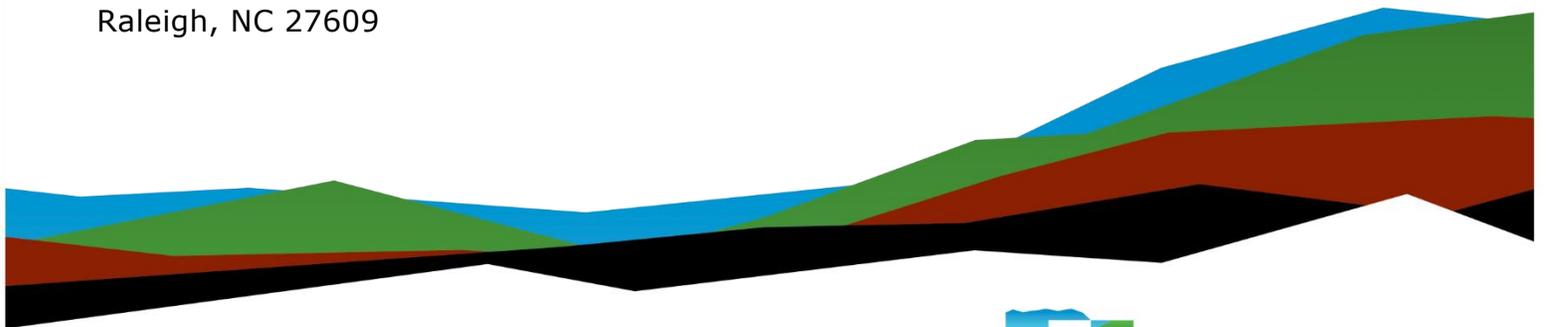


# S-13-130 (Rudolph Sikes Road) Bridge Replacement over Clay Creek Chesterfield County, SC Geotechnical Baseline Report

August 21, 2023 (rev1) | SCDOT Project ID: P041956  
Terracon Project No.: 7323P100

## Prepared for:

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



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

- Facilities
- Environmental
- Geotechnical
- Materials



521 Clemson  
Columbia, SC 29229  
P (803) 741-9000  
[Terracon.com](http://Terracon.com)

August 21, 2023 (rev1)

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

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

Re: Geotechnical Baseline Report  
S-13-130 Bridge Replacement over Clay Creek  
Chesterfield County, South Carolina  
SCDOT Project ID.: P041956  
Terracon Project No.: 7323P100

Dear Mr. Franklin:

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

## **Introduction**

HNTB Corporation (HNTB) has contracted Terracon to perform subsurface exploration, laboratory testing and very preliminary engineering recommendations for the replacement of the S-13-130 bridge over Clay Creek in Chesterfield County, South Carolina. The proposed bridge intends to replace the existing one. The results of subsurface exploration and laboratory testing have been separately presented in a Geotechnical Subsurface Data Report (GSDR). For convenience, those data are also provided here in this Geotechnical Baseline Report (GBR) along with a characterization of the subsurface conditions for the project. Very preliminary geotechnical recommendations are associated with the requested scope of study and are included in this GBR. This GBR 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-13-130 (Rudolph Sikes Road) crossing over Clay Creek in Chesterfield County, South Carolina. Site location and exploration plans are presented in Appendix A of this report. Based on the conceptual plans by HNTB dated 6/9/2023, the replacement bridge will be constructed on essentially the same alignment as the current bridge. The existing bridge is a multi-span structure supported by deep foundations. The conceptual plans show that the replacement bridge will be a single-span structure supported by deep foundations.

## Geotechnical Testing

The geotechnical exploration for this project was performed between June 22 and June 23, 2023. 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-13-130-1 and S-13-130-2)
- One (1) offset boring near S-13-130-1 for bulk sample collection

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 Construction Support Services, LLC after completion.

### Laboratory Testing

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

- Eight (8) Natural Moisture Content Tests
- Five (5) Atterberg Limits Tests
- Five (5) 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 Tests (pH, chloride content, sulfate content, and resistivity tests)

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.

## Subsurface Conditions

### Regional Geology

The bridge site is located on route S-13-130, approximately 8 miles east of the town of Pageland in Chesterfield County, South Carolina. The site is located in the Piedmont Physiographic Province of South Carolina. The Piedmont Unit is bounded by the Blue Ridge Unit to the west and the Upper Coastal Plain Subunit to the east. Based on mapping, the bedrock underlying the site is mainly comprised of metamorphic, metaigneous, and metavolcanic rock, referred to as metatuff, of the Cambrian to Neoproterozoic Age (1 BYA to 485.4 MYA). Soils overlying bedrock in the Piedmont are typically considered to be residual soils (soils weathered in place from bedrock). The existing bridge end bents and approach embankments contain fill overlying the residual soils. The subsurface encountered significant Intermediate Geomaterials (IGM) below a shallow surficial residual soil layer. Due to the depth of IGM, the actual bedrock was not reached.

### Soil and Rock Stratification

The soils encountered at this site consist of fill in the upper 4 to 12 feet, followed by residual soils of silts and clays down to about 12 feet below ground surface. The residuum is comprised of Intermediate Geomaterials (IGM) with N values typically in the range of 50/1" to 50/0". The borings were terminated after reaching a depth of 65 feet below the roadway surface and penetrating over 50 feet of IGM. A summary of subsurface strata found during subsurface exploration is provided in the table below.

Geology	Approximate Elevation of Layer Bottom (ft, NAVD88)	USCS Soil Type	Measured Field N Value	Plasticity Index	Fines Content	REC / RQD
Asphalt	313	--	--	--	--	--
Fill	301 to 309	CL	0 to 14	14 to 24	76 to 86	--
Residuum	PMDE <sup>1</sup>	ML, CL	4 to 100+	19	55 to 69	--

1. PMDE = Present to Maximum Depth Explored

## Design and Construction Considerations

### Foundations

Steel H-piles driven into holes pre-drilled into the IGM material are anticipated to be feasible for the proposed bridge end bents. Assuming redundant piles, Table 9-3 GDM 2022 allows using a resistance factor of 0.6 for redundant piles with wave equation, and 0.65 for redundant piles with PDA and calibrated wave equation.

According to the conceptual bridge plans by HNTB dated 6/9/2023, about 4 to 5 feet of new fill is planned at the end bent embankments. Considering the soft to firm clays and silts present above the IGM, it is anticipated that foundations will be installed after the approach embankment construction. The pile design must account for any downdrag loads subjected to the piles should fill be anticipated and placed after installing foundation piles.

We have observed relatively consistent depth of IGM, as seen in **Soil and Rock Stratification**. Therefore, we expect relatively consistent tip elevations at each end bent. Resistance of piles driven to practical refusal in IGM will be limited by their structural resistance. Therefore, likely reinforced pile tips will be required to limit the damage to the pile ends. Pile drivability using the wave equation should be performed along with estimating stresses during driving and, in general, verifying the ability of the Contractor’s selected hammer to drive the piles to the desired penetration while preventing overstressing.

As an alternative to driven piles set in pre-drilled holes, drilled shafts socketed well into IGM could also be considered for foundation support. For the design of the drilled shafts in IGM, and assuming redundant drilled shafts, a resistance factor of 0.70 for side friction and 0.65 for end bearing is allowed to be used in accordance with Table 9-4 of the SCDOT GDM 2022. It must be noted that side resistance along the cased length of the drilled shaft will not be considered in the calculated axial resistances.

### Corrosion and Deterioration

Corrosion testing was performed on a composite sample obtained from split spoons in the upper 10 feet. Corrosion testing included pH, resistivity, chlorides, and sulfates content as summarized in Table below. Corrosion test results are included in Appendix B.

Corrosion Test	Results Bent 2, Boring S-13-130-1 Composite Sample from 0 to 10 feet	Indication of Corrosivity <sup>1</sup>
pH	6.6	Less than 5.5
Resistivity	5,300 ohm-cm	Less than 2,000 ohm-cm
Chloride	24 ppm	Greater than 500 ppm

Corrosion Test	Results Bent 2, Boring S-13-130-1 Composite Sample from 0 to 10 feet	Indication of Corrosivity <sup>1</sup>
Sulfate	12 ppm	Greater than 1,000 ppm

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

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

## Embankment Construction

Based on the conceptual plans by HNTB, cut excavation is expected in front of the end bents and up to 5 feet of fill behind the end bents. Bulk samples were obtained near End Bent 2 from the top 5 feet of existing embankment material. Per our scope, the bulk sample was tested for soil classification and was also remolded to 95% of the Standard Proctor prior to being tested under CU Triaxial Compression. Test results are presented in Appendix B and are summarized in the table below.

Sample No.	Station	Offset (ft)	Sample Depth (ft)	USCS Soil Type	Compaction		Shear Strength <sup>1</sup>	
					Optimum Moisture (%)	Max Dry Density (pcf)	c', c (psf)	φ', φ (°)
S-13-130-1	29+36.62	1.25 R	0 – 5	CL	17.2	108.5	187, 778	32, 6

1. Based on a maximum deviator stress failure criterion

## 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.**

Phillip A. Morrison, P.E.  
Senior Engineer  
SC Registration No. 17275

Abdul Q. Fekrat, PhD, P.E.  
Project Engineer  
SC Registration No. 38531

Reviewed by Terracon’s Authorized Project Reviewer: David J. Corley, P.E.

## **Appendix A**

### **Field Exploration**

- Exhibit A-1 – Site Location Map
- Exhibit A-2 – Exploration Plan
- Exhibit A-3 – Subsurface Profile
- Exhibit A-4 – Summary of Boring Data
- Exhibit A-5 – GeoScoping Form (2 Pages)
- Exhibit A-6 – Field Exploration Description (2 Pages)
- Exhibit A-7 – Soil Description Terms
- Exhibit A-8 – Soil/Rock Symbols
- Exhibit A-9 – Boring Logs (4 Pages)
- Exhibit A-10 – Grout Logs (3 Pages)

Note: All exhibits are one page unless noted above.

**Site Location Map – Exhibit A-1**

S-13-130 BRO Clay Creek | Chesterfield County, SC  
Terracon Project No. 7323P100 | SCDOT Project ID: P041956

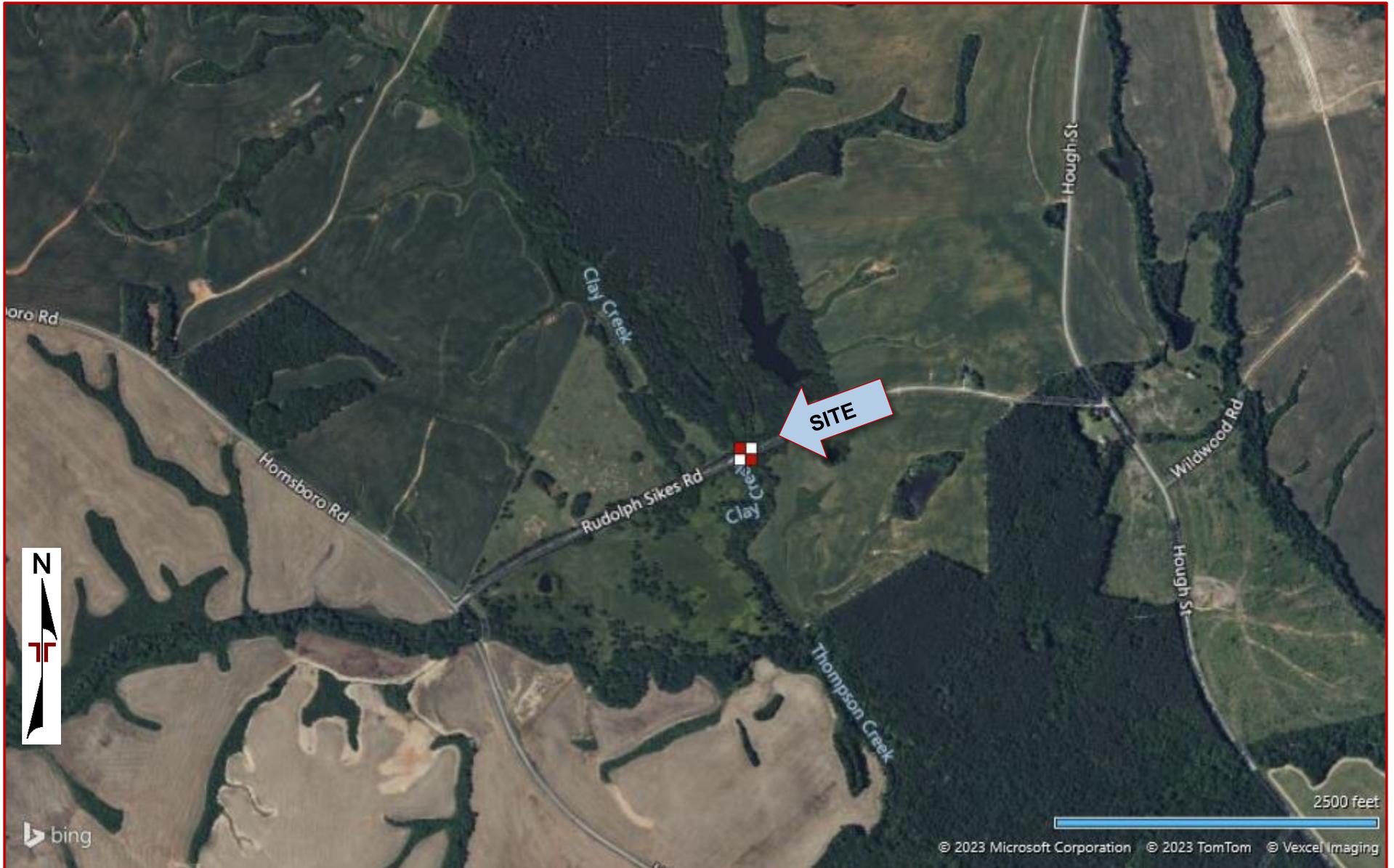


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY  
QUADRANGLES INCLUDE: HORNSBORO, SC (1/1/1983) and MT CROGHAN, NC (1/1/1983).

**Exploration Plan – Exhibit A-2**

S-13-130 BRO Clay Creek | Chesterfield County, SC

Terracon Project No. 7323P100 | SCDOT Project ID: P041956

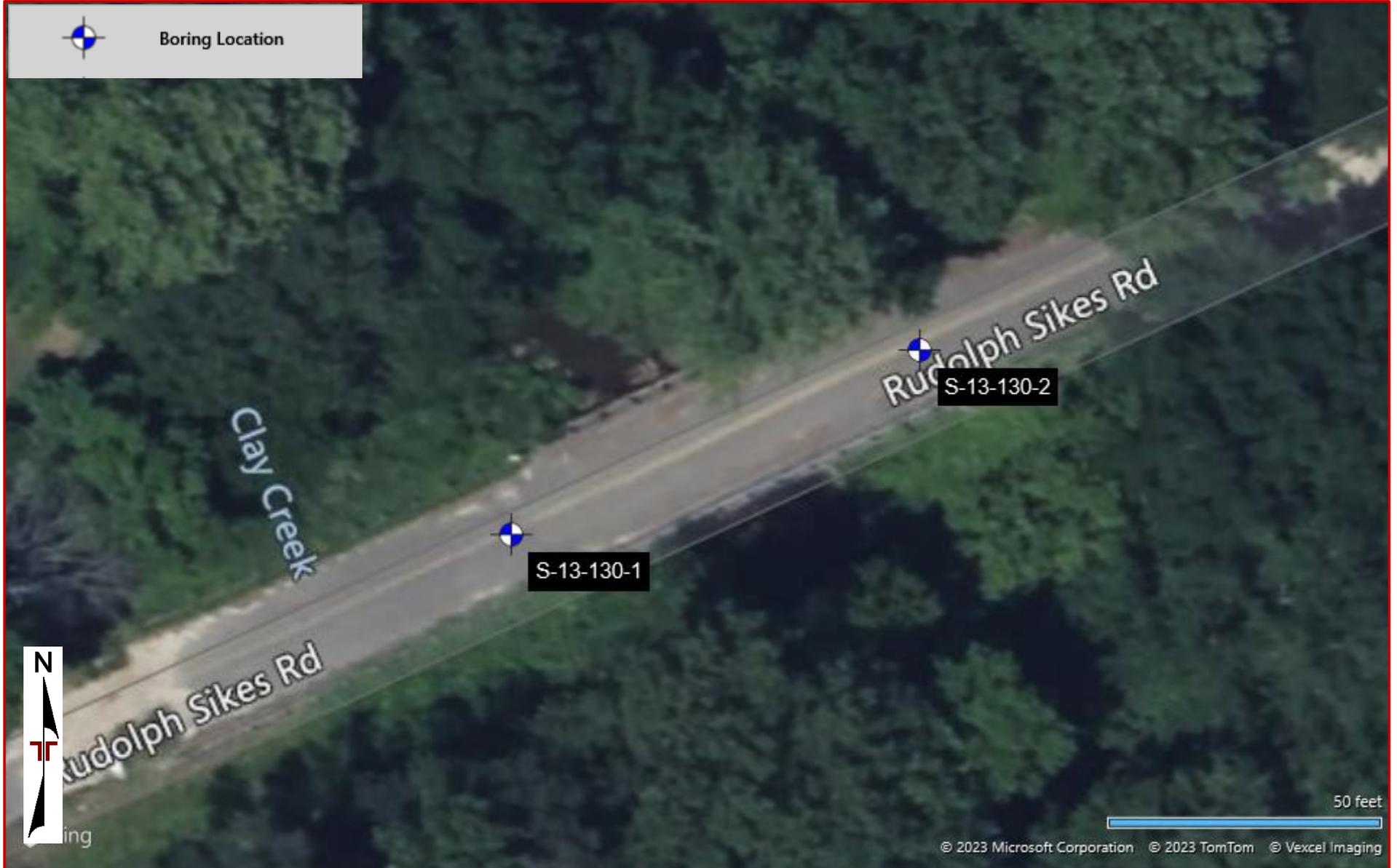
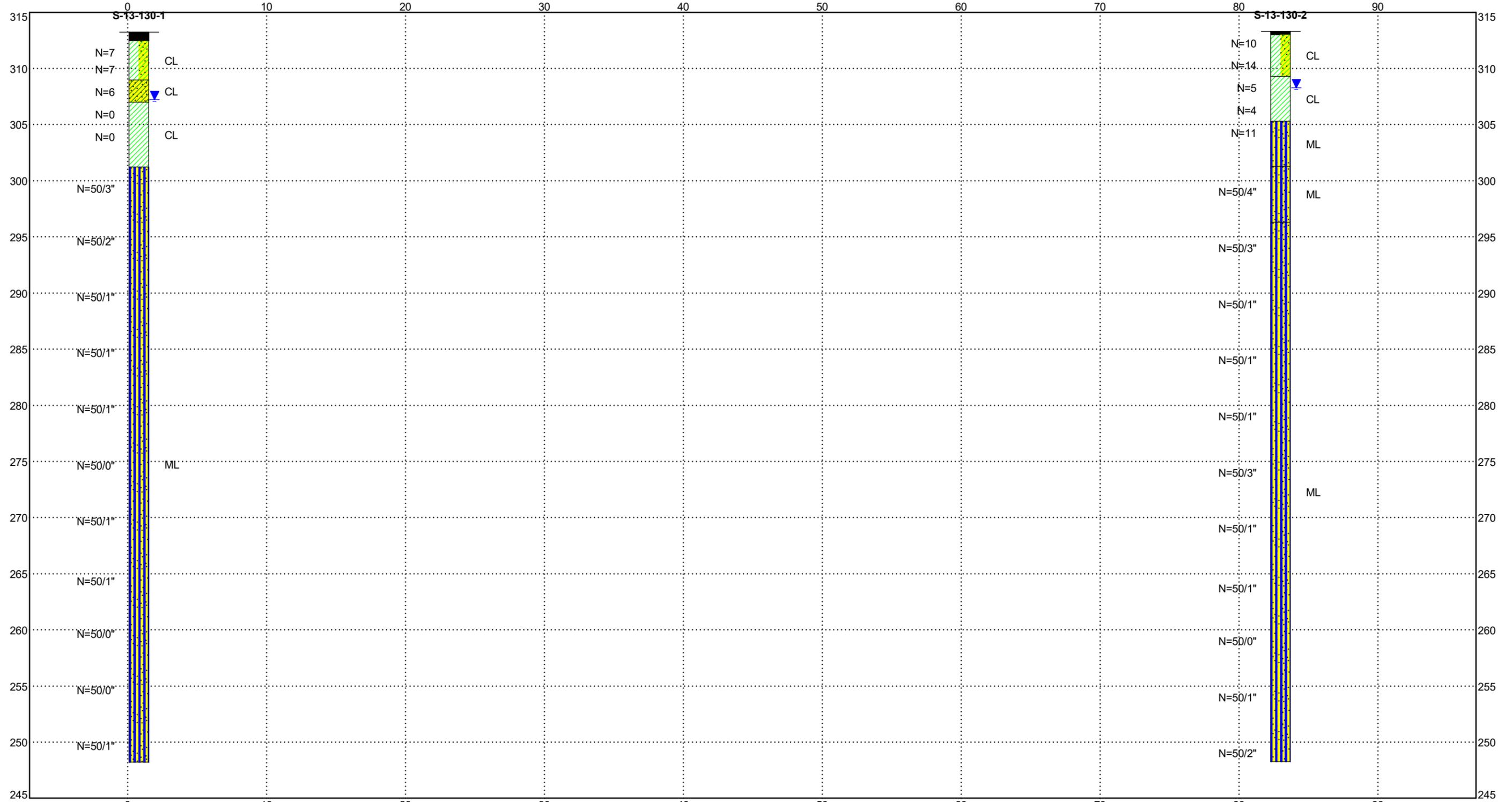


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. SEATTLE\_DB\_S-13-130\_THOMSON\_CREEK - TERRACON GINT.GPJ TERRACON\_DATATEMPLATE.GDT 8/21/23



**Explanation**

- Asphalt
- Lean Clay with Sand
- Sandy Lean Clay
- Lean Clay
- Sandy Silt
- Borehole Number
- Borehole Lithology

**NOTES:**

See Exhibit for orientation of soil profile.  
Soils profile provided for illustration purposes only.  
Soils between borings may differ  
AR - Auger Refusal  
BT - Boring Termination

- Water Level Reading at time of drilling.
- Water Level Reading after drilling.

