

S-23-310 (Crestwood Drive) over Langston Tributary

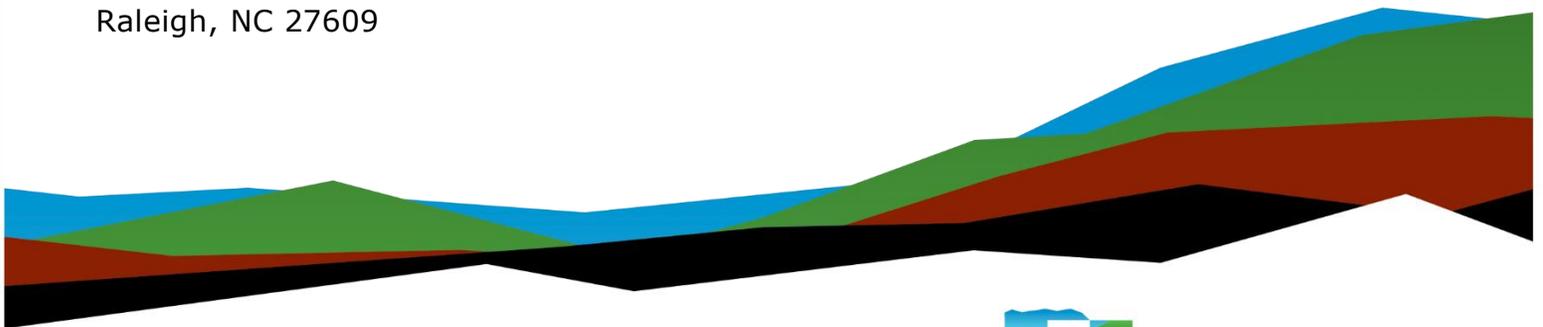
Greenville County, SC

Geotechnical Baseline Report

November 5, 2024 | SCDOT Project ID: P041162
Terracon Project No.: 8623P180 Revision 2

Prepared for:

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



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

- Facilities
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November 5, 2024

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

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

Re: Geotechnical Baseline Report
S-23-310 over Langston Tributary
Greenville County, South Carolina
SCDOT Project ID.: P041162
Terracon Project No.: 8623P180 Revision 1

Dear Mr. Franklin:

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

Introduction

HNTB Corporation (HNTB) has contracted Terracon to perform subsurface exploration, laboratory testing and limited preliminary geotechnical design considerations for a new box culvert along S-23-310 over Langston Tributary in Greenville County, South Carolina. The box culvert will replace the existing bridge. The results of subsurface exploration and laboratory testing have been separately presented in a Geotechnical Subsurface Data Report (GSDR). For convenience, the data is also provided in this Geotechnical Baseline Report (GBR) along with a characterization of the subsurface conditions for the project. Limited preliminary geotechnical design and construction considerations that are associated with the requested scope of work are included in this GBR. This GBR was prepared in general accordance with the 2022 SCDOT Geotechnical Design Manual (GDM).

Project Description

The project site is located at the S-23-310 (Crestwood Drive) crossing over Langston Tributary in Greenville County, South Carolina. Site location and exploration plans are presented in Appendix A of this report. Based on the conceptual plans by HNTB provided to Terracon on

November 1, 2024, the culvert will be constructed on a new road alignment that is slightly shifted to the west of the current alignment. The current plan indicates the new culvert will be a double-cell, 10 feet by 10 feet, cast-in-place box culvert that is 107 feet long. The overall height of the culvert is 11 feet 8 inches with a width of 22 feet.

Geotechnical Testing

The geotechnical exploration for this project was performed between June 5 and June 6, 2024. The results of our fieldwork 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-23-310-1 and S-23-310-2)
- One (1) offset boring near S-23-310-1 for bulk sample collection
- One (1) Downhole Shear Wave Velocity Test (DHT-1) located in Boring S-23-310-1
- One (1) Cone Penetration Test sounding (S-23-310-1C)

The tests were performed at the approximate locations as approved by SCDOT. A description of our testing methods and graphical logs outlining the soil conditions at each test location are presented in Appendix A. The test locations were established in the field by Terracon and surveyed by Thomas and Hutton, LLC after completion. Station and offset are based on the plans provided at the time the tests were performed.

Laboratory Testing

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

- Six (6) Natural Moisture Content Tests
- Six (6) Atterberg Limits Tests
- Four (4) Fines Content Tests
- Two (2) Grain Size Tests with Hydrometer
- One (1) Remolded, Consolidated-Undrained (CU) Triaxial Compression Test with Pore Pressure Readings
- One (1) Standard Proctor Test
- One (1) Corrosivity Suite (pH, chloride content, sulfate content, and resistivity tests)
- Five (5) Compressive Strength of Rock Cores

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

Subsurface Conditions

Regional Geology

The site is located on route S-23-310 in Greenville County, South Carolina. The site lies generally within the Piedmont Physiographic complex. More specifically, the site is located within the Paris Mountain Thrust Sheet. According to regional geologic mapping and published geologic reports, the project area is mapped in an area with Sillimanite mica schist composed of sillimanite, biotite, muscovite and smaller amounts of quartz rock. Areas with granite gneiss rock are mapped near the site. The approach embankments contain existing fill above alluvial and/or residual soils, very dense residual soils and bedrock.

Soil and Rock Stratification

At boring S-23-310-1 loose silty sand fill was encountered in the upper 6 feet, followed by alluvial soils consisting of very loose silty sand and very soft silt to about 13 feet below ground surface, followed by bedrock. At boring S-23-310-2 residual loose silty sand was encountered to a depth of about 2 feet overlying very dense residual silty sand extending to bedrock at about 12 feet below existing site grade. Bedrock was present to the maximum depth explored of 51 feet at Boring S-23-310-1 and 22 feet at S-23-310-2. Groundwater was not encountered at boring S-23-310-1, but was encountered at a depth of 13 feet below the existing ground surface at boring S-23-130-2, measured after drilling.

| Geology | Approximate Elevation of Layer Bottom (feet, NAVD88) | USCS Soil Type | Measured Field N Value | Plasticity Index | Fines Content | REC / RQD |
|-----------------------|--|----------------|------------------------|------------------|---------------|------------------|
| Asphalt / Gravel | 1018 to 1024 | -- | -- | -- | -- | -- |
| Fill ³ | 1013 | SM | 5 to 6 | NP ² | 30 to 35 | -- |
| Alluvium ³ | 1006 | SM / ML | 0 to 2 | NP ² | 44 to 87 | -- |
| Residuum ⁴ | 1012 | SM | 9 to 100+ | NP ² | 13 | -- |
| Rock | PMDE ¹ | -- | -- | -- | -- | 93-100% / 53-88% |

1. PMDE = Present to Maximum Depth Explored
2. NP = non-plastic
3. Only present at S-23-310-1.
4. Only present at S-23-310-2.

Seismic Conditions

According to SCDOT Seismic Design Specifications for Highway Bridges version 2.0, seismic effects for box culverts and buried structures need not be considered, except when they are

subject to unstable ground. However, based on the preliminary status of the project seismic design parameters are being provided as information for the design build teams.

Acceleration Design Response Spectrum (ADRS)

The shear wave and compression wave velocity results, as measured at Boring S-23-310-1 using downhole seismic tests, were provided to SCDOT. SCDOT used these velocity measurements to develop Acceleration Design Response Spectrum (ADRS) curves by determining the seismic hazard and evaluating the local site effects on the response spectra.

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

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

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

| Seismic Design Parameter | FEE | SEE |
|--------------------------|------|------|
| PGA | 0.01 | 0.02 |
| S_{DS} | 0.02 | 0.04 |
| S_{D1} | 0.00 | 0.01 |

Design and Construction Considerations

Foundations

The preliminary plans show the culvert invert elevation range between 1,005.8 feet to 1,009.7 feet that equates to an approximate bearing elevation of 1,005 feet to 1,009 feet. Based on the borings performed along the existing roadway alignment the top of rock ranges between elevations 1,006 feet to 1,013 feet. At the time of drilling groundwater was observed in Boring S-23-310-2 at an elevation of 1,011 feet, and groundwater was estimated in CPT Sounding S-23-310-1C at elevation 1,008 feet using the pore water pressure data.

The culvert bearing elevation is anticipated to be below the groundwater table and bearing in rock and/or soil. To achieve the bearing elevation, difficult excavation through very dense

residual soils/IGM should be anticipated. In boring S-23-310-1 very soft silts and very loose silty sands were encountered above the rock and may not be suitable bearing material or working platform for the installation of the box culvert. If these soils are encountered during construction, they should be removed to the top of rock and replaced with suitable fill or lean concrete to provide a stable surface for construction of the box culvert. Dewatering should be performed in accordance with SCDOT specifications.

We have observed variability in the top of rock and thickness of IGM, as seen in **Soil and Rock Stratification**. Therefore, we expect variability in the bearing elevations along the culvert. If unsuitable soils are removed during construction, there should be sufficient bearing capacity to support the box culvert.

Conceptual plans show wing walls, slabs, and riprap will be placed at the culvert inlet and outlet to protect it from scour.

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 Boring S-23-310-1 Composite Sample from 2 to 10 feet | Indication of Corrosivity ¹ |
|----------------|--|--|
| pH | 5.3 | Less than 5.5 |
| Resistivity | 2,230 ohm-cm | Less than 2,000 ohm-cm |
| Chloride | 132 ppm | Greater than 500 ppm |
| Sulfate | 90 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 aggressive. Interpretation of these data should be communicated with the project’s structural engineer.

Embankment Construction

Based on the conceptual plans by HNTB, fill will be required to achieve the final roadway grades. It is anticipated that the backfill heights at the box culvert will be up to 12 feet and side slopes along the roadway are unknown at this time. A bulk sample was obtained from the top 5 feet of existing embankment material. Per our scope, a bulk sample was tested for soil classification and was also remolded to about 95% of the Standard-effort Proctor prior to being tested for shear strength envelopes under CU Triaxial Compression with pore pressure readings. Test results are presented in Appendix B and summarized in the table below.

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November 5, 2024 | Terracon Project No. 8623P180 R2 | SCDOT Project ID: P041162



| Sample No. | Station | Offset (ft) | Sample Depth (ft) | USCS Soil Type | Compaction | | Shear Strength ¹ | |
|-------------------|---------|-------------|-------------------|----------------|----------------------|-----------------------|-----------------------------|------------------------------|
| | | | | | Optimum Moisture (%) | Max Dry Density (pcf) | Total | Effective |
| S-23-310-1 Offset | 23+24 | 13 R | 0 - 5 | SM | 10.4 | 121.6 | c=0 psi $\phi=28^\circ$ | c'=0 psi $\phi'=37^\circ$ |

1. Based on a maximum deviator stress failure criterion

Seismic Induced Soil Shear Strength Loss (SSL)

A few feet of very soft alluvial silts were noted below the existing fill at boring location S-23-310-1 and appears to be likely at or below the predicted ground water elevation of about 1012 feet (coincident with approximate creek level). These low consistency/density soils are susceptible to soil shear strength loss (SSL) during design seismic events. Additional soil and ground water evaluation and SSL screening should be performed to assess potential for liquefaction related settlement and stability impacts on the planned culvert foundations and embankment slopes.

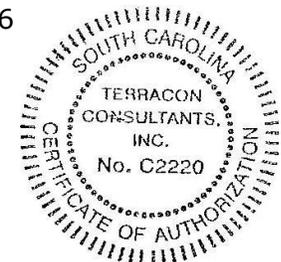
Closure

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

Sincerely,
Terracon Consultants, Inc.

Maggie McKenney, EIT
Senior Staff Engineer

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



Appendix A

Field Exploration

- Exhibit A-1 – Site Location Map
- Exhibit A-2 – Exploration Plans (2 Pages)
- Exhibit A-3 – 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 (3 Pages)
- Exhibit A-10 – Rock Core Photograph Logs (3 pages)
- Exhibit A-11 – Geophysical Testing Results
- Exhibit A-12 – CPT Sounding Logs

Note: All exhibits are one page unless noted above

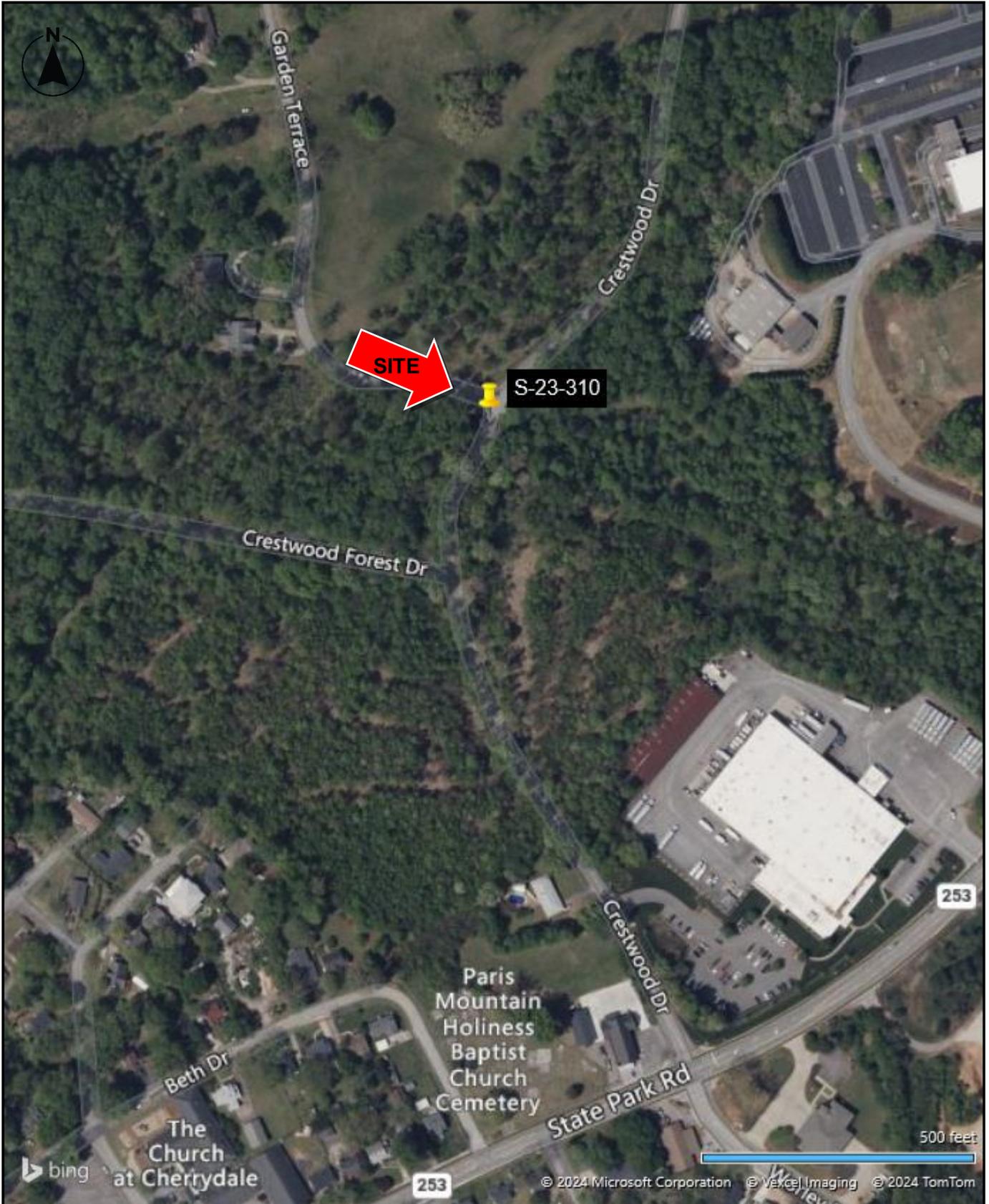


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

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



72 Pointe Cir
Greenville, South Carolina 29615

| |
|--|
| SITE LOCATION |
| S-23-310 over Langston Tributary Crestwood Drive Greenville County, SC |

| |
|---------|
| Exhibit |
| A-1 |



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

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

| | |
|----------------|-----------|
| Project Number | 8623P180 |
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 72 Pointe Cir
 Greenville, South Carolina 29615

