GEOTECHNICAL DATA REPORT

Appomattox River HDD Water Main Crossing
Prince George County and
City of Colonial Heights, Virginia

RK&K
RK&K Reference 20041.001

Schnabel Reference 21C13226
May 31, 2022

Schnabel ENGINEERING

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May 31, 2022

Ms. Kathy Marshal, PE, CCM
RK&K
2100 East Cary Street, Suite 309
Richmond, VA 23223

Subject: **Geotechnical Data Report, Appomattox River HDD Water Main Crossing, Prince George County and City of Colonial Heights, Virginia (RK&K Reference 20041.001, Schnabel Reference 21C13226)**

Dear Ms. Marshal:

SCHNABEL ENGINEERING, LLC (Schnabel) is pleased to submit our geotechnical engineering report for this project. This study was performed in accordance with our proposal dated November 15, 2021 and authorized by you on December 17, 2021.

PROJECT DESCRIPTION

Site and Project Description

The site is located on the south side of the Temple Avenue (Route 144) crossing of the Appomattox River in the City of Colonial Heights, Chesterfield County, and Prince George County. The project consists of constructing a new 20-inch or 24-inch water main approximately 1,550 lf using horizontal directional drilling (HDD) under the Appomattox River. We understand that the bottom of the pipe is anticipated to be about 40 to 50 ft below grade. The HDD entry and exit are expected to be located outside of the paved areas associated with commercial properties near the wooded areas adjacent to the river. The HDD portion of the water line will tie into an existing water line on the south side of Route 144.

The ground surface elevations at the site vary from about EL 9 to 2 on the west bank and EL 17 to 13 on the east bank of the river. A site vicinity map is included at the end of this report as Figure 1.

We obtained the project and site information through communication with you and a concept sketch provided by you. We obtained the site information through our site reconnaissance and review of GIS data.

SUBSURFACE EXPLORATION AND TESTING PROGRAM

We performed a subsurface exploration and field-testing program to identify the subsurface stratigraphy underlying the site and to evaluate the geotechnical properties of the materials encountered. This

program included test borings. Exploration methods used are discussed below. The appendices contain the results of our exploration.

Subsurface Exploration Methods

Test Borings

Our subcontractor, Fishburne Drilling, Inc, drilled two test borings under our observation between April 22 and 25, 2022. The Standard Penetration Test (SPT) was performed at selected depths in the borings. Appendix A includes specific observations, remarks, and logs for the borings; classification criteria; drilling methods; and sampling protocols. Figures 2A and 2B indicates the approximate test boring locations. We will retain soil samples up to 45 days beyond the issuance of this report, unless you request other disposition. The borings were backfilled with cement-bentonite grout using a tremie pipe. The upper 5 feet of the borings were backfilled with surrounding soils and the surface was graded smooth.

The SPT samples were obtained using a hydraulically driven automatic trip hammer (ATH). Most correlations with SPT data are based on N-values collected with a safety hammer. The energy applied to the split-spoon sampler using the ATH is about 33 percent greater than that applied using the safety hammer, resulting in lower N-values. The hammer blows shown on the boring logs are uncorrected for the higher energy. However, we correct SPT N values for the higher energy when using N values in our analyses.

Previous Explorations by Others

VDOT performed a subsurface exploration at this site around January 1980 for the Route 144 Bridge over the Appomattox River project. The stratigraphy encountered is similar to the stratigraphy encountered in our borings. Appendix C includes the VDOT Engineering Geology sheets from the project, including logs for the borings performed.

These data were developed by others and we were not present during collection of this information. We have reviewed the data for reasonableness, but we assume no responsibility for the completeness and accuracy of this information.

Soil Laboratory Testing

Our laboratory and subcontracted laboratory performed tests on selected SPT and Shelby Tube soil samples obtained during the subsurface exploration. The testing aided in the classification of materials encountered in the subsurface exploration and provided data for use in the development of recommendations for design parameters. Laboratory testing included:

- Natural Moisture Contents (ASTM D2216)
- Grain Size Distributions (ASTM D6913)
- Hydrometer Analysis (ASTM D422)
- Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D4318)
- Resistivity and pH tests (AASHTO T288 and T289)
- Water-soluble Sulfate and Chloride Tests for soil (EPA SW9056A)
- Unconsolidated-Undrained Triaxial Compression Test (ASTM D2850)

Results of selected tests are shown on the boring logs in Appendix A and the remaining test results are included in Appendix B.

SITE GEOLOGY AND SUBSURFACE CONDITIONS

Site Geology

We reviewed existing geologic data and information in our files. Based on this review, the geologic stratigraphy consists of recent alluvial soils deposited by the Appomattox River above undifferentiated Quaternary and Tertiary aged terrace deposits of the Tabb through Windsor formations. Theses terrace deposits typically consist of a mixture of clay, silt, sand, and gravel. Below the terrace deposits are soils of the Potomac formation. The Potomac formation consists of Cretaceous aged soils, light gray to pinkish, greenish and bluish gray quartzo-feldspathic sand, fine to coarse grained, pebbly, poorly sorted and commonly thick-bedded. Sand is interbedded with gray to green, massive to thick-bedded sandy clay and silt, commonly mottled red or reddish-brown. Beneath the Potomac Formation lies the Petersburg granite formation and its overlying residual soils. These residual soils are derived from the chemical and physical weathering of the underlying granite rock.

The above stratigraphy is typical in the area. However, in the immediate vicinity of the project site, some of the above strata may have been eroded or excavated and replaced with recent alluvial deposits or fill. A subsurface profile is included, at the end of this report, as Figure 3.

Generalized Subsurface Stratigraphy

We characterized the following generalized subsurface stratigraphy based on the exploration and laboratory test data included in the appendices.

Topsoil (Ground Cover):

Topsoil thicknesses ranged from about 3 to 24 inches.

Stratum A: Alluvium

Below the surface materials, alluvial soils were encountered to a depth of about 5 ft west of the river and 21 ft east of the river. The fine-grained alluvium, Stratum A1, consists of elastic silt and elastic silt with sand (MH) and coarse-grained alluvium, Stratum A2, consists of silty sand (SM) and poorly-graded sand with silt (SP-SM), containing varying amounts of mica, root fragments, and organic matter.

Index testing was performed on two soil samples from Stratum A1. These soils had Liquid Limit values of 56 and 61, Plasticity Index values of 21 and 20, and contained about 76 and 97 percent fines, respectively. The natural moisture content of soils from Stratum A varied from about 18 to 47 percent. Based on the SPT blow counts, Stratum A1 had SPT N-Values of up 0 to 5 blows per foot (bpf) and Stratum A2 had SPT N-Values of 4 to 8 bpf. This corresponds to a consistency of very soft to firm and a relative density of loose to medium dense.

We performed an Unconsolidated-Undrained (UU) Triaxial Compression test on a Shelby Tube sample of soil from Stratum A1 with a confining pressure of 6psi. This sample was located about 16 ft below grade (about EL 0) and had a compressive strength of 9.1 psi (1,310 psf) and an undrained shear strengths of 655 psf. The sample had a natural density of 107 pcf.

Stratum B: Terrace Deposits

Below the alluvial soils of Stratum A, each boring encountered coarse-grained Quaternary to Tertiary aged terrace deposits, Stratum B, to depths of about 69 and 39 ft. Stratum B consists of well-graded sand (SW), well-graded gravel with silt and sand (GW-GP), clayey sand (SC), and clayey gravel with sand (SC). Running sands, the phenomenon of soil infiltrating the drilling equipment due to excessive pore water pressure, was encountered in each boring and included in the remarks portion on the boring logs. We identified the coarse-grained terrace soils with a medium dense to very dense relative density as Stratum B2 (SPT N-values of 9 to 47 bpf) and the coarse-grained soils with a very loose relative density as Stratum B3 (SPT N-values up to 1 bpf).

Index testing was performed on six samples from this stratum. The percent gravel for this stratum measured to be about 3 to 46 percent. It should be noted that the SPT sampler has an opening of 1.375 inches and therefore the gravel content may not be adequately quantified with this sampling method. The percent fines for this stratum varied from about 2 to 27 percent. The soil samples had Liquid Limit values of 29 to 40, Plasticity Index values of 12 to 18, and two samples were non-plastic. The natural moisture content of soil samples measured varied from about 7 to 24 percent.

Testing was performed on one sample from Stratum B to evaluate the corrosion potential of this stratum. The sample had a pH of 6.3, Redox Potential of 346 mV, Resistivity of 15,000 ohm-cm, tested negative for sulfides, and had less than 10ppm of chlorides and sulfates.

Stratum C: Potomac Formation

Below the soils Stratum B, Boring B-01 each boring encountered soils of the Potomac formation. Boring B-01 encountered coarse-grained soils of the Potomac formation, Stratum C2, at a depth of about 69 ft (EL -63). Boring B-02 encountered fine-grained soils of the Potomac formation, Stratum C1, from a depth of about 37 to 48 ft (EL -21 to -32) above Stratum C2. Both boring were terminated in Stratum C2.

The fine-grained soils of the Potomac formation, Stratum C1, generally classify as firm to stiff elastic silt (MH) with trace sand and containing various amounts of mica and organic matter (lignite).

We performed index testing, an Unconsolidated-Undrained (UU) Triaxial Compression test, and tests to evaluate the corrosion potential on a Shelby Tube sample from Stratum C1. This sample had a Liquid Limit value of 104, a Plasticity Index value of 38, and contained 92.4 percent fines. The sample had a natural density of about 95 pcf, a natural moisture content of 69.6 percent, and contained organic matter (lignite), which contributed to the low natural density of the sample. The sample was located about 46 ft below grade (about EL -30). The UU test was performed with a confining pressure of 20psi. The sample had a compressive strength of 25.3 psi (3,643 psf), an undrained shear strength of 1,822 psf. From corrosion potential resting, the sample had a pH of 5.3, Redox Potential of 15 mV, Resistivity of 6,900 ohm-cm, and contained trace sulfides.

The coarse-grained soils of the Potomac formation, Stratum C2, generally classify as dense to very dense clayey sand with gravel (SC), and clayey sand (SC). Index testing was performed on one sample from Stratum C2. The sample had a Liquid Limit value of 65, a Plasticity Index value of 37, and contained 23.9 percent fines. The natural moisture content of soils from Stratum C2 varied from about 5 to 16 percent.

Groundwater

We observed groundwater at depths of about 2 and 10 ft (EL 4 and 6), at Borings B-01 and B-02, respectively. The test boring logs in Appendix A include groundwater observations obtained during our subsurface exploration. These data include depths to groundwater encountered during drilling, upon drilling completion, and following completion of the boring.

The groundwater levels on the logs indicate our estimate of the hydrostatic water table at the time of our subsurface exploration. The final design should anticipate the fluctuation of the hydrostatic water table depending on variations in precipitation, surface runoff, pumping, tidal action, evaporation, leaking utilities, stream levels, and similar factors.

GEOTECHNICAL RECOMMENDATIONS

We based our geotechnical engineering analysis on the information developed from our limited subsurface exploration and soil laboratory testing. We understand that trenchless (HDD) installation methods have been selected and that the alignment has not been set.

Recommended Design Parameters

The design soil parameters requested are provided in Table 1. These parameters were developed using results from the laboratory testing and published correlations.

Table 1: Soil Design Parameters

Stratum	Soil Types	SPT N-Values (bpf)	Unit Weight, γ (pcf)	Angle of Internal Friction, Φ (deg)	Cohesion, c (psf)	Small-Strain Shear Modulus, G_{max} (psf)[4]
A1	MH	0 to 5	95 to 105[1] 100-110[2] (107[2,3])	0	500 to 750 (655[3])	125,000
A2	SM SP-SM	2 to 8	110 to120[1] 115 to 125[2]	28 to 30	0	170,000
B2	SW SC GW-GM	8 to 29	125 to 135[2]	30 to 34	0	260,000
	SC w/ Gravel	30 +	130 to 140[2]	34 to 38	0	450,000
B3	SC	0 to 2	110-130[2]	28	0	50,000
C1	MH	5 to 8	90-100[2] (95[2,3])	0	1,500 to 2,000 (1,821[3])	175,000
C2	SC	22+	130-140[2]	36 to 40	0	600,000

Notes: [1] Moist Unit Weight, [2] Saturated Unit Weight, [3] Measured from Laboratory Test, [4] Small-strain shear modulus developed with correlations from Table 6 in FHWA GEC No. 3 (1997).

LIMITATIONS

We based the analyses and recommendations submitted in this report on the information revealed by our exploration. We attempted to provide for normal contingencies, but the possibility remains that unexpected conditions may be encountered during construction.

This report has been prepared to aid in the evaluation of this site and to assist in the design of the project. It is intended for use concerning this specific project. We based our recommendations on information on the site and proposed construction as described in this report. Substantial changes in location or grading should be brought to our attention so we can modify our report as needed. We would appreciate an opportunity to review the plans and specifications as they pertain to the recommendations contained in this report, and to submit our comments to you based on this review.

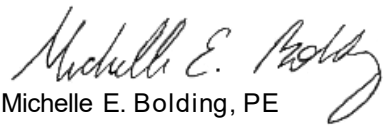
We have endeavored to complete the services identified herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions as this project. No other representation, express or implied, is included or intended, and no warranty or guarantee is included or intended in this report, or other instrument of service.

We appreciate the opportunity to be of service for this project. Please call us if you have any questions regarding this report.

