



Geotechnical Baseline Report

SC 215 (Buffalo-West Springs Hwy) Bridge
Replacement over Fairforest Creek

Union County, SC
March 22, 2023





March 22, 2023

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

Dear Mr. Harris,

We have completed the Geotechnical Baseline Report for the SC 215 (Buffalo-West Springs Hwy.) Bridge Replacement over Fairforest Creek in Union County, SC. Please call at your convenience if you have questions or comments. HDR appreciates the opportunity to provide geotechnical engineering services to the South Carolina Department of Transportation.

Sincerely,
HDR

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



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

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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 SC 215 Bridge Replacement over Fairforest Creek, in Union County, South Carolina. The proposed bridge intends to replace the existing bridge over Fairforest Creek on Buffalo West Springs Hwy.

This Geotechnical Baseline Report was prepared in general accordance with the 2022 SCDOT Geotechnical Design Manual (GDM). Geotechnical data including standard penetration testing (SPT), cone penetration testing (CPT), bulk sampling, rock cores, shear wave velocity measurements, and a variety of laboratory tests are presented herein to provide 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 northwest of Union, approximately half a mile east of the intersection of SC 215 with Meadow Woods Rd. It is bound to the east by Mudbridge Rd and to the west by Fairforest Heights. A Site Vicinity Map is included in Appendix A.

The existing bridge over Fairforest Creek is approximately 294 feet in length and 31 feet wide and will be removed and replaced with a new bridge along a shifted alignment. The proposed multi span replacement bridge will be approximately 296 feet in length and will accommodate two 12-foot lanes with 8-foot shoulders. Construction is anticipated to be completed with maintenance of traffic on the existing bridge.

2 Investigative Procedures

The geotechnical subsurface exploration at the project site was performed by F&ME Consultants in January 2023. The subsurface investigation consisted of standard penetration test (SPT) borings, rock core samples, bulk sample soil collection, CPTs, and shear wave velocity measurements with MASW testing. Two additional SPT borings were performed by F&ME Consultants in March 2023.

A test location plan showing all testing locations is included in Appendix A. The boring logs, rock core photos, CPT logs, and MASW shear wave velocity profile from the subsurface investigation are included in Appendix B.

2.1 Drilling and Sampling

A total of seven (7) SPT borings were performed during the subsurface investigation. These consisted of five (5) bridge borings, B-52 through B-56, and two (2) roadway borings for a potential cut retaining wall, R-1 and R-2. Auger refusal was encountered in all bridge borings at depths ranging between 11.3 feet to 34.5 feet. Roadway borings R-1 and R-2 were terminated at depths of 45.0 feet and 35.0 feet respectively. Advancement of the

bridge borings B-52, B-53, B-54, B-55 and B-56 below auger refusal was accomplished with NQ rock coring techniques. These were terminated at depths between 40.8 feet and 62.0 feet.

The boring logs from the subsurface investigations are included in Appendix B. The borings were advanced by a CME 550X using mud rotary and driven casing drilling techniques. Soil sampling and penetration testing was performed in general accordance with ASTM D-1586 and ASTM D-1587. SPT's were typically conducted continuously in the top 10 feet of each boring followed by 5-foot intervals thereafter until auger refusal was encountered. SPT's were carried out utilizing a standard 1.4-inch I.D., 2-inch O.D, split barrel, or split-spoon sampler. Blow counts recorded at these intervals were produced from SPT hammer with an energy ratio of 87%. The hammer energy ratio is identified on each boring log. SPT hammer energy measurements on the CME 550X drill rig were performed with a pile driving analyzer (PDA) and the SPT Hammer Energy Calibration Reports are included in Appendix E.

One (1) bulk sample was obtained at boring BS-6 collectively from 5 feet below the existing ground surface from auger cuttings. The collected rock core samples were evaluated in the field and the percentage of core recovery (REC) and Rock Quality Designation (RQD) were recorded.

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

2.2 Cone Penetrometer Testing

Two (2) cone penetrometer tests (CPT-25 and CPT-26) were performed by F&ME Consultants, Inc., one near each end bent of the existing bridge. Upon encountering refusal, the CPTs were terminated at depths of 8.6 feet and 17.6 feet. CPT sounding logs are included in Appendix B.

2.3 MASW Survey

Shear wave velocity measurements were obtained by F&ME Consultants from one (1) Multi-Channel Analysis of Surface Waves, MASW-13, performed on the existing bridge end where boring B-52 was drilled. Active survey data was obtained by a sledgehammer striking an aluminum block and polyethylene block and recording of the resulting vibrations. Passive survey data consisted of the collection of ambient background vibrations resulting from drilling equipment. The resulting shear-wave data from this investigation produced an average shear-wave velocity of 1167.1 ft/sec for the 0 to 100-foot interval. The MASW survey report is included in Appendix B.

2.4 Groundwater Conditions

The stabilized groundwater level recorded approximately 24 hours after completion of investigation operations indicated a groundwater depth of 20.2 feet, 1.4 feet and 23 feet for boring B-52, B-53 and B-56, respectively. These depths correspond to elevations 415.6 feet, 412.1 feet and 412.1 feet.

Groundwater level was recorded at the time of completion of soil drilling and/or rock coring at borings B-52, B-53, B-54, B-55, B-56, R-1 and R-2 at depths of 17.9 feet, 2.8 feet, 3.3

feet, 2.3 feet, 10.2 feet, 26.2 feet and 18.3 feet. These depths correspond to elevations 417.9 feet, 410.7 feet, 410.0 feet, 410.8 feet, 424.9 feet, 415.0 feet and 420.1 feet.

These reported groundwater levels are interpreted to be dependent upon seasonal fluctuations, individual event intensity and/or level of Fairforest Creek.

2.5 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 Hole No.	Station ^a	Offset (ft)	Latitude	Longitude	Top of Boring Elevation (ft)	Test Type	Total Depth (ft)
B-52	253+83	51 RT	34.71665	-81.70914	435.8	SPT/RC	42.8
B-53	254+96	50 RT	34.7165	-81.70945	413.5	SPT/RC	62.0
B-54	255+66	50 RT	34.71637	-81.70964	413.3	SPT/RC	52.0
B-55	256+46	49 RT	34.71625	-81.70986	413.1	SPT/RC	41.3
B-56	257+38	49 RT	34.71611	-81.71012	435.1	SPT/RC	40.8
R-1	250+64	35 RT	34.71713	-81.70825	441.2	SPT	45.0
R-2	251+94	38 RT	34.71692	-81.70859	438.4	SPT	35.0
BS-6	257+25	65 RT	34.71616	-81.71011	433.3	BULK	5.0
CPT-25	253+81	49 RT	34.71611	-81.71014	435.3	CPT	8.6
CPT-26	257+37	50 RT	34.71665	-81.70913	435.9	CPT	17.6
MASW-13	near boring B-52					MASW	100.0

^a Stations based on latest SC 215 alignment.

3 Laboratory Test Program

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

Laboratory testing was performed in general accordance with ASTM or AASHTO test procedures. Representative samples were classified in accordance with the AASHTO and Unified Soil Classification System (USCS). Table 3-1 summarizes the testing types and quantity of each test performed. For detailed laboratory information, refer to Appendix C.

Table 3-1. Laboratory Testing Summary

Test Type	Quantity
Natural Moisture Content	33
Atterberg Limits	23
Grain Size Analysis with Hydrometer	3
Grain Size Analysis with #200 Wash	6
#200 Wash	18
CU Triaxial	1
Unconfined Compression of Rock	13
Standard Proctor	1
Corrosion Series	1

3.1 Soil and Rock Properties

Split spoon soil samples from the preliminary geotechnical subsurface site exploration for this bridge site were grouped and classified into AASHTO and USCS soil classifications. According to the AASHTO Soil Classification System, the classifications of these samples ranged from A-1-b to A-7-6. According to the Unified Soil Classification System, the classifications of these samples ranged from silty gravel with sand (GM) to clayey sand (SC) and sandy silt (ML). Tested samples yielded liquid limits ranging from 0 to 46 and plasticity indices ranging from 0 to 17.

Corrosion series test were performed on select split spoon samples. Standard proctor testing and remolded CU triaxial tests were performed on the collected bulk sample. Finally, thirteen (13) unconfined compression tests were performed on recovered rock samples with unconfined strength results ranging from 9,900 psi to 50,270 psi. Results of laboratory testing are included in Appendix C.

4 Subsurface Conditions

4.1 Regional Geology

The bridge site is located on SC 215 in Union County, South Carolina and crosses over Fairforest Creek which is part of the Broad 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 Upper 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 (Butler, 1991). Soils overlying bedrock in the

Piedmont are typically considered to be residual soil (soil weathered in place from bedrock). However, Fair Forest 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 dominated by silty sand, silty clayey sand and sandy elastic silt. These comprise the alluvial and residual soils overlying the gneiss bedrock. Bedrock was intercepted within a depth of 11.3 feet to 34.5 feet from the existing ground.

Roadway fill consisting of loose silty sand and medium dense poorly-graded sand with silt was interpreted to range from depths of 0.6 feet to 2.0 feet of the profile. Alluvium was sampled as sandy silt, lean clay with sand, silty sand, and silty clayey sand. Residual soil underlying the alluvial soils range from loose to very dense silty sand to firm to stiff sandy elastic silt. The thickness of the residual zone ranged from 3.3 feet to 22.5 feet. Gneiss makes up the bedrock underlying the project site. Recovered rock core was in general fresh to highly weathered. Discontinuities were spaced very close to close, with planar and irregular, slickensided to very rough joint surfaces. Rock core recovery ranged from 0 to 100 percent, RQD ranged from 0 to 100 percent, and rock unconfined compression testing revealed strong to extremely strong rock with values ranging from 9,900 psi to 50,270 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)	USCS Soil Type	SPT-N ⁽¹⁾	Plasticity Index ⁽¹⁾	Fines Content ⁽¹⁾	REC / RQD
Roadway Fill	436-435	SM, SP-SM	7-11 (9)	-	-	-
Alluvium	414-413	SM, SC-SM, ML, CL	0-6 (3)	0-15 (7)	17-73 (47)	-
Residuum	439-400	SM, MH, SC, SP-SM, GP-GM, GM	3-100+ (42)	0-17 (2)	8-53 (28)	-
Rock	414-379	-	-	-	-	10-100% / 0-100% (59%) / (34%)

⁽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, 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, $V_s=2,500$ 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 (S_{DS}), and one-second period acceleration (S_{D1}) 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	0.01 g	0.02 g
S_{DS}	0.02 g	0.03 g
S_{D1}	0.00 g	0.01 g

5.2 Shear Strength Loss (SSL)

Based on a preliminary review of the physical properties of the site soils, these do not appear to be susceptible to shear strength loss during the design earthquake.

6 Design and Construction Considerations

6.1 Foundations

Driven steel H-piles are anticipated to be the most feasible foundation type for the proposed bridge abutments. Based on Table 9-3 in SCDOT GDM 2022, assuming redundant piles, a resistance factor of 0.5 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 for any reason foundation piles will already be in-place when the approach embankment construction begins, foundation pile design must account for any downdrag loads subjected to 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 resistance. Reinforced pile tips will be required to penetrate to dense soils and rock. 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.

Due to the potential of encountering shallow rock at the pile locations, pile pre-drilling may be required for the pile installation. The water table level may have an impact on the pre-drilled hole stability. If unstable soil conditions are encountered at these locations, temporary casing may be required to stabilize the pre-drilled holes.

For the bridge interior bents, drilled shafts in dense residual soils or socketed into rock appear to be the most appropriate foundation type due to potentially anticipated scour conditions. 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 a few inches into 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 redundant drilled shafts are used. It must be noted that side resistance along the cased length of the drilled shaft, anticipated to extend to the top of rock, will not be considered in the calculated axial resistances. For the installation of drilled shafts in dense soils, the slurry method of construction may be more appropriate for the excavation of soils below the water table. Resistance factors for side friction and end bearing for the design of drilled shafts in soils and intermediate geomaterials (IGM) shall be in accordance with Table 9-4 of the SCDOT GDM 2022. Excavation for bridge foundations is expected to encounter PWR zones overlying bedrock as well as very hard rock conditions within the competent bedrock.

6.2 Embankment Slopes

Slope stability issues may occur if the new bridge approach embankments are built over the soft/loose alluvial soils encountered at the site. Assessment of the slope stability of the bridge approach embankments and evaluation of any necessary ground improvement measures must be explored during the design phase of the project.

6.3 Retaining Walls

Placement of a retaining wall parallel to SC-215 and within less than 300 feet from the bridge over Fairforest Creek may be required to eliminate the impacts of the proposed roadway alignment to an upslope property. The maximum height of the retaining wall is approximately 22 feet.

6.4 Corrosion and Deterioration

Corrosion testing of a representative split spoon sample was performed by F&ME Consultants and the results are included in Appendix C. The full corrosion and deterioration testing results included pH, resistivity, chlorides and sulfates content and are summarized in Table 6-1 below.

Table 6-1. Corrosion Series Laboratory Testing Summary

Test Hole No.	Alignment	Station	Offset	Sample Depth (ft)	Chloride (ppm)	Sulfate (ppm)	pH	Restivity (ohm-cm)
B-53	SC 215	254+96	50 RT	18.5-25.0	64	18	6.6	30,452

Based on the criteria set forth in section 7.18 in SCDOT GDM 2022, the environmental classification of the project site is non-aggressive. Interpretation of these data shall be communicated with the structural engineer for the project.

6.5 Embankment Construction

Some fill quantities may be required for construction of the embankments on this project. Assuming that the majority of embankment construction will utilize the available on-site materials, a bulk sample obtained from the top 5 ft of existing embankment material along the alignment was used to provide a better characterization of the material locally available. The bulk samples were tested for soil classification and was also remolded and compacted to 95% of the Standard Proctor prior to being tested under CU Triaxial Compression. Results are summarized in Table 6-2 below.

Table 6-2. Bulk Sample Testing Summary

Sample No.	Station	Offset (ft)	Sample Depth (ft)	USCS Soil Type	Compaction		Shear Strength			
					Optimum Moisture (%)	Max Dry Density (pcf)	c' (psf)	ϕ' (°)	c (psf)	ϕ (°)
BS-6	257+25	65 RT	0.0-5.0	CL	108.7	17.8	89	32.4	161	13.3

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 SC 215 Bridge over Fairforest Creek in Union 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.

8 References

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

DHEC, SC, et al. "DHEC S.C. Watershed Atlas" *Live Healthy S.C.*, 14 Apr. 2016, <https://gis.dhec.sc.gov/watersheds/>

SCDNR "Geologic Map of South Carolina", March 2012
<https://www.dnr.sc.gov/geology/>

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

Appendix A. Site Vicinity Map, Test Location Plan, Subsurface Profile



HDR ENGINEERING INC.
OF THE CAROLINAS

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SC 215 (Buffalo-West Springs Hwy) over Fairforest Creek

COUNTY

UNION

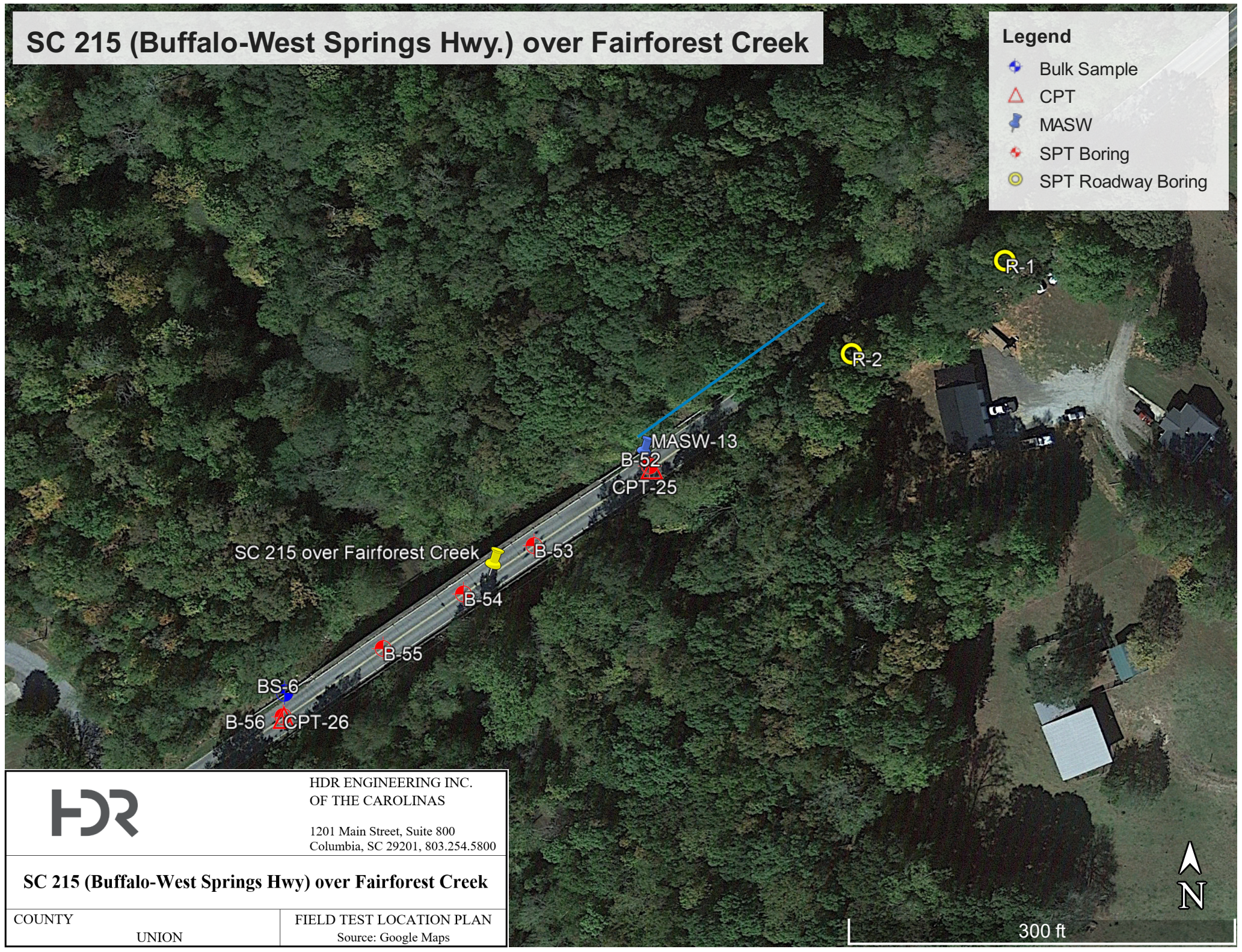
SITE VICINITY MAP

Source: Google Maps

SC 215 (Buffalo-West Springs Hwy.) over Fairforest Creek

Legend

- Bulk Sample
- CPT
- MASW
- SPT Boring
- SPT Roadway Boring



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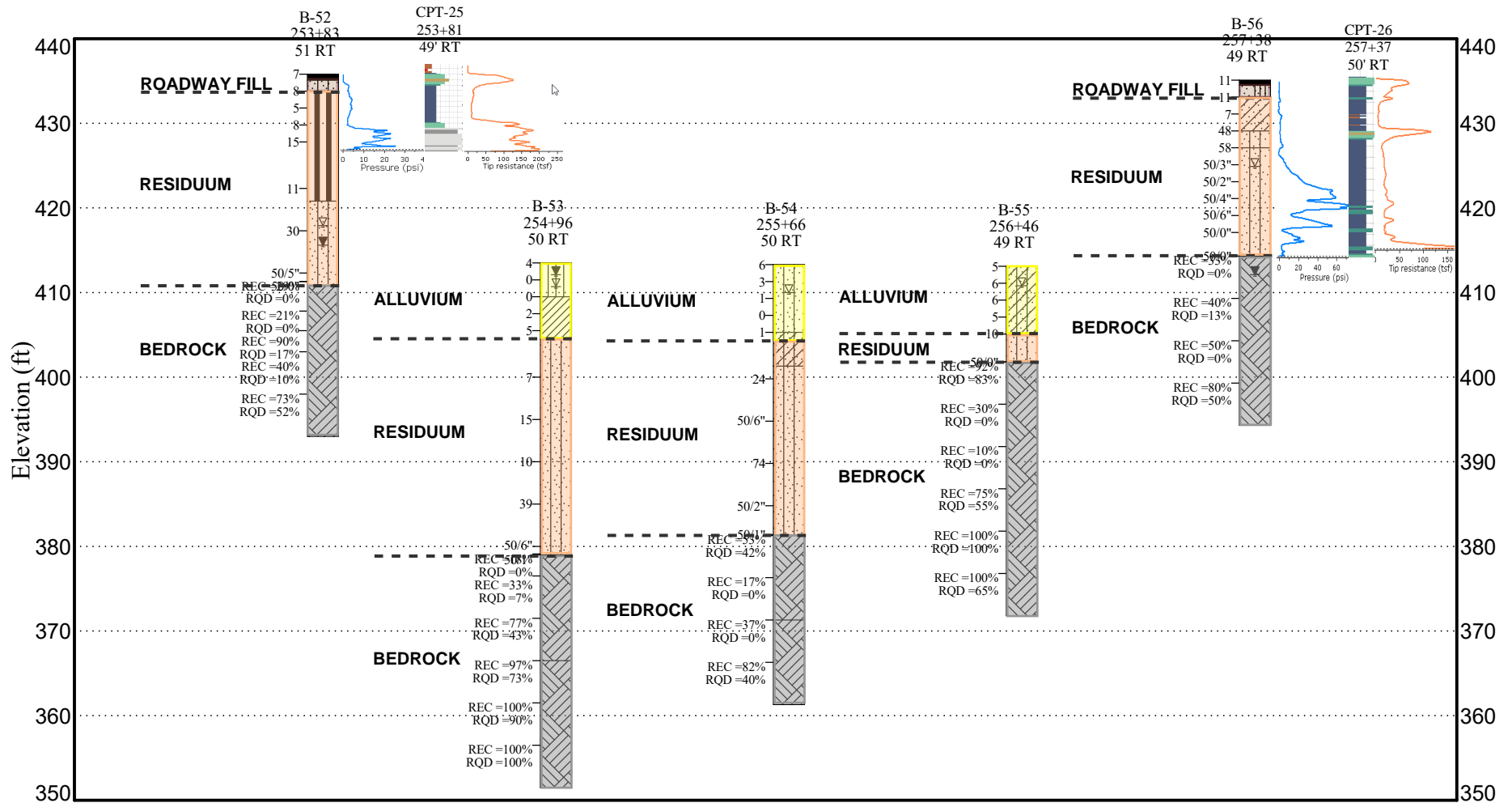
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SC 215 (Buffalo-West Springs Hwy) over Fairforest Creek

COUNTY	UNION	FIELD TEST LOCATION PLAN
		Source: Google Maps



300 ft



BORING	ELEVATION	STATION	OFFSET
B-52	435.8	253+83	51 RT
B-53	413.5	254+96	50 RT
B-54	413.3	255+66	50 RT
B-55	413.1	256+46	49 RT
B-56	435.1	257+38	49 RT

	<u>Roadway Fill</u> - Silty Sand, Poorly-graded Sand with silt (SM, SP-SM/A-2-4)
	<u>Alluvium</u> - Sandy Silt, Lean Clay with sand, Silty Sand, Silty Clayey Sand (ML, CL, SM, SC-SM/A-7-6, A-6, A-4)
	<u>Residuum</u> - Sandy Elastic Silt, Silty Sand, Clayey Sand (MH, SM, SC/A-7-5, A-2-4, A-4, A-7-6)
	<u>Bedrock</u> - Gneiss



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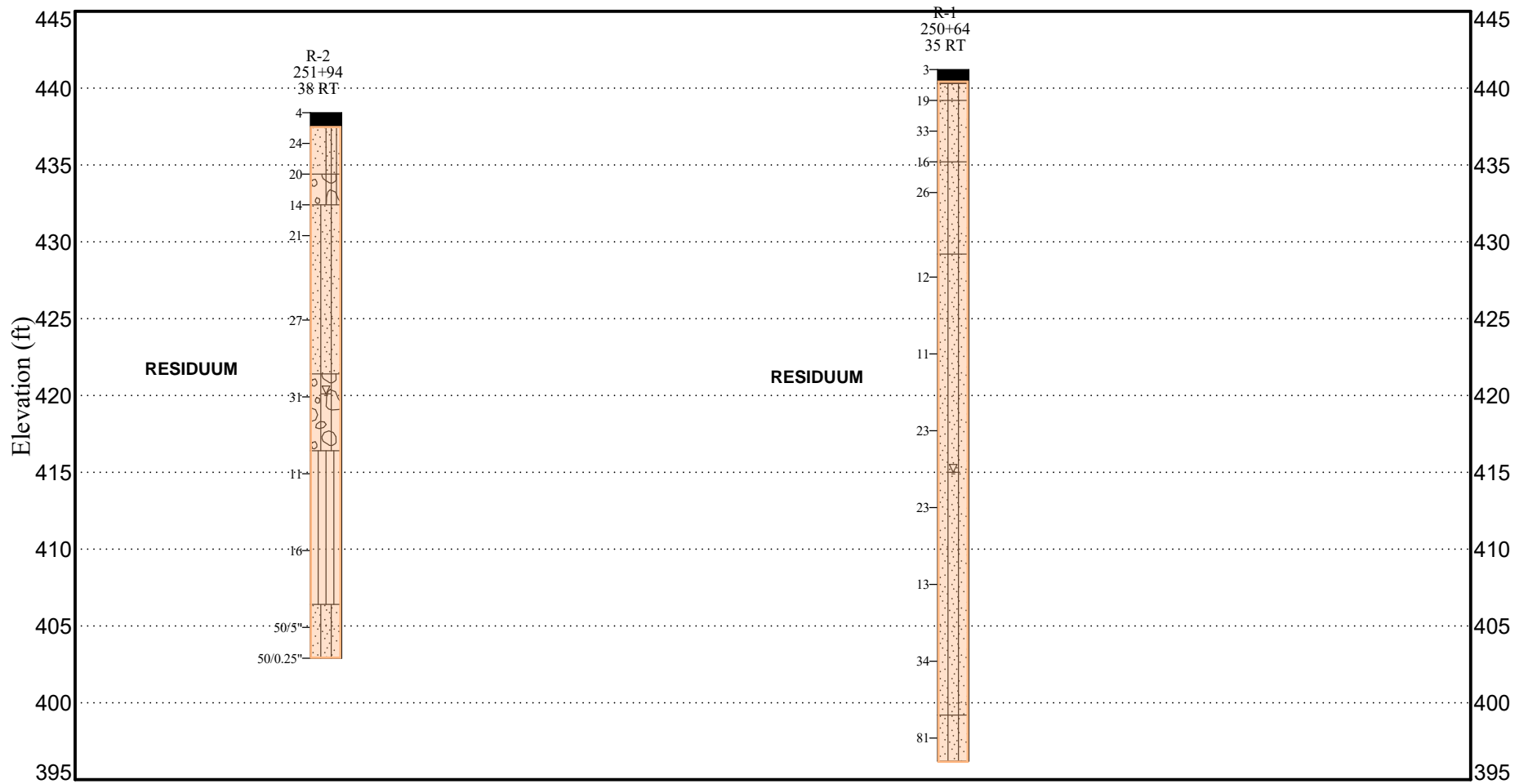
SUBSURFACE PROFILE

SC 215 over Fairforest Creek
Union, SC County, South Carolina

PROJECT ID.
P041236

DATE
Feb 2023

PLATE
1



BORING	ELEVATION	STATION	OFFSET
R-1	441.2	250+64	35 RT
R-2	438.4	251+94	38 RT



Residuum - Silty Sand, Poorly-graded Sand with silt, Poorly-graded Gravel with sand and silt, Silty Gravel with sand, Silt with sand (SM, SP-SM, GP-GM, GM, ML/A-2-4, A-1-b)



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SUBSURFACE PROFILE

SC 215 over Fairforest Creek
Union, SC County, South Carolina




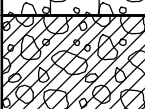
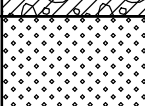
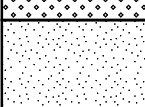
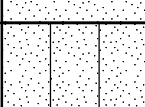
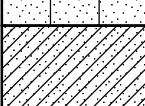
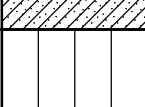
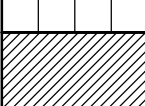
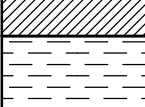
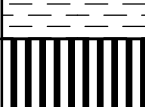

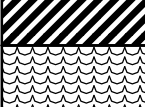
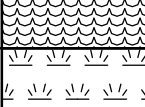
PROJECT ID.
P041236

DATE
Mar 2023

PLATE
2

Appendix B. Boring Logs, Rock Core Photos, CPT Logs, MASW Profile

SOIL CLASSIFICATION CHART

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

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

SCDOT Soil Test Log Descriptors

a

-

Relative Density / Consistency Terms

Relative Density ¹			Consistency ²		
Descriptive Term	Relative Density	SPT Blow Count	Descriptive Term	Unconfined Compression Strength (q _u) (tsf)	SPT Blow Count
Very Loose	0 to 15%	< 4	Very Soft	<0.25	<2
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	Very Stiff	2.01 to 4.00	16 to 30
			Hard	>4.01	> 31

b

Moisture Condition

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

c

Color

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

d

Angularity¹

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

e

HCl Reaction³

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

f

Cementation³

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

g

Particle-Size Range¹

Gravel		Sand	
mm	Sieve size	mm	Sieve size
Fine	4.76 to 19.1	Fine	0.074 to 0.42
Coarse	19.1 to 76.2	Medium	0.42 to 2.00
		Coarse	4.00 to 4.76

h

Primary Soil Type^{1,2}

The primary soil type will be shown in all capital letters

i

USCS Soil Designation

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

j

AASHTO Soil Designation

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

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

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

SCDOT Soil Test Log Descriptors

k **Rock Type**
Indicate type of rock encountered (i.e. granite, limestone, shale, slate, etc.)

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

m **Texture**
Describe the nonfracture structural features. Stratification is the layering of sedimentary rock and foliation is the layering of metaphoric rock

<u>Descriptive Term</u>	<u>Criteria</u>
Very Thickly Bedded	> 1.0 m
Thickly Bedded	0.5 to 1.0 m
Thinly Bedded	50 to 500 mm
Very Thinly Bedded	10 to 50 mm
Laminated	2.5 to 10 mm
Thinly Laminated	< 2.5 mm

n **Grain Size and Shape**
Describe the size and shape of all visible grains, typically used on sedimentary rock.

<u>Size</u>		<u>Sieve size</u>
<u>Descriptor</u>	<u>mm</u>	
Very coarse grained	> 4.75	Grain sizes greater than popcorn kernels
Coarse grained	2.00 – 4.75	Individual grains easy to distinguish by eye
Medium grained	0.425 – 2.00	Individual grains distinguished by eye
Fine grained	0.075 – 0.425	Individual grains distinguished with difficulty
Very Fine grained	< 0.075	Individual grains cannot be distinguished by unaided eye
<u>Shape</u>		
<u>Descriptive Term</u>	<u>Criteria</u>	
Angular	Shows little wear; edges and corners are sharp	
Subangular	Shows definite effects of wear; edges and corners are slightly rounded off	
Subrounded	Shows considerable wear; edges and corners are rounded to smooth curves	
Rounded	Shows extreme wear; edges and corners are smoother to broad curves	
Well-rounded	Completely worn; edges and corners are not present	

o **Weathering / Alteration**
Weathering is the physical disintegration of the minerals by atmospheric processes. Alteration is disintegration of the minerals by geothermal processes.

<u>Description</u>	<u>Recognition</u>
Residual Soil	Original minerals of rock have been entirely decomposed to secondary minerals, and original rock fabric is not apparent; material can be easily broken by hand
Completely Weathered / Altered	Original minerals of rock have been almost entirely decomposed to secondary minerals, although the original fabric may be intact; material can be granulated by hand
Highly Weathered / Altered	More than half of the rock is decomposed; rock is weakened so that a minimum 1-7/8 inch diameter sample can be easily broken readily by hand across rock fabric
Moderately Weathered / Altered	Rock is discolored and noticeably weakened, but less than half is decomposed; a minimum 1-7/8 inch diameter sample cannot be broken readily by hand across rock fabric
Slightly Weathered / Altered	Rock is slightly discolored, but not noticeably lower in strength than fresh rock
Fresh	Rock shows no discoloration, loss of strength, or other effect of weathering / alteration

Figure 6-16, SCDOT Soil Test Log Descriptors – Rock

SCDOT Soil Test Log Descriptors
p**Rock Strength**

Provide a qualitative assessment of the rock strength using either a geologic hammer or knife.

Description	Recognition	Approximately Uniaxial Compressive Strength (psi)
Extremely Weak Rock	Can be indented by thumbnail	35 – 150
Very Weak Rock	Can be peeled by pocket knife	150 – 700
Weak Rock	Can be peeled with difficulty by pocket knife	700 – 3,500
Medium Strong Rock	Can be indented 3/16 inch with sharp end of pick	3,500 – 7,200
Strong Rock	Requires one hammer blow to fracture	7,200 – 14,500
Very Strong Rock	Requires many hammer blows to fracture	14,500 – 35,000
Extremely Strong Rock	Can only be chipped with hammer blows	> 35,000

q**Strike and Dip**

Dip of fracture surface measured relative to horizontal with bearing and direction (i.e. N30°down, etc.)

r**Discontinuity Type****s****Discontinuity Width (millimeters)****t****Amount of Infilling**

F - Fault	W - Wide (12.5 – 50)	Su - Surface Stain
J - Joint	MW - Moderately Wide (2.5 – 12.5)	Sp - Spotty
Sh - Shear	N - Narrow (1.25 – 2.5)	Pa - Partially Filled
Fo - Foliation	VN - Very Narrow (< 1.25)	Fi - Filled
V - Vein	T - Tight (0)	No - None
B - Bedding		

u**Type of Infilling****v****Surface Shape of Joint****w****Discontinuity Spacing (feet)**

Cl - Clay	Wa - Wavy	EW - Extremely Wide (> 65)
Ca - Calcite	Pl - Planar	W - Wide (22 – 65)
Ch - Chloride	St - Stepped	M - Moderate (7.5 – 22)
Fe - Iron Oxide	Ir - Irregular	C - Close (2 – 7.5)
Gy - Gypsum/Talc		VC - Very Close (< 2)
H - Healed		
No - None		
Py - Pyrite		
Qz - Quartz		
Sd - Sand		

x**Roughness of Surface**

Slk - Slickensided (surface has smooth, glassy finish with visual evidence of striations)
S - Smooth (surface appears smooth and feels so to the touch)
SR - Slightly Rough (asperities on the discontinuity surfaces are distinguishable and can be felt)
R - Rough (some ridges and side-angle steps are evident; asperities are clearly visible, and discontinuity surface feels very abrasive)
VR - Very Rough (near-vertical steps and ridges occur on the discontinuity surface)

Figure 6-17, SCDOT Soil Test Log Descriptors – Rock (con't)

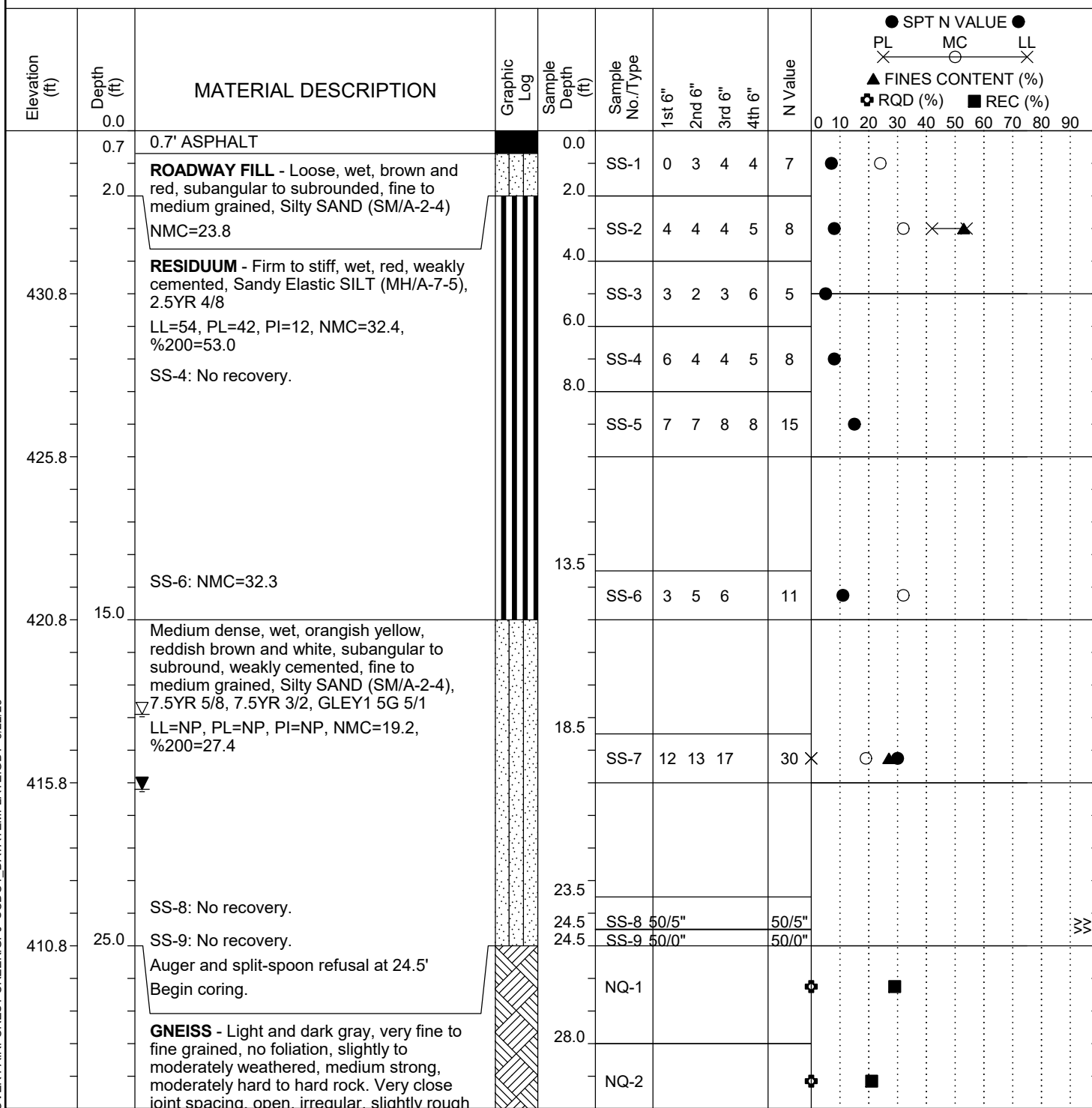


Appendix B. Subsurface Investigation

Boring Logs

SCDOT Soil Test Log

Project ID:	P041236	County:	Union, SC	Boring No.:	B-52
Site Description:	SC 215 over Fairforest Creek			Route:	SC 215
Eng./Geo.:	K. Hughes/HDR	Boring Location:	253+83	Offset:	51 RT
Elev.:	435.8 ft	Latitude:	34.71665	Longitude:	-81.70914
Date Started:	1/12/2023				
Total Depth:	42.8 ft	Soil Depth:	24.5 ft	Core Depth:	18.3 ft
Date Completed:	1/12/2023				
Bore Hole Diameter (in):	2.97"	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW	Hammer Type:	Automatic
Energy Ratio:	87%				
Core Size:	NQ	Driller:	J. Phillips/F&ME	Groundwater:	TOB 17.9 ft
24HR	20.2 ft				



LEGEND

Continued Next Page

SAMPLER TYPE

DRILLING METHOD

SS - Split Spoon
UD - Undisturbed Sample
AWG - Rock Core, 1-1/8"

NQ - Rock Core, 1-7/8"
CU - Cuttings
CT - Continuous Tube

HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing

RW - Rotary Wash
RC - Rock Core

SCDOT Soil Test Log

Project ID:	P041236	County:	Union, SC	Boring No.:	B-52
Site Description:	SC 215 over Fairforest Creek			Route:	SC 215
Eng./Geo.:	K. Hughes/HDR	Boring Location:	253+83	Offset:	51 RT
Elev.:	435.8 ft	Latitude:	34.71665	Longitude:	-81.70914
Date Started:	1/12/2023				
Total Depth:	42.8 ft	Soil Depth:	24.5 ft	Core Depth:	18.3 ft
Date Completed:	1/12/2023				
Bore Hole Diameter (in):	2.97"	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW	Hammer Type:	Automatic
Energy Ratio:	87%				
Core Size:	NQ	Driller:	J. Phillips/F&ME	Groundwater:	TOB 17.9 ft
24HR	20.2 ft				

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	● SPT N VALUE ● PL X — MC — LL X ▲ FINES CONTENT (%) + RQD (%) ■ REC (%)
400.8		to rough, with surface stains. NQ-1: %REC=29, RQD=0, 2.0 min/ft, GSI=15-20 NQ-2: %REC=21, RQD=0, GSI=15-20 NQ-3: %REC=90, RQD=17, 2.7 min/ft, GSI=20-25 NQ-4: Joints tight to open. %REC=40, RQD=10, 1.1 min/ft, GSI=20-25		30.3	NQ-3						0 10 20 30 40 50 60 70 80 90 + 20 ■ 80
395.8		NQ-5: Fresh to slightly weathered, medium strong to strong, moderately hard to hard rock. Very close to close joint spacing, very tight to tight, planar, smooth to slightly rough. %REC=73, RQD=52, 2.0 min/ft, qu=50,270 psi, GSI=40-45, RMR=65		32.8	NQ-4						+ 20 ■ 40
390.8	42.8	Boring terminated at 42.8' (Elev. 393.0')		37.8	NQ-5						+ 50 ■ 70
385.8											
380.8											

LEGEND

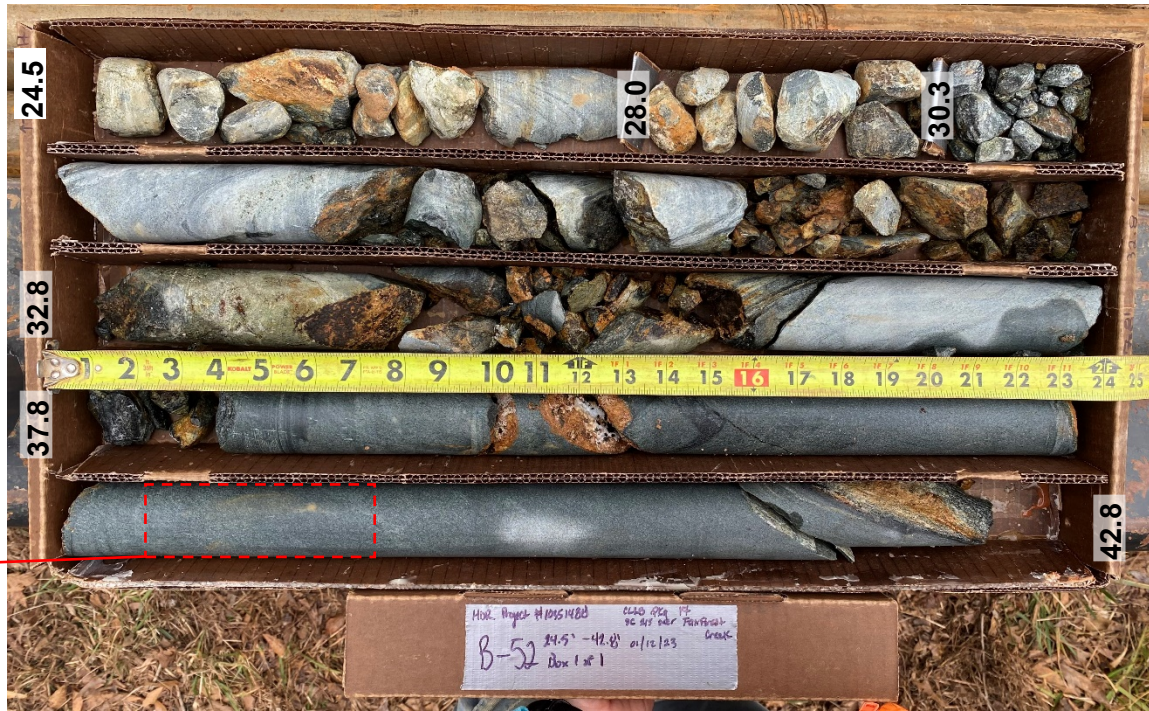
SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SC.DOT SC 215 OVER FAIRFOREST CREEK.GPJ SCDOT_DATATEMPLATE.GDT 3/22/23

Rock Core Photos

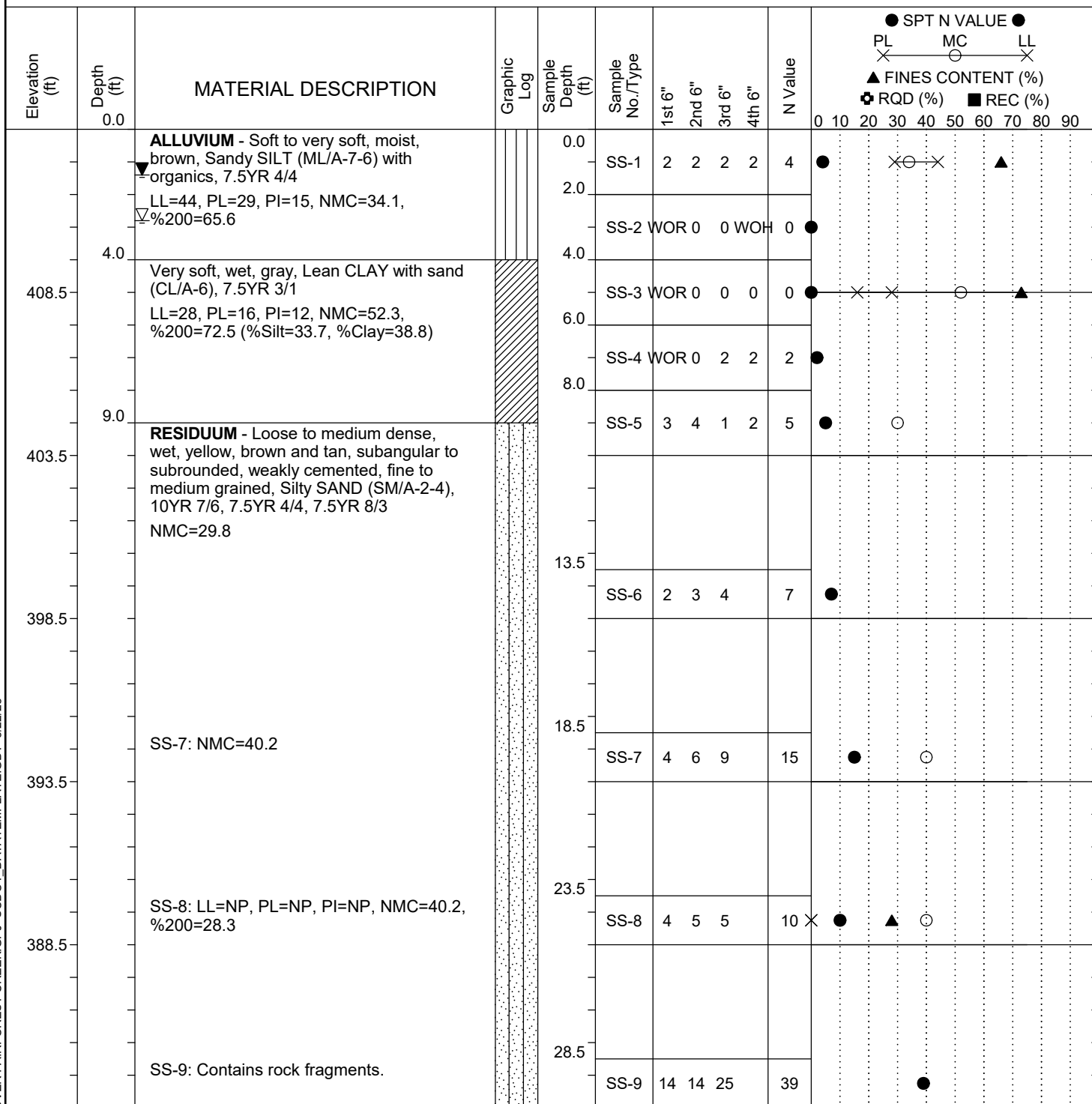
B-52

Box 1 of 1 (24.5' to 42.8')



SCDOT Soil Test Log

Project ID:	P041236	County:	Union, SC	Boring No.:	B-53
Site Description:	SC 215 over Fairforest Creek			Route:	SC 215
Eng./Geo.:	K. Hughes/HDR	Boring Location:	254+96	Offset:	50 RT
Elev.:	413.5 ft	Latitude:	34.7165	Longitude:	-81.70945
Date Started:	1/16/2023				
Total Depth:	62 ft	Soil Depth:	34.5 ft	Core Depth:	27.5 ft
Date Completed:	1/16/2023				
Bore Hole Diameter (in):	2.97"	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW	Hammer Type:	Automatic
Energy Ratio:	87%				
Core Size:	NQ	Driller:	J. Phillips/F&ME	Groundwater:	TOB 2.8 ft
24HR	1.4 ft				



LEGEND

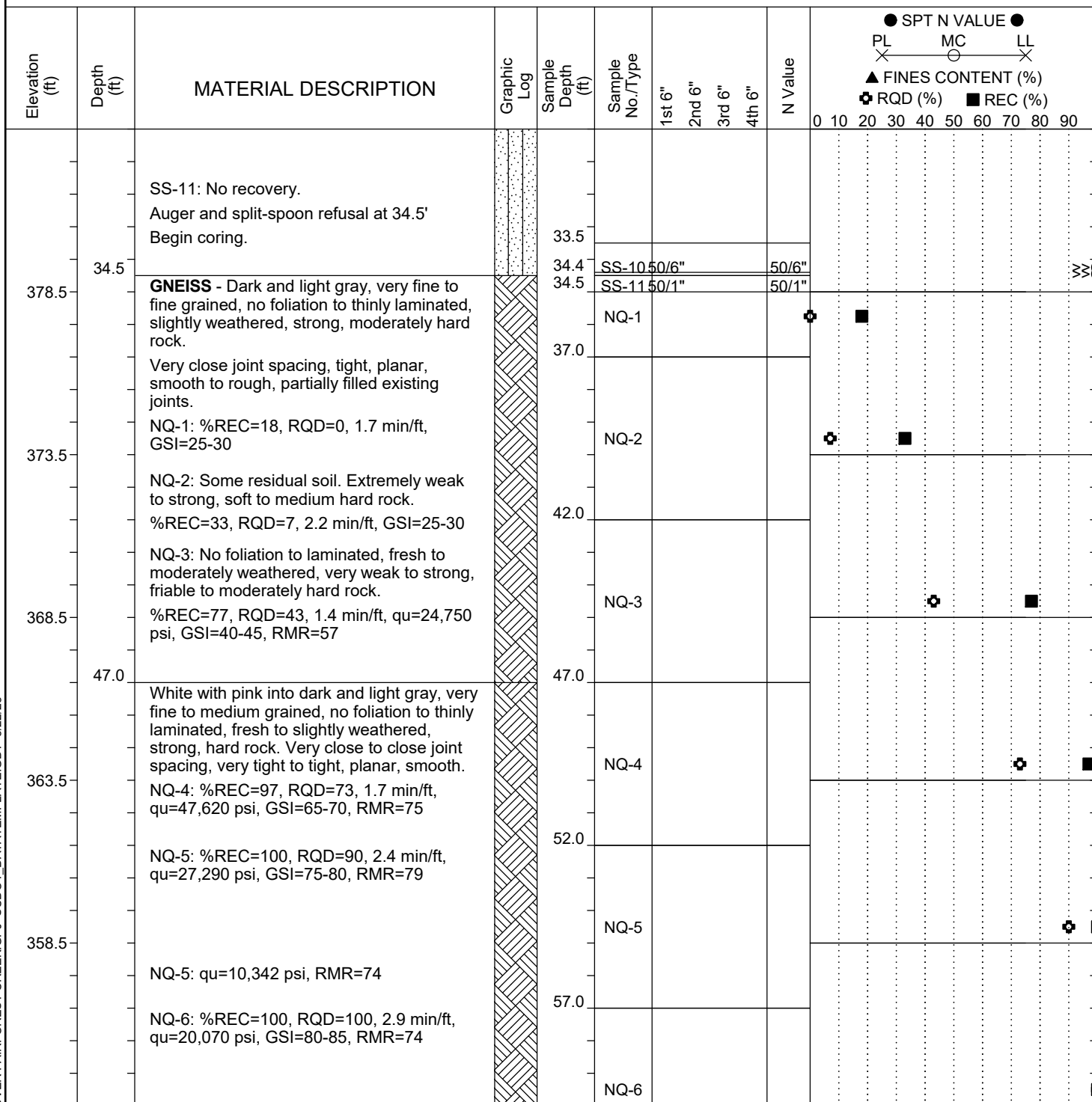
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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving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

SC.DOT SC 215 OVER FAIRFOREST CREEK.GPJ SCDOT_DATATEMPLATE.GDT 3/22/23

SCDOT Soil Test Log

Project ID:	P041236	County:	Union, SC	Boring No.:	B-53
Site Description:	SC 215 over Fairforest Creek			Route:	SC 215
Eng./Geo.:	K. Hughes/HDR	Boring Location:	254+96	Offset:	50 RT
Elev.:	413.5 ft	Latitude:	34.7165	Longitude:	-81.70945
Date Started:	1/16/2023				
Total Depth:	62 ft	Soil Depth:	34.5 ft	Core Depth:	27.5 ft
Date Completed:	1/16/2023				
Bore Hole Diameter (in):	2.97"	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW	Hammer Type:	Automatic
Energy Ratio:	87%				
Core Size:	NQ	Driller:	J. Phillips/F&ME	Groundwater:	TOB 2.8 ft
24HR	1.4 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	

SCDOT Soil Test Log

Project ID:	P041236	County:	Union, SC	Boring No.:	B-53
Site Description:	SC 215 over Fairforest Creek			Route:	SC 215
Eng./Geo.:	K. Hughes/HDR	Boring Location:	254+96	Offset:	50 RT
Elev.:	413.5 ft	Latitude:	34.7165	Longitude:	-81.70945
Date Started:	1/16/2023				
Total Depth:	62 ft	Soil Depth:	34.5 ft	Core Depth:	27.5 ft
Date Completed:	1/16/2023				
Bore Hole Diameter (in):	2.97"	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW	Hammer Type:	Automatic
Energy Ratio:	87%				
Core Size:	NQ	Driller:	J. Phillips/F&ME	Groundwater:	TOB 2.8 ft
24HR	1.4 ft				

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	● SPT N VALUE ● PL — MC — LL X — X — X ▲ FINES CONTENT (%) + RQD (%) ■ REC (%)
	62.0	Boring terminated at 62.0' (Elev. 351.5')									0 10 20 30 40 50 60 70 80 90
348.5											
343.5											
338.5											
333.5											
328.5											

LEGEND

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

SC.DOT SC 215 OVER FAIRFOREST CREEK GPJ SCDOT_DATATEMPLATE.GDT 3/22/23

Rock Core Photos

B-53

Box 1 of 3 (34.5' to 47.0')



B-53

Box 2 of 3 (47.0' to 57.0')



B-53
Box 3 of 3 (57.0' to 62.0')



SCDOT Soil Test Log

Project ID:	P041236	County:	Union, SC	Boring No.:	B-54
Site Description:	SC 215 over Fairforest Creek			Route:	SC 215
Eng./Geo.:	K. Hughes/HDR	Boring Location:	255+66	Offset:	50 RT
Elev.:	413.3 ft	Latitude:	34.71637	Longitude:	-81.70964
Date Started:	1/17/2023				
Total Depth:	52 ft	Soil Depth:	32 ft	Core Depth:	20 ft
Date Completed:	1/18/2023				
Bore Hole Diameter (in):	2.97"	Sampler Configuration		Liner Required:	Y (N)
Liner Used:	Y (N)				
Drill Machine:	CME 550X	Drill Method:	RW	Hammer Type:	Automatic
Energy Ratio:	87%				
Core Size:	NQ	Driller:	J. Phillips/F&ME	Groundwater:	TOB 3.3 ft
24HR	N.M.				