EXPLORATION PLAN

S-23-310 over Langston Tributary
 Crestwood Drive
 Greenville County, SC

Exhibit

A-2

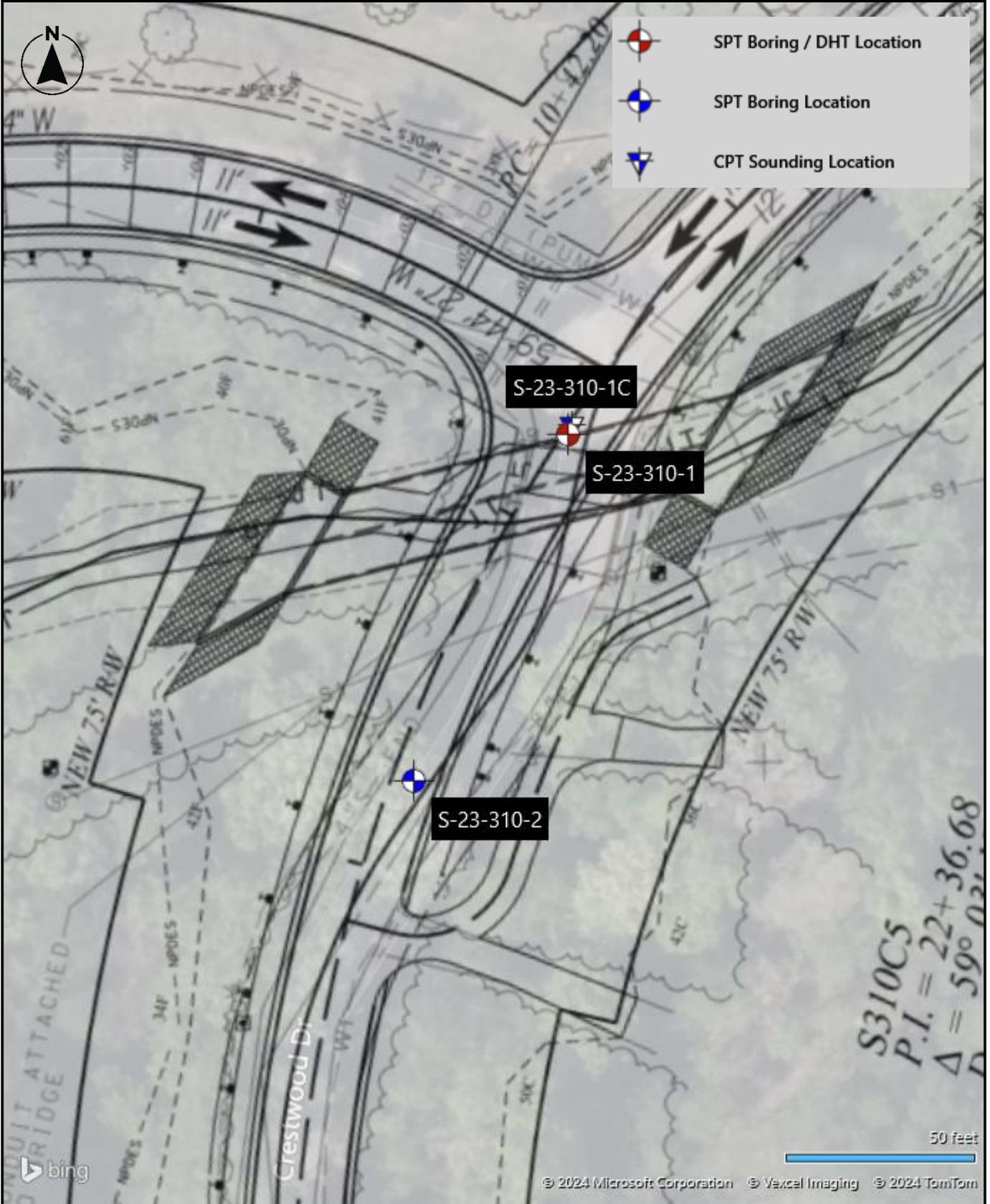


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

PRELIMINARY SITE PLAN PROVIDED BY HNTB

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

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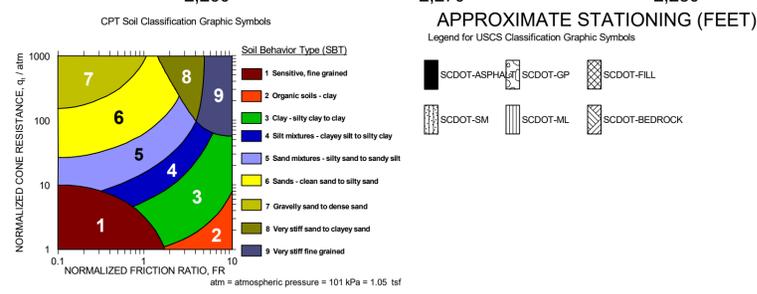
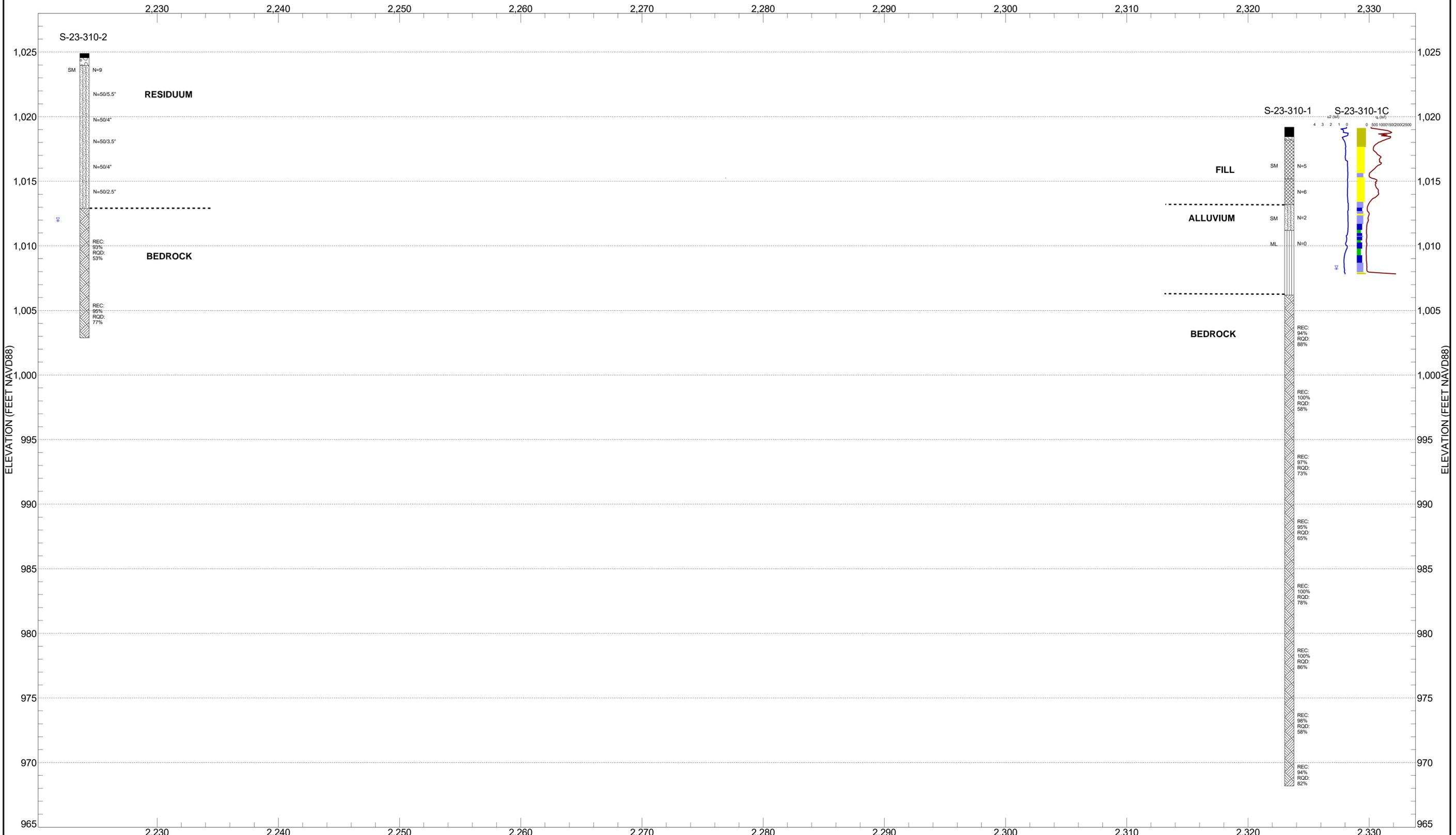
EXPLORATION PLAN

S-23-310 over Langston Tributary
Crestwood Drive
Greenville County, SC

Exhibit

A-2

APPROXIMATE STATIONING (FEET)



NOTES:

- See Exhibit for orientation of soil profile.
- See General Notes in Appendix for symbols and soil classifications.
- Soils profile provided for illustration purposes only.
- Soils between borings may differ.
- For presentation purposes, some locations are offset to allow display of both borings and CPTs.
- BT - Boring Termination (F)
- CPTT - CPT Termination (F)

Water Level Reading at time of drilling

Water Level Reading after drilling

| | | | | | |
|----------------------|-----------------------|--|--|--|---------|
| Project Manager: DJC | Project No.: 6623P180 | <p>72 Points Cir Greenville, SC PH: 864-292-2901 FAX: 864-292-6361</p> | SUBSURFACE PROFILE | | EXHIBIT |
| Drawn by: MEM | Scale: N.T.S. | | Section Along Crestwood Drive | | |
| Approved by: JNA | File Name: | | S-23-310 (CRESTWOOD DRIVE) OVER LANGSTON TRIBUTARY | | |
| Date: 1/14/2024 | | | SCDOT PROJECT ID: F041162 GREENVILLE COUNTY, SC | | |
| | | | | | A-3 |

THIS BORING LOGS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. RINK FENCE CPT & SBT FENCE A1 #623P180 SCDOT BRIDGE PACK IN INTERNAL S-23-310 OVER LANGSTON TRIBUTARY.GPJ TERRACON_DATA\TEMPLATE.GDT 11/6/24

Summary of Boring Data – Exhibit A-4

S-23-310 over Langston Tributary | Greenville County, SC
Terracon Project No. 8623P180 | SCDOT Project ID: P041162



Summary of Boring Data

| Boring No. | Ground Elevation (ft) | Test Depth (ft) | Northing (ft) | Easting (ft) | Latitude (°) | Longitude (°) | Station (ft) ¹ | Offset (ft) ¹ |
|-------------|-----------------------|-----------------|---------------|--------------|--------------|---------------|---------------------------|--------------------------|
| S-23-310-1 | 1019.2 | 51 | 1117650.37 | 1580127.56 | 34.897212 | -82.400164 | 23+24 | 1 R |
| S-23-310-2 | 1024.9 | 22 | 1117560.17 | 1580085.79 | 34.896963 | -82.400299 | 22+24 | 6 R |
| S-23-310-1C | 1019.2 | 11.4 | 1117652.86 | 1580128.60 | 34.897219 | -82.400161 | 23+27 | 1 R |

1. Plans were provided by HNTB after the field exploration and survey. Station and offset values are estimated based on overlay in Google Earth TM.
2. A bulk sample was collected about 10.5 feet and 13.5 feet east of S-23-310-1.

GeoScoping Form

| PROJECT INFORMATION | | | |
|---------------------|-------------|---------------|-----------------|
| Project ID: | P041162 | Date of Trip: | 6/6/2024 |
| County: | Greenville | Location: | Sans Souci |
| Rd/ Route: | S-23-310 | Local Name: | Crestwood Drive |
| Attendees: | M. McKenney | | |

| EXISTING BRIDGE INFORMATION | | | |
|--|------------------------------|--|--------------|
| Bridge Length: | 30 ft | Bridge Width: | 28 ft |
| Superstructure Type: | Concrete framing and decking | Substructure Type: | Timber piles |
| Begin Bridge Sta ¹ : | 22+91 | End Bridge Sta ¹ : | 23+21 |
| Begin Bridge Embankment Sta ¹ : | 21+91 | End Bridge Embankment Sta ¹ : | 24+21 |
| Structure Number: | 04543 | Posted Weight Limit: | 14 tons |
| Crossing: | Langston Tributary | Skew: | N/A |
| Latitude: | 34.897219° | Longitude: | -82.400161° |
| Existing Fill Height: | approx 6 ft | Approx Existing Slope Angle: | 2H:1V |
| 1. Begin & End Bridge Embankment 100 ft down Sta. or up Sta., respectively. Sta. estimated from overlay of bridge plan provided by HNTB. | | | |

| EXISTING ROADWAY EMBANKMENT INFORMATION | | | |
|---|---|------------------------------|-------------|
| Begin Project Sta: | 21+50 | Begin Bridge Embankment Sta: | 21+91 |
| Accessibility Issues: | None Observed | | |
| Ground Cover: | Asphalt pavement and grassed shoulders | | |
| Existing Fill Height: | N/A | Approx Existing Slope Angle: | 2H:1V |
| Local Development: | developed - residential | | |
| Topography: | slope to creek | | |
| Traffic Control Necessary: | Yes, lane closure | | |
| Surface Soils: | Silty sand w/ gravel | Muck: | No |
| Exposed Rock in Stream Bed: | Yes | Exposed Rock in banks: | No |
| Wetlands on Site: | Yes | Wetland Adjacent: | Yes |
| Depth FG to Water: | 11 feet | Water Depth: | 1 to 2 feet |
| Depth to Existing Ground: | approximately 13 feet at center of bridge | | |
| Scour Condition at EB: | N/A | Scour Condition at IB: | N/A |

| | | | |
|-----------------------------|---|------------------------------|-------------|
| End Bridge Embankment Sta: | 24+21 | End Project Sta: | 25+50 |
| Accessibility Issues: | None Observed | | |
| Ground Cover: | Asphalt pavement and grassed shoulders | | |
| Existing Fill Height: | 6 feet, sloping | Approx Existing Slope Angle: | 2H:1V |
| Local Development: | developed - residential | | |
| Topography: | graded slope to creek | | |
| Traffic Control Necessary: | Yes, lane closure | | |
| Surface Soils: | Silty sand | Muck: | No |
| Exposed Rock in Stream Bed: | Yes | Exposed Rock in banks: | No |
| Wetlands on Site: | Yes | Wetland Adjacent: | Yes |
| Depth FG to Water: | 11 feet | Water Depth: | 1 to 2 feet |
| Depth to Existing Ground: | approximately 13 feet at center of bridge | | |
| Scour Condition at EB: | N/A | Scour Condition at IB: | N/A |

GeoScoping Form

| UTILITIES INFORMATION | |
|-----------------------|--|
| Attached: | A fiber line was observed to be attached to the bridge deck on the west side of the bridge |
| Above Ground: | N/A |
| Underground: | An underground waterline was observed in the east shoulder An underground sewerline was observed south of the bridge running east to west |

| Comments: |
|-----------|
| |

Field Exploration Description Overview

The testing locations were proposed to and approved by SCDOT and located in the field by Terracon using measurements from existing structures shown on the provided drawings. The borings were surveyed by Thomas and Hutton after testing and drilling was complete. The locations, as shown in the Exploration Plans, are shown to the scale indicated.

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

Soil Test Borings (STB)

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

- SCDOT Geotechnical Design Manual 2022
- 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 sampling program is summarized in the following table:

| Test ID | Total Depth | Interval of Continuous Sampling |
|----------------------|--------------------------------|---------------------------------|
| S-23-310-1 | 51 feet w/ 38 feet rock coring | 2 to 10 feet |
| S-23-310-2 | 22 feet w/ 10 feet rock coring | 0.5 to 12 feet |
| S-23-310-1 Offset | 5 feet | Bulk Sample ¹ |
| S-23-310-1C | 11.4 feet (refusal) | CPT - No sampling |

1. Bulk sample was obtained with 2 ¼-inch Hollow Stem Auger (HSA).

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.

Exhibit A-6 – Field Exploration Description

S-23-310 over Langston Tributary | Greenville County, SC
Terracon Project No. 8623P180 | SCDOT Project ID: P041162



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 Moderately |
| 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

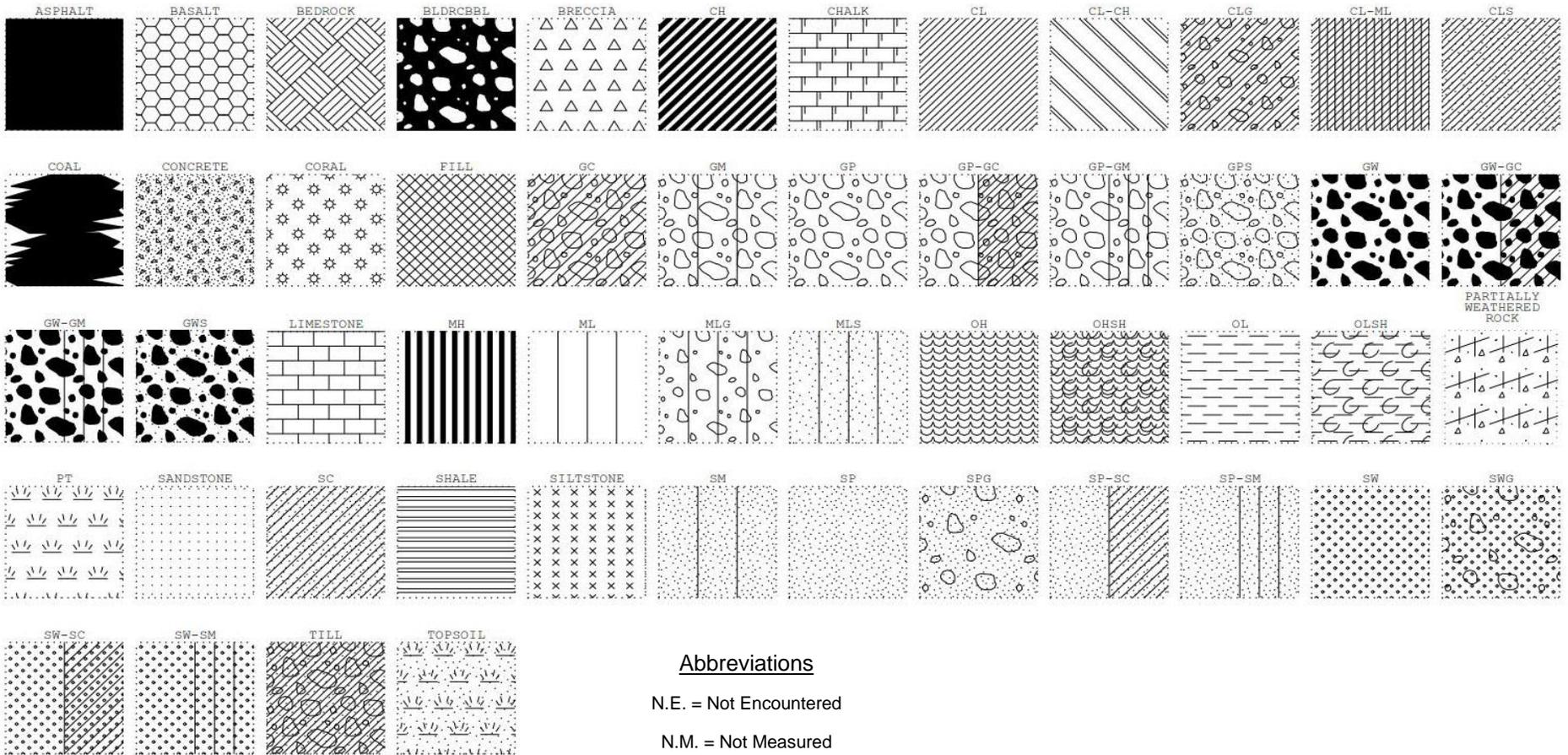
| RQD, as a percentage | Diagnostic Description |
|----------------------|------------------------|
| Exceeding 90 | Excellent |
| 90 – 75 | Good |
| 75 – 50 | Fair |
| 50 – 25 | Poor |
| Less than 25 | Very poor |

^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.



Abbreviations

N.E. = Not Encountered

N.M. = Not Measured

Project Manager:
MEM
Drawn by:
K.JZ
Checked by:
SG
Approved by:
DJC

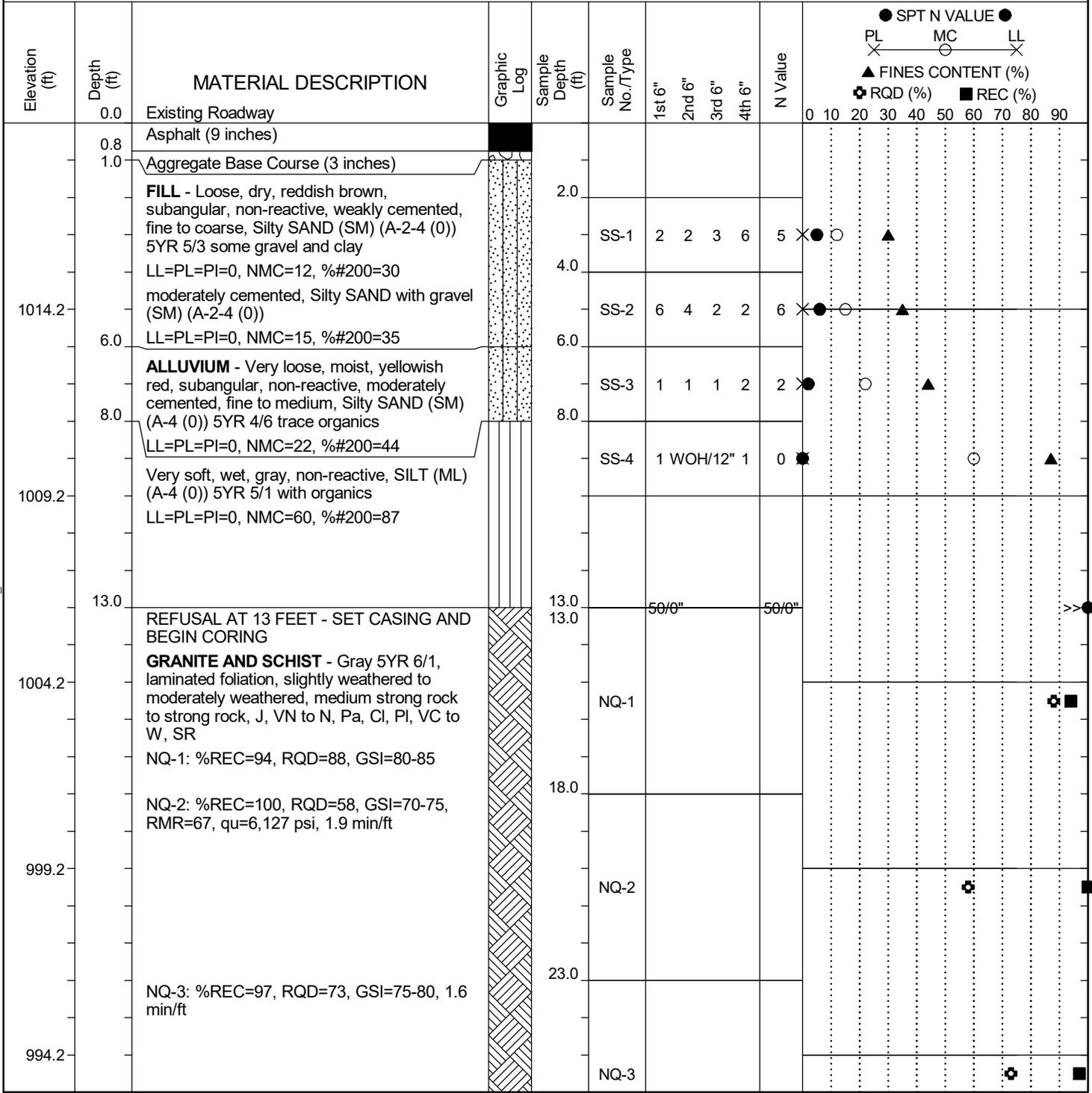
Project No.
8623P180
Scale:
N.T.S.
File Name:
Soil - Rock - Log
Date:
Jul 2023


