

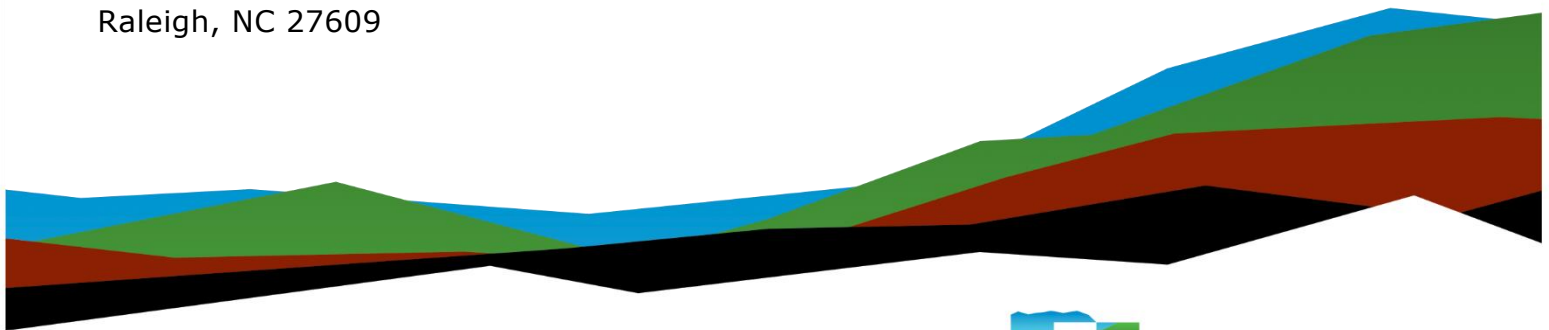
S-42-197 (Old Spartanburg Highway) Bridge Replacement over South Tyger River

Spartanburg County, SC Geotechnical Baseline Report

March 21, 2025 | SCDOT Project ID: P041164
Terracon Project No.: 8623P180

Prepared for:

HNTB Corporation
343 E. Six Forks Road, Suite 200
Raleigh, NC 27609



Nationwide
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March 21, 2025

HNTB Corporation
343 E. Forks Road, Suite 200
Raleigh, NC 27609

Attn: Mr. Spencer Franklin, PE, Senior Vice President
P: 919-546-8997

Re: Geotechnical Baseline Report
S-42-197 Bridge Replacement over South Tyger River
Spartanburg County, South Carolina
SCDOT Project ID.: P041164
Terracon Project No.: 8623P180

Dear Mr. Franklin:

Terracon Consultants Inc. (Terracon) has completed the exploration, testing and limited engineering analysis services for the above-referenced project. The services were conducted in general accordance with our Task Order Number 001, dated May 25, 2023.

Introduction

HNTB Corporation (HNTB) has contracted Terracon to perform subsurface exploration, laboratory testing and limited preliminary engineering recommendations for the replacement of the S-42-197 Bridge over South Tyger River in Spartanburg County, South Carolina. The results of the subsurface exploration and laboratory testing have been separately presented in a Geotechnical Subsurface Data Report (GSDR). For convenience, the data are also provided here in this Geotechnical Baseline Report (GBR) along with a characterization of the subsurface conditions for the project. Limited preliminary geotechnical design and construction considerations associated with the requested scope of work are included in this GBR. This GBR was prepared in general accordance with the 2022 SCDOT Geotechnical Design Manual (GDM).

Project Description

The project site is located at the S-42-197 (Old Spartanburg Highway) crossing over South Tyger River in Spartanburg County, South Carolina. Site location and exploration plans are presented in Appendix A of this report. Based on the conceptual plans by HNTB dated

3/13/2025, the replacement bridge will be constructed on the same alignment as the current bridge. The current plan indicates the new bridge will be a 210-ft long multi-span bridge constructed with an adjacent cored slab for spans A and C and an adjacent box beam for span B.

Geotechnical Testing

The geotechnical exploration for this project was performed between January 8 and January 17, 2025. The results of our field work and our associated laboratory testing are included in Appendices A and B.

Field Exploration

Our field exploration consisted of the following:

- Three (3) Standard Penetration Test (SPT) Borings (S-42-197-1, S-42-197-2, and S-42-197-3)
- Two (2) offset auger probes near S-42-197-3 for bulk sample collection
- One (1) Downhole Shear Wave Velocity Test (DHT-1) performed in casing installed within Boring S-42-197-1
- Two (2) Cone Penetration Test soundings (S-42-197-1C and S-42-197-2C).

The tests were performed at the approximate locations that were approved by SCDOT. A description of our testing methods and graphical logs outlining the soil conditions at each test location are presented in Appendix A. The test locations were established in the field by Terracon and surveyed by Thomas & Hutton after completion.

Laboratory Testing

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

- Twenty-eight (28) Natural Moisture Content Tests
- Seven (7) Atterberg Limits Tests
- Eight (8) Grain Size Tests
- Five (5) Grain Size Tests with Hydrometer
- One (1) Remolded, Consolidated-Undrained (CU) Triaxial Compression Test with Pore Pressure Readings
- One (1) Standard Proctor Test
- One (1) Corrosivity Suite (pH, chloride content, sulfate content, and resistivity tests)
- Eight (8) Compressive Strength of Rock Cores

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

Subsurface Conditions

Regional Geology

The bridge site is located on route S-42-197 in Spartanburg County, South Carolina. The site lies generally within the Piedmont Physiographic Province. More specifically, the site is located within the Laurens Thrust Stack. According to regional geologic mapping and published geologic reports, the project area is mapped in an area with porphyroblastic biotite-quartz-plagioclase gneiss interlayered with biotite schist, sillimanite-mica schist, amphibolite, and small bodies of marble. The bridge end bents and approach embankments contain existing fill above alluvial and/or residual soils, very dense residual soils classified as Intermediate Geomaterials (IGM) and bedrock.

Soil and Rock Stratification

Borings S-42-197-1 and S-42-197-3 encountered 11 ½ to 13 inches of asphalt, and Boring S-42-19-2 the bridge deck consisted of 1 ½ inches of asphalt and 5 inches of concrete. Beneath the existing roadway section, embankment fill soil consisting of very loose to medium dense silty to clayey sand was encountered to approximately 6 to 10 feet below the existing ground surface. In Boring S-42-197-2 the water surface was encountered 17 feet below the bridge deck and the mudline 20 feet below the bridge deck. Under the fill soils and mudline, alluvial soils consisting of very loose to medium dense poorly-graded sands to clayey/silty sands were encountered to approximate depths of 22 to 29 feet below the ground surface. Below the alluvium soils, residual soils consisting of very loose to very dense silty sands were encountered to approximate depths of 38 ½ to 43 ½ feet below ground surface, with some residual soils characterized as being intermediate geomaterials (IGM) exhibiting SPT N values of more than 100 blows per foot (bpf), followed by bedrock. Bedrock was present to the maximum depth explored of 52 feet to 63 ½ feet below the ground surface.

Geology	Approximate Elevation of Layer Bottom (ft, NAVD88)	USCS Soil Type	Measured Field N Value	Plasticity Index	Fines Content	REC / RQD
Fill ¹	567 to 571	SM, SC,	3 to 14	11 to 15	36 to 37	--
Alluvium	548 to 555	SP-SM, SC, SC-SM, SP	0 to 18	NP to 16	4 to 25	--
Residuum	533 to 538	SM	3 to 100+	--	20 to 26	--
Rock	PMDE	--	--	--	--	42-100% / 9-97%

1. Only encountered in Borings S-42-197-1 and S-42-197-3 only.
2. PMDE = Present to Maximum Depth Explored
3. NP = non-plastic

Seismic Conditions

According to SCDOT Seismic Design Specifications for Highway Bridges version 2.0, the proposed bridge will be an Operational Classification II (OC II). Per SCDOT GDM 2022, the proposed bridge shall be designed to meet the performance limits for an OC II bridge.

Acceleration Design Response Spectrum (ADRS)

The shear wave and compression wave velocity results, as measured at Boring S-42-197-1 using downhole seismic tests, were provided to SCDOT. SCDOT used these velocity measurements to develop Acceleration Design Response Spectrum (ADRS) curves by determining the seismic hazard and evaluating the local site effects on the response spectra.

SCDOT provided "3-Point Acceleration Design Response Spectrum" curves along with a table that included pseudo-spectral accelerations (PSA) for 5% critical damping and at selected frequencies, consistent with a Geologically Realistic (B-C Boundary) condition (shear wave velocity, $V_s = 2,500$ feet per second). 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

The table below provides the maximum considered earthquake peak ground acceleration (PGA), the short period acceleration (S_{DS}), and one-second period acceleration (S_{D1}) for the FEE and SEE earthquakes at the ground surface. A copy of the "3-Point Acceleration Design Response Spectrum" provided by SCDOT is included in Appendix C.

Seismic Design Parameter	FEE	SEE
PGA	0.01	0.03
S_{DS}	0.03	0.05
S_{D1}	0.00	0.01

Soil Shear Strength Loss (SSL) Analysis

A layer of alluvium soils (very loose to loose silty/clayey sand) were encountered in the borings and is located below the river and groundwater level. Therefore, soil shear strength loss (SSL) screening should be performed to assess potential for liquefaction related settlement and stability impacts on the planned bridge foundations and embankment slopes. Additional soil and groundwater evaluation may be required.

Design and Construction Considerations

Foundations

Driven steel H-piles driven to practical refusal on rock or within IGM materials (i.e., >20 blows per inch with appropriately sized hammer) are expected to be feasible for the proposed bridge end bents.

The approximate elevation to the top of very dense residual soils (IGM) at End Bent 1 is 539 feet and at End Bent 4 is 543 feet, NAVD88. The IGM is about 4 feet thick at Bent 1 overlying bedrock with a RQD of 14% at the top of rock and about 5 feet thick at Bent 4 overlying bedrock with a RQD of 70% at the top of rock. Per section 16.3.1 of the GDM, reinforced pile tips will be needed to minimize potential pile damage while penetrating through IGM to the top of rock. Pile drivability using the wave equation should be performed 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 of the pile. Appropriate group effect should be considered as necessary per GDM Chapter 16.

According to the conceptual bridge plans by HNTB dated 3/13/2025, minimal fill is expected at the end bent embankments. Foundations should typically be installed after the approach embankment construction to reduce potential downdrag settlement issues. The pile design should account for drag loads, should new fill be placed after installing foundation piles.

Drilled shafts are anticipated to be feasible for the proposed bridge interior Bents 2 and 3. Assuming redundant drilled shafts, Table 9-4 GDM 2022 allows using a resistance factor of 0.60 (both side resistance and end bearing) for a single redundant drilled shaft in rock. It is assumed that the drilled shaft will be cased to the top of rock and the side resistance along the casing length will not be considered in estimating axial resistance. Appropriate group effects should be considered as necessary per GDM Chapter 16.

We have observed variability in the top of rock and thickness of IGM, as seen in **Soil and Rock Stratification**. Therefore, there is a potential for variability in foundation tip elevations at each bent location. Resistance of piles driven to practical refusal in IGM or rock will be limited by their structural resistance.

Corrosion and Deterioration

Corrosion testing was performed on a composite sample obtained from split spoons in the upper 2 to 30 feet. Corrosion testing included pH, resistivity, chlorides, and sulfates content are summarized in the table below, and the test results are included in Appendix B.

Geotechnical Baseline Report

S-42-197 Bridge Replacement over South Tyger River | Spartanburg County, SC
March 21, 2025 | Terracon Project No. 8623P180 | SCDOT Project ID: P041164



Corrosion Test	Results	Indication of Corrosivity ¹
	Bent 1, Boring S-42-197-3 Composite Sample from 2 to 30 feet	
pH	7.1	Less than 5.5
Resistivity	2,814 ohm-cm	Less than 2,000 ohm-cm
Chloride	145 ppm	Greater than 500 ppm
Sulfate	70 ppm	Greater than 1,000 ppm

1. AASHTO LRFD bridge design specifications, Ninth Edition 2020, Section 10.7.5.

Based on the criteria for electro-chemical properties in the GDM Section 7.18, the electro-chemical classification of the project site is non-aggressive. Interpretation of these data should be communicated with the project's structural engineer.

Embankment Construction

Based on the conceptual plans by HNTB, minimal fill will be placed to meet the proposed grade with some embankment cut below the bridge and relatively short 2H:1V riprap lined slopes shown at the end abutments. Bulk samples were obtained near End Bent 1 from the top 5 feet of existing embankment material. Per our scope, a bulk sample was tested for soil classification and was also remolded to about 95% of the Standard-effort Proctor prior to being tested for shear strength envelopes under CU Triaxial Compression with pore pressure readings. Test results are presented in Appendix B and summarized in the table below.

Sample No.	Station	Offset (ft)	Sample Depth (ft)	USCS Soil Type	Compaction		Shear Strength ¹	
					Optimum Moisture (%)	Max Dry Density (pcf)	Total (psi / °)	Effective (psi / °)
S-42-197-3 Bulk	67+87	6 R	1 – 5	SC	13.7	114.5	c=3.9 ø=20	c'=2.6 ø'=33

1. Based on a maximum deviator stress failure criterion

Geotechnical Baseline Report

S-42-197 Bridge Replacement over South Tyger River | Spartanburg County, SC
March 21, 2025 | Terracon Project No. 8623P180 | SCDOT Project ID: P041164



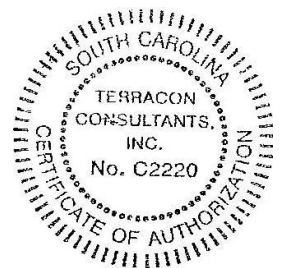
Closure

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

Sincerely,
Terracon Consultants, Inc.

Maggie McKenney, EIT
Senior Staff Engineer

Jonathan Ard, PE
Regional Service Manager
SC Registration No. 30886



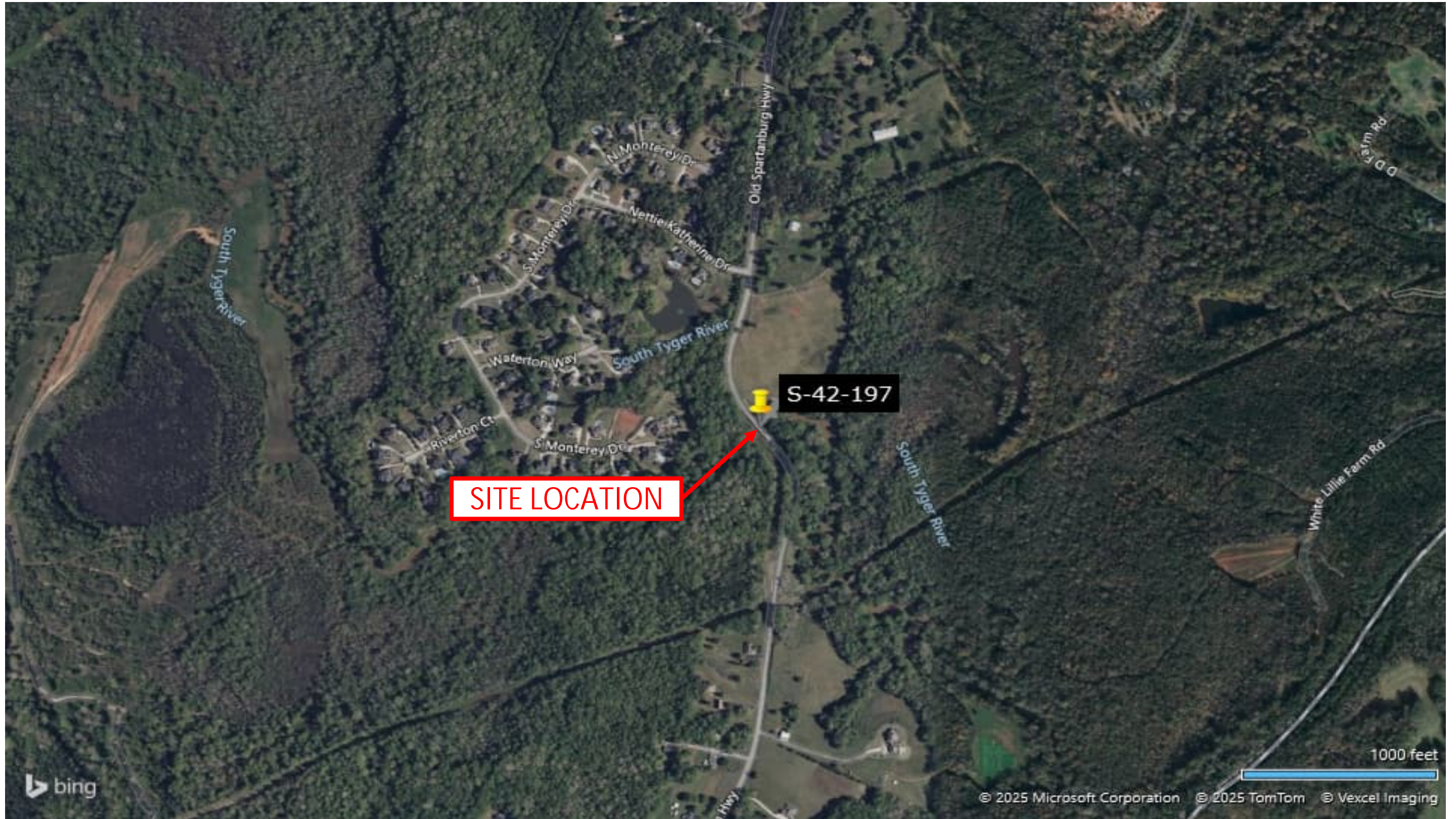
Reviewed by Terracon's Authorized Project Reviewer: Abdul Fekrat, P.E

Appendix A

Field Exploration

- Exhibit A-1 – Site Location Map
- Exhibit A-2 – Aerial Exploration Plan
- Exhibit A-3 – Boring Location Diagram
- Exhibit A-4 – Field Testing Summary
- Exhibit A-5 – GeoScoping Form (2 Pages)
- Exhibit A-6 – Field Exploration Description (3 Pages)
- Exhibit A-7 – Soil/Rock Description Terms (2 Pages)
- Exhibit A-8 – Soil/Rock Symbols
- Exhibit A-9 – Boring Logs (6 Pages)
- Exhibit A-10 – Grout Logs (4 Pages)
- Exhibit A-11 – Rock Core Photograph Logs (3 Pages)
- Exhibit A-12 – Geophysical Testing Results
- Exhibit A-13 – CPT Sounding Logs (2 Pages)

Note: All exhibits are one page unless noted above



AERIAL PHOTOGRAPHY PROVIDED BY BING
DIAGRAM IS FOR GENERAL LOCATION ONLY,
AND IS NOT INTENDED FOR CONSTRUCTION
PURPOSES

Project Mgr:	JA	Project No.	8623P180
Drawn by:	MM	Scale:	AS SHOWN
Checked by:	JA	Date:	3/20/2025
Approved by:	JA		



SITE LOCATION MAP	
S-42-197 (Old Spartanburg Highway) Bridge Replacement over South Tyger River	
Spartanburg County, SC	P041164

EXHIBIT
A-1



AERIAL PHOTOGRAPHY PROVIDED BY BING
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PURPOSES

Project Mgr:	JA
Drawn by:	MM
Checked by:	JA
Approved by:	JA

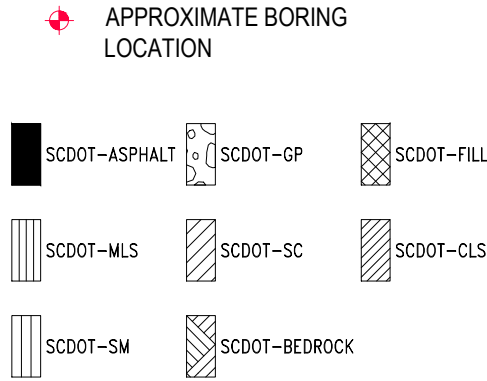
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Date:	3/20/2025



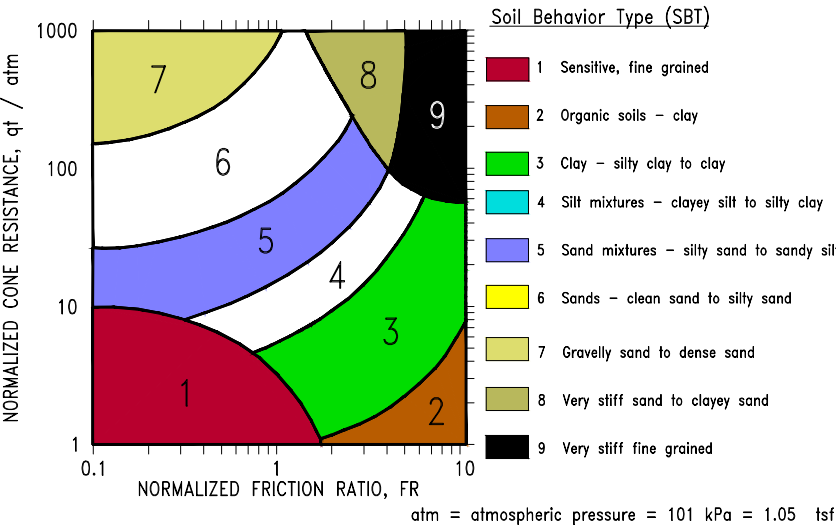
AERIAL EXPLORATION PLAN	
S-42-197 (Old Spartanburg Highway) Bridge Replacement over South Tyger River	
Spartanburg County, SC	P041164

EXHIBIT
A-2

LEGEND

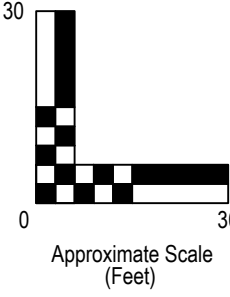
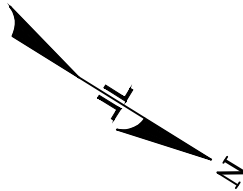


CPT Soil Classification Graphic Symbols

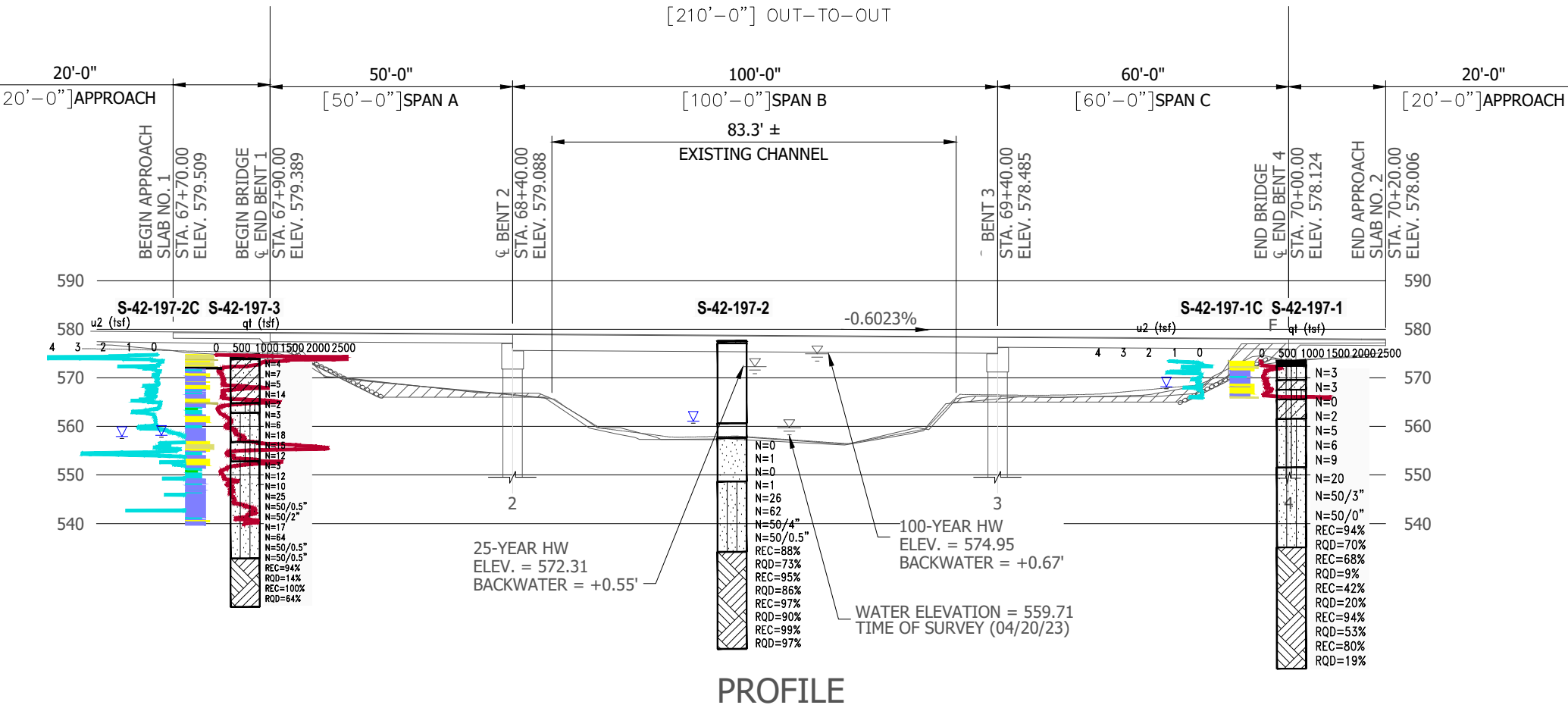
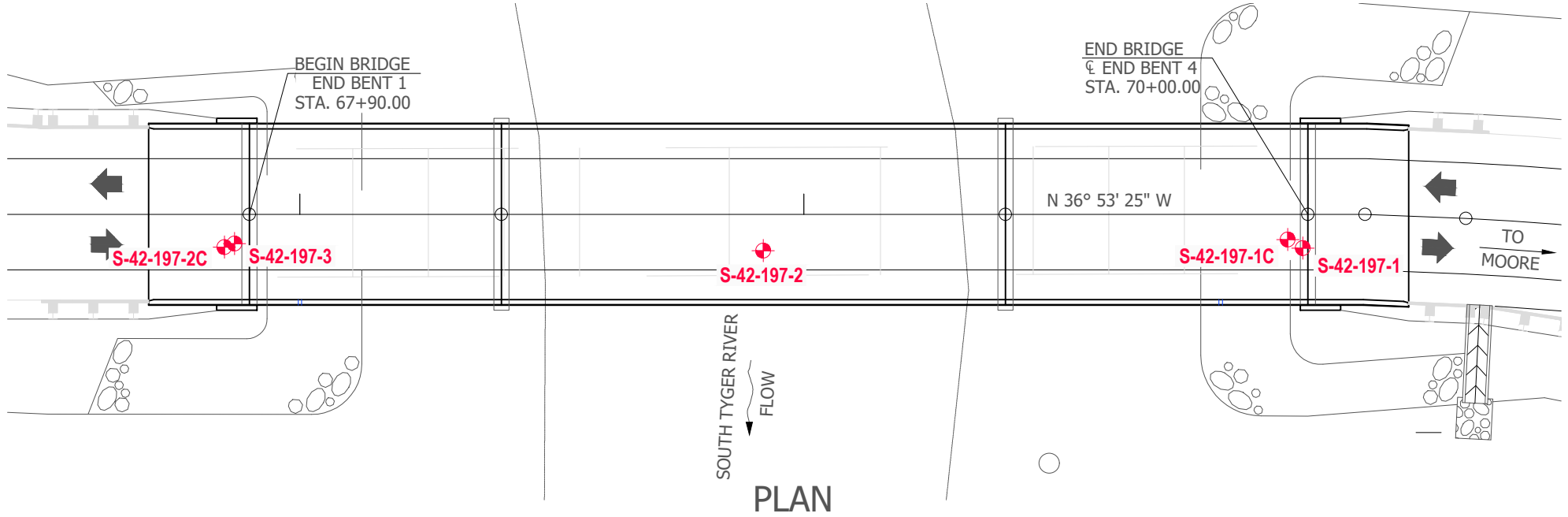


Water Level Reading at time of drilling.

Water Level Reading after drilling.



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



Project Mgr:	MM	Project No.	8623P180	 72 Pointe Circle Greenville, SC 29615 864-292-2901 864-292-6361	BORING LOCATION DIAGRAM SCDOT PROJECT ID: P041164 S-42-197 SOUTH TYGER RIVER SPARTANBURG COUNTY SOUTH CAROLINA	EXHIBIT A-3
Drawn By:	RLW	Scale:	AS SHOWN			
Checked By:	MM/MRF	File No.	8623P180 PC			
Approved By:	JNA	Date:	MARCH 2025			

Soil Testing Location Table - Exhibit A-4

S-42-197 Bridge Replacement over South Tyger River | Spartanburg County, SC

Terracon Project No.: 8623P180 | SCDOT Project ID: P041164



Test Number	Type	Test Hole Local	Northing	Easting	Latitude	Longitude	Station ¹	Offset ¹	Elevation ² (ft)	Depth (ft)
S-42-197-1	STB	End Bridge	1089159.34	1695814.47	34.82265	-82.01348	69+99	6.7-R	577.1	63.5
S-42-197-1C	CPT	End Bridge	1089156.56	1695814.53	34.82264	-82.01348	69+96	5-R	577.1	7.7
S-42-197-2	STB	Interior Bridge	1089074.61	1695878.49	34.82242	-82.01326	68+92	7.2-R	577.0	63.5
S-42-197-3	STB	Begin Bridge	1088989.81	1695940.56	34.82219	-82.01305	67+87	5.8-R	577.2	52.0
S-42-197-2C	CPT	Begin Bridge	1088988.50	1695942.42	34.82219	-82.01304	67+85	6.5-R	577.2	35.2

1. Stations and offsets are based on the state plane coordinates collected by Thomas & Hutton, and Terracon measuring from the centerline.

2. Elevations are based on NAVD 88.

3. A composite bulk sample was collected approximately 3.8 feet and 4.8 feet southeast of S-42-197-3.

Exhibit A-5: GeoScoping Form

PROJECT INFORMATION			
Project ID:	P041164	Date of Trip:	1/8/2025
County:	Spartanburg	Location:	Spartanburg
Rd/ Route:	S-42-197	Local Name:	Old Spartanburg
Attendees:	M. McKenney		Highway

EXISTING BRIDGE INFORMATION			
Bridge Length:	195 ft	Bridge Width:	27.5 ft
Superstructure Type:	Concrete framing and decking	Substructure Type:	Timber Piles
Begin Bridge Sta ¹ :	67+90	End Bridge Sta ¹ :	70+00
Begin Bridge Embankment Sta ¹ :	66+90	End Bridge Embankment Sta ¹ :	71+00
Structure Number:	05624	Posted Weight Limit:	35 tons
Crossing:	South Tyger River	Skew:	N/A
Latitude:	34.82242°	Longitude:	-82.01326°
Existing Fill Height:	approx 6 to 10 ft	Approx Existing Slope Angle:	2H:1V
1. Begin & End Bridge Embankment 100 ft down Sta. or up Sta., respectively. Sta. estimated from overlay of bridge plan provided by HNTB.			

EXISTING ROADWAY EMBANKMENT INFORMATION			
Begin Project Sta:	66+15	Begin Bridge Embankment Sta:	66+90
Accessibility Issues:	None Observed		
Ground Cover:	Asphalt pavement and grassed shoulders		
Existing Fill Height:	10 feet, sloping	Approx Existing Slope Angle:	2H:1V
Local Development:	developed - residential		
Topography:	graded slope to river		
Traffic Control Necessary:	Yes		
Surface Soils:	clayey sand	Muck:	No
Exposed Rock in Stream Bed:	No	Exposed Rock in banks:	No
Wetlands on Site:	Yes	Wetland Adjacent:	Yes
Depth FG to Water:	17 feet	Water Depth:	2 feet
Depth to Existing Ground:	approximately 19 feet at center of bridge		
Scour Condition at EB:	Critical	Scour Condition at IB:	Critical

End Bridge Embankment Sta:	71+00	End Project Sta:	71+80
Accessibility Issues:	None Observed		
Ground Cover:	Asphalt pavement and grassed shoulders		
Existing Fill Height:	6 feet, sloping	Approx Existing Slope Angle:	2H:1V
Local Development:	developed - residential		
Topography:	graded slope to river		
Traffic Control Necessary:	Yes		
Surface Soils:	silty sand	Muck:	No
Exposed Rock in Stream Bed:	No	Exposed Rock in banks:	No
Wetlands on Site:	Yes	Wetland Adjacent:	Yes
Depth FG to Water:	17 feet	Water Depth:	2 feet
Depth to Existing Ground:	approximately 19 feet at center of bridge		
Scour Condition at EB:	Critical	Scour Condition at IB:	Critical

Exhibit A-5: GeoScoping Form

UTILITIES INFORMATION	
Attached:	A waterline was observed to be attached along the southwest side of the bridge.
Above Ground:	Overhead power was observed along the southwest side of the bridge and crossing diagonally over the north end of the bridge.
Underground:	An underground gas line was observed along the southwest side of the bridge.

Comments:

Field Exploration Description Overview

The testing locations were determined by Terracon and submitted to SCDOT for approval. Terracon located the test locations in the field using handheld GPS and measurements from existing structures shown on the provided drawings. The borings were surveyed by Thomas & Hutton after testing and drilling was complete. The locations, as shown in the Exploration Plans, are shown to the scale indicated.

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

Soil Test Borings (STB)

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

- SCDOT Geotechnical Design Manual 2022
- ASTM D5783, "Standard Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geo-environmental Exploration"
- ASTM D6151, "Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling"
- ASTM D1586 "Test Method for Penetration Test and Split-Barrel Sampling of Soils"
- ASTM D4220 "Standard Practices for Preserving and Transporting Soil"
- ASTM D2113 "Standard Practice for Rock Core Drilling and Sampling of Rock for Site Exploration"
- ASTM D5079 "Standard Practices for Preserving and Transporting Rock Core Samples"

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

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

consistency (based on standard penetration resistance). The designations shown on the logs are described in the 2022 SCDOT Geotechnical Design Manual, Chapter 6.

The borings were advanced either to the planned drilling depth at which they were terminated, or to refusal of the drilling equipment. Select borings were continued below this depth using diamond bit rock coring techniques. NQ2 sized cores were recovered from the borehole. The rock recovery ratios (REC, percentage of the total core run), Rock Quality Designation (RQD, percentage of the total core run of pieces greater than 4 inches) were recorded along with a description of the rock. An explanation of the rock descriptions shown on the logs is provided in the SCDOT GDM Chapter 6. Photos of the recovered rock core specimens are provided in the Rock Core Photograph Log.

Groundwater readings were collected from the soil test borings after 24 hours if site constraints allowed the borings to stay open. If collected, water levels are indicated on the boring logs. The borings were advanced using mud rotary drilling techniques, and time-of-drilling water levels may not be reliable.

At the conclusion of the work, the boreholes were backfilled with the drill cuttings and clean sand. The upper 20 feet of the tests in the existing roadways and embankments were grouted with a cement bentonite grout. Test locations performed in existing pavements were capped with cold-patch asphalt.

Cone Penetration Test (CPT) Soundings

Cone Penetration Test soundings were conducted in accordance with ASTM D5778 *Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils*.

Downhole Shear Wave Velocity Test (DHT)

One downhole seismic test was performed in a cased borehole drilled for this project. After the test boring was completed, the boring was filled with a fluid water/cement/bentonite grout and then a threaded PVC pipe casing (capped at the bottom end) was inserted into the borehole, providing a uniform bond between the soil and pipe exterior.

The downhole seismic test consisted of placing two downhole triaxial geophones at selected depth intervals in the borehole casing. The geophone was connected to a recording device (Seismic Source Daq Link 5 Seismograph) at the surface and clamped to the side of the casing at the selected test depth. The geophones are equipped with a spring-arm that is released at the bottom of the boring. The spring expands and forces the geophone against the casing wall. The interval between each geophone and each test depth was 3 feet for the entire depth of the cased borehole. An instrumented hammer was then used to strike a steel plate with cleats at the bottom (often called a shear wave golf shoe) that penetrated the ground and prevented sliding when struck. The steel plate was oriented to generate horizontal shear waves (SH) at the surface. An additional plate was also struck to better produce compression waves. The horizontal distance was measured, and the plate was set exactly 10 feet from the

Exhibit A-6 – Subsurface Exploration Description

S-42-197 BRO South Tyger River | Spartanburg County, SC
Terracon Project No. 8623P180 | SCDOT Project ID: P041164



borehole. The recorder was set to record the arrival times of the shear waves at the geophone locations. At least 15 blows (5 in each direction on the golf shoe, and 5 on the steel plate) were struck for each test depth to electronically stack and polarize the observed data, and to increase the signal-to-noise ratio. The data was stored on computer disks for processing and computation. The geophone was raised to the next depth interval and the process was repeated.

Shear Wave Velocity Test Results shows the downhole shear wave velocity and compressive wave velocity test results. The data was evaluated using the Fixed Interval method. S-wave arrival times using the Interval method were picked based on the onset of the signal (first break) as observed in the software package TomTime by GeoTom.

SOIL DESCRIPTION TERMS

Relative Density/Consistency Terms

<u>Relative Density</u> ¹			<u>Consistency</u> 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 and less	Very Soft	0.25 and less	2 and less
Loose	16 to 35%	5 to 10	Soft	0.26 to 0.50	3 to 4
Medium Dense	36 to 65%	11 to 30	Firm	0.51 to 1.00	5 to 8
Dense	66 to 85%	31 to 50	Stiff	1.01 to 2.00	9 to 15
Very Dense	86 to 100%	51 and more	Very Stiff	2.01 to 4.00	16 to 30
			Hard	4.01 and more	31 and more

Moisture Condition

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

Color

Describe the sample color while sample is still moist.