Project Manager:  
Drawn by: BCR  
Approved by: AQF  
Date: 8/21/2023

Project No.: 7323P100  
Scale:  
File Name:

**Terracon**  
521 Clemson Rd  
Columbia, SC  
PH. 803-741-9000 FAX. 803-741-9900

**SUBSURFACE PROFILE**  
S-13-130 BRIDGE REPLACEMENT OVER CLAY CREEK  
CHESTERFIELD COUNTY  
SOUTH CAROLINA

EXHIBIT  
**A-3**

**Summary of Boring Data – Exhibit A-4**

S-13-130 BRO Clay Creek | Chesterfield County, SC

Terracon Project No. 7323P100 | SCDOT Project ID: P041956



**Summary of Boring Data**

Boring No.	Ground Elevation ft.	Test Depth ft.	Northing	Easting	Latitude	Longitude	Station	Offset
S-13-130-1	313.2	65.0	1078206.17	2222600.99	34.794461	80.258595	29+36.62	1.25R
S-13-130-2	313.3	65.0	1078240.39	2222675.71	34.794554	80.258346	28+54.44	0.47R

Note: A bulk sample was collected near S-13-130-1.

## GeoScoping Form

PROJECT INFORMATION	
Project ID: P041956	Date of Trip: 6/22/23
County: Chesterfield	Location: Pageland
Rd/Route: S-13-130	Local Name: Rudolph Sikes
Attendees: <b>A. Beaty</b>	

EXISTING BRIDGE INFORMATION	
Bridge Length: 75 feet	Bridge Width: 26 Feet
Superstructure Type: Concrete framing and decking	Substructure Type: Concrete Piles
Begin Bridge Sta.: 28+54	End Bridge Sta.: 29+29
Begin Bridge Embankment Sta. <sup>1</sup> 27+54	End Bridge Embankment Sta. <sup>1</sup> : 30+29
Structure Number: 03620	Posted Weight Limit: N/A
Crossing: Clay Creek	Skew: 30 degrees
Latitude: 34.794512° N	Longitude: 80.258477° W
Existing Fill Height: 12 feet	Approximate Existing Slope Angle: 2H:1V

<sup>1</sup>Begin and End Bridge Embankment 100 feet down station or up station from bridge, respectively

EXISTING ROADWAY EMBANKMENT INFORMATION	
Begin Project Sta.: 23+00	Begin Bridge Embankment Sta. <sup>1</sup> : 33+50
Accessibility Issues: None	
Ground Cover: Asphalt Pavement	
Existing Fill Height: 12	Approximate Existing Slope Angle: 2H:1V
Local Development (undeveloped, developed residential, developed commercial, developed industrial, etc.): Undeveloped	
Topography (level, flat, rolling, steep, hillside, valley, swamp, gully, etc.): Rolling	
Traffic Control Necessary (Y/N):	
No	
Surface Soil: Clay	Muck (Y/N): No
Exposed Rock (Y/N): No	In Stream Bed (Y/N): No
	In Banks (Y/N): No
Wetlands On-Site (Y/N): Yes (Stream)	Wetlands Adjacent (Y/N): Yes (Stream)
Depth FG to Water: 5 feet	Water Depth: 8 feet
Depth to Existing Ground: 13 feet	
Scour Condition at EB: None observed	Scour Condition at IB: None Observed
End Bridge Embankment Sta. <sup>1</sup> : 29+29	End Project Sta.: 33+50
Accessibility Issues: None Bridge Closed	
Ground Cover: Asphalt Pavement	
Existing Fill Height: 12 feet	Approximate Existing Slope Angle: 2H:1V
Local Development (undeveloped, developed residential, developed commercial, developed industrial, etc.): Undeveloped	
Topography (level, flat, rolling, steep, hillside, valley, swamp, gully, etc.): Rolling	
Traffic Control Necessary (Y/N): No	
Surface Soil: Clay	Muck (Y/N): No
Exposed Rock (Y/N): No	In Stream Bed (Y/N): No
	In Banks (Y/N): No
Wetlands On-Site (Y/N): Yes (Stream)	Wetlands Adjacent (Y/N): Yes (Stream)
Depth FG to Water:	Water Depth:
Depth to Existing Ground: 13 feet	
Scour Condition at EB: None	Scour Condition at IB: Not observed due to water depth

## GeoScoping Form

UTILITIES INFORMATION
Attached:
Above Ground/ Overhead: None
Underground:

COMMENTS

**Instructions:**

1. Attach boring location plan for bridge and roadway.
2. Attach all photographs taken, photographs to be labeled as to direction looking in and what is being depicted.
3. Fill out GeoScoping Form as completely as possible, using additional sheets as necessary to describe site conditions.
4. If representative of GEC on site during GeoScoping, include GEC representative's name and contact number in Attendees block.

**Exhibit A-6**

S-13-130 BRO Clay Creek | Chesterfield County, SC  
August 21, 2023 (rev1) | Terracon Project No. 7323P100 | SCDOT Project ID: P041956



## 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 Construction Support Services, 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"

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-13-130-1	100 feet or 10 feet rock coring	0 to 10 feet
S-13-130-2	100 feet or 10 feet rock coring	0 to 10 feet
S-13-130-1 Bulk	5 feet	Bulk Sample

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

**Exhibit A-6**

S-13-130 BRO Clay Creek | Chesterfield County, SC  
August 21, 2023 (rev1) | Terracon Project No. 7323P100 | SCDOT Project ID: P041956



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.

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 were backfilled with the drill cuttings and clean sand. The upper 20 feet of the boreholes were grouted with a cement bentonite grout and capped with cold-patch asphalt.

## 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 Moderately
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

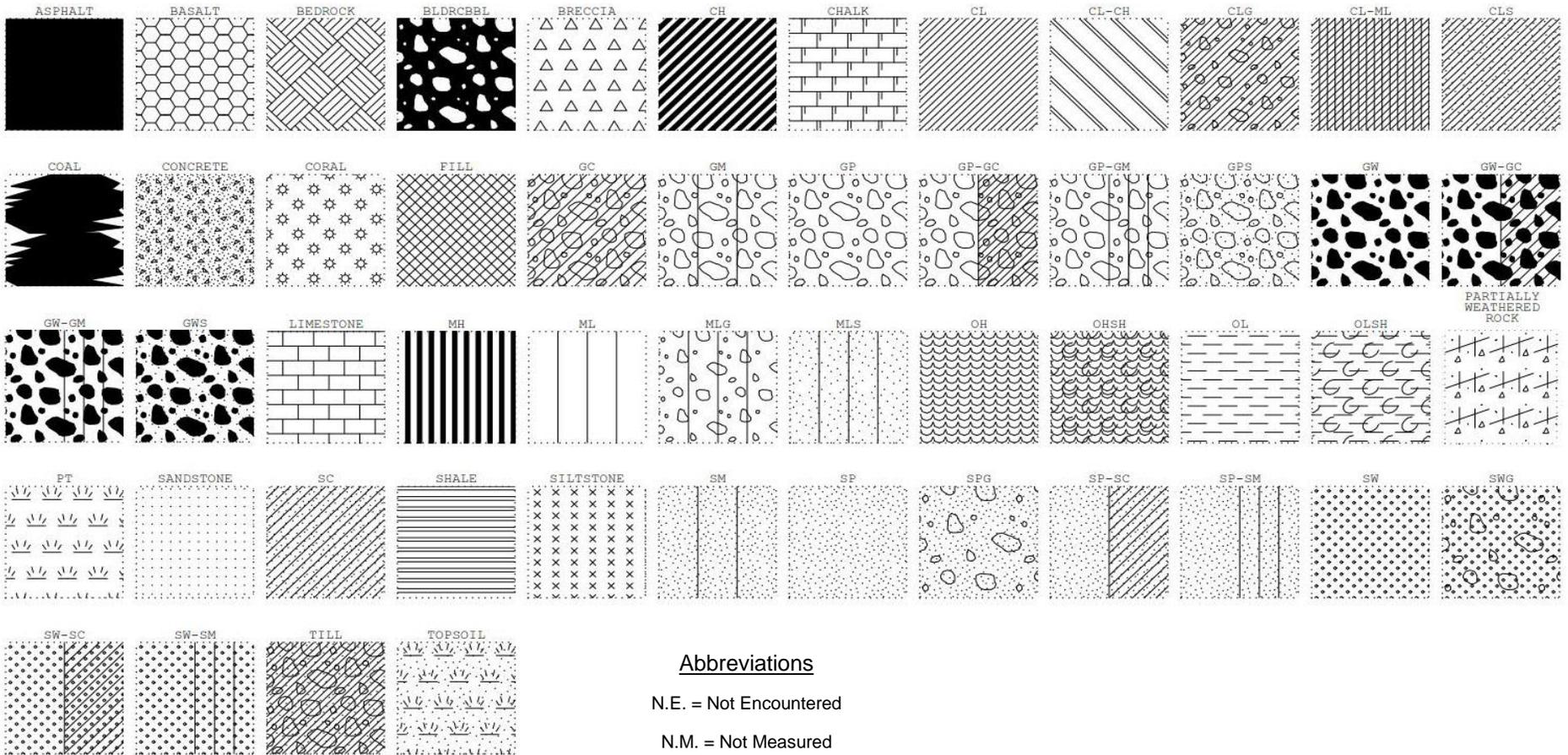
### AASHTO Soil Designation

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



Project Manager:  
 PAM  
 Drawn by:  
 KJZ  
 Checked by:  
 PAM  
 Approved by:  
 DJC

Project No.  
 7323P100  
 Scale:  
 N.T.S.  
 File Name:  
 Soil - Rock - Log  
 Date:  
 Jul 2023



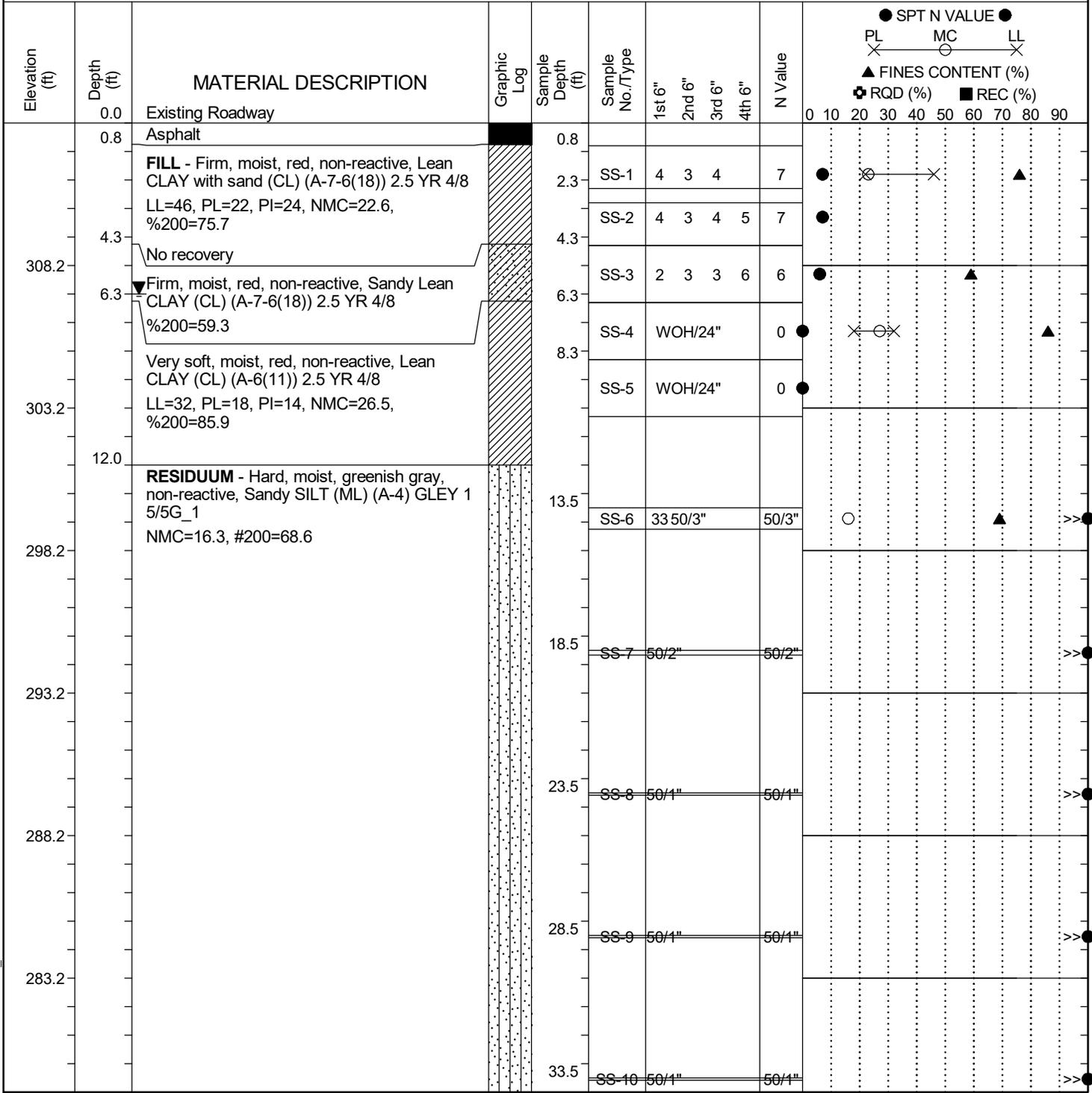
521 Clemson Road  
 Columbia, SC 29229  
 PH. (803) 741-9000 FAX. (803) 741-9900

SOIL AND ROCK SYMBOLS

Exhibit A-8

# SCDOT Soil Test Log

<b>Project ID:</b> P041956	<b>County:</b> Chesterfield	<b>Boring No.:</b> S-13-130-1
<b>Site Description:</b> S-13-130 BRO Clay Creek	<b>Route:</b> S-13-130	
<b>Eng./Geo.:</b> A. Beaty	<b>Boring Location:</b> 29+36.62	<b>Offset:</b> 1.25 R
<b>Alignment:</b> Existing		
<b>Elev.:</b> 313.2 ft	<b>Latitude:</b> 34.794461	<b>Longitude:</b> -80.258595
<b>Date Started:</b> 6/22/2023		
<b>Total Depth:</b> 65 ft	<b>Soil Depth:</b> 65 ft	<b>Core Depth:</b> 0 ft
<b>Date Completed:</b> 6/23/2023		
<b>Bore Hole Diameter (in):</b> 3	<b>Sampler Configuration</b>	<b>Liner Required:</b> Y (N)
<b>Liner Used:</b> Y (N)		
<b>Drill Machine:</b> DR1109	<b>Drill Method:</b> RW	<b>Hammer Type:</b> Automatic
<b>Energy Ratio:</b> 93.9%		
<b>Core Size:</b>	<b>Driller:</b> S. Truesdale	<b>Groundwater:</b> TOB N.M.
		<b>24HR:</b> 6 ft



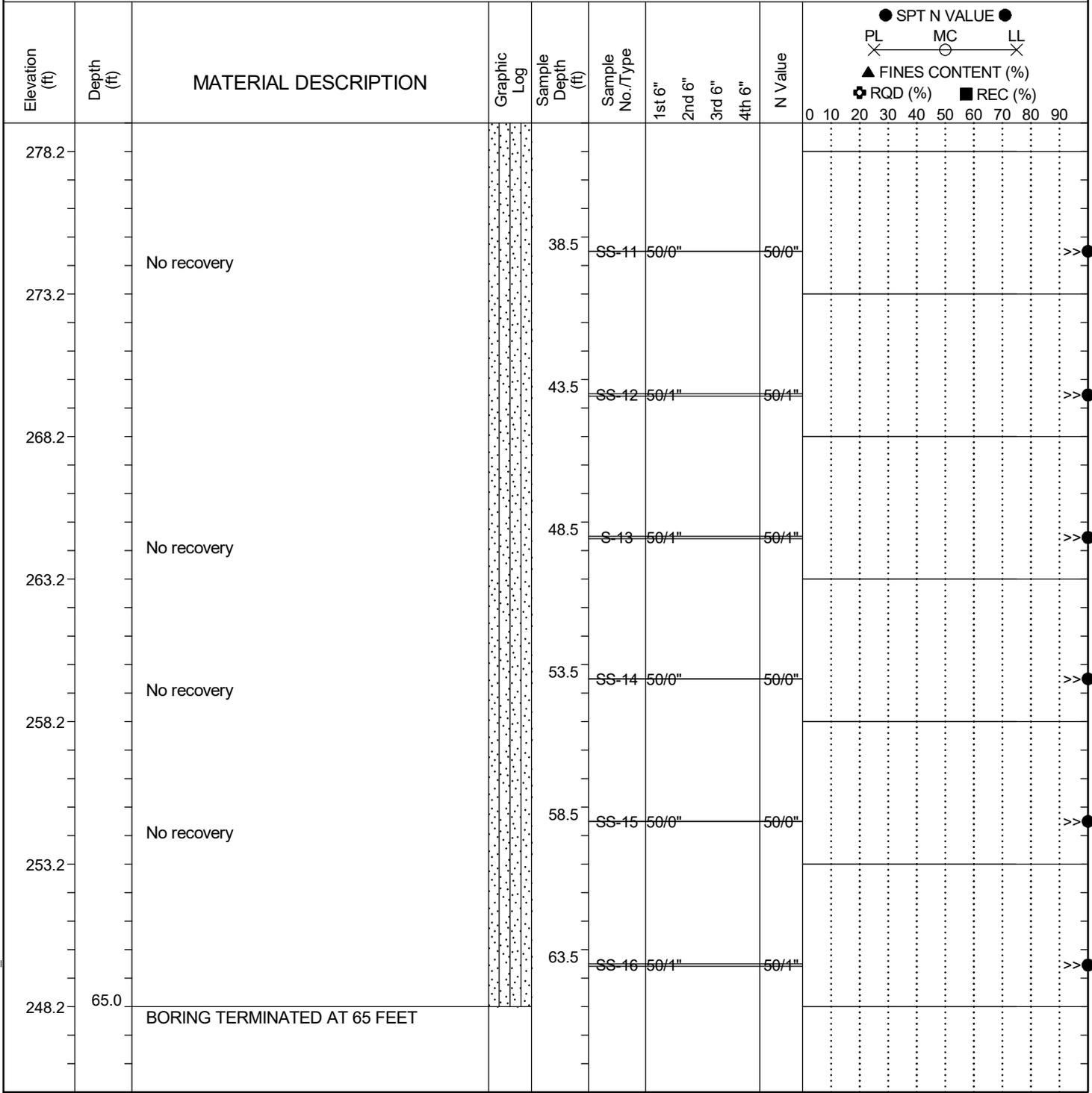
**LEGEND** Continued Next Page

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

SC.DOT SCDOT S-13-130.GPJ SCDOT DATATEMPLATE.GDT 8/18/23

# SCDOT Soil Test Log

<b>Project ID:</b> P041956	<b>County:</b> Chesterfield	<b>Boring No.:</b> S-13-130-1
<b>Site Description:</b> S-13-130 BRO Clay Creek	<b>Route:</b> S-13-130	
<b>Eng./Geo.:</b> A. Beaty	<b>Boring Location:</b> 29+36.62	<b>Offset:</b> 1.25 R
<b>Alignment:</b> Existing		
<b>Elev.:</b> 313.2 ft	<b>Latitude:</b> 34.794461	<b>Longitude:</b> -80.258595
<b>Date Started:</b> 6/22/2023		
<b>Total Depth:</b> 65 ft	<b>Soil Depth:</b> 65 ft	<b>Core Depth:</b> 0 ft
<b>Date Completed:</b> 6/23/2023		
<b>Bore Hole Diameter (in):</b> 3	<b>Sampler Configuration</b>	<b>Liner Required:</b> Y (N)
<b>Liner Used:</b> Y (N)		
<b>Drill Machine:</b> DR1109	<b>Drill Method:</b> RW	<b>Hammer Type:</b> Automatic
<b>Energy Ratio:</b> 93.9%		
<b>Core Size:</b>	<b>Driller:</b> S. Truesdale	<b>Groundwater:</b> TOB N.M.
		<b>24HR:</b> 6 ft