Sincerely,

SCHNABEL ENGINEERING, LLC

Jacob J. Maser, GIT
Staff Geologist

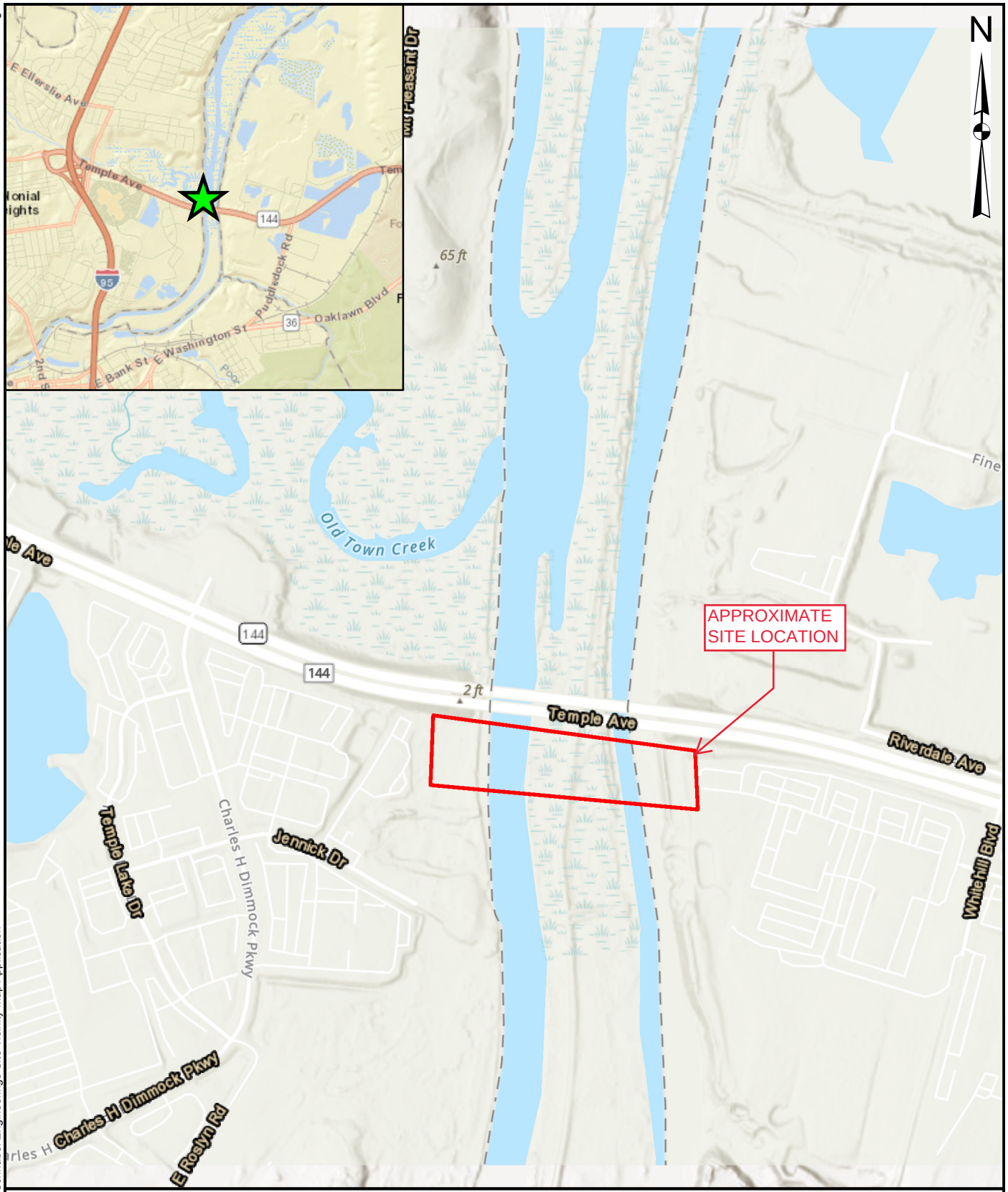


Michelle E. Bolding, PE
Associate

JJM:MEB:rwl

Figures
Appendix A: Subsurface Exploration Data
Appendix B: Soil Laboratory Test Data
Appendix C: Historical Subsurface Exploration Data

FIGURES



Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Esri, HERE, Garmin, (c) OpenStreetMap contributors
Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community

NOT TO SCALE

Schnabel ENGINEERING

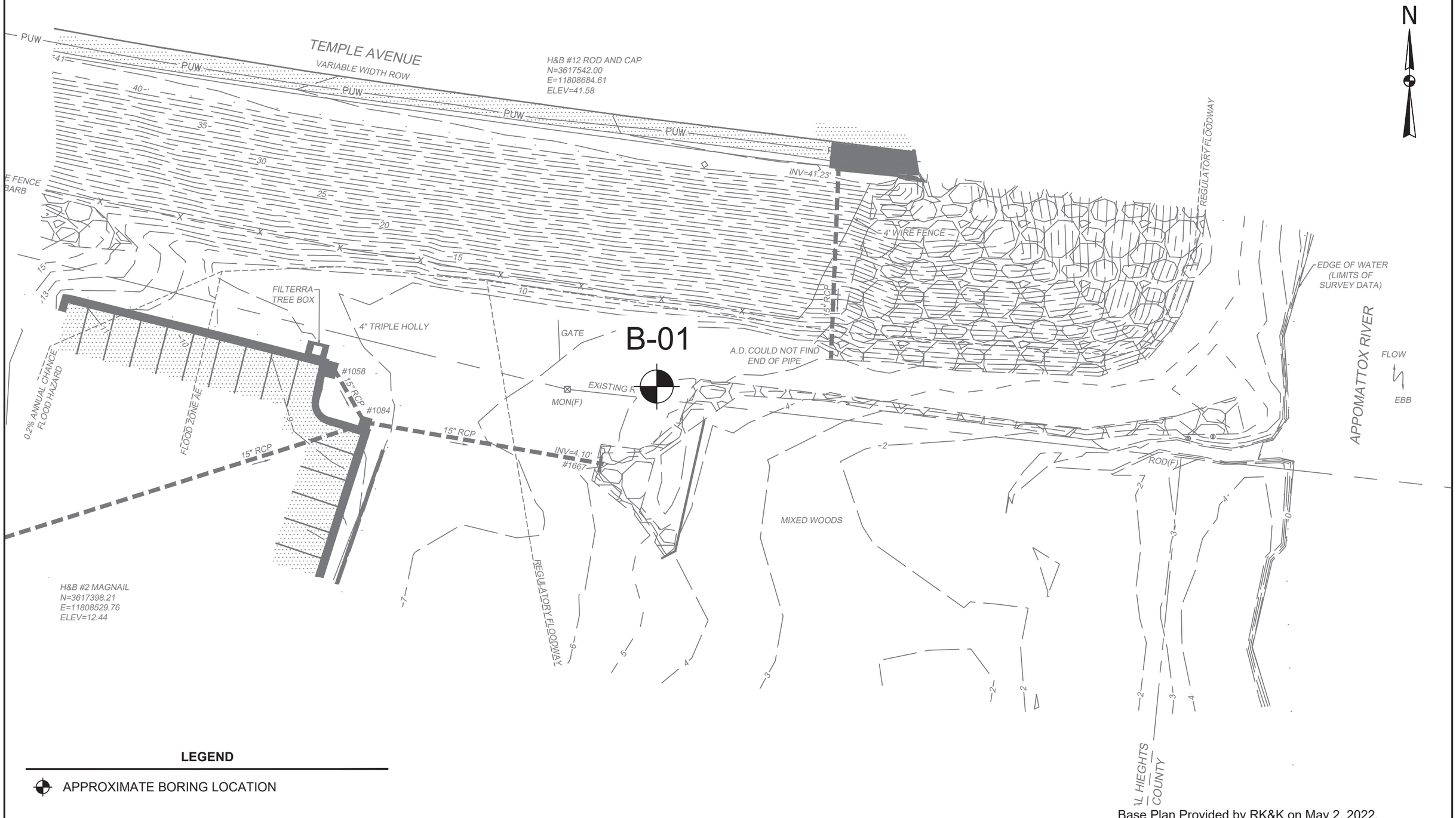
APPOMATTOX RIVER HDD WATER MAIN CROSSING
PRINCE GEORGE COUNTY AND
CITY OF COLONIAL HEIGHTS, VIRGINIA
PROJECT NO. 21C13226

SITE VICINITY MAP

FIGURE 1

5/31/2022 This Map was Created In Schnabel Engineerings Site Vicinity Map Application

arcgis



LEGEND

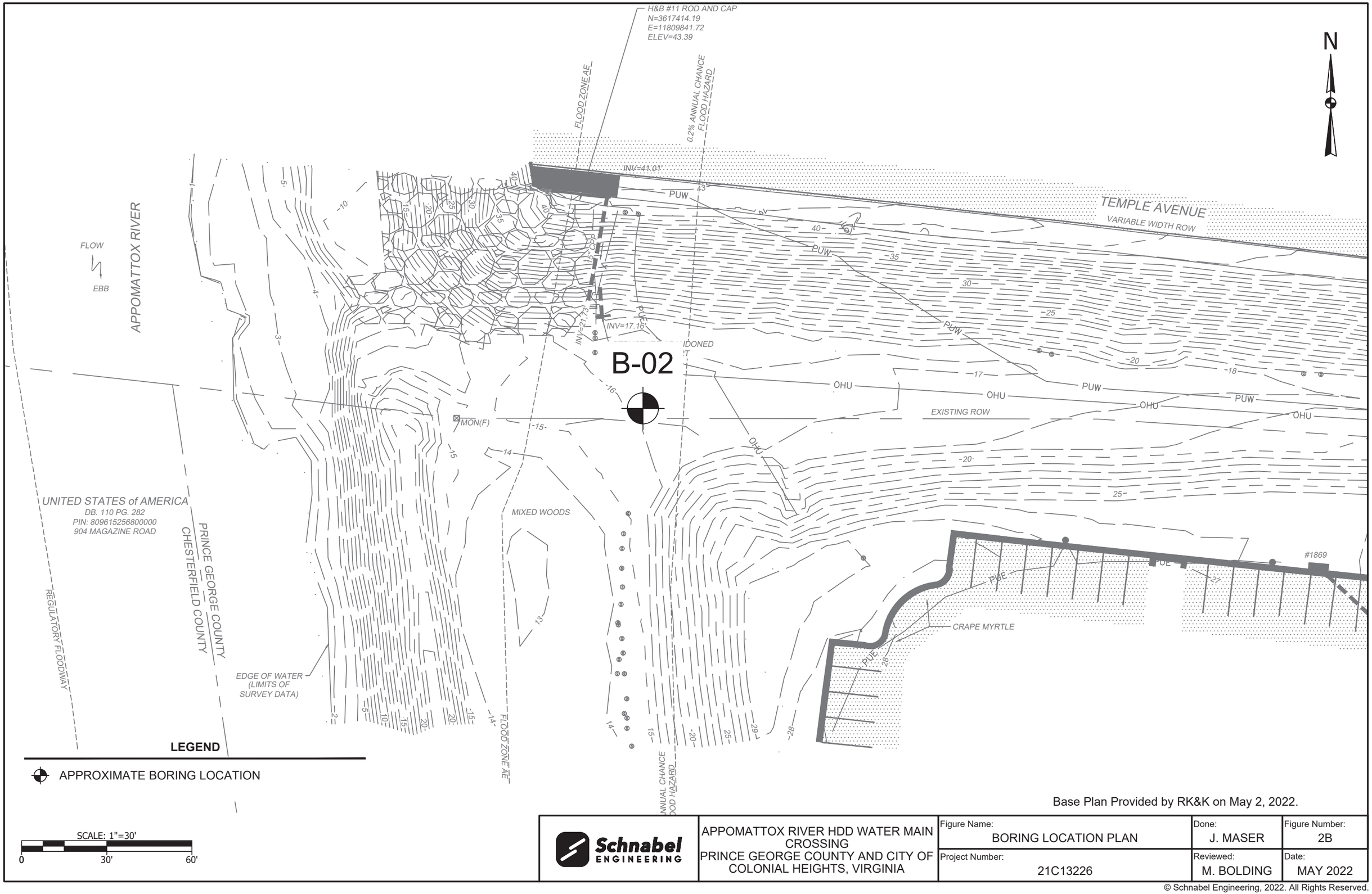
APPROXIMATE BORING LOCATION

SCALE: 1"=30'

0 30' 60'

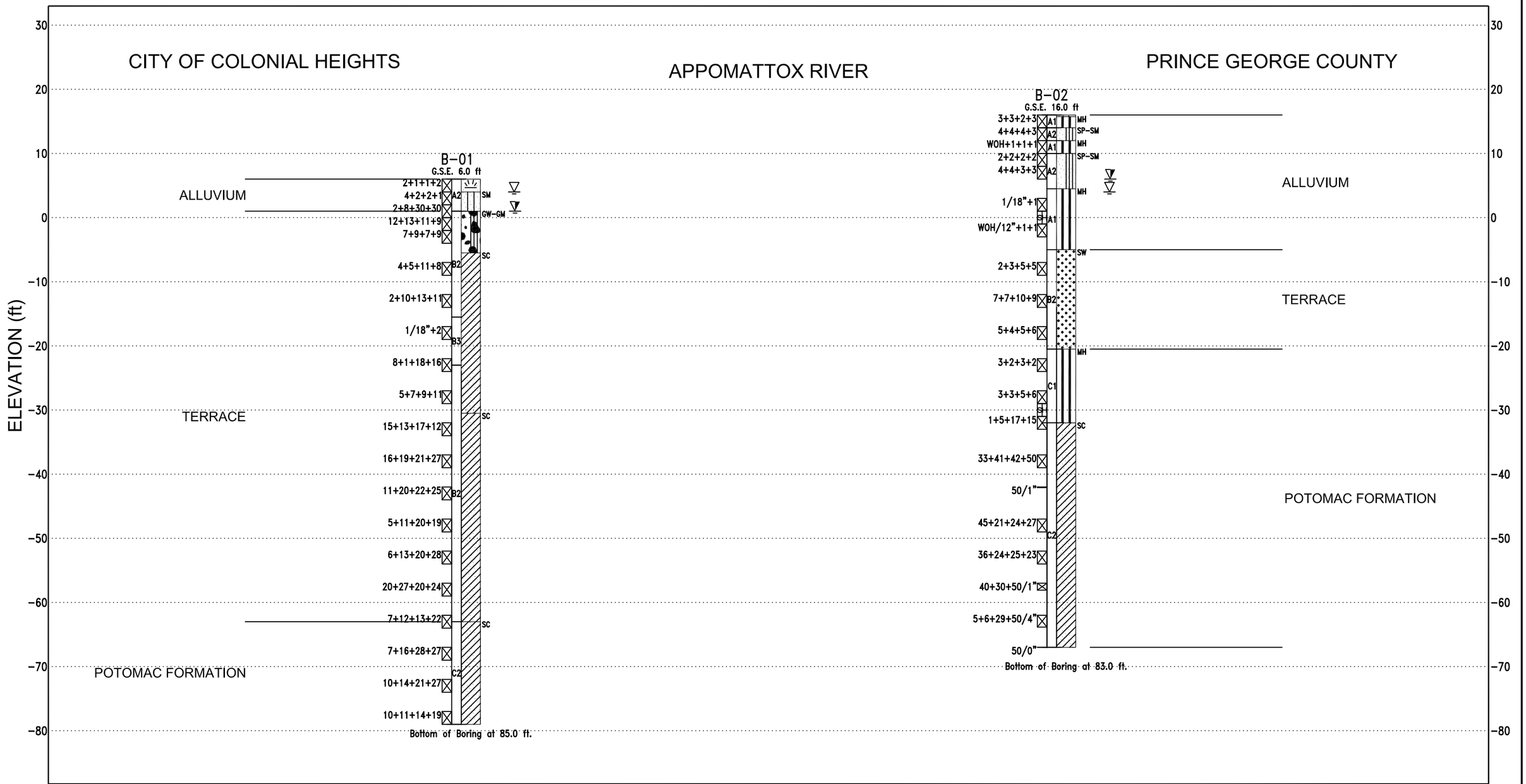
Base Plan Provided by RK&K on May 2, 2022.