Angularity¹

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

HCl Reaction³

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

Cementation³

<u>Descriptive Term</u>	<u>Criteria</u>
Weakly Cemented	Crumbles or breaks with handling or little finger pressure
Cemented	Crumbles or breaks with considerable finger pressure
Strongly Cemented	Will not crumble or break with finger pressure

Particle-Size Range¹

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

Primary Soil Type^{1, 2}

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

USCS Soil Designation

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

AASHTO Soil Designation

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

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

DESCRIPTION OF ROCK PROPERTIES

WEATHERING

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

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

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

Joint, Bedding, and Foliation Spacing in Rock^a

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

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

Rock Quality Designation (RQD)^a

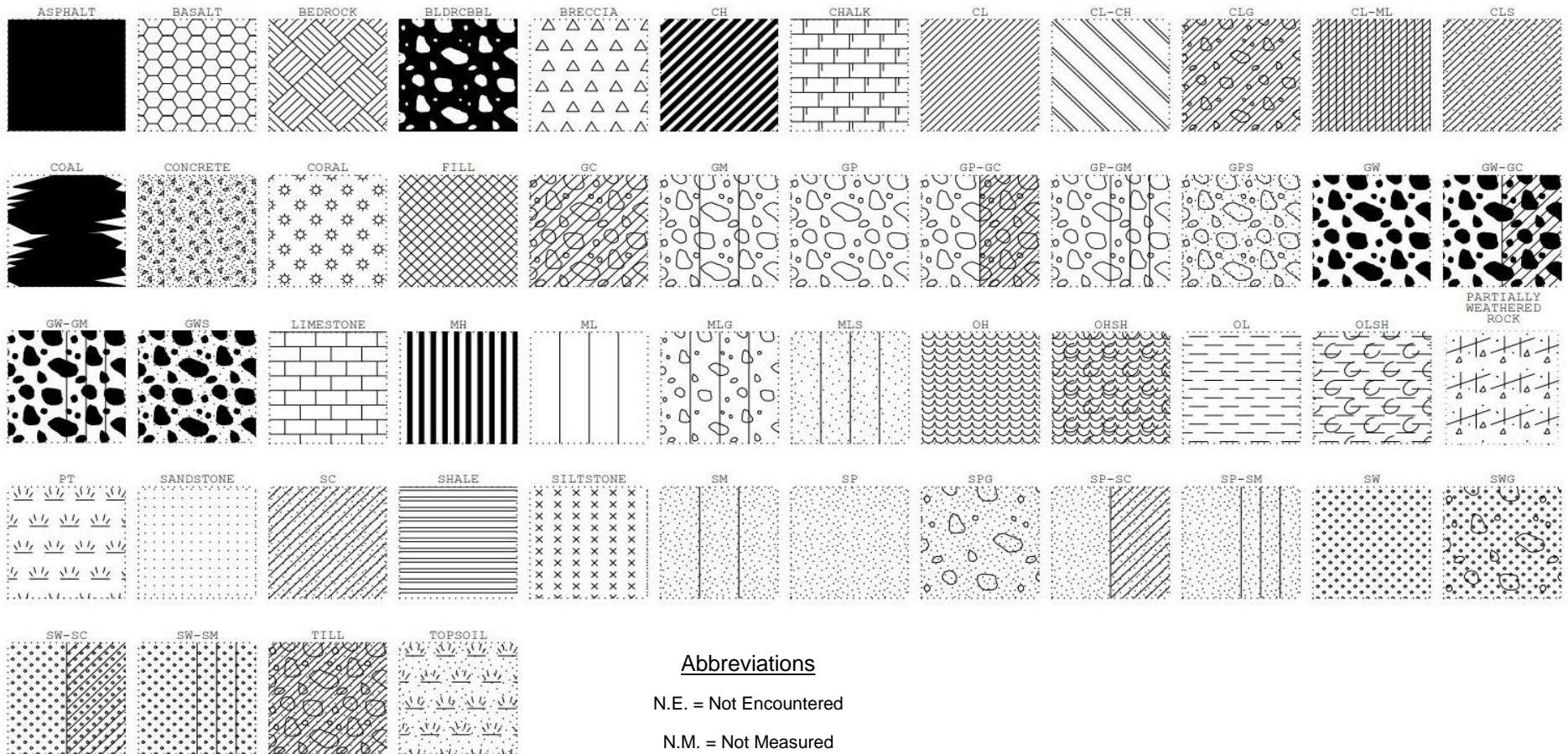
RQD, as a percentage	Diagnostic Description
Exceeding 90	Excellent
90 – 75	Good
75 – 50	Fair
50 – 25	Poor
Less than 25	Very poor

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

Joint Openness Descriptors

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

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



Project Manager:	MEM
Drawn by:	KJZ
Checked by:	SG
Approved by:	DJC

Project No.	8623P180
Scale:	N.T.S.
File Name:	Soil – Rock – Log
Date:	Jul 2023



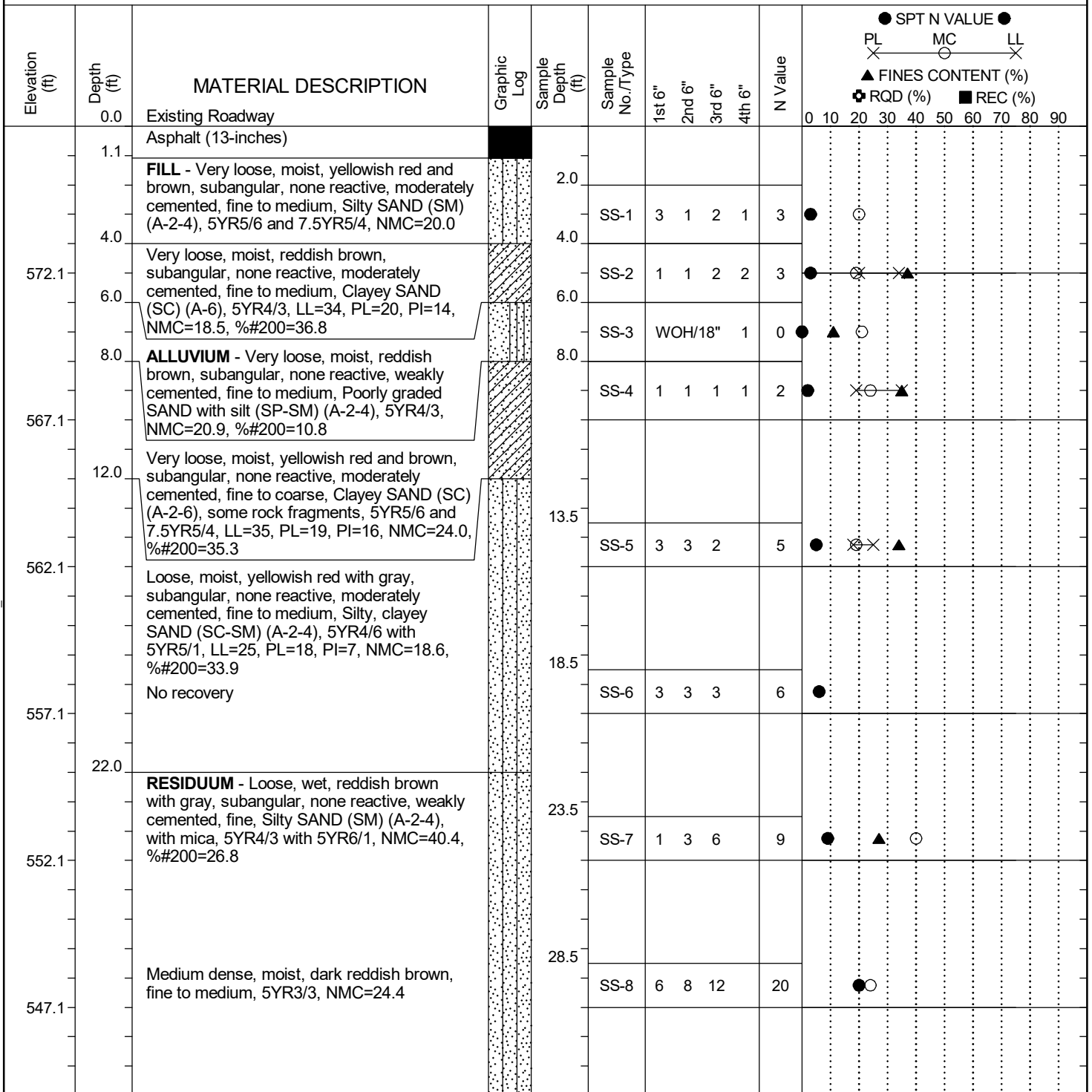
72 Pointe Circle
PH. (864) 292-2901
Greenville, SC 29615
FAX. (864) 292-6361

SOIL AND ROCK SYMBOLS

Exhibit A-8

SCDOT Soil Test Log

Project ID: P041164				County: Spartanburg		Boring No.: S-42-197-1		
Site Description:		S-42-197 (Old Spartanburg Highway) BRO South Tyger River					Route: S-42-197	
Eng./Geo.: M. McKenney		Boring Location: 69+99		Offset: 6.7R		Alignment: Existing		
Elev.: 577.12		Latitude: 34.82265		Longitude: -82.01348		Date Started: 1/8/2025		
Total Depth: 63.5 ft		Soil Depth: 38.5 ft		Core Depth: 25 ft		Date Completed: 1/8/2025		
Bore Hole Diameter (in): 4		Sampler Configuration		Liner Required: Y Ⓝ		Liner Used: Y Ⓝ		
Drill Machine: DR#1327		Drill Method: RW/RC		Hammer Type: Automatic		Energy Ratio: 92.6%		
Core Size: NQ2		Driller: B. Burnette		Groundwater: TOB N.M.		24HR N.M.		



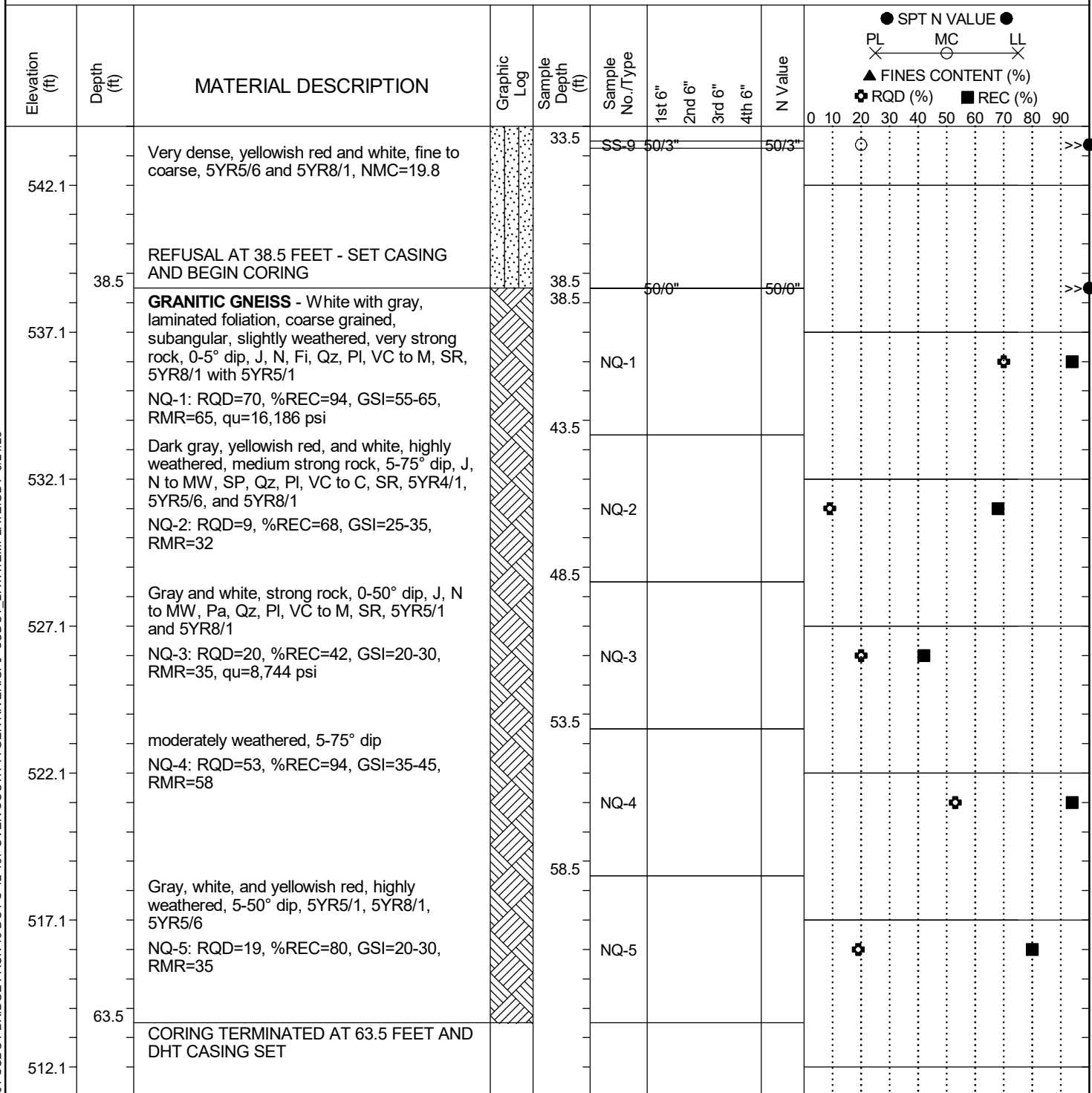
LEGEND

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

SCDOT Soil Test Log

Project ID:	P041164	County:	Spartanburg	Boring No.:	S-42-197-1
Site Description:	S-42-197 (Old Spartanburg Highway) BRO South Tyger River			Route:	S-42-197
Eng./Geo.:	M. McKenney	Boring Location:	69+99	Offset:	6.7R
Elev.:	577.12	Latitude:	34.82265	Longitude:	-82.01348
Date Started:	1/8/2025				
Total Depth:	63.5 ft	Soil Depth:	38.5 ft	Core Depth:	25 ft
Date Completed:	1/8/2025				
Bore Hole Diameter (in):	4	Sampler Configuration		Liner Required:	Y (N)
Liner Used:	Y (N)				
Drill Machine:	DR#1327	Drill Method:	RW/RC	Hammer Type:	Automatic
Energy Ratio:	92.6%				
Core Size:	NQ2	Driller:	B. Burnette	Groundwater:	TOB N.M.
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 8623P180T SCDOT BRIDGE PACK 19 DOT S-42-197 OVER SOUTH TYGER RIVER.GPJ SCDOT_DATATEMPLATE.GDT 3/21/25

SCDOT Soil Test Log

Project ID:	P041164	County:	Spartanburg	Boring No.:	S-42-197-2
Site Description:	S-42-197 (Old Spartanburg Highway) BRO South Tyger River			Route:	S-42-197
Eng./Geo.:	M. McKenney	Boring Location:	68+92	Offset:	7.2R
Elev.:	577.02	Latitude:	34.82242	Longitude:	-82.01326
Date Started:	1/9/2025				
Total Depth:	63.5 ft	Soil Depth:	23.5 ft	Core Depth:	20 ft
Date Completed:	1/9/2025				
Bore Hole Diameter (in):	4	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	DR#1327	Drill Method:	RW/RC	Hammer Type:	Automatic
Energy Ratio:	92.6%				
Core Size:	NQ2	Driller:	B. Burnette	Groundwater:	TOB 17 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 (%)
	0.0	Existing Roadway									0 10 20 30 40 50 60 70 80 90
	0.1	Asphalt (1.5-inches)									
	0.5	Concrete (5-inches)									
		Air Gap (16.5-feet)									
572.0											
567.0											
562.0											
557.0	20.0	Mud line									
		ALLUVIUM - No recovery		21.0	SS-1	3	WOH/18"			0 ●	
		Very loose, moist, reddish brown, subangular, none reactive, weakly cemented, fine to coarse, Poorly graded SAND (SP) (A-3), 5YR5/4, NMC=29.4, %200=3.8		23.0	SS-2	3	WOH 1	1		1 ▲	○
552.0				25.0	SS-3	1	WOH/18"			0 ●	
		reddish brown and white, 5YR4/4 and 5YR8/1		27.0	SS-4	WOH/12"	1	2		1 ●	
547.0	29.0	RESIDUUM - Medium dense, dry, yellowish red and reddish brown, subangular, none reactive, weakly cemented, fine to medium, Silty SAND (SM) (A-2-4), 5YR4/6 and 5YR4/3, NMC=13.1, %200=20.8		29.0	SS-5	5	11	15	20	26	○ ▲ ●

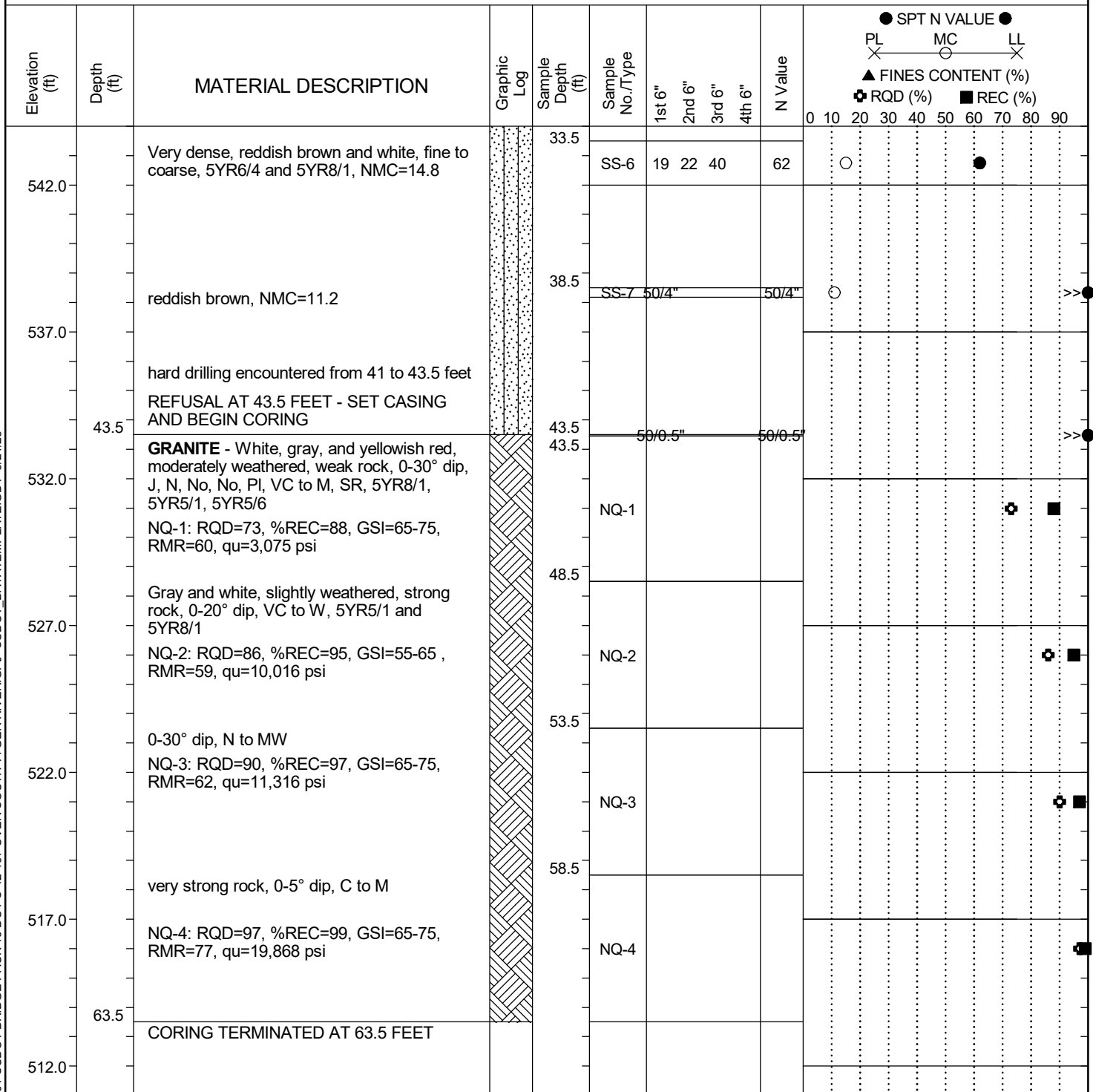
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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving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

SCDOT Soil Test Log

Project ID:	P041164	County:	Spartanburg	Boring No.:	S-42-197-2
Site Description:	S-42-197 (Old Spartanburg Highway) BRO South Tyger River			Route:	S-42-197
Eng./Geo.:	M. McKenney	Boring Location:	68+92	Offset:	7.2R
Elev.:	577.02	Latitude:	34.82242	Longitude:	-82.01326
Date Started:	1/9/2025				
Total Depth:	63.5 ft	Soil Depth:	23.5 ft	Core Depth:	20 ft
Date Completed:	1/9/2025				
Bore Hole Diameter (in):	4	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	DR#1327	Drill Method:	RW/RC	Hammer Type:	Automatic
Energy Ratio:	92.6%				
Core Size:	NQ2	Driller:	B. Burnette	Groundwater:	TOB 17 ft
24HR:	N.M.				



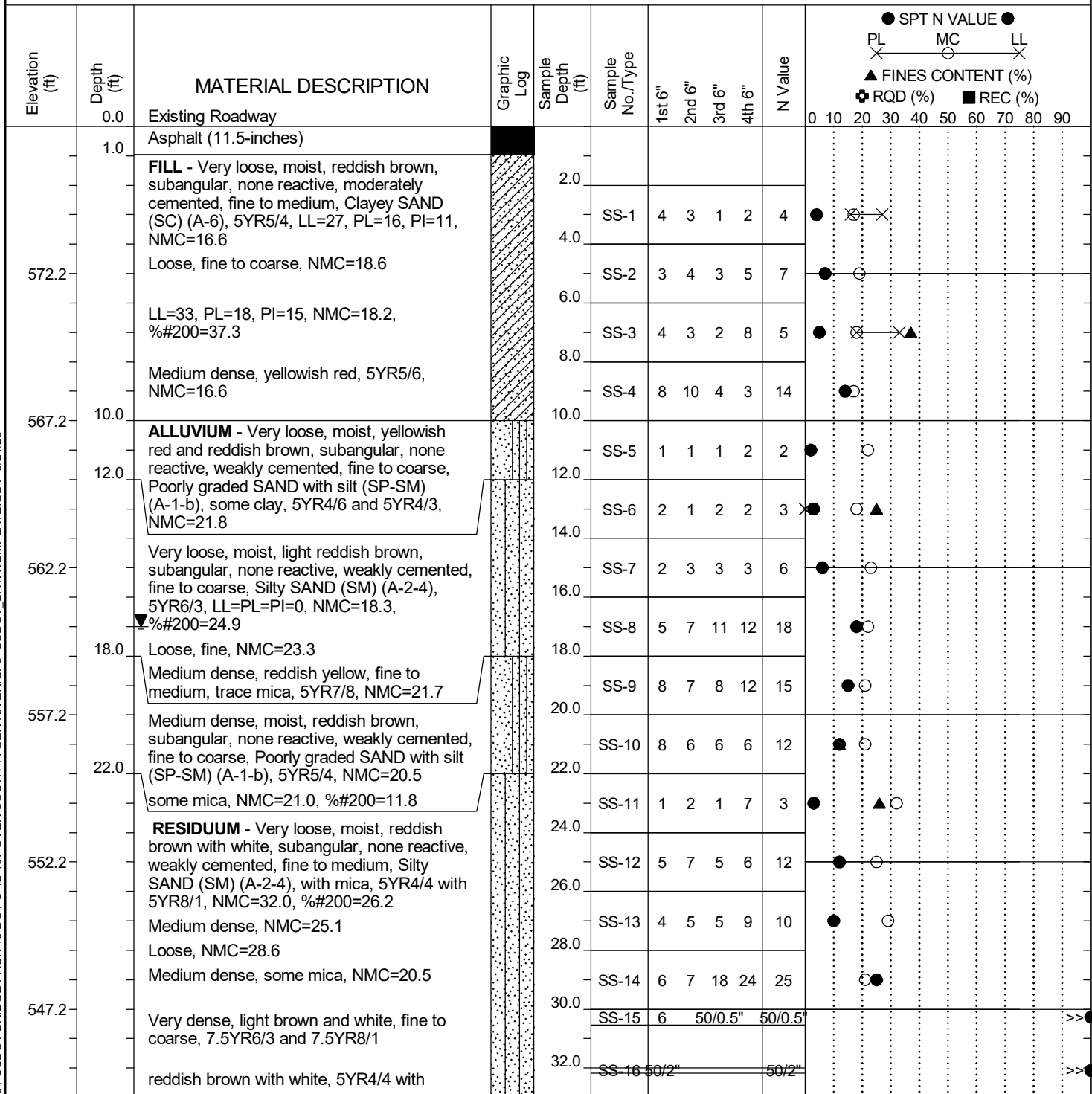
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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving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

SC.DOT 8623P180T SCDOT BRIDGE PACK 19 DOT S-42-197 OVER SOUTH TYGER RIVER.GPJ SCDOT_DATATEMPLATE.GDT 3/21/25

SCDOT Soil Test Log

Project ID:	P041164	County:	Spartanburg	Boring No.:	S-42-197-3
Site Description:	S-42-197 (Old Spartanburg Highway) BRO South Tyger River			Route:	S-42-197
Eng./Geo.:	M. McKenney	Boring Location:	67+87	Offset:	5.8R
Elev.:	577.21	Latitude:	34.82219	Longitude:	-82.01305
Date Started:	1/8/2025				
Total Depth:	52 ft	Soil Depth:	42 ft	Core Depth:	10 ft
Date Completed:	1/9/2025				
Bore Hole Diameter (in):	4	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	DR#554	Drill Method:	RW/RC	Hammer Type:	Automatic
Energy Ratio:	91.3%				
Core Size:	NQ2	Driller:	G. Robinson	Groundwater:	TOB N.M.
24HR	17 (2 hr)				



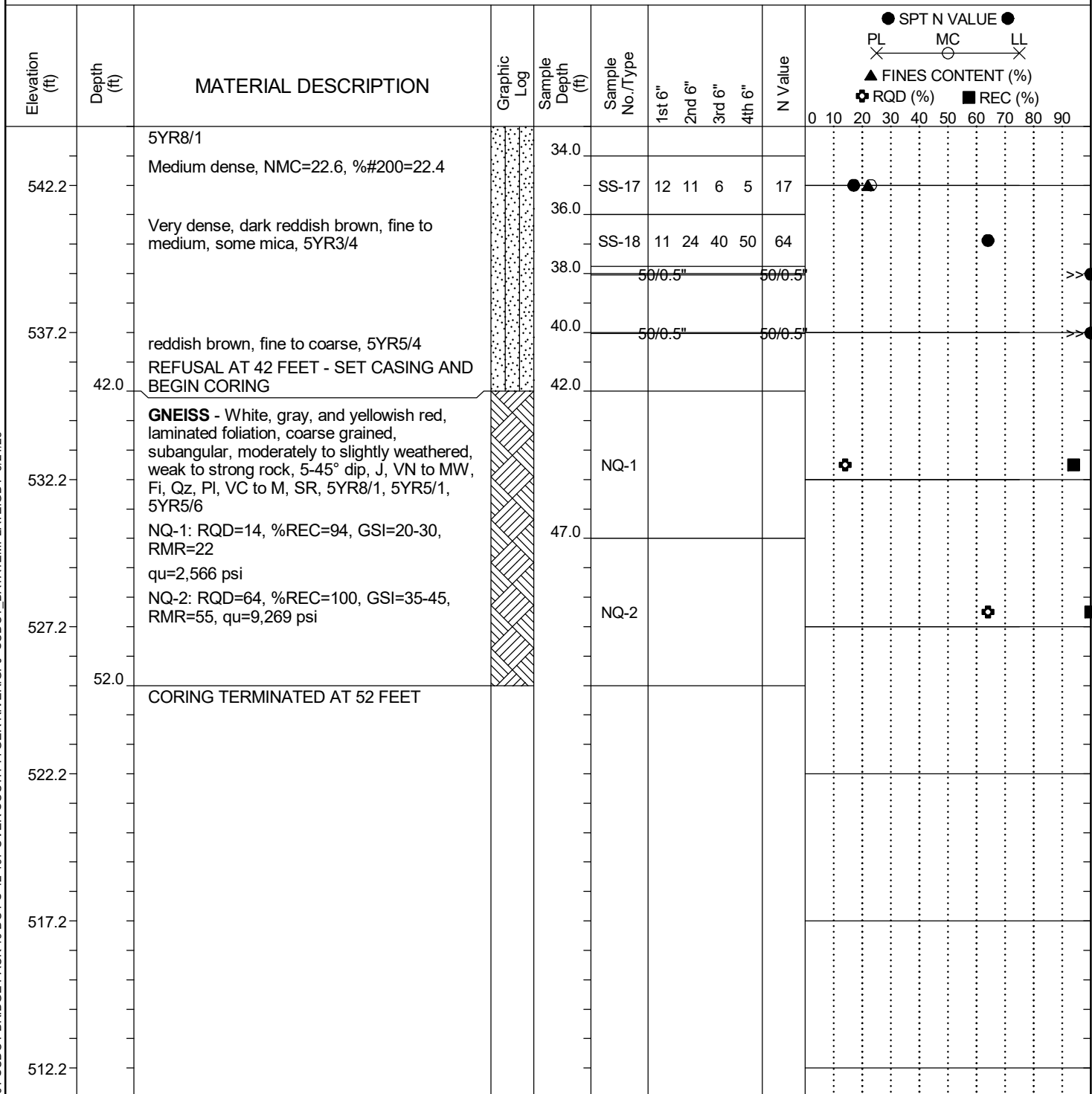
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SAMPLER TYPE		DRILLING METHOD	
SS	- Split Spoon	HSA	- Hollow Stem Auger
UD	- Undisturbed Sample	CFA	- Continuous Flight Augers
AWG	- Rock Core, 1-1/8"	DC	- Driving Casing
NQ	- Rock Core, 1-7/8"	RW	- Rotary Wash
CU	- Cuttings	RC	- Rock Core
CT	- Continuous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

SCDOT Soil Test Log

Project ID: P041164				County: Spartanburg		Boring No.: S-42-197-3		
Site Description:		S-42-197 (Old Spartanburg Highway) BRO South Tyger River					Route: S-42-197	
Eng./Geo.: M. McKenney		Boring Location: 67+87		Offset: 5.8R		Alignment: Existing		
Elev.: 577.21	Latitude: 34.82219	Longitude: -82.01305	Date Started: 1/8/2025					
Total Depth: 52 ft	Soil Depth: 42 ft	Core Depth: 10 ft	Date Completed: 1/9/2025					
Bore Hole Diameter (in): 4		Sampler Configuration		Liner Required: Y (N)		Liner Used: Y (N)		
Drill Machine: DR#554		Drill Method: RW/RC	Hammer Type: Automatic		Energy Ratio: 91.3%			
Core Size: NQ2	Driller: G. Robinson	Groundwater: TOB N.M.		24HR: 17 (2 hr)				



LEGEND

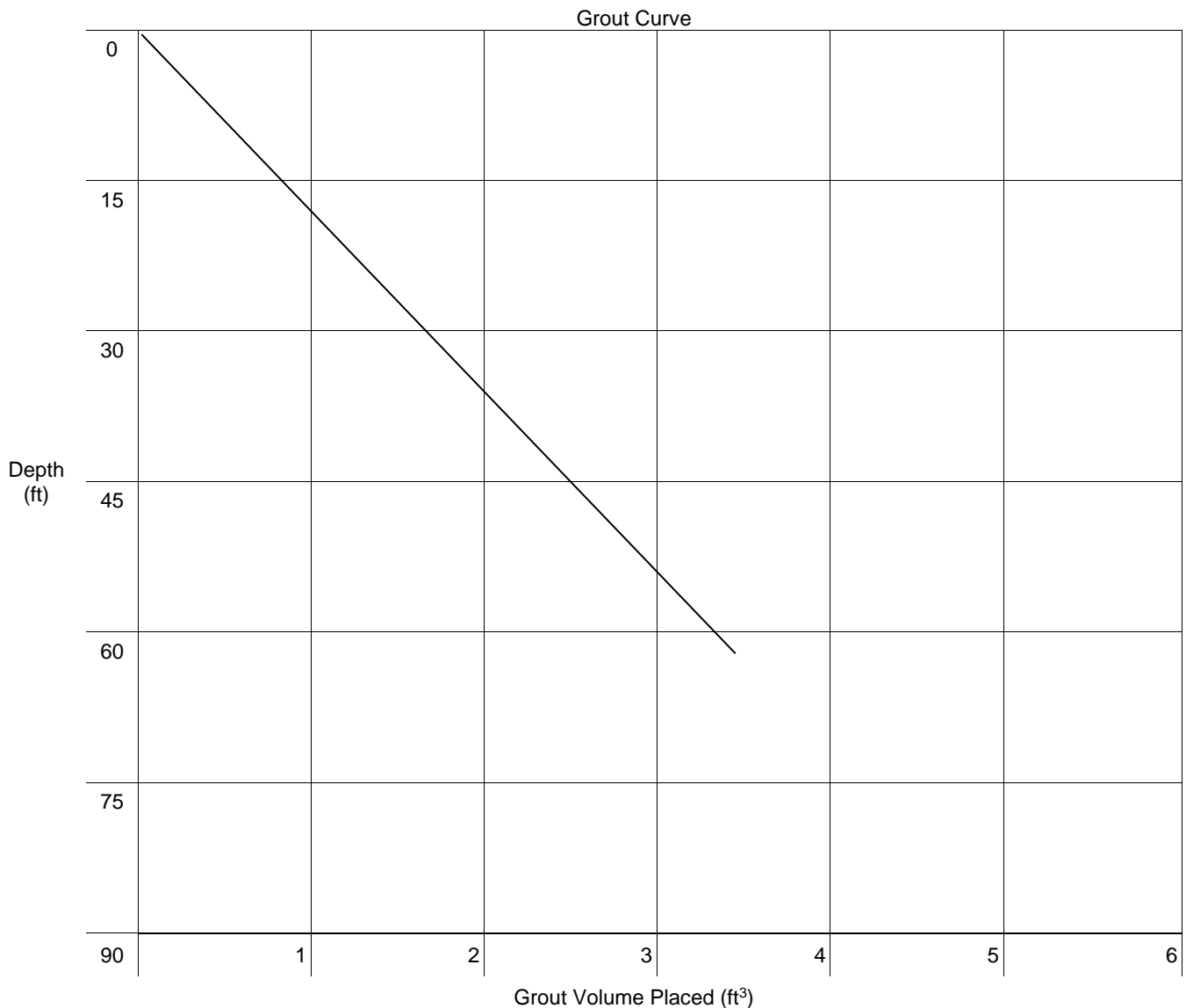
SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SC.DOT 8623P180T SCDOT BRIDGE PACK 19 DOT S-42-197 OVER SOUTH TYGER RIVER.GPJ SCDOT_DATATEMPLATE.GDT 3/21/25



Exhibit A-10: GROUT LOG OF TEST HOLES FOR GEOTECHNICAL ON-CALL

Project Name:	S-42-197 BRO South Tyger River		Test Hole No.:	S-42-197-1	
Project ID:	P041164		Station:	69+99	
Consultant Firm:	Terracon Consultants, Inc.	Date	1/9/25	Offset:	6.7R
Grouted By:	Burnette				
Notes:	Mix design: 1 pound cement mix, 1 pound bentonite, 6 pounds water				

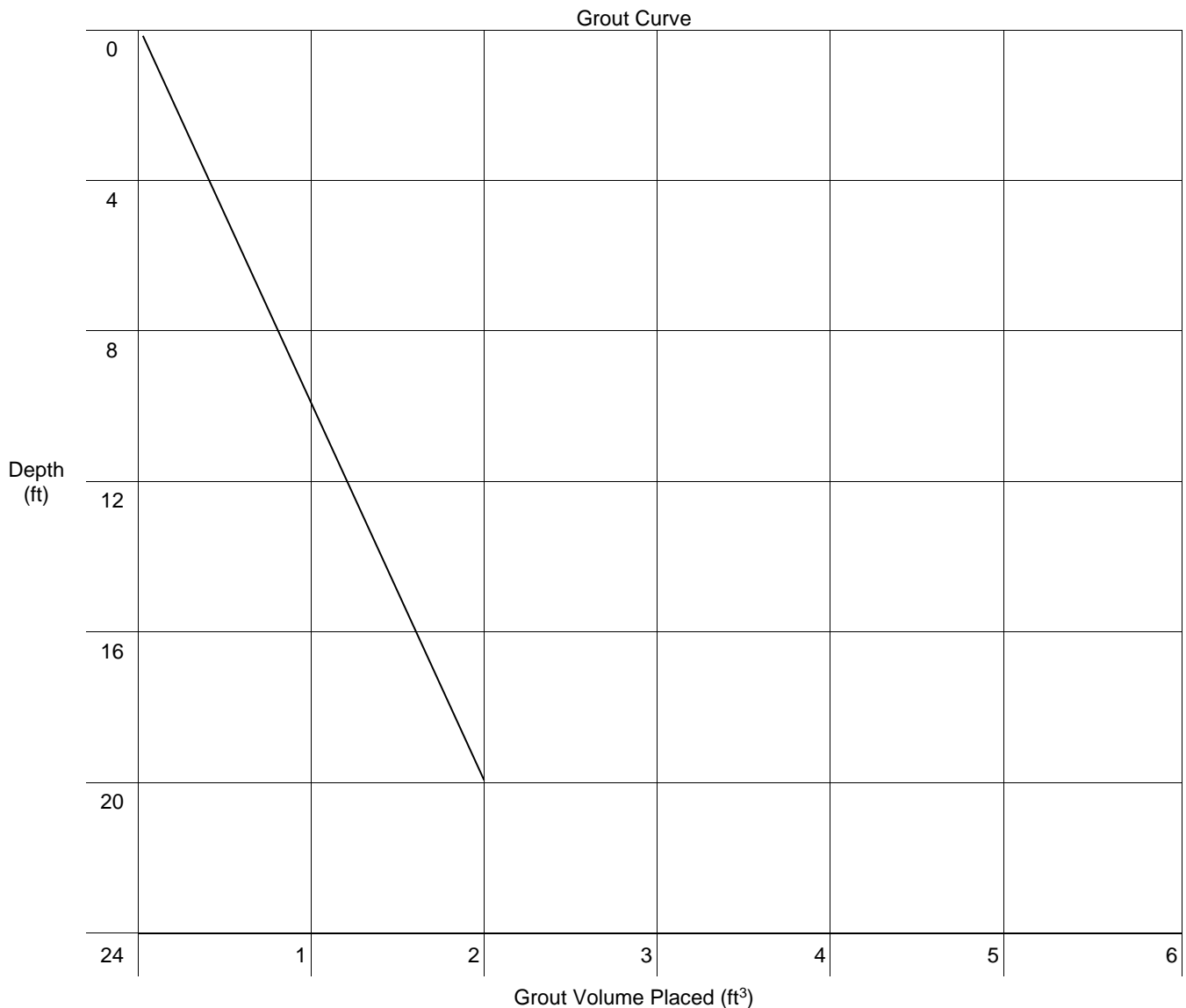


Number of Bags On-Site	20	ea.
Depth of Test Hole Grouted	63	ft.
Diameter of Test Hole	0.33	ft.
Area of Test Hole	0.09	ft²
Volume of Test Hole	5.4	ft³
Volume of Casing (If applicable)	2.1	ft³
Theoretical Volume of Test Hole	3.3	ft³
Number of Bags Used	6	ea.
Volume Placed	3.5	ft³