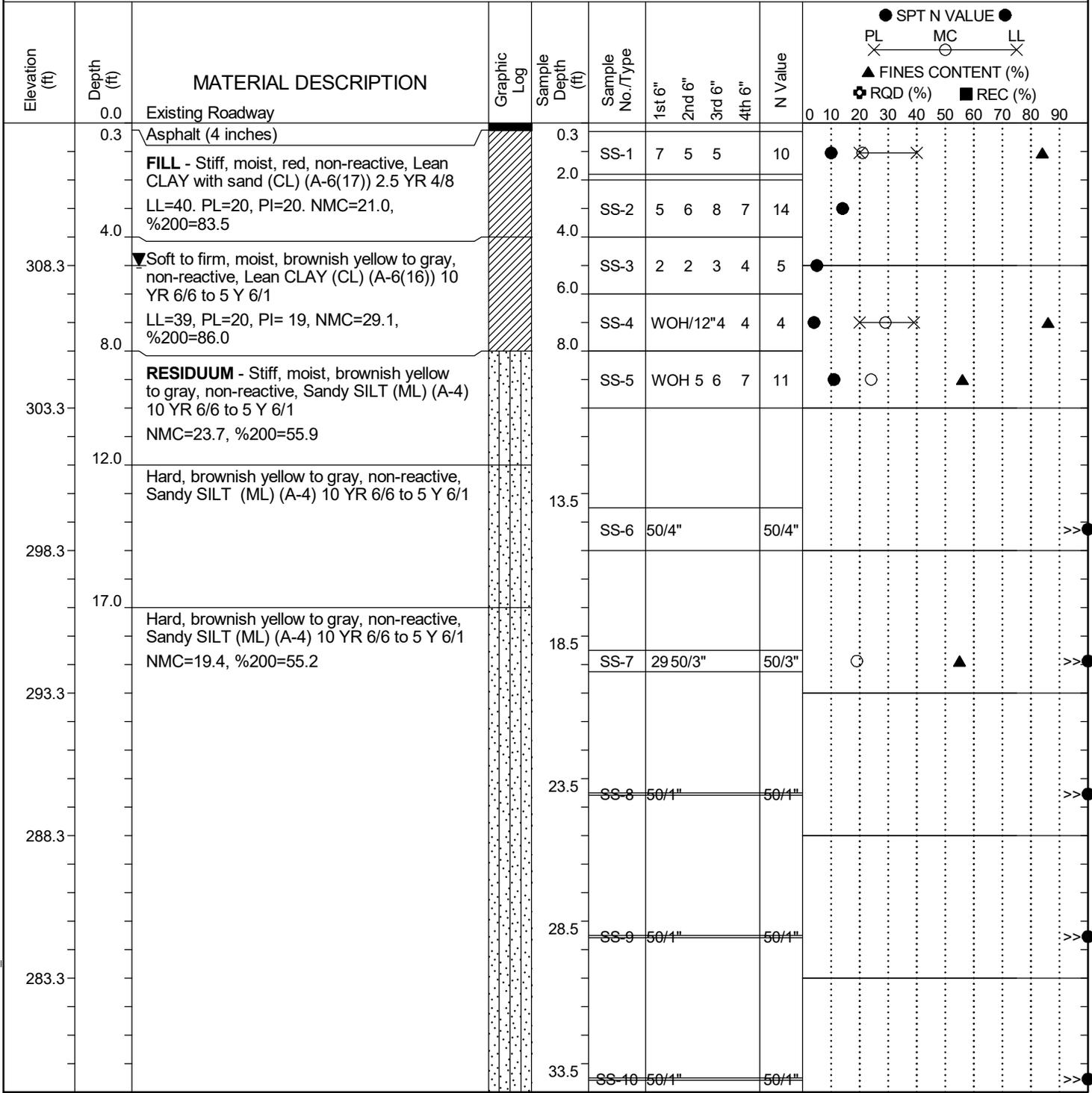
### LEGEND

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 SCDOT S-13-130.GPJ SCDOT DATATEMPLATE.GDT 8/18/23

# SCDOT Soil Test Log

<b>Project ID:</b> P041956	<b>County:</b> Chesterfield	<b>Boring No.:</b> S-13-130-2
<b>Site Description:</b> S-13-130 BRO Clay Creek		<b>Route:</b> S-13-130
<b>Eng./Geo.:</b> A. Beaty	<b>Boring Location:</b> 28+54.44	<b>Offset:</b> 0.47 R
<b>Alignment:</b> Existing	<b>Date Started:</b> 6/22/2023	<b>Date Completed:</b> 6/23/2023
<b>Elev.:</b> 313.3 ft	<b>Latitude:</b> 34.794554	<b>Longitude:</b> -80.258347
<b>Total Depth:</b> 65 ft	<b>Soil Depth:</b> 65 ft	<b>Core Depth:</b> 0 ft
<b>Bore Hole Diameter (in):</b> 3	<b>Sampler Configuration</b>	<b>Liner Required:</b> Y (N)
<b>Liner Used:</b> Y (N)	<b>Drill Machine:</b> DR1109	<b>Drill Method:</b> RW
<b>Hammer Type:</b> Automatic	<b>Energy Ratio:</b> 93.9%	<b>Groundwater:</b> TOB N.M.
<b>Core Size:</b>	<b>Driller:</b> S. Truesdale	<b>24HR:</b> 5 ft



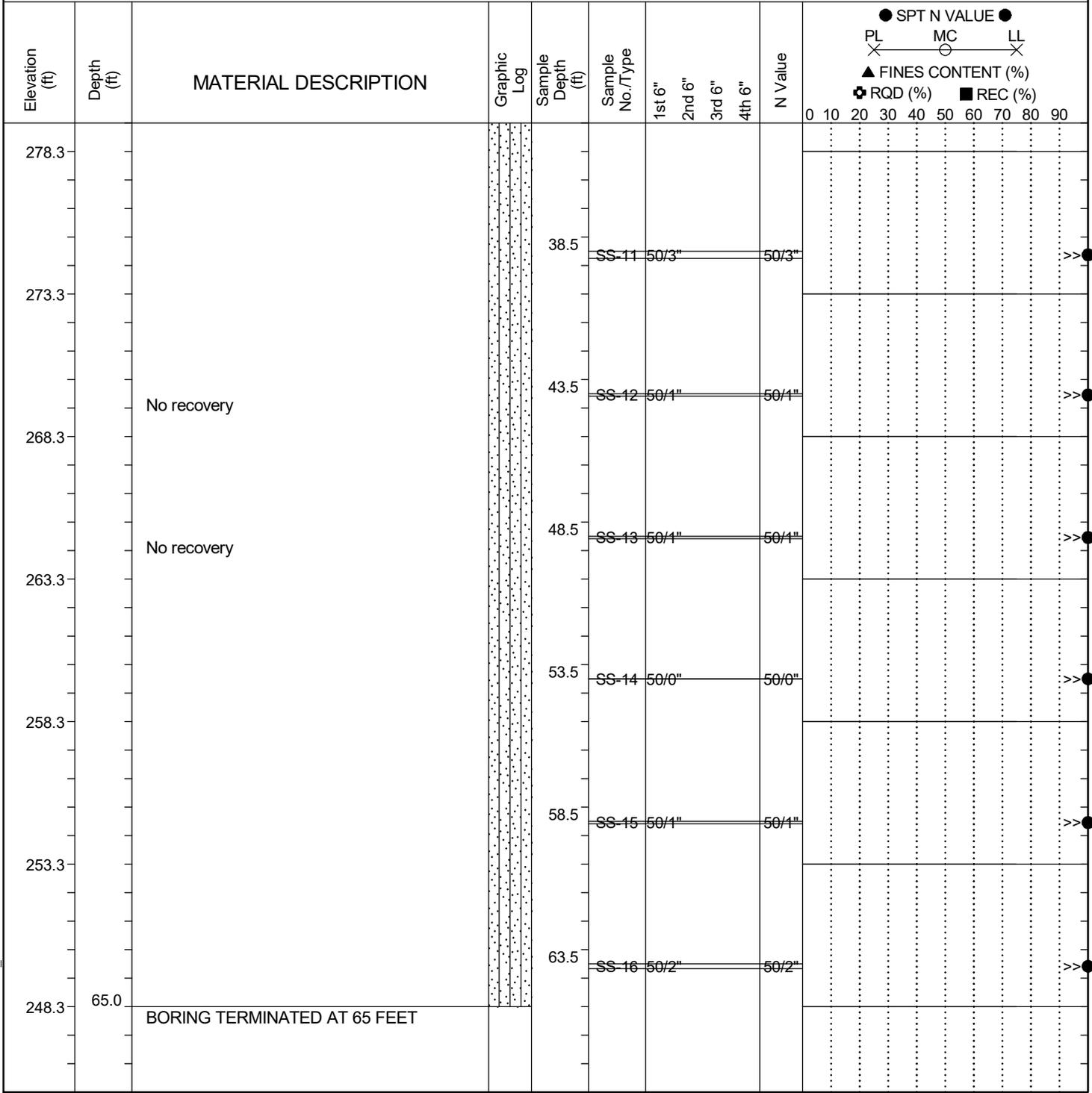
LEGEND Continued Next Page

<b>SAMPLER TYPE</b>		<b>DRILLING METHOD</b>	
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 SCDOT S-13-130.GPJ SCDOT DATATEMPLATE.GDT 8/18/23

# SCDOT Soil Test Log

<b>Project ID:</b> P041956	<b>County:</b> Chesterfield	<b>Boring No.:</b> S-13-130-2
<b>Site Description:</b> S-13-130 BRO Clay Creek	<b>Route:</b> S-13-130	
<b>Eng./Geo.:</b> A. Beaty	<b>Boring Location:</b> 28+54.44	<b>Offset:</b> 0.47 R
<b>Alignment:</b> Existing		
<b>Elev.:</b> 313.3 ft	<b>Latitude:</b> 34.794554	<b>Longitude:</b> -80.258347
<b>Date Started:</b> 6/22/2023		
<b>Total Depth:</b> 65 ft	<b>Soil Depth:</b> 65 ft	<b>Core Depth:</b> 0 ft
<b>Date Completed:</b> 6/23/2023		
<b>Bore Hole Diameter (in):</b> 3	<b>Sampler Configuration</b>	<b>Liner Required:</b> Y (N)
<b>Liner Used:</b> Y (N)		
<b>Drill Machine:</b> DR1109	<b>Drill Method:</b> RW	<b>Hammer Type:</b> Automatic
<b>Energy Ratio:</b> 93.9%		
<b>Core Size:</b>	<b>Driller:</b> S. Truesdale	<b>Groundwater:</b> TOB N.M.
		<b>24HR:</b> 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	

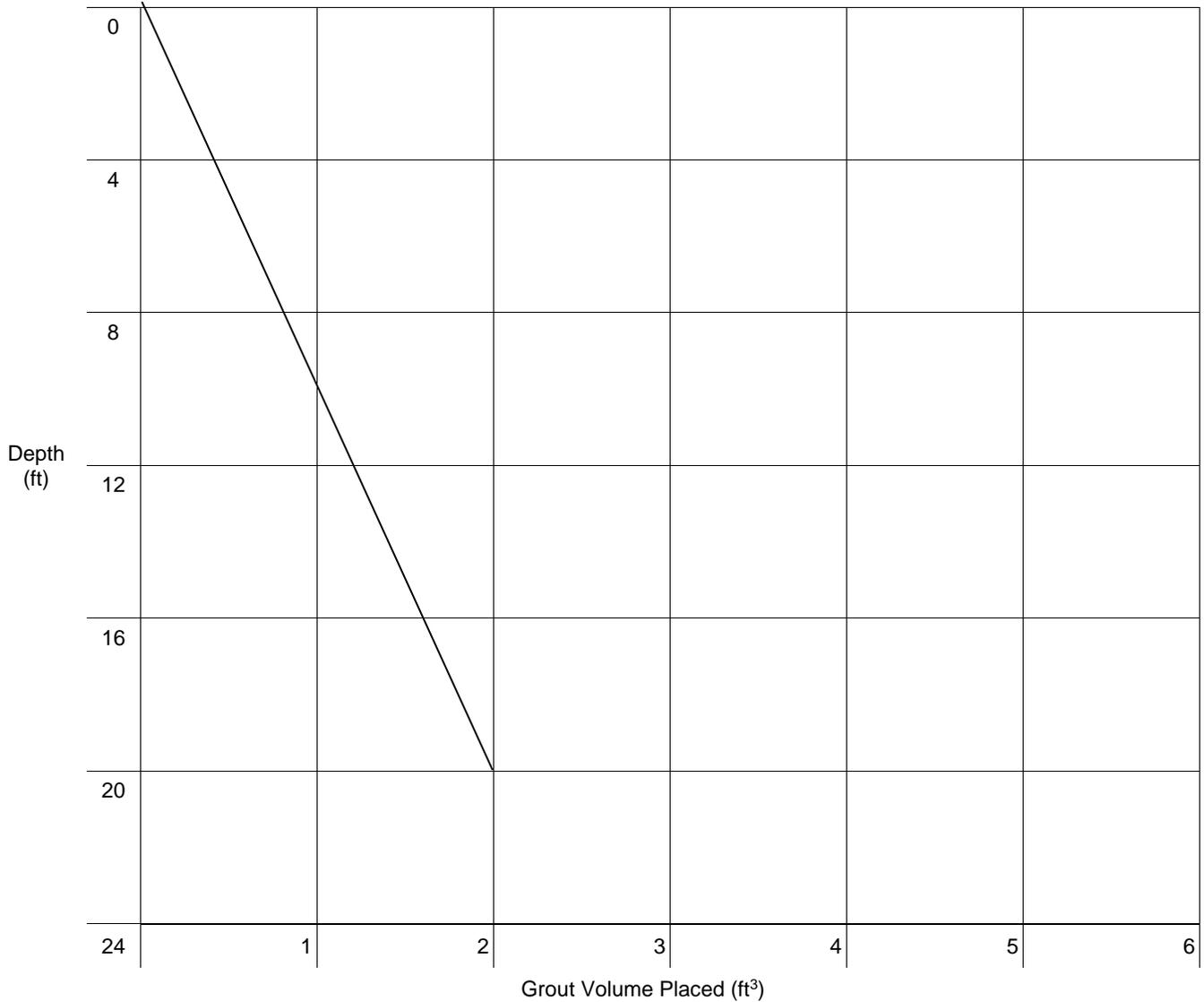
SC.DOT SCDOT S-13-130.GPJ SCDOT\_DATATEMPLATE.GDT 8/18/23



## GROUT LOG OF TEST HOLES FOR GEOTECHNICAL ON-CALL

Project Name:	S-13-130 BRO Clay Creek		Test Hole No.:	S-13-130-1
Project ID:	P041956		Station:	29+36.62
Consultant Firm:	Terracon Consultants, Inc.		Offset:	1.25 R
Grouted By (Driller's Name):	Truesdale	Date	6/23/23	
Notes:	Mix design: 1 pound cement, 1 pound bentonite, 6 pounds water			

Grout Curve



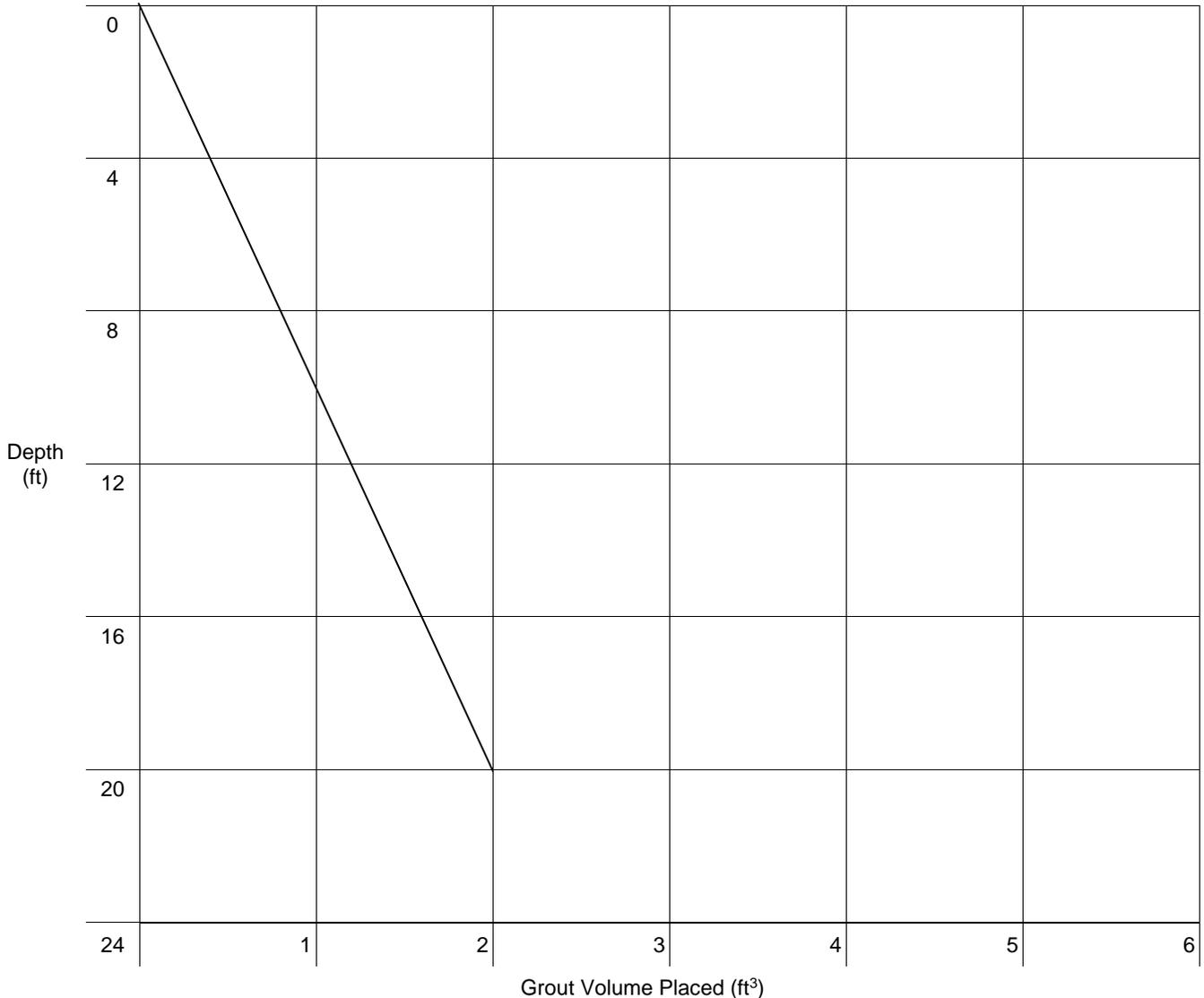
Number of Bags On-Site	20	ea.
Depth of Test Hole Grouted	20	ft.
Diameter of Test Hole	0.33	ft.
Area of Test Hole	0.09	ft <sup>2</sup>
Volume of Test Hole	1.74	ft <sup>3</sup>
Volume of Casing (If applicable)	-	ft <sup>3</sup>
Theoretical Volume of Test Hole	1.74	ft <sup>3</sup>
Number of Bags Used	2.5	ea.
Volume Placed	2	ft <sup>3</sup>