Schnabel ENGINEERING	APPOMATTOX RIVER HDD WATER MAIN CROSSING PRINCE GEORGE COUNTY AND CITY OF COLONIAL HEIGHTS, VIRGINIA	Figure Name: BORING LOCATION PLAN	Done: J. MASER	Figure Number: 2A
		Project Number: 21C13226	Reviewed: M. BOLDING	Date: MAY 2022



Base Plan Provided by RK&K on May 2, 2022.

Schnabel ENGINEERING	APPOMATTOX RIVER HDD WATER MAIN CROSSING PRINCE GEORGE COUNTY AND CITY OF COLONIAL HEIGHTS, VIRGINIA	Figure Name: BORING LOCATION PLAN	Done: J. MASER	Figure Number: 2B
		Project Number: 21C13226	Reviewed: M. BOLDING	Date: MAY 2022



Schnabel ENGINEERING	APPOMATTOX RIVER HDD WATER MAIN CROSSING PRINCE GEORGE COUNTY AND CITY OF COLONIAL HEIGHTS, VIRGINIA	Figure Name: SUBSURFACE PROFILE	Done: J. MASER	Figure Number: 3
		Project Number: 21C13226	Reviewed: M. BOLDING	Date: MAY 2022

APPENDIX A

SUBSURFACE EXPLORATION DATA

Subsurface Exploration Procedures
General Notes for Subsurface Exploration Logs
Identification of Soil
Boring Logs, B-01 through B-02

SUBSURFACE EXPLORATION PROCEDURES

Test Borings – Hollow Stem Augers

The borings are advanced by turning a continuous flight auger with a center opening of 2¼ or 3¼ inches. A plug device blocks off the center opening while augers are advanced. Cuttings are brought to the surface by the auger flights. Sampling is performed through the center opening in the hollow stem auger, by standard methods, after removal of the plug. Usually, no water is introduced into the boring using this procedure.

Standard Penetration Test Results

The numbers in the Sampling Data column of the boring logs represent Standard Penetration Test (SPT) results. Each number represents the blows needed to drive a 2-inch O.D., 1⅜-inch I.D. split-spoon sampler 6 inches, using a 140-pound hammer falling 30 inches. The sampler is typically driven a total of 18 or 24 inches. The first 6 inches are considered a seating interval. The total of the number of blows for the second and third 6-inch intervals is the SPT "N value." The SPT is performed according to ASTM D1586.

The SPT samples were obtained using a hydraulically driven automatic trip hammer (ATH). Most correlations with SPT data are based on N-values collected with a safety hammer. The energy applied to the split-spoon sampler using the ATH is about 33 percent greater than that applied using the safety hammer, resulting in lower N-values. The hammer blows shown on the boring logs are uncorrected for the higher energy. However, we correct SPT N values for the higher energy when using N values in our analyses.

Soil Classification Criteria

The group symbols on the logs represent the Unified Soil Classification System Group Symbols (ASTM D2487) based on visual observation and limited laboratory testing of the samples. Criteria for visual identification of soil samples are included in this appendix. Some variation can be expected between samples visually classified and samples classified in the laboratory.

Pocket Penetrometer Results

The values following "PP=" in the sampling data column of the logs represent pocket penetrometer readings. Pocket penetrometer readings provide an estimate of the unconfined compressive strength of fine-grained soils.

Boring Locations and Elevations

Boring locations were located using sub-meter GPS equipment. Approximate boring locations are shown on Figures 2A and 2B. Ground surface elevations at the boring locations were obtained from the site topographic plan. and are indicated on the boring logs. Locations and elevations should be considered no more accurate than the methods used to determine them.

GENERAL NOTES FOR SUBSURFACE EXPLORATION LOGS

1. Numbers in sampling data column next to Standard Penetration Test (SPT) symbols indicate blows required to drive a 2-inch O.D., 1⅜-inch I.D. sampling spoon 6 inches using a 140 pound hammer falling 30 inches. The Standard Penetration Test (SPT) N value is the number of blows required to drive the sampler 12 inches, after a 6 inch seating interval. The Standard Penetration Test is performed in general accordance with ASTM D1586.
2. Visual classification of soil is in accordance with terminology set forth in "Identification of Soil." The ASTM D2487 group symbols (e.g., CL) shown in the classification column are based on visual observations.
3. Estimated water levels indicated on the logs are only estimates from available data and may vary with precipitation, porosity of the soil, site topography, and other factors.
4. Refusal at the surface of rock, boulder, or other obstruction is defined as an SPT resistance of 50 blows for 1 inch or less of penetration.
5. The logs and related information depict subsurface conditions only at the specific locations and at the particular time when drilled or excavated. Soil conditions at other locations may differ from conditions occurring at these locations. Also, the passage of time may result in a change in the subsurface soil and water level conditions at the subsurface exploration location.
6. The stratification lines represent the approximate boundary between soil and rock types as obtained from the subsurface exploration. Some variation may also be expected vertically between samples taken. The soil profile, water level observations and penetration resistances presented on these logs have been made with reasonable care and accuracy and must be considered only an approximate representation of subsurface conditions to be encountered at the particular location.
7. Key to symbols and abbreviations:

S-1, SPT — Sample No., Standard Penetration Test
5+10+10 — Number of blows in each 6-inch increment

SH-1, SH — Sample No., 2" or 3" Shelby Tube Sample
Rec=24", 100% — Recovery in inches, Percent Recovery

S-1, SAMPLE — Sample No., Hand Auger or Test Pit sample

LL	Liquid Limit
MC	Moisture Content (percent)
PID	Photoionization Detector Reading (ppm)
PL	Plastic Limit
PP	Pocket Penetrometer Reading (tsf)
%Passing#200	Percent by weight passing a No. 200 Sieve

IDENTIFICATION OF SOIL

I. DEFINITION OF SOIL GROUP NAMES (ASTM D2487)

			SYMBOL	GROUP NAME
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels – More than 50% of coarse fraction retained on No. 4 sieve Coarse, ¾" to 3" Fine, No. 4 to ¾"	Clean Gravels Less than 5% fines	GW	WELL GRADED GRAVEL
			GP	POORLY GRADED GRAVEL
		Gravels with fines More than 12% fines	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	Sands – 50% or more of coarse Fraction passes No. 4 sieve Coarse, No. 10 to No. 4 Medium, No. 40 to No. 10 Fine, No. 200 to No. 40	Clean Sands Less than 5% fines	SW	WELL GRADED SAND
			SP	POORLY GRADED SAND
		Sands with fines More than 12% fines	SM	SILTY SAND
			SC	CLAYEY SAND
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays – Liquid Limit less than 50 Low to medium plasticity	Inorganic	CL	LEAN CLAY
			ML	SILT
		Organic	OL	ORGANIC CLAY
				ORGANIC SILT
	Silts and Clays – Liquid Limit 50 or more Medium to high plasticity	Inorganic	CH	FAT CLAY
			MH	ELASTIC SILT
		Organic	OH	ORGANIC CLAY
				ORGANIC SILT
Highly Organic Soils	Primarily organic matter, dark in color and organic odor		PT	PEAT

II. DEFINITION OF SOIL COMPONENT PROPORTIONS (ASTM D2487)

			Examples
Adjective Form	GRAVELLY SANDY	>30% to <50% coarse grained component in a fine-grained soil	GRAVELLY LEAN CLAY
	CLAYEY SILTY	>12% to <50% fine grained component in a coarse-grained soil	SILTY SAND
"With"	WITH GRAVEL WITH SAND	>15% to <30% coarse grained component in a fine-grained soil	FAT CLAY WITH GRAVEL
	WITH GRAVEL WITH SAND	>15% to <50% coarse grained component in a coarse-grained soil	POORLY GRADED GRAVEL WITH SAND
	WITH SILT WITH CLAY	>5% to <12% fine grained component in a coarse-grained soil	POORLY GRADED SAND WITH SILT

III. GLOSSARY OF MISCELLANEOUS TERMS

SYMBOLS ..... Unified Soil Classification Symbols are shown above as group symbols. A dual symbol "-" indicates the soil belongs to two groups. A borderline symbol "/" indicates the soil belongs to two possible groups.

FILL..... Man-made deposit containing soil, rock and often foreign matter.

PROBABLE FILL..... Soils which contain no visually detected foreign matter but which are suspect with regard to origin.

DISINTEGRATED ROCK (DR)..... Residual materials with a standard penetration resistance (SPT) between 60 blows per foot and refusal. Refusal is defined as a SPT of 100 blows for 2" or less penetration.

PARTIALLY WEATHERED ROCK (PWR)..... Residual materials with a standard penetration resistance (SPT) between 100 blows per foot and refusal. Refusal is defined as a SPT of 100 blows for 2" or less penetration.

BOULDERS & COBBLES..... Boulders are considered rounded pieces of rock larger than 12 inches, while cobbles range from 3 to 12 inch size.

LENSES..... 0 to ½ inch seam within a material in a test pit.

LAYERS..... ½ to 12 inch seam within a material in a test pit.

POCKET ..... Discontinuous body within a material in a test pit.

MOISTURE CONDITIONS..... Wet, moist or dry to indicate visual appearance of specimen.

COLOR ..... Overall color, with modifiers such as light to dark or variation in coloration.

Schnabel ENGINEERING **TEST BORING LOG**

Project: Appomattox River HDD Water Main Crossing
Prince George County and City of
Colonial Heights, Virginia

Boring Number: **B-01**
Contract Number: 21C13226
Sheet: 1 of 4

Contractor: Fishburne Drilling, Inc.
Chesapeake, Virginia
Contractor Foreman: J. Raasio
Schnabel Representative: E. Walsh
Equipment: CME-55 (Track)
Method: 3-1/4" I.D. Hollow Stem Auger

Hammer Type: Auto Hammer (140 lb)
Dates Started: 4/22/22 **Finished:** 4/22/22
X: 11808731.6 ft **Y:** 3617461.6 ft
Coordinate System: VA State Plane (S)
Ground Surface Elevation: 6± (ft) **Total Depth:** 85.0 ft

Groundwater Observations

	Date	Time	Depth	Casing	Caved
Encountered ▽	4/22	9:42 AM	2.0'	---	---
Completion ▼	4/22	3:24 PM	5.0'	---	---

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	Topsoil; 24 inches					S-01, SPT 2+1+1+2 REC=12", 50%		ALLUVIUM
2.0	SILTY SAND, fine to medium grained sand; wet, brown and gray, contains root fragments, loose	SM	4.0	A2		S-02, SPT 4+2+2+1 REC=14", 58%	MC = 17.8%	
						S-03, SPT 2+8+30+30 REC=6", 25%		
5.0	WELL GRADED GRAVEL WITH SILT AND SAND, fine and coarse grained gravel; wet, brown, dense		1.0		5			TERRACE
						S-04, SPT 12+13+11+9 REC=10", 42%	LL = NP MC = 9.9% % Passing #200 = 9.1	
	Change: medium dense	GW-GM				S-05, SPT 7+9+7+9 REC=0", 0%		
					10			
11.5	CLAYEY SAND, fine to coarse grained sand; wet, white and orangish brown, trace gravel, medium dense		-5.5	B2				
						S-06, SPT 4+5+11+8 REC=24", 100%	LL = 31 PL = 20 MC = 19.8% % Passing #200 = 20.6	
		SC			15			
	Change: few gravel, dense					S-07, SPT 2+10+13+11 REC=6", 25%		

(continued)

Schnabel ENGINEERING **TEST BORING LOG**

Project: Appomattox River HDD Water Main Crossing
Prince George County and City of
Colonial Heights, Virginia

