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

Calibration Factors	528AWJ		
Bridge 1 ($\mu\text{E/V}$)	205.26	Bridge 2 ($\mu\text{E/V}$)	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

PDA CALIBRATION FACTOR

417.3 mv/5000g

(83.5 μ v/g)

R²: 0.999987 [Chip programmed]

Operator: William Johnson

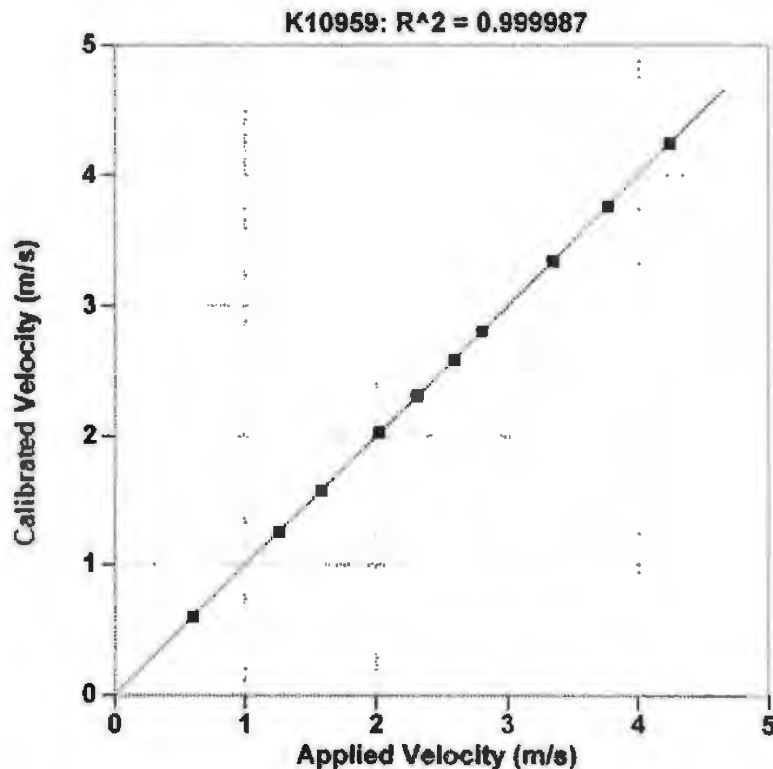
Ref Acc 1: 69096! Cal on: 27Jan2021
978 g's/volt

Ref Acc 2: 69132! Cal on: 09Feb2021
960 g's/volt

William Johnson

Signed

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



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

PDA CALIBRATION FACTOR

425.7 mv/5000g

(85.1 μ v/g)

R²: 0.999987 [Chip programmed]

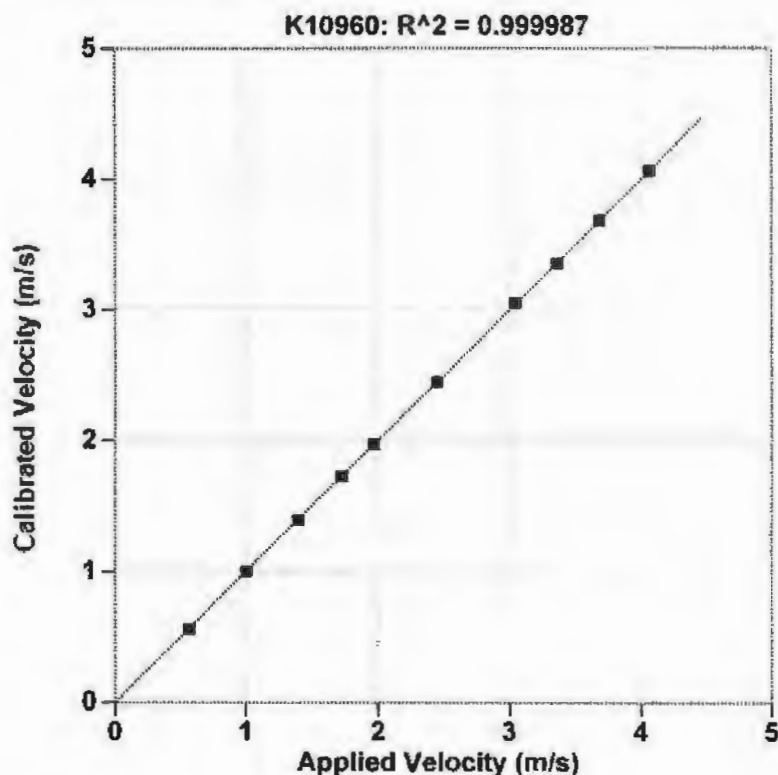
Ref Acc 1: 63479! Cal on: 09Sep2020
1080 g's/volt

Ref Acc 2: 65538! Cal on: 27Jan2020
1040 g's/volt

Operator: William Johnson


Signed

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



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

PDA CALIBRATION FACTOR

407.0 mv/5000g

(81.4 μ v/g)

R²: 0.999989 [Chip programmed]

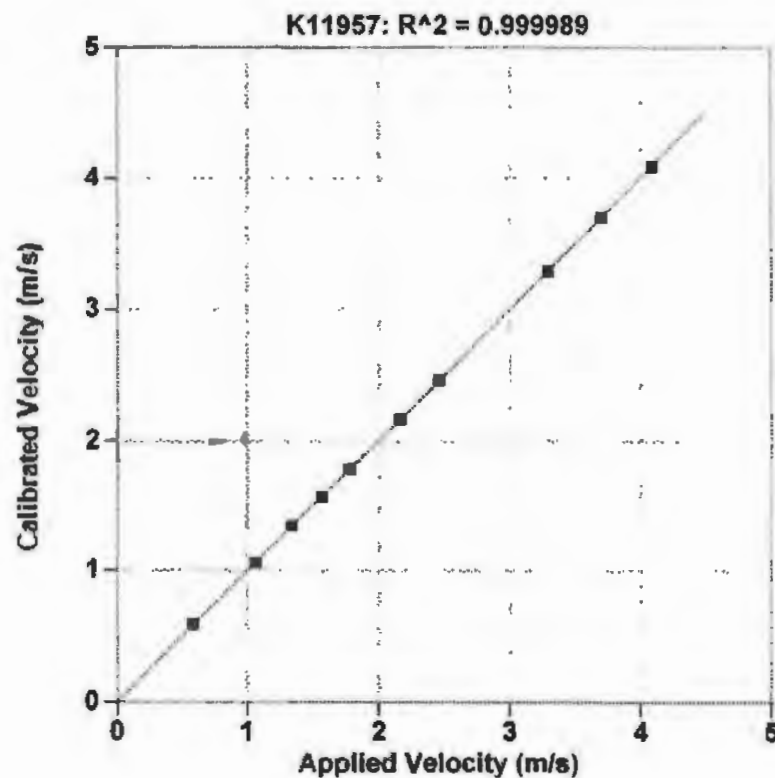
Operator: William Johnson

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

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

William Johnson
Signed

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



Reference Velocity m/s	S/N K11957 Velocity 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

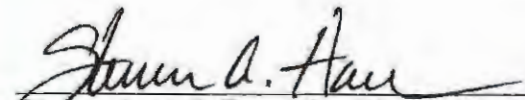


This documents that
Robert E. Kral
Carolinas Geotechnical Group
has on May 20, 2016 achieved the rank of
ADVANCED

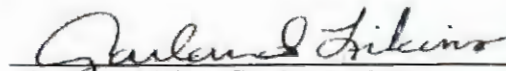
on the Dynamic Measurement and Analysis Proficiency Test.

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