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

SOIL AND ROCK SYMBOLS

SCDOT Soil Test Log

| | | |
|---|-------------------------------|-------------------------------|
| Project ID: P041162 | County: Greenville | Boring No.: S-23-310-1 |
| Site Description: S-23-310 over Langston Tributary | Route: S-23-310 | |
| Eng./Geo.: S. Greaber | Boring Location: 23+24 | Offset: 1 R |
| Alignment: Proposed | Date Started: 6/5/2024 | |
| Elev.: 1019.2 ft | Latitude: 34.8972121 | Longitude: -82.4001641 |
| Total Depth: 51 ft | Soil Depth: 13 ft | Core Depth: 38 ft |
| Date Completed: 6/6/2024 | | |
| Bore Hole Diameter (in): 4 | Sampler Configuration | Liner Required: Y (N) |
| Liner Used: Y (N) | | |
| Drill Machine: DR#554 | Drill Method: RW/RC | Hammer Type: Automatic |
| Energy Ratio: 88.5% | | |
| Core Size: NQ2 | Driller: B. Burnette | Groundwater: TOB N.M. |
| 24HR: N.M. | | |



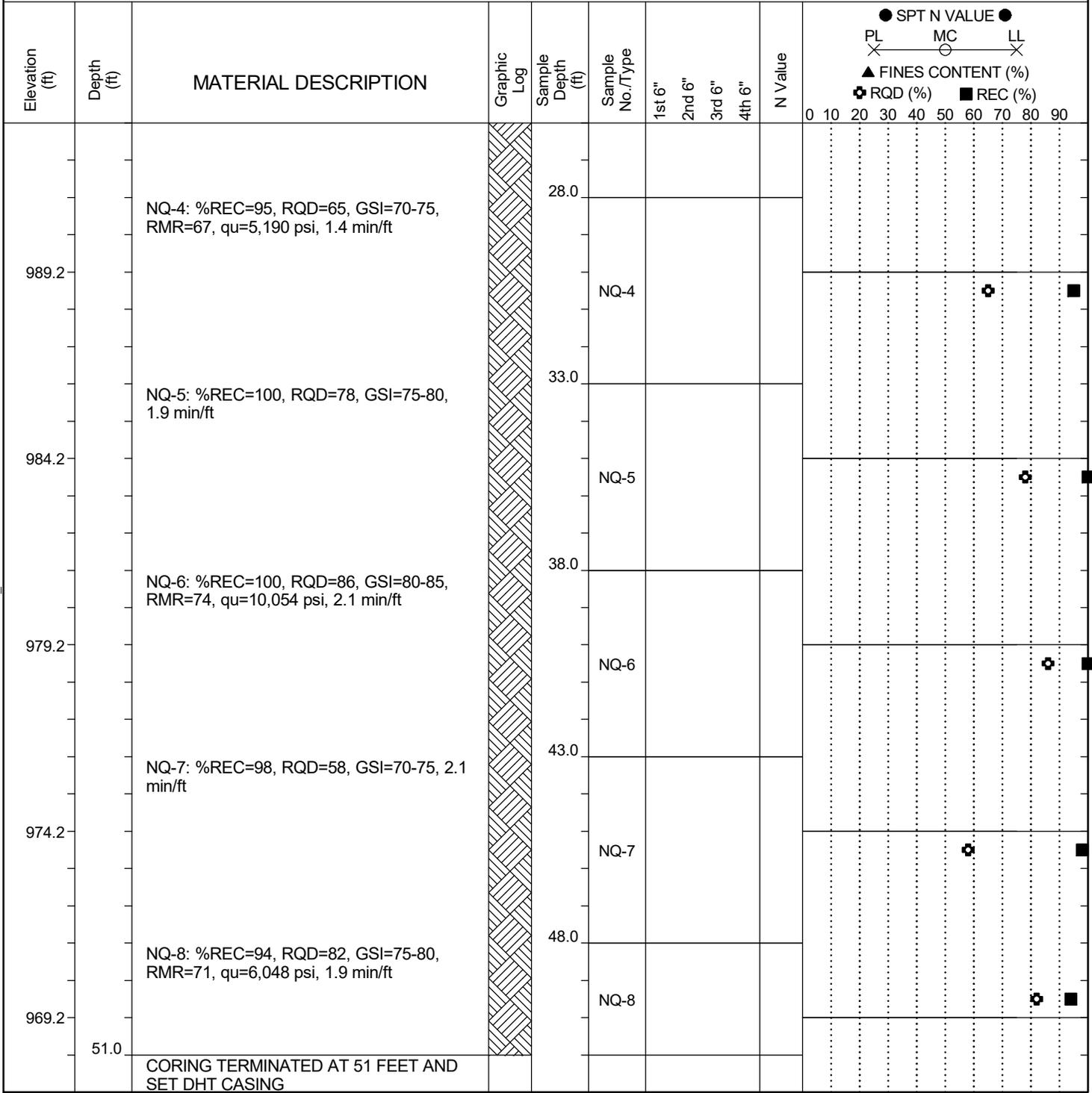
LEGEND Continued Next Page

| 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 | |

SC.DOT 8623P180T SCDOT BRIDGE PACK SCDOT S-23-310 OVER LANGSTON TRIBUTARY.GPJ SCDOT_DATATEMPLATE.GDT 9/20/24

SCDOT Soil Test Log

| | | |
|---|-------------------------------|---------------------------------|
| Project ID: P041162 | County: Greenville | Boring No.: S-23-310-1 |
| Site Description: S-23-310 over Langston Tributary | | Route: S-23-310 |
| Eng./Geo.: S. Greaber | Boring Location: 23+24 | Offset: 1 R |
| Alignment: Proposed | Date Started: 6/5/2024 | Date Completed: 6/6/2024 |
| Elev.: 1019.2 ft | Latitude: 34.8972121 | Longitude: -82.4001641 |
| Total Depth: 51 ft | Soil Depth: 13 ft | Core Depth: 38 ft |
| Bore Hole Diameter (in): 4 | Sampler Configuration | Liner Required: Y (N) |
| Liner Used: Y (N) | Drill Machine: DR#554 | Drill Method: RW/RC |
| Hammer Type: Automatic | Energy Ratio: 88.5% | Core Size: NQ2 |
| Driller: B. Burnette | Groundwater: TOB | 24HR: N.M. |



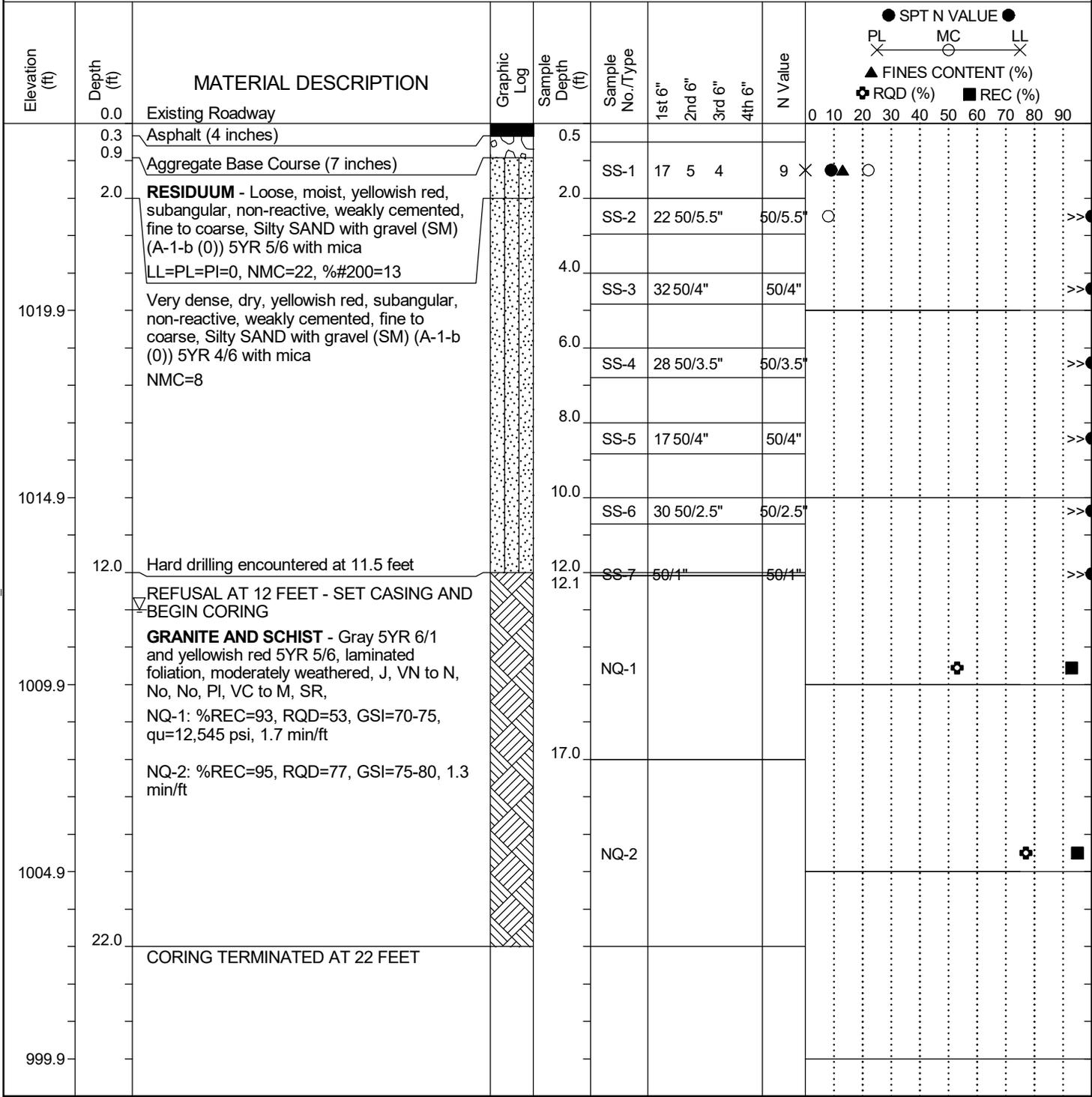
LEGEND

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

SC.DOT 8623P180T SCDOT BRIDGE PACK SCDOT S-23-310 OVER LANGSTON TRIBUTARY.GPJ SCDOT_DATATEMPLATE.GDT 9/20/24

SCDOT Soil Test Log

| | | |
|---|-------------------------------|-------------------------------|
| Project ID: P041162 | County: Greenville | Boring No.: S-23-310-2 |
| Site Description: S-23-310 over Langston Tributary | | Route: S-23-310 |
| Eng./Geo.: S. Greaber | Boring Location: 22+24 | Offset: 6 R |
| Alignment: Proposed | Date Started: 6/6/2024 | |
| Elev.: 1024.9 ft | Latitude: 34.8969627 | Longitude: -82.4002993 |
| Total Depth: 22 ft | Soil Depth: 12 ft | Core Depth: 10 ft |
| Date Completed: 6/6/2024 | | |
| Bore Hole Diameter (in): 4 | Sampler Configuration | Liner Required: Y (N) |
| Liner Used: Y (N) | | |
| Drill Machine: DR#554 | Drill Method: RW/RC | Hammer Type: Automatic |
| Energy Ratio: 88.5% | | |
| Core Size: NQ2 | Driller: B. Burnette | Groundwater: TOB 13 ft |
| 24HR: N.M. | | |



LEGEND

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

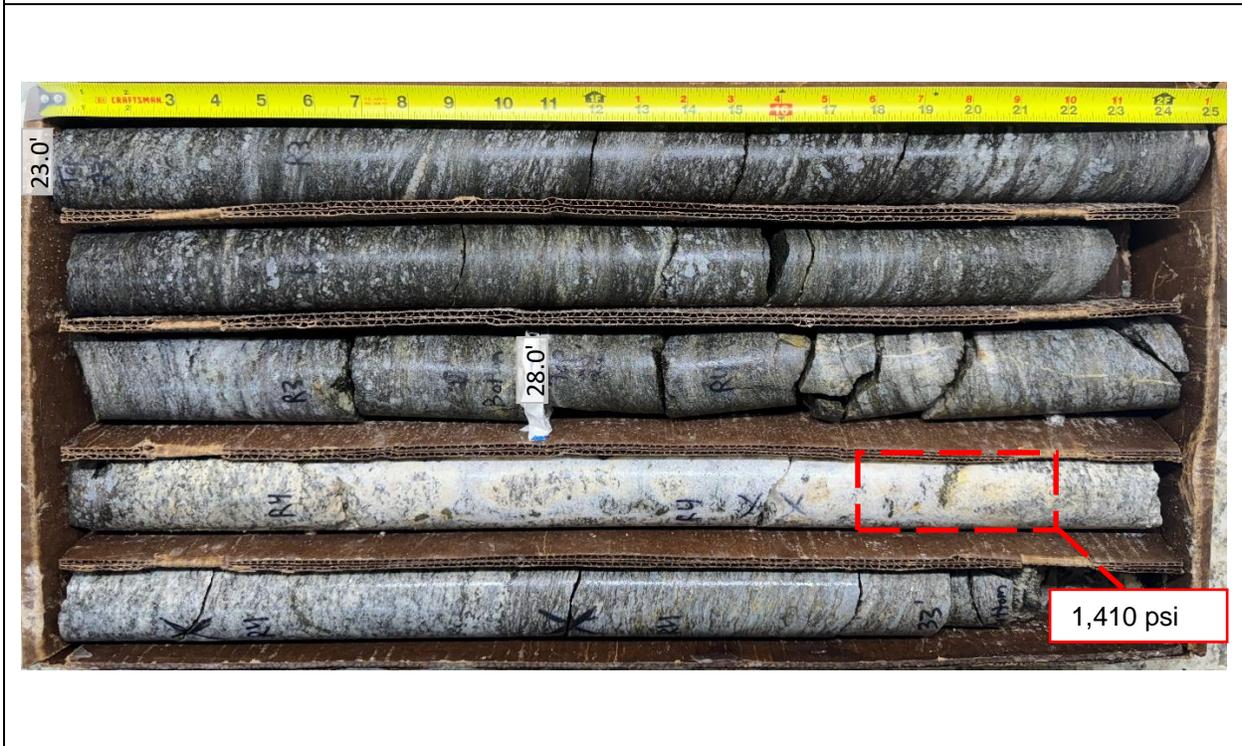
SC.DOT 8623P180T SCDOT BRIDGE PACK SCDOT S-23-310 OVER LANGSTON TRIBUTARY.GPJ SCDOT_DATATEMPLATE.GDT 9/20/24

Rock Core Photograph Logs – Exhibit A-10

S-23-310 over Langston Tributary | Greenville County, SC
Terracon Project No. 8623P180 | SCDOT Project ID: P041162



S-23-310-1, NQ-1 and NQ-2 (13 to 23 feet)



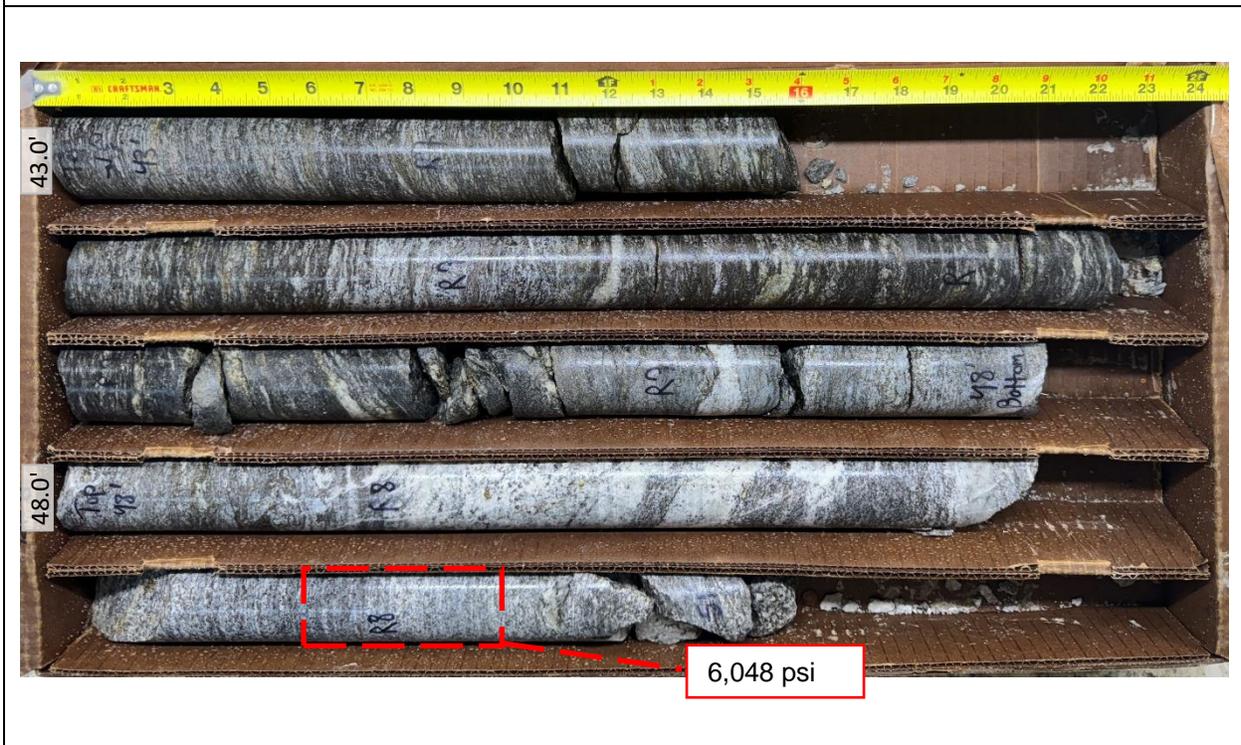
S-23-310-1, NQ-3 and NQ-4 (23 to 33 feet)

Rock Core Photograph Logs – Exhibit A-10

S-23-310 over Langston Tributary | Greenville County, SC
Terracon Project No. 8623P180 | SCDOT Project ID: P041162



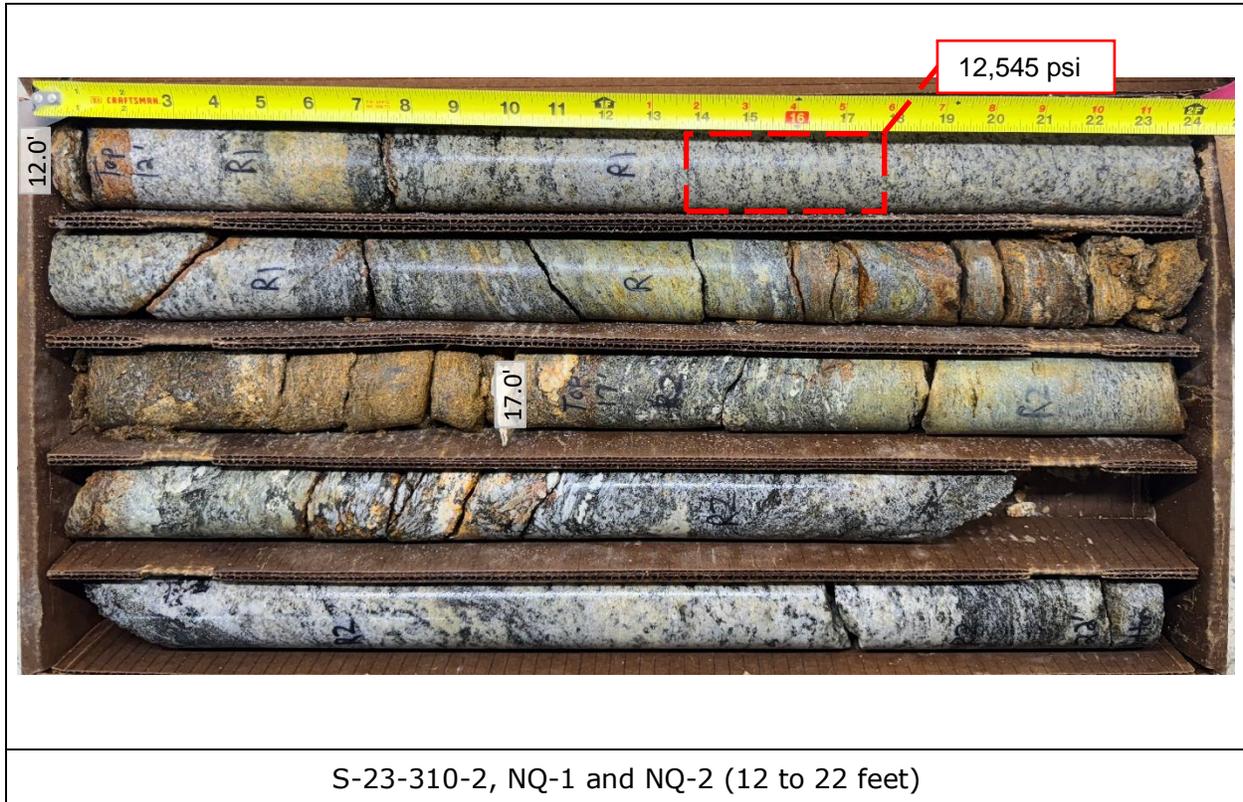
S-23-310-1, NQ-5 and NQ-6 (33 to 43 feet)



