

# S-39-32 (Shady Grove Road) Bridge Replacement over Crow Creek

Pickens County, SC

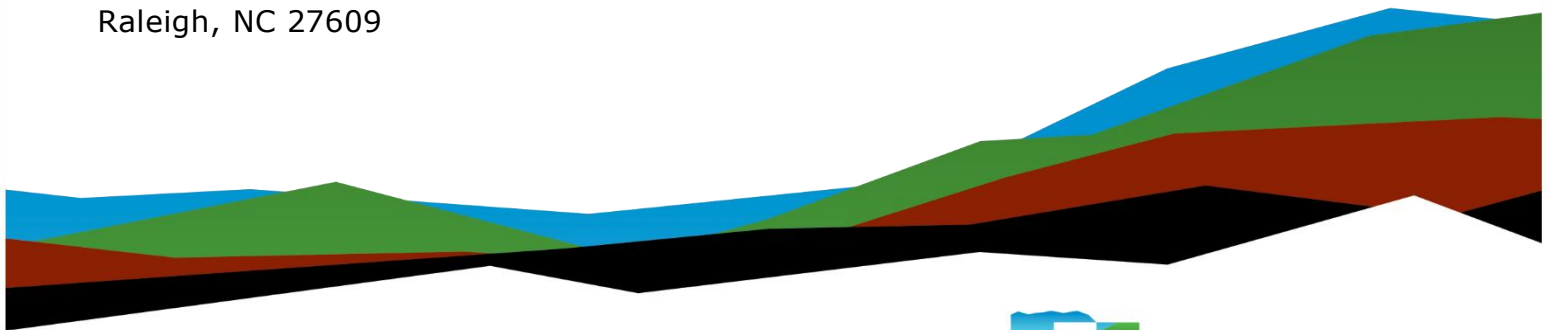
## Geotechnical Subsurface Data Report

October 30, 2024 | SCDOT Project ID: P041168

Terracon Project No.: 8623P180 Revision 1

### Prepared for:

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



Nationwide  
[Terracon.com](https://terracon.com)

- Facilities
- Environmental
- Geotechnical
- Materials



72 Pointe Circle  
Greenville, SC 29615  
P (864) 292-2901  
[Terracon.com](https://www.terracon.com)

October 30, 2024

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 Subsurface Data Report  
S-39-32 Bridge Replacement over Crow Creek  
Pickens County, South Carolina  
SCDOT Project ID.: P041168  
Terracon Project No.: 8623P180 Revision 1

Dear Mr. Franklin:

Terracon Consultants Inc. (Terracon) has completed the exploration, testing and limited engineering analysis services (contained in the geotechnical baseline report) 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-39-32 bridge over Crow Creek in Pickens County, South Carolina. This will be a complete bridge replacement within the project existing alignment. This GSDR was prepared in general accordance with the 2022 SCDOT Geotechnical Design Manual (GDM) and Preconstruction Design Memorandum (PCDM) 11 - Supplemental Design Criteria for Low Volume Bridge Replacement Projects.

## Project Description

The project site is located at the S-39-32 (Shady Grove Road) crossing over Crow Creek in Pickens County, South Carolina. Site location and exploration plans are presented in Appendix A of this report. Based on the conceptual plans by HNTB dated 8/30/2024, the replacement bridge will be constructed on the same alignment as the current bridge. The current plan

indicates the new bridge will be a 150-ft long multi-span bridge constructed with a prestressed concrete cored slab for span A and AASHTO Type BIII-36 Box Beams for span B.

## Geotechnical Testing

The geotechnical exploration for this project was performed between August 15 and August 16, 2024. 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:

- Two (2) Standard Penetration Test (SPT) Borings (S-39-32-1 and S-39-32-2)
- One (1) Downhole Shear Wave Velocity Test (DHT-1) located in Boring S-39-32-2 Offset
- Two (2) Cone Penetration Test soundings (S-39-32-1C and S-39-32-2C)

The tests were performed at the approximate locations as 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. Station and offset are based on the plans provided at the time the borings were performed. Station and offset are based on the plans provided at the time the tests were performed.

### Laboratory Testing

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

- Fifteen (15) Natural Moisture Content Tests
- Six (6) Atterberg Limits Tests
- Seven (7) Fines Content Tests
- Four (4) 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)
- Four (4) Compressive Strength of Rock Cores

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

## 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.

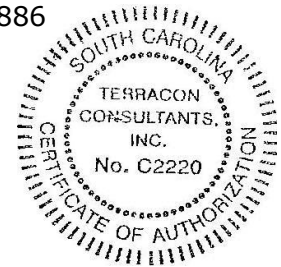
Sincerely,

**Terracon Consultants, Inc.**



Maggie McKenney, EIT  
Senior Staff Engineer

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





## **Appendix A**

### **Field Exploration**

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

Note: All exhibits are one page unless noted above

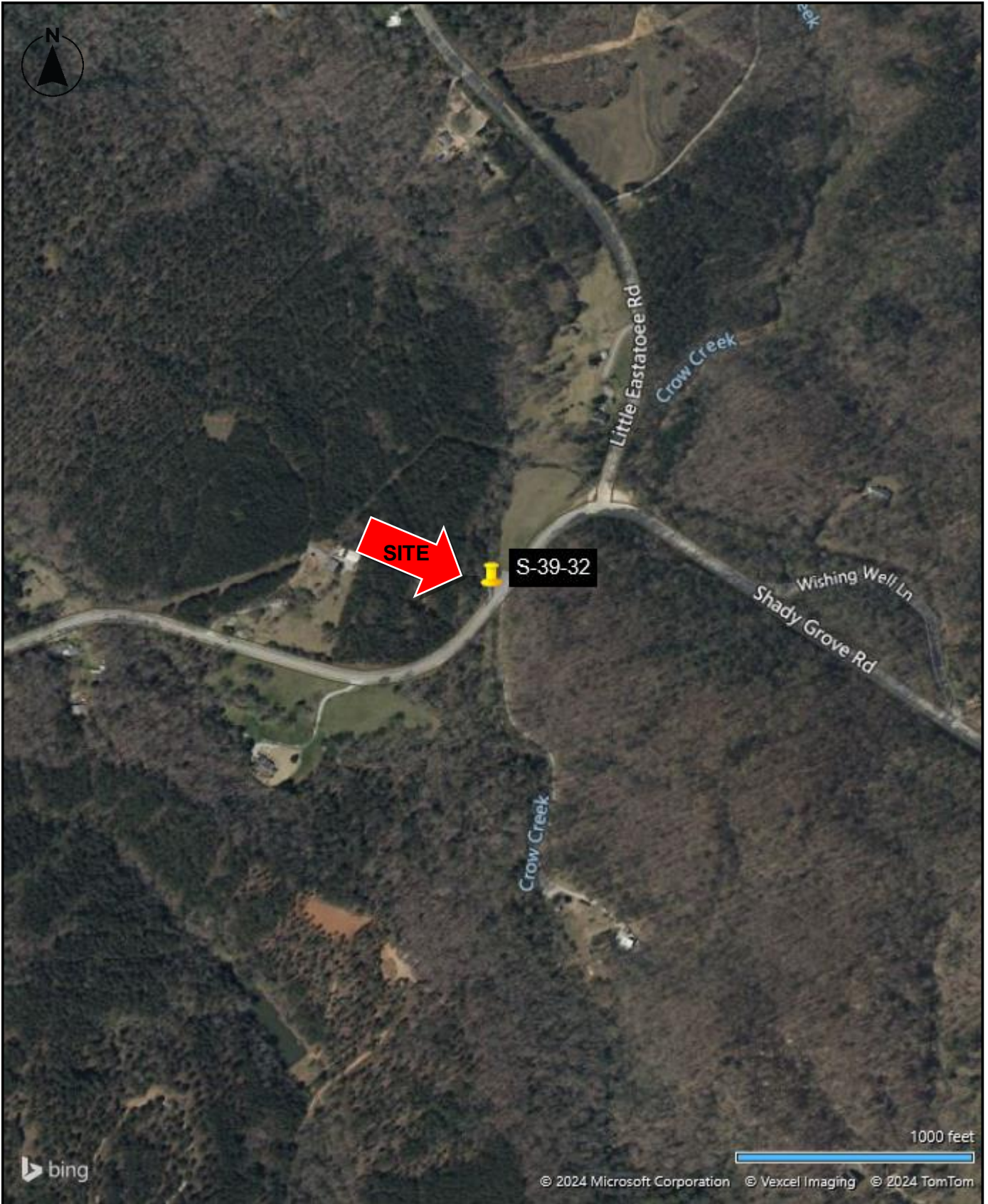


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND  
IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED  
BY MICROSOFT BING MAPS



Project Number	8623P180	  72 Pointe Cir Greenville, South Carolina 29615	SITE LOCATION		Exhibit  A-1
Scale	AS SHOWN		S-39-32 BRO Crow Creek Shady Grove Road Pickens County, SC		
Client	HNTB				
Date	9/13/2024				



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

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

Project Number	8623P180
Scale	AS SHOWN
Client	HNTB
Date	9/13/2024



72 Pointe Cir  
Greenville, South Carolina 29615

EXPLORATION PLAN
S-39-32 BRO Crow Creek Shady Grove Road Pickens County, SC

Exhibit
A-2



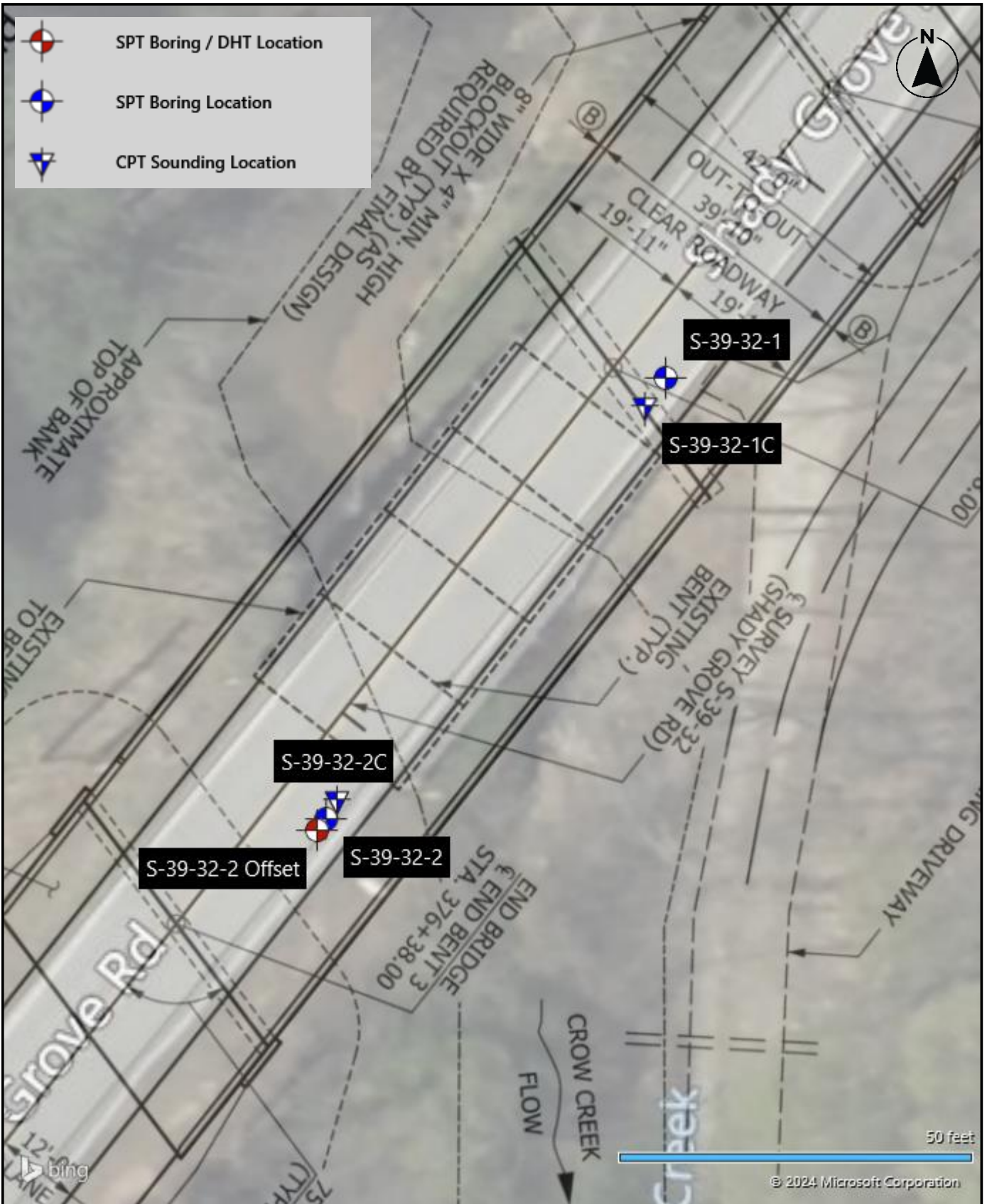


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

PRELIMINARY SITE PLAN PROVIDED BY HNTB

Project Number	8623P180
Scale	AS SHOWN
Client	HNTB
Date	9/13/2024



72 Pointe Cir  
Greenville, South Carolina 29615

## EXPLORATION PLAN

S-39-32 BRO Crow Creek  
Shady Grove Road  
Pickens County, SC

Exhibit

A-2

### Summary of Boring Data – Exhibit A-3

S-39-32 Bridge Replacement over Crow Creek | Pickens County, SC  
Terracon Project No. 8623P180 | SCDOT Project ID: P041168



#### Summary of Boring Data

Boring No.	Ground Elevation (ft)	Test Depth (ft)	Northing (ft)	Easting (ft)	Latitude (°)	Longitude (°)	Station (ft) <sup>1</sup>	Offset (ft) <sup>1</sup>
S-39-32-1	858.4	36	1126980.94	1450753.48	34.917286	-82.832064	375+34	7 L
S-39-32-2	858.6	28.6	1126919.73	1450704.38	34.917115	-82.832225	376+13	8 L
S-39-32-2 Offset	858.7	50	1126918.12	1450703.06	34.917111	-82.832229	376+15	8 L
S-39-32-1C	858.3	21.1	1126977.12	1450750.47	34.917275	-82.832074	375+39	7 L
S-39-32-2C	858.6	16.5	1126922.47	1450705.97	34.917123	-82.832219	376+10	7 L

1. Plans were provided by HNTB after the field exploration and survey. Station and offset values are estimated based on overlay in Google Earth <sup>TM</sup>.
2. A composite bulk sample was collected about 5 feet northeast of S-39-32-1 and about 4.5 feet southwest of S-39-32-2.
3. Station and offset are based on the plans provided at the time the tests were performed.

## GeoScoping Form

PROJECT INFORMATION			
Project ID:	P041168	Date of Trip:	8/15/2024
County:	Pickens	Location:	Sunset
Rd/ Route:	S-39-32	Local Name:	Shady Grove Road
Attendees:	M. McKenney		

EXISTING BRIDGE INFORMATION			
Bridge Length:	60 ft	Bridge Width:	27.5 ft
Superstructure Type:	Concrete framing and decking	Substructure Type:	Timber Piles
Begin Bridge Sta <sup>1</sup> :	374+88	End Bridge Sta <sup>1</sup> :	376+38
Begin Bridge Embankment Sta <sup>1</sup> :	373+88	End Bridge Embankment Sta <sup>1</sup> :	377+38
Structure Number:	03448	Posted Weight Limit:	45 tons
Crossing:	Crow Creek	Skew:	N/A
Latitude:	34.917219°	Longitude:	-82.832158°
Existing Fill Height:	approx 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:	373+85	Begin Bridge Embankment Sta:	373+88
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 creek		
Traffic Control Necessary:	Yes, lane closure		
Surface Soils:	silty sand	Muck:	No
Exposed Rock in Stream Bed:	Yes	Exposed Rock in banks:	No
Wetlands on Site:	Yes	Wetland Adjacent:	Yes
Depth FG to Water:	13 feet	Water Depth:	1 to 2 feet
Depth to Existing Ground:	approximately 14 feet at center of bridge		
Scour Condition at EB:	Critical	Scour Condition at IB:	Critical

End Bridge Embankment Sta:	377+38	End Project Sta:	377+00
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 creek		
Traffic Control Necessary:	Yes, lane closure		
Surface Soils:	silty sand	Muck:	No
Exposed Rock in Stream Bed:	Yes	Exposed Rock in banks:	No
Wetlands on Site:	Yes	Wetland Adjacent:	Yes
Depth FG to Water:	13 feet	Water Depth:	1 to 2 feet
Depth to Existing Ground:	approximately 14 feet at center of bridge		
Scour Condition at EB:	Critical	Scour Condition at IB:	Critical

GeoScoping Form

UTILITIES INFORMATION	
Attached:	A waterline was observed attached along the northeast side of the bridge.
Above Ground:	Overhead power was observed on the southwest side of the road
Underground:	N/A

Comments:

## Field Exploration Description

### Overview

The testing locations were proposed to and approved by SCDOT and located in the field by Terracon using measurements from existing structures shown on the provided drawings. The borings were surveyed by Thomas and Hutton, LLC after testing and drilling was complete. The locations as shown in the Exploration Plan 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
- Preconstruction Design Memorandum (PCDM) 11 - Supplemental Design Criteria for Low Volume Bridge Replacement Projects
- 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. The initial sampling program is summarized in the following table:

Test ID	Total Depth	Interval of Continuous Sampling
S-39-32-1	36 feet w/ 10 feet rock coring	0.5 to 26 feet
S-39-32-2 <sup>1</sup>	28.6	0.5 to 10 feet
S-39-32-2 Offset <sup>1</sup>	50 feet w/ 20 feet rock coring	No sampling
S-39-32-1/2 Offsets	5 feet	Composite Bulk Sample <sup>2</sup>
S-39-32-1C	21.1 feet (refusal)	CPT - No sampling
S-39-32-2C	16.5 feet (refusal)	CPT - No sampling

1. Boring S-39-32-2 was offset 2 feet southwest for rock coring due to the core barrel being lost in the original borehole.
2. Composite bulk sample was obtained with 2 ¼-inch Hollow Stem Auger (HSA).



## **Exhibit A-5 – Field Exploration Description**

S-39-32 Bridge Replacement over Crow Creek | Pickens County, SC  
Terracon Project No. 8623P180 | SCDOT Project ID: P041168



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.

As practical, groundwater readings were collected from each of the soil test borings after 24 hours. These water levels are indicated on the boring logs. The borings were advanced using mud rotary drilling techniques. As the drilling method introduces water into the borehole, time-of-drilling water levels may not be reliable.

At the conclusion of the work, the boreholes and sounding holes were backfilled with the drill cuttings and clean sand. The upper 20 feet of those in the embankments were grouted with a cement bentonite grout and 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 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> <sup>1</sup>			<u>Consistency</u> <sup>2</sup>		
Descriptive Term	Relative Density	SPT Blow Count	Descriptive Term	Unconfined Compression Strength (q <sub>u</sub> ) (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.

