

S-46-1086 Bridge Replacement over Beaverdam Creek

York County, SC

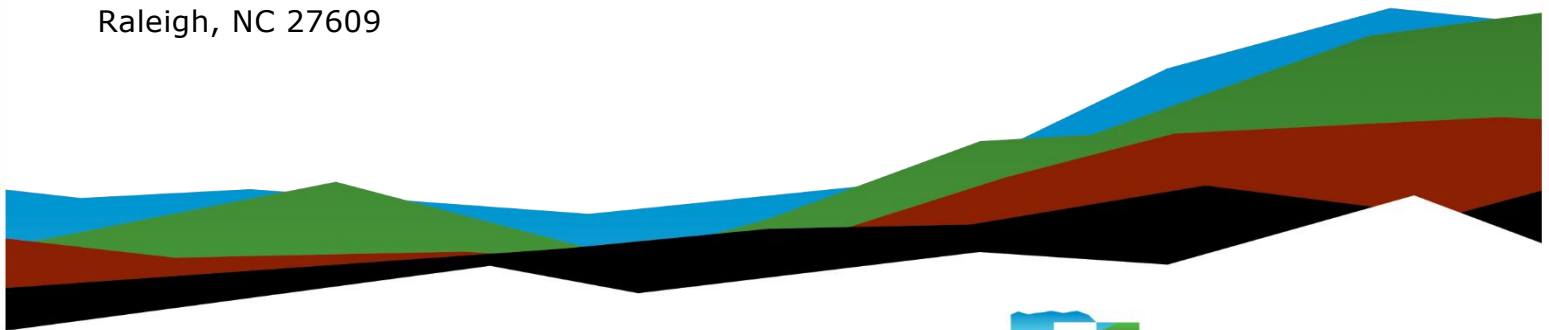
Geotechnical Baseline Report

August 21, 2023 (rev1) | SCDOT Project ID: P041173

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 Road
Columbia, SC 29229
P (803) 741-9000
[Terracon.com](https://www.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-46-1086 Bridge Replacement over Beaverdam Creek
York County, South Carolina
SCDOT Project ID.: P041173
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-46-1086 bridge over Beaverdam Creek in York County, South Carolina. The proposed bridge intends to replace the existing one. The results of subsurface exploration and laboratory testing has 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).

Project Description

The project site is located at the S-46-1086 (Barrett Road) crossing over Beaverdam Creek in York County, South Carolina. Site location and exploration plans are presented in Appendix A of this report. Based on the conceptual plans by HNTB dated 6/22/2023, 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 15 and June 16, 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-46-1086-1 and S-46-1086-2)
- One (1) offset boring of S-46-1086-2 for bulk sample collection
- One (1) Downhole Shear Wave Velocity Test (DHT-1) located in Boring S-46-1086-1
- Two (2) Cone Penetration Test soundings (S-46-1086-1C and S-46-1086-2C)

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 Construction Support Services, LLC after completion. Photographs of the drill rig set up at each boring location are provided in Appendix A.

Laboratory Testing

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

- Nine (9) Natural Moisture Content Tests
- Five (5) 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 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-46-1086, approximately 2 miles north of the town of Clover in York 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. The bedrock underlying the site mainly consists of diorite rock of Neoproterozoic Age (538.8 MYA to 1 BYA). The bridge end bents and approach embankments contain fill overlying minimal alluvial soils and residual soils, which gradually changes to Intermediate Geomaterials (IGM) above the bedrock.

Soil and Rock Stratification

The soils encountered at this site consist of existing fill in the upper 8 feet, followed by minimal alluvial soils of sandy lean clay and residual soils of silty sand. The residuum includes a deep zone of IGM materials classifying as silty sands. Rock was encountered at depth of 43 feet below ground surface at Boring S-46-1086-1 and 38 feet at Boring S-46-1086-2. The RQD of these encountered rocks ranged from 0% to 86%. The rock was found to be jointed with narrow discontinuity that are very closely spaced and have irregular joint shape. The joints contained no infilling and had a slightly rough surface. 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	746	--	--	--	--	--
Fill	739	CL, CH, ML	3 to 20	29	62 to 63	--
Alluvium	737	CL	0	11	65	--
Residuum	704 to 709	SM	7 to 100+	NP	32 to 46	--
Rock	PMDE ¹	--	--	--	--	40-100% / 0 - 86%

1. PMDE = Present to Maximum Depth Explored

Seismic Conditions

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

Acceleration Design Response Spectrum (ADRS)

The shear wave and compression wave velocity results, as measured at Boring S-46-1086-1 using downhole seismic tests, were provided to SCDOT. SCDOT used these velocity measurements to develop Acceleration Design Response Spectrum (ADRS) curves by determining the seismic hazard and evaluating the local site effects on the response spectra.

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

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

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

Seismic Design Parameter	FEE	SEE
PGA	0.03g	0.05g
S_{DS}	0.07g	0.12g
S_{D1}	0.01g	0.02g

Design and Construction Considerations

Foundations

Driven steel H-piles 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 0.5 for a single redundant pile with wave equation, and 0.65 for a single redundant pile with PDA and calibrated wave equation. Appropriate group effect should be considered as necessary per GDM Chapter 16. According to the conceptual bridge plans by HNTB dated 6/22/2023, up to 8 feet of fill is anticipated at the end bent embankments. Foundations to be installed after the approach embankment construction to avoid any potential downdrag issues. 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 low to medium variability in top of rock and thickness of IGM, as seen in **Soil and Rock Stratification**. Resistance of piles driven to practical refusal in IGM or rock will be limited by their structural resistance. Therefore, reinforced pile tips will likely be required to penetrate to IGM and rock. Pile drivability using the wave equation should be performed along with estimating stresses during driving and, in general, verifying the ability of the Contractor's selected hammer to drive the piles to the desired penetration while preventing overstressing.

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 1, S-46-998-2 Composite Sample from 0.0 to 10.0 feet	Indication of Corrosivity ¹
pH	5.93	Less than 5.5
Resistivity	7,200 ohm-cm	Less than 2,000 ohm-cm
Chloride	12 ppm	Greater than 500 ppm
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 with benching is expected in front of the end bents, along with fill behind the end bents. A bulk sample was obtained near End Bent 1 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.

Geotechnical Baseline Report

S-46-1086 BRO Beaverdam Creek | York County, SC

August 21, 2023 (rev1) | Terracon Project No. 7323P100 | SCDOT Project ID: P041173



Sample No.	Station	Offset (ft)	Sample Depth (ft)	USCS Soil Type	Compaction		Shear Strength ¹	
					Optimum Moisture (%)	Max Dry Density (pcf)	c', c (psf)	φ', φ (°)
S-46-1086-2	34+93.45	4.92 L	0-5	CL	18.5	103.2	115, 418	31, 10

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 (3 Pages)
- Exhibit A-7 – Soil/Rock Description Terms (2 Pages)
- Exhibit A-8 – Soil/Rock Symbols
- Exhibit A-9 – Boring Logs (4 Pages)
- Exhibit A-10 – CPT Sounding Logs (2 Pages)
- Exhibit A-11 – Geophysical Testing Results
- Exhibit A-12 – Grout Logs (4 Pages)
- Exhibit A-13 – Rock Core Photograph Log (2 Pages)

Note: All exhibits are one page unless noted above.

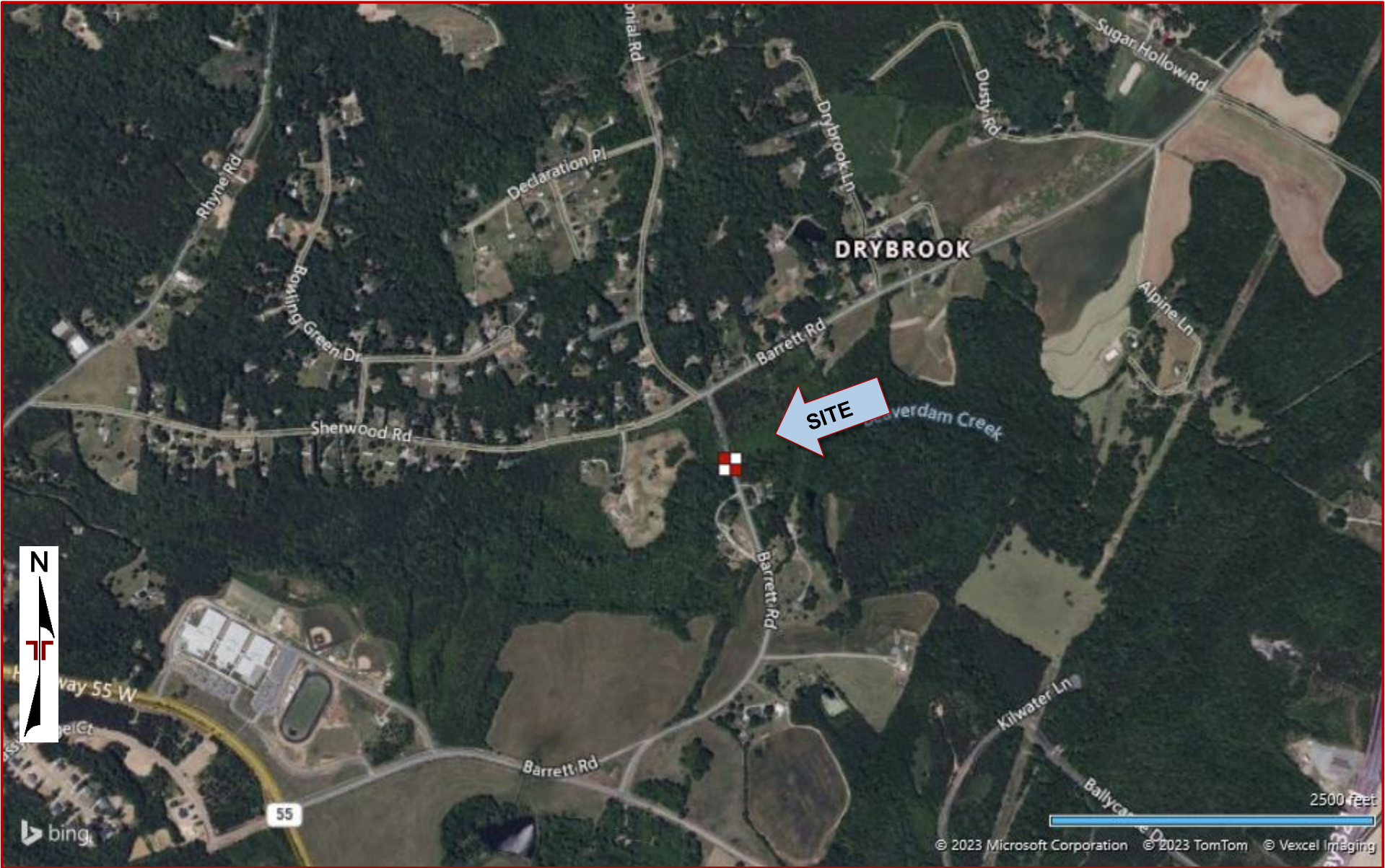


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT
 INTENDED FOR CONSTRUCTION PURPOSES

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



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

AERIAL PHOTOGRAPHY PROVIDED BY
MICROSOFT BING MAPS

Summary of Boring Data – Exhibit A-4

S-46-1086 BRO Beaverdam Creek | York County, SC

August 10, 2023 | Terracon Project No. 7323P100 | SCDOT Project ID: P041173



Summary of Boring Data

Boring No.	Ground Elevation ft.	Test Depth ft.	Northing	Easting	Latitude	Longitude	Station	Offset
S-46-1086-1	747.0	62.5	1202728.091	1930566.548	35.138538	-81.232194	35+66.01	5.62 L
S-46-1086-2	747.1	48.2	1202659.586	1930590.467	35.138350	-81.232113	34+93.45	4.92 L
S-46-1086-1C	747.0	12.6	1202731.283	1930566.428	35.138547	-81.232194	35+69.07	4.71 L
S-46-1086-2C	747.1	29.0	1202661.902	1930589.989	35.138357	-81.232115	34+95.80	4.63 L

Note: A bulk sample was collected near S-46-1086-2.

GeoScoping Form

PROJECT INFORMATION	
Project ID: P041173	Date of Trip: 6/15/2023
County: York	Location: Rock Hill
Rd/Route: S-46-1086	Local Name: Barrett Road
Attendees: A. Beaty	

EXISTING BRIDGE INFORMATION	
Bridge Length: 59 feet	Bridge Width: 26 Feet
Superstructure Type: Concrete framing and decking	Substructure Type: Arch Culvert
Begin Bridge Sta.: 34+73	End Bridge Sta.: 35+73
Begin Bridge Embankment Sta. ¹ 34+50	End Bridge Embankment Sta. ¹ 36+00
Structure Number: 03560	Posted Weight Limit: 23 Tons
Crossing: Beaver Dam Creek	Skew: 20 degrees
Latitude: 35.1384573° N	Longitude: 81.2321413° W
Existing Fill Height: 8 feet	Approximate Existing Slope Angle: N/A Culvert

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

EXISTING ROADWAY EMBANKMENT INFORMATION	
Begin Project Sta.: 31+00	Begin Bridge Embankment Sta. ¹ 35+00
Accessibility Issues: None	
Ground Cover: Asphalt Pavement	
Existing Fill Height: 8	Approximate Existing Slope Angle: 2H:1V
Local Development (undeveloped, developed residential, developed commercial, developed industrial, etc.): Developed Residential	
Topography (level, flat, rolling, steep, hillside, valley, swamp, gully, etc.): Rolling	
Traffic Control Necessary (Y/N):	
Yes	
Surface Soil: Clay	Muck (Y/N): No
Exposed Rock (Y/N): No	In Stream Bed (Y/N): No
	In Banks (Y/N): Yes
Wetlands On-Site (Y/N): Yes (Stream)	Wetlands Adjacent (Y/N): No
Depth FG to Water: 13 Feet	Water Depth: < 1 Foot
Depth to Existing Ground: 13 Feet	
Scour Condition at EB: N/A	Scour Condition at IB: N/A
End Bridge Embankment Sta. ¹ 36+59	End Project Sta.: 39+50
Accessibility Issues: None	
Ground Cover: Asphalt Pavement	
Existing Fill Height: 8 feet	Approximate Existing Slope Angle: 2H:1V
Local Development (undeveloped, developed residential, developed commercial, developed industrial, etc.): Undeveloped Residential	
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): No
Depth FG to Water: 13 Feet	Water Depth: < 1 Foot
Depth to Existing Ground: 13 Feet	
Scour Condition at EB: N/A	Scour Condition at IB: N/A

GeoScoping Form

UTILITIES INFORMATION
Attached:
Above Ground/ Overhead: Power Lines along East side of the Culvert
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-46-1086 BRO Beaverdam Creek | York County, SC

August 21, 2023 (rev1) | Terracon Project No. 7323P100 | SCDOT Project ID: P041173



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"
- 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-46-1086-1	100 feet or 15 feet rock coring	0 to 10 feet
S-46-1086-2	100 feet or 10 feet rock coring	0 to 40 feet
S-29-1086-2 Bulk	5 feet	Bulk Sample
S-29-292-1C	60 feet or refusal	CPT - No sampling
S-29-292-2C	60 feet or refusal	CPT - No sampling

Exhibit A-6

S-46-1086 BRO Beaverdam Creek | York County, SC

August 21, 2023 (rev1) | Terracon Project No. 7323P100 | SCDOT Project ID: P041173



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> ¹			<u>Consistency</u> ²		
Descriptive Term	Relative Density	SPT Blow Count	Descriptive Term	Unconfined Compression Strength (q _u) (tsf)	SPT Blow Count
Very Loose	0 to 15%	4 and less	Very Soft	0.25 and less	2 and less
Loose	16 to 35%	5 to 10	Soft	0.26 to 0.50	3 to 4
Medium Dense	36 to 65%	11 to 30	Firm	0.51 to 1.00	5 to 8
Dense	66 to 85%	31 to 50	Stiff	1.01 to 2.00	9 to 15
Very Dense	86 to 100%	51 and more	Very Stiff	2.01 to 4.00	16 to 30
			Hard	4.01 and more	31 and more

Moisture Condition

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

Color

Describe the sample color while sample is still moist.

Angularity¹

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

HCl Reaction³

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

Cementation³

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

Particle-Size Range¹

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

Primary Soil Type^{1, 2}

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

USCS Soil Designation

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

AASHTO Soil Designation

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

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

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

³Use as required

DESCRIPTION OF ROCK PROPERTIES

WEATHERING

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

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

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

Joint, Bedding, and Foliation Spacing in Rock^a

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

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

Rock Quality Designation (RQD)^a

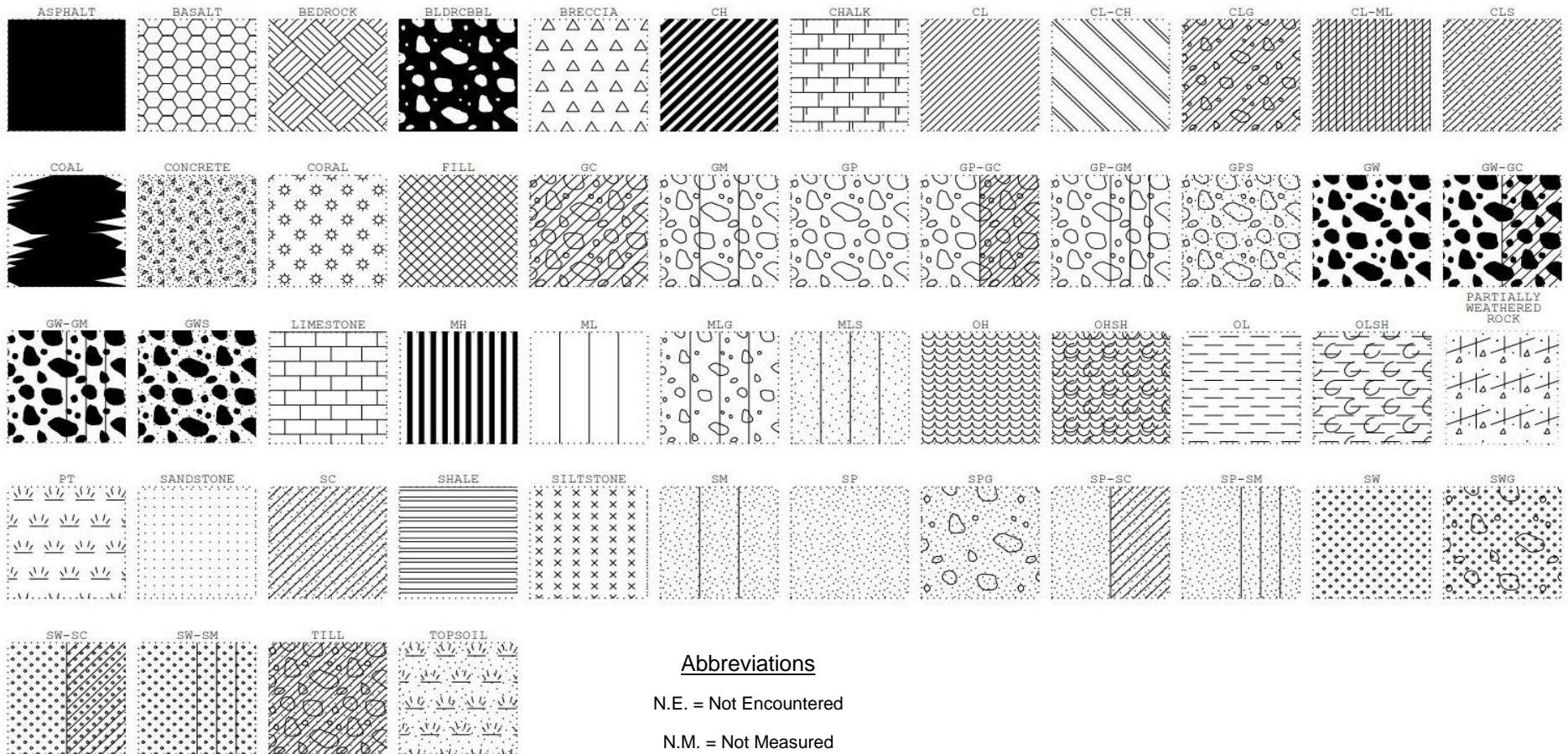
RQD, as a percentage	Diagnostic Description
Exceeding 90	Excellent
90 – 75	Good
75 – 50	Fair
50 – 25	Poor
Less than 25	Very poor

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

Joint Openness Descriptors

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

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



Project Manager:	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



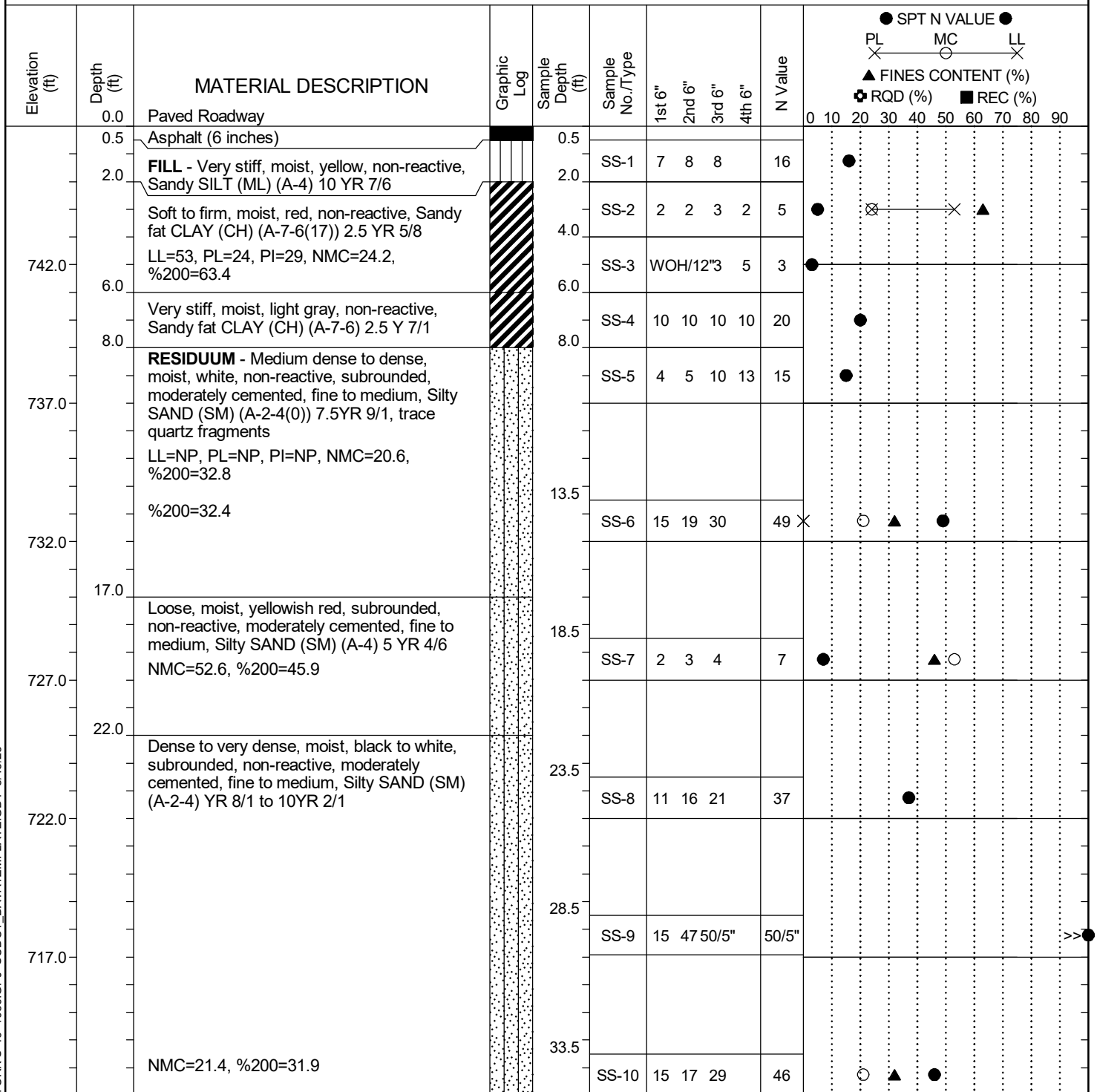
521 Clemson Road
Columbia, SC 29229
PH. (803) 741-9000 FAX. (803) 741-9900

SOIL AND ROCK SYMBOLS

Exhibit A-8

SCDOT Soil Test Log

Project ID:	P041173				County:	York		Boring No.:	S-46-1086-1		
Site Description:		S-46-1086 RBO Beaverdam Creek						Route:	S-46-1086		
Eng./Geo.:	Beaty		Boring Location:	35+66.01		Offset:	5.62 L		Alignment:	Existing	
Elev.:	747.0 ft		Latitude:	35.138538		Longitude:	-81.232194		Date Started:	6/15/2023	
Total Depth:	62.5 ft		Soil Depth:	43 ft		Core Depth:	19.5 ft		Date Completed:	6/15/2023	
Bore Hole Diameter (in):			4		Sampler Configuration		Liner Required:	Y (N)		Liner Used:	Y (N)
Drill Machine:		DR1109		Drill Method:	RW/RC		Hammer Type:	Automatic		Energy Ratio:	93.9%
Core Size:		NQ2		Driller:	S. Truesdale		Groundwater:	TOB	N.M.		24HR N.M.