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	● SPT N VALUE ● PL MC LL X—O—X ▲ FINES CONTENT (%) + RQD (%) ■ REC (%) 0 10 20 30 40 50 60 70 80 90
408.3	0.0	ALLUVIUM - Loose to very loose, moist to wet, brown, subangular, fine to medium Silty SAND (SM/A-4) with organics, 7.5YR 4/4, 7.5YR 4/6 LL=NP, PL=NP, PI=NP, NMC=29.9, %200=43.7 SS-3: LL=25, PL=22, PI=3, NMC=33.0, %200=43.8		0.0	SS-1	WOH 3	3	2		6	●
	2.0			2.0	SS-2	2	2	1	2	3	X ●
	4.0			4.0	SS-3	WOH 1	0			1	● X X O ▲
	6.0			6.0	SS-4	WOH 0	0			0	●
403.3	8.0	Very loose, wet, gray, subangular, fine to medium grained, Silty, Clayey SAND (SC-SM/A-4), 7.5YR 3/1 LL=26, PL=20, PI=6, NMC=35.5, %200=47.9 (%Silt=28.3, %Clay=19.6)		8.0	SS-5	WOR 0	1	0		1	● X X O ▲
398.3	12.0	RESIDUUM - Medium dense to very dense, moist to wet, grayish brown, dark brown and black, subangular to subrounded, weakly cemented, fine to medium grained, Silty SAND (SM/A-2-4), 2.5Y 5/4, 10YR 4/2, 10YR 2/1 NMC=13.7		13.5	SS-6	5	16	8		24	O ●
393.3				18.5	SS-7	27	50			50/6"	>> ●
388.3		LL=NP, PL=NP, PI=NP, NMC=15.1, %200=20.1		23.5	SS-8	24	34	40		74	X O ▲ ●
		SS-10: No recovery.		28.5	SS-9	26	50/2"			50/2"	>> ●

LEGEND

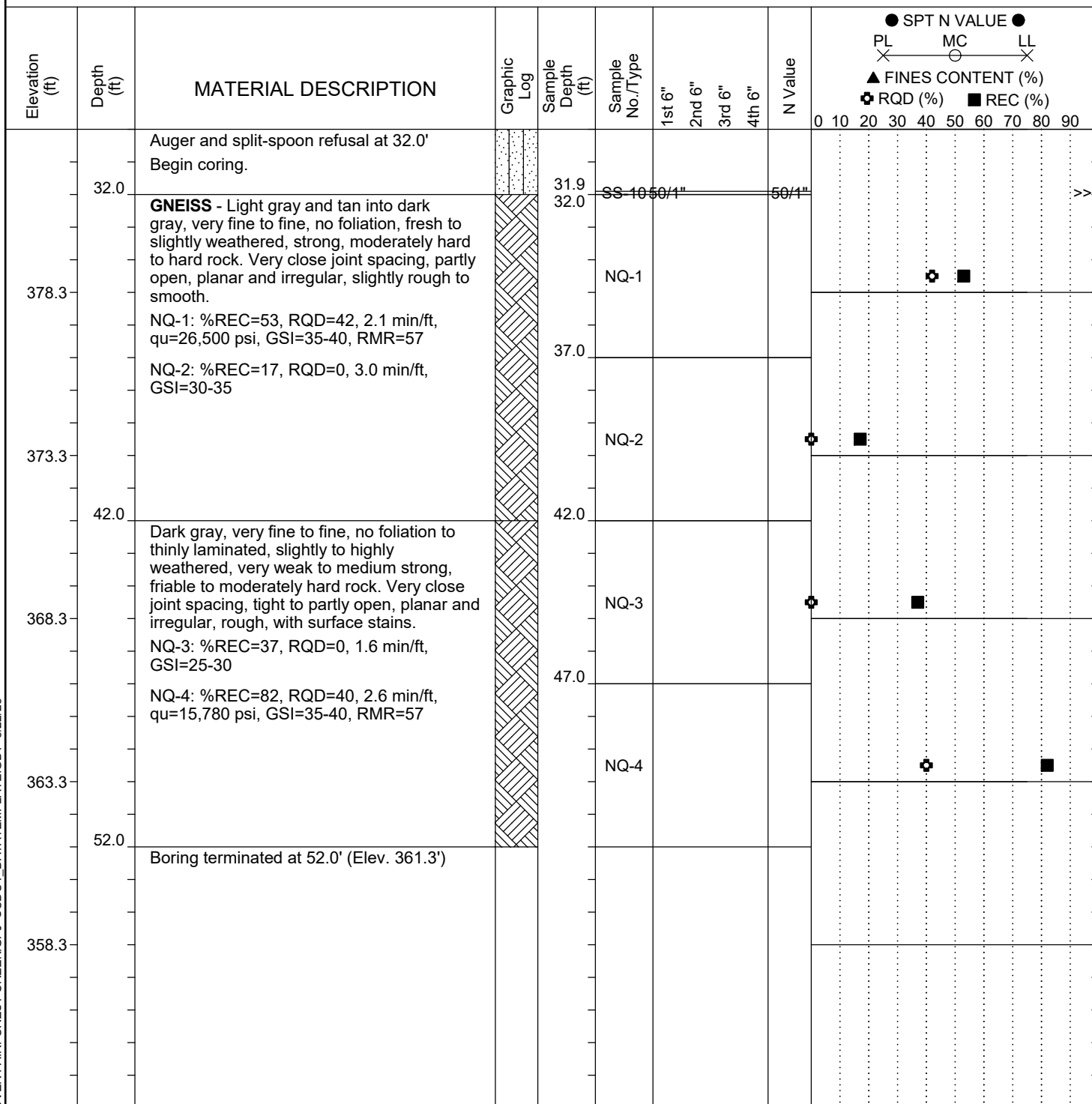
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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving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

SC.DOT SC 215 OVER FAIRFOREST CREEK.GPJ SCDOT_DATATEMPLATE.GDT 3/22/23

SCDOT Soil Test Log

Project ID:	P041236	County:	Union, SC	Boring No.:	B-54
Site Description:	SC 215 over Fairforest Creek			Route:	SC 215
Eng./Geo.:	K. Hughes/HDR	Boring Location:	255+66	Offset:	50 RT
Elev.:	413.3 ft	Latitude:	34.71637	Longitude:	-81.70964
Date Started:	1/17/2023				
Total Depth:	52 ft	Soil Depth:	32 ft	Core Depth:	20 ft
Date Completed:	1/18/2023				
Bore Hole Diameter (in):	2.97"	Sampler Configuration		Liner Required:	Y (N)
Liner Used:	Y (N)				
Drill Machine:	CME 550X	Drill Method:	RW	Hammer Type:	Automatic
Energy Ratio:	87%				
Core Size:	NQ	Driller:	J. Phillips/F&ME	Groundwater:	TOB 3.3 ft
24HR:	N.M.				



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 SC 215 OVER FAIRFOREST CREEK GPJ SCDOT_DATATEMPLATE.GDT 3/22/23

Rock Core Photos

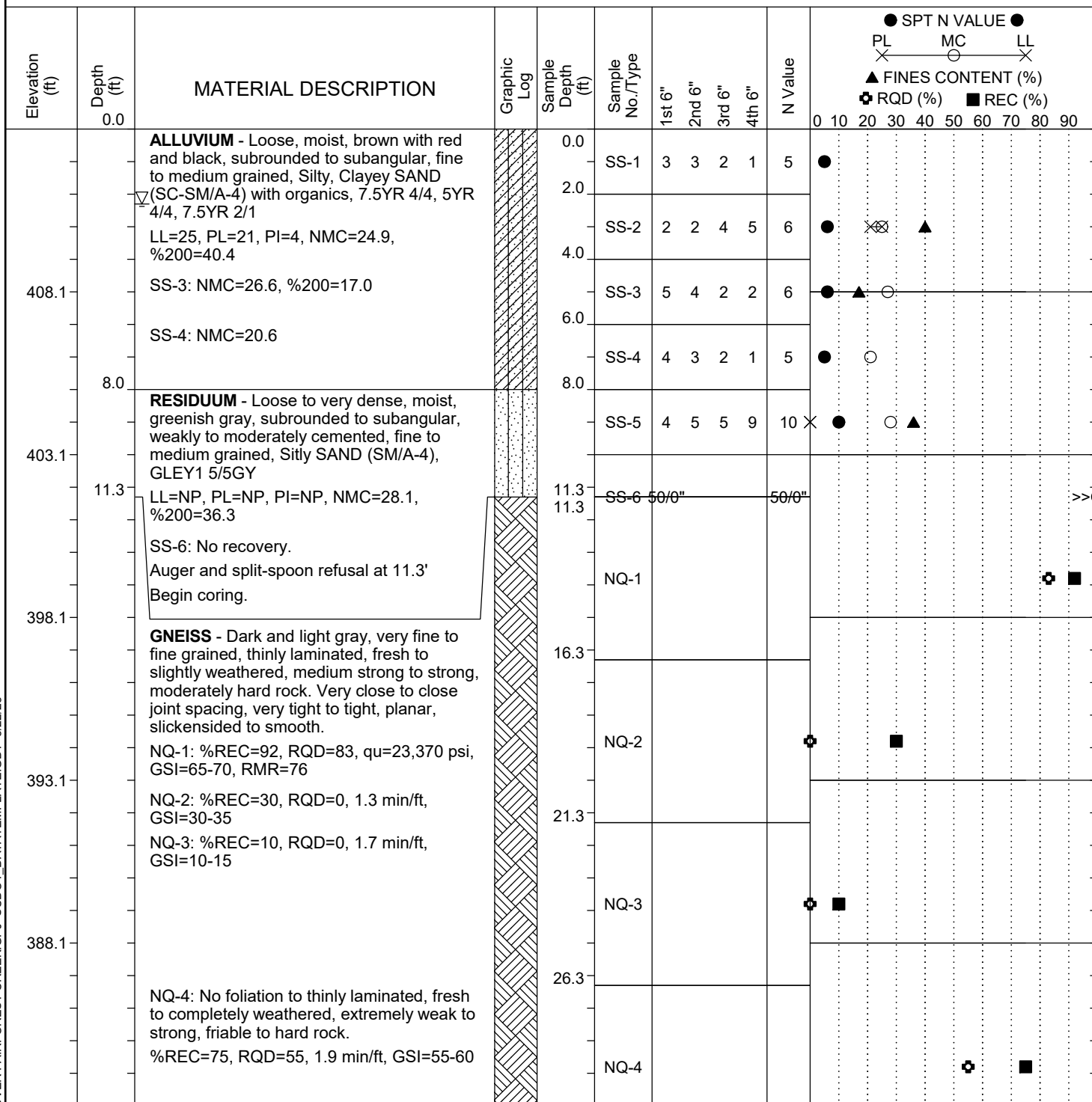
B-54

Box 1 of 1 (32.0' to 52.0')



SCDOT Soil Test Log

Project ID:	P041236	County:	Union, SC	Boring No.:	B-55
Site Description:	SC 215 over Fairforest Creek			Route:	SC 215
Eng./Geo.:	K. Hughes/HDR	Boring Location:	256+46	Offset:	49 RT
Elev.:	413.1 ft	Latitude:	34.71625	Longitude:	-81.70986
Date Started:	1/18/2023				
Total Depth:	41.3 ft	Soil Depth:	11.3 ft	Core Depth:	30 ft
Date Completed:	1/18/2023				
Bore Hole Diameter (in):	2.97"	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW	Hammer Type:	Automatic
Energy Ratio:	87%				
Core Size:	NQ	Driller:	J. Phillips/F&ME	Groundwater:	TOB 2.3 ft
24HR	N.M.				



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	

SCDOT Soil Test Log

Project ID:	P041236	County:	Union, SC	Boring No.:	B-55
Site Description:	SC 215 over Fairforest Creek			Route:	SC 215
Eng./Geo.:	K. Hughes/HDR	Boring Location:	256+46	Offset:	49 RT
Elev.:	413.1 ft	Latitude:	34.71625	Longitude:	-81.70986
Date Started:	1/18/2023				
Total Depth:	41.3 ft	Soil Depth:	11.3 ft	Core Depth:	30 ft
Date Completed:	1/18/2023				
Bore Hole Diameter (in):	2.97"	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW	Hammer Type:	Automatic
Energy Ratio:	87%				
Core Size:	NQ	Driller:	J. Phillips/F&ME	Groundwater:	TOB 2.3 ft
24HR	N.M.				

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	● SPT N VALUE ● PL X — MC — LL X ▲ FINES CONTENT (%) + RQD (%) ■ REC (%)
378.1	41.3	NQ-5: Fresh, strong, hard rock. Close joint spacing. %REC=100, RQD=100, 2.1 min/ft, qu=11,200 psi, GSI=80-85, RMR=74 NQ-5: qu=22,860, RMR=79 NQ-6: %REC=100, RQD=65, 2.4 min/ft, qu=9,900 psi, GSI=80-85, RMR=67		31.3							
					NQ-5						
373.1				36.3							
					NQ-6						
		Boring terminated at 41.3' (Elev. 371.8')									
368.1											
363.1											
358.1											

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 SC 215 OVER FAIRFOREST CREEK.GPJ SCDOT_DATATEMPLATE.GDT 3/22/23

Rock Core Photos

B-55

Box 1 of 3 (11.3' to 26.3')



B-55

Box 2 of 3 (26.3' to 36.3')

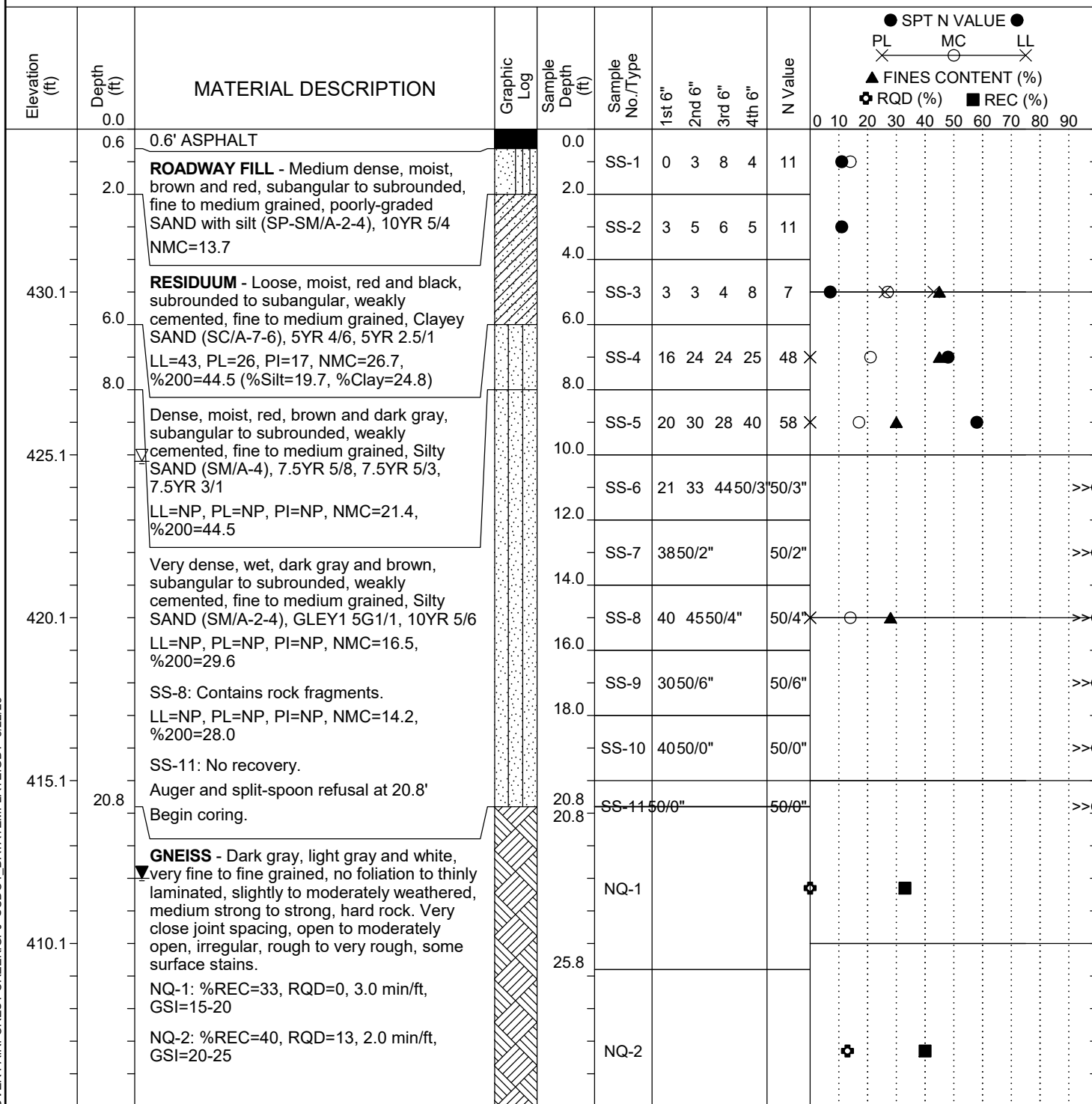


B-55
Box 3 of 3 (36.3' to 41.3')



SCDOT Soil Test Log

Project ID:	P041236	County:	Union, SC	Boring No.:	B-56
Site Description:	SC 215 over Fairforest Creek			Route:	SC 215
Eng./Geo.:	K. Hughes/HDR	Boring Location:	257+38	Offset:	49 RT
Elev.:	435.1 ft	Latitude:	34.71611	Longitude:	-81.71012
Date Started:	1/13/2023				
Total Depth:	40.8 ft	Soil Depth:	20.8 ft	Core Depth:	20 ft
Date Completed:	1/13/2023				
Bore Hole Diameter (in):	2.97"	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW	Hammer Type:	Automatic
Energy Ratio:	87%				
Core Size:	NQ	Driller:	J. Phillips/F&ME	Groundwater:	TOB 10.2 ft
24HR	23 ft				



LEGEND

Continued Next Page

SC.DOT SC 215 OVER FAIRFOREST CREEK.GPJ SCDOT_DATATEMPLATE.GDT 3/22/23

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:	P041236	County:	Union, SC	Boring No.:	B-56
Site Description:	SC 215 over Fairforest Creek			Route:	SC 215
Eng./Geo.:	K. Hughes/HDR	Boring Location:	257+38	Offset:	49 RT
Elev.:	435.1 ft	Latitude:	34.71611	Longitude:	-81.71012
Date Started:	1/13/2023				
Total Depth:	40.8 ft	Soil Depth:	20.8 ft	Core Depth:	20 ft
Date Completed:	1/13/2023				
Bore Hole Diameter (in):	2.97"	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW	Hammer Type:	Automatic
Energy Ratio:	87%				
Core Size:	NQ	Driller:	J. Phillips/F&ME	Groundwater:	TOB 10.2 ft
24HR	23 ft				

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	● SPT N VALUE ● PL X — MC — LL X ▲ FINES CONTENT (%) + RQD (%) ■ REC (%)
400.1	40.8	NQ-3: Light gray, white, green and pink, very fine to medium grained, no foliation, slightly weathered, strong, hard rock. Very close joint spacing, very tight to partly open, planar, smooth to slightly rough. %REC=50, RQD=0, 2.0 min/ft, GSI=25-30		30.8							
					NQ-3						
395.1		NQ-4: Light gray with green, very fine to fine grained, no foliation, moderately weathered, medium strong to strong, hard rock. Very close to close joint spacing, tight to partly open, planar, smooth to slightly rough, with partially filled existing joints. %REC=80, RQD=50, 1.5 min/ft, qu=38,760 psi, GSI=30-35, RMR=65		35.8							
					NQ-4						
390.1		Boring terminated at 40.8' (Elev. 394.3')									
385.1											
380.1											

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 SC 215 OVER FAIRFOREST CREEK GPJ SCDOT_DATATEMPLATE.GDT 3/22/23

Rock Core Photos

B-56

Box 1 of 1 (20.8' to 40.8')



Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	SPT N VALUE				N Value	FINES CONTENT (%)								
						1st 6"	2nd 6"	3rd 6"	4th 6"		PL	MC	LL	RQD (%)	REC (%)				
	0.0	0.9' ASPHALT		0.0															
	0.9	RESIDUUM - Loose, moist, reddish brown, subangular to subrounded, weakly cemented, fine to medium grained, Silty SAND (SM/A-2-4), 2.5YR 4/4		2.0	SS-1	0	0	3	5	3	●								
	2.0		4.0	SS-2	7	9	10	9	19	○	■								
436.2		Medium dense to dense, dry to moist, reddish brown with white, subangular to subrounded, weakly cemented, fine to coarse grained, Silty SAND (SM/A-2-4) with rock fragments, 2.5YR 4/4, 7.5YR 9.5/1 NMC=10.9, %200=18.6		6.0	SS-3	16	15	18	13	33		●							
	6.0	Medium dense to dense, moist, light brown and red with white, subangular to subrounded, weakly to moderately cemented, fine to medium grained, Silty SAND (SM/A-2-4), 7.5YR 5/2, 2.5YR 4/6, 7.5YR 9.5/1 LL=NP, PL=NP, PI=NP, NMC=16.2, %200=24.1		8.0	SS-4	4	7	9	14	16	×	●	▲						
431.2	12.0		13.5	SS-5	15	14	12	15	26		●								
426.2		Medium dense to dense, dry to moist, brown, red and silver, subangular, weakly cemented, fine to medium grained, Silty SAND (SM/A-2-4), 7.5YR 4/3, 2.5YR 4/6 LL=NP, PL=NP, PI=NP, NMC=29.0, %200=24.6		13.5	SS-6	4	6	6		12	×	●	▲	○					
				18.5	SS-7	4	5	6		11		●							
421.2				23.5	SS-8	5	9	14		23	×		●	▲					
416.2				28.5	SS-9	8	11	12		23		●							

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	

SCDOT Soil Test Log

Project ID:	P041236	County:	Union, SC	Boring No.:	R-1
Site Description:	SC 215 over Fairforest Creek			Route:	SC 215
Eng./Geo.:	B. Gedney/HDR	Boring Location:	250+64	Offset:	35 RT
Elev.:	441.2 ft	Latitude:	34.71713	Longitude:	-81.70825
Date Started:	3/8/2023				
Total Depth:	45 ft	Soil Depth:	45 ft	Core Depth:	0 ft
Date Completed:	3/8/2023				
Bore Hole Diameter (in):	2.97"	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW	Hammer Type:	Automatic
Energy Ratio:	87%				
Core Size:		Driller:	L. Guempel/F&ME	Groundwater:	TOB 26.2 ft
24HR	N.M.				

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	● SPT N VALUE ● PL X — MC — LL X ▲ FINES CONTENT (%) + RQD (%) ■ REC (%)
406.2		SS-10: LL=NP, PL=NP, PI=NP, NMC=34.6, %200=27.6		33.5	SS-10	4	4	9		13 X	● ▲ ○
401.2				38.5	SS-11	9	16	18		34	●
42.0		Very dense, dry to moist, brown and white, subangular, weakly cemented, fine to coarse grained, Silty SAND (SM/A-2-4), 7.5YR 4/3, 7.5YR 9.5/1		43.5	SS-12	41	35	46		81 X	○ ▲ ●
396.2	45.0	LL=NP, PL=NP, PI=NP, NMC=15.5, %200=22.9									
		Boring terminated at 45.0' (Elev. 396.2')									
391.2											
386.2											

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 SC 215 OVER FAIRFOREST CREEK.GPJ SCDOT_DATATEMPLATE.GDT 3/22/23

SCDOT Soil Test Log

Project ID:	P041236	County:	Union, SC	Boring No.:	R-2
Site Description:	SC 215 over Fairforest Creek			Route:	SC 215
Eng./Geo.:	B. Gedney/HDR	Boring Location:	251+94	Offset:	38 RT
Elev.:	438.4 ft	Latitude:	34.71692	Longitude:	-81.70859
Date Started:	3/8/2023				
Total Depth:	35 ft	Soil Depth:	35 ft	Core Depth:	0 ft
Date Completed:	3/8/2023				
Bore Hole Diameter (in):	2.97"	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW	Hammer Type:	Automatic
Energy Ratio:	87%				
Core Size:		Driller:	L. Guempel/F&ME	Groundwater:	TOB 18.3 ft
24HR	N.M.				

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	● SPT N VALUE ● PL X MC X LL X ▲ FINES CONTENT (%) + RQD (%) ■ REC (%)
	0.0	0.9' ASPHALT		0.0							
	0.9	RESIDUUM - Loose to medium dense, dry to moist, brown and red, subangular, weakly cemented, fine to coarse grained, poorly-graded SAND with silt (SP-SM/A-2-4), 7.5YR 3/3, 2.5YR 4/4		2.0	SS-1	0	0	4	4	4	●
	4.0	NMC=13.0, %200=12.2		4.0	SS-2	8	11	13	16	24	▲ ●
433.4	6.0	SS-2: Contains rock fragments.		6.0	SS-3	12	9	11	13	20	▲ ●
	8.0	Medium dense, dry, dark brown, subangular, weakly cemented, medium to coarse grained, poorly-graded GRAVEL with silt and sand (GP-GM/A-1-b), 7.5YR 3/3		8.0	SS-4	3	6	8	9	14	●
428.4		NMC=6.2, %200=7.7			SS-5	4	9	12	19	21	X ● ○ ▲
	13.5	Medium dense, moist, brownish-red, weakly cemented, fine to medium grained, Silty SAND (SM/A-2-4), 5YR 4/4		13.5							
		LL=NP, PL=NP, PI=NP, NMC=25.2, %200=32.7									
423.4		SS-6: Contains rock fragments.			SS-6	5	12	15		27	●
	17.0	Dense, dry, black with reddish-brown, angular to subangular, weakly cemented, fine to coarse grained, Silty GRAVEL (GM/A-1-b) with sand, 7.5YR 2.5/1, 5YR 4/6		18.5	SS-7	10	14	17		31	X ○ ▲ ●
418.4		LL=NP, PL=NP, PI=NP, NMC=16.6, %200=21.2									
	22.0	Soft, moist, reddish brown and silver, weakly cemented, Silty SAND (SM/A-2-4), 5YR 4/6		23.5	SS-8	6	6	5		11	●
413.4											
	28.5	SS-9: Contains rock fragments.		28.5	SS-9	5	5	11		16	●

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 SC 215 OVER FAIRFOREST CREEK GPJ SCDOT_DATATEMPLATE.GDT 3/22/23

SCDOT Soil Test Log

Project ID:	P041236	County:	Union, SC	Boring No.:	R-2
Site Description:	SC 215 over Fairforest Creek			Route:	SC 215
Eng./Geo.:	B. Gedney/HDR	Boring Location:	251+94	Offset:	38 RT
Elev.:	438.4 ft	Latitude:	34.71692	Longitude:	-81.70859
Date Started:	3/8/2023				
Total Depth:	35 ft	Soil Depth:	35 ft	Core Depth:	0 ft
Date Completed:	3/8/2023				
Bore Hole Diameter (in):	2.97"	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	CME 550X	Drill Method:	RW	Hammer Type:	Automatic
Energy Ratio:	87%				
Core Size:		Driller:	L. Guempel/F&ME	Groundwater:	TOB 18.3 ft
24HR	N.M.				

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	● SPT N VALUE ● PL X — MC — LL X ▲ FINES CONTENT (%) + RQD (%) ■ REC (%)
	32.0	Very dense, wet, dark gray, subangular to subrounded, weakly cemented, fine to medium grained, Silty SAND (SM/A-2-4), 7.5YR 4/1									
403.4	35.5	Boring terminated at 35.0' (Elev. 403.4')		33.5	SS-10	8	2550/5"		50/5"		
				35.0	SS-15	0.25"			50/0.25"		
398.4											
393.4											
388.4											
383.4											

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 SC 215 OVER FAIRFOREST CREEK.GPJ SCDOT_DATATEMPLATE.GDT 3/22/23



Appendix B. Subsurface Investigation

CPT Logs

Total depth: 8.56 ft, Date: 11/18/2022

Surface Elevation: 435.90 ft

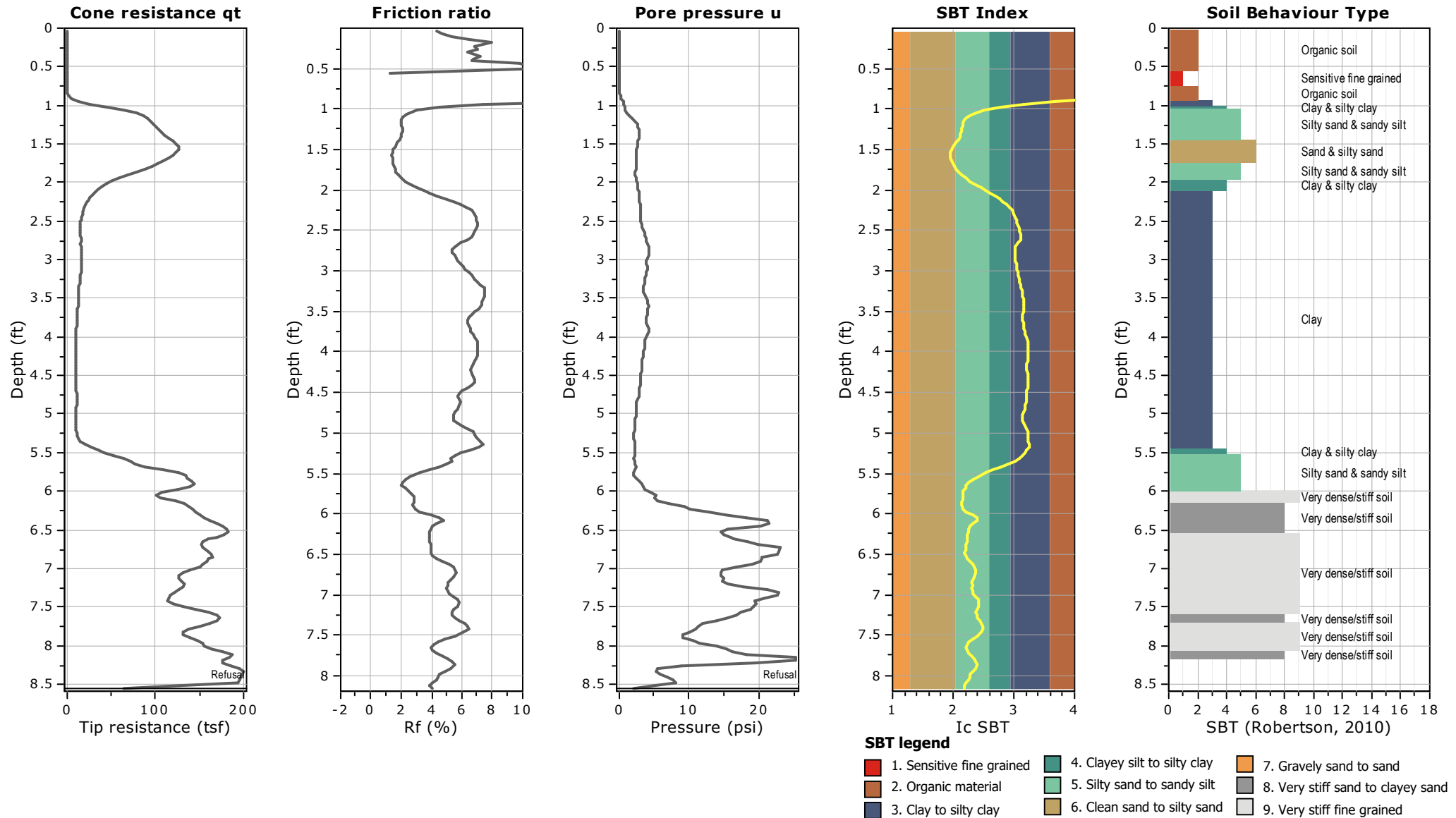
Coords: lat 34.716654° lon -81.709132°

Cone Type: DDG1330

Cone Operator: F&ME Consultants

Project: SC 215 over Fair Forest Creek

Location: Union County, SC



Total depth: 17.59 ft, Date: 11/18/2022

Surface Elevation: 435.30 ft

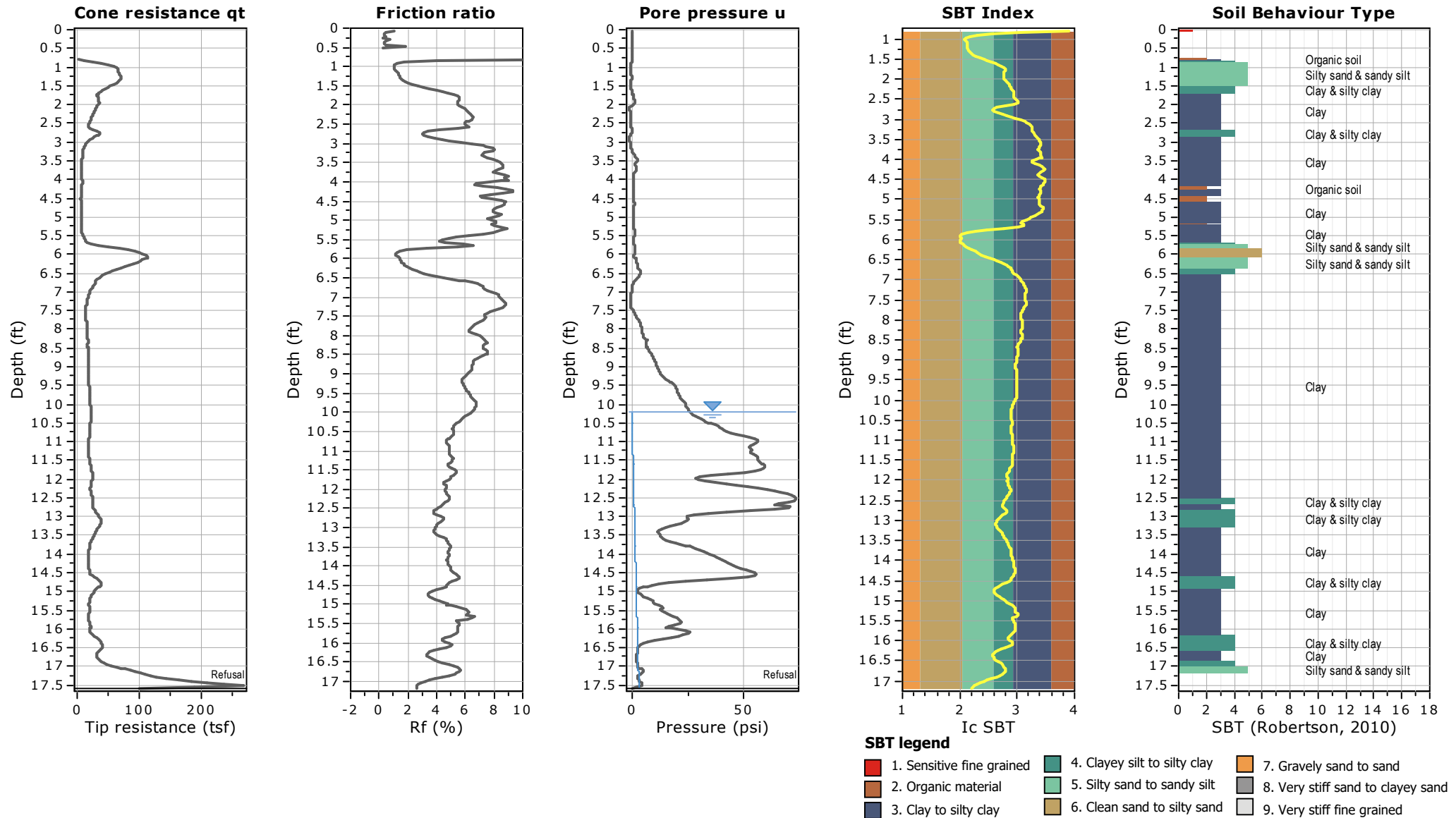
Coords: lat 34.716107° lon -81.710114°

Cone Type: DDG1330

Cone Operator: F&ME Consultants

Project: SC 215 over Fair Forest Creek

Location: Union County, SC





Appendix B. Subsurface Investigation

Multichannel Analysis of Surface Waves (MASW)

February 28, 2023

Ms. Lila Leon, P.E., PhD
South Carolina Geotechnical Lead
HDR
1201 Main Street Suite 800
Columbia, South Carolina 29201

Re: Report of Multi-Channel Analysis of Surface Waves
SC-215 Replacement Bridge over Fairforest Creek
Union County, South Carolina
F&ME Project No.: G6658.006

Dear Ms. Leon:

On January 19th, 2023, F&ME Consultants performed one (1) Multi-Channel Analysis of Surface Waves (MASW) test near the SC-215 bridge over Fairforest Creek to determine the average shear wave velocity to a depth of 100 feet at the location. A 16-channel Geometrics ES-3000 seismograph with 4.5 Hz geophones was used for data collection. Active and Passive survey data was obtained using a 225-foot linear array with 16 geophones spaced at 15 feet.

A 16-pound sledge hammer striking an aluminum block and a polyethylene block were used as the energy source for the active survey. Ten (10) active shots were performed at various distances (25, 50, and 100 feet) off the array ends. Resultant vibrations were recorded with a sample rate of 0.5 milliseconds and a recording length of 2 seconds after each hammer blow. The data was stacked five times at each location to minimize the effect of unknown ambient vibrations commonly referred to as noise. The stacking process increases the signal to noise ratio.

The passive survey consisted of the collection of ambient background vibrations, which consisted of drilling equipment. Fifty (50) recordings with a record length of 32 seconds and a sample rate of 2 milliseconds were made during this phase of data acquisition.

Prior to departing the site, the data collected from both the passive and active surveys were reviewed and checked for variations from what would be typically expected from the prevailing area geology.

After completion of passive and active survey the data was processed and analyzed using Geometric's SeisImager software suite (Pickwin and WaveEq). This resulted in a one-dimensional subsurface shear wave velocity curve that is developed utilizing both the passive and active survey data. The data from the active survey defines the near surface shear wave velocities, while the passive survey data defines deeper shear wave velocities due to the lower frequencies. The resulting curve represents the average shear wave velocities below the surface arrays to a depth of 100 feet.



The resulting Shear Wave Velocity Curve, Vs100, for the location defined on Figure 1 of this report. The following table summarizes the average shear wave velocity (Vs100) at the aforementioned location.

Boring No.	Average Shear Wave Velocity (Vs100)
MASW-13	1167.1 ft/sec

It has been a pleasure working for you on this project and we appreciate the opportunity to be of service. Please contact us if you have any questions or concerns.