### Angularity<sup>1</sup>

<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 Reaction<sup>3</sup>

<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

### Cementation<sup>3</sup>

<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 Range<sup>1</sup>

<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<sup>1, 2</sup>

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

<sup>1</sup>Applies to coarse-grained soils (major portion retained on No. 200 sieve)

<sup>2</sup>Applies to fine-grained soils (major portion passing No. 200 sieve)

<sup>3</sup>Use as required

## DESCRIPTION OF ROCK PROPERTIES

### WEATHERING

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

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

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

### Joint, Bedding, and Foliation Spacing in Rock<sup>a</sup>

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

<sup>a</sup>Spacing 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)<sup>a</sup>

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

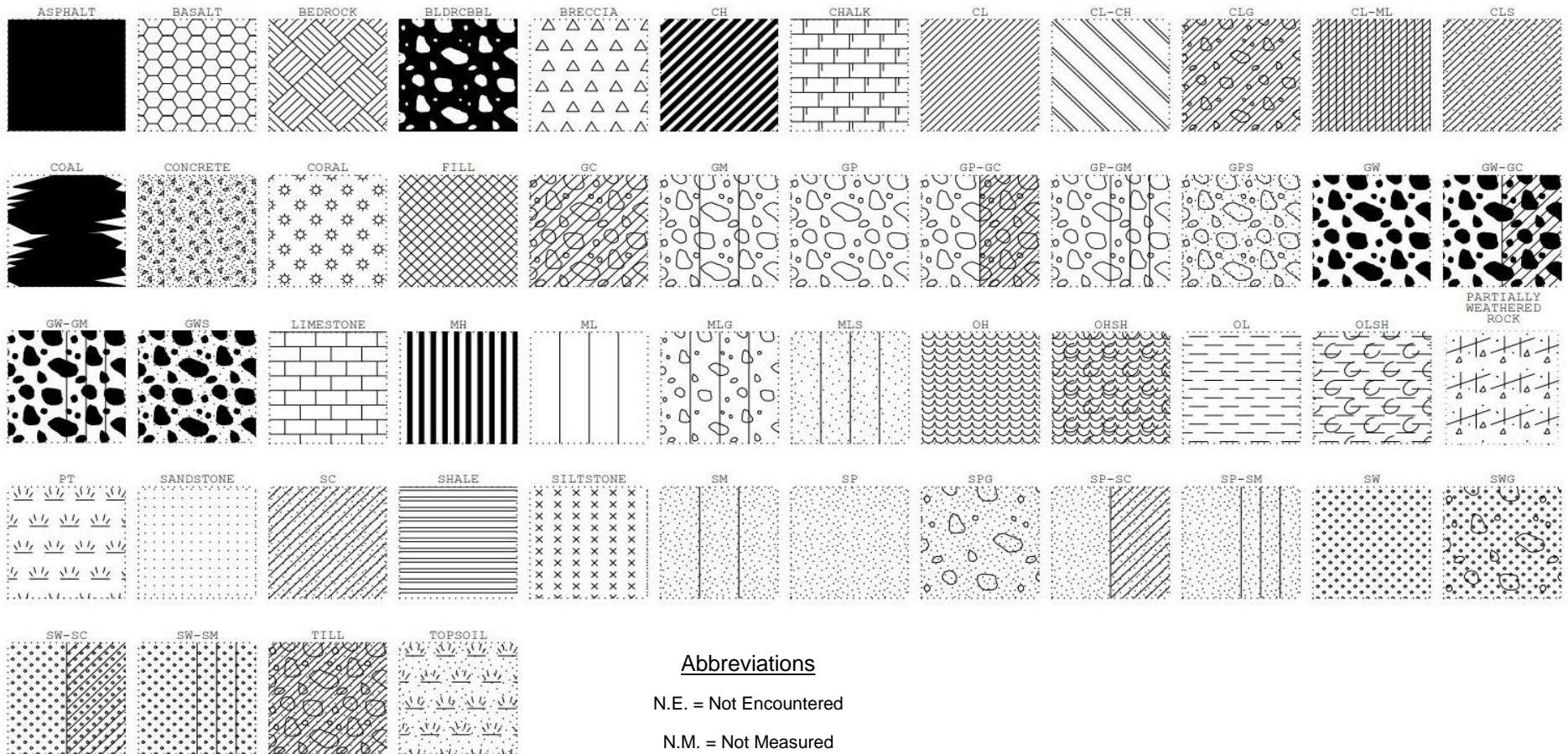
<sup>a</sup>RQD (given as a percentage) = length of core in pieces 4 in. and longer/length of run.

### Joint Openness Descriptors

Openness	Descriptor
No Visible Separation	Tight
Less than 1/32 in.	Slightly open
1/32 to 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



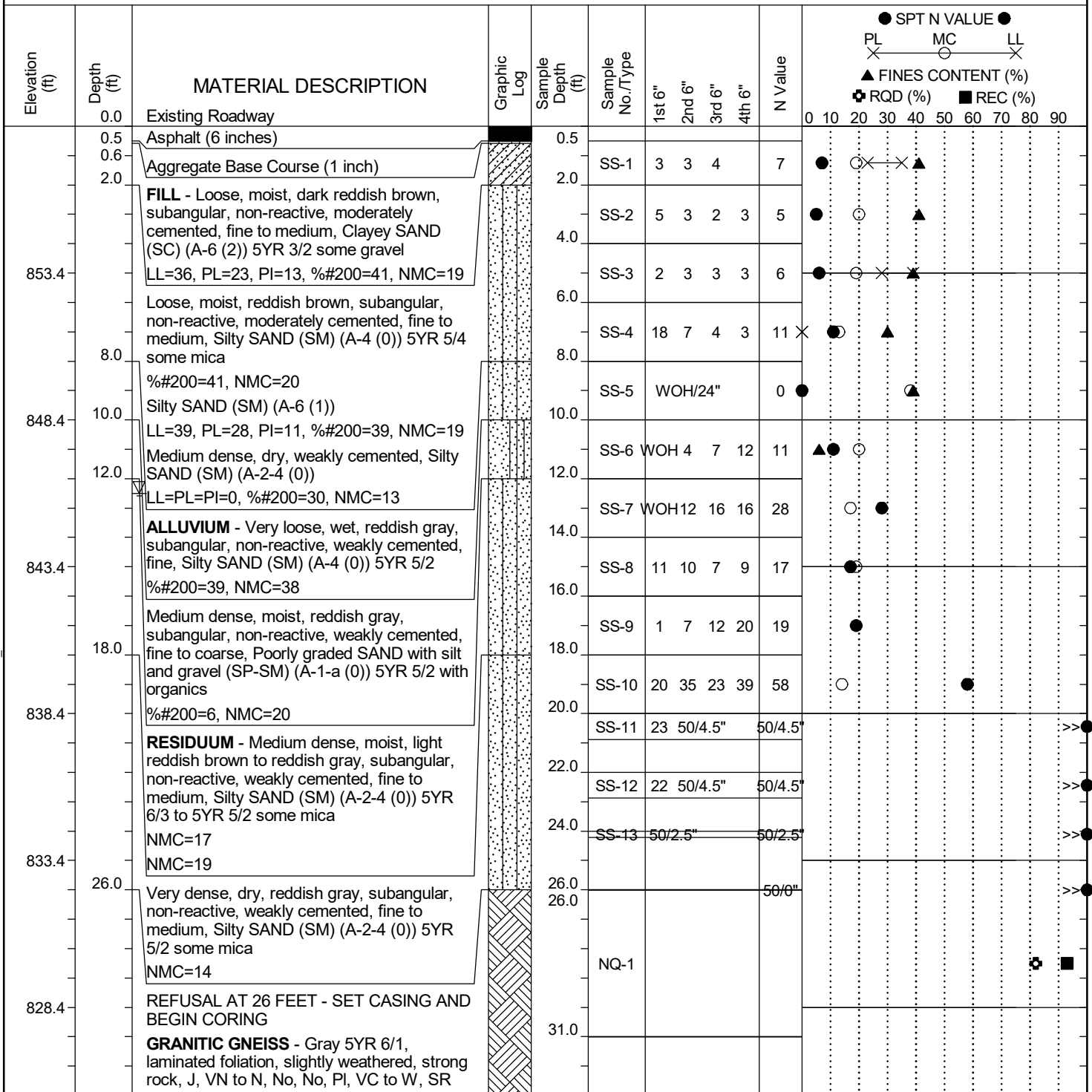
72 Pointe Circle  
PH. (864) 292-2901  
Greenville, SC 29615  
FAX. (864) 292-6361

## SOIL AND ROCK SYMBOLS

Exhibit A-7

# SCDOT Soil Test Log

<b>Project ID:</b>	P041168				<b>County:</b>	Pickens		<b>Boring No.:</b>	S-39-32-1			
<b>Site Description:</b>		S-39-32 BRO Crow Creek							<b>Route:</b>	S-39-32		
<b>Eng./Geo.:</b>	S. Greaber		<b>Boring Location:</b>	375+34		<b>Offset:</b>	7 L		<b>Alignment:</b>	Existing		
<b>Elev.:</b>	858.4 ft		<b>Latitude:</b>	34.9172856		<b>Longitude:</b>	-82.8320644		<b>Date Started:</b>	8/16/24		
<b>Total Depth:</b>	36 ft		<b>Soil Depth:</b>	26 ft		<b>Core Depth:</b>	10 ft		<b>Date Completed:</b>	8/16/2024		
<b>Bore Hole Diameter (in):</b>			4		<b>Sampler Configuration</b>		<b>Liner Required:</b>	Y (N)		<b>Liner Used:</b>	Y (N)	
<b>Drill Machine:</b>		DR#554		<b>Drill Method:</b>	RW/RC		<b>Hammer Type:</b>	Automatic		<b>Energy Ratio:</b>	88.5%	
<b>Core Size:</b>		NQ2		<b>Driller:</b>	G. Robinson		<b>Groundwater:</b>	<b>TOB</b>	12.5 ft		<b>24HR</b>	N.M.



## LEGEND

Continued Next Page

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

SC.DOT 8623P180T SCDOT BRIDGE PACK 19 S-39-32 OVER CROW CREEK-DOT.GPJ SCDOT\_DATATEMPLATE.GDT 9/23/24

# SCDOT Soil Test Log

<b>Project ID:</b> P041168				<b>County:</b> Pickens		<b>Boring No.:</b> S-39-32-1	
<b>Site Description:</b> S-39-32 BRO Crow Creek				<b>Route:</b> S-39-32			
<b>Eng./Geo.:</b> S. Greaber		<b>Boring Location:</b> 375+34		<b>Offset:</b> 7 L		<b>Alignment:</b> Existing	
<b>Elev.:</b> 858.4 ft		<b>Latitude:</b> 34.9172856		<b>Longitude:</b> -82.8320644		<b>Date Started:</b> 8/16/24	
<b>Total Depth:</b> 36 ft		<b>Soil Depth:</b> 26 ft		<b>Core Depth:</b> 10 ft		<b>Date Completed:</b> 8/16/2024	
<b>Bore Hole Diameter (in):</b> 4		<b>Sampler Configuration</b>		<b>Liner Required:</b> Y (N)		<b>Liner Used:</b> Y (N)	
<b>Drill Machine:</b> DR#554		<b>Drill Method:</b> RW/RC		<b>Hammer Type:</b> Automatic		<b>Energy Ratio:</b> 88.5%	
<b>Core Size:</b> NQ2		<b>Driller:</b> G. Robinson		<b>Groundwater:</b> TOB 12.5 ft		<b>24HR</b> 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	<div> <div> ● SPT N VALUE ● </div> <div> PL X MC O LL X </div> <div> ▲ FINES CONTENT (%) </div> <div> ⊕ RQD (%) ■ REC (%) </div> </div>
823.4	36.0	NQ-1: %REC=93, RQD=82, GSI=80-85, RMR=74, qu=12,659, 2.5 min/ft NQ-2: %REC=91, RQD=81, GSI=75-80, RMR=74, qu=8,796, 1.4 min/ft CORING TERMINATED AT 36 FEET			NQ-2						<div> <div> 0 10 20 30 40 50 60 70 80 90 </div> <div> <div> ⊕ </div> <div> ■ </div> </div> </div>
818.4											
813.4											
808.4											
803.4											
798.4											
793.4											

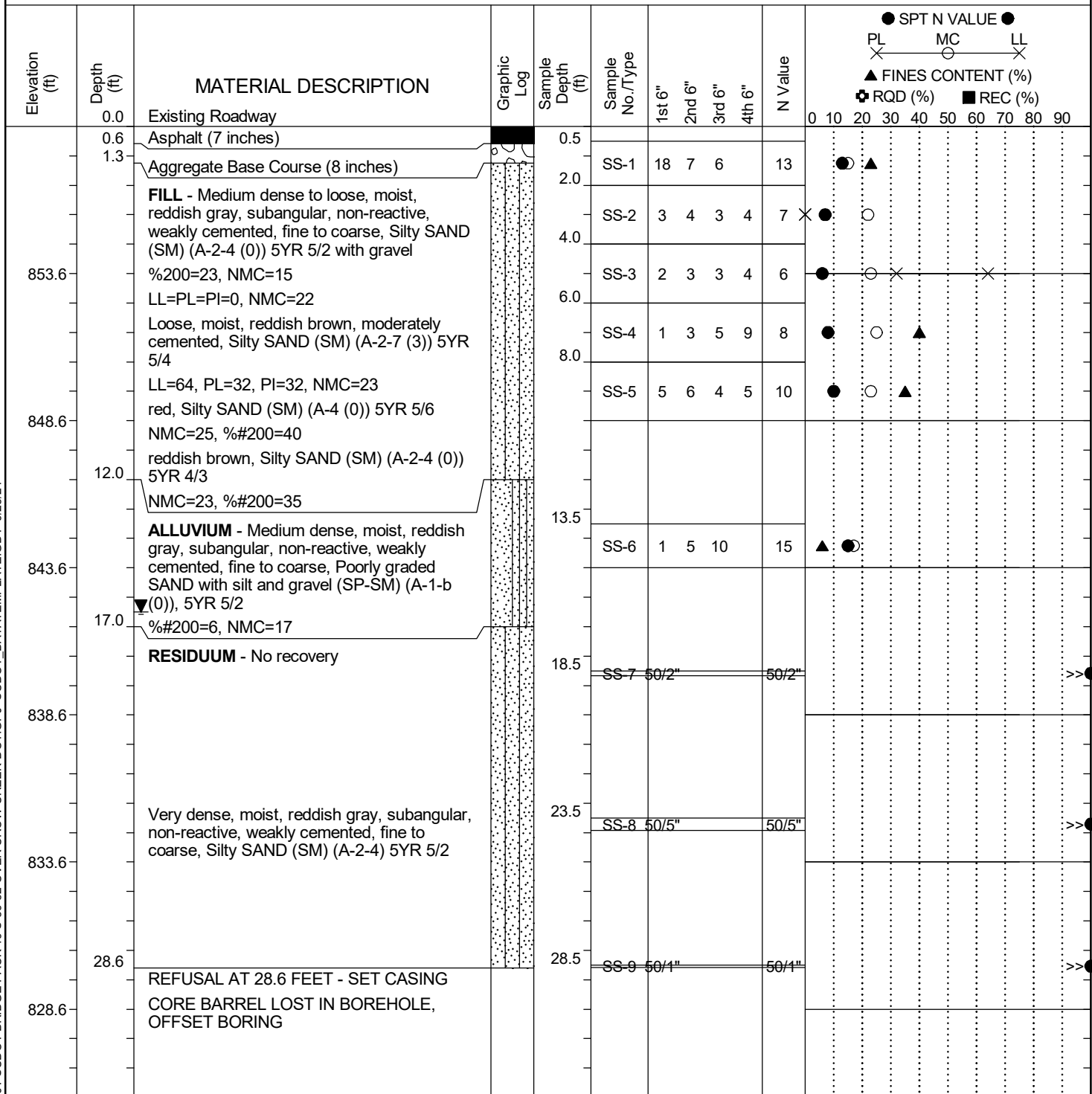
## LEGEND

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

SC.DOT 8623P180T SCDOT BRIDGE PACK 19 S-39-32 OVER CROW CREEK-DOT.GPJ SCDOT\_DATATEMPLATE.GDT 9/23/24

# SCDOT Soil Test Log

<b>Project ID:</b>	P041168	<b>County:</b>	Pickens	<b>Boring No.:</b>	S-39-32-2
<b>Site Description:</b>	S-39-32 BRO Crow Creek			<b>Route:</b>	S-39-32
<b>Eng./Geo.:</b>	M. McKenney	<b>Boring Location:</b>	376+13	<b>Offset:</b>	8 L
<b>Elev.:</b>	858.6 ft	<b>Latitude:</b>	34.917115	<b>Longitude:</b>	-82.8322245
<b>Total Depth:</b>	28.6 ft	<b>Soil Depth:</b>	28.6 ft	<b>Core Depth:</b>	0 ft
<b>Date Started:</b>	8/15/24				
<b>Date Completed:</b>	8/15/2024				
<b>Bore Hole Diameter (in):</b>	4	<b>Sampler Configuration</b>	<b>Liner Required:</b> Y (N)		<b>Liner Used:</b> Y (N)
<b>Drill Machine:</b>	DR#1327	<b>Drill Method:</b>	RW	<b>Hammer Type:</b>	Automatic
<b>Energy Ratio:</b>	92.6%				
<b>Core Size:</b>	N/A	<b>Driller:</b>	B. Burnette	<b>Groundwater:</b>	TOB N.M.
<b>24HR</b>	16.5 ft				



## 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 S-39-32 OVER CROW CREEK-DOT.GPJ SCDOT\_DATATEMPLATE.GDT 9/23/24



# SCDOT Soil Test Log

<b>Project ID:</b> P041168				<b>County:</b> Pickens		<b>Boring No.:</b> S-39-32-2 Offset	
<b>Site Description:</b> S-39-32 BRO Crow Creek				<b>Route:</b> S-39-32			
<b>Eng./Geo.:</b> S. Greaber		<b>Boring Location:</b> 376+15		<b>Offset:</b> 8 L		<b>Alignment:</b> Existing	
<b>Elev.:</b> 858.7 ft		<b>Latitude:</b> 34.9171106		<b>Longitude:</b> -82.8322288		<b>Date Started:</b> 8/16/2024	
<b>Total Depth:</b> 50 ft		<b>Soil Depth:</b> 30 ft		<b>Core Depth:</b> 20 ft		<b>Date Completed:</b> 8/16/2024	
<b>Bore Hole Diameter (in):</b> 4		<b>Sampler Configuration</b>		<b>Liner Required:</b> Y (N)		<b>Liner Used:</b> Y (N)	
<b>Drill Machine:</b> DR#1327		<b>Drill Method:</b> RW/RC		<b>Hammer Type:</b> Automatic		<b>Energy Ratio:</b> 92.6%	
<b>Core Size:</b> NQ2		<b>Driller:</b> B. Burnette		<b>Groundwater:</b> TOB N.M.		<b>24HR</b> 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
853.7		Offset 2 feet southwest of boring S-39-32-2 for rock coring due to core barrel lost in original borehole Rotary wash to refusal - no sampling		0.0							
848.7											
843.7											
838.7											
833.7											
828.7	30.0	REFUSAL AT 30 FEET - SET CASING AND BEGIN CORING <b>GRANITIC GNEISS</b> - Gray 5YR 6/1, laminated foliation, moderately to slightly		30.0	NQ-1						

## LEGEND

Continued Next Page

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

SC.DOT 8623P180T SCDOT BRIDGE PACK 19 S-39-32 OVER CROW CREEK-DOT.GPJ SCDOT\_DATATEMPLATE.GDT 9/23/24

# SCDOT Soil Test Log

<b>Project ID:</b>	P041168	<b>County:</b>	Pickens	<b>Boring No.:</b>	S-39-32-2 Offset
<b>Site Description:</b>	S-39-32 BRO Crow Creek	<b>Route:</b>	S-39-32		
<b>Eng./Geo.:</b>	S. Greaber	<b>Boring Location:</b>	376+15	<b>Offset:</b>	8 L
<b>Elev.:</b>	858.7 ft	<b>Latitude:</b>	34.9171106	<b>Longitude:</b>	-82.8322288
<b>Date Started:</b>	8/16/2024				
<b>Total Depth:</b>	50 ft	<b>Soil Depth:</b>	30 ft	<b>Core Depth:</b>	20 ft
<b>Date Completed:</b>	8/16/2024				
<b>Bore Hole Diameter (in):</b>	4	<b>Sampler Configuration</b>		<b>Liner Required:</b>	Y (N)
<b>Liner Used:</b>	Y (N)				
<b>Drill Machine:</b>	DR#1327	<b>Drill Method:</b>	RW/RC	<b>Hammer Type:</b>	Automatic
<b>Energy Ratio:</b>	92.6%				
<b>Core Size:</b>	NQ2	<b>Driller:</b>	B. Burnette	<b>Groundwater:</b>	TOB N.M.
<b>24HR</b>	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	<div> <div> ● SPT N VALUE ● </div> <div> PL X MC X LL X </div> <div> ▲ FINES CONTENT (%) </div> <div> ⊕ RQD (%) ■ REC (%) </div> </div>
823.7		weathered, strong to very strong rock, J, N, Su, Cl, Pl, VC to M, SR		35.0							
		NQ-1: %REC=67, RQD=52, GSI=60-65, 2.5 min/ft									
		NQ-2: %REC=93, RQD=50, GSI=65-70, RMR=60, qu=7,701 psi, 1.3 min/ft			NQ-2						
818.7		NQ-3: %REC=94, RQD=70, GSI=70-75, 2.3 min/ft		40.0							
					NQ-3						
813.7		NQ-4: %REC=96, RQD=93, GSI=80-85, RMR=82, qu=15,455 psi, 4.5 min/ft		45.0							
					NQ-4						
808.7	50.0	CORING TERMINATED AT 50 FEET AND SET DHT CASING									
803.7											
798.7											
793.7											

## 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 S-39-32 OVER CROW CREEK-DOT.GPJ SCDOT\_DATATEMPLATE.GDT 9/23/24

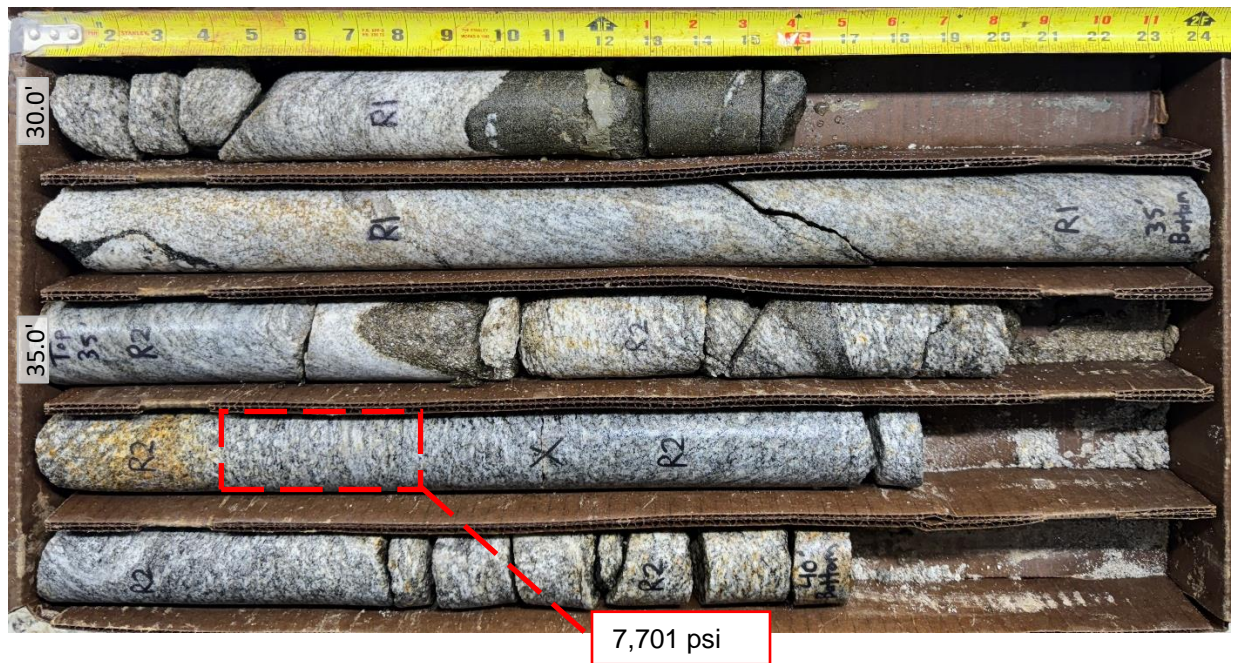
**Rock Core Photograph Logs – Exhibit A-9**