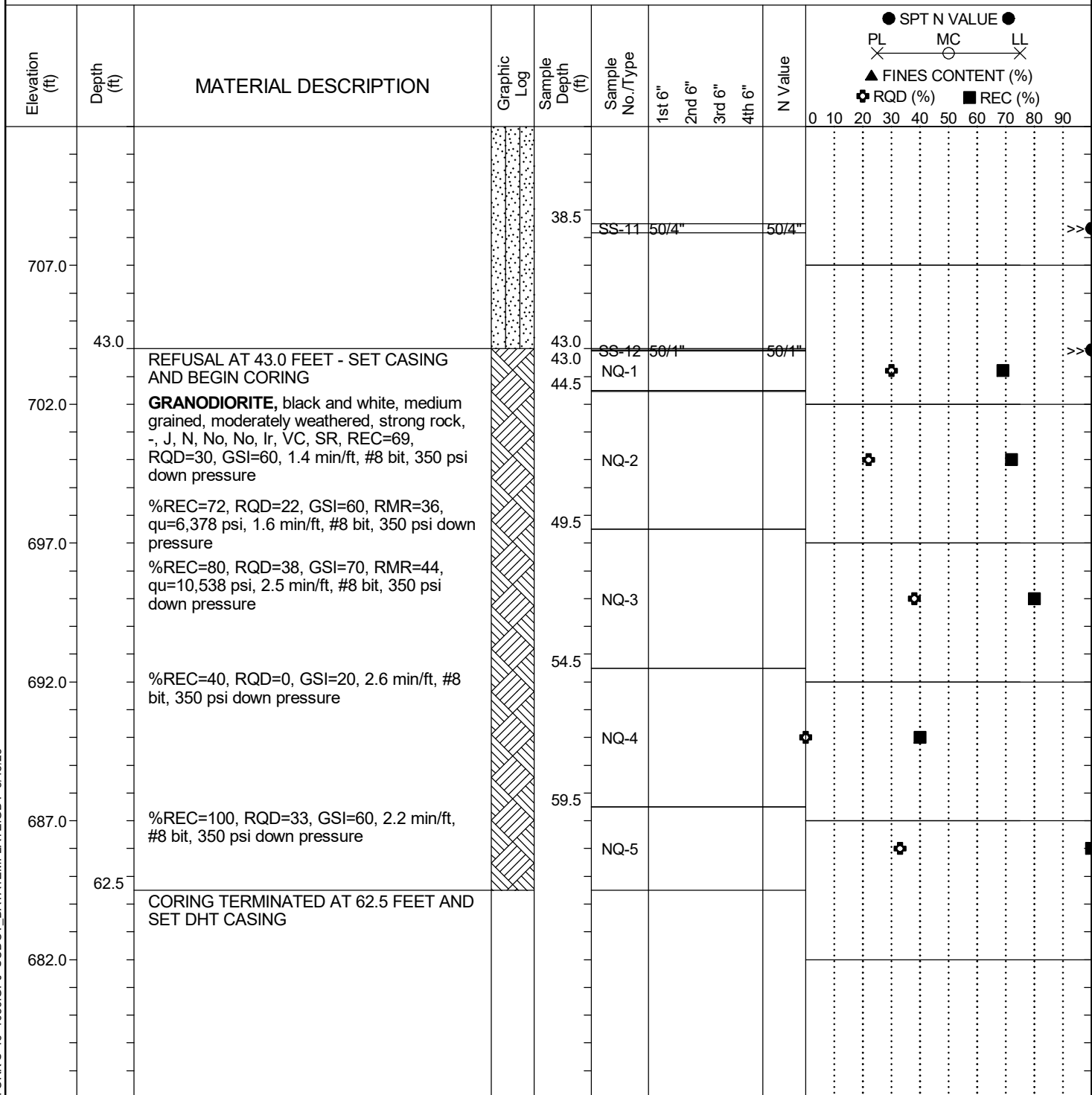
LEGEND

Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P041173	County:	York	Boring No.:	S-46-1086-1
Site Description:	S-46-1086 RBO Beaverdam Creek			Route:	S-46-1086
Eng./Geo.:	Beaty	Boring Location:	35+66.01	Offset:	5.62 L
Elev.:	747.0 ft	Latitude:	35.138538	Longitude:	-81.232194
Total Depth:	62.5 ft	Soil Depth:	43 ft	Core Depth:	19.5 ft
Date Started:	6/15/2023				
Date Completed:	6/15/2023				
Bore Hole Diameter (in):	4	Sampler Configuration		Liner Required:	Y (N)
Liner Used:	Y (N)	Drill Machine:	DR1109	Drill Method:	RW/RC
Hammer Type:	Automatic	Energy Ratio:	93.9%		
Core Size:	NQ2	Driller:	S. Truesdale	Groundwater:	TOB N.M.
24HR	N.M.				



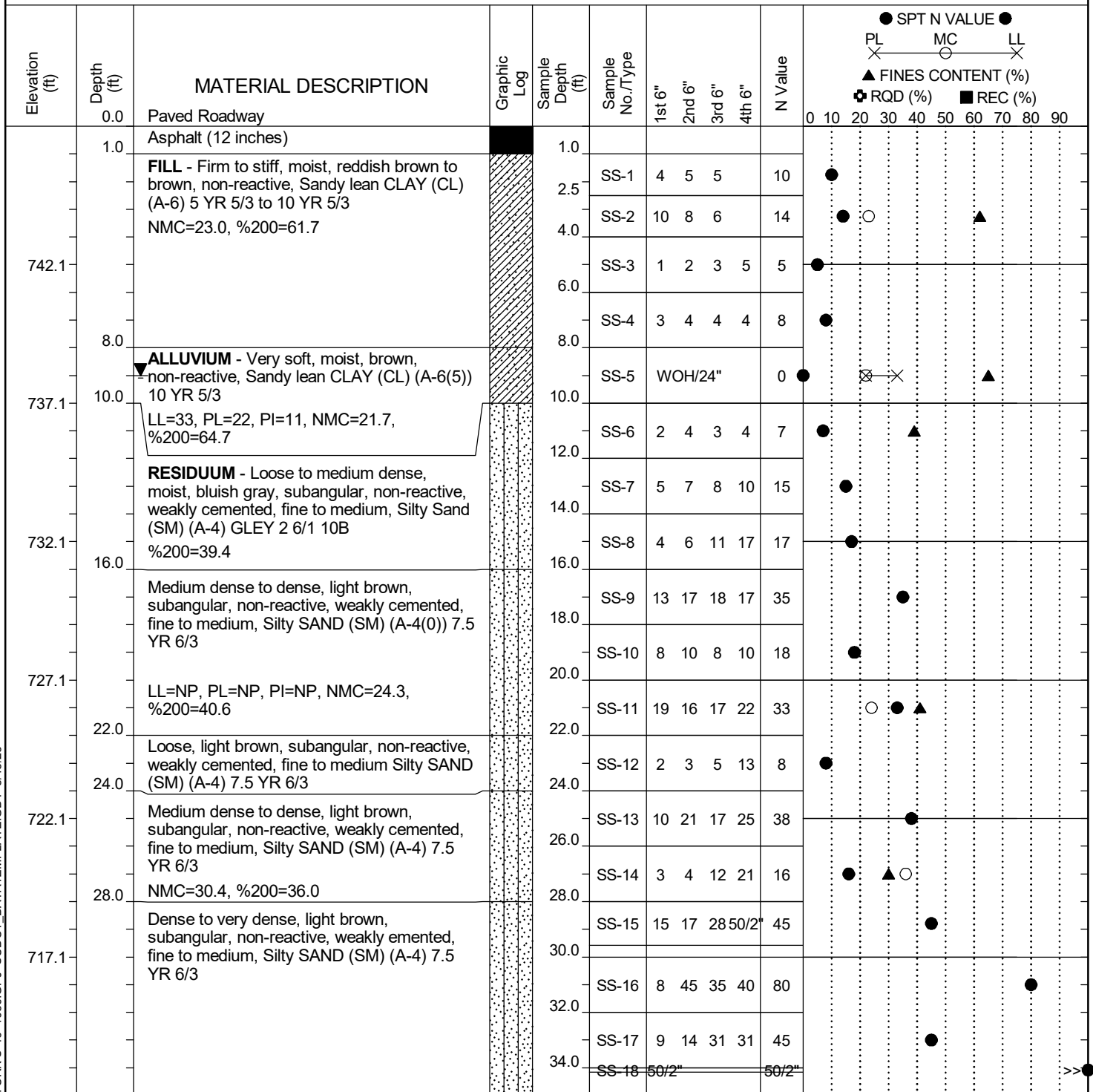
LEGEND

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

SC.DOT SCDOT YORK S-46-1086.GPJ SCDOT_DATATEMPLATE.GDT 8/18/23

SCDOT Soil Test Log

Project ID:	P041173				County:	York		Boring No.:	S-46-1086-2						
Site Description:		S-46-1086 RBO Beaverdam Creek						Route:	S-46-1086						
Eng./Geo.:	Morrison		Boring Location:		34+93.45		Offset:	4.92 L		Alignment:	Existing				
Elev.:	747.1 ft		Latitude:		35.138350		Longitude:		-81.232113		Date Started:		6/15/2023		
Total Depth:		48.2 ft		Soil Depth:		38.2 ft		Core Depth:		10 ft		Date Completed:		6/16/2023	
Bore Hole Diameter (in):			4		Sampler Configuration			Liner Required:		Y (N)		Liner Used:		Y (N)	
Drill Machine:		DR543		Drill Method:		RW/RC		Hammer Type:		Automatic		Energy Ratio:		93.5%	
Core Size:		NQ2		Driller:		S. Truesdale		Groundwater:		TOB N.M.		24HR		9 ft	



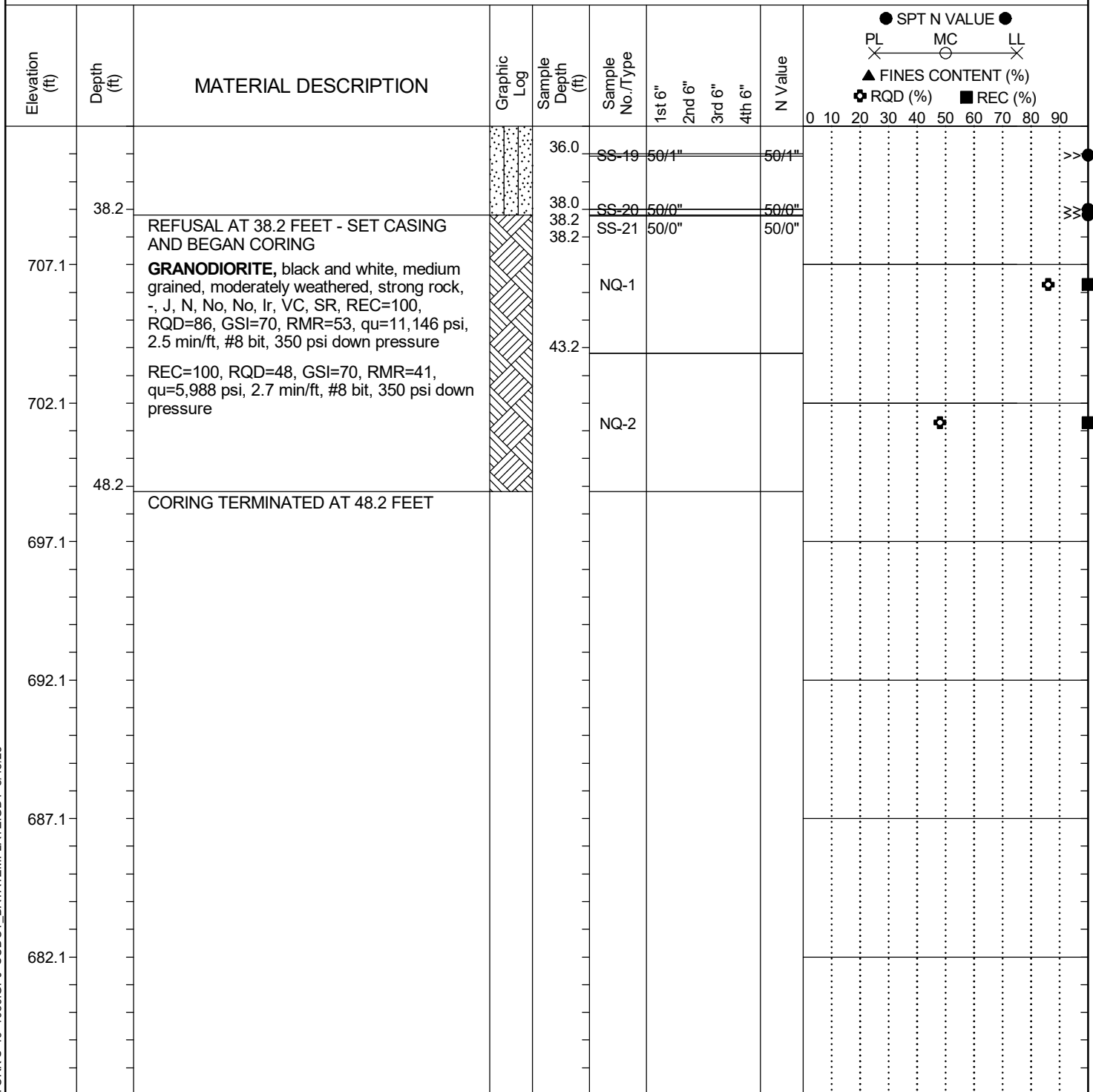
LEGEND

Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P041173				County:	York		Boring No.:	S-46-1086-2						
Site Description:		S-46-1086 RBO Beaverdam Creek						Route:	S-46-1086						
Eng./Geo.:	Morrison		Boring Location:		34+93.45		Offset:	4.92 L		Alignment:	Existing				
Elev.:	747.1 ft		Latitude:		35.138350		Longitude:		-81.232113		Date Started:		6/15/2023		
Total Depth:		48.2 ft		Soil Depth:		38.2 ft		Core Depth:		10 ft		Date Completed:		6/16/2023	
Bore Hole Diameter (in):			4		Sampler Configuration			Liner Required:		Y (N)		Liner Used:		Y (N)	
Drill Machine:		DR543		Drill Method:		RW/RC		Hammer Type:		Automatic		Energy Ratio:		93.5%	
Core Size:		NQ2		Driller:		S. Truesdale		Groundwater:		TOB N.M.		24HR		9 ft	



LEGEND

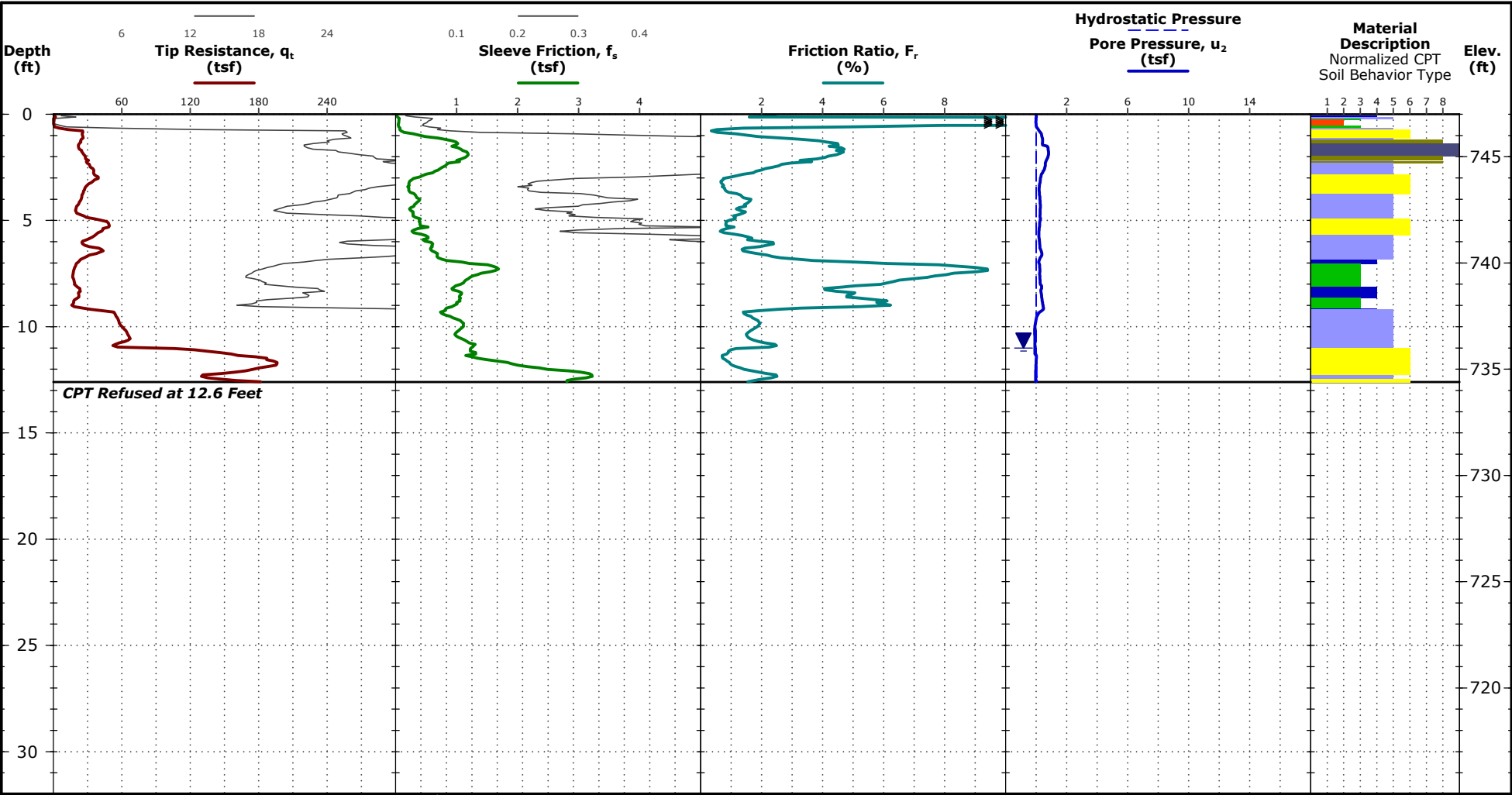
SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

CPT Sounding ID S-46-1086-1C

Elevation: 747.0 (ft)

Latitude: 35.138547° Longitude: -81.232194°
Station: 35+69.07 Offset: L 4.71

CPT Started: 6/27/2023
CPT Completed: 6/27/2023



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: TG 73-200
Operator: AF/BR
CPT sensor calibration reports available upon request
Probe No. 5617 with net area ratio of 0.84
 U_2 pore pressure transducer location
Manufactured by Geotech A.B.- Calibrated 5/31/2023
Tip and sleeve areas of 10 cm² and 150 cm²
Ring friction reducer with O.D. of 2 in

Water Level Observation

11 ft measured water depth
(used in normalizations and correlations)

Normalized Soil Behavior Type (Robertson 1990)

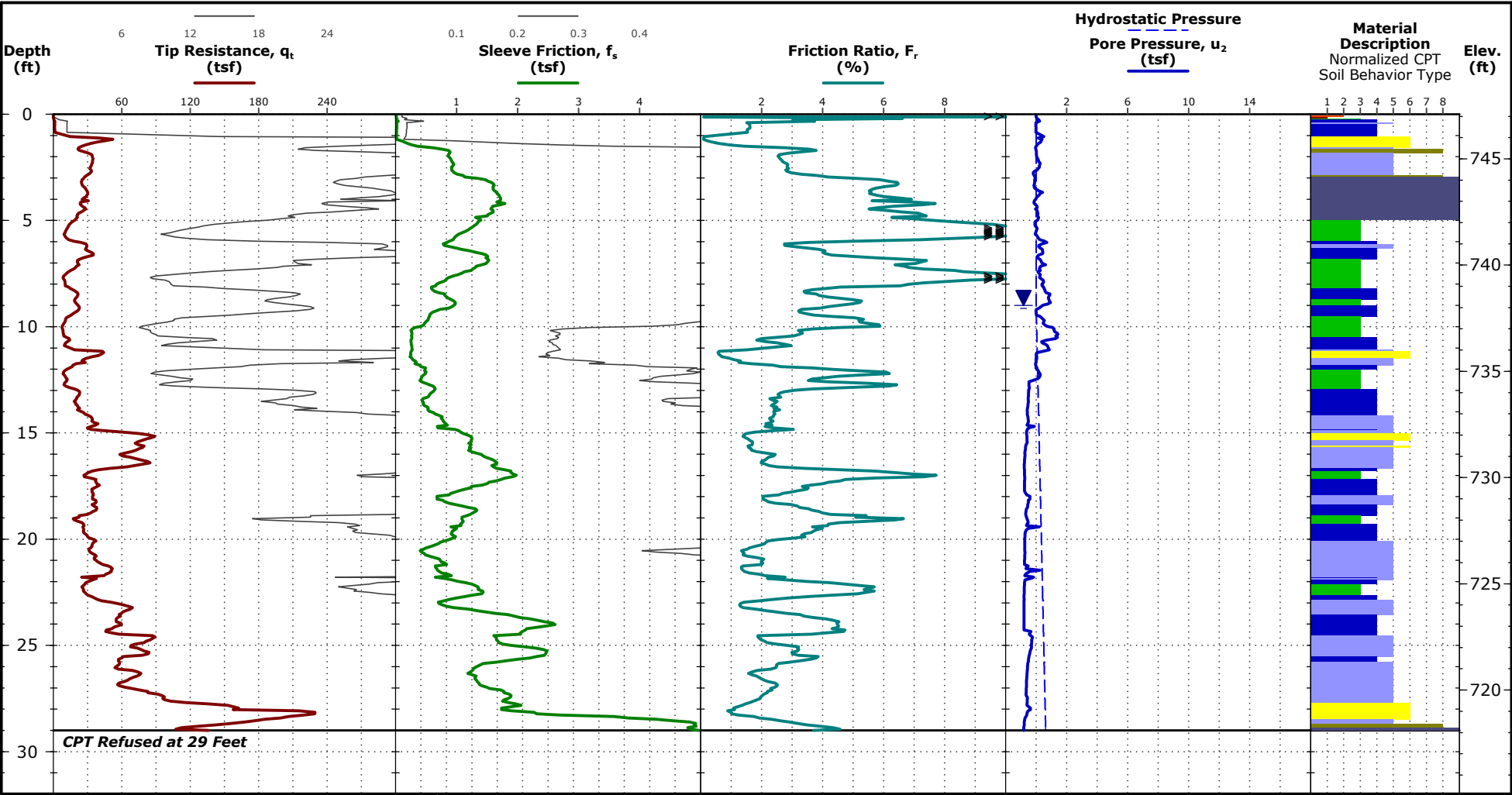
- 1 Sensitive, fine grained
- 2 Organic soils - clay
- 3 Clay - silty clay to clay
- 4 Silt mixtures - clayey silt to silty clay
- 5 Sand mixtures - silty sand to sandy silt
- 6 Sands - clean sand to silty sand
- 7 Gravelly sand to dense sand
- 8 Very stiff sand to clayey sand
- 9 Very stiff fine grained

CPT Sounding ID S-46-1086-2C

Elevation: 747.1 (ft)

Latitude: 35.138357° Longitude: -81.232115°
Station: 34+95.80 Offset: L 4.63

CPT Started: 6/27/2023
CPT Completed: 6/27/2023



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](#)