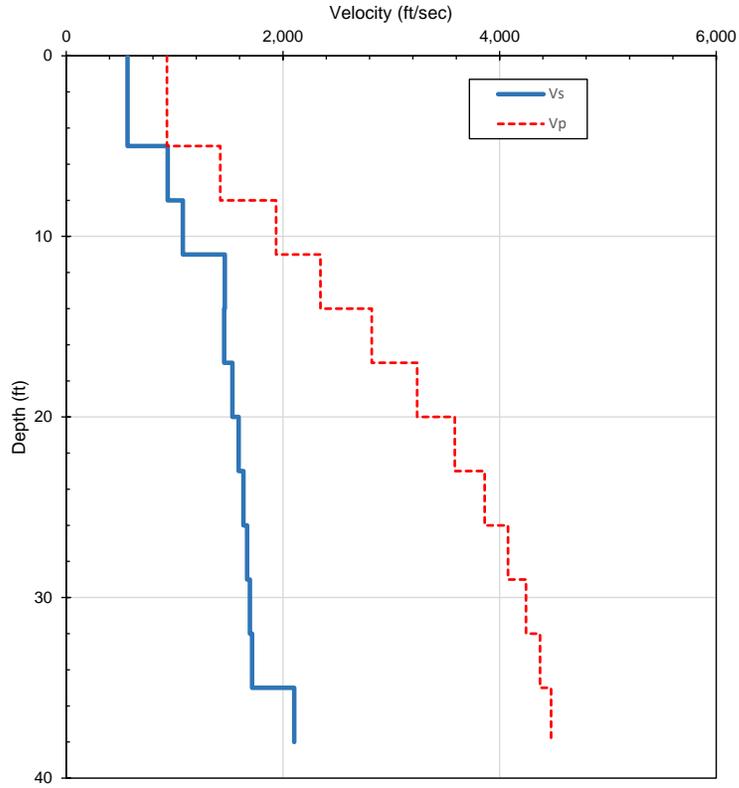
S-23-310-1, NQ-7 and NQ-8 (43 to 51 feet)

Rock Core Photograph Logs – Exhibit A-10

S-23-310 over Langston Tributary | Greenville County, SC
Terracon Project No. 8623P180 | SCDOT Project ID: P041162



Downhole Seismic Velocity Fixed Interval Method



| Depth (ft) | Vp (ft/sec) | Vs (ft/sec) | Δi (ft) | Δt (sec) | Est. In-Situ Unit Wt (pcf) |
|---|-------------|-------------|-----------------|------------------|----------------------------|
| 5 | 929 | 566 | 5 | 0.00884 | 100 |
| 8 | 1422 | 937 | 3 | 0.00320 | |
| 11 | 1936 | 1077 | 3 | 0.00279 | |
| 14 | 2347 | 1463 | 3 | 0.00205 | 173 |
| 17 | 2820 | 1458 | 3 | 0.00206 | |
| 20 | 3240 | 1533 | 3 | 0.00196 | |
| 23 | 3587 | 1591 | 3 | 0.00189 | |
| 26 | 3862 | 1635 | 3 | 0.00183 | 158 |
| 29 | 4078 | 1669 | 3 | 0.00180 | |
| 32 | 4245 | 1696 | 3 | 0.00177 | |
| 35 | 4374 | 1716 | 3 | 0.00175 | 182 |
| 38 | 4476 | 2104 | 3 | 0.00143 | |
| 100 | | | 2000 | 62 | 0.03100 |
| Unit Weight of Soil estimated from SPT results | | | | | |
| Unit Weight of Rock based on average results from compression tests | | | | | |
| Sum of Data Over Profile | | | 38 | 0.03135 | |
| Weighted Average Shear Wave Velocity Over Profile | | | 1,212 ft/sec | | |
| Est. Weighted Average Shear Wave Velocity Over 100-Ft ¹ | | | 1,604 ft/sec | | |

1. Assuming shear wave of 2,000 f/s for rock below 38 feet.

| | |
|--------------|----|
| Project Mgr: | MM |
| Prepared by: | MM |
| Checked by: | SG |
| Approved by: | |

| | |
|-------------|-----------|
| Project No. | 8623P180 |
| Scale: | NA |
| Date: | 9/12/2024 |



Terracon
Consulting Engineers and Scientists

72 Pointe Circle
Ph: (864) 292-2901

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

GEOPHYSICAL TESTING RESULTS

DOWNHOLE SEISMIC TEST

S-23-310 (Crestwood Drive) over Langston Tributary

GREENVILLE COUNTY, SOUTH CAROLINA

P041162

| | |
|----------|------------|
| TEST NO. | S-23-310-1 |
| EXHIBIT | A-11 |

CPT Sounding ID S-23-310-1C

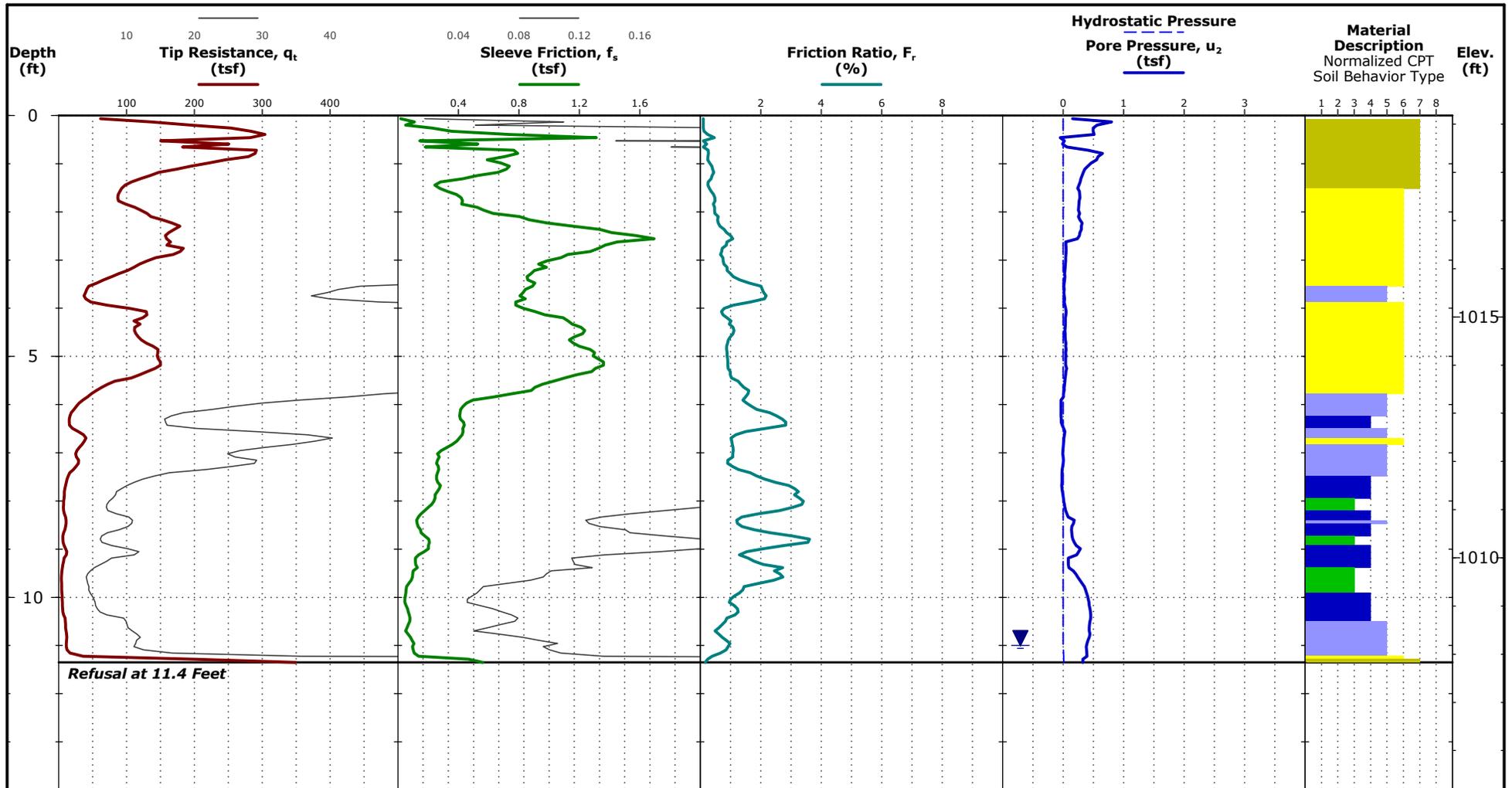


72 Pointe Cir
 Greenville, SC

CPT Started: 8/21/2024
 CPT Completed: 8/21/2024

Elevation: 1019.18 (ft)
 Elevation Reference: Elevations were provided by others.

Latitude: 34.897219° Longitude: -82.400161°
 Station: 23+27 Offset: 1 R



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

Notes
 Test Location: See [Exploration Plan](#)

CPT Equipment
 CPT Rig: CR#CPT03
 Operator: AM/BR
 CPT sensor calibration reports available upon request
 Probe No. 6025 with net area ratio of .84
 Manufactured by Geoprobe Systems- Calibrated 4/17/2024
 Tip and sleeve areas of 10 cm² and 150 cm²

Water Level Observation
 11 ft estimated water depth
 (used in normalizations and correlations)

Normalized Soil Behavior Type (Robertson 1990)

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

Appendix B – Laboratory Testing

S-23-310 over Langston Tributary | Greenville County, SC Terracon
Project No. 8623P180 | SCDOT Project ID: P041162



Appendix B

Laboratory Testing

Exhibit B-1 – Laboratory Testing Description
Summary of Laboratory Data
Laboratory Data Sheets (21 Pages)

Note: All exhibits are one page unless noted above.

Summary of Laboratory Results

| Boring ID | Depth (Ft.) | Soil Classification USCS & AASHTO | Liquid Limit | Plastic Limit | Plasticity Index | % Gravel | % Sand | % Fines | % Silt | % Clay | Water Content (%) | Proctor Dry Density (pcf)/Opt. Moisture (%) |
|-------------------|-------------|---|--------------|---------------|------------------|----------|--------|---------|--------|--------|-------------------|---|
| S-23-310-1 | 2-4 | SILTY SAND(SM) / A-2-4 (0) | NP | NP | NP | 8.5 | 61.6 | 29.8 | | | 11.9 | |
| S-23-310-1 | 4-6 | SILTY SAND WITH GRAVEL(SM) / A-2-4 (0) | NP | NP | NP | 17.5 | 47.3 | 35.2 | | | 15.2 | |
| S-23-310-1 | 6-8 | SILTY SAND(SM) / A-4 (0) | NP | NP | NP | 0.0 | 56.0 | 44.0 | 23.4 | 20.7 | 22.4 | |
| S-23-310-1 | 8-10 | SILT(ML) / A-4 (0) | NP | NP | NP | 0.0 | 13.2 | 86.8 | 49.2 | 37.6 | 59.7 | |
| S-23-310-1 Offset | 0-5 | SILTY SAND(SM) / A-2-4 (0) | NP | NP | NP | 5.8 | 69.6 | 24.6 | | | | 121.6 / 10.4 |
| S-23-310-2 | 0.5-2 | SILTY SAND WITH GRAVEL(SM) / A-1-B (0) | NP | NP | NP | 17.5 | 69.5 | 13.0 | | | 22.2 | |
| S-23-310-2 | 2-2.96 | SILTY SAND WITH GRAVEL(SM) / A-1-B | | | | | | | | | 8.0 | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |



INDEX PROPERTIES VERSUS DEPTH

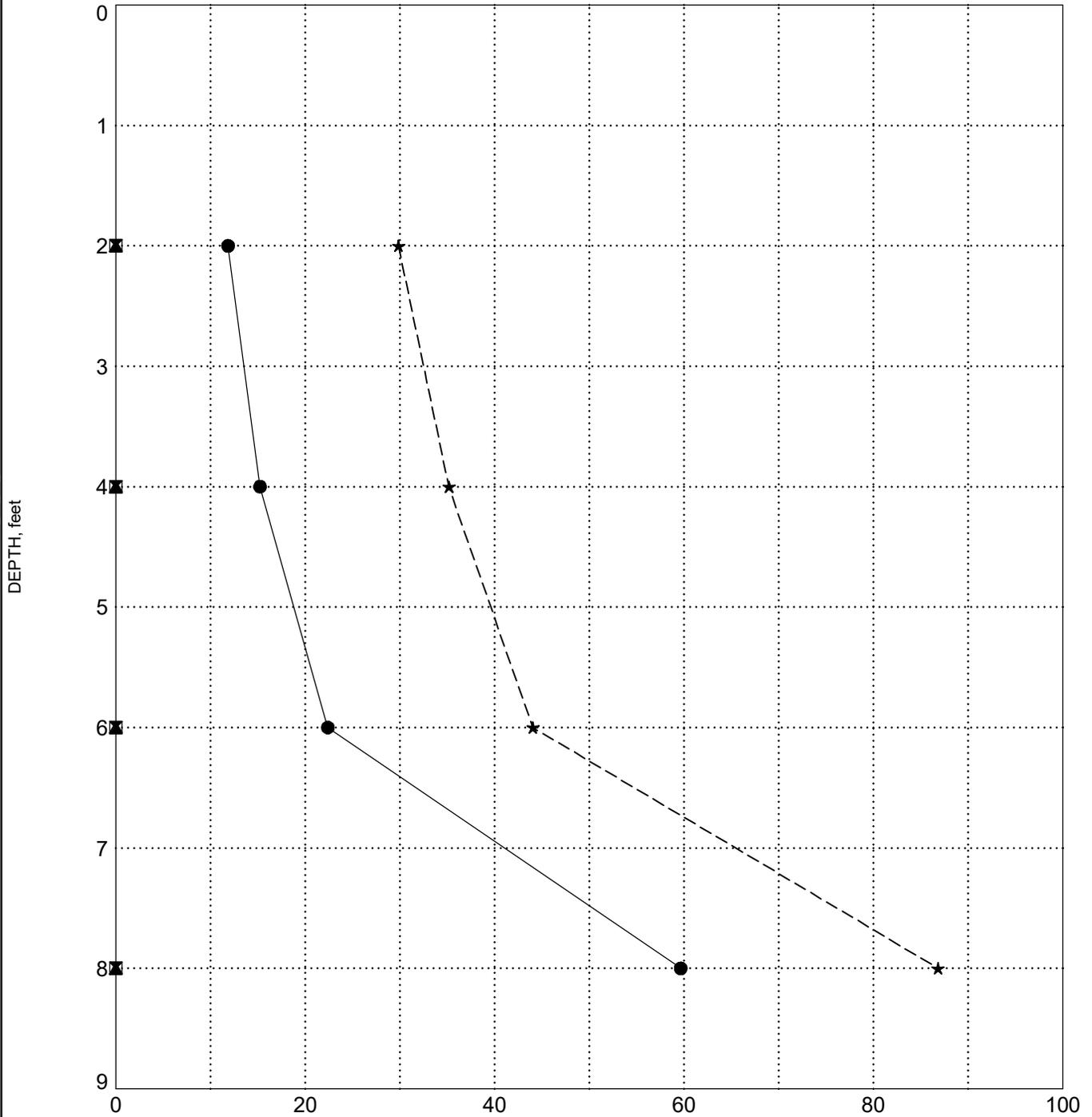
PROJECT ID P041162

PROJECT NAME S-23-310 over Langston Tributary

PROJECT COUNTY Greenville

SURFACE ELEVATION: 1019.2

BORING S-23-310-1



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

INDEX PROPS 8623P180T SCDOT BRIDGE PACK SCDOT S-23-310 OVER LANGSTON TRIBUTARY.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 9/20/24



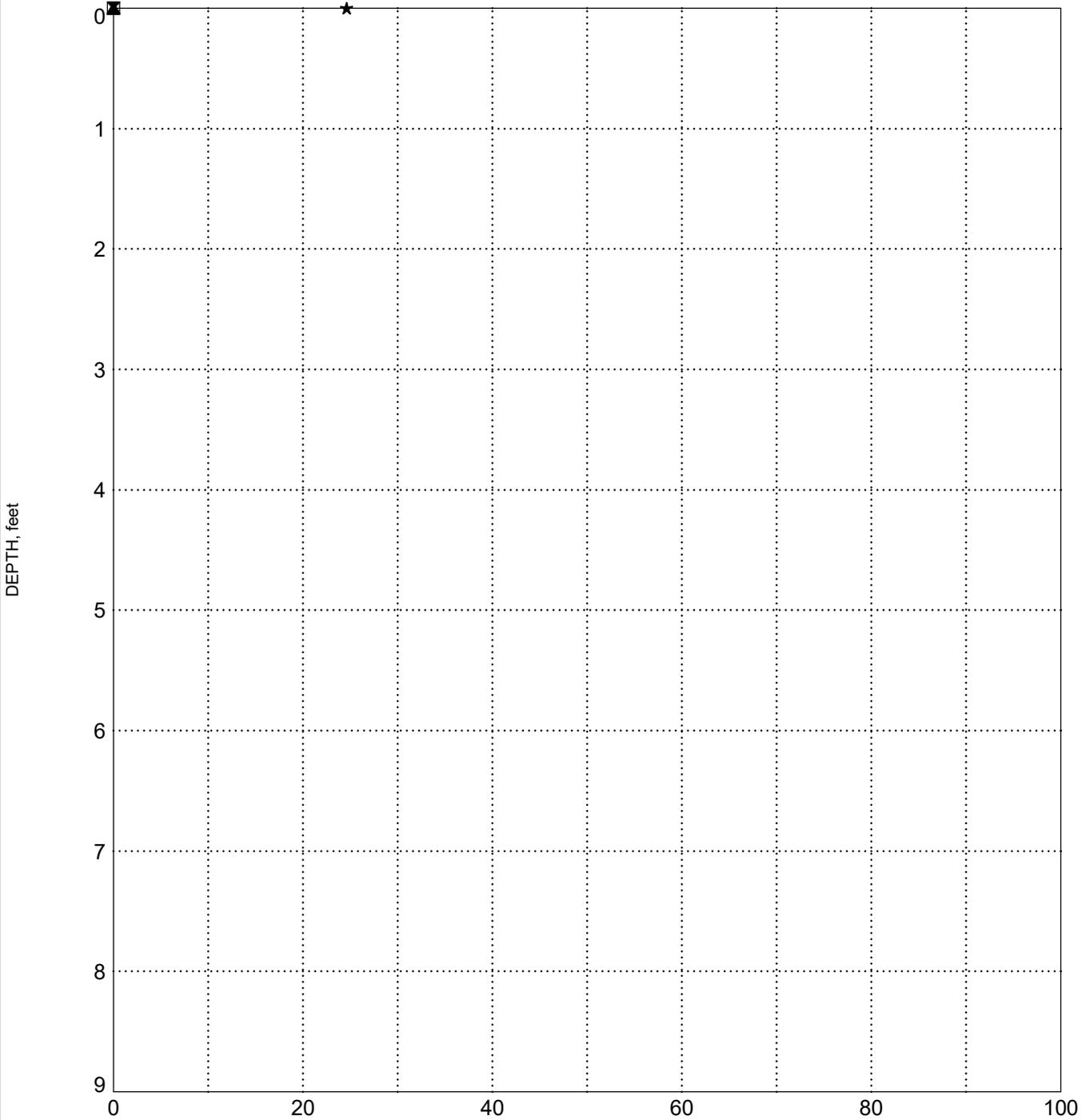
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P041162

PROJECT NAME S-23-310 over Langston Tributary

PROJECT COUNTY Greenville

BORING S-23-310-1 Offset



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

INDEX PROPS 8623P180T SCDOT BRIDGE PACK SCDOT S-23-310 OVER LANGSTON TRIBUTARY.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 9/20/24