S-39-32 BRO Crow Creek | Pickens County, SC

Terracon Project No. 8623P180 | SCDOT Project ID: P041168



S-39-32-1, NQ-1 and NQ-2 (26 to 36 feet)



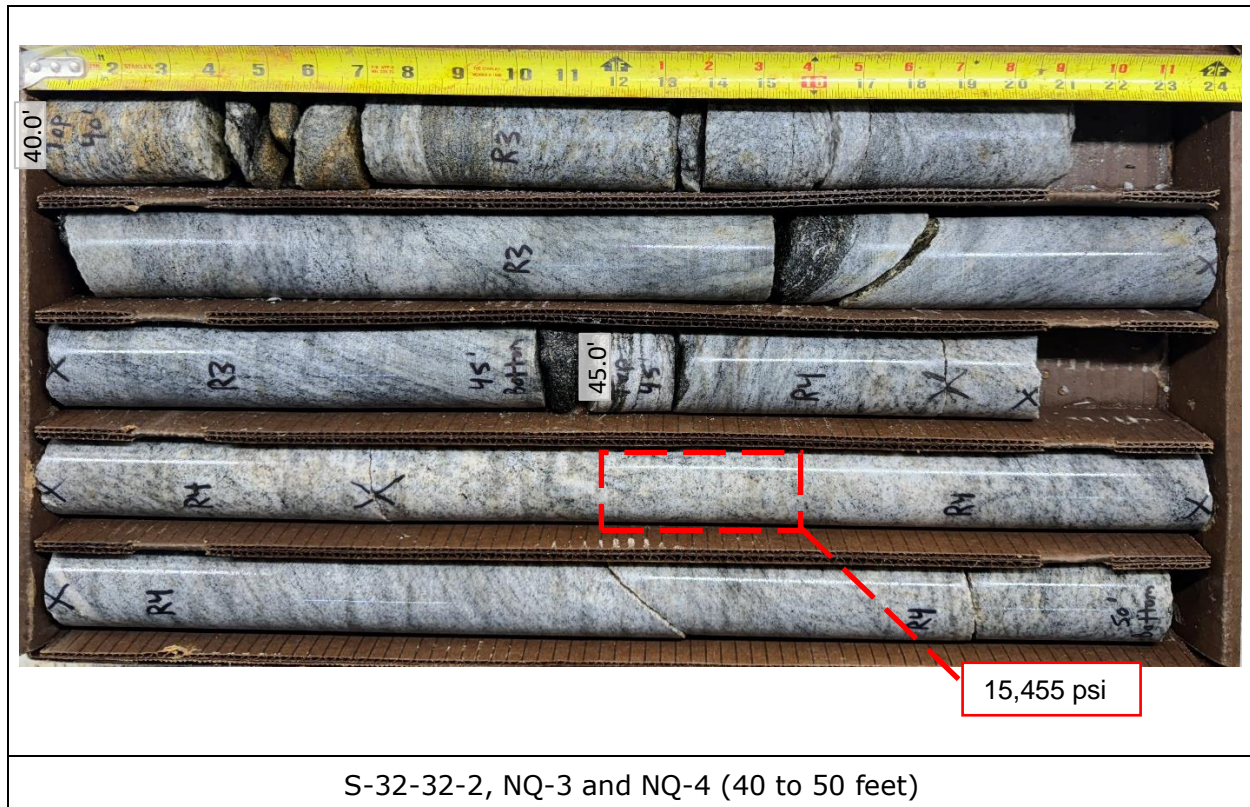
S-39-32-2, NQ-1 and NQ-2 (30 to 40 feet)



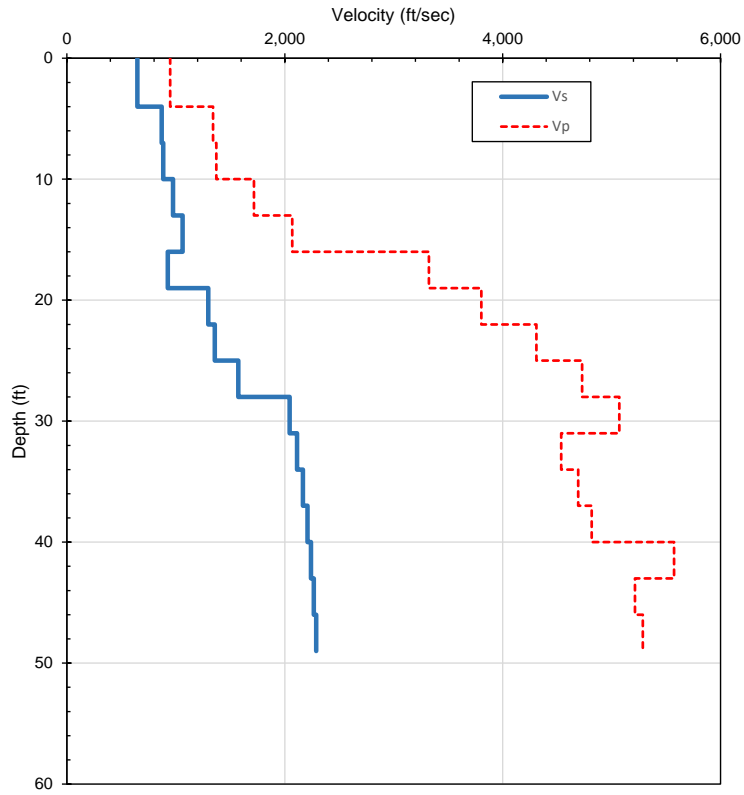
**Rock Core Photograph Logs – Exhibit A-9**

S-39-32 BRO Crow Creek | Pickens County, SC

Terracon Project No. 8623P180 | SCDOT Project ID: P041168




# Downhole Seismic Velocity Fixed Interval Method



Depth (ft)	Vp (ft/sec)	Vs (ft/sec)	Δi (ft)	Δt (sec)	Est. In-Situ Unit Wt (pcf)
4	948	647	4	0.00618	100
7	1342	870	3	0.00345	
10	1372	885	3	0.00339	
13	1717	975	3	0.00308	125
16	2068	1062	3	0.00282	130
19	3323	927	3	0.00324	
22	3805	1297	3	0.00231	
25	4309	1357	3	0.00221	
28	4729	1573	3	0.00191	
31	5070	2045	3	0.00147	165
34	4537	2113	3	0.00142	
37	4693	2166	3	0.00139	
40	4817	2208	3	0.00136	
43	5573	2241	3	0.00134	
46	5215	2267	3	0.00132	
49	5286	2289	3	0.00131	
100                      2250                      51                      0.02267  Unit Weight of Soil estimated from SPT results Unit Weight of Rock based on average results from compression tests					
Sum of Data Over Profile			49	0.03819	
Weighted Average Shear Wave Velocity Over Profile			1,283 ft/sec		
Est. Weighted Average Shear Wave Velocity Over 100-Ft <sup>1</sup>			1,643 ft/sec		

1. Assuming shear wave of 2,250 f/s for rock below 49 feet.

Project Mgr: MM	Project No.  8623P180	 Consulting Engineers and Scientists	GEOPHYSICAL TESTING RESULTS		TEST NO. S-39-32-2 Offset
Prepared by: MM			DOWNHOLE SEISMIC TEST		
Checked by: SG			S-39-32 (Shady Grove Road) Bridge Replacement over Crow Creek PICKENS COUNTY, SOUTH CAROLINA		
Approved by:			P041168		
	Scale: NA				EXHIBIT A-10
	Date:  9/12/2024	72 Pointe Circle Ph: (864) 292-2901 Greenville, South Carolina Fax: (864) 292-6361			

# CPT Sounding ID S-39-32-1C

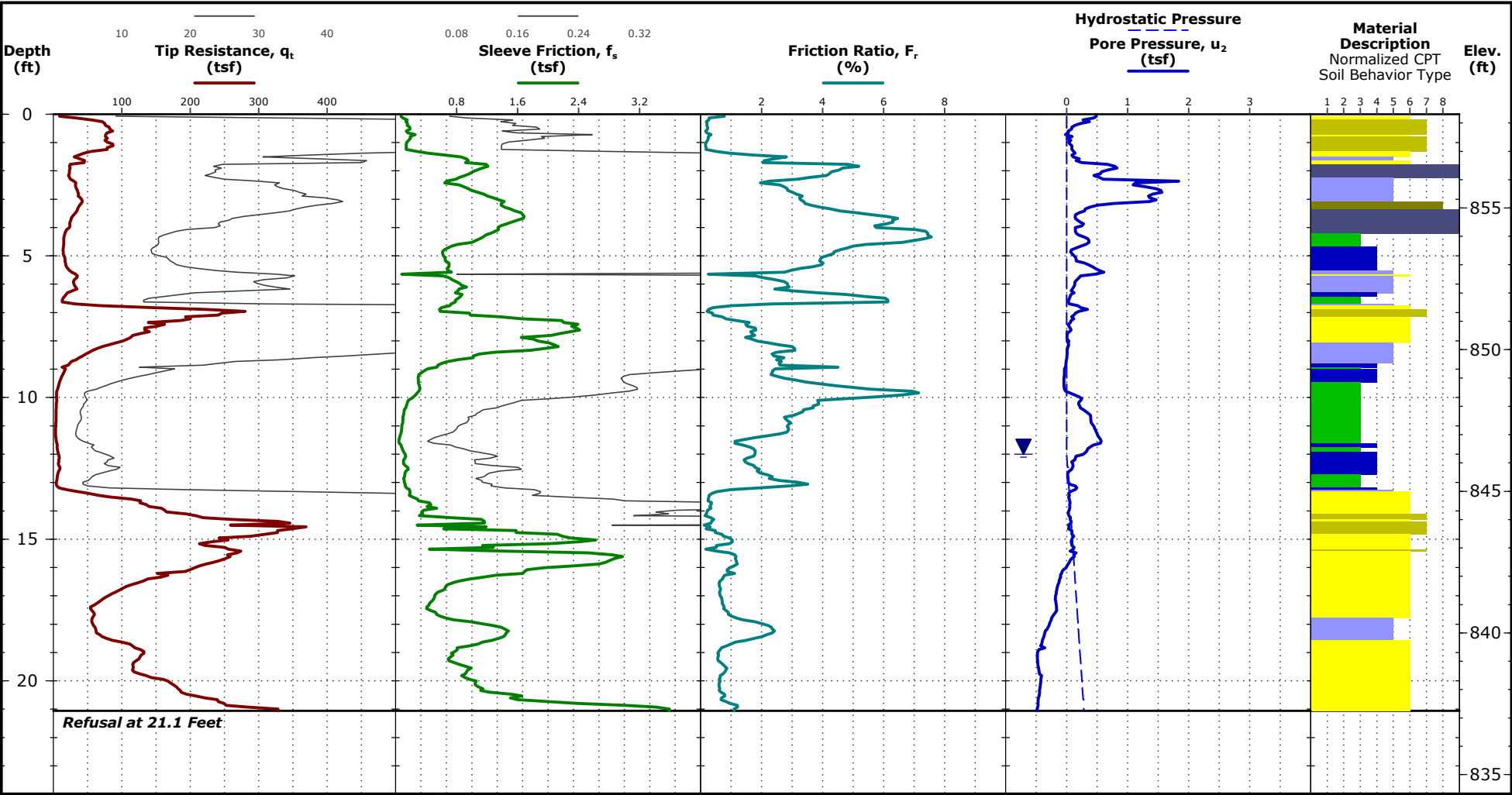


72 Pointe Cir  
Greenville, SC

Elevation: 858.31 (ft)  
Elevation Reference: Elevations were provided by others.

Latitude: 34.917275° Longitude: -82.832074°  
Station: 375+39 Offset: 7 R

CPT Started: 8/22/2024  
CPT Completed: 8/22/2024



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/BR  
CPT sensor calibration reports available upon request  
Probe No. 6025 with net area ratio of .84  
Manufactured by Geoprobe Systems- Calibrated 4/17/2024  
Tip and sleeve areas of 10 cm<sup>2</sup> and 150 cm<sup>2</sup>

## Water Level Observation

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

## Normalized Soil Behavior Type (Robertson 1990)

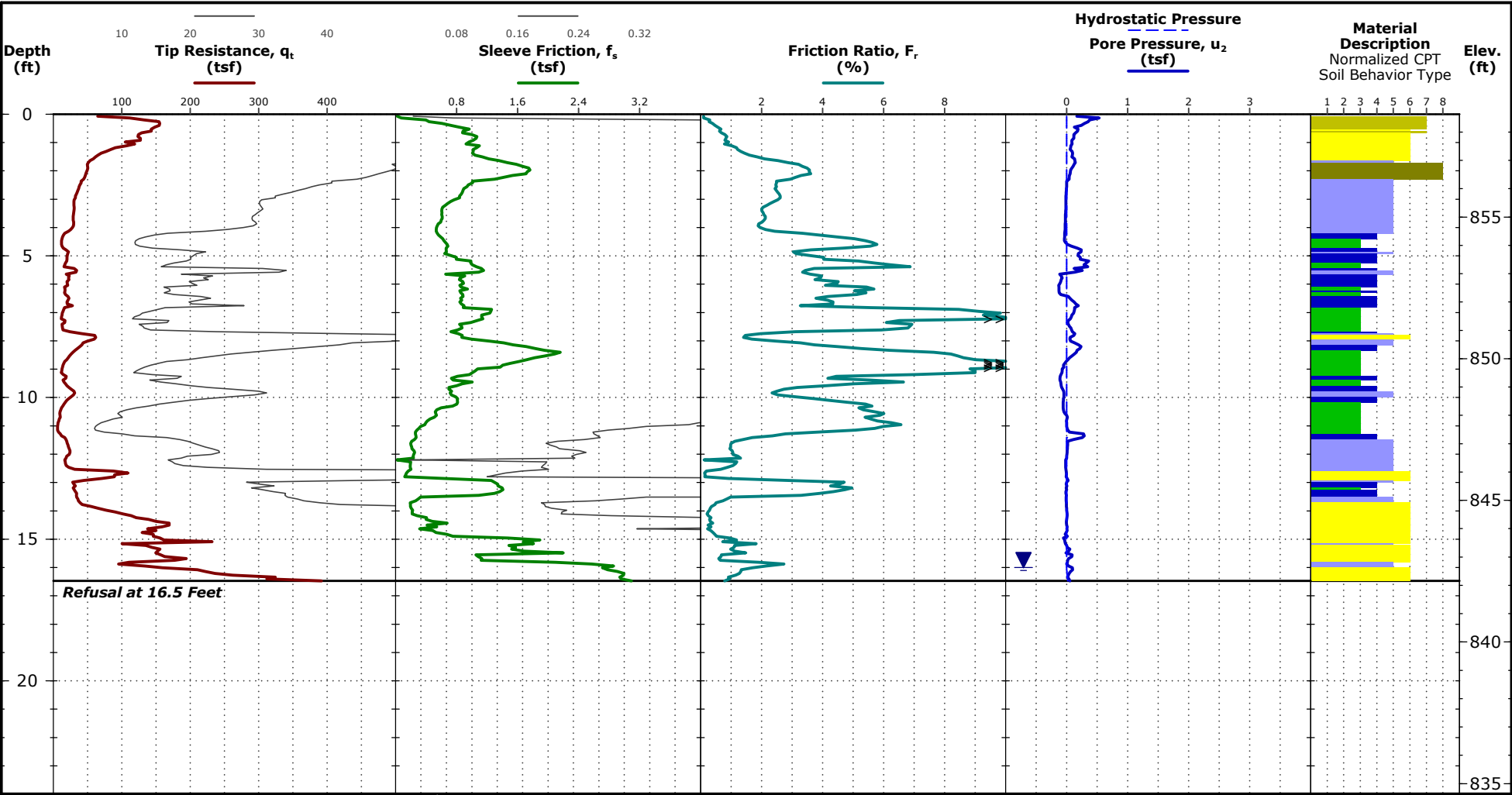
- 1 Sensitive, fine grained
- 2 Organic soils - clay
- 3 Clay - silty clay to clay
- 4 Silt mixtures - clayey silt to silty clay
- 5 Sand mixtures - silty sand to sandy silt
- 6 Sands - clean sand to silty sand
- 7 Gravelly sand to dense sand
- 8 Very stiff sand to clayey sand
- 9 Very stiff fine grained

CPT Sounding ID S-39-32-2C

Elevation: 858.63 (ft)  
Elevation Reference: Elevations were provided by others.

Latitude: 34.917123° Longitude: -82.832219°  
Station: 376+10 Offset: 7 R

CPT Started: 8/22/2024  
CPT Completed: 8/22/2024



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/BR  
CPT sensor calibration reports available upon request  
Probe No. 6025 with net area ratio of .84  
Manufactured by Geoprobe Systems- Calibrated 4/17/2024  
Tip and sleeve areas of 10 cm<sup>2</sup> and 150 cm<sup>2</sup>

**Water Level Observation**  
▼ 16 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 silt
- 6 Sands - clean sand to silty sand
- 7 Gravelly sand to dense sand
- 8 Very stiff sand to clayey sand
- 9 Very stiff fine grained

## **Appendix B – Laboratory Testing**

S-39-32 Bridge Replacement over Crow Creek | Pickens County, SC  
Terracon Project No. 8623P180 | SCDOT Project ID: P041168



# **Appendix B**

## **Laboratory Testing**

Exhibit B-1 – Laboratory Testing Description  
Summary of Laboratory Data  
Laboratory Data Sheets (20 Pages)

Note: All exhibits are one page unless noted above.