Exhibit A-10: GROUT LOG OF TEST HOLES FOR GEOTECHNICAL ON-CALL

Project Name:	S-42-197 BRO South Tyger River		Test Hole No.:	S-42-197-3
Project ID:	P041164		Station:	67+87
Consultant Firm:	Terracon Consultants, Inc.	Date	1/9/2025	Offset:
Grouted By:	Burnette			5.8R
Notes:	Mix design: 1 pound cement mix, 1 pound bentonite, 6 pounds water			

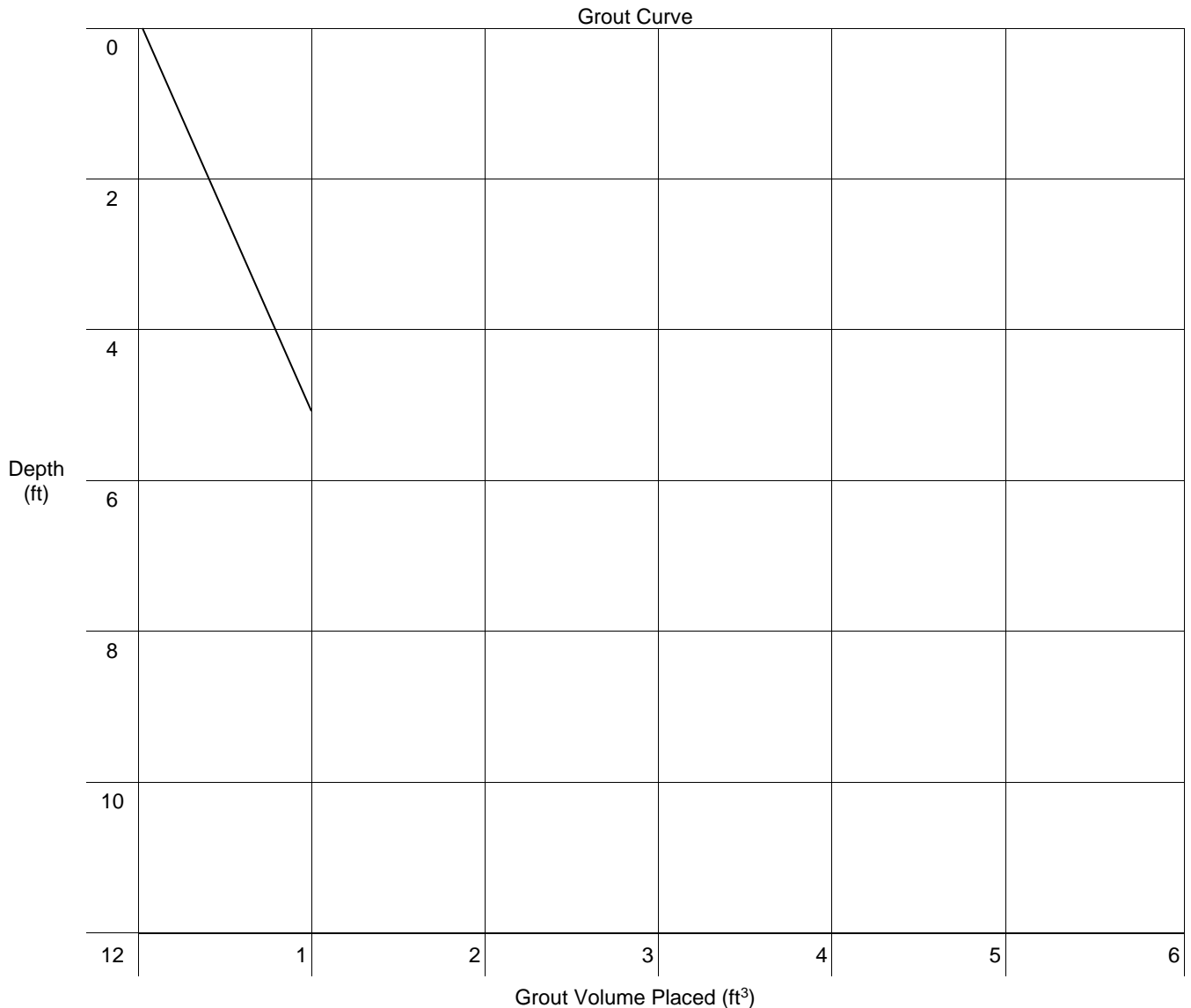


Number of Bags On-Site	20	ea.
Depth of Test Hole Grouted	20	ft.
Diameter of Test Hole	0.33	ft.
Area of Test Hole	0.09	ft²
Volume of Test Hole	1.74	ft³
Volume of Casing (If applicable)	-	ft³
Theoretical Volume of Test Hole	1.74	ft³
Number of Bags Used	2.5	ea.
Volume Placed	2	ft³



Exhibit A-10: GROUT LOG OF TEST HOLES FOR GEOTECHNICAL ON-CALL

Project Name:	S-42-197 BRO South Tyger River		Test Hole No.:	S-42-197-3
Project ID:	P041164		Station:	Bulk 1
Consultant Firm:	Terracon Consultants, Inc.		Offset:	67+83
Grouted By:	Burnette	Date	1/9/2025	6R
Notes:	Mix design: 1 pound cement mix, 1 pound bentonite, 6 pounds water			

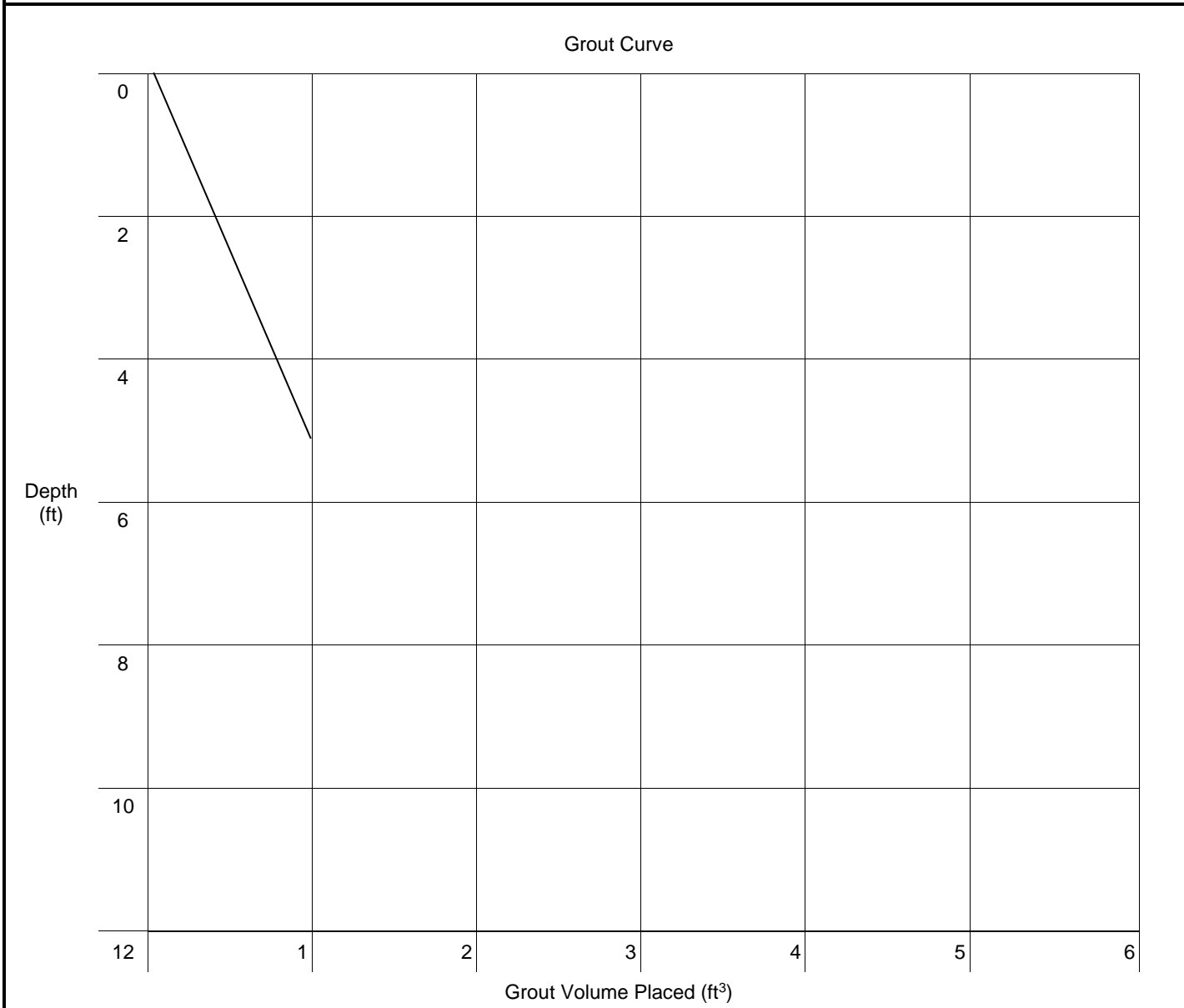


Number of Bags On-Site	20	ea.
Depth of Test Hole Grouted	5	ft.
Diameter of Test Hole	0.5	ft.
Area of Test Hole	0.20	ft²
Volume of Test Hole	1.0	ft³
Volume of Casing (If applicable)	-	ft³
Theoretical Volume of Test Hole	1.0	ft³
Number of Bags Used	2	ea.
Volume Placed	1.0	ft³



Exhibit A-10: GROUT LOG OF TEST HOLES FOR GEOTECHNICAL ON-CALL

Project Name:	S-42-197 BRO South Tyger River	Test Hole No.:	S-42-197-3
Project ID:	P041164	Station:	Bulk 2
Consultant Firm:	Terracon Consultants, Inc.	Offset:	67+82
Grouted By:	Burnette	Date	1/9/2025
Notes:	Mix design: 1 pound cement mix, 1 pound bentonite, 6 pounds water		



Number of Bags On-Site	20	ea.
Depth of Test Hole Grouted	5	ft.
Diameter of Test Hole	0.5	ft.
Area of Test Hole	0.20	ft ²
Volume of Test Hole	1.0	ft ³
Volume of Casing (If applicable)	-	ft ³
Theoretical Volume of Test Hole	1.0	ft ³
Number of Bags Used	2	ea.
Volume Placed	1.0	ft ³

Rock Core Photograph Logs – Exhibit A-11

S-42-197 BRO over South Tyger River | Spartanburg County, SC

Terracon Project No. 8623P180 | SCDOT Project ID: P041164



S-42-197-1, NQ-1 and NQ-2 (38.5 to 48.5 feet)



S-42-197-1, NQ-3 and NQ-4 (48.5 to 58.5 feet)

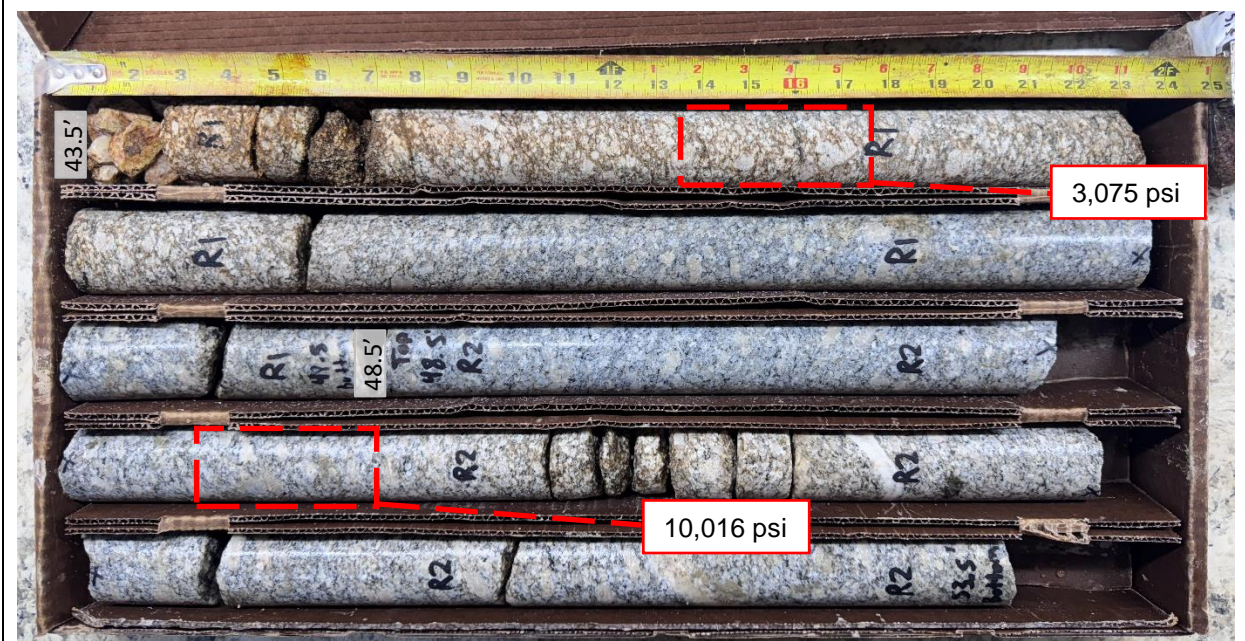
Rock Core Photograph Logs – Exhibit A-11

S-42-197 BRO over South Tyger River | Spartanburg County, SC

Terracon Project No. 8623P180 | SCDOT Project ID: P041164



S-42-197-1, NQ-5 (58.5 to 63.5 feet)



S-42-197-2, NQ-1 and NQ-2 (43.5 to 53.5 feet)

Rock Core Photograph Logs – Exhibit A-11

S-42-197 BRO over South Tyger River | Spartanburg County, SC
Terracon Project No. 8623P180 | SCDOT Project ID: P041164

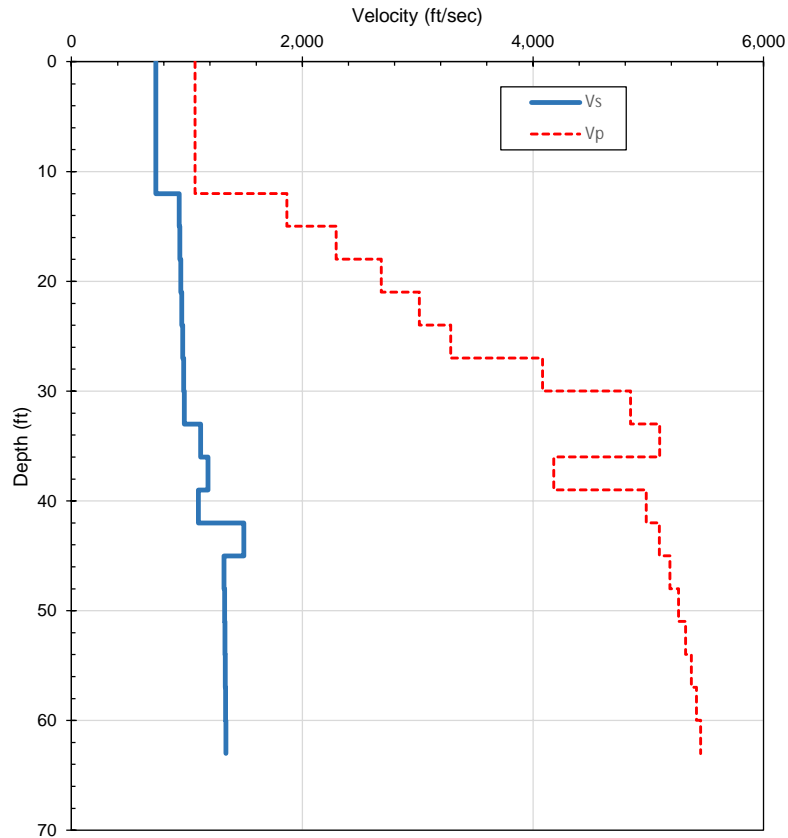


S-42-197-2, NQ-3 and NQ-4 (53.5 to 63.5 feet)



S-42-197-3, NQ-1 and NQ-2 (42.0 to 52.0 feet)

Downhole Seismic Velocity Fixed Interval Method



Depth (ft)	Vp (ft/sec)	Vs (ft/sec)	Δi (ft)	Δt (sec)	Est. In-Situ Unit Wt (pcf)
12	1071	732	12	0.01639	105
15	1868	933	3	0.00322	
18	2295	937	3	0.00320	
21	2685	946	3	0.00317	
24	3017	955	3	0.00314	
27	3289	963	3	0.00312	125
30	4083	970	3	0.00309	
33	4846	976	3	0.00307	
36	5100	1117	3	0.00269	130
39	4182	1183	3	0.00254	
42	4983	1098	3	0.00273	165
45	5096	1495	3	0.00201	
48	5188	1322	3	0.00227	
51	5263	1326	3	0.00226	
54	5325	1330	3	0.00226	
57	5375	1333	3	0.00225	
60	5418	1336	3	0.00225	
63	5453	1338	3	0.00224	
Unit Weight of Soil estimated from SPT results					
Unit Weight of Rock based on average results from compression tests					
Sum of Data Over Profile			63	0.06189	
Weighted Average Shear Wave Velocity Over Profile					
1,018 ft/sec					

Project Mgr:	MM
Prepared by:	MM
Checked by:	JA
Approved by:	JA

Project No.	8623P180
Scale:	NA
Date:	2/25/2025



Terracon
Consulting Engineers and Scientists

72 Pointe Circle
Ph: (864) 292-2901

Greenville, South Carolina
Fax: (864) 292-6361

GEOPHYSICAL TESTING RESULTS	
DOWNHOLE SEISMIC TEST	
S-42-197 (Old Spartanburg Hwy) Bridge Replacement over South Tyger River	
SPARTANBURG COUNTY, SOUTH CAROLINA	
P041164	

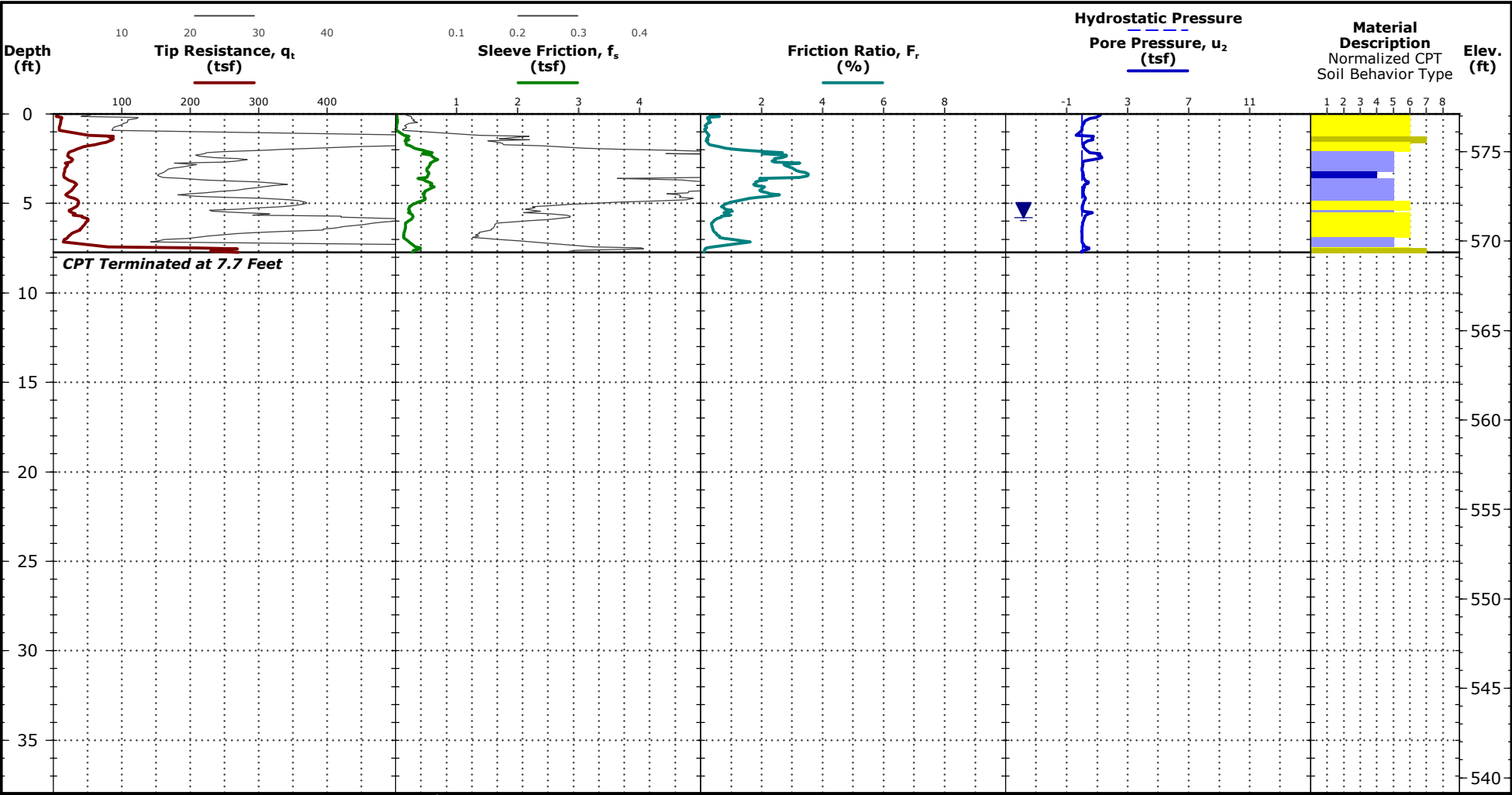
TEST NO. S-42-197-1
EXHIBIT A-12

CPT Sounding ID S-42-197-1C

Elevation: 577.1 (ft)
Elevation Reference: Elevations were provided by others.

Latitude: 34.822643° Longitude: -82.013476°
North: 1089156.5568 East: 1695814.5332
Station: 69+96 Offset: 5R

CPT Started: 1/17/2025
CPT Completed: 1/17/2025



See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data, if any.
See [Supporting Information](#) for explanation of symbols and abbreviations.

Notes

Test Location: See [Exploration Plan](#)

CPT Equipment

CPT Rig: CR#CPT03
Operator: AM/LB
CPT sensor calibration reports available upon request
Probe No. 5851 with net area ratio of .86
 U_2 pore pressure transducer location
Manufactured by Geoprobe Systems- Calibrated 2/16/2024
Tip and sleeve areas of 10 cm² and 150 cm²
Ring friction reducer with O.D. of 2 in

Water Level Observation

▼ 5.8 ft estimated water depth
(used in normalizations and correlations)

Normalized Soil Behavior Type
(Robertson 1990)

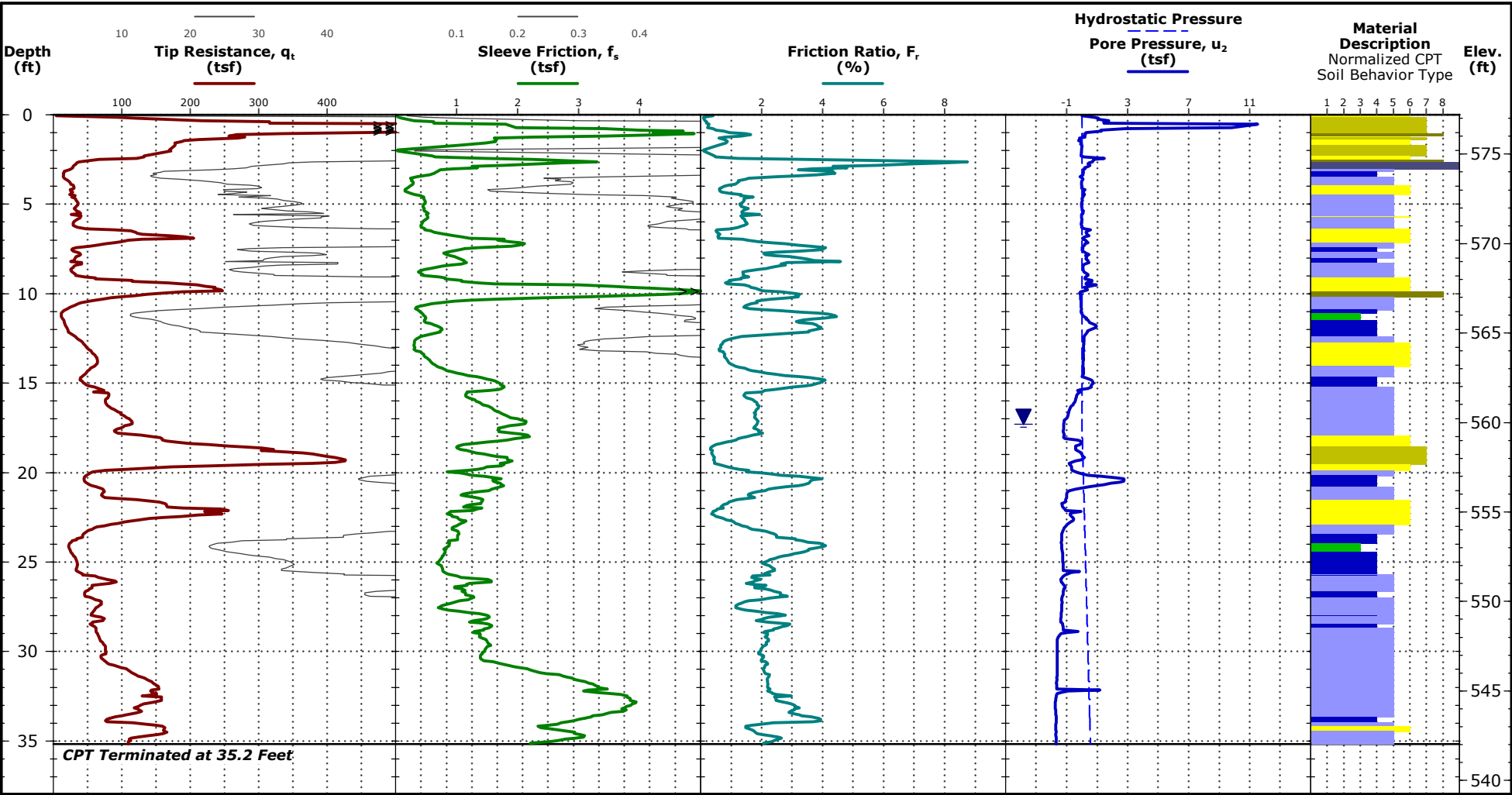
- 1 Sensitive, fine grained
- 2 Organic soils - clay
- 3 Clay - silty clay to clay
- 4 Silt mixtures - clayey silt to silty clay
- 5 Sand mixtures - silty sand to sandy clay
- 6 Sands - clean sand to silty sand
- 7 Gravely sand to dense sand
- 8 Very stiff sand to clayey sand
- 9 Very stiff fine grained

CPT Sounding ID S-42-197-2C

Terracon
72 Pointe Cir
Greenville, SC
CPT Started: 1/17/2025
CPT Completed: 1/17/2025

Elevation: 577.2 (ft)
Elevation Reference: Elevations were provided by others.

Latitude: 34.822185° Longitude: -82.013045°
North: 1088988.5038 East: 1695942.4217
Station: 67+85 Offset: 6.5R



See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data, if any.
See [Supporting Information](#) for explanation of symbols and abbreviations.

Notes

Test Location: See [Exploration Plan](#)

CPT Equipment

CPT Rig: CR#CPT03
Operator: AM/LB
CPT sensor calibration reports available upon request
Probe No. 5851 with net area ratio of .86
 u_2 pore pressure transducer location
Manufactured by Geoprobe Systems- Calibrated 2/16/2024
Tip and sleeve areas of 10 cm² and 150 cm²
Ring friction reducer with O.D. of 2 in

Water Level Observation

▼ 17.3 ft estimated water depth
(used in normalizations and correlations)

Normalized Soil Behavior Type
(Robertson 1990)

- 1 Sensitive, fine grained
- 2 Organic soils - clay
- 3 Clay - silty clay to clay
- 4 Silt mixtures - clayey silt to silty clay
- 5 Sand mixtures - silty sand to sandy clay
- 6 Sands - clean sand to silty sand
- 7 Gravely sand to dense sand
- 8 Very stiff sand to clayey sand
- 9 Very stiff fine grained

Appendix B – Laboratory Testing

S-42-197 BRO South Tyger River | Spartanburg County, SC
Terracon Project No. 8623P180 | SCDOT Project ID: P041164



Appendix B

Laboratory Testing

Exhibit B-1 – Laboratory Testing Description
Summary of Laboratory Data (2 Pages)
Laboratory Data Sheets (29 Pages)

Note: All exhibits are one page unless noted above.

Exhibit B-1 – Laboratory Testing Description

S-42-197 BRO South Tyger River | Spartanburg County, SC
Terracon Project No. 8623P180 | SCDOT Project ID: P041164



Laboratory Testing Description

The samples collected during the field exploration were taken to our laboratory for additional testing. The laboratory testing scope was developed by the SCDOT and laboratory assignment was performed by Terracon. The laboratory tests were conducted on selected soil samples from the borings and the bulk sample locations. The test results are presented in this appendix.

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

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

■ Moisture Content	AASHTO T265/(ASTM D2216)
■ Atterberg Limits	AASHTO T89/T90(ASTM D4318)
■ Proctor (Standard effort)	AASHTO T99/ (ASTM D698)
■ Triaxial Shear CU w/ PP	AASHTO T297/(ASTM D4767)
■ Grain Size Distribution	ASTM D6913
■ Hydrometer	ASTM D7928
■ Compressive Strength of Rock Cores	ASTM D7012
■ Corrosion Series	AASHTO D422
	AASHTO T289/ASTM G51
	AASHTO T290/ASTM C1580
	AASHTO T291

Summary of Laboratory Results

Boring ID	Depth (Ft.)	Soil Classification USCS & AASHTO	Liquid Limit	Plastic Limit	Plasticity Index	% Gravel	% Sand	% Fines	% Silt	% Clay	Water Content (%)	Proctor Dry Density (pcf)/Opt. Moisture (%)
S-42-197-1	2-4	SILTY SAND(SM) / A-2-4 **									20.0	
S-42-197-1	4-6	CLAYEY SAND(SC) / A-6 (1)	34	20	14	0.1	63.2	36.8			18.5	
S-42-197-1	6-8	POORLY GRADED SAND WITH SILT(SP-SM) / A-2-4 **				0.0	89.2	10.8			20.9	
S-42-197-1	8-10	CLAYEY SAND(SC) / A-2-6 (1)	35	19	16	14.1	50.6	35.3	12.6	22.7	24.0	
S-42-197-1	13.5-15	SILTY, CLAYEY SAND(SC-SM) / A-2-4 (0)	25	18	7	2.7	63.4	33.9	15.4	18.5	18.6	
S-42-197-1	23.5-25	SILTY SAND(SM) / A-2-4 **				0.0	73.2	26.8			40.4	
S-42-197-1	28.5-30	SILTY SAND(SM) / A-2-4 **									24.4	
S-42-197-1	33.5-33.75	SILTY SAND(SM) / A-2-4 **									19.8	
S-42-197-2	23-25	POORLY GRADED SAND(SP) / A-3 **				0.2	96.1	3.8	1.3	2.4	29.4	
S-42-197-2	29-31	SILTY SAND(SM) / A-2-4 **				2.1	77.2	20.8			13.1	
S-42-197-2	33.5-35	SILTY SAND(SM) / A-2-4 **									14.8	
S-42-197-2	38.5-38.83	SILTY SAND(SM) / A-2-4 **									11.2	
S-42-197-3	2-4	CLAYEY SAND(SC) / A-6 **	27	16	11						16.6	
S-42-197-3	4-6	CLAYEY SAND(SC) / A-6 **									18.6	
S-42-197-3	6-8	CLAYEY SAND(SC) / A-6 (1)	33	18	15	1.9	60.8	37.3			18.2	
S-42-197-3	8-10	CLAYEY SAND(SC) / A-6 **									16.6	
S-42-197-3	10-12	POORLY GRADED SAND WITH SILT(SP-SM) / A-1-b **									21.8	
S-42-197-3	12-14	SILTY SAND(SM) / A-2-4 (0)	NP	NP	NP	0.7	74.4	24.9	8.9	16.0	18.3	
S-42-197-3	14-16	SILTY SAND(SM) / A-2-4 **									23.3	

** Where index test was not conclusive, soil was classified per ASTM D2488 - Visual-Manual Procedure

Summary of Laboratory Results

Boring ID	Depth (Ft.)	Soil Classification USCS & AASHTO	Liquid Limit	Plastic Limit	Plasticity Index	% Gravel	% Sand	% Fines	% Silt	% Clay	Water Content (%)	Proctor Dry Density (pcf)/Opt. Moisture (%)
S-42-197-3	16-18	SILTY SAND(SM) / A-2-4 **									21.7	
S-42-197-3	18-20	POORLY GRADED SAND WITH SILT(SP-SM) / A-1-b **									20.5	
S-42-197-3	20-22	POORLY GRADED SAND WITH SILT(SP-SM) / A-1-b **				2.9	85.2	11.8	8.4	3.5	21.0	
S-42-197-3	22-24	SILTY SAND(SM) / A-2-4 **				1.7	72.1	26.2			32.0	
S-42-197-3	24-26	SILTY SAND(SM) / A-2-4 **									25.1	
S-42-197-3	26-28	SILTY SAND(SM) / A-2-4 **									28.6	
S-42-197-3	28-30	SILTY SAND(SM) / A-2-4 **									20.5	
S-42-197-3	34-36	SILTY SAND(SM) / A-2-4 **				0.9	76.7	22.4			22.6	
S-42-197-3 Bulk	1-5	CLAYEY SAND(SC) / A-4 (0)	26	18	8	5.8	58.0	36.2			12.6	114.5 / 13.7