INDEX PROPERTIES VERSUS DEPTH

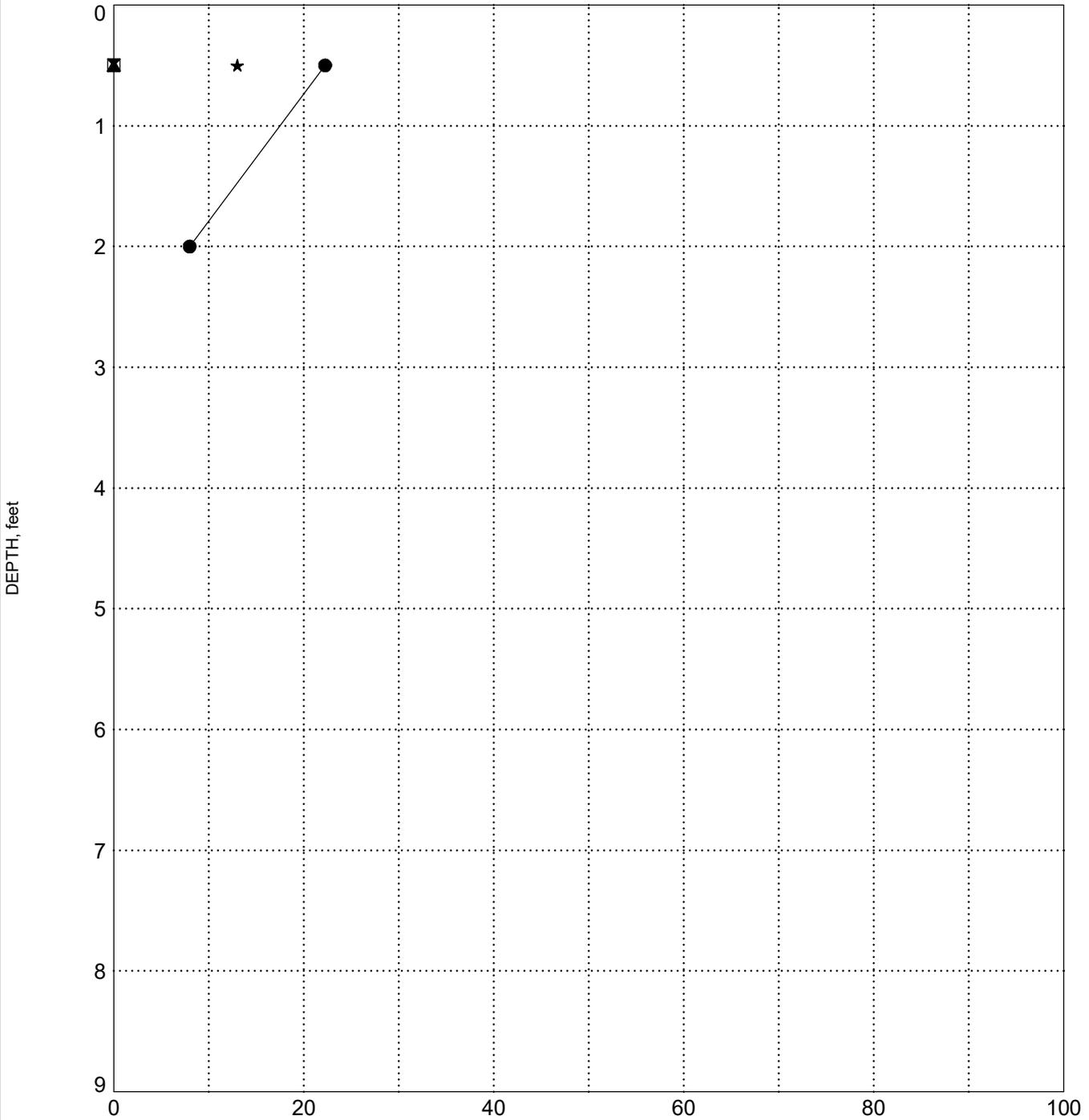
PROJECT ID P041162

PROJECT NAME S-23-310 over Langston Tributary

PROJECT COUNTY Greenville

SURFACE ELEVATION: 1024.9

BORING S-23-310-2

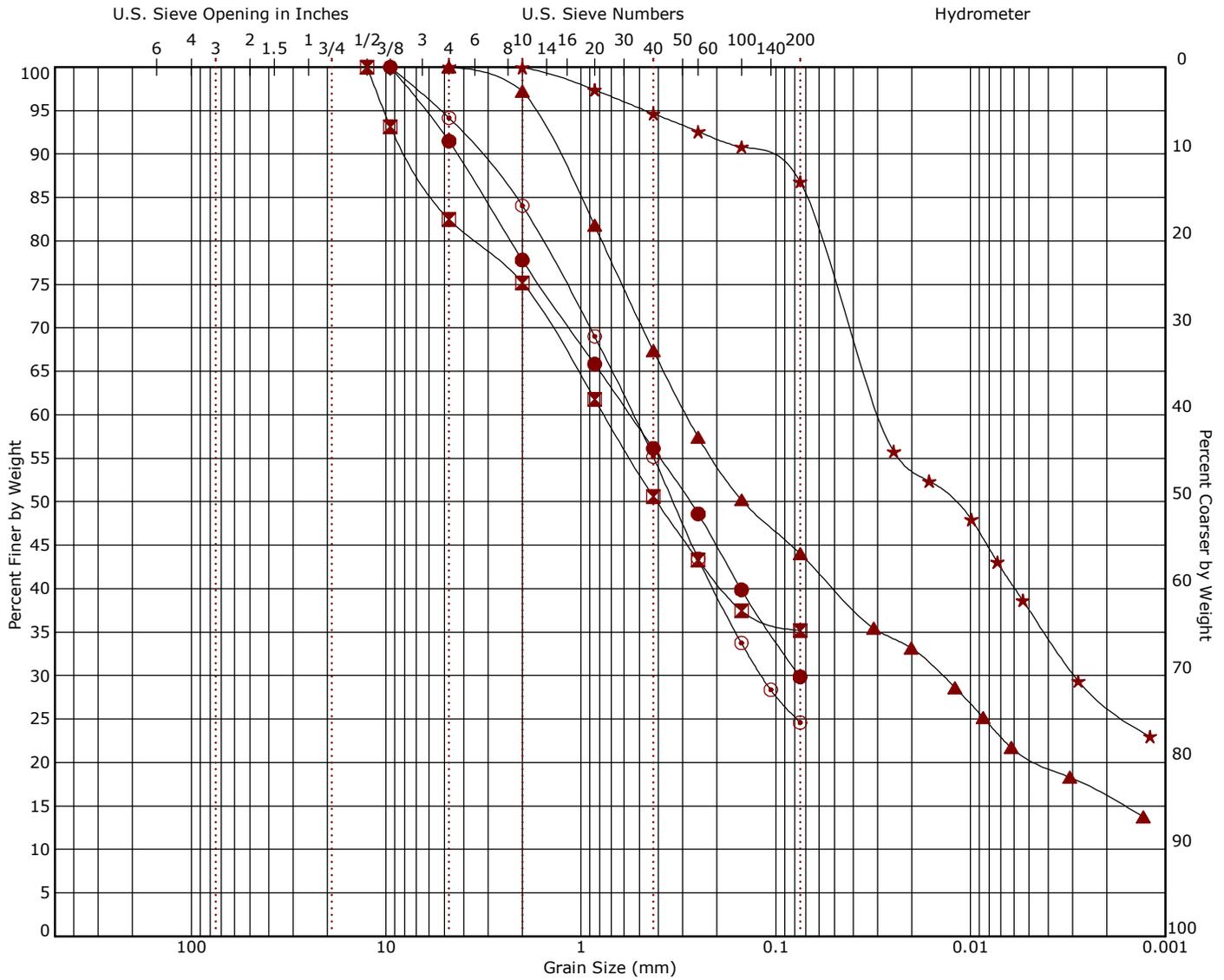


| LEGEND | |
|--------|---------------|
| ● | Water Content |
| ☒ | Plastic Limit |
| ▲ | Liquid Limit |
| ★ | Fines |

INDEX PROPS 8623P180T SCDOT BRIDGE PACK SCDOT S-23-310 OVER LANGSTON TRIBUTARY.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 9/20/24

Grain Size Distribution

ASTM D422 / ASTM C136



Cobbles |
 Gravel |
 Sand |
 Silt or Clay

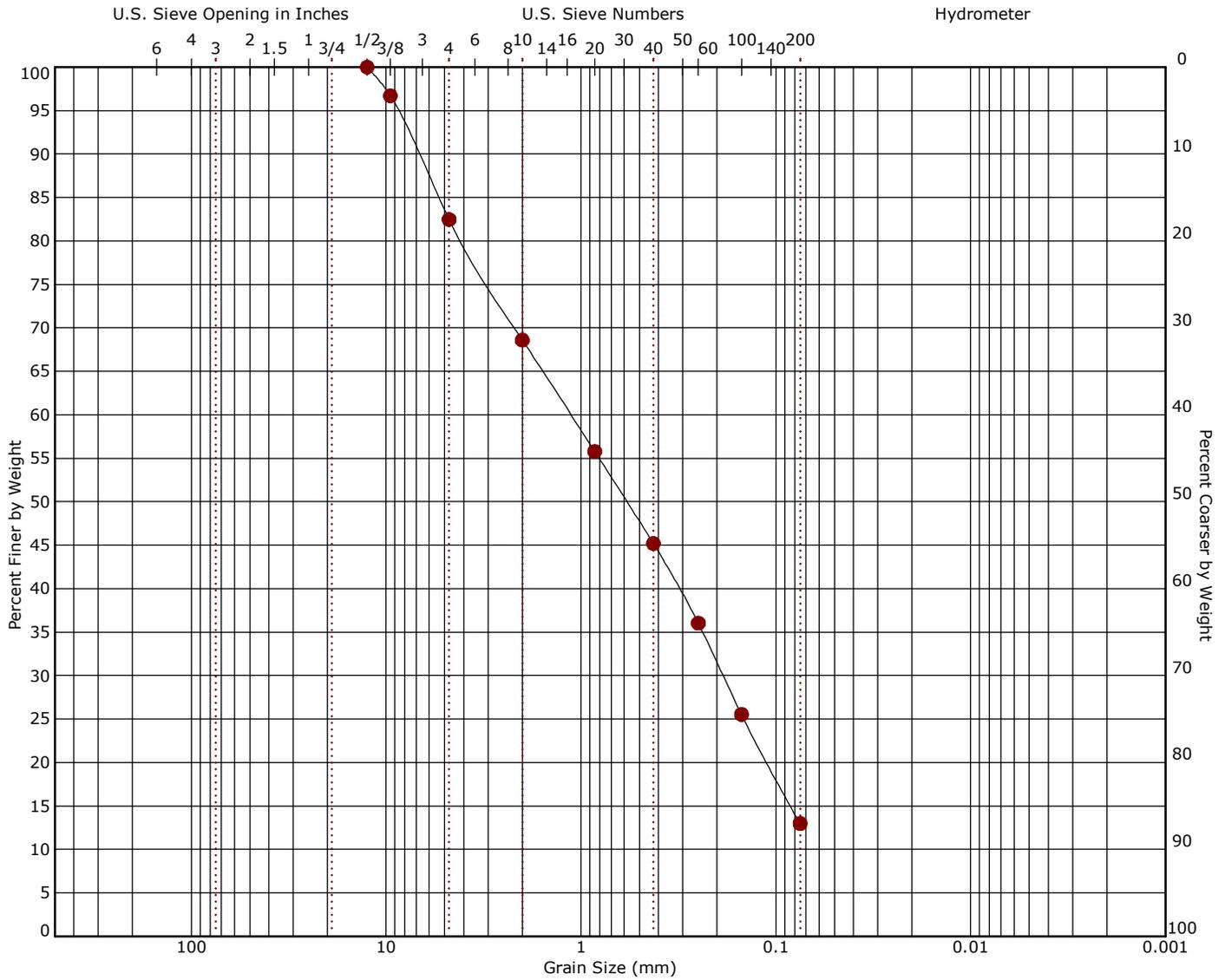
coarse |
 fine |
 coarse |
 medium |
 fine

| Boring ID | Depth (Ft) | USCS Classification | USCS | AASHTO | LL | PL | PI | Cc | Cu |
|---------------------|------------|------------------------|------|-----------|----|----|----|----|----|
| ● S-23-310-1 | 2 - 4 | SILTY SAND | SM | A-2-4 (0) | NP | NP | NP | | |
| ☒ S-23-310-1 | 4 - 6 | SILTY SAND with GRAVEL | SM | A-2-4 (0) | NP | NP | NP | | |
| ▲ S-23-310-1 | 6 - 8 | SILTY SAND | SM | A-4 (0) | NP | NP | NP | | |
| ★ S-23-310-1 | 8 - 10 | SILT | ML | A-4 (0) | NP | NP | NP | | |
| ⊙ S-23-310-1 Offset | 0 - 5 | SILTY SAND | SM | A-2-4 (0) | NP | NP | NP | | |

| Boring ID | Depth (Ft) | D ₁₀₀ | D ₆₀ | D ₃₀ | D ₁₀ | %Cobbles | %Gravel | %Sand | %Fines | %Silt | %Clay |
|---------------------|------------|------------------|-----------------|-----------------|-----------------|----------|---------|-------|--------|-------|-------|
| ● S-23-310-1 | 2 - 4 | 9.5 | 0.56 | 0.076 | | 0.0 | 8.5 | 61.6 | 29.8 | | |
| ☒ S-23-310-1 | 4 - 6 | 12.5 | 0.76 | | | 0.0 | 17.5 | 47.3 | 35.2 | | |
| ▲ S-23-310-1 | 6 - 8 | 4.75 | 0.287 | 0.014 | | 0.0 | 0.0 | 56.0 | | 23.4 | 20.7 |
| ★ S-23-310-1 | 8 - 10 | 4.75 | 0.029 | 0.003 | | 0.0 | 0.0 | 13.2 | | 49.2 | 37.6 |
| ⊙ S-23-310-1 Offset | 0 - 5 | 9.5 | 0.541 | 0.118 | | 0.0 | 5.8 | 69.6 | 24.6 | | |

Grain Size Distribution

ASTM D422 / ASTM C136



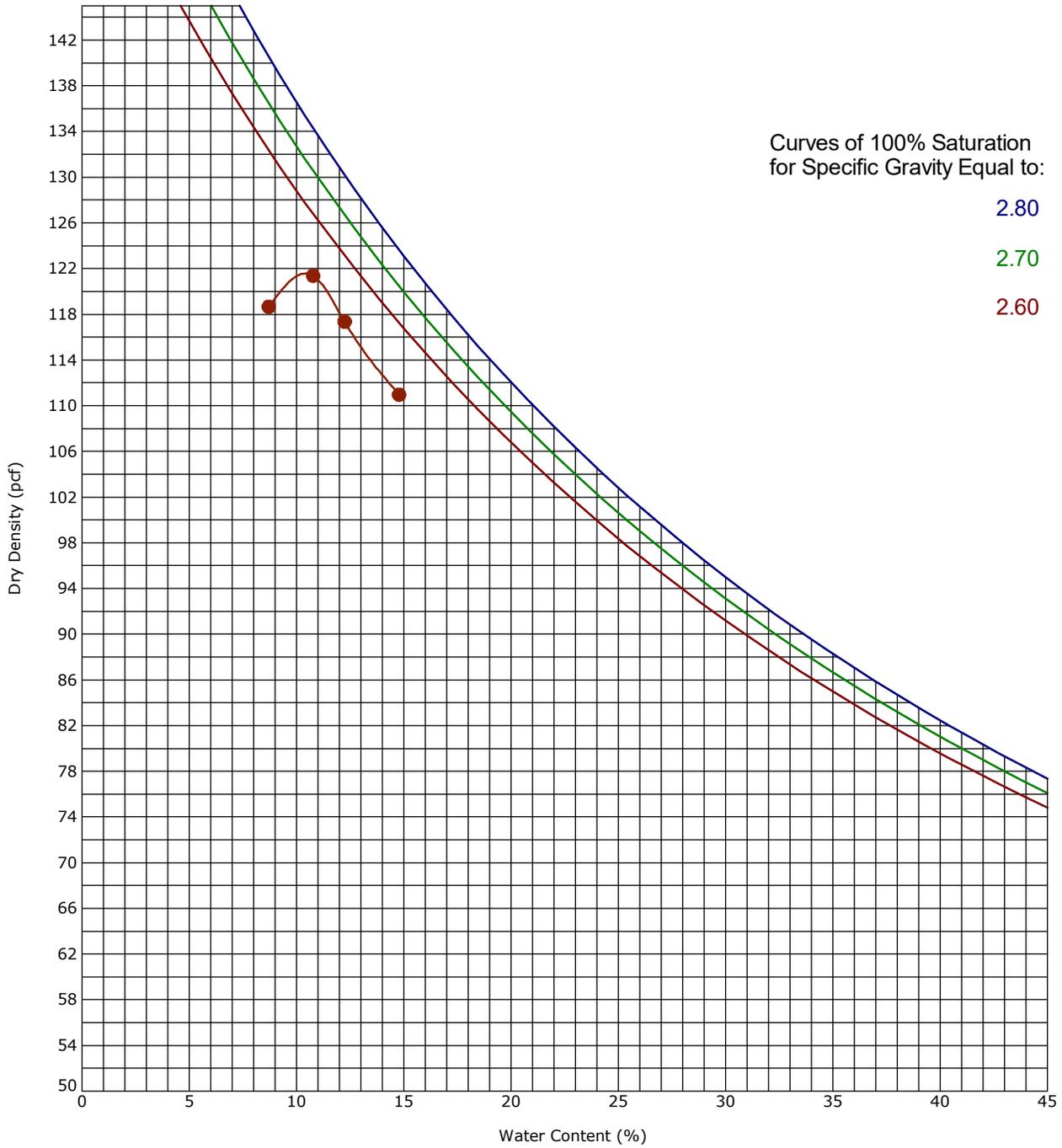
Cobbles |
 Gravel (coarse | fine) |
 Sand (coarse | medium | fine) |
 Silt or Clay

| Boring ID | Depth (Ft) | USCS Classification | USCS | AASHTO | LL | PL | PI | Cc | Cu |
|--------------|------------|------------------------|------|-----------|----|----|----|----|----|
| ● S-23-310-2 | 0.5 - 2 | SILTY SAND with GRAVEL | SM | A-1-b (0) | NP | NP | NP | | |