Boring Number: **B-01**
Contract Number: 21C13226
Sheet: 2 of 4

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
				B2				
	Change: very loose					S-08, SPT 1/18"+2 REC=6", 25%	MC = 16.0%	
				B3	25			
	Change: white and orangish brown, medium dense	SC				S-09, SPT 8+1+18+16 REC=24", 100%	LL = 29 PL = 17 MC = 18.4% % Passing #200 = 20.0 Resistivity = 15000 Ohms-cm Redox = 346 mv Sulfides = 0 pH = 6.33	
					30			
						S-10, SPT 5+7+9+11 REC=24", 100%	MC = 21.6%	
					35			
36.5	CLAYEY SAND WITH GRAVEL, fine to coarse grained sand; wet, orangish brown and gray, dense		-30.5	B2				
						S-11, SPT 15+13+17+12 REC=24", 100%	LL = 33 PL = 21 MC = 20.5% % Passing #200 = 27.3	
					40			
		SC						
	Change: very dense					S-12, SPT 16+19+21+27 REC=18", 75%	MC = 7.3%	
					45			
								Auger grinding

(continued)

Schnabel ENGINEERING TEST BORING LOG	Project: Appomattox River HDD Water Main Crossing Prince George County and City of Colonial Heights, Virginia	Boring Number: **B-01** Contract Number: 21C13226 Sheet: 3 of 4

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	Change: brown and white				50	S-13, SPT 11+20+22+25 REC=22", 92%	LL = 40 PL = 22 MC = 12.6% % Passing #200 = 27.5	
	Change: dense				55	S-14, SPT 5+11+20+19 REC=14", 58%		Running sands. Water added to augers.
		SC		B2	60	S-15, SPT 6+13+20+28 REC=18", 75%	MC = 24.1%	
	Change: very dense				65	S-16, SPT 20+27+20+24 REC=24", 100%		Running sands. Rods stuck in auger. Remove augers. Re-auger to 68 ft.
69.0	CLAYEY SAND, fine to medium grained sand; wet, bluish gray, contains mica, very dense		-63.0		70	S-17, SPT 7+12+13+22 REC=24", 100%		POTOMAC FORMATION
		SC		C2		S-18, SPT 7+16+28+27	MC = 16.0%	

(continued)

Schnabel ENGINEERING TEST BORING LOG	Project: Appomattox River HDD Water Main Crossing Prince George County and City of Colonial Heights, Virginia	Boring Number: **B-01** Contract Number: 21C13226 Sheet: 4 of 4

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
					75	REC=20", 83%		
	Change: dense	SC		C2	80	S-19, SPT 10+14+21+27 REC=24", 100%		
						S-20, SPT 10+11+14+19 REC=24", 100%		
85.0			-79.0		85			

Bottom of Boring at 85.0 ft.
Boring terminated at selected depth.
Boring backfilled with cement/bentonite grout through tremie pipe upon completion.

Schnabel ENGINEERING **TEST BORING LOG**

Project: Appomattox River HDD Water Main Crossing
Prince George County and City of
Colonial Heights, Virginia

Boring Number: **B-02**
Contract Number: 21C13226
Sheet: 1 of 4

Contractor: Fishburne Drilling, Inc.
Chesapeake, Virginia
Contractor Foreman: J. Raasio
Schnabel Representative: E. Walsh
Equipment: CME-55 (Track)
Method: 3-1/4" I.D. Hollow Stem Auger

Hammer Type: Auto Hammer (140 lb)
Dates Started: 4/25/22 **Finished:** 4/25/22
X: 11809864 ft **Y:** 3617340.9 ft
Coordinate System: VA State Plane (S)
Ground Surface Elevation: 16± (ft) **Total Depth:** 83.0 ft

Groundwater Observations

	Date	Time	Depth	Casing	Caved
Encountered ▽	4/25	10:36 AM	12.0'	---	---
Completion ▼	4/25	1:40 PM	10.0'	---	---

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
0.3	Topsoil; 3 inches		15.8					
	ELASTIC SILT WITH SAND; moist, brown, firm	MH		A1		S-01, SPT 3+3+2+3 REC=10", 42%	MC = 27.6% PP = 1.00 tsf	ALLUVIUM
2.0	POORLY GRADED SAND WITH SILT, fine to medium grained sand; moist, brown, medium dense	SP-SM	14.0	A2		S-02, SPT 4+4+4+3 REC=16", 67%		
4.0	ELASTIC SILT WITH SAND; moist, brown, contains mica, soft	MH	12.0	A1	5	S-03, SPT WOH+1+1+1 REC=6", 25%	LL = 56 PL = 35 MC = 43.1% % Passing #200 = 76.1	
6.0	POORLY GRADED SAND WITH SILT, fine to coarse grained sand; moist, greenish brown, contains mica, loose	SP-SM	10.0	A2		S-04, SPT 2+2+2+2 REC=10", 42%	MC = 20.5%	
					10	S-05, SPT 4+4+3+3 REC=8", 33%		
11.5	ELASTIC SILT; wet, grayish brown, trace sand, contains mica, and organics, very soft	MH	4.5	A1		S-06, SPT 1/18"+1 REC=6", 25%	PP <0.25 tsf	
					15	UD-01, SH REC=24", 100%	LL = 61 PL = 41 MC = 47.1% % Passing #200 = 96.6 PP = 0.50 tsf PP = 0.50 tsf	
						S-07, SPT WOH/12"+1+1 REC=18", 75%		

(continued)

Schnabel ENGINEERING TEST BORING LOG	Project: Appomattox River HDD Water Main Crossing Prince George County and City of Colonial Heights, Virginia	Boring Number: **B-02** Contract Number: 21C13226 Sheet: 2 of 4

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
		MH		A1				
21.0	WELL GRADED SAND, coarse to fine sand; wet, gray, trace gravel, and silt, medium dense		-5.0					TERRACE
					25	S-08, SPT 2+3+5+5 REC=20", 83%	MC = 18.5%	
		SW		B2	30	S-09, SPT 7+7+10+9 REC=10", 42%	LL = NP MC = 11.6% % Passing #200 = 2.2	Running sands. Water added to augers.
					35	S-10, SPT 5+4+5+6 REC=0", 0%		
36.5	ELASTIC SILT; wet, greenish gray, few sand, contains lignite, firm		-20.5					POTOMAC FORMATION
					40	S-11, SPT 3+2+3+2 REC=18", 75%	PP = 1.00 tsf	
		MH		C1				
	Change: stiff				45	S-12, SPT 3+3+5+6 REC=18", 75%	PP = 1.00 tsf	
						UD-02, SH REC=24", 100%	LL = 104 PL = 66 MC = 69.6% % Passing #200 = 92.4	

(continued)

Schnabel ENGINEERING **TEST BORING LOG**

Project: Appomattox River HDD Water Main Crossing
Prince George County and City of
Colonial Heights, Virginia

Boring Number: **B-02**
Contract Number: 21C13226
Sheet: 3 of 4

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
		MH		C1		S-13, SPT 1+5+17+15 REC=0", 0%	PP = 1.50 tsf Resistivity = 6900 Ohms-cm Redox = 15 mv Sulfides = Trace pH = 5.27	
48.0	CLAYEY SAND WITH GRAVEL, coarse to fine sand; wet, bluish white and light brown, very dense		-32.0		50			
						S-14, SPT 33+41+42+50 REC=18", 75%	LL = 65 PL = 28 MC = 16.0% % Passing #200 = 23.9	
					55			
						S-15, SPT 50/1" REC=1", 100%		
					60			
		SC		C2				
						S-16, SPT 45+21+24+27 REC=5", 21%	MC = 5.1%	
					65			Auger grinding
						S-17, SPT 36+24+25+23 REC=10", 42%		
					70			
						S-18, SPT 40+30+50/1"		

(continued)

Schnabel ENGINEERING **TEST BORING LOG**

Project: Appomattox River HDD Water Main Crossing
Prince George County and City of
Colonial Heights, Virginia

Boring Number: **B-02**
Contract Number: 21C13226
Sheet: 4 of 4

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
						REC=4", 31%		Auger grinding
					75			
		SC		C2		S-19, SPT 5+6+29+50/4" REC=4", 18%		Running sands. Water added to auger.
					80			
83.0			-67.0			S-20, SPT 50/0" REC=0"		

Bottom of Boring at 83.0 ft.
Boring terminated at selected depth.
Boring backfilled with cement/bentonite grout through tremie pipe upon completion.

APPENDIX B

SOIL LABORATORY TEST DATA

Summary of Laboratory Tests
Gradation Curves
Atterberg Limits
Unconsolidated-Undrained Triaxial Shear Tests
Corrosion Potential Tests

Summary Of Laboratory Tests

Project Number: 21C13226

Boring No.	Sample Depth ft / Elevation ft	Sample Type	Description of Soil Specimen	Stratum	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Retained No. 4 Sieve	% Passing No. 10 Sieve	% Passing No. 40 Sieve	% Passing No. 200 Sieve	Percent Silt	Percent Clay	Testing Laboratory
B-01	6.0 - 8.0 / 0.0 - -2.0	Jar	WELL GRADED GRAVEL WITH SILT (GW-GM), fine and coarse gravel, brown	B2	9.9	NP	NP	NP	45.9	42.6	20.2	9.1	--	--	RICH
B-01	13.0 - 15.0 / -7.0 - -9.0	Jar	CLAYEY SAND (SC), fine to coarse grained sand, trace gravel, brown	B2	19.8	31	20	11	3.2	92.5	44.8	20.6	--	--	RICH
B-01	28.0 - 35.0 / -22.0 - -29.0	Jar	CLAYEY SAND (SC), fine to coarse grained sand, few gravel, orangish brown	B2	18.4	29	17	12	8.5	85.5	46.4	20.0	--	--	RICH
B-01	38.0 - 40.0 / -32.0 - -34.0	Jar	CLAYEY SAND WITH GRAVEL (SC), fine to coarse grained sand , orangish brown and gray	B2	20.5	33	21	12	16.5	77.8	38.7	27.3	19.3	8.0	RICH
B-01	48.0 - 50.0 / -42.0 - -44.0	Jar	CLAYEY SAND WITH GRAVEL (SC), fine to coarse grained sand, brown, white and gray	B2	12.6	40	22	18	31.1	59.7	36.9	27.5	--	--	RICH
B-02	4.0 - 6.0 / 12.0 - 10.0	Jar	ELASTIC SILT WITH SAND (MH), contains mica, brown	A1	43.1	56	35	21	--	--	92.5	76.1	--	--	RICH
B-02	15.0 - 17.0 / 1.0 - -1.0	Tube	ELASTIC SILT (MH), trace sand, contains organic matter, gray	A1	47.1	61	41	20	--	100.0	99.2	96.6	61.6	35.0	RICH

Notes:
1. Soil tests in general accordance with ASTM standards.
2. Soil classifications are in general accordance with ASTM D2487(as applicable), based on testing indicated and visual classification.
3. Key to abbreviations: NP=Non-Plastic; -- indicates no test performed

Schnabel ENGINEERING

Project: Appomattox River HDD Water Main Crossing
Prince George County and City of
Colonial Heights, Virginia

Summary Of Laboratory Tests

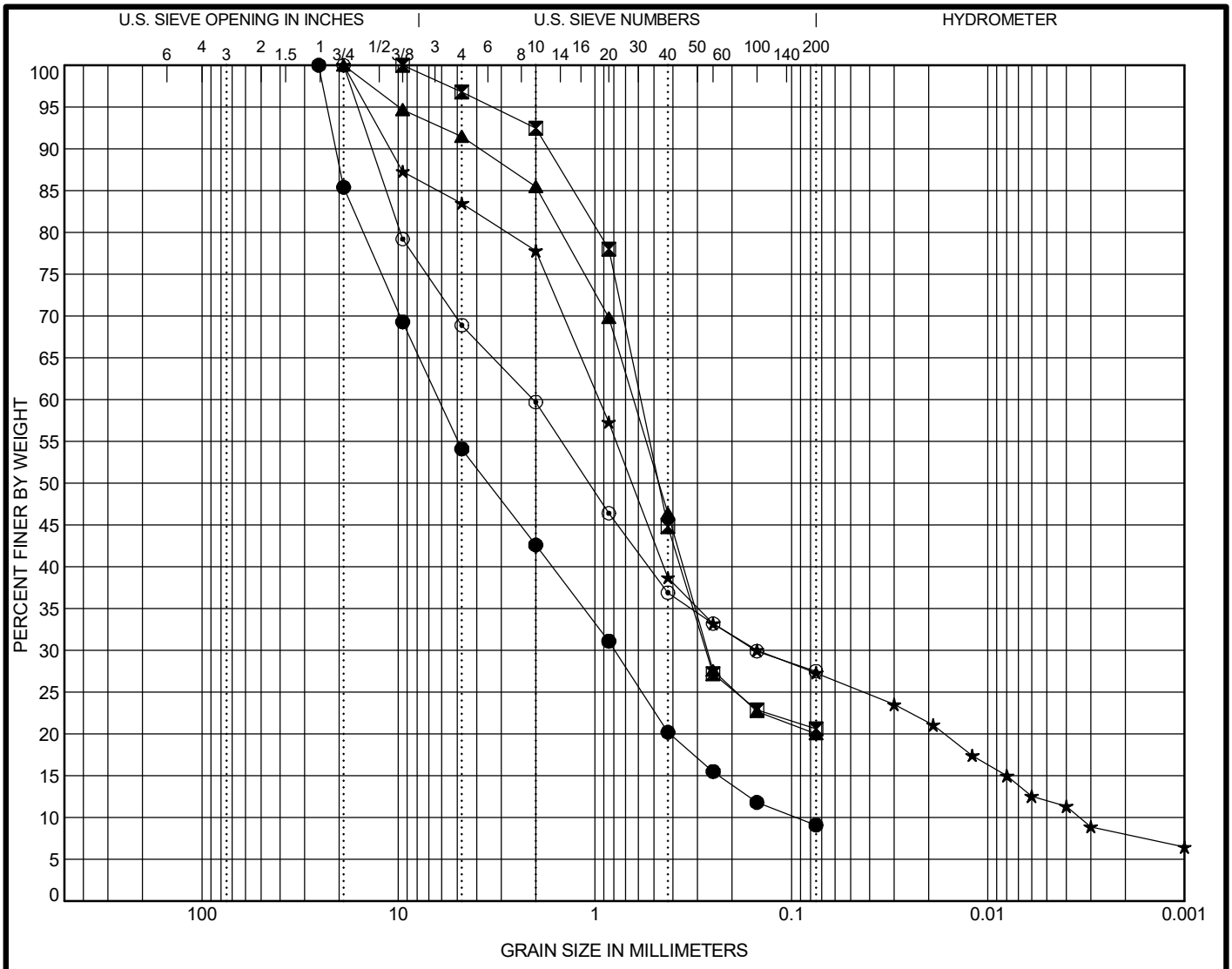
Project Number: 21C13226

Boring No.	Sample Depth ft / Elevation ft	Sample Type	Description of Soil Specimen	Stratum	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Retained No. 4 Sieve	% Passing No. 10 Sieve	% Passing No. 40 Sieve	% Passing No. 200 Sieve	Percent Silt	Percent Clay	Testing Laboratory
B-02	28.0 - 30.0 / -12.0 - -14.0	Jar	WELL-GRADED SAND (SW), coarse to fine grained sand, trace gravel, trace silt, brown	B2/B3	11.6	NP	NP	NP	6.7	76.3	13.0	2.2	--	--	RICH
B-02	45.0 - 47.0 / -29.0 - -31.0	Tube	ELASTIC SILT (MH), few sand, contains lignite, dark gray	C1	69.6	104	66	38	0.0	99.7	97.9	92.4	61.8	30.6	RICH
B-02	53.0 - 55.0 / -37.0 - -39.0	Jar	CLAYEY SAND WITH GRAVEL (SC), coarse to fine grained sand, brown	C2	16.0	65	28	37	15.8	75.9	39.0	23.9	--	--	RICH