## GROUT LOG OF TEST HOLES FOR GEOTECHNICAL ON-CALL

Project Name:	S-13-130 BRO Clay Creek		Test Hole No.:	S-13-130-2
Project ID:	P041956		Station:	28+54.44
Consultant Firm:	Terracon Consultants, Inc.		Offset:	0.47R
Grouted By (Driller's Name):	Truesdale	Date	6/23/23	
Notes:	Mix design: 1 pound cement, 1 pound bentonite, 6 pounds water			

Grout Curve

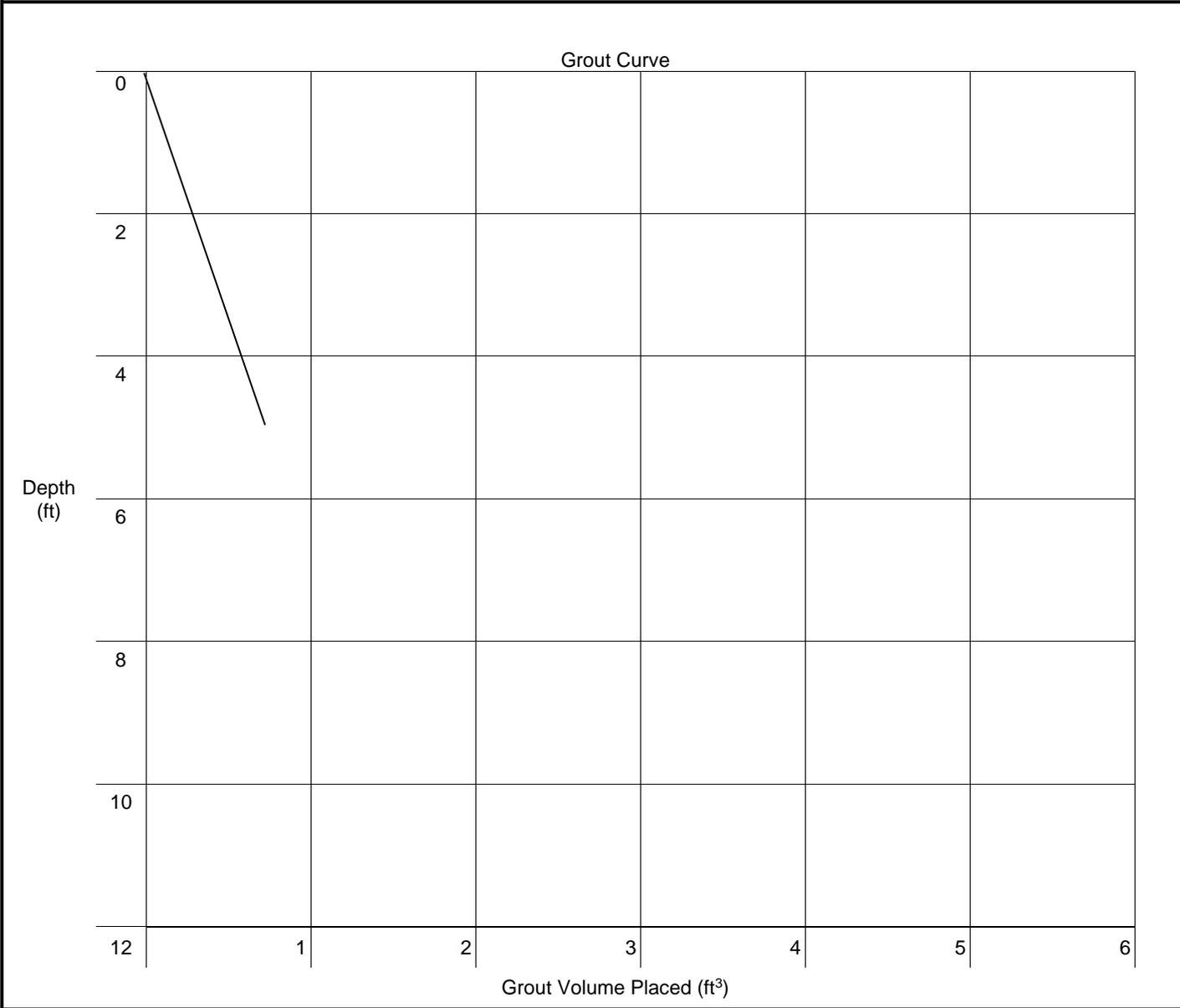


Number of Bags On-Site	20	ea.
Depth of Test Hole Grouted	20	ft.
Diameter of Test Hole	0.33	ft.
Area of Test Hole	0.09	ft <sup>2</sup>
Volume of Test Hole	1.74	ft <sup>3</sup>
Volume of Casing (If applicable)	-	ft <sup>3</sup>
Theoretical Volume of Test Hole	1.74	ft <sup>3</sup>
Number of Bags Used	2.5	ea.
Volume Placed	2	ft <sup>3</sup>



## GROUT LOG OF TEST HOLES FOR GEOTECHNICAL ON-CALL

Project Name:	S-13-130 BRO Clay Creek	
Project ID:	P041956	Test Hole No.: <u>(BULK)</u>
Consultant Firm:	Terracon Consultants, Inc.	Station: <u>29+36.62</u>
Grouted By (Driller's Name):	Truesdale	Date <u>6/22/23</u> Offset: <u>1.25 R</u>
Notes:	Mix design: 1 pound cement, 1 pound bentonite, 6 pounds water	



Number of Bags On-Site	20	ea.
Depth of Test Hole Grouted	5	ft.
Diameter of Test Hole	0.5	ft.
Area of Test Hole	0.2	ft <sup>2</sup>
Volume of Test Hole	1.0	ft <sup>3</sup>
Volume of Casing (If applicable)	-	ft <sup>3</sup>
Theoretical Volume of Test Hole	1.0	ft <sup>3</sup>
Number of Bags Used	1.5	ea.
Volume Placed	0.7	ft <sup>3</sup>

## **Appendix B**

### **Laboratory Testing**

Exhibit B-1 – Laboratory Testing Description  
Summary of Laboratory Data  
Laboratory Data Sheets (14 Pages)

Note: All exhibits are one page unless noted above.

**Exhibit B-1**

S-13-130 BRO Clay Creek | Chesterfield County, SC  
August 21, 2023 (rev1) | Terracon Project No. 7323P100 | SCDOT Project ID: P041956



**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 samples locations. The test results are presented in this appendix.

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

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

- Moisture Content AASHTO T265/(ASTM D2216)
- Atterberg Limits AASHTO T89/T90(ASTM D4318)
- Wash 200 AASHTO T11/(ASTM D1140)
- 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

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. SMART LAB SUMMARY-LANDSCAPE\_A S-13-130 THOMSON CREEK.GPJ TERRACON\_DATATEMPLATE.GDT 8/16/23

BORING ID	Depth (Ft.)	Soil Classification USCS & AASHTO	Liquid Limit	Plastic Limit	Plasticity Index	% Fines	% Gravel	% Sand	% Silt	% Clay	Water Content (%)
S-13-130-1 Bulk	0-5	LEAN CLAY with SAND(CL) / A-6 (12)	38	19	19	70.9					18.3
S-13-130-1	0.8-2.8	LEAN CLAY with SAND(CL) / A-7-6 (18)	46	22	24	75.7					22.6
S-13-130-1	4.3-6.3					59.3	2.0	38.7	35.1	24.2	
S-13-130-1	6.3-8.3	LEAN CLAY(CL) / A-6 (11)	32	18	14	85.9	0.0	14.1	52.1	33.8	26.5
S-13-130-1	13.5-14.3					68.6					16.3
S-13-130-2	0.3-1.8	LEAN CLAY with SAND(CL) / A-6 (17)	40	20	20	83.5					21.0
S-13-130-2	6-8	LEAN CLAY(CL) / A-6 (16)	39	20	19	86.0	0.0	14.0	49.7	36.3	29.1
S-13-130-2	8-10					55.9	0.3	43.9	35.0	20.8	23.7
S-13-130-2	18.5-20					55.2					19.4

PROJECT: S-13-130 BRO Clay Creek

SITE: Chesterfield County, SC



PH. 803-741-9000

FAX. 803-741-9900

PROJECT NUMBER: 7323P100

CLIENT: HNTB



# INDEX PROPERTIES VERSUS DEPTH

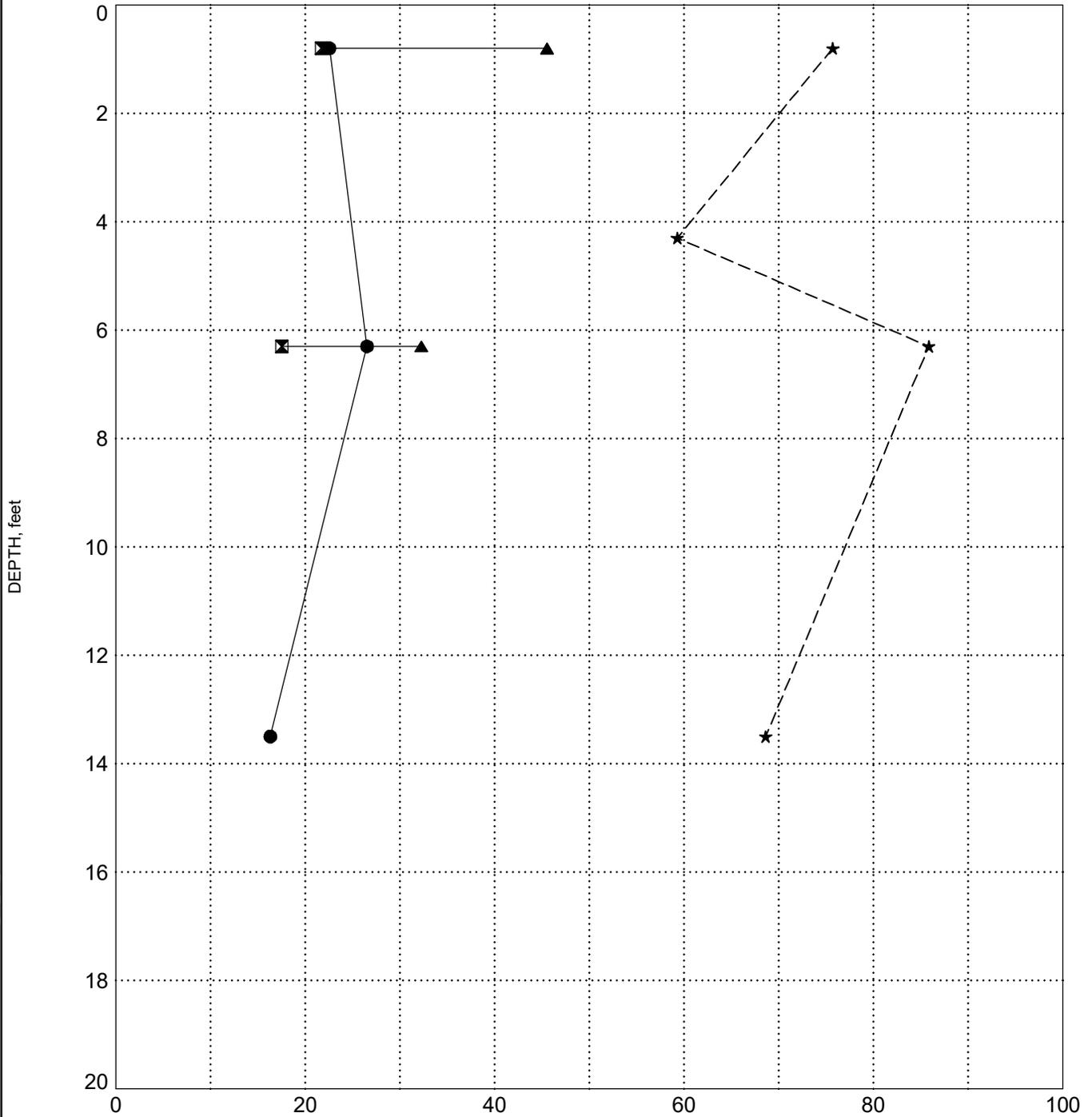
PROJECT ID P041956

PROJECT NAME S-13-130 BRO Clay Creek

PROJECT COUNTY Chesterfield

SURFACE ELEVATION: 313.2

## BORING S-13-130-1



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



# INDEX PROPERTIES VERSUS DEPTH

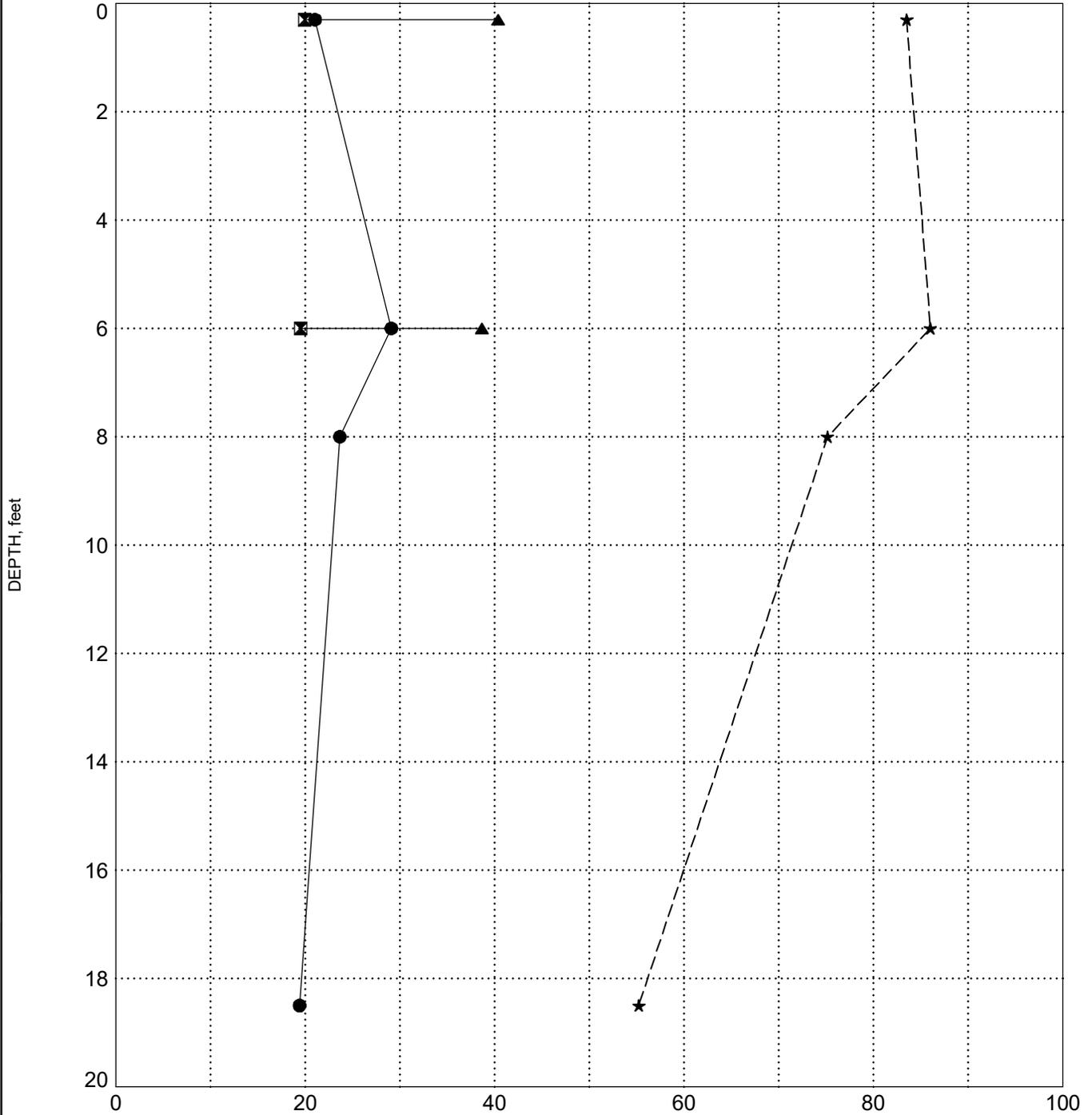
PROJECT ID P041956

PROJECT NAME S-13-130 BRO Clay Creek

PROJECT COUNTY Chesterfield

SURFACE ELEVATION: 313.3

## BORING S-13-130-2



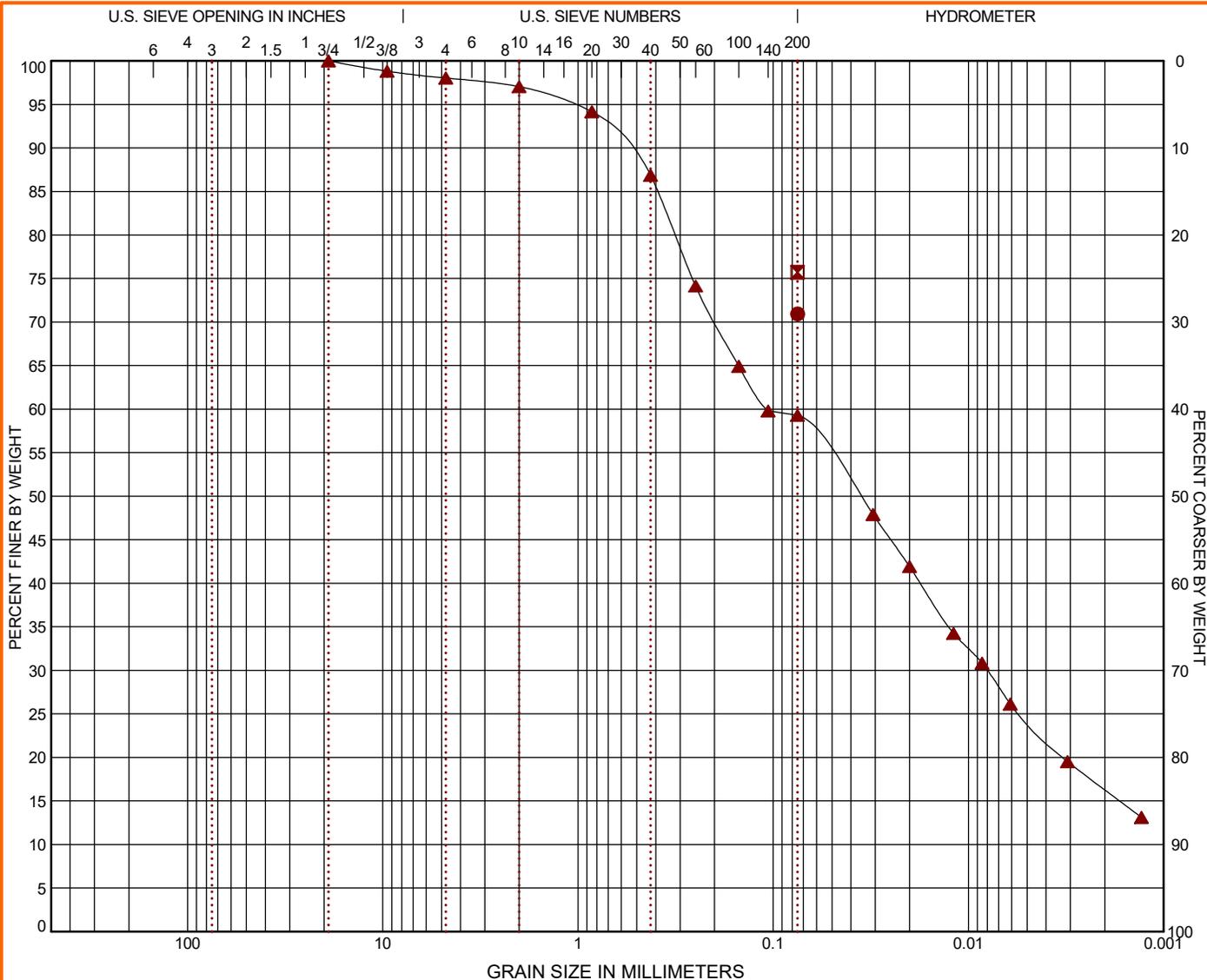
LEGEND	
●	Water Content
☒	Plastic Limit
▲	Liquid Limit
★	Fines