** Where index test was not conclusive, soil was classified per ASTM D2488 - Visual-Manual Procedure



INDEX PROPERTIES VERSUS DEPTH

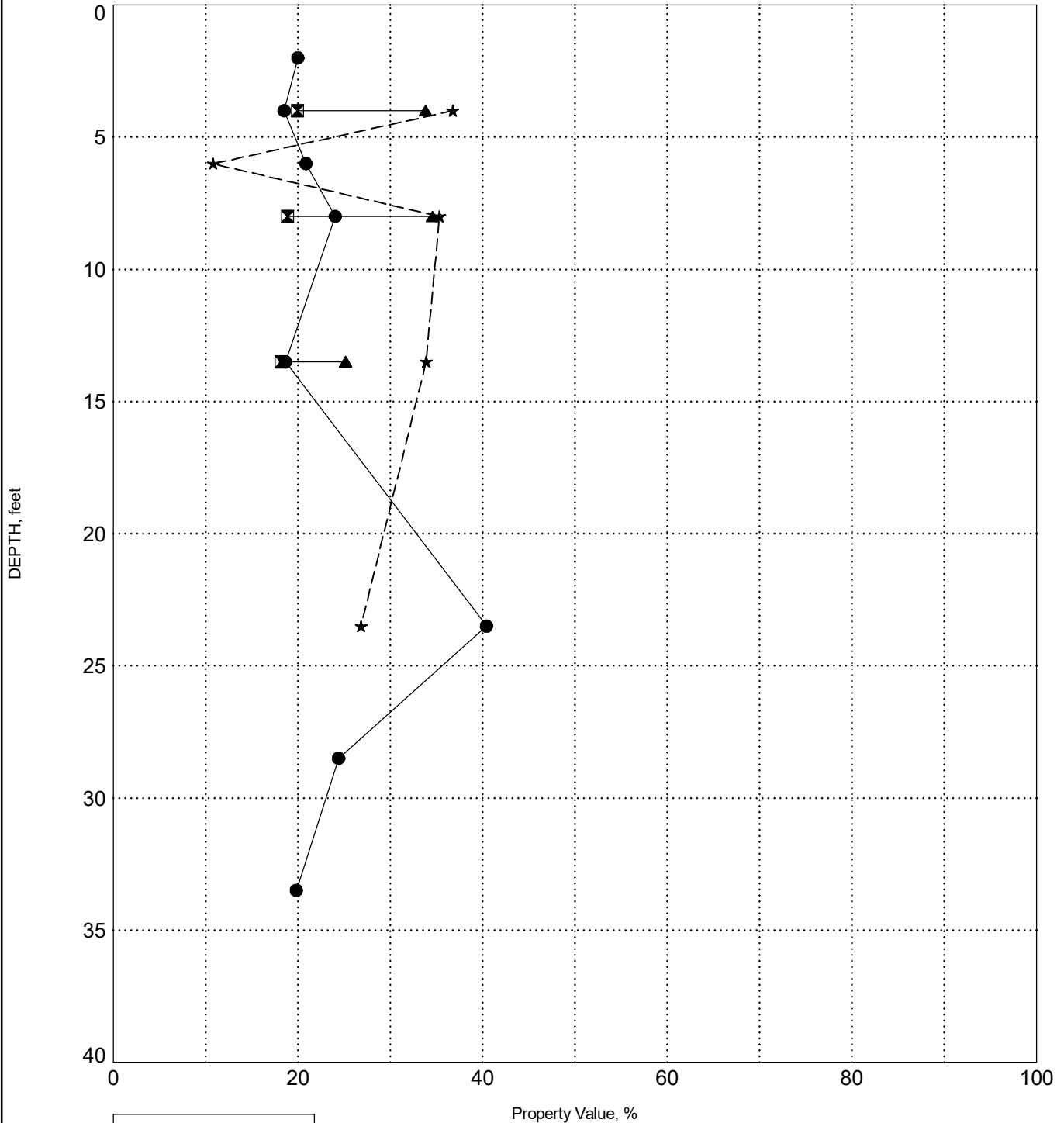
PROJECT ID P041164

PROJECT NAME S-42-197 (Old Spartanburg Highway) BRO South Tyger River

PROJECT COUNTY Spartanburg

SURFACE ELEVATION: 577.1

BORING S-42-197-1



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



INDEX PROPERTIES VERSUS DEPTH

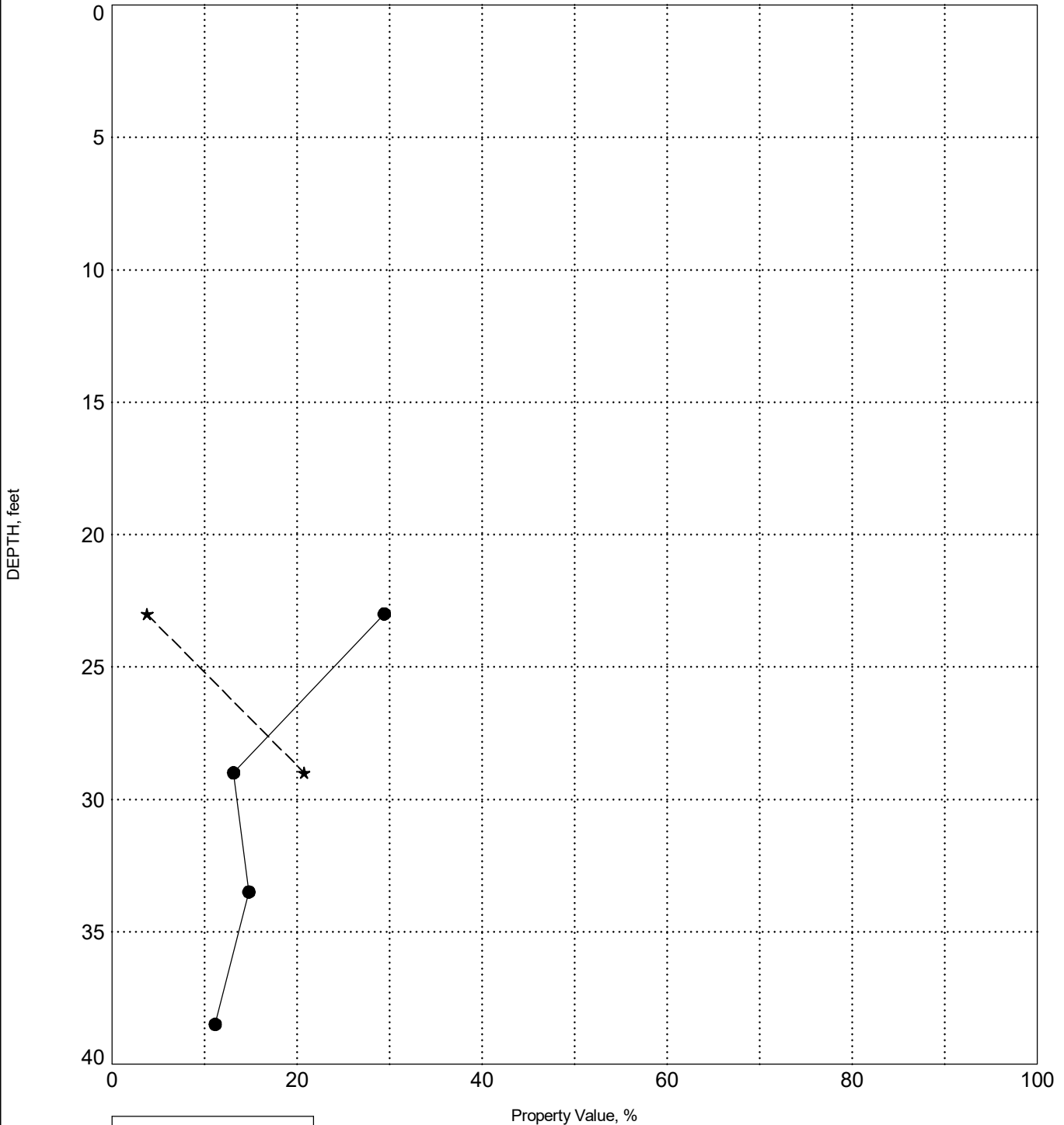
PROJECT ID P041164

PROJECT NAME S-42-197 (Old Spartanburg Highway) BRO South Tyger River

PROJECT COUNTY Spartanburg

SURFACE ELEVATION: 577.0

BORING S-42-197-2



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



INDEX PROPERTIES VERSUS DEPTH

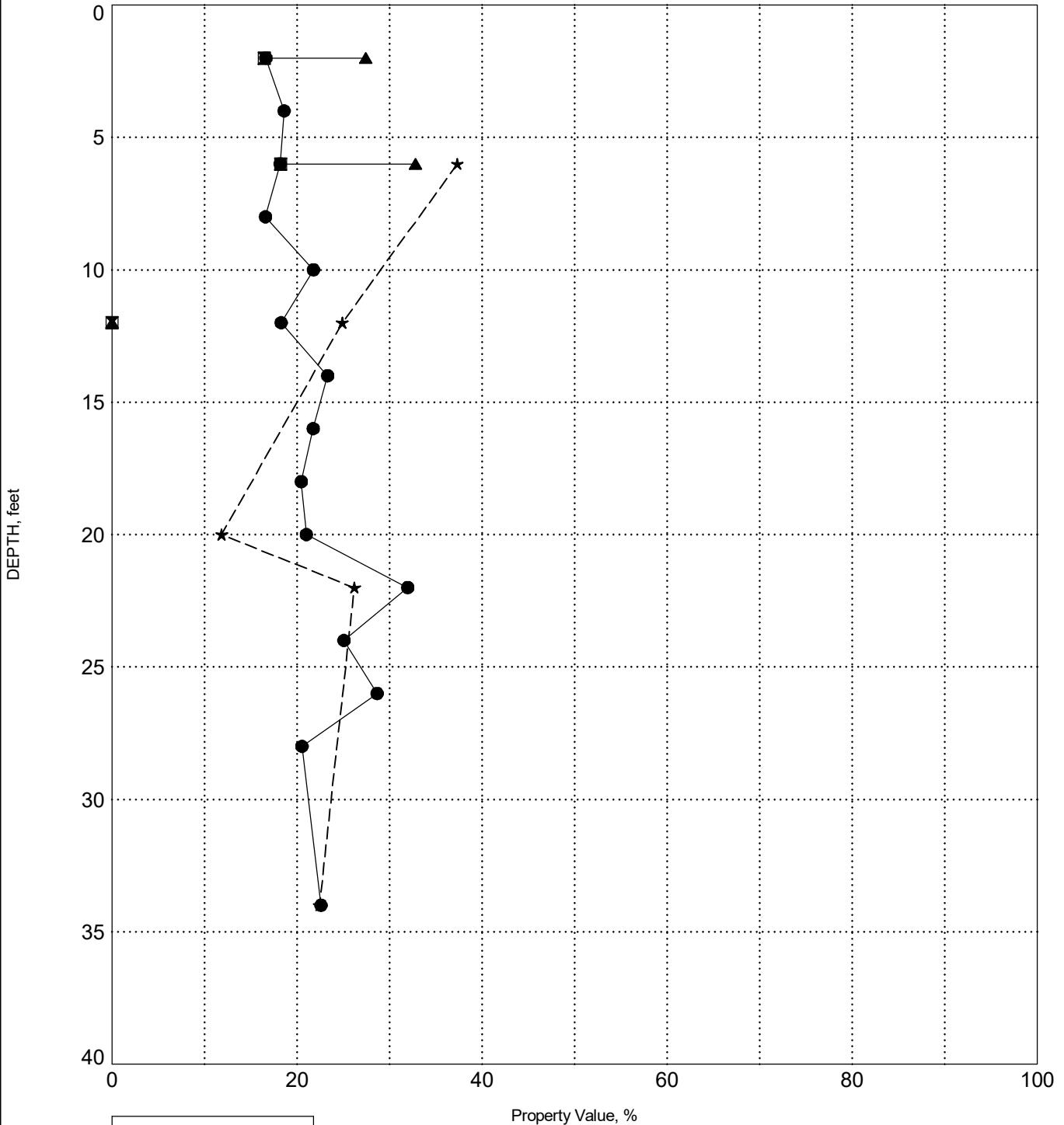
PROJECT ID P041164

PROJECT NAME S-42-197 (Old Spartanburg Highway) BRO South Tyger River

PROJECT COUNTY Spartanburg

SURFACE ELEVATION: 577.2

BORING S-42-197-3



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



INDEX PROPERTIES VERSUS DEPTH

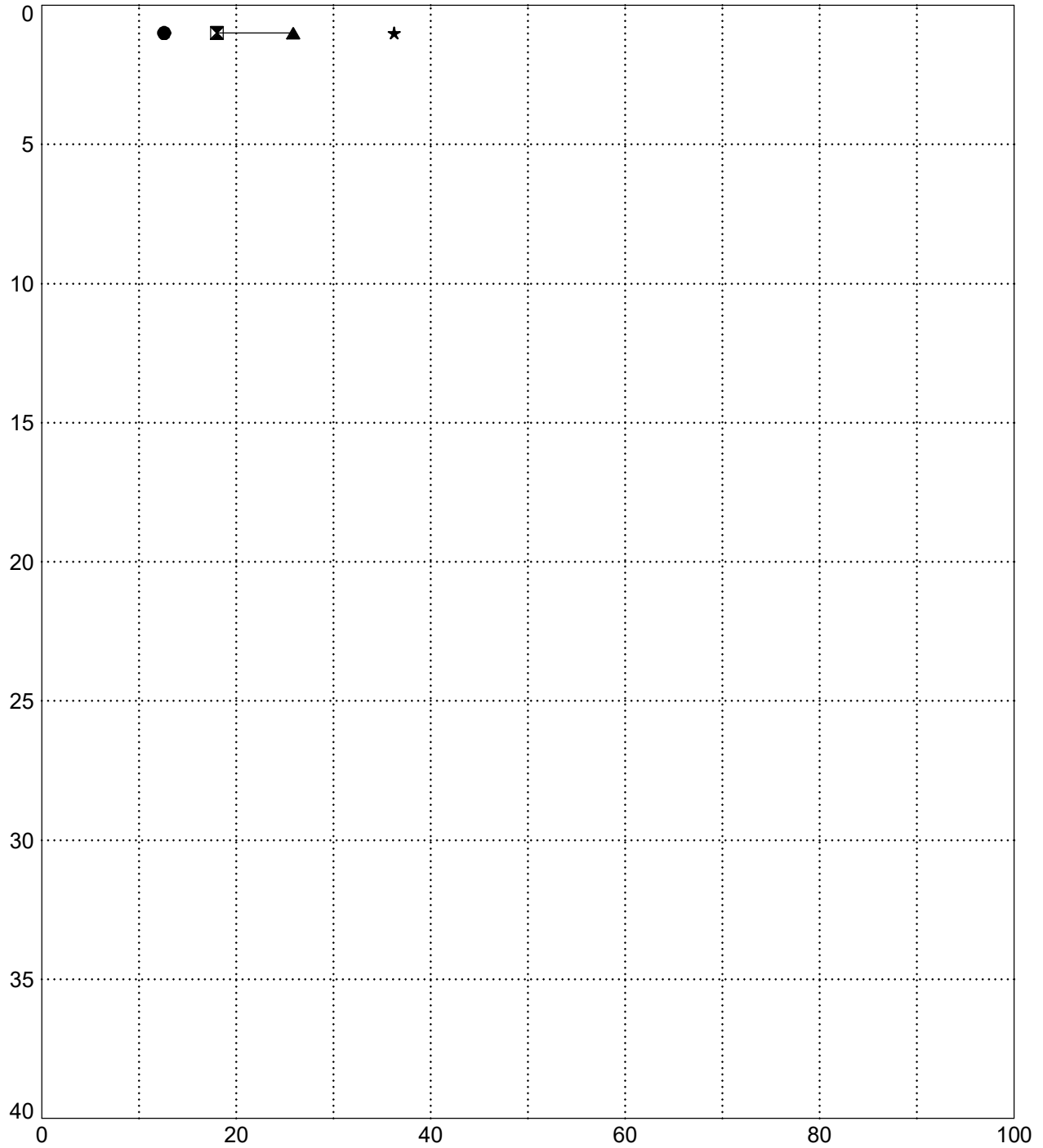
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PROJECT NAME S-42-197 (Old Spartanburg Highway) BRO South Tyger River

PROJECT COUNTY Spartanburg

SURFACE ELEVATION: 577.0

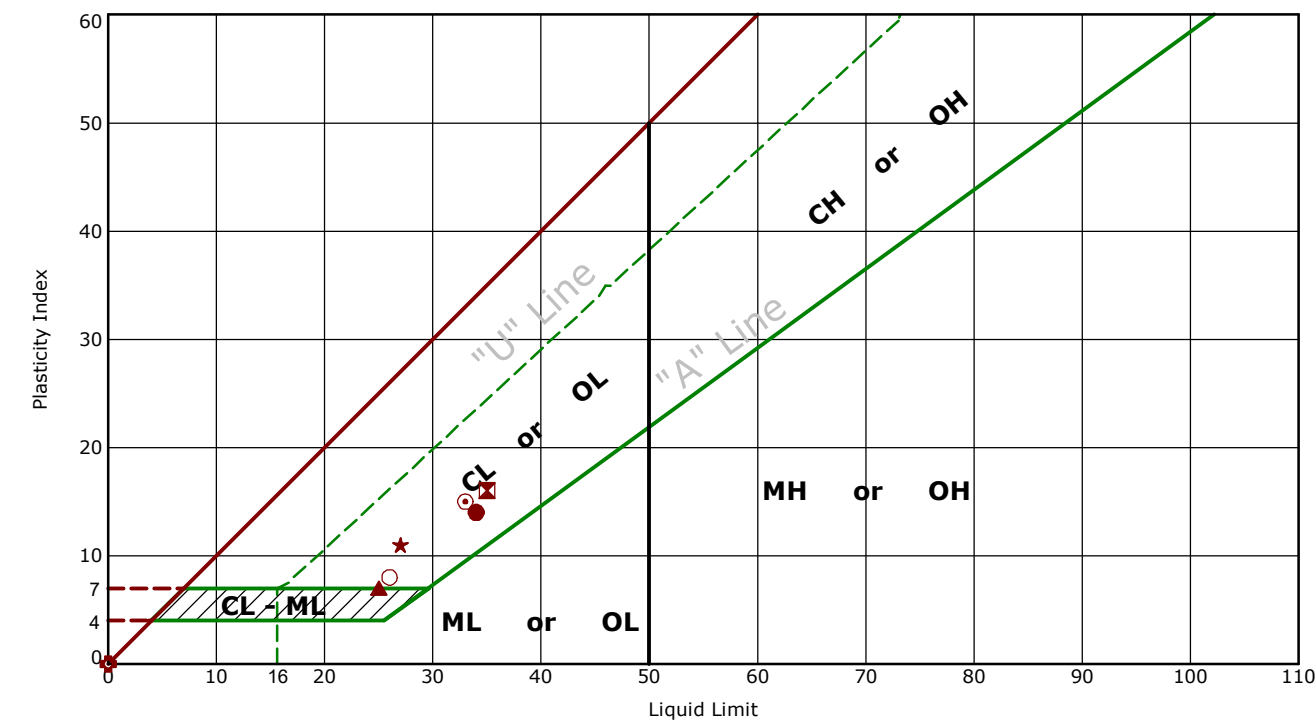
BORING S-42-197-3 Bulk



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

Atterberg Limit Results

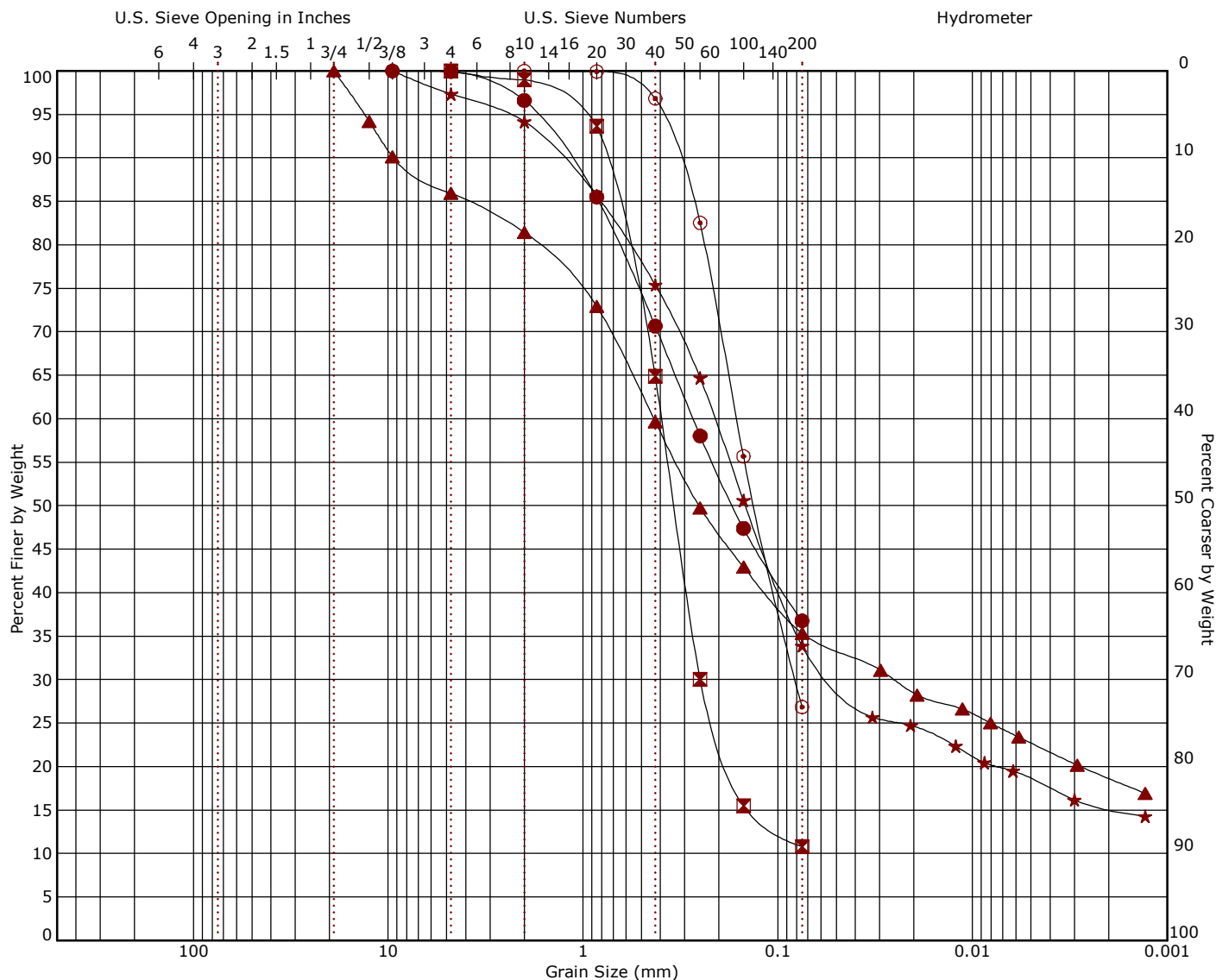
ASTM D4318



	Boring ID	Depth (Ft)	LL	PL	PI	Fines	AASHTO	Description
●	S-42-197-1	4 - 6	34	20	14	36.8	A-6 (1)	CLAYEY SAND
⊠	S-42-197-1	8 - 10	35	19	16	35.3	A-2-6 (1)	CLAYEY SAND
▲	S-42-197-1	13.5 - 15	25	18	7	33.9	A-2-4 (0)	SILTY, CLAYEY SAND
★	S-42-197-3	2 - 4	27	16	11		A-6	CLAYEY SAND
⊙	S-42-197-3	6 - 8	33	18	15	37.3	A-6 (1)	CLAYEY SAND
⊕	S-42-197-3	12 - 14	NP	NP	NP	24.9	A-2-4 (0)	SILTY SAND
○	S-42-197-3 Bulk	1 - 5	26	18	8	36.2	A-4 (0)	CLAYEY SAND

Grain Size Distribution

ASTM D422 / ASTM C136



Cobbles

Gravel

coarse

fine

Sand

coarse

medium

fine

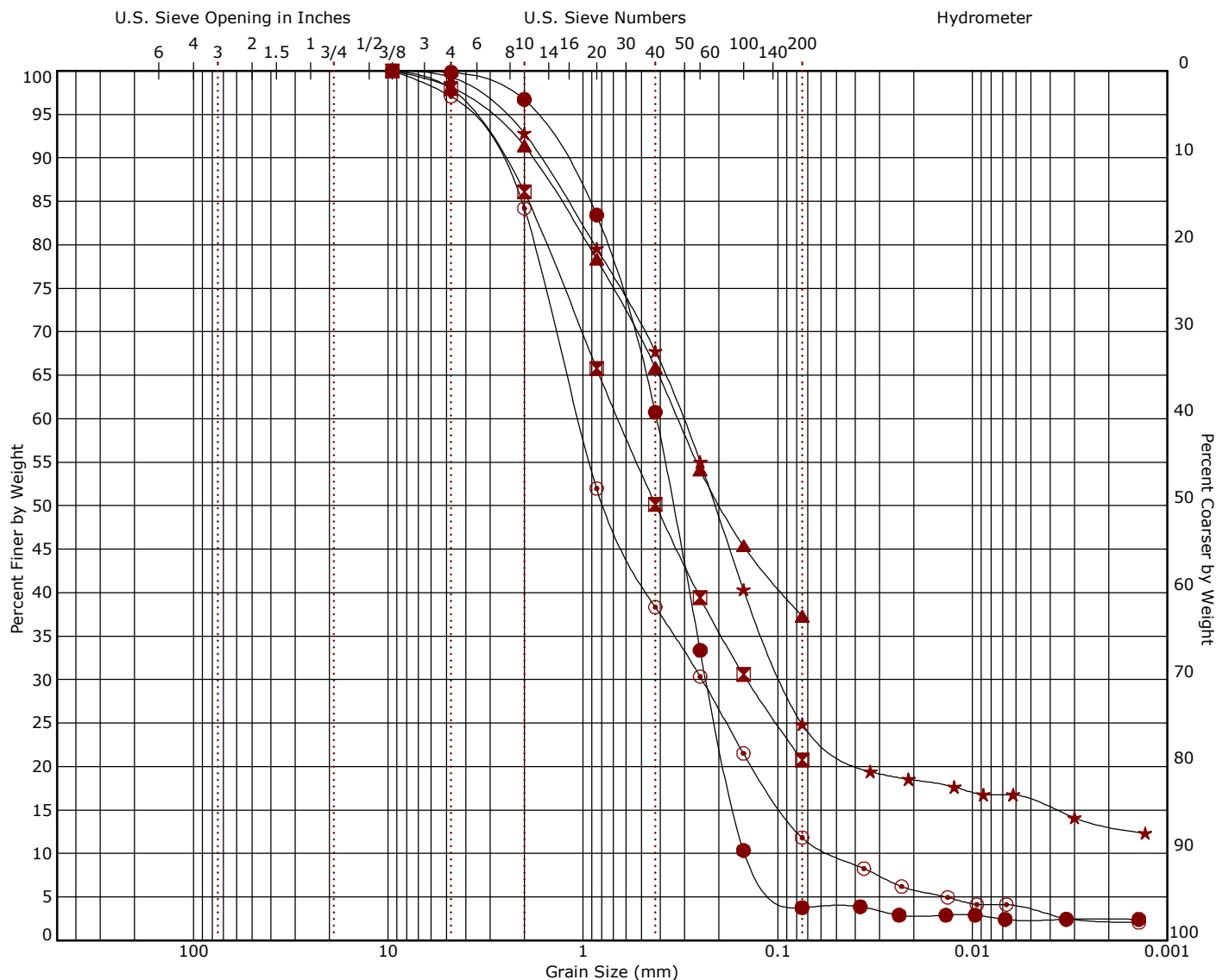
Silt or Clay

Boring ID	Depth (Ft)	USCS Classification	USCS	AASHTO	LL	PL	PI	Cc	Cu
● S-42-197-1	4 - 6	CLAYEY SAND	SC	A-6 (1)	34	20	14		
⊠ S-42-197-1	6 - 8	POORLY GRADED SAND with SILT	SP-SM	A-2-4				2.39	5.95
▲ S-42-197-1	8 - 10	CLAYEY SAND	SC	A-2-6	35	19	16		
★ S-42-197-1	13.5 - 15	SILTY, CLAYEY SAND	SC-SM	A-2-4 (0)	25	18	7		
⊙ S-42-197-1	23.5 - 25	SILTY SAND	SM	A-2-4					

Boring ID	Depth (Ft)	D ₁₀₀	D ₆₀	D ₃₀	D ₁₀	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
● S-42-197-1	4 - 6	9.5	0.272			0.0	0.1	63.2	36.8		
⊠ S-42-197-1	6 - 8	4.75	0.395	0.25		0.0	0.0	89.2	10.8		
▲ S-42-197-1	8 - 10	19	0.432	0.025		0.0	14.1	50.6		12.6	22.7
★ S-42-197-1	13.5 - 15	9.5	0.211	0.05		0.0	2.7	63.4		15.4	18.5
⊙ S-42-197-1	23.5 - 25	2	0.163	0.081		0.0	0.0	73.2	26.8		

Grain Size Distribution

ASTM D422 / ASTM C136



Cobbles

Gravel

coarse

fine

Sand

coarse

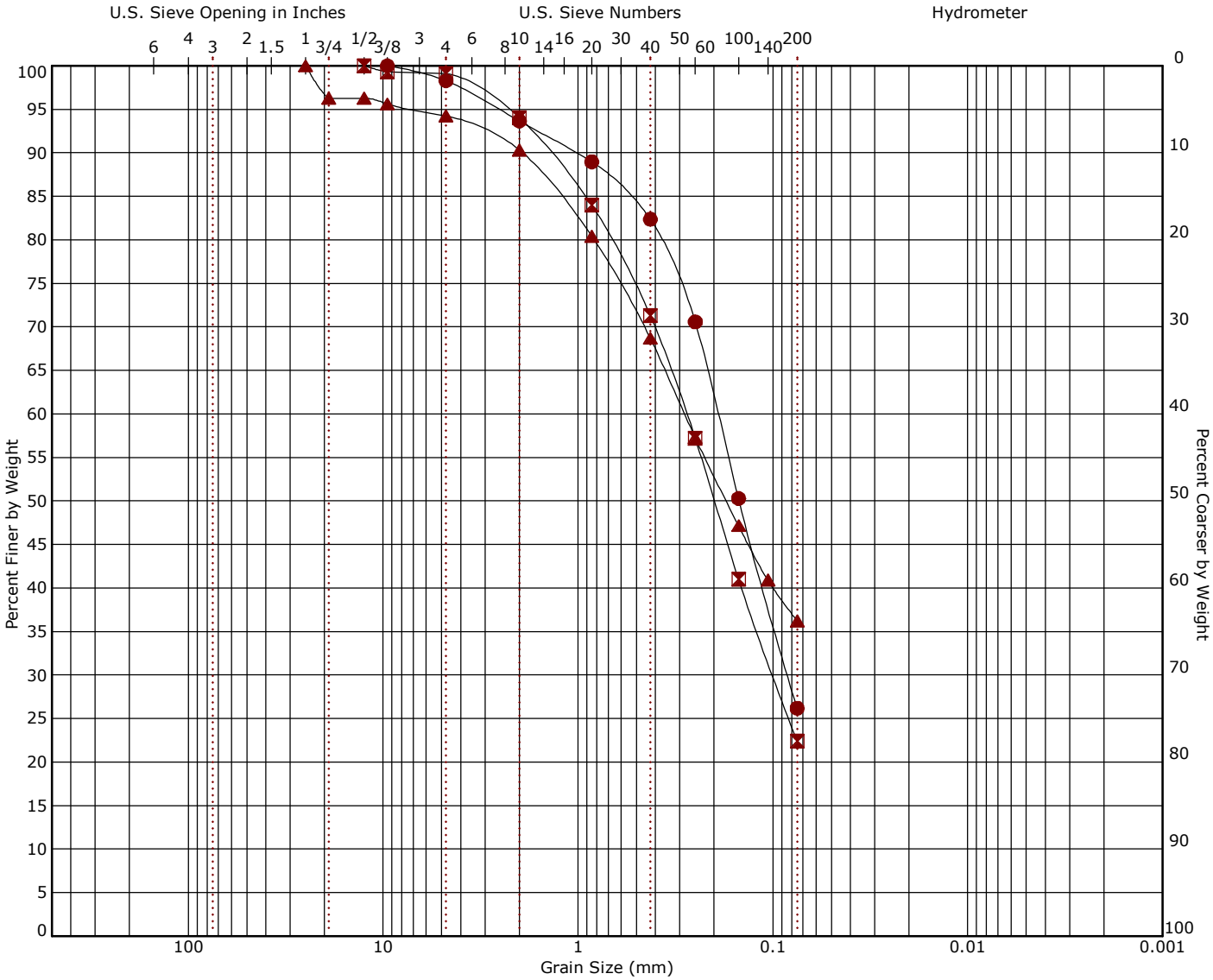
medium

fine

Silt or Clay

Boring ID	Depth (Ft)	USCS Classification				USCS	AASHTO	LL	PL	PI	Cc	Cu
●S-42-197-2	23 - 25	POORLY GRADED SAND				SP	A-3				0.92	3.01
☒S-42-197-2	29 - 31	SILTY SAND				SM	A-2-4					
▲S-42-197-3	6 - 8	CLAYEY SAND				SC	A-6 (1)	33	18	15		
★S-42-197-3	12 - 14	SILTY SAND				SM	A-2-4 (0)	NP	NP	NP		
⊗S-42-197-3	20 - 22	POORLY GRADED SAND with SILT				SP-SM	A-1-b				1.11	20.45
Boring ID	Depth (Ft)	D ₁₀₀	D ₆₀	D ₃₀	D ₁₀	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay	
●S-42-197-2	23 - 25	9.5	0.419	0.232	0.139	0.0	0.2	96.1		1.3	2.4	
☒S-42-197-2	29 - 31	9.5	0.658	0.144		0.0	2.1	77.2	20.8			
▲S-42-197-3	6 - 8	9.5	0.326			0.0	1.9	60.8	37.3			
★S-42-197-3	12 - 14	9.5	0.307	0.094		0.0	0.7	74.4		8.9	16.0	
⊗S-42-197-3	20 - 22	9.5	1.052	0.245	0.051	0.0	2.9	85.2		8.4	3.5	

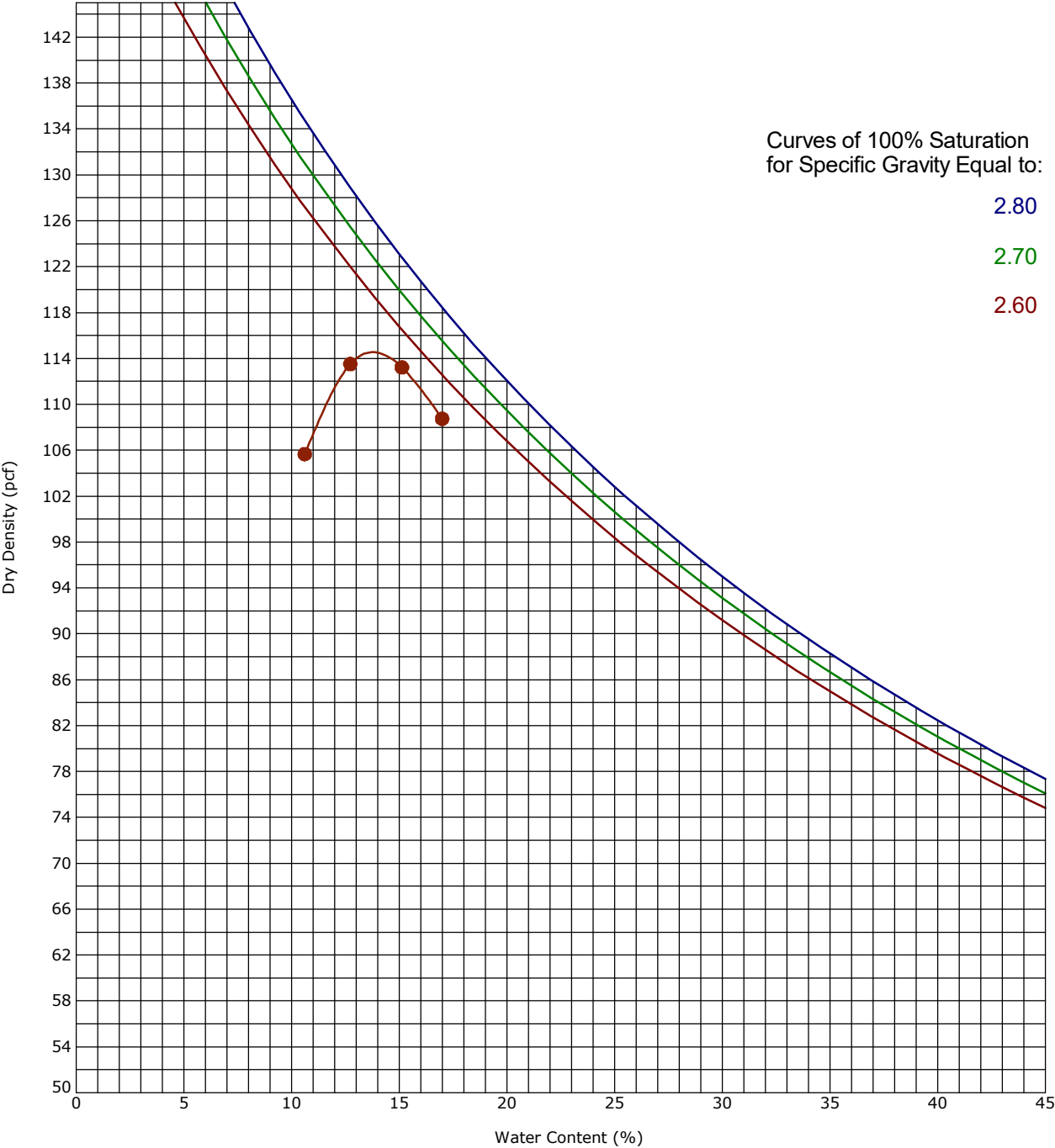
Grain Size Distribution
ASTM D422 / ASTM C136



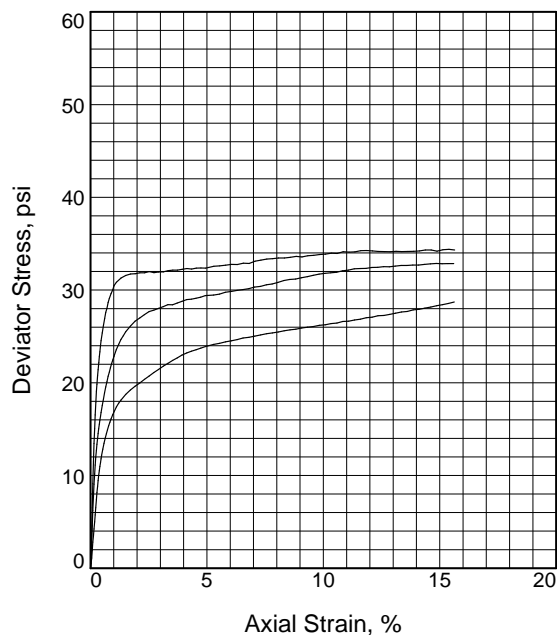
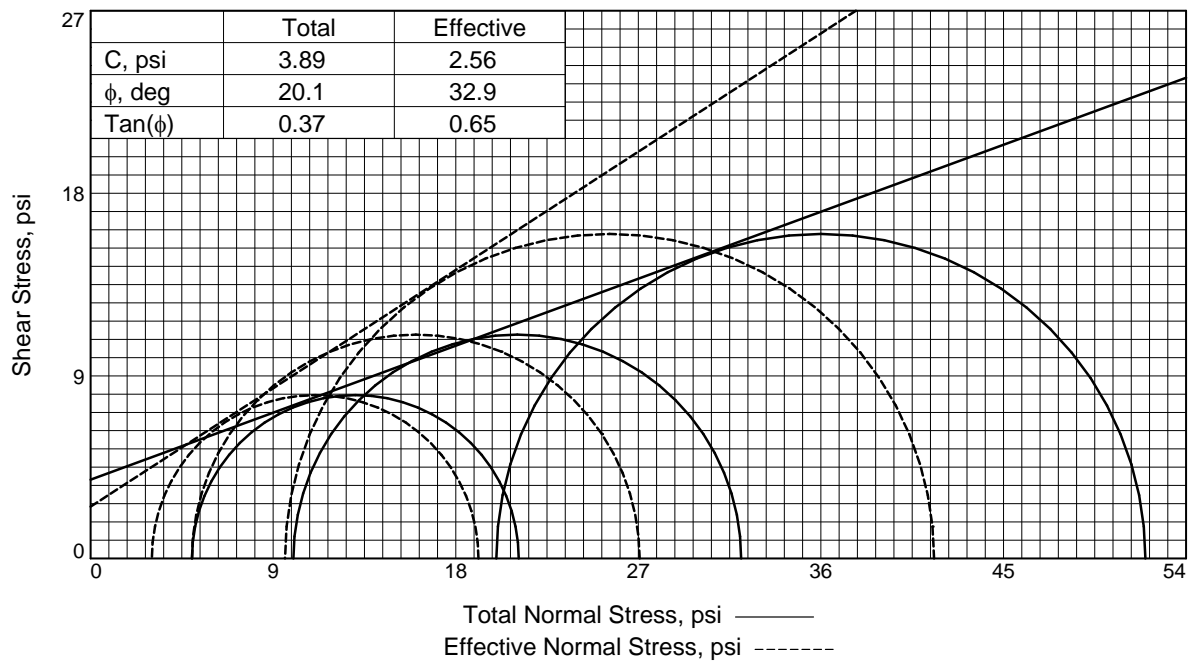
Cobbles		Gravel		Sand			Silt or Clay				
		coarse	fine	coarse	medium	fine					
Boring ID	Depth (Ft)	USCS Classification			USCS	AASHTO	LL	PL	PI	Cc	Cu
●S-42-197-3	22 - 24	SILTY SAND			SM	A-2-4					
☒S-42-197-3	34 - 36	SILTY SAND			SM	A-2-4					
▲S-42-197-3 Bulk	1 - 5	CLAYEY SAND			SC	A-4 (0)	26	18	8		
Boring ID	Depth (Ft)	D ₁₀₀	D ₆₀	D ₃₀	D ₁₀	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●S-42-197-3	22 - 24	9.5	0.192	0.084		0.0	1.7	72.1	26.2		
☒S-42-197-3	34 - 36	12.5	0.278	0.099		0.0	0.9	76.7	22.4		
▲S-42-197-3 Bulk	1 - 5	25	0.284			0.0	5.8	58.0	36.2		

Moisture-Density Relationship

ASTM D698-Method B



Boring ID		Depth (Ft)		Description of Materials			
S-42-197-3 Bulk		1 - 5		CLAYEY SAND(SC)			
Fines (%)	Fraction > mm size	LL	PL	PI	Test Method	Maximum Dry Density (pcf)	Optimum Water Content (%)
36	0.0	26	18	8	ASTM D698-Method B	114.5	13.7



Sample No.		1	2	3
Initial	Water Content, %	13.5	13.6	13.6
	Dry Density, pcf	109.0	109.2	109.3
	Saturation, %	66.7	67.6	68.0
	Void Ratio	0.5457	0.5441	0.5420
	Diameter, in.	2.80	2.80	2.80
	Height, in.	5.62	5.62	5.62
At Test	Water Content, %	18.5	18.5	17.8
	Dry Density, pcf	112.4	112.4	113.9
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.4992	0.4999	0.4799
	Diameter, in.	2.76	2.76	2.75
	Height, in.	5.58	5.58	5.57
Strain rate, in./min.		0.001	0.001	0.001
Back Pressure, psi		50.0	50.0	50.0
Cell Pressure, psi		55.0	60.0	70.0
Fail. Stress, psi		16.1	22.1	32.0
Excess Pore Pr., psi		2.0	5.0	10.4
Ult. Stress, psi		28.4	32.8	34.3
Excess Pore Pr., psi		-3.1	-0.8	8.5
$\bar{\sigma}_1$ Failure, psi		19.1	27.1	41.6
$\bar{\sigma}_3$ Failure, psi		3.0	5.0	9.6

Type of Test:

CU with Pore Pressures

Sample Type: Remolded

Description: Clayey Sand (SC)

LL= 26

PL= 18

PI= 8

Specific Gravity= 2.7

Remarks: Specimens were remolded to approximately 95% MDD at optimum water content.