Notes:
1. Soil tests in general accordance with ASTM standards.
2. Soil classifications are in general accordance with ASTM D2487(as applicable), based on testing indicated and visual classification.
3. Key to abbreviations: NP=Non-Plastic; -- indicates no test performed

Schnabel ENGINEERING

Project: Appomattox River HDD Water Main Crossing
Prince George County and City of
Colonial Heights, Virginia



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen			Sample Description	LL	PL	PI	Cc	Cu
●	B-01	6.0 ft	**WELL GRADED GRAVEL WITH SILT (GW-GM), fine and coarse gravel, brown**	**NP**	**NP**	**NP**	**1.07**	**65.79**
⊠	B-01	13.0 ft	**CLAYEY SAND (SC), fine to coarse grained sand, trace gravel, brown**	**31**	**20**	**11**	**--**	**--**
▲	B-01	28.0 ft	**CLAYEY SAND (SC), fine to coarse grained sand, few gravel, orangish brown**	**29**	**17**	**12**	**--**	**--**
★	B-01	38.0 ft	**CLAYEY SAND WITH GRAVEL (SC), fine to coarse grained sand , orangish brown and gray**	**33**	**21**	**12**	**6.92**	**278.33**
⊙	B-01	48.0 ft	**CLAYEY SAND WITH GRAVEL (SC), fine to coarse grained sand, brown, white and gray**	**40**	**22**	**18**	**--**	**--**

Specimen			Test Method	Testing Lab	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-01	6.0 ft	**ASTM D6913**	**RICH**	**25.4**	**6.22**	**0.79**	**0.094**	**45.9**	**45.0**	**9.1**	
⊠	B-01	13.0 ft	**ASTM D6913**	**RICH**	**9.5**	**0.58**	**0.27**	**--**	**3.2**	**76.2**	**20.6**	
▲	B-01	28.0 ft	**ASTM D6913**	**RICH**	**19**	**0.64**	**0.27**	**--**	**8.5**	**71.5**	**20.0**	
★	B-01	38.0 ft	**ASTM D422**	**RICH**	**19**	**0.95**	**0.15**	**0.003**	**16.5**	**56.2**	**19.3**	**8.0**
⊙	B-01	48.0 ft	**ASTM D6913**	**RICH**	**19**	**2.06**	**0.15**	**--**	**31.1**	**41.4**	**27.5**	

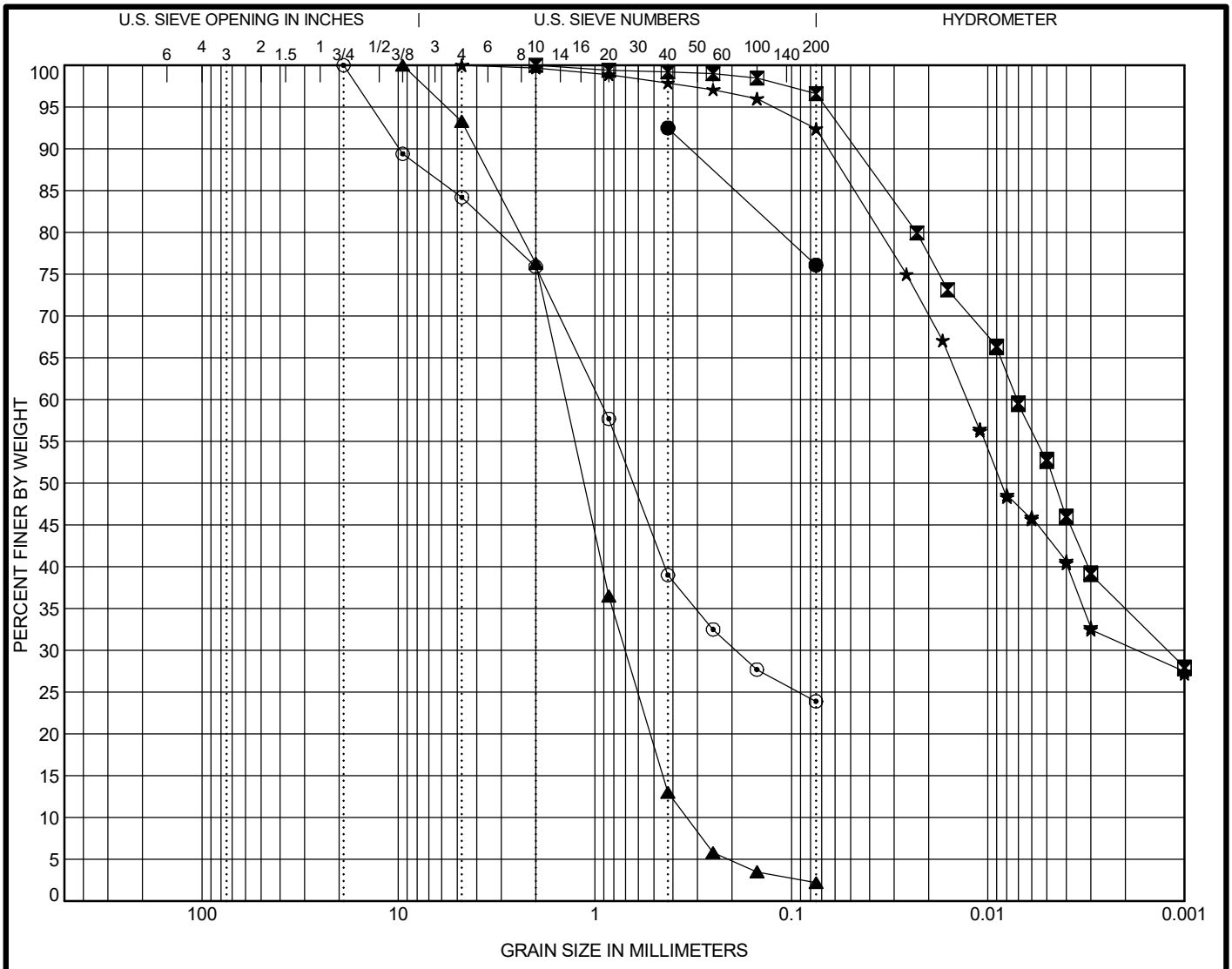
Schnabel ENGINEERING

GRADATION CURVES

Project: Appomattox River HDD Water Main Crossing
Prince George County and City of
Colonial Heights, Virginia

Contract: 21C13226

SIEVE 5 SHEET 21C13226 LOGS.GPJ SCHNABEL DATA TEMPLATE 2010_02 25.GDT 5/26/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen			Sample Description	LL	PL	PI	Cc	Cu
●	B-02	4.0 ft	ELASTIC SILT WITH SAND (MH), contains mica, brown	56	35	21	--	--
⊠	B-02	15.0 ft	ELASTIC SILT (MH), trace sand, contains organic matter, gray	61	41	20	--	--
▲	B-02	28.0 ft	WELL-GRADED SAND (SW), coarse to fine grained sand, trace gravel, trace silt, brown	NP	NP	NP	1.03	4.13
★	B-02	45.0 ft	ELASTIC SILT (MH), few sand, contains lignite, dark gray	104	66	38	--	--
⊙	B-02	53.0 ft	CLAYEY SAND WITH GRAVEL (SC), coarse to fine grained sand, brown	65	28	37	--	--

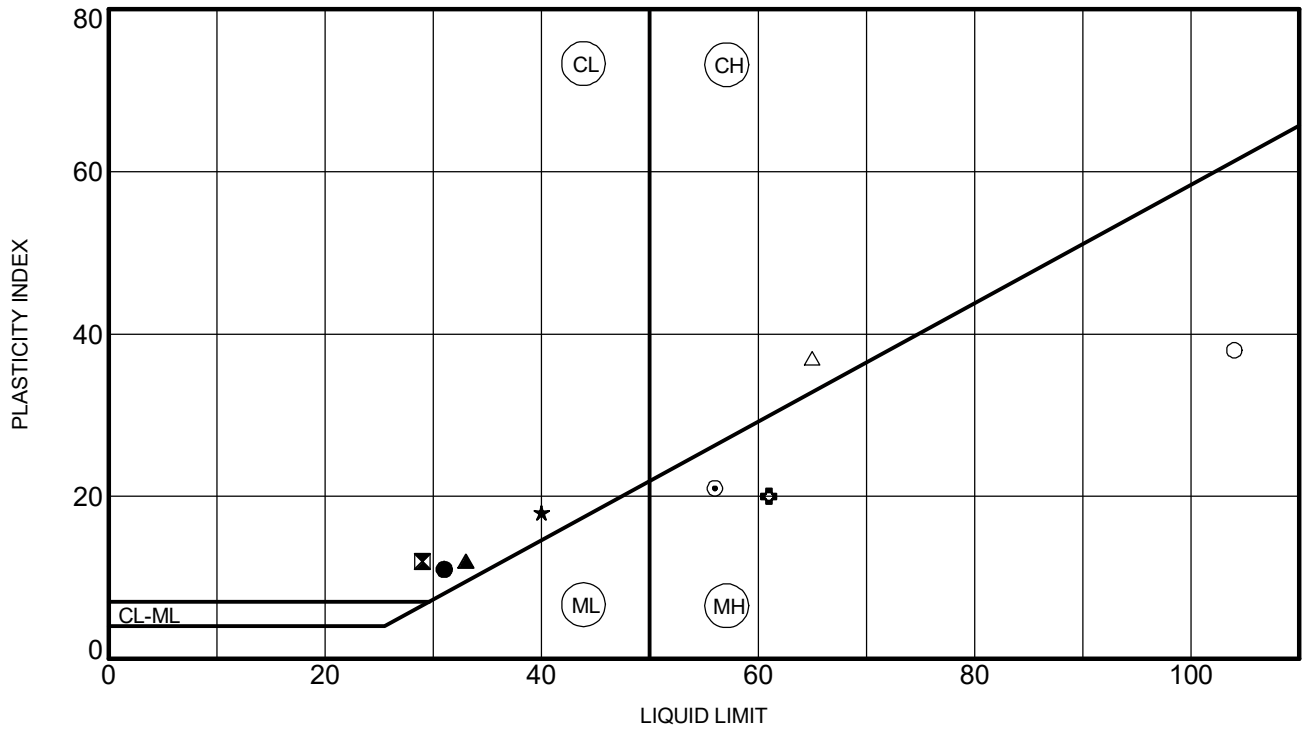
Specimen			Test Method	Testing Lab	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-02	4.0 ft	ASTM D6913	RICH	0.425	--	--	--	0.0	23.9	76.1	
⊠	B-02	15.0 ft	ASTM D422	RICH	2	0.01	0	--	0.0	3.4	61.6	35.0
▲	B-02	28.0 ft	ASTM D6913	RICH	9.5	1.41	0.7	0.341	6.7	91.1	2.2	
★	B-02	45.0 ft	ASTM D422	RICH	4.75	0.01	0	--	0.0	7.6	61.8	30.6
⊙	B-02	53.0 ft	ASTM D6913	RICH	19	0.95	0.19	--	15.8	60.3	23.9	

Schnabel ENGINEERING

GRADATION CURVES

Project: Appomattox River HDD Water Main Crossing
Prince George County and City of
Colonial Heights, Virginia

Contract: 21C13226



PLOTTED DATA REPRESENTS SOIL PASSING NO. 40 SIEVE

	Specimen		LL	PL	PI	Fines	Testing Lab	Description
●	B-01	13.0 ft	31	20	11	21	RICH	CLAYEY SAND (SC), fine to coarse grained sand, trace gravel, brown
⧓	B-01	28.0 ft	29	17	12	20	RICH	CLAYEY SAND (SC), fine to coarse grained sand, few gravel, orangish brown
▲	B-01	38.0 ft	33	21	12	27	RICH	CLAYEY SAND WITH GRAVEL (SC), fine to coarse grained sand , orangish brown and gray
★	B-01	48.0 ft	40	22	18	28	RICH	CLAYEY SAND WITH GRAVEL (SC), fine to coarse grained sand, brown, white and gray
⊙	B-02	4.0 ft	56	35	21	76	RICH	ELASTIC SILT WITH SAND (MH), contains mica, brown
✿	B-02	15.0 ft	61	41	20	97	RICH	ELASTIC SILT (MH), trace sand, contains organic matter, gray
○	B-02	45.0 ft	104	66	38	92	RICH	ELASTIC SILT (MH), few sand, contains lignite, dark gray
△	B-02	53.0 ft	65	28	37	24	RICH	CLAYEY SAND WITH GRAVEL (SC), coarse to fine grained sand, brown