Sincerely,

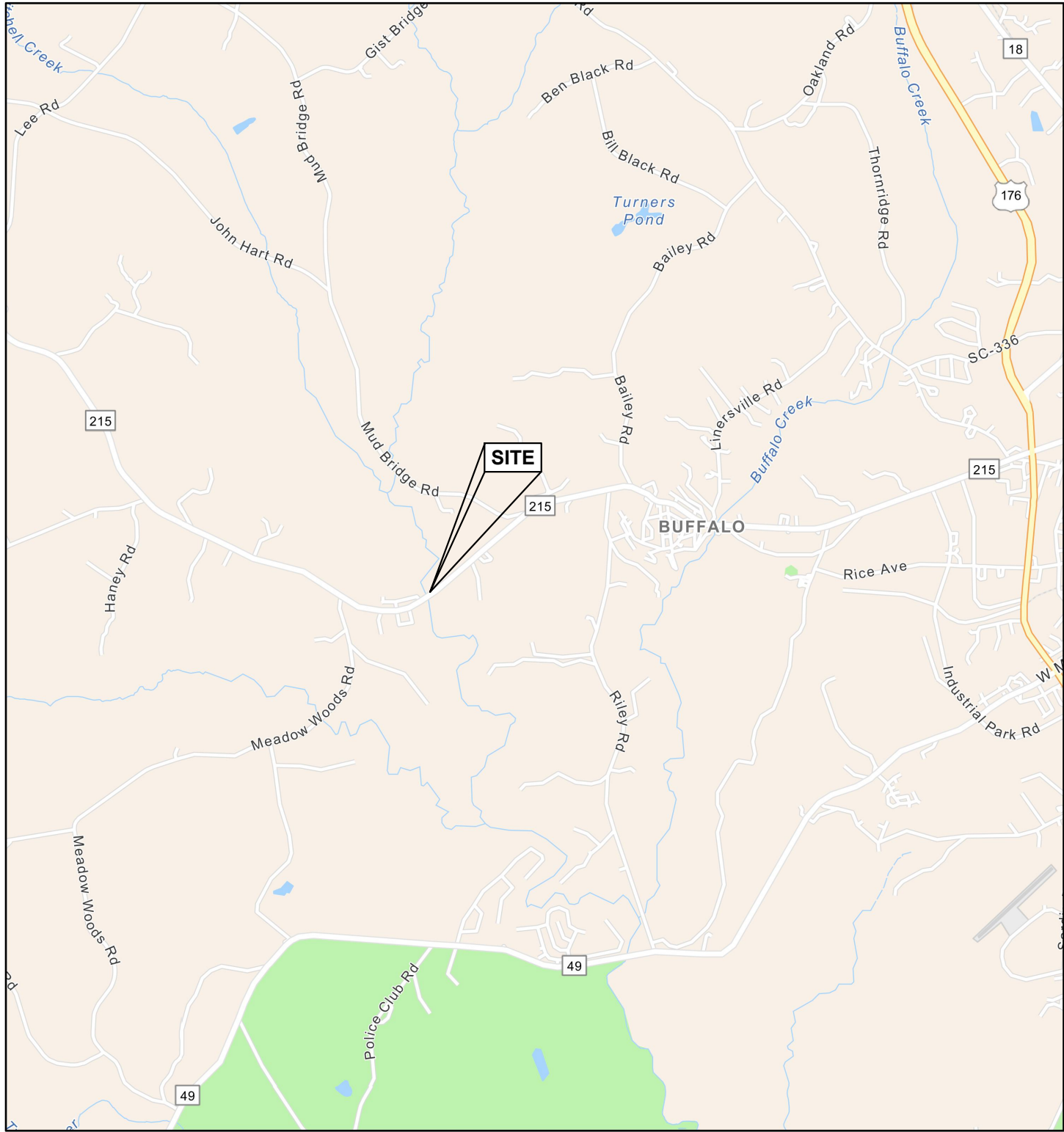
F&ME CONSULTANTS



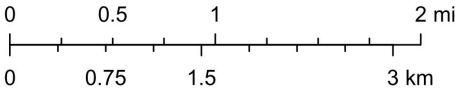
Alex M Chandler, EIT
Geotechnical Staff Professional



John F Hamilton, PE
Geotechnical Design Manager



1:72,000



F&ME CONSULTANTS, INC.
COLUMBIA, SC

SC 215 OVER FAIRFOREST CREEK
UNION COUNTY, SOUTH CAROLINA

SITE VICINITY MAP

F&ME JOB NO. G6658.006

SCALE: AS NOTED

FIGURE 1

4			
3			
2			
1			
REV.	BY	DATE	DESCRIPTION OF REVISION
TOPO.		DATE	
DWG.	CTC	DATE 2.20.23	GROUP -- --
R/W		DATE	



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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 2.20.23	GROUP ____ - ____
R/W		DATE	

SC 215 OVER FAIRFOREST CREEK
UNION COUNTY, SOUTH CAROLINA

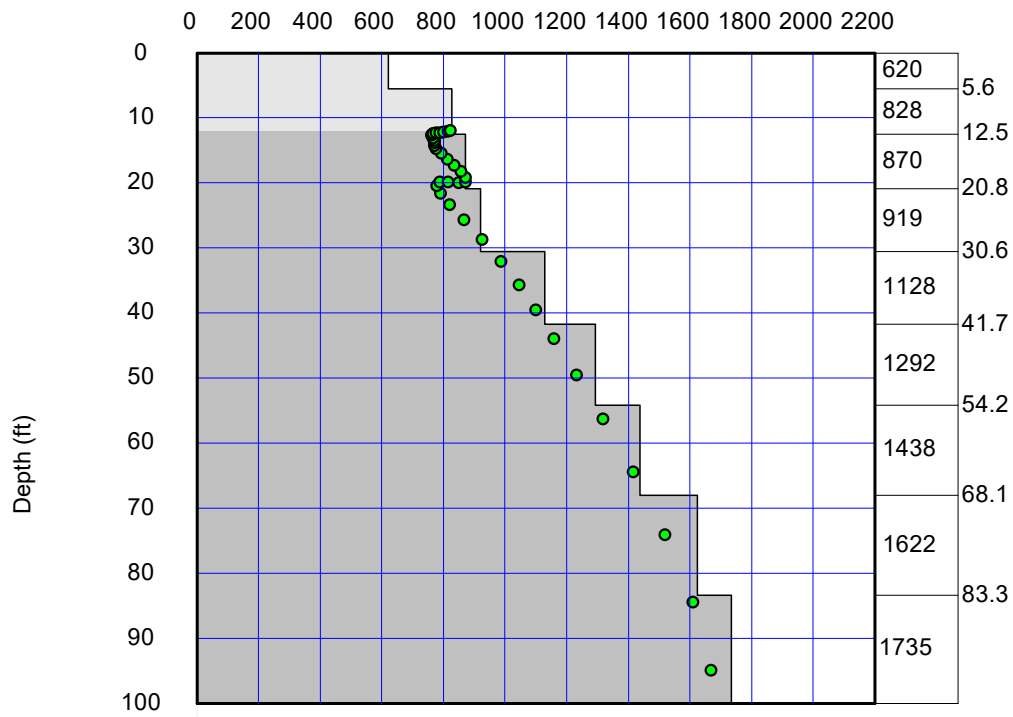
MASW LOCATION PLAN

F&ME JOB NO. G6658.006

SCALE: 1"=100'

FIGURE 2

S-wave velocity (ft/s)



S-wave velocity model (initial) : SC215FairForestC FinalVs100.rst

Average Vs 100ft = 1167.1 ft/sec

Appendix C. Laboratory Testing



SUMMARY OF LABORATORY RESULTS

PAGE 1 OF 1

PROJECT ID P041236

PROJECT NAME SC 215 over Fairforest Creek

PROJECT COUNTY Union, SC

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Classification	Water Content (%)	Dry Density (pcf)	Saturation (%)	Void Ratio
B-52	0.0							23.8			
B-52	2.0	54	42	12	0.075	53	MH	32.4			
B-52	13.5							32.3			
B-52	18.5	NP	NP	NP	0.075	27	SM	19.2			
B-53	0.0	44	29	15	0.075	66	ML	34.1			
B-53	4.0	28	16	12	0.075	73	CL	52.3			
B-53	8.0							29.8			
B-53	18.5	NP	NP	NP	0.075	28	SM	40.2			
B-54	2.0	NP	NP	NP	0.075	44	SM	29.9			
B-54	4.0	25	22	3	0.075	44	SM	33.0			
B-54	8.0	26	20	6	0.075	48	SC-SM	35.5			
B-54	13.5							13.7			
B-54	23.5	NP	NP	NP	0.075	20	SM	15.1			
B-55	2.0	25	21	4	0.075	40	SC-SM	24.9			
B-55	4.0				0.075	17	SM	26.6			
B-55	6.0							20.6			
B-55	8.0	NP	NP	NP	0.075	36	SM	28.1			
B-56	0.0							13.7			
B-56	4.0	43	26	17	0.075	45	SC	26.7			
B-56	6.0	NP	NP	NP	0.075	45	SM	21.4			
B-56	8.0	NP	NP	NP	0.075	30	SM	16.5			
B-56	14.0	NP	NP	NP	0.075	28	SM	14.2			
R-1	2.0				0.075	19	SM	10.9			
R-1	6.0	NP	NP	NP	0.075	24	SM	16.2			
R-1	13.5	NP	NP	NP	0.075	25	SM	29.0			
R-1	23.5	NP	NP	NP	0.075	28	SM	25.8			
R-1	33.5	NP	NP	NP	0.075	28	SM	34.6			
R-1	43.5	NP	NP	NP	0.075	23	SM	15.5			
R-2	2.0				0.075	12	SP-SM	13.0			
R-2	4.0				0.075	8	GP-GM	6.2			
R-2	8.0	NP	NP	NP	0.075	33	SM	25.2			
R-2	18.5	NP	NP	NP	0.075	21	SM	16.6			



Rock Coring Summary

PAGE 1 OF 1

PROJECT ID P041236

PROJECT NAME SC 215 over Fairforest Creek

PROJECT COUNTY Union, SC

Borehole	Core Run Number	Core Run Top Depth	REC (%)	RQD (%)	q _u (psi)	Poisson's Ratio	Secant Modulus (ksi)	Unit Weight (pcf)	RMR	GSI
B-52	NQ-1	24.5	29	0						18
B-52	NQ-2	28.0	21	0						18
B-52	NQ-3	30.3	90	17						23
B-52	NQ-4	32.8	40	10						23
B-52	NQ-5	37.8	73	52	50270	0.27	19400	196	65	43
B-53	NQ-1	34.5	18	0						28
B-53	NQ-2	37.0	33	7						28
B-53	NQ-3	42.0	77	43	24750	0.18	5830	187	57	43
B-53	NQ-4	47.0	97	73	47620	0.21	13600	192	75	68
B-53	NQ-5	52.0	100	90	27290	0.28	15600	199	79	78
B-53	NQ-5	52.0	100	90	10342	0.16	4210	172	74	78
B-53	NQ-6	57.0	100	100	20070	0.11	10500	187	74	83
B-54	NQ-1	32.0	53	42	26500	0.28	14200	191	57	38
B-54	NQ-2	37.0	17	0						33
B-54	NQ-3	42.0	37	0						28
B-54	NQ-4	47.0	82	40	15780	0.12	7230	170	57	38
B-55	NQ-1	11.3	92	83	23370	0.17	11200	193	76	68
B-55	NQ-2	16.3	30	0						33
B-55	NQ-3	21.3	10	0						13
B-55	NQ-4	26.3	75	55						58
B-55	NQ-5	31.3	100	100	11200	0.20	8100	185	74	83
B-55	NQ-5	31.3	100	100	22860	0.15	11500	185	79	83
B-55	NQ-6	36.3	100	65	9900	0.31	7620	185	67	83
B-56	NQ-1	20.8	33	0						18
B-56	NQ-2	25.8	40	13						23
B-56	NQ-3	30.8	50	0						28
B-56	NQ-4	35.8	80	50	38760	0.24	8000	172	65	33



INDEX PROPERTIES VERSUS DEPTH

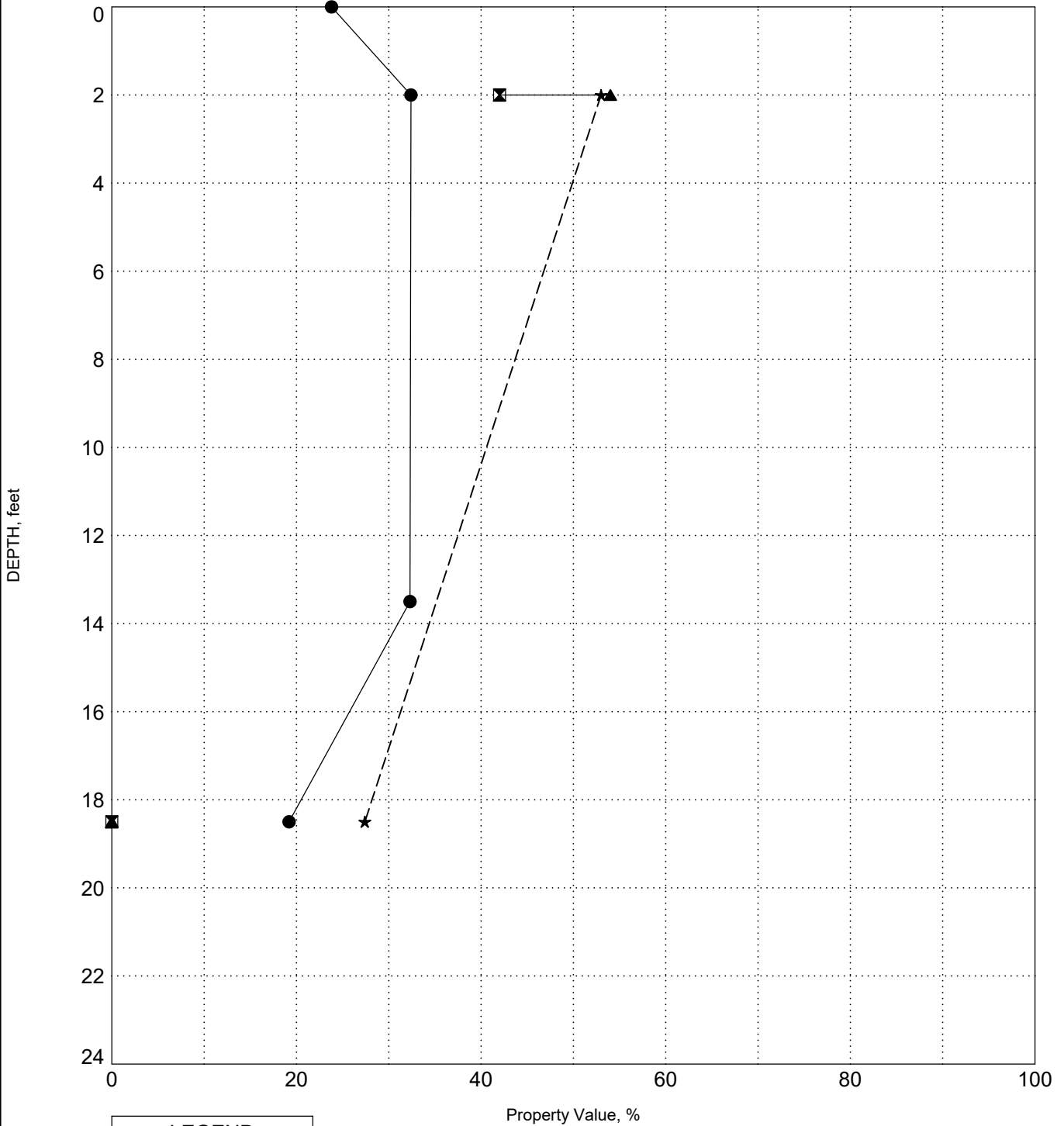
PROJECT ID P041236

PROJECT NAME SC 215 over Fairforest Creek

PROJECT COUNTY Union, SC

SURFACE ELEVATION: 435.8

BORING B-52



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



INDEX PROPERTIES VERSUS DEPTH

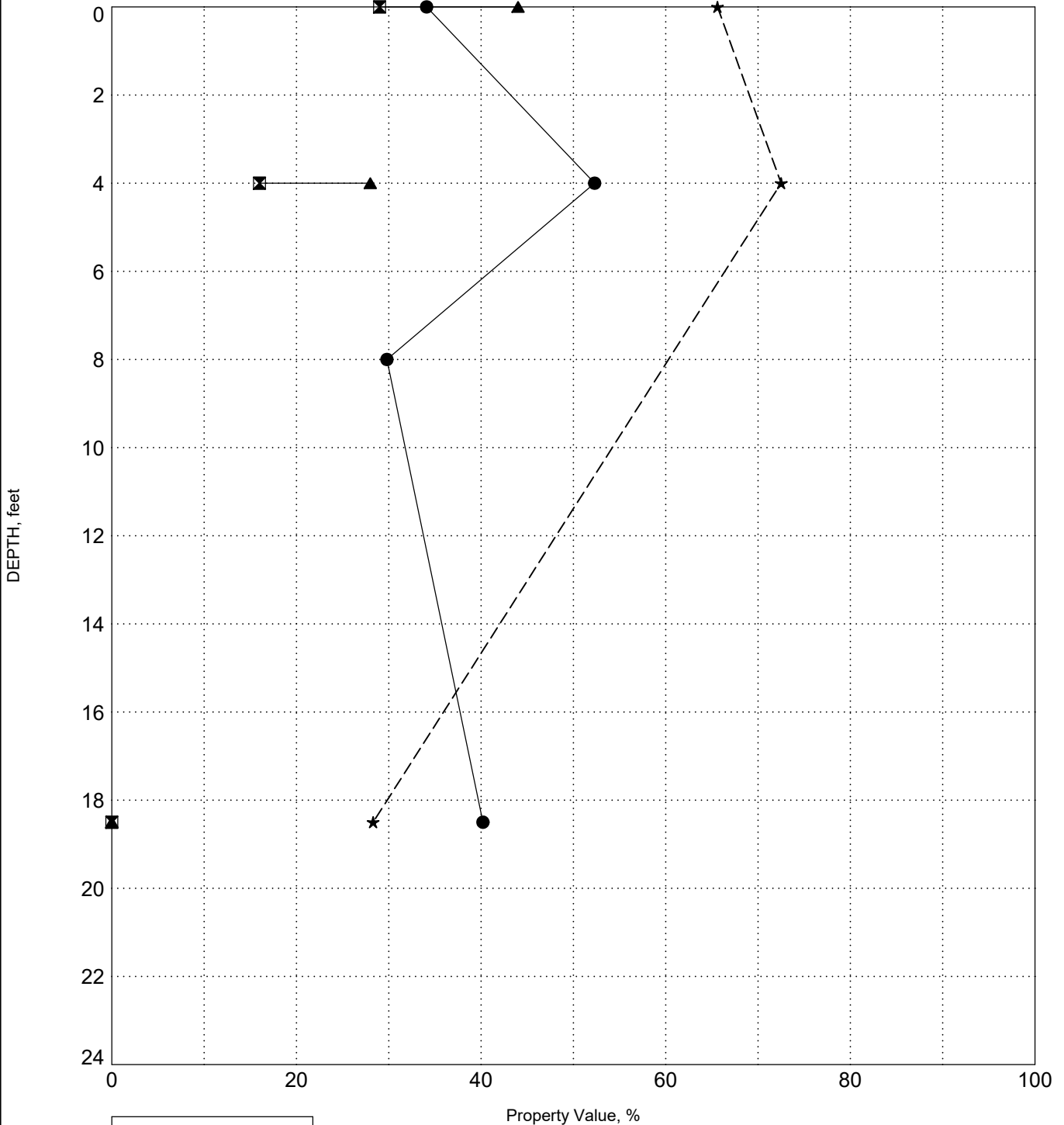
PROJECT ID P041236

PROJECT NAME SC 215 over Fairforest Creek

PROJECT COUNTY Union, SC

BORING B-53

SURFACE ELEVATION: 413.5



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



INDEX PROPERTIES VERSUS DEPTH

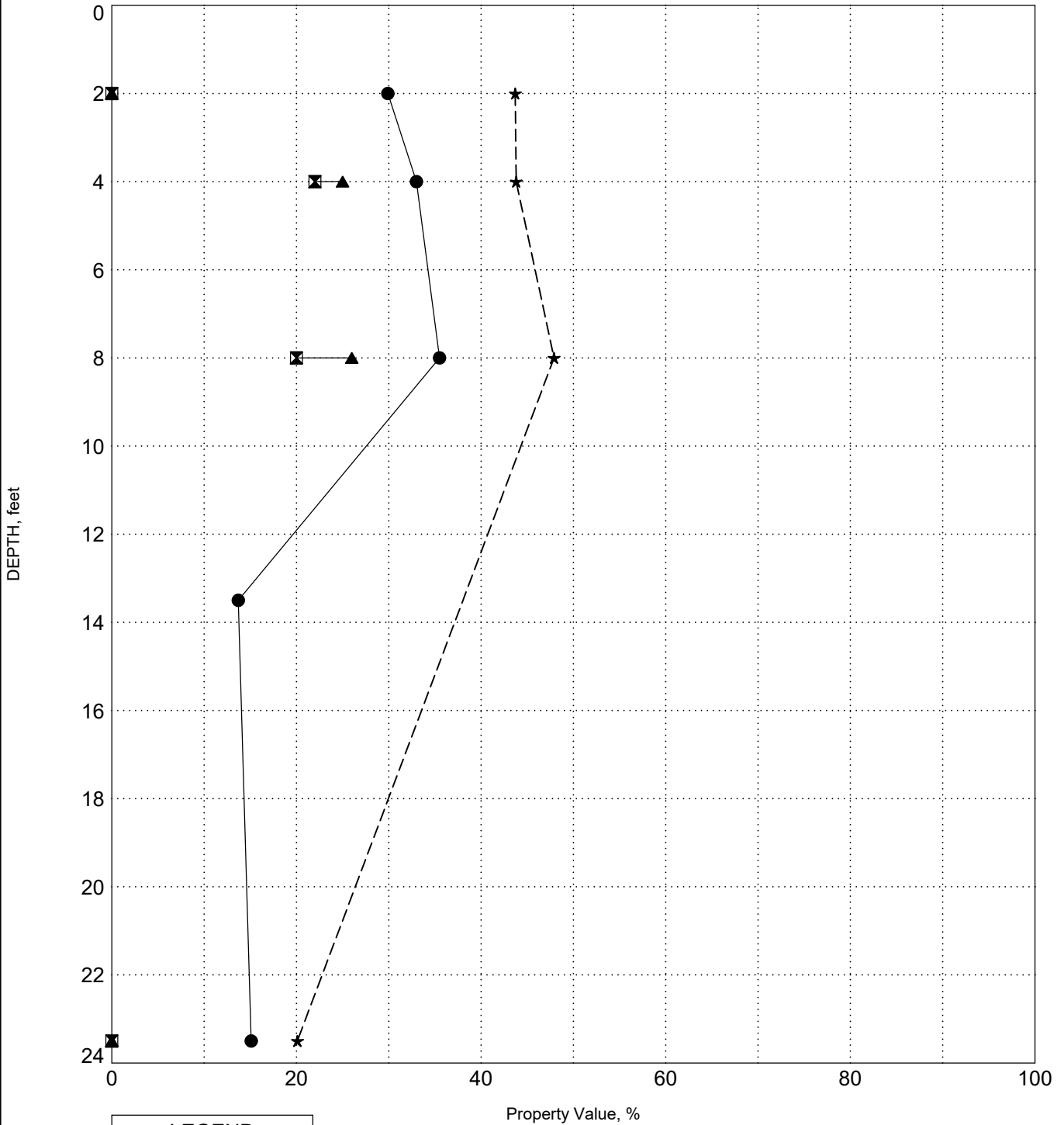
PROJECT ID P041236

PROJECT NAME SC 215 over Fairforest Creek

PROJECT COUNTY Union, SC

SURFACE ELEVATION: 413.3

BORING B-54



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



INDEX PROPERTIES VERSUS DEPTH

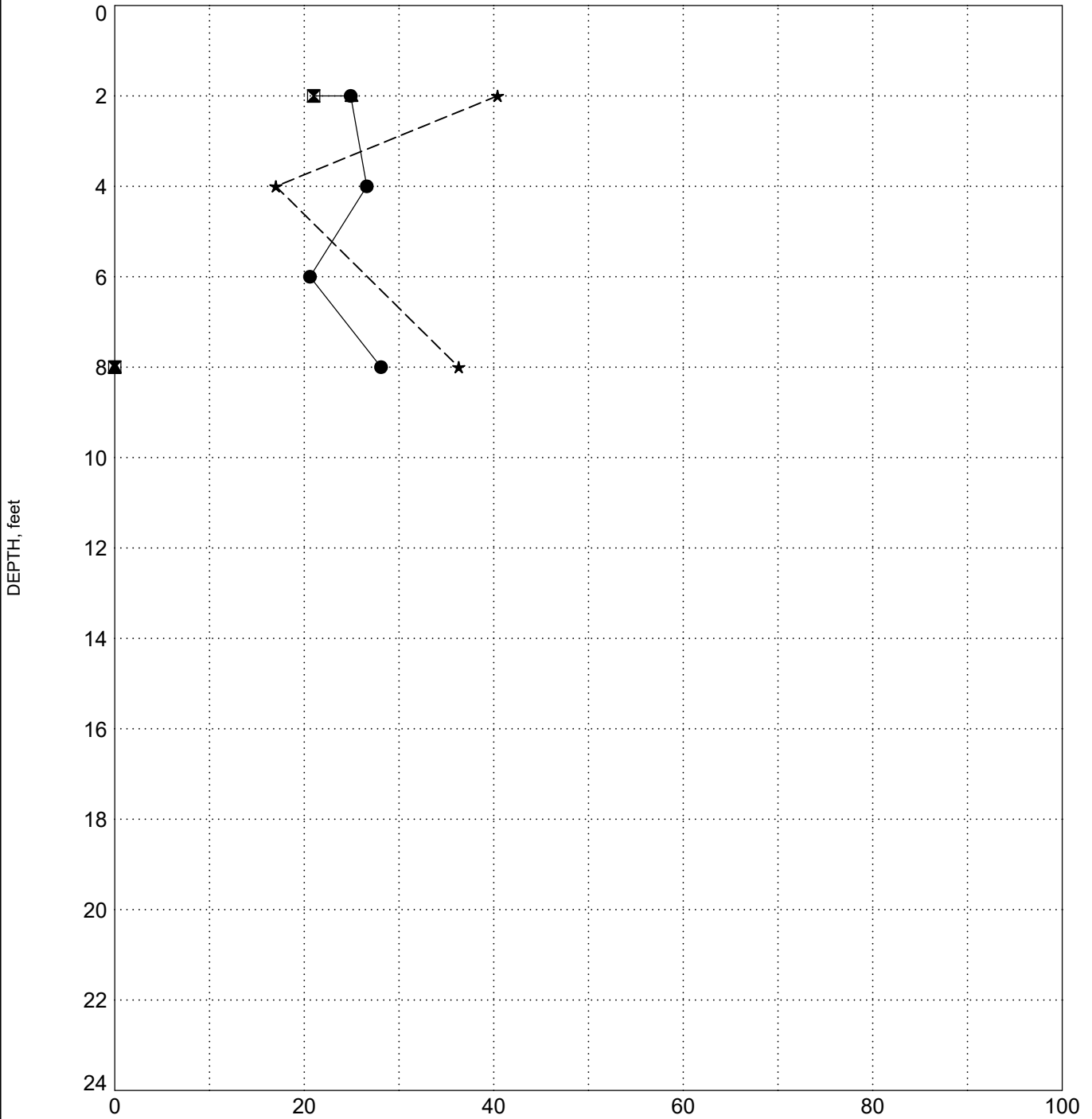
PROJECT ID P041236

PROJECT NAME SC 215 over Fairforest Creek

PROJECT COUNTY Union, SC

SURFACE ELEVATION: 413.1

BORING B-55



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



INDEX PROPERTIES VERSUS DEPTH

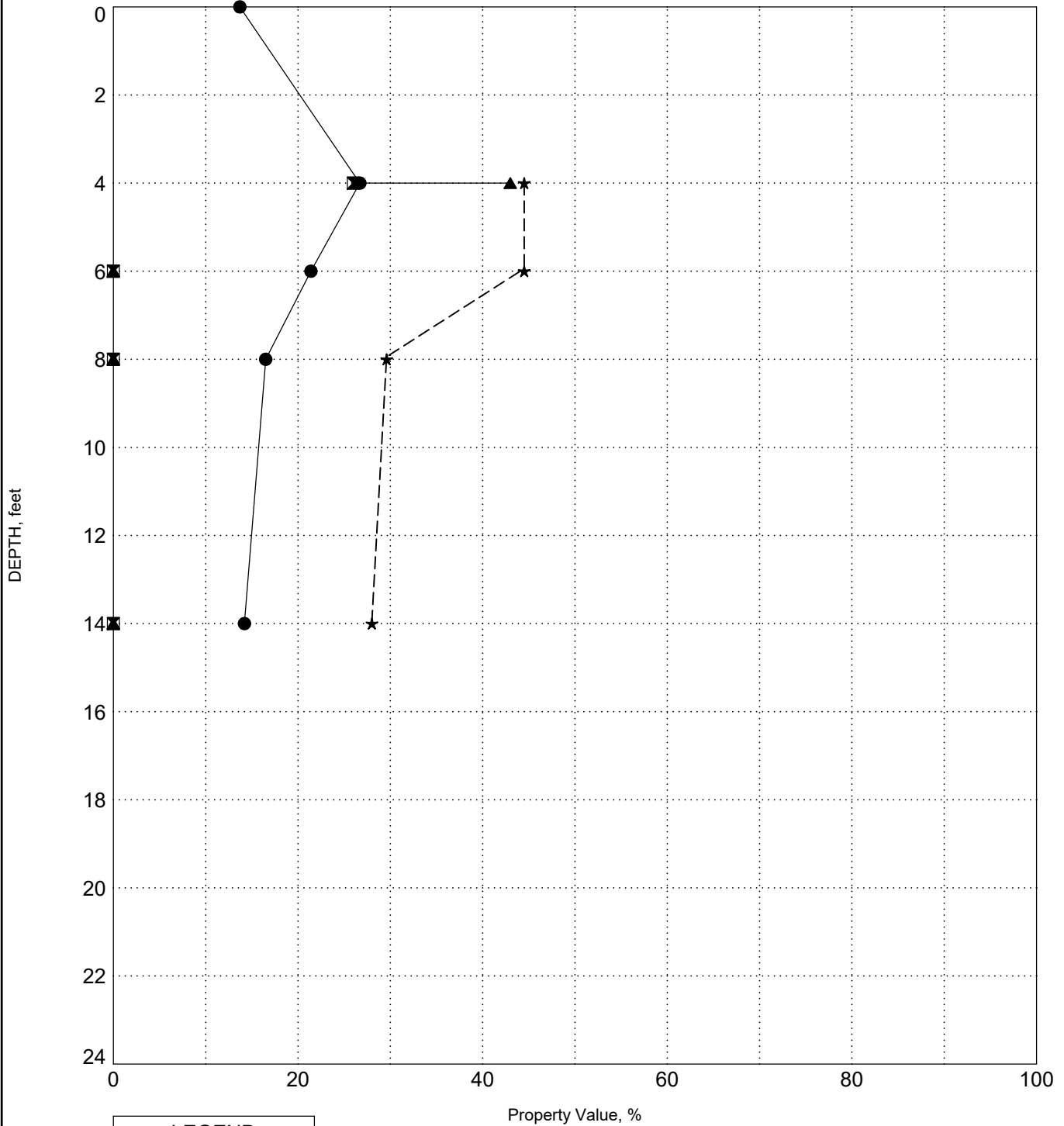
PROJECT ID P041236

PROJECT NAME SC 215 over Fairforest Creek

PROJECT COUNTY Union, SC

SURFACE ELEVATION: 435.1

BORING B-56



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



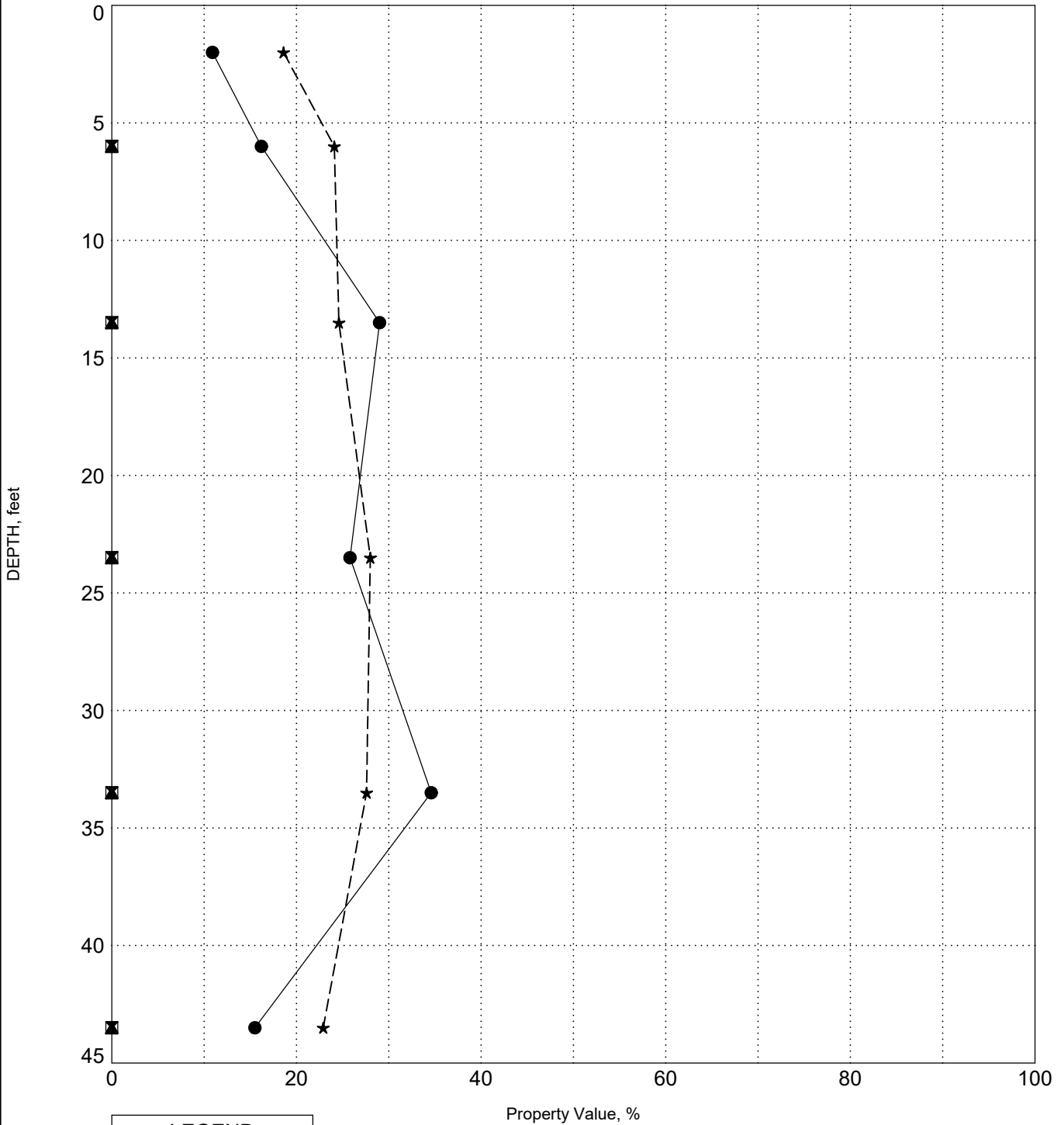
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P041236

PROJECT NAME SC 215 over Fairforest Creek

PROJECT COUNTY Union, SC

BORING R-1



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



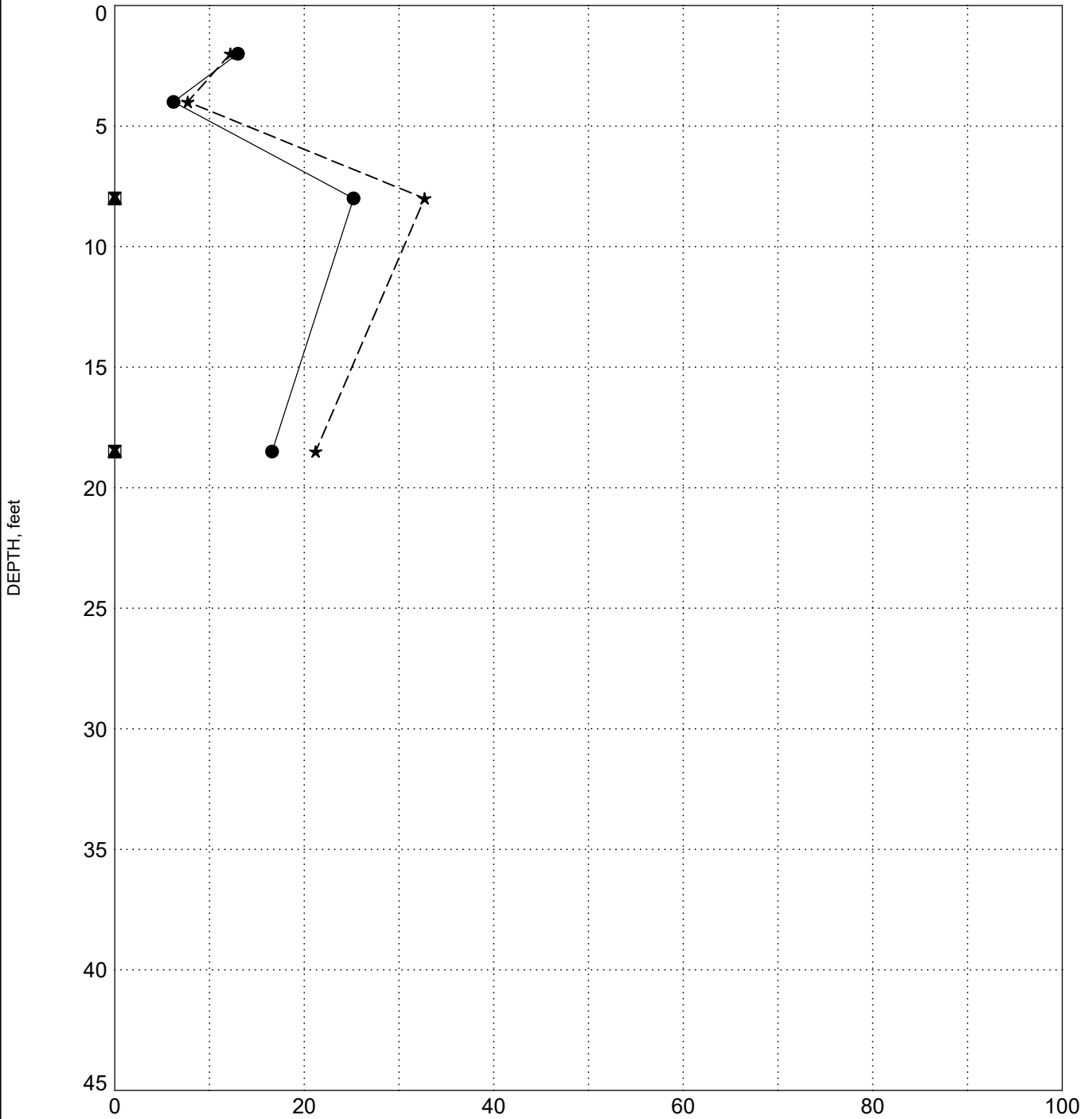
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P041236

PROJECT NAME SC 215 over Fairforest Creek

PROJECT COUNTY Union, SC

BORING R-2



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



Laboratory Testing Procedures

Grain Size Distribution

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

Hydrometer

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

Atterberg Limits

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

Moisture Content

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

Standard Proctor

Standard Proctor testing has been conducted following ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600kN-m/m³)).

Consolidated-Undrained Triaxial Test

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

Corrosion Series

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

Compressive Strength of Rock Cores

Compressive strength of rock cores has been conducted following ASTM D7012 Standard Test for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures.



Appendix C. Laboratory Testing

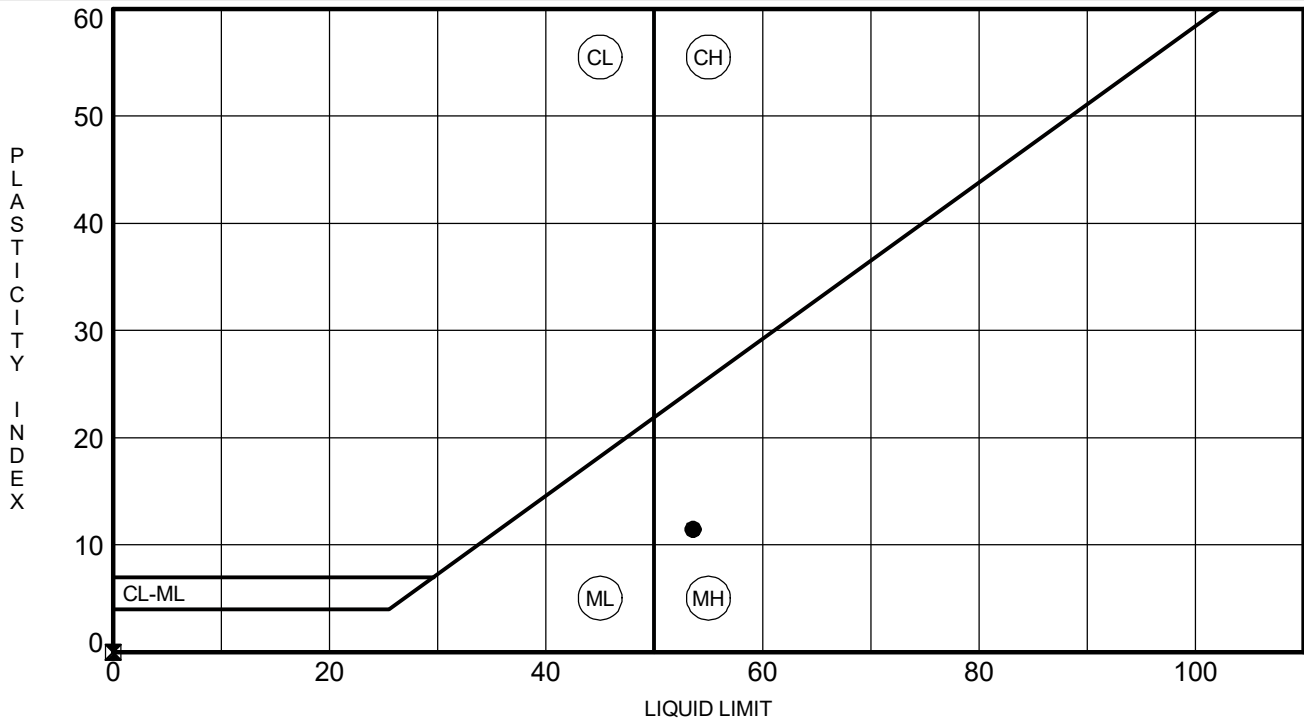
Split Spoon Samples

ATTERBERG LIMITS' RESULTS

PROJECT ID P041236

PROJECT NAME SC 215 RBO Fairforest Creek

PROJECT COUNTY Union County

[illegible]

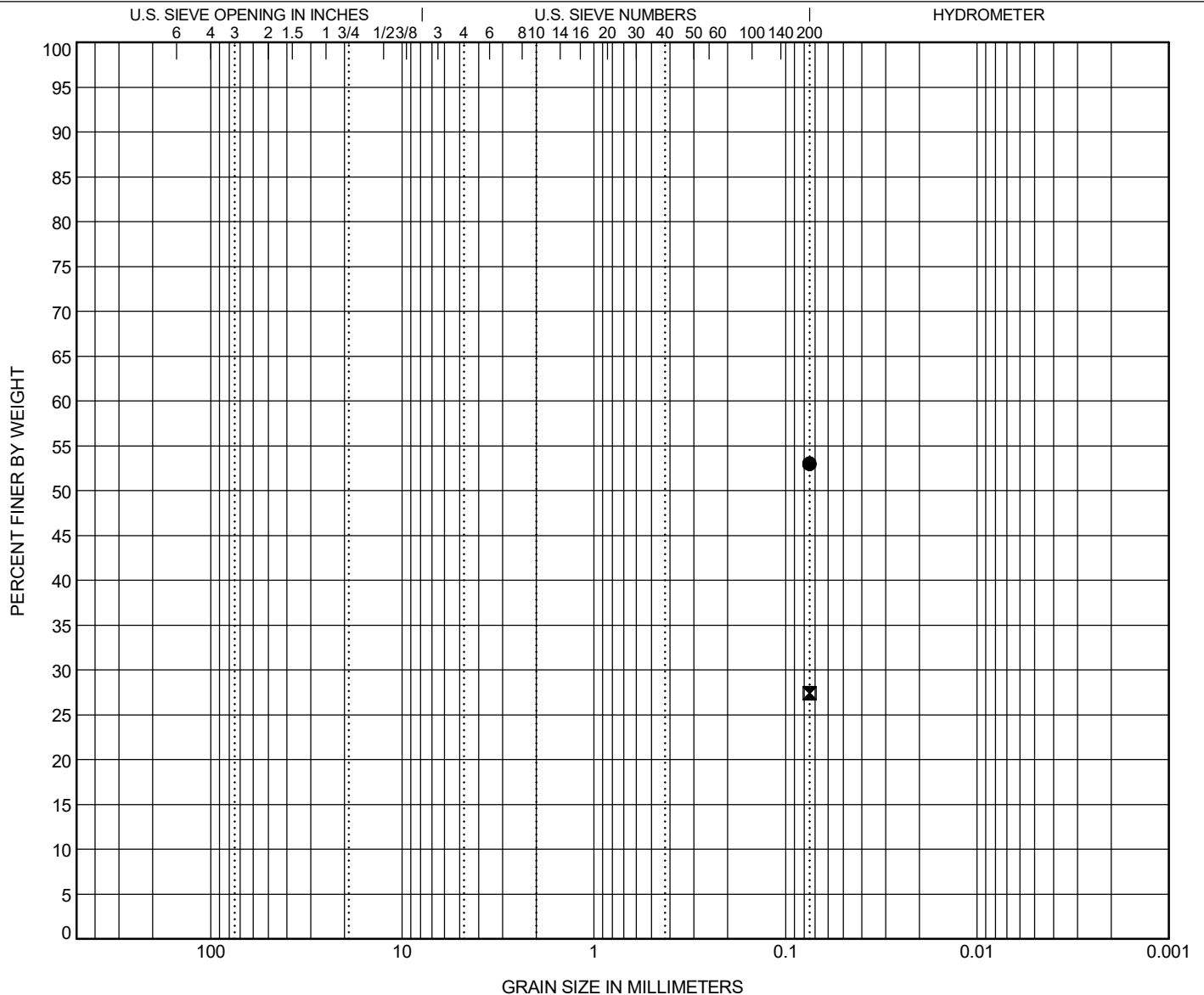


GRAIN SIZE DISTRIBUTION

PROJECT ID P041236

PROJECT NAME SC 215 RBO Fairforest Creek

PROJECT COUNTY Union County



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-52	4.0	SANDY ELASTIC SILT (MH/A-7-5)					54	42	12		
■ B-52	20.0	SILTY SAND (SM/A-2-4)					NP	NP	NP		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay	
● B-52	4.0	0.075						53.0			
■ B-52	20.0	0.075						27.4			

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: SC 215 Fairforest Creek **SCDOT PROJECT ID:** P041236
SAMPLE NUMBER: 23-0161 **DATE SAMPLE RECEIVED:** 1/19/2023
DESCRIPTION OF SOIL: Various
TESTED BY: CM & DH **DATE SETUP:** 1/20/2023
WEIGHED BY: MD **DATE OF WEIGHING:** 1/23/2023

BORING NO.	B-52	B-52	B-52	B-52	
SAMPLE NO.	SS-1	SS-2	SS-6	SS-7	
SAMPLE DEPTH (FT.)	0.0 - 2.0	2.0 - 4.0	13.5 - 15.0	18.5 - 20.0	
WATER CONTENT, W%	23.8	32.4	32.3	19.2	

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%					



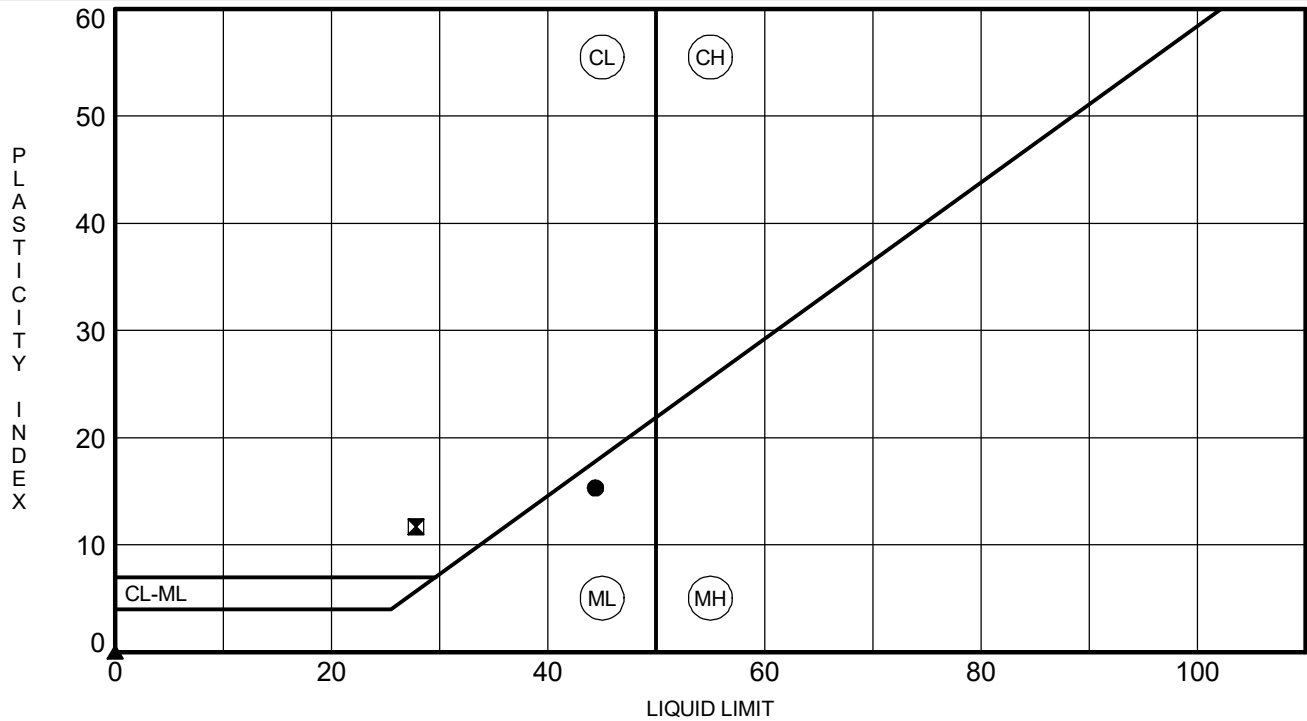
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ATTERBERG LIMITS' RESULTS

PROJECT ID P041236

PROJECT NAME SC 215 RBO Fairforest Creek

PROJECT COUNTY Union County

[illegible]

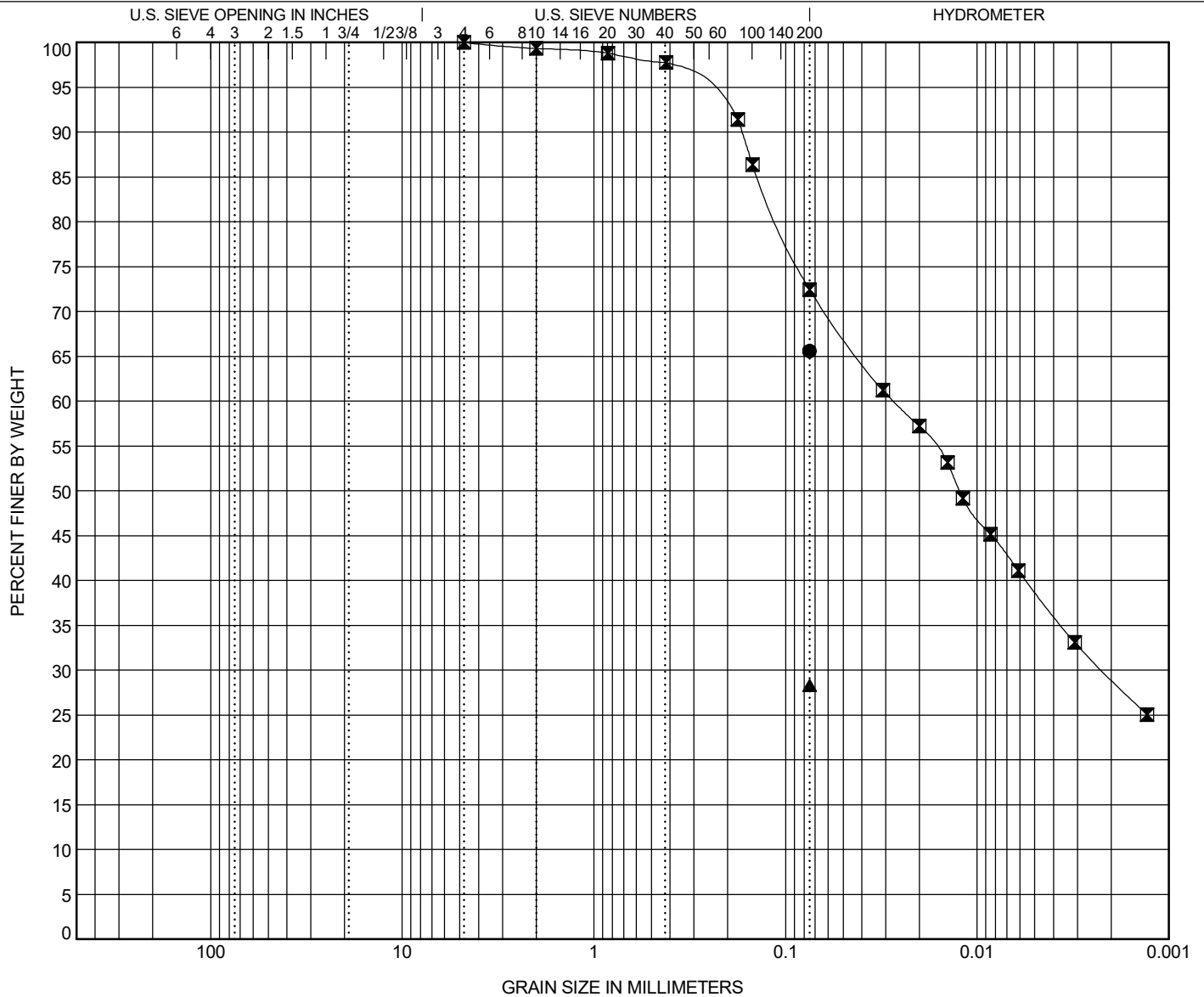


GRAIN SIZE DISTRIBUTION

PROJECT ID P041236

PROJECT NAME SC 215 RBO Fairforest Creek

PROJECT COUNTY Union County



F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: SC 215 Fairforest Creek **SCDOT PROJECT ID:** P041236
SAMPLE NUMBER: 23-0176 **DATE SAMPLE RECEIVED:** 1/19/2023
DESCRIPTION OF SOIL: Various
TESTED BY: CM & DH **DATE SETUP:** 1/20/2023
WEIGHED BY: MD **DATE OF WEIGHING:** 1/23/2023

BORING NO.	B-53	B-53	B-53	B-53	
SAMPLE NO.	SS-1	SS-3	SS-5	SS-7 & SS-8	
SAMPLE DEPTH (FT.)	0.0 - 2.0	4.0 - 6.0	8.0 - 10.0	18.5 - 25.0	
WATER CONTENT, W%	34.1	52.3	29.8	40.2	

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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CHLORIDE ION CONTENT IN SOILS

AASHTO T 291 - 94 (2018) (Method B)

Client: F&ME Consultants, Inc.
 Client Reference: SC 215 Fairforest Cr.
 Project No.: 2023-077-001
 Lab ID: 2023-077-001-001

Boring No.: B-53
 Depth (ft): 18.5-25.0'
 Sample No.: SS-7/SS-8
 Description: Brown Soil

(- # 10 Sieve material)

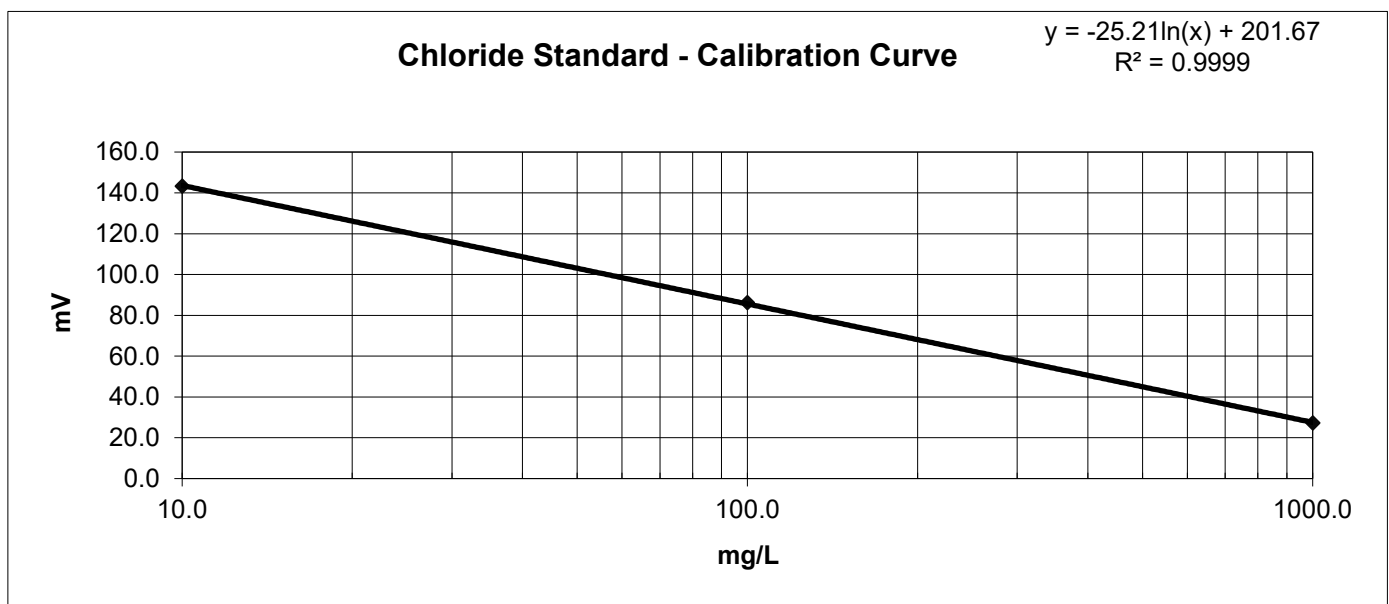
CHLORIDE STANDARD: CALIBRATION CURVE

STANDARD	MILLIVOLTS (mV)
10.0 mg/L	143.3
100.0 mg/L	86.2
1000.0 mg/L	27.2

MEASUREMENT OF CHLORIDES

Sample Weight (g):	100.0	CONCENTRATION	CONCENTRATION
Water added to Sample (ml):	100.0	(mg/L)	(mg/kg)
Size of Sample Aliquot (ml):	25.0		
Sample Reading (mV):	96.9	63.79	63.79

Notes: 1) Samples and standards were buffered by the addition of an equal volume of the 0.2 M KNO₃ solution (1:1 volume).
 2) Samples were dried for a minimum of 12 hours at 110 °F ± 5°C.