Figure _____

Client: HNTB North Carolina PC

Project: S-42-197 (Old Spartanburg Highway) BRO South Tyger River

Source of Sample: S-42-197-3

Depth: 1-3'

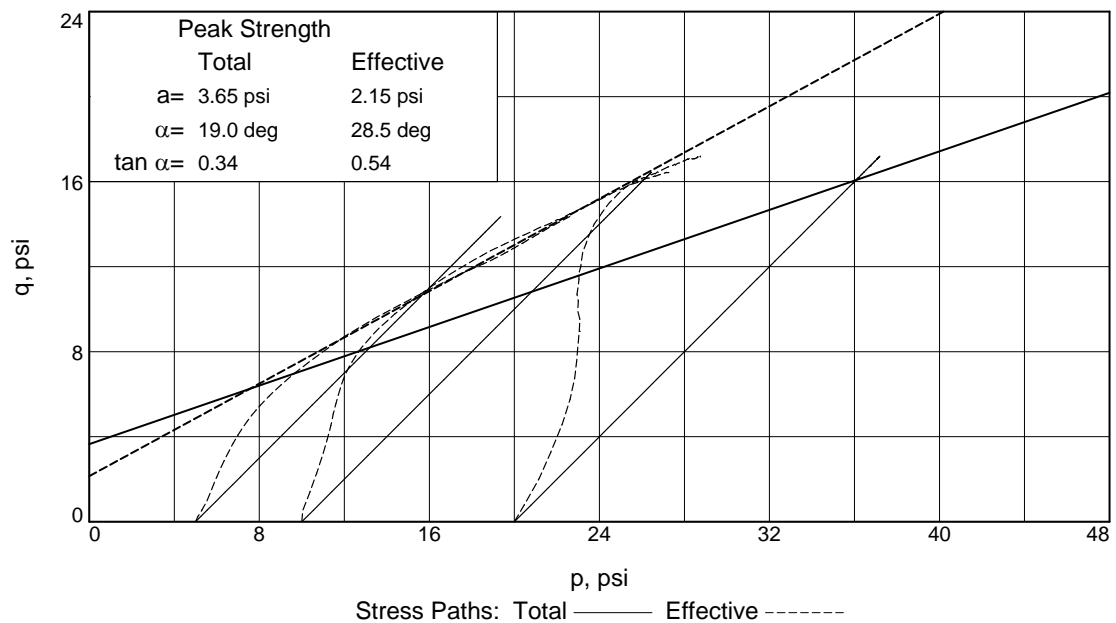
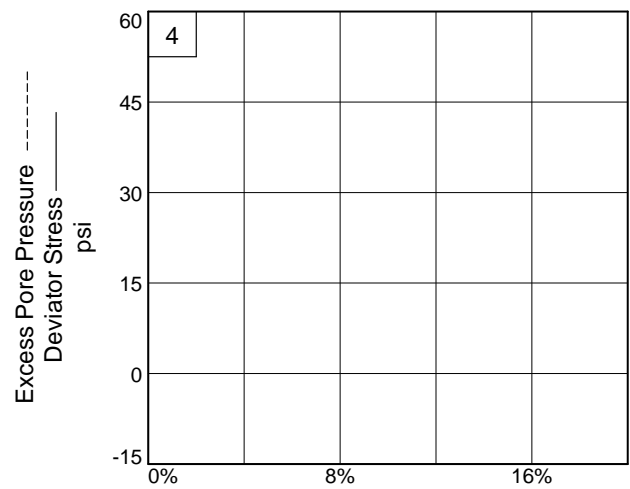
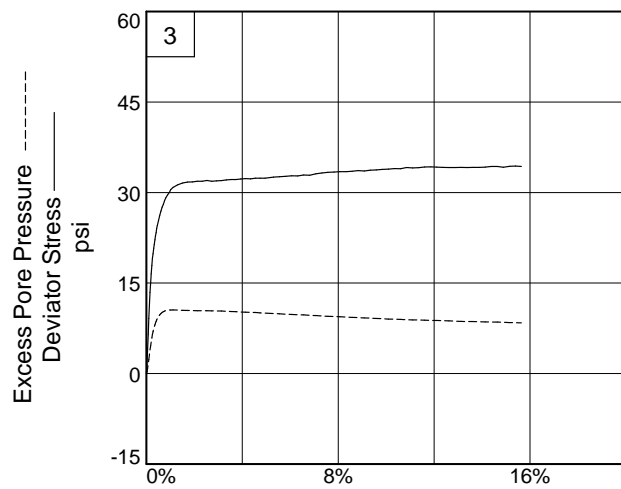
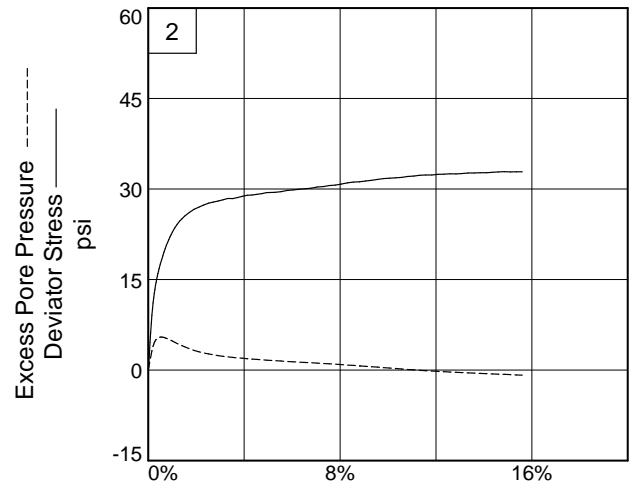
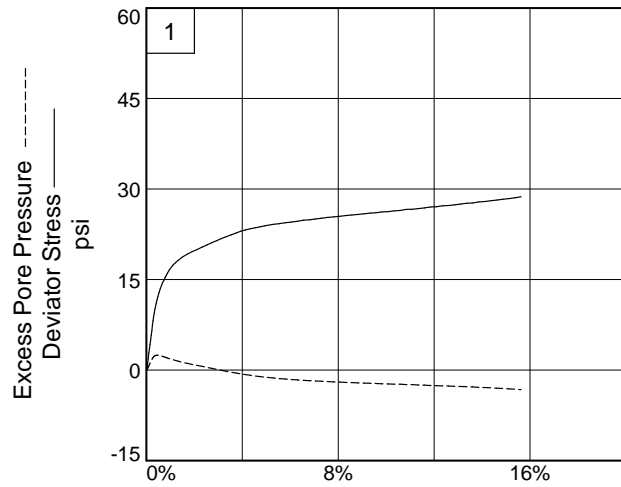
Proj. No.: 89623P180

Date Sampled: 1/8/2025

TRIAXIAL SHEAR TEST REPORT

Terracon Consultants, Inc.

Chattanooga, TN



Client: HNTB North Carolina PC

Project: S-42-197 (Old Spartanburg Highway) BRO South Tyger River

Source of Sample: S-42-197-3

Depth: 1-3'

Project No.: 89623P180

Figure _____

Terracon Consultants, Inc.

750 Pilot Road, Suite F
Las Vegas, Nevada 89119
(702) 597-9393



Client

HNTB North Carolina PC

Project

SCDOT Bridge Package 19 - South Tyger River

Sample Submitted By: Terracon (86)

Date Received: 2/7/2025

Lab No.: 25-0053

Results of Corrosion Analysis

Sample Number	--
Sample Location	S-42-197-3
Sample Depth (ft.)	2.0-20.0
pH Analysis, AASHTO T289	7.11
Water Soluble Sulfate (SO ₄), AASHTO T290 (mg/kg)	70
Sulfides, ASTM D4658, (ppm)	Nil
Red-Ox, ASTM G200, (mV)	+730
Chlorides, AASHTO T291, (mg/kg)	145
Saturated Minimum Resistivity, ASTM G-57, (ohm cm)	2814

Analyzed By

A handwritten signature in black ink, appearing to read 'N. Campo'.

Nathan Campo
Laboratory Coordinator

The tests were performed in general accordance with applicable ASTM and AWWA test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.



Rock Coring Summary

PAGE 1 OF 1

PROJECT ID P041164

PROJECT NAME S-42-197 (Old Spartanburg Highway) BRO South Tyger River

PROJECT COUNTY Spartanburg

Borehole	Core Run Number	Core Run Top Depth	REC (%)	RQD (%)	q _u (psi)	Poisson's Ratio	Secant Modulus (ksi)	Unit Weight (pcf)	RMR	GSI
S-42-197-1	NQ-1	38.5	94	70	16186	0.22	778	159	65	60
S-42-197-1	NQ-2	43.5	68	9					32	30
S-42-197-1	NQ-3	48.5	42	20	8744	0.14	590	174	35	25
S-42-197-1	NQ-4	53.5	94	53					58	40
S-42-197-1	NQ-5	58.5	80	19					32	25
S-42-197-2	NQ-1	43.5	88	73	3075	0.13	171	156	60	70
S-42-197-2	NQ-2	48.5	95	86	10016	0.18	640	163	59	60
S-42-197-2	NQ-3	53.5	97	90	11316	0.18	674	162	62	70
S-42-197-2	NQ-4	58.5	99	97	19868	0.16	917	163	77	70
S-42-197-3	NQ-1	42.0	94	14	2566	0.00	105	175	22	25
S-42-197-3	NQ-2	47.0	100	64	9269	0.01	855	170	55	40



Compressive Strength and Elastic Moduli of Intact Rock Core
Specimens under Varying Stress and Temperatures
ASTM D 7012
Method D

Laboratory Services Group 192 Exchange Boulevard Glendale Heights, IL 60139 Phone: (630) 717-4263 Fax: (630) 357-9489

Project No.: 8623P180 Tested By: EB Date: 3/12/2025
Project Name: SCDOT Bridge Package 19 Calculated By: EB Date: 3/12/2025
Checked By: WPQ Date: 3/14/2025

Sample No. S-42-197-1 Run/Sam No.: NQ-1
Depth (ft): 38.7'-40.3'
Description: Very Pale Brown / Brownish Yellow Marble Core

Rock Sample Moisture Condition at Time of Test: As Received

ASTM D4543 TOLERANCE CHECK

Side Straightness	Maximum Gap ≤ 0.020 in.					Tolerance Met	
End Flatness: Max.	Diameter 1a	in	Diameter 1b	in	≤ 0.0010	Tolerance Met	
End Flatness: Max.	Diameter 2a	in	Diameter 2b	in	≤ 0.0010	Tolerance Met	
Perpendicularity Slope	Diameter 1a		Diameter 1b		≤ 0.0043	Tolerance Met	
Perpendicularity Slope	Diameter 2a		Diameter 2b		≤ 0.0043	Tolerance Met	

Length (in): 1) 4.238 2) 4.238 3) 4.238 Avg. 4.238 in

Diameter (in): 1) 1.953 2) 1.974 3) 1.974 Avg. 1.967 in

Uniaxial Compressive Strength: 16,186 psi Mass: 538.7 g

Load: 49,169 lbs. Wet Unit Weight: 159.4 pcf

L/D: 2.2 Dry Unit Weight: 159.1 pcf

Water Content: 0.2 %

Young's Modulus	
Et (50% Co)	7.78E+05

Time to Failure: 2.80 min

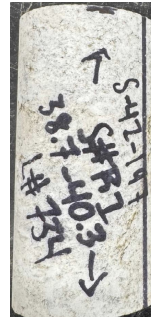
Load Rate: 293 lbs/sec

Poisson's Ratio	
ut (50% Co)	0.217

REMARKS:

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- Prepared in general accordance to ASTM D4543
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Before



After



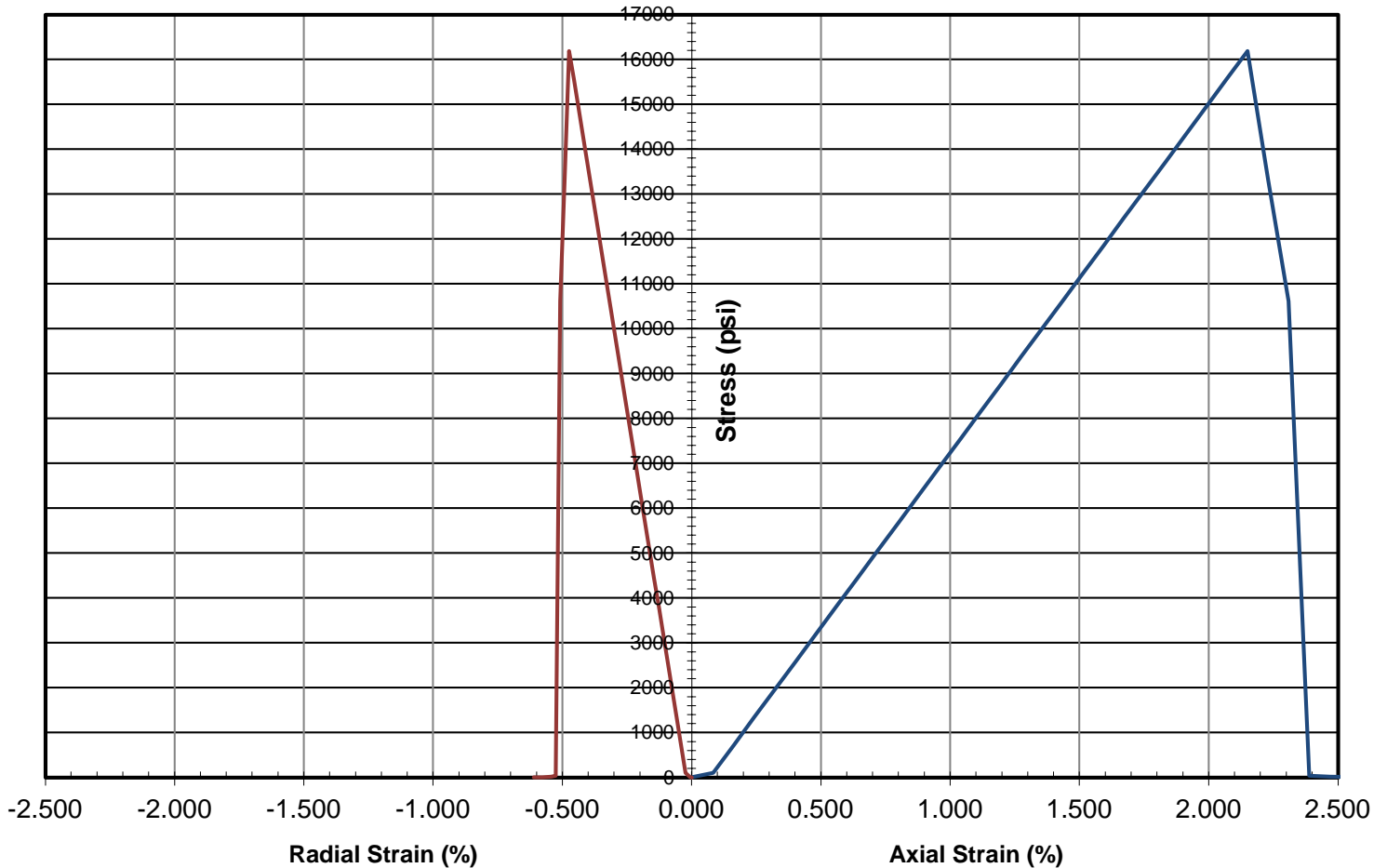


Compressive Strength and Elastic Moduli of Intact Rock Core
Specimens under Varying Stress and Temperatures
ASTM D 7012
Method D

Laboratory Services Group	192 Exchange Boulevard	Glendale Heights, IL 60139	Phone: (630) 717-4263	Fax: (630) 357-9489
Project No.:	8623P180	Tested By:	EB	Date: 03/12/25
Project Name:	SCDOT Bridge Package 19	Calculated By:	EB	Date: 03/12/25
Boring No.:	S-42-197-1	Run No.:	NQ-1	Date: 03/14/25
Depth (ft):	38.7'-40.3'	Checked By:	WPQ	

Stress vs Radial Strain

Stress vs Axial Strain



Young's Modulus

C_o Max =	16,186	psi	50% C_o Max	8,093	psi	E_t (50%) C_o =	7.78E+05	psi
			10% C_o Max	1,619	psi			

Poisson's Ratio

C_o Max =	16,186	psi	50% C_o Max	8,093	psi	ν_t (50%) C_o =	0.217
			10% C_o Max	1,619	psi		



**Compressive Strength and Elastic Moduli of Intact Rock Core
Specimens under Varying Stress and Temperatures
ASTM D 7012
Method D**

Laboratory Services Group *192 Exchange Boulevard* *Glendale Heights, IL 60139* *Phone: (630) 717-4263* *Fax: (630) 357-9489*

Project No.: 8623P180
Project Name: SCDOT Bridge Package 19

Tested By: EB
Calculated By: EB
Checked By: WPQ

Date: 3/12/2025
Date: 3/12/2025
Date: 3/14/2025

Sample No. S-42-197-1 Run/Sam No.: NQ-3
Depth (ft): 49.5'-50.3'
Description: Light Greenish Gray Gabbro Core

Rock Sample Moisture Condition at Time of Test: As Received

ASTM D4543 TOLERANCE CHECK

Side Straightness	Maximum Gap ≤ 0.020 in.						Tolerance Met	Yes
End Flatness: Max.	Diameter 1a	0.0006	in	Diameter 1b	0.0008	in	≤ 0.0010	Tolerance Met Yes
End Flatness: Max.	Diameter 2a	0.0007	in	Diameter 2b	0.0008	in	≤ 0.0010	Tolerance Met Yes
Perpendicularity Slope	Diameter 1a	0.00031		Diameter 1b	0.00036		≤ 0.0043	Tolerance Met Yes
Perpendicularity Slope	Diameter 2a	0.00041		Diameter 2b	0.00041		≤ 0.0043	Tolerance Met Yes

Length (in): 1) 4.287 2) 4.288 3) 4.287 Avg. 4.287 in

Diameter (in): 1) 1.953 2) 1.953 3) 1.952 Avg. 1.952 in

Uniaxial Compressive Strength: 8,744 psi Mass: 585.9 g

Load: 26,177 lbs. Wet Unit Weight: 173.9 pcf

L/D: 2.2 Dry Unit Weight: 173.2 pcf

Water Content: 0.4 %

Young's Modulus	
Et (50% Co)	<u>5.90E+05</u>

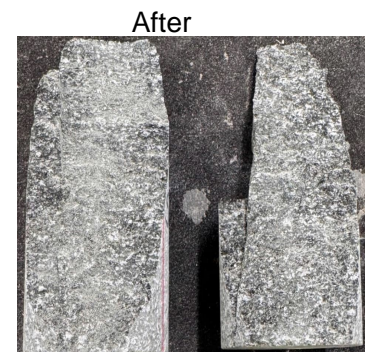
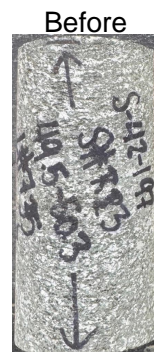
Time to Failure: 2.40 min

Poisson's Ratio	
ut (50% Co)	<u>0.144</u>

Load Rate: 182 lbs/sec

REMARKS:

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- 7 _____
- 8 _____
- 9 _____



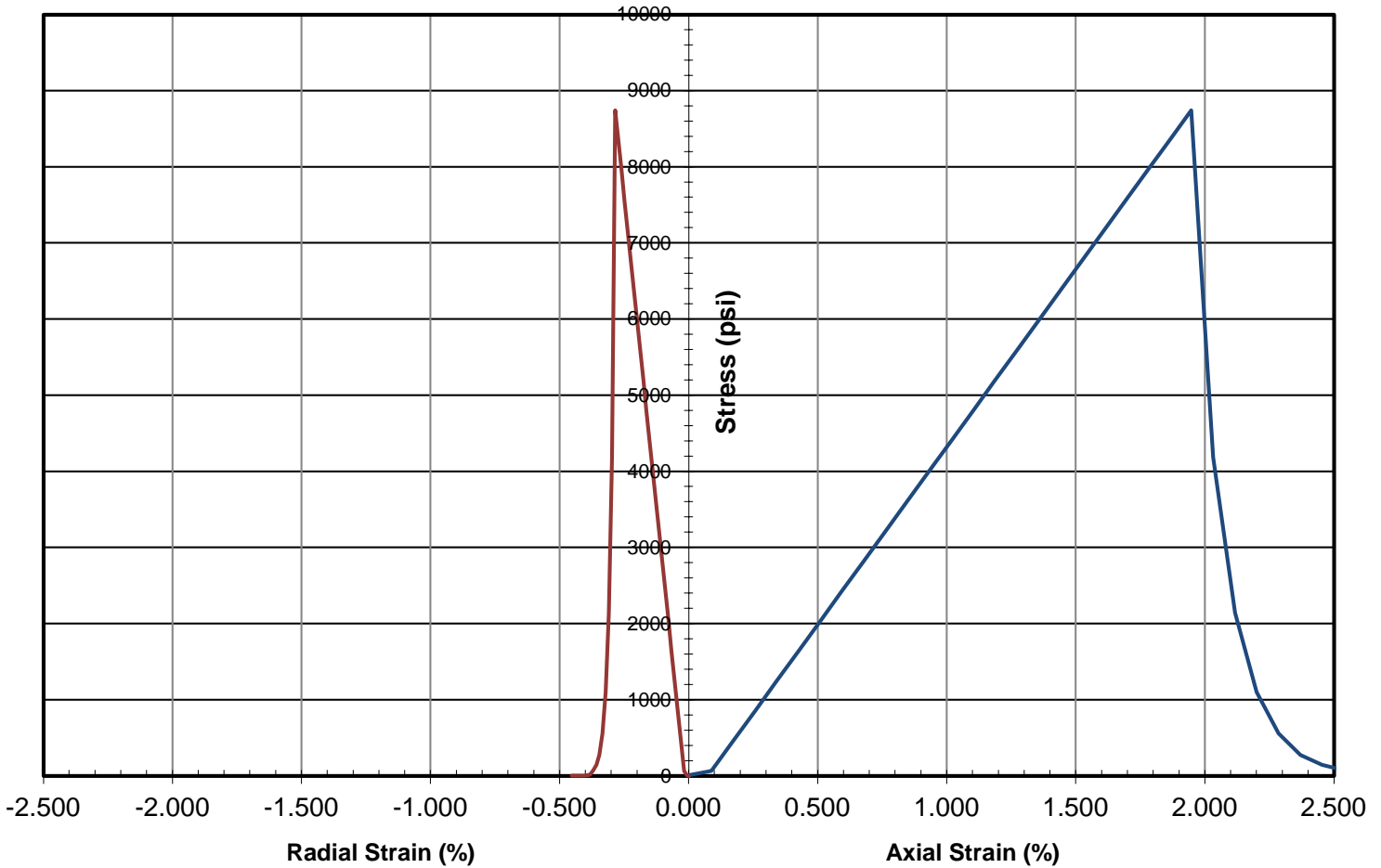


Compressive Strength and Elastic Moduli of Intact Rock Core
Specimens under Varying Stress and Temperatures
ASTM D 7012
Method D

Laboratory Services Group		192 Exchange Boulevard		Glendale Heights, IL 60139		Phone: (630) 717-4263		Fax: (630) 357-9489	
Project No.:	8623P180			Tested By:	EB			Date:	03/12/25
Project Name:	SCDOT Bridge Package 19			Calculated By:	EB			Date:	03/12/25
Boring No.	S-42-197-1			Run No.:	NQ-3			Date:	03/14/25
Depth (ft):	49.5'-50.3'								

Stress vs Radial Strain

Stress vs Axial Strain



Young's Modulus

C_o Max = 8,744 psi 50% C_o Max 4,372 psi E_t (50%) C_o = 5.90E+05 psi
10% C_o Max 874 psi

Poisson's Ratio

C_o Max = 8,744 psi 50% C_o Max 4,372 psi ν_t (50%) C_o = 0.144
10% C_o Max 874 psi



**Compressive Strength and Elastic Moduli of Intact Rock Core
Specimens under Varying Stress and Temperatures
ASTM D 7012
Method D**

Laboratory Services Group 192 Exchange Boulevard Glendale Heights, IL 60139 Phone: (630) 717-4263 Fax: (630) 357-9489

Project No.: <u>8623P180</u>	Tested By: <u>EB</u>	Date: <u>3/12/2025</u>
Project Name: <u>SCDOT Bridge Package 19</u>	Calculated By: <u>EB</u>	Date: <u>3/12/2025</u>
	Checked By: <u>WPQ</u>	Date: <u>3/14/2025</u>

Sample No. S-42-197-2 Run/Sam No.: NQ-1
Depth (ft): 44.2'-45.3'
Description: Light Yellowish Brown/ Light Gray Sandstone Core

Rock Sample Moisture Condition at Time of Test: As Received

ASTM D4543 TOLERANCE CHECK

Side Straightness	Maximum Gap \leq 0.020 in.					Tolerance Met	
End Flatness: Max.	Diameter 1a	in	Diameter 1b	in	\leq 0.0010	Tolerance Met	
End Flatness: Max.	Diameter 2a	in	Diameter 2b	in	\leq 0.001	Tolerance Met	
Perpendicularity Slope	Diameter 1a		Diameter 1b		\leq 0.0043	Tolerance Met	
Perpendicularity Slope	Diameter 2a		Diameter 2b		\leq 0.0043	Tolerance Met	

Length (in): 1) 4.116 2) 4.116 3) 4.116 Avg. 4.116 in

Diameter (in): 1) 1.955 2) 1.955 3) 1.954 Avg. 1.954 in

Uniaxial Compressive Strength: 3,075 psi Mass: 505.8 g

Load: 9,223 lbs. Wet Unit Weight: 156.1 pcf

L/D: 2.1 Dry Unit Weight: 151.7 pcf

Water Content: 2.9 %

Young's Modulus	
Et (50% Co)	<u>1.71E+05</u>

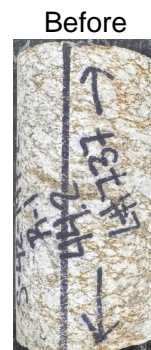
Time to Failure: 2.50 min

Load Rate: 61 lbs/sec

Poisson's Ratio	
ut (50% Co)	<u>0.132</u>

REMARKS:

- 1 _____
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- 5 _____
- 6 Prepared in general accordance to ASTM D4543
- 7 _____
- 8 _____
- 9 _____



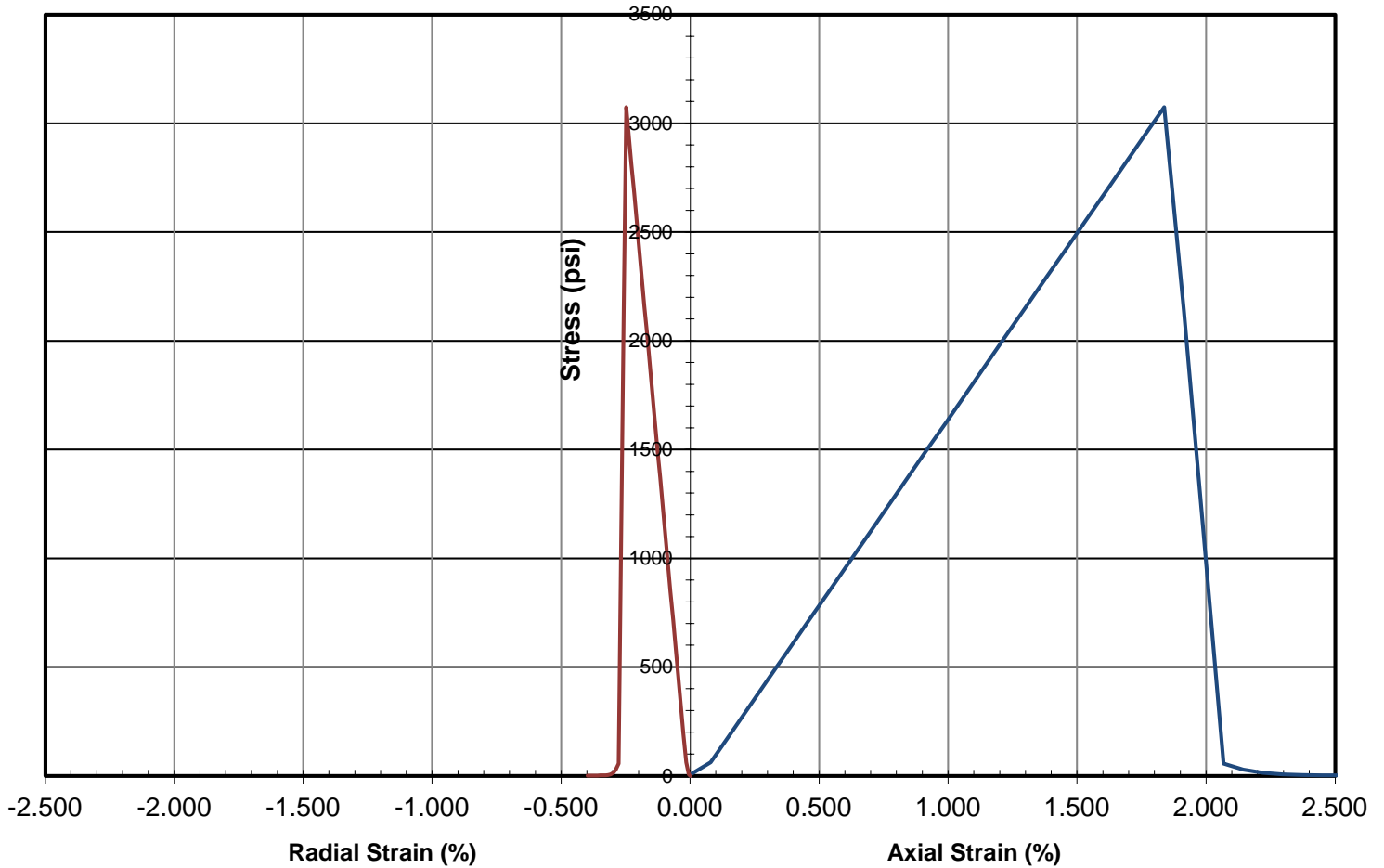


Compressive Strength and Elastic Moduli of Intact Rock Core
Specimens under Varying Stress and Temperatures
ASTM D 7012
Method D

Laboratory Services Group	192 Exchange Boulevard	Glendale Heights, IL 60139	Phone: (630) 717-4263	Fax: (630) 357-9489
Project No.:	8623P180	Tested By:	EB	Date: 03/12/25
Project Name:	SCDOT Bridge Package 19	Calculated By:	EB	Date: 03/14/25
Boring No.:	S-42-197-2	Run No.:	NQ-1	Date: 03/14/25
Depth (ft):	44.2'-45.3'	Checked By:	WPQ	

Stress vs Radial Strain

Stress vs Axial Strain



Young's Modulus

C_o Max = 3,075 psi 50% C_o Max 1,537 psi
10% C_o Max 307 psi

E_t (50%) C_o = 1.71E+05 psi

Poisson's Ratio

C_o Max = 3,075 psi 50% C_o Max 1,537 psi
10% C_o Max 307 psi

ν_t (50%) C_o = 0.132



Compressive Strength and Elastic Moduli of Intact Rock Core
Specimens under Varying Stress and Temperatures

ASTM D 7012

Method D

Laboratory Services Group

192 Exchange Boulevard

Glendale Heights, IL 60139

Phone: (630) 717-4263

Fax: (630) 357-9489

Project No.: 8623P180
Project Name: SCDOT Bridge Package 19

Tested By: EB
Calculated By: EB
Checked By: WPQ

Date: 3/12/2025
Date: 3/12/2025
Date: 3/14/2025

Sample No. S-42-197-2 Run/Sam No. NQ-2
Depth (ft): 49.8'-50.6'
Description: Light Gray / Speckled Black Granodiorite Core

Rock Sample Moisture Condition at Time of Test: As Received

ASTM D4543 TOLERANCE CHECK

Side Straightness	Maximum Gap \leq 0.020 in.					Tolerance Met
End Flatness: Max.	Diameter 1a	in	Diameter 1b	in	\leq 0.0010	Tolerance Met
End Flatness: Max.	Diameter 2a	in	Diameter 2b	in	\leq 0.0010	Tolerance Met
Perpendicularity Slope	Diameter 1a		Diameter 1b		\leq 0.0043	Tolerance Met
Perpendicularity Slope	Diameter 2a		Diameter 2b		\leq 0.0043	Tolerance Met

Length (in): 1) 4.175 2) 4.175 3) 4.175 Avg. 4.175 in

Diameter (in): 1) 1.955 2) 1.956 3) 1.956 Avg. 1.955 in

Uniaxial Compressive Strength: 10,016 psi Mass: 536.4 g

Load: 30,077 lbs. Wet Unit Weight: 163.0 pcf

L/D: 2.1 Dry Unit Weight: 162.4 pcf

Water Content: 0.4 %

Time to Failure: 2.40 min

Load Rate: 209 lbs/sec

Young's Modulus

Et (50% Co) 6.40E+05

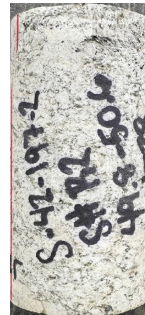
Poisson's Ratio

ut (50% Co) 0.184

REMARKS:

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- Prepared in general accordance to ASTM D4543
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Before



After



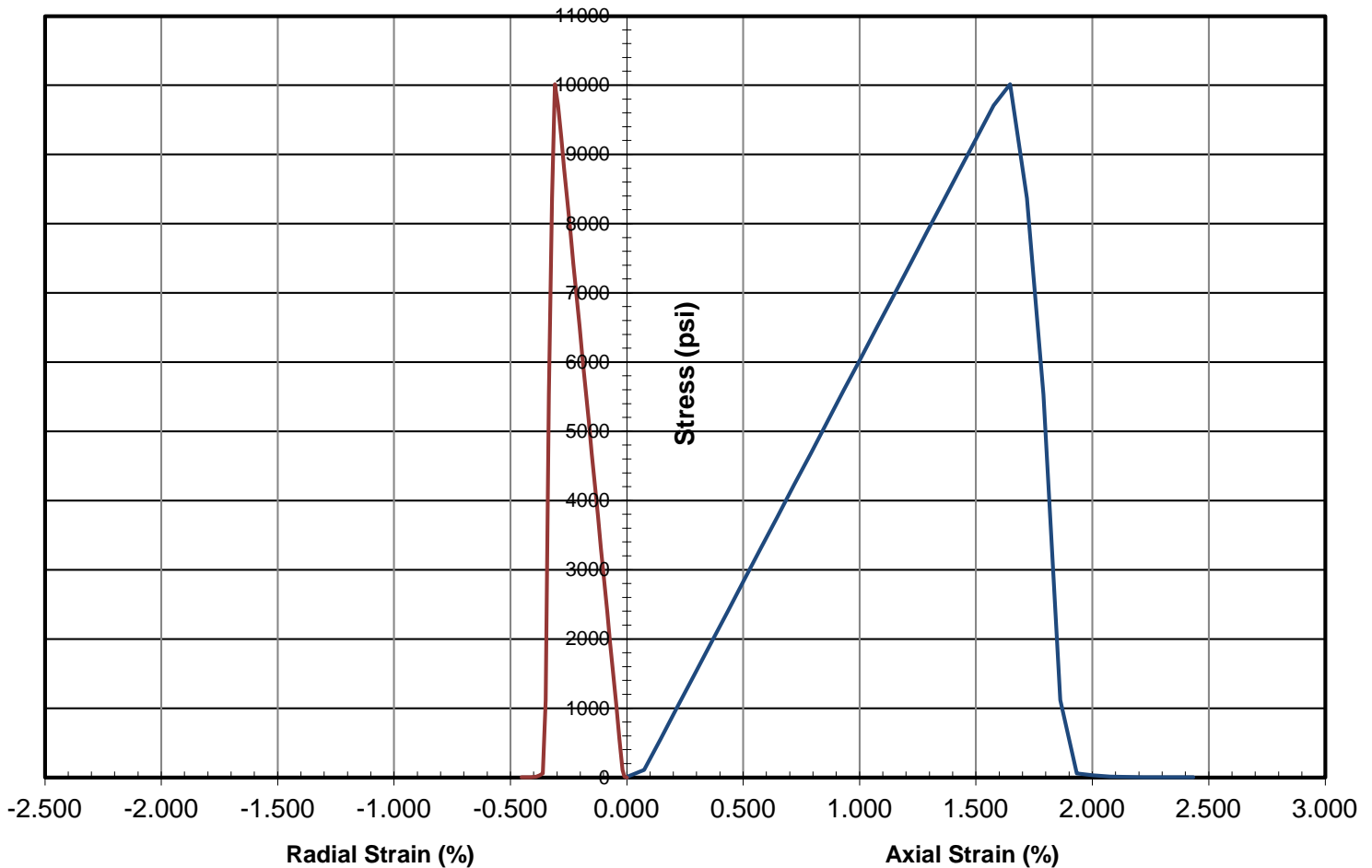


Compressive Strength and Elastic Moduli of Intact Rock Core
Specimens under Varying Stress and Temperatures
ASTM D 7012
Method D