Schnabel ENGINEERING

ATTERBERG LIMITS

Project: Appomattox River HDD Water Main Crossing
Prince George County and City of
Colonial Heights, Virginia

Contract: 21C13226

ATTERBERG_LIMITS 21C13226 LOGS.GPJ SCHNABEL DATA TEMPLATE 2008 04 22.GDT 5/26/22

Unconsolidated Undrained Triaxial Compression Test

Project: Appomattox River HDD
Location: Prince George County and City of Colonial Heights, VA

Schnabel Contract: 21C13226
Boring No.: B-02
Depth: 45 to 47 ft
Elevation: -29 to -31 ft
Confining Stress (psi): 20.0

Date: 5/5/2022
Reviewed by: DS

Soil Description: *ELASTIC SILT (MH), few sand, contains organic matter (lignite), dark gray*

Failure Sketch

Specimen Conditions	
Diameter (in)	2.857
Height (in)	6.052
Area (in^2)	6.41
Moisture (%):	69.2
Weight (gm)	970.60
ρ_{wet} (pcf)	95.31
ρ_{dry} (pcf)	56.3
Void Ratio	1.97
Saturation, %	94

Shear Testing Conditions	
Cell Pressure (psi):	20.0
Rate of Strain (%/min):	1.1

Specimen Type: Undisturbed

Axial Strain at Failure (%): *6.0*
Compressive Strength (psi): *25.3*
Major Principal Stress (psi): *45.3*
Minor Principal Stress (psi): *20.0*

Liquid Limit: 104
Plasticity Index: 38
% finer than No. 200: 92.4
Specific Gravity: 2.4
Remarks: *Undrained Shear Strength, S_U = 1,822 psf*

Reading No.	Deviator Load[1] (lbs)	Axial Strain (%)	Corrected Area[2] (in^2)	σ_1 (psi)	σ_3 (psi)	Deviator Stress (psi)
Initial	0.0	0.00	6.31	20.0	20.0	0.0
1	3.4	0.10	6.31	20.5	20.0	0.5
2	6.4	0.21	6.32	21.0	20.0	1.0
3	10.3	0.30	6.33	21.6	20.0	1.6
4	14.7	0.40	6.33	22.3	20.0	2.3
5	24.0	0.50	6.34	23.7	20.0	3.8
6	53.7	1.00	6.37	28.4	20.0	8.4
7	76.6	1.50	6.40	31.8	20.0	11.9
8	98.6	2.01	6.44	35.2	20.0	15.2
9	117.1	2.50	6.47	37.9	20.0	17.9
10	132.3	3.00	6.50	40.2	20.0	20.2
11	155.9	4.00	6.57	43.5	20.0	23.5
12	169.4	5.00	6.64	45.2	20.0	25.2
13	172.2	6.00	6.71	45.3	20.0	25.3
14	162.5	7.00	6.78	43.6	20.0	23.6
15	157.6	8.00	6.86	42.6	20.0	22.6
16	155.5	9.00	6.93	42.0	20.0	22.0
17	154.9	10.00	7.01	41.6	20.0	21.6
18	130.9	10.19	7.02	37.9	19.8	18.1
19						
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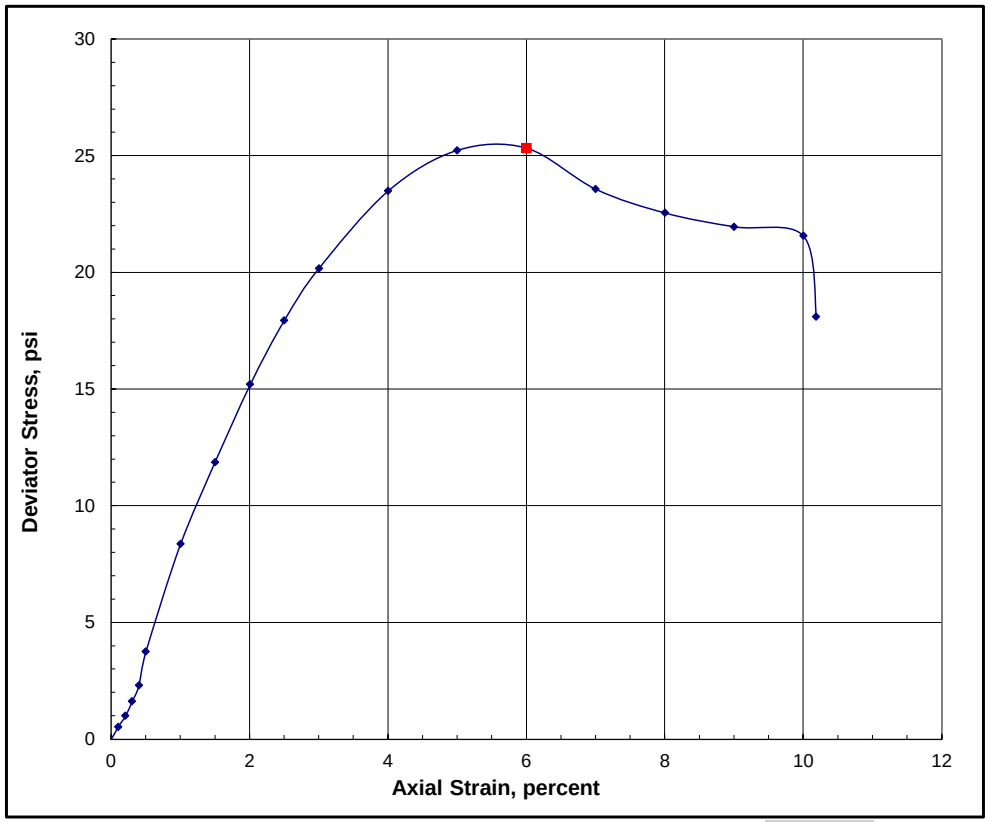


Notes: 1. Deviator load corrected for membrane effects.
2. Right Cylinder Correction Method

Testing Lab: RICH

Unconsolidated Undrained Triaxial Compression Test

Project:	Appomattox River HDD
	Prince George County and
Location:	City of Colonial Heights, VA

Schnabel Contract:	21C13226
Boring No.:	B-02
Depth:	15 to 17 ft
Elevation:	1 to -1 ft
Confining Stress (psi):	6.0

Date: 5/5/2022
Reviewed by: DS

Failure Sketch

Specimen Conditions	
Diameter (in)	2.855
Height (in)	6.123
Area (in^2)	6.40
Moisture (%):	47.2
Weight (gm)	1102.70
ρ_{wet} (pcf)	107.17
ρ_{dry} (pcf)	72.8
Void Ratio	1.30
Saturation, %	97

Shear Testing Conditions	
Cell Pressure (psi):	6.0
Rate of Strain (%/min):	1.0

Specimen Type: Undisturbed

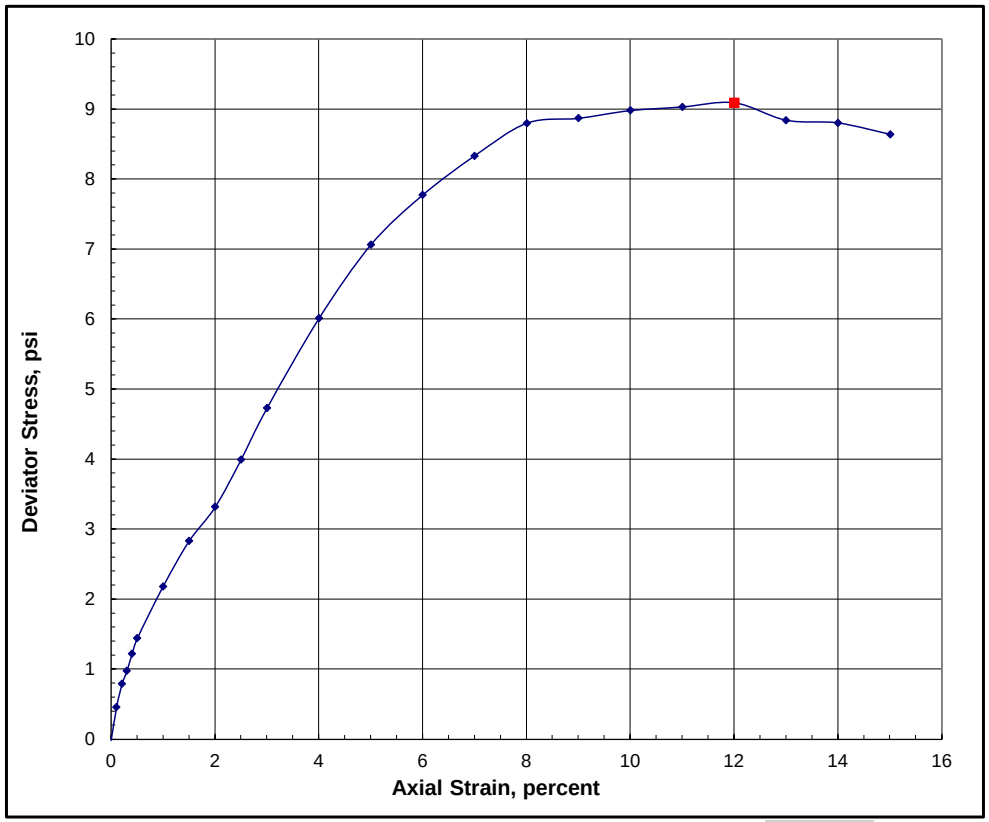
Soil Description: *ELASTIC SILT (MH), trace sand, contains organic matter, gray*

Axial Strain at Failure (%):	*12.0*
Compressive Strength (psi):	*9.1*
Major Principal Stress (psi):	*15.1*
Minor Principal Stress (psi):	*6.0*

Liquid Limit:	61
Plasticity Index:	20
% finer than No. 200:	96.6
Specific Gravity:	2.6

Remarks: *Undrained Shear Strength, S_U = 655 psf*

Reading No.	Deviator Load[1] (lbs)	Axial Strain (%)	Corrected Area[2] (in^2)	σ_1 (psi)	σ_3 (psi)	Deviator Stress (psi)
Initial	0.0	0.00	6.39	6.0	6.0	0.0
1	3.0	0.10	6.40	6.5	6.0	0.5
2	5.1	0.21	6.40	6.8	6.0	0.8
3	6.4	0.30	6.41	7.0	6.0	1.0
4	8.0	0.40	6.41	7.2	6.0	1.2
5	9.4	0.50	6.42	7.4	6.0	1.4
6	14.5	1.00	6.45	8.2	6.0	2.2
7	18.9	1.50	6.49	8.8	6.0	2.8
8	22.4	2.01	6.52	9.3	6.0	3.3
9	27.1	2.50	6.55	10.0	6.0	4.0
10	32.3	3.00	6.59	10.7	6.0	4.7
11	41.5	4.00	6.66	12.0	6.0	6.0
12	49.4	5.01	6.73	13.1	6.0	7.1
13	55.1	6.00	6.80	13.8	6.0	7.8
14	59.9	7.00	6.87	14.3	6.0	8.3
15	64.1	8.01	6.94	14.8	6.0	8.8
16	65.7	9.00	7.02	14.9	6.0	8.9
17	67.5	10.00	7.10	15.0	6.0	9.0
18	69.0	11.01	7.18	15.0	6.0	9.0
19	70.5	12.01	7.26	15.1	6.0	9.1
20	69.8	13.00	7.34	14.8	6.0	8.8
21	70.7	14.00	7.43	14.8	6.0	8.8
22	70.6	15.01	7.52	14.6	6.0	8.6
23						
24						
25						
26						



Notes:
1. Deviator load corrected for membrane effects.
2. Right Cylinder Correction Method

Testing Lab: RICH

Summary Of Laboratory Tests

Project Number: 21C13226

Boring No.	Sample Depth ft / Elevation ft	Sample Type	Description of Soil Specimen	Stratum	Natural Moisture (%)	Liquid Limit	Plasticity Index	Percent Gravel	Percent Sand	Percent Fines	pH	Oxidation Reduction Potential (mV)	Resistivity (ohm-cm)	Sulfides	Testing Laboratory
B-01	28.0 - 35.0 -22.0 - -29.0	Jar	CLAYEY SAND (SC), fine to coarse grained sand, few gravel, orangish brown	B2	18.4	29	12	8.5	71.5	20.0	6.33	346	15000	0	RICH
B-02	45.0 - 47.0 -29.0 - -31.0	Tube	ELASTIC SILT (MH), few sand, contains lignite, dark gray	C1	69.6	104	38	0.0	7.6	--	5.27	15	6900	Trace	RICH

Notes:
1. Soil tests in general accordance with ASTM standards.
2. Soil classifications are in general accordance with ASTM D2487(as applicable), based on testing indicated and visual classification.
3. Key to abbreviations: NP=Non-Plastic; -- indicates no test performed

Schnabel ENGINEERING

Project: Appomattox River HDD Water Main Crossing
Prince George County and City of
Colonial Heights, Virginia

1941 Reymet Road ● Richmond, Virginia 23237 ● Tel: (804)-358-8295 Fax: (804)-358-8297

Certificate of Analysis

Final Report

Laboratory Order ID 22E0786

Client Name:	Schnabel Engineering, LLC 9800 Jeb Stuart Pkwy Ste 200 Glen Allen, VA 23059	Date Received:	May 13, 2022 14:30
		Date Issued:	May 19, 2022 13:41
		Project Number:	21C13226
Submitted To:	Dom Snyder	Purchase Order:	
Client Site I.D.:	Appomattox River HDD Water Main Crossing		

Enclosed are the results of analyses for samples received by the laboratory on 05/13/2022 14:30. If you have any questions concerning this report, please feel free to contact the laboratory.