Notes:

Tested By JAM Date 2/14/23 Checked By JLK Date 2/15/23

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

pH Determination
(AASHTO T289)

Project Name:	SC 215 RBO Fairforest Creek	SCDOT Project ID:	P041236
Sample Location:	B-53	Sample Elev./Depth:	18.5 - 25.0
Sample Description:	Silty SAND (SM/A-2-4)	Date Sampled:	1/19/2023
Tested By:	R. Coldiron	Date Tested:	1/23/2023

FME Lab ID No.	23-0178			
Sample ID	B-53			
Depth (ft.)	18.5 - 25.0			
pH Value	6.57			
Temperature (°C)	19.6			

Date Reviewed: 1/3/2023Reviewed By: J. Hiers

**SOIL RESISTIVITY
(AASHTO T288)**

Project Name:	SC 215 RBO Fairforest Creek	SCDOT Project ID:	P041236
Location:	Union County, SC	FME Lab ID No.:	23-0178
Sampled By:	HDR	Date Sampled:	1/19/2023
Soil Description:	Silty SAND (SM/A-2-4)	Date Received:	1/16/2023
Tested By:	CM	Date Tested:	2/7/2023

Boring No.	Sample Depth (ft.)	Minimum Soil Resistivity, Ω -cm
B-53	18.5 - 25.0	30,452

Date Reviewed: 2/9/2023 Reviewed By: J. Hiers

Water-Soluble Sulfate Ion Content in Soil AASHTO T 290-95 (2020)

Client: F&ME Consultants, Inc.
Client Reference: SC 215 Fairforest Cr.
Project No.: 2023-077-001
Lab ID: 2023-077-001-001

Boring No.: B-53
Depth (ft): 18.5-25.0'
Sample No.: SS-7/SS-8
Soil Description: Brown Soil

Sulfate Standard - Calibration Curve Spectrophotometer Readings

<u>Sulfate Ion Concentrations (mg/L)</u>								
0.0	4.0	10.0	20.0	30.0	40.0	60.0	80.0	100.0
<u>Spectrophotometer Readings (FAU)</u>								
Underrange	Underrange	8	18	36	61	126	165	247

Measurement of Barium Chloride Turbidity

(Sample contains 5.0 mL NaCl solution and 0.3 g BaCl₂·2H₂O)

Sample Weight (g): 100.0
Water added to Sample (mL): 300.0
Size of Sample Aliquot (mL): 50.0
Sample Reading (FAU): 15

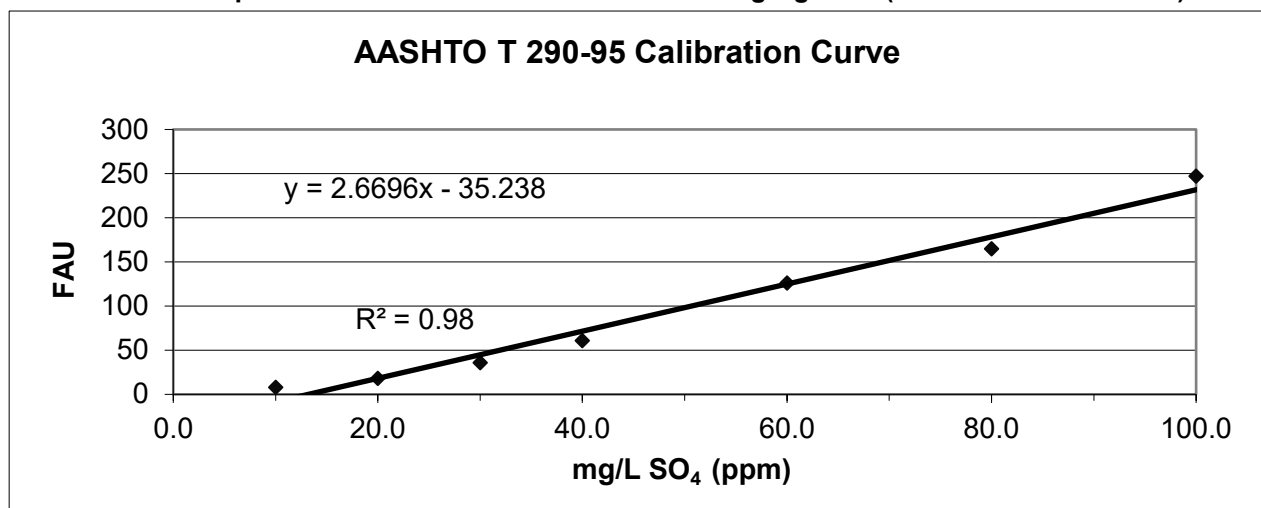
Sample Diluted: No

Sulfate Solution Added (ml): 5

Sample Moisture Content

Tare Number: 1744
Weight of Tare & Wet Sample (g): 185.61
Weight of Tare & Dry Sample (g): 183.00
Weight of Tare (g): 83.03
Weight of Water (g): 2.61
Weight of Dry Sample (g): 99.97
Moisture Content (%): 2.61

Sample Sulfate Ion Concentration:	18.32	mg/L SO ₄ (ppm)
Sample Sulfate Ion Content:	55.0	mg/Kg SO ₄ (not corrected for moisture)
Sample Sulfate Ion Content:	56.4	mg/Kg SO ₄ (corrected for moisture)

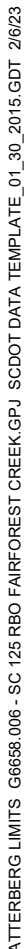


Tested by: JAM Date: 2/15/23 Checked by: BRB Date: 2/16/2023

page 1 of 1 DCN: CT-S87 DATE: 3/5/2020 REVISION: 1



PROJECT COUNTY Union County

[illegible]

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: SC 215 Fairforest Creek **SCDOT PROJECT ID:** P041236
SAMPLE NUMBER: 23-0179 **DATE SAMPLE RECEIVED:** 1/19/2023
DESCRIPTION OF SOIL: Various
TESTED BY: CM & DH **DATE SETUP:** 1/20/2023
WEIGHED BY: MD **DATE OF WEIGHING:** 1/23/2023

BORING NO.	B-54	B-54	B-54	B-54	B-54
SAMPLE NO.	SS-2	SS-3	SS-5	SS-6	SS-8
SAMPLE DEPTH (FT.)	2.0 - 4.0	4.0 - 6.0	8.0 - 10.0	13.5 - 15.0	23.5 - 25.0
WATER CONTENT, W%	29.9	33.0	35.5	13.7	15.1

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

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

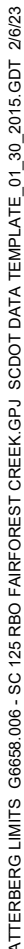
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					



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PROJECT COUNTY Union County

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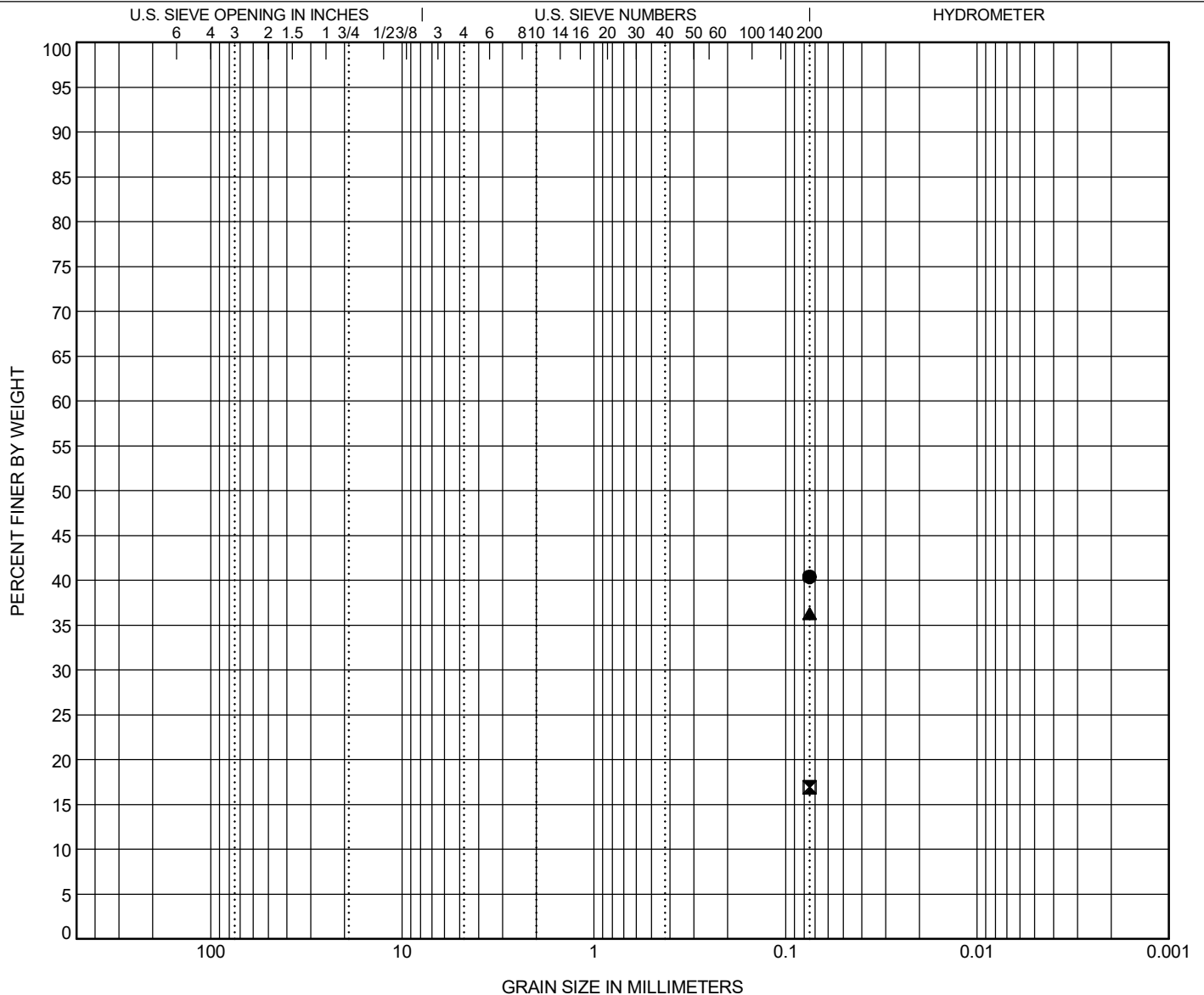


GRAIN SIZE DISTRIBUTION

PROJECT ID P041236

PROJECT NAME SC 215 RBO Fairforest Creek

PROJECT COUNTY Union County



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-55	4.0	SILTY, CLAYEY SAND (SC-SM/A-4)					25	21	4		
■ B-55	6.0	SILTY SAND (SM)									
▲ B-55	10.0	SILTY SAND (SM/A-4)					NP	NP	NP		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay	
● B-55	4.0	0.075						40.4			
■ B-55	6.0	0.075						17.0			
▲ B-55	10.0	0.075						36.3			

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: SC 215 Fairforest Creek **SCDOT PROJECT ID:** P041236
SAMPLE NUMBER: 23-0180 **DATE SAMPLE RECEIVED:** 1/19/2023
DESCRIPTION OF SOIL: Various
TESTED BY: CM & DH **DATE SETUP:** 1/20/2023
WEIGHED BY: MD **DATE OF WEIGHING:** 1/23/2023

BORING NO.	B-55	B-55	B-55	B-55	
SAMPLE NO.	SS-2	SS-3	SS-4	SS-5	
SAMPLE DEPTH (FT.)	2.0 - 4.0	4.0 - 6.0	6.0 - 8.0	8.0 - 10.0	
WATER CONTENT, W%	24.9	26.6	20.6	28.1	

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

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

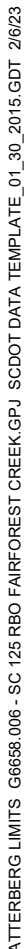
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH (FT.)					
WATER CONTENT, W%					



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PROJECT COUNTY Union County

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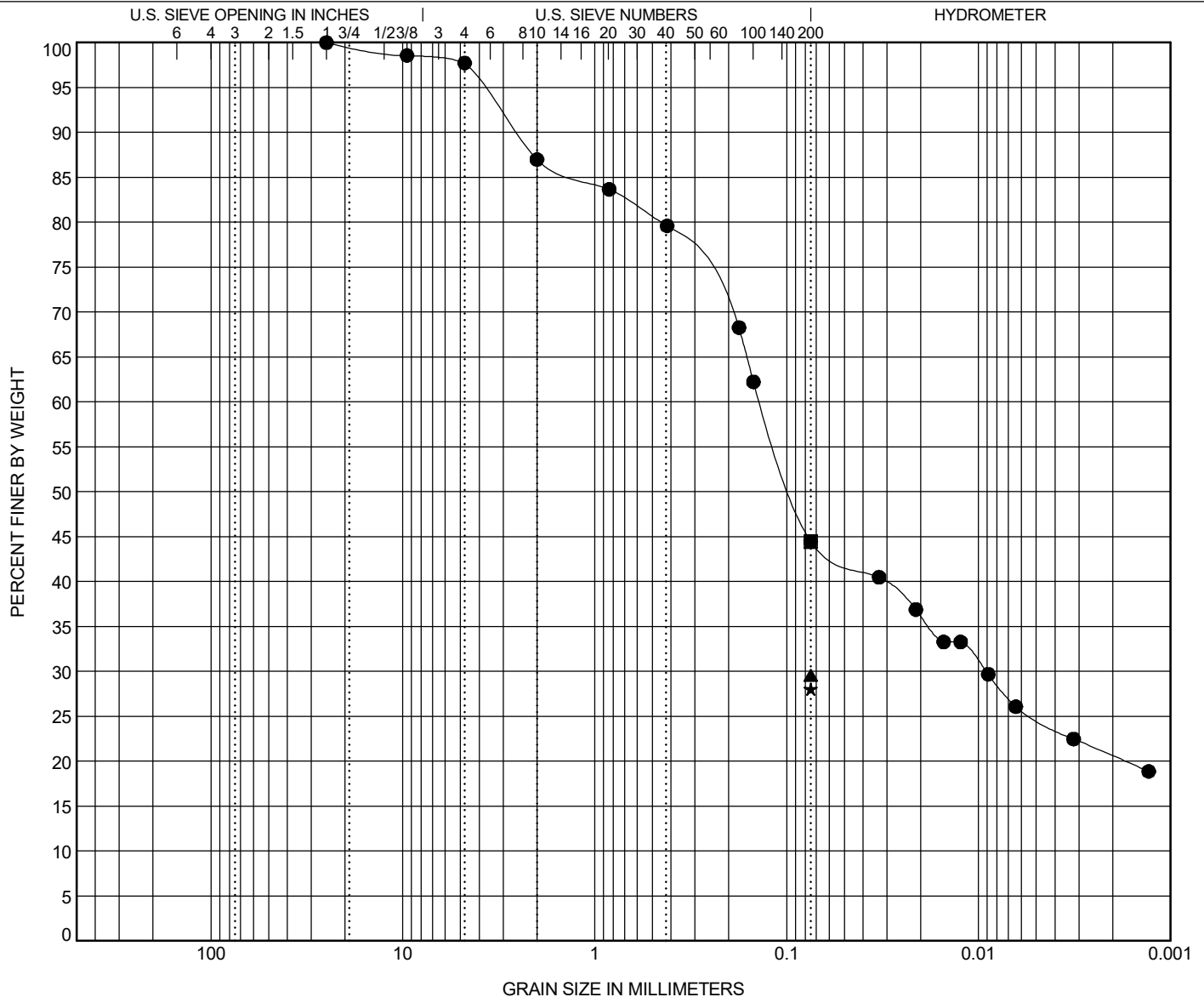


GRAIN SIZE DISTRIBUTION

PROJECT ID P041236

PROJECT NAME SC 215 RBO Fairforest Creek

PROJECT COUNTY Union County



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE		DEPTH	Classification					LL	PL	PI	Cc	Cu
●	B-56	6.0	CLAYEY SAND (SC/A-7-6)					43	26	17		
▣	B-56	8.0	SILTY SAND (SM/A-4)					NP	NP	NP		
▲	B-56	10.0	SILTY SAND (SM/A-2-4)					NP	NP	NP		
★	B-56	16.0	SILTY SAND (SM/A-2-4)					NP	NP	NP		
BOREHOLE		DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay		
●	B-56	6.0	25	0.137	0.009		2.3	53.2	19.7	24.8		
▣	B-56	8.0	0.075						44.5			
▲	B-56	10.0	0.075						29.6			
★	B-56	16.0	0.075						28.0			

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: SC 215 Fairforest Creek **SCDOT PROJECT ID:** P041236
SAMPLE NUMBER: 23-0162 **DATE SAMPLE RECEIVED:** 1/19/2023
DESCRIPTION OF SOIL: Various
TESTED BY: CM & DH **DATE SETUP:** 1/20/2023
WEIGHED BY: MD **DATE OF WEIGHING:** 1/23/2023

BORING NO.	B-56	B-56	B-56	B-56	B-56
SAMPLE NO.	SS-1	SS-3	SS-4	SS-5	SS-8
SAMPLE DEPTH (FT.)	0.0 - 2.0	4.0 - 6.0	6.0 - 8.0	8.0 - 10.0	14.0 - 16.0
WATER CONTENT, W%	13.7	26.7	21.4	16.5	14.2

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%					



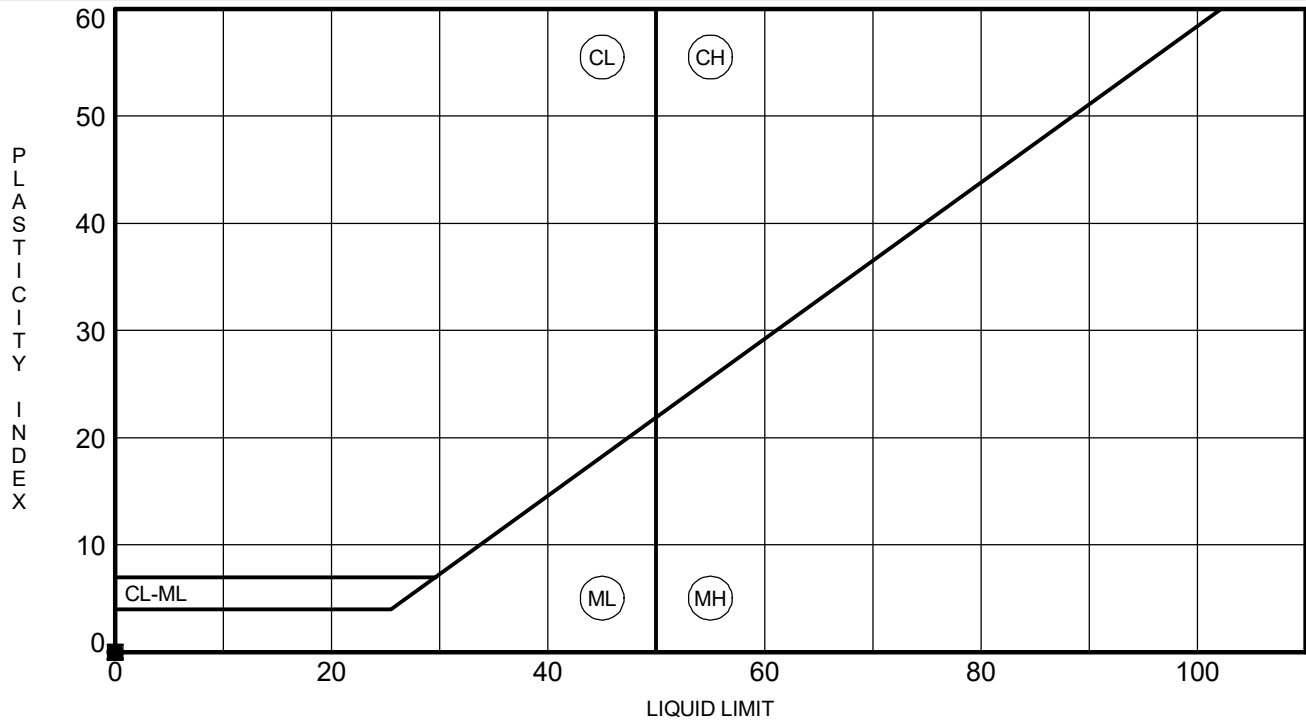
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ATTERBERG LIMITS' RESULTS

PROJECT ID P041236

PROJECT NAME SC 215 RBO Fairforest Creek

PROJECT COUNTY Union County

[illegible]

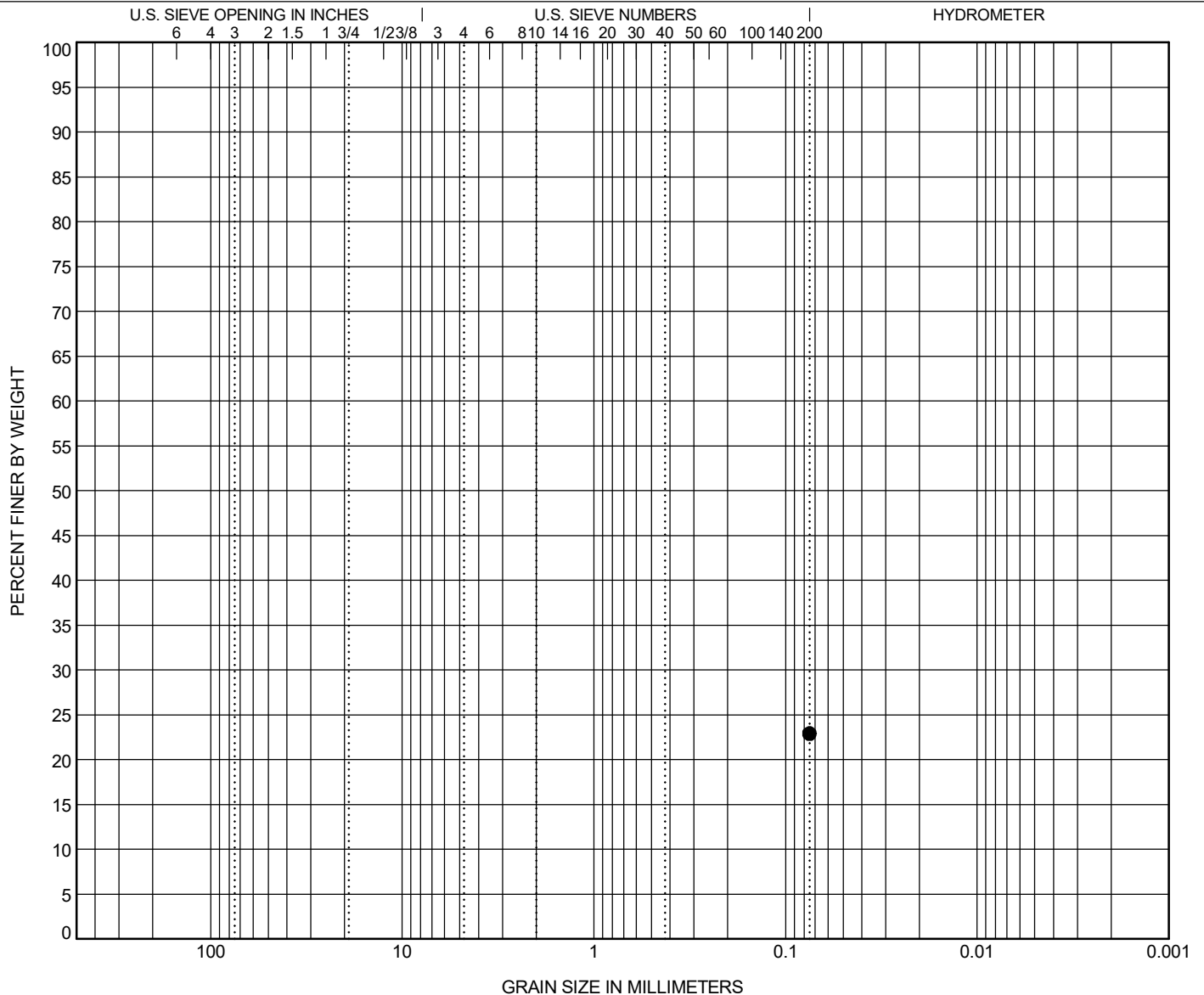


GRAIN SIZE DISTRIBUTION

PROJECT ID P041236

PROJECT NAME SC 215 RBO Fairforest Creek

PROJECT COUNTY Union County



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● R-1	45.0	SILTY SAND (SM/A-2-4)					NP	NP	NP		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay		
● R-1	45.0	0.075							22.9		

GRAIN SIZE G6658.006 - SC 215 RBO FAIRFOREST CREEK.GPJ SCDOT DATA TEMPLATE 01_30_2015.GDT 3/15/23

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: SC 215 Fairforest Creek **SCDOT PROJECT ID:** P041238
SAMPLE NUMBER: 23-0664 **DATE SAMPLE RECEIVED:** 3/9/2023
DESCRIPTION OF SOIL: Various
TESTED BY: CM & MW **DATE SETUP:** 3/9/2023
WEIGHED BY: DH **DATE OF WEIGHING:** 3/10/2023

BORING NO.	R-1	R-1	R-1	R-1	R-1
SAMPLE NO.	SS-2	SS-4	SS-6	SS-8	SS-10
SAMPLE DEPTH (FT.)	2.0 - 4.0	6.0 - 8.0	13.5 - 15.0	23.5 - 25.0	33.5 - 35.0
WATER CONTENT, W%	10.9	16.2	29.0	25.8	34.6

BORING NO.	R-1				
SAMPLE NO.	SS-12				
SAMPLE DEPTH (FT.)	43.5 - 45.0				
WATER CONTENT, W%	15.5				

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

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

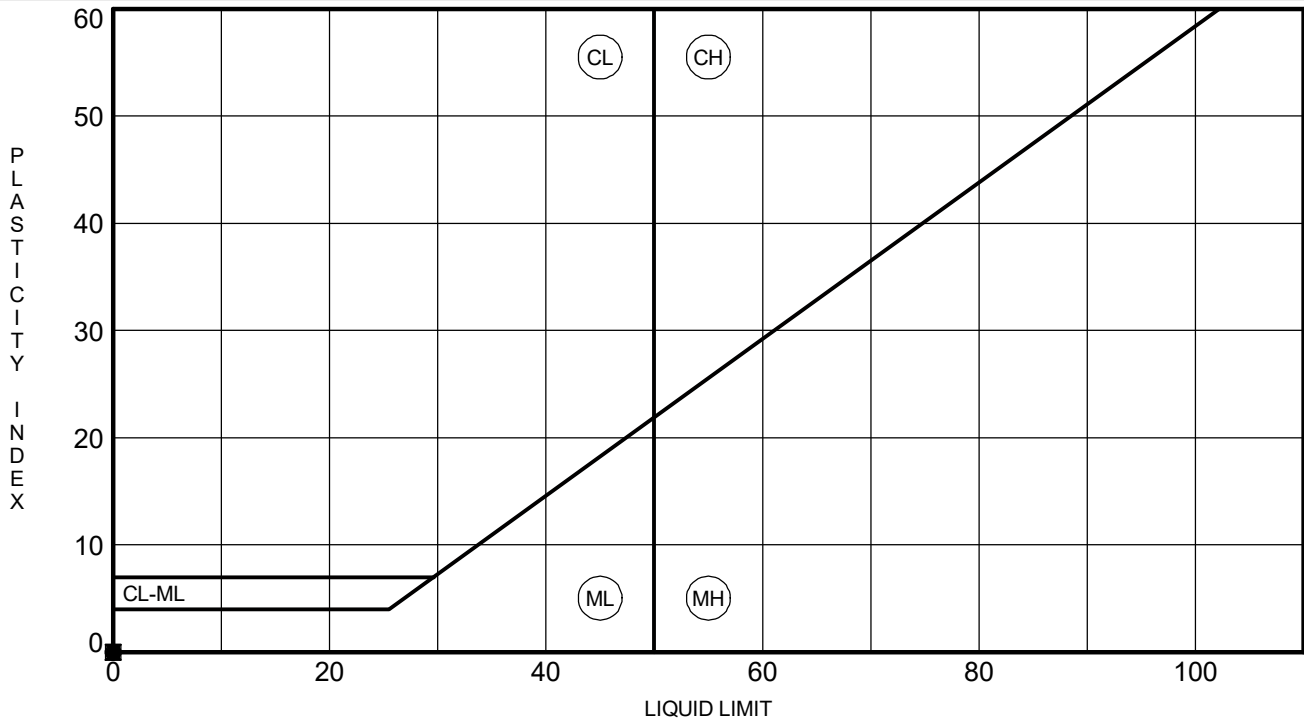


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PROJECT NAME SC 215 RBO Fairforest Creek

PROJECT COUNTY Union County

[illegible]

WATTERBERG LIMITS G6658.006 - SC 215 RBO FAIRFOREST CREEK.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 3/15/23

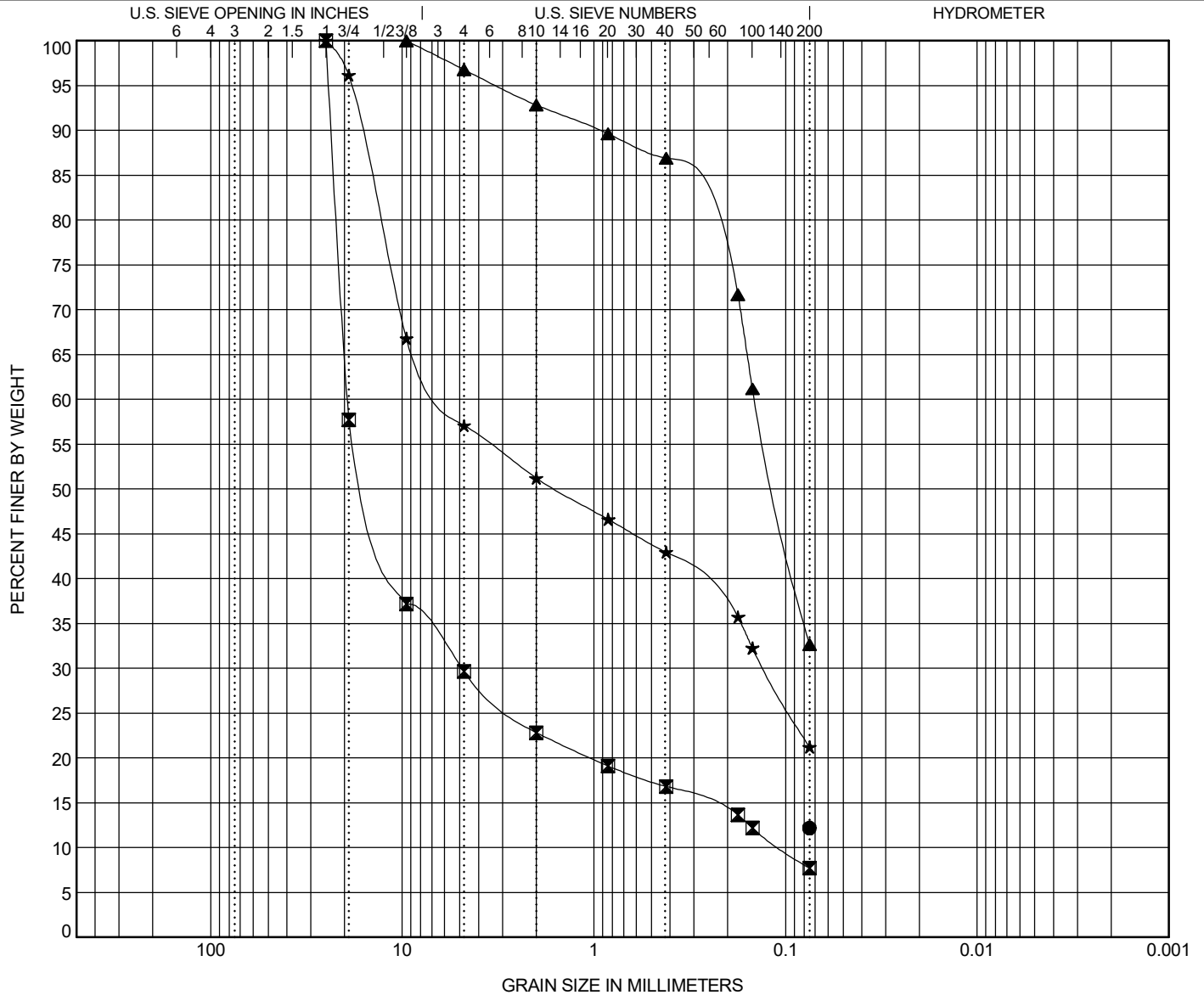


GRAIN SIZE DISTRIBUTION

PROJECT ID P041236

PROJECT NAME SC 215 RBO Fairforest Creek

PROJECT COUNTY Union County



F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: SC 215 Fairforest Creek **SCDOT PROJECT ID:** P041238
SAMPLE NUMBER: 23-0665 **DATE SAMPLE RECEIVED:** 3/9/2023
DESCRIPTION OF SOIL: Various
TESTED BY: CM & MW **DATE SETUP:** 3/9/2023
WEIGHED BY: DH **DATE OF WEIGHING:** 3/10/2023

BORING NO.	R-2	R-2	R-2	R-2	
SAMPLE NO.	SS-2	SS-3	SS-5	SS-7	
SAMPLE DEPTH (FT.)	2.0 - 4.0	4.0 - 6.0	8.0 - 10.0	18.5 - 20.0	
WATER CONTENT, W%	13.0	6.2	25.2	16.6	

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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Appendix C. Laboratory Testing

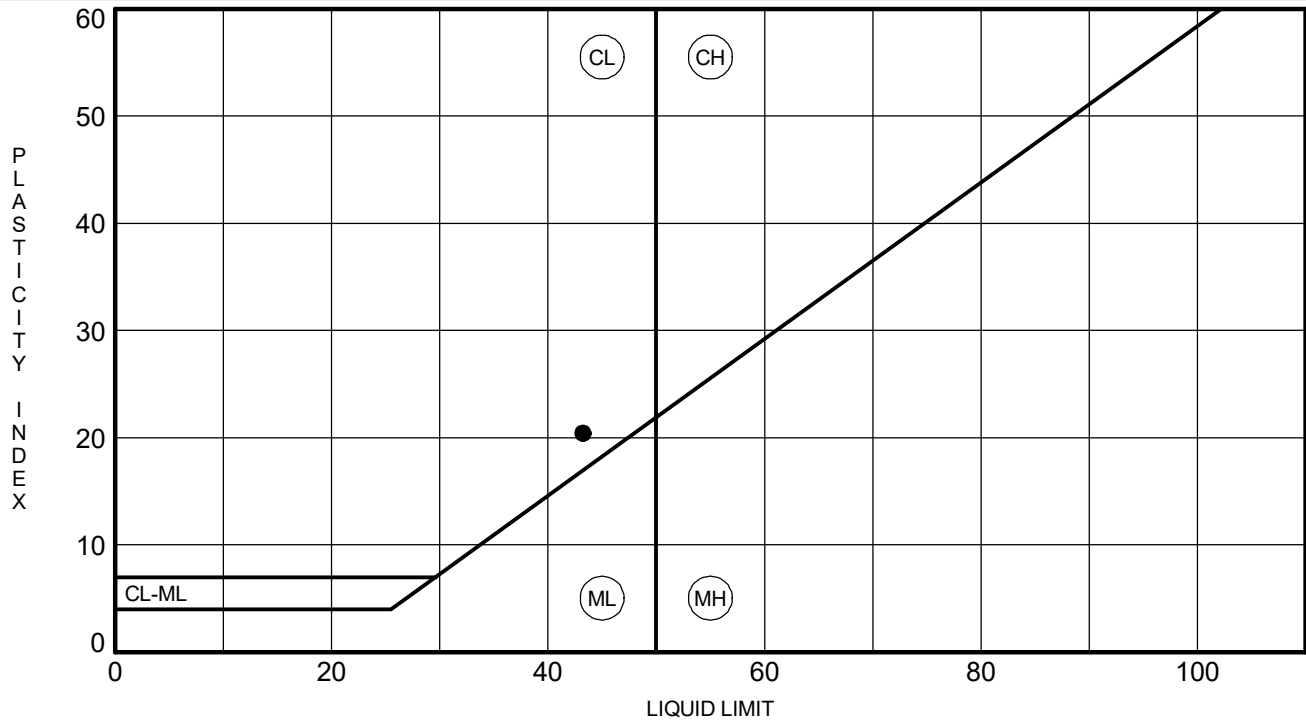
Bulk Samples

ATTERBERG LIMITS' RESULTS

PROJECT ID P041236

PROJECT NAME SC 215 RBO Fairforest Creek

PROJECT COUNTY Union County

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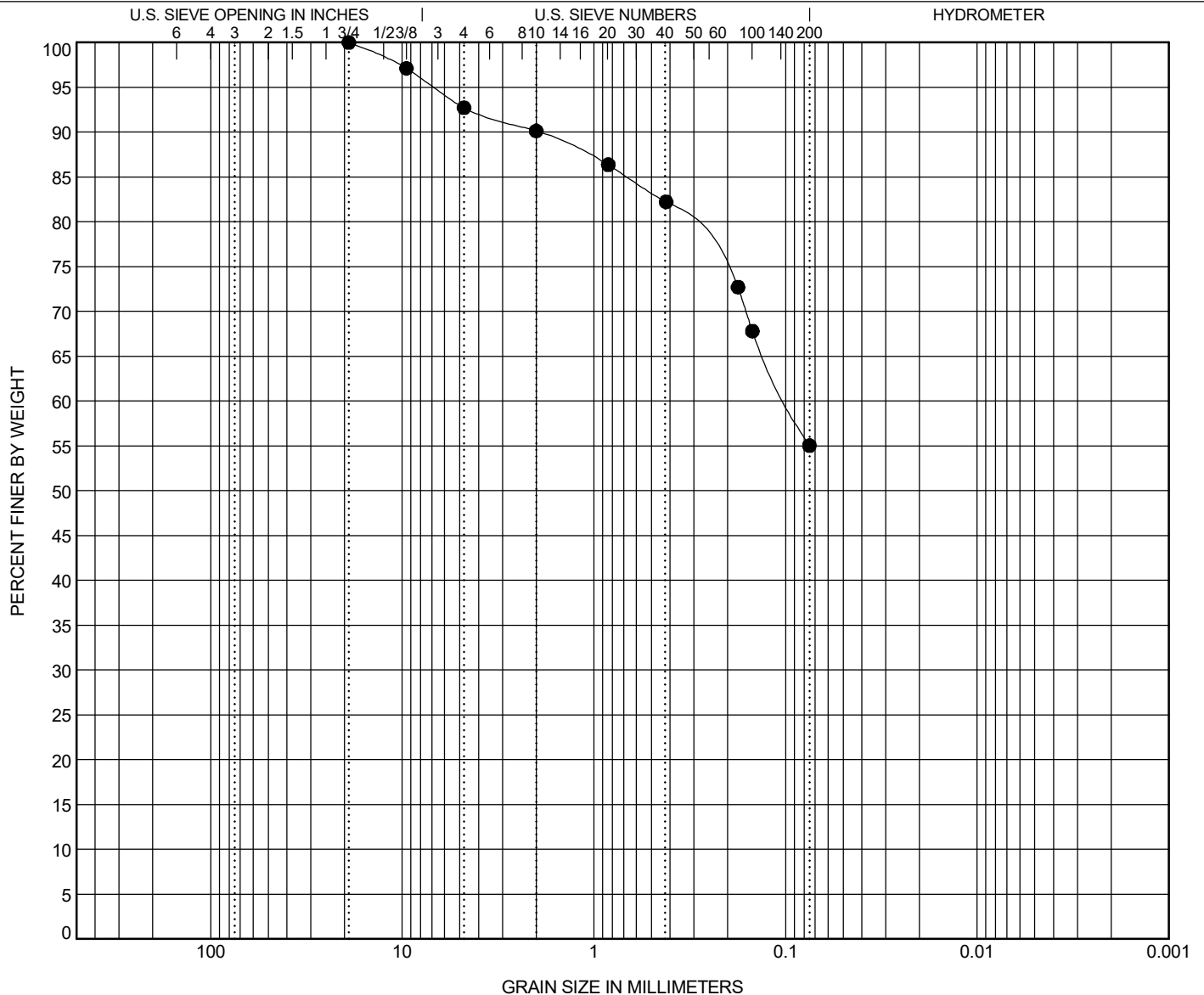


GRAIN SIZE DISTRIBUTION

PROJECT ID P041236

PROJECT NAME SC 215 RBO Fairforest Creek

PROJECT COUNTY Union County



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● BS-6	5.0	SANDY LEAN CLAY (CL/A-7-6)					43	23	20		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay	
● BS-6	5.0	19	0.098			7.3	37.7	55.0			

F&ME CONSULTANTS, INC.