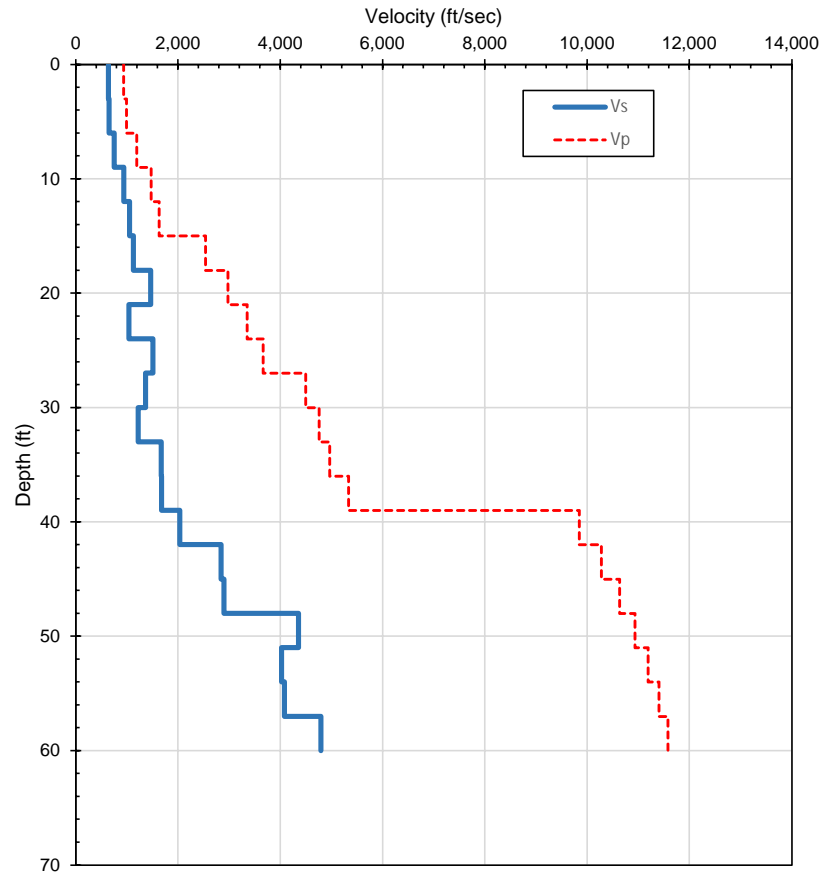
CPT Equipment
CPT Rig: TG 73-200
Operator: AF/BR
CPT sensor calibration reports available upon request
Probe No. 5617 with net area ratio of 0.84
 u_2 pore pressure transducer location
Manufactured by Geotech A.B.- Calibrated 5/31/2023
Tip and sleeve areas of 10 cm² and 150 cm²
Ring friction reducer with O.D. of 2 in

Water Level Observation
▼ 9 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

Downhole Seismic Velocity Fixed Interval Method



Depth (ft)	Vp (ft/sec)	Vs (ft/sec)	Δi (ft)	Δt (sec)
3	934	638	3	0.00470
6	989	654	3	0.00459
9	1,193	753	3	0.00398
12	1,474	941	3	0.00319
15	1,628	1,052	3	0.00285
18	2,537	1,127	3	0.00266
21	2,975	1,466	3	0.00205
24	3,353	1,044	3	0.00287
27	3,663	1,511	3	0.00199
30	4,497	1,365	3	0.00220
33	4,757	1,222	3	0.00245
36	4,965	1,670	3	0.00180
39	5,334	1,680	3	0.00179
42	9,845	2,038	3	0.00147
45	10274	2845	3	0.00105
48	10634	2897	3	0.00104
51	10935	4359	3	0.00069
54	11188	4026	3	0.00075
57	11400	4084	3	0.00073
60	11580	4794	3	0.00063
Sum of Data Over Profile				60
Weighted Average Shear Wave Velocity Over Profile				1,380 ft/sec

Project Mgr: DC
Prepared by: RK
Checked by: AF
Approved by:

Project No.
EN23P100
Scale: NA
Date:
7/19/2023

 Consulting Engineers and Scientists	
1800 Reynolds Avenue Ph: (843) 884-1234	North Charleston, South Carolina Fax: (843) 884-9234

GEOPHYSICAL TESTING RESULTS	
DOWNHOLE SEISMIC TEST	
S-46-1086 (Barrett Rd) Bridge Replacement over Beaverdam Creek	
YORK COUNTY, SOUTH CAROLINA	
P041173	

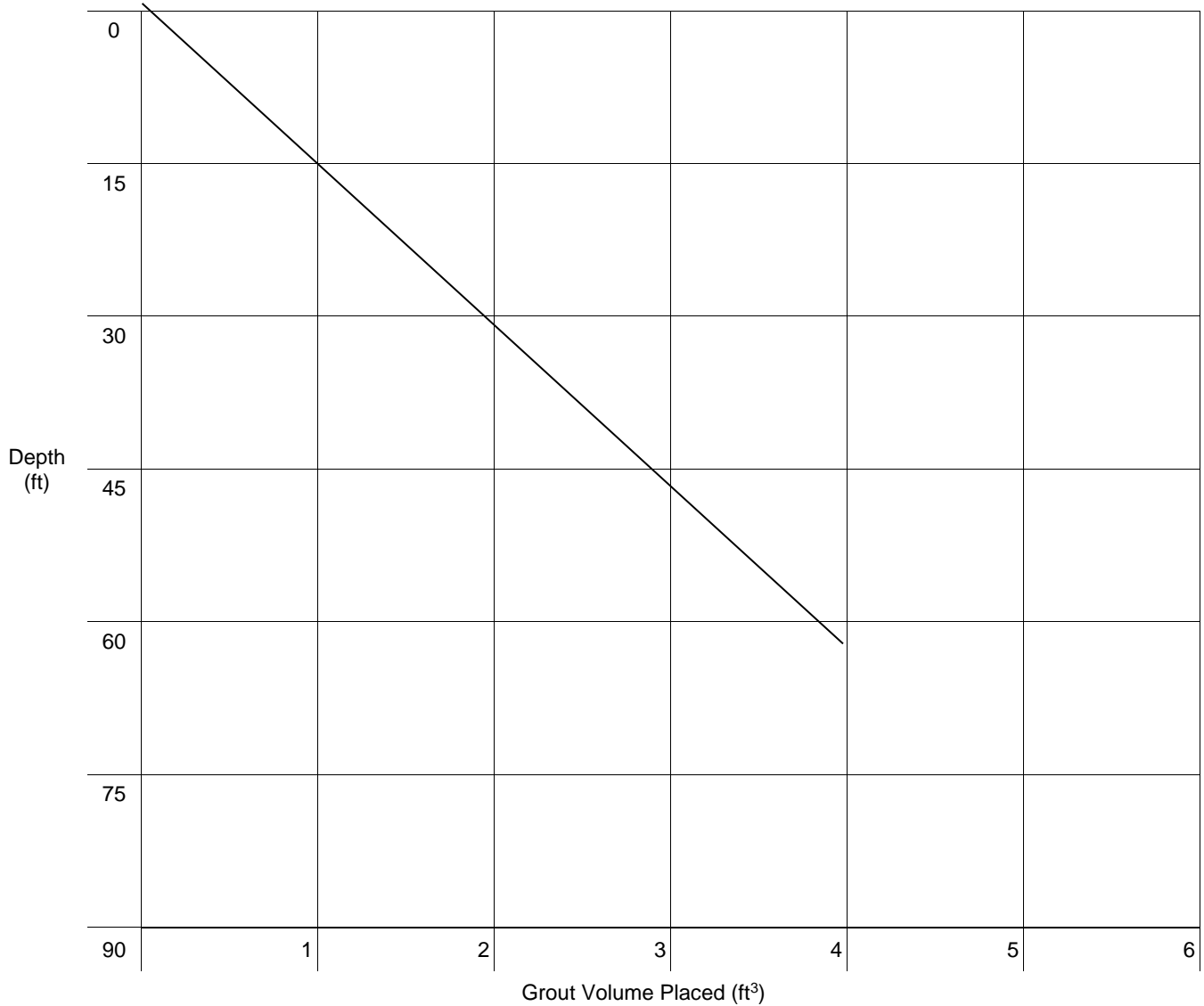
TEST NO.
S-46-1086-1



GROUT LOG OF TEST HOLES FOR GEOTECHNICAL ON-CALL

Project Name:	S-46-1086 RBO Beaverdam Creek		Test Hole No.:	S-46-1086-1
Project ID:	P041173		Station:	35+66.01
Consultant Firm:	Terracon Consultants, Inc.		Offset:	5.62 L
Grouted By (Driller's Name):	Truesdale	Date	6/15/23	
Notes:	Mix design: 1 pound cement, 1 pound bentonite, 6 pounds water			

Grout Curve



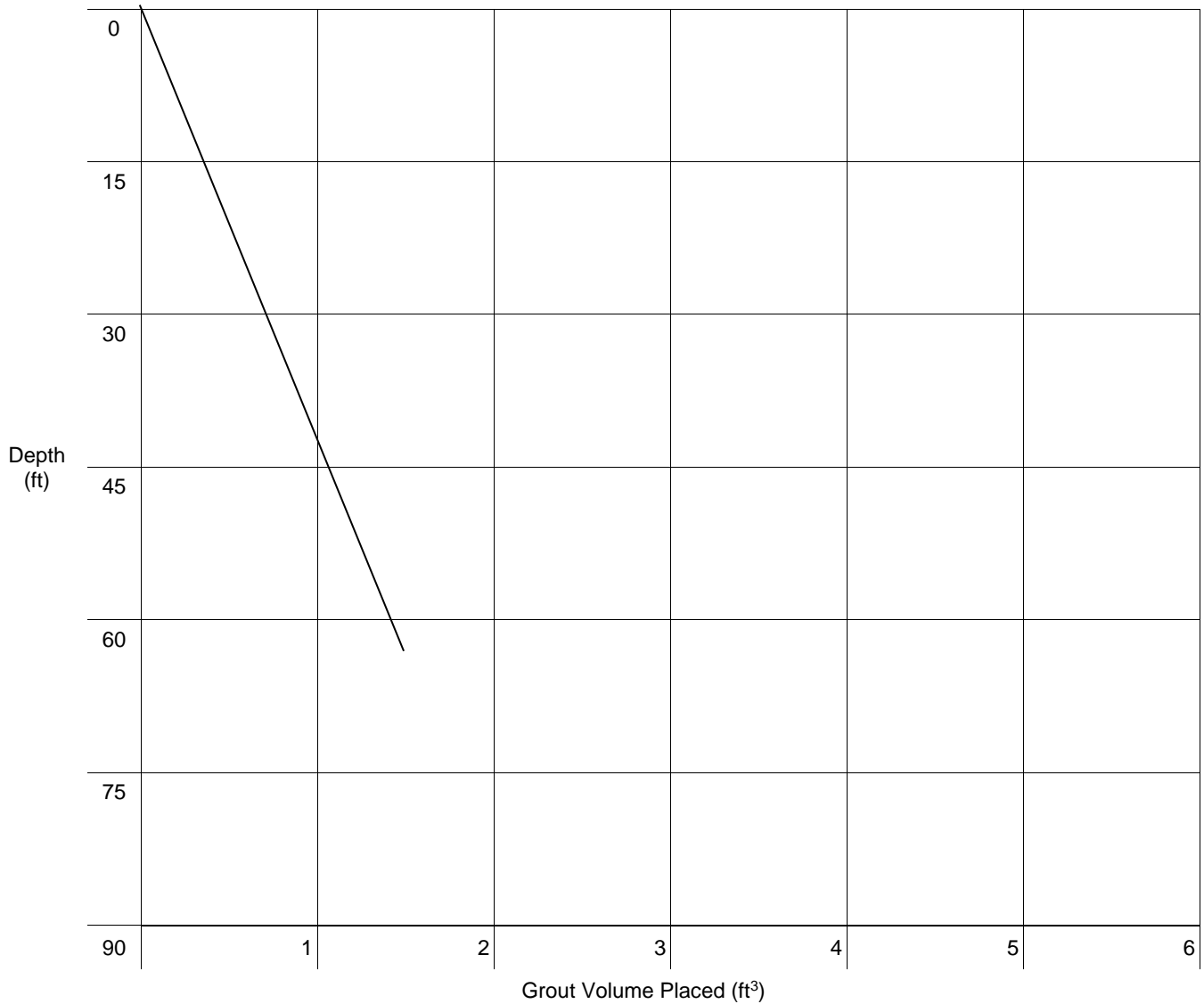
Number of Bags On-Site	20	ea.
Depth of Test Hole Grouted	62.5	ft.
Diameter of Test Hole	0.33	ft.
Area of Test Hole	0.09	ft²
Volume of Test Hole	5.4	ft³
Volume of Casing (If applicable)	1.7	ft³
Theoretical Volume of Test Hole	3.7	ft³
Number of Bags Used	5	ea.
Volume Placed	4.0	ft³



GROUT LOG OF TEST HOLES FOR GEOTECHNICAL ON-CALL

Project Name:	S-46-1086 RBO Beaverdam Creek		Test Hole No.:	S-46-1086-1
Project ID:	P041173		Station:	35+66.01
Consultant Firm:	Terracon Consultants, Inc.		Offset:	5.62 L
Grouted By (Driller's Name):	Truesdale	Date	7/15/23	
Notes:	Mix design: 1 pound cement, 1 pound bentonite, 6 pounds water			

Grout Curve



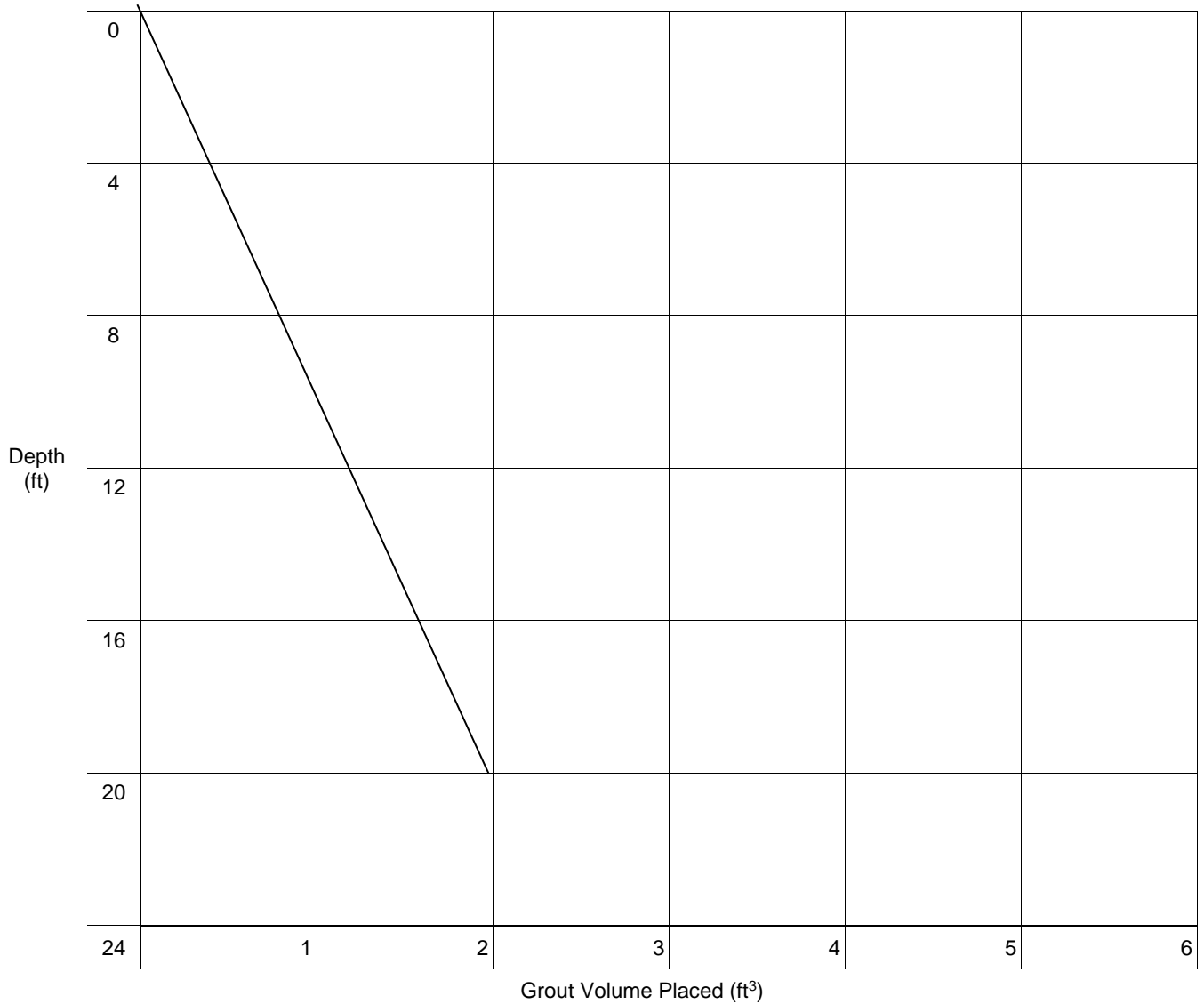
Number of Bags On-Site	20	ea.
Depth of Test Hole Grouted	62	ft.
Diameter of Test Hole	0.17	ft.
Area of Test Hole	0.022	ft²
Volume of Test Hole	1.36	ft³
Volume of Casing (If applicable)	-	ft³
Theoretical Volume of Test Hole	1.36	ft³
Number of Bags Used	2	ea.
Volume Placed	1.5	ft³



GROUT LOG OF TEST HOLES FOR GEOTECHNICAL ON-CALL

Project Name:	S-46-1086 RBO Beaverdam Creek		Test Hole No.:	S-46-1086-2
Project ID:	P041173		Station:	34+93.45
Consultant Firm:	Terracon Consultants, Inc.		Offset:	4.92 L
Grouted By (Driller's Name):	Costner	Date	6/16/23	
Notes:	Mix design: 1 pound cement, 1 pound bentonite, 6 pounds water			

Grout Curve

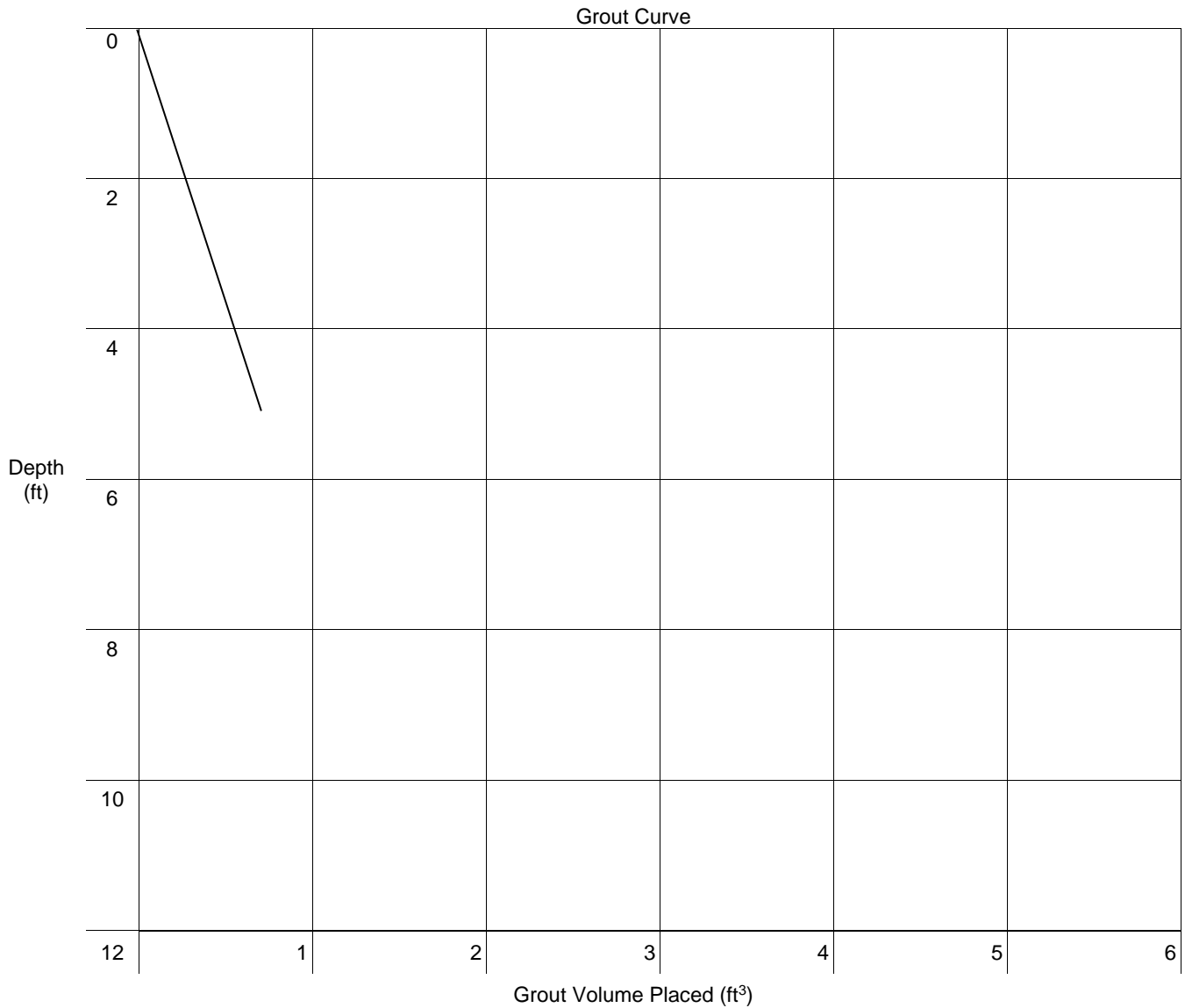


Number of Bags On-Site	20	ea.
Depth of Test Hole Grouted	20	ft.
Diameter of Test Hole	0.33	ft.
Area of Test Hole	0.09	ft²
Volume of Test Hole	1.74	ft³
Volume of Casing (If applicable)	-	ft³
Theoretical Volume of Test Hole	1.74	ft³
Number of Bags Used	2.5	ea.
Volume Placed	2	ft³

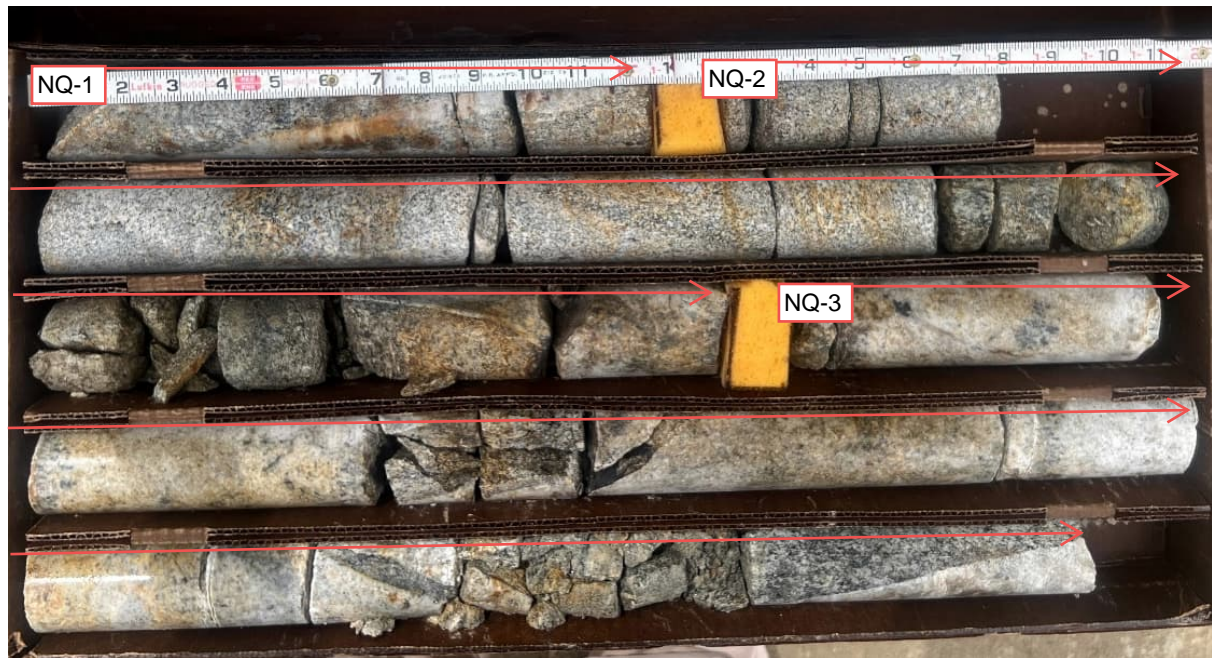


GROUT LOG OF TEST HOLES FOR GEOTECHNICAL ON-CALL

Project Name:	S-46-1086 RBO Beaverdam Creek	S-46-1086-2
Project ID:	P041173	Test Hole No.: (BULK)
Consultant Firm:	Terracon Consultants, Inc.	Station: 34+93.45
Grouted By (Driller's Name):	Costner	Date 6/16/23 Offset: 4.92 L
Notes:	Mix design: 1 pound cement, 1 pound bentonite, 6 pounds water	