Sincerely,

Ted Soyars

Technical Director

End Notes:

The test results listed in this report relate only to the samples submitted to the laboratory and as received by the Laboratory.

Unless otherwise noted, the test results for solid materials are calculated on a wet weight basis. Analyses for pH, dissolved oxygen, temperature, residual chlorine and sulfite that are performed in the laboratory do not meet NELAC requirements due to extremely short holding times. These analyses should be performed in the field. The results of field analyses performed by the Sampler included in the Certificate of Analysis are done so at the client's request and are not included in the laboratory's fields of certification nor have they been audited for adherence to a reference method or procedure.

The signature on the final report certifies that these results conform to all applicable NELAC standards unless otherwise specified. For a complete list of the Laboratory's NELAC certified parameters please contact customer service.

TNI Accredited
VELAP ID 460021

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Certificate of Analysis

Final Report

Client Name:	Schnabel Engineering, LLC 9800 Jeb Stuart Pkwy Ste 200 Glen Allen VA, 23059	Date Issued: Project Number: Purchase Order:	May 19, 2022 13:41 21C13226
Submitted To:	Dom Snyder		
Client Site I.D.:	Appomattox River HDD Water Main Crossing		

ANALYTICAL REPORT FOR SAMPLES

Laboratory Order ID 22E0786

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
B-01 28Ft	22E0786-01	Solids	05/11/2022 15:06	05/13/2022 14:30

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Final Report

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Submitted To:	Dom Snyder		
Client Site I.D.:	Appomattox River HDD Water Main Crossing		

Laboratory Order ID: 22E0786

Analytical Results

Sample I.D. B-01 28Ft **Laboratory Sample ID:** 22E0786-01

Grab Date/Time: 05/11/2022 15:06

Field Residual Cl: **Field pH:**

Parameter	Samp ID	Method	Result	Qual	Reporting Limit	D.F.	Sample Prep Date/Time	Analysis Date/Time	Analyst
Ion Chromatography Analyses									
Chloride	01	SW9056A	<10.0 mg/kg		10.0	1	05/17/22 15:27	05/17/22 15:27	MGG
Sulfate	01	SW9056A	<10.0 mg/kg		10.0	1	05/17/22 15:27	05/17/22 15:27	MGG

Analytical Summary

Sample ID	Preparation Factors Initial / Final	Method	Batch ID	Sequence ID	Calibration ID
Ion Chromatography Analyses		**Preparation Method:**	**No Prep IC**		
22E0786-01	10.1 g / 100 mL	SW9056A	BFE0644	SFE0666	AB20157

ENTHALPY ANALYTICAL

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Certificate of Analysis

Final Report

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Submitted To:	Dom Snyder		
Client Site I.D.:	Appomattox River HDD Water Main Crossing		

QC Analytical Summary

Sample ID	Preparation Factors Initial / Final	Method	Batch ID	Sequence ID	Calibration ID
Ion Chromatography Analyses			**Preparation Method:**	**No Prep IC**	
BFE0644-BLK1	10.0 g / 100 mL	SW9056A	BFE0644	SFE0666	AB20157
BFE0644-BS1	10.0 g / 100 mL	SW9056A	BFE0644	SFE0666	AB20157
BFE0644-BSD1	10.0 g / 100 mL	SW9056A	BFE0644	SFE0666	AB20157
BFE0644-MS1	10.0 g / 100 mL	SW9056A	BFE0644	SFE0666	AB20157
BFE0644-MSD1	10.0 g / 100 mL	SW9056A	BFE0644	SFE0666	AB20157

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Final Report

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Submitted To:	Dom Snyder		
Client Site I.D.:	Appomattox River HDD Water Main Crossing		

Ion Chromatography Analyses - Quality Control

Enthalpy Analytical

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qual
Batch BFE0644 - No Prep IC										
Blank (BFE0644-BLK1)				Prepared & Analyzed: 05/17/2022						
Sulfate	<10.0 mg/kg	10.0	mg/kg							
Chloride	<10.0 mg/kg	10.0	mg/kg							
LCS (BFE0644-BS1)				Prepared & Analyzed: 05/17/2022						
Sulfate	18.8 mg/L	10	mg/L	20.0	mg/L	93.8	90-110			
Chloride	19.2 mg/L	10	mg/L	20.0	mg/L	96.1	90-110			
LCS Dup (BFE0644-BSD1)				Prepared & Analyzed: 05/17/2022						
Sulfate	18.8 mg/L	10	mg/L	20.0	mg/L	94.2	90-110	0.335	15	
Chloride	19.2 mg/L	10	mg/L	20.0	mg/L	96.1	90-110	0.0312	15	
Matrix Spike (BFE0644-MS1)	**Source: 22E0787-01**			Prepared & Analyzed: 05/17/2022						
Sulfate	363 mg/kg	10.0	mg/kg	100	289 mg/kg	74.2	90-110			M
Chloride	111 mg/kg	10.0	mg/kg	100	12.7 mg/kg	97.8	90-110			
Matrix Spike Dup (BFE0644-MSD1)	**Source: 22E0787-01**			Prepared & Analyzed: 05/17/2022						
Sulfate	362 mg/kg	10.0	mg/kg	100	289 mg/kg	73.5	90-110	0.199	15	M
Chloride	110 mg/kg	10.0	mg/kg	100	12.7 mg/kg	97.3	90-110	0.444	15	

ENTHALPY ANALYTICAL

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Submitted To:	Dom Snyder		
Client Site I.D.:	Appomattox River HDD Water Main Crossing		

Certified Analyses included in this Report

Analyte	Certifications
SW9056A in Solids	
Chloride	VELAP,NCDEQ
Sulfate	VELAP,NCDEQ

Code	Description	Laboratory ID	Expires
MADEP	Massachusetts DEP	M-VA913	06/30/2022
MdDOE	Maryland DE Drinking Water	341	12/31/2022
NC	North Carolina DENR	495	07/31/2022
NCDEQ	North Carolina DEQ	495	12/31/2022
NCDOH	North Carolina Department of Health	51714	07/31/2022
NJDEP	NELAP-New Jersey DEP	VA015	06/30/2022
NYDOH	New York DOH Drinking Water	12096	04/01/2023
PADEP	NELAP-Pennsylvania Certificate #007	68-03503	10/31/2022
VELAP	NELAP-Virginia Certificate #11821	460021	06/14/2022
WVDEP	West Virginia DEP	350	11/30/2022

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Client Site I.D.:	Appomattox River HDD Water Main Crossing		

Summary of Data Qualifiers

M	Matrix spike recovery is outside established acceptance limits
RPD	Relative Percent Difference
Qual	Qualifers
-RE	Denotes sample was re-analyzed
D.F.	Dilution Factor. Please also see the Preparation Factor in the Analysis Summary section.
TIC	Tentatively Identified Compounds are compounds that are identified by comparing the analyte mass spectral pattern with the NIST spectral library. A TIC spectral match is reported when the pattern is at least 75% consistent with the published pattern. Compound concentrations are estimated and are calculated using an internal standard response factor of 1.
PCBs, Total	Total PCBs are defined as the sum of detected Aroclors 1016, 1221, 1232, 1248, 1254, 1260, 1262, and 1268.

Effective: Feb 14, 2014

CHAIN OF CUSTODY

PAGE OF ____

AWS COC_v140214.xls

COMPANY NAME: Schnabel Engineering	INVOICE TO: SAME	Project Name: Appomattox River HDD Water Main Crossing
CONTACT: Dom Snyder	INVOICE CONTACT: Dom Snyder	SITE NAME:
ADDRESS:9800 JEB Stuart Pkwy, Suite 100, Glen Allen, VA 23059	INVOICE ADDRESS: SAME	PROJECT NUMBER: 21C13226
PHONE #: 804-649-7035	INVOICE PHONE #: SAME	P.O. #:
FAX #: 804-264-3244	EMAIL: dsnyder@schnabel-eng.com	Pretreatment Program:
Is sample for compliance reporting? NO	Is sample from a chlorinated supply? NO	PWS I.D. #:
Sampled by: Mary Patkovics Signature:		Turn Around Time: 5 Day(s)

Matrix Codes: WW=Waste Water/Storm Water GW=Ground Water DW=Drinking Water S=Soil/Solids OR=Organic A=Air WP=Wipe OT=Other_____

CLIENT SAMPLE I.D.	Grab	Composite	Field Filtered (Dissolved)	Composite Start Date	Composite Start Time	Grab Date or Composite Stop Date	Grab Time or Composite Stop Time	Time Preserved	Matrix (See Codes)	Number of Containers	ANALYSIS / (PRESERVATIVE) Sulfate	Chloride							COMMENTS
B-01 28FT	X					5/11/2022	15:06		S	1	X	X							
																			271
B-06 (water)																			JH
9)																			ice
10)																			

Preservative Codes: N=Nitric Acid C=Hydrochloric Acid S=Sulfuric Acid H=Sodium Hydroxide A=Ascorbic Acid Z=Zinc Acetate T=Sodium Thiosulfate M=Methanol
PLEASE NOTE PRESERVATIVE(S), INTERFERENCE CHECKS or PUMP RATE (L/min)

RELINQUISHED: DATE / TIME 5/12/22 1146	RECEIVED: DATE / TIME 5/12/22 1146	QC Data Package	LAB USE ONLY COOLER TEMP 2.4 °C
RELINQUISHED: DATE / TIME 5/12/22 1435	RECEIVED: DATE / TIME JH 5/12/22 1430	Level I ☐ Level II ☐ Level III ☐ Level IV ☐	
RELINQUISHED: DATE / TIME	RECEIVED: DATE / TIME		

22E0786

Schnabel 22E0786
Appomattox River HDD Water Ma
Recd: 05/13/2022 Due: 05/20/2022

v130325002

ENTHALPY ANALYTICAL

1941 Reymet Road ● Richmond, Virginia 23230 ● Tel: (804)-358-8295 Fax: (804)-358-8297

Certificate of Analysis

Final Report

Client Name:	Schnabel Engineering, LLC 9800 Jeb Stuart Pkwy Ste 200 Glen Allen VA, 23059	Date Issued: Project Number: Purchase Order:	May 19, 2022 13:41 21C13226
Submitted To:	Dom Snyder		
Client Site I.D.:	Appomattox River HDD Water Main Crossing		

Sample Conditions Checklist

Samples Received at:	**2.40°C**
How were samples received?	AWS Courier
Were Custody Seals used? If so, were they received intact?	No
Are the custody papers filled out completely and correctly?	Yes
Do all bottle labels agree with custody papers?	Yes
Is the temperature blank or representative sample within acceptable limits or received on ice, and recently taken?	Yes
Are all samples within holding time for requested laboratory tests?	Yes
Is a sufficient amount of sample provided to perform the tests included?	Yes
Are all samples in appropriate containers for the analyses requested?	Yes
Were volatile organic containers received?	No
Are all volatile organic and TOX containers free of headspace?	NA
Is a trip blank provided for each VOC sample set? VOC sample sets include EPA8011, EPA504, EPA8260, EPA624, EPA8015 GRO, EPA8021, EPA524, and RSK-175.	NA
Are all samples received appropriately preserved? Note that metals containers do not require field preservation but lab preservation may delay analysis.	Yes