## Exhibit B-1 – Laboratory Testing Description

S-39-32 Bridge Replacement over Crow Creek | Pickens County, SC  
Terracon Project No. 8623P180 | SCDOT Project ID: P041168



### 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:

■ Rock Compressive Strength	ASTM D7012
■ Moisture Content	AASHTO T265/(ASTM D2216)
■ Atterberg Limits	AASHTO T89/T90(ASTM D4318)
■ Wash 200	AASHTO T11/(ASTM D1140)
■ Proctor (Standard effort)	AASHTO T99/ (ASTM D698)
■ Triaxial Shear CU w/ PP	AASHTO T297/(ASTM D4767)
■ Grain Size Distribution	ASTM D6913
■ Hydrometer	ASTM D7928
■ 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-39-32-1	0.5-2	CLAYEY SAND(SC) / A-6 (2)	36	23	13	1.1	57.5	41.4			19.3	
S-39-32-1	2-4	SILTY SAND(SM) / A-4 (0)				1.9	57.2	40.9			20.4	
S-39-32-1	4-6	SILTY SAND(SM) / A-6 (1)	39	28	11	2.7	58.4	38.9			19.2	
S-39-32-1	6-8	SILTY SAND(SM) / A-2-4 (0)	NP	NP	NP	0.0	70.5	29.5			12.9	
S-39-32-1	8-10	SILTY SAND(SM) / A-4 (0)				0.0	61.0	39.0	28.7	10.3	37.7	
S-39-32-1	10-12	POORLY GRADED SAND with SILT and GRAVEL(SP-SM) / A-1-A (0)				39.7	54.5	5.8	4.0	1.8	20.2	
S-39-32-1	12-14	SILTY SAND(SM) / A-2-4 (0)									16.6	
S-39-32-1	14-16	SILTY SAND(SM) / A-2-4 (0)									19.1	
S-39-32-1	18-20	SILTY SAND(SM) / A-2-4 (0)									13.8	
S-39-32-2	0.5-2	SILTY SAND(SM) / A-2-4 (0)				13.4	63.3	23.2			14.9	
S-39-32-2	2-4	SILTY SAND(SM) / A-2-4 (0)	NP	NP	NP						21.6	
S-39-32-2	4-6	SILTY SAND(SM) / A-2-7 (3)	64	32	32						23.4	
S-39-32-2	6-8	SILTY SAND(SM) / A-4 (0)				7.7	52.8	39.5			24.5	
S-39-32-2	8-10	SILTY SAND(SM) / A-2-4 (0)				3.8	61.7	34.5	14.8	19.7	23.2	
S-39-32-2	13.5-15	POORLY GRADED SAND with SILT and GRAVEL(SP-SM) / A-1-B (0)				22.9	71.0	6.1	3.9	2.2	16.9	
S-39-32-1/2 Offset	0	SILTY SAND(SM) / A-2-4 (0)	NP	NP	NP	5.2	60.9	33.9				112.6 / 13.8



# INDEX PROPERTIES VERSUS DEPTH

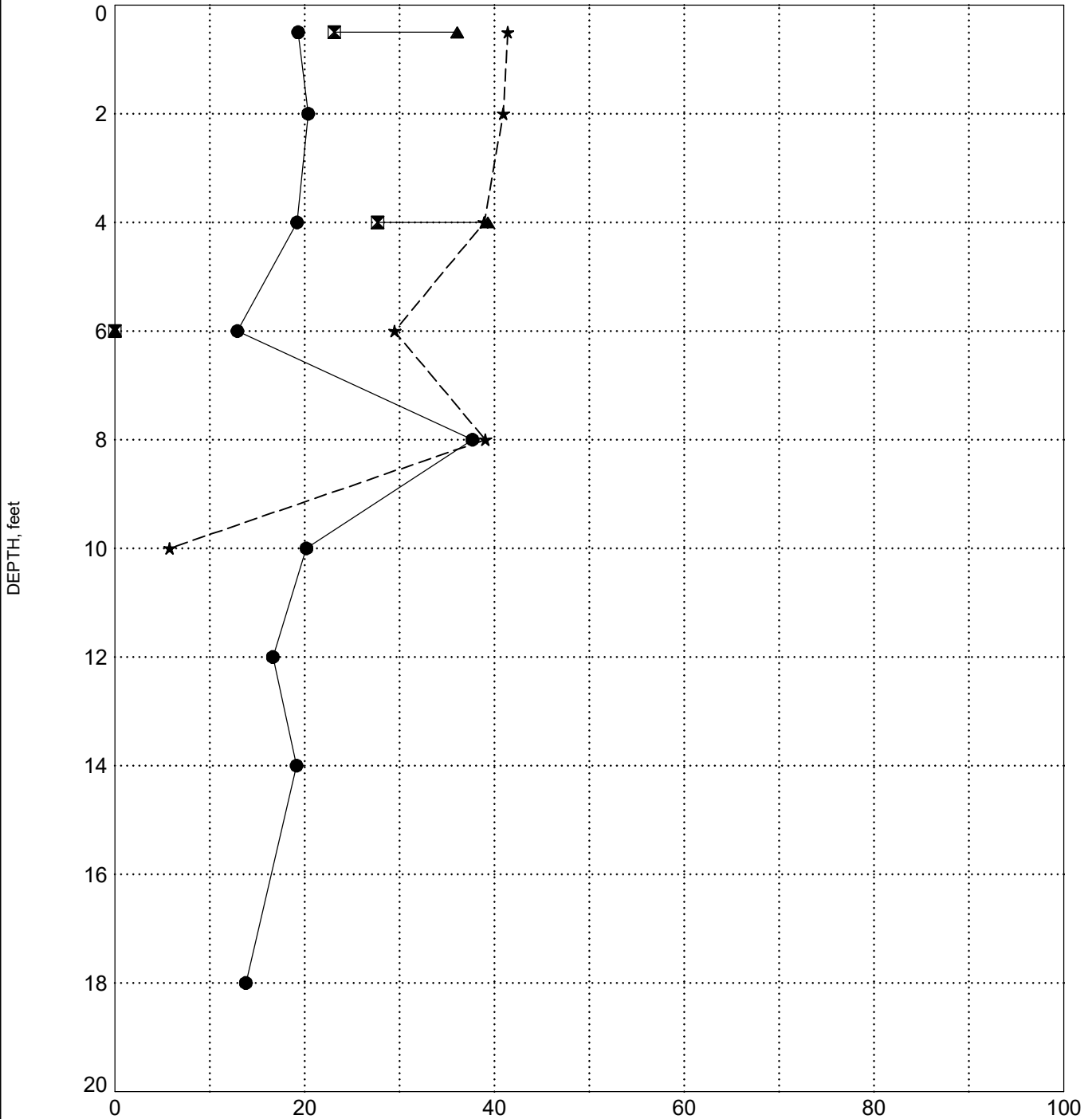
PROJECT ID P041168

PROJECT NAME S-39-32 BRO Crow Creek

PROJECT COUNTY Pickens

SURFACE ELEVATION: 858.4

## BORING S-39-32-1



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



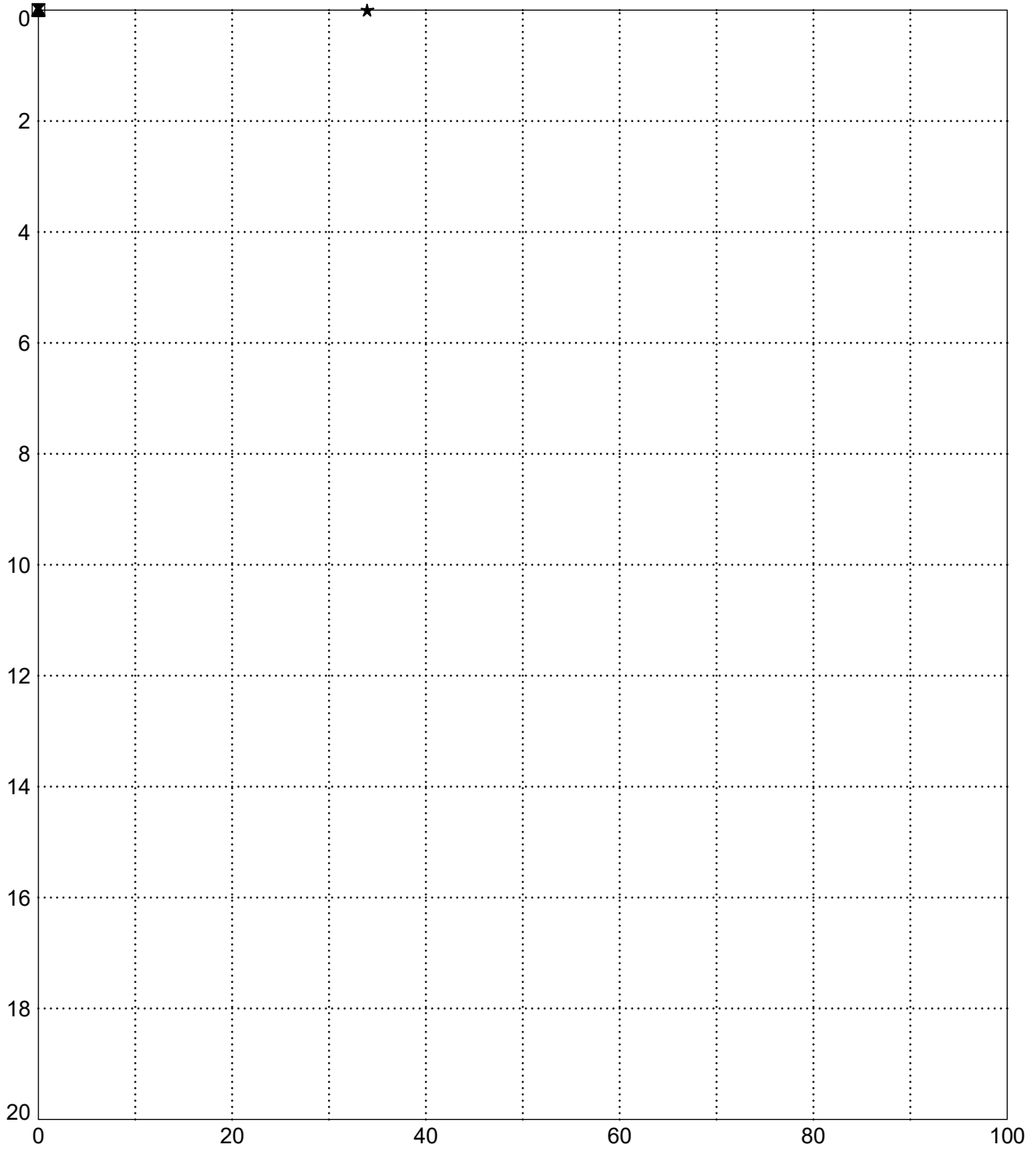
# INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P041168

PROJECT NAME S-39-32 BRO Crow Creek

PROJECT COUNTY Pickens

## BORING S-39-32-1/2 Offset



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



# INDEX PROPERTIES VERSUS DEPTH

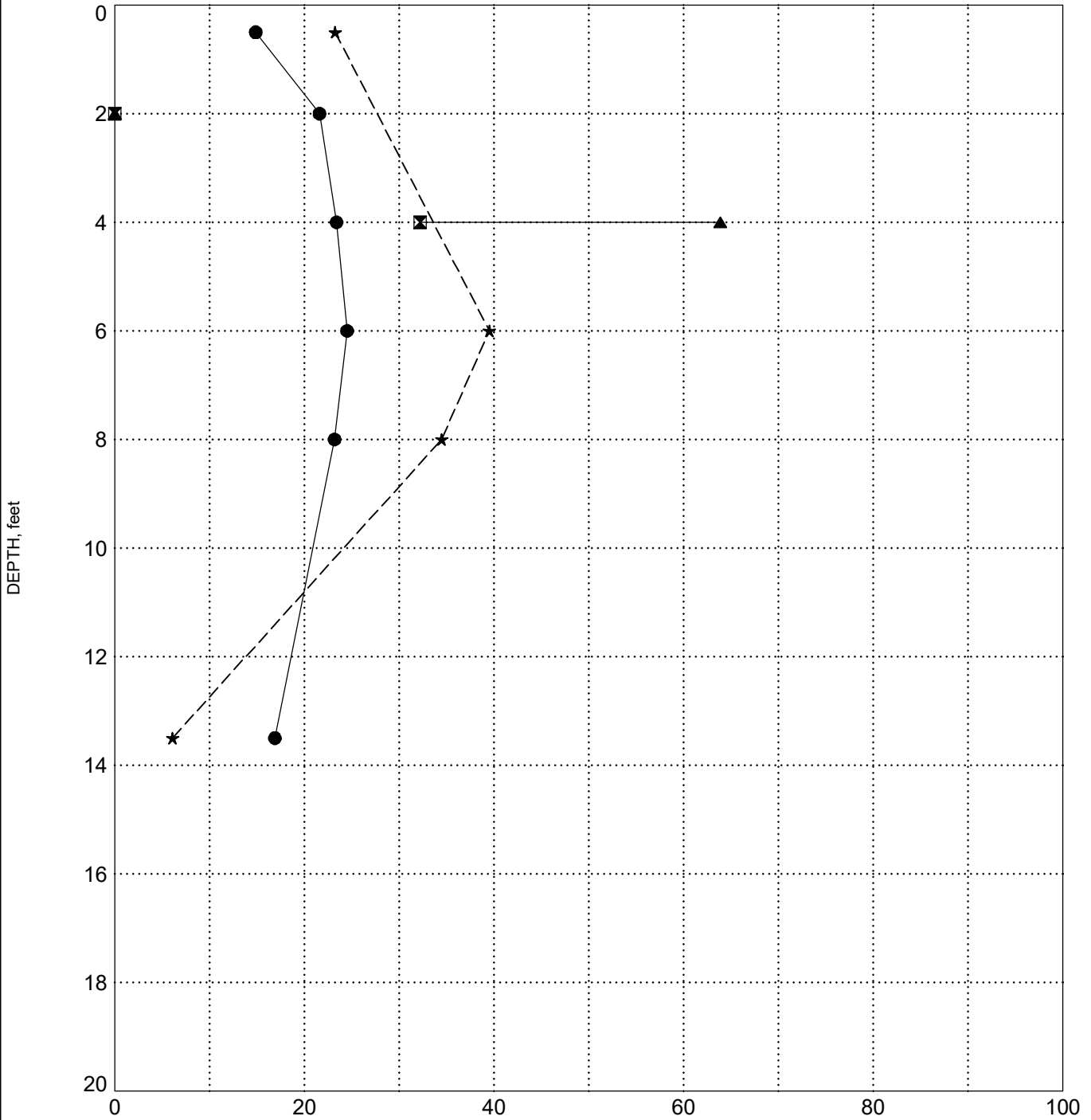
PROJECT ID P041168

PROJECT NAME S-39-32 BRO Crow Creek

PROJECT COUNTY Pickens

SURFACE ELEVATION: 858.6

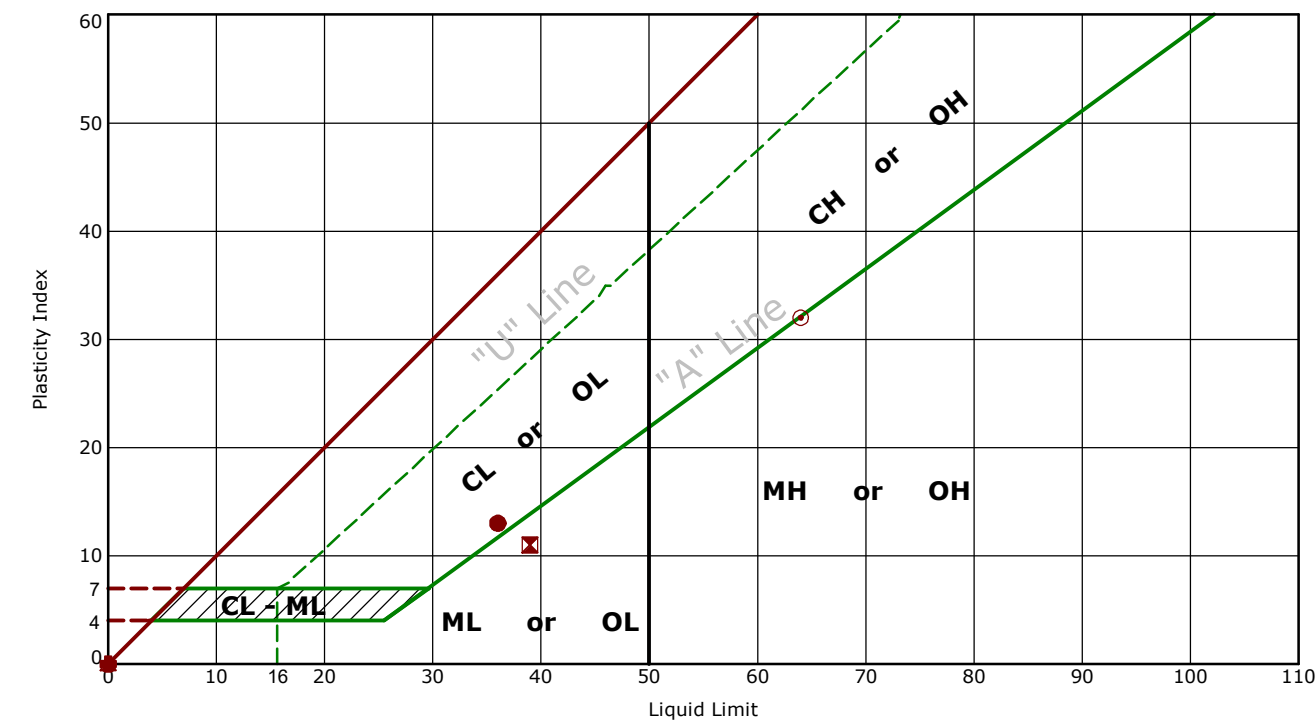
## BORING S-39-32-2



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

# Atterberg Limit Results

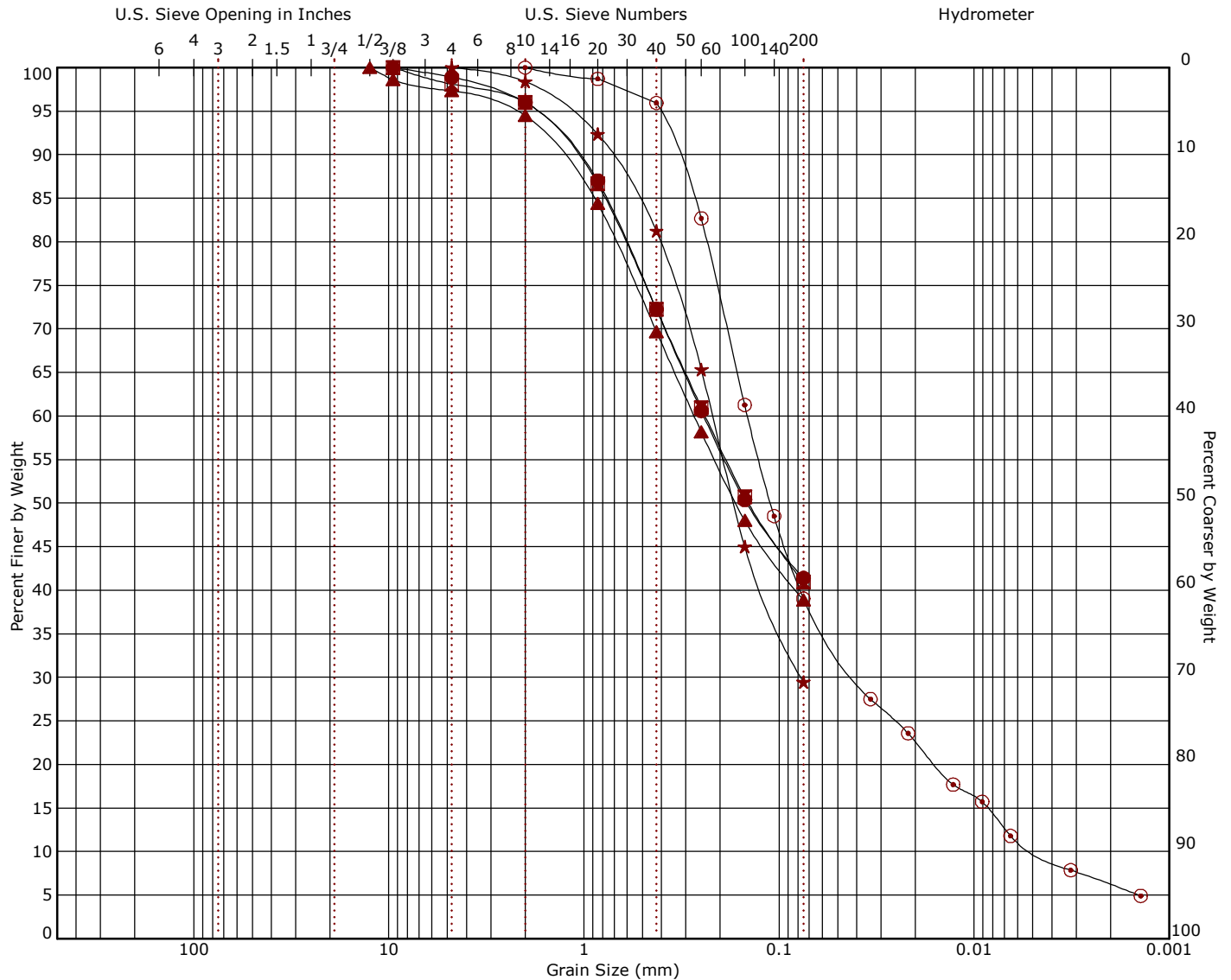
ASTM D4318



	Boring ID	Depth (Ft)	LL	PL	PI	Fines	AASHTO	Description
●	S-39-32-1	0.5 - 2	36	23	13	41.4	A-6 (2)	CLAYEY SAND
⊠	S-39-32-1	4 - 6	39	28	11	38.9	A-6 (1)	SILTY SAND
▲	S-39-32-1	6 - 8	NP	NP	NP	29.5	A-2-4 (0)	SILTY SAND
★	S-39-32-2	2 - 4	NP	NP	NP		A-2-4 (0)	SILTY SAND
⊙	S-39-32-2	4 - 6	64	32	32		A-2-7 (3)	SILTY SAND
⊕	S-39-32-1/2 Offset	0 - 5	NP	NP	NP	33.9	A-2-4 (0)	SILTY 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-39-32-1	0.5 - 2	CLAYEY SAND	SC	A-6 (2)	36	23	13		
☒ S-39-32-1	2 - 4	SILTY SAND	SM	A-4 (0)					
▲ S-39-32-1	4 - 6	SILTY SAND	SM	A-6 (1)	39	28	11		
★ S-39-32-1	6 - 8	SILTY SAND	SM	A-2-4 (0)	NP	NP	NP		
⊙ S-39-32-1	8 - 10	SILTY SAND	SM	A-4 (0)				2.39	30.78