MOISTURE CONTENT DETERMINATION (AASHTO T265)

PROJECT: SC 215 Fairforest Creek **SCDOT PROJECT ID:** P041236
SAMPLE NUMBER: 23-0181 **DATE SAMPLE RECEIVED:** 1/19/2023
DESCRIPTION OF SOIL: Sandy Lean CLAY (CL/A-7-6)
TESTED BY: CM & DH **DATE SETUP:** 1/20/2023
WEIGHED BY: MD **DATE OF WEIGHING:** 1/23/2023

BORING NO.	BS-6				
SAMPLE NO.	--				
SAMPLE DEPTH (FT.)	0.0 - 5.0				
WATER CONTENT, W%	28.8				

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

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

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



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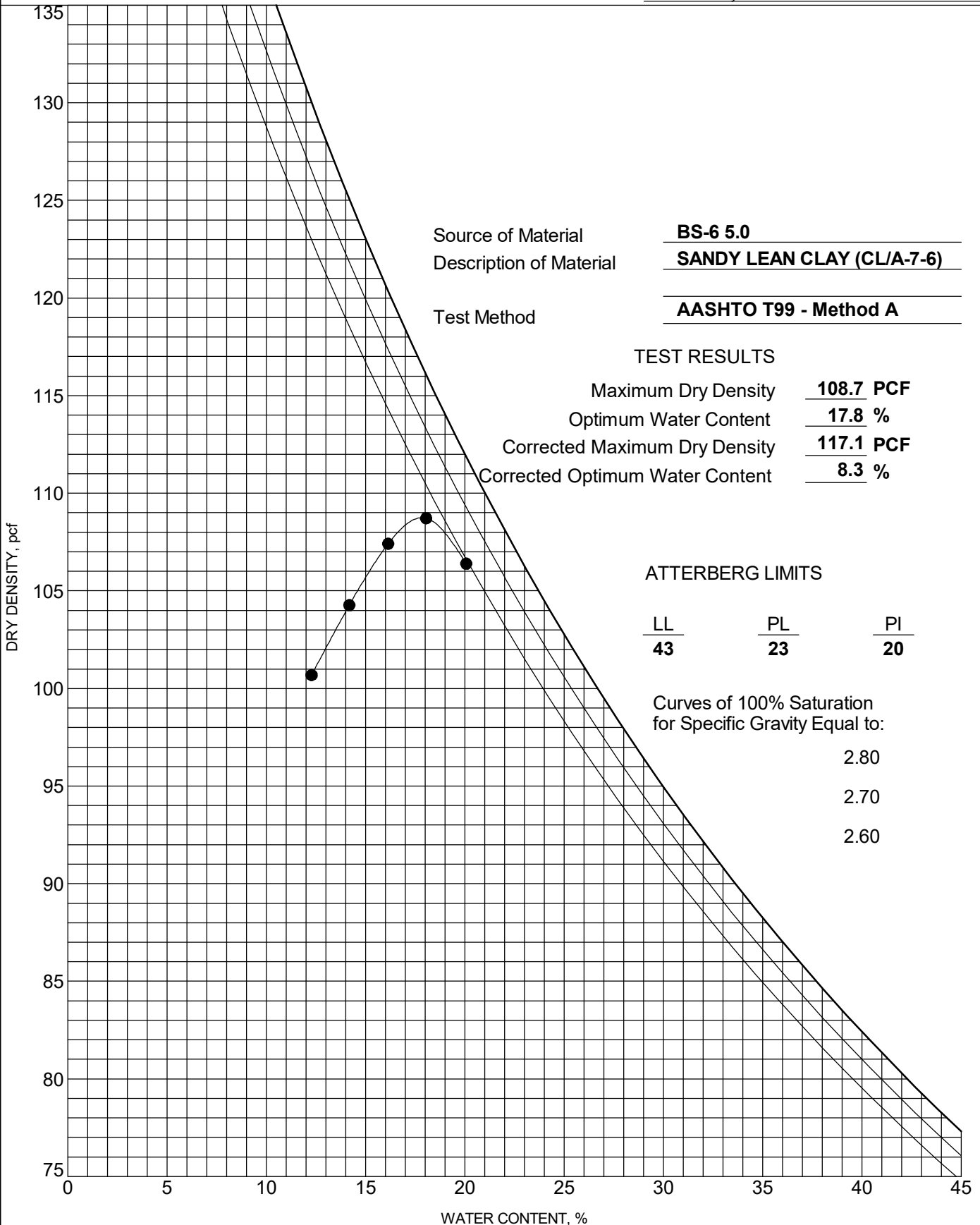


MOISTURE-DENSITY RELATIONSHIP

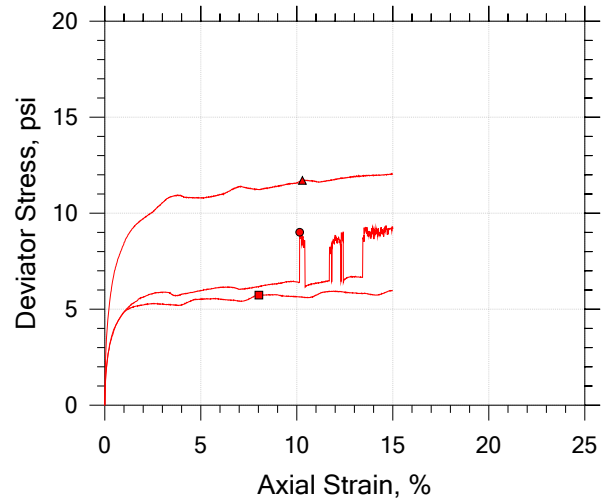
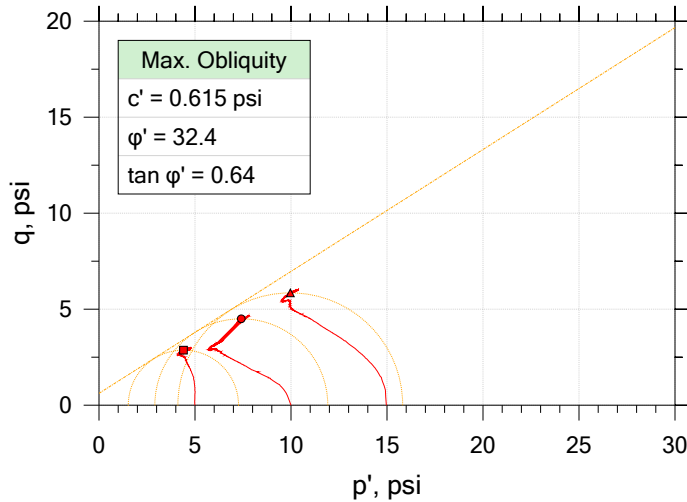
PROJECT ID P041236

PROJECT NAME SC 215 RBO Fairforest Creek

PROJECT COUNTY Union County



Consolidated Undrained by AASHTO T297

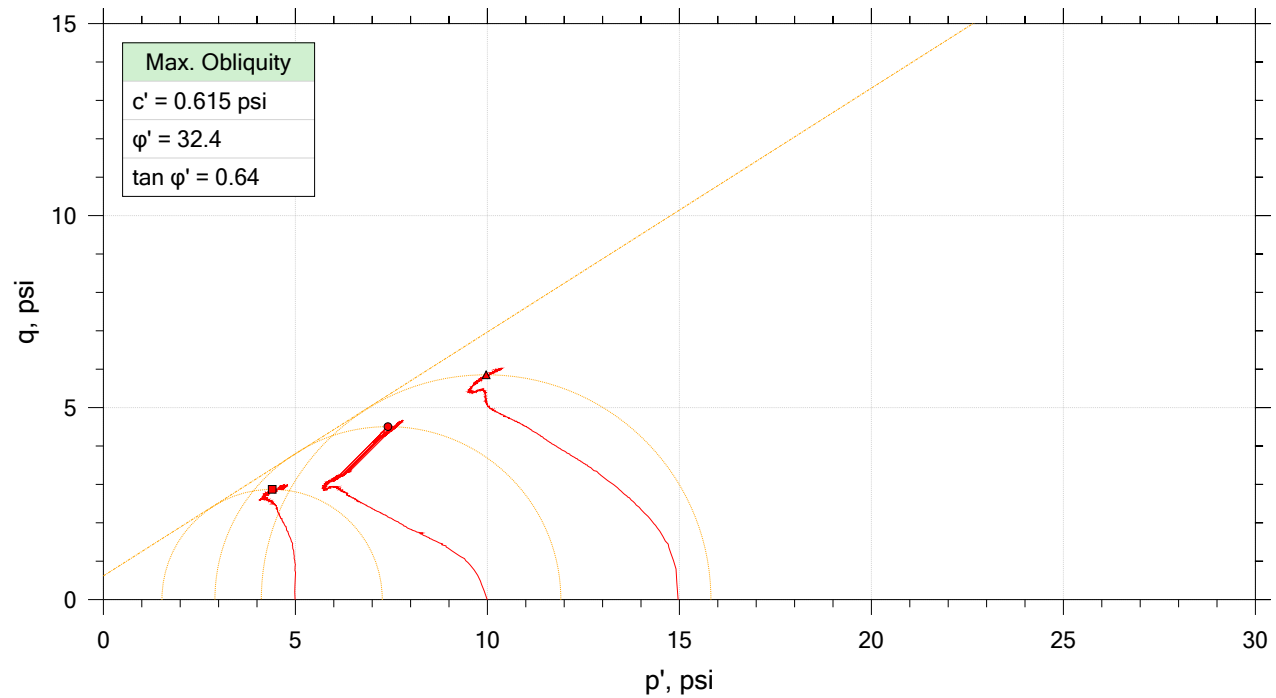
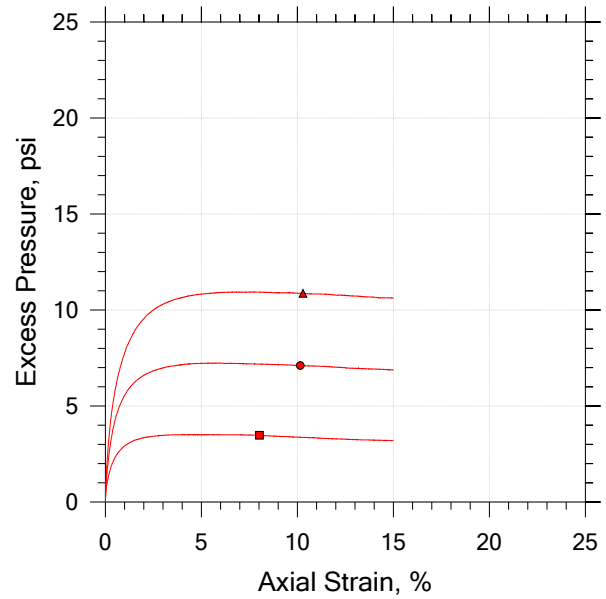
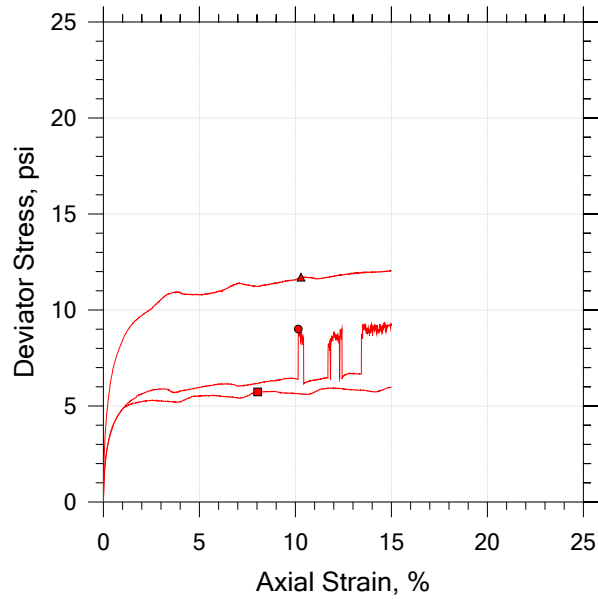


Symbol	■	●	▲	
Sample ID	23-0181	23-0181	23-0181	
Depth	0.0' - 5.0'	0.0' - 5.0'	0.0' - 5.0'	
Test Number	A	B	C	
Initial				
Height, in	6.000	6.000	6.000	
Diameter, in	2.800	2.800	2.800	
Moisture Content (from Cuttings), %	17.5	17.5	17.5	
Dry Density, pcf	103.	103.	103.	
Saturation (Wet Method), %	76.0	76.0	75.9	
Void Ratio	0.618	0.617	0.617	
Final				
Moisture Content, %	23.3	21.5	19.8	
Dry Density, pcf	103.	106.	109.	
Cross-Sectional Area (Method A), in ²	6.151	6.055	5.907	
Saturation, %	100.0	100.0	100.0	
Void Ratio	0.624	0.577	0.530	
Back Pressure, psi	101.0	97.98	101.0	
Vertical Effective Consolidation Stress, psi	4.971	9.904	14.86	
Horizontal Effective Consolidation Stress, psi	4.999	10.00	14.97	
Vertical Strain after Consolidation, %	0.2631	1.494	1.807	
Volumetric Strain after Consolidation, %	1.828	4.404	6.581	
Time to 50% Consolidation, min	3.500	3.500	4.200	
Shear Strength, psi	2.869	4.505	5.854	
Strain at Failure, %	8.03	10.2	10.3	
Strain Rate, %/min	0.0005000	0.0005000	0.0005000	
Deviator Stress at Failure, psi	5.738	9.010	11.71	
Effective Minor Principal Stress at Failure, psi	1.525	2.904	4.110	
Effective Major Principal Stress at Failure, psi	7.263	11.91	15.82	
B-Value	0.95	0.94	0.95	


Notes:
 - Before Shear Saturation set to 100% for phase calculation.
 - Moisture Content determined by ASTM D2216.
 - Atterberg Limits determined by ASTM D4318.
 - Deviator Stress includes membrane correction.
 - Values for c and ϕ determined from best-fit straight line for the specific test conditions.
 Actual strength parameters may vary and should be determined by an engineer for site conditions.

	Project Name: SC 215 RBO Fairforest Creek	Location: Union County	Project Number: P041236
	Boring Number: BS-6	Tester: RMC	Checker: WAP/ WJG
	Sample Number: 23-0181	Test Date: 2/1/2023	Depth: 0.0' - 5.0'
	Test Number: ABC	Preparation: Remolded	Elevation:
	Description: Sandy Lean CLAY (CL/A-7-6)	LL=43, PL=23, PI=20, %200=55.0	
	Remarks: Max Dry Density=108.7 pcf, OMC=17.8%, Samples Molded at 95%		

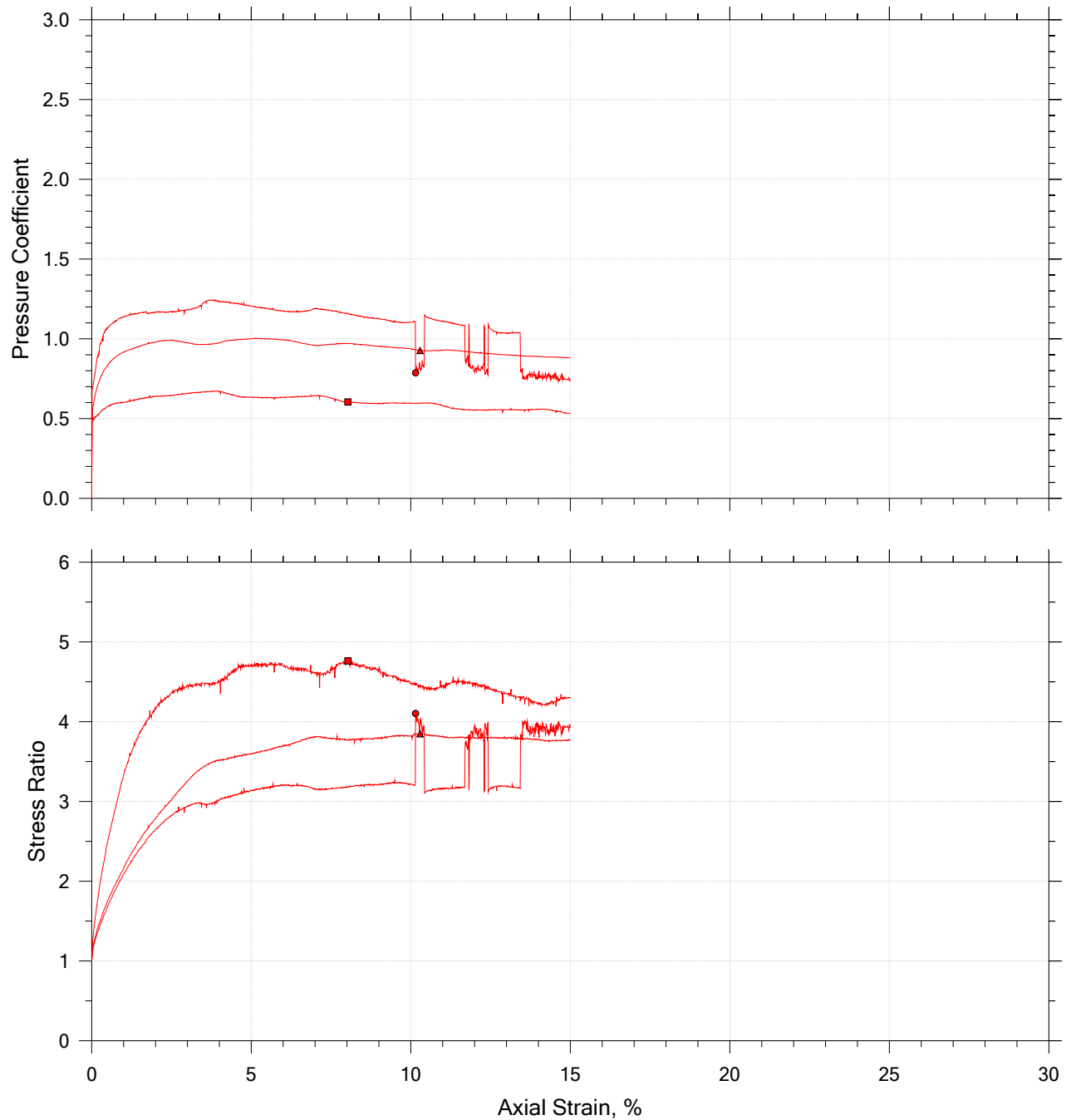
Consolidated Undrained by AASHTO T297




	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	23-0181	A	0.0' - 5.0'	RMC	2/1/2023	WAP/ WJG	2/9/2023	BS-6.A.dat
●	23-0181	B	0.0' - 5.0'	RMC	2/1/2023	WAP/ WJG	2/9/2023	BS-6.B.dat
▲	23-0181	C	0.0' - 5.0'	RMC	2/2/2023	WAP/ WJG	2/9/2023	BS-6.C.dat

	Project Name: SC 215 RBO Fairforest Creek	Location: Union County	Project Number: P041236
	Boring Number: BS-6	Tester: RMC	Checker: WAP/ WJG
	Sample Number: 23-0181	Test Date: 2/1/2023	Depth: 0.0' - 5.0'
	Test Number: ABC	Preparation: Remolded	Elevation:
	Description: Sandy Lean CLAY (CL/A-7-6) LL=43, PL=23, PI=20, %200=55.0		
	Remarks: Max Dry Density=108.7 pcf, OMC=17.8%, Samples Molded at 95%		

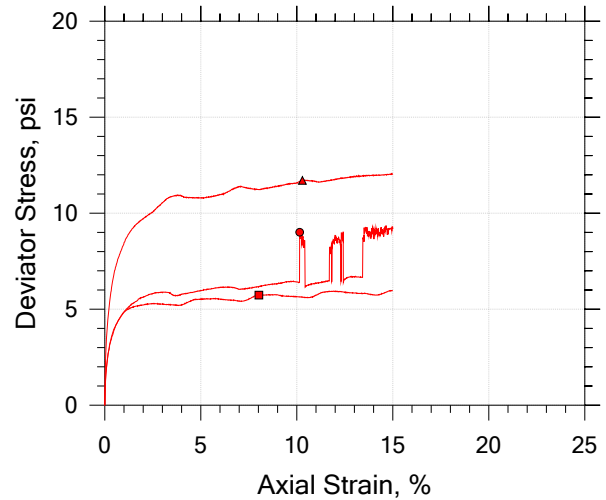
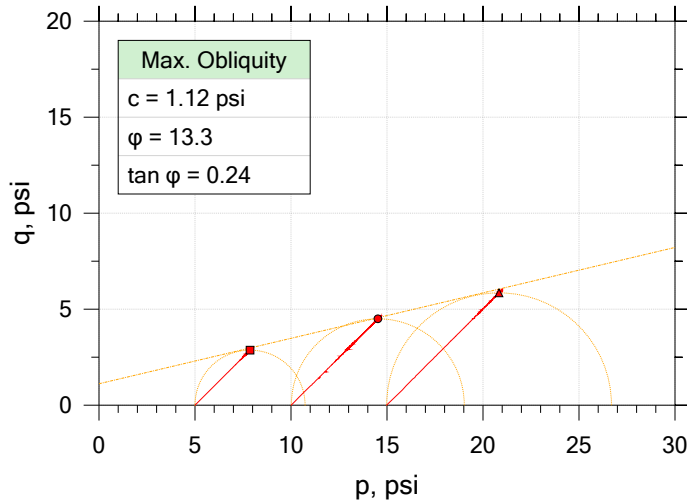
Consolidated Undrained by AASHTO T297



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	23-0181	A	0.0' - 5.0'	RMC	2/1/2023	WAP/ WJG	2/9/2023	BS-6.A.dat
●	23-0181	B	0.0' - 5.0'	RMC	2/1/2023	WAP/ WJG	2/9/2023	BS-6.B.dat
▲	23-0181	C	0.0' - 5.0'	RMC	2/2/2023	WAP/ WJG	2/9/2023	BS-6.C.dat


	Project Name: SC 215 RBO Fairforest Creek	Location: Union County	Project Number: P041236
	Boring Number: BS-6	Tester: RMC	Checker: WAP/ WJG
	Sample Number: 23-0181	Test Date: 2/1/2023	Depth: 0.0' - 5.0'
	Test Number: ABC	Preparation: Remolded	Elevation:
	Description: Sandy Lean CLAY (CL/A-7-6) LL=43, PL=23, PI=20, %200=55.0		
	Remarks: Max Dry Density=108.7 pcf, OMC=17.8%, Samples Molded at 95%		

Consolidated Undrained by AASHTO T297

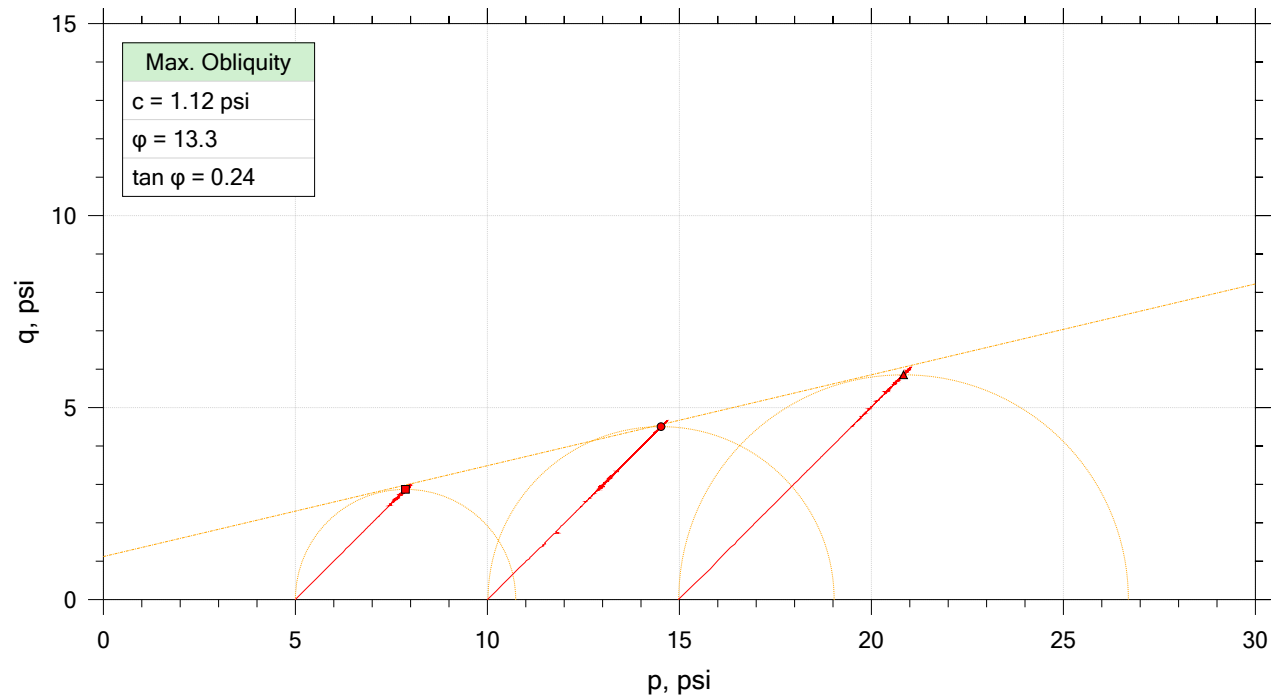
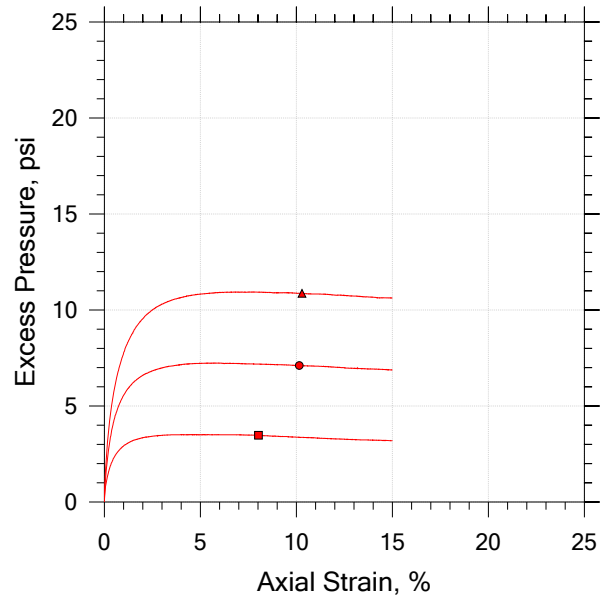
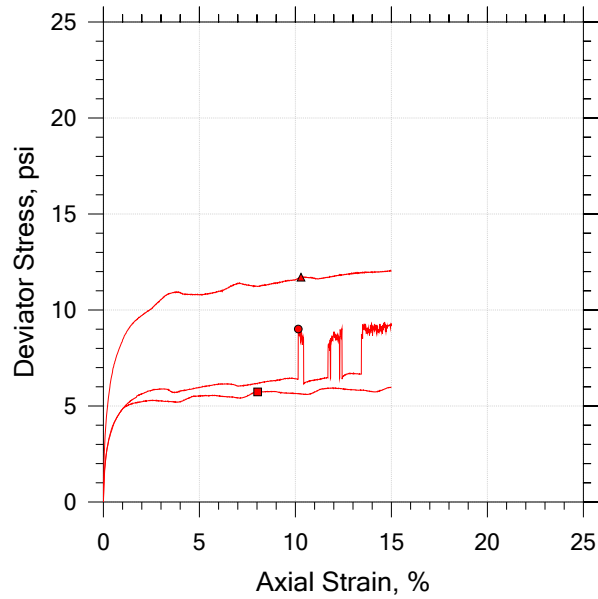


Symbol	■	●	▲	
Sample ID	23-0181	23-0181	23-0181	
Depth	0.0' - 5.0'	0.0' - 5.0'	0.0' - 5.0'	
Test Number	A	B	C	
Initial				
Height, in	6.000	6.000	6.000	
Diameter, in	2.800	2.800	2.800	
Moisture Content (from Cuttings), %	17.5	17.5	17.5	
Dry Density, pcf	103.	103.	103.	
Saturation (Wet Method), %	76.0	76.0	75.9	
Void Ratio	0.618	0.617	0.617	
Final				
Moisture Content, %	23.3	21.5	19.8	
Dry Density, pcf	103.	106.	109.	
Cross-Sectional Area (Method A), in ²	6.151	6.055	5.907	
Saturation, %	100.0	100.0	100.0	
Void Ratio	0.624	0.577	0.530	
Back Pressure, psi	101.0	97.98	101.0	
Vertical Effective Consolidation Stress, psi	4.971	9.904	14.86	
Horizontal Effective Consolidation Stress, psi	4.999	10.00	14.97	
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Shear Strength, psi	2.869	4.505	5.854	
Strain at Failure, %	8.03	10.2	10.3	
Strain Rate, %/min	0.0005000	0.0005000	0.0005000	
Deviator Stress at Failure, psi	5.738	9.010	11.71	
Effective Minor Principal Stress at Failure, psi	1.525	2.904	4.110	
Effective Major Principal Stress at Failure, psi	7.263	11.91	15.82	
B-Value	0.95	0.94	0.95	


Notes:
 - Before Shear Saturation set to 100% for phase calculation.
 - Moisture Content determined by ASTM D2216.
 - Atterberg Limits determined by ASTM D4318.
 - Deviator Stress includes membrane correction.
 - Values for c and ϕ determined from best-fit straight line for the specific test conditions.
 Actual strength parameters may vary and should be determined by an engineer for site conditions.

	Project Name: SC 215 RBO Fairforest Creek	Location: Union County	Project Number: P041236
	Boring Number: BS-6	Tester: RMC	Checker: WAP/ WJG
	Sample Number: 23-0181	Test Date: 2/1/2023	Depth: 0.0' - 5.0'
	Test Number: ABC	Preparation: Remolded	Elevation:
	Description: Sandy Lean <u>CLAY (CL/A-7-6)</u> LL=43, PL=23, PI=20, %200=55.0		
	Remarks: Max Dry Density=108.7 pcf, OMC=17.8%, Samples Molded at 95%		

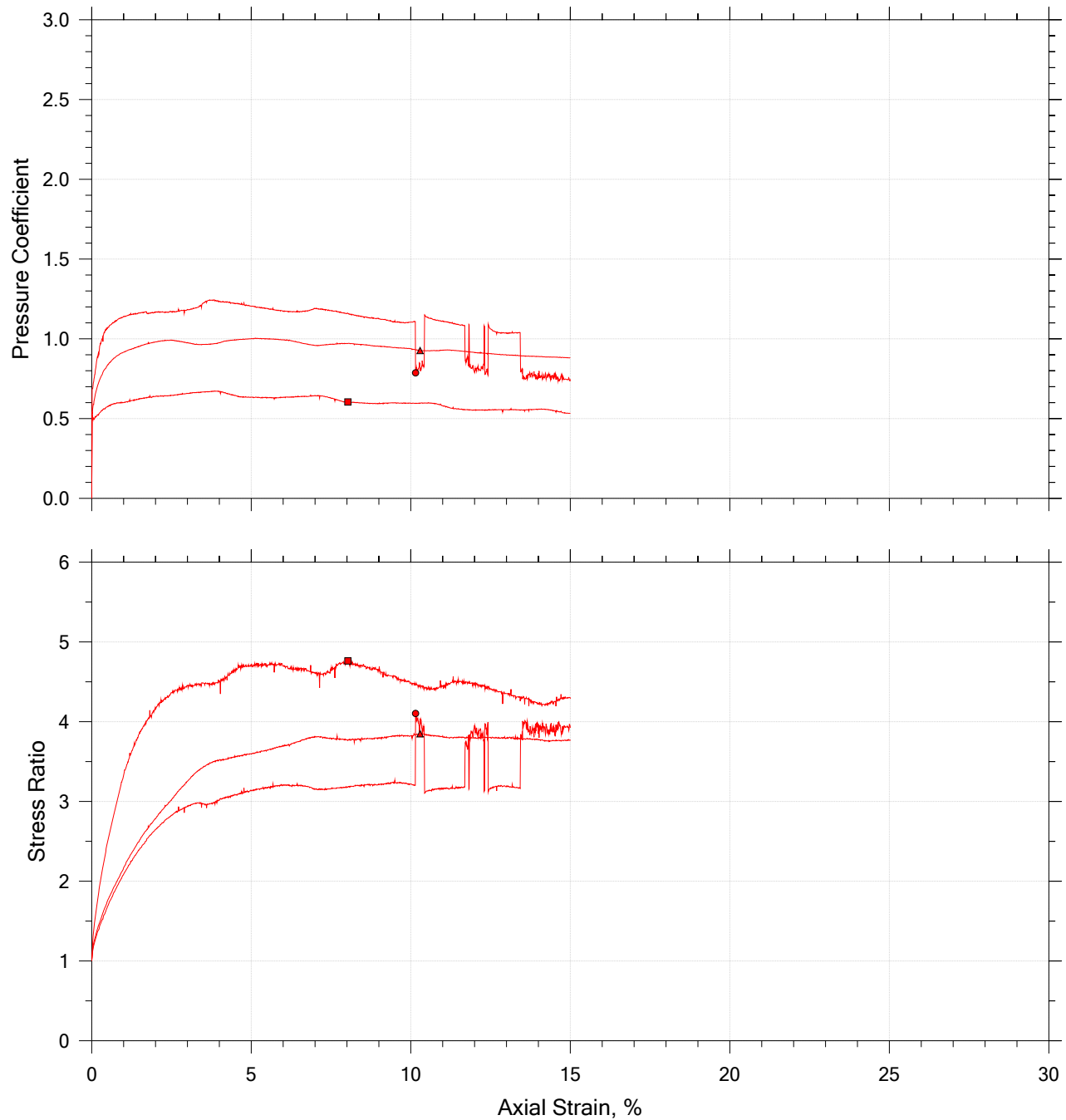
Consolidated Undrained by AASHTO T297




	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	23-0181	A	0.0' - 5.0'	RMC	2/1/2023	WAP/ WJG	2/9/2023	BS-6.A.dat
●	23-0181	B	0.0' - 5.0'	RMC	2/1/2023	WAP/ WJG	2/9/2023	BS-6.B.dat
▲	23-0181	C	0.0' - 5.0'	RMC	2/2/2023	WAP/ WJG	2/9/2023	BS-6.C.dat

	Project Name: SC 215 RBO Fairforest Creek	Location: Union County	Project Number: P041236
	Boring Number: BS-6	Tester: RMC	Checker: WAP/ WJG
	Sample Number: 23-0181	Test Date: 2/1/2023	Depth: 0.0' - 5.0'
	Test Number: ABC	Preparation: Remolded	Elevation:
	Description: Sandy Lean CLAY (CL/A-7-6) LL=43, PL=23, PI=20, %200=55.0		
	Remarks: Max Dry Density=108.7 pcf, OMC=17.8%, Samples Molded at 95%		

Consolidated Undrained by AASHTO T297



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	23-0181	A	0.0' - 5.0'	RMC	2/1/2023	WAP/ WJG	2/9/2023	BS-6.A.dat
●	23-0181	B	0.0' - 5.0'	RMC	2/1/2023	WAP/ WJG	2/9/2023	BS-6.B.dat
▲	23-0181	C	0.0' - 5.0'	RMC	2/2/2023	WAP/ WJG	2/9/2023	BS-6.C.dat

	Project Name: SC 215 RBO Fairforest Creek	Location: Union County	Project Number: P041236
	Boring Number: BS-6	Tester: RMC	Checker: WAP/ WJG
	Sample Number: 23-0181	Test Date: 2/1/2023	Depth: 0.0' - 5.0'
	Test Number: ABC	Preparation: Remolded	Elevation:
	Description: Sandy Lean CLAY (CL/A-7-6) LL=43, PL=23, PI=20, %200=55.0		
	Remarks: Max Dry Density=108.7 pcf, OMC=17.8%, Samples Molded at 95%		



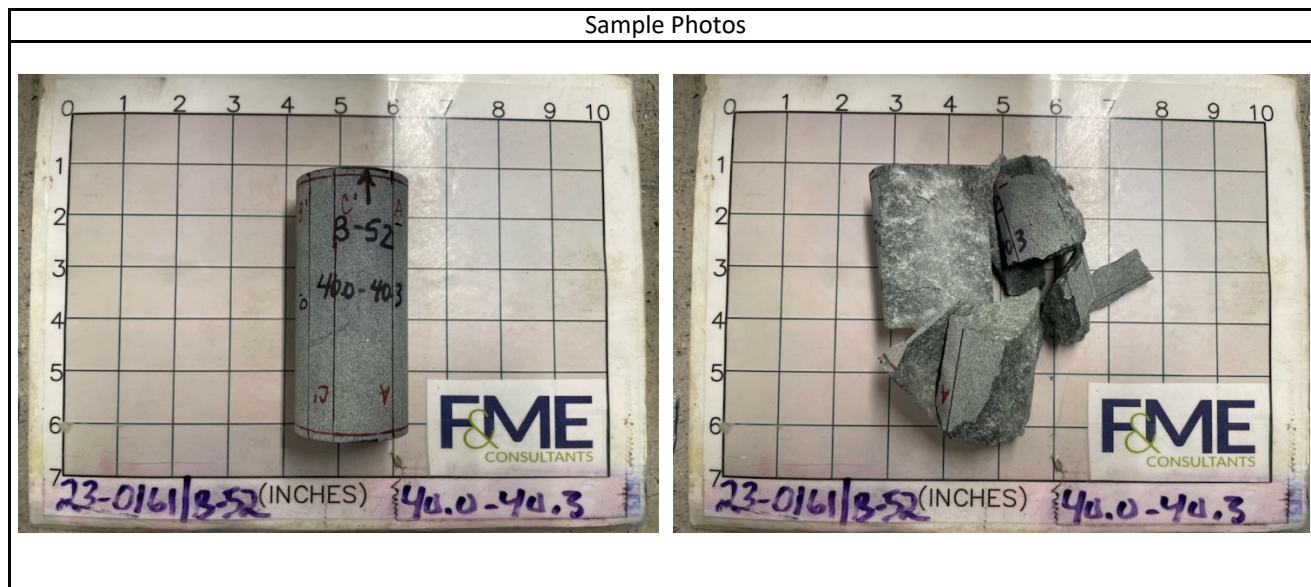
Appendix C. Laboratory Testing

Rock Cores

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

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.863	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.258	Reviewed By	WJG
Boring	B-52	Unit Weight (pcf)	196.3	Core Size	NQ
Sample No.	NQ-5 / 23-0161	L/D Ratio	2.29	Recovery	73%
Depth	40.0' - 40.3'	Load Rate (psi/sec)	20	RQD	52%
Description	Black/White/Gray Gneiss				

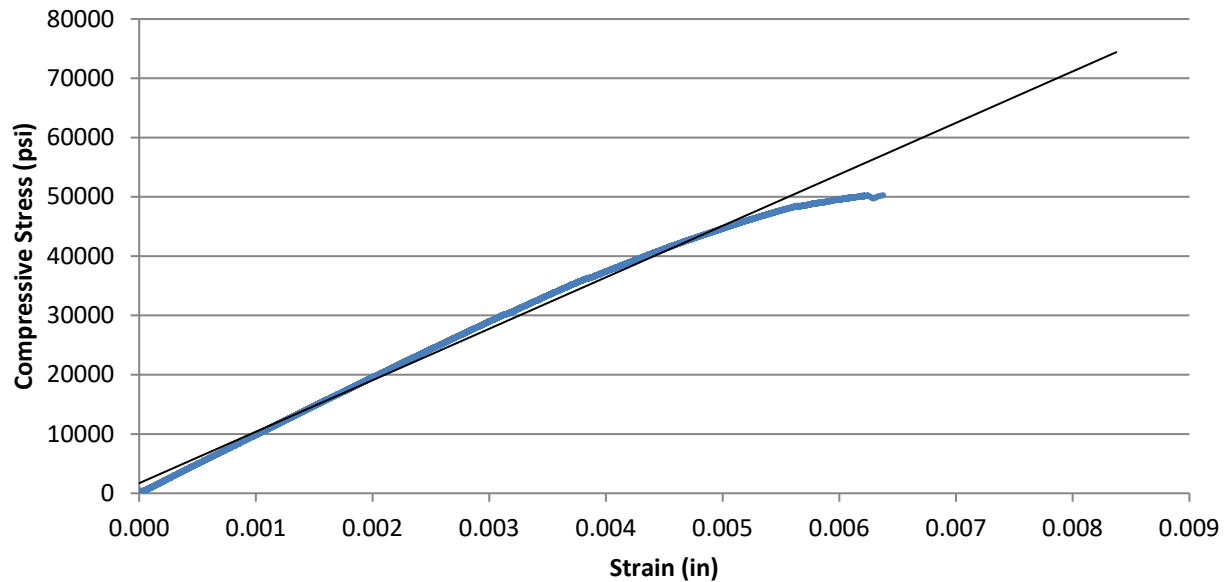
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-507	165	13,730	5,037	19.88	0.33
20%	-1021	297	27,419	10,058	19.70	0.29
30%	-1535	424	41,114	15,083	19.66	0.28
40%	-2059	555	54,831	20,115	19.54	0.27
50%	-2588	689	68,526	25,138	19.43	0.27
60%	-3145	780	82,297	30,190	19.20	0.25
70%	-3712	925	95,936	35,194	18.96	0.25
80%	-4362	1135	109,616	40,212	18.44	0.26
90%	-5086	1545	123,352	45,251	17.79	0.30
100%	-6374	582	137,030	50,269		



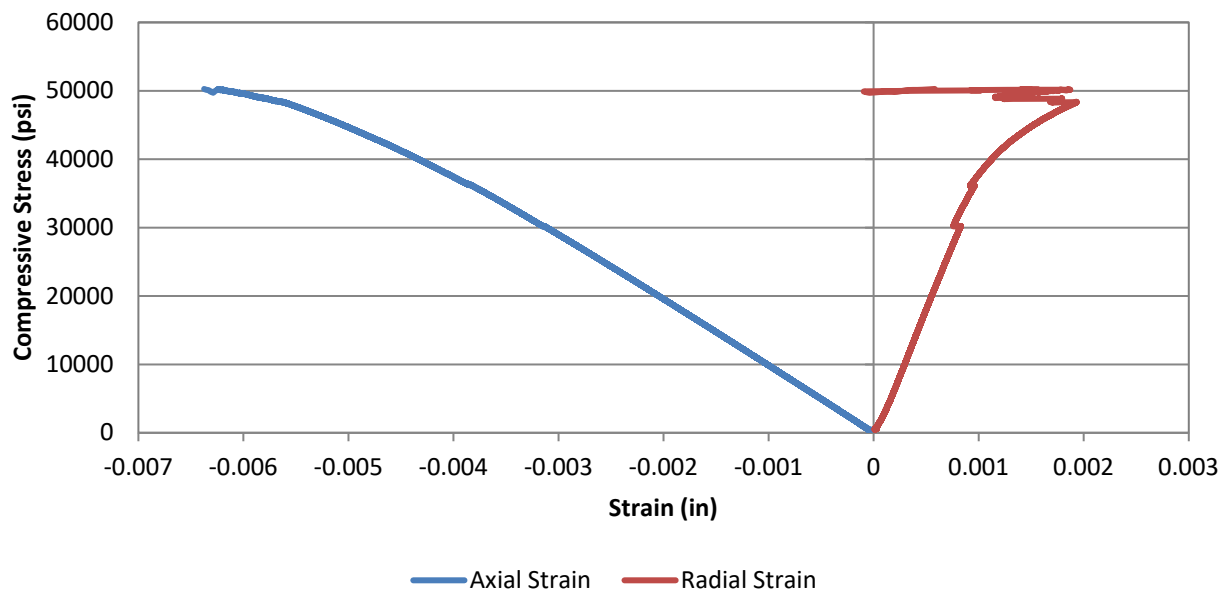
Test Results			
Unconfined Compressive Strength (psi)		50,270	Elastic Modulus (psi)
			1.94E+07
			Poisson's Ratio in Elastic Range
			0.27
Comments	Elastic range was taken as between 0.001 and 0.004 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.863	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.258	Reviewed By	WJG
Boring	B-52	Unit Weight (pcf)	196.3	Core Size	NQ
Sample No.	NQ-5 / 23-0161	L/D Ratio	2.29	Recovery	73%
Depth	40.0' - 40.3'	Load Rate (psi/sec)	20	RQD	52%
Description	Black/White/Gray Gneiss				

Axial Stress vs. Strain



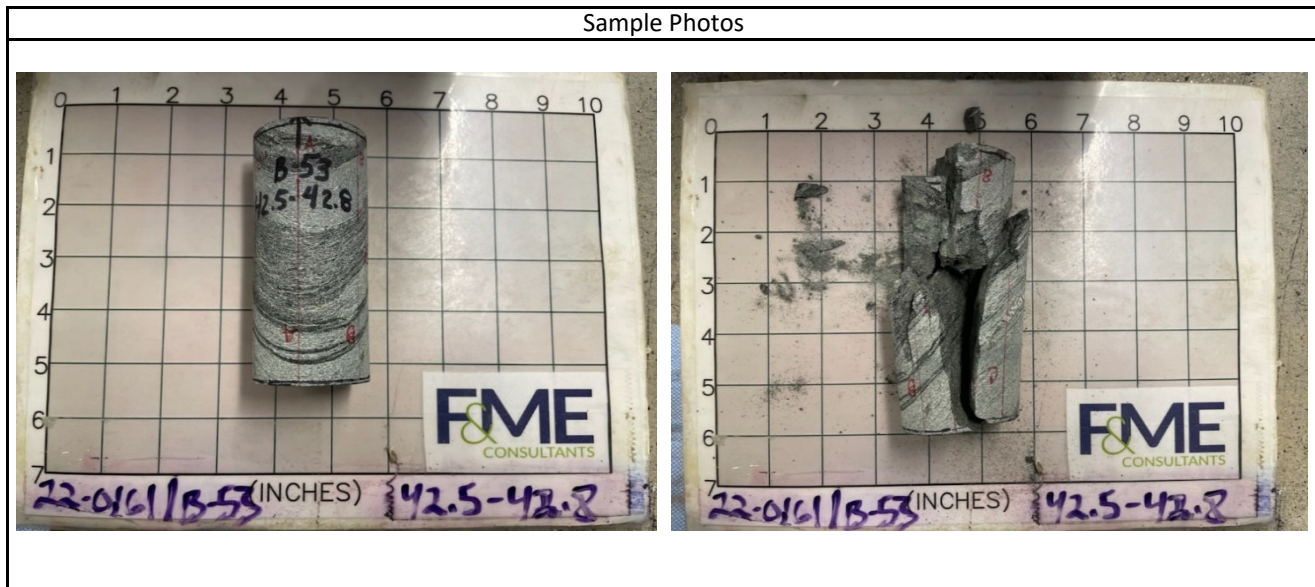
Stress vs. Strain



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

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.862	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.128	Reviewed By	WJG
Boring	B-53	Unit Weight (pcf)	187.2	Core Size	NQ
Sample No.	NQ-3 / 22-0178A	L/D Ratio	2.22	Recovery	77%
Depth	42.5' - 42.8'	Load Rate (psi/sec)	20	RQD	43%
Description	Black/White/Gray Gneiss				

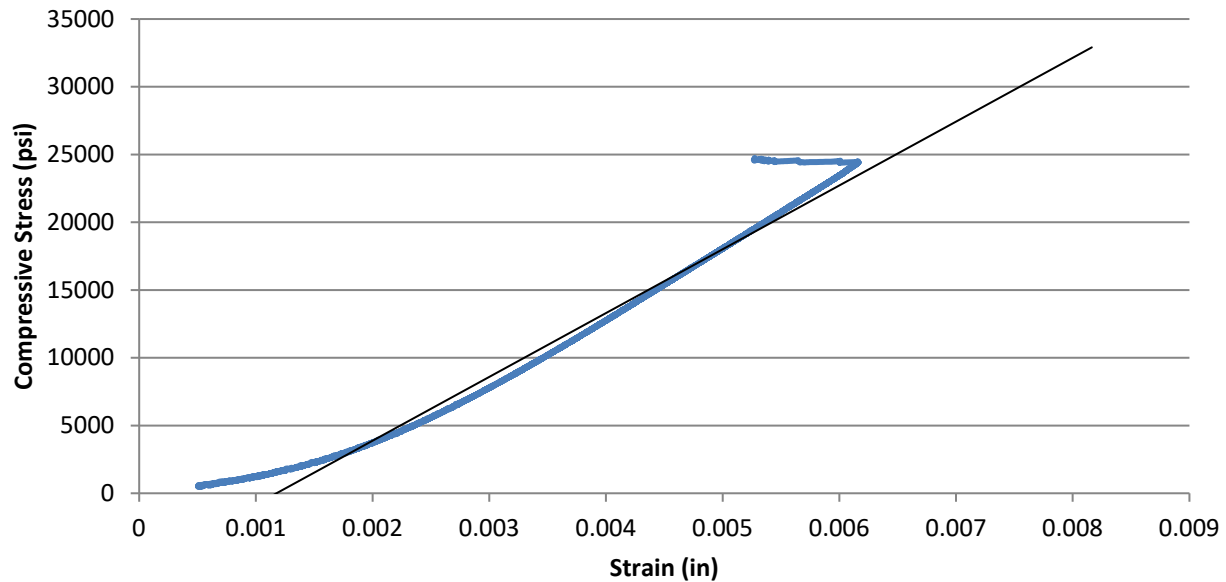
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-1579	60	6,738	2,475	3.13	0.04
20%	-2334	227	13,439	4,935	4.23	0.10
30%	-2926	404	20,262	7,441	5.09	0.14
40%	-3434	590	26,918	9,885	5.76	0.17
50%	-3927	803	33,764	12,399	6.32	0.20
60%	-4401	1042	40,495	14,871	6.76	0.24
70%	-4858	1318	47,135	17,310	7.13	0.27
80%	-5320	1646	53,830	19,769	7.43	0.31
90%	-5784	2070	60,663	22,278	7.70	0.36
100%	-5274	2886	67,383	24,746		



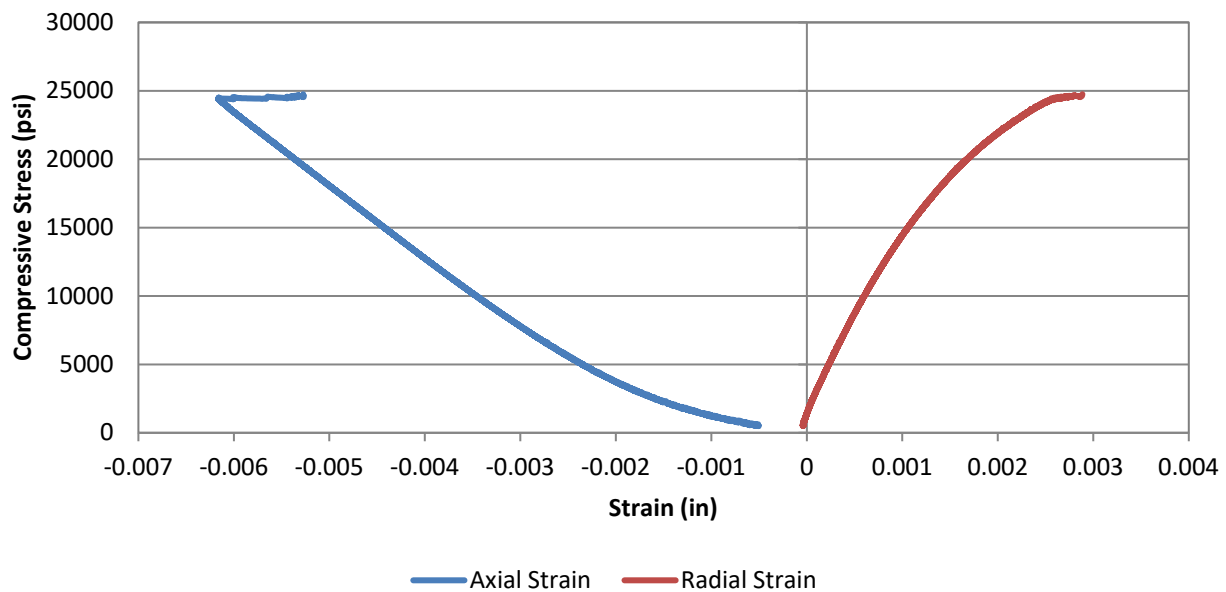
Test Results			
Unconfined Compressive Strength (psi)		24,750	Elastic Modulus (psi)
			5.83E+06
			Poisson's Ratio in Elastic Range
			0.18
Comments	Elastic range was taken as between 0.002 and 0.005 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.862	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.128	Reviewed By	WJG
Boring	B-53	Unit Weight (pcf)	187.2	Core Size	NQ
Sample No.	NQ-3 / 22-0178A	L/D Ratio	2.22	Recovery	77%
Depth	42.5' - 42.8'	Load Rate (psi/sec)	20	RQD	43%
Description	Black/White/Gray Gneiss				