APPENDIX C

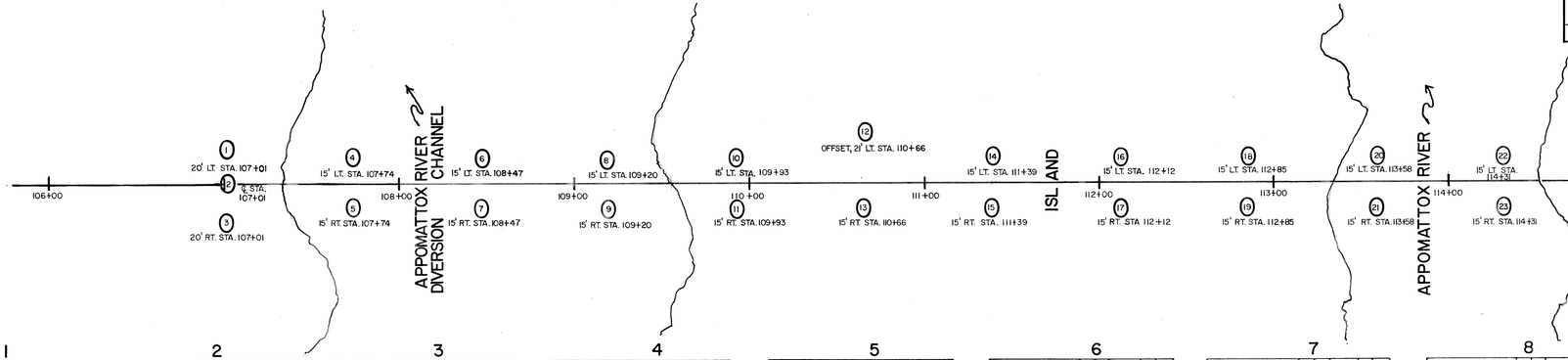
PREVIOUS GEOTECHNICAL DATA

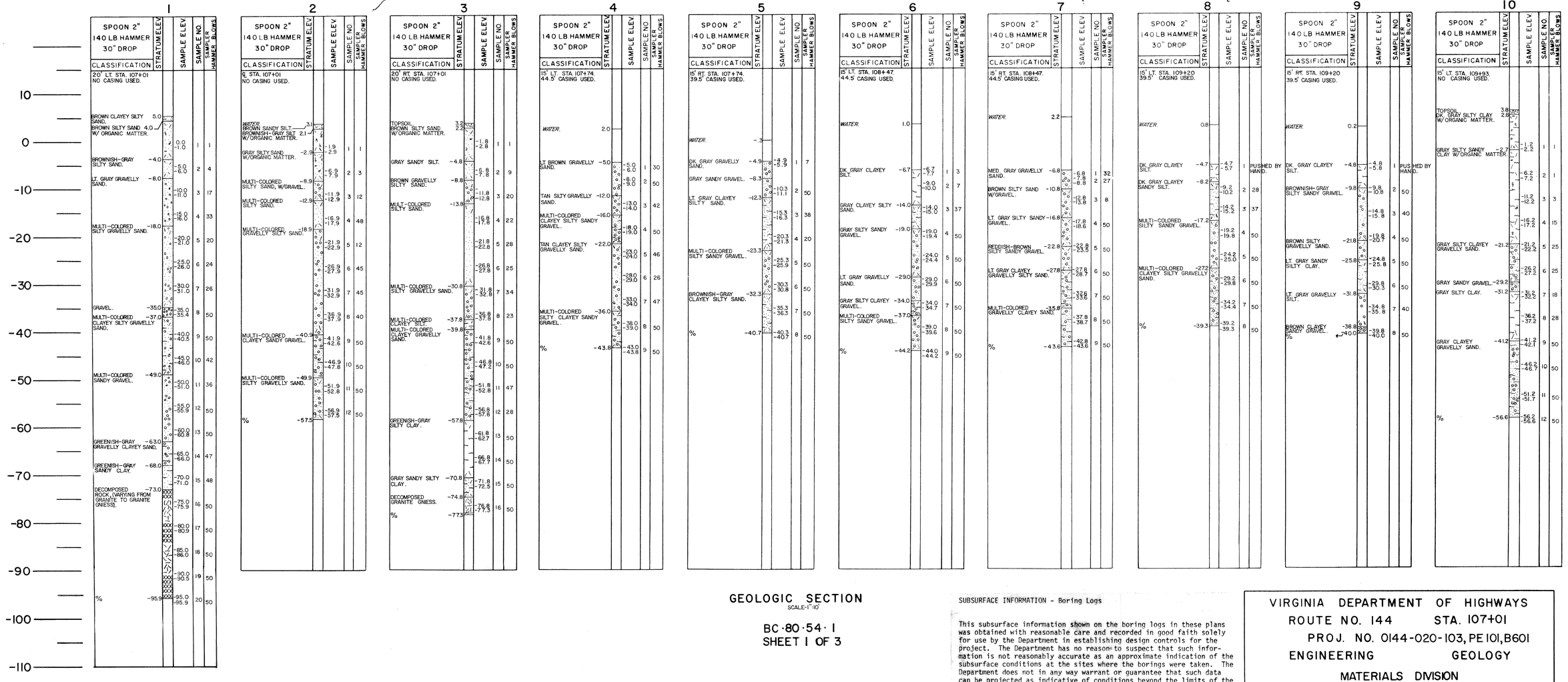
VDOT Borings (1980), 3 pages

PUB. RD. REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.	TOTAL SHEETS

PLAN

SCALE- 1" 40'





GEOLOGIC SECTION

SCALE-1"-10'

BC-80-54-1
SHEET 1 OF 3

SUBSURFACE INFORMATION - Boring Logs

This subsurface information shown on the boring logs in these plans was obtained with reasonable care and recorded in good faith solely for use by the Department in establishing design controls for the project. The Department has no reason to suspect that such information is not reasonably accurate as an approximate indication of the subsurface conditions at the sites where the borings were taken. The Department does not in any way warrant or guarantee that such data can be projected as indicative of conditions beyond the limits of the borings shown; and any such projections by bidders are purely interpretive and altogether speculative. Further, the Department does not in any way guarantee, either expressly or by implication, the sufficiency of the information for bid purposes.

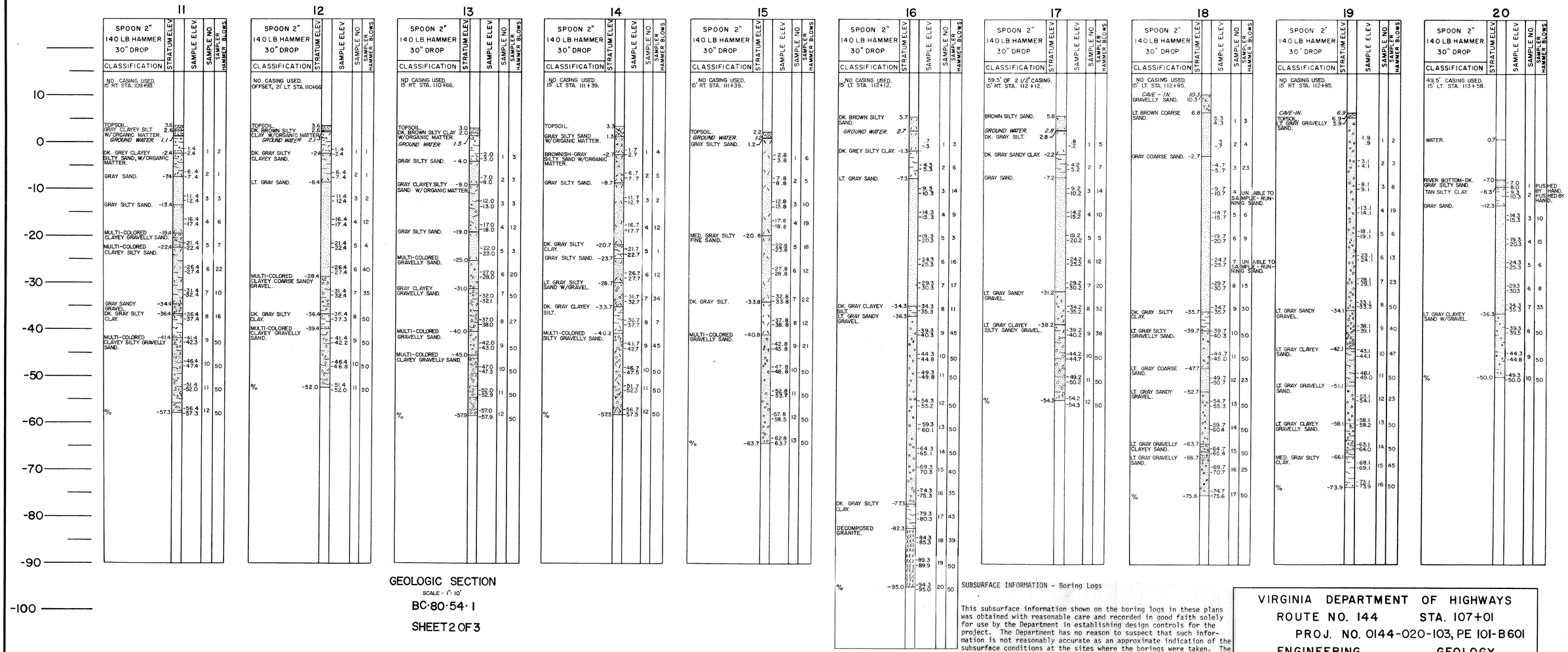
The boring logs are made available to bidders in order that they may have access to subsurface data identical to that which is possessed by the Department, and are not intended as a substitute for personal investigation, interpretation and judgment by the bidders.

VIRGINIA DEPARTMENT OF HIGHWAYS
ROUTE NO. 144 STA. 107+01
PROJ. NO. 0144-020-103, PE101, B601
ENGINEERING GEOLOGY
MATERIALS DIVISION
RTE. 144 OVER APPOMATTOX RIVER
CHESTERFIELD COUNTY
JANUARY 16, 1980

NOTE-
EQUIPMENT: S&H CORE DRILL, CME B B-34.
%: ELEVATION AT BOTTOM OF DRILL HOLE.

Drawn by: D. F. STAPLES
Traced by:
Checked by: R. J. TUCKER

PUB. RD. REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.	TOTAL SHEETS



GEOLOGIC SECTION

SCALE - 1" = 10'

BC-80-54-1

SHEET 2 OF 3

Drawn by: D. F. STAPLES
Traced by:
Checked by: R. J. TUCKER

SUBSURFACE INFORMATION - Boring Logs

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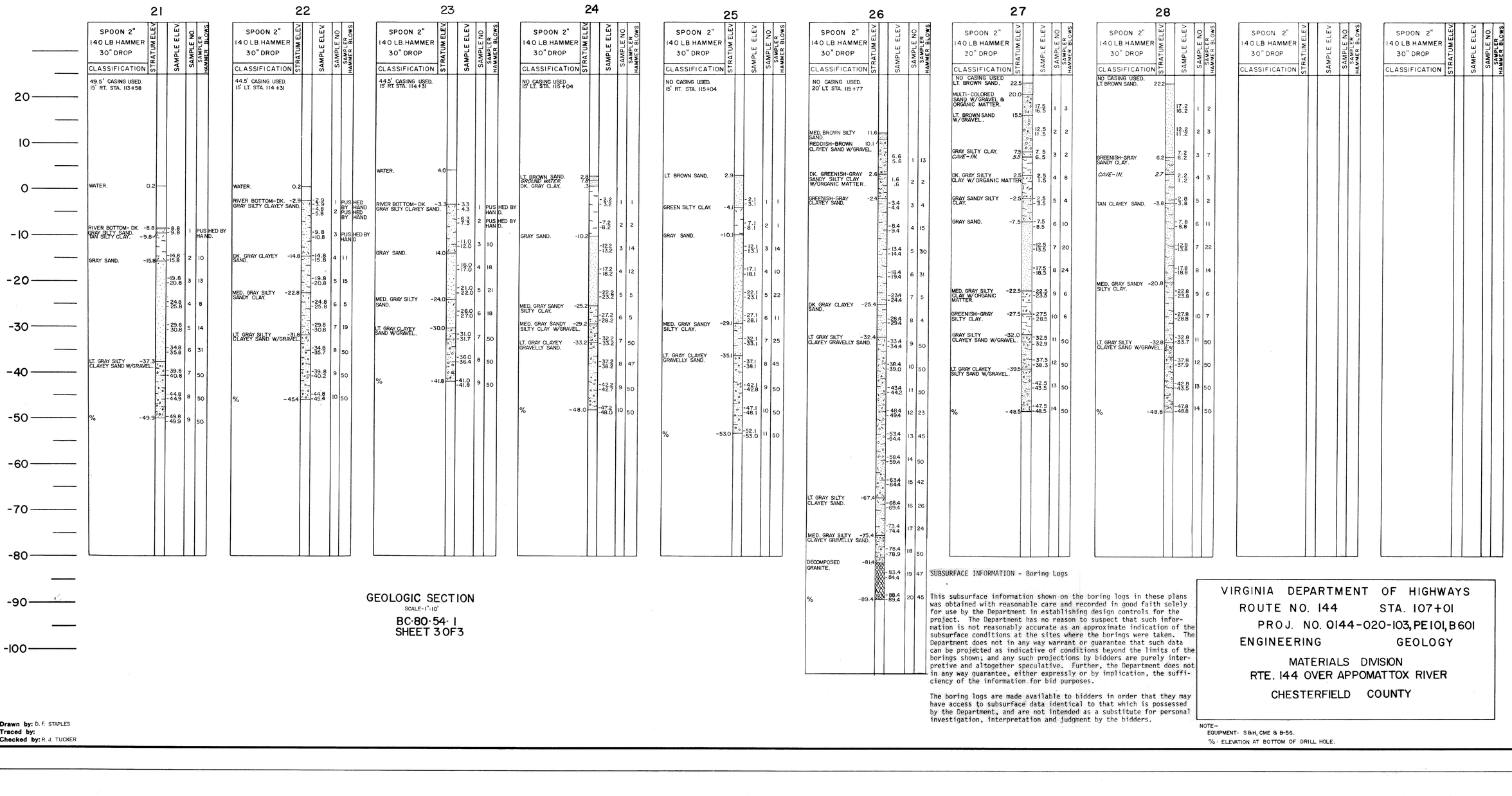
ROUTE NO. 144 STA. 107+01
PROJ. NO. 0144-020-103, PE 101-B601
ENGINEERING GEOLOGY
MATERIALS DIVISION
RTE. 144 OVER APPOMATTOX RIVER
CHESTERFIELD COUNTY

NOTE:
EQUIPMENT- SBH, CME & B-34
%- ELEVATION AT BOTTOM OF DRILL HOLE.

PUB. RD. REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.	TOTAL SHEETS



GEOLOGIC SECTION

SCALE- 1"=10'

BC-80-54-1
SHEET 3 OF 3

SUBSURFACE INFORMATION - Boring Logs

This subsurface information shown on the boring logs in these plans was obtained with reasonable care and recorded in good faith solely for use by the Department in establishing design controls for the project. The Department has no reason to suspect that such information is not reasonably accurate as an approximate indication of the subsurface conditions at the sites where the borings were taken. The Department does not in any way warrant or guarantee that such data can be projected as indicative of conditions beyond the limits of the borings shown; and any such projections by bidders are purely interpretive and altogether speculative. Further, the Department does not in any way guarantee, either expressly or by implication, the sufficiency of the information for bid purposes.

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ROUTE NO. 144 STA. 107+01
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ENGINEERING GEOLOGY
MATERIALS DIVISION
RTE. 144 OVER APPOMATTOX RIVER
CHESTERFIELD COUNTY

NOTE-
EQUIPMENT: S&H, CME & B-56.
%: ELEVATION AT BOTTOM OF DRILL HOLE.

Drawn by: D. F. STAPLES
Traced by:
Checked by: R. J. TUCKER