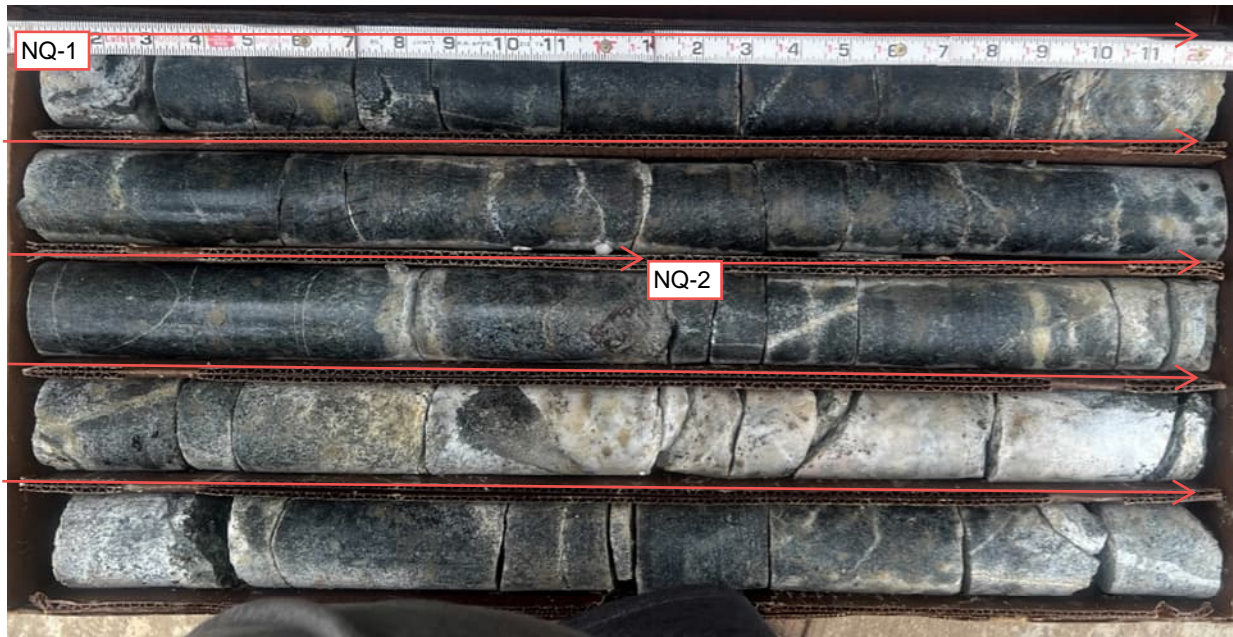
Number of Bags On-Site	20	ea.
Depth of Test Hole Grouted	5	ft.
Diameter of Test Hole	0.5	ft.
Area of Test Hole	0.2	ft ²
Volume of Test Hole	1.0	ft ³
Volume of Casing (If applicable)	-	ft ³
Theoretical Volume of Test Hole	1.0	ft ³
Number of Bags Used	1.5	ea.
Volume Placed	0.7	ft ³



S-46-1086-1, NQ-1, NQ-2, and NQ-3



S-46-1086-1, NQ-4 and NQ-5



S-46-1086-2, NQ-1 and NQ-2

Appendix B

Laboratory Testing

Exhibit B-1 – Laboratory Testing Description
Summary of Laboratory Data
Laboratory Data Sheets (24 Pages)

Note: All exhibits are one page unless noted above.

Exhibit B-1

S-46-1086 BRO Beaverdam Creek | York County, SC

August 21, 2023 (rev1) | Terracon Project No. 7323P100 | SCDOT Project ID: P041173



Laboratory Testing Description

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

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

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

■	Moisture Content	AASHTO T265/(ASTM D2216)
■	Atterberg Limits	AASHTO T89/T90(ASTM D4318)
■	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

PAGE 1 OF 1

BORING ID	Depth (Ft.)	Soil Classification USCS & AASHTO	Liquid Limit	Plastic Limit	Plasticity Index	% Fines	% Gravel	% Sand	% Silt	% Clay	Water Content (%)
S-46-1086-1	2-4	SANDY FAT CLAY(CH) / A-7-6 (17)	53	24	29	63.4					24.2
S-46-1086-1	8-10	SILTY SAND(SM) / A-2-4 (0)	NP	NP	NP	32.8	0.0	67.2	26.4	6.3	20.6
S-46-1086-1	13.5-15					32.4	2.5	65.1	26.9	5.4	
S-46-1086-1	18.5-20					45.9					52.6
S-46-1086-1	33.5-35					31.9					21.4
S-46-1086-2	2.5-4					61.7					23.0
S-46-1086-2	8-10	SANDY LEAN CLAY(CL) / A-6 (5)	33	22	11	64.7	0.0	35.3	33.3	31.4	21.7
S-46-1086-2	10-12					39.4	9.8	50.8	29.4	9.9	
S-46-1086-2	20-22	SILTY SAND(SM) / A-4 (0)	NP	NP	NP	40.6					24.3
S-46-1086-2	26-28					36.0					30.4
S-46-1086-2 Bulk	0-5	SANDY LEAN CLAY(CL) / A-6 (4)	30	18	12	56.5					14.8
PROJECT: S-46-1086 BRO Beaverdam Creek			<div>Terracon</div> <div>521 Clemson Rd Columbia, SC</div>					PROJECT NUMBER: 7323P100			
SITE: York County, SC								CLIENT: NHTB			
			PH. 803-741-9000 FAX. 803-741-9900								



INDEX PROPERTIES VERSUS DEPTH

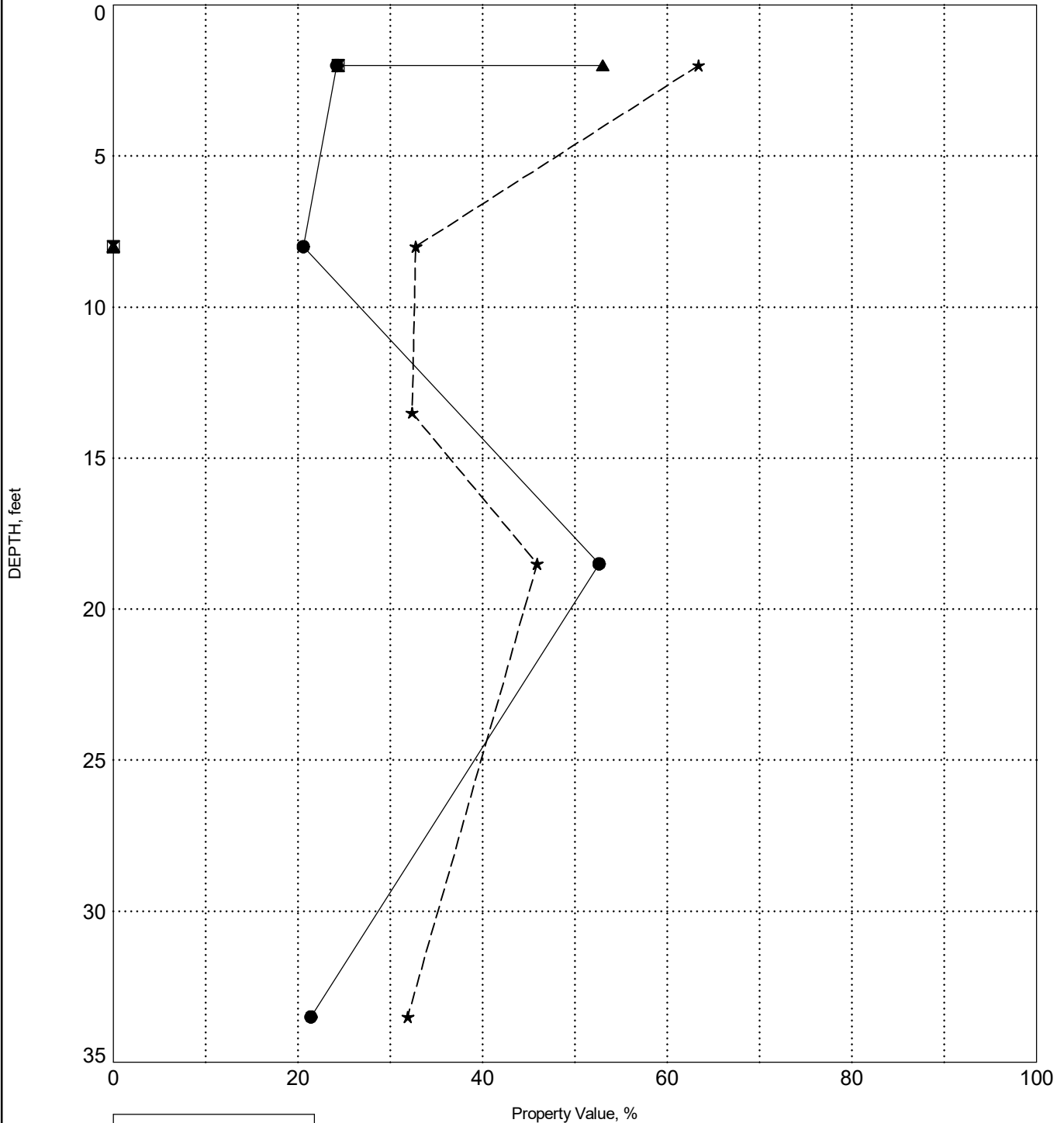
PROJECT ID P041173

PROJECT NAME S-46-1086 RBO Beaverdam Creek

PROJECT COUNTY York

SURFACE ELEVATION: 747.0

BORING S-46-1086-1



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



INDEX PROPERTIES VERSUS DEPTH

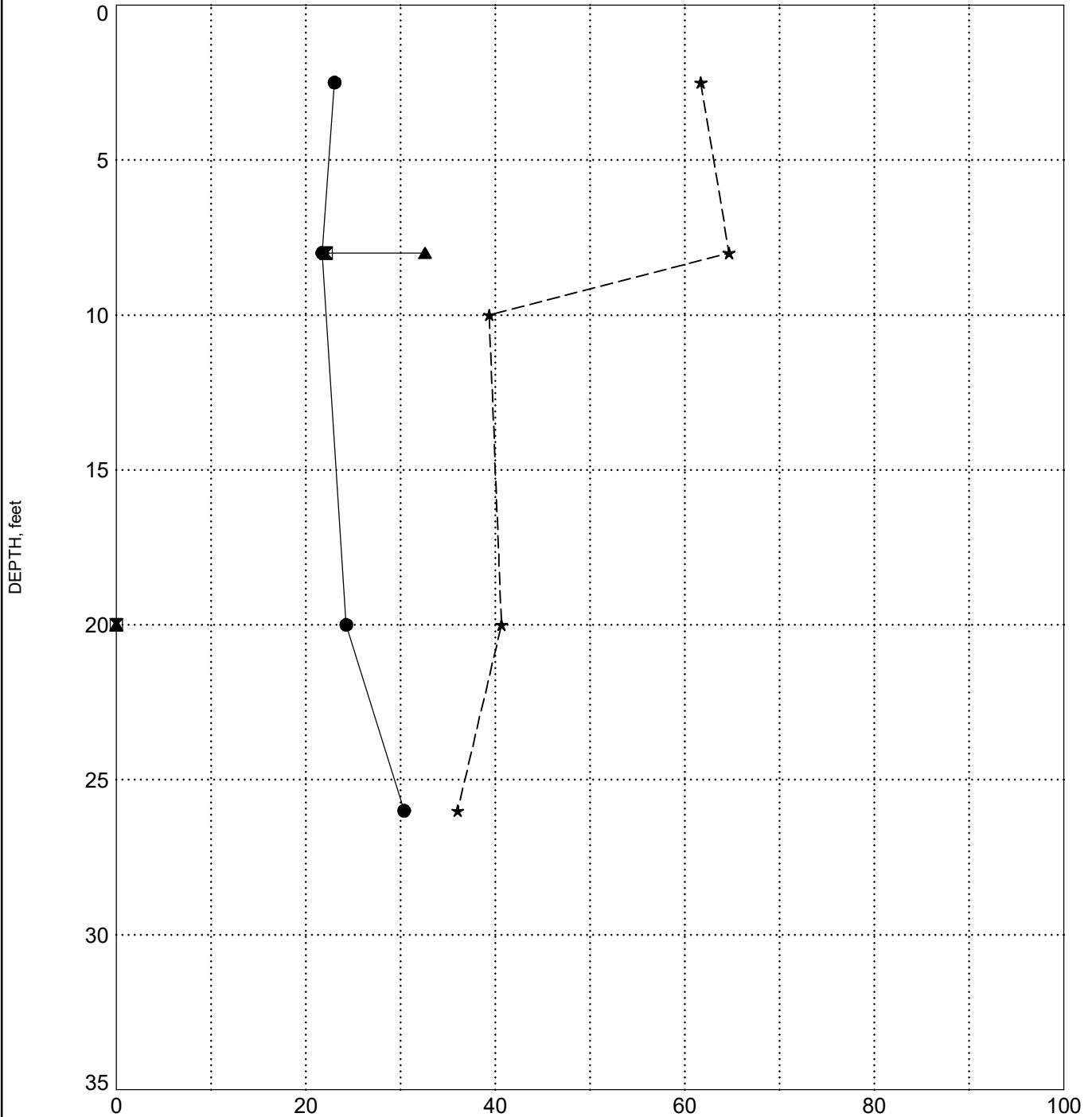
PROJECT ID P041173

PROJECT NAME S-46-1086 RBO Beaverdam Creek

PROJECT COUNTY York

SURFACE ELEVATION: 747.1

BORING S-46-1086-2

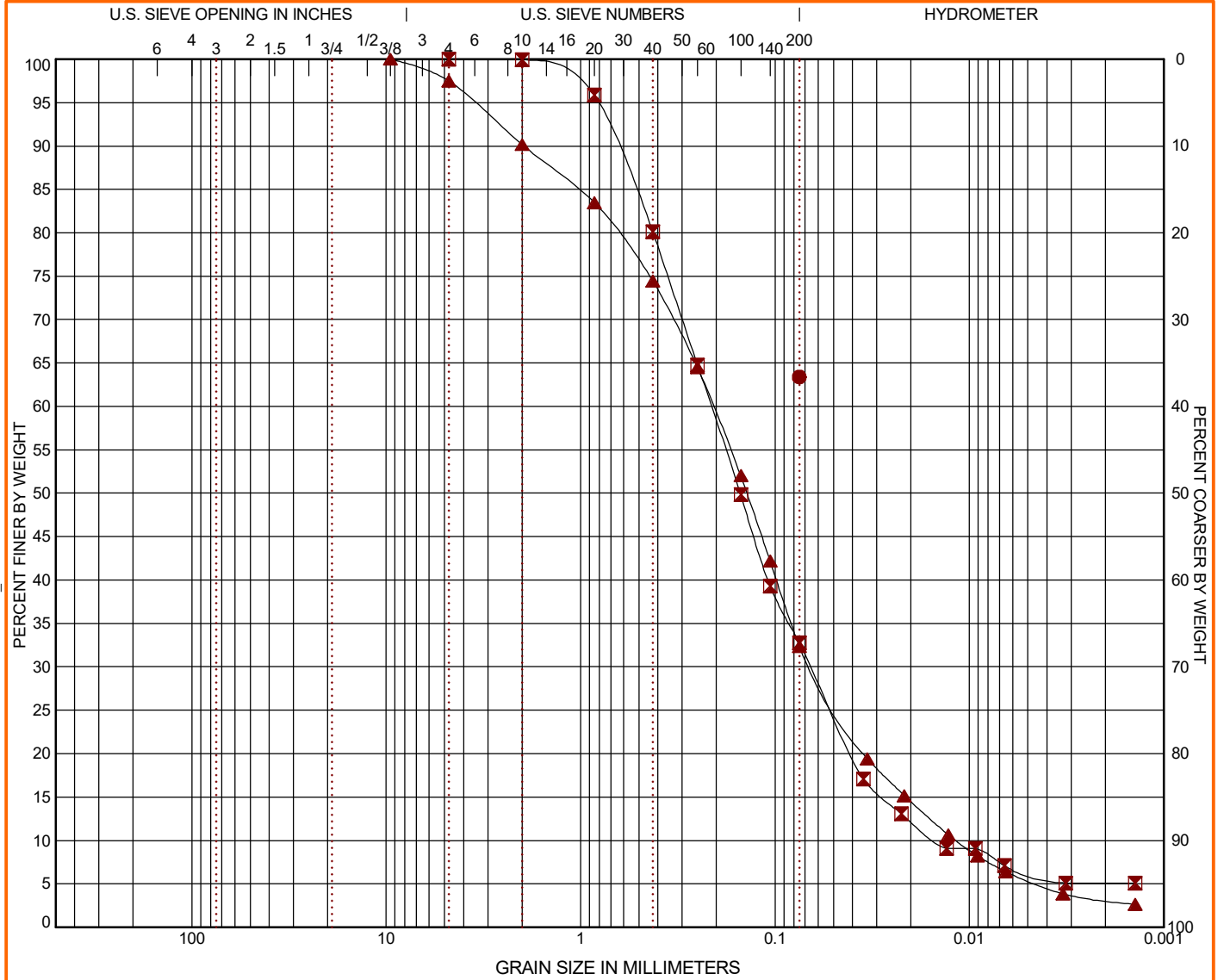


LEGEND	
●	Water Content
■	Plastic Limit
▲	Liquid Limit
★	Fines

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: AASHTO DESC-1 S-46-1086 BEAVERDAM CREEK.GPJ TERRACON_DATATEMPLATE.GDT 8/18/23



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
● S-46-1086-1	2 - 4					63.4		CH
☒ S-46-1086-1	8 - 10	0.0	0.0	67.2	26.4		6.3	SM
▲ S-46-1086-1	13.5 - 15	0.0	2.5	65.1	26.9		5.4	

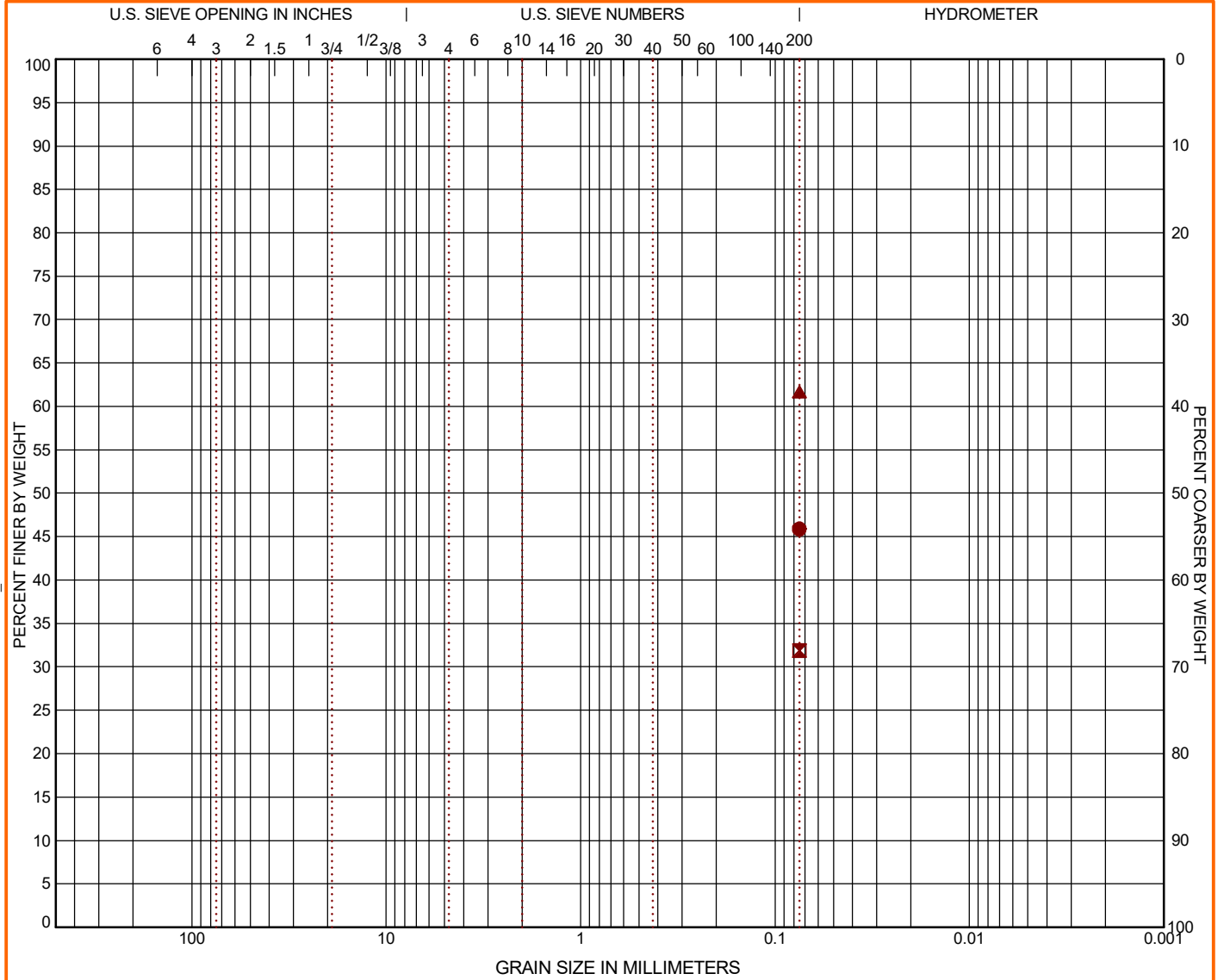
GRAIN SIZE				SOIL DESCRIPTION			
	●	☒	▲	Sieve	% Finer	Sieve	% Finer
D ₆₀		0.213	0.208	#200	63.39	3/8"	100.0
D ₃₀		0.066	0.065	#4	100.0	#4	97.48
D ₁₀		0.015	0.012	#10	99.91	#10	90.15
				#20	95.89	#20	83.48
				#40	80.1	#40	74.43
				#60	64.74	#60	64.45
				#100	49.83	#100	52.01
				#140	39.31	#140	42.19
				#200	32.76	#200	32.36
COEFFICIENTS				REMARKS			
	●	☒	▲				
C _c		1.37	1.72				
C _u		14.35	17.79				
				●	A-7-6 (17)		
				☒	A-2-4 (0)		
				▲			

PROJECT: S-46-1086 BRO Beaverdam Creek	<p>521 Clemson Rd Columbia, SC</p>	PROJECT NUMBER: 7323P100
SITE: York County, SC		CLIENT: NHTB

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: AASHTO DESC-1 S-46-1086 BEAVERDAM CREEK.GPJ TERRACON_DATATEMPLATE.GDT 8/18/23



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
● S-46-1086-1	18.5 - 20					45.9		
■ S-46-1086-1	33.5 - 35					31.9		
▲ S-46-1086-2	2.5 - 4					61.7		

GRAIN SIZE				SOIL DESCRIPTION			
	●	■	▲	Sieve	% Finer	Sieve	% Finer
D ₆₀				#200	45.89	#200	31.89
D ₃₀				#200		#200	
D ₁₀				#200		#200	
COEFFICIENTS				REMARKS			
	●	■	▲				
C _c							
C _u							

PROJECT: S-46-1086 BRO Beaverdam Creek	<p>521 Clemson Rd Columbia, SC</p>	PROJECT NUMBER: 7323P100
SITE: York County, SC		CLIENT: NHTB