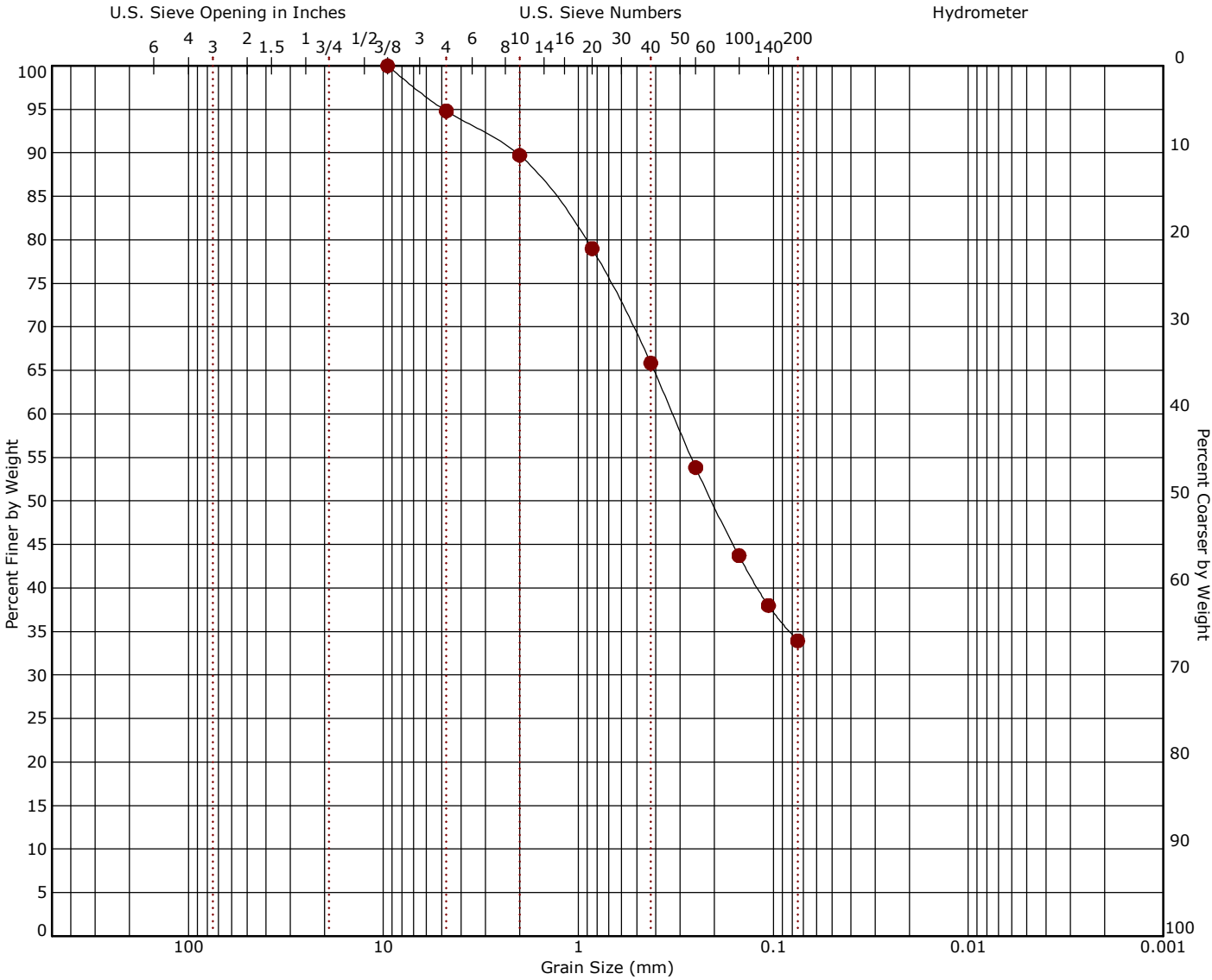
Boring ID	Depth (Ft)	D <sub>100</sub>	D <sub>60</sub>	D <sub>30</sub>	D <sub>10</sub>	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
● S-39-32-1	0.5 - 2	9.5	0.243			0.0	1.1	57.5	41.4		
☒ S-39-32-1	2 - 4	9.5	0.238			0.0	1.9	57.2	40.9		
▲ S-39-32-1	4 - 6	12.5	0.272			0.0	2.7	58.4	38.9		
★ S-39-32-1	6 - 8	4.75	0.219	0.077		0.0	0.0	70.5	29.5		
⊙ S-39-32-1	8 - 10	2	0.145	0.04	0.005	0.0	0.0	61.0		28.7	10.3

## ASTM D422 / ASTM C136

Facilities | Environmental | **Geotechnical** | Materials



Grain Size Distribution  
ASTM D422 / ASTM C136



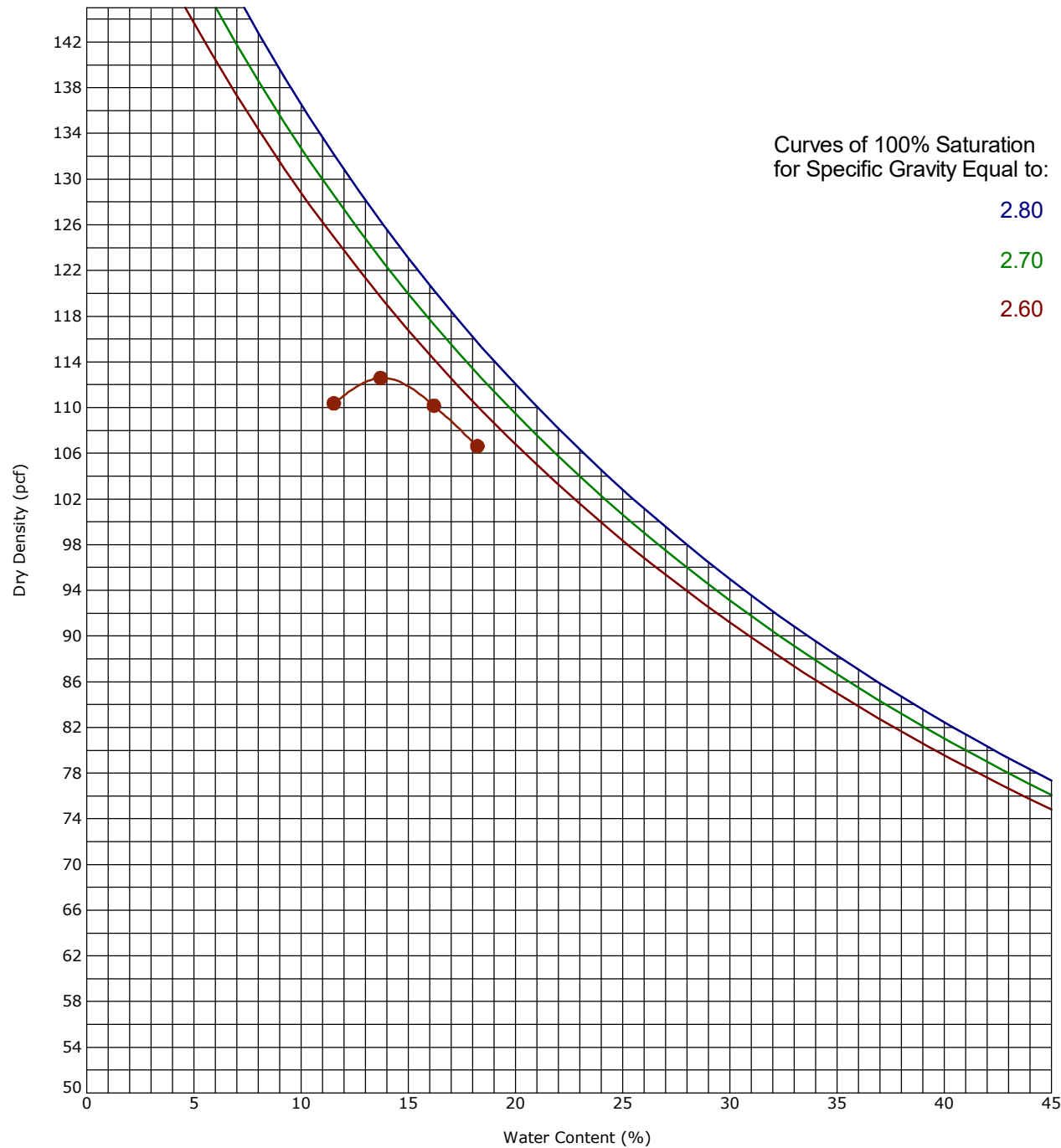
Cobbles		Gravel		Sand			Silt or Clay			
		coarse	fine	coarse	medium	fine				

Boring ID	Depth (Ft)	USCS Classification			USCS	AASHTO	LL	PL	PI	Cc	Cu
S-39-32-1/2 Offset	0 - 5	SILTY SAND			SM	A-2-4 (0)	NP	NP	NP		

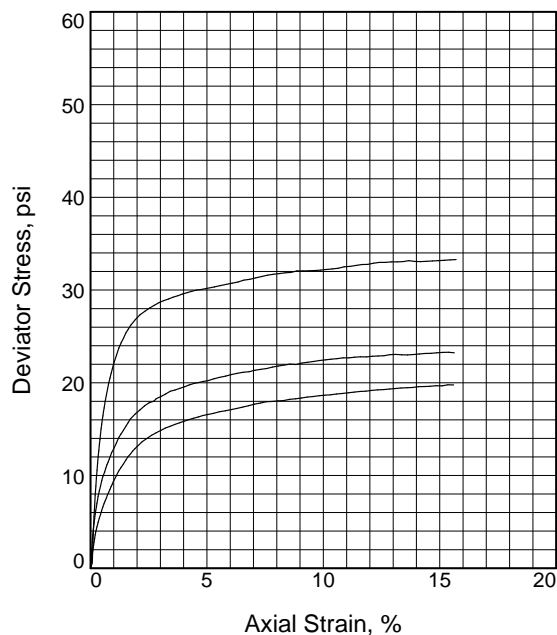
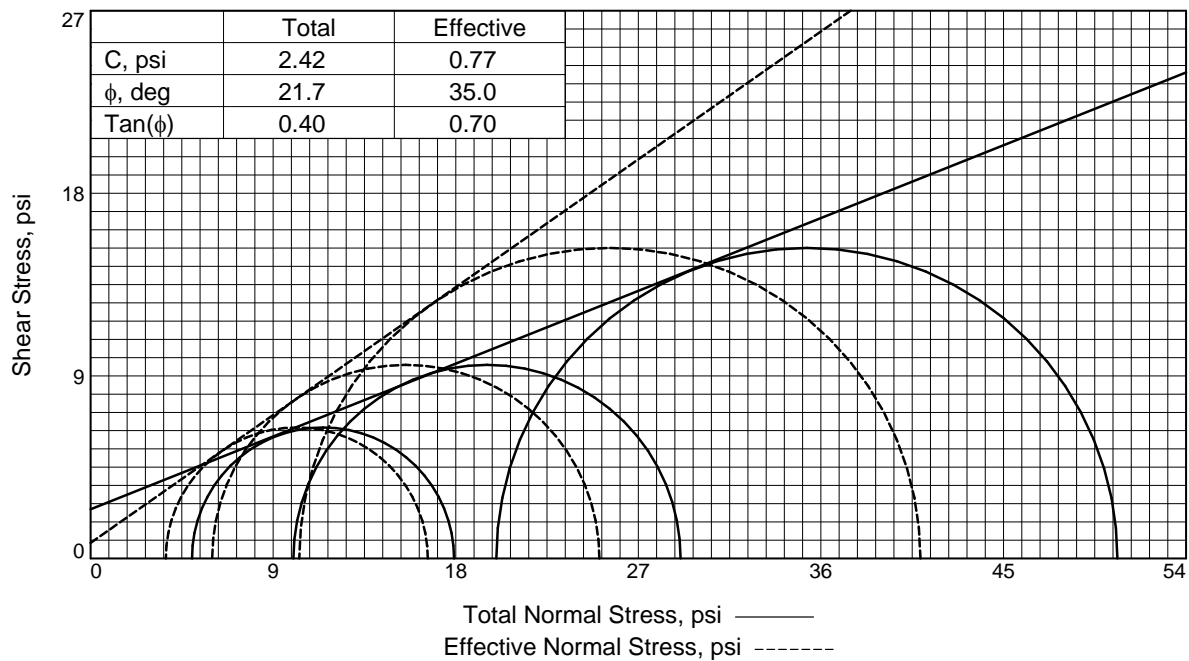
Boring ID	Depth (Ft)	D <sub>100</sub>	D <sub>60</sub>	D <sub>30</sub>	D <sub>10</sub>	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
S-39-32-1/2 Offset	0 - 5	9.5	0.328			0.0	5.2	60.9	33.9		

# Moisture-Density Relationship

## ASTM D698-Method B



Boring ID		Depth (Ft)		Description of Materials			
S-39-32-1/2 Offset		0-5		SILTY SAND(SM)			
Fines (%)	Fraction > mm size	LL	PL	PI	Test Method	Maximum Dry Density (pcf)	Optimum Water Content (%)
34	0.0	NP	NP	NP	ASTM D698-Method B	112.6	13.8



Sample No.		1	2	3
Initial	Water Content, %	13.8	14.0	14.0
	Dry Density, pcf	106.8	107.4	107.0
	Saturation, %	64.4	66.3	65.8
	Void Ratio	0.5782	0.5700	0.5755
	Diameter, in.	2.80	2.80	2.80
	Height, in.	5.62	5.62	5.62
At Test	Water Content, %	20.0	20.2	18.9
	Dry Density, pcf	109.5	109.1	111.5
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.5396	0.5456	0.5112
	Diameter, in.	2.77	2.79	2.76
	Height, in.	5.59	5.58	5.55
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		12.9	19.1	30.6
Excess Pore Pr., psi		1.3	4.0	9.7
Ult. Stress, psi		19.7	23.3	33.2
Excess Pore Pr., psi		-2.3	0.7	8.3
$\bar{\sigma}_1$ Failure, psi		16.6	25.1	40.9
$\bar{\sigma}_3$ Failure, psi		3.7	6.0	10.3

#### Type of Test:

CU with Pore Pressures

**Sample Type:** Remolded

**Description:** Silty Sand (SM)

LL= NP

PI= NP

**Specific Gravity=** 2.7

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

**Figure** \_\_\_\_\_

**Client:** HNTB North Carolina PC

**Project:** S-39-32 (Shady Grove Road) BRO Crow Creek

**Source of Sample:** S-39-32-1/2 Offset **Depth:** 0-5'

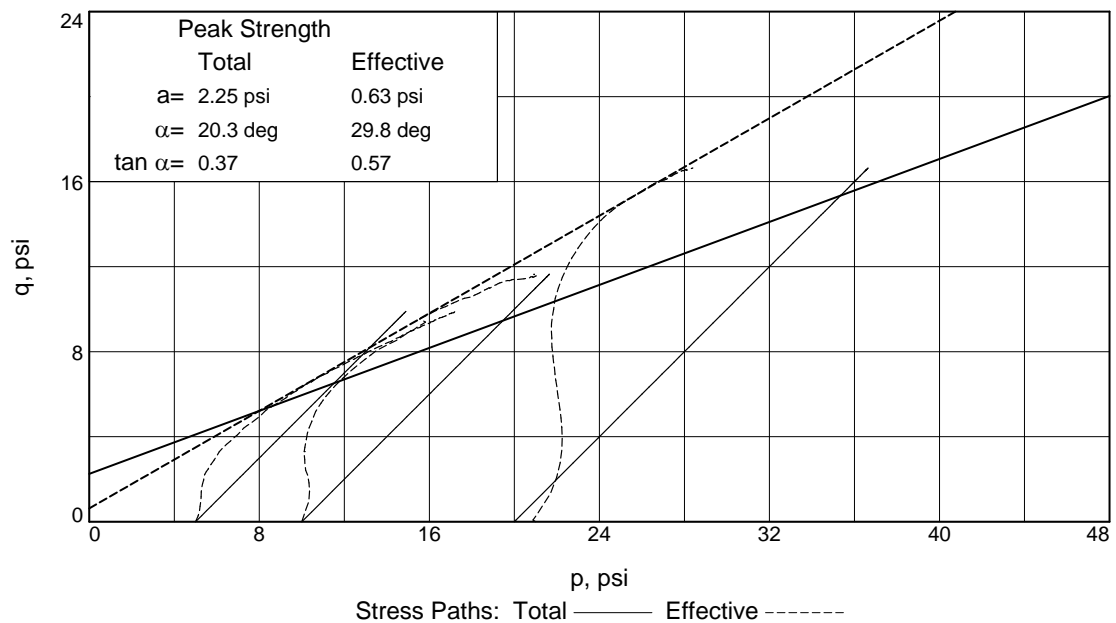
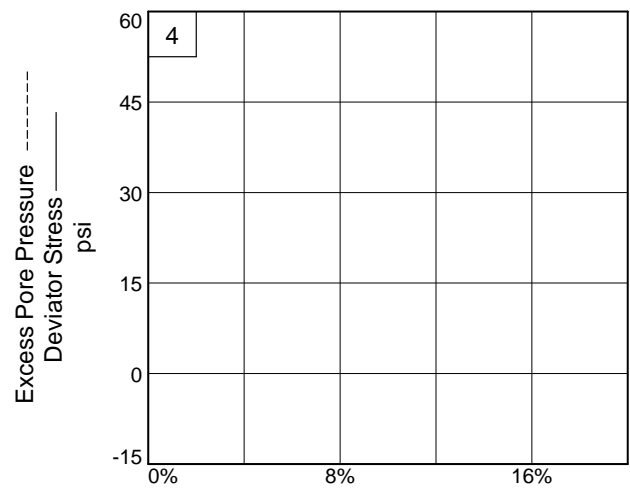
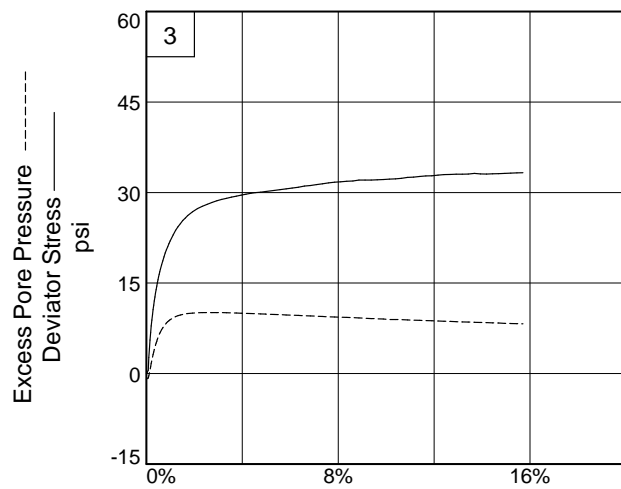
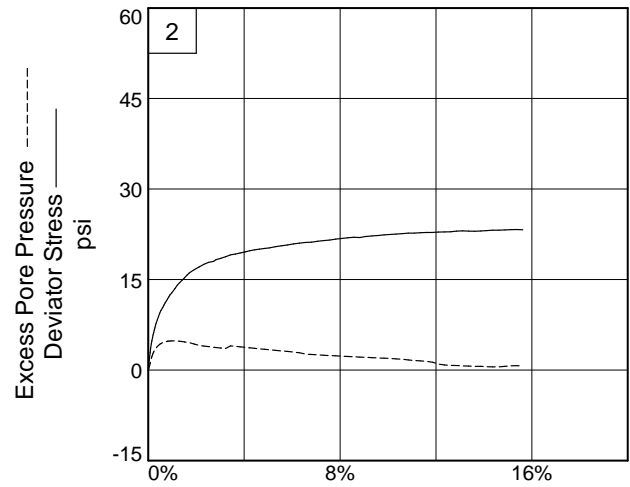
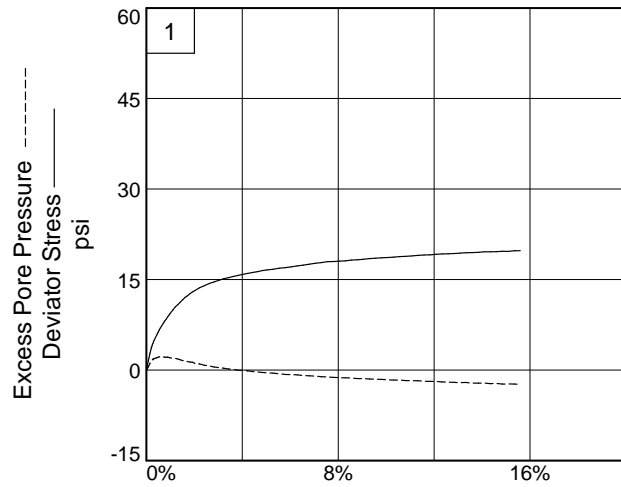
**Proj. No.:** 8623P180

**Date Sampled:** N/A

TRIAXIAL SHEAR TEST REPORT

Terracon Consultants, Inc.