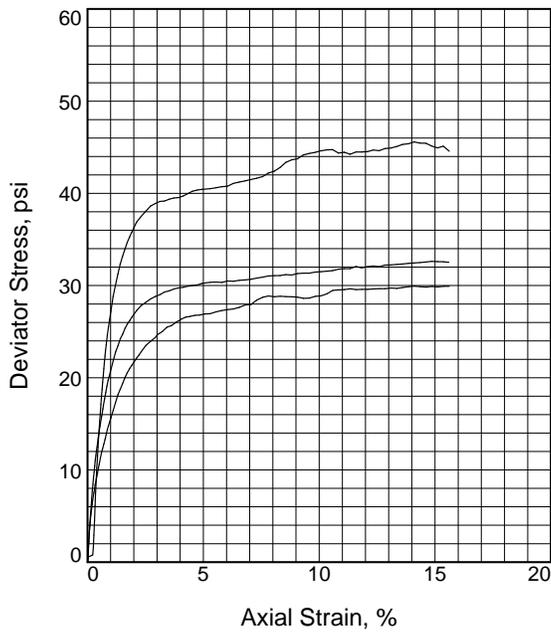
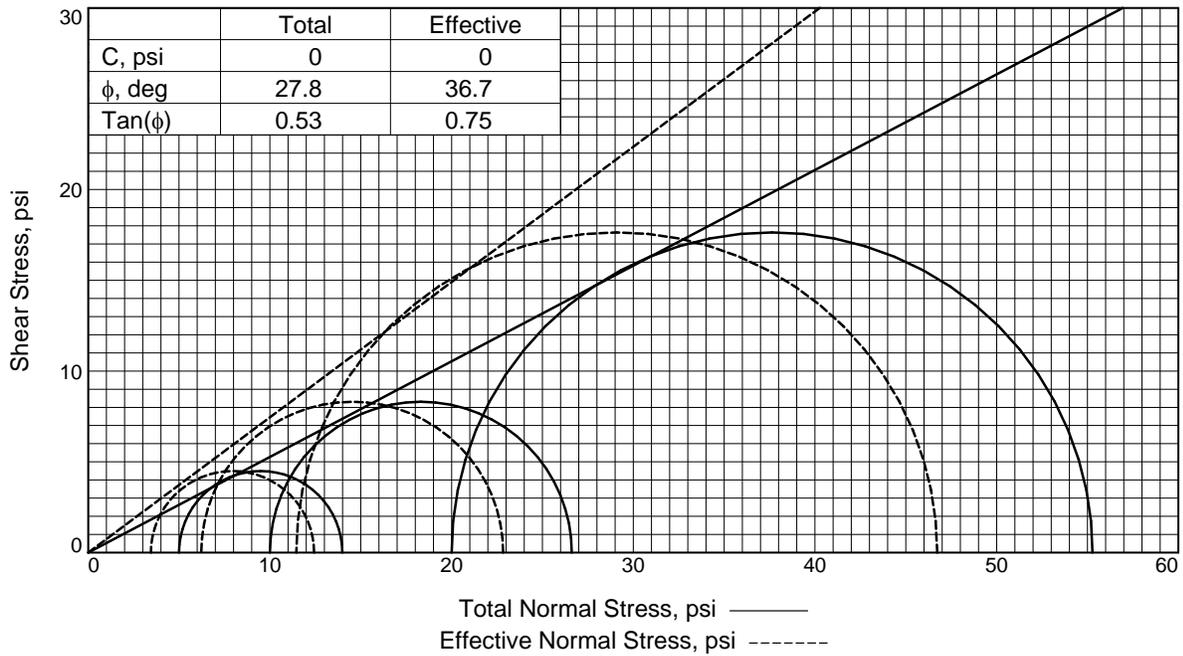
| Boring ID | Depth (Ft) | D ₁₀₀ | D ₆₀ | D ₃₀ | D ₁₀ | %Cobbles | %Gravel | %Sand | %Fines | %Silt | %Clay |
|--------------|------------|------------------|-----------------|-----------------|-----------------|----------|---------|-------|--------|-------|-------|
| ● S-23-310-2 | 0.5 - 2 | 12.5 | 1.127 | 0.186 | | 0.0 | 17.5 | 69.5 | 13.0 | | |

Moisture-Density Relationship

ASTM D698-Method B



| Boring ID | | Depth (Ft) | | Description of Materials | | | | |
|-------------------|--------------------|------------|----|--------------------------|--------------------|---------------------------|---------------------------|--|
| S-23-310-1 Offset | | 0 - 5 | | SILTY SAND(SM) | | | | |
| Fines (%) | Fraction > mm size | LL | PL | PI | Test Method | Maximum Dry Density (pcf) | Optimum Water Content (%) | |
| 25 | 0.0 | NP | NP | NP | ASTM D698-Method B | 121.6 | 10.4 | |



| Sample No. | 1 | 2 | 3 | |
|-------------------------------|------------------|--------|--------|--------|
| Initial | Water Content, % | 10.3 | 10.2 | 10.3 |
| | Dry Density, pcf | 115.7 | 116.0 | 115.9 |
| | Saturation, % | 61.0 | 60.7 | 61.4 |
| | Void Ratio | 0.4572 | 0.4537 | 0.4547 |
| | Diameter, in. | 2.80 | 2.80 | 2.80 |
| | Height, in. | 5.62 | 5.62 | 5.62 |
| At Test | Water Content, % | 15.2 | 15.1 | 14.8 |
| | Dry Density, pcf | 119.6 | 119.7 | 120.5 |
| | Saturation, % | 100.0 | 100.0 | 100.0 |
| | Void Ratio | 0.4095 | 0.4081 | 0.3985 |
| | Diameter, in. | 2.76 | 2.76 | 2.75 |
| | Height, in. | 5.58 | 5.59 | 5.58 |
| Strain rate, in./min. | 0.001 | 0.001 | 0.001 | |
| Back Pressure, psi | 50.0 | 50.0 | 50.0 | |
| Cell Pressure, psi | 55.0 | 60.0 | 70.0 | |
| Fail. Stress, psi | 9.0 | 16.6 | 35.3 | |
| Excess Pore Pr., psi | 1.5 | 3.8 | 8.5 | |
| Ult. Stress, psi | 29.8 | 32.6 | 44.9 | |
| Excess Pore Pr., psi | -4.8 | -1.2 | 6.2 | |
| $\bar{\sigma}_1$ Failure, psi | 12.4 | 22.8 | 46.7 | |
| $\bar{\sigma}_3$ Failure, psi | 3.5 | 6.2 | 11.5 | |

Type of Test:

CU with Pore Pressures

Sample Type: Remolded

Description: Silty Sand (SM)

LL= NP

PI= NP

Specific Gravity= 2.7

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

Figure _____

Client: HNTB North Carolina PC

Project: S-23-310 (Crestwood Drive) over Langston Tributary

Source of Sample: S-23-310-1 Offset **Depth:** 0-5'

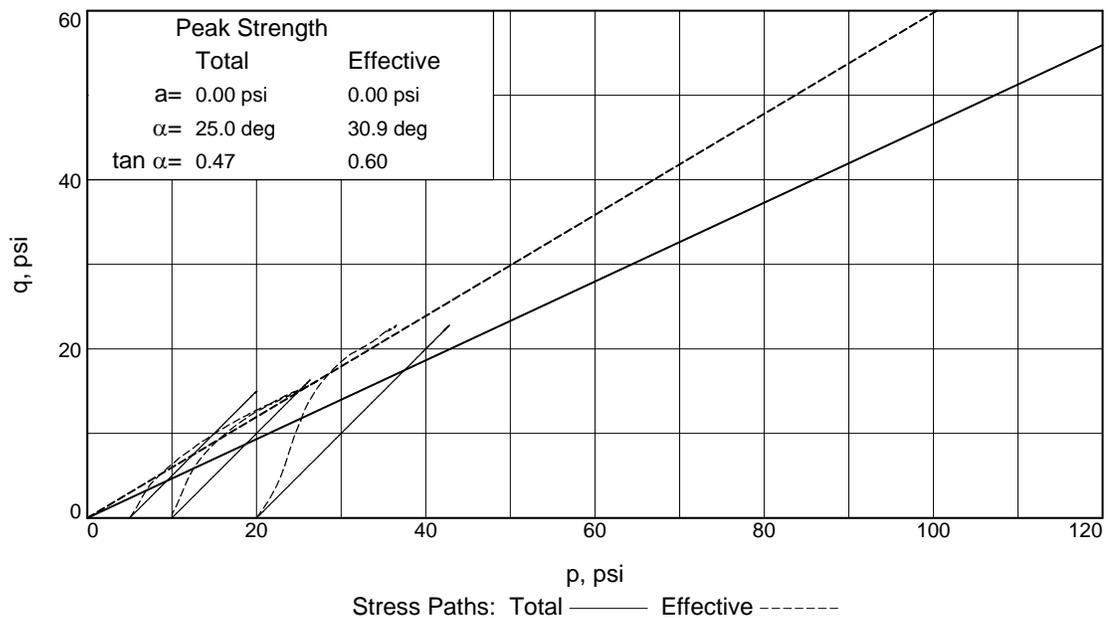
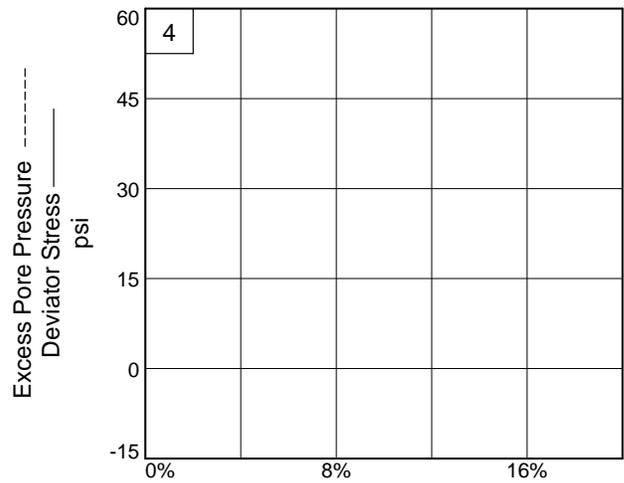
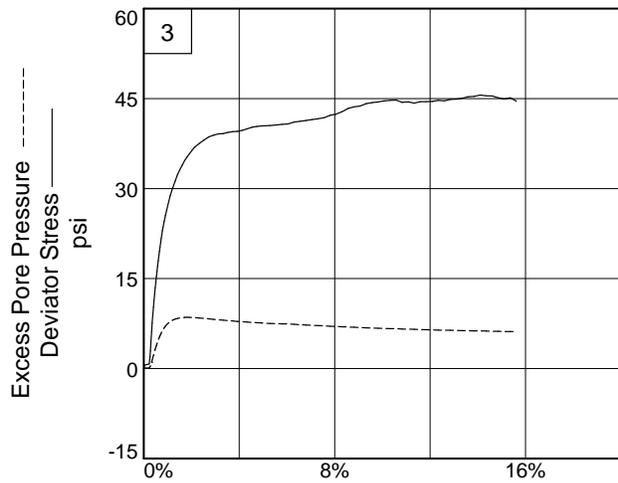
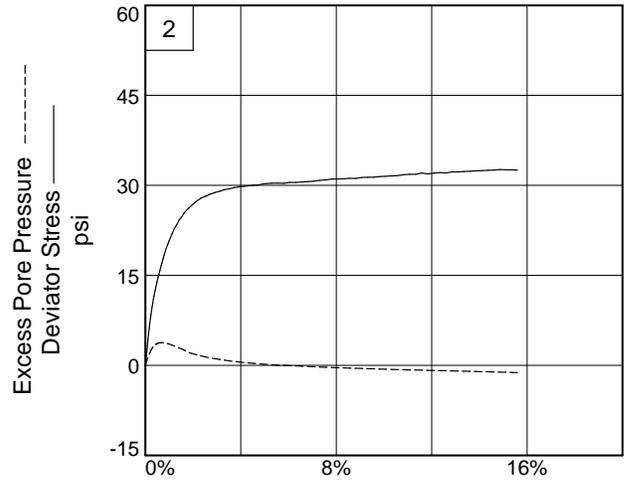
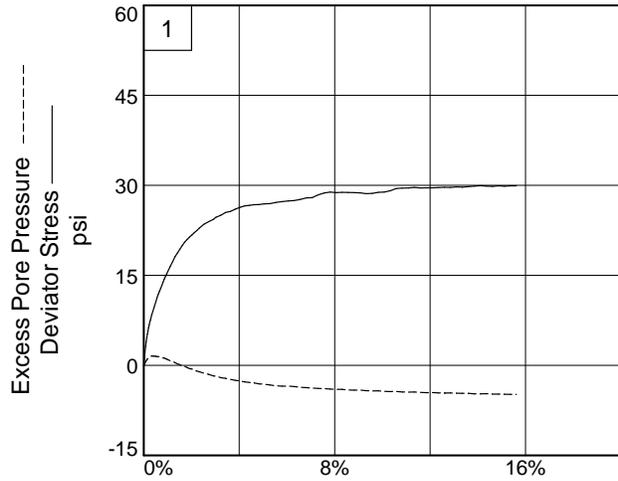
Proj. No.: 8623P180

Date Sampled: N/A

TRIAxIAL SHEAR TEST REPORT

Terracon Consultants, Inc.

Chattanooga, TN



Client: HNTB North Carolina PC

Project: S-23-310 (Crestwood Drive) over Langston Tributary

Source of Sample: S-23-310-1 Offset **Depth:** 0-5'

Project No.: 8623P180

Figure _____

Terracon Consultants, Inc.

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



Client

HNTB North Carolina PC

Project

S-23-310 (Crestwood Drive) over Langston Tributary

Sample Submitted By: Terracon (86)

Date Received: 8/16/2024

Lab No.: 24-0279

Results of Corrosion Analysis

| | |
|--|------------|
| Sample Number | S-23-310-1 |
| Sample Location | -- |
| Sample Depth (ft.) | 2.0-10.0 |
| pH Analysis, AASHTO T289 | 5.26 |
| Water Soluble Sulfate (SO4), AASHTO T290 (mg/kg) | 90 |
| Chlorides, AASHTO T291, (mg/kg) | 132 |
| Saturated Minimum Resistivity, AASHTO T288, (ohm-cm) | 2231 |

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

Analyzed By _____

Nathan Campo
Laboratory Coordinator

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



Rock Coring Summary

PROJECT ID P041162

PROJECT NAME S-23-310 over Langston Tributary

PROJECT COUNTY Greenville

| 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-23-310-1 | NQ-1 | 13.0 | 94 | 88 | | | | | | 80 |
| S-23-310-1 | NQ-2 | 18.0 | 100 | 58 | 6127 | 0.07 | 817 | 173 | 67 | 70 |
| S-23-310-1 | NQ-3 | 23.0 | 97 | 73 | | | | | | 75 |
| S-23-310-1 | NQ-4 | 28.0 | 95 | 65 | 5190 | 0.28 | 177 | 158 | 67 | 70 |
| S-23-310-1 | NQ-5 | 33.0 | 100 | 78 | | | | | | 75 |
| S-23-310-1 | NQ-6 | 38.0 | 100 | 86 | 10054 | 0.04 | 1204 | 182 | 74 | 80 |
| S-23-310-1 | NQ-7 | 43.0 | 98 | 58 | | | | | | 70 |
| S-23-310-1 | NQ-8 | 48.0 | 94 | 82 | 6048 | 0.03 | 1065 | 168 | 71 | 75 |
| S-23-310-2 | NQ-1 | 12.1 | 93 | 53 | 12545 | 0.46 | 1243 | 164 | 70 | 70 |
| S-23-310-2 | NQ-2 | 17.0 | 95 | 77 | | | | | | 75 |

ROCK CORING SUMMARY 8623P180T SCDOT BRIDGE PACK SCDOT S-23-310 OVER LANGSTON TRIBUTARY.GPJ SCDOT_DATATEMPLATE.GDT 9/20/24

Client

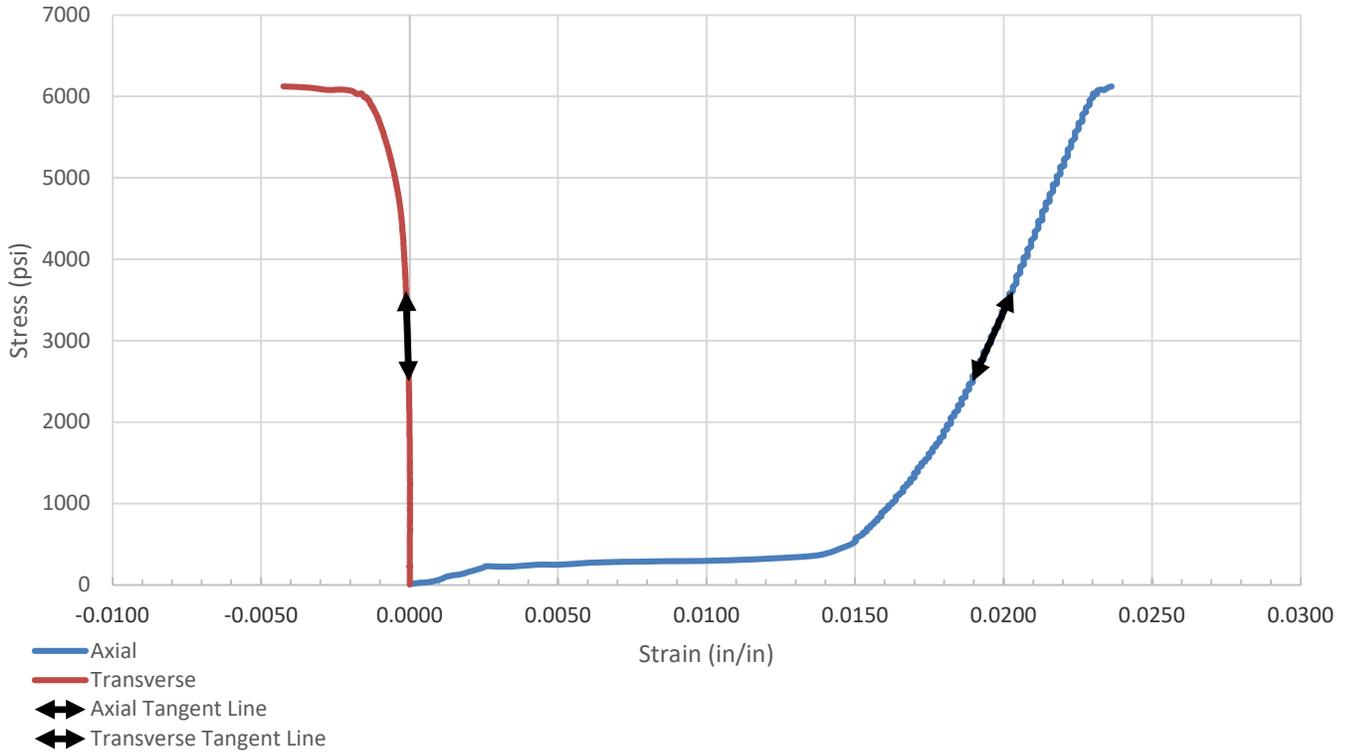
HNTB North Carolina PC
 Attn: Spencer Franklin
 343 E Six Forks Rd Ste 200
 Raleigh, NC 27609

Project

SCDOT Bridge Package 19

Project No. 8623P180

ASTM D7012 Stress/ Strain Curve



SAMPLE LOCATION

| | | | |
|--------------|-------------------------|---------------|-----------|
| Site: | SCDOT Bridge Package 19 | | |
| Description: | Schist | | |
| Boring: | S-23-310-1 | Depth (feet): | 21.3-22.8 |

SPECIMEN INFORMATION

| | | | |
|---------------|------|-----------------|--------|
| Sample No.: | R2 | Mass (g): | 550.91 |
| Length (in.): | 4.07 | Diameter (in.): | 1.95 |
| L/D Ratio: | 2.09 | Density (pcf): | 172.67 |

TEST RESULTS

| | |
|--|--------|
| Failure Load (lbs): | 18297 |
| Failure Strain (%): | 2.72 |
| Unconfined Compressive Strength (psi): | 6,127 |
| Elastic Modulus, E, (ksi): | 817 |
| Poisson's Ratio, u: | 0.069 |
| Time of Failure (min): | 00:56 |
| Rate of Loading (psi/sec): | 0.041 |
| Moisture Content Post-break: | 0.0021 |

Client

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

Project

SCDOT Bridge Package 19

Project No. 8623P180

Equipment:

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

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

Notes:

Per ASTM D4543, this specimen has not met the requirements for straightness, by exceeding 0.02 inches.

Per ASTM D4543, this specimen has not met the requirements for perpendicularity, by exceeding 0.250°.

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

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

According to ASTM D7012 Section 8.2.1, this specimen, although not meeting all requirements of ASTM D4543 is acceptable for testing. However, the results reported may differ from results obtained from a test specimen that meets the requirements of D4543.