ASTM D422 / ASTM C136



GRAIN SIZE			
	●	☒	▲
D ₆₀	0.061	0.146	
D ₃₀	0.004	0.043	
D ₁₀		0.005	
COEFFICIENTS			
	●	☒	▲
C _c		2.50	
C _u		28.81	

SOIL DESCRIPTION	
●	A-6 (5)
☒	
▲	A-4 (0)
REMARKS	
●	
☒	
▲	

Terracon
521 Clemson Rd
Columbia, SC

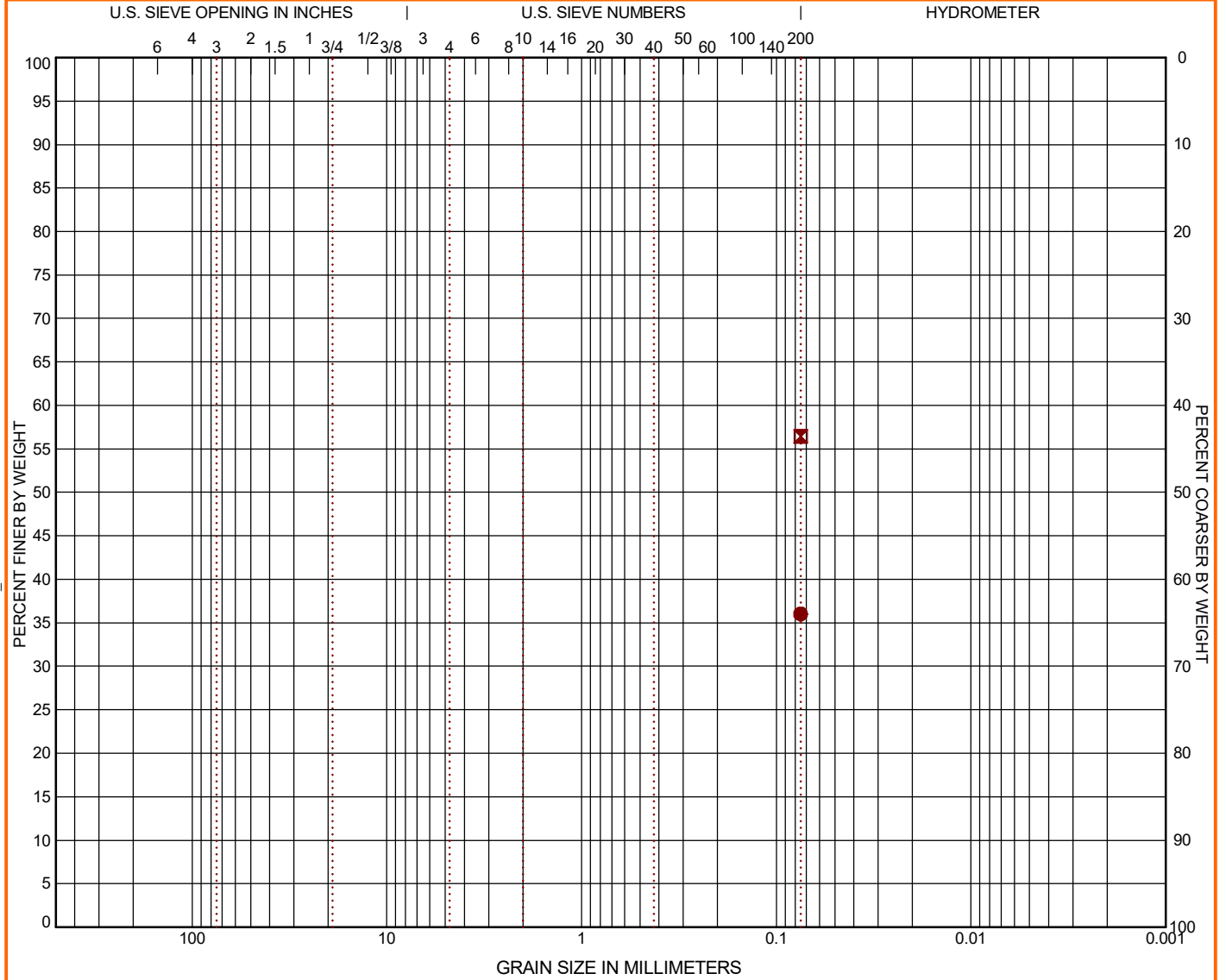
CLIENT: NHTB

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: AASHTO DESC-1 S-46-1086 BEAVERDAM CREEK.GPJ TERRACON_DATATEMPLATE.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-46-1086 BEAVERDAM CREEK.GPJ TERRACON_DATATEMPLATE.GDT 8/18/23



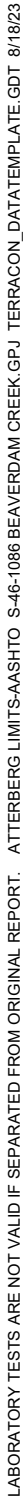
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
S-46-1086-2	26 - 28					36.0		
S-46-1086-2 Bulk	0 - 5					56.5		CL

GRAIN SIZE				SOIL DESCRIPTION			
D ₆₀							
D ₃₀							
D ₁₀							
COEFFICIENTS				REMARKS			
C _c							
C _u							

PROJECT: S-46-1086 BRO Beaverdam Creek	<p>521 Clemson Rd Columbia, SC</p>	PROJECT NUMBER: 7323P100
SITE: York County, SC		CLIENT: NHTB

ASTM D4318



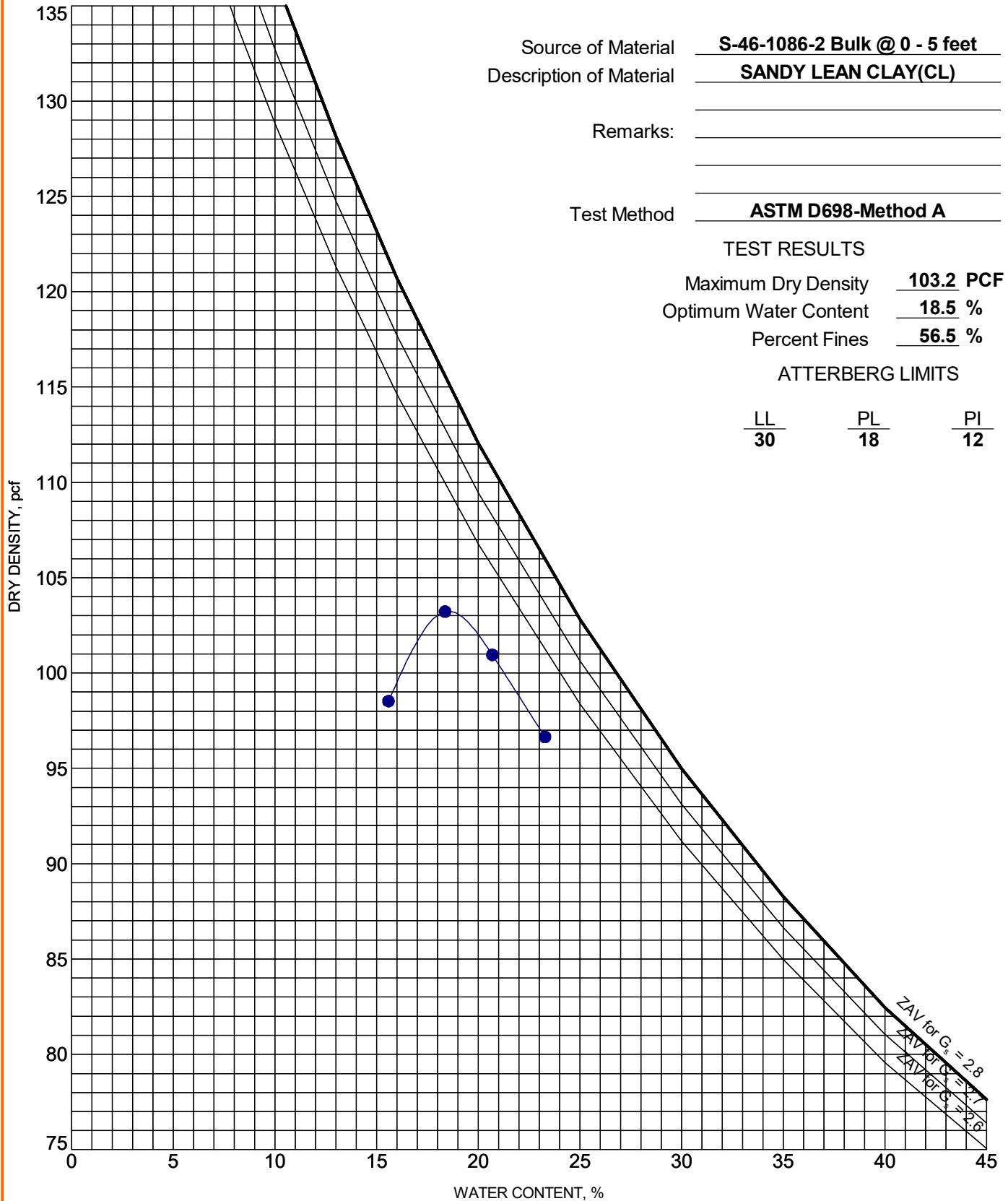
CLIENT: NHTB

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT.

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V2 S-46-1086 BEAVERDAM CREEK.GPJ TERRACON_DATATEMPLATE.GDT 8/18/23



PROJECT: S-46-1086 BRO Beaverdam Creek

SITE: York County, SC

Terracon
521 Clemson Rd
Columbia, SC

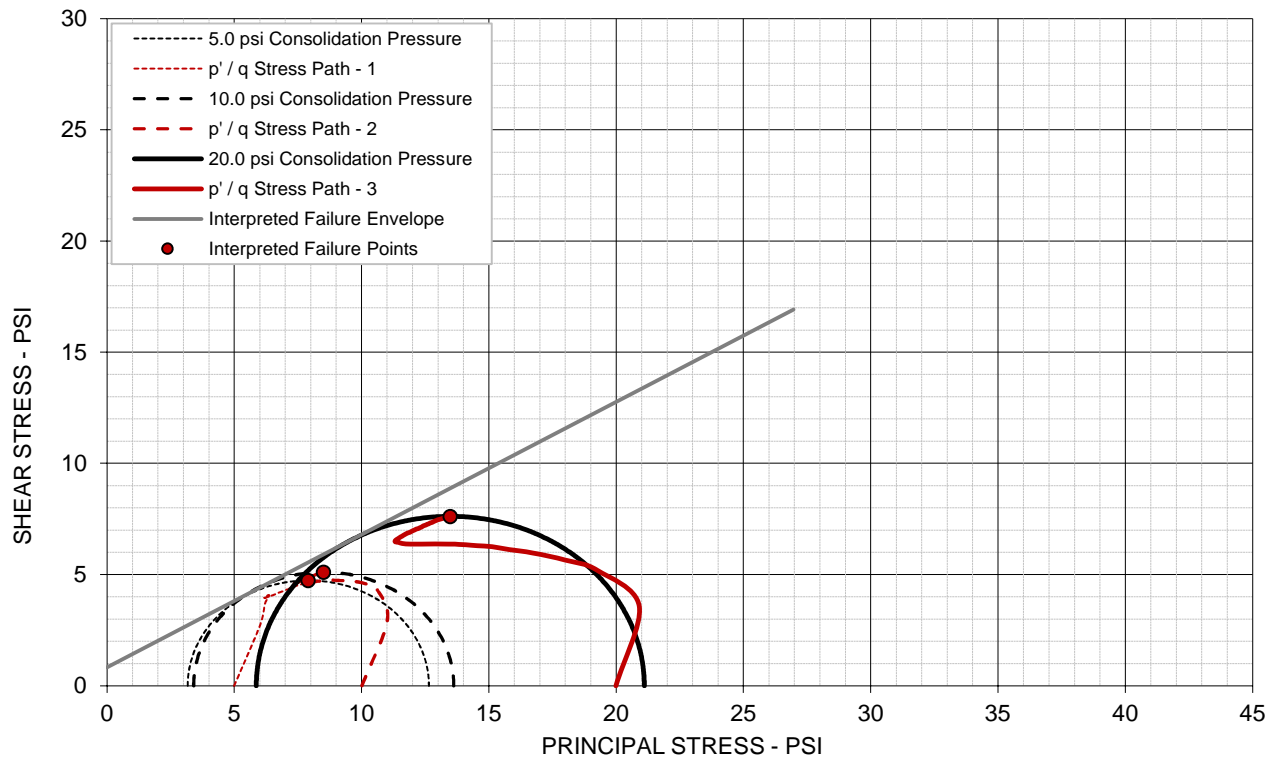
PROJECT NUMBER: 7323P100

CLIENT: NHTB

ICU TRIAXIAL COMPRESSION TEST

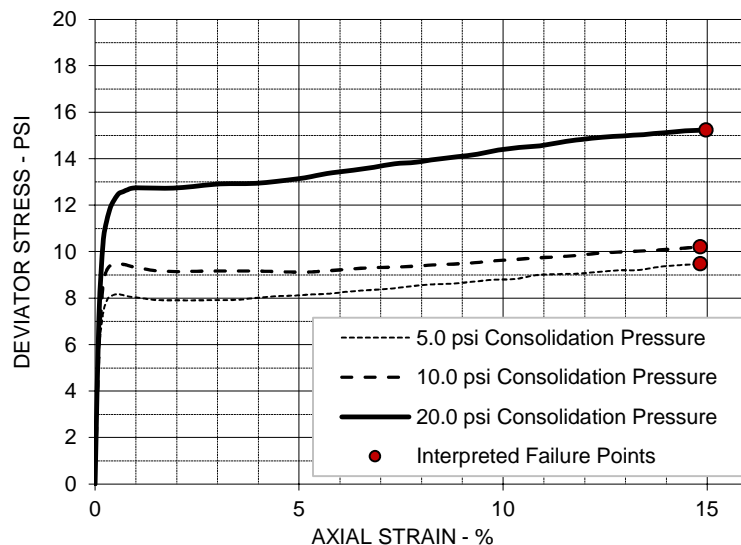
ASTM D4767 / AASHTO T297

Failure Criteria: Max Deviator Stress



EFFECTIVE STRESS PARAMETERS

$\phi' = 30.8$ deg $c' = 0.8$ psi



SPECIMEN NO.	1	2	3
INITIAL			
Moisture Content - %	18.6	18.6	18.6
Dry Density - pcf	98.0	98.0	98.0
Diameter - inches	2.86	2.86	2.86
Height - inches	6.00	6.00	6.00
AT TEST			
Final Moisture - %	24.8	24.1	23.1
Dry Density - pcf	98.1	98.7	99.9
Calculated Diameter (in.)	2.83	2.84	2.81
Height - inches	5.95	5.95	5.89
Effect. Consol. Stress - psi	5.0	10.0	20.0
Failure Stress - psi	9.48	10.21	15.24
Total Pore Pressure - psi	81.8	86.6	94.1
Strain Rate - %/min.	0.0335	0.0334	0.0338
Failure Strain - %	14.8	14.8	15.0
σ_1' Failure - psi	12.64	13.62	21.10
σ_3' Failure - psi	3.17	3.40	5.86

TEST DESCRIPTION

ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION

SAMPLE TYPE: Remolded

DESCRIPTION: Sandy Lean Clay (CL) / A-6 (4)

SAMPLE ID: S-46-1086-2 Bulk 0-5'

SPECIFIC GRAVITY: 2.65

LL: 30 PL: 18 PI: 12 Percent -200: 56.5%

Remarks: Remolded to 95% of the Standard Proctor

PROJECT INFORMATION

PROJECT: S-46-1086 BRO Beaverdam Creek

LOCATION: York County, SC

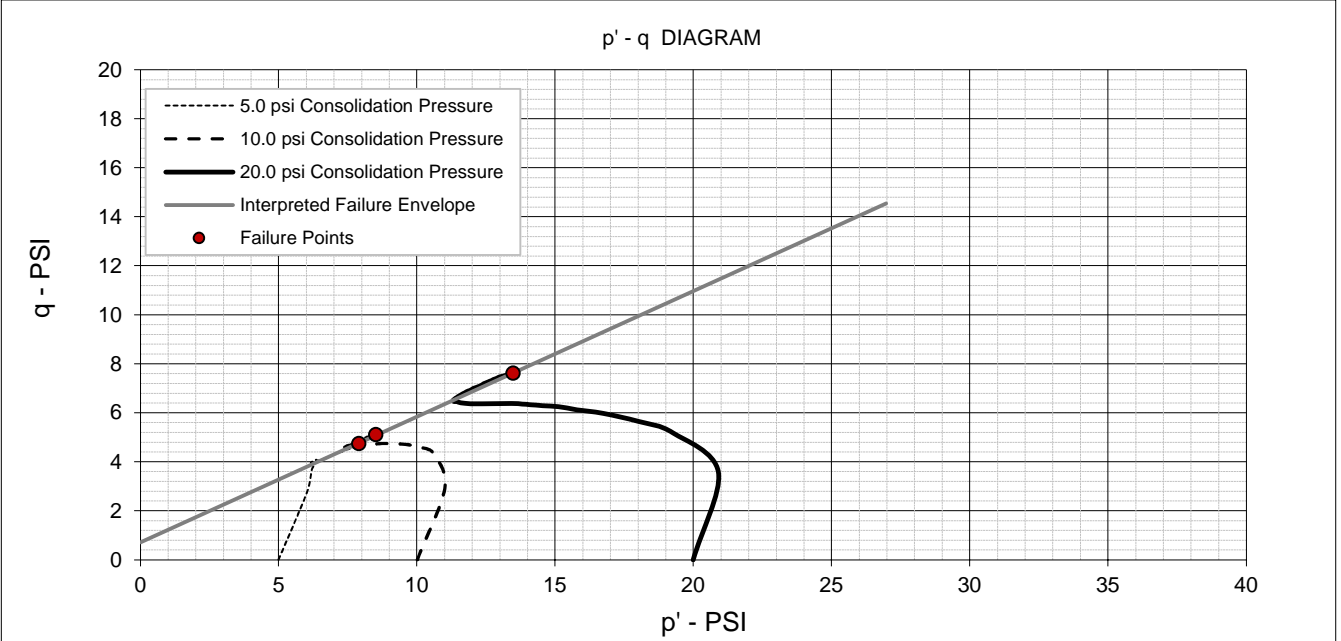
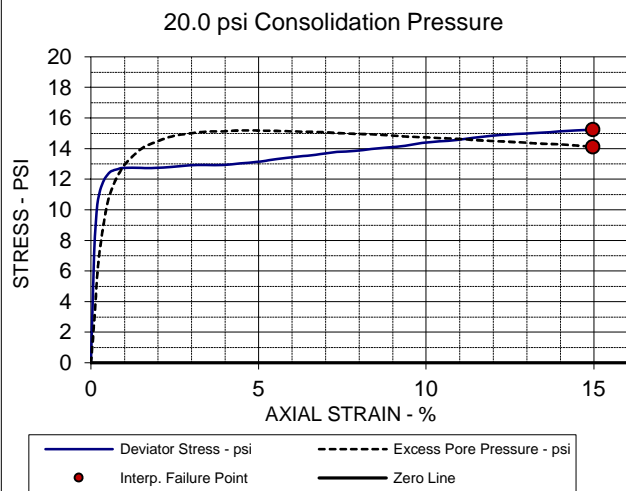
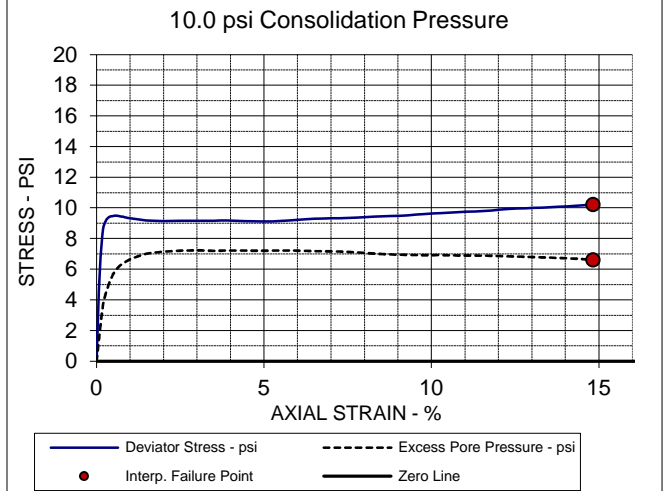
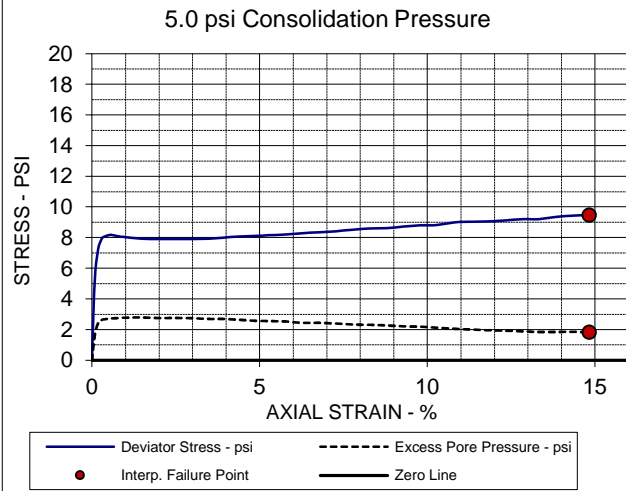
PROJECT #: 7323P100


CLIENT: HNTB

DATE: 07/05/23

521 Clemson Road
Columbia, SC





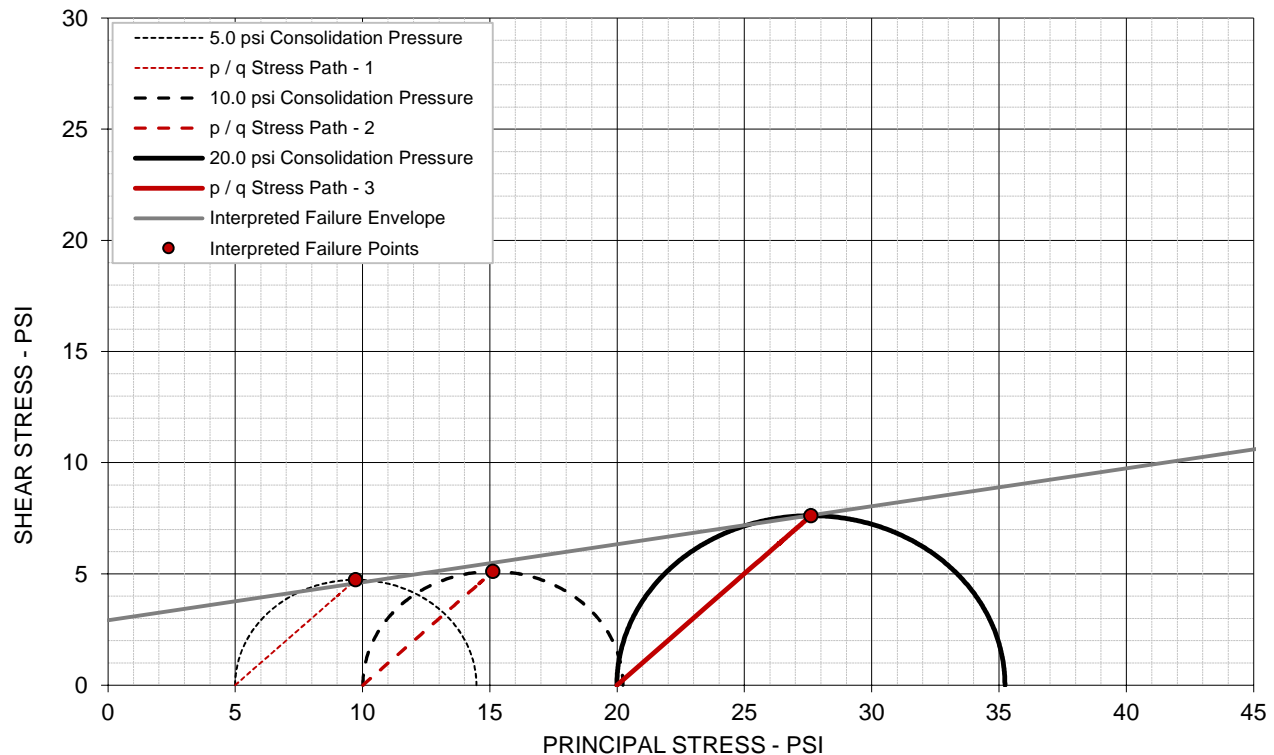
EFFECTIVE STRESS PARAMETERS	R ² = 1.00	α = 27.1 deg	a = 0.7 psi
PROJECT: S-46-1086 BRO Beaverdam Creek		ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION TEST	
LOCATION: York County, SC		CLIENT: HNTB	
SAMPLE ID: S-46-1086-2 Bulk 0-5'		<div>521 Clemson Road Columbia, SC</div> <div></div>	
DESCRIPTION: Sandy Lean Clay (CL) / A-6 (4)			



ICU TRIAXIAL COMPRESSION TEST

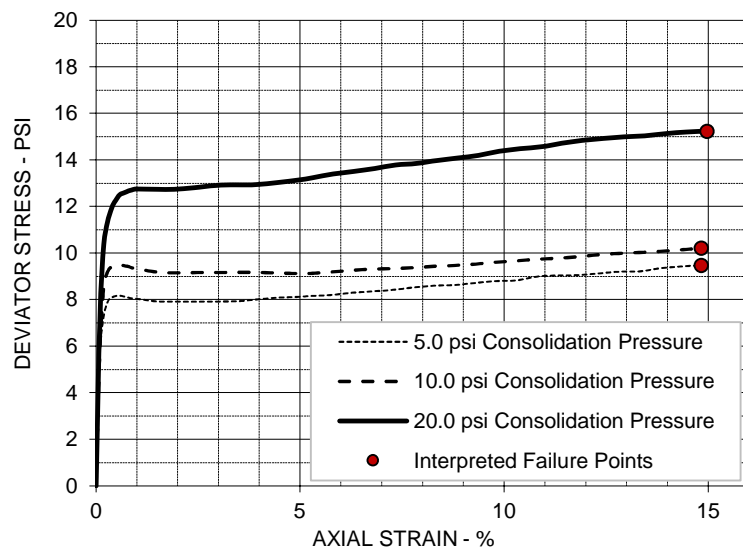
ASTM D4767 / AASHTO T297

Failure Criteria: Max Deviator Stress



TOTAL STRESS PARAMETERS

$\phi = 9.7$ deg $c = 2.9$ psi



SPECIMEN NO.