Chattanooga, TN



**Client:** HNTB North Carolina PC

**Project:** S-39-32 (Shady Grove Road) BRO Crow Creek

**Source of Sample:** S-39-32-1/2 Offset

**Depth:** 0-5'

**Project No.:** 8623P180

**Figure** \_\_\_\_\_

**Terracon Consultants, Inc.**

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



**Client**

HNTB North Carolina PC

**Project**

S-39-32 (Shady Grove Road) BRO Crow Creek

**Sample Submitted By:** Terracon (86)

**Date Received:** 8/29/2024

**Lab No.:** 24-0289

**Results of Corrosion Analysis**

<b>Sample Number</b>	S-39-32-1
<b>Sample Location</b>	--
<b>Sample Depth (ft.)</b>	0.5-12.0
pH Analysis, AASHTO T289	6.27
Water Soluble Sulfate (SO4), AASHTO T290 (mg/kg)	33
Chlorides, AASHTO T291, (mg/kg)	45
Saturated Minimum Resistivity, AASHTO T288, (ohm-cm)	8040

**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.



PROJECT ID P041168 PROJECT NAME S-39-32 BRO Crow Creek  
PROJECT COUNTY Pickens

Borehole	Core Run Number	Core Run Top Depth	REC (%)	RQD (%)	q <sub>u</sub> (psi)	Poisson's Ratio	Secant Modulus (ksi)	Unit Weight (pcf)	RMR	GSI
S-39-32-1	NQ-1	26.0	93	82	12659	0.00	1243	166	74	80
S-39-32-1	NQ-2	31.0	91	81	8796	0.00	1000	165	74	75
S-39-32-2 Offset	NQ-1	30.0	67	52						60
S-39-32-2 Offset	NQ-2	35.0	93	50	7701	0.00	617	165	60	65
S-39-32-2 Offset	NQ-3	40.0	94	70						70
S-39-32-2 Offset	NQ-4	45.0	96	93	15455	0.00	1264	166	82	80



## Client

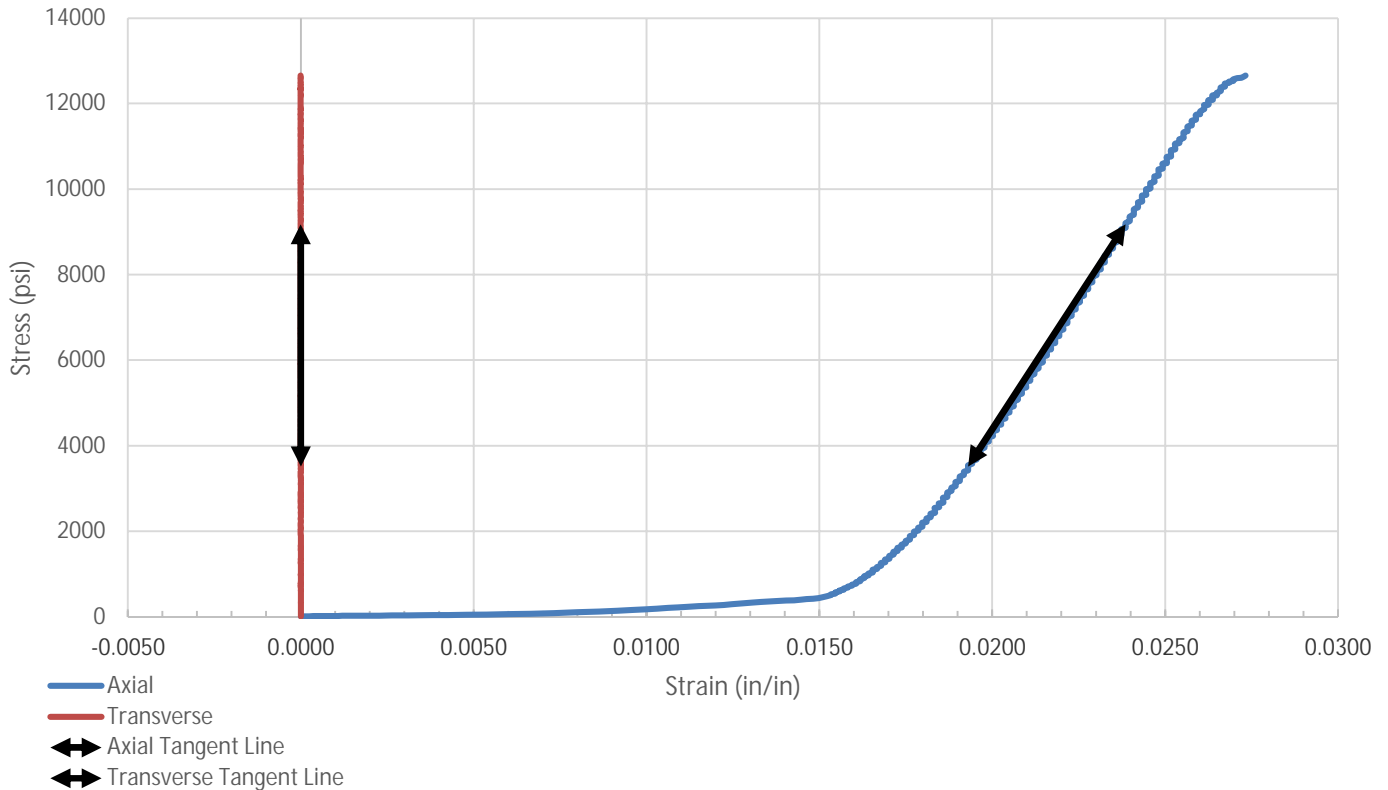
HNTB North Carolina PC  
Attn: Spencer Franklin  
343 E Six Forks Rd Ste 200  
Raleigh, NC 27609

## Project

S-39-32 (Shady Grove Road) BRO Crow Creek

Project No. 8623P180

### ASTM D7012 Stress/ Strain Curve



## SAMPLE LOCATION

Site:	SCDOT Bridge Package 19		
Rock Type:	Granite		
Boring:	S-39-32-1	Depth (feet):	26-28.7

## SPECIMEN INFORMATION

Sample No.:	R1	Mass (g):	561.61
Length (in.):	4.18	Diameter (in.):	1.98
L/D Ratio:	2.1	Density (pcf):	166.23

## TEST RESULTS

Failure Load (lbs):	38977
Failure Strain (%):	3.12
Unconfined Compressive Strength (psi):	12,659
Elastic Modulus, E, (ksi):	1243
Poisson's Ratio, u:	0.001
Time of Failure (min):	01:58
Rate of Loading (psi/sec):	107.459
Moisture Content Post-break:	0.01%



---

**Client**

HNTB North Carolina PC  
Attn: Spencer Franklin  
343 E Six Forks Rd Ste 200  
Raleigh, NC 27609

**Project**

SCDOT Bridge Package 19

Project No. 8623P180

---

**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 perpendicularity, by exceeding 0.250°.

Per ASTM D4543, this specimen has not met the requirements for flatness, by exceeding 0.001 inches.

Per ASTM D4543, this specimen has not met the requirements for parallelism, by exceeding 0.25°.

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

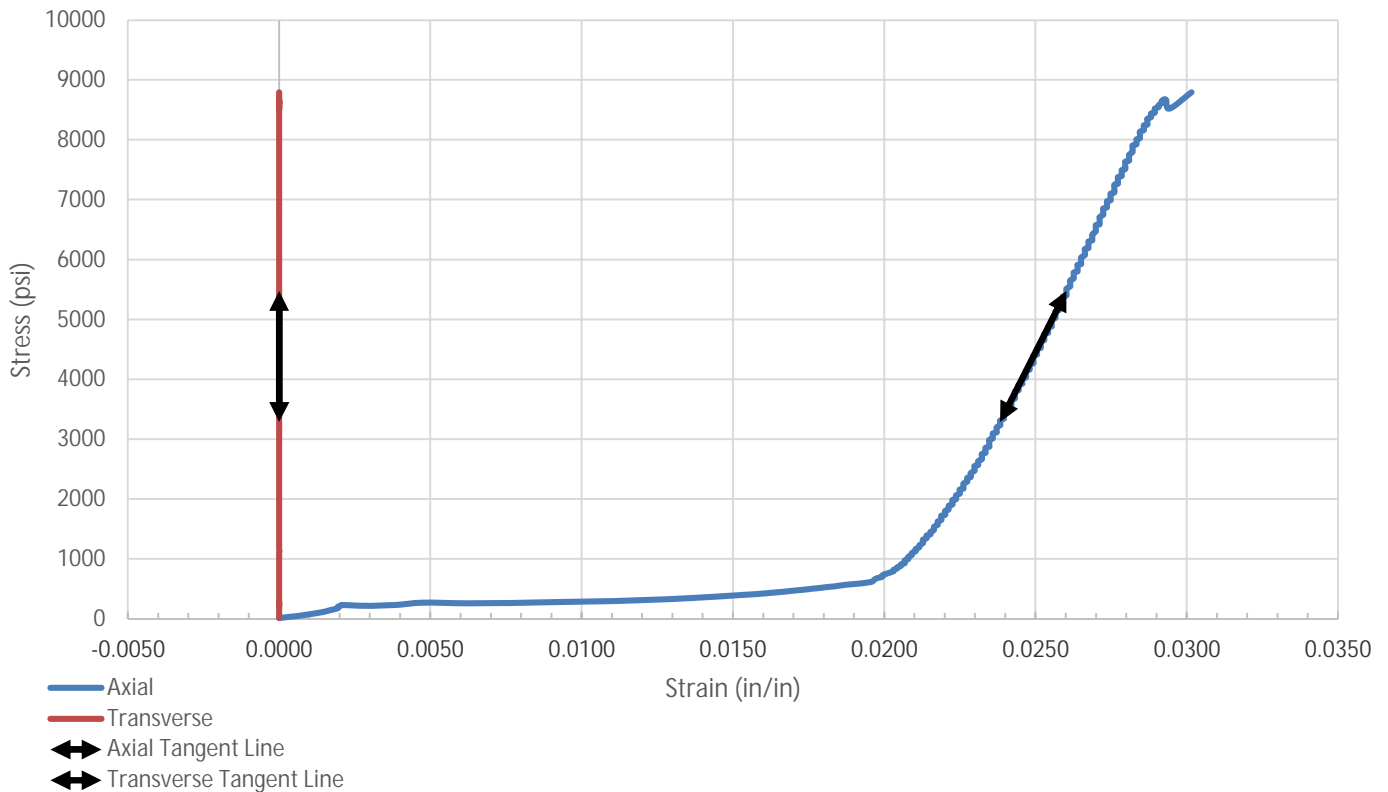
HNTB North Carolina PC  
Attn: Spencer Franklin  
343 E Six Forks Rd Ste 200  
Raleigh, NC 27609

## Project

S-39-32 (Shady Grove Road) BRO Crow Creek

Project No. 8623P180

### ASTM D7012 Stress/ Strain Curve



## SAMPLE LOCATION

Site:	SCDOT Bridge Package 19		
Rock Type:	Granite		
Boring:	S-39-32-1	Depth (feet):	31-32.6

## SPECIMEN INFORMATION

Sample No.:	R2	Mass (g):	555.26
Length (in.):	4.12	Diameter (in.):	1.99
L/D Ratio:	2.1	Density (pcf):	165.07

## TEST RESULTS

Failure Load (lbs):	27359
Failure Strain (%):	3.53
Unconfined Compressive Strength (psi):	8,796
Elastic Modulus, E, (ksi):	1000
Poisson's Ratio, u:	0.0005
Time of Failure (min):	01:19
Rate of Loading (psi/sec):	110.787
Moisture Content Post-break:	0.01%

---

**Client**

HNTB North Carolina PC  
Attn: Spencer Franklin  
343 E Six Forks Rd Ste 200  
Raleigh, NC 27609

**Project**

SCDOT Bridge Package 19

Project No. 8623P180

---

**Equipment:****TICCS ID:**

Calipers: W-54522

Scale: B-71466

Dial Indicator: C-70608

Compression (spherically seated): C-48999

---

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Per ASTM D4543, this specimen has not met the requirements for parallelism, by exceeding 0.25°.

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## Client

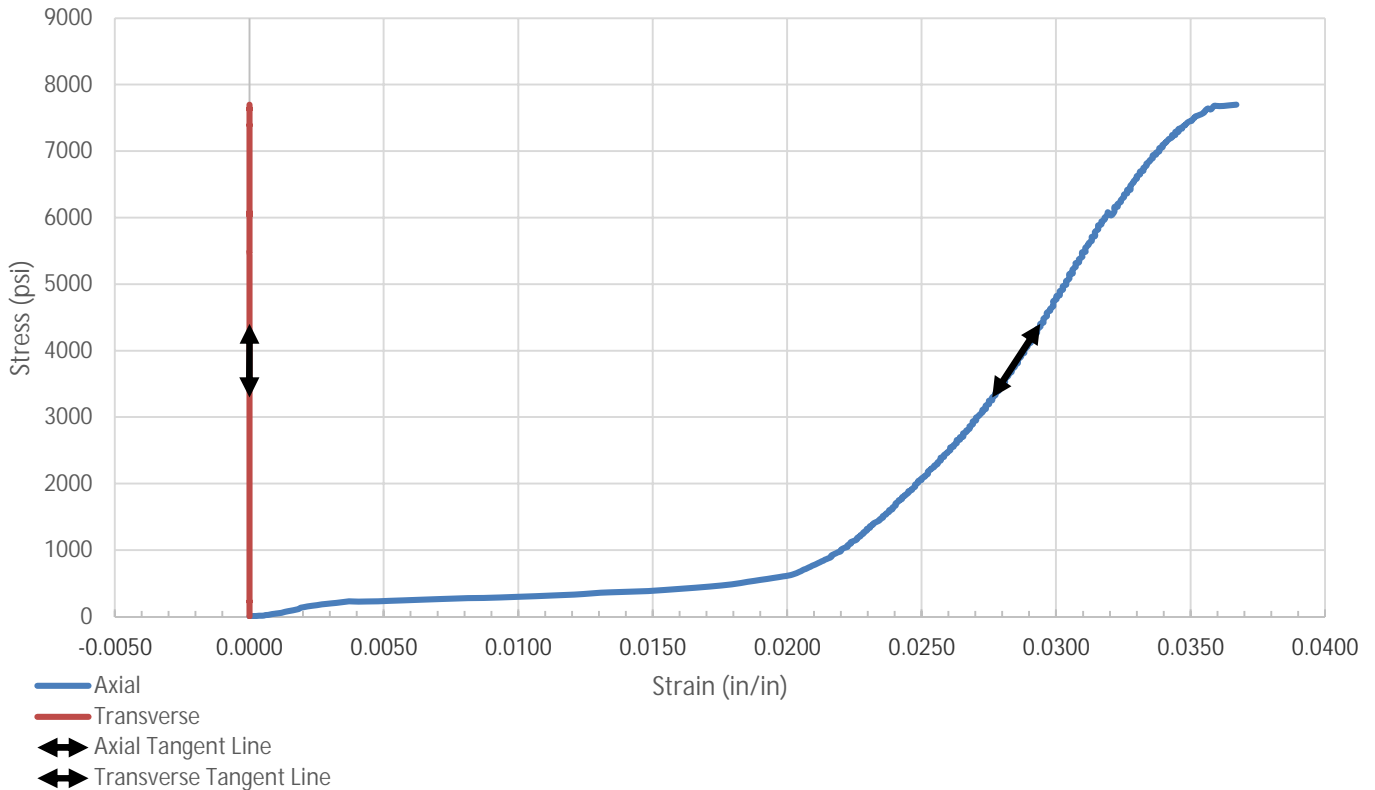
HNTB North Carolina PC  
Attn: Spencer Franklin  
343 E Six Forks Rd Ste 200  
Raleigh, NC 27609

## Project

S-39-32 (Shady Grove Road) BRO Crow Creek

Project No. 8623P180

### ASTM D7012 Stress/ Strain Curve



## SAMPLE LOCATION

Site:	SCDOT Bridge Package 19		
Rock Type:	Granite		
Boring:	S-39-32-2	Depth (feet):	36.7-37.5

## SPECIMEN INFORMATION

Sample No.:	R2	Mass (g):	559.13
Length (in.):	4.19	Diameter (in.):	1.98
L/D Ratio:	2.1	Density (pcf):	165.10

## TEST RESULTS

Failure Load (lbs):	23713
Failure Strain (%):	3.96
Unconfined Compressive Strength (psi):	7,701
Elastic Modulus, E, (ksi):	617
Poisson's Ratio, u:	0.003
Time of Failure (min):	01:11
Rate of Loading (psi/sec):	108.167
Moisture Content Post-break:	0.01%

---

**Client**

HNTB North Carolina PC  
Attn: Spencer Franklin  
343 E Six Forks Rd Ste 200  
Raleigh, NC 27609

**Project**

SCDOT Bridge Package 19

Project No. 8623P180

---

**Equipment:****TICCS ID:**

Calipers: W-54522

Scale: B-71466

Dial Indicator: C-70608

Compression (spherically seated): C-48999

---

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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

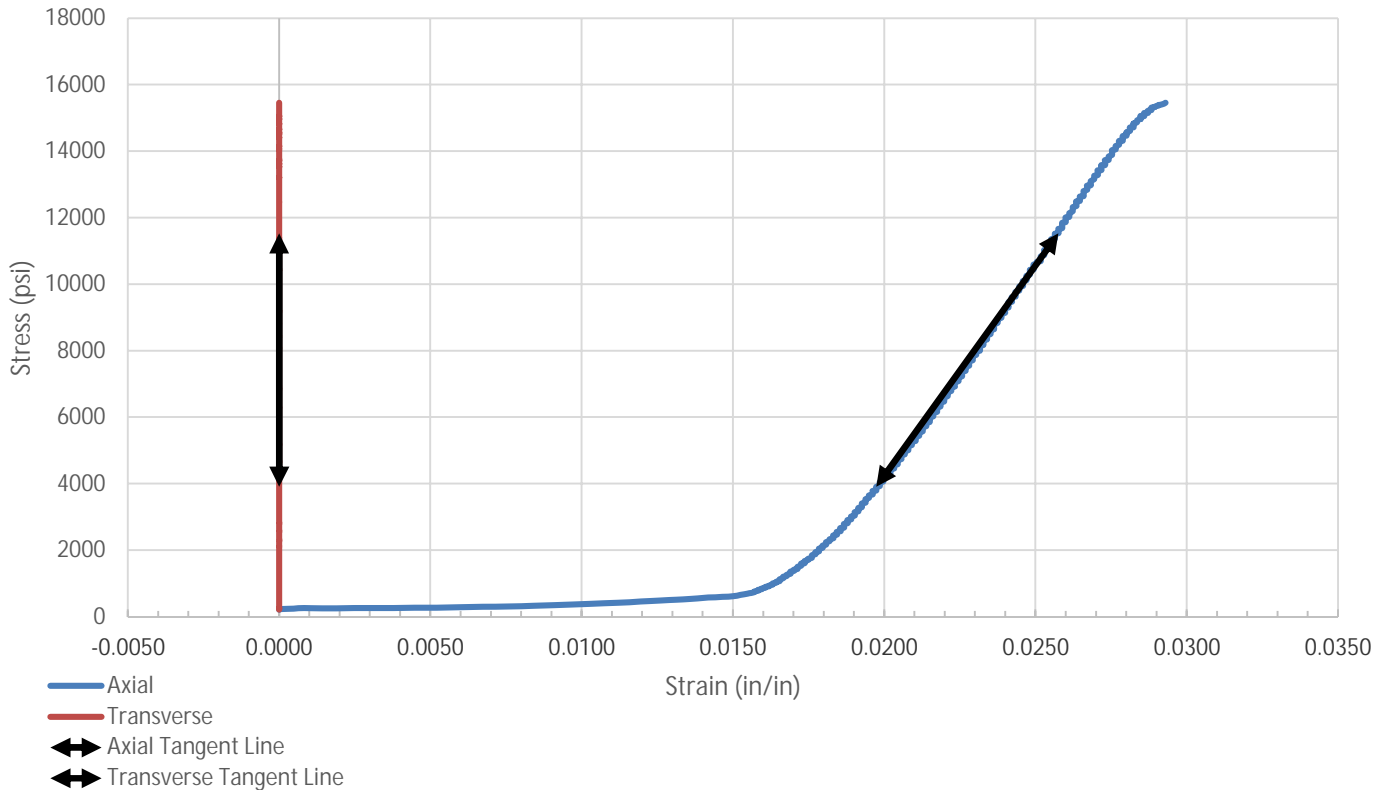
HNTB North Carolina PC  
Attn: Spencer Franklin  
343 E Six Forks Rd Ste 200  
Raleigh, NC 27609

## Project

S-39-32 (Shady Grove Road) BRO Crow Creek

Project No. 8623P180

### ASTM D7012 Stress/ Strain Curve



## SAMPLE LOCATION

Site:	SCDOT Bridge Package 19		
Rock Type:	Granite		
Boring:	S-39-32-2	Depth (feet):	46.3-47.8

## SPECIMEN INFORMATION

Sample No.:	R-4	Mass (g):	568.19
Length (in.):	4.24	Diameter (in.):	1.98
L/D Ratio:	2.1	Density (pcf):	165.80

## TEST RESULTS

Failure Load (lbs):	47586
Failure Strain (%):	3.34
Unconfined Compressive Strength (psi):	15,455
Elastic Modulus, E, (ksi):	1264
Poisson's Ratio, u:	0.0003
Time of Failure (min):	02:20
Rate of Loading (psi/sec):	110.706
Moisture Content Post-break:	0.01%



---

**Client**

HNTB North Carolina PC  
Attn: Spencer Franklin  
343 E Six Forks Rd Ste 200  
Raleigh, NC 27609

**Project**

SCDOT Bridge Package 19

Project No. 8623P180

---

**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:  
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## **Appendix C – Supporting Documents**

S-39-32 Bridge Replacement over Crow Creek | Pickens County, SC  
Terracon Project No. 8623P180 | SCDOT Project ID: P041168



## **Appendix C**

### **Supporting Documents**

3-Point Acceleration Design Response Spectrum By SCDOT  
Rig Calibration Report – DR#554 (5 Pages)  
Rig Calibration Report – DR#1327 (8 Pages)

Note: All exhibits are one page unless noted above.