Axial Stress vs. Strain



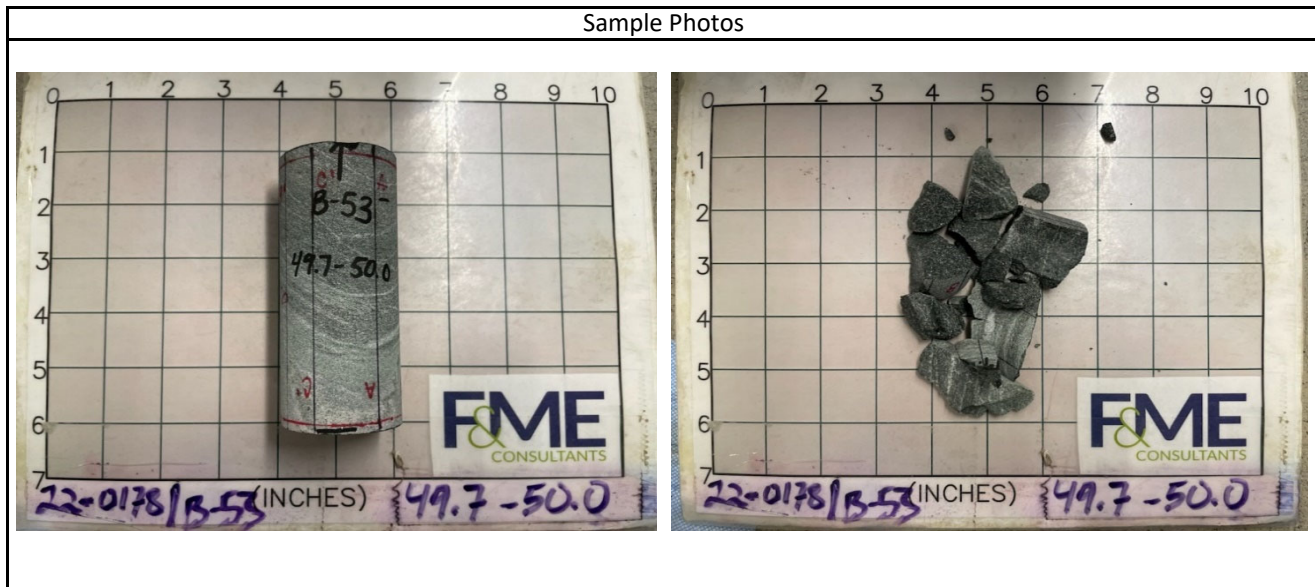
Stress vs. Strain



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

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.862	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.268	Reviewed By	WJG
Boring	B-53	Unit Weight (pcf)	192.3	Core Size	NQ
Sample No.	NQ-4 / 22-0178B	L/D Ratio	2.29	Recovery	97%
Depth	49.7' - 50.0'	Load Rate (psi/sec)	30	RQD	73%
Description	Black/White/Gray Gneiss				

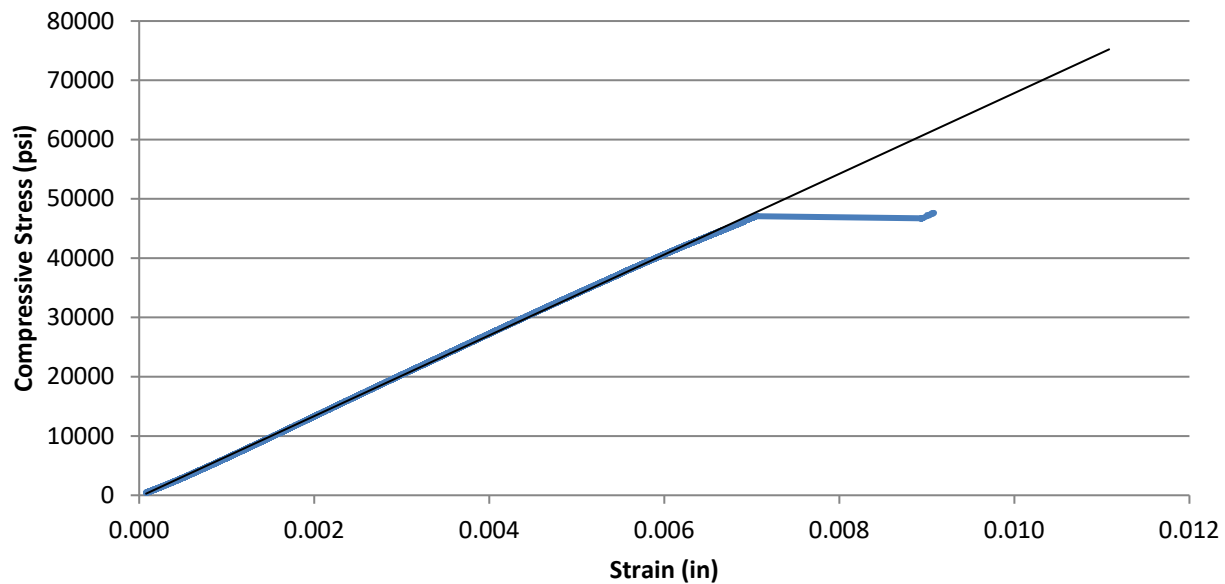
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-774	53	12,968	4,762	12.31	0.07
20%	-1461	199	25,939	9,526	13.04	0.14
30%	-2136	349	38,901	14,286	13.38	0.16
40%	-2810	513	51,820	19,030	13.55	0.18
50%	-3506	701	64,838	23,811	13.58	0.20
60%	-4194	904	77,806	28,574	13.63	0.22
70%	-4891	1127	90,758	33,330	13.63	0.23
80%	-5609	1383	103,790	38,116	13.59	0.25
90%	-6361	1739	116,768	42,882	13.48	0.27
100%	-9082	1549	129,671	47,621		



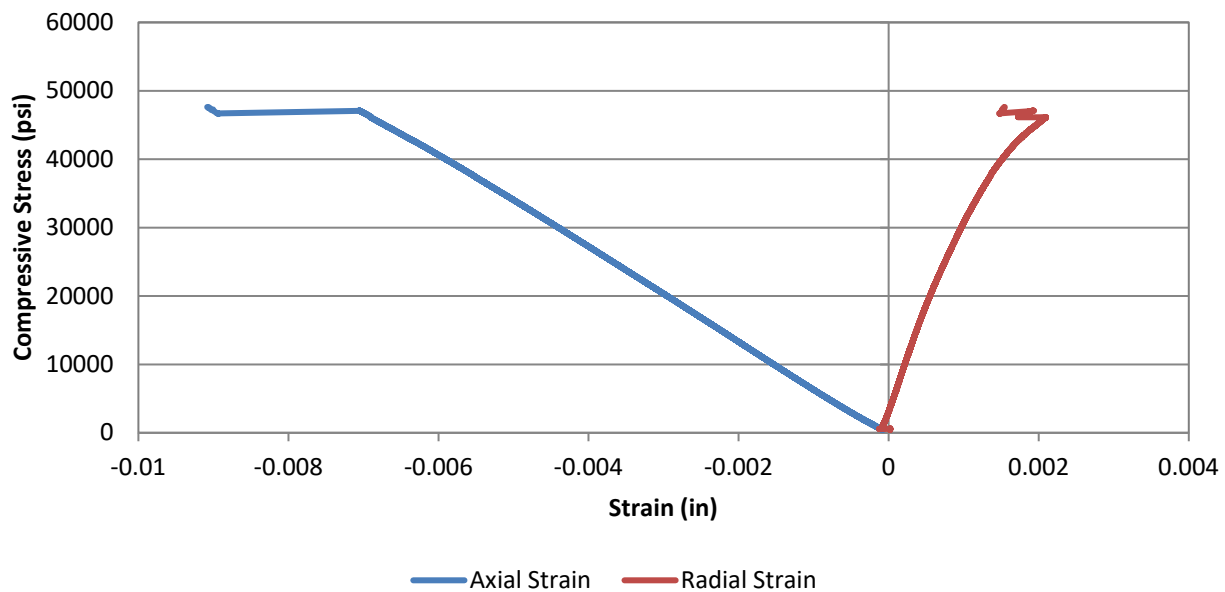
Test Results				
Unconfined Compressive Strength (psi)		47,620	Elastic Modulus (psi)	1.36E+07
			Poisson's Ratio in Elastic Range	0.21
Comments	Elastic range was taken as between 0.002 and 0.006 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.			

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.862	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.268	Reviewed By	WJG
Boring	B-53	Unit Weight (pcf)	192.3	Core Size	NQ
Sample No.	NQ-4 / 22-0178B	L/D Ratio	2.29	Recovery	97%
Depth	49.7' - 50.0'	Load Rate (psi/sec)	30	RQD	73%
Description	Black/White/Gray Gneiss				

Axial Stress vs. Strain



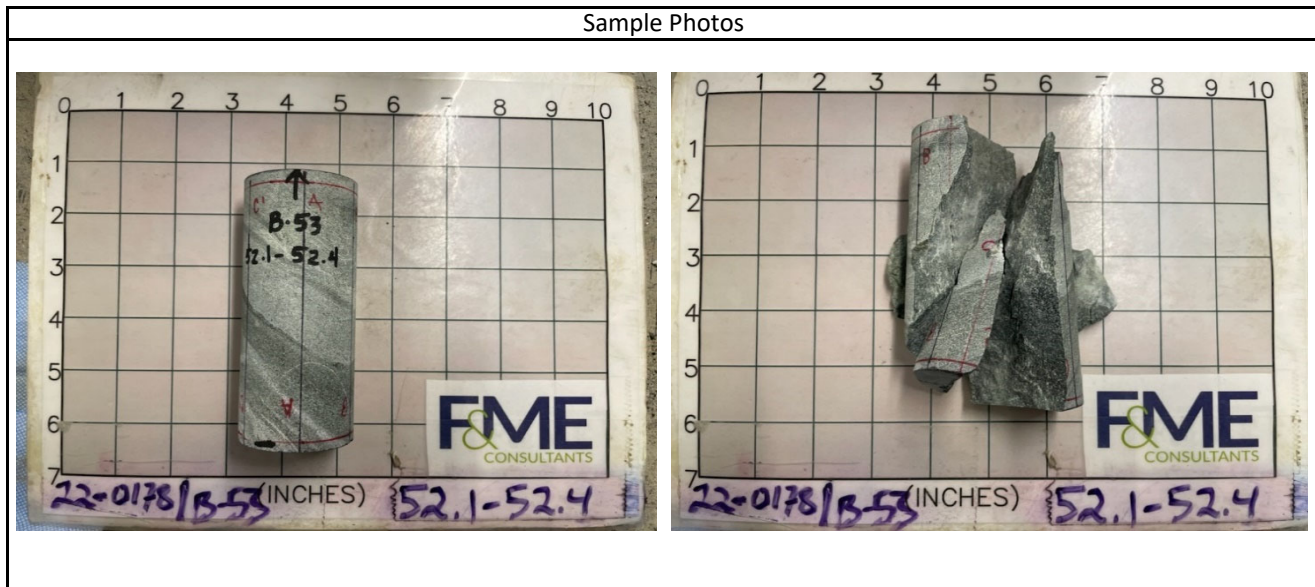
Stress vs. Strain



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

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.862	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.33	Reviewed By	WJG
Boring	B-53	Unit Weight (pcf)	198.6	Core Size	NQ
Sample No.	NQ-5 / 22-0178C	L/D Ratio	2.33	Recovery	100%
Depth	52.1' - 52.4'	Load Rate (psi/sec)	30	RQD	90%
Description	Black/White/Gray Gneiss				

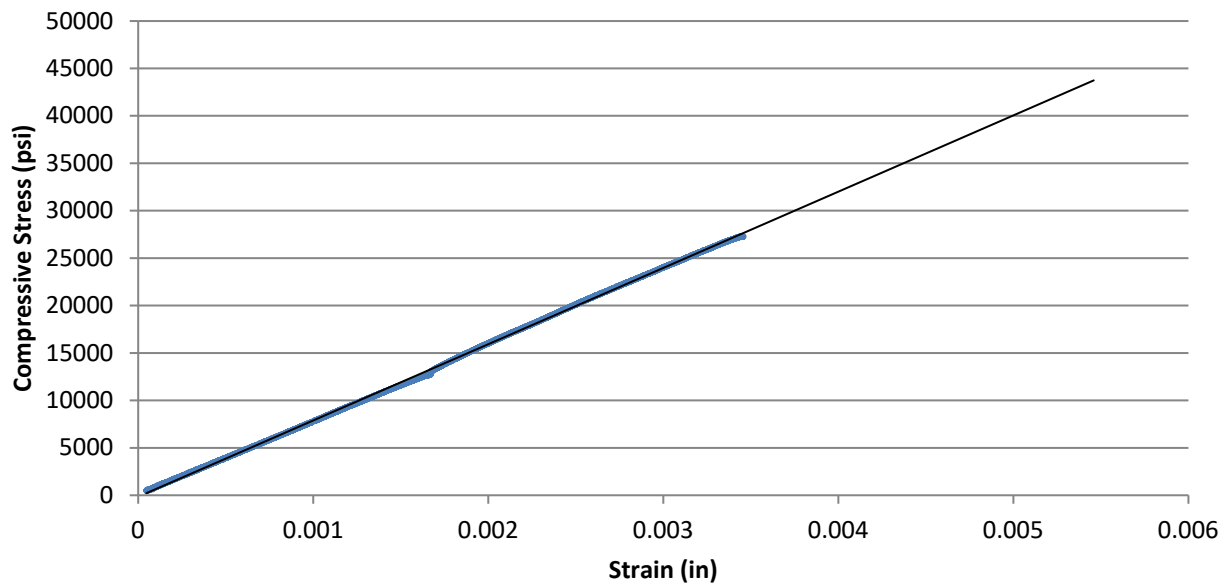
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-343	66	7,498	2,754	16.04	0.19
20%	-697	139	14,868	5,460	15.66	0.20
30%	-1047	200	22,218	8,159	15.58	0.19
40%	-1407	262	29,717	10,913	15.51	0.19
50%	-1733	662	37,175	13,652	15.75	0.38
60%	-2039	1031	44,645	16,396	16.08	0.51
70%	-2381	1556	52,172	19,160	16.09	0.65
80%	-2719	2101	59,479	21,843	16.07	0.77
90%	-3072	3137	66,900	24,568	15.99	1.02
100%	-3459	3744	74,317	27,292		



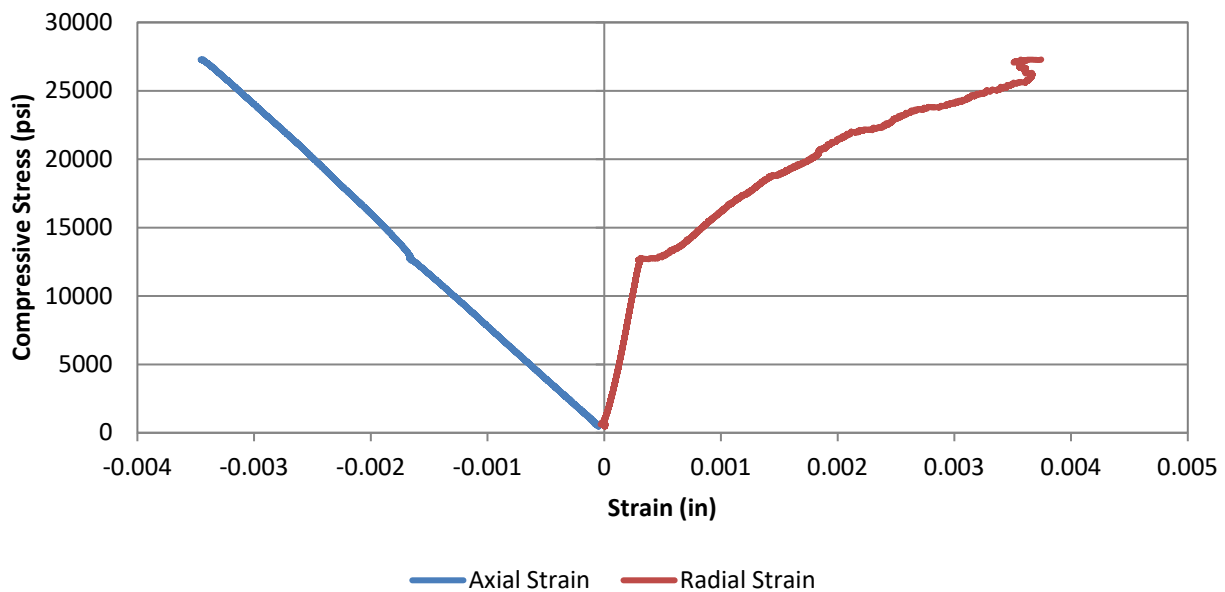
Test Results			
Unconfined Compressive Strength (psi)		27,290	Elastic Modulus (psi)
			1.56E+07
			Poisson's Ratio in Elastic Range
			0.28
Comments	Elastic range was taken as between 0.001 and 0.002 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.862	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.33	Reviewed By	WJG
Boring	B-53	Unit Weight (pcf)	198.6	Core Size	NQ
Sample No.	NQ-5 / 22-0178C	L/D Ratio	2.33	Recovery	100%
Depth	52.1' - 52.4'	Load Rate (psi/sec)	30	RQD	90%
Description	Black/White/Gray Gneiss				

Axial Stress vs. Strain



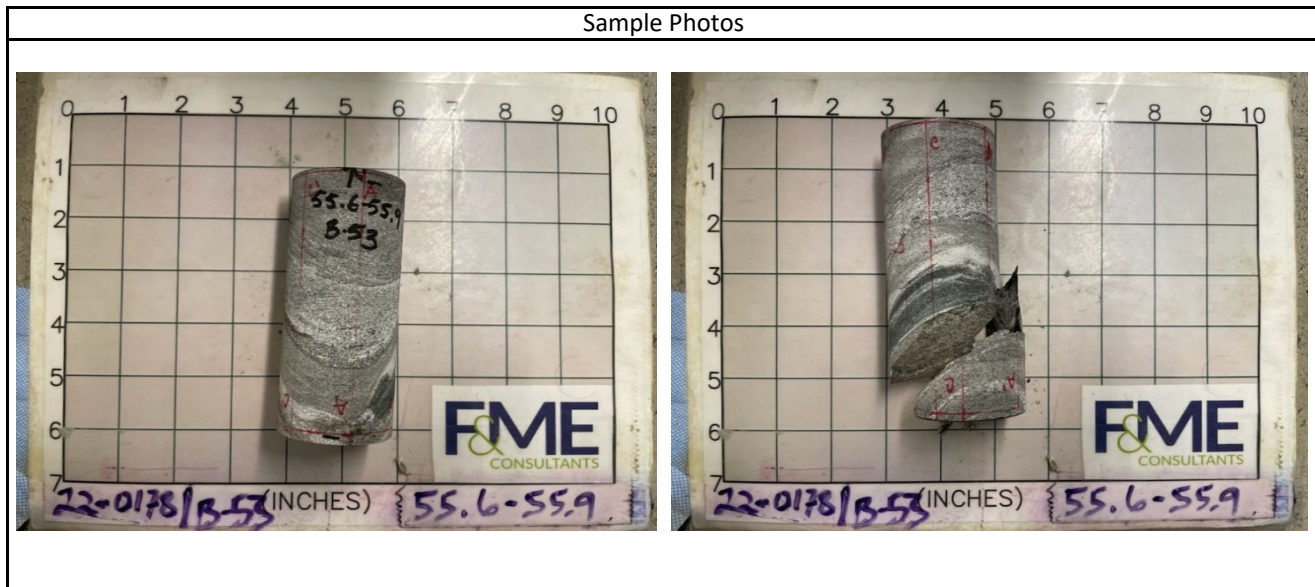
Stress vs. Strain



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

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.862	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.202	Reviewed By	WJG
Boring	B-53	Unit Weight (pcf)	171.9	Core Size	NQ
Sample No.	NQ-5 / 22-0178D	L/D Ratio	2.26	Recovery	100%
Depth	55.6' - 55.9'	Load Rate (psi/sec)	30	RQD	90%
Description	Black/White/Gray Gneiss				

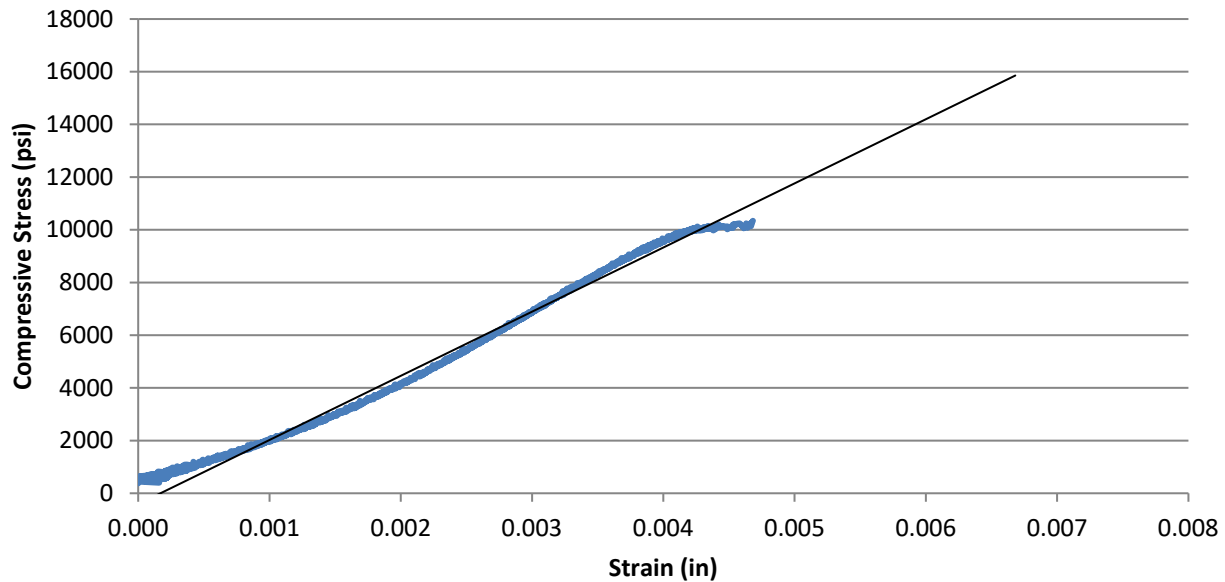
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-374	-42	2,813	1,033	5.53	-0.11
20%	-1035	119	5,670	2,082	4.02	0.11
30%	-1555	224	8,487	3,117	4.01	0.14
40%	-1994	308	11,217	4,119	4.13	0.15
50%	-2411	411	14,088	5,174	4.29	0.17
60%	-2766	542	16,899	6,206	4.49	0.20
70%	-3120	752	19,729	7,245	4.64	0.24
80%	-3489	1036	22,587	8,295	4.75	0.30
90%	-3906	1361	25,394	9,326	4.78	0.35
100%	-4682	1602	28,162	10,342		



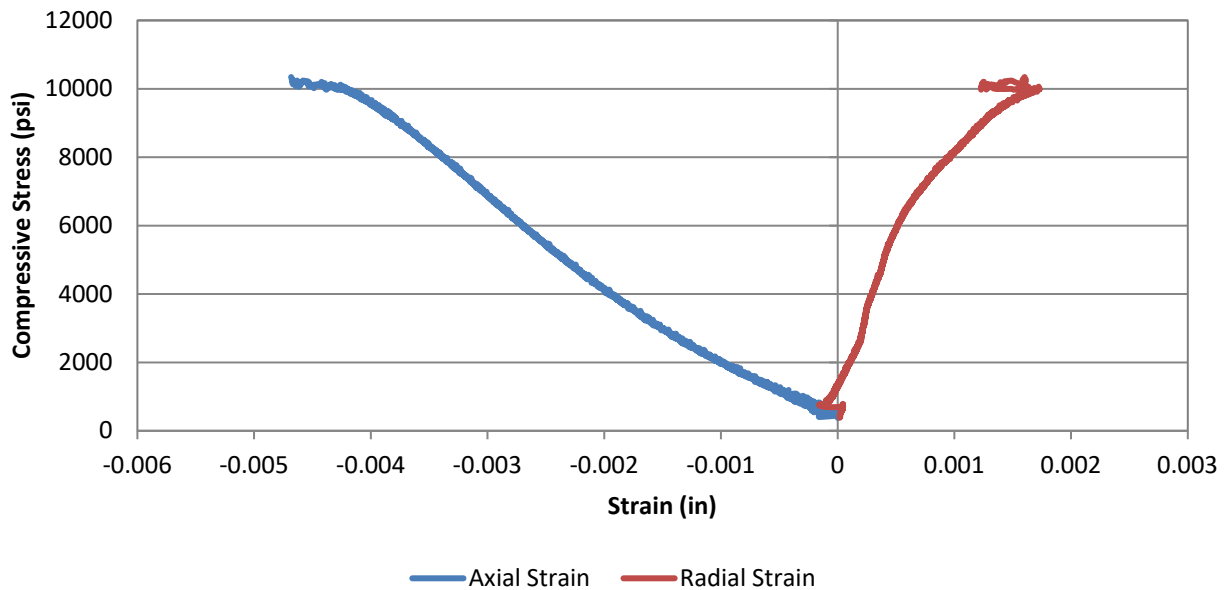
Test Results			
Unconfined Compressive Strength (psi)		10,342	Elastic Modulus (psi)
			4.21E+06
			Poisson's Ratio in Elastic Range
			0.16
Comments	Elastic range was taken as between 0.001 and 0.003 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.862	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.202	Reviewed By	WJG
Boring	B-53	Unit Weight (pcf)	171.9	Core Size	NQ
Sample No.	NQ-5 / 22-0178D	L/D Ratio	2.26	Recovery	100%
Depth	55.6' - 55.9'	Load Rate (psi/sec)	30	RQD	90%
Description	Black/White/Gray Gneiss				

Axial Stress vs. Strain



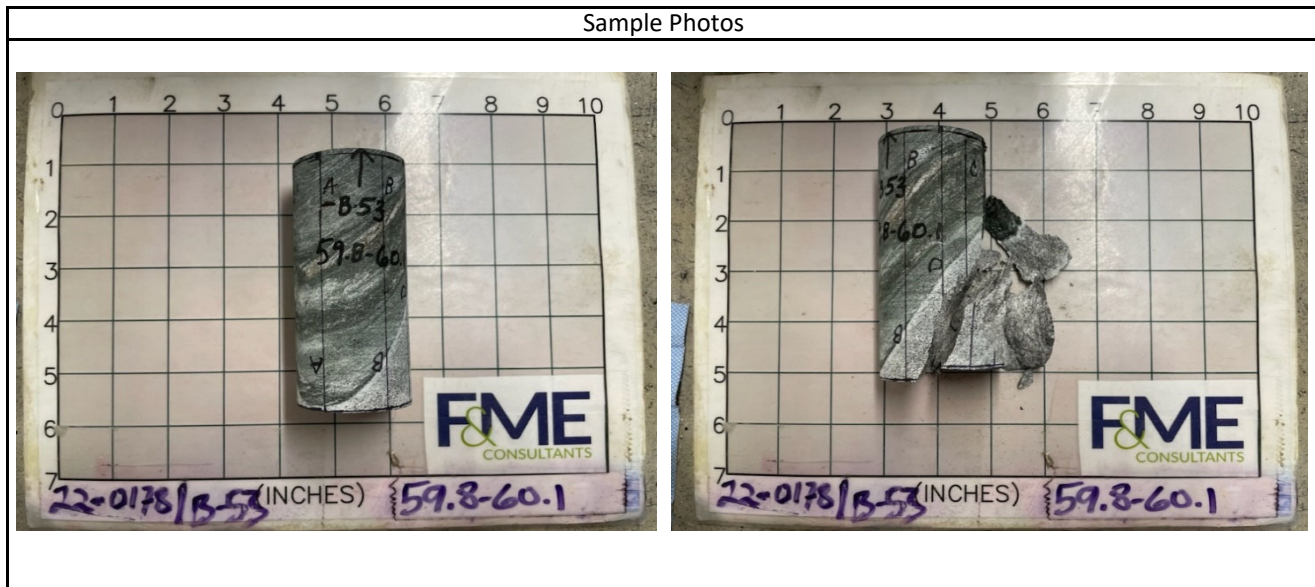
Stress vs. Strain



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

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.865	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.073	Reviewed By	WJG
Boring	B-53	Unit Weight (pcf)	186.8	Core Size	NQ
Sample No.	NQ-6 / 22-0178E	L/D Ratio	2.18	Recovery	100%
Depth	59.8' - 60.1'	Load Rate (psi/sec)	30	RQD	100%
Description	Black/White/Gray Gneiss				

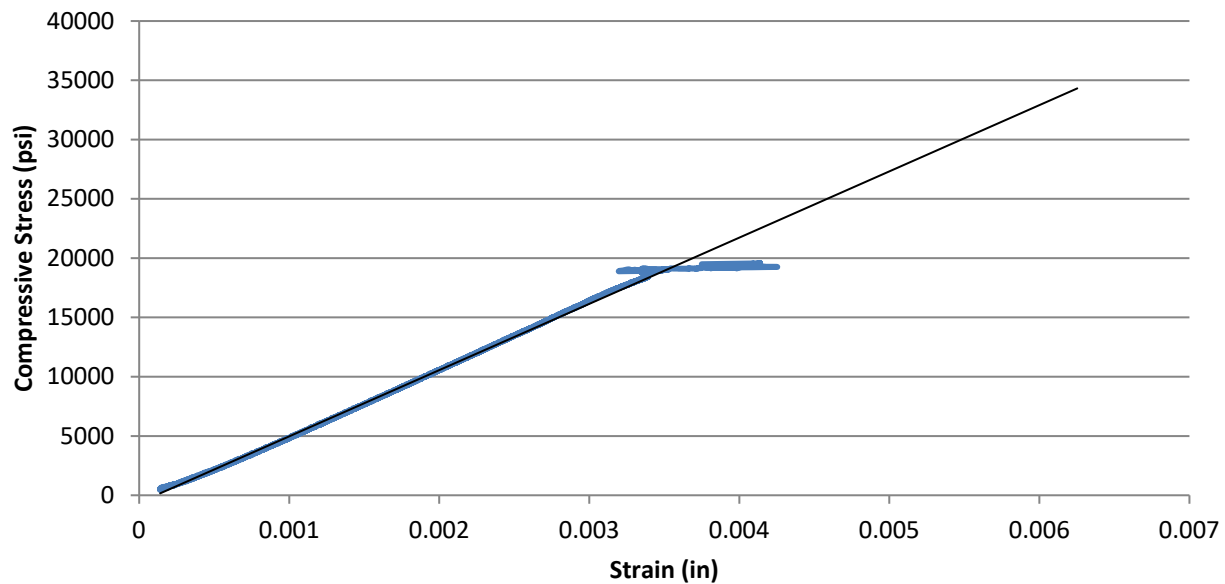
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-469	48	5,479	2,006	8.55	0.10
20%	-847	89	10,845	3,970	9.37	0.11
30%	-1213	130	16,476	6,031	9.94	0.11
40%	-1562	171	21,927	8,027	10.28	0.11
50%	-1909	216	27,416	10,036	10.51	0.11
60%	-2257	262	32,889	12,039	10.67	0.12
70%	-2601	314	38,380	14,050	10.80	0.12
80%	-2945	370	43,833	16,046	10.90	0.13
90%	-3312	436	49,314	18,052	10.90	0.13
100%	0	147	54,819	20,067		



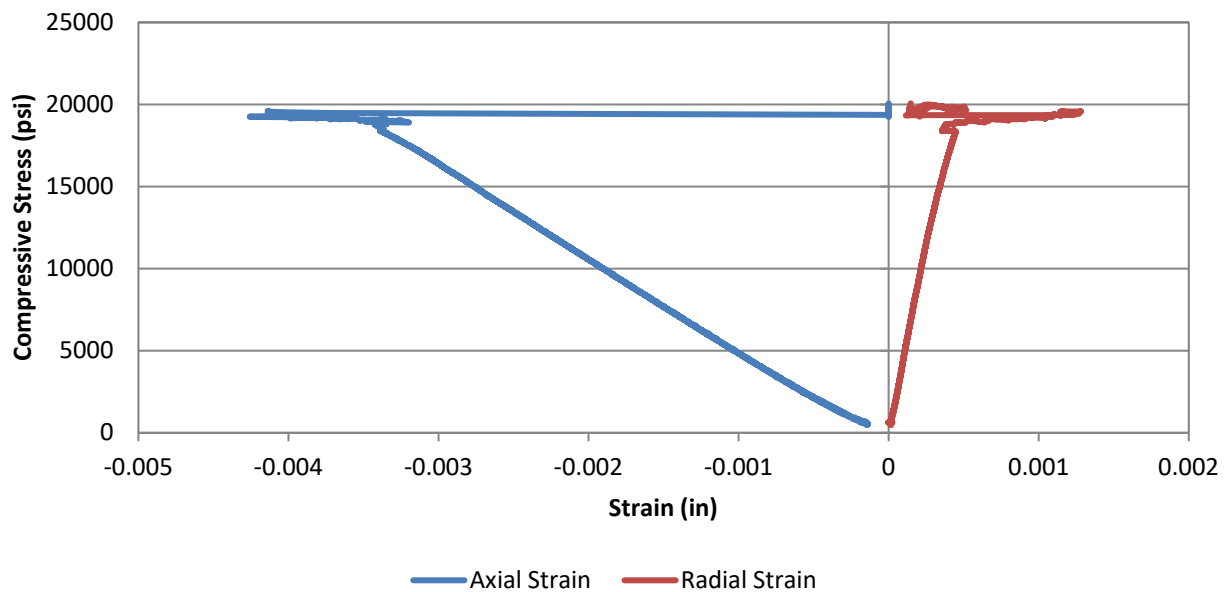
Test Results			
Unconfined Compressive Strength (psi)		20,070	Elastic Modulus (psi)
			1.05E+07
			Poisson's Ratio in Elastic Range
			0.11
Comments	Elastic range was taken as between 0.001 and 0.003 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.865	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.073	Reviewed By	WJG
Boring	B-53	Unit Weight (pcf)	186.8	Core Size	NQ
Sample No.	NQ-6 / 22-0178E	L/D Ratio	2.18	Recovery	100%
Depth	59.8' - 60.1'	Load Rate (psi/sec)	30	RQD	100%
Description	Black/White/Gray Gneiss				

Axial Stress vs. Strain



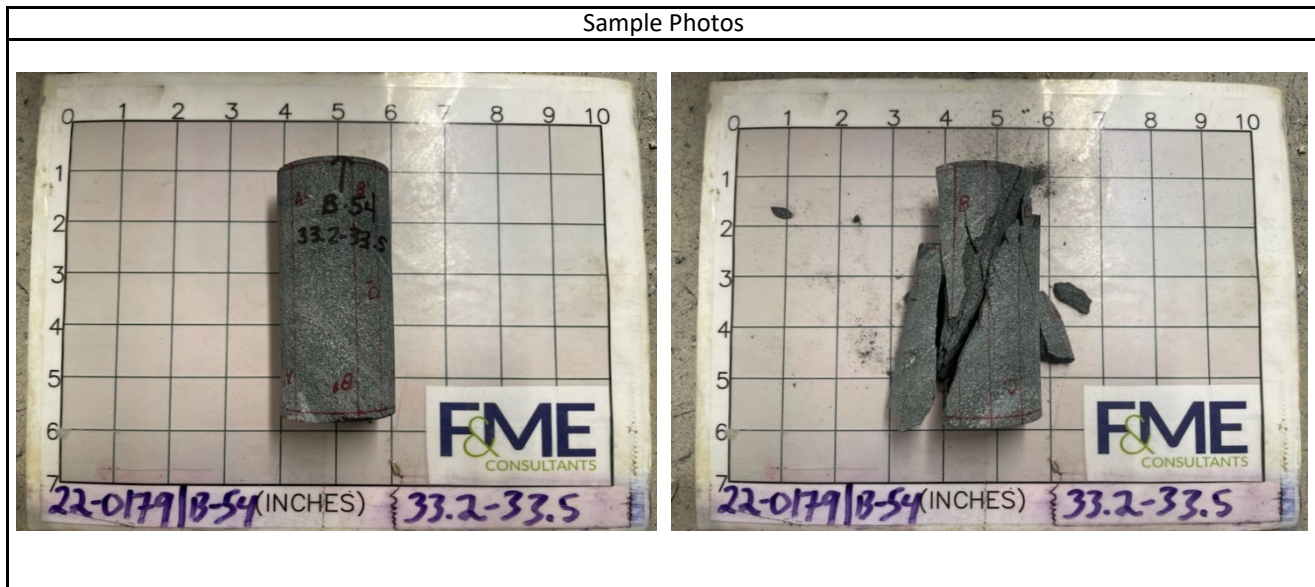
Stress vs. Strain



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

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.864	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.108	Reviewed By	WJG
Boring	B-54	Unit Weight (pcf)	191.1	Core Size	NQ
Sample No.	NQ-1 / 22-0179A	L/D Ratio	2.20	Recovery	53%
Depth	33.2' - 33.5'	Load Rate (psi/sec)	30	RQD	42%
Description	Black/White/Gray Gneiss				

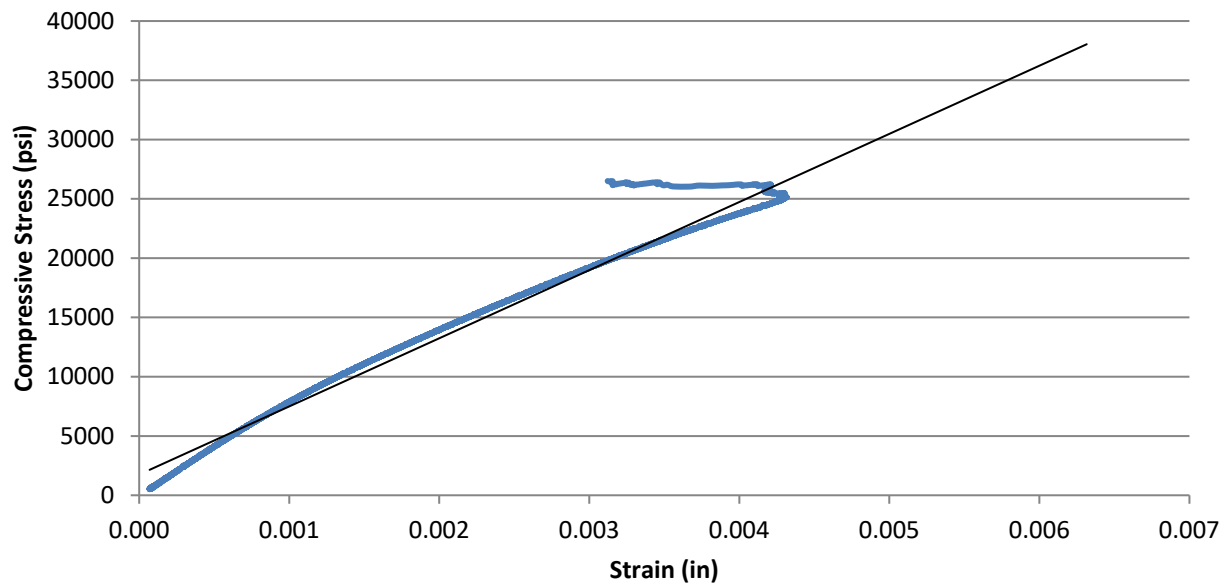
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-322	76	7,236	2,652	16.47	0.24
20%	-649	157	14,445	5,293	16.31	0.24
30%	-1003	243	21,607	7,918	15.78	0.24
40%	-1421	357	28,940	10,605	14.92	0.25
50%	-1878	514	36,127	13,239	14.10	0.27
60%	-2359	709	43,452	15,923	13.50	0.30
70%	-2865	981	50,608	18,545	12.94	0.34
80%	-3414	1363	57,878	21,210	12.42	0.40
90%	-4018	1982	65,058	23,841	11.87	0.49
100%	-3123	4471	72,315	26,500		



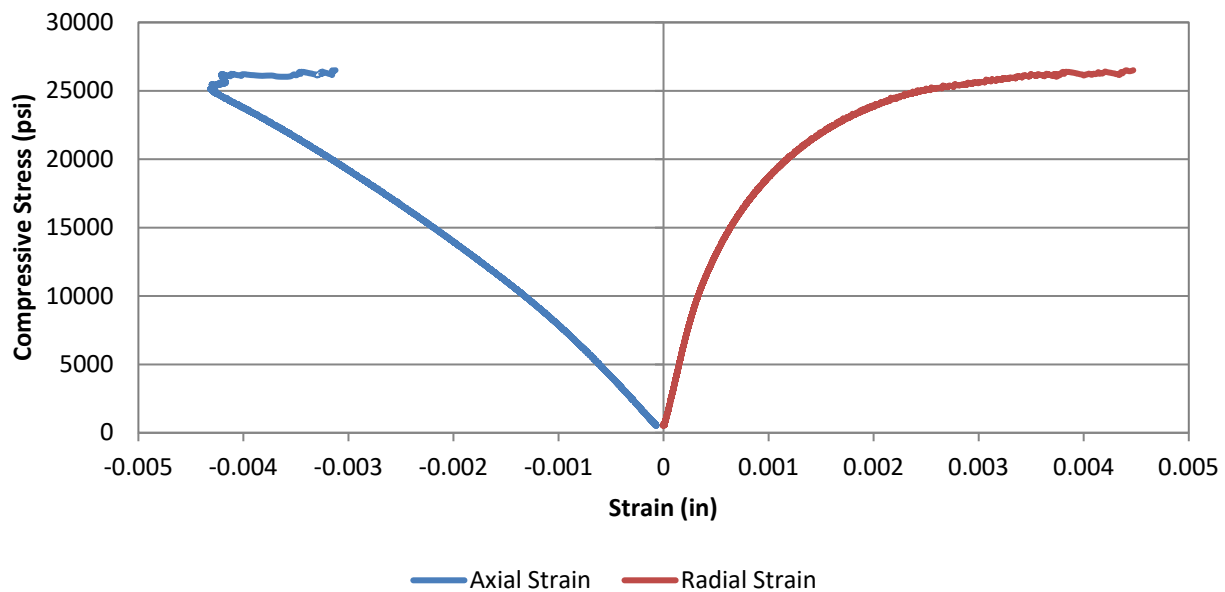
Test Results				
Unconfined Compressive Strength (psi)		26,500	Elastic Modulus (psi)	1.42E+07
			Poisson's Ratio in Elastic Range	0.28
Comments	Elastic range was taken as between 0.001 and 0.003 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.			