1 2 3

INITIAL

Moisture Content - %	18.6	18.6	18.6
Dry Density - pcf	98.0	98.0	98.0
Diameter - inches	2.86	2.86	2.86
Height - inches	6.00	6.00	6.00

AT TEST

Final Moisture - %	24.8	24.1	23.1
Dry Density - pcf	98.1	98.7	99.9
Calculated Diameter (in.)	2.83	2.84	2.81
Height - inches	5.95	5.95	5.89
Effect. Consol. Stress - psi	5.0	10.0	20.0
Failure Stress - psi	9.48	10.21	15.24
Total Pore Pressure - psi	81.8	86.6	94.1
Strain Rate - %/min.	0.0335	0.0334	0.0338
Failure Strain - %	14.8	14.8	15.0
σ_1 Failure - psi	14.47	20.22	35.23
σ_3 Failure - psi	4.99	10.01	19.99

TEST DESCRIPTION

ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION

SAMPLE TYPE: Remolded

DESCRIPTION: Sandy Lean Clay (CL) / A-6 (4)

SAMPLE ID: S-46-1086-2 Bulk 0-5'

SPECIFIC GRAVITY: 2.65

LL: 30 PL: 18 PI: 12 Percent -200: 56.5%

Remarks: Remolded to 95% of the Standard Proctor

PROJECT INFORMATION

PROJECT: S-46-1086 BRO Beaverdam Creek

LOCATION: York County, SC

PROJECT #: 7323P100

CLIENT: HNTB

DATE: 07/05/23

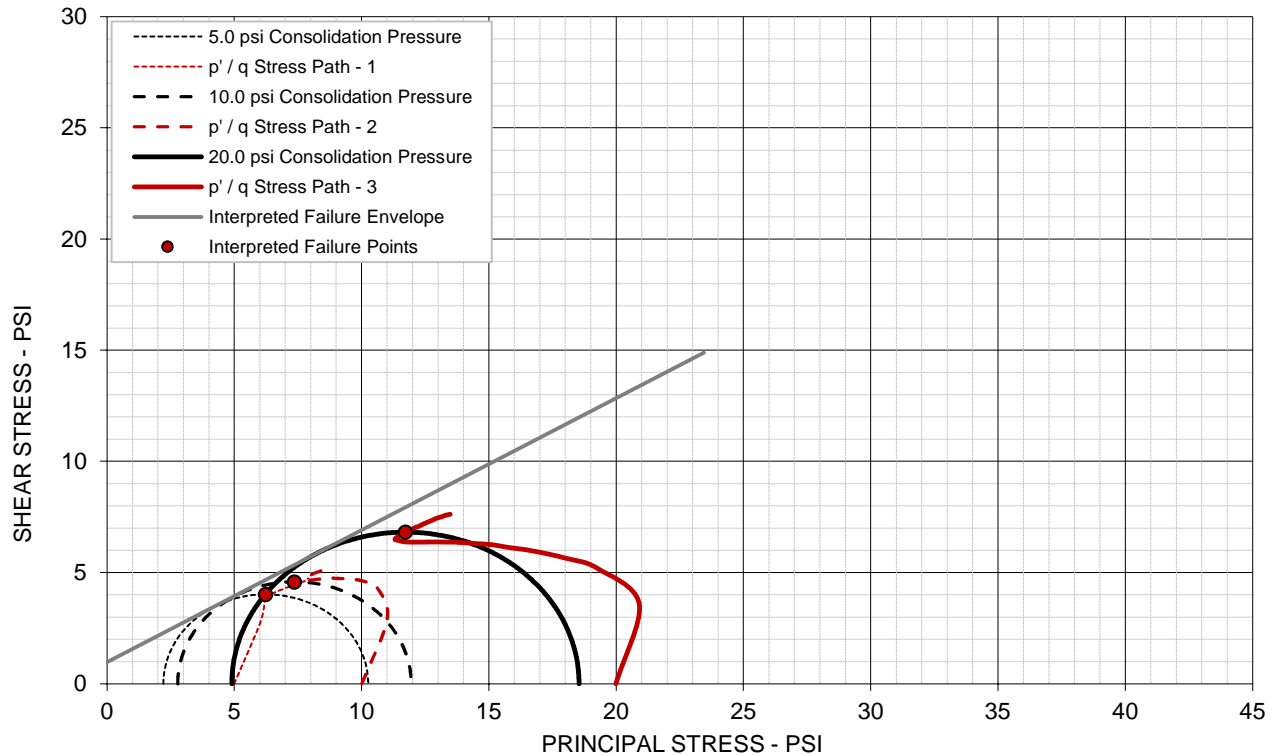
521 Clemson Road
Columbia, SC



ICU TRIAXIAL COMPRESSION TEST

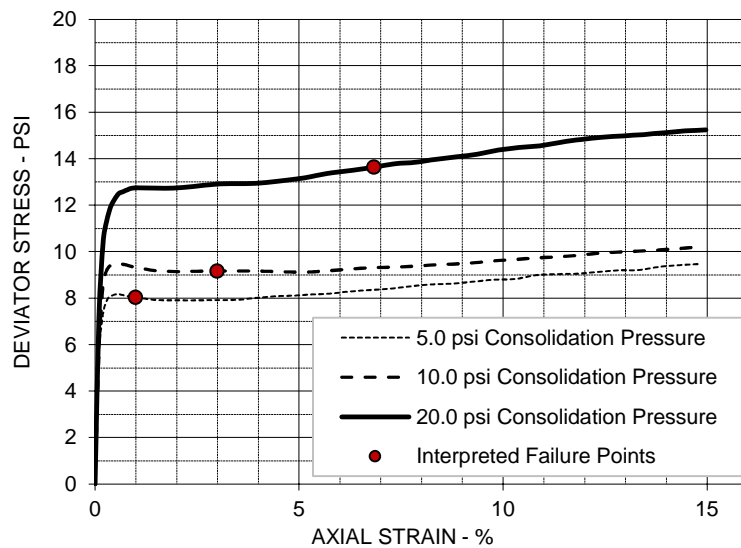
ASTM D4767 / AASHTO T297

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



EFFECTIVE STRESS PARAMETERS

$\phi' = 30.7 \text{ deg}$ $c' = 1.0 \text{ psi}$



SPECIMEN NO.

1 2 3

INITIAL

Moisture Content - %	18.6	18.6	18.6
Dry Density - pcf	98.0	98.0	98.0
Diameter - inches	2.86	2.86	2.86
Height - inches	6.00	6.00	6.00

AT TEST

Final Moisture - %	24.8	24.1	23.1
Dry Density - pcf	98.1	98.7	99.9
Calculated Diameter (in.)	2.83	2.84	2.81
Height - inches	5.95	5.95	5.89
Effect. Consol. Stress - psi	5.0	10.0	20.0
Failure Stress - psi	8.04	9.17	13.64
Total Pore Pressure - psi	82.8	87.2	95.1
Strain Rate - %/min.	0.0335	0.0334	0.0338
Failure Strain - %	1.0	3.0	6.8
σ_1' Failure - psi	10.26	11.95	18.54
σ_3' Failure - psi	2.21	2.78	4.90

TEST DESCRIPTION

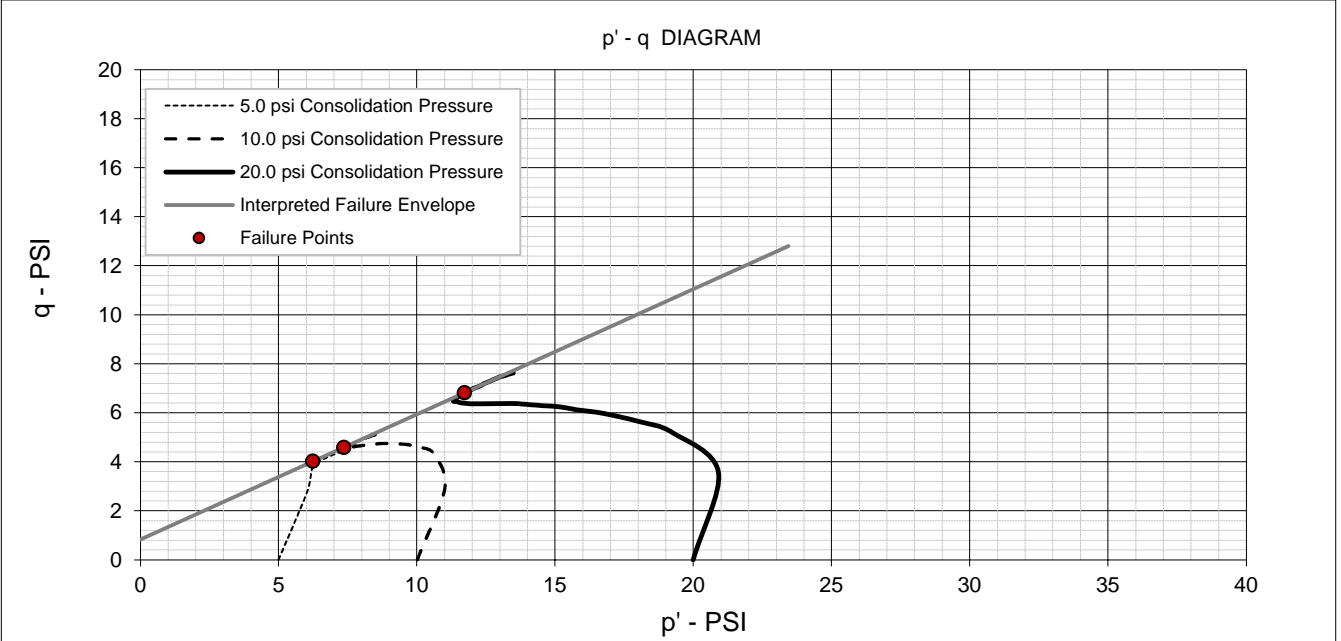
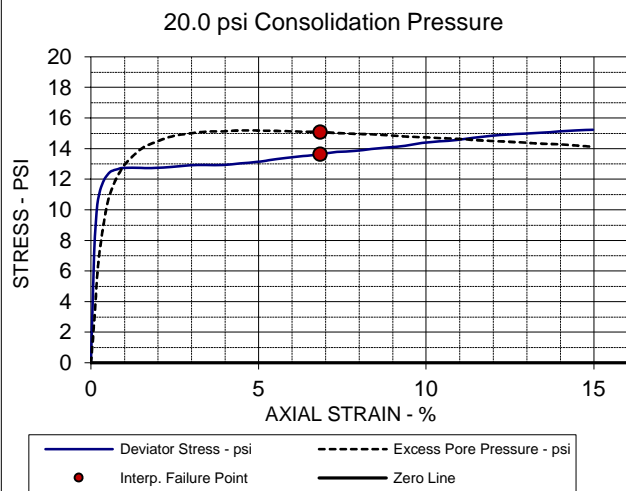
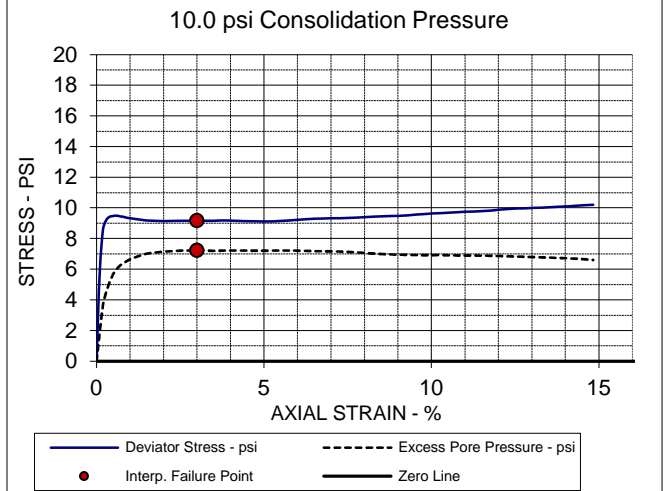
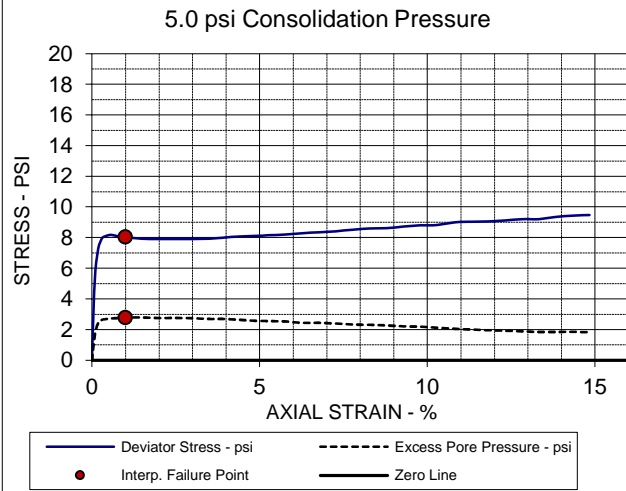
ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION
 SAMPLE TYPE: Remolded
 DESCRIPTION: Sandy Lean Clay (CL) / A-6 (4)
 SAMPLE ID: S-46-1086-2 Bulk 0-5'
 SPECIFIC GRAVITY: 2.65
 LL: 30 PL: 18 PI: 12 Percent -200: 56.5%
 Remarks: Remolded to 95% of the Standard Proctor


PROJECT INFORMATION

PROJECT: S-46-1086 BRO Beaverdam Creek
 LOCATION: York County, SC
 PROJECT #: 7323P100
 CLIENT: HNTB
 DATE: 07/05/23

521 Clemson Road
 Columbia, SC





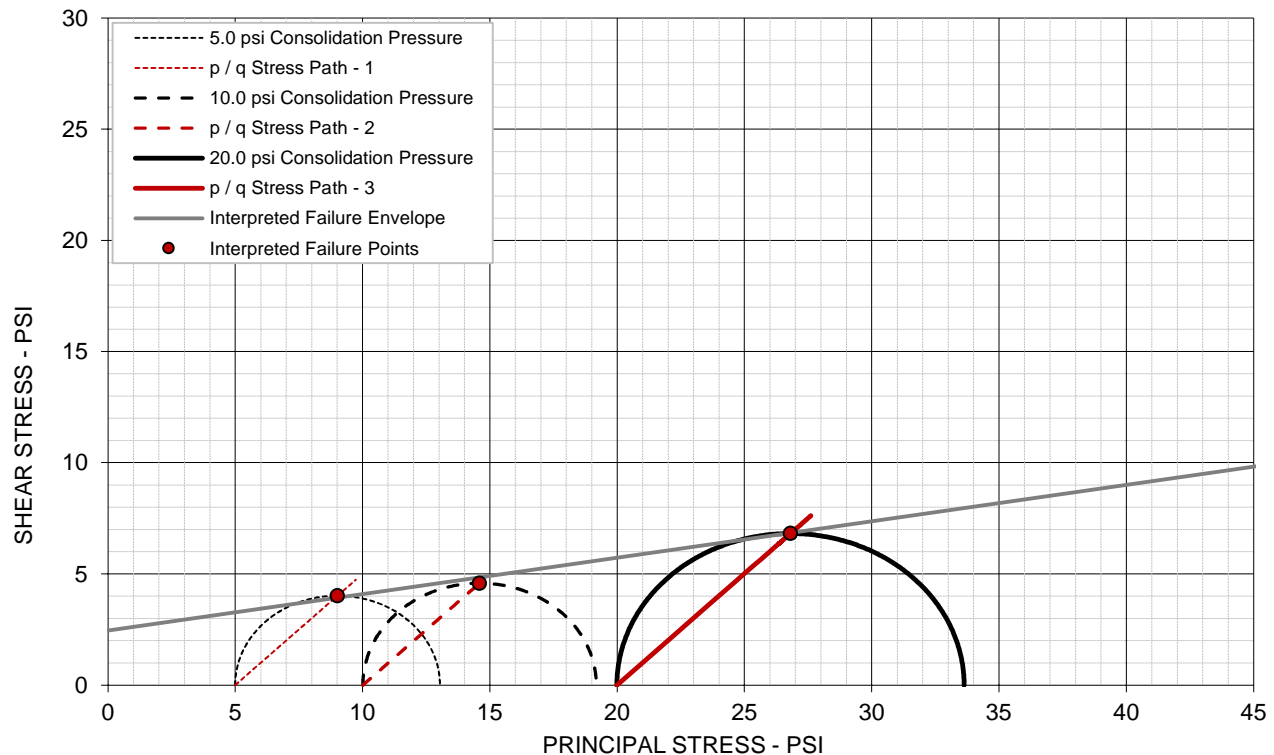
EFFECTIVE STRESS PARAMETERS		R ² = 1.00	α = 27.1 deg	a = 0.8 psi
PROJECT: S-46-1086 BRO Beaverdam Creek			ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION TEST	
LOCATION: York County, SC			CLIENT: HNTB	
SAMPLE ID: S-46-1086-2 Bulk 0-5'			<div>521 Clemson Road Columbia, SC</div> <div></div>	
DESCRIPTION: Sandy Lean Clay (CL) / A-6 (4)				



ICU TRIAXIAL COMPRESSION TEST

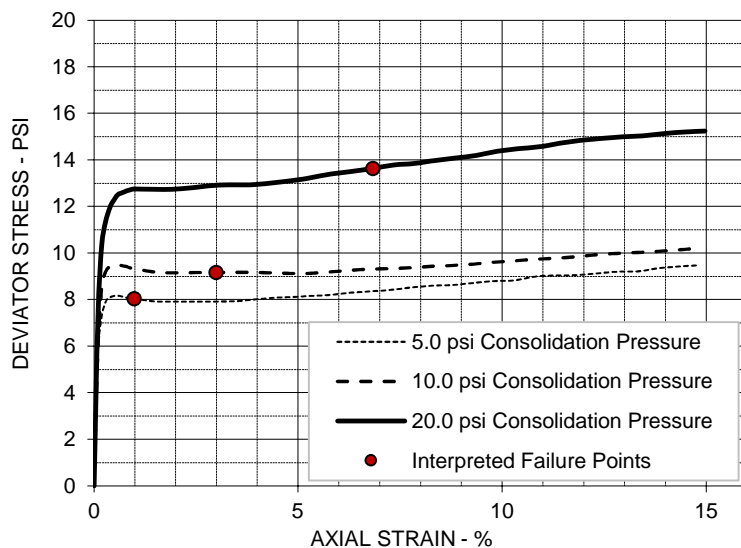
ASTM D4767 / AASHTO T297

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



TOTAL STRESS PARAMETERS

$\phi = 9.3 \text{ deg}$ $c = 2.5 \text{ psi}$



SPECIMEN NO.

1 2 3

INITIAL

Moisture Content - %	18.6	18.6	18.6
Dry Density - pcf	98.0	98.0	98.0
Diameter - inches	2.86	2.86	2.86
Height - inches	6.00	6.00	6.00

AT TEST

Final Moisture - %	24.8	24.1	23.1
Dry Density - pcf	98.1	98.7	99.9
Calculated Diameter (in.)	2.83	2.84	2.81
Height - inches	5.95	5.95	5.89
Effect. Consol. Stress - psi	5.0	10.0	20.0
Failure Stress - psi	8.04	9.17	13.64
Total Pore Pressure - psi	82.8	87.2	95.1
Strain Rate - %/min.	0.0335	0.0334	0.0338
Failure Strain - %	1.0	3.0	6.8
σ_1 Failure - psi	13.03	19.18	33.62
σ_3 Failure - psi	4.99	10.01	19.99

TEST DESCRIPTION

ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION
 SAMPLE TYPE: Remolded
 DESCRIPTION: Sandy Lean Clay (CL) / A-6 (4)
 SAMPLE ID: S-46-1086-2 Bulk 0-5'
 SPECIFIC GRAVITY: 2.65
 LL: 30 PL: 18 PI: 12 Percent -200: 56.5%
 Remarks: Remolded to 95% of the Standard Proctor

PROJECT INFORMATION

PROJECT: S-46-1086 BRO Beaverdam Creek
 LOCATION: York County, SC
 PROJECT #: 7323P100
 CLIENT: HNTB
 DATE: 07/05/23

521 Clemson Road
 Columbia, SC





Rock Coring Summary

PAGE 1 OF 1

PROJECT ID P041173

PROJECT NAME S-46-1086 RBO Beaverdam Creek

PROJECT COUNTY York

Borehole	Core Run Number	Core Run Top Depth	REC (%)	RQD (%)	q _u (psi)	Poisson's Ratio	Secant Modulus (ksi)	Unit Weight (pcf)	RMR	GSI
S-46-1086-1	NQ-1	43.0	69	30						60
S-46-1086-1	NQ-2	44.5	72	22	6378	0.61	567	160	36	60
S-46-1086-1	NQ-3	49.5	80	38	10538	0.41	878	161	44	70
S-46-1086-1	NQ-4	54.5	40	0						20
S-46-1086-1	NQ-5	59.5	100	33						60
S-46-1086-2	NQ-1	38.2	100	86	11146	0.00	699	177	53	70
S-46-1086-2	NQ-2	43.2	100	48	5988	0.02	691	174	41	70

Report Number: 7323P100
Service Date: 06/02/23
Report Date: 07/10/23



Client

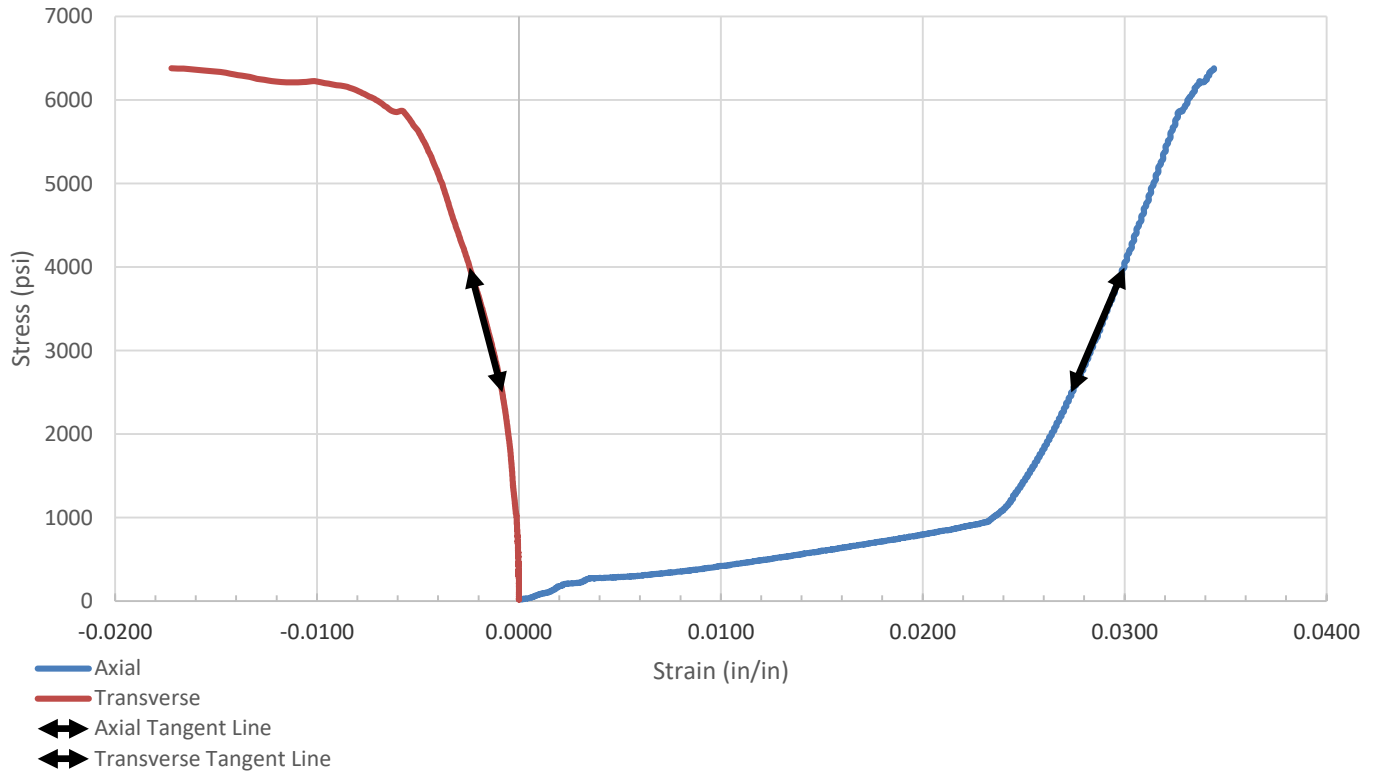
HNTB North Carolina PC
Attn: Spencer Franklin
343 E Six Forks Rd Ste 200
Raleigh, NC 27609

Project

SCDOT Bridge Package 20

Project No. 7323P100

ASTM D7012 Stress/ Strain Curve



SAMPLE LOCATION

Site:	S-46-1086		
Rock Type:	Granodiorite		
Boring:	S-46-1086-1	Depth (feet):	44.5

SPECIMEN INFORMATION

Sample No.:	L-4082 (NQ -2)	Mass (g):	543.15
Length (in.):	4.19	Diameter (in.):	1.98
L/D Ratio:	2.1	Density (pcf):	160.142

TEST RESULTS

Failure Load (lbs):	19679
Failure Strain (%):	3.49
Unconfined Compressive Strength (psi):	6,378
Elastic Modulus, E, (ksi):	567
Poisson's Ratio, u:	0.611
Time of Failure (min):	03:00
Rate of Loading (psi/sec):	35.435
Moisture Content Post-break:	0.4%

Report Number: 7323P100

Service Date: 06/02/23

Report Date: 07/10/23

Client

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

Project

SCDOT Bridge Package 20

Project No. 7323P100

ASTM D4543 Test Results:

<u>Parameter</u>	<u>Data</u>
Side Straightness:	0.0043
Perpendicularity Deviation:	
Diameter 1a:	0.0039
Diameter 1b:	0.0018
Diameter 2a:	0.0038
Diameter 2b:	0.0014
Max Deviation from Flatness:	0.0027
Parallelism Deviation:	
Diameter a:	0.01
Diameter b:	0.05

Equipment:

	TICCS ID:
Calipers:	W-44049
Scale:	B-71466
Dial Indicator:	C-70608
Compression (spherically seated):	C-48999

Samples were prepared and tested in general accordance with ASTM D4543 and D7012.