Client

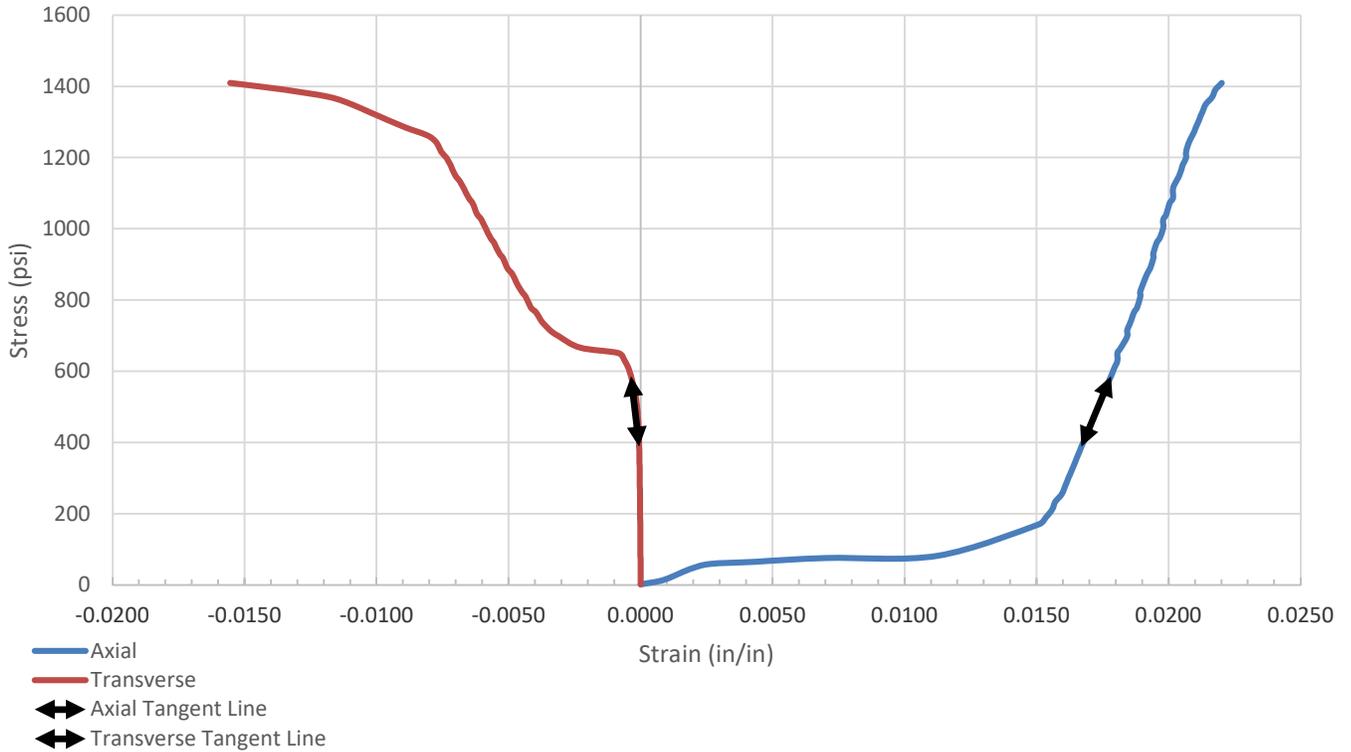
HNTB North Carolina PC
 Attn: Spencer Franklin
 343 E Six Forks Rd Ste 200
 Raleigh, NC 27609

Project

SCDOT Bridge Package 19

Project No. 8623P180

ASTM D7012 Stress/ Strain Curve



SAMPLE LOCATION

| | | | |
|--------------|-------------------------|---------------|-----------|
| Site: | SCDOT Bridge Package 19 | | |
| Description: | Granite | | |
| Boring: | S-23-310-1 | Depth (feet): | 30.4-31.1 |

SPECIMEN INFORMATION

| | | | |
|---------------|------|-----------------|--------|
| Sample No.: | R4 | Mass (g): | 507.69 |
| Length (in.): | 4.05 | Diameter (in.): | 1.96 |
| L/D Ratio: | 2.07 | Density (pcf): | 158.28 |

TEST RESULTS

| | |
|--|--------|
| Failure Load (lbs): | 15658 |
| Failure Strain (%): | 2.33 |
| Unconfined Compressive Strength (psi): | 5,190 |
| Elastic Modulus, E, (ksi): | 177 |
| Poisson's Ratio, u: | 0.278 |
| Time of Failure (min): | 00:13 |
| Rate of Loading (psi/sec): | 0.041 |
| Moisture Content Post-break: | 0.0050 |

Client

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

Project

SCDOT Bridge Package 19

Project No. 8623P180

Equipment:

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

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

Notes:

Per ASTM D4543, this specimen has not met the requirements for perpendicularity, by exceeding 0.250°.

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

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

According to ASTM D7012 Section 8.2.1, this specimen, although not meeting all requirements of ASTM D4543 is acceptable for testing. However, the results reported may differ from results obtained from a test specimen that meets the requirements of D4543.

Client

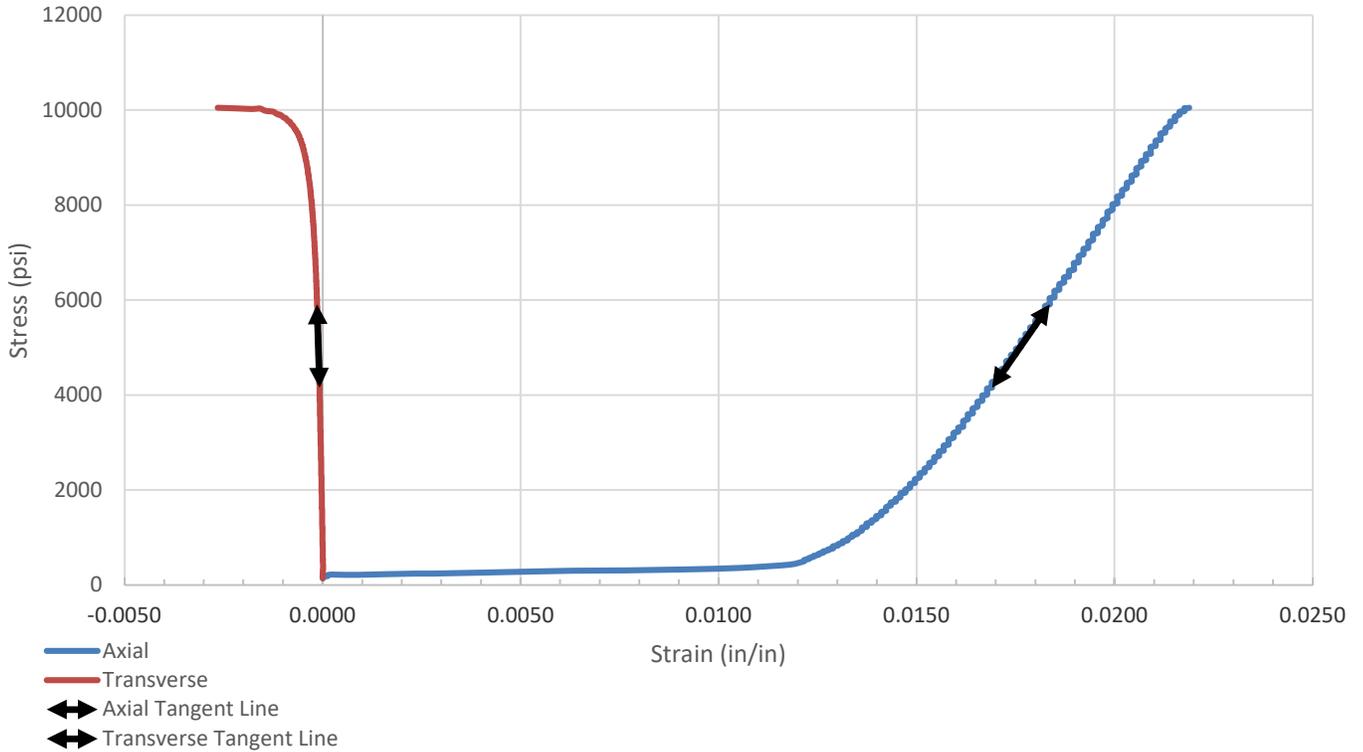
HNTB North Carolina PC
 Attn: Spencer Franklin
 343 E Six Forks Rd Ste 200
 Raleigh, NC 27609

Project

SCDOT Bridge Package 19

Project No. 8623P180

ASTM D7012 Stress/ Strain Curve



SAMPLE LOCATION

| | | | |
|--------------|-------------------------|---------------|-----------|
| Site: | SCDOT Bridge Package 19 | | |
| Description: | Gneiss | | |
| Boring: | S-23-310-1 | Depth (feet): | 41.5-42.7 |

SPECIMEN INFORMATION

| | | | |
|---------------|------|-----------------|--------|
| Sample No.: | R6 | Mass (g): | 586.63 |
| Length (in.): | 4.12 | Diameter (in.): | 1.95 |
| L/D Ratio: | 2.11 | Density (pcf): | 181.63 |

TEST RESULTS

| | |
|--|--------|
| Failure Load (lbs): | 30025 |
| Failure Strain (%): | 2.69 |
| Unconfined Compressive Strength (psi): | 10,054 |
| Elastic Modulus, E, (ksi): | 1204 |
| Poisson's Ratio, u: | 0.040 |
| Time of Failure (min): | 01:31 |
| Rate of Loading (psi/sec): | 0.041 |
| Moisture Content Post-break: | 0.0011 |

Client

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

Project

SCDOT Bridge Package 19

Project No. 8623P180

Equipment:

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

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

Notes:

Per ASTM D4543, this specimen has not met the requirements for perpendicularity, by exceeding 0.250°.

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

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

According to ASTM D7012 Section 8.2.1, this specimen, although not meeting all requirements of ASTM D4543 is acceptable for testing. However, the results reported may differ from results obtained from a test specimen that meets the requirements of D4543.

Client

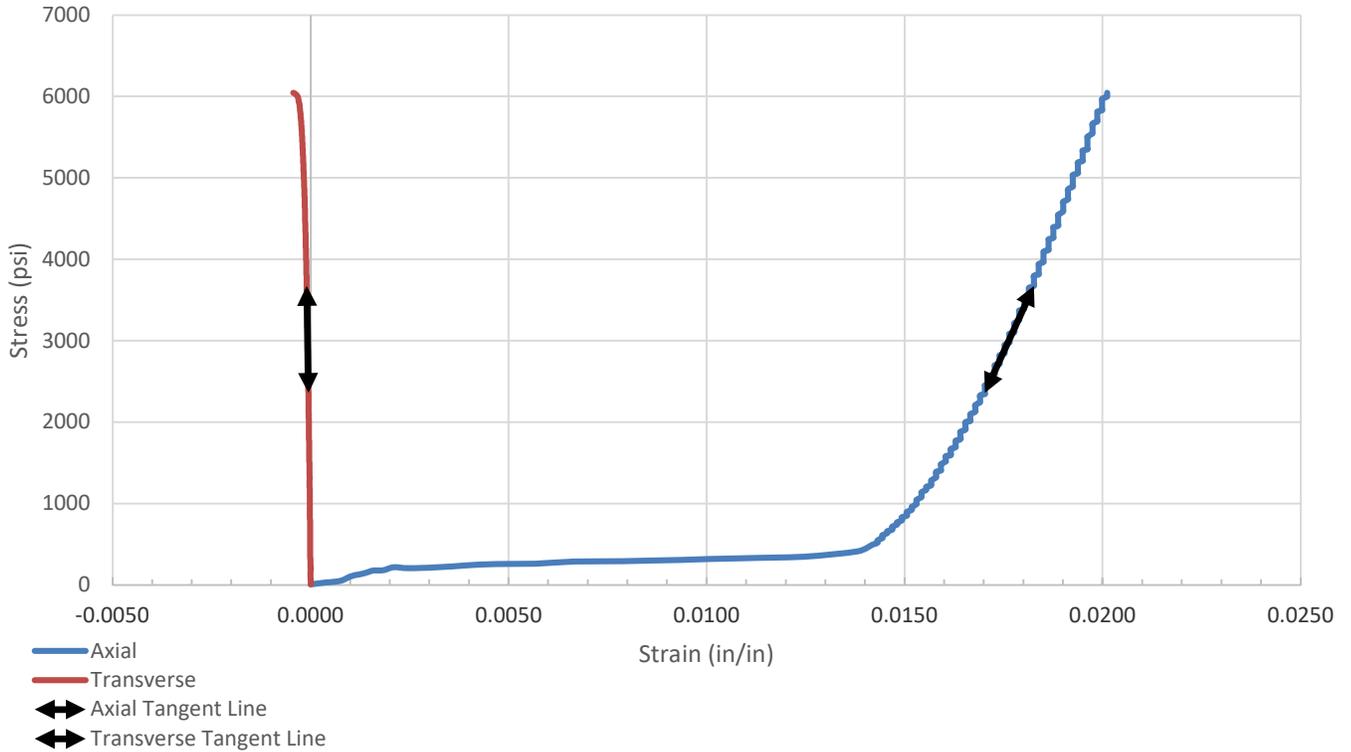
HNTB North Carolina PC
 Attn: Spencer Franklin
 343 E Six Forks Rd Ste 200
 Raleigh, NC 27609

Project

SCDOT Bridge Package 19

Project No. 8623P180

ASTM D7012 Stress/ Strain Curve



SAMPLE LOCATION

| | | | |
|--------------|-------------------------|---------------|-----------|
| Site: | SCDOT Bridge Package 19 | | |
| Description: | Gneiss | | |
| Boring: | S-23-310-1 | Depth (feet): | 49.8-50.4 |

SPECIMEN INFORMATION

| | | | |
|---------------|------|-----------------|--------|
| Sample No.: | R8 | Mass (g): | 535.11 |
| Length (in.): | 4.06 | Diameter (in.): | 1.95 |
| L/D Ratio: | 2.08 | Density (pcf): | 168.13 |

TEST RESULTS

| | |
|--|--------|
| Failure Load (lbs): | 18061 |
| Failure Strain (%): | 2.32 |
| Unconfined Compressive Strength (psi): | 6,048 |
| Elastic Modulus, E, (ksi): | 1065 |
| Poisson's Ratio, u: | 0.034 |
| Time of Failure (min): | 00:55 |
| Rate of Loading (psi/sec): | 0.041 |
| Moisture Content Post-break: | 0.0029 |

Client

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

Project

SCDOT Bridge Package 19

Project No. 8623P180

Equipment:

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

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

Notes:

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

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

According to ASTM D7012 Section 8.2.1, this specimen, although not meeting all requirements of ASTM D4543 is acceptable for testing. However, the results reported may differ from results obtained from a test specimen that meets the requirements of D4543.

Client

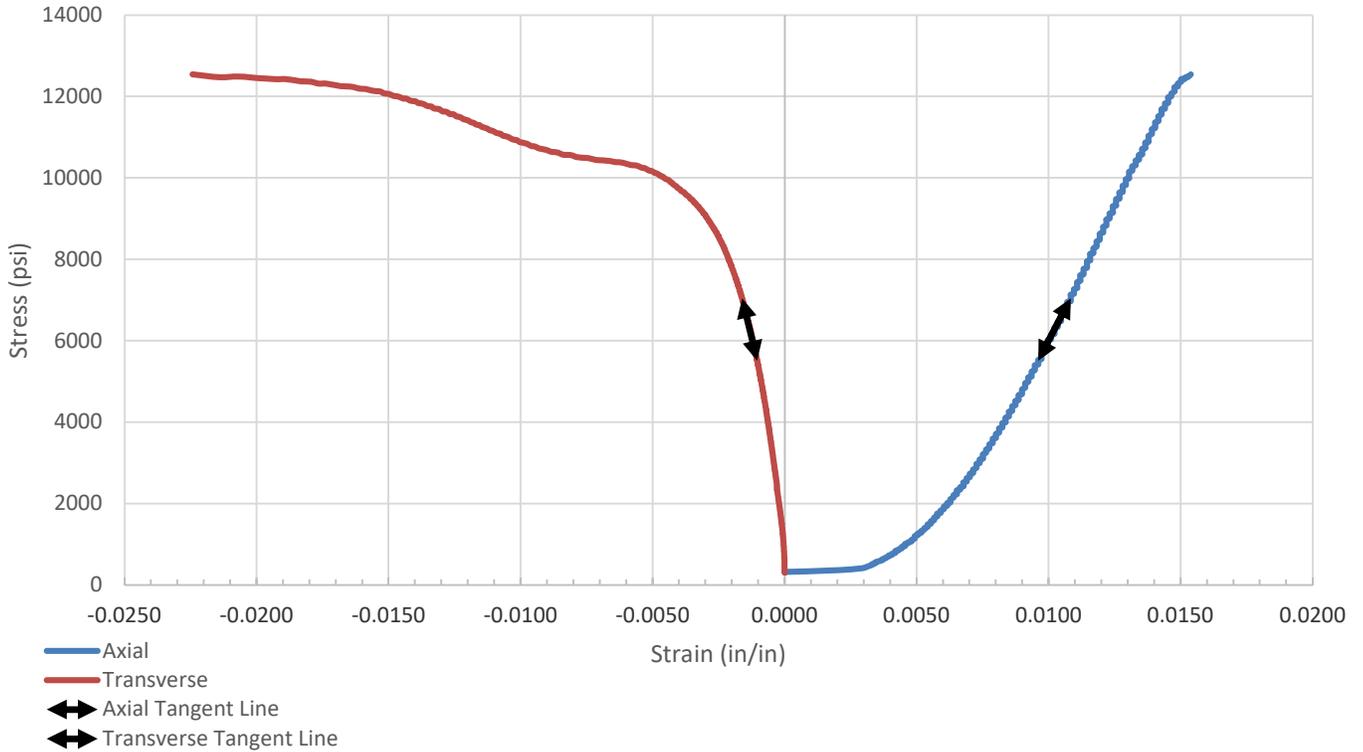
HNTB North Carolina PC
 Attn: Spencer Franklin
 343 E Six Forks Rd Ste 200
 Raleigh, NC 27609

Project

SCDOT Bridge Package 19

Project No. 8623P180

ASTM D7012 Stress/ Strain Curve



SAMPLE LOCATION

| | | | |
|--------------|-------------------------|---------------|-----------|
| Site: | SCDOT Bridge Package 19 | | |
| Description: | Granite | | |
| Boring: | S-23-310-2 | Depth (feet): | 12.7-14.0 |

SPECIMEN INFORMATION

| | | | |
|---------------|------|-----------------|--------|
| Sample No.: | R1 | Mass (g): | 528.04 |
| Length (in.): | 4.07 | Diameter (in.): | 1.96 |
| L/D Ratio: | 2.08 | Density (pcf): | 163.81 |

TEST RESULTS

| | |
|--|--------|
| Failure Load (lbs): | 37852 |
| Failure Strain (%): | 1.83 |
| Unconfined Compressive Strength (psi): | 12,545 |
| Elastic Modulus, E, (ksi): | 1243 |
| Poisson's Ratio, u: | 0.463 |
| Time of Failure (min): | 01:52 |
| Rate of Loading (psi/sec): | 0.041 |
| Moisture Content Post-break: | 0.0013 |

Client

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

Project

SCDOT Bridge Package 19

Project No. 8623P180

Equipment:

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

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

Notes:

Per ASTM D4543, this specimen has not met the requirements for perpendicularity, by exceeding 0.250°.

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

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

According to ASTM D7012 Section 8.2.1, this specimen, although not meeting all requirements of ASTM D4543 is acceptable for testing. However, the results reported may differ from results obtained from a test specimen that meets the requirements of D4543.

Appendix C – Supporting Documents

S-23-310 over Langston Tributary | Greenville County, SC Terracon
Project No. 8623P180 | SCDOT Project ID: P041162



Appendix C

Supporting Documents

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

Note: All exhibits are one page unless noted above.