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.864	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.108	Reviewed By	WJG
Boring	B-54	Unit Weight (pcf)	191.1	Core Size	NQ
Sample No.	NQ-1 / 22-0179A	L/D Ratio	2.20	Recovery	53%
Depth	33.2' - 33.5'	Load Rate (psi/sec)	30	RQD	42%
Description	Black/White/Gray Gneiss				

Axial Stress vs. Strain



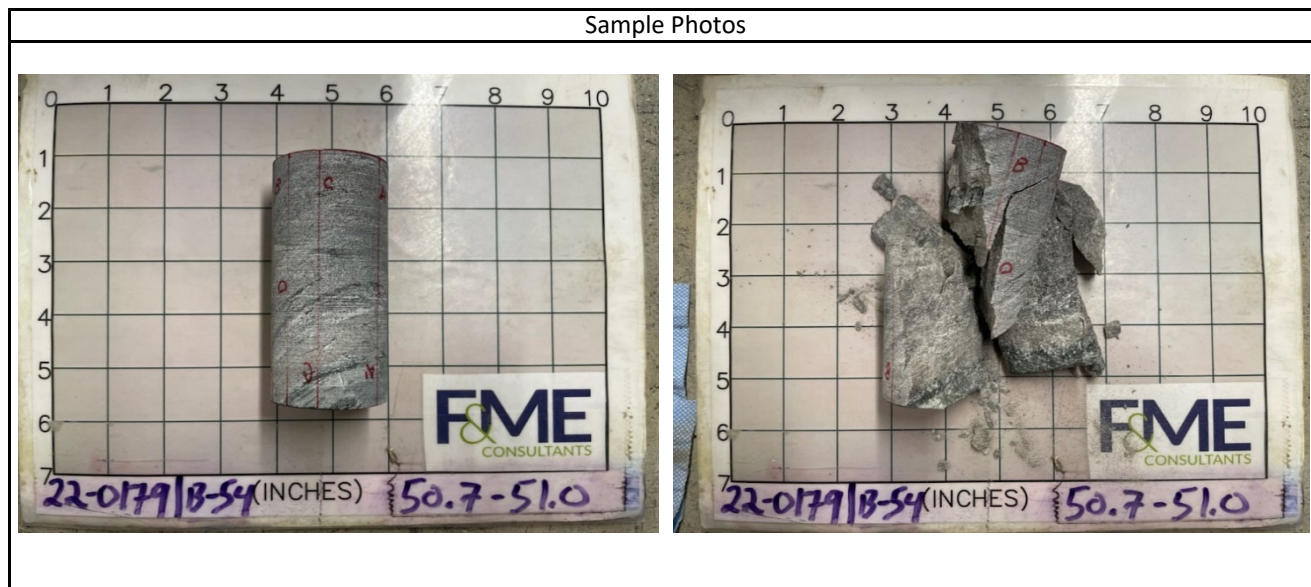
Stress vs. Strain



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

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.864	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	3.924	Reviewed By	WJG
Boring	B-54	Unit Weight (pcf)	169.8	Core Size	NQ
Sample No.	NQ-4 / 22-0179B	L/D Ratio	2.11	Recovery	82%
Depth	50.7' - 51.0'	Load Rate (psi/sec)	30	RQD	40%
Description	Black/White/Gray Gneiss				

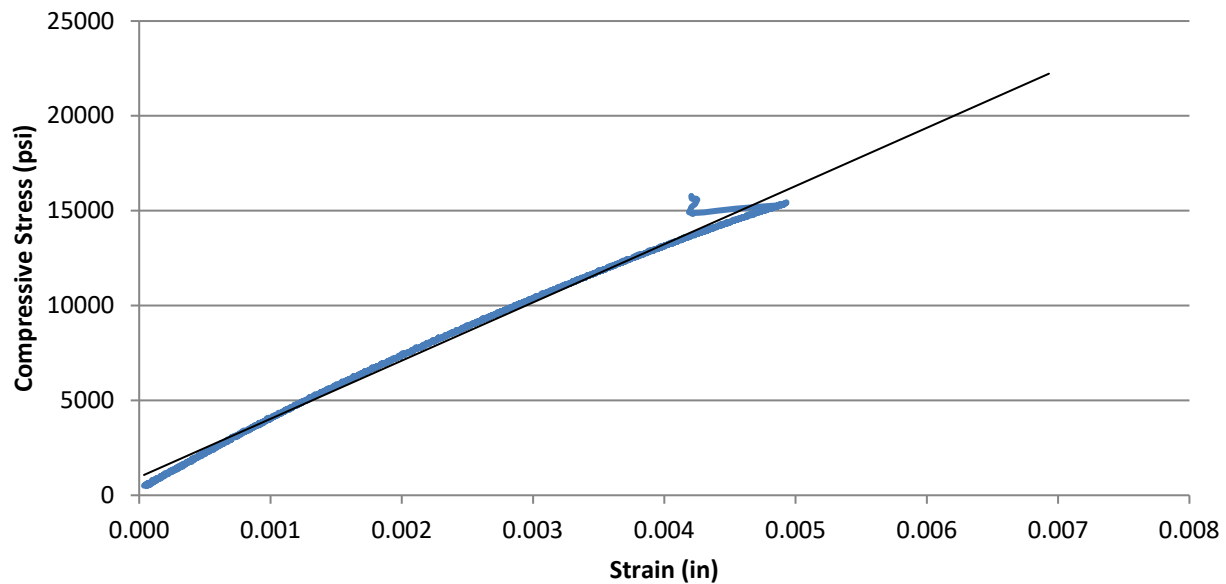
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-323	39	4,353	1,595	9.88	0.12
20%	-758	84	8,691	3,185	8.40	0.11
30%	-1203	129	12,988	4,760	7.91	0.11
40%	-1658	177	17,210	6,307	7.61	0.11
50%	-2161	238	21,482	7,872	7.28	0.11
60%	-2689	318	25,823	9,463	7.04	0.12
70%	-3238	421	30,225	11,076	6.84	0.13
80%	-3791	554	34,411	12,610	6.65	0.15
90%	-4427	765	38,796	14,217	6.42	0.17
100%	-4206	1373	43,057	15,779		



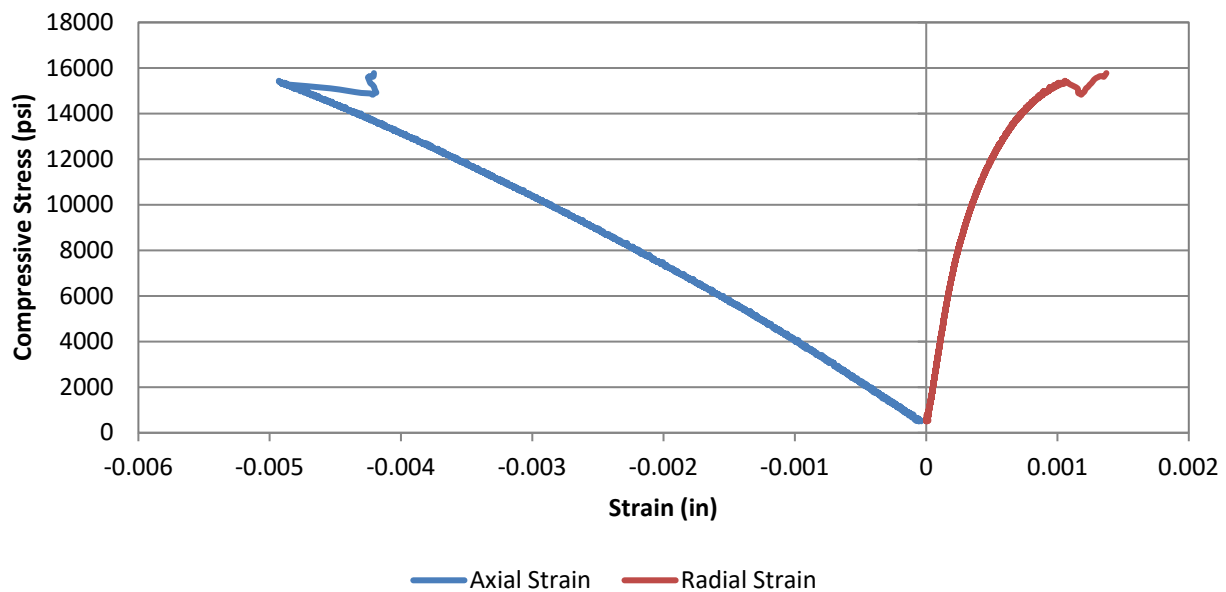
Test Results			
Unconfined Compressive Strength (psi)	15,780	Elastic Modulus (psi)	7.23E+06
		Poisson's Ratio in Elastic Range	0.12
Comments	Elastic range was taken as between 0.001 and 0.004 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.864	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	3.924	Reviewed By	WJG
Boring	B-54	Unit Weight (pcf)	169.8	Core Size	NQ
Sample No.	NQ-4 / 22-0179B	L/D Ratio	2.11	Recovery	82%
Depth	50.7' - 51.0'	Load Rate (psi/sec)	30	RQD	40%
Description	Black/White/Gray Gneiss				

Axial Stress vs. Strain



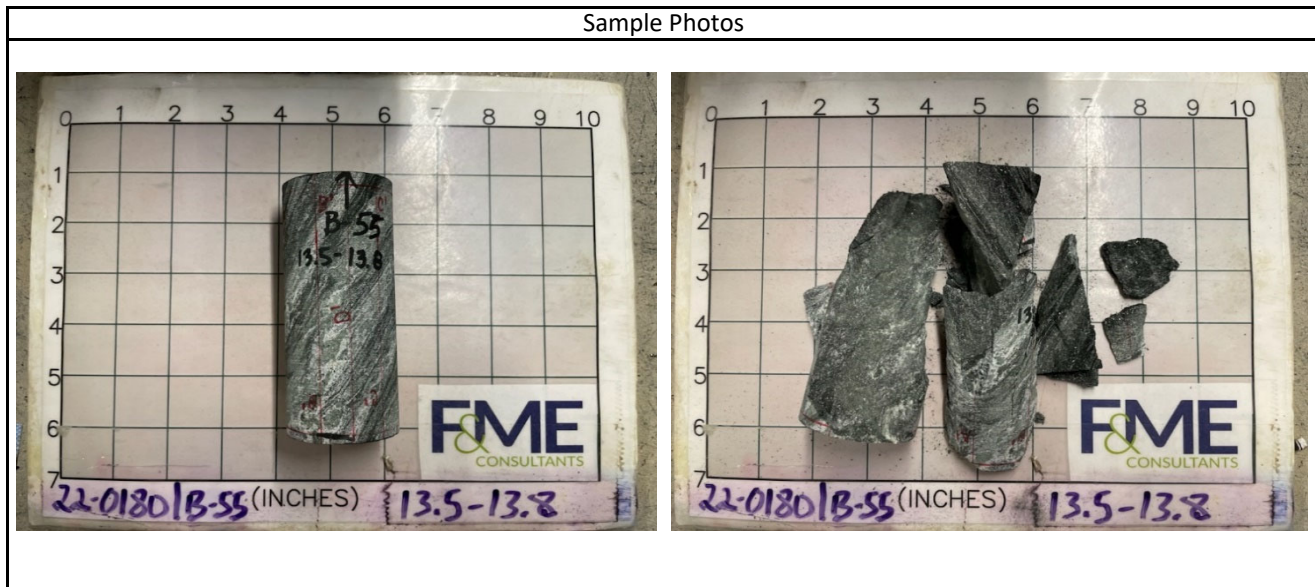
Stress vs. Strain



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

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.869	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.275	Reviewed By	WJG
Boring	B-55	Unit Weight (pcf)	192.9	Core Size	NQ
Sample No.	NQ-1 / 22-0180A	L/D Ratio	2.29	Recovery	92%
Depth	13.5' - 13.8'	Load Rate (psi/sec)	30	RQD	83%
Description	Black/White/Gray Gneiss				

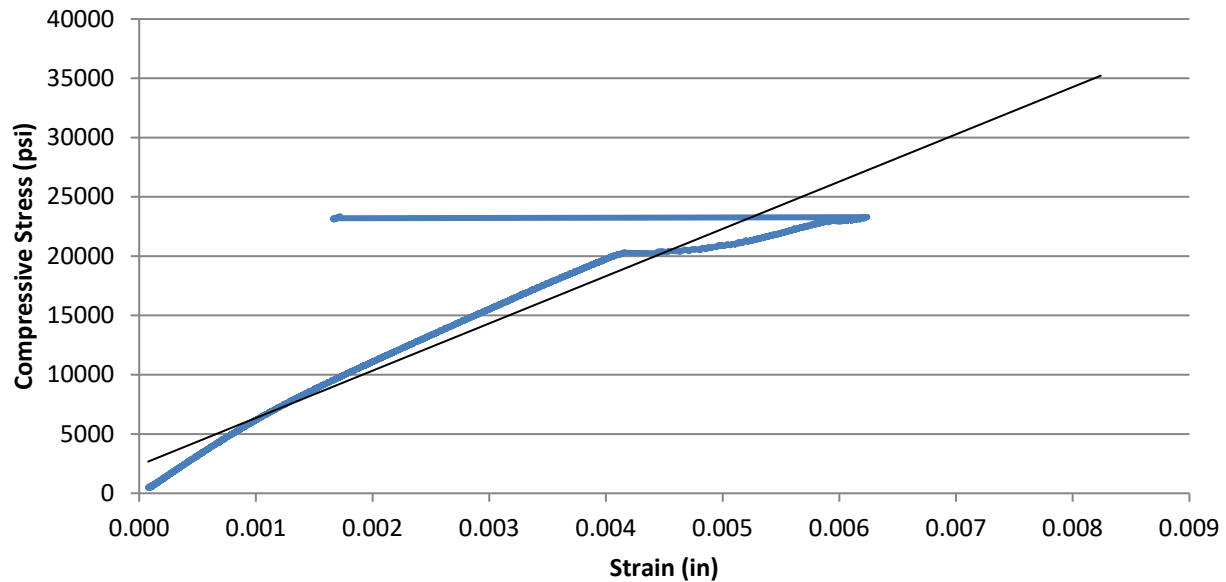
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-380	53	6,496	2,368	12.46	0.14
20%	-737	115	12,885	4,697	12.74	0.16
30%	-1159	181	19,294	7,032	12.13	0.16
40%	-1620	259	25,679	9,360	11.56	0.16
50%	-2136	369	32,041	11,679	10.93	0.17
60%	-2650	499	38,459	14,018	10.58	0.19
70%	-3191	660	44,886	16,361	10.26	0.21
80%	-3740	853	51,348	18,716	10.01	0.23
90%	-5110	1136	57,722	21,040	8.23	0.22
100%	-1723	-210	64,125	23,373		



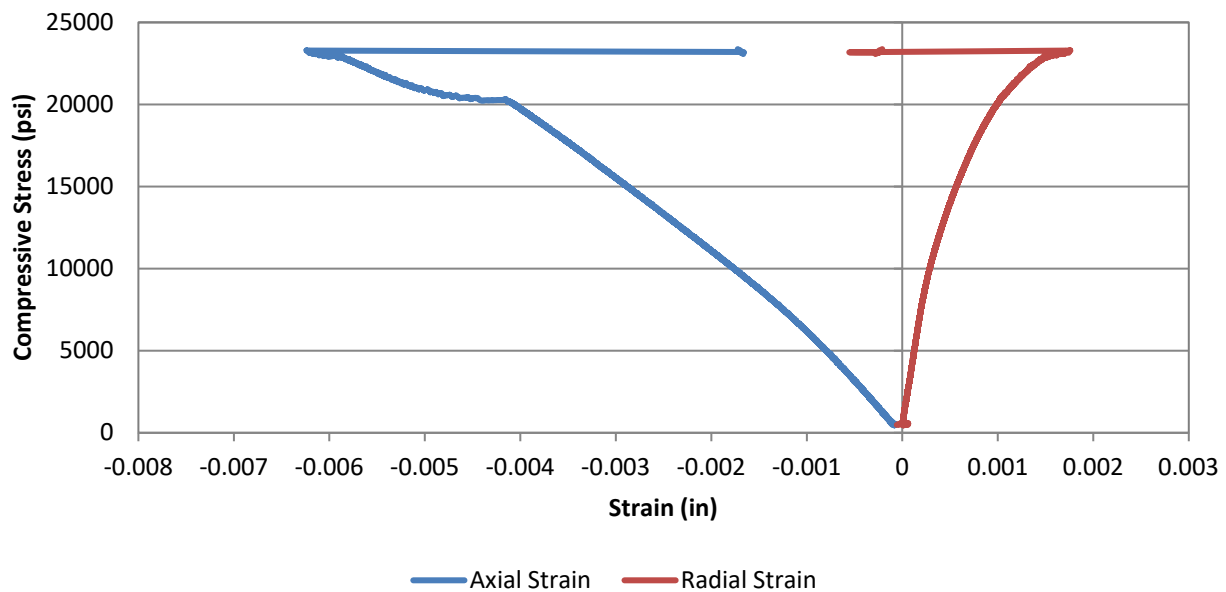
Test Results			
Unconfined Compressive Strength (psi)		23,370	Elastic Modulus (psi)
			1.12E+07
			Poisson's Ratio in Elastic Range
			0.17
Comments	Elastic range was taken as between 0.001 and 0.003 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.869	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.275	Reviewed By	WJG
Boring	B-55	Unit Weight (pcf)	192.9	Core Size	NQ
Sample No.	NQ-1 / 22-0180A	L/D Ratio	2.29	Recovery	92%
Depth	13.5' - 13.8'	Load Rate (psi/sec)	30	RQD	83%
Description	Black/White/Gray Gneiss				

Axial Stress vs. Strain



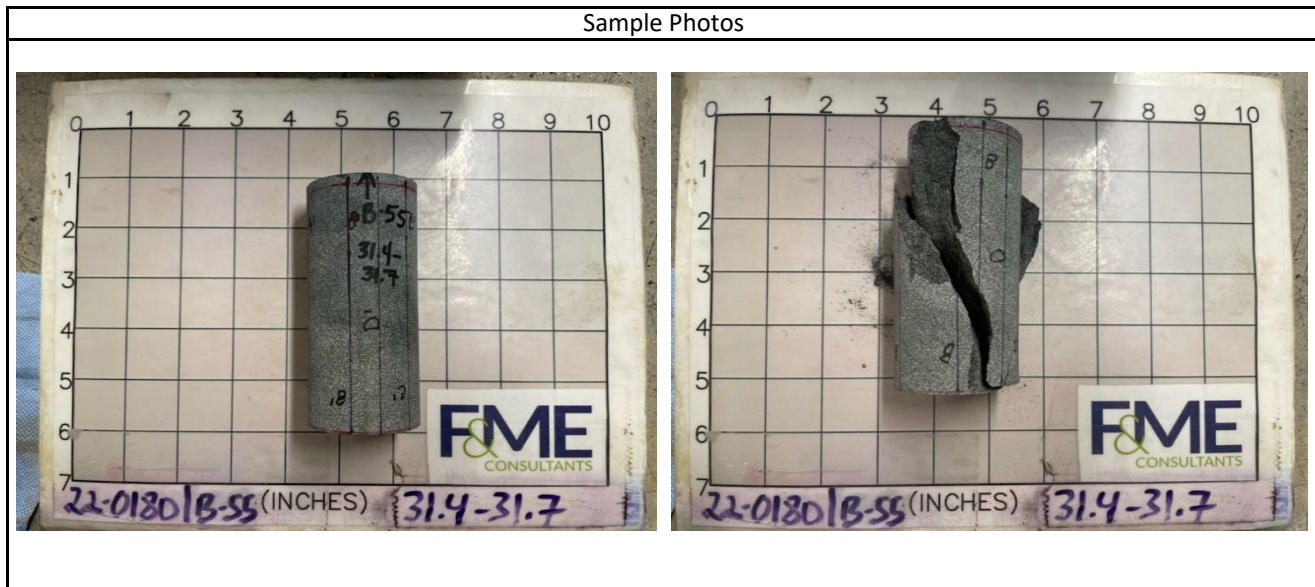
Stress vs. Strain



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

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.867	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.138	Reviewed By	WJG
Boring	B-55	Unit Weight (pcf)	185.4	Core Size	NQ
Sample No.	NQ-5 / 22-0180B	L/D Ratio	2.22	Recovery	100%
Depth	31.4' - 31.7'	Load Rate (psi/sec)	30	RQD	100%
Description	Black/White/Gray Gneiss				

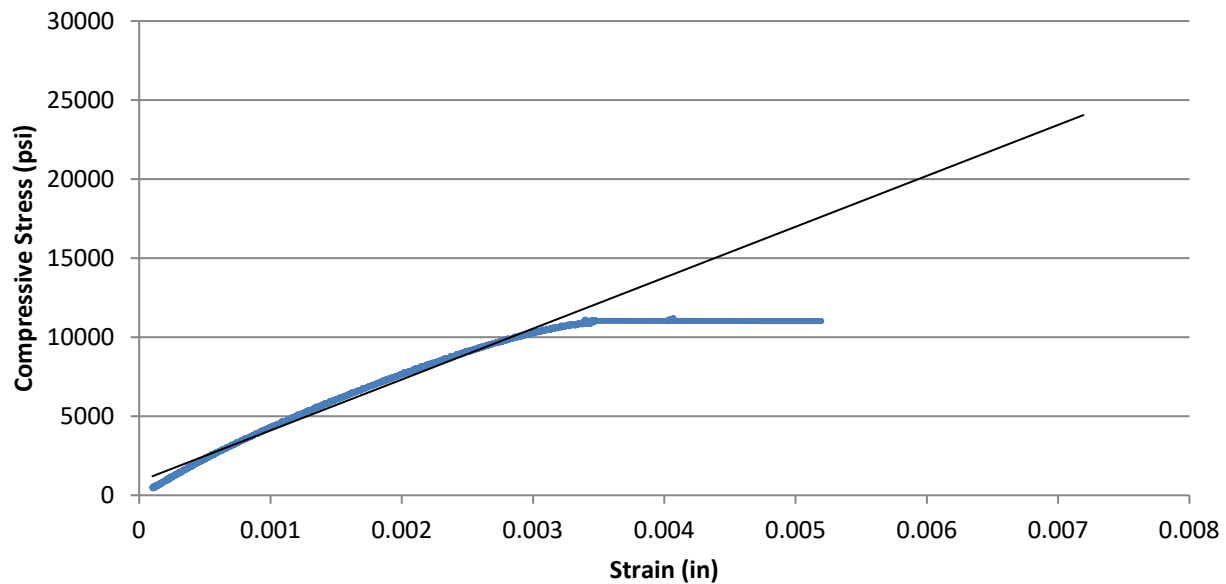
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-247	46	3,033	1,108	8.97	0.19
20%	-494	90	6,246	2,281	9.24	0.18
30%	-758	140	9,255	3,381	8.92	0.18
40%	-1054	202	12,291	4,490	8.52	0.19
50%	-1371	273	15,368	5,613	8.19	0.20
60%	-1704	352	18,436	6,734	7.90	0.21
70%	-2063	445	21,495	7,852	7.61	0.22
80%	-2454	553	24,515	8,955	7.30	0.23
90%	-2915	695	27,692	10,115	6.94	0.24
100%	-4069	1878	30,723	11,222		



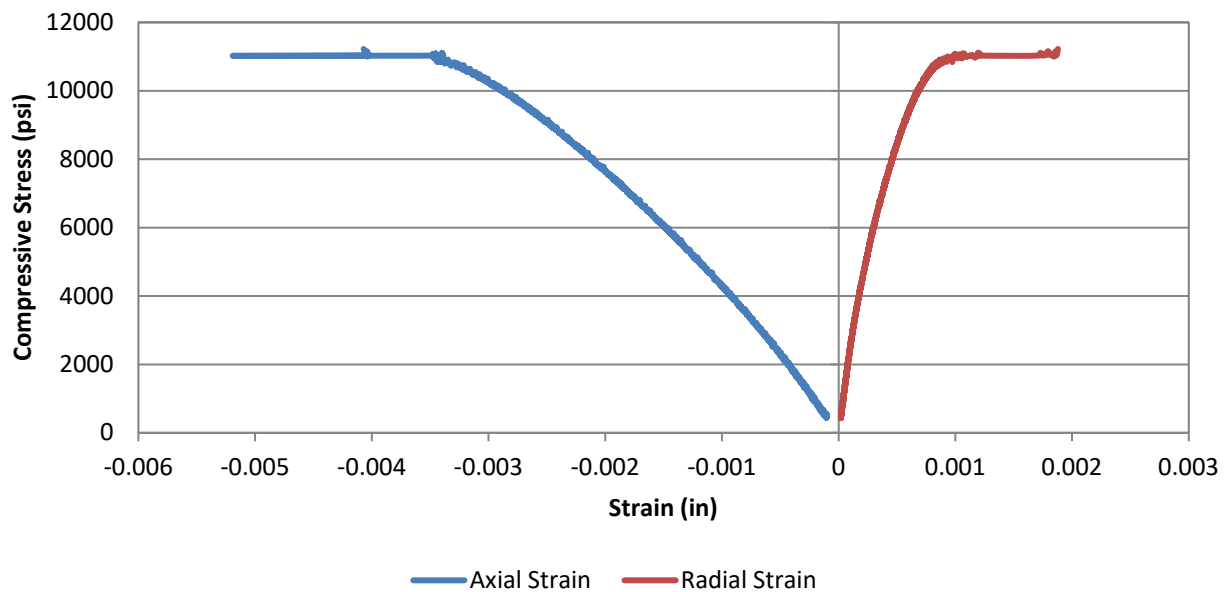
Test Results			
Unconfined Compressive Strength (psi)		11,200	Elastic Modulus (psi)
			8.10E+06
			Poisson's Ratio in Elastic Range
			0.20
Comments	Elastic range was taken as between 0.001 and 0.002 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.867	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.138	Reviewed By	WJG
Boring	B-55	Unit Weight (pcf)	185.4	Core Size	NQ
Sample No.	NQ-5 / 22-0180B	L/D Ratio	2.22	Recovery	100%
Depth	31.4' - 31.7'	Load Rate (psi/sec)	30	RQD	100%
Description	Black/White/Gray Gneiss				

Axial Stress vs. Strain



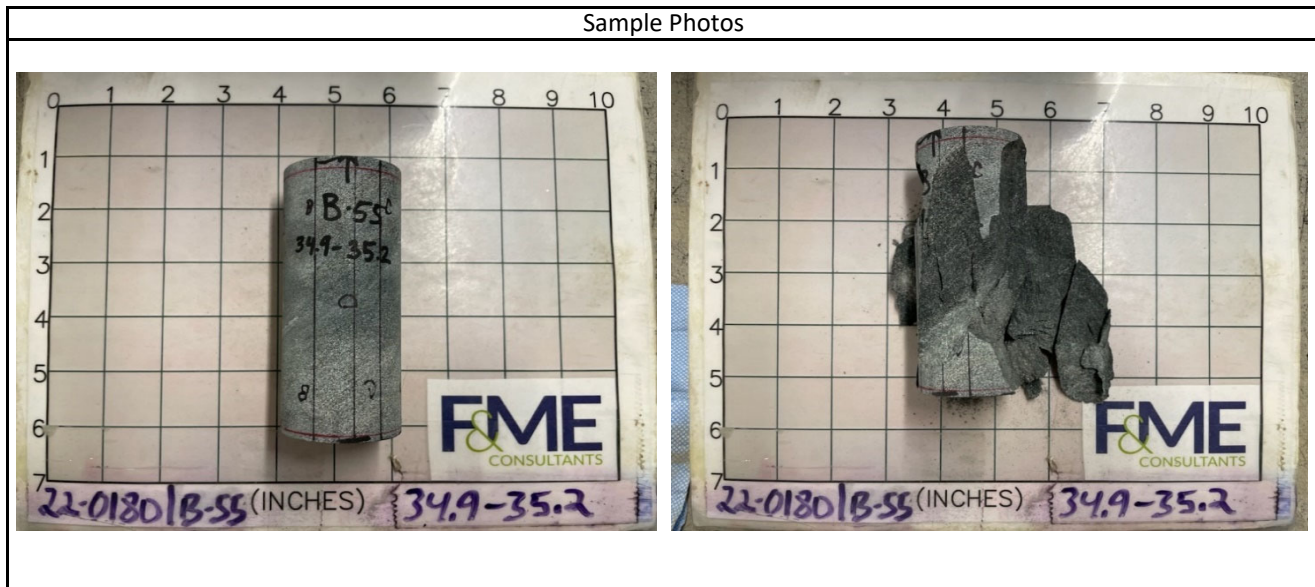
Stress vs. Strain



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

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.865	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.194	Reviewed By	WJG
Boring	B-55	Unit Weight (pcf)	184.5	Core Size	NQ
Sample No.	NQ-5 / 22-0180C	L/D Ratio	2.25	Recovery	100%
Depth	34.9' - 35.2'	Load Rate (psi/sec)	20	RQD	100%
Description	Black/White/Gray Gneiss				

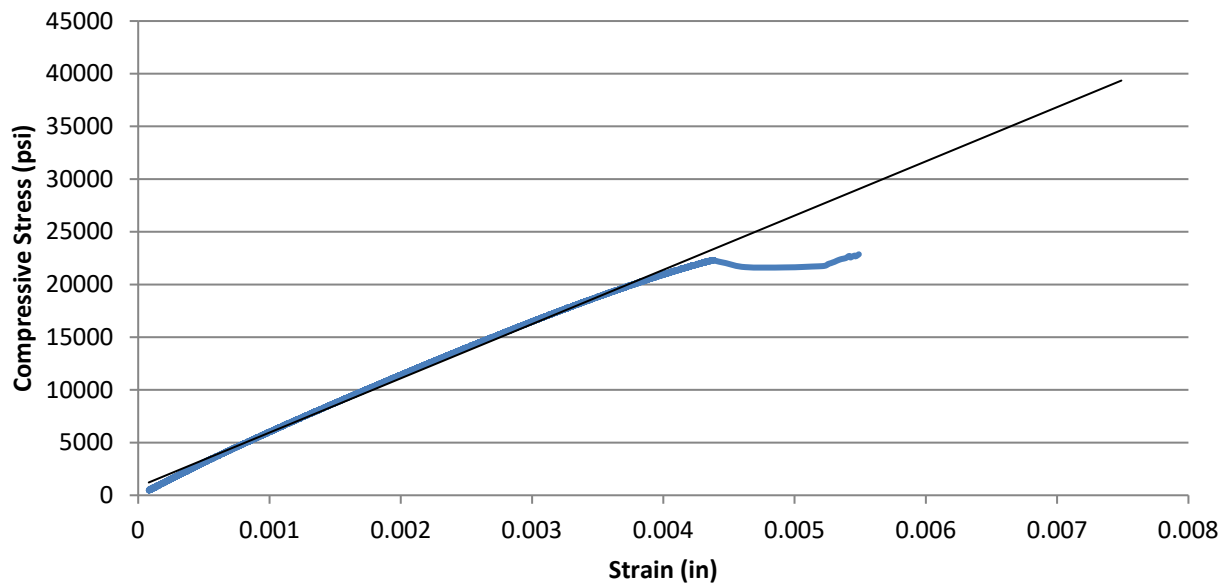
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-363	85	6,272	2,296	12.64	0.23
20%	-738	131	12,402	4,540	12.30	0.18
30%	-1150	182	18,707	6,848	11.91	0.16
40%	-1569	240	24,923	9,123	11.63	0.15
50%	-2006	305	31,257	11,442	11.40	0.15
60%	-2438	370	37,366	13,678	11.22	0.15
70%	-2899	443	43,714	16,002	11.04	0.15
80%	-3380	517	49,970	18,292	10.82	0.15
90%	-3919	616	56,216	20,578	10.50	0.16
100%	-5489	-480	62,451	22,861		



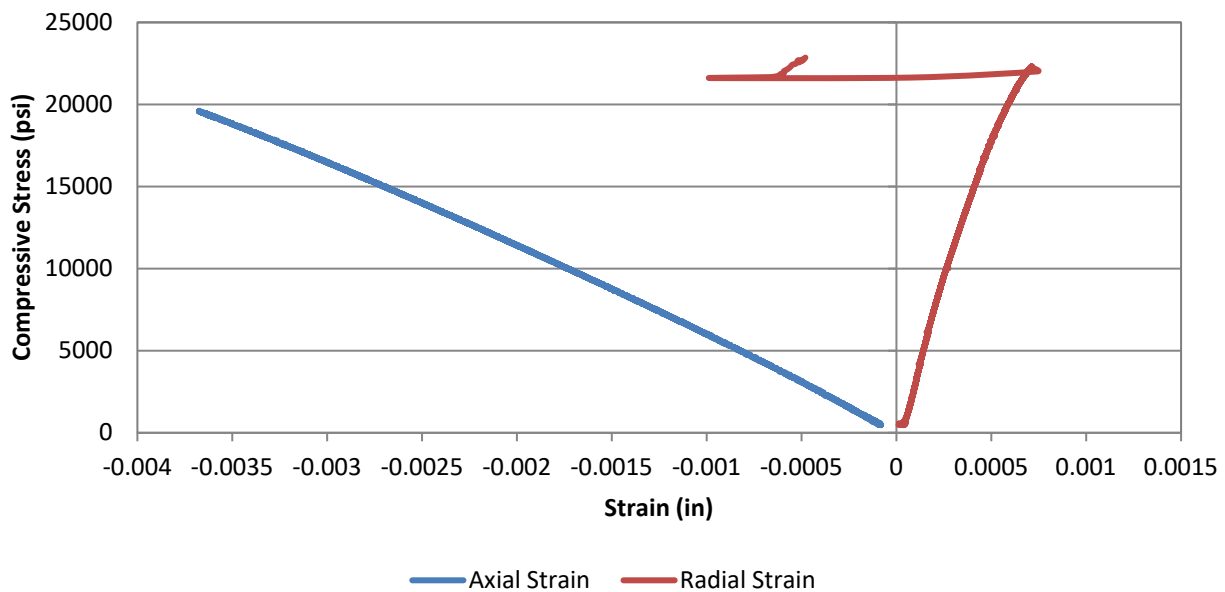
Test Results				
Unconfined Compressive Strength (psi)		22,860	Elastic Modulus (psi)	1.15E+07
			Poisson's Ratio in Elastic Range	0.15
Comments	Elastic range was taken as between 0.001 and 0.003 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.			

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.865	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.194	Reviewed By	WJG
Boring	B-55	Unit Weight (pcf)	184.5	Core Size	NQ
Sample No.	NQ-5 / 22-0180C	L/D Ratio	2.25	Recovery	100%
Depth	34.9' - 35.2'	Load Rate (psi/sec)	20	RQD	100%
Description	Black/White/Gray Gneiss				

Axial Stress vs. Strain



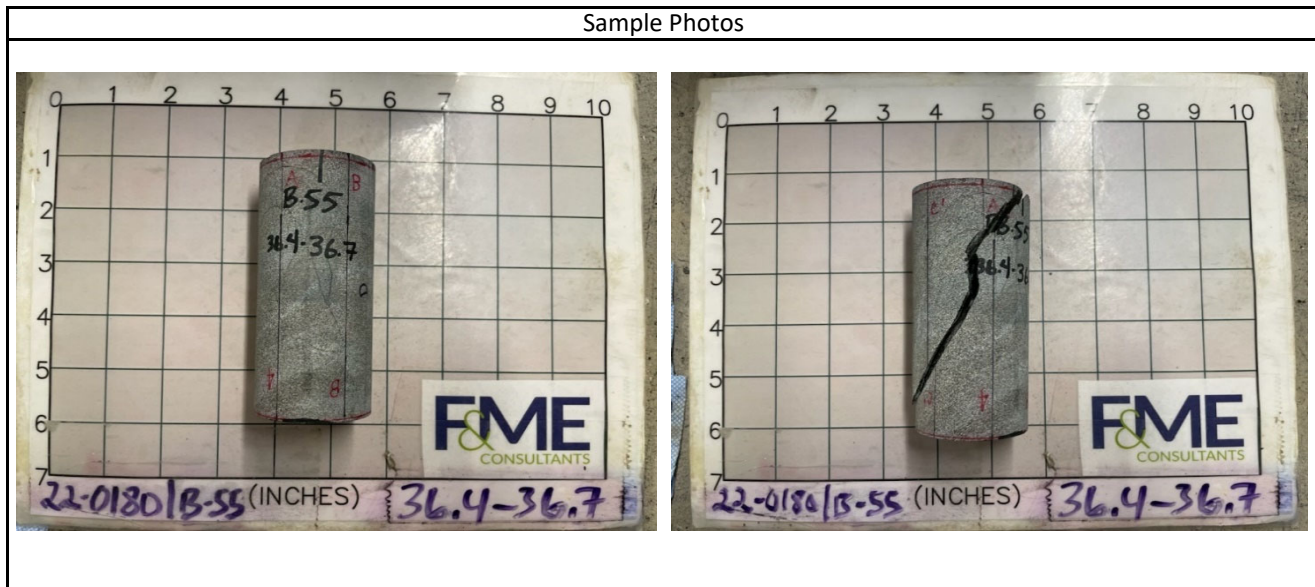
Stress vs. Strain



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

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.865	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.101	Reviewed By	WJG
Boring	B-55	Unit Weight (pcf)	184.6	Core Size	NQ
Sample No.	NQ-6 / 22-0180D	L/D Ratio	2.20	Recovery	100%
Depth	36.4' - 36.7'	Load Rate (psi/sec)	20	RQD	65%
Description	Black/White/Gray Gneiss				

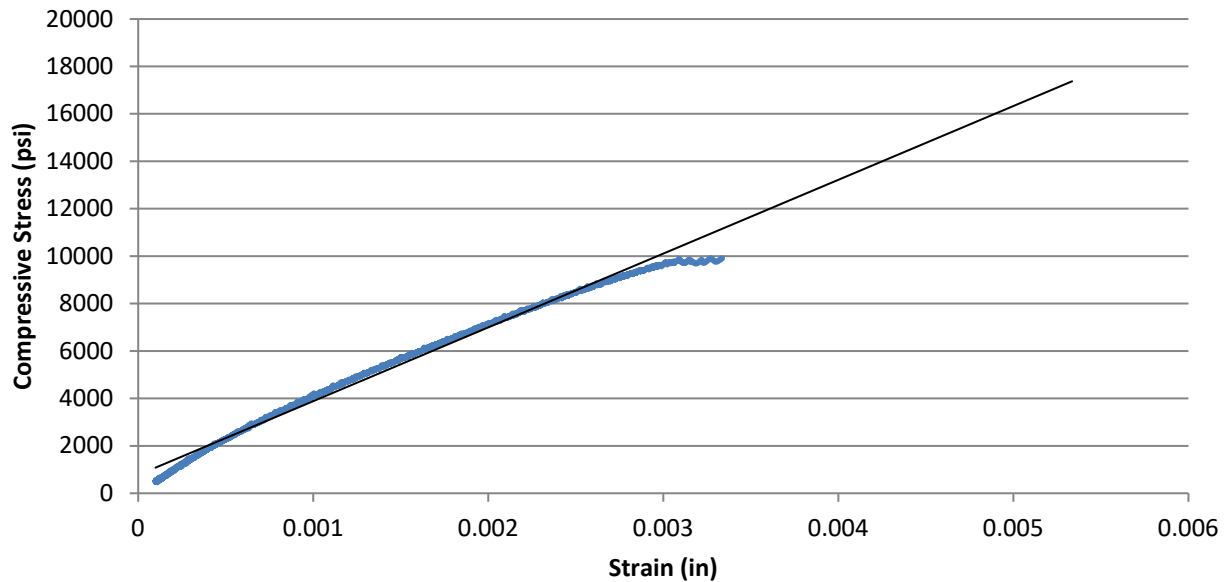
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-206	86	2,751	1,007	9.78	0.42
20%	-433	145	5,460	1,999	9.23	0.34
30%	-679	220	8,116	2,971	8.75	0.32
40%	-960	303	10,814	3,958	8.25	0.32
50%	-1274	395	13,551	4,961	7.79	0.31
60%	-1597	489	16,298	5,966	7.47	0.31
70%	-1930	593	18,914	6,924	7.18	0.31
80%	-2285	717	21,671	7,933	6.94	0.31
90%	-2669	846	24,346	8,912	6.68	0.32
100%	-3336	1225	27,057	9,905		



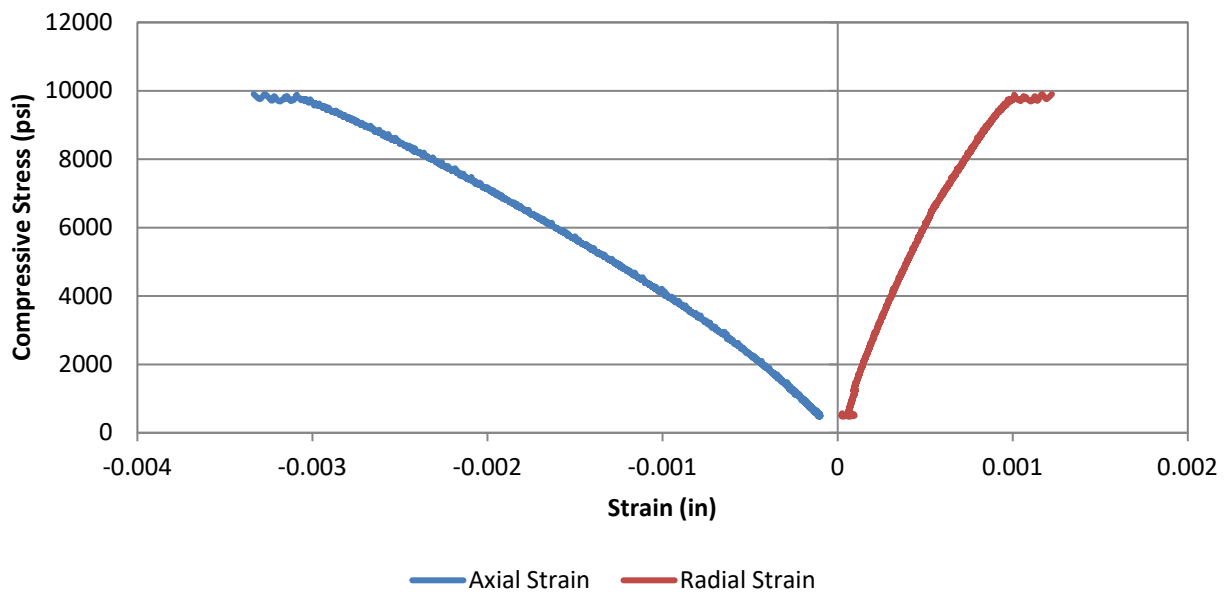
Test Results			
Unconfined Compressive Strength (psi)	9,900	Elastic Modulus (psi)	7.62E+06
		Poisson's Ratio in Elastic Range	0.31
Comments	Elastic range was taken as between 0.001 and 0.002 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.865	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.101	Reviewed By	WJG
Boring	B-55	Unit Weight (pcf)	184.6	Core Size	NQ
Sample No.	NQ-6 / 22-0180D	L/D Ratio	2.20	Recovery	100%
Depth	36.4' - 36.7'	Load Rate (psi/sec)	20	RQD	65%
Description	Black/White/Gray Gneiss				

Axial Stress vs. Strain



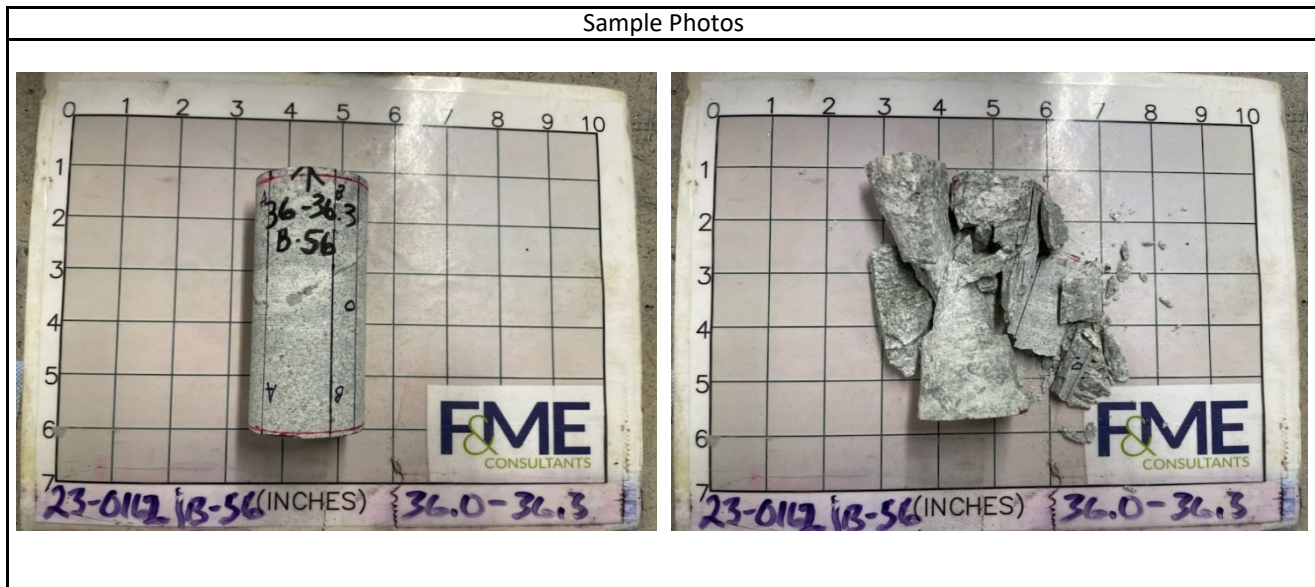
Stress vs. Strain



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

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.864	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.179	Reviewed By	WJG
Boring	B-56	Unit Weight (pcf)	171.8	Core Size	NQ
Sample No.	NQ-4 / 23-0162	L/D Ratio	2.24	Recovery	80%
Depth	36.0' - 36.3'	Load Rate (psi/sec)	20	RQD	50%
Description	Black/White/Gray Gneiss				

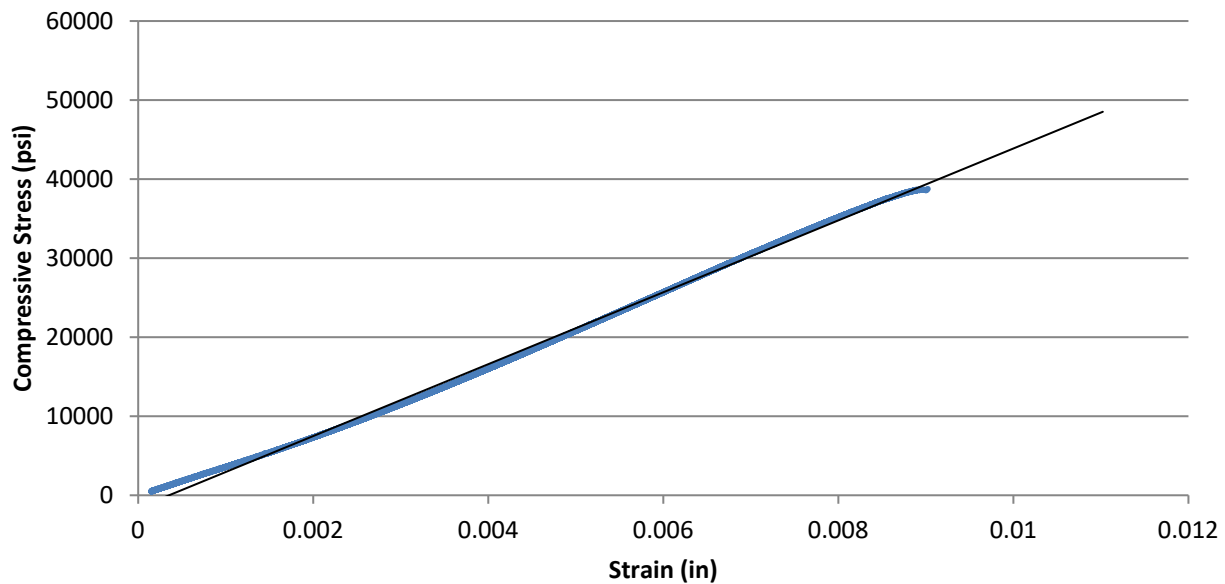
Test Data						
Percent of Failure Load	Strain (10^{-6})		Load (lbs)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio
	Axial	Radial				
10%	-1080	236	10,579	3,877	7.18	0.22
20%	-2107	450	21,166	7,756	7.36	0.21
30%	-3037	679	31,738	11,630	7.66	0.22
40%	-3896	925	42,354	15,521	7.97	0.24
50%	-4701	1188	52,841	19,364	8.24	0.25
60%	-5507	1489	63,431	23,244	8.44	0.27
70%	-6305	1834	74,212	27,195	8.63	0.29
80%	-7100	2205	84,631	31,013	8.74	0.31
90%	-7930	2821	95,188	34,882	8.80	0.36
100%	-9022	2917	105,764	38,758		



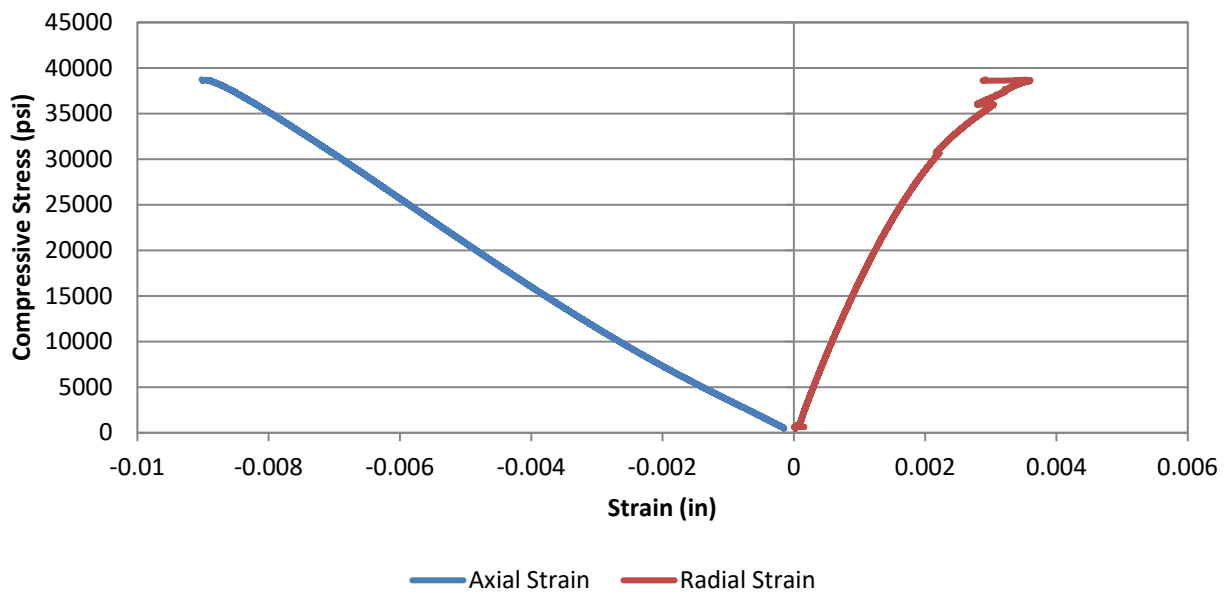
Test Results			
Unconfined Compressive Strength (psi)		38,760	Elastic Modulus (psi)
			8.00E+06
			Poisson's Ratio in Elastic Range
			0.24
Comments	Elastic range was taken as between 0.002 and 0.006 inches of axial strain. This range was chosen to avoid any non-linear behavior from the initial loading and the inflection point at the end of the elastic range.		