INDEX PROPS SCDOT S-13-130-GPJ SCDOT DATA TEMPLATE\_01\_30\_2015.GDT 8/18/23

# GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: AASHTO DESC-1 S-13-130 THOMSON CREEK.GPJ TERRACON\_DATATEMPLATE.GDT 8/16/23



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
● S-13-130-1 Bulk	0 - 5					70.9		CL
☒ S-13-130-1	0.8 - 2.8					75.7		CL
▲ S-13-130-1	4.3 - 6.3	0.0	2.0	38.7	35.1		24.2	

GRAIN SIZE		
	●	☒ ▲
D <sub>60</sub>		0.107
D <sub>30</sub>		0.008
D <sub>10</sub>		

●		☒		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#200	70.93	#200	75.72	3/4"	100.0
				3/8"	98.81
				#4	98.03
				#10	97.03
				#20	94.17
				#40	86.85
				#60	74.15
				#100	64.92
				#140	59.8
				#200	59.29

SOIL DESCRIPTION
● A-6 (12)
☒ A-7-6 (18)
▲
REMARKS
●
☒
▲

COEFFICIENTS		
	●	☒ ▲
C <sub>c</sub>		
C <sub>u</sub>		

PROJECT: S-13-130 BRO Clay Creek

SITE: Chesterfield County, SC



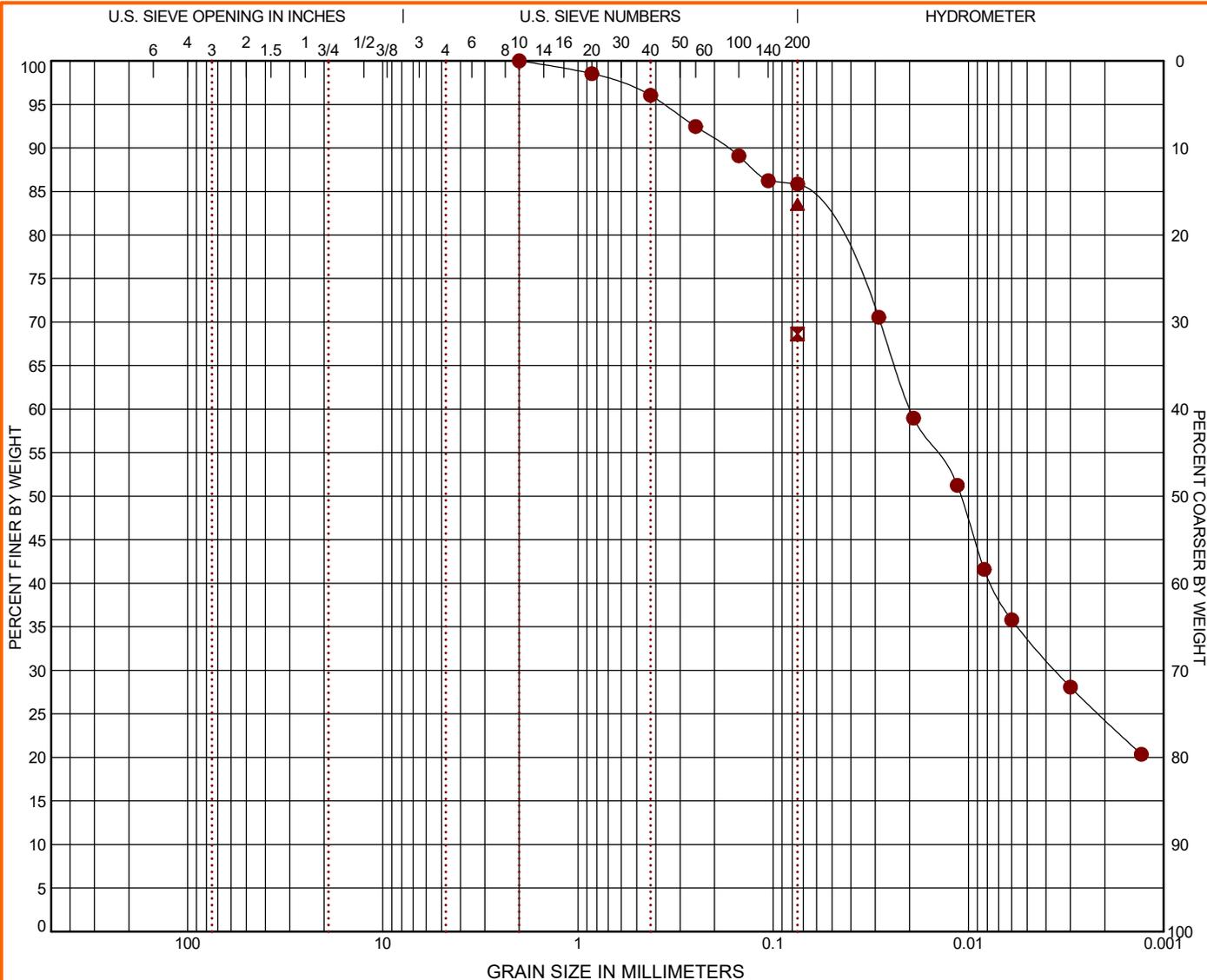
PROJECT NUMBER: 7323P100

CLIENT: HNTB

# GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: AASHTO DESC-1 S-13-130 THOMSON CREEK.GPJ TERRACON\_DATATEMPLATE.GDT 8/16/23



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	
0.0	0.0	0.0	14.1	52.1	33.8	

BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
● S-13-130-1	6.3 - 8.3	0.0	0.0	14.1	52.1	68.6	33.8	CL
☒ S-13-130-1	13.5 - 14.3					68.6		
▲ S-13-130-2	0.3 - 1.8					83.5		CL

GRAIN SIZE			
	●	☒	▲
D <sub>60</sub>	0.02		
D <sub>30</sub>	0.004		
D <sub>10</sub>			
COEFFICIENTS			
	●	☒	▲
C <sub>c</sub>			
C <sub>u</sub>			

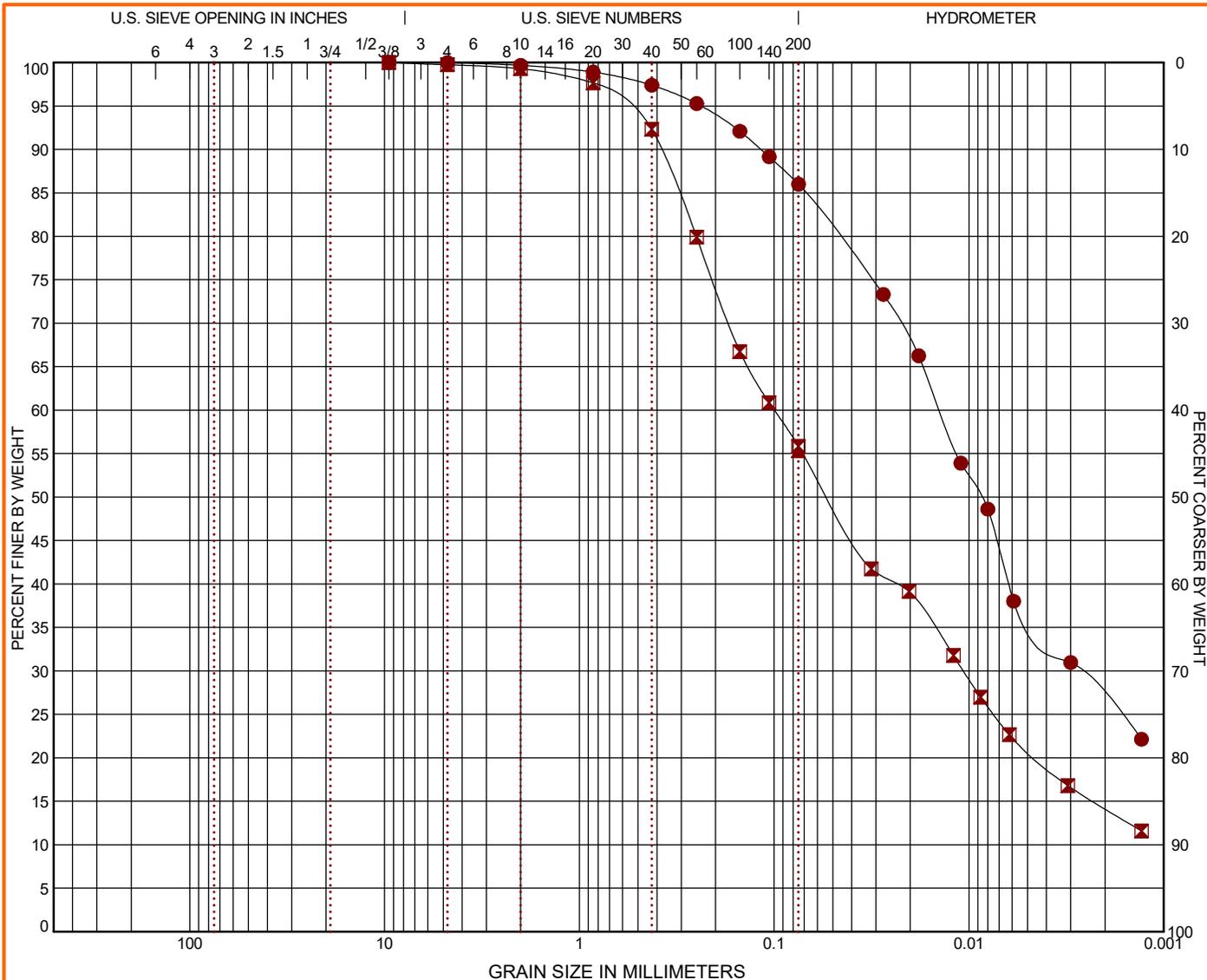
●		☒		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#10	100.0	#200	68.62	#200	83.52
#20	98.53				
#40	96.04				
#60	92.46				
#100	89.09				
#140	86.23				
#200	85.85				

SOIL DESCRIPTION	
●	A-6 (11)
☒	
▲	A-6 (17)
REMARKS	
●	
☒	
▲	

PROJECT: S-13-130 BRO Clay Creek	 521 Clemson Rd Columbia, SC	PROJECT NUMBER: 7323P100
SITE: Chesterfield County, SC		CLIENT: HNTB

# GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
● S-13-130-2	6 - 8	0.0	0.0	14.0	49.7		36.3	CL
☒ S-13-130-2	8 - 10	0.0	0.3	43.9	35.0		20.8	
▲ S-13-130-2	18.5 - 20					55.2		

GRAIN SIZE			
	●	☒	▲
D <sub>60</sub>	0.014	0.1	
D <sub>30</sub>	0.003	0.011	
D <sub>10</sub>			

●		☒		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
3/8"	100.0	3/8"	100.0	#200	55.22
#4	99.97	#4	99.73		
#10	99.66	#10	99.29		
#20	98.89	#20	97.66		
#40	97.39	#40	92.31		
#60	95.27	#60	79.91		
#100	92.09	#100	66.74		
#140	89.15	#140	60.86		
#200	86.0	#200	55.85		

SOIL DESCRIPTION	
●	A-6 (16)
☒	
▲	

COEFFICIENTS			
	●	☒	▲
C <sub>c</sub>			
C <sub>u</sub>			

REMARKS	
●	
☒	
▲	

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: AASHTO DESC-1 S-13-130 THOMSON CREEK.GPJ TERRACON\_DATATEMPLATE.GDT 8/16/23

PROJECT: S-13-130 BRO Clay Creek  
SITE: Chesterfield County, SC



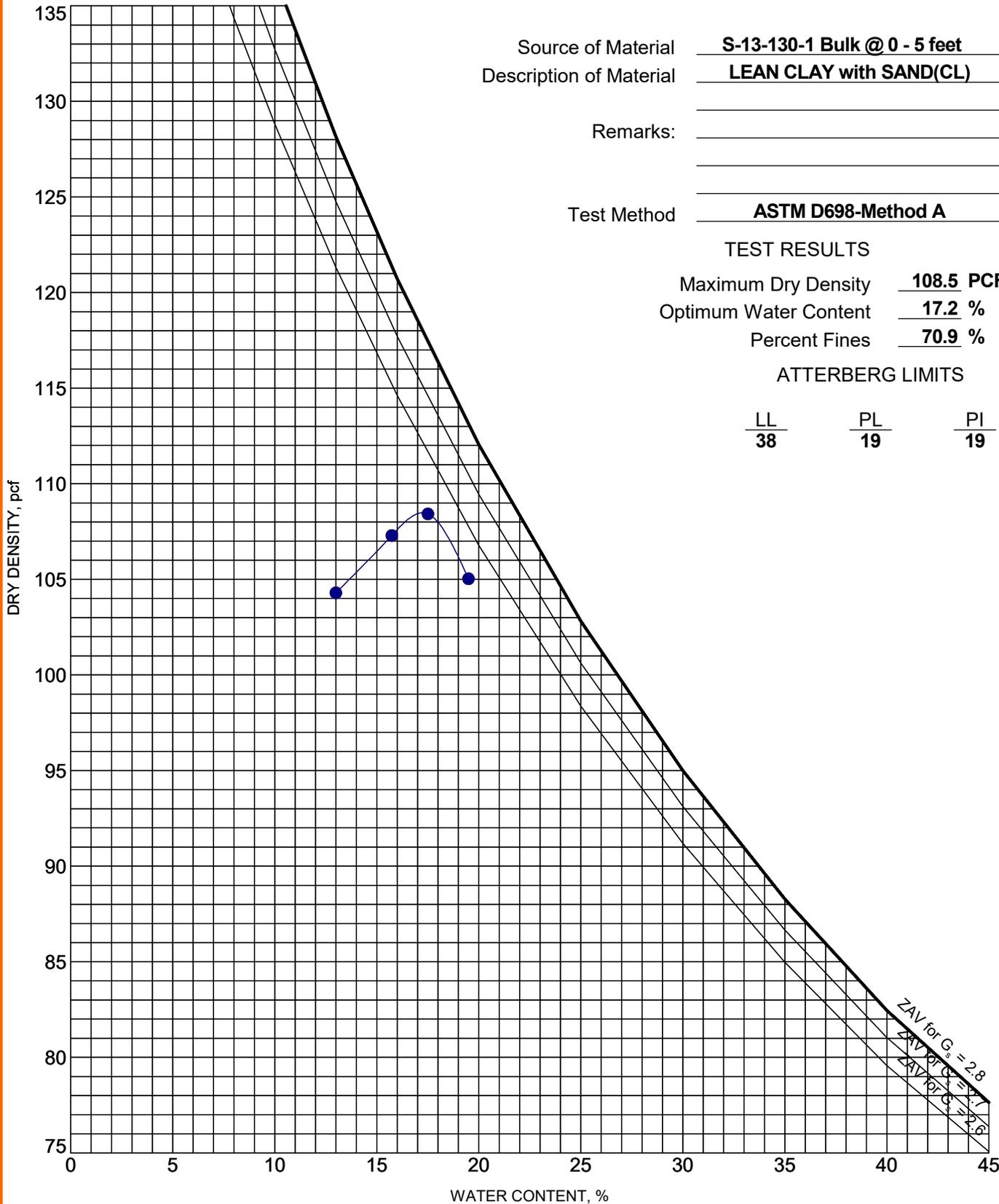
PROJECT NUMBER: 7323P100  
CLIENT: HNTB



# MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTON - V2 S-13-130 THOMSON CREEK.GPJ TERRACON\_DATATEMPLATE.GDT 8/16/23



Source of Material S-13-130-1 Bulk @ 0 - 5 feet  
 Description of Material LEAN CLAY with SAND(CL)  
 Remarks: \_\_\_\_\_  
 Test Method ASTM D698-Method A

PROJECT: S-13-130 BRO Clay Creek

SITE: Chesterfield County, SC



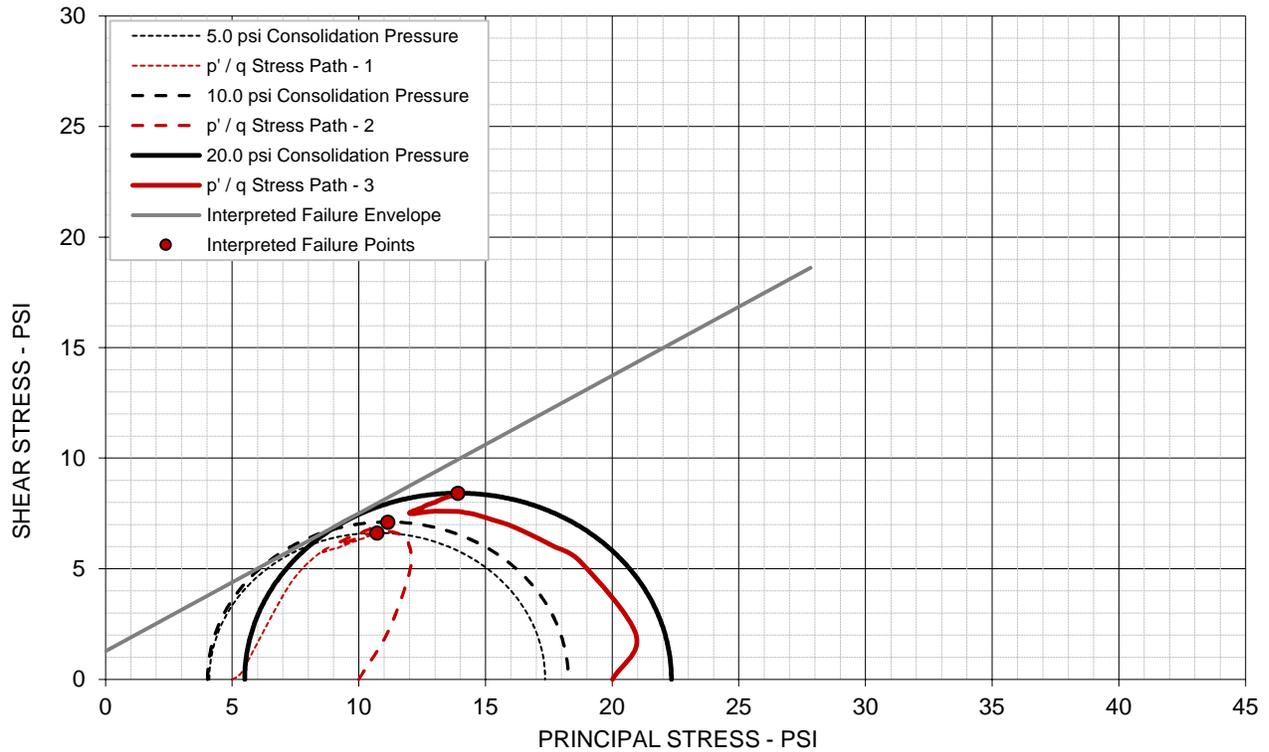
PROJECT NUMBER: 7323P100

CLIENT: HNTB

# ICU TRIAXIAL COMPRESSION TEST

## ASTM D4767 / AASHTO T297

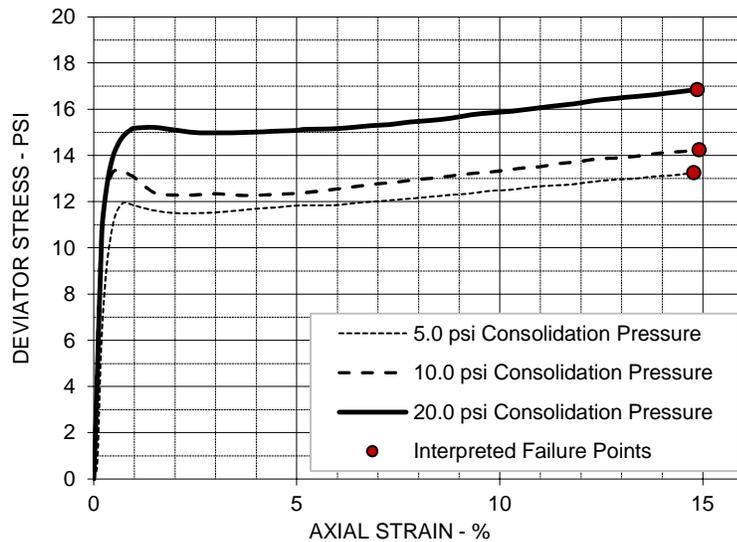
Failure Criteria: Max Deviator Stress



### EFFECTIVE STRESS PARAMETERS

$\phi' = 31.9 \text{ deg}$

$c' = 1.3 \text{ psi}$



SPECIMEN NO.	1	2	3
INITIAL			
Moisture Content - %	17.1	17.1	17.1
Dry Density - pcf	103.1	103.2	103.2
Diameter - inches	2.86	2.86	2.86
Height - inches	6.00	6.00	6.00
AT TEST			
Final Moisture - %	21.7	21.1	20.5
Dry Density - pcf	103.2	103.6	104.3
Calculated Diameter (in.)	2.84	2.85	2.83
Height - inches	5.97	5.98	5.94
Effect. Consol. Stress - psi	5.0	10.0	20.0
Failure Stress - psi	13.26	14.24	16.84
Total Pore Pressure - psi	80.9	86.0	94.5
Strain Rate - %/min.	0.0334	0.0331	0.0336
Failure Strain - %	14.8	14.9	14.9
$\sigma_1'$ Failure - psi	17.35	18.26	22.33
$\sigma_3'$ Failure - psi	4.09	4.03	5.49