Laboratory Services Group	192 Exchange Boulevard	Glendale Heights, IL 60139	Phone: (630) 717-4263	Fax: (630) 357-9489
Project No.:	8623P180	Tested By:	EB	Date: 03/12/25
Project Name:	SCDOT Bridge Package 19	Calculated By:	EB	Date: 03/12/25
Boring No.:	S-42-197-2	Run No.:	NQ-2	Date: 03/14/25
Depth (ft):	49.8'-50.6'	Checked By:	WPQ	

Stress vs Radial Strain

Stress vs Axial Strain



Young's Modulus

C_0 Max = 10,016 psi 50% C_0 Max 5,008 psi E_t (50%) C_0 = 6.40E+05 psi
10% C_0 Max 1,002 psi

Poisson's Ratio

C_0 Max = 10,016 psi 50% C_0 Max 5,008 psi ν_t (50%) C_0 = 0.184
10% C_0 Max 1,002 psi



**Compressive Strength and Elastic Moduli of Intact Rock Core
Specimens under Varying Stress and Temperatures
ASTM D 7012
Method D**

Laboratory Services Group 192 Exchange Boulevard Glendale Heights, IL 60139 Phone: (630) 717-4263 Fax: (630) 357-9489

Project No.: 8623P180
Project Name: SCDOT Bridge Package 19

Tested By: EB
Calculated By: EB
Checked By: WPQ

Date: 3/12/2025
Date: 3/12/2025
Date: 3/14/2025

Sample No. S-42-197-2 Run/Sam No.: NQ-3
Depth (ft): 54.0'-54.7'
Description: Brown/ Speckled Black Grandiorite Core

Rock Sample Moisture Condition at Time of Test: As Received

ASTM D4543 TOLERANCE CHECK

Side Straightness	Maximum Gap \leq 0.020 in.					Tolerance Met	
End Flatness: Max.	Diameter 1a	in	Diameter 1b	in	\leq 0.0010	Tolerance Met	
End Flatness: Max.	Diameter 2a	in	Diameter 2b	in	\leq 0.0010	Tolerance Met	
Perpendicularity Slope	Diameter 1a		Diameter 1b		\leq 0.0043	Tolerance Met	
Perpendicularity Slope	Diameter 2a		Diameter 2b		\leq 0.0043	Tolerance Met	

Length (in): 1) 4.101 2) 4.102 3) 4.102 Avg. 4.101 in

Diameter (in): 1) 1.956 2) 1.957 3) 1.957 Avg. 1.956 in

Uniaxial Compressive Strength: 11,316 psi Mass: 525.0 g

Load: 34,014 lbs. Wet Unit Weight: 162.2 pcf

L/D: 2.1 Dry Unit Weight: 161.8 pcf

Water Content: 0.3 %

Young's Modulus	
Et (50% Co)	<u>6.74E+05</u>

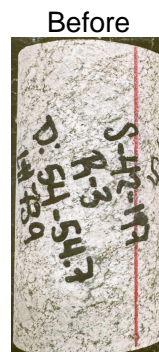
Time to Failure: 2.30 min

Poisson's Ratio	
ut (50% Co)	<u>0.180</u>

Load Rate: 246 lbs/sec

REMARKS:

- 1 _____
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- 5 _____
- 6 Prepared in general accordance to ASTM D4543
- 7 _____
- 8 _____
- 9 _____



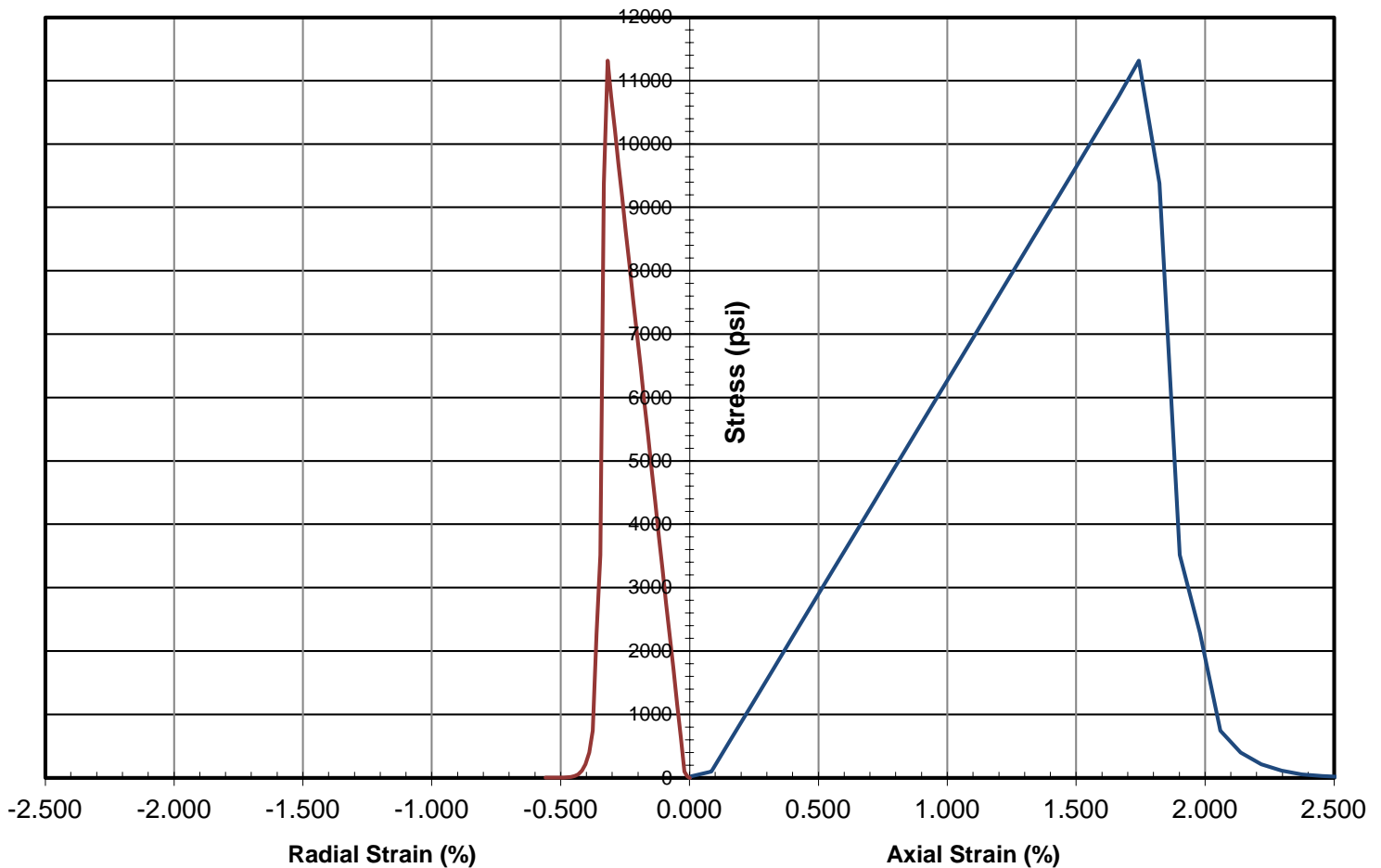


Compressive Strength and Elastic Moduli of Intact Rock Core
Specimens under Varying Stress and Temperatures
ASTM D 7012
Method D

Laboratory Services Group	192 Exchange Boulevard	Glendale Heights, IL 60139	Phone: (630) 717-4263	Fax: (630) 357-9489
Project No.:	8623P180	Tested By:	EB	Date: 03/12/25
Project Name:	SCDOT Bridge Package 19	Calculated By:	EB	Date: 03/12/25
Boring No.:	S-42-197-2	Run No.:	NQ-3	Date: 03/14/25
Depth (ft):	54.0'-54.7'	Checked By:	WPQ	

Stress vs Radial Strain

Stress vs Axial Strain



Young's Modulus

C_0 Max = 11,316 psi 50% C_0 Max 5,658 psi
10% C_0 Max 1,132 psi

E_t (50%) C_0 = 6.74E+05 psi

Poisson's Ratio

C_0 Max = 11,316 psi 50% C_0 Max 5,658 psi
10% C_0 Max 1,132 psi

ν_t (50%) C_0 = 0.180



Compressive Strength and Elastic Moduli of Intact Rock Core
Specimens under Varying Stress and Temperatures

ASTM D 7012

Method D

Laboratory Services Group

192 Exchange Boulevard

Glendale Heights, IL 60139

Phone: (630) 717-4263

Fax: (630) 357-9489

Project No.: 8623P180
Project Name: SCDOT Bridge Package 19

Tested By: EB
Calculated By: EB
Checked By: WPQ

Date: 3/12/2025
Date: 3/12/2025
Date: 3/14/2025

Sample No. S-42-197-2 Run/Sam No.: NQ-4
Depth (ft): 60.1'-61.1'
Description: Light Gray Speckled Black Grandiorite Core

Rock Sample Moisture Condition at Time of Test: As Received

ASTM D4543 TOLERANCE CHECK

Side Straightness	Maximum Gap ≤ 0.020 in.					Tolerance Met
End Flatness: Max.	Diameter 1a	in	Diameter 1b	in	≤ 0.0010	Tolerance Met
End Flatness: Max.	Diameter 2a	in	Diameter 2b	in	≤ 0.0010	Tolerance Met
Perpendicularity Slope	Diameter 1a		Diameter 1b		≤ 0.0043	Tolerance Met
Perpendicularity Slope	Diameter 2a		Diameter 2b		≤ 0.0043	Tolerance Met

Length (in): 1) 4.215 2) 4.215 3) 4.215 Avg. 4.215 in

Diameter (in): 1) 1.959 2) 1.960 3) 1.960 Avg. 1.959 in

Uniaxial Compressive Strength: 19,868 psi Mass: 544.3 g

Load: 59,906 lbs. Wet Unit Weight: 163.2 pcf

L/D: 2.2 Dry Unit Weight: 162.8 pcf

Water Content: 0.2 %

Time to Failure: 3.30 min

Load Rate: 303 lbs/sec

Young's Modulus

Et (50% Co) 9.17E+05

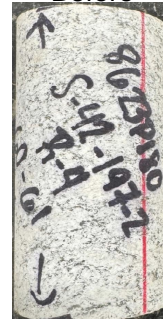
Poisson's Ratio

ut (50% Co) 0.162

REMARKS:

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- Prepared in general accordance to ASTM D4543
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Before



After



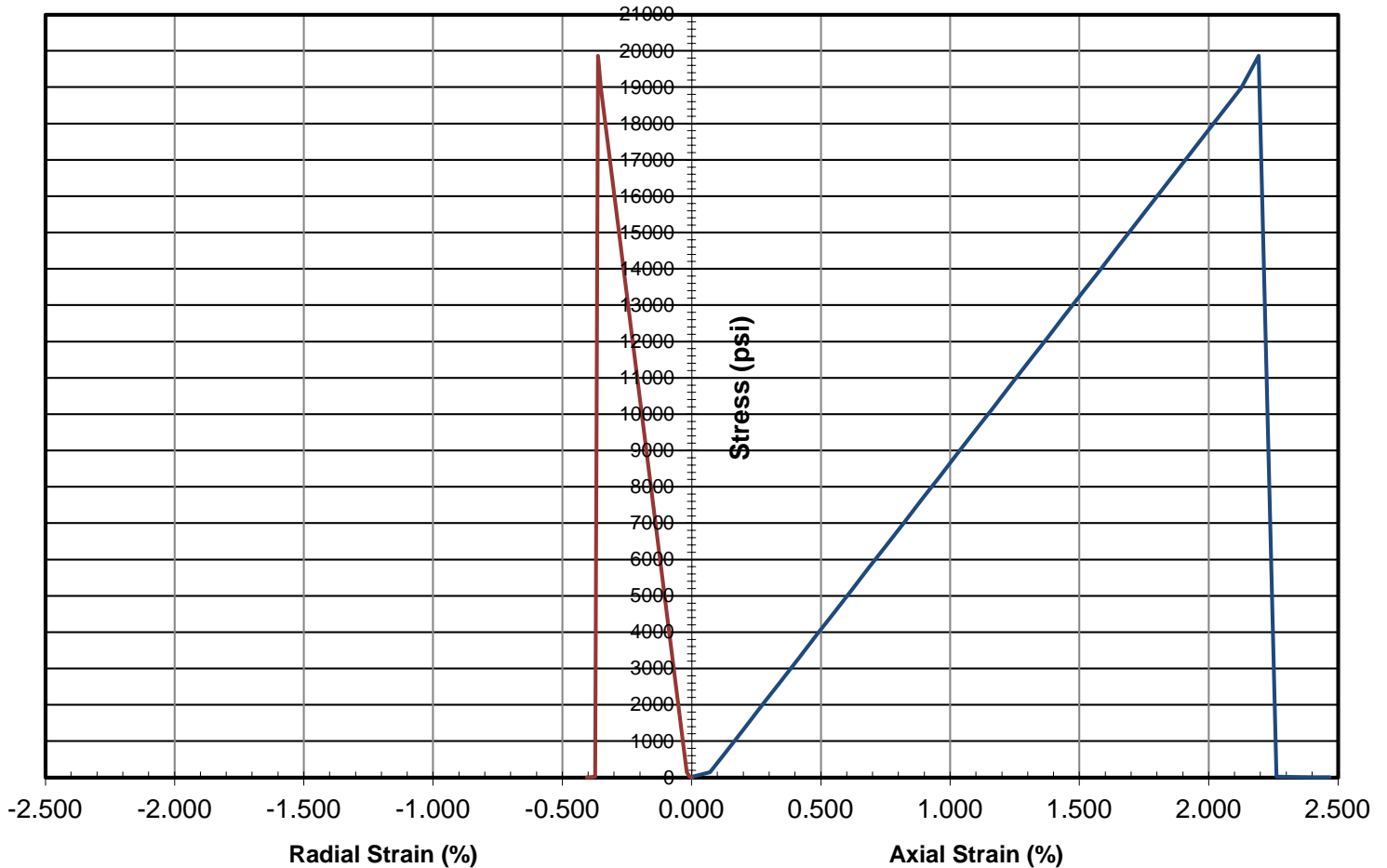


Compressive Strength and Elastic Moduli of Intact Rock Core
Specimens under Varying Stress and Temperatures
ASTM D 7012
Method D

Laboratory Services Group	192 Exchange Boulevard	Glendale Heights, IL 60139	Phone: (630) 717-4263	Fax: (630) 357-9489
Project No.:	8623P180	Tested By:	EB	Date: 03/12/25
Project Name:	SCDOT Bridge Package 19	Calculated By:	EB	Date: 03/12/25
Boring No.:	S-42-197-2	Run No.:	NQ-4	Date: 03/14/25
Depth (ft):	60.1'-61.1'	Checked By:	WPQ	

Stress vs Radial Strain

Stress vs Axial Strain



Young's Modulus

C_o Max = 19,868 psi 50% C_o Max 9,934 psi
10% C_o Max 1,987 psi

E_t (50%) C_o = 9.17E+05 psi

Poisson's Ratio

C_o Max = 19,868 psi 50% C_o Max 9,934 psi
10% C_o Max 1,987 psi

ν_t (50%) C_o = 0.162

Client

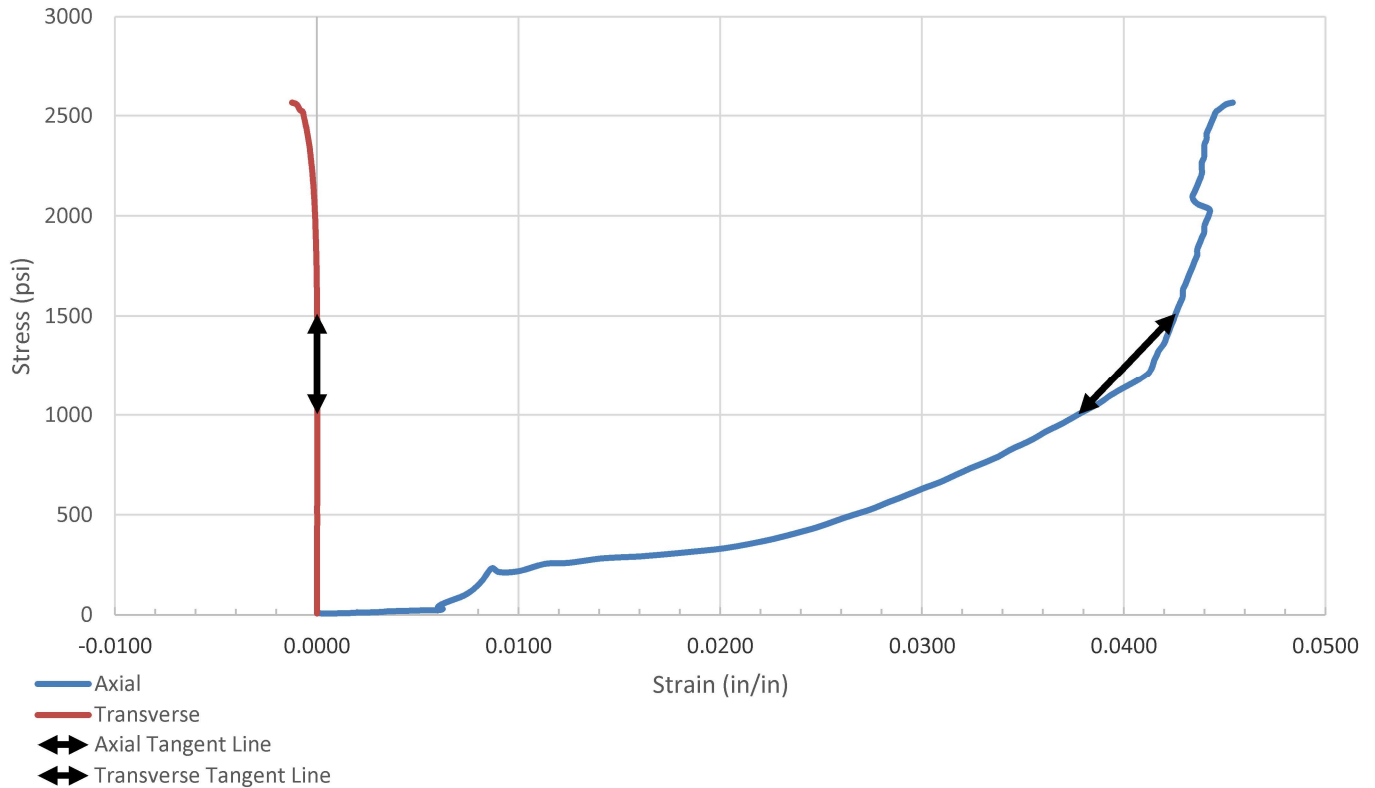
HNTB North Carolina PC
4922 O'Hear Avenue Suite 203
North Charleston, SC 29402

Project

SCDOT Bridge Package 19
Multiple Sites

Project No. 8623P180

ASTM D7012 Stress/ Strain Curve



SAMPLE LOCATION

Site:	SCDOT Bridge Package 19		
Rock Type:	Gneiss		
Boring:	S-42-197-3	Depth (feet):	47.1

SPECIMEN INFORMATION

Sample No.:	NQ-2	Mass (g):	576.97
Length (in.):	4.26	Diameter (in.):	1.94
L/D Ratio:	2.2	Density (pcf):	174.55

TEST RESULTS

Failure Load (lbs):	7580
Failure Strain (%):	4.54
Unconfined Compressive Strength (psi):	2,566
Elastic Modulus, E, (ksi):	105
Poisson's Ratio, u:	0.002
Time of Failure (min):	00:21
Rate of Loading (psi/sec):	124.551
Moisture Content Post-break:	0.5%



Client

HNTB North Carolina PC
4922 O'Hear Avenue Suite 203
North Charleston, SC 29402

Project

SCDOT Bridge Package 19
Multiple Sites

Project No. 8623P180

ASTM D4543 Test Results:

<u>Parameter</u>	<u>Data</u>
Side Straightness:	0.0055
Perpendicularity Deviation:	
Diameter 1a:	0.0067
Diameter 1b:	0.0011
Diameter 2a:	0.0067
Diameter 2b:	0.0043
Max Deviation from Flatness:	0.0025
Parallelism Deviation:	
Diameter a:	0.07
Diameter b:	0.29

Equipment:

	TICCS ID:
Calipers:	W-54522
Scale:	B-71466
Dial Indicator:	C-70608
Compression (spherically seated):	C-48999

Samples were prepared and tested in accordance with ASTM D4543 and D7012. Deviations, if any, are noted below:
Notes:

Per ASTM D4543, this specimen has not met the requirements for straightness, by exceeding 0.02 inches.
Per ASTM D4543, this specimen has not met the requirements for perpendicularity, by exceeding 0.250°.
Per ASTM D4543, this specimen has not met the requirements for flatness, by exceeding 0.001 inches.
According to ASTM D7012 Section 8.2.1, this specimen, although not meeting all requirements of ASTM D4543 is acceptable for testing. However, the results reported may differ from results obtained from a test specimen that meets the requirements of D4543.

Client

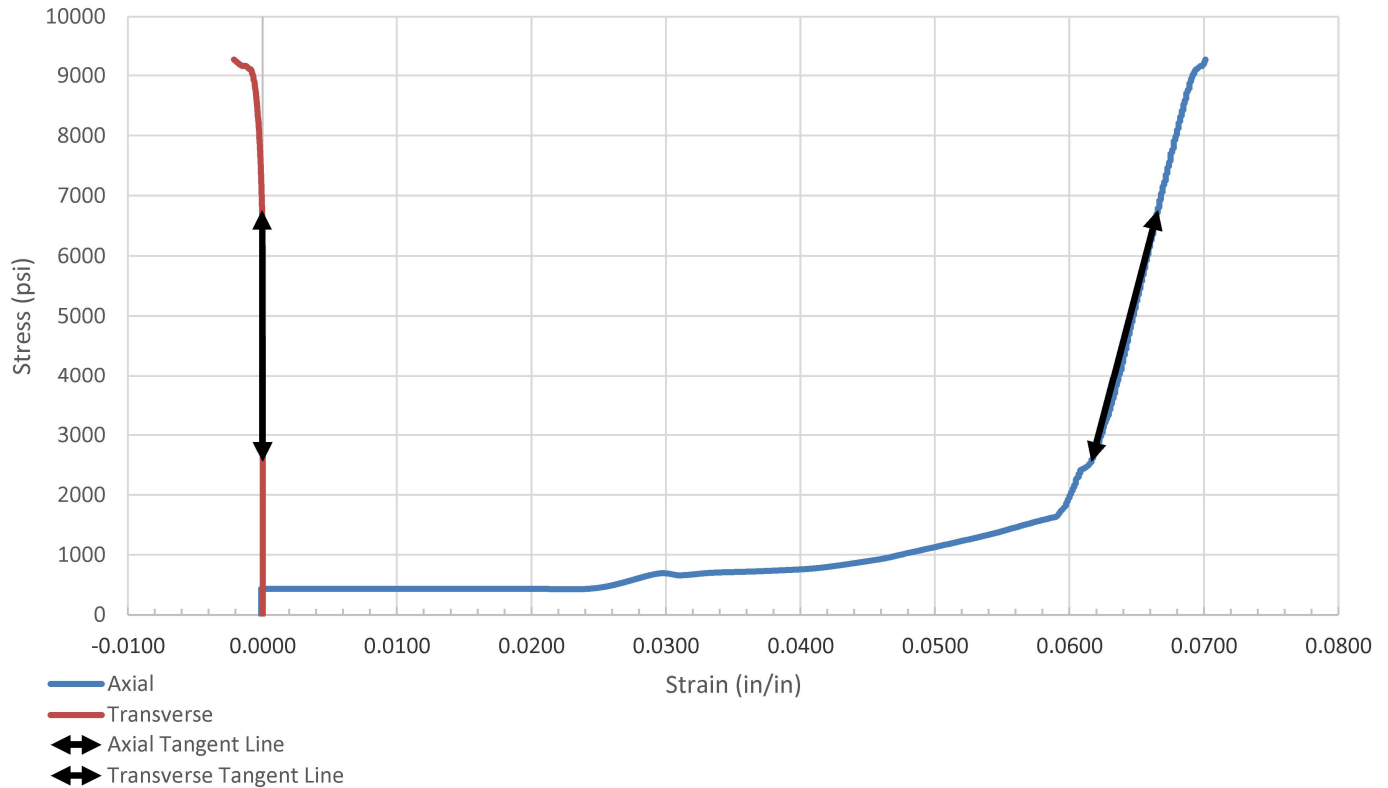
HNTB North Carolina PC
4922 O'Hear Avenue Suite 203
North Charleston, SC 29402

Project

SCDOT Bridge Package 19
Multiple Sites

Project No. 8623P180

ASTM D7012 Stress/ Strain Curve



SAMPLE LOCATION

Site:	SCDOT Bridge Package 19		
Rock Type:	Gneiss		
Boring:	S-42-197-3	Depth (feet):	51.3

SPECIMEN INFORMATION

Sample No.:	NQ-2	Mass (g):	568.07
Length (in.):	4.26	Diameter (in.):	1.95
L/D Ratio:	2.2	Density (pcf):	170.10

TEST RESULTS

Failure Load (lbs):	27667
Failure Strain (%):	7.01
Unconfined Compressive Strength (psi):	9,269
Elastic Modulus, E, (ksi):	855
Poisson's Ratio, u:	0.009
Time of Failure (min):	01:02
Rate of Loading (psi/sec):	149.018
Moisture Content Post-break:	0.2%

Client

HNTB North Carolina PC
4922 O'Hear Avenue Suite 203
North Charleston, SC 29402

Project

SCDOT Bridge Package 19
Multiple Sites

Project No. 8623P180

ASTM D4543 Test Results:

<u>Parameter</u>	<u>Data</u>
Side Straightness:	0.0016
Perpendicularity Deviation:	
Diameter 1a:	0.0055
Diameter 1b:	0.0108
Diameter 2a:	0.0025
Diameter 2b:	0.0083
Max Deviation from Flatness:	0.0018
Parallelism Deviation:	
Diameter a:	0.21
Diameter b:	1.22

Equipment:

	TICCS ID:
Calipers:	W-54522
Scale:	B-71466
Dial Indicator:	C-70608
Compression (spherically seated):	C-48999

Samples were prepared and tested in accordance with ASTM D4543 and D7012. Deviations, if any, are noted below:
Notes:

Per ASTM D4543, this specimen has not met the requirements for straightness, by exceeding 0.02 inches.
Per ASTM D4543, this specimen has not met the requirements for perpendicularity, by exceeding 0.250°.
Per ASTM D4543, this specimen has not met the requirements for flatness, by exceeding 0.001 inches.
According to ASTM D7012 Section 8.2.1, this specimen, although not meeting all requirements of ASTM D4543 is acceptable for testing. However, the results reported may differ from results obtained from a test specimen that meets the requirements of D4543.

Appendix C

Supporting Documents

3-Point Acceleration Design Response Spectrum by SCDOT
Rig Calibration Report – DR#1327 (8 Pages)
Rig Calibration Report – DR#554 (9 Pages)

Note: All exhibits are one page unless noted above.

3-Point Acceleration Design Response Spectrum

SCDOT v3.2 - 06/01/2023

Project ID:	P041164				Latitude:	34.8224	
Route:	S-42-197		County:	42 - Spartanburg		Longitude:	82.0133
Project:	Old Spartanburg Highway over Tyger River						

Designer:	D. Sapkota - Support
Date:	3/5/2025

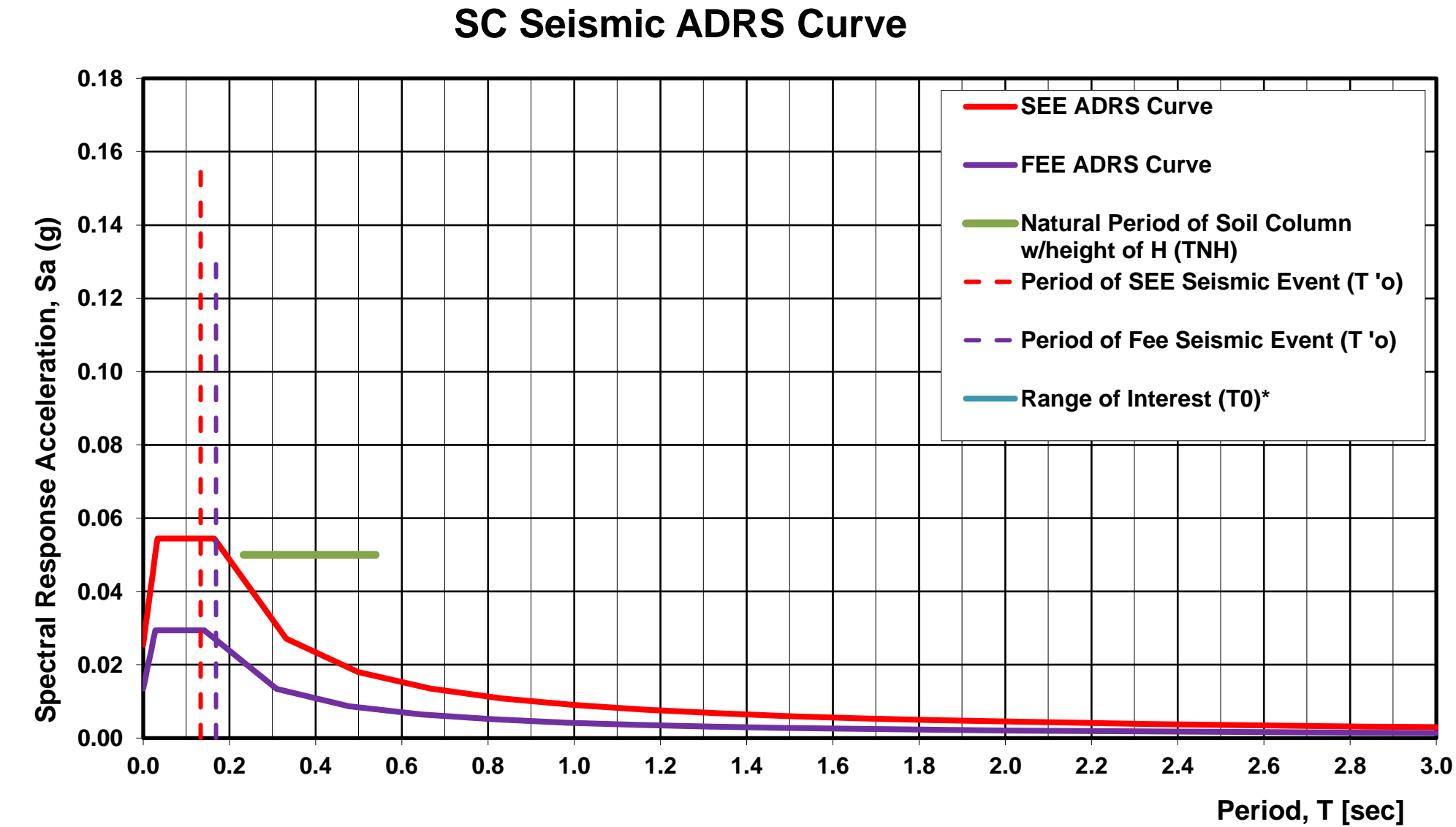
Design EQ	PGA	S _{DS}	S _{D1}	M _W	R	PGV	D _{a5-95}	T' _o
	g	g	g	-	km	inches/sec	sec	sec
FEE	0.01	0.03	0.00	7.30	235.47	0.16	54.12	0.17
SEE	0.03	0.05	0.01	6.55	168.30	0.34	35.54	0.13

Fundamental Period of Structure, T ₀ sec	Range of Interest sec		V* _{s,H} ft/sec	H ft	T _{NH} sec	
	0.5*T ₀	2.0*T ₀			(4*H)/V* _{s,H}	(6*H)/V* _{s,H}
0.00	0.00	0.00	1479.57	133.00	0.23	0.54
0.00	0.00	0.00				

H = B-C Boundary

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

South Carolina Piedmont
*Same Geologic Condition as used in SCENARIO_PC (2006)



FEE Data		SEE Data	
T	S _a	T	S _a
0.00	0.014	0.00	0.025
0.00	0.016	0.01	0.030
0.01	0.019	0.01	0.035
0.01	0.021	0.02	0.040
0.02	0.024	0.02	0.045
0.02	0.027	0.03	0.050
0.03	0.029	0.03	0.054
0.04	0.029	0.04	0.054
0.05	0.029	0.06	0.054
0.06	0.029	0.07	0.054
0.07	0.029	0.08	0.054
0.08	0.029	0.09	0.054
0.08	0.029	0.10	0.054
0.09	0.029	0.11	0.054
0.10	0.029	0.12	0.054
0.11	0.029	0.13	0.054
0.12	0.029	0.14	0.054
0.13	0.029	0.15	0.054
0.14	0.029	0.17	0.054
0.31	0.013	0.33	0.027
0.48	0.009	0.50	0.018
0.65	0.006	0.67	0.014
0.81	0.005	0.83	0.011
0.98	0.004	1.00	0.009
1.15	0.004	1.17	0.008
1.32	0.003	1.33	0.007
1.49	0.003	1.50	0.006
1.65	0.003	1.67	0.005
1.82	0.002	1.83	0.005
1.99	0.002	2.00	0.005
2.16	0.002	2.17	0.004
2.33	0.002	2.33	0.004
2.50	0.002	2.50	0.004
2.66	0.002	2.67	0.003
2.83	0.001	2.83	0.003
3.00	0.001	3.00	0.003

SPT Automatic Hammer Energy Measurement Report

Drill Rig Model: Geoprobe 3126GT

Drill Rig Serial Number: 3126S5V224106

Asset Number: DR#1327

September 13, 2024

September 13, 2024

Terracon Consultants Inc.
72 Pointe Circle
Greenville, SC 29615

Attn: Nitin Dudani
E: nitin.dudani@terracon.com

Re: SPT Automatic Hammer Energy Measurement Report
Rig No: 1327
Terracon Project Number: 73245115

Dear Mr. Dudani:

This report provides the Energy Transfer Ratio (ETR) for the Standard Penetration Testing (SPT) automatic hammer as summarized below:

Table 1: Hammer Efficiency Summary

Drill Rig Make/Model	Drill Rig Serial Number	Drill Rig Year	Asset Number	Energy Transfer Ratio (ETR)	Hammer Efficiency Correction (C_e)
Geoprobe	3126S5V224106	2024	DR#1327	92.6% ± 1.75%	1.54

*Please Note: according to ASTM standard, a minimum of three recordings should be collected at five-foot intervals no shallower than twenty feet below current ground surface (bgs). The sample intervals were obtained between 30 and 50 feet bgs.

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

Ryan C. Wakeford, P.E.
Geotechnical Engineer

Susheel R. Kolwalkar

Susheel R. Kolwalkar, Ph.D., P.E.
Regional Services Manager



Micah Hatch, P.E.
Geotechnical Department Manager



Attachments:

- Exhibit A: SPT Representative Blow
- Exhibit B: SPT Analyzer Literature and Equipment Calibrations
- Exhibit C: SPT Analyzer Results
- Exhibit D: Field Log
- Exhibit E: Copy of Certificate of Proficiency

Facilities | Environmental | Geotechnical | Materials |



Prepared for:

Terracon Consultants, Inc.
Greenville, South Carolina



1.0 MEASUREMENT SUMMARY

ITEM	DESCRIPTION
Drill Rig Owner	Terracon Consultant, Inc. – Greenville, SC
Drill Rig Operator	Brett Burnett: Terracon Exploration
Testing Date	9/5/2024
Testing Location	Sumter County, SC
Boring Identification	B-3
Energy Measurement Depths	30 ft, 40 ft, 45 ft, 50 ft
Subsurface Soils	Poorly graded sands (SP) to clayey sands (SC)
Hammer Type/Height	140 pounds (automatic) with 2.5-foot drop height
Boring Method	Mud rotary
Drill Rods	<ul style="list-style-type: none"> AWJ 1-3/4" outside diameter 1-1/4" inside diameter 1.15 in² cross sectional area 1/4" wall thickness
Calibration Testing Equipment	<ul style="list-style-type: none"> 2-foot AWJ rod instrumented w/ two strain gauges and two accelerometers manufactured by Pile Dynamics Inc. (PDI) SN: 746AWJ Model SPT Analyzer™ (PDA) SN: 4621 TB
ASTM Methods Used	ASTM D1586, Standard Test Method for Standard Penetration Test and Split-Barrel Sampling of Soils ASTM D4633-16, Standard Method for Energy Measurement for Dynamic Penetrometers
SPT Calibration Personnel	Ryan Wakeford – Intermediate PDA Proficiency, Terracon Consultants, Inc.

2.0 PURPOSE AND SCOPE OF WORK

The North Charleston office of Terracon Consultants, Inc. conducted SPT energy measurements in accordance with ASTM D4633-16 at a site off Panola Road in Sumter County, South Carolina. Energy measurements on the rig were taken during eight samples events.