Project	SC 215 RBO Fairforest Creek			Date	2/27/2023
Project No.	G6655.003	Sample Diameter (in.)	1.864	Tested By	WAP
SCDOT ID	P041236	Sample Length (in.)	4.179	Reviewed By	WJG
Boring	B-56	Unit Weight (pcf)	171.8	Core Size	NQ
Sample No.	NQ-4 / 23-0162	L/D Ratio	2.24	Recovery	80%
Depth	36.0' - 36.3'	Load Rate (psi/sec)	20	RQD	50%
Description	Black/White/Gray Gneiss				

Axial Stress vs. Strain



Stress vs. Strain



Appendix D. ADRS Curves

3-Point Acceleration Design Response Spectrum

SCDOT v3.1.1 - 11/29/2022

Project ID:	P041236	Latitude:	34.7164
Route:	SC 215	County:	44 - Union
Project:	SC 215 over Fairforest Creek		
		Longitude:	81.7096

Designer:	N. Harman - Support
Date:	3/1/2023

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	0.01	0.02	0.00	7.30	214.10	0.14	51.98	0.03
SEE	0.02	0.03	0.01	6.48	149.13	0.31	33.13	0.09

Fundamental Period of Structure, T ₀	Range of Interest		V _{s,H} *	H	T _{NH}	
	sec				sec	
sec	0.5*T ₀	2.0*T ₀	ft/sec	ft	(4*H)/V _{s,H} *	(6*H)/V _{s,H} *
0.00	0.00	0.00	665.43	25.00	0.15	0.23
0.00	0.00	0.00	H = B-C Boundary			

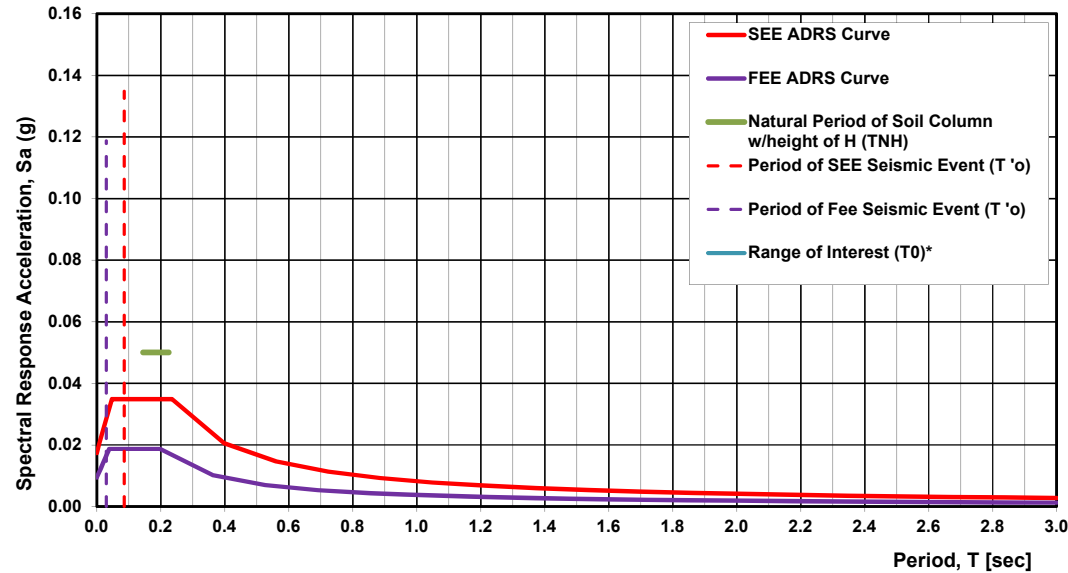
H = B-C Boundary

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	0.009
0.01	0.011
0.01	0.012
0.02	0.014
0.03	0.016
0.03	0.017
0.04	0.019
0.05	0.019
0.07	0.019
0.08	0.019
0.09	0.019
0.11	0.019
0.12	0.019
0.13	0.019
0.14	0.019
0.16	0.019
0.17	0.019
0.18	0.019
0.20	0.019
0.36	0.010
0.53	0.007
0.69	0.005
0.86	0.004
1.02	0.004
1.19	0.003
1.35	0.003
1.52	0.002
1.68	0.002
1.85	0.002
2.01	0.002
2.18	0.002
2.34	0.002
2.51	0.001
2.67	0.001
2.84	0.001
3.00	0.001

SEE Data

T	S _a
0.00	0.017
0.01	0.020
0.02	0.023
0.02	0.026
0.03	0.029
0.04	0.032
0.05	0.035
0.06	0.035
0.08	0.035
0.09	0.035
0.11	0.035
0.13	0.035
0.14	0.035
0.16	0.035
0.17	0.035
0.19	0.035
0.20	0.035
0.22	0.035
0.24	0.035
0.40	0.021
0.56	0.015
0.72	0.011
0.89	0.009
1.05	0.008
1.21	0.007
1.37	0.006
1.54	0.005
1.70	0.005
1.86	0.004
2.02	0.004
2.19	0.004
2.35	0.003
2.51	0.003
2.67	0.003
2.84	0.003
3.00	0.003

Appendix E. SPT Hammer Energy Calibration Report

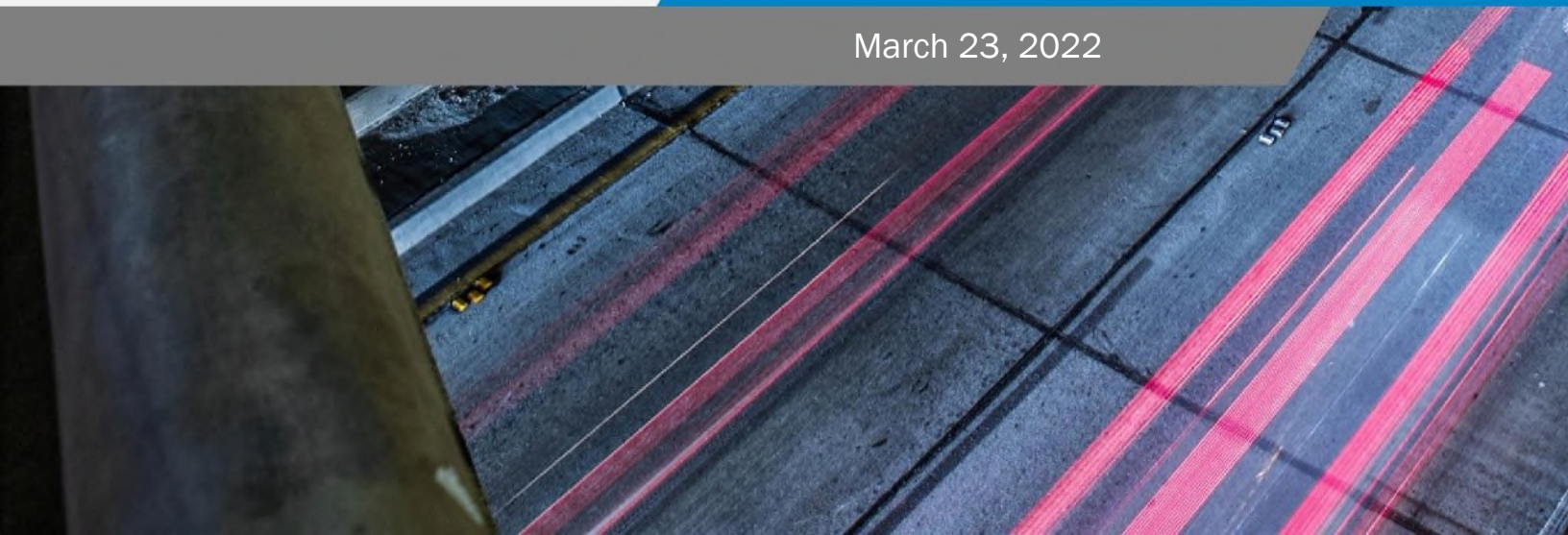


CAROLINAS
GEOTECHNICAL
GROUP

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 294593)
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 294593, 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 R. Huffstetler 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 34.770561, -81.245581. 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	294593
Operator	R. Huffstetler
Carrier	ATV
Hammer Information	
Model / Type	CME / Auto
Serial Number	N/A
Anvil Height (inches)	11.5
Anvil Diameter (inches)	2.5
Drop Height (inches)	30
Ram Weight (pounds)	140
Ram Serial Number	N/A
Drilling and Instrumented Rod Information	
Drill Rod Type	AWJ
OD (inches)	1.75
ID (inches)	1.25
Cross-Sectional Area (in ²)	1.19
Typical Lengths (feet)	5
Instrumented Rod Type	AWJ (SN 528)
OD (inches)	1.75
ID (inches)	1.25
Cross-Sectional Area (in ²)	1.19
Total Instrumented Rod Length (feet)	2.00
Length Below Gages (feet)	0.70
Split-Spoon Length (feet)	2.85

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 56.9 to 59.1 blows per minute (BPM) during dynamic testing. The measured transferred hammer energy (EFV) ranged from 278.9 to 324.9 foot-pounds, which corresponds to Energy Transfer Ratio (ETR) values of 79.7 to 92.8%, 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	4-7-9 / 16	SA SILT	57.9	293.4	83.8
2	33½ - 35	35	38.6	4-6-8 / 14	SA SILT	58.6	312.1	89.2
3	38½ - 40	40	43.6	3-4-6 / 10	SA SILT	58.5	312.0	89.1
Overall Average						58.3	304.6	87.0

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 304.6 foot-pounds, with an average ETR of 87.0%.

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:

386129C0A4C1462...
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 294593) 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



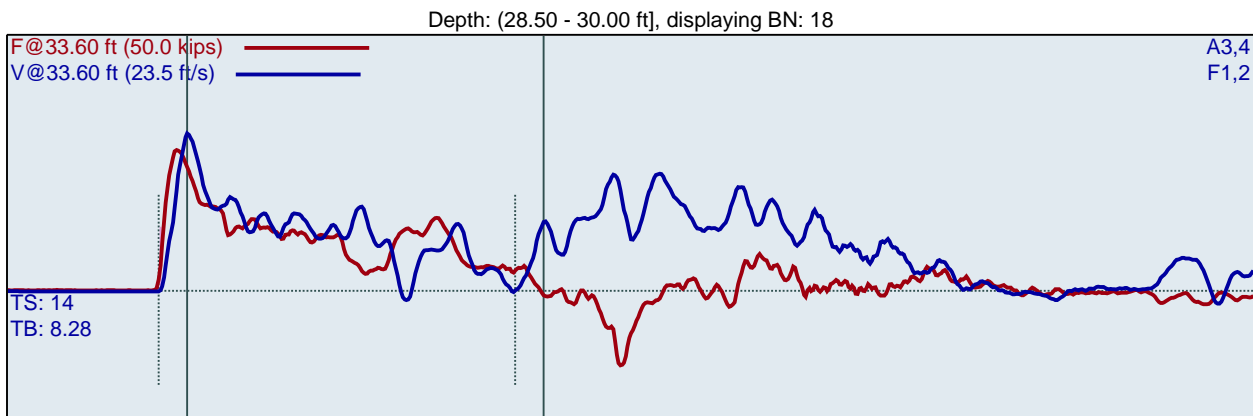
APPENDIX I

CME 550X (SN 294593)
REK
B-4

B-4
Interval start: 3/11/2022

AR: 1.19 in²
LE: 33.60 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft³
EM: 30000 ksi



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

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

BPM: Blows/Minute

FMX: Maximum Force

VMX: Maximum Velocity

DMX: Maximum Displacement

CSX: Compression Stress Maximum

DFN: Final Displacement

EFV: Maximum Energy

ETR: Energy Transfer Ratio - Rated

LP	BL#	BC	BPM	FMX	VMX	DMX	CSX	DFN	EFV	ETR
ft		/6"	bpm	kips	ft/s	in	ksi	in	ft-lb	%
28.63	1	4	1.9	25.9	15.6	1.7	21.8	1.5	255.9	73.1
28.75	2	4	48.5	25.4	15.0	1.5	21.4	1.5	273.4	78.1
28.88	3	4	53.5	25.8	15.0	1.5	21.7	1.5	287.5	82.1
29.00	4	4	56.4	25.6	15.5	1.6	21.5	1.5	318.9	91.1
29.07	5	7	57.0	25.9	14.9	1.3	21.7	0.9	301.8	86.2
29.14	6	7	56.9	25.7	15.6	1.2	21.6	0.9	311.6	89.0
29.21	7	7	57.6	25.8	15.2	1.1	21.7	0.9	300.2	85.8
29.29	8	7	57.4	26.3	15.8	1.1	22.1	0.9	300.9	86.0
29.36	9	7	57.9	26.3	14.5	1.0	22.1	0.9	303.6	86.7
29.43	10	7	58.0	26.7	15.5	0.9	22.4	0.9	296.7	84.8
29.50	11	7	57.8	26.4	15.2	0.9	22.2	0.9	297.2	84.9
29.56	12	9	58.1	27.0	15.1	0.9	22.7	0.7	298.4	85.3
29.61	13	9	58.3	27.5	15.2	0.9	23.1	0.7	297.8	85.1
29.67	14	9	58.1	26.9	14.9	0.8	22.6	0.7	292.8	83.6
29.72	15	9	58.2	26.9	14.4	0.8	22.6	0.7	284.8	81.4
29.78	16	9	58.5	27.2	14.6	0.8	22.8	0.7	288.2	82.4
29.83	17	9	58.5	26.9	14.3	0.8	22.6	0.7	278.9	79.7
29.89	18	9	58.2	27.5	14.5	0.7	23.1	0.7	281.7	80.5
29.94	19	9	58.3	27.1	14.3	0.7	22.8	0.7	279.1	79.7
30.00	20	9	58.2	27.5	14.5	0.7	23.1	0.7	280.6	80.2
Average			57.9	26.7	14.9	0.9	22.5	0.7	293.4	83.8
Std Dev			0.5	0.6	0.5	0.2	0.5	0.1	9.7	2.8
Maximum			58.5	27.5	15.8	1.3	23.1	0.9	311.6	89.0
Minimum			56.9	25.7	14.3	0.7	21.6	0.7	278.9	79.7

N-value: 16

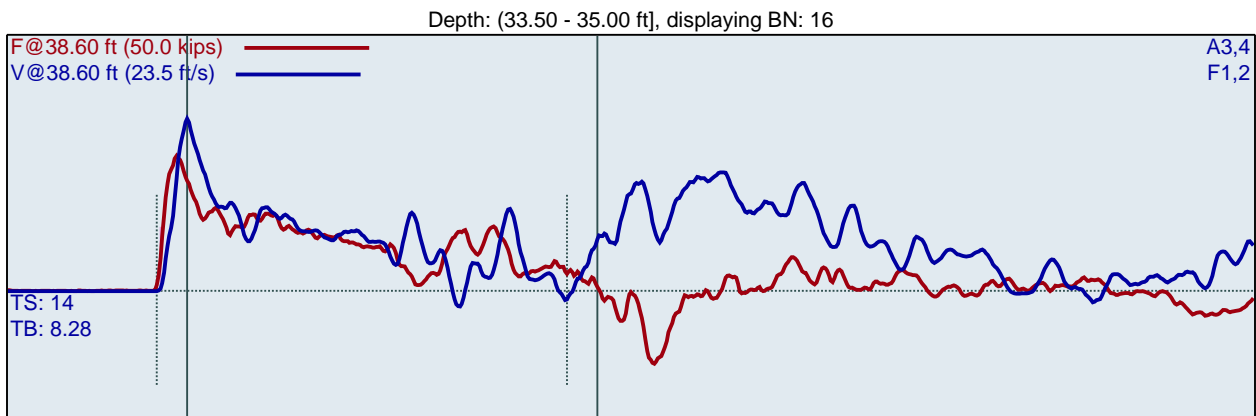
Sample Interval Time: 19.99 seconds.

CME 550X (SN 294593)
REK
B-4

B-4
Interval start: 3/11/2022

AR: 1.19 in²
LE: 38.60 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft³
EM: 30000 ksi



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

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

LP ft	BL#	BC /6"	BPM bpm	FMX kips	VMX ft/s	DMX in	CSX ksi	DFN in	EFV ft-lb	ETR %
33.63	1	4	1.9	26.7	15.8	2.0	22.4	1.5	277.0	79.1
33.75	2	4	53.0	26.2	16.2	1.5	22.0	1.5	289.7	82.8
33.88	3	4	56.1	26.4	16.2	1.5	22.2	1.5	320.7	91.6
34.00	4	4	57.4	26.5	16.6	1.5	22.3	1.5	332.4	95.0
34.08	5	6	58.1	26.8	16.7	1.1	22.5	1.0	315.1	90.0
34.17	6	6	58.2	27.1	16.6	1.1	22.7	1.0	309.7	88.5
34.25	7	6	58.7	27.2	16.8	1.1	22.9	1.0	316.1	90.3
34.33	8	6	58.6	26.2	16.5	1.0	22.0	1.0	315.5	90.1
34.42	9	6	58.6	26.4	16.5	1.0	22.2	1.0	317.3	90.7
34.50	10	6	58.6	26.7	16.4	1.0	22.4	1.0	319.3	91.2
34.56	11	8	58.6	26.2	16.6	0.8	22.0	0.7	304.0	86.9
34.63	12	8	58.9	26.5	16.2	0.8	22.2	0.7	311.7	89.0
34.69	13	8	58.4	26.7	16.7	0.8	22.4	0.7	315.8	90.2
34.75	14	8	59.1	26.3	16.1	0.8	22.1	0.7	308.5	88.2
34.81	15	8	58.8	27.1	16.3	0.8	22.8	0.7	311.2	88.9
34.88	16	8	58.7	26.4	15.8	0.8	22.1	0.7	310.5	88.7
34.94	17	8	58.6	26.4	15.9	0.8	22.1	0.7	306.6	87.6
35.00	18	8	59.0	26.3	15.9	0.8	22.1	0.7	307.8	87.9
Average			58.6	26.6	16.4	0.9	22.3	0.9	312.1	89.2
Std Dev			0.3	0.3	0.3	0.1	0.3	0.1	4.3	1.2
Maximum			59.1	27.2	16.8	1.1	22.9	1.0	319.3	91.2
Minimum			58.1	26.2	15.8	0.8	22.0	0.7	304.0	86.9

N-value: 14

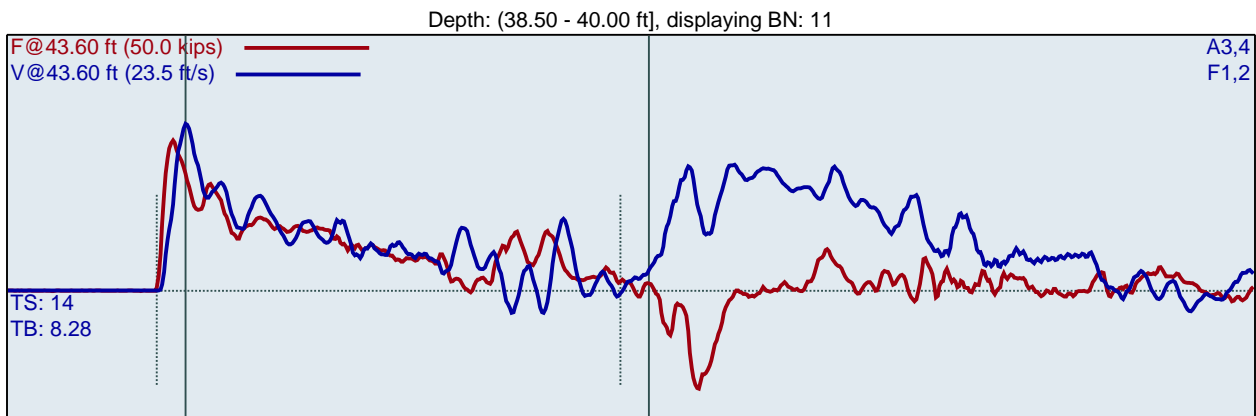
Sample Interval Time: 17.58 seconds.

CME 550X (SN 294593)
REK
B-4

B-4
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



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 %
38.67	1	3	1.9	28.0	15.2	2.0	23.5	2.0	277.0	79.2
38.83	2	3	54.1	28.1	15.5	2.0	23.6	2.0	321.3	91.8
39.00	3	3	56.4	29.4	15.7	2.0	24.7	2.0	314.0	89.7
39.13	4	4	57.6	27.8	15.5	1.5	23.3	1.5	309.2	88.3
39.25	5	4	58.5	28.4	15.6	1.5	23.8	1.5	312.7	89.4
39.38	6	4	58.1	28.2	15.4	1.5	23.7	1.5	324.9	92.8
39.50	7	4	58.9	29.7	15.7	1.5	24.9	1.5	317.1	90.6
39.58	8	6	58.4	28.5	15.5	1.1	24.0	1.0	310.1	88.6
39.67	9	6	58.6	28.1	15.5	1.1	23.6	1.0	312.8	89.4
39.75	10	6	58.7	29.1	15.4	1.1	24.4	1.0	307.5	87.8
39.83	11	6	58.6	29.4	15.3	1.1	24.7	1.0	311.1	88.9
39.92	12	6	58.6	27.9	15.0	1.1	23.4	1.0	307.6	87.9
40.00	13	6	58.7	28.5	15.1	1.0	24.0	1.0	307.1	87.7
Average			58.5	28.6	15.4	1.3	24.0	1.2	312.0	89.1
Std Dev			0.3	0.6	0.2	0.2	0.5	0.2	5.2	1.5
Maximum			58.9	29.7	15.7	1.5	24.9	1.5	324.9	92.8
Minimum			57.6	27.8	15.0	1.0	23.3	1.0	307.1	87.7

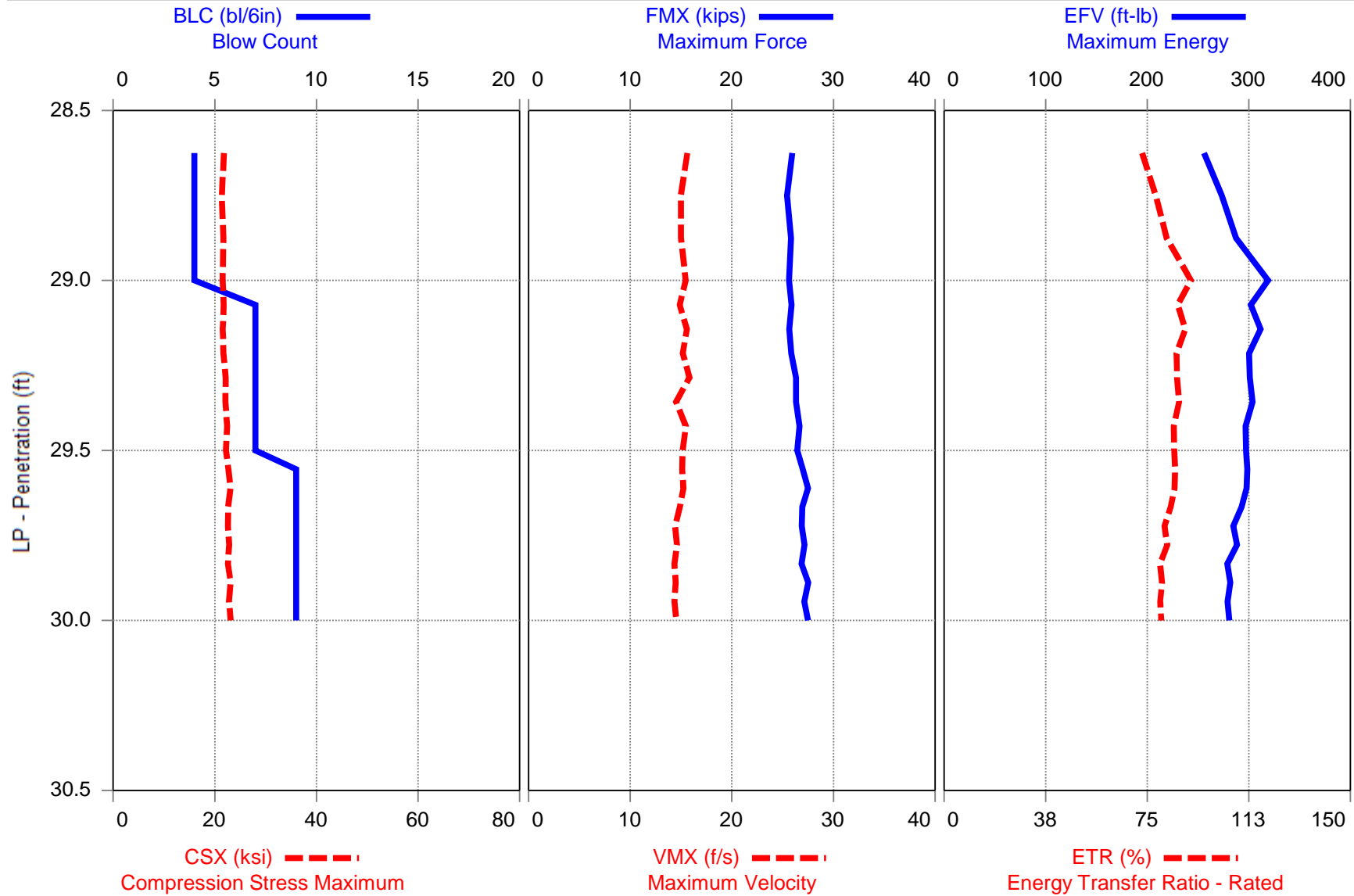
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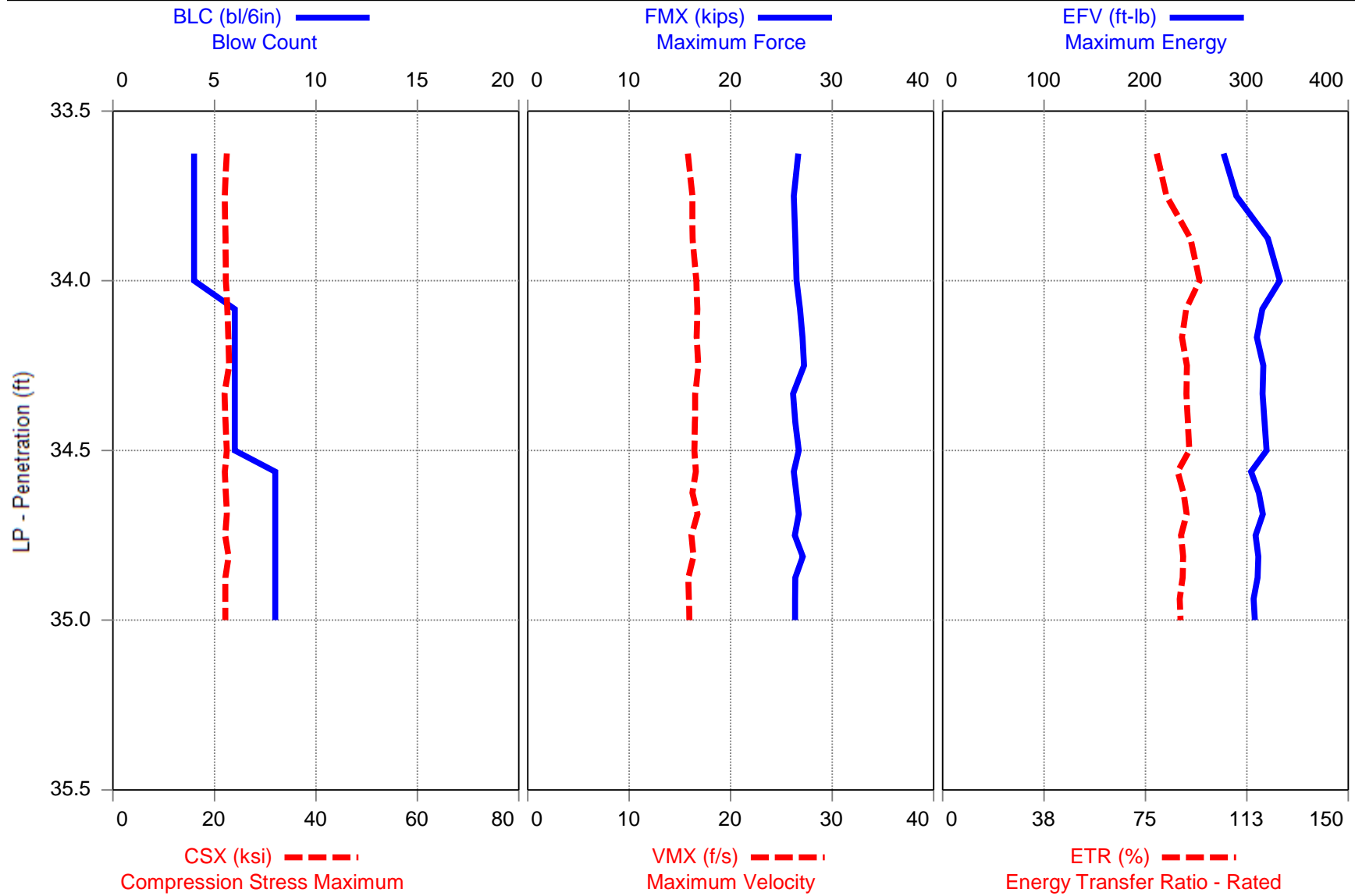
Sample Interval Time: 12.41 seconds.

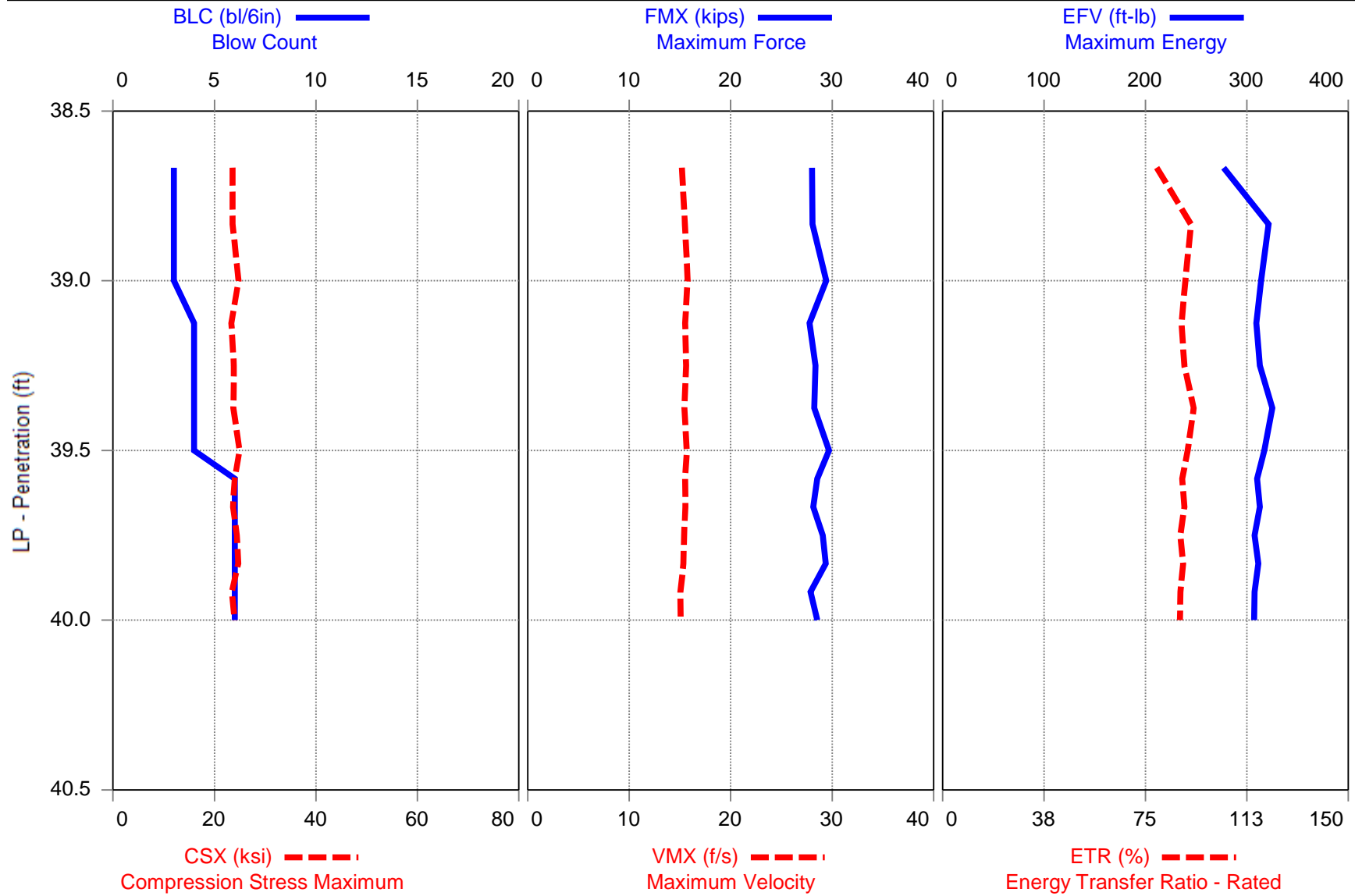
Summary of SPT Test Results

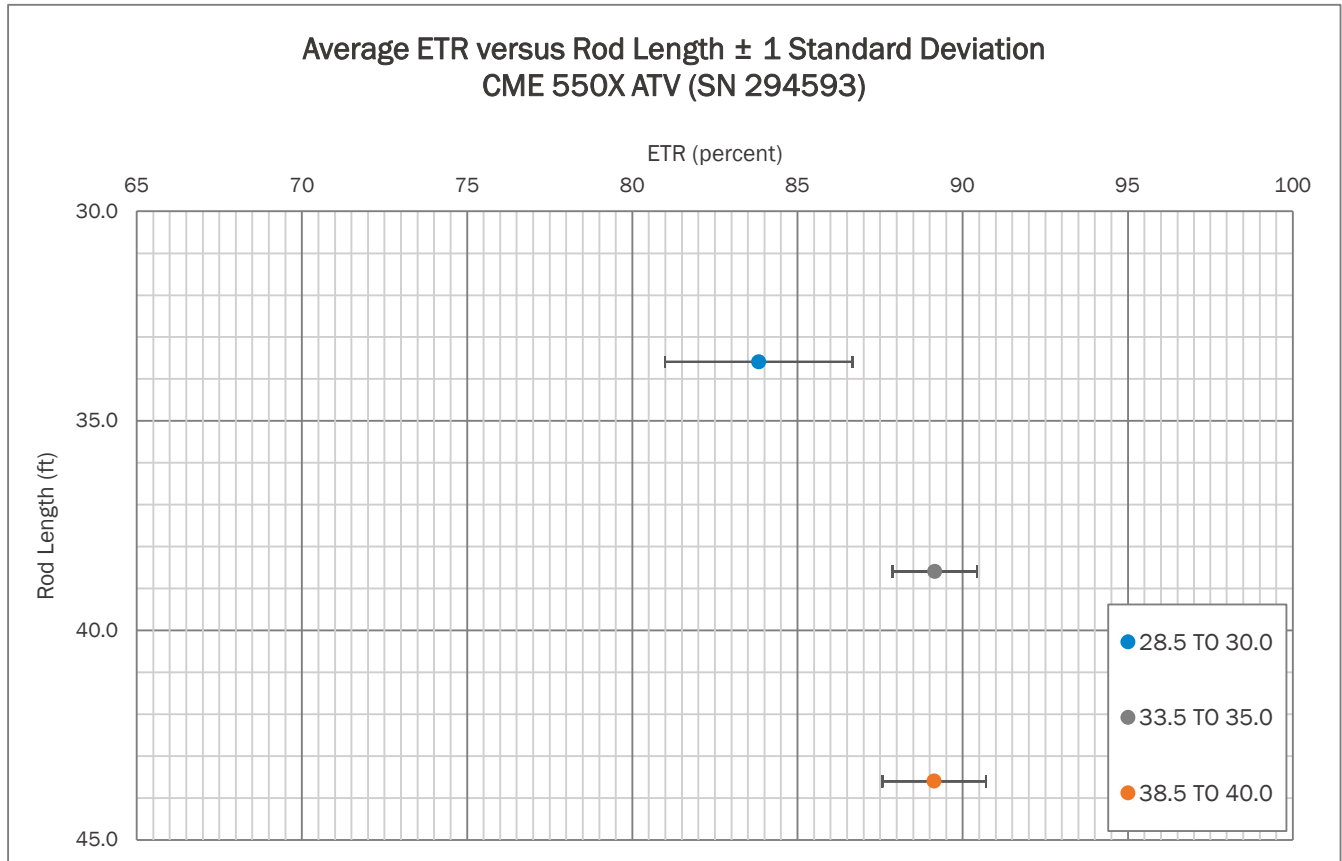
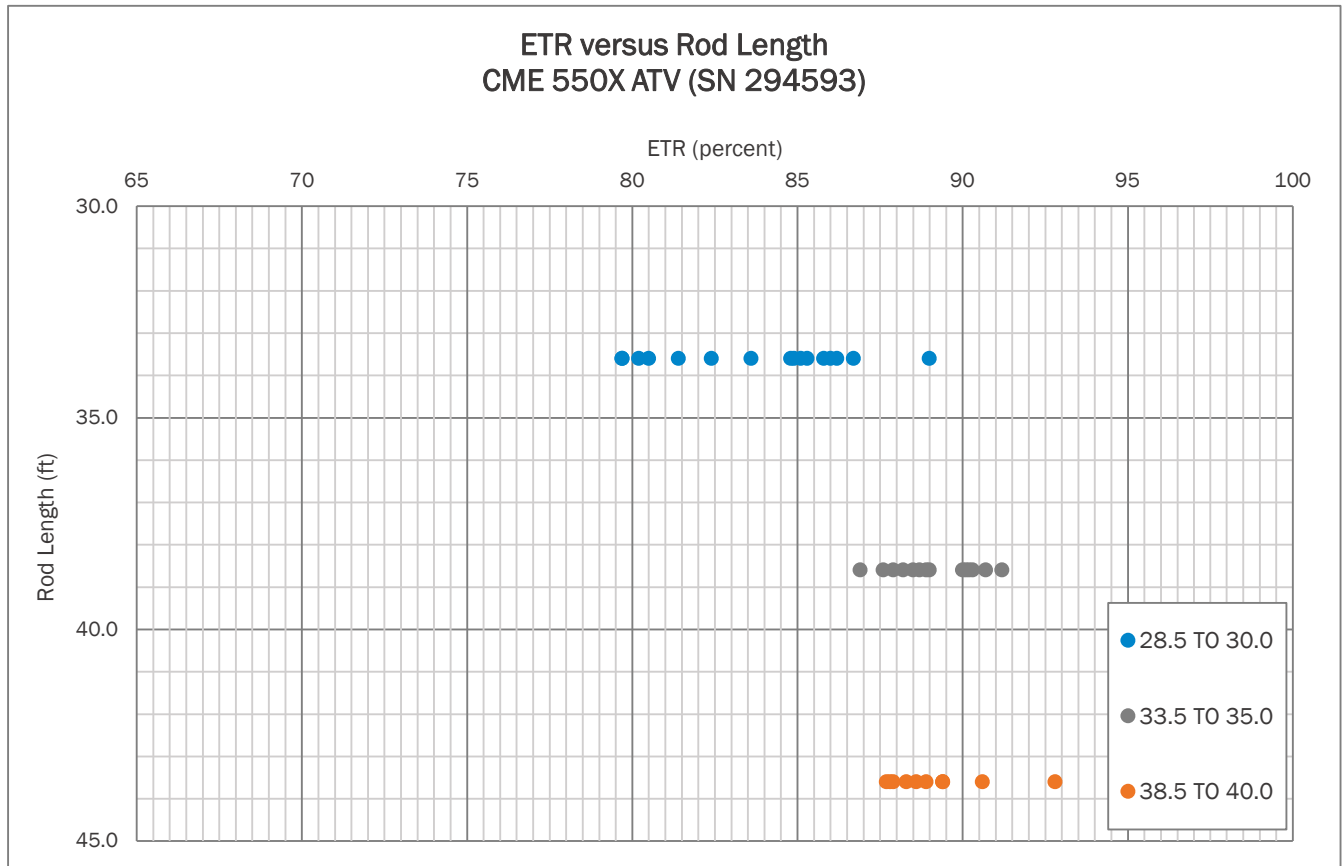
Project: CME 550X (SN 294593), Test Date: 3/11/2022

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							
Instr. Length ft	Start Depth ft	Final Depth ft	Blows Applied /6"	N Value	N60 Value	Average BPM bpm	Average FMX kips	Average VMX ft/s	Average DMX in	Average CSX ksi	Average DFN in	Average EFV ft-lb	Average ETR %
33.60	28.50	30.00	4-7-9	16	23	57.9	26.7	14.9	0.9	22.5	0.7	293.4	83.8
38.60	33.50	35.00	4-6-8	14	20	58.6	26.6	16.4	0.9	22.3	0.9	312.1	89.2
43.60	38.50	40.00	3-4-6	10	14	58.5	28.6	15.4	1.3	24.0	1.2	312.0	89.1
Overall Average Values:						58.3	27.1	15.5	1.0	22.8	0.9	304.6	87.0
Standard Deviation:						0.5	1.0	0.7	0.2	0.8	0.2	11.6	3.3
Overall Maximum Value:						59.1	29.7	16.8	1.5	24.9	1.5	324.9	92.8
Overall Minimum Value:						56.9	25.7	14.3	0.7	21.6	0.7	278.9	79.7











APPENDIX II

SPT Hammer Energy Field Form

Project: SPT HAMMER ENERGY
Project No.: 240021095
Boring No.: B-4

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

On-site Personnel

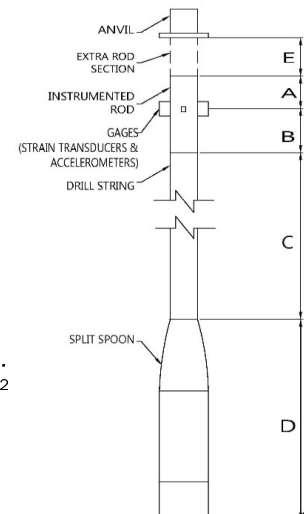
Drilling Company: BRECCIA CONSTRUCTION, LLC
Rig Operator: R. HUFFSTETLER
Engr/Geologist: N/A
Client Rep.: N/A
Analyzer Oper.: R. KRAL

Rig/Hammer Info

Drill Rig Make/Model: CME 550X
Carrier Type: ATV
Rig Serial No.: 294593 (DR-4)
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	407.00
	A4	K10959	417.30
Strain	F3	528AWJ-1	205.26
	F4	528AWJ-2	205.86

Date of Test	Test Depth Increment (ft to ft)	Test Time Start / Stop (military)	Length of Drill String (ft) (C)	(LE) Length below Gages (ft) (B) + (C) + (D)	Avg. Meas. Hammer Rate (BPM)	SPT Blow Counts				Drop Height in Tolerance (y/n)	Soil Class.
						6"	12"	18"	N-Value		
11-Mar	28.5 TO 30.0	0855/0856	30	33.6	57	4	7	9	16	Y	SA SI
11-Mar	33.5 TO 35.0	0902/0902	35	38.6	58	4	6	8	14	Y	SA SI
11-Mar	38.5 TO 40.0	0909/0909	40	43.6	58	3	4	6	10	Y	SA SI

Notes:

TESTING PERFORMED AT 1817 LOWRYS HIGHWAY IN CHESTER, SOUTH CAROLINA (CHESTER COUNTY). THE APPROXIMATE COORDINATES ARE 34.770561, -81.245581.

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

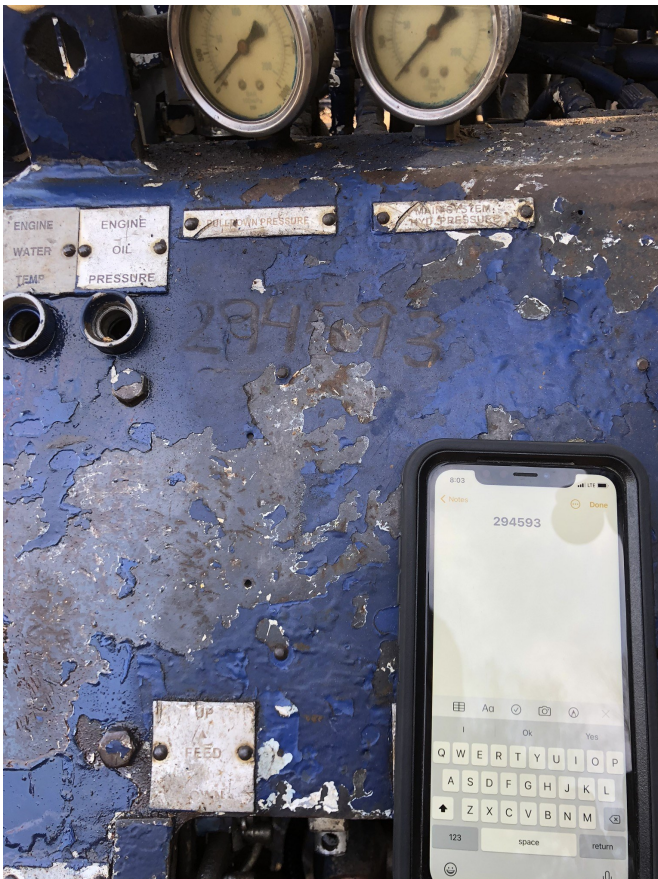


Figure No. 3: Serial Number Plate



Figure No. 4: Automatic Hammer

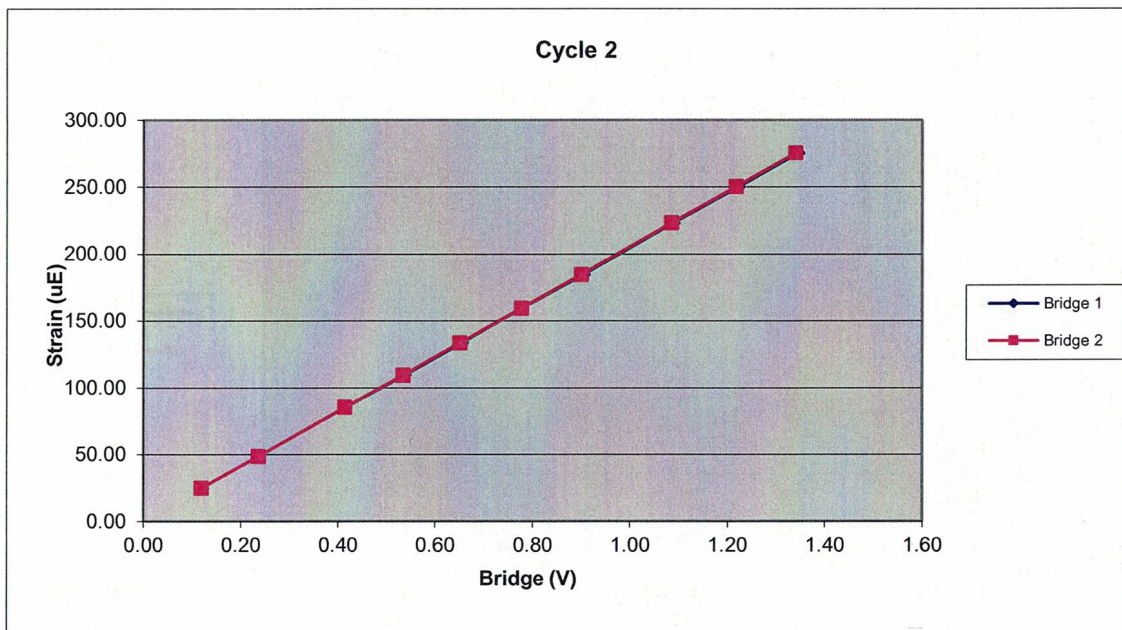


APPENDIX III

528AWJ		Cycle 2		
Sample	Force (lb)	Strain (μ E)	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 (μ E/V)	204.74	Strain Calibration (μ 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]

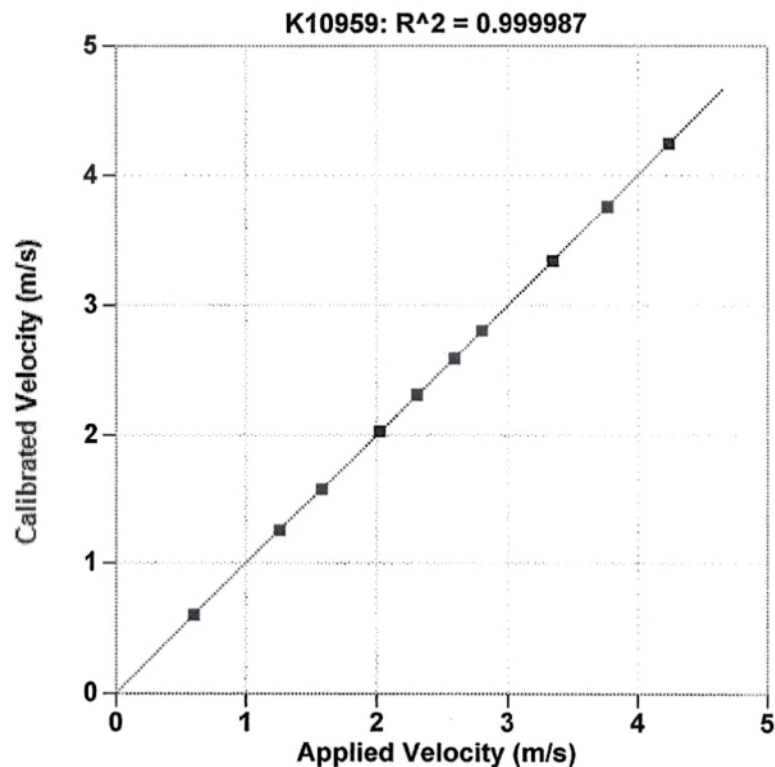
Operator: William Johnson

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

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


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 $\mu\text{v/g}$)

R²: 0.999987 [Chip programmed]

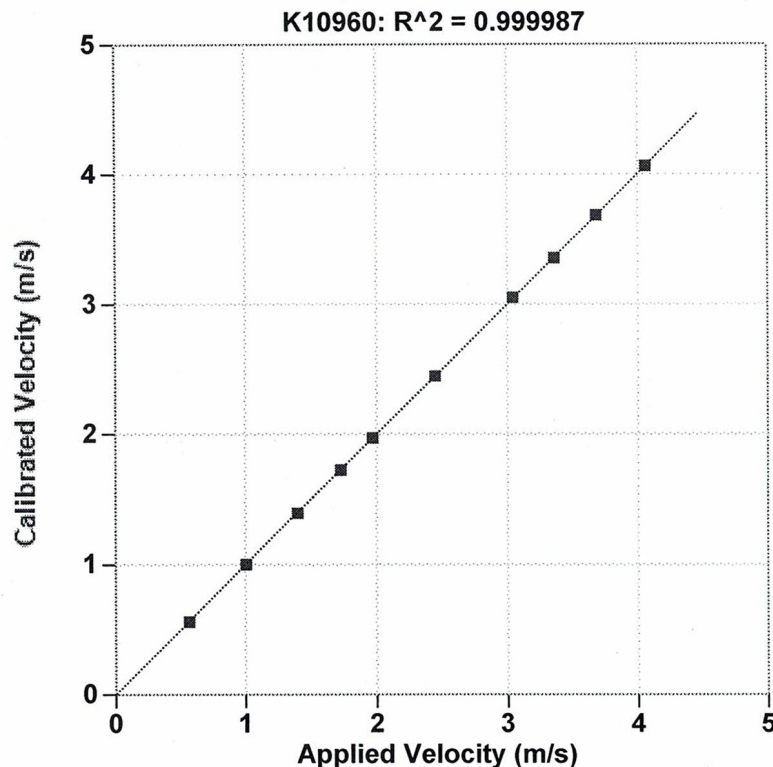
Operator: William Johnson

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

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


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

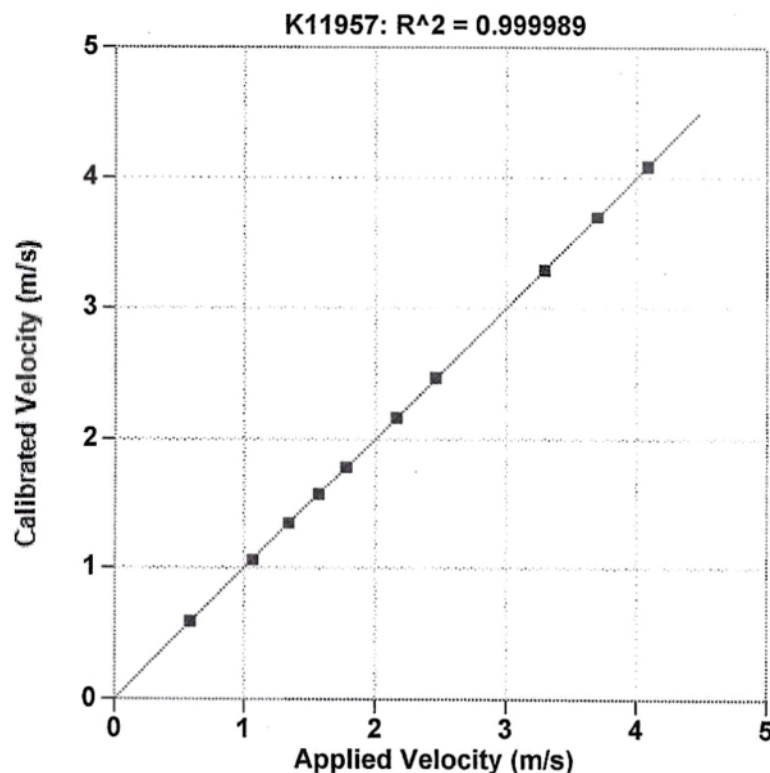
Ref Acc 1: 63479! Cal on: 22Jan2021
1079 g's/volt

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



Signed

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



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

Maximum Acceleration: 894 g's



APPENDIX IV



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