### TEST DESCRIPTION

ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION

SAMPLE TYPE: Remolded

DESCRIPTION: Lean Clay with Sand (CL) / A-6 (12)

SAMPLE ID: S-13-130-1 Bulk 0-5'

SPECIFIC GRAVITY: 2.65

LL: 38 PL: 19 PI: 19 Percent -200: 70.9%

Remarks: Remolded to 95% of the Standard Proctor

### PROJECT INFORMATION

PROJECT: S-13-130 BRO Clay Creek

LOCATION: Chesterfield County, SC

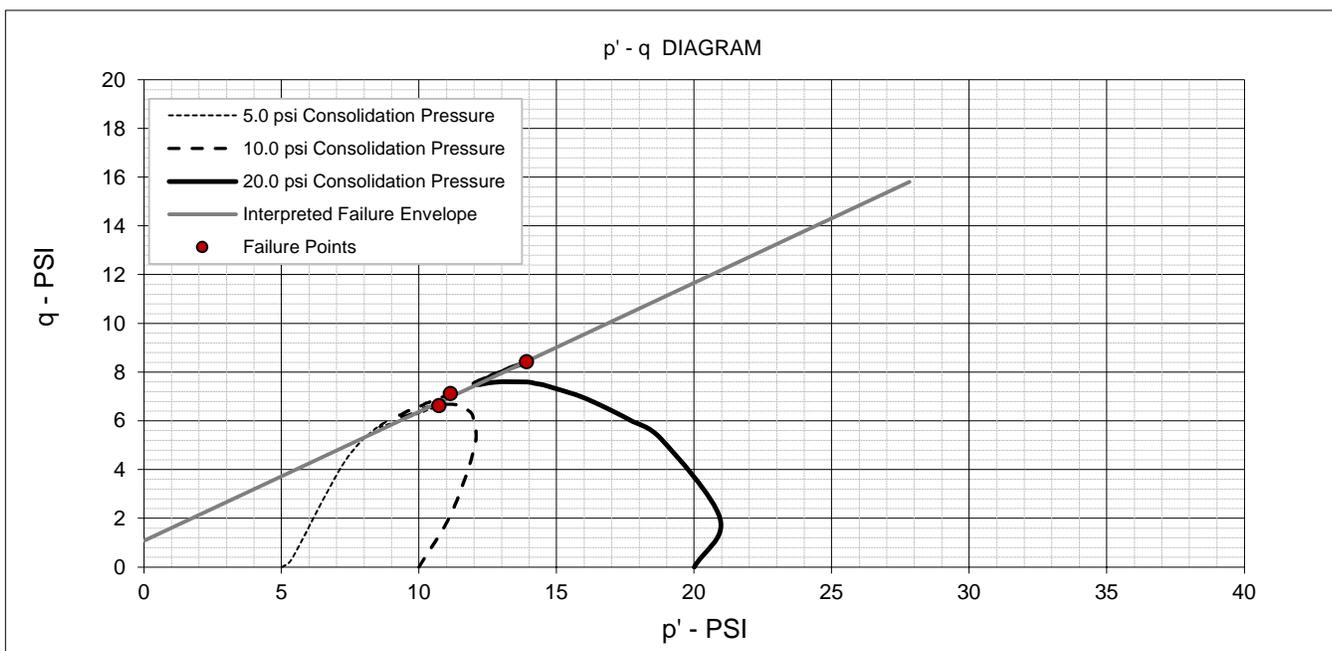
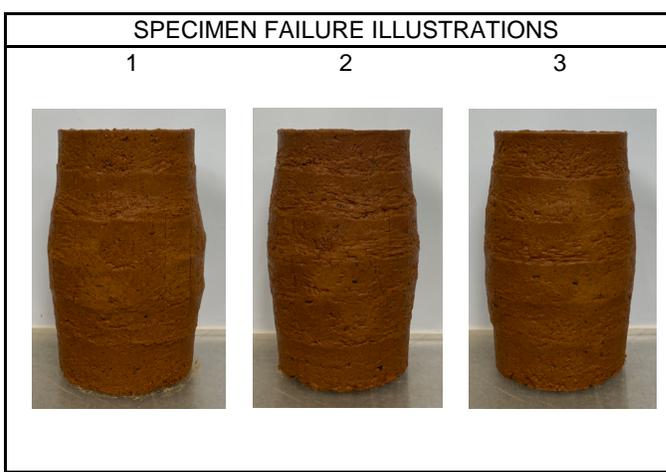
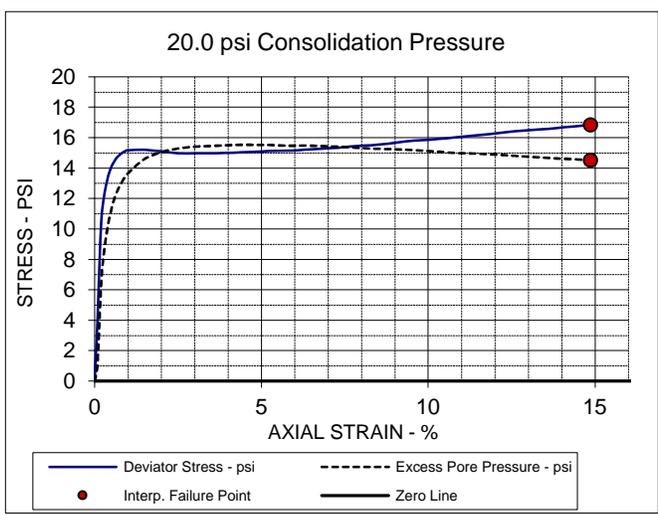
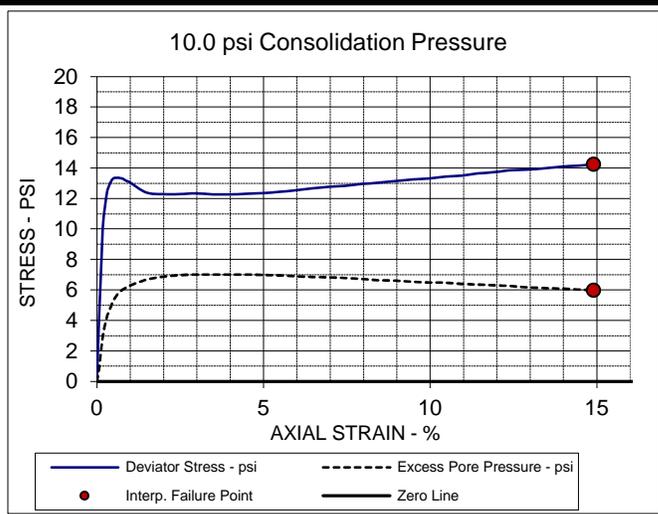
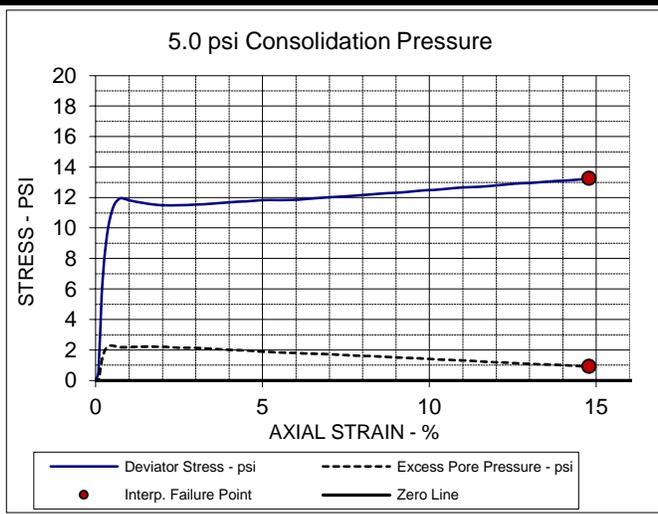
PROJECT #: 7323P100

CLIENT: HNTB

DATE: 07/12/23

521 Clemson Road  
Columbia, SC



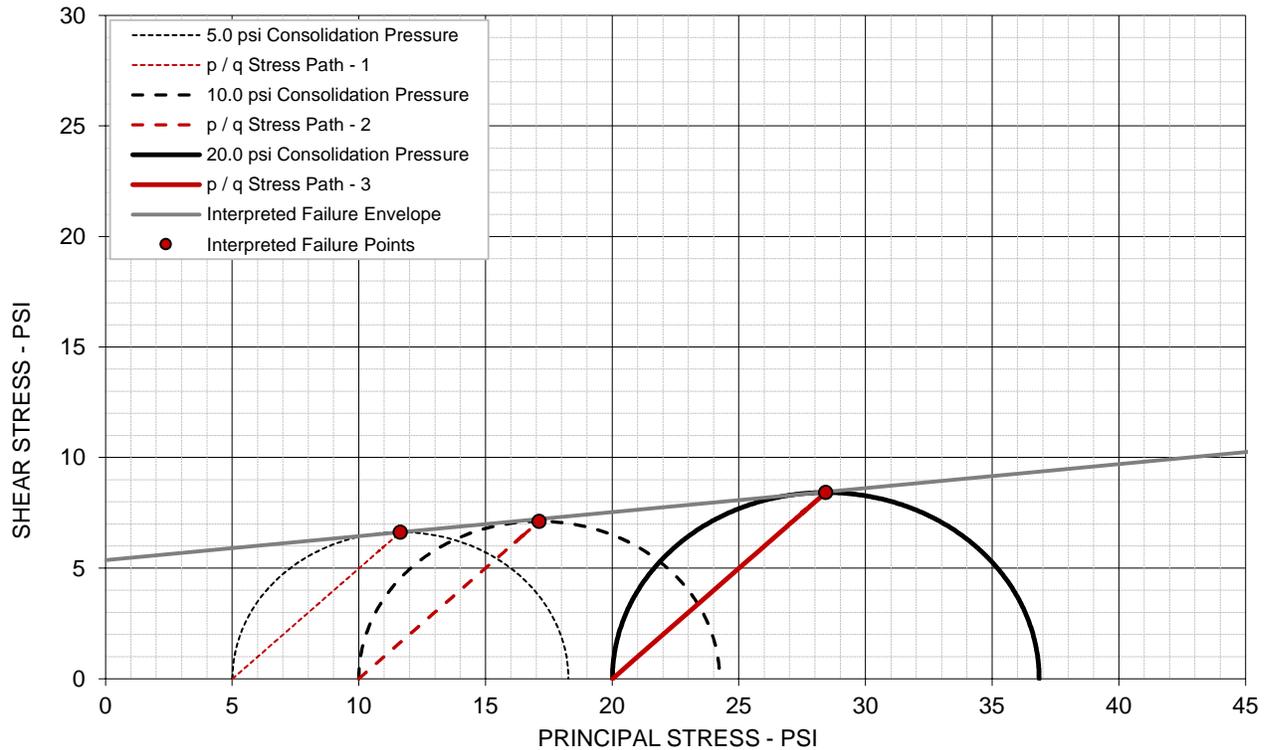


<b>EFFECTIVE STRESS PARAMETERS</b>		$R^2 = 0.99$	$\alpha = 27.9 \text{ deg}$	$a = 1.1 \text{ psi}$
PROJECT: S-13-130 BRO Clay Creek		ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION TEST		
LOCATION: Chesterfield County, SC		CLIENT: HNTB		
SAMPLE ID: S-13-130-1 Bulk 0-5'		521 Clemson Road		
DESCRIPTION: Lean Clay with Sand (CL) / A-6 (12)		Columbia, SC		

# ICU TRIAXIAL COMPRESSION TEST

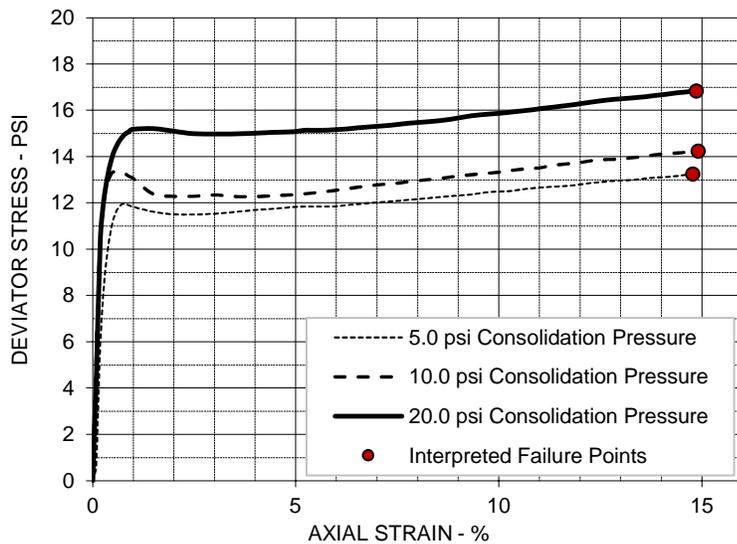
## ASTM D4767 / AASHTO T297

Failure Criteria: Max Deviator Stress



### TOTAL STRESS PARAMETERS

$\phi = 6.2$  deg       $c = 5.4$  psi



SPECIMEN NO.	1	2	3
INITIAL			
Moisture Content - %	17.1	17.1	17.1
Dry Density - pcf	103.1	103.2	103.2
Diameter - inches	2.86	2.86	2.86
Height - inches	6.00	6.00	6.00
AT TEST			
Final Moisture - %	21.7	21.1	20.5
Dry Density - pcf	103.2	103.6	104.3
Calculated Diameter (in.)	2.84	2.85	2.83
Height - inches	5.97	5.98	5.94
Effect. Consol. Stress - psi	5.0	10.0	20.0
Failure Stress - psi	13.26	14.24	16.84
Total Pore Pressure - psi	80.9	86.0	94.5
Strain Rate - %/min.	0.0334	0.0331	0.0336
Failure Strain - %	14.8	14.9	14.9
$\sigma_1$ Failure - psi	18.27	24.23	36.85
$\sigma_3$ Failure - psi	5.01	9.99	20.01

### TEST DESCRIPTION

ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION

SAMPLE TYPE: Remolded

DESCRIPTION: Lean Clay with Sand (CL) / A-6 (12)

SAMPLE ID: S-13-130-1 Bulk 0-5'

SPECIFIC GRAVITY: 2.65

LL: 38      PL: 19      PI: 19      Percent -200: 70.9%

Remarks: Remolded to 95% of the Standard Proctor

### PROJECT INFORMATION

PROJECT: S-13-130 BRO Clay Creek

LOCATION: Chesterfield County, SC

PROJECT #: 7323P100

CLIENT: HNTB

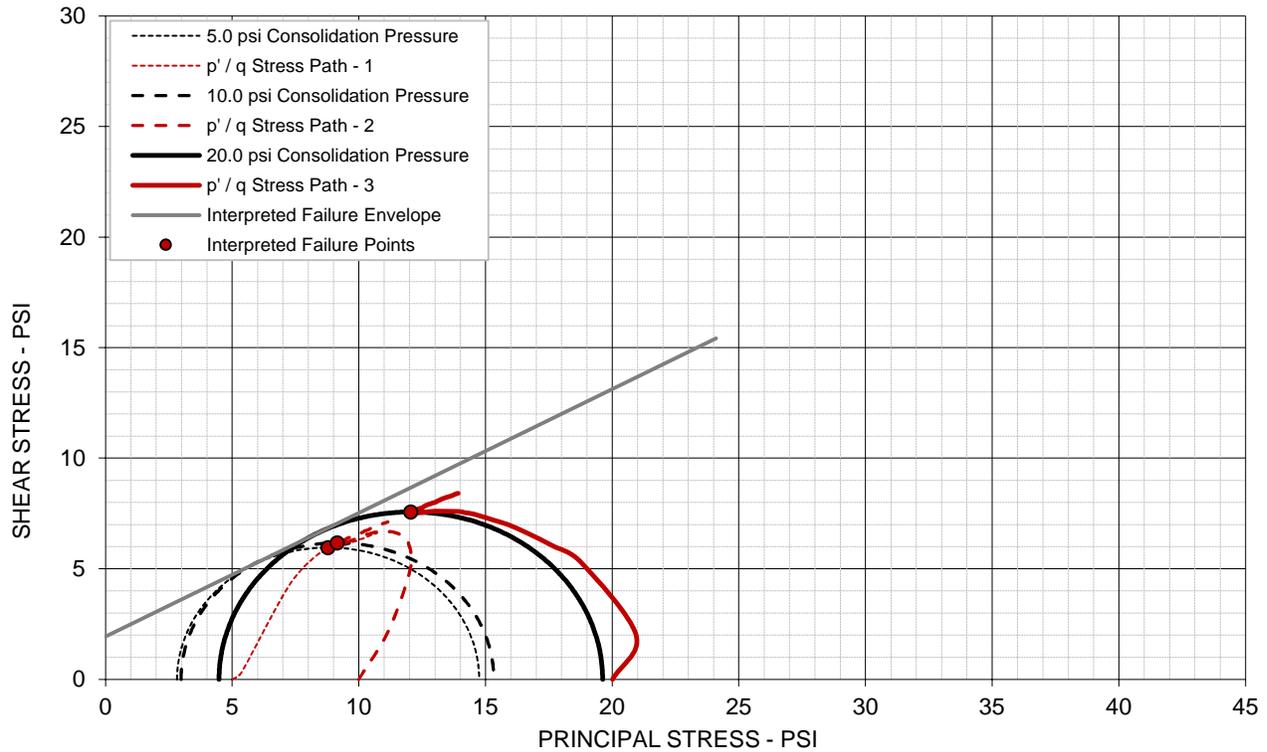
DATE: 07/12/23

521 Clemson Road  
Columbia, SC



# ICU TRIAXIAL COMPRESSION TEST ASTM D4767 / AASHTO T297

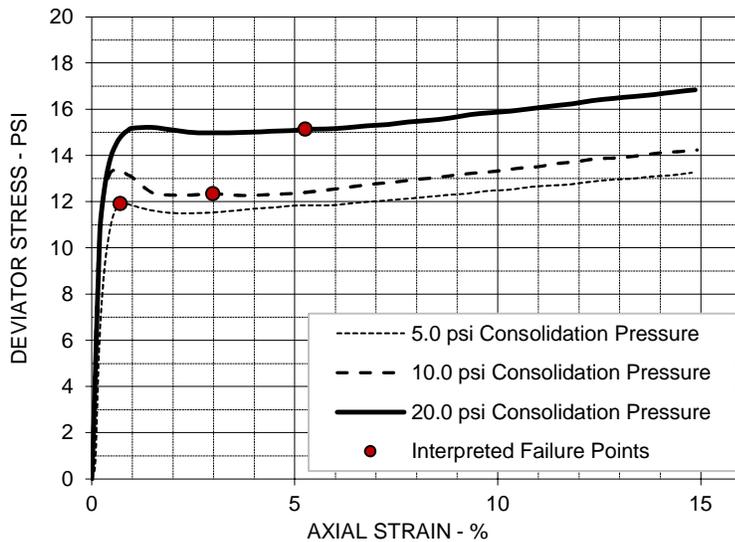
Failure Criteria: Max Obliquity ( $s_1': s_3'$ )