3-Point Acceleration Design Response Spectrum

SCDOT v3.2 - 06/01/2023

| | |
|-------------------------|-----------------------------|
| Project ID: P041162 | Latitude: 34.8972 |
| Route: S-23-310-1 | Longitude: 82.4002 |
| County: 23 - Greenville | Project: Langston Tributary |

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

| Design EQ | PGA | S _{DS} | S _{D1} | M _W | R | PGV | D ₉₅₋₉₅ | T' _o |
|-----------|------|-----------------|-----------------|----------------|--------|------------|--------------------|-----------------|
| | g | g | g | - | km | inches/sec | sec | sec |
| FEE | 0.01 | 0.02 | 0.00 | 6.63 | 213.43 | 0.18 | 43.94 | 0.17 |
| SEE | 0.02 | 0.04 | 0.01 | 5.66 | 103.17 | 0.39 | 21.83 | 0.13 |

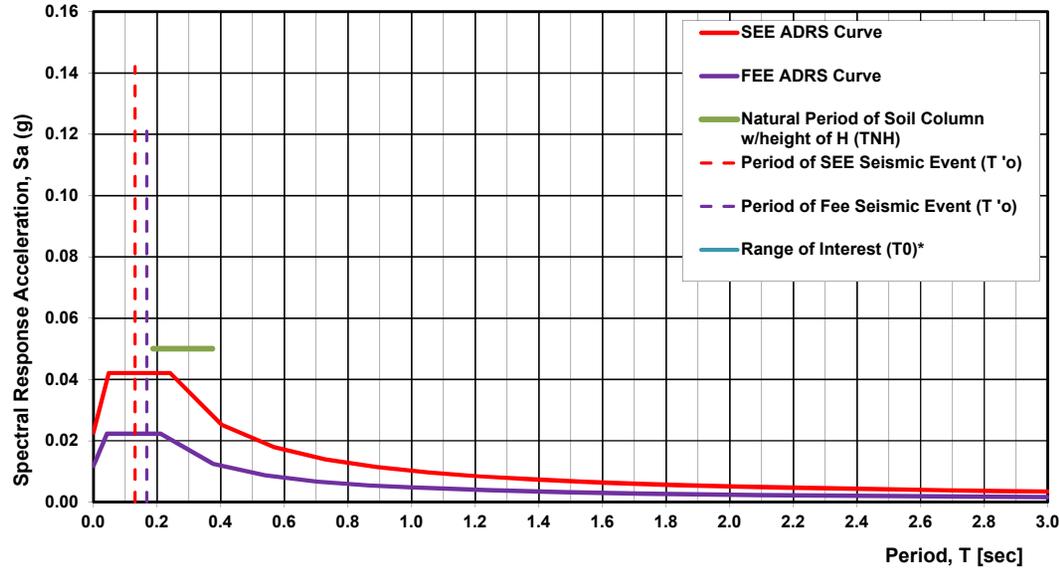
| Fundamental Period of Structure, T _o | Range of Interest | | V* _{s,H} | H | T _{NH} | |
|---|--------------------|--------------------|-------------------|-------|-------------------------|-------------------------|
| | sec | | | | sec | |
| sec | 0.5*T _o | 2.0*T _o | ft/sec | ft | (4*H)/V* _{s,H} | (6*H)/V* _{s,H} |
| 0.00 | 0.00 | 0.00 | 673.65 | 42.00 | 0.19 | 0.37 |
| 0.00 | 0.00 | 0.00 | | | | |

H = B-C Boundary

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

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

SC Seismic ADRS Curve



FEE Data

| T | S _a |
|------|----------------|
| 0.00 | 0.012 |
| 0.01 | 0.013 |
| 0.01 | 0.015 |
| 0.02 | 0.017 |
| 0.03 | 0.019 |
| 0.04 | 0.020 |
| To | 0.022 |
| 0.06 | 0.022 |
| 0.07 | 0.022 |
| 0.08 | 0.022 |
| 0.10 | 0.022 |
| 0.11 | 0.022 |
| 0.13 | 0.022 |
| 0.14 | 0.022 |
| 0.15 | 0.022 |
| 0.17 | 0.022 |
| 0.18 | 0.022 |
| 0.20 | 0.022 |
| Ts | 0.022 |
| 0.38 | 0.013 |
| 0.54 | 0.009 |
| 0.70 | 0.007 |
| 0.87 | 0.005 |
| 1.03 | 0.005 |
| 1.20 | 0.004 |
| 1.36 | 0.003 |
| 1.52 | 0.003 |
| 1.69 | 0.003 |
| 1.85 | 0.003 |
| 2.02 | 0.002 |
| 2.18 | 0.002 |
| 2.34 | 0.002 |
| 2.51 | 0.002 |
| 2.67 | 0.002 |
| 2.84 | 0.002 |
| 3.00 | 0.002 |

SEE Data

| T | S _a |
|------|----------------|
| 0.00 | 0.023 |
| 0.01 | 0.026 |
| 0.02 | 0.029 |
| 0.03 | 0.032 |
| 0.04 | 0.036 |
| 0.04 | 0.039 |
| To | 0.042 |
| 0.06 | 0.042 |
| 0.08 | 0.042 |
| 0.10 | 0.042 |
| 0.11 | 0.042 |
| 0.13 | 0.042 |
| 0.14 | 0.042 |
| 0.16 | 0.042 |
| 0.18 | 0.042 |
| 0.19 | 0.042 |
| 0.21 | 0.042 |
| 0.23 | 0.042 |
| Ts | 0.042 |
| 0.40 | 0.025 |
| 0.57 | 0.018 |
| 0.73 | 0.014 |
| 0.89 | 0.011 |
| 1.05 | 0.010 |
| 1.21 | 0.008 |
| 1.38 | 0.007 |
| 1.54 | 0.007 |
| 1.70 | 0.006 |
| 1.86 | 0.005 |
| 2.03 | 0.005 |
| 2.19 | 0.005 |
| 2.35 | 0.004 |
| 2.51 | 0.004 |
| 2.68 | 0.004 |
| 2.84 | 0.004 |
| 3.00 | 0.003 |

SPT Automatic Hammer Energy Measurement Report

Drill Rig Model: GeoProbe 3126
 Drill Rig Serial Number: 3126TTS52010006
 Asset Number: DR#554

August 21, 2023



July 19, 2023

Terracon
 72 Pointe Circle
 Greenville, South Carolina 29607

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

Re: SPT Automatic Hammer Energy Measurement Report
 Rig Serial Number: 3126TTS52010006
 Terracon Project Number: DYX0500

Dear Ms. McKenney:

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

Table 1: Hammer Efficiency Summary

| Drill Rig Make/Model | Drill Rig Serial Number | Drill Rig Year | Asset Number | Energy Transfer Ratio (ETR) | Hammer Efficiency Correction (Ce) |
|----------------------|-------------------------|----------------|--------------|-----------------------------|-----------------------------------|
| GeoProbe 3126 | 3126TTS52010006 | 2021 | GP#554 | 88.5% ± 4.2% | 1.48 |

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

Jim Smith

James P. Smith
 National Manager of Equipment & Training

Rob Kramer

Rob Kramer
 Group Manager Geophysics

Attachments:

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

Prepared for:
 Terracon
 Greenville-Spartanburg, South Carolina

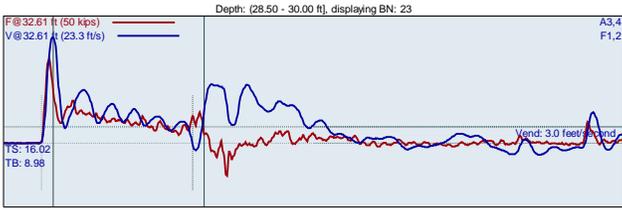


MEASUREMENT SUMMARY

| ITEM | DESCRIPTION |
|-------------------------------|---|
| Drill Rig Owner | Terracon Greenville-Spartanburg – Greenville, SC |
| Drill Rig Operator | Brett Burnett; Terracon Exploration Services |
| Testing Date | 08/21/2023 |
| Testing Location | Spartanburg, SC |
| Boring Identification | B-1 |
| Hammer Type | 140 pounds (automatic) |
| Boring Method | Hollow Stem Auger |
| Drill Rods | <ul style="list-style-type: none"> 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 | Jim Smith, National Manager of Equipment and Training |

Exhibit A PDA SPT Analyzer Results

GP554-3126 28.530
JIM SMITH Interval start: 8/21/2023
TB-1
AR: 1.20 in/2 SP: 0.492 k/ft3
LE: 32.61 ft EM: 30000 ksi
WS: 16807.9 fts



F1 : [648AWJ1] 226.21 PDICAL (1) FF1 A3 (PR): [K4483] 410.187 mv/6.4w5000g (1) VF1
F2 : [648AWJ2] 225.58 PDICAL (1) FF1 A4 (PR): [K10491] 421.907 mv/6.4w5000g (1) VF1

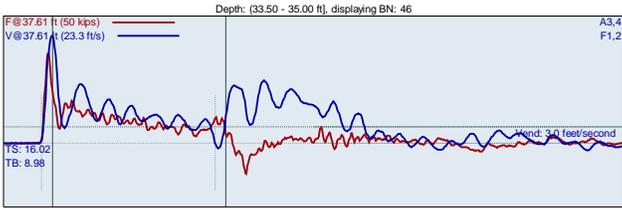
FMX: Maximum Force EFV: Maximum Energy
VMX: Maximum Velocity ETR: Energy Transfer Ratio - Rated
BPM: Blows/Minute

| BL# | BC /6" | FMX kips | VMX fts | BPM bpm | EFV ft-lb | ETR % |
|-----|--------|----------|---------|---------|-----------|-------|
| 1 | 6 | 40 | 19.4 | 1.9 | 234 | 84.1 |
| 2 | 6 | 39 | 19.2 | 51.9 | 232 | 83.4 |
| 3 | 6 | 25 | 16.9 | 52.7 | 274 | 78.2 |
| 4 | 6 | 28 | 17.9 | 52.4 | 273 | 77.9 |
| 5 | 6 | 32 | 19.6 | 52.6 | 294 | 83.9 |
| 6 | 6 | 27 | 17.3 | 53.1 | 269 | 79.5 |
| 7 | 8 | 38 | 19.0 | 52.7 | 289 | 82.5 |
| 8 | 8 | 39 | 19.6 | 52.4 | 305 | 87.2 |
| 9 | 8 | 36 | 19.2 | 52.7 | 290 | 82.8 |
| 10 | 8 | 28 | 18.2 | 52.5 | 292 | 83.4 |
| 11 | 8 | 38 | 19.0 | 53.0 | 293 | 83.8 |
| 12 | 8 | 35 | 19.4 | 52.6 | 282 | 80.4 |
| 13 | 8 | 36 | 19.1 | 52.9 | 299 | 85.3 |
| 14 | 8 | 34 | 19.8 | 52.8 | 307 | 87.7 |
| 15 | 11 | 34 | 19.5 | 52.7 | 307 | 87.6 |
| 16 | 11 | 33 | 19.5 | 52.9 | 299 | 85.6 |
| 17 | 11 | 36 | 19.4 | 52.7 | 308 | 88.1 |
| 18 | 11 | 37 | 18.5 | 52.8 | 320 | 91.4 |
| 19 | 11 | 32 | 19.6 | 52.9 | 301 | 86.1 |
| 20 | 11 | 39 | 18.7 | 52.9 | 301 | 85.9 |
| 21 | 11 | 26 | 17.5 | 52.8 | 277 | 79.1 |
| 22 | 11 | 30 | 19.1 | 52.6 | 306 | 87.4 |
| 23 | 11 | 33 | 19.5 | 52.7 | 298 | 85.1 |
| 24 | 11 | 35 | 19.9 | 52.4 | 303 | 86.5 |
| 25 | 11 | 36 | 19.4 | 53.1 | 313 | 89.6 |

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

Sample Interval Time: 27.36 seconds.

GP554-3126 28.530
JIM SMITH Interval start: 8/21/2023
TB-1
AR: 1.20 in/2 SP: 0.492 k/ft3
LE: 37.61 ft EM: 30000 ksi
WS: 16807.9 fts



F1 : [648AWJ1] 226.21 PDICAL (1) FF1 A3 (PR): [K4483] 410.187 mv/6.4w5000g (1) VF1
F2 : [648AWJ2] 225.58 PDICAL (1) FF1 A4 (PR): [K10491] 421.907 mv/6.4w5000g (1) VF1

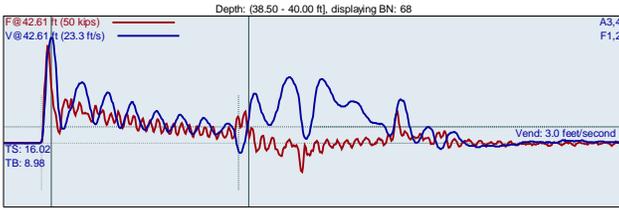
| BL# | BC /6" | FMX kips | VMX fts | BPM bpm | EFV ft-lb | ETR % |
|-------------|--------|----------|---------|---------|-----------|-------|
| 26 | 5 | 38 | 19.1 | 1.9 | 302 | 86.4 |
| 27 | 5 | 35 | 18.9 | 52.0 | 301 | 86.1 |
| 28 | 5 | 29 | 18.8 | 52.0 | 299 | 85.5 |
| 29 | 5 | 35 | 19.2 | 52.7 |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

Sample Interval Time: 25.16 seconds.

GP554-3126
JIM SMITH

28.5-30
Interval start: 8/21/2023

AR: 1.20 in/2 SP: 0.492 k/ft
LE: 42.61 ft EM: 30000 ksi
WS: 16807.9 ft/s



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

| BL# | BC /6" | FMX kips | VMX ft/s | BPM bpm | EFV ft-lb | ETR % |
|---------|--------|-------------|----------|---------|-----------|-------|
| 49 | 5 | 34 | 19.6 | 1.9 | 307 | 87.6 |
| 50 | 5 | 34 | 19.3 | 52.0 | 301 | 86.1 |
| 51 | 5 | 27 | 16.5 | 52.7 | 279 | 79.4 |
| 52 | 5 | 33 | 19.9 | 52.5 | 310 | 88.6 |
| 53 | 5 | 29 | 17.7 | 52.7 | 288 | 82.2 |
| 54 | 8 | 29 | 18.6 | 52.5 | 295 | 84.2 |
| 55 | 8 | 23 | 15.6 | 52.9 | 287 | 82.0 |
| 56 | 8 | 34 | 20.1 | 52.6 | 323 | 92.2 |
| 57 | 8 | 28 | 18.1 | 52.8 | 295 | 84.3 |
| 58 | 8 | 38 | 18.8 | 53.1 | 312 | 89.1 |
| 59 | 8 | 35 | 19.2 | 52.6 | 329 | 94.0 |
| 60 | 8 | 36 | 19.3 | 52.9 | 327 | 93.3 |
| 61 | 8 | 40 | 19.7 | 52.8 | 323 | 92.4 |
| 62 | 9 | 35 | 18.8 | 53.0 | 320 | 91.3 |
| 63 | 9 | 37 | 19.1 | 52.7 | 320 | 91.3 |
| 64 | 9 | 35 | 19.9 | 52.9 | 327 | 93.4 |
| 65 | 9 | 29 | 18.8 | 52.7 | 314 | 89.7 |
| 66 | 9 | 35 | 19.7 | 53.0 | 342 | 97.8 |
| 67 | 9 | 36 | 19.9 | 52.8 | 331 | 94.5 |
| 68 | 9 | 38 | 19.3 | 52.8 | 335 | 95.8 |
| 69 | 9 | 36 | 19.9 | 52.5 | 325 | 92.9 |
| 70 | 9 | 39 | 19.5 | 52.9 | 329 | 94.0 |
| Average | | 34 | 19.1 | 52.8 | 320 | 91.3 |
| Std Dev | | 4 | 1.0 | 0.2 | 15 | 4.1 |
| Maximum | | 40 | 20.1 | 53.1 | 342 | 97.8 |
| Minimum | | 23 | 15.6 | 52.5 | 287 | 82.0 |
| | | N-value: 17 | | | | |

Sample Interval Time: 23.91 seconds.

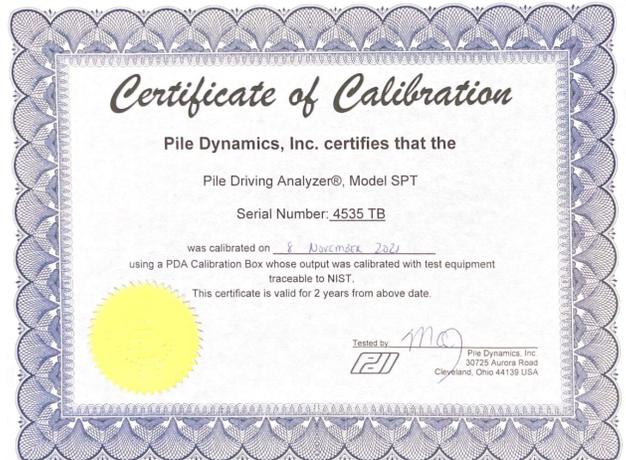
Summary of SPT Test Results

Project: GP554-3126, Test Date: 8/21/2023

| Blow/Minute | Force | N Value | N60 Value | Average FMX kips | Average VMX ft/s | Average BPM bpm | Average EFV ft-lb | Average ETR % |
|--------------------------------|--------|---------|-----------|------------------|------------------|-----------------|-------------------|---------------|
| 32.61 | 6-8-11 | 19 | 28 | 34 | 19.2 | 52.8 | 299 | 85.6 |
| 37.61 | 5-8-10 | 18 | 26 | 36 | 19.6 | 52.6 | 312 | 89.1 |
| 42.61 | 5-8-9 | 17 | 25 | 34 | 19.1 | 52.8 | 320 | 91.3 |
| Overall Average Values: | | | | 35 | 19.3 | 52.7 | 310 | 88.5 |
| Standard Deviation: | | | | 4 | 0.8 | 0.2 | 15 | 4.2 |
| Overall Maximum Value: | | | | 41 | 20.6 | 53.1 | 342 | 97.8 |
| Overall Minimum Value: | | | | 23 | 15.6 | 52.2 | 277 | 79.1 |



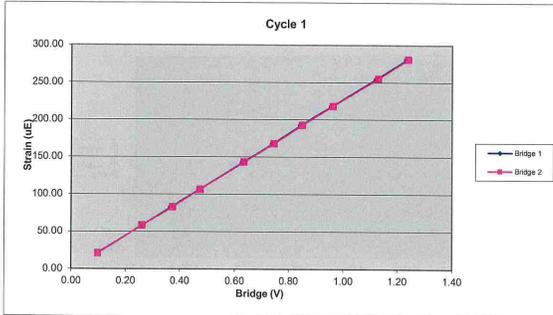
Exhibit B
PDA Equipment Calibration



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

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

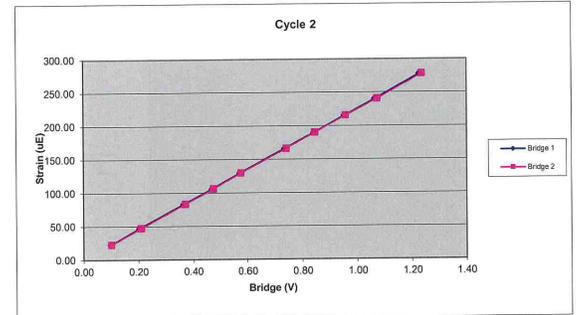
| Force Strain Calibration | |
|--------------------------|----------|
| EA (Kips) | 35527.98 |
| Offset | 51.69 |
| Correlation | 0.999986 |



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

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

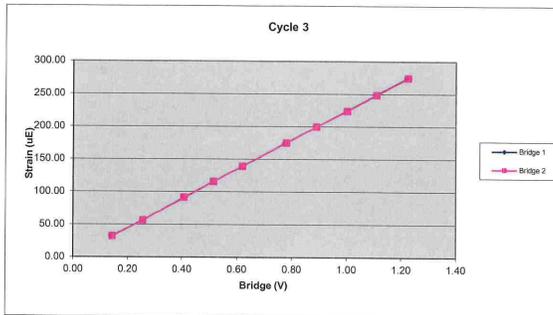
| Force Strain Calibration | |
|--------------------------|----------|
| EA (Kips) | 36073.41 |
| Offset | -2.66 |
| Correlation | 0.999993 |



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

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

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



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

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

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

Pile Dynamics Inc
30725 Aurora Rd
Solon, OH 44139

Traceable to N.I.S.T.

Accelerometer Calibration Certificate
Pile Dynamics, Inc.



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

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

PDA CALIBRATION FACTOR
410.2 mv/5000g
(62.0 µv/g)
R²: 0.999973 [Chip programmed]

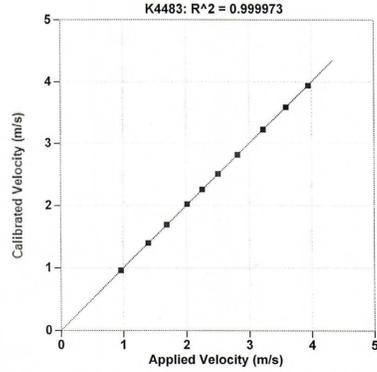
Operator: William Johnson

William Johnson
Signed

Ref Acc 1: 690961 Cal on: 27Jan2021
978 g's/volt

Ref Acc 2: 691321 Cal on: 09Feb2021
960 g's/volt

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



Accelerometer Calibration Certificate
Pile Dynamics, Inc.



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

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

PDA CALIBRATION FACTOR
421.9 mv/5000g
(84.4 µv/g)
R²: 0.999915 [Chip programmed]

Operator: William Johnson

William Johnson
Signed

Ref Acc 1: 691321 Cal on: 09Feb2021
960 g's/volt

Ref Acc 2: 690961 Cal on: 27Jan2021
978 g's/volt

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