### 3-Point Acceleration Design Response Spectrum

SCDOT v3.2 - 06/01/2023

Project ID:	P041168	Latitude:	34.9173
Route:	S-39-32	County:	39 - Pickens
Project:	BRO Crow Creek		
		Longitude:	82.8321

Designer:	D. Sapkota - Support
Date:	10/15/2024

Design EQ	PGA	S <sub>DS</sub>	S <sub>D1</sub>	M <sub>W</sub>	R	PGV	D <sub>5-95</sub>	T' <sub>o</sub>
	g	g	g	-	km	inches/sec	sec	sec
FEE	0.01	0.03	0.00	6.47	246.70	0.19	47.32	0.17
SEE	0.03	0.05	0.01	5.65	111.97	0.40	22.72	0.13

Fundamental Period of Structure, T <sub>0</sub>	Range of Interest		V <sub>s,H</sub> *	H	T <sub>NH</sub>	
	sec				sec	
	0.5*T <sub>0</sub>	2.0*T <sub>0</sub>			(4*H)/V <sub>s,H</sub> *	(6*H)/V <sub>s,H</sub> *
sec			ft/sec	ft		
0.00	0.00	0.00	985.88	60.00	0.17	0.37
0.00	0.00	0.00	H = B-C Boundary			

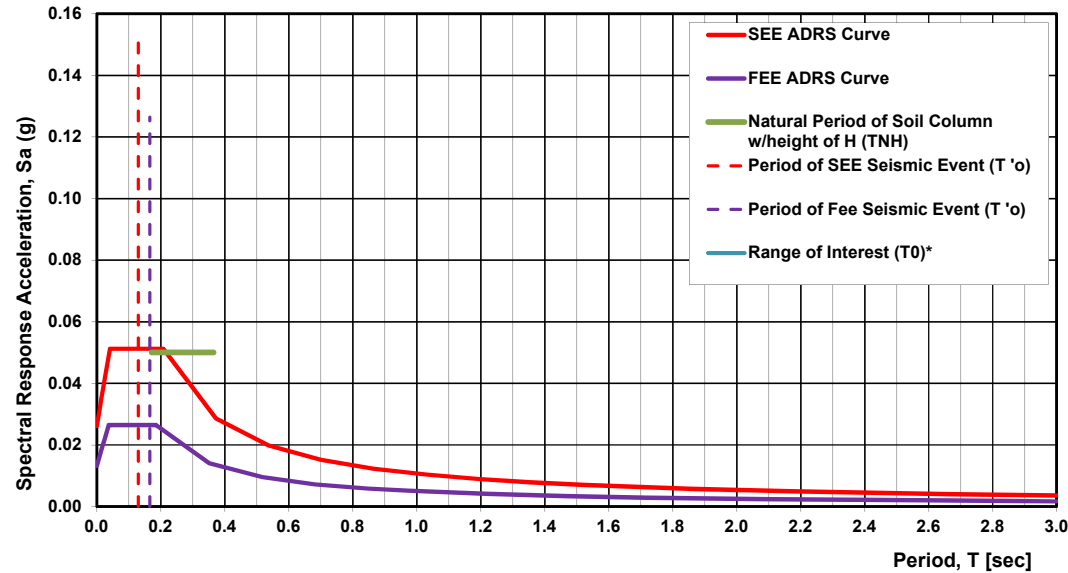
H = B-C Boundary

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

South Carolina Piedmont

\*Same Geologic Condition as used in SCENARIO\_PC (2006)

### SC Seismic ADRS Curve



#### FEE Data

T	S <sub>a</sub>
0.00	0.013
0.01	0.015
0.01	0.018
0.02	0.020
0.02	0.022
0.03	0.024
0.04	0.026
0.05	0.026
0.06	0.026
0.07	0.026
0.09	0.026
0.10	0.026
0.11	0.026
0.12	0.026
0.14	0.026
0.15	0.026
0.16	0.026
0.17	0.026
0.19	0.026
0.35	0.014
0.52	0.010
0.68	0.007
0.85	0.006
1.01	0.005
1.18	0.004
1.35	0.004
1.51	0.003
1.68	0.003
1.84	0.003
2.01	0.002
2.17	0.002
2.34	0.002
2.50	0.002
2.67	0.002
2.83	0.002
3.00	0.002

#### SEE Data

T	S <sub>a</sub>
0.00	0.026
0.01	0.030
0.01	0.035
0.02	0.039
0.02	0.043
0.03	0.047
0.04	0.051
0.06	0.051
0.07	0.051
0.08	0.051
0.10	0.051
0.11	0.051
0.12	0.051
0.14	0.051
0.15	0.051
0.17	0.051
0.18	0.051
0.19	0.051
0.21	0.051
0.37	0.029
0.54	0.020
0.70	0.015
0.87	0.012
1.03	0.010
1.19	0.009
1.36	0.008
1.52	0.007
1.69	0.006
1.85	0.006
2.01	0.005
2.18	0.005
2.34	0.005
2.51	0.004
2.67	0.004
2.84	0.004
3.00	0.004

## For Boring S-39-32-1

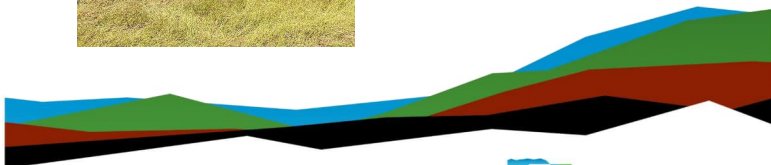
# SPT Automatic Hammer Energy Measurement Report

Drill Rig Model: GeoProbe 3126

Drill Rig Serial Number: 3126TTS52010006

Asset Number: DR#554

August 21, 2023



### Prepared for:

Terracon  
Greenville-Spartanburg, South Carolina



July 19, 2023

Terracon  
72 Pointe Circle  
Greenville, South Carolina 29607

Attn: Maggie McKenney  
E: m.mckenney@terracon.com

**Re:** SPT Automatic Hammer Energy Measurement Report  
Rig Serial Number: 3126TTS52010006  
Terracon Project Number: DYXX0500

Dear Ms. McKenney:

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 (Ce)
GeoProbe 3126	3126TTS52010006	2021	GP#554	88.5% ± 4.2%	1.48

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

*James P. Smith*

James P. Smith  
National Manager of Equipment & Training

*Rob Kramer*

Rob Kramer  
Group Manager Geophysics

### Attachments:

Exhibit A: PDA SPT Analyzer Results  
Exhibit B: PDA Equipment Calibration

Facilities | Environmental | **Geotechnical** | Materials |



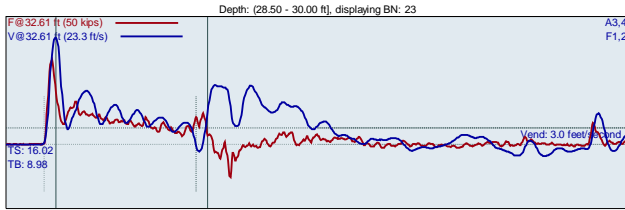
## MEASUREMENT SUMMARY

ITEM	DESCRIPTION
Drill Rig Owner	Terracon Greenville-Spartanburg - Greenville, SC
Drill Rig Operator	Brett Burnett; Terracon Exploration Services
Testing Date	08/21/2023
Testing Location	Spartanburg, SC
Boring Identification	B-1
Hammer Type	140 pounds (automatic)
Boring Method	Hollow Stem Auger
Drill Rods	<ul style="list-style-type: none"> <li>AWJ</li> <li>1-3/4" outside diameter</li> <li>3/16" wall thickness</li> </ul>
Calibration Testing Equipment	<ul style="list-style-type: none"> <li>2-foot AWJ rod instrumented w/ two strain gauges and two accelerometers</li> <li>Model SPT Analyzer™ (PDA)</li> </ul>
ASTM Methods Used	<p><b>ASTM D1586</b>, Standard Test Method for Standard Penetration Test and Split-Barrel Sampling of Soils</p> <p><b>ASTM D4633-16</b>, Standard Method for Energy Measurement for Dynamic Penetrometers</p>
SPT Calibration Personnel	Jim Smith, National Manager of Equipment and Training

### Exhibit A

#### PDA SPT Analyzer Results

GP554-3126 28.5/30  
JIM SMITH Interval start: 8/21/2023  
TB-1  
AR: 1.20 in/2 SP: 0.492 k/ft3  
LE: 32.61 ft EM: 30000 ksi  
WS: 16807.9 fts



F1 : [648AWJ1] 226.21 PDICAL (1) FF1 A3 (PR): [K4483] 410.187 mv/6.4v/5000g (1) VF1  
F2 : [648AWJ2] 225.58 PDICAL (1) FF1 A4 (PR): [K10491] 421.907 mv/6.4v/5000g (1) VF1

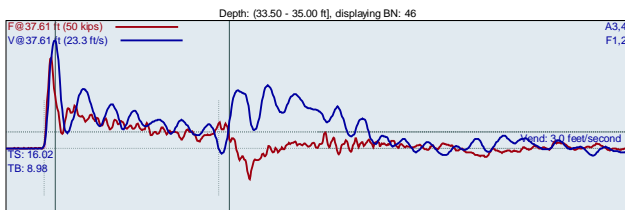
FMX: Maximum Force EFV: Maximum Energy  
VMX: Maximum Velocity ETR: Energy Transfer Ratio - Rated  
BPM: Blows/Minute

BL#	BC /6"	FMX kips	VMX ft/s	BPM bpm	EFV ft-lb	ETR %
1	6	40	19.4	1.9	234	84.1
2	6	39	19.2	51.9	232	83.4
3	6	25	16.9	52.7	274	78.2
4	6	28	17.9	52.4	273	77.9
5	6	32	19.6	52.6	294	83.9
6	6	27	17.3	53.1	268	76.5
7	8	38	19.0	52.7	289	82.5
8	8	39	19.6	52.4	305	87.2
9	8	36	19.2	52.7	290	82.8
10	8	28	18.2	52.5	292	83.4
11	8	38	19.0	53.0	293	83.8
12	8	35	19.4	52.6	282	80.4
13	8	36	19.1	52.9	299	85.3
14	8	34	19.8	52.8	307	87.7
15	11	34	19.5	52.7	307	87.6
16	11	33	19.5	52.9	299	85.6
17	11	36	19.4	52.7	308	88.1
18	11	37	18.5	52.8	320	91.4
19	11	32	19.6	52.9	301	86.1
20	11	39	18.7	52.9	301	85.9
21	11	26	17.5	52.8	277	79.1
22	11	30	19.1	52.6	306	87.4
23	11	33	19.5	52.7	298	85.1
24	11	35	19.9	52.4	303	86.5
25	11	36	19.4	53.1	313	89.6

Average	34	19.2	52.8	299	85.6
Std Dev	3	0.6	0.2	10	3.0
Maximum	39	19.9	53.1	320	91.4
Minimum	26	17.5	52.4	277	79.1
N-value: 19					

Sample Interval Time: 27.36 seconds.

GP554-3126 28.5/30  
JIM SMITH Interval start: 8/21/2023  
TB-1  
AR: 1.20 in/2 SP: 0.492 k/ft3  
LE: 37.61 ft EM: 30000 ksi  
WS: 16807.9 fts



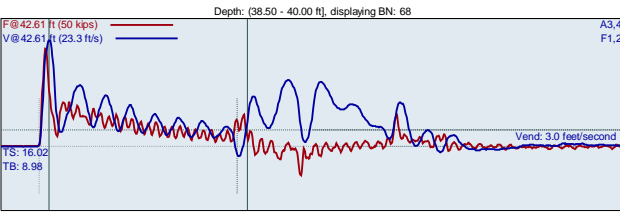
F1 : [648AWJ1] 226.21 PDICAL (1) FF1 A3 (PR): [K4483] 410.187 mv/6.4v/5000g (1) VF1  
F2 : [648AWJ2] 225.58 PDICAL (1) FF1 A4 (PR): [K10491] 421.907 mv/6.4v/5000g (1) VF1

BL#	BC /6"	FMX kips	VMX ft/s	BPM bpm	EFV ft-lb	ETR %
26	5	38	19.1	1.9	302	86.4
27	5	35	18.9	52.0	301	86.1
28	5	29	18.8	52.0	299	85.5
29	5	35	19.2	52.7	299	85.5
30	5	37	19.4	52.5	297	84.8
31	8	37	19.5	52.4	307	87.7
32	8	26	16.4	52.7	282	80.5
33	8	34	19.5	52.4	307	87.6
34	8	40	19.1	52.2	307	87.6
35	8	37	19.4	52.6	299	85.5
36	8	40	20.6	52.4	321	91.7
37	8	41	19.6	52.8	308	87.9
38	8	40	19.8	52.7	313	89.5
39	10	34	20.2	52.2	323	92.2
40	10	32	19.4	52.8	297	84.9
41	10	36	19.8	52.6	311	88.8
42	10	37	19.7	52.5	317	90.7
43	10	35	20.0	52.6	324	92.6
44	10	38	19.5	52.7	308	88.1
45	10	34	20.1	52.4	322	92.0
46	10	35	19.7	52.4	322	92.0
47	10	37	19.9	52.6	314	89.7
48	10	37	19.8	52.7	332	94.8
Average		36	19.6	52.6	312	89.1
Std Dev		3	0.8	0.2	12	3.3
Maximum		41	20.6	52.8	332	94.8
Minimum		26	16.4	52.2	282	80.5
N-value: 18						

Sample Interval Time: 25.16 seconds.



GP554-3126  
JIM SMITH  
TB-1  
AR: 1.20 in/2  
LE: 42.61 ft  
WS: 16807.9 ft/s  
28.5-30  
Interval start: 8/21/2023  
SP: 0.492 kft/s  
EM: 30000 ksi



F1 : [648AWJ1] 226.21 PDICAL (1) FF1		A3 (PR): [K4483] 410.187 mm/6.4v/5000g (1) VF1				
F2 : [648AWJ2] 225.58 PDICAL (1) FF1		A4 (PR): [K10491] 421.907 mm/6.4v/5000g (1) VF1				
BL#	BC /6"	FMX kips	VMX ft/s	BPM bpm	EFV ft-lb	ETR %
49	5	34	19.6	1.9	307	87.6
50	5	34	19.3	52.0	301	86.1
51	5	27	16.5	52.7	278	79.4
52	5	33	19.9	52.5	310	88.6
53	5	29	17.7	52.7	288	82.2
54	8	29	18.6	52.5	295	84.2
55	8	23	15.6	52.9	287	82.0
56	8	34	20.1	52.6	323	92.2
57	8	28	18.1	52.8	295	84.3
58	8	38	18.8	53.1	312	89.1
59	8	35	19.2	52.6	329	94.0
60	8	36	19.3	52.9	327	93.3
61	8	40	19.7	52.8	323	92.4
62	9	35	18.8	53.0	320	91.3
63	9	37	19.1	52.7	320	91.3
64	9	35	19.9	52.9	327	93.4
65	9	29	18.8	52.7	314	89.7
66	9	35	19.7	53.0	342	97.8
67	9	36	19.9	52.8	331	94.5
68	9	38	19.3	52.8	335	95.8
69	9	36	19.9	52.5	325	92.9
70	9	39	19.5	52.9	329	94.0
Average		34	19.1	52.8	320	91.3
Std Dev		4	1.0	0.2	15	4.1
Maximum		40	20.1	53.1	342	97.8
Minimum		23	15.6	52.5	287	82.0
N-value: 17						

Sample Interval Time: 23.91 seconds.

Summary of SPT Test Results

Project: GP554-3126, Test Date: 8/21/2023		EFV: Maximum Energy ETR: Energy Transfer Ratio - Rated					
FMX: Maximum Force							
VMX: Maximum Velocity							
BPM: Blows/Minute							
Length	Blows	N	N60	Average	Average	Average	Average
ft	Applied	Value	Value	FMX	VMX	BPM	EFV
	/6"			kips	ft/s	bpm	ft-lb
							%
32.61	6-8-11	19	28	34	19.2	52.8	299
37.61	5-8-10	18	26	36	19.6	52.6	312
42.61	5-8-9	17	25	34	19.1	52.8	320
Overall Average Values:				35	19.3	52.7	310
Standard Deviation:				4	0.8	0.2	15
Overall Maximum Value:				41	20.6	53.1	342
Overall Minimum Value:				23	15.6	52.2	277



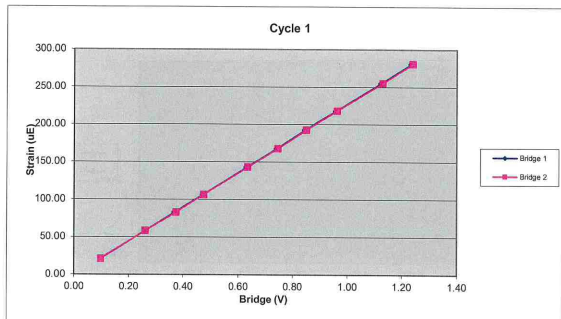
Exhibit B  
PDA Equipment Calibration



648AWJ		Cycle 1		
Sample	Force (lb)	Strain (µE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	799.99	21.12	0.10	0.10
3	2111.63	58.22	0.26	0.26
4	2997.39	82.70	0.37	0.37
5	3848.07	106.26	0.47	0.47
6	5131.83	143.07	0.63	0.63
7	6017.79	167.81	0.74	0.75
8	6872.07	192.74	0.85	0.85
9	7783.57	218.15	0.96	0.96
10	9136.93	255.02	1.12	1.13
11	10026.70	280.73	1.24	1.24

Bridge 1		Bridge 2	
Force Calibration (lb/V)	8120.30	Force Calibration (lb/V)	8089.75
Offset	-4.24	Offset	-2.24
Correlation	0.999998	Correlation	0.999995
Strain Calibration (µE/V)	228.56	Strain Calibration (µE/V)	227.70
Offset	-1.57	Offset	-1.51
Correlation	0.999991	Correlation	0.999983

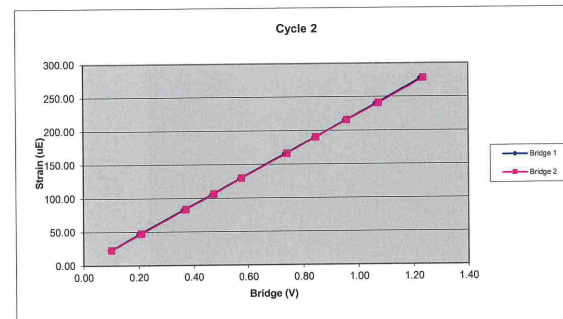
Force Strain Calibration	
EA (Kips)	35527.98
Offset	51.69
Correlation	0.999986



648AWJ		Cycle 2		
Sample	Force (lb)	Strain (µE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	805.54	22.23	0.10	0.10
3	1679.81	47.04	0.20	0.21
4	2989.11	83.03	0.37	0.37
5	3830.62	105.81	0.47	0.47
6	4658.00	129.50	0.57	0.58
7	5984.74	165.81	0.74	0.74
8	6848.87	189.76	0.84	0.84
9	7747.90	215.15	0.95	0.96
10	8674.21	240.08	1.07	1.07
11	9994.82	277.48	1.23	1.24

Bridge 1		Bridge 2	
Force Calibration (lb/V)	8127.14	Force Calibration (lb/V)	8103.79
Offset	10.37	Offset	-14.59
Correlation	0.999997	Correlation	0.999997
Strain Calibration (µE/V)	225.29	Strain Calibration (µE/V)	224.64
Offset	0.36	Offset	-0.33
Correlation	0.999990	Correlation	0.999992

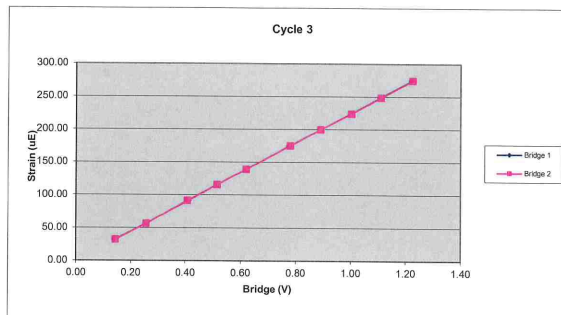
Force Strain Calibration	
EA (Kips)	36073.41
Offset	-2.66
Correlation	0.999993



648AWJ		Cycle 3		
Sample	Force (lb)	Strain (µE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	1153.24	31.90	0.14	0.14
3	2056.55	56.28	0.26	0.26
4	3310.19	91.18	0.41	0.41
5	4155.51	115.51	0.51	0.51
6	5035.81	139.16	0.62	0.62
7	6303.78	175.10	0.78	0.78
8	7221.91	199.87	0.89	0.89
9	8120.94	223.92	1.00	1.00
10	9001.15	248.68	1.11	1.11
11	9931.66	274.33	1.22	1.23

Bridge 1		Bridge 2	
Force Calibration (lb/V)	8132.32	Force Calibration (lb/V)	8118.57
Offset	-20.37	Offset	-15.36
Correlation	0.999998	Correlation	0.999997
Strain Calibration (µE/V)	224.79	Strain Calibration (µE/V)	224.41
Offset	-0.57	Offset	-0.43
Correlation	0.999984	Correlation	0.999985

Force Strain Calibration	
EA (Kips)	36175.62
Offset	0.42
Correlation	0.999984



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

Calibration Factors		648AWJ	
Bridge 1 (µE/V)	226.21	Bridge 2 (µE/V)	225.58
EA Factor (Kips)	35925.67	Area (in <sup>2</sup> )	1.20

Calibrated by: *Aht*  
Calibrated Date: 3/3/2022

Pile Dynamics Inc  
30725 Aurora Rd  
Solon, OH 44139

Traceable to N.I.S.T.