### EFFECTIVE STRESS PARAMETERS

$\phi' = 29.2$  deg

$c' = 1.9$  psi



SPECIMEN NO.	1	2	3
INITIAL			
Moisture Content - %	17.1	17.1	17.1
Dry Density - pcf	103.1	103.2	103.2
Diameter - inches	2.86	2.86	2.86
Height - inches	6.00	6.00	6.00
AT TEST			
Final Moisture - %	21.7	21.1	20.5
Dry Density - pcf	103.2	103.6	104.3
Calculated Diameter (in.)	2.84	2.85	2.83
Height - inches	5.97	5.98	5.94
Effect. Consol. Stress - psi	5.0	10.0	20.0
Failure Stress - psi	11.92	12.35	15.14
Total Pore Pressure - psi	82.2	87.0	95.5
Strain Rate - %/min.	0.0334	0.0331	0.0336
Failure Strain - %	0.7	3.0	5.3
$\sigma_1'$ Failure - psi	14.75	15.33	19.62
$\sigma_3'$ Failure - psi	2.82	2.98	4.48

### TEST DESCRIPTION

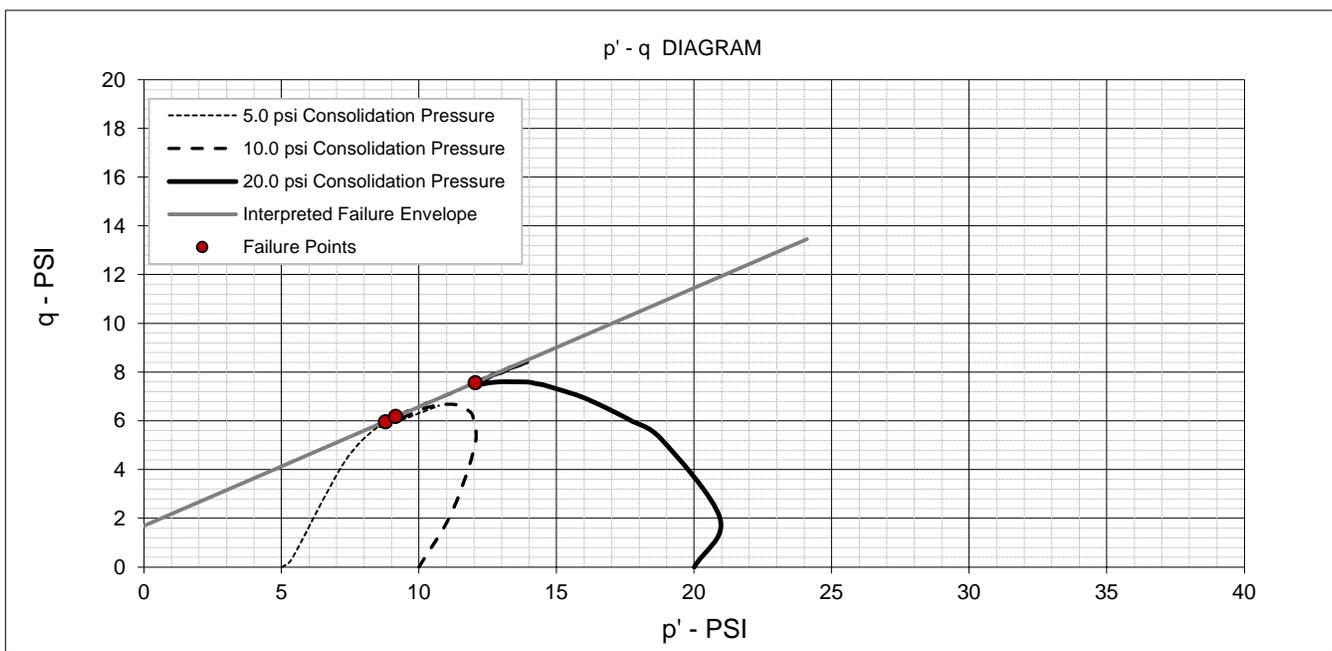
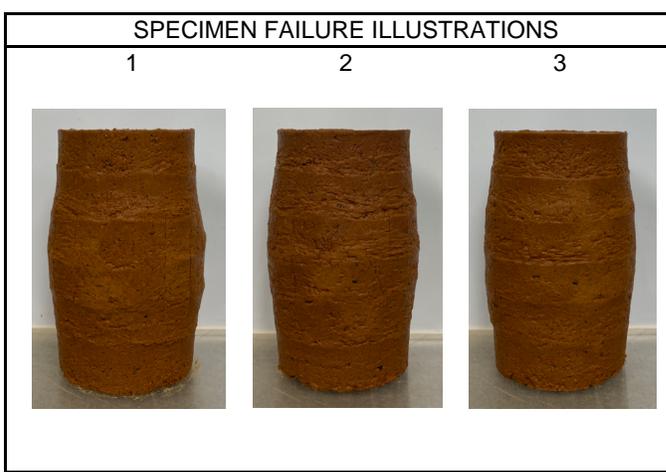
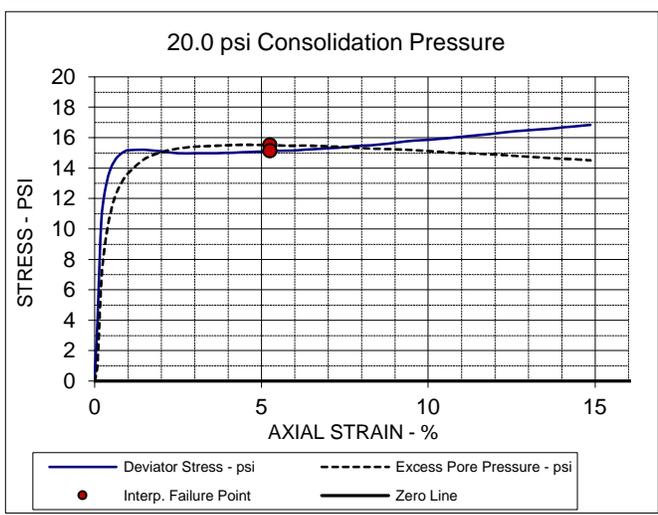
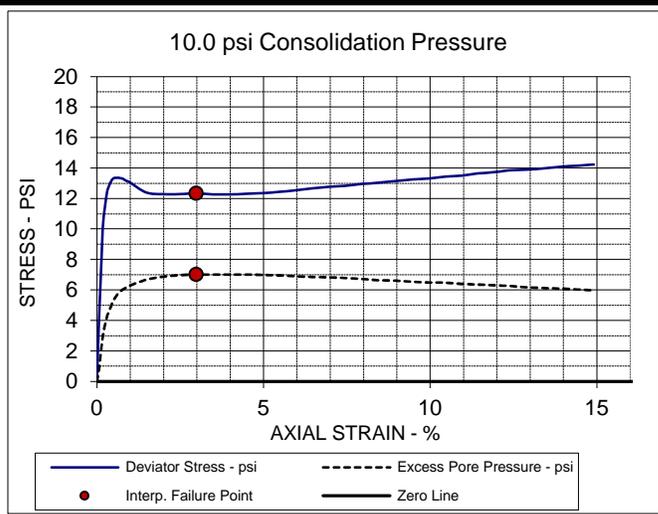
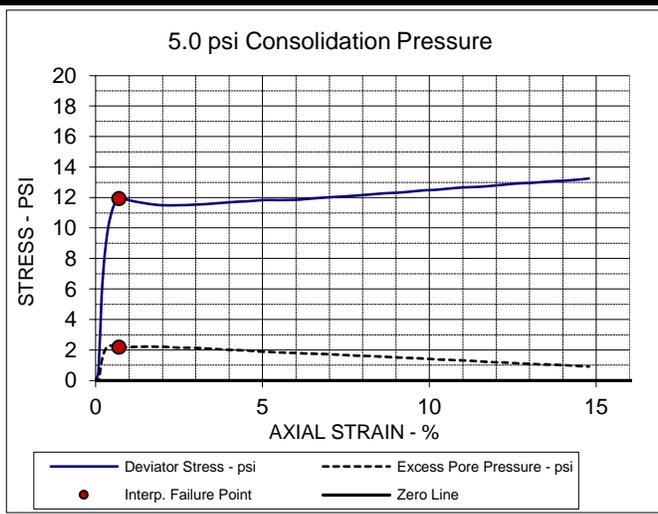
ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION  
 SAMPLE TYPE: Remolded  
 DESCRIPTION: Lean Clay with Sand (CL) / A-6 (12)  
 SAMPLE ID: S-13-130-1 Bulk 0-5'  
 SPECIFIC GRAVITY: 2.65  
 LL: 38 PL: 19 PI: 19 Percent -200: 70.9%  
 Remarks: Remolded to 95% of the Standard Proctor

### PROJECT INFORMATION

PROJECT: S-13-130 BRO Clay Creek  
 LOCATION: Chesterfield County, SC  
 PROJECT #: 7323P100  
 CLIENT: HNTB  
 DATE: 07/12/23

521 Clemson Road  
 Columbia, SC

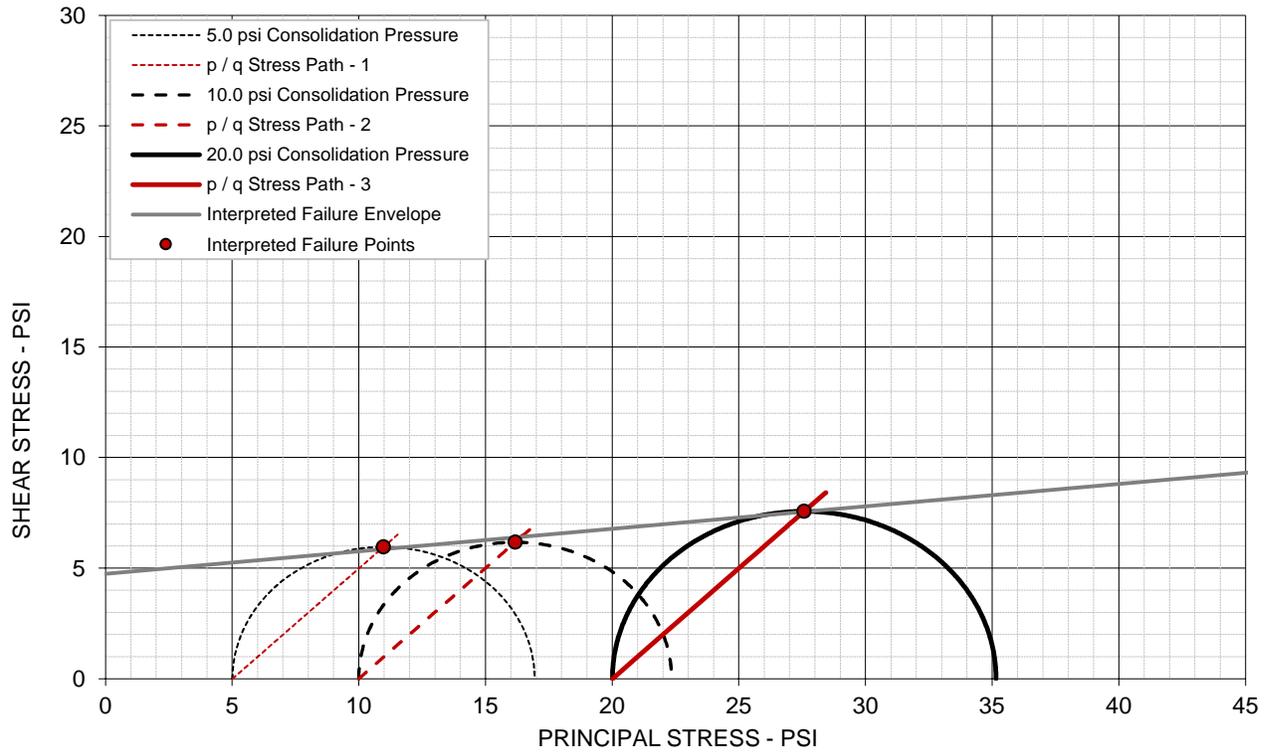




EFFECTIVE STRESS PARAMETERS		$R^2 = 1.00$	$\alpha = 26.0 \text{ deg}$	$a = 1.7 \text{ psi}$
PROJECT: S-13-130 BRO Clay Creek		ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION TEST		
LOCATION: Chesterfield County, SC		CLIENT: HNTB		
SAMPLE ID: S-13-130-1 Bulk 0-5'		521 Clemson Road		
DESCRIPTION: Lean Clay with Sand (CL) / A-6 (12)		Columbia, SC		

## ICU TRIAXIAL COMPRESSION TEST ASTM D4767 / AASHTO T297

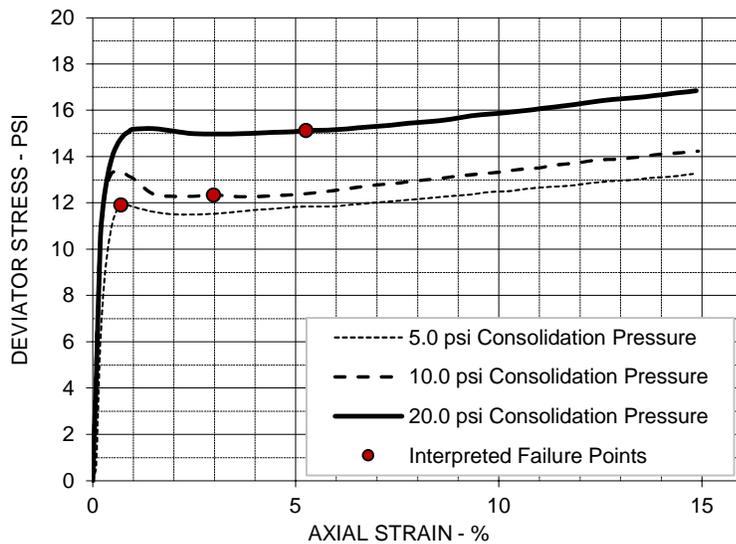
Failure Criteria: Max Obliquity (s1': s3')



### TOTAL STRESS PARAMETERS

$\phi = 5.8$  deg

$c = 4.8$  psi



SPECIMEN NO.	1	2	3
INITIAL			
Moisture Content - %	17.1	17.1	17.1
Dry Density - pcf	103.1	103.2	103.2
Diameter - inches	2.86	2.86	2.86
Height - inches	6.00	6.00	6.00
AT TEST			
Final Moisture - %	21.7	21.1	20.5
Dry Density - pcf	103.2	103.6	104.3
Calculated Diameter (in.)	2.84	2.85	2.83
Height - inches	5.97	5.98	5.94
Effect. Consol. Stress - psi	5.0	10.0	20.0
Failure Stress - psi	11.92	12.35	15.14
Total Pore Pressure - psi	82.2	87.0	95.5
Strain Rate - %/min.	0.0334	0.0331	0.0336
Failure Strain - %	0.7	3.0	5.3
$\sigma_1$ Failure - psi	16.94	22.34	35.15
$\sigma_3$ Failure - psi	5.01	9.99	20.01

### TEST DESCRIPTION

ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION

SAMPLE TYPE: Remolded

DESCRIPTION: Lean Clay with Sand (CL) / A-6 (12)

SAMPLE ID: S-13-130-1 Bulk 0-5'

SPECIFIC GRAVITY: 2.65

LL: 38 PL: 19 PI: 19 Percent -200: 70.9%

Remarks: Remolded to 95% of the Standard Proctor

### PROJECT INFORMATION

PROJECT: S-13-130 BRO Clay Creek

LOCATION: Chesterfield County, SC

PROJECT #: 7323P100

CLIENT: HNTB

DATE: 07/12/23

521 Clemson Road  
Columbia, SC



---

**Client**

HNTB North Carolina PC  
Raleigh, NC

**Project**

S-13-130 BRO Clay Creek  
7323P100

**Date Received:** 6/27/2023

---

**Results from Corrosion Testing**

---

<b>Sample Location</b>	S-13-130-1
<b>Sample Depth (ft.)</b>	0'-10'

pH Analysis, ASTM G 51	6.63
------------------------	------

Water Soluble Sulfate (SO <sub>4</sub> ), ASTM D516-07 (mg/kg)	12
---	----

Chlorides, APHA 4500-Cl <sup>-</sup> E, (mg/kg)	24
---	----

Resistivity (Saturated), ASTM G 57, (ohm-cm)	5300
--	------

---

**Analyzed By:** Kyle Lemcke  
Laboratory Manager

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.

## **Appendix C**

### **Supporting Documents**

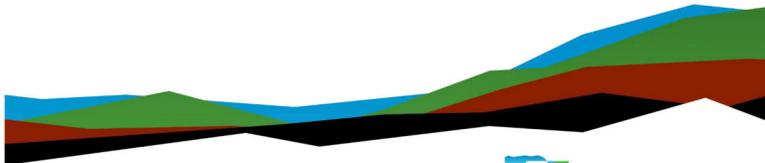
Rig Calibration Report (5 Pages)

Note: All exhibits are one page unless noted above.

# SPT Automatic Hammer Energy Measurement Report

Drill Rig Model: Diedrich D-50  
 Drill Rig Serial Number: D50-479  
 Asset Number: DR#1109

July 3, 2023



**Prepared for:**

Terracon Consultants, Inc.  
 Columbia, South Carolina



## MEASUREMENT SUMMARY

ITEM	DESCRIPTION
<b>Drill Rig Owner</b>	Terracon Consultant, Inc. – Columbia, SC
<b>Drill Rig Operator</b>	Shiver Truesdale; Terracon Exploration
<b>Testing Date</b>	07/03/2023
<b>Testing Location</b>	Columbia, SC
<b>Boring Identification</b>	B-1
<b>Hammer Type</b>	140 pounds (automatic)
<b>Boring Method</b>	Rotary Wash
<b>Drill Rods</b>	<ul style="list-style-type: none"> <li>■ AWJ</li> <li>■ 1-3/4" outside diameter</li> <li>■ 3/16" wall thickness</li> </ul>
<b>Calibration Testing Equipment</b>	<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>
<b>ASTM Methods Used</b>	<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>
<b>SPT Calibration Personnel</b>	Micah Hatch– Department Manager, Terracon Consultants, Inc.