3.0 TEST RESULTS

Table 2: SPT Hammer Energy Calibration Testing Summary

Boring	Start Depth ¹ (ft)	Rod Length ² (ft)	Rod Sections ³		Measured Blow Counts (blows/6 Inches)				SPT N _{meas} (bpf)	Soil Type ⁴	
					2 ft	5 ft	10 ft	1 st Inc.			2 nd Inc.
B-3	28.5	33.7	0	6	0	4	5	6	-	11	SP
	38.5	43.7	0	8	0	7	10	10	-	20	SP
	43.5	48.7	0	9	0	4	5	7	-	12	SP
	48.5	53.7	0	10	0	4	4	7	-	11	SP

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

Table 3: Energy Measurement and Analysis Summary

Boring	Start Depth ¹ (ft)	SPT N _m (bpf)	No. of Blows ²	EMX ³ (ft-lbs)			ETR ³ (%)		
				Max.	Min.	Ave.	Std. Dev.	Ave.	Std. Dev.
B-3	28.5	11	11	340	313	327	8.8	93.4	2.5
	38.5	20	20	334	309	318	5.6	90.9	1.6
	43.5	12	12	330	309	323	5.5	92.4	1.6
	48.5	11	11	334	320	328	4.5	93.7	1.3
Average:				335	313	334	6.1	92.6	1.75

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

Table 4: Hammer Blow Rate Summary

Boring	Start Depth ¹ (ft)	SPT N _{meas} (bpf)	No. of Blows ²	BPM ³			
				Max.	Min.	Ave.	Std. Dev.
B-3	28.5	11	11	53.8	53.1	53.5	0.2
	38.5	20	20	53.7	53.0	53.4	0.1
	43.5	12	12	53.6	53.2	53.4	0.1
	48.5	11	11	53.8	53.1	53.4	0.2
Average:				53.7	53.1	53.4	0.2

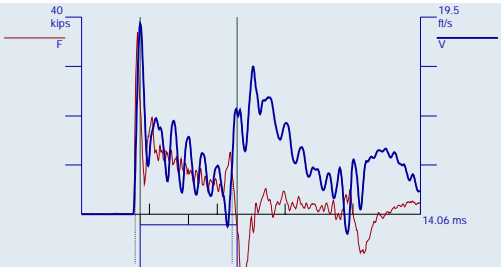
1. Boring ID and depth from existing ground surface to start of SPT.
2. Number of blows used in energy calibration analysis. Limited to measurements recorded during the second and third 6-inch sampling intervals at each depth or during the 1st increment if refusal conditions were encountered.
3. BPM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

Exhibit A

SPT Representative Blow

GRL Engineers, Inc.
GEOPROBE 3126GT
28.5-30
B3
PDA Operator: RW

Pile Driving Analyzer ® (PDA)
Version: 2022.35.2



BN 13
05Sep2024 10:07:23 AM

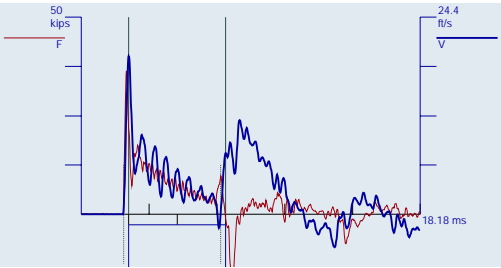
CSX	32.1 ksi
DMX	1.11 in
EFV	331 ft-lb
ETR	94.7 %
BPM	53.8 bpm
RAT	1.0
VMX	18.9 ft/s
FMX	37 kips
DFN	1.00 in
MEX	1070 µE
AMX	3001 g/s
FVP	0.6

LE	33.70 ft
AR	1.15 in ²
EM	30000 ksi
SP	0.492 k/ft ³
WS	16807.9 ft/s
WC	16766.2 ft/s
JC	0.90
JF	1.00

F1: [746AWJ1]	222.05 PDICAL (1) FF1
F2: [746AWJ2]	222.19 PDICAL (1) FF1
A3 (PR): [K14007]	407.233 mvi/6.4vi/5000g (1) VF1
A4 (PR): [K14006]	375.226 mvi/6.4vi/5000g (1) VF1

GRL Engineers, Inc.
GEOPROBE 3126GT
38.5-40
B3
PDA Operator: RW

Pile Driving Analyzer ® (PDA)
Version: 2022.35.2

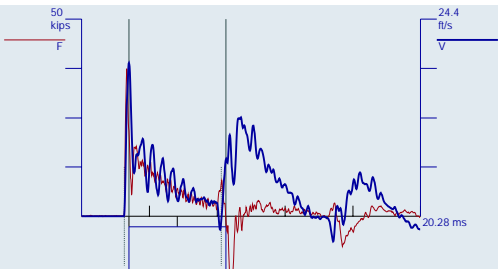


BN 25
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CSX	31.7 ksi
DMX	0.66 in
EFV	324 ft-lb
ETR	92.6 %
BPM	53.4 bpm
RAT	1.1
VMX	19.6 ft/s
FMX	36 kips
DFN	0.60 in
MEX	1056 µE
AMX	3358 g/s

LE	43.70 ft
AR	1.15 in ²
EM	30000 ksi
SP	0.492 k/ft ³
WS	16807.9 ft/s
WC	16807.7 ft/s
JC	0.90
JF	1.00

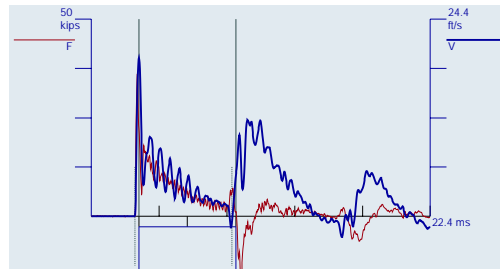
F1: [746AWJ1]	222.05 PDICAL (1) FF1
F2: [746AWJ2]	222.19 PDICAL (1) FF1
A3 (PR): [K14007]	407.233 mvi/6.4vi/5000g (1) VF1
A4 (PR): [K14006]	375.226 mvi/6.4vi/5000g (1) VF1



BN 14
 05Sep2024 10:32:57 AM

CSX	32.6 ksi
DMX	0.91 in
EFV	325 ft-lb
ETR	92.8 %
BPM	53.4 bpm
RAT	1.0
VMX	19.0 ft/s
FMX	37 kips
DFN	0.86 in
MEX	1086 µE
AMX	3426 g's
LE	48.70 ft
AR	1.15 in ²
EM	30000 ksi
SP	0.492 kN/m ³
WS	16807.9 ft/s
WC	16793.1 ft/s
JC	0.90
JF	1.00

F1: [746AWJ1]	222.05 PDICAL (1) FF1
F2: [746AWJ2]	222.19 PDICAL (1) FF1
A3 (PR): [K14007]	407.233 mvi/6.4v/5000g (1) VF1
A4 (PR): [K14006]	375.226 mvi/6.4v/5000g (1) VF1



BN 13
 05Sep2024 10:42:13 AM

CSX	31.5 ksi
DMX	1.01 in
EFV	320 ft-lb
ETR	91.4 %
BPM	53.7 bpm
RAT	1.1
VMX	19.6 ft/s
FMX	36 kips
DFN	0.86 in
MEX	1049 µE
AMX	4077 g's
LE	53.70 ft
AR	1.15 in ²
EM	30000 ksi
SP	0.492 kN/m ³
WS	16807.9 ft/s
WC	16781.3 ft/s
JC	0.90
JF	1.00

F1: [746AWJ1]	222.05 PDICAL (1) FF1
F2: [746AWJ2]	222.19 PDICAL (1) FF1
A3 (PR): [K14007]	407.233 mvi/6.4v/5000g (1) VF1
A4 (PR): [K14006]	375.226 mvi/6.4v/5000g (1) VF1



SPT Analyzer

SPT Analyzer

Measures the energy transferred into an instrumented SPT rod during a Standard Penetration Test (SPT)

Reliable. Simplified. Rugged.

The SPT Analyzer determines the energy transferred by SPT hammers using force and velocity measurements, for improved reliability of SPT N-values.

What is SPT?

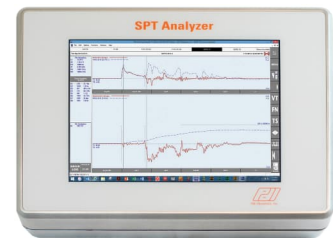
The Standard Penetration Test (SPT) is a widely-employed soil exploration tool that involves using an SPT hammer to drive a split sampler at the bottom of a drill string to obtain soil samples. The number of blows required to penetrate the last 300mm (1ft) is the "N value" which is related to soil strength.

Why measure the energy transferred by the SPT hammer?

Several different types of SPT hammers are used to conduct Standard Penetration Tests. Their varying efficiencies influence the N value. The measured N value is normalized by multiplying it by the ratio of the measured energy transferred to the rod to 60% of the theoretical potential energy. The normalization compensates for the variability of the efficiencies of different SPT hammer types, and improves the reliability of soil strength estimates used in geotechnical applications.

The SPT Analyzer is furnished with a 0.6m sub assembly (or section) of an SPT rod (AW, NW or other type) instrumented with two strain gage bridges, and calibrated by Pile Dynamics. Once in the field, two accelerometers are bolted to the rod section. The instrumented section is inserted at the top of the drill string between the hammer and the existing sampling rod. The sensors on the rod are connected to the SPT Analyzer.

Smart Sensor technology allows the SPT Analyzer to read the rod instrumentation, obtaining the sensor calibration and rod cross sectional area.



- Calculates energy transferred by SPT hammers using force and velocity measurements
- Determines N Value to help improve reliability of soil strength estimates
- Offers simplified reporting and analysis option to speed testing results
- Operates in English, SI, or Metric units



Exhibit B

SPT Analyzer Literature and Equipment Calibrations

EN ISO 22486-3:2005/ASTM Compliant

The SPT Analyzer is compliant with EN ISO 22476-3:2005. ASTM D1586 recommends normalizing results from any SPT test using energy measurements. When these tests are performed to determine the liquefaction potential of sands, ASTM D6066 not only recommends but mandates the normalization. ASTM D4633 states that the only acceptable method of determining energy for normalization of N values is by force and velocity measurements.

These quantities are input to the SPT Analyzer automatically. This significantly simplifies the initial test setup.

The strain gages and accelerometers obtain the force and velocity signals necessary for the calculation of transferred energy to the drill string for each hammer blow. The energy is displayed in real time on the SPT Analyzer screen.

Output

SPT Analyzer data is stored and transferred to a computer via USB memory stick. The software furnished with the SPT Analyzer has a Report Creation Option that makes it quick and easy to summarize results and create output graphs of Force, Velocity, Energy and Displacement versus Time, as well as numerical, statistical, and graphical results for each data set. The software is fully customizable.



Pile Dynamics, Inc. (PDI) is the world leader in developing, manufacturing and supplying state of the art QA/QC products and systems for the deep foundations industry. The company is headquartered in Cleveland, Ohio, USA, with offices and representatives worldwide. For additional information visit us at www.pile.com or contact info@pile.com.

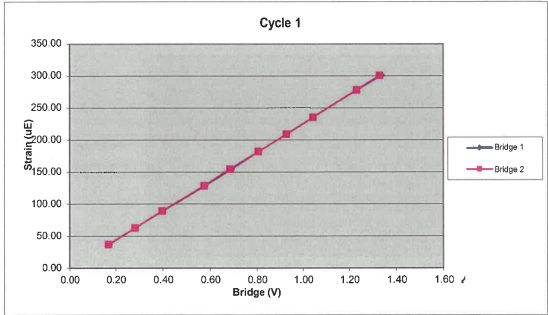
www.pile.com | +1 (216) 831-6131 | info@pile.com



746AWJ		Cycle 1			
Sample	Force (lb)	Strain (µE)	Bridge 1 (V)	Bridge 2 (V)	
1	0.00	0.00	0.00	0.00	
2	1296.93	37.22	0.17	0.17	
3	2135.32	62.74	0.28	0.28	
4	3028.79	89.39	0.40	0.40	
5	4377.09	128.61	0.58	0.57	
6	5243.07	154.57	0.69	0.68	
7	6143.17	181.90	0.81	0.81	
8	7067.05	208.93	0.93	0.93	
9	7958.18	236.42	1.04	1.05	
10	9380.66	278.02	1.23	1.23	
11	10161.74	300.76	1.34	1.33	

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7605.07	Force Calibration (lb/V)	7606.74
Offset	-0.16	Offset	12.66
Correlation	0.999997	Correlation	0.999990
Strain Calibration (µE/V)	225.99	Strain Calibration (µE/V)	226.04
Offset	-1.01	Offset	-0.63
Correlation	0.999989	Correlation	0.999992

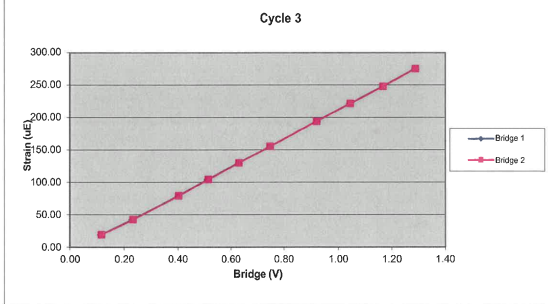
Force Strain Calibration	
EA (Kips)	33651.50
Offset	33.98
Correlation	0.999994



746AWJ		Cycle 3			
Sample	Force (lb)	Strain (µE)	Bridge 1 (V)	Bridge 2 (V)	
1	0.00	0.00	0.00	0.00	
2	886.16	19.27	0.11	0.12	
3	1786.75	42.28	0.23	0.23	
4	3083.67	79.12	0.40	0.40	
5	3943.80	104.13	0.51	0.51	
6	4839.52	129.87	0.63	0.63	
7	5750.14	155.24	0.75	0.75	
8	7079.92	194.22	0.92	0.92	
9	8007.70	221.43	1.04	1.05	
10	8943.28	247.95	1.17	1.17	
11	9871.55	275.44	1.29	1.29	

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7659.96	Force Calibration (lb/V)	7667.39
Offset	13.76	Offset	-1.59
Correlation	0.999999	Correlation	0.999998
Strain Calibration (µE/V)	219.43	Strain Calibration (µE/V)	219.64
Offset	-7.95	Offset	-8.39
Correlation	0.999934	Correlation	0.999939

Force Strain Calibration	
EA (Kips)	34904.41
Offset	291.93
Correlation	0.999935



Accelerometer Calibration Certificate
Pile Dynamics, Inc.



Calibrated by Pile Dynamics, Inc.
Calibration performed on MAY 1 6 2024

Serial No: K14006 Temperature: 24.0 °C
Model: PR Humidity: 42%
Calibrated on: Channel 3 on 8G 5161 LE

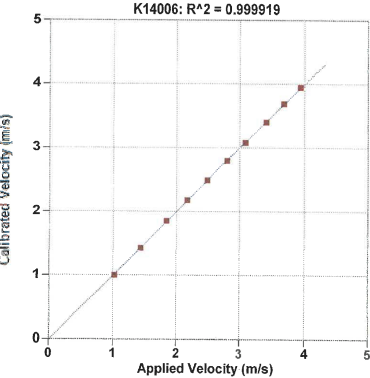
PDA CALIBRATION FACTOR
375.2 mv/5000g
(75.0 μ v/g)
R²: 0.999919 [Chip programmed]

Operator: William Johnson

Ref Acc 1: 78268! Cal on: 11Jan2024
986 g/s/volt
Ref Acc 2: 78270! Cal on: 11Jan2024
971 g/s/volt

Signed

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



Reference Velocity m/s	S/N K14006 Velocity m/s
1.015	1.001
1.426	1.425
1.839	1.850
2.171	2.177
2.489	2.491
2.800	2.796
3.087	3.078
3.408	3.397
3.681	3.688
3.938	3.946

Maximum Acceleration: 848 g's

Version: 2020.30.170 -0.17

Accelerometer Calibration Certificate
Pile Dynamics, Inc.



Calibrated by Pile Dynamics, Inc.
Calibration performed on MAY 1 6 2024

Serial No: K14007 Temperature: 23.8 °C
Model: PR Humidity: 42%
Calibrated on: Channel 4 on 8G 5161 LE

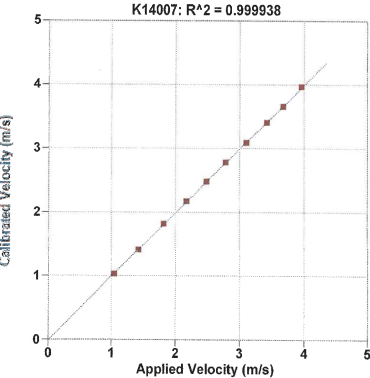
PDA CALIBRATION FACTOR
407.2 mv/5000g
(81.4 μ v/g)
R²: 0.999938 [Chip programmed]

Operator: William Johnson

Ref Acc 1: 78268! Cal on: 11Jan2024
986 g/s/volt
Ref Acc 2: 78270! Cal on: 11Jan2024
971 g/s/volt

Signed

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



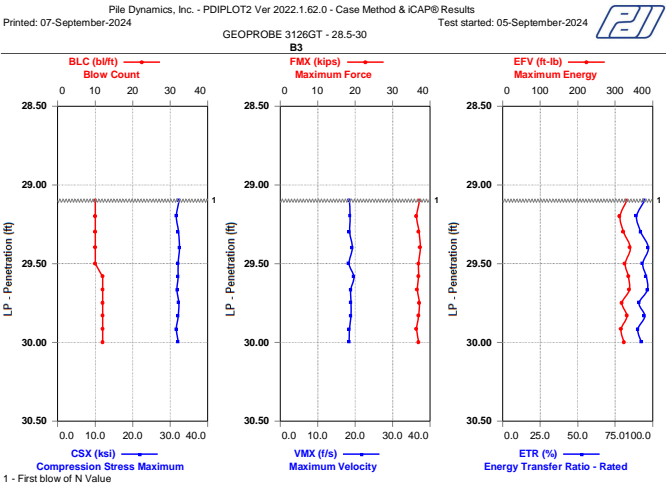
Reference Velocity m/s	S/N K14007 Velocity m/s
1.042	1.032
1.417	1.411
1.812	1.817
2.168	2.173
2.478	2.483
2.777	2.783
3.098	3.090
3.411	3.406
3.666	3.657
3.955	3.967

Maximum Acceleration: 852 g's

Version: 2020.30.170 -0.28



Exhibit C
SPT Analyzer Results



Case Method & iCAP® Results

GEOPROBE 3126GT - 28.5-30

Date: 05-September-2024

OP: RW
AR: 1.15 in²
LE: 33.70 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft³
EM: 30,000 ksi
JC: 0.00

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

BL#	Depth ft	BLC b/ft	FMX kips	VMX f/s	EMX ft-lb	EFV ft-lb	ETR (%)	BPM bpm	DMX in	DFN in	CSX ksi
5	29.10	10	37	18.4	331.0	331.0	94.6	53.1	1.58	1.20	32.3
6	29.20	10	36	18.7	312.7	312.7	89.3	53.4	1.47	1.20	31.7
7	29.30	10	37	18.5	323.0	323.0	92.3	53.6	1.54	1.20	32.2
8	29.40	10	37	19.2	340.4	340.4	97.3	53.4	1.57	1.20	32.5
9	29.50	10	37	18.4	326.6	326.6	93.3	53.5	1.48	1.20	32.1
10	29.58	12	37	19.6	335.5	335.5	95.9	53.3	1.41	1.00	32.1
11	29.67	12	37	18.8	338.0	338.0	96.6	53.7	1.58	1.00	31.8
12	29.75	12	37	18.9	318.3	318.3	90.9	53.5	1.37	1.00	32.3
13	29.83	12	37	18.9	331.4	331.4	94.7	53.8	1.11	1.00	32.1
14	29.92	12	36	18.5	315.2	315.2	90.1	53.8	1.09	1.00	31.7
15	30.00	12	37	18.4	324.1	324.1	92.6	53.6	1.07	1.00	32.1
Average			37	18.8	326.9	326.9	93.4	53.5	1.39	1.09	32.1
Std. Dev.			0	0.4	8.8	8.8	2.5	0.2	0.19	0.10	0.3
Maximum			37	19.6	340.4	340.4	97.3	53.8	1.58	1.20	32.5
Minimum			36	18.4	312.7	312.7	89.3	53.1	1.07	1.00	31.7

Total number of blows analyzed: 11

BL# Sensors

5-15 F1: [746AWJ1] 222.1 (1.00); F2: [746AWJ2] 222.2 (1.00); A3: [K14007] 407.2 (1.00);
A4: [K14006] 375.2 (1.00)

BL# Comments

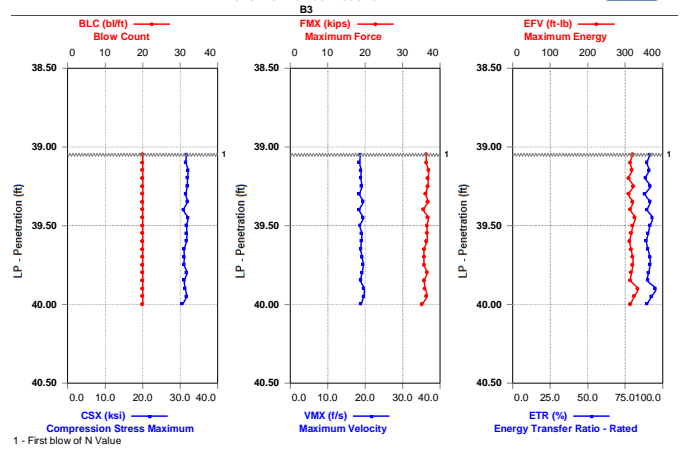
5 First blow of N Value

Time Summary

Drive 15 seconds 10:07 AM - 10:07 AM BN 1 - 15

GEOPROBE 3126GT - 38.5-40

Test started: 05-September-2024



Case Method & iCAP® Results

GEOPROBE 3126GT - 38.5-40

Date: 05-September-2024

OP: RW
AR: 1.15 in²
LE: 43.70 ft
WS: 16,807.9 f/s
SP: 0.492 k/ft³
EM: 30,000 ksi
JC: 0.00

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

BL#	Depth ft	BLC b/ft	FMX kips	VMX f/s	EMX ft-lb	EFV ft-lb	ETR (%)	BPM bpm	DMX in	DFN in	CSX ksi
7	39.05	20	36	18.7	320.4	320.4	91.5	53.3	0.91	0.60	31.6
8	39.10	20	36	18.5	313.6	313.6	89.6	53.2	0.65	0.60	31.6
9	39.15	20	37	18.9	318.4	318.4	91.0	53.4	0.66	0.60	32.1
10	39.20	20	37	18.9	309.8	309.8	88.5	53.5	0.64	0.60	31.9
11	39.25	20	37	19.1	321.4	321.4	91.8	53.2	0.93	0.60	31.9
12	39.30	20	36	18.5	309.3	309.3	88.4	53.5	0.64	0.60	31.5
13	39.35	20	37	19.5	320.6	320.6	91.6	53.0	0.69	0.60	31.9
14	39.40	20	36	18.4	314.3	314.3	89.8	53.3	0.80	0.60	30.9
15	39.45	20	37	19.5	326.5	326.5	93.3	53.5	0.92	0.60	32.0
16	39.50	20	36	18.6	320.6	320.6	91.6	53.5	1.02	0.60	31.7
17	39.55	20	37	19.1	316.4	316.4	90.4	53.7	0.68	0.60	31.8
18	39.60	20	36	19.0	312.4	312.4	89.2	53.3	0.66	0.60	31.7
19	39.65	20	36	18.8	315.8	315.8	90.2	53.5	0.70	0.60	31.1
20	39.70	20	36	19.2	320.1	320.1	91.5	53.4	0.78	0.60	31.1
21	39.75	20	36	19.5	320.9	320.9	91.7	53.3	0.63	0.60	31.0
22	39.80	20	37	19.2	317.1	317.1	90.6	53.5	0.74	0.60	31.7
23	39.85	20	36	18.8	315.1	315.1	90.0	53.5	0.61	0.60	31.1
24	39.90	20	36	19.7	333.6	333.6	95.3	53.5	0.83	0.60	31.3
25	39.95	20	36	19.6	323.9	323.9	92.6	53.4	0.66	0.60	31.7
26	40.00	20	35	18.9	313.5	313.5	89.6	53.5	0.60	0.60	30.6
Average			36	19.0	318.2	318.2	90.9	53.4	0.74	0.60	31.5
Std. Dev.			0	0.4	5.6	5.6	1.6	0.1	0.12	0.00	0.4
Maximum			37	19.7	333.6	333.6	95.3	53.7	1.02	0.60	32.1
Minimum			35	18.4	309.3	309.3	88.4	53.0	0.60	0.60	30.6

Total number of blows analyzed: 20

BL# Sensors

7-26 F1: [746AWJ1] 222.1 (1.00); F2: [746AWJ2] 222.2 (1.00); A3: [K14007] 407.2 (1.00);
A4: [K14006] 375.2 (1.00)

BL# Comments

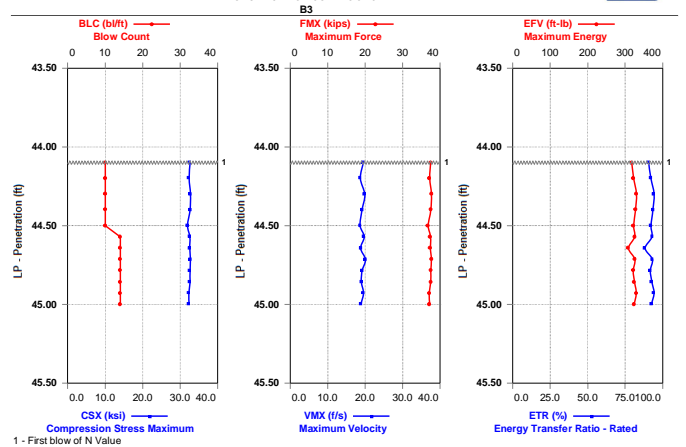
7 First blow of N Value

Time Summary

Drive 28 seconds 10:24 AM - 10:24 AM BN 1 - 26

GEOPROBE 3126GT - 43.5-45

Test started: 05-September-2024



Case Method & iCAP® Results

GEOPROBE 3126GT - 43.5-45

B3
Date: 05-September-2024

OP: RW
AR: 1.15 in² SP: 0.492 k/ft²
LE: 48.70 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.00

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

ETR: Energy Transfer Ratio - Rated

BL#	Depth ft	BLC bl/ft	FMX kips	VMX f/s	EMX ft-lb	EFV ft-lb	ETR (%)	BPM bpm	DMX in	DFN in	CSX ksi
5	44.10	10	37	19.5	317.4	317.4	90.7	53.2	1.23	1.19	32.6
6	44.20	10	37	18.7	322.7	322.7	92.2	53.3	1.22	1.20	32.4
7	44.30	10	38	19.9	330.1	330.1	94.3	53.4	1.30	1.20	32.8
8	44.40	10	38	19.2	327.2	327.2	93.5	53.5	1.22	1.20	32.6
9	44.50	10	37	18.6	323.0	323.0	92.3	53.5	1.21	1.20	32.0
10	44.57	14	37	19.7	325.2	325.2	92.9	53.4	0.95	0.85	32.6
11	44.64	14	37	18.8	309.1	309.1	88.3	53.6	0.90	0.85	32.5
12	44.71	14	38	20.1	326.0	326.0	93.2	53.5	1.06	0.86	32.8
13	44.79	14	37	19.2	321.1	321.1	91.8	53.4	1.05	0.86	32.6
14	44.86	14	37	19.0	324.7	324.7	92.8	53.4	0.91	0.86	32.6
15	44.93	14	37	19.5	329.6	329.6	94.2	53.5	0.99	0.86	32.3
16	45.00	14	37	18.8	323.5	323.5	92.4	53.4	0.89	0.86	32.3
Average		37	19.3	323.3	323.3	92.4	53.4	1.08	1.00		32.5
Std. Dev.		0	0.5	5.5	6.5	1.6	0.1	0.15	0.17	0.2	
Maximum		38	20.1	330.1	330.1	94.3	53.6	1.30	1.20	32.8	
Minimum		37	18.6	309.1	309.1	88.3	53.2	0.89	0.85	32.0	

Total number of blows analyzed: 12

BL# Sensors

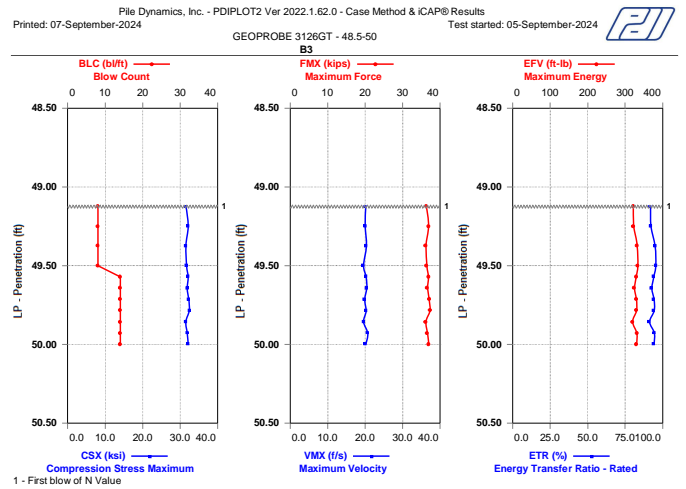
5-16 F1: [746AWJ1] 222.1 (1.00); F2: [746AWJ2] 222.2 (1.00); A3: [K14007] 407.2 (1.00);
A4: [K14006] 375.2 (1.00)

BL# Comments

5 First blow of N Value

Time Summary

Drive 16 seconds 10:32 AM - 10:33 AM BN 1 - 16



Case Method & iCAP® Results

GEOPROBE 3126GT - 48.5-50

B3
Date: 05-September-2024

OP: RW
AR: 1.15 in² SP: 0.492 k/ft²
LE: 53.70 ft EM: 30,000 ksi
WS: 16,807.9 f/s JC: 0.00

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

ETR: Energy Transfer Ratio - Rated

BL#	Depth ft	BLC bl/ft	FMX kips	VMX f/s	EMX ft-lb	EFV ft-lb	ETR (%)	BPM bpm	DMX in	DFN in	CSX ksi
5	49.13	8	36	20.1	321.6	321.6	91.9	53.3	1.81	1.50	31.6
6	49.25	8	37	20.1	323.0	323.0	92.3	53.4	1.81	1.50	32.1
7	49.38	8	36	20.3	332.2	332.2	94.9	53.5	1.50	1.50	31.5
8	49.50	8	36	19.6	334.0	334.0	95.4	53.3	1.50	1.50	31.7
9	49.57	14	37	20.3	329.3	329.3	94.1	53.8	0.87	0.86	32.1
10	49.64	14	37	20.4	324.8	324.8	92.8	53.4	1.00	0.86	31.9
11	49.71	14	37	19.9	329.7	329.7	94.2	53.2	0.89	0.86	32.2
12	49.79	14	37	20.2	330.1	330.1	94.3	53.7	0.89	0.86	32.4
13	49.86	14	36	19.6	319.8	319.8	91.4	53.7	1.01	0.86	31.5
14	49.93	14	37	20.7	331.0	331.0	94.6	53.1	0.91	0.86	31.9
15	50.00	14	37	20.1	330.2	330.2	94.4	53.2	1.03	0.86	32.1
Average		37	20.1	327.8	327.8	93.7	53.4	1.20	1.09		31.9
Std. Dev.		0	0.3	4.5	4.5	1.3	0.2	0.36	0.31	0.3	
Maximum		37	20.7	334.0	334.0	95.4	53.8	1.81	1.50	32.4	
Minimum		36	19.6	319.8	319.8	91.4	53.1	0.87	0.86	31.5	

Total number of blows analyzed: 11

BL# Sensors

5-15 F1: [746AWJ1] 222.1 (1.00); F2: [746AWJ2] 222.2 (1.00); A3: [K14007] 407.2 (1.00);
A4: [K14006] 375.2 (1.00)

BL# Comments

5 First blow of N Value

Time Summary

Drive 15 seconds 10:42 AM - 10:42 AM BN 1 - 15

Exhibit D

Field Log





SPT HAMMER CALIBRATION FIELD WORKSHEET

PROJECT NAME: 7324515
PROJECT NO.: Terracon Assets Site
BORING NO.: 8-3
CLIENT:

ARRIVAL TIME:
DEPART TIME:
TOTAL TRAVEL:
TOTAL TIME:
CLIENT REP:
MILEAGE:

DATE: 9/5/24
TERRACON REP: WJ
PDA MODEL/SN: SPT 462 TR
TERRACON RIG #: 1327

DRILL RIG DATA

Type/Transport: Truck
Manufacturer: GOMACO
Model No.: 3126 GT
Serial No.: 312654224106
Year Built: 2024
Modifications: N/A
Maint. Schedule: 50 hrs

SPT HAMMER DATA

Type: A-10
Manufacturer: GOMACO
Lifting Mechanism: Crane
Model No.: AD131
Serial No.: 10001
Hammer Weight: 140
Hammer Operator(s): B. Bennett

PDA INPUT DATA

Operator: OP WJ
Project No./Location: 7324515/
Rig Model & SN: PN GOMACO/3126 GT
Hammer Type, LM, Rods: PD 4620/AD131
Drill Rod Area (in²): AR 4.15

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

NOTES: $28.6 + 25 + 1.875 = 55.475$
 $34 \frac{3}{8} + 25 + 1.875 = 59.875$
 $28.6 + 0.88 = 29.48$
 $= 3.5$

'LE' is measured from the center of the strain gauges to the bottom of split spoon sampler

TRANSDUCER INFORMATION

Gage SN Calibration
F1/F3: 746 AWJ1 222.05
F2/F4: 746 AWJ2 222.19
A1/A3: K14002 407.23
A2/A4: K14006 375.23

SPT TESTING INFORMATION

Start Time	Soil	Stick Up Length (ft)	Depth (ft)		'LE' (ft)	Rods & Lengths	PDA Blows		SPT Blows			
			Start	End			Start	End	1st 6"	2nd 6"	3rd 6"	4th 6"
9:55	SC		23.5	25	28.7	5'x5	1	30	5	10	14	24
10:05	SP		28.5	30	33.7	5'x6	3	18	4	5	6	11
10:10	CL		33.5	35	38.7	5'x7	1	18	0	0	0	0
10:15	SP		38.5	40	43.7	5'x8	3	30	7	10	10	20
10:25	SP		43.5	45	48.7	5'x9	1	18	4	5	7	12
10:35	SP		48.5	50	53.7	5'x10	1	17	4	4	7	11
10:50	SC		53.5	55	58.7	5'x11	1	6	2	1	2	3
11:10	SC		58.5	60	63.7	5'x12	1	2	0	0	0	1

Individual pairs of F or V signals versus time shall be very similar for good quality data.

If you see Force goes negative before 2L/C after impact, drill rod joints should be carefully tightened for good quality data

PICTURE NUMBERS AND INFO:

Take Photo of Each Rigs, Boring Locations at the Site

Terracon SPT Rig Calibration Worksheet.xlsx



This documents that
Susheel R. Kolwalker
Terracon Consultants

has on March 11, 2016 achieved the rank of

EXPERT

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.

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. 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. This certificate can be verified at www.PDAproficiencytest.com.

Steven A. Hall, Executive Director
Pile Driving Contractors Association

Garland Likins, Senior Partner
Pile Dynamics, Inc.

No. 2005



Exhibit E

Copy of Certificate of Proficiency

Facilities | Environmental | Geotechnical | Materials 4



This documents that
Ryan Wakeford
Terracon Consultants, Inc.
has on March 15, 2019 achieved the rank of
INTERMEDIATE

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 Intermediate level seek Advanced, Master or Expert levels through additional study within four 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. 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. This certificate can be verified at www.PDAproficiencytest.com.

Frank T. Peters, Executive Director
Pile Driving Contractors Association

Garland Likins, Senior Partner
Pile Dynamics, Inc.

No. 2898

SPT Automatic Hammer Energy Measurement Report

Drill Rig Model: Geoprobe 3126GT

Drill Rig Serial Number: 3126GTS52010006

Asset Number: DR#554

September 19, 2024

September 19, 2024

Terracon Consultants Inc.
72 Pointe Circle
Greenville, SC 29615Attn: Nitin Dudani
E: nitin.dudani@terracon.comRe: SPT Automatic Hammer Energy Measurement Report
Rig No: 554
Terracon Project Number: 86235101

Dear Mr. Dudani:

This report provides the Energy Transfer Ratio (ETR) for the Standard Penetration Testing (SPT) automatic hammer as summarized below:

Table 1: Hammer Efficiency Summary

Drill Rig Make/Model	Drill Rig Serial Number	Drill Rig Year	Asset Number	Energy Transfer Ratio (ETR)	Hammer Efficiency Correction (C _E)
Geoprobe	3126GTS52010006	2020	DR#554	91.3% ± 1.8%	1.52

*Please Note: according to ASTM standard, a minimum of three recordings should be collected at five-foot intervals no shallower than twenty feet below current ground surface (bgs). The sample intervals were obtained between 30 and 50 feet bgs.

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

Ryan C. Wakeford, P.E.
Geotechnical Engineer

Susheel R. Kolwalkar

Susheel R. Kolwalkar, Ph.D., P.E.
Regional Services ManagerMicah Hatch, P.E.
Geotechnical Department Manager

Attachments:

- Exhibit A: SPT Representative Blow
- Exhibit B: SPT Analyzer Literature and Equipment Calibrations
- Exhibit C: SPT Analyzer Results
- Exhibit D: Field Log
- Exhibit E: Copy of Certificate of Proficiency

Facilities | Environmental | Geotechnical | Materials |



Prepared for:

Terracon Consultants, Inc.
Greenville, South Carolina

1.0 MEASUREMENT SUMMARY

ITEM	DESCRIPTION
Drill Rig Owner	Terracon Consultant, Inc. – Greenville, SC
Drill Rig Operator	Brett Burnett: Terracon Exploration
Testing Date	9/10/2024
Testing Location	Laurens County, SC
Boring Identification	B-1 Offset
Energy Measurement Depths	35 ft, 40 ft, 45 ft, 50 ft
Subsurface Soils	Silty sands (SM)
Hammer Type/Height	140 pounds (automatic) with 2.5-foot drop height
Boring Method	Hollow stem auger
Drill Rods	<ul style="list-style-type: none">AWJ1-3/4" outside diameter1-1/4" inside diameter1.15 in² cross sectional area1/4" wall thickness
Calibration Testing Equipment	<ul style="list-style-type: none">2-foot AWJ rod instrumented w/ two strain gauges and two accelerometers manufactured by Pile Dynamics Inc. (PDI)SN: 746AWJModel SPT Analyzer™ (PDA) SN: 4621 TB
ASTM Methods Used	<ul style="list-style-type: none">ASTM D1586, Standard Test Method for Standard Penetration Test and Split-Barrel Sampling of SoilsASTM D4633-16, Standard Method for Energy Measurement for Dynamic Penetrometers
SPT Calibration Personnel	Ryan Wakeford – Intermediate PDA Proficiency, Terracon Consultants, Inc.

2.0 PURPOSE AND SCOPE OF WORK

The North Charleston office of Terracon Consultants, Inc. conducted SPT energy measurements in accordance with ASTM D4633-16 at a site off Golden Acres Road in Laurens County, South Carolina. Energy measurements on the rig were taken during five samples events.