Accelerometer Calibration Certificate  
Pile Dynamics, Inc.



Calibrated by Pile Dynamics, Inc.  
Calibration performed on 26Oct2021

Serial No: K4483 Temperature: 22.1 °C  
Model: PR Humidity: 45%  
Calibrated on: Channel 3 on 8G 5161 LE

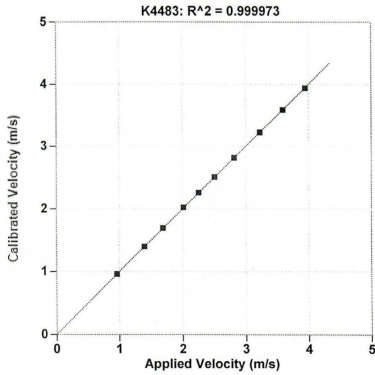
PDA CALIBRATION FACTOR  
410.2 mv/5000g  
(62.0  $\mu$ v/g)  
R<sup>2</sup>: 0.999973 [Chip programmed]

Operator: William Johnson

Signed

Ref Acc 1: 690961 Cal on: 27Jan2021  
978 g's/volt  
Ref Acc 2: 691321 Cal on: 09Feb2021  
960 g's/volt

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



Date printed: 26Oct2021, version: 2020.30.170 0.57

Accelerometer Calibration Certificate  
Pile Dynamics, Inc.



Calibrated by Pile Dynamics, Inc.  
Calibration performed on 25Jan2022

Serial No: K10491 Temperature: 19.3 °C  
Model: PR Humidity: 30%  
Calibrated on: Channel 3 on 8G 5161 LE

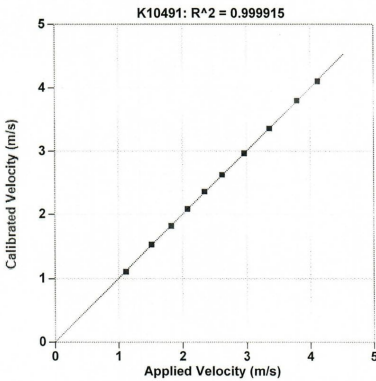
PDA CALIBRATION FACTOR  
421.9 mv/5000g  
(84.4  $\mu$ v/g)  
R<sup>2</sup>: 0.999915 [Chip programmed]

Operator: William Johnson

Signed

Ref Acc 1: 691321 Cal on: 09Feb2021  
960 g's/volt  
Ref Acc 2: 690961 Cal on: 27Jan2021  
978 g's/volt

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



Date printed: 25Jan2022, version: 2020.30.170 0.05

## For Boring S-39-32-2

## 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 29615Attn: Nitin Dudani  
E: nitin.dudani@terracon.comRe: 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

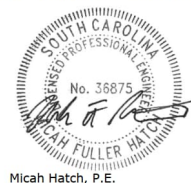
Drill Rig Make/Model	Drill Rig Serial Number	Drill Rig Year	Asset Number	Energy Transfer Ratio (ETR)	Hammer Efficiency Correction (C <sub>e</sub> )
Geoprobe	3126S5V224106	2024	DR#1327	92.6% ± 1.75%	1.54

\*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 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	9/5/2024
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"> <li>AWJ</li> <li>1-3/4" outside diameter</li> <li>1- 1/4" inside diameter</li> <li>1.15 in<sup>2</sup> cross sectional area</li> <li>1/4" wall thickness</li> </ul>
Calibration Testing Equipment	<ul style="list-style-type: none"> <li>2-foot AWJ rod instrumented w/ two strain gauges and two accelerometers manufactured by Pile Dynamics Inc. (PDI)</li> <li>SN: 746AWJ</li> <li>Model SPT Analyzer™ (PDA) SN: 4621 TB</li> </ul>
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 <sup>1</sup>  (ft)	Rod Length <sup>2</sup>  (ft)	Rod Sections <sup>3</sup>		Measured Blow Counts				SPT N <sub>meas</sub>  (bpf)	Soil Type <sup>4</sup>	
					(blows/6 inches)						
			2 ft	5 ft	10 ft	1 <sup>st</sup> Inc.	2 <sup>nd</sup> Inc.	3 <sup>rd</sup> Inc.	4 <sup>th</sup> 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 <sup>1</sup> (ft)	SPT N <sub>m</sub> (bpf)	No. of Blows <sup>2</sup>	EMX <sup>3</sup> (ft-lbs)				ETR <sup>3</sup> (%)		
				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 <sup>1</sup> (ft)	SPT N <sub>meas</sub> (bpf)	No. of Blows <sup>2</sup>	BPM <sup>3</sup>			
				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

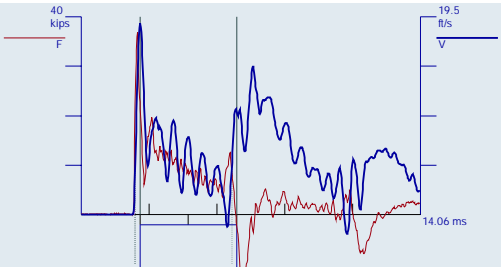
1. Boring ID and depth from existing ground surface to start of SPT.  
2. Number of blows used in energy calibration analysis. Limited to measurements recorded during the second and third 6-inch sampling intervals at each depth or during the 1st increment if refusal conditions were encountered.  
3.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

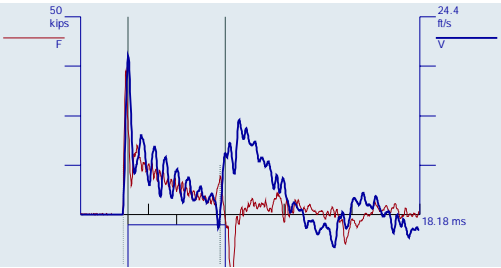
CSX 32.1 ksi  
DMX 1.11 in  
EFV 331 ft-lb  
ETR 94.7 %  
BPM 53.8 bpm  
RAT 1.0  
VMX 18.9 ft/s  
FMX 37 kips  
DFN 1.00 in  
MEX 1070 µE  
AMX 3001 g/s  
FVP 0.6

LE 33.70 ft  
AR 1.15 in<sup>2</sup>  
EM 30000 ksi  
SP 0.492 k/ft<sup>3</sup>  
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 mv/6.4v/5000g (1) VF1  
A4 (PR): [K14006] 375.226 mv/6.4v/5000g (1) VF1

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

Pile Driving Analyzer ® (PDA)  
Version: 2022.35.2



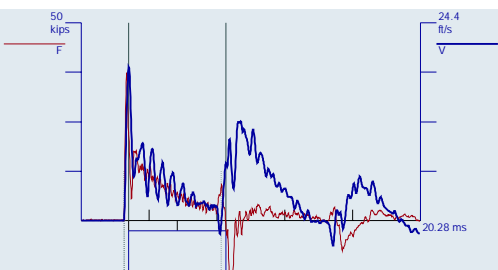
BN 25  
05Sep2024 10:24:35 AM

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<sup>2</sup>  
EM 30000 ksi  
SP 0.492 k/ft<sup>3</sup>  
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 mv/6.4v/5000g (1) VF1  
A4 (PR): [K14006] 375.226 mv/6.4v/5000g (1) VF1



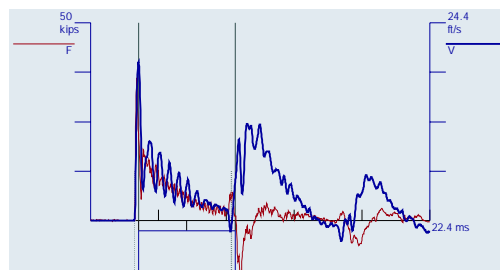


BN 14  
05Sep2024 10:32:57 AM

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<sup>2</sup>  
EM 30000 ksi  
SP 0.492 k/ft<sup>3</sup>  
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 mv/6.4v/5000g (1) VF1  
A4 (PR): [K14006] 375.226 mv/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<sup>2</sup>  
EM 30000 ksi  
SP 0.492 k/ft<sup>3</sup>  
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 mv/6.4v/5000g (1) VF1  
A4 (PR): [K14006] 375.226 mv/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?

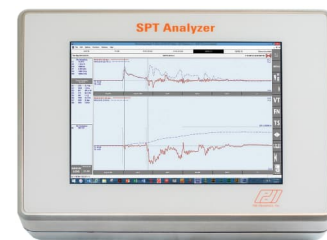
The Standard Penetration Test (SPT) is a widely-employed soil exploration tool that involves using an SPT hammer to drive a split sampler at the bottom of a drill string to obtain soil samples. The number of blows required to penetrate the last 300mm (1ft) is the "N value" which is related to soil strength.

### 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](http://www.pile.com) or contact [info@pile.com](mailto:info@pile.com).

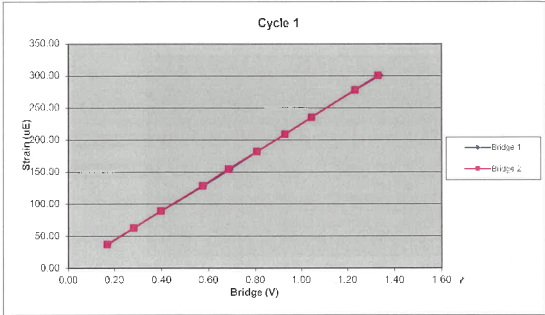
[www.pile.com](http://www.pile.com) | +1 (216) 831-6131 | [info@pile.com](mailto:info@pile.com)



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	235.42	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	0.999999
Strain Calibration (µE/V)	225.99	Strain Calibration (µE/V)	226.04
Offset	-1.01	Offset	-0.83
Correlation	0.999989	Correlation	0.999992

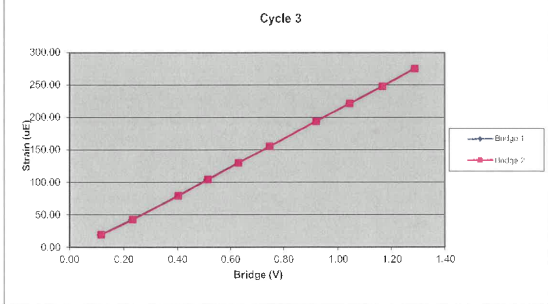
Force Strain Calibration	
EA (Kips)	33651.50
Offset	33.98
Correlation	0.999994



746AWJ		Cycle 3		
Sample	Force (lb)	Strain (µE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	838.16	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	1.06
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

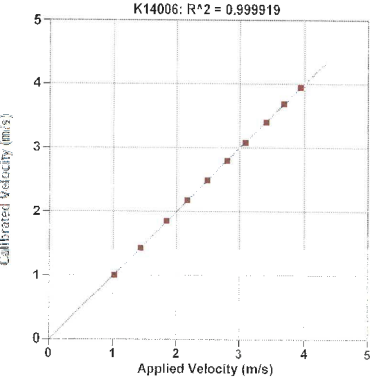
PDA CALIBRATION FACTOR  
375.2 mv/5000g  
(75.0  $\mu$ v/g)  
R<sup>2</sup>: 0.999919 [Chip programmed]

Operator: William Johnson

Signed

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

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



Version 2020 09 11 16:42:17

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

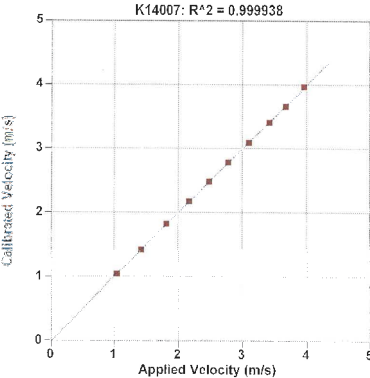
PDA CALIBRATION FACTOR  
407.2 mv/5000g  
(81.4  $\mu$ v/g)  
R<sup>2</sup>: 0.999938 [Chip programmed]

Operator: William Johnson

Signed

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

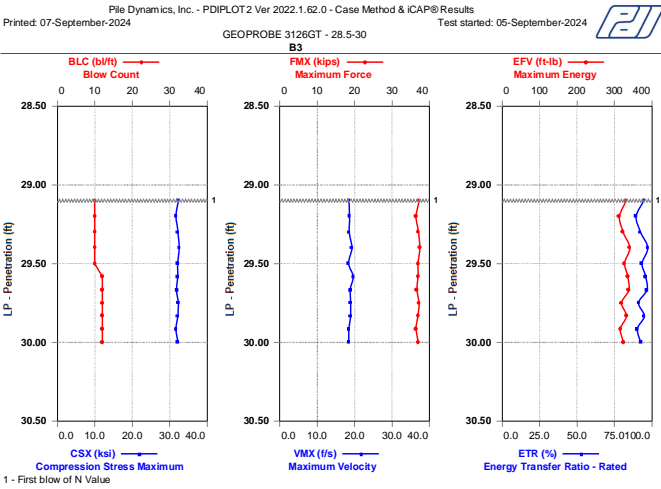
Reference accelerometer calibrations are traceable to the United States National Institute of Standards and Technology (NIST).



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Exhibit C  
SPT Analyzer Results



Case Method & iCAP® Results

GEOPROBE 3126GT - 28.5-30

B3

OP: RW  
AR: 1.15 in²  
LE: 33.70 ft  
WS: 16.807 g f/s  
SP: 0.492 klf/ft  
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

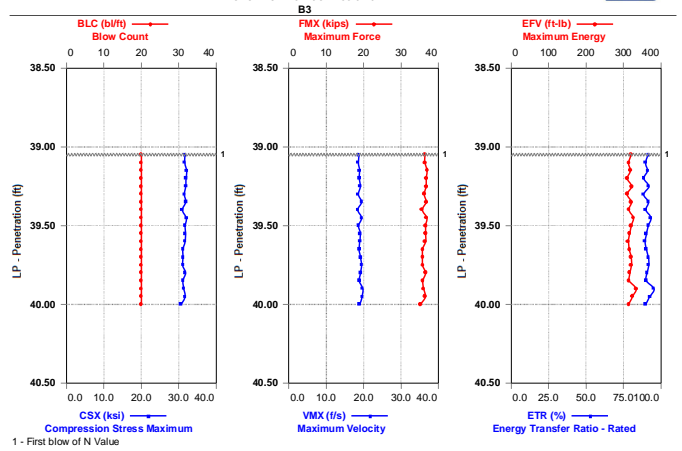
5-15 F1: [746AWJ1] 222.1 (1.00); F2: [746AWJ2] 222.2 (1.00); A3: [K14007] 407.2 (1.00);  
A4: [K14006] 375.2 (1.00)

BL# Comments

5 First blow of N Value

Time Summary

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



Case Method & iCAP® Results

GEOPROBE 3126GT - 38.5-40

B3

OP: RW  
AR: 1.15 in²  
LE: 43.70 ft  
WS: 16.807 g f/s  
SP: 0.492 klf/ft  
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

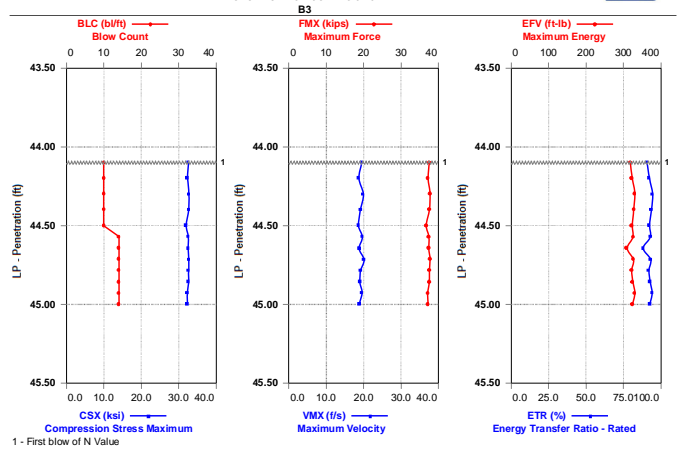
7-26 F1: [746AWJ1] 222.1 (1.00); F2: [746AWJ2] 222.2 (1.00); A3: [K14007] 407.2 (1.00);  
A4: [K14006] 375.2 (1.00)

BL# Comments

7 First blow of N Value

Time Summary

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



Case Method & iCAP® Results

GEOPROBE 3126GT - 43.5-45

B3

Date: 05-September-2024

OP: RW  
AR: 1.15 in²  
LE: 48.70 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	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	0.92	32.5
Std. Dev.		0	0.5	5.5	5.5	1.6	0.1	0.15	0.17	0.2	0.2
Maximum		38	20.1	330.1	330.1	94.3	53.6	1.30	1.20	0.86	32.8
Minimum		37	18.6	309.1	309.1	88.3	53.2	0.89	0.85	0.86	32.0

Total number of blows analyzed: 12

BL# Sensors

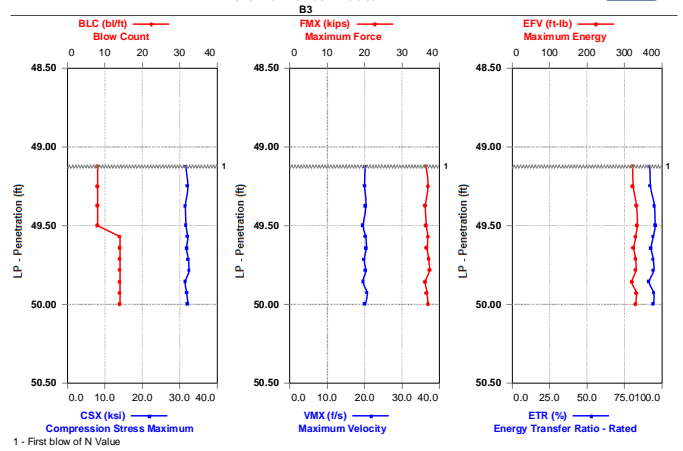
5-16 F1: [746AWJ1] 222.1 (1.00); F2: [746AWJ2] 222.2 (1.00); A3: [K14007] 407.2 (1.00);  
A4: [K14006] 375.2 (1.00)

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  
LE: 53.70 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	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	53.1	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	0.91	31.9
Std. Dev.		0	0.3	4.5	4.5	1.3	0.2	0.36	0.31	0.3	0.3
Maximum		37	20.7	334.0	334.0	95.4	53.8	1.81	1.50	0.86	32.4
Minimum		36	19.6	319.8	319.8	91.4	53.1	0.87	0.86	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 Associates, Inc.  
BORING NO.: 8-3  
CLIENT:

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

DATE: 9/5/24  
TERRACON REP: (Signature)  
PDA MODEL/SN: SPT 4621 TR  
TERRACON RIG #: 1327

### DRILL RIG DATA

Type/Transport: Truck  
Manufacturer: Geopac  
Model No.: 3126 GS  
Serial No.: 7126554224106  
Year Built: 2024  
Modifications: N/A  
Maint. Schedule: 50 hrs

### SPT HAMMER DATA

Type: A40  
Manufacturer: Geopac  
Lifting Mechanism: Chain  
Model No.: AD1131  
Serial No.: 10001  
Hammer Weight: 140  
Hammer Operator(s): B. R. Hest

### PDA INPUT DATA

Operator: OP (Signature)  
Project No./Location: 7324515/  
Rig Mode & SN: PN 60000/3126 GS  
Hammer Type, LM, Rods: PD 420/ANJ  
Drill Rod Area (in<sup>2</sup>): AR 1.15

Elastic Modulus (ksi): EM 3000  
Specific Weight (kip/ft<sup>3</sup>): SP 0.492  
Wave Speed (ft/sec): WS 16808  
Increment Length (ft): LI 0.5  
Sampling Freq. (kHz): FR 50

### 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 375.83

NOTES: 286.25 + 1.875  
34.36 + 25 + 10.25 = 28.78  
SPLIT SPOON SAMPLER LENGTH 38' + 0.88' = 3.3

'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"
9:55	CL		27.5	25	48.7	5'x5	1	30	5	10	14	24
10:05	SP		28.5	30	53.7	5'x6	3	18	4	5	6	11
10:10	CL		33.5	35	58.7	5'x7	1	1	0	0	0	0
10:15	SP		38.5	40	63.7	5'x8	3	30	7	10	10	20
10:25	SP		43.5	45	68.7	5'x9	1	18	4	5	7	12
10:35	SP		48.5	50	73.7	5'x10	1	17	4	4	7	11
10:50	SC		53.5	55	78.7	5'x11	1	6	2	1	2	3
11:10	CL		58.5	60	83.7	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](http://www.PDAproficiencytest.com).

(Signature)  
Steven A. Hall, Executive Director  
Pile Driving Contractors Association

(Signature)  
Garland Likins, Senior Partner  
Pile Dynamics, Inc.

No. 2005

Exhibit E

Copy of Certificate of Proficiency