July 03, 2023

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

Attn: Chris Costner  
 E: chris.costner@terracon.com

**Re:** SPT Automatic Hammer Energy Measurement Report  
 Rig Serial Number: D50-479 Terracon Project Number: DUXX0500

Dear Mr. Costner:

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)
Diedrich D50	D50-479	2021	DR#1109	93.9% ± 2.3%	1.57

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

James P. Smith  
 National Manager of Equipment & Training

Rob Kramer  
 Geophysical Services Manager, COG

**Attachments:**

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

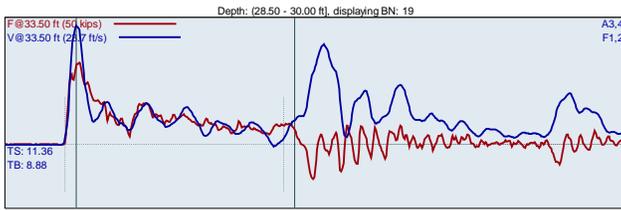
## Exhibit A PDA SPT Analyzer Results

Diedrich D50 (SN 479)  
M. Hatch  
B-13 (PN 73235076)

28.5-30  
Interval start: 7/3/2023

AR: 1.18 in/2  
LE: 33.50 ft  
WS: 16807.9 fts

SP: 0.492 k/ft<sup>3</sup>  
EM: 30000 ksi



F1 : [512AWJ] 207.75 PDICAL (1) FF1  
F2 : [512AWJ2] 208.76 PDICAL (1) FF1

A3 (PR): [K5998] 403.535 mw/6.4w/5000g (1) VF1  
A4 (PR): [K10493] 411.89 mw/6.4w/5000g (1) VF1

BL#	BC /6"	FMX kips	VMX fts	BPM bpm	EFV ft-lb	ETR %
3	6	32	23.8	48.1	315	89.9
4	6	34	23.8	47.8	319	91.3
5	6	32	23.5	48.4	316	90.4
6	6	32	23.3	47.8	324	92.5
7	6	32	23.0	48.3	325	92.8
8	6	32	22.2	48.2	316	90.4
9	6	32	22.0	47.7	324	92.7
10	6	32	22.7	48.5	324	92.7
11	6	32	21.6	47.9	326	93.3
12	6	31	21.3	48.4	326	93.1
13	9	32	21.7	47.7	329	94.1
14	9	32	22.1	48.0	328	93.3
15	9	32	21.8	47.9	331	94.7
16	9	31	21.7	48.2	329	93.9
17	9	32	21.8	48.1	334	95.4
18	9	33	22.2	47.5	338	96.5
19	9	32	22.1	48.4	340	97.1
20	9	32	22.2	48.1	328	93.2
21	9	32	22.7	47.8	332	94.8
Average		32	22.1	48.1	329	93.9
Std Dev		0	0.4	0.3	6	1.6
Maximum		33	23.0	48.5	340	97.1
Minimum		31	21.3	47.5	316	90.4
N-value: 15						

Sample Interval Time: 22.48 seconds.

Average	32	20.9	48.1	318	90.7
Std Dev	1	1.0	0.2	6	1.7
Maximum	33	22.3	48.3	327	93.5
Minimum	30	19.2	47.7	302	86.2
N-value: 21					

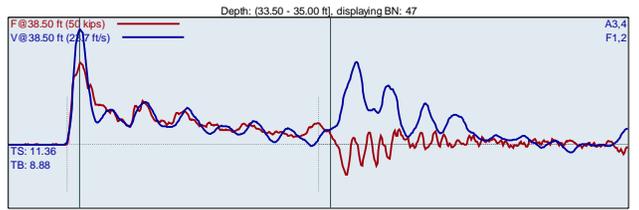
Sample Interval Time: 32.40 seconds.

Diedrich D50 (SN 479)  
M. Hatch  
B-13 (PN 73235076)

28.5-30  
Interval start: 7/3/2023

AR: 1.18 in/2  
LE: 38.50 ft  
WS: 16807.9 fts

SP: 0.492 k/ft<sup>3</sup>  
EM: 30000 ksi



F1 : [512AWJ] 207.75 PDICAL (1) FF1  
F2 : [512AWJ2] 208.76 PDICAL (1) FF1

A3 (PR): [K5998] 403.535 mw/6.4w/5000g (1) VF1  
A4 (PR): [K10493] 411.89 mw/6.4w/5000g (1) VF1

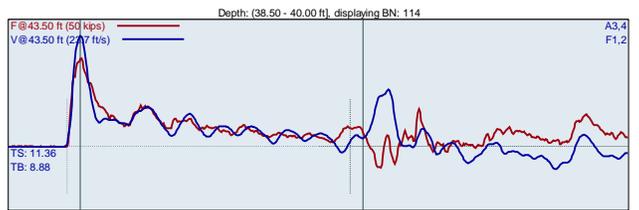
BL#	BC /6"	FMX kips	VMX fts	BPM bpm	EFV ft-lb	ETR %
23	7	32	19.5	48.3	314	89.7
24	7	31	19.4	48.4	305	87.0
25	7	31	19.9	48.1	311	88.9
26	7	31	19.4	48.2	310	88.6
27	7	31	19.5	48.0	311	88.8
28	7	31	19.9	48.1	310	88.7
29	9	31	19.6	48.0	314	89.8
30	9	32	19.8	48.3	314	89.7
31	9	30	19.2	48.0	309	88.3
32	9	31	19.7	48.2	313	89.5
33	9	31	19.6	47.9	313	89.5
34	9	30	19.3	48.0	310	88.7
35	9	32	21.2	48.3	319	91.2
36	9	32	21.3	48.3	321	91.7
37	9	33	22.0	48.1	327	93.5
38	12	32	20.4	48.2	302	86.2
39	12	32	21.6	47.9	319	91.2
40	12	32	21.1	47.9	321	91.7
41	12	31	20.4	48.0	311	88.9
42	12	31	20.9	48.1	324	92.6
43	12	32	21.8	48.0	322	92.1
44	12	32	22.3	48.1	323	92.3
45	12	32	21.4	48.1	317	90.6
46	12	32	21.8	48.2	323	92.4
47	12	32	21.5	48.2	322	92.0
48	12	33	22.0	48.2	320	91.4
49	12	32	21.8	47.7	322	92.1

Diedrich D50 (SN 479)  
M. Hatch  
B-13 (PN 73235076)

28.5-30  
Interval start: 7/3/2023

AR: 1.18 in/2  
LE: 43.50 ft  
WS: 16807.9 fts

SP: 0.492 k/ft<sup>3</sup>  
EM: 30000 ksi



F1 : [512AWJ] 207.75 PDICAL (1) FF1  
F2 : [512AWJ2] 208.76 PDICAL (1) FF1

A3 (PR): [K5998] 403.535 mw/6.4w/5000g (1) VF1  
A4 (PR): [K10493] 411.89 mw/6.4w/5000g (1) VF1

BL#	BC /6"	FMX kips	VMX fts	BPM bpm	EFV ft-lb	ETR %
51	17	35	21.7	47.4	339	96.8
52	17	35	21.7	48.4	336	96.0
53	17	35	21.7	48.2	336	96.1
54	17	34	21.7	48.2	337	96.3
55	17	34	21.7	48.1	339	96.9
56	17	34	21.2	48.1	337	96.2
57	17	34	21.2	48.3	336	95.9
58	17	33	21.2	48.4	322	92.1
59	17	35	22.2	48.1	343	98.0
60	17	33	21.2	48.0	324	92.6
61	17	34	21.8	48.3	337	96.3
62	17	34	21.7	48.0	331	94.5
63	17	33	21.3	48.2	335	95.6
64	17	34	21.8	48.2	336	95.9
65	17	34	22.1	48.0	329	94.0
66	17	33	21.4	48.3	336	96.1
67	19	34	21.7	48.5	331	94.7
68	19	33	21.3	47.8	336	95.9
69	19	33	21.2	48.2	334	95.3
70	19	35	22.9	47.8	344	98.4
71	19	34	22.1	46.1	339	96.9
72	19	33	20.9	48.3	333	95.0
73	19	33	20.8	48.1	331	94.4
74	19	34	20.7	47.9	329	94.1
75	19	34	20.9	48.2	331	94.6
76	19	34	21.1	47.7	343	97.9
77	19	35	20.9	46.3	332	94.9
78	19	35	21.1	48.3	336	96.1
79	19	34	20.5	48.1	338	96.5
80	19	34	20.6	48.4	338	96.7
81	19	34	20.4	48.3	328	93.2

82	19	33	20.2	48.0	336	96.0
83	19	34	20.3	48.3	333	95.1
84	19	33	20.1	47.7	325	92.8
85	19	33	19.9	48.4	330	94.4
86	31	35	20.5	47.9	332	94.9
87	31	34	20.5	48.1	330	94.3
88	31	33	20.3	47.8	324	92.5
89	31	33	20.8	48.3	336	95.9
90	31	33	20.6	48.0	331	94.6
91	31	34	20.4	48.4	338	96.7
92	31	33	20.2	48.5	329	94.0
93	31	34	20.6	48.0	336	96.1
94	31	34	20.7	48.6	334	95.3
95	31	34	20.5	48.6	334	95.4
96	31	34	20.3	48.5	331	94.5
97	31	33	20.3	48.4	331	94.6
98	31	34	20.3	48.5	332	94.9
99	31	33	20.5	48.4	333	95.2
100	31	33	20.0	48.0	338	96.5
101	31	34	21.1	48.3	332	94.8
102	31	33	20.0	48.1	334	95.4
103	31	34	20.2	48.8	329	93.9
104	31	33	20.0	48.3	331	94.4
105	31	33	20.1	48.1	330	94.3
106	31	35	20.4	47.9	334	95.5
107	31	34	20.2	48.3	331	94.5
108	31	34	20.1	48.0	335	95.7
109	31	34	20.0	48.3	327	93.3
110	31	34	20.0	47.9	330	94.2
111	31	34	20.3	47.6	331	94.6
112	31	34	20.5	47.2	333	95.1
113	31	35	20.4	47.6	336	95.9
114	31	35	20.6	47.7	335	95.7
115	31	34	20.6	47.2	335	95.7
116	31	34	20.6	47.2	339	96.7
Average	34	34	20.6	48.1	333	95.2
Std Dev	1	0.6	0.4	4	1.2	
Maximum	35	22.9	48.8	344	98.4	
Minimum	33	19.9	47.2	324	92.5	

N-value: 50

Sample Interval Time: 81.06 seconds.

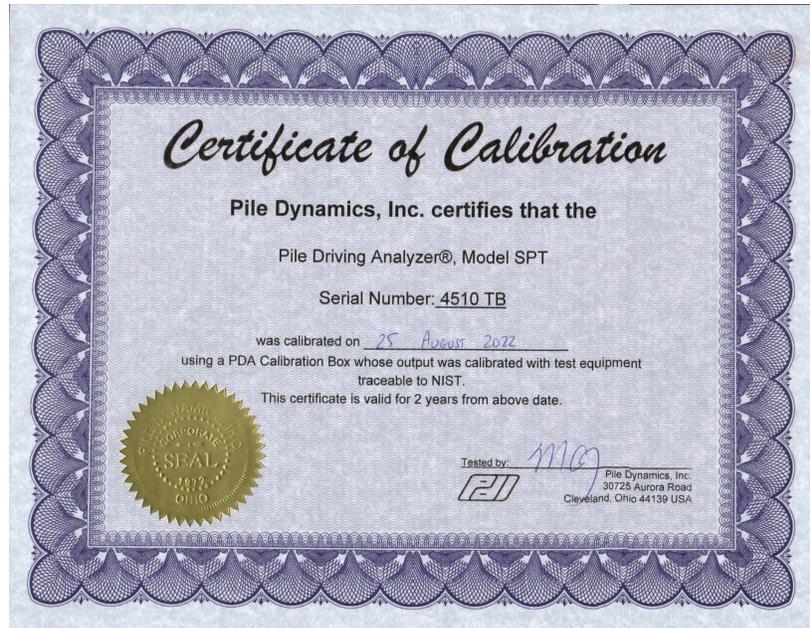
Summary of SPT Test Results

Project: Deditch D50 (SN 479), Test Date: 7/3/2023

BPM: Blows/Minute		N Value	N60 Value	Average FMX kips	Average VMX lbs	Average BPM bpm	Average EFV ft/lb	Average ETR %
Inst. Length ft	Blows Applied /ft							
33.50	6-6-9	15	23	32	22.1	48.1	329	93.9
38.50	7-8-12	21	32	32	20.9	48.1	318	90.7
43.50	17-19-31	50	78	34	20.6	48.1	333	95.2
<b>Overall Average Values:</b>				33	20.9	48.1	328	93.9
<b>Standard Deviation:</b>				1	0.9	0.3	8	2.3
<b>Overall Maximum Value:</b>				35	23.0	48.8	344	98.4
<b>Overall Minimum Value:</b>				30	19.2	47.2	302	96.2



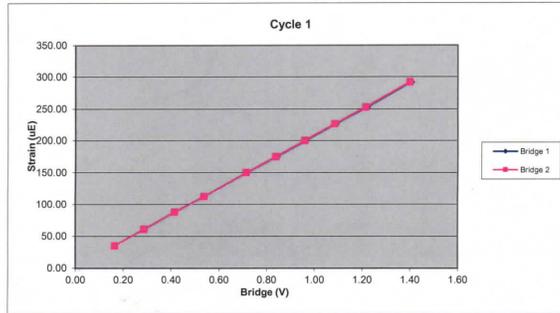
**Exhibit B**  
**PDA Equipment Calibration**



512AWJ		Cycle 1			
Sample	Force (lb)	Strain (µE)	Bridge 1 (V)	Bridge 2 (V)	
1	0.00	0.00	0.00	0.00	
2	1203.06	34.31	0.16	0.16	
3	2126.16	60.40	0.29	0.29	
4	3077.44	86.97	0.42	0.42	
5	3982.41	111.72	0.54	0.54	
6	5285.39	149.30	0.72	0.72	
7	6200.50	174.57	0.84	0.84	
8	7099.62	199.59	0.96	0.96	
9	8021.85	226.03	1.09	1.08	
10	8981.90	252.42	1.22	1.21	
11	10350.08	291.62	1.40	1.40	

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7371.63	Force Calibration (lb/V)	7404.01
Offset	-2.95	Offset	-5.32
Correlation	1.000000	Correlation	0.999999
Strain Calibration (µE/V)	207.13	Strain Calibration (µE/V)	208.04
Offset	0.34	Offset	0.27
Correlation	0.999991	Correlation	0.999992

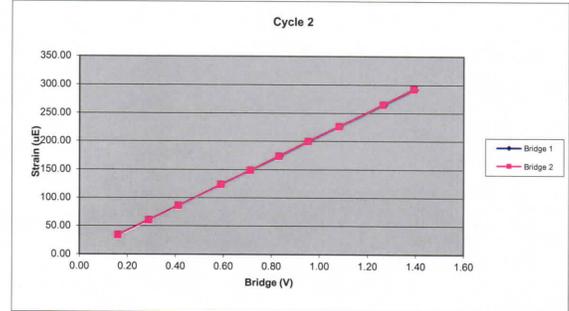
Force Strain Calibration	
EA (Kips)	35589.20
Offset	-14.99
Correlation	0.999992



512AWJ		Cycle 2			
Sample	Force (lb)	Strain (µE)	Bridge 1 (V)	Bridge 2 (V)	
1	0.00	0.00	0.00	0.00	
2	1195.16	33.02	0.16	0.16	
3	2140.49	59.36	0.29	0.29	
4	3060.77	84.68	0.41	0.41	
5	4361.31	122.48	0.59	0.59	
6	5276.03	147.78	0.71	0.71	
7	6152.73	172.65	0.83	0.83	
8	7048.15	198.82	0.96	0.95	
9	8008.49	225.14	1.08	1.08	
10	9364.20	264.06	1.27	1.26	
11	10320.35	291.14	1.40	1.39	

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7383.19	Force Calibration (lb/V)	7408.85
Offset	1.99	Offset	1.61
Correlation	0.999999	Correlation	1.000000
Strain Calibration (µE/V)	209.13	Strain Calibration (µE/V)	209.86
Offset	-1.28	Offset	-1.29
Correlation	0.999988	Correlation	0.999991

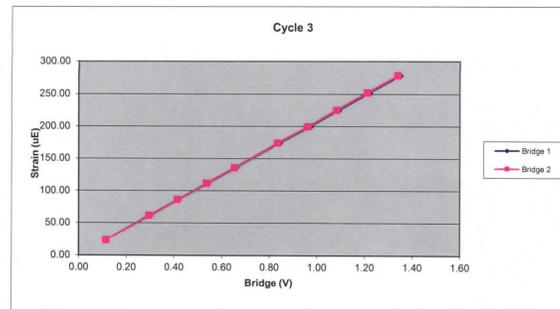
Force Strain Calibration	
EA (Kips)	35302.85
Offset	47.38
Correlation	0.999989



512AWJ		Cycle 3			
Sample	Force (lb)	Strain (µE)	Bridge 1 (V)	Bridge 2 (V)	
1	0.00	0.00	0.00	0.00	
2	843.37	22.72	0.11	0.11	
3	2199.17	60.67	0.30	0.29	
4	3069.54	85.62	0.42	0.41	
5	3979.10	110.64	0.54	0.54	
6	4849.18	135.11	0.66	0.65	
7	6197.28	173.33	0.84	0.84	
8	7134.13	198.98	0.97	0.96	
9	8033.64	224.83	1.09	1.08	
10	8976.83	251.64	1.22	1.21	
11	9937.94	277.86	1.35	1.34	

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7369.64	Force Calibration (lb/V)	7419.12
Offset	-2.56	Offset	0.17
Correlation	0.999999	Correlation	0.999999
Strain Calibration (µE/V)	206.99	Strain Calibration (µE/V)	208.38
Offset	-1.03	Offset	-0.95
Correlation	0.999995	Correlation	0.999995

Force Strain Calibration	
EA (Kips)	35602.66
Offset	34.21
Correlation	0.999994



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

Calibration Factors		512AWJ	
Bridge 1 (µE/V)	207.75	Bridge 2 (µE/V)	208.76
EA Factor (Kips)	35498.24	Area (in <sup>2</sup> )	1.18

Calibrated by: *Sean D...*  
Calibrated Date: 8/31/2022

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 03Aug2022

Serial No: K5998      Temperature: 74.7 °F  
 Model: PR      Humidity: 53%  
 Calibrated on: Channel 3 on 8G 5161 LE

**PDA CALIBRATION FACTOR**  
**403.5 mv/5000g**  
 (80.7  $\mu$ v/g)  
 R<sup>2</sup>: 0.999911 [Chip programmed]

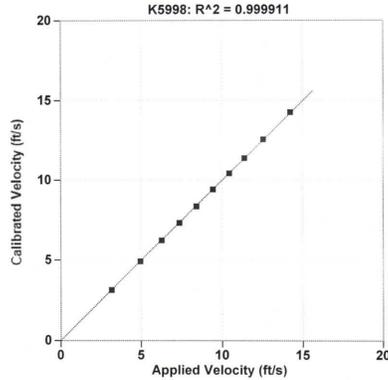
Operator: William Johnson

*William Johnson*  
 Signed

Ref Acc 1: 72505!      Cal on: 24Mar2022  
 1035 g/s/volt

Ref Acc 2: 72517!      Cal on: 24Mar2022  
 1049 g/s/volt

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



**Accelerometer Calibration Certificate**  
**Pile Dynamics, Inc.**



Calibrated by Pile Dynamics, Inc.  
 Calibration performed on 03Aug2022

Serial No: K10493      Temperature: 74.7 °F  
 Model: PR      Humidity: 53%  
 Calibrated on: Channel 3 on 8G 5161 LE

**PDA CALIBRATION FACTOR**  
**411.9 mv/5000g**  
 (82.4  $\mu$ v/g)  
 R<sup>2</sup>: 0.999966 [Chip programmed]

Operator: William Johnson

*William Johnson*  
 Signed

Ref Acc 1: 72505!      Cal on: 24Mar2022  
 1035 g/s/volt

Ref Acc 2: 72517!      Cal on: 24Mar2022  
 1049 g/s/volt

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