Report Number: 7323P100
Service Date: 06/02/23
Report Date: 07/10/23



Client

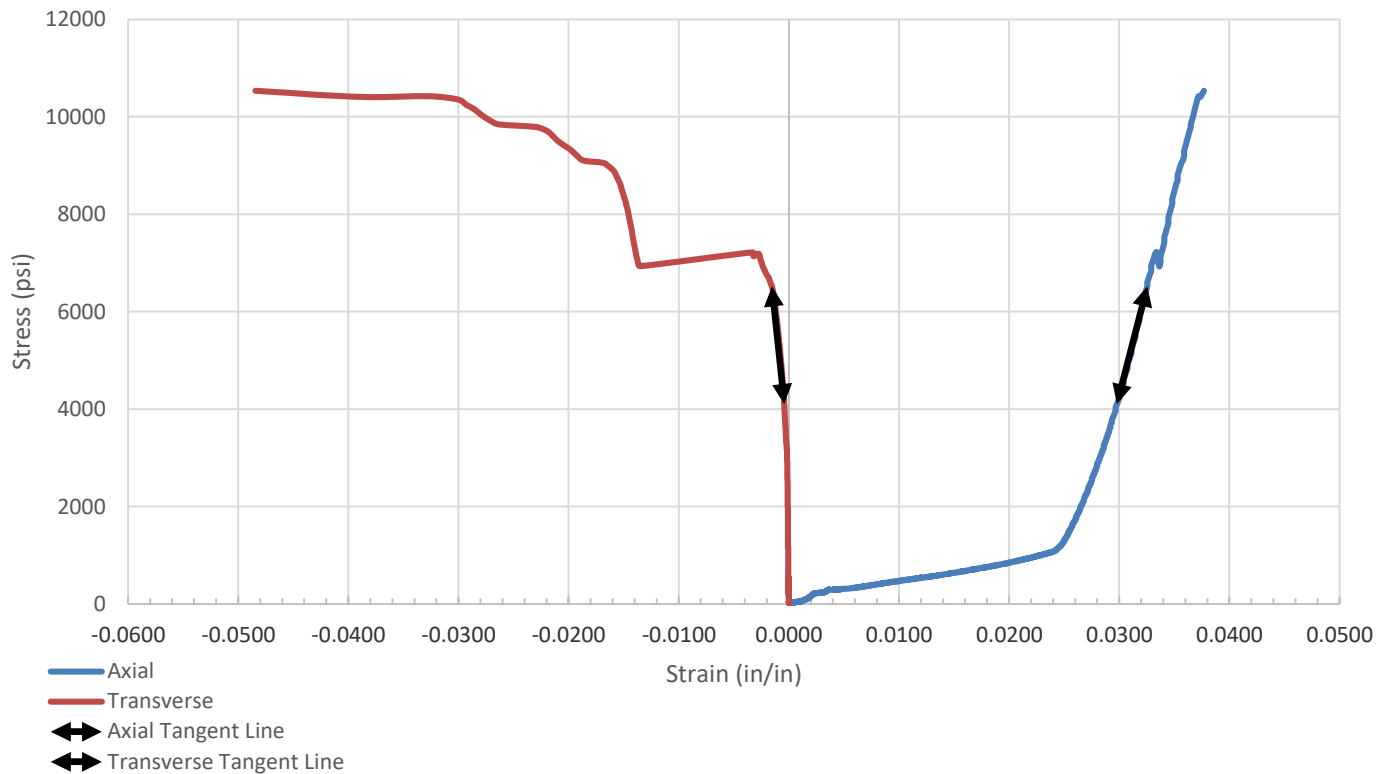
HNTB North Carolina PC
Attn: Spencer Franklin
343 E Six Forks Rd Ste 200
Raleigh, NC 27609

Project

SCDOT Bridge Package 20

Project No. 7323P100

ASTM D7012 Stress/ Strain Curve



SAMPLE LOCATION

Site:	S-46-1086		
Rock Type:	Granodiorite		
Boring:	S-46-1086-1	Depth (feet):	49.5

SPECIMEN INFORMATION

Sample No.:	L-4083 (NQ -3)	Mass (g):	546.64
Length (in.):	4.2015	Diameter (in.):	1.98
L/D Ratio:	2.1	Density (pcf):	160.568

TEST RESULTS

Failure Load (lbs):	32546
Failure Strain (%):	3.77
Unconfined Compressive Strength (psi):	10,538
Elastic Modulus, E, (ksi):	878
Poisson's Ratio, ν :	0.408
Time of Failure (min):	03:43
Rate of Loading (psi/sec):	47.172
Moisture Content Post-break:	0.1%

Report Number: 7323P100

Service Date: 06/02/23

Report Date: 07/10/23

Client

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

Project

SCDOT Bridge Package 20

Project No. 7323P100

ASTM D4543 Test Results:

<u>Parameter</u>	<u>Data</u>
Side Straightness:	0.0310
Perpendicularity Deviation:	
Diameter 1a:	0.0021
Diameter 1b:	0.0233
Diameter 2a:	0.0027
Diameter 2b:	0.0255
Max Deviation from Flatness:	0.0025
Parallelism Deviation:	
Diameter a:	0.09
Diameter b:	3.11

Equipment:

	TICCS ID:
Calipers:	W-44049
Scale:	B-71466
Dial Indicator:	C-70608
Compression (spherically seated):	C-48999

Samples were prepared and tested in general accordance with ASTM D4543 and D7012.

Report Number: 7323P100
Service Date: 06/02/23
Report Date: 07/10/23



Client

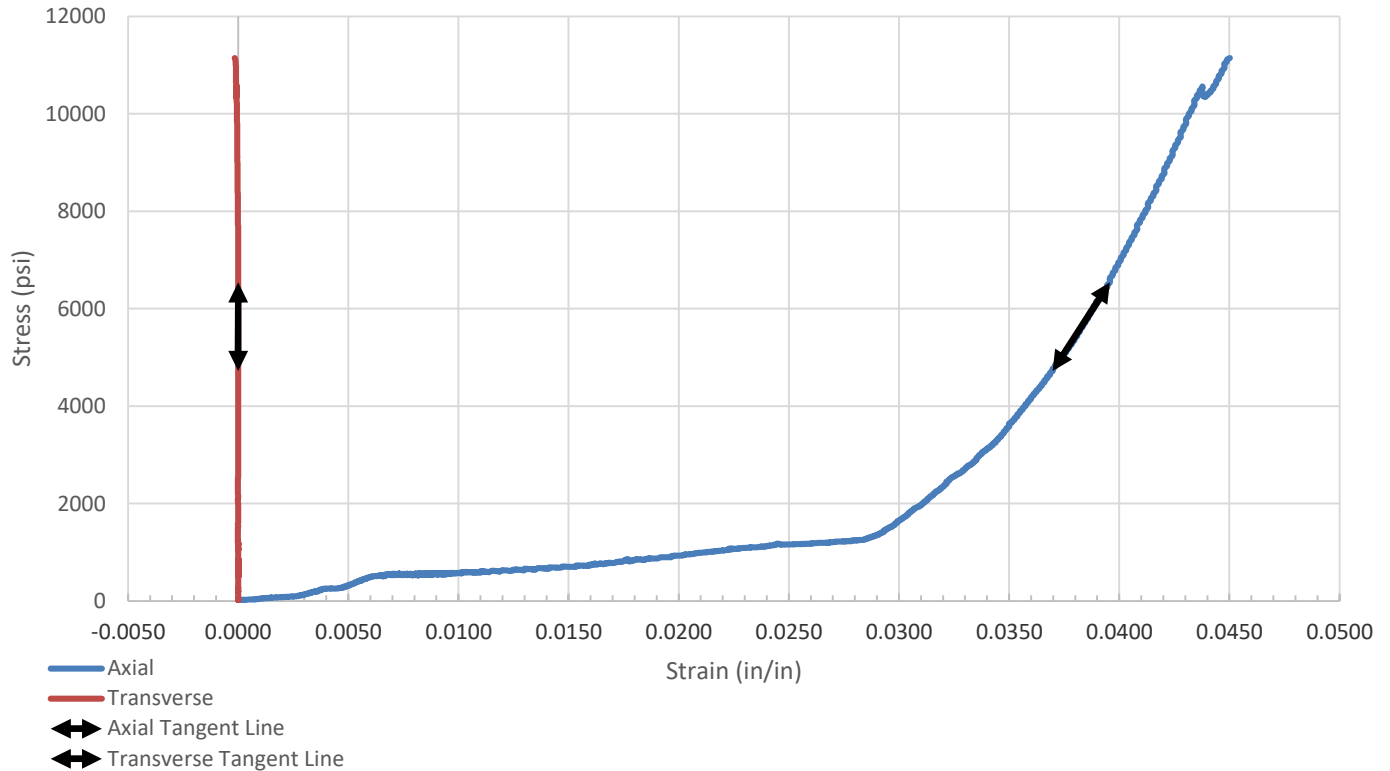
HNTB North Carolina PC
Attn: Spencer Franklin
343 E Six Forks Rd Ste 200
Raleigh, NC 27609

Project

SCDOT Bridge Package 20

Project No. 7323P100

ASTM D7012 Stress/ Strain Curve



SAMPLE LOCATION

Site:	S-46-1086		
Rock Type:	Granodiorite		
Boring:	S-46-1086-2	Depth (feet):	38.2

SPECIMEN INFORMATION

Sample No.:	L-4084 (NQ-1)	Mass (g):	579.7
Length (in.):	4.064	Diameter (in.):	1.98
L/D Ratio:	2.1	Density (pcf):	176.842

TEST RESULTS

Failure Load (lbs):	34251
Failure Strain (%):	4.54
Unconfined Compressive Strength (psi):	11,146
Elastic Modulus, E, (ksi):	699
Poisson's Ratio, u:	0.002
Time of Failure (min):	03:30
Rate of Loading (psi/sec):	52.976
Moisture Content Post-break:	0.5%

Report Number: 7323P100

Service Date: 06/02/23

Report Date: 07/10/23

Client

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

Project

SCDOT Bridge Package 20

Project No. 7323P100

ASTM D4543 Test Results:

<u>Parameter</u>	<u>Data</u>
Side Straightness:	0.0093
Perpendicularity Deviation:	
Diameter 1a:	0.0122
Diameter 1b:	0.0035
Diameter 2a:	0.0103
Diameter 2b:	0.0041
Max Deviation from Flatness:	0.0019
Parallelism Deviation:	
Diameter a:	0.06
Diameter b:	0.47

Equipment:

	TICCS ID:
Calipers:	W-44049
Scale:	B-71466
Dial Indicator:	C-70608
Compression (spherically seated):	C-48999

Samples were prepared and tested in general accordance with ASTM D4543 and D7012.

Report Number: 7323P100
Service Date: 06/02/23
Report Date: 07/10/23



Client

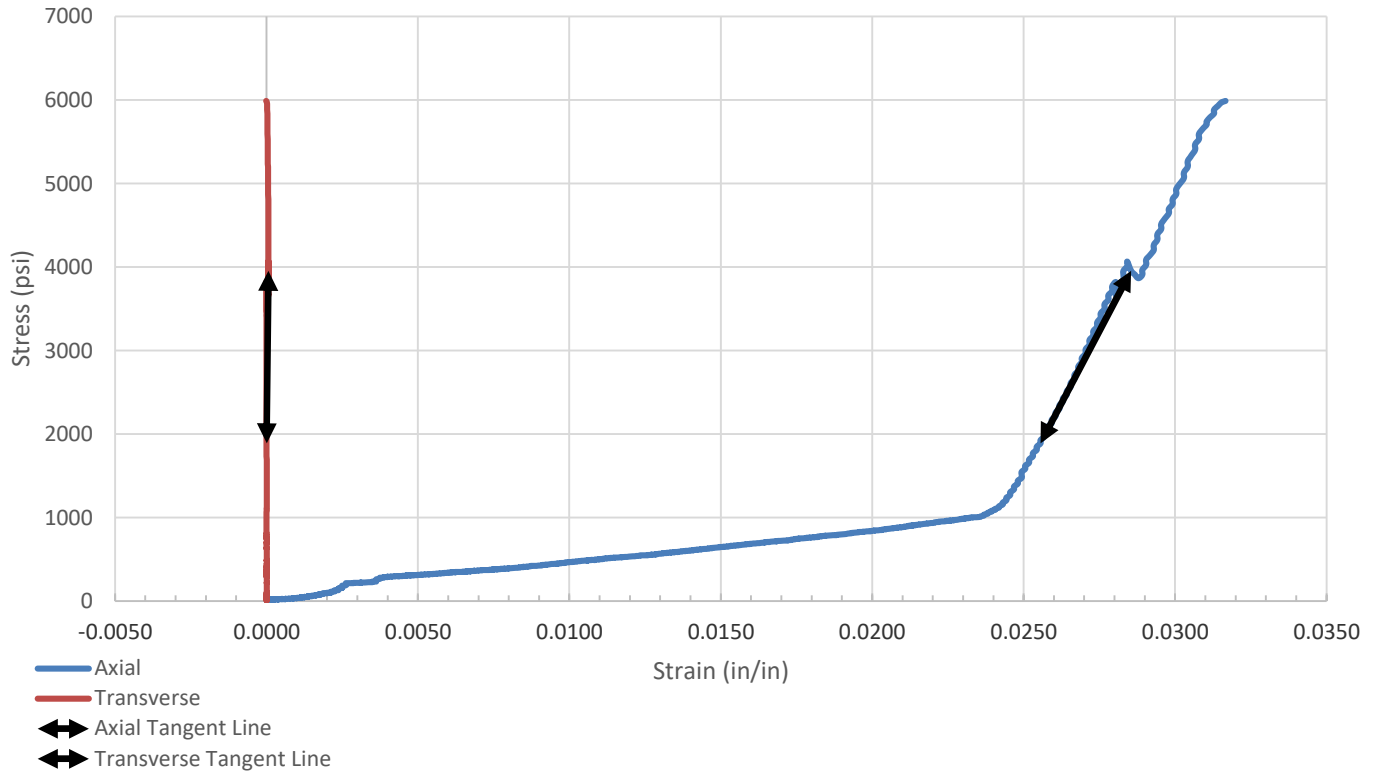
HNTB North Carolina PC
Attn: Spencer Franklin
343 E Six Forks Rd Ste 200
Raleigh, NC 27609

Project

SCDOT Bridge Package 20

Project No. 7323P100

ASTM D7012 Stress/ Strain Curve



SAMPLE LOCATION

Site:	S-46-1086		
Rock Type:	Granodiorite		
Boring:	S-46-1086-2	Depth (feet):	43.2

SPECIMEN INFORMATION

Sample No.:	L-4165 (NQ -2)	Mass (g):	564.24
Length (in.):	4.032	Diameter (in.):	1.98
L/D Ratio:	2.0	Density (pcf):	173.667

TEST RESULTS

Failure Load (lbs):	18380
Failure Strain (%):	3.17
Unconfined Compressive Strength (psi):	5,988
Elastic Modulus, E, (ksi):	691
Poisson's Ratio, u:	0.020
Time of Failure (min):	03:05
Rate of Loading (psi/sec):	32.365
Moisture Content Post-break:	0.4%

Report Number: 7323P100

Service Date: 06/02/23

Report Date: 07/10/23

Client

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

Project

SCDOT Bridge Package 20

Project No. 7323P100

ASTM D4543 Test Results:

<u>Parameter</u>	<u>Data</u>
Side Straightness:	0.0150
Perpendicularity Deviation:	
Diameter 1a:	0.0064
Diameter 1b:	0.0215
Diameter 2a:	0.0112
Diameter 2b:	0.0327
Max Deviation from Flatness:	0.0043
Parallelism Deviation:	
Diameter a:	0.36
Diameter b:	3.52

Equipment:

	TICCS ID:
Calipers:	W-44049
Scale:	B-71466
Dial Indicator:	C-70608
Compression (spherically seated):	C-48999

Samples were prepared and tested in general accordance with ASTM D4543 and D7012.

Client

HNTB North Carolina PC
Raleigh, NC

Project

S-46-1086 BRO Beaverdam Creek
7323P100

Date Received: 6/27/2023

Results from Corrosion Testing

Sample Location	S-46-1086-2
Sample Depth (ft.)	0'-10'

pH Analysis, ASTM G 51	5.93
------------------------	------

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

Chlorides, APHA 4500-Cl ⁻ E, (mg/kg)	12
---	----

Resistivity (Saturated), ASTM G 57, (ohm-cm)	7200
--	------

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

3-Point Acceleration Design Response Spectrum by
SCDOT
Rig Calibration Report (10 Pages)

Note: All exhibits are one page unless noted above.

3-Point Acceleration Design Response Spectrum

SCDOT v3.2 - 06/01/2023

Project ID:	P041173	Latitude:	35.1385
Route:	S-46-1086	County:	46 - York
Project:	Bridge Replacement over Beaverdam Creek (Barrett Road)		
		Longitude:	81.2322

Designer:	N. Harman - Support
Date:	7/20/2023

Design EQ	PGA	S _{DS}	S _{D1}	M _W	R	PGV	D ₅₋₉₅	T' _o
	g	g	g	-	km	inches/sec	sec	sec
FEE	0.03	0.07	0.01	7.31	221.23	0.32	52.58	0.17
SEE	0.05	0.12	0.02	7.33	221.33	0.67	53.02	0.16

Fundamental Period of Structure, T _o	Range of Interest		V _{s,H}	H	T _{NH}	
	sec	sec			sec	sec
	0.5*T _o	2.0*T _o	ft/sec	ft	(4*H)/V _{s,H}	(6*H)/V _{s,H}
0.00	0.00	0.00	1088.44	42.00	0.12	0.23
0.00	0.00	0.00				

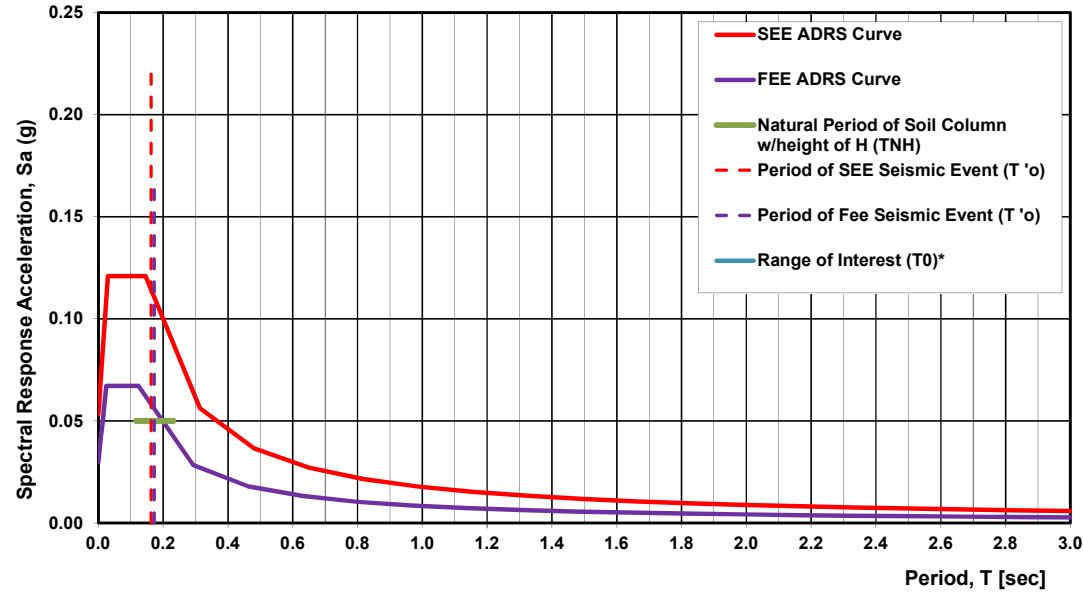
H = B-C Boundary

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

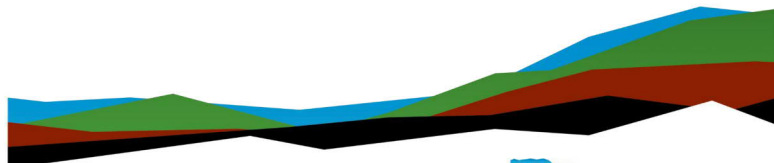


FEE Data		SEE Data	
T	S _a	T	S _a
0.00	0.030	0.00	0.053
0.00	0.036	0.00	0.065
0.01	0.042	0.01	0.076
0.01	0.048	0.01	0.087
0.02	0.055	0.02	0.098
0.02	0.061	0.02	0.110
0.02	0.067	0.03	0.121
0.03	0.067	0.04	0.121
0.04	0.067	0.05	0.121
0.05	0.067	0.06	0.121
0.06	0.067	0.07	0.121
0.07	0.067	0.08	0.121
0.07	0.067	0.09	0.121
0.08	0.067	0.10	0.121
0.09	0.067	0.11	0.121
0.10	0.067	0.12	0.121
0.11	0.067	0.13	0.121
0.12	0.067	0.14	0.121
0.12	0.067	0.15	0.121
0.29	0.028	0.31	0.056
0.46	0.018	0.48	0.037
0.63	0.013	0.65	0.027
0.80	0.010	0.82	0.022
0.97	0.009	0.99	0.018
1.14	0.007	1.15	0.015
1.31	0.006	1.32	0.013
1.48	0.006	1.49	0.012
1.65	0.005	1.66	0.011
1.82	0.005	1.82	0.010
1.98	0.004	1.99	0.009
2.15	0.004	2.16	0.008
2.32	0.004	2.33	0.008
2.49	0.003	2.50	0.007
2.66	0.003	2.66	0.007
2.83	0.003	2.83	0.006
3.00	0.003	3.00	0.006

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
Drill Rig Owner	Terracon Consultant, Inc. - Columbia, SC
Drill Rig Operator	Shiver Truesdale; Terracon Exploration
Testing Date	07/03/2023
Testing Location	Columbia, SC
Boring Identification	B-1
Hammer Type	140 pounds (automatic)
Boring Method	Rotary Wash
Drill Rods	<ul style="list-style-type: none"> AWJ 1-3/4" outside diameter 3/16" wall thickness
Calibration Testing Equipment	<ul style="list-style-type: none"> 2-foot AWJ rod instrumented w/ two strain gauges and two accelerometers Model SPT Analyzer™ (PDA)
ASTM Methods Used	<p>ASTM D1586, Standard Test Method for Standard Penetration Test and Split-Barrel Sampling of Soils</p> <p>ASTM D4633-16, Standard Method for Energy Measurement for Dynamic Penetrometers</p>
SPT Calibration Personnel	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

James P. Smith
 National Manager of Equipment & Training

Rob Kramer

Rob Kramer
 Geophysical Services Manager, COG

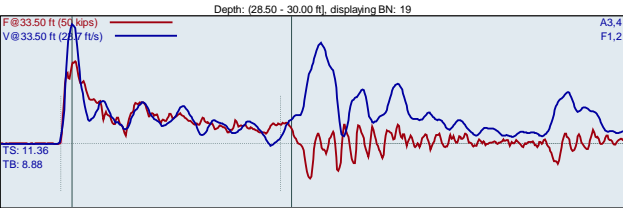
Attachments:

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



Exhibit A

PDA SPT Analyzer Results



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

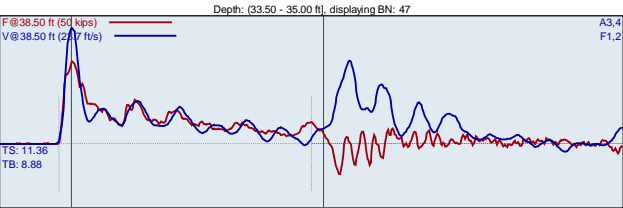
A3 (PR): [K5998] 403.535 mw/6.4v5000g (1) VF1
A4 (PR): [K10453] 411.89 mw/6.4v5000g (1) VF1

FMX: Maximum Force
VMX: Maximum Velocity
BPM: Blows/Minute

EFV: Maximum Energy
ETR: Energy Transfer Ratio - Rated

BL#	BC /6"	FMX kips	VMX ft/s	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	323	94.1
14	9	32	22.1	48.0	326	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	326	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.