3.0 TEST RESULTS

Table 2: SPT Hammer Energy Calibration Testing Summary

Boring	Start Depth ¹ (ft)	Rod Length ² (ft)	Rod Sections ³		Measured Blow Counts (blows/6 Inches)				SPT N _{meas} (bpf)	Soil Type ⁴	
					1 st Inc.	2 nd Inc.	3 rd Inc.	4 th Inc.			
			1 ft	5 ft	10 ft	1 st Inc.	2 nd Inc.	3 rd Inc.	4 th Inc.		
B-1 Offset	33.5	38.7	0	7	0	2	4	6	-	10	SM
	38.5	43.7	0	8	0	5	6	9	-	15	SM
	43.5	48.7	0	9	0	4	6	9	-	15	SM
	48.5	53.7	1	10	0	9	14	18	-	32	SM

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

Table 3: Energy Measurement and Analysis Summary

Boring	Start Depth ¹ (ft)	SPT N _m (bpf)	No. of Blows ²	EMX ³ (ft-lbs)				ETR ³ (%)	
				Max.	Min.	Ave.	Std. Dev.	Ave.	Std. Dev.
B-1 Offset	33.5	10	10	321	304	313	5	89.4	1.4
	38.5	15	15	335	315	322	5	91.9	1.5
	43.5	15	15	345	319	328	7	93.8	2.1
	48.5	32	32	334	299	315	8	90.1	2.2
Average:				334	309	320	6	91.3	1.8

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

Table 4: Hammer Blow Rate Summary

Boring	Start Depth ¹ (ft)	SPT N _{meas} (bpf)	No. of Blows ²	BPM ³			
				Max.	Min.	Ave.	Std. Dev.
B-1 Offset	33.5	10	10	51.6	50.8	51.4	0.2
	38.5	15	15	51.6	51.2	51.4	0.1
	43.5	15	15	51.7	51.3	51.5	0.1
	48.5	32	32	51.9	51.3	51.5	0.1
Average:				51.7	51.2	51.5	0.1

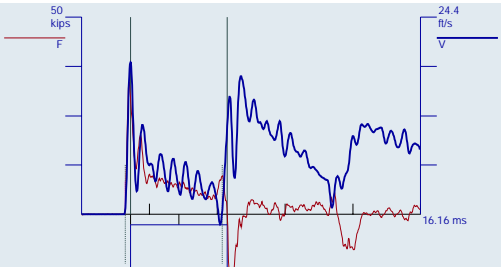
1. Boring ID and depth from existing ground surface to start of SPT.
2. Number of blows used in energy calibration analysis. Limited to measurements recorded during the second and third 6-inch sampling intervals at each depth or during the 1st increment if refusal conditions were encountered.
3. BPM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

Exhibit A

SPT Representative Blow

GRL Engineers, Inc.
GEOPROBE 3126GT 2020
33.5-35
B-1 Offset
PDA Operator: RW

Pile Driving Analyzer ® (PDA)
Version: 2022.35.2



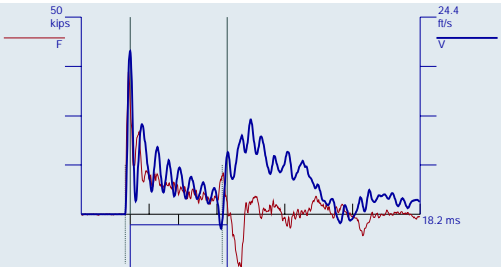
BN 1
10Sep2024 01:22:50 PM

CSX	29.2 ksi
DMX	3.27 in
EFV	312 ft-lb
ETR	89.1 %
BPM	1.9 bpm
RAT	1.1
VMX	18.8 ft/s
FMX	34 kips
DFN	3.00 in
MEX	972 µE
AMX	3838 g's
LE	38.70 ft
AR	1.15 in ²
EM	30000 ksi
SP	0.492 kN/m ³
WS	16807.9 ft/s
WC	16753.2 ft/s
JC	0.90
JF	1.00

F1: [746AWJ1] 222.05 PDICAL (1) FF1
F2: [746AWJ2] 222.19 PDICAL (1) FF1
A3 (PR): [K14006] 375.226 mvi/6.4v/5000g (1) VF1
A4 (PR): [K14007] 407.233 mvi/6.4v/5000g (1) VF1

GRL Engineers, Inc.
GEOPROBE 3126GT 2020
38.5-40
B-1 Offset
PDA Operator: RW

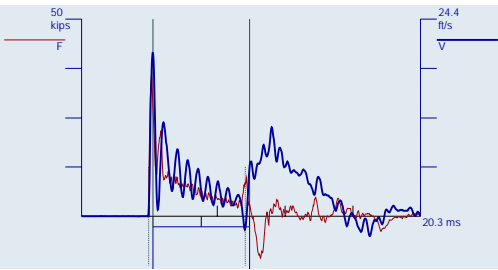
Pile Driving Analyzer ® (PDA)
Version: 2022.35.2



BN 18
10Sep2024 01:29:43 PM

CSX	31.5 ksi
DMX	1.33 in
EFV	321 ft-lb
ETR	91.6 %
BPM	51.3 bpm
RAT	1.1
VMX	20.2 ft/s
FMX	36 kips
DFN	1.33 in
MEX	1051 µE
AMX	4673 g's
LE	43.70 ft
AR	1.15 in ²
EM	30000 ksi
SP	0.492 kN/m ³
WS	16807.9 ft/s
WC	16807.7 ft/s
JC	0.90
JF	1.00

F1: [746AWJ1] 222.05 PDICAL (1) FF1
F2: [746AWJ2] 222.19 PDICAL (1) FF1
A3 (PR): [K14006] 375.226 mvi/6.4v/5000g (1) VF1
A4 (PR): [K14007] 407.233 mvi/6.4v/5000g (1) VF1

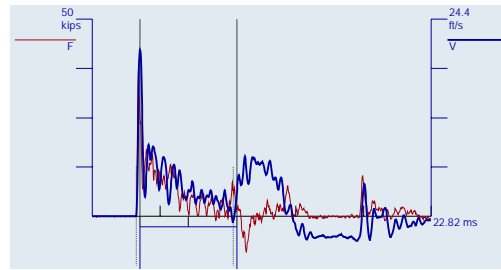


BN 19
 10Sep2024 01:37:35 PM

CSX 30.9 ksi
 DMX 0.89 in
 EFV 324 ft-lb
 ETR 92.5 %
 BPM 51.5 bpm
 RAT 1.1
 VMX 20.2 ft/s
 FMX 36 kips
 DFN 0.67 in
 MEX 1030 µE
 AMX 4669 g's

LE 48.70 ft
 AR 1.15 in²
 EM 30000 ksi
 SP 0.492 kN/m³
 WS 16807.9 ft/s
 WC 16793.1 ft/s
 JC 0.90
 JF 1.00

F1: [746AWJ1] 222.05 PDICAL (1) FF1
 F2: [746AWJ2] 222.19 PDICAL (1) FF1
 A3 (PR): [K14006] 375.226 mmi/6.4v/5000g (1) VF1
 A4 (PR): [K14007] 407.233 mmi/6.4v/5000g (1) VF1



BN 39
 10Sep2024 01:45:37 PM

CSX 33.0 ksi
 DMX 0.67 in
 EFV 315 ft-lb
 ETR 90.1 %
 BPM 51.5 bpm
 RAT 0.8
 VMX 20.6 ft/s
 FMX 38 kips
 DFN 0.33 in
 MEX 1098 µE
 AMX 4875 g's

LE 54.70 ft
 AR 1.15 in²
 EM 30000 ksi
 SP 0.492 kN/m³
 WS 16807.9 ft/s
 WC 16779.1 ft/s
 JC 0.90
 JF 1.00

F1: [746AWJ1] 222.05 PDICAL (1) FF1
 F2: [746AWJ2] 222.19 PDICAL (1) FF1
 A3 (PR): [K14006] 375.226 mmi/6.4v/5000g (1) VF1
 A4 (PR): [K14007] 407.233 mmi/6.4v/5000g (1) VF1



SPT Analyzer

SPT Analyzer

Measures the energy transferred into an instrumented SPT rod during a Standard Penetration Test (SPT)

Reliable. Simplified. Rugged.

The SPT Analyzer determines the energy transferred by SPT hammers using force and velocity measurements, for improved reliability of SPT N-values.

What is SPT?

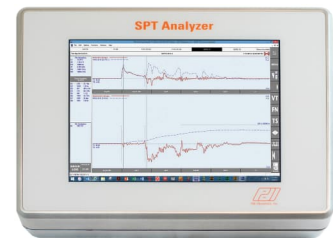
The Standard Penetration Test (SPT) is a widely-employed soil exploration tool that involves using an SPT hammer to drive a split sampler at the bottom of a drill string to obtain soil samples. The number of blows required to penetrate the last 300mm (1ft) is the "N value" which is related to soil strength.

Why measure the energy transferred by the SPT hammer?

Several different types of SPT hammers are used to conduct Standard Penetration Tests. Their varying efficiencies influence the N value. The measured N value is normalized by multiplying it by the ratio of the measured energy transferred to the rod to 60% of the theoretical potential energy. The normalization compensates for the variability of the efficiencies of different SPT hammer types, and improves the reliability of soil strength estimates used in geotechnical applications.

The SPT Analyzer is furnished with a 0.6m sub assembly (or section) of an SPT rod (AW, NW or other type) instrumented with two strain gage bridges, and calibrated by Pile Dynamics. Once in the field, two accelerometers are bolted to the rod section. The instrumented section is inserted at the top of the drill string between the hammer and the existing sampling rod. The sensors on the rod are connected to the SPT Analyzer.

Smart Sensor technology allows the SPT Analyzer to read the rod instrumentation, obtaining the sensor calibration and rod cross sectional area.



- Calculates energy transferred by SPT hammers using force and velocity measurements
- Determines N Value to help improve reliability of soil strength estimates
- Offers simplified reporting and analysis option to speed testing results
- Operates in English, SI, or Metric units



Exhibit B

SPT Analyzer Literature and Equipment Calibrations

EN ISO 22486-3:2005/ASTM Compliant

The SPT Analyzer is compliant with EN ISO 22476-3:2005. ASTM D1586 recommends normalizing results from any SPT test using energy measurements. When these tests are performed to determine the liquefaction potential of sands, ASTM D6066 not only recommends but mandates the normalization. ASTM D4633 states that the only acceptable method of determining energy for normalization of N values is by force and velocity measurements.

These quantities are input to the SPT Analyzer automatically. This significantly simplifies the initial test setup.

The strain gages and accelerometers obtain the force and velocity signals necessary for the calculation of transferred energy to the drill string for each hammer blow. The energy is displayed in real time on the SPT Analyzer screen.

Output

SPT Analyzer data is stored and transferred to a computer via USB memory stick. The software furnished with the SPT Analyzer has a Report Creation Option that makes it quick and easy to summarize results and create output graphs of Force, Velocity, Energy and Displacement versus Time, as well as numerical, statistical, and graphical results for each data set. The software is fully customizable.



Pile Dynamics, Inc. (PDI) is the world leader in developing, manufacturing and supplying state of the art QA/QC products and systems for the deep foundations industry. The company is headquartered in Cleveland, Ohio, USA, with offices and representatives worldwide. For additional information visit us at www.pile.com or contact info@pile.com.

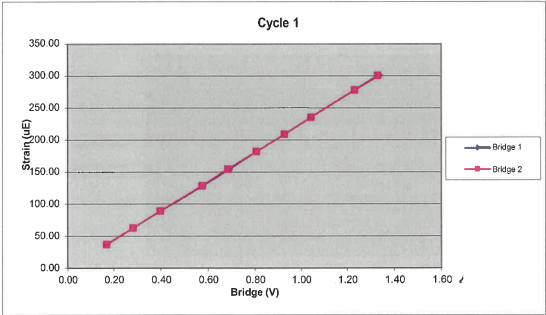
www.pile.com | +1 (216) 831-6131 | info@pile.com



746AWJ		Cycle 1			
Sample	Force (lb)	Strain (µE)	Bridge 1 (V)	Bridge 2 (V)	
1	0.00	0.00	0.00	0.00	
2	1296.93	37.22	0.17	0.17	
3	2135.32	62.74	0.28	0.28	
4	3028.79	89.39	0.40	0.40	
5	4377.09	128.61	0.58	0.57	
6	5243.07	154.57	0.69	0.68	
7	6143.17	181.90	0.81	0.81	
8	7067.05	208.93	0.93	0.93	
9	7958.18	236.42	1.04	1.05	
10	9380.66	278.02	1.23	1.23	
11	10161.74	300.76	1.34	1.33	

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7605.07	Force Calibration (lb/V)	7606.74
Offset	-0.16	Offset	12.66
Correlation	0.999997	Correlation	0.999990
Strain Calibration (µE/V)	225.99	Strain Calibration (µE/V)	226.04
Offset	-1.01	Offset	-0.63
Correlation	0.999989	Correlation	0.999992

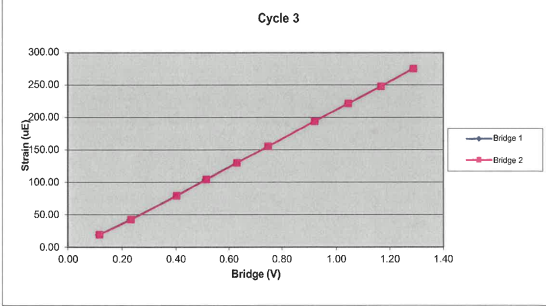
Force Strain Calibration	
EA (Kips)	33651.50
Offset	33.98
Correlation	0.999994



746AWJ		Cycle 3			
Sample	Force (lb)	Strain (µE)	Bridge 1 (V)	Bridge 2 (V)	
1	0.00	0.00	0.00	0.00	
2	886.16	19.27	0.11	0.12	
3	1786.75	42.28	0.23	0.23	
4	3083.67	79.12	0.40	0.40	
5	3943.80	104.13	0.51	0.51	
6	4839.52	129.87	0.63	0.63	
7	5750.14	155.24	0.75	0.75	
8	7079.92	194.22	0.92	0.92	
9	8007.70	221.43	1.04	1.05	
10	8943.28	247.95	1.17	1.17	
11	9871.55	275.44	1.29	1.29	

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7659.96	Force Calibration (lb/V)	7667.39
Offset	13.76	Offset	-1.59
Correlation	0.999999	Correlation	0.999998
Strain Calibration (µE/V)	219.43	Strain Calibration (µE/V)	219.64
Offset	-7.95	Offset	-8.39
Correlation	0.999934	Correlation	0.999939

Force Strain Calibration	
EA (Kips)	34904.41
Offset	291.93
Correlation	0.999935



Accelerometer Calibration Certificate
Pile Dynamics, Inc.



Calibrated by Pile Dynamics, Inc.
Calibration performed on MAY 16 2024

Serial No: K14006 Temperature: 24.0 °C
Model: PR Humidity: 42%
Calibrated on: Channel 3 on 8G 5161 LE

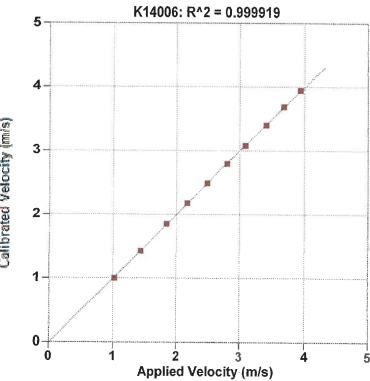
PDA CALIBRATION FACTOR
375.2 mv/5000g
(75.0 μ v/g)
R²: 0.999919 [Chip programmed]

Operator: William Johnson

Ref Acc 1: 78268! Cal on: 11Jan2024
986 g's/volt
Ref Acc 2: 78270! Cal on: 11Jan2024
971 g's/volt

Signed

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



Version: 2020.30.170 -0.17

Accelerometer Calibration Certificate
Pile Dynamics, Inc.



Calibrated by Pile Dynamics, Inc.
Calibration performed on MAY 16 2024

Serial No: K14007 Temperature: 23.8 °C
Model: PR Humidity: 42%
Calibrated on: Channel 4 on 8G 5161 LE

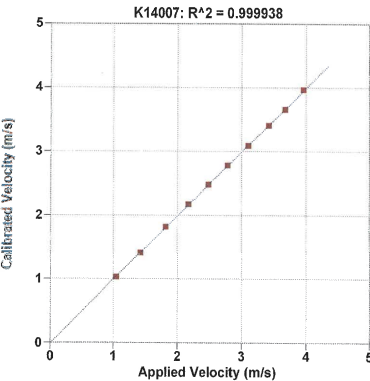
PDA CALIBRATION FACTOR
407.2 mv/5000g
(81.4 μ v/g)
R²: 0.999938 [Chip programmed]

Operator: William Johnson

Ref Acc 1: 78268! Cal on: 11Jan2024
986 g's/volt
Ref Acc 2: 78270! Cal on: 11Jan2024
971 g's/volt

Signed

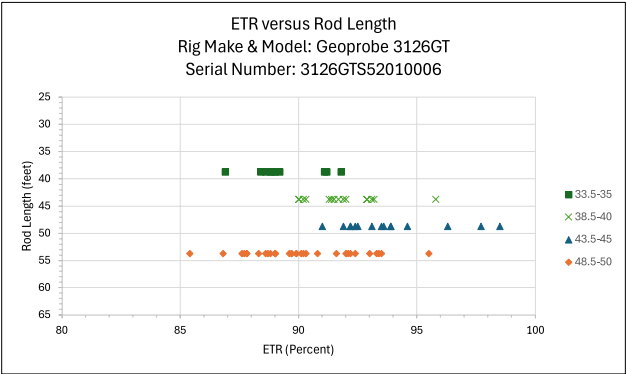
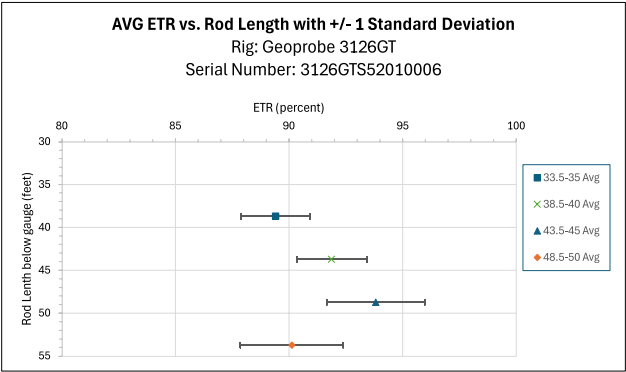
Reference accelerometer calibrations are traceable to the United States National Institute of Standards and Technology (NIST).

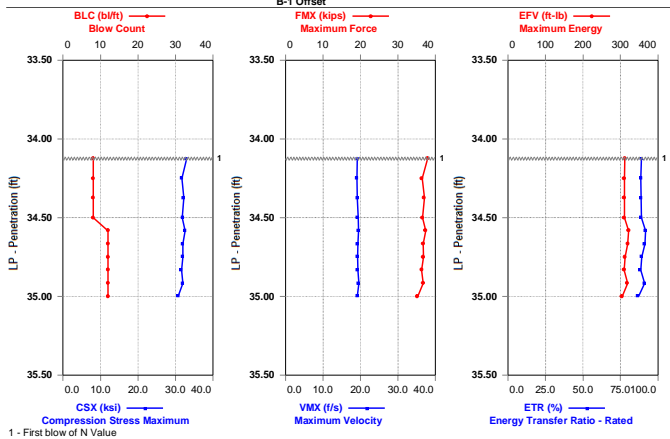


Version: 2020.30.170 -0.28



Exhibit C
SPT Analyzer Results





GEOPROBE 3126GT 2020 - 33.5-35

OP: RW Date: 10-September-2024

AR: 1.15 in² SP: 0.492 k/ft²

LE: 38.70 ft EM: 30,000 ksi

WS: 16,807.9 f/s JC: 0.00

FMX: Maximum Force BPM: Blows/Minute

VMX: Maximum Velocity DMX: Maximum Displacement

EMX: Maximum Energy DFN: Final Displacement

EFV: Maximum Energy CSX: Compression Stress Maximum

ETR: Energy Transfer Ratio - Rated

BL#	Depth ft	BLC bl/ft	FMX kips	VMX ft/s	EMX ft-lb	EFV ft-lb	ETR (%)	BPM bpm	DMX in	DFN in	CSX ksi
3	34.13	8	38	19.2	311.4	311.4	89.0	50.8	2.20	1.50	33.0
4	34.25	8	36	19.0	310.2	310.2	88.6	51.4	2.20	1.50	31.7
5	34.38	8	37	19.2	310.8	310.8	88.8	51.2	1.77	1.50	32.2
6	34.50	8	37	19.3	311.0	311.0	88.9	51.3	1.75	1.50	31.8
7	34.58	12	37	19.5	321.3	321.3	91.8	51.5	1.49	1.00	32.5
8	34.67	12	37	19.3	319.2	319.2	91.2	51.3	1.46	1.00	31.9
9	34.75	12	37	19.3	312.1	312.1	89.2	51.3	1.44	1.00	32.0
10	34.83	12	36	19.3	309.4	309.4	88.4	51.5	1.39	1.00	31.6
11	34.92	12	37	19.5	318.7	318.7	91.1	51.5	1.44	1.00	31.9
12	35.00	12	35	19.2	304.1	304.1	86.9	51.6	1.29	1.00	30.6
Average			37	19.3	312.8	312.8	89.4	51.4	1.64	1.20	31.9
Std. Dev.			1	0.1	5.0	5.0	1.4	0.2	0.31	0.24	0.6
Maximum			38	19.5	321.3	321.3	91.8	51.6	2.20	1.50	33.0
Minimum			35	19.0	304.1	304.1	86.9	50.8	1.29	1.00	30.6

Total number of blows analyzed: 10

BL# Sensors

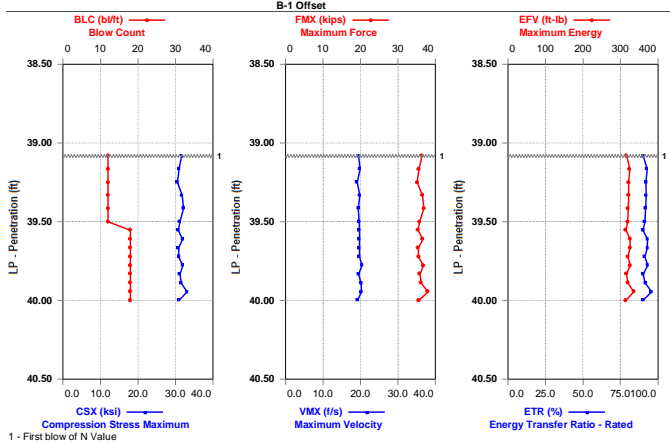
3-12 F1: [746AWJ1] 222.1 (1.00); F2: [746AWJ2] 222.2 (1.00); A3: [K14006] 375.2 (1.00);
A4: [K14007] 407.2 (1.00)

BL# Comments

3 First blow of N Value

Time Summary

Drive 12 seconds 1:22 PM - 1:23 PM BN 1 - 12



GEOPROBE 3126GT 2020 - 38.5-40

OP: RW Date: 10-September-2024

AR: 1.15 in² SP: 0.492 k/ft²

LE: 43.70 ft EM: 30,000 ksi

WS: 16,807.9 f/s JC: 0.00

FMX: Maximum Force BPM: Blows/Minute

VMX: Maximum Velocity DMX: Maximum Displacement

EMX: Maximum Energy DFN: Final Displacement

EFV: Maximum Energy CSX: Compression Stress Maximum

ETR: Energy Transfer Ratio - Rated

BL#	Depth ft	BLC bl/ft	FMX kips	VMX ft/s	EMX ft-lb	EFV ft-lb	ETR (%)	BPM bpm	DMX in	DFN in	CSX ksi
6	39.08	12	36	19.5	315.9	315.9	90.3	51.4	1.29	1.00	31.6
7	39.17	12	36	19.9	325.0	325.0	92.9	51.5	1.38	1.00	31.0
8	39.25	12	35	19.2	321.8	321.8	91.9	51.4	1.50	1.00	30.5
9	39.33	12	37	19.8	322.0	322.0	92.0	51.4	1.55	1.00	31.8
10	39.42	12	37	19.5	321.0	321.0	91.7	51.4	1.47	1.00	32.1
11	39.50	12	36	19.6	319.6	319.6	91.3	51.6	1.15	1.00	31.1
12	39.56	18	35	19.7	315.1	315.1	90.0	51.2	0.94	0.67	30.8
13	39.61	18	37	19.7	325.9	325.9	93.1	51.5	1.04	0.67	31.9
14	39.67	18	35	19.7	325.3	325.3	92.9	51.3	1.08	0.67	30.8
15	39.72	18	35	19.7	319.9	319.9	91.4	51.4	0.98	0.67	30.8
16	39.78	18	37	20.4	326.3	326.3	93.2	51.6	1.00	0.67	32.0
17	39.83	18	36	19.5	315.5	315.5	90.2	51.6	0.97	0.67	31.2
18	39.89	18	36	20.2	320.4	320.4	91.5	51.3	0.97	0.67	31.5
19	39.94	18	38	20.2	335.3	335.3	95.8	51.4	1.17	0.67	33.1
20	40.00	18	36	19.2	315.1	315.1	90.0	51.6	1.03	0.67	31.0
Average			36	19.7	321.6	321.6	91.9	51.4	1.17	0.80	31.4
Std. Dev.			1	0.3	5.3	5.3	1.5	0.1	0.21	0.16	0.7
Maximum			38	20.4	335.3	335.3	95.8	51.6	1.55	1.00	33.1
Minimum			35	19.2	315.1	315.1	90.0	51.2	0.94	0.67	30.5

Total number of blows analyzed: 15

BL# Sensors

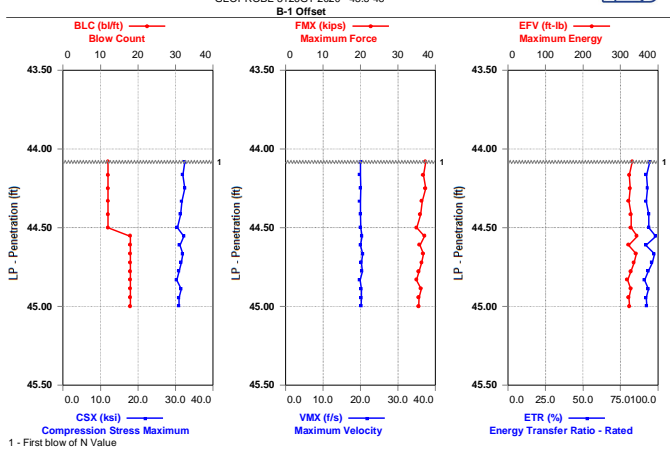
6-20 F1: [746AWJ1] 222.1 (1.00); F2: [746AWJ2] 222.2 (1.00); A3: [K14006] 375.2 (1.00);
A4: [K14007] 407.2 (1.00)

BL# Comments

6 First blow of N Value

Time Summary

Drive 22 seconds 1:29 PM - 1:29 PM BN 1 - 20



Case Method & iCAP® Results

GEOPROBE 3126GT 2020 - 43.5-45

OP: RW Date: 10-September-2024

AR: 1.15 in² SP: 0.492 k/ft²

LE: 48.70 ft EM: 30,000 ksi

WS: 16,807.9 f/s JC: 0.00

FMX: Maximum Force BPM: Blows/Minute

VMX: Maximum Velocity DMX: Maximum Displacement

EMX: Maximum Energy DFN: Final Displacement

EFV: Maximum Energy CSX: Compression Stress Maximum

ETR: Energy Transfer Ratio - Rated

BL#	Depth ft	BLC b/ft	FMX kips	VMX f/s	EMX ft-lb	EFV ft-lb	ETR (%)	BPM bpm	DMX in	DFN in	CSX ksi
5	44.08	12	37	20.0	331.2	331.2	94.6	51.5	1.50	1.00	32.5
6	44.17	12	37	19.9	323.4	323.4	92.4	51.6	1.51	1.00	32.0
7	44.25	12	37	20.1	325.8	325.8	93.1	51.3	1.32	1.00	32.5
8	44.33	12	36	19.9	322.7	322.7	92.2	51.4	1.20	1.00	31.7
9	44.42	12	36	20.0	328.8	328.8	93.9	51.7	1.11	1.00	31.3
10	44.50	12	35	20.1	328.7	328.7	93.9	51.4	1.12	1.00	30.5
11	44.56	18	37	20.4	344.6	344.6	98.5	51.5	1.08	0.67	32.2
12	44.61	18	36	20.0	321.8	321.8	91.9	51.4	0.93	0.67	31.2
13	44.67	18	37	20.6	341.9	341.9	97.7	51.5	1.13	0.67	32.0
14	44.72	18	36	20.3	336.9	336.9	96.3	51.7	1.14	0.67	31.5
15	44.78	18	36	20.5	327.4	327.4	93.5	51.5	1.15	0.67	31.0
16	44.83	18	35	19.9	318.6	318.6	91.0	51.3	1.13	0.67	30.4
17	44.89	18	36	20.2	327.8	327.8	93.6	51.6	1.12	0.67	31.5
18	44.94	18	36	20.2	322.7	322.7	92.2	51.5	1.00	0.67	31.0
19	45.00	18	36	20.2	323.9	323.9	92.5	51.5	0.89	0.67	30.9
Average			36	20.1	328.4	328.4	93.8	51.5	1.16	0.80	31.5
Std. Dev.			1	0.2	7.2	7.2	2.1	0.1	0.17	0.16	0.6
Maximum			37	20.6	344.6	344.6	98.5	51.7	1.51	1.00	32.5
Minimum			35	19.9	318.6	318.6	91.0	51.3	0.89	0.67	30.4

Total number of blows analyzed: 15

BL# Sensors

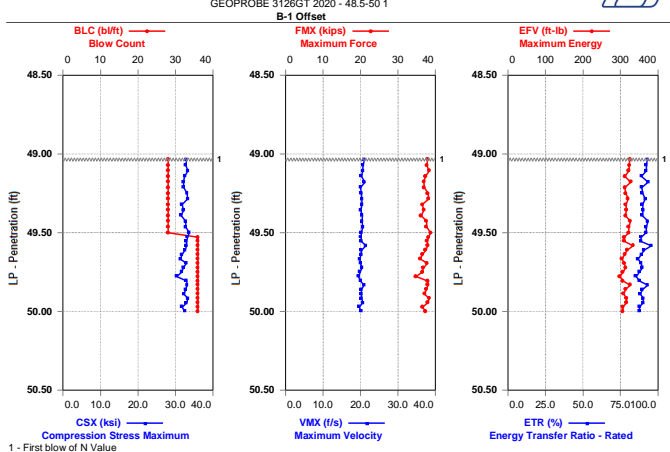
5-19 F1: [746AWJ1] 222.1 (1.00); F2: [746AWJ2] 222.2 (1.00); A3: [K14006] 375.2 (1.00); A4: [K14007] 407.2 (1.00)

BL# Comments

5 First blow of N Value

Time Summary

Drive 20 seconds 1:37 PM - 1:37 PM BN 1 - 19



Case Method & iCAP® Results

GEOPROBE 3126GT 2020 - 48.5-50.1

OP: RW Date: 10-September-2024

AR: 1.15 in² SP: 0.492 k/ft²

LE: 54.70 ft EM: 30,000 ksi

WS: 16,807.9 f/s JC: 0.00

FMX: Maximum Force BPM: Blows/Minute

VMX: Maximum Velocity DMX: Maximum Displacement

EMX: Maximum Energy DFN: Final Displacement

EFV: Maximum Energy CSX: Compression Stress Maximum

ETR: Energy Transfer Ratio - Rated

BL#	Depth ft	BLC b/ft	FMX kips	VMX f/s	EMX ft-lb	EFV ft-lb	ETR (%)	BPM bpm	DMX in	DFN in	CSX ksi
10	49.04	28	38	21.1	325.4	325.4	93.0	51.3	0.93	0.43	33.0
11	49.07	28	38	20.7	323.4	323.4	92.4	51.5	0.97	0.43	32.8
12	49.11	28	38	20.6	322.7	322.7	92.2	51.4	0.85	0.43	33.3
13	49.14	28	37	20.2	311.5	311.5	89.0	51.5	0.71	0.43	32.4
14	49.18	28	37	21.1	327.2	327.2	93.5	51.4	0.74	0.43	32.1
15	49.21	28	37	20.0	311.7	311.7	89.0	51.6	0.75	0.43	32.2
16	49.25	28	38	20.3	314.5	314.5	89.9	51.3	0.63	0.43	33.1
17	49.29	28	38	20.4	320.7	320.7	91.6	51.6	0.78	0.43	33.2
18	49.32	28	37	20.4	314.7	314.7	89.9	51.6	0.67	0.43	31.8
19	49.36	28	37	20.1	315.6	315.6	90.2	51.5	0.63	0.43	32.1
20	49.39	28	36	20.5	313.8	313.8	89.7	51.5	0.68	0.43	31.5
21	49.43	28	38	20.4	326.8	326.8	93.4	51.5	0.77	0.43	32.7
22	49.46	28	38	20.5	322.5	322.5	92.1	51.5	0.81	0.43	32.7
23	49.50	28	39	20.3	322.2	322.2	92.0	51.6	0.72	0.43	33.6
24	49.53	36	38	20.1	310.5	310.5	88.7	51.6	0.55	0.33	33.2
25	49.56	36	38	20.3	310.2	310.2	88.6	51.6	0.58	0.33	32.9
26	49.58	36	38	21.4	334.2	334.2	95.5	51.3	0.72	0.33	33.0
27	49.61	36	37	20.2	317.7	317.7	90.8	51.4	0.59	0.33	32.5
28	49.64	36	37	20.2	311.5	311.5	89.0	51.7	0.55	0.33	31.8
29	49.67	36	36	19.8	303.9	303.9	86.8	51.5	0.64	0.33	31.3
30	49.69	36	38	20.0	310.8	310.8	88.8	51.6	0.55	0.33	32.9
31	49.72	36	37	20.4	313.8	313.8	89.7	51.5	0.65	0.33	32.0
32	49.75	36	36	19.9	307.2	307.2	87.8	51.9	0.59	0.33	31.7
33	49.78	36	35	19.5	299.0	299.0	85.4	51.4	0.63	0.33	30.3
34	49.81	36	38	20.0	307.1	307.1	87.8	51.4	0.54	0.33	32.9
35	49.83	36	38	20.9	326.4	326.4	93.3	51.6	0.73	0.33	33.1
36	49.86	36	38	20.3	313.6	313.6	89.6	51.5	0.62	0.33	32.7
37	49.89	36	37	20.2	309.1	309.1	88.3	51.5	0.60	0.33	32.2
38	49.92	36	38	20.3	316.2	316.2	90.3	51.4	0.67	0.33	33.3
39	49.94	36	38	20.6	315.4	315.4	90.1	51.5	0.67	0.33	33.0
40	49.97	36	37	19.6	306.5	306.5	87.6	51.5	0.71	0.33	31.8
41	50.00	36	37	20.3	307.0	307.0	87.7	51.5	0.55	0.33	32.5
Average			37	20.3	315.4	315.4	90.1	51.5	0.68	0.37	32.5
Std. Dev.			1	0.4	7.8	7.8	2.2	0.1	0.11	0.05	0.7
Maximum			39	21.4	334.2	334.2	95.5	51.9	0.97	0.43	33.6
Minimum			35	19.5	299.0	299.0	85.4	51.3	0.54	0.33	30.3

Total number of blows analyzed: 32

BL# Sensors

10-41 F1: [746AWJ1] 222.1 (1.00); F2: [746AWJ2] 222.2 (1.00); A3: [K14006] 375.2 (1.00); A4: [K14007] 407.2 (1.00)

BL# Comments
10 First blow of N Value

Time Summary
Drive 46 seconds 1:44 PM - 1:45 PM BN 1 - 41

Exhibit D
Field Log



SPT HAMMER CALIBRATION
FIELD WORKSHEET

PROJECT NAME: Clinton 26 Commerce Park
PROJECT NO.: 867-5161
BORING NO.: B-1 offset
CLIENT:

ARRIVAL TIME: _____
DEPART TIME: _____
TOTAL TRAVEL: _____
TOTAL TIME: _____
CLIENT REP: _____
MILEAGE: _____
DATE: 9/10/24
TERRACON REP: RW
PDA MODEL/SN: SPT 4621 TB
TERRACON RIG #: 554

DRILL RIG DATA

Type/Transport: Track
Manufacturer: Geoprobe
Model No.: 3126 GT
Serial No.: 31266T552010006
Year Built: 2020
Modifications: -
Maint. Schedule: -

SPT HAMMER DATA

Type: Auto
Manufacturer: Geoprobe
Lifting Mechanism: Chain
Model No.: -
Serial No.: -
Hammer Weight: 140
Hammer Operator(s): B. Burnett

PDA INPUT DATA

Operator: OP RW Elastic Modulus (ksi): EM 3000
Project No./Location: PJ 867-5161 / Clinton Specific Weight (kips/ft³): SP 0.492
Rig Model & SN: PN 3126GT 552010006 Wave Speed (ft/sec): WS 16808
Hammer Type, LM, Rods: PD Auto/AWJ Increment Length (ft): LI 0.5
Drill Rod Area (in²): AR 1.15 Sampling Freq. (kHz): FR 50

TRANSDUCER INFORMATION

Gage SN Calibration
F1/F3: 246AWJ1 222.05
F2/F4: 246AWJ2 222.53
A1/A3: R14007 402.23
A2/A4: R14006 375.23

NOTES:

SPLIT SPOON SAMPLER LENGTH 2.86'

'LE' is Measured from the Center of the Strain Gauges to the bottom of Split Spoon Sampler

SPT TESTING INFORMATION

Start Time	Soil	Stick Up Length (ft)	Depth (ft)		'LE' (ft)	Rods & Lengths	PDA Blows		SPT Blows			
			Start	End			Start	End	1st 6"	2nd 6"	3rd 6"	4th 6"
1:15	SM		28.5	30	33.7	5' x 6	1	10	2	3	3	6
1:25	SM		33.5	35	38.7	5' x 7	1	13	2	4	6	10
1:30	SM		38.5	40	43.7	5' x 8	1	21	5	6	9	15
1:35	SM		43.5	45	48.7	5' x 9	1	20	4	6	9	15
1:45	SM		48.5	50	53.7	5' x 10	1	42	9	14	18	32
					54.7	5' x 11						

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

PICTURE NUMBERS AND INFO:
Take Photo of Each Rig, Boring Locations at the Site



This documents that
Susheel R. Kolwalker
Terracon Consultants
has on March 11, 2016 achieved the rank of
EXPERT

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.

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. 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. This certificate can be verified at www.PDAproficiencytest.com.


Steven A. Hall, Executive Director
Pile Driving Contractors Association


Garland Likins, Senior Partner
Pile Dynamics, Inc.

No. 2005



This documents that
Ryan Wakeford
Terracon Consultants, Inc.
has on March 15, 2019 achieved the rank of
INTERMEDIATE

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 Intermediate level seek Advanced, Master or Expert levels through additional study within four 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. 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. This certificate can be verified at www.PDAproficiencytest.com.


Frank T. Peters, Executive Director
Pile Driving Contractors Association


Garland Likins, Senior Partner
Pile Dynamics, Inc.

No. 2898