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

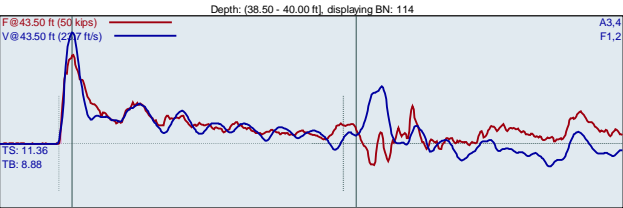
A3 (PR): [K5998] 403.535 mw/6.4v5000g (1) VF1
A4 (PR): [K10453] 411.89 mw/6.4v5000g (1) VF1

FMX: Maximum Force
VMX: Maximum Velocity
BPM: Blows/Minute

EFV: Maximum Energy
ETR: Energy Transfer Ratio - Rated

BL#	BC /6"	FMX kips	VMX ft/s	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

Sample Interval Time: 32.40 seconds.



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

A3 (PR): [K5998] 403.535 mw/6.4v5000g (1) VF1
A4 (PR): [K10453] 411.89 mw/6.4v5000g (1) VF1

FMX: Maximum Force
VMX: Maximum Velocity
BPM: Blows/Minute

EFV: Maximum Energy
ETR: Energy Transfer Ratio - Rated

BL#	BC /6"	FMX kips	VMX ft/s	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	344	98.4
70	19	35	22.9	47.7	344	98.4
71	19	34	22.1	48.1	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	48.3	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	326	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	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: Dietrich D50 (SN 479), Test Date: 7/3/2023										EFV: Maximum Energy	
FMX: Maximum Force										ETR: Energy Transfer Ratio - Rated	
VMX: Maximum Velocity											
BPM: Blows/Minute											
Test Length ft		Blows Applied /ft	N Value	N50 Value	Average FMX kips	Average VMX ft/s	Average BPM bpm	Average EFV ft-lb	Average ETR %		
33.50		6-6-9	15	23	32	22.1	48.1	329	93.9		
38.50		7-9-12	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		
Overall Average Values:					33	20.9	48.1	328	93.9		
Standard Deviation:					1	0.9	0.3	8	2.3		
Overall Maximum Value:					35	23.0	48.8	344	98.4		
Overall Minimum Value:					30	19.2	47.2	302	86.2		



Exhibit B

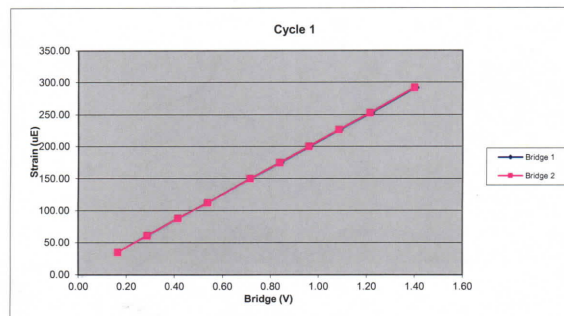
PDA Equipment Calibration



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

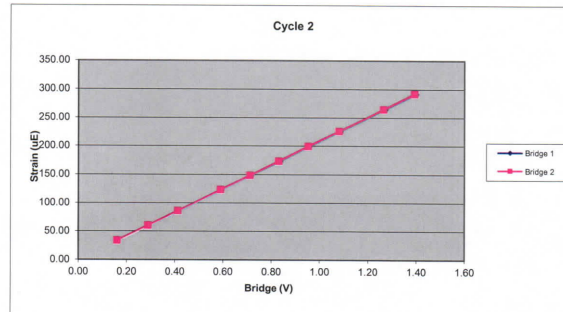
Force Strain Calibration	
EA (Kips)	35589.20
Offset	-14.99
Correlation	0.999992



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

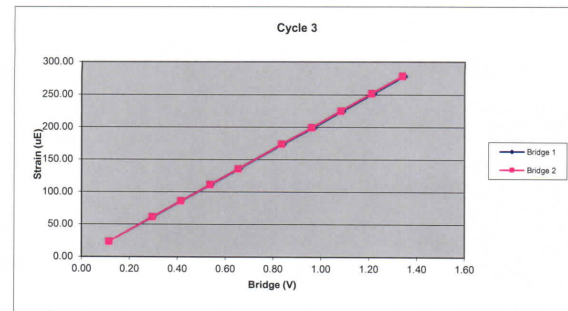
Force Strain Calibration	
EA (Kips)	35302.85
Offset	47.38
Correlation	0.999989



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 ²)	1.18

Calibrated by: Sam Davis
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

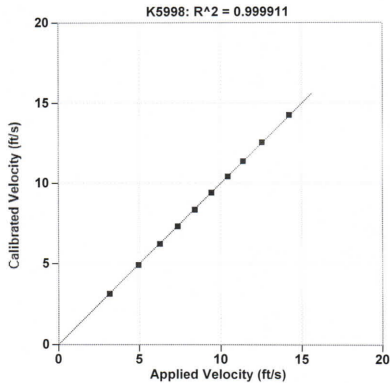
PDA CALIBRATION FACTOR
403.5 mv/5000g
(80.7 μ v/g)
R²: 0.999911 [Chip programmed]

Operator: 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).



Date printed: 03Aug2022, version: 2020.30.170 -1.89

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

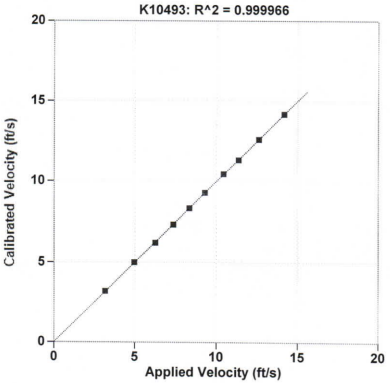
PDA CALIBRATION FACTOR
411.9 mv/5000g
(82.4 μ v/g)
R²: 0.999966 [Chip programmed]

Operator: 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).



Date printed: 03Aug2022, version: 2020.30.170 -1.65

SPT Automatic Hammer Energy Measurement Report

Drill Rig Model: CME 45C
Serial Number: 406484
Terracon Drill Rig Asset Number: DR#543
July 29, 2022



Prepared for:
Terracon Consultants, Inc.
Columbia Exploration Services

Prepared by:
Terracon Consultants, Inc.
Exploration Services Group



July 29, 2022

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

Attn: Mr. Phillip Morris
E: phillip.morrison@terracon.com

Re: SPT Automatic Hammer Energy Measurement Report
Terracon Drill Rig DR#543; CME 45C
Terracon Project Number: DUXX0500

Dear Mr. Phillip Morrison:

This report provides the Energy Transfer Ratio (ETR) for the SPT automatic hammer found on drill rig model CME 45C; Terracon Drill Rig Asset Number DR#543 (Serial Number: 406484).

Table 1: Hammer Measurement Summary

Drill Rig Model	Serial No.	Drill Rig Year	Drill Rig No.	Energy Transfer Ratio (ETR)	Hammer Efficiency Correction (Ce)
CME 45C	406484	2018	DR#543	93.5% ± 4.5%	1.56

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

Sincerely,
Terracon Consultants, Inc.

Smith,
James P.
James Smith
National Exploration Manager

Digitally signed by Smith, James P.
DN: cn=James P. Smith, email=j.smith@terracon.com,
c=US, o=Terracon Consultants, Inc., ou=Exploration Services Group
Reason: I have the following comment:
Date: 2022.08.10 17:46:58 -0400

Jerry Salsgiver, P.E.
Assistant National Manager

Attachments:
Exhibit A: Measurement Information
Exhibit B: PDA SPT Analyzer Results

Terracon Consultants, Inc. 10841 S. Ridgeview Road Olathe, KS 66061
P (407) 446 2527 terracon.com

terracon.com

Terracon

Environmental Facilities Geotechnical Materials

Environmental Facilities Geotechnical Materials

Exhibit A Measurement Information

MEASUREMENT INFORMATION

ITEM	DESCRIPTION
Drill Rig Identification	Drill Rig Model: CME 45C Drill Rig Year: 2018 Terracon Drill Rig Asset No.: DR#543; Serial No. 406484
Drill Rig Owner	Terracon Consultants, Inc. – Columbia, SC
Drill Rig Operator	Aaron Bowen; Columbia Exploration
Testing Date	07/28/2022
Testing Location	Columbia, SC
Boring Identification	B-1
Hammer Type	140 pounds (automatic)
Boring Method	Rotary Wash
Drill Rods	■ AWJ ■ 1 3/4" outside diameter ■ 3/16" wall thickness
Testing Equipment	■ 2-foot AWJ rod instrumented w/ 2 strain gauges and 2 accelerometers ■ Model SPT Analyzer™ (PDA)
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
Personnel	Jim Smith – National Exploration Manager - Terracon Consultants, Inc.

Exhibit B

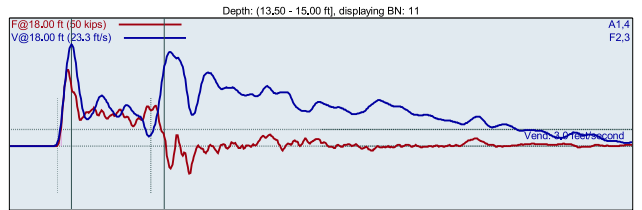
PDA SPT ANALYZER RESULTS

Pile Dynamics, Inc.
SPT Analyzer Results

Page 1 of 5
PDA-S Ver. 2018.24 - Printed: 7/29/2022

DU-543-406484
Jim Smith
AR: 1.20 in²
LE: 18.00 ft
WS: 16807.9 fts

13.5-15.1
Test date: 7/28/2022
SP: 0.492 k/ft³
EM: 30000 ksi



F2 : [648AWJ1] 226,21 PDICAL (1) FF1
F3 : [648AWJ2] 225,58 PDICAL (1) FF1

A1 (PR): [K4484] 353,907 mv/6.4v/5000g (1) VF1
A4 (PR): [K4483] 410,187 mv/6.4v/5000g (1) VF1

FMX: Maximum Force
VMX: Maximum Velocity
BPM: Blows/Minute

EFV: Maximum Energy
ETR: Energy Transfer Ratio - Rated

BL#	BC /6"	FMX kips	VMX ft/s	BPM	EFV ft-lb	ETR %
1	2	28	18.4	1.9	279	79.8
2	2	30	18.4	51.6	276	78.9
3	2	31	18.9	51.6	305	87.1
4	2	30	18.3	51.6	309	88.2
5	9	30	18.4	51.7	319	91.2
6	9	29	19.0	51.5	318	91.0
7	9	29	18.5	51.3	305	87.0
8	9	29	18.4	51.2	313	89.3
9	9	30	18.0	51.0	317	90.5
10	9	29	18.6	51.1	317	90.5
11	9	30	18.5	51.0	302	86.1
12	9	30	19.3	51.0	312	88.1
13	9	30	18.8	51.0	321	91.6
Average		30	18.6	51.3	312	89.2
Std Dev		1	0.3	0.3	6	1.8
Maximum		31	19.3	51.7	321	91.6
Minimum		29	18.0	51.0	302	86.1

N-value: 11

Sample Interval Time: 14.02 seconds.

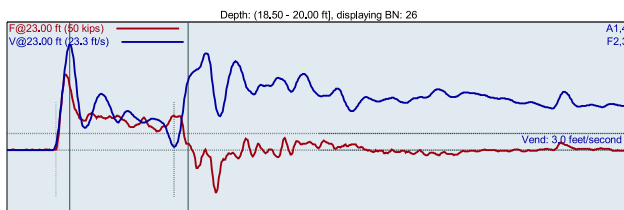
Responsive ■ Resourceful ■ Reliable

Pile Dynamics, Inc.
SPT Analyzer Results

Page 2 of 5
PDA-S Ver. 2018.24 - Printed: 7/29/2022

DU-543-406484
Jim Smith
AR: 1.20 in²
LE: 23.00 ft
WS: 16807.9 fts

13.5-15.1
Test date: 7/28/2022
SP: 0.492 k/ft³
EM: 30000 ksi



F2 : [648AWJ1] 226,21 PDICAL (1) FF1
F3 : [648AWJ2] 225,58 PDICAL (1) FF1

A1 (PR): [K4484] 353,907 mv/6.4v/5000g (1) VF1
A4 (PR): [K4483] 410,187 mv/6.4v/5000g (1) VF1

BL#	BC /6"	FMX kips	VMX ft/s	BPM	EFV ft-lb	ETR %
14	5	29	18.1	1.9	322	91.9
15	5	29	19.0	55.9	320	91.3
16	5	30	18.7	55.3	315	90.3
17	5	30	19.2	55.4	334	95.6
18	5	29	19.5	55.7	317	90.5
19	5	29	19.0	55.8	316	90.3
20	5	29	19.4	55.1	320	91.3
21	5	29	18.8	55.9	320	91.5
22	5	30	19.3	55.2	324	92.5
23	5	29	19.2	55.5	320	91.6
24	5	29	19.0	55.6	314	89.7
25	5	30	18.7	55.4	330	94.2
26	5	29	19.2	55.0	310	88.5
27	5	29	18.5	55.2	301	86.0
28	5	30	18.4	54.6	311	88.8
Average		29	19.0	55.3	317	90.4
Std Dev		0	0.3	0.4	8	2.2
Maximum		30	19.4	55.9	330	94.2
Minimum		29	18.4	54.6	301	86.0

N-value: 10

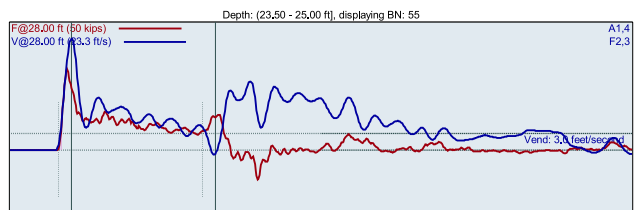
Sample Interval Time: 15.13 seconds.

Pile Dynamics, Inc.
SPT Analyzer Results

Page 3 of 5
PDA-S Ver. 2018.24 - Printed: 7/29/2022

DU-543-406484
Jim Smith
AR: 1.20 in²
LE: 28.00 ft
WS: 16807.9 fts

13.5-15.1
Test date: 7/28/2022
SP: 0.492 k/ft³
EM: 30000 ksi



F2 : [648AWJ1] 226,21 PDICAL (1) FF1
F3 : [648AWJ2] 225,58 PDICAL (1) FF1

A1 (PR): [K4484] 353,907 mv/6.4v/5000g (1) VF1
A4 (PR): [K4483] 410,187 mv/6.4v/5000g (1) VF1

BL#	BC /6"	FMX kips	VMX ft/s	BPM	EFV ft-lb	ETR %
29	12	1	0.4	1.9	3	0.9
30	12	30	19.1	63.1	340	97.2
31	12	29	20.1	55.5	357	101.9
32	12	29	20.1	55.2	364	104.0
33	12	10	7.3	78.6	55	15.7
34	12	31	20.4	41.0	361	103.2
35	12	31	19.8	57.1	346	98.8
36	12	31	20.0	55.3	342	97.6
37	12	30	19.6	55.6	342	97.8
38	12	31	19.9	55.6	332	94.8
39	12	31	19.8	55.5	337	96.3
40	12	31	19.9	55.5	336	95.9
41	9	31	19.6	55.6	345	98.4
42	9	31	20.1	55.2	335	95.6
43	9	31	19.6	55.6	341	97.4
44	9	31	20.2	55.4	341	97.3
45	9	32	19.5	55.4	341	97.5
46	9	31	19.9	55.5	349	99.7
47	9	31	19.8	55.3	344	98.1
48	9	31	19.9	55.5	346	98.9
49	9	31	19.9	55.6	341	97.6
50	8	31	19.9	55.2	347	99.2
51	8	31	20.0	55.6	338	96.6
52	8	31	20.1	55.2	341	97.4
53	8	32	20.1	55.4	352	100.7
54	8	32	19.8	55.8	348	99.3
55	8	32	20.3	55.1	345	98.5
56	8	32	20.0	55.6	347	99.2
57	8	31	20.0	55.5	340	97.1

Average	31	19.9	55.4	344	98.1
Std Dev	0	0.2	0.2	4	1.2
Maximum	32	20.3	55.8	352	100.7
Minimum	31	19.5	55.1	335	95.6

N-value: 17

Sample Interval Time: 30.24 seconds.

Summary of SPT Test Results

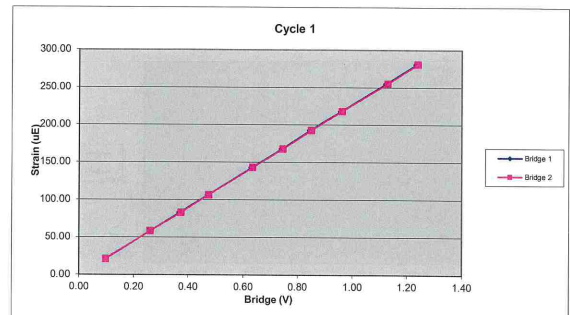
Project: DU-543-406484, Test Date: 7/28/2022						EFV: Maximum Energy ETR: Energy Transfer Ratio - Rated		
FMX: Maximum Force VMX: Maximum Velocity BPM: Blows/Minute								
Blow Length ft	Blows Applied /ft	N Value	N50 Value	Average FMX kips	Average VMX ft/s	Average BPM blm	Average EFV ft-lb	Average ETR %
18.00	20.0	11	17	30	18.6	51.3	312	89.2
23.00	15.0	10	15	29	19.0	55.3	317	90.4
28.00	12.0	17	26	31	19.9	55.4	344	98.1
Overall Average Values:				30	19.3	54.2	327	93.3
Standard Deviation:				1	0.7	1.9	16	4.5
Overall Maximum Value:				32	20.3	55.9	352	100.7
Overall Minimum Value:				29	18.0	51.0	301	86.0



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

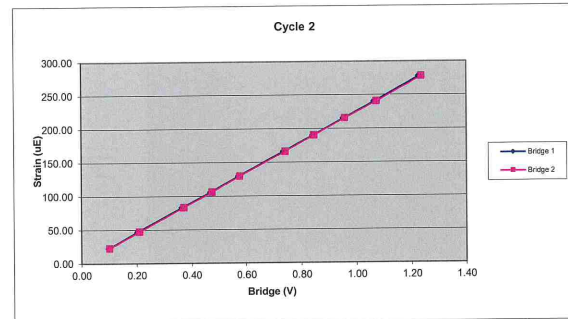
Force Strain Calibration	
EA (Kips)	35527.98
Offset	51.69
Correlation	0.999986



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
Offset	10.37
Correlation	0.999997
Strain Calibration (µE/V)	225.29
Offset	0.36
Correlation	0.999990

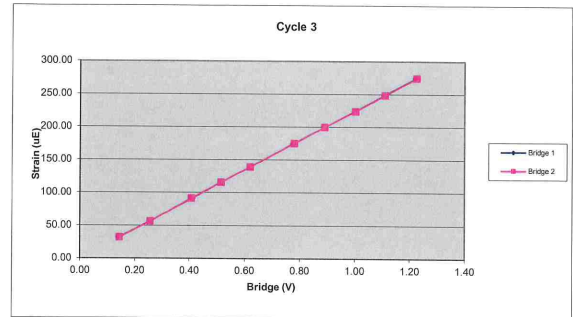
Force Strain Calibration	
EA (Kips)	36073.41
Offset	-2.66
Correlation	0.999993



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
Offset	-20.37
Correlation	0.999998
Strain Calibration (µE/V)	224.79
Offset	-0.57
Correlation	0.999984

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	225.58
EA Factor (Kips)	35925.67	1.20

Calibrated by: *Ant*
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

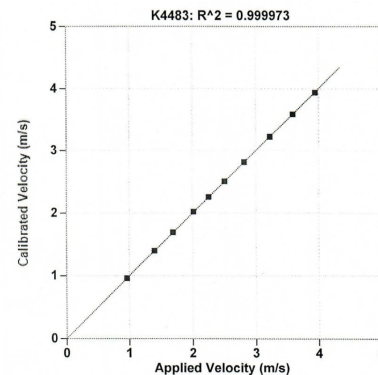
410.2 mv/5000g
(82.0 µV/g)
R²: 0.999973 [Chip programmed]

Operator: William Johnson

Ref Acc 1: 69096I Cal on: 27Jan2021
978 g's/volt
Ref Acc 2: 69132I Cal on: 09Feb2021
960 g's/volt

William Johnson
Signed

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



Reference Velocity m/s	S/N K4483 Velocity m/s
0.964	0.962
1.399	1.401
1.691	1.700
2.014	2.022
2.254	2.257
2.507	2.508
2.815	2.814
3.226	3.220
3.590	3.591
3.947	3.941

Maximum Acceleration: 874 g's

Accelerometer Calibration Certificate
Pile Dynamics, Inc.



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

Serial No: K4484 Temperature: 19.3 °C
Model: PR Humidity: 30%
Calibrated on: Channel 4 on 8G 5161 LE

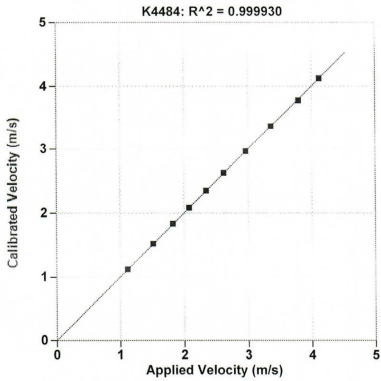
PDA CALIBRATION FACTOR
353.9 mv/5000g
(70.8 µv/g)
R^2: 0.999930 [Chip programmed]

Ref Acc 1: 69132! Cal on: 09Feb2021
960 g's/volt
Ref Acc 2: 69096! Cal on: 27Jan2021
978 g's/volt

Operator: William Johnson

Signed

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



Reference Velocity m/s	S/N K4484 Velocity m/s
1.117	1.124
1.518	1.523
1.823	1.835
2.078	2.080
2.344	2.349
2.616	2.624
2.963	2.962
3.360	3.357
3.794	3.778
4.121	4.122

Maximum Acceleration: 916 g's